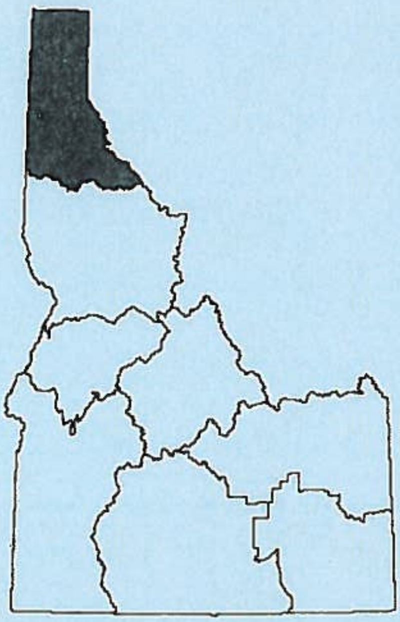
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERY MANAGEMENT ANNUAL REPORT

Virgil Moore, Director



PANHANDLE REGION

2011

Jim Fredericks, Regional Fishery Manager
Melo Maiolie, Regional Fishery Biologist
Ryan Hardy, Regional Fishery Biologist
Rob Ryan, Regional Fishery Biologist
Mark Liter, Regional Fishery Biologist

January 2013
IDFG #12-110

2011 Panhandle Region Annual Fishery Management Report

Table of Contents

Page

CHAPTER 1: CHANNEL CATFISH STOCKING EVALUATION

ABSTRACT 1
INTRODUCTION 2
STUDY AREA 2
Fernan Lake 2
Hauser Lake 3
Cocolalla Lake 3
Jewel Lake 3
METHODS 4
RESULTS 5
DISCUSSION 7
MANAGEMENT RECOMMENDATIONS 8
Tables 9
Figures 12

CHAPTER 2: COEUR D'ALENE LAKE FISHERY INVESTIGATIONS

ABSTRACT 20
INTRODUCTION 21
OBJECTIVES 21
STUDY AREA 22
METHODS 22
Kokanee Estimates by Trawling 22
Kokanee Estimates by Hydroacoustics 23
Chinook Salmon Stocking Tests 24
Chinook Salmon to Kokanee Correlations 24
Chinook Salmon Redd Counts 24
RESULTS 25
Kokanee Estimates by Trawling 25
Kokanee Estimates by Hydroacoustics 25
Chinook Salmon Stocking Tests 26
Chinook Salmon to Kokanee Correlations 26
Chinook Salmon Redd Counts 26
DISCUSSION 27
Kokanee Population Estimates 27

Chinook Salmon to Kokanee Correlations 27
MANAGEMENT RECOMMENDATIONS 28
Tables 29
Figures 36

CHAPTER 3: SPIRIT LAKE KOKANEE
ABSTRACT 44
OBJECTIVE 45
INTRODUCTION 45
STUDY AREA 45
METHODS 46
Hydroacoustics 46
Trawling 46
RESULTS 46
Hydroacoustics 46
Trawling 47
DISCUSSION 47
Kokanee abundance 47
MANAGEMENT RECOMMENDATIONS 49
Tables 50
Figures 54

CHAPTER 4: UPPER PRIEST LAKE AND THOROFARE LAKE TROUT CONTROL
ABSTRACT 56
INTRODUCTION 57
METHODS 57
Lake Trout Removal 57
Thorofare Netting Evaluation 58
RESULTS 58
Lake Trout Removal 58
Thorofare Netting Evaluation 59
DISCUSSION 59
Lake Trout Removal 59
Thorofare Netting Evaluation 60
MANAGEMENT RECOMMENDATIONS 60
Tables 61
Figures 63

CHAPTER 5: STATUS OF PYGMY WHITEFISH IN SPIRIT AND PRIEST LAKES

ABSTRACT 67
INTRODUCTION 68
OBJECTIVES 68
STUDY AREA 68
METHODS 68
RESULTS 69
Spirit Lake 69
Priest Lake 70
DISCUSSION 70
MANAGEMENT RECOMMENDATIONS 71
Tables 72
Figures 73

CHAPTER 6: PEND OREILLE WALLEYE MONITORING
ABSTRACT 78
INTRODUCTION 79
METHODS 80
RESULTS 81
DISCUSSION 82
MANAGEMENT RECOMMENDATIONS 84
Table 85
Figures 86

