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Robert Hand, Regional Fishery Biologist
Tobyn Rhodes, Fishery Technician
Joe DuPont, Regional Fishery Manager

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2007 Clearwater Region – Fishery Management Annual Report

MOUNTAIN LAKES MONITORING IN CONSIDERATION OF AMPHIBIAN RISK ASSESSMENT IN NORTH CENTAL IDAHO

ABSTRACT

Past studies on high mountain lakes within the Clearwater Region have provided baseline information on amphibian and fish population status. This information was utilized to develop an amphibian risk assessment based on impacts from fish and the amount of fishless lakes and ponds within HUC5 watersheds throughout the Clearwater Region. In 2006, a 20 year study was designed to evaluate long term trends in amphibian populations and to determine whether fish stocking was a threat to their persistence on a watershed level. The year 2007 was the second year of this study. In 2007, Idaho Department of Fish and Game personnel completed monitoring surveys on five lakes within the Storm Creek drainage, a low amphibian risk HUC5 watershed in the Selway Bitterroot Wilderness. Fire closures throughout the watershed prohibited field crews from conducting surveys on nine lakes, therefore these lakes will be surveyed in 2008. Through visual encounter surveys, Columbia spotted frogs *Rana luteiventris* were observed in 60% of the lakes (3 of 5 lakes) while long-toed salamanders *Ambystoma macrodactylum* were not documented in any of the lakes. Past studies (1996-1997) documented Columbia spotted frogs in all five lakes and long-toed salamanders in three of five lakes. The decline in amphibian presence was observed in lakes with and without fish. Fish were documented in 40% of the lakes (2 of 5 lakes) by gill netting and visual observations in 2008. Rainbow trout *Oncorynchus mykiss* were present in one of the lakes surveyed, and westslope cutthroat *Oncorynchus clarkii lewisi*, rainbow trout, and their hybrids were present in the other lake. Fish distribution had not changed from past studies.

Authors:

Tobyn Rhodes
IDFG, Clearwater Region Fishery Technician

John Earhart
IDFG, Clearwater Region Fishery Technician

Joe DuPont
IDFG, Clearwater Region 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 decline are numerous and include: habitat destruction/fragmentation, introduction of predators/competitors, increased UV-B radiation, and pathogen infection (Alford and Richards 1999; Corn 2000; Pilliod and Peterson 2000; Marsh and Trenham 2001). Throughout the North Central Mountains of Idaho, impacts on amphibian populations from introductions of trout into historically fishless lakes are a cause for concern. Trout have been stocked into high mountain lakes to provide recreational 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 efforts or self sustaining populations from legacy stocking efforts (Bahls 1992).

High mountain lake ecosystems in North Central Idaho contain amphibians such as long-toed salamanders *Ambystoma macrodactylum*, Columbia spotted frogs *Rana luteiventris*, Idaho giant salamanders *Dicamptodon aterrimus*, western toads *Bufo boreas*, and Rocky Mountain tailed frogs *Ascaphus montanus*. The Idaho Department of Fish and Game (IDFG) Clearwater Region contains 711 mountain lakes located within the Bitterroot National Forest, Clearwater National Forest, and Nez Perce National Forest. These three national forests encompass in entirety or portions of five wilderness areas (the Frank Church, Gospel Hump, Hells Canyon, Mallard Larkins, and Selway Bitterroot). Approximately 400 high mountain lakes were previously inventoried within these management areas through cooperation between the IDFG and United States Forest Service (USFS). These surveys found that amphibians, especially long-toed salamanders, were less common in lakes with fish then lakes without fish (Murphy 2002). Other studies have examined relationships between introduced trout and salamanders. Negative impacts on amphibian populations have been attributed to trout preying upon amphibians at larval stages (Murphy 2002; Graham and Powell 1999).

Long-toed salamanders occupy a wide range over the western United States. The majority of long-toed salamanders in Idaho sub-alpine lakes have a two year larval stage making individuals more susceptible to predation by fish (Murphy 2002). No research has provided conclusive evidence that long-toed salamanders populations are declining within their respective ranges or that ranges are contracting (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 2007 was the second 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 (Figure 1). Within these national forests are eight HUC4 sub-basin drainages containing 105 mountain lake management areas at the HUC5 level. 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 River, and the Hells Canyon reach of the Snake River. The 105 HUC5 watersheds were stratified by amphibian risk class (none, low, moderate, and elevated) and two were randomly chosen from each risk class for long term monitoring over the next 20 years (Figure 2).

During 2007, all lakes surveyed occurred in the Storm Creek HUC5 watershed which is located in the Lochsa River HUC4 sub-basin on the eastern central edge of the Clearwater Region (Appendix A). The Storm Creek watershed has a drainage area of 12,705 hectares (ha). Storm Creek flows 23.0 km from the northeast and is the main tributary draining into White Sands Creek. There are 14 high mountain lakes within the Storm Creek HUC5 watershed that are located at elevations of 1,963 to 2,227 m (Appendix A). The lakes cover approximately 33.4 ha of surface area, ranging from 0.2 to 9.3 ha, and have maximum depths ranging from 0.6 to 22.0 m. Based on previous lake surveys, fish presence was documented in 36% of the lakes (5 of 14) which represented 44% of the available surface area (14.7 of 33.4 ha) (Appendix A and Table 1). At least one amphibian species was observed in all 14 lakes surveyed previously (1991, 1996 and 1997). Five of these lakes were surveyed in 2007 and included North East Ranger, Ranger, Section 27, Siah, and Storm lakes. Photos of each lake and routes taken to access them are displayed in Appendices B and C.

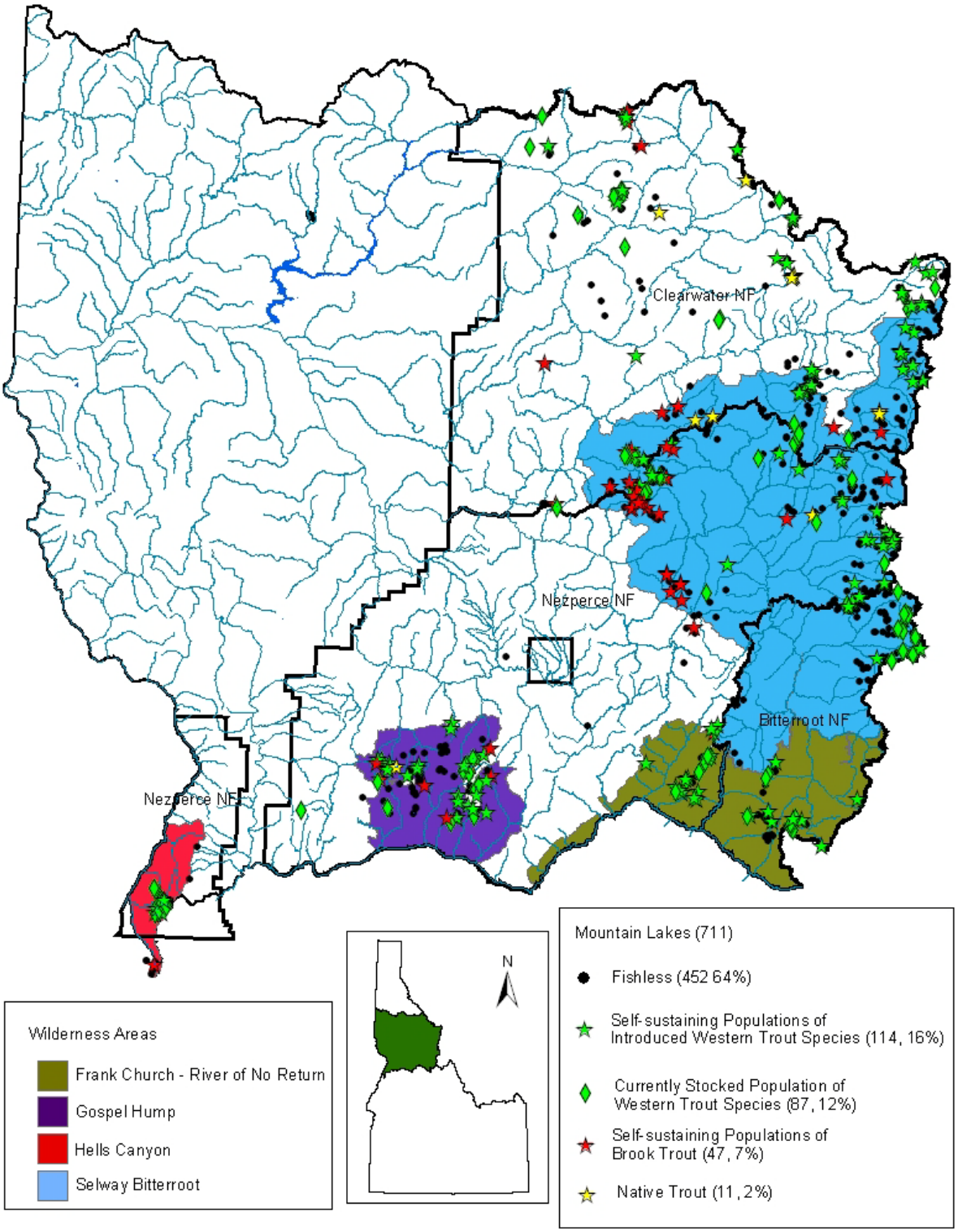

Figure 1. Distribution and fish related status of mountain lakes in the IDFG Clearwater Region indicating National Forest and Wilderness area boundaries.

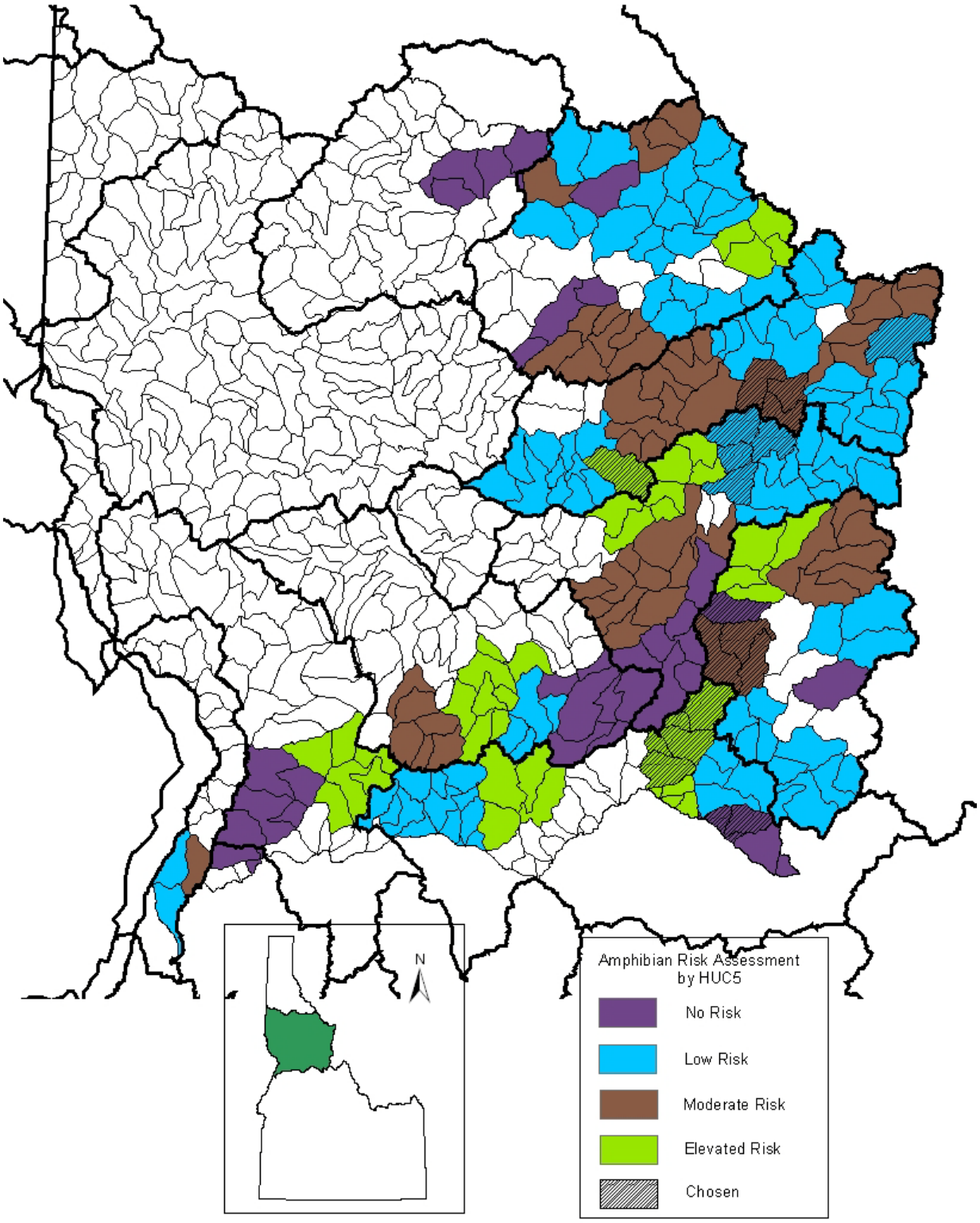

Figure 2. HUC5 watersheds classified by amphibian risk assessment with watersheds chosen for long term monitoring.

Table 1. Fish and amphibian species observed in past surveys in lakes within the Storm Creek HUC5 watershed (low amphibian risk category), Clearwater National Forest.

Lake name	Last survey date	Fish species observed	Amphibian species observed
Dan	8/21/1991	RBT	CSF
Dodge	8/20/1991	RBT	CSF
Lookout	7/30/1996	RBT	CSF
Maud	8/22/1991	None	CSF/LTS
Middle Storm	8/22/1997	None	CSF/LTS
N.E. Ranger	9/10/1996	None	CSF/LTS
N. Section 25	9/10/1996	None	CSF/LTS
N. Storm	8/22/1997	None	CSF
Old Stormy	9/10/1996	None	CSF/LTS
Ranger	9/9/1996	RBT	CSF
Section 27	9/8/1996	None	CSF/LTS
Siah	9/9/1996	RBT/WCT	CSF
S. Section 25	9/10/1996	None	CSF/LTS
Storm	8/21/1997	None	CSF/LTS

RBT=Rainbow trout, WCT=Westslope cutthroat trout, CSF=Columbia spotted frog, LTS=Long-toed salamander

METHODS

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 (Schriever 2006). The amphibian risk assessment is based on the amount of fishless habitat that exists within a watershed at the HUC 5 level. 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 HUC 5 watershed basis. The amphibian risk assessment for these high mountain lake ecosystems has four categories: control or no risk, low, moderate, and elevated (Figure 2).

- *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 AND a minimum 20% of the lake surface area within the watershed is fishless.
- *Moderate* – 50% of lakes within a watershed are fishless OR 20% of surface area is fishless.
- *Elevated* – Meets neither requirement, less than 50% of the lakes within a watershed are fishless AND 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 for sampling. This resulted in four HUC 5 watersheds containing 33 lakes within the Nez Perce N.F. and four HUC 5 watersheds containing 40 lakes within the Clearwater N.F. 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 HUC 5 watersheds to be sampled each field season. Each selected watershed will then be sampled five times over 20 years. In 2007, The Storm Creek HUC5 watershed was selected for sampling in 2007 (Figure 2). The following is a list of the HUC5 watersheds that were randomly selected.

- ⇒ Control (no risk category)
  - Goat Creek HUC5 watershed form the Upper Selway River
  - Upper Meadow Creek HUC5 watershed form Lower Selway River
- ⇒ Low risk category
  - N.F. Moose Creek HUC5 watershed from Lower Selway River
  - Storm Creek HUC5 watershed from Lochsa River
- ⇒ Moderate risk category
  - Running Creek HUC5 watershed from Upper Selway River
  - Warm Spring Creek HUC5 watershed from Lochsa River
- ⇒ Elevated risk category
  - Bargamin Creek HUC5 watershed from Middle Salmon River
  - Old Man Creek HUC5 watershed from Lochsa River

Sampling protocol can be separated into three separate sections including examining indicators of amphibian populations, fish stock, and lake habitat characteristics (Appendix D). Amphibians were surveyed by using a modified Visual Encounter Survey (VES) (Crump and Scott 1994). All amphibians encountered were counted, identified to species, and the life stage they were in. Amphibian larvae (especially Columbia spotted frogs) encountered in large groups and were denoted in data sheets as TMTC or Too Many To Count. Amphibian sampling was performed from shore or wading through the littoral zone when the lake substrate permitted. Each VES was performed twice in order to determine a detectability estimate.

Over night gill net sets (~12 hrs.) were conducted on each lake to assess the fishery. Gill nets were set and retrieved by the use of a float tube. Gill nets used were packable Swedish multi-meshed 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 was set nearest to the shore. Captured fish were weighed and measured for total length. Stomach samples and scales were collected from all fish mortalities which was usually high among trout. Stomach sample analyses were collected to determine if trout captured in the gill nets were preying upon amphibians. Scale samples were collected to determine fish age and will be compared to stocking records to determine if natural recruitment is occurring. Stomach samples and scales will be examined when sufficient funding is acquired. Fish data will be analyzed by examining length frequency indices and Catch Per Unit Effort (CPUE) for each gill net set.

Zooplankton samples were collected from a series of horizontal shallow (at 5 m in length from shoreline and just below lake surface) and 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 was 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 (bathometry) determined by making multiple traversing passes with a portable depth sounder. Each lake was given a brief description including: location of surrounding forest, talus slopes, inlets, outlets, associated wetlands, large rocks, woody debris, 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, date, time, weather, slope, aspect, national forest, ranger district, campsite inventories, and directions/distance from trailheads. Zooplankton samples will be stored and analyzed when sufficient funding is acquired. 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).

Data from this sampling effort will be pooled with past data (Appendix E). After all lakes are surveyed from each of the randomly selected HUC5 watersheds an analysis will be conducted to evaluate the impacts that native and stocked fish have on the long term persistence of amphibians. This will be done on both the HUC5 and HUC4 watershed levels.

RESULTS

Mountain lakes field personnel from the IDFG and USFS (Clearwater National Forest) worked collaboratively in 2007 to conduct mountain lake surveys. Personnel surveyed five lakes in the Storm Creek HUC5 watershed. Wildland fire and subsequent area closure prevented personnel from sampling all 14 lakes in the Storm Creek watershed and all lakes in the Warm springs Creek watershed during the 2007 field season. The five Storm Creek watershed lakes sampled in 2007 were; Northeast Ranger, Ranger, Section 27, Siah, and Storm lakes. The lakes ranged in size from 0.3 to 5.4 ha, in maximum depth from 1.0 to 22.0 m, and in elevation from 1,963 to 1,999 m (Table 2). Lakes within the Storm Creek watershed were previously sampled in 1991, 1996, and 1997 (Table 1). During 2007, fish (previously stocked salmonids) were present in 40% of lakes (2 of 5) which represented 56% of lake surface area sampled (Tables 3). Fish species present in the lakes sampled were westslope cutthroat trout *Oncorhynchus clarkii lewisi*, rainbow trout *Oncorhynchus mykiss*, and rainbow x westslope cutthroat hybrids (Table 3). Amphibians were observed in 60% of lakes (3 of 5) and 43% of lake surface area sampled in 2007 (Table 3). Fish and amphibians occurred together in 20% of lakes (1 of 5) which represented 37% of lake surface area sampled.

Table 2. General characteristics of the five lakes surveyed in the Storm Creek HUC5 watershed (low amphibian risk category), Clearwater National Forest, in 2007.

Lake name	Survey date	Longitude WGS 84	Latitude WGS 84	Size (ha)	Maximum depth (m)	Elevation (m)
N.E Ranger	7/11/2007	114.4062	46.5186	0.32	1.0	1999
Ranger	7/10/2007	114.4160	46.5149	2.74	4.2	1999
Section 27	7/9/2007	114.4383	46.5168	0.47	1.2	1999
Siah	7/8/2007	114.4437	46.5232	5.26	21.9	1963
Storm	7/21/2007	114.3623	46.5562	5.42	12.3	1992

Table 3. Comparisons of fishes and amphibians observed in five high mountain lakes located within the Storm Creek HUC5 watershed, Clearwater National Forest, between 2007 and the most previous time surveyed.

Lake name	Previous survey date	Previous fish species	2007 fish species	Previous amphibians	2007 amphibians
N.E Ranger	9/10/1996	None	None	CSF/LTS	CSF
Ranger	9/9/1996	RBT	RBT	CSF	None
Section 27	9/8/1996	None	None	CSF/LTS	CSF
Siah	9/9/1996	RBT/WCT	WCT/RBT/ Hybrids	CSF	CSF
Storm	8/21/1997	None	None	CSF/LTS	None

RBT=Rainbow trout, WCT=Westslope cutthroat trout, CSF=Columbia spotted frog, LTS=Long-toed salamander

Both lakes with fish (Siah and Range lakes) are considered II.A management classification types (fish present and low/moderate natural reproduction; Appendix F). Ranger Lake was last stocked in 1974 with rainbow trout fry. Siah Lake was last stocked with rainbow trout fry in 1989 and with cutthroat fry in 1994. Fish presence in these lakes represents no change from historical inventories and management classification (Table 3). An overnight gill net set (12.5 hrs.) on Ranger Lake captured 11 rainbow trout, with a CPUE of 0.88 fish per hour (Table 4). Rainbow trout captured from Ranger Lake ranged in length from 125 to 405 mm and in weight from 115 to 625 g (Figures 3 and 4; and Table 5). An over night gill net set on Siah Lake (15 hrs.) captured 23 fish (westslope cutthroat, rainbow, and cutthroat x rainbow hybrids) with a CPUE of 1.53 fish per hour (Table 4). Fishes captured in Siah Lake ranged in length from 106-473 mm and in weight from 9 to 1,015 g (Figures 5 and 6; and Table 5).

Table 4. Summary of fish lengths captured in overnight gill net sets in the Storm Creek HUC5 watershed (2007), Clearwater National Forest.

Lake name	Min. fish weight (g)	Max. fish weight (g)	Average weight (g)	Standard deviation
Ranger Lake	115	625	320	170
Siah Lake	9	1015	324	265

Table 5. Summary of fish weights captured in overnight gill net sets in the Storm Creek HUC5 watershed (2007), Clearwater National Forest

Lake name	CPUE (fish/hr)	Min. fish length (mm)	Max. fish length (mm)	Average length (mm)	Standard deviation
Ranger Lake	0.88	125	405	285	74
Siah Lake	1.53	106	473	294	87

In 2007, no long-toed salamanders were observed in the five lakes sampled (Table 6) whereas in previous surveys, long-toed salamanders were observed in 3 of the 5 lakes sampled (Table 3). This represents a 60% decline in the number of lakes and a 43% decline in lake surface area from where long-toed salamanders were previously observed. Columbia spotted frogs were observed in 60% of lakes (3 of 5) and 42% of lake surface area sampled in 2007 (Table 6) whereas previously Columbia spotted frogs were observed in all five lakes (Table 3). This represents a 60% decline in the number of lakes and a 58% decline in lakes surface area from where Columbian spotted frogs were previously observed.

Northeast Ranger and Section 27 Lakes were considerably smaller in size in 2007 (~0.15 and ~0.10 ha respectively) than in 1996 (0.32 and 0.47 ha respectively). Fire burned through much of the area in the Storm Creek HUC5 watershed in 2003 and burnt forested areas directly adjacent to Ranger, Section 27, and Siah lakes.

Table 6. Summary of findings from visual encounter surveys in 2007 mountain lakes surveys in the Storm Creek HUC5 watershed (low amphibian risk category), Clearwater National Forest.

Lake name	CSF adults	CSF subadults	CSF larva	CSF egg masses	CSF total	LTS adults	LTS larva	LTS total
N.E Ranger	3	0	TMTC	0	3	0	0	0
Ranger	0	0	0	0	0	0	0	0
Section 27	2	3	TMTC	0	5	0	0	0
Siah	8	10	TMTC	0	18	0	0	0
Storm	0	0	0	0	0	0	0	0

CSF=Columbia spotted frog, LTS=Long-toed salamander, TMTC=Too many to count

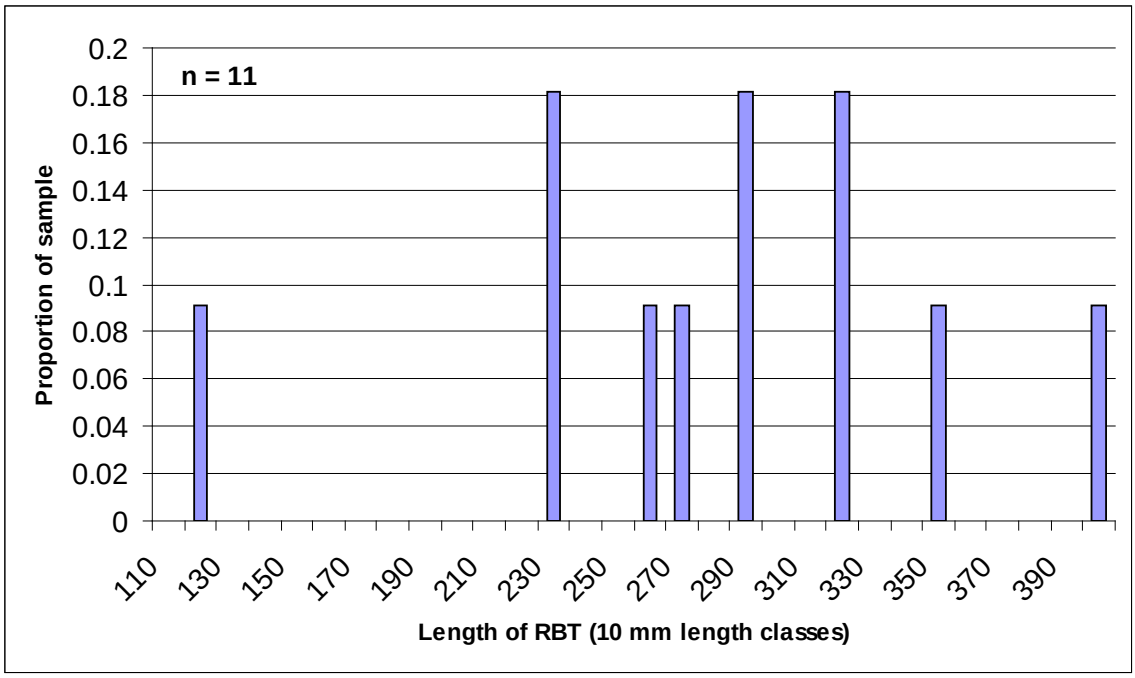

Figure 3. Length frequency of rainbow trout captured in overnight gill net set (2007) on Ranger Lake, Clearwater National Forest

Figure 4. Rainbow trout captured from overnight gill net set (2007) on Ranger Lake, Clearwater National Forest.

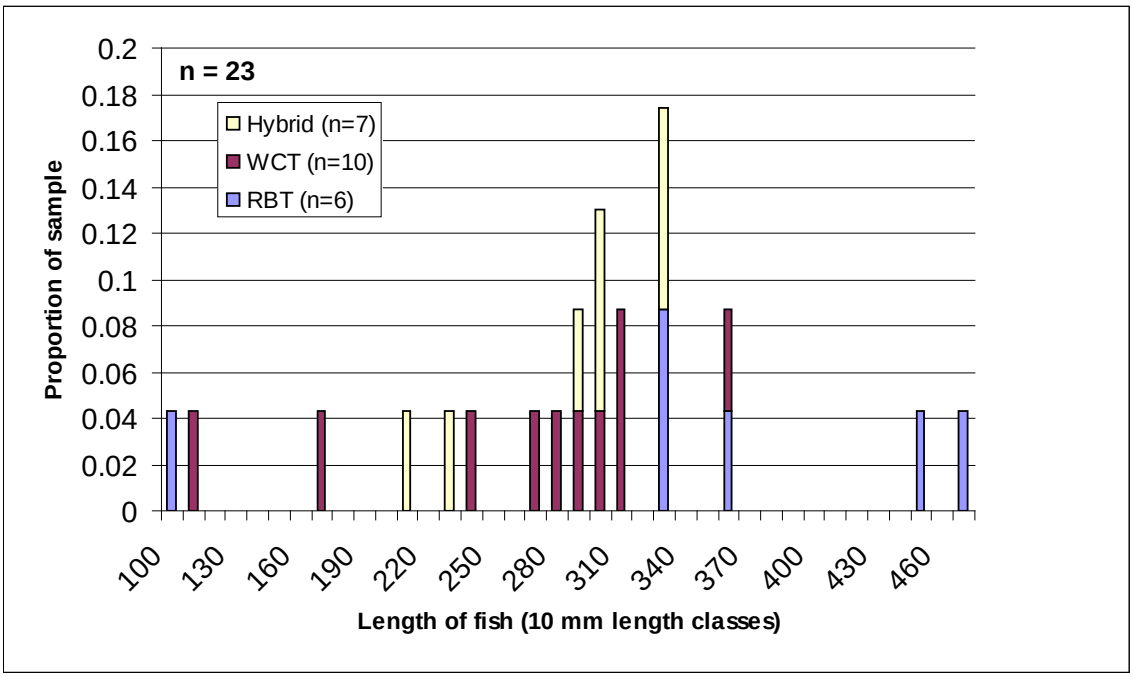

Figure 5. Length frequency of rainbow, westslope cutthroat, and rainbow x cutthroat hybrid trout captured in overnight gill net set (2007) on Siah Lake, Clearwater National Forest.

Figure 6. Rainbow trout, westslope cutthroat trout, and rainbow x cutthroat hybrid captured from overnight gil net set (2007) on Siah Lake, Clearwater National Forest.

DISCUSSION

Occurrence of amphibians on a HUC5 watershed basis can be analyzed in 2008 when all lakes within the Storm Creek HUC5 watershed will be sampled. Preliminary work in 2007 suggests that amphibian distribution in the lakes we surveyed has diminished. This does not appear to be related to the presence of fish as both lakes with and without fish experienced an absence of amphibians from previous surveys.

Fire burned through the Storm Creek watershed in 2003 and again in 2007. Fire effects may temporally disrupt breeding and amphibian movements which may change amphibian occupancy (observations). However, a study by Hossack and Corn (2007) found that fire did not negatively impact the distribution of Long-toed salamanders or Columbia spotted frogs and that in recently burned wetlands both occupancy and colonization of each species actually increased for two to three years after the fire. Work by Owen (1989) found that extended periods of drought can influence salamander and frog occurrence in lakes. Below average snow pack (major form of precipitation in Northern Idaho) and above average temperature has occurred for the past 10-15 years in our study area and may explain the reason for the decline in amphibian occurrence in the lakes we surveyed in 2007. Other factors also believed to influence amphibian abundance and distribution include: increases in UVA and UVB radiation, changes in water temperature or chemistry, wetland loss, disruption of amphibian population dynamics, change in fish population structure, the high degree of variability in amphibian breeding, and/or amphibian infections or pathogens such as *Batrachochytrium dendrobatidis* (Bd Chytrid) the causative agent of chytridiomycosis (Gibbs 1993; Bradford et al. 1994; Blaustein et al. 1998; Knapp et al. 2001; Daszak et el. 2003; Linder et al. 2003,). A study by Carey (1993) suggests that localized stressors such as increases in UVA, UVB, and or reduced hydroperiod may act to suppress the immune systems of amphibians and that making them more susceptible to the infection of fungal pathogens like Bd chytrid. Thus, multiple stressors may be the cause (and act to compound) amphibian decline in many areas (Linder et al. 2003).

Eutrophication, infilling, and/or lower water levels will impact the abundance of lakes and size of lakes (both depth and surface area) within a watershed, all of which may have ramifications on mountain lake management, amphibian risk assessment classifications, and amphibian population dynamics. As eutrophication, infilling, and/or lower water levels of mountain lakes occurs, HUC5 watershed amphibian risk amphibian 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 Section 27 Lake provides an example of change in total lake surface area and the amount of lakes in the Storm Creek Watershed. The change of Section 27 Lake to an open meadow represents a 0.47 ha reduction in surface area within the Storm Creek watershed (reducing the overall lake surface area within the watershed from 33.37 ha to 32.90 ha) and reducing the amount of lakes from 14 to 13.

This year (2007) was the second year of the long term monitoring project, thus temporal and spatial patterns in amphibian occurrences can not yet be determined because multiple cycles of sampling are necessary. A long term trend analysis of amphibian occurrence is needed to determine if fish presence and fishless habitat influence amphibians on a HUC5 watershed basis. Furthermore, if amphibian occurrence is impacted by fish presence then management can be changed to reflect more appropriate stocking areas, schedules, and densities.

RECOMMENDATIONS

Continuation of monitoring of HUC5 watersheds within the Clearwater Region is recommended as part of the long-term amphibian risk assessment. In 2008, field crews will work into the fall sampling mountain lakes in attempts to survey any lakes that field crews were unable to survey as part of the monitoring effort in 2006 and 2007. Managers from the IDFG and USFS may want to consider a manner in which to classify fire effects documented in mountain lakes monitoring.

ACKNOWLEDGEMENTS

Funding for 2007 high mountain lakes monitoring was a shared effort between IDFG, Clearwater Region and USFS, Clearwater National Forest. Personnel from IDFG and USFS cooperated on monitoring of lakes in the Clearwater National Forest and Selway-Bitterroot Wilderness. Field personnel that aided in 2007 mountain lakes monitoring include; Ed Kee and Dave Schoen from the USFS, Clearwater National Forest and John Earhart from the IDFG, Clearwater Region.

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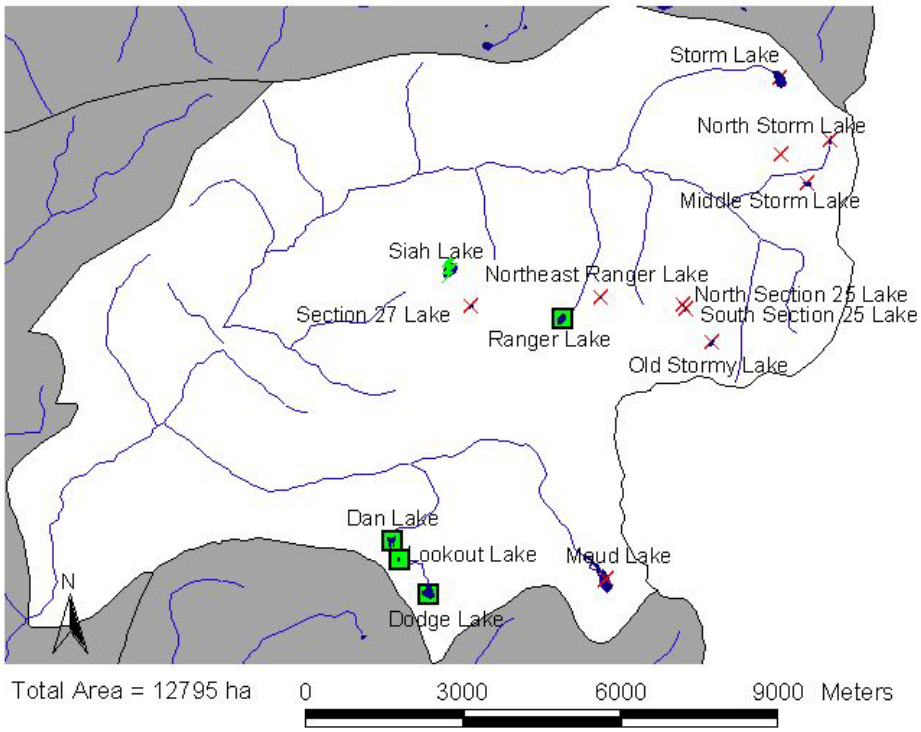
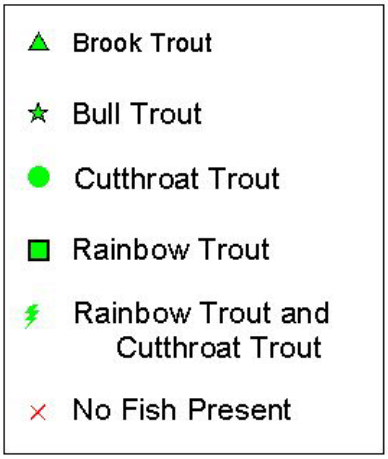
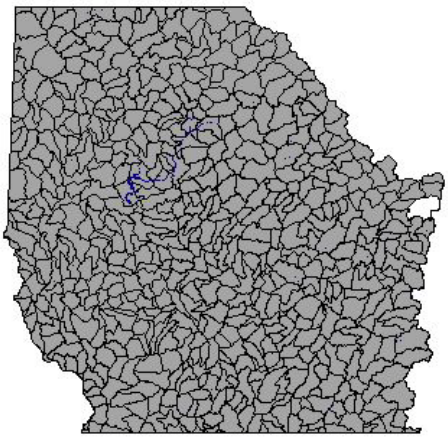
APPENDICES

Appendix A. Storm Creek watershed, mountain lakes management area (Clearwater National Forest), historical fish, and amphibian status within these lakes.

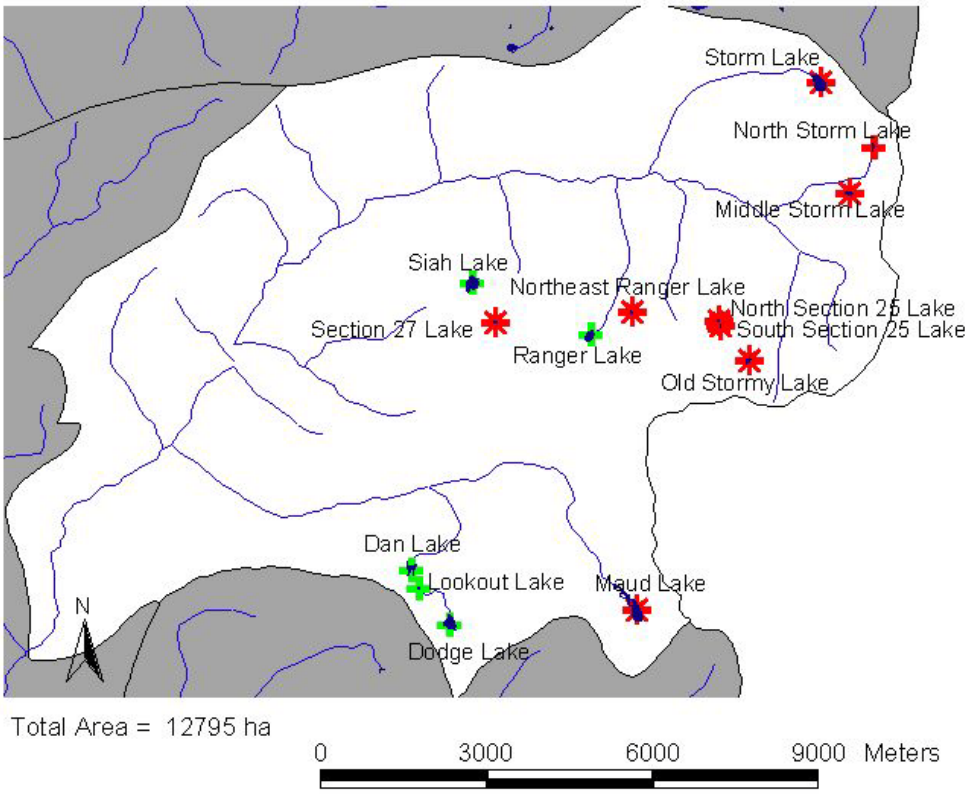


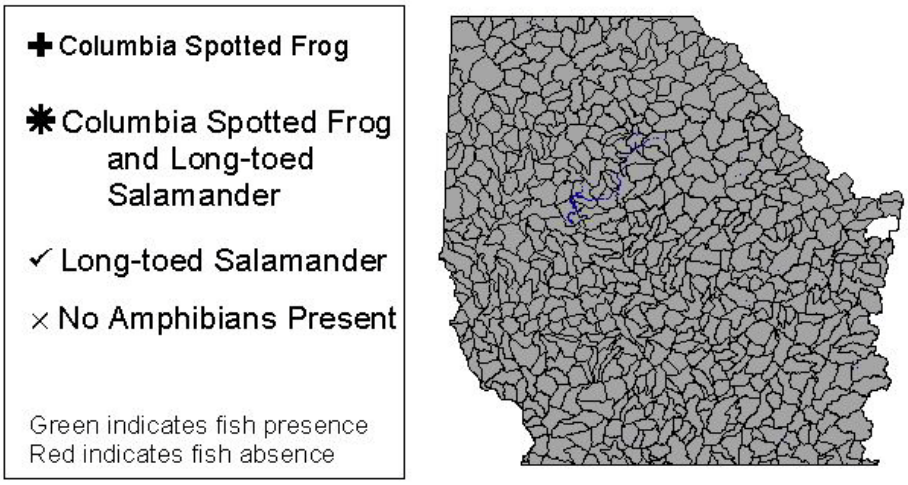




Historical Fish Status.

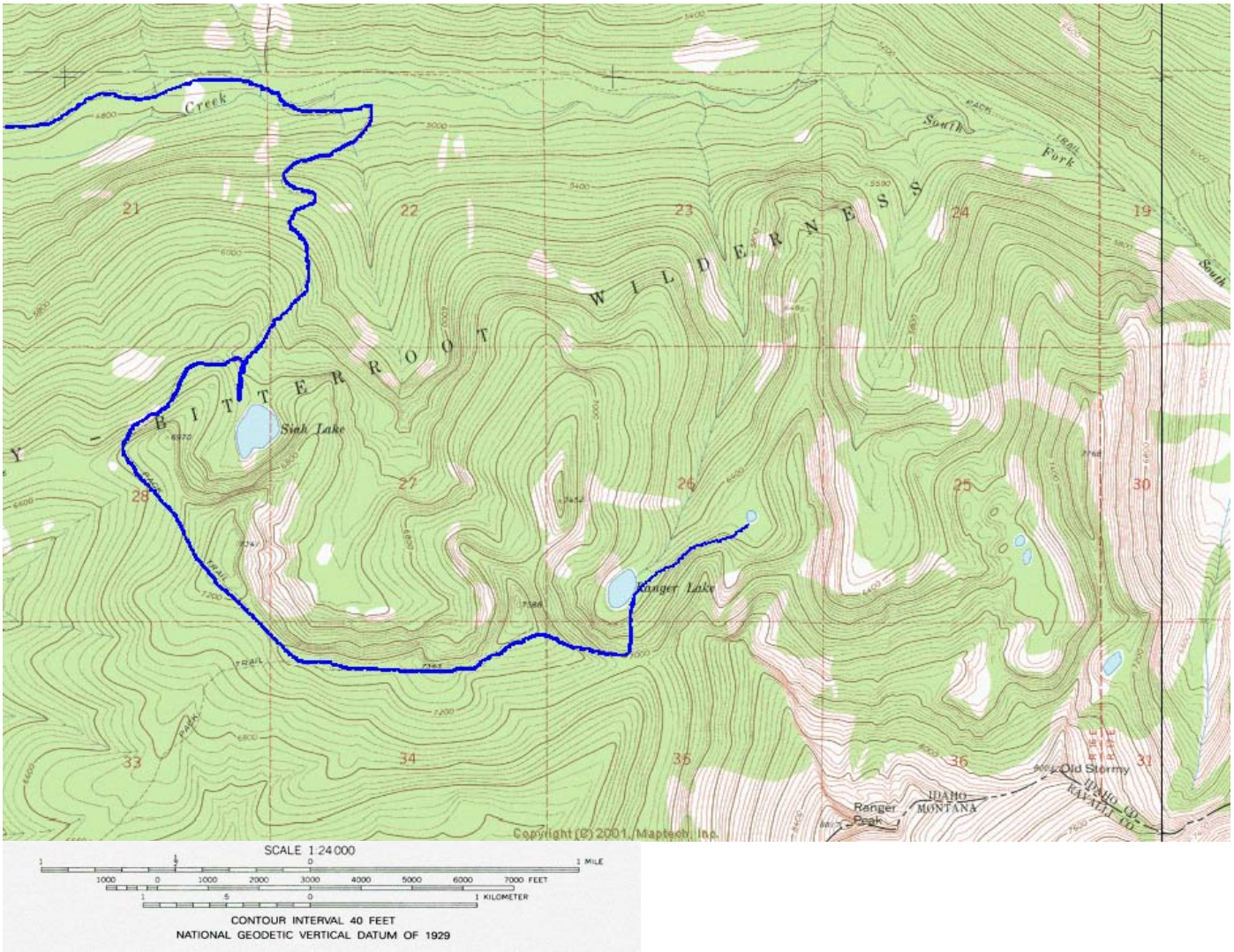
Appendix A. Continued.





