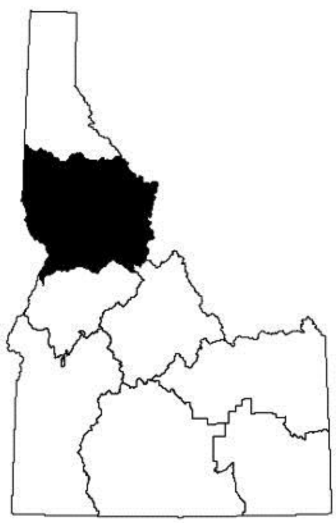
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Virgil Moore, Director



CLEARWATER REGION

2012

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

COMPREHENSIVE ASSESSMENT OF THE CLEARWATER REGION LOWLAND LAKE PROGRAM

ABSTRACT

Idaho's Clearwater Region has a substantial diversity of fishing opportunities. However, many of these fisheries may not be easily accessible to the majority of anglers. As a result, the Clearwater Region's lowland lake program has been designed and managed to provide additional fishing and harvest opportunities with easy access. Managing this program is a priority for the Clearwater Region fisheries staff. Creel surveys conducted from 1993 - 2005 found that, on average, anglers spent 148,065 hours annually fishing lowland lakes in the Clearwater Region. Additionally, an economic survey conducted in 2011 indicated these lakes accounted for 55,931 fishing trips and over $4.0 million in economic value to the region.

Due to the economic and recreational importance of these fisheries, IDFG personnel conducted a comprehensive assessment of nine lowland reservoirs in the Clearwater Region during 2012. These surveys were designed to provide fish population, angler effort and catch, limnology, and habitat data to enable us to develop a long term management plan for each reservoir.

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INTRODUCTION

Idaho's Clearwater Region has a substantial diversity of fishing opportunities. However, many of these fisheries may not be easily accessible to the majority of anglers: large rivers with anadromous fisheries, high elevation rivers and streams managed with restrictive regulations to manage wild cutthroat trout populations, and mountain lakes with difficult access. As a result, the Clearwater Region's lowland lake program has been designed and managed to provide additional fishing and harvest opportunities with easy access. Managing this program is a priority for the Clearwater Region fisheries staff.

Economics and Angler Effort

In 2011, the Idaho Department of Fish and Game (IDFG) conducted a statewide survey of Idaho's anglers. The results of this survey indicated that anglers fished 3,661,837 days in Idaho during 2011, generating $548,351,483 in statewide retail sales, not including $14,962,572 spent on fishing licenses and permits (IDFG unpublished data). In the Clearwater Region alone, anglers fished 640,517 days, and spent $86,628,005 during 2011 (Table 1). The Clearwater Region manages fisheries in nine lowland lakes: Deer Creek Reservoir, Elk Creek Reservoir, Mann Lake, Moose Creek Reservoir, Soldier's Meadow Reservoir, Spring Valley Reservoir, Tolo Lake, Waha Lake, and Winchester Lake. These lakes accounted for 55,931 fishing trips and over $4.0 million in economic value to the region in 2011 (Table 2). A tenth lowland lake, Deyo Reservoir was completed in 2012 near Weippe, Idaho. Construction of this reservoir was not completed at the time of the economic survey and was therefore not included.

Creel surveys conducted from 1993 - 2005 found that, on average, anglers spent 148,065 hours annually fishing lowland lakes in the Clearwater Region. Individually, the lakes range from a low of 3,877 hours of effort annually at Waha Lake to a high of 43,097 hours of effort annually at Winchester Lake (Figure 1). On average, this effort consisted of 74.4% bank, 20.6% boat, and 5.0% ice fishing hours. Anglers averaged 234,096 fish caught and 149,139 fish harvested (Figure 2) annually. Average catch rates ranged from 1.3 - 2.2 fish/hour, and average harvest rates range from 0.8 - 1.6 fish/hour. Effort appears to be influenced to some extent by ease of access for anglers. The reservoirs closest to major public roads and with the best shoreline access have the highest angler effort. As we plan for the future, access issues should be taken into account for improving angler effort and satisfaction.

Lowland lakes are an integral part of the state's fisheries management program. In an effort to increase easily-accessible fishing opportunity for a broad range of anglers, several objectives have been developed to guide the management of these bodies of water:

1. Provide a diversity of angling opportunities of types desired by the public.

2. Maintain or enhance the quality of fish habitat.

3. Increase populations of suitable fish species to the carrying capacity of the habitat.

4. Maintain or improve angler success rates for fishable species.

Current Lowland Lake Management Strategy

The region's fisheries management staff uses a variety of management tools meet these goals and angler needs. A diversity of angling opportunity has been created through the stocking of various fish species, special regulations, the promotion of some reservoirs as family friendly fishing waters due to higher catch rates and on-site amenities, renovations, and vegetation control.

The regional hatchery trout program is primarily contained within the lowland lake program. This is due to the general failure of stocking hatchery Rainbow Trout *Oncorhynchus mykiss* in rivers and streams to establish successful fisheries, and the low return to creel that makes these stockings economically unfeasible. As part of the lowland lake program, hatchery trout provide an easily accessible harvest opportunity, they create an "instant" fishery when they are stocked, and they meet very high angler demand in areas where natural reproduction is unable to match harvest pressure. Catchable size (203 mm - 254 mm) hatchery Rainbow Trout have been stocked at times and locations where they will be most available to anglers. They are the primary fishery in the lowland lake program, and are managed with the goals of maintaining a catch rate ≥ 0.5 fish/hour and returning at least 40% of the fish stocked to angler catch in each lake (IDFG 2013). In 2005 and 2012, catch rates for hatchery trout alone in individual lakes ranged from 0.8 - 4.0 fish/hour (Figure 3), all above the 0.5 fish/hour catch rate goal for lowland lakes. Creel survey results have shown hatchery trout account for an average of 72% of the fish harvested from the region's lowland lakes (Appendix B).

In addition to catchable hatchery trout, fingerling trout can also be stocked in our lowland lakes and reservoirs. Fingerling trout utilize the natural food resources that occur in the lakes to facilitate a put-grow-take fishery. Because these fish grow to catchable size in a natural setting, they often resemble wild trout and are more desirable to anglers. Although these fish return to the creel at lower rates than catchable size fish, they are substantially cheaper to stock. Historically, fingerling Rainbow Trout were stocked in many regional lowland reservoirs. However, in 2012, the only fingerling trout stocked were Brook Trout *Salvelinus fontinalus* in Deer Creek Reservoir.

The lowland lakes in the Clearwater Region also provide fishing opportunities for warm-water species. Warm-water species currently available in the region's lowland lakes are Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *Micropterus dolomieu*, Yellow Perch *Perca flavescens*, Bluegill *Lepomis macrochirus*, Pumpkinseed *L. gibbosus*, Black Crappie *Pomoxis nigromaculatus,* White Crappie *P. annularis*, Channel Catfish *Ictalurus punctatus*, and Black Bullhead *Ampiurus melas*. Tiger muskellunge *Esox lucius* X *E. masquinongy*, a cross between northern pike and muskellunge, have been stocked into Winchester Lake and Spring Valley Reservoir to provide a trophy component in the lowland lake program. Catch and harvest of warm-water species is managed with simple fishing rules. Bass harvest in all lowland lakes is managed under a daily bag limit of six fish with no size limits except for Mann Lake (305 mm minimum). All other warm-water fish within the region have no bag, size, or possession limits.

Creel Survey

Creel surveys are a widely used fisheries management tool that enables fishery managers to estimate angler effort and catch. However, creel surveys are often very personnel intensive resulting in high cost. In order to reduce costs while increasing data collection, a variety of new techniques are being used. Fishing report cards rely on anglers to self-report their catch and effort data, reducing effort to collect completed trip data. However, some studies have shown report card data can be biased. Carline (1972) found report card catch data was two times higher than catch data collected during in person interviews. He found that using report card data seriously overestimated seasonal harvest in the associated fisheries. Conversely, Kozfkay and Dillon (2010) found report card data to be un-biased and comparable to actual interview data during a white sturgeon fishery creel. Using remote cameras increased the frequency of angler counts at small impoundments in Southern Idaho (Dave Tuescher, personal communication). In locations with limited access sites, cars counted from parking lot pictures combined with interviews (fisherman per vehicle) can estimate total anglers. This greatly increases the frequency of angler counts with minimal expense and personnel time.

As part of the region's 2012 lowland lake creel, we tested these additional methods for collecting angler creel data at appropriate lakes. By testing these methods during the intensive creel survey conducted in 2012, we will gain additional direction on where these methods may be used in the future and what potential biases are associated with them.

Habitat Monitoring

An important component of creating and maintaining good fisheries is managing the fish habitat itself. Many of the region's lowland reservoirs and ponds are experiencing eutrophication. Nutrients primarily come from human sources (cultural eutrophication), and result in algae blooms, dense littoral vegetation, and reduced water transparency. A number of the region's lowland lakes are >50 years in age. As reservoirs age, a variety of physical, chemical and biological changes occur (Kimmel and Groeger 1986), often related to eutrophication.

Aquatic plant communities are a natural part of the littoral zone of many reservoirs, and as such they are an important part of healthy and diverse aquatic ecosystems. They play an important role in maintaining a balanced ecosystem for both wildlife and humans. Balance can become disrupted when invasive (both native and exotic) vegetation species expand to a point of becoming a nuisance for recreation and/or healthy fish populations. Excessive macrophyte growth can inhibit recreation activities such as fishing, boating, and swimming, and reduce property and scenic values. From a fisheries perspective, excessive vegetation can adversely affect the predator-prey balance by providing too much cover for prey (Bettolli et al. 1992; Dibble et al. 1996). Additionally, the entire fish community can be jeopardized in the summer as temperatures increase and dense plant growth decomposes. Warmer water and dense plant growth create a large biological oxygen demand, depleting oxygen levels in the reservoir (Lovell et al. 2012). Treatments with the aquatic herbicide Reward® in regional reservoirs have resulted in only short-term success in our reservoirs, but have been successful in small ponds (DuPont et al. 2012). Due to the limited success of small scale herbicide treatments in regional reservoirs, other techniques for controlling nuisance aquatic vegetation need to be considered, including biological, mechanical, physical, and chemical control methods.

A successful aquatic vegetation management plan begins with assessing the current plant community. This is done to determine the underlying cause of the problem, and to provide pre-treatment data for determining the level of success of future aquatic vegetation treatments. It is not only important to understand the surface area coverage but also the types of vegetation present and how they affect the fish community and the ability of anglers to fish. The next step is developing a management plan based on the data collected, plant ecology, and aquatic community relationships. All management options presented should include efficacy, cost, health and environmental impacts, and public response for comparison and determining the best strategy (Cook et al. 2005). Once management strategies are selected and implemented, proper monitoring and evaluation is imperative for determining success or failure. All sampling methods employed, for both initial assessments and monitoring programs, should be designed to answer specific management questions.

Sustainable and fishable fish populations require adequate food resources. Zooplankton communities provide the main food source for age-0 fish during their first summer and can have a significant impact of year class strength as age-0 fish move into their first winter. In addition, trout stocked into put and grow fisheries have been shown to rely heavily on zooplankton such as *Daphnia pulex* (Wang et al. 1996). Welker et al. (1994) found that growth and survival of larval gizzard shad as well as growth of larval Bluegill was influenced by zooplankton prey density. Research has also shown that the presence of a voracious planktivore can have negative effects not only on the zooplankton population but also other fish species. DeVries and Stein (1992) found declines in recruitment of Bluegill in association with peak abundance of gizzard shad, an open-water planktivorous fish. In our reservoirs, high densities of Bluegill and/or Yellow Perch may reduce the zooplankton available for other species rearing at the same time. This could reduce the potential for a put and grow Rainbow Trout fishery or a quality warm water fishery in the region. Limited zooplankton community work has been conducted within the region’s lowland lakes. In order to design new management strategies or provide justification for current strategies a more in depth study of the zooplankton communities is warranted.

OBJECTIVES

The overall objective of this study was to evaluate the current status of the Clearwater Region’s lowland lake program during a single field season. Data from this study will then be used to inform fisheries management decisions and evaluate the current fishery strategies in the lowland lake program. Specific objectives for the study are as follows:

1. Evaluate fish communities through the standard IDFG lowland lake survey protocol.

2. Quantify angler effort, catch, harvest, and exploitation through a roving-access design creel survey.

3. Conduct angler opinion surveys to evaluate satisfaction in current fisheries and potential management changes.

4. Evaluate feasibility and effectiveness of car counters and trail cameras for providing angler count data.

5. Evaluate effectiveness of voluntary angler survey cards as a lower cost creel survey tool.

6. Evaluate angler exploitation rates of hatchery catchable trout in regional reservoirs and ponds utilizing IDFG “Tag You’re It” program.

7. Evaluate zooplankton communities using monthly sampling and ZQI protocol.

8. Quantify coverage of aquatic vegetation and its potential effects on angling.

STUDY AREA

Surveys were conducted on regional reservoirs shown in Figure 4. Study area descriptions for each reservoir can be found in individual reservoir chapters.

METHODS

Population Survey

Fish were sampled at each reservoir using a combination of boat electrofishing and trap nets (IDFG 2012). One hour of boat electrofishing and one overnight trap net set were used in each reservoir, except for Tolo Lake and Deer Creek Reservoir. Due to its smaller size, only 30 minutes of electrofishing was used in Tolo Lake, which allowed us to sample the entire shoreline. A simplified fish community survey was conducted on Deer Creek Reservoir, which consisted only of one hour of boat electrofishing. This modification was due to the presence of only trout in this reservoir. Gill nets were not utilized in any surveys, as previous surveys in these reservoirs have shown they generally only catch hatchery trout (which, due to the timing of these surveys, were usually stocked within a week or two of capture).

Boat mounted electrofishing was conducted using pulsed D.C. current from a Honda 5000w generator and an ETS MBS-1DP pulsator. All electrofishing was conducted at night in the spring. Electrofishing was divided into 10-minute sample units, with fish collected in each sample unit processed and recorded separately. This allows for the calculation of variance estimates necessary for comparisons to other surveys and for calculating the appropriate sample size for future surveys (IDFG 2012). Species, length, and weight were recorded for each fish collected.

Indiana style trap nets consisted of a front box maze of two six foot wide by three foot high steel frames with center braces and four 30" diameter hoops with two 8" throats, and a 50' long x 3' high leader. Mesh size was 3/4" throughout.

The length distribution of each fish population was described using Proportional Size Distribution (PSD) (Guy et al. 2007; Neumann et al. 2012). Proportional Size Distribution is an updated name for the Proportional Stock Density metric developed by Anderson (1980). Proportional Size Distribution was calculated to provide information on population balance:

$$PSD = \frac{\#\ fish \geq qualitysize}{\#\ fish \geq stocksize} * 100$$

Quality size and stock size correspond to lengths considered to be the minimum size at which anglers will first catch the species (stock) and consider the fish to be of desirable size (quality). These lengths are 200 mm and 300 mm for Largemouth Bass, 80 mm and 150 mm for Bluegill, and 130 mm and 200 mm for Black Crappie (Gablehouse 1984; Neumann et al. 2012). Proportional Size Distribution values of 40 - 70 for Largemouth Bass and 20 - 40 for Bluegill and crappie are considered to be indicative of balance (Anderson 1980).

Proportional Size Distribution decision models were developed to diagnose current predator-prey dynamics in each reservoir (Schramm and Willis 2012). These models plot predator (Largemouth Bass) PSD versus prey (Bluegill, Pumpkinseed, Black Crappie) PSD and provide recommended management actions for each situation (see Schramm and Willis 2012 for details).

Fish condition was examined using relative weight (W_r) according to the formula:

$$W_r = \frac{W}{W_s} * 100$$

where W is the observed weight of the fish and W_s is the length-specific standard weight predicted by a weight-length regression. This equation is:

$$log_{10}\ Ws = a + (b * log_{10}\, total\ length)$$

where *a* is the intercept and *b* is the slope of standard weight equations developed for many fish species (Wege and Anderson 1978; Neumann et al. 2012). Relative weights represented in each population for each species were plotted using scatter plots. Trend lines within this data were used to estimate relative health of each species within each lake.

Age and growth information was calculated from scale samples. For most species, scales were collected from all fish sampled. When large numbers of fish were collected, scale samples were taken from every 5th fish measured. Scales were removed from all fish between the dorsal fin and lateral line (Quist et al. 2012). A picture was taken of one scale from each fish using a Ken-a-Vision PupilCam camera mounted on a Fisher Scientific Micromaster compound microscope. These pictures were uploaded into FishBC software for measuring the scale radius and distance from the focus to each annuli. Back-calculated of length at age was determined using the Fraser-Lee equation (Quist et al. 2012):

$$Li\ =\ c\ +\ (Lc - c)(Si/Sc)$$

Where:
c = size of each fish at time of scale formation
S_i = the scale radius at annulus formation
S_c = the overall scale radius
L_i = the length at annulus formation
L_c = the fish length at capture

The variable “c” was determined by the Y-intercept of a regression line plotting scale radius (x-axis) versus fish length (y-axis).

Mortality rates were determined using catch curves for each species in each reservoir directly from the scale data (Miranda and Bettoli 2007; Allen and Hightower 2010). . Each catch curve plots the age of the fish collected versus the $\log_e$ of the number of fish captured. The slope of this line represents the annual instantaneous mortality rate (Z). The annual survival rate (S) is calculated as $S = e^{-Z}$, and the annual mortality rate (A) is A = 1 - S. Substantial variation in catch-curve mortality estimates can occur when the oldest age groups have very few number of individuals captured (Allen and Hightower 2010). Thus, if the oldest age groups had <5 fish, they were removed from the analysis.

Creel Survey

Creel surveys were conducted from November 28, 2011 - November 28, 2012. Using a roving - access survey design. Uniform sampling with one day period (from 0.5 hours before sunrise to 0.5 hours after sunset) was utilized. Sampling was divided into a north route (Spring Valley Reservoir, Moose Creek Reservoir, and Elk Creek Reservoir) and a south route (Mann Lake, Waha Lake, Tolo Lake, Soldiers Meadows Reservoir, and Winchester Lake). The route and starting point for each route was randomly generated at the beginning of the creel for the entire creel design. Due to its remoteness, Deer Creek Reservoir was surveyed with digital cameras and angler report cards only (see below). Sampling intervals were a calendar month.

Interviews and angler counts were conducted a minimum of four weekdays and four weekend days per interval at each reservoir. Each angler count was separated into four sections: 1) total bank anglers 2) total boat anglers 3) total cars, and 4) total cars associated with people fishing. This allowed us to separate angler effort type and non-angling use. Total hours fished, number of fish caught, fish species, and fish lengths were recorded during interviews. Each angler was interviewed separately and not as a group. Angler opinion surveys were also conducted in conjunction with the creel surveys. After conducting the initial angler count upon arrival at the reservoir, creel clerks parked at the main access point for each reservoir. Access survey duration was stratified based upon previous knowledge of angler use of each lake and travel time needed to complete each route. Creel clerks stayed at lakes for one, two, or three hours depending on angler use and travel time. All anglers and non-anglers leaving the lake during this time were interviewed to collect completed trip data.

Moultrie® GameSpyi60 digital game cameras were utilized to increase the number of angler counts at several reservoirs (Waha Lake, Soldier's Meadows Reservoir, Deer Creek Reservoir, and Tolo Lake). Cameras were placed at the main access point on each lake and positioned to take pictures of parking areas. Cameras were programmed to take a picture every hour to estimate use at that time. We estimated angler counts by expanding cars in the field of view by the average number of anglers per car. During the winter hike-in season at Deer Creek Reservoir, there was only one access route. The camera was set up to be motion activated to produce an actual census of anglers using the lake, not an instantaneous count.

Angler survey cards (Figure 5) and on-site return boxes (Figure 6) were used to increase the number of completed trip interviews at all reservoirs. Creel clerks conducted incomplete trip interviews at the end of their access survey time during each sample period and instructed anglers to turn in cards at the end of their trip. Each card was labeled with the date and interview ID so that data could later be revised. A second instantaneous count was conducted on each lake at the end of the day as time permitted. In addition, each box had blank survey cards on the side that anglers could self-report creel data when no creel clerks were present.

Angler effort (e_i), for a fishing period (i) was estimated using:

$$e_i = I_i * T$$

where I_i is the instantaneous count of anglers multiplied by the length of the fishing period (T). Total effort (E) for a survey period is calculated by expansion:

$$E = \sum_{i=1}^{n} (\frac{e_i}{\pi_i})$$

where π_i is the total probability that fishing period (i) is included in the sample. Standard errors (SE) for effort estimates were calculated as:

$$SE(E) = \sqrt{(Var(E_1) + (Var(E_2)}$$

E_1 and E_2 represent effort from weekdays and weekends respectively. Full equations for calculating variance of angler effort are listed in Pollack et al. (1994).

Angler catch was estimated using:

$$C = E * R_1$$

The catch rate calculated from complete trips (R_1), is calculated as:

$$R_1 = \frac{\sum_{i=1}^{n} c_i}{\sum_{i=1}^{n} L_i}$$

This is the sum of the catches (c_i) divided by the sum of the trip lengths (L_i). Standard errors for effort estimates were calculated as:

$$SE(E) = \sqrt{(Var(C_1) + (Var(C_2)}$$

C_1 and C_2 represent catch from weekdays and weekends respectively. Full equations for calculating variance of angler catch are listed in Pollack et al. (1994).

Angler Exploitation Surveys

We calculated exploitation (fish harvested) and total use (harvested or caught but released) using tag return data according to the methods presented in Meyer et al. (2010) Hatchery Rainbow Trout were tagged at IDFG fish hatcheries and at stocking locations and released during major stocking events during the 2011 and 2012 stocking season. Fish were tagged with Hallprint T-bar anchor tags model FD-94. In addition, Largemouth Bass >203 mm were tagged during surveys at Spring Valley Reservoir, Mann Lake, Waha Lake, Moose Creek Reservoir, Tolo Lake, Elk Creek Reservoir, and Winchester Lake. Tagging data was submitted to our Nampa Fisheries Research office and uploaded to the IDFG “Tag You’re It” database. Tagging, data entry and analysis was conducted based on the methodology of the IDFG “Tag You’re It”/Fish Data Base program (Meyer et. al 2010).

Limnology

Limnology sampling, consisting of dissolved oxygen, conductivity, and temperature profiles, was conducted monthly on regional lowland reservoirs. These samples were taken to provide information on habitat quality, the quantity of habitat available to Rainbow Trout, and to provide historical documentation. Dissolved oxygen (DO) and temperature profiles were taken from a boat with a YSI model 550A meter at the surface and 1 m increments down to the bottom of the lake. The boat was kept stationary in the deepest part of the lake while measurements were taken. Temperature was recorded in ˚C, and dissolved oxygen in mg/L.

The volume of each reservoir available for Rainbow Trout to survive was calculated using a minimum DO concentration and a temperature at which Rainbow Trout become stressed. The volume of each reservoir available for Rainbow Trout was calculated as the total volume of water in each reservoir between the IDFG standard temperature and oxygen limits. We used the IDFG standards of 5.0 mg/L and 21.0˚C for DO and temperature, respectively (Horton 1992). A minimum DO concentration of 5.0 mg/L is considered a point at which Rainbow Trout growth, food conversion, and swimming performance rates become limited (Davis 1975, Bjornn and Reiser 1991). It should be noted that this is below the 23.0˚C determined to be the temperature at which Rainbow Trout begin experiencing high stress levels and actively seek cooler temperatures (Bjornn and Reiser 1991), and the 29.0˚C determined to be the upper lethal limit or critical thermal limit (i.e. the maximum temperature these fish can tolerate) for Rainbow Trout (Lee and Rinne 1980, Carline and Machung 2001, Rodnick et al. 2004).

ZQI and Zooplankton

Monthly zooplankton sampling was conducted on all lowland lakes from April - November during the 2012 field season. The first sample in each reservoir was collected prior to stocking. The second sample was collected approximately two weeks post stocking at each lake and monthly thereafter. Samples were collected with a Wisconsin style plankton net (80 micron mesh, 30 cm diameter mouth). The boat was anchored at the deepest location on each lake based upon bathymetric maps and depth finder readings. When anchoring the boat, the anchor was slowly dropped and slack in the anchor line was let out to let the boat drift away from the anchor location. Three vertical tows were taken from that location. Tows were started 1m above the bottom of the lake to avoid disturbing sediment. Depth of tow was recorded on each sample jar. Samples were rinsed into sample jars and stored in 70% ethyl alcohol. Samples were labeled with date, reservoir, number of tows, depth of tow, and personnel present using a Rite-in-the-Rain label placed inside the sample jar.

Samples were diluted into a known volume container (typically 100 ml). Zooplankton were counted from subsamples using 5 ml aliquots. Subsamples were counted until 200 of the most dominant families were observed. The density of zooplankton in each individual tow was then estimated expanding the subsample estimate by total volume to the tow. Tow volume (π) was calculated by:

$$\pi \cdot r^2 \times h$$

where r = radius of the net and h = depth of tow.

Zooplankton were counted based on two categories, cladoceran (Ceriodaphnia, Diaphanasoma, and Daphnia) and copepods (Cyclopoids and calanoids). All zooplankton within these groups were enumerated within the sample. In addition, the first 30/sample cladocerans and/or most abundant zooplanktor in the sample were measured under the dissecting microscope to establish a length distribution for the sample.

With this sample protocol we were able to establish an index of zooplankton quantity for each of the nine lowland lakes. Zooplankton abundance was plotted out over the fishing season. Plots included overall zooplankton present as well as cladoceran and copepod abundance. We were able to look at changes in the zooplankton community across the season and how stocking affects zooplankton availability.

Additional zooplankton sampling using the Zooplankton Quality Index (ZQI) was conducted on all lowland lakes from August 21 - 30, 2012 using the protocols outlined in Teuscher (1999). In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for each reservoir. This sampling was done in addition to more intensive zooplankton sampling in order to allow for comparisons of the different sampling methods. The ZQI, which is a measure of both abundance and size, is on average 0.35 for reservoirs in the Clearwater Region (Appendix E). ZQI values from 0.1 - 0.6 are considered moderate and indicate that there is sufficient competition for food resources to potentially impact trout populations (Teuscher 1999).

<u>Vegetation</u>

Aquatic vegetation surveys were conducted on all regional reservoirs from August 23 - September 13, 2012 to quantify the extent of plant populations, provide a baseline for comparisons to potential post-treatment coverage, and determine its potential impact on angling. All sampling was conducted when plant communities were at their maximum coverage.

Two sampling techniques were employed. The first technique consisted of quantifying plant populations using the Point-Intercept Method (Parsons 2001) for determining presence/absence. At each sampling site, the boat was anchored to prevent drifting from wind or currents. Two rake tosses were conducted from the port side of boat with a 0.91 m aquatic vegetation rake, and all species of vegetation collected were recorded. The second sampling technique was the development and implementation of a “fishability” index to quantify potential impact of aquatic vegetation on angler’s ability to fish. We termed this methodology as the “Davids’ Fishability Index” to recognize the person who thought of this technique. This technique employed the use of fishing techniques similar to those most commonly used on regional reservoirs to determine where anglers can and cannot fish effectively. At each site sampled using the Point-Intercept Method, personnel casted five times with each of two rods: 1) outfitted with a bobber and bait, and 2) outfitted with a spinning lure. Each cast was conducted in a different direction from other casts to thoroughly sample the water around each sample location. Casts were made out to a distance of 7 - 10 m, allowed to settle, and retrieved at a moderate pace to mimic that of someone fishing. For each cast, the fishability of that location was recorded using the following scale:

1 = no vegetation detected during cast.
2 = vegetation felt during retrieve but none present on hooks
3 = lure retrieved with vegetation present on hooks
4 = lure broken off on vegetation during retrieve
5 = dense/matted surface vegetation, unable to cast

The final score for each location was calculated as an average of the five casts.

<u>Hypolimnetic Aeration</u>

In 2002, we installed a hypolimnetic aeration system at Winchester Lake to reduce the phosphorous load in the water by increasing the dissolved oxygen levels in the hypolimnion. The aeration system consisted of eight floating units driven by four air compressors (two units run by each compressor). Each floating aeration unit is a 10’ x 10’ aluminum trough with two floats attached and covered with a low A-frame roof. They had two 36” pipes attached vertically to the bottom of the trough. The intake pipe was 15' long, while the return pipe was 20' long. These lengths of pipe were used to ensure the water moved through the system was drawn from and returned to the hypolimnion to avoid de-stratifying the reservoir. The air compressors were housed in sheds on the opposite side of the lake from Winchester State Park to reduce potential noise pollution. Originally, 2" PVC pipe was used to transfer air from the compressor to each unit. This pipe was weighted with pieces of railroad track to keep it on the bottom of the reservoir. The air pipe is attached to a diffuser at the bottom of the intake pipe. After multiple failures, the 2" PVC pipe was replaced with 1" self-weighted flexible air hose.

A hypolimnetic aeration system works by taking water from the bottom of the lake, bringing it to the surface where it is oxygenated by contact with air, then returned to the bottom of the lake (Figure 7). A compressor releases air at the bottom of a vertical pipe. As the air rises, it forces water up the pipe into the attached trough. As the level of the water increases in the trough, gravity forces water back down a second pipe to the bottom of the lake.

Monthly evaluations of the project were conducted by collecting DO and temperature profiles both inside and outside of the hypolimnetic aeration system to evaluate how much oxygen is being added to the water. These samples were taken by lowering the YSI 550A probe down inside both the uptake and return pipes. Samples were taken at 5m and 3m of depth inside each pipe. Additionally, samples were taken inside the aeration trough at the surface above both the uptake and return pipes. The overall increase in DO is determined by subtracting the DO level 5m down the uptake pipe (water just entering the system) from the DO level 5m down the return pipe (water just prior to leaving the system). Dissolved oxygen and temperature profiles were also taken outside of the units at distances of 1 m, 5 m, 10 m, and 15 m.

Table 1. Economic value of fishing and angler effort by counties in the Clearwater Region in 2011 (IDFG *unpublished data*), as determined by an economic survey conducted by Idaho Department of Fish and Game.

County	Total Spending	Total Days Fishing	Total Trips	Average Trip Spending
Nez Perce	$ 17,696,661	133,728	89,152	$ 199
Lewis	$ 2,207,681	25,823	18,445	$ 120
Latah	$ 1,356,664	25,204	19,388	$ 70
Clearwater	$ 31,014,573	231,863	110,411	$ 281
Idaho (Region 2 portion) @	$ 34,352,426	223,898	97,347	$ 346
TOTALS	$ 86,628,005	640,517	334,743	$ 203

Table 2. Economic value of lowland lakes in the Clearwater Region (IDFG 2012), as determined by economic surveys conducted by Idaho Department of Fish and Game in 2003 and 2011.

2003

Water body	Total spending	Total trips	Average Trip spending
Elk Creek Reservoir	878,343	8,131	108
Mann Lake	452,056	6,733	67
Moose Creek Reservoir	430,529	7,525	57
Soldier's Meadow Reservoir	228,099	4,636	49
Spring Valley Reservoir	402,383	16,635	24
Tolo Lake	20,520	650	32
Waha Lake	12,209	741	16
Winchester Lake	1,260,642	21,075	60
Totals	$3,684,781	66,126	$52

2011

Water body	Total spending	Total trips	Average Trip spending
Deer Creek Reservoir	75,707	1,175	64
Elk Creek Reservoir	862,923	7,882	109
Mann Lake	323,807	8,554	38
Moose Creek Reservoir	624,434	6,174	101
Soldier's Meadow Reservoir	245,876	2,494	99
Spring Valley Reservoir	382,791	10,507	36
Tolo Lake	21,627	210	103
Waha Lake	46,965	1,665	28
Winchester Lake	1,499,856	18,445	120
Totals	$4,008,279	55,931	$79

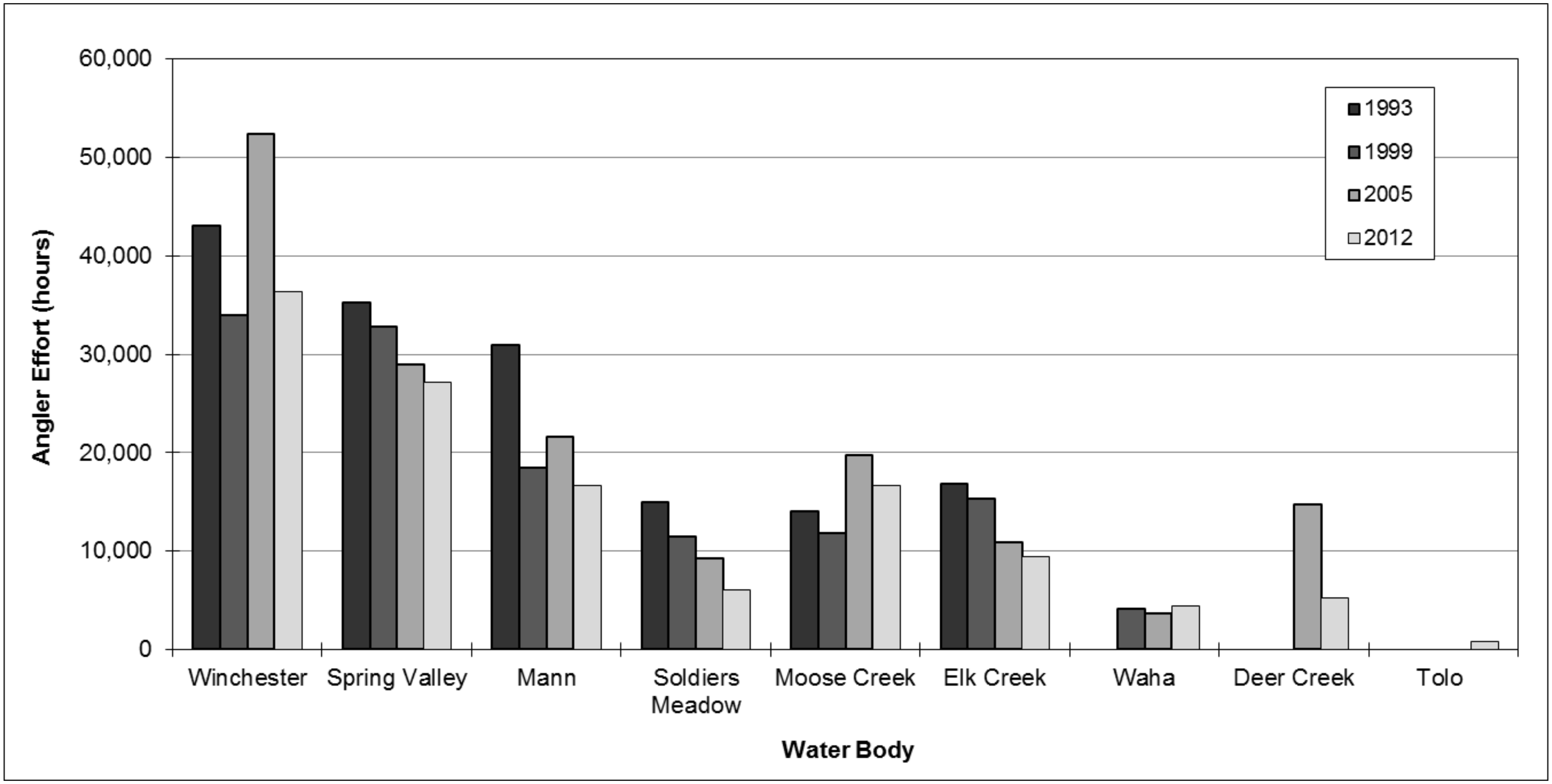

Figure 1. Estimated angler effort from creel surveys of nine lowland lakes and reservoirs in the Clearwater Region from 1993 – 2012.

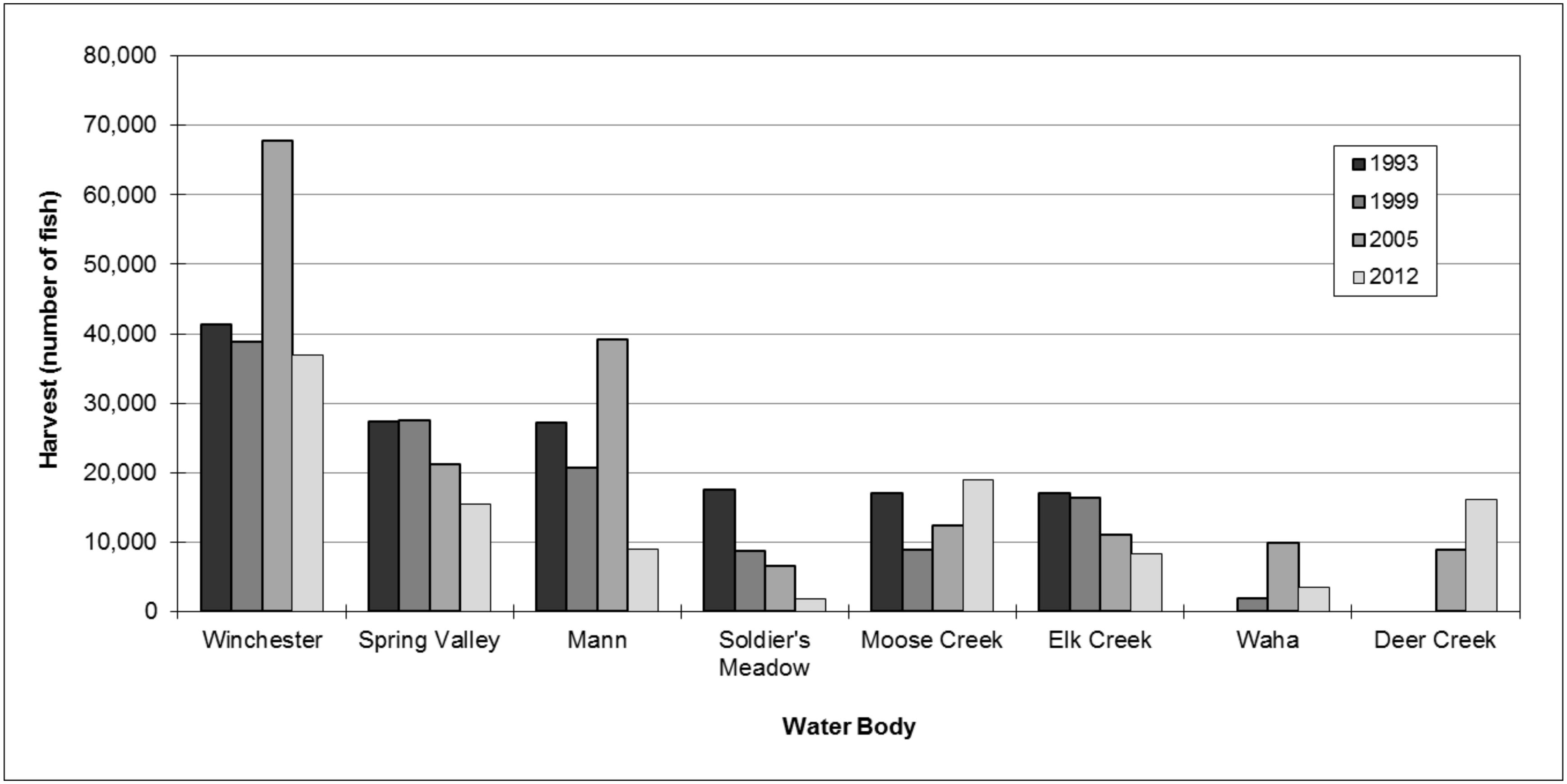

Figure 2. Estimated angler harvest from creel surveys of eight lowland lakes and reservoirs in the Clearwater Region from 1993–2012.

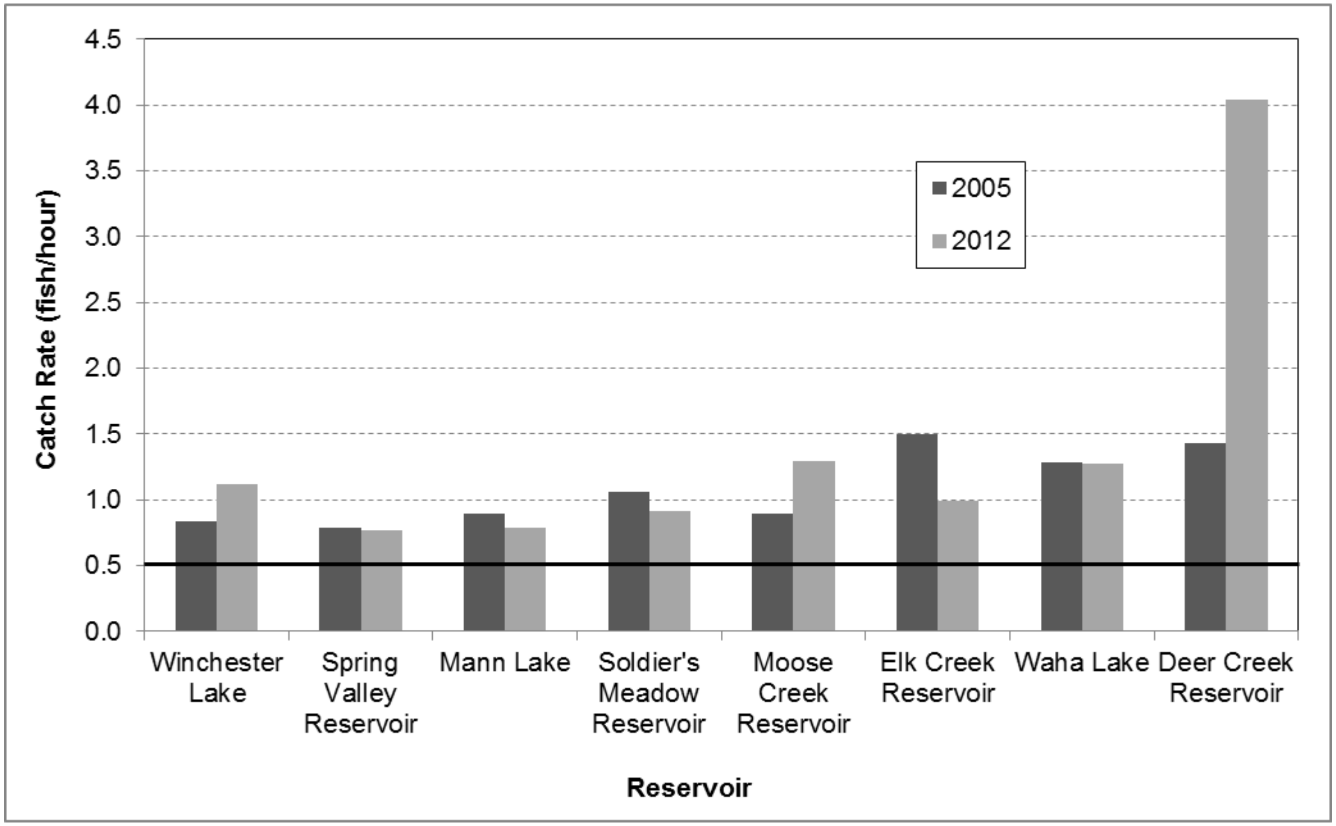

Figure 3. Estimated catch rates (fish/hour) of hatchery Rainbow Trout from creel surveys of eight lowland lakes and reservoirs in the Clearwater Region in 2005 and 2012. Catch rates were not available for surveys conducted in 1993 and 1999. Minimum management objective of 0.5 fish/hour shown with a thick solid line

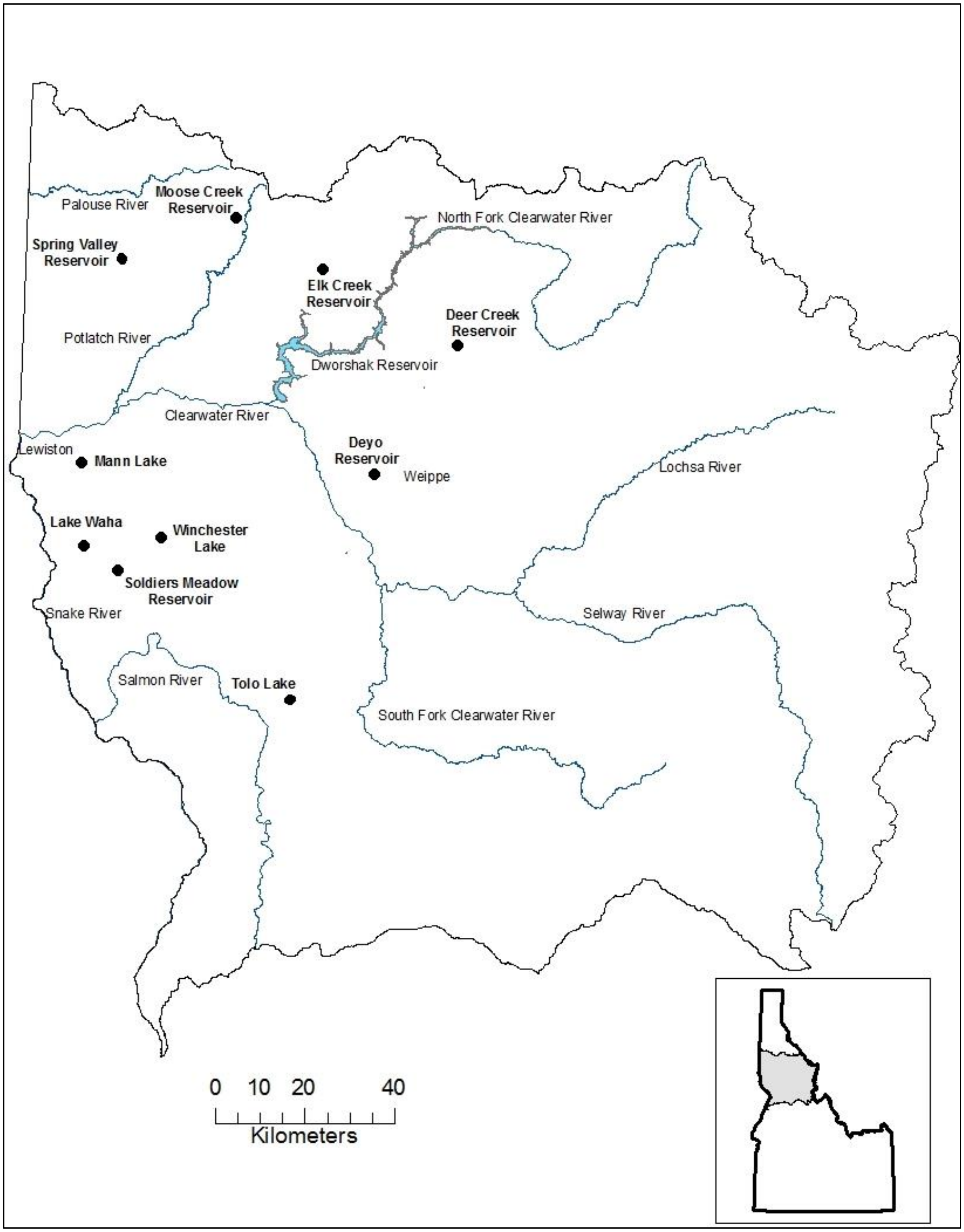

Figure 4. Map showing locations of reservoirs surveyed in the Clearwater Region, Idaho, during 2012.

Date: ______________

Fishing Report Card

*** **Please fill out one card for each angler, thank you.**

How long did you fish today: Start ____________ End ____________

Please circle type of fishing: **BANK** **BOAT** **FLOAT TUBE/PONTOON BOAT** **ICE**

Please circle method of fishing: **LURE** **BAIT** **FLY**

What was your targeted fish? **Trout** **Bass** **Crappie** **Bluegill** **Any Fish** **Other** _________

Please record the total number of fish released and kept in the spaces below:

Rainbow Trout		**Bass**		**Other** __________		**Other** __________	
Released	Kept	Released	Kept	Released	Kept	Released	Kept

Comments:

___

___

___

Reservoir: __________________________ Interview ID: __________________________

Figure 5. Voluntary angler survey report card used for angler surveys in the Clearwater Region during the 2012 creel.

Figure 6. Volunteer angler survey card drop box and sign used for angler surveys in the Clearwater Region during the 2012 creel.

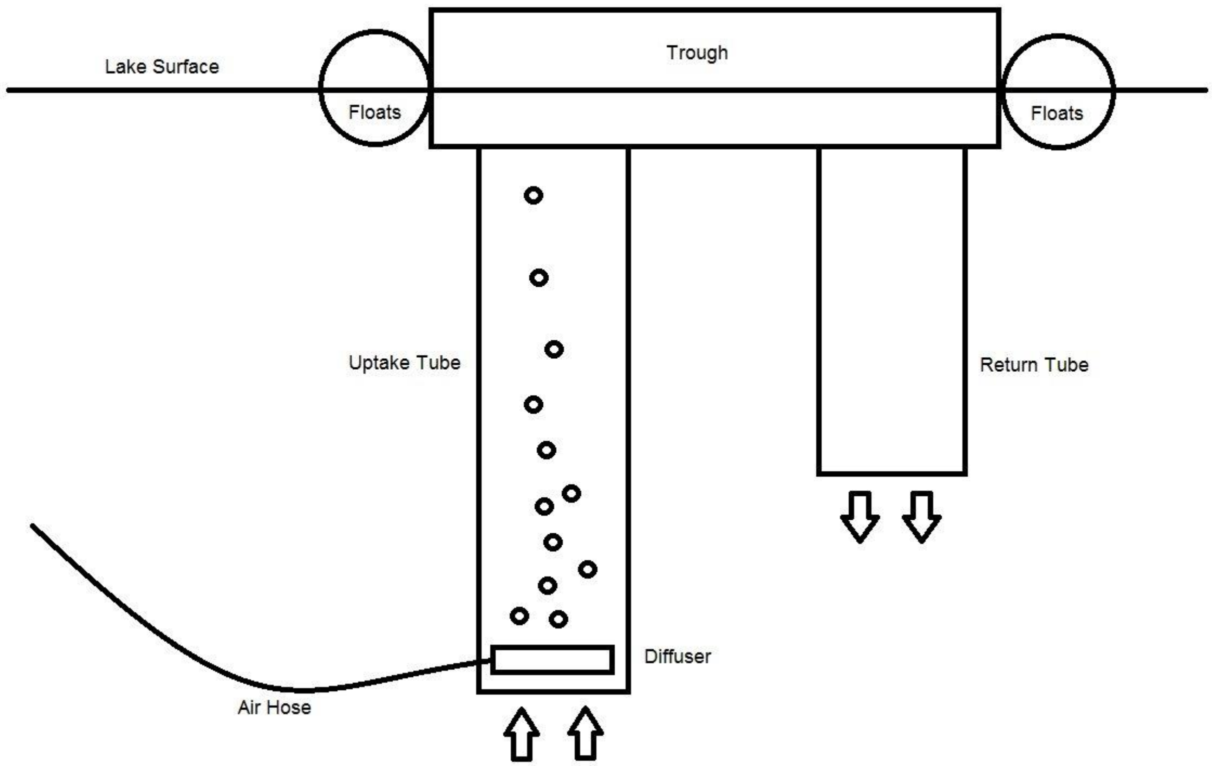

Figure 7. Diagram of hypolimnetic aeration unit installed on Winchester Lake, Idaho, in 2002.

SPORTFISH ASSESSMENT OF DEER CREEK RESERVOIR

ABSTRACT

In 2012, a comprehensive assessment of Deer Creek Reservoir was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 58 fish including Rainbow Trout, Westslope Cutthroat Trout, and Brook Trout. Creel surveys estimated angler effort at 5,254 hours. The angler catch rate for all fish species combined was 4.3 fish/hour.

Angler exploitation of hatchery catchable size Rainbow Trout was estimated at 36.2% for the creel survey. However, angler exploitation was estimated at 15.4% by the “Tag You’re It” program. The large difference between these two estimates should be explored in the future to determine which method is more accurate.

Methods to control the introduced Golden Shiner population should be explored and implemented. Stocking a piscivorous salmonid could help with reducing the population. Additionally, we recommend reducing the number of catchable size Rainbow Trout stocked annually to reduce fish densities and improve forage opportunities.

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INTRODUCTION

Despite being fairly remote, Deer Creek Reservoir (DCR) is an important part of the lowland lake program, as it provides a location for trout harvest in an area where all stream/river fishing is under restrictive harvest rules of two trout per day. Even with its remote location, DCR accounted for an estimated 14,709 hours of angler effort in 2005. An economic survey conducted in 2011 estimated 1,175 angler trips to DCR for an estimated total economic expenditure of $75,707 (IDFG *unpublished data*). While other reservoirs are closer to these population centers, DCR is a popular place to fish due to its proximity to some smaller communities, easy fishing access, unique fishing opportunities, and good catch rates for trout.

Deer Creek Reservoir is a trout-only fishery, containing Rainbow Trout, Westslope Cutthroat Trout *O. carkii lewisi*, and Brook Trout. Dace *Rhinichthys sp*., and Redside Shiners *Richardsonius balteatus* are the only native non-game fish that may occur in the reservoir.

Deer Creek Reservoir has been renovated twice with rotenone (2006 and 2010) to remove illegally introduced Golden Shiners *Notemigonus crysoleucas*. Any potential benefits Golden Shiners may provide as forage for predatory fish are far outweighed by fishery losses via competition with trout that forage primarily on zooplankton. The potential threat of Golden Shiner from DCR extends to other nearby waters. Golden Shiner have the potential to directly compete with kokanee *O. nerka* in nearby Dworshak Reservoir. Kokanee are one of the most popular fish in Dworshak Reservoir, which accounted for and estimated 21,008 angler trips and $4,130,389 in economic expenditures in 2011 (IDFG *unpublished data*). Persistence of Golden Shiners in DCR will certainly provide a continual source for natural migration down Reeds Creek into Dworshak Reservoir, and a source for additional illegal introduction throughout other area waters.

Golden Shiners were discovered in several ponds in the nearby Schmidt Creek drainage (near Weippe, Idaho) during the construction of Deyo Reservoir. Nez Perce Tribe fisheries biologists have also reported Golden Shiners in Orofino Creek and Jim Ford Creek. This suggests that Golden Shiners are now widespread and will be difficult to keep out of DCR and Deyo Reservoir in the future.

Current Management

Deer Creek Reservoir is the only lowland lake in the region that is managed solely as a cold-water trout fishery. It has been managed as a put-and-take Rainbow Trout fishery, and put-and-grow Westslope Cutthroat Trout and Brook Trout fisheries. A total of 24,290 catchable Rainbow Trout and 8,100 sterile Brook Trout were stocked in 2012, and 5,009 fingerling Westslope Cutthroat Trout were stocked in 2011 to maintain an overall catch rate of >0.5 fish/hour (IDFG 2013). The reservoir is managed under general fishing regulations including year round seasons, no length limits, and a six trout limit with no bait or hook restrictions. Gas motors are allowed, but may only be operated in such a way as to not create a visible wake. While fishing is open year round, road access is restricted from October 1 - May 19. The current management priority is to provide a desirable fishing experience to a broad diversity of angler types.

Reservoir Management Goals

1. Maintain catch rate of >0.5 fish/hour for hatchery Rainbow Trout.

2. Provide a diversity of fishery opportunities by stocking other put-and-grow trout species.

STUDY SITE

Deer Creek Reservoir is the most remote of the Clearwater Region's lowland reservoirs, located approximately 140 km and 185 km from the region's largest population centers of Lewiston, ID (pop. 32,119) and Moscow, ID (pop. 24,080). Deer Creek Reservoir is located in Clearwater County, Idaho, 21 km north of the town of Pierce, Idaho (Figure 4). It is a 47.0 hectare reservoir located at an elevation of 1,006 meters. It has a maximum depth of 11 m, and a maximum volume of 759 acre-ft. Completed in 2003, it is the second newest reservoir in the state of Idaho. It was created by damming Deer Creek, a tributary of Reeds Creek that flows into Dworshak Reservoir. The reservoir and watershed is owned by Potlatch Corporation and is used primarily for timber harvest. Idaho Department of Fish and Game leases the reservoir property from Potlatch Corporation. Today, the reservoir is used extensively by boaters and anglers. It provides excellent trout fishing, with some growing to over 500 mm after two years.

RESULTS

Population Survey

A fish survey of DCR was conducted on May 22, 2012, which consisted of 1,800 seconds of electrofishing. Electrofishing was separated into three 10-minute sample periods. Sampling resulted in the capture of 58 fish including Rainbow Trout (n = 52), Westslope Cutthroat Trout (n = 5), and Brook Trout (n = 1). The electrofishing catch rate was 116.0 fish/hour. Rainbow Trout collected ranged from 164 - 324 mm in total length (Figure 8), with an average length of 243 mm. Westslope Cutthroat Trout collected ranged from 215 - 242 mm total length (TL), with an average length of 229 mm (Figure 9). The one Brook Trout collected was 206 mm TL. No golden shiners were collected during the electrofishing survey, but they were observed in the reservoir during the survey.

Creel Survey

Creel surveys were conducted on DCR from December 1st, 2011 through October 20th, 2012. A total of 4,605 instantaneous angler counts were conducted by remote camera during the creel survey, resulting in an estimated total angler effort of 5,254 hours (SE ± 349; Table 3). Slightly more effort occurred on weekdays (52.4%) than weekends (47.6%). The highest angler effort occurred in the summer months from June - August, with monthly effort estimates ranging from 1,109 - 1,319 hours. Approximately 159 hours of effort (3.0%) was estimated to have occurred during the annual road closure period (October 1 - May 20).

Catch rate and harvest data for the 2012 creel survey on DCR was based on 146 voluntary angler report cards. These were used instead of in-person interviews due to the remoteness of DCR. Anglers caught an estimated 24,429 fish during 2012, including 22,539 (92.3%) Rainbow Trout, 1,020 (4.2%) Brook Trout, and 869 (3.6%) Westslope Cutthroat Trout. The catch rate for all fish combined was 4.3 fish/hour. The catch rates for individual species were 4.0 fish/hour for Rainbow Trout, 0.2 fish/hour for Brook Trout, and 0.1 fish/hour for Westslope Cutthroat Trout. Anglers harvested an estimated 16,107 fish during 2012 (Appendix A), or about 66% of the fish caught. The overall harvest rate was 2.8 fish/hour. Harvest in 2012 consisted of 14,960 (92.9%) Rainbow Trout, 868 (5.4%) Brook Trout, and 279 (1.7%) Westslope Cutthroat Trout (Appendix A). Ninety-three percent of the fishery at DCR is supported by hatchery catchable size Rainbow Trout (Figure 10). The majority of these fish (99.5%) were harvested from June - October (Appendix C). The estimated exploitation rate was 47.1%. With fingerling Brook Trout and Westslope Cutthroat Trout also stocked, the entire fishery is supported by hatchery stocking.

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery catchable size Rainbow Trout stocked in DCR in 2011 and 2012. Rainbow Trout were tagged on May 10, 2011 (n = 397), October 19, 2011 (n = 400), and May 10, 2012 (n = 400). Exploitation rates through 365 days at large were 12.2% for the May, 2011 stocking (Table 4), 8.6% for the October, 2011 stocking, and 14.8% for the May 2012 stocking. Exploitation rates for 366 - 730 days at large were 1.6% for the May, 2011 tagging event, 0.0% for the October, 2011 event, and 8.6% for the April 2012 event. No exploitation occurred beyond 730 days at large for any stocking event.

Angler total use (fish harvested plus fish released) rates through 365 days at large (Table 4; Appendix D) were 12.2% for the May 2011 stocking, 10.4% for the October, 2011 stocking, and 16.9% for the May 2012 stocking. Total use rates for 366 - 730 days at large were 2.5% for the May, 2011 tagging event, 0.0% for the October, 2011 event, and 8.6% for the April 2012 event. No use occurred beyond 720 days at large for any stocking event.

Limnology

Limnology samples were collected monthly from May - December, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being quite evident (Figure 11). Dissolved oxygen profiles in early May - September showed anoxic conditions were present in the hypolimnion. October and December profiles were homogenous due to fall turnover. Monthly temperature measurements showed very similar patterns to the DO measurements (Figure 11). To look at potential diel changes in temperature and DO profiles, measurements were taken at 1:15 pm and 6:45 pm on August 28, 2012, and at 6:45 am on August 29, 2012 (Figure 12). There was a drop in surface temperature and in DO at the thermocline overnight.

During July, water temperatures were >21°C down to a depth of 2 m, and DO at this time was <5.0 mg/L below 4 m in depth. This resulted in a condition in which 35% of the water in DCR was conducive for Rainbow Trout survival during July (Figure 13). Fall turnover did not cause a drop in DO to <5.0 mg/L. Utilizing an upper thermal limit of 25°C did not result in a smaller reduction in volume in July (Figure 13).

Zooplankton

Zooplankton samples were collected monthly from May - December, 2012. The population was composed of five taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Ceriodaphnia, and Calanoida. The composition changed from primarily Cyclopoida (>79.1%) in May and June to primarily Daphnia (>49.2%) in August and September (Figure 14). July, October, and December samples were fairly evenly split between Cyclopoida, Daphnia, and Calanoida.

Zooplankton density (# of individuals/m^3) was also highly variable. Cyclopoida densities ranged from 116 - 12,824/m^3 with an average of 5,108/m^3 (Figure 15). Density peaked in June and July. Daphnia and Calanoids peaked in July, with densities ranging from 34 - 12,235/m^3 and 6 - 10,300/m^3 (Figure 15). All three of these taxa saw similar fluctuations in density, with a peak in mid-summer followed by a sharp drop to near 0/m^3, then a steady increase through the end of the year. Chydoridae and Ceriodaphnia were only found in densities <1,000/ m^3. Average lengths of Daphnia ranged from 0.62 - 1.29 mm (Figure 16), with an increasing trend seen throughout the summer. Average lengths of Cyclopoida ranged from 0.42 - 0.71 mm (Figure 16), with a declining trend seen throughout the summer. Length frequency distributions from each sample show that the percent of Daphnia >1.3 mm in length ranged from 0.0 - 54.4% of the individuals collected (Figure 17). Length frequency distributions from each sample show that no Cyclopoids >1.3 mm in length were collected in any sample (Figure 18).

ZQI sampling was conducted on August 28, 2012. Biomass (0.23 g/m^3) was below the regional average of 0.58 g/m^3 for the 150 µm net, but above the regional average at 0.50 (g/m^3) for the 500 µm net and 0.18 (g/m^3) for the 750 µm net (Appendix E). The ZPR was calculated to be 0.37 and the ZQI was 0.25, both also below the regional average. However, the ZQI was the second highest for any regional reservoir.

Aquatic Vegetation

Vegetation surveys were conducted on August 13, 2012. A total of 73 sites were sampled. Vegetation was collected by rake tosses at 16 (22%) sample sites (Figure 19). Sample sites along the shoreline accounted for 49.3% (n = 36) of all sample sites. Vegetation was collected at 27.8% (n = 10) of these sites. Additionally, 62.5% of all sample sites with vegetation were along the shoreline (Figure 19). Five types of vegetation were identified: filamentous algae *Rhizoclonium sp.* and *Cladophora sp*., pondweed *Potamogetan sp.*, macrophytic algae *Nitella sp*., water starwort *Calitriche heterophylla*, cattail *Typha* sp., and white water buttercup *Ranunculus aquatilis*. Filamentous algae was the most commonly encountered vegetation, occurring at 13 (18%) sites where vegetation was collected (Appendix F). Pondweed was the second most common vegetation (12%), followed by macrophytic algae (10%), water starwort (10%), cattail (3%), and white water buttercup (1%).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 73 sites. Vegetation was encountered at 12 (16.4%) sites (Figure 20). Vegetation was present on hooks at 11 (15.1%) sites, while dense matted surface vegetation prevented casting at one (1.4%) site. Sixty-two percent of the surveyed sites were along the shoreline; and based on the DFI, angling at 22.2% of these sites would be negatively influence by vegetation.

DISCUSSION

Population Survey

The results of the fish survey showed that DCR is dominated by hatchery catchable trout, with a few Westslope Cutthroat Trout and Brook Trout that were stocked as fingerlings. These fish were all of catchable size, but no fish >330 mm were collected. The lack of larger trout is likely due to the complete renovation of DCR in 2010 and the high abundance of Golden Shiner that were found in the reservoir. After the reservoir renovations in 2006, reports by anglers indicated that hatchery Rainbow Trout up to 508 mm were caught beginning two years post-renovation. Thus, if these past growth rates continued, we would expect to see trophy sized trout in DCR beginning in 2013. However, the Golden Shiner are probably reducing the quality and quantity of zooplankton available to hatchery trout. In addition, stocking densities of catchable size fish increased from 19,756 in 2010, to 27,410 in 2011, and 24,290 in 2012 (Figure 21). Introduction of piscivorous trout (such as tiger trout) should be evaluated to see if they could reduce the Golden Shiner population and maintain the trout only status in this reservoir.

Creel Survey

Angler effort in 2012 (5,245 hours) declined 64% from the 14,709 hours of effort estimated in 2005 (Figure 1). This change in effort may be due to differences in methods used for the two surveys. Effort estimates for the 2005 survey relied on only 41 in-person angler counts, whereas the 2012 survey effort was estimated from 4,605 instantaneous camera counts. It is likely that the 2005 effort estimate is biased high due to the low number of counts and the lack of randomization of time of day when counts were made. Future angler counts on remote reservoirs like Deer Creek Reservoir should continue to utilize the trail cameras, as these provide hourly counts, which isn't possible (or realistic) with in-person counts due to budget constraints.

Information collected from angler opinion surveys at other reservoirs in 2012 indicated that an enjoyable fishing trip is not predicated solely upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience at DCR (such as improved amenities) could improve angler satisfaction and use at this reservoir.

Angler Exploitation

Catch rates and harvest rates for hatchery Rainbow Trout increased substantially from 2005 to 2012, increasing from 1.5 fish/hour to 4.0 fish/hour and 0.6 fish/hour to 2.7 fish/hour, respectively. This is well above the management goal of a 0.5 fish/hour catch rate for hatchery fish. Angler catch and harvest rates tend to be biased high with self-report cards, with the bias towards successful anglers because unsuccessful anglers are less likely to return a card (Carline 1972, Fraidenburg and Bargmann 1982, Pollack et al. 1994). Catch rates and harvest rates for hatchery Rainbow Trout averaged 79% and 70% higher for self-report cards than what was estimated for creel surveys at seven regional reservoirs where both methods were utilized during these 2012 surveys. Thus, the use of angler self-report cards to estimate catch and harvest at DCR is likely the cause of much of the discrepancy between these two exploitation estimates. If we correct the catch and harvest estimates for DCR using these figures, then an estimated 12,592 Rainbow Trout were actually caught, with 8,800 actually harvested during the creel survey. This results in a corrected exploitation rate of 36.2% for the creel survey. While this is much closer to the 15.4% exploitation estimated by the tagging program, the two estimates are still quite different.

Additionally, an estimated 868 Brook Trout and 279 Westslope Cutthroat Trout harvested in 2012. These fish, which were stocked as fingerlings in 2011, had entered the fishery and were providing the diversity of opportunity that was intended. Angler exploitation for the 2011/2012 fingerling stockings was estimated at 12.6% for Brook Trout and 17.3% for Westslope Cutthroat Trout, based on harvest rates calculated from angler self-report cards. Assuming that the reporting bias is similar to that seen for Rainbow Trout in other regional waters (79% higher on average), then the adjusted exploitation was around 7.0% for Brook Trout and 9.7% for Westslope Cutthroat Trout. It makes sense to utilize fingerlings when feasible, as they are a less expensive product per fish stocked, and they are a more desirable product for the angling public. The cost per fish stocked is about nine times higher for catchable size trout versus fingerlings for fish produced by IDFG hatcheries (Byrne, personal communication). Based on the differences in cost per fish stocked, and the exploitation rates, the estimated average cost per fish harvested was only 10% higher for catchable size trout. With the cost per harvested fish relatively similar, other factors such as angler preference and the potential impact of tiger trout on fingerling stockings must be taken into consideration.

Anglers tend to prefer fish stocked as fingerlings, as they are perceived to have better flesh quality.

Catch rates of fingerling Brook Trout (0.2 fish/hour) and Westslope Cutthroat Trout (0.1 fish/hour) were below the 0.5 fish/hr goal. However, these data suggest that fingerling stockings can work in DCR. Fingerling plantings of Rainbow Trout could also be successful to the point that the combined catch rates of all fingerlings plantings would achieve our reservoir goal of > 0.5 fish/hr. However, we are concerned that the Golden Shiner population may increase and reduce the success of fingerling plants. As such, until we find a way to reduce and control the Golden Shiner population, we recommend continuing stocking catchable rainbows.

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) were utilized to evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate of stocked hatchery Rainbow Trout was 12.2% for the spring 2011 tagging event (Table 4) and 16.9% for the spring 2012 events. There was use from the 2011 spring stocking past the one year mark (Appendix D), indicating that there is some carryover from these stockings. The estimated total use rate for 366 - 730 days at large were 1.6% for the spring 2011 stocking, and 8.6% for the spring 2012 stocking. This is a good sign, as carryover increases the opportunity for angler to catch these fish and provides a more desirable product.

The total use rates for hatchery Rainbow Trout through June, 2014 were therefore estimated to be 14.7% for the spring 2011 tagging events (Table 4) and 25.5% for the spring 2012 events. These estimates were below the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). Additionally, these estimates were below the IDFG management goal of a 40% total use rate for stocked hatchery Rainbow Trout (Appendix D). Tag returns from both the spring 2011 (Figure 22), and spring 2012 (Figure 23) stockings show similar patterns. Most tags are returned by the end of September each year, coinciding with most of the fishing effort that occurs from May - September (Table 3). With high catch rates, and total use rates below the statewide management goal, we recommend reducing future spring stocking numbers.

The success of our fall stockings is also of interest for the regional tagging program. Tag returns resulted in a total use rate for stocked hatchery Rainbow Trout of 10.4% for the October, 2011 tagging event. This rate was also below the total use rate for both spring stockings, which would be expected due to lower angler effort during the winter months (Table 3). Fish tagged during the fall of 2011 were caught (starting the next spring) all the way through August, 2012 (Figure 24), indicating that these fish were able to overwinter and were available to the fishery for almost a year post stocking. With such a low return to creel rate, and little fishing pressure during the fall and winter, we should consider discontinuing fall stockings in DCR.

Comparing angler exploitation of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 13.3% while the creel survey estimated it to be 47.1%. Differences in angler exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the use of bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Angler exploitation based on the “Tag You’re It” program (Meyer et al. 2009) was only slightly higher for the 2012 stockings than the 2011 stockings (Appendix D). This trend was only seen in DCR, as exploitation declined in five of the six regional reservoirs where data existed from both years. Some of this may be attributable to possible changes in angler effort, better fishing conditions, higher survival of hatchery trout, or a higher tag return rate in 2012.

Limnology

High temperatures and low DO levels are often a concern for our lowland reservoir trout fisheries. Based on the IDFG standards for temperature and DO thresholds, the volume of water available for Rainbow Trout to survive was reduced to 35% in June, 2012 (Figure 14). We believe this is a suitable amount of habitat for trout to survive in this reservoir. Trout have been found to congregate in small areas during times when habitat is limited without having population level effects (Stevens and DuPont 2011). Oxygen levels in DCR have shown an improvement over time. Since 2005, DO >5.0mg/L has improved from a maximum depth only 2 m for the majority of 2005 to a maximum depth of 4 m for the majority of 2012.

An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion. This is a concern for the fall stocking of catchable trout in DCR, as fall turnover can reduce the dissolved oxygen levels of the reservoir to below the 5.0 mg/L needed for Rainbow Trout. However, this situation has only occurred once (in 2005) since monthly sampling began in 2005. To avoid potential fish kills, fall stockings should be conducted after fall turnover.

Zooplankton

Large sized zooplankton taxa, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987). The zooplankton community in DCR was dominated by Daphnia and Cyclopoida through most of 2012, indicating the presence of a viable food source. In 2012, Daphnia collected averaged 1.1 mm, and Cyclopoida averaged 0.6 mm in length (Figure 16). These average lengths are below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Approximately 23.2% of Daphnia and no Cyclopoids were at or above preferred size (Figures 17 and 18) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 51.7% of the Daphnia population, and 4.7% of the Cyclopoida population, were ≥1.0 mm in length.

ZQI scores (0.25) indicate that we should reduce the numbers of planktivores in the reservoir to improve forage opportunity. The average length of zooplankton below preferred size, and moderate ZQI value, are likely caused in part due to the large numbers of Golden Shiner present in the reservoir. Burdick and Cooper (1956) determined that minnow species are often more detrimental to the survival of trout due to competition for food than they are beneficial in providing forage for the larger trout. As such, we should consider introducing a picivorous salmonid species, such as Tiger Trout *Salmo trutta x Salvelinus fontinalis* to reduce the abundance of Golden Shiner. If successful, Tiger Trout would utilize the biomass tied up in Golden Shiners and help reduce predation on the zooplankton population, both of which should improve growth for all trout species in DCR.

Aquatic Vegetation

Monitoring vegetation in DCR is an important part of managing the reservoir. As seen in our surveys, vegetation was present at 22% of the sites samples. Most of the vegetation was found in the upper end of the reservoir, with some also next to the boat ramp. Vegetation presence alone, however, doesn't provide the entire picture. We must also consider what types of vegetation are present and what effects it has on fish populations and recreation in the reservoir. For example, pondweed and macrophytic algae can become widespread and are difficult to remove. Currently, very little of DCR was unfishable. Preventing the further spread of nuisance vegetation in the reservoir will be a primary management goal over the next few years. This is important, as prevention/control at current vegetation levels will be much easier and cheaper than treating a reservoir that is full of vegetation.

MANAGEMENT RECOMMENDATIONS

1. Consider introducing a piscivorous salmonid to help control the Golden Shiner population.

2. Continue stocking multiple salmonid species to provide a diversity of opportunity.

3. Consider stocking fingerling Rainbow Trout if we are able to reduce and control Golden Shiner abundance.

4. Reduce catchable-sized Rainbow Trout stocking densities to achieve better growth.

5. Monitor aquatic vegetation and use herbicides for control while coverage remains minimal.

6. Assess the pros and cons of allowing year-round road access to the reservoir. Discuss the options with Potlatch Corporation.

Table 3. Summary of angler effort (hours) as determined through a creel survey conducted on Deer Creek Reservoir, Idaho, from November 28, 2011 to November 28, 2012.

Month	Total Weekday	Total Weekend	Total Effort	Standard Error	Percent Error
December	0	2	2	2	128.6
January	0	0	0	0	--
February	12	3	15	13	85.9
March	0	26	26	26	100.0
April	0	27	27	15	55.8
May	251	358	609	150	24.7
June	705	614	1,319	268	20.3
July	700	571	1,271	108	8.5
August	658	451	1,109	94	8.5
September	313	387	700	69	9.9
October	115	61	175	28	15.8
Totals	2,753	2,501	5,254	349	6.6

Table 4. Angler exploitation (harvest) and total use (released or harvested) of hatchery catchable size Rainbow Trout stocked in Deer Creek Reservoir, Idaho, in 2011 and 2012, within 365 days post-stocking.

2011

Hatchery	Tagging date	Treatment	Tags released	Disposition			Adjusted exploitation		Adjusted total use	
				Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Clearwater	5/10/2011	Normal production	397	21	0	0	12.2%	4.8%	12.2%	4.8%
	10/19/2011		400	15	1	2	8.6%	3.9%	10.4%	4.3%
Average							10.4%	4.3%	11.3%	4.5%

2012

Hatchery	Tagging date	Treatment	Tags Released	Disposition			Adjusted exploitation		Adjusted total use	
				Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Clearwater	5/10/2012	Production	400	21	1	2	14.8%	4.6%	16.9%	4.9%

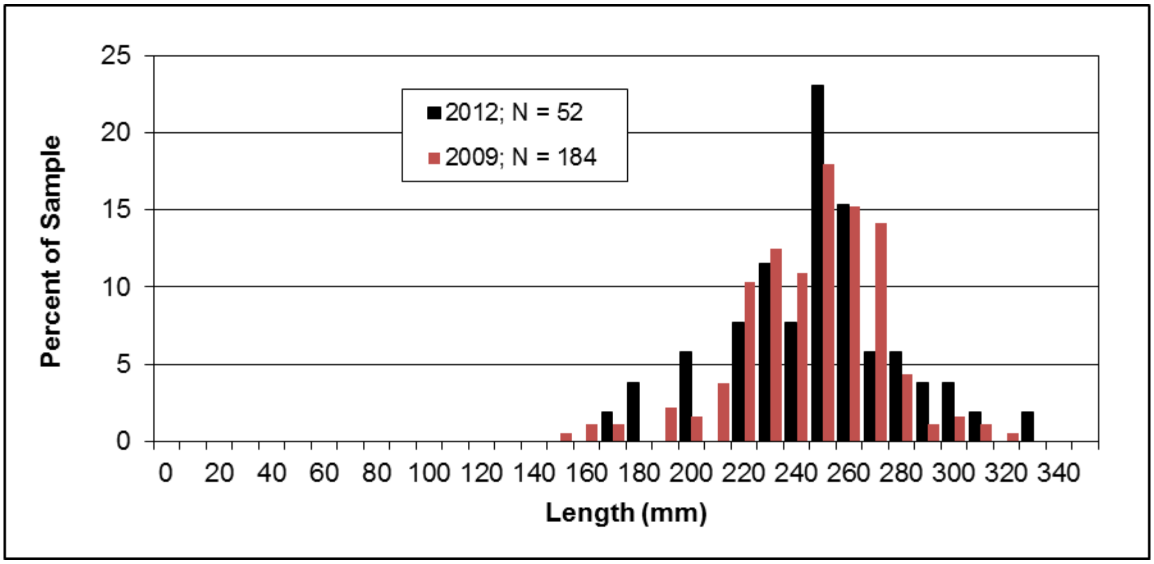


Figure 8. Length frequency distributions of Rainbow Trout collected through electrofishing in Deer Creek Reservoir, Idaho, in 2009 and 2012.

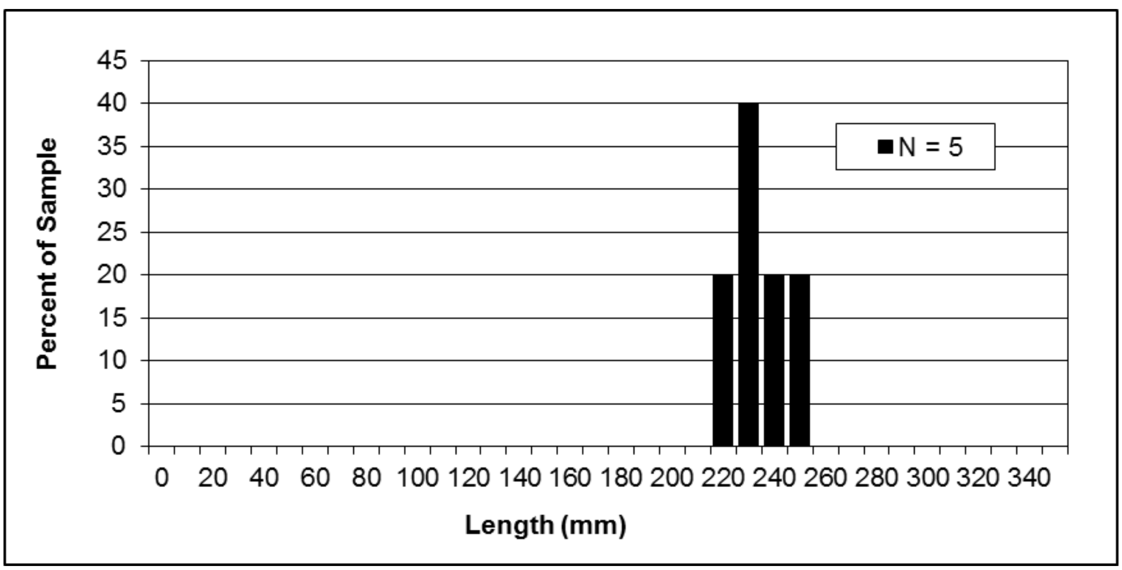


Figure 9. Length frequency distributions of Westslope Cutthroat Trout collected through electrofishing in Deer Creek Reservoir, Idaho, in 2012

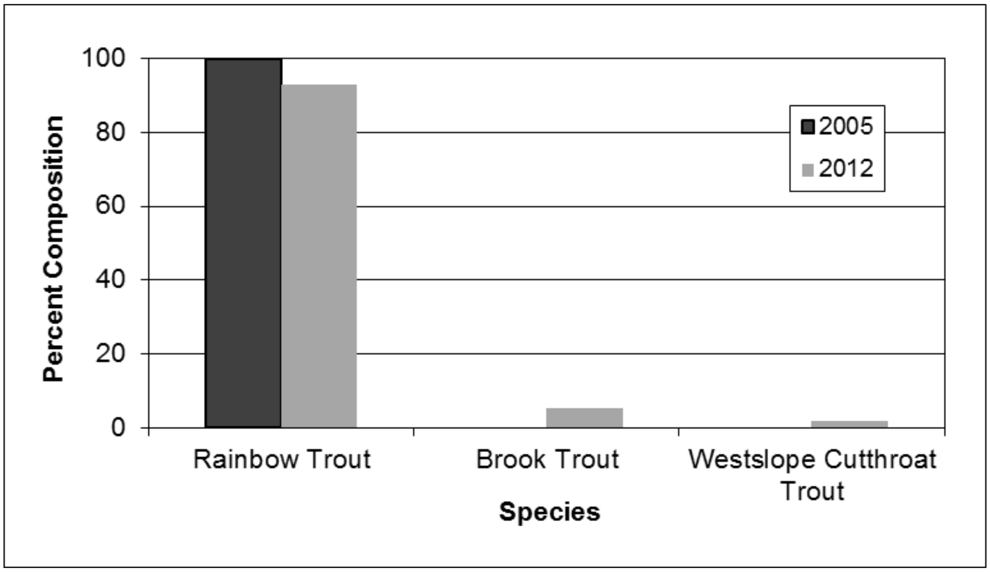


Figure 10. Composition of fishes harvested as determine through creel surveys conducted at Deer Creek Reservoir, Idaho, in 2005 and 2012.

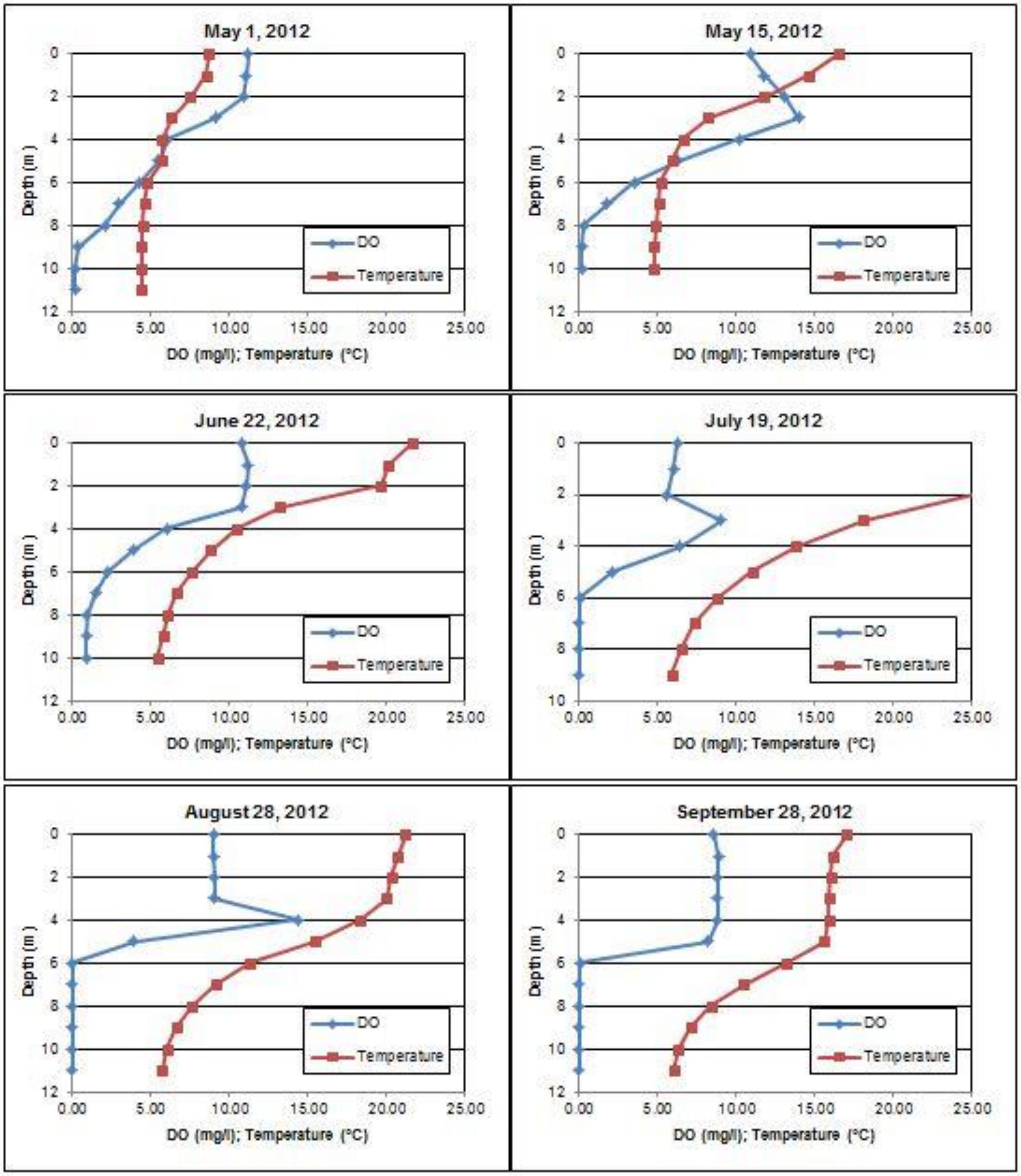


Figure 11. Dissolved oxygen (DO) and temperature profiles by month from Deer Creek Reservoir, Idaho, during 2012.

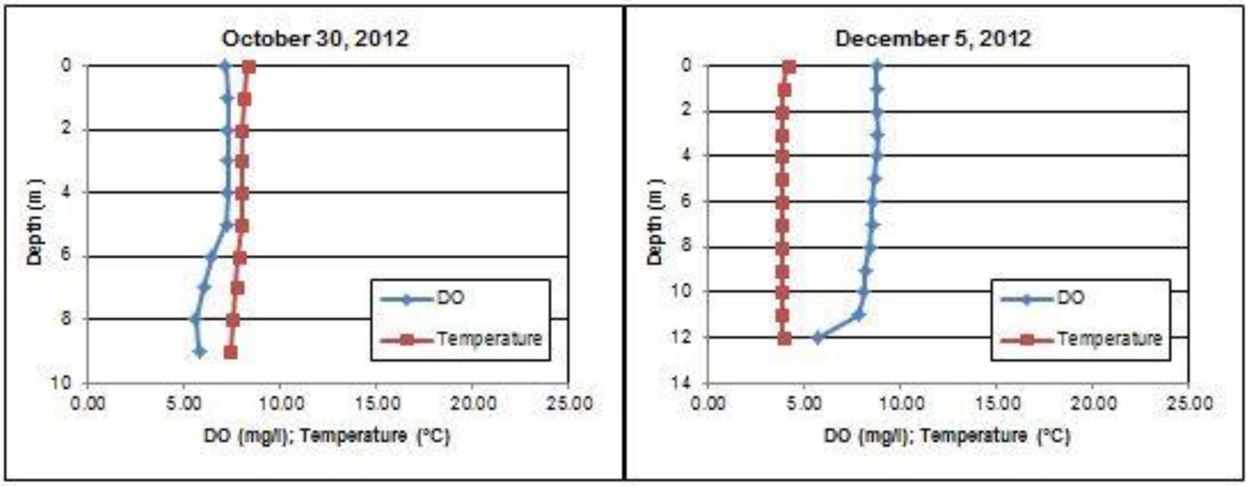


Figure 11. (continued).

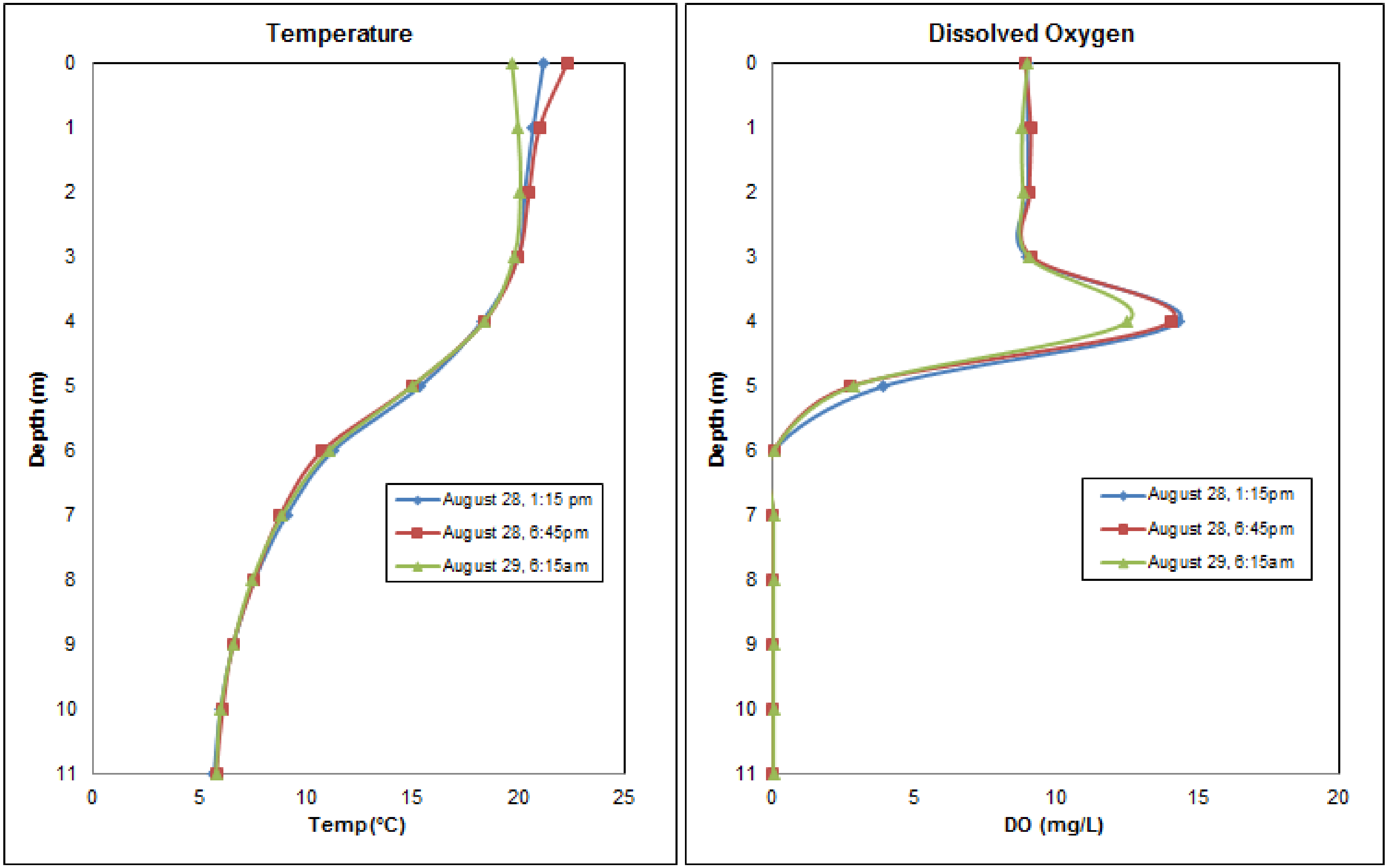


Figure 12. Diel changes in temperature and dissolved oxygen (DO) in Deer Creek Reservoir, Idaho, from August 28 - 29, 2012.

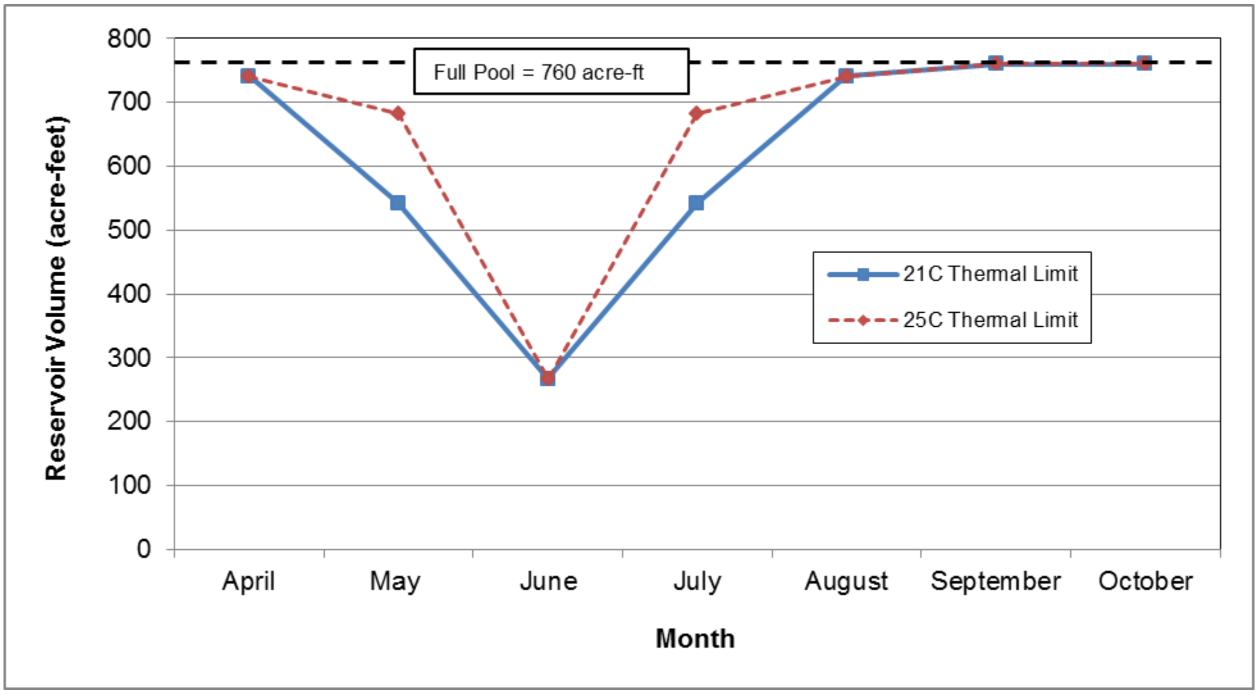


Figure 13 Estimated trout habitat available in Deer Creek Reservoir, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit, and upper thermal limits of 21°C and 25°C.

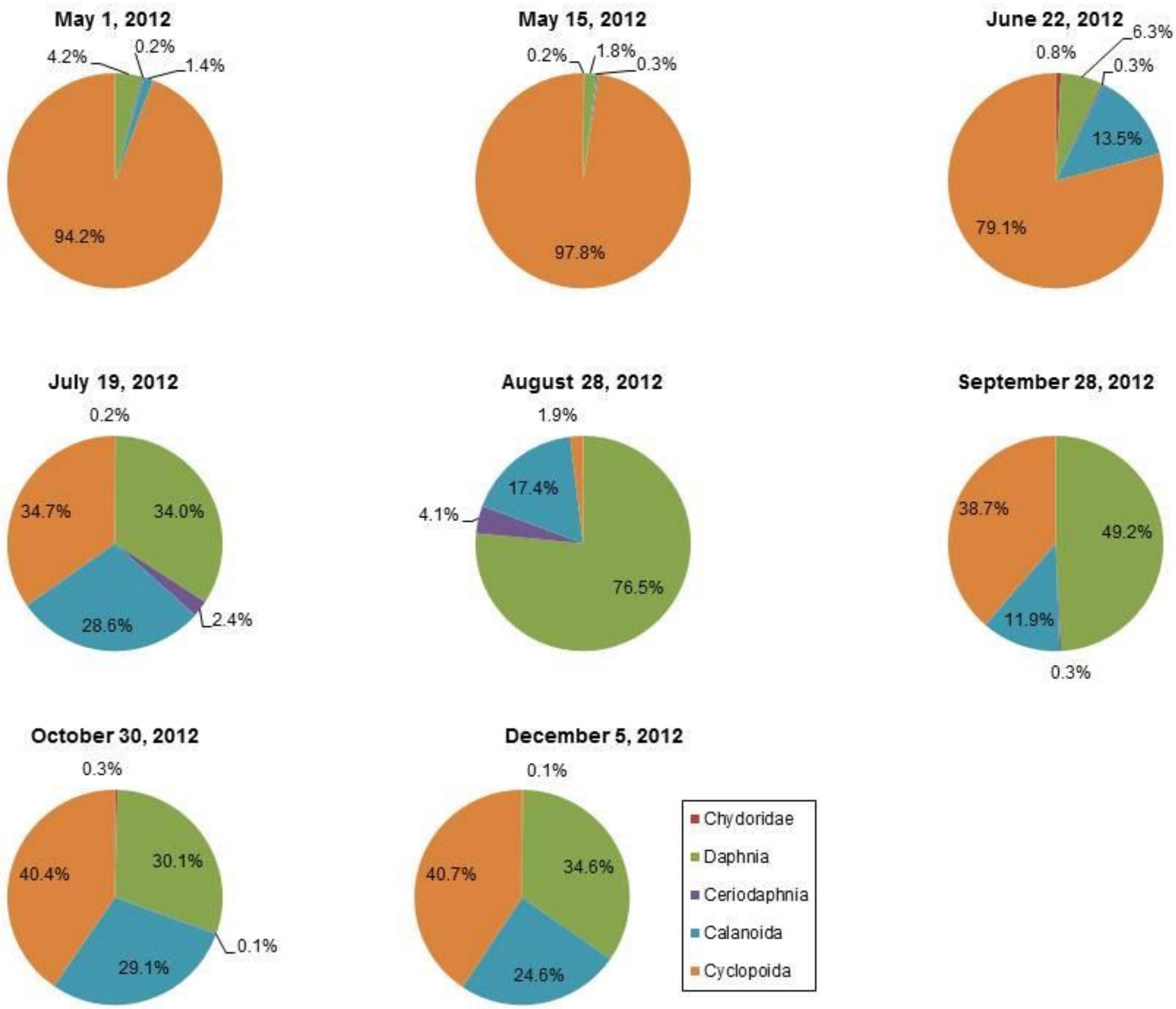
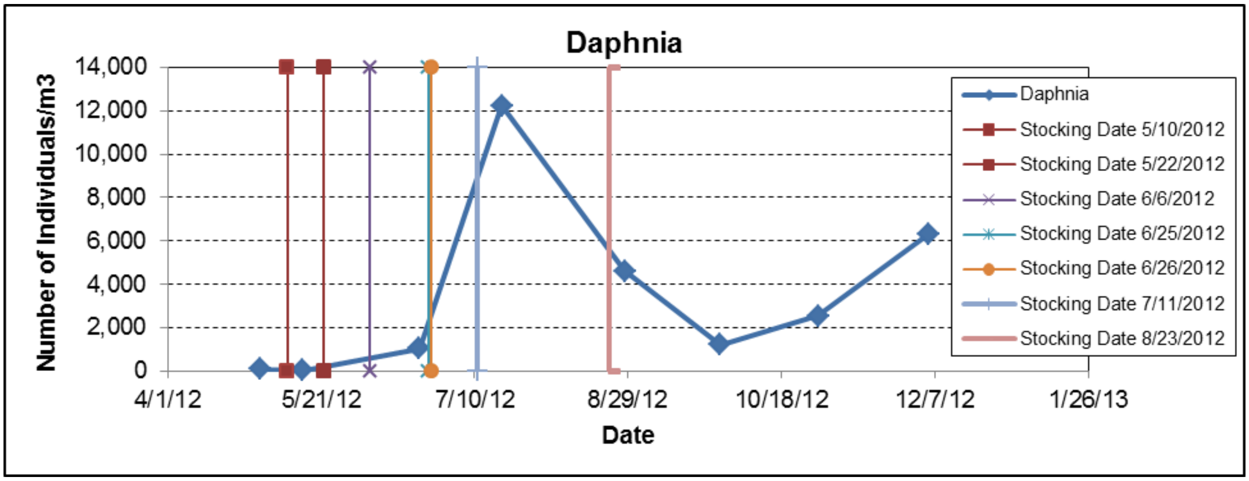
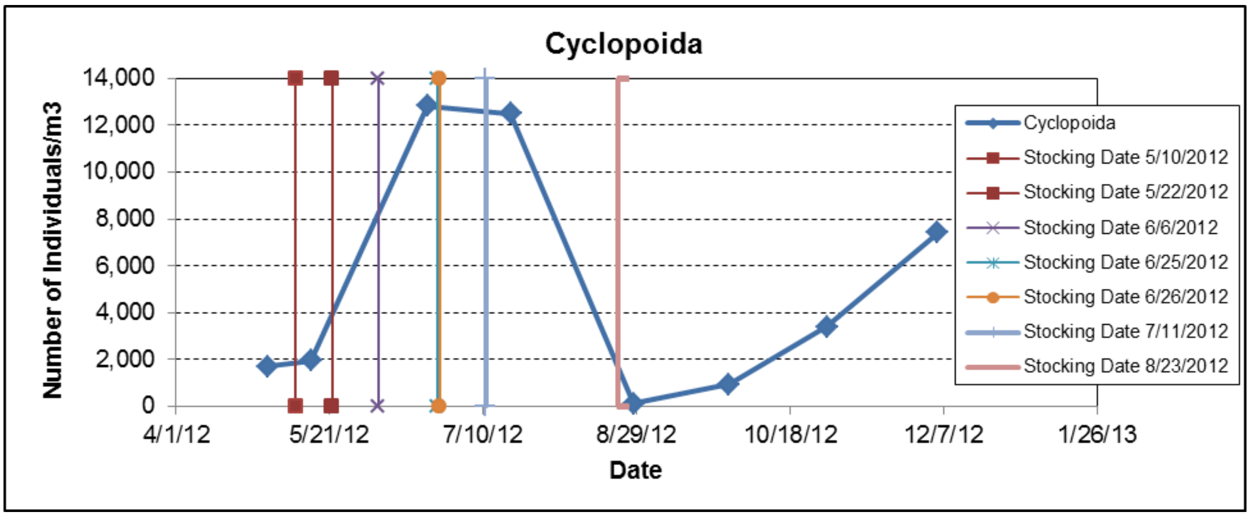


Figure 14. Zooplankton community composition based on monthly samples collected in Deer Creek Reservoir, Idaho, during 2012.





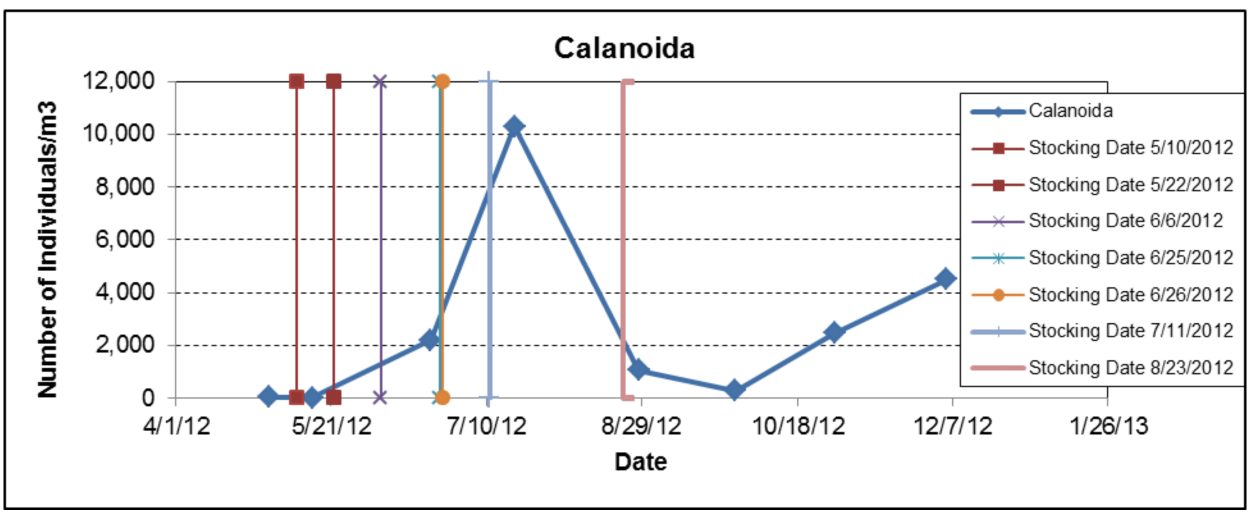
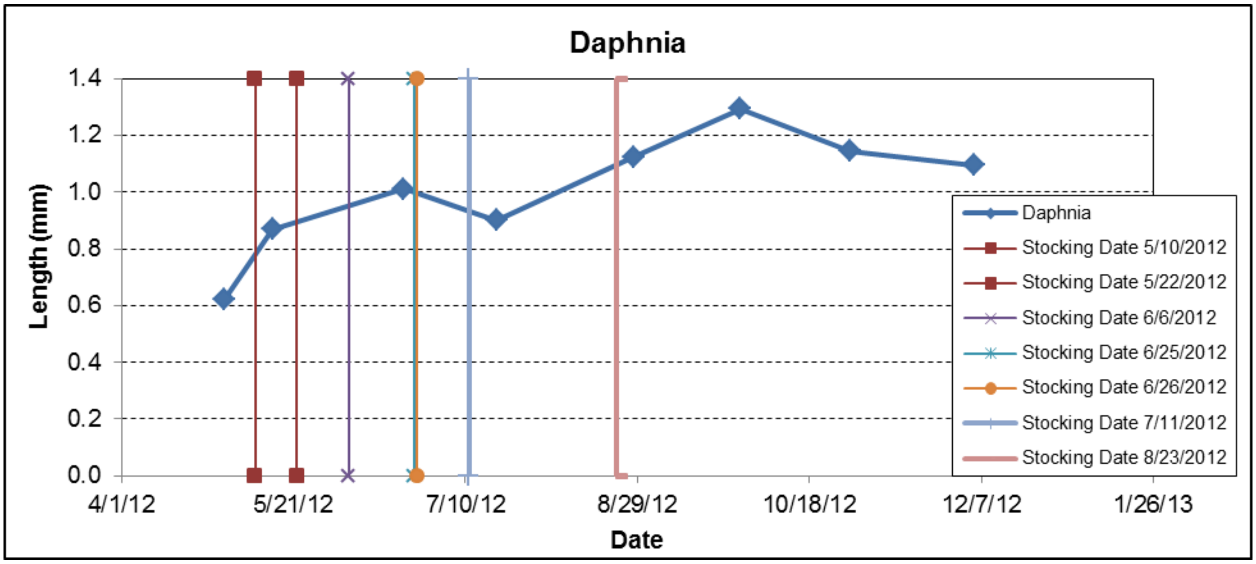


Figure 15. Population densities (number of individuals/m^3) of zooplankton collected monthly from Deer Creek Reservoir, Idaho, in 2012.



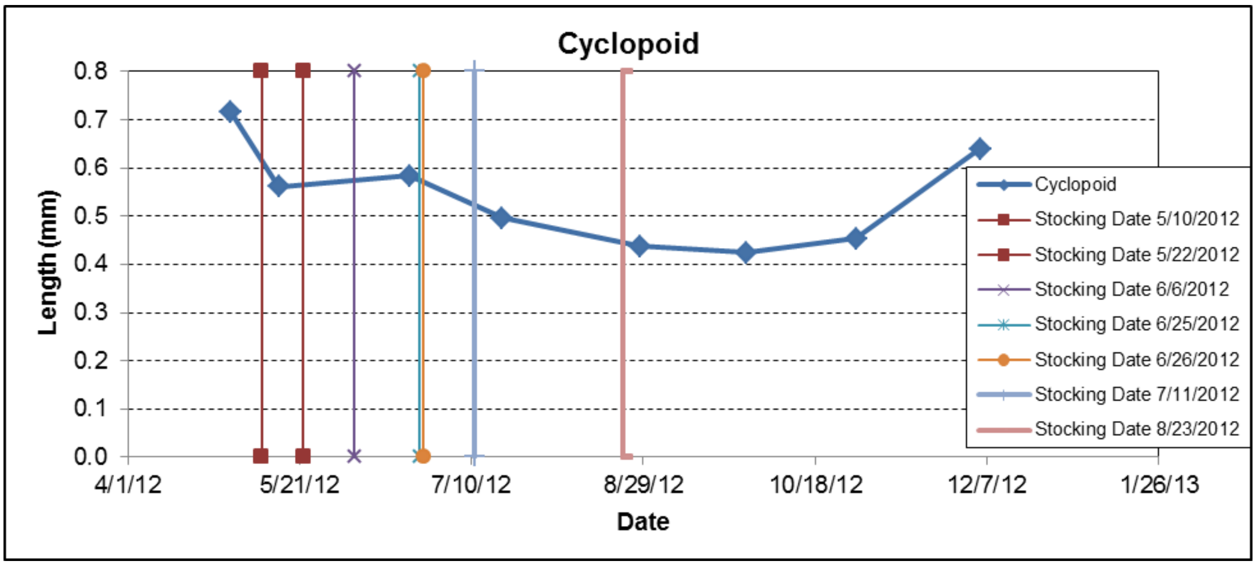


Figure 16. Average length (mm) of zooplankton collected monthly from Deer Creek Reservoir, Idaho in 2012.

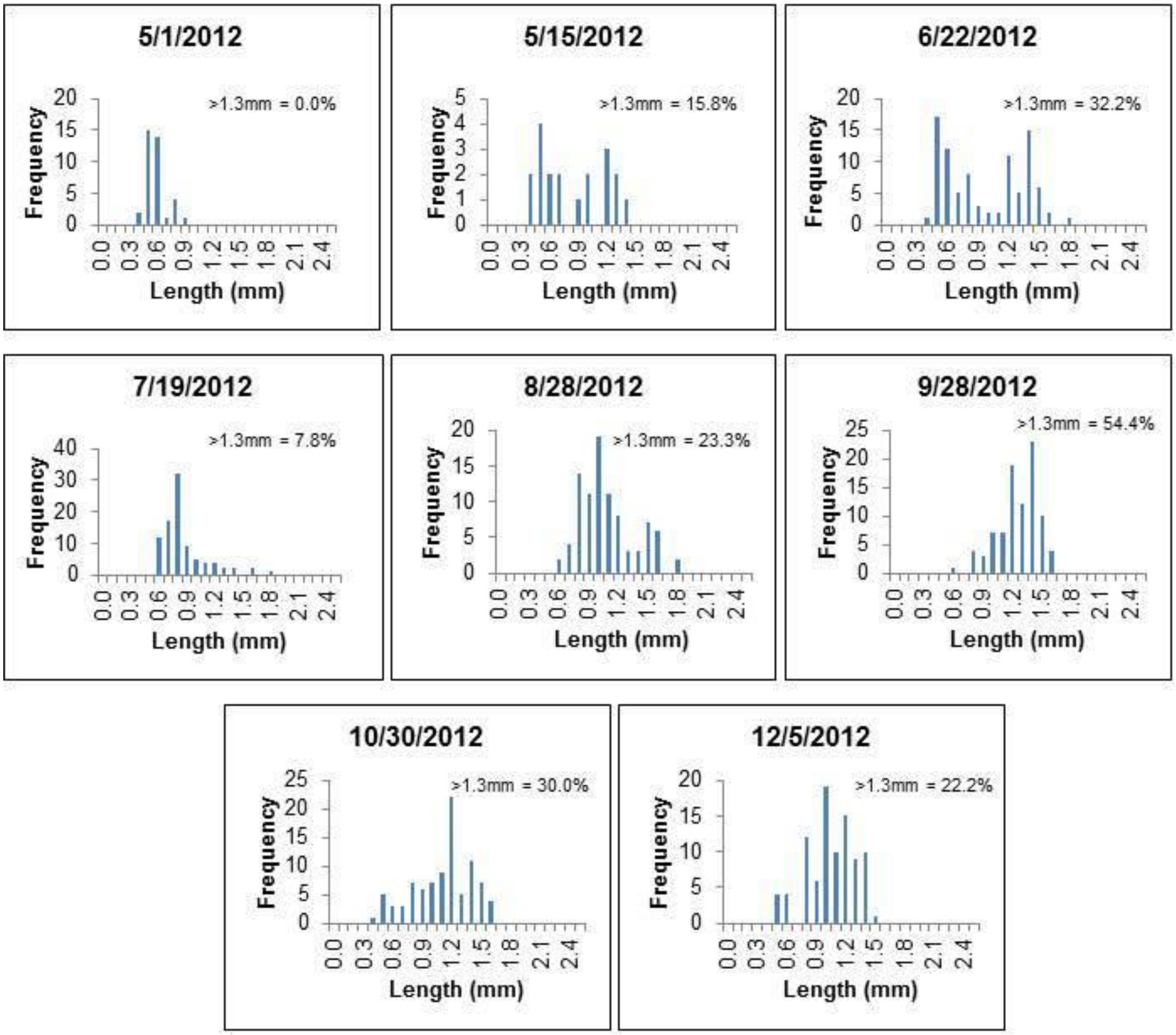


Figure 17. Length frequency distribution of Daphnia collected from monthly sampling in Deer Creek Reservoir, Idaho, during 2012.

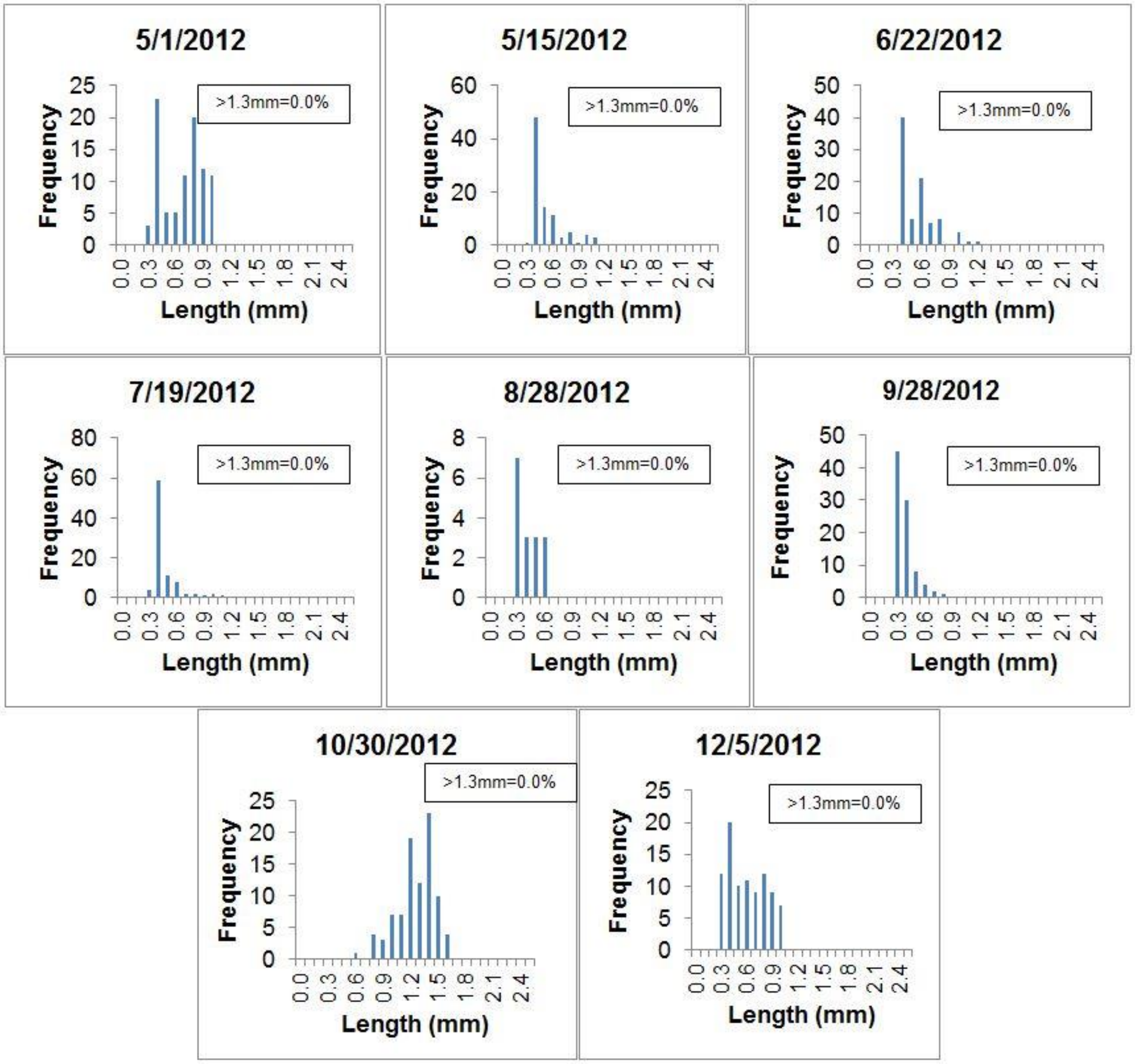


Figure 18. Length frequency distribution of Cyclopoids collected from monthly sampling in Deer Creek Reservoir, Idaho, during 2012.

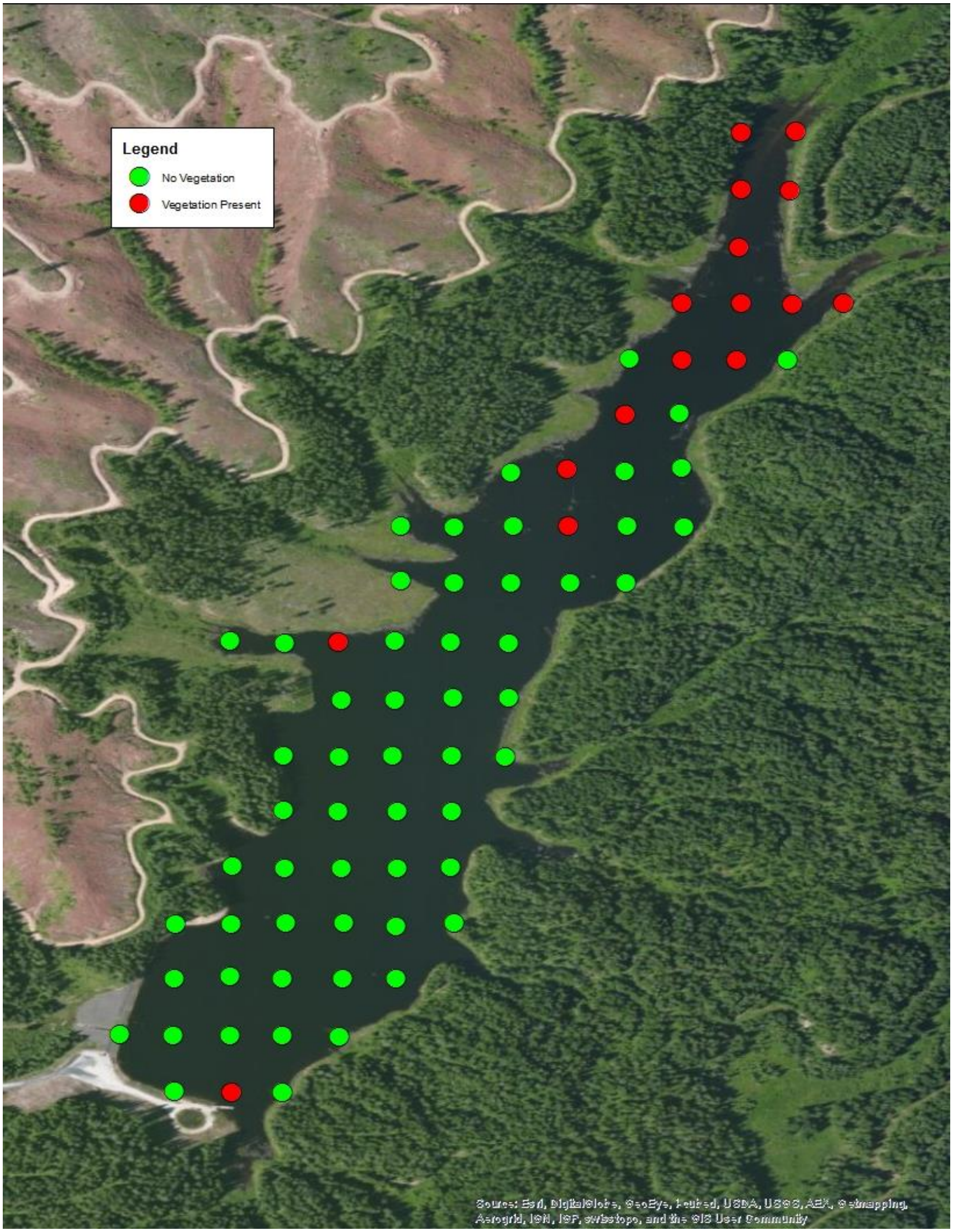


Figure 19. Locations where aquatic vegetation was collected during vegetation sampling of Deer Creek Reservoir, Idaho, during 2012.

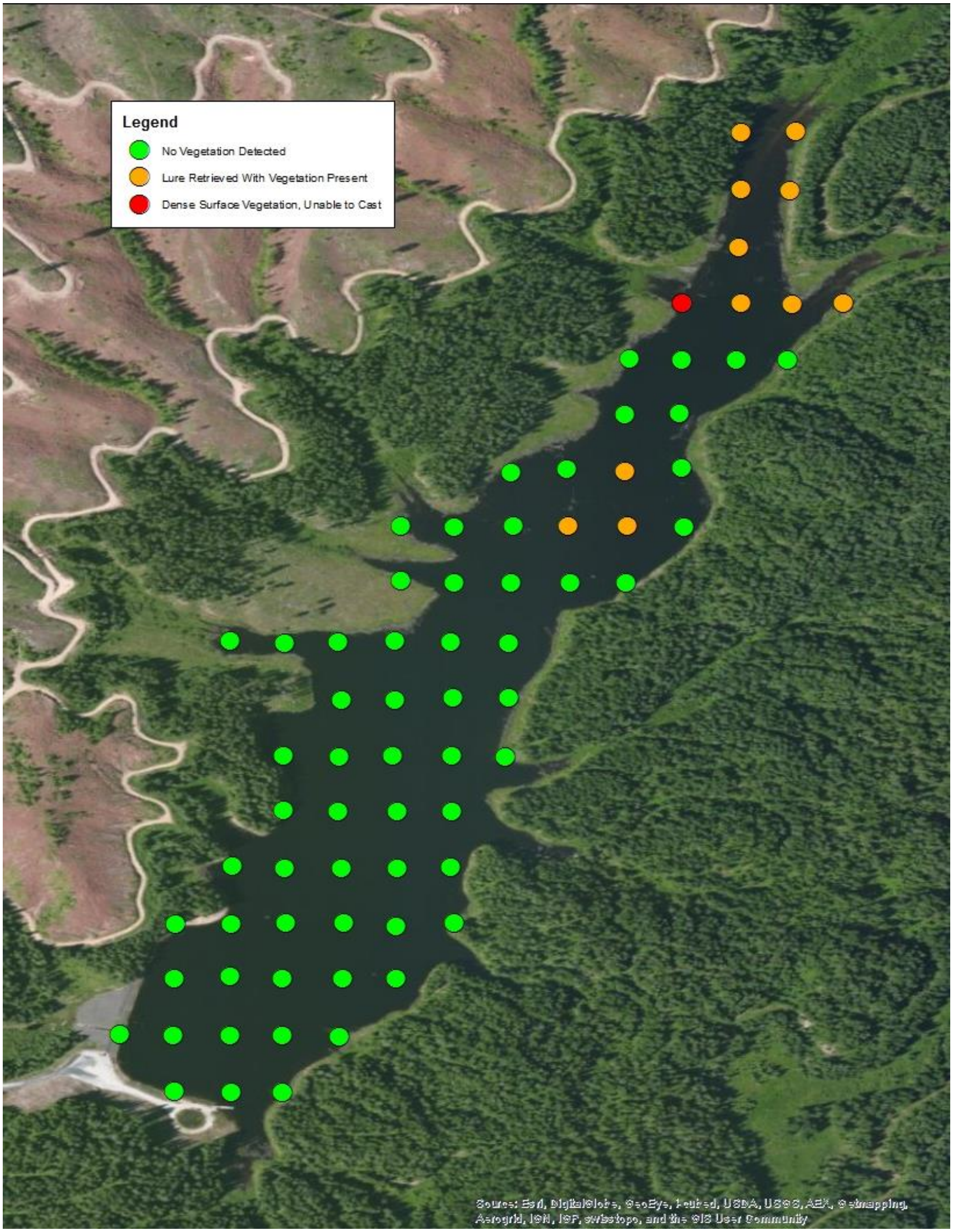


Figure 20. Fishability (using Davids' Fishability Index) at set locations in Deer Creek Reservoir, Idaho, during 2012.

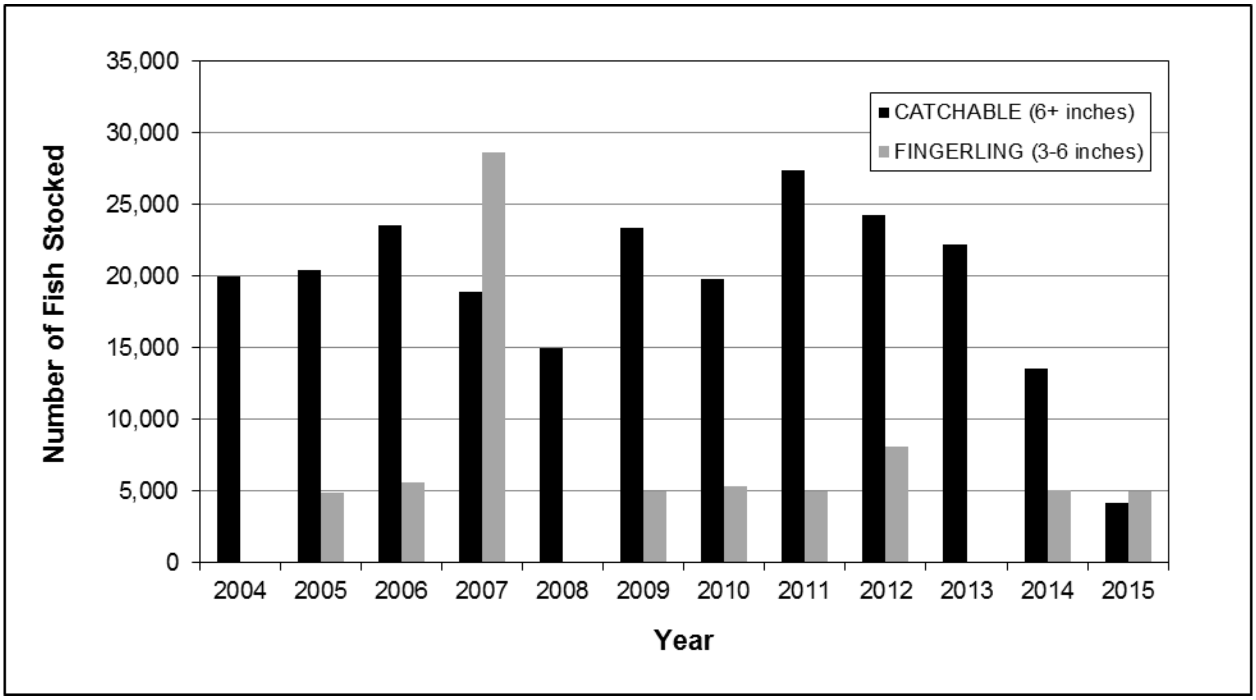


Figure 21. Number of hatchery trout (Rainbow, Westslope Cutthroat, and Brook) stocked in Deer Creek Reservoir, by size, from 2004 - 2015.

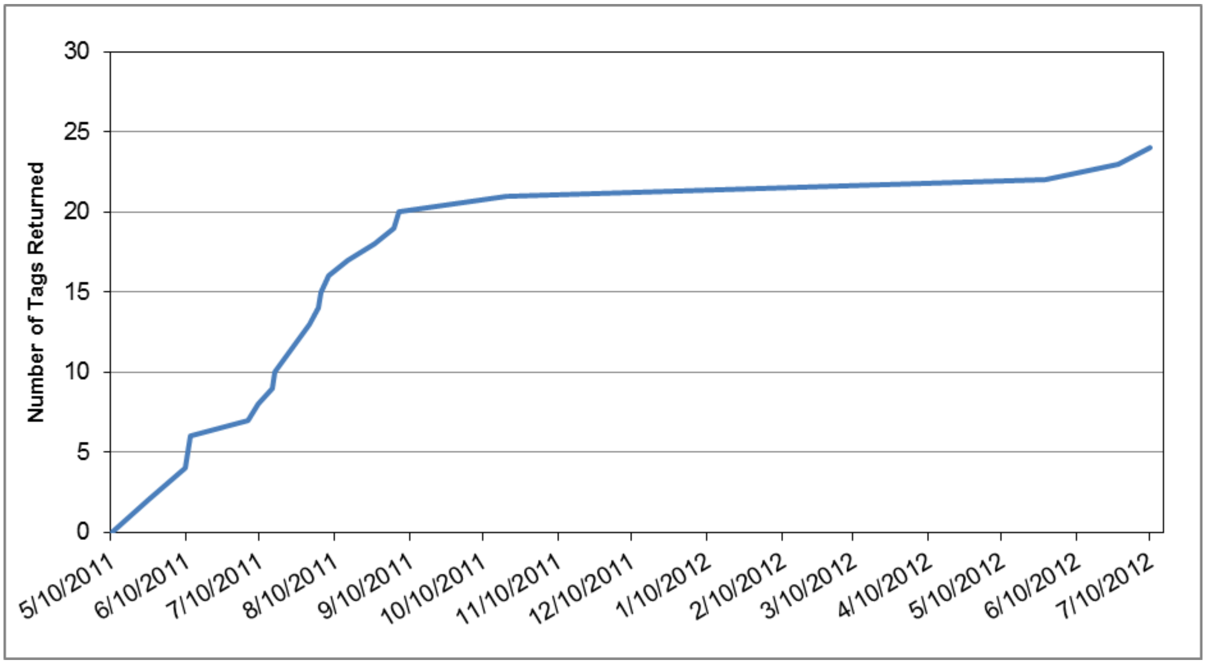


Figure 22. Cumulative number of hatchery catchable Rainbow Trout harvested from Deer Creek Reservoir, Idaho, from a May 10, 2011 stocking event, based on angler tag returns surveys (397 fish tagged).

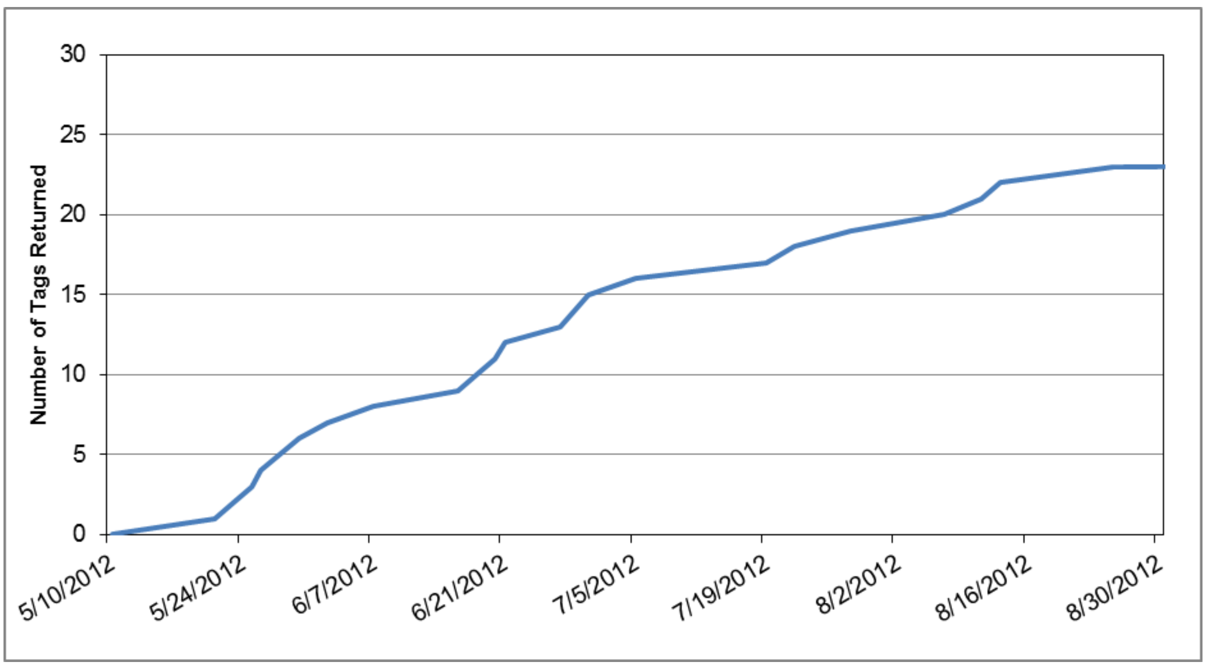


Figure 23. Cumulative number of hatchery catchable Rainbow Trout harvested from Deer Creek Reservoir, Idaho, from a May 10, 2012 stocking event, based on angler tag returns (400 fish tagged).

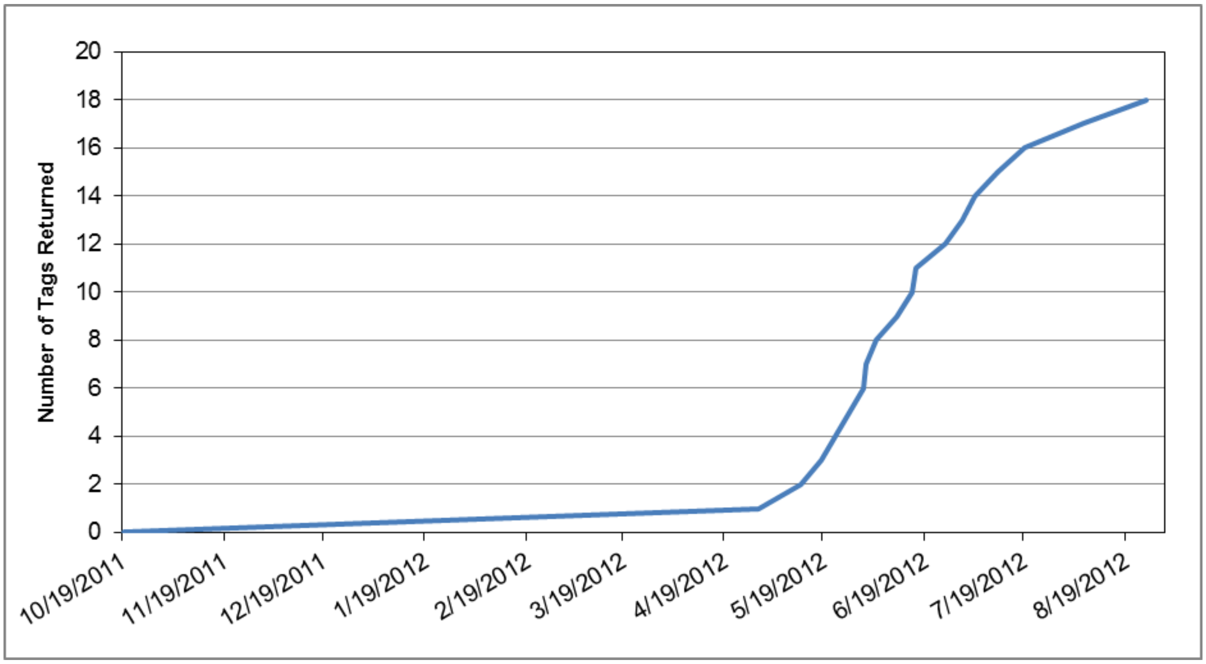


Figure 24. Cumulative number of hatchery catchable Rainbow Trout harvested from Deer Creek Reservoir, Idaho, from an October 19, 2011 stocking event, based on angler tag returns (400 fish tagged).

SPORTFISH ASSESSMENT OF ELK CREEK RESERVOIR

ABSTRACT

In 2012, a comprehensive assessment of Elk Creek Reservoir was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 434 fish including Pumpkinseed, Black Crappie, Largemouth Bass, Bluegill, Brook Trout, Smallmouth Bass, and Black Bullhead. The results of this survey indicate that while ECR has a quality Largemouth Bass fishery, the Bluegill/Pumpkinseed/Black Crappie fishery needs some improvement.

Creel surveys estimated angler effort at 9,398 hours. This estimated effort was a 38.4% decline from the high of 15,266 hours estimated in 1993. Angler effort declined in seven of the eight regional reservoirs surveyed in both 2005 and 2012. This decline may be a result of the declines in participation in outdoor recreation activities during the 1990’s and early 2000’s. However, these changes may also be the result of improvements in the accuracy of our creel survey methodology from 2005 to 2012. The angler catch rate for all fish species combined was estimated at 2.0 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 1.2 fish/hour, well above the statewide management goal of >0.5 fish caught/hour. Angler exploitation of hatchery catchable size Rainbow Trout was estimated at 35.3% for the creel survey while angler exploitation was estimated at 20.0% by the “Tag You’re It” program. This substantial difference may have been caused by factors such as a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. The large difference between these two estimates should be explored in the future to determine which method is more accurate. Changes in stocking abundance and timing of Rainbow Trout are not recommended in ECR, as angler catch rates for hatchery Rainbow Trout have met our management goal of >0.5 fish caught/hour for each creel survey since 1993. Additionally, total use (fish caught + fish harvested) exceeds the statewide reservoir average and is close to our statewide management goal of 40% for hatchery catchable Rainbow Trout.

Over the last 10 - 15 years, the upper end of ECR has been experiencing excessive algae and aquatic vegetation growth due to high nutrient levels. Control methods such as barley straw and small scale herbicide treatments have been used with varying effectiveness. A variety of other options such as grass carp, Phoslock®, and full scale herbicide treatments were explored. However, it was determined that spot treatments around popular fishing spots would be the most cost effective option.

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INTRODUCTION

Elk Creek Reservoir (ECR) is an important part of the Clearwater Region's lowland lake program, as it provides recreational and economic opportunities for the adjacent community of Elk River, Idaho. An economic survey conducted in 2011 estimated 7,882 angler trips were taken to ECR for an estimated total economic expenditure of $862,923 (IDFG *unpublished data*). It is approximately a 113 km drive from the region's largest population center of Lewiston, Idaho (pop. 32,119) and Clarkston, Washington (pop.7,331).

Elk Creek Reservoir is a mixed fishery, containing both cold-water and warm-water species. Anglers primarily target the put and take hatchery Rainbow Trout fishery, and the naturally reproducing Brook Trout fishery. Previous creel surveys have estimated that 68.6% - 94.1% of fish harvested in ECR were hatchery Rainbow Trout (Hand 2009). The reservoir also has a significant warm-water fishery including Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *M. dolomieu*, Bluegill *Lepomis macrochirus*, Pumpkinseed *L. gibbosus*, Black Crappie *Pomoxis nigromaculatus*, and Black Bullhead *Ameiurus melas*. The only non-game fish species documented is the Redside Shiner.

Data from the 2012 surveys was intended to assess the current put-and-take hatchery catchable program and Brook Trout fishery, and increase the quality of the warm-water fishery.

Current Management

Elk Creek Reservoir is managed as a put-and-take trout fishery, with 10,000 catchable Rainbow Trout stocked in 2012 to maintain the management goal of a >0.5 fish/hour catch rate (IDFG 2013). The reservoir is managed under statewide general fishing regulations with the exception of Brook Trout. Harvest for these fish in the reservoir and in Elk Creek has been limited by including them in the six trout bag limit in order to enhance the fishery in the reservoir. Additionally, boat activity on Elk Creek Reservoir is limited to electric motors only. The current management priority for Elk Creek Reservoir is to provide a desirable fishing experience to a broad diversity of angler types.

Reservoir Management Goals

1. Maintain catch rate of >0.5 fish/hour for hatchery Rainbow Trout.
2. Maintain a Brook Trout fishery.
3. Maintain a Largemouth Bass fishery, and yield fishery for Black Crappie and Bluegill.
4. Manage aquatic vegetation as needed to improve fisheries and angler effort.

STUDY SITE

Elk Creek Reservoir is located adjacent to the town of Elk River, and is approximately 89 km east of Moscow, Idaho. It is an 18.7 hectare reservoir with a maximum depth of 7 m, and lies at an elevation of 945 m. Potlatch Corporation originally constructed ECR as a log-holding pond. The original dam washed out in 1937, and subsequently the Reservoir and surrounding property (165 hectares) was conveyed (through a quitclaim deed) to the IDFG in 1938. The Department reconstructed the Dam in 1950. The reservoir was chemically treated in October 1950 prior to refill. Idaho Department of Fish and Game reconstructed the dam and spillway most recently in 1987. Idaho Department of Fish and Game owns the land surrounding ECR, while the Elk River Recreation District manages it for camping and day-use recreation such as fishing, swimming, and organized boat races.

RESULTS

Population Survey

A fishery survey of ECR was conducted on June 7, 2012 which consisted of 60 minutes of night electrofishing and one trap net night. Electrofishing was separated into six 10-minute electrofishing periods. The electrofishing and one overnight trap net set resulted in the capture of 434 fish including Pumpkinseed (n = 209), Black Crappie (n = 99), Largemouth Bass (n = 60), Bluegill (n = 45), Brook Trout (n = 13), Smallmouth Bass (n = 4), and Black Bullhead (n = 4). The electrofishing catch rate was 434 fish/hour (Figure 25). Only one Pumpkinseed was collected by the trap net. Catch rates for each of the six 10-minute electrofishing samples ranged from 17 - 231 fish/sample (Table 5). The variability from the six samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). To have a 90% confidence (2-tail test) with 25% precision estimate of CPUE in an electrofishing sample of ECR, an estimated 57 10-minute electrofishing samples would be needed for a whole fish community survey (Table 5).

Largemouth Bass:

Largemouth Bass collected ranged from 127 - 482 mm in total length (Figure 26) with an average length of 251 mm. Nineteen of the 60 fish collected (32%) were over 300 mm in length. This is the highest number and percentage of fish >300 mm captured in the six surveys conducted since 1995. Largemouth Bass CPUE (60 fish/hour) was the second highest since a high of 67 in 1995. Largemouth Bass PSD was 61 (Figure 27), the third straight increase, and the second highest since 1995. Relative weights ranged from 65 - 120, with an average of 83 (Figure 28). Relative weight was generally higher for larger fish than for smaller fish. Scale samples were analyzed from Largemouth Bass collected in 2012 (n = 54). These fish ranged in age from 1 - 8 years (Table 6). Annual growth rates ranged from 34 - 79 mm/year. A catch curve (Figure 29) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.349 for fish aged 2 - 8 (R^2 = 0.722). Thus, the annual survival rate (S) was 71%, and total annual mortality (A) was 29%.

Bluegill and Pumpkinseed:

Bluegill collected ranged from 94 - 206 mm in length (Figure 30), with an average of 124 mm. Most (75.5%) of the fish were between 90 - 140 mm. The PSD of 23 in 2012 (Figure 31) was the second highest since a high of 50 in 1995. Relative weight ranged from 57 - 140, with an average of 90 (Figure 32). Relative weight was generally higher for larger fish than for smaller fish. Scale samples (n = 40) indicated bluegill ranged in age from 2 - 4 years (Table 7). Annual growth rates ranged from 20 - 46 mm/year. Annual instantaneous mortality (Z) was -1.686 for fish aged 3 - 4 (R^2 = 1) (Figure 33). Thus, the annual survival rate (S) was 19%, and total annual mortality (A) was 81%.

Pumpkinseed collected ranged from 76 - 176 mm in length (Figure 34), with an average of 117 mm. The PSD of 4 in 2012 (Figure 35) was the second lowest since 1995. Relative weights ranged from 59 - 134, with an average of 94 (Figure 36). Relative weight was generally higher for larger fish than for smaller fish. Scale samples (n = 80) indicated Pumpkinseed ranged in age from 3 - 8 years (Table 8). Annual growth rates ranged from 11 - 39 mm/year. Annual instantaneous mortality (Z) was -2.015 for fish aged 5 - 6 (R^2 = 1) (Figure 37). Thus, the annual survival rate (S) was 13%, and total annual mortality (A) was 87%.

Black Crappie:

Black Crappie collected ranged from 77 - 261 mm in length (Figure 38), with an average of 163 mm. The PSD of 39 in 2012 (Figure 39) was the highest for the six samples conducted since 1995. Relative weights ranged from 49 - 110, with an average of 80 (Figure 40). Relative weight was generally higher for larger fish than for smaller fish. Scale samples (n = 60) indicated Black Crappie ranged in age from 2 - 5 years (Table 9). Annual growth rates ranged from 30 - 50 mm/year. Annual instantaneous mortality (Z) was -0.941 for fish aged 3 - 5 (R^2 = 0.620) (Figure 41). Thus, the annual survival rate (S) was 39%, and total annual mortality (A) was 61%.

Brook Trout:

Brook Trout collected ranged from 115 - 306 mm in length (Figure 42), with an average of 235 mm. Smallmouth Bass collected ranged in length from 207 - 465 mm. Black Bullhead collected ranged from 210 - 253 mm in length.

Creel Survey

Angler Effort:

Creel surveys were conducted on ECR from November 28th, 2011 through November 28th, 2012. A total of 201 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 9,398 hours (SE ± 1,231; Table 10). Slightly more effort occurred on weekends (52%) than weekdays (48%). Effort consisted of 61% bank, 23% boat, and 16% ice anglers. The highest angler effort occurred in the summer months from May - August, with monthly effort estimates ranging from 1,024 - 2,572 hours (Table 10).

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on ECR was based on 64 completed trip interviews and 127 angler report cards. Anglers caught an estimated 18,762 fish during 2012, resulting in a catch rate of 2.0 fish/hour. Hatchery Rainbow Trout accounted for 58.7% (n = 11,019) of the fish caught during the 2012 creel survey (Figure 43). Catch of warm-water species included 2,205 Bluegill (11.8%), 1,027 Black Crappie (5.5%), 1,012 Largemouth Bass (5.4%), 90 Smallmouth Bass (0.5%), and four Black Bullhead (<0.1%). Anglers harvested an estimated 8,364 fish during 2012 (Appendix A), 44.6% of the fish caught. The harvest rate for all fish combined was estimated to be 0.8 fish/hour. Harvest in 2012 consisted of 5,980 (71.5%) hatchery trout, 2,238 (26.8%) Brook Trout, 86 (1.0%) Largemouth Bass, 37 Bluegill (<1.0%), 18 (<1.0%) Black Crappie, and 5 (<1.0%) Smallmouth Bass (Figure 44). Harvested Largemouth Bass measured by creel clerks (n = 5) ranged in length from 271 - 505 mm, and averaged 399 mm (Figure 26).

A total of 11,019 hatchery Rainbow Trout were estimated to have been caught during the survey, with 5,980 harvested (Appendix B). This is a catch rate of 1.2 fish/hour and a harvest rate of 0.6 fish/hour. The majority of the fish (75.3%) were harvested from April - July (Appendix C). Of the Rainbow Trout harvested, 3,799 (63.5%) were stocked in 2012, while 2,181 (36.5%) were holdover Rainbow Trout stocked in 2011. Rainbow Trout were determined to be holdover if they were caught in the spring before any spring stockings occurred. The estimated exploitation rate was 25.3%. Harvested Rainbow Trout measured by creel clerks (n = 174) ranged in length from 182 - 345 mm, and averaged 284 mm. A total of 3,405 Brook Trout (17% of fish caught) were estimated to have been caught, with 2,238 harvested. Harvested Brook Trout measured by creel clerks (n = 52) ranged in length from 150 - 295 mm, and averaged 232 mm.

Angler Satisfaction:

A total of 357 public opinion surveys were conducted at ECR in conjunction with the creel survey. All constituents using the lake were interviewed. Fifty-four percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 45). Camping (23.6%), “other” (14.9%), and picnicking (7.3%) were the other responses. Of the people interviewed, 74% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at ECR. Results from those individuals were used to characterize angler’s opinions. Sixty percent of people interviewed rated their fishing experience as excellent or good (Figure 46). The most common reasons for a positive rating were catching their target species (16%) and nice to be outside (16%; Figure 47). Forty percent of people interviewed rated their fishing experience as fair or poor (Figure 47). The most common reasons for a negative rating were poor fishing (22%) and aquatic vegetation (6%; Figure 48). The most commonly targeted fish species were trout and crappie, both with 43% of the responses (Figure 49). Warm-water species comprised 48% of the targeted fish species responses for ECR. Six percent of people interviewed were not targeting a particular fish species while fishing.

Fifty two percent of people interviewed did not support a proposal to increase the creel limit on Brook Trout in ECR (Figure 52). Forty three percent supported the proposal without specifying what creel limits they would prefer, while 3.8% supported a Brook Trout limit of six, and 0.5 % preferred a Brook Trout limit of 10.

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery catchable size Rainbow Trout stocked in ECR in 2011 and 2012. Rainbow Trout were tagged on June 14, 2011 (n = 400), October 26, 2011 (n = 397), and June 20, 2012 (n = 400). Exploitation rates through 365 days at large were 54.7% for the June, 2011 tagging event, 16.2% for the October, 2011 event, and 21.9% for the June 2012 event (Table 11). Exploitation rates for 366 - 730 days at large for each stocking event were 0.8% for the June, 2011 tagging event, 0.0% for the October, 2011 event, and 0.8% for the June, 2012 event. One fish from the June, 2012 stocking was harvested beyond 730 days.

Angler total use (fish harvested plus fish released) rates through 365 days at large were 70.8% for the June, 2011 tagging event, 26.7% for the October, 2011 event, and 29.6% for the June, 2012 stocking (Table 11; Appendix D). Total use rates for 366 - 730 days at large were 0.8% for the June, 2011 tagging event, 0.0% for the October, 2011 event, and 0.8% for the June, 2012 event. One fish from the June, 2012 stocking was caught beyond 730 days.

Twenty Largemouth Bass were collected by electrofishing and tagged on June 7, 2012 to assess angler exploitation. Through June, 2015 four tagged fish had been reported caught, with two of these being harvested. The estimated exploitation rate was 22.0%, and the total use rate was 44.0%.

Limnology

Limnology samples were collected monthly from May - December, 2012. Dissolved oxygen profiles were fairly consistent throughout the year. Concentrations stayed around 10 mg/L throughout the water column, except for summer months when DO dropped in the hypolimnion (Figure 53). Temperature profiles were also fairly consistent from surface to bottom, except for summer months when temperatures in the epilimnion increased (Figure 53). To look at potential diel changes in temperature and DO profiles, measurements were taken at 19:43 on July 25, 2012, and 05:30 on July 26, 2012 (Figure 54). There were only slight differences in temperature at the surface, and in DO from 1 - 2 m in depth.

Temperatures >21°C and DO levels <5.0 mg/L can reduce the volume of water available for trout to survive in a reservoir. During 2012, water temperatures >21°C only occurred during the July and August, when it was >21°C down to a depth of 1 m and 2 m. Dissolved oxygen at this time was only <5.0 mg/L below 4 m in both months. Thus, there was water in ECR year-round that was conducive for Rainbow Trout survival.

Zooplankton

Zooplankton samples were collected monthly from April - December, 2012. The population was composed of six taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Bosmina, Ceriodaphnia, and Calanoida. The composition changed from primarily Chydoridae (54.8%) in April samples to primarily Cyclopoida (>41.4%) in most other months (Figure 55). Daphnia was the most common taxa in August (42.2%).

Zooplankton densities (# of individuals/m^3) were also highly variable. Most species were found at very low densities, except for a large spike in July - August. Daphnia densities ranged from <10 - 23,904/m^3 with an average of 3,356/m^3 (Figure 56). Other than the August sample, densities were never over 1,740/m^3. Cyclopoida densities ranged from <10 - 23,328/m^3 with an average of 6,366/m^3. Ceriodaphnia densities ranged from 0 - 16,010/m^3 with an average of 2,125/m^3.

Average length of Daphnia ranged from 0.33 - 0.81 mm, with an overall increase seen through the year (Figure 57). Average length of Cyclopoida ranged from 0.46 - 0.83 mm, with a decline seen in the early summer after stockings of Rainbow Trout (Figure 57). Average lengths then increased through the rest of the year. Length frequency distributions from each sample show that Daphnia >1.3 mm in length ranged from 0.0 - 2.1% of the individuals collected (Figure 58). Length frequency distributions from each sample show that no Cyclopoids >1.3 mm in length were found in any samples collected in 2012 (Figure 59).

Additionally, ZQI sampling was conducted on August 21, 2012. Biomass was 0.36 (g/m^3) for the 150 µm net, 0.12 (g/m^3) for the 500 µm net, and 0.10 (g/m^3) for the 750 µm net (Appendix E). The ZPR was calculated to be 0.80 and the ZQI was 0.18.

Aquatic Vegetation

Vegetation surveys were conducted from July 25 - 27, 2012. A total of 105 sites were sampled. Vegetation was collected by rake tosses at 99 (94.3%) sample sites (Figure 60). Seven types of vegetation were identified: filamentous algae, macrophytic algae, pondweed, Coontail *Ceratophyllum demersum*, Elodea *Elodea canadensis*, Water Star-wort, and Northern Watermilfoil *Myriophyllum sibiricum*. Elodea was the most commonly encountered vegetation, occurring at 90 (86%) sites where vegetation was collected. Macrophytic algae was the second most common, occurring at 69 (66%) sites, followed by filamentous algae (59%), pondweed (57%), Coontail (6%), Water Star-wort (6%), and Northern Watermilfoil (4%). Sample sites along the shoreline accounted for 39.0% (N = 41) of all sample sites. Vegetation was collected at 100.0% of these sites. Additionally, 41.4% (N = 41) of all sample sites with vegetation were along the shoreline (Figure 57).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 105 sites. Vegetation was encountered at 56 (53.3%) of the sites (Figure 58). Vegetation was present on hooks at 49 (46.7%) sites, while dense matted surface vegetation prevented casting at seven (6.7%) sites. Thirty-nine percent of the surveyed sites were along the shoreline; and based on the DFI, angling at 65.9% of these sites would be negatively influence by vegetation.

DISCUSSION

Population Survey

The fish community in ECR is a mixed fishery, with both warm-water and cold-water fish. Naturally reproducing Brook Trout and stocked hatchery Rainbow Trout provide excellent cold-water fisheries, while Largemouth Bass, Black Crappie, and Pumpkinseed provide warm-water fishing opportunities. The warm-water fish community has experienced an interesting change over surveys conducted from 1995 - 2012 (Figure 22). Largemouth Bass have become more numerous, while Smallmouth Bass have gradually become scarce. Additionally, the CPUE of other warm-water species (Black Crappie, Bluegill, and Pumpkinseed) have also increased. These changes are possibly attributable to changes in habitat within the reservoir, as ECR continues to experience sedimentation issues.

The results of the fisheries survey conducted in 2012 indicated that for an electrofishing survey of ECR, 57 10-minute samples would be needed for a whole fish community estimate with 90% confidence (2-tail test) and 25% precision (Table 5; IDFG 2012). This high number of samples is a result of the wide variability in the number of fish collected in each sample, and in the low number of several species collected. As this number of samples is not realistic, we recommend conducting future samples with enough 10-minute samples to sample the entire shoreline. Additional surveys in the future may help improve our ability to detect smaller changes in CPUE.

Largemouth Bass:

Elk Creek Reservoir's Largemouth Bass population has changed substantially over the six samples conducted since 1995. The 60 fish collected in 2012 was the second highest behind the 168 collected in 1995. The length frequency distribution shows a wide range in sizes with both small and large fish present (Figure 23). An increase in the number of larger size fish has increased PSD over the last four samples to 61 in 2012. This PSD value is within the balanced population range of 40 - 70 (Anderson 1980). As mentioned above, these changes are possibly attributable to changes in habitat within the reservoir. The continued sedimentation occurring at the upper end of the reservoir is likely causing a shift in habitat from that preferred by Smallmouth Bass to that preferred by Largemouth Bass.

Largemouth Bass collected in 2012 averaged 251 mm in length at capture, the highest of any regional reservoir (Appendix J). However, with growth rates ranging from 31 - 79 mm per year, slow growth (compared to other regional reservoirs) appears to be an issue in ECR. These rates were above the regional average for fish aged 1 - 6, but below the regional average for fish aged 7 - 8. Additionally, average length at age was above the regional average for all age fish except age 3 (Appendix J). This above-average growth has resulted in Largemouth Bass at ECR entering the fishery (stock size of 200 mm) at age 3, and reaching quality size (300 mm) at age 4 (Appendix K). The regional average to stock size is age 3 and to quality size is age 5 (Appendix K). This age to quality size is also below the average age of 4.4 years for 40 Idaho populations described by Beamesderfer and North (1995), and equal to a modeled estimate of four years based on thermal degree days described by McCauley and Kilgour (1990).

Largemouth Bass growth appears to be good compared to other regional reservoirs, especially for a reservoir at this elevation and temperature regime. However, inadequate food resources may be an issue. Largemouth Bass relative weights in ECR averaged 83 in 2012, but increased as fish get larger (Figure 25). There was a noticeable difference in relative weights based on size, as Largemouth Bass <200 mm averaged 78 and those >300 mm averaged 96. There were very few fish in the stock to quality size range (200 - 300 mm), possibly indicating a food resource bottleneck or a year class failure several years ago. This could suggest potential growth issues in the future as these smaller fish get bigger. However, a lack of sufficient food resources does not appear to be an issue, as numerous Bluegill and Pumkinseed 30 - 200 mm in length have been collected during the last few surveys. It is likely that Largemouth Bass may be crowded below 200 mm, reducing growth rates and reducing Bluegill and Pumpkinseed PSD through excessive predation. This is reflected by the low W_r values of small bass with high annual mortality and low angler harvest of Bluegill.

Bluegill and Pumpkinseed:

The Pumpkinseed population in ECR has seen little change in the range of lengths (mostly 50 - 180 mm) over the six surveys conducted since 1995. Proportional Size Distribution continues to be low, with only one sample (2005) within the range of 20 - 60 considered indicative of a balanced population. These values are similar to those seen in Moose Creek Reservoir (MCR) (average PSD of 9) over seven surveys conducted since 2001. The average length of Pumpkinseed (117 mm) in ECR was slightly below the average (123 mm) in MCR. Annual growth of Pumpkinseed in ECR ranged from 7 - 29 mm, similar to the 5 - 40 mm for MCR. On average, they reach stock size (80 mm) at age three in both ECR and MCR. The slow growth of Pumpkinseed in ECR is most likely due to the reservoir's shorter growing season and higher elevation.

More Bluegill were collected in ECR in 2012 than in any previous survey. However, Bluegill continue to have a much lower abundance than Pumpkinseed (Figure 22). There was a shift in the length frequency distribution towards larger Bluegill in 2012, evidenced by the increase in PSD to 23 after three consecutive surveys with PSD values of 0. This put the PSD value for 2012 within the range of 20 - 60 which is considered to be a balanced Bluegill population for only the second survey conducted since 1995 (Figure 28). However both Bluegill and Pumpkinseed PSDs were the lowest of any regional reservoir (Appendix I). Even with this shift toward larger fish, the average length of Bluegill (124 mm) in ECR was the second lowest of the six lakes surveyed that contain Bluegill (Appendix I). These low PSD values are likely due to stunting and/or limited food resources. This is supported by the small average size of Bluegill (124 mm) and the lack of larger zooplankton. Annual growth of Bluegill in ECR ranged from 36 - 56 mm. Annual growth was below the regional average for age 1 fish and above the regional average for fish age 2 - 4 (Appendix I). On average, Bluegill reach stock size (80 mm) at age two, the same as the regional average.

The estimated annual mortality rates of 81% for Bluegill age 3 - 4 (Appendix I) and 87% for Pumkinseed aged 5 - 6 in ECR was the highest calculated for any regional reservoir. Additionally, it was above the average annual mortality of 74% calculated for 46 mid-western Bluegill populations (Coble 1988). Coble (1988) also calculated the average annual exploitation rate of those 46 populations to be 27%. Angler exploitation of Bluegill and Pumpkinseed in ECR could not be calculated for ECR. With PSD values for both Bluegill and Pumpkinseed below the range of a balanced population, harvest of larger individuals may be an issue. This is to be expected, as anglers usually prefer to keep the larger fish they catch (Aday and Graeb 2012). Crawford and Allen (2006) saw exploitation rates of Bluegill increase up to three times as fish size increased. This could ultimately influence the size structure of the population, if larger fish are harvested at high rates. If harvest was an issue, implementation of restrictive fishing regulations could be considered. However, care must be taken when implementing restrictive regulations as they can result in little or no benefit in terms of fish size structure or angler catch rates if implemented improperly (Crawford and Allen 2006). In ECR, harvest appears to be very low, as few of either species have been documented during creel surveys conducted since 1993 (Appendix A). However, annual mortality is high, suggesting that predation is likely the primary source of mortality. Thus, we do not recommend any changes to the regulations for Bluegill or Pumpkinseed, as restrictive regulations would have little or no effect due to the limited harvest. Alternatively, encouraging harvest of smaller bass would likely be a more beneficial strategy to improve Bluegill PSD. A minimum length limit for Bluegill could then be considered if reducing bass predation shows the potential to improve Bluegill growth.

Black Crappie:

The Black Crappie population in ECR had a much wider range of lengths than was seen in previous samples, with fish collected from 70 - 268 mm. The presence of larger fish resulted in a PSD value of 39, the highest of any sample collected since 1995. Age and growth analysis of Black Crappie from ECR showed that the majority of the population in 2012 was age 3, confirming the highly variable recruitment commonly seen in smaller reservoirs (Beam 1983; McDonough and Buchanan 1991; Allen 1997). The successful recruitment years do not coincide across reservoirs in Idaho’s Clearwater Region, indicating that environmental factors are not the primary driving force behind successful year classes.

Warm-water Fishes Predator:Prey Dynamics:

A comparison of the average PSD of predator species (Largemouth Bass and Smallmouth Bass) to prey species (Bluegill, Pumpkinssed, and Black Crappie) can be used to determine predator:prey dynamics in a reservoir and provide insight into potential population issues (Schramm and Willis 2012). Prior to 2012, four of the five fishery surveys showed the predator:prey relationship fell in Cell 7 which indicates a warm-water fish population dominated by smaller sized predators and smaller sized prey (Figure 59). In 2012, the PSD distribution landed in Cell 9, which is characterized by a larger sized predators and smaller sized prey. This is a desirable predator-prey relationship for producing a high-quality Largemouth Bass fishery. However, this can indicate a prey population that is overcrowded, slow growing, and/or has a high mortality rate. A high predator PSD can result from an abundance of large bass or a lack of small bass. In the case of ECR, both of these are occurring, as few Largemouth Bass between 200 - 300 mm were collected (Figure 23). However, there were numerous Largemouth Bass collected <200 mm in length, so we would expect to see the PSD value decline over the next few years as these fish grow. This indicates that while ECR has a quality Largemouth Bass fishery, the Bluegill/Pumpkinseed/Black Crappie fishery needs some improvement.

Brook Trout:

Brook Trout are an important part of the fishery in ECR. Only 13 Brook Trout were collected during the electrofishing survey, with all <307 mm in length. This does not suggest a cause for concern, as the survey is primarily geared towards warm-water species along the shoreline. However, the 52 harvested Brook Trout measured by creel clerks ranged in length from 150 - 295 mm, and averaged 232 mm. This indicates that while there appears to be a good population of Brook Trout in ECR, the fish tend to be small.

Creel Survey

Angler Effort:

The year-long creel survey resulted in an estimated 9,398 hours of angler effort in 2012. This was the fifth most effort of the nine regional reservoirs surveyed (Figure 1). This estimated effort was the lowest of the four creel surveys conducted on the reservoir since 1993, and was a 38.4% drop from the high of 15,266 hours estimated in 1993 (Figure 1). Similarly, angler effort declined in seven of the eight regional reservoirs (87.5%; Figure 1) surveyed in both 2005 and 2012.

There may be several reasons for the apparent decline in fishing effort seen in ECR. Declines in participation in outdoor recreation activities during the 1990's and early 2000's, including fishing and hunting, have been well documented as people have more and more choices competing for their free time (USFWS 2006; DFO 2007; Cordell et al. 2008; Sutton et al. 2009). Studies have shown large percentages of anglers fish less often than they used to, primarily due to "work/family commitments" (46 - 75%) and "other leisure activities" (41 - 46%) (Felder and Ditton 2001; Sutton 2007; Sutton et al. 2009). Economic surveys conducted by IDFG in 2003 and 2011 (Table 2) show a similar trend, with most regional reservoirs (87.5%) experiencing declines in effort (total trips). However, sales of fishing licenses in Idaho have shown an overall increasing trend from 1993 - 2012, contradicting these national trends (Appendix H). While this does not directly correlate to effort in a given lake, it does provide some evidence that participation in fishing in Idaho is not necessarily declining.

A second potential cause for the decline in effort is the accuracy of our creel surveys. The 2012 creel survey is likely more accurate than previous surveys, as it was conducted using more angler counts and interviews. More rigorous methods were incorporated in the 2012 study design compared to past surveys. Previous creel surveys were conducted with minimal staff, and therefore effort/catch/harvest may be more biased due to small sample sizes of angler counts and interviews. This bias could have resulted in inflated effort estimates from previous surveys. Future surveys should employ similar strategies as we did during this survey to make results more comparable to 2012 surveys and reduce uncertainty and bias of the results.

Catch and Harvest:

Harvest composition has stayed fairly consistent, with hatchery Rainbow Trout making up 71.5 - 94.1% of the harvest from 1993 - 2012 (Figure 44). Brook Trout accounted for 26.8% of the harvest in 2012, with warm-water species accounting for 1.7% of the harvest in 2012. Based on the 2012 creel survey, most anglers either targeted Black Crappie (46.2%) or hatchery Rainbow Trout and Brook Trout (45.7%; Figure 48). Few anglers targeted any other species. Interestingly, trout comprised 98.3% of the harvest, whereas Black Crappie represented just 0.2% even though they were the preferred target for many anglers. It is also interesting that Black Crappie have never been abundant in ECR, but anglers still went there to catch them. We saw a similar response in MCR as well. This indicates the high desire by anglers to catch Black Crappie, likely due to their desired flesh quality.

With many anglers targeting trout, catch and harvest rates tend to be high. Harvest rates for hatchery Rainbow Trout ranged from 0.60 - 1.0 fish/hour for creel surveys conducted from 1993 - 2012. The hatchery trout return to creel had declined from 52.6% in 1993 to 30.3% in 2005 before rising to 38.0% in 2012. Brook Trout were the second most harvested species of fish (26.8%) in ECR in 2012. Most of the angling effort for Brook Trout occurs during from December - March in the winter ice fishery. Due to several requests from anglers for increased limits of Brook Trout, we asked anglers their opinion on this issue during the 2012 creel survey (the daily limit at the time of this survey was 6 fish - trout and Brook Trout combined). A slight majority of anglers interviewed (51.9%) said they would not support an increase in the Brook Trout limit (Figure 49). Of those who said they would support an increase in the Brook Trout limit, 42.9% did not specify what creel limits they would prefer, 3.8% said they would prefer a separate Brook Trout daily limit of six fish, and 0.5 % would prefer a separate Brook Trout daily limit of 10 fish.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (60.3%) rated their fishing trip as “Good” or “Excellent” (Figure 46). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 53.9% of the responses (Figure 47). While the quality of fishing played the major role in one’s fishing experience, the most common other response was “nice to be outside” (15.9%). This indicates that an enjoyable fishing trip is not predicated solely upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as simplified fishing rules, year-round fishing opportunities, easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself. Surprisingly, only 6.7% of respondents listed aquatic vegetation as a reason for a poor rating. Numerous complaints in previous years suggested that aquatic vegetation was affecting many anglers’ fishing experience. The low number of responses during the 2012 survey indicates that although there is aquatic vegetation throughout the reservoir during the summer months, it does not have a large influence on an angler’s satisfaction.

Angler Exploitation

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the “Tag You’re It” program (Meyer et al. 2009) were also utilized to help evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate of stocked hatchery Rainbow Trout was 70.8% for the spring 2011 tagging events (Table 11) and 29.6% for the spring 2012 events. There was use from both the 2011 and 2012 spring stockings past the one year mark (Appendix D), indicating that there is some carryover from these stockings. The estimated total use rates for 366 - 730 days at large were 0.8% for both the 2011 and 2012 stockings. There was no use beyond 730 days at large.

The total use rate of stocked hatchery Rainbow Trout through June, 2014 were therefore estimated to be 71.6% for the spring 2011 tagging events (Table 11) and 30.4% for the spring 2012 events. These estimates were above the statewide average of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). The estimate for 2011 was well above the IDFG management goal of a 40% total use rate for stocked hatchery Rainbow Trout (Appendix D). Tag returns from the spring 2011 and 2012 stockings show similar patterns, with most returns occurring by the end of September each year (Figures 60 and 61). This is to be expected since most of the effort occurs from May - August each year (Table 10). Based on this information, no changes are suggested for future spring stockings.

The success of our fall stockings is also of interest to the region. Tag returns resulted in a total use rate for stocked hatchery Rainbow Trout of 26.7% from the October, 2011 tagging event. This is slightly below the statewide average of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). It is also below the IDFG management goal of a 40% total use rate for stocked hatchery Rainbow Trout (Appendix D). Tagged fish were caught all the way through August, 2012 (Figure 62), indicating that these fish were able to overwinter and were available to the fishery for up to a year post stocking. For this reason, fall stockings should be continued as these fish are an important part of the winter ice fishery and provide a larger sized fish to be caught the following spring.

Comparing angler exploitation of hatchery Rainbow Trout from the “Tag You’re It” program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 20.0% while the creel survey estimated it to be 25.3%. Differences in angler harvest between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the use of bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Angler exploitation based on the “Tag You’re It” program (Meyer et al. 2009) was lower for the 2012 stockings than the 2011 stockings (Appendix D). This trend was seen in five of the six regional reservoirs where data existed from both years (Appendix D). Some of this may be attributable to possible changes in angler effort, the continued presence of nuisance aquatic vegetation around much of the reservoir’s shoreline (Figure 60), or the possibility that anglers became accustomed/desensitized to the tagging program and returned the tags at a lower rate. The better water conditions seen in 2012 versus 2011 were also a likely factor.

In summary, changes in stocking abundance and timing of Rainbow Trout are not recommended in ECR for the following reasons. Angler catch rates for hatchery Rainbow Trout have met our management goal of >0.5 fish caught/hour based on each creel survey since

1993, and catch rates have never greatly exceeded this goal. Additionally, total use exceeds the statewide reservoir average and is close to our statewide management goal (40% total use rate) for our overall stocking efforts. The stocking efforts provide a diversity of opportunities for anglers including shore, boat and ice fishing. Finally, the majority of catch (71.5%) in ECR was supported by catchable Rainbow Trout in 2012.

Limnology

As we have seen in previous years, ECR continues to have anoxic conditions in the hypolimnion. The combination of an anoxic hypolimnion and warm surface waters reduces the volume of the reservoir available for fish to live during the summer months, especially temperature sensitive hatchery trout (Figure 50). These conditions force the more temperature sensitive trout to live in either the warmer epilimnion with higher DO, or cooler water with less DO, both of which can cause stress. The combination of high water temperature and marginal DO concentrations compounds the stress on hatchery trout, which can result in disease and fish kills (Bjornn and Reiser 1991, Carline and Machung 2001). In 2012, the volume of water available for Rainbow Trout to survive was reduced during the summer months. However, there was at least some suitable habitat throughout the summer for Rainbow Trout to survive into the fall and winter fishery. This is confirmed by tag returns from the angler exploitation surveys which show that tagged Rainbow Trout were caught throughout the summer months (Figures 60 - 62).

An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion, such as Elk Creek Reservoir. This is a concern for our fall stocking of catchable trout in this reservoir, as fall turnover can reduce the dissolved oxygen levels of the reservoir to below the 5.0 mg/L needed for Rainbow Trout. However, fall turnover did not cause this issue in 2012 (Figure 50). To avoid potential fish kills, fall stockings should be conducted once DO levels have returned to >5.0 mg/L after reservoir turnover.

Zooplankton

Larger sized zooplankton taxa, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in ECR was dominated by Daphnia and Cyclopoida through most of 2012, indicating the presence of a viable food source (Figure 52). In 2012, Daphnia collected averaged 0.7 mm in length, and Cyclopoida averaged 0.6 mm in length (Figure 53, Figure 54). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Additionally, no more than 6.3% of Daphnia and 5.0% of Cyclopoids were at or above preferred size (Figures 55 and 56) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, only 14.5% of the Daphnia population and 5.6% of the Cyclopoida population were ≥1.0 mm in length.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for ECR. The ZQI, which is a measure of both abundance and size, was 0.18, below the average (0.35) for reservoirs in the Clearwater Region (Appendix E). ZQI values from 0.1 - 0.6 are considered moderate and indicate that there is sufficient competition for food resources to potentially impact trout populations (Teuscher 1999). This data indicates that larger zooplankton individuals are being cropped off or that few individuals grow to this size. This suggests that we may need to reduce the number of planktivores to allow for more forage opportunities for fish in ECR.

Aquatic Vegetation

Over the last 10 - 15 years, the upper end of ECR has been experiencing excessive algae and aquatic vegetation growth due to high nutrient levels. Uncontrolled algae growth can color the water green or brown, lead to nuisance surface scum, poor water clarity, noxious odors and an overall reduction in a lake's recreational value. Additionally, the nuisance aquatic vegetation and algae are a contributing factor to the low hypolimnetic DO levels seen in ECR during the late summer and early fall. This organic material consumes oxygen as it decomposes, thus reducing oxygen levels in the hypolimnion.

When excessive levels, or "blooms", of algae occur, it is often desirable to control the growth directly. Typically this is accomplished by treating the lake with commercial algaecides containing copper compounds. These chemical treatments are effective short-term controls of algae. However, repeated applications of these chemicals can result in a long-term buildup of copper in the lake sediments creating environmental and health concerns. Copper compounds are also toxic to non-target organisms such as zooplankton and insect larvae that are important food sources for fish. Additionally, some fish species such as trout are highly sensitive to copper compounds, making the use of chemical treatments undesirable in many lakes. In Elk Creek Reservoir, water chemistry is such that to effectively treat the algae, the concentrations of copper compounds used would be lethal to trout. Other side effects of these chemicals are long waiting periods after application before the water is again safe for irrigation, drinking, and recreational activities.

In addition to contributing to low DO levels, vegetation can also affect fishing and other recreational activities. In ECR, 94% of the sample sites had vegetation (Figure 57). About 40% of these sites were located along the shoreline, and 100.0% of all shoreline sites had vegetation. The DFI sampling found that fishing would be negatively influenced by vegetation at 53% of sample sites, with 7% of the sites rendered unfishable. Additionally, fishing at 66% of shoreline sites would be negatively influenced by vegetation according to the DFI.

Since 61% of angler effort in 2012 was from the bank, the fact that much of the shoreline is affected by vegetation indicates that vegetation could be reducing angling opportunity and/or the quality of the fishing experience. Although only 6% of anglers in the 2012 creel survey complained about vegetation, we have received many complaints from anglers (by phone and in person) over the past few years due to frustrations with vegetation. Vegetation usually becomes a problem later in the summer, when there are lower levels of effort. This suggests that vegetation may be part of the cause of the reduced effort we see at this time of year. This can result in reduced satisfaction with their experience at the reservoir and could even result in anglers no longer fishing at ECR.