CHAPTER 7: FERNAN AND HAUSER LAKE CREEL SURVEYS
ABSTRACT 89
INTRODUCTION 90
OBJECTIVE 90
STUDY AREA 90
Fernan Lake 90
Hauser Lake 91
METHODS 91
RESULTS 91
Fernan Lake 91
Hauser Lake 92
DISCUSSION 92
Fernan Lake 92
Hauser Lake 93
MANAGEMENT RECOMMENDATIONS 94
Tables 95

Figure 101
CHAPTER 8: PRIEST LAKE KOKANEE SPAWNER SURVEY
ABSTRACT 102
INTRODUCTION 103
OBJECTIVE 103
METHODS 103
RESULTS 103
DISCUSSION 103
MANAGEMENT RECOMMENDATION 104
Table 105
Figure 106

CHAPTER 9: UPPER PRIEST LAKE PURSE SEINE EVALUATION
ABSTRACT 107
INTRODUCTION 108
METHODS 108
RESULTS 108
DISCUSSION 109

CHAPTER 10: LOWLAND LAKES HATCHERY TROUT EXPLOITATION
ABSTRACT 110
INTRODUCTION 111
OBJECTIVE 111
STUDY SITE 111
Freeman Lake 111
Jewel Lake 111
Robinson Lake 112
Smith Lake 112
Bull Moose Lake 112
METHODS 113
RESULTS 113
DISCUSSION 114
MANAGEMENT RECOMMENDATIONS 114
Table 115

CHAPTER 11: HAYDEN LAKE INVESTIGATIONS
ABSTRACT 116
INTRODUCTION 117
STUDY AREA 117

OBJECTIVES 117
METHODS 118
Hydroacoustic Survey 118
Zooplankton Sampling 118
RESULTS 119
Hydroacoustic Survey 119
Zooplankton Survey 119
DISCUSSION 119
Hydroacoustic Survey 119
Zooplankton Survey 120
MANAGEMENT RECOMMENDATIONS 120
Tables 121
Figures 122

CHAPTER 12: BULL TROUT REDD COUNTS
ABSTRACT 124
INTRODUCTION 125
STUDY SITES 125
OBJECTIVES 125
METHODS 125
RESULTS and Discussion 126
Pend Oreille Core Area 126
Priest Lake Core Area 126
Kootenai River Core Area 126
Coeur d'Alene Lake Core Area 127
North Fork Clearwater River Core Area 127
MANAGEMENT RECOMMENDATION 127
Tables 128
Figures 134

CHAPTER 13: CUTTHROAT TROUT X RAINBOW TROUT HYBRIDIZATION IN THE NORTH FORK OF THE COEUR D'ALENE RIVER
ABSTRACT 135
INTRODUCTION 136
STUDY SITE 136
OBJECTIVES 136
METHODS 136
RESULTS 137
DISCUSSION 138

MANAGEMENT RECOMMENDATION 138
Tables 139
Figures 140

CHAPTER 14: TROUT SURVEYS IN THE COEUR D'ALENE, ST. MARIES AND PRIEST RIVERS
ABSTRACT 144
INTRODUCTION 145
OBJECTIVE 145
STUDY SITES 145
METHODS 145
RESULTS 146
North Fork Coeur d'Alene River 146
St. Maries River 146
Priest River 147
DISCUSSION 147
North Fork Coeur d'Alene River 147
Priest River 148
St. Maries River 148
MANAGEMENT RECOMMENDATIONS 148
ACKNOWLEDGEMENTS 148
Tables 149
Figures 154

LITERATURE CITED 161

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 1: CHANNEL CATFISH STOCKING EVALUATION

ABSTRACT

Tandem hoop net series (HNS) baited with two different commercially prepared bait types (soybean cake and cheese logs) were evaluated to capture channel catfish *Ictalurus punctatus* in four north Idaho lakes. Eighteen HNS consisting of 1,558 individual net hours ranging from 68-125 hours/set were fished from June 27 to August 11, 2011 resulting in a sample of 3,802 channel catfish. Number of channel catfish captured/HNS ranged from 115 to 134 tandem hoop nets baited with soybean cakes and from 7 to 233 fish/series for nets baited with cheese logs. Overall, nets baited with soybean cake caught 62% of all channel catfish sampled and averaged 97 fish/net while nets baited with cheese logs averaged 38 fish/net. Using pectoral spine cross-sections, mean back-calculated length-at-age determinations were made for 177 channel catfish from Hauser Lake. Approximately 59% of Hauser Lake channel catfish were ≤ age-3 and 13% ≥ age-6. Based on catch curve analysis of channel catfish age-2 to age-15, total annual mortality was 40%. The majority of channel catfish sampled in four north Idaho lakes were above the minimum stock length (280 mm) with few individuals above quality length (>410 mm) sampled. On average, channel catfish sampled weighed above or near 100% of the standard weight and condition (W_r) varied little by length category (i.e., sub-stock, stock, quality). A total of 329 channel catfish from three lakes were tagged with Carlin dangler tags to assess angler exploitation. After correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation for channel catfish was estimated at 4% in Fernan Lake, 1% in Hauser Lake and 0% in Cocolalla and Jewel lakes. Advantages of using hoop nets include: reduced mortality, the ability to sample a variety of age classes with a single gear type, and minimal catch of non-target species.