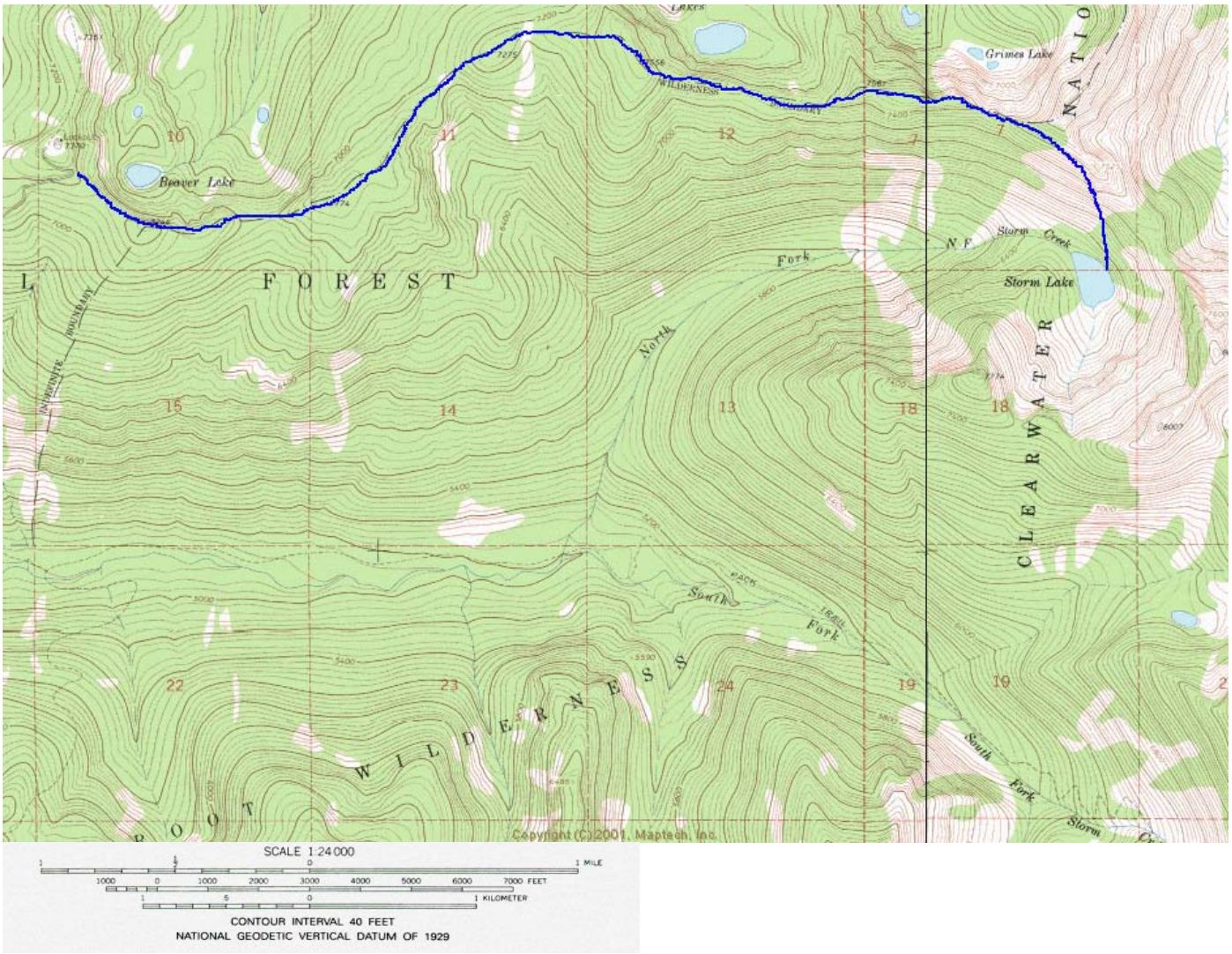
Historical amphibian status

Appendix B. Topographic maps of lakes surveyed in 2007 located in the Storm Creek Watershed, Clearwater National Forest, and the routes used to access each lake.



Routes used to access Siah, Ranger, and N.E. Ranger lakes.

Appendix B. Continued.



Route used to access Storm Lake.

Appendix C. Photographs showing lakes surveyed in 2007 from the Storm Creek HUC5 watershed in the Clearwater National Forest.

Northeast Ranger Lake

Appendix C. Continued.

Ranger Lake

Section 27 Lake

Appendix C. Continued.

Siah Lake

Appendix D. Clearwater Region mountain lakes data sheet (page 1).

HIGH MOUNTAIN LAKES SURVEY DATA SHEET

Lake Name:	**Survey Date (mm-dd-yy)**
Drainage:	**Legal Description:** Township - Range - Section -
County:	**Elevation (m)**
National Forest – Ranger Distict	**Northing (GPS) -** **Easting (GPS) -**
Crew Members:	**Topo Map (7.5')**
	IDFG Lake #

Lake Description:

HABITAT PARAMETERS

Physical Data	**Chemical Data**
Surface Area (Hectares) -	**Conductivity (µs) -**
Aspect -	**pH -**
Maximum Lake Depth (m) -	**Water Temperature (° C) (shallow) -**
% Bottom Composition < than 3.0 m deep(littoral) -	**Air Temperature (°C) -**
Secchi Disc (m) -	**Weather -**

Littoral zone substrate composition (%)

Bedrock _____ Boulders_____ Rubble_____ Gravel_____ Sand_____ Silt_____ Organic debris_____ Logs_____

Stream Characteristics

Stream	1	2	3	4	5	6	7
Inlet (I) of Outlet (O)							
Width (m)							
Depth (m)							
Water Speed (1 – 4)							
Dominant Substrate							
Barrier Type							
Distance to Barrier							
% Spawning Sub, (Gr,Sa), 1 – 50 m							
Number of fish observed							

Mountain lakes data sheet (Page 2).

Forest Cover

% Shore Forest Cover (0-10m) _____ | % Open Ground (0- 10 m) _____

Dominant Tree Species and % of each:

Fish Population Data

Fish Species present:

Gill Net – Time and CPUE: _____ | Angling – Time and CPUE: _____

Last Year Stocked (Year, Date, Species, Density) -

Number - Species	Length (mm)	Weight (g)	Number - Species	Length (mm)	Weight (g)
1.			11.		
2.			12.		
3.			13.		
4.			14.		
5.			15.		
6.			16.		
7.			17.		
8.			18.		
9.			19.		
10.			20.		

Fish Stomach Content -

Fish Condition -

Zooplankton Samples

Deep Tows (2 tows and Depth (m) of tows) - | Shallow Tows (4 tows, 5 m. in length) -

Aquatic Invertebrates

Family and Abundance -

1.	5.
2.	6.
3.	7.
4.	8.

Amphibian Survey (VES)

Survey Description:

Survey Start Time (hhmm)_____ Total Survey Duration - _____

Species	# Adults	# Subadults	# Larvae	# Egg Masses	Comments
Columbia Spotted Frog					
Western Long-toed Salamander					
Tailed Frog					
Common Garter Snake					
Western Terrestrial Garter Snake					

Animal Observations

Species	# Number	Location	Species	# Number	Location
1.			6.		
2.			7.		
3.			8.		
4.			9.		
5.			10.		

Campsite Impacts

Campsite ID.	Size(m)	Impact	Campsite ID.	Size(m)	Impact
A			C		
B			D		

% of Lake Accessible by Trail _____ Total Distance to Lake from Trailhead (km) _____ Distance Bushwacked (km)

Appendix E. Data from high mountain lake surveys in 2006 in the Clearwater Region that will be used in the long term assessment evaluating the impacts of native and stocked fish on the long term persistence of amphibians.

Lake Name	HUC5 Watershed	Amphibian Risk Rating	Previous Survey Date	Previous Fish Status	2006 Fish Status	Previous Amphibians Observed	Amphibians Observed in 2006
Bilk Mountain	Goat Creek	Control	8/10/2003	None	None	CSF	CSF/LTS
Florence	Old Man Creek	Elevated	7/23/1991	WCT	WCT	CSF/LTS	CSF/LTS
Goat	Goat Creek	Control	7/9/1986	None	Not Surveyed	CSF	Not Surveyed
Fox Peak (lower)	N. Fork Moose Creek	Low	8/28/2001	None	None	CSF/LTS	CSF
Fox Peak (upper)	N. Fork Moose Creek	Low	8/28/2001	None	None	CSF/LTS	CSF
Isaac	N. Fork Moose Creek	Low	8/17/1988	RBT/WCT	WCT	CSF	CSF
Isaac Creek	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF
Mud	Goat Creek	Control	8/11/2003	None	None	CSF/LTS	CSF/LTS
Section 28	N. Fork Moose Creek	Low	8/30/2001	None	Not Surveyed	CSF/LTS	Not Surveyed
West Moose (#1)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF/LTS
West Moose (#2)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF/LTS
West Moose (#3)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF/LTS
West Moose (#4)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF/LTS
West Moose (#5)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF/LTS
West Moose (#6)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF/LTS
West Moose (#7)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF
West Moose (#8)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF
West Moose (#9)	N. Fork Moose Creek	Low	Not surveyed	None suspected	None	Not Surveyed	CSF

RBT=Rainbow trout, WCT=Westslope cutthroat trout, CSF=Columbia spotted frog, LTS=Long-toed salamander

Appendix F. Mountain lake fish management classifications .

Management classification	Classification meaning
I.A.	Fishless lake with stocking record
I.B.	Fishless lake with no stocking record
II.A.	Fish present with low/moderate natural reproduction
II.B.	Fish present with high level of natural reproduction
III.A.	Native trout lake with possible pure strain
III.B.	Native trout lake - probable hybrids from past stocking
IV.A.	Stockable lake not suitable for further stocking
IV.B.	Stockable lake suitable for further stocking

TIGER MUSKELLUNGE AS A BIOLOGICAL CONTROL AGENT OF BROOK TROUT IN NORTH CENTRAL IDAHO MOUNTAIN LAKES

ABSTRACT

Self-sustaining brook trout *Salvelinus fontinalis* populations within lakes in north central Idaho are legacy remnants of past stocking efforts. Bull trout *S. confluentus* recovery and/or persistence in areas downstream of these high mountain lakes may be affected by the presence of brook trout. In cooperative efforts between the Idaho Department of Fish and Game (IDFG) and the United States Forest Service (USFS), F_1 tiger muskellunge hybrids (male northern pike *Esox lucius* and a female muskellunge *E. masquinongy with* male hybrids functionally sterile and females with reduced reproductive capabilities) were stocked at high densities (40 fish/hectare of lake surface area) into 4 lakes containing brook trout populations on June 29, 2006. Tiger muskellunge were introduced into these lakes to eliminate or suppress the brook trout that occurred in them and decrease the threat to downstream native fish populations. These lakes were Fly, Heather and Platinum lakes in the North Fork Clearwater River HUC4 watershed and Running Lake in the Upper Selway River HUC4 watershed. Prior to the tiger muskellunge introduction, IDFG and USFS personnel performed Petersen mark and recapture surveys on June 23-26, 2006 and October 30, 2004 using angling and gill netting to determine brook trout population estimates in Fly, Platinum, Heather, and Running Lakes. Additionally, gill netting efforts were utilized to assess the size structure and CPUE of brook trout on all four lakes. All four lakes were resurveyed in 2007 to assess changes in the brook trout populations and size compositions. Results from 2007 showed significantly larger cumulative length frequency distributions and decreases in CPUE of brook trout in Fly, Platinum, and Running Lakes while no significant changes were observed in Heather Lake. The significant reduction of small size classes of brook trout in the three lakes was likely due to tiger muskellunge predation. Fly and Platinum lakes, were considerably smaller than Running and Heather lakes and the changes in brook trout population size structure and CPUE was much more evident. Further sampling of the lakes to assess the impacts from Tiger Muskellunge introductions will continue through 2010.

Brook trout removal efforts from 2005 to 2007 in the Ice Meadow section of Elizabeth Creek have resulted in an 82% reduction in their abundance. Decreases were not as pronounced from 2006 to 2007 as it was from 2005 to 2006. Although the number of brook trout removed in 2007 was less than was removed in 2006 the CPUE actually increased in 2007. It's unclear if this is because more effort occurred in 2006 or if was because the fish were larger in 2007 making them easier to collect. Regardless, this suggests that as brook trout abundance decreases the ability to totally eliminate them from Elizabeth Creek may become more difficult.

Authors

Tobyn Rhodes, Fishery Technician
John Earhart, Fishery Technician
Joe DuPont, Fishery Manager

INTRODUCTION

In the mid 20th century, brook trout *Salvelinus fontinalis* were introduced into mountain lake ecosystems throughout Idaho. Several lakes of the Five Lakes Butte area which drain into headwater streams of the North Fork of the Clearwater River (NFCR) HUC 4 drainage and some lakes within the Selway River HUC4 drainage were previously stocked with brook trout and continue to maintain self-sustaining populations of brook trout (Figure 1). Brook trout can often coexist with native fish species (Gunckel et al. 2002), although, brook trout have been found to impact bull trout *S. confluentus* populations through competitive interaction, predation, and hybridization (Scott and Crossman 1973; Cavendar 1978; Leary et al.1983; Balon 1984; Markle 1992; Mullan at al. 1992; Rieman and McIntrye 1993). Bull trout are currently listed as a threatened species under the Endangered Species Act (USFWS 1998). Brook trout have also been found to displace native westslope cutthroat *Oncorhynchus clarkii lewisi* through interspecific competition (Irving1987; Griifith 1988; Dunham et al. 2000; Dunham et al. 2002). The removal of brook trout should reduce the risks to native fish assemblages. However the removal of self sustaining brook trout populations has proved difficult (Dunham et al. 2002).

One technique that has been attempted to eliminate brook trout in mountain lakes is the introductions of tiger muskellunge (F_1 hybrid, a male Northern pike *Esox lucius* and a female Muskellunge *E. masquinongy*) (Schriever and Murphy IDFG draft). Tiger muskellunge males are functionally sterile and the females have reduced reproductive capabilities. Consequently, there are no risks of developing self sustaining tiger muskellunge populations when stocked into water bodies. Tiger muskellunge have aggressive piscivirous feeding habits and is typically utilized in sport fisheries to augment other fish populations in lowland lake settings. When stocked at low densities tiger muskellunge usually do not have a controlling effect on other fish populations (Schriever and Murphy IDFG draft). A typical stocking rate of tiger muskellunge is approximately ten fish per hectare of lake surface area. Stocking tiger muskellunge at high densities, such as 40 fish per hectare, however, has been found to eliminate brook trout from high mountain lakes in some cases (Schriever and Murphy IDFG draft). Tiger muskellunge that escape lakes which they were stocked will likely have low rates of survival due to the high gradient streams indicative of north central Idaho headwater areas (Schriever and Murphy IDFG draft).

Tiger muskellunge were introduced into two high mountain lakes (Ice Lake in the NFCR drainage and Lower Rainbow Lake in the Selway River drainage) in 1998 and 1999 by the IDFG Clearwater Region and Clearwater and Nez Perce national forests to evaluate their effectiveness at removing brook trout. The success of this program varied largely on the density of tiger muskellunge introduced into the lakes. One lake (Ice Lake) was stocked with a high density of tiger muskellunge (40.7 fish per hectare of surface area); and when coupled with the removal of brook trout from lake inlets and outlets by electrofishing, was successful in removing brook trout from the lake. The other lake (Lower Rainbow Lake) was initially stocked with a low density of tiger muskellunge (5.7 fish per hectare of surface area and five years later stocked at a high density of 40 fish per hectare). Brook trout abundance and their size structure significantly changed in this lake but were not successfully removed. To further evaluate the use of tiger muskellunge as a control or suppressing agent on brook trout, the IDFG and USFS selected four lakes to introduce tiger muskellunge into. All four lakes had self sustaining brook trout populations and fed into tributaries with native bull trout and westslope cutthroat trout. Specifically the objectives of this study were as follows:

OBJECTIVES

1. Evaluate factors that influence the success on tiger muskellunge introductions in reducing or removing brook trout populations from high mountain lakes.

2. Evaluate the use of electrofishing in removing brook trout from low gradient sections of stream.

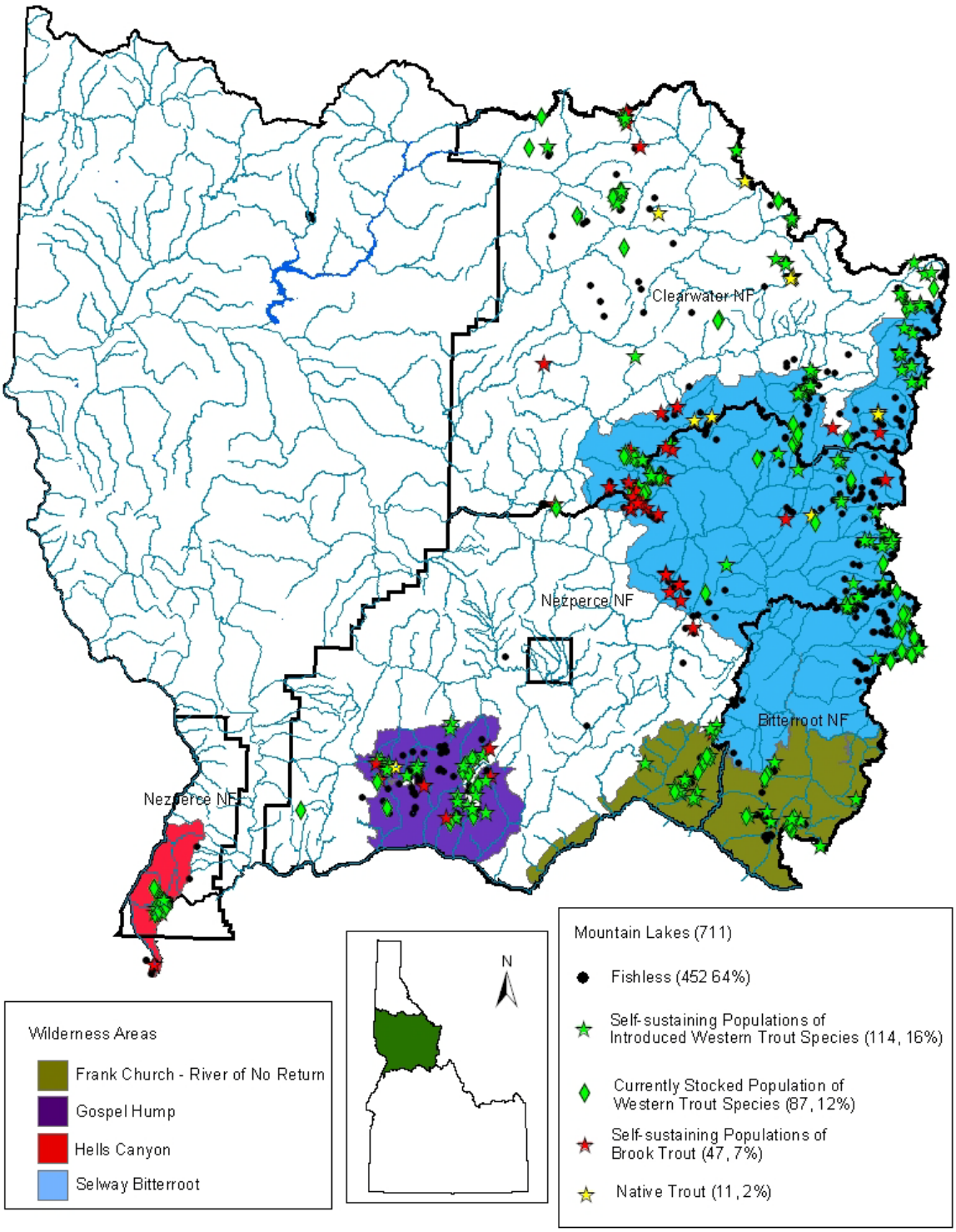


Figure 1. Distribution and fish related status of mountain lakes in the IDFG Clearwater Region.

STUDY SITE

Tiger muskellunge were introduced into Fly, Heather, Platinum, and Running lakes. Fly, Heather, and Platinum lakes are located in the Clearwater National forest and drain into Meadow Creek, a tributary to the upper NFCR HUC5 watershed (Appendix A). High densities of bull trout and westslope cutthroat occur in Meadow Creek (Hanson et al. 2006). Fly, Platinum, and Heather lakes are considered a concentrated source population of brook trout that may affect downstream native fish populations. Running Lake is located in the Nez Perce National Forest and drains into Running Creek, a headwater tributary to the Upper Selway River HUC 4 sub-basin drainage (Appendix A). Running Creek also has native bull trout and cutthroat trout (USFWS 1998). Running Lake is considered a large source population of brook trout in the Selway River drainage. The Ice Meadow section of Elizabeth Creek was revisited in 2007 for the third time to conduct brook trout removal. This low gradient section of stream is a tributary to the Black Canyon reach of the NFCR within the Clearwater National Forest (Appendix A).

Fly Lake

Fly Lake is situated 7.9 km south of the Five Lakes Butte area and 3.2 km north of Fly hill within the Clearwater National Forest. Fly Lake is located in a cirque type landform with a north-east aspect and is completely surrounded by sub-alpine forest composed mostly of sub-alpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) (Appendix B). Fly Lake is at an elevation of 1,652 m, has a maximum depth of 3.3 m, and a surface area of 1.02 ha. There is a small amount of woody debris that has collected around the single lake outlet. Fly Lake's littoral zone is composed mainly of silt (Table1). Fly lake has multiple small inlets that field crews classified as seeps which were composed mainly of silt substrates (Table 2). The single outlet to Fly Lake (situated on the northeast shore of the lake) drains into a high gradient unnamed stream and has a substrate dominated by boulders and rubble (Table 3). The unnamed stream formed by the Fly Lake outlet converges with Meadow Creek 11.7 km upstream from the confluence of Meadow Creek and the upper NFCR. The route used to access Fly Lake can be referenced in Appendix C.

Heather Lake

Heather Lake is located in the Five Lakes Butte Area within the Clearwater National Forest. Heather Lake is located in a low cirque type landform with a north-west aspect and is surrounded by sub-alpine forest and Idaho granitic bedrock batholithic outcroppings (Appendix B). Heather Lake is located at an elevation of 1,875 m, has a maximum depth of 9.0 meters, and a surface area 2.62 ha. The littoral zone in Heather Lake is composed mainly of silt (Table 1). There are two inlets to Heather Lake. The major inlet has substrate dominated by silt, sand, and gravel (Table 2). The main outlet to Heather Lake is located on the southwest side of the lake. The outlet at Heather Lake may be seasonally dry and has a dominant substrate of silt (Table 3). The unnamed creek draining Heather Lake's main outlet converges with Meadow

Creek at 23.3 km from the confluence of Meadow Creek and the upper NFCR. The route used to access Heather Lake can be referenced in Appendix C.

Table 1. The littoral zone composition of lakes stocked with tiger muskellunge in 2006 within the Clearwater Region.

Lake name	% Bedrock	% Boulder	% Rubble	% Gravel	% Sand	% Silt	% Organic debris	% Logs
Fly	0	0	0	0	0	60	0	40
Heather	20	10	5	5	5	55	0	0
Platinum	0	10	5	0	0	65	0	20
Running	0	10	0	50	10	15	10	5

Table 2. Major Inlet characteristics of lakes stocked with tiger muskellunge in 2006 in the Clearwater Region.

Lake name	# of inlets	depth/width at mouth (m)	Length (m)	Dominant substrate	Barrier type/ distance from mouth (m)	% Spawning substrate
Fly	Seeps	NA	NA	NA	NA	NA
Heather	2	0.4/2.0	> 1000	silt / sand / gravel	waterfall/100	5
Platinum	Seeps	NA	NA	NA	NA	NA
Running	1	0.0/0.1	40	silt	waterfall/20	15

Table 3. Outlet characteristics of lakes stocked with tiger muskellunge in 2006 in the Clearwater Region.

Lake name	# of outlets	depth/width at outlet (m)	dominant substrate	Barrier type/ distance from outlet (m)	% Spawning substrate
Fly	1	0.08 / 0.5	Boulders /Rubble	High Gradient / 10	0
Heather	1	0.05 / 0.2	Silt	Seasonally dry / 5	0
Platinum	1	0.05 / 0.5	Rubble / Silt	none	0
Running	1	0.10 / 5.0	Silt / Gravel / LWD	LWD / 5	0

LWD = large woody debris

Platinum Lake

Platinum Lake is located in the Five Lakes Butte Area within the Clearwater National Forest. Platinum Lake is located in a cirque type landform with a north-east aspect and is surrounded by sub-alpine forest, Idaho granitic bedrock batholithic outcroppings, and talus slopes (Appendix B). Platinum Lake occurs at an elevation of 1,753 m, has maximum depth of 4.1 m, and a surface area of 1.00 ha. The littoral zone in Platinum Lake is composed of mainly silt (Table 1). Platinum Lake has multiple small inlets (seeps) and one main outlet that is dominated by a rubble and silt composition (Tables 2 and 3). The main inlet and outlet to Platinum Lake are low gradient. The main outlet to Platinum Lake is situated on the north shore of the lake and drains into an unnamed stream which flows into the upper headwaters of Meadow Creek at 19.7 km from the confluence of Meadow Creek and the upper NFCR. Platinum Lake has a moderate amount of woody debris which has collected mostly around the main inlet and outlet of the lake in the form of submerged logs. Route used to access Platinum Lake can be referenced in Appendix C.

Running Lake

Running Lake is situated 2.8 km south of Bilk Mountain in the Nez Perce National Forest. Running Lake is located in a cirque landform with a northeast aspect and is surrounded by sub-alpine forest, talus slopes, and bedrock outcroppings (Appendix B). Running lake is located at an elevation of 2,008 m, has a maximum depth of 14.0 m, and a surface area of 8.4 ha. The littoral zone in Running Lake is composed mainly of gravel (Table 1). The inlet at Running Lake is dominated by a silt substrate (Table 2). The main outlet draining Running Lake is on the northeast side of the lake and is composed of silt and gravel substrate with LWD also concentrated around the outlet (Table 3). The unnamed creek from Running Lake converges with Running Creek 38.1 km upstream from the confluence of Running Creek and the Upper Selway River. The route used to access Running Lake can be referenced in Appendix C.

Elizabeth Creek – Ice Meadow

Ice Lake drains into the headwaters of Elizabeth Creek, which is a tributary to the Black Canyon reach of the NFCR in the Clearwater National Forest. Elizabeth Creek is one of three major catchments that make up the Long Creek HUC5 watershed. Elizabeth Creek (9.5 km long) is mostly a high gradient stream (>20%) and is considered an upstream barrier to brook trout. Approximately 150 m downstream (northeast) of Ice Lake is a low gradient (< 2%) section of Elizabeth Creek (Elevation 1,682 m) which meanderers through a meadow known as Ice Meadow for a length of about 600 m (Appendix B). This reach of stream was identified in after introducing tiger muskellunge into Ice Lake in 1998 and is believed to be the only reach of Elizabeth Creek that supports a reproducing population of brook trout. There are two barriers (falls) between Ice Lake and Ice Meadow that prevent brook trout from reaching Ice Lake from Ice Meadow. The route used to access Ice Meadow can be referenced in Appendix C.

METHODS

Brook trout population estimates were conducted on each lake prior to stocking of tiger muskellunge. Mark and recapture population estimates were made using the adjusted Petersen estimate (Ricker, 1975). Brook trout were initially collected using hook and line sampling and marked with an adipose fin clip. Angling was conducted from both shore and by float tube, using a variety of angling tackle and bait. After marking brook trout, two 40 m gill nets were set overnight (approximately 12 hours) to recapture marked fish and document baseline CPUE and length frequencies to compare with future net sets. Gill nets used were multi-meshed experimental nets containing three mesh sizes from 10 to 38mm. Total length and weight were recorded for all fish captured. The brook trout population estimate was for all fish sizes collected in gill nets, and we assumed gill nets sample brook trout size in proportion to their availability. The CPUE and length frequencies of brook trout gill netted in 2006 represented baseline conditions of pre tiger muskellunge introductions. The CPUE and length frequencies from these monitoring efforts will represent the manner in which change in brook trout population structure will be measured.

Tiger muskellunge were obtained from the IDFG Hagerman Hatchery and transported to locations on the NFCR and Selway Rivers. Most tiger muskellunge stocked in 2006 were > 250mm in order to decrease their vulnerability to predators and increase first year over-winter survival. Fire suppression helicopters from the USFS with water buckets were employed to stock the tiger muskellunge into high mountains lakes (Fly, Platinum, Heather, and Running). Tiger muskellunge were transported in loads of 20 to 50 fish per 100 gallon fire bucket. Helicopter pilots transporting tiger muskellunge to mountain lake locations were provided with mountain lake GPS coordinates by the IDFG. All tiger muskellunge were stocked on June 29, 2006.

Fly, Platinum, Heather, and Running lakes were all gill netted in 2007 using the same methodology as employed in 2006. Length frequency distributions of brook trout gill netted in 2007 were compared to the length frequency of brook trout gill netted prior to tiger muskellunge introductions in 2006. A Kolmogorov-Smirnov two-sample test was utilized to test for significant differences (α=0.05) between pre and post introduction cumulative length frequency distributions in Fly, Heather, Platinum, and Running lakes. All statistical comparisons were conducted using the NPAR1WAY procedure in SAS (SAS 1999).

Field personnel must return to the four lakes for three to five years following tiger muskellunge introductions and continue gill net sampling to evaluate how brook trout populations have changed (CPUE and length frequencies). Lakes identified with inlets and outlets that have suitable brook trout spawning habitat and or rearing habitat may require electrofishing to remove any brook trout that utilize them. Physical attributes of each lake including littoral zone composition, inlet characteristics, and outlet characteristics will be documented through visual observations (Appendix D). These variables will be compared to changes in brook trout CPUE and length frequency to assess their influence of tiger muskellunge introductions in eliminating or suppressing brook trout within the four lakes.

The Ice Meadow section of Elizabeth Creek was electrofished for the third year in a row (2005-2007) in an effort to remove brook trout from this 600 m reach of stream. This was part of a follow up procedures associated with the introduction of tiger muskellunge in 1998 and 1999 to remove brook trout from the Elizabeth Creek watershed. Removal efforts were accomplished by divided this 600 m reach of stream into six 100 m sections. Each section was blocked netted, and double pass electrofishing was utilized to capture and remove brook trout encountered. Electrofishing time for each pass was recorded to standardize effort. All brook trout captured within Ice Meadow were measured for length and removed (killed). Change in the brook trout population within Ice Meadow will be analyzed by examining CPUE, length frequency, and suspected age frequency from 2005 – 2007.

RESULTS

In 2007, IDFG and USFS personnel resampled brook trout populations in Fly, Platinum, Heather, and Running lakes, one year after the introduction of tiger muskellunge. Personnel from IDFG and the USFS also returned to the Ice Meadow section of Elizabeth Creek to remove brook trout for a third straight year using electroshocking.

Fly Lake

In 2006, prior to tiger muskellunge introductions, the brook trout population estimate for Fly Lake was 299 fish ranging from 109-274 mm in length (Tables 4 and 5). This estimate was made by capturing and marking 68 brook trout (by an adipose fin clip) through hook and line sampling on June 22-23 followed by gill netting on June 23 (overnight set) in which 64 brook trout were collected, 14 of which were recaptures (Table 5). An overnight gill net set (15 hr) on June 28, 2007 was used to determine status of brook trout in Fly Lake after stocking 40.2 tiger muskellunge per hectare on June 29, 2006 (Table 4). In 2007, gill netting efforts captured 20 brook trout (Figures 2 and 4). The CPUE for brook trout in 2007 was 1.3, about 4.0 times lower than what was observed in 2006 (Table 6). Two live tiger muskellunge were also captured, measured (362 and 442 mm) and released back into the lake alive (Figure 5). Other tiger muskellunge were observed lying in wait and actively moving throughout the lake littoral zone of Fly Lake.

Total lengths of brook trout captured in 2007 ranged from 255 to 297 with a mean total length of 274 mm (Table 6). Average total length of brook trout increased from 231 mm in 2006 to 274mm in 2007 (Figure 2 and Table 5). Minimum total lengths of brook trout captured in the gill net increased from 109 mm in 2006 to 255 mm in 2007. Maximum total lengths also increased from 274 mm in 2006 to 297 mm in 2007. The cumulative length frequency distribution was significantly greater in 2007 than the 2006 distributions ($p<0.0001$, Figure 3).

Table 4. Physical characteristics of lakes in the Clearwater Region stocked with tiger muskellunge on June 29, 2006 and the brook trout population estimate prior to tiger muskellunge introductions.

Lake name	Lake size (ha)	Max. lake depth (mm)	Total # of TM Stocked (density)	2006 BKT population est.
Fly	1.02	3.3	41(40 fish/ha)	299 (293 fish/ha)
Heather	2.62	9.0	106 (40 fish/ha)	N/A
Platinum	1.00	4.1	40 (40 fish/ha)	148 (148 fish/ha)
Running	8.40	14	349 (40 fish/ha)	3,389 (403 fish/ha)

TM = Tiger Muskellunge; BKT=Brook trout

Table 5. Population estimates (N), using an Adjusted Petersen Estimate, of brook trout in five high mountain lakes in the Clearwater Region prior to tiger muskellunge introductions in 2006.

					90% CI		
Lake	M	C	R	N	UL	LL	Fish/ha
Fly	68	64	14	299	407	191	293
Heather	19	8	0	N/A	N/A	N/A	N/A
Platinum	7	36	1	148	285	11	148
Running	390	77	8	3,389	5,047	1,658	403

Table 6. Comparisons of brook trout catch rates and lengths in high mountain lakes in the Clearwater Region gill netted pre (2004 and 2006) and post (2007) tiger muskellunge introduction.

Lake name	CPUE (fish/hr)	Min length (mm)	Max length (mm)	Avg. length (mm)	Standard deviation
Fly Lake 2006	5.33	109	274	231	40.12
Fly Lake 2007	*1.33*	255	297	274	12.30
Heather Lake 2004	*0.64*	142	353	309	69.52
Heather Lake 2007	*1.00*	218	374	322	42.50
Platinum Lake 2006	3.00	128	330	220	50.12
Platinum Lake 2007	0.79	241	332	294	28.28
Running Lake 2006	5.31	100	225	181	21.44
Running Lake 2007	3.87	102	220	190	18.71

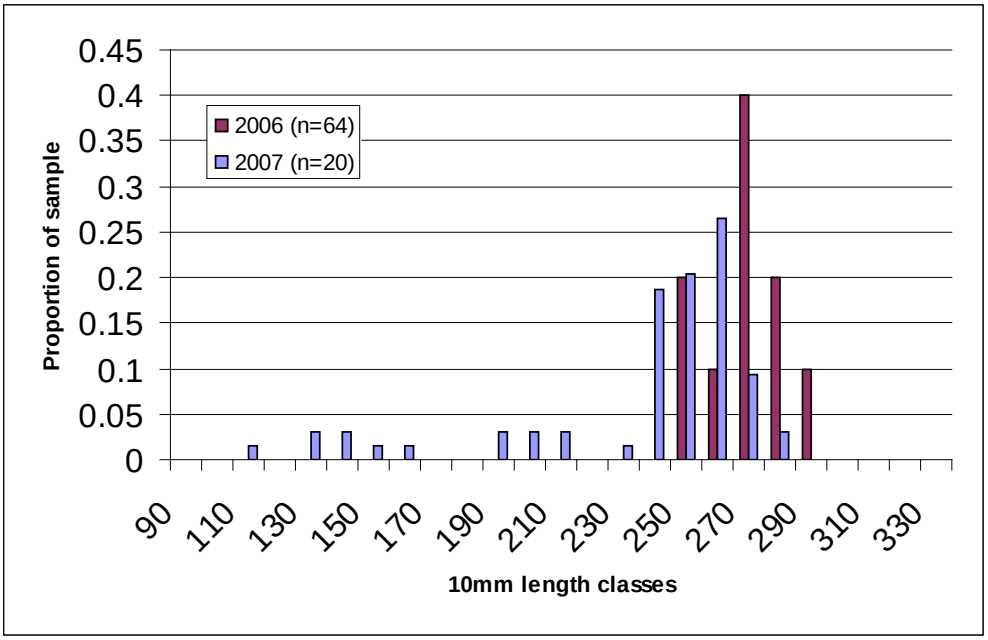


Figure 2. Length frequency of brook trout captured by gill netting in Fly Lake in the Clearwater Region, pre (2006) and post (2007) tiger muskellunge introductions.

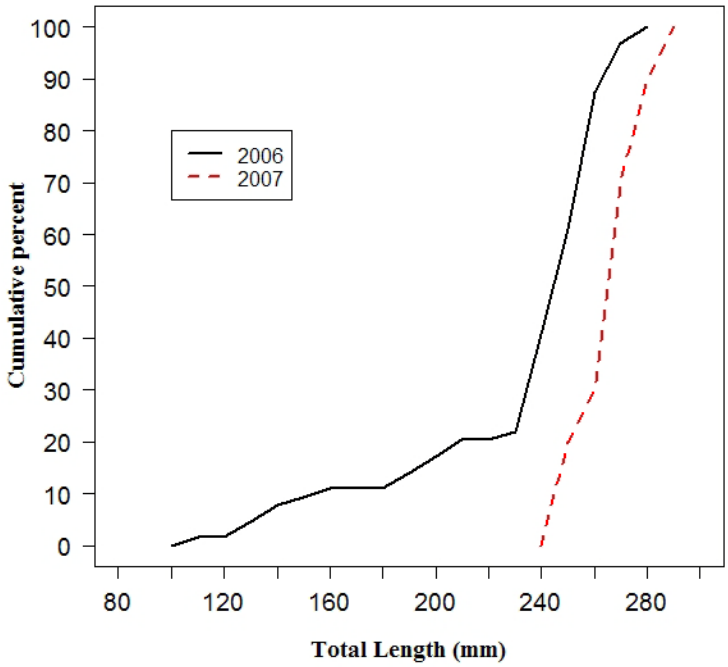


Figure 3. Cumulative length frequency of brook trout captured by gill nets in Fly Lake in Clearwater Region, pre (2006) and post (2007) tiger muskellunge introductions.

Figure 4. Brook trout captured in an over night gill net set from Fly Lake in the Clearwater Region (2007), one year following tiger muskellunge introductions.

Figure 5. Tiger Muskellunge captured and released from gill net in 2007, approximately one year after being stocked in Fly Lake, Clearwater Region.

Heather Lake

Brook trout sampling in Heather Lake was not possible on the scheduled day (June 22, 2006) due to ice coverage. Consequently, data collected previously in 2004 was used to represent baseline brook trout conditions prior to tiger muskellunge introductions (June 29, 2006). On October 30, 2004, 19 brook trout were collected and marked (adipose clip) using short gill net sets (approximately 25 minutes each) over a four hour period resulting in a CPUE of 4.8 fish /hr (Table 5). The night following the marking run, gill nets were set overnight (12.5 gill net hours) and eight brook trout were captured resulting in a CPUE of 0.6 fish/hr (Table 6). No marked brook trout were recaptured making a population estimate impossible. Total lengths of brook trout captured in 2004 ranged from 142 to 353 mm (Table 6). An overnight gill net set (16 hr) on June 27, 2007 was used to determine the status of brook trout in Heather Lake about one year after stocking tiger muskellunge (Table 4). Gill netting efforts captured 16 brook trout and no tiger muskellunge (Figure 8). The CPUE for brook trout in 2007 was 1.0 which was 1.5 times higher than observed in 2004 (Table 6). Total lengths of brook trout captured in 2007 ranged from 218 mm to 374 mm with a mean total length of 322 mm (Table 5). Tiger muskellunge were observed in 2007 after visually searching the entire littoral zone of the lake.

Minimum, maximum and mean lengths of brook trout all increased in 2007 as compared to captures from gill netting efforts in 2004 (Figure 6 and Table 6). Average total brook trout length increased from 309 mm in 2004 to 322 mm in 2007. Minimum total brook trout length increased from 142 mm in 2004 to 218 mm in 2007, and maximum length increased from 353 mm in 2004 to 374 mm in 2007. There was no significant difference between the cumulative length frequency distributions between 2004 and 2007 ($p=0.9920$, Figure 7)

Platinum Lake

In 2006, prior to tiger muskellunge introductions, the brook trout population estimation in Platinum Lake was 148 fish ranging in length from 128-300 mm (Tables 4 and 6). This estimate was made by marking seven brook trout (by an adipose fin clip) in 30 hours of hook and line sampling on June 25, 2006 followed by a 14 hr overnight gill net set in which 36 brook trout were captured, one of which was a recapture (Table 5). An overnight gill net set (14 hr) on June 26, 2007 was used to determine the status of brook trout in Platinum Lake after stocking 40.0 tiger muskellunge per hectare on June 29, 2006 (Table 4). In 2007, gill netting efforts captured 11 brook trout and no tiger muskellunge (Figure 11). The CPUE for brook trout in 2007 was 0.8, about 3.7 times lower than what was observed in 2006 (Table 6). No tiger muskellunge were observed in 2007 after visually searching the entire littoral zone of the lake. Trout fry were observed in the main outlet from Platinum Lake.

Total lengths of brook trout captured in 2007 ranged from 241 to 323 mm with a mean total length of 294 mm (Table 6). Mean total brook trout length increased form 219 mm in 2006 to 294 mm in 2007 (Figure 9 and Table 6). Minimum brook trout total lengths increased from 128 mm in 2006 to 241 mm in 2007, and maximum total length increased slightly from 330 mm in 2006 to 332 mm in 2007. The cumulative length frequency distribution of brook trout was significantly greater in 2007 than 2006 ($p=0.0011$, Figure 10).