Reducing the quantity of aquatic vegetation (primarily the floating mats and dense beds in the upper reservoir) in ECR could improve both the forage success for predators (Bettolli et al. 1992; Dibble et al. 1996) and improve the recreational opportunities in the reservoir. Control can be difficult, as the floating mats of vegetation move easily through wind and wave action, effectively spreading them around the reservoir.

To address the nuisance vegetation problems in ECR, several techniques have been implemented in an attempt to reduce the quantity of vegetation. From 2000 - 2005, barley straw was used as an alternative method of algae control. The technique of using barley for algae control was developed in England in the 1980's, where it is widely used in many bodies of water, including large reservoirs and canals (Welch et al. 1990; Barrett et al. 1999). Barley straw works as it decomposes and releases certain chemicals that can control some algae populations. Once the straw begins to produce sufficient amounts of the chemical, it has been found to control some algae species for four to six months. Therefore, the straw could be applied in mid-late April and control algal growth through the summer. As opposed to copper based algaecides, the chemicals resulting from the decomposition of barley straw have not be found to cause any ill effects to fish, waterfowl, or humans. The chemicals produced during this process are naturally occurring, which provides a safer control of nuisance algae in ponds and lakes. This strategy met with limited results when IDFG attempted it during 2002 - 2006. The limited success was believed due to high fluctuations in water level, large volumes of water flowing into the reservoir, and the high nutrient content of the water. The program was discontinued due to a lack of success.

Aquatic vegetation can also be controlled using herbicide treatments such as liquid Reward® (DuPont et al. 2011). We have found this herbicide can reduce surface coverage of aquatic vegetation 20-30%. However, vegetation coverage returned to pre-treatment levels approximately eight weeks after the treatment. Maintaining adequate control would require multiple treatments per year and could cost in excess of $6,000/year in a water body the size of ECR.

Due to the limited success of small scale herbicide treatments in regional reservoirs, we researched other techniques that could be used to control nuisance aquatic vegetation. These techniques included biological, mechanical, physical, and other chemical control methods (Appendix L). The recommended control measures for regional reservoirs and ponds included winter drawdown, benthic barriers, and grass carp. Benthic barriers would not be appropriate for ECR, as there is too much vegetation coverage, and they will not address the floating mats. Winter drawdown is not an option, either, as ECR does not have a drain system and therefore cannot be drawn down far enough to have an effect on vegetation.

Grass carp have been shown to be effective at controlling nuisance aquatic vegetation (Avault 1965, Mitzner 1978, Hanlon et al. 2000), including the species present in ECR. However, numerous studies point out that a moderate level of control is difficult to achieve, as control is often either "all or nothing" (Kirk 1992, Mitzner 1994, Pauley et al. 1998, Bonar et al. 2002). Due to the ease in which they could leave the reservoir, either upstream or over the spillway, we do not recommend their use in ECR.

One new potential option for vegetation control is the SePro product Phoslock®, which permanently binds free reactive phosphorous, thus removing much of the phosphorous available for plant growth. This product has proven effective, with Total Phosphorous levels in the water column reduced by 52 - 80% in case studies (Robb et al. 2003; McNabb 2011; SeaPro 2014). Phoslock® has also been shown to bind up to 69% of soluble phosphorous levels in the top 4 cm of substrate and 27% in the top 10 cm of substrate (Cook et al. 2005; Meis et al. 2012). This is important, as most of the soluble phosphorous that is released into the water column is estimated to come from the top 4-10 cm of substrate (Cook et al. 2005; Meis et al. 2012). However, a whole lake treatment of ECR would be prohibitively expensive, with costs ranging from $255 - $510/acre-ft in product alone (Appendix L). Due to budget limitations, it is not likely to be a realistic option unless outside funding sources were secured. If this option is used, intensive limnological sampling should be conducted before and after treatment to monitor the effects.

Due to the limited potential success and/or high cost of many vegetation control methods, several options should be reconsidered. Herbicides and mechanical removal methods (hand cutting, harvesting), while not feasible for whole lake control, could be potential options for control in small areas such as around popular fishing areas and the boat ramp. While small scale herbicide treatments did not provide long-term control, the eight weeks of control seen from previous single applications (DuPont et al. 2011) would provide improved recreational opportunity during the height of the fishing season in June and July (Table 10). Treating elodea and algae (which is not controlled by Reward®) at ECR would cost approximately $325 per surface acre using both Reward® and GreenClean Pro® for each treatment. Mechanical control, such as hand-cutting or pulling, could also be effective for short-term control in small areas. As with many other options, re-vegetation usually begins within a few weeks (Nicholson 1981; Cooke et al. 2005). It is difficult to estimate the cost of physical control because most of the cost is associated with labor (Cooke et al. 2005), especially if SCUBA divers would be required for deeper water. Divers would likely be needed for some areas in ECR, as water depths are >2m through most of the upper end of the reservoir. The use of volunteers would greatly reduce the costs, but would not likely be a reliable source of labor on an annual basis. A concern with using this option in ECR is that the low visibility of the reservoir would reduce effectiveness. Thus, we recommend utilizing spot treatments of herbicides around docks and popular fishing spots in the spring to provide summer control of nuisance aquatic vegetation during the height of the fishing season.

MANAGEMENT RECOMMENDATIONS

1. Conduct future lake surveys with five 10-minute electrofishing.

2. Discontinue use of trap nets for fish sampling due to their low effectiveness and high variability.

3. Continue stocking hatchery Rainbow Trout at the current rates and times of year.

4. Utilize spot treatments of herbicides around docks and popular fishing areas to help control of nuisance aquatic vegetation during the summer.

Table 5. Number of fish collected by species in each 10-minute electrofishing sample conducted during fisheries surveys of Elk Creek Reservoir, Idaho, in 2012. Table includes estimated number of 10-minute electrofishing samples (n) required to generate CPUE with 90% confidence and 25% precision.

	Count of fish collected									
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Largemouth Bass	24	9	6	0	16	5	60	10.0	8.6	46
Smallmouth Bass	0	0	0	2	2	0	4	0.7	1.0	n/a
Black Crappie	27	3	7	11	30	21	99	16.5	11.1	28
Bluegill	25	1	4	1	10	4	45	7.5	9.2	92
Pumpkinseed	140	4	7	10	37	11	209	34.8	52.9	142
Brook Trout	13	0	0	0	0	0	13	2.2	5.3	369
Black Bullhead	2	0	1	0	1	0	4	0.7	0.8	n/a
Total	231	17	25	24	96	41	434	72.3	82.9	57

Table 6. Back-calculated length at age of Largemouth Bass collected through electrofishing in Elk Creek Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus							
Class	Age	n	1	2	3	4	5	6	7	8
2011	1	2	81							
2010	2	27	78	145						
2009	3	8	74	138	186					
2008	4	3	96	160	246	316				
2007	5	6	79	139	200	281	338			
2006	6	3	78	161	236	289	358	408		
2005	7	3	91	167	244	299	363	411	442	
2004	8	2	82	140	204	268	343	396	435	470
n		54	54	52	25	17	14	8	5	2
Length at Age			79	146	211	290	348	406	439	470

Table 7. Back-calculated length at age of Bluegill collected through electrofishing in Elk Creek Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus			
Class	Age	n	1	2	3	4
2011	1	0	0			
2010	2	8	59	93		
2009	3	27	39	75	112	
2008	4	5	64	111	154	175
n		40	40	40	32	5
Length at Age			46	83	119	175

Table 8. Back-calculated length at age of Pumpkinseed collected through electrofishing in Elk Creek Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus							
Class	Age	n	1	2	3	4	5	6	7	8
2011	1	0	0							
2010	2	0	0	0						
2009	3	16	43	71	95					
2008	4	11	41	64	89	112				
2007	5	45	36	58	81	105	123			
2006	6	6	37	63	89	114	132	147		
2005	7	1	46	69	93	110	129	140	151	
2004	8	1	43	64	91	106	122	132	152	163
n		80	80	80	80	64	53	8	2	1
Length at Age			39	62	85	107	124	144	151	163

Table 9. Back-calculated length at annuli of Black Crappie collected through electrofishing in Elk Creek Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus				
Class	Age	n	1	2	3	4	5
2011	1	0	0				
2010	2	2	58	92			
2009	3	46	50	90	122		
2008	4	5	46	81	140	173	
2007	5	7	46	81	121	159	189
n		60	60	60	58	12	7
Length at Age			50	88	123	165	189

Table 10. Summary of angler effort (hours) collected from a creel survey conducted on Elk Creek Reservoir, Idaho, from November 28, 2011 to November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	42			42	75			75	117	0	0	117	66	56.2
January	112			112	76			76	188	0	0	188	95	50.8
February	381			381	544			544	925	0	0	925	569	61.5
March	127	0	0	127	195	0	0	195	322	0	0	322	265	82.2
April		271	0	271		13	0	13		284	0	284	271	95.5
May		704	117	821		396	228	624		1,100	345	1,445	721	49.9
June		606	347	953		1,292	327	1,619		1,898	673	2,572	493	19.2
July		772	107	879		580	359	939		1,351	466	1,818	327	18.0
August		418	174	592		235	197	432		653	371	1,024	297	29.0
September		48	16	64		288	111	399		336	127	463	195	42.2
October		69	173	242		0	0	0		69	173	242	198	82.1
November		0	0	0		0	0	0		0	0	0	0	--
Totals	661	2,888	934	4,483	890	2,803	1,222	4,915	1,551	5,691	2,156	9,398	1,231	13.1

Table 11. Angler exploitation (harvest) of hatchery catchable size Rainbow Trout stocked in Elk Creek Reservoir, Idaho, in 2011 and 2012, through 365 days post-stocking. Total use = fish harvested + fish released

2011

Hatchery	Tagging date	Treatment	Tags released	Disposition			Adjusted exploitation		Adjusted total use	
				Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Clearwater	6/14/2011	Production	400	95	10	18	54.7%	12.6%	70.8%	15.2%
	10/26/2011		397	28	1	17	16.2%	5.6%	26.7%	7.7%
Average							35.5%	9.1%	48.8%	11.5%

2012

Hatchery	Tagging date	Treatment	Tags released	Disposition			Adjusted exploitation		Adjusted total use	
				Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Clearwater	6/20/2012	production	400	31	6	5	21.9%	5.7%	29.6%	6.9%

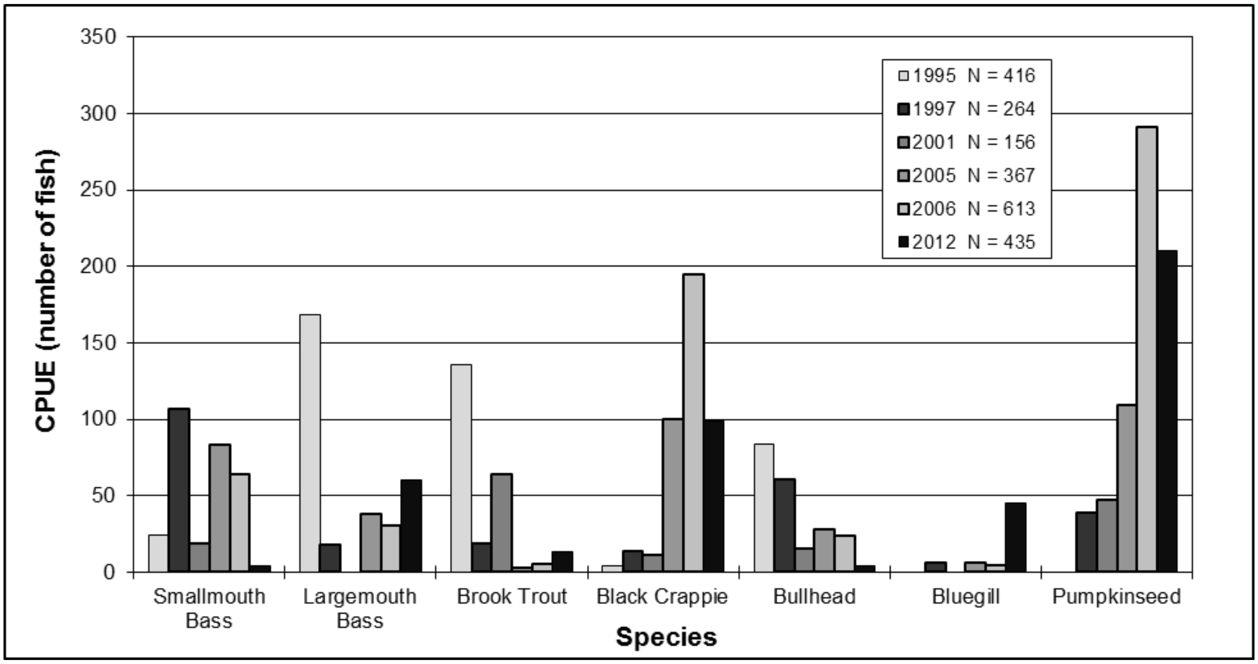


Figure 25. Catch per unit effort (CPUE; number of fish/hour) of fish collected through electrofishing in Elk Creek Reservoir, Idaho, from 1995 - 2012.

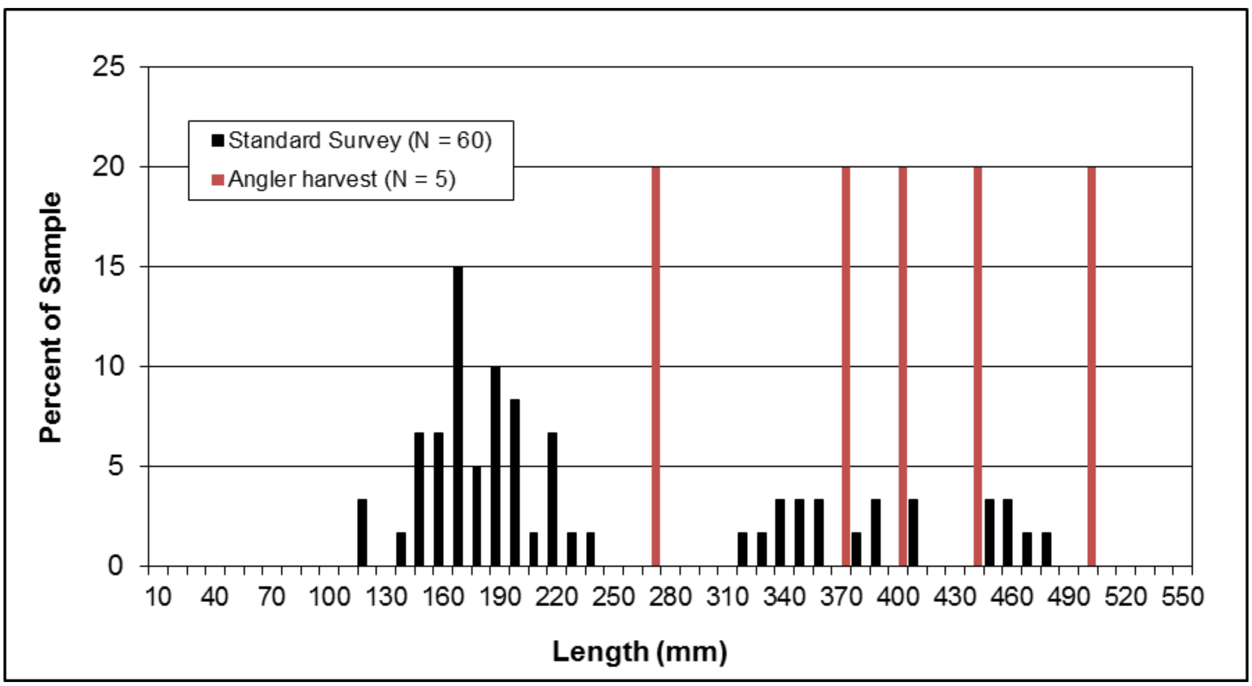


Figure 26. Comparison of Largemouth Bass length frequency distributions from fish collected through electrofishing and by anglers in Elk Creek Reservoir, Idaho, during 2012.

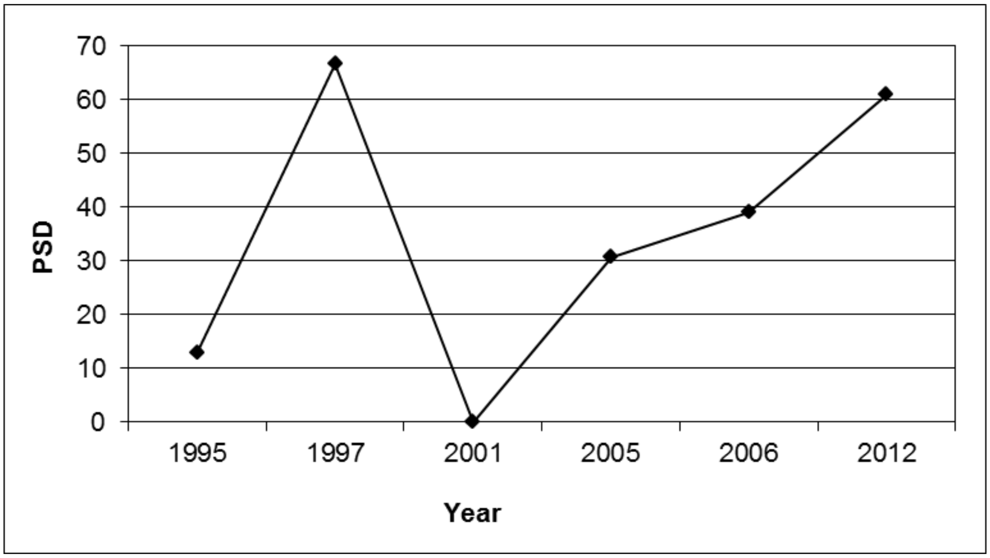


Figure 27. Proportional Size Distribution (PSD) values of Largemouth Bass collected through electrofishing in Elk Creek Reservoir, Idaho, from 1995 - 2012.

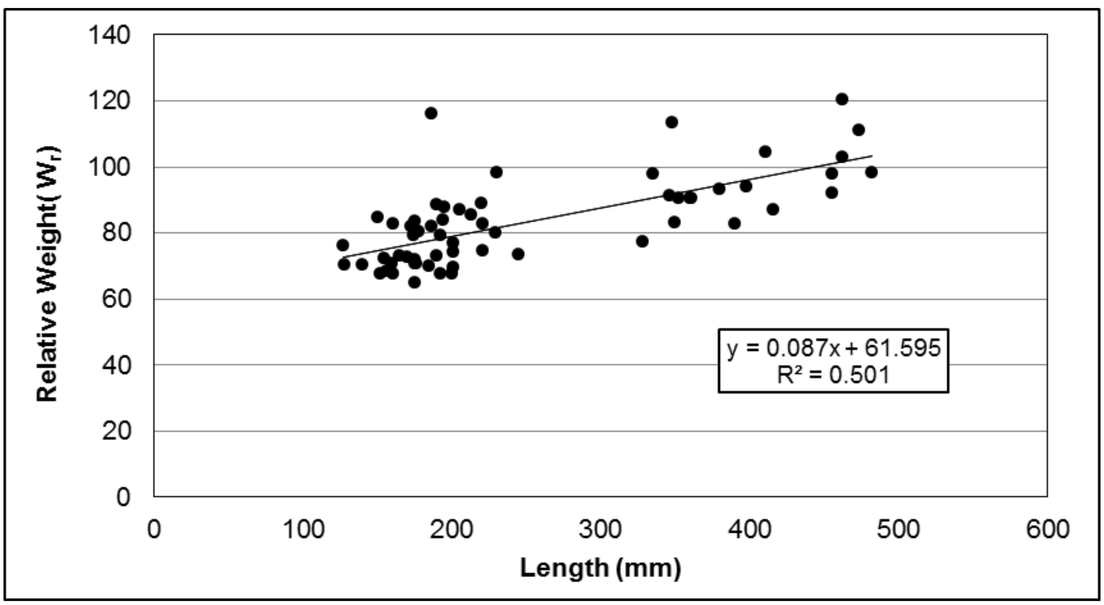


Figure 28. Relative weight (W_r) values of Largemouth Bass collected though electrofishing in Elk Creek Reservoir, Idaho, in 2012.

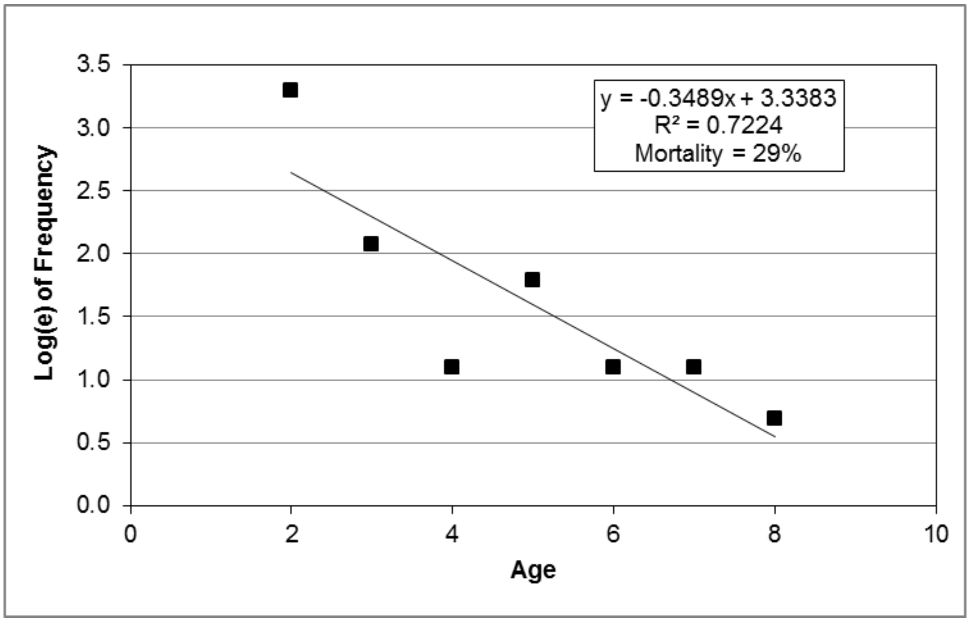


Figure 29. Catch curve for estimating annual mortality of Largemouth Bass collected through electrofishing in Elk Creek Reservoir, Idaho, in 2012.

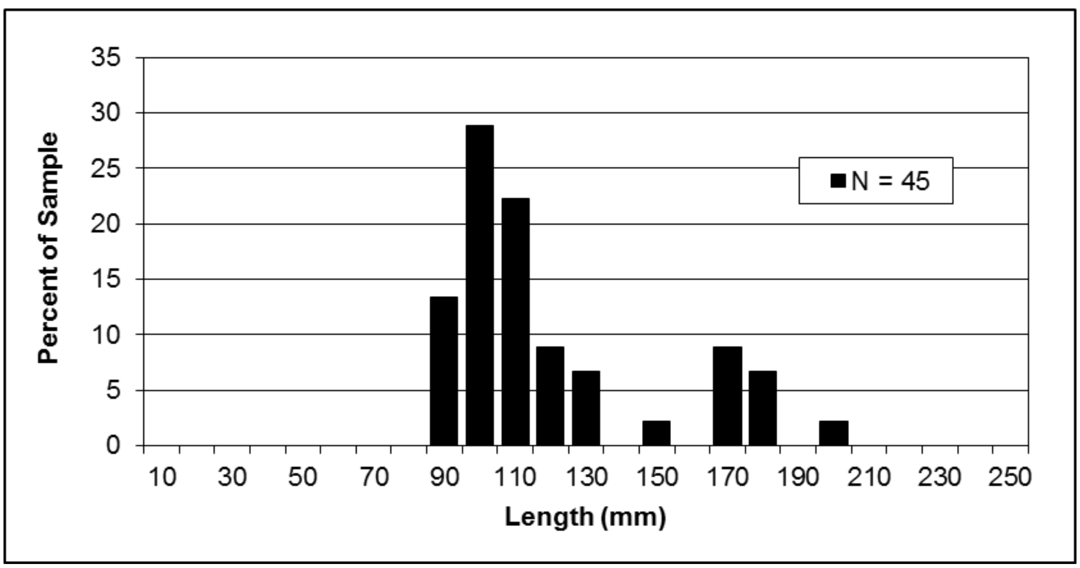


Figure 30. Length frequency distribution of Bluegill collected through electrofishing in Elk Creek Reservoir, Idaho, during 2012.

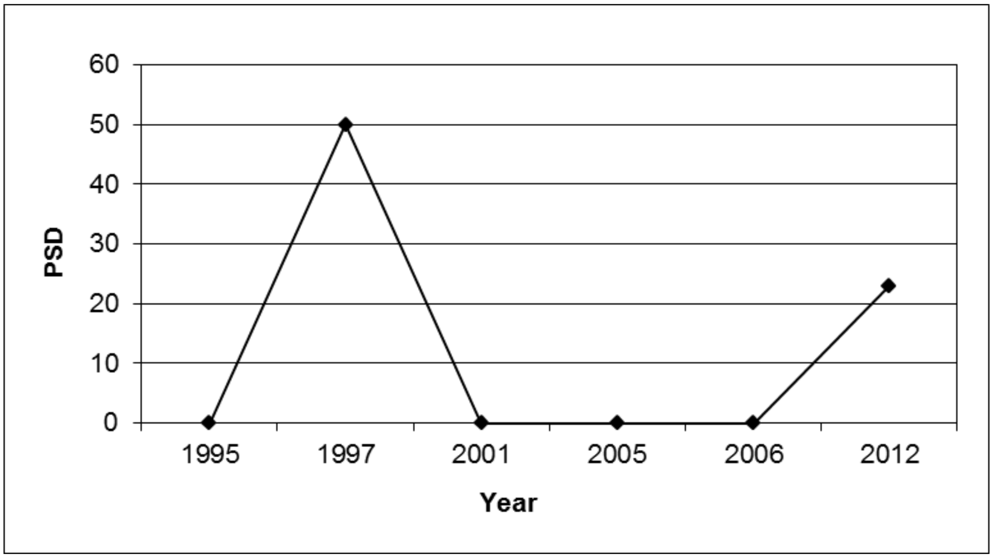


Figure 31. Proportional Size Distribution (PSD) values of Bluegill collected through electrofishing in Elk Creek Reservoir, Idaho, from 1995 - 2012.

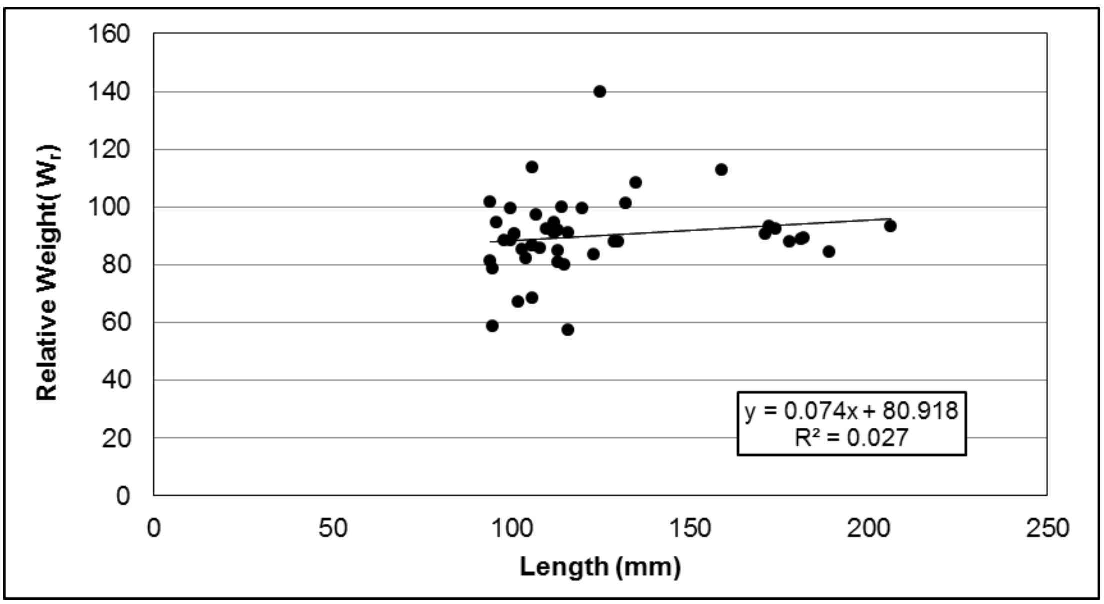


Figure 32. Relative weight (W_r) values of Bluegill collected though electrofishing in Elk Creek Reservoir, Idaho, in 2012.

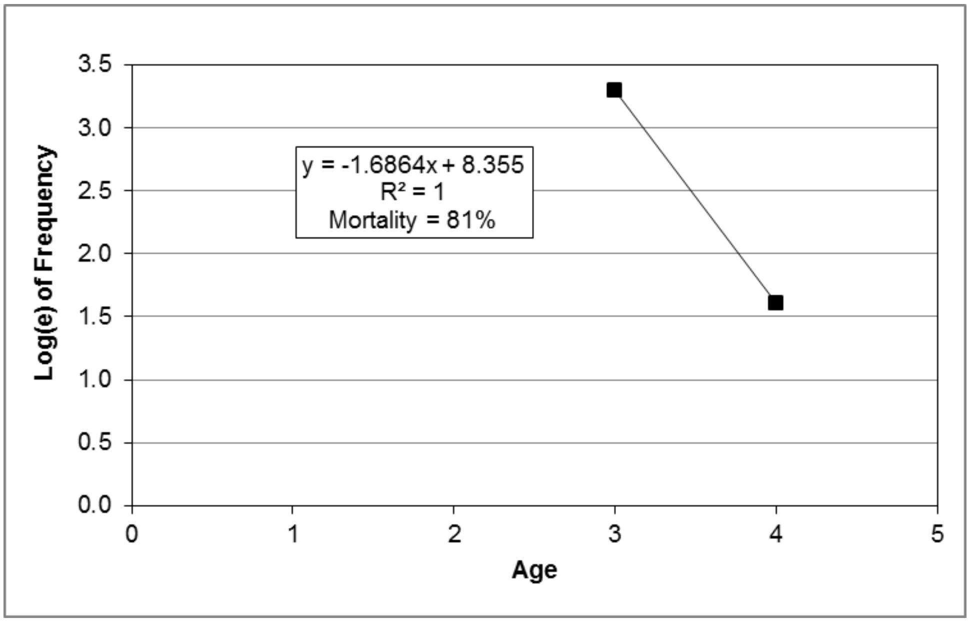


Figure 33. Catch curve for estimating annual mortality of Bluegill collected through electrofishing in Elk Creek Reservoir, Idaho, in 2012.

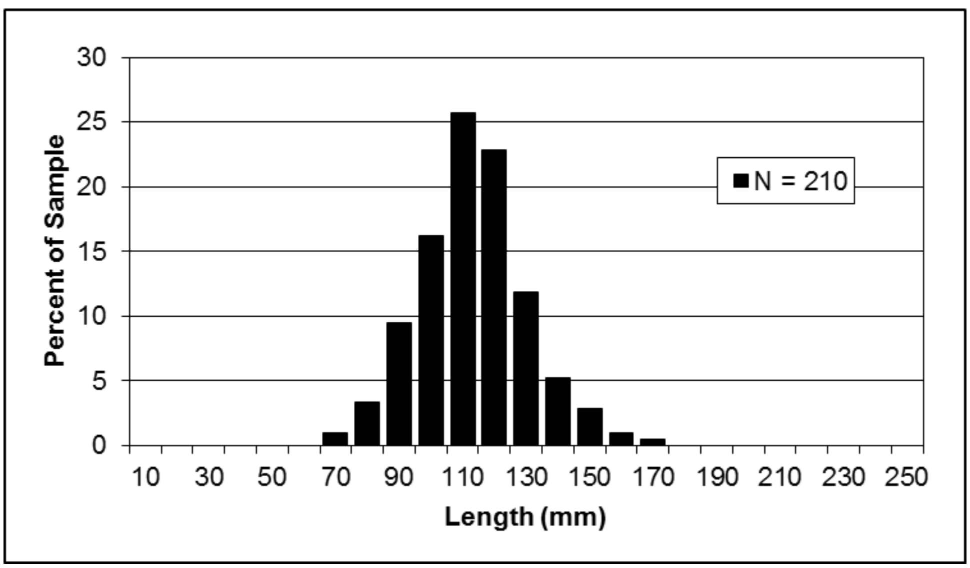


Figure 34. Length frequency distributions of Pumpkinseed collected though electrofishing in Elk Creek Reservoir, Idaho, during 2012.

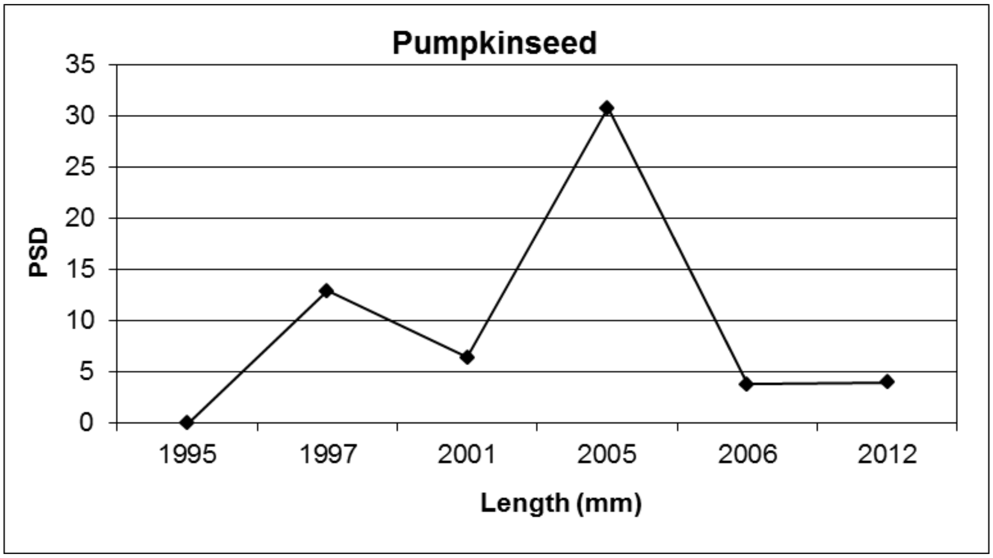


Figure 35. Proportional Size Distribution (PSD) values of Pumpkinseed collected though electrofishing in Elk Creek Reservoir, Idaho, from 1995 - 2012.

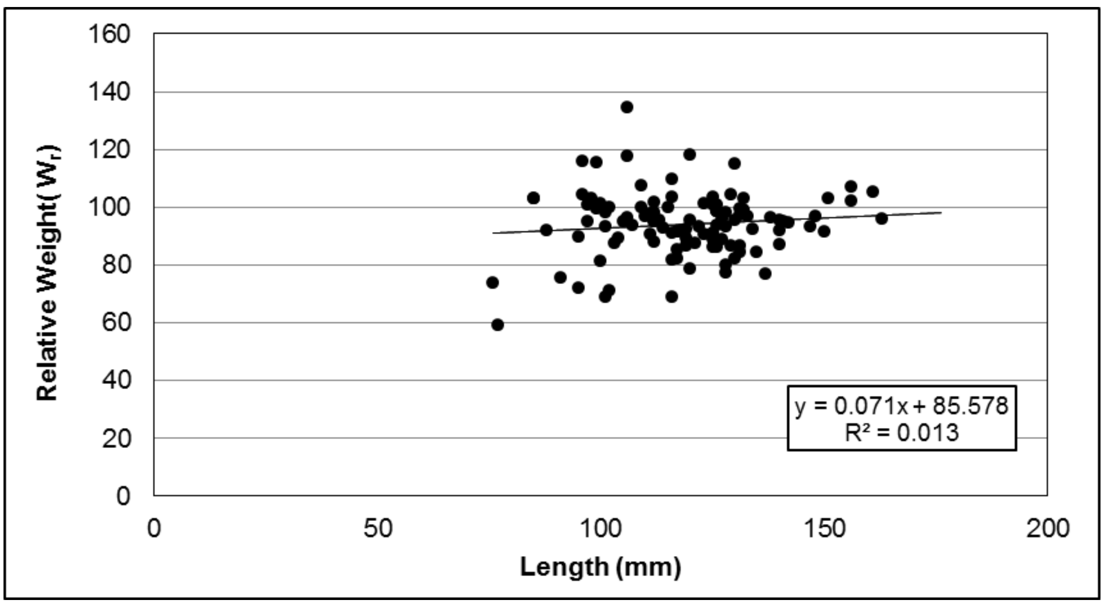


Figure 36. Relative weight (W_r) values of Pumpkinseed collected though electrofishing in Elk Creek Reservoir, Idaho, in 2012.

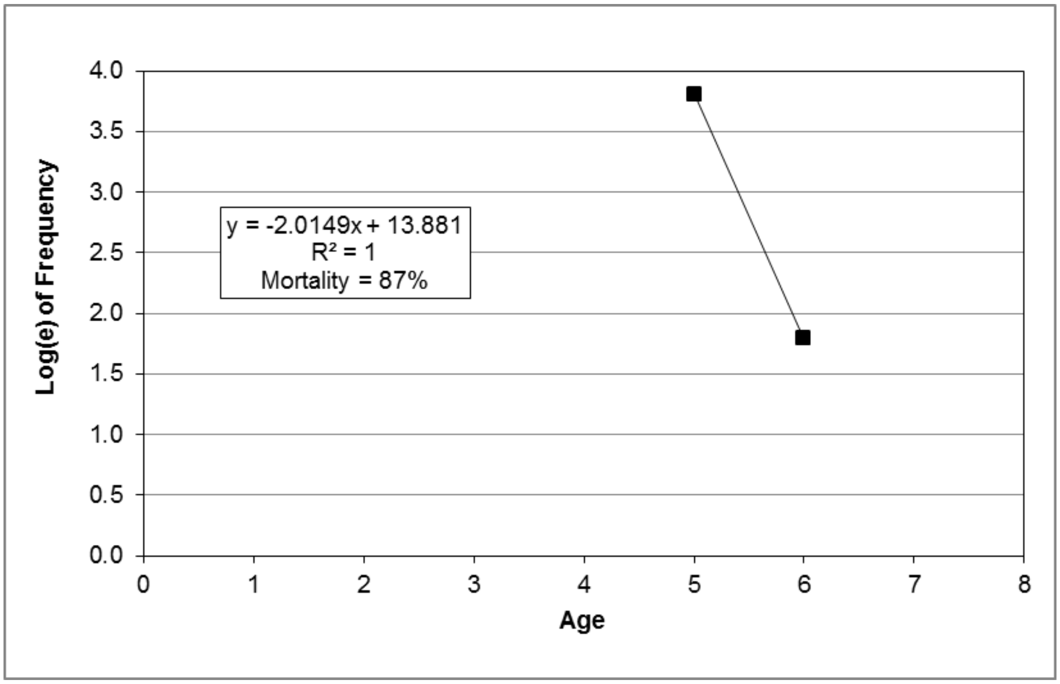


Figure 37. Catch curve for estimating annual mortality of Pumpkinseed collected though electrofishing in Elk Creek Reservoir, Idaho, in 2012.

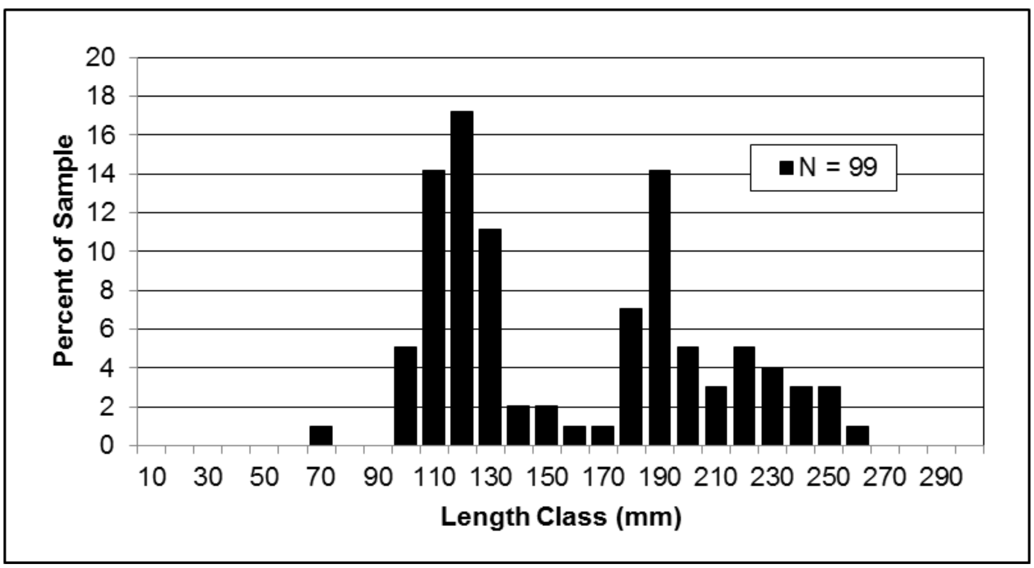


Figure 38. Length frequency distributions of Black Crappie collected though electrofishing in Elk Creek Reservoir, Idaho, during 2012.

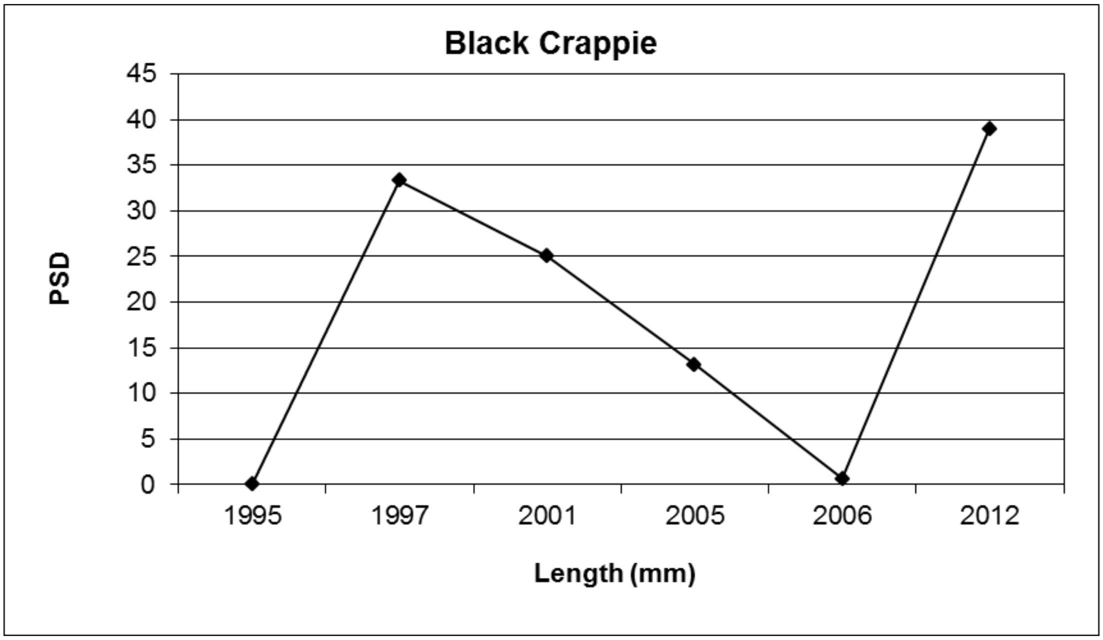


Figure 39. Proportional Size Distribution (PSD) values of Black Crappie collected though electrofishing in Elk Creek Reservoir, Idaho, from 1997 - 2012.

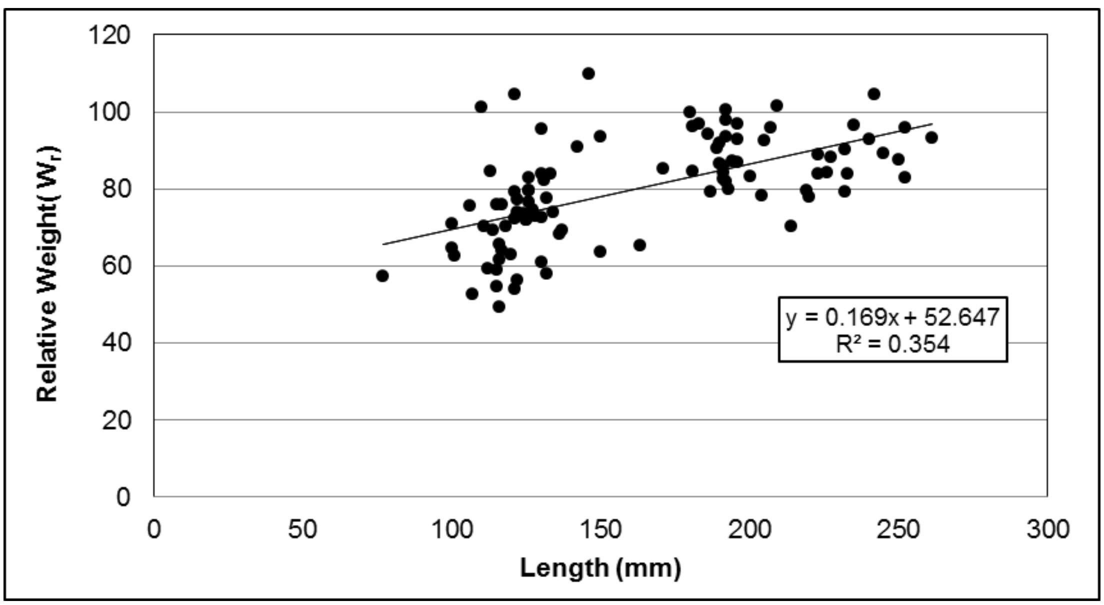


Figure 40. Relative weight (W_r) values of Black Crappie collected though electrofishing in Elk Creek Reservoir, Idaho, in 2012.

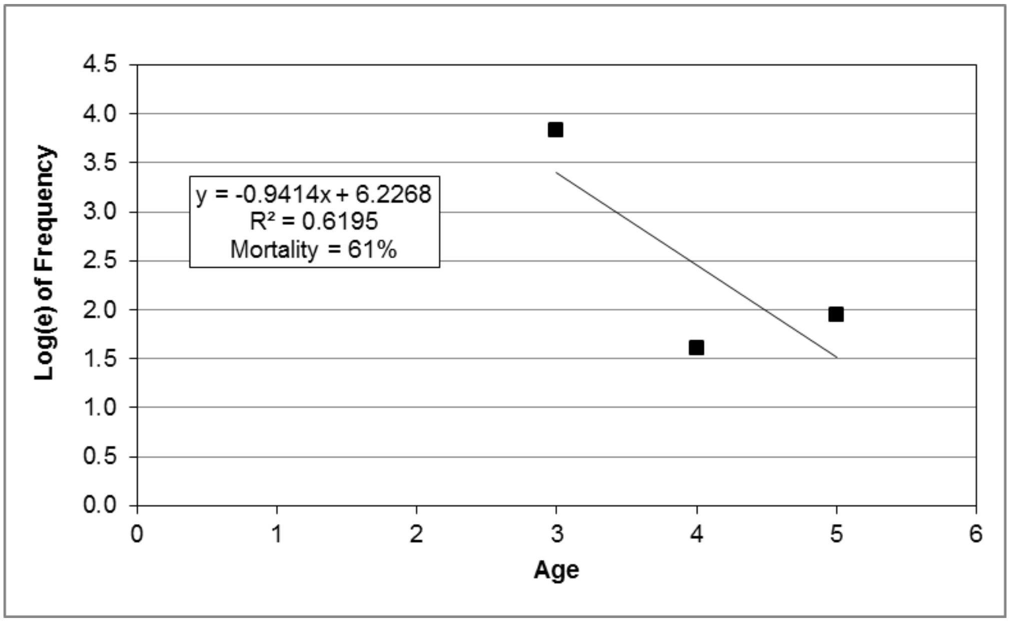


Figure 41. Catch curve for estimating annual mortality of Black Crappie collected though electrofishing in Elk Creek Reservoir, Idaho, in 2012.

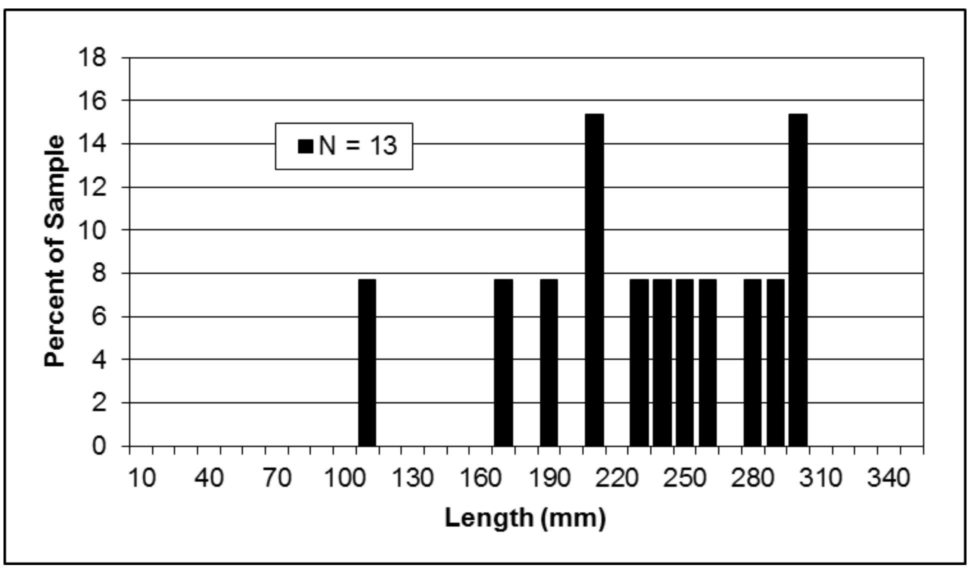


Figure 42. Length frequency distributions of Brook Trout collected though electrofishing in Elk Creek Reservoir, Idaho, during 2012.

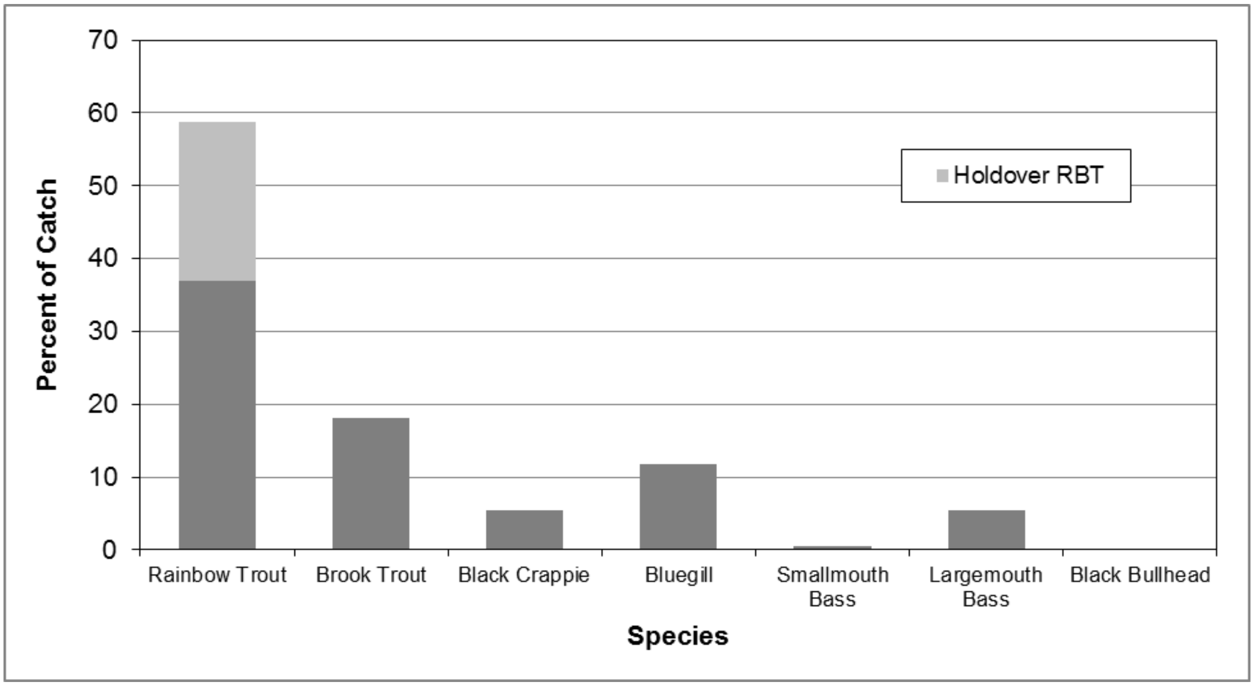


Figure 43. Composition of fishes caught in Elk Creek Reservoir, Idaho, as estimated by a creel survey conducted from November 28, 2011 to Nov 28, 2012.

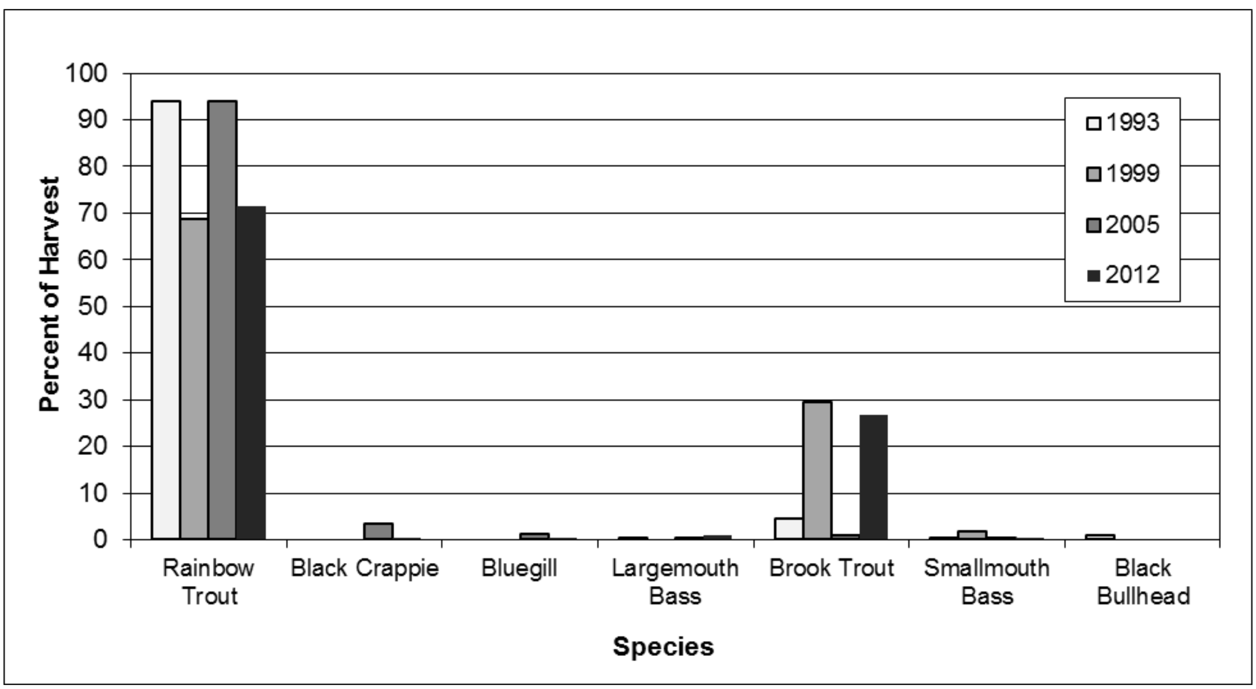


Figure 44. Composition of fishes harvested in Elk Creek Reservoir, Idaho, as estimated by creel surveys conducted from 1993 - 2012.

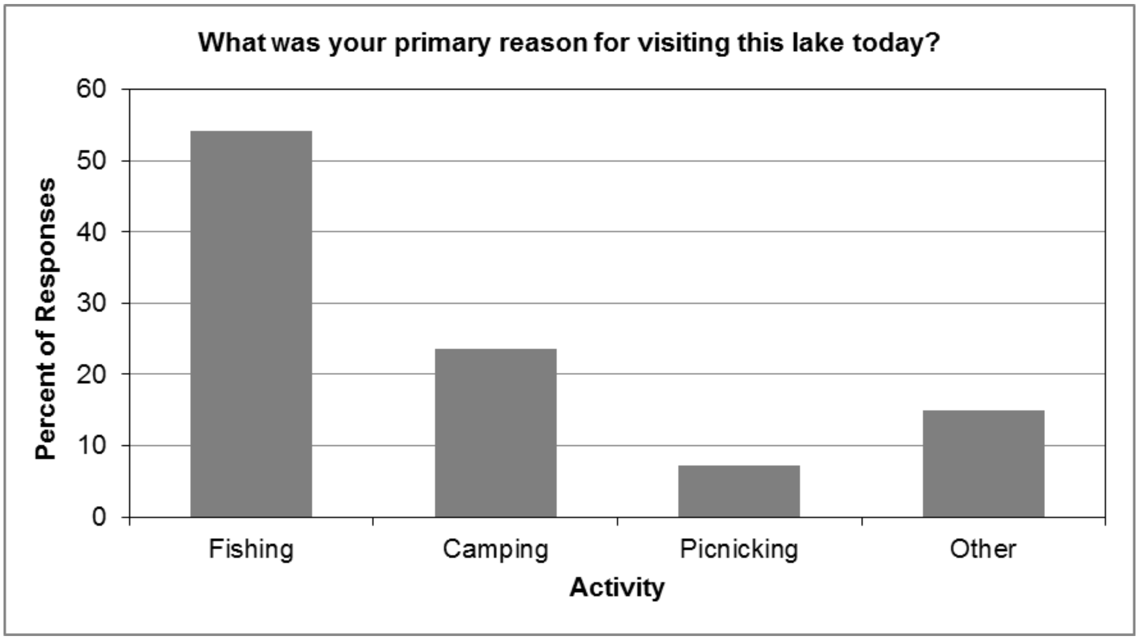


Figure 45. Summary of constituent responses to the primary reason for visiting Elk Creek Reservoir, Idaho, during a creel survey conducted from November 2, 2011 to November 28, 2012.

Figure 46. Summary of constituent responses regarding their overall fishing experience at Elk Creek Reservoir, Idaho, during a creel survey conducted from November 28, 2011 to Nov 28, 2012.

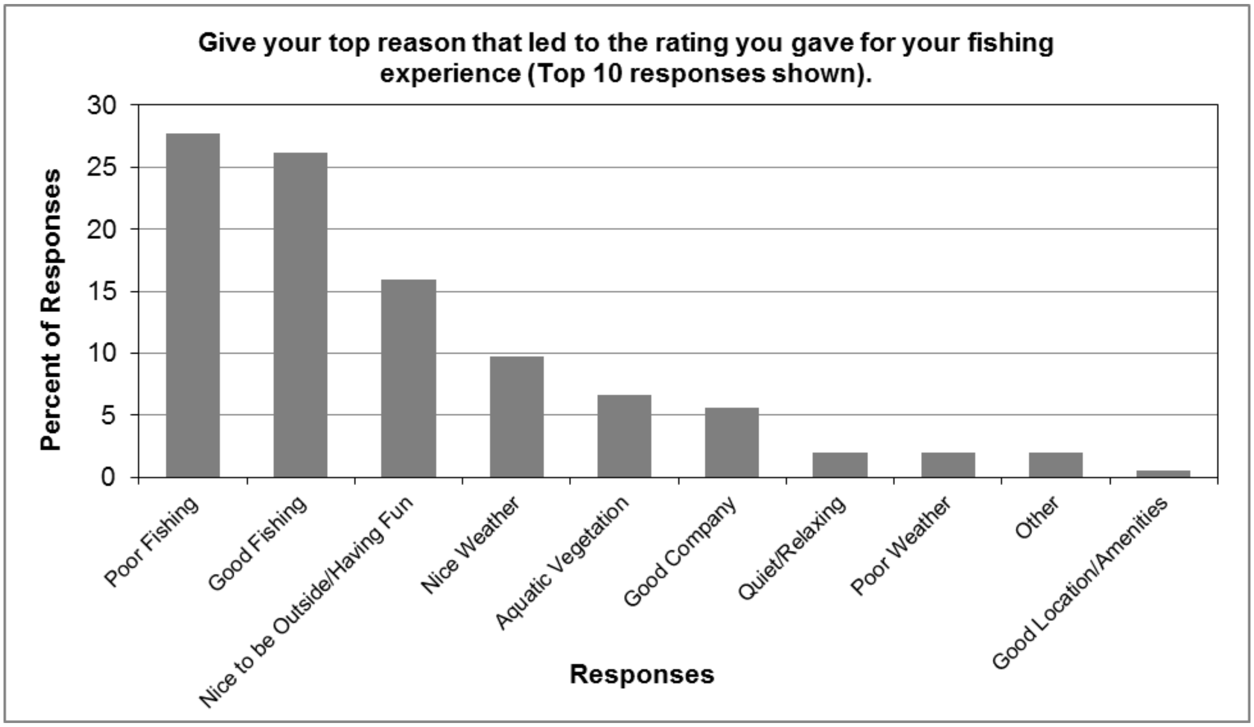


Figure 47. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day at Elk Creek Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012 (Only 10 most common answers shown).

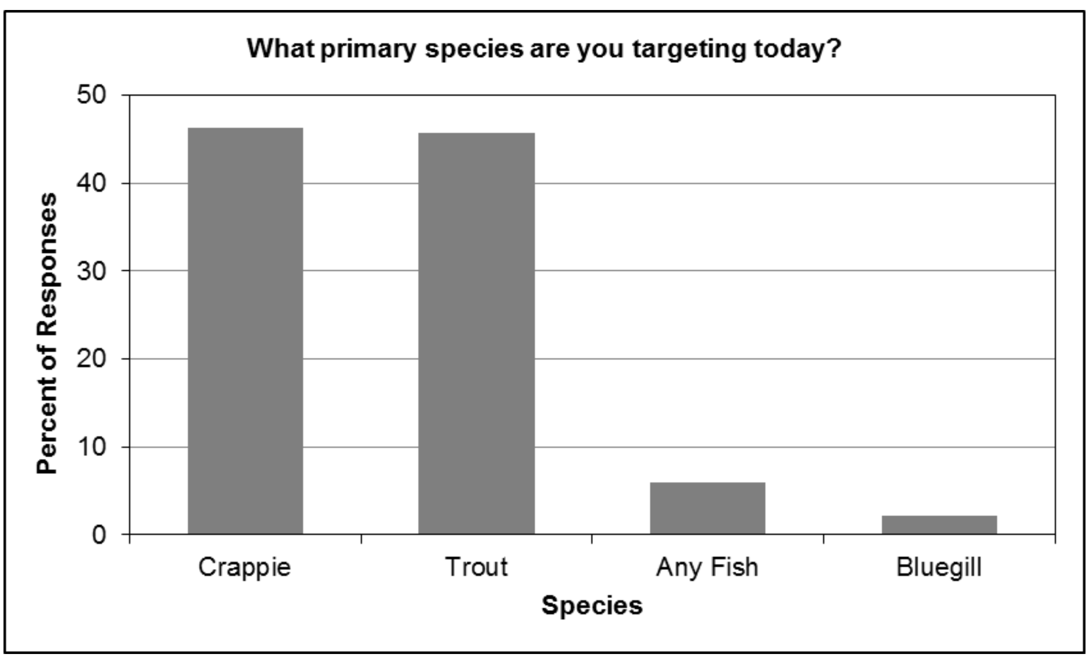


Figure 48. Summary of constituent responses regarding target fish species at Elk Creek Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to Nov 28, 2012.

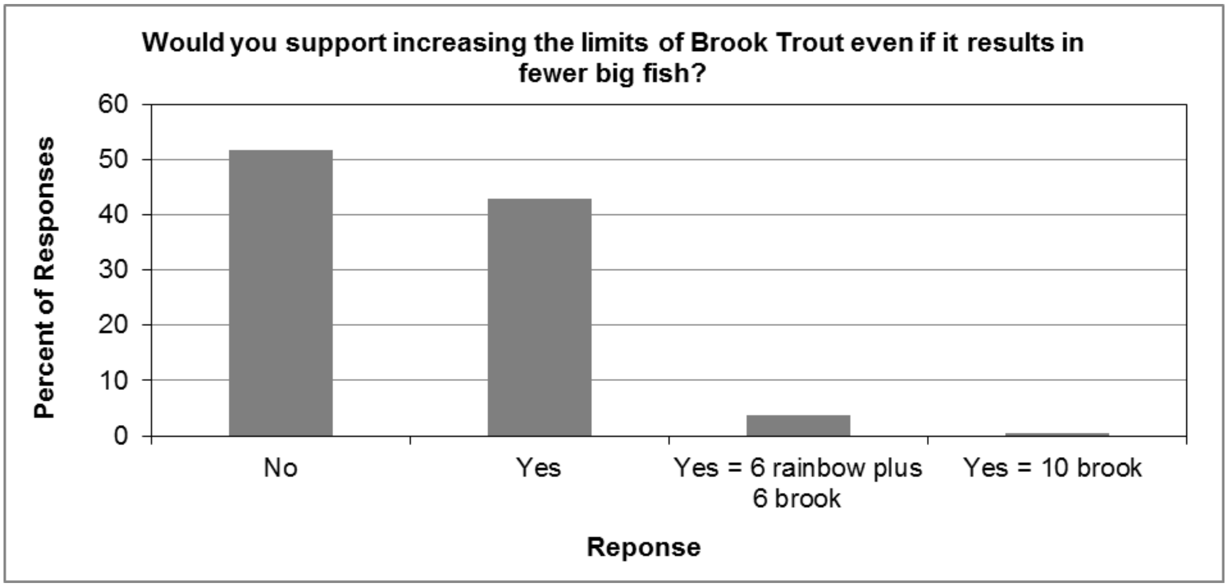


Figure 49. Summary of constituent responses regarding a potential change in Brook Trout regulations in Elk Creek Reservoir, Idaho, during a creel survey conducted from November 28, 2011 to Nov 28, 2012.

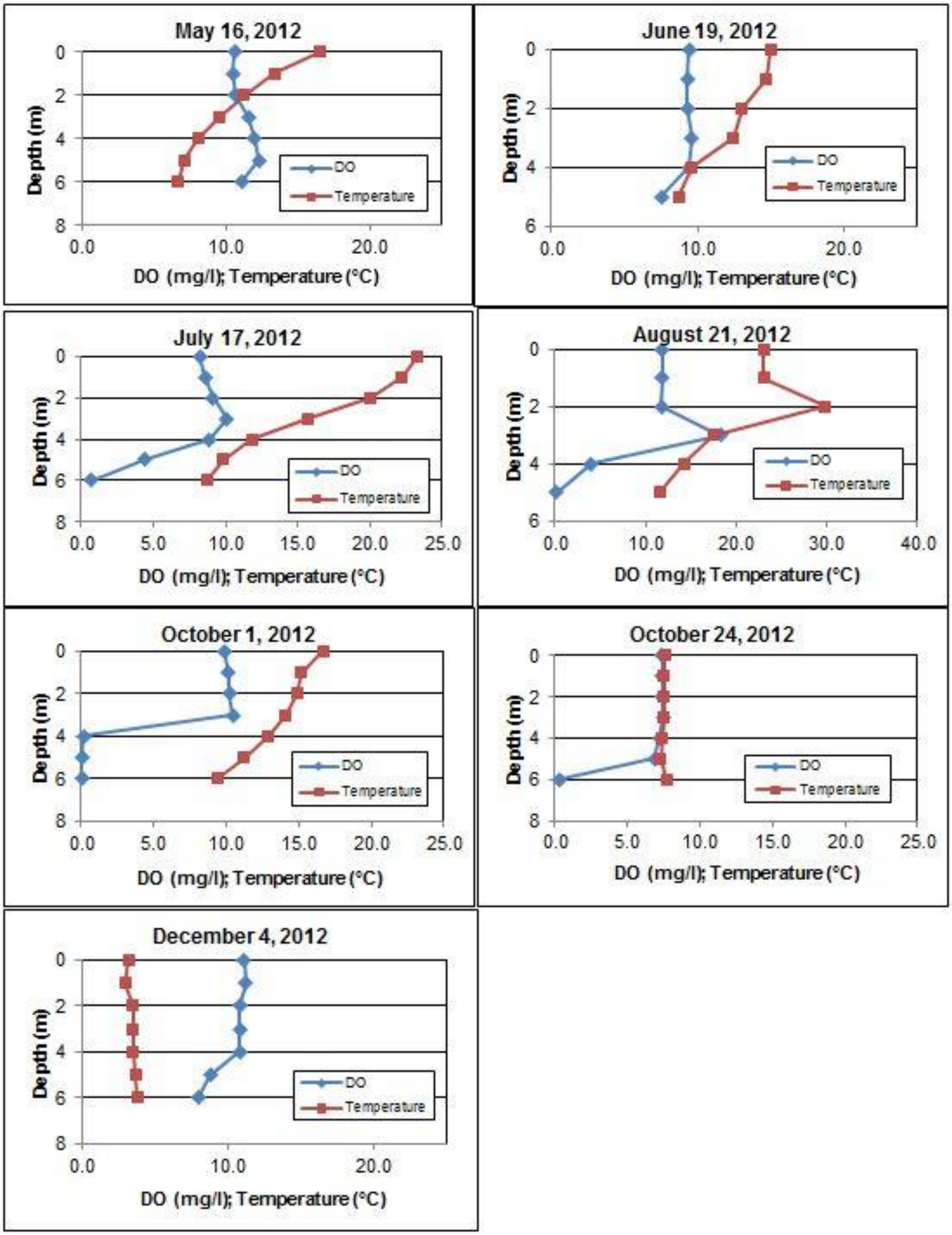


Figure 50. Dissolved oxygen (DO) and temperature profiles collected in Elk Creek Reservoir, Idaho, during 2012.

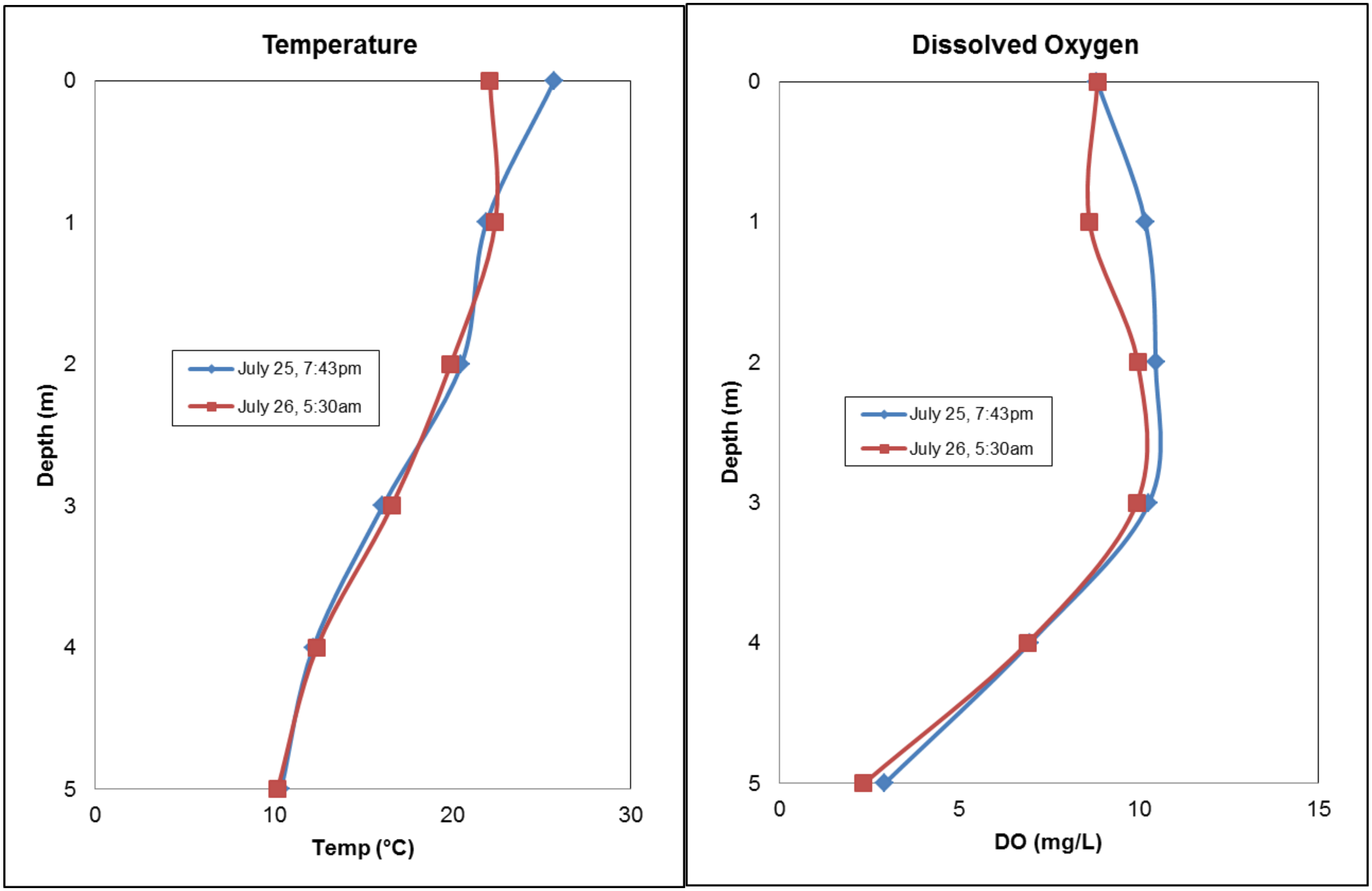


Figure 51. Diel changes in temperature and dissolved oxygen in Elk Creek Reservoir, Idaho, from July 25 - 26, 2012

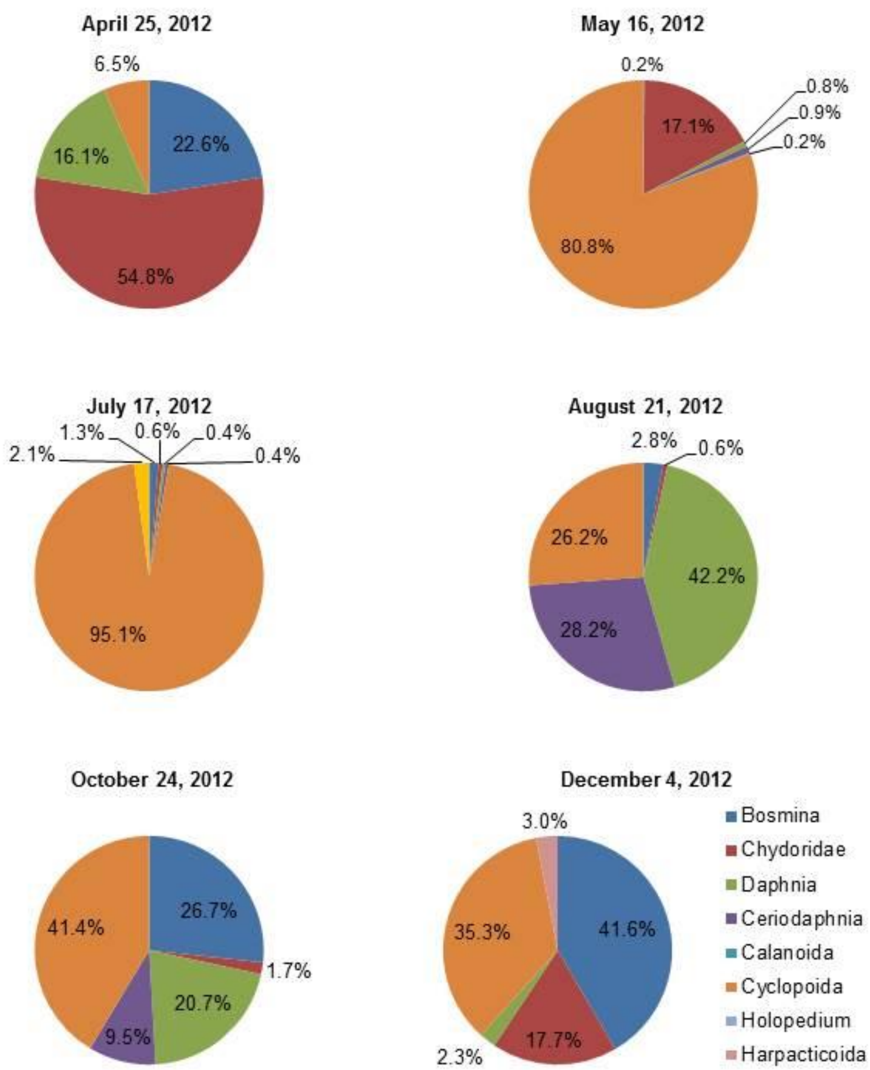


Figure 52. Zooplankton community composition based on monthly samples collected in Elk Creek Reservoir, Idaho, during 2012.

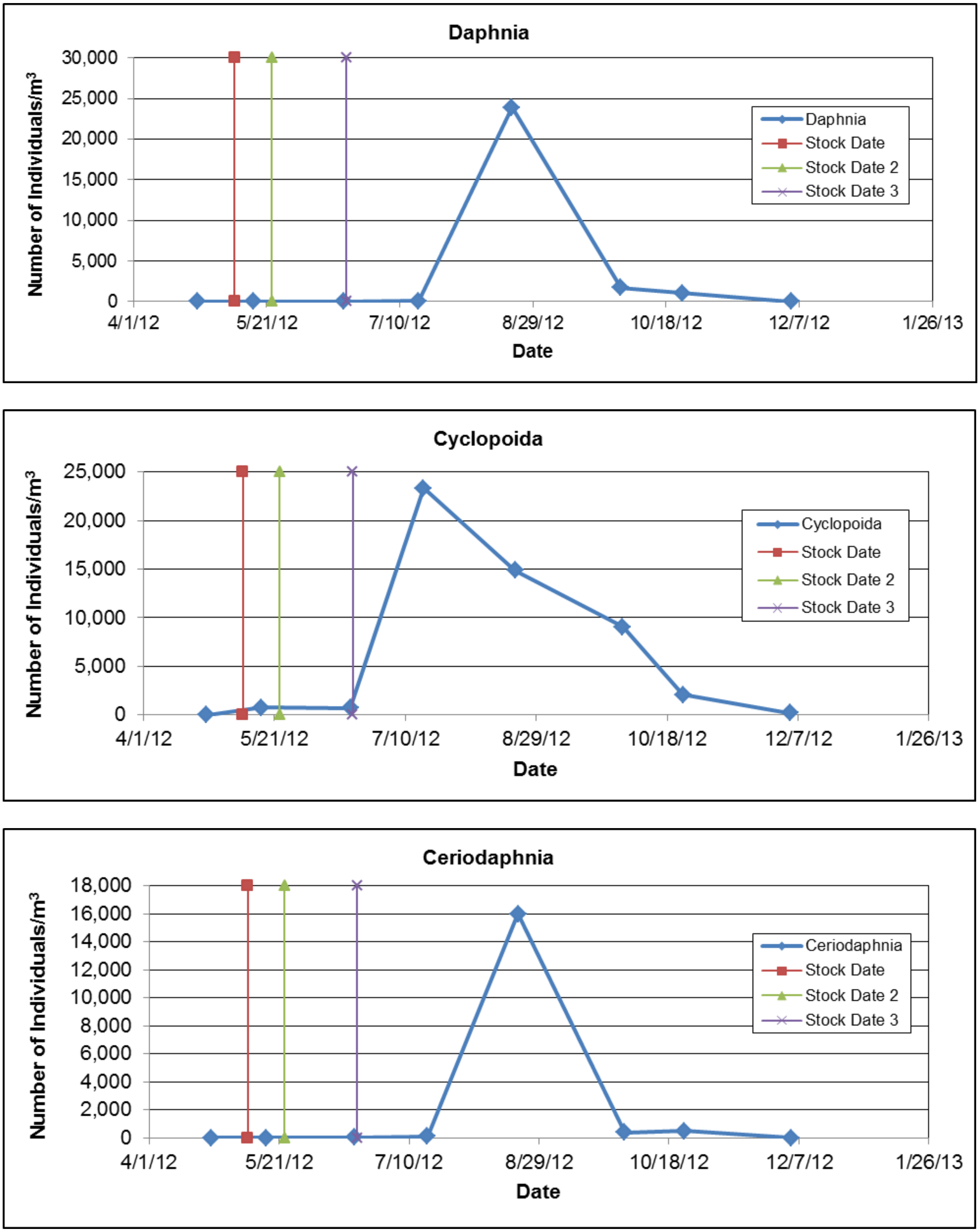
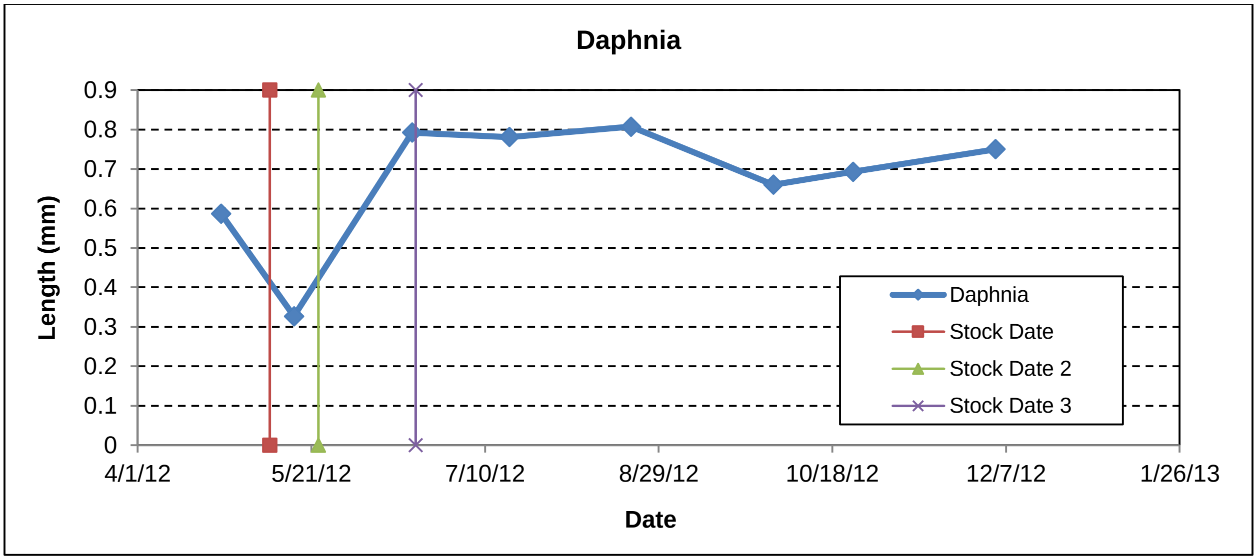


Figure 53. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Elk Creek Reservoir, Idaho, in 2012.



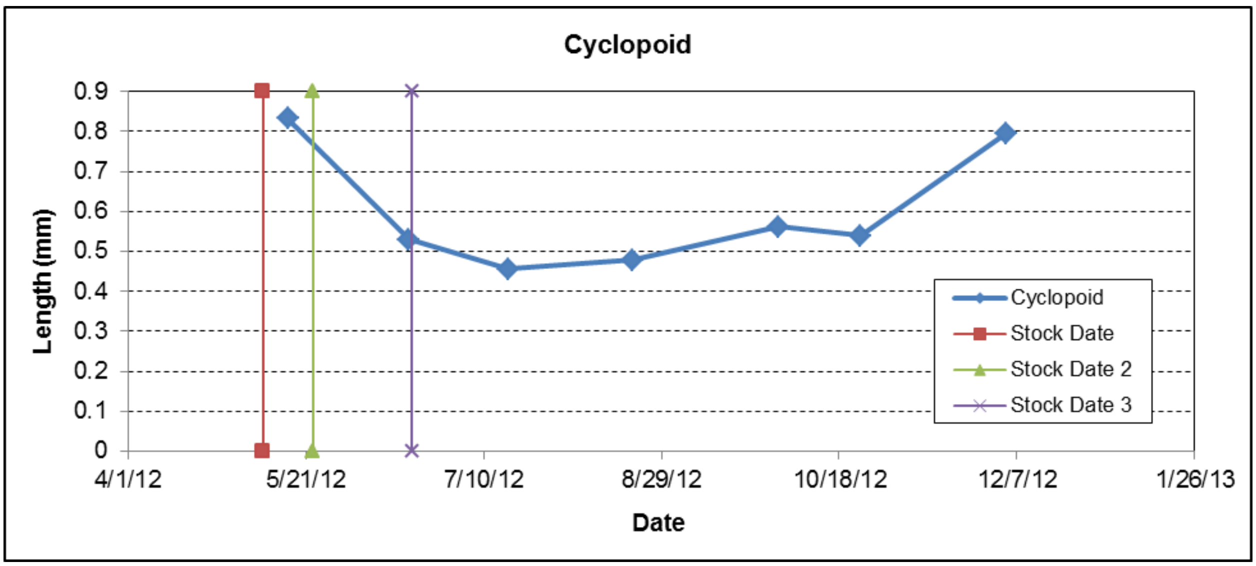


Figure 54. Average length (mm) of zooplankton collected from monthly samples in Elk Creek Reservoir, Idaho, in 2012.

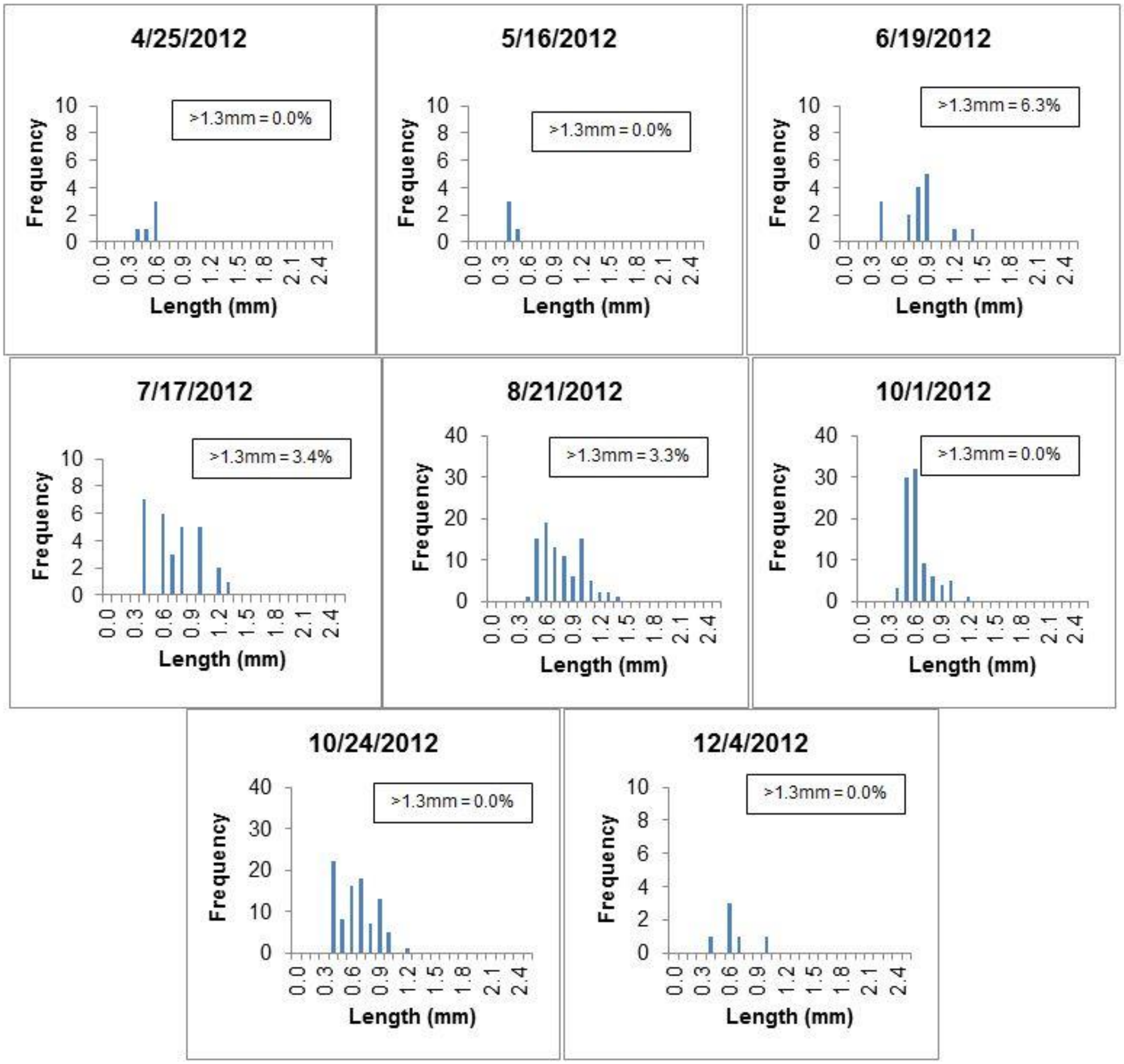


Figure 55. Length frequency distribution of Daphnia collected from monthly sampling in Elk Creek Reservoir, Idaho, in 2012.

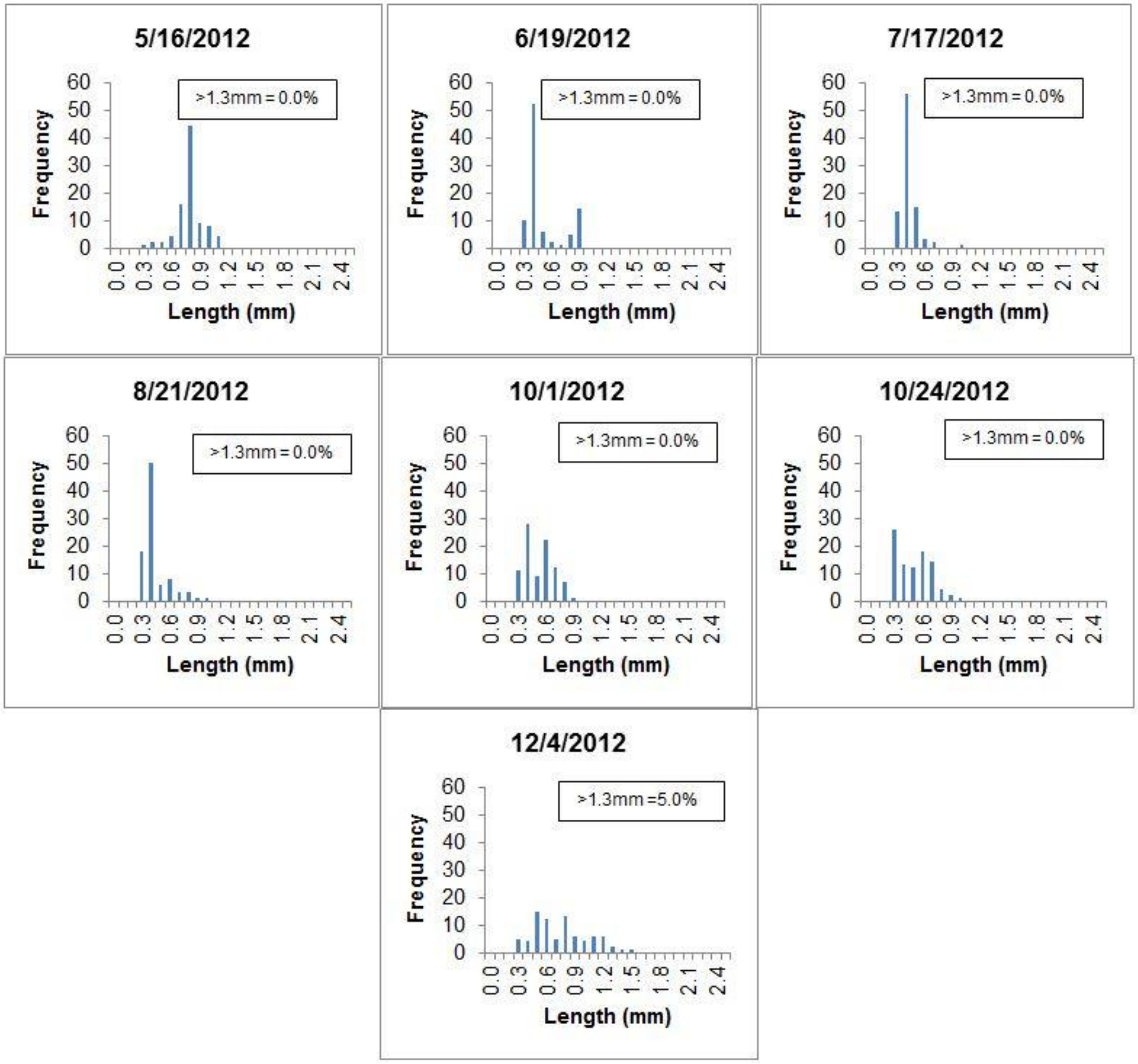


Figure 56. Length frequency distribution of Cyclopoida collected from monthly sampling in Elk Creek Reservoir, Idaho, in 2012.

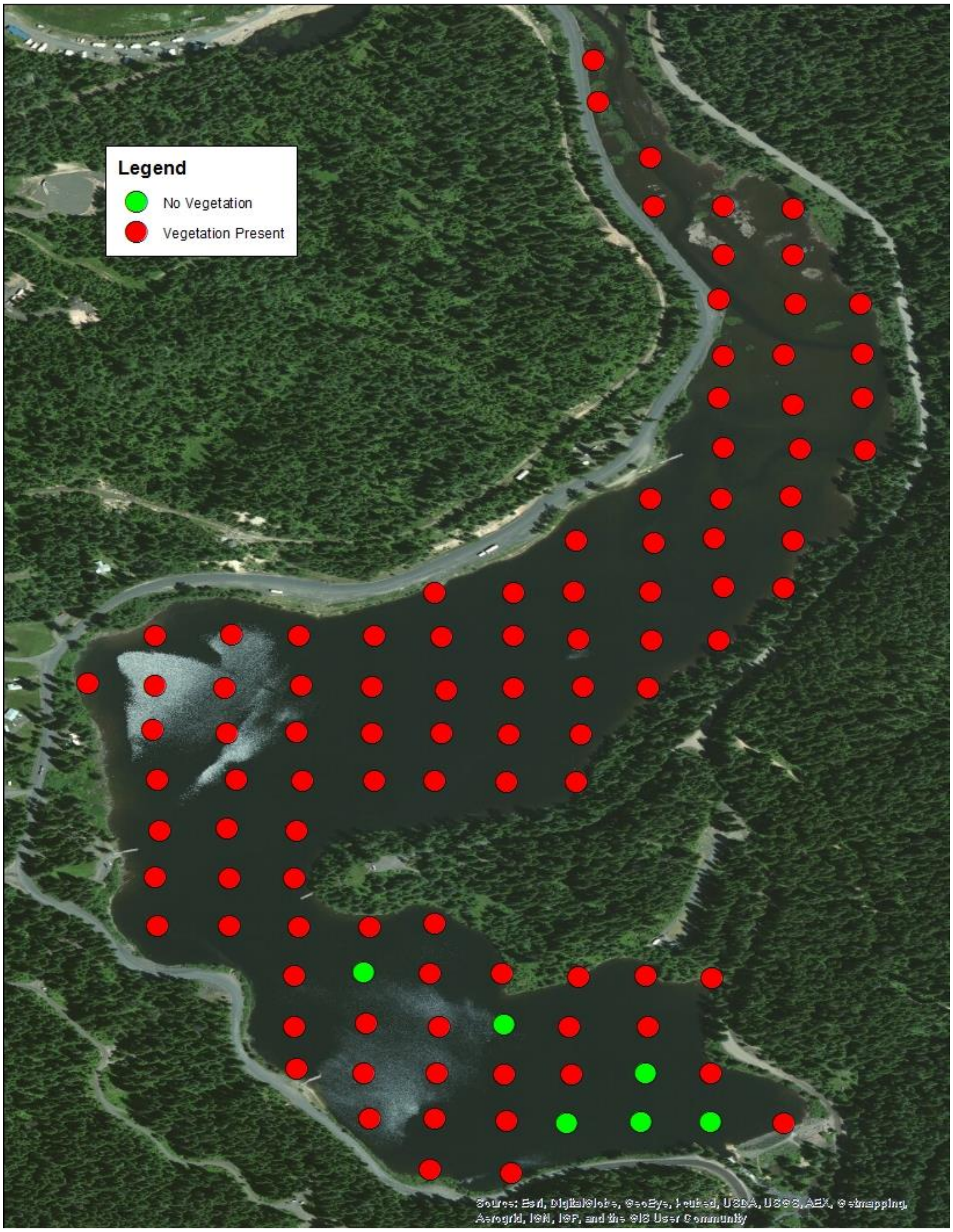


Figure 57. Locations where aquatic vegetation was collected during vegetation sampling in Elk Creek Reservoir, Idaho, during 2012.

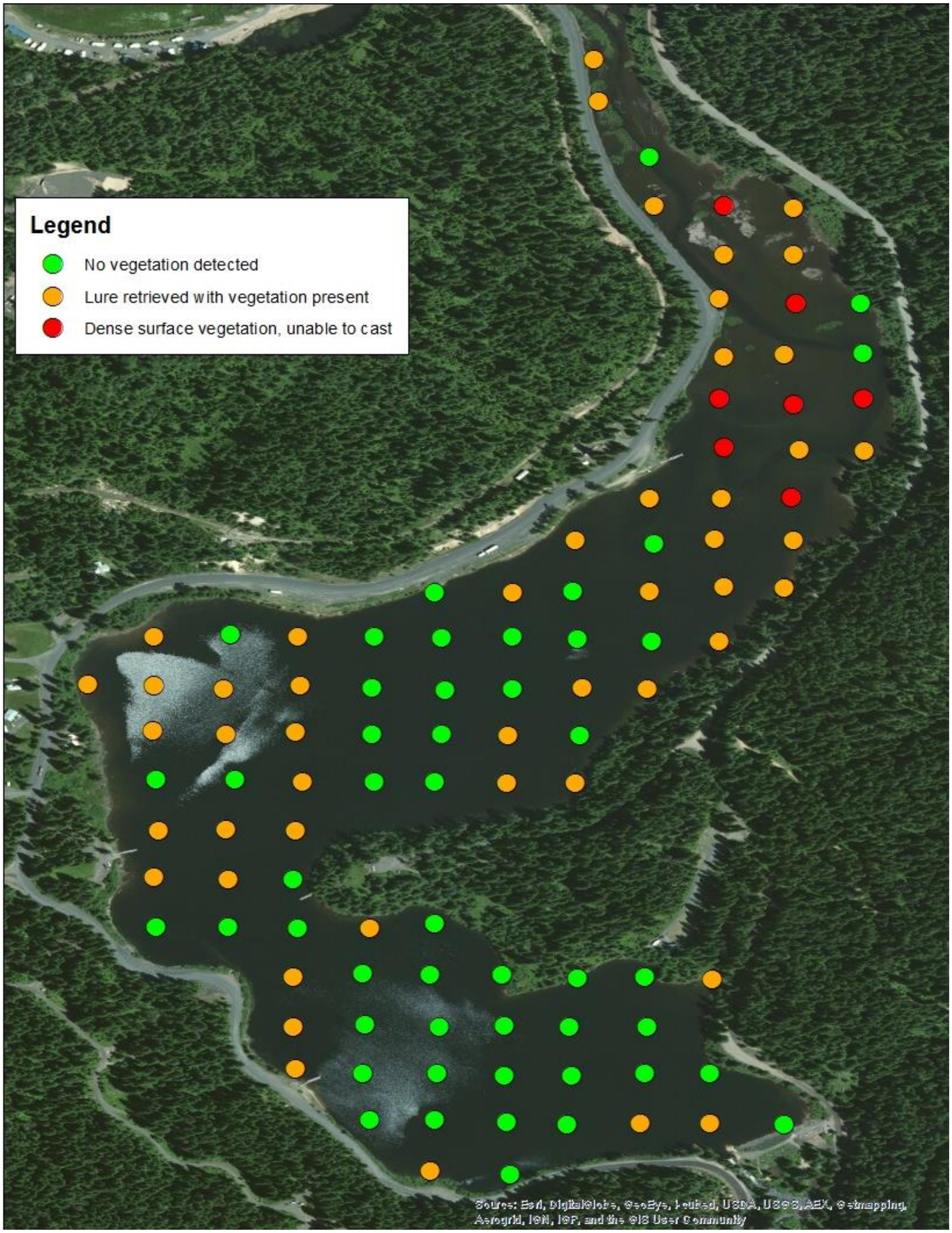


Figure 58. Fishability (using Davids' Fishability Index) at set locations in Elk Creek Reservoir, Idaho, during 2012.

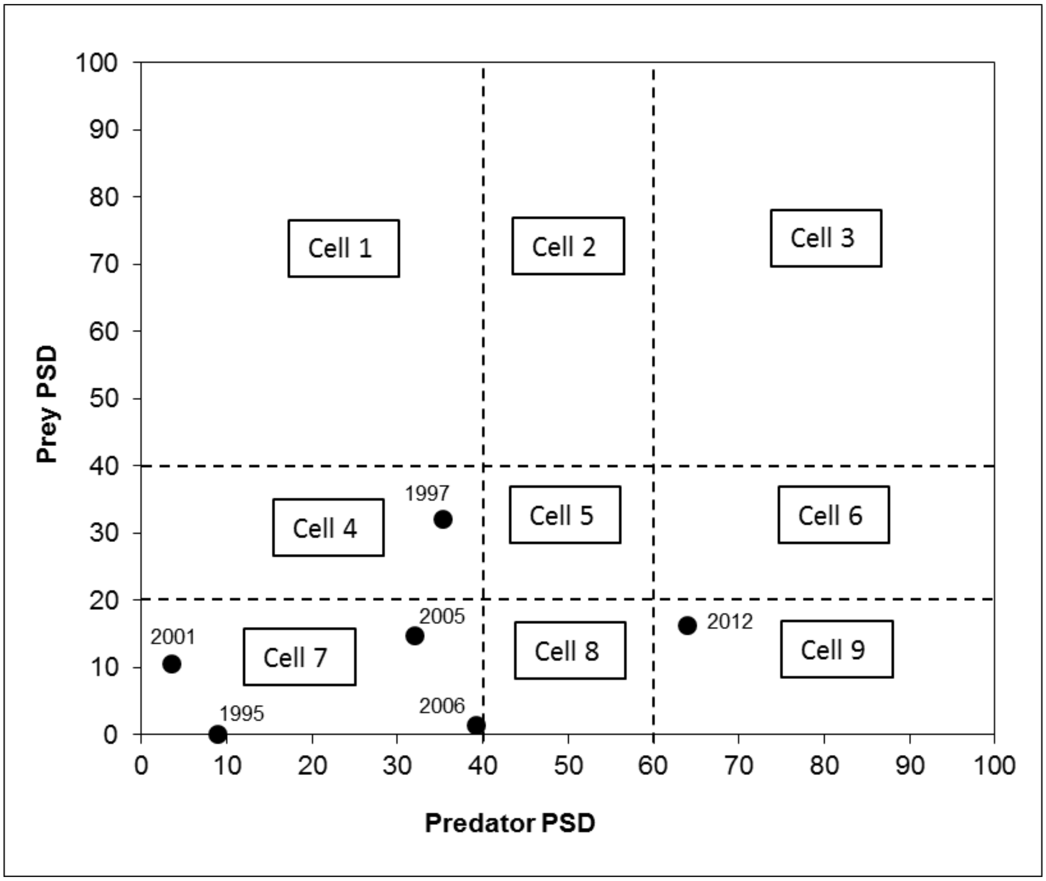


Figure 59. Comparison of predator (Largemouth Bass, Smallmouth Bass) and prey (Bluegill, Pumpkinseed, Black Crappie) proportional size distribution (PSD) from standard lake surveys conducted in Elk Creek Reservoir, Idaho, from 1995 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

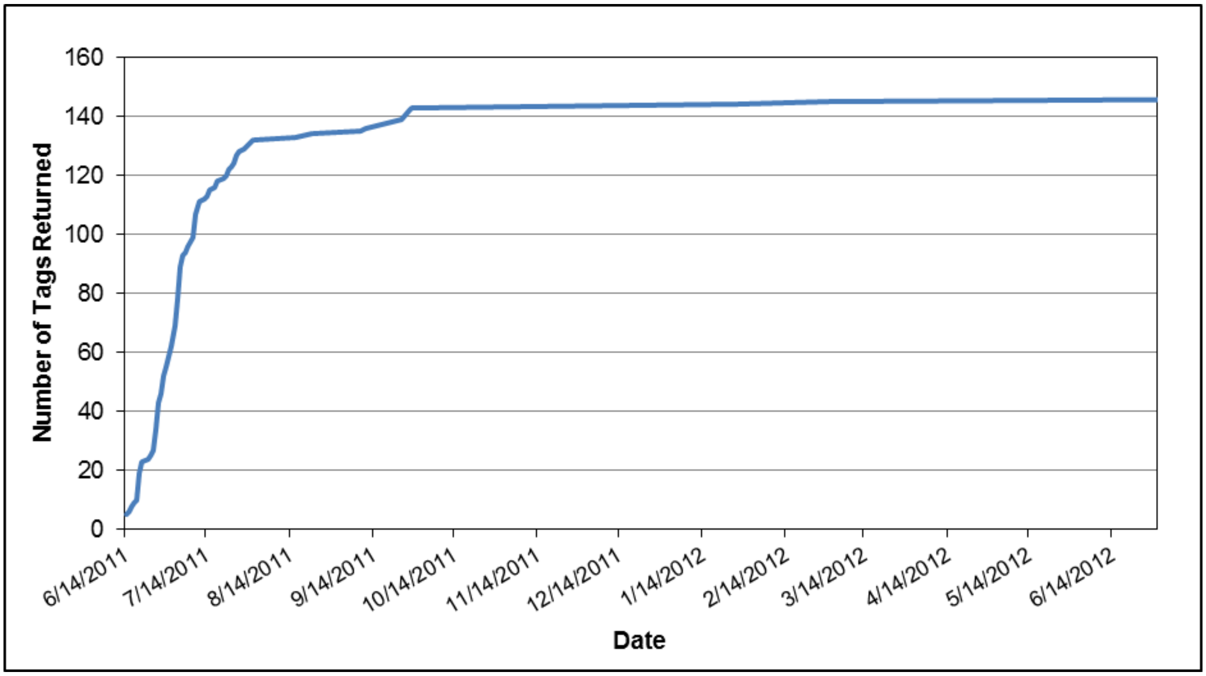


Figure 60. Cumulative number of hatchery catchable Rainbow Trout harvested from Elk Creek Reservoir, Idaho, from a June 14, 2011 stocking event, based on self-reported tag returns (400 fish tagged).

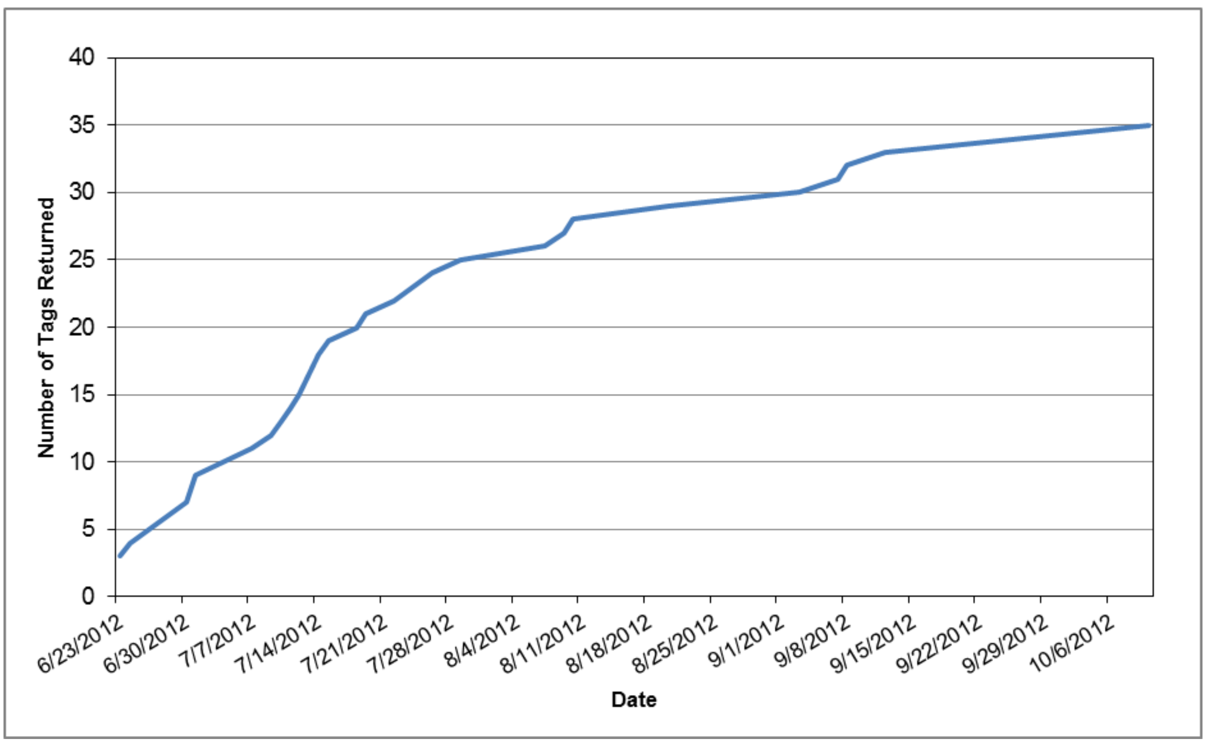


Figure 61. Cumulative number of hatchery catchable Rainbow Trout harvested from Elk Creek Reservoir, Idaho, from a June 20, 2012 stocking event, based on self-reported tag returns (400 fish tagged).

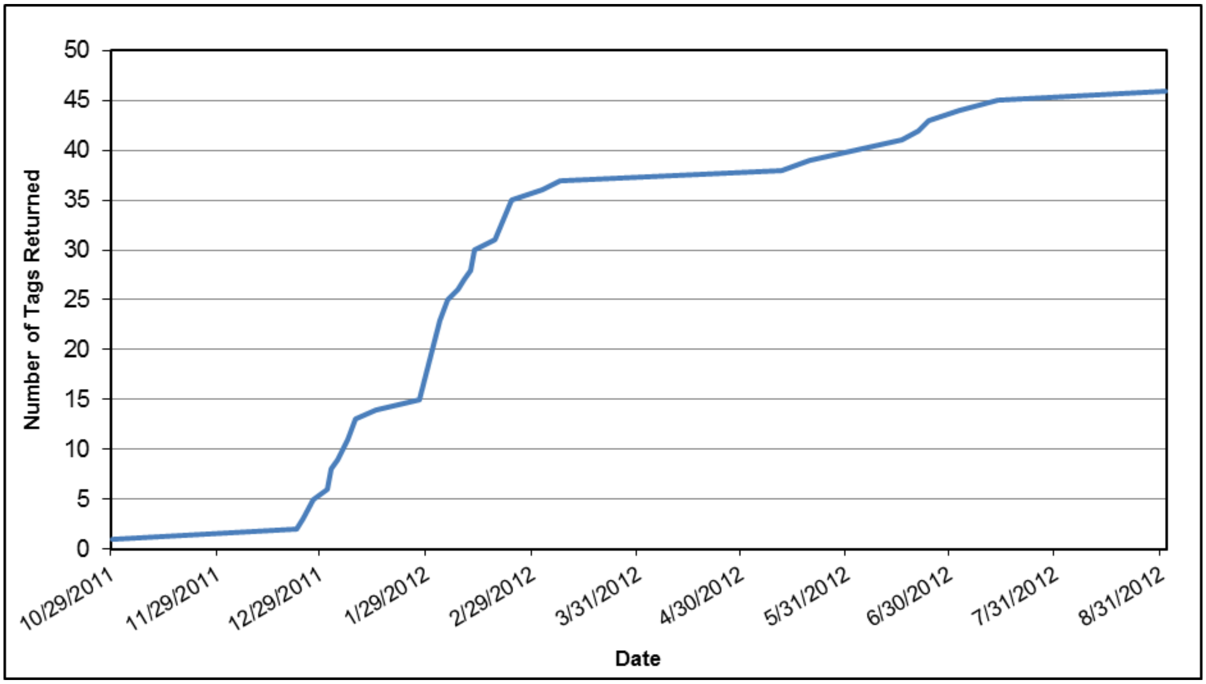


Figure 62. Cumulative number of hatchery catchable Rainbow Trout harvested from Elk Creek Reservoir, Idaho, from an October 26, 2011 stocking event, based on self-reported tag returns (397 fish tagged).

SPORTFISH ASSESSMENT OF MANN LAKE

ABSTRACT

In 2012, a comprehensive assessment of Mann Lake was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 172 fish including Black Crappie, Largemouth Bass, Black Bullhead, Pumpkinseed, Bluegill, and Channel Catfish. The results of this survey indicate that Mann Lake has a balanced predator:prey population, and a quality Largemouth Bass fishery.

Creel surveys estimated angler effort at 16,661 hours. This estimated effort was the lowest of the four creel surveys conducted on Mann Lake since 1993, and was a 22.7% decline from the high of 21,562 hours estimated in 2005. Angler effort declined in seven of the eight regional reservoirs surveyed in both 2005 and 2012. This decline may be a result of the declines in participation in outdoor recreation activities during the 1990's and early 2000's. However, these changes may also be the result of improvements in the accuracy of our creel survey methodology from 2005 to 2012.

The angler catch rate for all fish species combined was estimated at 1.2 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 0.8 fish/hour, well above the statewide management goal of >0.5 fish caught/hour. Tag returns for the fall stockings in 2011 and 2012 were 3.5% and 0%. Due to these very low return rates, and low levels of effort during the winter, we recommend the elimination of fall stockings of catchable size Rainbow Trout in Mann Lake.

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INTRODUCTION

Mann Lake is an important part of the Clearwater Region's lowland lake program, as it is the closest reservoir (3 km) to the largest population center in the Clearwater Region of Lewiston, ID, (pop. 32,119) and Clarkston, Washington (pop.7,331). An economic survey conducted in 2011 estimated 8,554 angler trips were taken to Mann Lake for an estimated total economic expenditure of $323,807 (IDFG unpublished data).

Mann Lake is largely targeted by anglers participating in the put and take hatchery Rainbow Trout fishery. Previous creel surveys have estimated that 21.1% - 89.8% of fish harvested from Mann Lake were hatchery Rainbow Trout (Hand 2009). Despite the popularity of trout fishing, Mann Lake also contains a significant warm-water fishery including Largemouth Bass, Black Crappie, Bluegill, Pumpkinseed, Black Bullhead, and Channel Catfish. The only non-game fish species documented is the Largescale Sucker *Catostomus macrocheilus*. In addition to fishing, Mann Lake is a popular location for other recreational activities such as bird watching, walking dogs, and taking children to play.

Current Management

Mann Lake is managed as a put-and-take trout fishery with approximately 36,020 catchable Rainbow Trout stocked in 2012 to maintain the management goal of >0.5 fish/hour catch rate (IDFG 2013). The lake is also managed to provide a Largemouth Bass fishery and a yield fishery on Black Crappie and Bluegill. Channel Catfish are stocked periodically to provide an additional fishing opportunity. General fishing regulations apply with the exception of a 305 mm minimum length limit for Largemouth Bass. Boat activity on Mann Lake is restricted to electric motors only, and no boats are allowed from October 1 - December 31. The current management priority is to provide a desirable fishing experience to a broad diversity of angler types.

Reservoir Management Goals

1. Maintain catch rate of >0.5 fish/hour for hatchery Rainbow Trout.

2. Maintain a Largemouth Bass fishery, and yield fishery for Black Crappie and Bluegill.

3. Diversify the fishery with periodic stockings of Channel Catfish.

STUDY SITE

Mann Lake is located 3 km east of Lewiston, Idaho (Figure 4). It is a 58 hectare reservoir that lies at an elevation of 549 meters. It has a mean depth of 6.4 meters, a maximum depth of 15.0 meters, and has a maximum volume of 1,740 acre-ft. It was originally constructed in 1907. Additional height was added to the dam in the 1950's. Mann Lake was most recently drained for repair in 1984. It is the final storage basin for the Lewiston Orchards Irrigation District's (LOID) watershed. Annual water level fluctuations are common in Mann Lake. The magnitude of these fluctuations depends on the water yield of the LOID-managed watershed and irrigation demands. The water level generally falls during the summer months when residential irrigation demands are high. The reservoir will remain below full pool until the following spring run-off. Spawning success and recruitment of warm water species can be greatly affected by annual water level fluctuations. However, largemouth Bass production and predator/prey interactions can both be benefited by these drops in water level late in the summer.

RESULTS

Population Survey

A fishery survey of Mann Lake was conducted on May 24, 2012. Six 10-minute electrofishing periods were conducted on the reservoir for a total of 3,600 sec. of electrofishing effort. The electrofishing and one overnight trap net set resulted in the capture of 172 fish including Black Crappie (n = 57), Largemouth Bass (n = 51), Black Bullhead (n = 26), Pumpkinseed (n = 20), Bluegill (n = 14), and Channel Catfish (n = 4; Figure 63). The electrofishing catch rate was 172.0 fish/hour. No fish were collected in the trap net. Due to a data collection error, the first three 10-minutes electrofishing samples were combined on the datasheets. Catch rates for the other three 10-minute samples ranged from 23 - 51 fish/sample (Table 12).

Largemouth Bass:

Largemouth Bass collected ranged from 70 - 516 mm in TL (Figure 64), with an average TL of 205 mm. Eleven of the 56 fish collected (19.6%) were over 300 mm in length. This is slightly above the average of 18.9% of the sample >300 mm for the seven surveys conducted since 1993. Largemouth Bass CPUE (51 fish/hour) was the fourth highest since 1993 (Figure 63). Largemouth Bass PSD was 54 in 2012 (Figure 65). This was an increase over 2010 and continues a general upward trend seen since 2001. Relative weight ranged from 58 - 134, with an average of 101 (Figure 66). Relative weight was slightly higher for larger fish than for smaller fish. Largemouth Bass age (n = 49) ranged from 1 - 8 years (Table 13). Annual growth rates ranged from 27 - 91 mm. Annual instantaneous mortality (Z) was -0.325 for fish aged 1 - 6 (R^2 = 0.855). Thus, the annual survival rate (S) was 72.3%, and total annual mortality (A) was 27.7% (Figure 67).

Black Crappie:

Black Crappie collected ranged from 69 - 315 mm in length (Figure 68), with an average of 116 mm. Most of the fish (71.9%) were between 69 - 110 mm. Length frequency distributions shifted towards larger fish in samples collected from 2003 - 2010. Black Crappie CPUE (57 fish/hour) was the third highest since 1993 (Figure 63). The PSD of 31 in 2012 (Figure 69) was the second straight decline since 2007. Relative weights ranged from 57 - 121, with an average of 85 (Figure 70). Relative weight was generally higher for larger fish than for smaller fish. Black Crappie collected in 2012 (n = 57) ranged in age from 1 - 5 years (Table 14). Annual growth rates ranged from 28 - 79 mm. Annual instantaneous mortality (Z) was -1.040 for fish aged 1 - 3 (R^2 = 0.981). Thus, the annual survival rate (S) was 35.4%, and total annual mortality (A) was 64.6% (Figure 71).

Bluegill:

Bluegill collected ranged from 107 - 165 mm in length, with an average of 133 mm (Figure 72). Bluegill CPUE (14 fish/hour) was the second lowest since 2001 (Figure 63). The PSD of 55 in 2012 (Figure 73) was the second highest for samples collected since 2001. Relative weights ranged from 64 - 135, with an average of 111 (Figure 74). Relative weight was generally higher for larger fish than for smaller fish. Bluegill ranged in age from 1 - 3 years (n = 14) (Table 15). These fish (Table 15). Annual growth rates ranged from 48 - 54 mm. A catch curve for estimating mortality could not be developed due to low sample sizes.

Pumpkinseed:

Pumpkinseed collected ranged from 61 - 193 mm in length, with an average of 149 mm (Figure 75). Most of the fish (75.0%) were between 140 - 189 mm. Length frequency distributions have been fairly similar since 2000, with the majority of fish in the 120 - 200 mm range each year. Pumpkinseed CPUE (20 fish/hour) was the second lowest since 2001 (Figure 63). The PSD of 75 in 2012 was the second highest of any sample collected since 2001 (Figure 76). Relative weights ranged from 94 - 131, with an average of 108 (Figure 77). Relative weight was generally lower for larger fish than for smaller fish. Scale samples were analyzed from Pumpkinseed collected in 2012 (n = 20). These fish ranged in age from 1 - 4 years (Table 16). Annual growth rates ranged from 19 - 73 mm. A catch curve could not be developed to calculate mortality due low sample size.

Channel Catfish:

Channel Catfish collected ranged in length from 292 - 433 (Figure 78), with an average of 355 mm. Black Bullhead collected ranged from 76 - 385 mm in length (Figure 79), with an average of 227 mm.

Creel Survey

Angler Effort:

Creel surveys were conducted on Mann Lake from November 28th, 2011 through November 28th, 2012. A total of 185 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 16,661 hours (SE ± 1,449; Table 17). This was the lowest of the four creel surveys conducted on the reservoir since 1993 (Figure 1). Slightly more effort occurred on weekdays (53.5%) than weekends (46.5%). Effort consisted of 70.3% bank, and 29.7% boat anglers. There was no ice fishing on Mann Lake during the survey. The highest angler effort occurred from April - August, with monthly effort estimates during that period ranging from 1,567 - 3,819 hours (Table 17).

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on Mann Lake was based on 636 completed trip interviews. Anglers caught an estimated 17,848 fish during 2012, resulting in a catch rate of 1.2 fish/hour. Hatchery Rainbow Trout accounted for 71.7% (n = 12,802) of the fish caught during the 2012 creel survey (Figure 80). Catch of warm-water species included 2,431 Black Crappie (13.6%), 1,189 Bluegill (6.7%), 984 Largemouth Bass (5.5%), 257 Channel Catfish (1.4%), 105 Black Bullhead (0.6%), and 81 Pumpkinseed (0.5%). Anglers harvested an estimated 8,997 fish during 2012 (Appendix A), 50.4% of the fish caught. The harvest rate for all fish combined was estimated to be 0.6 fish/hour. Harvest in 2012 consisted of 81.2% hatchery trout (n = 7,307), 11.9% Black Crappie (n = 1,189), 3.7% Bluegill (n = 331), 1.9% Channel Catfish (n = 169), 0.5% Pumpkinseed (n = 49), 0.5% Black Bullhead (n = 49), and 0.2% Largemouth Bass (n = 18; Figure 81). All harvested fish encountered during creel surveys were measured for total length. Harvested Largemouth Bass measured by creel clerks (n = 3) ranged in length from 216 - 447 mm, and averaged 332 mm (Figure 64). Harvested Bluegill measured by creel clerks (n = 17) ranged in length from 143 - 264 mm, and averaged 175 mm (Figure 72). Harvested Black Crappie measured by creel clerks (n = 90) ranged in length from 162 - 330 mm, and averaged 230 mm (Figure 68). Harvested Channel Catfish measured by creel clerks (n = 19) ranged in length from 279 - 487 mm, and averaged 396 mm (Figure 78).

A total of 12,802 hatchery Rainbow Trout were estimated to have been caught during the survey, with 7,307 harvested (Appendix B). No holdover Rainbow Trout were caught or harvested. This is a catch rate of 0.8 fish/hour and a harvest rate of 0.5 fish/hour. The majority of the fish (76.2%) were harvested from April - July (Appendix C), with all fish harvested from April - September. The estimated exploitation rate was 20.7%. Harvested Rainbow Trout measured by creel clerks (n = 374) ranged in length from 206 - 325 mm, and averaged 271 mm.

Angler Satisfaction:

A total of 848 public opinion surveys were conducted at Mann Lake in conjunction with the creel survey. All constituents using the lake were interviewed. Fifty-two percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 82). “Other” (36.8%) and bird watching (8.3%) were the next most common responses. Of the people interviewed, 70.3% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at Mann Lake. Fifty-three percent of people interviewed rated their fishing experience as excellent or good (Figure 83). The most common reasons for a positive rating were related to good fishing (21.6%) and “nice to be outside” (16.3%; Figure 84). Forty-seven percent of people interviewed rated their fishing experience as fair or poor (Figure 83). The most common reasons for a negative rating were related to poor fishing (36.5%; Figure 84).

The most commonly targeted fish species was hatchery Rainbow Trout (32.6%; Figure 85). Thirty-eight percent of people interviewed were not targeting a particular fish species while fishing. Warm-water species comprised 27.9% of the targeted fish species responses for Mann Lake.

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery catchable size Rainbow Trout stocked in Mann Lake in 2011 and 2012. Rainbow Trout were tagged on April 7, 2011 (n = 400), May 10, 2011 (n = 399), October 12, 2011 (n = 199), April 04, 2012 (n = 600), and October 10, 2012 (n = 400). Exploitation rates through 365 days at large averaged 28.3% for the spring 2011 tagging event (Table 18), 1.2% for the October, 2011 events, 21.6% for the April 2012 events, and 0.0% for the October, 2012 event. There was no exploitation beyond 365 days at large. Angler total use (fish harvested plus fish released) rates through 365 days at large (Table 18; Appendix D) averaged 46.5% for the spring 2011 tagging events, 3.5% for the October, 2012 events, 27.7% for the April 2012 events, and 0.0% for the October 2012 stocking.

An angler exploitation survey was conducted on Largemouth Bass collected during a standard lowland lake survey on May 30, 2012 (n = 20). Through June, 2014, four tagged fish had been reported caught. None of these fish were harvested, resulting in an estimated annual exploitation rate of 0.0%, and total use rate of 44.0%

Limnology

Limnology samples were collected monthly from April - November, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being evident. Dissolved oxygen profiles in April, October, and November were very homogenous, while typical anoxic conditions were present in the hypolimnion from late May through August (Figure 86). Monthly temperature measurements showed very similar patterns in each month, with little change in most months (Figure 86). To look at potential diel changes in temperature and DO profiles, measurements were taken at 19:30 on August 16, 2012, and at 05:57 and 11:00 on August 17, 2012 (Figure 87). There were noticeable drops in DO down to 3.0 m overnight, but almost no change in temperature.

Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. In June and July, water temperatures were >21°C down to a depth of 2 m and 4 m (Figure 88). In August, water temperature was >21°C down to a depth of 10 m (Figure 88). Dissolved oxygen levels <5.0 mg/L occurred below 4 m from June - September. These conditions resulted in no water in Mann Lake being conducive for Rainbow Trout survival in July and August (Figure 88). Utilizing an upper thermal limit of 25°C, 39.8% of the water volume would have been conducive for Rainbow Trout survival in the month of July (Figure 88).

Zooplankton

Zooplankton samples were collected monthly from April - November, 2012. The population was composed of six taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Bosmina, Ceriodaphnia, and Calanoida. The community composition changed substantially throughout the field season (Figure 89), with Daphnia, Cyclopoida, Bosmina, Calanoida and Ceriodaphnia all making up the majority of at least one sample.

Densities (# of individuals/m^3) were also highly variable. Bosmina densities were 137,006/m^3 in April, but dropped to <600/m^3 the rest of the year (Figure 90). Calanoioda, Daphnia, and Cyclopoida densities all followed similar trends. Daphnia densities dropped from a high of 40,871/m^3 in April, but rebounded in the fall. The densities of these taxa all dropped substantially after the first stocking of Rainbow Trout. Chydoridae (77,433/m^3) and Ceriodaphnia (1,161/m^3) densities peaked in August, but remained low the rest of the year (Figure 90). Average lengths of Daphnia ranged from 0.90 - 1.26 mm (Figure 91), with a slight decline through the year. Average lengths of Cyclopoida ranged from 0.41 - 0.66 mm (Figure 91) and also declined through the year. Length frequency distributions from each sample show that the percent of Daphnia >1.3 mm in length ranged from 8.9 - 41.1% of the individuals (Figure 92). Length frequency distributions for from each sample show that no Cyclopoids >1.3 mm in length were collected (Figure 93).

Additionally, ZQI sampling was conducted on August 23, 2012. Biomass was above the regional average at 0.83 (g/m^3) for the 150 µm net, but below the regional average at 0.05 (g/m^3) for the 500 µm net and 0.02 (g/m^3) for the 750 µm net (Appendix E). The ZPR was calculated to be 0.37 and the ZQR was 0.03, both of which were also below the regional average.

Aquatic Vegetation

Vegetation surveys were conducted on August 8, 2012. A total of 97 sites were sampled. Vegetation was collected by rake tosses at 22 (22.7%) sample sites (Figure 94). Four types of vegetation were identified: filamentous algae, macrophytic algae, pondweed, and smartweed *Polygonum amphibium*. Filamentous algae was the most commonly encountered vegetation, occurring at all 22 sites (22.7%) where vegetation was collected (Appendix F). Macrophytic algae (21.6%) was the second most common, followed by pondweed (9.3%) and smartweed (2.1%). Sample sites along the shoreline accounted for 25.8% (n = 25) of all sample sites. Vegetation was collected at 72.0% of these sites. Additionally, 81.8% (n = 18) of all sample sites with vegetation were along the shoreline (Figure 94).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 97 sites. No vegetation was encountered at 89 (91.8%) of the sites (Figure 95). Vegetation was encountered at 8 (8.2%) sites. Vegetation was present on hooks at all eight sites. There were no sites where lures were broken off on vegetation, nor where dense matted surface vegetation prevented casting. The DFI and rake toss sampling showed similar patterns of shoreline vegetation. Eight percent of the DFI sites sampled were negatively affected by vegetation; however, none were rendered unfishable. Eighty-eight percent of these sites were along the shoreline, with 28.0% of shoreline sites being negatively influenced by vegetation according to the DFI.

DISCUSSION

Population Survey

Hatchery Rainbow Trout provide an excellent put-and-take fishery for Mann Lake, while Largemouth Bass and Black Crappie provide warm-water fishing opportunities. Little has changed in the Mann Lake fishery over the last seven samples other than the Black Crappie fishery (Figure 63). Black Crappie declined in numbers from 2001 - 2010. This was primarily due to the presence of excellent recruitment during the early 2000's, which resulted in a very large population of smaller fish and very high angler harvest rates. As these successful recruitment years ended, harvest and natural mortality reduced the population size while increasing fish length. This is easily apparent in PSD values over this time period (Figure 69). In 2012, CPUE increased again, indicating that we may be experiencing another period of good recruitment. Other warm-water fish species have seen some fluctuations in CPUE, but no obvious trends appear.

The 2012 fish population survey was conducted in six 10-minute electrofishing samples. The variability from the six samples was to be used to estimate statistical power and sample size for future surveys (IDFG 2012). However, due to a data recording error, the first three 10-minute samples were combined on the datasheet, and were therefore not included in the statistical analysis. Thus, the estimate of the number of samples needed is based on only three samples. For 90% confidence (2-tail test) and 25% precision, eleven 10-minute samples would be needed for a whole fish community survey (Table 12). Due to the data error, we will conduct enough 10-minute samples in order to sample the entire shoreline.

Largemouth Bass:

As with other species in the reservoir, the Largemouth Bass population in Mann Lake appears to be meeting objectives. Of the 807 Largemouth Bass collected during lake surveys since 2001, 38.8% (n = 313) were >250 mm and 29.2% (n = 236) were >300 mm. This is higher than the 6.0% >300 mm at Winchester Lake, 10.8% >300 mm at Spring Valley Reservoir, and 22.3% >300 mm at Moose Creek Reservoir. This has resulted in PSD values near or within the balanced population range of 40 - 60 for every survey since 2003 (Anderson 1980). Some of this is likely attributable to the 305 mm minimum size limit in effect on Mann Lake.

The slow growth experience by Largemouth Bass in many regional reservoirs does not appear to be an issue in Mann Lake. Largemouth Bass collected in 2012 averaged 205 mm in length at capture, below the average of 228 mm for regional reservoirs (Appendix J). However, growth rates ranged from 12 - 91 mm per year, well above the regional average for fish age 1 - 7. The higher than average growth for older fish was likely influenced by small sample size (n = 1) for fish age 8 and 9. Average length at age was above the regional average for fish aged 3 - 8 (Appendix J). This above-average growth has resulted in Largemouth Bass at Mann Lake entering the fishery (stock size of 200 mm) at age 3, and reaching quality size (300 mm) at age 4 (Appendix K). The regional average to stock size is age 3 and to quality size is age 5 (Appendix K). This age to quality size is below the average age of 4.4 years for 40 Idaho populations described by Beamesderfer and North (1995), and comparable to the modeled estimate of 4 years based on thermal degree days described by McCauley and Kilgour (1990). The above average growth is most likely due to Mann Lake's elevation being the lowest among regional reservoirs. This provides a longer growing season that occurs at the other reservoirs.

Creel surveys of Mann Lake estimated that 18 Largemouth Bass were harvested in 2012. It is worth noting that one Largemouth Bass below the minimum length limit was encountered in the creel survey. This suggests that there is some illegal harvest of smaller fish occurring in the reservoir. Using the population estimate of 697 fish >200 mm calculated for Mann Lake by Hand et al. (2012), angler exploitation was 2.6% based on harvest estimated during the 2012 creel survey. This is close to the exploitation rate of 0.0% estimated from Largemouth Bass tagged in 2012 (Meyer et al. 2009; IDFG unpublished data). Allen et al. (2008) found the average fishing mortality rate of Largemouth Bass populations to be 30.0% for 32 separate studies, suggesting Mann Lake has much lower bass harvest than expected. Total annual mortality of Largemouth Bass in Mann Lake was estimated to be 27.7% from data collected in 2012. This is below the average of 40.0% estimated for regional reservoirs (Appendix J), and below the average total annual mortality of 57.0% for the populations analyzed by Allen et al. (2008). From this data for Mann Lake, we can estimate that total natural mortality is 25.1 - 27.7%, above the 18% average estimated for the 40 Idaho populations described by Beamesderfer and North (1995).

Bluegill:

The Bluegill population has seen little change in the range of length (mostly 110 - 210 mm) over the three samples collected since 2007. Similarly, there has been little change in PSD since 2003, with values staying within the range of 20 - 60 which is considered indicative of a balanced population. However, PSD was below the regional average of 49 for Bluegill (Appendix I). The average length of Bluegill (133 mm) in Mann Lake was also below the regional average (141 mm) of the six lakes surveyed that contain Bluegill (Appendix I). Annual growth of Bluegill in Mann Lake ranged from 45 - 54 mm. Each year's growth was near or above the regional average (Appendix I). On average, Bluegill reach stock size (80 mm) at age one, the earliest age of any regional reservoir.

The Bluegill harvested by anglers in Mann Lake during 2012 were in the upper end of the range of lengths found in the population (106 - 165 mm), and averaged (175 mm) much larger than the population average of 131 mm (Figure 72). This is to be expected, as anglers usually prefer to keep the larger fish they catch (Aday and Graeb 2012). Not enough Bluegill were collected in the standard lake survey to calculate mortality rates. Considering that an estimated 333 Bluegill were harvested, with an average length of 175 mm, Mann Lake supports a small but quality Bluegill fishery.

Black Crappie:

The results of the fish survey show that the Black Crappie population was dominated by smaller fish, mostly age 1 - 2 (Table 14). This was not surprising, as highly variable recruitment in crappie populations is common in smaller reservoirs (Beam 1983; McDonough and Buchanan 1991; Allen 1997). The successful recruitment years do not coincide across reservoirs in the Clearwater Region, indicating that environmental factors are not the primary driving force behind successful year classes. Over the last 3 - 4 years, anglers have reported catching fewer but larger fish. The Black Crappie harvested by anglers in Mann Lake during 2012 were in the upper end of the range of lengths found in the population (69 - 315 mm), and averaged (230 mm) much larger than the population average of 116 mm (Figure 68). This average is above the quality size of 230 mm (Gablehouse 1983). With an estimated 1,071 Black Crappie harvested at an average length of 230 mm, Mann Lake still supports a small but quality crappie fishery despite the fluctuations caused by variable recruitment.

Pumpkinseed:

The Pumpkinseed population has seen little change in the range of lengths (mostly 70 - 200 mm) over the five samples collected since 2001. Proportional Size Distribution has shown some fluctuation from 36 - 80, with values generally above the range of 20 - 60 considered indicative of a balanced population. These values are higher than those seen in SVR (29) and MCR (8) in 2012. The average length of Pumpkinseed (133 mm) in Mann Lake was also above the average seen in SVR (131 mm), and MCR (123 mm). Annual growth of Pumpkinseed in Mann Lake ranged from 26 - 73 mm, much higher than the range seen in MCR (5 - 40 mm) and ECR (7 - 29 mm). On average, they reach stock size (80 mm) at age two, which was faster than in MCR and ECR (3 years). This is not surprising, as Mann Lake has better growing conditions due to its warmer water and lower elevation. With only an estimated 49 Pumpkinseed harvested in 2012, no regulations are needed to protect against overharvest.

Warm-water Fishes Predator:Prey Dynamics:

A comparison of predator and prey PSD values can provide a good assessment of population balance (Schramm and Willis 2012; Figure 96). In Mann Lake, all six samples occur in Cells 1 - 3, with most being either in or near Cell 2 (Figure 96). Fish communities that fall into Cell 2 generally are considered to be in balance, with a relatively abundant population of quality prey species. However, it could also indicate that prey spawning or recruitment may be limited. This is a possibility in Mann Lake, as Black Crappie are a major component of the available prey, and they experience variable recruitment in this reservoir.

In most years, summer drawdowns occur late enough that spawning in not likely affected. Water level drawdowns are often used intentionally to manage fish populations. They can stimulate fish productivity by reestablishing conditions similar to when a reservoir was first filled (Miranda and Muncy 1987; Cooke et al. 2005). Other potential effects are increased predation on stunted prey populations, reduced predation on eggs by Centrarchids, and reduced competition for resources for young-of-year Largemouth Bass (Heman et al. 1969; Miranda et al. 1984). The result can be improved sport fisheries through increased biomass and sizes of game fish, and a reduction in abundance of stunted Bluegill, crappie, or other planktivores. These effects of water level drawdown are likely contributing to the quality warm-water fishery found in Mann Lake.

Overall, the data for Mann Lake indicates that the reservoir has a healthy balance of both predator and prey species. With the combination of larger Largemouth Bass, numerous harvestable prey species, and hatchery catchable Rainbow Trout, the only recommended change to the current management of the reservoir or regulations is eliminate fall stocking of hatchery Rainbow Trout.

Creel Survey

Angler Effort:

The year-long creel survey resulted in an estimated 16,661 hours of angler effort in 2012. This was the third highest effort of the nine regional reservoirs surveyed (Figure 1). However, it was the lowest level effort of the four creel surveys conducted on Mann Lake since 1993, and was a 22.7% drop from the 21,562 hours estimated in 2005 (Figure 1). Similarly, angler effort declined in seven of the eight regional reservoirs (87.5%; Figure 1) surveyed in both 2005 and 2012. Additionally, three other reservoirs (Spring Valley Reservoir, Soldier's Meadow Reservoir, and Elk Creek Reservoir) have experienced steady declines in effort over all four creel surveys conducted since 1993.

There may be several reasons for the decline in effort seen in Mann Lake. An actual decline in effort is, of course, the most likely reason. Declines in participation in outdoor recreation activities during the 1990's and early 2000's, including fishing and hunting, have been well documented (USFWS 2006; DFO 2007; Cordell et al. 2008; Sutton et al. 2009) as people have more and more choices competing for their free time. Studies (Felder and Ditton 2001; Sutton 2007; Sutton et al. 2009) have shown large percentages of anglers fish less often than they used to, primarily due to "work/family commitments" (46 - 75%) and "other leisure activities" (41 - 46%). Economic surveys conducted by IDFG in 2003 and 2011 (Table 2) show a similar trend, with most regional reservoirs (87.5%) experiencing declines in effort (total trips). However, there is data that contradicts these trends. Sales of fishing licenses in Idaho have shown an overall increasing trend from 1993 - 2012 (Appendix H). While this does not directly correlate to effort in a given lake, it does provide some evidence that participation in fishing in Idaho is not necessarily declining.

A second potential cause for the decline in effort is the accuracy of our creel surveys. The 2012 creel survey is likely more accurate than previous surveys, as it was conducted using more angler counts and interviews. Additionally, more appropriate creel survey and statistical analysis methods were incorporated in the study design. Previous creel surveys were conducted with minimal staff, and therefore effort/catch/harvest may be more biased due to small sample sizes of angler counts and interviews. This bias could have inflated effort estimates during previous surveys.

Catch and Harvest:

Based on the 2012 creel survey, most anglers either stated that they were fishing for "any fish" (37.9%), or targeted hatchery Rainbow Trout (32.6%; Figure 81). Black Crappie (14.4%) and Largemouth Bass (12.6%) were also of importance to anglers. Harvest rates for hatchery Rainbow Trout declined from a high of 0.9 fish/hr in 1993 to a low of 0.4 fish/hour in 2005. The harvest rate then rose slightly to 0.5 fish/hour in 2012. However, the hatchery Rainbow Trout exploitation rate has declined in each survey from a high of 57.6% in 1993 to a low of 20.7% in 2012. This is likely related to lower angling effort at Mann Lake.

Harvest composition in 2012 changed substantially from the 1999 and 2005 surveys, with most of the harvest consisting of hatchery Rainbow Trout (Figure 81). Warm-water species accounted for 40.7% of the harvest in 1999 and 88.9% of the harvest in 2005, but dropped to 18.8% of the harvest in 2012. This change is likely due to a decline in the size of the Black Crappie population. Black Crappie have been a very popular fish in Mann Lake since around 2003, when several successful years of recruitment created a very large population. In 2005, anglers harvested an estimated 28,041 Black Crappie (Hand 2009), and continued to report excellent fishing for several years afterwards. With the harvest of warm-water species declining to 1,690 fish in 2012, the harvest composition has shifted back to primarily hatchery Rainbow Trout, even though their harvest numbers have declined as well.

Catch rates for hatchery Rainbow Trout have been above the management goal of >0.5 fish/hour in each creel survey since 1993. With catch rates above our management goal, and 81.2% of the fishery supported by catchable Rainbow Trout in 2012, reducing catchable trout stocking is not recommended. However, observations made during creel surveys concluded that no Rainbow Trout stocked as fingerlings were harvested during creel surveys in 1999 - 2012. The failure of fingerling establishment in Mann Lake is likely due to competition and predation from Black Crappie and Largemouth Bass, as well as warm summer temperatures which limit carryover in this reservoir. Thus, future fingerling stockings should be discontinued.

Anglers harvested an estimated 171 Channel Catfish in 2012. This is the highest estimated harvest for the four surveys conducted since 1993. While representing a small portion of the effort and harvest in Mann Lake, these fish do provide a diversity of fishing opportunity. Creel clerks measured 19 of the fish harvested in 2012, and these fish ranged in length from 279 - 487 mm, with a 396 mm average. These were all at or above the 280 mm considered to be stock size, and averaged near the 411 mm considered to be of quality size (Gablehouse 1983) for Channel Catfish. Considering the size of fish caught in 2012, plus the fact that the Idaho state record was caught there in 2001, Mann Lake continues to have an excellent Channel Catfish fishery. As such, Channel Catfish should continue to be stocked in Mann Lake.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (53.9%) rated their fishing trip as “Good” or “Excellent” (Figure 83). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 62.3% of the responses. While the quality of fishing played the major role in one’s fishing experience, the most common other response was “nice to be outside” (16.3%). This indicates that an enjoyable fishing trip is not completely predicated upon the quality of the fishing, but is often due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as simplified fishing rules, year-round fishing opportunities, easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself. Thus, we recommend adding additional docks to improve access to the reservoir, as the shoreline is often muddy and unappealing to many anglers.

Angler Exploitation

Catchable-sized hatchery trout are providing a successful put-and-take fishery at Mann Lake. Angler total use rates through June, 2014 were estimated to be 46.5% for the spring 2011 tagging events (Table 18) and 27.7% for the spring 2012 events, with no angler use past 365 days. These estimates were at or above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). The estimate for 2011 was also above the IDFG management goal of a 40.0% total use rate for hatchery catchable Rainbow Trout (Appendix D). Tag returns from both the spring 2011 (Figure 97) and spring 2012 (Figure 98) stockings show similar patterns, with all returns occurring by the end of September each year. This is to be expected since most of the effort occurs from April - August each year (Table 17). Based on this information, no changes are suggested for future spring stockings.

The success of our fall stockings is also of interest for the regional tagging program. Tag returns resulted in angler total use rates of 3.5% for the October, 2011 stocking, and 0.0% for the October, 2012 stocking. This is well below the management goal of a 40% total use rate for hatchery catchable Rainbow Trout, and the statewide average rate of 28% calculated for Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). This confirms the effort data from the 2012 creel survey which shows that very little effort and no harvest of hatchery Rainbow Trout occurred in Mann Lake from October - March (Table 17; Appendix C). Interestingly, the two fish reported from the October 2011 stocking were caught in May and July, 2012, indicating that these fish were able to overwinter and were available for the following spring/summer fishery. However, with such low angler use, and only 2.3% of the effort occurring during the winter, we believe these fish could be better utilized elsewhere. As such, we recommend the elimination of fall stockings of catchable Rainbow Trout in Mann Lake.

Comparing angler exploitation of hatchery Rainbow Trout from the “Tag You’re It” program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a slight difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 16.9% while the creel survey estimated it to be 20.7%. Differences in angler exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the use of bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. However, the difference seen at Mann Lake is small, and is likely not statistically significant. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Angler exploitation based on the “Tag You’re It” program (Meyer et al. 2009) was lower for the 2012 stockings than the 2011 stockings (Appendix D). This trend was seen in five of the six regional reservoirs where data existed from both years. Some of this may be attributable to possible changes in angler effort, or the possibility that anglers became accustomed/ desensitized to the tagging program and returned the tags at a lower rate. The better water conditions seen in 2012 versus 2011 were also a likely factor.

Limnology

As we have seen in previous years, Mann Lake continues to experience anoxic conditions in the hypolimnion during some summer months. The combination of an anoxic hypolimnion and warm surface waters greatly reduces the volume of the reservoir available for fish to live during the summer months, especially temperature sensitive hatchery trout (Figure 88). These conditions force the more temperature sensitive trout to live in either the warmer epilimnion with higher DO, or cooler water with less DO, both of which can cause stress. The combination of high water temperature and marginal DO concentrations compounds the stress on hatchery trout, which can result in disease and fish kills (Bjornn and Reiser 1991, Carline and Machung 2001).

Despite stressful (if not lethal) water conditions for trout, hatchery Rainbow Trout continued to be caught in July and August. Based on the IDFG standards for temperature and DO thresholds, the volume of water available for Rainbow Trout to survive was reduced to zero in July and August, 2012. This would indicate that there was very little, if any, chance that hatchery trout stocked in the spring would have a chance to survive through the summer and be available to the fishery in the fall. Also, no hatchery Rainbow Trout were harvested after September (Appendix C) in the creel, and no tagged fish were returned after September (Figures 94 and 95). From this information, it is apparent that we should not stock any hatchery trout in Mann Lake after May. However, an analysis of the dates of tag returns from the May 10th, 2011 and April 4th, 2012 angler exploitation tag releases show that hatchery Rainbow Trout were caught past the July and August, 2012 temperature/DO sample dates. In fact, 15.0% of the tag returns occurred after the August, 2012 sample (Figure 98), with tag returns reported all the way through September 28th, 2012. Some of this is due to angler's targeting fish that congregate around the cooler water entering Mann Lake at the inlet. Hatchery Rainbow Trout tend to congregate around this area due to the cooler water and higher DO, and anglers know to fish there. Trout have been found to congregate in small areas during times when habitat is limited without having population level effects (Stevens and DuPont 2011). Thus, some trout were able to survive through the summer.

While we do see Rainbow Trout surviving through the summer, the poor carryover is likely due to temperature and predation. Mann Lake is the lowest elevation reservoir in the region, and is subject to annual water drawdowns for irrigation. Even though there is some thermal refuge available, some trout are likely exposed to prolonged period of high temperatures that would cause stress and mortality. Predation is also likely an issue in Mann Lake. Predatory fish, such as Largemouth Bass, can impact stocked rainbow trout. Christensen and Moore (2010) found that up to 6.3% of stocked Rainbow Trout were consumed by Largemouth Bass in a Washington lake. Predatory birds are likely contributing as well. Meyer et al. (2015) found that White Pelican *Pelecanus erythrorhynchos* predation on hatchery trout averaged 18% and Double Crested-Cormorant *Phalacrocorax* auritus predation averaged 14% across 12 study waters. The results of this study showed that predation by these bird species can often exceed the total catch by anglers in some waters. White Pelicans, Double-Crested Cormorants, Osprey *Pandion haliaetus*, and Bald Eagles *Haliaeetus leucocephalus* are all known to frequent Mann Lake. Thus, Largemouth Bass and predatory birds are likely having an impact on the hatchery Rainbow Trout population in Mann Lake. Predation by birds should be monitored in the coming years as the presence of White Pelicans and Double-Crested Cormorants appears to be increasing.

Zooplankton

Larger sized zooplankton species, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in Mann Lake was dominated by Daphnia and Cyclopoida through much of 2012, indicating the presence of a viable food source. In 2012, Daphnia collected averaged 1.0 mm in length, and Cyclopoida averaged 0.5 mm in length (Figure 91). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). From 8.9 - 41.1% of Daphnia and 0.0% of Cyclopoids were at or above preferred size (Figures 89 and 90) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 49.6% of the Daphnia population and 3.7% of the Cyclopoida population were ≥1.0 mm in length. Daphnia densities and average length declined throughout the summer. A rebound in zooplankton abundance did not occur in summer despite D.O. and temperature limitations to trout. The most likely cause was predation by trout and warm-water species.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for Mann Lake. The ZQI, which is a measure of both abundance and size, was 0.03, well below the average (0.35) for reservoirs in the Clearwater Region (Appendix E). ZQI values <0.10 are considered poor and indicate that there food resources are limited (Teuscher 1999). The data suggests that while zooplankton were numerous, larger preferred zooplankton individuals (such as Daphnia) were in low abundance, indicating that they are likely being cropped off. Even with high summer water temperatures and little carry-over of trout from one year to the next, the survival of Rainbow Trout through the summer indicates that Mann Lake is capable of sustaining a spring/summer put-and-take Rainbow Trout fishery. However, the lack of a quality zooplankton population indicates that we should not utilize fingerling trout, and that we should not increase stocking rates of catchable size Rainbow Trout.

Aquatic Vegetation

While aquatic vegetation is not currently an issue in Mann Lake, it will be an important part of managing the reservoir going forward. Visual monitoring of the vegetation levels in Mann Lake should continue to ensure that coverage does not increase. With nearby reservoirs (Winchester Lake, Moose Creek Reservoir) experiencing large amounts of nuisance aquatic vegetation growth, the potential for these species to be transported into Mann Lake is high. Fortunately, the annual water drawdowns that currently occur in Mann Lake should reduce the opportunity for nuisance species to become problematic.

MANAGEMENT RECOMMENDATIONS

1. Conduct the next standard lake surveys with enough 10-minute electrofishing samples to sample the entire shoreline. Utilize this data to estimate of the number of samples needed to detect 25% change in CPUE in future samples.

2. Eliminate fall stockings of hatchery catchable Rainbow Trout due to low exploitation rates and low angler effort during the winter.

Table 12. Number of fish collected by species in each 10-minute electrofishing sample conducted on Mann Lake, Idaho, in 2012, and the estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 90% confidence and 25% precision.

	Count of fish collected									
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Largemouth Bass	28	*	*	7	5	11	51	7.7	3.1	7
Black Crappie	16	*	*	22	11	8	57	13.7	7.4	13
Bluegill	6	*	*	5	2	1	14	2.7	2.1	27
Pumpkinseed	9	*	*	10	1	0	20	3.7	5.5	98
Channel Catfish	3	*	*	1	0	0	4	0.3	0.6	131
Brown Bullhead	13	*	*	6	4	3	26	4.3	1.5	5
Total	75	*	*	51	23	23	172	32.3	16.2	11

*Samples 1-3 were combined on data sheets.
Mean, STDev, and n are based on samples 4 - 6.

Table 13. Back-calculated length at age of Largemouth Bass collected from Mann Lake, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus							
Class	Age	n	1	2	3	4	5	6	7	8
2011	1	19	83							
2010	2	11	81	135						
2009	3	9	103	175	224					
2008	4	4	104	176	239	270				
2007	5	0	0	0	0	0	0			
2006	6	4	107	185	282	342	386	428		
2005	7	1	75	180	266	314	388	456	506	
2004	8	1	143	187	255	326	400	442	477	504
n		49	49	30	19	10	6	6	2	1
Length at Age			91	162	243	309	389	435	492	504

Table 14. Back-calculated length-at-age of Black Crappie collected from Mann Lake, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus				
Class	Age	n	1	2	3	4	5
2011	1	40	78				
2010	2	11	83	58			
2009	3	5	77	53	69		
2008	4	0	0	0	0	0	
2007	5	1	93	60	63	71	28
n		57	57	17	6	1	1
Length at Age			79	56	68	71	28

Table 15. Back-calculated length-at-age of Bluegill collected from Mann Lake, Idaho in 2012.

Year Class	Age	n	Back-calculated length (mm) at each annulus		
			1	2	3
2011	1	1	90		
2010	2	8	53	104	
2009	3	5	50	92	145
n		14	14	13	5
Length at Age			54	100	145

Table 16. Back-calculated length-at-age of Pumpkinseed collected from Mann Lake, Idaho, in 2012.

Year Class	Age	n	Back-calculated length (mm) at each annulus			
			1	2	3	4
2011	1	3	55			
2010	2	5	87	134		
2009	3	11	72	123	161	
2008	4	1	76	120	167	187
n		20	20	17	12	1
Length at Age			73	126	161	187

Table 17. Summary of angler effort (hours) as determined through a creel survey conducted on Mann Lake, Idaho, in 2011 – 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	0	42	0	42	0	43	0	43	0	85	0	85	60	70.7
January	0	0	0	0	0	0	0	0	0	0	0	0	--	--
February	0	0	0	0	0	0	0	0	0	0	0	0	--	--
March	0	143	0	143	0	585	0	585	0	728	0	728	215	29.6
April	0	1,218	25	1,243	0	832	261	1,093	0	2,050	286	2,336	798	34.1
May	0	1,349	411	1,760	0	1,339	720	2,059	0	2,689	1,131	3,819	450	11.8
June	0	1,386	589	1,975	0	1,050	392	1,443	0	2,436	982	3,418	723	21.2
July	0	955	1,274	2,229	0	662	762	1,424	0	1,618	2,036	3,653	750	20.5
August	0	801	174	976	0	500	91	591	0	1,301	265	1,567	304	19.4
September	0	171	171	342	0	334	74	408	0	505	245	750	357	47.6
October	0	0	0	0	0	96	0	96	0	96	0	96	96	100.0
November	0	209	0	209	0	0	0	0	0	209	0	209	209	100.0
Totals	0	6,275	2,644	8,919	0	5,441	2,301	7,742	0	11,716	4,945	16,661	1,499	9.0

Table 18. Angler exploitation (based on angler tag returns) of hatchery catchable size Rainbow Trout stocked in Mann Lake, Idaho, in 2011 and 2012, through 365 days post-stocking. Total use = fish harvested + fish released.

2011

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted exploitation: Estimate	Adjusted exploitation: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
Hagerman	4/7/2011	Normal production	400	49	10	23	28.2%	7.9%	47.2%	11.3%
	5/10/2011	High density	200	19	2	15	21.9%	8.7%	41.4%	12.6%
		Low density	199	30	4	10	34.7%	11.4%	50.9%	14.3%
	10/12/2011	Clearsprings 2N	100	1	0	1	2.3%	3.8%	4.6%	5.4%
		Hayspur 3N	99	0	0	1	0.0%	---	2.3%	3.8%
Average							17.4%	8.0%	29.3%	9.5%

2012

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted exploitation: Estimate	Adjusted exploitation: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
Hagerman	04-Apr-12	High density	200	14	1	2	19.7%	7.1%	24.0%	7.9%
		Low density	200	13	4	1	18.3%	6.9%	25.4%	8.2%
		Medium density	200	19	2	3	26.8%	8.4%	33.8%	9.6%
Lyons Ferry	10-Oct-12	Production	400	0	0	0	0.0%	---	0.0%	---
Average							16.2%	7.5%	20.8%	8.6%

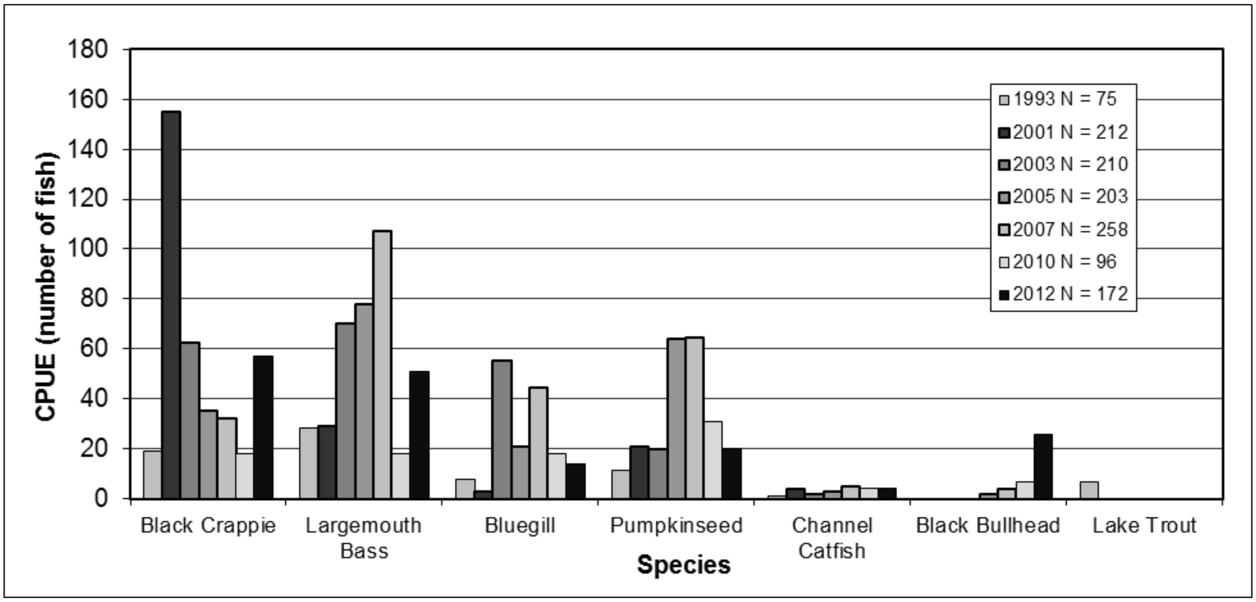


Figure 63. Catch per unit effort (CPUE; number of fish/hour) of fishes collected from electrofishing Mann Lake, Idaho, from 1993 - 2012.

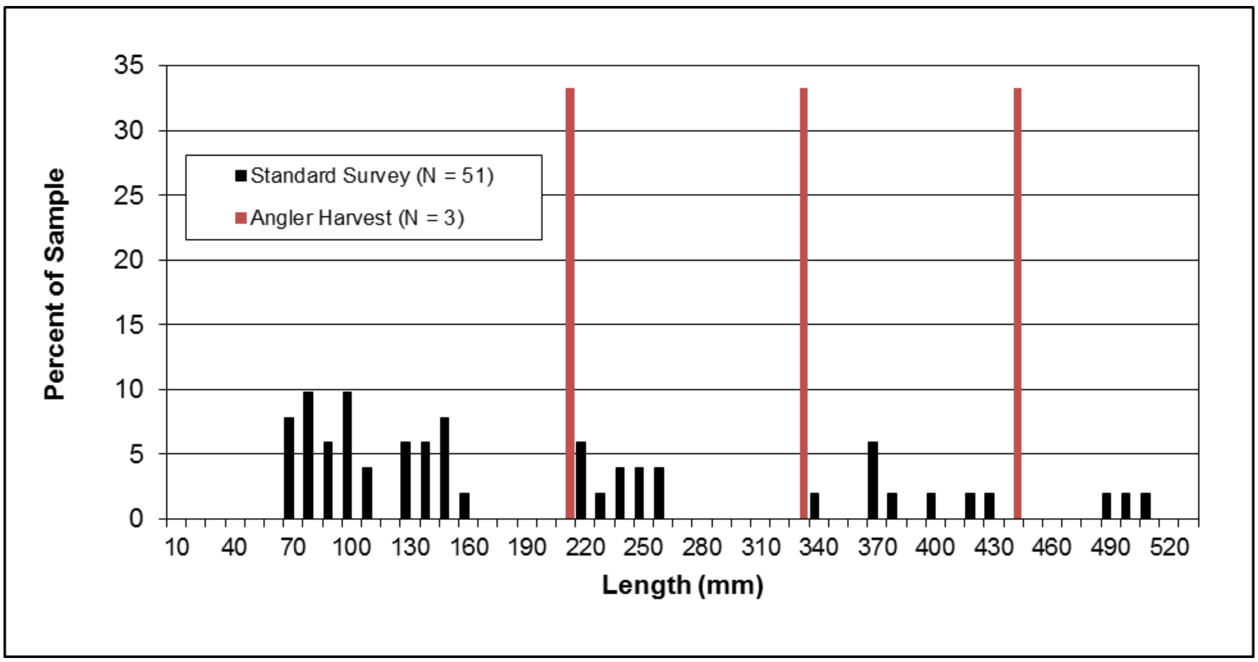


Figure 64. Comparison of Largemouth Bass length frequency distributions collected through electrofishing, and fish harvested by anglers in Mann Lake, Idaho, during 2012.

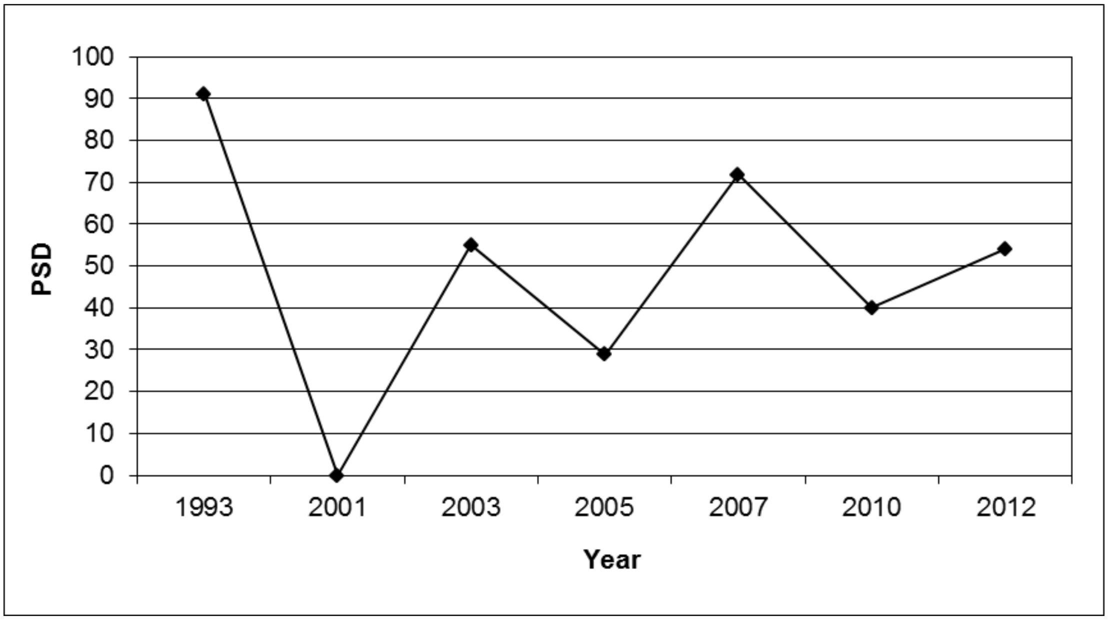


Figure 65. Proportional Size Distribution (PSD) values of Largemouth Bass collected from Mann Lake, Idaho, from 1993 - 2012.

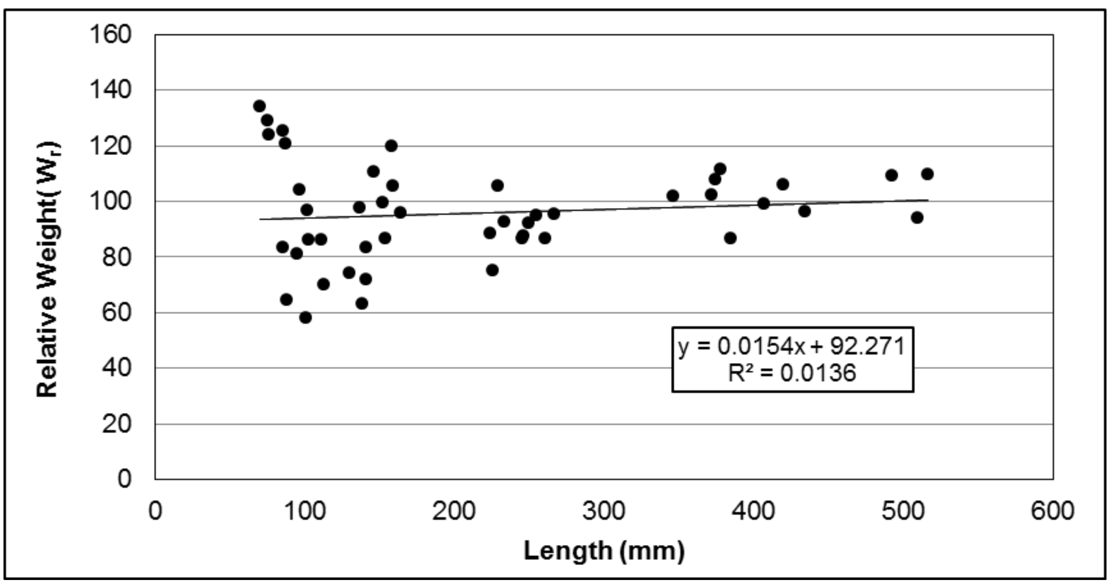


Figure 66. Relative weight (Wr) values of Largemouth Bass collected from Mann Lake, Idaho, in 2012.

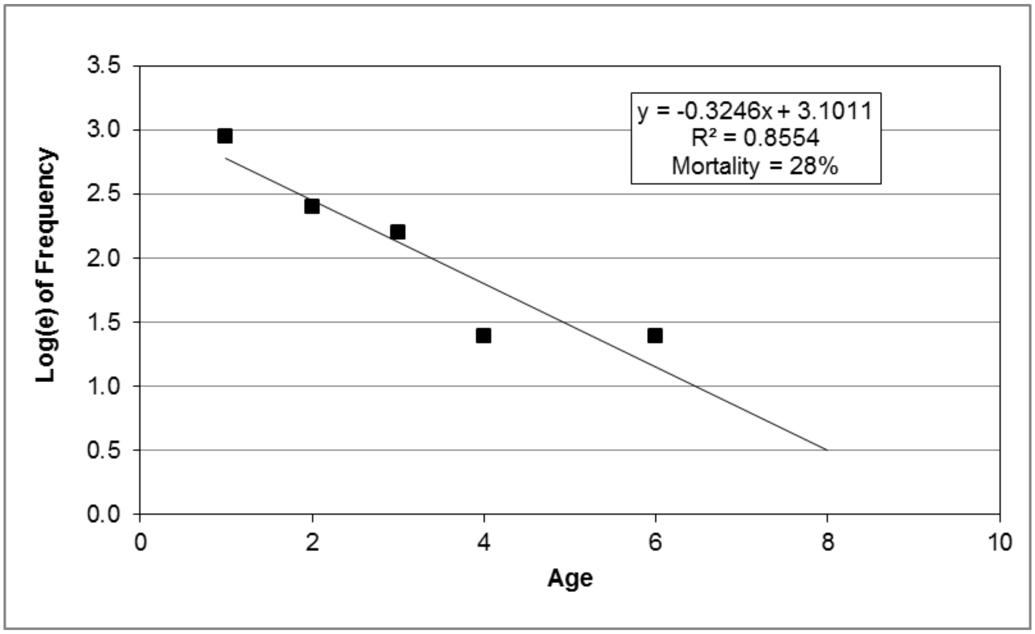


Figure 67. Catch curve for estimating annual mortality of Largemouth Bass collected from Mann Lake, Idaho, in 2012.

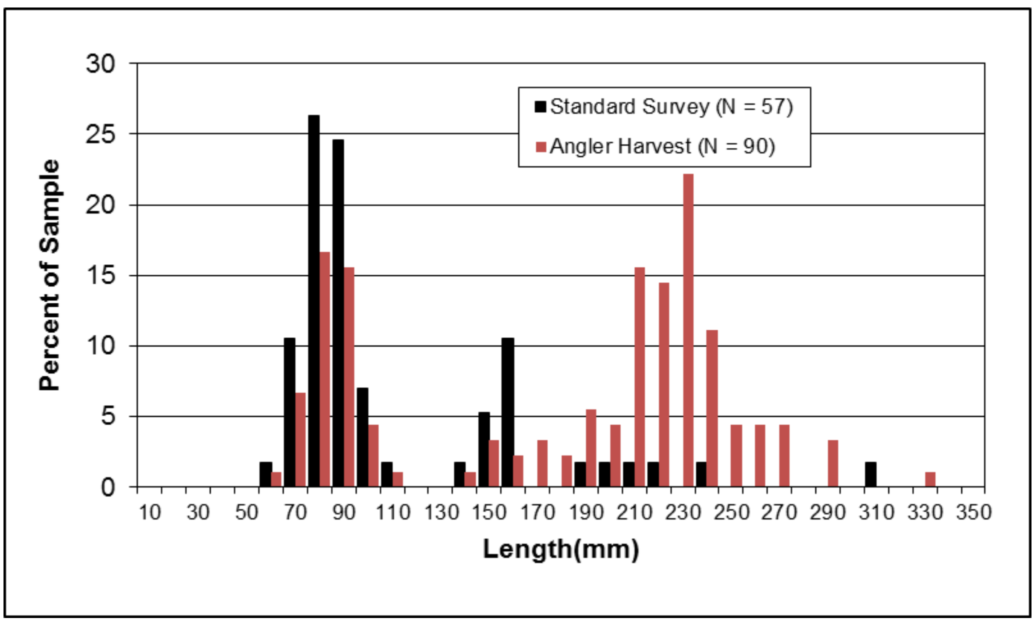


Figure 68. Comparison of Black Crappie length frequency distributions from fish collected through electrofishing, and fish harvested by anglers in Mann Lake, Idaho, during 2012.

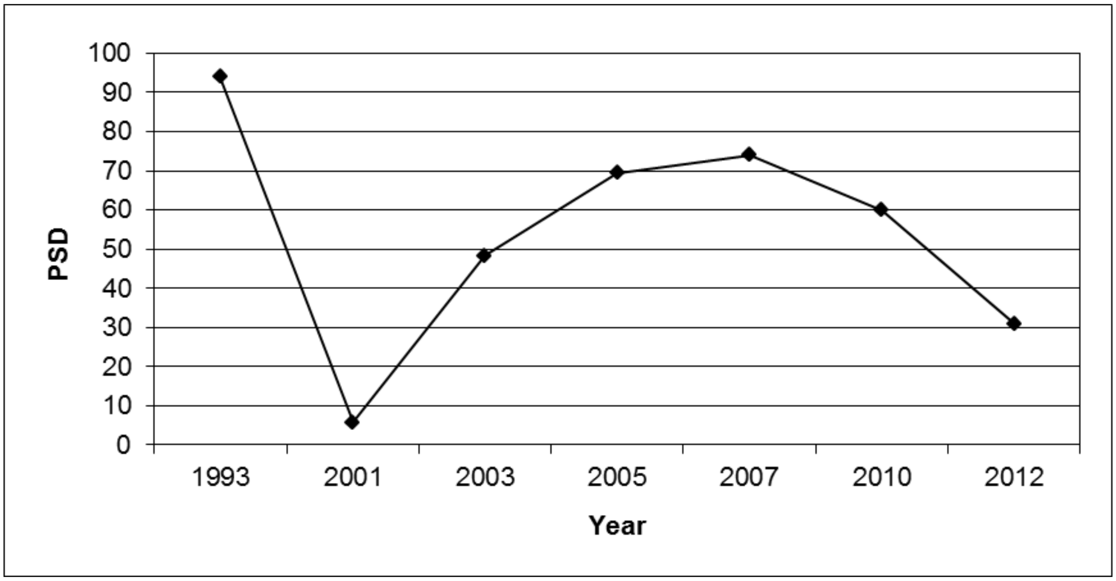


Figure 69. Proportional Size Distribution (PSD) values of Black Crappie collected from Mann Lake, Idaho, from 1993 - 2012.

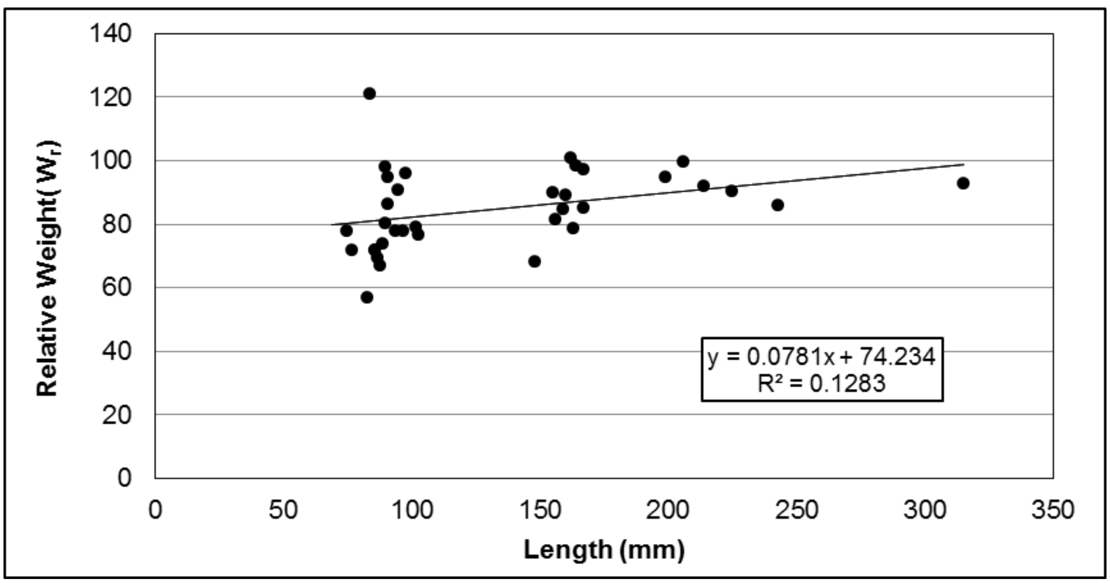


Figure 70. Relative weight (W_r) values of Black Crappie collected from Mann Lake, Idaho, in 2012.