Authors:

Mark Liter
Regional Fishery Biologist

Kelly Carter-Lynn
Fishery Technician

Brian Hammond
Fishery Technician

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Channel catfish *Ictalurus punctatus* belong to the family Ictaluridae, in the catfish order Siluriformes. The order includes over 2,000 species; most of them inhabit the fresh waters of the tropics. Channel catfish are native to parts of Quebec, Ontario and Manitoba, south from the St. Lawrence River and tributaries including all of the Gulf States and Mexico, but not the Atlantic slope drainages (Scott and Crossman 1998) (Figure 1). Channel catfish have been widely introduced outside this native range and can be found almost everywhere in the United States (Scott and Crossman 1998).

Channel catfish spawn in late spring or summer when water temperatures reach 24°-29.5°C (Scott and Crossman 1998). Because cooler water temperatures in north Idaho are not conducive to successful channel catfish reproduction channel catfish numbers are controlled by stocking and angler harvest. State-wide, Idaho Department of Fish and Game (IDFG) has stocked channel catfish into 67 waterbodies since 1967. In the past 24 years IDFG has introduced channel catfish into a number of north Idaho rivers and lakes, attempting to increase predation on overabundant forage fish populations and/or add angling opportunity and diversity to mixed-species fisheries. Of the 11 water bodies planted with channel catfish in the Panhandle Region since 1987, six lakes continue to be stocked annually (Table 1). Channel catfish stocked into north Idaho lakes in 2011 ranged from 119-330 mm with a mean total length of 249 mm. Ideally channel catfish should be stocked large enough to escape predation by largemouth bass and provide a suitable fishery in a relatively short time. Krummrich and Heidinger (1973) found channel catfish less than 200 m TL were highly vulnerable to predation by largemouth bass while Storck and Newman (1988) showed that stocking 200 mm channel catfish gave the greatest return for the investment.

Current Idaho regulations set no bag limit, size, or possession limits on channel catfish and exploitation rates have not been estimated for most Idaho catfish fisheries, therefore, it is important to evaluate key characteristics of channel catfish populations in north Idaho lakes to ensure the most efficient use of limited hatchery resources. The objective of this study was to evaluate baited hoop nets, set in tandem as a tool to sample channel catfish and to evaluate channel catfish size structure, condition, and angler exploitation in four north Idaho lakes.

STUDY AREA

Fernan Lake

Fernan Lake is located in Kootenai County just east of Coeur d'Alene, ID (Figure 2). The Fernan Lake watershed is approximately 4,872 ha; has a surface area of 154 ha and a mean depth of 8.5 m. In 2003 the Idaho Department of Environmental Quality categorized Fernan Lake as mesotrophic. Most of the shoreline is forested; however, the northwest end of the lake is residential. There are several wetlands located on the east, west and northern areas of the lake. Fernan Lake supports both a warmwater and a coldwater fishery and is considered one of the most successful urban fisheries in the state. Natural reproduction maintains the warmwater species: bluegill *Lepomis macrochicrus,* largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui,* black crappie *Pomoxis nigromaculatus*, brown bullhead *Ameiurus nebulosus*, pumpkinseed *L. gibbosus*, tench *Tinca tinca*, northern pike *Esox lucius* and yellow perch *Percha flavescens*, while rainbow trout *Oncorhynchus mykiss* are stocked on a regular basis. In 2011, 19,102 catchable triploid rainbow trout and 6,214 fingerling westslope cutthroat *O. clarkii* were stocked into Fernan Lake.

A few brook trout *Salvelinus fontinalis* and cutthroat trout enter the lake via Fernan Creek and Coeur d'Alene Lake respectively. Channel catfish were first stocked into the lake in 1987 with two to six thousand catfish stocked annually.