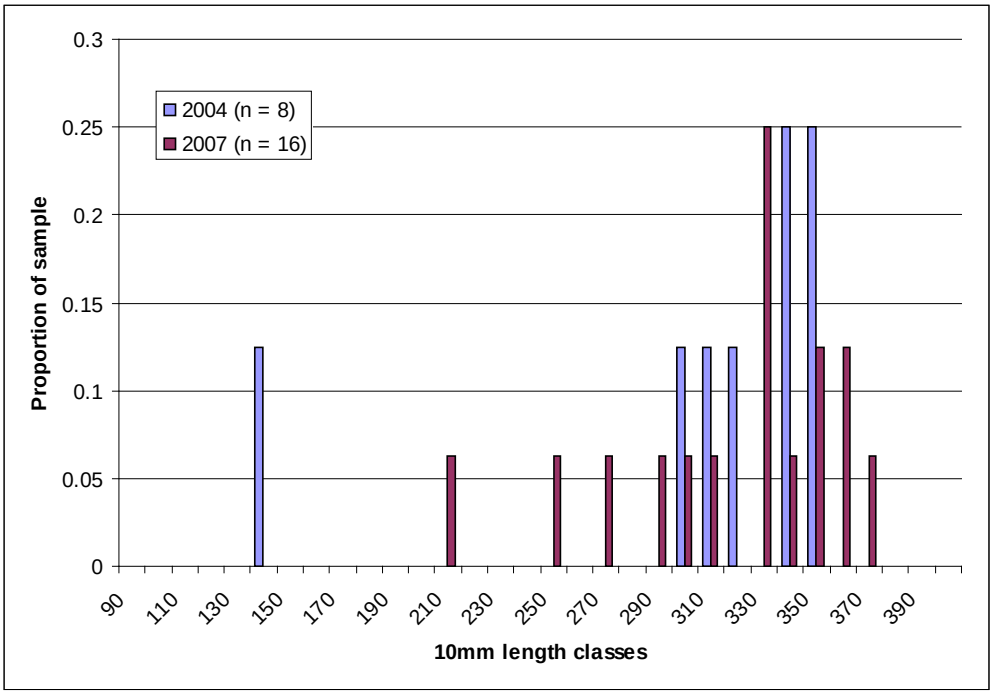


Figure 6. Length frequency of brook trout captured by gill netting in Heather Lake in the Clearwater Region, pre (2004) and post (2007) tiger muskellunge introductions.

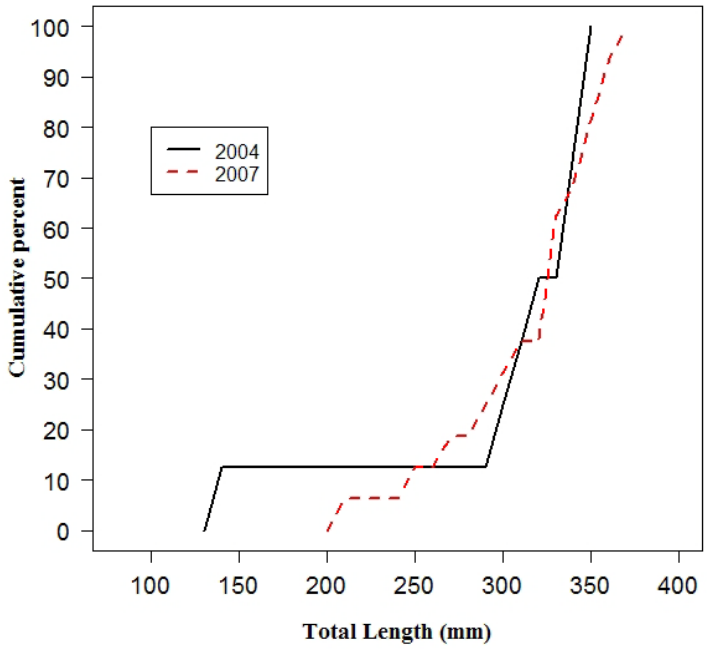


Figure 7. Cumulative length frequency of brook trout captured by gill nets in Heather Lake in the Clearwater Region, pre (2004) and post (2007) tiger muskellunge introductions.

Figure 8. Brook trout captured in an overnight gill net set on Heather Lake in the Clearwater Region (2007), one year after tiger muskellunge introductions.

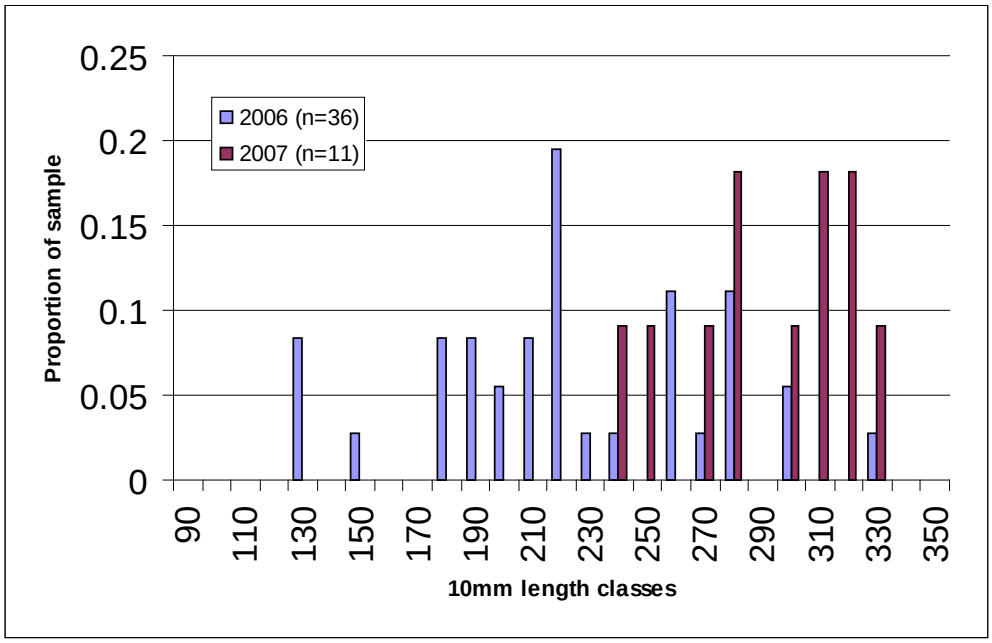


Figure 9. Length frequency of brook trout captured by gill netting in Platinum Lake in the Clearwater Region, pre (2006) and post (2007) tiger muskellunge introductions.

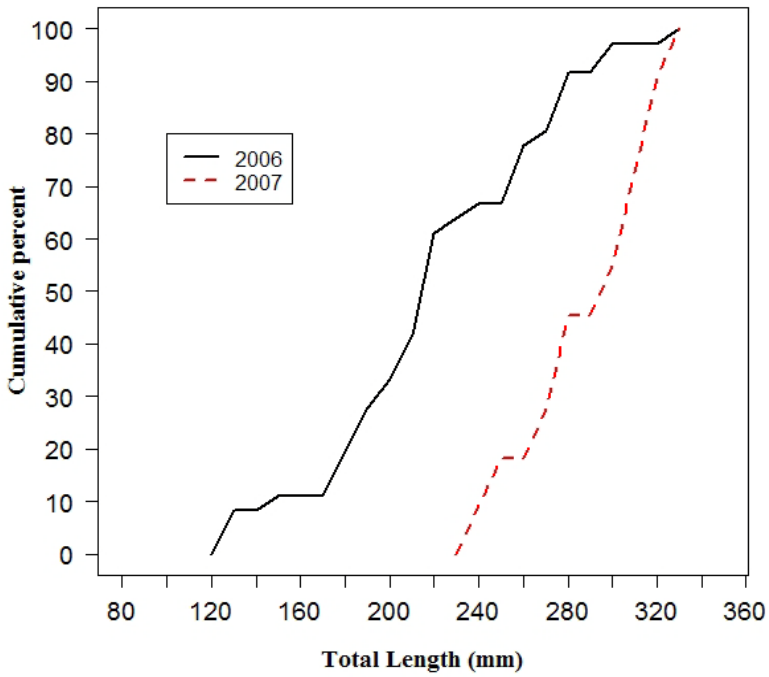


Figure 10. Cumulative length frequency of brook trout captured by gill nets in Platinum Lake in the Clearwater Region, pre (2006) and post (2007) tiger muskellunge introductions.

Figure 11. Brook trout captured in overnight gill net set on Platinum Lake in the Clearwater Region (2007), one year after tiger muskellunge introductions.

Running Lake

In 2006, prior to tiger muskellunge introductions, the brook trout population estimation in Platinum Lake was 3,389 fish ranging in length from 100-225 mm (Tables 4 and 6). This estimate was made by marking 390 brook trout (by an adipose fin clip) in 62.5 hours of hook and line sampling on June 28-30, 2006 followed by a 14.5 hour overnight gill net set in which 77 brook trout were captured, 8 of which were recaptures (Table 5). Two overnight gill netting efforts (19 hr and 12 hr) on July 23 and July 25, 2007 were used to determine the status of brook trout in Running Lake after stocking 41.6 tiger muskellunge per hectare on June 29, 2006 (Table 4). Separate gill netting efforts on Running Lake were combined for analysis and totaled 31 hours. In 2007, gill netting efforts captured 120 brook trout and no tiger muskellunge. The CPUE for brook trout in 2007 was 3.9, about 1.4 times lower than what was observed in 2006 (Table 6). No tiger muskellunge were observed in 2007 after visually searching the entire littoral zone of the lake.

Total lengths of brook trout captured during the 2007 sampling events ranged from 102 mm to 220 mm with a mean total length of 188 mm (Table 6). Minimum and mean total lengths of brook trout slightly increased from 2006 to 2007 while maximum lengths slightly decreased (Figure 12 and Table 6). Minimum brook trout total length increased from 100 mm in 2006 to 120 mm in 2007. Mean total length increased from 181 in 2006 to 190 in 2007, and maximum length decreased from 225 mm in 2006 to 220 mm in 2007. The cumulative length frequency distribution was significantly greater in 2007 than in 2006 ($p=0.0001$).

Elizabeth Creek – Ice Meadow

Ice Meadow was revisited on August 1-16, 2007, and double pass electrofishing was utilized to capture and remove brook trout from a 600 m reach (six consecutive 100 m transects) of Elizabeth Creek. Electrofishing efforts removed 308 brook trout. No other fish species were observed. Brook trout ranged in total length from 16 mm to 218 mm with a mean total length of 91 mm (Figure 14 and Table 7). The total number of brook trout removed from this section of stream has declined each year sampling occurred (2005 to 2007) (Table 8). The CPUE of fish captured decreased from 3.3 fish/min. in 2005 to 1.8 fish/min. in 2006, but increased from 2006 to 2007 to 2.2 fish/min. (Table 8). Total number of age 0 brook trout removed from Elizabeth Creek in Ice Lake meadow has decreased from over 1000 fish in 2005, to approximately 500 in 2006, to 190 fish in 2007 (Figure 15 and Table 7). Total number of age 1+ brook trout removed decreased from 633 fish in 2005 to approximately 90 fish in 2006 and increased to approximately 120 fish in 2007 (Figure 15 and Table 6).

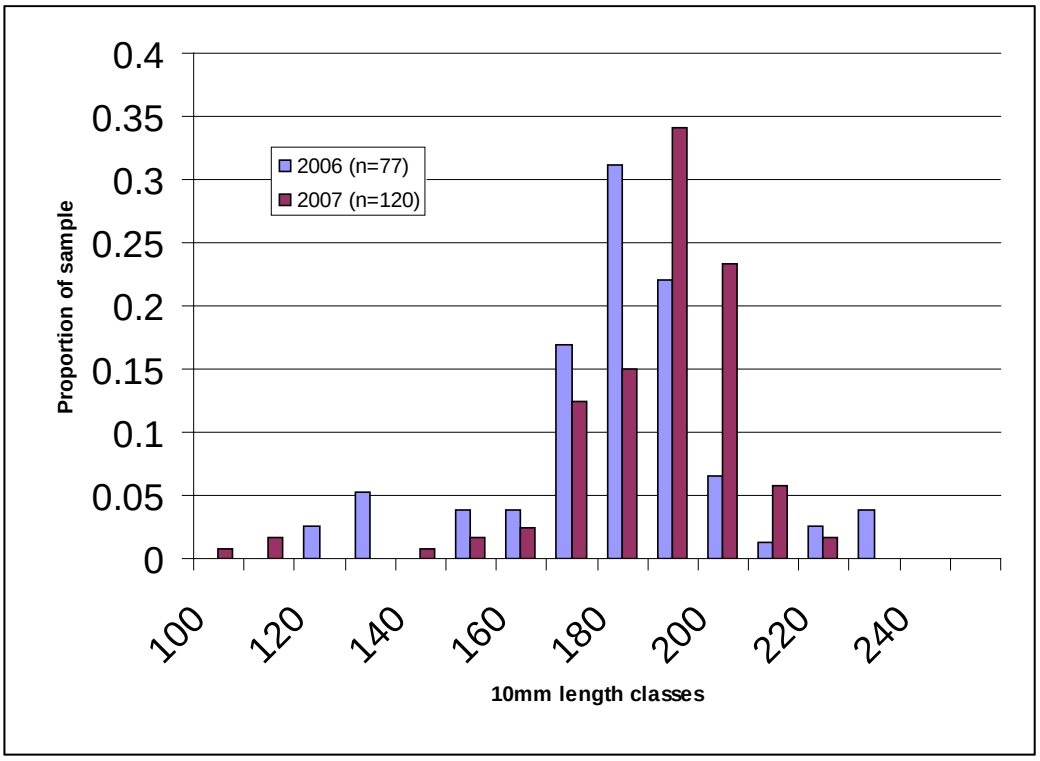


Figure 12. Length frequency of brook trout captured by gill netting in Running Lake in the Clearwater Region, pre (2006) and post (2007) tiger muskellunge introductions.

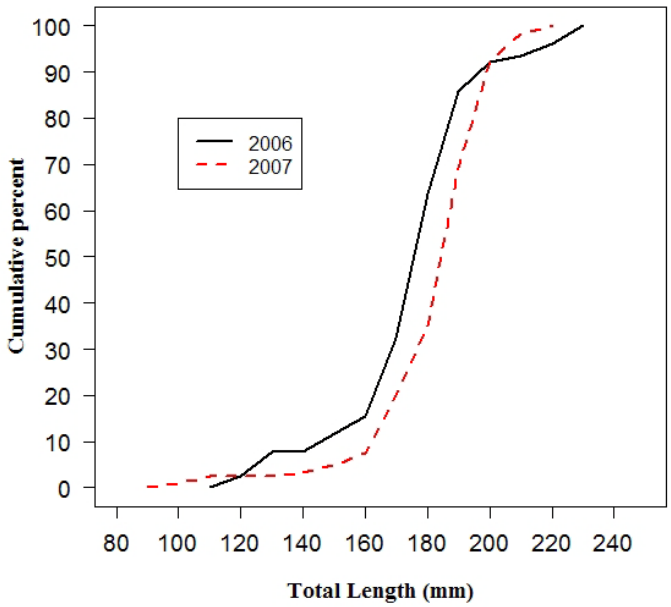


Figure 13. Cumulative-frequency distribution for brook trout sampled in Running Lake in the Clearwater Region, pre (2006) and post (2007) tiger muskellunge introductions.

Table 7. Summary of brook trout (BKT) lengths removed from through electrofishing six 100 meters transects on Elizabeth Creek in Ice meadow (2007) in the Clearwater Region.

Min. BKT length (mm)	Max BKT length (mm)	Average BKT Length	Standard deviation of BKT length
16	218	90.90	41.90

Table 8. Summary of brook trout (BKT) removed from Elizabeth Creek (Ice Meadow) in the Clearwater Region during 2005, 2006, and 2007.

Brook trout removed	2005	2006	2007
Age 0 (<100mm)	1049	507	190
Age +1 (≥100mm)	663	89	118
TOTAL	1712	596	308
CPUE fish/minute	3.3	1.8	2.2

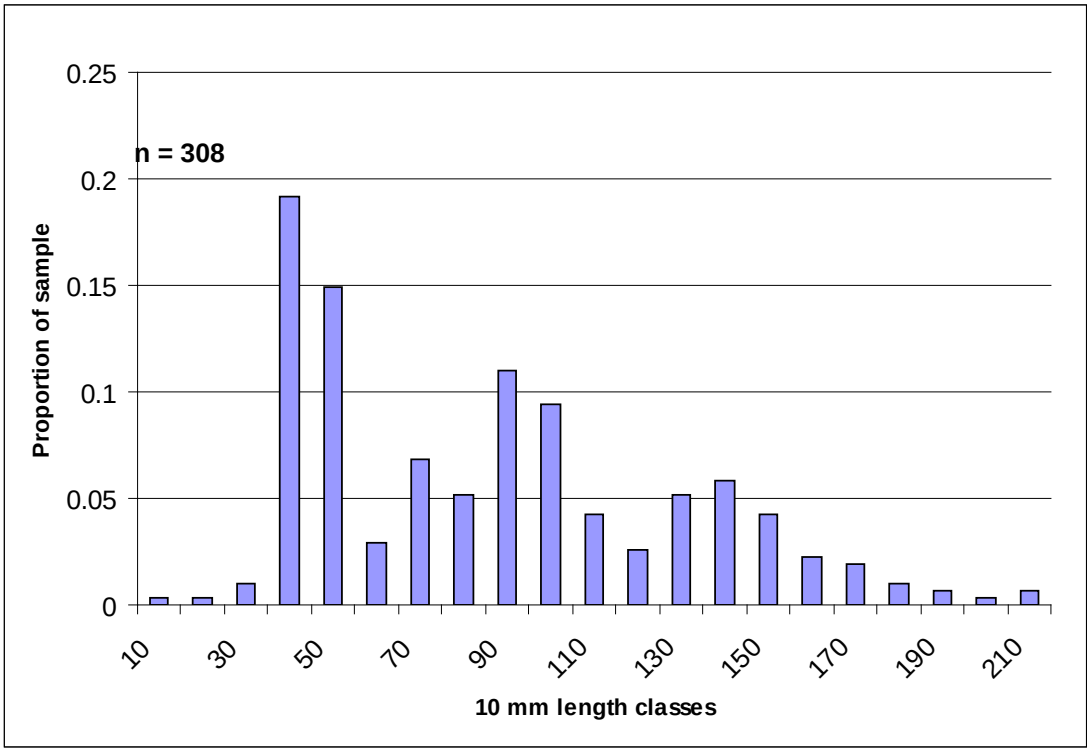


Figure 14. Length frequency of brook trout removed from Elizabeth Creek (Ice Meadow) in the Clearwater Region (2007).

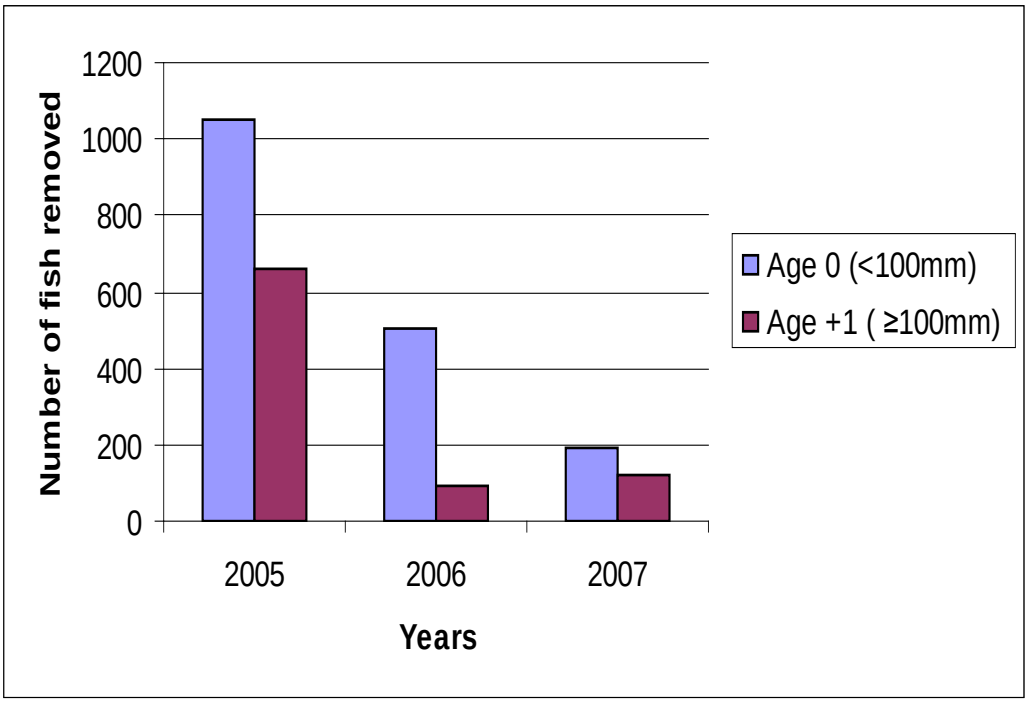


Figure 15. Age frequency of brook trout removed from Elizabeth Creek (Ice Meadow) in the Clearwater Region (2005-2007).

DISCUSSION

The CPUE of brook trout decreased in three of four high mountain lakes with self sustaining brook trout populations one year after introductions of tiger muskellunge. Length frequencies of brook trout also shifted toward larger size classes. The average minimum size of brook trout increased by 76 mm and the average maximum size increased by 15 mm. The predominant reason for the increase in size of brook trout was likely caused by the tiger muskellunge targeting smaller sized brook trout (< 250 mm). The first year following introductions, most tiger muskellunge were < 450 mm. Tiger Muskellunge tend to feed on prey 25-43% their body length (Wahl and Stein 1988). Schriever and Murphy (In Prep) also found that average size of brook trout increased in high mountain lakes one year after tiger muskellunge introductions as they tended to target brook trout < 250 mm. As tiger muskellunge grow, they will be able to prey upon increasingly larger brook trout and should be able to influence all size classes of brook trout in these lakes. The increase in maximum size of brook trout is likely due to increased growth rates due to a release in intraspecific competition, also similar to what Schriever and Murphy (In Prep) found.

It's not clear what influence tiger muskellunge introductions had on spawning success as age-0 brook trout are not recruited to the gill nets. However, it is suspected that brook trout attempting to spawn along shore would be harassed or preyed upon by tiger muskellunge. The spawning behavior of brook trout that spawned in tributaries or outlets would likely not be influenced by tiger muskellunge as they are not known to enter small streams. Multiple years of sampling post tiger muskellunge introduction will allow for reinforcement that change in/eradication of brook trout populations can be attributed to tiger muskellunge introductions at stocking densities of around 40 fish/hectare.

The only lake that did not show any significant changes in brook trout CPUE and size one year after tiger muskellunge stocking was Heather Lake. Heather Lake was the only lake not surveyed in 2006 due to ice. Consequently, a 2004 sampling event that occurred in the fall (October 30, 2004) was used to portray brook trout CPUE and size structure, pre-tiger muskellunge introductions. Gill net efficiency in the fall could be lower because brook trout may be spawning in tributaries or other areas not gill netted. Additionally, a small sample size of eight fish was collected decreasing the statistical power of the test. Finally a single overnight gill net set may not be effective in sampling Heather Lake due to the relatively large lake area (2.6 ha). Regardless of the non significant changes in the cumulative distribution, younger size classes (around the 150 mm size class) from the 2004 Heather Lake sampling event where not represented in 2007. Further sampling is necessary to assess the effectiveness of tiger muskellunge as a biological control within the lake. Other studies have pointed out that prey density has more of an influence than the size of the prey on the ability of tiger muskellunge to remove the prey from a lake (Tomocko et al 1984). Thus, the number of brook trout within a given lake may have more influence on tiger muskellunge predation than the size of the brook trout in the lake.

It is likely that the effectiveness of tiger muskellunge to control brook trout may be increased in relatively small lakes (< 1 ha) with short inlets and outlets that would provide minimal refuge for brook trout (Schriever and Murphy, In Prep.; Knapp and Matthews 1998). Running Lake (8.4 ha), like Heather Lake (2.6 ha) is relatively large and changes in brook trout CPUE and size structure was also not as pronounced as in the smaller mountain lakes (Fly and Platinum lakes) we evaluated. Smaller, shallower lakes may improve the effectiveness of tiger muskellunge to control brook trout, especially during winter months when prey and predator may be confined to a small area within the lake. The larger Running and Heather lakes may offer a wider range in habitat complexity which could decreases the effectiveness of tiger muskellunge predation on brook trout. Schriever and Murphy (In Prep) postulated that an absence of wood and emergent vegetation would increase the effectiveness of tiger muskellunge predation on brook trout. However, studies by Tomocko et al.(1984) have shown that absence or presence of vegetation did not influence tiger muskellunge predation on bluegill. In addition, similar studies within other IDFG Regions have concluded that hiding cover provided by woody debris and aquatic vegetation may increase the effectiveness of tiger muskellunge to prey upon brook trout as this hiding cover allows area from which tiger muskellunge can ambush brook trout (Martin Koenig, IDFG, Personal Communication). Based on these findings it would lead us to believe that in larger and deeper lakes where there is more open water habitat, feeding by an ambush predator like tiger muskellunge would be less effective. Finally, larger lakes may be able to support more brook trout, with different size class structures and significant changes in populations may not be observed as quickly as in smaller mountain lakes. The changes in brook trout populations (little to no recruitment, more obvious shifts in size class structure and CPUE) that have been observed in one year in smaller mountain lakes may take a longer period to observe similar results in larger mountain lakes.

The length of a high mountain lake inlet and outlet may also dictate how effective tiger muskellunge are in reducing/removing brook trout from them. Longer inlets and outlets may provide more area for brook trout to take refuge from tiger muskellunge and increase spawning success. Inlets and outlets that are seasonally dry may force brook trout to inhabit lakes with tiger muskellunge. In addition, inlets and outlets with little flow may freeze solid during winter also forcing brook trout to inhabit lakes with tiger muskellunge. High mountain lakes with longer inlets and outlets with significant permanent flow may also require electrofishing removal efforts to make brook trout eradication possible. Heather Lake and Running Lake both have inlets 20 to 100 m in length with permanent flow. These inlets may require electrofishing for brook trout eradication to be successful. Fly and Platinum lakes have only small seep type inlets and will likely not require any electrofishing in these areas. Due to the outlet length, flow and the absence of barriers, the outlet from Platinum Lake may require electrofishing for brook trout eradication to be successful (Table 3). Low gradient sections of stream below Heather, Platinum, and Running lakes have been identified that may contain brook trout. It is unclear if these fish can migrate upstream into these lakes during different flow conditions. Fly Lake has mostly high gradient sections of stream below the lake that is an upstream barrier to fish.

Two tiger muskellunge were sampled during our 2007 gill netting. As explained by Hanson et al. (1986), sampling of tiger muskellunge after a stocking event can be difficult because their ability to escape capture by gill nets. Field crews in 2007 observed that tiger muskellunge were likely being caught in the gill net but were freeing themselves from the net by tearing holes with their sharp teeth and gill-rakers. The packable high mountain lake gill nets are constructed of fine monofilament making them susceptible to tearing. To verify the presence of tiger muskellunge in all four lakes field crews had to rely on observations of tiger muskellunge from the littoral zone or by means of angling. At Platinum Lake no tiger muskellunge were observed through a littoral zone search or in the gill net, but when the gill net was pulled the next morning many new small holes in the gill net were observed.

Brook trout removal efforts from 2005 to 2007 in the Ice Meadow section of Elizabeth Creek have resulted in an 82% reduction in their abundance. Decreases were not as pronounced from 2006 to 2007 as it was from 2005 to 2006. Although the number of brook trout removed in 2007 was less than was removed in 2006 the CPUE actually increased in 2007. It's unclear if this is because we just put more effort in during 2006 or if was because the fish were larger in 2007 making them easier to collect. Regardless, this suggests that as brook trout abundance decreases the ability to totally eliminate them from a given area may become more difficult. Work by Gidley and DuPont (In Press) found that brook trout can effectively be removed from short reaches of stream when intensive removal efforts (5 to 10 passes annually over 3 years) are employed. Numerous other efforts to eliminate brook trout from reaches of stream have proven ineffective due to stream length and complexity, side tributaries, immigration, and/or inability to employ intensive removal efforts (Thompson and Rahel 1996; Meyer et al. 2006) Although, brook trout were not eradicated from stream reaches within Ice meadow on Elizabeth Creek their densities were significantly reduced (82%) in three years. Elizabeth Creek in Ice Meadow does not have complex habitat and we are only trying to address 600 m of stream. Based on these conditions, continued high intensity removal efforts may be effective in eradicating brook trout from this reach of stream if immigration does not occur. If it is believed that this reach of stream is a brook trout source to reaches downstream, than current removal efforts may be warranted.

RECOMMENDATIONS

1. Continue monitoring brook trout populations in lakes stocked with tiger muskellunge for five years, to evaluate their effectiveness at removing brook trout from lakes.

2. Conduct in depth analysis of lake inlet and outlet characteristics stocked with tiger muskellunge.

3. Conduct in depth analysis of lake littoral zone composition stocked with tiger muskellunge.

4. Evaluate whether Elizabeth Creek at Ice Meadows is a source population of brook trout and is worthy of continued removal efforts.

ACKNOWLEDGEMENTS

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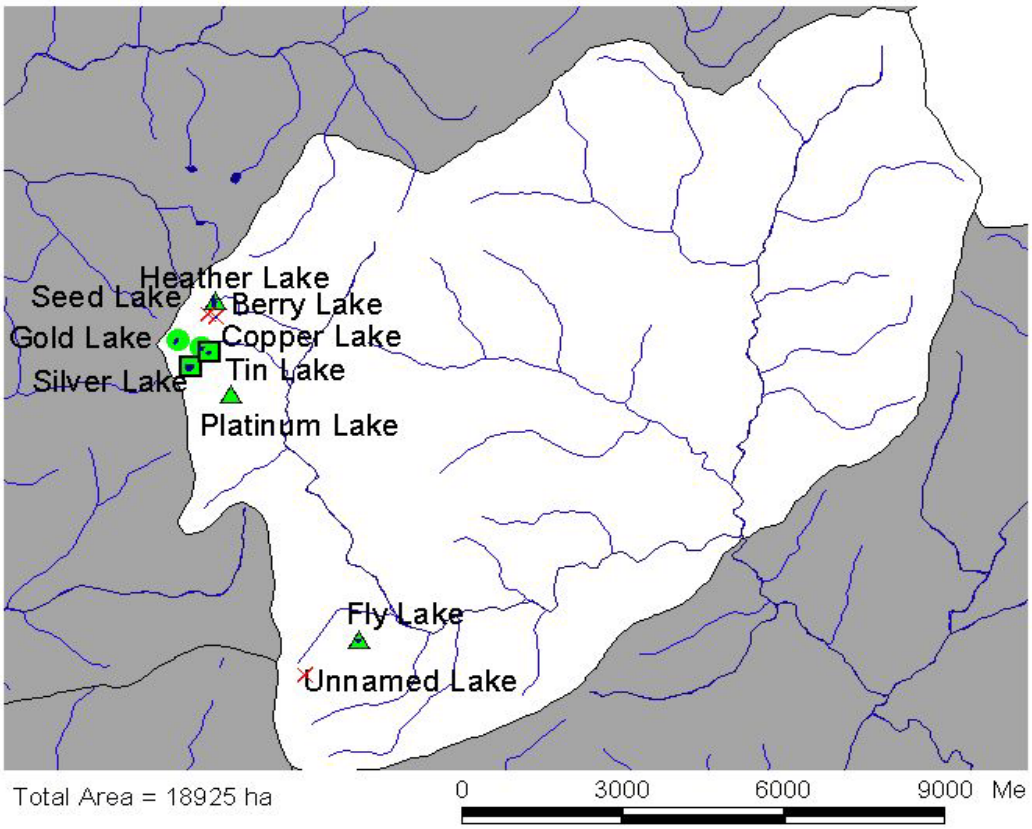
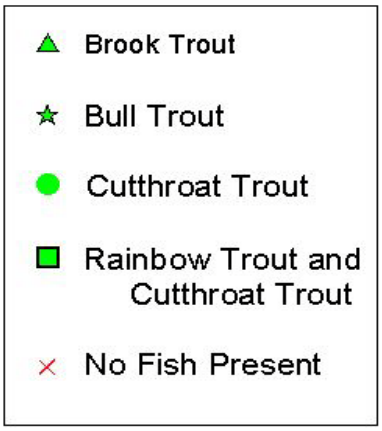
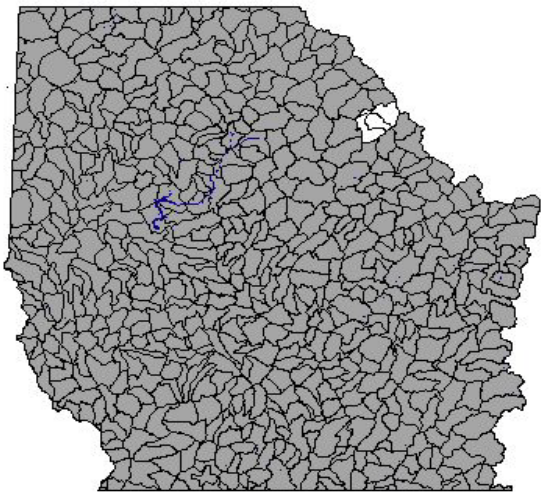
APPENDICES

Appendix A. Locations and fish status of high mountain lakes introduced with tiger muskellunge in the Idaho Fish and Game Clearwater Region during 2006 to suppress or eradicate brook trout.

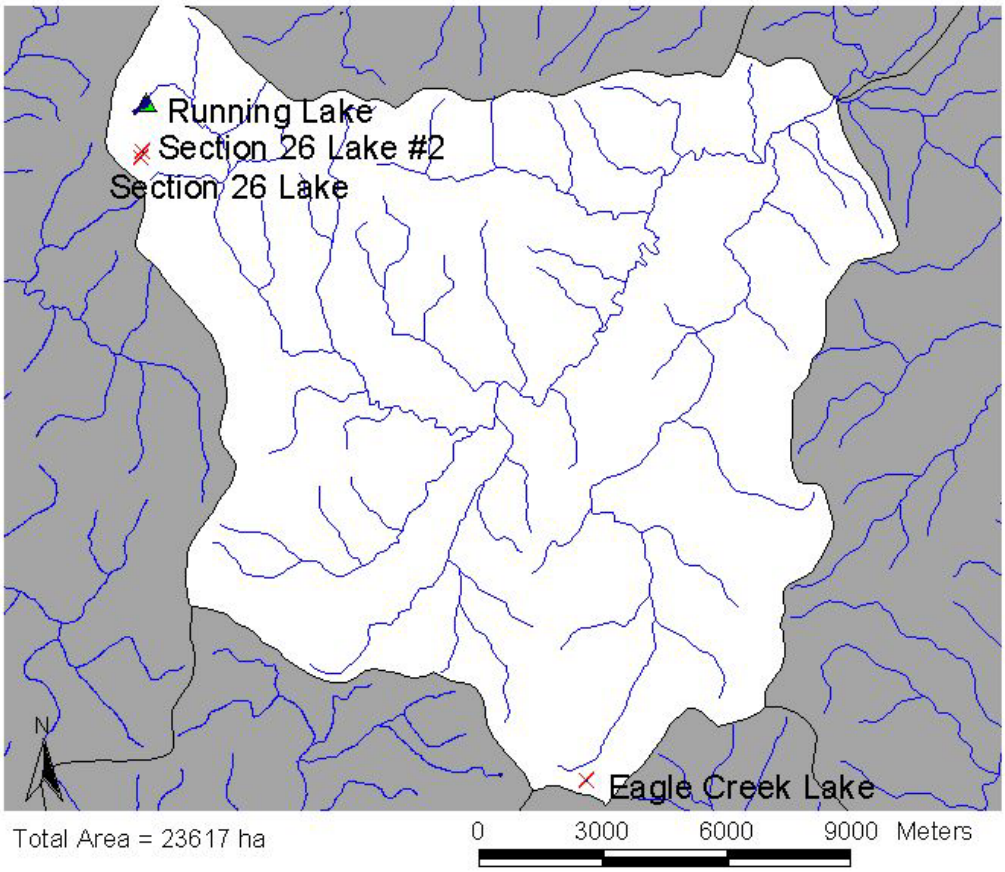


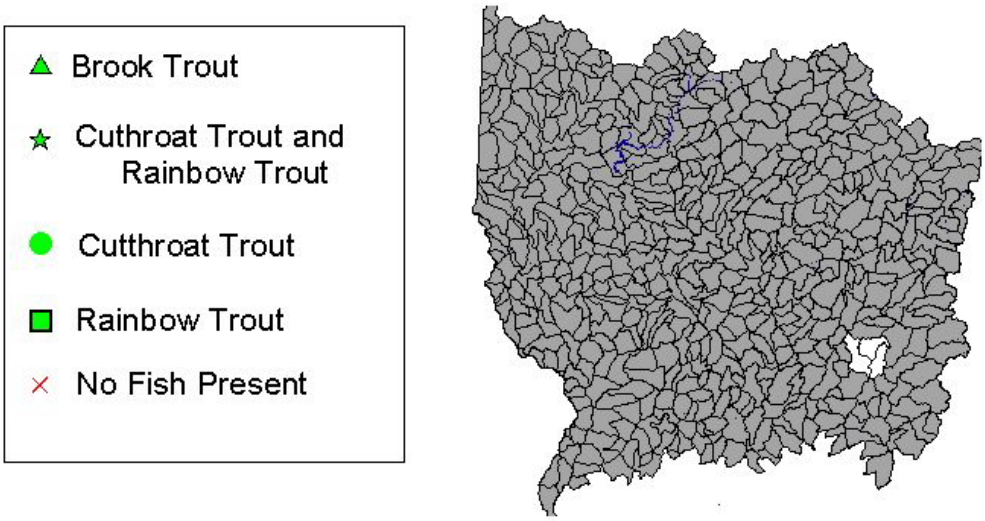




Locations of Fly, Heather and Platinum lakes in the Clearwater National Forest

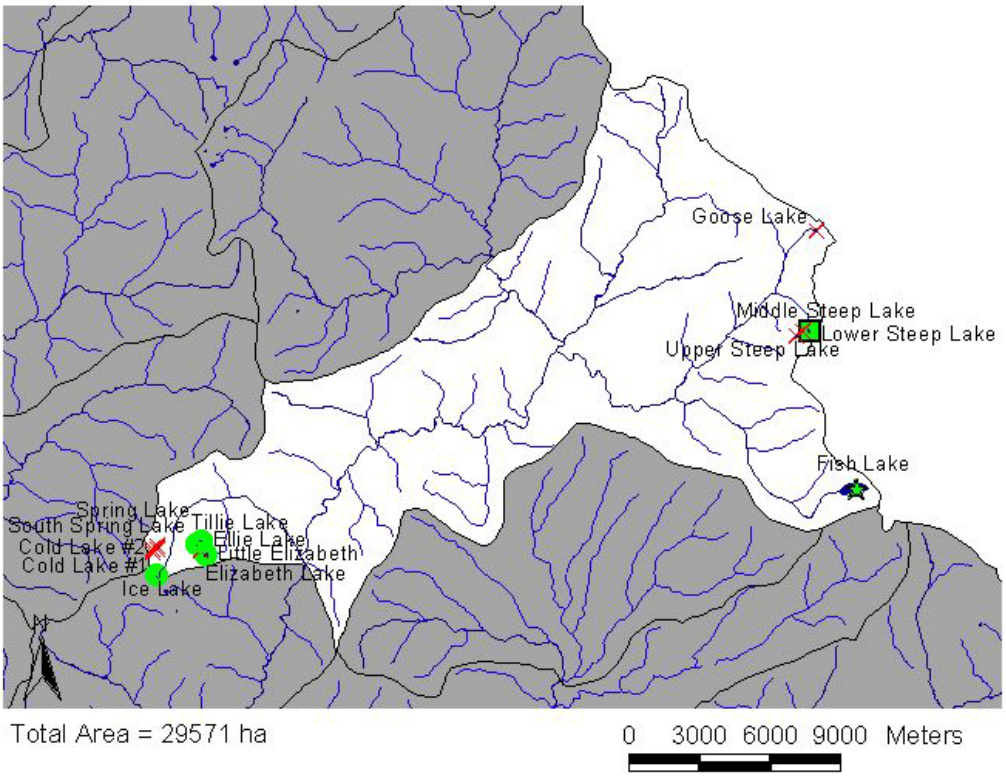
Appendix A. Continued.

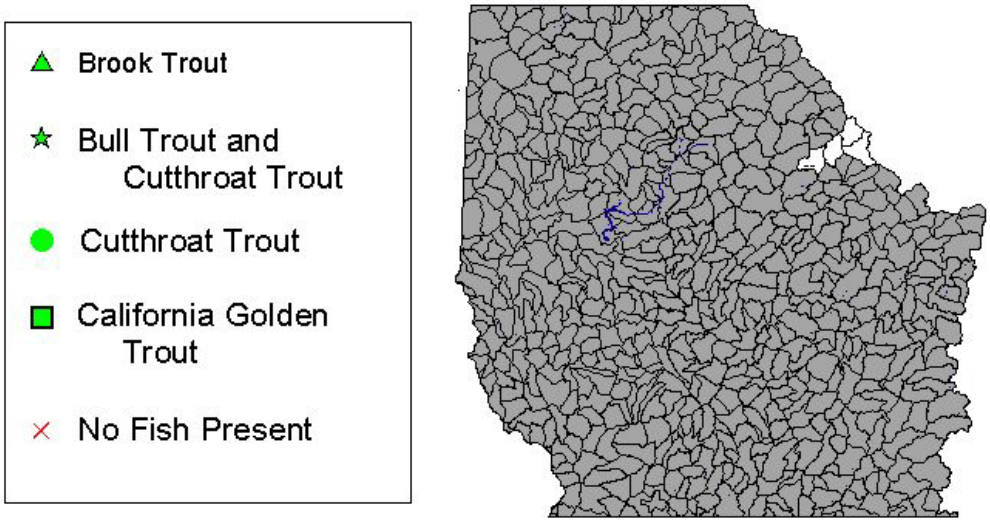




Location of Running Lake in the Nez Perce National Forest

Appendix A. Continued.





Location of Ice Lake in the Clearwater National Forest

Appendix B. Photographs showing lakes and streams surveyed in 2007 in the Clearwater Region. Photograph below shows Fly Lake from the Headwaters North Fork Clearwater River HUC5 watershed.

Fly Lake in the headwaters of the North Fork Clearwater River.

Appendix B. Continued.

Heather Lake from the Headwaters of the North Fork Clearwater River.