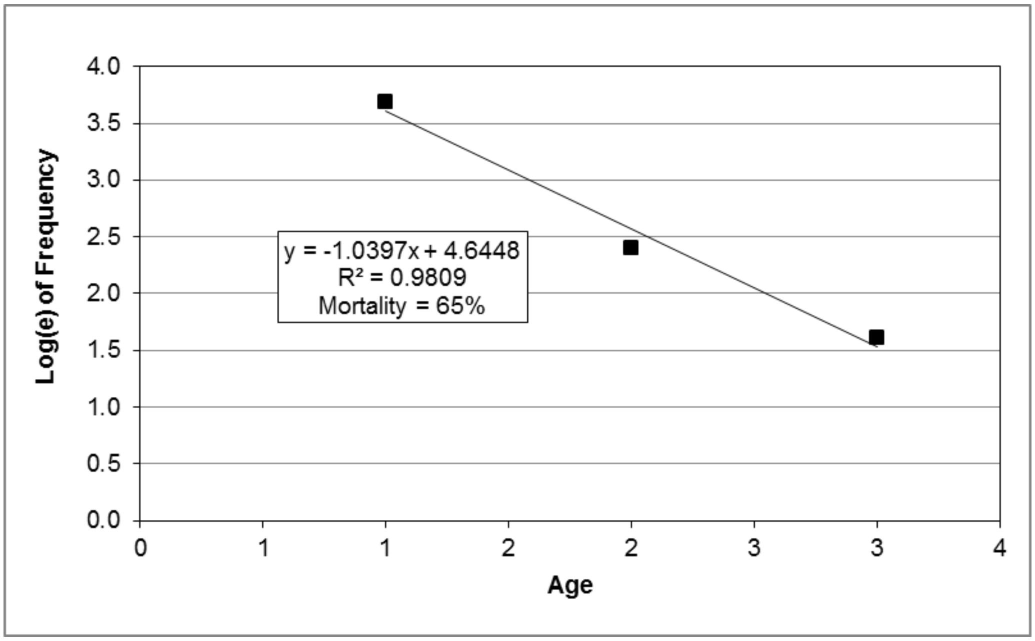


Figure 71. Catch curve for estimating annual mortality of Black Crappie collected from Mann Lake, Idaho, in 2012

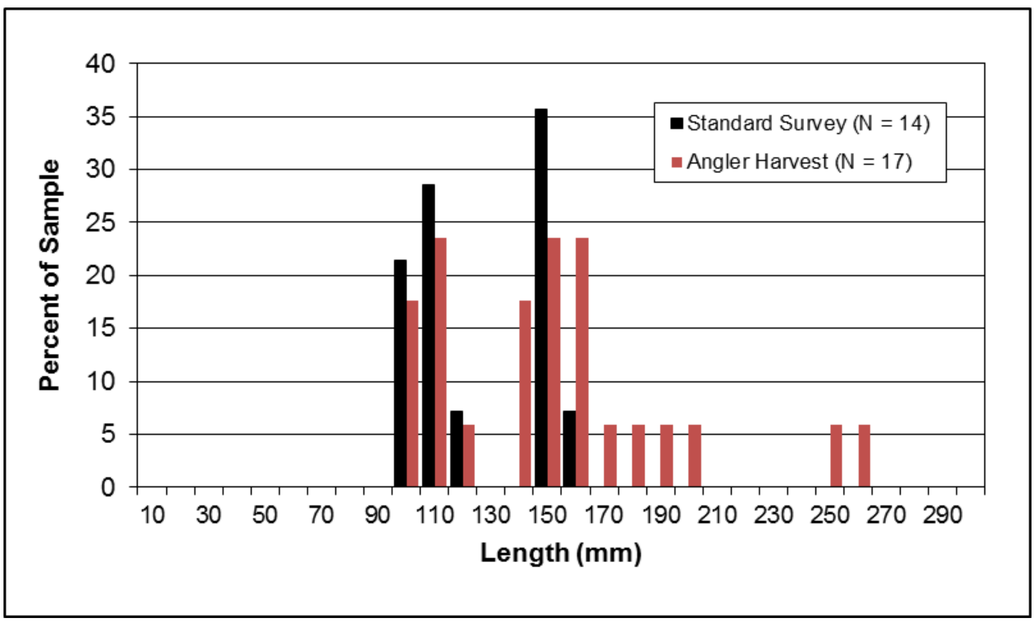


Figure 72. Comparison of length frequency distributions of Bluegill collected through electrofishing, and fish harvested by anglers in Mann Lake, Idaho, during 2012.

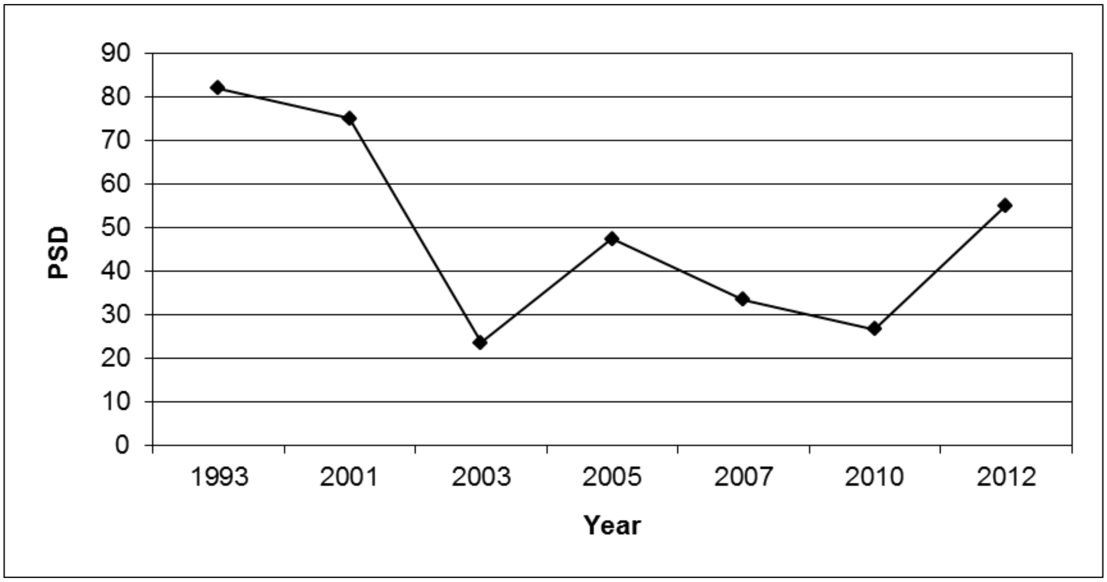


Figure 73. Proportional Size Distribution (PSD) values of Bluegill collected through electrofishing from Mann Lake, Idaho, from 1993 - 2012.

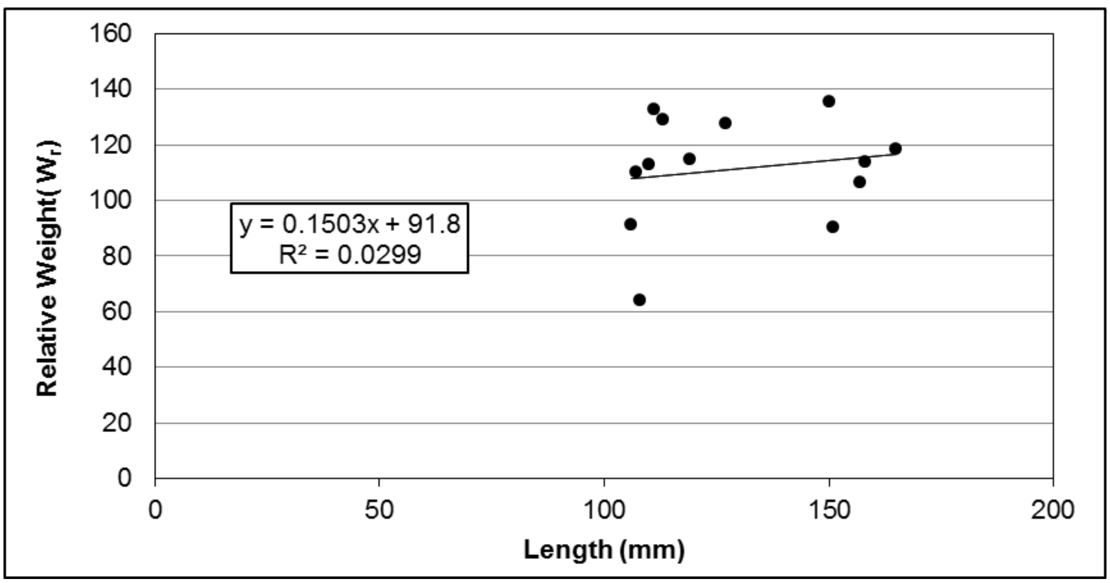


Figure 74. Relative weight (W_r) values of Bluegill collected through electrofishing from Mann Lake, Idaho, in 2012.

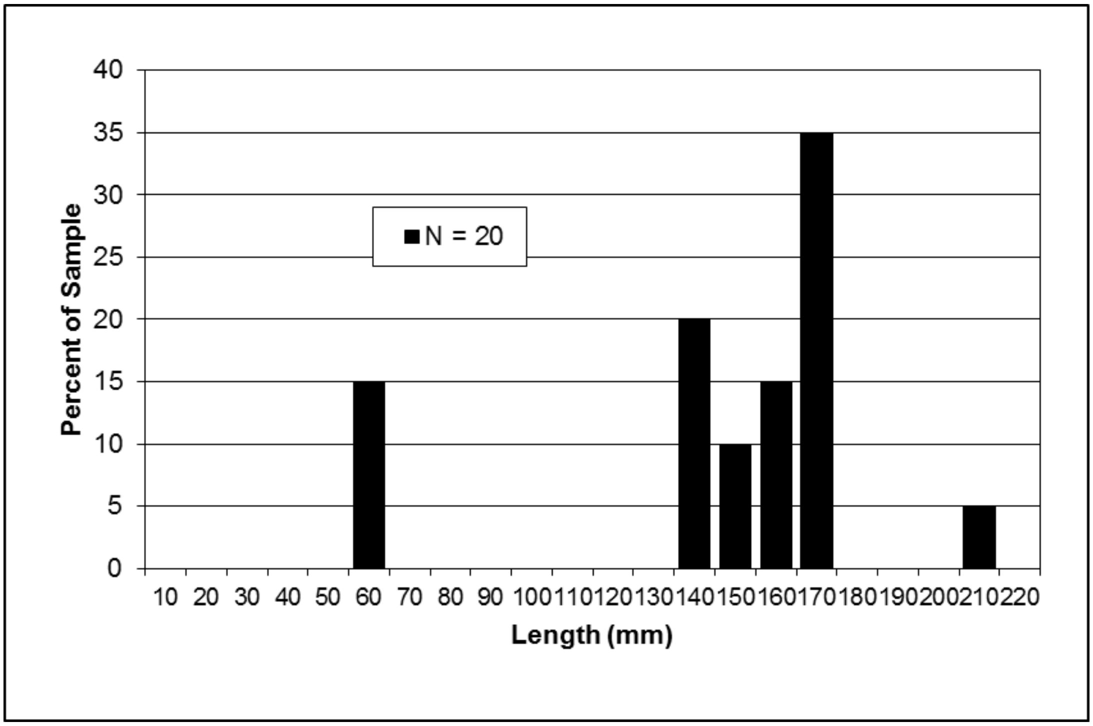


Figure 75. Length frequency distributions of Pumpkinseed collected through electrofishing from Mann Lake, Idaho, in 2012.

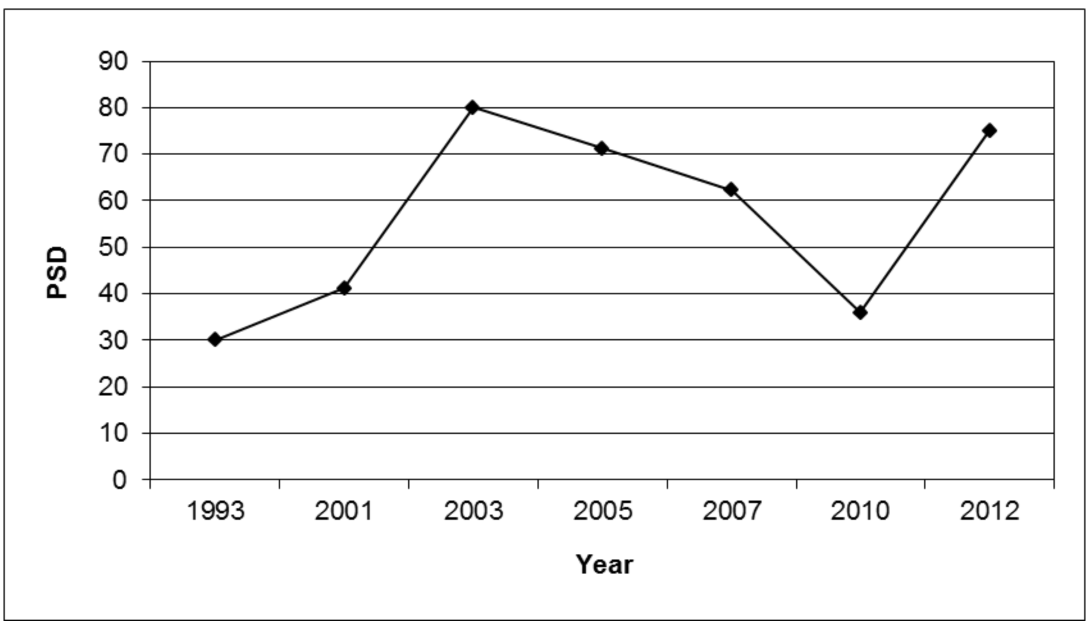


Figure 76. Proportional Size Distribution (PSD) values of Pumpkinseed collected through electrofishing from Mann Lake, Idaho, from 1993 - 2012.

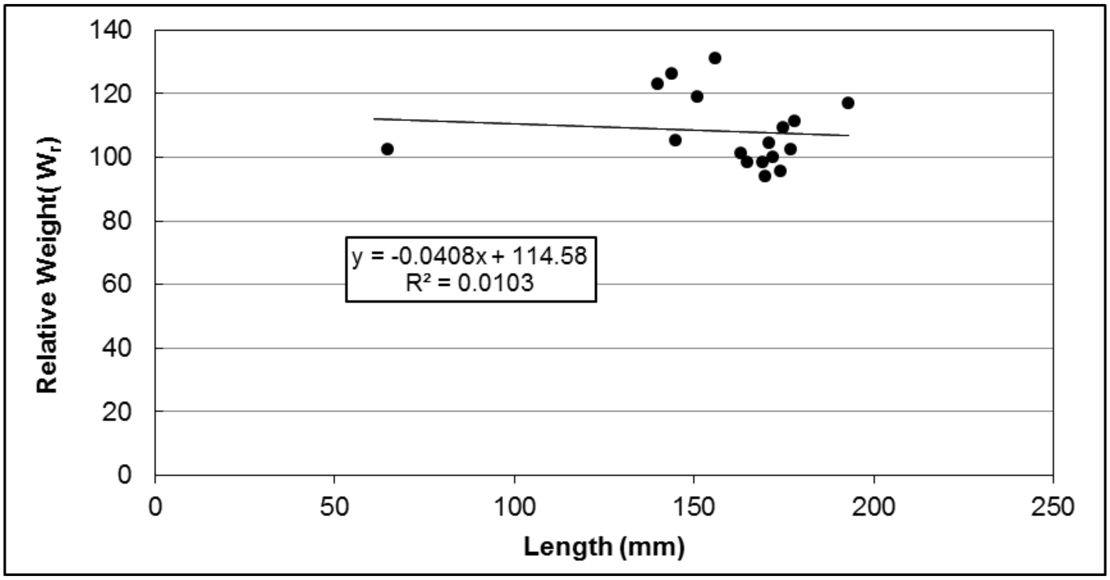


Figure 77. Relative weight (W_r) values of Pumpkinseed collected through electrofishing from Mann Lake, Idaho, in 2012.

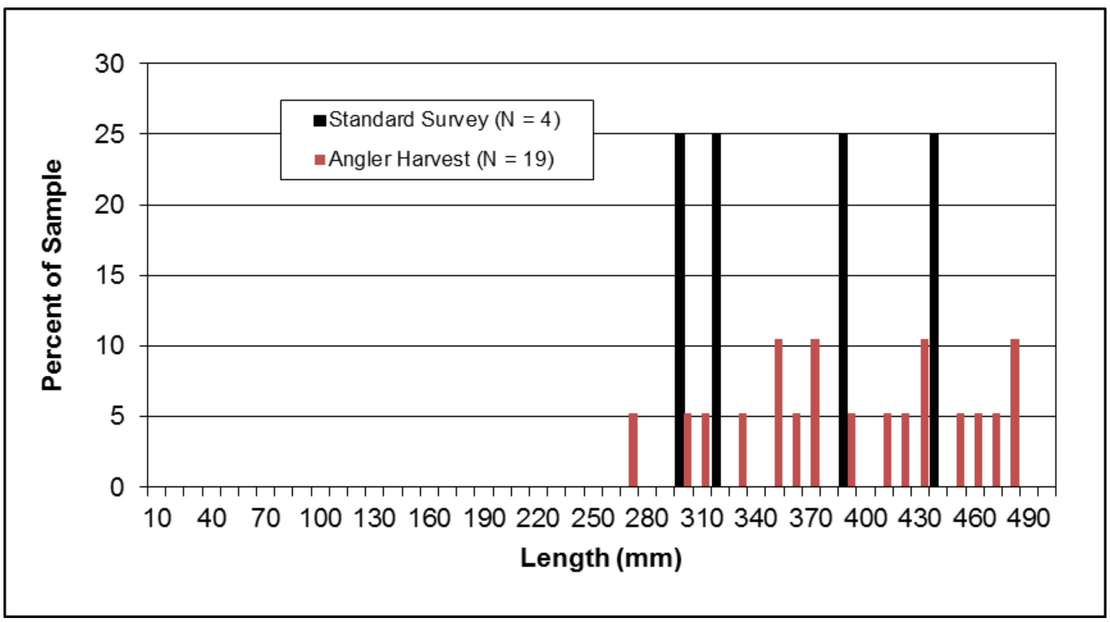


Figure 78. Comparison of length frequency distributions of Channel Catfish collected through electrofishing, and fish harvested by anglers in Mann Lake, Idaho, during 2012.

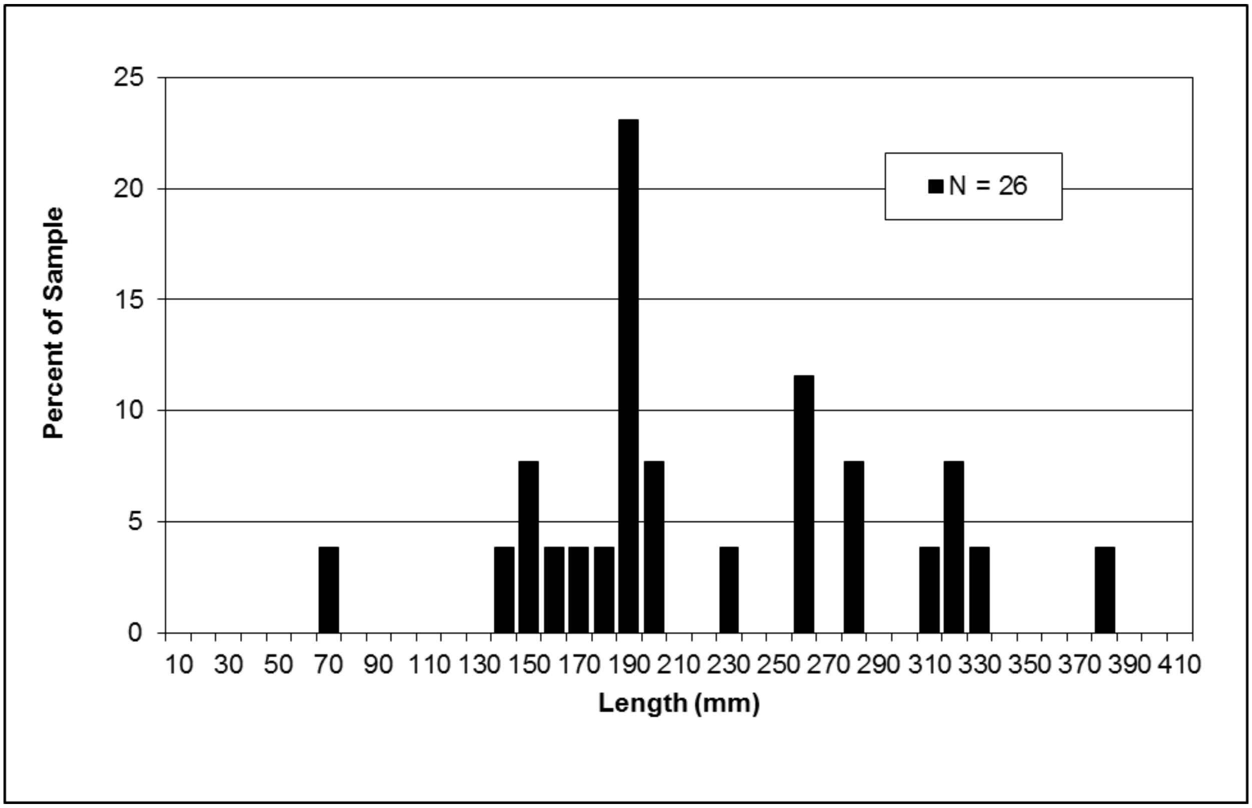


Figure 79. Length frequency distributions of Black Bullhead collected through electrofishing from Mann Lake, Idaho, in 2012.

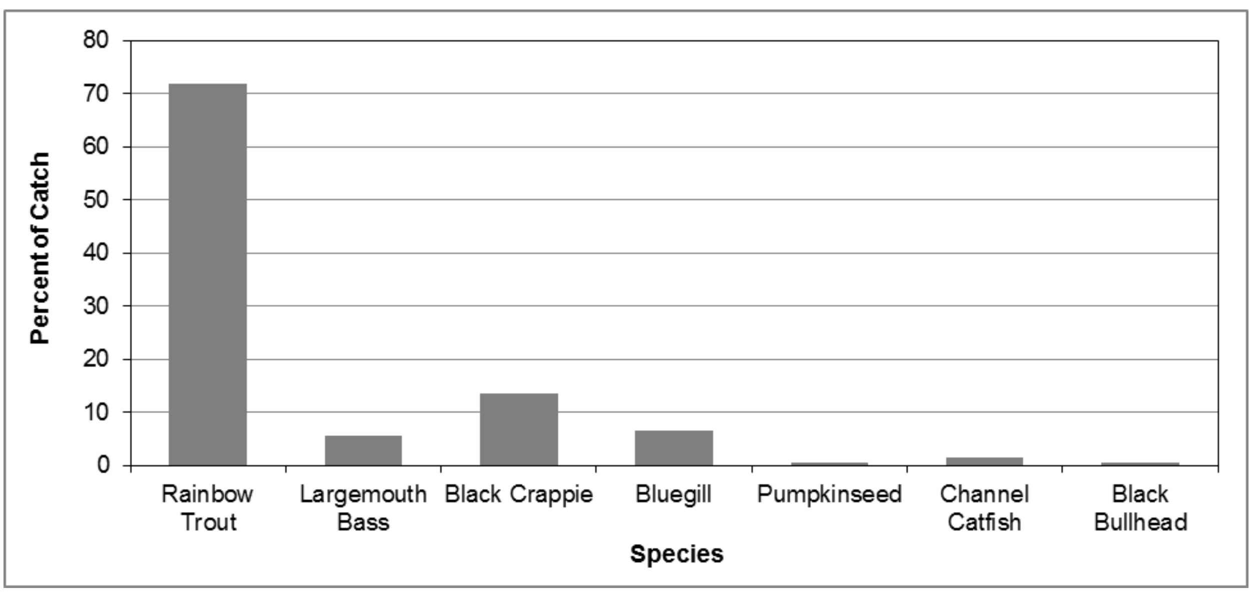


Figure 80. Composition of fishes caught in Mann Lake, Idaho, as estimated by a creel survey conducted from November 28, 2011 - November 28, 2012.

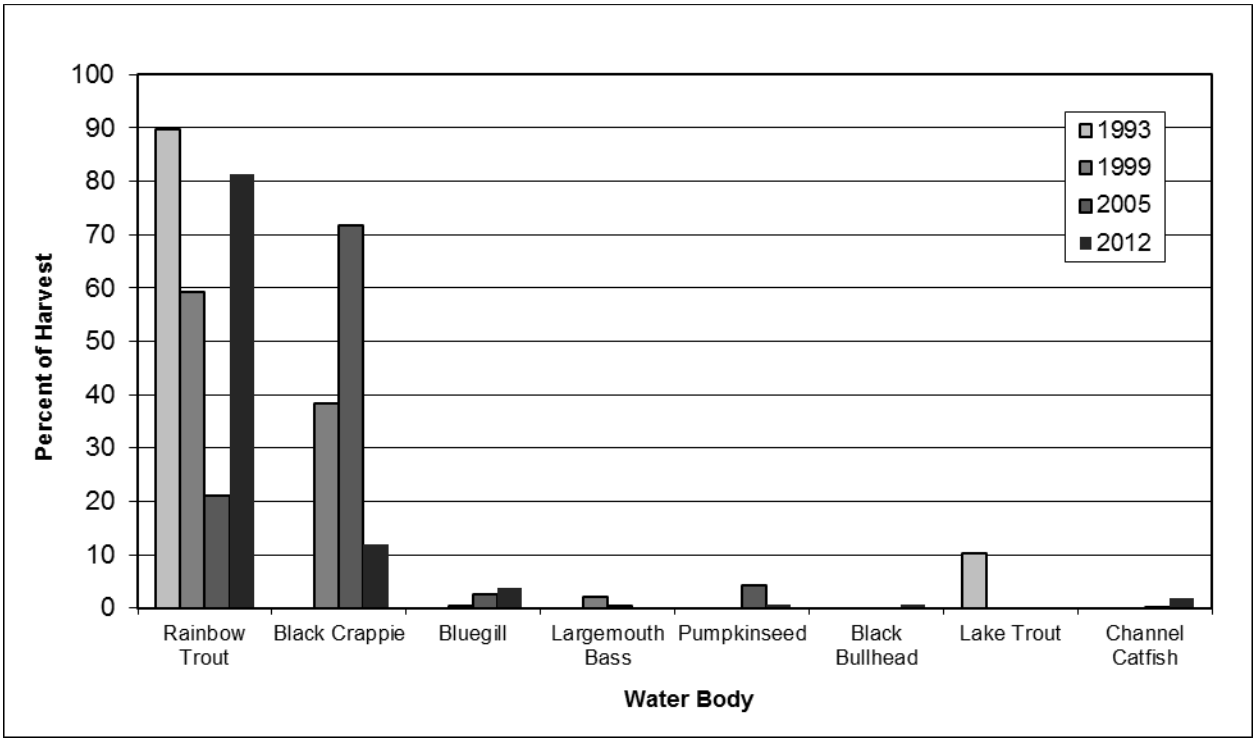


Figure 81. Composition of fish harvested during creel surveys conducted at Mann Lake, Idaho, from 1993 - 2012.

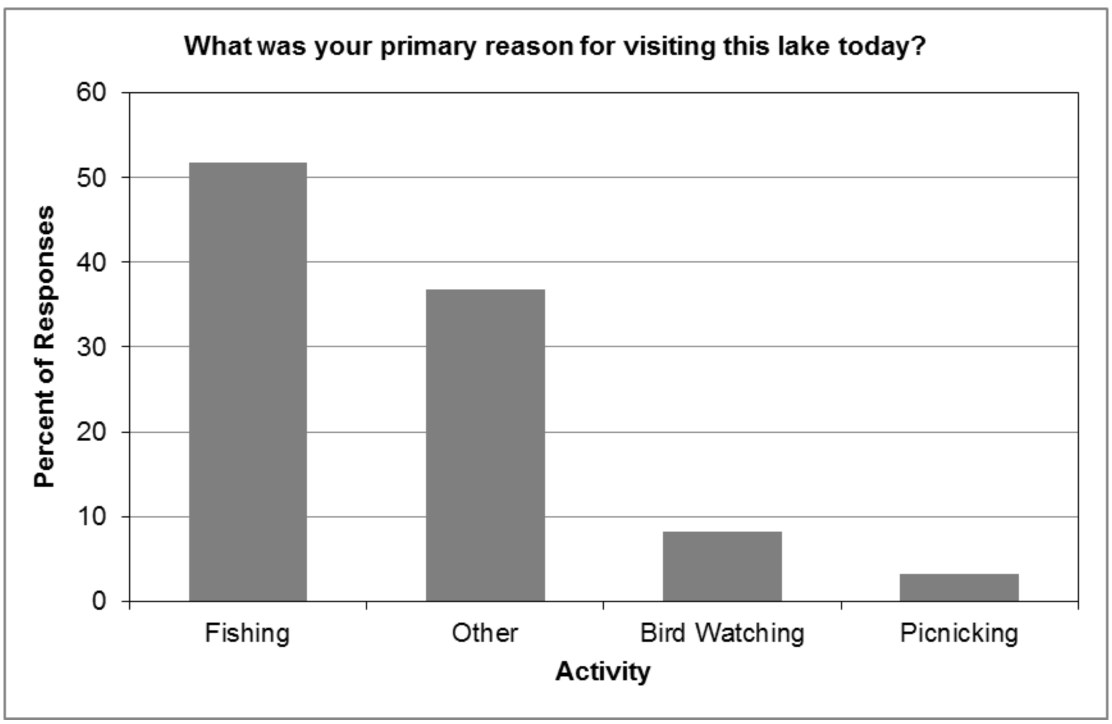


Figure 82. Summary of angler responses to the primary reason for visiting Mann Lake, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

Figure 83. Summary of angler responses regarding their overall fishing experience at Mann Lake, Idaho, during a creel survey conducted from November 28, 2011 – November 28, 2012.

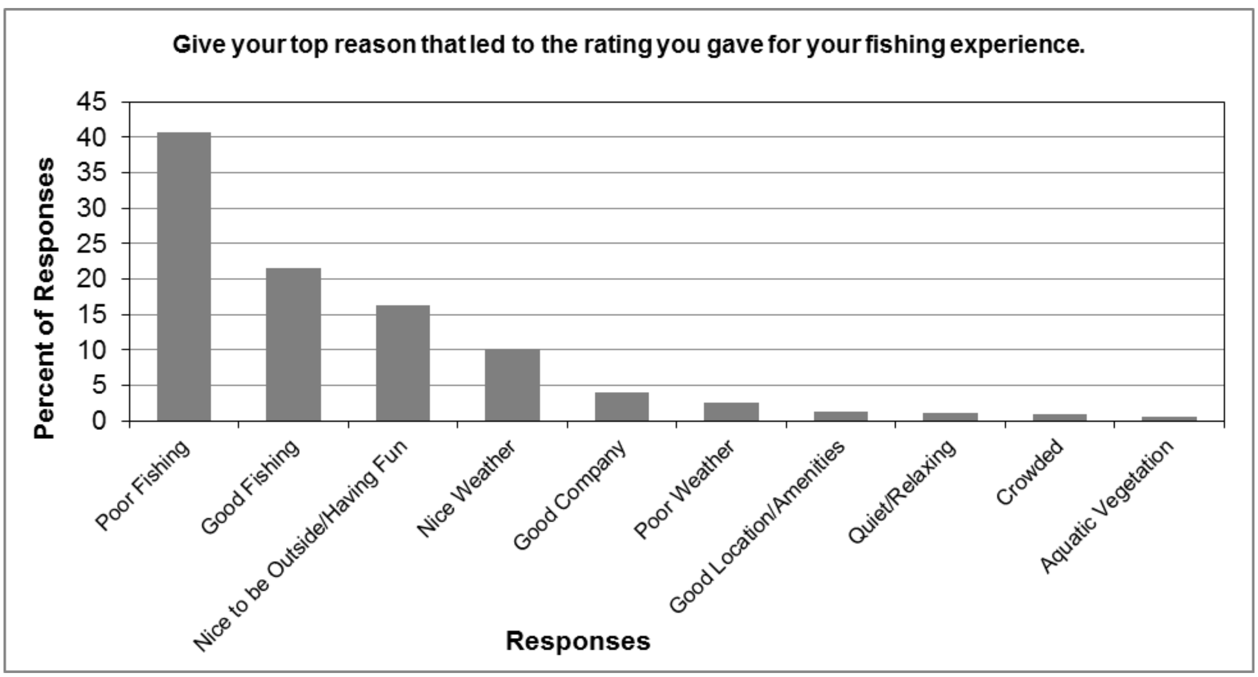


Figure 84. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day when fishing at Mann Lake, Idaho, as determined through a creel survey conducted from November 28, 2011 - November 28, 2012 (Only 10 most common answers shown).

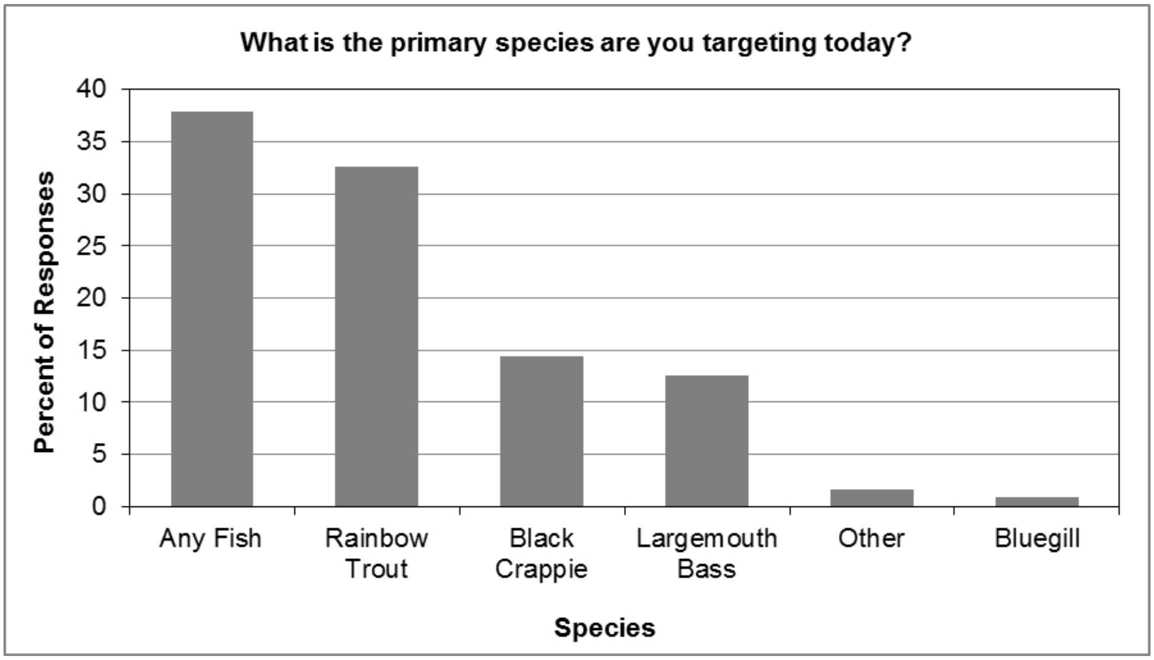


Figure 85. Summary of angler responses regarding target fish species at Mann Lake, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

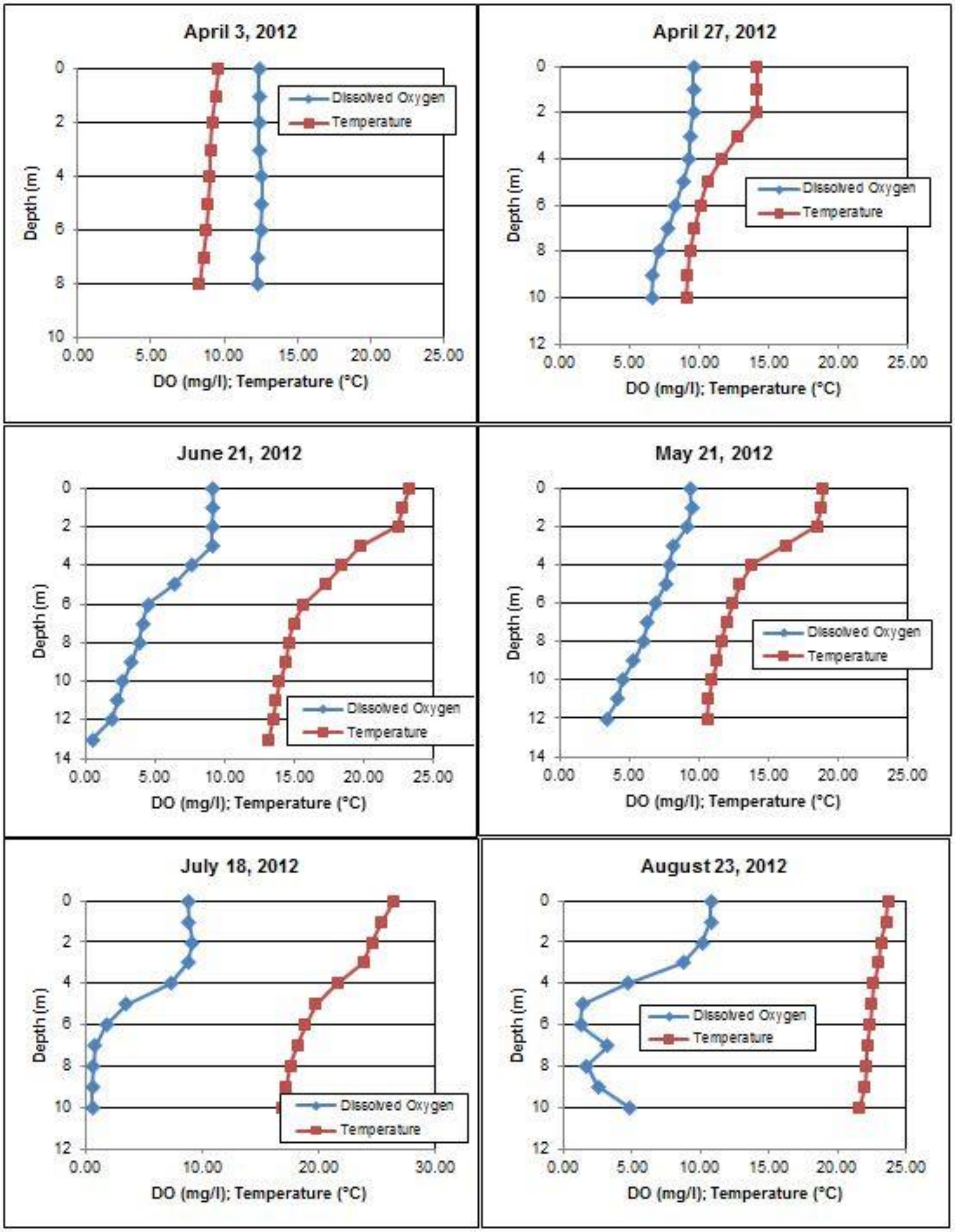


Figure 86. Dissolved oxygen (DO) and temperature profiles collected in Mann Lake, Idaho, during 2012.

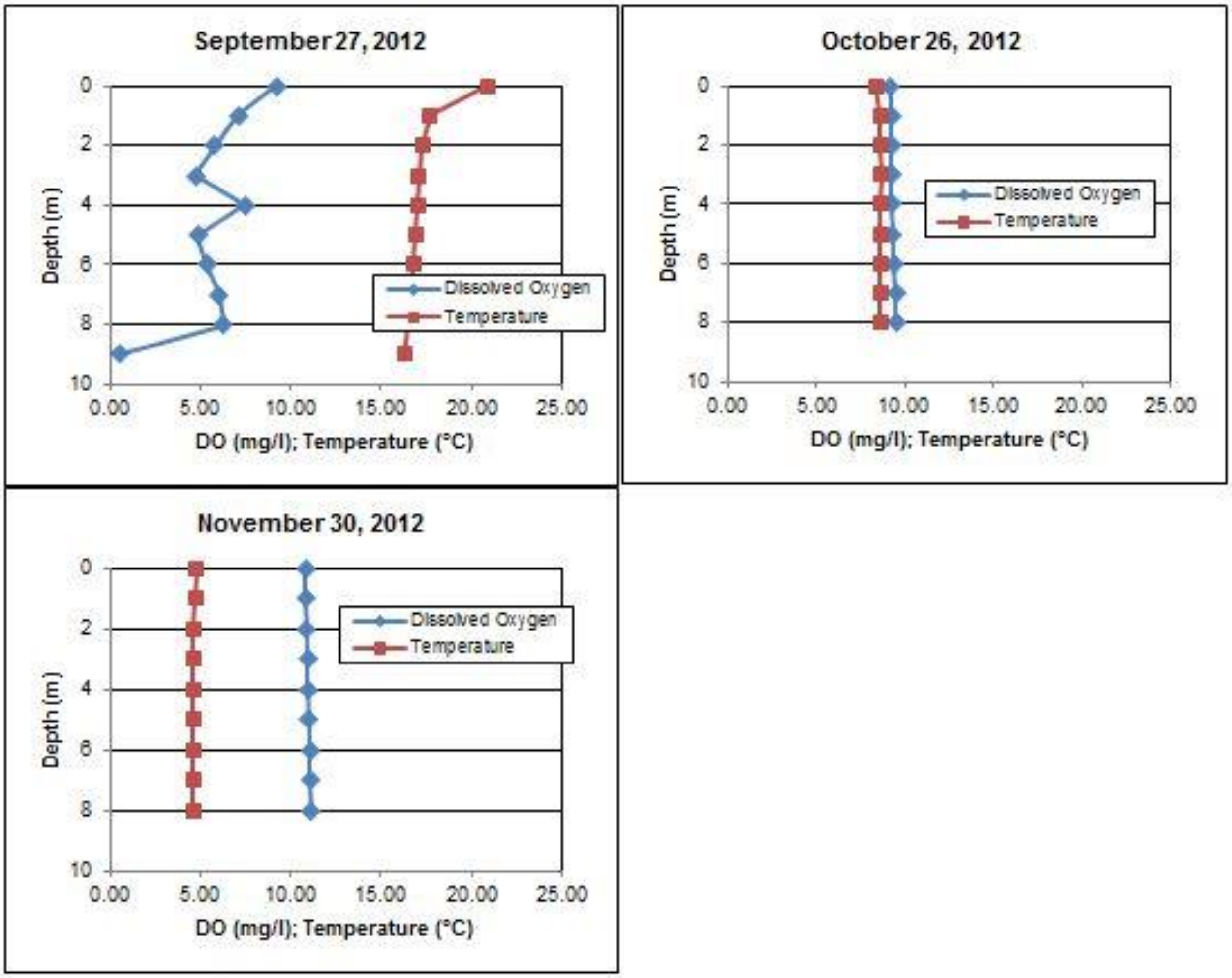


Figure 89. Continued.

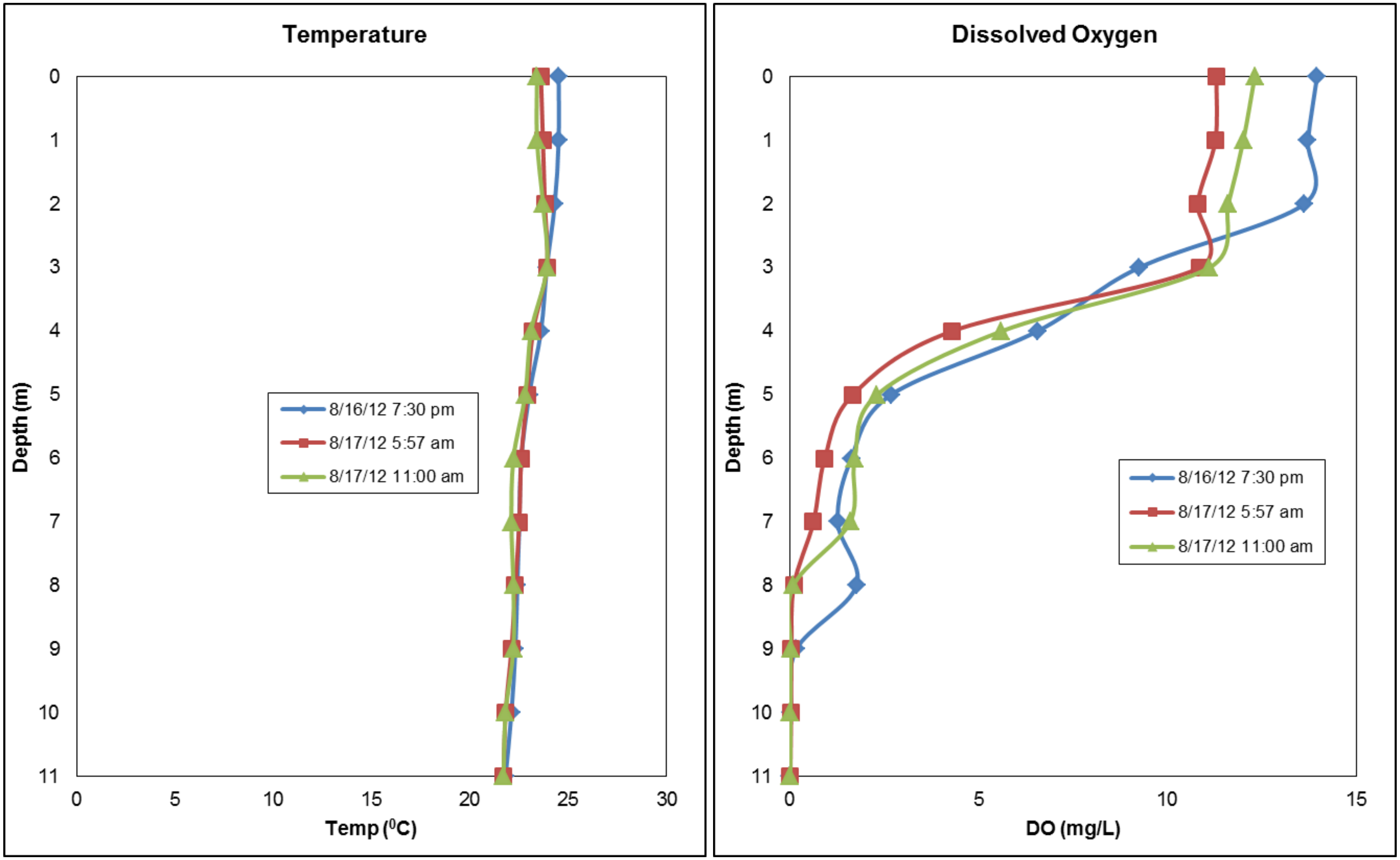


Figure 87. Diel changes in temperature and dissolved oxygen (DO) in Mann Lake, Idaho, from August 16 - 17, 2012.

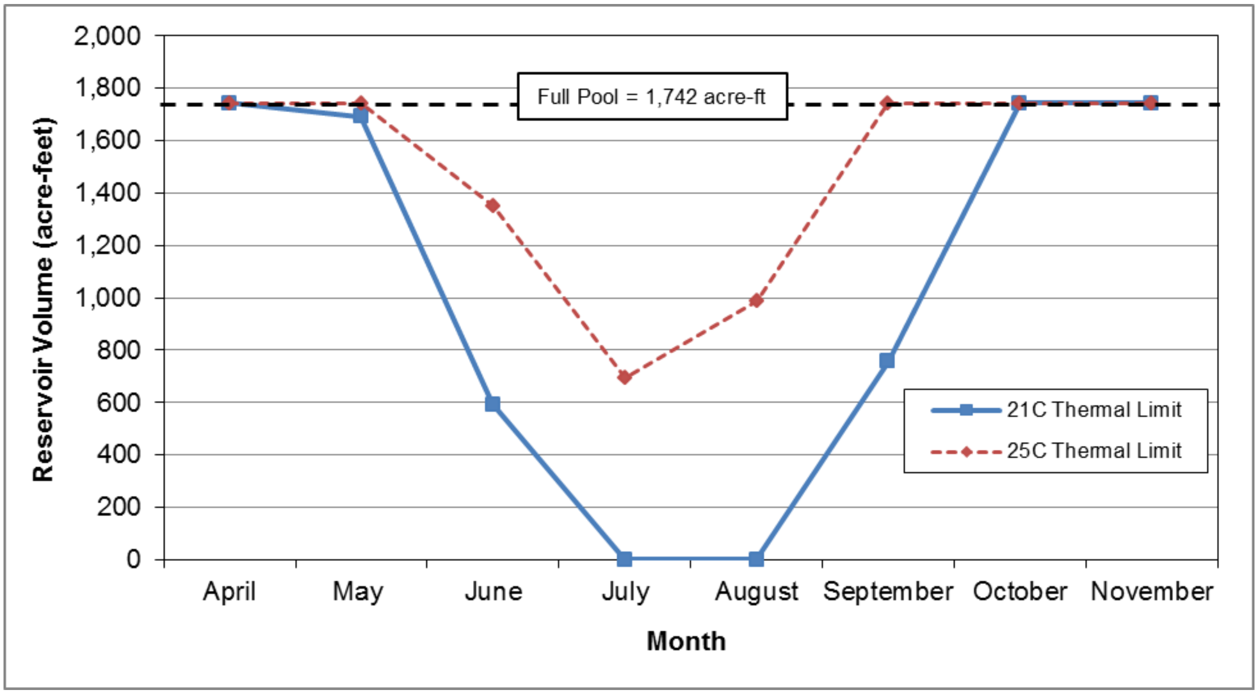


Figure 88. Estimated trout habitat available in Mann Lake, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit, and upper thermal limits of 21°C and 25°C.

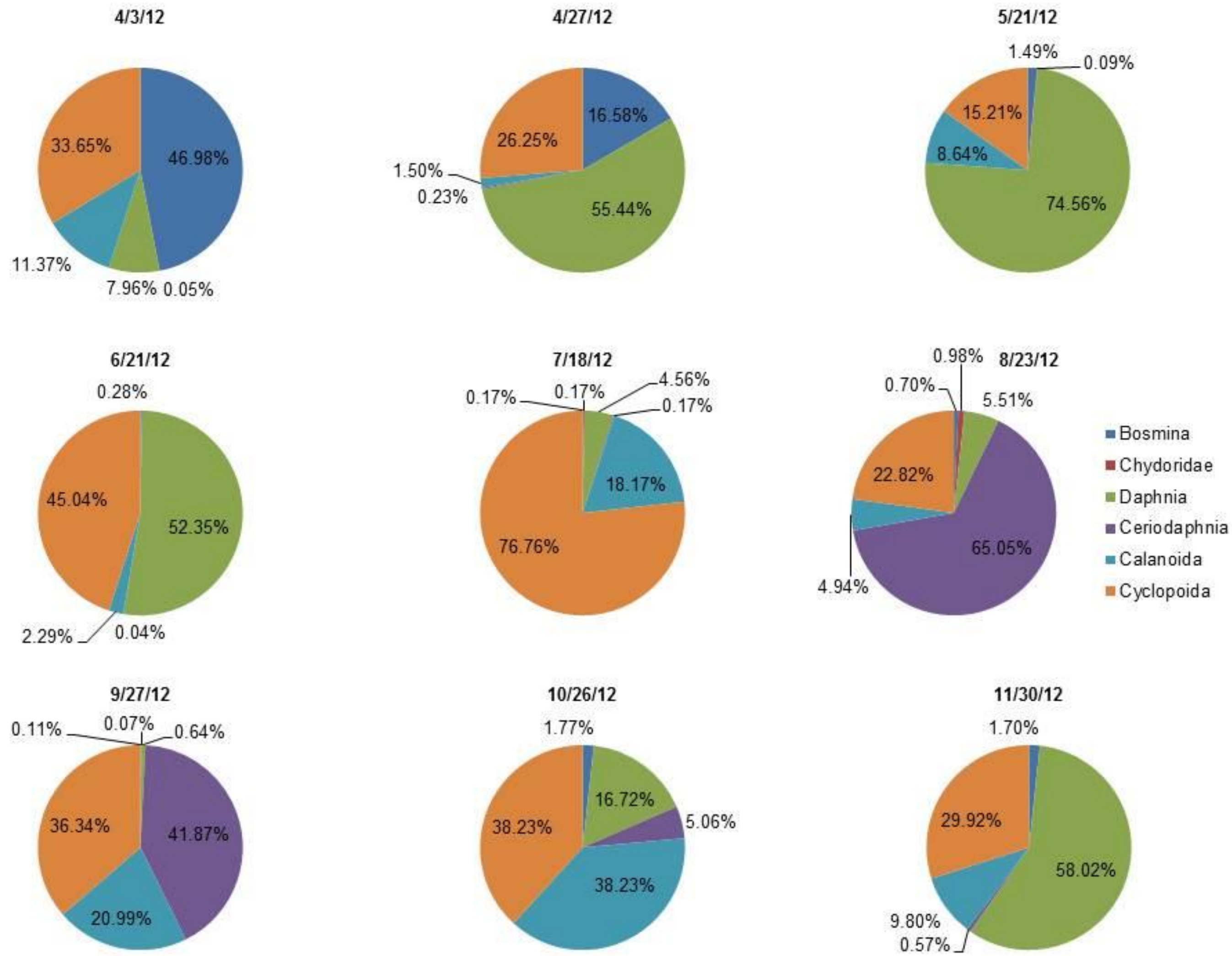


Figure 89. Zooplankton community composition based on monthly samples collected in Mann Lake, Idaho, during 2012.

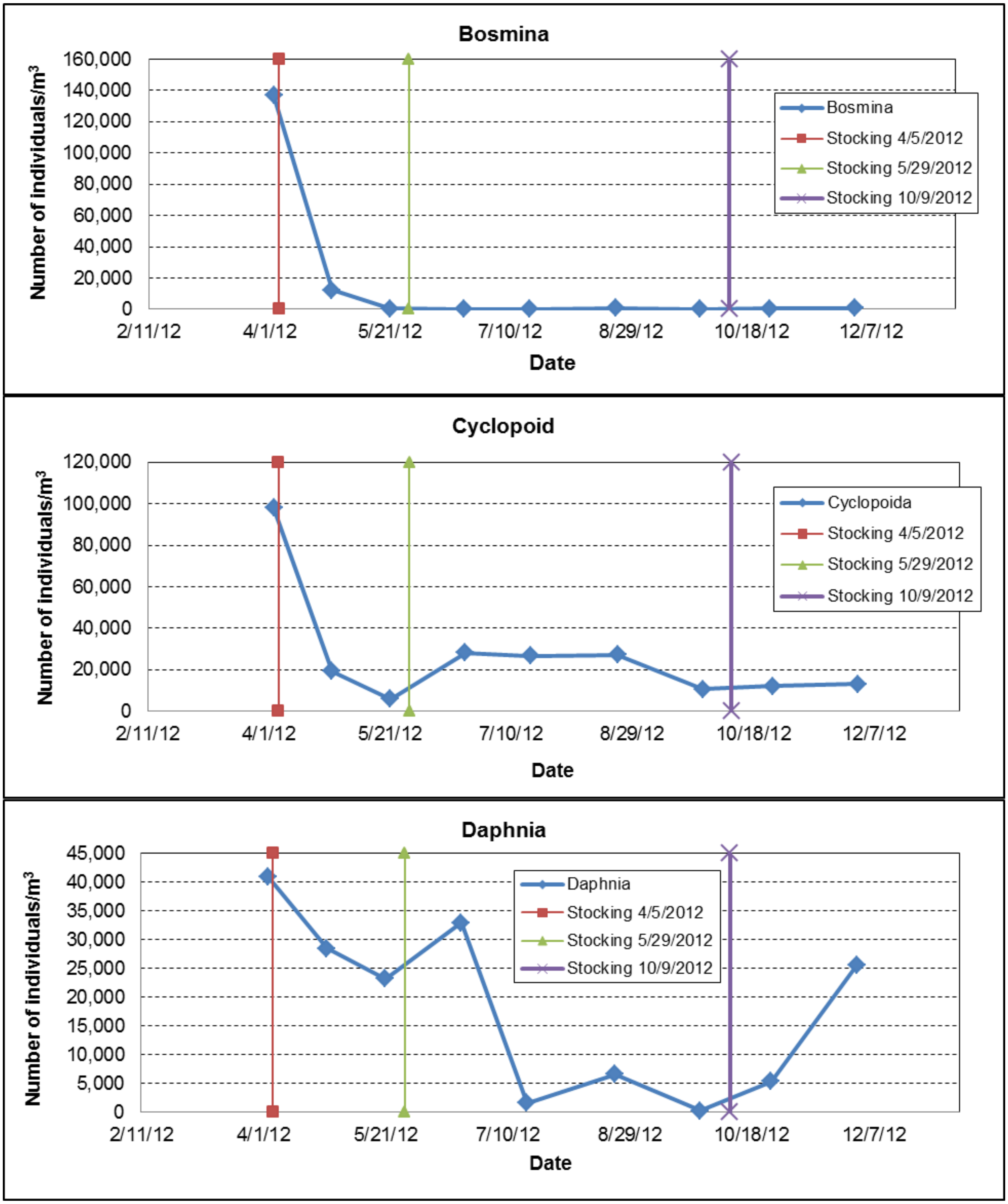


Figure 90. Zooplankton population densities (number of individuals/m^3) from monthly samples collected from Mann Lake, Idaho, during 2012.

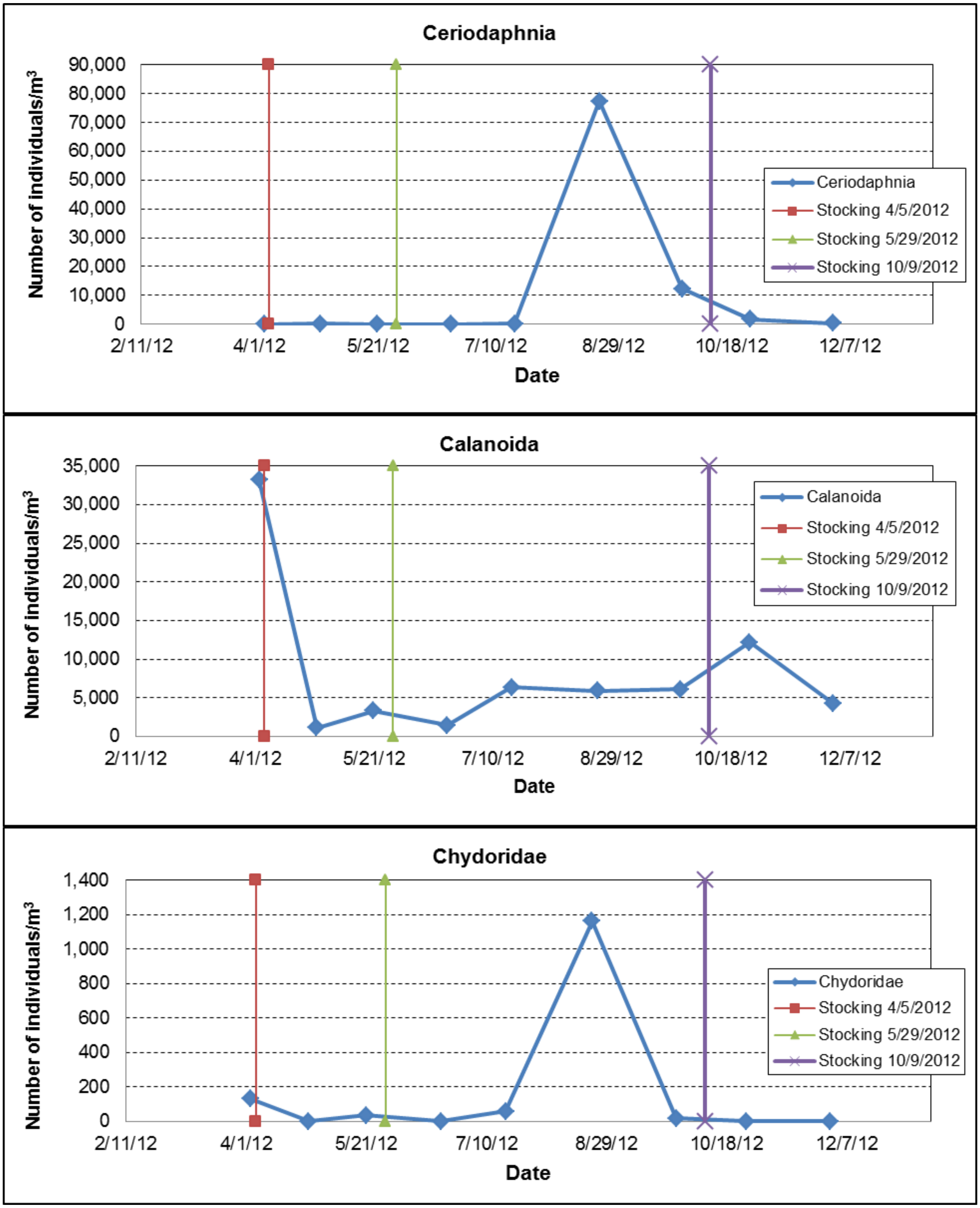
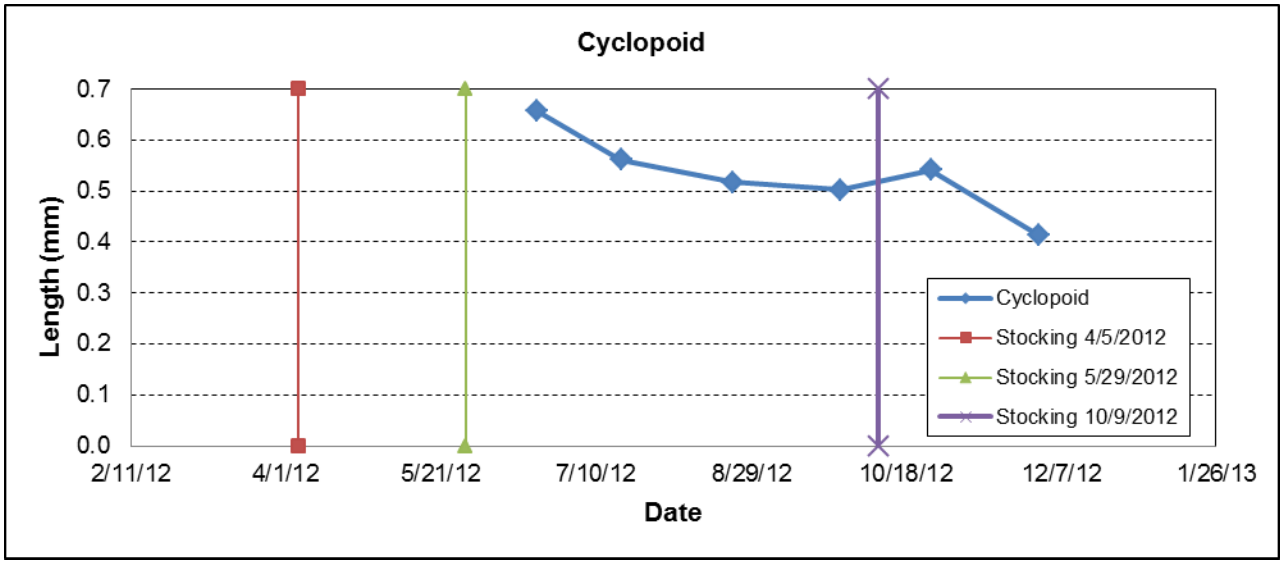


Figure 90. Continued.



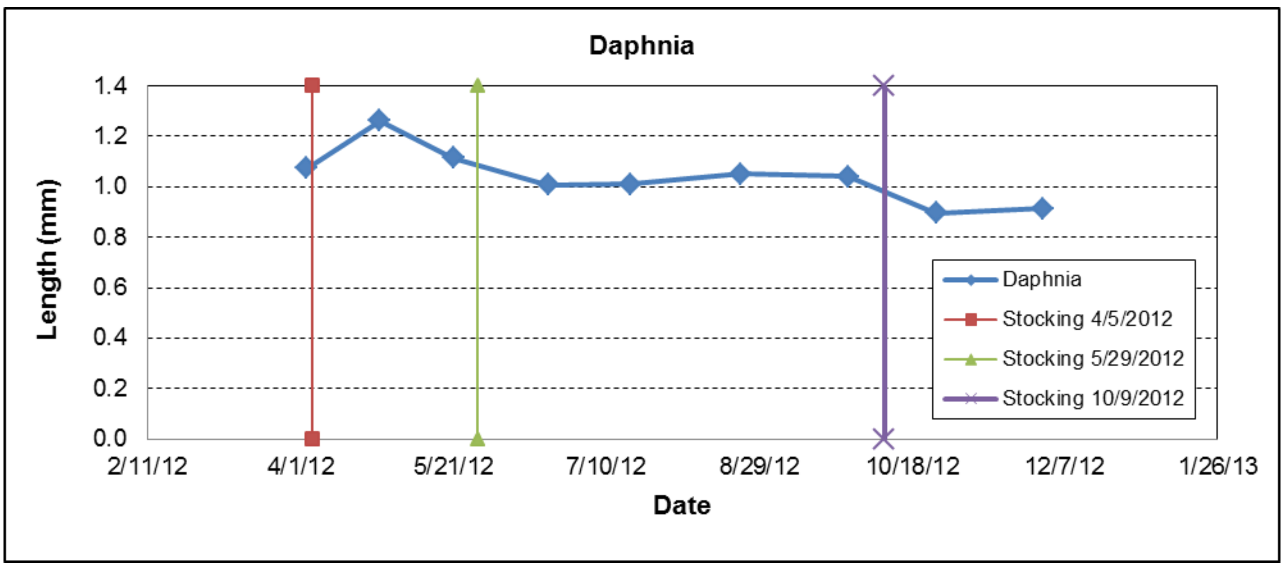


Figure 91. Average length (mm) of zooplankton collected from monthly sampling in Mann Lake, Idaho, during 2012.

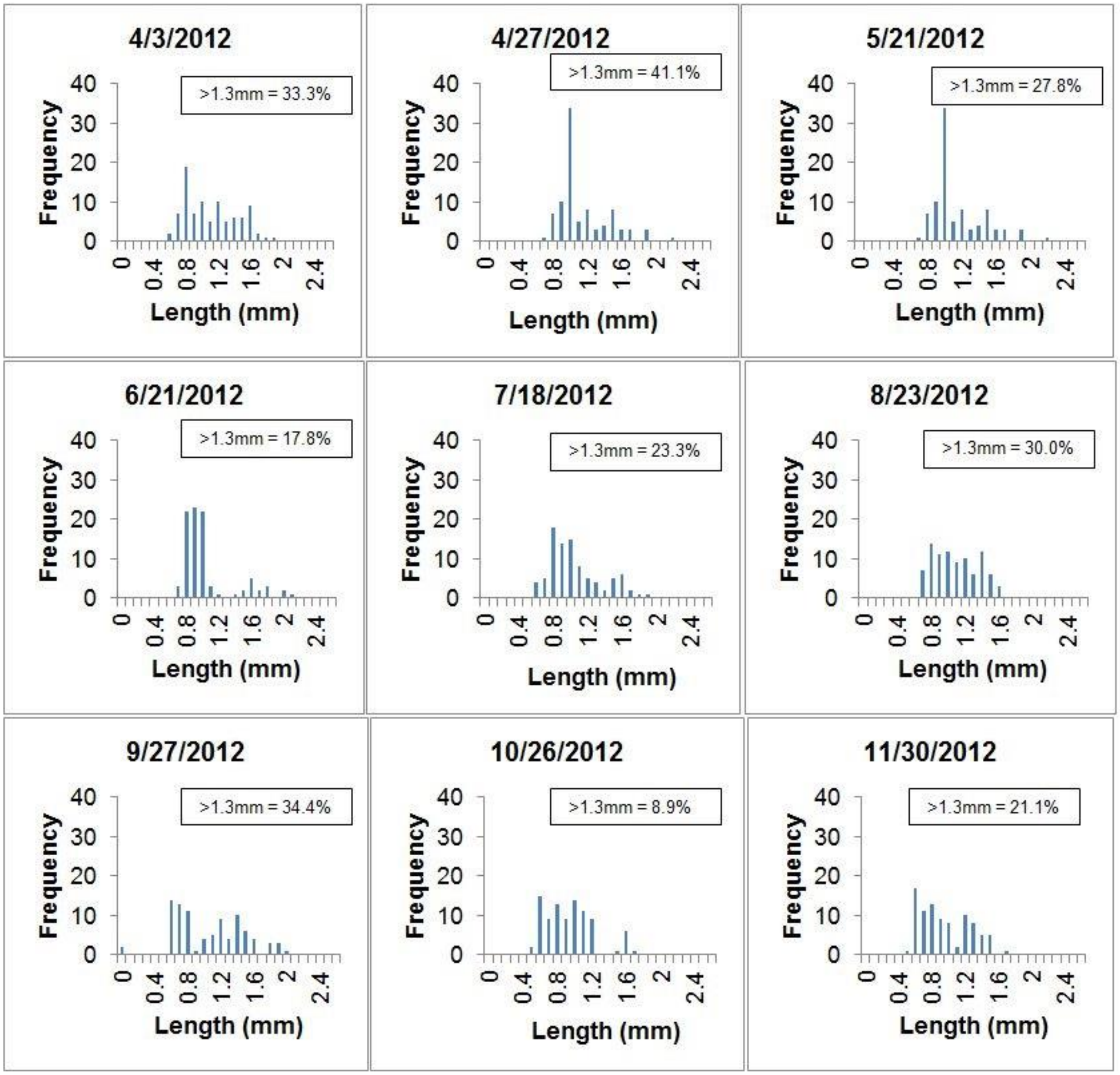


Figure 92. Length frequency distribution of Daphnia collected from monthly sampling in Mann Lake, Idaho, during 2012.

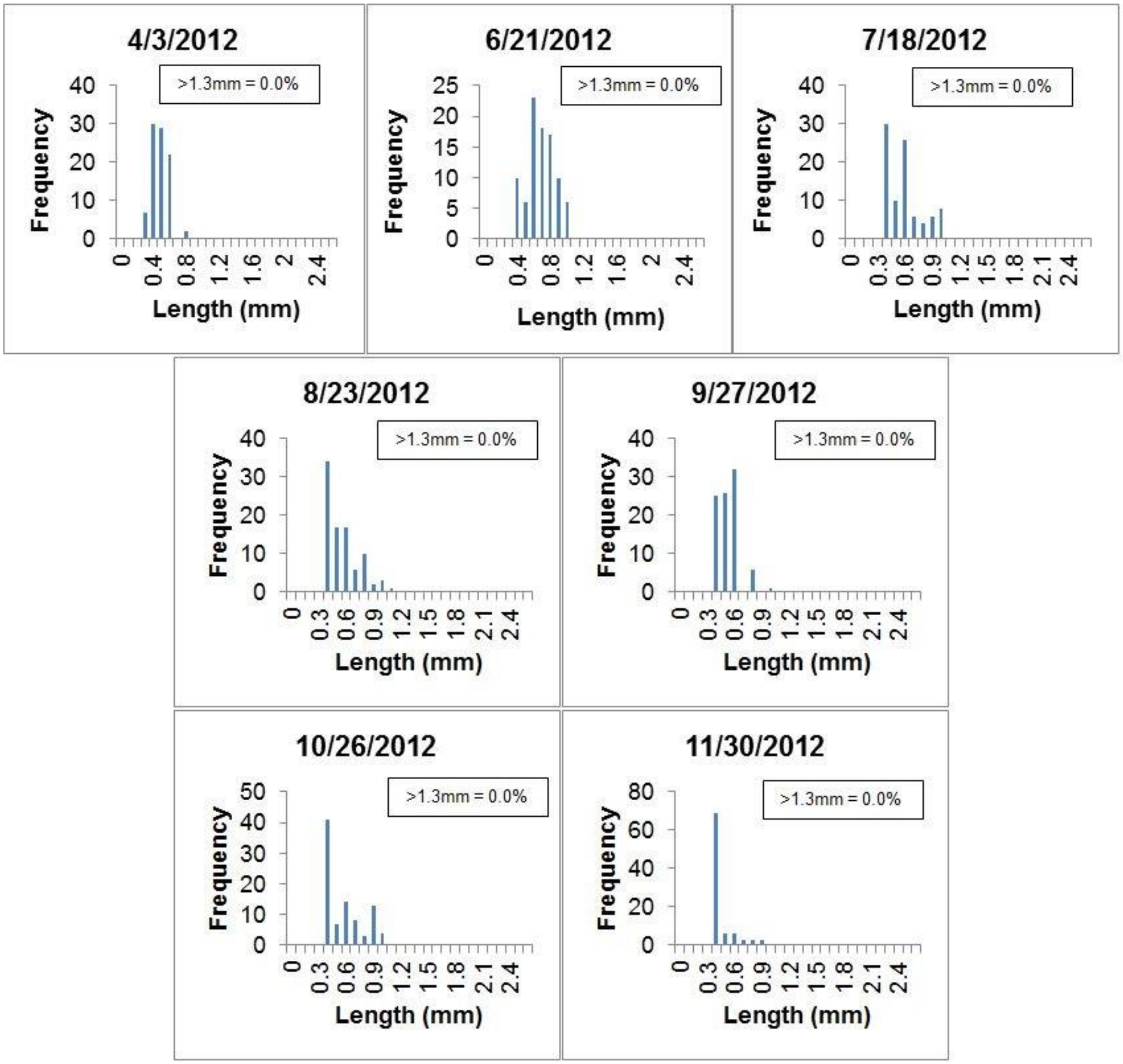


Figure 93. Length frequency distribution of Cyclopoids collected from monthly sampling in Mann Lake, Idaho, during 2012.

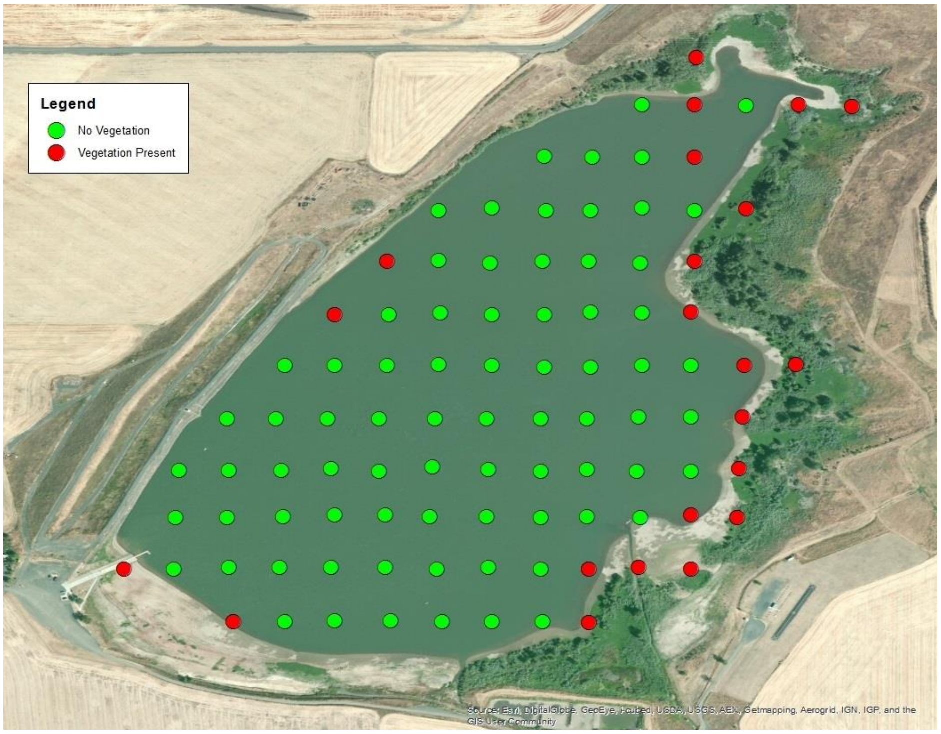


Figure 94. Locations where aquatic vegetation was collected during vegetation sampling of Mann Lake, Idaho, during 2012.

Figure 95. Fishability at vegetation sample locations based on Davids' Fishability Index sampling of Mann Lake, Idaho, during 2012.

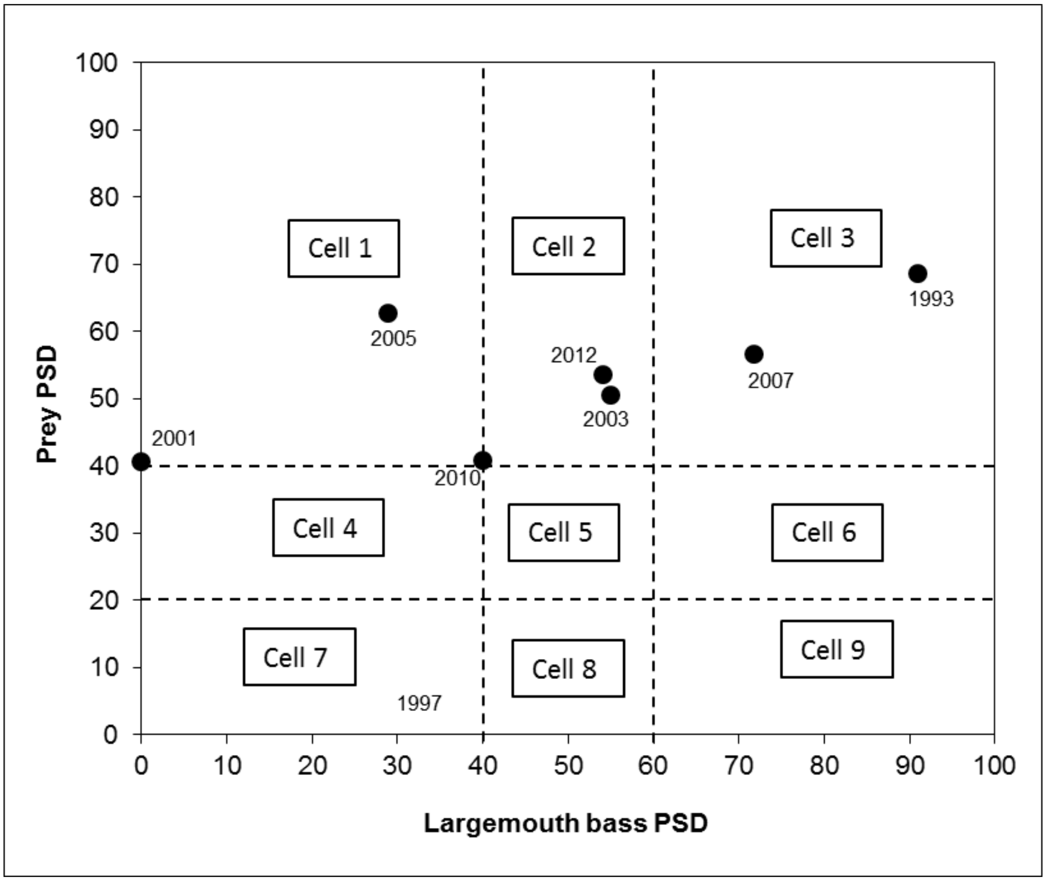
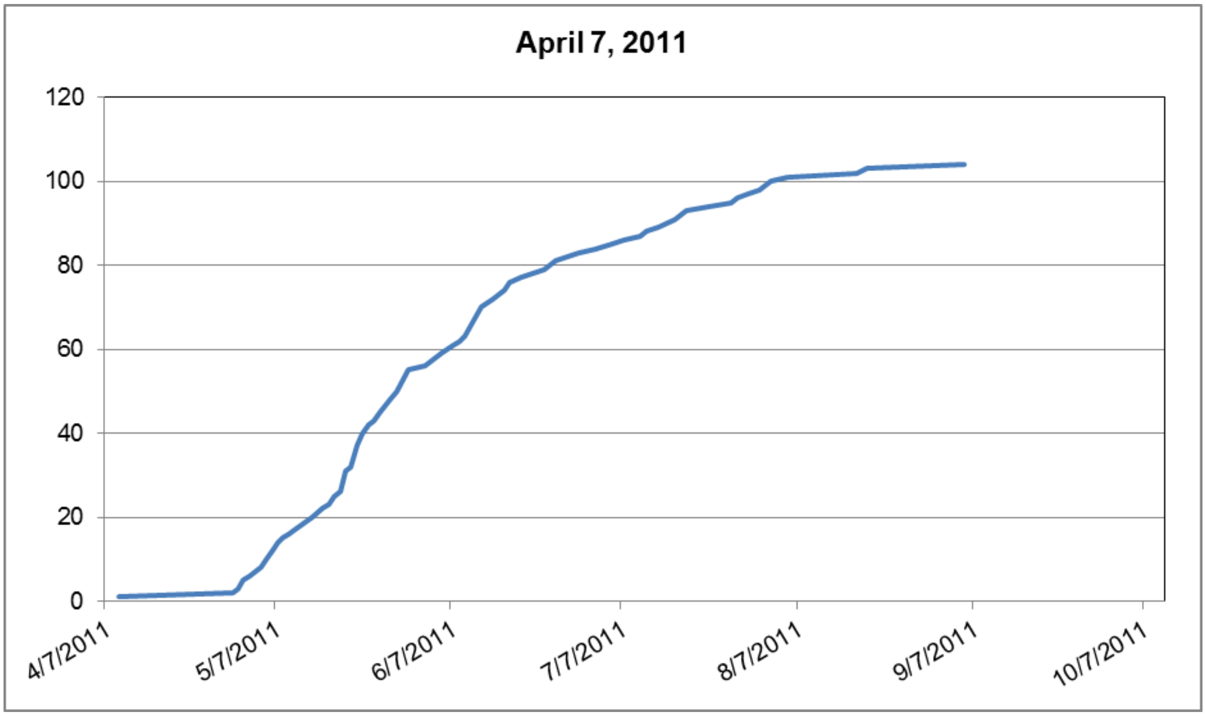


Figure 96. Comparison of predator (Largemouth Bass) and prey (Bluegill, Black Crappie, and Pumpkinseed) proportional size distribution (PSD) from standard lake surveys conducted in Mann Lake Idaho, from 1993 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).



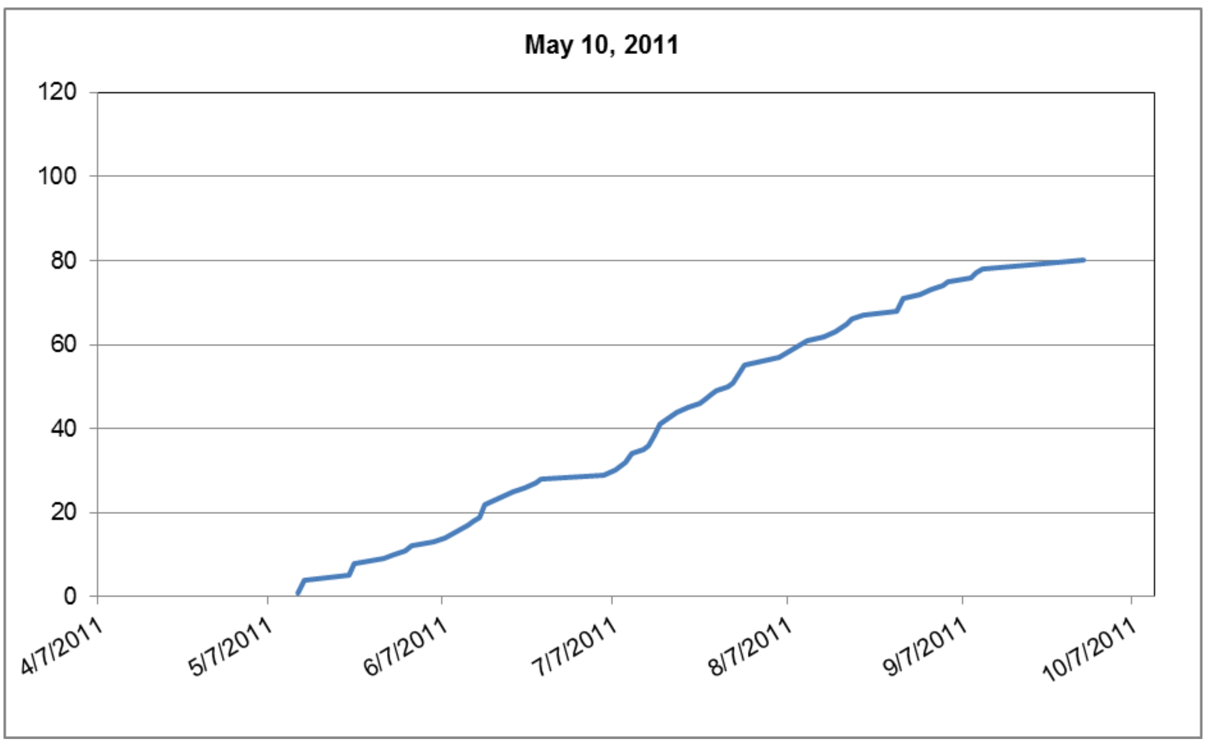


Figure 97. Cumulative number of hatchery catchable Rainbow Trout harvested from Mann Lake, Idaho, after April 7th and May 10th, 2011 stockings, based on angler exploitation surveys (799 fish tagged).

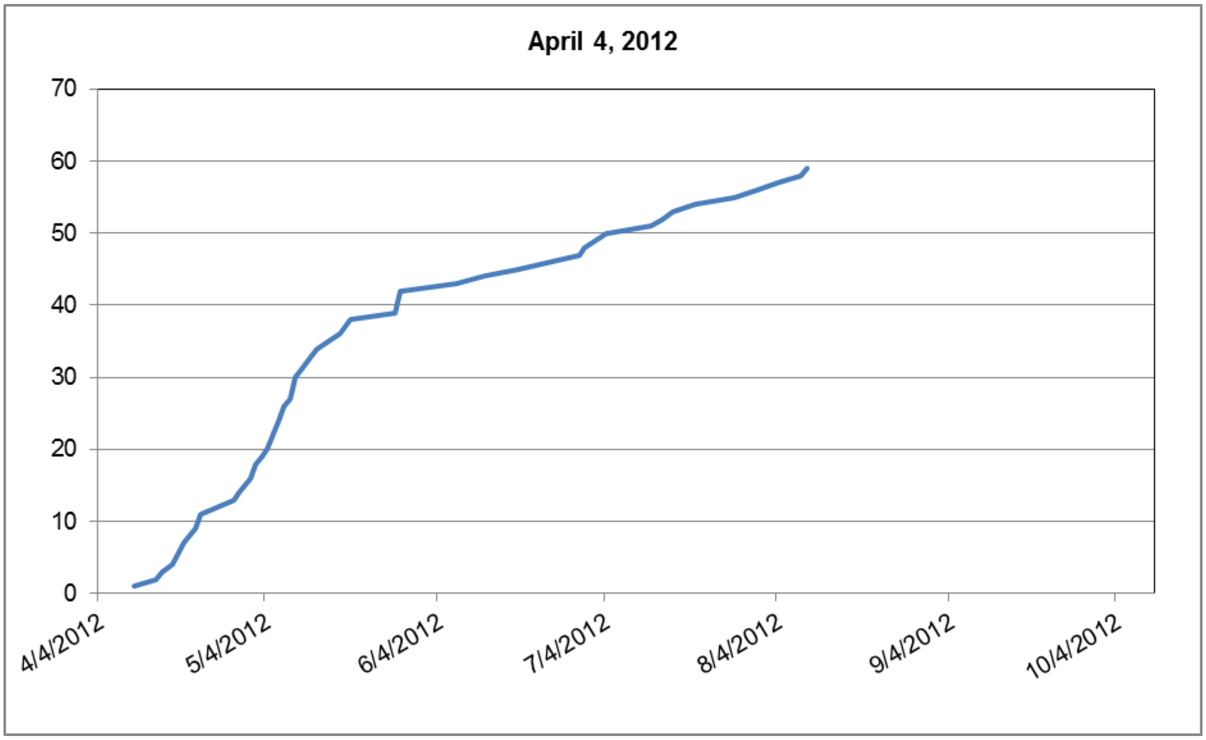


Figure 98. Cumulative number of hatchery catchable Rainbow Trout harvested from Mann Lake, Idaho, after April 4th, 2012 stocking, based on angler exploitation surveys (600 fish tagged).

SPORTFISH ASSESSMENT OF MOOSE CREEK RESERVOIR

ABSTRACT

In 2012, a comprehensive assessment of Moose Creek Reservoir was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 411 fish including Bluegill, Pumpkinseed, Largemouth Bass, Black Crappie, and Black Bullhead. The results of this survey indicate that while MCR has a balanced prey population, the Largemouth Bass population is showing an increasing Proportion Stock Density, and declining CPUE. This suggests a lack of successful recruitment of Largemouth Bass in recent years that is resulting in a shift towards an imbalanced fishery. Additionally, with the increasing levels of harvest seen over the last few creel surveys (and the harvest of larger fish), harvest appears to be having an impact on the Largemouth Bass at this time. Monitoring harvest levels and the predator:prey balance should continue to determine if there is a need for restrictive regulations.

Creel surveys estimated angler effort at 16,639 hours. This was the second highest of the four creel surveys conducted since 1993, but was a 16% declined from the high of 19,784 hours estimated in 2005. Angler effort declined in seven of the eight regional reservoirs surveyed in both 2005 and 2012. This decline may be a result of the declines in participation in outdoor recreation activities during the 1990's and early 2000's. However, these changes may also be the result of improvements in the accuracy of our creel survey methodology from 2005 to 2012. The angler catch rate for all fish species combined was estimated at 2.3 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 1.4 fish/hour, well above the statewide management goal of >0.5 fish caught/hour. Angler exploitation of hatchery catchable size Rainbow Trout was estimated at 68.9% for the creel survey while angler exploitation was estimated at 18.8% by the "Tag You're It" program. This substantial difference may have been caused by factors such as a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. The large difference between these two estimates should be explored in the future to determine which method is more accurate. Changes in stocking abundance and timing of Rainbow Trout are not recommended in MCR, as angler catch rates for hatchery Rainbow Trout have met our management goal of >0.5 fish caught/hour for each creel survey since 1993. Additionally, total use (fish caught + fish harvested) exceeds the statewide reservoir average and is close to our statewide management goal of 40% for hatchery catchable Rainbow Trout.

Over the last few years, MCR has been experiencing excessive aquatic vegetation growth, with vegetation present at 95.4% of sample sites. Due to the potential negative impacts on fisheries and recreation, we recommend implementing vegetation control measures in the future. Due to cost and effectiveness issues, we suggest evaluating winter drawdown as a control method.

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INTRODUCTION

Moose Creek Reservoir (MCR) is approximately a 58 km drive from Moscow, ID (pop. 24,080) and 74 km from Pullman, WA (pop. 29,913). An economic survey conducted in 2011 estimated 6,174 total angler trips to MCR for an estimated total economic expenditure of $624,434 (IDFG unpublished data). Moose Creek Reservoir contains six species of game fish: Largemouth Bass, Black Crappie, Pumpkinseed, Bluegill, Black Bullhead, and Rainbow Trout. The only non-game fish species documented is the Largescale Sucker. The hatchery Rainbow Trout catchable program is maintained through annual stockings averaging approximately 19,000 fish a year since 2002. Warm-water species have maintained natural populations without supplemental stockings since their introduction. The percent of the fishery supported by hatchery trout has stayed consistent, ranging from 83% in 2005 to 89% in 1999 (Hand et al. 2005). Total angler effort on Moose Creek Reservoir during 2005 was estimated at 19,874 hours (Hand et al. 2005).

During the summer, a large portion of the reservoir (80-90%) is densely vegetated with aquatic macrophytes. The reservoir was drained and reconstructed in 1999. This effort and other aquatic vegetation treatments have been directed at controlling Pondweed found within the reservoir. These treatments have largely been unsuccessful and aquatic vegetation continues to be a significant management concern within MCR.

Moose Creek Reservoir is an important fishery to maintain high catch rates and angler satisfaction. Data from these surveys was intended to assess the current put-and-take hatchery catchable program, provide insights on how to potentially increase holdover capabilities for stocked Rainbow Trout, and increase the quality of the warm-water fishery that appears to be a significant portion of the fishery.

Current Management

Moose Creek Reservoir is a mixed fishery, containing both cold-water and warm-water species. It is managed as a put-and-take trout fishery with catchable Rainbow Trout stocked annually to maintain a catch rate of >0.5 fish/hour (IDFG 2013). Moose Creek Reservoir has simplified regulations including year round seasons, no length limits, general six fish limit for trout and bass, no creel limits for other species, and no restrictions on fishing gear. Boat activity on Moose Creek Reservoir is restricted to electric motors only. The current management priority is to provide a desirable fishing experience to families and individuals alike.

Reservoir Management Goals

1. Maintain total catch rate of >0.5 fish/hour.

2. Maintain warm-water fishery for Largemouth Bass, Black Crappie, and Bluegill.

3. Manage aquatic vegetation as needed to improve fisheries and angler effort.

STUDY SITE

Moose Creek Reservoir (MCR) is located in Latah County approximately three miles from the town of Bovill, ID (Figure 4). Moose Creek Reservoir is the site of an abandoned clay mining operation, and is located on land owned by the Idaho Department of Lands. The IDFG leases the reservoir and land surrounding the reservoir (81 acres) for the purpose of providing fishing opportunities for the public. The Latah County Recreation District manages camping and day-use recreation on approximately 28 hectares surrounding the reservoir (through a sublease from IDFG). It is a 10.9 ha reservoir that lies at an elevation of 878 meters. In 1998, MCR was drained and dredged to reduce nuisance aquatic vegetation and improve angler access. The reservoir has a maximum depth of 3.9 meters with approximately 90% of the reservoir less than 2.4 meters deep. Overnight camping and day use facilities are available at MCR. It is located in the Potlatch River drainage and has an Endangered Species Act listed steelhead population present in Moose Creek below the dam.

RESULTS

Population Surveys

A fishery survey of MCR was conducted on June 14, 2012 which consisted of 60 minutes of electrofishing and one trap net night. Electrofishing was separated into six 10-minute periods. The electrofishing and one trap net set resulted in the capture of 411 fish including Bluegill (n = 255), Pumpkinseed (n = 100), Largemouth Bass (n = 26), Black Crappie (n = 19), and Black Bullhead (n = 11). The electrofishing catch rate was 408 fish/hour (Figure 99). Only three Bluegill were collected by the trap net. Catch rates for each of the six 10-minute samples ranged from 50 - 98 fish/sample (Table 19). The variability from the six samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). To have a 90% confidence (2-tail test) with 25% precision estimate of fish captured in an electrofishing sample of MCR, an estimated three sample periods would be needed for a whole fish community survey (Table 19). To have a 90% confidence with 25% precision estimate to track just Largemouth Bass or Bluegill, an estimated nine or four sample periods, respectively, would need to be conducted respectively (Table 19).

Largemouth Bass:

Largemouth Bass collected ranged from 129 - 472 mm in length (Figure 100) with an average length of 250 mm. Nine of the 26 fish collected (35%) were over 300 mm in length. This is above the average of 24% of fish >300 mm captured in the seven surveys conducted since 2001. Largemouth Bass CPUE (26 fish/hour) was the second lowest since 2001. Largemouth Bass PSD was 67 (Figure 101), the highest we have documented during sampling from 2001 - 2012. Relative weights (W_r;) ranged from 61 - 112, with an average of 82 (Figure 102). Relative weight was generally lower for smaller fish than for larger fish. Scale samples indicated (n = 23) these fish ranged in age from 2 - 8 years (Table 20). Annual growth rates ranged from 42 - 73 mm. Annual instantaneous mortality (Z) was -0.511 for fish aged 3 - 6 (R^2 = 0.791) (Figure 103). Thus, the annual survival rate (S) was 60%, and total annual mortality (A) was 40%.

Bluegill:

Bluegill collected ranged from 31 - 193 mm in length, with an average of 123 mm (Figure 104). Length frequency distributions have been fairly similar since 2000, with the majority of fish in the 90 - 180 mm range each year. The PSD of 23 in 2012 was an increase over 2010 (Figure 105). Relative weights ranged from 50 - 158, with an average of 91 (Figure 106). Relative weight was similar across the range of lengths. Scale samples indicated Bluegill collected in 2012 (n = 98) ranged in age from 1 - 7 years (Table 21). Annual growth rates ranged from 12 - 49 mm. Annual instantaneous mortality (Z) was -0.424 for fish aged 3 - 5 (R^2 = 0.986) (Figure 107). Thus, the annual survival rate (S) was 65%, and total annual mortality (A) was 35%.

Black Crappie:

Black Crappie collected ranged from 142 - 247 mm in length, with an average of 185 mm (Figure 108). Length frequency distributions shifted towards larger fish from 2006 - 2010, but back towards smaller fish in 2012. The PSD of 33 in 2012 (Figure 109) was a decrease from a high of 79 2010, and the second lowest for samples collected from 2001 - 2012. Relative weights ranged from 56 - 131, with an average of 79 (Figure 110). Relative weight was similar across the range of lengths. Black Crappie collected in 2012 (n = 18) ranged in age from 3 - 6 years (Table 22). Annual growth rates ranged from 33 - 52 mm. A catch curve for estimating mortality was not developed due more age-5 fish than age-4 fish.

Pumpkinseed:

Pumpkinseed collected ranged from 54 - 172 mm in length, with an average of 123 mm (Figure 111). Most of the fish (75.5%) were between 90 - 159 mm. Length frequency distributions have been fairly similar since 2000, with the majority of fish in the 90 - 159 mm range each year. The PSD of 8 2012 (Figure 112) was the second highest for samples collected from 2001 - 2012. Relative weights ranged from 59 - 140, with an average of 100 (Figure 113). Relative weight in general was lower for larger fish. Scale samples were analyzed from Pumpkinseed collected in 2012 (n = 76). These fish ranged in age from 2 - 6 years (Table 23). Annual growth rates ranged from 5 - 40 mm. A catch curve (Figure 114) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.388 for fish aged 4 - 5 (R^2 = 1). Thus, the annual survival rate (S) was 68%, and total annual mortality (A) was 32%.

Creel Surveys

Angler Effort:

Creel surveys were conducted on MCR from November 28th, 2011 through November 28th, 2012. A total of 206 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 16,639 hours (SE ± 1,244; Table 24). Slightly more effort occurred on weekdays (52%) than weekends (48%). Effort consisted of 83% bank, 10% boat, and 7% ice anglers. The highest angler effort occurred in the summer months from May - September, with monthly effort estimates ranging from 1,472 - 3,789 hours.

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on MCR was based on 182 completed trip interviews. Anglers caught an estimated 38,848 fish during 2012, resulting in a catch rate of 2.3 fish/hour. Hatchery Rainbow Trout accounted for 64% (n = 24,882) of the fish caught during the 2012 creel survey (Figure 115). Warm-water species caught included 10,932 Bluegill (28%), 1,786 Black Crappie (5%), 978 Largemouth Bass (3%), and 47 Black Bullhead (<1%). Anglers harvested an estimated 18,954 fish during 2012 (Appendix A), 49% of the fish caught. The harvest rate for all fish combined was estimated to be 1.1 fish/hour. Harvest in 2012 consisted of 85% hatchery trout (n = 16,265), 11% Bluegill (n = 2,177), 2% Largemouth Bass (n = 315), and 1% Black Crappie (n = 197; Figure 116). All harvested fish encountered during creel surveys were measured for total length. Harvested Largemouth Bass ranged in length from 249 - 455 mm, and averaged 289 mm (Figure 100). Harvested Bluegill ranged in length from 122 - 292 mm, and averaged 166 mm (Figure 104). Harvested Black Crappie ranged in length from 170 - 230 mm, and averaged 198 mm (Figure 108).

A total of 24,882 hatchery Rainbow Trout were estimated to have been caught during the survey, with 16,265 harvested (Appendix B). This is a catch rate of 1.4 fish/hour and a harvest rate of 0.9 fish/hour. Holdover Rainbow Trout accounted for 2,660 (11%) of the hatchery trout caught and 1,657 of the ones harvested (10%). The estimated exploitation rate for stocked Rainbow Trout was 68.9%. Harvested Rainbow Trout measured by creel clerks (n = 552) ranged in length from 177 - 341 mm, and averaged 270 mm.

Angler Satisfaction:

A total of 595 public opinion surveys were conducted at MCR in conjunction with the creel survey. All constituents using the lake were interviewed. Seventy-one percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 117). “Other” (17%) and camping (12%) were the next most common responses. Of the people interviewed, 87% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at MCR. Results from those individuals were used to characterize angler’s opinions. Sixty-three percent of people interviewed rated their fishing experience as excellent or good (Figure 118). The most common reasons for a positive rating were catching their target species (21%) and nice to be outside (15%; Figure 119). Thirty-seven percent of people interviewed rated their fishing experience as fair or poor (Figure 118). The most common reasons for a negative rating were poor fishing (30%) and poor weather (4%; Figure 119). The most commonly targeted fish species were Rainbow Trout (46%) and Black Crappie (42%; Figure 120). Eight percent of people interviewed were not targeting a particular fish species while fishing. Anglers targeting Largemouth Bass and Bluegill comprised less than 5% of the anglers.

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery Rainbow Trout stocked in MCR in 2011 and 2012. Rainbow Trout were tagged on April 25, 2011 (n = 398), October 12, 2011 (n = 397), April 24, 2012 (n = 699), May 12, 2012 (n = 1,199) and October 22, 2012 (n = 400). Exploitation rates through 365 days at large averaged 43.4% for the April, 2011 tagging events, 20.3% for the October, 2011 event, 17.7% for the spring 2012 events, and 46.5% for the October, 2012 stocking (Table 25). Exploitation rates for 366 - 730 days at large averaged 0.9% for the April, 2011 tagging events, 0.0% for the October, 2011 event, 0.3% for the spring 2012 events, and 0.0% for the October 2012 event. There was no exploitation beyond 730 days at large.

Angler total use (fish harvested plus fish released) rates through 365 days at large (Table 25; Appendix D) averaged 53.3% for the April, 2011 tagging events, 27.9% for the October, 2011 event, 24.0% for the spring 2012 events, and 52.9% for the October 2012 stocking (Appendix D). Angler total use rates for 366 - 730 days at large for each stocking event averaged 0.9% for the April, 2011 tagging events, 0.0% for the October, 2011 event, 0.3% for the spring 2012 events, and 0.0% for the October 2012 event.

An angler exploitation survey was conducted on Largemouth Bass tagged during a standard lowland lake survey on June 13, 2012 (n = 11). Through June, 2014, one tagged fish had been reported caught. This fish was harvested, resulting in annual estimated exploitation and total use rates of 20.0%.

Limnology

Limnology samples were collected monthly from April to November, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being quite evident. Dissolved oxygen profiles in May, late October, and December were very homogenous, while typical anoxic conditions were present in the hypolimnion from July to early October (Figure 120). Monthly temperature measurements showed similar patterns to the DO measurements (Figure 120). To look at potential diel changes in temperature and DO profiles, measurements were taken at 1:06pm and 7:15pm on August 24th, 2012, and at 5:30am on August 2nd, 2012 (Figure 121). There was a drop in surface temperature overnight, and some slight variations in DO at 2 - 3 m, but no changes elsewhere.

Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to rainbow trout and can result in reduced survival. During July and August water temperatures were >21°C down to a depth of 3 m, and DO was <5.0mg/L below 4 m (Figure 120). Using these metrics, a 1 m section of the reservoir was conducive for long term Rainbow Trout survival. In August, DO was <5.0 mg/L below 2 m in depth, resulting in a condition in which no water in MCR was conducive for long term Rainbow Trout survival. Utilizing an upper thermal limit of 25^{o}C also resulted in reduced volume conducive for Rainbow Trout survival during June-September 2012.

Zooplankton

Zooplankton samples were collected monthly from April to December, 2012. The population was composed of five taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Bosmina, Ceriodaphnia, and Calanoida. The composition changed from primarily Cyclopoida (>73%) in May - June samples to primarily Daphnia (>42%) in July, and October - December (Figure 123).

Densities (# of individuals/m^3) were also highly variable. Daphnia densities ranged from 8 - 32,520/m^3 with an average of 11,356/m^3 (Figure 124). Cyclopoida densities ranged from 461 - 17,616/m^3 with an average of 5,994/m^3. Ceriodaphnia densities ranged from 2 - 6,326/m^3 with an average of 1,480/m^3. Densities peaked for Daphnia in July and October, for Cyclopoida in August, and for Ceriodaphnia in July. Average lengths of Cyclopoida ranged from 0.37 - 0.79 mm, and Daphnia from 0.36 - 0.83 mm (Figure 125). Length frequency distributions from each sample show that Daphnia >1.3 mm in length ranged from 0.0 - 2.1% of the individuals collected (Figure 126). Length frequency distributions from each sample show that no Cyclopoids >1.3 mm in length were found in any samples collected in 2012 (Figure 127).

Additionally, ZQI sampling was conducted on August 21, 2012. Biomass was 0.35 (g/m^3) for the 150 µm net, 0.07 (g/m^3) for the 500 µm net, and 0.07 (g/m^3) for the 750 µm net (Appendix E). The ZPR was calculated to be 1.00 and the ZQR was 0.15.

Aquatic Vegetation

Vegetation surveys were conducted on August 25, 2012. A total of 87 sites were sampled. Vegetation was collected by rake tosses at 83 (95.4%) sample sites (Figure 128). Eight types of vegetation were identified (Appendix F): filamentous algae, macrophytic algae, Elodea, Coontail, Pondweed, Water Starwort, Pond Lily *Nuphar polysepala*, and Bladderwort *Ultricularia vulgaris*. Pondweed was the most commonly encountered vegetation, occurring at 72 (82.7%) sites where vegetation was collected. Filamentous algae was the second most common, occurring at 47 (54.0%) sites, followed by Bladderwort (35.6%), Water Starwort (18.3%), macrophytic algae (17.2%), Elodea (17.2%), Coontail (12.6%), and Pond Lily (4.6%).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 87 sites. Vegetation was encountered while casting and retrieving tackle at 68 (78.1%) sites (Figure 129). Vegetation was present on hooks at 52 (59.7%) sites, while dense matted surface vegetation prevented casting at 16 (18.4%) sites. Sixty-two percent of the surveyed sites were along the shoreline; and based on the DFI, angling at 94.1% of these sites would be negatively influence by vegetation.

DISCUSSION

Population Survey

The fish community in MCR Lake is a two-story fishery, with both warm-water and cold-water fish. Stocked hatchery Rainbow Trout provides an excellent put-and-take fishery, while Largemouth Bass, Bluegill, and Black Crappie provide warm-water fishing opportunities. A few changes have occurred in the MCR fishery over the last seven samples (Figure 99). The Largemouth Bass population has experience a decline in CPUE while Bluegill and Pumpkinseed have increased substantially. In contrast, the Black Crappie population has stayed relatively stable. The changes seen in the warm-water fishery may be due to changes in vegetation in MCR. There has been a steady increase in vegetation coverage through the seven samples conducted since 2001. This is likely influencing these fish populations by providing more cover for Bluegill and Pumpkinseed and reducing the predation opportunities for Largemouth Bass.

The results of the fisheries survey conducted in 2012 indicated that for an electrofishing survey of MCR, three 10-minute samples would be needed for a whole fish community estimate with 90% confidence (2-tail test) and 25% precision (Table 19). To sample just Largemouth Bass, we would need nine 10-minute samples. Due to the size of MCR, we can sample the entire shoreline to improve our estimates. Therefore, we recommend conducting enough 10-minute electrofishing samples in order to sample the entire shoreline of the reservoir.

Largemouth Bass:

Moose Creek Reservoir's Largemouth Bass population in 2012 was characterized with numerous fish <300 mm and a few fish up to 500 mm. Of the 829 Largemouth Bass collected during lake surveys since 1997, 43.7% (n = 362) were >250 mm and 22.3% (n = 185) were >300 mm. This has resulted in PSD values generally within or near the balanced population range of 40 - 70 (Anderson 1980) for every survey since 2001. However, the population has changed over time, with CPUE declining and PSD increasing. This suggests that recruitment has likely been poor over the last few years.

As with many of the region's reservoirs, Largemouth Bass experience slow growth in MCR. This is to be expected for reservoirs at this latitude and elevation which have shorter growing seasons than populations farther south or at lower elevations. Temperature is one of the most important abiotic factors controlling growth rates (Colby and Nepszy 1981; McCauley and Kilgour 1990; Beamesderfer and North 1995; Wehrly et al. 2007). With its location in northern Idaho at an elevation of 878 m, MCR is expected to have fewer heating degree days than occur in most of the Largemouth Bass range (McCauley and Kilgour 1990; Beamesderfer and North 1995).

Because of this shorter growing season, we would expect Largemouth Bass in MCR to grow slower than most other bass populations across the nation. Although the Largemouth Bass collected in 2012 had a larger average length than the regional reservoir average (Appendix J), annual growth rates were at or below the regional average for all year classes. Additionally, average length at age was below the regional average for fish age 1 - 4 (Appendix J). This slower growth has resulted in Largemouth Bass at MCR entering the fishery (stock size of 200 mm) at age 4, and not reaching quality size (300 mm) until age 5 (Appendix K). The regional average to stock size is age 3 and to quality size is age 5 (Appendix K). This age to quality size is also above the average age of 4.4 years for 40 Idaho populations described by Beamesderfer and North (1995), and a modeled estimate of four years based on thermal degree days described by McCauley and Kilgour (1990). This indicates that while slow growth is expected for Largemouth Bass at higher latitudes and elevation, growth is still low in MCR.

Food resources can also play an important role in the growth of Largemouth Bass. Relative weights of Largemouth Bass in MCR averaged 82, but increase rapidly as fish got larger (Figure 102). This may indicate the smaller fish have limited food resources, poor foraging conditions, and/or increased competition due to high abundance. Numerous Bluegill under 100 mm have been collected in recent surveys suggesting food resources are not likely an issue. However, high densities of aquatic vegetation such as occur in MCR have been found to reduce forage success of Largemouth Bass (Bettolli et al. 1992; Dibble et al. 1996). Lower CPUE in 2012 than previous surveys suggests that largemouth bass abundance is declining making it unlikely that competition due to high an abundance of smaller fish is the reason for their lower relative weights. Vegetation control could improve relative weights and growth due to improved forage opportunities.

Where slow growing bass populations occur, even low exploitation rates have been found to prevent Largemouth Bass from reaching larger sizes (Bennett et al. 1991b). Creel surveys indicate that Largemouth Bass harvest has increased substantially in MCR, with an estimated 315 fish harvested in 2012. Using the population estimate of 893 fish calculated by Hand et al. (2012), angler exploitation was 35%. This is higher than the annual angler exploitation rate of 20.0% (through June 2014) calculated for fish tagged in 2012. However, the exploitation rate was based on a very low sample size. These exploitation rates are close to the average rate of 30% exploitation for 32 separate studies analyzed by Allen et al (2008). The annual mortality rate estimated through scale analysis was 40%. This suggests that annual natural mortality is relatively low and that most annual mortality is due to angler exploitation. Most of the fish harvested by anglers during the 2012 creel survey were generally small (Figure 100). The 10 fish measured ranged in length from 249 - 455 mm, and averaged 289 mm. With mostly small fish being harvested, this indicates that there were few fish of quality size or above in the population. With few Largemouth Bass >300 mm in length in the population and slow growth, even the low levels of harvest estimated during recent creel surveys could have an impact on the population (Bennett et al. 1991b). This suggests that the appearance of a stunted bass population is at least partly due to exploitation.

Bluegill:

The Bluegill population has seen little change in the range of lengths (mostly 90 - 180 mm) over the seven samples collected since 2001. The PSD value of 23 in 2012 was within the range of 20 - 60 which is considered to be a balanced population. However, it was below the regional average PSD of 49 for Bluegill (Appendix I). The average length of Bluegill (123 mm) in MCR was the lowest of any of the six lakes surveyed that contain Bluegill (Appendix I). Annual growth of Bluegill in MCR ranged from 5 - 49 mm. Each year’s growth was below the regional average, except for age 7 fish (Appendix I). On average, Bluegill reach stock size (80 mm) at age two. Additionally, relative weights for Bluegill in MCR were low for fish of all size. The slow growth and below average relative weights may be due in part to poor foraging conditions caused by dense vegetation and increased competition from numerous fish (CPUE has increased substantially).

The Bluegill harvested by anglers in MCR during 2012 were in the upper end of the range of lengths found in the population (31 - 193 mm), and averaged (165 mm) much larger than the population average of 123 mm (Figure 104). This is generally to be expected, as anglers usually prefer to keep the larger fish they catch (Aday and Graeb 2012), and indicates that there are enough quality size fish to produce a good fishery. The harvest of the larger individuals in the population may indicate why we saw a reduction in average size from previous surveys (Figure 104). Bluegill harvest has increased every creel survey since 1993, reaching a high in 2012. This is a good sign, as increased harvest of Bluegill would help maintain a higher quality fishery, although it is difficult to get anglers to harvest enough to maintain a balanced population over time (Cooke et al. 2001; Isermann and Paukert 2010). Crawford and Allen (2006) saw exploitation rates of Bluegill increase up to three times as fish size increased. This could ultimately influence the size structure of the population, if larger fish are harvested at high rates. However, the annual mortality rate of 35% estimated for Bluegill in MCR was second lowest calculated for regional reservoirs (Appendix I). It was also well below the average annual mortality of 74% calculated for 46 mid-western Bluegill populations (Coble 1988). Coble (1988) also calculated the average annual exploitation rate of those 46 populations to be 27%. Although angler exploitation of Bluegill in MCR could not be calculated, compared to other reservoirs, both angler exploitation and natural mortality appear to be lower than average. It must be noted that even though total mortality is low, Bluegill do not reach quality size until age six. This is similar to other regional reservoirs (Appendix I), but with slow growth rates, even low mortality rates could have an impact on the size structure of the population.

With the below average length and slow growth rates for Bluegill in MCR, implementation of restrictive fishing regulations might seem like a good management strategy. However, care must be taken when implementing restrictive regulations, as they can result in little or no benefit in terms of fish size structure or angler catch rates (Crawford and Allen 2006) if implemented improperly. This can result in reduced angler effort and satisfaction. Since Bluegill harvested from MCR still average over quality size and experience lower than average annual mortality, we do not recommend any changes to the regulations for Bluegill. If PSD and average lengths continue to decline, restrictive regulations may become necessary to protect the size structure of this quality fishery. Alternately, vegetation control could help improve the Bluegill fishery by reducing available cover, thus increasing predation by Largemouth Bass.

Black Crappie:

As with many of our smaller reservoirs, the Black Crappie population in MCR is dominated by fish over 150 mm, with no smaller fish captured in samples. Age and length data shows a lack of recruitment over the previous couple years. Inconsistent recruitment such as this is often common in smaller reservoirs (Beam 1983; McDonough and Buchanan 1991; Allen 1997). The successful recruitment years do not coincide across all reservoirs, indicating that environmental factors are not the primary driving force behind successful year classes. The PSD in 2012 dropped for the first time since 2004 after increasing each of the previous four samples (Figure 109). This suggests that in addition to poor recruitment, fewer large fish are present as well. A lack of quality size fish (230 mm; Gablehouse 1983) was apparent from angler harvest as well, with no fish >239 mm measured during creel surveys. Combined with poor relative weights, this data suggests that the Black Crappie population is in decline, likely due to poor recruitment, harvest, and reduced habitat due to widely spread dense aquatic vegetation. Vegetation control could help improve the fishery by reducing available cover, thus increasing predation opportunities.

Pumpkinseed:

The Pumpkinseed population in MCR has seen little change in the range of lengths (mostly 80 - 170 mm) over the seven surveys conducted since 2001. Proportional Size Distribution continues to be low, with only one sample (2005) within the range of 20 - 60 considered indicative of a balanced population. These values are similar to those seen in ECR (average PSD of 10) over six surveys conducted since 1995. The average length of Pumpkinseed (123 mm) in MCR was slightly above the average (117 mm) in ECR. Annual growth of Pumpkinseed in MCR ranged from 5 - 40 mm, similar to the 7 - 29 mm for ECR. On average, they reach stock size (80 mm) at age three in both MCR and ECR. The slow growth of Pumpkinseed in MCR may be due to factors such as the reservoir's shorter growing season and higher elevation, or excessive weed growth and high Largemouth Bass harvest, which can lead to overpopulation.

Warm-water Fishes Predator:Prey Dynamics:

A comparison of the average PSD of predator species (Largemouth Bass) to prey species (Bluegill, Pumpkinseed, and Black Crappie) can be used to determine predator:prey dynamics in a reservoir and provide insight into potential population issues (Schramm and Willis 2012). In MCR, six of the seven samples since 2001 occurred either in or very close to Cells 4, 5, or 6, which all indicate a balanced prey population (Figure 130). Even though only the 2001 sample fell into Cell 5 (balanced predator and prey), they were all reasonably close, indicating that the predator-prey relationship in MCR is generally close to a balanced state and stable. The 2012 sample landed in Cell 6, which is characterized by a high predator PSD and a balanced prey PSD. This is a desirable predator-prey relationship for producing a high-quality Largemouth Bass fishery. Many of the previous samples showed slightly low Largemouth Bass PSD. Low PSD can be an indicator of a stunted population of Largemouth Bass and/or overharvest of fish by anglers (Schramm and Willis 2012).

Although there was improvement in predator:prey PSD values and a wide length frequency distribution for Largemouth Bass in 2012, we have some concerns regarding this population. The increasing PSD and declining CPUE of Largemouth Bass, combined with the increasing CPUE of Bluegill and Pumpkinseed, suggests a lack of successful recruitment of Largemouth Bass in recent years is resulting in a shift towards an imbalanced fishery. Additionally, with the increasing levels of harvest seen over the last few creel surveys (and the harvest of large fish), harvest appears to be having an impact on the Largemouth Bass at this time. Monitoring harvest levels and the predator:prey balance should continue in the future. This should occur before and after the implementation of any vegetation control projects.

Creel Survey

Angler Effort:

The year-long creel survey resulted in an estimated 16,639 hours of angler effort in 2012. This was the second highest of the four creel surveys conducted on the reservoir since 1993, but was a 16% drop from the high of 19,784 hours estimated in 2005 (Figure 1). Similarly, angler effort declined in seven of the eight regional reservoirs (87.5%; Figure 1) surveyed in both 2005 and 2012.

While effort did decline in MCR, this reservoir has not experienced the continuing trend of decline in effort over the four creel surveys like that seen in several other regional reservoirs (Figure 1). This may be due to the presence of the campground at MCR. This campground is generally full throughout the summer months, which would likely mediate potential large changes in the use of a reservoir. There may be several reasons for the perceived decline in effort seen in MCR from 2005 to 2012. It could be an actual decline in effort, as participation in outdoor recreation activities (including fishing) has declined (USFWS 2006; DFO 2007; Cordell et al. 2008; Sutton et al. 2009) as people have more and more choices competing for their free time. Economic surveys conducted by IDFG in 2003 and 2011 (Table 2) show a similar trend, with most regional reservoirs (87.5%) experiencing declines in effort (total trips). However, the decline in effort could also be due to changes in the accuracy of our creel surveys. The 2012 creel survey is likely more accurate than previous surveys, as it was conducted using more angler counts and interviews. Additionally, more appropriate creel survey and statistical analysis methods were incorporated in the study design. Previous creel surveys were conducted with minimal staff, and therefore effort/catch/harvest may be more biased due to small sample sizes of angler counts and interviews. Future surveys should employ similar strategies as we did during this survey to make results more comparable from year to year.

Catch and Harvest:

Based on the 2012 creel survey, most anglers either targeted hatchery Rainbow Trout (46) or Black Crappie (42%). Few anglers targeted any other species. Interestingly, Rainbow Trout comprised 86% of the harvest, whereas Black Crappie represented just 1%. It is also interesting that Black Crappie have never been abundant in Moose Creek Reservoir, but anglers still went there to catch them. We saw a similar response in ECR as well. This indicates the high desire by anglers to catch Black Crappie, likely due to their desired flesh quality. Even though only 3.3% of anglers indicated that they were targeting Bluegill, they were the second most harvested species, comprising 28% of the harvest in 2012. This suggests that many people catch (and keep) Bluegill even if they are necessarily targeting that species.

More Rainbow Trout were harvested in Moose Creek Reservoir in 2012 than in any previous years we did a survey. This is partially because we stocked more fish in 2012 than the other years (Appendix B). However, it was also because we documented one of the highest catch rates (1.4 fish/hr) in 2012. The angler exploitation rate for hatchery Rainbow Trout was estimated at 68.9% in 2012. This was within the range of 45.8 - 83.7% seen in previous creel surveys and well above the IDFG management goal of 40% return to creel. In addition, each creel survey since 1993 have been above or at the management goal of >0.5 fish/hour.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (62.5%) rated their fishing trip as "Good" or "Excellent" (Figure 118). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 63.3% of the responses. While the quality of fishing played the major role in one's fishing experience, the most common other response was "nice to be outside" (15.1%). This indicates that an enjoyable fishing trip is not predicated solely upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as simplified fishing rules, year-round fishing opportunities, easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself.

Of the people who rated their fishing experience as poor or fair, 30% indicated that poor fishing was the primary reason for their rating. Surprisingly, only 0.7% of respondents listed aquatic vegetation as a reason for a poor rating. Numerous complaints in previous years suggested that aquatic vegetation was affecting many anglers' fishing experience, and we would expect this to be a primary reason for a negative fishing experience. The low number of responses during the 2012 survey indicates that although there is aquatic vegetation along most of the shoreline, it is not affecting fishing for most anglers. A likely explanation for many of the "poor fishing" responses is that 32% of anglers indicated that Black Crappie were their target species; but Black Crappie comprised only 5% of the fish caught and 1% of the harvest.

Angler Exploitation

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) were also utilized to help evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate of stocked hatchery Rainbow Trout was 53.3% for the spring 2011 tagging events (Table 25) and 24.0% for the spring 2012 events. There was use from both the 2011 and 2012 spring stockings past the one year mark, indicating that there is some carryover from these stockings (Appendix D). The estimated total use for 366 - 730 days at large was 0.9% for 2011 and 0.3% for 2012. This is a good sign, as carryover increases the opportunity for angler to catch these fish. There was no use past 730 days at large.

The total use rates for hatchery Rainbow Trout through June, 2014 were therefore estimated to be 54.2% for the spring 2011 tagging events (Table 25) and 24.3% for the spring 2012 events. These estimates were near or above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). The 2011 estimate was also above the IDFG management goal of a 40% total use rate for hatchery catchable Rainbow Trout (Appendix D). However, the estimate for the spring 2012 stocking was below this management goal (Appendix D). Tag returns from both the spring 2011 and spring 2012 stockings show similar patterns, with most returns occurring by August each year (Figures 131 and 132). This is to be expected since most of the effort occurs from May - August (Table 24).

The success of our fall stockings is also of interest for the regional tagging program. Tag returns resulted in total use rate of 27.9% for the October, 2011 tagging, and 52.9% for the October, 2012 tagging. These are both above the mean of 15.7% calculated for hatchery Rainbow Trout in Idaho reservoirs and ponds from 2006 - 2009 (Koenig 2012; Cassinelli 2014) and the statewide average return to creel of 18.0% for reservoirs in 2011 (Cassinelli 2014). In addition, the 2012 stocking is above the IDFG management goal of a 40% total use rate for hatchery catchable Rainbow Trout (Appendix D). Tagged fish from the October 2011 stocking were caught all the way through July, 2012, indicating that these fish were able to overwinter and were available to contribute to the fishery the following summer (Figure 133). Harvest occurred in every month except October and January, indicating that there is angler effort practically year-round. Fall stockings should be continued as these fish are an important part of the winter ice fishery, and due to the above average exploitation rates seen in 2011 and 2012.

Comparing angler exploitation of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 18.8% while the creel survey estimated it to be 68.9%. Differences in exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the bias from the use of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Angler exploitation was lower for the 2012 stockings than the 2011 stockings (Table 25) (Meyer et al. 2009). This trend was seen in five of the six regional reservoirs where data existed from both years (Appendix D). Some of this may be attributable to possible changes in angler effort, the continued presence of nuisance aquatic vegetation throughout much of the reservoir, or the possibility that anglers became accustomed/desensitized to the tagging program and returned the tags at a lower rate (Figure 128). The better water conditions seen in 2012 versus 2011 were also a likely factor.

At this time, no changes to the hatchery trout stocking program are needed. Angler catch rates for hatchery Rainbow Trout have met our management goal of >0.5 fish caught/hour based on each creel survey since 1993, and catch rates have never greatly exceeded this goal. Additionally, angler total use rates exceed the statewide reservoir average and statewide management goal (40% total use rate) for our overall stocking efforts. The stocking efforts provide a diversity of opportunities for anglers including shore, boat and ice fishing. Finally, the majority of catch (73%) in MCR was supported by catchable Rainbow Trout in 2012.

Limnology

As we have seen in previous years, MCR continues to have anoxic conditions in the hypolimnion. The combination of an anoxic hypolimnion and warm surface waters greatly reduces the volume of the reservoir available for fish to live during the summer months, especially temperature sensitive hatchery trout (Figure 120). These conditions force the more temperature sensitive trout to live in either the warmer epilimnion with higher DO, or cooler water with less DO, both of which can cause stress. The combination of high water temperature and marginal DO concentrations compounds the stress on hatchery trout, which can result in disease and fish kills (Bjornn and Reiser 1991, Carline and Machung 2001).

Based on the IDFG standards for temperature and DO thresholds, the volume of water available for Rainbow Trout to survive was reduced zero during August, 2012. This would indicate that there was very little, if any, chance that hatchery trout stocked in the spring would have a chance to survive through the summer and be available to the fishery in the fall. From this information, it would be logical to infer that we should not stock any hatchery trout in MCR after May. Looking at dates of tag returns from the April, 2011 stocking, only one tag was returned after August 11, 2012. This would suggest that few of the trout survived through the end of the summer. However, an analysis of the dates of tag returns from the April and May, 2012 angler exploitation tag releases show that hatchery Rainbow Trout were caught into September, 2012. This indicates that trout were able to survive through the summer, and also suggests that the IDFG 21°C upper thermal limit for Rainbow Trout is not an appropriate measure for our lowland reservoirs. The 25°C thermal limit seen in the literature (Bjornn and

Reiser 1991;Lee and Rinne 1980, Carline and Machung 2001, Rodnick et al. 2004) appear to be more appropriate. The data from these two years of exploitation surveys indicate that hatchery Rainbow Trout can survive through the summer in MCR, but with variable success.

An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion, such as Elk Creek Reservoir. This is a concern for our fall stocking of catchable trout in this reservoir, as fall turnover can reduce the dissolved oxygen levels of the reservoir to below the 5.0 mg/L needed for Rainbow Trout. However, fall turnover did not cause this issue in 2012 (Figure 120). To avoid potential fish kills, fall stockings should be conducted once DO levels have returned to >5.0 mg/L after reservoir turnover.

Zooplankton

Larger sized zooplankton species, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in MCR was dominated by Daphnia and Cyclopoida in 2012, indicating the presence of a viable food source. In 2012, Daphnia collected averaged 0.7 mm in length, and Cyclopoida averaged 0.5 mm in length (Figure 125). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Additionally, no more than 2.1% of Daphnia and no Cyclopoids were at or above preferred size during 2012 (Figures 123 and 124). However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, only 10.7% of the Daphnia population and 4.6% of the Cyclopoida population were ≥1.0 mm in length. This indicates that there is little food available for hatchery Rainbow Trout and juvenile warm-water species to eat. Either larger zooplankton are being cropped off, or few reach this preferred size. This could be due to the large population of Bluegill and high stocking rates in MCR.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for MCR. The ZQI, which is a measure of both abundance and size, was 0.15, below the average for reservoirs in the Clearwater Region (Appendix E). ZQI values from 0.1 - 0.6 are considered moderate and indicate that there is sufficient competition for food resources to potentially impact trout populations (Teuscher 1999). This data also indicates that larger zooplankton individuals are being cropped off or that few individuals grow to this size. This suggests that we may need to reduce the number of planktivores to allow for more forage opportunities for fish in MCR. This could be accomplished through reduced stocking rates of hatchery Rainbow Trout. Additionally, reducing the quantity of vegetation may also help reduce the number of plantivores by increasing predation on smaller warm-water fish.

Aquatic Vegetation

The nuisance aquatic vegetation and algae mentioned previously are a contributing factor to the low DO levels in the reservoir. This organic material consumes oxygen as it decomposes, thus reducing oxygen levels in the hypolimnion.

Monitoring vegetation in MCR is an important part of managing the reservoir. As seen in our surveys, vegetation was present at 95.4% of the sites samples. Vegetation presence alone, however, doesn’t provide the entire picture. We must also consider what types of vegetation are present and what effects it has on fish populations and recreation in the reservoir. In the case of MCR, Pondweed and filamentous algae were the predominant types of vegetation present. Both vegetation types grow quickly and tend to form dense mats across the water’s surface. This can greatly reduce forage success for predators such as Largemouth Bass, and increase the abundance of prey species (Bettolli et al. 1992; Dibble et al. 1996).

In addition to being a potential problem for fish populations, vegetation can also affect fishing and other recreation. The presence/absence of vegetation alone does not provide information about these potential effects. The results of the DFI indicates that an anglers ability to fish could be negatively influenced at 74% of the sites with 22% of the sites rendered unfishable due to dense mats of vegetation. When we evaluated just the shoreline sites, where most people fish, we found that aquatic vegetation could potentially negatively influence anglers fishing along around 94% of the shoreline.

Many complaints from anglers result from frustrations with vegetation. This can result in reduced satisfaction with their experience at the reservoir and could even result in anglers no longer fishing at MCR. The 16% drop in effort from 2005 may be at least partially attributable to the increase in aquatic vegetation coverage over the last few years. Although less than 1% of anglers in the 2012 creel survey complained about vegetation, we have received many complaints from anglers (by phone and in person) over the past few years due to frustrations with vegetation. Vegetation usually becomes a problem later in the summer, when there are lower levels of effort. This suggests that vegetation may be part of the cause of the reduced effort we see at this time of year. This can result in reduced satisfaction with their experience at the reservoir and could even result in anglers no longer fishing at MCR.

Reducing the quantity of aquatic vegetation in MCR could improve both the forage success for Largemouth Bass (Bettolli et al. 1992; Dibble et al. 1996) and the recreational opportunities in the reservoir. Previously, herbicide treatments using liquid Reward® were conducted in MCR and Winchester Lake (DuPont et al. 2011) to address submerged vegetation. These applications reduced the surface coverage from approximately 30 - 40% around the boat ramp and fishing docks to 10 - 15% coverage. However, vegetation coverage returned to pre-treatment levels within a few weeks after the treatment. Maintaining adequate control would require multiple whole-lake treatments per year.

Due to the limited success of small scale herbicide treatments in regional reservoirs, we researched in the literature other techniques that could be used to control nuisance aquatic vegetation. These techniques included biological, mechanical, physical, and other chemical control methods (Appendix L). The recommended control measures for regional reservoirs and ponds were determined to be winter drawdown, benthic barriers, and grass carp. Benthic barriers would not be appropriate for MCR, as there is too much vegetation coverage, and they will not address the floating mats of algae and vegetation that can occur.

A potential control choice is grass carp. Grass carp have been shown to be effective at controlling nuisance aquatic vegetation (Avault 1965, Mitzner 1978, Hanlon et al. 2000), including the species present in MCR. However, numerous studies point out that a moderate level of control is difficult to achieve, as control is often either “all or nothing” (Kirk 1992, Mitzner 1994, Pauley et al. 1998, Bonar et al. 2002). The use of grass carp should be approached cautiously. It is recommended to start stocking grass carp at a low stocking rate of 3 - 6 fish/acre, as overstocking is detrimental and is difficult to correct. More grass carp can be added if additional control is needed. Grass carp would cost an estimated $2,690 - $5,380 at this lower stocking rate (Appendix L). Monitoring their effectiveness should be conducted for several years, as control may not become apparent for up to two years post-stocking (Bonar et al. 2002: Cooke et al. 2005). While not the primary choice for MCR, they could be a potential option if they could be prevented from migrating out of the reservoir.

The other option was winter drawdown. In addition to potential vegetation control, there are potential positive effects of winter drawdown on fish populations as well. Water level drawdowns are often used intentionally to manage fish populations. They can stimulate fish productivity by reestablishing conditions similar to when a reservoir was first filled (Miranda and Muncy 1987; Cooke et al. 2005). Other potential effects are increased predation on stunted prey populations, reduced predation on eggs by Centrarchids, and reduced competition for resources for young-of-year Largemouth Bass (Heman et al. 1969; Miranda et al. 1984). The result can be improved sport fisheries through increased biomass and sizes of game fish, and a reduction in abundance of stunted Bluegill, crappie, or other planktivores.

However, there are potential negative factors associated with water drawdowns, including the establishment of other species of unwanted aquatic vegetation, potential low DO and fish kills, failure to refill the reservoir the following spring, and impacts to invertebrates (Cooke et al. 2005). Cooke (1980) reviewed various drawdown studies and found their level of success varied by aquatic plant species. Some species such as *Potamogeton robbinsii* were reduced while others actually increased after drawdown (Cooke 1980). Since *Potomogeton*, the species that often establishes after a drawdown is already well established in MCR, this is not a concern. The other issues were not of enough concern to eliminate drawdown as a management option. Thus, winter drawdown was determined to be the best choice of control. It is a cheap and easy option to implement with the water control outlet present at MCR. If successful, spot treatments of aquatic herbicides could be used to control any regrowth as it occurs.

In addition to winter drawdown, we should explore options to reduce the phosphorous load in MCR for long-term control of phosphorous and aquatic vegetation. One potential option for phosphorous control is the SePro product Phoslock®, which permanently binds free reactive phosphorous. This product has proven effective, with Total Phosphorous levels in the water column reduced by 52 - 80% in case studies (Robb et al. 2003; McNabb 2011; SeaPro 2014). Phoslock® has also been shown to bind up to 69% of soluble phosphorous levels in the top 4 cm of substrate and 27% in the top 10 cm of substrate (Cook et al. 2005; Meis et al. 2012). This is important, as most of the soluble phosphorous that is released into the water column is estimated to come from the top 4-10 cm of substrate (Cook et al. 2005; Meis et al. 2012). However, a whole lake treatment of MCR would be expensive, with costs ranging from $255 - $510/acre-ft in product alone (Apppendix L). Due to budget limitations, it is not likely to be a realistic option unless outside funding sources were secured. If this option is used, intensive limnological sampling should be conducted before and after treatment to monitor the effects. As such, we should continue to explore other options for long-term control of phosphorous and aquatic vegetation.

MANAGEMENT RECOMMENDATIONS

1. Conduct future standard lake surveys with enough 10-minute electrofishing samples to sample the entire shoreline.

2. Discontinue use of trap nets for fish sampling due to their low effectiveness and high variability.

3. Evaluate the use of a winter drawdown to control aquatic vegetation.

4. No changes are recommended for either spring or fall stockings of hatchery catchable size rainbow trout.

Table 19. Number of fish collected by species in each 10-minute electrofishing sample conducted during a fisheries survey of Moose Creek Reservoir, Idaho, in 2012, and the estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 90% confidence and 25% precision.

Species	Count of fish collected EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Largemouth Bass	6	6	5	1	3	5	26	4.3	2.0	9
Black Crappie	5	4	3	2	2	3	19	3.2	1.2	6
Bluegill	56	29	41	24	48	54	252	42.0	13.2	4
Pumpkinseed	26	12	16	22	8	16	100	16.7	6.5	7
Black Bullhead	5	0	1	1	4	0	11	1.8	2.1	59
Total	98	51	66	50	65	78	408	68.0	18.0	3

Table 20. Back-calculated length at annuli of Largemouth Bass collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

Year Class	Age	n	Back-calculated length (mm) at each annulus 1	2	3	4	5	6	7	8
2011	1	0	0							
2010	2	2	71	119						
2009	3	11	68	128	178					
2008	4	3	73	132	177	222				
2007	5	3	81	136	210	250	289			
2006	6	2	88	158	206	247	287	332		
2005	7	1	66	123	170	215	265	336	394	
2004	8	1	74	115	165	218	262	307	344	393
n		23	23	23	21	10	7	4	2	1
Length at Age			73	131	184	234	281	327	369	393

Table 21. Back-calculated length at annuli of Bluegill collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012

Year Class	Age	n	Back-calculated length (mm) at each annulus 1	2	3	4	5	6	7
2011	1	1	39						
2010	2	24	60	93					
2009	3	35	44	77	111				
2008	4	21	51	88	122	147			
2007	5	15	43	72	108	139	162		
2006	6	1	36	55	82	105	135	161	
2005	7	1	58	91	115	135	158	169	181
n		98	98	97	73	38	17	2	1
Length at Age			49	83	113	142	160	165	181

Table 22. Back-calculated length at annuli of Black Crappie collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus					
Class	Age	n	1	2	3	4	5	6
2011	1	0	0					
2010	2	0	0	0				
2009	3	10	50	96	154			
2008	4	2	50	89	148	191		
2007	5	5	61	98	139	170	203	
2006	6	1	35	92	118	154	188	221
n		18	18	18	18	8	6	1
Length at Age			52	95	147	173	201	221

Table 23. Back-calculated length at annuli of Pumpkinseed collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus					
Class	Age	n	1	2	3	4	5	6
2011	1	0	0					
2010	2	2	33	56				
2009	3	26	43	71	104			
2008	4	28	40	69	100	127		
2007	5	19	36	61	96	126	144	
2006	6	1	56	85	113	140	167	172
n		76	76	76	74	48	20	1
Length at Age			40	68	101	127	145	172

Table 24. Summary of angler effort (hours) as determined through a creel survey conducted on Moose Creek Reservoir, Idaho, from November 28, 2011 to November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	84	0	0	84	118	0	0	118	201	0	0	201	69	34
January	156	0	0	156	46	0	0	46	202	0	0	202	46	23
February	278	0	0	278	91	0	0	91	368	0	0	368	156	42
March	215	0	0	215	156	0	0	156	371	0	0	371	150	41
April	0	406	0	406	0	287	0	287	0	693	0	693	432	62
May	0	1,408	293	1,701	0	1,836	252	2,088	0	3,244	545	3,789	643	17
June	0	1,733	217	1,949	0	1,114	223	1,337	0	2,846	439	3,286	673	20
July	0	1,886	129	2,015	0	1,649	106	1,755	0	3,535	235	3,770	386	10
August	0	1,237	0	1,237	0	773	83	856	0	2,010	83	2,093	445	21
Septembei	0	369	64	433	0	780	260	1,040	0	1,148	324	1,472	266	18
October	0	104	0	104	0	120	24	144	0	224	24	248	106	43
November	0	70	0	70	0	76	0	76	0	146	0	146	103	71
Totals	732	7,211	703	8,646	410	6,634	948	7,992	1,142	13,846	1,651	16,639	1,244	7

Table 25. Angler exploitation (based on angler tag returns) of hatchery catchable sized Rainbow Trout stocked in Moose Creek Reservoir, Idaho, in 2011 and 2012, through 365 days post-stocking. Total use = fish harvested + fish released.

2011

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted harvest: Estimate	Adjusted harvest: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
Hagerman	4/25/2011	High density	200	32	4	5	36.8%	11.8%	47.2%	13.6%
		Low density	198	43	4	4	50.0%	14.2%	59.3%	15.7%
	10/12/2011	Normal production	396	35	7	6	20.3%	6.5%	27.9%	7.9%
Total							35.7%	10.8%	44.8%	12.4%

2012

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted harvest: Estimate	Adjusted harvest: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
American Falls	5/2/2012	High density	200	13	0	0	18.3%	6.9%	18.3%	6.9%
		Low density	200	15	4	2	21.1%	7.4%	29.6%	8.9%
		Medium density	200	9	1	2	12.7%	5.6%	16.9%	6.6%
Hagerman	5/2/2012	High density	200	9	1	0	12.7%	5.6%	14.1%	6.0%
		Low density	200	11	5	1	15.5%	6.3%	24.0%	7.9%
		Medium density	199	22	1	4	31.2%	9.2%	38.3%	10.3%
	10/22/2012	Production	400	66	6	3	46.5%	9.3%	52.9%	10.1%
Nampa	4/24/2012	High density	200	9	2	5	12.7%	5.6%	22.6%	7.7%
		Low density	200	14	2	3	19.7%	7.1%	26.8%	8.4%
		Medium density	199	15	3	1	21.3%	7.4%	26.9%	8.5%
		Production	100	4	2	2	11.3%	7.4%	22.6%	10.4%
Total							20.3%	7.1%	26.6%	8.3%

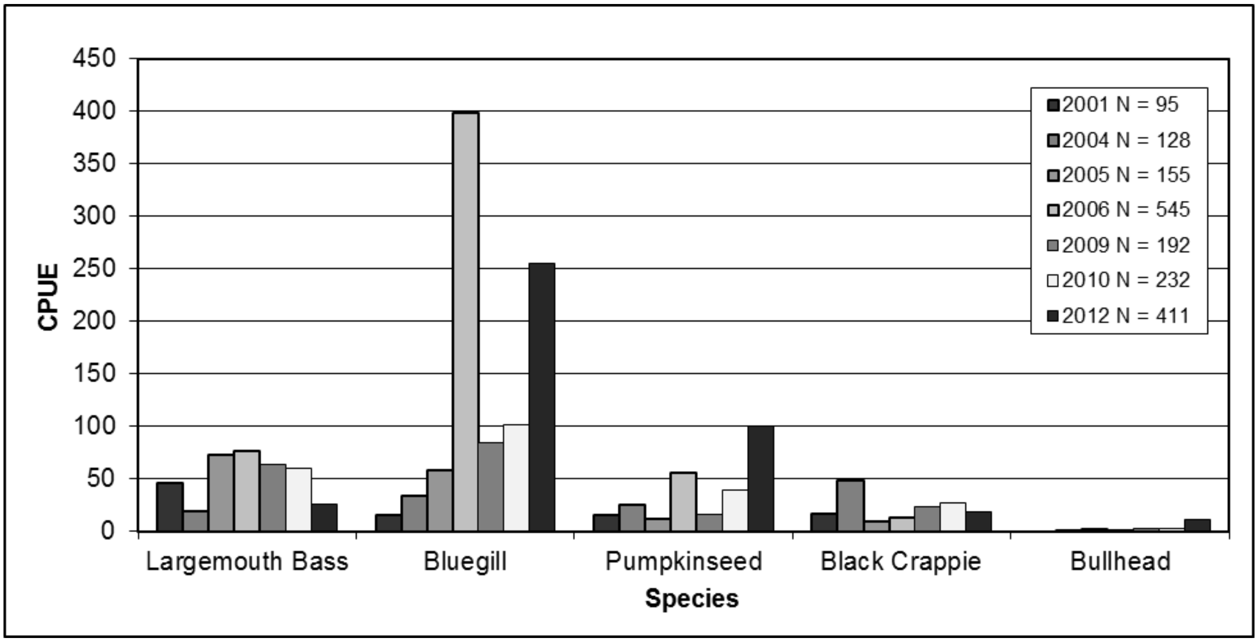


Figure 99. Catch per unit effort (CPUE; number of fish/hour) of fishes collected through electrofishing in Moose Creek Reservoir, Idaho, from 2001 - 2012

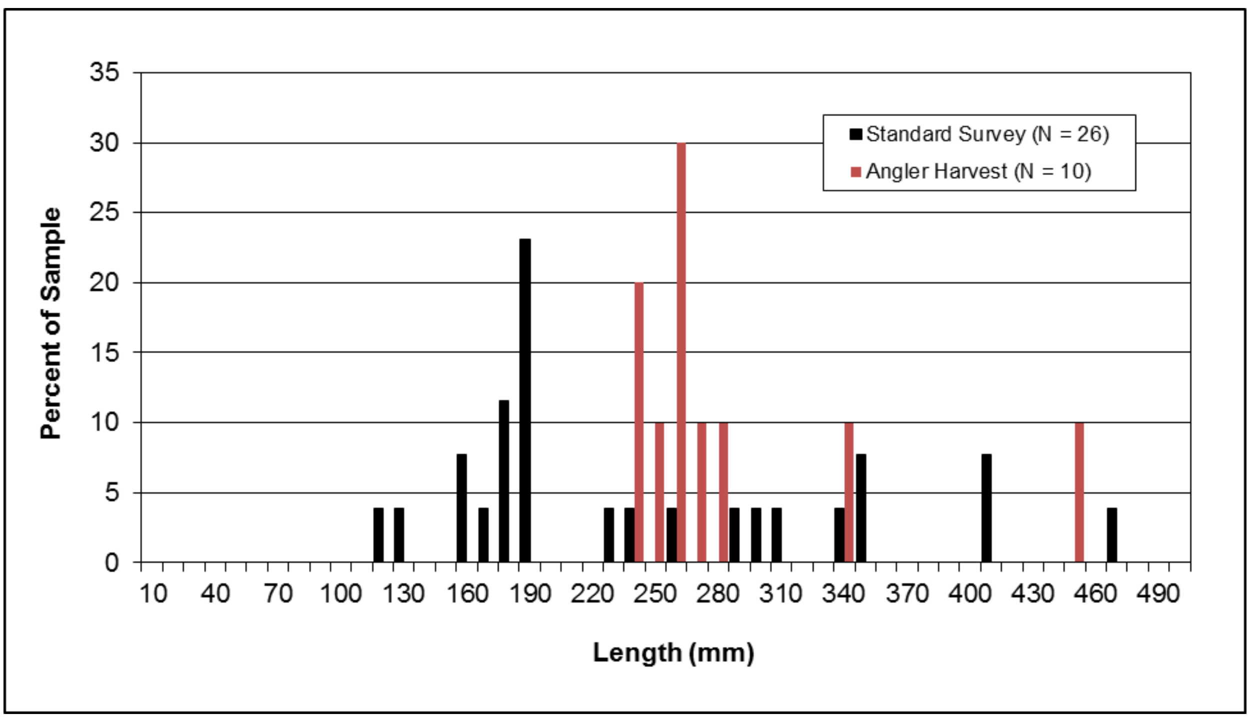


Figure 100. Comparison of Largemouth Bass length frequency distributions from fish collected through electrofishing, and harvested by anglers in Moose Creek Reservoir, Idaho, in 2012.

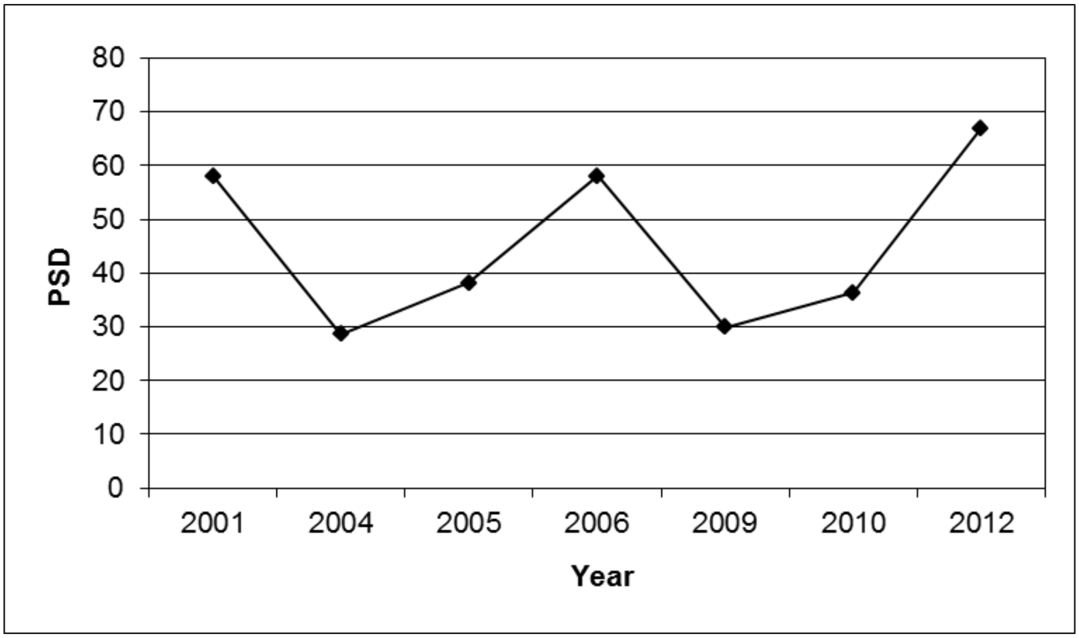


Figure 101. Proportional Size Distribution (PSD) values of Largemouth Bass collected through electrofishing in Moose Creek Reservoir, Idaho, from 2001 - 2012.

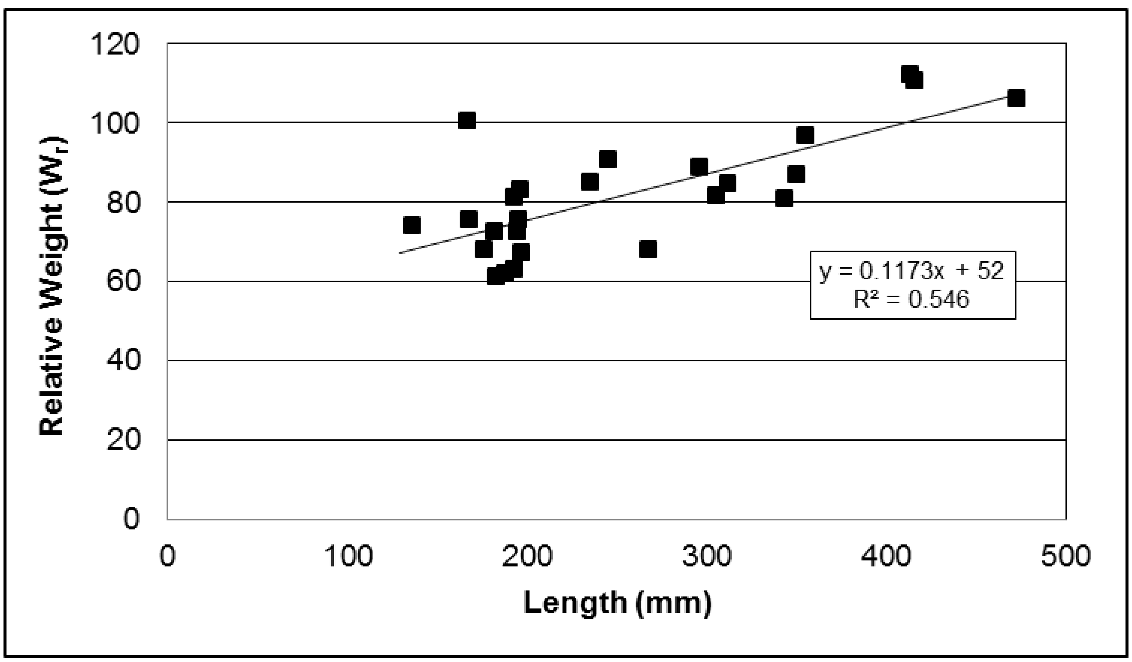


Figure 102. Relative weight (W_r) values of Largemouth Bass collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

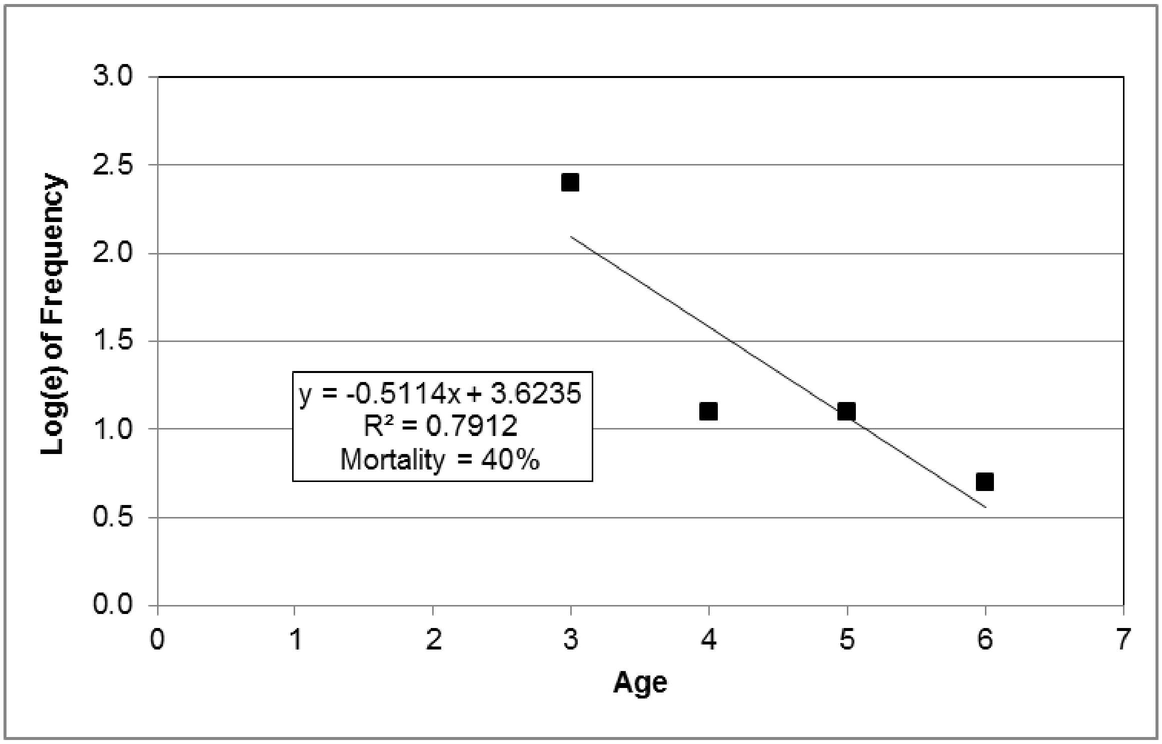


Figure 103. Catch curve for estimating annual mortality of Largemouth Bass collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

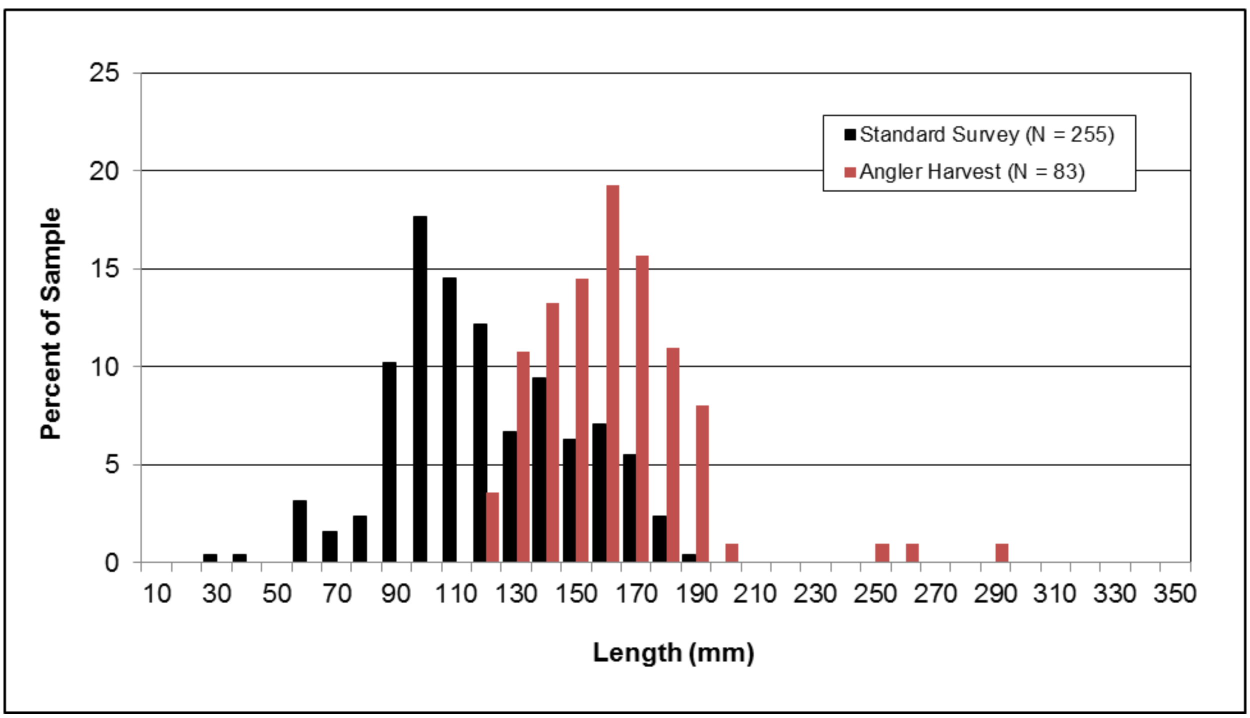


Figure 104. Comparison of Bluegill length frequency distributions from fish collected through electrofishing, and harvested by anglers in Moose Creek Reservoir, Idaho, in 2012.

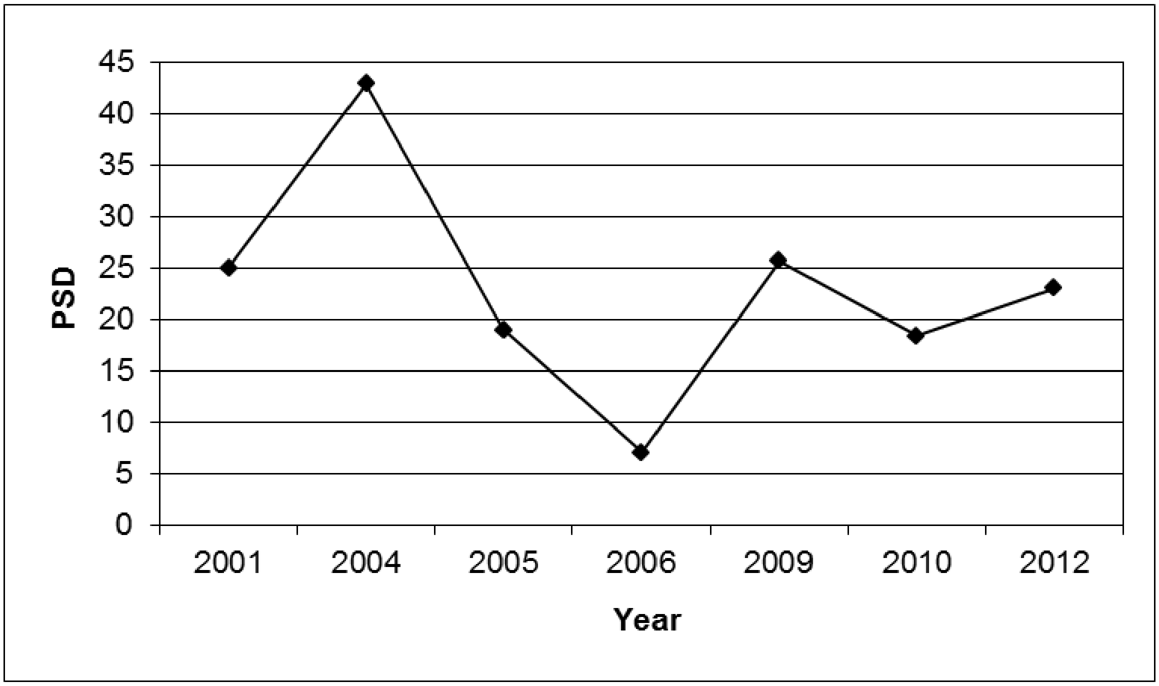


Figure 105. Proportional Size Distribution (PSD) values of Bluegill collected through electrofishing in Moose Creek Reservoir, Idaho, from 2001 - 2012.

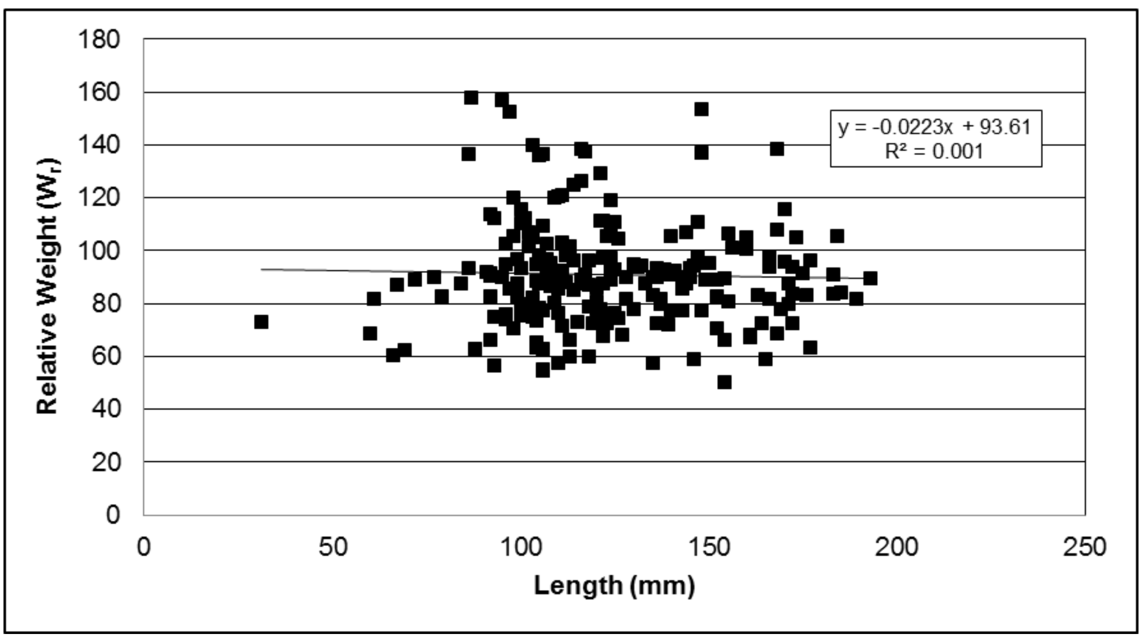


Figure 106. Relative weight (W_r) values of Bluegill collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

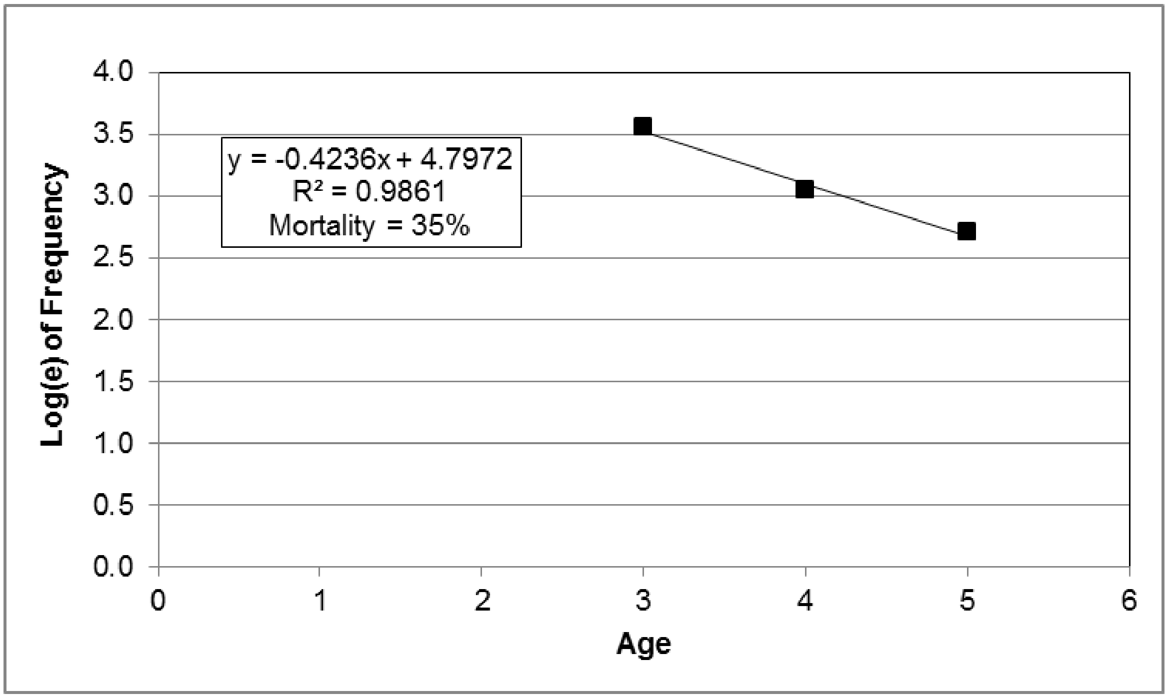


Figure 107. Catch curve for estimating annual mortality of Bluegill collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012

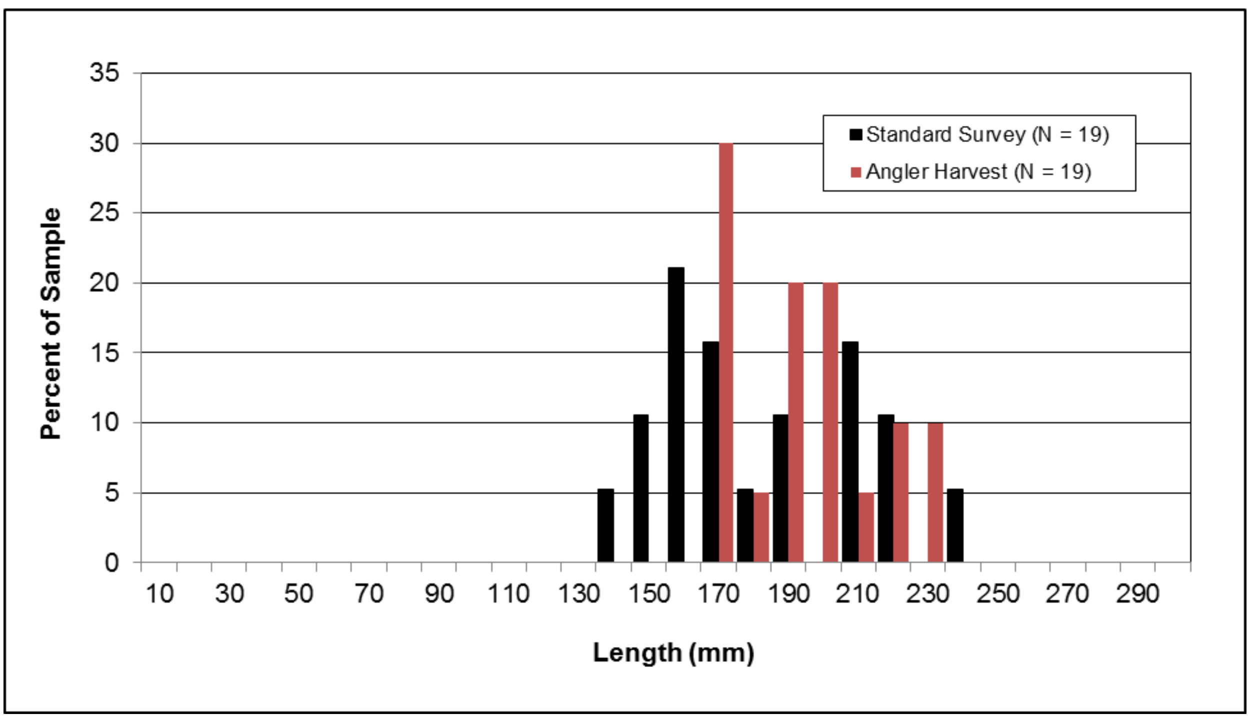


Figure 108. Length frequency distributions of Black Crappie collected through electrofishing, and harvested by anglers in Moose Creek Reservoir, Idaho, in 2012

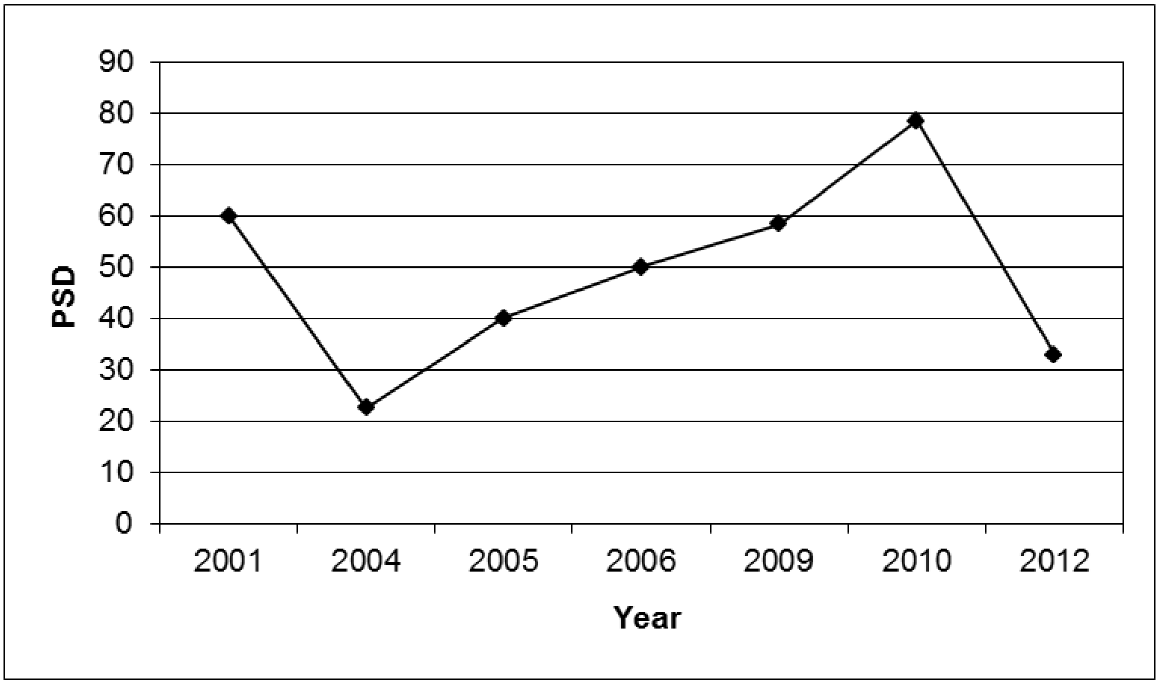


Figure 109. Proportional Size Distribution (PSD) values of Black Crappie collected through electrofishing in Moose Creek Reservoir, Idaho, from 2001 to 2012.

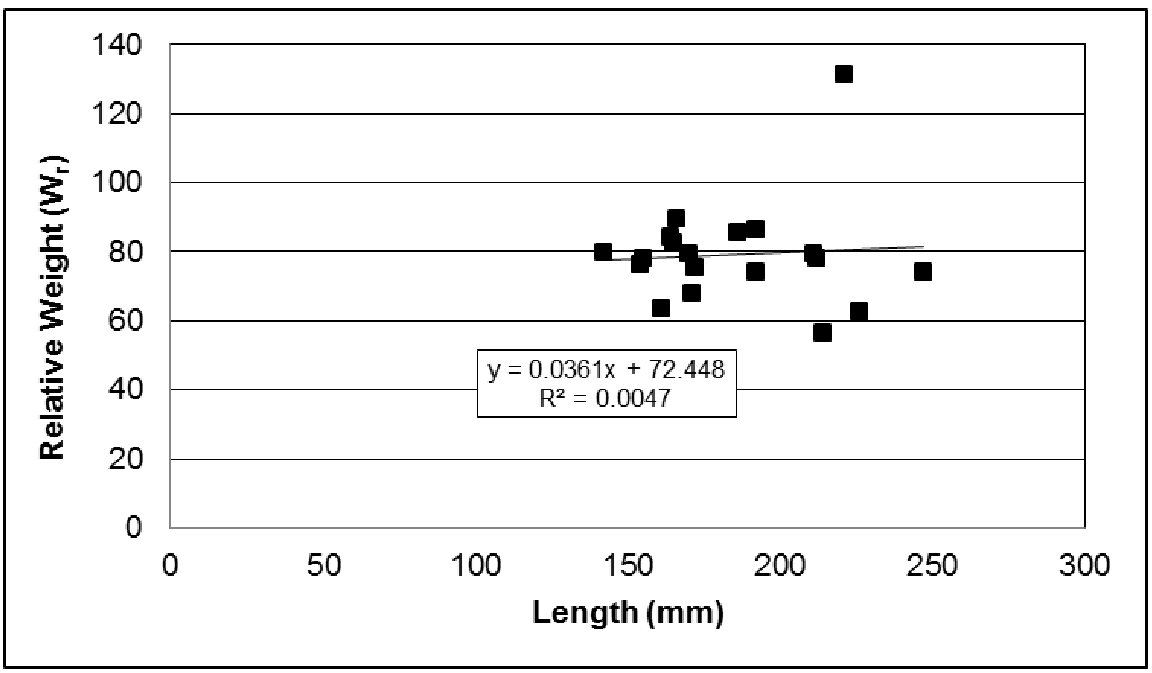


Figure 110. Relative weight (W_r) values of Black Crappie collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

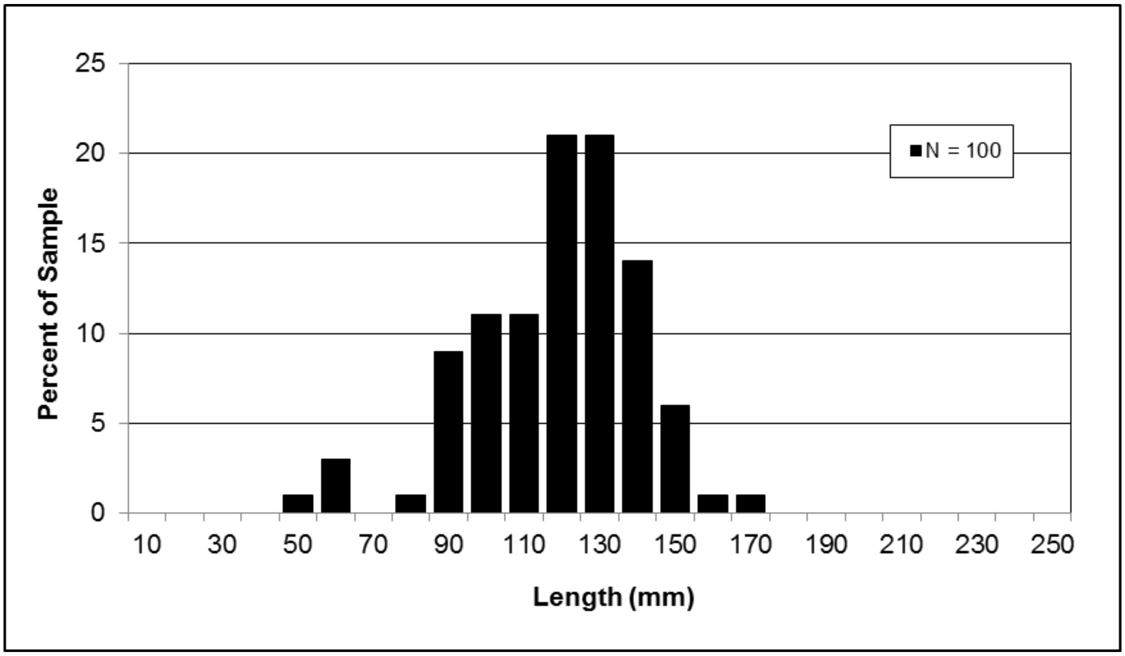


Figure 111. Length frequency distributions of Pumpkinseed collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

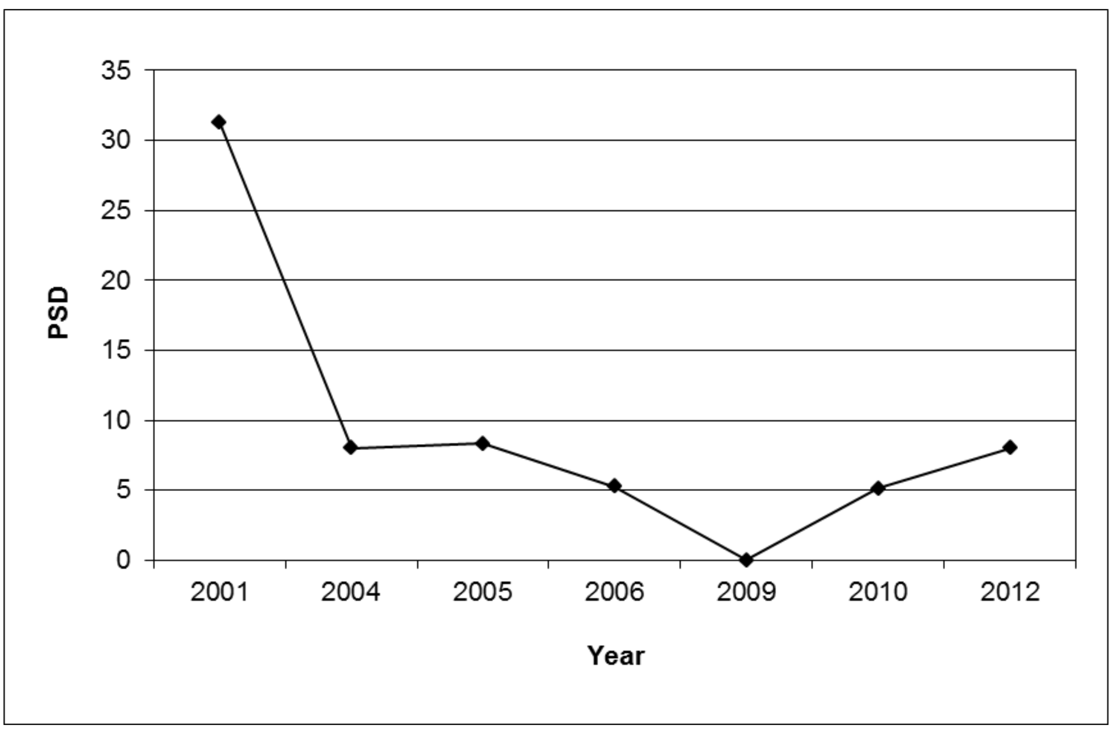


Figure 112. Proportional Size Distribution (PSD) values of Pumpkinseed collected through electrofishing in Moose Creek Reservoir, Idaho, from 2001 – 2012

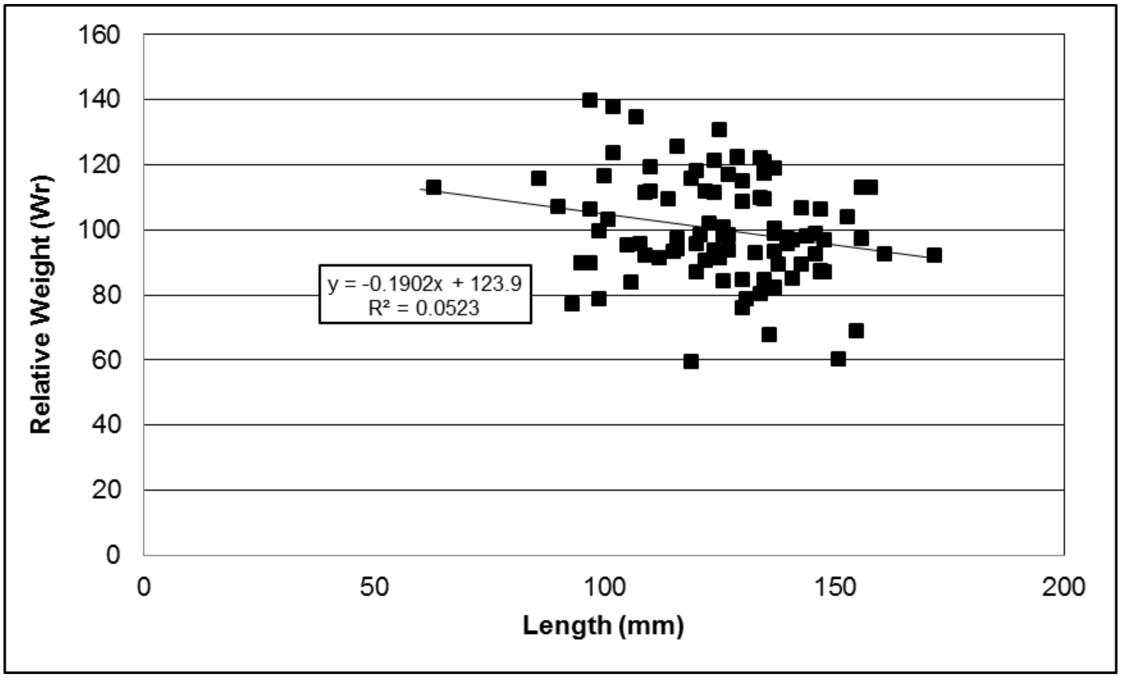


Figure 113. Relative weight (W_r) values of Pumpkinseed collected through electrofishing in Moose Creek Reservoir, Idaho, in 2012.