Hauser Lake

Hauser Lake is a meso-eutrophic lake, with a surface area of 253 ha located 20 km northwest of Coeur d'Alene, ID, near the Washington border (Figure 2). The lake has a mean depth of 6.4 m and a maximum depth of 12.2 m. Public boating access to Hauser Lake is limited to a single boat launch on the south side that is utilized extensively by pleasure boaters and anglers. Numerous roadside access points are scattered around the perimeter. The western and northern shorelines are populated by macrophytes while the eastern shoreline has rock outcrops and riprap along a roadside with steeply sloping banks. About 50% of the shoreline is developed with seasonal and year-round residences.

The lake supports a popular warmwater fishery with bluegill, black crappie, brown bullhead, yellow perch, largemouth and smallmouth bass and pumpkinseed providing angling opportunity. Channel catfish were first stocked in Hauser Lake in 1989 with between 2,400 and 8,000 catfish stocked annually. Additionally, 33,781 early spawner kokanee fingerlings, 54,395 westslope cutthroat fingerlings and 17,348 rainbow trout catchables were stocked in Hauser Lake in 2011. Tiger musky *E. masquinongy* x *lucius* were stocked in Hauser Lake beginning in 1989; however, in recent years stocking has not been possible due to a lack of disease free fish.

Cocolalla Lake

Cocolalla Lake is located in Bonner County 12 km south of Sagle, ID (Figure 2). The lake has a surface area of 326 ha and a mean depth of 8 m. Cocolalla Lake is in an advanced state of eutrophication and has potential low oxygen/high temperature limiting conditions for salmonids during late summer. Boat access is available via an IDFG maintained boat ramp at the north end. The western and northern shorelines are developed with year-round and seasonal residences with the entire eastern shoreline owned by Burlington Northern Santa Fe Railway Company. The primary summer fisheries on Cocolalla Lake are for hatchery supported rainbow trout and channel catfish. Channel catfish were introduced in 1985 to utilize the abundant yellow perch and pumpkinseed forage base. Approximately five to nine thousand catfish have been stocked in Cocolalla Lake annually. In 2011, 22,548 fingerling westslope cutthroat, 1,740 catchable westslope trout and 25,200 fingerling triploid rainbow trout were stocked. The lake contains a total of 11 game fish species. Yellow perch are the most abundant game fish by number followed by largemouth bass. Bluegill, brown trout, brook trout, black crappie and brown bullhead are also present.

Jewel Lake

Jewel Lake is a 12 ha lake located in Bonner County, ID 12 km west of Cocolalla Lake and 5.6 km southeast of Laclede, ID (Figure 2). The land around the lake is owned by a single landowner who has allowed public access since 1951 in exchange for IDFG maintaining the boat launch. Jewel Lake is eutrophic and has a maximum depth of 10 m. In the late 1970s yellow perch were illegally introduced, became overpopulated and stunted. IDFG personnel renovated the lake with rotenone in 1989 to remove yellow perch; however, by 1992 yellow perch had reestablished their population. In 2007 all species present in Jewel Lake were game fish and included bluegill, black crappie, channel catfish, rainbow trout and pumpkinseed. In 2011, 5,924 catchable rainbow trout were stocked in Jewel Lake. Channel catfish were first stocked in Jewel Lake in 2001 with 300-1500 catfish stocked annually. Few bluegill are in the quality designation and do not appear to be contributing a substantial fishery. Jewel Lake was once managed as a quality trout fishery, however, the fishery has deteriorated, and due to poor growth the lake is presently managed under the Family Fishing Water regulations and is stocked with put-and-take rainbow trout.

METHODS

Channel catfish were sampled with baited tandem hoop nets as described by Michaletz and Sullivan (2002) in Hauser, Fernan, Cocolalla and Jewel lakes. Each hoop net series (HNS) consisted of three hoop nets (Figure 3), attached bridle to cod end. A 5.4 kg winged anchor was attached to the rear end of the rear net and the front end of the front net to increase tension and improve stability during fishing. Additional 2.7 kg weights were attached between the middle and front net and to the bridle on the rear net so that the nets would not collapse when fish were being removed. Each net in a series was baited with two bags containing 1.8 kg of commercially prepared cheese logs (Boatcycle, Inc., Henderson TX.) or soybean cake (MaxYield Cooperative, West Bend, IA) as a fish attractant.