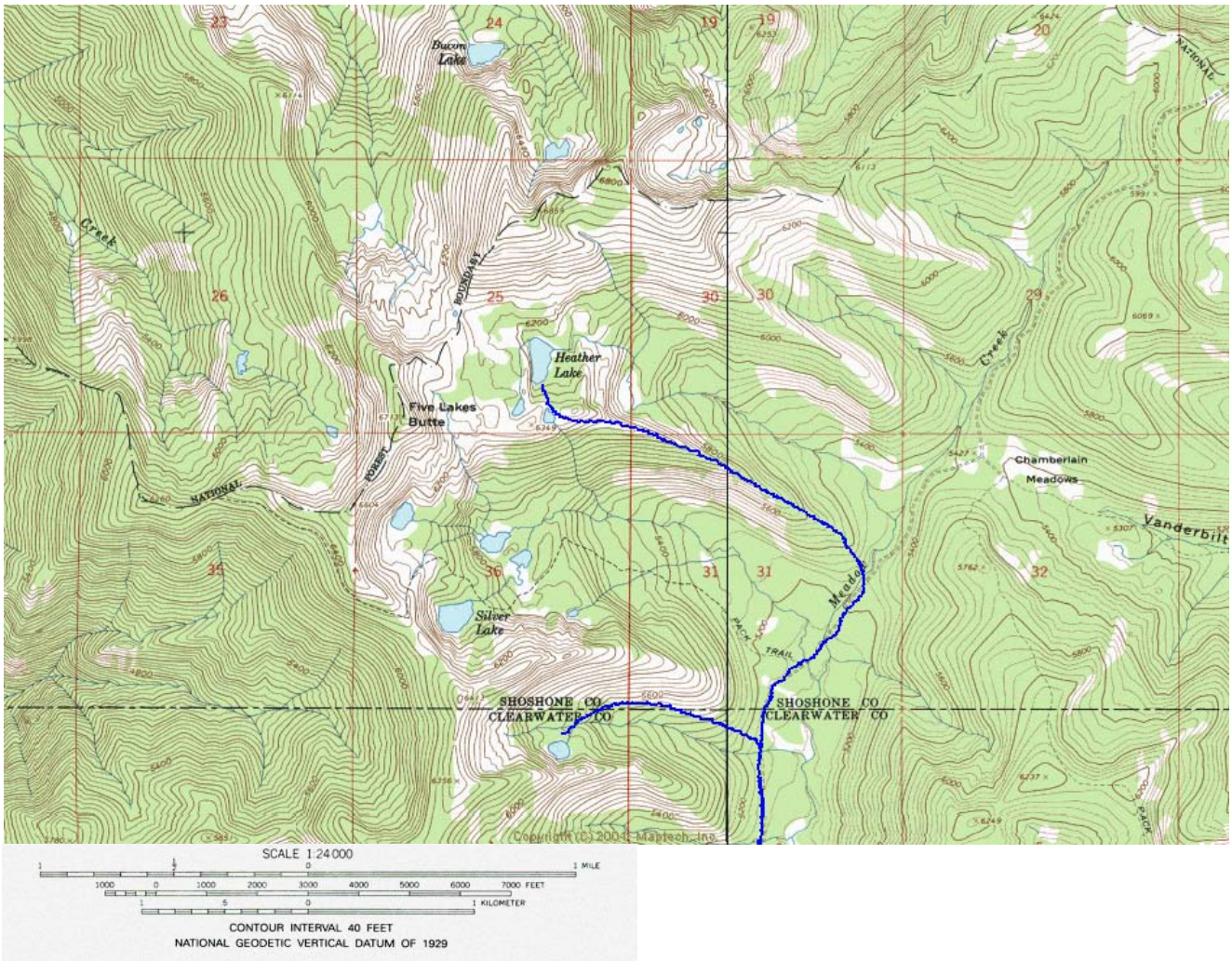
Platinum Lake from the Headwaters of the North Fork Clearwater River.

Appendix B. Continued.

Running Lake from the headwaters of the upper Selway River.

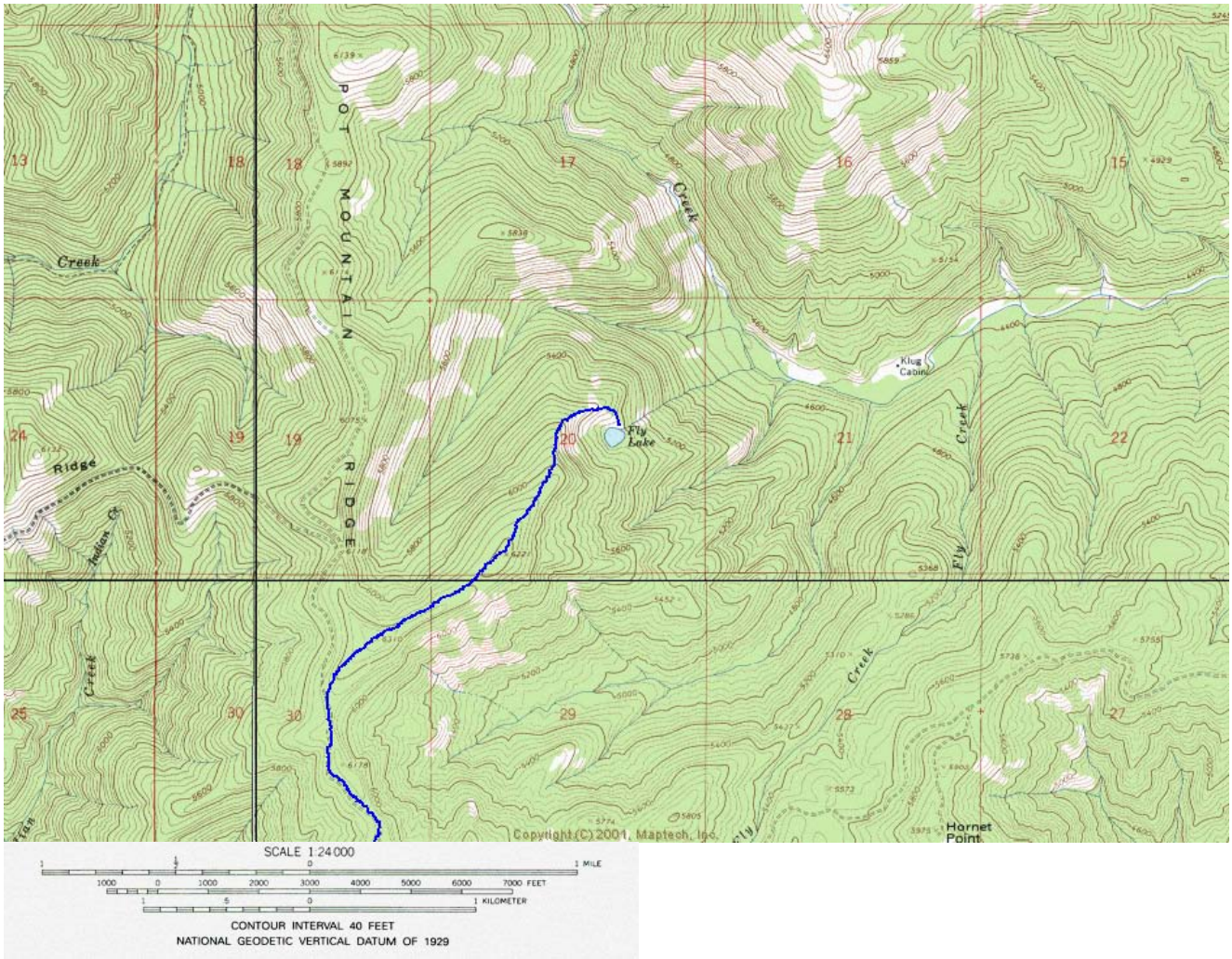
Ice Meadow of Elizabeth Creek where brook trout were removed in 2005-2007.

Appendix C. Topographic maps of area surrounding lakes and streams surveyed in 2007 with routes used to access them.



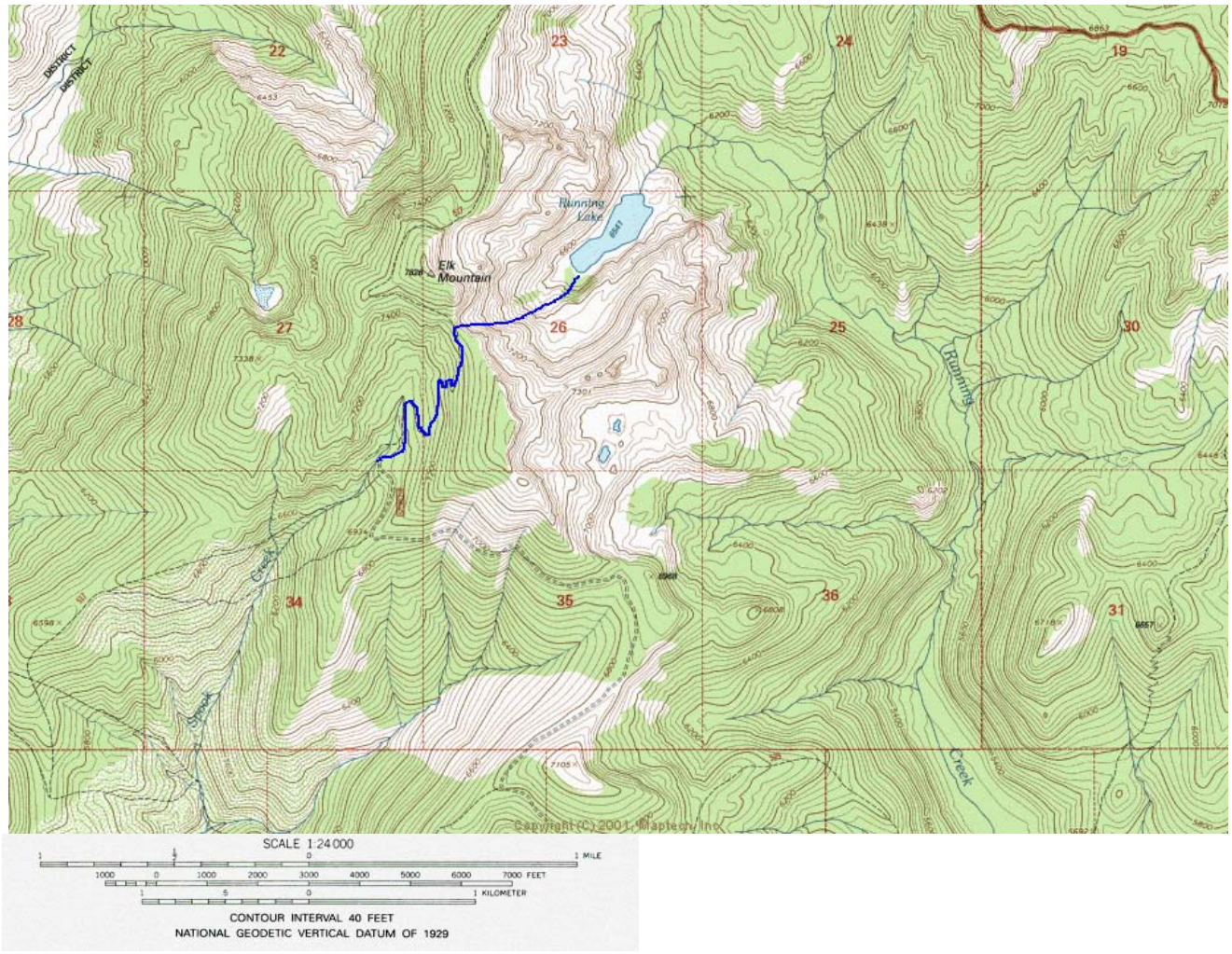
Routes used to access Heather and Platinum Lakes.

Appendix C. Continued.



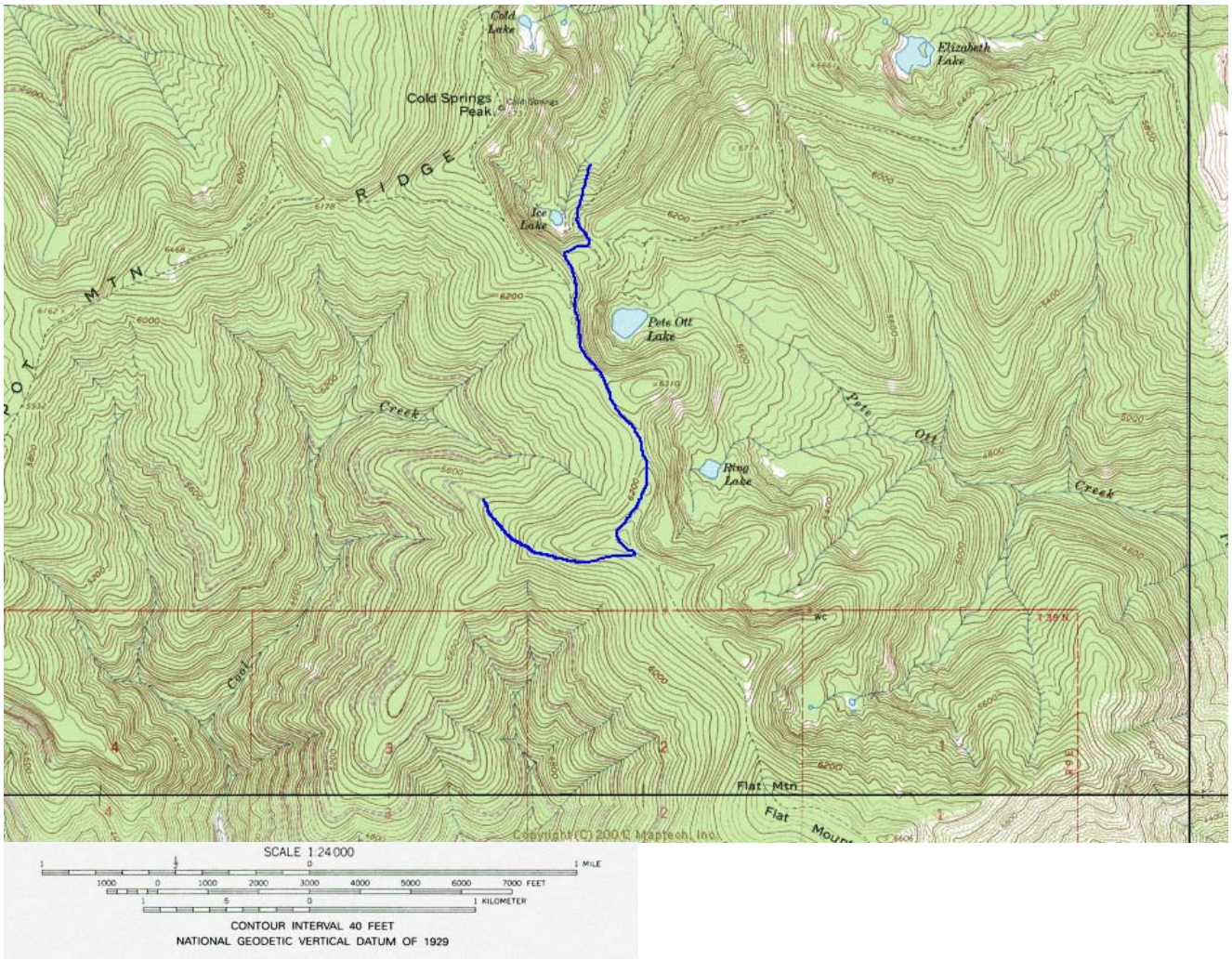
Routes used to access Fly Lake.

Appendix C. Continued.



Routes used to access Running Lake.

Appendix C. Continued.



Routes used to access the Ice Meadow area of Elizabeth Creek.

Appendix D. Clearwater Region mountain lakes data sheet (page 1) with the physical lake attributes (habitat parameters) section highlighted.

HIGH MOUNTAIN LAKES SURVEY DATA SHEET

Lake Name:	**Survey Date (mm-dd-yy)**
Drainage:	**Legal Description:** Township - Range - Section -
County:	**Elevation (m)**
National Forest – Ranger Distict	**Northing (GPS) -** **Easting (GPS) -**
Crew Members:	**Topo Map (7.5')**
	IDFG Lake #

Lake Description:

HABITAT PARAMETERS

Physical Data	**Chemical Data**
Surface Area (Hectares) -	**Conductivity (µs) -**
Aspect -	**pH -**
Maximum Lake Depth (m) -	**Water Temperature (° C) (shallow) -**
% Bottom Composition < than 3.0 m deep(littoral) -	**Air Temperature (°C) -**
Secchi Disc (m) -	**Weather -**

Littoral zone substrate composition (%)

Bedrock _____ Boulders_____ Rubble_____ Gravel_____ Sand_____ Silt_____ Organic debris_____ Logs_____

Stream Characteristics

Stream	1	2	3	4	5	6	7
Inlet (I) of Outlet (O)							
Width (m)							
Depth (m)							
Water Speed (1 – 4)							
Dominant Substrate							
Barrier Type							
Distance to Barrier							
% Spawning Sub, (Gr,Sa), 1 – 50 m							
Number of fish observed							

2007 Clearwater Region – Fishery Management Annual Report

LOWLAND LAKE INVESTIGATIONS

METHODS

The annual smallmouth bass *Micropterus dolomieui* survey of Dworshak Reservoir consists of electrofishing three shoreline sites in their entirety: Magnus Bay, Swamp Creek bay, and the shoreline beginning directly across from the Dent Boat Ramp to the Dent Bridge. Electrofishing time is recorded for each section, and all fish are weighed (g) and measured for total length (mm).

Fish community surveys were conducted on Mann Lake, Waha Lake, and Winchester Lake using Idaho Department of Fish and Game (IDFG) standard survey protocol. Results were reported in catch-per-unit-effort (CPUE). One "unit" of effort consisted of: one hour of boat electrofishing, one floating and one sinking gill net, and one trap net. Boat mounted electrofishing was conducted using pulsed D.C. current from a portable generator and a Coffelt VVP-2E pulsator. Standard floating and sinking experimental gill nets were 45.7 m long by 1.8 m deep with six panels of different size mesh. Mesh sizes were 19.0 mm, 25.4 mm, 31.8 mm, 38.1 mm, 50.8 mm, and 63.5 mm square. Indiana style trap nets consisted of a front box maze of two, 1.8 m wide by 0.9 m high steel frames with center braces and four 0.8 m diameter hoops with two 0.2 m throats, and a 15.2 m long x 0.9 m high leader. Mesh size was 19.0 mm throughout.

RESULTS AND DISCUSSION

Fish Stocking and General Population Management

We enhanced resident fish populations and sport fishing in lowland lakes and reservoirs of the Clearwater Region by stocking approximately 193,750 fingerling rainbow trout *Oncorhynchus mykiss* and 4,994 fingerling westslope cutthroat trout *O. clarkii lewisi* (Table 1). Lakes, ponds and reservoirs were stocked with 212,273 catchable size rainbow trout (Table 2). Additionally, 1,985 channel catfish *Ictalurus punctatus* were stocked into Mann Lake, 183 channel catfish were stocked into Tolo Lake, 100 tiger muskellunge were stocked into Winchester Lake, and 51 tiger muskellunge were stocked into Spring Valley Reservoir.

Seven children's fishing clinics were held on Free Fishing Day, June 9, 2007. An estimated 458 children and 503 adults attended the events (Table 3). Continuing the new statewide effort to address angler recruitment, pilot events were held at Mann Lake and Spring Valley Reservoir. This involved increased advertisement, requests for assistance from local vendors, contests, and educational stations. Contests were held for casting accuracy and biggest fish caught, with prizes given for 1st-3rd place. The educational stations included Gyotaku fish printing, tanks with live fish, informational posters about fish found in Idaho, fishing lessons, and a fish cleaning/cooking station where participants could clean their fish and have them cooked by IDFG personnel. Fly fishing lessons were also available at Spring Valley Reservoir.

Table 1. Fingerling rainbow trout and westslope cutthroat trout stocked in the lowland lakes and reservoirs of the Clearwater Region of Idaho in 2007.

Water	Rainbow trout	Cutthroat trout	Total
Deer Creek Reservoir	23,650	4,994	28,644
Mann Lake	33,060		33,060
Soldier's Meadow Reservoir	33,060		33,060
Spring Valley Reservoir	33,060		33,060
Winchester Lake	70,920		70,920
Total	193,750	4,994	198,744

Table 2. Catchable size rainbow trout stocked in lakes, ponds, and reservoirs of the Clearwater Region of Idaho in 2007.

Water	April	May	June	July	August	September	October	Total
Camp Grizzly Pond			501					501
Campbells Pond	2,015	1,530	3,200			1,000		7,745
Deer Creek Reservoir	3,952	7,502	7,497			1,100		20,051
Elk Creek Reservoir		7,502	15,090					22,592
Fenn Pond		758	1,121		250			2,129
Five Mile Pond		510	698		180			1,388
Henry's Gulch Pond	496	1,010						1,506
Hordeman Pond	279							279
Jaype Mill Pond		510	995	250				1,755
Karolyn's Pond		510	1,294		318	500		2,622
Levee Pond	713	390	597	248	249	250		2,447
Mann Lake	13,120	11,510					10,850	35,480
Moose Creek Reservoir	9,600					4,900		14,500
Powell Pond		1,895	995			550		3,440
Robinson Pond	992	3,007	425					4,424
Soldier's Meadow Reservoir		10,240						10,240
Spring Valley Reservoir	12,800		12,400			7,350		32,550
Waha Lake		5,104	8,060					13,164
Winchester Lake	8,960	16,000				4,900	5,600	35,460
Total	52,927	67,978	52,873	498	997	20,550	16,450	212,273

Table 3. Number of participants at seven Free Fishing Day events held on June 9, 2007 in the Clearwater Region of Idaho.

	2007 participants		
Location	kids	adults	Total
Mann Lake	100	100	200
Spring Valley Reservoir	150	200	350
Deer Creek Reservoir	25	35	60
Karolyn's Pond	30	40	70
Fenn Pond	30	20	50
Long Gulch	12	8	20
Wilkin's Pond	111	100	211
Total	458	503	961

POPULATION SURVEYS

Deer Creek Reservoir

Several fish surveys were conducted during 2007 to look for golden shiners *Notemigonus crysoleucas* that might have survived the 2006 rotenone treatment. None were detected during the surveys.

Dworshak Reservoir

An annual smallmouth bass monitoring survey was conducted on Dworshak Reservoir from June 12-13, 2007. A total of 124 smallmouth bass were collected in 26,569 seconds of electrofishing, slightly fewer than were collected in 2006 (Figure 8). The fish collected ranged in length from 67-505 mm (Figure 9). However, almost all of the fish were from 130-269 mm. The average size of fish appears to be smaller than in the previous two years. The 505 mm fish was the largest smallmouth bass ever collected during this annual survey. Smallmouth bass proportional stock density (PSD; Gablehouse 1983) was 5.2 in 2007, the lowest it has been since 1998 (Figure 10).

Mann Lake

Clearwater Region fisheries management personnel conducted a standard lake survey of Mann Lake on May 29, 2007. This survey resulted in the capture of 255 fish, including largemouth bass *Micropterus salmoides* (N = 106), pumpkinseed *Lepomis gibbosus* (N = 64), bluegill *L. macrochirus* (N = 44), black crappie *Pomoxis nigromaculatus* (N = 32), channel catfish (N = 5), and black bullhead *Ameiurus nebulosus* (N = 4), A comparison of catch per unit effort between samples collected in 2001, 2003, 2005, and 2007 is shown in Figure 11.

The number of largemouth bass collected has increased in each of the last four samples. In addition, the length frequency distributions show a shift toward larger fish over the last three samples, with many fish collected over 300 mm (Figure 12). In contrast to the 2005 sample, in 2007 we collected numerous fish in the 300-370 mm range. Largemouth bass PSD was 71.7 in 2007, the highest it has been over the last four samples (Figure 13). PSD values for largemouth bass from 40-70 are considered in balance (Anderson and Gutreuter 1983). Relative weights ranged from 80-150, increasing with length (Figure 14). These values were very similar to those calculated for 2005.

The number of black crappie collected in the sample has declined every year since 2001. However, the length frequency distribution shows that the average size has increased each year (Figure 15). In addition, black crappie PSD has also increased each year, to 74.1 in 2007 (Figure 16). This indicates that the population is declining in size, allowing the remaining fish to grow larger due to the decrease in competition for food resources. Increased angler harvest in recent years is likely a major contributing factor. Increased competition with bluegill/pumpkinseed and predation by largemouth bass and catfish are additional factors that may be causing the decline. Black crappie relative weights were mostly in the 90-100 range for both the 2005 and 2007 samples (Figure 17), indicating good food availability. This is a marked improvement from the 2003 sample when relative weights were mostly at or below 80.

Bluegill have also seen an increase in average size over the last three samples (Figure 18). However, PSD values declined from 47.4 in 2005 to 33.3 in 2007 (Figure 19). Relative weight values for bluegill have remained constant for the last three samples, mainly ranging from 100-120 (Figure 20). Pumpkinseed collected in 2007 ranged from 60-190 mm (Figure 21).

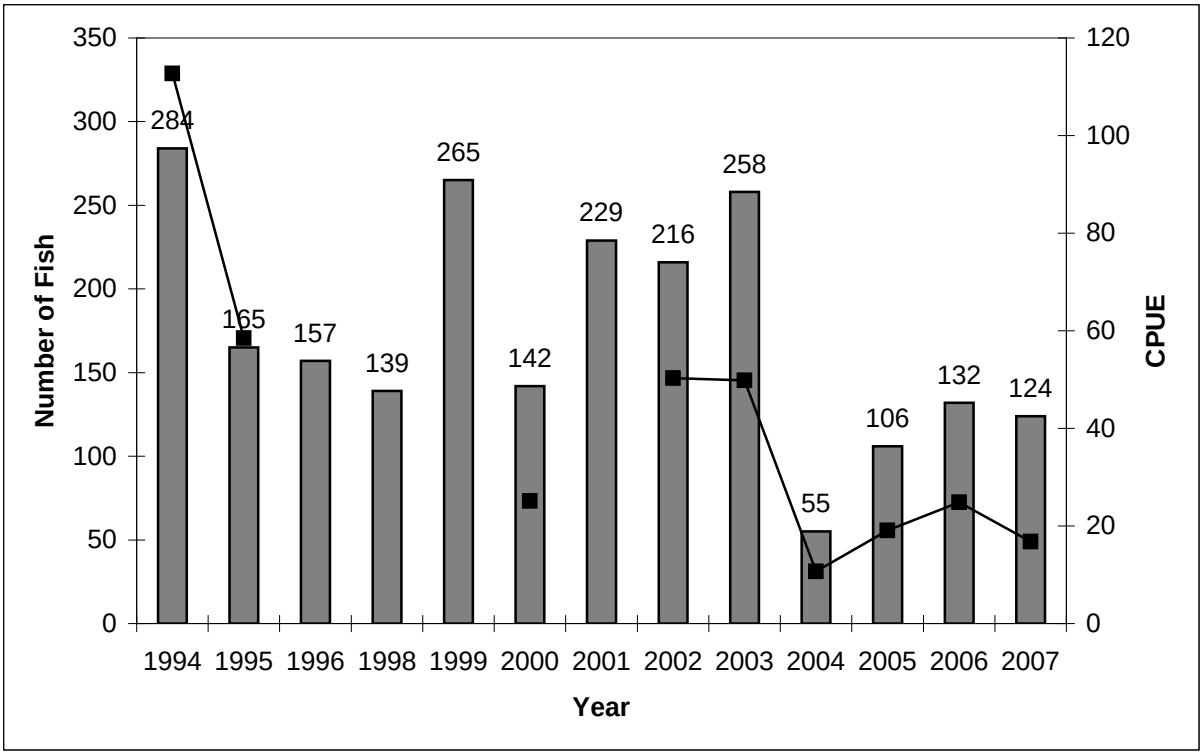


Figure 8. Number and catch per unit effort (CPUE) of smallmouth bass collected during annual population surveys of Dworshak Reservoir, Idaho, from 1994-2007 (N values shown).

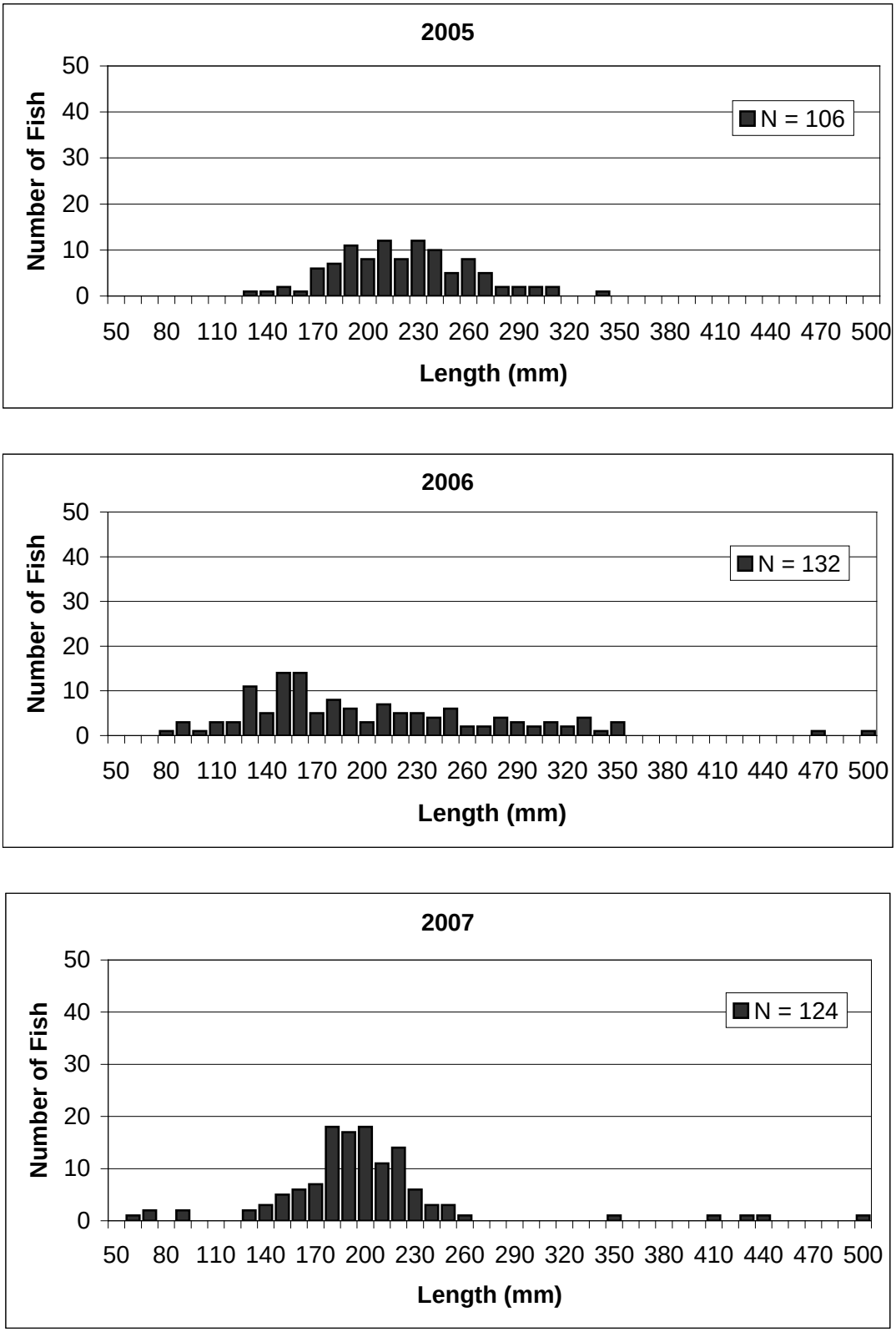


Figure 9 Length frequency distributions of smallmouth bass collected during annual population surveys of Dworshak Reservoir, Idaho, from 2005-2007.

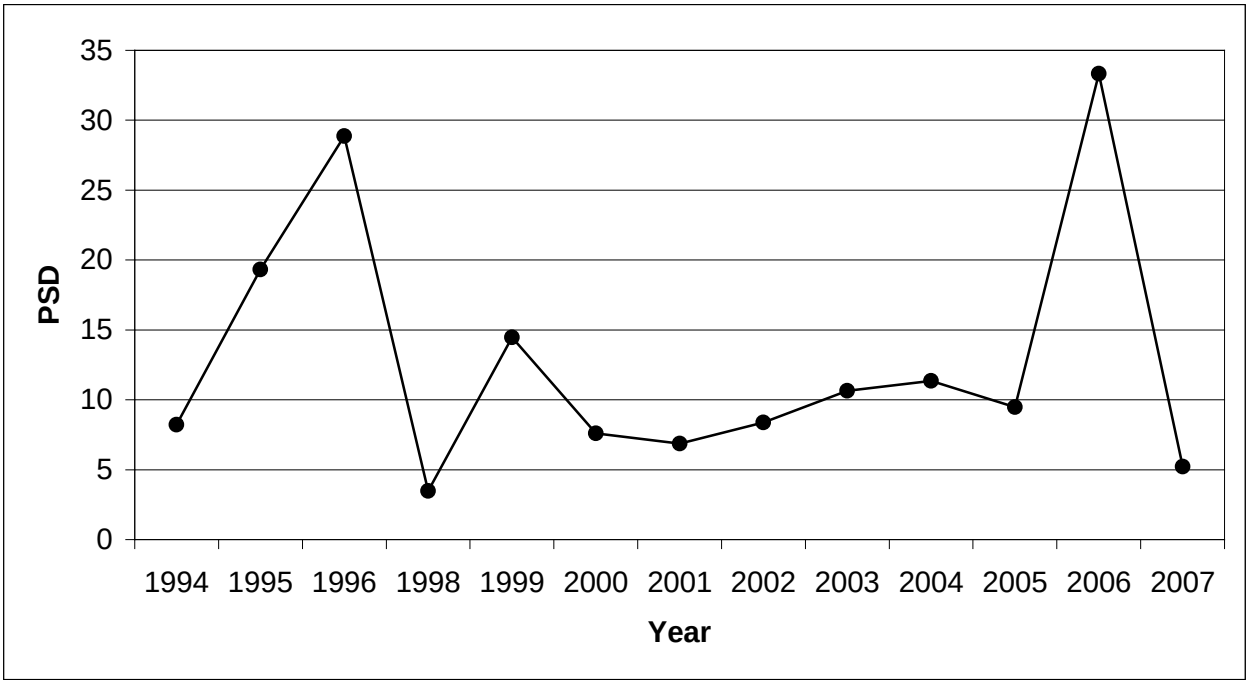
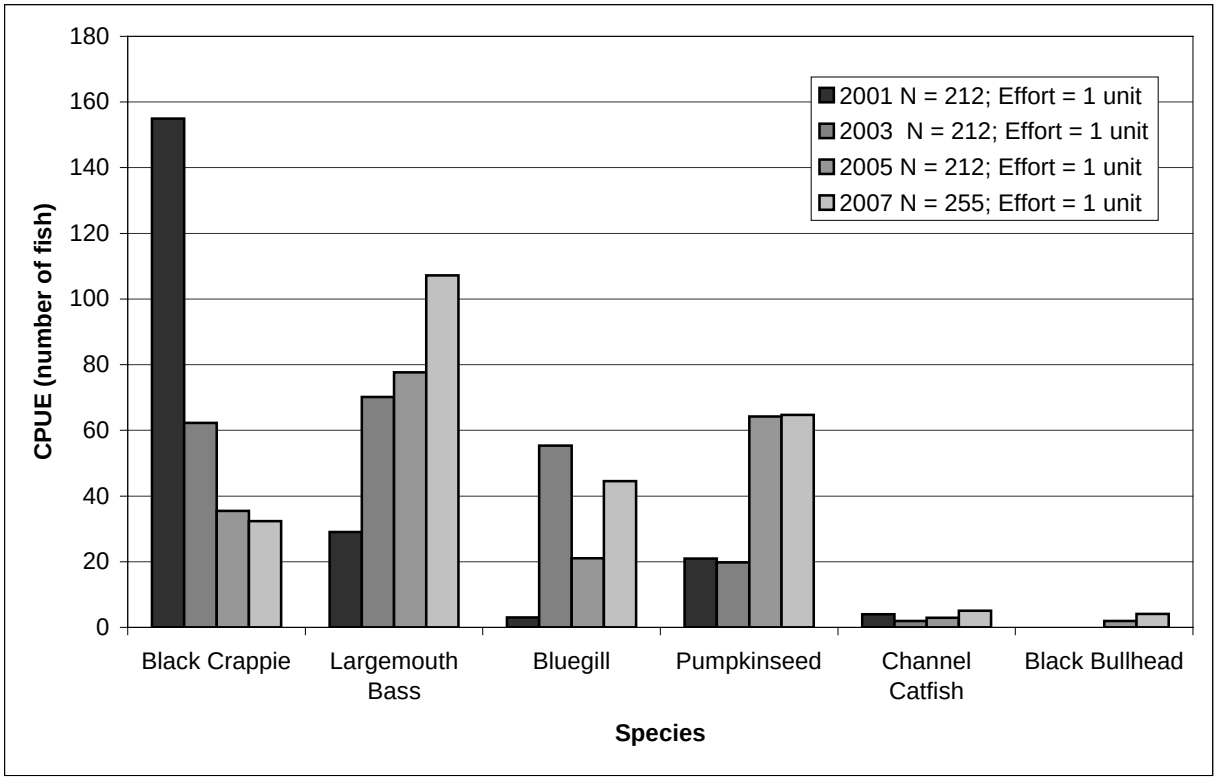


Figure 10. Proportional stock density (PSD) of smallmouth bass collected during annual population surveys of Dworshak Reservoir, Idaho, from 1994-2007.



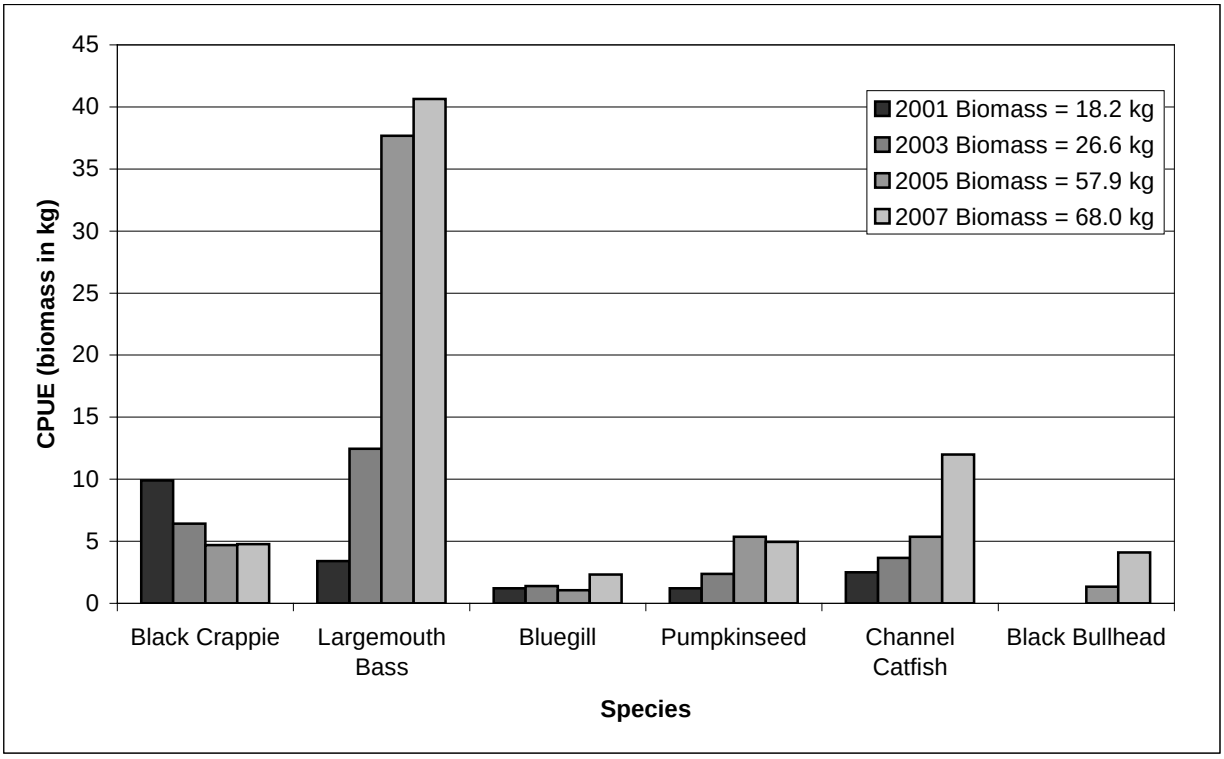


Figure 11. Catch per unit effort (CPUE) of fish collected from standard lake surveys of Mann Lake, Idaho, in 2001, 2003, 2005, and 2007, by number of fish and biomass.

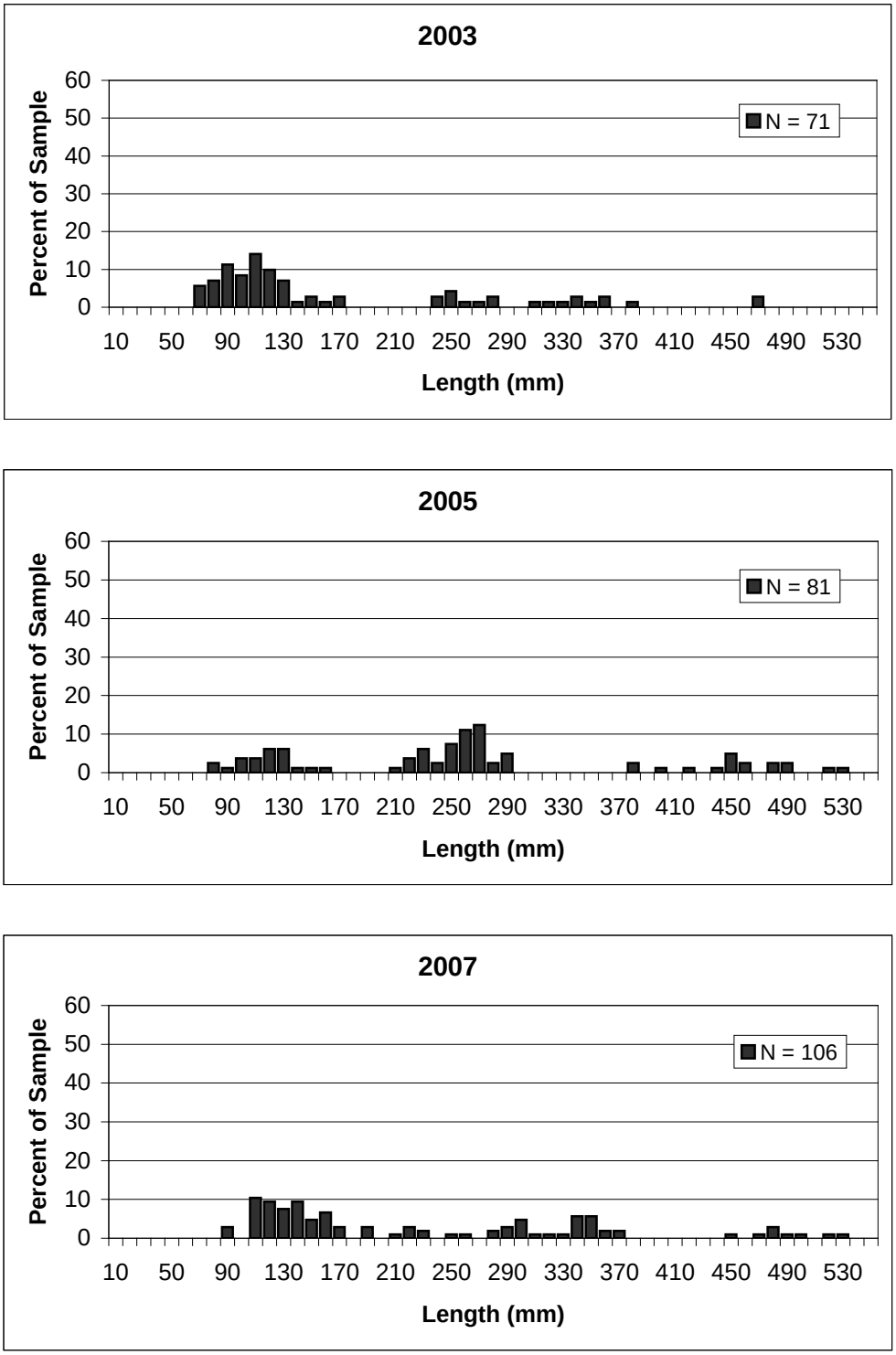


Figure 12. Length frequency distributions of largemouth bass collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.