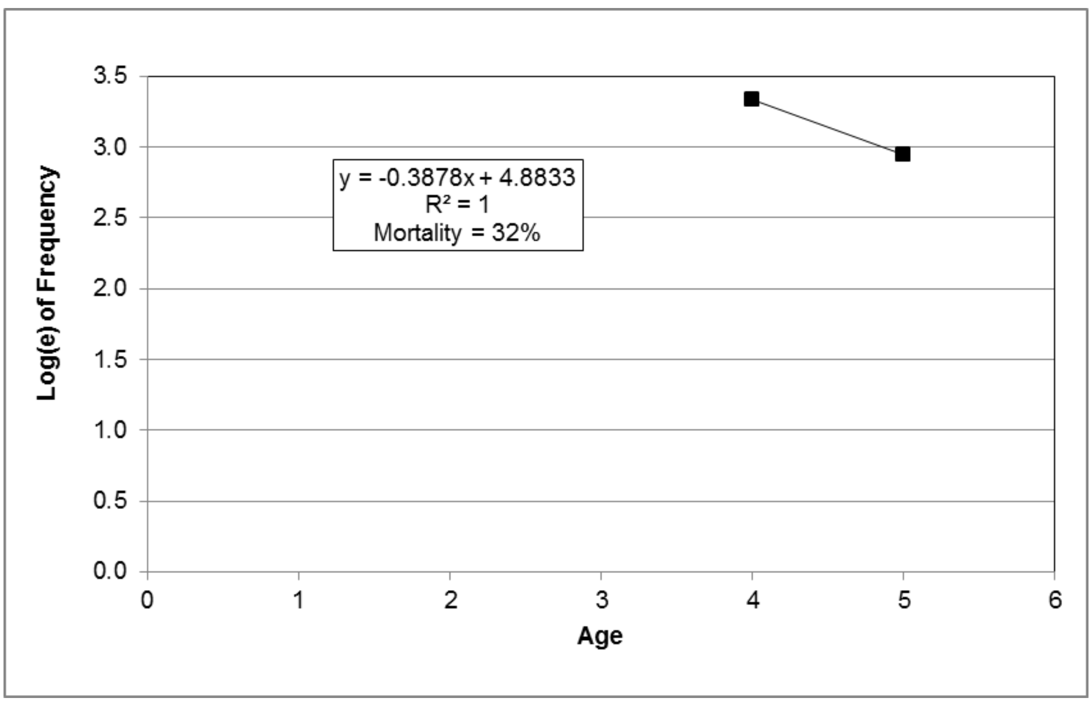


Figure 114. Catch curve for estimating annual mortality of Pumpkinseed collected through electrofishing in Winchester Lake, Idaho, in 2012.

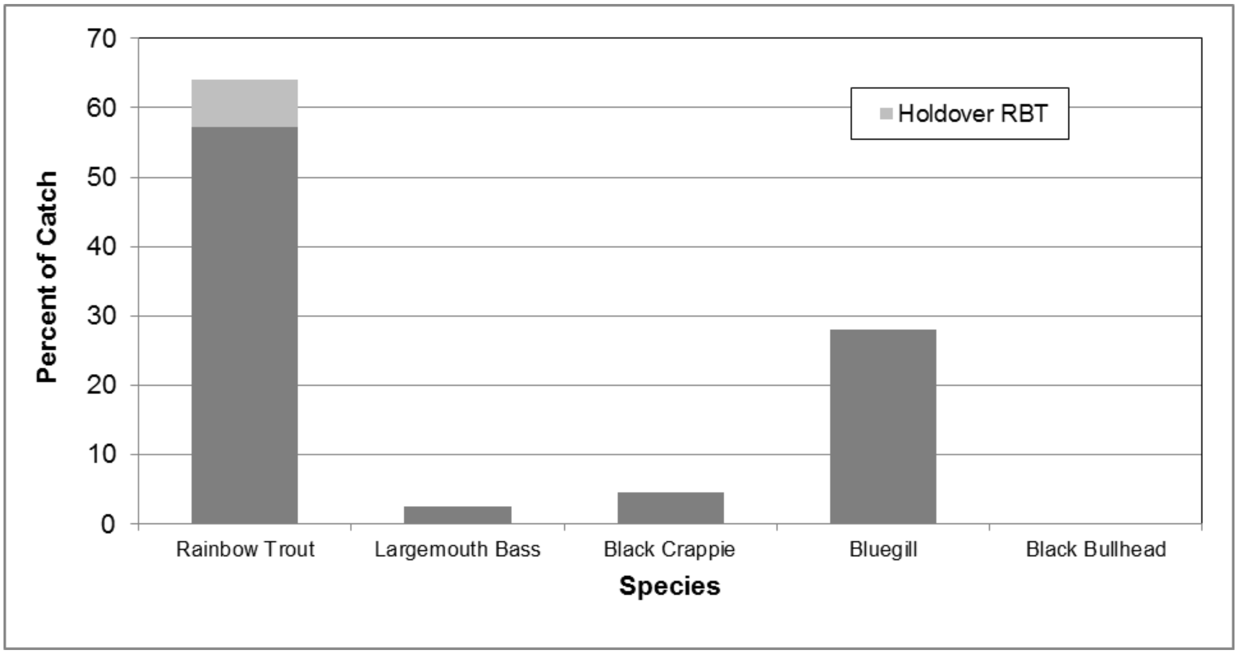


Figure 115. Composition of fishes caught in Moose Creek Reservoir, Idaho, as estimated by a creel survey conducted from November 28, 2011 to November 28, 2012.

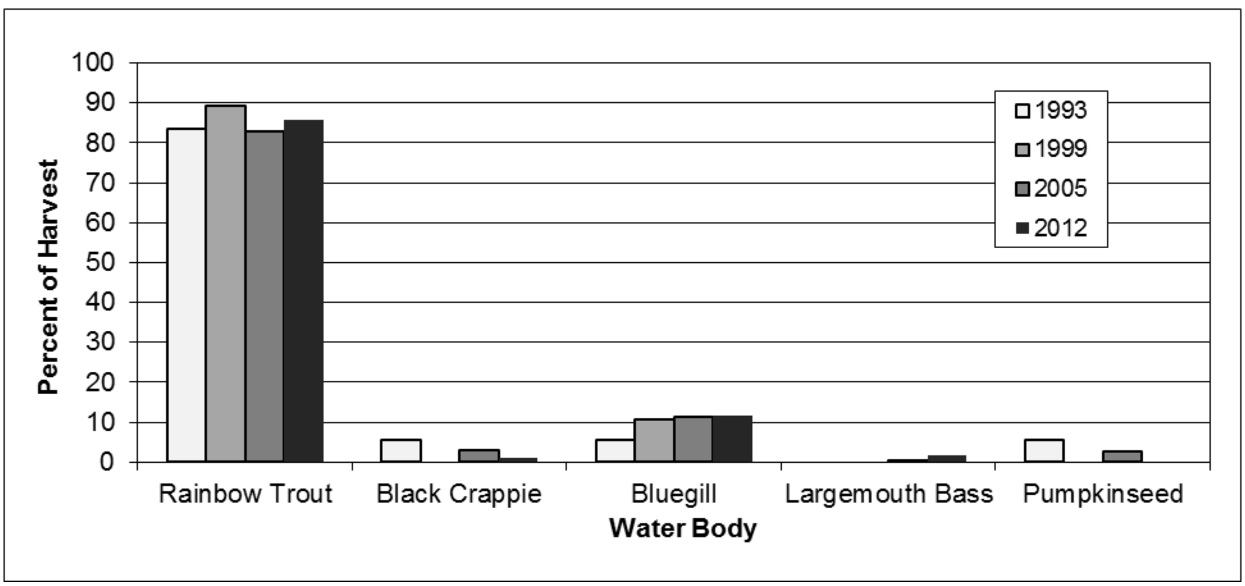


Figure 116. Composition of fishes harvested in Moose Creek Reservoir, Idaho, as estimated by creel surveys conducted from 1993 - 2012.

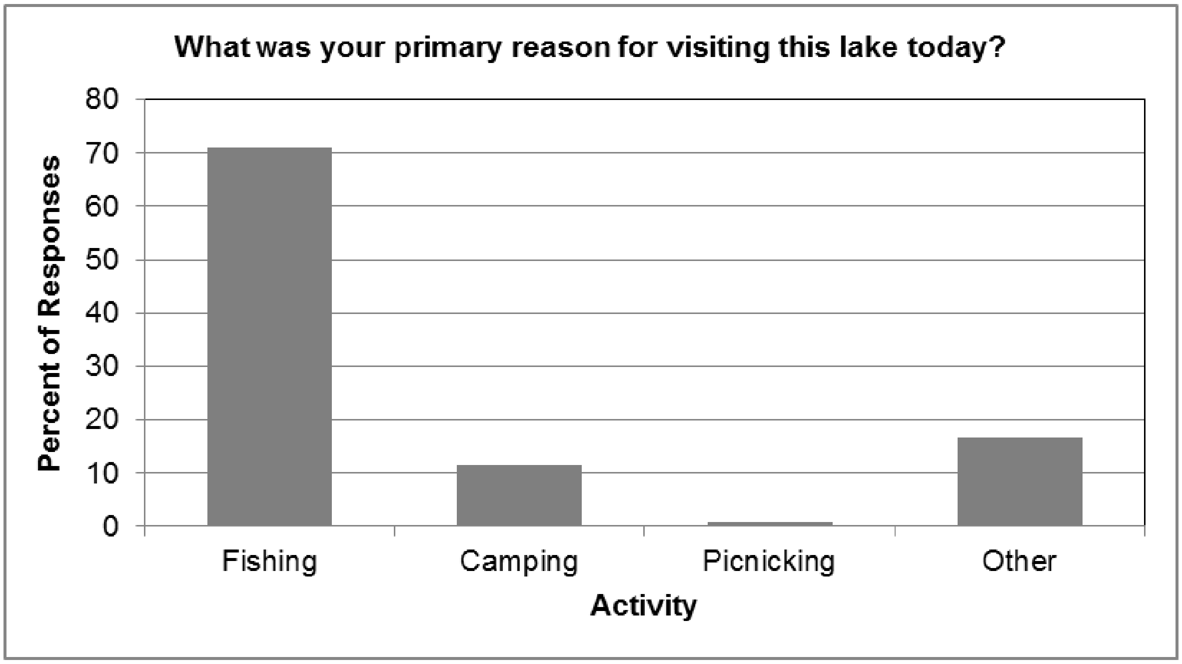


Figure 117. Summary of angler responses to the primary reason for visiting Moose Creek Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

Figure 118. Summary of angler responses regarding their overall fishing experience at Moose Creek Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

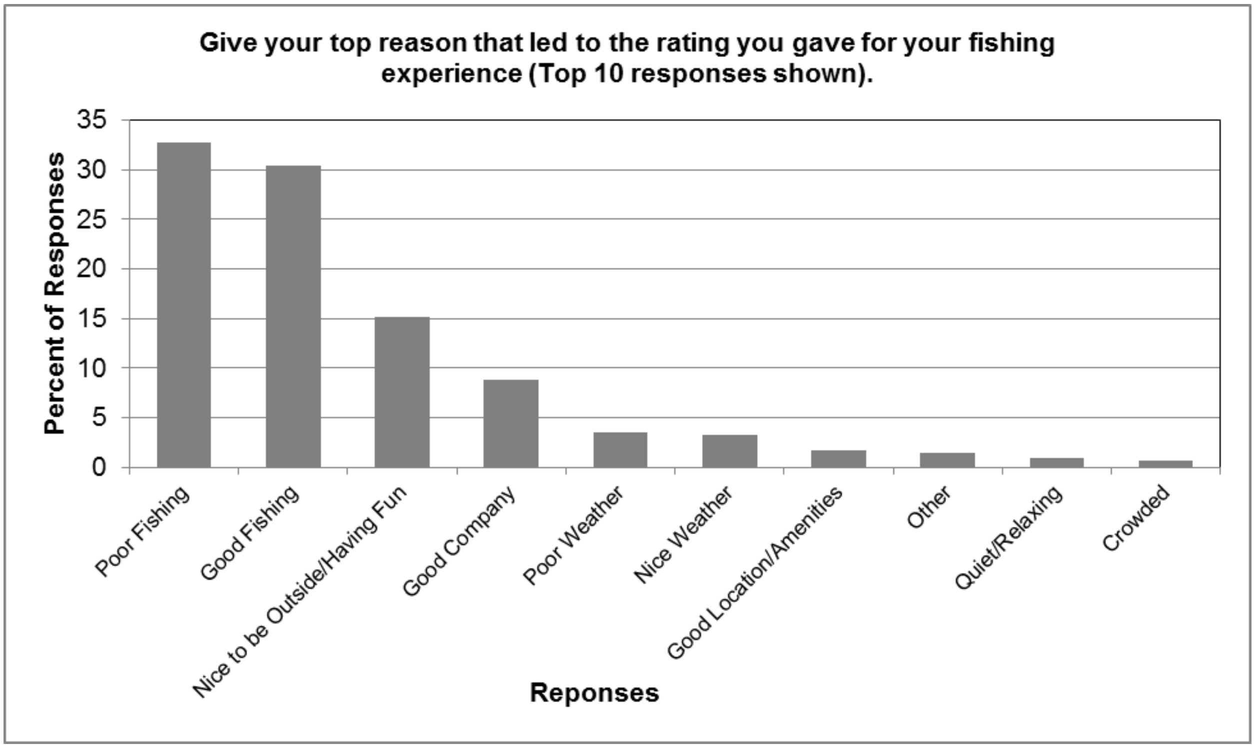


Figure 119. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day at Moose Creek Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 - November 28, 2012 (Only 10 most common answers shown).

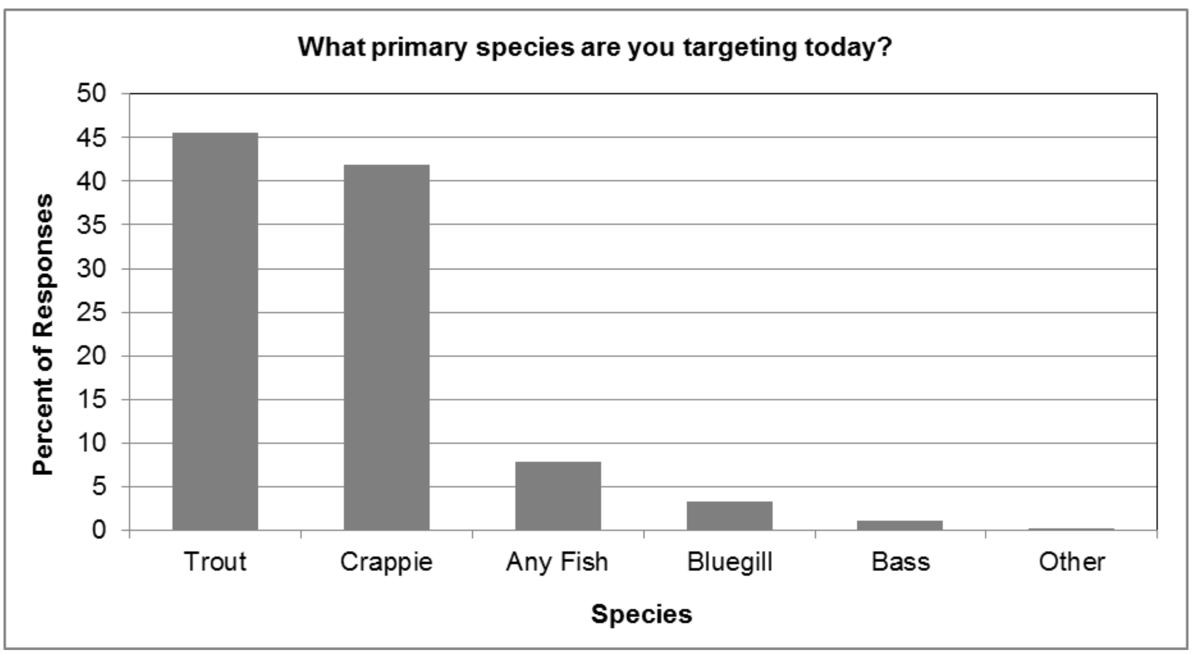


Figure 120. Summary of angler responses regarding target fish species at Moose Creek Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

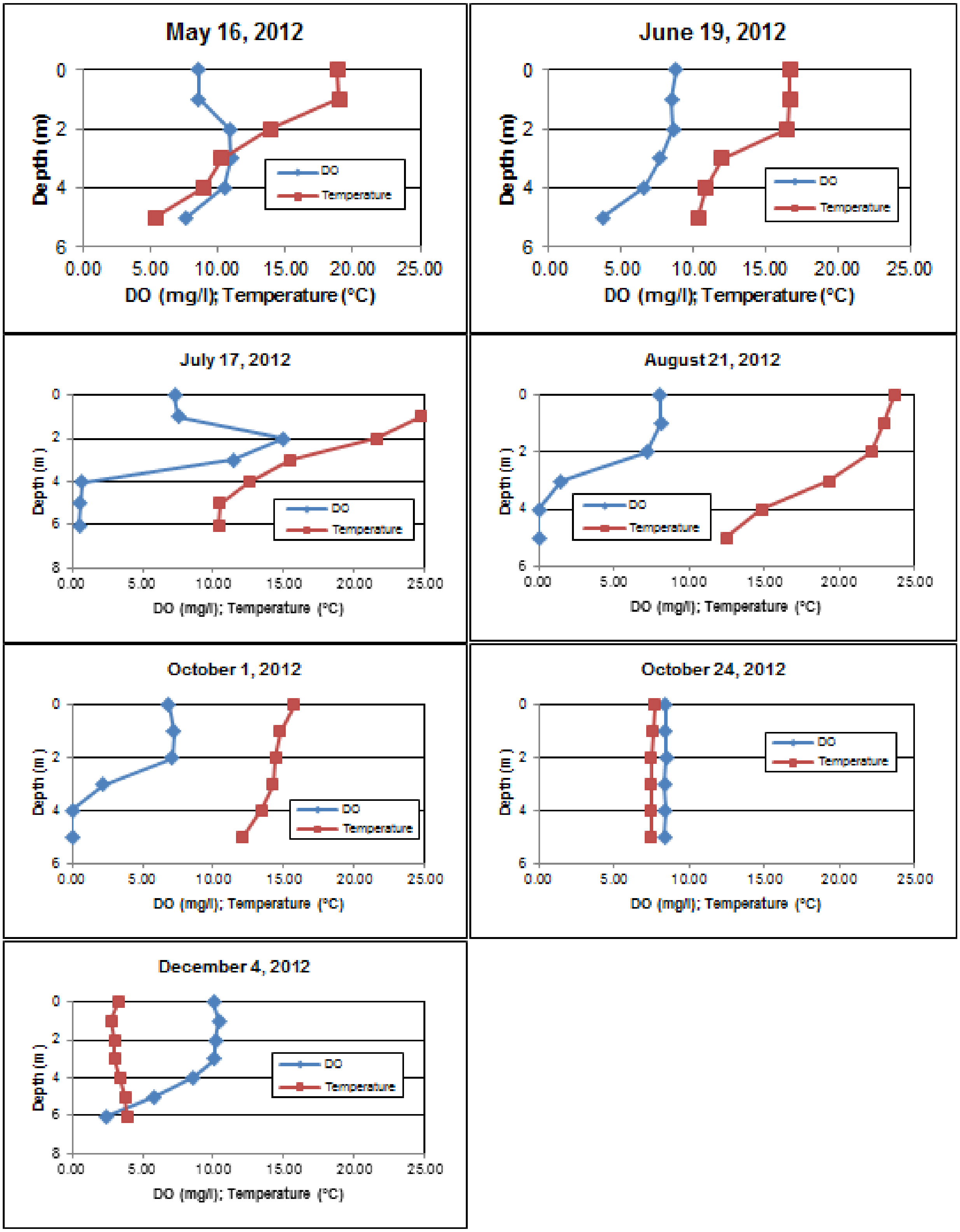


Figure 121. Dissolved oxygen (DO) and temperature profiles collected in Moose Creek Reservoir, Idaho, during 2012.

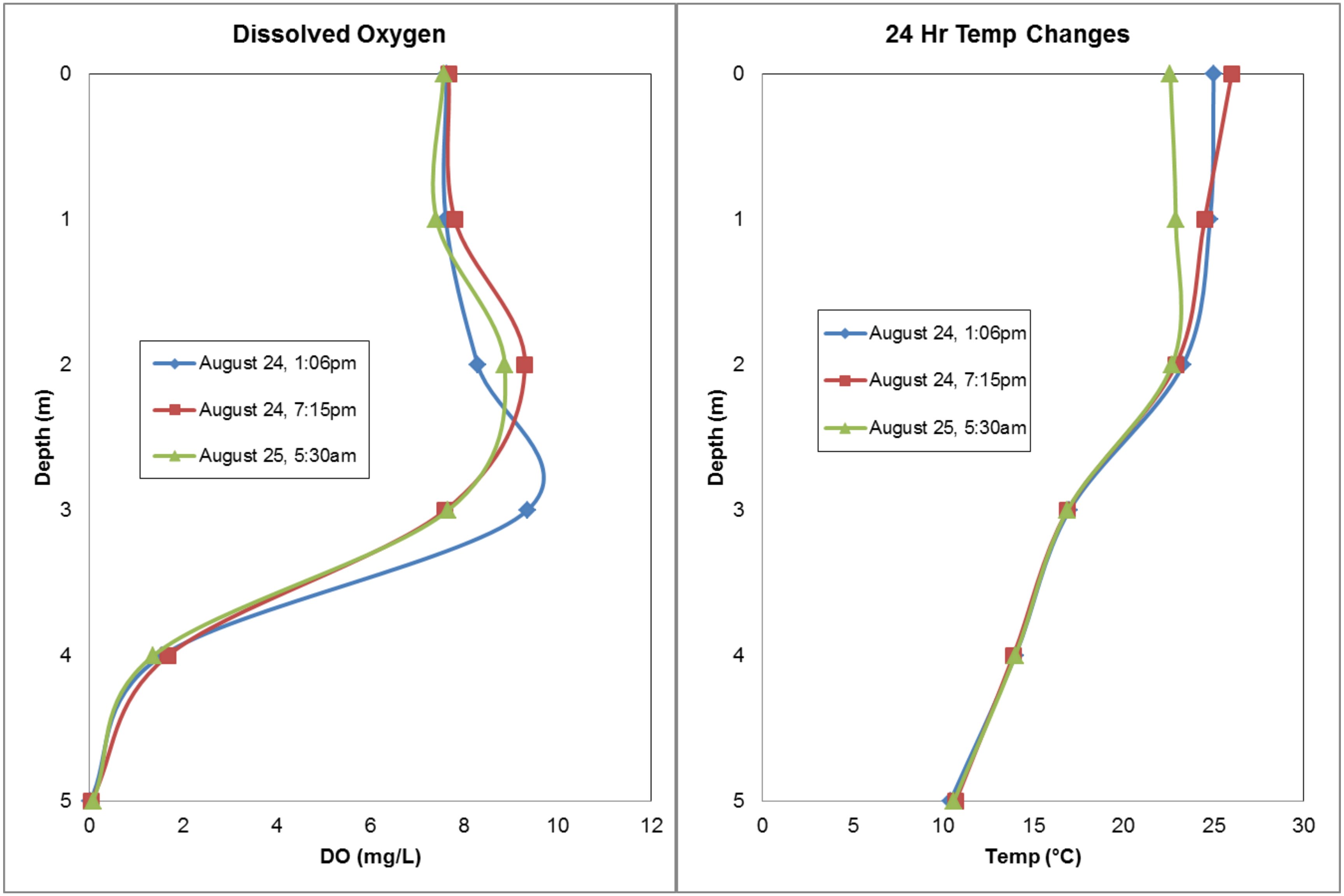


Figure 122. Diel changes in temperature and dissolved oxygen (DO) in Moose Creek Reservoir, Idaho, from August 24 - 25, 2012.

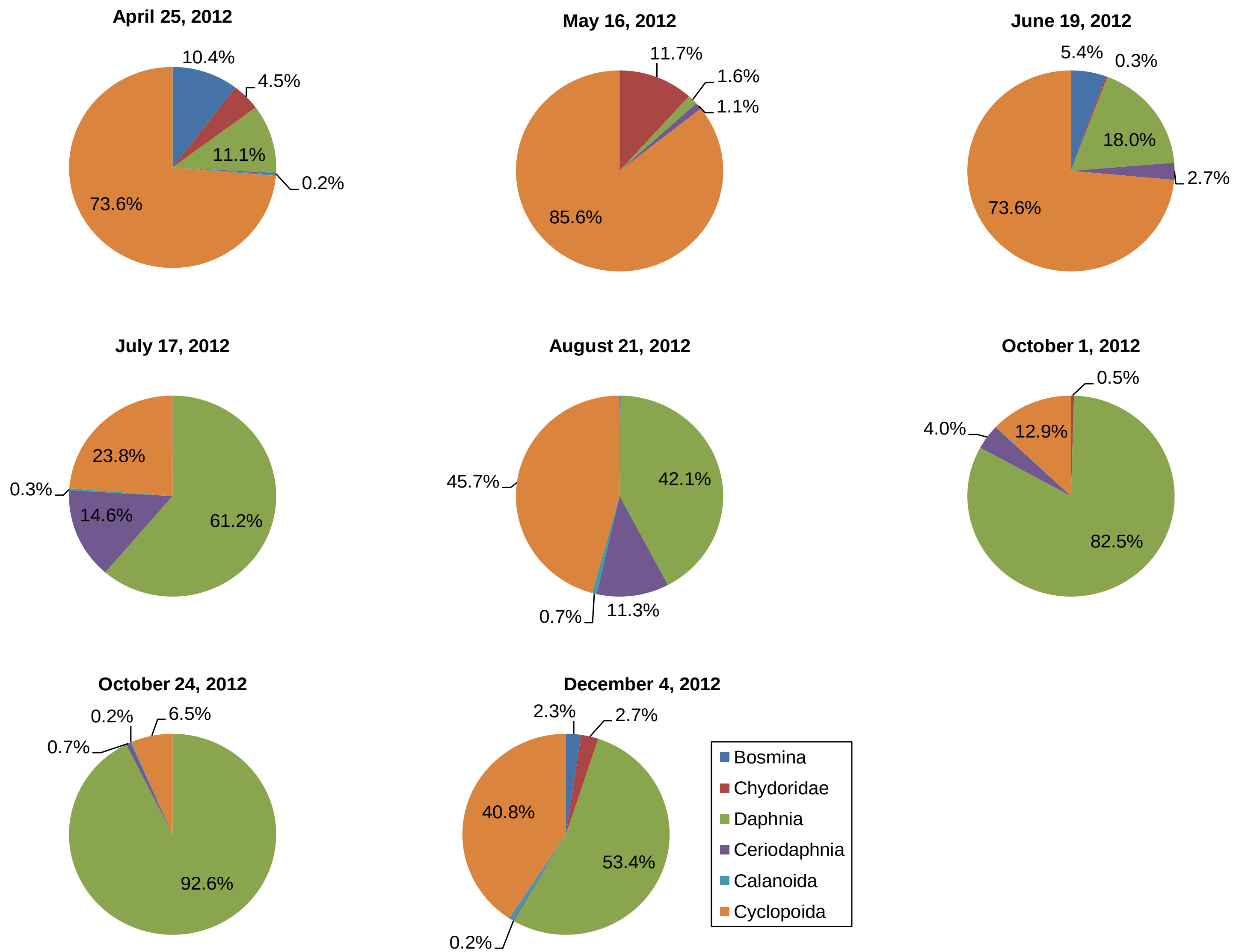


Figure 123. Zooplankton community composition based on monthly samples collected in Moose Creek Reservoir, Idaho, in 2012.

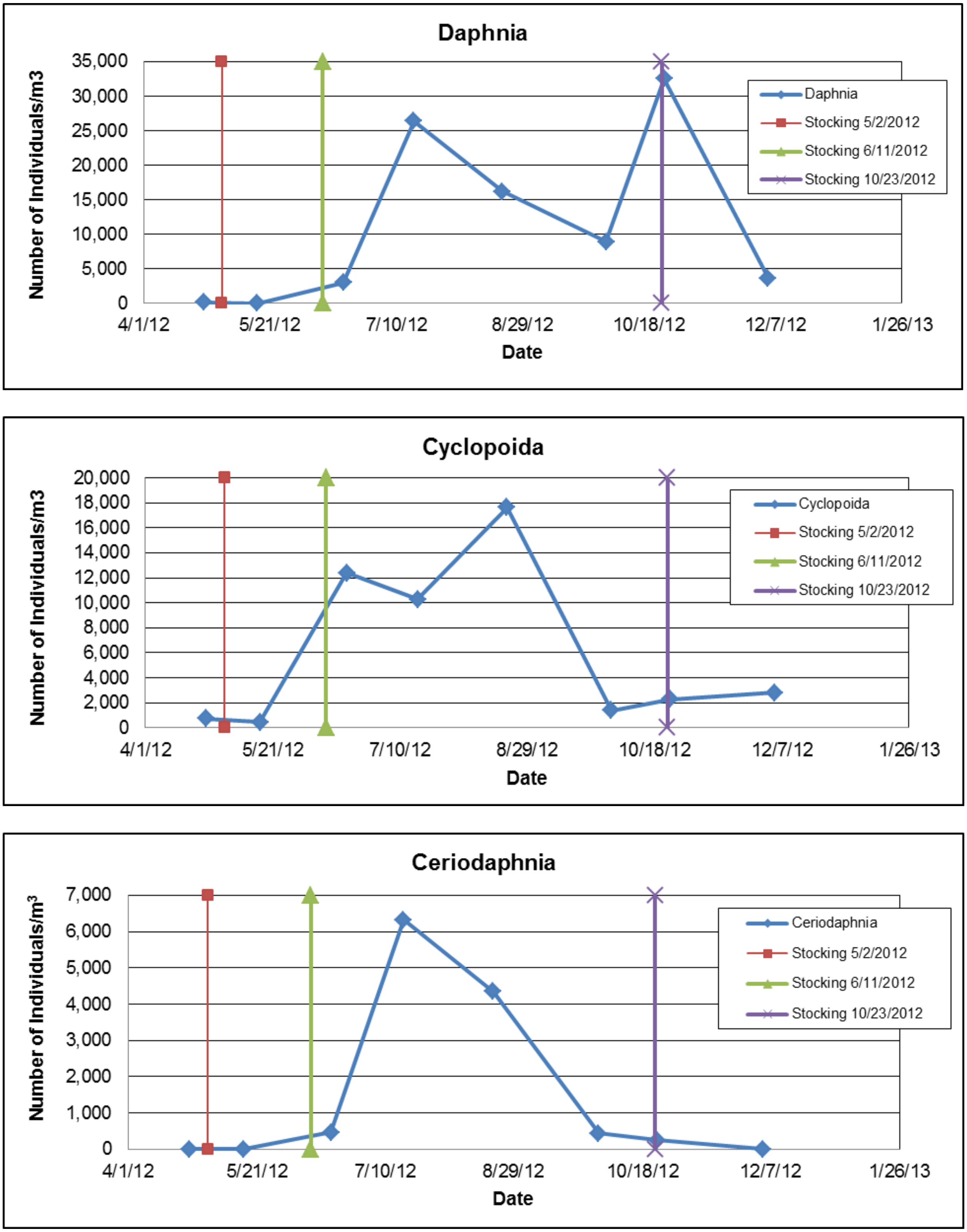
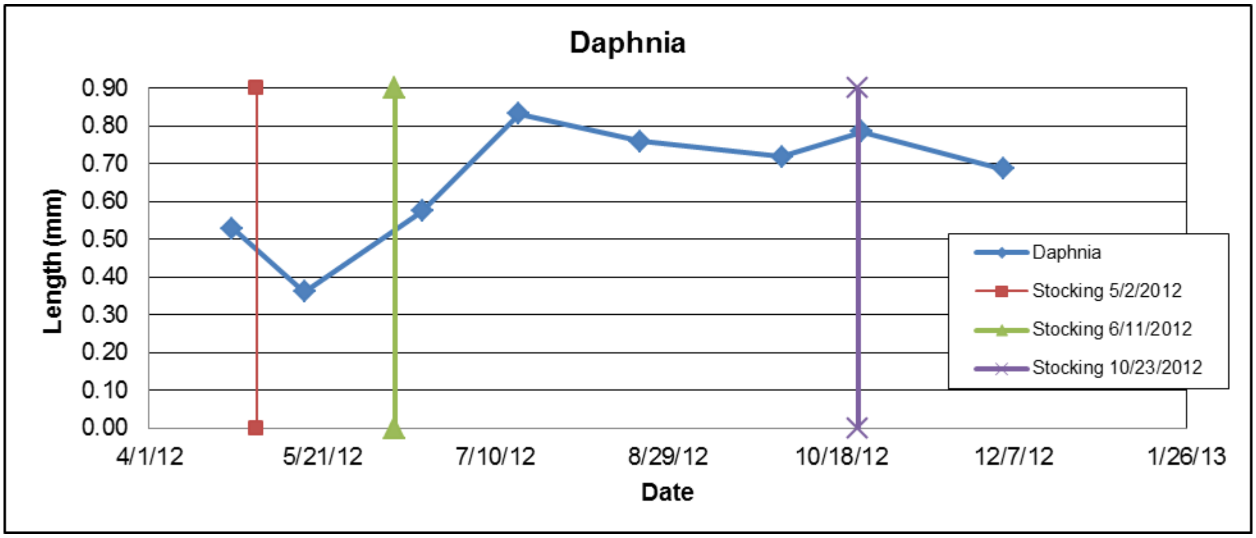


Figure 124. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Moose Creek Reservoir, Idaho, in 2012.



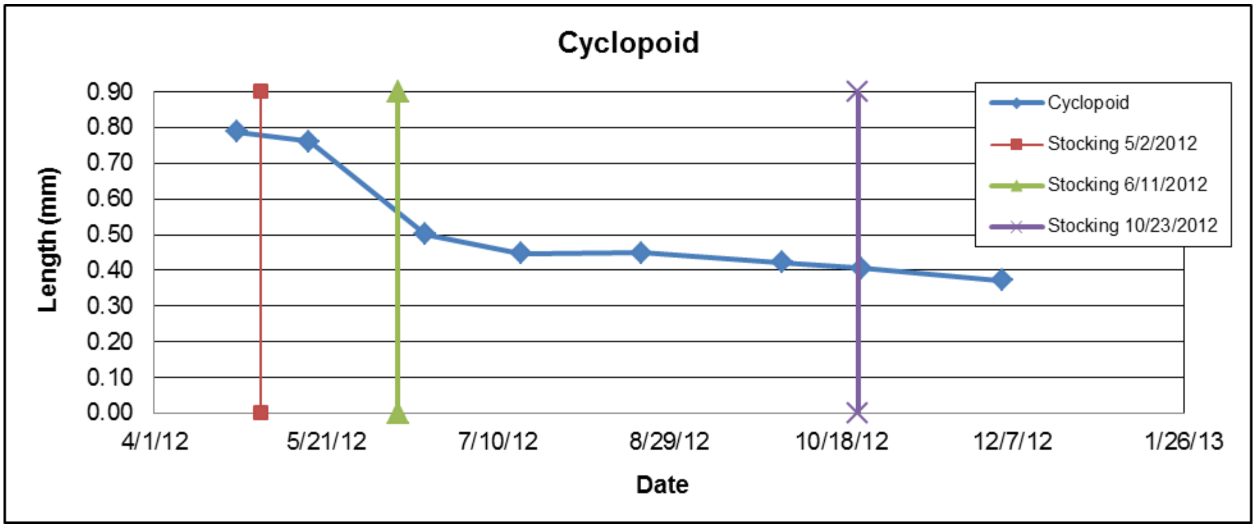


Figure 125. Average length (mm) of zooplankton collected from monthly samples in Moose Creek Reservoir Lake, Idaho, in 2012.

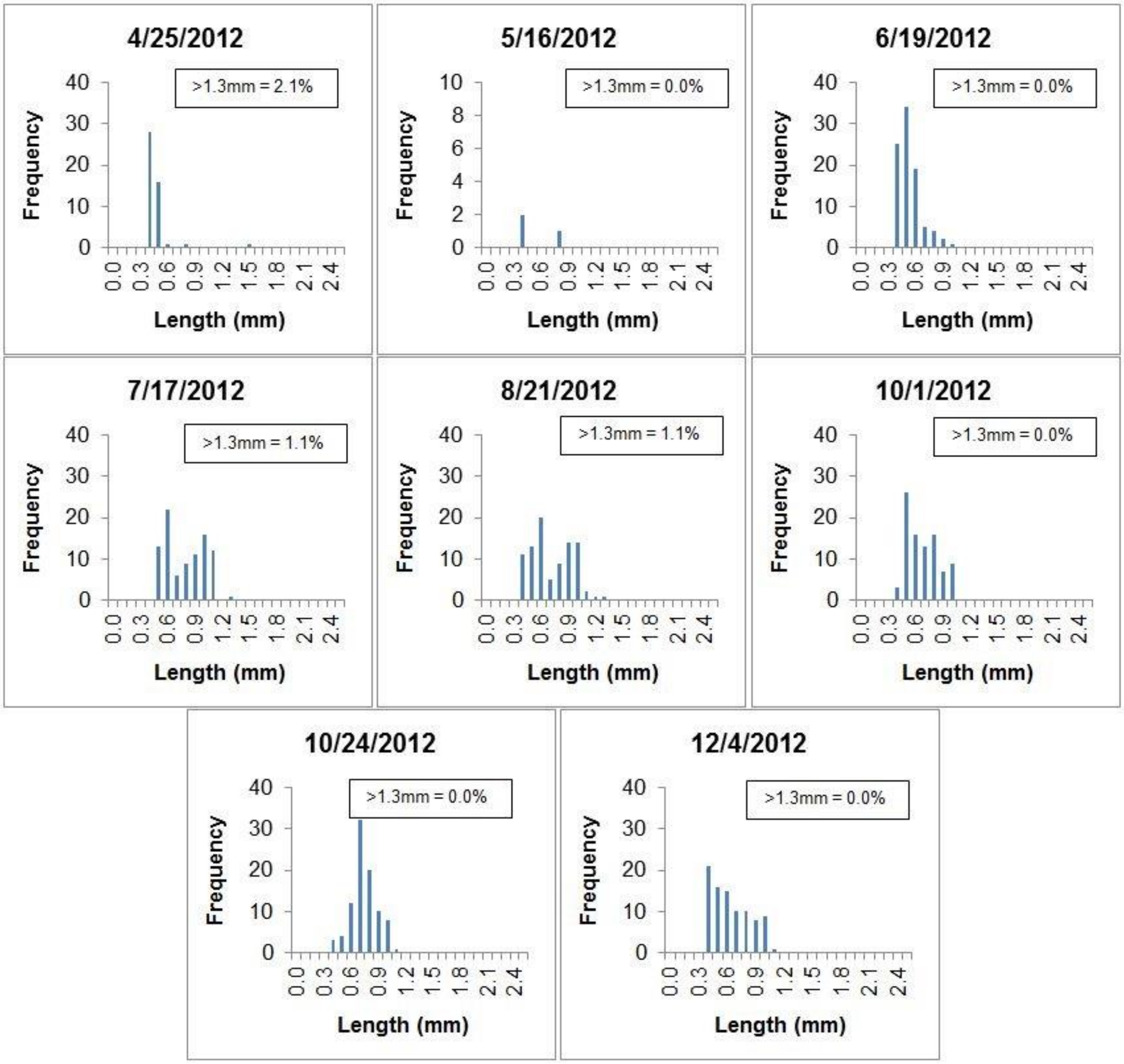


Figure 126. Length frequency distribution of Daphnia collected from monthly sampling in Moose Creek Reservoir, Idaho, in 2012.

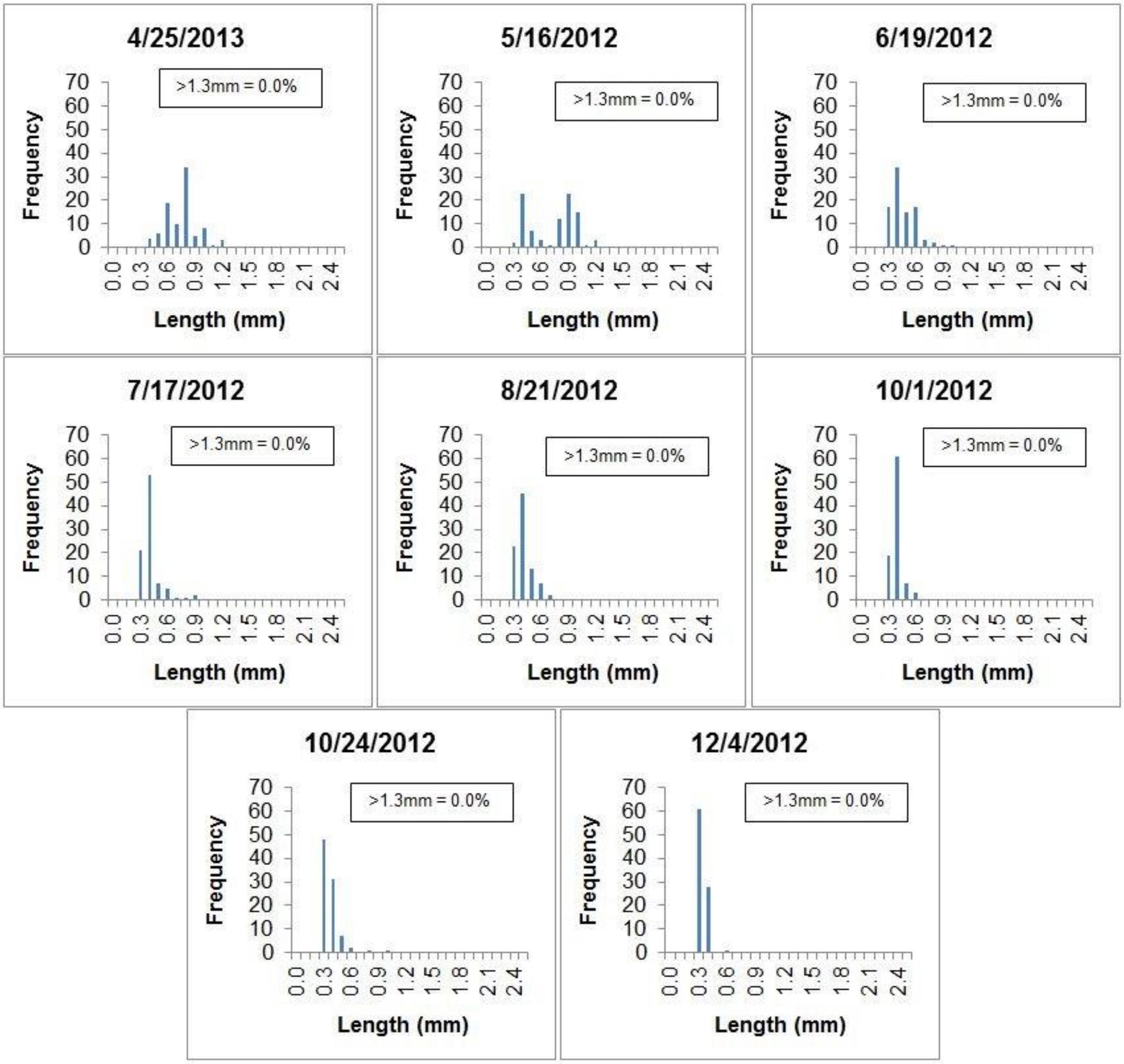


Figure 127. Length frequency distribution of Cyclopoida collected from monthly sampling in Moose Creek Reservoir, Idaho, in 2012. Up to 90 individuals measured per sample. Percent of sample >1.3 mm listed for each graph.

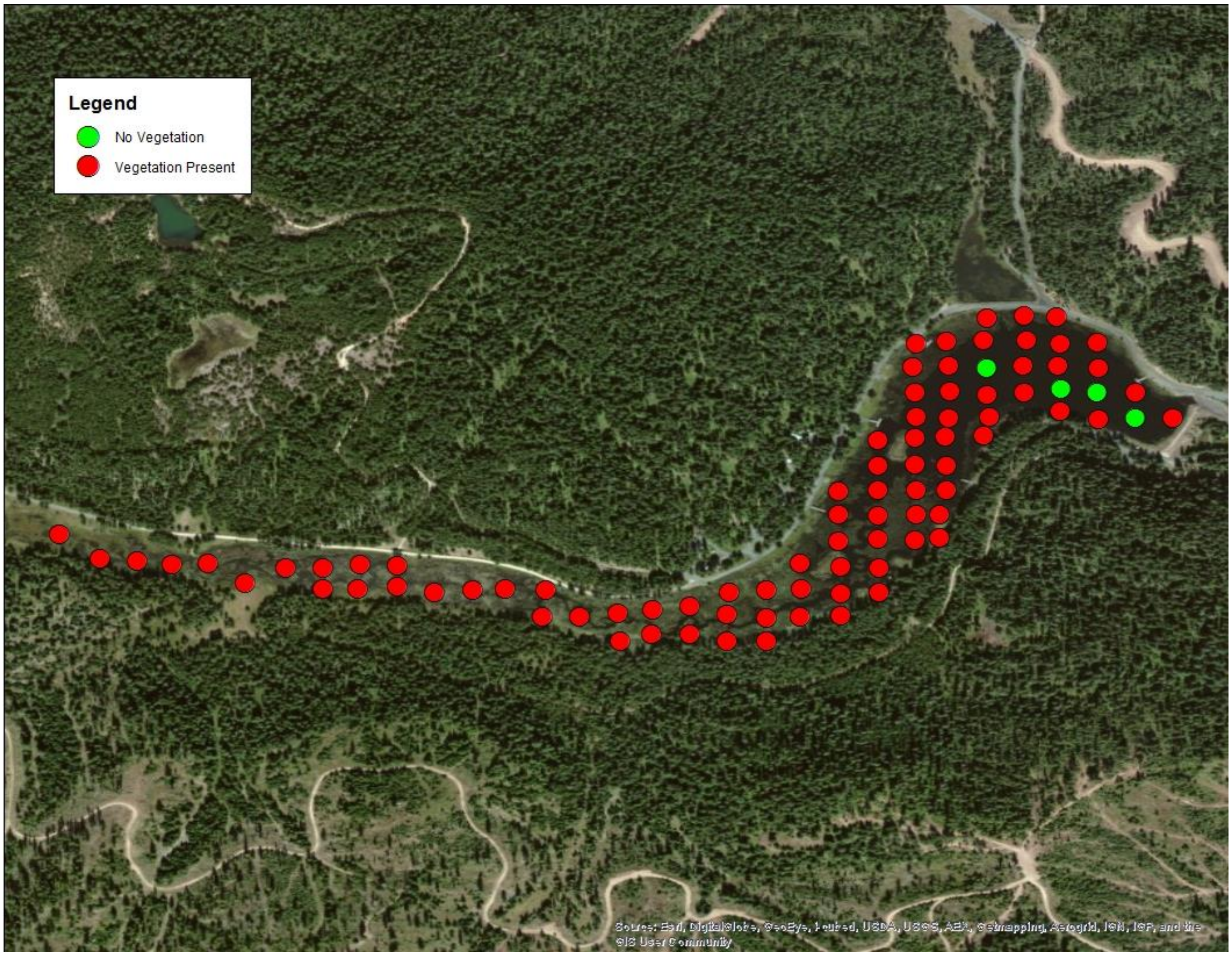


Figure 128. Locations where aquatic vegetation was collected during vegetation sampling in Moose Creek Reservoir, Idaho, during 2012.

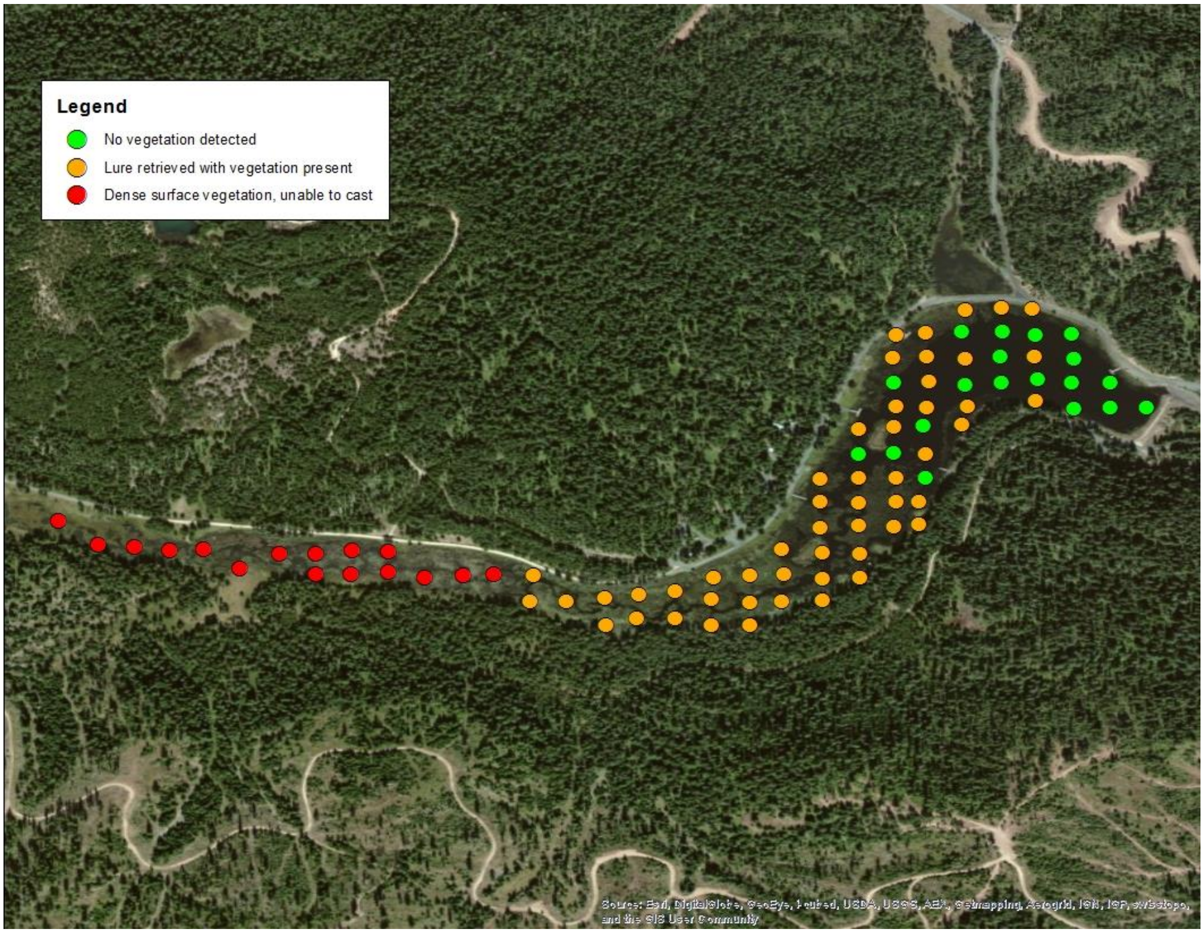


Figure 129. Fishability (using Davids' Fishability Index) at set locations in Moose Creek Reservoir, Idaho, during 2012.

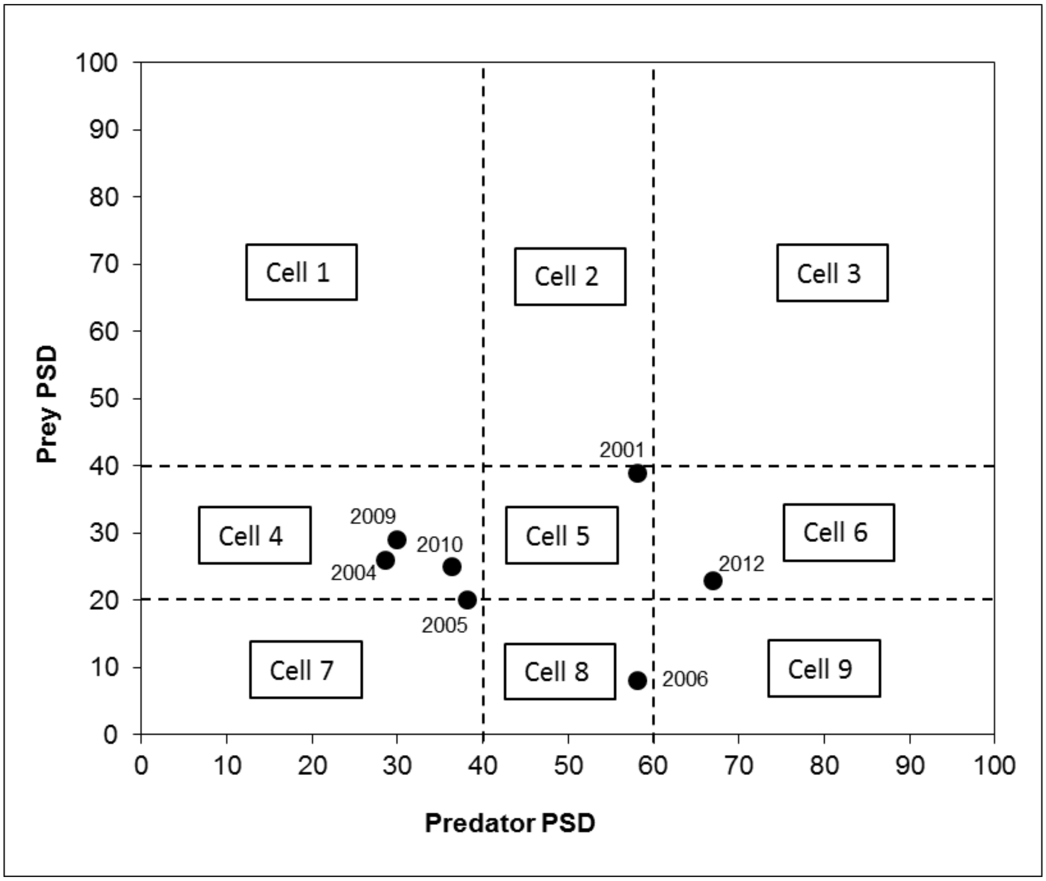


Figure 130. Comparison of predator (Largemouth Bass) and prey (Bluegill, Pumpkinseed, black crappie) proportional size distribution (PSD) from electrofishing surveys conducted in Moose Creek Reservoir Idaho, from 1997 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

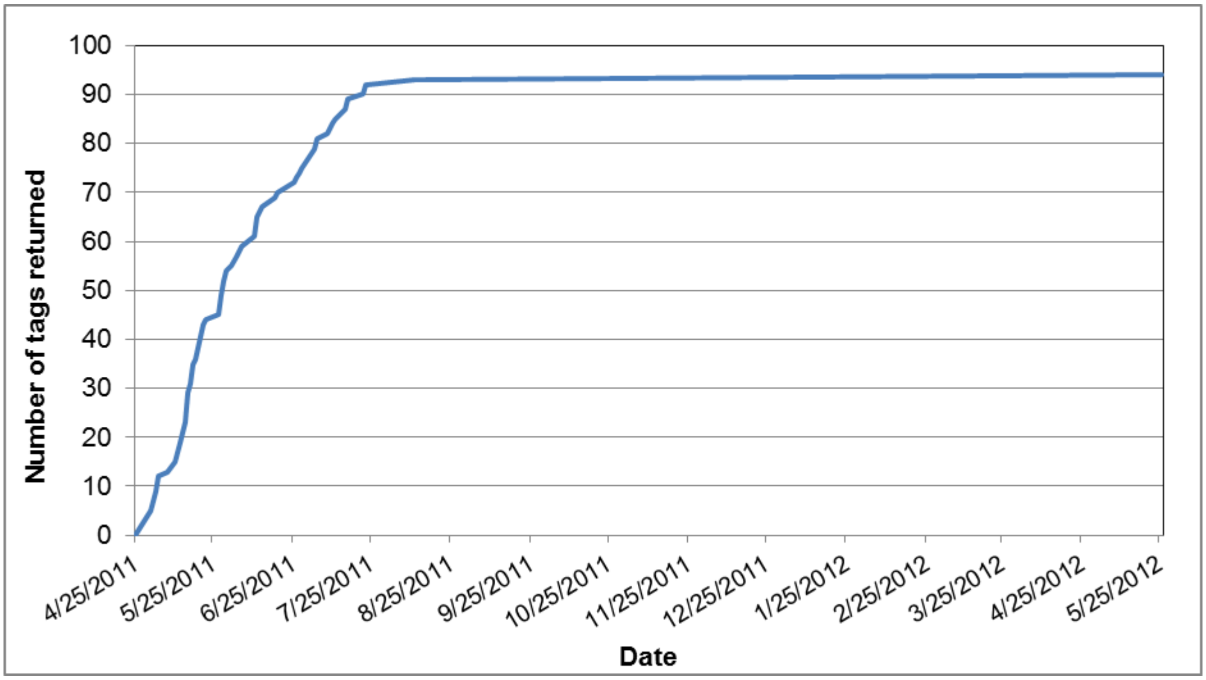


Figure 131. Cumulative number of hatchery catchable Rainbow Trout harvested from Moose Creek Reservoir, Idaho, from an April 25th, 2011 stocking event, based on angler tag returns (797 fish tagged).

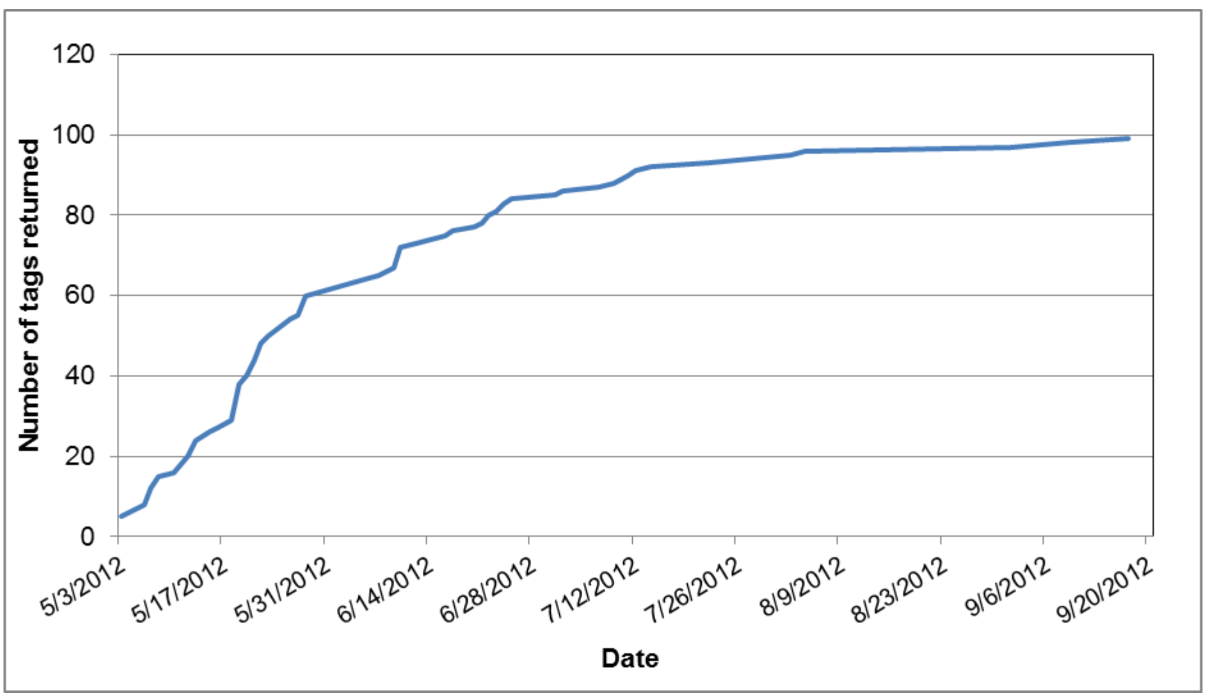


Figure 132. Cumulative number of hatchery catchable Rainbow Trout harvested from Moose Creek Reservoir, Idaho, from April 24th and May 2nd, 2012 stocking events, based on angler tag returns (1,998 fish tagged).

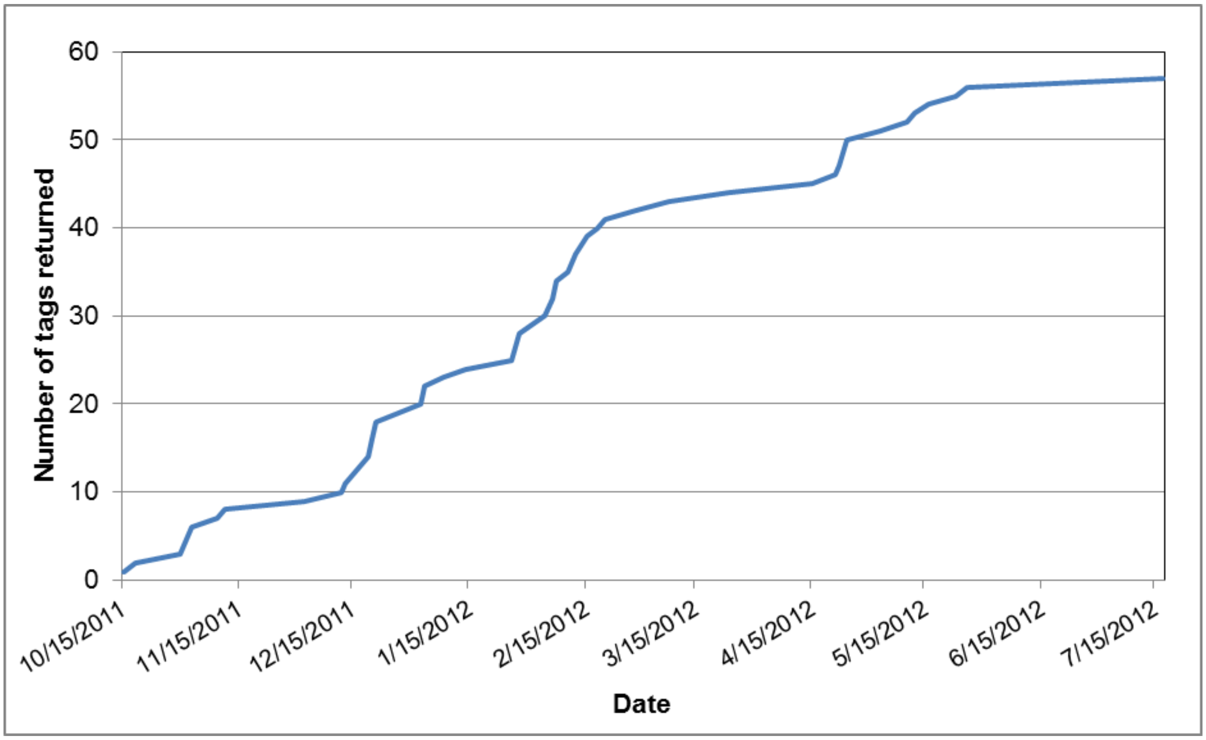


Figure 133. Cumulative number of hatchery catchable Rainbow Trout harvested from Moose Creek Reservoir, Idaho, from a October 12th, 2011 stocking event, based on angler tag returns (1,797 fish tagged).

SPORTFISH ASSESSMENT OF SOLDIER'S MEADOW RESERVOIR

ABSTRACT

In 2012, a comprehensive assessment of Soldier's Meadow Reservoir was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 214 fish including Yellow Perch, Black Bullhead, and Black Crappie. The results of this survey indicate that SMR is dominated by stunted Yellow Perch and Black Bullhead populations. This, combined with our lack of success in establishing a predator population (Largemouth Bass), indicates that there is insufficient predation occurring to provide control of these prey populations.

Creel surveys estimated angler effort at 6,049 hours. This was the lowest effort estimated for the four creel surveys conducted in SMR since 1993. Angler effort declined in seven of the eight regional reservoirs surveyed in both 2005 and 2012. This decline may be a result of the declines in participation in outdoor recreation activities during the 1990's and early 2000's. However, these changes may also be the result of improvements in the accuracy of our creel survey methodology from 2005 to 2012. The angler catch rate for all fish species combined was estimated at 1.7 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 1.0 fish/hour, well above the statewide management goal of >0.5 fish caught/hour. Angler exploitation of hatchery catchable size Rainbow Trout was estimated at 18.4% for the creel survey while angler exploitation was estimated at 5.7% by the "Tag You're It" program. This large difference may have been caused by factors such as a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. The large difference between these two estimates should be explored in the future to determine which method is more accurate.

The information collected in this survey continues to show a trend of stunted fish populations and a decline in angler effort and satisfaction. We asked anglers during the 2012 creel survey if they would support a renovation of the reservoir to remove the stunted fish. The majority (61%) supported this type of action to improve the fishery. However, anglers were split on the type of fishery they would prefer post-renovation. Based on this information, we recommend renovating SMR with rotenone to remove the stunted populations of Yellow Perch, Black Bullhead, and Black Crappie. Public meeting should be held to provide public input on potential management options for the reservoir, taking into account what the reservoir is capable of sustaining, and how it fits into the regional lowland lake program.

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Regional Fisheries Manager

INTRODUCTION

Soldier's Meadow Reservoir (SMR) is located in the western part of the Clearwater Region. An economic survey conducted in 2011 estimated little angler use, with only 2,494 angler trips for an estimated total economic expenditure of $245,876 (IDFG unpublished data). Anglers fishing SMR primarily target put-and-take hatchery Rainbow Trout. Previous creel surveys have estimated that 73.4% - 97.6% of fish harvested in SMR were hatchery Rainbow Trout (Hand 2009). The reservoir also has a Largemouth Bass, Black Crappie, Yellow Perch *Perca flavescens*, and Black Bullhead. However, these species do not provide much of a fishery, as the Yellow Perch, Black Crappie, and Black Bullhead have overpopulated the reservoir and resulted in stunted sizes smaller than what anglers prefer to target.

Current Management

Soldier's Meadow Reservoir is a mixed fishery, containing both cold-water and warm-water species. It is managed as a put-and-take trout fishery with approximately 7,830 catchable Rainbow Trout stocked in 2012 to maintain the management goal of >0.5 fish/hour catch rate (IDFG 2013). The reservoir is also managed for a Largemouth Bass fishery, and a yield fishery on Black Crappie, and Yellow Perch. The reservoir is managed with general regulations including year round seasons, no length limits, six trout limit trout and bass, and no gear restrictions. Boat activity on SMR is restricted to electric motors only. The current management priority is to provide a desirable fishing experience to a wide diversity of anglers.

Reservoir Management Goals

1. Maintain catch rate of >0.5 fish/hour for hatchery Rainbow Trout.

2. Maintain yield fisheries for Black Crappie and Yellow Perch.

STUDY SITE

Soldier's Meadow Reservoir is located 45 km southeast of Lewiston Idaho, and 10 km west of Winchester, Idaho (Figure 4). It is a 47.8 hectare reservoir that lies at an elevation of 1,378 meters. It has a mean depth of 5.6 meters, a maximum depth of 14.0 meters, and a maximum volume of 2,360 acre-ft. Soldier's Meadow Reservoir was constructed for the Lewiston Orchards Irrigation District (LOID) to retain water for irrigation purposes. Its primary water supply is from Webb and Captain John creeks. Annual water level fluctuations up to 5 m are commonplace. Water reductions usually begin by late June or early July as water is discharged downstream and eventually diverted into Mann Lake for storage. Low pool generally occurs during late fall towards the end of the irrigation season. Severity and timing of water level fluctuations is dependent on water yield in the LOID-managed watershed and by irrigation demand. The timing of annual variations in water level can have effects on the spawning success of warm-water species. Low pool levels through the winter have a negative effect on carrying capacity.

RESULTS

Population Survey

A fishery survey of SMR was conducted on May 29, 2012 which consisted of 60 minutes of electrofishing and one trap net night. Electrofishing was separated into six 10-minute periods.

The electrofishing and one trap net set resulted in the capture of 214 fish including Yellow Perch (n = 126), Black Bullhead (n = 81), Black Crappie (n = 4), and Largemouth Bass (n = 3; Figure 134). The combined electrofishing catch rate was 163.0 fish/hour. Catch rates for each of the six 10-minute electrofishing samples ranged from 3 - 87 fish/sample (Table 26). The variability from the six samples was used to estimate statistical power and sample size for future electrofishing surveys (IDFG 2012). To have a 90% confidence (2-tail test) with 25% precision estimate of fish captured in sample of SMR, an estimated 60 sample periods would be needed for a whole fish community survey (Table 26).Fifty-one fish were collected by the trap net, primarily Yellow Perch (n = 46), followed by Black Bullhead (n = 4), and Black Crappie (n = 1).

Yellow Perch:

Yellow Perch collected ranged from 54 - 194 mm in length (Figure 135), with an average of 131 mm. Yellow Perch CPUE was 126 fish/hour, the highest since 2003 (Figure 134). Proportional size distribution for Yellow Perch in 2012 was one, similar to what was seen in 2009 (Figure 136). Relative weight ranged from 35 - 125, and averaged 84 (Figure 137). Yellow Perch were composed almost exclusively of fish age 1-3 years, with only 1 older age-6 individual caught. (n = 80)(Table 27). Annual growth rates ranged from 13 - 58 mm. A catch curve for estimating mortality could not be developed due to not having enough scale samples from multiple age classes.

Black Bullhead:

Black Bullhead collected ranged from 130 - 186 mm in length, with an average length of 165 mm (Figure 138). Black Bullhead CPUE was 81 fish/hour in 2012, a decline from a high of 253 fish/hour in 2009 (Figure 134). Proportional size distribution for Black Bullhead in 2012 was zero (Figure 139). This represents no change from surveys conducted in 2005 and 2009 after a high of 100 during the 2003 survey.

Largemouth Bass:

Largemouth Bass collected in 2012 ranged from 299 - 330 mm in length, with an average length of 317 mm. Largemouth Bass CPUE (3 fish/hour) was <7.0 fish/hour for every sample collected from 2003 - 2012. Proportional size distribution and relative weights were not calculated due to small sample size. Scale samples were not analyzed for age, growth, and mortality due to small sample size.

Black Crappie:

Black Crappie collected ranged from 58 - 220 mm in length, with an average of 125 mm. Black Crappie CPUE was 6 fish/hour, the lowest since 2003 (Figure 134). Proportional size distribution and relative weights were not calculated due to small sample size. Scale samples were not analyzed for age, growth, and mortality due to small sample size.

Creel Survey

Angler Effort:

Creel surveys were conducted on SMR from November 28th, 2011 through November 28th, 2012. A total of 186 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 6,049 hours (SE ± 706; Table 28). This was the lowest effort documented of the four creel surveys conducted on the reservoir since 1993 (Figure 1). Slightly more effort occurred on weekends (52.6%) than weekdays (47.4%). Effort consisted of 77.9% bank, 19.7% boat, and 2.4% ice anglers. The highest angler effort occurred in the summer months from May - September, with monthly effort estimates ranging from 0 - 2,144 hours (Table 28).

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on SMR was based on 105 completed trip interviews. Anglers caught an estimated 10,042 fish during 2012 (Appendix A), resulting in a catch rate of 1.7 fish/hour. Hatchery Rainbow Trout accounted for 64.8% (4,895) of the fish caught during the 2012 creel survey (Figure 140). Catch of warm-water species included 2,734 Black Bullhead (20.1%), 2,168 Yellow Perch (9.6%), and 208 Black Crappie (5.4%). Anglers harvested an estimated 2,077 fish during 2012 (Appendix A), 20.7% of the fish caught. The harvest rate for all fish combined was estimated to be 0.3 fish/hour. Harvest in 2012 consisted of 1,439 hatchery Rainbow Trout (69.2%), 616 Yellow Perch (29.7%), and 23 Black Crappie (1.1%; Figure 141). All harvested fish encountered during creel surveys were measured for total length. Harvested Yellow Perch measured by creel clerks ranged in length from 130 to 190 mm, and averaged 160 mm (Figure 135).

A total of 4,895 hatchery Rainbow Trout were caught during the survey, with 1,439 harvested (Appendix B). This is a catch rate of 1.0 fish/hour and a harvest rate of 0.3 fish/hour. Of the fish caught, 145 were holdover Rainbow Trout, with none harvested. All of the fish were harvested from May - July (Appendix C). The estimated exploitation rate was 18.4%. Harvested Rainbow Trout measured by creel clerks (n = 54) ranged in length from 180 to 303 mm, and averaged 265 mm.

Angler Satisfaction:

A total of 236 public opinion surveys were conducted at SMR in conjunction with the creel survey. All constituents using the lake were interviewed. Sixty-three percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 142). Camping (17.8%) and “other” (12.9%) were the next most common responses. Of the people interviewed, 79.7% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at SMR. Forty-four percent of people interviewed rated their fishing experience as fair or poor (Figure 143). The most common reasons for a negative rating were related to poor fishing (42.3%) and poor weather (7.1%; Figure 144). Fifty-six of people interviewed rated their fishing experience as excellent or good (Figure 143). The most common reasons for a positive rating were related to good fishing (21.2%) and “nice to be outside” (14.1%; Figure 144).

The most commonly targeted fish was hatchery Rainbow Trout (30.0%; Figure 145). Fifty-four percent of people interviewed were not targeting a particular fish species while fishing. Warm-water species (Black Crappie and Largemouth Bass) comprised 11.9% of the targeted fish species responses for SMR. Yellow Perch were targeted 4.2% of the time.

Sixty percent of people interviewed supported a proposal to renovate SMR with rotenone to eliminate stunted Yellow Perch, Black Crappie, and Black Bullhead populations (Figure 146). The majority of anglers interviewed (51.6%) would like the lake to be restocked as a two story fishery, with both trout and warm-water species (Figure 147). Twenty-five percent would prefer trout only, and 22.2% would like warm-water fish only (Figure 147).

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery catchable size Rainbow Trout stocked in SMR on May 15, 2012 (n = 400). The exploitation rate through 365 days at large was estimated to be 5.7% (Table 29). Total use (fish harvested plus fish released) through 365 days at large was also 5.7% (Table 29; Appendix D), as no fish were released. Angler exploitation and total use for 366 - 730 days at large were both 0.8%. No use occurred beyond 720 days at large.

Limnology

Limnology samples were collected monthly from April - October, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being quite evident (Figure 148). Dissolved oxygen profiles for April and May began with high concentrations at the surface, and slowly declined with depth (Figure 148). Low/no DO conditions were present in the hypolimnion from late June through September while the DO profile for October was very homogenous due to fall turnover. Monthly temperature measurements showed very similar patterns to the DO measurements (Figure 148). To look at potential diel changes in temperature and DO profiles, measurements were taken at 19:45 and on August 15, 2012, and at 06:16 and 11:51 on August 16, 2012 (Figure 149). There were drops in both surface temperature and DO overnight, but no changes occurred below the thermocline at 6.0 m.

Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. During July, water temperatures were >21°C down to a depth of 2 m, and DO at this time was <5.0 mg/L below 4 m in depth. This resulted in 24.7% of the water volume in SMR being conducive for Rainbow Trout long-term survival (Figure 150). Utilizing an upper thermal limit of 25°C, 64.5% of the water volume would be conducive for Rainbow Trout long-term survival (Figure 150). However, the volume of the reservoir available for Rainbow Trout was reduced to zero in October using either thermal limit, as DO levels dropped to <5.0mg/L through the entire water column (Figure 150).

Zooplankton

Zooplankton samples were collected monthly from April through November, 2012. The population was composed of six taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Ceriodaphnia, Bosmina, and Calanoida. The composition changed from primarily Cyclopoida (>52.8%) in both April and May samples to primarily Ceriodaphnia (>80.6%) in August - October (Figure 151).

Densities (# of individuals/m^3) were also highly variable. Ceriodaphnia densities were very low in April (139/m^3) and increased to 158,253/m^3 in October (Figure 152). The average density was 46,277/m^3. Daphnia, Cyclopoida, Bosmina, and Chydoridae all had low densities in spring and fall, but peaked in the summer (Figure 152). Average lengths of Cyclopoida ranged from 0.51 - 0.81 mm (Figure 153). Average length declined after the spring stocking of Rainbow Trout, but recovered in July. Average lengths of Daphnia ranged from 0.76 - 1.10 mm (Figure 153). Average length declined after the spring stocking, but then increased throughout the summer. Length frequency distributions from each sample show that the percent of Daphnia

>1.3 mm in length ranged from 13.3 - 62.2% of the individuals collected (Figure 154). Length frequency distributions from each sample show that no samples contained Cyclopoids >1.3 mm (Figure 155).

Additionally, ZQI sampling was conducted on August 23, 2012. Biomass for the 150 µm net was the third highest for any reservoir at 0.70 (g/m^3). However, biomass was the lowest with 0.00 (g/m^3) for the 500 µm net, and 0.00 (g/m^3) for the 750 µm net (Appendix E). The ZPR and ZQR were also the lowest of any regional reservoir, with both calculated at 0.00.

Aquatic Vegetation

Vegetation surveys were conducted on August 9, 2012. A total of 105 sites were sampled. Vegetation was collected by rake tosses at 17 (16%) sample sites (Figure 156). Seven types of vegetation were identified: filamentous algae, Smartweed, Bullrush *Scirpus acutus*, pondweed, Water Star-wort *Calitriche heterophylla*, White Water Buttercup, and macrophytic algae. Filamentous algae was the most commonly encountered vegetation, occurring at 16 (15%) sites where vegetation was collected (Appendix F). Smartweed was the second most common, occurring at 10 (10%) sites, followed by Bullrush (9%), pondweed (9%), Water Star-wort (3%), White Water Buttercup (1%), and macrophytic algae (1%). Sample sites along the shoreline accounted for 41.0% (n = 43) of all sample sites. Vegetation was collected at 39.5% of these sites. Additionally, 100% (n = 17) of all sample sites with vegetation were along the shoreline (Figure 155).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 105 sites. Vegetation was encountered while casting and retrieving tackle at three (2.9%) sites (Figure 157). Vegetation was present on hooks at all three of those sites. Dense matted surface vegetation that would prevent casting was not encountered at any site. The DFI and rake toss sampling showed similar patterns of shoreline vegetation. Of the DFI sample sites, 7.3% were negatively affected by vegetation, with none rendered unfishable. All of the affected sites were along the shoreline, with 7.0% of shoreline sites being negatively influenced by vegetation according to the DFI.

DISCUSSION

Population Survey

Soldiers Meadow Reservoir currently supports stunted Yellow Perch and Black Bullhead populations of marginal fishing quality. Illegal fish introductions occurred several times over the last 25 years, including Black Crappie (circa 1992), and Black Bullhead (circa 2001) Yellow Perch (circa 2006). Largemouth Bass (>300 mm) have been stocked several times by IDFG beginning in 2002 in an attempt to control these species through predation. Sampling since 1994 has shown a decline in Black Crappie with a corresponding increase in Black Bullhead and especially Yellow Perch (Figure 134). Sampling in 2012 showed a fishery that is dominated by relatively small fish. Average lengths of Black Crappie (125 mm), Yellow Perch (131 mm), and Black Bullhead (165 mm) were all substantially lower than the 200 mm, 200 mm, and 230 mm lengths considered to be quality size for these species (Anderson and Gutreuter 1983). This is likely a result of stunting due to overpopulation and/or overharvest. A stunted population is an indication of poor growth, and can be caused by limited food sources, inefficient foraging conditions (too much or too little cover), inadequate thermal regimes (short growing season), or too many fish.

Sampling in 2012 indicated that for an electrofishing survey of SMR, 60 10-minute samples would be needed for a whole fish community estimate with 90% confidence (2-tail test) and 25% precision (Table 26). This high number of samples is a result of the wide variability in the number of fish collected in each sample, and in the low number of several species collected. As this number of samples is not realistic, we recommend continuing with six 10-minute samples for each survey to maintain consistency with previous surveys. Additional surveys in the future may help improve our ability to detect smaller changes in CPUE.

Yellow Perch:

Annual growth rates ranged from 13 - 58 mm, similar to the 11 - 60 mm annual growth rates seen in Waha Lake. However, on average, Yellow Perch in SMR don't reach stock size (130 mm) until age 3, and no individuals reach quality size (200 mm). Length at age was below the average length of 191 mm at age 3 found in nine small impoundments in South Dakota (Guy and Willis 1991), the average length of 160 mm at age 3 for 28 populations in mid-western U.S and Canadian impoundments (Willis et al. 1991), and the average length of 250 mm at age 3 found in Cascade Reservoir, Idaho (Jansen et al. 2012). Harvest, food availability, and/or overcrowding are likely causes of the slow growth seen in SMR and appearance of a stunted population.

Angler harvest of larger fish is a probably not responsible for the appearance of a stunted Yellow Perch population. Age analysis indicated that Yellow Perch in SMR were composed of almost exclusively age 2 - 3 individuals (Table 27). With Yellow Perch present in the reservoir since at least 2005, we would expect a wider age distribution. Even with angler harvest of larger fish, we would still expect to see a few large fish. With so few fish older than age 3, mortality appears to be very high for fish once they reach this age. The low levels of effort and low harvest rates suggest that fishing mortality is only playing a small role in the lack of older/larger fish. Thus, natural mortality is likely the primary cause of the lack of larger Yellow Perch in SMR. This could be caused by a lack of food resources due to large numbers of small fish in the reservoir. The relative weight data for fish collected for 2012 supports this, as the average relative weight was 84 (Figure 137). Additionally, relative weights declined as fish got larger, indicating that there were fewer food resources available to sustain larger fish (Figure 137). The large numbers of small fish are likely due to the lack of sufficient numbers of predators to control the population, resulting in a stunted population.

Black Bullhead:

Black Bullhead have also become overpopulated in SMR, with a relatively small average length of 165 mm. With a PSD of zero, no Black Bullhead collected in the fish survey were of quality size (230 mm). Therefore, it is not surprising that none of the 1,325 Black Bullhead estimated to have been caught by anglers in 2012 were harvested. No fish larger than 185 mm were collected by fish surveys from 2005 - 2012. The only time larger fish were present was in the 2003 sample. Since no Black Bullhead were sampled or observed in the reservoir previous, to 2003, this likely indicates that these fish were illegally introduced just prior to the 2003 sample, and subsequently have become overpopulated and stunted.

Largemouth Bass:

Largemouth Bass were stocked in 2008 and 2009 in an effort to improve the stunted Black Bullhead and Yellow Perch populations observed during the 2005 survey(DuPont et al. 2011; Hand et al. 2012). However, with only three Largemouth Bass collected during the 2012 fish survey, and no small fish present to indicate successful recruitment, it appears these stockings were unsuccessful. The large numbers of small Black Bullhead and Yellow Perch in the reservoir likely made successful spawning and recruitment of Largemouth Bass nearly impossible due to predation and competition for food resources (Anderson and Weithman 1978; Guy and Willis 1991). This is common in small impoundments when predator:prey dynamics are out of balance with few predators to control the overcrowding of prey species (Aday and Graeb 2012).

Black Crappie:

Surveys in 2012 show the Black Crappie population continues to decline (Figure 134). The four fish collected in 2012 was the fewest for any sample conducted since 1994. This decline coincides with increasing Black Bullhead and Yellow Perch CPUE(Figure 134). This suggests that Black Crappie are being outcompeted by these other species for space and food resources. Poor, and highly variable recruitment is also likely an issue, as highly variable recruitment in crappie populations is common in smaller reservoirs (Beam 1983; McDonough and Buchanan 1991; Allen 1997). As with Largemouth Bass, the large numbers of small Black Bullhead and Yellow Perch in the reservoir likely made successful spawning and recruitment of Black Crappie nearly impossible due to predation and competition for food resources (Anderson and Weithman 1978; Guy and Willis 1991). This is common in small impoundments when predator:prey dynamics are out of balance with few predators to control the overcrowding of prey species (Aday and Graeb 2012). The annual drawdown of SMR occurs during late summer, which should not affect spawning of warm-water fish.

With only four fish collected in 2012, no age and growth, or mortality information could be developed from the 2012 sample. Black Crappie continue to be present in low numbers, but are not likely to provide much fishing opportunity.

<u>Creel Survey</u>

Angler Effort:

The year-long creel survey resulted in an estimated 6,049 hours of angler effort in 2012. This was the lowest of the four creel surveys conducted on the reservoir since 1993, and represents the third consecutive drop in effort since a high of 17,620 hours in 1993 (Figure 1). Angler effort declined in seven of the eight regional reservoirs (87.5%; Figure 1) that were surveyed in both 2005 and 2012. Additionally, three other reservoirs (Spring Valley Reservoir, Mann Lake, and Elk Creek Reservoir) have experienced steady declines in effort over all four creel surveys conducted since 1993.

There may be several reasons for the decline in effort seen in SMR. An actual decline in effort is, of course, the most likely reason. Declines in participation in outdoor recreation activities during the 1990's and early 2000's, including fishing and hunting, have been well documented (USFWS 2006; DFO 2007; Cordell et al. 2008; Sutton et al. 2009) as people have more and more choices competing for their free time. Studies (Felder and Ditton 2001; Sutton 2007; Sutton et al. 2009) have shown large percentages of anglers fish less often than they used to, primarily due to "work/family commitments" (46 - 75%) and "other leisure activities" (41 - 46%). Economic surveys conducted by IDFG in 2003 and 2011 (Table 2) show a similar trend, with most regional reservoirs (87.5%) experiencing declines in effort (total trips). However, there is data that contradicts these trends. Sales of fishing licenses in Idaho have shown an overall increasing trend from 1993 - 2012 (Appendix H). While this does not directly correlate to effort in a given lake, it does provide some evidence that participation in fishing in Idaho is not necessarily declining.

The declining fishery in SMR, lower level of angler satisfaction (compared to other reservoirs to insure this is the case), and degraded nature of the access site could also explain why effort has declined at this reservoir. As the quality of the fishery has declined, anglers would be less likely to return, especially if they continued to have poor fishing experiences.

It should be noted that the 2012 creel survey is likely more accurate than previous surveys, as it was conducted using more angler counts and interviews. Additionally, more appropriate creel survey and statistical analysis methods were incorporated in the study design. Previous creel surveys were conducted with minimal staff, and therefore effort/catch/harvest may be more biased due to small sample sizes of angler counts and interviews. Future surveys should employ similar strategies as we did during this survey to make results more comparable from year to year.

Catch and Harvest:

Harvest composition in 2012 consisting almost entirely of hatchery Rainbow Trout with other species accounting for 30.8% of the harvest (Figure 140). In 2005, angler preference had shifted somewhat from hatchery trout to other species due to the establishment of illegally introduced Yellow Perch, Black Bullhead, and Black Crappie. Species other than trout accounted for 26.6% of the harvest in 2005. The low harvest numbers of non-trout species in 2012 is likely due to the small average size of warm water fish in the reservoir, as average lengths for most species were well below the sizes preferred by anglers.

Angler exploitation rates estimated by creel surveys have declined from a high of 78.9% in 1993 to a low of 18.4% in 2012 (Appendix B). Considering the decline in angler effort, this is not surprising. Concurrently, there has been a decline in harvest rates for hatchery Rainbow Trout, from a high of 1.1 fish/hour in 1993 to a low of 0.4 fish/hour in 2012. These are concerning trends, as it indicates that not only are fewer anglers fishing at SMR, but those that do fish are less successful. Even with the declines in effort and exploitation rates for catchable Rainbow Trout, catch rates for each creel survey since 1993 have been above the management goal of >0.5 fish/hour. Observations made during creel surveys concluded that no Rainbow Trout stocked as fingerlings were harvested during creel surveys in 1999 - 2012. The failure of fingerling establishment in SMR is likely due to competition and predation from the overpopulation of Yellow Perch, Black Crappie, and Black Bullhead. Future fingerling stockings should be conducted only after a full reservoir renovation.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (55.9%) rated their fishing trip as Good or Excellent (Figure 143). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 58.3% of the responses. The most common reason given for a rating was “poor fishing” (42.3%), with the second most common reason being “good fishing” (21.2%). While the quality of fishing played the major role in one’s fishing experience, the most common other response was “nice to be outside” (14.1%). This indicates that an enjoyable fishing trip is not predicated solely upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as year-round fishing opportunities, improved access and on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself. However, the annual water fluctuations and frequent vandalism to current facilities at SMR should be taken into account before any additional improvements are made. The annual water drawdown greatly limits the use of boats on this reservoir, with water levels often dropping far enough by late August to render the boat ramp unusable. Extending the boat ramp and adding some docks could greatly improve angler access.

The combination of creel and fish population information points to a trend of stunted fish populations and a continuing decline in angler effort. Knowing that the fishery in SMR was declining, we asked anglers during the 2012 creel survey if they would support a renovation of the reservoir to remove the stunted fish (Figure 146). The majority (61%) supported this type of action to improve the fishery. However, anglers were split on the type of fishery they would prefer post-renovation. The majority preferred a two story fishery (52%), while a warm-water only fishery was the least popular at (22%). This was surprising, as IDFG personnel have fielded dozens of calls about this issue, with almost all of the callers preferring a warm-water only fishery. With the continued decline of angler effort and majority support for renovating the reservoir, we recommend that SMR be treated with rotenone to remove all fish. Angler opinions should then be collected to help direct future management of SMR.

Angler Exploitation

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) were utilized to evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate of stocked hatchery Rainbow Trout was 5.7% for the spring 2012 tagging event (Table 29). The estimated total use rate for 366 - 730 days at large was 0.8%. This is a good sign, as carryover increases the opportunity for angler to catch these fish and provides a more desirable product.

The total use rate through June, 2014 was therefore estimated to be 6.5% for the spring 2012 stocking (Appendix D). This estimate was below the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). Additionally, this estimate was below the IDFG management goal of a 40% total use rate for stocked hatchery Rainbow Trout (Appendix D). Tag returns from the spring 2012 (Figure 158) stocking show returns occurring steadily from May - October. This suggests that fish were able to survive throughout the summer and were available for the fall and winter fishery. However, with the exploitation rate in SMR well below the management goal and statewide average, we recommend reducing the annual rate and using IDFG "magnum" size catchable Rainbow Trout once they become available. These fish have been shown to return to creel at higher rates (Cassinelli 2014) than standard sized hatchery trout, likely due to angler preference for larger fish (Aday and Graeb 2012).

Comparing angler exploitation of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 5.7% while the creel survey estimated it to be 18.4%. Differences in angler exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Limnology

Based on the IDFG standards for temperature and DO thresholds (Horton 1992), the volume of water available for Rainbow Trout to survive was reduced to 24.7% in July, 2012 (Figure 150). Even with this reduction, there was suitable habitat available for trout were able to survive through the summer. An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion. This would be a concern for potential fall stocking of catchable trout in SMR, as fall turnover can reduce the dissolved oxygen levels of the reservoir to <5.0 mg/L needed for Rainbow Trout. This situation occurred during October of 2012. This was the first time this has happened since sampling began in 2005. To avoid potential fish kills, any fall stockings should be conducted once DO levels rise above 5.0mg/L after fall turnover.

Zooplankton

Larger sized zooplankton species, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987). The zooplankton community in SMR was dominated by Cyclopoida, Bosmina, and Ceriodaphnia in 2012, indicating the presence of a smaller, less desirable viable food source. In 2012, Daphnia collected averaged 1.0 mm in length, and Cyclopoida averaged 0.6 mm in length (Figure 153). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Additionally, up to 25.0% of Daphnia and no Cyclopoids were at or above preferred size (Figures 151 and 152) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 48.3% of the Daphnia population and 5.2% of the Cyclopoida population were ≥1.0 mm in length. This indicates that there is some food available for hatchery Rainbow Trout to eat.

The ZQI for ECR, which is a measure of both abundance and size, was 0.00 (Appendix E). ZQI values <0.1 are considered low and indicate that zooplankton resources are limiting and may potentially impact trout populations (Teuscher 1999). This sampling also indicated that zooplankton biomass was high. The data suggests that larger zooplankton individuals are being cropped off by late summer. We may need to reduce the number of planktivores in SMR to allow for more forage opportunities. This could be accomplished through reduced stocking rates of hatchery Rainbow Trout, or reducing the numbers of Yellow Perch, Black Bullhead, and Black Crappie through a renovation project.

If a reservoir renovation is conducted, additional zooplankton surveys should be conducted post-renovation to compare community size and composition to pre-renovation metrics. This could provide some insight into the potential for successful fingerling stockings, and the effects of stunted fish populations on a zooplankton community. Without an improvement in the quantity of large zooplankton, it would be difficult to implement a successful fingerling Rainbow Trout fishery. These fish need an adequate food source to survive in the reservoir long enough (at least 1 - 2 years) to enter the fishery.

Aquatic Vegetation

With only 16% of sample sites containing vegetation and 3% of sites affecting fishing (based on DFI), vegetation in SMR is not generally an issue for either fisheries management or recreational use of the reservoir. The few sites that contained vegetation were all shoreline sites located in the shallow upper arms of the reservoir where there is little access or angling effort. While aquatic vegetation is not currently an issue in SMR, visual monitoring of the vegetation levels should continue to ensure that coverage does not increase. However, the large annual water drawdowns that currently occur in SMR should reduce the opportunity for nuisance species to become problematic.

MANAGEMENT RECOMMENDATIONS

1. Conduct future fish surveys with six 10-minute electrofishing samples.

2. Discontinue fingerling Rainbow Trout stocking until the reservoir is chemically treated to remove stunted populations of Yellow Perch, Black Bullhead, and Black Crappie.

3. Scope angler opinions on the future management of the SMR fishery.

4. Utilize an upper thermal limit of 25°C for Rainbow Trout when evaluating volume of reservoir available for trout.

Table 26. Number of fish collected by species in each 10-minute electrofishing sample conducted during a fisheries survey of Soldier's Meadow Reservoir, Idaho, in 2012, and the estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 95% confidence and 25% precision.

	Count of fish collected									
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Largemouth Bass	0	2	0	1	0	0	3	0.5	0.8	122
Black Crappie	0	2	1	0	0	0	3	0.5	0.8	122
Yellow Perch	50	15	15	0	0	0	80	13.3	19.4	92
Brown Bullhead	37	18	4	8	3	7	77	12.8	13.0	45
Total	87	37	20	9	3	7	163	27.2	31.8	60

Table 27. Back-calculated length-at-age of Yellow Perch collected through electrofishing in Soldier's Meadow Reservoir, Idaho in 2012.

Year			Back-calculated length (mm) at each annulus					
Class	Age	n	1	2	3	4	5	6
2011	1	2	55					
2010	2	42	58	106				
2009	3	35	58	102	134			
2008	4	0	0	0	0	0		
2007	5	0	0	0	0	0	0	
2006	6	1	52	78	114	137	162	175
n		80	80	78	36	1	1	1
Length at Age			58	104	133	137	162	175

Table 28. Summary of angler effort (hours) as determined through a creel survey conducted on Soldier's Meadow Reservoir, Idaho, from November 28, 2011 to November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	total shore	total boat	Total effort	Standard error	Percent error
December	0	0	0	0	26	0	0	26	26	0	0	26	26	100
January	0	0	0	0	61	0	0	61	61	0	0	61	23	37
February	0	0	0	0	45	0	0	45	45	0	0	45	32	71
March	0	0	0	0	13	13	0	26	13	13	0	26	20	77
April	0	0	0	0	0	0	0	0	0	0	0	0	0	--
May	0	264	44	308	0	274	86	360	0	538	130	668	244	37
June	0	693	0	693	0	845	158	1,002	0	1,538	158	1,695	338	20
July	0	622	343	964	0	998	181	1,179	0	1,620	524	2,144	411	19
August	0	697	0	697	0	91	121	212	0	788	121	909	316	35
September	0	0	171	171	0	178	89	267	0	178	260	438	229	52
October	0	0	0	0	0	0	0	0	0	0	0	0	0	--
November	0	36	0	36	0	0	0	0	0	36	0	36	36	100
Totals	0	2,312	558	2,870	145	2,398	636	3,179	145	4,710	1,194	6,049	706	12

Table 29. Angler exploitation (based on angler tag returns) of hatchery catchable size Rainbow Trout stocked in Soldier's Meadow Reservoir, Idaho, in 2012, through 365 days post-stocking. Total use = fish harvested + fish released.

				Disposition			Adjusted exploitation		Adjusted total use	
Hatchery	Tagging date	Treatment	Tags released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Hagerman	5/15/2012	Hayspur 3N	200	2	0	0	2.8%	2.6%	2.8%	2.6%
		Troutlodge 3N	200	6	0	0	8.5%	4.6%	8.5%	4.6%
Average							5.7%	3.6%	5.7%	3.6%

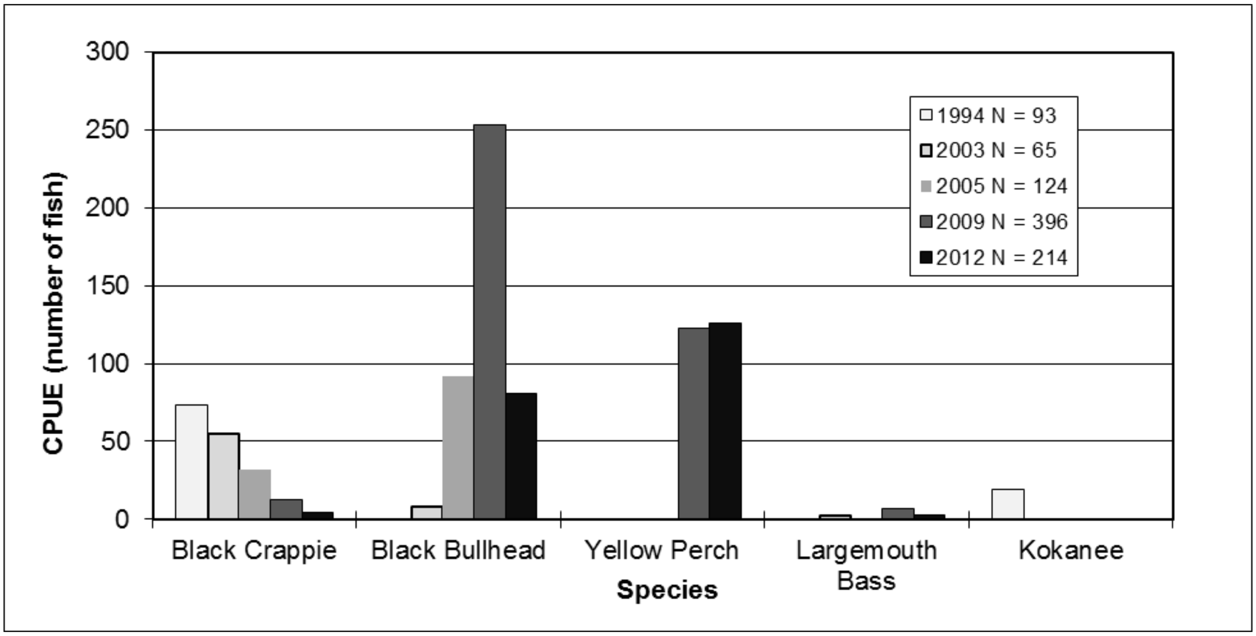


Figure 134. Catch per unit effort (CPUE; number of fish/hour) of fishes collected through electrofishing in Soldier's Meadow Reservoir, Idaho, from 1994 - 2012.

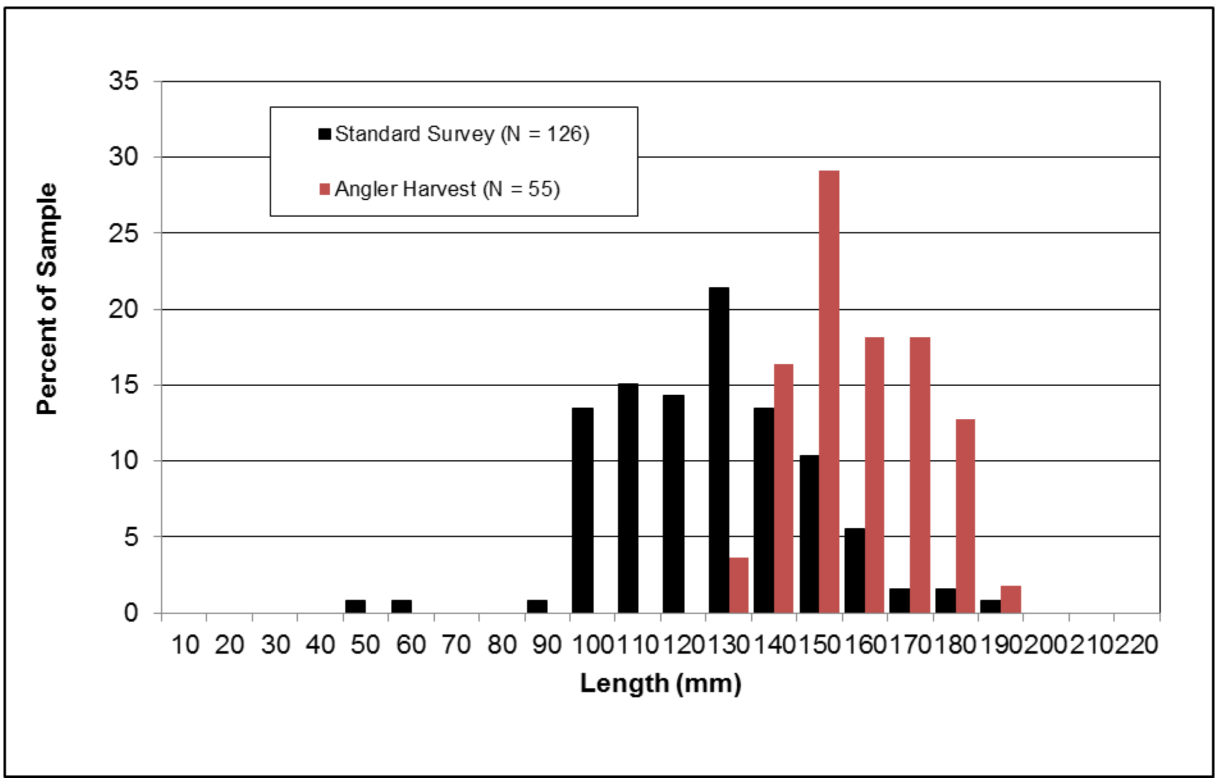


Figure 135. Comparison of Yellow Perch length frequency distributions from fishes collected through electrofishing and by anglers in Soldier's Meadow Reservoir, Idaho, in 2012.

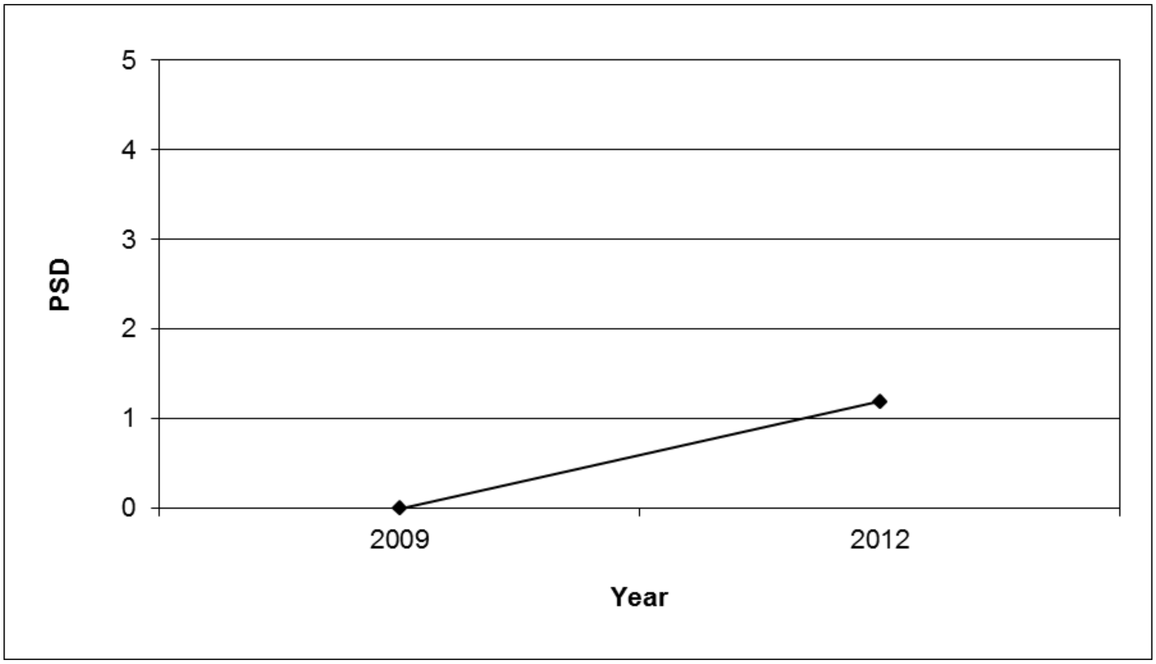


Figure 136. Proportional Size Distribution (PSD) values of Yellow Perch collected through electrofishing in Soldier's Meadow Reservoir, Idaho, from 2009 - 2012. Yellow Perch were likely introduced into Soldier's Meadow Reservoir around 2006.

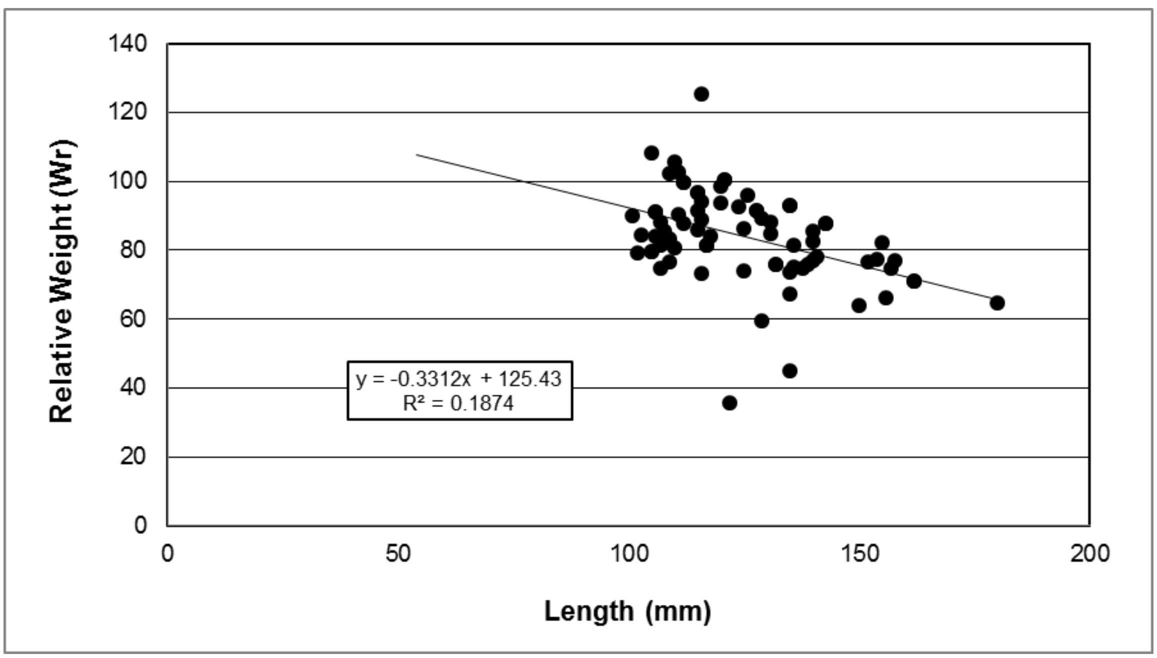


Figure 137. Relative weight (Wr) values of Yellow Perch collected through electrofishing in Soldier's Meadow Reservoir, Idaho, in 2012.

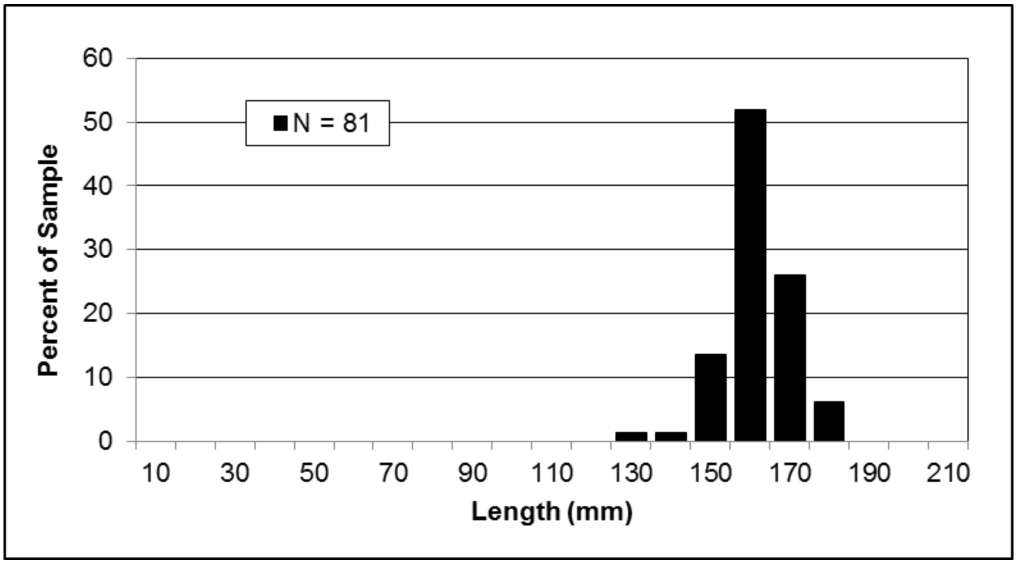


Figure 138. Length frequency distribution of Black Bullhead collected through electrofishing in Soldier's Meadow Reservoir, Idaho, in 2012.

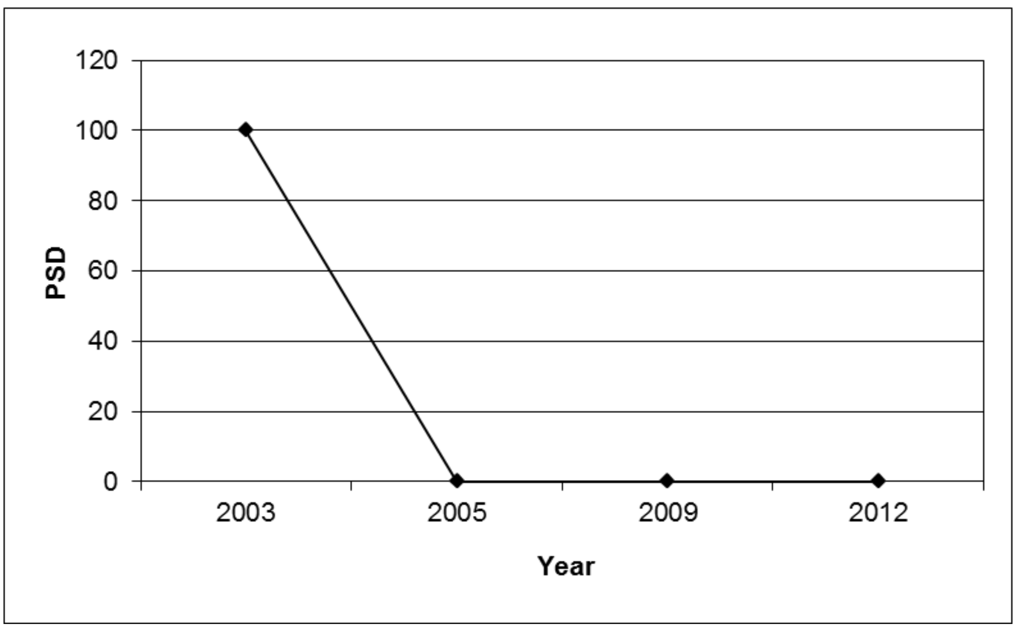


Figure 139. Proportional Size Distribution (PSD) values of Black Bullhead collected through electrofishing in Soldier's Meadow Reservoir, Idaho, from 2003 - 2012.

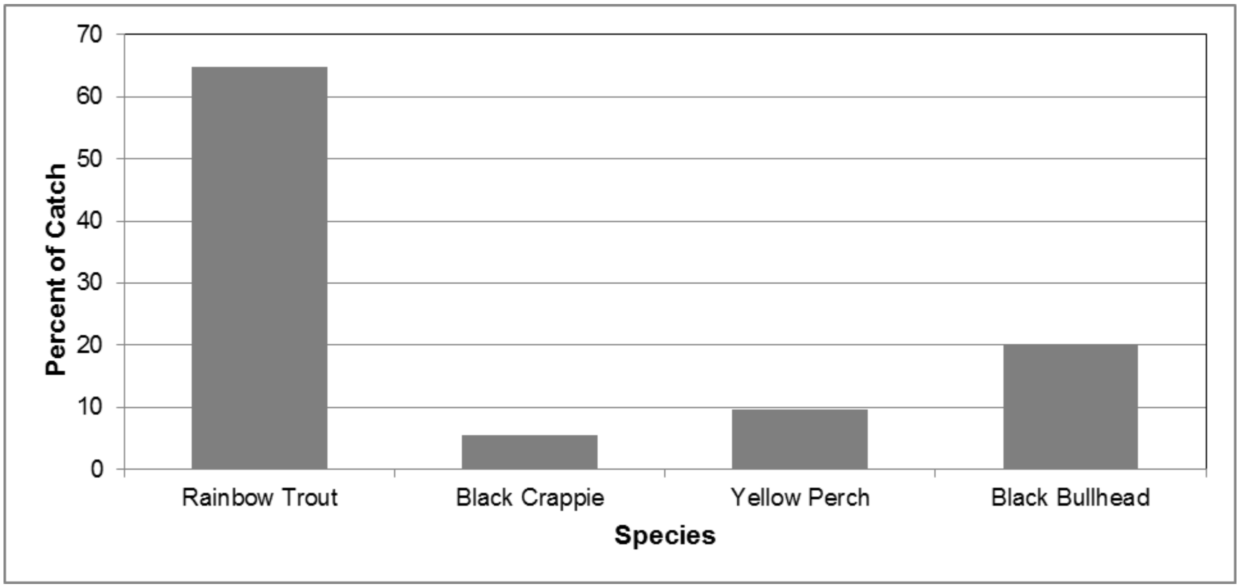


Figure 140. Composition of fishes caught in Soldier's Meadow Reservoir, Idaho, as estimated by a creel survey conducted from November 28, 2011 to Nov 28, 2012.

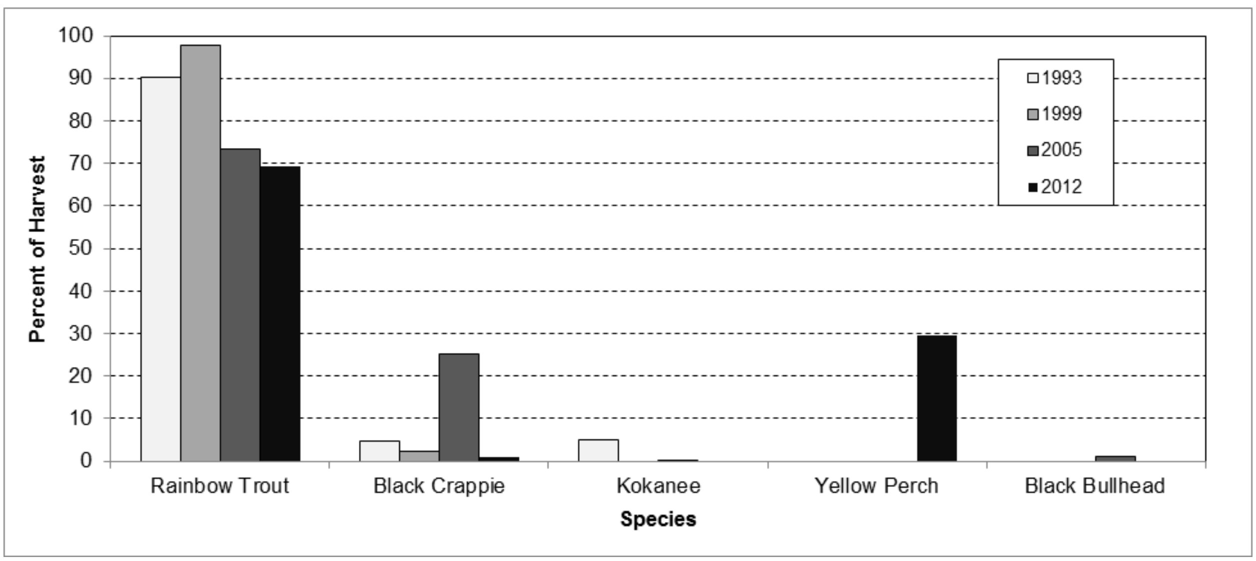


Figure 141. Composition of fishes harvested during creel surveys conducted at Soldier's Meadow Reservoir, Idaho, from 1993 - 2012.

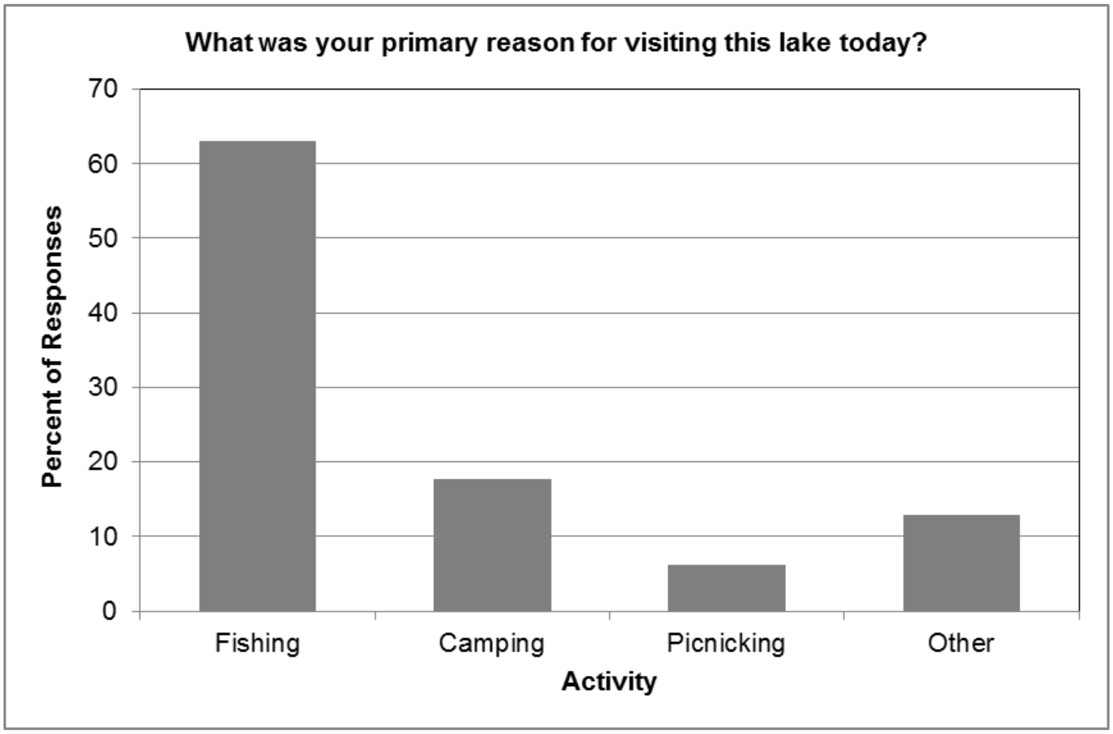


Figure 142. Summary of angler responses to the primary reason for visiting Soldier's Meadow Reservoir, Idaho, collected during a creel survey conducted from November 28, 2011 to November 28, 2012.

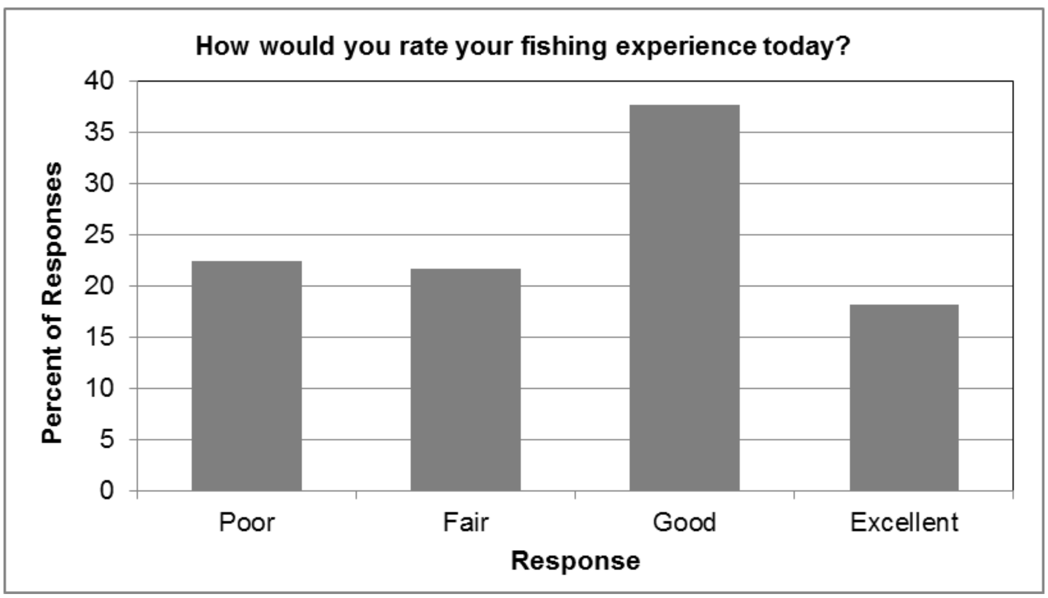


Figure 143. A Summary of angler responses regarding their overall fishing experience at Soldier's Meadow Reservoir, Idaho, collected during a creel survey conducted from November 28, 2011 to November 28, 2012.

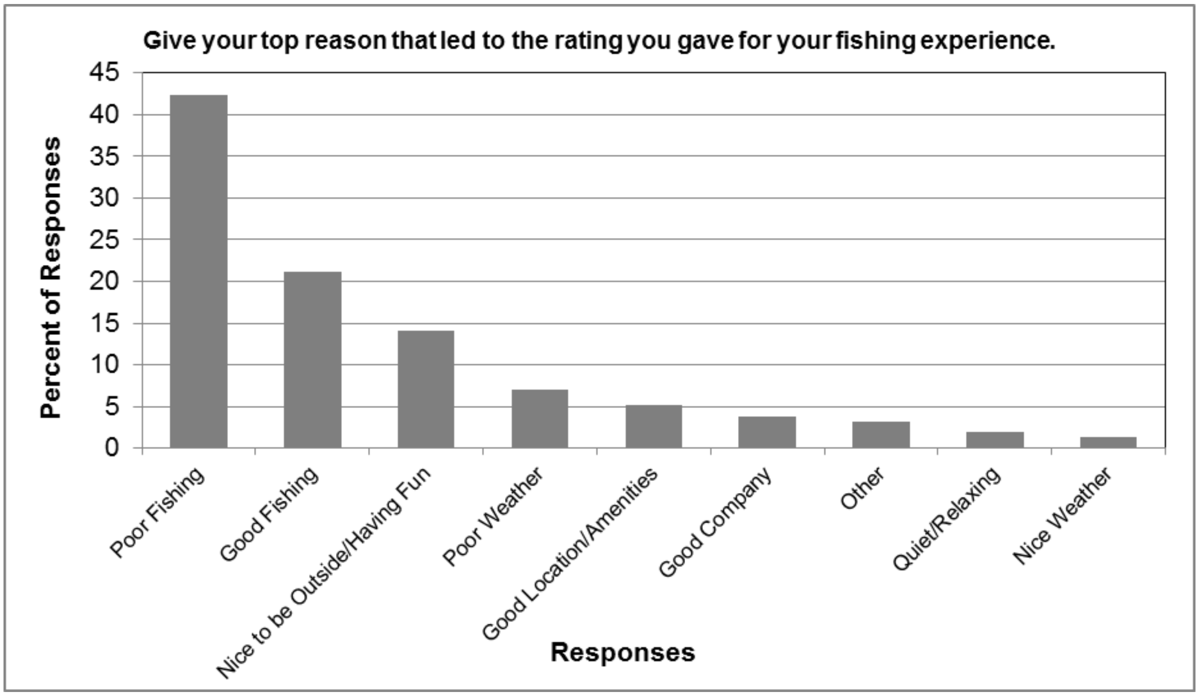


Figure 144. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day when fishing at Soldier's Meadow Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

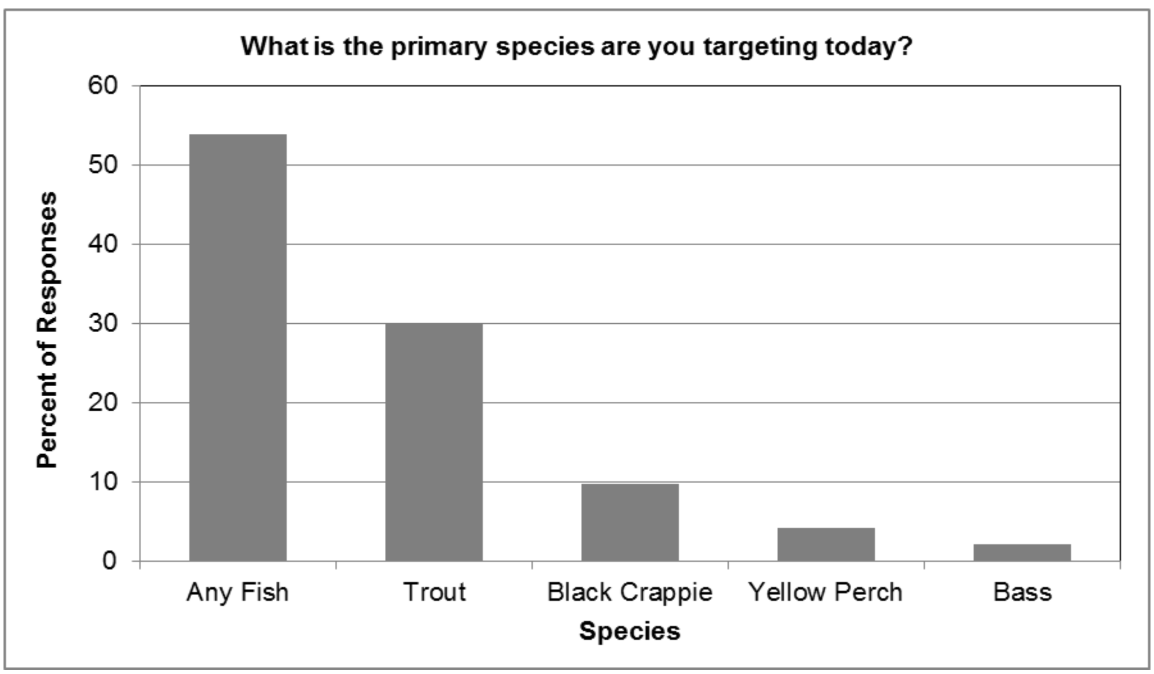


Figure 145. A summary of angler responses regarding target fish species at Soldier's Meadow Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

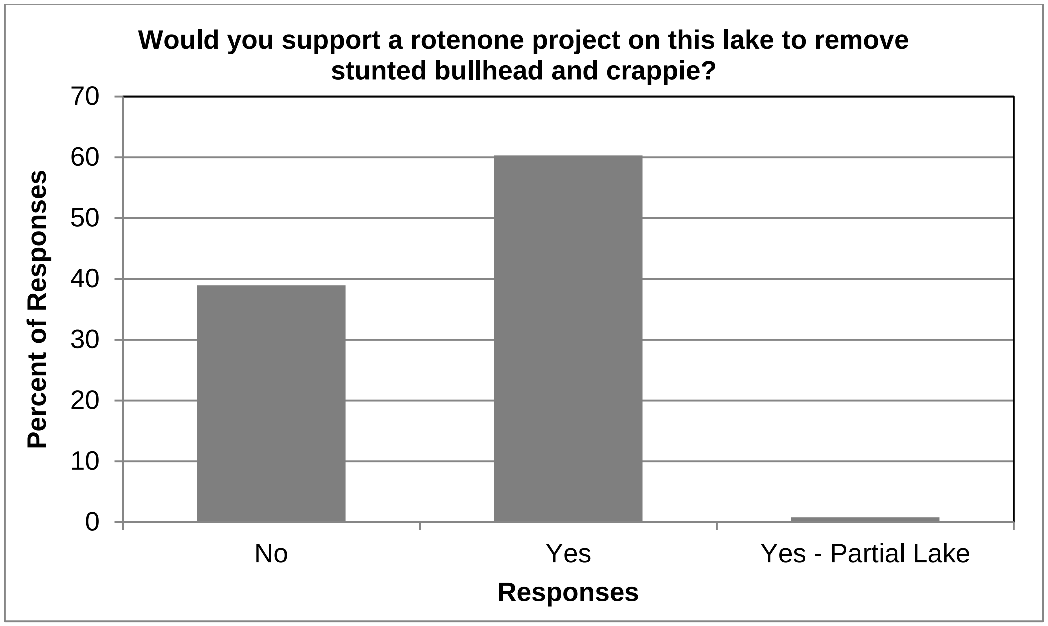


Figure 146. Summary of angler responses regarding the possibility of renovating Soldier's Meadow Reservoir, Idaho, with Rotenone to remove stunted Black Crappie and Black Bullhead, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

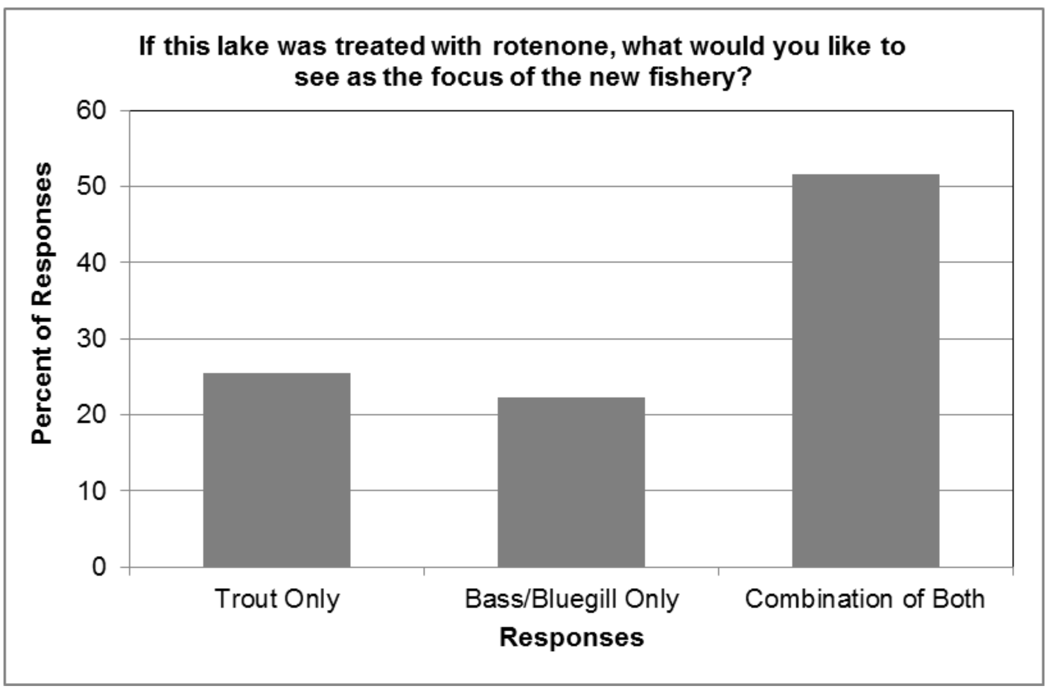


Figure 147. Summary of angler responses regarding the type of fishery preferred for Soldier's Meadow Reservoir, Idaho, after a potential renovation with Rotenone to remove stunted Black Crappie and Black Bullhead, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

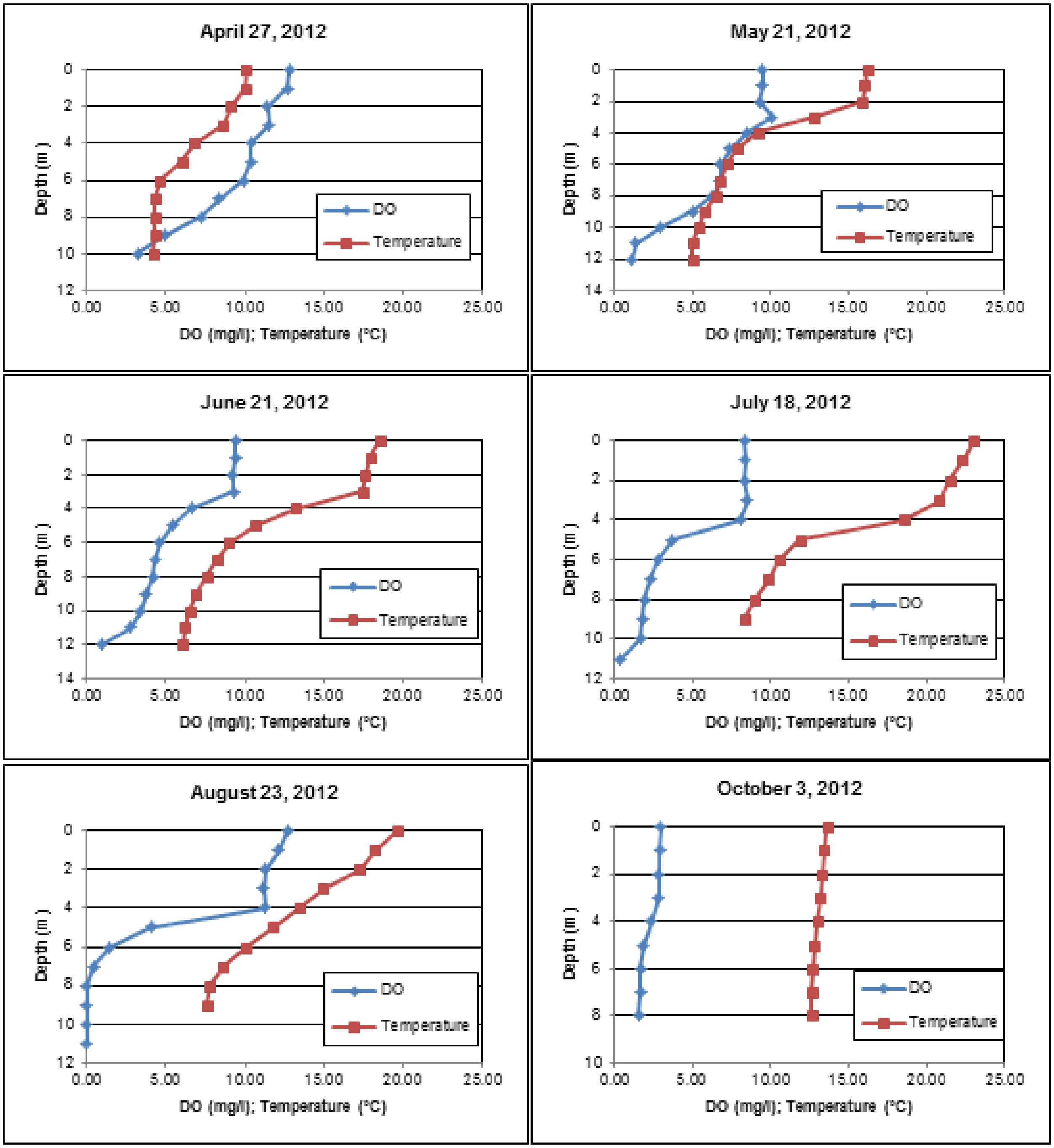


Figure 148. Dissolved oxygen (DO) and temperature profiles collected in Soldier's Meadow Reservoir, Idaho, during 2012.

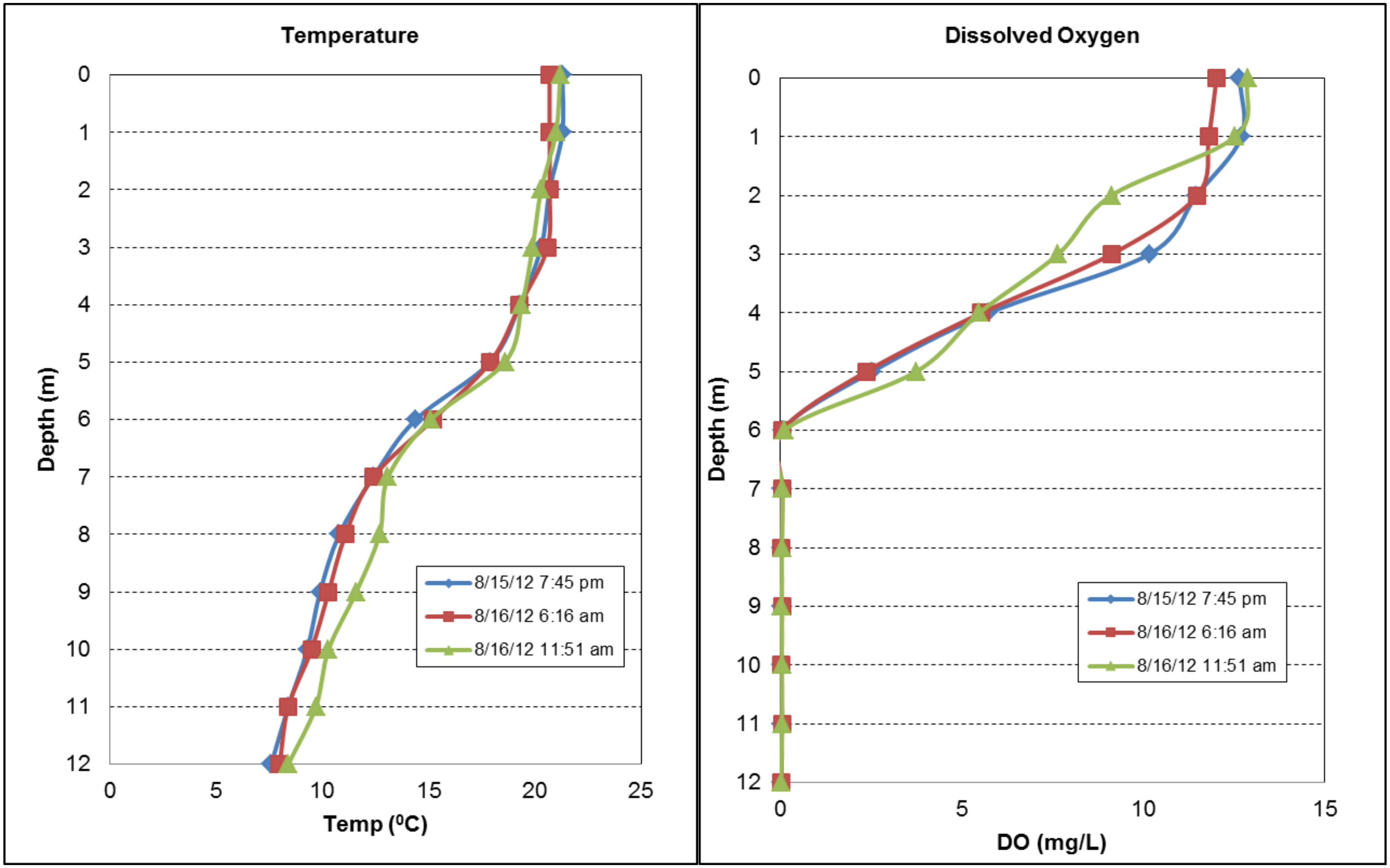


Figure 149. Diel changes in temperature and dissolved oxygen (DO) in Soldier's Meadow Reservoir, Idaho, in August 15 - 16, 2012.

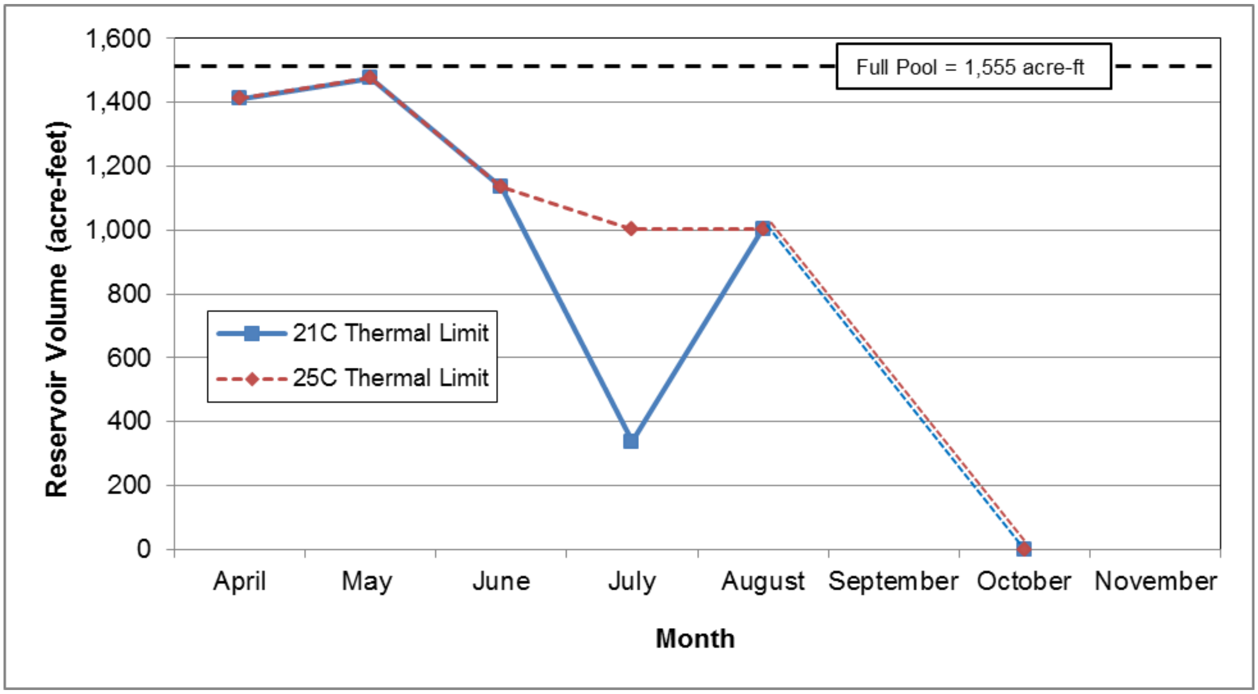


Figure 150. Estimated trout habitat available in Soldier's Meadow Reservoir, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit and upper thermal limits of 21°C and 25°C.

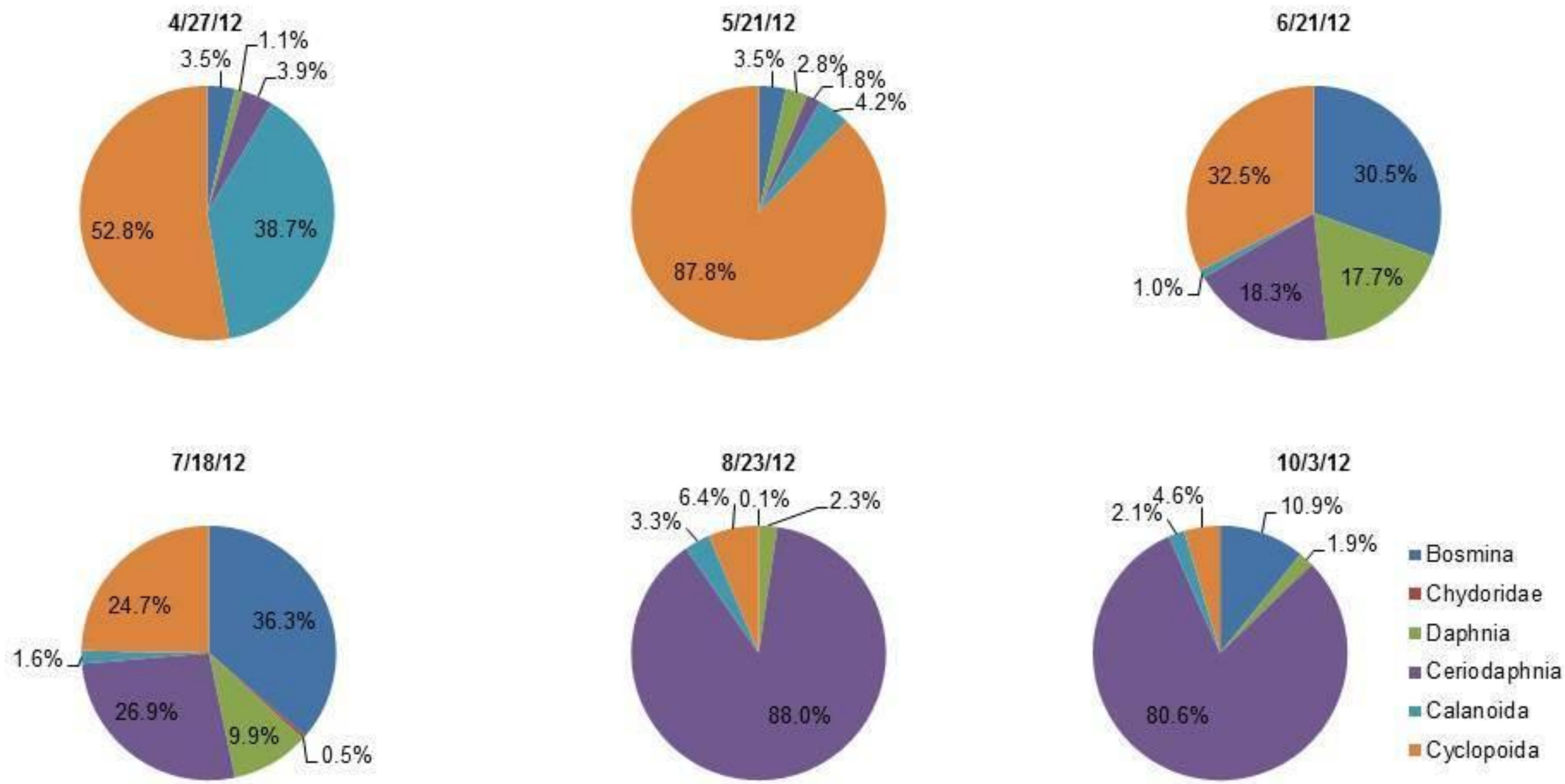
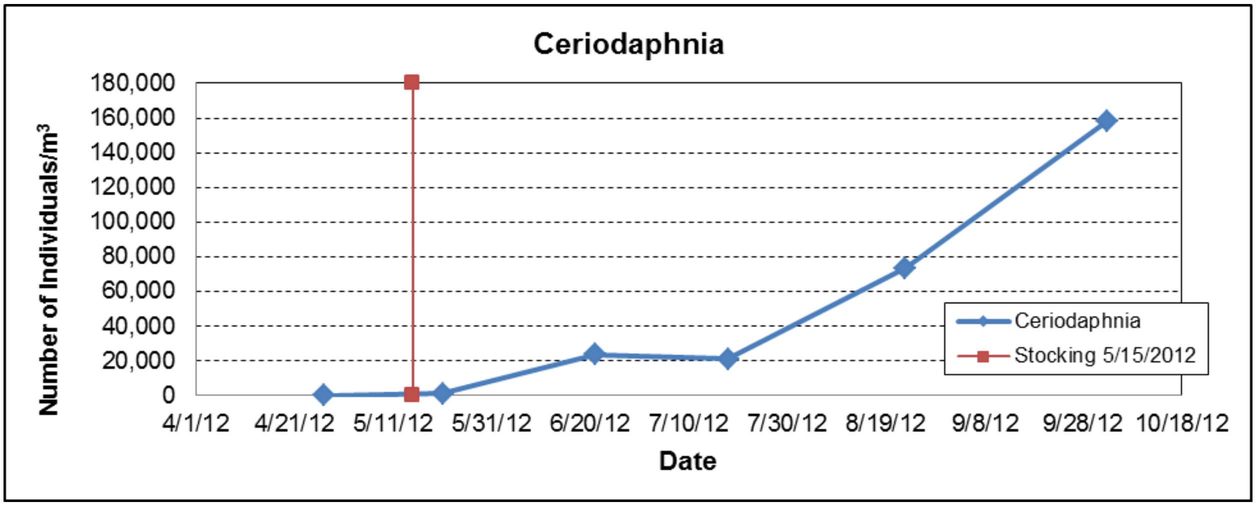
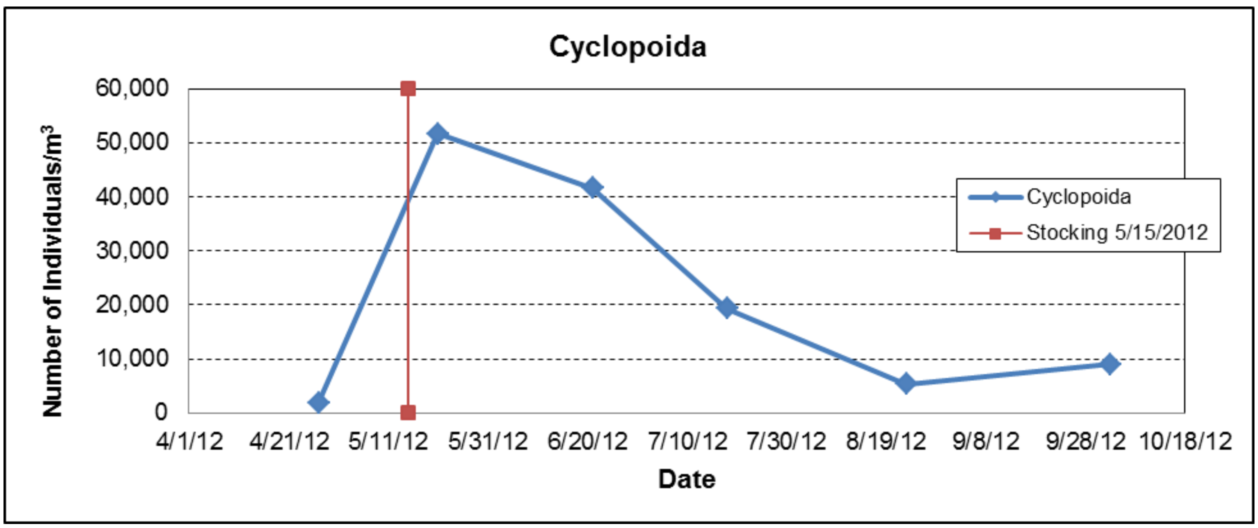


Figure 151. Zooplankton community composition based on monthly samples collected in Soldier's Meadow Reservoir, Idaho, during 2012.





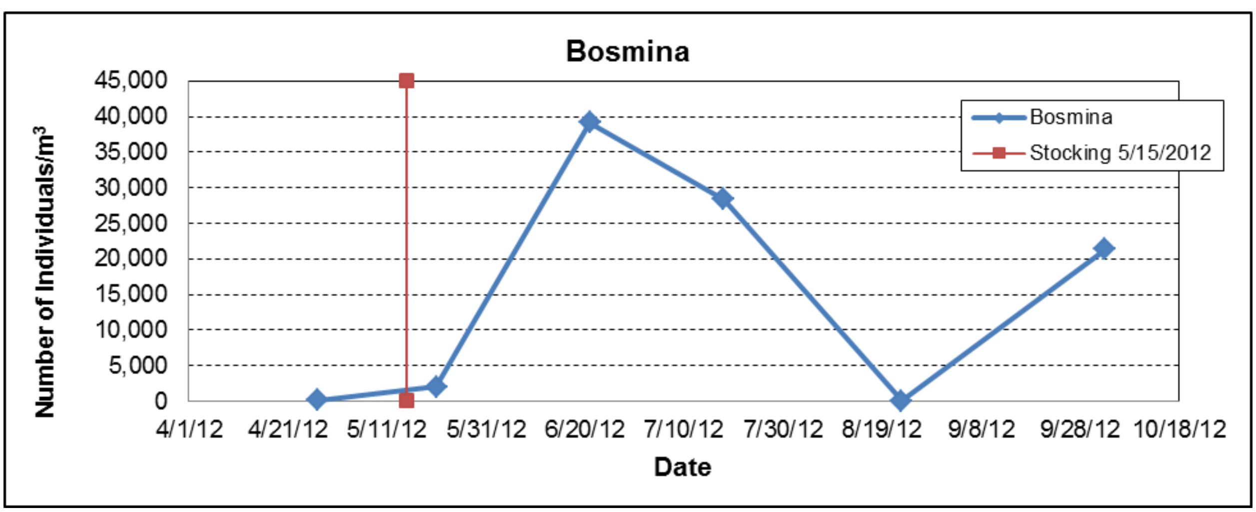
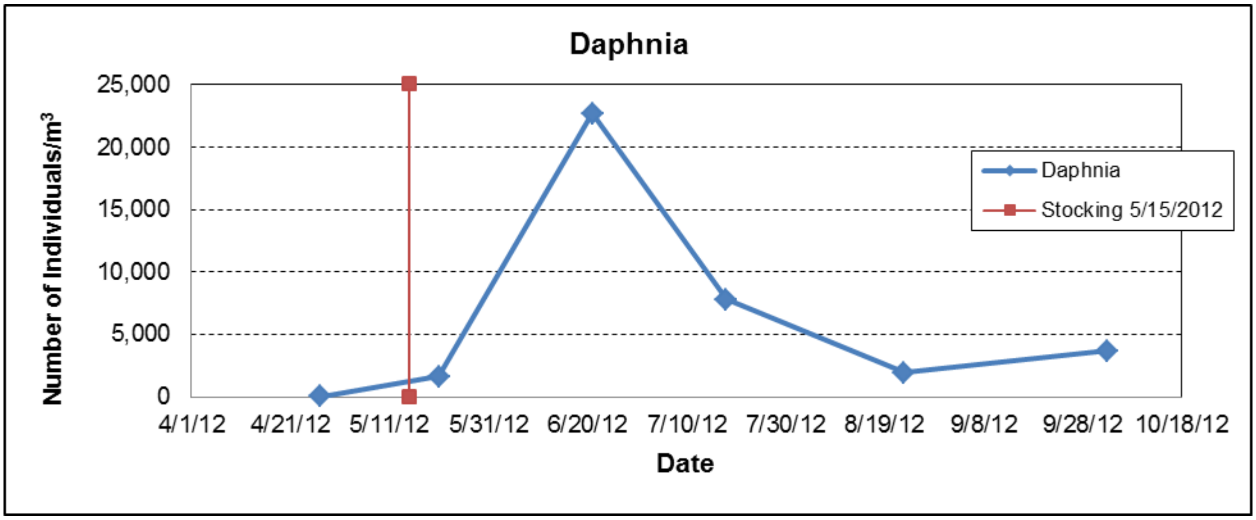
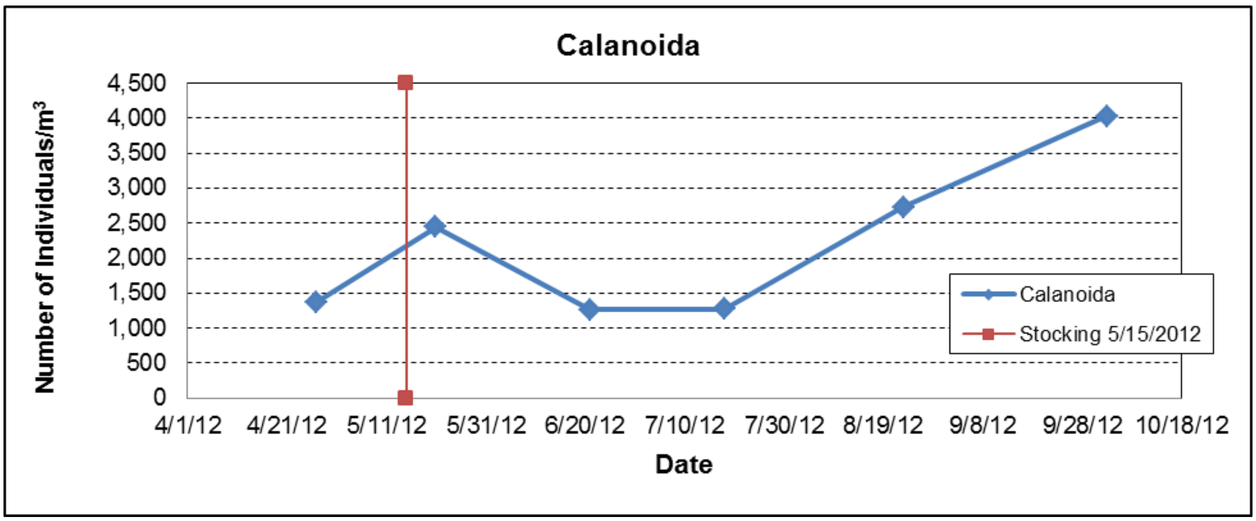


Figure 152. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Soldier's Meadow Reservoir, Idaho, in 2012.





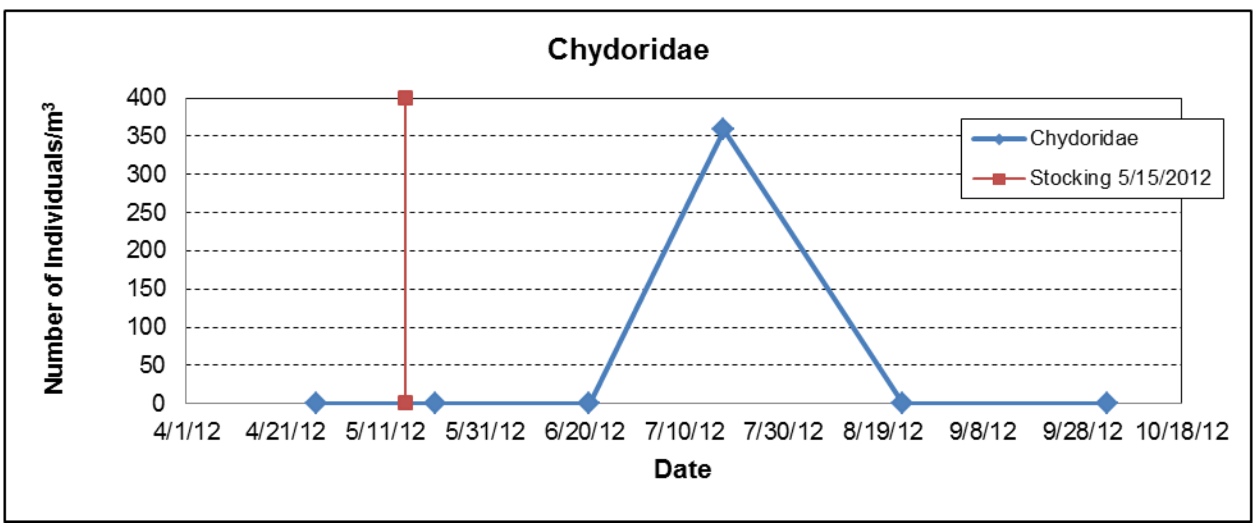
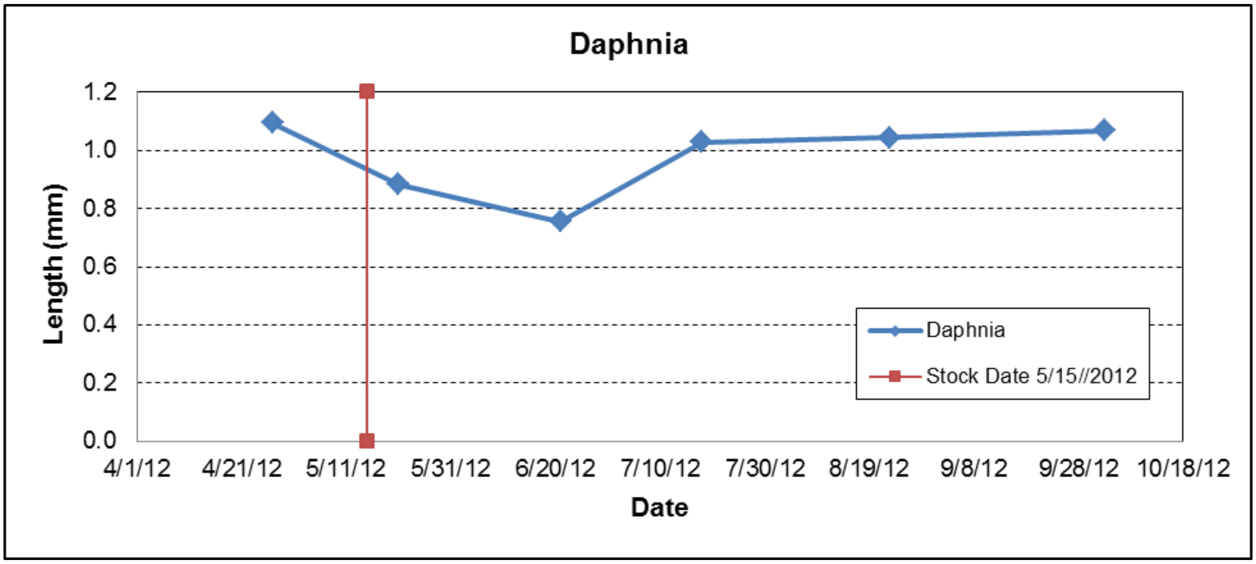


Figure 152. Continued



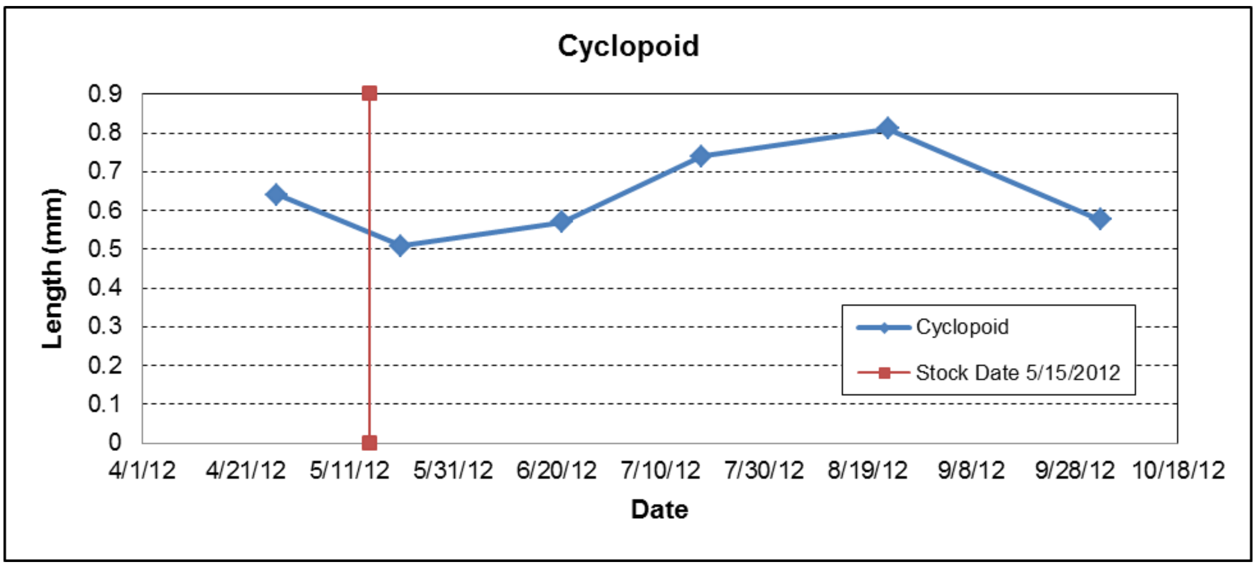


Figure 153. Average length (mm) of zooplankton collected from monthly samples in Soldier's Meadow Reservoir, Idaho, in 2012.

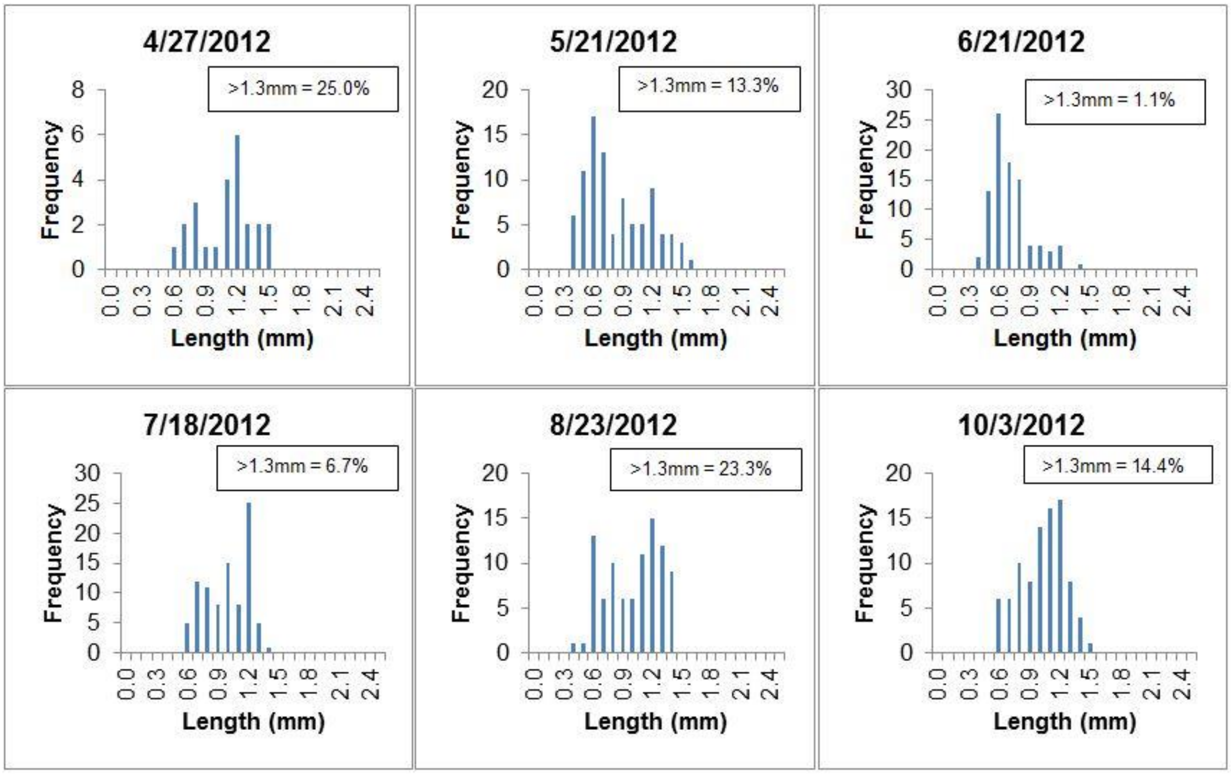


Figure 154. Length frequency distributions of Daphnia collected from monthly sampling in Soldier's Meadow Reservoir, Idaho, in 2012.

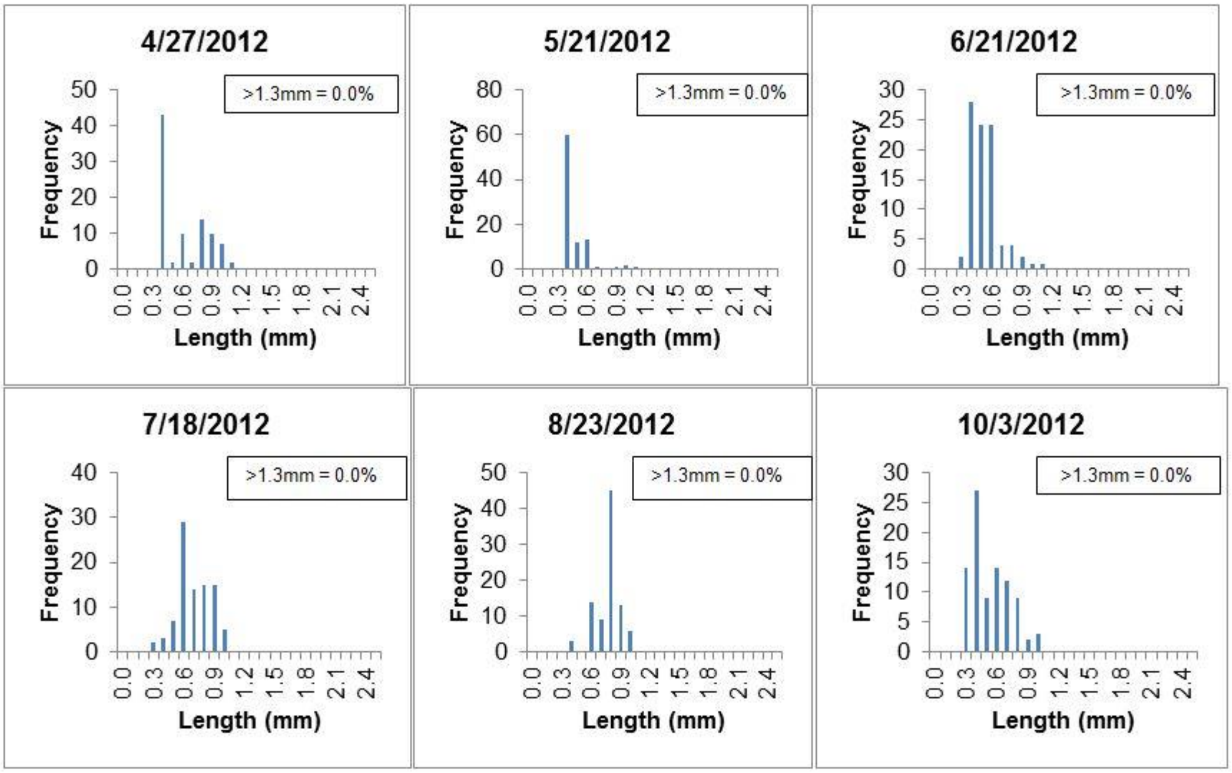


Figure 155. Length frequency distributions of Cyclopoida collected from monthly sampling in Soldier's Meadow Reservoir, Idaho, in 2012.

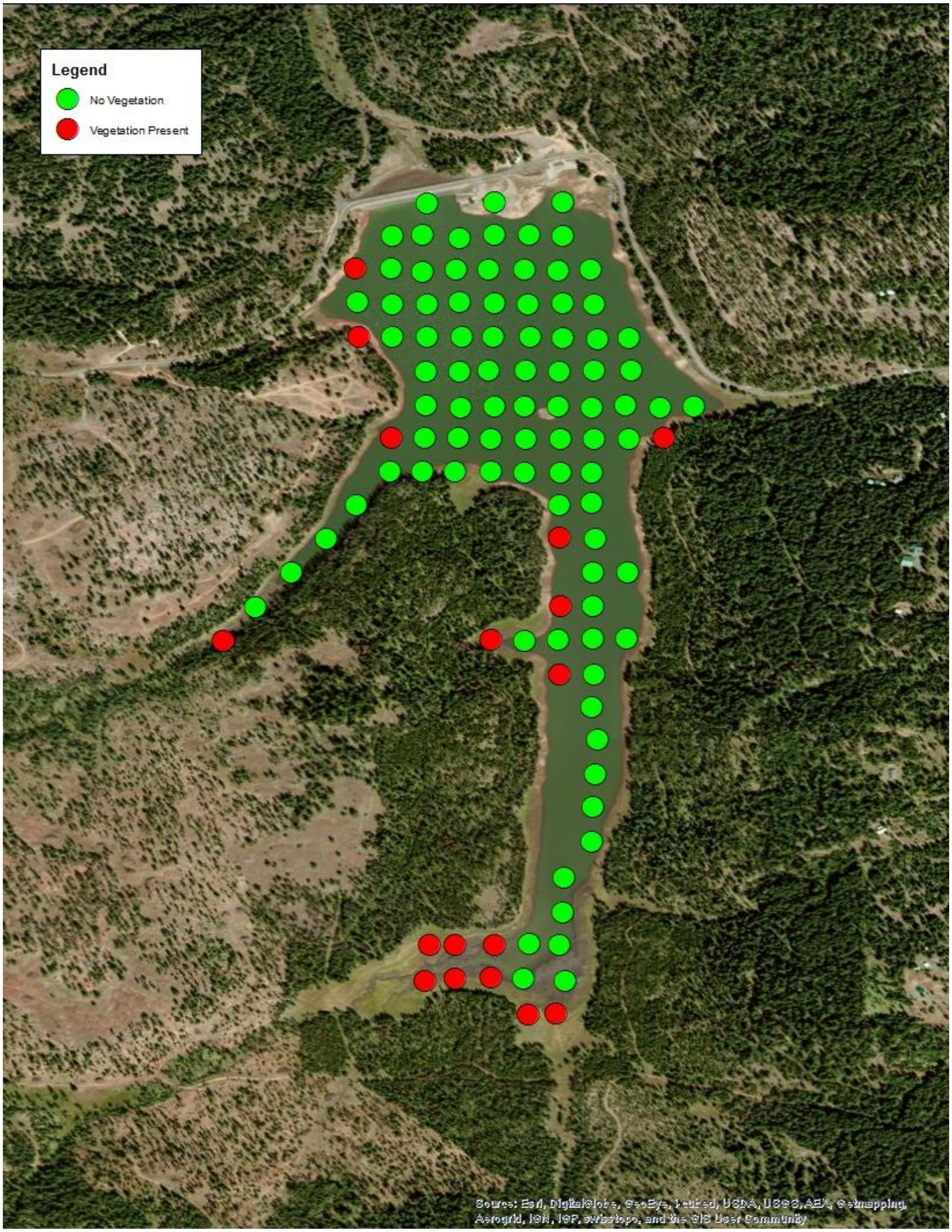


Figure 156. Locations where aquatic vegetation was collected during vegetation sampling of Soldier's Meadow Reservoir, Idaho, during 2012.