We fished two HNS made up of 91 cm diameter hoops each measuring approximately 3.4 m in length, made up of seven metal hoops constructed of #15 twine with 25.4 mm bar mesh, and equipped with 6 m bridles that separated consecutive nets. Two-fingered crow foot throats were attached to the second and fourth hoop. To prevent escapement from the cod end, the rear throat was tied shut with 25 mm rope.

For each sampling trip two tandem HNS were set parallel to shore in the littoral zone of each lake at depths ranging from 3-4 m. Anoxic water below the thermocline was avoided to reduce fish mortality and increase catches. Steep slopes were identified and avoided to prevent nets from rolling into deeper water. Each HNS was left undisturbed for 72-96 hours before nets were retrieved. Three to four day soak durations were used because we anticipated lower densities of channel catfish than in reservoirs sampled by Michaletz and Sullivan (2002) and Sullivan and Gale (1999). This procedure was repeated 2-4 times at each lake. We deployed baited hoop nets on Hauser Lake on June 23 when water temperatures reached 19.3° C and finished sampling on August 11 with a water temperature of 21.1°C at Cocolalla Lake.

All live fish were released immediately after processing. Catches were recorded separately for each net within a series but results were pooled by HNS for analysis. Catch-per-unit-effort (CPUE) was expressed as the number of channel catfish caught per HNS/72 hrs. For example, the catch of catfish in a three net series (HNS) was divided by the number of hours the net was set; then multiplied by 72 to get the number of fish that would have been caught in a standardized 72 h set. Natural log transformation was used to normalize CPUE data prior to analysis.

On retrieval, fish were removed from the nets and placed in live wells. Channel catfish were measured for TL and weight was recorded in g. Pectoral spines were removed for age and growth determinations. The right spine was removed by grasping the spine at the articulation, pressing flat against the body, and rotating it in a counterclockwise direction allowing the entire spine to be removed (Ashley and Garling 1980). Spines were stored dry in scale envelopes on which length, weight and location where recorded. Pectoral spines were sectioned at the distal end of the basal groove using a Buehler Isomet Low Speed Saw (Koch and Quist 2007). Spine sections were examined through a dissection microscope (7-45X). Measurements used to determine age at annulus formation were taken using an image analysis system. Two or three readers estimated the age of structures and disagreements were resolved by mutual examination of questionable structures.

Channel catfish were tagged with Carlin dangler tags to assess angler exploitation. Carlin dangler tags were attached to channel catfish by U-shaped stainless steel wire. The open ends of the U-shaped wire were inserted into hypodermic needles, passed through the body the body of the fish between the dorsal pterygiophores. When the needles were withdrawn the wires were pulled snugly against the body and the ends crimped together. Tags were labeled on two sides with one side stating "IDFG 1-866-258-0338" and the other side with a tag number. IDFG operates a toll free automated hotline and website through which anglers can report tags, although some tags were mailed in or dropped off at the Panhandle Regional Office. Additionally, IDFG distributes posters and stickers to license vendors, regional offices and sporting goods outlets that publicize tagging efforts and explains how to report tags and how information is used. To determine angler exploitation, the number of fish harvested by anglers (determined by tags returns) was divided by the number of fish we tagged. We assumed a 53% reporting rate, which is typical of non-reward tags (Meyer et al. 2010), and adjusted the return rate accordingly to provide an exploitation estimate. Tag loss was estimated at 0% as Carlin dangler tags typically eliminate the uncertainty associated with tag loss; Travnichek 2004 and Holley 2006; while tagging mortality was assumed to be 3% based on work conducted on rainbow trout by Meyer et al. (2010).

Total annual mortality was estimated by generating a catch curve from the age frequency data weighted catch curve analysis described by Guy and Brown (2007). Weighted catch curve analysis deflates the influence of older and rarer fish. Growth information was determined by using the Von Bertalanffy equation through the FAST software.

We calculated channel catfish relative weights (Wr), which compares weights of channel catfish found in north Idaho lakes to that of a standard developed from multiple populations. Relative weight was calculated using the formula:

$Wr = (W/Ws) \times 100$, where W is the actual fish weight (g), and Ws is a standard weight for fish of the same length. Minimum total lengths to calculate Ws as specified by Brown et al. 1995 is 70 mm, however, our minimum length used was 150 mm.

We calculated Proportional Stock Density (PSD), which is a numerical descriptor of length-frequency data (Anderson 1976) for channel catfish. PSD is calculated as number of fish ≥ minimum quality length/ number of fish ≥ minimum stock length. For channel catfish, quality length (% related to world record size) was set at 410 mm and stock length (approximate size recruited to the sampling gear); was set at 280 mm (Gabelhouse 1984).