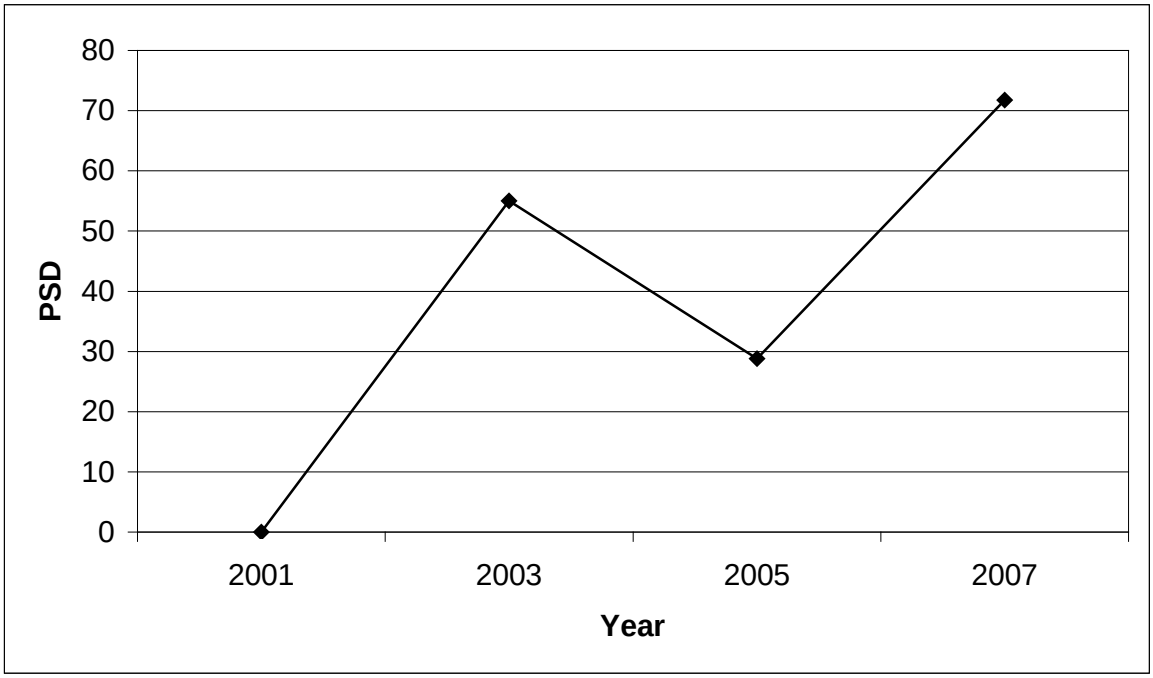
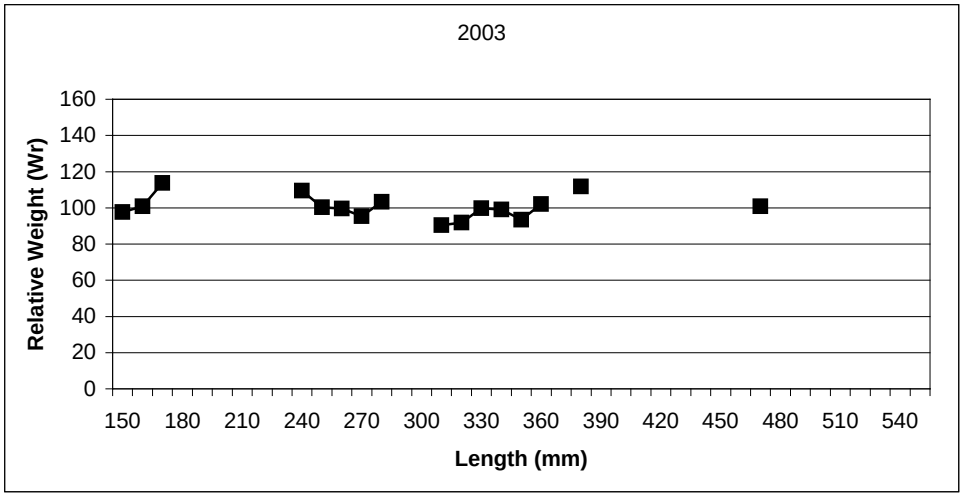
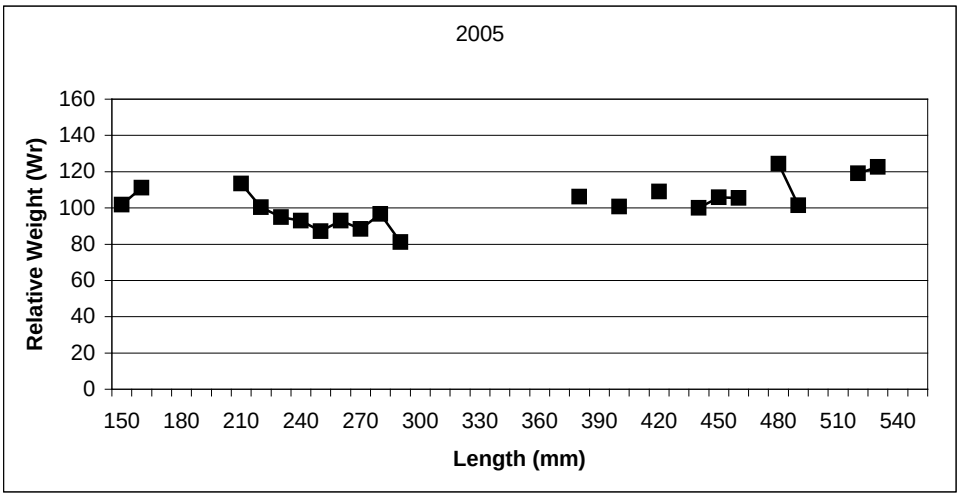


Figure 13. Proportional stock density (PSD) of largemouth bass collected from standard lake surveys of Mann Lake, Idaho, from 2001-2007.





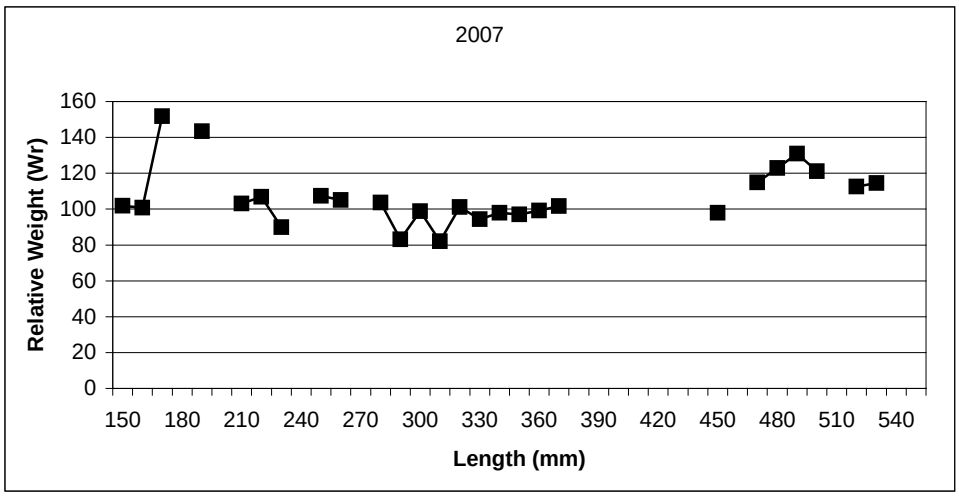
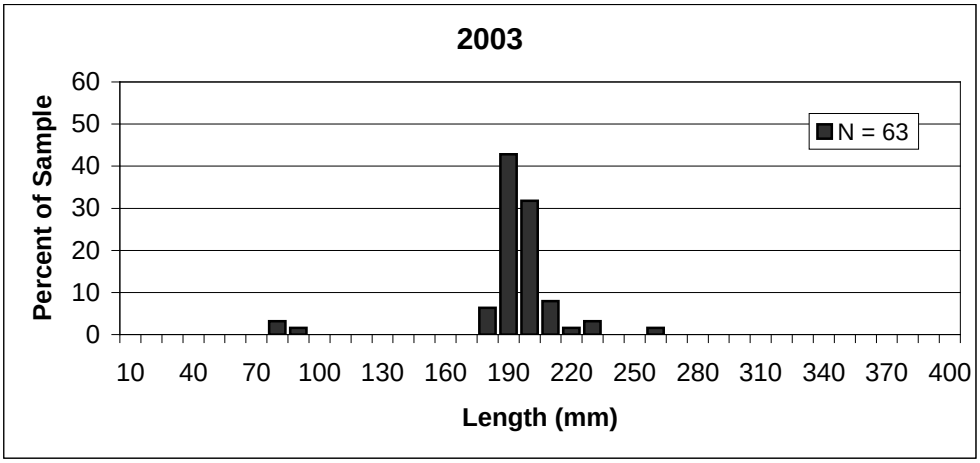
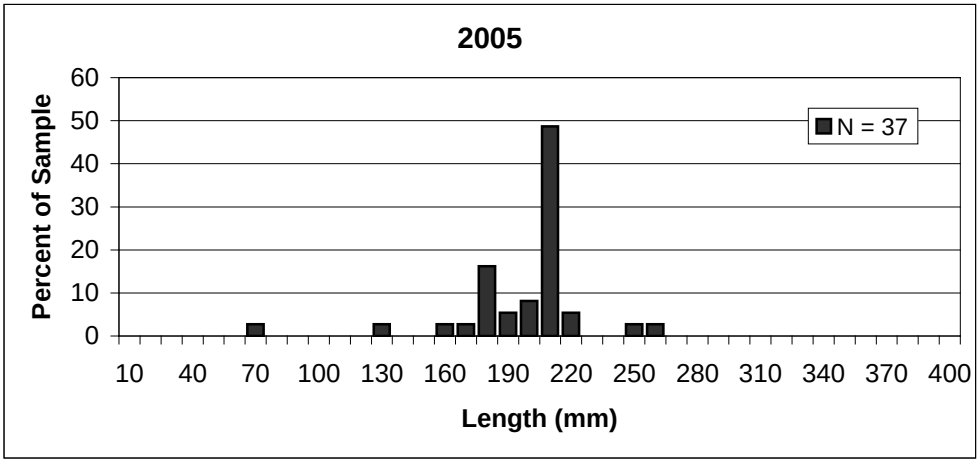


Figure 14. Average relative weights (Wr) for largemouth bass collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.





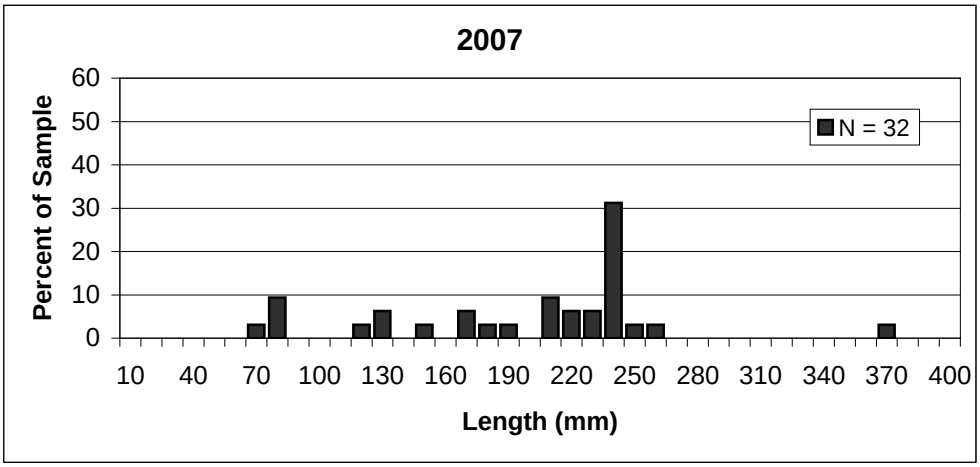


Figure 15. Length frequency distributions of black crappie collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.

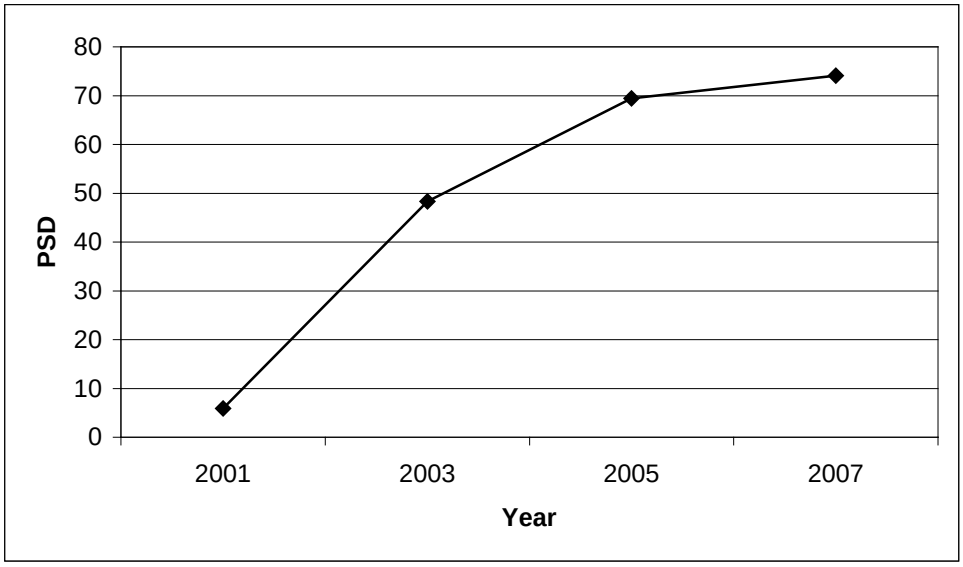


Figure 16. Proportional stock density (PSD) of black crappie collected from standard lake surveys of Mann Lake, Idaho, from 2001-2007.

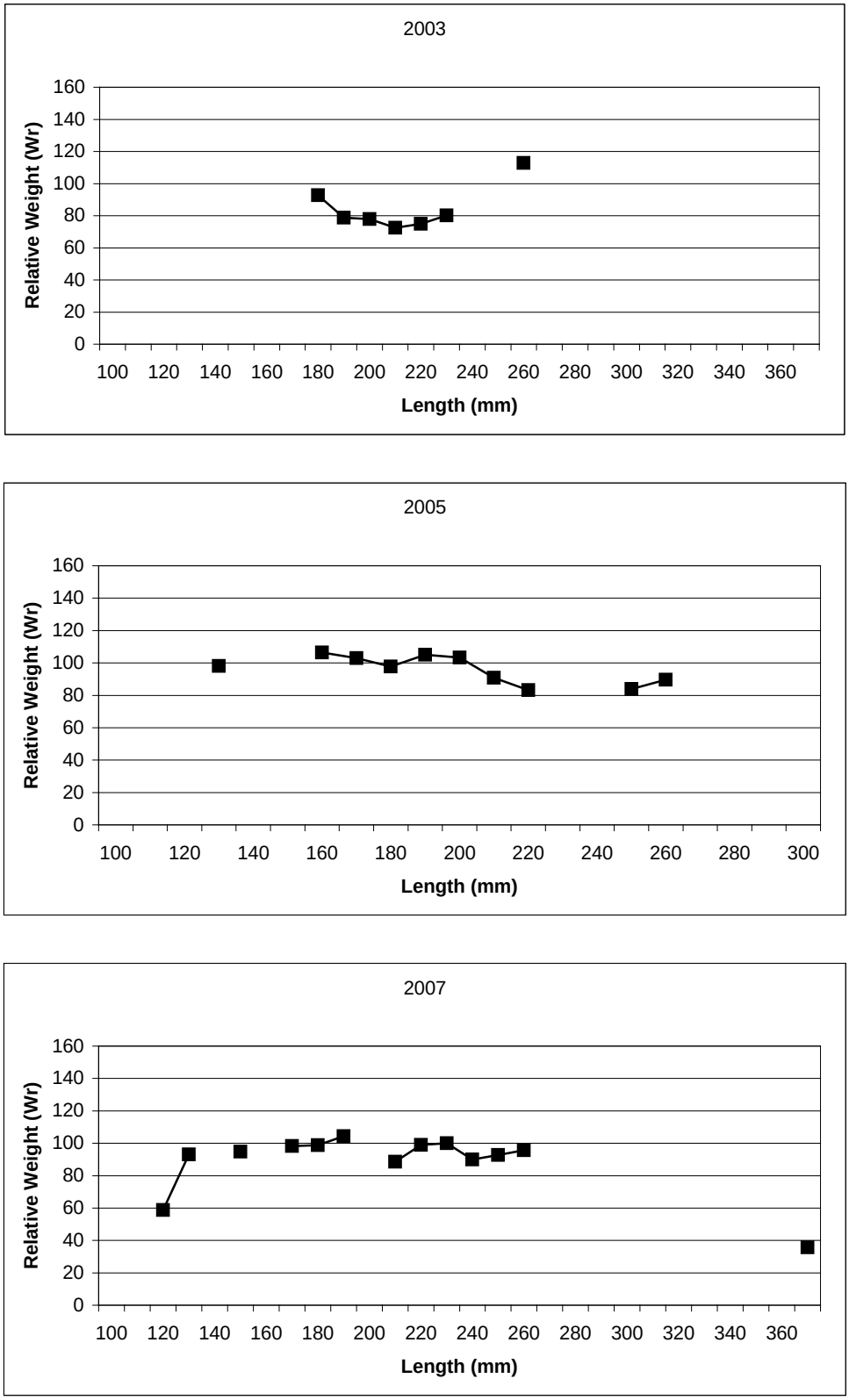
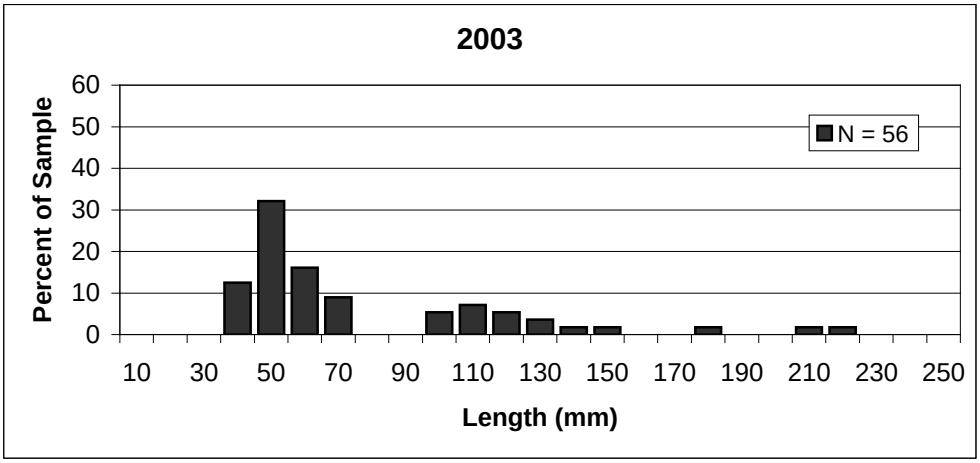
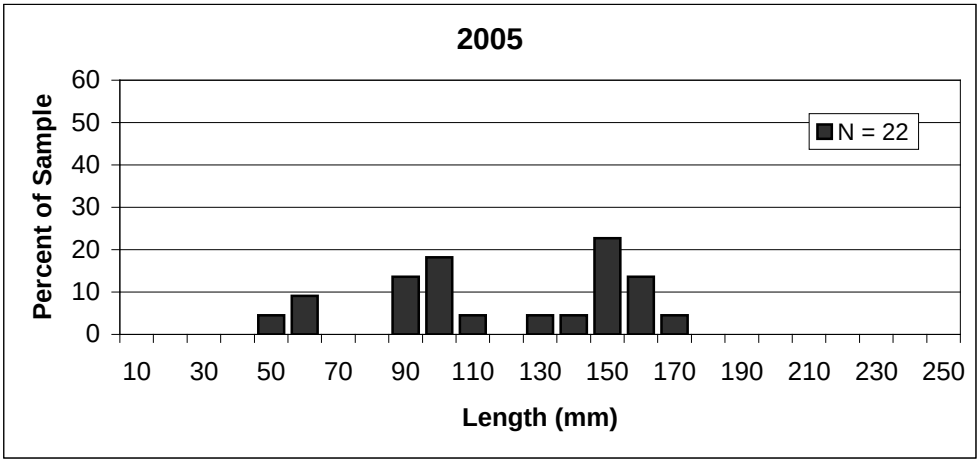


Figure 17. Average relative weights (Wr) for black crappie collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.





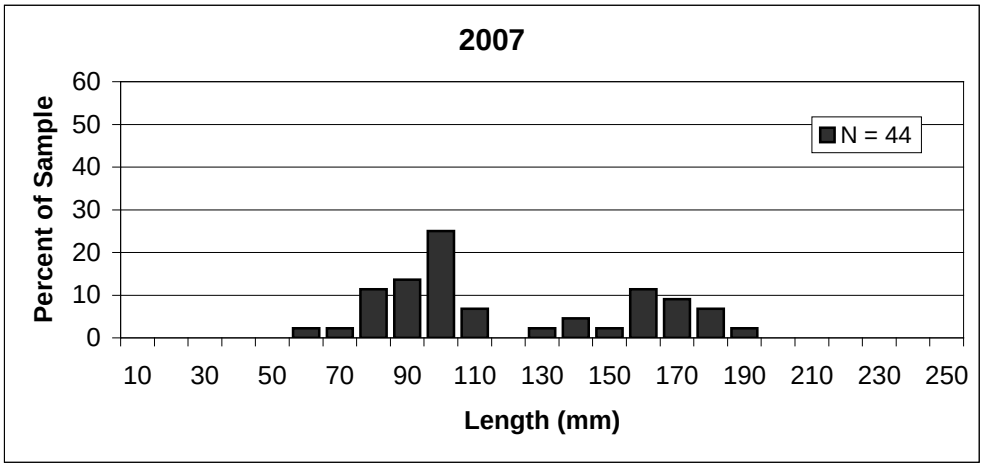


Figure 18. Length frequency distributions of bluegill collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007

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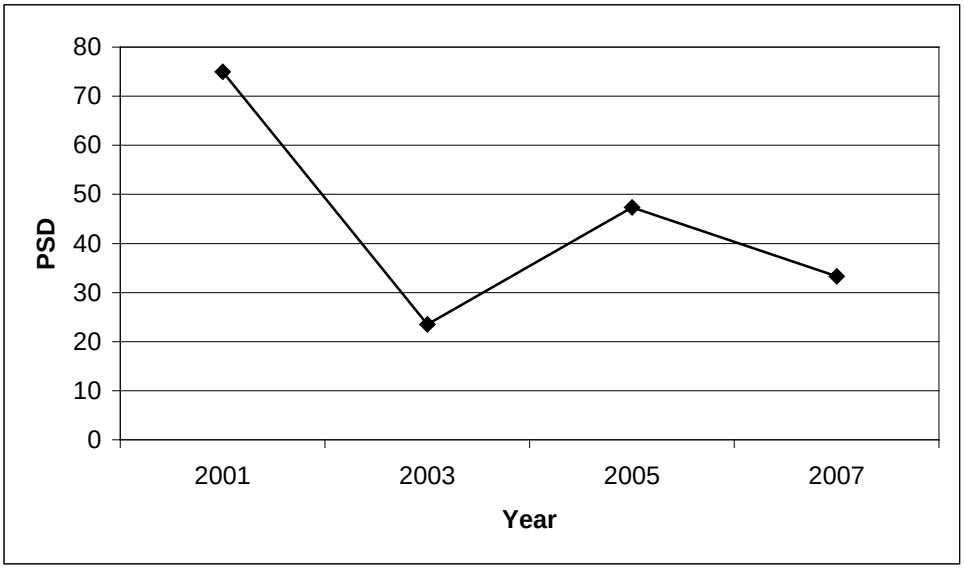
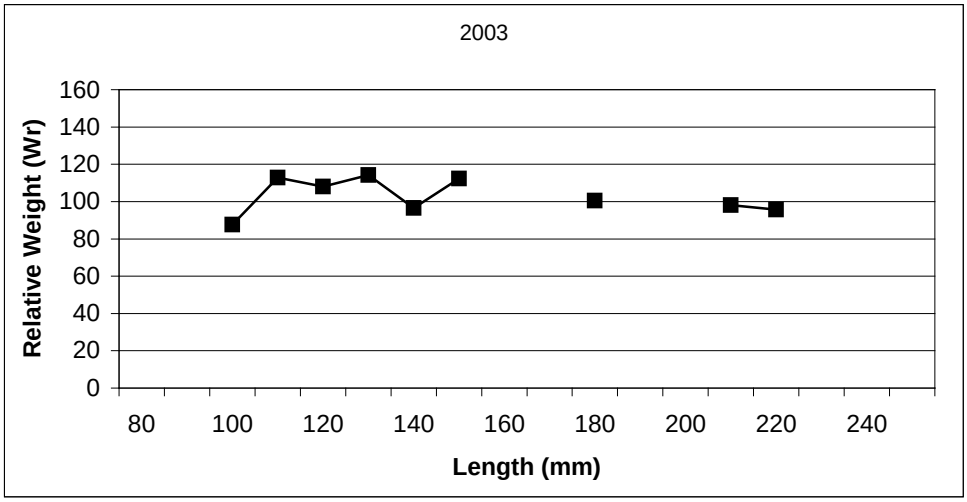
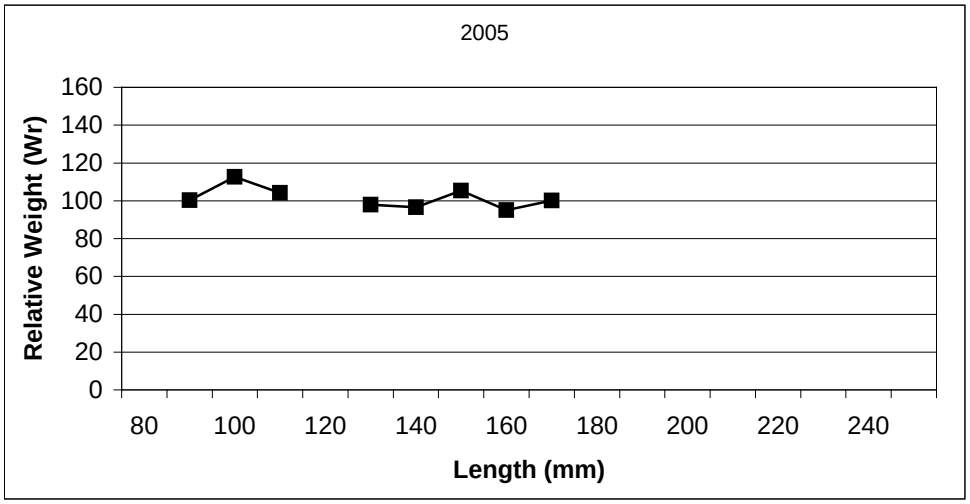


Figure 19. Proportional stock density (PSD) of bluegill collected from standard lake surveys of Mann Lake, Idaho, from 2001-2007.





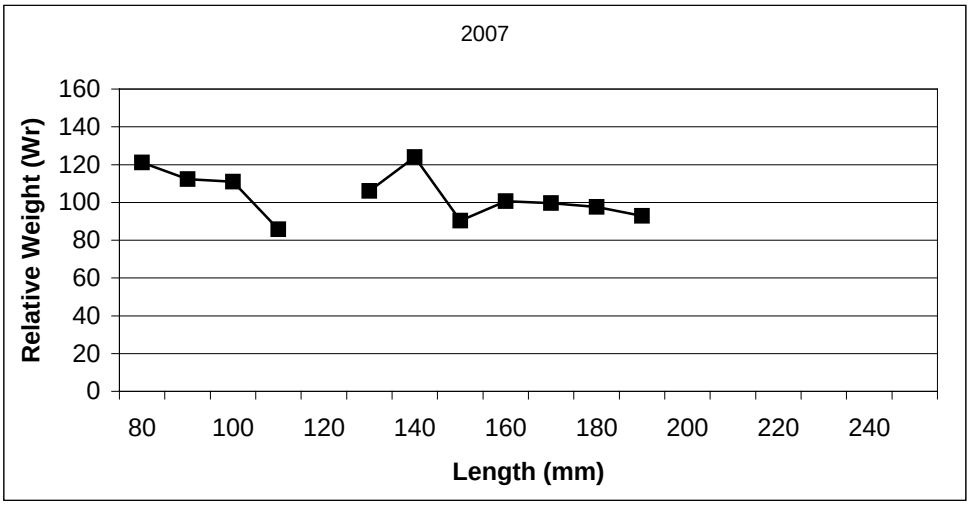
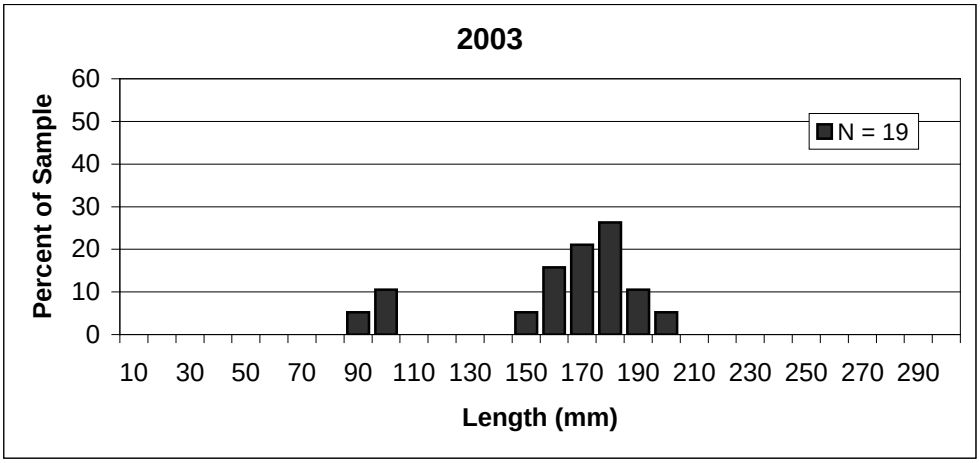
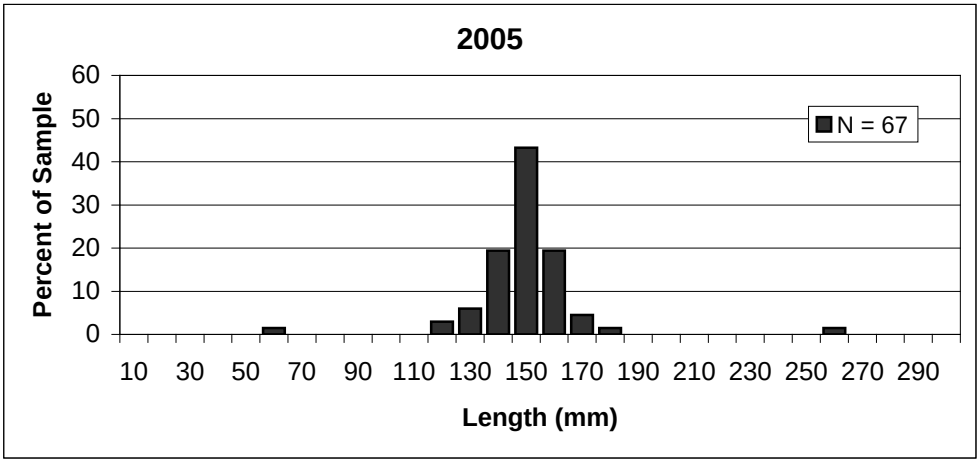


Figure 20. Average relative weights (Wr) for bluegill collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.





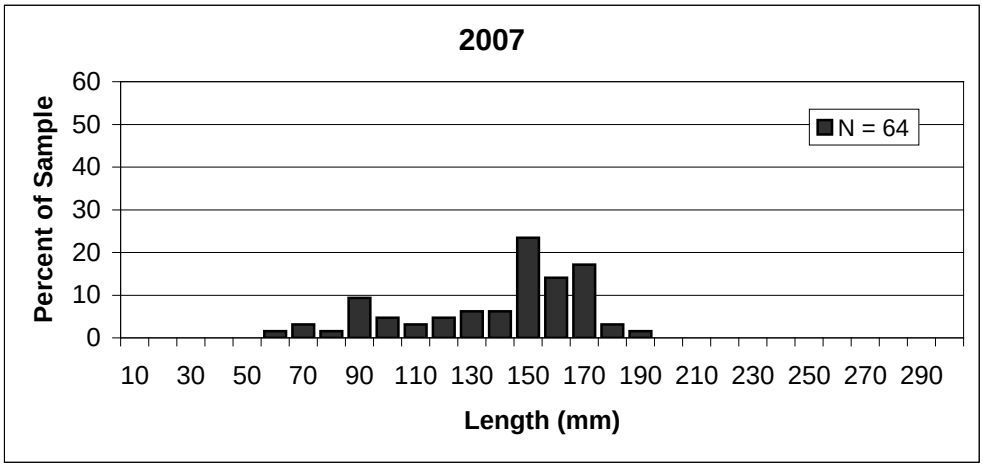


Figure 21. Length frequency distributions of pumpkinseed collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.

This was much wider distribution than seen in previous samples with the presence of smaller fish that were not collected in previous samples. However, most of the fish were still in the 120-189 mm range. PSD values for pumpkinseed were 62.3 in 2007, the second straight decline after a high of 80.0 in 2003 (Figure 22). Pumpkinseed relative weights, after remaining constant for the previous two samples, varied widely in 2007 from 81-168 (Figure 23). However, they averaged slightly above 100, as in previous years.

Figure 24 provides a graphical representation of predator vs. prey PSD values over time as they relate to population balance.

Waha Lake

Clearwater Region fisheries management personnel conducted a standard lake survey of Waha Lake on May 30, 2007. This survey resulted in the capture of 119 fish, including smallmouth bass (N = 53), yellow perch *Perca flavescens* (N = 63), and black crappie (N = 3). A comparison of catch per unit effort between samples collected from 2001 - 2007 is shown in Figure 25.

Smallmouth bass caught in 2007 ranged in length from 50-290 mm. A comparison of length frequency distributions from the last three samples shows a trend toward larger fish and a wider distribution of sizes in 2007 (Figure 26). PSD for smallmouth bass was 3.3 (Figure 27), well below the range of 30-60 considered to be indicative of good balance. However this was a slight increase from the PSD of 0 recorded in the previous two samples. Smallmouth bass relative weights were more varied than in previous samples (Figure 28); however, they averaged slightly below 80 which is comparable to previous years.

Yellow perch collected in 2007 ranged in length from 40-290 mm. A comparison of length frequency distributions (Figure 29) shows a shift toward larger fish over the last three samples. Yellow perch PSD values have also shown an overall increase over recent samples (Figure 30), with a PSD of 43.6 in 2007. This PSD is right in the range of 30-50 considered to be indicative of balance. Relative weights for fish collected in 2007 mostly ranged from 80-100 (Figure 31), similar to previous years.

No splake *Salvelinus namaycush X Salvelinus fontinalis* or kokanee *O. nerka* were collected in 2007.

Winchester Lake

Clearwater Region fisheries management personnel conducted a standard lake survey of Winchester Lake on May 31, 2007. This survey resulted in the capture of 807 fish including largemouth bass (N = 228), bluegill (N = 365), yellow perch (N = 203), black crappie (N = 10), and tiger muskellunge (N = 1). A comparison of catch per unit effort between samples collected in 2003-2005, and 2007 is shown in Figure 32.

Largemouth bass collected in 2007 ranged in length from 110-460 mm in length. The length frequency distribution shows that most of the largemouth bass collected in 2007 were in the 110-300 mm range (Figure 33), with few fish over 400 mm. This is similar to length frequency distribution seen in 2005. Largemouth bass PSD dropped for the second straight year to 13.9 (Figure 34). This is well below the range of 40-70 suggested as indicative of a balanced population. The PSD combined with the recent length frequency distributions indicate a bass population dominated by smaller individuals. Relative weights for fish collected in 2007 were variable, but generally were between 80 -110, indicating good condition (Figure 35).

More bluegill were captured in 2007 than in any previous sample. These fish ranged in length from 80-210 mm in length. A comparison of length frequency distributions over the last three samples shows a shift toward larger fish (Figure 36). This is also evidenced by a sharp increase in PSD to 79.5, up from 49.6 in 2005 (Figure 37). This is well above the range of 20-40 suggested as indictive of a balanced population. Combined with a bass population dominated by small bass, the predator-prey relationship in Winchester Lake is out of balance.

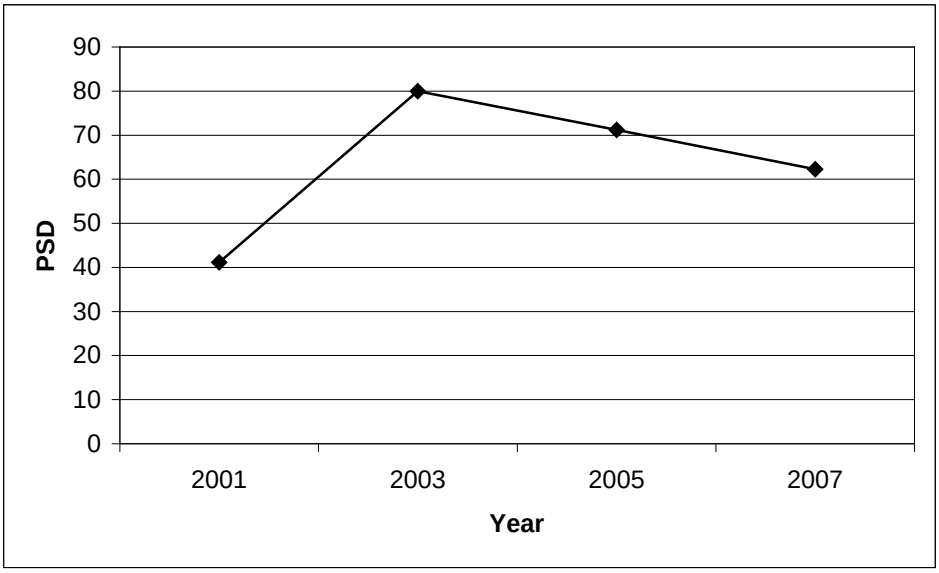
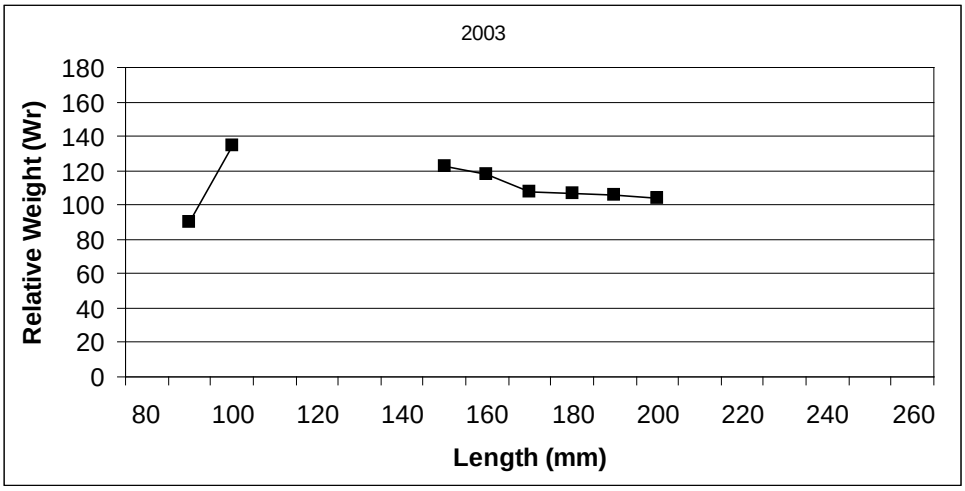
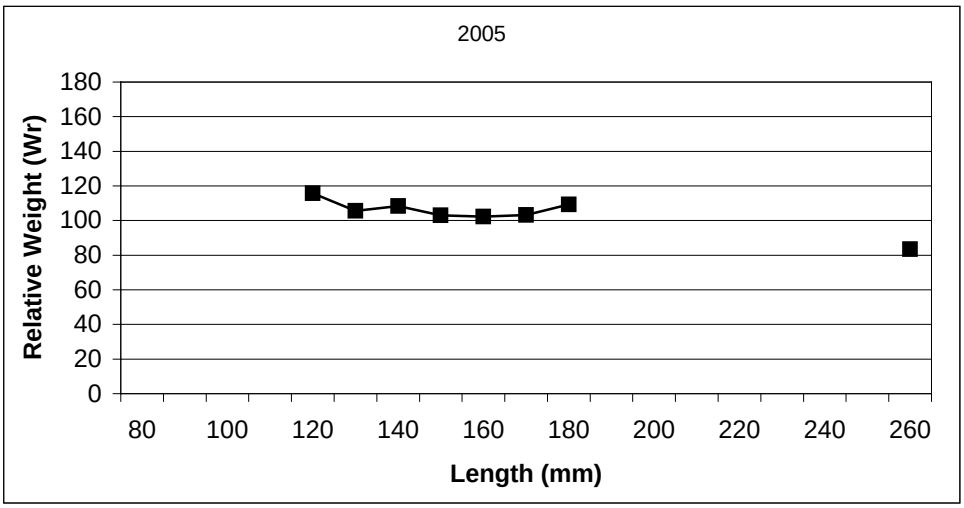


Figure 22. Proportional stock density (PSD) of pumpkinseed collected from standard lake surveys of Mann Lake, Idaho, from 2001-2007.