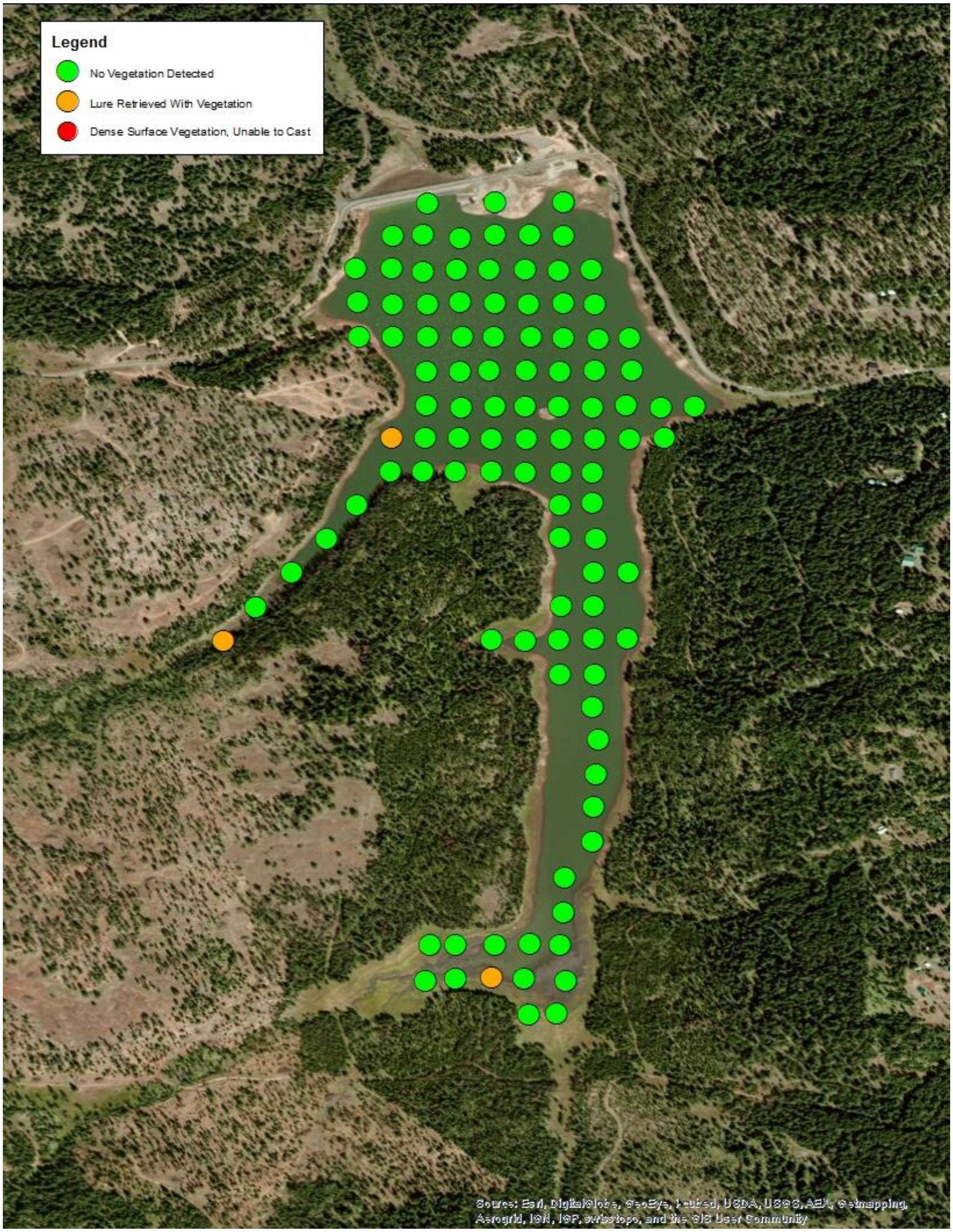


Figure 157. Fishability (using Davids' Fishability Index) at set locations in Soldiers Meadow Reservoir, Idaho, during 2012.

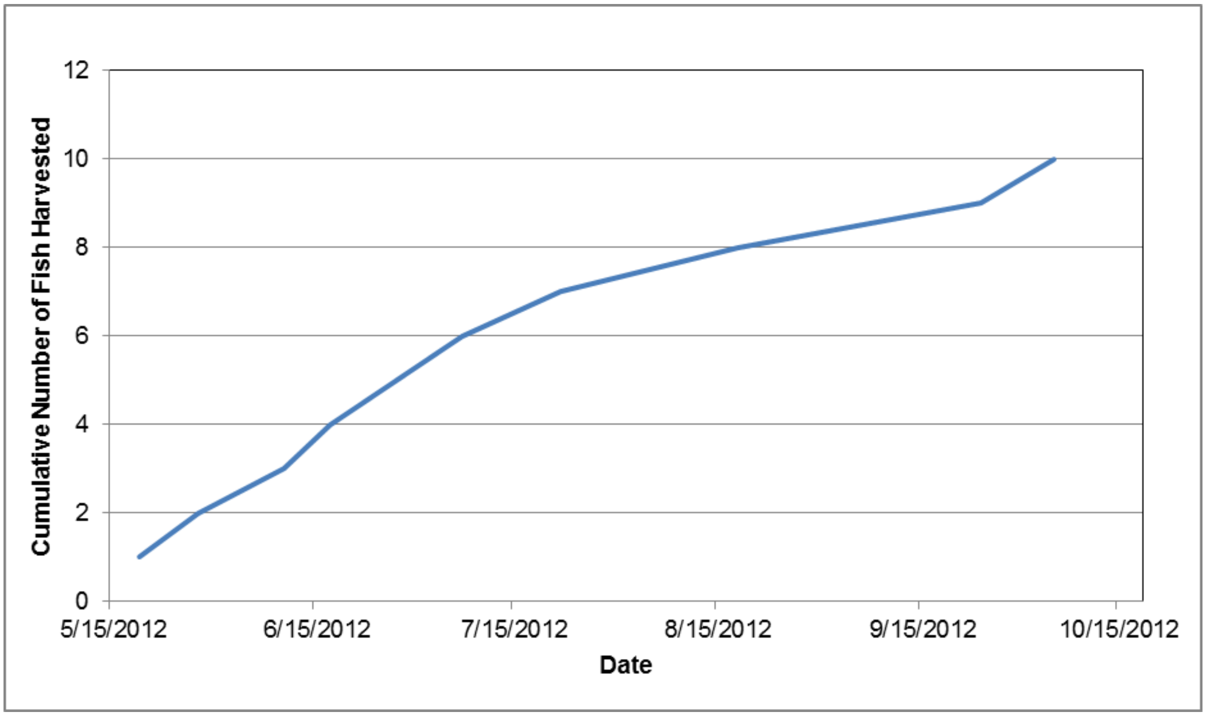


Figure 158. Cumulative number of hatchery catchable Rainbow Trout harvested from Soldier's Meadow Reservoir, Idaho, after May 15th, 2012 stocking, based on angler tag returns (400 fish tagged).

SPORTFISH ASSESSMENT OF SPRING VALLEY RESERVOIR

ABSTRACT

In 2012, a comprehensive assessment of Spring Valley Reservoir was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 940 fish including Bluegill, Largemouth Bass, Pumpkinseed, Black Bullhead, Black Crappie, and Channel Catfish. The results of this survey indicate that the Largemouth Bass fishery continues to be dominated by relatively small fish. The prey population is characterized by an abundance of quality sized Bluegill. Due to the increase in harvest of Largemouth Bass, we recommend the implementation of restrictive regulations to improve the size structure of this population.

Creel surveys estimated angler effort at 27,129 hours. This was the lowest of the four creel surveys conducted on the reservoir since 1993. Angler effort declined in seven of the eight regional reservoirs surveyed in both 2005 and 2012. This decline may be a result of the declines in participation in outdoor recreation activities during the 1990's and early 2000's. However, these changes may also be the result of improvements in the accuracy of our creel survey methodology from 2005 to 2012. The angler catch rate for all fish species combined was estimated at 1.4 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 0.8 fish/hour, above the statewide management goal of >0.5 fish caught/hour.

Changes in stocking abundance and timing of catchable size Rainbow Trout are not recommended in ECR, as angler catch rates for hatchery Rainbow Trout have met our management goal of >0.5 fish caught/hour for each creel survey since 1993. Additionally, total use (fish caught + fish harvested) on average exceeds the statewide management goal of 40% for hatchery catchable Rainbow Trout. However, we do recommend the elimination of fingerling Rainbow Trout stockings.

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INTRODUCTION

Spring Valley Reservoir (SVR) is a high use fishery located within the northern portion of the Clearwater Region. It is an important fishery in the lowland lake program given its close proximity to local population bases and maintaining high catch rates and angler satisfaction is imperative.. Spring Valley Reservoir is approximately 29 km from Moscow, ID (pop. 24,080) and 44 km from Pullman, WA (pop. 29,913). Spring Valley Reservoir is the closest public fishery to both of these major population centers and receives high levels of angler effort for that reason. Also, given the reservoirs close proximity to Pullman, WA, non-resident angling effort is likely higher than many of our other regional lowland lakes. Estimated non-resident angling effort on a normal fishing day is about 20% based upon enforcement checks (Barry Cummings, personal communication). An economic survey conducted in 2011 estimated anglers took 10,507 trips to Spring Valley Reservoir for an estimated total economic expenditure of $382,791 over a one year period (IDFG unpublished data).

Spring Valley Reservoir is largely targeted by anglers participating in its put-and-take hatchery Rainbow Trout fishery. A previous creel survey in 2005 estimated 65% of fish harvested in SVR were hatchery Rainbow Trout (Hand 2009). However, SVR also has a significant warm-water fishery component of Largemouth Bass, Black Crappie, Bluegill, Pumpkinseed, Black Bullhead and tiger muskellunge *Esox masquinongy x Esox lucius*. The remaining 35% of fish harvest during the 2005 creel was attributed to these species (Hand 2009).

Data from the 2012 surveys was intended to assess the current put-and-take hatchery catchable program, provide insights on how to potentially increase holdover capabilities for stocked Rainbow Trout, and increase the quality of the warm-water fishery.

Current Management

Spring Valley Reservoir is a mixed fishery, containing both cold-water and warm-water species. It is managed as a put-and-take trout fishery with catchable Rainbow Trout stocked annually to maintain a catch rate of >0.5 fish/hour, and for yield fisheries for Black Crappie and Bluegill (IDFG 2013). Additionally, 40,000 finglerling Rainbow Trout are stocked each year. Tiger muskellunge are stocked periodically to provide an additional trophy fishing opportunity. The reservoir is managed as a family friendly fishing water with simplified regulations including year round seasons, no length limits (except tiger muskellunge), general six fish limit for trout and bass, no creel limits for other species (except tiger muskellunge), and no restrictions on fishing gear. Boat activity on Spring Valley Reservoir is restricted to electric motors only. The current management priority is to provide a desirable fishing experience for a wide diversity of anglers.

Reservoir Management Goals

1. Maintain catch rate of >0.5 fish/hour for hatchery Rainbow Trout.

2. Maintain a Largemouth Bass fishery, and yield fisheries for Bluegill and Black Crappie.

3. Diversify fishery with periodic stockings of tiger muskellunge.

4. Manage aquatic vegetation as needed to improve fishing and angler effort.

STUDY SITE

Spring Valley Reservoir is a 19.8 hectare reservoir located in Latah County approximately 13 km east of Troy, Idaho at an elevation of 726 meters. It has a mean depth of 3.6 meters, a maximum depth of 8.8 meters, and a maximum volume of 735 acre-ft. The reservoir is eutrophic and prone to algal blooms in the late summer. The surrounding watershed is dominated by timberlands with some limited agricultural areas above the reservoir. Spring Valley Reservoir was originally constructed in 1961 by IDFG to create a recreational fishery. In 1993, the spillway was reconfigured to meet the dam safety specifications of the Idaho Department of Water Resources. Facilities at the reservoir include a boat ramp, picnic pavilion, vault toilets, numerous ADA accessible fishing docks, and primitive camp sites.

RESULTS

Population Survey

A fishery survey was performed on SVR June 13, 2012. Six 10-minute electrofishing periods were conducted on the reservoir for a total of 3,600 seconds of electrofishing effort. The electrofishing and one overnight trap net set resulted in the capture of 940 fish including Bluegill (n = 722), Largemouth Bass (n = 91), Pumpkinseed (n = 55), Black Bullhead (n = 44), Black Crappie (n = 13), and Channel Catfish (n = 1). The electrofishing catch rate was 940.0 fish/hr. (Figure 159). Fourteen fish were collected by the trap net: 13 Bluegill and one Pumpkinseed. Catch rates for each of the six 10-minute samples ranged from 73 - 215 fish/sample (Table 30). The variability from the six samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). To have 90% confidence (2-tail test) with 25% precision estimate of fish captured in an electrofishing sample of SVR, an estimated five sample periods would be needed for a whole fish community survey (Table 30). To have a 90% confidence with 25% precision estimate to track just Largemouth Bass or Bluegill, an estimated two or seven sample periods would need to be conducted respectively (Table 30).

Largemouth Bass:

Largemouth Bass collected ranged from 50 - 522 mm in length (Figure 160), with an average total length of 205 mm. Fourteen fish sampled (15%) were >305 mm in length. Largemouth Bass CPUE (91 fish/hr) was the lowest of the eleven surveys conducted since 1993. Largemouth Bass PSD was 50 in 2012, a marked increase after declining during the previous three surveys (Figure 161). Relative weight of Largemouth Bass ranged from 58 - 150 with an average of 92 (Figure 162). Relative weight was generally higher for larger fish than for smaller fish. Scale samples were analyzed from Largemouth Bass collected in 2012 (n = 87). These fish ranged in age from 1 - 9 years (Table 31). Annual growth rates ranged from 28 - 81 mm (Table 31). A catch curve (Figure 163) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.61 for fish aged 2 - 7 (R^2 = 0.829) based upon catch curve analysis (Figure 163). Thus, the annual survival rate (S) was 54% and total annual mortality (A) was 46%.

Bluegill:

Bluegill collected ranged from 29 - 191 mm in length with an average of 140 mm (Figure 164). Bluegill comprised 78% of fish captured during the 2012 survey (Figure 159). Ninety-nine fish sampled (13%) were >152 mm in length. Bluegill CPUE was 735 fish/hr. The PSD was 45 in 2012, a continued increase from a low of 16 in 2006 (Figure 165). Relative weights ranged from

50 - 138 with an average of 100 (Figure 166). Relative weights were generally higher for larger fish than for smaller fish. Scale samples were analyzed from Bluegill collected in 2012 (n = 96). These fish ranged in age from 1 - 6 years (Table 32). Average annual growth rates ranged from 9 - 91 mm. Average annual growth for age-1 Bluegill has steadily declined from 98 - 70 mm/year since 2006 (Table 32). A catch curve (Figure 167) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.58 for fish aged 2 - 6 (R^2 = 0.688). Thus, the annual survival rate (S) was 56%, and total annual mortality (A) was 44%.

Black Crappie collected ranged from 64 - 255 mm in length (Figure 168) with an average of 172 mm. Five Black Crappie (38%) were >200 mm in length. Black Crappie CPUE was 13 fish/hr. Black Crappie comprised 1% of the fish captured during the 2012 survey (Figure 159). Black Crappie PSD was 64, a decrease from the previous survey in 2010 (Figure 169). Relative weights of Black Crappie ranged from 50 - 143 with an average of 92 (Figure 170).

Pumpkinseed collected ranged from 81 - 161 mm in length (Figure 171) with an average of 131 mm. Six Pumpkinseed (11%) were >152 mm. Pumpkinseed CPUE was 56 fish/hr. Pumpkinseed comprised 6% of the catch during the 2012 survey (Figure 159). Pumpkinseed PSD was 29. Surveys in 2012 were the first time adequate numbers of Pumpkinseed were sampled to estimate PSD. Relative weights of Pumpkinseed ranged from 58 - 136 with an average of 107 (Figure 172).

Black Bullhead collected ranged from 234 - 323 mm in length (Figure 173) with an average of 278 mm. Black Bullhead CPUE was 44 fish/hr. Black Bullhead comprised 5% of the catch during the 2012 survey (Figure 159). Black Bullhead PSD increased to 100 from 33 between surveys in 2010 and 2012 (Figure 174).

Channel catfish were surveyed during the 2012 standard lake survey on Spring Valley Reservoir for the first time on record.

Creel Survey

Angler Effort:

Creel surveys were conducted on SVR from November 28, 2011 through November 28, 2012. A total of 131 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 27,129 hours (SE ±2,056; Table 33). This was the lowest of the four creel surveys conducted on the reservoir since 1993 (Figure 1). Angler effort type was estimated at 3,478, 21,568, and 2,083 hours for ice, shore, and boat anglers respectively (Table 33). We estimated 55% of the angler effort on SVR occurred during weekend days and 45% occurred during weekdays (Table 33). The highest angler effort occurred in the summer from May - July with monthly angler effort estimates ranging from 5,033 - 6,038 hours. High angler effort was also observed during the ice fishery in February, with an estimated 1,808 hours of effort (Table 33).

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on SVR was based on 351 complete trip interviews. Anglers caught an estimated 33,157 fish during 2012 (Appendix A), resulting in a catch rate of 1.4 fish/hour. Hatchery Rainbow Trout accounted for 55% (n = 20,195) of the fish caught during the 2012 creel survey (Figure 175). Catch of warm-water species included 10,643 Bluegill (32%), 1,491 Largemouth Bass (5%), 485 Black Crappie (2%), and 343 Pumpkinseed (1%). Anglers harvested an estimated 15,405 fish during 2012 (Appendix A), 46% of the fish caught. The harvest rate for all species was estimated to be 0.6 fish/hr. Harvest in 2012 consisted of 81% hatchery trout (n = 12,385), 18% Bluegill (n = 2,702), 1% Largemouth Bass (n = 174), <1% Pumpkinseed (n = 114), and <1% Black Crappie (n = 30; Figure 176). All harvested fish encountered during creel surveys were measured for total length. Harvested Largemouth Bass ranged in length from 169 - 389 mm, and averaged 243 mm (Figure 160). Harvested Bluegill ranged in length from 124 - 275 mm, and averaged 170 mm (Figure 164). Harvested Black Crappie ranged in length from 162 - 270 mm, and averaged 226 mm (Figure 168).

A total of 20,195 hatchery Rainbow Trout were estimated to have been caught during the survey, with 12,385 harvested (Appendix B). This is a catch rate of 0.8 fish/hour and a harvest rate of 0.4 fish/hour. The majority of the fish (76.3%) were harvested from May - July (Appendix C). Of the Rainbow Trout harvested, 11,251 (90.8%) were stocked in 2012, while 1,134 (9.1%) were holdover Rainbow Trout stocked in 2011. Rainbow Trout were determined to be holdover if they were caught in the spring before the first spring stocking occurred. The estimated angler exploitation rate was 34%. Harvested Rainbow Trout measured by creel clerks (n = 545) ranged in length from 158 - 398 mm, and averaged 272 mm.

Angler Satisfaction:

A total of 994 public opinion survey interviews were conducted at SVR in conjunction with the creel survey. All constituents using the lake were interviewed. Sixty-four percent of people interviewed identified fishing as their primary reason for visiting SVR (Figure 177). Camping and picnicking were the next most common responses at 5% and 2%. However, 29% of people interviewed cited other reasons for visiting the lake that were not identified. Of the people interviewed 76% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience and potential management strategies at SVR. Fifty-eight percent of people interviewed rated their fishing experience as excellent or good (Figure 178). The most common reasons for a positive rating were related to good fishing (24%) and “nice to be outside” (18%; Figure 179). Forty-two percent of people interviewed rated their fishing experience as fair or poor (Figure 178). The most common reasons for a negative rating were related to poor fishing (30%; Figure 179).

The most commonly targeted fish species was hatchery Rainbow Trout (44%; Figure 180). Forty-six percent of people interviewed were not targeting a particular fish species while fishing (Figure 180). Warm-water species comprised only 10% of the targeted fish species responses for SVR (Figure 180).

Seventy-nine percent of people interviewed were in support of management actions at SVR to reduce the Bluegill and Black Crappie populations in order to increase size structure; even if these changes would result in decreased catch rates (Figure 181).

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery catchable Rainbow Trout stocked in SVR in 2011 and 2012. Rainbow Trout were tagged on May 10, 2011 (n = 400), October 12, 2011 (n = 400), May 1-2, 2012 (n = 1,800), and October 22, 2012 (n = 398). Exploitation rates through 365 days at large (Table 34) for each stocking event averaged

47.2% for the May 2011 tagging event, 65.1% for the October 2011 event, 29.4% for the spring 2012 events, and 53.1% for the October 2012 event. Exploitation rates for 366 - 730 days at large for each stocking event averaged 0.8% for the May 2011 tagging event, 2.5% for the October 2011 event, 0.2% for the spring 2012 events, and 0.0% for the October 2012 event. No exploitation occurred beyond 730 days at large.

Angler total use (fish harvested plus fish released) rates through 365 days at large (Table 34; Appendix D) averaged 65.0% for the spring 2011 tagging events, 68.5% for the October 2011 event, 33.2% for the April 2012 events, and 62.3% for the October 2012 event. Total use for 366 - 730 days at large for each stocking event averaged 0.8% for the spring 2011 tagging events, 2.5% for the October 2011 event, 0.2% for the spring 2012 events, and 0.0% for the October 2012 event.

An angler exploitation survey was conducted on Largemouth Bass tagged during a standard lowland lake survey on June 12, 2012 (n = 27). Through June, 2014, one tagged fish was reported as caught and released. The estimated exploitation rate was 0.0%, with a total use rate of 8.1%.

Limnology

Limnology samples were collected monthly from April - November, 2012. Water temperatures in SVR at the beginning of the field season were largely unstratified at the beginning of the field season with water temperature at approximately 5.0^{o}C (Figure 182). The water column began to stratify in late April and was stratified in the epilimnion, metalimnion and hypolimnion by mid-May with surface temperatures of nearly 20^{o}C (Figure 182). Surface temperatures at SVR remained above 25^{o}C through the August 21st sample period (Figure 182). SVR was unstratifed by the October 24th sample period with a water temperature of ~ 9.0^{o}C throughout the water column (Figure 182). The upper 3 - 4 m of SVR exceeded the thermal limit of Rainbow Trout during the months of July and August (Figure 182).

When stratified, the dissolved oxygen level in SVR remained above the 5 mg/l minimum for Rainbow Trout during the 2012 field season (Figure 182). From May - October 2012 dissolved oxygen levels dropped to near 0.0 mg/l below 4 - 5 m in depth (Figure 182). After the lake had turned over prior to the October 24th sampling period, dissolved oxygen levels were uniformly between 5.5 and 6.0 mg/l throughout the water column (Figure 182). Dissolved oxygen and water temperature profiles taken on July 23 - 24 showed minimal difference between the end of daylight and pre-dawn sample periods (Figure 183).

Full pool volume of SVR has been estimated at 735 acre-ft (Hand et al. 2012). Usable Rainbow Trout water volume based on a 5.0 mg/l dissolved oxygen level and 21^{o}C upper thermal (Horton 1992) limit was reduced during June - September in 2012 (Figure 184). Usable habitat was so limited based on these criteria that we estimated SVR to have no usable Rainbow Trout habitat available during our August limnology survey (Figure 184). Usable Rainbow Trout water volume based on a 5.0 mg/l dissolved oxygen level and 25^{o}C upper thermal limit was also reduced during June-September 2012 (Figure 184). Using these criteria, the most limited Rainbow Trout usable volume was 292 acre-ft during the month of July (Figure 184).

Zooplankton

Zooplankton samples were collected monthly from April - November, 2012. The population was composed of six taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Bosmina, Ceriodaphnia, and Calanoida. Early season zooplankton surveys showed Cyclopoida as the dominate zooplankton taxa (>56%) within SVR (Figure 185). Daphnia taxa were the dominate zooplankton sampled during the remainder of the 2012 field season except for the October 1st and November 28th sample dates when cyclopoida and bosmina were the dominate taxa present (Figure 185).

Densities (# of individuals/m^3) were also highly variable. Daphnia density increased from 150 to 31,000/m^3 from April - July (Figure 186). Daphnia densities became depressed from mid-summer through early fall and then rapidly increased from 3,175 - 45,805 individuals/m^3 from the October 1st - October 24th sample events (Figure 186). Daphnia densities dramatically decreased after the third stocking event on October 23rd down to 6,669/m^3 by November 28th (Figure 186). Cyclopoida densities ranged from 1,027 - 26,637/m^3. Densities increased from April - May to their highest point before declining to their lowest in July after the second stocking of hatchery catchable Rainbow Trout in early June (Figure 186). Cyclopoida densities then increased in August and remained stable through November. Bosmina densities remained below 3,578/m^3 until the November sample, when it spiked dramatically to 159,868/m^3. Average lengths of Cyclopoida ranged from 0.44 - 0.81 mm, while average lengths of Daphnia ranged from 0.79 - 1.25 mm (Figure 187). Both taxa showed similar patterns in length frequency, with slight declines after the first stocking of hatchery rainbow trout in early May. This was followed by increases in July to their largest average size, and subsequent declines to smaller sizes. Length frequency distributions from each sample show that the percent of Daphnia >1.3 mm in length ranged from 0.0 - 53.3% of the individuals collected (Figure 188). Length frequency distributions from each sample show that Cyclopoids >1.3 mm in length were only present in the April 25th, 2012 sample (Figure 189).

Additionally, ZQI sampling was conducted on August 23, 2012. Biomass was below the regional average at 0.50 (g/m^3) for the 150 µm net, 0.16 (g/m^3) for the 500 µm net, and 0.12 (g/m^3) for the 750 µm net (Appendix E). The ZPR was calculated to be 0.80, above the regional average, while the ZQR was below the regional average 0.22.

Aquatic Vegetation

Vegetation surveys were conducted on July 23rd, 2012. A total of 90 sites were sampled. Vegetation was collected by rake tosses at 32 (35.6%) sample sites (Figure 190). Six types of vegetation were identified: filamentous algae, needle spikerush *Eleocharis* sp, American and Bigleaf Pondweed, brittlewort *Nitella* sp, American elodea, and coontail. Filamentous algae was the most commonly encountered vegetation, occurring at 31 (34.4%) sites where vegetation was collected (Appendix F). Needle spikerush was the second most common, occurring at 17 (18.9%) sites, followed by pondweed (12.2%), macrophytic algae (5.6%), elodea (2.2%), and coontail (1.1%). Sample sites along the shoreline accounted for 33.3% (n = 30) of all sample sites. Vegetation was collected at 63.6% (n = 21) of these sites. Additionally, 65.6% of all sample sites with vegetation were along the shoreline (Figure 190).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 90 sites. No vegetation was encountered at 66 (73.3%) of the sites (Figure 191). Vegetation was encountered at 24 (26.7%) sites. Vegetation was present on hooks at 24 (26.7%) sites, while dense matted surface vegetation was not encountered. The DFI and rake toss sampling showed similar patterns of shoreline vegetation. Seventy-seven percent of the affected sites were along the shoreline, with 56.7% of shoreline sites being negatively influenced by vegetation according to the DFI.

DISCUSSION

Population Survey

The fish community in SVR is a two-story fishery, with both warm-water and cold-water fish. Stocked hatchery Rainbow Trout provides an excellent put-and-take fishery, while Largemouth Bass and Bluegill provide warm-water fishing opportunities. The fish survey in 2012 showed that numerous changes are occurring. Largemouth Bass CPUE dropped to its lowest for sampled collected since 1993, while Bluegill CPUE was the highest during that time frame (Figure 159). Additionally, Pumpkinseed have become established after appearing for the first time in the 2012 sample, and Black Bullhead CPUE also rose to its highest level. Black Crappie, however, have remained steady with low numbers.

The results of the fisheries survey conducted in 2012 indicated that for an electrofishing survey of SVR, five 10-minute samples would be needed for a whole fish community estimate with 90% confidence (2-tail test) and 25% precision (Table 30). To sample just Largemouth Bass, we would only need two 10-minute samples. However, due to the size of SVR, we can sample the entire shoreline to improve our estimates. Therefore, we recommend conducting enough 10-minute electrofishing samples in order to sample the entire shoreline of the reservoir.

Largemouth Bass:

The Largemouth Bass population in SVR has generally been dominated by relatively small fish. Of the 2,280 Largemouth Bass collected during surveys since 1997, 17.3% (n = 394) were >250 mm and 10.8% (n = 246) were >300 mm. However, SVR continues to have fish in numerous length groups up to 520 mm, with one 600 mm fish collected during sampling in 2008. This has resulted in PSD values that have fluctuated between 19 and 66, but have mostly been below or within the balanced population range of 40 - 60 (Schramm and Willis 2012). Low PSD can be an indicator of a stunted population of Largemouth Bass and/or overharvest of fish by anglers (Schramm and Willis 2012). A stunted population is an indication of poor growth, and can be caused by limited food sources, inefficient foraging conditions (too much or too little cover), inadequate thermal regimes (short growing season), or too many fish.

Largemouth Bass collected in 2012 averaged 205 mm in length at capture, the lowest of any regional reservoir (Appendix J). Growth rates ranged from 18 - 88 mm per year and averaged 55 mm per year. Average length at age was at or above the regional average for all age fish (Appendix J and K). This relatively slow growth has resulted in Largemouth Bass at SVR not entering the fishery (stock size of 200 mm) until age 3, and not reaching quality size (300 mm) until age 5. This age to quality size is above the average age of 4.4 years for 40 Idaho populations described by Beamesderfer and North (1995), and a modeled estimate of four years based on thermal degree days described by McCauley and Kilgour (1990).

Temperature is one of the most important abiotic factors controlling growth rates (Colby and Nepszy 1981; McCauley and Kilgour 1990; Wehrly et al. 2007). With its location in northern Idaho at an elevation of 726 m, and with fewer heating degree days than occur in most of the specie’s range (Beamesderfer and North 1995), SVR has a relative short growing season compared to other reservoirs. As such, inadequate thermal regime likely contributes to the slow growth seen in SVR.

Angler harvest of larger fish is another possible explanation for the appearance of a stunted population. Some harvest of predators by anglers can result in reduced competition, increased food resources available for the remaining predators, and help maintain good predator-prey balance (Swingle 1950; Flickinger and Bulow 1993). However, overharvest can result in the appearance of a stunted population with many smaller fish and few large fish. Creel surveys of SVR estimated that 174 Largemouth Bass were harvested in 2012. Using the population estimate of 664 fish >200mm calculated for SVR by Hand et al. (2012), angler exploitation was 26.2% based on the 2012 creel survey. This compares to the annual angler exploitation rates of 27.5% and 8.1% for fish tagged in SVR during 2008 and 2012 using the "Tag You're It" program (Meyer et al. 2009; IDFG unpublished data). Allen et al. (2008) found the average fishing mortality rate of Largemouth Bass populations to be 30% for 32 separate studies. Total annual mortality of Largemouth Bass in SVR was estimated to be 46% from data collected in 2012. This is above the average of 40% estimated for regional reservoirs (Appendix J), but below the average total annual mortality of 57% for the populations analyzed by Allen et al. (2008). From this data for SVR, we can estimate that total natural mortality is 19 - 38%, above the 18% average estimated for the 40 Idaho populations described by Beamesderfer and North (1995).

Even though 300 mm is considered the minimum quality size for anglers (Gablehouse 1983), the fish harvested by anglers during the 2012 creel survey were generally small (Figure 160). The 10 fish measured ranged in length from 169 - 389 mm, and averaged 243 mm. Most of the fish harvested were <300 mm in length. This suggests that there were few fish of quality size or above in the population, which was also supported by our fish surveys. With few Largemouth Bass >300 mm in length in the population, and slow growth due to short growing seasons, even the low levels of harvest estimated during recent creel surveys could have an impact on the population. This suggests that while slow growth is a major contributor to the appearance of a stunted population, harvest is at least partly responsible for the scarcity of larger fish.

Overall, the data for SVR indicates that Largemouth Bass were experiencing slow growth rates and cropping from anglers. As such, restrictive regulations could be implemented to improve the size structure of the population. Length limits, such as a minimum length or a protective slot, could be considered if there is a desire to increase the size structure of Largemouth Bass. Minimum length limits are recommended for fish populations that exhibit low rates of recruitment and natural mortality, good growth rates, and high fishing mortality (Novinger 1984; Wilde 1997). They are generally used to protect the reproductive potential of fish populations, prevent overexploitation, increase angler catch rates, and promote predation on prey species (Noble and Jones 1993; Maceina et al. 1998; Iserman and Paukert 2010). Wilde (1997) compiled data from 91 evaluations of Largemouth Bass responses to length limits. Overall, minimum length limits increased population size and angler catch rates, but failed to increase PSD or angler harvest.

Slot limits are recommended for populations with high recruitment and low growth rates. They are used to increase numbers of the protected size fish, promote growth of smaller fish by reducing competition (through harvest), and increase production of larger fish (Anderson 1976; Iserman and Paukert 2010). Slot limits for predatory fish such as Largemouth Bass can also be used to manipulate prey fish populations by allowing the predators to grow larger (Anderson 1976). The previously mentioned study by Wilde (1997), and a study of 14 small mid-western reservoirs by Novinger (1990), indicate that slot limits were successful in restructuring Largemouth Bass populations by increasing population size and the number of both quality and preferred size fish (and thus increased PSD), but did not increase angler catch rates or harvest rates. When slot limits do fail to restructure Largemouth Bass populations it is usually because anglers harvest few fish below the slot limit (Gablehouse 1987; Summers 1990; Martin 1995). This effectively results in a minimum size limit. However, this may not be an issue in SVR, as most of the fish anglers harvested in 2012 were <300 mm in length (Figure 160). Fish this size would be below most standard slot limit sizes (305/356 mm - 406 mm).

More restrictive regulations for Largemouth Bass could improve the Largemouth Bass size structure by allowing more fish to grow beyond 305 mm. An increase in predator size structure would increase the predation on Bluegill, potentially improving Bluegill size structure. Although fewer anglers preferred to target Bluegill versus Rainbow Trout and Largemouth Bass (Figure 180), anglers were overwhelmingly if favor (79%) of improving the size structure of the Bluegill fishery even if it means catching fewer fish. Lower densities of Bluegill should result in improved growth rates and PSD. In an effort to reduce Bluegill abundance and increase their growth rates, more restrictive rules on Largemouth Bass should be considered. We recommend adopting a 305 mm - 406 mm slot limit for Largemouth Bass to improve bass and bluegill size distribution.

Bluegill:

The Bluegill population has seen a slight shift in the range of lengths (mostly 100 - 160 mm) towards larger fish over the four samples collected since 2006. As such, there has been a steady increase in PSD, with values increasing from 15 - 45. These values have been within the range of 20 - 60, indicative of a balanced population since 2008. However, PSD was below the regional average of 49 for Bluegill (Appendix I). The average length of Bluegill (140 mm) in SVR Lake was virtually identical to the regional average (141 mm) of the six lakes surveyed that contain Bluegill (Appendix I). Annual growth of Bluegill in SVR ranged from 9 - 91 mm. On average, Bluegill reach stock size (80 mm) at age one, the earliest age of any regional reservoir. However, growth was below the regional average every year beyond age one (Appendix I)..

The Bluegill harvested by anglers in SVR during 2012 were in the upper end of the range of lengths found in the population (29 - 191 mm), and averaged (170 mm) much larger than the population average of 140 mm (Figure 164). This is to be expected, as anglers usually prefer to keep the larger fish they catch (Aday and Graeb 2012).

The mortality rate for Bluegill (ages 1 - 6) was estimated at 44%. However, it was estimated at only 17% for Bluegill ages 2 - 5 (Figure 192). This suggests that mortality is much higher for fish after age 5 due to harvest, spawning stress, and natural mortality. The low mortality rate for younger fish is likely related to Bluegill size structure in SVR, where there are fewer small fish available for predation, and low levels of angling mortality. The mortality rate for Bluegill in SVR was considerably lower than the 59 - 87% observed by Coble (1988) in a series of studies conducted on mid-western United States impoundments. Considering that an estimated 2,702 Bluegill were harvested in 2012 with an average length of 170 mm, SVR supports a good Bluegill fishery. With low levels of harvest, no regulations are needed to protect against overharvest.

Black Crappie

As with many of our smaller reservoirs, the Black Crappie population in SVR is dominated by fish over 180 mm, with few smaller fish captured in samples. Length data from

2012 (no fish <120 mm) shows a lack of recruitment over the previous couple years. Historical age and growth analysis for SVR also generally shows the highly variable recruitment common in smaller reservoirs (Beam 1983; McDonough and Buchanan 1991; Allen 1997). The successful recruitment years do not coincide across reservoirs, indicating that environmental factors are not the primary driving force behind successful year classes. No age and growth, or mortality information could be developed from the 2012 sample, as only 13 Black Crappie were collected in the survey. However, Black Crappie continue to be present in low numbers and provide some fishing opportunity.

Pumpkinseed:

Pumpkinseed appeared for the first time in the 2010 sample, indicating they were illegally introduced around 2009. From 2010 to 2012, the CPUE increased as they become established (Figure 159). Their abundance is still low compared to Bluegill, but should be monitored in future surveys. Proportional Size Distribution in 2012 (29) was considered indicative of a balanced population. These values are higher than those seen in Elk Creek Reservoir (average PSD of 6) over six surveys conducted since 1995. The average length of Pumpkinseed (131 mm) in SVR was close to that seen in Mann Lake (133 mm) and MCR (123 mm). With only an estimated 114 Pumpkinseed harvested in 2012, no regulations are needed to protect against overharvest.

Warm-water Fishes Predator:Prey Dynamics:

A comparison of PSD distributions can be used to determine predator:prey dynamics in a reservoir and provide insight into potential population issues (Schramm and Willis 2012; Figure 193). In SVR, this relationship has shifted around the plot for samples collected since 1997, with each of the last four samples occurring in a different cell. The 2012 sample landed in Cell 2, which is characterized by a predator population that is likely in balance with a prey base PSD that is a little high. Often this means an abundance of quality sized Bluegill, which was evidenced by the 170 mm average size of Bluegill harvested in 2012 (Figure 164). It is noteworthy that prey PSD (especially Bluegill) has increased steadily over the last four samples, indicating that the population is shifting towards larger fish. In fact, 45% of the Bluegill collected from the standard fish survey in 2012 were of quality size (>150 mm). Angler harvest data from SVR shows high catch of Bluegill (n = 10,643), but much lower harvest (n = 2,702). The relatively low level of Bluegill harvest, combined with a steadily increasing length distribution suggests that there was a strong year-class a few years ago that is now recruiting into quality size. Increased harvest of Bluegill would help maintain a higher quality fishery, but it is difficult to get anglers to harvest enough to maintain a balanced population over time (Cooke et al. 2001; Isermann and Paukert 2010). In the next few years, we may see another large recruitment year and a resulting drop in PSD while these fish are smaller. At that time, the use of artificial methods to reduce Bluegill density in SVR should be explored to improve the size structure of this popular game fish. Control methods could include winter drawdown, partial lake rotenone treatments, and removal by boat electrofishing.

Creel Survey

Angler Effort:

The year-long creel survey resulted in an estimated 27,129 hours of angler effort in 2012. This was the second most effort at any of the nine regional reservoirs surveyed (Figure 1). The popularity of SVR stems from its proximity to two major population bases (Moscow, Idaho and Pullman, Washington), easy fishing access, amenities such as numerous docks and picnic tables, and good catch rates for trout and warm-water fish. As such, IDFG has promoted SVR as a family-friendly fishing water. Even though SVR had the second highest estimated angler effort of any regional reservoir in 2012, the effort was the lowest of the four creel surveys conducted on the reservoir since 1993. In fact, angler effort has declined over all four creel surveys conducted on SVR since 1993 (Figure 1). Angler effort declined in seven of the eight regional reservoirs (87.5%; Figure 1) surveyed in both 2005 and 2012. Additionally, three other reservoirs (Mann Lake, Soldier's Meadow Reservoir, and Elk Creek Reservoir) experienced steady declines in effort over all four creel surveys.

There may be several reasons for the decline in effort seen in SVR. An actual decline in effort is, of course, the most likely reason. Declines in participation in outdoor recreation activities during the 1990's and early 2000's, including fishing and hunting, have been well documented (USFWS 2006; DFO 2007; Cordell et al. 2008; Sutton et al. 2009) as people have more and more choices competing for their free time. Studies (Felder and Ditton 2001; Sutton 2007; Sutton et al. 2009) have shown large percentages of anglers fish less often than they used to, primarily due to "work/family commitments" (46 - 75%) and "other leisure activities" (41 - 46%). Economic surveys conducted by IDFG in 2003 and 2011 (Table 2) show a similar trend, with most regional reservoirs (87.5%) experiencing declines in effort (total trips). However, there is data that contradicts these trends. Sales of fishing licenses in Idaho have shown an overall increasing trend from 1993 - 2012 (Appendix H). While this does not directly correlate to effort in a given lake, it does provide some evidence that participation in fishing in Idaho is not necessarily declining.

A second potential cause for the decline in effort is the accuracy of our creel surveys. The 2012 creel survey is likely more accurate than previous surveys, as it was conducted using more angler counts and interviews. Additionally, more appropriate creel survey and statistical analysis methods were incorporated in the study design. Previous creel surveys were conducted with minimal staff, and therefore effort/catch/harvest may be more biased due to small sample sizes of angler counts and interviews. This bias could have inflated effort estimates during previous surveys.

Catch and Harvest:

Based on the 2012 creel survey, most anglers either targeted hatchery Rainbow Trout (44%; Figure 180), or stated that they were fishing for "any fish" (46%). As such, Rainbow Trout have made up the majority of the harvest composition over the last four creel surveys (Figure 176). Few anglers targeted any other species in 2012. With most anglers targeting hatchery Rainbow Trout, catch and harvest rates tend to be high. The harvest rate for hatchery Rainbow Trout declined to 0.4 fish/hour in 2012, the fourth consecutive decline since 1993. Harvest of hatchery Rainbow Trout also declined for the fourth consecutive survey from an estimated 26,223 in 1993 to 12,385 in 2012 (Appendix B). The hatchery trout exploitation rate has also declined, with the 34.0% estimated in 2012 below the 42.0 - 67.0% range seen in previous creel surveys.

Catch rates for hatchery Rainbow Trout have been above the management goal of >0.5 fish/hour in each creel survey since 1993. With catch and harvest rates above the management goal, and 80.4% of the fishery supported by catchable Rainbow Trout in 2012, there does not appear to be a need to reduce the number of catchable size trout stocked in SVR. Conversely, observations made during creel surveys concluded that no Rainbow Trout stocked as fingerlings were harvested during creel surveys in 1999 - 2012. The failure of fingerling establishment in

SVR is likely due to competition and predation from Bluegill, Black Crappie, and Largemouth Bass. Thus, future fingerling stockings should be discontinued.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (57.6%) still rated their fishing trip as Good or Excellent (Figure 177). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 54.5% of the responses. While the quality of fishing played the major role in one's fishing experience, the most common other response was "nice to be outside" 17.9%). This indicates that an enjoyable fishing trip is not predicated upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as simplified fishing rules, year-round fishing opportunities, easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself. Continuing to add and repair/replace docks, toilets, and picnic pavilions will all help improve anglers' experience at SVR.

Angler Exploitation

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) were utilized to evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate was 65.0% for the spring 2011 tagging events (Table 34) and 33.2% for the spring 2012 events. There was exploitation from both the 2011 and 2012 spring stockings past the one year mark (Appendix D), indicating that there is some carryover from these stockings. Total use for 366 - 730 days at large was 0.8% for 2011 and 0.2% for 2012. This is a good sign, as carryover increases the opportunity for angler to catch these fish.

The total use through June, 2014 was therefore estimated to be 65.8% for the spring 2011 tagging events and 33.4% for the spring 2012 events (Appendix D). These estimates were above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). The estimate for 2011 was also above the IDFG management goal of a 40% total use rate for hatchery catchable Rainbow Trout (Appendix D). However, the estimate for the spring 2012 stocking was slightly below this management goal (Appendix D). Tag returns from both the spring 2011 and spring 2012 (Figures 194 and 195) stockings show similar patterns, with most returns occurring by August each year. This is to be expected since most of the effort occurs from April - September each year (Table 33). Given high levels of angler effort and angler exploitation of hatchery catchable we do not suggest any major changes to the hatchery catchable program. The hatchery Rainbow Trout program should continue to provide high stocking rates to meet angler demand and any potential changes in management of SVR to potentially enhance warm-water fishing opportunities need to be weighed against potential impacts to the hatchery program.

The success of our fall stockings is also of interest for the regional tagging program. Tag returns through June, 2014 resulted in total use rates of 68.5% for the October, 2011 tagging and 62.3% for the October, 2012 tagging. These were both above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). They were also above the IDFG management goal of a 40%

total use rate for stocked hatchery Rainbow Trout (Appendix D). Tagged fish from the October 2011 stocking were caught all the way through June, 2012 (Figure 196), indicating that these fish were able to overwinter and were available to the fishery the following summer. However, tagged fish from the October, 2012 stocking were only caught through early December, 2012 (Figure 197).

Comparing angler exploitation of hatchery Rainbow Trout from the “Tag You’re It” program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated angler exploitation to be 38.3% while the creel survey estimated it to be 34.0%. Differences in angler exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the use of bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Angler exploitation based on the “Tag You’re It” program (Meyer et al. 2009) was lower for the 2012 stockings than the 2011 stockings (Appendix D). This trend was seen in five of the six regional reservoirs where data existed from both years. Some of this may be attributable to possible changes in angler effort or the possibility that anglers became accustomed/ desensitized to the tagging program and returned the tags at a lower rate. The better water conditions seen in 2012 versus 2011 were also a likely factor.

Limnology

Limnological sampling during the 2012 field season showed low dissolved oxygen levels and high water temperatures throughout much of the summer (July - September) in SVR. Even in 2011, when exploitation rates were much higher than 2012, most tag reports occurred prior to August (Figures 191 and 192). Given the high level of effort in late spring and early summer at SVR, moving spring time stockings a month earlier into April may be warranted to increase angler exploitation prior to the low dissolved oxygen and high water temperature time periods later in the summer. Based upon the 2012 creel data, 79.2% of angler effort on SVR occurs prior to August. This is likely due to the stocking schedule and water quality issues later in the summer. If spring time stockings are moved earlier in the year we should increase exploitation on these stockings.

Based on the IDFG standards for temperature and DO thresholds, the volume of water available for Rainbow Trout to survive was reduced to zero in August, 2012. This would indicate that there was very little, if any, chance that hatchery trout stocked in the spring would have a chance to survive through the summer and be available to the fishery in the fall. However, an analysis of the dates of tag returns from the May, 2011 and 2012 angler exploitation tag releases show that hatchery Rainbow Trout were caught into November each year. This indicates that trout were able to survive through the summer, and also suggests that the IDFG 21°C upper thermal limit for Rainbow Trout (Horton 1992) is not an appropriate measure for our lowland reservoirs. The 25°C thermal limit seen in the literature (Bjornn and Reiser 1991;Lee and Rinne 1980, Carline and Machung 2001, Rodnick et al. 2004) appear to be more appropriate, and would indicate that 39.7% of the reservoir volume would still be available for Rainbow Trout. Regardless, the months of July and August have the most significant limiting potential for Rainbow Trout recruitment to a fall fishery. Additionally, the fall stocking should be timed to avoid potential low DO levels during fall turnover, and to reap the benefits of the resulting zooplankton boom prior to winter.

An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion, such as SVR. This is a concern for our fall stocking of catchable trout in this reservoir, as fall turnover can reduce the dissolved oxygen levels of the reservoir to <5.0 mg/L needed for Rainbow Trout. However, this issue did not occur in 2012, as oxygen levels remained >5.0 mg/L throughout the water column following fall turnover (Figure 182). To avoid potential fish kills, fall stockings should be conducted once DO levels have returned to >5.0 mg/L after reservoir turnover.

Zooplankton

Larger sized zooplankton species, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in SVR was dominated by Daphnia and Cyclopoida in 2012, indicating the presence of a viable food source. In 2012, Daphnia collected averaged 1.0 mm in length, and Cyclopoida averaged 0.6 mm in length (Figure 187). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Additionally, up to 53.3% of Daphnia and 4.4% of Cyclopoids were at or above preferred size (Figures 185 and 186) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 42.5% of the Daphnia population and 7.3% of the Cyclopoida population were ≥1.0 mm in length. This indicates that there is food available for hatchery Rainbow Trout and juvenile warm-water species to eat.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for SVR. The ZQI, which is a measure of both abundance and size, was 0.22, below the average (0.35) for reservoirs in the Clearwater Region (Appendix E). ZQI values from 0.1 - 0.6 are considered moderate and indicate that there is sufficient competition for food resources to potentially impact fish populations (Teuscher 1999). The zooplankton biomass was also calculated to be low. This data also indicates that larger zooplankton individuals are being cropped off or that few individuals grow to this size. This suggests that we may need to reduce the number of planktivores to allow for more forage opportunities for fish in SVR. This could be accomplished through reduced stocking rates of hatchery Rainbow Trout. Additionally, this could be accomplished by increasing predation on smaller warm-water fish.

Aquatic Vegetation

In the past, nuisance aquatic vegetation has been an issue in SVR, with winter drawdown considered the best option for vegetation control. Although vegetation mapping conducted during the 2012 field season shows the majority of SVR to be clear of vegetation, over 60% of the shoreline where most angling occurs did have vegetation (Figure 190). In addition, the DFI found that aquatic vegetation in 57% of the shoreline had the potential to negatively influence fishing (Figure 191). As such, winter drawdown to control vegetation is worth consideration. It should be known that there is a high level of uncertainty regarding the success of winter drawdown as a tool for vegetation control. Cooke (1980) reviewed various drawdown studies and found their level of success varied by aquatic plant species. Some species such as *Potamogeton robbinsii* were reduced while others actually increased after drawdown (Cooke 1980). Spring Valley Reservoir has a variety of aquatic vegetation species including some *Potamogeton* sp. that may be reduced. A variety of other species in the lake may not be affected or may be made worse by drawdown.

Water drawdown in SVR may have other benefits as well. Water level drawdowns are often used intentionally to manage fish populations. They can stimulate fish productivity by reestablishing conditions similar to when a reservoir was first filled (Miranda and Muncy 1987; Cooke et al. 2005). Other potential effects are increased predation on stunted prey populations, reduced predation on eggs by Centrarchids, and reduced competition for resources for young-of-year Largemouth Bass (Heman et al. 1969; Miranda et al. 1984). The result can be improved sport fisheries through increased biomass and sizes of game fish, and a reduction in abundance of stunted Bluegill, crappie, or other planktivores. The use of winter drawdown in SVR as a method to congregate fish and decrease available habitat may reduce overall Bluegill density and have subsequent positive effects on surviving Bluegill growth rates the following year. As mentioned above, anglers overwhelmingly supported management action at SVR that would increase size of Bluegill and Black Crappie even if catch rates were reduced (Figure 181).

Additionally, an extended slow-release drawdown out of SVR would likely have a positive effect on downstream rearing habitat available for juvenile Steelhead. Bowersox et al. (2010) have found the Steelhead population in the Big Bear Creek drainage (downstream of SVR) to be highly density-dependent and habitat limited. Spring Valley Reservoir drains into Little Bear Creek which is a major tributary to the Big Bear Creek system. Surveys conducted on Little Bear Creek in late summer have shown the creek to be subject to late-summer dewatering (Bowersox et al. 2010). If water releases out of SVR began in July and were allowed to continue through early fall, we believe Steelhead habitat and subsequent Steelhead production could be increased downstream. Potential effects on angler effort and satisfaction in SVR must be taken into account before implementing this strategy on a long-term basis.

MANAGEMENT RECOMMENDATIONS

1. Continue stocking catchable hatchery Rainbow Trout at current levels to maintain management goal of >0.5 fish/hour catch rates.

2. Eliminate stockings of fingerling Rainbow Trout.

3. Conduct spring hatchery Rainbow Trout stocking in April instead of May to increase angler exploitation during late-spring and early summer.

4. Explore efficacy of mid-summer through early fall water level drawdown to reduce standing crop of Bluegill and improve downstream Steelhead habitat.

5. Evaluate methods for increasing Bluegill mortality to improve size structure.

6. Utilize an upper thermal limit of 25°C for Rainbow Trout when evaluating volume of reservoir available for trout.

7. Conduct future standard lake surveys with enough 10-minute electrofishing samples to sample the entire shoreline.

8. Recommend adopting a slot limit for Largemouth Bass to improve bass and bluegill size distribution.

Table 30. Number of fish collected by species in each 10-minute electrofishing sample conducted during a standard lowland lake survey of Spring Valley Reservoir, Idaho, in 2012, and the estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 90% confidence and 25% precision.

	Count of fish collected									
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Largemouth Bass	20	15	11	15	12	18	91	15.2	3.4	2
Black Crappie	4	3	0	1	3	2	13	2.2	1.5	20
Bluegill	98	92	184	144	52	152	722	120.3	48.1	7
Pumpkinseed	14	9	11	10	3	8	55	9.2	3.7	7
Channel Catfish	0	1	0	0	0	0	1	0.2	0.4	n/a
Black Bullhead	4	0	9	10	3	18	44	7.3	6.4	34
Total	140	120	215	180	73	198	926	154.3	53.4	5

Table 31. Back-calculated length at annuli of Largemouth Bass collected during an electrofishing survey of Spring Valley Reservoir, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus								
Class	Age	n	1	2	3	4	5	6	7	8	9
2011	1	28	78								
2010	2	39	80	151							
2009	3	6	104	178	226						
2008	4	4	89	167	240	278					
2007	5	6	84	135	187	262	335				
2006	6	2	73	114	161	214	302	388			
2005	7	1	76	132	177	213	239	287	333		
2004	8	0	0	0	0	0	0	0	0	0	
2003	9	1	70	151	201	272	335	384	426	468	496
N		87	87	59	20	14	10	4	2	1	1
Average Length			81	152	207	257	319	362	380	468	496

Table 32. Back-calculated length at annuli of Bluegill collected during an electrofishing survey of Spring Valley Reservoir, Idaho, in 2012.

Year Class	Age	n	Back-calculated length (mm) at each annulus					
			1	2	3	4	5	6
2011	1	2	70.3					
2010	2	32	88.9	107.2				
2009	3	23	91.9	112.9	130.8			
2008	4	19	93.3	116.8	135.8	151.5		
2007	5	18	94.6	117.5	135.6	150.1	161.6	
2006	6	2	98.2	119.2	134.3	145.2	155.8	165.3
n		96	96	94	62	39	20	2
Average Length			91	113	134	151	161	165

Table 33. Summary of angler effort (hours) as determined through a creel survey conducted on Spring Valley Reservoir, Idaho, from November 28, 2011 - November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	238	0	0	238	246	0	0	246	483	0	0	483	238	49
January	357	0	0	357	426	0	0	426	784	0	0	784	311	40
February	381	0	0	381	1,428	0	0	1,428	1,808	0	0	1,808	688	38
March	72	0	0	72	332	0	0	332	403	0	0	403	259	64
April	0	406	0	406	0	992	0	992	0	1,398	0	1,398	558	40
May	0	2,699	235	2,933	0	1,932	168	2,100	0	4,631	403	5,033	1,244	25
June	0	2,231	303	2,534	0	3,163	342	3,505	0	5,394	645	6,038	832	14
July	0	2,508	107	2,615	0	2,654	286	2,939	0	5,161	393	5,554	805	14
August	0	1,673	226	1,899	0	735	114	848	0	2,407	340	2,747	411	15
September	0	513	96	609	0	1,290	102	1,392	0	1,803	198	2,001	314	16
October	0	311	35	345	0	96	0	96	0	407	35	441	222	50
November	0	139	70	209	0	228	0	228	0	367	70	437	126	29
Totals	1,047	10,478	1,072	12,597	2,431	11,089	1,011	14,532	3,478	21,568	2,083	27,129	2,056	7

Table 34. Angler exploitation of hatchery catchable size Rainbow Trout stocked in Spring Valley Reservoir, Idaho, in 2011 and 2012, through 365 days post-stocking. Total use = fish harvested + fish released.

2011

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted exploitation: Estimate	Adjusted exploitation: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
Hagerman	5/10/2011	Normal production	400	82	12	19	47.2%	11.3%	65.0%	14.3%
	10/12/2011	High density	200	57	1	0	65.6%	16.7%	66.8%	16.9%
		Low density	200	56	1	4	64.5%	16.5%	70.2%	17.5%
Average							59.1%	14.8%	67.3%	16.2%

2012

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted exploitation: Estimate	Adjusted exploitation: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
American Falls	02-May-12	High density	200	14	1	1	19.7%	7.1%	22.6%	7.7%
		Low density	200	26	0	0	36.7%	10.0%	36.7%	10.0%
		Medium density	200	19	1	1	26.8%	8.4%	29.6%	8.9%
Hagerman	02-May-12	High density	200	23	2	3	32.4%	9.4%	39.5%	10.5%
		Low density	200	37	3	0	52.2%	12.3%	56.4%	12.9%
		Medium density	200	20	3	2	28.2%	8.7%	35.2%	9.8%
	22-Oct-12	Production	398	75	4	9	53.1%	10.2%	62.3%	11.4%
Nampa	01-May-12	High density	200	19	0	0	26.8%	8.4%	26.8%	8.4%
		Low density	200	15	1	3	21.1%	7.4%	26.8%	8.4%
		Medium density	200	15	1	2	21.1%	7.4%	25.4%	8.2%
Average							31.8%	8.9%	36.1%	9.6%

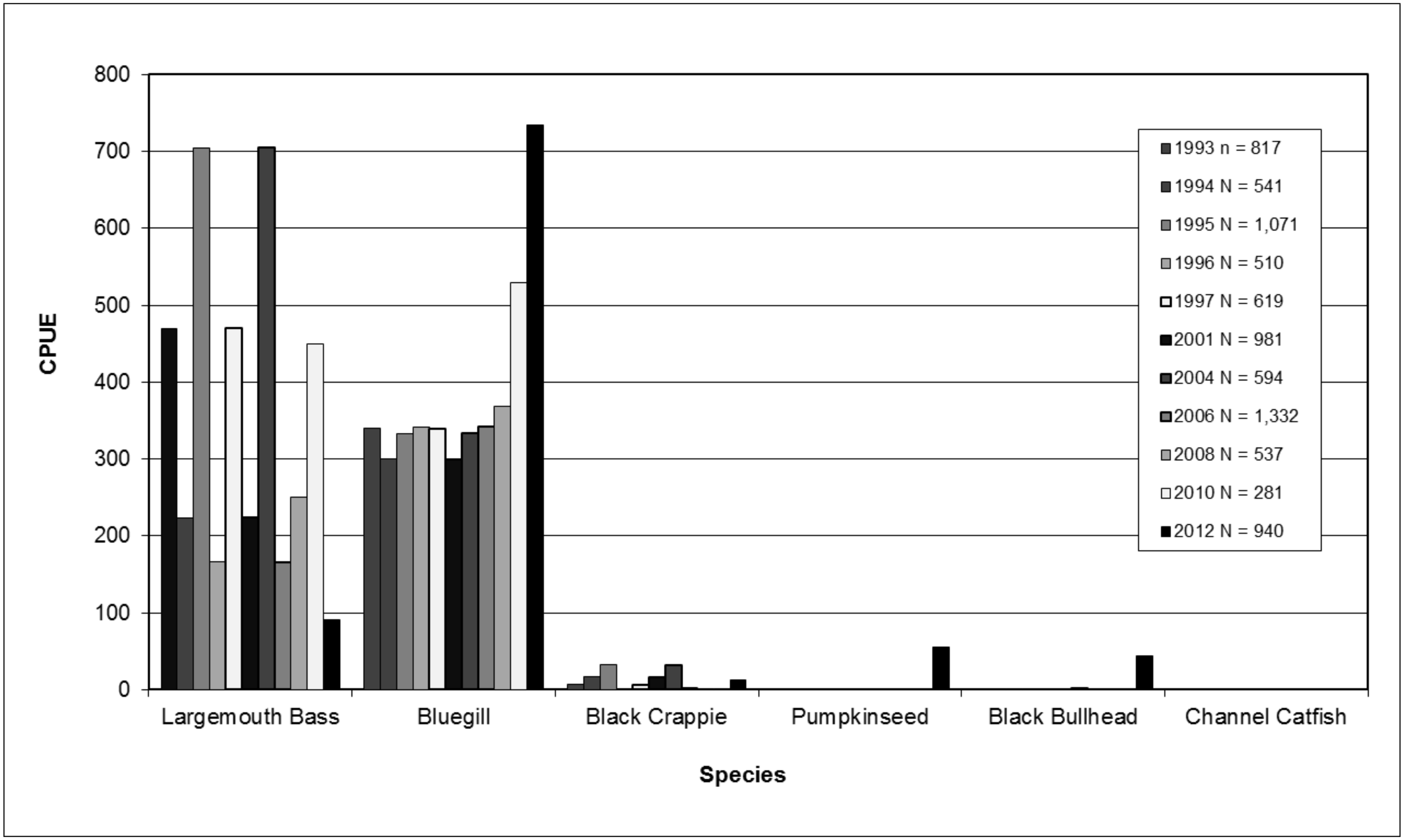


Figure 159. Catch per unit effort (CPUE; number of fish/hour) of fish collected through electrofishing in Spring Valley Reservoir, Idaho, from 1993 - 2012.

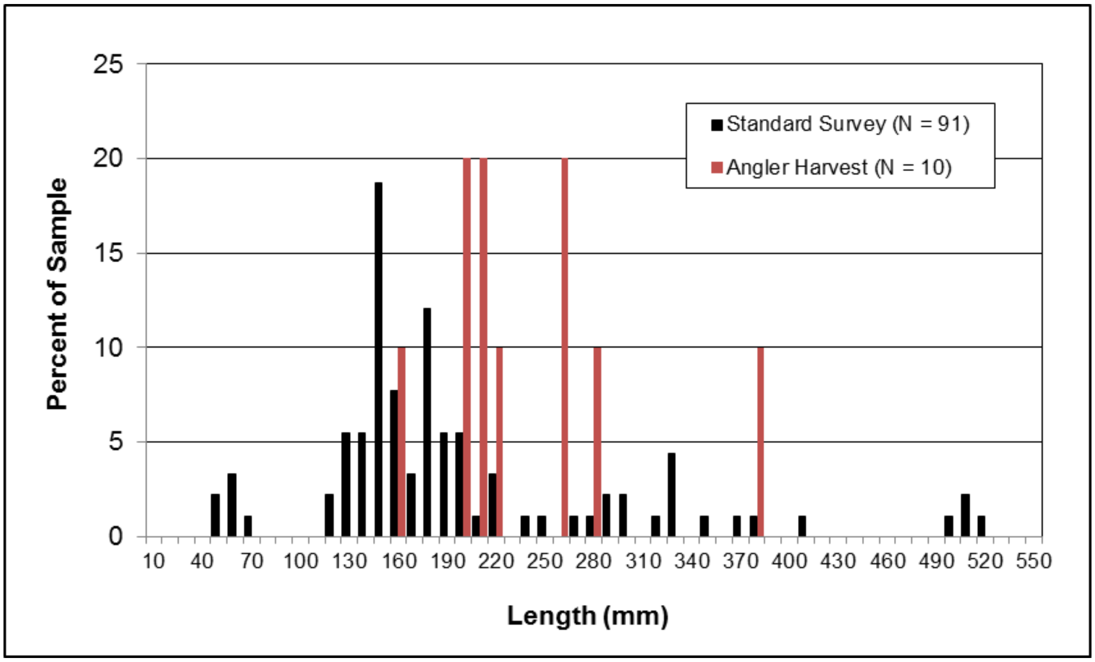


Figure 160. Comparison of Largemouth Bass length frequency distributions from fish collected through electrofishing, and fish harvested by anglers in Spring Valley Reservoir, Idaho, in 2012.

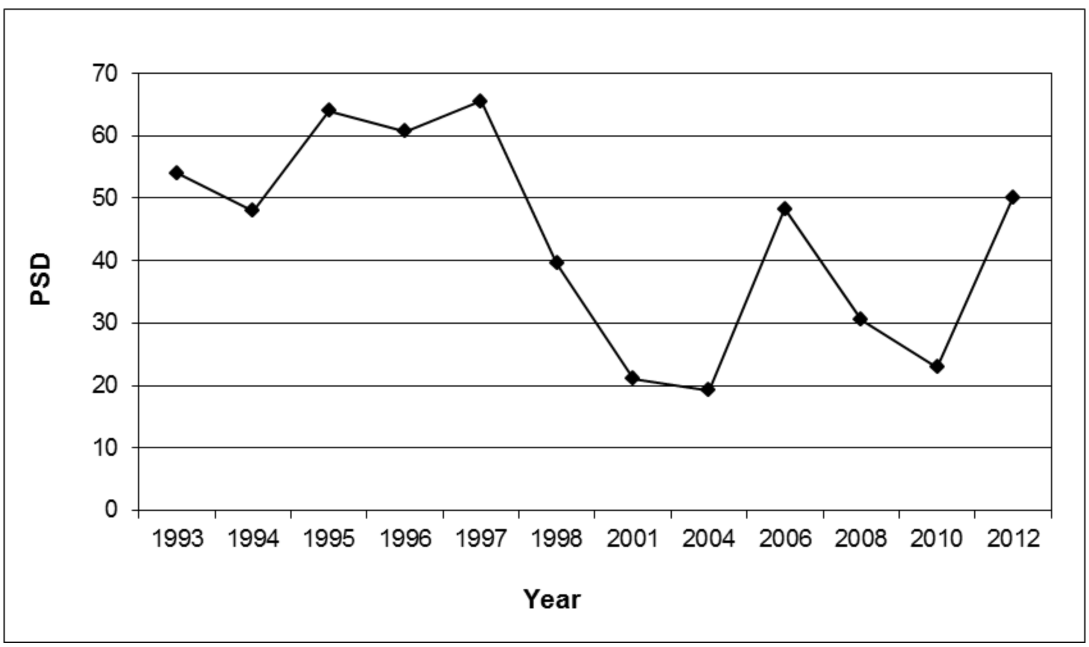


Figure 161. Proportional Size Distribution (PSD) values of Largemouth Bass collected through electrofishing in Spring Valley Reservoir, Idaho, from 1996 - 2012.

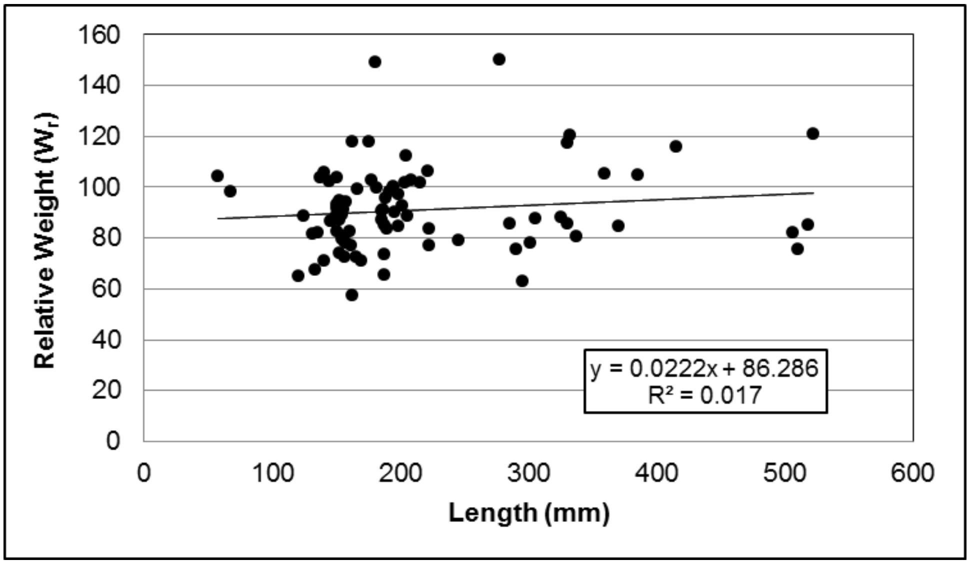


Figure 162. Relative weight (W_r) values of Largemouth Bass collected through electrofishing in Spring Valley Reservoir, Idaho, in 2012.

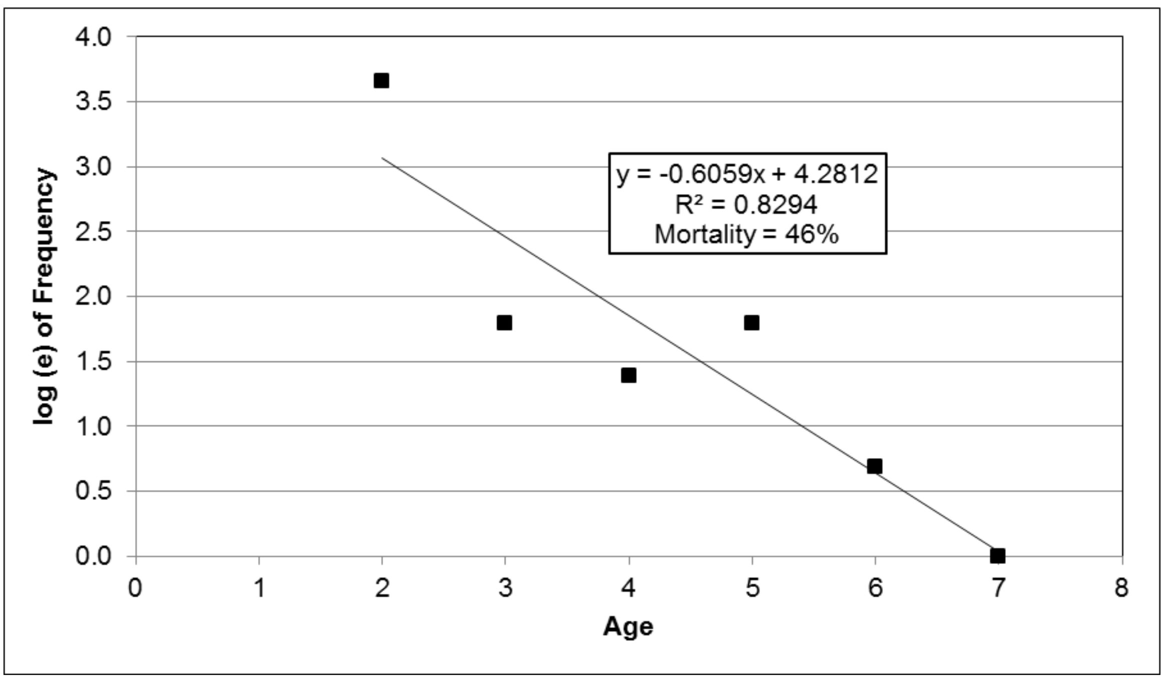


Figure 163. Catch curve for estimating annual mortality of Largemouth Bass collected through electrofishing in Spring Valley Reservoir, Idaho, in 2012.

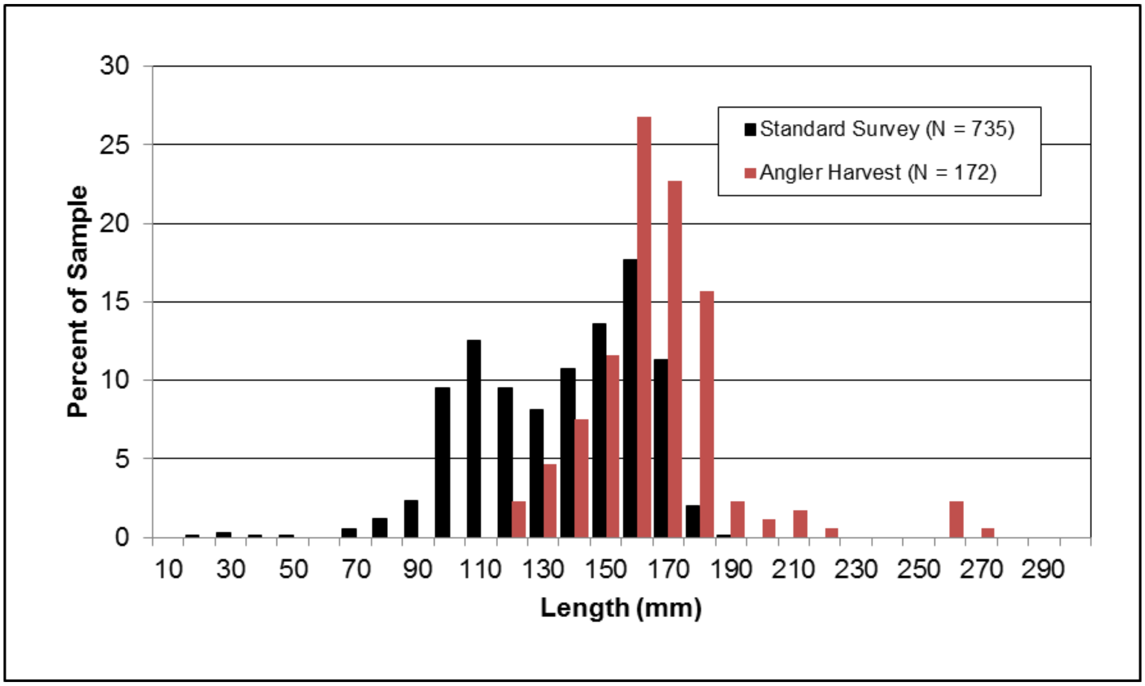


Figure 164. Comparison of Bluegill length frequency distributions from fish collected through electrofishing, and fish harvested by anglers in Spring Valley Reservoir, Idaho, in 2012.

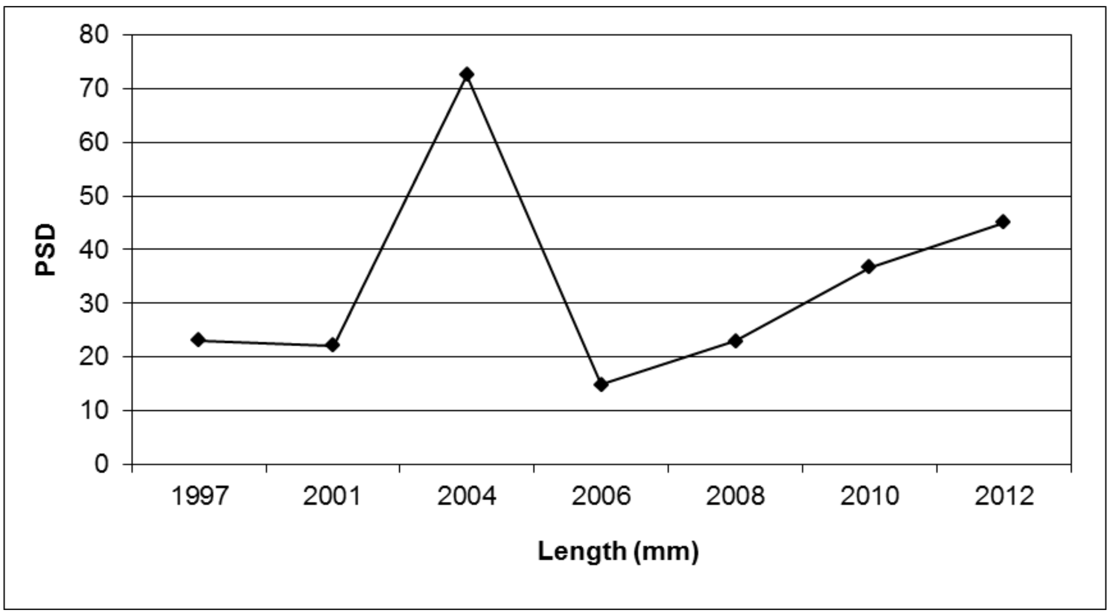


Figure 165. Proportional Size Distribution (PSD) values of Bluegill collected through electrofishing in Spring Valley Reservoir, Idaho, from 1997 - 2012.

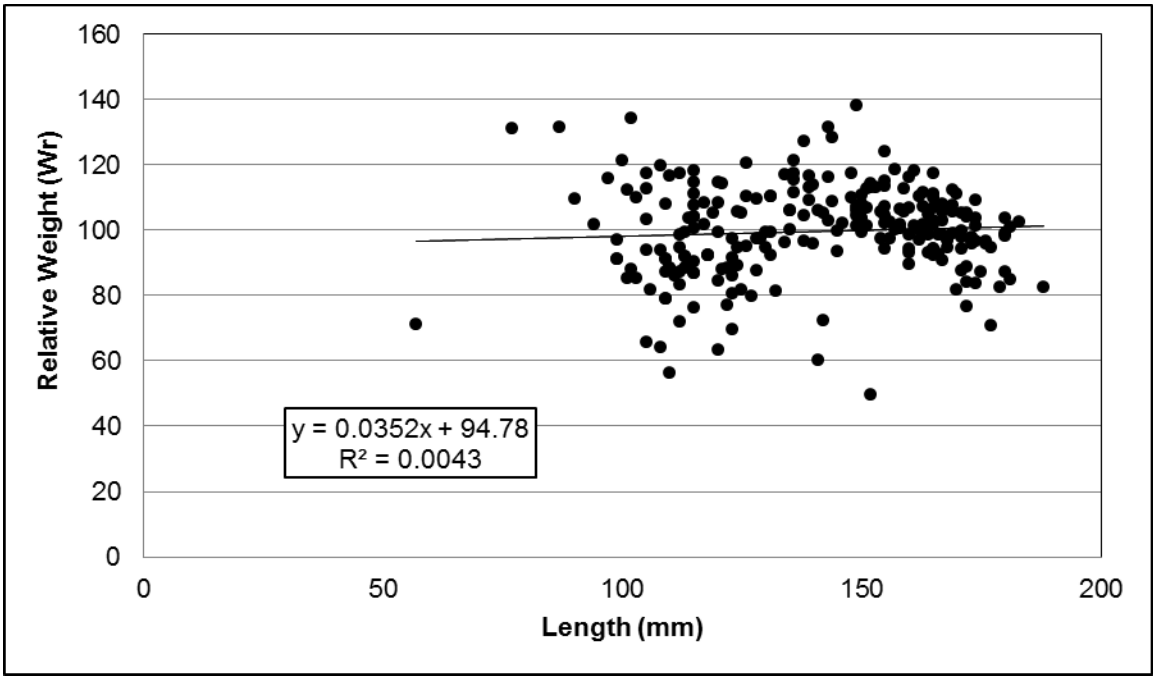


Figure 166. Relative weight (Wr) values of Bluegill collected through electrofishing in Spring Valley Reservoir, Idaho, in 2012.

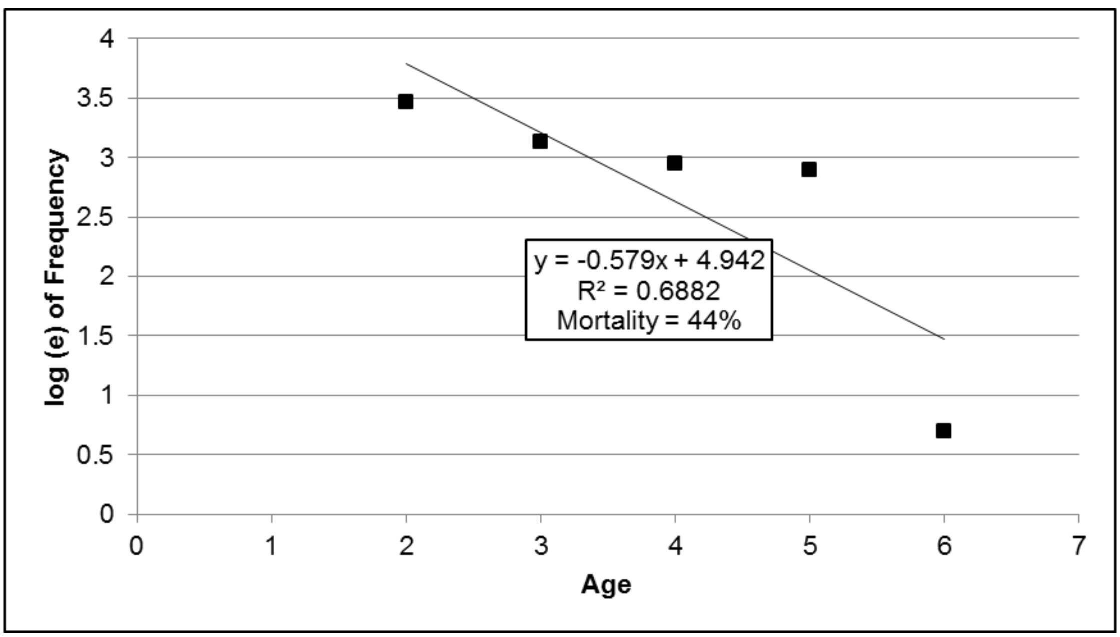


Figure 167. Catch curve for estimating annual mortality of Bluegill collected through Electrofishing in Spring Valley Reservoir, Idaho, in 2012.

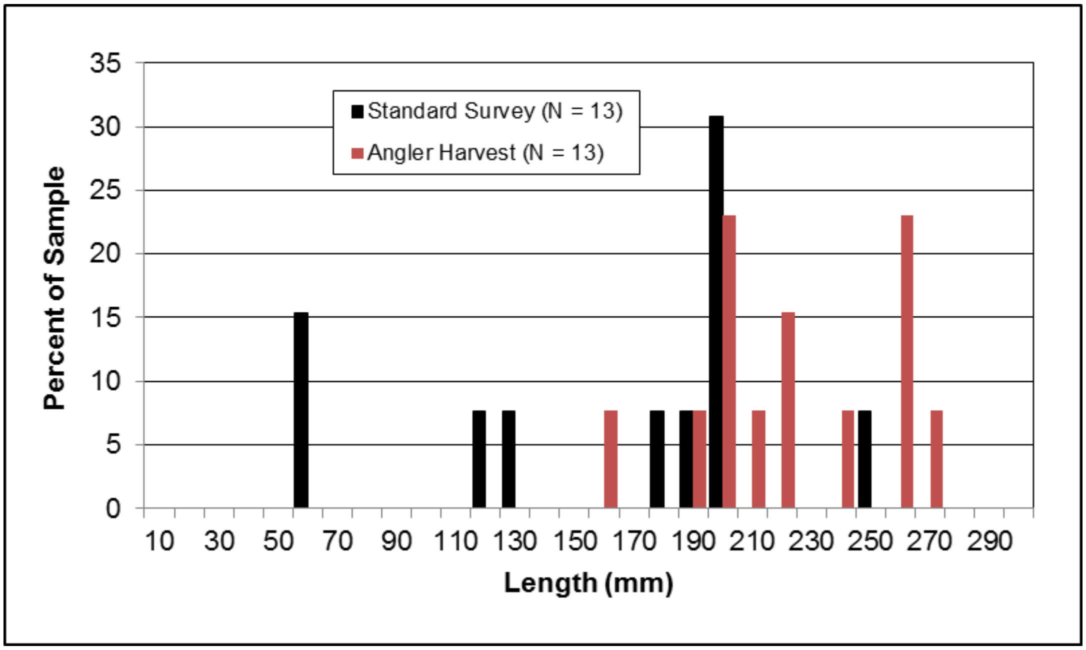


Figure 168. Comparison of Black Crappie length frequency distributions from fish collected through electrofishing, and fish harvested by anglers, in Spring Valley Reservoir, Idaho, in 2012.

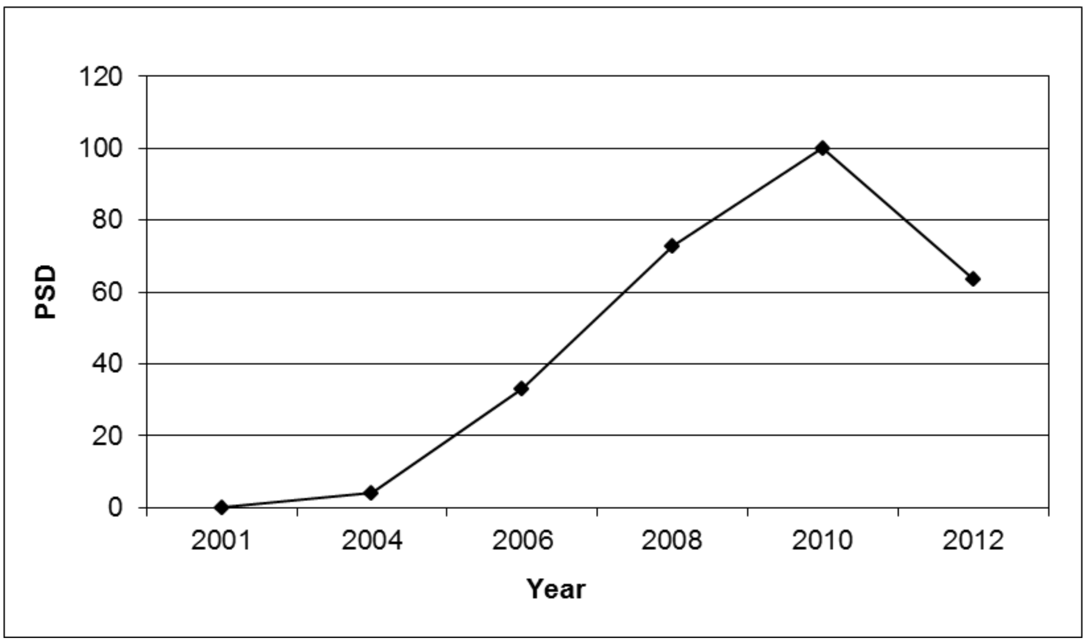


Figure 169. Proportional Size Distribution (PSD) values of Black Crappie collected through electrofishing in Spring Valley Reservoir, Idaho, from 2001 - 2012.

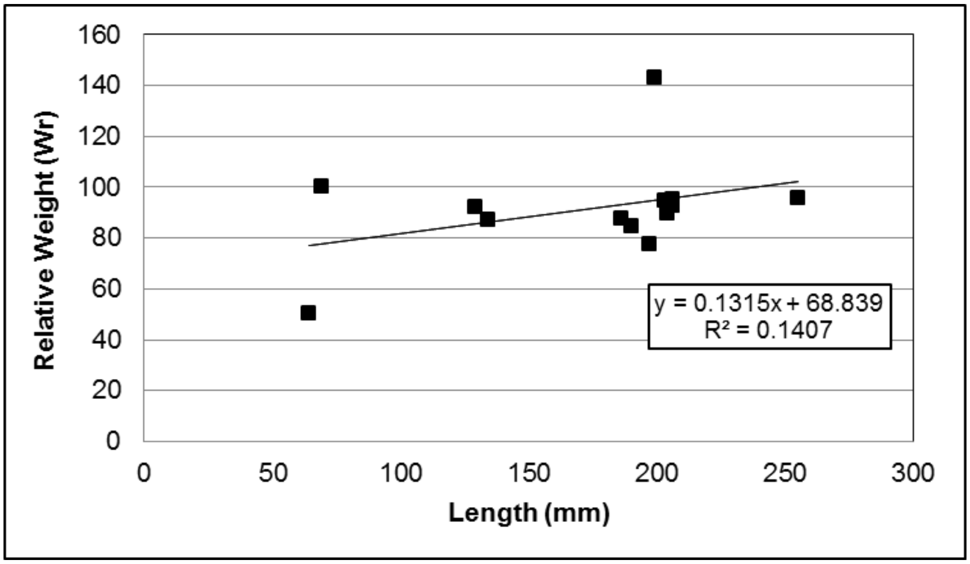


Figure 170. Relative weight (W_r) values of Black Crappie collected through electrofishing in Spring Valley Reservoir, Idaho, in 2012.

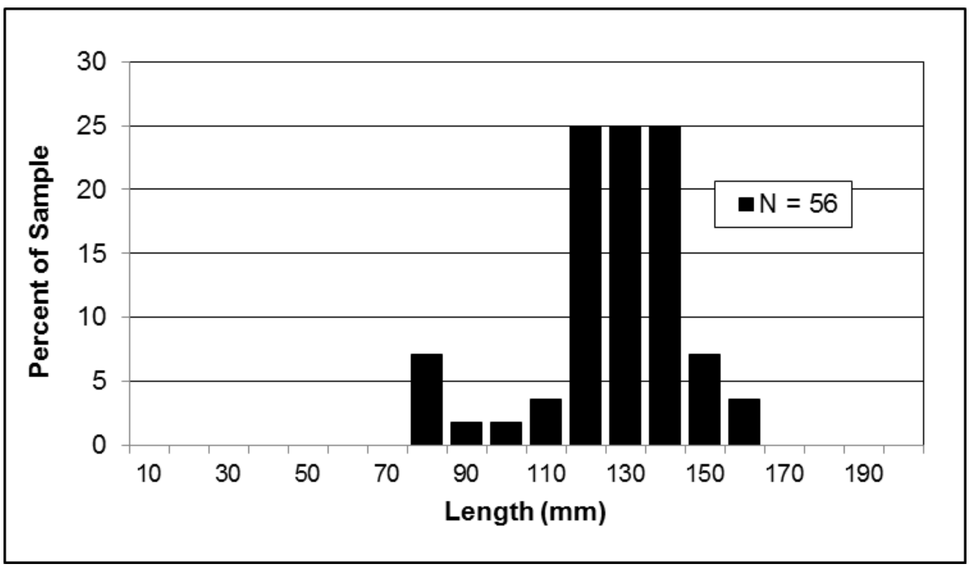


Figure 171. Length frequency distribution of Pumpkinseed collected through electrofishing in Spring Valley Reservoir, Idaho, during 2012.

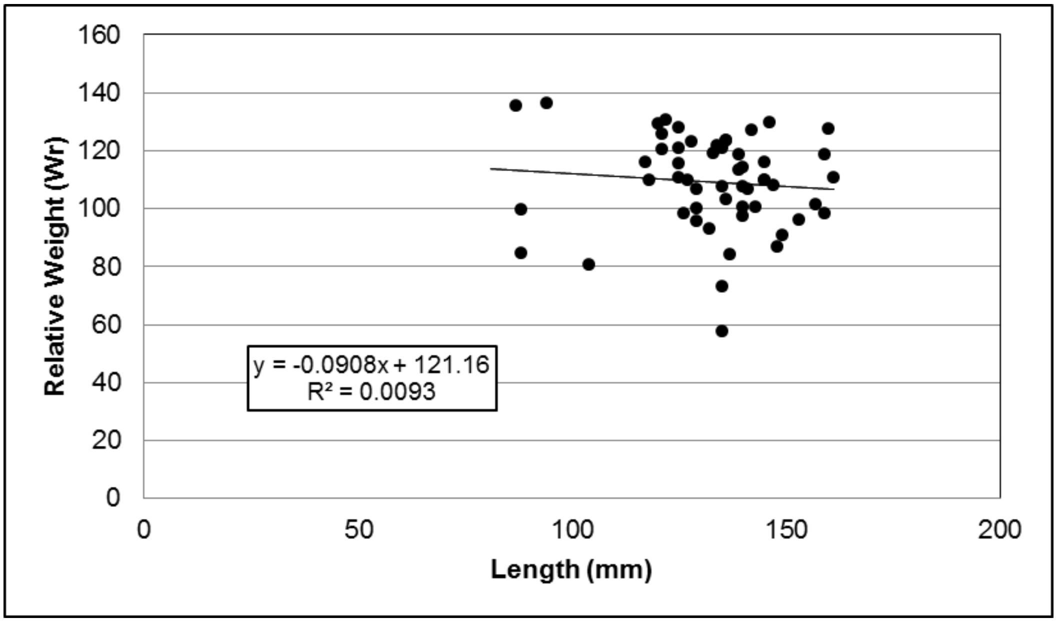


Figure 172. Relative weight (W_r) values of Pumpkinseed collected through electrofishing in Spring Valley Reservoir, Idaho, in 2012.

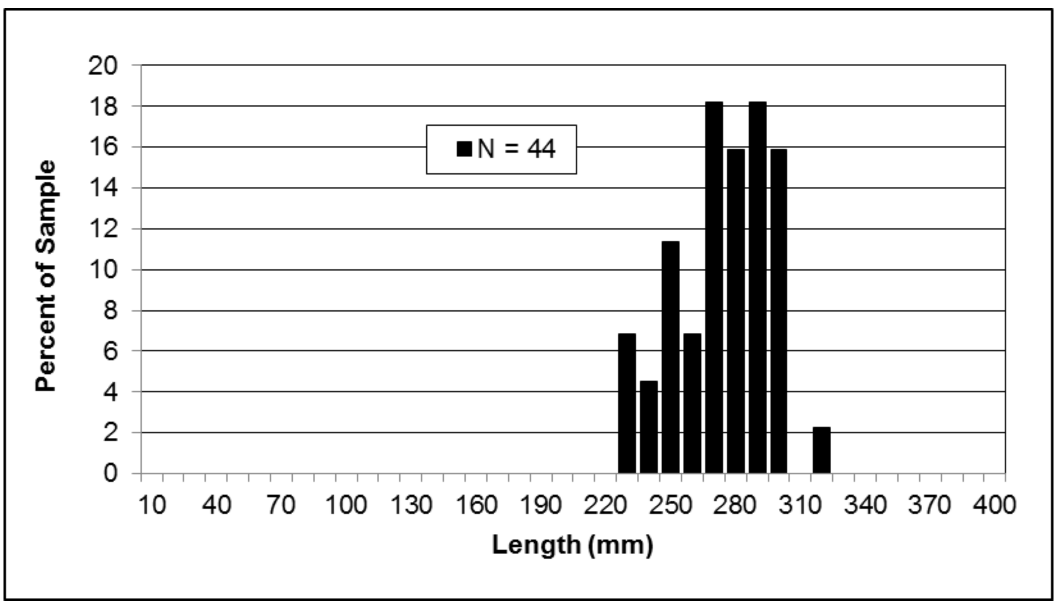


Figure 173. Length frequency distribution of Black Bullhead collected during through electrofishing in Spring Valley Reservoir, Idaho, in 2012.

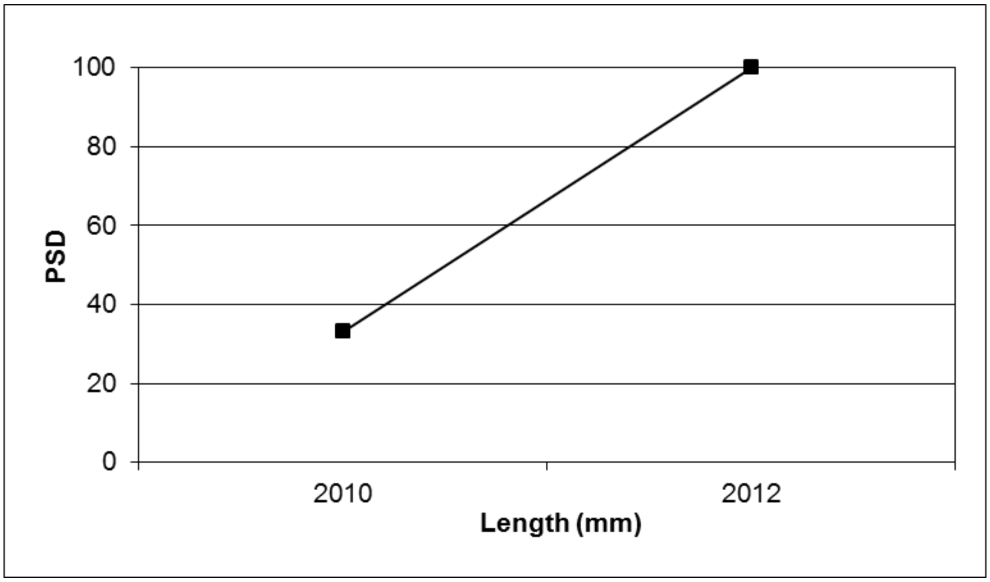


Figure 174. Proportional Size Distribution (PSD) values of Black Bullhead collected through electrofishing in Spring Valley Reservoir, Idaho, from 2010 - 2012.

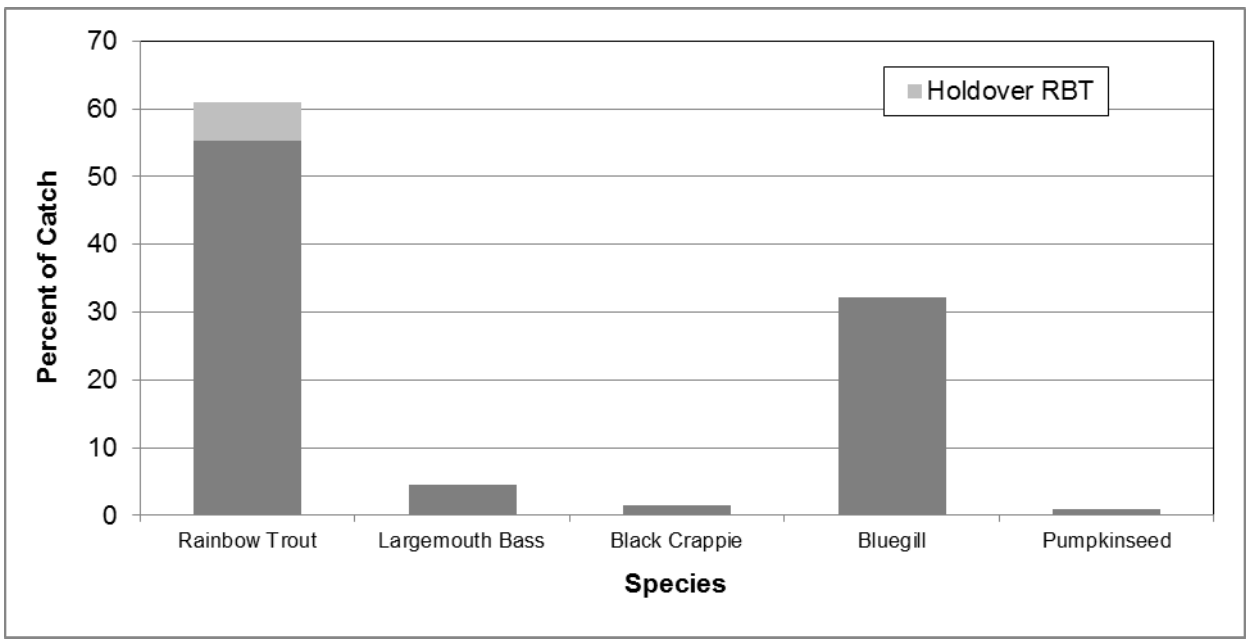


Figure 175. Composition of fishes caught in Spring Valley Reservoir, Idaho, as estimated by a creel survey conducted from November 28, 2011 - Nov 28, 2012.

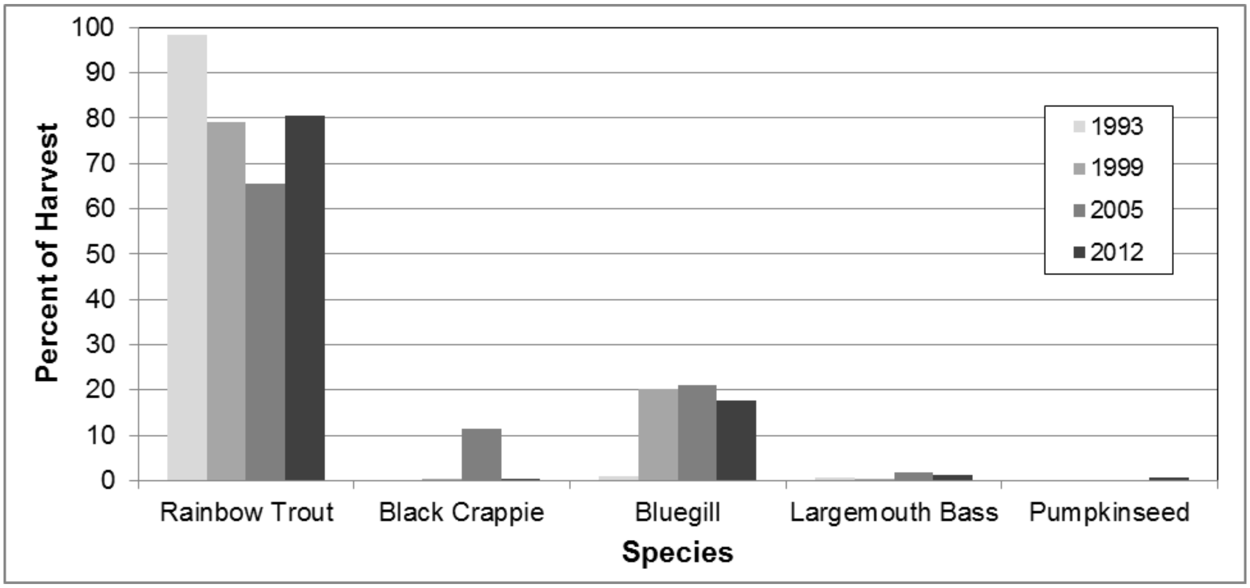


Figure 176. Composition of fishes harvested during creel surveys conducted at Spring Valley Reservoir, Idaho, from 1993 - 2012.

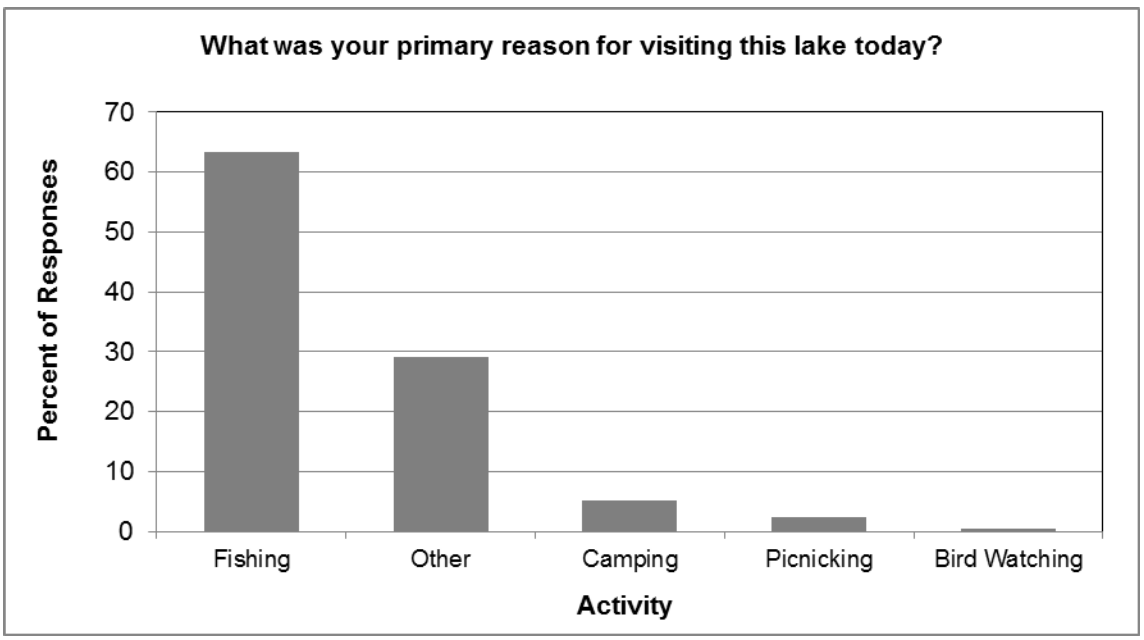


Figure 177. Summary of angler responses to the primary reason for visiting Spring Valley Reservoir, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

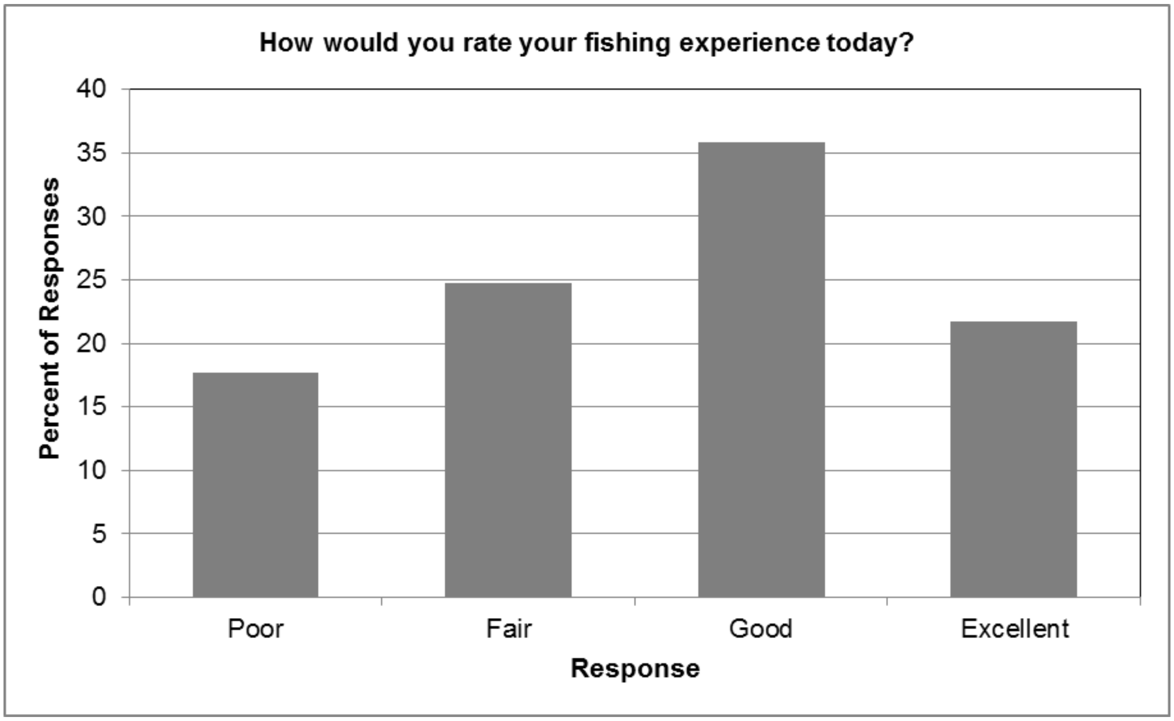


Figure 178. Summary of angler responses regarding their overall fishing experience at Spring Valley Reservoir, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

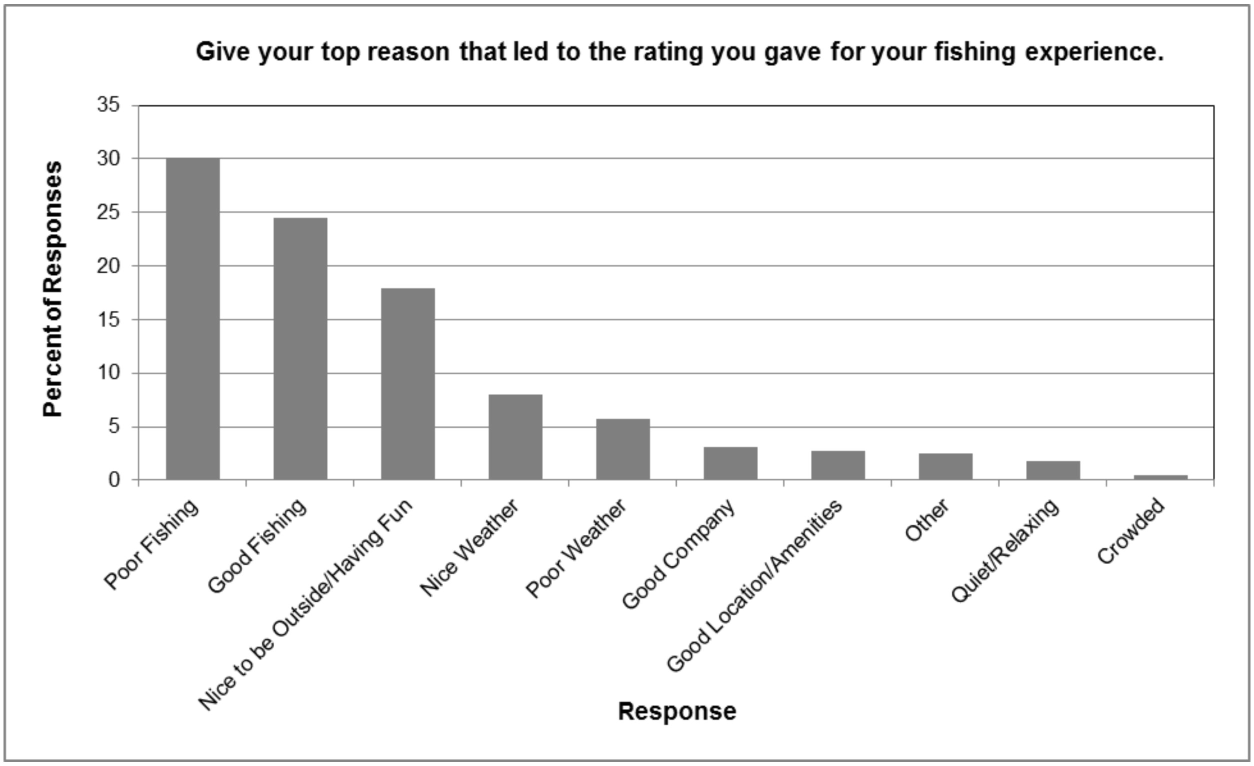


Figure 179. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day when fishing at Spring Valley Reservoir, Idaho, as determined through a creel survey conducted from November 28, 2011 - November 28, 2012 (Only 10 most common answers shown).

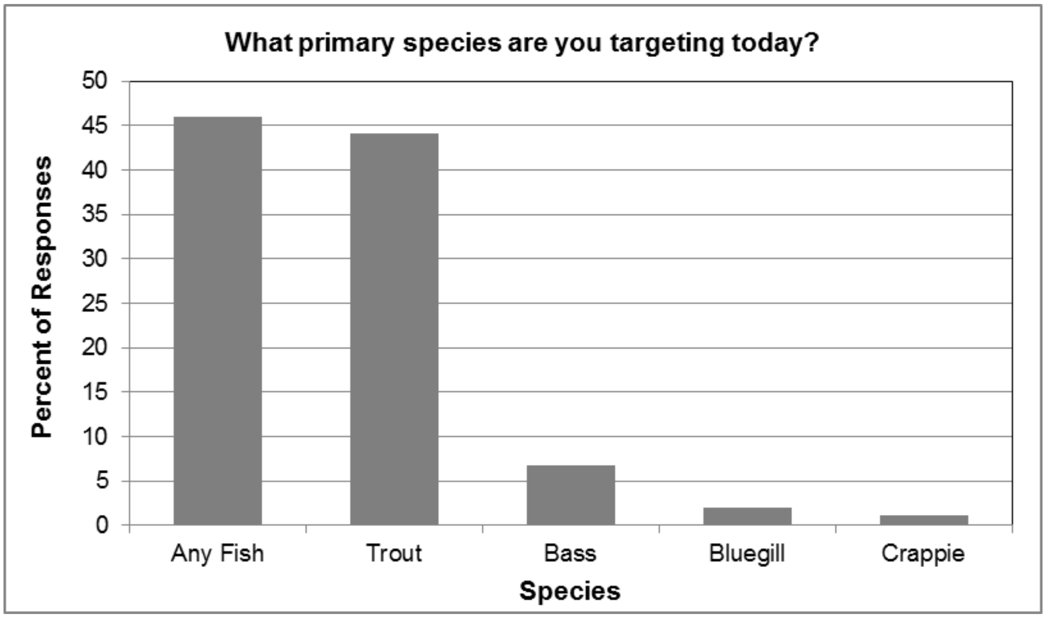


Figure 180. Summary of angler responses regarding target fish species at Spring Valley Reservoir, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

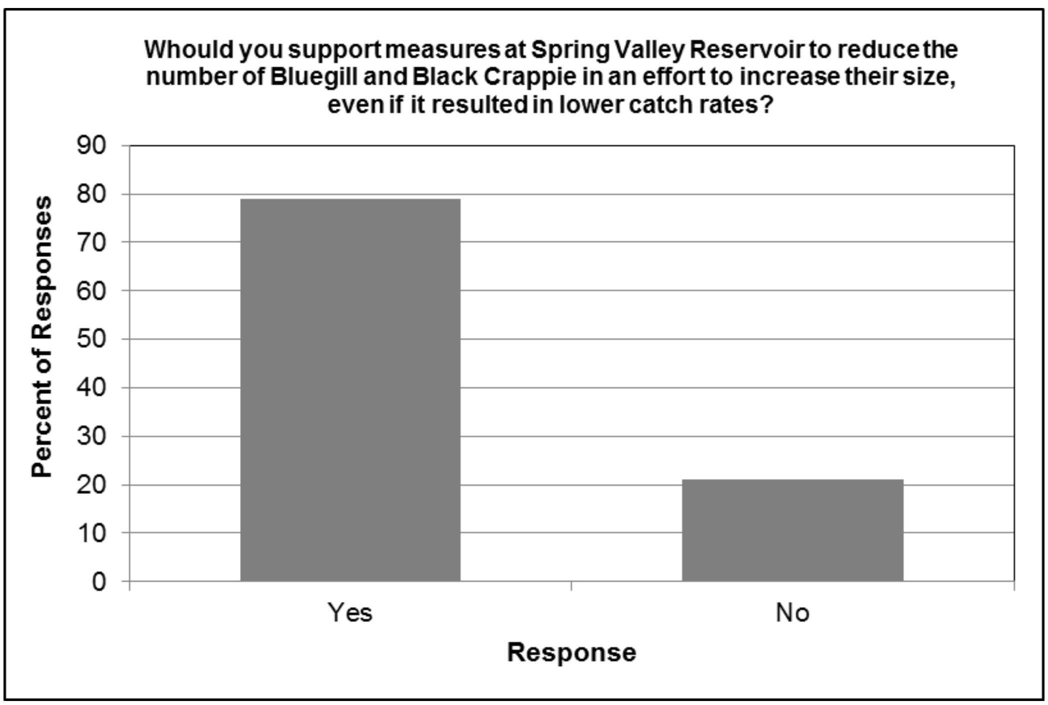


Figure 181. Summary of angler responses regarding possible management change at Spring Valley Reservoir, Idaho, to reduce Bluegill and crappie population to increase size structure, during a creel survey conducted from November 28, 2011 - November 28, 2012.

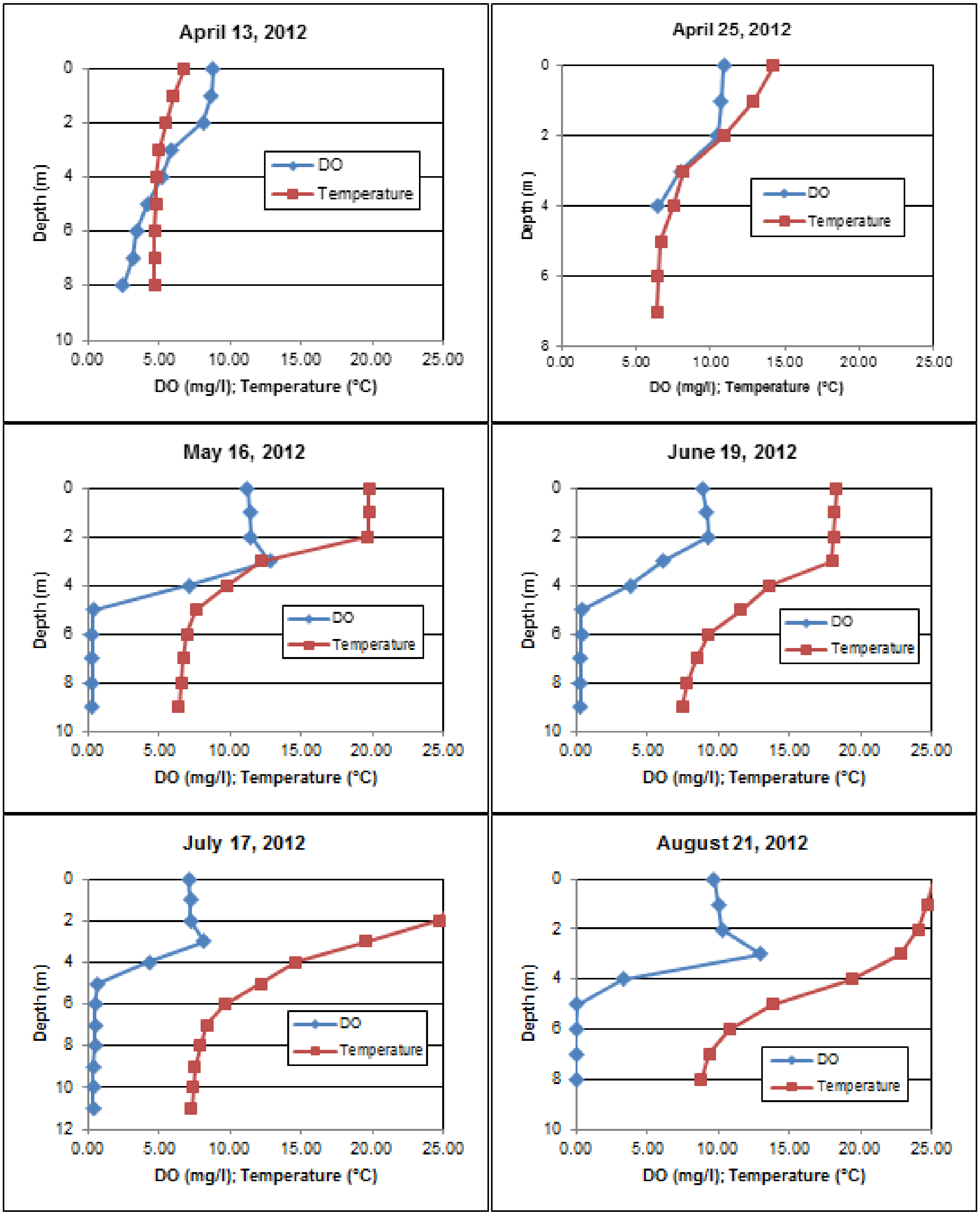


Figure 182. Dissolved oxygen (DO) and temperature profiles collected in Spring Valley Reservoir, Idaho, during 2012.

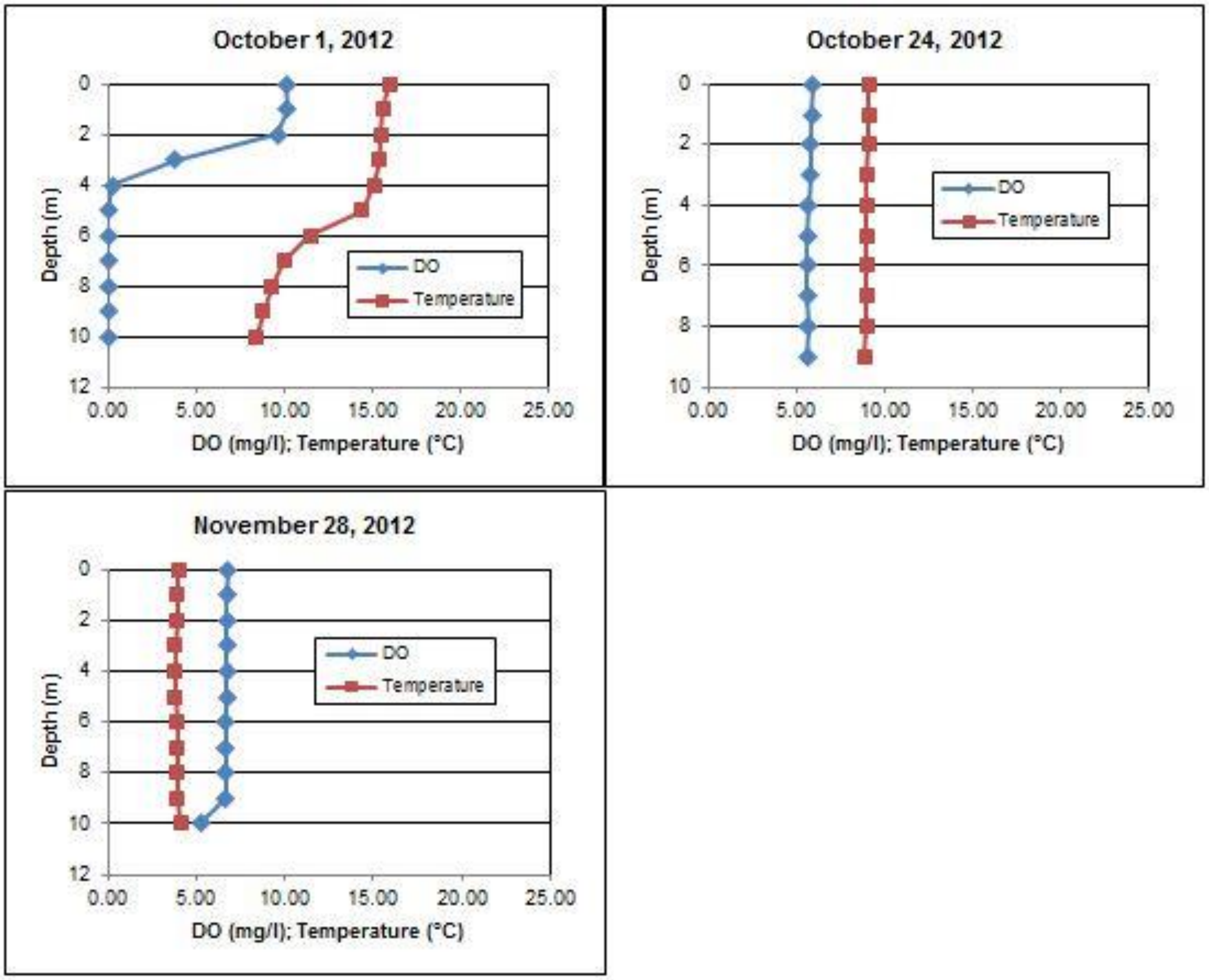


Figure 182. Continued

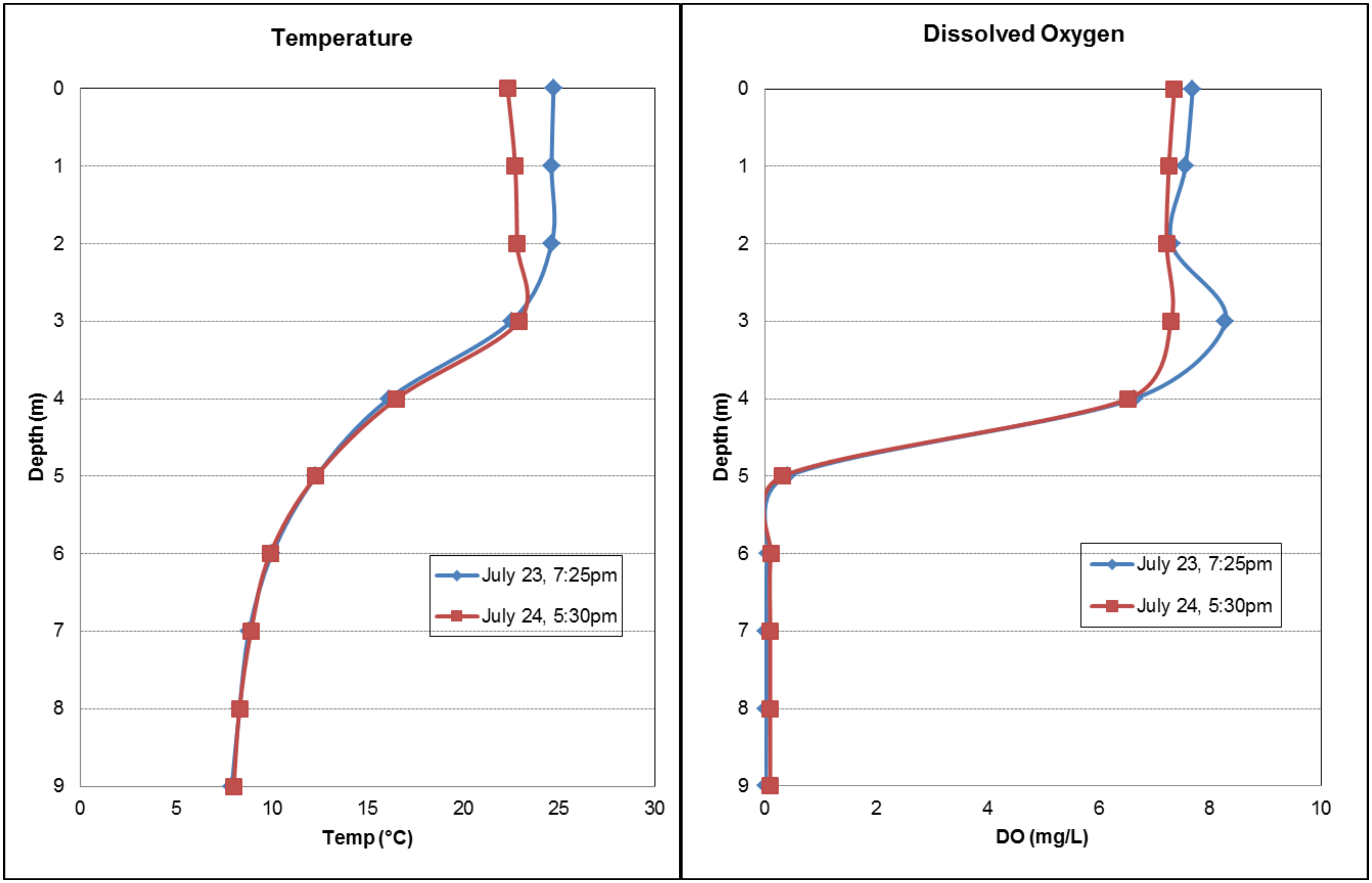


Figure 183. Diel changes in temperature and dissolved oxygen (DO) in Spring Valley Reservoir, Idaho, from July 23 - 24, 2012.

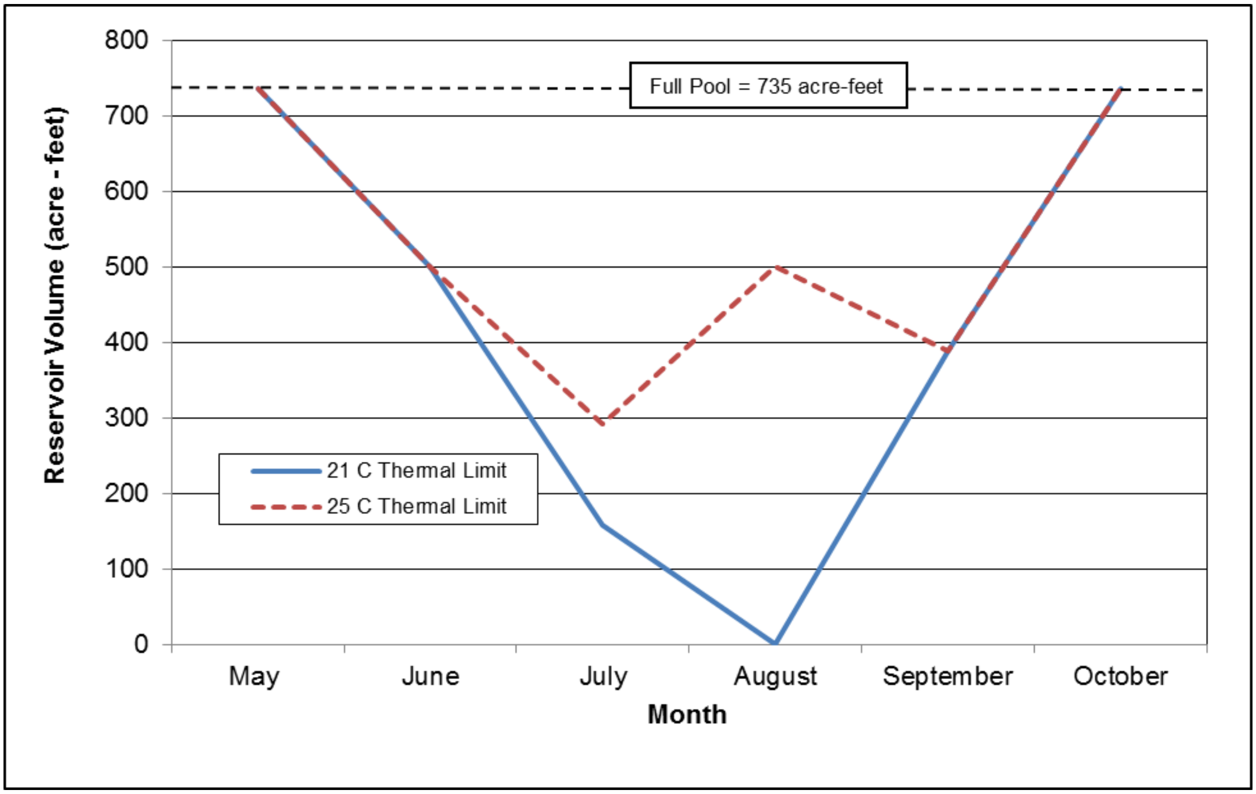


Figure 184. Estimate of trout habitat available in Spring Valley Reservoir, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit, and upper thermal limits of 21°C and 25°C.

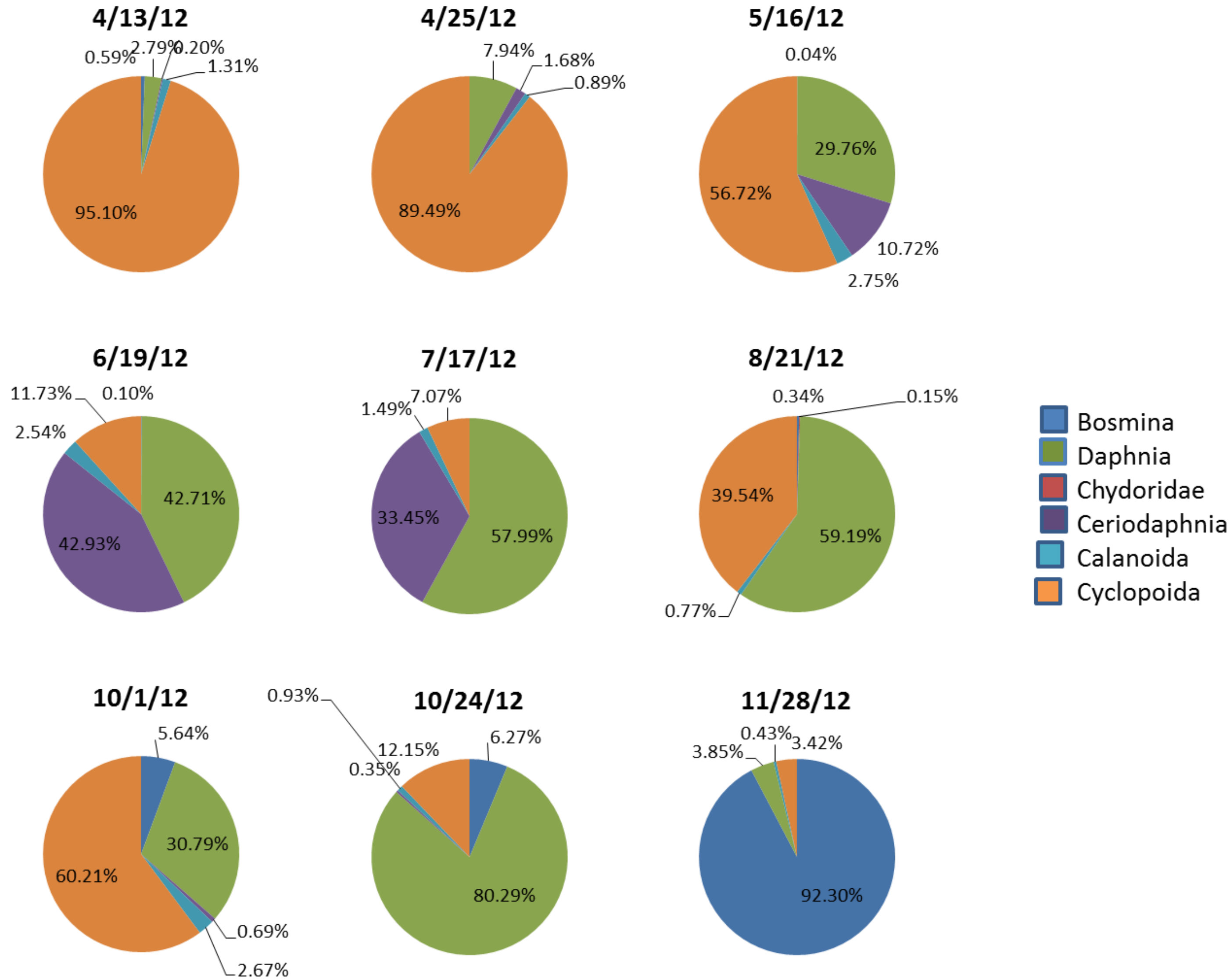


Figure 185. Zooplankton community composition based on monthly samples collected in Spring Valley Reservoir, Idaho, during 2012.

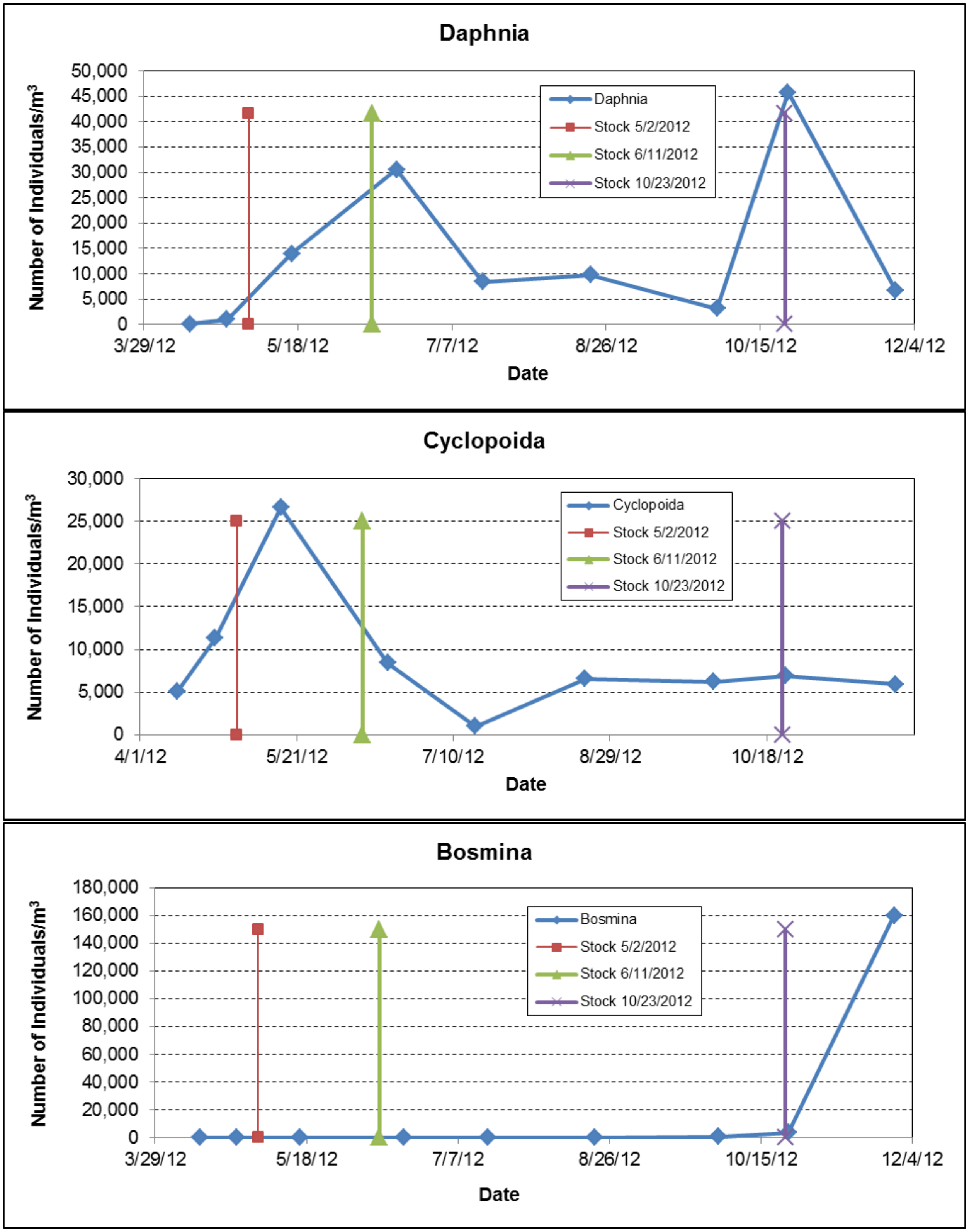
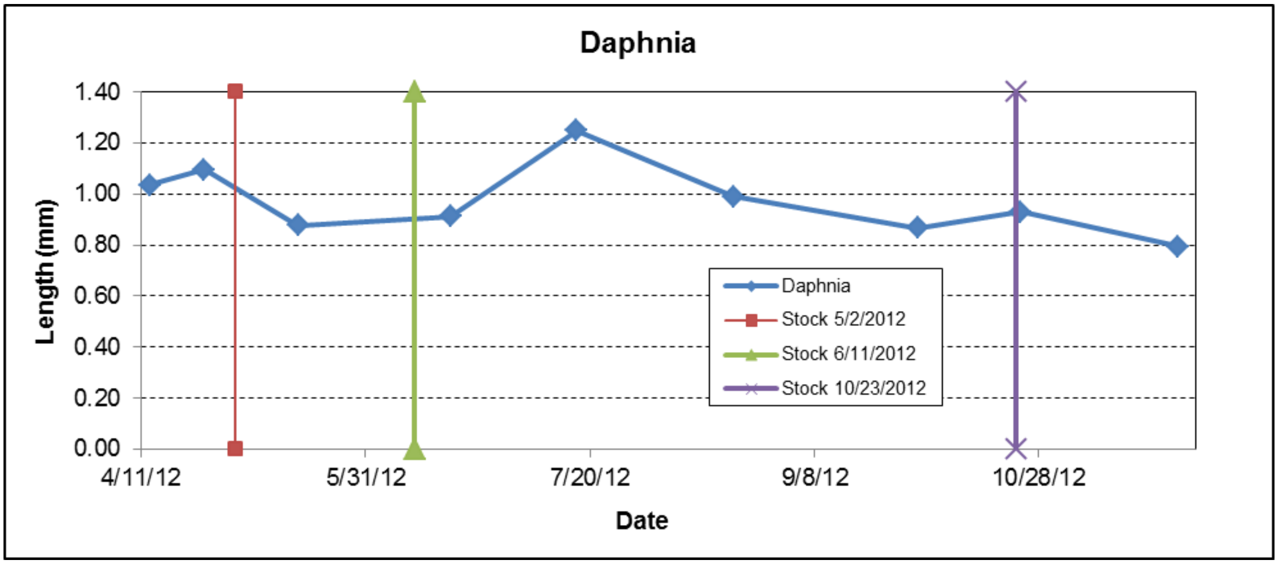


Figure 186. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Spring Valley Reservoir, Idaho, during 2012.



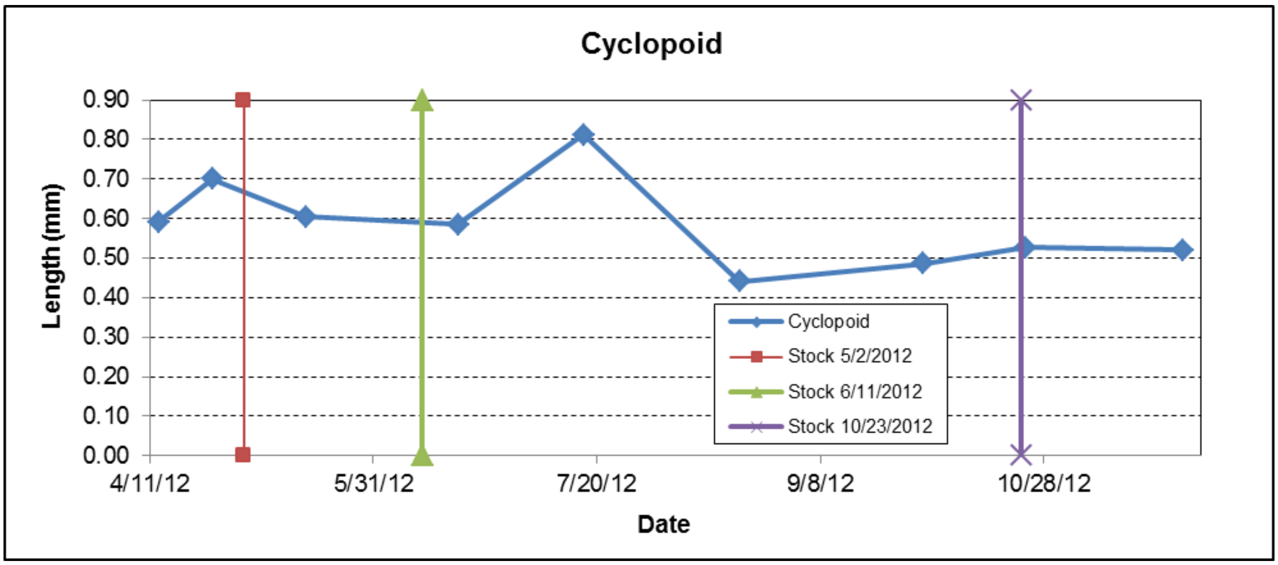


Figure 187. Average length (mm) of zooplankton collected from monthly samples in Spring Valley Reservoir, Idaho, during 2012.

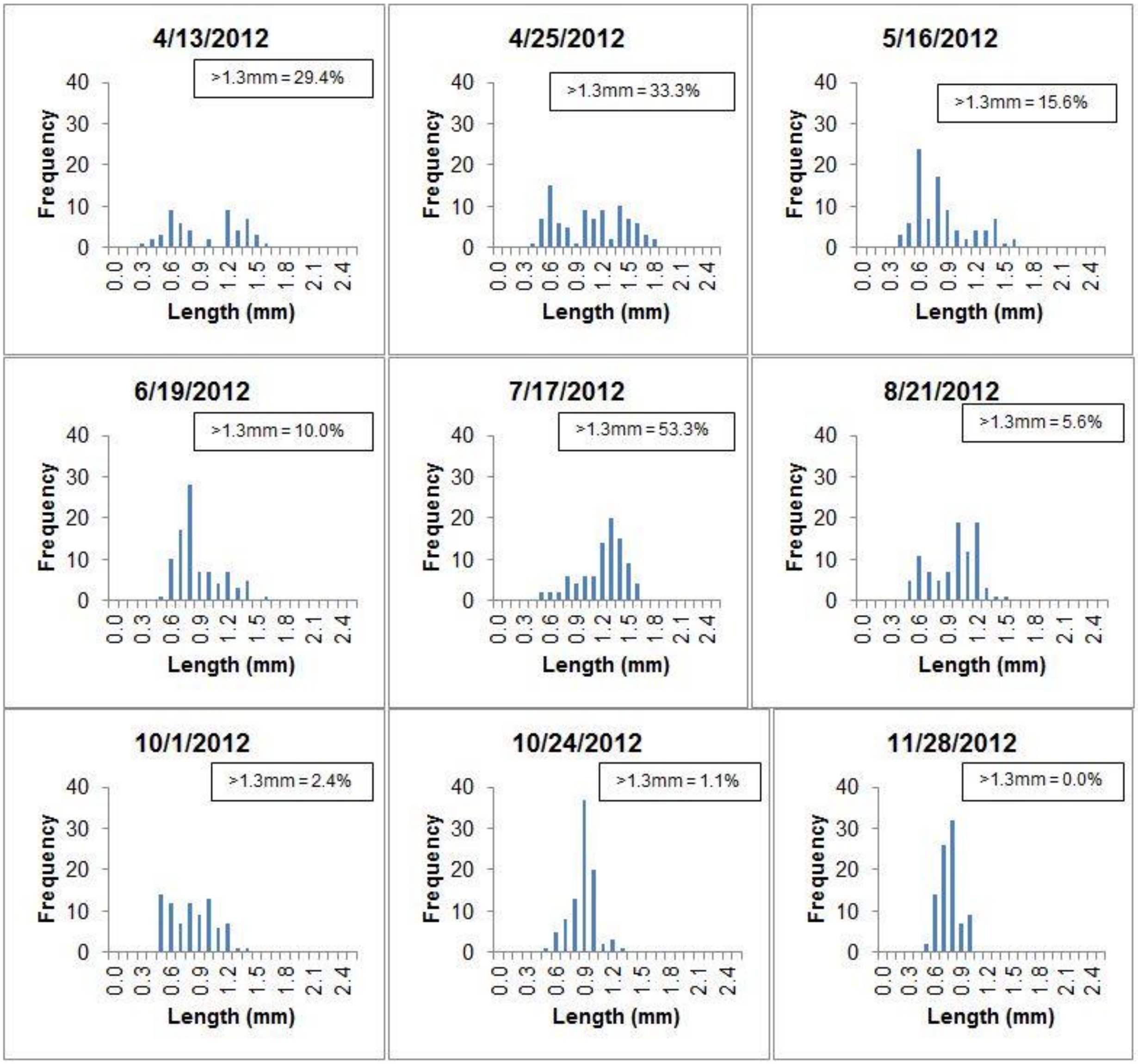


Figure 188. Length frequency distribution of Daphnia collected from monthly sampling in Spring Valley Reservoir, Idaho, during 2012.

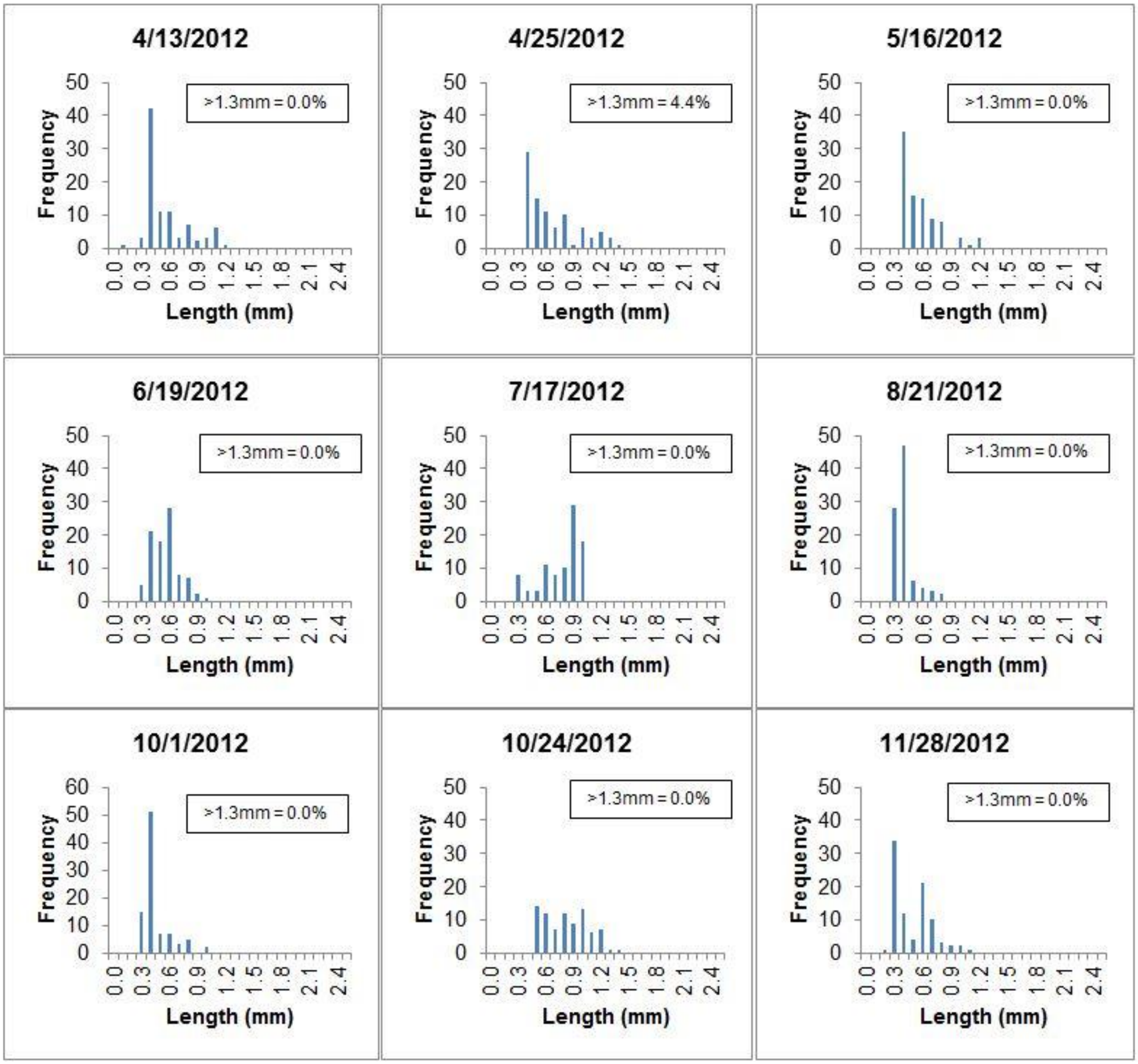


Figure 189. Length frequency distribution of Cyclopoida collected from monthly sampling in Spring Valley Reservoir, Idaho, during 2012.

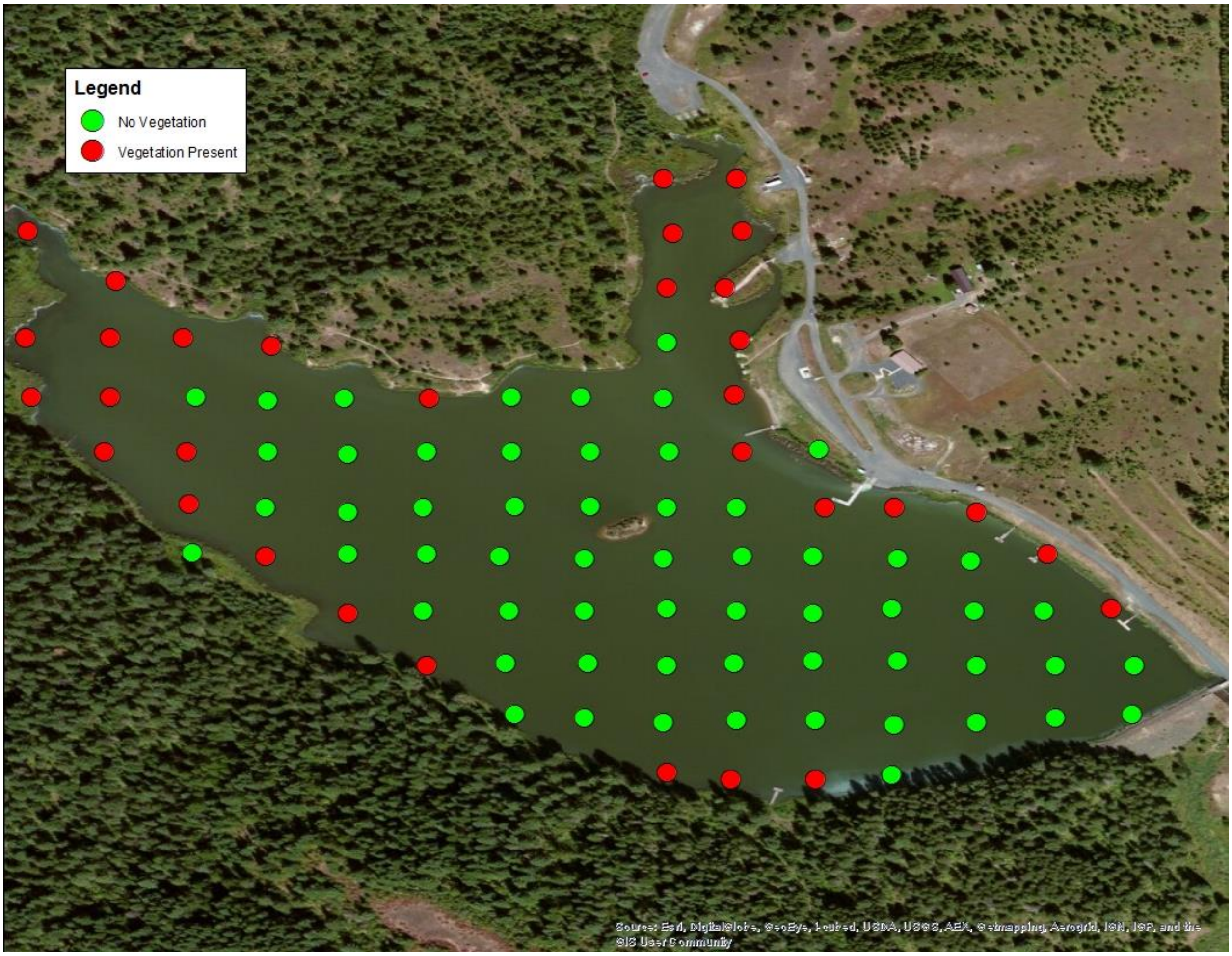


Figure 190. Locations where aquatic vegetation was collected during vegetation sampling of Spring Valley Reservoir, Idaho, during 2012.

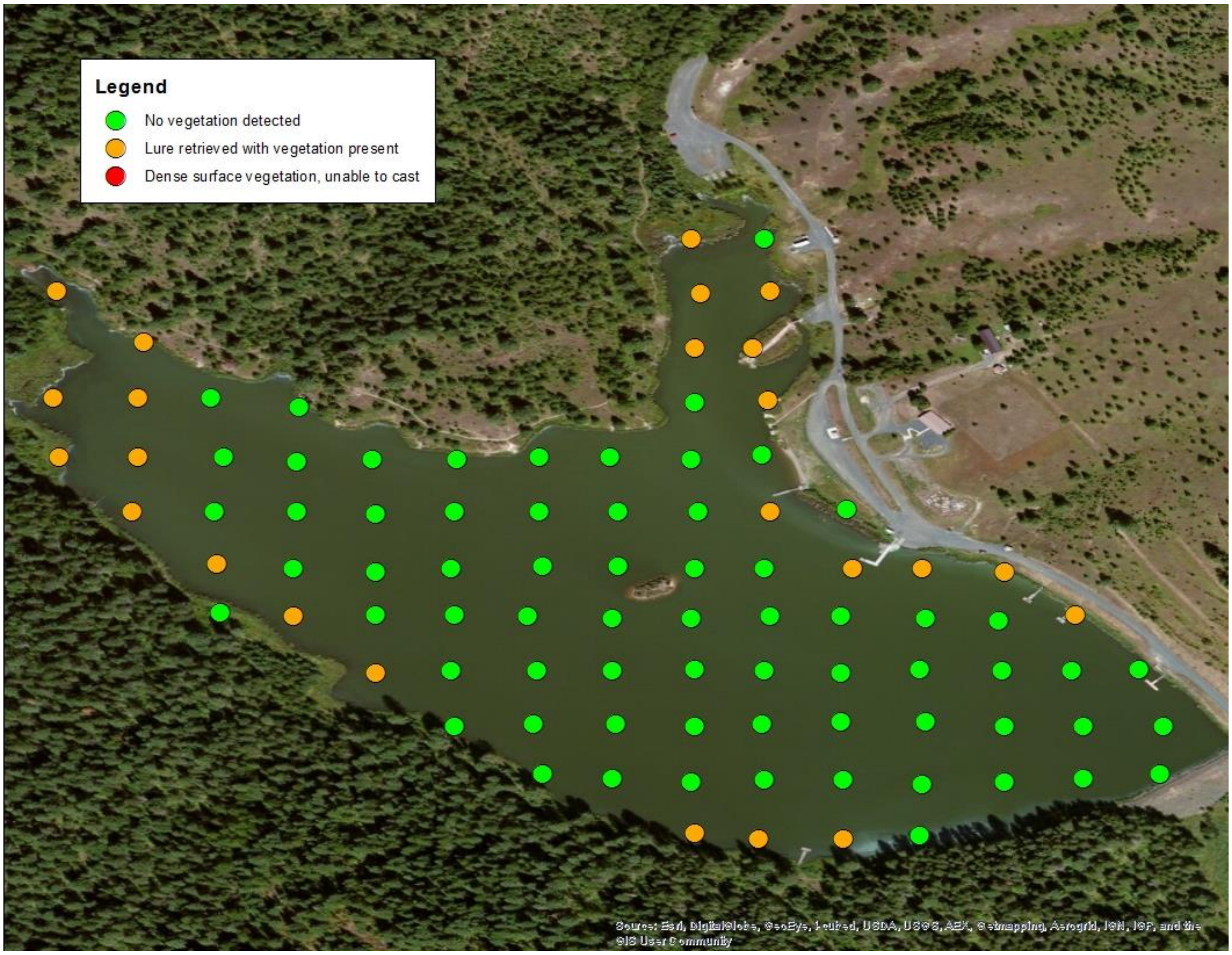


Figure 191. Fishability at vegetation sample locations based on Davids' Fishability Index on Spring Valley Reservoir, Idaho, during 2012.

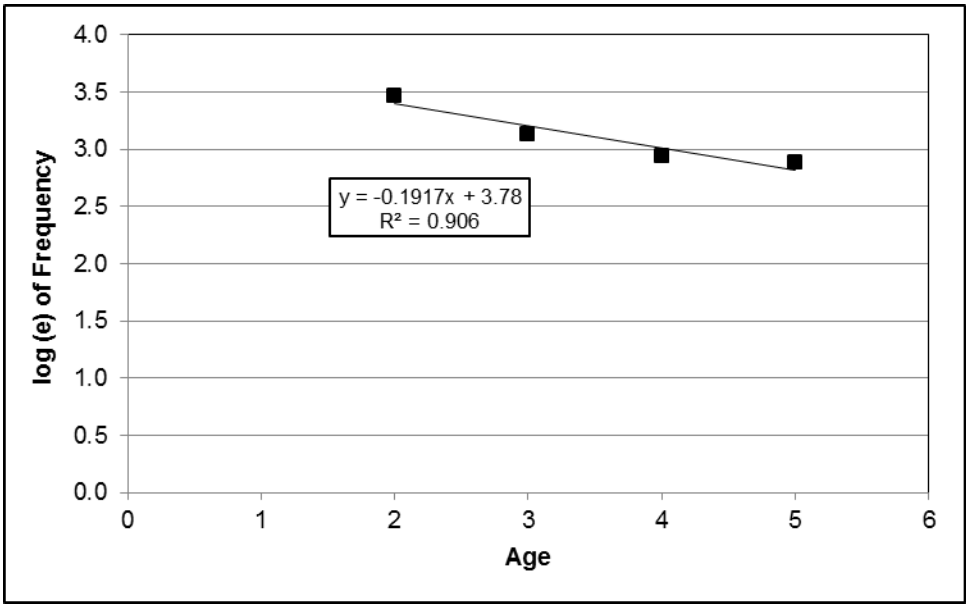


Figure 192. Catch curve for Bluegill age 2 - 5 based upon scale samples collected at Spring Valley Reservoir, Idaho, during the 2012 field season.

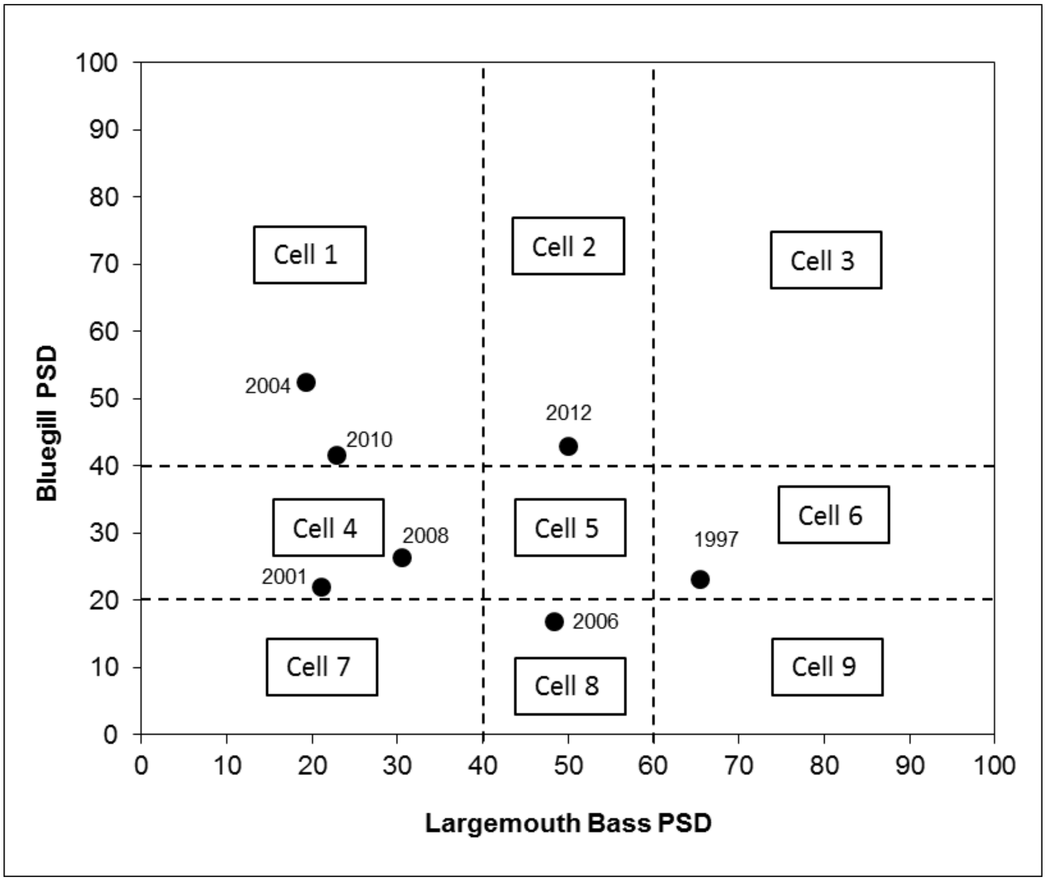


Figure 193. Comparison of predator (Largemouth Bass) and prey (Bluegill, Pumpkinseed, black crappie) proportional size distribution (PSD) from standard lake surveys conducted in Spring Valley Reservoir, Idaho, from 1997 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

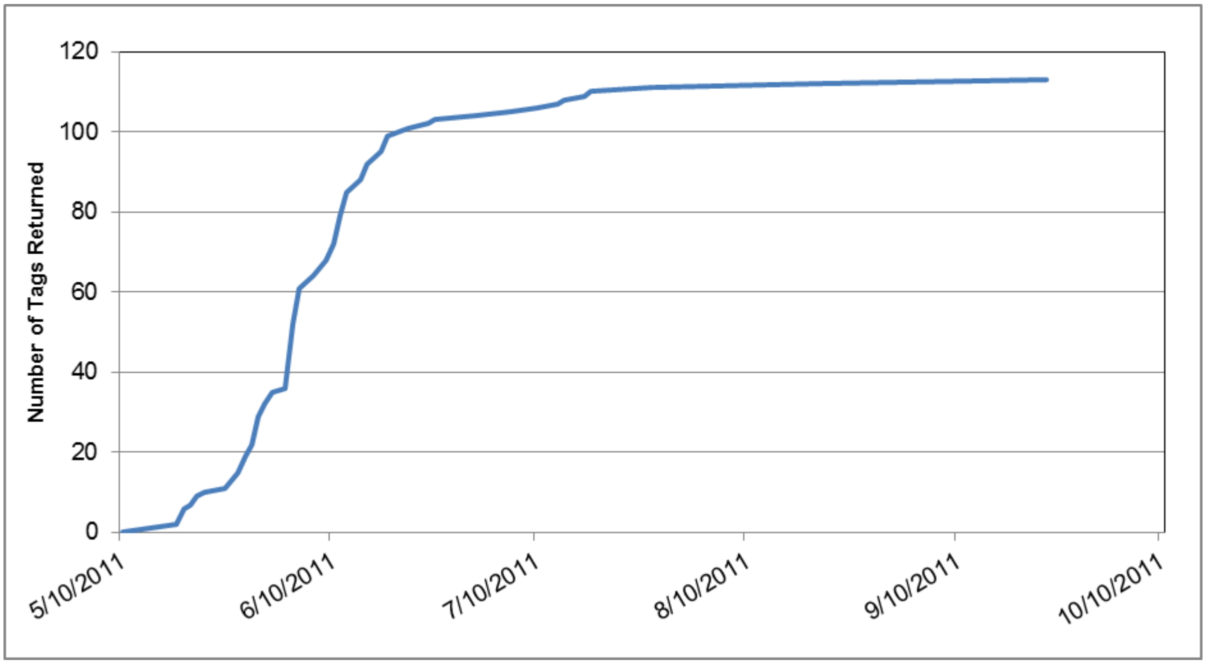


Figure 194. Cumulative number of hatchery catchable Rainbow Trout harvested from Spring Valley Reservoir, Idaho, after spring 2011 stockings, based on angler exploitation surveys (8 fish tagged).

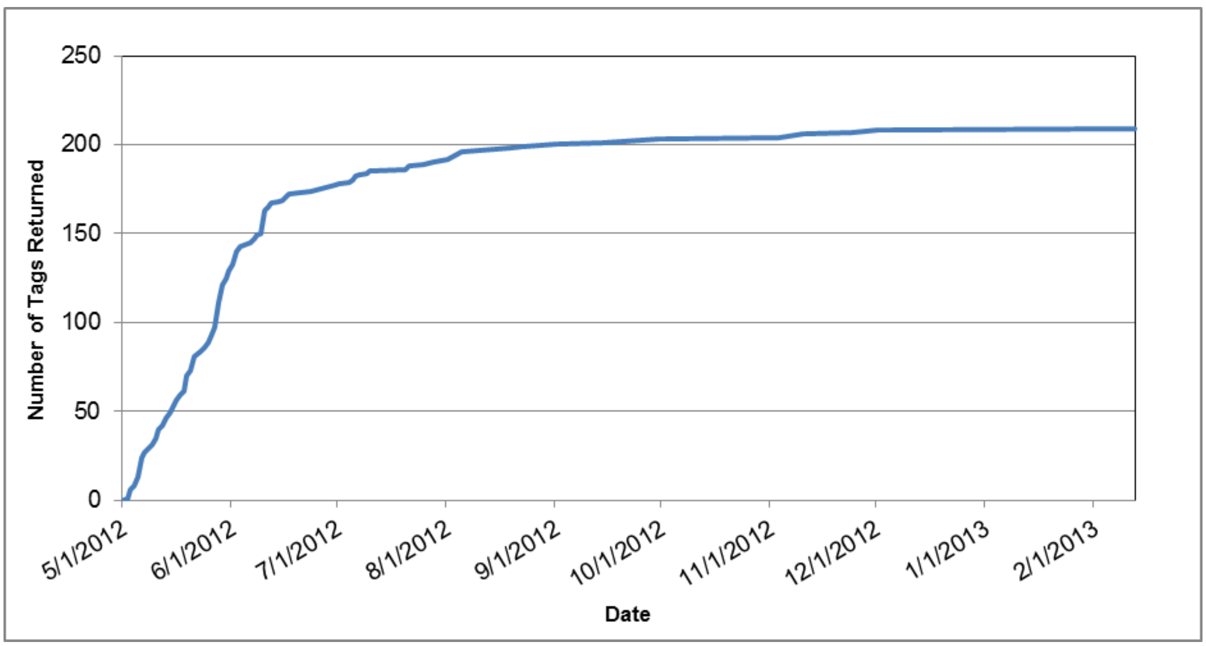


Figure 195. Cumulative number of hatchery catchable Rainbow Trout harvested from Spring Valley Reservoir, Idaho, after spring 2012 stocking, based on angler exploitation surveys (1,800 fish tagged).

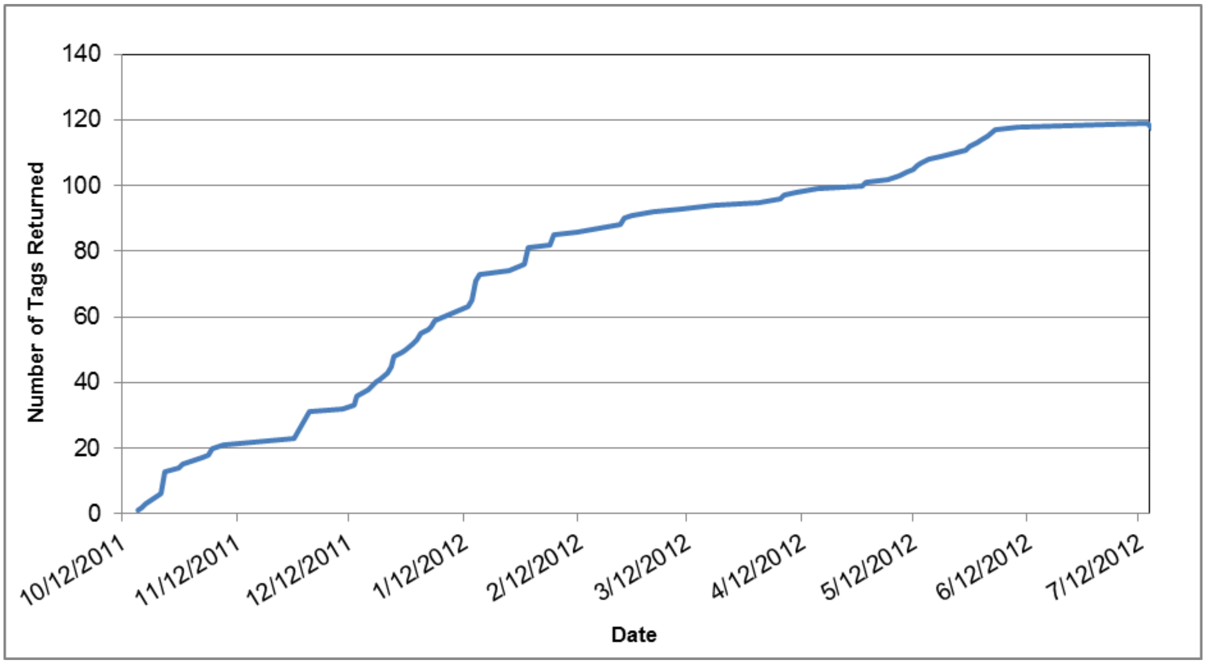


Figure 196. Cumulative number of hatchery catchable Rainbow Trout harvested from Spring Valley Reservoir, Idaho, after October 12th, 2011 stocking, based on angler exploitation surveys (400 fish tagged).

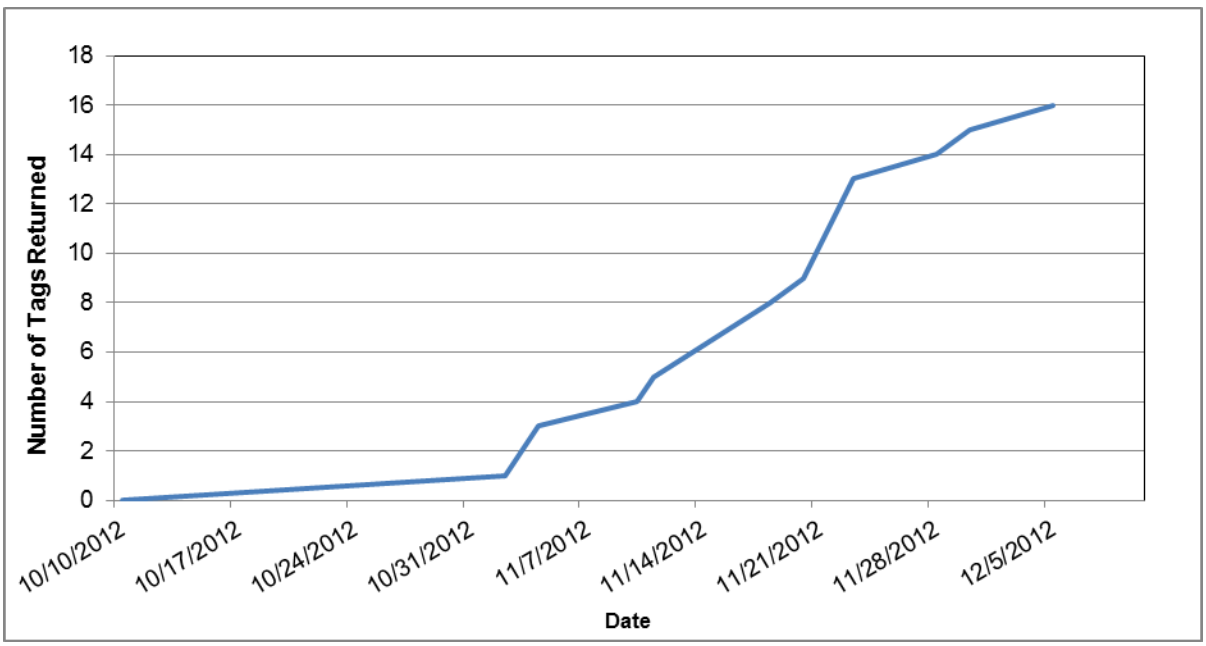


Figure 197. Cumulative number of hatchery catchable Rainbow Trout harvested from Spring Valley Reservoir, Idaho, after October 22nd, 2012 stocking, based on angler exploitation surveys (398 fish tagged).

SPORTFISH ASSESSMENT OF TOLO LAKE

ABSTRACT

In 2012, a comprehensive assessment of Tolo Lake was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 197 fish including Bluegill, Largemouth Bass, Black Crappie, White Crappie, and Black Bullhead. Since 1997, there has been a noticeable shift in species composition, from White Crappie to Bluegill, Largemouth Bass, and Black Crappie. It is possible that the decline of White Crappie has resulted in better recruitment and forage opportunities for these other species.

Creel surveys estimated angler effort at 803 hours. This was the first creel survey conducted on Tolo Lake, and was the lowest effort for any regional reservoir during the 2012 survey. The angler catch rate for all fish species combined was estimated at 1.3 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 0.3 fish/hour. While this is below the statewide management goal of >0.5 fish caught/hour, these fish were stocked just to increase opportunity and potentially draw more people to the lake. We believe that additional stockings and improved access could improve the catch rates in the future. Due to the limited access caused by shoreline vegetation, improving angler access should be a priority for this lake in the future.