RESULTS

A total of 3,802 channel catfish were captured in four north Idaho lakes using hoop nets baited with commercially prepared cheese logs and soybean cake. Eighteen HNS consisting of 1,558 individual net hours ranging from 68-125 hours/set were fished from June 27 to August 11. Only 10 channel catfish were captured in Jewel Lake, therefore Jewel Lake was not included in portions of this evaluation. Jewel Lake will be evaluated again in 2012.

CPUE ranged from 115 to 134 fish/series for tandem hoop nets baited with soybean cakes and from 7 - 233 fish/series for nets baited with cheese logs (Table 2). Overall, nets baited with soybean cake caught 62% of all channel catfish sampled and averaged 97 fish/net while nets baited with cheese logs averaged 38 fish/net. We compared the catch of catfish in hoop nets baited with the two bait types. On five occasions in Fernan Lake and Cocolalla Lake both types of bait were used on the same date. Mean number of catfish caught in nets with cheese logs was 258 fish, versus 392 in nets baited with soybean cake. We found no statistical difference between baits by testing if the paired difference between the catches was equal to zero (95% CI).

Channel catfish mortality was observed on only one occasion; eight (0.01% of total catch) mortalities occurred on August 11 when a catch of 1,113 channel catfish resulted in longer than normal handling time. Tandem hoop nets caught a variety of non-target species (Table 3) but mortality was usually less than 1%. Non-target species consisted mostly of bluegill, tench, pumpkinseed and black crappie. When comparing bait costs we found soybean cake to be more economical: soybean cake bait price per HNS was $22.97 compared to $35.20 per HNS for cheese logs (Table 4).

The majority of channel catfish sampled in three north Idaho lakes were above the minimum stock length (280 mm) with few individuals above quality length (>410 mm) (Table 5). Length frequencies of channel catfish captured in tandem hoop nets were similar between Hauser, Fernan, and Cocolalla Lakes and ranged from 93 to 558 mm TL (Figures 4 a,b,c).

Fernan Lake had the highest number of larger fish and the highest PSD followed by Cocolalla Lake (Tables 2 and 5).

On average, channel catfish sampled weighed above or near 100% of the standard weight and condition (W_r) varied little by length category (i.e., sub-stock, stock, quality) (Table 6, Figure 5). Sub-stock fish (<280 mm) W_r ranged from 95 in Jewel Lake to 109 in Hauser Lake. Relative weight of stock length fish (281 - 410 mm) ranged from 93 in Fernan to 108 in Cocolalla Lake and W_r for Quality length (>410 mm) channel catfish ranged from 104 in Cocolalla and Fernan lakes to 111 in Hauser Lake. The overall mean W_r of all fish was 96 in Jewel and Fernan lakes, 105 in Hauser Lake and 107 in Cocolalla Lake (Table 6).

We captured 503 channel catfish in Hauser Lake ranging from 206 mm to 507 mm in total length (Figure 4) and 206 g to 2,060 g in weight. Using pectoral spine cross-sections, mean back-calculated length-at-age determinations were made for 177 channel catfish from Hauser Lake. We will be evaluating channel catfish growth from Fernan and Cocolalla lakes in more detail in the coming months. Overall, mean length-at-age at capture is fairly similar among Hauser, Fernan, and Cocolalla lakes (Figure 6). Estimated ages of collected fish ranged from 2 to 15 years and the majority (44%) were between ages 3 and 4 years. Three-year old fish ranged from 235 mm to 367 TL mm in Hauser Lake. Channel catfish in the three lakes generally reach 300 mm at ages 3-4 and growth varied among Hauser, Fernan and Cocolalla lakes at older ages (Figure 6). On average channel catfish reached 410 mm (quality length) by ages 6-8 (Figure 6). Mean back calculated length-at-age for Hauser Lake channel catfish was compared to 102 populations from across the country (Hubert 1999). Channel catfish mean length-at-age for Hauser Lake was comparable to that described by Hubert (1999) up to age-4 then diverged each year thereafter (Figure 7). Based on mean back-calculated length-at-age (N=162), 62% of Hauser Lake channel catfish were ≤ age-3 and 13% ≥ age-6. Based on catch curve analysis of channel catfish age-2 to age-15, total annual mortality was 40% (Figure 8).