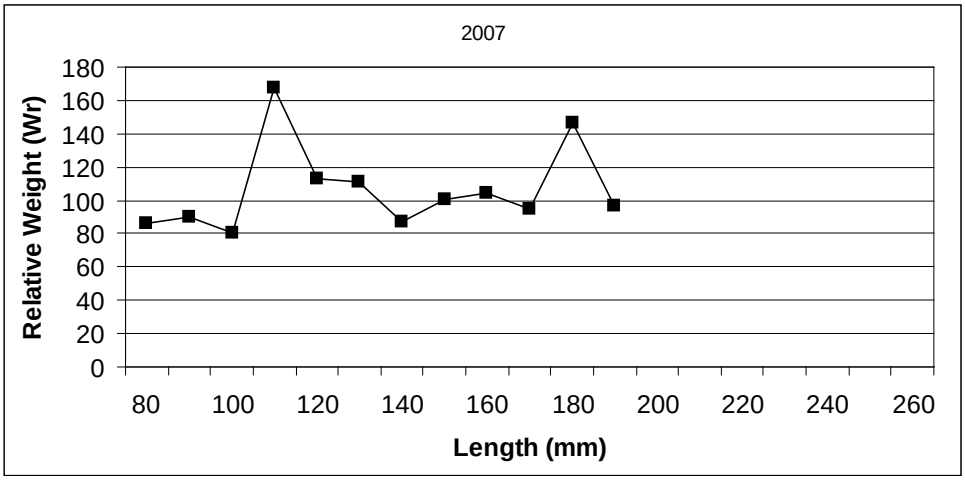


Figure 23. Average relative weights (Wr) for pumpkinseed collected from standard lake surveys of Mann Lake, Idaho, in 2003, 2005, and 2007.

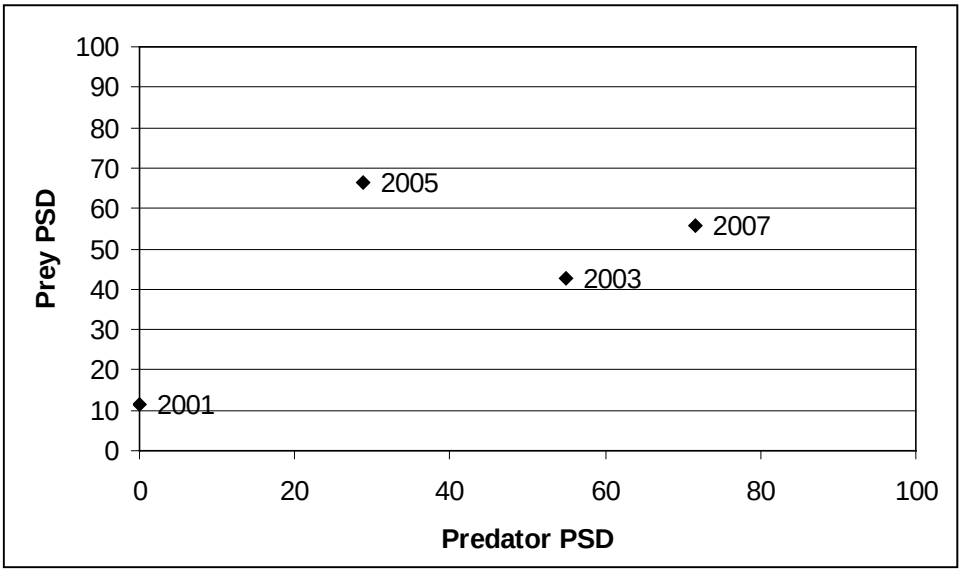
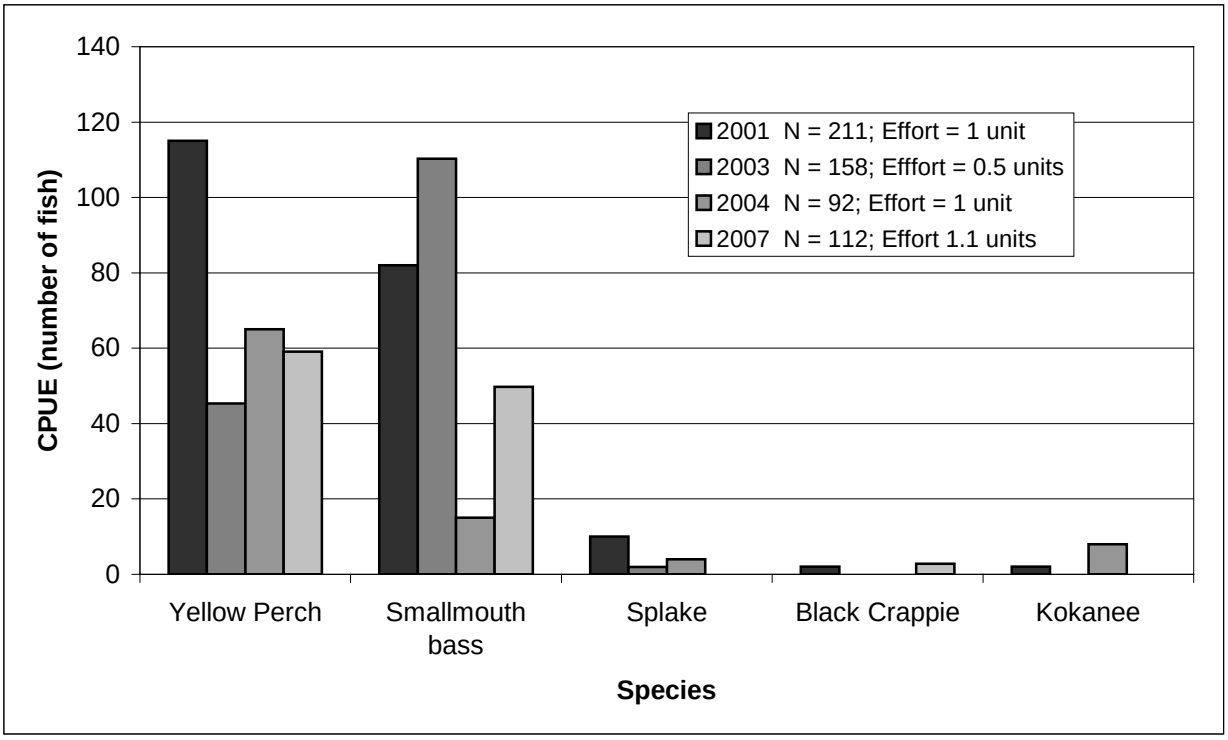


Figure 24. Predator vs. prey proportional stock density (PSD) from standard lake surveys of Mann Lake, Idaho, from 2001-2007.



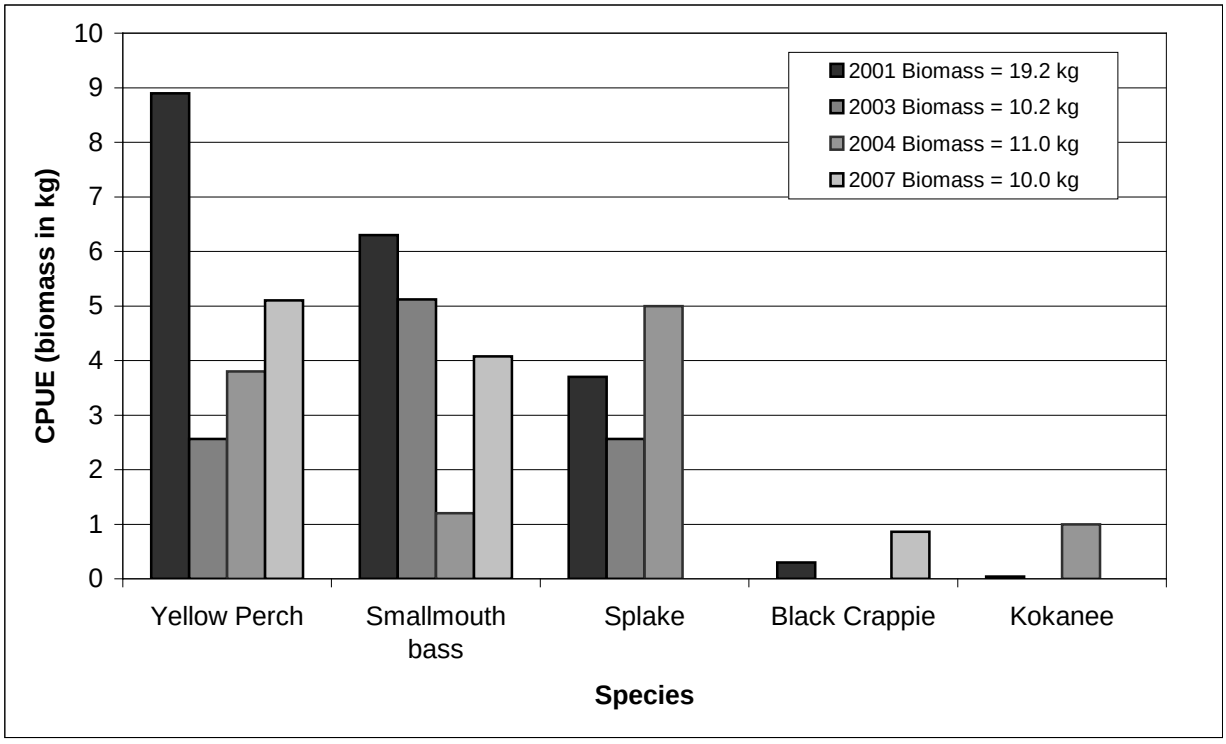


Figure 25. Catch per unit effort (CPUE) of fish collected from standard lake surveys of Waha Lake, Idaho, in 2001, 2003, 2004, and 2007, by number of fish and biomass.

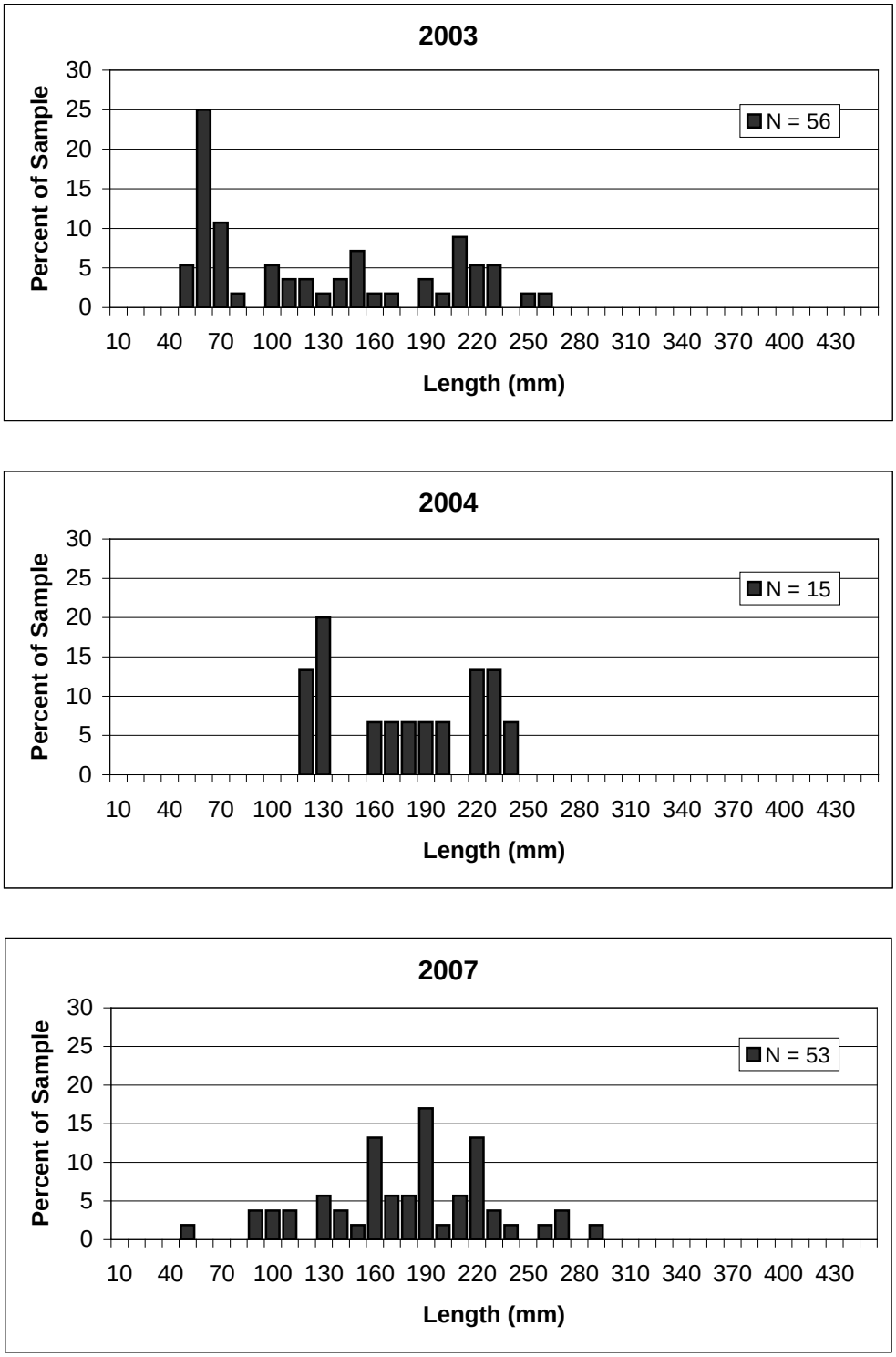


Figure 26. Length frequency distributions of smallmouth bass collected from standard lake surveys of Waha Lake, Idaho, in 2003, 2004, and 2007.

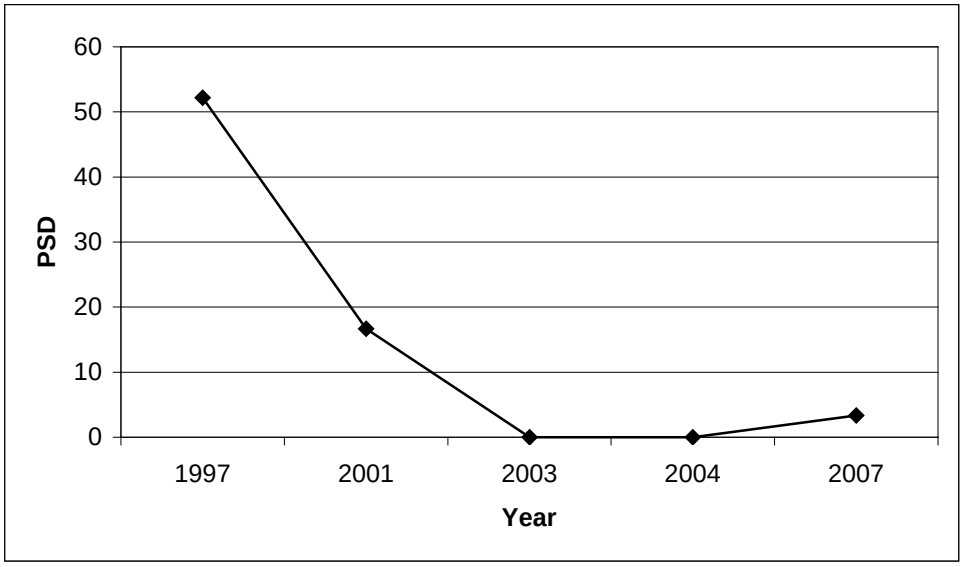
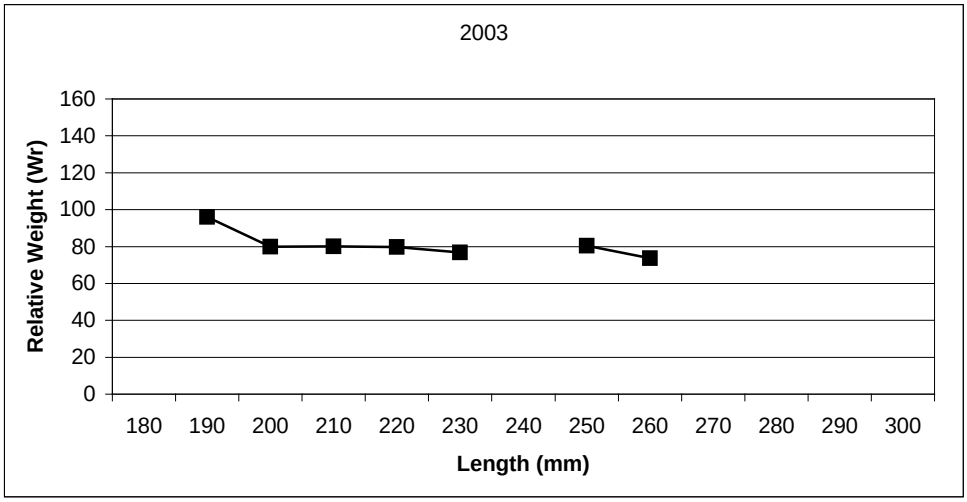
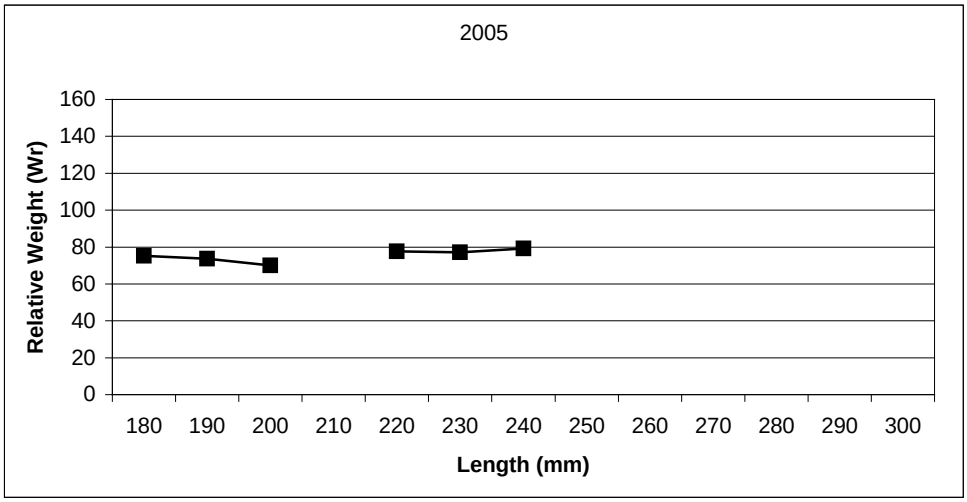


Figure 27. Proportional stock density (PSD) of smallmouth bass collected from standard lake surveys of Waha Lake, Idaho, from 1997-2007.





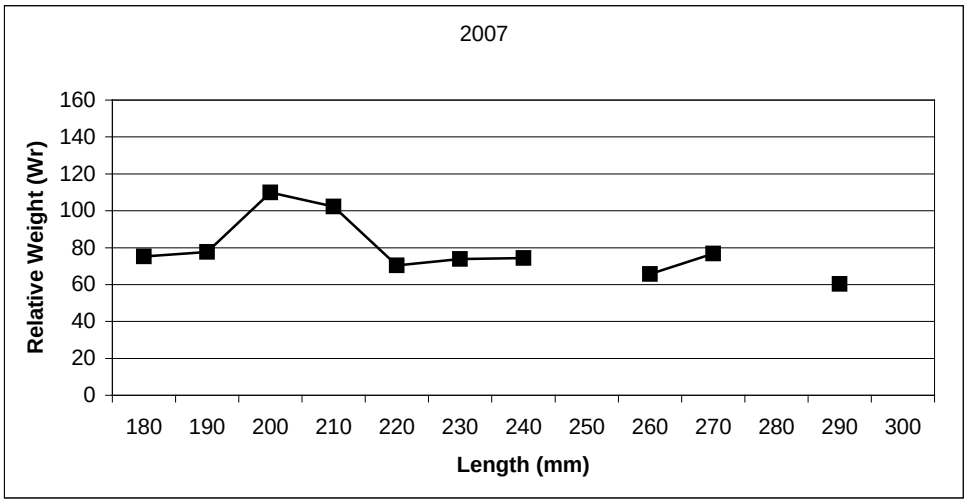


Figure 28. Average relative weights (Wr) for smallmouth bass collected from standard lake surveys of Waha Lake, Idaho, in 2003, 2004, and 2007.

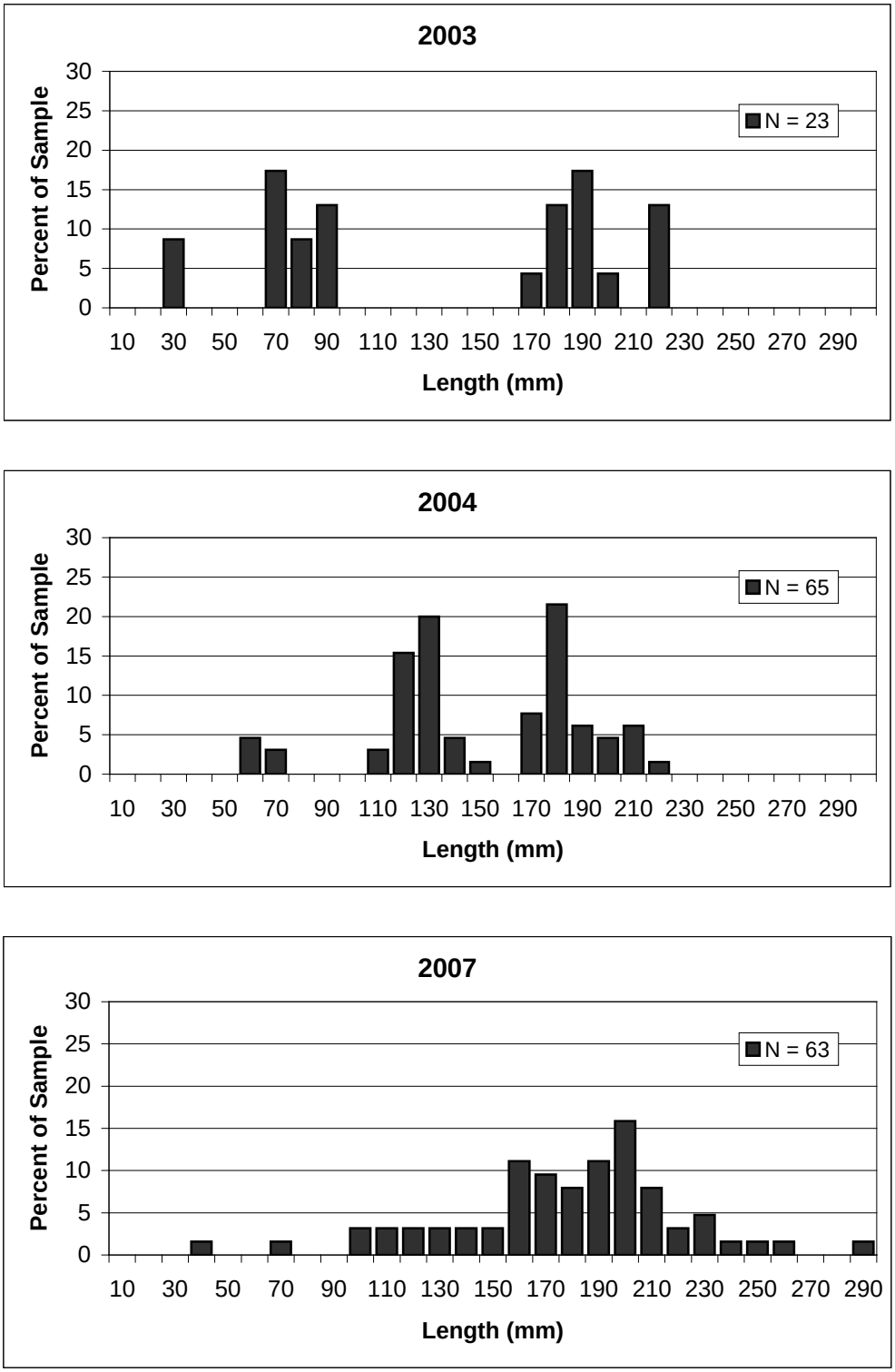


Figure 29. Length frequency distributions of yellow perch collected from standard lake surveys of Waha Lake, Idaho, in 2003, 2004, and 2007.

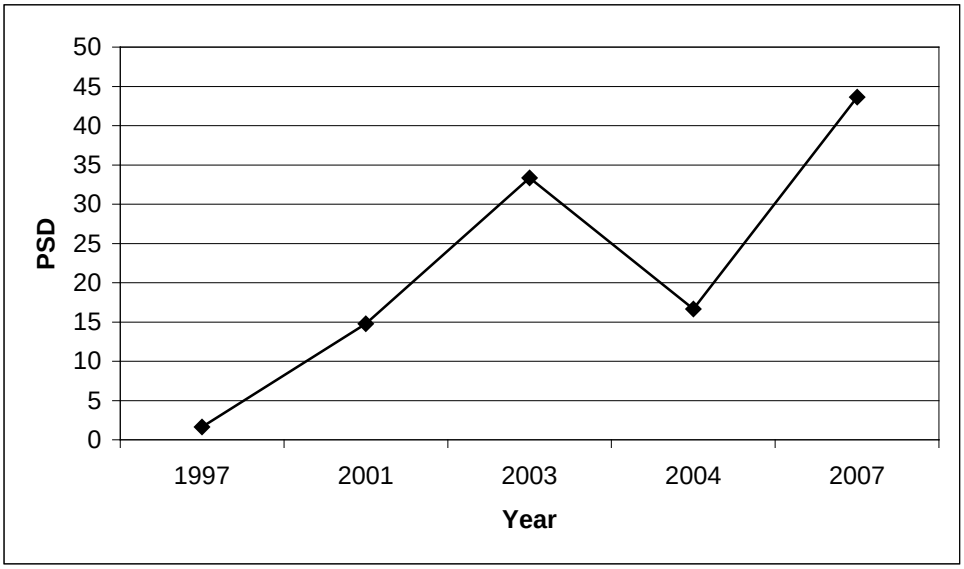
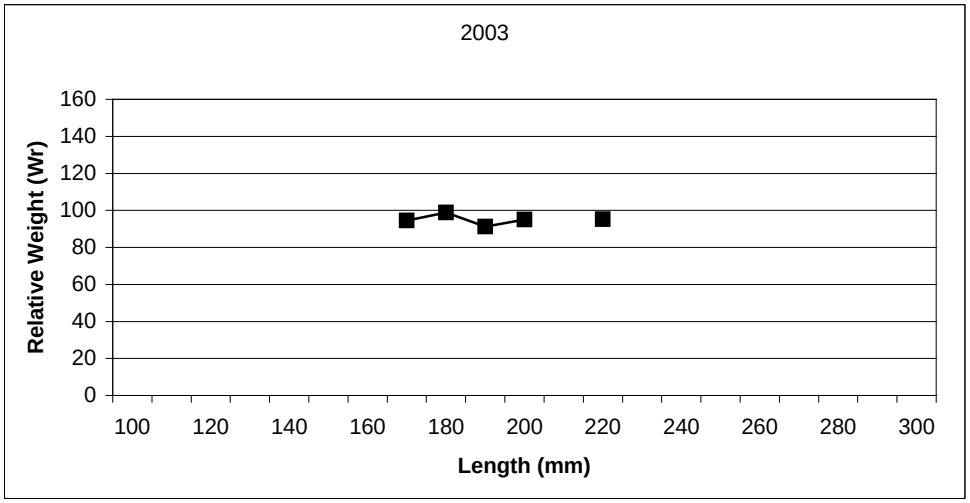
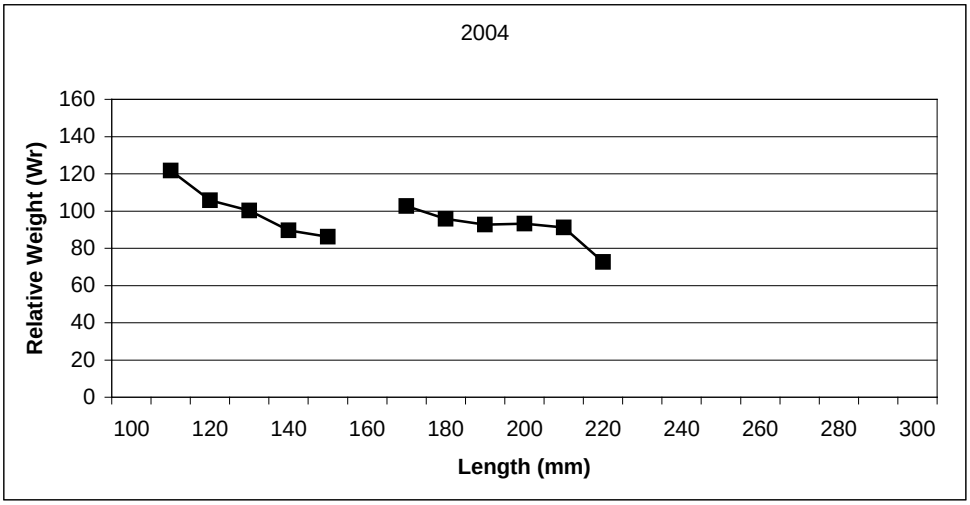


Figure 30. Proportional stock density (PSD) of yellow perch collected from standard lake surveys of Waha Lake, Idaho, from 1997-2007.





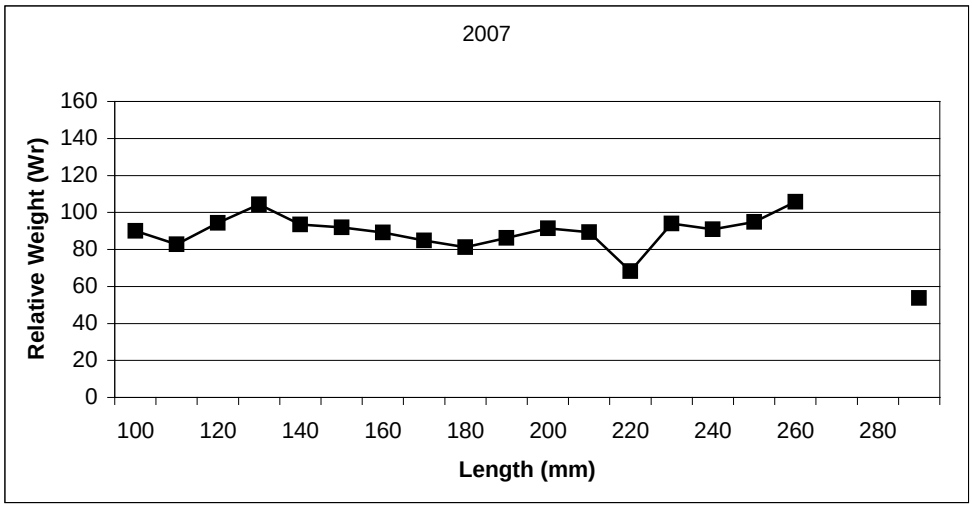
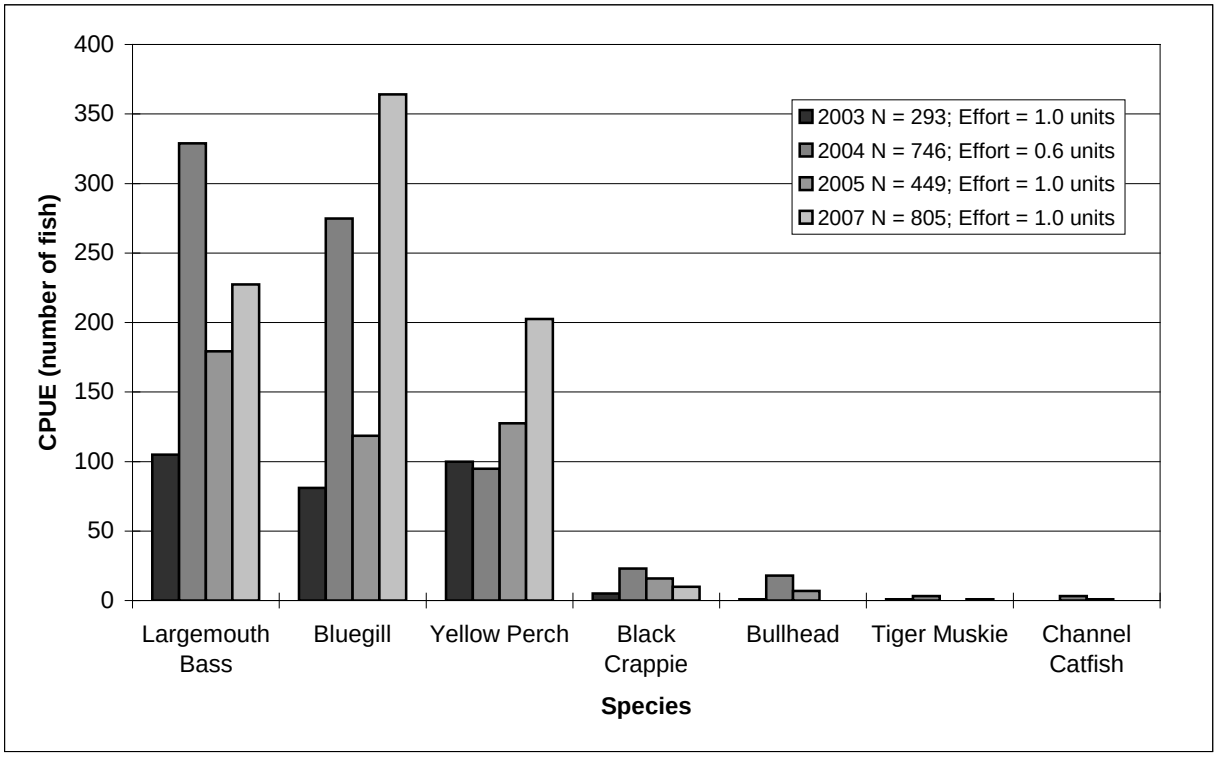


Figure 31. Average relative weights (Wr) for yellow perch collected from standard lake surveys of Waha Lake, Idaho, in 2003, 2004, and 2007.



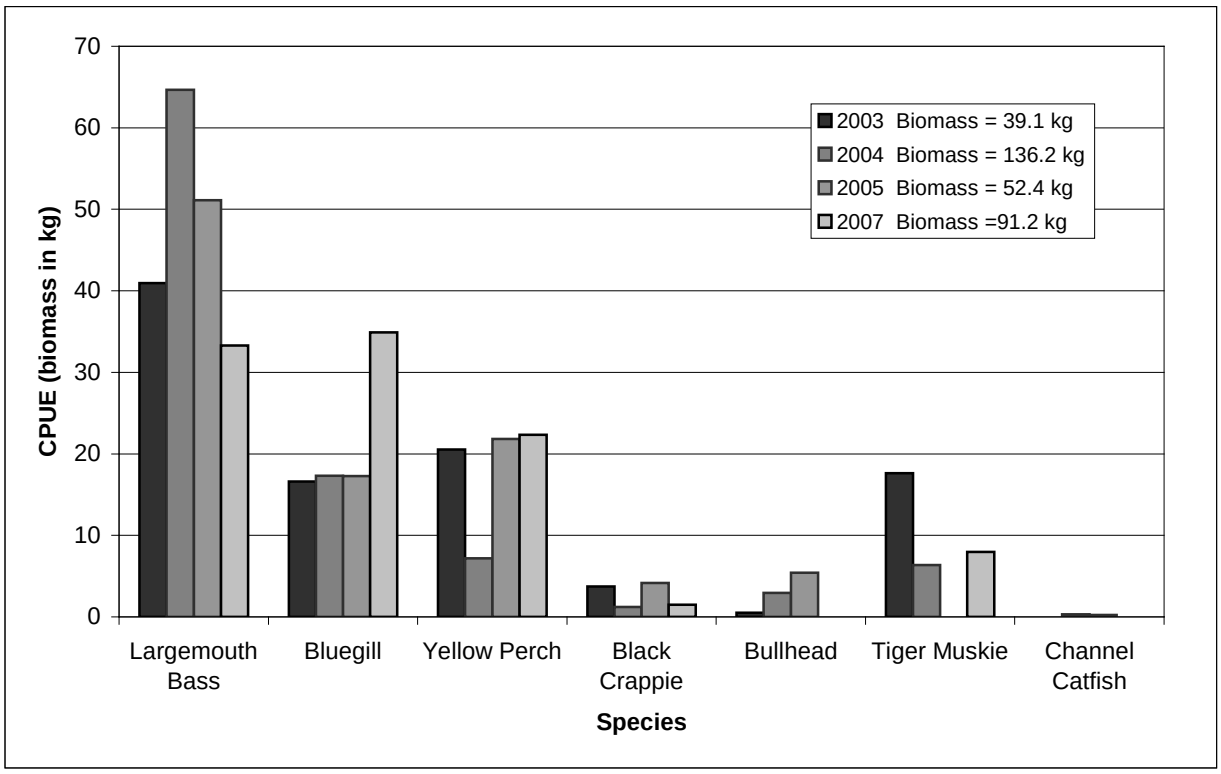
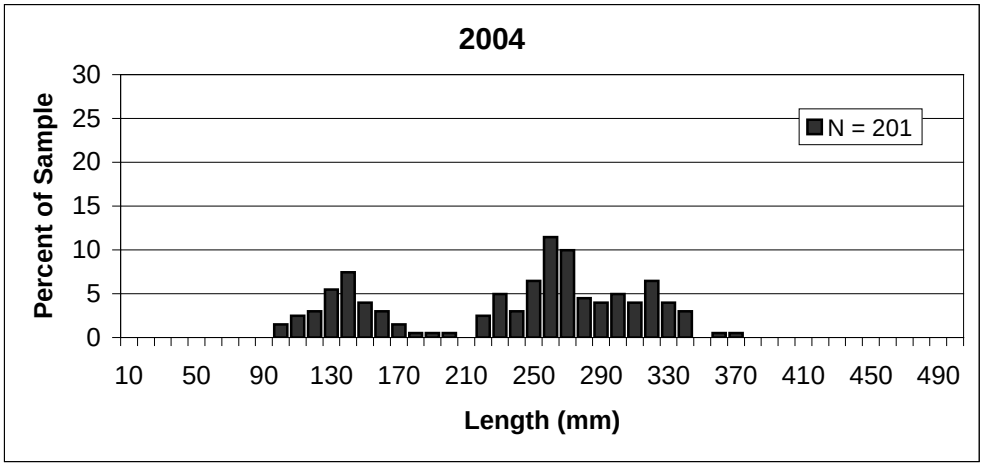
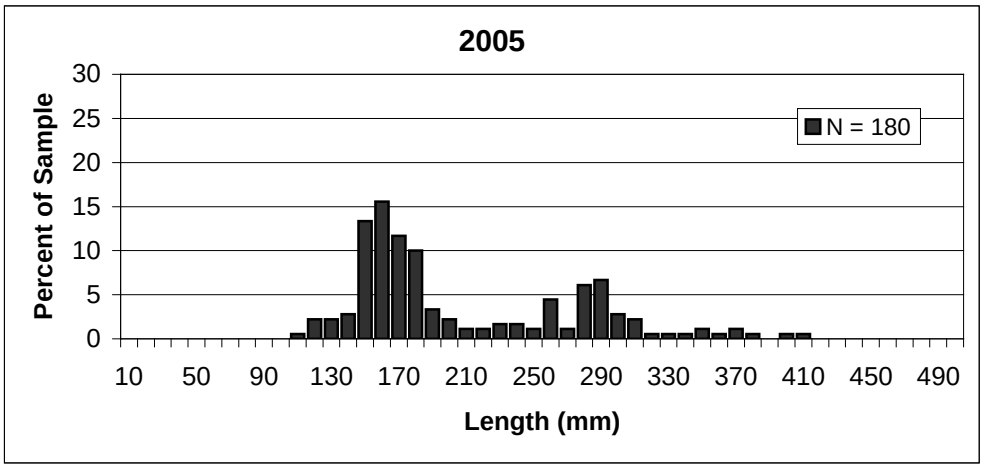


Figure 32. Catch per unit effort (CPUE) of fish collected from standard lake surveys of Winchester Lake, Idaho, in 2003-2005 and 2007 by number of fish and biomass.





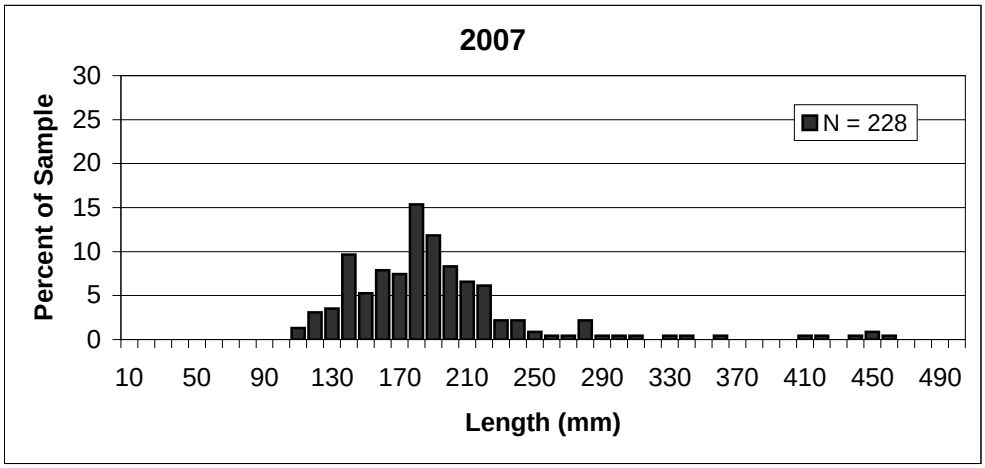


Figure 33. Length frequency distributions of largemouth bass collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.

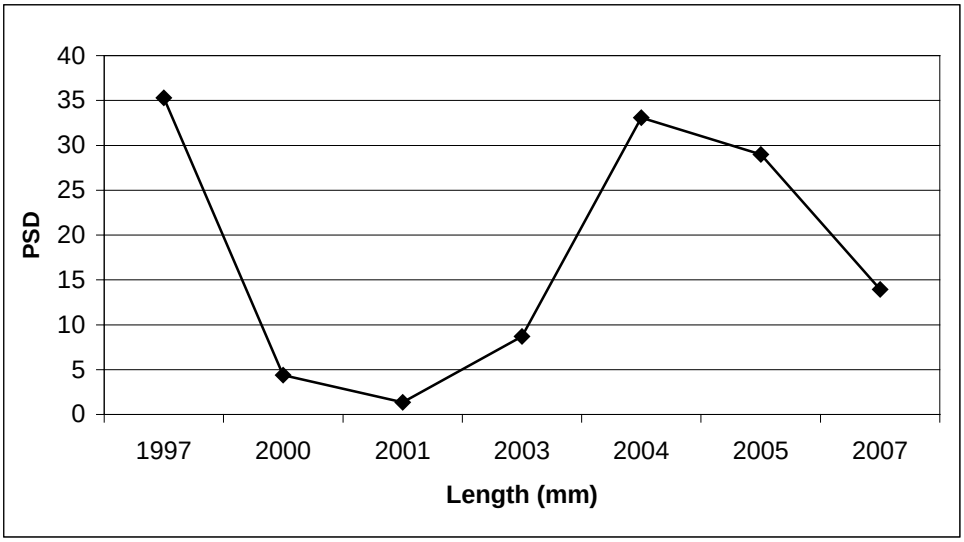


Figure 34. Proportional stock density (PSD) of largemouth bass collected from standard lake surveys of Winchester Lake, Idaho, from 1997-2007.