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INTRODUCTION

Tolo Lake is the closest lowland reservoir to Grangeville, Idaho (pop. 3,176). It is approximately a 120 km drive from Lewiston, ID (pop. 32,119) and Clarkston, WA (pop.7,331). An economic survey conducted in 2011 estimated 650 angler trips were taken to Tolo Lake for an estimated total economic expenditure of $20,520 (IDFG unpublished data). Tolo Lake is targeted by anglers primarily fishing for warm-water fish. It contains five species of game fish including Largemouth Bass, Black Crappie, White Crappie, Bluegill, and Channel Catfish. Data from the 2012 surveys was intended to assess the current warm-water fishery, and provide insights on how to improve the quality of the fishery.

Current Management

A limited number of Rainbow Trout have also been stocked into the lake to provide more fishing opportunity. The lake is designated as a family friendly fishing water with simplified regulations including year round seasons, no length limits, general six fish limit for trout and bass, no creel limits for other species, and no restrictions on fishing gear. Boat activity on Tolo Lake is restricted to electric motors only. The current management priority is to provide a desirable fishing experience to families and individuals alike.

Reservoir Management Goals

1. Maintain a Largemouth Bass fishery, and yield fisheries for Bluegill and Black Crappie.

2. Diversify fishery with periodic stockings of Channel Catfish and Rainbow Trout.

STUDY SITE

Tolo Lake is located in Idaho County approximately 8 km west of Grangeville, Idaho (Figure 4). It is an 8.1 hectare reservoir with a maximum depth of 4 m, a maximum volume of 247 acre-feet, and lies at an elevation of 985 meters. It was drained and dredged in 1995 to enhance fishery and waterfowl habitat. After refilling in 1996, the lake was stocked with 200 White Crappie, 181 Largemouth Bass, 159 Bluegill, and 32 Black Crappie. An additional stocking of Largemouth Bass was made in 2009 to provide continued fishing opportunities and increase predation on the crappie populations. The watershed is used primarily for agriculture and grazing.

RESULTS

Population Survey

A fishery survey of Tolo Lake was conducted on May 31, 2012 which consisted of 30 minutes of electrofishing and one trap net night. Only 30 minutes of electrofishing was used due to Tolo Lake's smaller size. This allowed us to sample the entire shoreline. Electrofishing was split into three 10-minute electrofishing periods. The electrofishing and one trap net set resulted in the capture of 197 fish including Bluegill (n = 99), Largemouth Bass (n = 46), Black Crappie (n = 41), White Crappie (n = 10), and Black Bullhead (n = 1). The electrofishing catch rate was 394 fish/hour (Figure 198). No fish were collected in the trap net. Catch rates for each of the three 10-minute electrofishing samples ranged from 83 - 205 fish/sample (Table 35). The variability from the three samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). For 90% confidence (2-tail test) and 25% precision, nine 10-minute samples would be needed for a whole fish community survey (Table 35).

Largemouth Bass:

Largemouth Bass collected ranged from 90 - 300 mm in length (Figure 199), with an average length of 246 mm. Only one of the 46 fish collected (2.2%) was >300 mm in length. This is similar to previous surveys, in which no more than one Largemouth Bass >300 mm has been captured in any survey. Largemouth Bass CPUE (92 fish/hour) was the highest since 1997 (Figure 198). Largemouth Bass PSD was two (Figure 200), a slight increase after declining for three straight surveys to zero in 2008. Relative weights ranged from 78 - 121, with an average of 93 (Figure 201). Relative weights were generally lower for larger fish than for smaller fish. Scale samples were analyzed from Largemouth Bass collected in 2012 (n= 45). These fish ranged in age from 1 - 7 years although no age 2 and 3 fish were collected (Table 36). Annual growth rates ranged from 30 - 78 mm. Annual instantaneous mortality (Z) was -0.936 for fish aged 4 - 6 (R^2 = 0.998) (Figure 202). Thus, the annual survival rate (S) was 39%, and total annual mortality (A) was 61%.

Bluegill:

Bluegill collected ranged from 80 - 256 mm in length (Figure 203), with an average of 182 mm. Most (75.5%) of the fish were between 160 - 229 mm. Length frequency distributions have been shifting towards larger fish since 2003. Additionally, Bluegill CPUE has been steadily increasing since 1997, reaching its highest level of 198 fish/hour in 2012 (Figure 198). The PSD of 92 in 2012 was the second highest after a high of 100 in 1997(Figure 204). Relative weights ranged from 47 - 170, with an average of 131 (Figure 205). Relative weights were generally lower for larger fish than for smaller fish. Scale samples were analyzed from Bluegill collected in 2012 (n = 67). These fish ranged in age from 2 - 6 years (Table 37). Annual growth rates ranged from 23 - 68 mm. Annual instantaneous mortality (Z) was -1.025 for fish aged 4 - 5 (R^2 = 1) (Figure 206). Thus, the annual survival rate (S) was 36%, and total annual mortality (A) was 64%.

Black Crappie and White Crappie:

Black Crappie collected ranged from 155 - 257 mm in length (Figure 207), with an average of 223 mm. Length frequency distributions have shifted towards larger fish since 2005. Additionally, Black Crappie CPUE has been steadily increasing since 1997, reaching its highest level of 82 fish/hour in 2012 (Figure 198). The PSD of 98 in 2012 (Figure 208) was the second highest since 1997. Relative weights ranged from 57 - 121, with an average of 100 (Figure 209). Relative weights were generally lower for larger fish than for smaller fish. Scale samples were analyzed from Black Crappie collected in 2012 (n = 31). These fish ranged in age from 2 - 6 years (Table 38). Annual growth rates ranged from 23 - 63 mm. A catch curve (Figure 210) was developed for estimating mortality. Annual instantaneous mortality (Z) was -1.050 for fish aged 5 - 6 (R^2 = 1). Thus, the annual survival rate (S) was 35%, and total annual mortality (A) was 65%.

White Crappie collected ranged from 67 - 235 mm in length (Figure 211), with an average of 212 mm. This average length is higher than the average lengths of 170 - 185 mm seen in samples from 2003 - 2008. White Crappie CPUE has been steadily decreasing since a high of 674 fish/hour in 2003. The PSD for White Crappie in 2012 was 100 (Figure 212), the highest it can be. Relative weights ranged from 79 - 111, with an average of 101 (Figure 213). Scale samples were analyzed from White Crappie collected in 2012 (n = 10). Only age 1 and age 5 fish were sampled (Table 39). Annual growth rates ranged from 32 - 69 mm. A catch curve for estimating mortality could not be developed due to not having enough age classes for analysis.

Channel Catfish and Black Bullhead:

One Black Bullhead, (65 mm TL) was also collected; the first since Tolo Lake has been sampled. No Channel Catfish were collected during the fish survey.

Creel Survey

Angler Effort:

Creel surveys were conducted on Tolo Lake from November 28th, 2011 through November 28th, 2012. A total of 62 instantaneous angler counts were conducted during the creel survey by creel clerks. An additional 5,036 instantaneous angler counts were taken by a trail camera. Total angler effort was estimated at 803 hours (SE ± 167; Table 40). More effort occurred on weekdays (55.9%) than weekends (44.1%). Effort consisted of 58.4% bank, 41.5% boat, and 0.1% ice anglers. The highest angler effort occurred from April - September, with monthly effort estimates ranging from 20 - 306 hours (Table 40).

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on Tolo Lake was based on five completed trip interviews and 34 completed angler report cards. Anglers caught an estimated 1,064 fish during 2012, resulting in a catch rate of 1.3 fish/hour. Hatchery Rainbow Trout accounted for 21.6% (n = 230) of the fish caught during the 2012 creel survey (Figure 214). Warm-water species caught included 390 Largemouth Bass (36.7%), 324 Black Crappie (30.5%), 83 Bluegill (7.8%), 23 White Crappie (2.2%), and 14 Channel Catfish (1.3%). Anglers harvested an estimated 291 fish during 2012, 27.3% of the fish caught (Appendix A). The harvest rate for all fish combined was estimated to be 0.4 fish/hour. Harvest in 2012 consisted of an estimated 156 Black Crappie (53.6%), 87 hatchery Rainbow Trout (29.9%), and 48 Largemouth Bass (16.5%; Figure 215). No warm-water fish were encountered during creel surveys to be measured for total length.

A total of 230 hatchery Rainbow Trout were estimated to have been caught during the survey, with 87 harvested (Appendix B). This is a catch rate of 0.3 fish/hour and a harvest rate of 0.1 fish/hour. Almost all of the fish were harvested in July (Appendix C). The estimated exploitation rate for stocked hatchery Rainbow Trout was 14.5%. Harvested Rainbow Trout measured by creel clerks (n = 4) ranged in length from 224 - 261 mm, and averaged 236 mm.

Angler Satisfaction:

A total of 25 public opinion surveys were conducted at Tolo Lake in conjunction with the creel survey. All constituents using the lake were interviewed. Thirty-five percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 216). “Other” (41.2%) and picnicking (23.5%) were the two other responses. Of the people interviewed, 88.2% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at Tolo Lake. Seventeen percent of people interviewed rated their fishing experience as excellent or good (Figure 217). The only response for a positive rating was “nice to be outside” (14.3%; Figure 217). Eighty-three percent of people interviewed rated their fishing experience as fair or poor (Figure 217). The most common reasons for a negative rating were related to poor fishing (50.0%) and poor amenities (14.3%; Figure 218).

The most commonly targeted fish were crappie (16.7%; Figure 219), although 83% of people interviewed were not targeting any particular species.

Limnology

Limnology samples were collected monthly from April - November, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being quite evident. Dissolved oxygen profiles in April, October, and November were very homogenous, while typical anoxic conditions were present in the hypolimnion in September (Figure 220). To look at potential diel changes in temperature and DO profiles, measurements were taken at 12:45 and 17:50 on August 1, 2012, and at 04:30 on August 2, 2012 (Figure 221). There were drops in both surface temperature and DO overnight, but little change occurred below 1.0 m.

Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. During July, water temperatures were >21°C down to a depth of 2 m, and DO at this time was <5.0 mg/L below 2 m in depth. Using these metrics, no water in Tolo Lake was conducive for Rainbow Trout survival (Figure 222). All other months from May - September also underwent reductions in volume for Rainbow Trout. Utilizing an upper thermal limit of 25°C, there was water in Tolo Lake conducive for Rainbow Trout survival throughout the year (Figure 222).

Zooplankton

Zooplankton samples were collected monthly from April - November, 2012. The population was composed of six taxa of zooplankton: Daphnia, Cyclopoida, Chydoridae, Ceriodaphnia, Bosmina, and Calanoida. The composition was primarily Cyclopoida in all months except August and October when Chydoridae was the primary taxa (Figure 223). Daphnia was the only other taxon that comprised a large portion of the population.

Densities (# of individuals/m^3) were also highly variable, with all taxa peaking for one sample, then returning to low levels (Figure 224). Cyclopoida was the most abundant, with a peak of 602,136/m^3 in the late April sample and a season average of 122,872/m^3 (Figure 224). Daphnia was the second most abundant with a peak of 432,371/m^3, and a season average of 61,020/m^3. No other taxa were found at levels above 5,000/m^3. Overall, zooplankton abundance dropped to very low levels from mid-July through mid-October. Average lengths of Cyclopoida ranged from 0.43 - 0.88 mm, with an overall decline seen through the sampling period (Figure 225). Average lengths of Daphnia ranged from 0.79 - 1.37 mm, with an overall increase seen through the sampling period (Figure 225). Length frequency distributions from each sample show that Daphnia >1.3 mm in length ranged from 0.0 - 57.1% of the individuals collected (Figure 226). Length frequency distributions from each sample show that Cyclopoids >1.3 mm in length (4.4%) were only found in the April 4th sample (Figure 227).

Additionally, ZQI sampling was conducted on August 23, 2012. Biomass was the second lowest for any reservoir at 0.23 (g/m^3) for the 150 µm net, and 0.00 (g/m^3) for the 500 µm net and 750 µm net (Appendix E). The ZPR was calculated to be 0.37 and the ZQR was 0.25.

Aquatic Vegetation

Vegetation surveys were conducted on August 15, 2012. A total of 49 sites were sampled. Vegetation was collected by rake tosses at 14 (28.6%) sample sites (Figure 228). Three types of vegetation were identified: filamentous algae *Rhizoclonium sp.* and *Cladophora sp*., pondweed *Potamogetan sp.*, and macrophytic algae *Nitella sp*. Filamentous algae and pondweed were the most commonly encountered vegetation, with both occurring at all 14 (28.6%) sites where vegetation was collected (Appendix F). Macrophytic algae was found at 8 (16.3%) sites. Shoreline sites accounted for 20.4% (n = 10) of all sample sites. Vegetation was collected at 40.0% of the shoreline sites. Additionally, 28.6% (n = 4) of all sample sites with vegetation were along the shoreline (Figure 228).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 49 sites. Vegetation was encountered at 15 (30.6%) sites (Figure 229). Vegetation was present on hooks at 10 (20.4%) sites, while dense matted surface vegetation prevented casting at five (10.2%) sites. Ten percent of the surveyed sites were along the shoreline; and based on the DFI, angling at 60% of these sites would be negatively influenced by vegetation.

DISCUSSION

Population Survey

The fish community in Tolo Lake was primarily composed of Bluegill, Largemouth Bass, and Black Crappie in 2012. Since 1997, there has been a noticeable shift in species composition. White Crappie dominated species composition in 1999 - 2005. Since 2003, their abundance has declined in every sample, with corresponding increases occurring with Bluegill, Largemouth Bass and Black Crappie. It is possible that the decline of White Crappie has resulted in better recruitment and forage opportunities for these other species.

The results of this fish survey have also shown improvements in the size structure and growth of all fish species sampled compared to previous surveys. We believe this is at least partly due to the 2009 repair of the diversion structure that supplies water to the lake. This has resulted in less water level fluctuation, improved water clarity, and fewer algae blooms. These changes should improve the diversity of food sources, foraging efficiency, and the quality of algae. Another reason for this change in size structure is likely due to a fish kill that occurred in the summer of 2011, which resulted in the loss of many Bluegill, crappie, and Largemouth Bass. This sudden drop in abundance should reduce intra and interspecies competition and likely result in improved growth.

The 2012 fishery survey was conducted in three 10-minute electrofishing samples. This time was sufficient to survey the entire shoreline of Tolo Lake. The variability from the three samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). For 90% confidence (2-tail test) and 25% precision, nine 10-minute samples would be needed for a whole fish community survey (Table 35). Given the size of the reservoir, this would result in the entire shoreline being sampled three times. As this is unrealistic, we recommend continuing to use three 10-minute samples, as this allows the entire shoreline to be sampled once.

Largemouth Bass:

Tolo Lake's Largemouth Bass population is difficult to analyze, as most of the fish collected were stocked by IDFG in 2009 (Hand et al. 2012) in an attempt to control overpopulated crappie through predation. This strategy does not appear to have been successful, as very little Largemouth Bass recruitment has occurred. In fact, only three Largemouth Bass <200 mm were collected during the fish survey in 2012 (Figure 199). Tolo Lake has generally been dominated by relatively small Largemouth Bass (160 - 309 mm) in samples collected from 1997 - 2012. Of the 105 Largemouth Bass collected during that span, 18.1% were >260 mm and 2.9% were >300 mm. This has resulted in PSD values below 13.0 for every sample collected since 1997, well below the balanced population range of 40 - 60 (Schramm and Willis 2012). Reproduction in Tolo Lake is likely restricted by predation from Bluegill, Crappie, and Channel Catfish.

Largemouth Bass growth rates are slightly lower than what we see in the other lowland lakes in the region. Additionally, it appears that a high (61%) annual mortality rate prevents them from reaching larger sizes where they become more effective predators and more desirable to anglers. Based on the creel survey, anglers harvested 48 bass, which is likely a major contributor to the high mortality rate in a small reservoir such as Tolo Lake. As such, we should explore implementing restrictive regulations to reduce angler harvest and annual mortality rates.

Bluegill:

This survey has shown a marked change in the Bluegill population since 2003. The CPUE increased from 6 fish/hour in 2003 to 198 fish/hour in 2012, and average length has increased from 125 mm to 182 mm. Accordingly, Bluegill PSD has increased from 0 in 2003 to 92 in 2012. Scale analysis suggests there were two successful year classes (2007 and 2008) that have led to these changes. The occurrence of successful year classes may be due to the decline in the White Crappie population, which was likely predating upon the juveniles of other species in the reservoir. This may be resulting in better recruitment and forage opportunities for these other species.

With the average Bluegill well over quality size (>150 mm), Tolo Lake now offers anglers an excellent Bluegill fishery. Unfortunately, it appears few anglers have taken advantage of this fishery. The limited amount of effort and harvest may be because anglers are not aware of this new fishery. Increasing public awareness of this fishery through various media sources may be effective in increased angler effort and harvest on bluegill in this lake. Increased harvest of Bluegill have been found to help maintain a higher quality fishery, but it is often difficult to get anglers to harvest enough fish to maintain a balanced population over time (Cooke et al. 2001; Isermann and Paukert 2010). This would especially be the case for Tolo Lake which incurs so little effort. Barring a large fish kill, we may see a continued increase in Bluegill size over the next few years as this year class continues to age. However, unless there is another large recruitment year, Tolo Lake will experience a decline in its Bluegill population size and a resulting drop in PSD as the older fish begin to die off.

Black Crappie and White Crappie:

As with many of our smaller reservoirs in the Region, the Black Crappie and White Crappie populations in Tolo Lake are dominated by just one or two year classes. Scale analysis shows that almost all of the crappie were age 5 (2007 year class). A boom and bust cycle for crappie has been reported for many smaller lakes and reservoirs across the nation (Beam 1983; McDonough and Buchanan 1991; Allen 1997). The successful recruitment years in our Region do not coincide across water bodies indicating that environmental factors are not the primary driving force behind successful year classes. It is interesting to note that since 2003, when White Crappie dominated the lake, their numbers have declined while the Black Crappie population has increased (Figure 198). It appears that Black Crappie are slowly displacing or outcompeting White Crappie in Tolo Lake.

Channel Catfish and Black Bullhead:

Fourteen Channel Catfish were estimated to have been caught by anglers in 2012. While representing a small portion of the effort and harvest in Tolo Lake, these fish do provide a diversity of fishing opportunity. As such, we should continue to stock Channel Catfish in Tolo Lake. However, stocking should be reduced based on the low level of effort and harvest. Additionally, this was the first time a Black Bullhead was collected in Tolo Lake, indicating a recent illegal introduction into the reservoir. Black Bullhead should be monitored over the next few years due to their potential for overpopulating small reservoirs.

Warm-water Fishes Predator:Prey Dynamics:

A comparison of the average PSD of predator species (Largemouth Bass) to prey species (Bluegill, Black Crappie, and White Crappie) can be used to determine predator:prey dynamics in a reservoir and provide insight into potential population issues (Schramm and Willis 2012). In Tolo Lake, this relationship has stayed in Cells 1, 4, 7 due to very low predator PSD (Figure 230). The 2012 sample landed in Cell 1. Fish communities that fall into Cell 1 generally have an overabundance of Largemouth Bass <300 mm, and few prey species <150 mm (Schramm and Willis 2012). Schramm and Willis (2012) have suggested that this scenario may be caused by a high predation rate from an abundant largemouth bass population on young bluegill. This would allow the few surviving Bluegill grow quickly to >150 mm (quality size). In this case the low Largemouth Bass PSD would indicate an overabundant population of 200 - 300 mm Largemouth Bass (Schramm and Willis 2012). However, in Tolo Lake that does not appear to be the case as Largemouth Bass recruitment appears limited and the larger fish may be related to past stocking efforts. In Tolo Lake, it appears that a boom and bust prey based coupled with a poor reproductive success for the predator is leading to this unbalanced system. Better understanding the boom and bust nature of this system is needed to better manage the fishery and expectations of anglers.

Creel Survey

Angler Effort:

The year-long creel survey in 2012 was the first ever conducted on Tolo Lake. It resulted in an estimated 803 hours of angler effort. This was the lowest effort for any regional reservoir during the 2012 survey. The low level of effort at can be attributed to its remote location, its relatively small size (8.1 ha), limited access (lake is surrounded by brushy shoreline vegetation), a lack of amenities (one small dock at the boat ramp), and a poor fishing experience (see section below on Angler Satisfaction).

Catch and Harvest:

Based on the 2012 creel survey, most anglers either stated they were fishing for "any fish" (83.3%; Figure 219), or targeting crappie (16.7%). Catch composition in 2012 was primarily warm-water species, with Black Crappie accounting for the majority of the harvest (50.2%; Figure 215). The catch rate for all species combined was 1.3 fish/hour, and the harvest rate was 0.7 fish/hour. The catch rate for Rainbow Trout was 0.3 fish/hour, and the harvest rate was 0.1 fish/hour, both well below the average catch rate of 1.3 fish/hour and harvest rate of 0.8 for regional reservoirs in 2012 (Appendix B). As this was the first creel survey conducted on Tolo Lake, no comparisons can be made to previous data.

Catch of hatchery Rainbow Trout was estimated to be 230 fish in 2012 (Appendix B). The estimated total use rate was 38.3%, close to the statewide management goal of 40% for hatchery catchable Rainbow Trout. The catchable Rainbow Trout were stocked into Tolo Lake to increase opportunities. There was no expectation for it to generate a lot extra attention to this lake. It was somewhat surprising to see that the 600 stocked rainbow trout actually resulted in about 30% of the harvest and generated the catch rates it did (0.3 fish/hr). This may suggest that additional stocking and improved access could improve the catch rates in the future.

Angler Satisfaction:

Based on angler surveys most anglers (83%) rated their experience as "poor" or "fair". Poor fishing (50% said this) was the number one contributing factor, as to why they gave the rating they did. In fact, nobody indicated that good fishing was a factor that played a role in their overall experience. The only positive response for a rating was "nice to be outside". This was somewhat surprising considering the addition of catchable Rainbow Trout and an improvement in Bluegill and Black Crappie size structure. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself. Thus, we recommend adding additional docks to improve access to the reservoir. The shoreline of Tolo Lake is almost completely covered with dense, brushy vegetation, making the dock at the boat ramp the primary access for bank anglers. Several docks spaced out from the boat ramp along the north and west side of the reservoir with a gravel walking path would improve access and could increase effort and improve angler's experiences. In addition, based on what we observed from the limited Rainbow Trout stocking, increasing stocking should result in higher catch rates and improved angler satisfaction.

Limnology

Sampling in 2012 showed that DO and temperature levels were suitable for Rainbow Trout in every month sampled except for July. This was a much broader range of months than expected due to the shallow nature of Tolo Lake. As such, Rainbow Trout are more likely to survive through the fishing season than previously thought. Thus, higher stocking rates could provide more benefit to anglers and improve effort and catch rates.

Zooplankton

Larger sized zooplankton taxa, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in Tolo Lake was dominated by Cyclopoida and Chydoridae through most of 2012, with Daphnia present primarily in April - June. In 2012, Daphnia collected averaged 1.0 mm in length, and Cyclopoida averaged 0.6 mm in length (Figure 225). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Additionally, up to 57.1% of Daphnia and 4.4% of Cyclopoids were at or above preferred size (Figures 223 and 224) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 42.3% of the Daphnia population and 5.1% of the Cyclopoida population were ≥1.0 mm in length.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for Tolo Lake. The ZQI, which is a measure of both abundance and size, was 0.00 (Appendix E). ZQI values <0.1 are considered low and indicate that zooplankton resources are limiting and may potentially impact trout populations (Teuscher 1999). This sampling also indicated that zooplankton biomass was low. With larger Daphnia available during the spring, and a poor ZQI (sampling done in August), the data suggests that larger zooplankton individuals are being cropped off by mid-summer. This is supported by the high zooplankton abundance in the spring and good relative weights of fish sampled, which suggests adequate food resources are available in the spring for good growth.

Aquatic Vegetation

Monitoring vegetation in Tolo Lake will be an important part of managing the reservoir in the future. As seen in our surveys, vegetation was present at 30.6% of the sites samples. Vegetation presence alone, however, doesn’t provide the entire picture. We must also consider what types of vegetation are present and what effects it has on fish populations and recreation in the reservoir. In the case of Tolo Lake, filamentous algae and pondweed were the predominant types of vegetation present. Both species are known to grow quickly and form dense mats across the water’s surface. This can greatly reduce forage success for predators such as Largemouth Bass, and increase the abundance of prey species (Bettolli et al. 1992; Dibble et al. 1996).

In addition to being a problem for fish populations, vegetation can also affect fishing and other recreation. Based on vegetation sampling and use of the DFI, vegetation could negatively influence fishing over 41% of its area and 60.0% of shoreline. With 58.4% of angler effort in 2012 ocurring from the bank, this could significantly reduce angling opportunity and/or the quality of the fishing experience. However, only 7.1% of anglers in the 2012 creel survey complained about vegetation, we have received complaints from anglers (by phone and in person) over the past few years regarding vegetation.

Reducing the quantity of aquatic vegetation in Tolo Lake could improve both the forage success for Largemouth Bass (Bettolli et al. 1992; Dibble et al. 1996) and the recreational opportunities in the reservoir. Previously, herbicide treatments using liquid Reward® were conducted in regional reservoirs and ponds (DuPont et al. 2011) to address submerged vegetation. These applications reduced the surface coverage from approximately 30 - 40% around boat ramps and fishing docks to 10 - 15% coverage. However, vegetation coverage returned to pre-treatment levels approximately eight weeks after the treatment. Maintaining adequate control would require multiple treatments per year.

Due to the limited success of small scale herbicide treatments in regional reservoirs, other techniques for controlling nuisance aquatic vegetation were researched by DuPont et al

(2011). These techniques included biological, mechanical, physical, and other chemical control methods that are often used for vegetation control throughout the country (Appendix L). The recommended control measures for regional reservoirs and ponds were determined to be winter drawdown, benthic barriers, and grass carp. Benthic barriers would not be appropriate for regional reservoirs due to the high cost of installation and maintenance of barriers over large areas. Additionally, they do not address the floating mats of algae and vegetation found in Tolo Lake. Winter drawdown is not option, either, as Tolo Lake is very shallow and does not have a drain system.

A potential control choice is grass carp. Grass carp have been shown to be effective at controlling nuisance aquatic vegetation (Avault 1965, Mitzner 1978, Hanlon et al. 2000), including the species present in Tolo Lake. However, numerous studies point out that a moderate level of control is difficult to achieve, as control is often either “all or nothing” (Kirk 1992, Mitzner 1994, Pauley et al. 1998, Bonar et al. 2002). The use of grass carp should be approached cautiously. It is recommended to start stocking grass carp at a low stocking rate of 3 - 6 fish/acre, as overstocking is detrimental and is difficult to correct. More grass carp can be added if additional control is needed. Grass carp would cost an estimated $2,700 - $4,400 at this lower stocking rate (Appendix L). Monitoring their effectiveness should be conducted for several years, as control may not become apparent for up to two years post-stocking (Bonar et al. 2002: Cooke et al. 2005).

Due to the limited potential success and/or high cost of many vegetation control methods, several options should be considered. Herbicides and mechanical removal methods (hand cutting, harvesting), while not feasible for whole lake control, could be potential options for control in small areas such as around popular fishing areas and the boat ramp. While small scale herbicide treatments did not provide long-term control, the eight weeks of control seen from previous single applications (DuPont et al. 2011) would provide improved recreational opportunity during the height of the fishing season in June and July (Table 40). Treating pondweed and algae (which is not controlled by Reward®) at Tolo Lake would cost approximately $325 per surface acre using both Reward® and GreenClean Pro® for each treatment. Mechanical control, such as hand-cutting or pulling, could also be effective for short-term control in small areas. As with many other options, revegetation usually begins within a few weeks (Nicholson 1981; Cooke et al. 2005). It is difficult to estimate the cost of physical control because most of the cost is associated with labor (Cooke et al. 2005), especially if SCUBA divers would be required for deeper water. Divers would likely be needed for some areas in Tolo Lake, as water depth is >2m around the end the dock, and much of the vegetation is away from the shoreline. The use of volunteers would greatly reduce the costs, but would not likely be a reliable source of labor on an annual basis. A concern with using this option in Tolo Lake is that the low visibility of the reservoir would reduce effectiveness. Thus, we recommend utilizing spot treatments of herbicides around docks and popular fishing spots in the spring to provide summer control of nuisance aquatic vegetation during the height of the fishing season. If vegetation levels continue to increase, the use of grass carp could be explored.

MANAGEMENT RECOMMENDATIONS

1. Increase angler access by adding more docks along the lake.

2. Conduct future fisheries surveys with three 10-minute electrofishing samples - enough to cover the entire shoreline once.

3. Explore ways to sample Channel Catfish in the lake.

4. Explore if stocking more RBT could improve catch rates and angler satisfaction.

5. Utilize spot treatments of herbicides around docks and fishing spots to provide summer control of nuisance aquatic vegetation.

6. Further assess the boom and bust nature of this fishery and the lack of Largemouth Bass recruitment.

7. Consider the implementation of restrictive regulations for Largemouth Bass due to high angler harvest and annual mortality rates.

Table 35. Number of fish collected by species in each 10-minute electrofishing sample conducted during a fisheries survey of Tolo Lake, Idaho, in 2012. Table includes estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 90% confidence and 25% precision.

	Count of fish collected						
Species	EF Sample 1	EF Sample 2	EF Sample 3	Total	Mean	STDev	n
Largemouth Bass	7	24	15	46	15.3	8.5	19
Black Crappie	23	16	2	41	13.7	10.7	38
White Crappie	9	0	1	10	3.3	4.9	135
Bluegill	47	38	14	99	33.0	17.1	16
Black Bullhead	0	1	0	1	0.3	0.6	184
Total	86	79	32	197	65.7	29.4	9

Table 36. Back-calculated length at age of Largemouth Bass collected through electrofishing in Tolo Lake, Idaho in 2012.

Year			Back-calculated length (mm) at each annulus						
class	Age	n	1	2	3	4	5	6	7
2011	1	3	89						
2010	2	0	0	0					
2009	3	0	0	0	0				
2008	4	26	81	141	189	234			
2007	5	11	74	128	179	222	257		
2006	6	4	65	113	167	202	238	266	
2005	7	1	57	89	131	159	193	225	254
n		45	45	42	42	42	16	5	1
Length at age			78	134	183	226	248	258	254

Table 37. Back-calculated length at age of Bluegill collected through electrofishing in Tolo Lake, Idaho in 2012.

Year			Back-calculated length (mm) at each annulus					
class	Age	n	1	2	3	4	5	6
2011	1	0	0					
2010	2	3	72	96				
2009	3	10	64	109	146			
2008	4	39	68	116	154	183		
2007	5	14	68	113	155	185	207	
2006	6	1	50	84	144	198	237	265
n		67	67	67	64	54	15	1
Length at age			68	113	153	184	209	265

Table 38. Back-calculated length at age of Black Crappie collected through electrofishing in Tolo Lake, Idaho in 2012.

Year class	Age	n	Back-calculated length (mm) at each annulus					
			1	2	3	4	5	6
2011	1	0	0					
2010	2	1	52	121				
2009	3	0	0	0	0			
2008	4	3	68	117	165	205		
2007	5	20	63	117	160	189	216	
2006	6	7	66	112	154	180	204	227
n		31	31	31	30	30	27	7
Length at age			64	116	159	189	213	227

Table 39. Back-calculated length at age of White Crappie collected through electrofishing in Tolo Lake, Idaho in 2012.

Year class	Age	n	Back-calculated length (mm) at each annulus				
			1	2	3	4	5
2011	1	1	67				
2010	2	0	0	0			
2009	3	0	0	0	0		
2008	4	0	0	0	0	0	
2007	5	9	69	119	154	195	228
n		10	10	9	9	9	9
Length at age			69	119	154	195	228

Table 40. Summary of angler effort (hours) as determined through a creel survey conducted on Tolo Lake, Idaho, from November 28, 2011 to November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	1			1	0			0	1			1	1	100
January	0			0	0			0	0			0	--	--
February	0	0	0	0	0	3	0	3	0	3	0	3	3	100
March	0	0	0	0	0	8	0	8	0	8	0	8	8	100
April		17	0	17		12	0	12		29	0	29	10	33
May		23	53	76		37	7	44		61	59	120	62	52
June		87	16	104		77	125	202		164	142	306	84	28
July		65	72	137		57	35	92		122	107	229	75	33
August		9	4	13		46	20	66		55	24	79	40	50
September		5	0	5		15	0	15		20	0	20	9	46
October		0	0	0		0	0	0		0	0	0	--	--
November		1	0	1		6	0	6		8	0	8	4	50
Totals	1	207	146	354	0	262	187	449	1	469	333	803	136	17

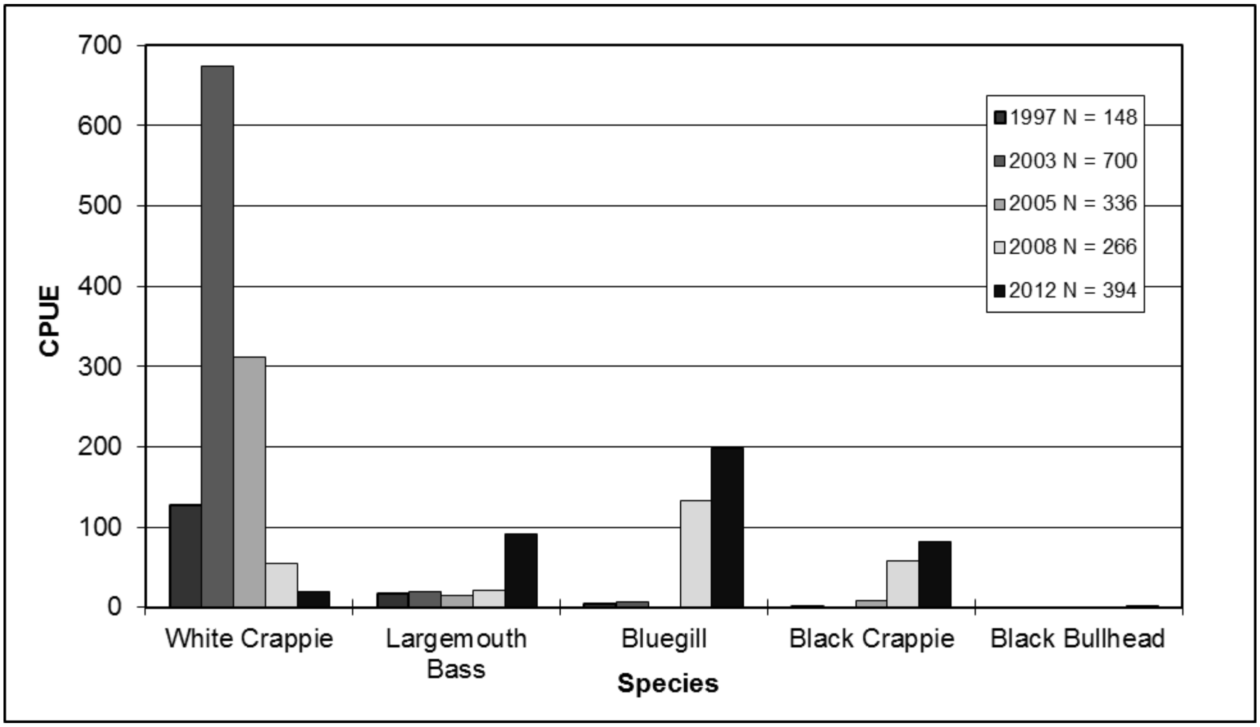


Figure 198. Catch per unit effort (CPUE; number of fish/hour) of fishes collected through electrofishing in Tolo Lake, Idaho, from 1997 - 2012.

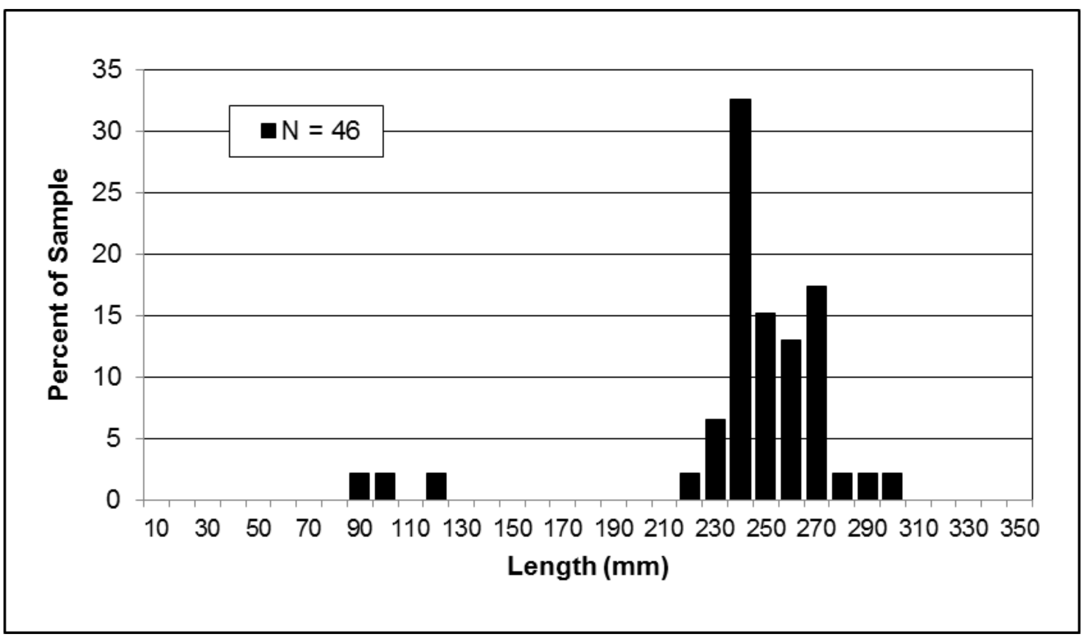


Figure 199. Length frequency distribution of Largemouth Bass collected through electrofishing in Tolo Lake, Idaho, during 2012.

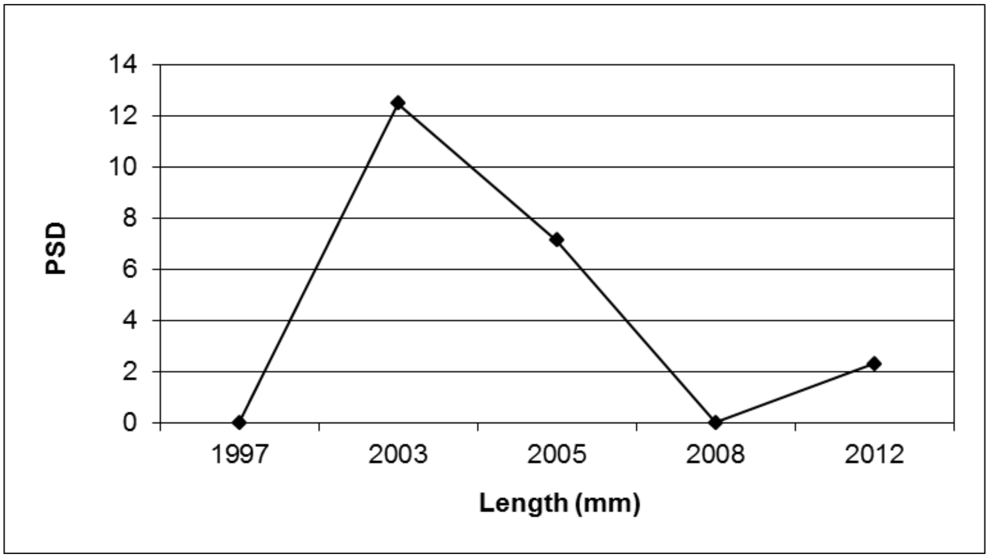


Figure 200. Proportional Size Distribution (PSD) values of Largemouth Bass collected through electrofishing in Tolo Lake, Idaho, from 1997 - 2012.

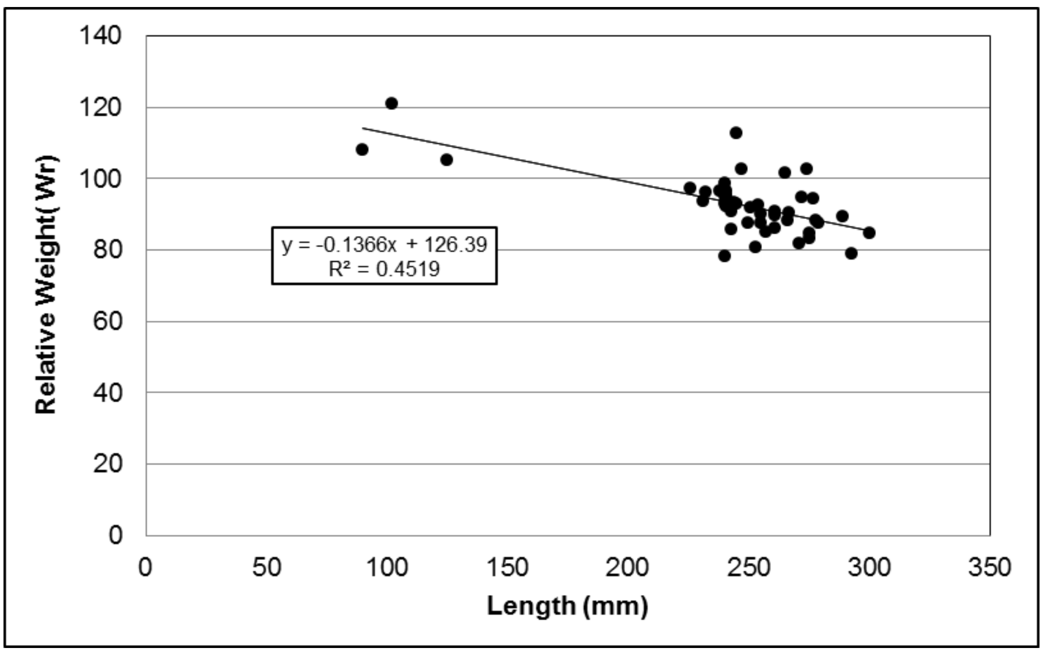


Figure 201. Relative weight (W_r) values of Largemouth Bass collected through electrofishing in Tolo Lake, Idaho, in 2012.

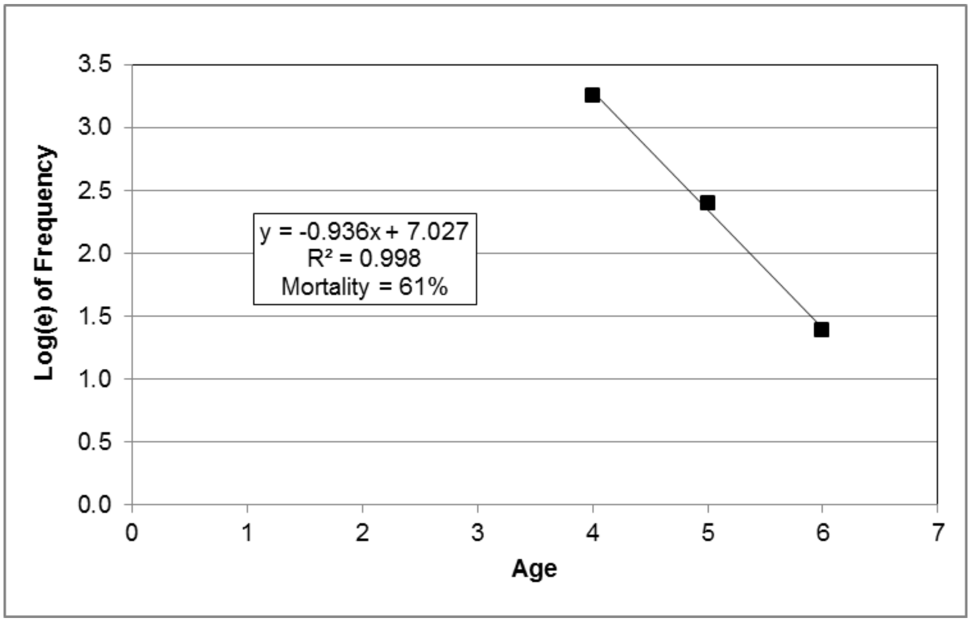


Figure 202. Catch curve for estimating annual mortality of Largemouth Bass collected through electrofishing in Tolo Lake, Idaho, in 2012.

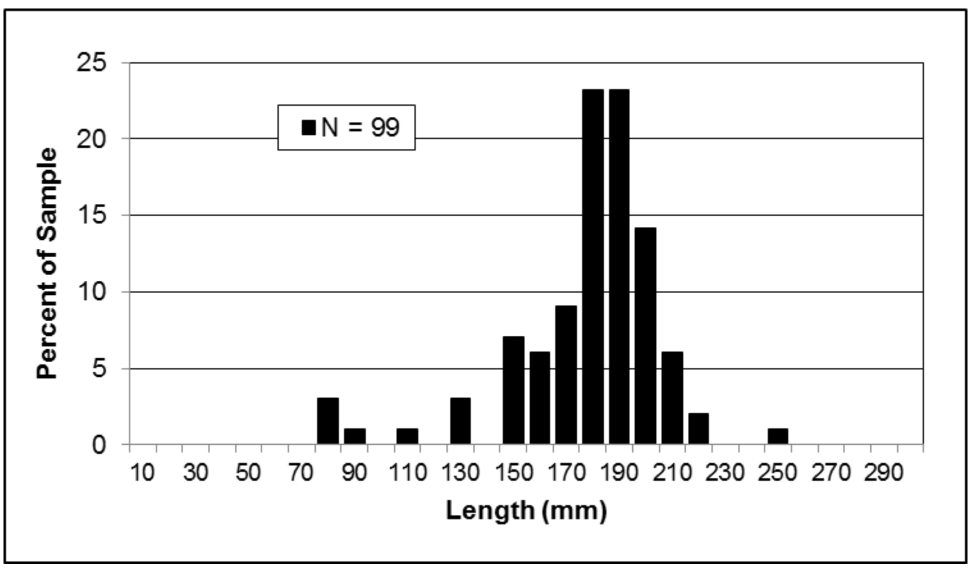


Figure 203. Length frequency distribution of Bluegill collected through electrofishing in Tolo Lake, Idaho, during 2012.

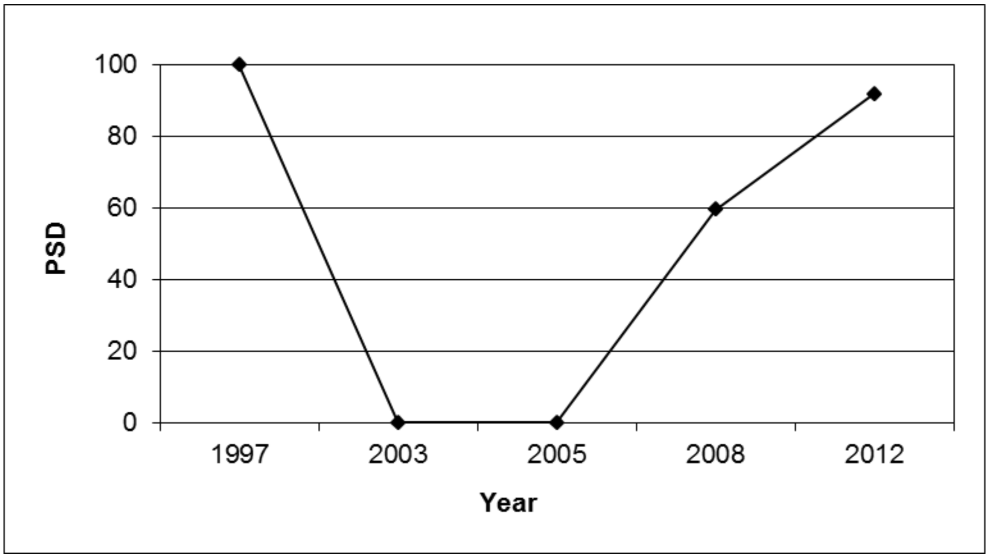


Figure 204. Proportional Size Distribution (PSD) values of Bluegill collected through electrofishing in Tolo Lake, Idaho, from 1997 - 2012.

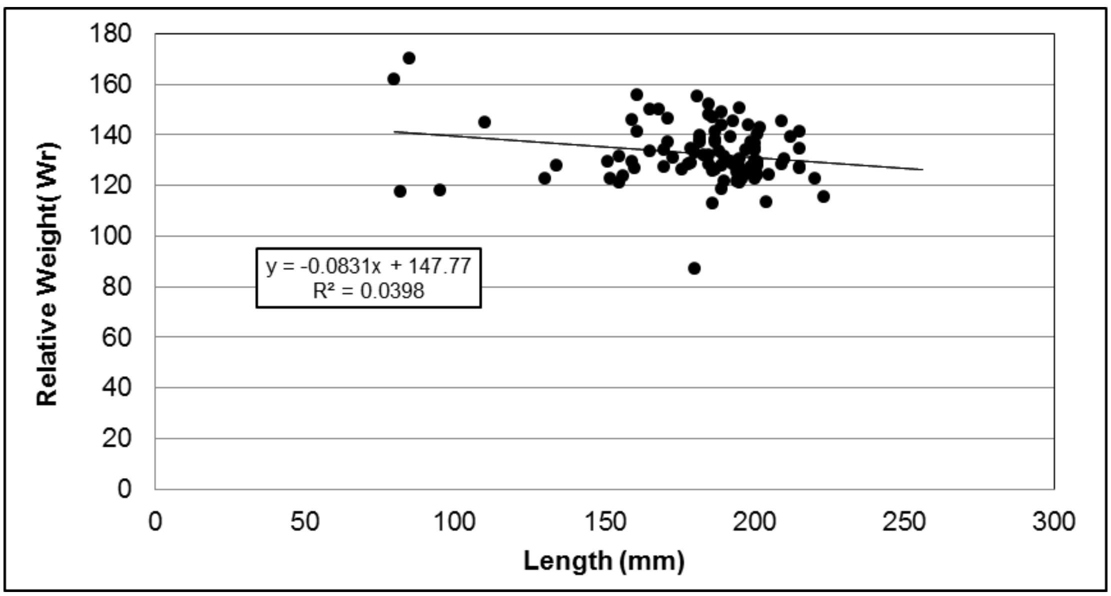


Figure 205. Relative weight (W_r) values of Bluegill collected through electrofishing in Tolo Lake, Idaho, in 2012.

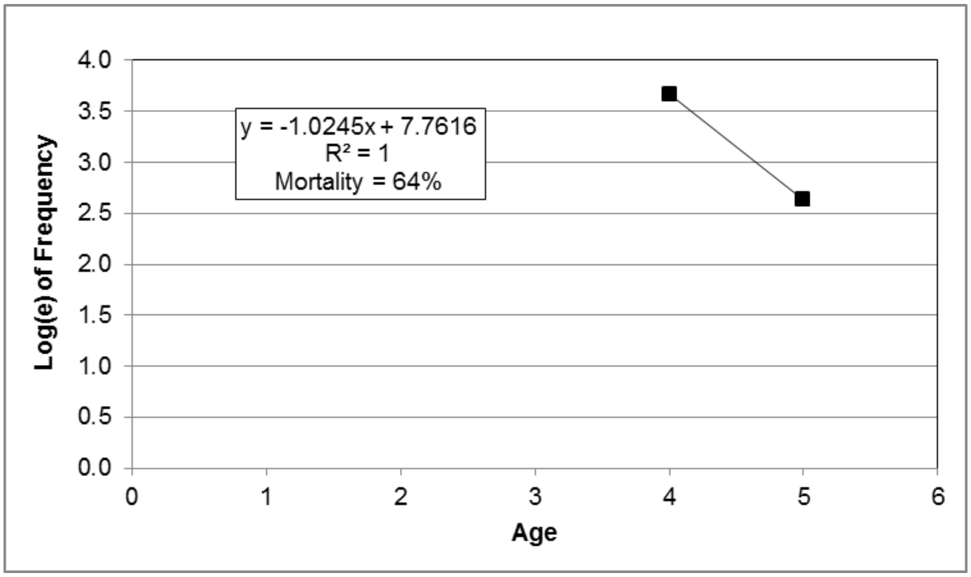


Figure 206. Catch curve for estimating annual mortality of Bluegill collected through electrofishing in Tolo Lake, Idaho, in 2012.

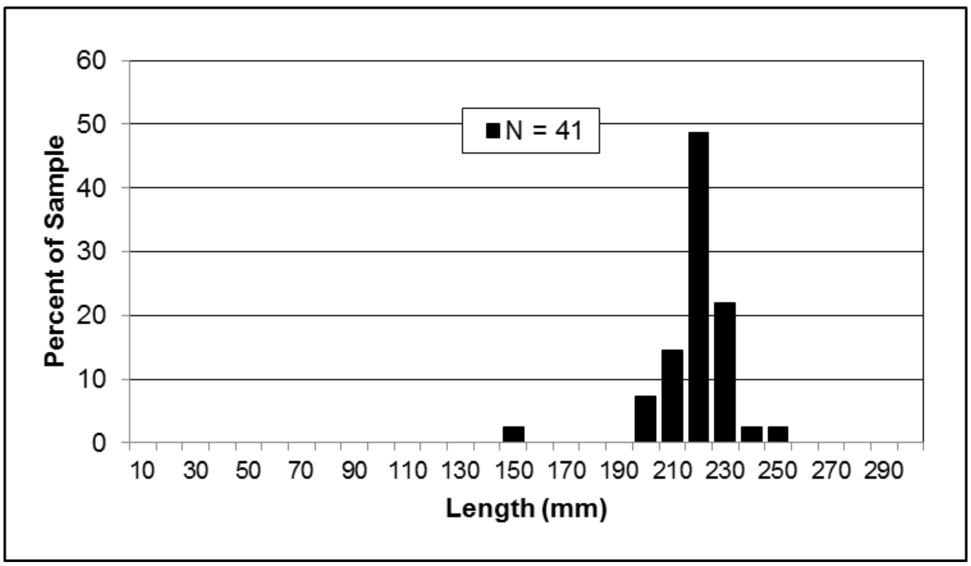


Figure 207. Length frequency distribution of Black Crappie collected through electrofishing in Tolo Lake, Idaho, during 2012.

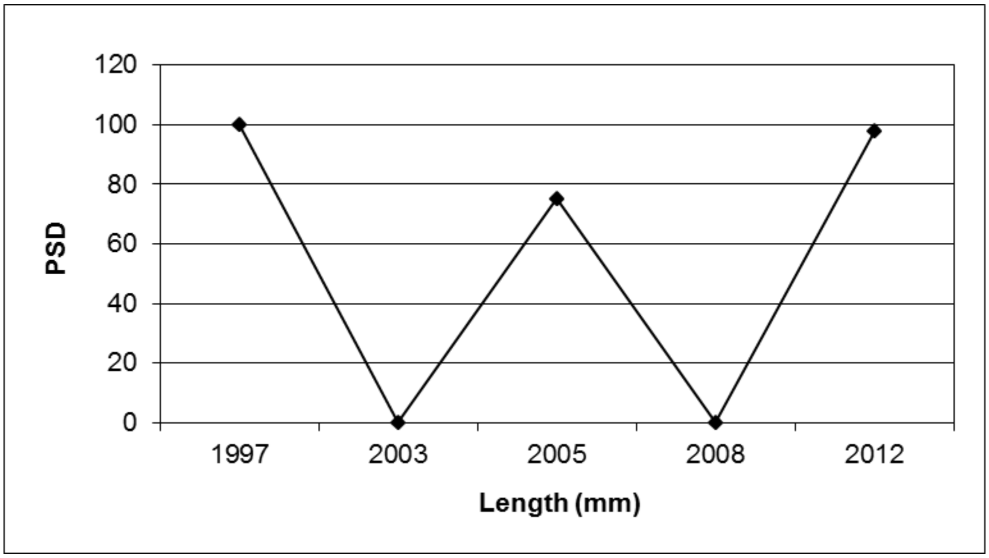


Figure 208. Proportional Size Distribution (PSD) values of Black Crappie collected through electrofishing in Tolo Lake, Idaho, from 1997 - 2012.

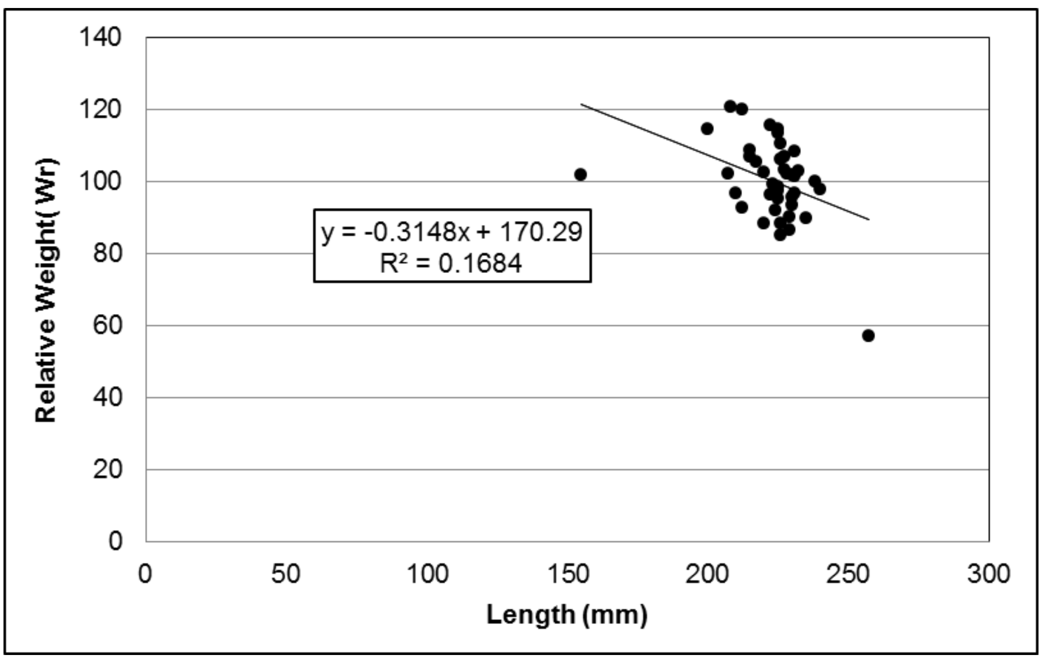


Figure 209. Relative weight (W_r) values of Black Crappie collected through electrofishing in Tolo Lake, Idaho, in 2012.

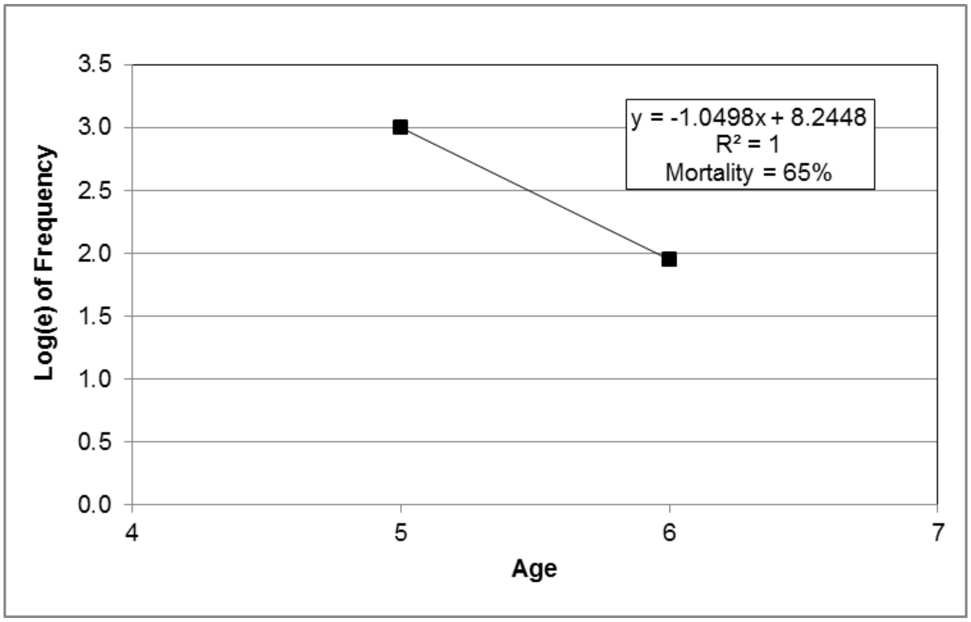


Figure 210. Catch curve for estimating annual mortality of Black Crappie collected through electrofishing in Tolo Lake, Idaho, in 2012.

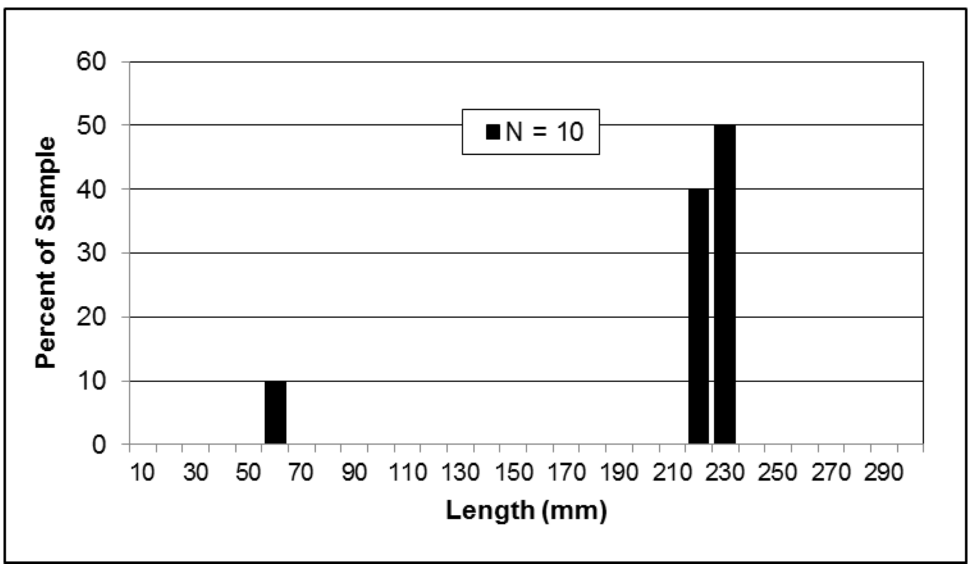


Figure 211. Length frequency distribution of White Crappie collected through electrofishing in Tolo Lake, Idaho, during 2012.

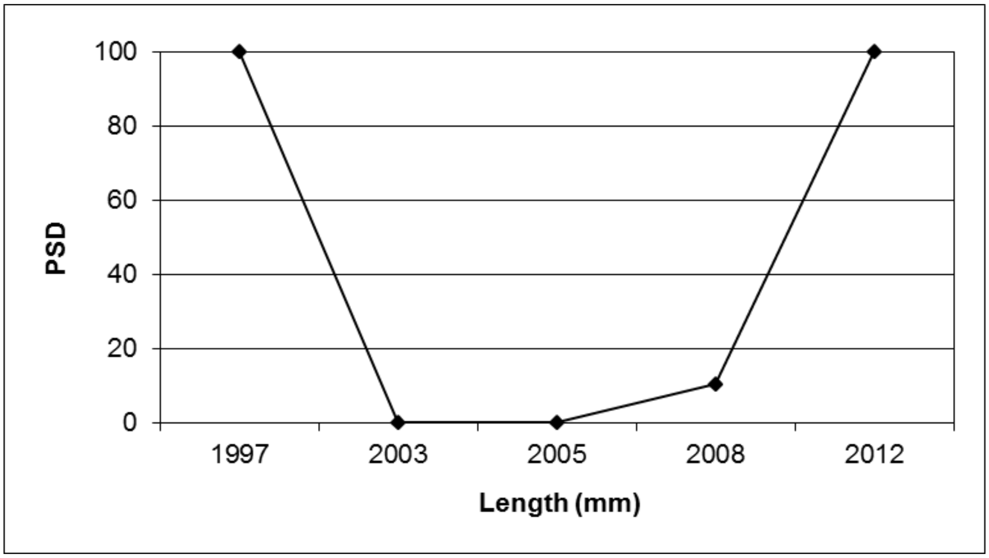


Figure 212. Proportional Size Distribution (PSD) values of White Crappie collected through electrofishing in Tolo Lake, Idaho, from 1997 - 2012.

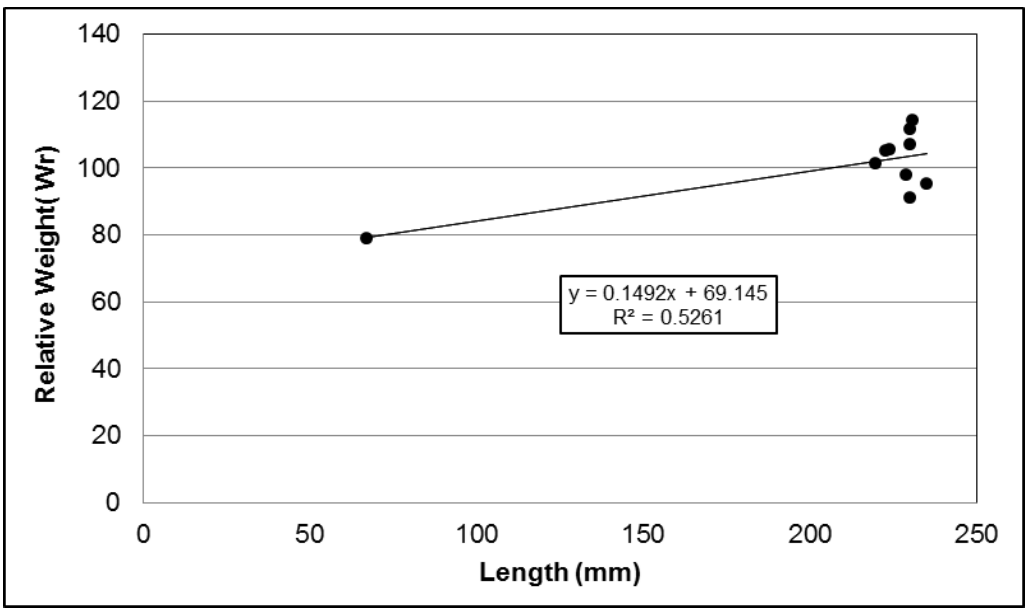


Figure 213. Relative weight (W_r) values of White Crappie collected through electrofishing in Tolo Lake, Idaho, in 2012.

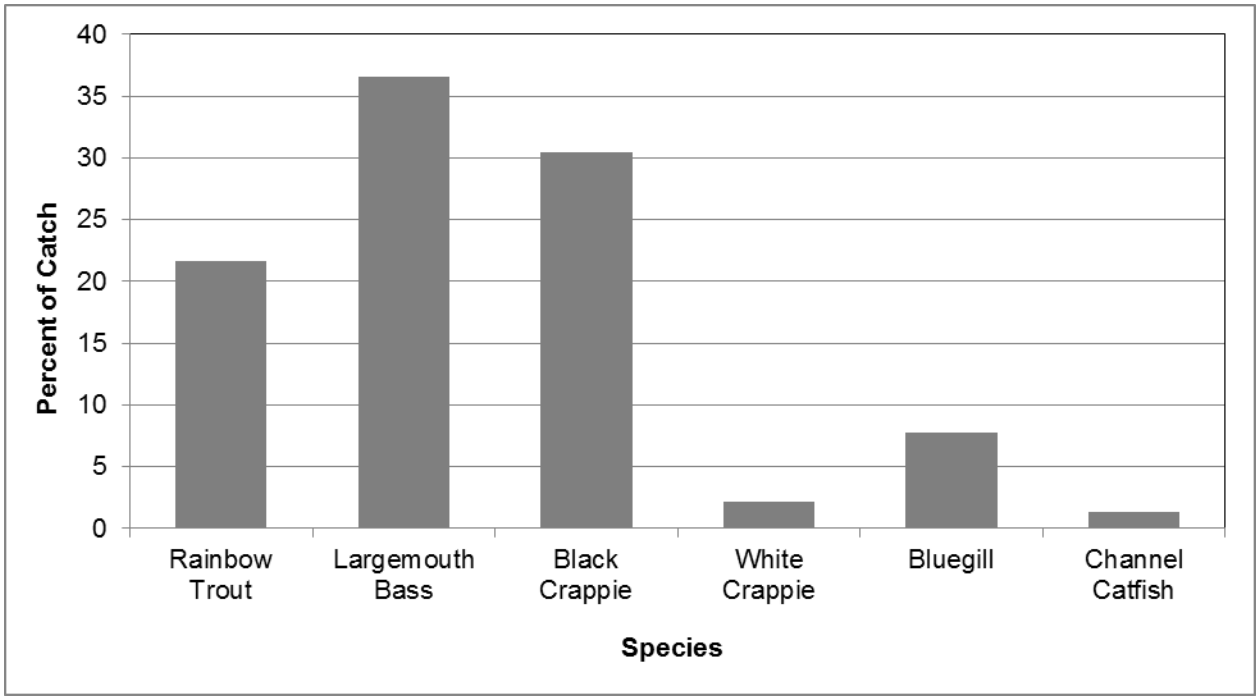


Figure 214. Composition of fishes caught in Tolo Lake, Idaho, as estimated by a creel survey conducted from November 28, 2011 to November 28, 2012.

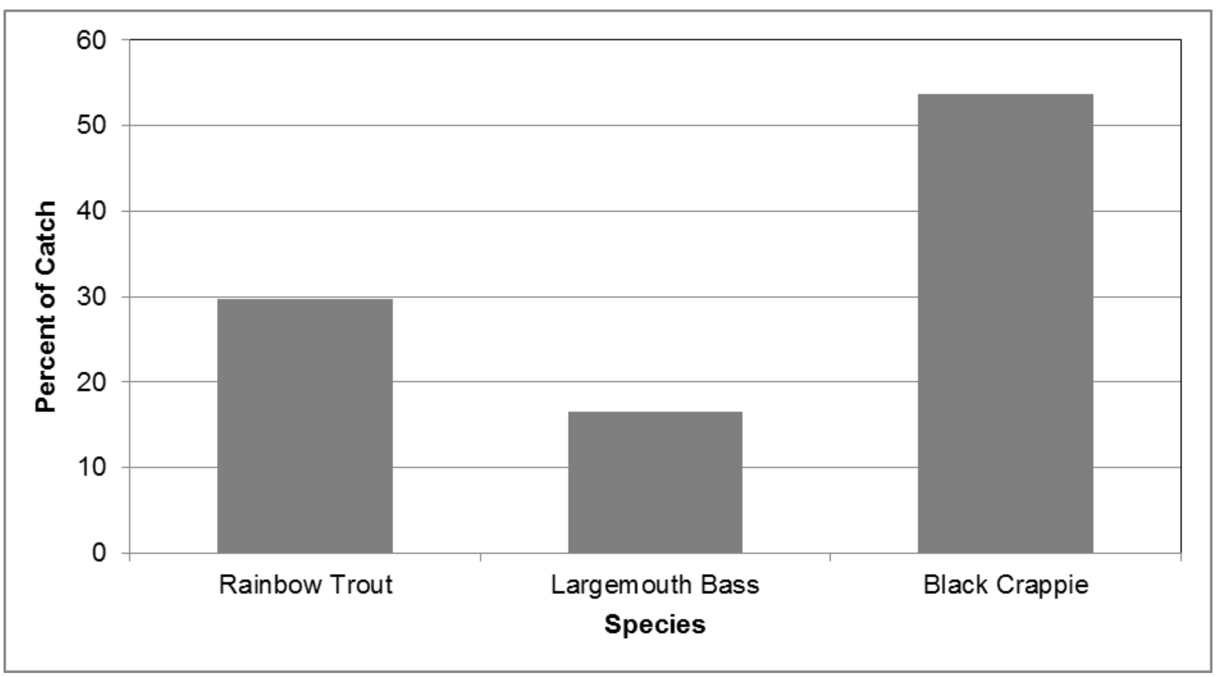


Figure 215. Composition of fishes harvested in Tolo Lake, Idaho, as estimated by a creel survey conducted from November 28, 2011 to November 28, 2012.

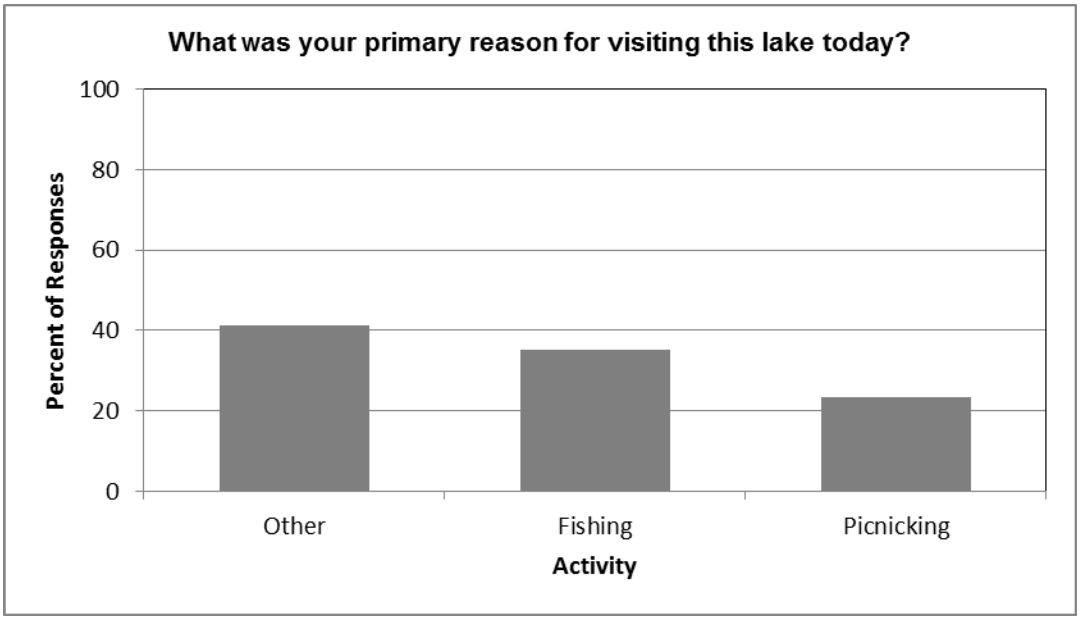


Figure 216. Summary of angler responses to the primary reason for visiting Tolo Lake, Idaho, as determined by a creel survey conducted from November 28, 2011 to November 28, 2012.

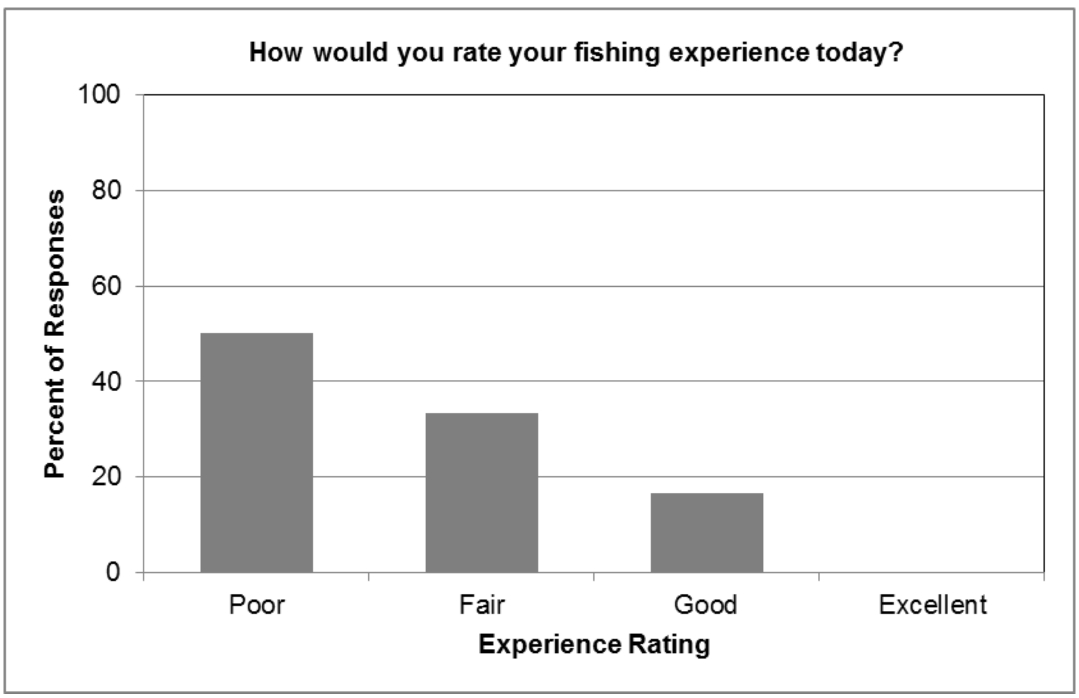


Figure 217. Summary of angler responses regarding their overall fishing experience at Tolo Lake, Idaho, as determined by a creel survey conducted from November 28, 2011 to November 28, 2012.

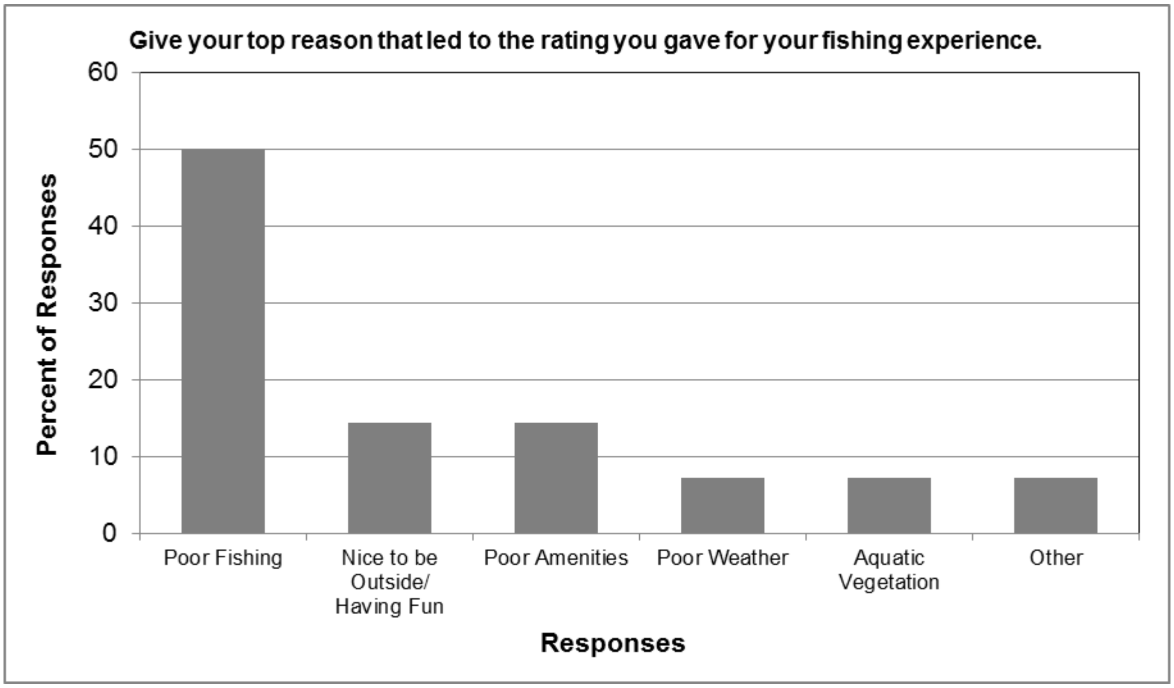


Figure 218. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day when fishing at Tolo Lake, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

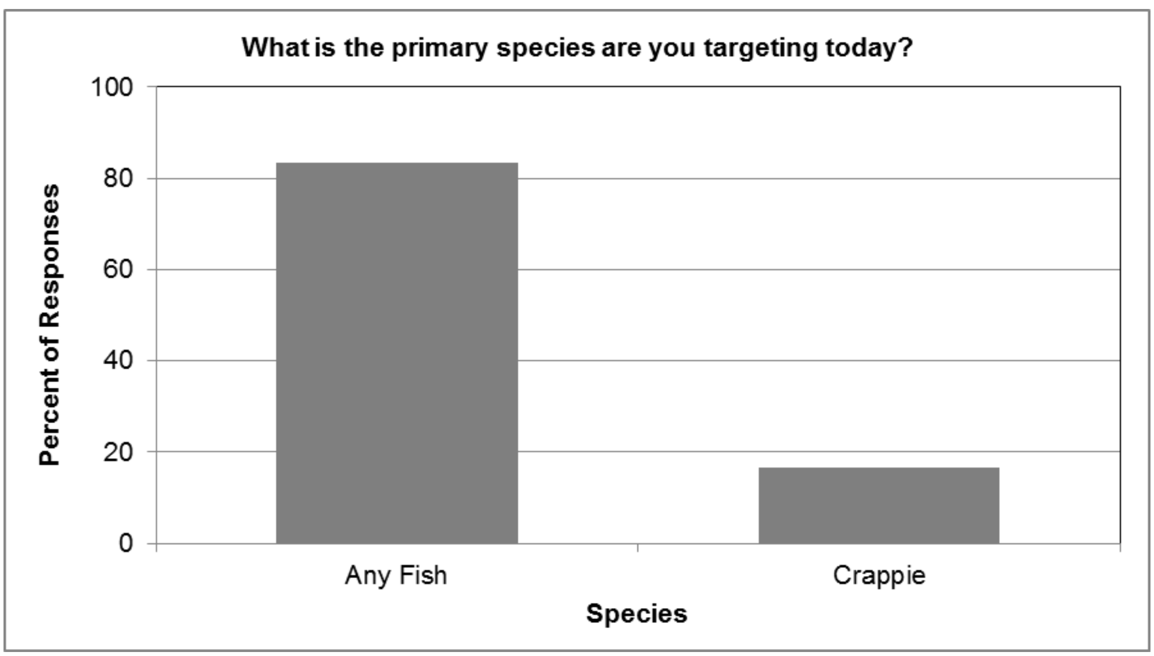


Figure 219. Summary of angler responses regarding target fish species at Tolo Lake, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

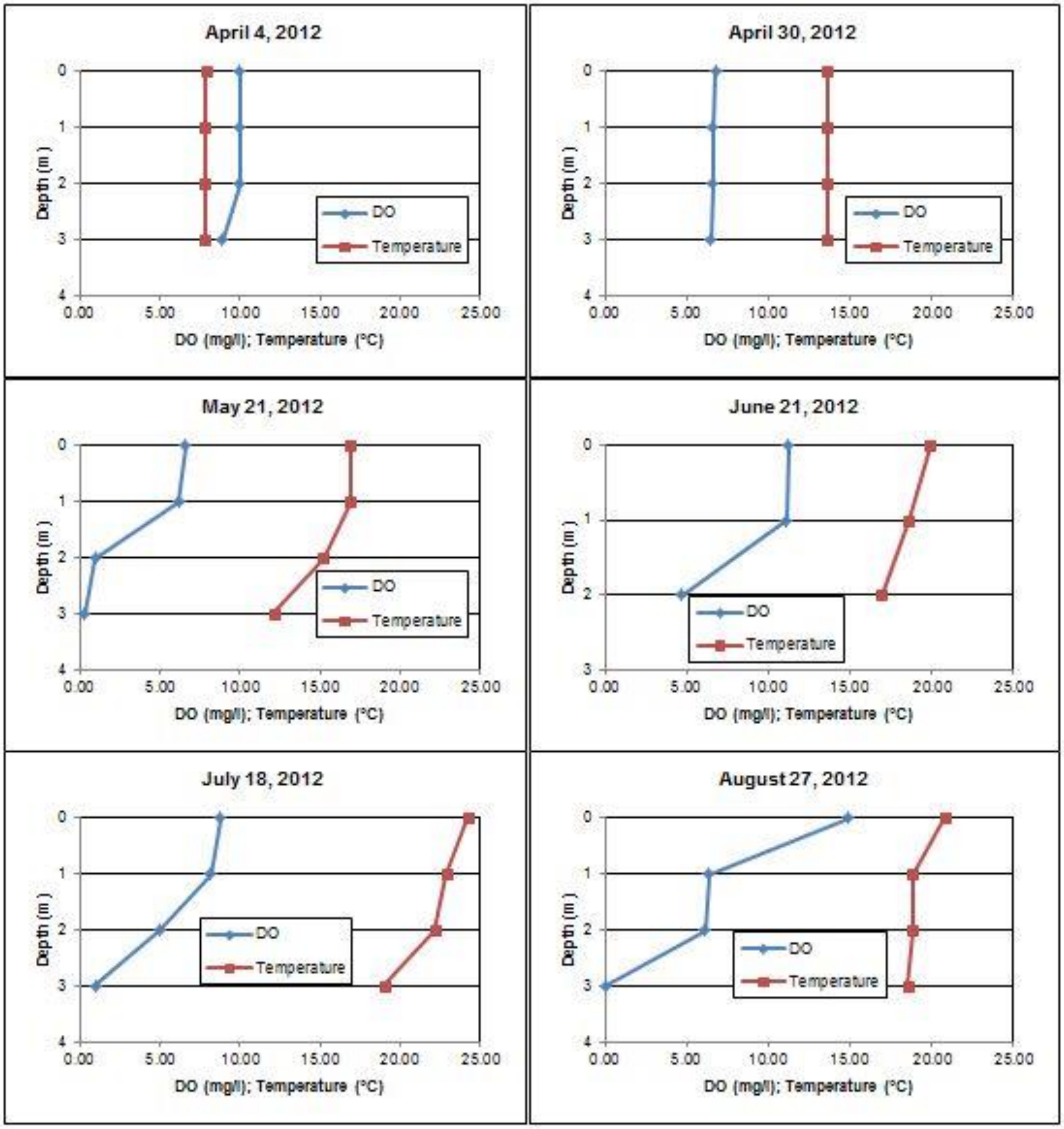


Figure 220. Dissolved oxygen (DO) and temperature profiles collected in Tolo Lake, Idaho, during 2012.

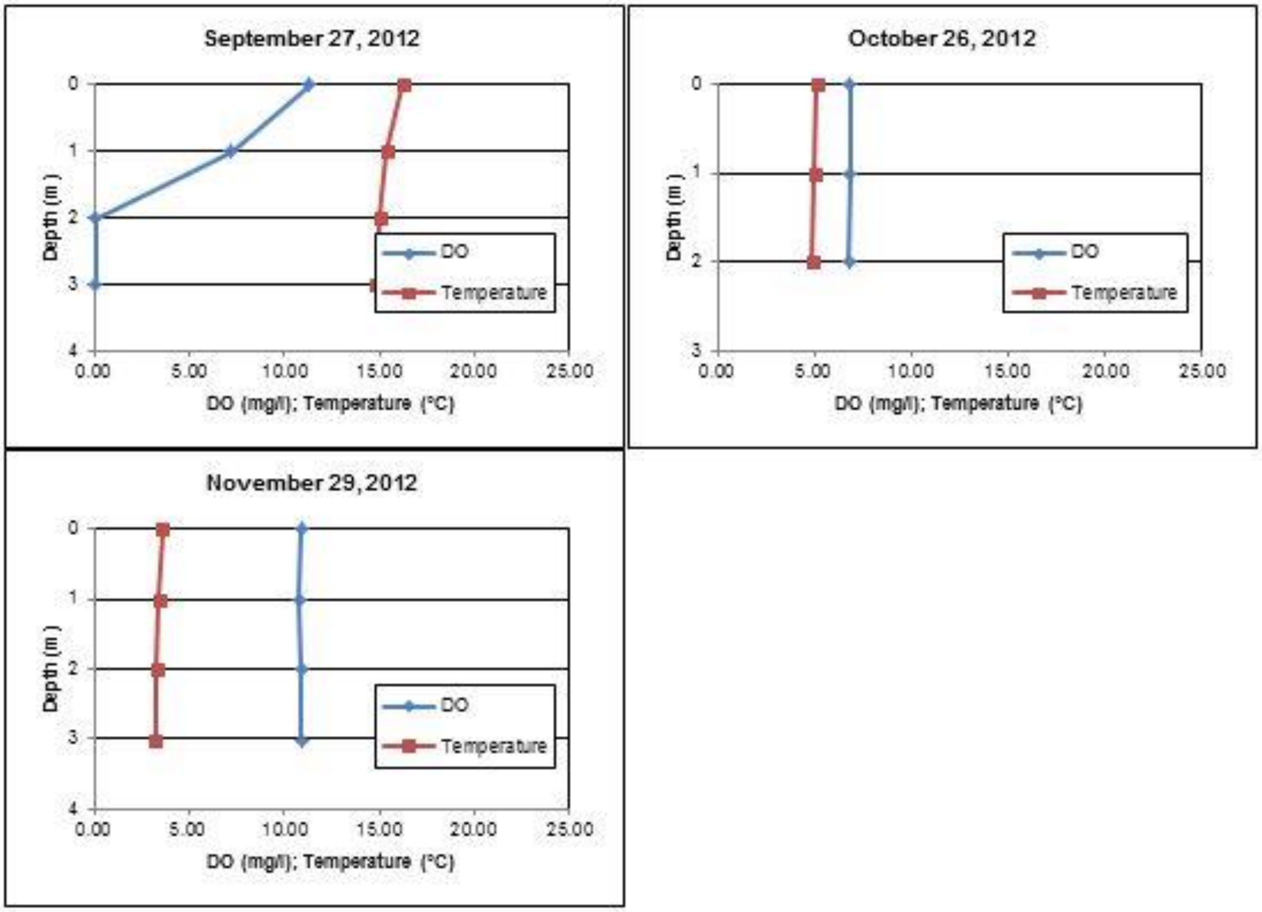


Figure 223. Continued.

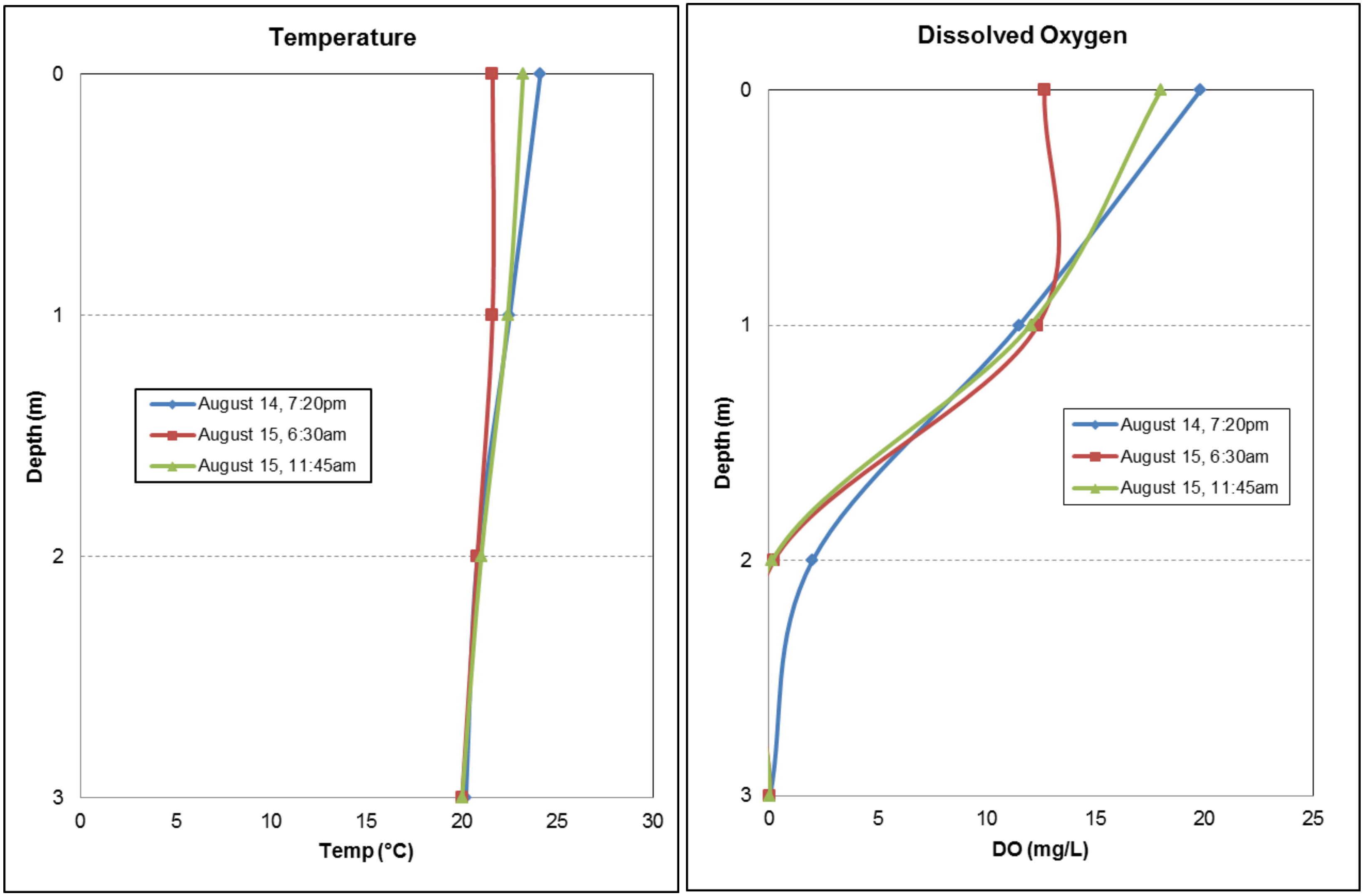


Figure 221. Diel changes in temperature and dissolved oxygen (DO) in Tolo Lake, Idaho, from August 14 - 15, 2012.

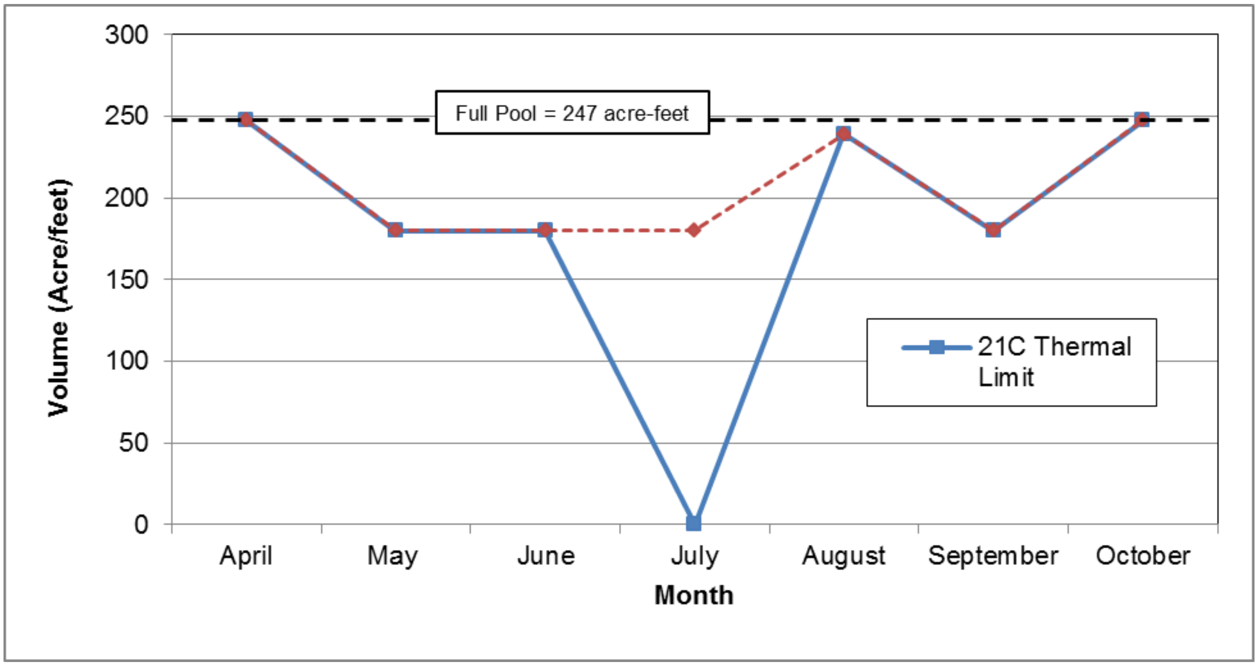


Figure 222. Estimated trout habitat available in Tolo Lake, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit, and upper thermal limits of 21°C and 25°C.

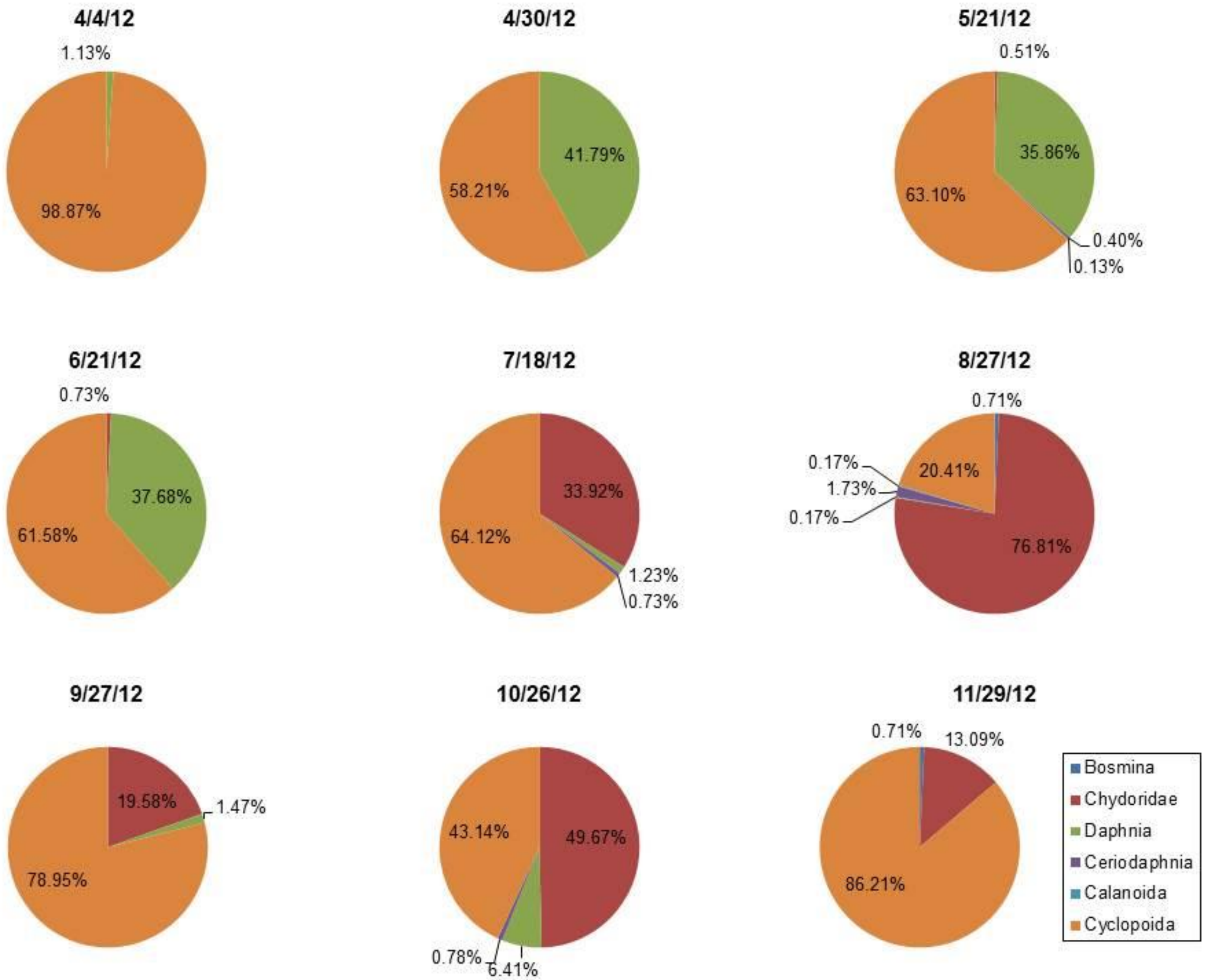
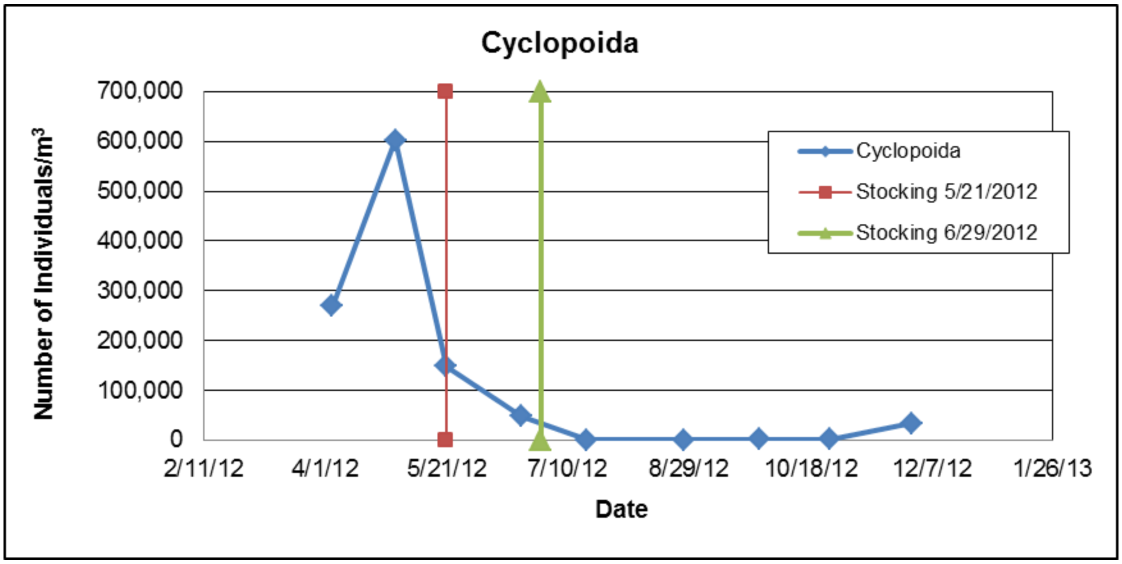


Figure 223. Zooplankton community composition based on monthly samples collected in Tolo Lake, Idaho, during 2012.



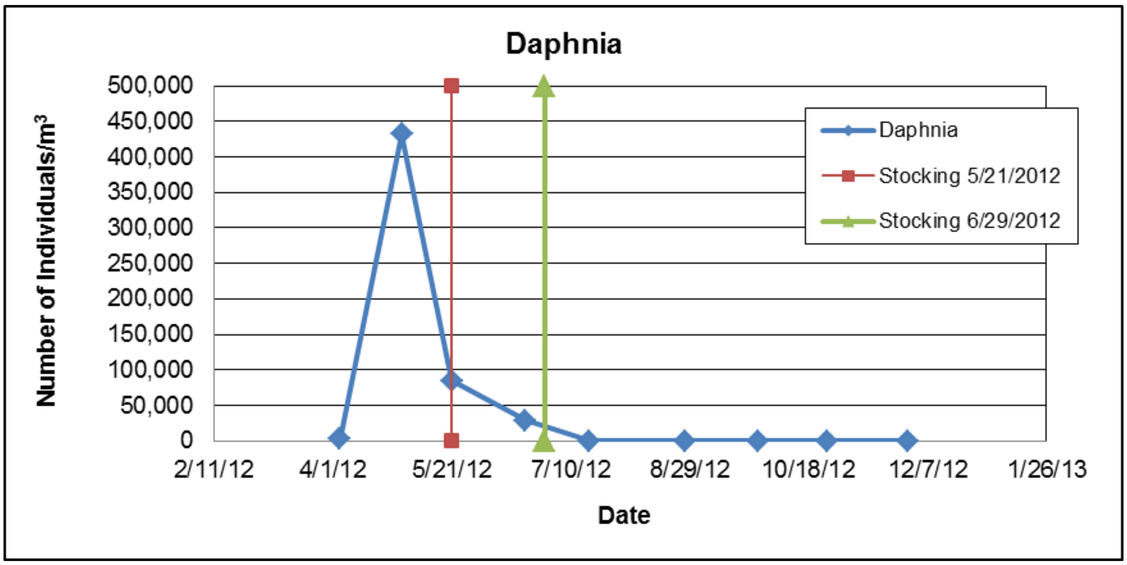
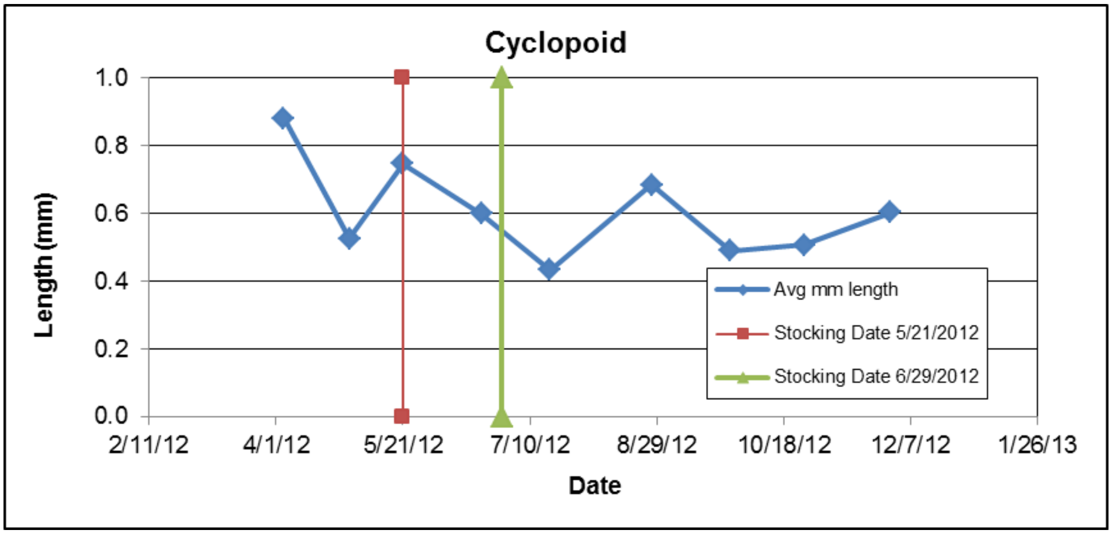


Figure 224. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Tolo Lake, Idaho, in 2012.



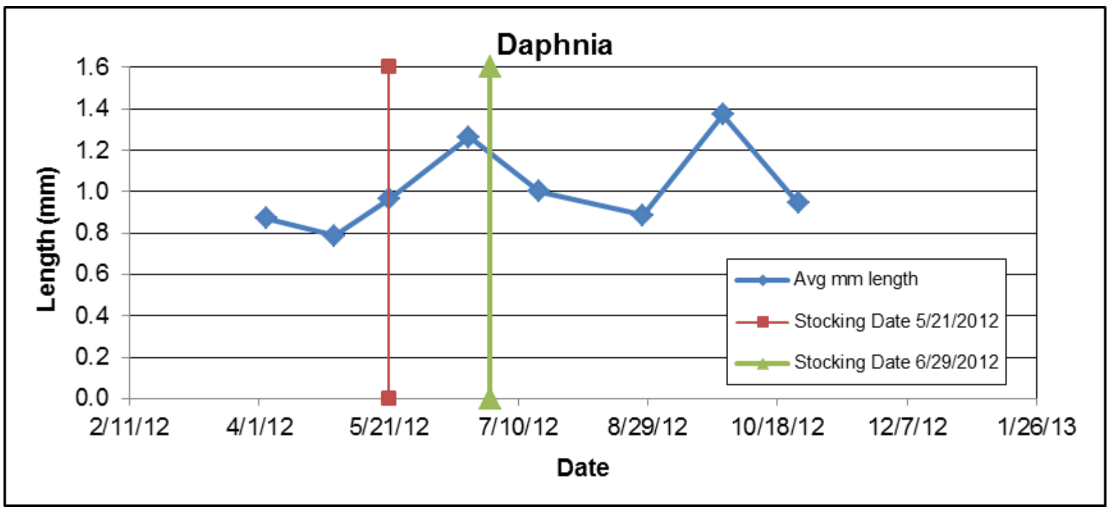


Figure 225. Average length (mm) of zooplankton collected from monthly samples in Tolo Lake, Idaho, in 2012.

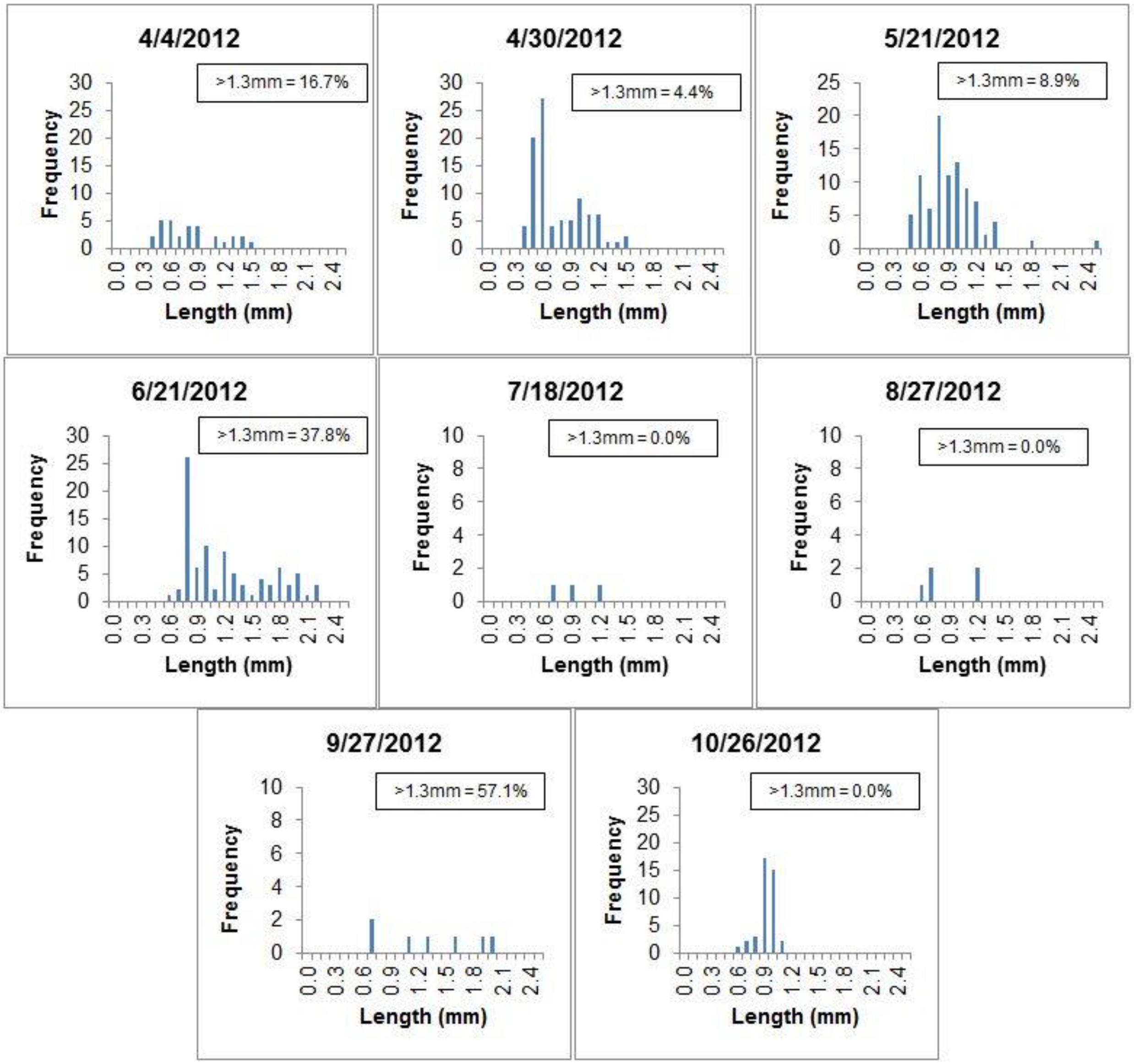


Figure 226. Length frequency distribution of Daphnia collected from monthly sampling in Tolo Lake, Idaho, in 2012.

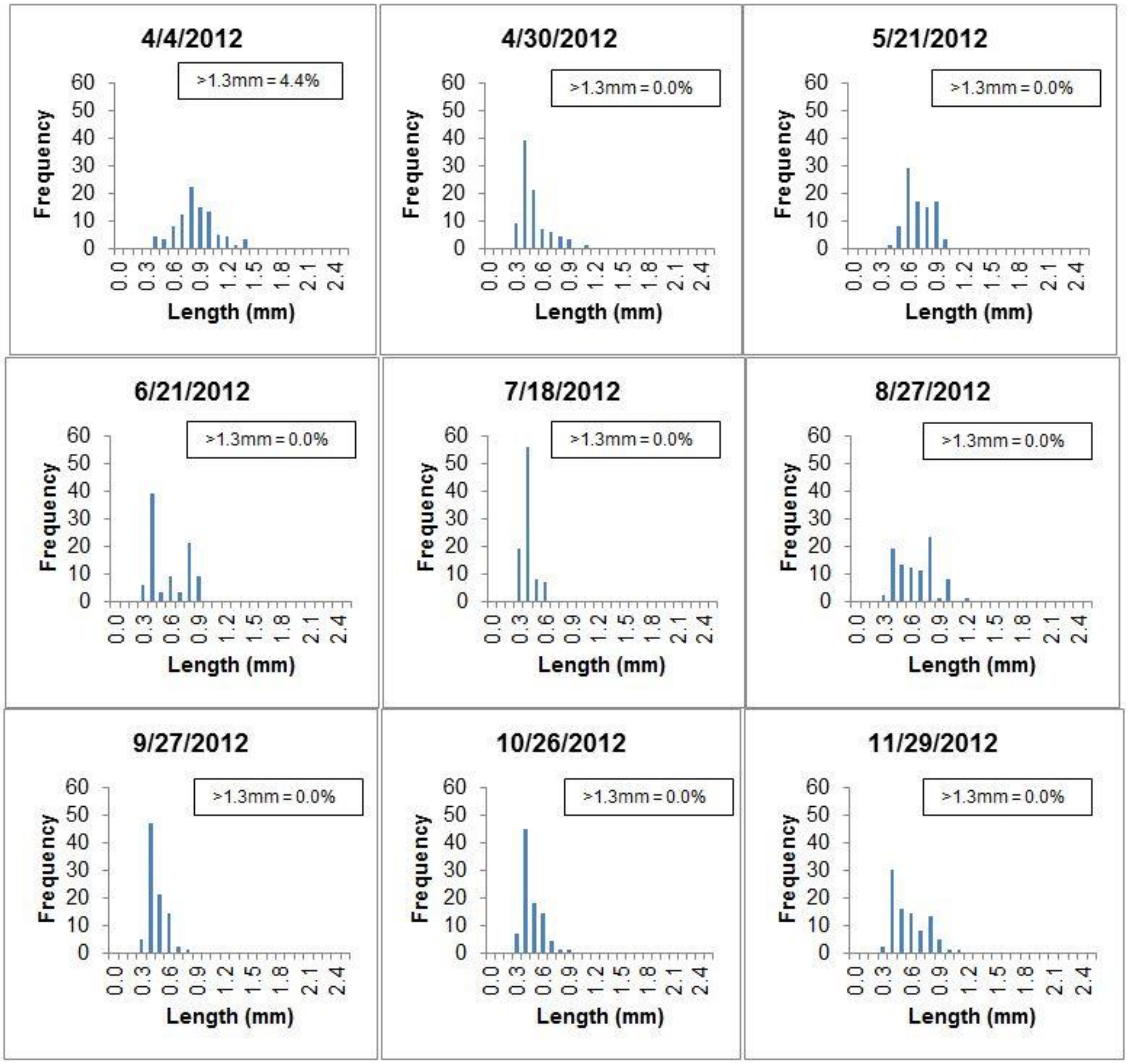


Figure 227. Length frequency distribution of Cyclopoids collected from monthly sampling in Tolo Lake, Idaho, in 2012.

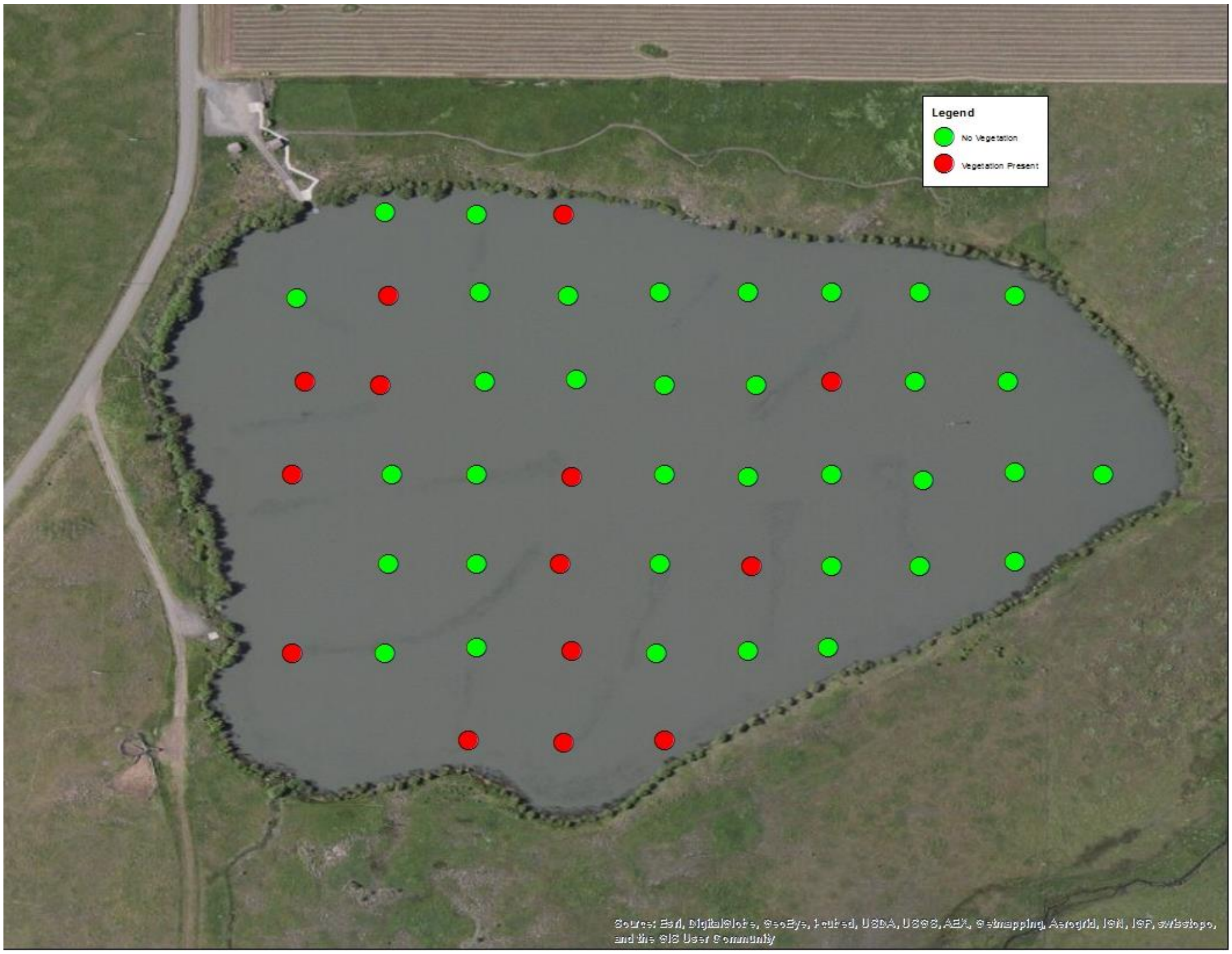


Figure 228. Locations where aquatic vegetation was collected during vegetation sampling of Tolo Lake, Idaho, during 2012.

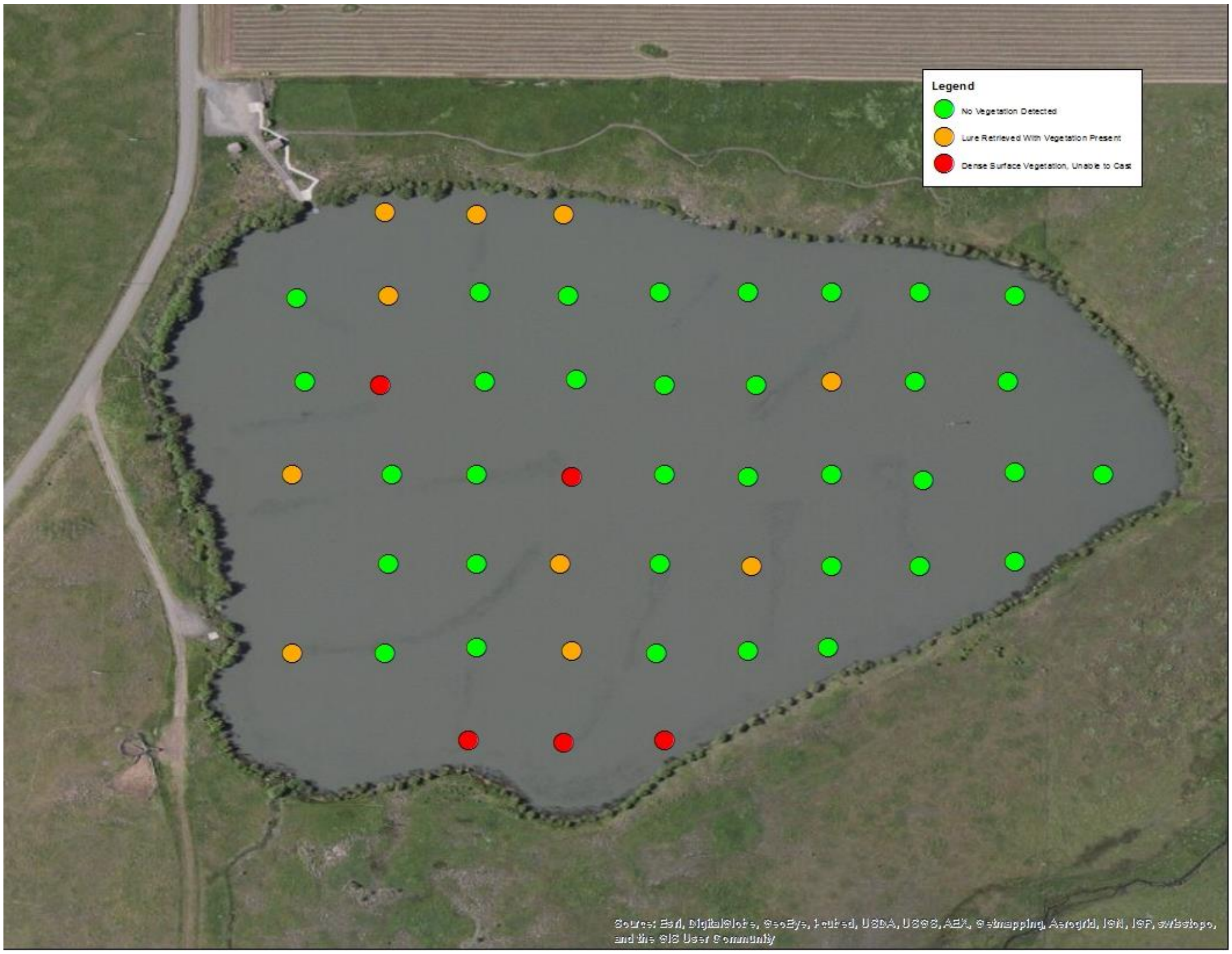


Figure 229. Fishability (using Davids' Fishability Index) at set locations in Tolo Lake, Idaho, in 2012.

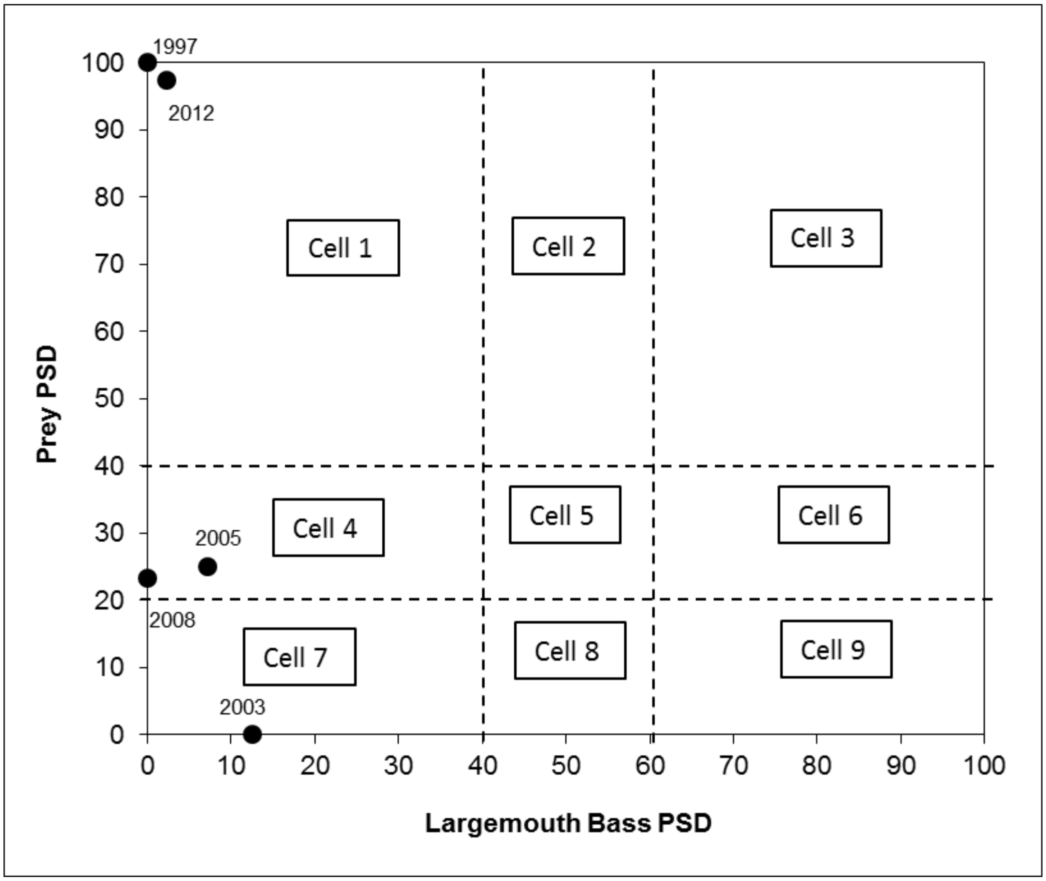


Figure 230. Comparison of predator (Largemouth Bass) and prey (Bluegill, Black Crappie, and White Crappie) proportional size distributions (PSD) from electrofishing surveys conducted in Tolo Lake Idaho, from 1997 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).Waha Lake

SPORTFISH ASSESSMENT OF WAHA LAKE

ABSTRACT

In 2012, a comprehensive assessment of Waha Lake was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 187 fish including Smallmouth Bass and Yellow Perch. The results of this survey suggest that the Smallmouth Bass fishery is dominated by small fish. However, we do not believe that we are accurately sampling the population due to the difficulties of electrofishing a lake with a steep shoreline. Conversely, Waha Lake has a small but quality Yellow Perch fishery.

Creel surveys estimated angler effort at 4,455 hours. This was the highest of the three creel surveys conducted on the lake since 1999, and represents a 22% increase in effort over the 3,649 hours estimated in 2005. The angler catch rate for all fish species combined was estimated at 2.1 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 1.3 fish/hour, well above the statewide management goal of >0.5 fish caught/hour. Angler exploitation of hatchery catchable size Rainbow Trout was estimated at 30.4% for the creel survey while angler exploitation was estimated at 14.1% by the “Tag You’re It” program. This substantial difference may have been caused by factors such as a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. The large difference between these two estimates should be explored in the future to determine which method is more accurate. At this time, we recommend reducing the number of hatchery catchable size Rainbow Trout stocked, but utilize “magnum” sized fish to maintain catch rates and improve angler satisfaction.

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INTRODUCTION

Waha Lake is approximately a 35 km drive to Lewiston, Idaho (pop. 32,119) and neighboring Clarkston, WA (pop. 7,331), the Clearwater Region's largest population center. An economic survey conducted in 2011 estimated 1,665 angler trips were taken to Waha Lake for an estimated total economic expenditure of $46,965 (IDFG unpublished data). In addition to fishing, Waha Lake is used for boating and swimming.

Waha Lake is largely targeted by anglers participating in the put and take hatchery Rainbow Trout fishery. Previous creel surveys have estimated that 23.8% to 89.9% of fish harvested in Waha Lake were hatchery Rainbow Trout (Hand 2009). Waha Lake also contains Smallmouth Bass, Black Crappie, Yellow Perch, and Kokanee *O. nerka*.

Poor water quality has been a problem in Waha Lake. This is due to high phosphorus levels, which cause algae blooms, poor water clarity, and low dissolved oxygen for fish. To address this issue, two hypolimnetic aeration units were installed in Waha Lake in 2002 (Hand 2009; DuPont et al. 2011). The purpose of these units was to increase the levels of oxygen in the hypolimnion to reduce the amount of phosphorous entering the water column and thus reduce the algae blooms.

Current Management

Waha Lake is a mixed fishery, containing both cold-water and warm-water species. It is managed as a put-and-take trout fishery with 10,115 catchable Rainbow Trout stocked in 2012 to maintain the management goal of >0.5 fish/hour catch rate (IDFG 2013). The lake is managed with simplified regulations including year round seasons, no length limits, general six fish limit for trout and bass, no creel limits for other species, and no restrictions on fishing gear. The current management priority is to provide a desirable fishing experience to families and individuals alike.

Reservoir Management Goals

1. Maintain a catch rate of >0.5 fish/hour for hatchery Rainbow Trout.

2. Maintain a warm-water fishery for Smallmouth Bass and Yellow Perch.

STUDY SITE

Waha Lake is located approximately 35 km southeast of Lewiston, Idaho, and 2 km east of Waha, Idaho (Figure 4). It is a 37.9 hectare naturally formed lake that lies at an elevation of 1,032 meters. It is the deepest of the region's lowland lakes with a mean depth of 19.6 meters and maximum depth of 33.0 meters. It has a maximum volume of 4,307 acre-ft. The Lewiston Orchards Irrigation District (LOID) manages the water level at Waha Lake. The lake's primary inlet is located on the West Fork of Sweetwater Creek where LOID created a diversion dam. Waha Lake takes time to reach full pool in the spring, with full pool often not reached until early June in most years. Minimum pool usually occurs in January when water level has been reduced by subsurface outflow and pumping for summer irrigation.

RESULTS

Population Survey

A fishery survey of Waha Lake was conducted on May 30, 2012 which consisted of six 10-minute electrofishing periods and one trap net night. The electrofishing and one trap net set resulted in the capture of 187 fish including Smallmouth Bass (n = 124), and Yellow Perch (n = 63; Figure 231). The electrofishing catch rate was 187.0 fish/hour. No fish were collected by the trap net. Catch rates for each of the six 10-minute electrofishing samples ranged from 22 - 53 fish/sample (Table 41). The variability from the six samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). To have a 90% confidence (2-tail test) with 25% precision estimate of fish captured in an electrofishing sample of Waha Lake, an estimated six 10-minute electrofishing samples would be needed for a whole fish community survey (Table 41).

Smallmouth Bass:

Smallmouth Bass collected in 2012 ranged from 55 - 452 mm in length, with an average length of 157 mm (Figure 229). Only five of the 124 fish collected (5.5%) were over 263 mm in length. Smallmouth Bass CPUE was 124 fish/hour, the highest since 2001 (Figure 231). Smallmouth Bass PSD was 10 (Figure 230), a slight increase over samples collected in 2003 - 2007. Relative weights ranged from 37 - 135, with an average of 79 (Figure 231). Relative weight was generally lower for larger fish than for smaller fish. Scale samples were analyzed from Smallmouth Bass collected in 2012 (n = 101). These fish ranged in age from 1 - 8 years (Table 42). Annual growth rates ranged from 33 - 65 mm. A catch curve (Figure 232) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.663 for fish aged 2 - 6 (R^2 = 0.817). Thus, the annual survival rate (S) was 51.6%, and total annual mortality (A) was 48.4%.

Yellow Perch:

Yellow Perch ranged from 65 - 244 mm in length (Figure 234), with an average of 177 mm. The length frequency distribution in 2012 was similar to that in 2007, with most of the fish in the 160 - 260 mm range. Yellow Perch CPUE was 63, the third highest since 2001 (Figure 230). Proportional size distribution for Yellow Perch in 2012 was 43 (Figure 237). This is the highest PSD recorded for Yellow Perch, and continues the increasing trend seen since 1997. Relative weights ranged from 61 - 118, and averaged 94 (Figure 238). Relative weights were generally lower for larger fish than for smaller fish. Scale samples were analyzed from Yellow Perch collected in 2012 (n = 62). These fish ranged in age from 1 - 7 years (Table 43). Annual growth rates ranged from 11 - 60 mm. A catch curve (Figure 239) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.387 for fish aged 2 - 7 (R^2 = 0.702). Thus, the annual survival rate (S) was 67.9%, and total annual mortality (A) was 32.1%.

Creel Survey

Angler Effort:

Creel surveys were conducted on Waha Lake from November 28th, 2011 through November 28th, 2012. A total of 187 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 4,455 hours (SE ± 521; Table 44). This was higher than the 4,105 and 3,649 hours estimated for the 1999 and 2005 creel surveys

(Figure 1). In 2012, slightly more effort occurred on weekdays (50.6%) than weekends (49.4%). Effort consisted of 58.5% bank, 33.0% boat, and 8.5% ice anglers. The highest angler effort occurred in the summer months from May - August, with monthly effort estimates ranging from 353 - 964 hours.

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on Waha Lake was based on 144 completed trip interviews. Anglers caught an estimated 9,503 fish during 2012 (Appendix A), resulting in a catch rate of 2.1 fish/hour. Hatchery Rainbow Trout accounted for 55.2% (n = 5,243) of the fish caught during the 2012 creel survey (Figure 240). A total of 3,936 other fish were caught, including 3,461 Smallmouth Bass (36.4%), 475 Yellow Perch (5.0%), and 325 kokanee (3.4%). Anglers harvested an estimated 3,428 fish during 2012 (Appendix A), 36.1% of the fish caught. The harvest rate for all fish combined was estimated to be 0.8 fish/hour. Harvest in 2012 consisted of 3,077 hatchery trout (89.8%), 276 Yellow Perch (8.0%), 55 Smallmouth Bass (1.6%), and 20 kokanee (0.6%; Figure 241). All harvested fish encountered during creel surveys were measured for total length. Harvested Yellow Perch measured by creel clerks ranged in length from 134 - 245 mm, and averaged 217 mm (Figure 234). Only two harvested Smallmouth Bass (253 mm; 279 mm) and one kokanee (227 mm) were measured during the creel survey.

A total of 5,243 hatchery Rainbow Trout were caught during the survey, with 3,077 harvested (Appendix B). This was a catch rate of 1.3 fish/hour and a harvest rate of 0.7 fish/hour (Appendix B). The majority of the fish (75.3%) were harvested from May - June (Appendix C). The estimated angle exploitation rate was 30.4%. Harvested Rainbow Trout measured by creel clerks (n = 107) ranged in length from 210 - 330 mm, and averaged 275 mm.

Angler Satisfaction:

A total of 157 public opinion surveys were conducted at Waha Lake in conjunction with the creel survey. Seventy percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 242). “Other” (29.9%) was the only other response given. Based on observations, most of these people were swimming. Of the people interviewed, 83.1% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at Waha Lake. Fifty-seven percent of people interviewed rated their fishing experience as excellent or good (Figure 243). The most common reasons for a positive rating were related to good fishing (24.6%) and “nice to be outside” (22.0%; Figure 244). Forty-three percent of people interviewed rated their fishing experience as fair or poor (Figure 243). The most common reasons for a negative rating were related to poor fishing (33.9%) and poor weather (5.1%; Figure 244).

The most commonly targeted fish was hatchery Rainbow Trout (38.7%; Figure 245). Forty-six percent of people interviewed were not targeting a particular fish species while fishing. Sixty-three percent of people interviewed would not support a proposal to implement trophy trout harvest rules of two fish >356 mm at Waha Lake (Figure 246).

Angler Exploitation

An angler exploitation (fish harvested) survey was conducted for hatchery catchable size Rainbow Trout stocked in Waha Lake in 2012. Rainbow Trout were tagged on April 18, 2012 (n = 100). The exploitation rate through 365 days at large was estimated at 14.1% (Table 45). Total use (fish harvested plus fish released) through 365 days at large was estimated at 16.9% (Table 45; Appendix D). There was no use estimated past 365 days at large.

Limnology

Limnology samples were collected monthly from April through November, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being quite evident. Dissolved oxygen profiles were generally homogenous in early spring and late fall. During the summer, DO begins declining at around 2 - 4 m in depth until fall turnover occurs (Figure 247). Monthly temperature measurements were also homogenous in spring and late fall. During summer, temperatures increase in the upper 10 - 12 m, but remained around 5°C below that depth (Figure 247). To look at potential diel changes in temperature and DO profiles, measurements were taken at 19:00 on August 15, 2012, and at 06:51 and 12:26 on August 16, 2012 (Figure 248). There was little difference in either temperature or DO across the three samples.

Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. During July and August, water temperatures were >21°C down to a depth of 3 m, and DO at this time was >5.0 mg/L through the entire water column. This resulted in the top 3 m of water (27.7% of lake volume) not being conducive for Rainbow Trout survival (Figure 249). Utilizing an upper thermal limit of 25°C water, volume conducive for Rainbow Trout survival was not reduced at any time during the year (Figure 249).

Zooplankton

Zooplankton samples were collected monthly from April - November, 2012. The population was composed of six taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Bosmina, and Calanoida. The composition changed from almost entirely Cyclopoida (>90.0%) in April and May to a mix of Cyclopoida, Bosmina, and Ceriodaphnia in June - August. Composition returned to primarily Cyclopoida in (>78.3%) in September - November (Figure 250).

Densities (# of individuals/m^3) were also highly variable (Figure 251). Bosmina, Daphnia, and Ceriodaphnia all saw densities peak during June and July, but remain low in other months. Calanoida densities varied, but continued to increase through the sampling period. Cyclopoida recorded its highest density (56,083/m^3) in the May sample, and maintained the highest densities for all sampling months. Average lengths of Cyclopoida ranged from 0.51 - 0.67 mm (Figure 250), with a slight decline in average length occurring through the year. Average lengths of Daphnia ranged from 0.68 - 1.08 mm (Figure 252), with an increase in average length occurring through the year. Increases in average length were seen in both taxa following the April stocking of hatchery Rainbow Trout, but slight declines in average length were seen after the August stocking. Length frequency distributions from each sample show that the percent of Daphnia >1.3 mm in length ranged from 0.0 - 27.8% of the individuals collected (Figure 253). Length frequency distributions from each sample show that no Cyclopoids >1.3 mm in length were collected in any sample (Figure 254).

Additionally, ZQI sampling was conducted on August 23, 2012. Biomass was 0.10 (g/m^3) for the 150 µm net, and 0.00 (g/m^3) for the 500 and 750 µm nets (Appendix E). These were the lowest values for any regional reservoir. The ZPR and ZQR were both calculated to be 0.00.

Aquatic Vegetation

No vegetation surveys or Davids' Fishabiltiy Index (DFI) surveys were conducted on Waha Lake due to the absence of aquatic vegetation.

DISCUSSION

Population Survey

The fish community in Waha Lake consists primarily of stocked hatchery Rainbow Trout to provide a put and take fishery. Other species include Smallmouth Bass, Yellow Perch (illegally introduced in 1993), and a small population of kokanee that is the result of some successful spawning since stocking ended in 2005. Black Crappie are also present, but have been sampled in only very low numbers since 1997. Smallmouth Bass and Yellow Perch dominate the fishery and may be cropping off Black Crappie.

The results of the fisheries survey conducted in 2012 indicated that for an electrofishing survey of Waha Lake, six 10-minute samples would be needed for a whole fish community estimate with 90% confidence (2-tail test) and 25% precision (Table 41). This is consistent with the length of sampling (3,600 s) conducted in previous samples. Sampling the entire shoreline to improve our accuracy is not realistic, as it would require at least twice the sample time. Thus, we recommend continuing with 6 10-minute samples.

Smallmouth Bass:

The Smallmouth Bass population in Waha Lake is dominated by small fish. Of the 355 Smallmouth Bass collected during surveys since 1997, only 10.7% were >250 mm and 4.5% >300 mm. This has resulted in PSD values below the balanced population range of 40 - 70 (Anderson 1980) for every survey since 2001. Low PSD can be an indicator of a stunted population of Smallmouth Bass and/or overharvest of fish by anglers (Schramm and Willis 2012). A stunted population is an indication of poor growth, and can be caused by limited food sources, inefficient foraging conditions (too much or too little cover), inadequate thermal regimes (short growing season), or too many fish. However, we do not believe that we are accurately sampling the population due to the difficulties of electrofishing a lake with steep shoreline. This is a similar problem encountered in Smallmouth Bass surveys on Dworshak Reservoir. Annual sampling and reports by anglers on Dworshak Reservoir has shown that larger Smallmouth Bass tend to inhabit deeper water away from the shoreline. This would result in not proportionally sampling the entire population of Smallmouth Bass, possibly resulting in artificially depressed PSD values. Development of techniques to properly sample fish populations in these type of lakes and reservoirs will be important for managing these water bodies in the future.

Temperature is one of the most important abiotic factors controlling growth rates (Colby and Nepszy 1981; McCauley and Kilgour 1990; Wehrly et al. 2007). With its location in northern Idaho at an elevation of 1,097 m, and with fewer heating degree days than occur in much of the specie's range (Beamesderfer and North 1995), Waha Lake has a relative short growing season. Smallmouth Bass collected in Waha Lake in 2012 averaged 157 mm in length at capture, below stock size (180 mm). Growth rates ranged from 33 - 65 mm per year. Not enough Smallmouth Bass were collected at any other regional reservoir in 2012 to enable direct comparisons with other regional lowland lakes. However, comparisons can be made to data collected in previous years (2003 - 2010) from Waha Lake, ECR, and Dworshak Reservoir (which has similar habitat characteristics). Average annual growth was similar to that seen in previous surveys conducted at these three water bodies, which had average annual growth rates ranging from 33 - 78 mm per year. Comparing length at age, SMB in Waha Lake collected in 2012 grew more slowly from age 1 - 5, but were above average length from age 6 - 8. Additionally, compared to the populations described by Beamesderfer and North (1995), it appears that Smallmouth Bass growth in Waha Lake is slow in younger fish, but catches up by the time they reach 300 mm. These growth rates have resulted in Smallmouth Bass at Waha Lake not entering the fishery (stock size of 180 mm) until age-4, and not reaching quality size (280 mm) until age-6. However, this age to quality size for Smallmouth Bass in Waha Lake is close to the average age of 5.1 years for six Idaho populations described by Beamesderfer and North (1995).

This data suggests that food availability may be a limiting factor. Relative weights of Smallmouth Bass in Waha Lake average 79, and decline as fish get larger (Figure 231). Fish in the stock to quality size range (200 - 300 mm) experience decreased condition compared to smaller and larger fish. This may indicate a lack of food resources and/or too many fish. A lack of sufficient food resources is likely. Even though Yellow Perch are a suitable prey species (Guy and Willis 1991; Aday and Graeb 2012), there are not likely enough of them to provide an adequate food source. It is also likely that the large annual fluctuations in lake level are causing inconsistent recruitment, which would complicate our ability to properly assess of growth and mortality.

In addition to slow growth, angler harvest of larger fish is another possible explanation for the appearance of a stunted population. Some harvest of predators by anglers can result in reduced competition, increased food resources available for the remaining predators, and help maintain good predator-prey balance (Swingle 1950; Flickinger and Bulow 1993). In contrast, overharvest can result in the appearance of a stunted population with many smaller fish and few large fish. Creel surveys of Waha Lake estimate that 55 Smallmouth Bass were harvested in 2012. Total annual mortality of Smallmouth Bass in Waha Lake was estimated to be 48% from data collected in 2012. This is below the natural mortality rate of 64% estimated for the 6 Idaho populations of Smallmouth Bass described by Beamesderfer and North (1995).

Even though 280 mm is considered the minimum quality size for anglers (Gablehouse 1983), the two harvested Smallmouth Bass encountered during the creel survey were below this size. With only two harvested fish encountered in creel surveys, it is difficult to draw any conclusions regarding the population in general. With few Smallmouth Bass >280 mm in length in the population based on electrofishing (Figure 229), and the slow growth seen in this lake, even the low levels of harvest estimated during recent creel surveys could have an impact on the population. This suggests that while slow growth and lack of sufficient food resources are likely the primary impacts, harvest could play a role in the lower number of larger fish.

A comparison of PSD distributions for both predator and prey can provide insight into potential population issues (Schramm and Willis 2012; Figure 255). In Waha Lake, five of the six years of sampling since 1997 occur either in Cells 1, 4, and 7. Fish communities that fall into these cells generally have an overabundance of Smallmouth Bass <300 mm quality size (or an underabundance of fish >300 mm), and little prey <150 mm present (Schramm and Willis 2012). As mentioned above, we are not confident in PSD metrics due to due to sampling limitations in steep sided lakes such as Waha Lake, and these predator:prey comparisons must be made with caution. However, populations that fall in these Cells are also characterized as often being food-limited, resulting in slow growing predators. This fits with the low relative weight and growth data mentioned previously, indicating that is a likely scenario in Waha Lake.

Yellow Perch:

The Yellow Perch population in Waha Lake has seen little change in the range of lengths (mostly 110 - 210 mm) over the four samples collected since 2003. However, there has been a shift in the length frequency distribution towards larger fish as evidenced by the increase in PSD (Figure 237). The PSD value of 43 in 2012 was the second highest PSD value calculated for Yellow Perch samples collected since 1997. The average length of Yellow Perch (171 mm) in Waha Lake was the highest among regional reservoirs. Annual growth of Yellow Perch in Waha Lake ranged from 10 - 60 mm, similar to that seen in other regional reservoirs. On average, Yellow Perch reach stock size (130 mm) at age 3, and quality size (200 mm) at age 5. The annual mortality rate estimated for Yellow Perch in Waha Lake was 32%. No comparisons were made with other regional reservoirs, as mortality could not be estimated for other regional populations due to small sample sizes. The length frequency distribution suggests that recruitment has not been consistent, especially in recent years. The large water level fluctuations that occur annually in Waha Lake may be having a negative impact on recruitment.

Yellow Perch harvested by anglers in Waha Lake during 2012 were in the upper end of the range of lengths found in the population (65 - 244 mm), and averaged (217 mm) much larger than the population average of 177 mm (Figure 234). The harvest of the larger individuals in the population is to be expected, as anglers usually prefer to keep the larger fish they catch (Aday and Graeb 2012). With an estimated 276 Yellow Perch harvested averaging over quality size, Waha Lake has a small but quality Yellow Perch fishery.

Creel Survey

Angler Effort:

The year-long creel survey resulted in an estimated 4,455 hours of angler effort in 2012. This was the highest of the three creel surveys conducted on the lake since 1999, and represents a 22% increase in effort over the 3,649 hours estimated in 2005 (Figure 1). However, compared to other regional reservoirs, effort at Waha Lake is low.

Despite its proximity to the population centers of Lewiston, Idaho, and Clarkston, Washington, Waha Lake continues to have the second lowest angler effort of all lowland reservoirs in the region (Figure 1). This is likely due to limited access, limited shoreline fishing opportunities (lake is surrounded by private property and fishing is difficult from shore), and lack of amenities (one public dock, boat ramp occasionally unusable due to water drawdown). Despite this, catch rates for hatchery Rainbow Trout (1.3 fish/hr in 2012) continue to be above the management goal of 0.5 fish/hour.

Catch and Harvest

Harvest composition has shifted from predominantly hatchery Rainbow Trout in 1999 to Yellow Perch in 2005, and back to Rainbow Trout in 2012 (Figure 241). This was the result of an estimated harvest of 7,215 Yellow Perch in 2005. Harvest of hatchery Rainbow Trout accounted for 89.8% of the harvest in 2012, with other species accounted for 10.2%.

Based on the 2012 creel survey, most anglers either stated they were fishing for "any fish" (46.2%; Figure 243) or targeting Rainbow Trout (38.7%). Few anglers targeted any other species. With most anglers targeting hatchery Rainbow Trout, catch and harvest rates tend to be high. The catch rate of 1.3 fish/hour and harvest rate of 0.7 fish/hour were right around the average catch rate of 1.3 fish/hour and harvest rate of 0.8 for regional reservoirs in 2012 (Appendix B). This catch rate is above the management goal of a 0.5 fish/hour catch rate for hatchery Rainbow Trout. Along with the increase in effort, harvest of hatchery Rainbow Trout increased from 2,357 in 2005 to 3,077 in 2012 (Appendix B). This represents a return to creel of 30.4% in 2012. The hatchery trout return to creel rate has stayed very consistent in Waha Lake, ranging from 28.1 - 31.6% in creel surveys conducted from 1999 - 2012.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (56.9%) rated their fishing trip as "Good" or "Excellent" (Figure 243). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 58.5% of the responses. While the quality of fishing played the major role in one's fishing experience, the most common other response was "nice to be outside" (22.0%). This indicates that an enjoyable fishing trip is not predicated solely upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as simplified fishing rules, year-round fishing opportunities, easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself.

With low annual angler effort and more difficult access, Waha Lake appeared to be a candidate for developing a trophy Rainbow Trout fishery in order to provide a diversity of opportunity in the Region. We considered the implementation of a trophy trout fishery consisting of a daily bag limit of only two fish >356 mm. However, the majority of anglers (64%) interviewed during the 2012 creel survey were opposed to this potential regulation. Thus, we recommend maintaining the current harvest regulation of six trout of any size. Additionally, with the exploitation rate in Waha Lake well below the management goal and statewide average, we recommend reducing the annual stocking and using IDFG "magnum" size catchables. These larger-sized fish have been shown to return to creel at higher rates (Cassinelli 2014) than standard sized hatchery trout, likely due to angler preference for larger fish (Aday and Graeb 2012).

Angler Exploitation

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) were utilized to evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate of stocked hatchery Rainbow Trout was 16.9% for the spring 2012 tagging event (Table 45). There was no angler use beyond 365 days at large, indicating there was little or no carryover. Thus, total use through June, 2014 was estimated to be 16.9%. This estimate was below the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). Additionally, this estimate was below the IDFG management goal of a 40% total use rate for stocked hatchery Rainbow Trout (Appendix D). With only six tag returns (Figure 256), little can be said about patterns of exploitation from this tagging event. Even though use rates are low, angler catch rates are above our management goal of 0.5 fish/hour, and hatchery rainbow trout are the most sought-after species in Waha Lake. As such, no changes are recommended for future spring stockings. An option in the future may be to utilize IDFG “magnum” size catchable Rainbow Trout. These fish have been shown to return to creel at higher rates (Cassinelli 2014) than standard sized hatchery trout, likely due to angler preference for larger fish (Aday and Graeb 2012).

Comparing angler exploitation of hatchery Rainbow Trout from the “Tag You’re It” program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 14.1% while the creel survey estimated it to be 30.4%. Differences in angler exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the use of bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Limnology

One area of concern for our hatchery trout stockings is the potential effects of low DO in the summer. In contrast to many of the reservoirs in the Clearwater Region, Waha Lake does not experience serious temperature and DO issues during the summer months. Based on the IDFG standards for temperature and DO thresholds, the volume of water available for Rainbow Trout to survive was reduced by 28% in July, 2012 (Figure 249). With only the top 3 m of water unsuitable, negative impacts on hatchery Rainbow Trout would be minimal. However, with suitable temperatures and DO levels, we would expect to see carry-over of hatchery Rainbow Trout. With no carry-over estimated for the spring 2012 stocking, it is apparent that other factors such as food availability are limiting the long-term survival of these fish. This should be explored to determine if we can improve the trout fishery in the lake.

Zooplankton

Larger sized zooplankton taxa, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in Waha Lake was dominated by Daphnia and Cyclopoida through most of 2012, indicating the presence of a viable food source. In 2012, Daphnia collected averaged 0.9 mm in length, and Cyclopoida averaged 0.6 mm in length (Figure 252). These average lengths are substantially below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). Additionally, no more than 27.8% of Daphnia and no Cyclopoids were at or above preferred size (Figures 250 and 251) during 2012. However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 39.0% of the Daphnia population and 1.2% of the Cyclopoida population were ≥1.0 mm in length.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for Waha Lake. The ZQI, which is a measure of both abundance and size, was 0.00 (Appendix E). ZQI values <0.1 are considered low and indicate that zooplankton resources are limiting and may potentially impact fish populations (Teuscher 1999). This sampling also indicated that zooplankton biomass was the lowest of any regional reservoir, indicating that there is an inadequate zooplankton population to support good populations of planktivorous species. Without an improvement in the quantity and quality of large zooplankton, it would be difficult to implement a successful fingerling Rainbow Trout fishery as these fish need an adequate food source to survive in the lake long enough (at least 1 - 2 years) to enter the fishery. This may also explain the lack of good carryover of catchable size Rainbow Trout. This would also be a concern for potential future stockings of other species such as kokanee. Further study is warranted to determine if this is a continuing trend, and what might be causing the lack of zooplankton given the relatively small fish populations.

MANAGEMENT RECOMMENDATIONS

1. Engage the public in discussion on how to manage the surrounding lowland lakes (Winchester, Mann, Soldier's Meadow, and Waha).

2. Utilize gillnets to better assess kokanee and Rainbow Trout growth and mortality.

3. Conduct future lake surveys with six 10-minute electrofishing samples to obtain a 90% confidence interval with 25% accuracy for comparing CPUE's.

4. Reduce the number of Rainbow Trout stocked annually, and utilize "magnum" sized fish.

5. Explore potential causes of poor quality zooplankton population.

Table 41. Number of fish collected by species in each 10-minute electrofishing sample conducted during a fisheries survey of Waha Lake, Idaho, in 2012, and the estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 90% confidence and 25% precision.

	Count of fish collected									
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Smallmouth Bass	17	16	20	25	19	27	124	20.7	4.4	3
Yellow Perch	36	10	2	3	6	6	63	10.5	12.8	91
Total	53	26	22	28	25	33	187	31.2	11.3	6

Table 42. Back-calculated length at age of Smallmouth Bass collected through electrofishing in Waha Lake, Idaho in 2012.

Year			Back-calculated length (mm) at each annulus							
class	Age	n	1	2	3	4	5	6	7	8
2011	1	1	68							
2010	2	38	63	103						
2009	3	23	64	108	152					
2008	4	24	64	112	163	197				
2007	5	11	68	121	167	205	233			
2006	6	2	81	144	205	248	285	308		
2005	7	1	86	129	194	238	292	330	359	
2004	8	1	80	167	229	265	315	358	399	432
n			101	100	62	39	15	4	2	1
Length at age			65	110	162	204	249	326	379	432

Table 43. Back-calculated length at age of Yellow Perch collected through electrofishing in Waha Lake, Idaho in 2012.

Year			Back-calculated length (mm) at each annulus						
class	Age	n	1	2	3	4	5	6	7
2011	1	3	56						
2010	2	16	62	112					
2009	3	12	59	109	165				
2008	4	17	59	102	153	197			
2007	5	12	62	100	150	182	211		
2006	6	0	0	0	0	0	0	0	
2005	7	2	59	90	120	175	211	229	240
n		62	62	59	43	31	14	2	2
Length at age			60	105	154	190	211	229	240

Table 44. Summary of angler effort (hours) as determined through a creel survey conducted on Waha Lake, Idaho, from November 28, 2011 to November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	125	--	--	125	32	--	--	32	157	0	0	157	129	82.2
January	223	--	--	223	0	--	--	0	223	0	0	223	--	--
February	0	--	--	0	0	--	--	0	0	0	0	0	--	--
March	0	--	--	0	0	121	0	121	0	121	0	121	72	59.7
April	--	0	61	61	--	98	0	98	--	98	61	159	87	54.9
May	--	59	274	332	--	158	58	216	--	217	331	548	137	24.9
June	--	202	289	491	--	251	223	473	--	453	512	964	253	26.2
July	--	236	129	364	--	172	118	290	--	408	247	655	176	26.9
August	--	244	139	383	--	258	76	333	--	501	215	717	160	22.3
September	--	171	0	171	--	260	104	364	--	431	104	535	234	43.8
October	--	104	0	104	--	144	0	144	--	248	0	248	177	71.7
November	--	0	0	0	--	128	0	128	--	128	0	128	128	100.0
Totals	349	1,015	891	2,255	32	1,590	578	2,200	381	2,605	1,469	4,455	521	11.7

Table 45. Angler exploitation of hatchery catchable size Rainbow Trout stocked in Waha Lake, Idaho, in 2012, through 365 days post-stocking. Total use = fish harvested + fish released.

				Disposition			Adjusted exploitation		Adjusted total use	
Hatchery	Tagging date	Treatment	Tags released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Hagerman	4/18/2012	Production	100	5	1	0	14.1%	8.2%	16.9%	9.0%

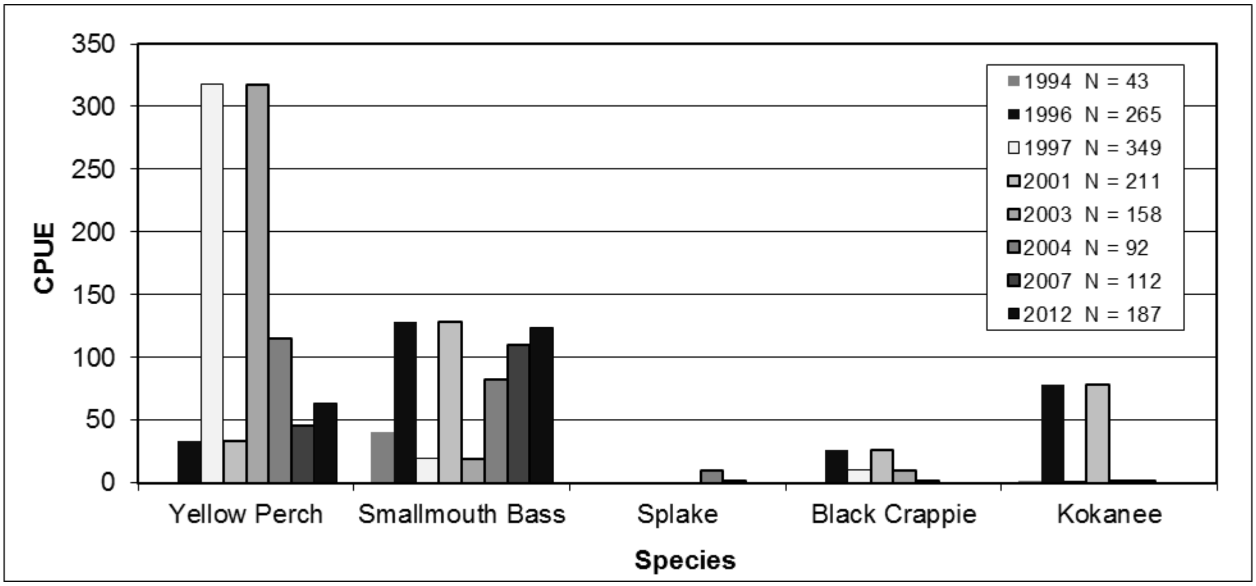


Figure 231. Catch per unit effort (CPUE; number of fish/hour) of fishes collected through electrofishing in Waha Lake, Idaho, from 1994 - 2012.

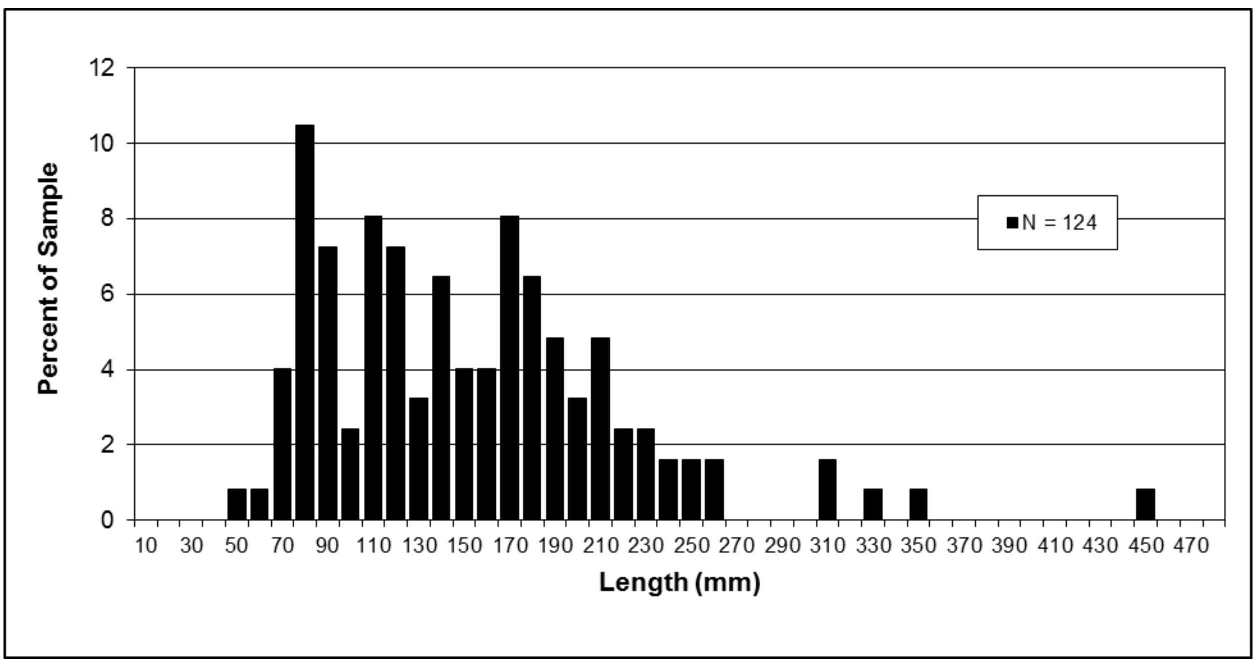


Figure 232. Length frequency distribution of Smallmouth Bass collected through electrofishing in Waha Lake, Idaho, in 2012.

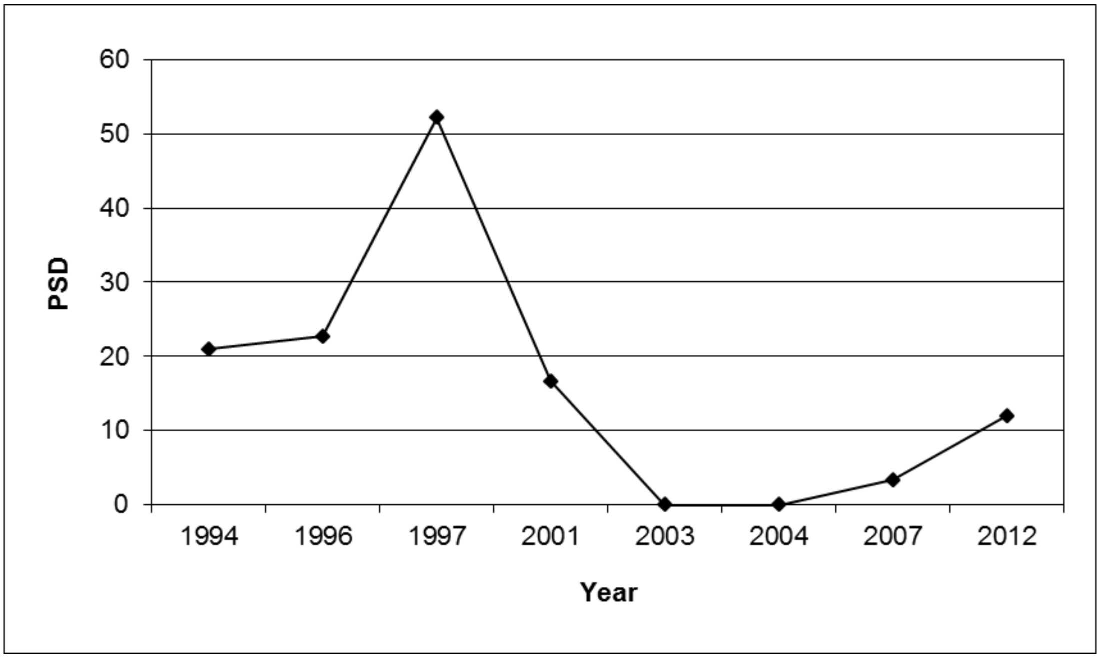


Figure 233. Proportional Size Distribution (PSD) values of Smallmouth Bass collected through electrofishing in Waha Lake, Idaho, from 1994 - 2012.

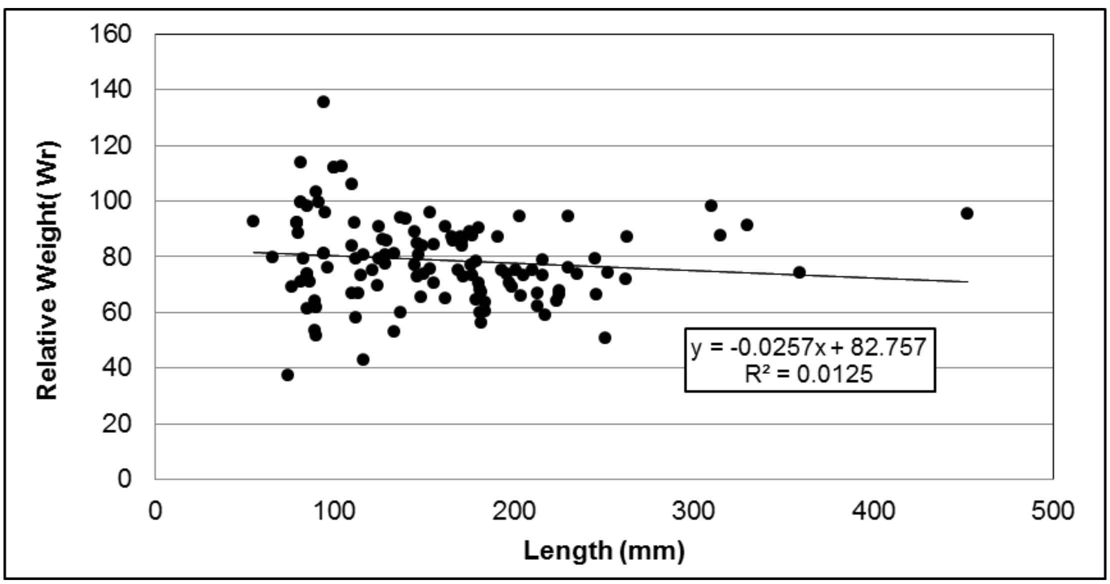


Figure 234. Relative weight (Wr) values of Smallmouth Bass collected through electrofishing in Waha Lake, Idaho, in 2012.

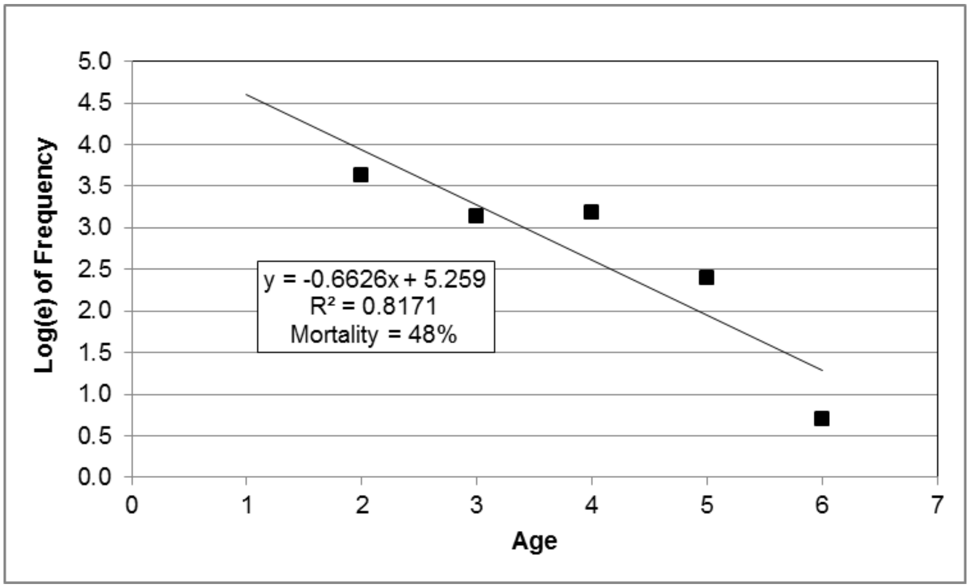


Figure 235. Catch curve for estimating annual mortality of Smallmouth Bass collected through electrofishing in Waha Lake, Idaho, in 2012.

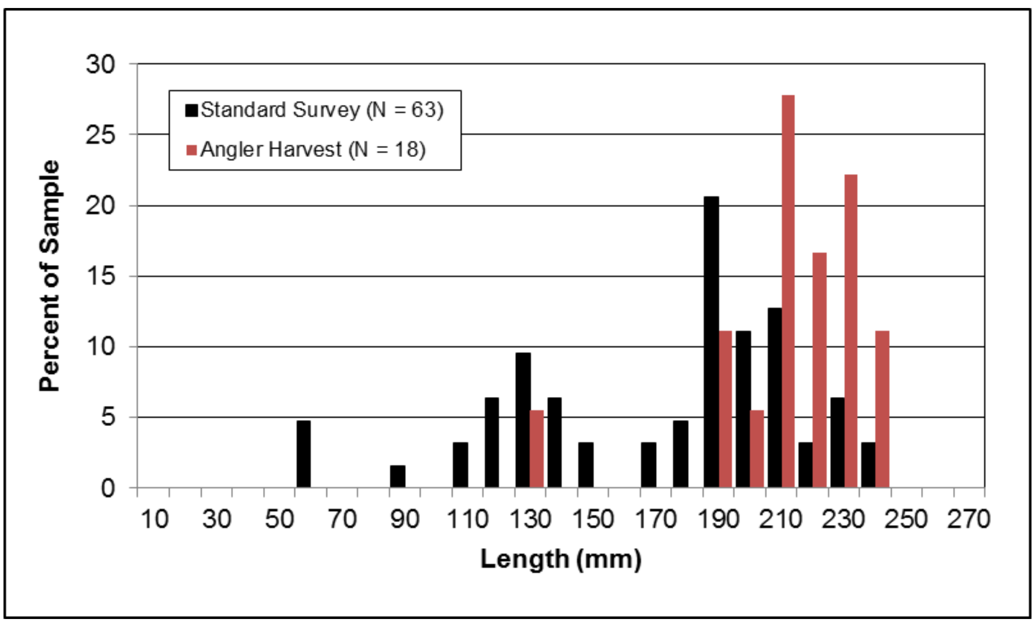


Figure 236. Comparison of Yellow Perch length frequency distributions from fishes collected through electrofishing and harvested by anglers in Waha Lake, Idaho, in 2012.

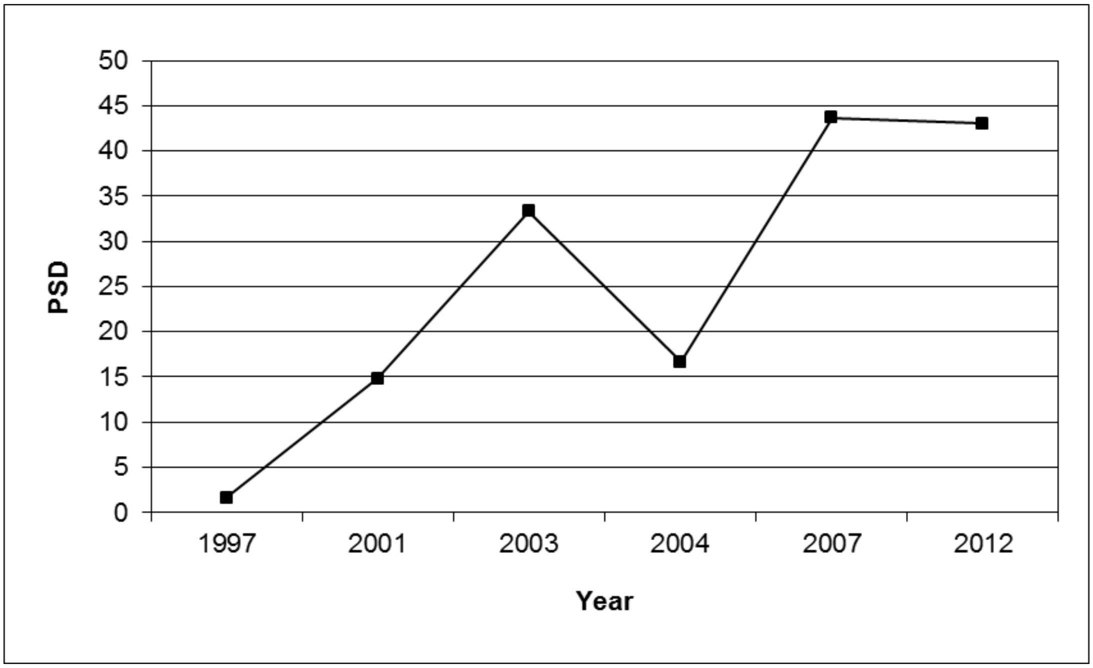


Figure 237. Proportional Size Distribution (PSD) values of Yellow Perch collected through electrofishing in Waha Lake, Idaho, from 1997 - 2012.

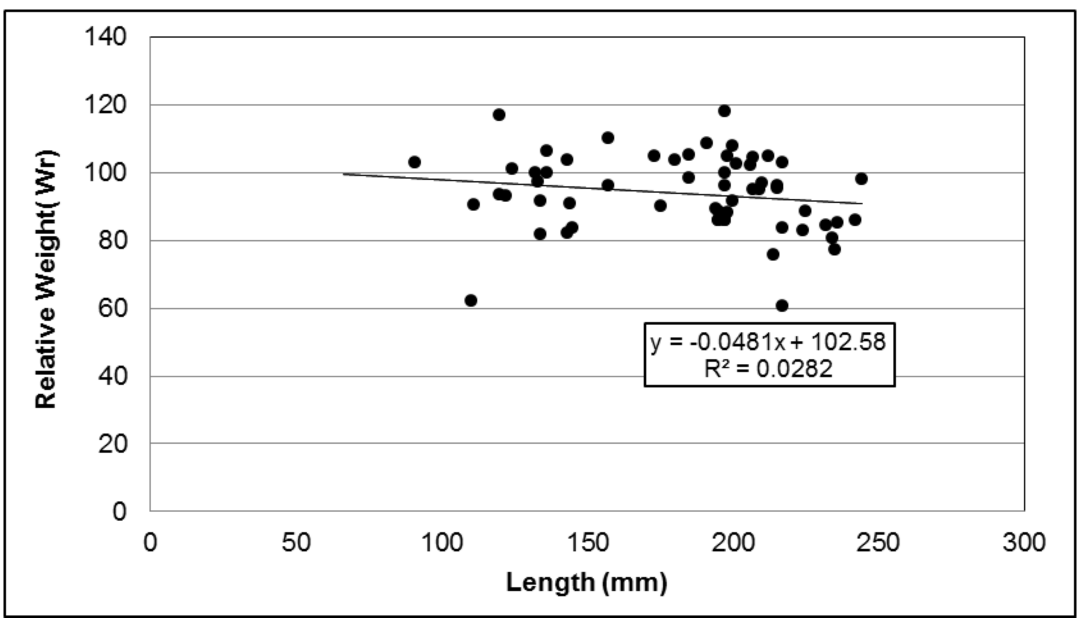


Figure 238. Relative weight (Wr) values of Yellow Perch collected through electrofishing in Waha Lake, Idaho, in 2012.