Through December 31, 2011, 3 of 105 tagged channel catfish in Fernarn Lake were returned. Through the same time period, anglers reported catching 1 of 120 tagged channel catfish tagged in Hauser (Table 6). No anglers tag returns were reported from Cocolalla or Jewel lakes. After correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation for channel catfish was estimated at 4% in Fernan Lake. Angler exploitation was estimated to be 1% for channel catfish in Hauser, and zero in Cocolalla and Jewel lakes in 2011 (Table 7).

DISCUSSION

While information exists on basic biology of channel catfish, population assessments to assist in the management of channel catfish are needed. One of the larger hindrances to management of channel catfish in north Idaho is inadequate data which stems from our inability to efficiently sample channel catfish. IDFG utilizes two floating and two sinking gill nets, 2 fyke nets and one hour of electrofishing while conducting standard lake surveys. This protocol typically provides small sample sizes that are inadequate for the assessment of channel catfish population dynamics (growth and mortality) and structure (abundance, size structure, and condition); the average number of channel catfish sampled in north Idaho lakes since 1995 was 17 per standard lake survey. Using baited hoop nets we were able to sample 500 - 2,400 channel catfish per lake in three north Idaho lakes. Vokoun et al. (2001) and Michaletz and Sullivan (2002) estimated that a sample of 300 - 400 channel catfish was necessary to conduct a precise length-frequency distribution.

Mean CPUE for nets baited with cheese logs in the three lakes was 108/HNS compared to 126/HNS for soybean cakes. Cheese log bait purchase price and shipping equated to $35.25/HNS vs. soybean cake which equated to $22.97/HNS. Considering similar catch rates and the fact that soybean cake is easier to store, requires no refrigeration and does not have the unpleasant odor associated with cheese logs, we recommend soybean cake as the bait to use when sampling channel catfish in Idaho lakes.

Advantages of using hoop nets include reduced mortality, the ability to sample a variety of age classes with a single gear type, and minimal by-catch. Different mesh sizes can produce different length-frequency distributions; however, mesh with 25 mm square openings appears to be optimal for sampling a broad range of channel catfish (Michaletz and Sullivan 2002; Hesse et al. 1982; Sullivan and Gale 1999).

We did not capture any channel catfish larger than 558 mm TL, so size biases for large fish may exist. Channel catfish larger than 600 mm TL were reported in previous IDFG studies and anglers occasionally report catching channel catfish larger than 558 mm from Panhandle Region lakes. However, Michaletz and Sullivan (2002) suggest that length frequencies of channel catfish captured in tandem hoop nets accurately reflect the size structure of the sampled population except for fish shorter than 250 mm TL. We recommend sampling in July prior to annual stocking to avoid complications of recently stocked fish and provide a more accurate assessment of the population for the fishing season.

Creel survey data collected during 5-month creel surveys on Hauser and Fernan lakes in 2011 estimated approximately 13% of angler effort was directed toward channel catfish on each of the two lakes (Liter et al. 2011 in press). Previous creel surveys estimated much less angler effort toward channel catfish in Hauser and Fernan lakes; however, no nighttime interviews were conducted during those surveys. Parrett et al (1999) found that over 50% of channel catfish harvest and catfish angling effort occurred at night in two Ohio impoundments.

There was a high degree of overlap in lengths between age groups. Channel catfish 300 - 350 mm in length may belong to age-groups 3 - 7 and fish 350 - 400 mm in length may belong to age-groups 4-8. The range of length in fish of the same age is not believed to be indicative of an error in age determination, but is probably a real difference in growth of various year classes due to different sources of fingerling and length at stocking. IDFG purchases fingerling channel catfish from Fish Breeders of Idaho Inc. who have obtained channel catfish fry from several different private hatcheries in Missouri, Arkansas and Oklahoma in recent years (Leo Ray, owner, personal communication). In 2012, we will sample channel catfish catchables as they are stocked and conduct age analysis comparing spines to otoliths to try and sort out some of the discrepancies we found in ages 1-2 fish.

Stocking rates ranged from 21 channel catfish/ha in Fernan Lake to 27 channel catfish/ha in Jewel Lake in 2011 (Table 1). Stocking of large channel catfish fingerlings into these lakes represent a substantial investment of effort and financial resources for IDFG as the cost of production and distribution averaged $.90 per channel catfish fingerling stocked in the Panhandle Region in 2011 (Tom Frew, IDFG Resident Hatchery Manager, Personal Communication).