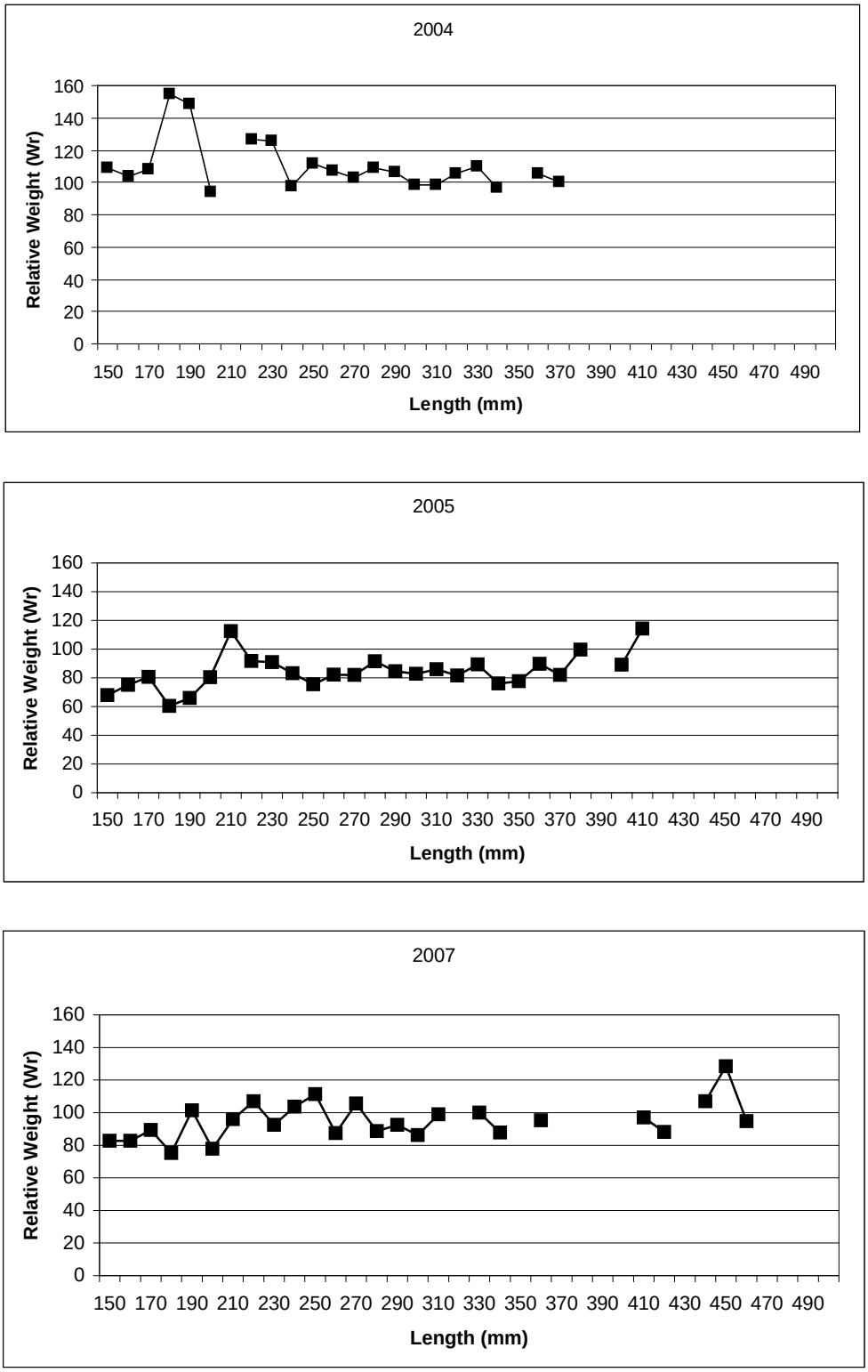
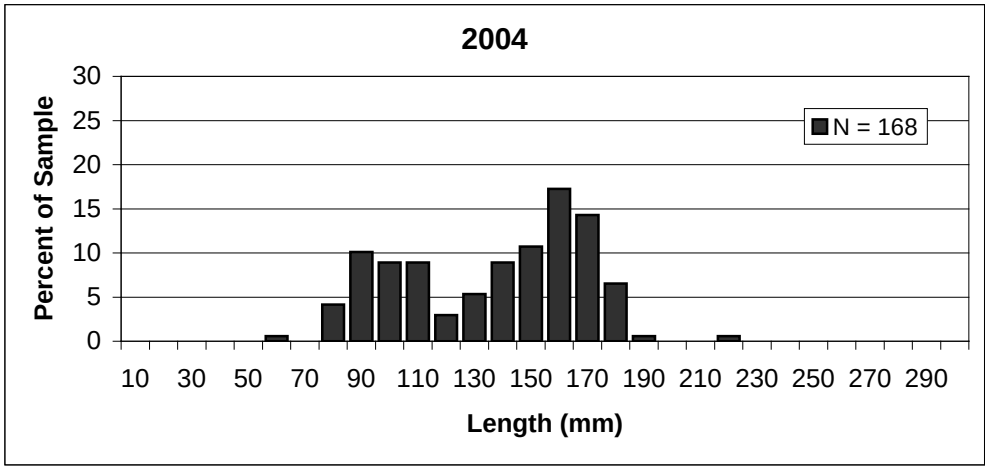
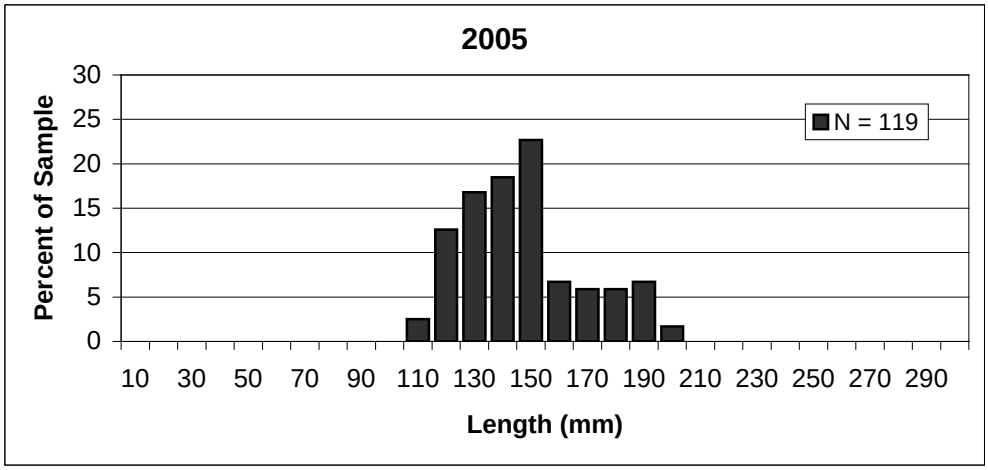


Figure 35. Average relative weights (Wr) for largemouth bass collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.





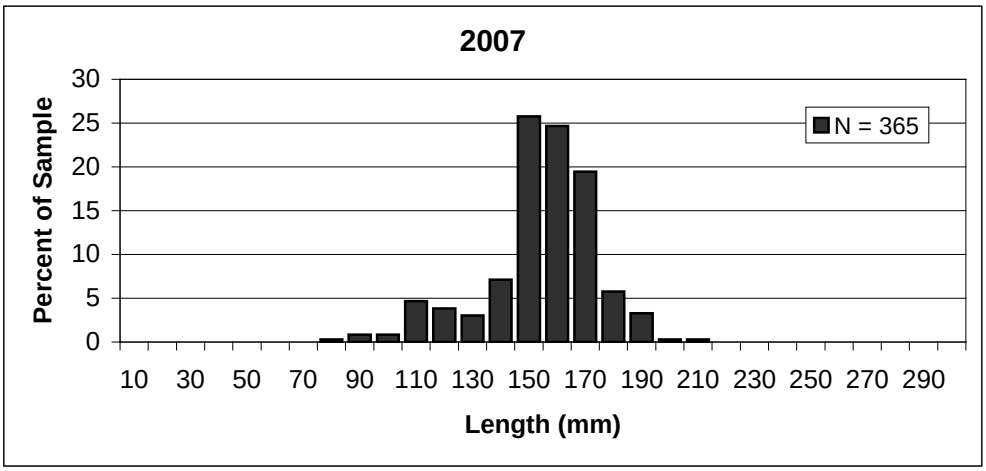


Figure 36. Length frequency distributions of bluegill collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.

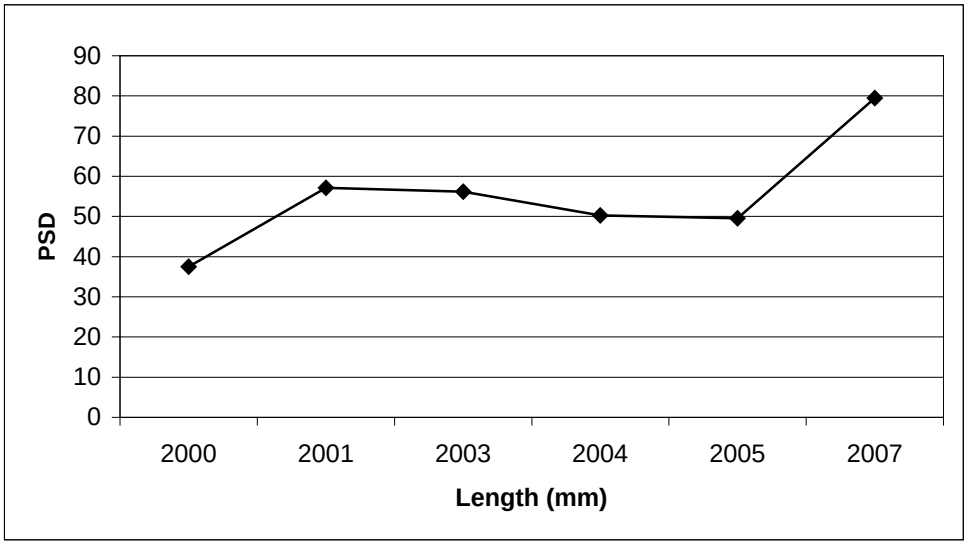


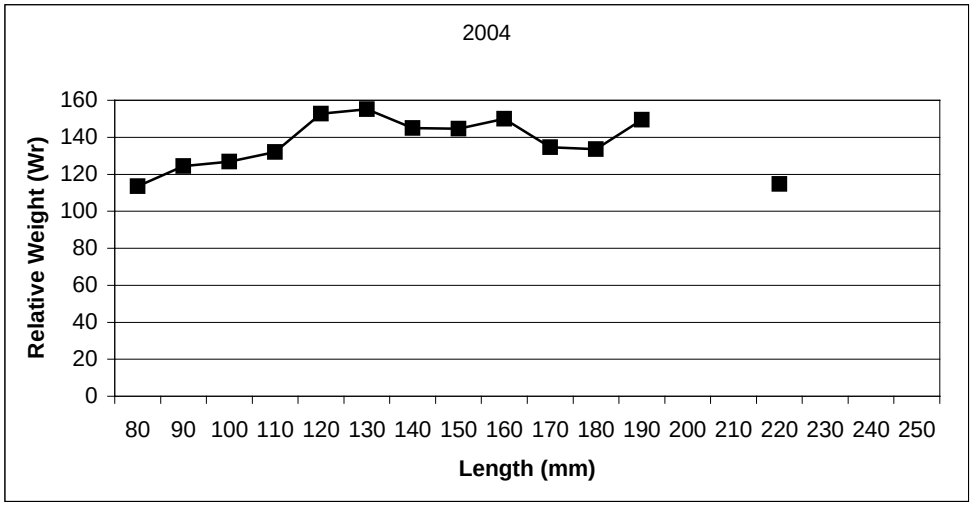
Figure 37. Proportional stock density (PSD) of bluegill collected from standard lake surveys of Winchester Lake, Idaho, from 2000-200

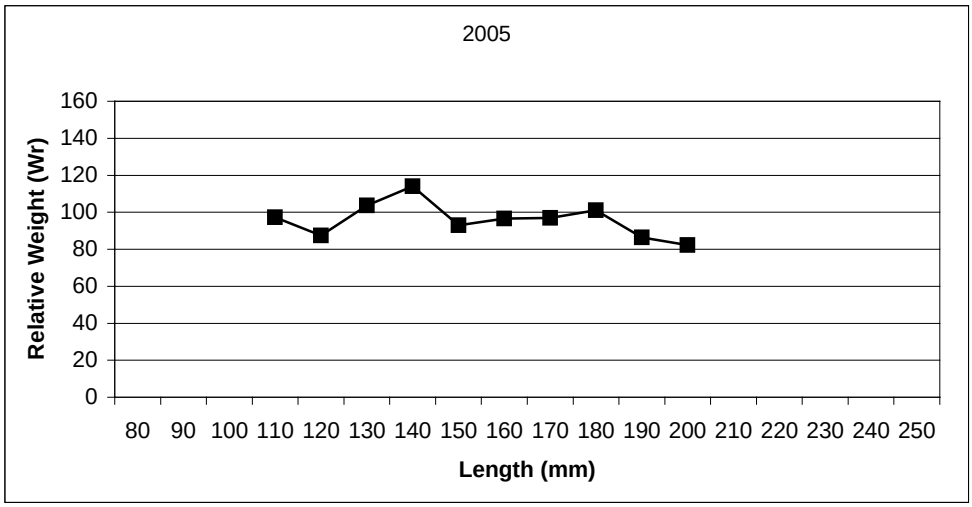
However, bluegill relative weights are generally around 100 (Figure 38), indicating good condition. This suggests that while there may be a problem with balance in the lake, bluegill have not overpopulated and/or stunted.

Yellow perch collected in 2007 ranged from 110-230 mm. While the average size of yellow perch has remained fairly stable over the last few samples, the length distribution has contracted (Figure 39). PSD values for yellow perch have remained stable over the last four samples, with a value of 30.9 calculated for 2007 (Figure 40). Relative weights for yellow perch decreased in 2007 (Figure 41). Additionally, they decrease as the fish get larger, indicating a possible decrease in food availability for larger fish.

Black crappie collected in 2007 ranged in length from 160-230 mm in length (Figure 42). PSD values for black crappie have fluctuated widely since 1997, with a value of 80.0 calculated for fish collected in 2007 (Figure 43).

Figure 44 provides a graphical representation of predator vs. prey PSD values over time as they relate to population balance. This chart shows that Winchester Lake generally has low predator abundance with high prey species recruitment and abundance.





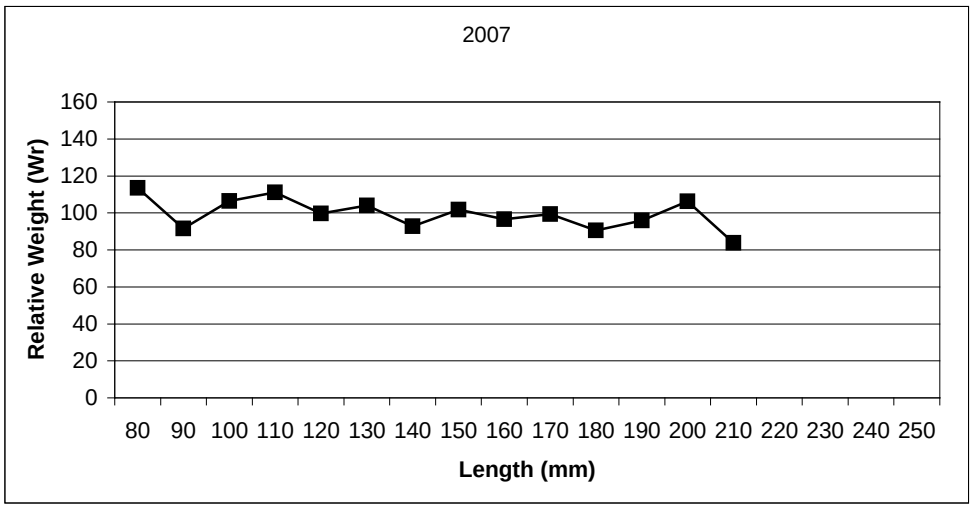


Figure 38. Average relative weights (Wr) for bluegill collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.

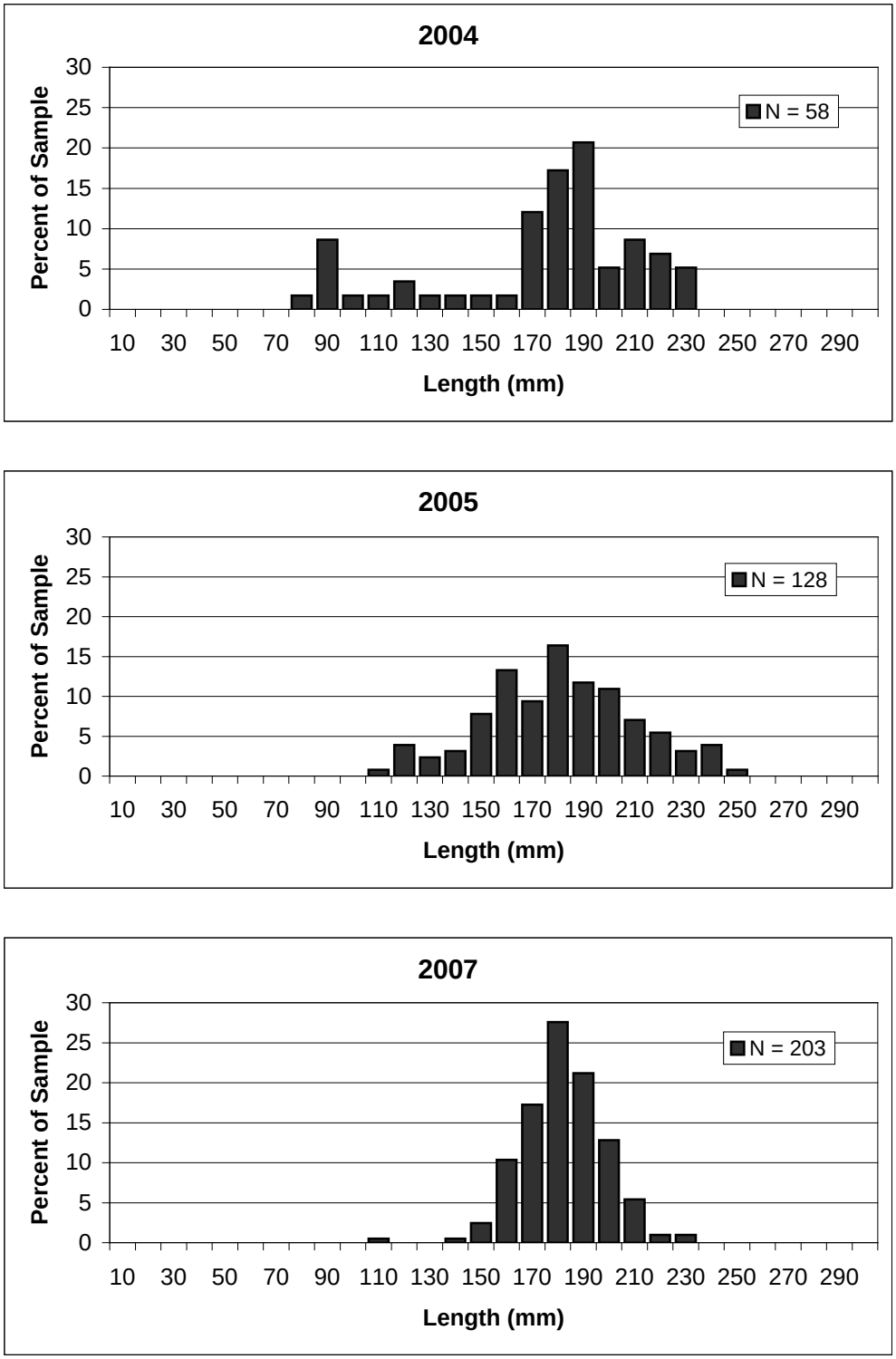


Figure 39. Length frequency distribution of yellow perch collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.

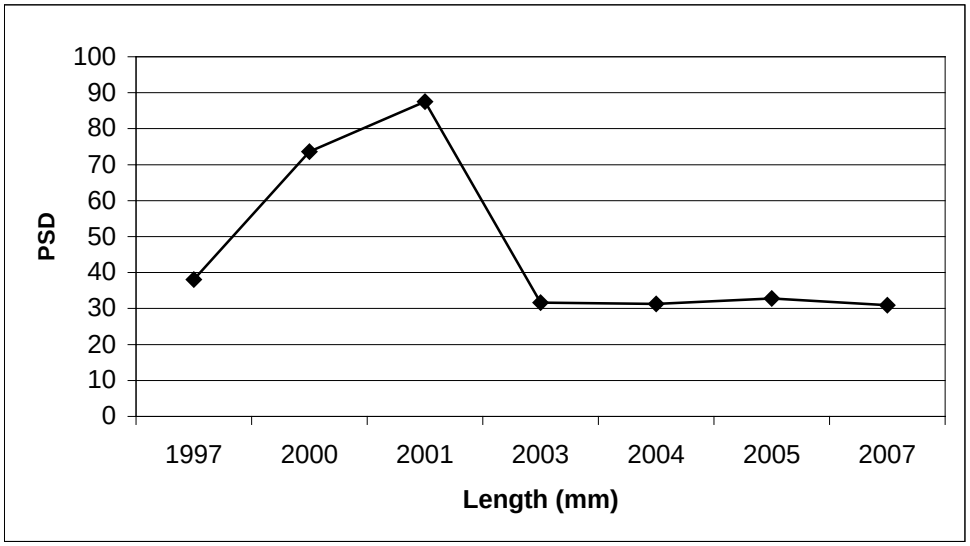
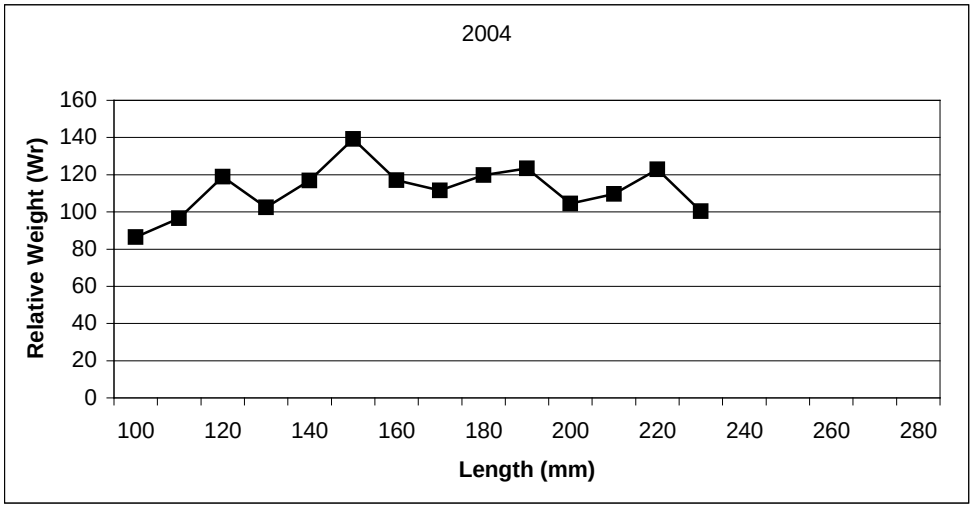
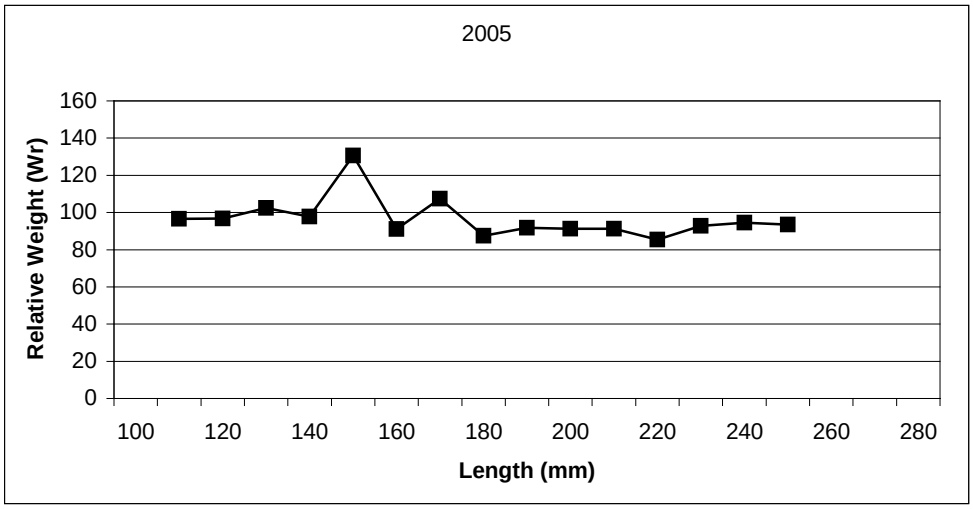


Figure 40. Proportional stock density (PSD) of yellow perch collected from standard lake surveys of Winchester Lake, Idaho, from 1997-2007.





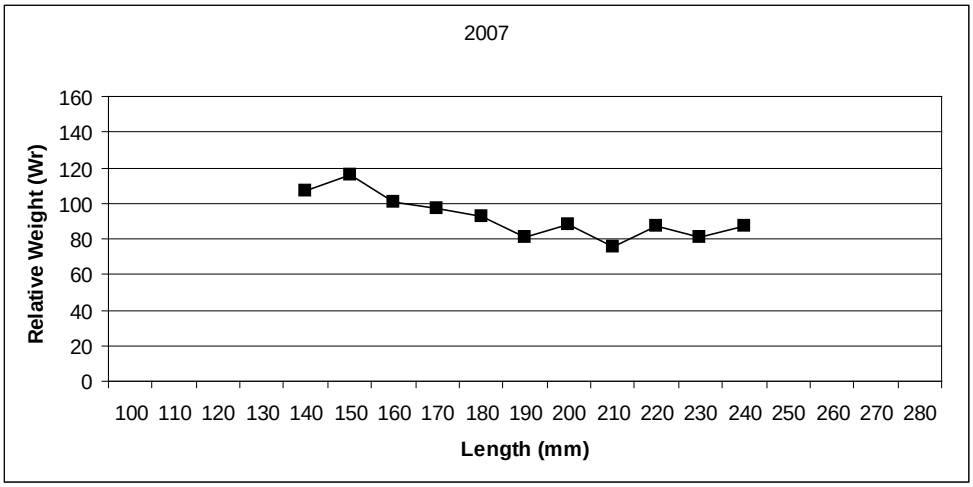


Figure 41. Average relative weights (Wr) for yellow perch collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.

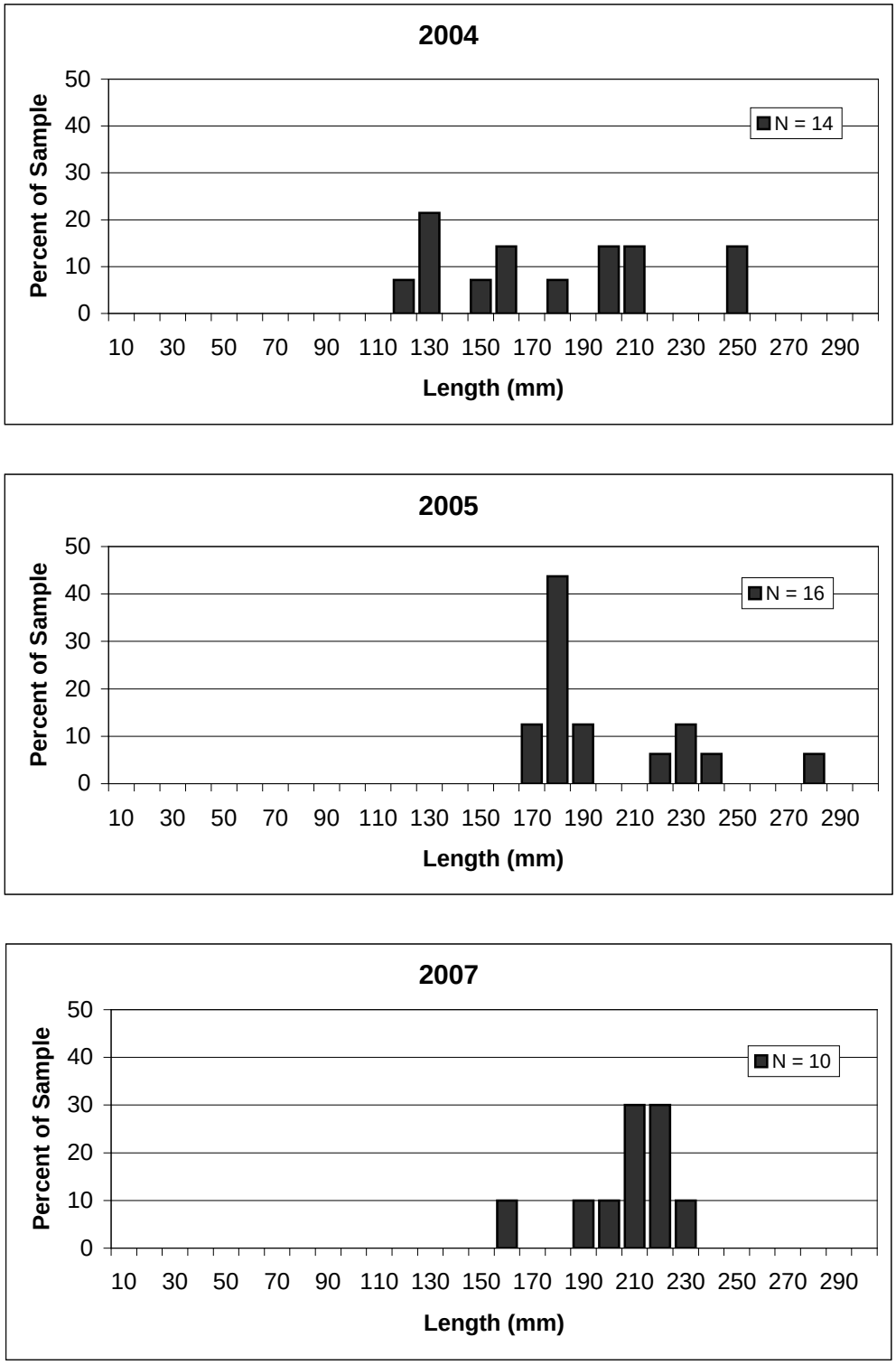


Figure 42. Length frequency distribution of black crappie collected from standard lake surveys of Winchester Lake, Idaho, in 2004, 2005, and 2007.

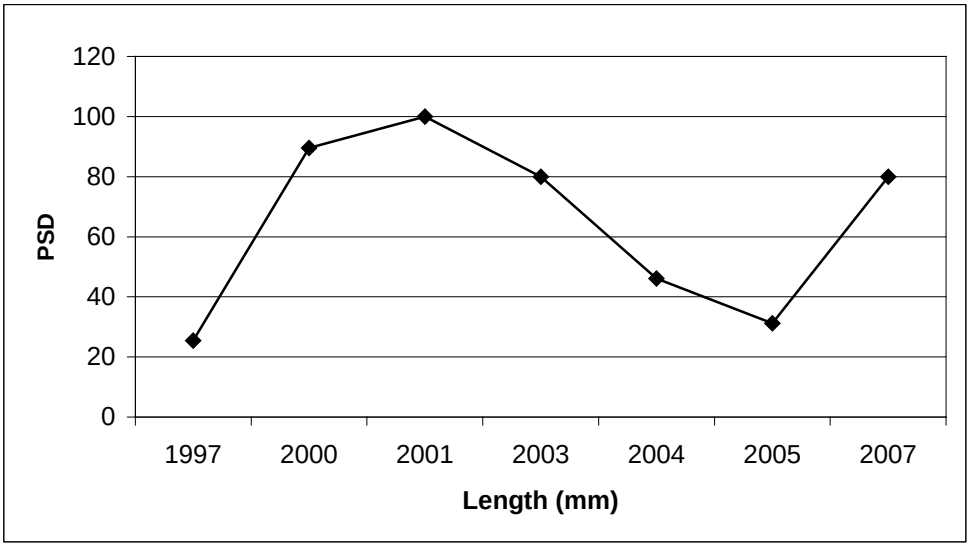


Figure 43. Proportional stock density (PSD) of black crappie collected from standard lake surveys of Winchester Lake, Idaho, from 1997-2007.

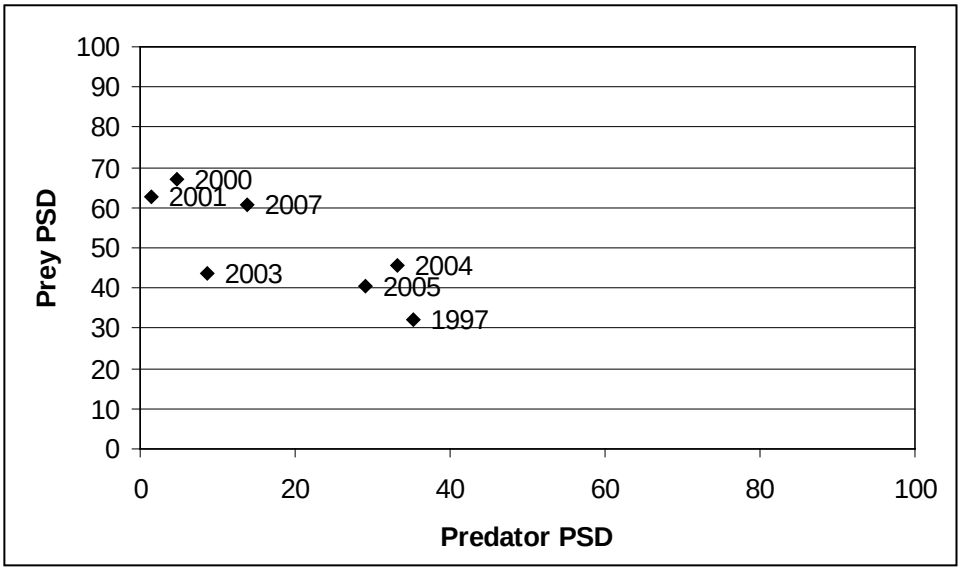


Figure 44. Predator vs. prey proportional stock density (PSD) from standard lake surveysof Winchester Lake, Idaho, from 1997 – 2007**.**

MANAGEMENT RECOMMENDATIONS

1. Continue three year rotation of lowland lake surveys, monthly dissolved oxygen and temperature profiles.

2. Conduct annual zooplankton surveys of all lowland lakes.

3. Conduct bass population estimates in regional lowland lakes to provide more data for management decisions.

4. Conduct quarterly observations of Deer Creek Reservoir to check for golden shiners.

5. If golden shiners persist in Deer Creek Reservoir, implement biological control utilizing a predator such as smallmouth bass or Eagle Lake rainbow trout. If smallmouth bass are used, they should be collected from Dworshak Reservoir.

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Gablehouse, D. W., Jr. 1983. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-085

RIVERS AND STREAMS INVESTIGATIONS

RESULTS AND DISCUSSION

Salmon River

The Idaho Department of Fish and Game annually stocks resident rainbow trout into the lower 100 km of the Salmon River. This stocking is funded by the Lower Snake River Compensation Plan (LSRCP) as part of their resident fisheries mitigation program. These fish are sampled annually by hook and line to collect population and food habit information. From August 13-15, 2007, approximately 108 rod hours resulted in one domestic Kamloops (250mm) being caught.

Additionally, 81 smallmouth bass were collected during this sampling period. These fish ranged in total length from 110-390 mm. The length frequency distribution is similar to that of the samples collected in 2004 and 2005 (Figure 45). The PSD value for smallmouth bass was 33.8, an marked increase after four straight years of decline (Figure 46).

Selway River

A hook-and-line survey of westslope cutthroat trout was conducted on the Selway River from July 11-17, 2007 in conjunction with an annual snorkel survey of the river and its tributaries. A total of 221 cutthroat trout were collected over six days of sampling. These fish ranged in total length from 150 to 409 mm. A comparison of length frequency distributions (Figure 47) shows a slight shift toward larger fish compared to samples collected in 2004 and 2005.

MANAGEMENT RECOMMENDATIONS

1. Conduct population and genetic sampling of westslope cutthroat trout in the Clearwater River drainage for the development of a westslope cutthroat trout management plan.

2. Continue collecting fish population data on Salmon and Selway rivers.

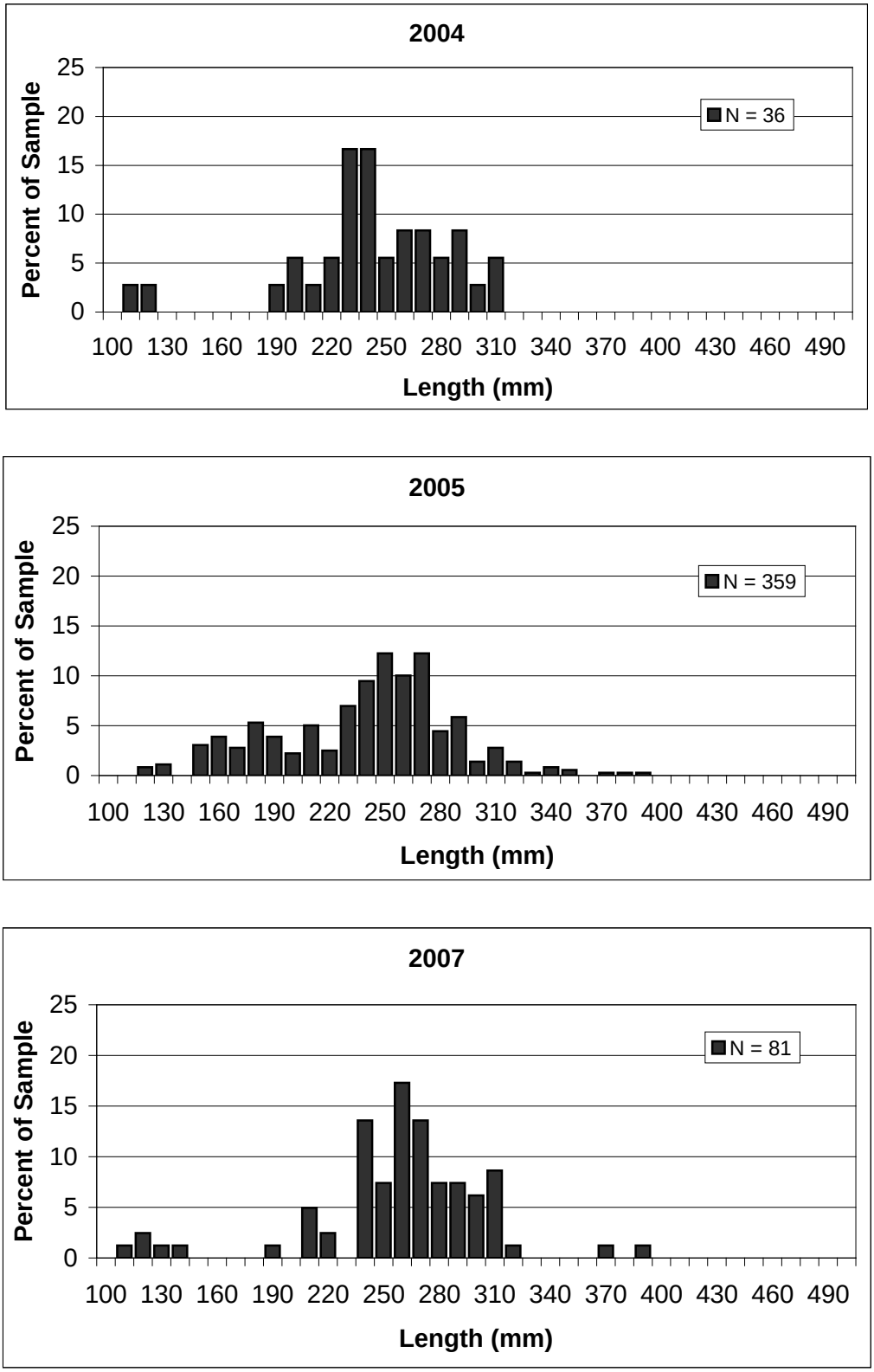

Figure 45. Length frequency distributions of smallmouth bass collected in the Lower Salmon River, Idaho, by hook and line sampling in 2004, 2005, and 2007.

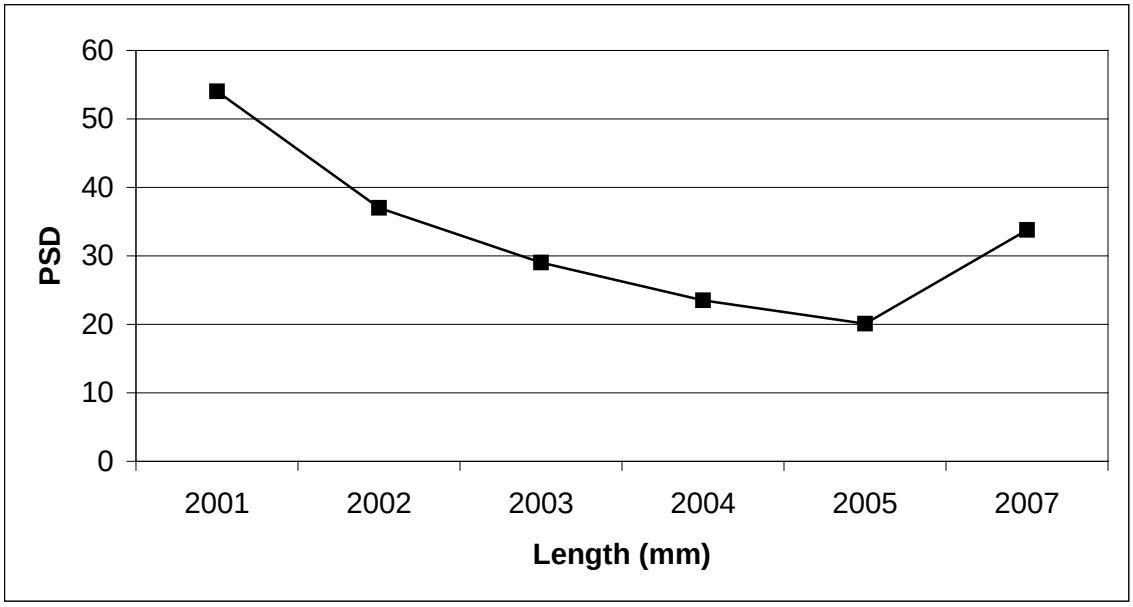

Figure 46. Proportional stock density (PSD) of smallmouth bass collected in the lower Salmon River, Idaho, by hook and line sampling, from 2001-2007.