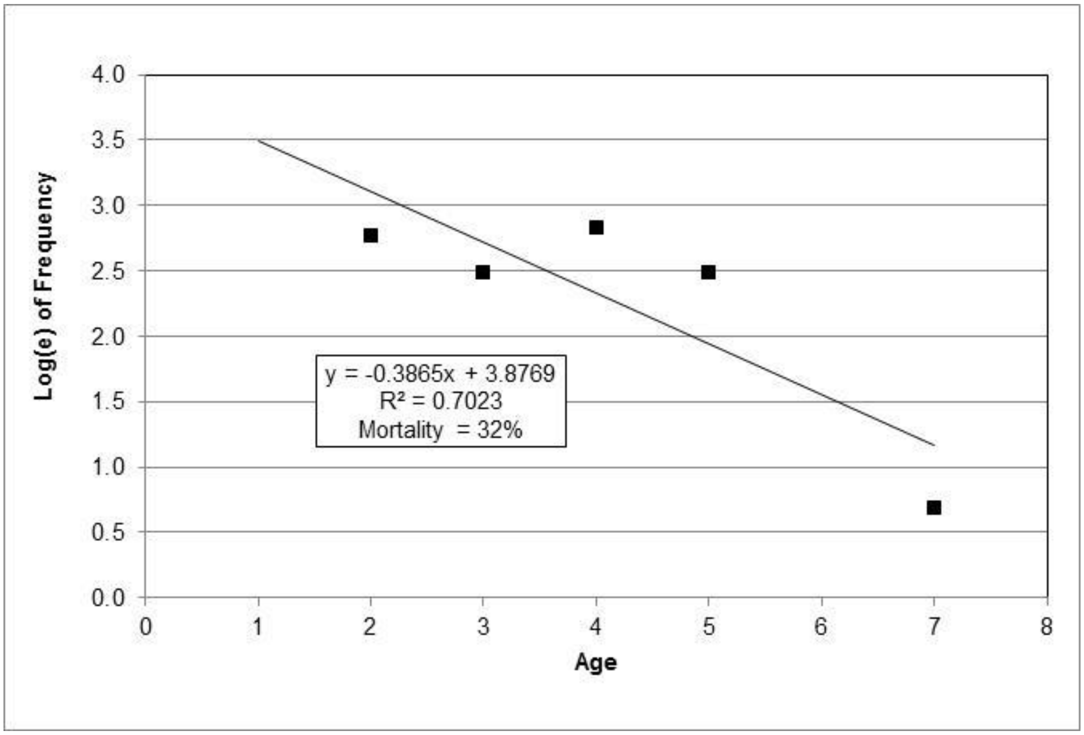


Figure 239. Catch curve for estimating annual mortality of Yellow Perch collected through electrofishing in Waha Lake, Idaho, in 2012.

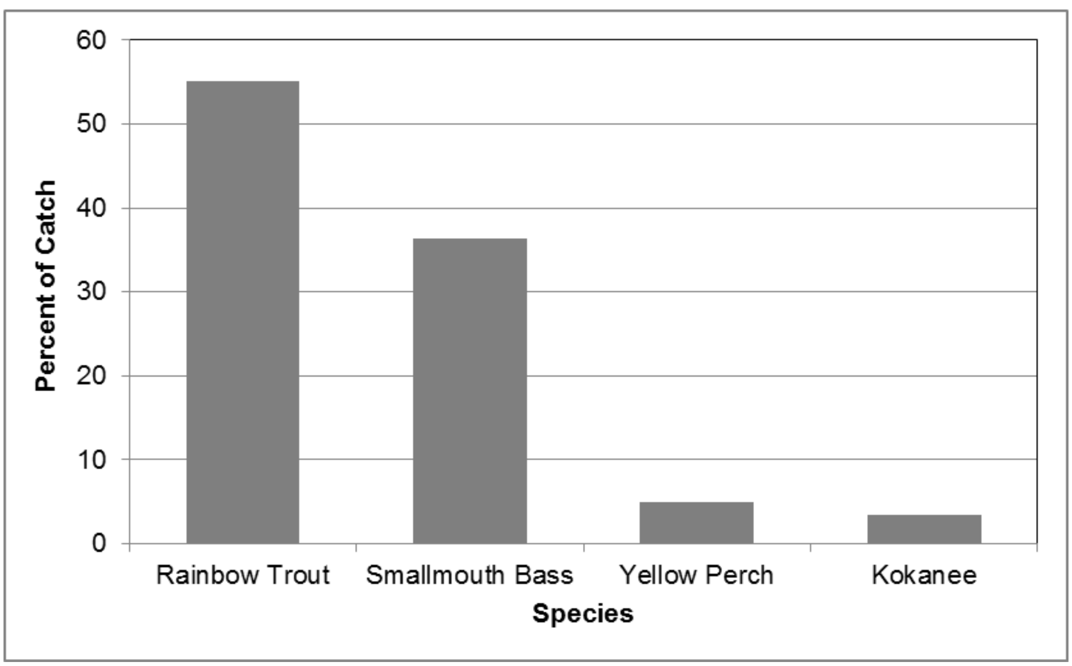


Figure 240. Composition of fishes caught in Waha Lake, Idaho, as estimated by a creel survey conducted from November 28, 2011 to November 28, 2012.

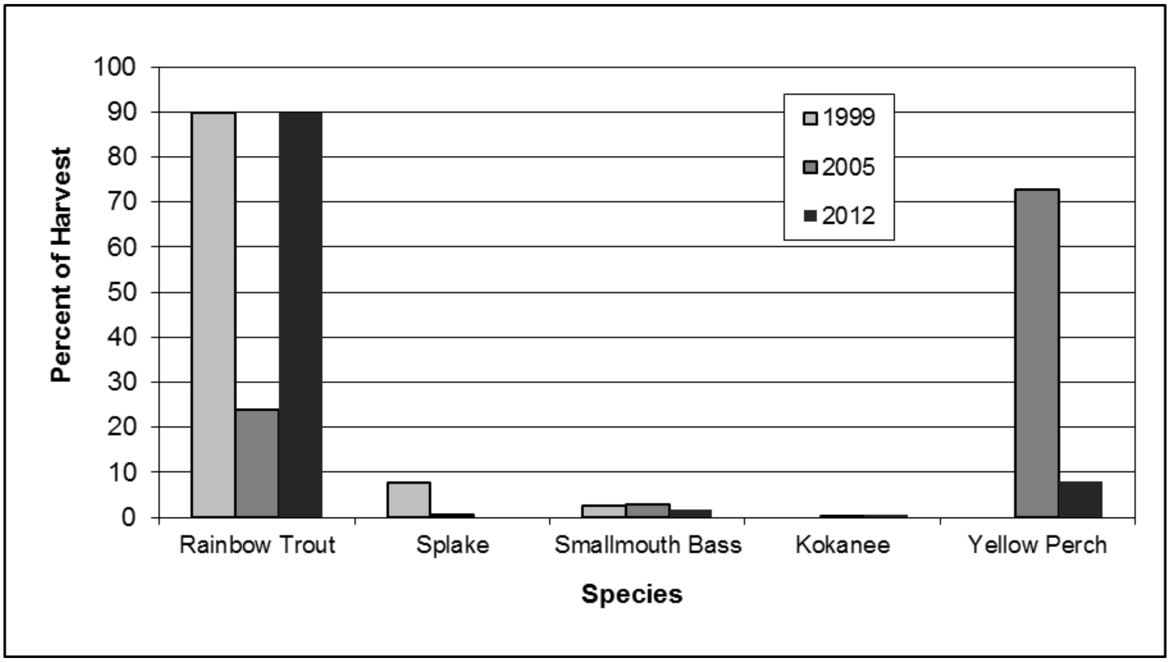


Figure 241. Composition of fishes harvested in Waha Lake, Idaho, as estimated by creel surveys conducted from 1999 - 2012.

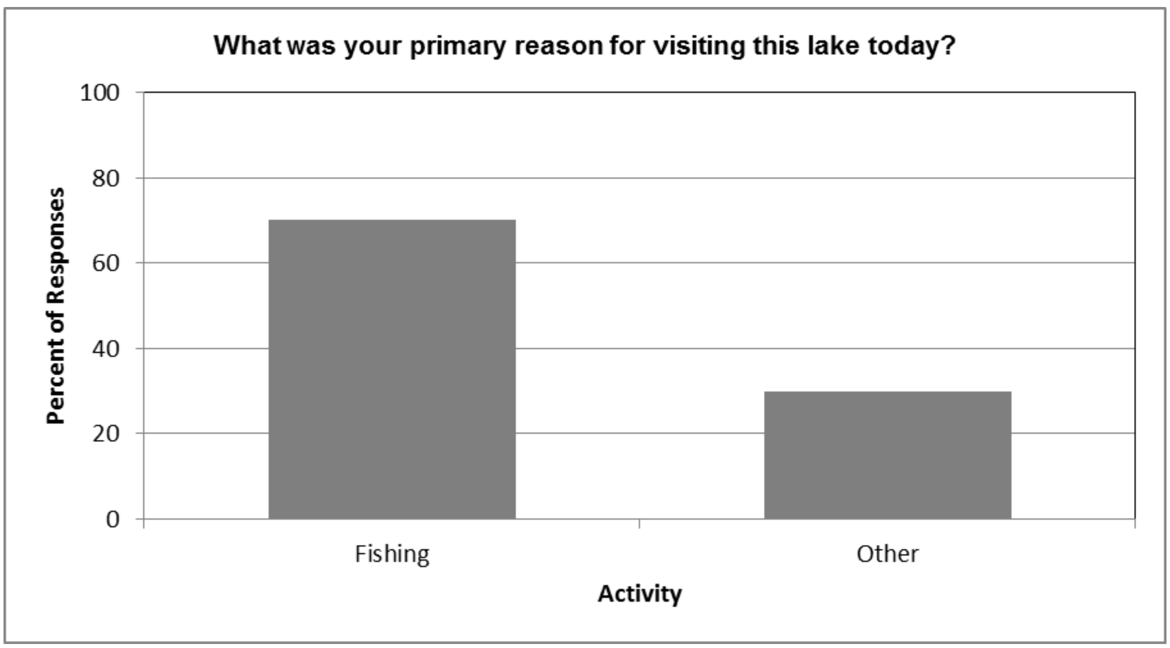


Figure 242. Summary of angler responses to the primary reason for visiting Waha Lake, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

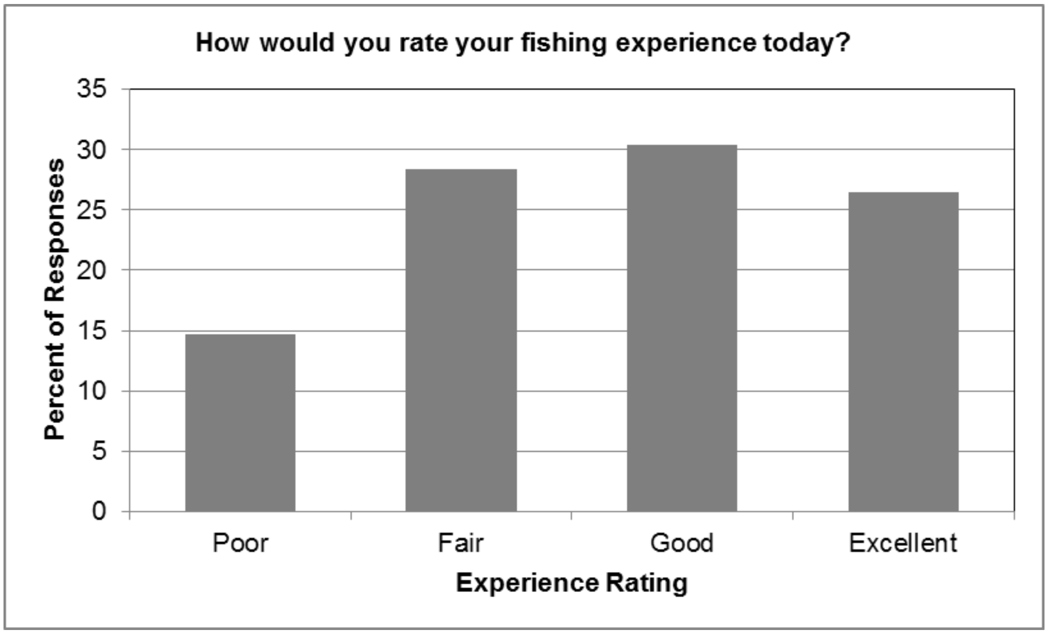


Figure 243. Summary of angler responses regarding their overall fishing experience at Waha Lake, Idaho, as determined though a creel survey conducted from November 28, 2011 to November 28, 2012.

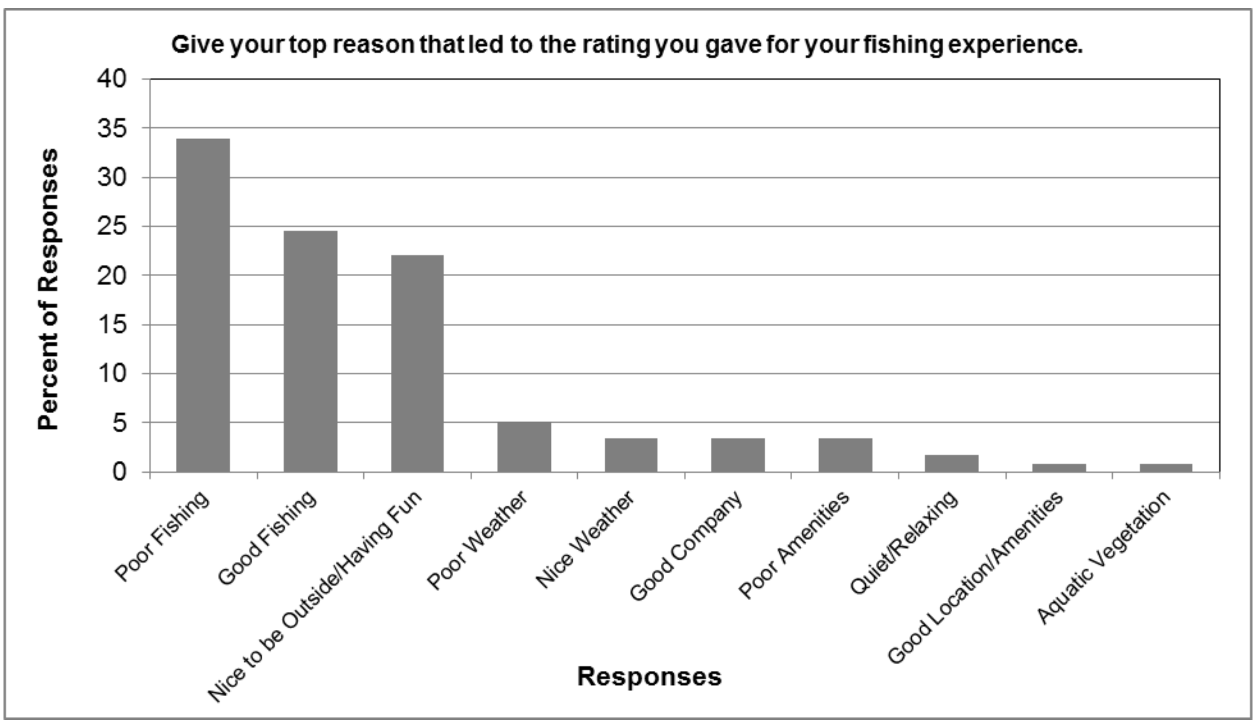


Figure 244. A summary of the most common responses anglers provided for what influenced the quality of their fishing experience for the day when fishing at Waha Lake, Idaho, as determined through a creel survey conducted from November 28, 2011 to November 28, 2012 (Only 10 most common answers shown).

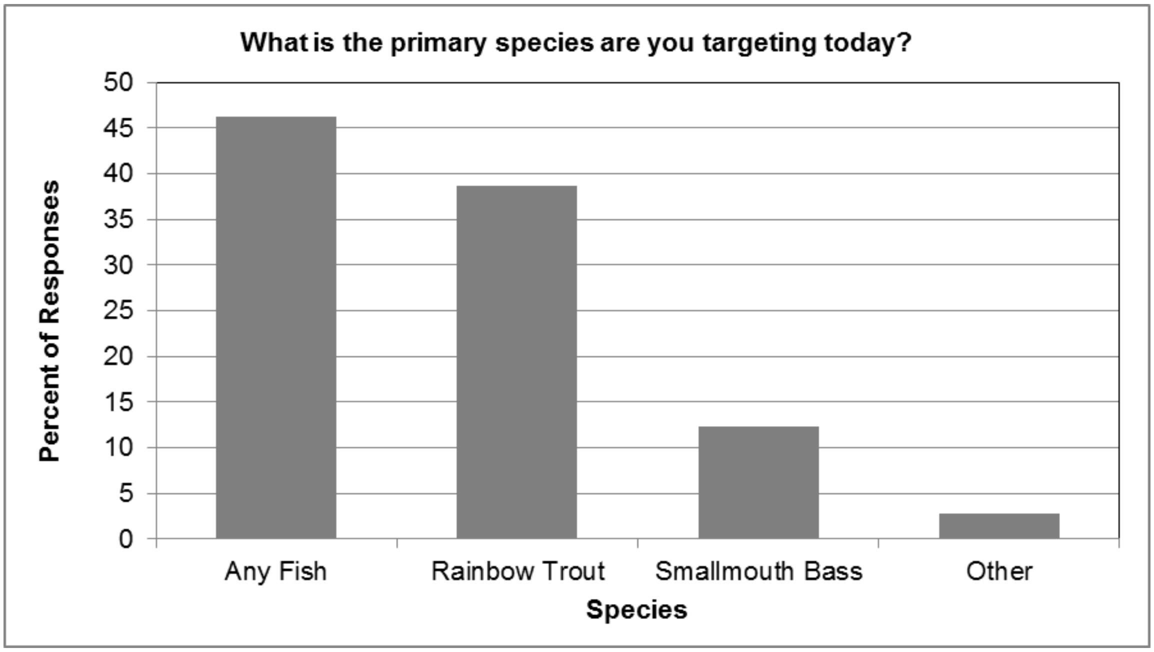


Figure 245. Summary of angler responses regarding target fish species at Waha Lake, Idaho, determined through a creel survey conducted from November 28, 2011 to November 28, 2012.

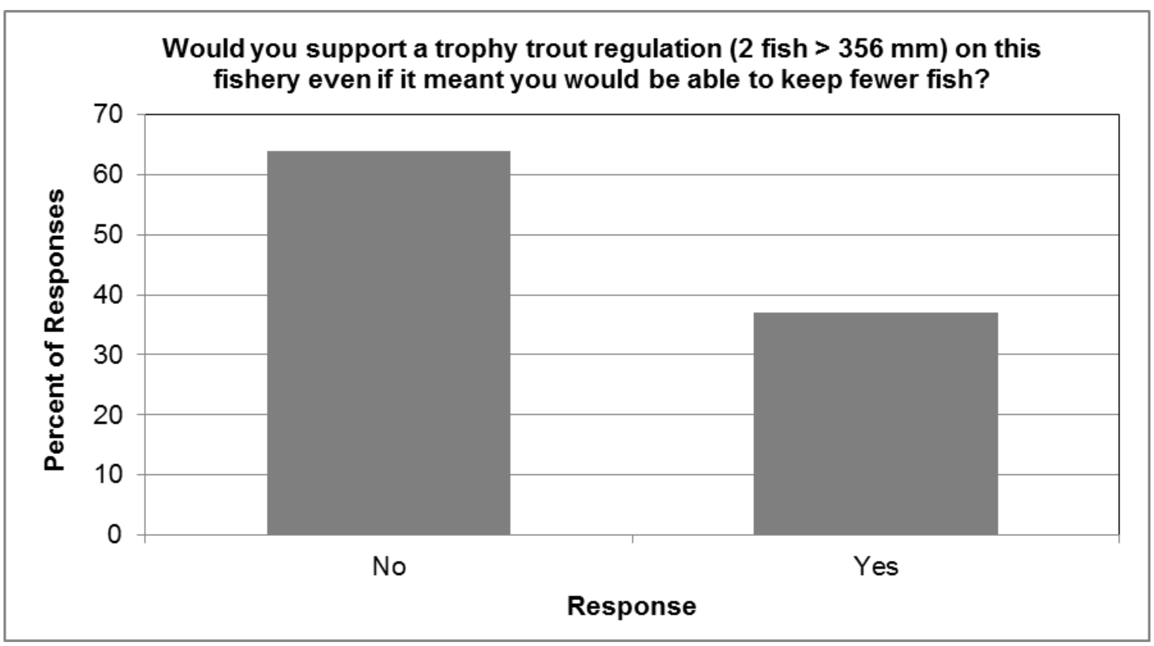


Figure 246. Summary of angler responses regarding a potential change in management to a trophy trout harvest rule of two fish >356 mm at Waha Lake, Idaho, during a creel survey conducted from November 28, 2011 to November 28, 2012.

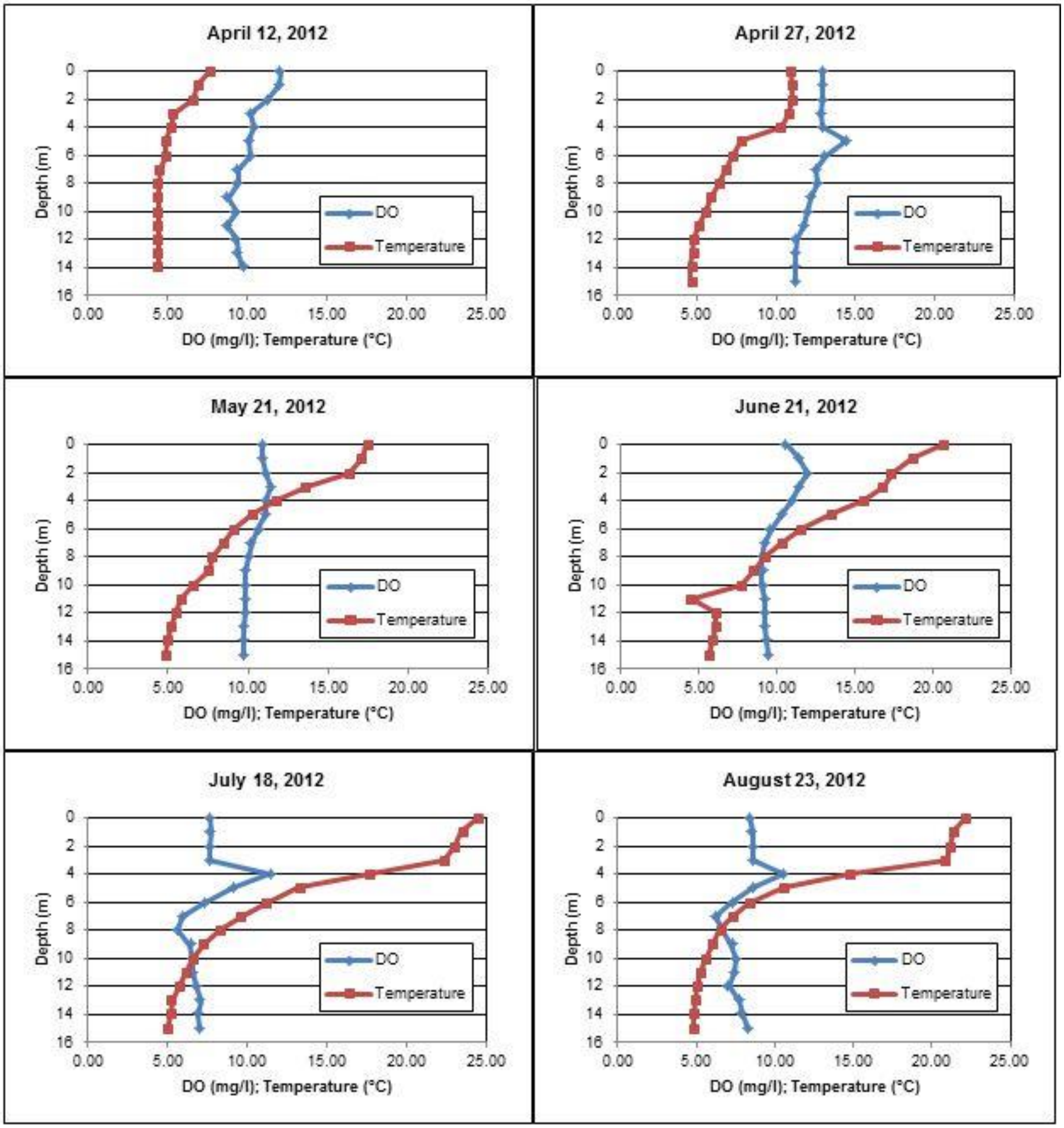


Figure 247. Dissolved oxygen (DO) and temperature profiles collected in Waha Lake, Idaho, during 2012.

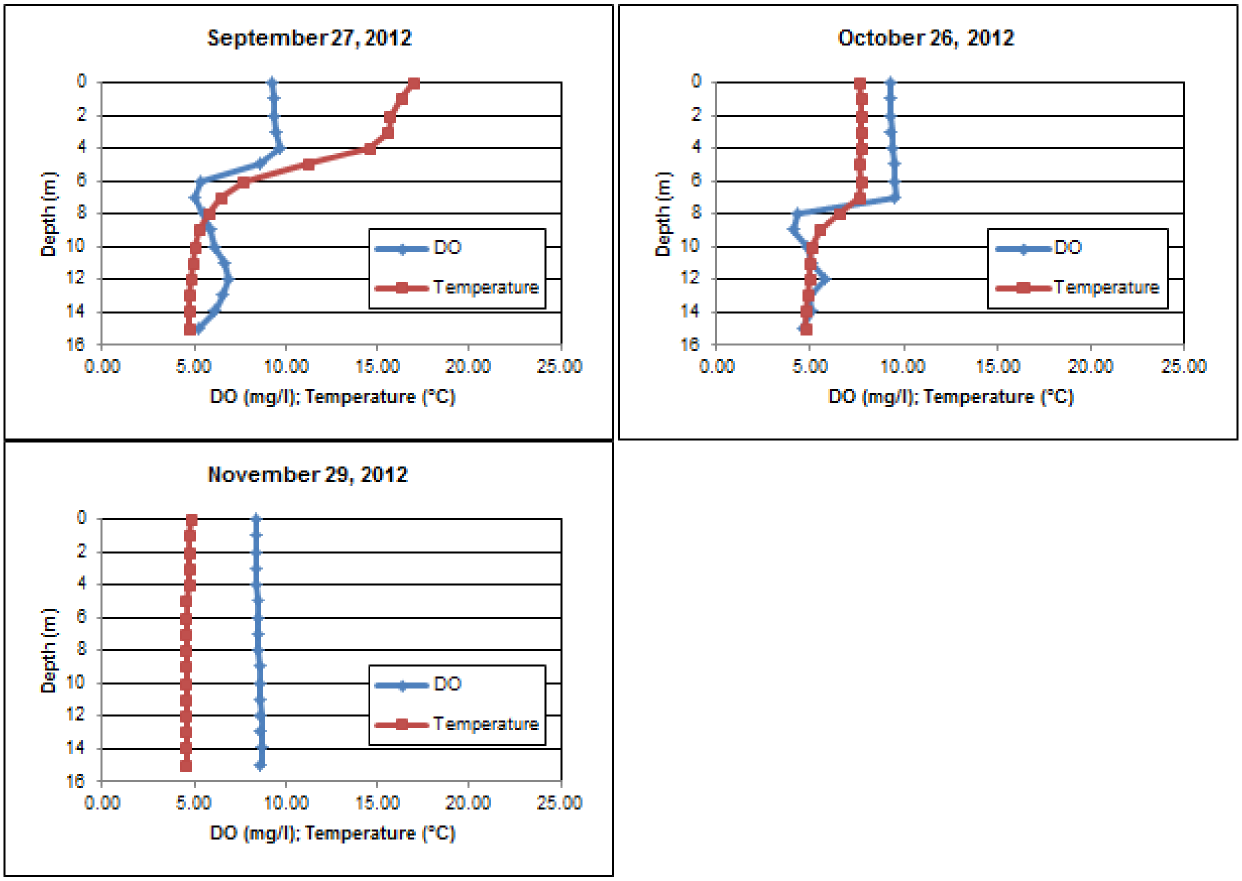


Figure 247. Continued.

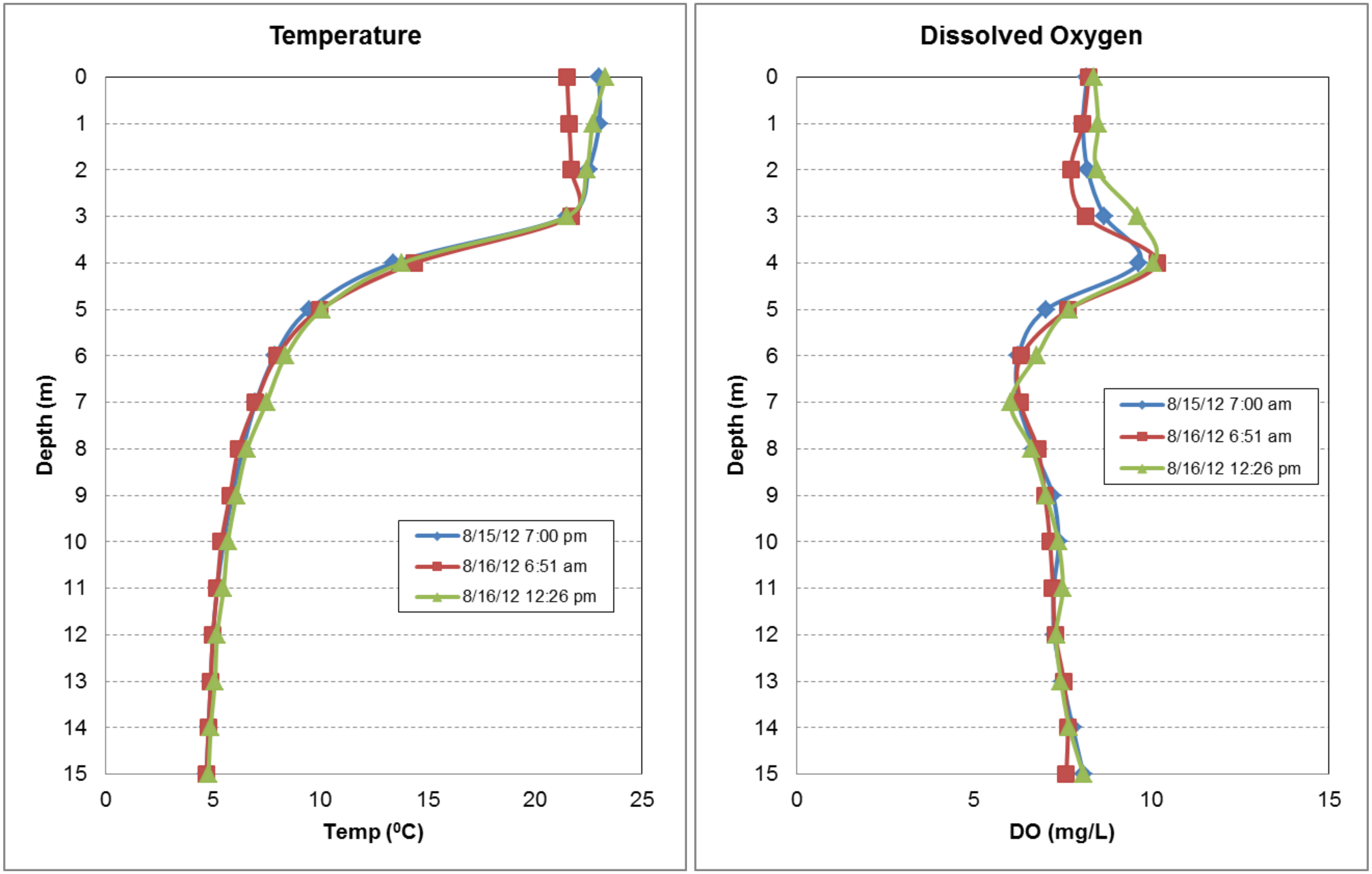


Figure 248. Diel changes in temperature and dissolved oxygen (DO) in Waha Lake, Idaho, from August 16 - 17, 2012.

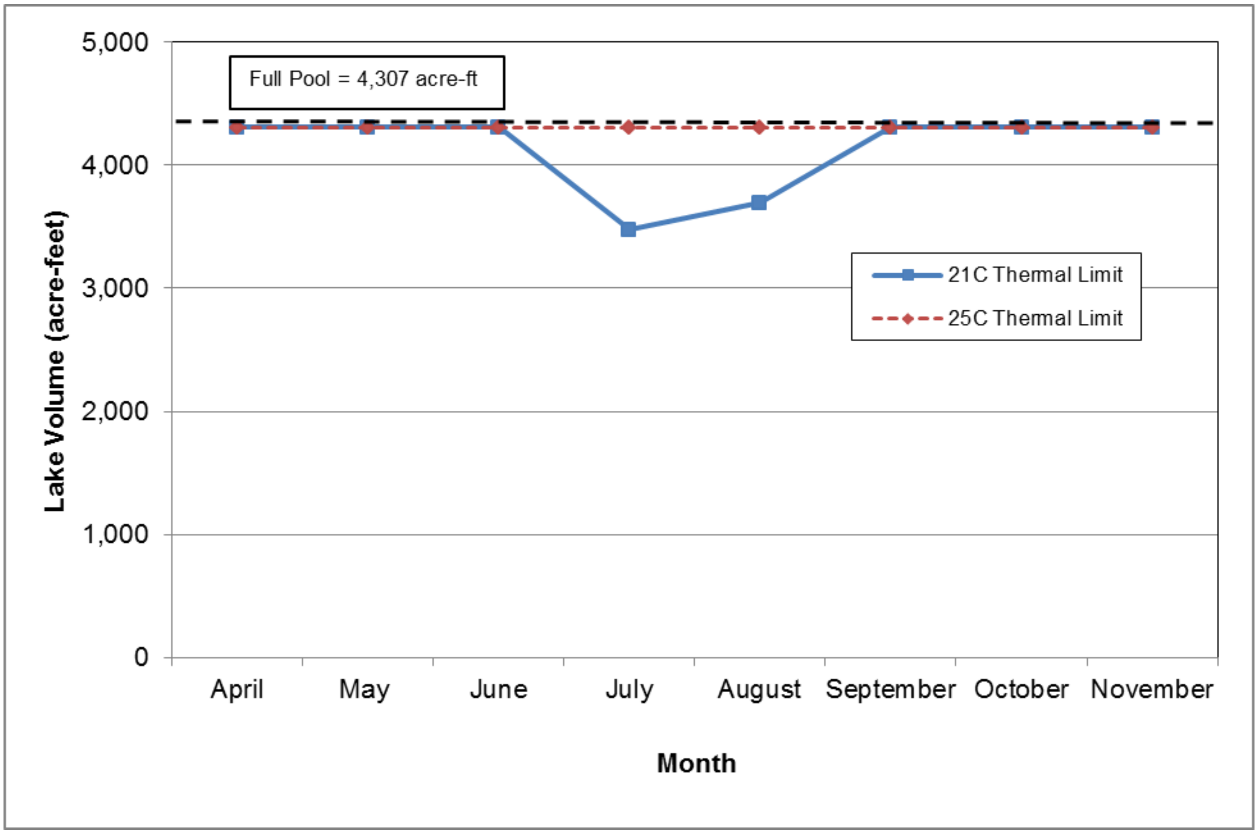


Figure 249. Estimated trout habitat available in Waha Lake, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit, and upper thermal limits of 21°C and 25°C.

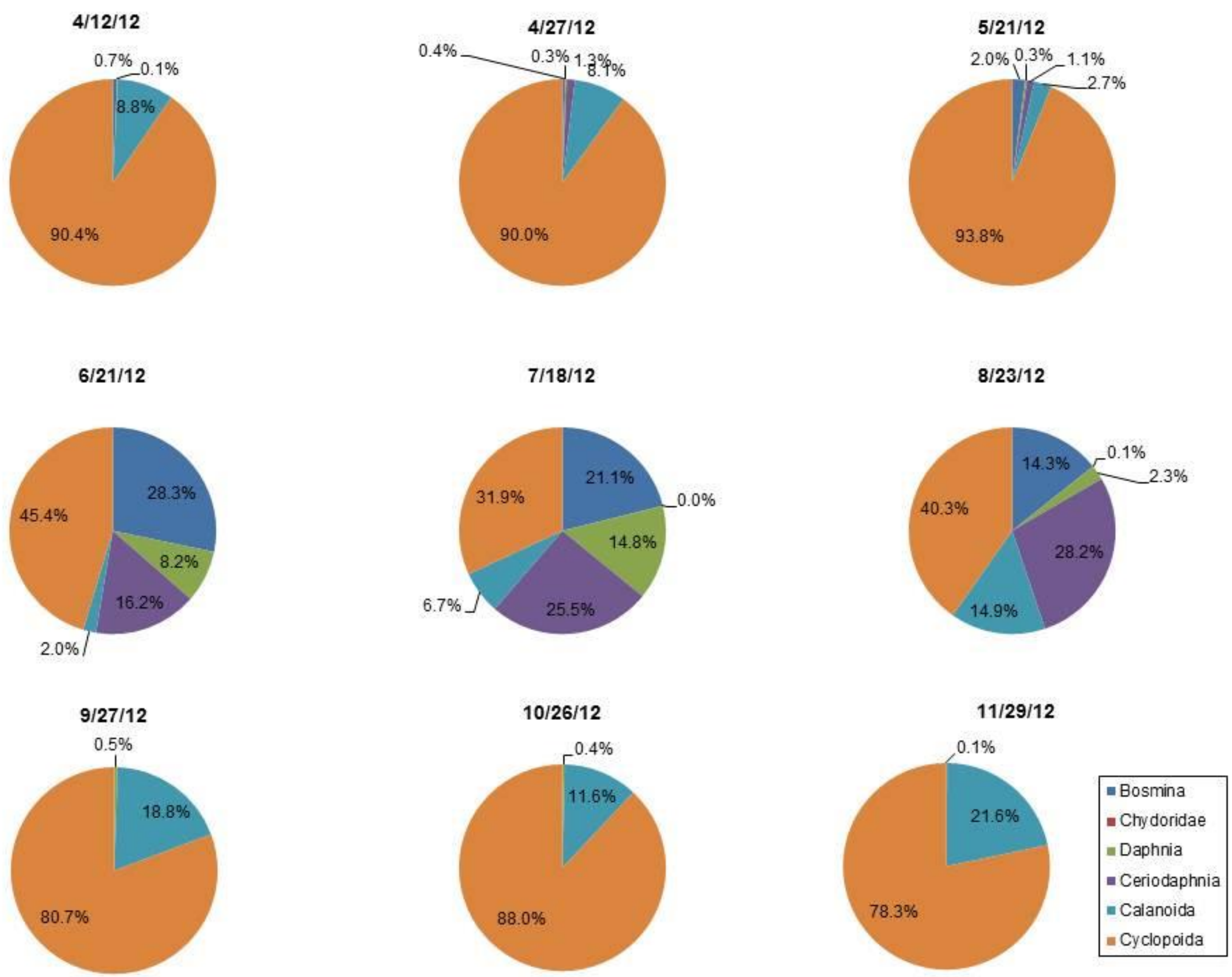


Figure 250. Zooplankton community composition based on monthly samples collected in Waha Lake, Idaho, during 2012.

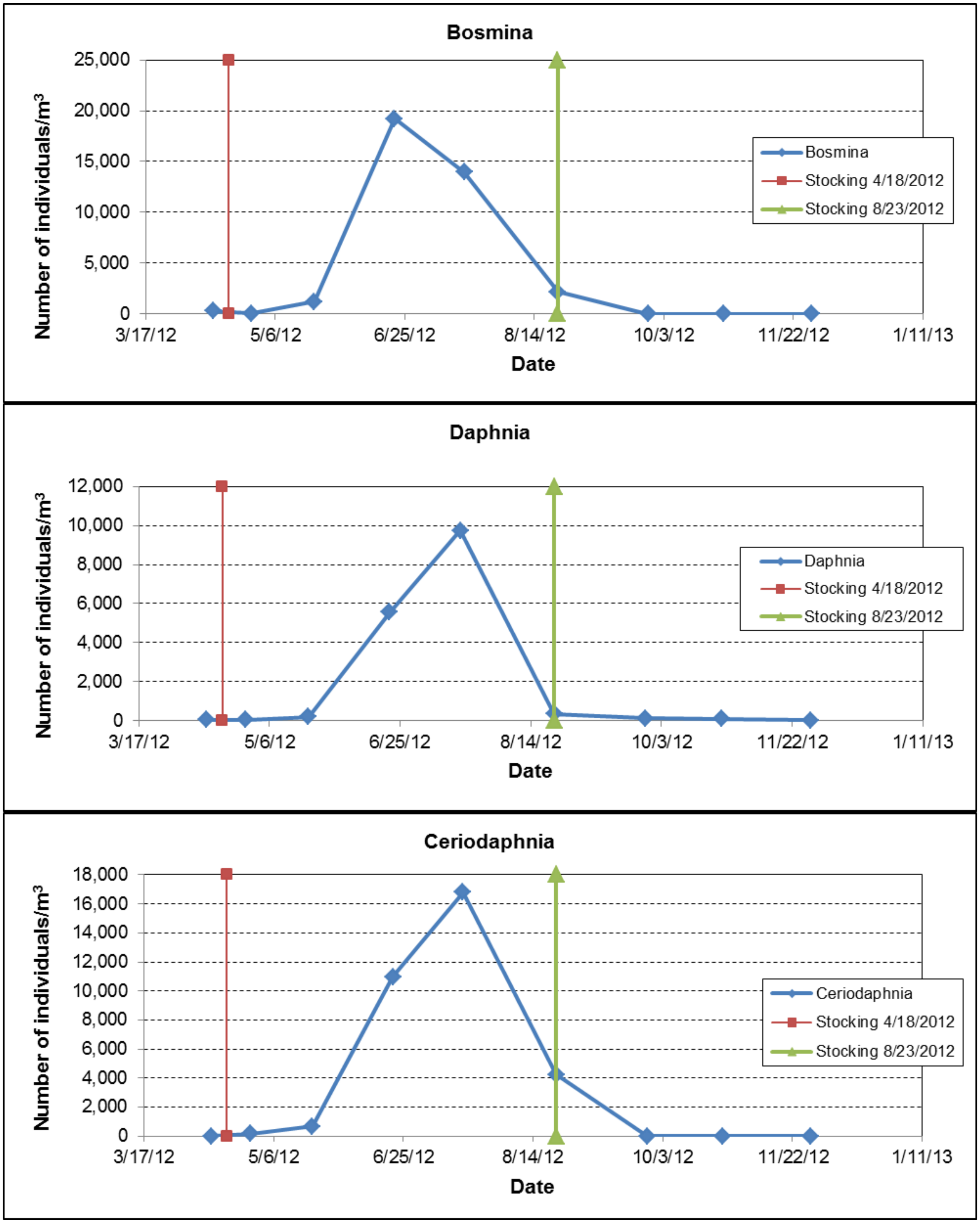
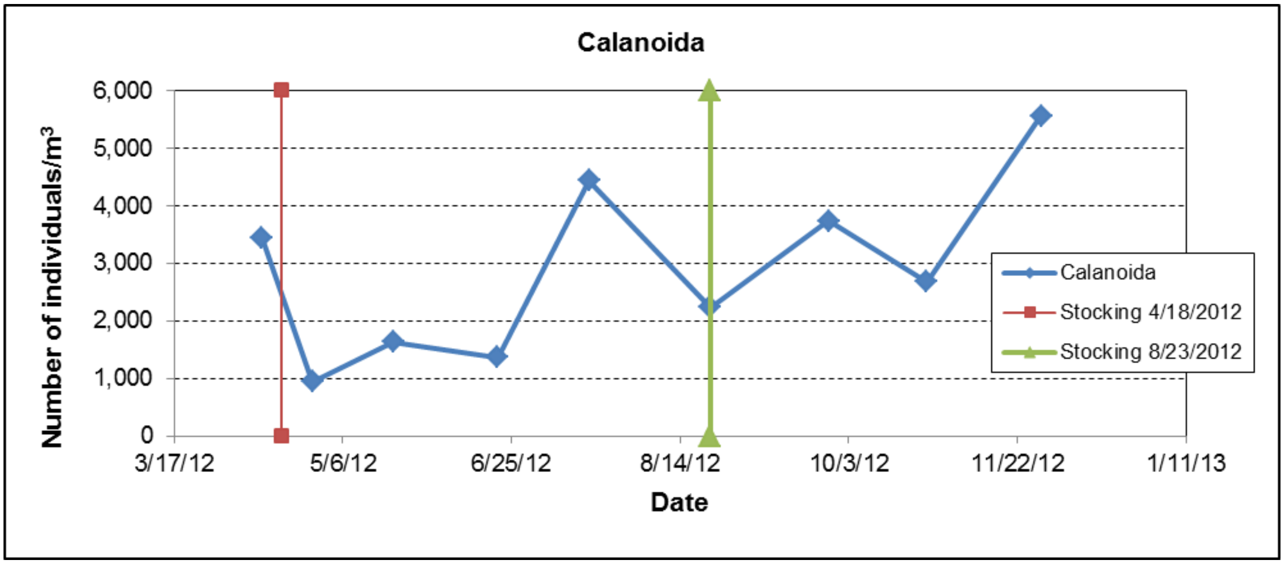


Figure 251. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Waha Lake, Idaho, in 2012.



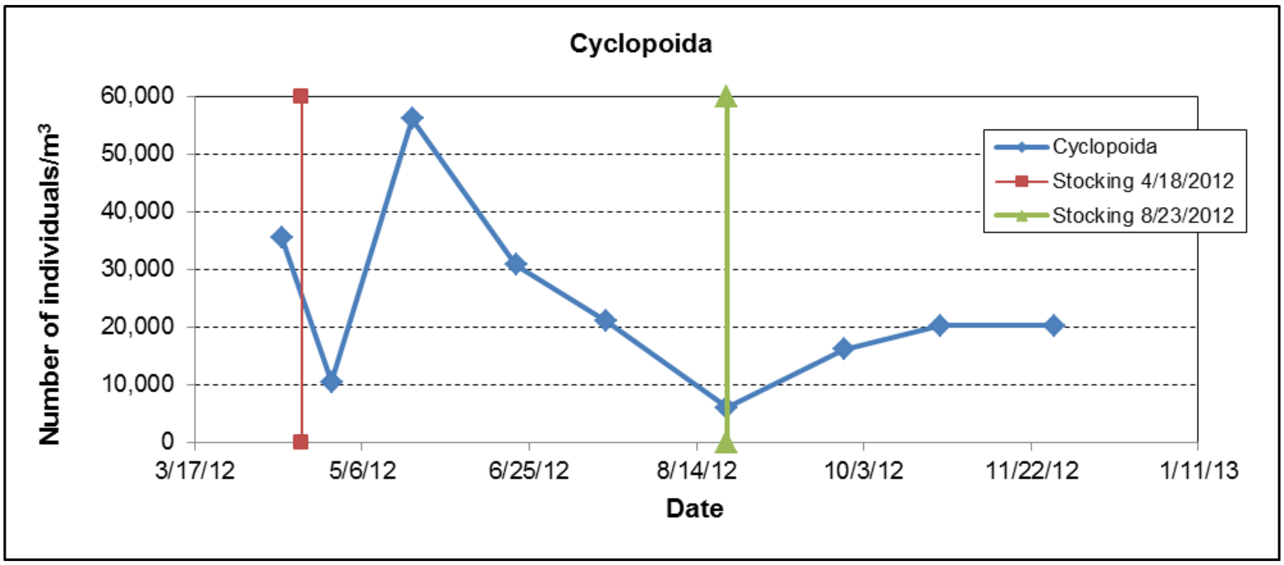


Figure 251. Continued.

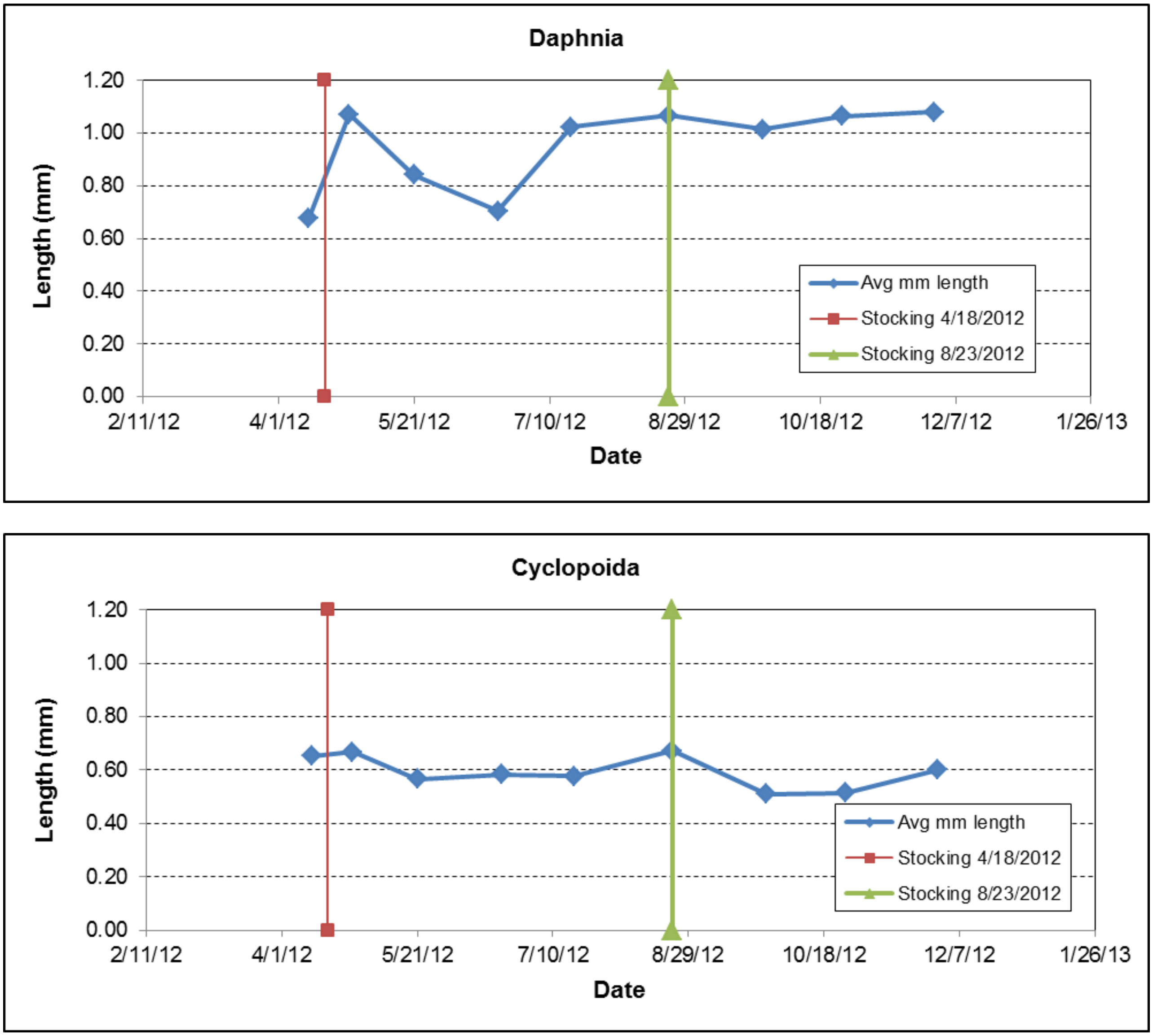


Figure 252. Average length (mm) of zooplankton collected from monthly sampling in Waha Lake, Idaho, in 2012.

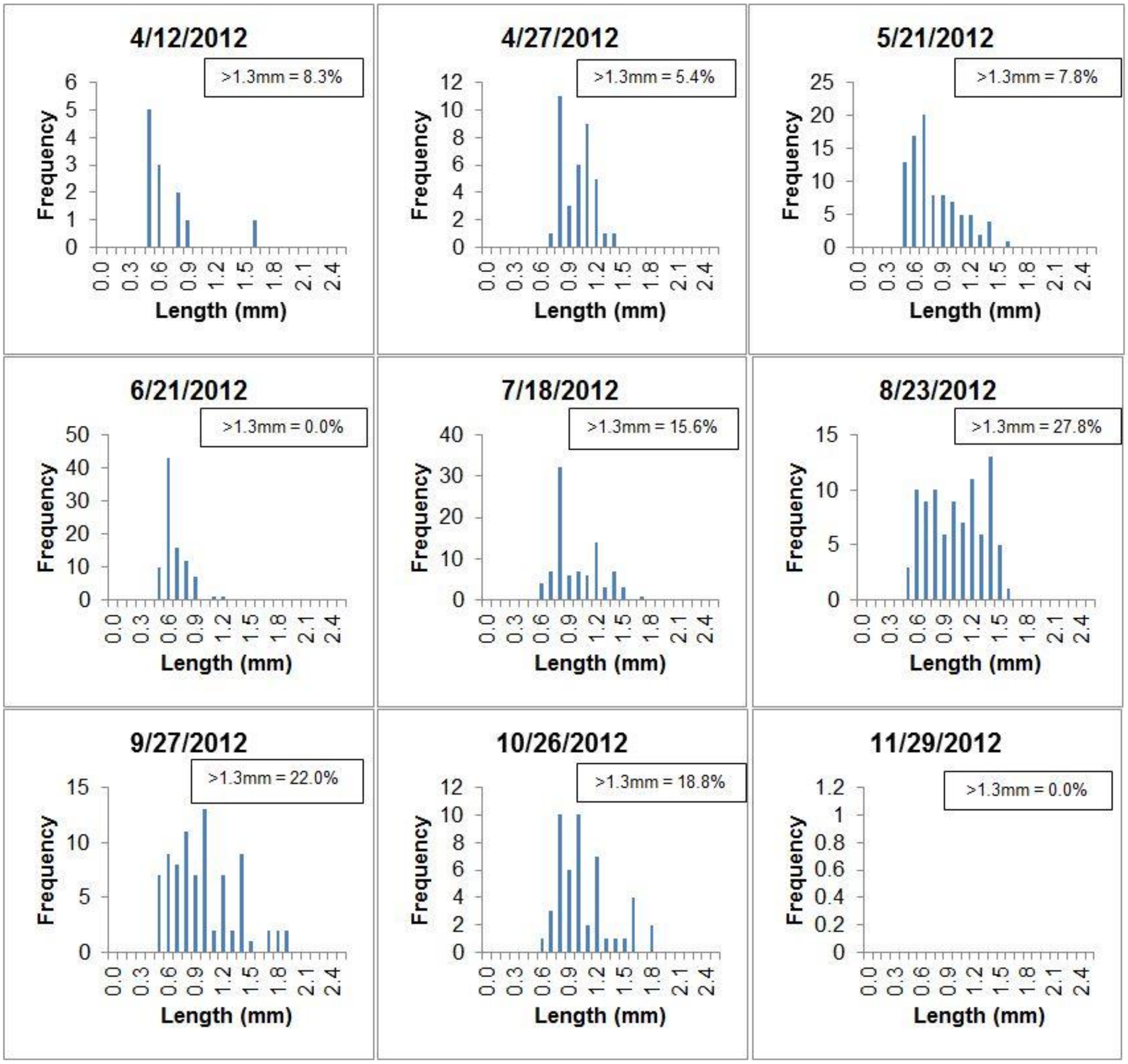


Figure 253. Length frequency distribution of Daphnia collected from monthly sampling in Waha Lake, Idaho, in 2012.

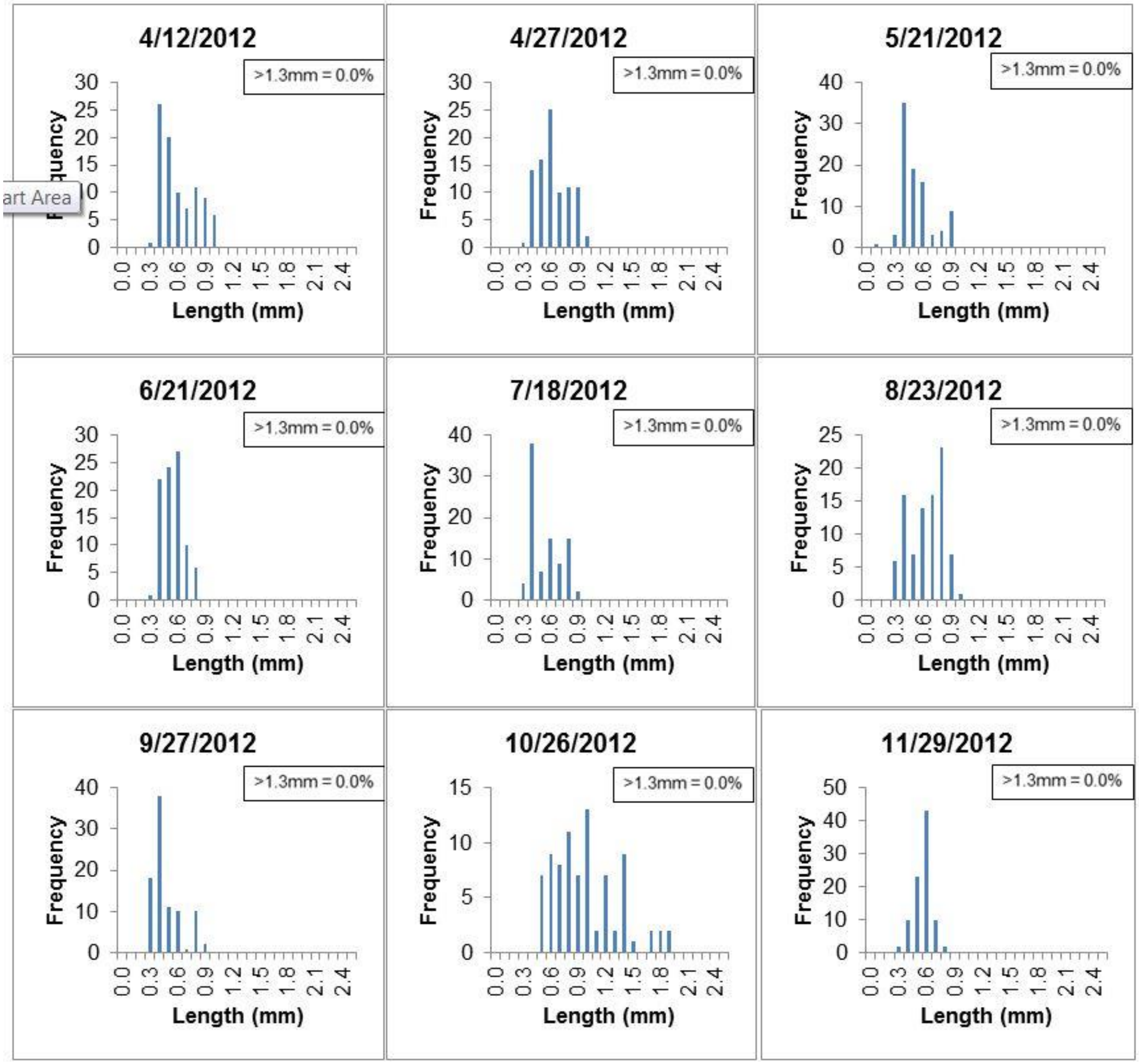


Figure 254. Length frequency distribution of Cyclopoida collected from monthly sampling in Waha Lake, Idaho, in 2012.

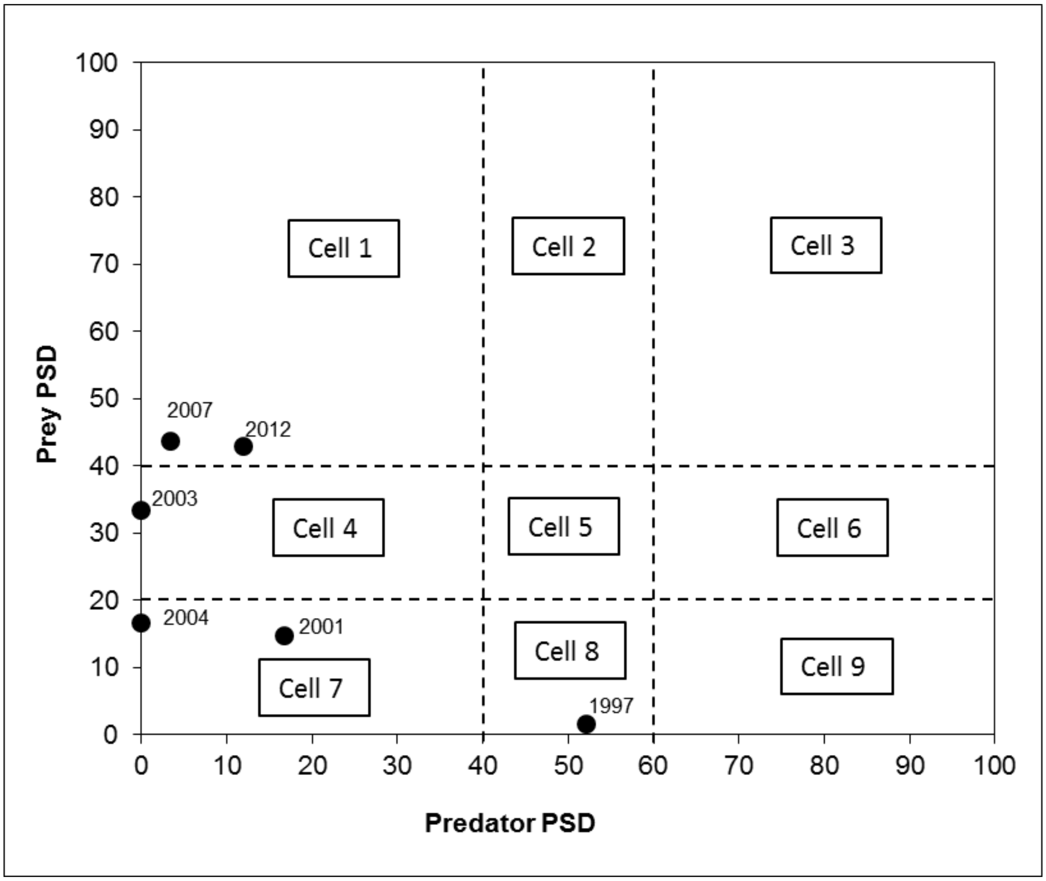


Figure 255. Comparison of predator (Smallmouth Bass) and prey (Yellow Perch and Black Crappie) proportional size distribution (PSD) from electrofishing surveys conducted in Waha Lake, Idaho, from 1997 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

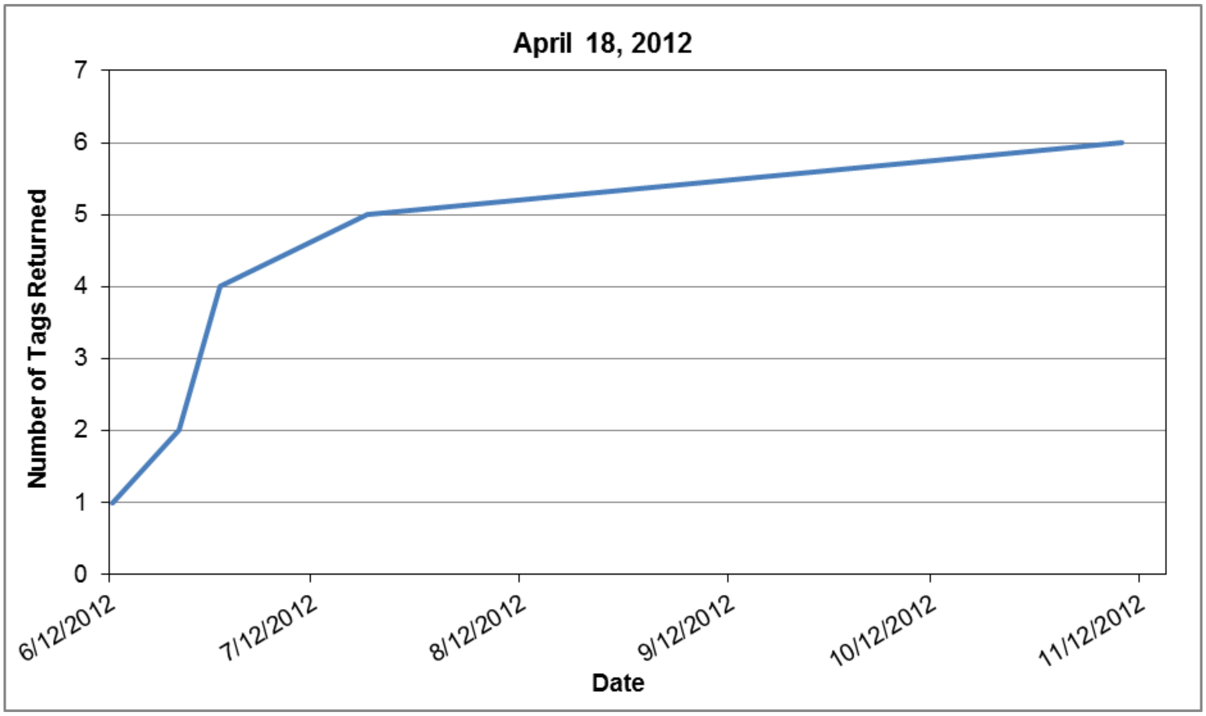


Figure 256. Cumulative number of hatchery catchable Rainbow Trout harvested from Waha Lake, Idaho, after April 18th, 2012 stocking, based on angler tag returns (100 fish tagged).

SPORTFISH ASSESSMENT OF WINCHESTER LAKE

ABSTRACT

In 2012, a comprehensive assessment of Winchester Lake was conducted to provide information for the long term management of this reservoir. The fish population survey resulted in the capture of 793 fish including Bluegill, Largemouth Bass, Yellow Perch, Black Crappie, Channel Catfish, and Black Bullhead. The results of this survey indicate that many of the fishery population trends in Winchester Lake seen in previous surveys are continuing. The Largemouth Bass population continues to be dominated by small fish. However, the Bluegill population has experienced a steady increase in numbers, with the highest CPUE occurring in 2012. We recommend scoping public opinion regarding restrictive regulations for Largemouth Bass.

Creel surveys estimated angler effort at 36,331 hours. This was the most effort at any of the nine regional reservoirs surveyed, with 33.9% more effort than Spring Valley Reservoir, the second most used reservoir. However, the effort was the second lowest of the four creel surveys conducted on the reservoir since 1993, and was a 30.6% drop from the 52,335 hours estimated in 2005 Angler effort declined in seven of the eight regional reservoirs surveyed in both 2005 and 2012. This decline may be a result of the declines in participation in outdoor recreation activities during the 1990's and early 2000's. However, these changes may also be the result of improvements in the accuracy of our creel survey methodology from 2005 to 2012.

The angler catch rate for all fish species combined was estimated at 1.8 fish/hour. The catch rate for hatchery Rainbow Trout was estimated at 1.1 fish/hour, well above the statewide management goal of >0.5 fish caught/hour. Angler exploitation of hatchery catchable size Rainbow Trout was estimated at 66.3% for the creel survey while angler exploitation was estimated at 29.9% by the "Tag You're It" program. This substantial difference may have been caused by factors such as a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. The large difference between these two estimates should be explored in the future to determine which method is more accurate. No changes are suggested for future stockings of Rainbow Trout.

Over the last 10 - 15 years, Winchester Lake has been experiencing excessive algae and aquatic vegetation growth due to high nutrient levels. A hypolimnetic aeration system was installed in 2002 in an attempt to break the phosphorous cycle in the reservoir by increasing dissolved oxygen levels in the hypolimnion. After 10 years of operation, we have concluded that while effective at adding some oxygen to the water around each unit, the system was not able to add enough oxygen to overcome the biological oxygen demand of the reservoir. Thus, we recommend removing the system from the lake. We also recommend utilizing spot treatments with aquatic herbicides to control excess vegetation in high use areas such as around docks, fishing spots, and the boat ramp.

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INTRODUCTION

Winchester Lake is an important part of the Clearwater Region's lowland lake program, as it supports the highest level of angler effort of any regional lowland lake. An economic survey conducted in 2011 estimated 18,445 angler trips were taken to Winchester Lake for an estimated total economic expenditure of $1,499,856 (IDFG unpublished data). It is approximately a 59 km drive from Lewiston, Idaho (pop. 32,119) and Clarkston, Washington (pop.7,331). While other reservoirs are closer to these population centers, Winchester Lake is a popular place to fish due to its proximity to some smaller communities, easy fishing access, good catch rates for trout and warm-water fish, and the adjacent Winchester Lake State Park. The state park, which receives up to 37,000 visitors annually, provides full service camping, a boat ramp, canoe rentals, picnicking, and a visitor center.

Anglers fishing Winchester Lake largely target the put and take hatchery Rainbow Trout fishery. Previous creel surveys have estimated that 35.8% - 98.6% of fish harvested in Winchester Lake were hatchery Rainbow Trout (Hand 2009). Winchester Lake also has a significant warm-water fishery including Largemouth Bass, Bluegill, Black Crappie, Yellow Perch, Channel Catfish, tiger muskellunge, and Black Bullhead.

Maintaining high catch rates and angler satisfaction Winchester Lake is imperative. Data from the 2012 surveys was intended to assess the current put-and-take hatchery catchable program, provide insights on how to potentially increase holdover capabilities for stocked Rainbow Trout, and increase the quality of the warm-water fishery that is a substantial portion of the fishery. However, poor water quality has become a problem in the reservoir. High phosphorus levels are causing algae blooms, poor water clarity, and low dissolved oxygen for fish. To address this issue, eight hypolimnetic aeration units were installed in the deeper areas of Winchester Lake in 2002 (Hand 2009; DuPont et al. 2011). The purpose of these units was to increase the levels of oxygen in the hypolimnion, thus providing additional habitat for fish and other aquatic organisms. If successful, this should result in better fishing, especially for trout, which need the well oxygenated cooler water to survive through the summer.

Current Management

Winchester Lake is a mixed fishery, containing both cold-water and warm-water species. It is managed as a put-and-take trout fishery, with 41,288 catchable Rainbow Trout stocked in 2012 to maintain the management goal of >0.5 fish/hour catch rate (IDFG 2013). The reservoir is also managed for a Largemouth Bass fishery, and a yield fishery on Black Crappie, Bluegill, and Yellow Perch. Channel Catfish and tiger muskellunge are stocked periodically to provide additional fishing opportunities. The reservoir is managed as a family friendly fishing water with simplified regulations including year round seasons, no length limits (except tiger muskellunge), general six fish limit for trout and bass, no creel limits for other species (except tiger muskellunge), and no restrictions on fishing gear. Boat activity on Winchester Lake is restricted to electric motors only. The current management priority is to provide a desirable fishing experience to families and individuals alike.

Reservoir Management Goals

1. Maintain catch rate of >0.5 fish/hour for hatchery Rainbow Trout.

2. Maintain yield fisheries for Bluegill, Black Crappie, and Yellow Perch.

3. Diversify fishery with periodic stockings of Channel Catfish and tiger muskellunge.

4. Evaluate hypolimnetic aeration system and determine if it is needed to reach Rainbow Trout catch rate goals.

5. Manage aquatic vegetation as needed to improve fisheries and angler effort.

STUDY SITE

Winchester Lake is located 0.8 km south of the town of Winchester, Idaho (Figure 4). It is a 44.4 hectare reservoir that lies at an elevation of 1,189 meters. It has a maximum depth of 9.8 m and a maximum volume of 1,500 acre-ft. It was created in 1910 by the damming of the headwaters of Lapwai Creek. It served as a mill pond by several lumber companies until it was drawn down in 1967 in order to install a new spillway and boat ramp (Moeller 1985). The City of Winchester discharged its municipal waste water into the lake until a new wastewater treatment facility was put into operation in 1972 (Moeller 1985). Today, the reservoir is characterized as highly eutrophic and prone to significant algal blooms and aquatic vegetation growth in the late summer. It is used extensively by boaters and fishermen, and is the focal point for the adjacent Winchester Lake State Park, which receives up to 37,000 visitors per year. Winchester Lake and its 3,159 ha watershed lie entirely within the Nez Perce Reservation. The watershed is used primarily for grazing, timber harvest, and recreation.

RESULTS

Population Survey

We sampled the fish community of Winchester Lake on May 30, 2012. Six 10-minute electrofishing periods were conducted on the reservoir for a total of 3,600 sec. of electrofishing effort. The electrofishing and one overnight trap net set resulted in the capture of 793 fish including Bluegill (n = 637), Largemouth Bass (n = 109), Yellow Perch (n = 38), Black Crappie (n = 6), Channel Catfish (n = 2), and Black Bullhead (n = 1; Figure 257). The electrofishing catch rate was 790.0 fish/hour). Only three fish were collected by the trap net; one each of Bluegill, Yellow Perch, and Black Crappie. Catch rates for each of the six 10-minute electrofishing samples ranged from 83 - 205 fish/sample (Table 46). The variability from the six samples was used to estimate statistical power and sample size for future surveys (IDFG 2012). To have a 90% confidence (2-tail test) with 25% precision estimate of fish captured in an electrofishing sample of Winchester Lake, an estimated six 10-minute electrofishing samples would be needed for a whole fish community survey (Table 46). To have a 90% confidence with 25% precision estimate to track just Largemouth Bass or Bluegill, an estimated eight or six sample periods would need to be conducted respectively (Table 46).

Largemouth Bass:

Largemouth Bass collected ranged from 102 - 475 mm in length (Figure 258), with an average length of 213 mm. Only six of the 109 fish collected (6%) were over 300 mm in length. This is less than half the average of 13.1 fish >300 mm captured in the nine surveys conducted since 1997. Largemouth Bass CPUE (109 fish/hour) was the third lowest since 1997 (Figure 257). Largemouth Bass PSD was 8 (Figure 259) in 2012, a slight increase after declining for three straight surveys. Relative weights ranged from 67 - 138, with an average of 94 (Figure 260). Relative weight was generally lower for larger fish than for smaller fish. Scale samples were analyzed from Largemouth Bass collected in 2012 (n = 106). These fish ranged in age from 1 - 9 years (Table 47). Annual growth rates ranged from 28 - 72 mm. A catch curve was developed for estimating mortality (Figure 261). Annual instantaneous mortality (Z) was -0.396 for fish aged 3 - 7 (R^2 = 0.688). Thus, the annual survival rate (S) was 67%, and total annual mortality (A) was 33%.

Bluegill:

Bluegill collected ranged from 54 - 256 mm in length (Figure 262), with an average of 144 mm. Most (76%) of the fish were between 120 - 179 mm. Length frequency distributions have been fairly similar since 2000, with the majority of fish in the 130 - 180 mm range each year; however, CPUE has increased steadily since 1996 (Figure 257). The PSD of 38 in 2012 (Figure 263) was the second straight decline since the high of 80 in 2007. However, it is in line with the values seen from 2000 - 2005. Relative weights ranged from 85 - 195, with an average of 129 (Figure 264). Relative weight was generally lower for larger fish than for smaller fish. Scale samples were analyzed from Bluegill collected in 2012 (n = 101). These fish ranged in age from 1 - 7 years (Table 48). Annual growth rates ranged from 8 - 64 mm. A catch curve (Figure 265) was developed for estimating mortality. Annual instantaneous mortality (Z) was -0.314 for fish aged 2 - 7 (R^2 = 0.9156). Thus, the annual survival rate (S) was 73%, and total annual mortality (A) was 27%.

Other Species:

Yellow Perch collected ranged from 97 - 256 mm in length (Figure 266), with an average of 163 mm. Yellow Perch CPUE was the second lowest since 1997 (Figure 257). Proportional size distribution for Yellow Perch in 2012 was 46 (Figure 267). Black Crappie collected ranged in length from 118 - 201 mm. Black Crappie CPUE has steadily declined since 2004 (Figure 257). Proportional size distribution for Black Crappie in 2012 was 25 (Figure 268). The two Channel Catfish collected were 451 mm and 495 mm in length, while the one Black Bullhead collected was 282 mm in length.

Creel Survey

Angler Effort:

Creel surveys were conducted on Winchester Lake from November 28th, 2011 through November 28th, 2012. A total of 177 instantaneous angler counts were conducted during the creel survey, resulting in an estimated total angler effort of 36,331 hours (SE ± 2,854; Table 49). This was the second lowest of the four creel surveys conducted on the reservoir since 1993 (Figure 1). Slightly more effort occurred on weekdays (54%) than weekends (46%). Effort consisted of 72% bank, 15% boat, and 13% ice anglers. The highest angler effort occurred in the summer months from May - September, with monthly effort estimates ranging from 4,435 - 9,950 hours (Table 49).

Catch and Harvest:

Catch rate and harvest data for the 2012 creel survey on Winchester Lake was based on 760 completed trip interviews. Anglers caught an estimated 67,162 fish during 2012 (Appendix A), resulting in a catch rate of 1.8 fish/hour. Hatchery Rainbow Trout accounted for 77% of the fish caught during the 2012 creel survey (Figure 269). Catch of warm-water species included 10,331 Bluegill (15%) and 3,383 Largemouth Bass (5%). Anglers harvested an estimated 36,978 fish during 2012 (Appendix A), 55% of the fish caught. The harvest rate for all fish combined was estimated to be 1.0 fish/hour. Harvest in 2012 consisted of 29,319 hatchery Rainbow Trout (79%), 5,026 Bluegill (14%), 1,795 Yellow Perch (5%), 479 Largemouth Bass (1%), 240 Black Crappie (<1%), and 119 Channel Catfish (<1%; Figure 268). All harvested fish encountered during creel surveys were measured for total length. Harvested Largemouth Bass ranged in length from 153 - 293 mm, and averaged 253 mm (Figure 258). Harvested Bluegill ranged in length from 123 - 288 mm, and averaged 187 mm (Figure 262). Harvested Yellow Perch ranged in length from 132 - 279 mm, and averaged 196 mm (Figure 266).

A total of 51,762 hatchery Rainbow Trout were estimated to have been caught during the survey, with 29,319 harvested (Appendix B). This is a catch rate of 1.1 fish/hour and a harvest rate of 0.7 fish/hour. The majority of the fish (75.3%) were harvested from April - July (Appendix C). Of the Rainbow Trout harvested, 28,300 (97%) were stocked in 2012, while 1,019 (3%) were holdover Rainbow Trout stocked in 2011. The estimated exploitation rate was 66.3%. Harvested Rainbow Trout measured by creel clerks (n = 1,165) ranged in length from 125 - 394 mm, and averaged 288 mm.

Angler Statisfaction:

A total of 950 public opinion surveys were conducted at Winchester Lake in conjunction with the creel survey. All constituents using the lake were interviewed. Eighty-three percent of the people interviewed identified fishing as their primary reason for using the lake (Figure 271). “Other” (12%) and camping (4%) were the next most common responses. Of the people interviewed, 89% had a current fishing license.

The subgroup that was participating in fishing activities was also asked additional questions regarding their fishing experience at Winchester Lake. Sixty-two percent of people interviewed rated their fishing experience as excellent or good (Figure 272). The most common reasons for a positive rating were related to good fishing (30%) and “nice to be outside” (19%; Figure 273). Thirty-eight percent of people interviewed rated their fishing experience as fair or poor (Figure 272). The most common reasons for a negative rating were related to poor fishing (28%; Figure 273).

The most commonly targeted fish species was hatchery Rainbow Trout (43%; Figure 274). Forty-one percent of people interviewed were not targeting a particular fish species while fishing. Warm-water species comprised 14% of the targeted fish species responses for Winchester Lake.

Angler Exploitation

Angler exploitation (fish harvested) surveys were conducted for hatchery catchable size Rainbow Trout stocked in Winchester Lake in 2011 and 2012. Rainbow Trout were tagged on April 25 - 26, 2011 (n = 1,595), October 10, 2011 (n = 396), April 18, 2012 (n = 1,857), and October 10, 2012 (n = 400). Exploitation rates through 365 days at large (Table 50) for each stocking event averaged 44.1% for the April, 2011 tagging events, 29.6% for the October, 2011 event, 30.0% for the April 2012 events, and 25.3% for the October 2012 event. Harvest rates for 366 - 730 days at large for each stocking event averaged 0.8% for the April, 2011 tagging events, 0.8% for the October, 2011 event, 3.1% for the April 2012 events, and 0.0% for the October 2012 event. One fish each from the April, 2011 and April 2012 stocking events was captured beyond 730 days at large.

Angler total use (fish harvested plus fish released) through 365 days at large (Table 50; Appendix D) averaged 58.4% for the April, 2011 tagging events, 38.4% for the October, 2011 event, 35.5% for the April, 2012 events, and 28.8% for the October, 2012 event. Total use for 366 - 730 days at large for each stocking event averaged 1.0% for the April, 2011 tagging events, 0.8% for the October, 2011 event, 3.3% for the April 2012 events, and 0.8% for the October 2012 event.

An angler exploitation survey was conducted on Largemouth Bass tagged during a standard lowland lake survey on May 30, 2012 (n = 48). Through June, 2014, seven tagged fish had been reported caught. Three of these were harvested, with the other four released. The estimated exploitation rate was 13.7%, with a total use rate of 32.1%.

Limnology

Limnology samples were collected monthly from April - November, 2012. Dissolved oxygen and temperature samples changed throughout the year, with seasonal patterns being quite evident. Dissolved oxygen profiles in early April and October were very homogenous, while typical anoxic conditions were present in the hypolimnion from late April through September (Figure 275). Monthly temperature measurements showed very similar patterns to the DO measurements (Figure 275). To look at potential diel changes in temperature and DO profiles, measurements were taken at 12:45 and 17:50 on August 1, 2012, and at 04:30 on August 2, 2012 (Figure 276). There were drops in both surface temperature and DO overnight, but no changes occurred below the thermocline at 3.0 m.

Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. During July, water temperatures were >21°C down to a depth of 2 m, and DO at this time was <5.0 mg/L below 1 m in depth. Using these metrics, no water in Winchester Lake was conducive for Rainbow Trout survival (Figure 277). Utilizing an upper thermal limit of 25°C, 35.5% of the water volume would be conducive for Rainbow Trout survival (Figure 277). In October, the entire water column had a DO concentration <5.0 mg/L following fall turnover. This also resulted in a condition in which no water in Winchester Lake was conducive for Rainbow Trout survival.

Zooplankton

Zooplankton samples were collected monthly from April - November, 2012. The population was composed of five taxa of zooplankton: Chydoridae, Daphnia, Cyclopoida, Bosmina, and Calanoida. The composition changed from primarily Cyclopoida (>76%) in both April samples to primarily Daphnia (>43%) in May - October (Figure 278). Bosmina and Calanoida were only present in the November sample.

Densities (# of individuals/m^3) were also highly variable. Chydoridae densities ranged from 139 - 16,257/m^3 with an average of 2,493/m^3. Other than the July sample, densities were never over 1,995/m^3. Daphnia and Cyclopoida densities peaked (@ 80,000/m^3) in the May sample (Figure 279), with subsequent declines through August. Densities then increased slightly through November. Chydoridae densities remained low throughout the sampling period with the exception of a large spike in July. Average lengths of Cyclopoida ranged from 0.50 - 0.88 mm (Figure 280), with a decline seen from March - June during the first three stocking of hatchery Rainbow Trout. A second decline was seen from August - November, with the final stocking occurring in October. Average lengths of Daphnia ranged from 1.08 - 1.42 mm (Figure 280), with a slightly increasing trend seen throughout the sampling. Both increases and decreases in average length were seen following the four stockings of hatchery Rainbow Trout. Length frequency distributions from each sample show that the percent of Daphnia >1.3 mm in length ranged from 13.3 - 62.2% of the individuals collected (Figure 281). Length frequency distributions from each sample show that the percent of Cyclopoids >1.3 mm in length ranged from 0.0 - 12.2% of the individuals collected (Figure 282).

Additionally, ZQI sampling was conducted on August 23, 2012. Biomass was the highest for any reservoir at 1.93 (g/m^3) for the 150 µm net, 0.66 (g/m^3) for the 500 µm net, and 0.94 (g/m^3) for the 750 µm net (Appendix E). The ZPR was calculated to be 1.42 and the ZQR was 2.29.

Aquatic Vegetation and Hypolimnetic Aeration

Vegetation surveys were conducted on August 1, 2012. A total of 123 sites were sampled. Vegetation was collected by rake tosses at 47 (38.2%) sample sites (Figure 283). Six types of vegetation were identified: filamentous algae *Rhizoclonium sp.* and *Cladophora sp*., macrophytic algae *Nitella sp*., elodea *Elodea canadensis*, coontail *Ceratophyllum demersum*, pondweed *Potamogetan sp.*, and white water buttercup *Ranunculus aquatilis*. Elodea was the most commonly encountered vegetation, occurring at all 47 (38%) sites where vegetation was collected (Appendix F). Filamentous algae was the second most common, occurring at 44 (35.8%) sites, followed by pondweed (14.6%), macrophytic algae (5.7%), coontail (4.1%), and white water buttercup (1.6%). Sample sites along the shoreline accounted for 69.1% (n = 85) of all sample sites. Vegetation was collected at 54.1% (n = 46) of these sites. Additionally, 97.8% of all sample sites with vegetation were along the shoreline (Figure 283).

The Davids' Fishabiltiy Index (DFI) was also conducted at all 123 sites. No vegetation was encountered at 95 (77.2%) of the sites (Figure 284). Vegetation was encountered at 28 (22.8%) sites. Vegetation was present on hooks at 19 (15.4%) sites, while dense matted surface vegetation prevented casting at nine (7.3%) sites. The DFI and rake toss sampling showed similar patterns of shoreline vegetation. All of the affected sites were along the shoreline, with 32.9% of shoreline sites being negatively influenced by vegetation according to the DFI.

Dissolved oxygen data has been collected to monitor and evaluate the hypolimnetic aeration system installed in 2002 - 2003. Average monthly increases in DO at the outlet of each aerator ranged from 0.7 - 2.0 mg/L (Table 51). From May - September, when additional DO is most needed, DO levels were 0.7 - 0.9 mg/L higher when water was returned to the hypolimnion. During these months, the DO level of water as it returned to the reservoir ranged from 1.2 - 4.1 mg/L (Table 51). Changes in DO were also measured outside of the units (Table 52). The greatest change in DO levels was measured at 1 m distance from the units, with a 1.0 mg/L increase in the spring/fall depths of 5 - 6 m and a 0.6 mg/L increase in the summer (Table 52).

DISCUSSION

Population Survey

The results of the standard fish survey in 2012 showed that many of the fishery population trends in Winchester Lake seen in previous surveys are continuing. Largemouth Bass and Yellow Perch both continue to fluctuate but remain fairly steady (Figure 257). However, the Bluegill population has experienced a steady increase in numbers, with the highest CPUE occurring in 2012.

The results of the fisheries survey conducted in 2012 indicated that for an electrofishing survey of Winchester Lake, 6 10-minute samples would be needed for a whole fish community estimate with 90% confidence (2-tail test) and 25% precision (Table 46). This is consistent with the length of sampling (3,600 s) conducted in previous samples. Sampling the entire shoreline to improve our accuracy is not realistic, as it would require at least twice the sample time. Thus, we recommend continuing with 6 10-minute samples.

Largemouth Bass:

In contrast to other species in Winchester Lake, the Largemouth Bass population is dominated by relatively small fish. Of the 3,045 Largemouth Bass collected during lake surveys since 1997, 15.0% (n = 458) were >250 mm and 6.0% (n = 183) were >300 mm. This has resulted in PSD values below the balanced population range of 40 - 70 (Anderson 1980) for every survey since 1997. Low PSD can be an indicator of a stunted population of Largemouth Bass and/or overharvest of fish by anglers (Schramm and Willis 2012). A stunted population is an indication of poor growth, and can be caused by limited food sources, inefficient foraging conditions (too much or too little cover), inadequate thermal regimes (short growing season), or too many fish.

Poor growth appears to be an issue in Winchester Lake. Largemouth Bass collected in 2012 averaged 213 mm in length at capture, below the average of 228 mm for regional reservoirs (Appendix J). Growth rates ranged from 30 - 72 mm per year. This was the lowest annual growth of any regional reservoir for fish age 1 - 4, but above the regional average for fish aged 7 - 9. The higher than average growth for older fish was likely influenced by small sample size (n = 1) for fish age 8 and 9. Additionally, average length at age was below the regional average for all age fish (Appendix J). This below-average growth has resulted in Largemouth Bass at Winchester Lake not entering the fishery (stock size of 200 mm) until age 4, and not reaching quality size (300 mm) until age 7. The regional average to stock size is age 3 and to quality size is age 5 (Appendix J). This age to quality size is also above the average age of 4.4 years for 40 Idaho populations described by Beamesderfer and North (1995), and a modeled estimate of four years based on thermal degree days described by McCauley and Kilgour (1990).

As mentioned above, slow growth can be caused by several factors. The aquatic vegetation and filamentous algae that grow in Winchester Lake through the summer and fall could potentially reduce forage success for predators such as Largemouth Bass, and increase the abundance of prey species (Bettolli et al. 1992; Dibble et al. 1996). Vegetation was present 38% of the sample sites in Winchester Lake, with 97.8% of those located along the shoreline. Of shoreline sites, 54.1% had vegetation present. While Winchester Lake does have aquatic vegetation, it does not appear to be abundant enough to reduce forage success for predators.

Temperature is one of the most important abiotic factors controlling growth rates (Colby and Nepszy 1981; McCauley and Kilgour 1990; Wehrly et al. 2007). With its location in northern Idaho at an elevation of 1,189 m, and with fewer heating degree days than occur in most of the specie's range (Beamesderfer and North 1995), Winchester Lake has a relative short growing season compared to other reservoirs. As such, inadequate thermal regime is likely a major cause of the slow growth seen in Winchester Lake.

Inadequate food resources may also be an issue. Relative weights of Largemouth Bass in Winchester Lake average 93, but decline as fish get larger (Figure 260). Fish in the stock to quality size range (200 - 300 mm) experience decreased condition compared to smaller and larger fish. This may indicate a food resource bottleneck, of too many fish and/or too little food availability. A lack of sufficient food resources is possible, as few Bluegill under 100 mm have been collected in the four fish surveys conducted since 2005 (Hand et al. In press).

In addition to slow growth, angler harvest of larger fish is another possible explanation for the appearance of a stunted population. Some harvest of predators by anglers can result in reduced competition, increased food resources available for the remaining predators, and help maintain good predator-prey balance (Swingle 1950; Flickinger and Bulow 1993). However, overharvest can result in the appearance of a stunted population with many smaller fish and few large fish. Creel surveys of Winchester Lake estimated that 479 Largemouth Bass were harvested in 2012. Using the population estimate of 2,065 fish >200 mm calculated for Winchester Lake by Hand et al. (2012), angler exploitation was 23.2% based on the 2012 creel survey. This is comparable to the annual angler exploitation rates of 22.4% and 13.7% calculated for fish tagged in Winchester Lake during 2008 and 2012 using the "Tag You're It" program (Meyer et al. 2009; IDFG unpublished data). Allen et al. (2008) found the average fishing mortality rate of Largemouth Bass populations to be 30% for 32 separate studies. Total annual mortality of Largemouth Bass in Winchester Lake was estimated to be 33% from data collected in 2012. This is below the average of 40% estimated for regional reservoirs (Appendix D), and below the average total annual mortality of 57% for the populations analyzed by Allen et al. (2008). From this data ,we can estimate that total natural mortality is 11 - 26%, close to the 18% average estimated for the 40 Idaho populations described by Beamesderfer and North (1995). It should be noted that mortality for Largemouth Bass older than age 6 is likely much higher than the annual estimate of 33%, as few fish older than this age are present in the reservoir. This indicates that angling and/or natural mortality have a large influence on the population once these fish reach 300 mm in length.

Even though 300 mm is considered the minimum quality size for anglers (Gablehouse 1983), the fish harvested by anglers during the 2012 creel survey were generally small (Figure 258). The 22 fish measured ranged in length from 153 - 293 mm, and averaged 253 mm. With such small fish being harvested, this indicates that there were few fish of quality size or above in the population which was also supported by our fish surveys. With few Largemouth Bass >300 mm in length in the population, and the slowest growth of any reservoir in the region, even the low levels of harvest estimated during recent creel surveys could have an impact on the population. This suggests that while slow growth is likely the primary cause of the appearance of a stunted population, harvest is at least partly responsible for the absence of larger fish. With the slow growth seen for Largemouth Bass, restrictive regulations could be implemented to improve the size structure of the population. Length limits, such as a minimum length or a protective slot, should be considered if there is a desire to increase the size structure of Largemouth Bass.

Minimum length limits are recommended for fish populations that exhibit low rates of recruitment and natural mortality, good growth rates, and high fishing mortality (Novinger 1984; Wilde 1997). They are generally used to protect the reproductive potential of fish populations, prevent overexploitation, increase angler catch rates, and promote predation on prey species (Noble and Jones 1993; Maceina et al. 1998; Iserman and Paukert 2010). Wilde (1997) compiled data from 91 evaluations of Largemouth Bass responses to length limits. Overall, minimum length limits increased population size and angler catch rates, but failed to increase PSD or angler harvest.

Slot limits are recommended for populations with high recruitment and low growth rates. They are used to increase numbers of the protected size fish, promote growth of smaller fish by reducing competition (through harvest), and increase production of larger fish (Anderson 1976; Iserman and Paukert 2010). Slot limits for predatory fish such as Largemouth Bass can also be used to manipulate prey fish populations by allowing the predators to grow larger (Anderson 1976). The previously mentioned study by Wilde (1997), and a study of 14 small mid-western reservoirs by Novinger (1990), indicate that slot limits were successful in restructuring Largemouth Bass populations by increasing population size and the number of both quality and preferred size fish (and thus increased PSD), but did not increase angler catch rates or harvest rates. When slot limits do fail to restructure Largemouth Bass populations it is usually because anglers harvest few fish below the slot limit (Gablehouse 1987; Summers 1990; Martin 1995). This effectively results in a minimum size limit. However, this may not be an issue in Winchester Lake, as most of the fish anglers harvested in 2012 were <300 mm in length (Figure 258). Fish this size would be below most standard slot limit sizes (305/356 mm - 406 mm).

Overall, the data for Winchester Lake indicates that Largemouth Bass were experiencing slow growth rates, cropping from anglers, and lower relative weights. More restrictive regulations for Largemouth Bass could improve the Largemouth Bass size structure by allowing more fish to grow beyond 305 mm. However, more anglers prefer to target Bluegill than Largemouth Bass (Figure 274) due to its family oriented fishery. Maintaining a quality Bluegill fishery is likely more important to the angling public than trying to produce a quality Largemouth Bass fishery. Thus, care must be taken to not disrupt the quality Bluegill fishery currently occurring in the reservoir. An increase in size structure and abundance of Largemouth Bass could reduce the number of quality Bluegill available for anglers. However, maintaining some control of Largemouth Bass harvest is necessary to influence Bluegill PSD through predation. Growth rates and condition factor are relatively good for Bluegill, suggesting lower densities are necessary to maintain this desirable fishery. Based on the data collected from Winchester Lake, we should scope restrictive regulations for Largemouth Bass to assess the public’s desire to increase their size structure. If the public desires an improved bass fishery, the best strategy would be to implement a 356 mm minimum size limit for Largemouth Bass. This could allow some improvement in the Largemouth Bass population structure without causing too much impact on quality size Bluegill. If the public prefers the current quality Bluegill fishery, no regulation changes should be implemented.

Bluegill:

The Bluegill population in Winchester Lake has seen little change in the range of lengths (mostly 110 - 210 mm) over the seven samples collected since 2000. However, there was a notable shift in the length frequency distribution towards smaller fish in 2012, evidenced by the decrease in PSD (Figure 263). Although PSD declined for the second consecutive survey, the PSD value of 49 in 2012 is still within the range of 20 - 60 which is considered to be a balanced population. It was also equal to the regional average PSD for Bluegill (Appendix I). Even with this shift toward smaller fish, the average length of Bluegill (144 mm) in Winchester Lake was above the average (141 mm) of the six lakes surveyed that contain Bluegill (Appendix I), and was the second highest average length of any lake. Annual growth of Bluegill in Winchester Lake ranged from 14 - 64 mm. Each year’s growth was generally around the regional average (Appendix I). On average, Bluegill reach stock size (80 mm) at age two. Bluegill in regional reservoirs reach stock size at age two, with the exceptions of Mann Lake and SVR (age 1).

The Bluegill harvested by anglers in Winchester Lake during 2012 were in the upper end of the range of lengths found in the population (54 - 256 mm), and averaged (187 mm) much larger than the population average of 144 mm (Figure 262). Considering that an estimated 5,026 Bluegill were harvested with an average length nearing preferred size (200 mm; Gablehouse 1983), Winchester Lake appears to support an excellent Bluegill fishery. The harvest of the larger individuals in the population may indicate why we are seeing a reduction in average size from previous surveys (Figure 263). This is to be expected, as anglers usually prefer to keep the larger fish they catch (Aday and Graeb 2012). Crawford and Allen (2006) saw exploitation rates of Bluegill increase up to three times as fish size increased. This could ultimately influence the size structure of the population, if larger fish are harvested at high rates. However, the annual mortality rate of 27% estimated for Bluegill in Winchester Lake was the lowest calculated for regional reservoirs (Appendix I). Additionally, it was also well below the average annual mortality of 74% calculated for 46 mid-western Bluegill populations (Coble 1988). This study also calculated the average annual exploitation rate of those 46 populations to be 27%. Although angler exploitation of Bluegill in Winchester Lake could not be calculated, compared to other reservoirs, both angler exploitation and natural mortality appear to be lower than average. It must be noted that, even though total mortality is low, Bluegill do not reach quality size until age five. This is in line with the average for other regional reservoirs (Appendix I), but with the slow growth rates, even low mortality rates could have an impact on the size structure of the population.

The low mortality seen in Winchester Lake may also be evidenced by the average relative weight of 129 calculated for fish collected in 2012. This is above the benchmark of 100 that indicates a fish is in good condition (Pope and Kruse 2007), and above the average of 110 calculated for other regional reservoirs (Appendix I). With almost all of the Bluegill collected considered to be in good condition, there appears to be excellent food resources for this population. There is a slight decline in condition as fish get longer, but the longest fish were still at or above relative weights of 100.

With the decline in PSD and average length, and slow growth rates, implementation of restrictive fishing regulations might seem like a good management strategy. However, care must be taken when implementing restrictive regulations as they can result in little or no benefit in terms of fish size structure or angler catch rates (Crawford and Allen 2006) if implemented improperly. This can result in reduced angler effort and satisfaction. Since Bluegill harvested from Winchester Lake still average close to preferred size (150 mm; Gablehouse 1983) and experience lower than average annual mortality, we do not recommend any changes to the regulations for Bluegill. If PSD and average lengths continue to decline, restrictive regulations may become necessary to protect the size structure of this quality fishery.

Other Species:

As with many of the lowland reservoirs found in Idaho's Clearwater Region, the Black Crappie population in Winchester Lake is dominated by fish over 180 mm, with few smaller fish captured in samples. Age and growth analysis of Black Crappie from Winchester Lake also generally shows the highly variable recruitment common in smaller reservoirs (Beam 1983; McDonough and Buchanan 1991; Allen 1997). The successful recruitment years do not coincide across reservoirs in Idaho's Clearwater Region, indicating that environmental factors are not the primary driving force behind successful year classes. No age and growth, or mortality information could be developed from the 2012 sample, as only five Black Crappie were collected in the survey.

One hundred nineteen channel catfish were estimated to have been harvested in 2012, similar to the estimated harvest of 133 in 2005. The harvest in 2012 was 11.8% of the 1,005 fish stocked in Winchester Lake in 2011 (none were stocked in 2012). While representing a small portion of the effort and harvest in Winchester Lake, these fish do provide a diversity of fishing opportunity. Creel clerks measured seven of the fish harvested in 2012, and these fish ranged in length from 375 - 615 mm, with a 478 mm average. These were all above the 280 mm considered to be stock size, and averaged over the 411 mm considered to be of quality size (Gablehouse 1983). As such, channel catfish should continue to be stocked in Winchester Lake. However, due to this low level of return, angler exploitation should be estimated utilizing the "Tag You're It" program to determine if changes to the stocking program are warranted.

Warm-water Fishes Predator:Prey Dynamics:

The low Largemouth Bass PSD in all samples conducted since 1997, coupled with Bluegill PSD values within the 20 - 60 range, indicates that Winchester Lake's predator prey relationship is in a Bluegill (prey) oriented (Anderson 1980; Willis et al. 1993), but unbalanced state. A comparison of PSD distributions for both Largemouth Bass and Bluegill can provide insight into potential population issues (Schramm and Willis 2012; Figure 285). In Winchester Lake, eight of the nine years of sampling since 1997 occur either in Cell 1 or are very close. Fish communities that fall into Cell 1 generally have an overabundance of Largemouth Bass <300 mm (or an underabundance of fish >300 mm) and few Bluegill <150 mm due their predation by the smaller Largemouth Bass (Schramm and Willis 2012). The surviving Bluegill grow quickly to >150 mm (quality size). This indicates that while there is a quality Bluegill fishery, the Largemouth Bass fishery needs some improvement.

Creel Survey

Angler Effort:

The year-long creel survey resulted in an estimated 36,331 hours of angler effort in 2012. This was the most effort at any of the nine regional reservoirs surveyed (Figure 1), with 33.9% more effort than Spring Valley Reservoir, the second most used reservoir. The popularity of Winchester Lake primarily stems from it being the focal point of Winchester Lake State Park. It is the only lowland reservoir in the Clearwater Region associated with a state park. The park provides a suite of amenities including a visitor center, full service hook-ups for camping, Park Ranger-led programs, hiking trails, numerous docks and picnic tables, boat ramp, and canoe rentals. Additionally, the reservoir is located near some smaller communities, has easy fishing access, and has good catch rates for trout and warm-water fish. As such, IDFG has promoted Winchester Lake as a family-friendly fishing water. These amenities help attract an estimated 109,603 visitors to the state park annually, many of whom take part in fishing the reservoir (Figure 286).

Even though Winchester Lake had the highest estimated effort of any regional reservoir in 2012, the effort was the second lowest of the four creel surveys conducted on the reservoir since 1993, and was a 30.6% drop from the 52,335 hours estimated in 2005 (Figure 1). Similarly, angler effort declined in seven of the eight regional reservoirs (87.5%; Figure 1) surveyed in both 2005 and 2012. Additionally, four reservoirs (Spring Valley Reservoir, Mann Lake, Soldier's Meadow Reservoir, and Elk Creek Reservoir) have experienced steady declines in effort over all four creel surveys conducted since 1993.

There may be several reasons for the perceived decline in effort seen in Winchester Lake. An actual decline in effort is, of course, the most likely reason. Declines in participation in outdoor recreation activities during the 1990's and early 2000's, including fishing and hunting, have been well documented (USFWS 2006; DFO 2007; Cordell et al. 2008; Sutton et al. 2009) as people have more and more choices competing for their free time. Studies (Felder and Ditton 2001; Sutton 2007; Sutton et al. 2009) have shown large percentages of anglers fish less often than they used to, primarily due to "work/family commitments" (46 - 75%) and "other leisure activities" (41 - 46%). Economic surveys conducted by IDFG in 2003 and 2011 (Table 2) show a similar trend, with most regional reservoirs (87.5%) experiencing declines in effort (total trips). However, there is data that contradicts these trends. Sales of fishing licenses in Idaho have shown an overall increasing trend from 1993 - 2012 (Appendix H). While this does not directly correlate to effort in a given lake, it does provide some evidence that participation in fishing in Idaho is not necessarily declining. Additionally, use of Winchester Lake State Park has increased from 2007 - 2013. Although the data does not cover the full time period of the economic surveys, it does indicate that more people are using the park and reservoir for recreational opportunities.

A second potential cause for the decline in effort is the accuracy of our creel surveys. The 2012 creel survey is likely more accurate than previous surveys, as it was conducted using more angler counts and interviews. Additionally, more appropriate creel survey and statistical analysis methods were incorporated in the study design. Previous creel surveys were conducted with minimal staff, and therefore effort/catch/harvest may be more biased due to small sample sizes of angler counts and interviews. This bias could have resulted in inflated effort estimates from previous surveys.

Catch and Harvest:

Harvest composition has shifted from hatchery trout to warm-water fish from 1993 - 2005 due to the establishment of illegally introduced Yellow Perch and Black Crappie (Figure 270). Warm-water species accounted for 38% of the harvest in 1993 and 65% of the harvest in 2005. This trend reversed in 2012, with warm-water species only accounting for 20.7% of the harvest, and coincided with a decline in Yellow Perch abundance.

Based on the 2012 creel survey, most anglers either targeted hatchery Rainbow Trout (43%; Figure 274), or stated that they were fishing for "any fish" (41%). Few anglers targeted any other species. With most anglers targeting hatchery Rainbow Trout, catch and harvest rates tend to be high. Harvest rates for hatchery Rainbow Trout rose from a low of 0.5 fish/hour in 2005 to 0.7 fish/hour in 2012. Harvest of hatchery Rainbow Trout has increased from an estimated 20,941 in 1999 to 29,319 in 2012 (Appendix B). This may be partially due to anglers releasing only 17,364 (42.4%) of the hatchery trout they caught in 2012. However, the hatchery trout return to creel has stayed fairly steady, with the 65.9% estimated in 2012 within the 59.8 - 73.1% range seen in previous creel surveys.

Catch rates for hatchery Rainbow Trout have been above the management goal of >0.5 fish/hour in each creel survey since 1999. With increasing catch and harvest rates, and 76.5% of the fishery supported by catchable Rainbow Trout in 2012, there does not appear to be a need to reduce the number of catchable size trout stocked in Winchester Lake. Conversely, observations made during creel surveys concluded that no Rainbow Trout stocked as fingerlings were harvested during creel surveys in 1999 - 2012. The failure of fingerling establishment in Winchester Lake is likely due to competition and predation from Yellow Perch, Black Crappie, and Largemouth Bass. Thus, future fingerling stockings should be discontinued.

Angler Satisfaction:

Based on angler surveys, the majority of anglers (61.9%) rated their fishing trip as "Good" or "Excellent" (Figure 272). While good fishing accounts for much of these positive experiences, a closer look at the reasons given for these ratings provides some insight as well. There is a range in the types of positive and negative responses given. The quality of fishing experience accounted for 60.4% of the responses. While the quality of fishing played the major role in one's fishing experience, the most common other response was "nice to be outside" (18.5%). This indicates that an enjoyable fishing trip is not predicated solely upon the quality of the fishing, but can be due to other elements of the trip. With this in mind, improvements to the fishing experience could encourage more people to get outside. Improvements such as simplified fishing rules, year-round fishing opportunities, easy access, and improved on-site amenities (docks, boat ramps, picnic tables, campgrounds, toilets) could improve angler satisfaction and effort even if there is no corresponding improvement to the fishing itself. Surprisingly, only 2.7% of respondents listed aquatic vegetation as a reason for a poor rating. Numerous complaints in previous years suggested that aquatic vegetation was affecting many anglers' fishing experience. The low number of responses during the 2012 survey indicates that although there is aquatic vegetation along much of the shoreline, it is not adversely affecting fishing for most anglers.

Angler Exploitation

Estimates of angler exploitation and total use of hatchery Rainbow Trout from the "Tag You're It" program (Meyer et al. 2009) were utilized to evaluate the effectiveness of our stocking program. Through 365 days at large, the estimated total use rate of stocked hatchery Rainbow Trout was 58.4% for the spring 2011 tagging events (Table 50) and 35.5% for the spring 2012 events. There was exploitation from both the 2011 and 2012 spring stockings past the one year mark (Appendix D), indicating that there is some carryover from these stockings. Angler catch for 366 - 730 days at large was 1.0% for 2011 and 3.3% for 2012. Additionally, one fish from each of the spring 2011 and spring 2012 stockings was caught more than two years past stocking. This is a good sign, as carryover increases the opportunity for angler to catch these fish.

The total use rates for hatchery Rainbow Trout through June, 2014 were therefore estimated to be 59.6% for the spring 2011 tagging events and 39.0% for the spring 2012 events (Appendix D). These estimates were above the average angler catch rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). These estimates were also at or above the IDFG management goal of a 40% angler total use rate for hatchery catchable Rainbow Trout (Appendix D). Tag returns from both the spring 2011 (Figure 287) and spring 2012 (Figure 288) stockings show similar patterns, with most returns occurring by the end of September each year. This is to be expected since most of the effort occurs from April - July each year (Table 49). Based on this information, no changes are suggested for future spring stockings.

The success of our fall stockings is also of interest for the regional tagging program. Tag returns resulted in total use rates of 38.4% for the October, 2011 tagging and 28.8% for the October, 2012 tagging. These were above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). They were below the IDFG management goal of a 40% total use rate for stocked hatchery Rainbow Trout (Appendix D); however, the 2011 rate is very close to the management goal. These rates are also below the total use rates from the spring stockings, which would be expected due to lower angler effort during the winter months (Table 49). Tagged fish from the October 2011 stocking were caught all the way through September, 2012 (Figure 289), indicating that these fish were able to overwinter and were available to the fishery for up to a year post stocking. Interestingly, very little harvest occurred in the fall until mid-December. This confirms the effort data from the creel survey which shows that little effort occurs in the late fall until the ice fishery begins. Fall stockings should be continued as these fish are an important part of the winter ice fishery.

Comparing angler exploitation of hatchery Rainbow Trout from the “Tag You’re It” program (Meyer et al. 2009) to the creel survey for the time period covered by the creel survey (Nov. 28, 2011 - Nov. 28, 2012) reveals a large difference in estimated exploitation rates (Appendix G). The tagging program estimated the exploitation rate to be 29.9% while the creel survey estimated it to be 66.3%. Differences in Total Use rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences in angler exploitation rates between the two survey methods were seen in all eight reservoirs where both surveys were conducted. Differences ranged from 3.8 - 50.0%, with an average of 20.3% (Appendix G). These differences may have been caused by factors such as the use of bias of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Angler exploitation based on the “Tag You’re It” program (Meyer et al. 2009) was lower for the 2012 stockings than the 2011 stockings (Appendix D). This trend was seen in five of the six regional reservoirs where data existed from both years. Some of this may be attributable to possible changes in angler effort, the continued presence of nuisance aquatic vegetation around much of the reservoir’s shoreline (Figure 283), or the possibility that anglers became accustomed/desensitized to the tagging program and returned the tags at a lower rate. The better water conditions seen in 2012 versus 2011 were also a likely factor.

Limnology

As we have seen in previous years, MCR continues to have anoxic conditions in the hypolimnion. The combination of an anoxic hypolimnion and warm surface waters greatly reduces the volume of the reservoir available for fish to live during the summer months, especially temperature sensitive hatchery trout (Figure 277). These conditions force the more temperature sensitive trout to live in either the warmer epilimnion with higher DO, or cooler water with less DO, both of which can cause stress. The combination of high water temperature and marginal DO concentrations compounds the stress on hatchery trout, which can result in disease and fish kills (Bjornn and Reiser 1991, Carline and Machung 2001).

Based on the IDFG standards for temperature and DO thresholds (Horton 1992), the volume of water available for Rainbow Trout to survive was reduced to zero in July, 2012. This would indicate that there was very little, if any, chance that hatchery trout stocked in the spring would have a chance to survive through the summer and be available to the fishery in the fall. From this information, it would be logical to infer that we should not stock any hatchery trout in Winchester Lake after May. However, an analysis of the dates of tag returns from the April 18, 2012 angler exploitation tag releases show that hatchery Rainbow Trout were caught well past the July 18, 2012 temperature/DO sample date. In fact, 21.2% of the tag returns occurred after July 18, 2012 (Figure 288), with tag returns reported all the way through November 30, 2012. This indicates that trout were able to survive through the summer, and also suggests that the IDFG 21°C upper thermal limit for Rainbow Trout (Horton 1992) is not an appropriate measure for our lowland reservoirs. The 25°C thermal limits seen in the literature (Bjornn and Reiser 1991;Lee and Rinne 1980, Carline and Machung 2001, Rodnick et al. 2004) appear to be more appropriate. Utilizing a 25°C upper thermal limit shows that 32.4% of the reservoir was still available to trout in July, providing them with enough habitat to survive the summer months.

An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion, such as Winchester Lake. This is a concern for our fall stocking of catchable trout in this reservoir, as fall turnover can reduce the dissolved oxygen levels of the reservoir to <5.0 mg/L needed for Rainbow Trout. This was seen in the October, 2012 limnology sample (Figure 287). To avoid potential fish kills, fall stockings should be conducted once DO levels have returned to >5.0 mg/L after reservoir turnover.

Zooplankton

Larger sized zooplankton species, especially Daphnia, often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). The zooplankton community in Winchester Lake was dominated by Daphnia and Cyclopoida in 2012, indicating the presence of a viable food source. In 2012, Daphnia collected averaged 1.2 mm in length, and Cyclopoida averaged 0.7 mm in length (Figure 280). These average lengths are below the length (≥1.3 mm) preferred by *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996); although, up to 62.2% of Daphnia and 12.2% of Cyclopoids were at or above preferred size (Figures 278 and 279). However, *Oncorhynchus* species are known to feed on zooplankton down to 1.0 mm in length. In 2012, 76.2% of the Daphnia population and 16.4% of the Cyclopoida population were ≥1.0 mm in length. This indicates that there is food available for hatchery Rainbow Trout and juvenile warm-water species to eat. With high percentages of the zooplankton population at edible size, it does not appear that larger zooplankton are being cropped off.

In order to get a better picture of the quality of the zooplankton population, we calculated the ZQI value for Winchester Lake. The ZQI, which is a measure of both abundance and size, was 2.29, by far the highest for reservoirs in the Clearwater Region (Appendix E). ZQI values from >0.6 are considered high and indicate that competition for food resources is unlikely for planktivores (Teuscher 1999). The overall biomass of zooplankton was also high, indicating that not only are there large zooplankton, but that they are abundant as well. This suggests that there is no need to reduce the number of planktivores. This data supports our recommendation to maintain current stocking rates of hatchery Rainbow Trout.

Aquatic Vegetation and Hypolimnetic Aeration

The nuisance aquatic vegetation and algae mentioned previously are a contributing factor to the low DO levels in the reservoir. This organic material consumes oxygen as it decomposes, thus reducing oxygen levels in the hypolimnion. As we have seen in previous years, Winchester Lake continues to have severe anoxic conditions in the hypolimnion. The combination of an anoxic hypolimnion and warm surface waters greatly reduces the volume of the reservoir available for fish to live during the summer months, especially temperature sensitive hatchery trout (Figure 277). These conditions force the more temperature sensitive trout to live in either the warmer epilimnion with higher DO, or cooler water with less DO, both of which can cause stress. The combination of high water temperature and marginal DO concentrations compounds the stress on hatchery trout, which can result in disease and fish kills (Bjornn and Reiser 1991, Carline and Machung 2001).

A hypolimnetic aeration system was installed in Winchester Lake in 2002 to break the phosphorous cycle in the reservoir by increasing DO levels in hypolimnion. In theory, this would increase the volume of water for trout to live in, and reduce the quantity of nuisance aquatic vegetation. During spring and summer months, sunlight and warm air temperature heat the surface water of the lake. Cold water, due to its higher density, is heavier and sinks to the bottom, creating a condition called thermal stratification in which the warm and cool layers of water don't mix. In the warm surface water, sunlight allows phytoplankton and macrophytes to grow and produce oxygen. As these plants die and sink, their decomposition uses up the oxygen in the deeper water (hypolimnion). Historically, the pattern of phytoplankton dynamics in Winchester Lake is characteristic of an unstable algal population (Entranco 1990). During the summer months, the algae population is almost exclusively composed of the blue-green algae *Aphanizomenon sp*. (Entranco 1990), which are actually a cyanobacteria. Blue-green algae are evolutionarily primitive, and most representatives are filamentous in structure; however, some unicellular members form large colonies. Blue-green algae are able to form large floating mats that can cover large areas of the surface of Winchester Lake. In addition, these algae are notable for causing odors that have resulted in complaints from some lake users. Some blue-green algae species may be toxic to animals and other algae (Miranda and Bettoli 2010; Stone et al. 2012).

As thermal stratification progresses through the summer, the thermocline rises from a depth of around 4 m in early June to 2 m or less in July and August (Entranco 1990; Hand 2009). Oxygen levels in the hypolimnion continue to decline until there is little to no oxygen present (anoxic conditions). These periods of no oxygen allow the release of phosphorus and highly soluble orthophosphate from the lake sediments into the waters of the hypolimnion (Cooke et al. 2005). During prolonged thermal stratification and anoxic conditions, phosphorous concentrations in Winchester Lake's hypolimnion can be over ten times higher than in surface waters (Entranco 1990; IDEQ 1999). The hypolimnion of Winchester Lake comprises approximately 50% of the lake's total volume. In recent years nearly 100% of the hypolimnion becomes anoxic during thermal stratification.

During the fall, colder air temperatures cool the lake's surface waters. When the surface water becomes cooler than the deep water, it sinks and the lake "turns over". This turnover allows the high concentrations of phosphorus and orthophosphates in the hypolimnion to mix with the surface water and re-enter the phosphorus cycle. The lake is thus fertilized for abundant plankton and macrophyte growth to occur the next summer and the cycle is repeated.

Many options were carefully considered for reducing the amount of phosphorous in the lake, including aeration, chemical treatment, dredging, and hypolimnetic water withdrawals (Table 53). After considering factors such as cost, public input, and environmental impacts, hypolimnetic aeration was determined to be the best option. Increasing the level of oxygen in the hypolimnion would reduce or prevent the movement of phosphorous bound in the sediment back into the water column, resulting in a reduction in the amount of "fertilizer" available for algae and aquatic macrophytes. This in turn reduces the loss of oxygen in the hypolimnion due to decomposition, thus breaking the cycle.

A summary of hypolimnetic aeration projects by Cooke et al. (2005) showed that 28 of 29 of the systems researched resulted in improvements to hypolimnetic DO, with increases up to 7 mg/L observed. This indicates that hypolimnetic aeration systems can be effective in improving DO levels in the hypolimnion of eutrophic reservoirs. In contrast, long-term monitoring of the aeration system in Winchester Lake from 2003 - 2010 showed increases in DO concentrations ranging from 0.7 - 2.0 mg/L (Table 51) in the water exiting the aeration system. This increase was similar to what was observed by Ashley (1983) and McQueen and Lean (1986), but was much lower than what was needed to increase the volume of Winchester Lake available for Rainbow Trout and/or break the phosphorous cycle. Improvement in DO concentrations to over 5 mg/L was a management goal, as this is considered the point at which trout growth, food conversion, and swimming performance rates become limited (Davis 1975; Bjornn and Reiser 1991). Increasing the volume of the reservoir with >5.0 mg/L DO would have improved the Rainbow Trout fishery by improving the ability of these fish to survive the warmer summer months.

The hypolimnetic aeration system in Winchester Lake, while successful at adding some oxygen to the water, appears to be inadequate to overcome the biological oxygen demand (BOD) of the reservoir. The higher increases in DO (>1.5 mg/L) generally occurred in the spring and fall months when oxygen levels were higher, and BOD was lower than in summer months. Thus, when the system was adding the most oxygen, it was usually at a time when the need for additional oxygen was not as great or not necessary. Additionally, during the summer months, some of the oxygen added to the water was consumed by the high BOD before it even left the aeration system (Table 51). This inability to overcome the reservoir BOD is usually attributable to undersized aerator capacity (Ashley 1983; McQueen et al. 1984; Cooke et al. 2005). This is most likely the case in Winchester Lake, as evidenced by the lack of improvement in DO levels beyond 5 m distance from the aeration units (Table 51). Using this 5 m radius of positive effect on DO levels, we calculate that approximately 318 hypolimnetic aeration units would be needed to improve DO levels in Winchester Lake. While this many units would likely improve the DO levels throughout most of the water column, it would still not meet the management goals of >5.0 mg/L DO levels in the hypolimnion, nor would it break the phosphorous cycle of the reservoir. Regardless, 318 aeration units would not be reasonable from a financial, recreational, or aesthetic perspective. The results in Table 52 show that while some improvements in hypolimnetic DO levels were seen, no improvements were seen at the bottom of the reservoir. With anoxic conditions present at the water/sediment interface, phosphorous would continue to be released into the water column. As we are not meeting either of the two management goals of this project, we recommend removing the hypolimnetic aeration system from Winchester Lake and looking at other options for improving water quality.

One potential option for phosphorous control is the SePro product Phoslock®, which permanently binds free reactive phosphorous. This product has proven effective, with Total Phosphorous levels in the water column reduced by 52 - 80% in case studies (Robb et al. 2003; McNabb 2011; SeaPro 2014). Phoslock® has also been shown to bind up to 69% of soluble phosphorous levels in the top 4 cm of substrate and 27% in the top 10 cm of substrate (Cook et al. 2005; Meis et al. 2012). This is important, as most of the soluble phosphorous that is released into the water column is estimated to come from the top 4-10 cm of substrate (Cook et al. 2005; Meis et al. 2012). However, a whole lake treatment of Winchester Lake would cost >$350,000 ($255 - $510/acre-ft) in product alone (Apppendix L). Due to budget limitations, it is not likely to be a realistic option unless outside funding sources were secured. If this option is used, intensive limnological sampling should be conducted before and after treatment to monitor the effects.

Monitoring vegetation in Winchester Lake is an important part of managing the reservoir. As seen in our surveys, vegetation was present at 38.2% of the sites samples. Vegetation presence alone, however, doesn't provide the entire picture. We must also consider what types of vegetation are present, where the vegetation is located, and what effects it has on fish populations and recreation in the reservoir. In the case of Winchester Lake, elodea and filamentous algae were the predominant types of vegetation present. Both species are known to grow quickly and form dense mats across the water's surface. This can greatly reduce forage success for predators such as Largemouth Bass, and increase the abundance of prey species (Bettolli et al. 1992; Dibble et al. 1996).

In addition to being a problem for fish populations, vegetation can also affect fishing and other recreation. Even though 38.2% of the sample sites in Winchester Lake had vegetation, 97.8% of the sites with vegetation were along the shoreline and 54.1% of all shoreline sites had vegetation. The DFI sampling showed a similar pattern. Fifteen percent of the DFI sites sampled were negatively affected by vegetation and 7.3% were rendered unfishable, resulting in 32.9% of shoreline sites being negatively influenced by vegetation according to the DFI.

Since 72% of angler effort in 2012 was from the bank, the fact that most of the vegetation occurs along the shore indicates that vegetation could be reducing angling opportunity and/or the quality of the fishing experience. Although only 2.7% of anglers in the 2012 creel survey complained about vegetation, we have received many complaints from anglers (by phone and in person) over the past few years due to frustrations with vegetation. This frustration can result in reduced satisfaction with their experience at the reservoir and could even result in anglers no longer fishing at Winchester Lake.

Reducing the quantity of aquatic vegetation (primarily along the shoreline and dock areas) in Winchester Lake could improve both the forage success for Largemouth Bass (Bettolli et al. 1992; Dibble et al. 1996) and the recreational opportunities in the reservoir. Previously, herbicide treatments using liquid Reward® were conducted in Winchester Lake (DuPont et al. 2011) to address submerged vegetation. These applications reduced the surface coverage from approximately 30 - 40% around the boat ramp and fishing docks to 10 - 15% coverage. However, vegetation coverage returned to pre-treatment levels approximately eight weeks after the treatment. Maintaining adequate control would require multiple treatments per year.

Due to the limited success of small scale herbicide treatments in regional reservoirs, other techniques for controlling nuisance aquatic vegetation were researched by DuPont et al (2011). These techniques included biological, mechanical, physical, and other chemical control methods that are often used for vegetation control throughout the country (Appendix L). The recommended control measures for regional reservoirs and ponds were determined to be winter drawdown, benthic barriers, and grass carp. Benthic barriers would not be appropriate for Winchester Lake, as there is too much vegetation coverage, and they will not address the floating mats of algae and vegetation that can occur. Winter drawdown may not be an option, either, as Winchester Lake does not have a functioning drain system. Furthermore, the reservoir drains into Lapwai Creek, which contains anadromous fish. Water withdrawal was considered during the development of the hypolimnetic aeration system but was rejected due concerns for anadromous fish and Idaho state water quality standards in Lapwai Creek.

A potential control choice is grass carp. Grass carp have been shown to be effective at controlling nuisance aquatic vegetation (Avault 1965, Mitzner 1978, Hanlon et al. 2000), including the species present in Winchester Lake. However, numerous studies point out that a moderate level of control is difficult to achieve, as control is often either "all or nothing" (Kirk 1992, Mitzner 1994, Pauley et al. 1998, Bonar et al. 2002). The use of grass carp should be approached cautiously. It is recommended to start stocking grass carp at a low stocking rate of 3 - 6 fish/acre, as overstocking is detrimental and is difficult to correct. More grass carp can be added if additional control is needed. Grass carp would cost an estimated $3,900 - $7,800 at this lower stocking rate (Appendix L). Monitoring their effectiveness should be conducted for several years, as control may not become apparent for up to two years post-stocking (Bonar et al. 2002: Cooke et al. 2005).

Due to the limited potential success and/or high cost of many vegetation control methods, several options should be reconsidered. Herbicides and mechanical removal methods (hand cutting, harvesting), while not feasible for whole lake control, could be potential options for control in small areas such as around popular fishing areas and the boat ramp. While small scale herbicide treatments did not provide long-term control, the eight weeks of control seen from previous single applications (DuPont et al. 2011) would provide improved recreational opportunity during the height of the fishing season in June and July (Table 49). Treating elodea and algae (which is not controlled by Reward®) at Winchester Lake would cost approximately $325 per surface acre using both Reward® and GreenClean Pro® for each treatment. Mechanical control, such as hand-cutting or pulling, could also be effective for short-term control in small areas. As with many other options, revegetation usually begins within a few weeks (Nicholson 1981; Cooke et al. 2005). It is difficult to estimate the cost of physical control because most of the cost is associated with labor (Cooke et al. 2005), especially if SCUBA divers would be required for deeper water. Divers would likely be needed for some areas in Winchester Lake, as water depths are >2m around the ends of most docks. The use of volunteers would greatly reduce the costs, but would not likely be a reliable source of labor on an annual basis. A concern with using this option in Winchester Lake is that the low visibility of the reservoir would reduce effectiveness. Thus, we recommend utilizing spot treatments of herbicides around docks and popular fishing spots in the spring to provide summer control of nuisance aquatic vegetation during the height of the fishing season.

MANAGEMENT RECOMMENDATIONS

1. Conduct future lake surveys in Winchester Lake with six 10-minute electrofishing samples to obtain a 90% confidence interval with 25% accuracy.

2. Evaluate angler exploitation of Channel Catfish.

3. Scope restrictive regulations for Largemouth Bass to assess if the public has a desire to increase their size structure.

4. Remove hypolimnetic aeration system.

5. Utilize an upper thermal limit of 25°C for Rainbow Trout when evaluating volume of reservoir available for trout.

6. Utilize spot treatments of herbicides around docks and fishing spots to provide summer control of nuisance aquatic vegetation.

Table 46. Number of fish collected by species in each 10-minute electrofishing sample conducted during a standard lowland lake survey of Winchester Lake, Idaho, in 2012, and the estimated number of 10-minute electrofishing samples (n) required to generate fish species estimates with 90% confidence and 25% precision.

	Count of fish collected									
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev	n
Largemouth Bass	16	32	10	14	21	16	109	18.2	7.7	8
Black Crappie	1	1	0	0	1	1	4	0.7	0.5	26
Bluegill	81	138	97	66	168	85	635	105.8	39.0	6
Yellow Perch	3	6	6	3	13	5	36	6.0	3.7	16
Channel Catfish	0	0	0	0	2	0	2	0.3	0.8	n/a
Brown Bullhead	0	0	1	0	0	0	1	0.2	0.4	n/a
Total	101	177	114	83	205	107	787	131.2	48.3	6

Table 47. Back-calculated length at age of Largemouth Bass collected during a standard lake survey of Winchester Lake, Idaho, in 2012.

Year			Back-calculated length (mm) at each annulus								
Class	Age	n	1	2	3	4	5	6	7	8	9
2011	1	0	0								
2010	2	23	74	117							
2009	3	30	75	134	180						
2008	4	13	74	127	178	214					
2007	5	20	65	113	158	200	232				
2006	6	14	72	119	159	196	227	252			
2005	7	4	71	124	168	214	252	283	309		
2004	8	1	69	115	166	208	249	285	332	370	
2003	9	1	76	142	195	254	328	374	408	436	469
n		106	106	106	83	53	40	20	6	2	1
Length at Age			72	123	170	205	235	266	329	403	469

Table 48. Back-calculated length at age of Bluegill collected during a standard lake survey of Winchester Lake, Idaho, in 2012.

Year Class	Age	n	Back-calculated length (mm) at each annulus 1	2	3	4	5	6	7
2011	1	1	54						
2010	2	32	66	109					
2009	3	23	64	106	136				
2008	4	20	64	108	137	157			
2007	5	16	59	104	140	167	182		
2006	6	8	72	116	152	175	196	208	
2005	7	1	67	119	151	175	201	215	223
n		101	101	100	68	45	25	9	1
Length at Age			64	108	140	164	187	209	223

Table 49. Summary of angler effort (hours) as determined through a creel survey conducted on Winchester Lake, Idaho, from November 28, 2011 - November 28, 2012.

Month	Ice weekday	Shore weekday	Boat weekday	Total weekday	Ice weekend	Shore weekend	Boat weekend	Total weekend	Total ice	Total shore	Total boat	Total effort	Standard error	Percent error
December	975	0	0	975	224	0	0	224	1,200	0	0	1,200	402	34
January	625	0	0	625	1,454	0	0	1,454	2,079	0	0	2,079	655	32
February	654	0	0	654	390	0	0	390	1,044	0	0	1,044	227	22
March	139	0	0	139	208	65	0	273	347	65	0	412	204	50
April	0	635	0	635	0	473	49	522	0	1,108	49	1,157	439	38
May	0	1,694	264	1,958	0	2,045	432	2,477	0	3,739	696	4,435	763	17
June	0	3,812	1,247	5,059	0	4,010	882	4,891	0	7,821	2,129	9,950	2,068	21
July	0	4,115	814	4,930	0	2,032	653	2,685	0	6,147	1,468	7,615	1,150	15
August	0	1,638	209	1,847	0	1,424	197	1,621	0	3,062	406	3,468	873	25
September	0	2,103	359	2,462	0	1,346	260	1,606	0	3,449	619	4,068	410	10
October	0	368	0	368	0	64	0	64	0	432	0	432	374	86
November	0	88	0	88	0	384	0	384	0	472	0	472	130	28
Totals	2,394	14,452	2,894	19,740	2,276	11,842	2,473	16,591	4,670	26,295	5,367	36,331	2,854	8

Table 50. Angler exploitation of hatchery catchable size Rainbow Trout stocked in Winchester Lake, Idaho, in 2011 and 2012, through 365 days post-stocking. Total use = fish harvested + fish released.

2011

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted harvest: Estimate	Adjusted harvest: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
American Falls	26-Apr-11	High density	200	44	7	8	50.6%	14.2%	67.9%	17.1%
		Low density	200	56	6	6	64.5%	16.5%	78.3%	18.7%
		Medium density	200	44	8	8	50.6%	14.2%	69.1%	17.3%
Hagerman	26-Apr-11	High density	200	34	2	6	39.1%	12.2%	48.3%	13.8%
		Low density	200	37	8	10	42.6%	12.8%	63.3%	16.3%
	12-Oct-11	Normal production	396	51	5	10	29.6%	8.2%	38.4%	9.8%
Nampa	26-Apr-11	High density	200	35	4	6	40.3%	12.4%	51.8%	14.4%
		Low density	200	36	7	2	41.4%	12.6%	51.8%	14.4%
		Medium density	195	20	9	2	23.6%	9.2%	36.6%	11.8%
Average							42.5%	12.5%	56.2%	14.9%

2012

Hatchery	Tagging date	Treatment	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted harvest: Estimate	Adjusted harvest: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
American Falls	18-Apr-12	High density	200	11	1	4	15.5%	6.3%	22.6%	7.7%
		Low density	199	20	1	4	28.3%	8.7%	35.4%	9.9%
		Medium density	200	21	0	4	29.6%	8.9%	35.2%	9.8%
Hagerman	18-Apr-12	High density	200	16	0	3	22.6%	7.7%	26.8%	8.4%
		Low density	200	26	0	5	36.7%	10.0%	43.7%	11.1%
		Medium density	200	22	3	1	31.0%	9.1%	36.7%	10.0%
Nampa	18-Apr-12	High density	400	17	1	2	24.0%	7.9%	28.2%	8.7%
		Low density	200	31	3	1	43.9%	11.1%	49.6%	12.0%
		Medium density	199	27	0	2	38.3%	10.3%	41.1%	10.7%
Lyons Ferry	10-Oct-12	production	199	36	3	2	25.3%	6.3%	28.8%	6.8%
Average							29.5%	8.6%	34.8%	9.5%

Table 51. Average monthly change in dissolved oxygen levels (DO; mg/L) within eight hypolimnetic aeration units installed on Winchester Lake, Idaho. Samples were collected monthly during February - November, from 2003 - 2010.

Month	Bottom of intake pipe	Maximum in surface trough	Bottom of return pipe	Change in DO
February	6.4	8.3	8.4	2.0
March	6.9	8.2	8.2	1.3
April	8.6	9.9	9.8	1.2
May	3.3	4.3	4.1	0.9
June	1.5	2.3	2.2	0.7
July	0.5	1.3	1.2	0.7
August	0.4	1.4	1.3	0.9
September	3.4	4.3	4.1	0.8
October	6.2	7.3	7.2	0.9
November	8.9	10.2	10.3	1.5

Table 52. Average difference in dissolved oxygen (DO; mg/L) levels between set distances from eight hypolimnetic aeration units installed on Winchester Lake, Idaho, and a control location 40 m away from the nearest unit. Samples were collected monthly during February - November from 2003 - 2010.

Summer months (May - September)

	Distance From Aeration Unit			
Depth (m)	1m	5m	10m	15m
1	0.1	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0
3	0.0	0.0	0.1	0.1
4	0.3	0.1	0.0	0.0
5	0.6	0.2	0.0	0.0
6	0.6	0.2	-0.1	-0.1
7	0.4	0.1	0.0	0.0
8	0.3	0.1	0.1	0.0
9	0.1	0.1	0.0	0.0
10	0.0	0.0	0.0	0.1

Spring/Fall months (Feb. - April, Oct., Nov.)

	Distance From Aeration Unit			
Depth (m)	1m	5m	10m	15m
1	0.0	0.1	0.0	0.1
2	0.1	0.0	-0.1	0.0
3	0.0	0.0	0.0	0.0
4	0.4	0.2	0.0	0.0
5	1.0	0.4	0.0	0.0
6	1.0	0.4	0.0	0.0
7	0.6	0.3	0.1	0.0
8	0.4	0.1	0.0	0.1
9	0.2	0.1	0.0	0.0
10	0.0	0.0	0.0	0.0

Table 53. Estimated treatment costs for different techniques to reduce phosphorous levels in Winchester Lake, Idaho, as determined by pre-project cost analysis conducted in 2000.

Technique	Estimated Cost	Annual Operating Cost	Water Quality Benefit	Comments
Lake Destratification	$20,000-30,000	$5,000	Would not achieve the target reduction of 446 pounds TP.	Significant adverse temperature impacts preclude further consideration.
Hypolimnetic Aeration	$100,000-$300,000	$5,000	Would not achieve the target reduction of 446 pounds TP.	Would increase DO and allow expanded volume of lake for inhabitation by fish and other organisms.
Aluminum Sulfate Treatment	$100,000 per treatment	Repeat in 5-10 years	Would likely provide the necessary in-lake phosphorus control.	In the absence of adequate watershed phosphorus control, treatment would be short lived. Health and toxicity concerns.
Dredging	$200,000-$800,000	None	Variablility in sediment phosphorus content indicate that TP control benefits are likely to be very uncertain.	Limited dredging could be beneficial in restoring depth and volume where sediment accumulation has occurred or where nuisance aquatic plant control is needed.
Hypolimnetic Withdrawl via Siphon Release	$0-$10,000	None	Could achieve annual reduction of 446 pounds of TP.	Could be esily implemented and monitored while watershed control methods are implemented and monitored. Exceeds water quality criteria of receiving water.
Hypolimnetic Withdrawl via pumping and land application	$200,000-$500,000 per mile	$10,000	Could achieve annual reduction of 446 pounds of TP.	Land application to cropland would provide 6" of water per acre to 500 acres in August-September or 250 acre feet of water to a constructed wetland.

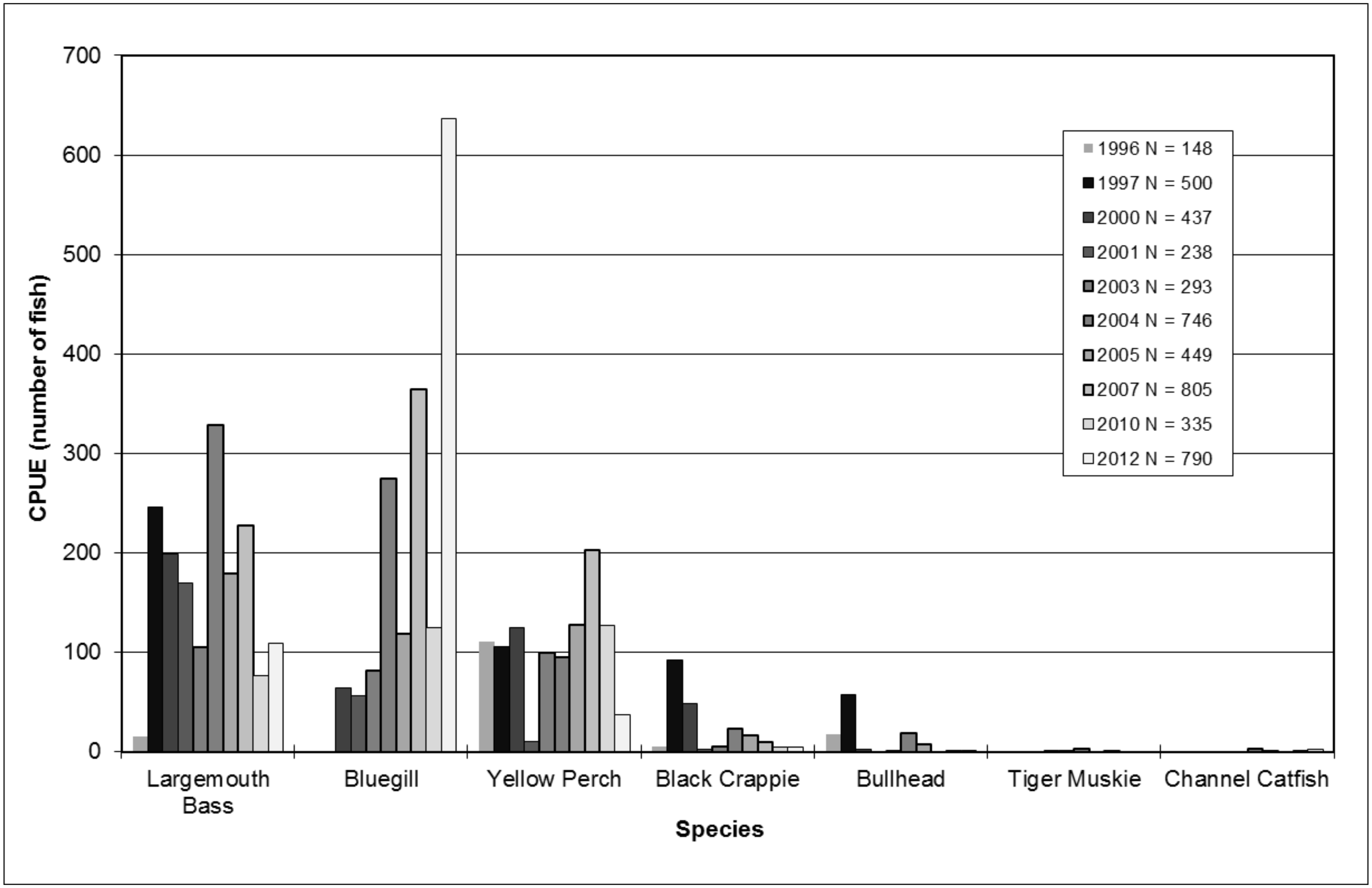


Figure 257. Catch per unit effort (CPUE; number of fish/hour) of fishes collected through electrofishing in Winchester Lake, Idaho, from 1996 - 2012.

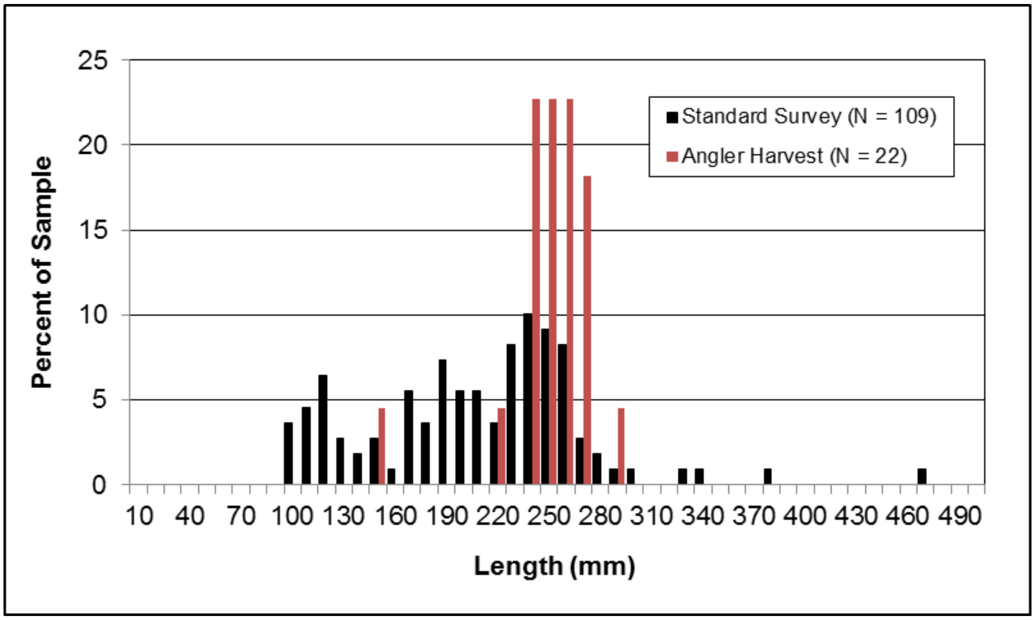


Figure 258. Comparison of Largemouth Bass length frequency distributions from fish collected through electrofishing, and fish harvested by anglers in Winchester Lake, Idaho, in 2012.

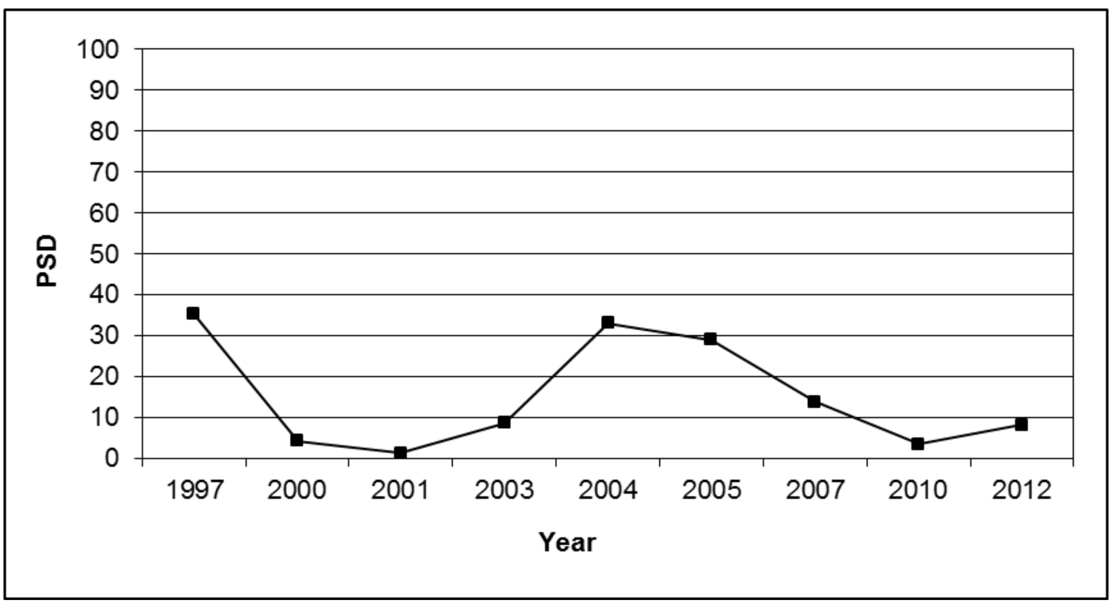


Figure 259. Proportional Size Distribution (PSD) values of Largemouth Bass collected through electrofishing in Winchester Lake, Idaho, from 1997 - 2012.

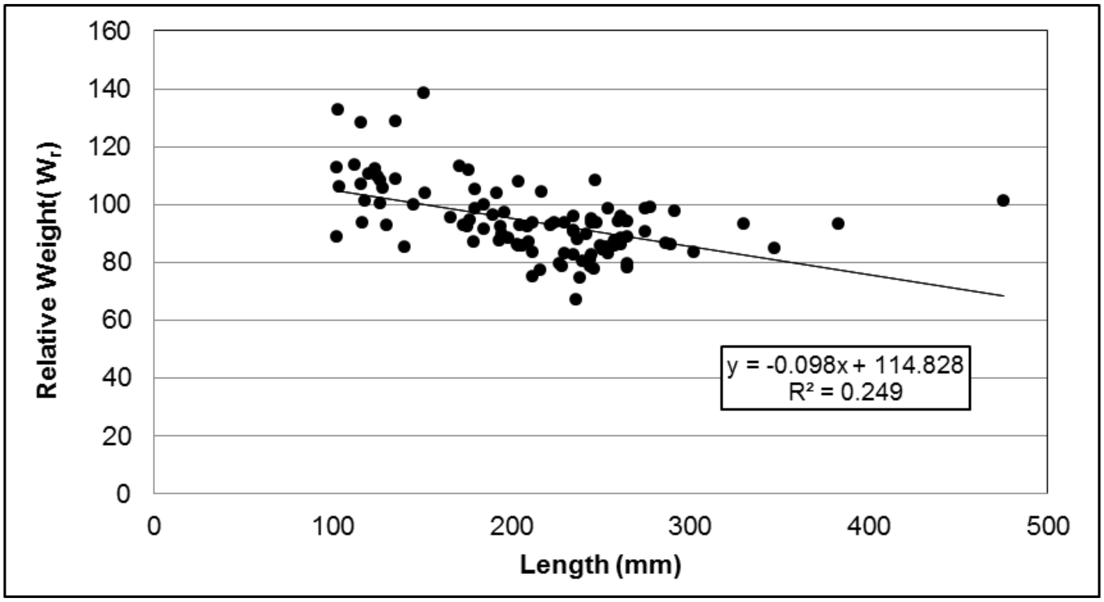


Figure 260. Relative weight (W_r) values of Largemouth Bass collected through electrofishing in Winchester Lake, Idaho, in 2012.

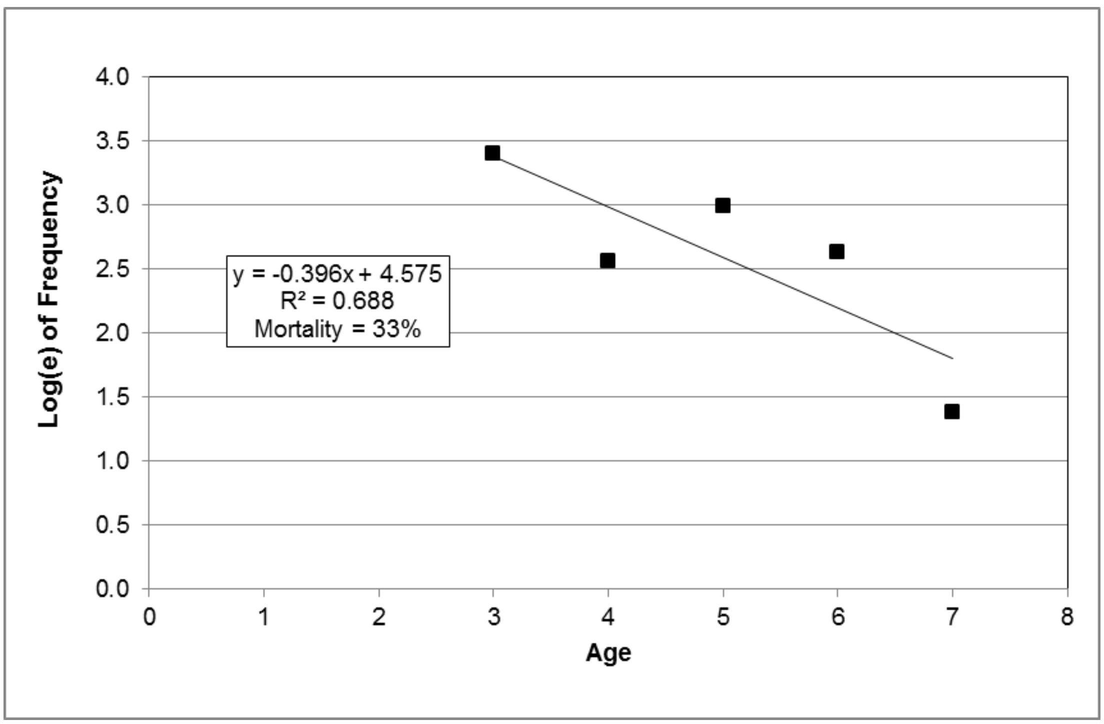


Figure 261. Catch curve for estimating annual mortality of Largemouth Bass collected through electrofishing in Winchester Lake, Idaho, in 2012.

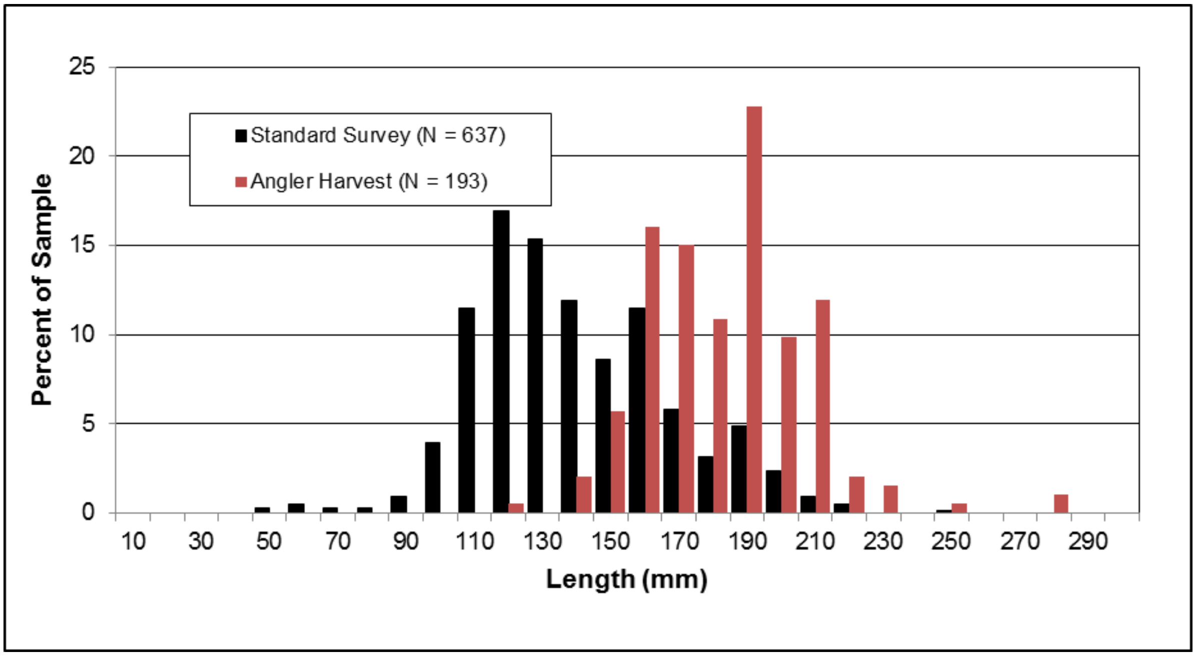


Figure 262. Comparison of Bluegill length frequency distributions from fish collected through electrofishing, and fish harvested by anglers in Winchester Lake, Idaho, in 2012.

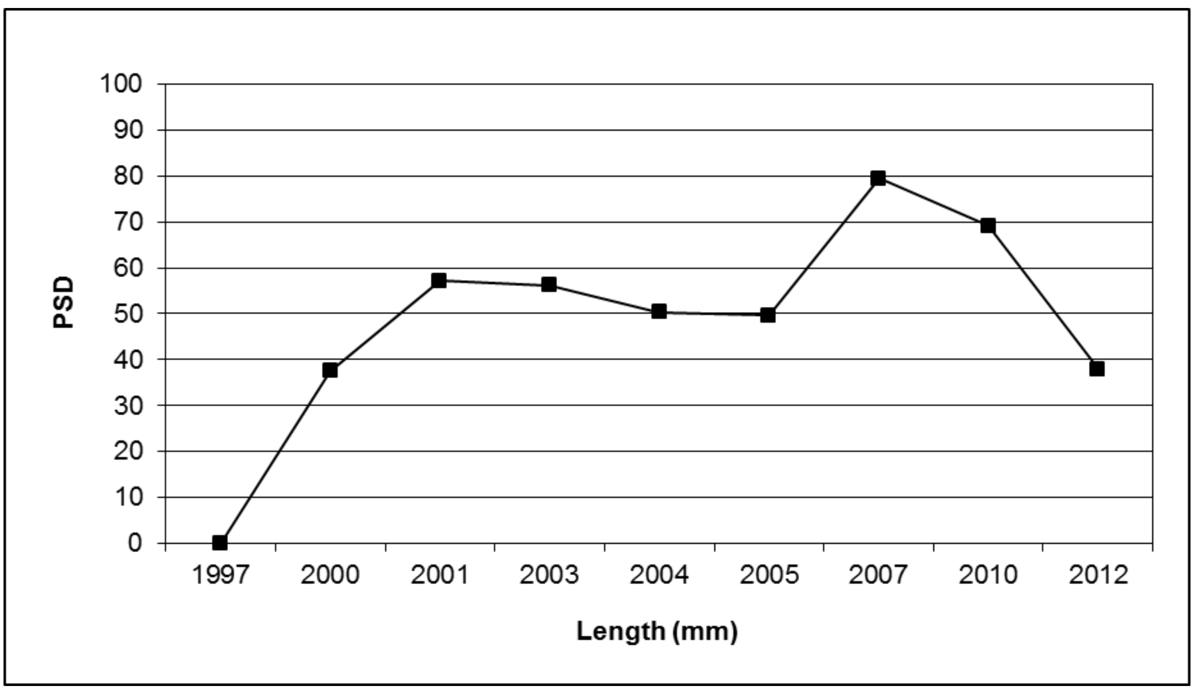


Figure 263. Proportional Size Distribution (PSD) values of Bluegill collected through electrofishing in Winchester Lake, Idaho, from 1997 - 2012. Bluegill were likely introduced into Winchester Lake in 1997 - 1998.

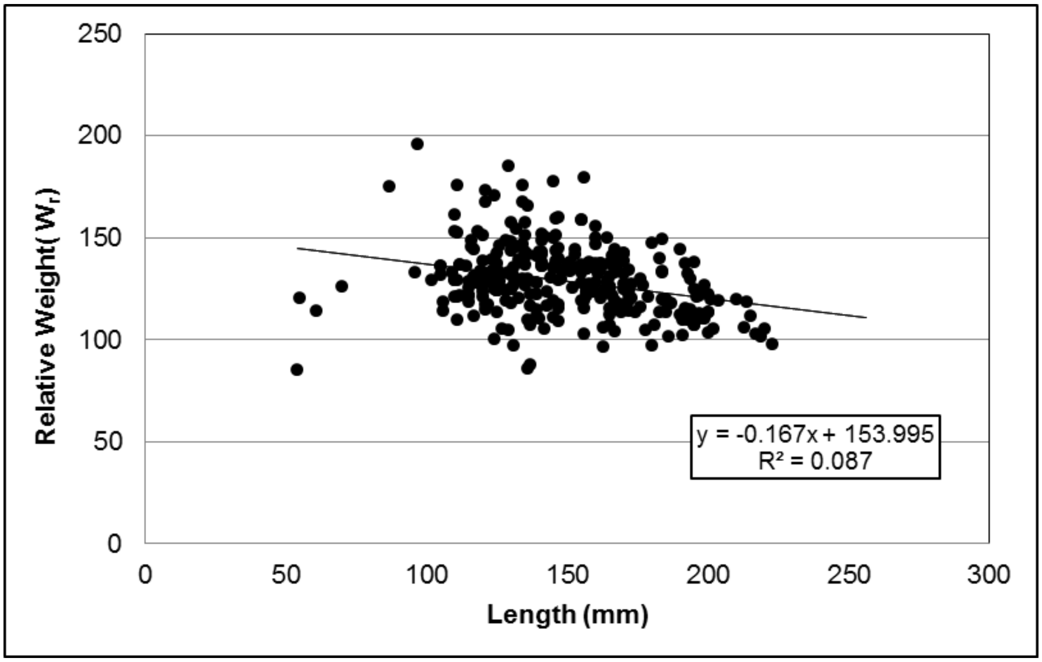


Figure 264. Relative weight (W_r) values of Bluegill collected through electrofishing in Winchester Lake, Idaho, in 2012.

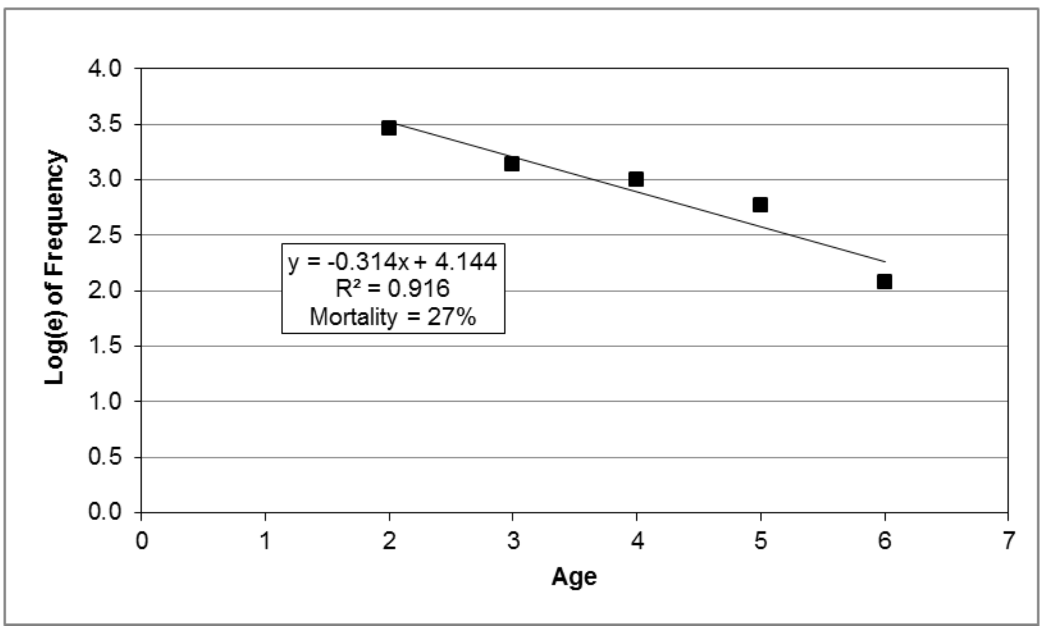


Figure 265. Catch curve for estimating annual mortality of Bluegill collected through electrofishing in Winchester Lake, Idaho, in 2012.

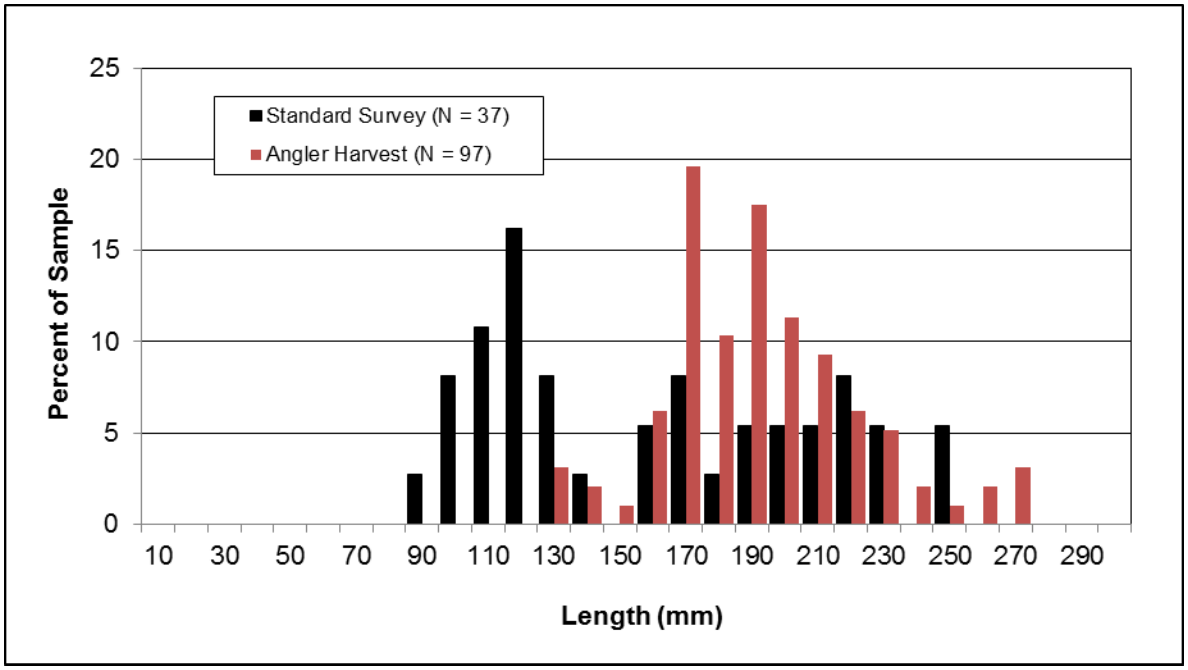


Figure 266. Comparison of Yellow Perch length frequency distributions from fish collected through electrofishing, and fish harvested by anglers in Winchester Lake, Idaho, in 2012.

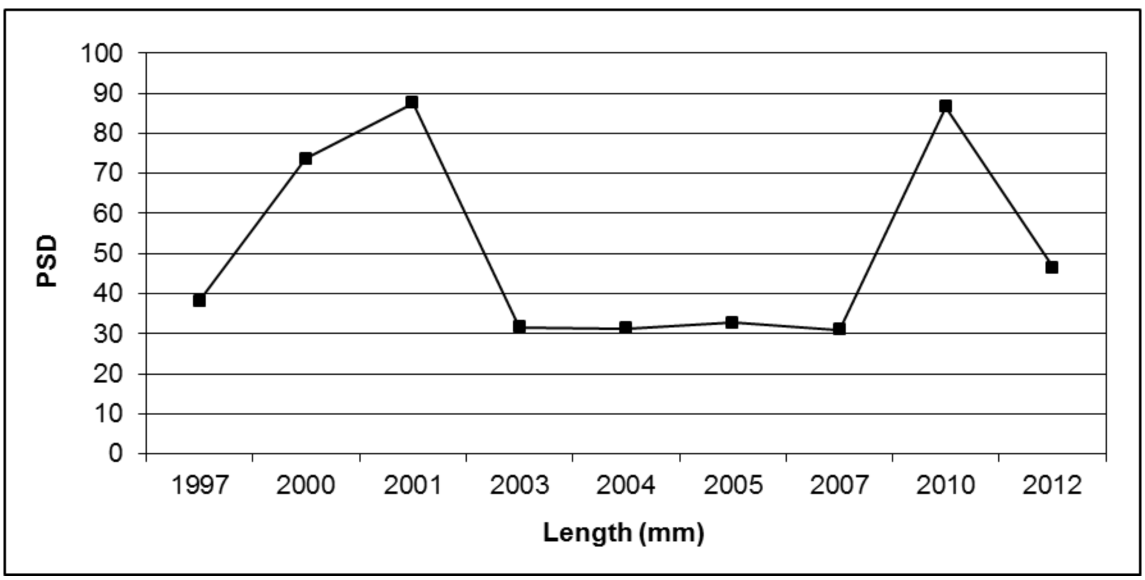


Figure 267. Proportional Size Distribution (PSD) values of Yellow Perch collected through electrofishing in Winchester Lake, Idaho, from 1997 - 2012.

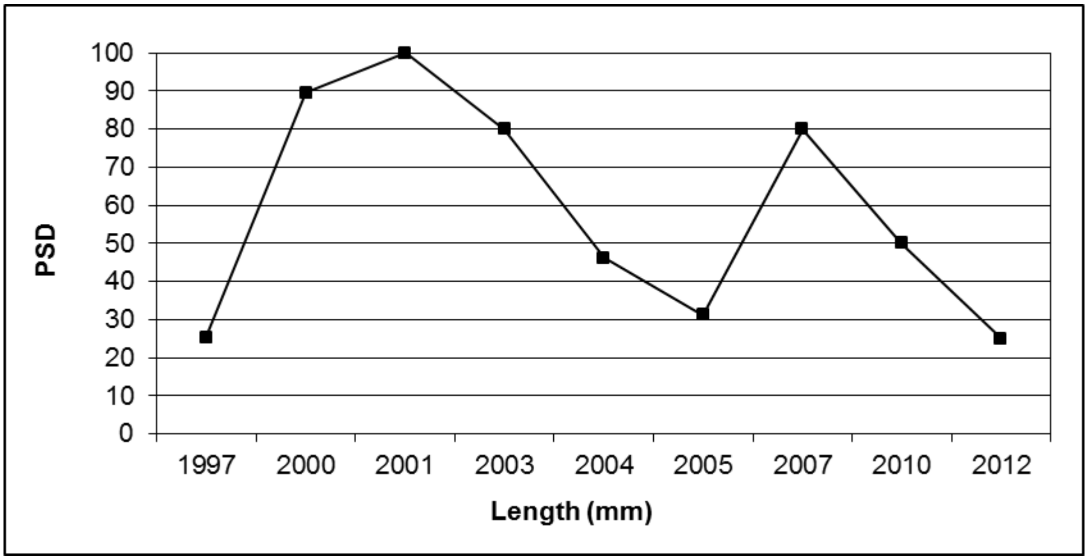


Figure 268. Proportional Size Distribution (PSD) values of Black Crappie collected through electrofishing in Winchester Lake, Idaho, from 1997 - 2012.

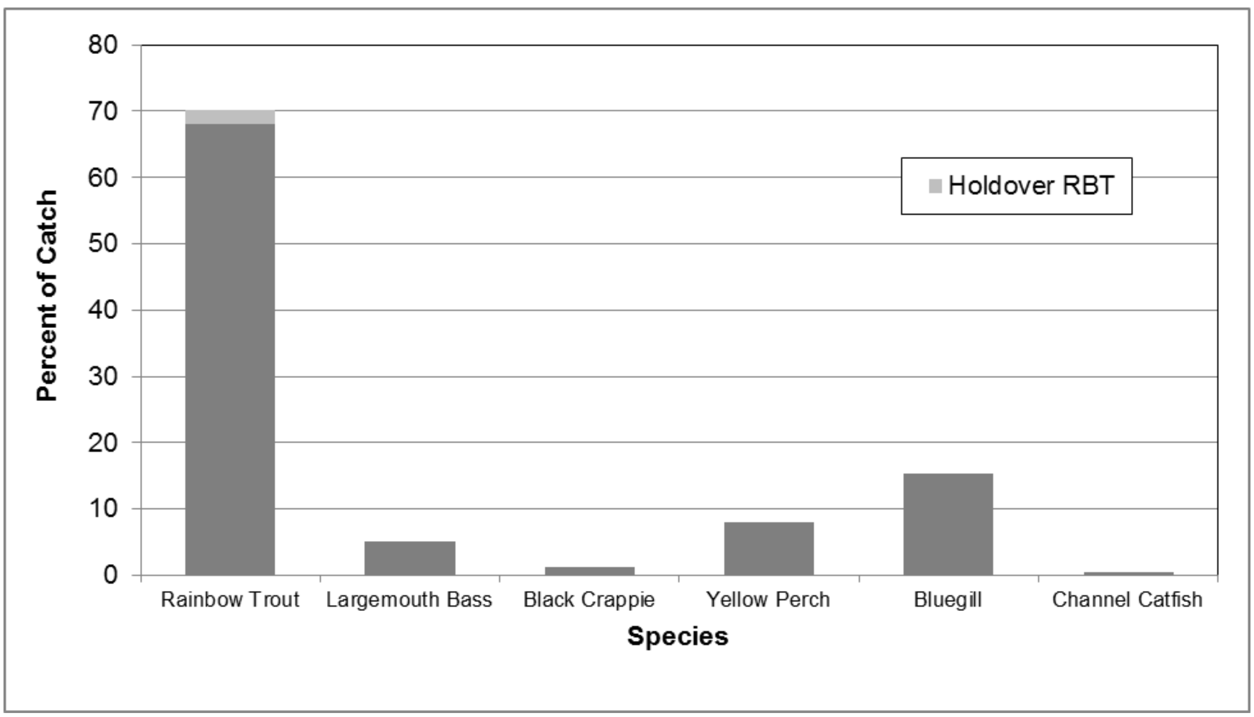


Figure 269. Composition of fishes caught in Winchester Lake, Idaho, as estimated by a creel survey conducted from November 28, 2011 - Nov 28, 2012.

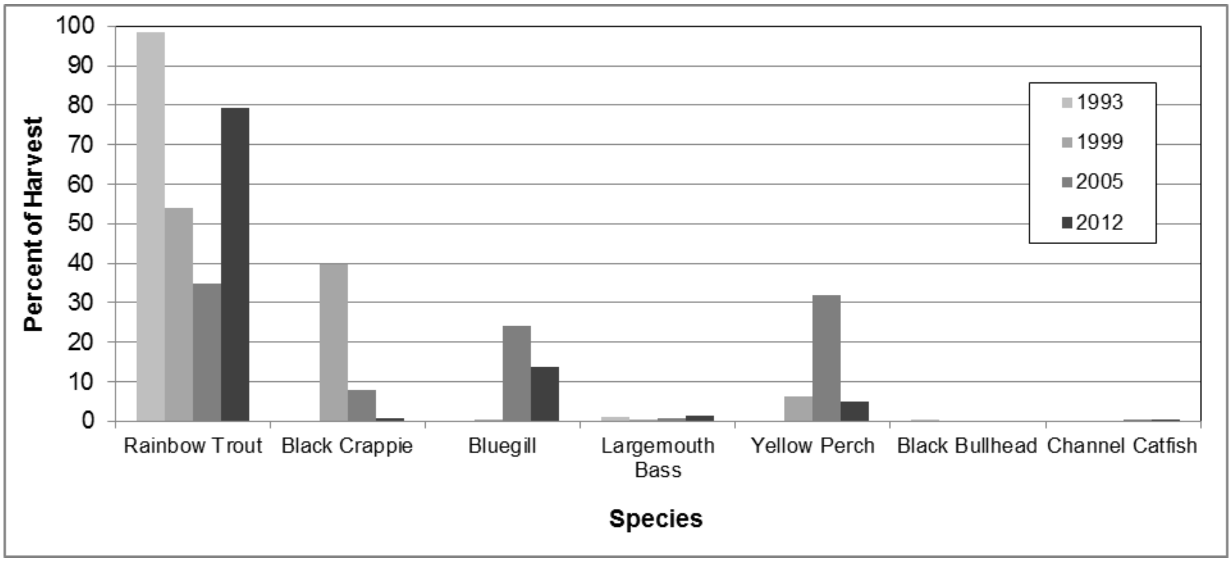


Figure 270. Composition of fishes harvested during creel surveys conducted at Winchester Lake, Idaho, from 1993 - 2012.

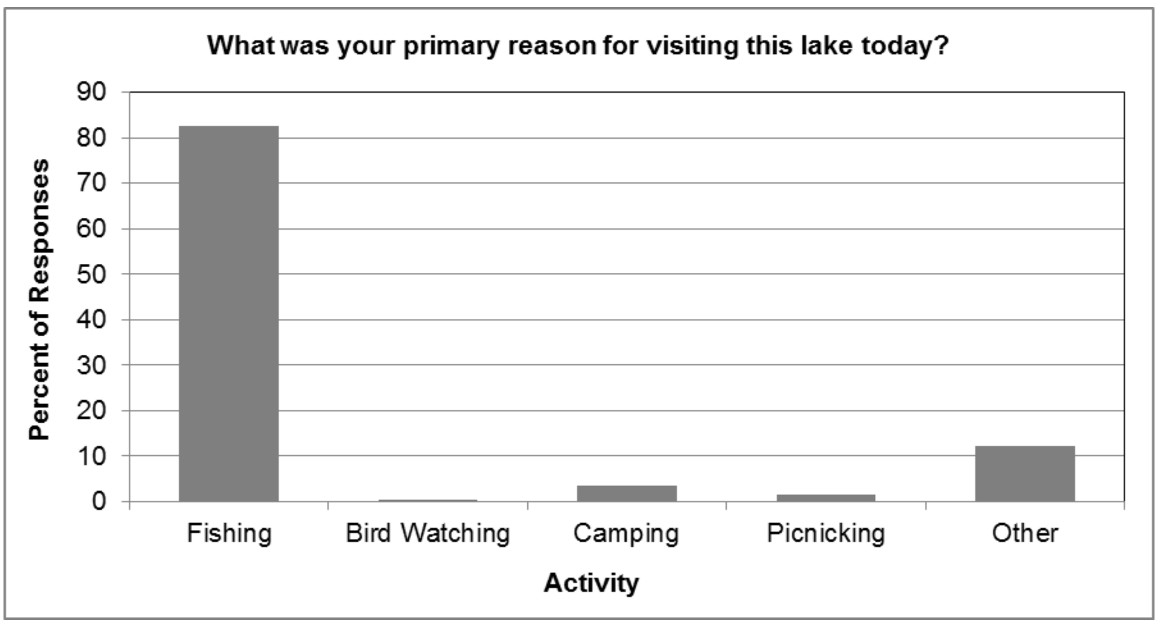


Figure 271. Summary of angler responses to the primary reason for visiting Winchester Lake, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

Figure 272. Summary of angler responses regarding their overall fishing experience at Winchester Lake, Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

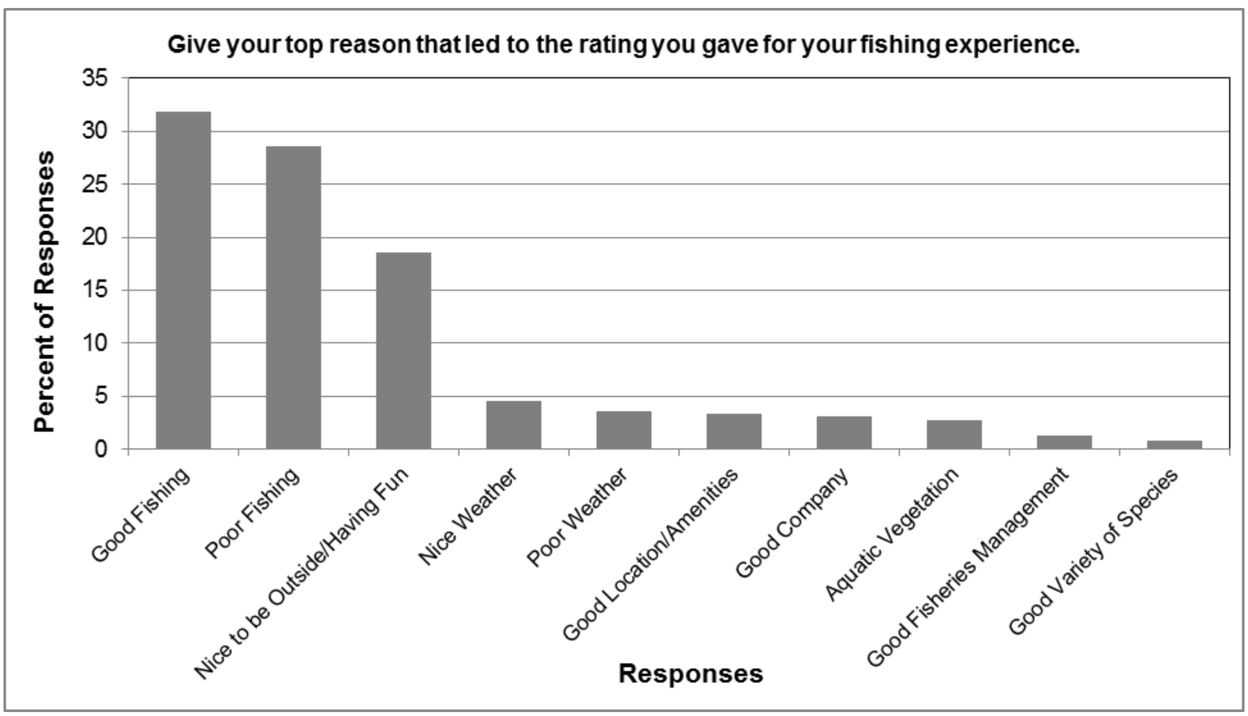


Figure 273. A summary of the most common responses anglers provided for what influencedthe quality of their fishing experience for the day when fishing at Winchester Lake, Idaho, as determined through a creel survey conducted from November 28, 2011 - November 28, 2012 (Only 10 most common answers shown).