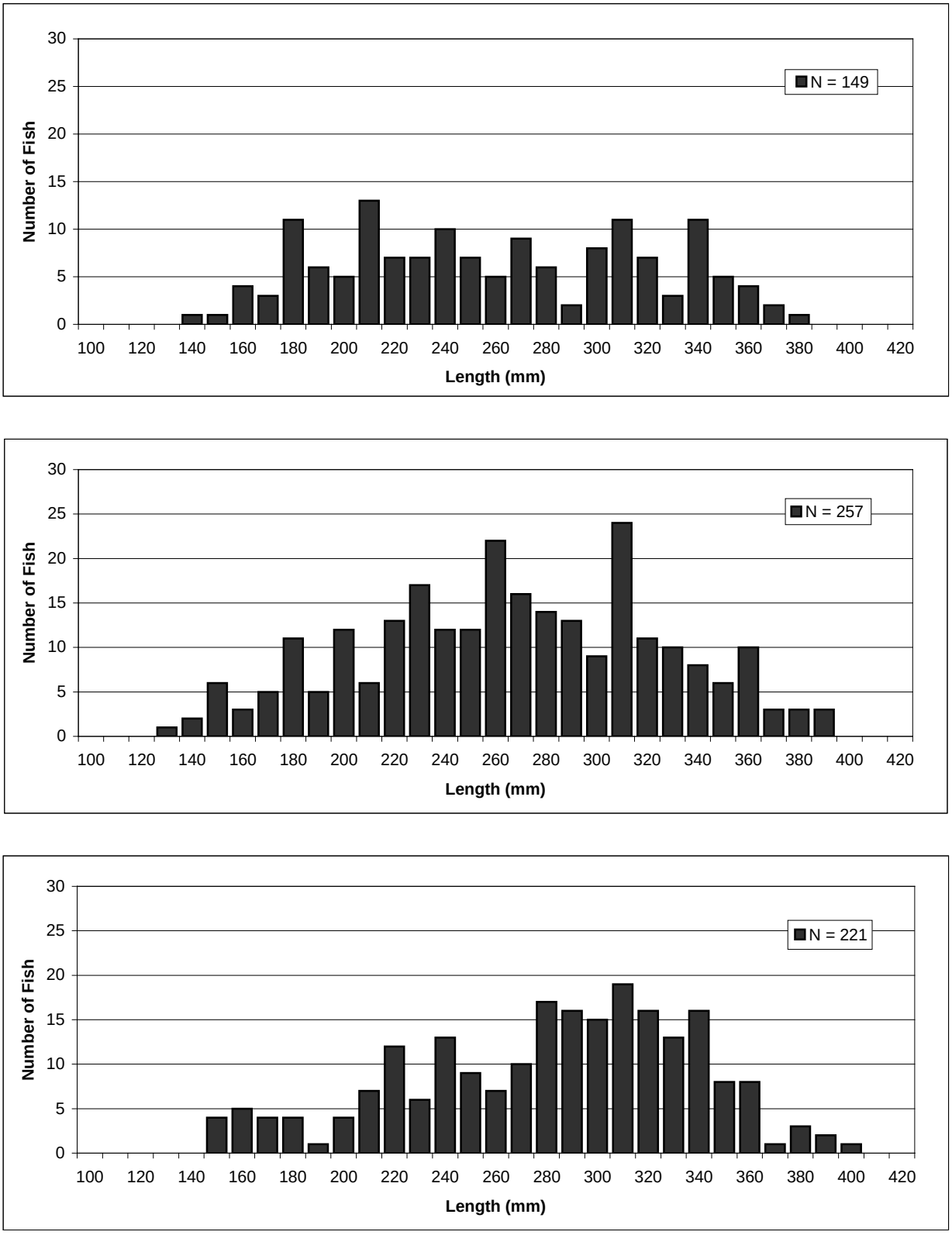

Figure 47. Length frequency distribution of westslope cutthroat trout collected in the Selway River, Idaho, by hook and line sampling in 2004, 2005, and 2007.

HABITAT MANAGEMENT

RESULTS AND DISCUSSION

Burling Pond (North Lewiston Pond)

The aquatic herbicide Reward® was applied on April 27th and July 27th in an effort to control nuisance aquatic vegetation that greatly reduces fishing opportunity. The vegetation in the Burling Pond is a combination of Elodea *Elodea canadensis* and filamentous algae. These applications were highly successful in eliminating the vegetation, thus improving angler access to this pond.

Deer Creek Reservoir

Monthly dissolved oxygen (DO) profiles are shown in Figure 48. As can be seen, DO levels drop considerably below four meters in the summer. This reduces the volume of the reservoir available for fish to live. Additionally, it forces trout to live in the warmer epilimnion instead of the preferred cooler water of the hypolimnion, which can cause stress.

Elk Creek Reservoir

The aquatic herbicide Reward® was applied on May 9th and July 24th in an effort to control nuisance aquatic vegetation that greatly reduces recreational opportunities on the reservoir. The vegetation in Elk Creek Reservoir is a combination of Elodea *Elodea canadensis* and filamentous algae. These applications had a poor level of success in eliminating the vegetation throughout the summer. This is likely due to the large areas of vegetation compared with the small areas treated, which allowed for rapid regrowth. Additionally, the upper portion of the reservoir, where the treatments were conducted, has substantial water inflow from Elk Creek. This caused quick dilution of the herbicide, thereby reducing its effectiveness. Conducting the first treatment a little later in the spring when flows are lower, and treating larger areas could improve the success of these treatments.

Monthly dissolved oxygen profiles are shown in Figure 49. As can be seen, DO levels drop considerably below three meters in the summer, and four meters in the spring and fall. This reduces the volume of the reservoir available for fish to live, especially trout. It also forces the more temperature sensitive trout to live in the warmer epilimnion instead of the preferred cooler water of the hypolimnion. This can cause stress and fish kills during the hot summer months.

Mann Lake

Monthly dissolved oxygen profiles are shown in Figure 50. As can be seen, DO levels remained above 4 mg/L down to a depth of 10 m from May – July. Low water levels prevented sampling from being collected beginning in August. Mann Lake does not experience the extreme stratification and loss of DO in the hypolimnion that is seen in other regional reservoirs. This is probably due to its relatively low organic load, and higher transfer of oxygen from wind and wave action (the reservoir is in open farmland as opposed to other reservoirs which are surrounded by trees). However, due to its lower elevation, Mann Lake become warmer than other reservoirs, which can cause stress (and sometimes fish kills) to the stocked trout.

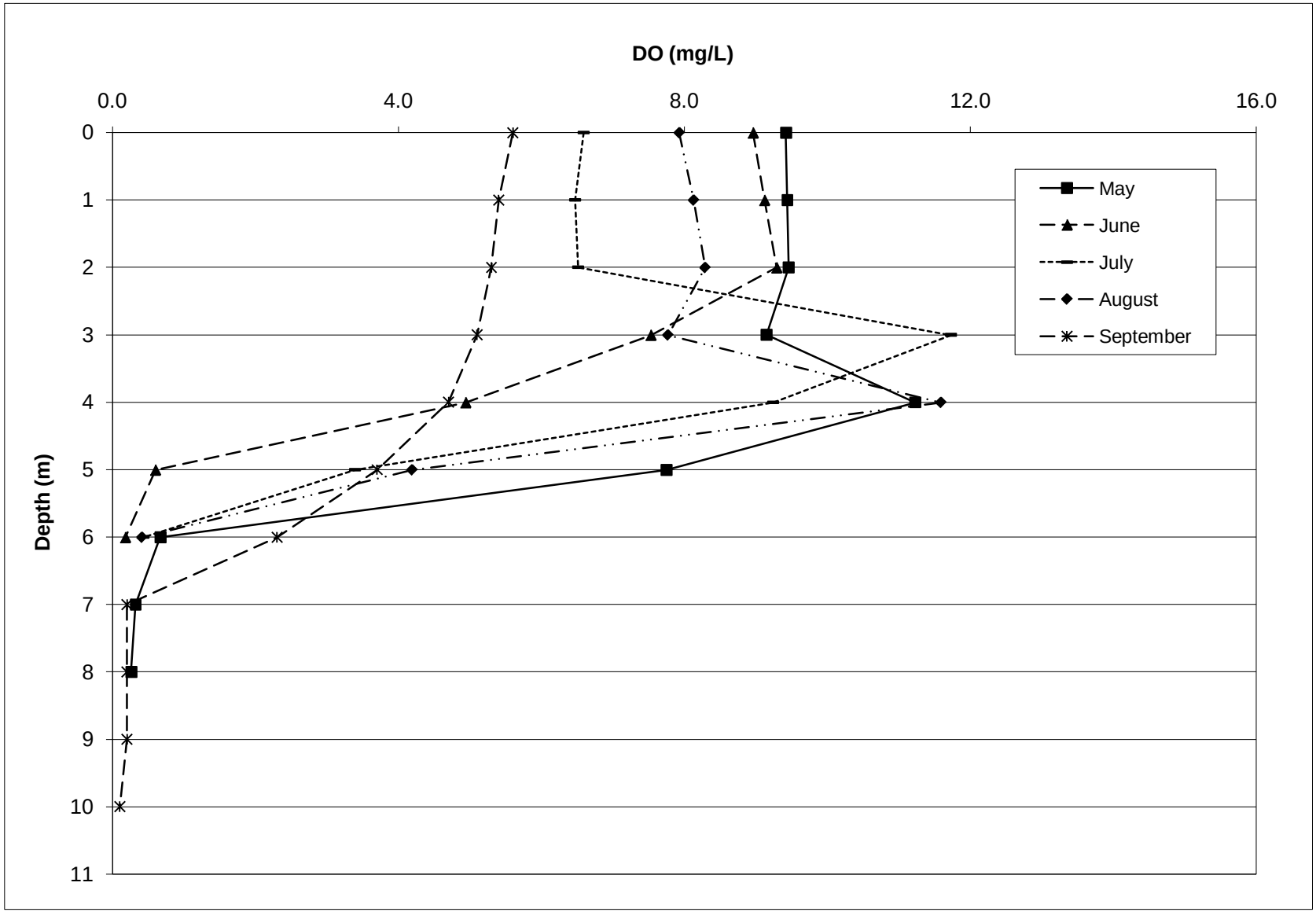

Figure 48. Monthly dissolved oxygen (DO) profiles of Deer Creek Reservoir, Idaho, during 2007.

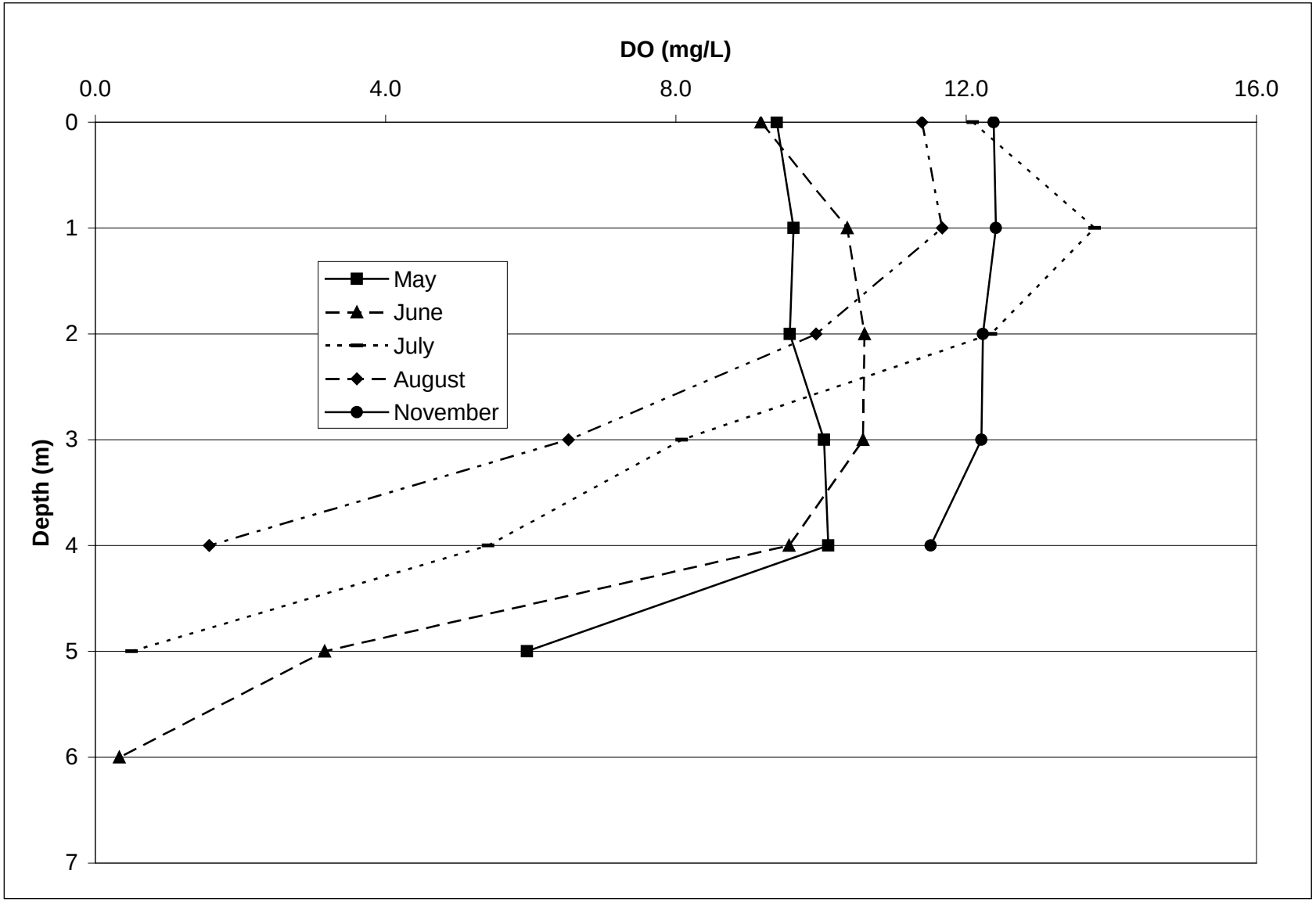

Figure 49. Monthly dissolved oxygen (DO) profiles of Elk Creek Reservoir, Idaho, during 2007.

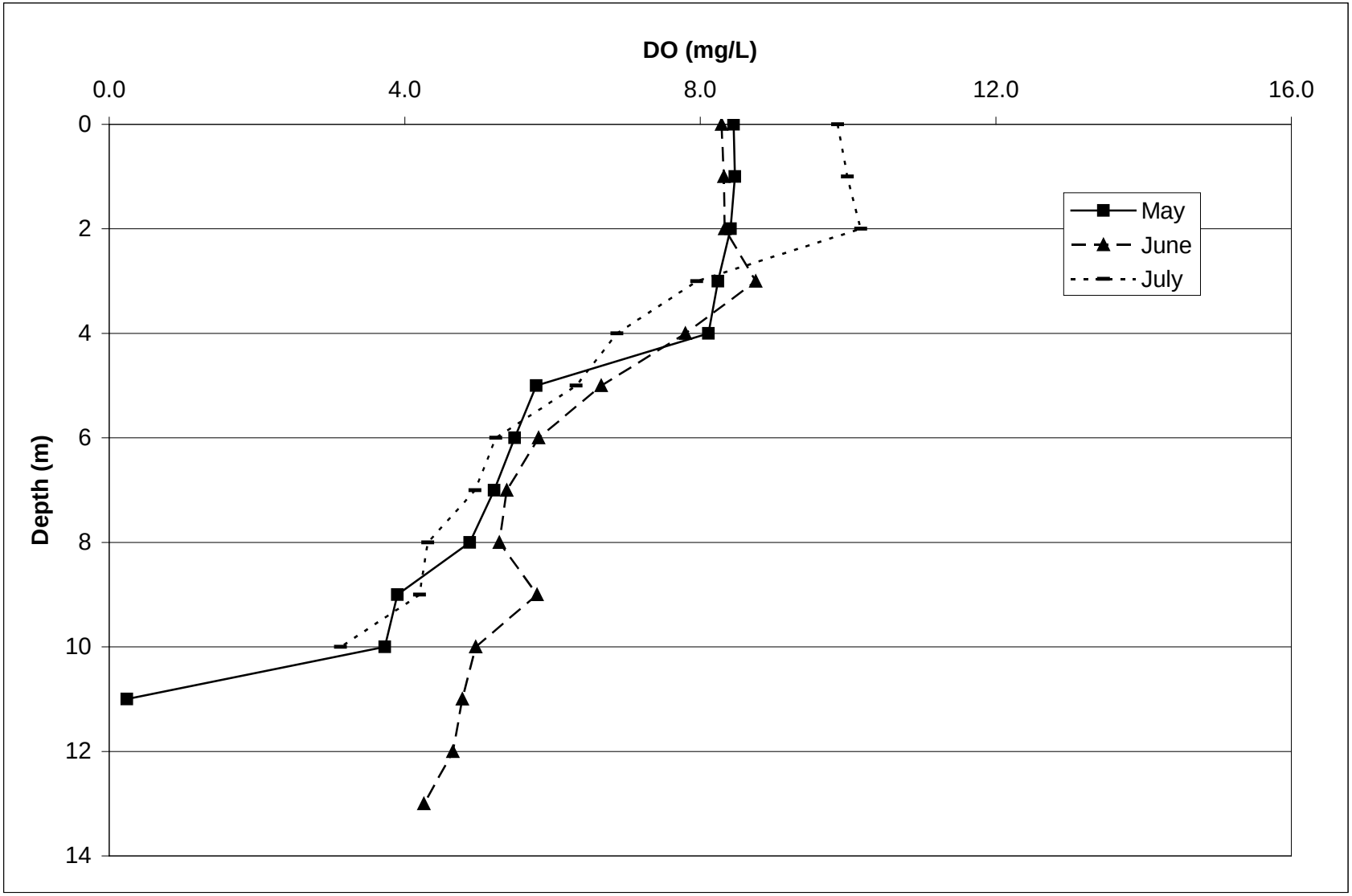

Figure 50. Monthly dissolved oxygen (DO) profiles of Mann Lake, Idaho, during 2007.

Moose Creek Reservoir

The aquatic herbicide Reward® was applied on May 9th and July 24th in an effort to control nuisance aquatic vegetation that greatly reduces recreational opportunities on the reservoir. The vegetation in Moose Creek Reservoir is a combination of Elodea *Elodea canadensis*, Large-leaf Pondweed *Potamogeton amplifolius*, and filamentous algae. These applications had a poor level of success in eliminating the vegetation throughout the summer. This is due to the large areas of vegetation compared with the small areas treated, which allowed for rapid regrowth; and the moderate effectiveness of the herbicide on the species present (Large-leaf Pondweed is noted for its high tolerance level to chemical control). For chemical treatments, conducting the first treatment earlier in the spring and treating larger areas may prove more effective.

Monthly dissolved oxygen profiles are shown in Figure 51. As can be seen, DO levels drop considerably below three meters in the summer. This reduces the volume of the reservoir available for fish to live, especially trout. It also forces the more temperature sensitive trout to live in the warmer epilimnion instead of the preferred cooler water of the hypolimnion. This can cause stress and fish kills during the hot summer months.

Robinson Pond

The aquatic herbicide Reward® was applied on April 27th and July 27th in an effort to control nuisance aquatic vegetation that greatly reduces fishing opportunity. The vegetation in Robinson Pond is a combination of Elodea *Elodea canadensis* and filamentous algae. These applications were highly successful in eliminating the vegetation, thus improving angler access to this pond.

Due to the decline of habitat quality in Robinson Pond (aquatic vegetation, low water), we were unable to stock hatchery trout in the pond during 2006. This has prompted IDFG and the Upper Clearwater Community Foundation in Kamiah to work on improving habitat quality in the pond and improving recreational access. The water from the spring is now being piped all the way from the spring to the pond. The upper half of this pipe was installed by the Flying B ranch as part of an agreement with IDFG.

Soldier's Meadow Reservoir

Monthly dissolved oxygen profiles are shown in Figure 52. As can be seen, DO levels drop considerably below four meters in the summer. This reduces the volume of the reservoir available for fish to live, especially trout. It also forces the more temperature sensitive trout to live in the warmer epilimnion instead of the preferred cooler water of the hypolimnion. This can cause stress and fish kills during the hot summer months.

Spring Valley Reservoir

The aquatic herbicide Reward® was applied on May 10th and July 24th in an effort to control nuisance aquatic vegetation that greatly reduces recreational opportunities. The vegetation in Spring Valley Reservoir is a combination of Elodea *Elodea sp.* and filamentous algae. These applications were moderately successful in eliminating the vegetation. Conducting the first application earlier in the spring, and applying the herbicide to larger areas may improve the level of success.

Monthly dissolved oxygen profiles are shown in Figure 53. As can be seen, DO levels drop considerably below two meters in late summer. This severely reduces the volume of the reservoir available for fish to live, especially trout. It also forces the more tempature sensitive trout to live in the warmer epilimnion instead of the preferred cooler water of the hypolimnion. This can cause stress and fish kills during the hot summer months.

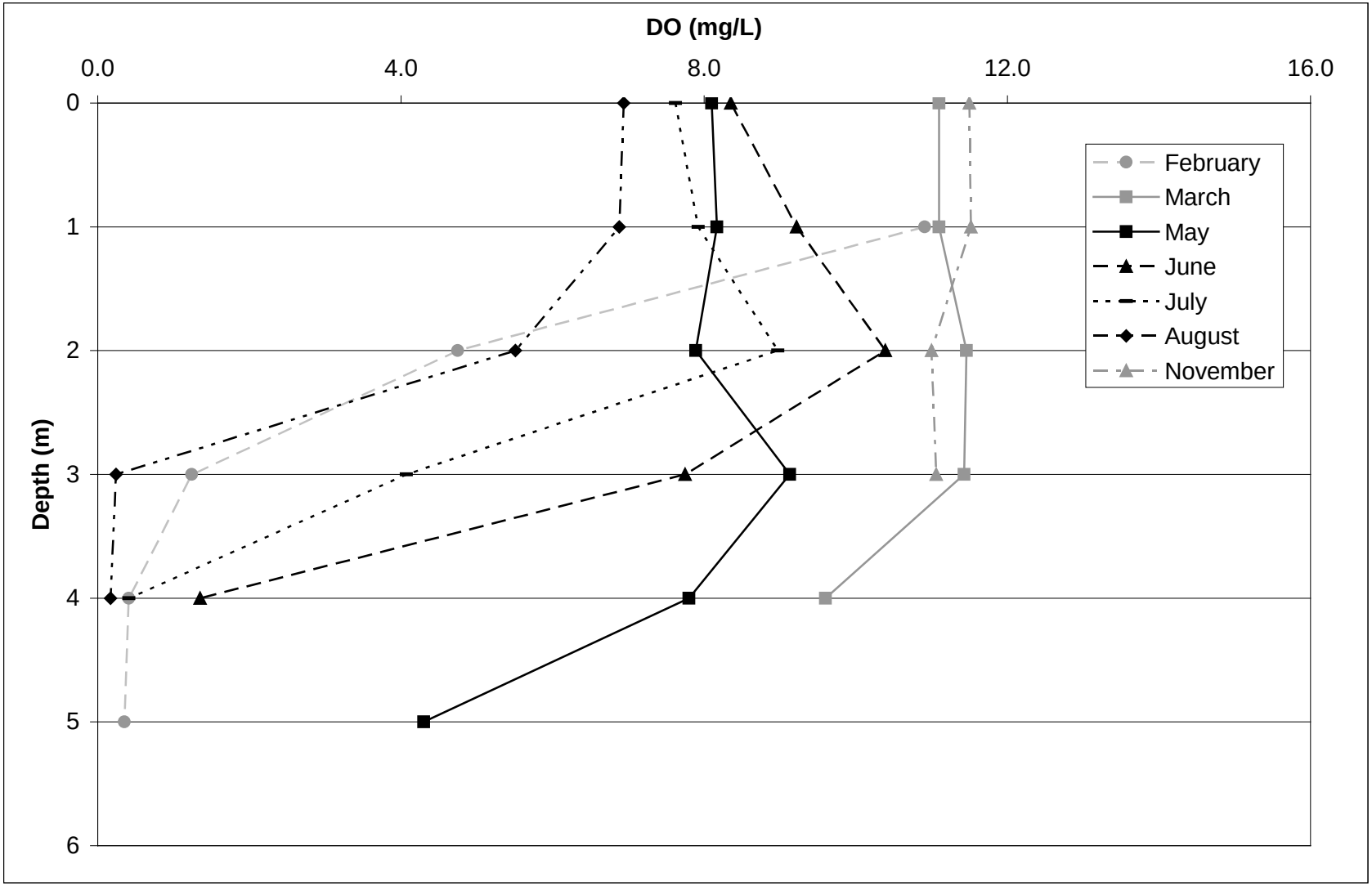

Figure 51. Monthly dissolved oxygen (DO) profiles of Moose Creek Reservoir, Idaho, during 2007.

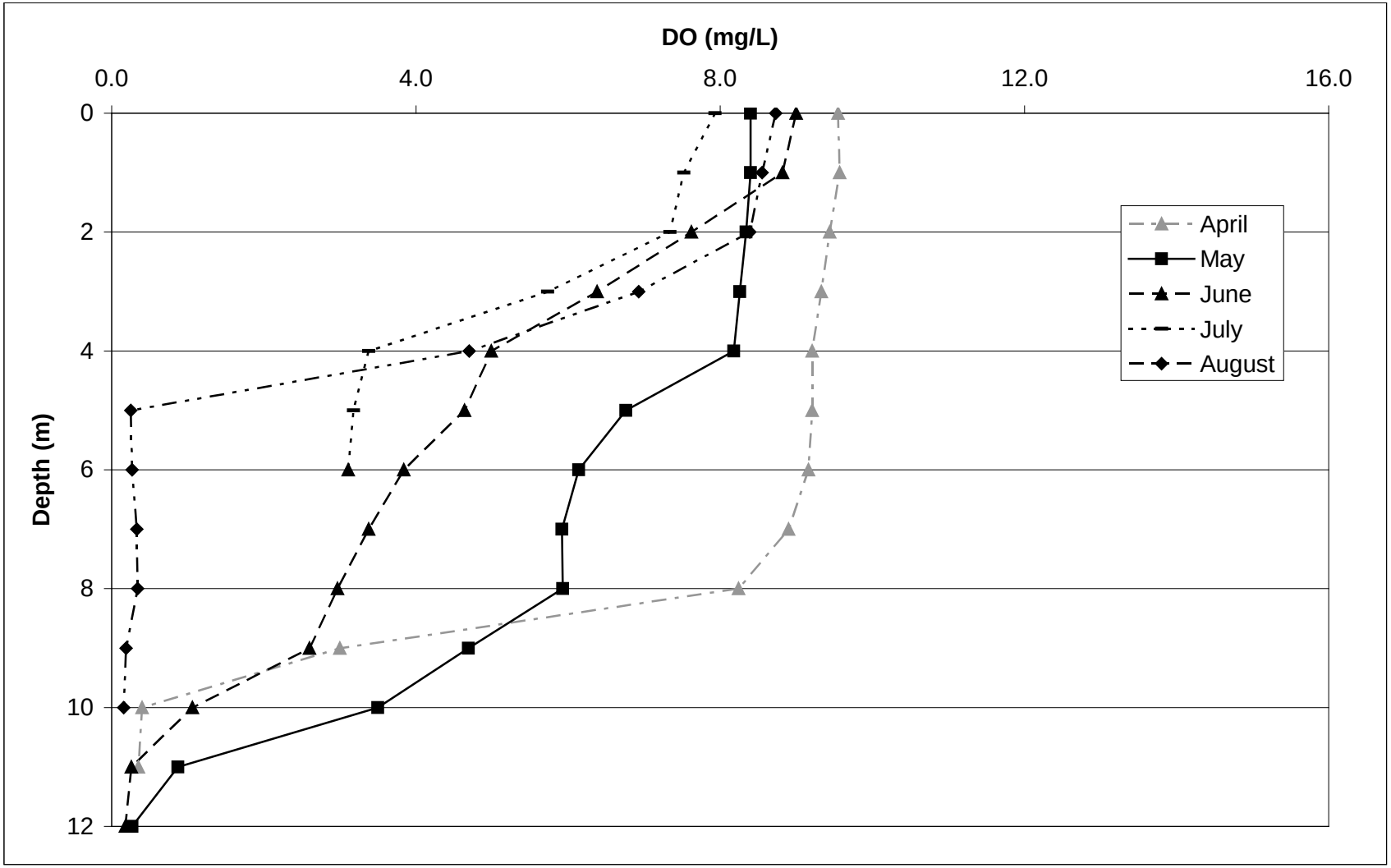

Figure 52. Monthly dissolved oxygen (DO) profiles of Soldier's Meadow Reservoir, Idaho, during 2007.

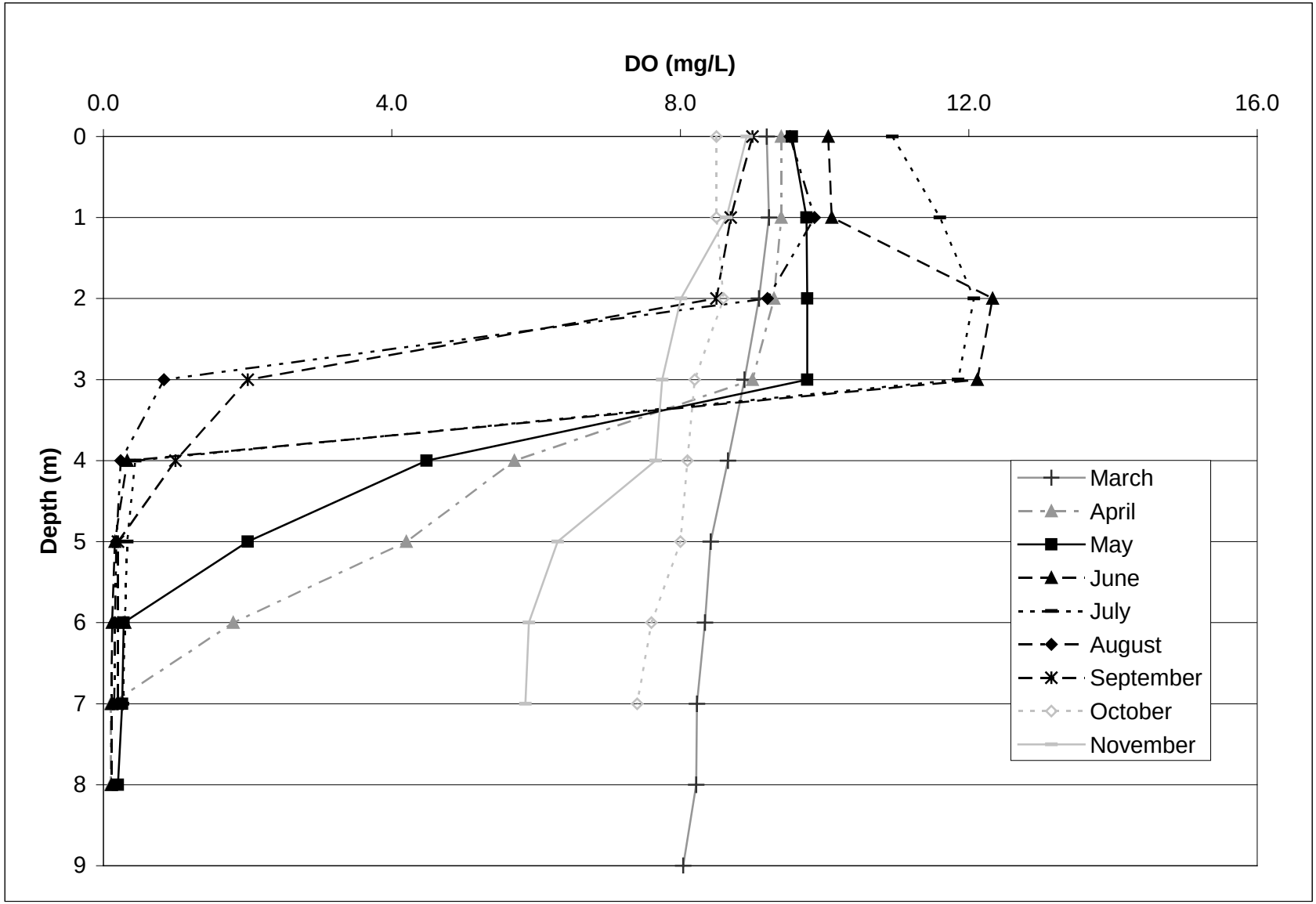

Figure 53. Monthly dissolved oxygen (DO) profiles of Spring Valley Reservoir, Idaho, during 2007.

Waha Lake

The hypolimnetic aeration system in Waha Lake was inoperable during 2007 due to ice damage from the previous winter. Maintenance on the aeration system could not be conducted due to extremely low water which prevented boats from being launched on the lake.

Monthly dissolved oxygen profiles are shown in Figure 54. As can be seen, DO levels remain high down to a depth of 14 m. Waha Lake is 100' deep and does not have the shallow stratification that the region's other small reservoirs experience.

Winchester Lake

The aquatic herbicide Reward® was applied on May 10th and July 25th in an effort to control nuisance aquatic vegetation that greatly reduces recreational opportunities. The vegetation in Winchester Lake is a combination of Elodea *Elodea canadensis* and filamentous algae. These applications were moderately successful in eliminating the vegetation. Conducting the first application earlier in the spring, and applying the herbicide to larger areas may improve the level of success.

Fish habitat and water quality issues continue to be addressed in Winchester Lake through the use of a hypolimnetic aeration system. In 2007, extensive repairs were made to the system. This included replacing the air compressors, replacing the submerged PVC air hose with self weighted flexible air hose, and fixing or replacing all anchor systems. This work greatly reduced the maintenance problems that have plagued this project for the last couple of years. The result was a system that now continually operates at full or nearly full capacity.

Monthly dissolved oxygen profiles illustrate the annual loss of oxygen in the hypolimnion of Winchester Lake during the summer months (Figure 55).

As can be seen, DO levels drop considerably below two meters in late summer. This severely reduces the volume of the reservoir available for fish to live, especially trout. It also forces the more temperature sensitive trout to live in the warmer epilimnion instead of the preferred cooler water of the hypolimnion. This can cause stress and fish kills during the hot summer months.

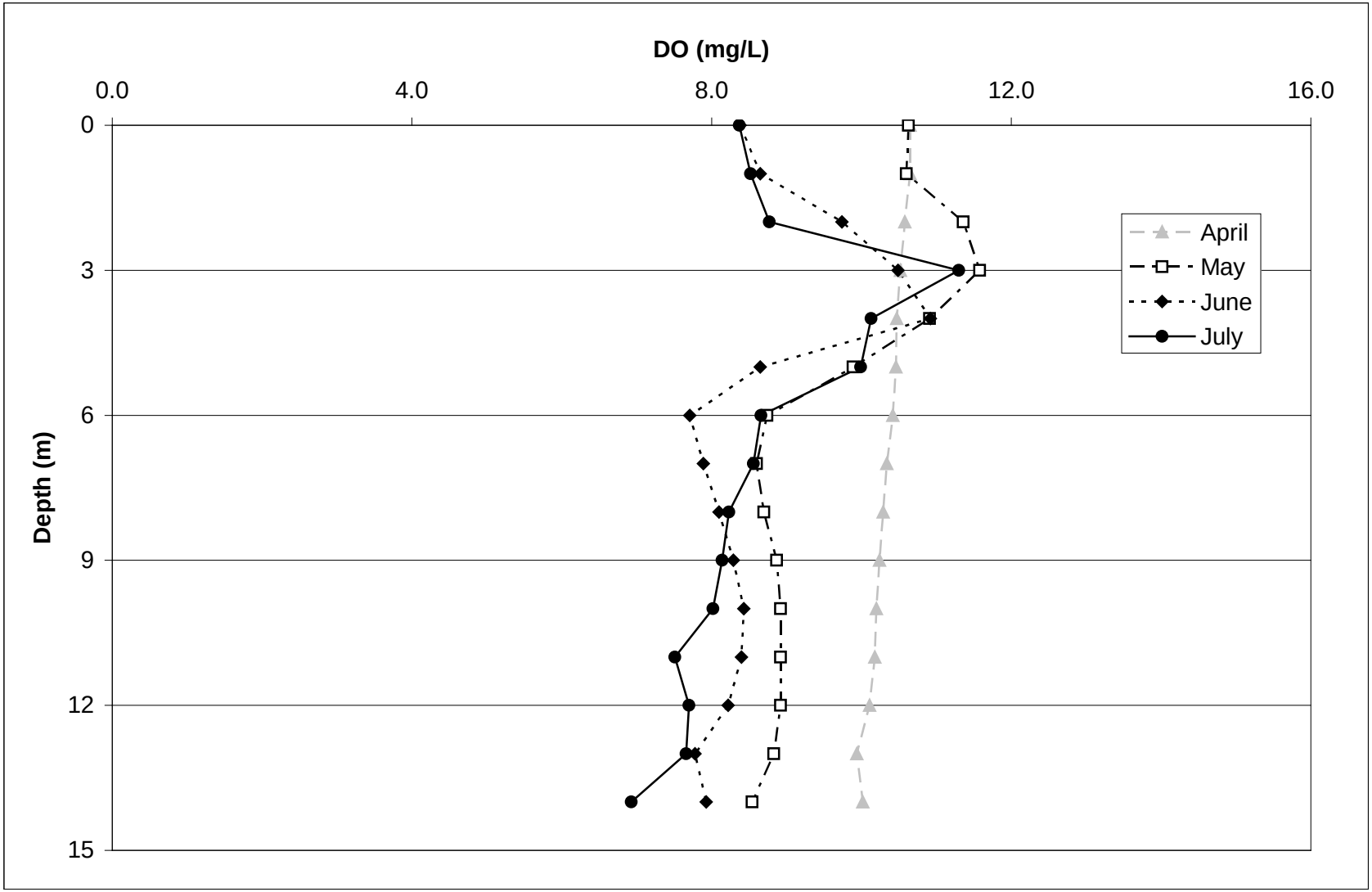

Figure 54. Monthly dissolved oxygen (DO) profiles of Waha Lake, Idaho, during 2007.

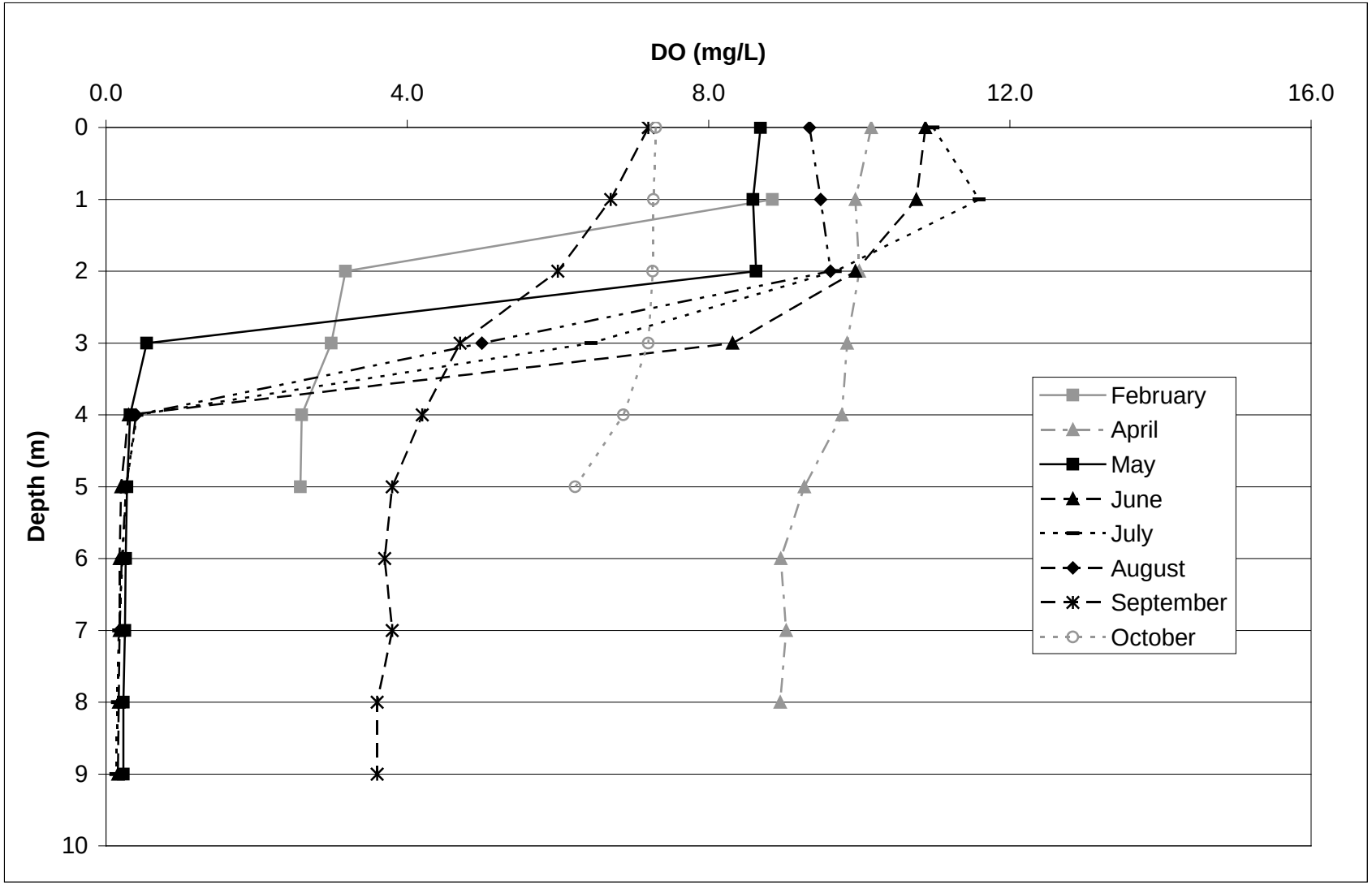

Figure 55. Monthly dissolved oxygen (DO) profiles of Winchester Lake, Idaho, during 2007.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring effectiveness of aeration systems through 2009, with project evaluation in December 2009.

2. Continue to utilize aquatic herbicide applications to improve habitat and access in regional ponds using full-pond treatments in the spring and summer.

3. Continue to utilize aquatic herbicide applications in regional lowland lakes for angler access. Increase the area of each treatment and conduct the first treatment in early spring to improve the effectiveness. Evaluate the effectiveness of these changes on the treatments.

4. Partner with the Clearwater Community Foundation to replace the existing corrugated water pipe at Robinson Pond with a smooth-walled sewer pipe that can be sealed and installed below ground. The purpose of this replacement would be a leak-free pipe that would be safe from vandalism and accidents, and would not interfere with the daily operations of the Flying-B Ranch. Additionally, it would provide the maximum volume of cool water possible to the pond year-round; thus, improving fish habitat and recreational opportunity.