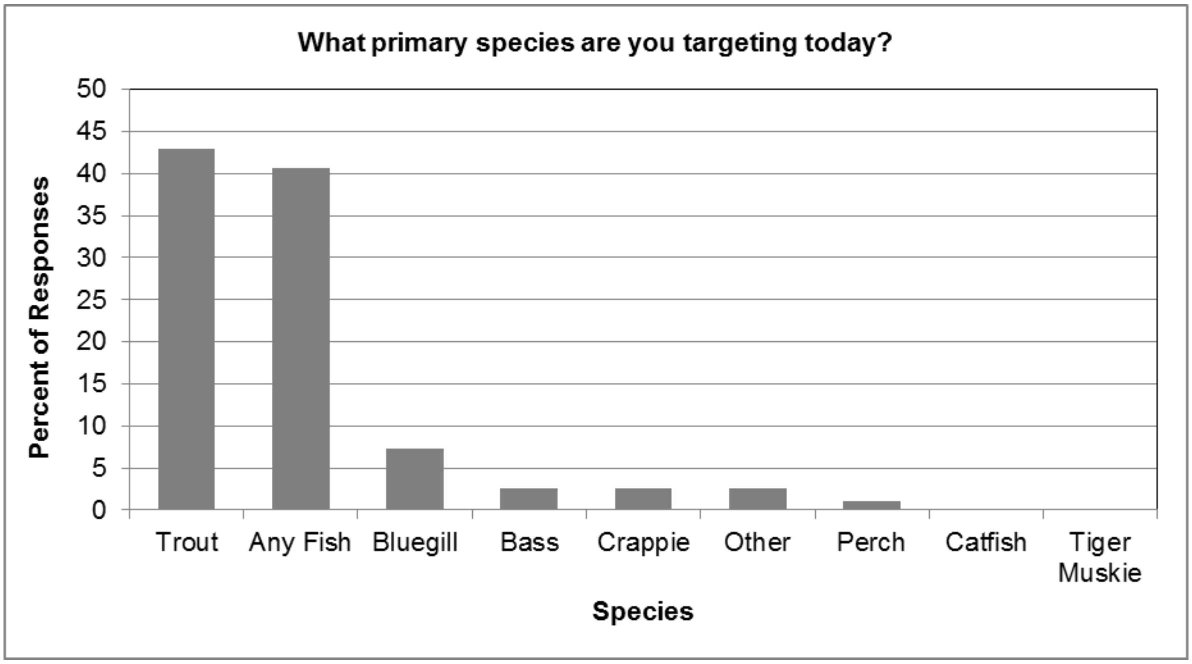


Figure 274. Summary of angler responses regarding target fish species at Winchester Lake,Idaho, during a creel survey conducted from November 28, 2011 - November 28, 2012.

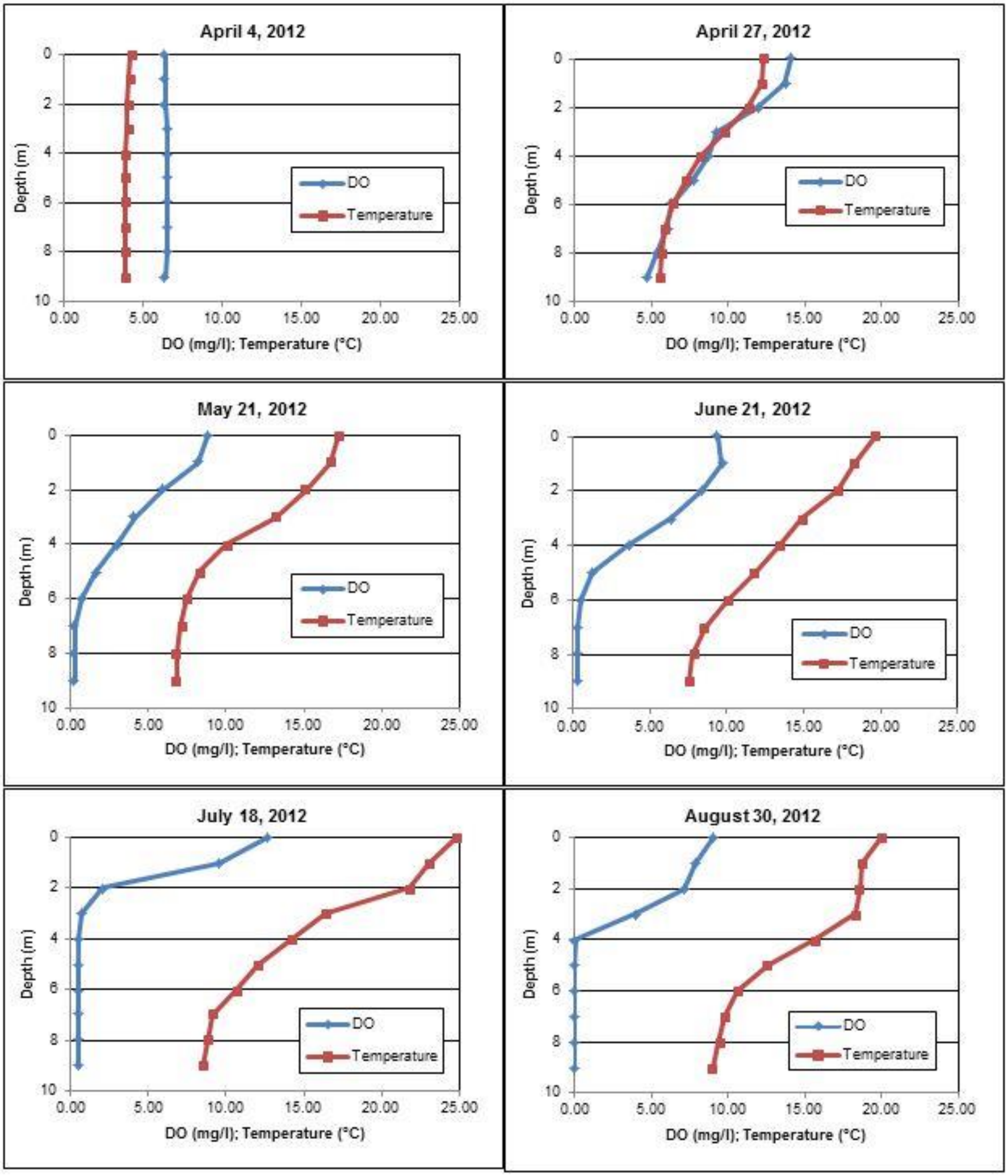


Figure 275. Dissolved oxygen (DO) and temperature profiles collected in Winchester Lake, Idaho, during 2012.

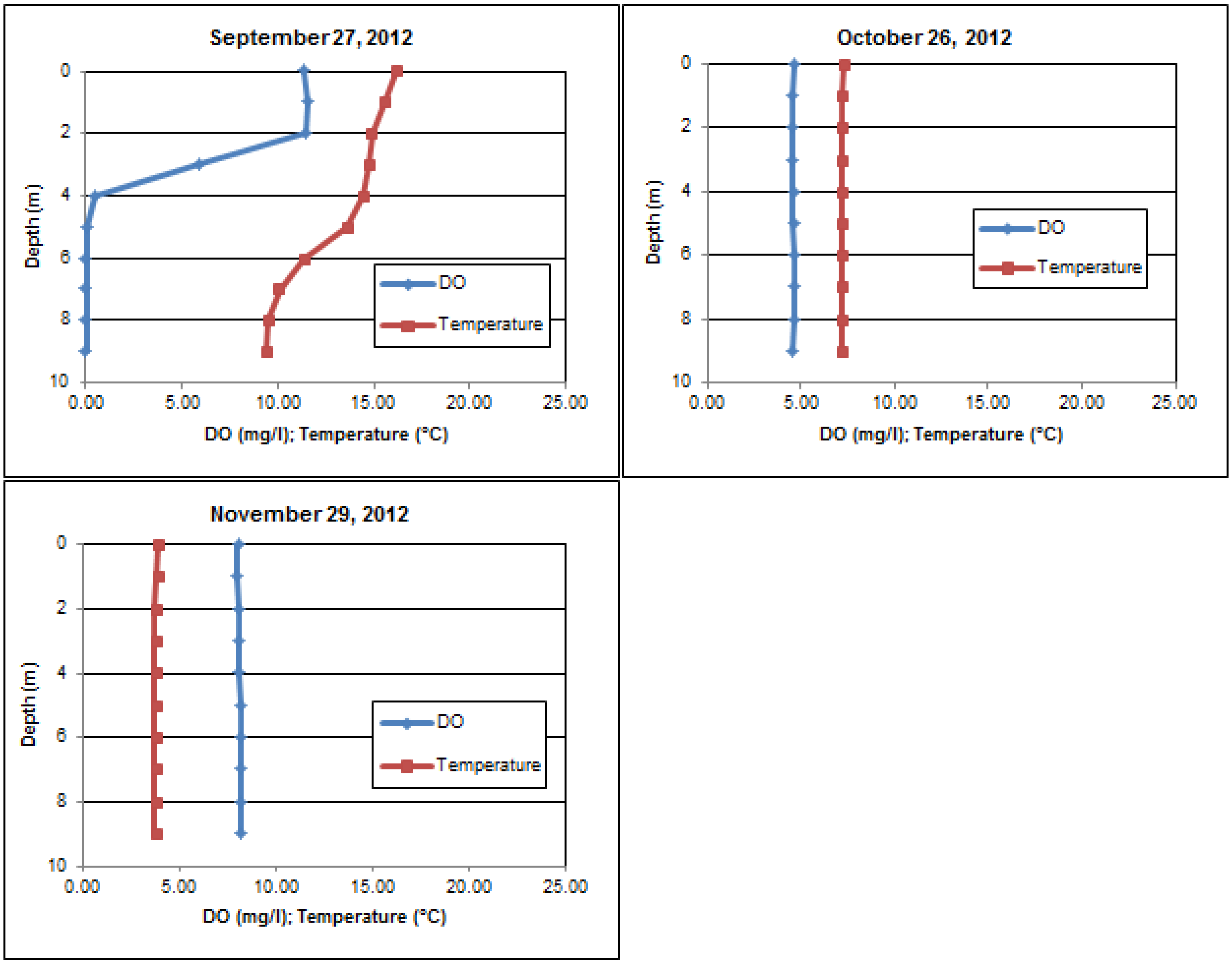


Figure 275. Continued.

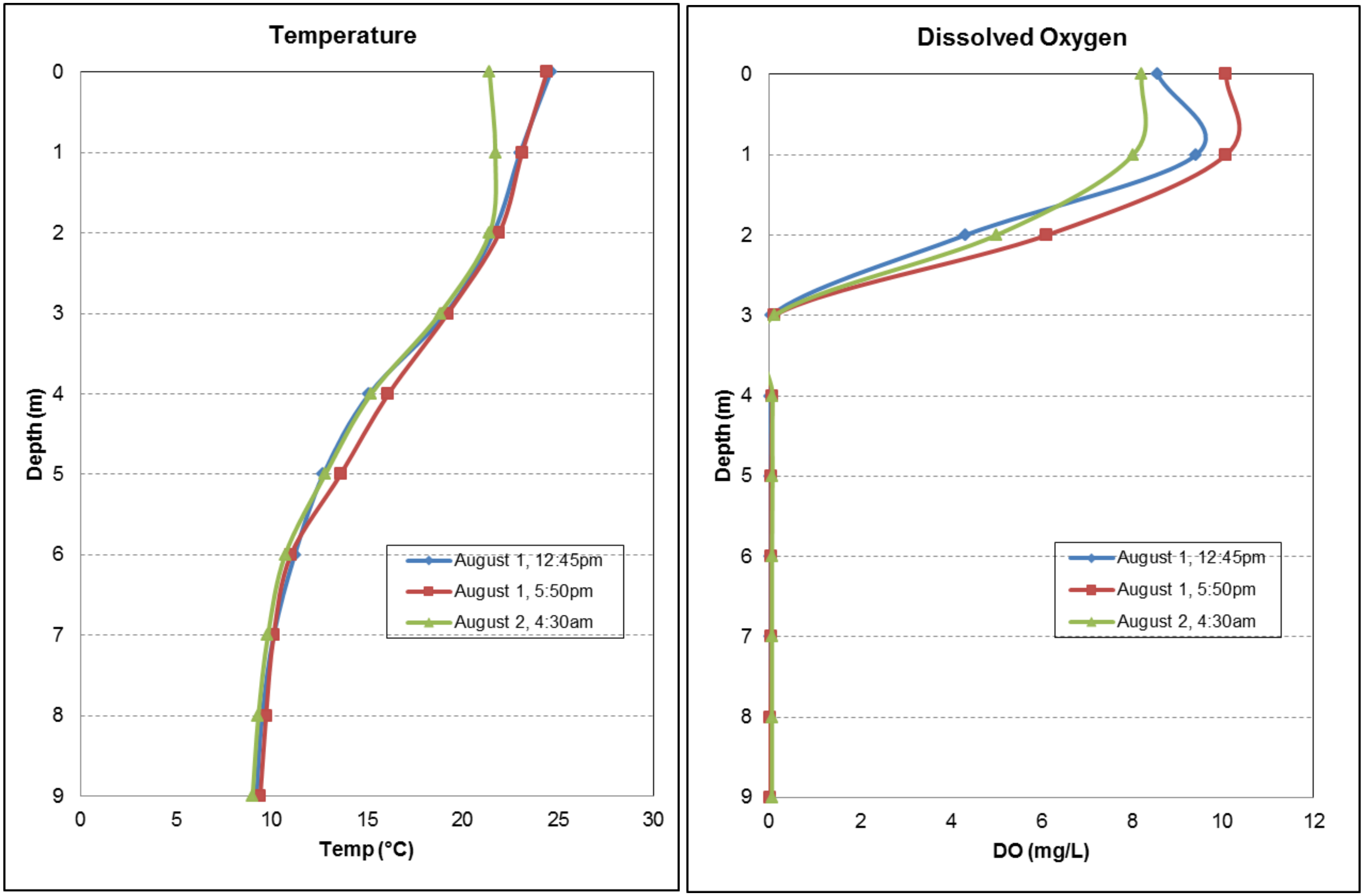


Figure 276. Diel changes in temperature and dissolved oxygen (DO) in Winchester Lake, Idaho, from August 1 - 2, 2012.

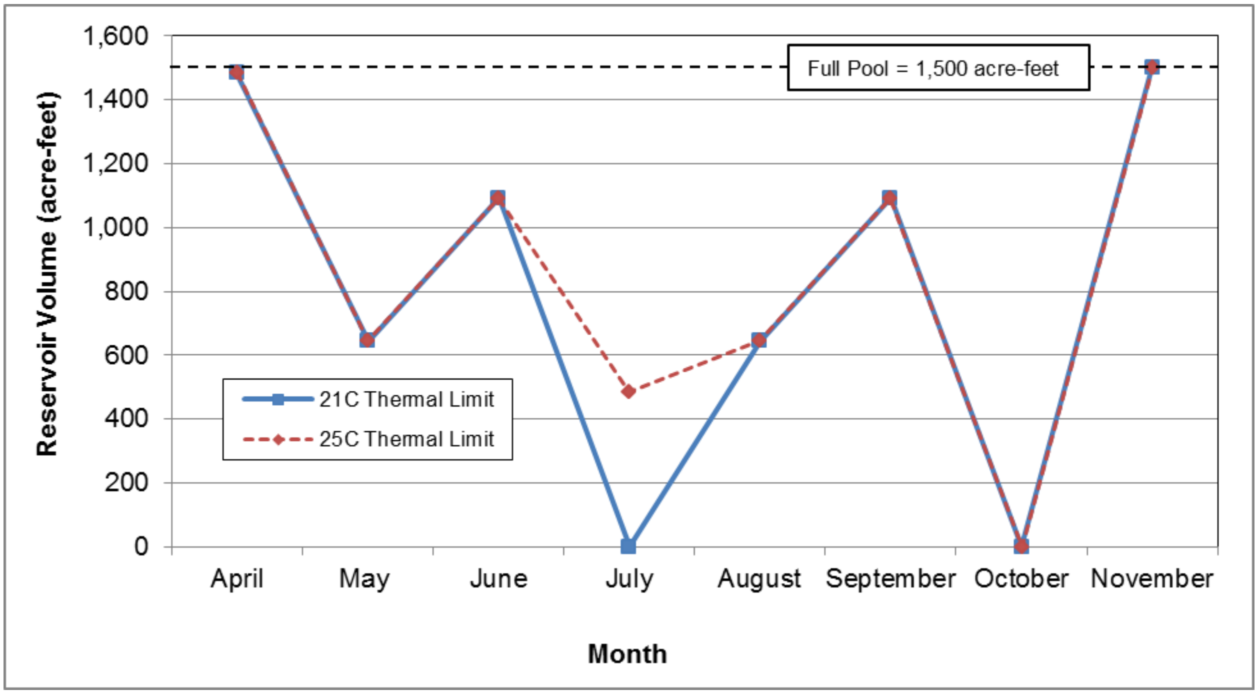


Figure 277. Estimated trout habitat available in Winchester Lake, Idaho, during 2012 based on 5.0 mg/L minimum dissolved oxygen limit, and upper thermal limits of 21°C and 25°C.

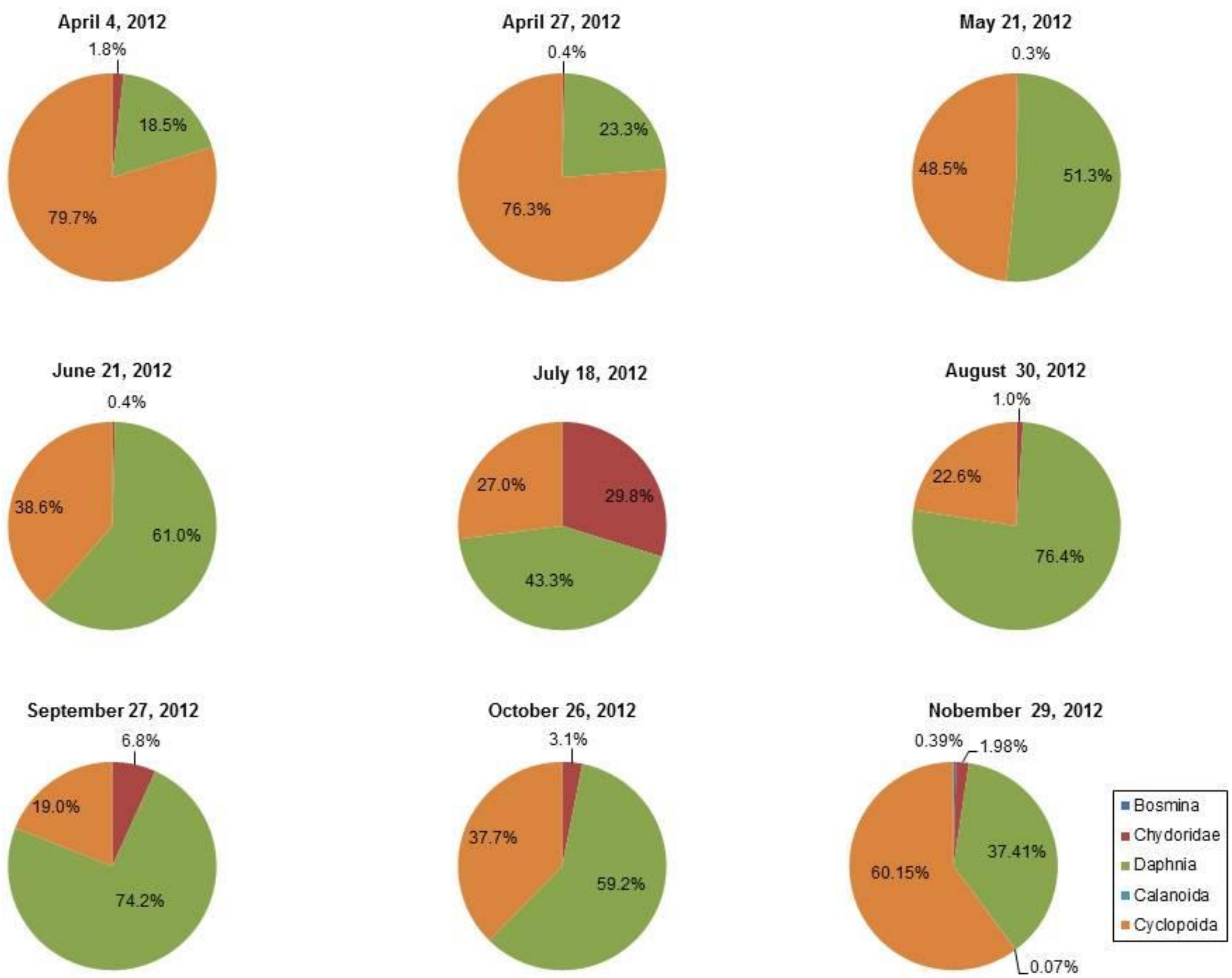


Figure 278. Zooplankton community composition based on monthly samples collected in Winchester Lake, Idaho, during 2012

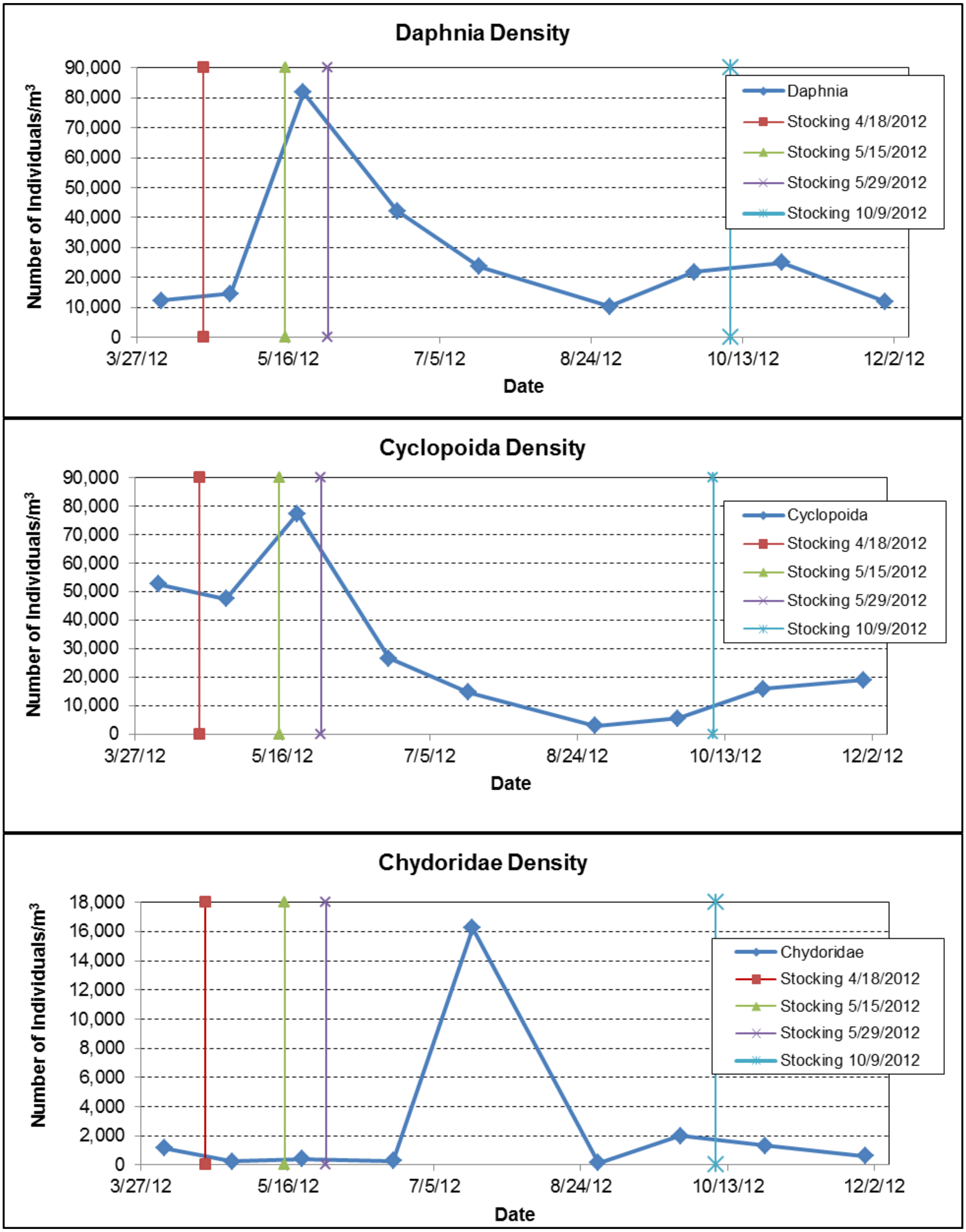
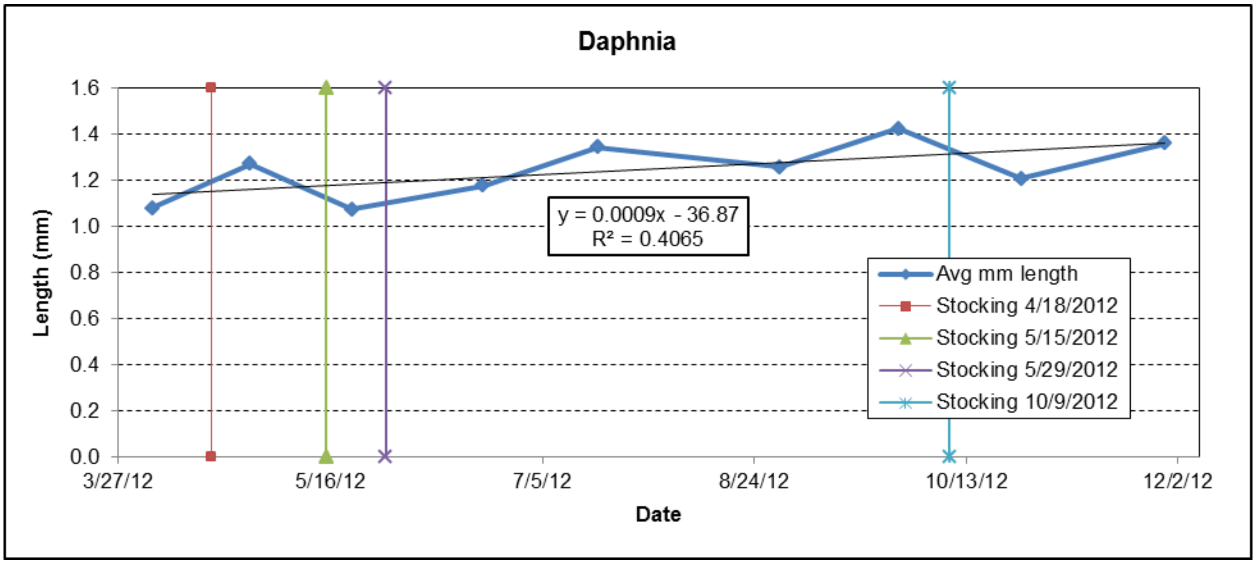


Figure 279. Population densities (number of individuals/m^3) from monthly zooplankton samples collected from Winchester Lake, Idaho, during 2012.



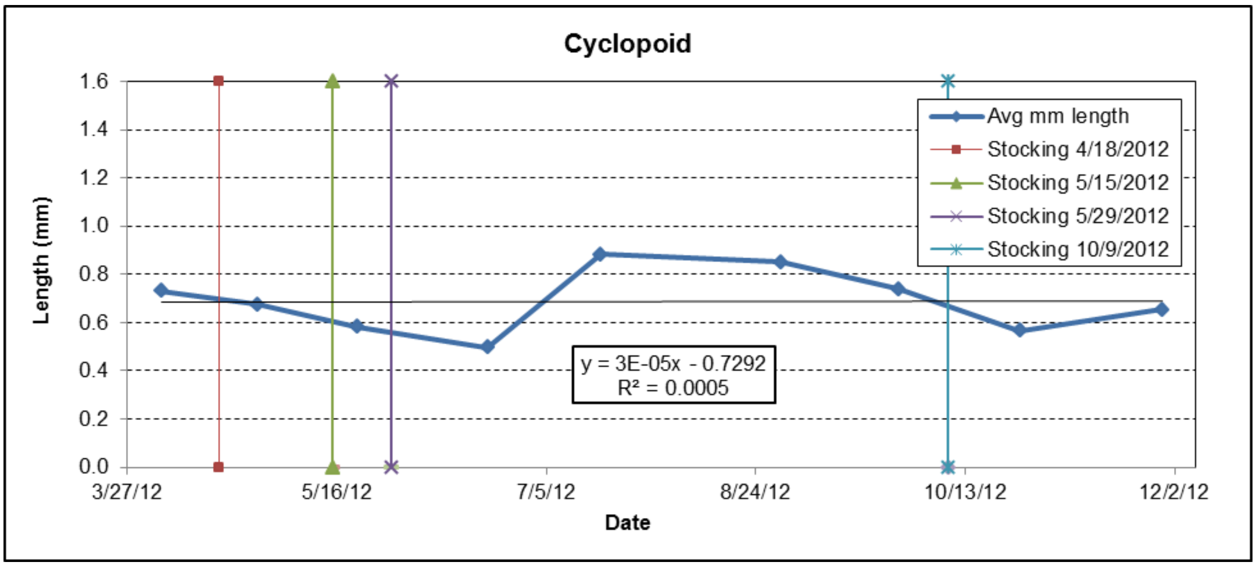


Figure 280. Average length (mm) of zooplankton collected from monthly samples in Winchester Lake, Idaho, during 2012.

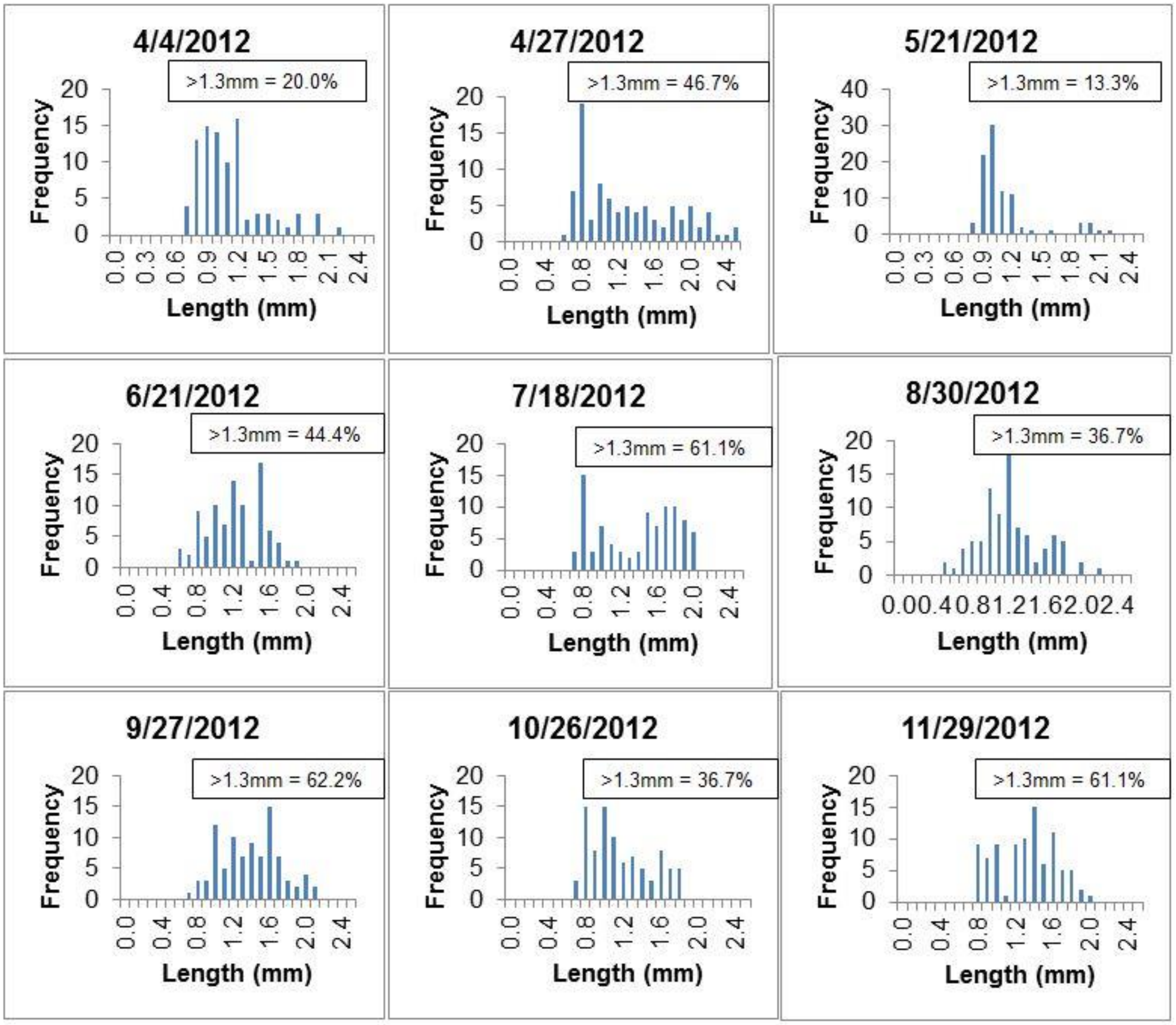


Figure 281. Length frequency distribution of Daphnia collected from monthly sampling in Winchester Lake, Idaho, during 2012.

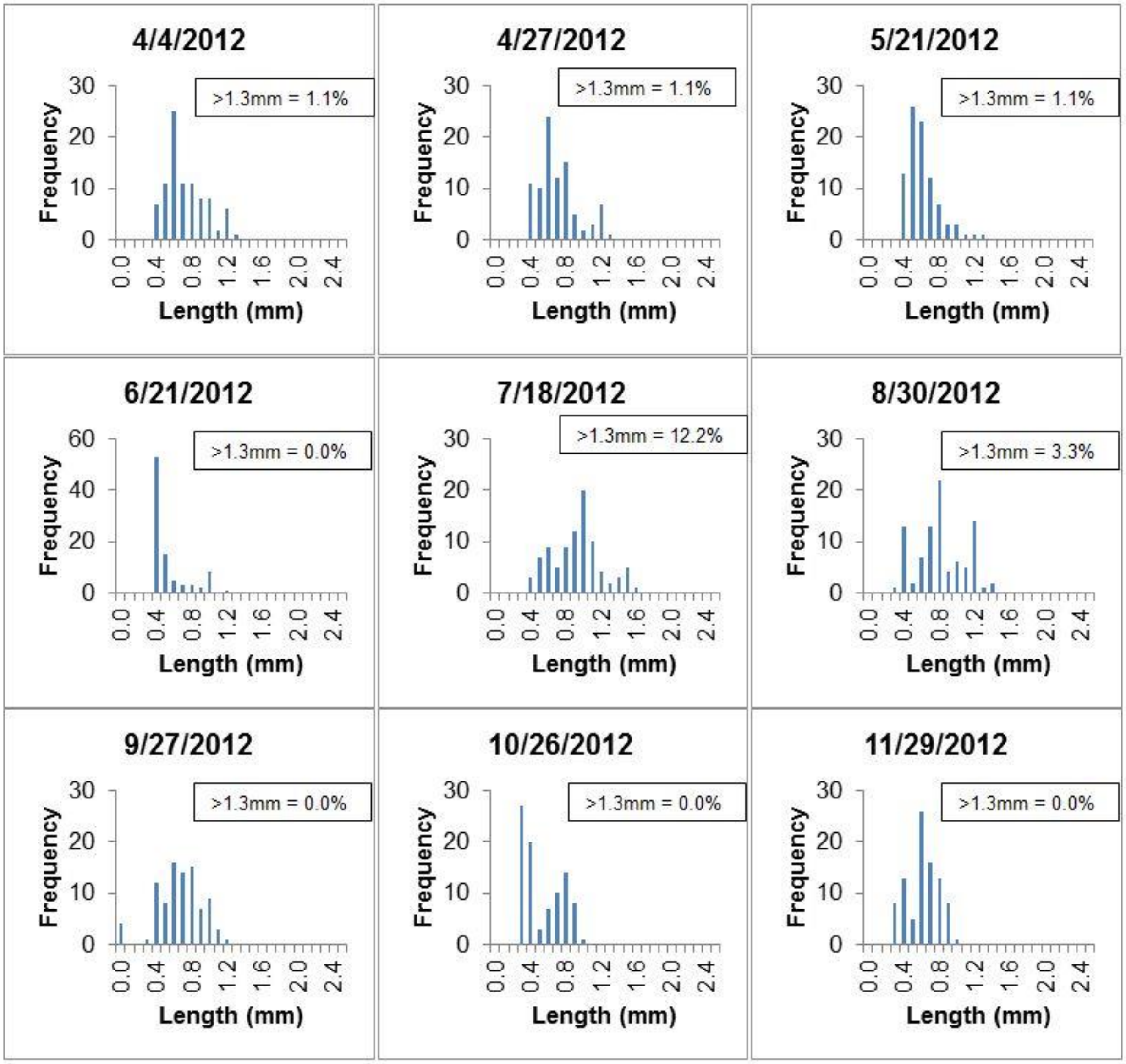


Figure 282. Length frequency distribution of Cyclopoida collected from monthly sampling in Winchester Lake, Idaho, during 2012.

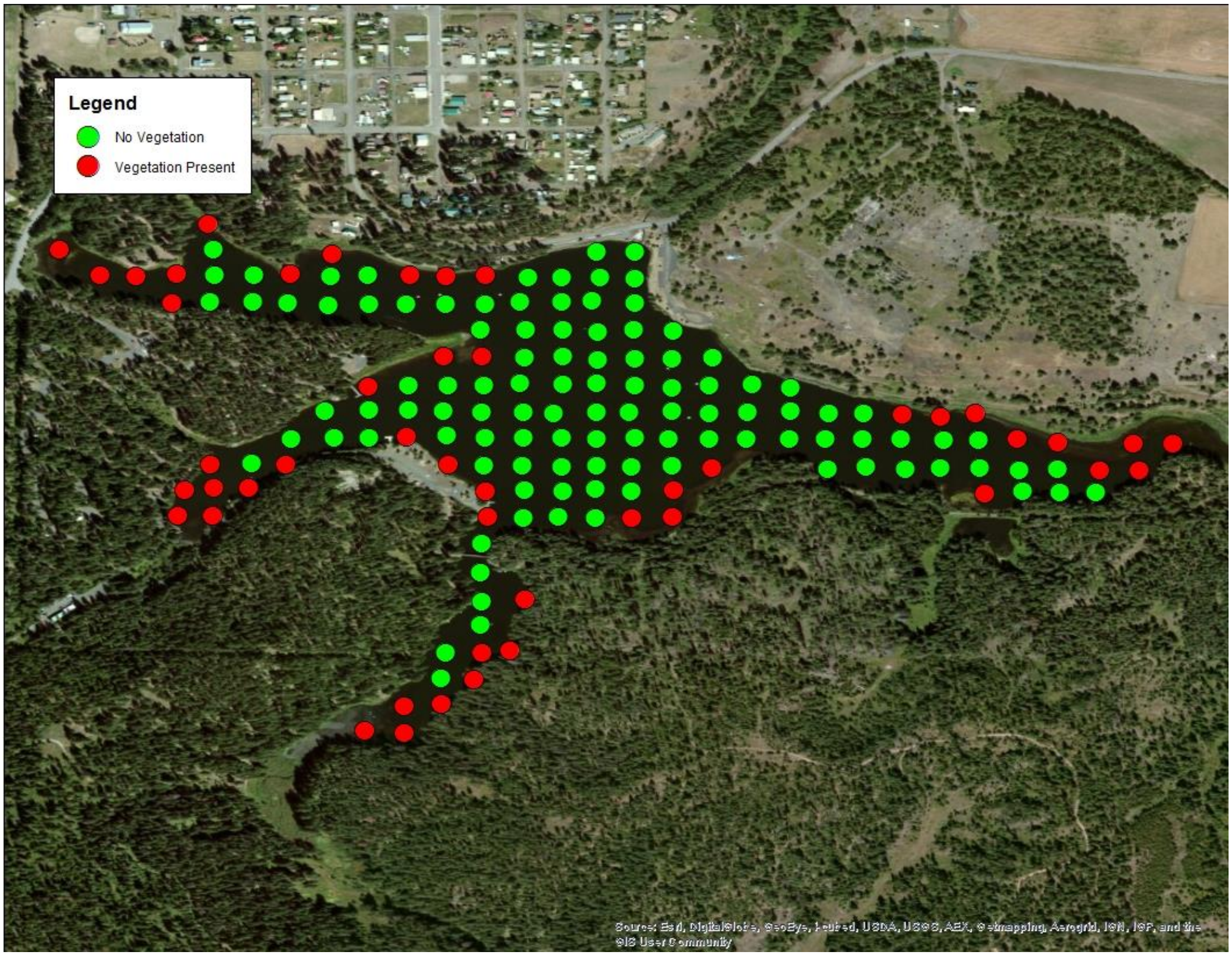


Figure 283. Locations where aquatic vegetation was collected during vegetation sampling of Winchester Lake, Idaho, during 2012.

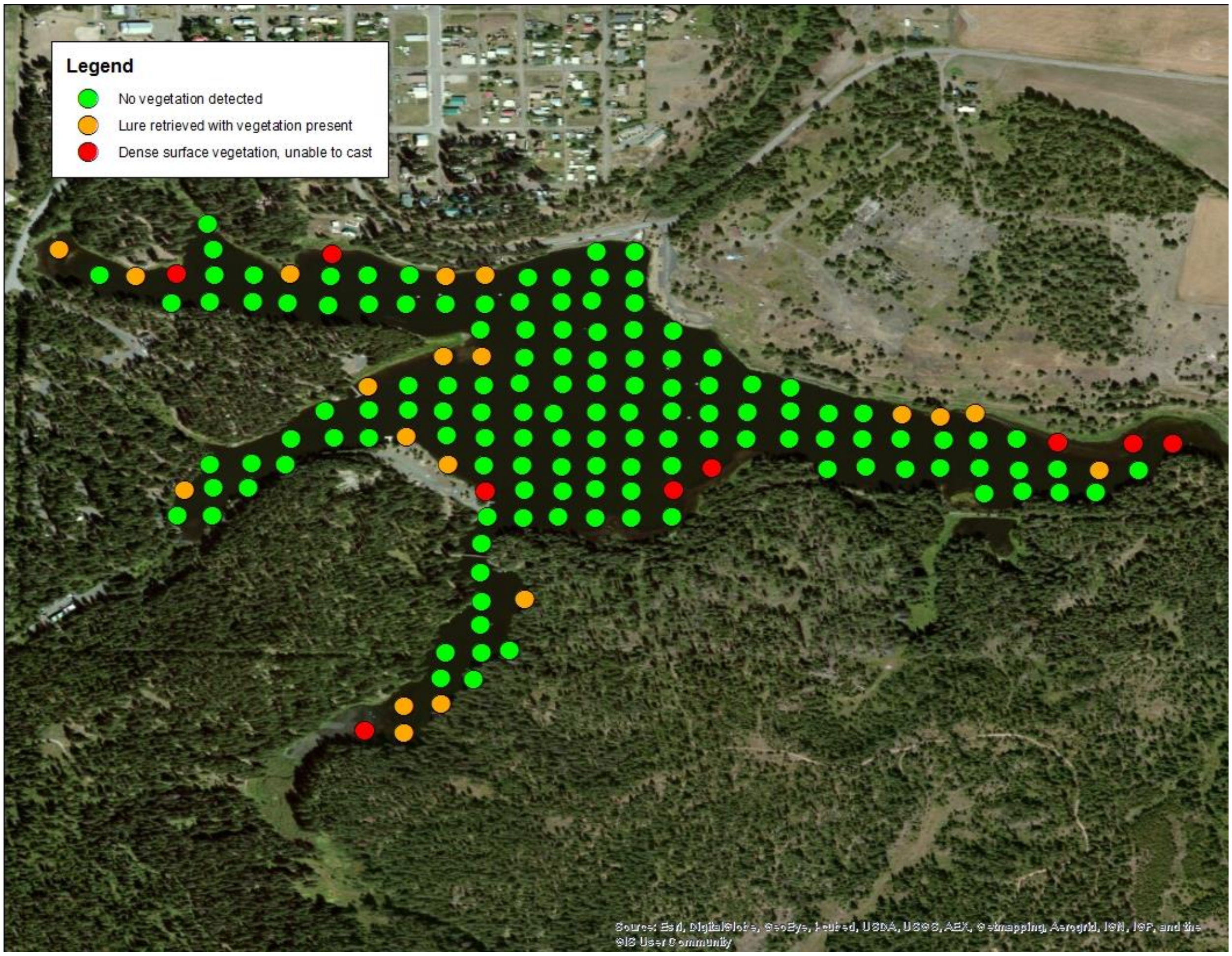


Figure 284. Fishability at vegetation sample locations based on Davids' Fishability Index sampling of Winchester Lake, Idaho, during 2012.

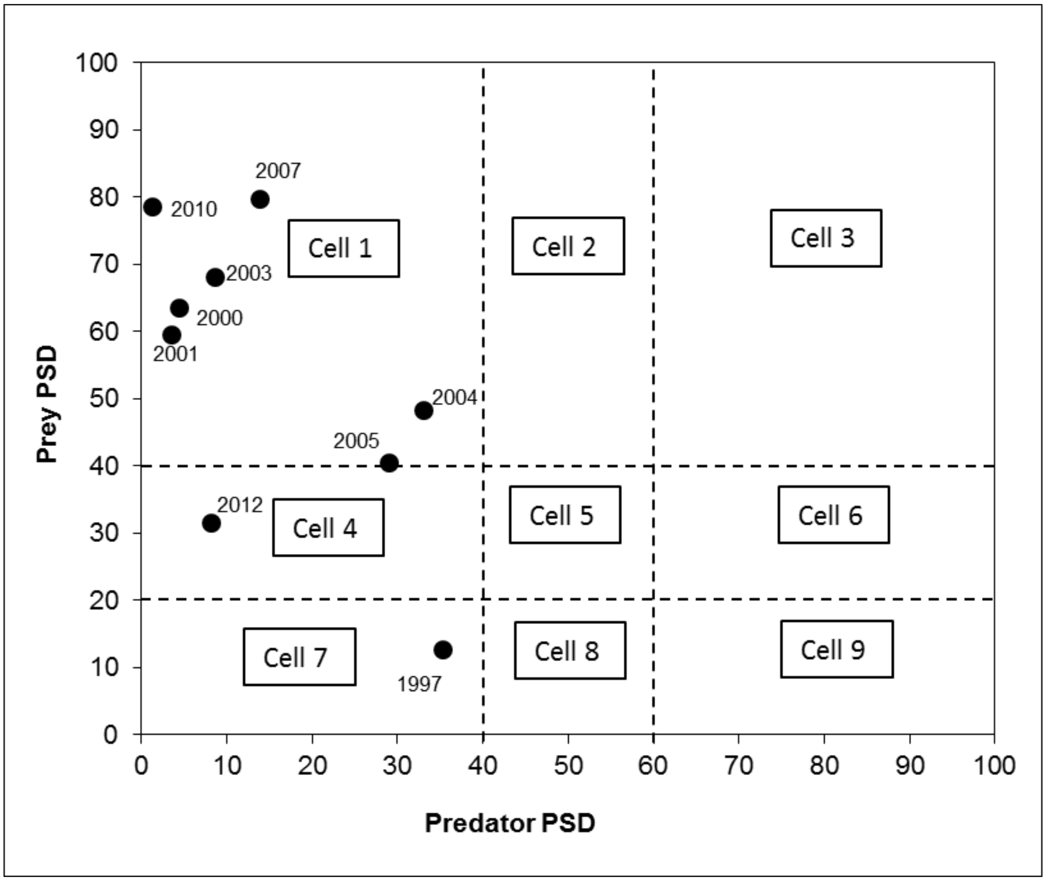


Figure 285. Comparison of predator (Largemouth Bass) and prey (Bluegill and Black Crappie) proportional size distribution (PSD) from standard lake surveys conducted in Winchester Lake Idaho, from 1997 - 2012. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

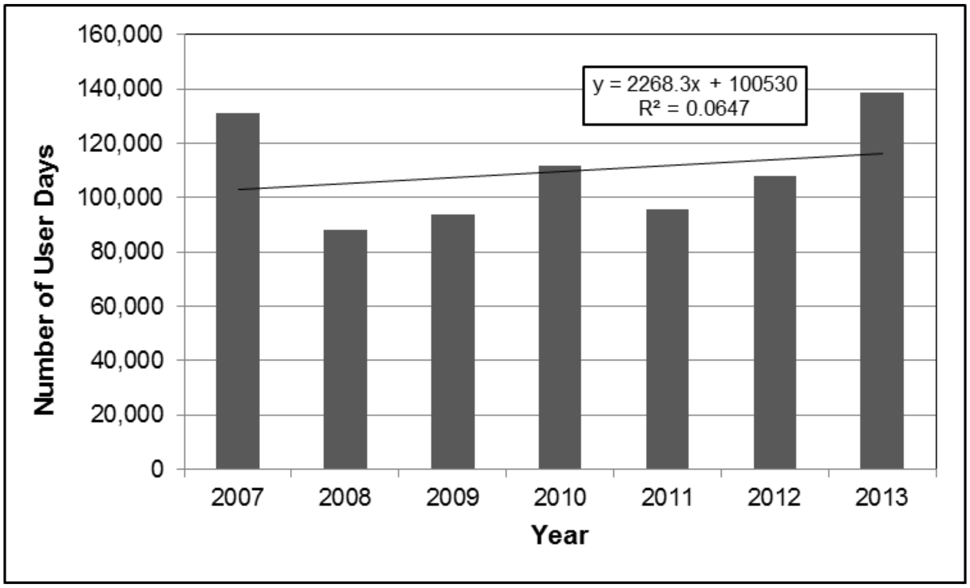


Figure 286. Estimated number of user days for Winchester Lake State Park, Idaho, from 2007 - 2013.

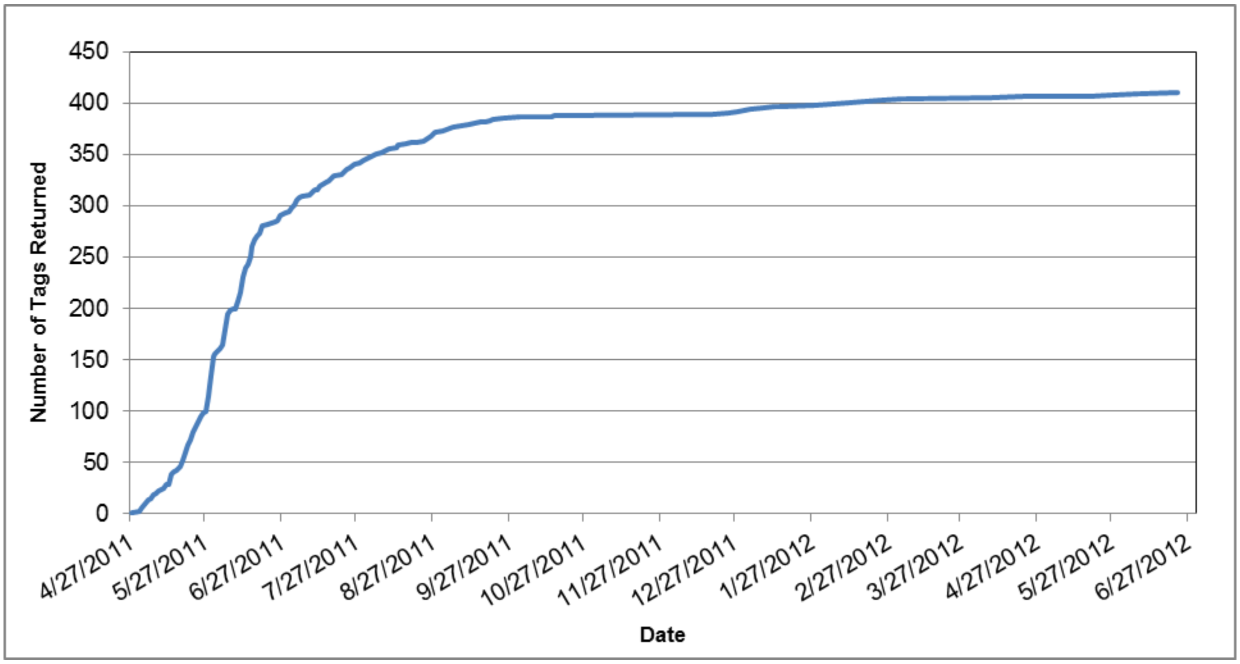


Figure 287. Cumulative number of hatchery catchable Rainbow Trout harvested from Winchester Lake, Idaho, after April 25th - 26th, 2011 stockings, based on angler exploitation surveys (1,595 fish tagged).

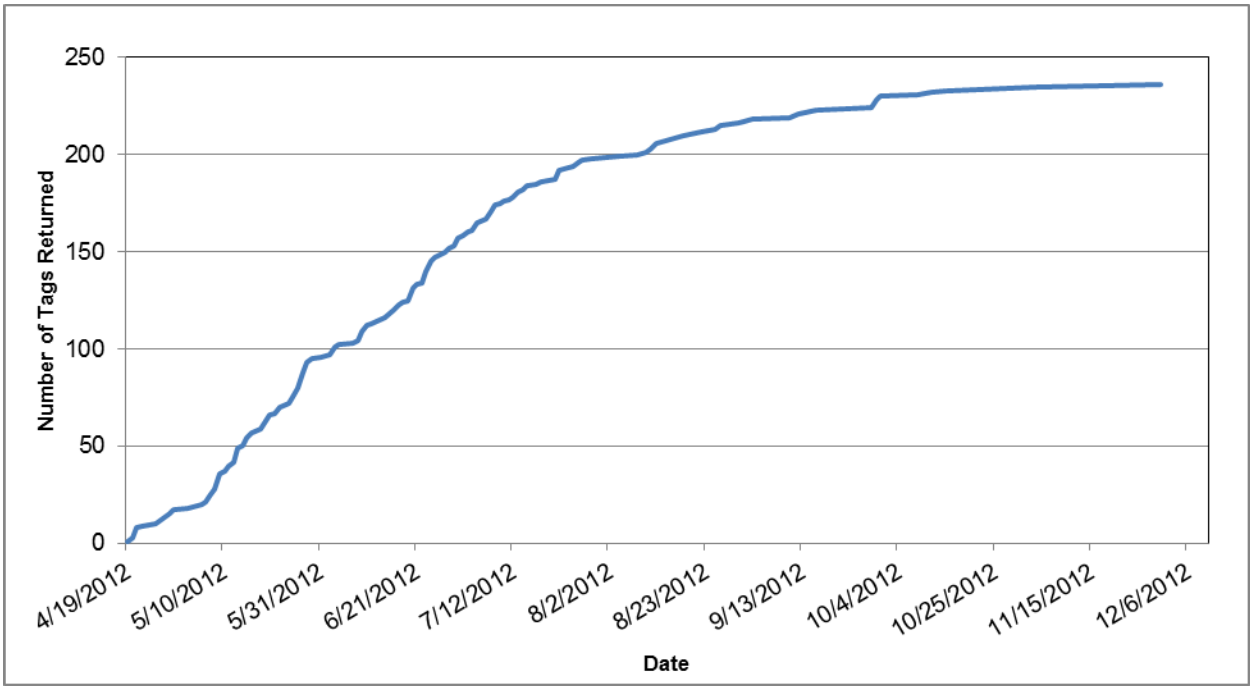


Figure 288. Cumulative number of hatchery catchable Rainbow Trout harvested from Winchester Lake, Idaho, after April 18th, 2012 stocking, based on angler exploitation surveys (1,797 fish tagged).

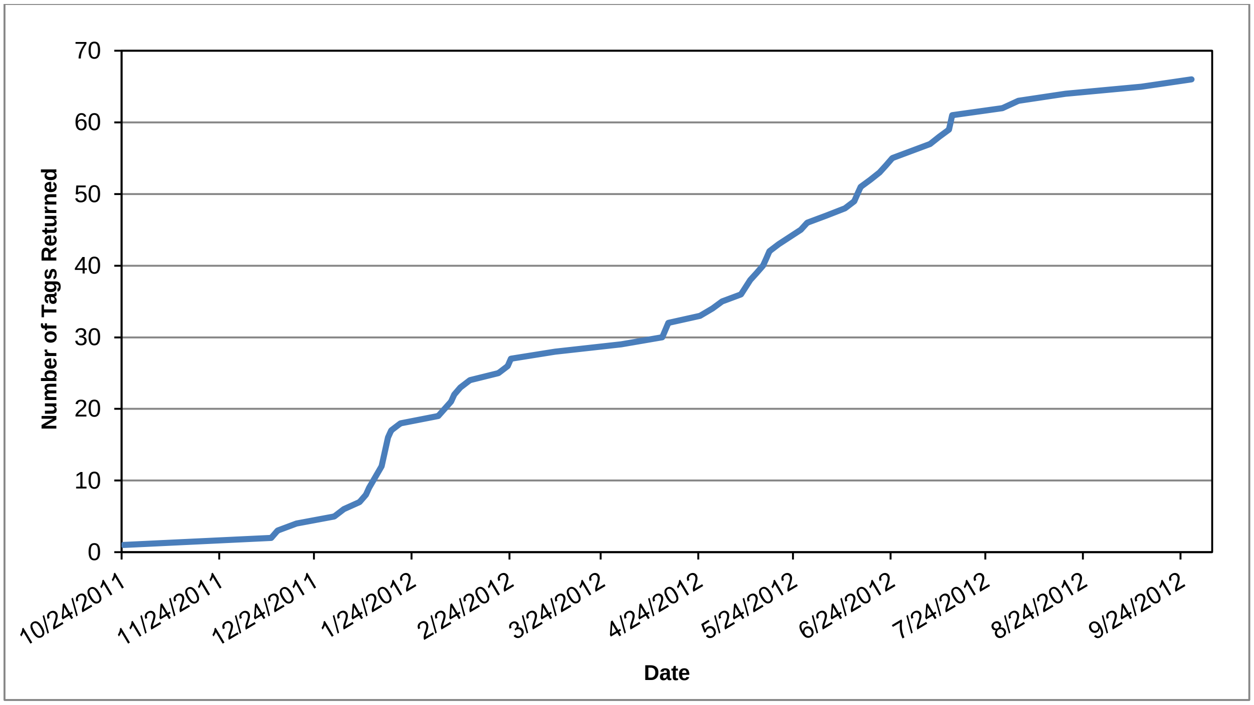


Figure 289. Cumulative number of hatchery catchable Rainbow Trout harvested from Winchester Lake, Idaho, after October 12th, 2011 stocking, based on angler exploitation surveys (400 fish tagged).

MOUNTAIN LAKES MONITORING IN CONSIDERATION OF AMPHIBIAN RISK ASSESSMENT IN NORTH CENTAL IDAHO

ABSTRACT

A 20 year study was designed in 2006 to evaluate long-term trends in amphibian populations within high mountain lakes in the IDFG Clearwater Region and to determine the extent fish stocking was a threat to their persistence. Mountain lake surveys prior to 2006 provide baseline information on amphibian and fish abundance and distribution and were utilized to develop an amphibian risk assessment based on the amount of fishless lakes and ponds within fifth field hydrologic unit code (HUC 5) watersheds throughout the Clearwater Region. In 2012, the seventh year of the long-term monitoring project, 37 lakes were surveyed. All 72 lakes in the study were sampled for first round monitoring from 2006 - 2012. Fifty-five of the 72 lakes have historical (1989 - 2003) baseline data for comparison. Chi-square analysis of the 55 lakes with historical records indicates that populations of Columbia Spotted Frog (p = 0.119) have not significantly declined, whereas Long-toed Salamander (p = 0.0015) have significantly declined. Nine of the 55 lakes that were historically surveyed had new amphibian observations, and four of these seven lakes (57%) had fish present in them. Alternately amphibian populations were not found in 16 of the 55 lakes where they had been historically observed, and 12 of these 16 lakes (75%) did not have fish in them. It is expected that amphibian observations will fluctuate over time depending on a host of factors including: metapopulation dynamics, global environmental conditions, pathogen outbreaks, weather patterns/disturbances, fluctuations in amphibian breeding, timing of surveys, and individual observer variability. At the time of this report, only short-term trends from historical records to first round monitoring can be observed. Multiple sampling rotations will be needed to conclusively determine the impact of the high mountain lake stocking program on the long-term persistence of amphibian species in the Clearwater Region.

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Fishery Manager

INTRODUCTION

Amphibian population reduction and species extinction has given urgency to amphibian conservation, inventory efforts to determine baseline data, and monitoring to determine trends in amphibian populations (Houlahan et al. 2000; Stuart et al. 2004; Beebee and Griffiths 2005; Orizaola and Brana 2006). Potential factors in amphibian population declines are numerous and include: habitat modification/fragmentation, introduction of predators/competitors, increased UV-B radiation, changes in precipitation/snowpack and pathogen infection (Alford and Richards 1999; Corn 2000; Pilliod and Peterson 2000; Marsh and Trenham 2001). Throughout the North Central Mountains of Idaho, direct (predation) and indirect (resource competition, habitat exclusion, and population fragmentation) impacts on amphibian populations from introductions of trout into historically fishless lakes are a cause for concern (Petranka 1983; Semlitsch 1988; Bradford 1989; Figiel and Semlitsch 1990; Bradford et al. 1993; Brönmark and Edenhamn 1994; Gulve 1994; Brãna et al. 1996; Tyler et al 1998). Trout have been stocked into high mountain lakes to provide recreational fishing opportunities to backcountry visitors. As much as 95% of previously and/or currently stocked high mountain lakes throughout the western United States that were once fishless, now contain fish through regular stocking or natural reproducation following historical stocking efforts (Bahls 1992). Murphy (2002) estimated that 96% of lakes within the Clearwater National Forest were historically fishless as the headwater area topography where lakes are located is relatively steep. According to historical stocking records, some lakes in North Central Idaho were stocked as early as the 1930s (Murphy 2002). Out of the estimated 3,000 mountain lakes in Idaho, approximately 1,355 lakes (45%) are stocked or have natural fish populations (IDFG 2012)

Mountain lake ecosystems in North Central Idaho contain amphibians such as Long-toed Salamanders (LTS) *Ambystoma macrodactylum* and Columbia Spotted Frogs (CSF) *Rana luteiventris*, although Idaho Giant Salamanders *Dicamptodon aterrimus*, Western Toads *Bufo boreas*, and Rocky Mountain Tailed Frogs *Ascaphus montanus* may also be present. Common reptiles found at these mountain lakes may also include Common Garter Snakes *Thamnophis sirtalis* and Western Terrestrial Garter Snakes *T. elegans*, both of which were historically (before fish introductions) the main amphibian predators (Murphy 2002). The Idaho Department of Fish and Game (IDFG) Clearwater Region contains 711 mountain lakes. Approximately 400 high mountain lakes were previously inventoried in the Clearwater Region through cooperation between the IDFG and United States Forest Service (USFS).

Murphy (2002) found that CSF occurrence (and breeding occurrence) in this area was not significantly different in lakes with or without fish after accounting for habitat effects (CSF were positively associated with increasing amounts of sedge meadow perimeter and silt/organic substrate). However, CSF abundance at all life stages was significantly lower in lakes with fish than without fish (Murphy 2002). Long-toed Salamander larvae and/or breeding adult occurrence and abundance (adults are typically terrestrial except to breed) was significantly less common in lakes with fish then lakes without fish (Murphy 2002). However, where native (not stocked) Westslope Cutthroat Trout (WCT) *Oncorhynchus clarki lewisi* existed in lakes, the impact on LTS was not as severe as compared to lakes that were historically fishless and later stocked with introduced western trout (Murphy 2002). Other studies have examined relationships between introduced trout and salamanders. Direct negative impacts by fish on amphibian populations have been mostly attributed to trout preying upon amphibians when they are at a larval stage or avoidance of lakes as breeding sites by terrestrial adults (indirect impact) (Kats et al. 1993; Figiel and Semlitsch 1990; Bradford et al. 1993; Knapp 1996; Pilliod 1996; Graham and Powell 1999; Murphy 2002).

Introduced fish populations may also indirectly impact amphibian gene flow, recolonization, and subsequent persistence. The degree of gene flow in mountain lake amphibians likely relies on connectivity between higher and lower elevations subpopulations (with low gene flow). Gene flow may also occur between neighboring lakes that are not necessarily within the same wet stream migration corridor when overland dispersal is not drastically limited by headwater topography, precipitation, and or canopy cover (Murphy 2002). Tallmon et al. (2000) suggests that long-toed salamanders within North Central Idaho are panmictic (randomly interbreeding populations) with high levels of within population variation providing evidence that populations are not evolving in complete isolation. Amphibian populations or demes in these headwater areas likely never evolved with native fish and may lack the appropriate defensive, behavioral, or chemical responses to coexist with introduced fish populations (Kats et al. 1988).

Westslope Cutthroat Trout, Rainbow Trout (RBT) *O. mykiss*, rainbow x cutthroat hybrids (HYB), and Brook Trout (BKT) *Salvelinus fontinalis* are the most common introduced fish species in high mountain lakes in the Clearwater Region. Although, many lakes within the study area have a stocking history that may include Yellowstone Cutthroat Trout *O. bouvieri*, California Golden Trout *O. mykiss aguabonita* (last stocked in 1990 in the Clearwater Region - Steep Lakes), and Arctic Grayling *Thymallus arcticus* (last stocked in 1982 in the Clearwater Region - Bald Mountain Lake), and various forms of trout hybrids. The term “introduced western trout” may be more appropriate for trout species in these lakes where natural reproduction is occurring, as the degree of hybridization is unknown in lakes where multiple species have been stocked (Behnke 1992). The Clearwater Region currently stocks 87 of its 711 high mountain lakes. Most lakes are stocked with WCT on a three year rotation by fixed wing aircraft.

Murphy (2002) also found that certain species of introduced trout tend to have a greater impact on amphibian occupancy than others. Brook Trout tend to impact CSF and especially LTS occurrence and breeding to a greater extent than the presence of either *Oncorhynchus* species. This impact is derived from differences in fish spawning times/behavior and variations in amphibian habitat usage just after ice off conditions in mountain lakes (Murphy 2002). Westslope Cutthroat Trout and RBT in these lakes spawn in spring/summer which often coincides with times that amphibian breeding occurs. As a result, these species are typically preoccupied with spawning in inlets or outlets while amphibians are typically breeding within the lake itself. This difference in spawning habitat use allows amphibians to breed with fewer disturbances by WCT and RBT (Murphy 2002). In contrast, BKT are fall spawners and are actively moving and foraging throughout the lake in spring and are more likely to prey upon any amphibian life stage and/or harass breeding adults (Murphy 2002). Furthermore, BKT tend to be more benthic oriented (where salamanders usually occur), utilize larger size prey items, and attain higher densities within mountain lakes than *Oncorhynchus* species (Griffith 1974). Columbia Spotted Frogs do not tend to be impacted by BKT presence to the same magnitude as LTS because of their different habitat associations and shorter length of larval stages.

Long-toed Salamanders occupy a wide range over the western United States and Canada. The majority of LTS in Idaho’s sub-alpine lakes have a two year larval stage making them susceptible to predation by fish for a longer period of time, and studies suggest that they are more susceptible to impacts by introduced fish than the CSF (Murphy 2002). Conclusive evidence of LTS decline is insufficient (Graham and Powell 1999). For this reason a long-term monitoring project (20 years) was initiated in the Clearwater Region to provide knowledge of the amphibian population dynamics within the north central mountains of Idaho. Long-term monitoring of mountain lakes will allow for amphibian population trends to be identified and will give managers the ability to determine whether sufficient fishless habitat exists to support amphibian populations into the future.

The year 2012 was the seventh year of a 20 year monitoring effort of mountain lakes within the IDFG Clearwater Region. This collaborative mountain lakes monitoring program examines amphibian populations, fish populations, and habitat parameters at a watershed (HUC5) landscape scale.

OBJECTIVES

1. Evaluate the long-term impacts of fish on amphibian populations within the high mountain lake ecosystems in the IDFG Clearwater Region.

2. Assess whether current fish management in high mountain lakes of North Central Idaho is sufficient to provide long-term persistence of amphibian populations.

STUDY SITE

The Bitterroot National Forest, Clearwater National Forest, and Nez Perce National Forest are located in North Central Idaho. These three national forests encompass in entirety or portions of four wilderness areas the Frank Church, Gospel Hump, Hells Canyon, and Selway Bitterroot and one Pioneer Area the Mallard Larkins. Within the Bitterroot, Clearwater, and Nez Perce National Forests are eight, fourth field hydrologic unit code (HUC4) sub-basin drainages containing 105 mountain lake management areas at the fifth field hydrologic unit code (HUC5) level (Appendix A). The HUC4 sub-basin drainages include: the North Fork of the Clearwater River, the South Fork of the Clearwater River, the Lochsa River, the Upper and Lower Selway River, the Middle Fork and Lower Salmon rivers, and the Hells Canyon reach of the Snake River. The 105 HUC5 watersheds within the larger HUC 4 sub-basins were stratified by amphibian risk class (none, low, moderate, and elevated) and two were randomly chosen to represent each risk class for long-term monitoring over the next 20 years (Appendices A and B). These eight HUC5 watersheds have 72 different lakes that will be surveyed multiple times over the duration of this study (Appendix C). In 2012 Big Harrington Creek HUC5 located within the Middle Salmon HUC4 was added to the study. Big Harrington Creek contains six lakes, all of which are thought to be fishless, placing it in the control amphibian risk category. The addition of these lakes will provide a larger statistical representation of the control risk category, whereas before this category was only represented by 6 lakes. Fires kept these lakes from being surveyed during the 2012 field season; therefore, these lakes are a top priority for sampling in 2013.

In 2012, IDFG personnel surveyed 37 lakes within six HUC5 watersheds (Figure 290). These watersheds included Warm Springs Creek, Storm Creek, Old Man Creek, and Upper Meadow Creek within the Clearwater National Forest, and Goat Creek, and Running Creek within the Nez Perce National Forest. Photographs, routes and bathymetric/surrounding area maps of lakes within the HUC5 watersheds are maintained in the Clearwater Region office within the mountain lakes database. As of 2012, not all of these files are complete, and will require completion in following years of the study. Available files are located in the shared drive at the address: S:\Fishery\MTN Lakes\Long Term Monitoring\Photos, Lake Maps, Routes.

METHODS

Sampling protocol can be separated into three separate sections including examining indicators of amphibian populations, fish stock, and lake habitat characteristics. Amphibians were surveyed by using a modified Visual Encounter Survey (VES; Crump and Scott 1994). All amphibians encountered were counted and identified to species and life stage. Amphibian larvae (especially CSF) that were encountered in large groups and were denoted in data sheets as “Too Many To Count” (TMTC) prior to 2011, but for 2011 and beyond estimates of abundance were made to improve data quality. Amphibian surveys were performed from shore or by wading through the littoral zone when the stability of the lake substrate permitted.

A single overnight gill net set (~12 hrs. with one net) was conducted on each lake to assess the fishery. Floating gill nets were set and retrieved using a float tube. Gill nets used were packable Swedish experimental gill nets that were 40 m in length and contained three panel sizes from 10 - 38 mm. The nets were set perpendicular to the shore with the smallest panel size set nearest to the shore. Captured fish were weighed (g) and measured for total length (mm). Stomach samples, scales, and otoliths were collected from all fish mortalities which was usually high among trout. Stomach samples analyses were used to determine if trout captured in the gill net were preying upon amphibians. Scale and otolith samples collected were used to determine growth and fish age. Age distribution was compared to stocking records to infer if natural recruitment is occurring. Fish sampling data was analyzed with length frequency indices and Catch Per Unit Effort (CPUE) for each gill net set. Relative weights were determined using index developed by Wege and Anderson (1978), calculated by $W_r = W/W_s$, where W_r is the relative weight, W is the actual weight (g), and W_s is the 75^{th} percentile length specific-standard weight. The standard weight used in the equation was proposed for rainbow trout populations by Anderson (1980) and for interior lentic cutthroat populations by Kruse and Hubert (1997).

Zooplankton samples were collected from four horizontal shallow tows (at 5 m in length from shoreline and just below lake surface) and three vertical deep tows (at the maximum depth in the lake) using a ten inch diameter circular net. Aquatic invertebrate families present at each lake were recorded when VES were performed. Water chemistry measurements were also collected and included: water surface temperature, pH, and conductivity. A site map of each lake surveyed was developed including lake depth (bathymetry) determined by making multiple traversing passes across each lake with a portable depth sounder. These maps are stored at (S:\Fishery\MTN Lakes\Long Term Monitoring\Photos, Lake Maps, Routes). Each lake was given a brief description including: location of surrounding forest, inlets, outlets, associated wetlands, large rocks, campsites, and descriptions of access to the lake. Substrate composition was visually estimated for the lake littoral zone and deeper visible areas. Species of trees and their relative composition was recorded for the surrounding forested areas adjacent to the lakes. Metadata for each lake included: name, survey date, time, weather, slope, aspect, national forest, ranger district, campsite inventories, and directions/distance from trailheads. Zooplankton samples were stored in the IDFG Clearwater Region laboratory and were analyzed by keying sample specimens to order, determining a density of each order for the volume of water from each tow, and determining average lengths of adults from each order. Other physical lake parameters will be analyzed on a four year basis when comparisons are made across amphibian risk categories and within watersheds (trend monitoring). A spreadsheet is being maintained that contains all survey data collected during mountain lakes monitoring (2006 - 2012) (S:\Fishery\MTN Lakes\Long Term Monitoring\Master Working Spreadsheets\Mountain Lakes Monitoring Database). This data set will be used to evaluate long term trends of fish presence, amphibian presence, and lake habitat factors that may be influencing any fish or amphibian population trends.

Study Design and Protocol Development

Prior to the 2006 high mountain lakes field season, a mountain lakes, long-term monitoring study design and protocol was developed. The study design and protocol addressed the amphibian risk assessment that has been developed through previous studies and inventories of high mountain lakes within North Central Idaho conducted by Bahls, Brimmer, and Murphy (Schriever 2006). The amphibian risk assessment is based on the amount of fishless habitat that exists within a watershed at the HUC5 level. At the individual HUC5 watershed level, it is assumed monitoring will be able to examine conditions that may dictate local response in the interactions of stocked fish and native amphibian populations to provide a more defined opportunity for prioritized management action (Murphy 2002). While there are many risk factors associated with amphibian declines, our assessment focused on considering impacts that may be associated with native and stocked fish in lakes on a HUC5 watershed basis. The amphibian risk assessment for these high mountain lake ecosystems has four categories: control or no risk, low, moderate, and elevated (Appendix B).

- *Control or no risk* – watershed has never experienced fish introductions through stocking activities.
- *Low* – At least 50% of the lakes within a watershed are fishless <u>AND</u> a minimum 20% of the lake surface area within the watershed is fishless.
- *Moderate* – 50% of lakes within a watershed are fishless <u>OR</u> 20% of surface area is fishless.
- *Elevated* – Meets neither requirement, less than 50% of the lakes within a watershed are fishless <u>AND</u> less than 20% of the surface area within the watershed is considered fishless.

Two watersheds (HUC5) were selected randomly from each of the amphibian risk categories (Region wide from all HUC5 watersheds that contained lakes) for sampling. This resulted in five HUC5 watersheds containing 33 lakes within the Nez Perce N.F. and three HUC5 watersheds containing 39 lakes within the Clearwater N.F, for a total of 72 lakes (Appendix B). Attempts will be made to sample all lakes within a selected watershed within the same field season. The 20 year period for the high mountain lakes long-term monitoring project will allow for the lakes in two randomly selected HUC5 watersheds to be sampled each field season. Each selected watershed will then be sampled in five efforts over 20 years. The repetition of sampling events will allow for comparisons to be made within (for trends) and between watersheds (for comparisons among amphibian risk classes). In addition, repetition of sampling events will address the normal patterns of recruitment fluctuations often common among amphibian populations. Lakes within Running, Goat, Upper Meadow, Storm, Old Man and Warm Springs HUC5 watersheds were selected for sampling in 2012. In 2012 it was determined that the Big Harrington Creek HUC5 should be added to the study in order to provide a larger representative for the control risk category. This will raise the total number of lakes in the study to 78 lakes.

Statistical Analysis

Short-term Monitoring

This is the third year that statistical comparisons of historical and contemporary amphibian population data were sufficient to meet statistical assumptions, although little changed from 2010. Chi-square analysis was used to examine trends across all lakes blocked by category: control, low, moderate, and elevated, and trends in all lakes combined. An Alpha (α) level of 0.10 was used to indicate if significant differences in distribution occurred between historical and more recent first round sampling efforts.

Long-term Monitoring

Evaluation of the long-term impacts of fish on amphibian populations within the high mountain lake ecosystems in the IDFG Clearwater Region will be assessed as multiple sampling rotations have been completed. The statistical methodology described below explains how we will evaluate the long-term impacts of fish on amphibian populations.

Incorporating detection probabilities in estimates of proportion of area (POA) occupied by an amphibian species can provide estimates of occupancy that are relatively unbiased in comparison to naive estimates of occupancy which tend to underestimate true POA (detection by total number of lakes or surface area within a watershed) (MacKenzie et al. 2002; Muths et al. 2005). Incorporating detection probabilities from multiple detection/non-detection surveys in POA estimates may be especially important for LTS larvae in mountains lakes that are often cryptic in both coloration and behavior often resulting in a false non-detection. The spreadsheet based program PRESENCE allows for the incorporation of sampling and site-specific covariates that tend to impact the probabilities of detection and occupancy for a given amphibian or reptile species. Sampling covariates are parameters that may vary with each survey such as; weather conditions, time of day, or observer, whereas site specific covariates vary by site (but are constant for that site throughout the year), such as; littoral zone composition, lake size, fish presence/density, and hydroperiod (MacKenzie 2002). Sampling covariates influence detection probabilities, whereas site specific covariates influence detection and/or occupancy probabilities. Probability of detection (p) references that a given species is detected at a site that is truly occupied and probability of occupancy (ψ) refers to a species present at a given site (Muths et al. 2005).

The program PRESENCE uses the Akaike Information Criteria (AIC) to examine models based on detection/non-detection data, sampling covariates, and site specific covariates to select the most parsimonious model (Akaike 1973; Burnham and Anderson 2002; Muths et al. 2005). The PRESENCE program also uses a goodness of fit test to evaluate the global or most parameterized model, over-dispersion, and variance (and variance inflation factors if necessary) (Burnham and Anderson 2002; Mackenzie and Bailey 2004; Muths et al. 2005). Analysis of the detection/non-detection data collected by the IDFG in North Central Idaho would likely need to be analyzed using a multiple season model (after completion of second sampling rotation and for every round of sampling, thereafter). Analysis of amphibian POA data with PRESENCE would allow for analysis for the regional concerns but may also ease transition of data into a larger national amphibian database maintained by the Amphibian Research and Monitoring Initiative (ARMI) at a later date.

RESULTS

Among Clearwater Region lakes >1,500 m in elevation (n = 703), fish-containing lakes are on average larger and deeper than fishless lakes (Figure 291). Most lakes that have not been sampled are small and at high elevation. The lakes selected for this monitoring study (n = 72) closely mimic regional patterns. In 2012, mountain lakes field personnel surveyed 37 lakes from six HUC5 watersheds (Table 54). Thirty-two of these lakes were surveyed for second round monitoring, while five lakes were surveyed for first round survey (Table 55). This completed the first round of surveys.

Fish Surveys

Fourteen of the 37 lakes surveyed in 2012 contain fish (Table 56). However two of the lakes could not be surveyed for fish due a Black Bear *Ursus americanus* destroying the inflatable float tube. The other 23 lakes were fishless.

Of the lakes surveyed, eight contained WCT, five contained BKT, and two contained RBT. Length frequency distributions for the most abundant fish in each lake include Brook Trout (Figure 292), Westslope Cutthroat Trout (Figure 293, and Rainbow Trout (Figure 294) Gill net CPUE ranged from 0.5 - 5.9 fish/hour, with an average of 2.2 fish/hour (Table 56). Average lengths and weights of fish collected are located in Table 56.

After one round of sampling, there are 55 study lakes for which we have both historical and first round survey data. Of these lakes, 29 historically had fish (Table 57). After the first round of surveys, fish were detected in 27 of those lakes. Goat Lake in the Bargamin Creek drainage and Kettle Lake in the Old Man Creek drainage had no fish sampled during the first round after having fish present historically (Table 58).

Amphibian Presence and Distribution

Columbia Spotted Frogs were detected in 32 of 37 survey lakes (86.5%) sampled in 2012 (Table 54). In the first round of sampling, 63 of 72 lakes (87.5%) had CSF present (Table 55). Of these, 23 lakes (36.5%) had fish present and 40 lakes (63.5%) did not have fish present. Within the 55 lakes surveyed both historically and in the first round, CSF were found in 51 lakes historically and in 49 lakes during round one (Table 59). Eight lakes (15.7%) actually experienced changes in CSF presence/absence between historical surveys and first round surveys. However, there was an overall net loss of two lakes (3.9%; Table 60). Fishless lakes and fish containing lakes both gained and lost lakes containing CSF.

Thus far, 44 lakes have been surveyed twice during the current project (Table 55). Of these, 36 lakes (81.8%) had CSF present in round one and 38 lakes (86.3%) had CSF present in round two (Table 61). One lake lost CSF in round two, while three lakes gained CSF, for a net gain of two lakes (Table 62). In round one, 11 (73.3%) of 15 lakes with fish contained CSF, while in round two, 13 (86.7%) lakes contained CSF. For fishless lakes, 25 (86.2%) of 29 lakes contained CSF in both round one and two.

Long-toed Salamanders were detected in 17 of 37 surveyed lakes (45.9%) sampled in 2012 (Table 54). In the first round of sampling, 26 of 72 lakes (36.1%) had LTS present (Table 55). Of these, three lakes (%) had fish present and 23 lakes (%) did not have fish present. Within the 55 lakes surveyed both historically and in the first round, LTS were found in 27 lakes (49.1%) historically and in 18 lakes (32.7%) during round one (Table 59). Twenty-one lakes (38.2%) actually experienced changes in LTS presence/absence between historical surveys and first round surveys. However, there was an overall net loss of nine lakes (33.3%; Table 60). Fishless lakes and fish containing lakes both gained and lost lakes containing LTS.

Thus far, 44 lakes have been surveyed twice during the current project (Table 55). Of these, 15 lakes (34.1%) had LTS present in round one and 21 lakes (47.7%) had LTS present in round two (Table 61). Eight lakes lost LTS in round two, while fourteen lakes gained LTS, for a net gain of six lakes (40.0%; Table 62). In round one, one (6.7%) of 15 lakes with fish contained LTS, while in round two, five (33.3%) lakes contained LTS. For fishless lakes, 14 (48.3%) of 29 lakes contained LTS, while in round two, 16 (55.2%) contained LTS.

Trends in amphibian presence

Chi-square analysis ($\alpha = 0.10$) of the 55 lakes with historical records indicates that the distribution of CSF ($p = 0.119$) has not significantly changed, whereas LTS ($p = 0.015$) have significantly changed (Table 63). According to chi-square analysis, no significant change in Columbia spotted frog presence has occurred within any of the risk categories between historical surveys and first round surveys (Table 63). Control and low risk categories were not evaluated using chi-square testing because of expected values of zero. Chi-square analysis suggests significant differences occurred in long-toed salamander populations within the control ($p<0.001$), low ($p < 0.001$) and moderate ($p = 0.060$) risk categories in the 55 lakes with historical records (Table 63). The elevated risk category, however, showed no change ($p = 1.0$; Table 63).

DISCUSSION

This was the seventh year of the long-term monitoring project. All 72 lakes in this study have been surveyed between 2006 and 2012 for first round monitoring. Fifty-five of the lakes surveyed have historical (1989 - 2003) baseline data for comparison (Tables 2 and 5). For those lakes, a general decline in amphibian presence was observed with a net decline in the number of lakes with CSF by two lakes and a net decline in the number of lakes with LTS by nine lakes (Table 60). However, chi-square analysis indicated that CSF presence had not significantly changed while LTS presence had changed significantly.

Historic surveys indicated that fish were present in 29 of the 55 survey lakes that have historic data. In the first round of surveys for this project, fish were found to occur in 27 of these lakes (Table 59). Most of the declines in LTS presence occurred in lakes without fish, whereas declines in CSF presence was relatively uniform between lakes with and without fish (Table 60). It is important to recognize that in the historic surveys, LTS were found in just five lakes with fish while they occurred in 23 lakes without fish (Table 61). Looking at the historical presence of LTS compared to the first round of sampling, we saw a net decline of nine lakes without fish and two lakes with fish (Table 60). It is interesting to note that the loss of LTS compared to historical presence is uniform among lakes with fish (40%; 2 of 5) and without fish (39%; 9 of 25). Columbia Spotted Frogs had an equal distribution between lakes with and without fish (Table 61).

At the time of this report, changes in CSF presence was small, with an overall net decline of just one lake (Table 61). Lakes with fish present saw a loss of three lakes and a gain of two when compared to historical presence of CSF. Lakes without fish saw a loss of two lakes as well as a gain of two lakes when compared to the historical presence of CSF. At this point, the net decline in lakes with CSF has been uniform over lakes with and without fish. No further efforts have been made to evaluate why these changes may have occurred. Local declines in frog distribution in other watersheds have been attributed to source and sink dynamics of frog metapopulations or environmental conditions threatening global amphibian populations such as increased UV-B radiation, changes in precipitation/snowpack and pathogen infection (Alford and Richards 1999; Corn 2000; Pilliod and Peterson 2000; Marsh and Trenham 2001). If CSF populations fluctuate because of these reasons rather than fish presence, then declines in frog observation may be a long-term trend across all risk categories.

No research has provided conclusive evidence that LTS are declining within their respective ranges or that ranges are contracting (Graham and Powell 1999). However, chi-square analysis in this study implied a significant change occurred in LTS population within the high mountain lakes of the Clearwater Region (Table 58). Long-toed salamanders were not found in sixteen lakes where they were historically observed. Most of these lakes did not have fish. In addition, declines across the established risk categories (based on fish presence) were in contrast to expected results, and suggest that factors other than, or in conjunction with, fish presence must be occurring to reduce the distribution of LTS. Generally, LTS migrations do not exceed 100 m from breeding ponds, and site fidelity is high (Anderson 1967a; Sheppard 1977; Powell et al. 1997). This suggests that life-history strategies and survival are a function of lake condition and its surrounding habitat. Factors such as temperature, osmoregulation, and food availability are basal to daily function, are a predictor of intermediate survival, and can vary between adjacent breeding sites (Stebbins, 1995). Such differences will have an impact on reproductive strategy, larval age structure, and post-metamorphic success of offspring within perspective lakes or ponds (Anderson, 1967a).

We must caution one from using this data to suggest that fish are not playing a role in the distribution of LTS. Although current trends indicates the loss of LTS is occurring in lakes without fish, the majority of the lakes with fish in them were already absent of LTS. For this reason, if declines occur in the future, it will have to be in lakes without fish. You can only lose amphibians from lakes from where they occurred, and you can only gain amphibians in lakes where they didn't occur.

Habitat that promotes prey availability, maximizes lake productivity, and minimizes predation, optimizes osmo/thermo regulation will promote amphibian fitness (Stebbins, 1995). Increased fitness of breeding adults has been shown to increase the size of egg yolk, increase the size of offspring at metamorphosis, and provide thermal tolerance advantages as adults (Stebbins, 1995). Declines in LTS abundance within this study may be due to receding water levels and reduction of marsh habitat. Eagle Lake (Running Creek watershed, moderate-risk) was dry in 2009, and four other LTS populations were lost from lakes less than one meter deep. Larval salamanders overwintering in shallow alpine lakes hibernate in water pockets formed between ice formation and bottom substrate (Zug, 1993). Overcrowding due to receding water levels can increase intraspecific competition among larvae, in turn, effecting their growth and time to metamorphosis (Anderson, 1967a, Stebbins, 1995). Shallower lakes can also freeze solid leaving no suitable hibernacula. Underground seeps may provide hibernacula for overwintering larvae and adults during harsh winters (Zug, 1995; Sheppard, 1997). Adjacent marshes may be a factor increasing reproductive success and promoting larval survival. Eighty-two percent of the lakes with LTS in our evaluation were dominated by sub alpine fir with adjacent meadows and marsh. Their average depth was 3.5 m with an average littoral zone (% of lake surface area < 3 m deep) of 84%.

Vonesh and De la Cruz (2002) suggest that amphibian populations are more likely to decline when environmental stressors result in higher mortality of post-metamorphic life stages as compared to stressors that result in mortality of embryos or larvae. Factors other than fish presence or lake size have also been suggested to reduce amphibian abundance in lakes. These includes fire activity, extended periods of drought, variability in lake productivity, UVA and UVB radiation, or pathogens such as *Batrachochytrium dendrobatidis* (Bd Chytrid) the causative agent of chytridiomycosis (Blaustein et al. 1985; Carey 1993; Bradford et al. 1994; Gibbs 2000; Knapp et al. 2001, Daszak et el. 2003; Linder et al. 2003). The Clearwater Region experienced drought like conditions for a 10 - 15 year period up through 2008, and many large fires occurred around lakes in our study. Multiple stressors may act to compound each other, influencing amphibian decline in many areas (Linder et al. 2003). These factors (in addition to ones discussed above) may provide a basis for understanding long term LTS and CSF declines. If we examine some of the data from the more recent surveys, it actually appears that there is a general increase in amphibian distribution. This increase could possibly be due to the wetter springs which the region has experienced since 2008.

Infilling, and/or lower water levels within small lakes can impact the number of lakes and lake surface area within a watershed which may have ramifications for mountain lake management, amphibian risk assessment classifications, and amphibian population dynamics. Reduction of habitat connectivity likely affects dispersal and migration capabilities of wetland fauna impacted by the loss of these small wetlands assuming fauna like amphibians are strictly using wet migration corridors (Gibbs 2000). As infilling, and/or lower water levels of mountain lakes occurs, HUC5 watershed amphibian risk categories are subject to change which may have an effect on the IDFG/USFS long-term mountain lakes monitoring effort (by changing the categories of watersheds already chosen by stratified random selection). The infilling of Eagle Creek Lake, North Wind Lake (lower), Bilk Mountain Lake, and Section 27 Lake provide examples of change in total lake surface area and the amount of lakes in the Running Creek, Warm Springs Creek, Goat Creek, and Storm Creek watersheds respectively.

Amphibian observations in high mountain lakes surveyed through the first round of sampling (2006 - 2012) suggest there is a declining trend in amphibian distribution. However, this information represents only the beginning of a long-term trend monitoring program, and amphibian populations are known to fluctuate over time. In fact, if we examine the 44 lakes that we have already surveyed for the second round (started in 2011), fifteen of these lakes (34%) were found to have long-toed salamander where they previously were not observed. Amphibian observations can fluctuate over time depending on a host of factors, including metapopulation dynamics, global and local environmental conditions, weather patterns/disturbances, fluctuations in amphibian breeding, timing of surveys, and individual observer variability (Blaustein et al. 1985; Carey 1993; Bradford et al. 1994; Gibbs 2000; Knapp et al. 2001; Daszak et el. 2003; Linder et al. 2003). Only after multiple sampling rotations through amphibian risk categories can we determine with certainty the impact of the high mountain lake stocking program on the long-term persistence of amphibian species.

RECOMMENDATIONS

1. Continue monitoring high mountain lakes within HUC5 watersheds in the Clearwater Region as part of the long-term amphibian risk assessment. Update lake number and surface area reduction as smaller lentic areas dry or fill, to determine if HUC5 watersheds change in amphibian risk classification.

2. Increase the sample size of control lake to improve statistical power, as some are disappearing because of infilling.

3. IDFG and USFS managers should consider a ways to classify fire effects documented in mountain lakes monitoring. Large fires have occurred in several of the HUC5 watersheds containing study lakes.

4. Monitor amphibians on a population scale rather than in terms of presence and absence to provide a more precise measure of the general declines currently occurring. Population models that incorporate probability of detection, growth rates, carrying capacities, and process noise are important for future testing and will give a clearer perspective of trends in mountain lake amphibian populations.

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Table 54. Summary of amphibian visual encounter surveys (VES) conducted on high mountain lakes in the Clearwater Region of Idaho, during 2012.

Lake Name	HUC 5 Watershed	CSF adults	CSF subadults	CSF larvae	LTS adults	LTS larvae	Fish present
Bilk Mountain	Goat Creek	2	1	0	0	0	N
Goat	Goat Creek	200	17	900	0	150	N
Mud	Goat Creek	25	30	3000	0	0	N
Dishpan	Old Man Creek	2	0	0	0	0	Y
Elizabeth	Old Man Creek	0	0	0	0	0	Y
Florence	Old Man Creek	2	0	0	0	0	Y
Hjort	Old Man Creek	2	0	0	0	0	Y
Lloyd	Old Man Creek	0	0	0	0	0	Y
Lottie	Old Man Creek	4	0	0	0	0	Y
Lottie Upper	Old Man Creek	9	0	0	0	0	Y
Maude East	Old Man Creek	15	11	0	0	2	Y
Maude North	Old Man Creek	3	0	3	0	0	N
Maude West	Old Man Creek	9	1	1	0	1	Y
Running	Running Creek	2	0	0	0	0	Y
Section 26(lower)	Running Creek	0	0	2	0	0	N
Section 26(upper)	Running Creek	0	0	0	0	0	N
Middle Storm	Storm Creek	16	0	2	1	13	N
N.E. Ranger	Storm Creek	7	2	200	1	7	N
North Section 25	Storm Creek	0	0	28	0	3	N
North Storm	Storm Creek	2	0	0	0	3	N
Old Stormy	Storm Creek	11	1	205	0	10	N
Ranger	Storm Creek	6	1	100	0	0	Y
Section 27	Storm Creek	14	2	0	5	0	N
Siah	Storm Creek	8	17	1300	0	0	Y
South Section 25	Storm Creek	14	1	3	0	0	N
Storm	Storm Creek	0	0	0	0	5	N
Bilk	Upper Meadow	23	9	1	0	1	N
Elk	Upper Meadow	100	73	105	0	37	N
Section 27	Upper Meadow	2	0	0	0	3	N
East Wind	Warm Springs Crk.	11	3	9	0	0	Y
Middle Wind	Warm Springs Crk.	9	0	0	0	0	Y
North Wind(lower)	Warm Springs Crk.	0	0	0	0	0	N
North Wind(upper)	Warm Springs Crk.	1	0	0	0	160	N
Northwest Wind	Warm Springs Crk.	3	1	0	0	0	N
South Wind	Warm Springs Crk.	1	0	21	0	54	N
West Wind	Warm Springs Crk.	10	1	19	0	1	N
Wind Pond	Warm Springs Crk.	1	1	0	1	2	N

Table 55. Summary of amphibian presence in high mountain lakes in the Clearwater Region of Idaho, from historical data and surveys conducted from 2006 - 2012.

Lake name	Watershed/risk level	Historical survey date	First round survey date	Second round survey date	Historical amphibians	First round amphibians	Second round amphibians	Change after first round
Bilk Mountain	Goat/Control	8/10/2003	8/18/2006	7/21/2012	CSF	CSF/LTS	CSF	NEW LTS
Goat	Goat/Control	7/9/1986	7/21/2012	NA	CSF	CSF/LTS	NA	NA
Mud	Goat/Control	8/11/2003	8/17/2006	7/19/2012	CSF/LTS	CSF/LTS	CSF	NO CHANGE
Bilk	Up.Meadow/Control	7/11/1986	7/22/2012	NA	CSF	CSF/LTS	NA	NA
Elk	Up.Meadow/Control	NA	7/25/2012	NA	NA	CSF/LTS	NA	NA
Section 27	Up.Meadow/Control	NA	7/23/2012	NA	NA	CSF/LTS	NA	NA
Fox Peak Lower	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	CSF/LTS	CSF	CSF/LTS	NO LTS
Fox Peak Upper	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	CSF/LTS	CSF	CSF/LTS	NO LTS
Isaac Creek	N.F. Moose/Low	NA	7/9/2006	8/20/2011	NA	CSF	CSF/LTS	NA
Isaac	N.F. Moose/Low	8/17/1988	7/7/2006	8/20/2011	CSF	CSF	CSF	NO CHANGE
Section 28	N.F. Moose/Low	8/30/2001	7/20/2009	NA	CSF/LTS	CSF/LTS	NA	NO CHANGE
West Moose #1	N.F. Moose/Low	NA	8/7/2006	9/25/2011	NA	CSF/LTS	CSF/LTS	NA
West Moose #2	N.F. Moose/Low	NA	8/5/2006	NA	NA	CSF	NA	NA
West Moose #3	N.F. Moose/Low	NA	8/3/2006	9/23/2011	NA	CSF/LTS	CSF/LTS	NA
West Moose #4	N.F. Moose/Low	NA	8/4/2006	9/23/2011	NA	CSF/LTS	CSF/LTS	NA
West Moose #5	N.F. Moose/Low	NA	8/4/2006	9/24/2011	NA	CSF/LTS	CSF	NA
West Moose #6	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	CSF/LTS	CSF/LTS	NA
West Moose #7	N.F. Moose/Low	NA	8/6/2006	9/24/2011	NA	CSF/LTS	CSF	NA
West Moose #8	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	CSF	LTS	NA
West Moose #9	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	CSF	CSF	NA
Dan	Storm/Low	8/21/1991	8/21/2009	NA	CSF	CSF	NA	NO CHANGE
Dodge	Storm/Low	8/20/1991	9/12/2010	NA	CSF	CSF	NA	NO CHANGE
Lookout	Storm/Low	7/30/1996	9/13/2010	NA	CSF	CSF	NA	NO CHANGE
Maud	Storm/Low	8/22/1991	9/14/2010	NA	CSF/LTS	CSF	NA	NO LTS
Middle Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	CSF/LTS	CSF	CSF/LTS	NO LTS

CSF=Columbia spotted frog, LTS=Long-toed salamander, NO LTS=no long-toed salamander observations, as seen in previous survey, NEW LTS= new long-toed salamander observations, not seen in previous survey.

Table 55. Continued.

Lake name	Watershed/risk level	Historical survey date	First round survey date	Second round survey date	Historical amphibians	First round amphibians	Second round amphibians	Change after first round
North Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	CSF/LTS	CSF	CSF/LTS	NO LTS
North Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	CSF	CSF	CSF/LTS	NO CHANGE
N.E. Ranger	Storm/Low	9/10/1996	7/11/2007	7/10/2012	CSF/LTS	CSF	CSF/LTS	NO LTS
Old Stormy	Storm/Low	9/10/1996	8/4/2012	NA	CSF/LTS	CSF/LTS	NA	NA
Ranger	Storm/Low	9/9/1996	7/10/2007	7/9/2012	CSF	NONE	CSF/LTS	NO CSF
Section 27	Storm/Low	9/8/1996	7/9/2007	7/9/2012	CSF/LTS	CSF	CSF/LTS	NO LTS
Siah	Storm/Low	9/9/1996	7/8/2007	7/7/2012	CSF	CSF	CSF/LTS	NO CHANGE
South Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	CSF/LTS	CSF	CSF	NO LTS
Storm	Storm/Low	8/21/1997	2/21/2007	8/6/2012	CSF/LTS	NONE	LTS	NO CSF/LTS
Eagle Creek	Running/Moderate	NA	9/7/2009	NA	NA	NONE	NA	NA
Running	Running/Moderate	8/15/2001	7/25/2008	7/23/2012	CSF	NONE	CSF	NO CSF
Section 26	Running/Moderate	NA	7/24/2008	7/24/2012	NA	NONE	CSF	NA
Section 26 #2	Running/Moderate	NA	7/24/2008	7/24/2012	NA	LTS	NONE	NA
Dodge	Warm Springs/Moderate	7/27/1996	7/20/2009	NA	CSF/LTS	CSF	NA	NO LTS
East Wind	Warm Springs/Moderate	8/11/1995	8/23/2008	8/18/2012	CSF/LTS	CSF	CSF	NO LTS
Hungry	Warm Springs/Moderate	7/8/1991	8/22/2011	NA	CSF	CSF	NA	NO CHANGE
Low. N. Wind	Warm Springs/Moderate	7/16/1996	8/25/2008	8/17/2012	CSF/LTS	NONE	NA	NO CSF/LTS
Middle Wind	Warm Springs/Moderate	8/12/1995	8/24/2008	8/16/2012	CSF	CSF	CSF	NO CHANGE
N.W. Wind	Warm Springs/Moderate	8/12/1995	7/17/2009	8/19/2012	CSF/LTS	CSF/LTS	CSF	NO CHANGE
South Wind	Warm Springs/Moderate	8/11/1995	8/23/2008	8/18/2012	CSF/LTS	CSF/LTS	CSF	NO CHANGE
Up. N. Wind	Warm Springs/Moderate	7/16/1996	8/25/2008	8/17/2012	LTS	CSF/LTS	CSF/LTS	NEW CSF
West Wind	Warm Springs/Moderate	8/12/1995	8/25/2008	8/17/2012	CSF	CSF	CSF/LTS	NO CHANGE
Wind Pond	Warm Springs/Moderate	8/12/1995	8/23/2008	8/19/2012	CSF/LTS	CSF/LTS	CSF/LTS	NO CHANGE

CSF=Columbia spotted frog, LTS=Long-toed salamander, NO LTS=no long-toed salamander observations, as seen in previous survey, NEW LTS= new long-toed salamander observations, not seen in previous survey.

Table 55. Continued.

Lake name	Watershed/ risk level	Historical survey date	First round survey date	Second round survey date	Historical amphibians	First round amphibians	Second round amphibians	Change after first round
Bleak Creek	Bargamin/Elevated	7/7/1989	8/13/2010	NA	CSF/LTS	CSF	NA	No LTS
Boston Mtn.	Bargamin/Elevated	9/7/1989	8/12/2010	NA	CSF/LTS	CSF	NA	No LTS
Goat Lake	Bargamin/Elevated	6/20/1989	7/19/2010	NA	LTS	CSF/LTS	NA	No change
Lake Creek E.	Bargamin/Elevated	7/6/1989	7/17/2010	NA	CSF	CSF/LTS	NA	New LTS
Lake Creek. S.	Bargamin/Elevated	7/12/1989	7/16/2010	NA	CSF	CSF/TF	NA	New TF
Lake Creek W.	Bargamin/Elevated	6/11/1989	7/17/2010	NA	CSF	CSF	NA	No change
MacArther	Bargamin/Elevated	8/5/1995	7/27/2008	NA	CSF/LTS	CSF	NA	No LTS
Stillman	Bargamin/Elevated	8/4/1995	7/28/2008	NA	CSF	CSF/LTS	NA	New LTS
Three Prong	Bargamin/Elevated	NA	9/6/2009	NA	NA	CSF/IGS	NA	New IGS
Chimney	Old Man/Elevated	7/7/1995	7/3/2010	NA	NONE	CSF	NA	New CSF
Dishpan	Old Man/Elevated	7/15/1995	9/28/2010	10/1/2012	CSF	CSF	CSF	No change
Elizabeth	Old Man/Elevated	7/16/1995	9/26/2010	9/30/2012	CSF	NONE	NONE	No CSF
Flea	Old Man/Elevated	7/13/1995	7/3/2010	NA	CSF	CSF/LTS	NA	New LTS
Florence	Old Man/Elevated	7/23/1991	7/22/2006	9/28/2012	CSF/LTS	CSF/LTS	CSF	No change
Hjort	Old Man/Elevated	7/15/1995	9/29/2010	9/29/2012	CSF	CSF	CSF	No change
Kettle	Old Man/Elevated	7/21/1991	8/1/2010	NA	CSF/LTS	CSF/LTS	NA	No change
Lloyd	Old Man/Elevated	7/15/1995	8/3/2010	9/30/2012	NONE	NONE	NONE	No change
Lottie	Old Man/Elevated	NA	7/29/2010	9/1/2012	NA	CSF	CSF	N/A
Lottie Upper	Old Man/Elevated	7/14/1991	7/29/2010	8/31/2012	CSF	CSF	CSF	No change
Maude East	Old Man/Elevated	7/16/1991	8/1/2010	9/1/2012	CSF	CSF	CSF/LTS	No change
Maude North	Old Man/Elevated	7/17/1991	7/31/2010	9/2/2012	CSF/LTS	CSF/LTS	CSF	No change
Maude West	Old Man/Elevated	7/25/1991	8/1/2010	9/1/2012	CSF	CSF	CSF/LTS	No change
Old Man	Old Man/Elevated	7/14/1995	7/28/2010	NA	CSF	CSF	NA	No change
Wood	Old Man/Elevated	7/20/1991	7/31/2010	NA	CSF/LTS	CSF/LTS	NA	No change

CSF=Columbia Spotted Frog, LTS=Long-toed Salamander, No LTS=no Long-toed Salamander observations, as seen in previous survey, New LTS= new Long-toed Salamander observations, not seen in previous survey.

Table 56. Summary of length, weight, and catch per unit effort (CPUE) of Westslope Cutthroat Trout captured in high mountain lakes in the Clearwater Region of Idaho, during 2012, using overnight gill net sets.

Lake Name	**Fish**	**Watershed**	**CPUE (fish/hr)**	**Average Length (mm)**	**Average Weight (g)**	**Average R_w**
Ranger	RBT	Storm Creek	0.5	264	234	88
Siah	WCT	Storm Creek	1.8	288	288	89
Running	BKT	Running Creek	5.9	180	49	78
East Wind	WCT	Warm Springs Creek	0.9	260	236	103
Middle Wind	WCT	Warm Springs Creek	4.2	207	101	95
Lottie Upper	BKT	Old Man Creek	2.1	227	158	106
Lottie	BKT	Old Man Creek	3.4	190	97	85
Maude West	WCT/HY	Old Man Creek	1.1	340	358	78
Maude East	WCT/HY	Old Man Creek	2.1	223	153	69
Florence	WCT	Old Man Creek	0.9	324	402	94
Hjort	BKT/WCT	Old Man Creek	0.3	224	129	76
Elizabeth	BKT/WCT	Old Man Creek	2.8	189	55	73

RBT = Rainbow Trout; WCT = Westslope Cutthroat Trout; BKT = Brook Trout; HY = rainbow x cutthroat hybrid

Table 57. Fish presence in 55 high mountain lakes in the Clearwater Region that were surveyed both historically (1986-2003) and during the first round (2006-2012) as part of a long term monitoring program. BKT = Brook Trout; WCT = Westslope Cutthroat Trout; RBT = Rainbow Trout.

	Fish Present			
Survey period	**None**	**BKT**	**BKT/WCT**	**RBT/WCT**
Historic	29	7	1	21
First Round	27	7	2	18

Table 58. Summary of fish presence in high mountain lakes in the Clearwater Region of Idaho, from historical data and surveys conducted from 2006 - 2012.

Lake Name	Watershed/ Risk level	Historical Survey Date	First Round Survey Date	Second Round Survey Date	Historical Fish	First Round Fish	Second Round Fish	Change after First Round
Bilk	Up.Meadow/Control	7/11/1986	7/22/2012	NA	NONE	NONE	NA	NA
Bilk Mountain	Goat/Control	8/10/2003	8/18/2006	7/21/2012	NONE	NONE	NONE	NO CHANGE
Bleak Creek	Bargamin/Elevated	7/7/1989	8/13/2010	NA	NONE	NONE	NA	NO CHANGE
Boston Mtn.	Bargamin/Elevated	9/7/1989	8/12/2010	NA	WCT	WCT	NA	NO CHANGE
Chimney	Old Man/Elevated	7/7/1995	7/3/2010	NA	BKT	BKT	NA	NO CHANGE
Dan	Storm/Low	8/21/1991	8/21/2009	NA	RBT	RBT	NA	NO CHANGE
Dishpan	Old Man/Elevated	7/15/1995	9/28/2010	10/1/2012	BKT	BKT	BKT	NO CHANGE
Dodge	Warm Springs/Moder	7/27/1996	7/20/2009	NA	NONE	NONE	NA	NO CHANGE
Dodge	Storm/Low	8/20/1991	9/12/2010	NA	RBT	RBT	NA	NO CHANGE
Eagle Creek	Running/Moderate	NA	9/7/2009	NA	NA	NONE	NA	NA
East Wind	Warm Springs/Moder	8/11/1995	8/23/2008	8/18/2012	WCT	WCT	NONE	NO CHANGE
Elizabeth	Old Man/Elevated	7/16/1995	9/26/2010	9/30/2012	BKT/WCT	BKT/WCT	BKT/WCT	NO CHANGE
Elk	Up.Meadow/Control	NA	7/25/2012	NA	NA	NA	NA	NA
Flea	Old Man/Elevated	7/13/1995	7/3/2010	NA	NONE	NONE	NA	NO CHANGE
Florence	Old Man/Elevated	7/23/1991	7/22/2006	9/28/2012	WCT	WCT	WCT	NO CHANGE
Fox Peak Lower	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	NONE	NONE	NONE	NO CHANGE
Fox Peak Upper	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	NONE	NONE	NONE	NO CHANGE
Goat	Goat/Control	7/9/1986	7/21/2012	NA	NONE	NONE	NA	NA
Goat Lake	Bargamin/Elevated	6/20/1989	7/19/2010	NA	WCT	NONE	NA	NO WCT
Hjort	Old Man/Elevated	7/15/1995	9/29/2010	9/29/2012	BKT	BKT	BKT/WCT	NO CHANGE
Hungry	Warm Springs/Moder	7/8/1991	8/22/2011	NA	WCT/RBT	WCT	NA	NO RBT
Isaac	N.F. Moose/Low	8/17/1988	7/7/2006	8/20/2011	WCT/RBT	WCT/RBT	WCT	NO CHANGE
Isaac Creek	N.F. Moose/Low	NA	7/9/2006	8/20/2011	NA	NONE	NONE	NA
Kettle	Old Man/Elevated	7/21/1991	8/1/2010	NA	RBT	NONE	NA	NO RBT
Lake Creek E.	Bargamin/Elevated	7/6/1989	7/17/2010	NA	WCT/RBT/X	WCT/RBT/X	NA	NO CHANGE
Lake Creek W.	Bargamin/Elevated	6/11/1989	7/17/2010	NA	RBT	RBT	NA	NO CHANGE
Lake Creek. S.	Bargamin/Elevated	7/12/1989	7/16/2010	NA	WCT/RBT	RBT	NA	NO WCT
Lloyd	Old Man/Elevated	7/15/1995	8/3/2010	9/30/2012	BKT	BKT	BKT	NO CHANGE
Lookout	Storm/Low	7/30/1996	9/13/2010	NA	RBT	RBT	NA	NO CHANGE
Lottie	Old Man/Elevated	NA	7/29/2010	9/1/2012	NA	BKT	BKT	NA
Lottie Upper	Old Man/Elevated	7/14/1991	7/29/2010	8/31/2012	BKT	BKT	BKT	NO CHANGE
Low. N. Wind	Warm Springs/Moder	7/16/1996	8/25/2008	8/17/2012	NONE	NONE	NONE	NO CHANGE
MacArther	Bargamin/Elevated	8/5/1995	7/27/2008	NA	WCT/RBT	WCT/RBT	NA	NO CHANGE
Maud	Storm/Low	8/22/1991	9/14/2010	NA	NONE	NONE	NA	NO CHANGE
Maude East	Old Man/Elevated	7/16/1991	8/1/2010	9/1/2012	RBT	RBT	WCT/HY	NO CHANGE
Maude North	Old Man/Elevated	7/17/1991	7/31/2010	9/2/2012	NONE	NONE	NONE	NO CHANGE

WCT=Cutthroat trout, RBT=Rainbow trout, BK=Brook trout, HY=RBT/CT Hybrid

Table 58 Continued.

Lake Name	Watershed/ Risk level	Historical Survey Date	First Round Survey Date	Second Round Survey Date	Historical Fish	First Round Fish	Second Round Fish	Change after First Round
Maude West	Old Man/Elevated	7/25/1991	8/1/2010	9/1/2012	RBT	RBT	WCT/HY	NO CHANGE
Middle Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	NONE	NONE	NONE	NO CHANGE
Middle Wind	Warm Springs/Moder	8/12/1995	8/24/2008	8/16/2012	WCT	WCT	WCT	NO CHANGE
Mud	Goat/Control	8/11/2003	8/17/2006	7/19/2012	NONE	NONE	NONE	NO CHANGE
N.E. Ranger	Storm/Low	9/10/1996	7/11/2007	7/10/2012	NONE	NONE	NONE	NO CHANGE
N.W. Wind	Warm Springs/Moder	8/12/1995	7/17/2009	8/19/2012	NONE	NONE	NONE	NO CHANGE
North Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	NONE	NONE	NONE	NO CHANGE
North Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	NONE	NONE	NONE	NO CHANGE
Old Man	Old Man/Elevated	7/14/1995	7/28/2010	NA	BKT	BKT	NA	NO CHANGE
Old Stormy	Storm/Low	9/10/1996	8/4/2012	NA	NONE	NONE	NA	NA
Ranger	Storm/Low	9/9/1996	7/10/2007	7/9/2012	RBT	RBT	RBT	NO CHANGE
Running	Running/Moderate	8/15/2001	7/25/2008	7/23/2012	BKT	BKT	BKT	NO CHANGE
Section 26	Running/Moderate	NA	7/24/2008	7/24/2012	NA	NONE	NONE	NA
Section 26 #2	Running/Moderate	NA	7/24/2008	7/24/2012	NA	NONE	NONE	NA
Section 27	Up.Meadow/Control	NA	7/23/2012	NA	NA	NA	NA	NA
Section 27	Storm/Low	9/8/1996	7/9/2007	7/9/2012	NONE	NONE	NONE	NO CHANGE
Section 28	N.F. Moose/Low	8/30/2001	7/20/2009	NA	NONE	NONE	NA	NO CHANGE
Siah	Storm/Low	9/9/1996	7/8/2007	7/7/2012	WCT/RBT	WCT/RBT	WCT/RBT	NO CHANGE
South Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	NONE	NONE	NONE	NO CHANGE
South Wind	Warm Springs/Moder	8/11/1995	8/23/2008	8/18/2012	NONE	NONE	NONE	NO CHANGE
Stillman	Bargamin/Elevated	8/4/1995	7/28/2008	NA	WCT	WCT	NA	NO CHANGE
Storm	Storm/Low	8/21/1997	2/21/2007	8/6/2012	NONE	NONE	NONE	NO CHANGE
Three Prong	Bargamin/Elevated	NA	9/6/2009	NA	NA	NONE	NA	NA
Up. N. Wind	Warm Springs/Moder	7/16/1996	8/25/2008	8/17/2012	NONE	NONE	NONE	NO CHANGE
West Moose #1	N.F. Moose/Low	NA	8/7/2006	9/25/2011	NA	NONE	NONE	NA
West Moose #2	N.F. Moose/Low	NA	8/5/2006	NA	NA	NONE	NA	NA
West Moose #3	N.F. Moose/Low	NA	8/3/2006	9/23/2011	NA	NONE	NONE	NA
West Moose #4	N.F. Moose/Low	NA	8/4/2006	9/23/2011	NA	NONE	NONE	NA
West Moose #5	N.F. Moose/Low	NA	8/4/2006	9/24/2011	NA	NONE	NONE	NA
West Moose #6	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	NONE	NONE	NA
West Moose #7	N.F. Moose/Low	NA	8/6/2006	9/24/2011	NA	NONE	NONE	NA
West Moose #8	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	NONE	NONE	NA
West Moose #9	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	NONE	NONE	NA
West Wind	Warm Springs/Moder	8/12/1995	8/25/2008	8/17/2012	WCT	WCT	WCT	NO CHANGE
Wind Pond	Warm Springs/Moder	8/12/1995	8/23/2008	8/19/2012	NONE	NONE	NONE	NO CHANGE
Wood	Old Man/Elevated	7/20/1991	7/31/2010	NA	NONE	NONE	NA	NO CHANGE

WCT=Cutthroat trout, RBT=Rainbow trout, BK=Brook trout, HY=RBT/CT Hybrid

Table 59. Presence of Columbia spotted frogs (CSF) and long-toed salamander (LTS) in 55 high mountain lakes in the Clearwater Region that were surveyed both historically (1986-2003) and more recently (2006-2012) as part of a long term monitoring program.

Historic

	Amphibian Presence			
Fish presence	CSF	No CSF	LTS	No LTS
Fish	25	2	5	22
No Fish	26	2	22	6

1st Round

	Amphibian Presence			
Fish presence	CSF	No CSF	LTS	No LTS
Fish	23	4	3	24
No Fish	26	2	15	13

Table 60. Changes in Columbian Spotted Frog (CSF) and Long-toed Salamander (LTS) presence in 55 high mountain lakes in the Clearwater Region that were surveyed both historically (1986-2003) and more recently (2006-2012) as part of a long term monitoring program.

Lakes with fish

Amphibian	Gain	Loss	Same	Net change
CSF	1	3	23	-2
LTS	2	4	21	-2

Lakes without fish

Amphibian	Gain	Loss	Same	Net change
CSF	2	2	24	0
LTS	4	11	13	-7

Table 61. Presence of Columbia spotted frogs (CSF) and long-toed salamander (LTS) in 44 high mountain lakes in the Clearwater Region that were surveyed for both 1st round and 2nd round monitoring (2006-2012).

1st Round

	Amphibian presence			
Fish presence	CSF	No CSF	LTS	No LTS
Fish	11	4	1	14
No Fish	25	4	14	15

2nd Round

	Amphibian presence			
Fish presence	CSF	No CSF	LTS	No LTS
Fish	13	2	5	10
No Fish	25	4	16	13

Table 62. Changes in Columbia spotted frogs (CSF) and long-toed salamander (LTS) presence in 44 high mountain lakes in the Clearwater Region that were surveyed for both 1st round and 2nd round monitoring (2006-2012).

Lakes with fish

Amphibian	Gain	Loss	Same	Net change
CSF	2	0	13	2
LTS	5	1	9	4

Lakes without fish

Amphibian	Gain	Loss	Same	Net change
CSF	1	1	27	0
LTS	10	8	11	2

Table 63. Results of Chi squared (χ^2) analysis for Columbia Spotted Frogs and Long-toed Salamanders sampled in 55 high mountain lakes of the Clearwater Region, Idaho, Comparisons were made between first round monitoring visual encounter surveys (VES) from 2006 - 2012 (actual values) and historical VES completed from 1989 - 2003 (expected values). Probability represents the chance the H0 is accepted (no change in amphibian presence).

Columbia Spotted Frogs

Lake risk level	Present (Actual)	Not Found (Actual)	Present (Expected)	Not Found (Expected)	χ^2	Probability
All Lakes	48	7	51	4	2.46	0.119
Control	4	0	4	0	n/a	n/a
Low	16	2	18	0	n/a	n/a
Moderate	9	2	10	1	1.1	0.294
Elevated	19	3	19	3	1.57E-18	1

Long-toed Salamanders

Lake risk level	Present (Actual)	Not Found (Actual)	Present (Expected)	Not Found (Expected)	χ^2	Probability
All Lakes	17	38	28	27	5.89	0.015
Control	4	0	1	3	12	0.00053
Low	2	16	11	7	18.94	1.35E-05
Moderate	4	7	7	4	3.54	0.06
Elevated	8	14	8	14	0	1

n/a = category in which χ^2 cannot be calculated due to no lakes being expected to have amphibians present/absent (creates a zero divisor).

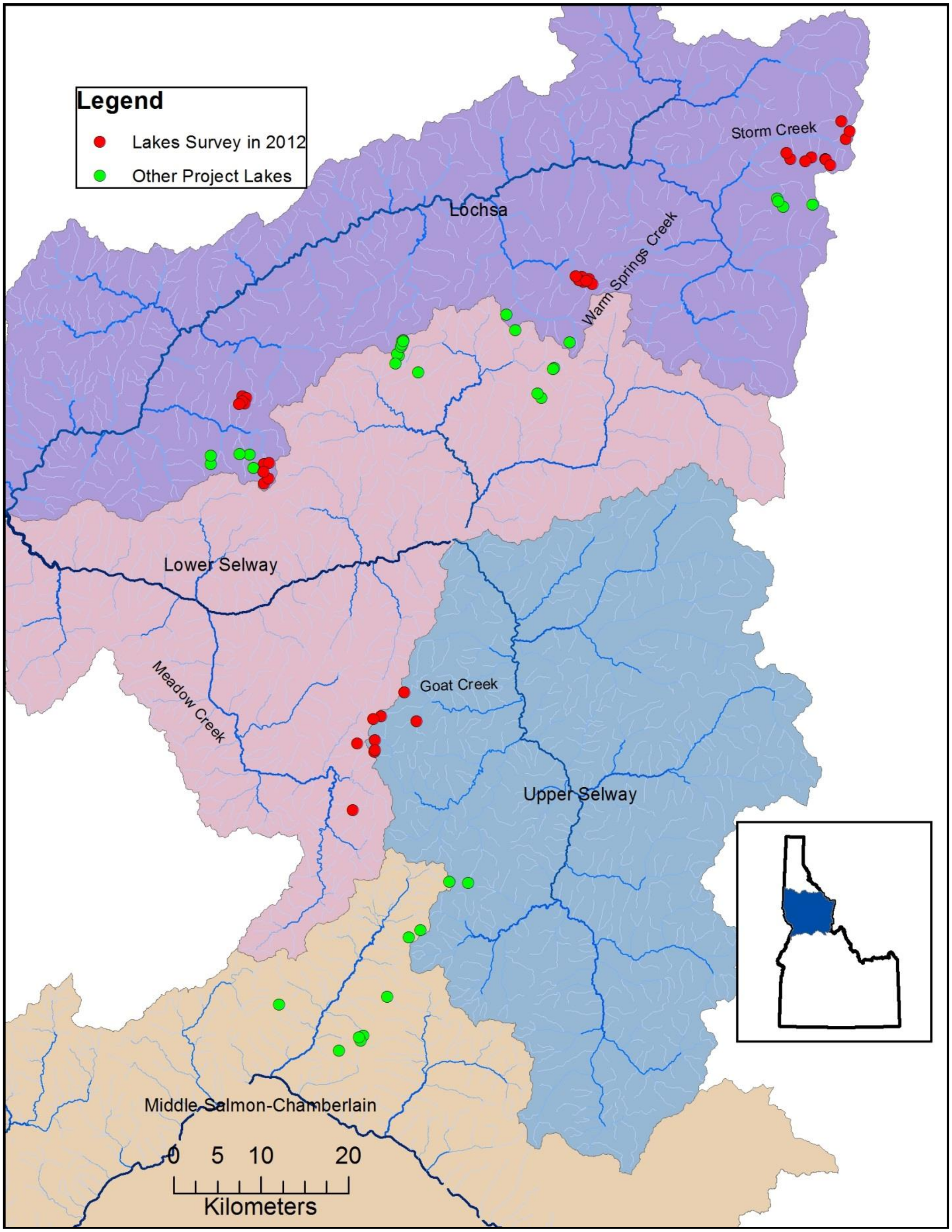

Figure 290. Map of the study area, which is contained by the Clearwater Region, Idaho.

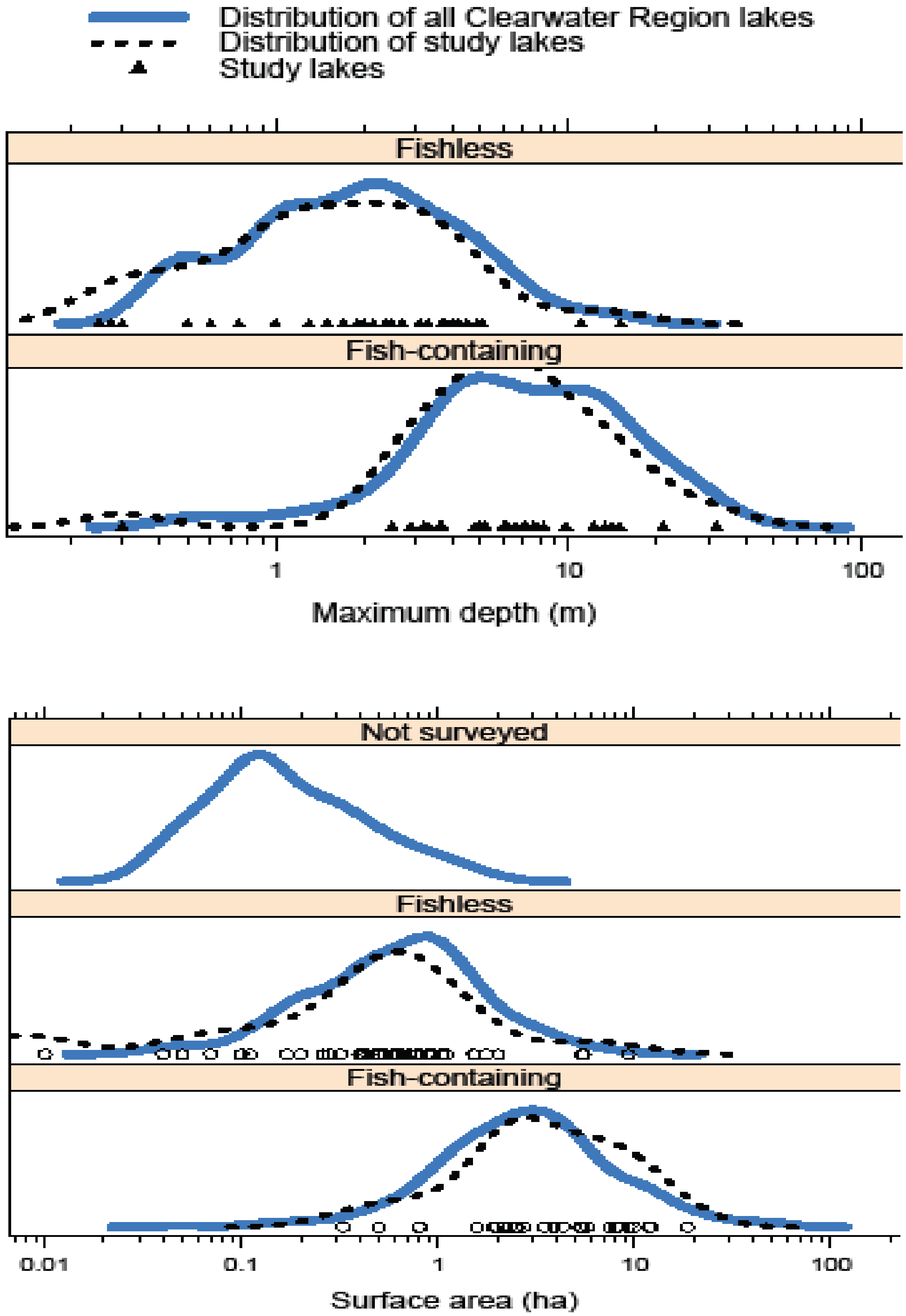

Figure 291. The distribution of mountain lakes in the Clearwater Region, Idaho, comparing fish status (fish-containing or fishless) by maximum depth, surface area, and elevation.

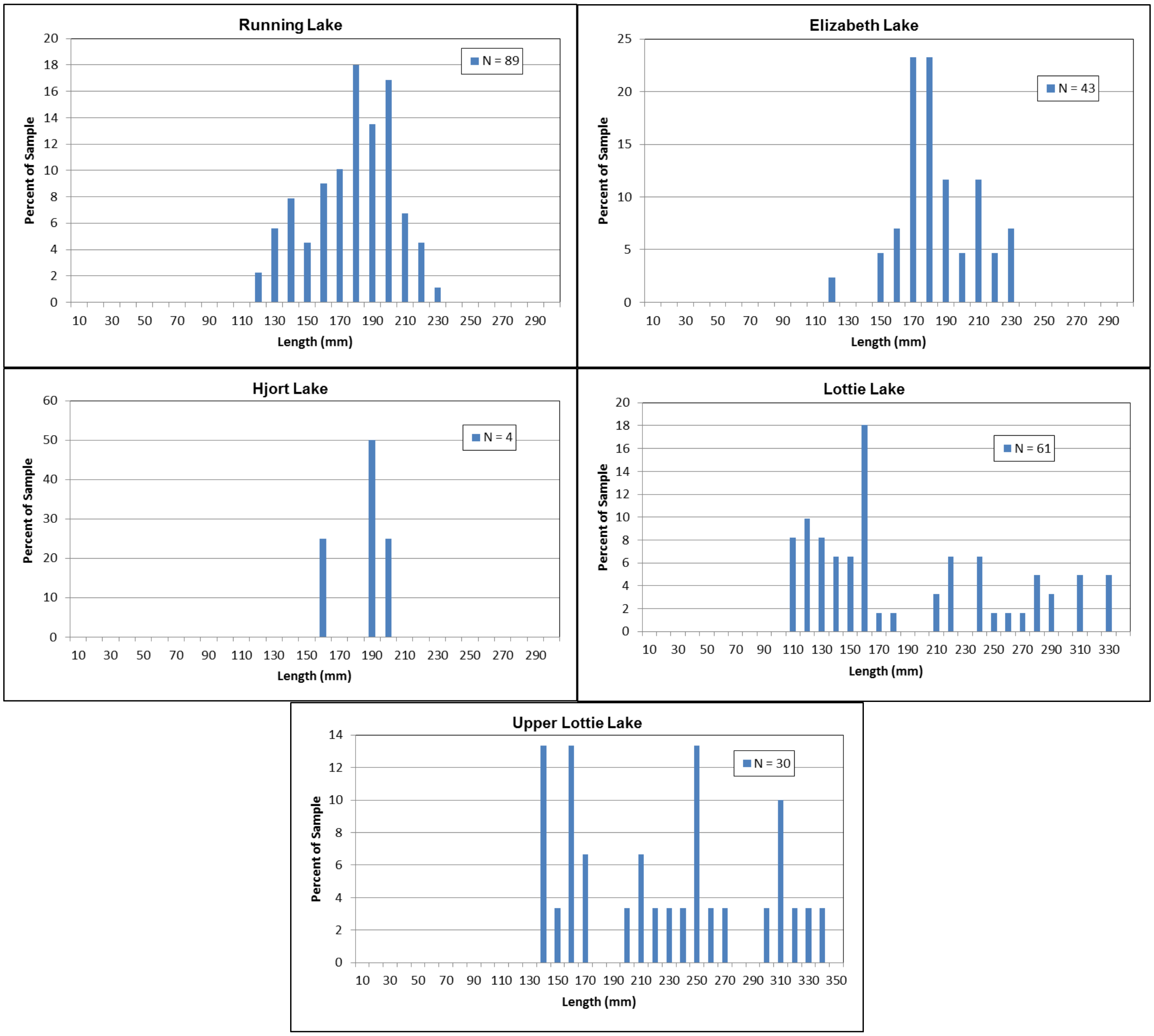

Figure 292. Length frequency histograms of Brook Trout captured in overnight gill net sets in high mountain lakes in the Clearwater Region, Idaho, in 2012.

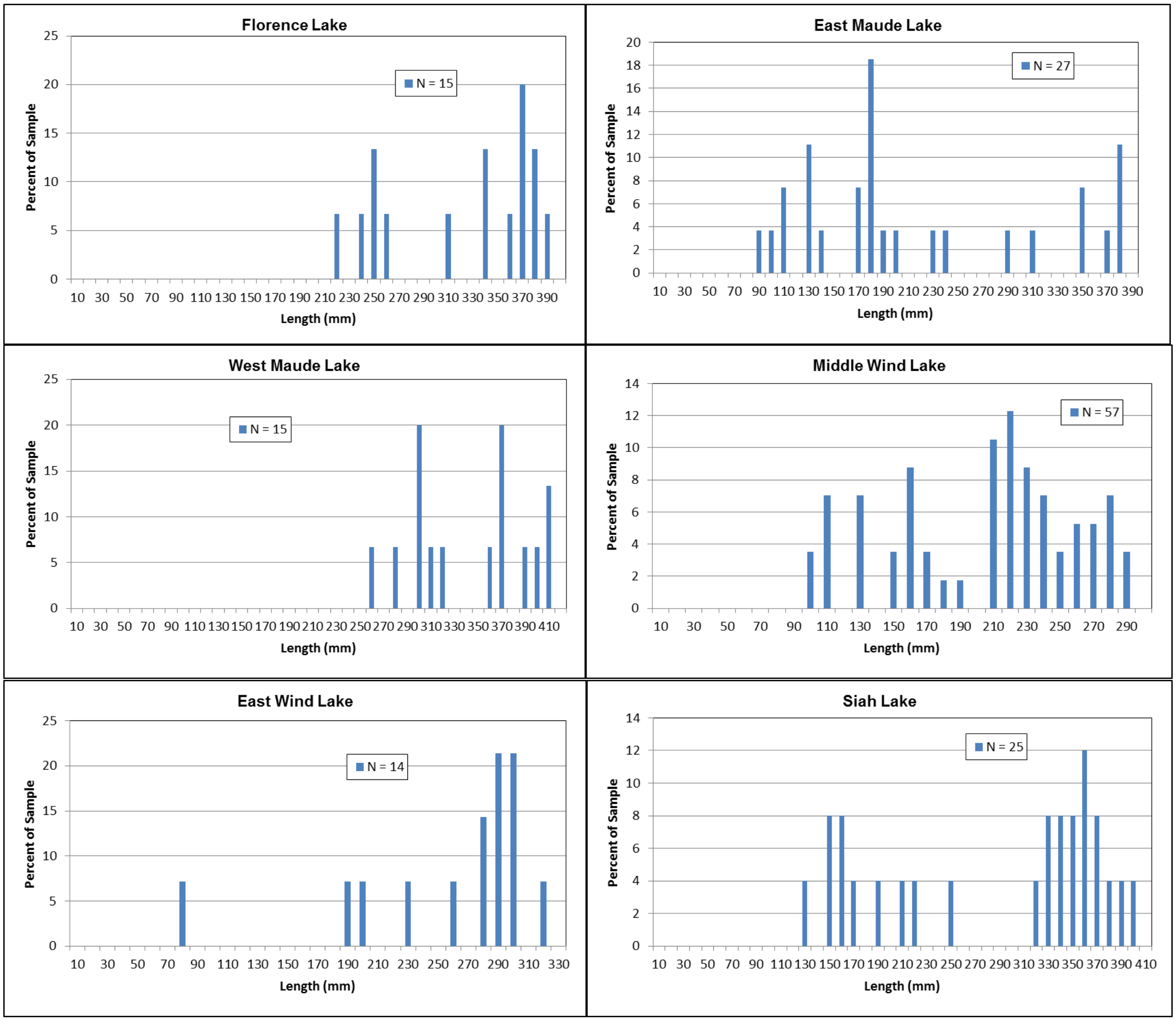

Figure 293. Length frequency distribution of Westlope Cutthroat Trout captured in overnight gill net sets in high mountain lakes in the Clearwater Region, Idaho, in 2012.

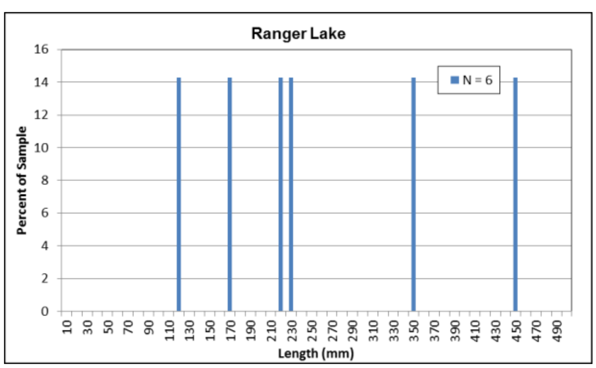

Figure 294. Length frequency distribution of Rainbow Trout captured in overnight gill net sets in Ranger Lake, Idaho, in 2012.

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APPENDICIES

Appendix A. Harvest summary from creel surveys conducted on lowland lakes in the Clearwater Region from 1993 - 2012.

1993 Lake	Number of fish caught	Number of fish harvested	Harvest Rainbow Trout	Holdover RBT	Largemouth Bass	Bluegill	Black Crappie	Yellow Perch	Pumpkin seed	Brook Trout	Splake	Smallmouth Bass	Kokanee	Black Bullhead	Lake Trout	Channel Catfish
Winchester	47,901	41,317	40,739		496									82		
Spring Valley	34,164	27,417	26,924		219	274										
Mann	31,885	27,133	24,365												2,768	
Soldier's Meadow	22,385	17,620	15,893				846						881			
Moose Creek	18,082	16,990	14,187			934	935		934							
Elk Creek	22,155	17,027	16,001		60					754		59		153		
Total	176,572	147,504	138,109		775	1,208	1,781		934	754		59	881	235	2,768	

1999 Lake	Number of fish caught	Number of fish harvested	Harvest Rainbow Trout	Holdover RBT	Largemouth Bass	Bluegill	Black Crappie	Yellow Perch	Pumpkin seed	Brook Trout	Splake	Smallmouth Bass	Kokanee	Black Bullhead	Lake Trout	Channel Catfish
Winchester	43,945	38,888	20,941		78	44	15,399	2,426								
Spring Valley	39,152	27,600	21,803		71	5,595	131									
Mann	24,508	20,635	12,231		417	90	7,897									
Soldier's Meadow	10,710	8,675	8,467				208									
Moose Creek	11,212	8,946	7,993			953										
Elk Creek	20,716	16,353	11,224							4,824		305				
Waha	2,406	1,933	1,737								147	49				
Total	152,649	123,030	84,396		566	6,682	23,635	2,426		4,824	147	354				

Appendix A. Continued

2005 Lake	Number of fish caught	Number of fish harvested	Harvest Rainbow Trout	Holdover RBT	Largemouth Bass	Bluegill	Black Crappie	Yellow Perch	Pumpkin seed	Brook Trout	Splake	Smallmouth Bass	Kokanee	Black Bullhead	Lake Trout	Channel Catfish
Winchester	141,374	67,741	23,560		600	16,394	5,346	21,708								133
Spring Valley	52,031	21,246	13,907		393	4,494	2,452									
Mann	67,407	39,122	8,271		166	984	28,041		1,628							32
Soldier's Meadow	16,161	6,531	4,791				1,646						20	74		
Moose Creek	36,753	12,347	10,222		36	1,401	373		315							
Elk Creek	23,591	11,047	10,392		12	122	370			103		15		33		
Waha	13,914	9,919	2,357					7,215			48	273	26			
Deer Creek	21,837	8,929	8,929													
Total	373,068	176,882	82,429		1,207	23,395	38,228	28,923	1,943	103	48	288	46	107		165

2012 Lake	Number of fish caught	Number of fish harvested	Harvest Rainbow Trout	Holdover RBT	Largemouth Bass	Bluegill	Black Crappie	Yellow Perch	Pumpkin seed	Brook Trout	Splake	Smallmouth Bass	Kokanee	Black Bullhead	Lake Trout	Channel Catfish	Westslope Cutthroat Trout
Winchester	67,162	36,978	28,300	1,019	479	5,026	240	1,795								119	
Spring Valley	33,157	15,405	11,251	1,134	174	2,702	30		114								
Mann	17,848	8,997	7,307		18	331	1,074		49					49		169	
Soldier's Meadow	10,042	2,078	1,439				23	616									
Moose Creek	38,848	18,954	14,608	1,657	315	2,177	197										
Elk Creek	18,762	8,364	3,799	2,181	86	37	18			2,238		5					
Waha	9,503	3,428	3,077					276				55	20				
Deer Creek	24,429	16,107	14,960							868							279
Tolo Lake	1,064	291	87		48		156										
Total	220,815	110,602	84,828	5,991	1,120	10,273	1,738	2,687	163	3,106		60	20	49		288	279

Appendix B. Estimates of catch rates and percent of fishery supported by hatchery Rainbow Trout for lowland lakes in the Clearwater Region 1993 - 2012.

1993	Hatchery Rainbow Trout							
	RBT	RBT	Holdover RBT	% of fishery	Catch rate	Harvest rate	Angler exploitation rate (harvest)	
Lake	stocked	harvested	harvested	supported by	(fish/hour)	(fish/hour)	creel survey	tagging
Winchester Lake	42,288	25,543	-----	61.8	-----	0.95	60.4	-----
Spring Valley Reservoir	45,000	26,223	-----	95.6	-----	0.76	58.3	-----
Mann Lake	42,290	24,365	-----	89.8	-----	0.88	57.6	-----
Soldier's Meadow Reservoir	15,070	11,891	-----	67.5	-----	1.06	78.9	-----
Moose Creek Reservoir	20,650	14,187	-----	83.5	-----	1.01	68.7	-----
Elk Creek Reservoir	30,210	15,900	-----	93.4	-----	0.99	52.6	-----
Total	195,508	118,109	-----	81.9	-----	0.94	62.8	-----

1999	Hatchery Rainbow Trout							
	RBT	RBT	Holdover RBT	% of fishery	Catch rate	Harvest rate	Angler exploitation rate (harvest)	
Lake	stocked	harvested	harvested	supported by	(fish/hour)	(fish/hour)	creel survey	tagging
Winchester Lake	35,000	20,941	-----	53.8	-----	0.62	59.8	-----
Spring Valley Reservoir	32,530	21,803	-----	79.0	-----	0.66	67.0	-----
Mann Lake	35,000	12,231	-----	59.3	-----	0.66	34.9	-----
Soldier's Meadow Reservoir	13,391	8,467	-----	97.6	-----	0.74	63.2	-----
Moose Creek Reservoir	17,450	7,993	-----	89.3	-----	0.68	45.8	-----
Elk Creek Reservoir	27,500	11,224	-----	68.6	-----	0.74	40.8	-----
Waha Lake	5,500	1,737	-----	89.9	-----	0.42	31.6	-----
Total	123,030	123,030	-----	76.8	-----	0.65	49.0	-----

Appendix B. Continued.

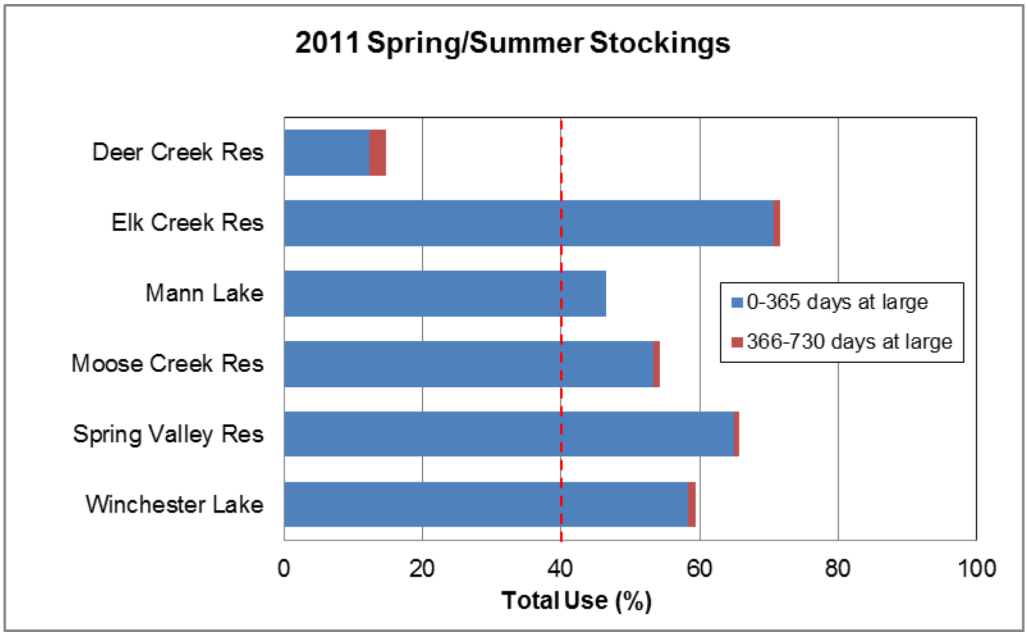
2005	Hatchery Rainbow Trout							
	RBT	RBT	Holdover RBT	% of fishery	Catch rate	Harvest rate	Angler exploitation rate (harvest)	
Lake	stocked	harvested	harvested	supported by	(fish/hour)	(fish/hour)	creel survey	tagging
Winchester Lake	32,225	23,560	-----	34.8	0.78	0.45	73.1	-----
Spring Valley Reservoir	33,126	13,907	-----	65.5	0.79	0.48	42.0	-----
Mann Lake	34,600	8,271	-----	21.1	0.89	0.38	23.9	-----
Soldier's Meadow Reservoir	21,800	4,791	-----	73.4	1.06	0.52	22.0	-----
Moose Creek Reservoir	12,210	10,222	-----	82.8	0.89	0.52	83.7	-----
Elk Creek Reservoir	34,342	10,392	-----	94.1	1.50	0.95	30.3	-----
Waha Lake	8,400	2,357	-----	23.8	1.28	0.65	28.1	-----
Deer Creek Reservoir	20,387	8,929	-----	100.0	1.43	0.59	43.8	-----
Total	197,090	82,429	-----	61.9	1.08	0.57	43.4	

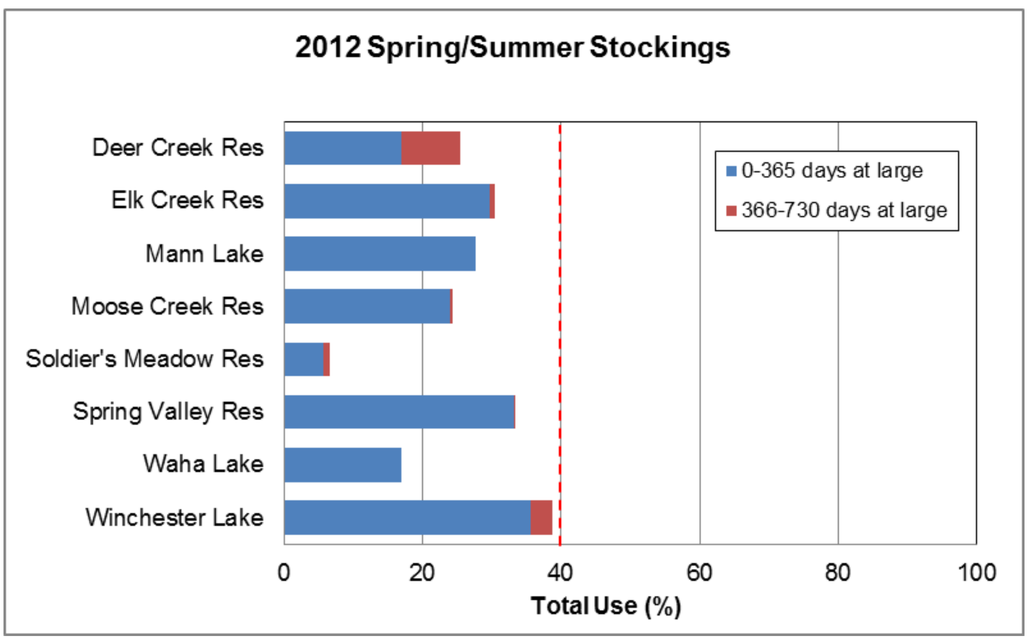
2012	Hatchery Rainbow Trout							
	RBT	RBT	Holdover RBT	% of fishery	Catch rate	Harvest rate	Angler exploitation rate (harvest)	
Lake	stocked	harvested	harvested	supported by	(fish/hour)	(fish/hour)	creel survey	tagging
Winchester Lake	42,663	28,300	1,019	79.3	1.10	0.70	66.3	29.9
Spring Valley Reservoir	33,060	11,251	1,134	80.3	0.77	0.44	34.0	38.3
Mann Lake	35,270	7,307	-----	81.2	0.80	0.50	20.7	16.9
Soldier's Meadow Reservoir	7,830	1,439	-----	69.2	0.89	0.29	18.4	5.7
Moose Creek Reservoir	21,208	14,608	1,657	72.7	1.40	0.86	68.9	18.8
Elk Creek Reservoir	15,000	3,799	2,181	71.5	1.20	0.60	25.3	20.0
Waha Lake	10,115	3,077	-----	89.8	1.30	0.70	30.4	14.1
Deer Creek Reservoir	31,780	14,960	-----	92.9	4.00	2.70	47.1	13.3
Tolo Lake	600	87	-----	21.6	0.30	0.10	14.5	-----
Total	197,526	84,828	5,991	82.3	1.47	0.86	36.2	19.6

Appendix C. Estimated number of hatchery Rainbow Trout harvested by month in reservoirs in the Clearwater Region of Idaho during a 2011 - 2012 creel survey.

Month	Deer Creek Reservoir	Elk Creek Reservoir	Mann Lake	Moose Creek Reservoir	Soldier's Meadow Reservoir	Spring Valley Reservoir	Tolo Lake	Waha Lake	Winchester Lake	Total
December	0	107	0	362	0	1,128	0	0	1,832	3,429
January	0	63	0	0	0	0	0	0	3,627	3,690
February	0	1,637	0	276	0	0	0	0	0	1,913
March	0	374	0	1,019	0	0	0	0	0	1,393
April	0	92	1,417	83	0	0	0	0	7,710	9,303
May	74	617	4,139	4,306	334	2,451	0	1,160	7,649	20,656
June	1,263	1,151	2,769	3,640	832	4,252	19	2,789	14,040	29,491
July	2,764	803	2,846	5,317	273	1,880	68	87	5,022	16,296
August	5,407	418	1,162	480	0	357	0	514	2,644	5,576
September	2,394	454	469	151	0	445	0	548	2,291	4,358
October	3,058	265	0	0	0	0	0	0	864	1,129
November	0	0	0	631	0	737	0	144	0	1,513
Totals	14,960	5,980	12,802	16,266	1,439	11,251	87	5,243	45,680	98,748

Appendix D. Summary of estimated angler total use (angler catch) of hatchery catchable Rainbow Trout based on "Tag You're It" tagging program in reservoirs of the Clearwater Region, Idaho, during 2011 and 2012. Dashed red lines indicate IDFG management goal of 40%.





Appendix D. Continued.

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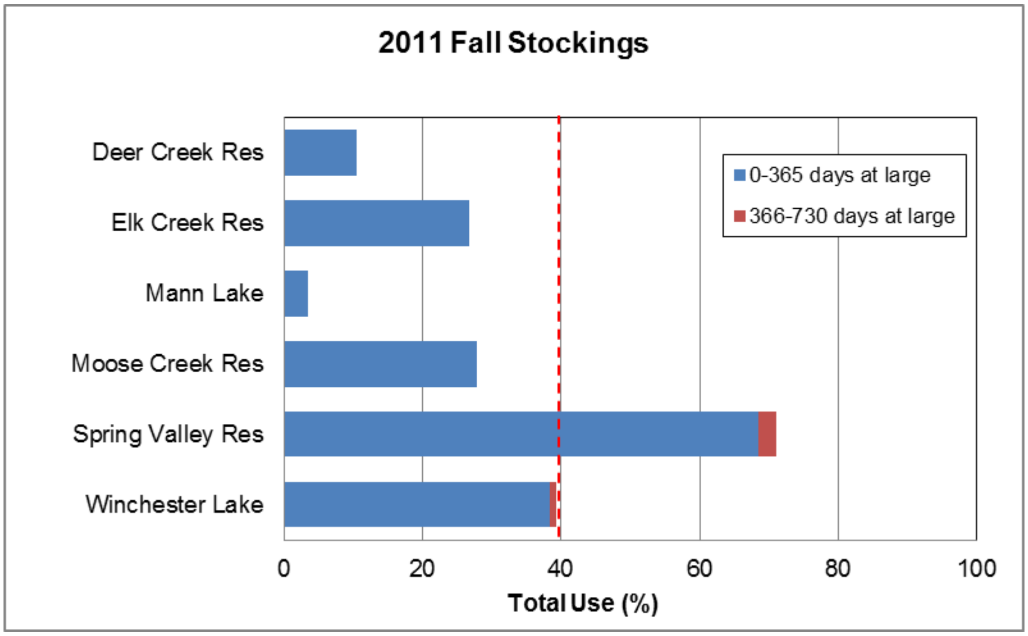
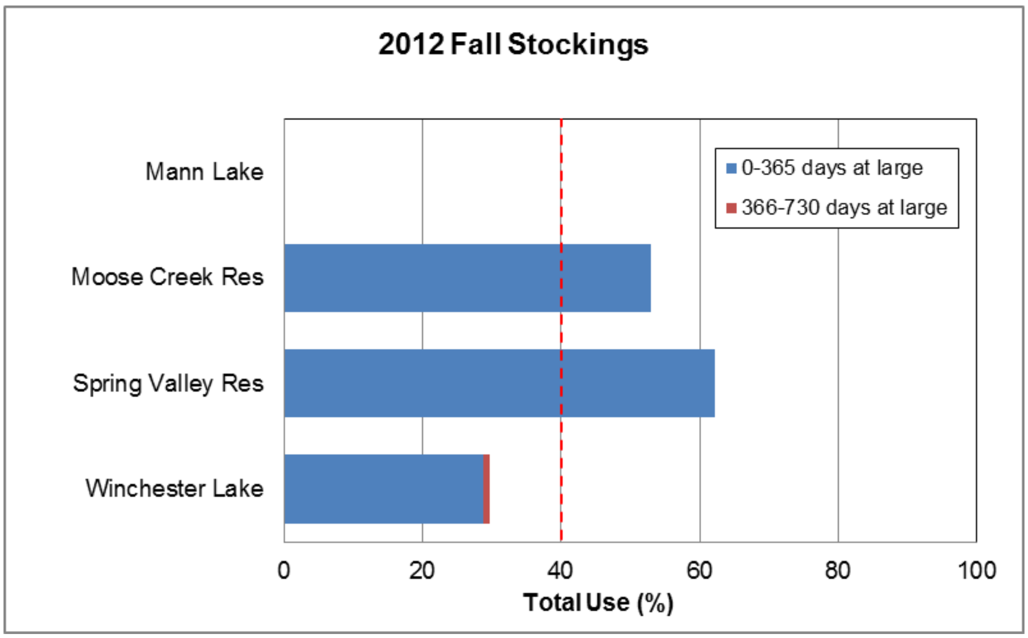




Appendix E. Results of ZQI zooplankton sampling conducted on reservoirs in the Clearwater Region of Idaho during August, 2012.

Reservoir	Biomass (g/m) 150µm	500µm	750µm	ZPR (750µm / 500µm)	ZQI (500µm + 750µm)ZPR
Spring Valley Reservoir	0.50	0.16	0.12	0.80	0.22
Elk Creek Reservoir	0.36	0.12	0.10	0.80	0.18
Moose Creek Reservoir	0.35	0.07	0.07	1.00	0.15
Winchester Lake	1.93	0.66	0.94	1.42	2.29
Soldiers Meadow Reservoir	0.70	0.00	0.00	0.00	0.00
Waha Lake	0.10	0.00	0.00	0.00	0.00
Mann Lake	0.83	0.05	0.02	0.37	0.03
Tolo Lake	0.23	0.00	0.00	0.00	0.00
Deer Creek Reservoir	0.23	0.50	0.18	0.37	0.25
Average	0.58	0.17	0.16	0.53	0.35

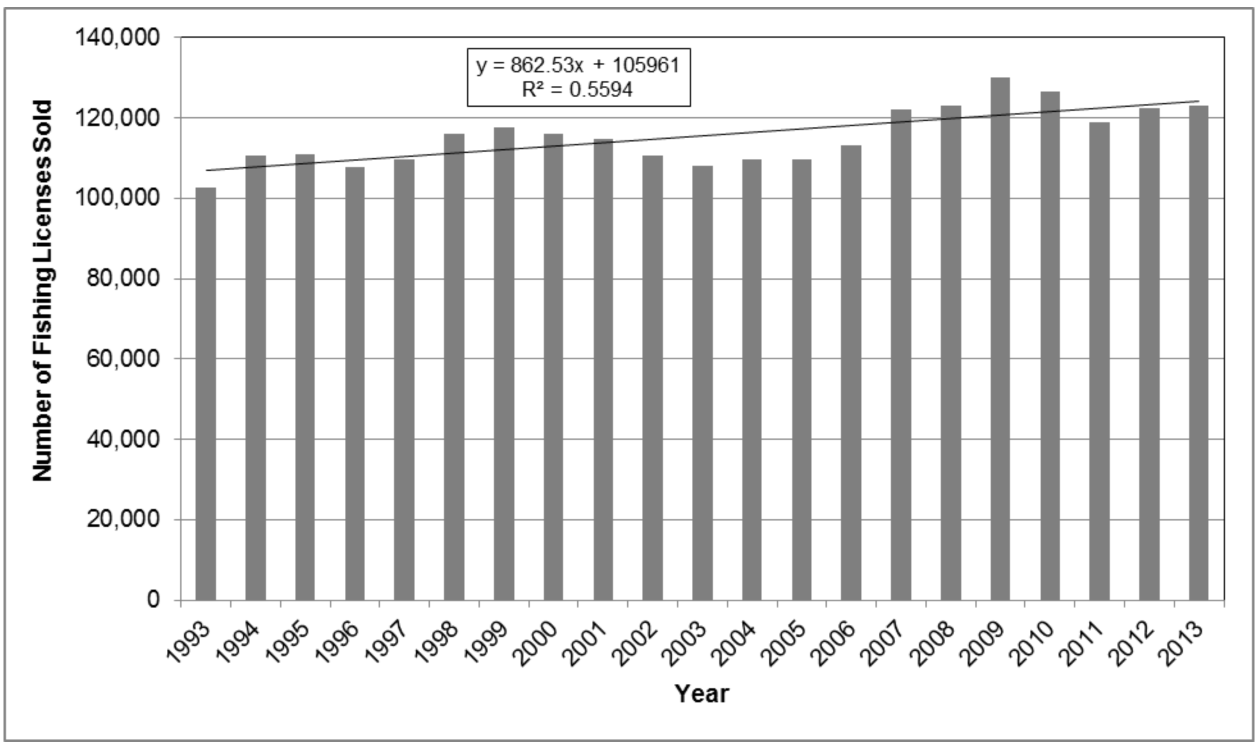
Appendix F. Percent of sample sites with each vegetation type present found in reservoirs in the Clearwater Region, Idaho, during 2012.

Species	Reservoir: Deer Creek Reservoir	Elk Creek Reservoir	Mann Lake	Moose Creek Reservoir	Spring Valley Reservoir	Soldier's Meadow Reservoir	Tolo Lake	Winchester Lake
Filamentous algae	18	59	23	65	34	15	29	36
Macrophytic algae	10	66	22	21	6	1	16	6
Pondweed	12	57	9	88	12	9	44	15
Elodea	---	86	---	21	2	---	---	38
Coontail	---	6	---	15	1	---	---	4
Water starwort	10	6	---	22	---	3	---	---
White water buttercup	1	---	---	---	---	1	---	2
Smartweed	---	---	2	---	---	10	---	---
Bladderwort	---	---	---	43	---	---	---	---
Needle spikerush	---	---	---	---	19	---	---	---
Bulrush	---	---	---	---	---	9	---	---
Pond Lily	---	---	---	6	---	---	---	---
Northern watermilfoil	---	4	---	---	---	---	---	---
Cattail	3	4	---	---	---	---	---	---

Appendix G. A comparison of proportion of hatchery catachable Rainbow Trout harvested by anglers (%) as estimated by creel surveys and the “Tag You’re It” tagging program for reservoirs in the Clearwater Region, Idaho, during 2012.

	Angler exploitation		
Reservoir	Creel survey	FLOY tagging	Difference
Deer Creek Reservoir	47.1	13.3	33.7
Elk Creek Reservoir	25.3	20.0	5.3
Mann Lake	20.7	16.9	3.8
Moose Creek Reservoir	68.9	18.8	50.0
Soldier's Meadow Reservoir	18.4	5.7	12.7
Spring Valley Reservoir	34.0	38.3	4.3
Waha Lake	30.4	14.1	16.3
Winchester Lake	66.3	29.9	36.4
Average	38.9	19.6	20.3

Appendix H. Number of fishing licenses sold annually in the state of Idaho from 1993 - 2013.



Appendix I. Comparisons of age, growth, and mortality metrics of Bluegill collected in lowland reservoirs in the Clearwater Region, Idaho, during standard fish surveys conducted in 2012.

					Average annual growth (mm) by age						
Reservoir	PSD	Average relative weight	Annual mortality	Average length at capture	1	2	3	4	5	6	7
Elk Creek Reservoir	23	90	81	124	46	37	38	20			
Mann Lake	55	111	---	133	54	48	52				
Moose Creek Reservoir	23	91	35	123	49	33	34	27	23	19	12
Spring Valley Reservoir	45	100	44	140	91	21	18	15	11	9	
Tolo Lake	92	131	64	182	68	46	39	29	23	28	
Winchester Lake	38	129	27	144	64	44	32	23	17	13	8
Average	46	109	50	141	62	38	36	23	19	17	10

					Average length (mm) at age							
Reservoir	PSD	Average relative weight	Annual mortality	Average length at capture	1	2	3	4	5	6	7	Theoretical maximum length
Elk Creek Reservoir	23	90	81	124	46	83	119	175				189
Mann Lake	55	111	---	133	54	100	145					165
Moose Creek Reservoir	23	91	35	123	49	83	113	142	160	165	181	193
Spring Valley Reservoir	45	100	44	140	91	113	134	151	161	165		183
Tolo Lake	92	131	64	182	68	113	153	184	209	265		276
Winchester Lake	38	129	27	144	64	108	140	164	187	209	223	223
Average	46	109	50	141	62	100	134	163	179	201	202	205

Appendix J. Comparisons of age, growth, and mortality metrics of Largemouth Bass collected in lowland reservoirs in the Clearwater Region, Idaho, during standard fish surveys conducted in 2012.

					Average annual growth (mm) at age								
Reservoir	PSD	Average relative weight	Annual mortality	Average length at capture	1	2	3	4	5	6	7	8	9
Elk Creek Reservoir	61	83	29	251	79	67	64	68	64	50	34	35	
Mann Lake	54	101	28	205	91	66	65	48	54	46	43	27	
Moose Creek Reservoir	67	82	40	250	73	58	52	43	42	52	47	49	
Spring Valley Reservoir	50	92	46	205	81	69	54	58	71	67	44	42	28
Tolo Lake	2	93	61	246	78	56	49	43	35	32	30		
Winchester Lake	8	94	33	213	72	51	46	40	34	28	30	33	34
Average	40	91	40	228	79	61	55	50	50	46	38	37	31

					Average length (mm) at age									
Reservoir	PSD	Average relative weight	Annual mortality	Average length at capture	1	2	3	4	5	6	7	8	9	Theoretical maximum length
Elk Creek Reservoir	61	83	29	251	79	146	211	290	348	406	439	470		482
Mann Lake	54	101	28	205	91	162	243	309	389	435	492	504		516
Moose Creek Reservoir	67	82	40	250	73	131	184	234	281	327	369	393		416
Spring Valley Reservoir	50	92	46	205	81	152	207	257	319	362	380	468	496	510
Tolo Lake	2	93	61	246	78	134	183	226	248	258	254			293
Winchester Lake	8	94	33	213	72	123	170	205	235	266	329	403	469	475
Region 2 Average	40	91	40	228	79	141	200	254	303	342	377	448	483	449
Beamesderfer and North (1995) Average					112	210	280	332	373	411	438	458	469	
McCauley and Kilgour (1990) Average							243	301	339	361	399	428		

Appendix K. Average number of years for Largemouth Bass to reach lengths of 305 mm and 356 mm, and for Bluegill and Black Crappie to reach lengths of 127 mm and 203 mm, in reservoirs located in the Clearwater Region, Idaho, based on age analysis of scales collected in 2012.

		Largemouth Bass		Bluegill		Black Crappie	
Reservoir	Elevation (m)	Years to 305 mm	Years to 356 mm	Years to 127 mm	Years to 203 mm	Years to 127 mm	Years to 203 mm
Mann Lake	564	4	5	3	--	2	4
Spring Valley Reservoir	853	5	8	3	--	3	6
Moose Creek Reservoir	914	6	7	4	--	3	7
Elk Creek Reservoir	982	5	6	2	--	4	7
Tolo Lake	1,003	--	--	2	5	3	--
Winchester Lake	1,204	7	8	3	6	2	--
Soldier's Meadow	1,372	--	--	--	--	3	--
Average	985	5	7	3	6	3	6

Appendix L. Options for control of nuisance aquatic vegetation for lowland lakes and reservoirs in the Clearwater Region, Idaho, including advantages, disadvantages, and estimated cost of treatment.

Management Method	Description	Treatment cost	Advantages	Disadvantages
Biological	Grass Carp (3-6 fish/acre)	$45 - $90/acre	Lon-term results, relatively inexpensive	Difficult to contain in water body, slower control than other options, potential "all or none" community response, potential increased turbidity, persistent
	Terrestrial Insects, Fungal Pathogens	N/A	Not applicable to species present	Not applicable to species present
Mechanical	Hand-Cutting/Pulling	Highly variable depending on labor costs and needs	Low-tech, Equipment is inexpensive	Labor-intensive, high labor expense; low-visibility restricts effectiveness
	Harvesting	>$600/acre	Effective and immediate removal of plant biomass	Expensive, floating plant material, resuspension of sediments, may spread infestation
	Grinding	N/A	Immediate removal of plant nuisance; no disposal issues	Resuspension of sediments, floating plant material, may spread infestation, decomposition of material in lake
Physical	Dredging	$200,000 - $800,000 (whole reservoir)	Removes plant material, creates deeper water, long-term results	Very expensive, must dispose of dredge sediment
	Drawdown	$<500	Inexpensive, can be very effective, moderate-term results	Potential severe environmental impacts for downstream and riparian areas, may allow more aggressive invasives to expand
	Benthic Barrier	$,5000 - $25,000/acre	Very effective, short-moderate term results	Expensive, best for small scale
	Shading (Aquashade®)	$20/acre-ft	Effective and generally inexpensive	Nonselective, not aesthetically pleasing, most options only applicable for small ponds and streams
	Nutrient Inactivation (Alum treatment)	N/A	Does not disturb bottom sediments	Impractical for rooted plants limited by nitrogen, clearer water can make problem worse
	Nutrient Inactivation (PhosLock treatment)	$255 - $510/acre-ft	Very effective, moderate-long term results	Expensive; Can affect phytoplankton community by reducing phosphorous concentrations
Chemical	Peroxide Based (GreenClean® Pro)	$165/acre-ft	Peroxide based algaecide, non-toxic to trout	May require multiple treatments
	Diquat (Reward®)	$158/acre	Rapid action, limited movement, few water use restrictions	Does not affect underground portion, not effective in muddy water
	Copper (Captain®)	$90/acre-ft	Rapid action, no water use restrictions	Does not biodegrade, toxic to trout
	2,4-D	N/A	Systemic	Poor public perception, more/longer water use restrictions, not effective on species present in regional reservoirs
	Endothall	N/A	Rapid action, limited movement	Does not affect underground portion, more/longer water use restrictions including 3 day restriction on using fish for food.
	Flouridone (Sonar® PR)	$1,000/acre	Few water use restrictions, low dosage, systemic	Long contact period needed
	Glyphosate	N/A	Low use restrictions, systemic	Not effective on species present in regional reservoirs
	Triclopyr	N/A	Systemic, no water use restrictions	Slow action, not effective on species present in regional reservoirs

Appendix M. Summary of responses (percent) to angler opinion surveys conducted on lowland reservoirs in the Clearwater Region, Idaho, from November 28, 2011 – November 28, 2012.

Primary reason for visiting thereservoir.

Reservoir	Fishing	Bird watching	Camping	Picnicking	Other
Deer Creek Reservoir					
Elk Creek Reservoir	54.2	----	23.6	7.3	14.9
Mann Lake	51.8	8.3	----	3.2	36.7
Moose Creek Reservoir	71.1	----	11.5	0.7	16.7
Soldier's Meadow Reservo	63.1	----	17.8	6.2	12.9
Spring Valley Reservoir	64.0	----	5.0	2.0	29.0
Tolo Lake	35.3	----	----	23.5	41.2
Waha Lake	70.1	----	----	----	29.9
Winchester Lake	82.5	0.2	3.6	1.4	12.3

Rate your fishing experience.

Reservoir	Poor	Fair	Good	Excellent
Deer Creek Reservoir				
Elk Creek Reservoir	14.1	25.5	34.8	25.6
Mann Lake	25.5	20.7	40.4	13.4
Moose Creek Reservoir	20.1	17.3	34.8	27.8
Soldier's Meadow Reservo	22.0	22.0	38.0	18.0
Spring Valley Reservoir	17.0	25.0	36.0	22.0
Tolo Lake	50.0	33.3	16.7	----
Waha Lake	14.7	28.4	30.4	26.5
Winchester Lake	21.2	16.8	34.4	27.6

What fish species are you targeting?

Reservoir	Any Fish	Rainbow Trout	Bass	Crappie	Bluegill	Perch	Catfish	Tiger Musky	Other
Deer Creek Reservoir									
Elk Creek Reservoir	5.9	45.7	----	46.2	2.2	----	----	----	----
Mann Lake	37.9	32.6	12.6	14.4	0.9	----	----	----	1.6
Moose Creek Reservoir	7.9	45.5	1.2	41.9	3.3	----	----	----	0.2
Soldier's Meadow Reservo	53.8	30.1	2.1	9.8	----	4.2	----	----	----
Spring Valley Reservoir	45.0	44.0	7.0	1.0	2.0	----	----	----	1.0
Tolo Lake	83.3	----	----	16.7	----	----	----	----	----
Waha Lake	46.2	38.7	12.3	----	----	----	----	----	2.8
Winchester Lake	40.7	42.9	2.6	2.6	7.3	1.1	0.2	0.1	2.5

Appendix M (con).

Top reason that influenced the answer given for "rate your fishing experience".

Reservoir	Poor fishing	Good fishing	Nice to be outside/having Fun	Nice weather	Poor weather	Good location/ amenities	Poor amenities	Aquatic vegetation	Other
Elk Creek Reservoir	24.7	22.1	23.6	9.7	---	---	---	6.2	---
Mann Lake	40.3	20.4	21.4	10.2	2.7	1.3	---	---	---
Moose Creek Reservoir	31.6	30.2	23.9	3.3	3.5	1.6	---	---	---
Soldier's Meadow Reservo	39.7	18.6	19.8	---	7.1	5.1	---	---	3.2
Spring Valley Reservoir	28.2	22.8	21.0	8.0	5.7	2.7	---	---	2.4
Tolo Lake	50.0	---	14.3	---	7.1	---	14.3	7.1	7.1
Waha Lake	28.7	23.8	26.2	3.3	4.9	---	3.3	---	---
Winchester Lake	28.3	29.9	21.7	4.5	3.6	3.3	---	2.7	---

Appendix N. Summary of catch and harvest (percent of total) by anglers at reservoirs in the Clearwater Region, Idaho, as estimated by a creel survey conducted from November 28, 2011 - November 28, 2012.

Angler Catch

Reservoir	Rainbow Trout	Holdover RBT	Largemouth Bass	Black Crappie	Bluegill	Pumpkin seed	Yellow Perch	Channel Catfish	Black Bullhead	Smallmouth Bass	White Crappie	Kokanee	Brook Trout	Westslope Cutthroat Trout
Deer Creek Reservoir	92.3	----	----	----	----	----	----	----	----	----	----	----	4.2	3.6
Elk Creek Reservoir	37.0	21.7	5.4	5.5	11.8	----	----	----	<0.1	0.5	----	----	18.1	----
Mann Lake	71.7	----	5.5	13.6	6.7	0.5	----	1.4	0.6	----	----	----	----	----
Moose Creek Reservoir	57.9	6.8	2.5	4.6	28.1	----	----	----	0.1	----	----	----	----	----
Soldier's Meadow Reservoir	47.3	1.4	0.4	2.1	----	----	21.6	----	27.2	----	----	----	----	----
Spring Valley Reservoir	55.2	5.7	4.5	1.5	32.1	1.0	----	----	----	----	----	----	----	----
Tolo Lake	21.6	----	38.4	30.1	6.9	----	----	1.3	----	----	1.7	----	----	----
Waha Lake	55.2	----	----	----	----	----	5.0	----	----	36.4	----	3.4	----	----
Winchester Lake	68.0	2.2	5.0	1.2	15.4	----	7.9	0.2	----	----	----	----	----	----

Angler Harvest

Reservoir	Rainbow Trout	Holdover RBT	Largemouth Bass	Black Crappie	Bluegill	Pumpkin seed	Yellow Perch	Channel Catfish	Black Bullhead	Smallmouth Bass	Kokanee	Brook Trout	Westslope Cutthroat Trout
Deer Creek Reservoir	92.9	----	----	----	----	----	----	----	----	----	----	5.4	1.7
Elk Creek Reservoir	45.4	26.1	1.0	0.2	0.4	----	----	----	----	0.1	----	26.8	----
Mann Lake	81.2	----	0.2	11.9	3.7	0.5	----	1.9	0.5	----	----	----	----
Moose Creek Reservoir	77.4	8.6	1.6	1.0	11.4	----	----	----	----	----	----	----	----
Soldier's Meadow Reservoir	69.2	----	----	1.1	----	----	29.7	----	----	----	----	----	----
Spring Valley Reservoir	73.0	7.4	1.1	0.2	17.5	0.7	----	----	----	----	----	----	----
Tolo Lake	29.9	----	19.8	50.3	----	----	----	----	----	----	----	----	----
Waha Lake	89.8	----	----	----	----	----	8.1	----	----	1.6	0.6	----	----
Winchester Lake	76.5	2.8	1.3	0.6	13.6	----	4.9	0.3	----	----	----	----	----

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