Growth of channel catfish in north Idaho is slow compared to southerly populations but they appear to be long lived. Catfish, 535 mm and age-15 were captured in Hauser Lake and age-12 (≥525 mm) in Fernan and Cocolalla lakes; a literature review by Hubert (1999*b*) indicated that only 23 of 102 North American channel catfish populations contained fish older than age 11. Mosher (1999) reported that in the wild, channel catfish over ten years of age and 530 mm TL are unusual. While channel catfish growth is influenced by a combination of various biotic and abiotic factors, colder water temperature of north Idaho may be the limiting factor relative to channel catfish growth rates. Slow growth rates in north Idaho lakes may also be a function of density dependent stocking rates. In 2012, we will begin to examine this with reduced stocking numbers planned for several lakes. There is likely a surplus of channel catfish in Hauser, Fernan and Cocolalla lakes and harvest is regulated by factors other than catfish abundance. We recommend a reduction in channel catfish stocking rates in each of the four north Idaho lakes studied in 2011. A reduction in stocking rates or alternate year stocking will probably provide adequate harvest opportunity and may allow for improved growth rates for channel catfish in north Idaho lakes. A reduction will probably go unnoticed by most anglers as channel catfish exploitation appears to be less than 10% in each lake (Liter et al. 2011 in press).

MANAGEMENT RECOMMENDATIONS

1. Consider reducing the number of channel catfish stocked each year or stock Panhandle Region lakes on alternate years.

2. Consider implementation of baited hoop nets, baited with soybean cake when sampling channel catfish in Panhandle Region lowland lakes. Channel catfish sampling should take place in July prior to stocking to avoid complications of recently stocked fish and provide a more accurate assessment of the population for the fishing season.

Table 1. Past five years channel catfish stocking history for four Panhandle Region lowland lakes surveyed in 2011.

Lake	Surface area (ha)	2007		2008		2009		2010		2011	
		# Stocked	#/ha	# Stocked	#/ha	# Stocked	#/ha	# Stocked	#/ha	# Stocked	#/ha
Hauser	223	4,980	22	4,730	21	5,508	25	5,000	22	5,544	25
Fernan	145	4,921	34	3,741	26	3,021	21	3,000	21	3,011	21
Cocolalla	326	9,020	28	8,048	25	8,015	25	7,498	23	8,008	25
Jewel	11.6	1,368	118	352	30	350	30	350	30	308	27

Table 2. Number of channel catfish captured, range (TL mm), PSD, and CPUE for cheese logs and soybean cake in four Panhandle Region lowland lakes in 2011.

				CPUE	
Lake	*N*	Range (mm)	PSD	Cheese	Soybean
Hauser	503	206-507mm	2	7	134
Fernan	833	240-558mm	12	233	131
Cocolalla	2456	181-548mm	3	86	115
Jewel	10	251-326mm	0	2	5

Table 3. Number of fish captured, species, mean length and range (mm) of by-catch in each of the four Panhandle Region lowland lakes sampled in 2011 channel catfish evaluations.

	Hauser		Fernan		Cocolalla		Jewel	
Species	**N**	**Mean Length (Range)**	**N**	**Mean Length (Range)**	**N**	**Mean Length (Range)**	**N**	**Mean Length (Range)**
Bluegill	485	165mm (93-296)	202	169mm (110-215)	2	160mm (149-170)	31	131mm (120-145)
Black Crappie	61	214mm (98-264)	1	164mm	3	275mm (255-295)	30	168mm (145-182)
Tench	355	405mm (173-516)	117	397mm (275-469)				
Brown Bullhead	26	285mm (208-340)	8	248mm (207-280)	21	264mm (229-300)		
Yellow Perch	4	183mm (153-200)	1	232mm	44	199mm (176-240)		
Pumpkinseed	38	134mm (100-237)	6	144mm (125-162)	13	137mm (124-148)		
Rainbow Trout	2	259mm (236-282)			2	378mm (265-490)	25	270mm (230-305)
Longnose Sucker					1	394mm		
Largescale Sucker					7	455mm (397-502)		

Table 4. Comparison of bait costs (soybean cake and cheese logs) and price per hoop net series (HNS) for channel catfish evaluation in four Panhandle Region lowland lakes in 2011.

	Price/box	Shipping/box	Total Cost	Avg. box wt	Price/Bait bag (6 bags/HNS)	Price/HNS
Soybean Cake	$21	$44	$65	67 pounds	$3.83	$22.97
Cheese log	$40	$48	$88	55 pounds	$5.87	$35.20

Table 5. Surface area (ha), number sampled and number of channel catfish sampled per 50 mm length group in four Panhandle Region lowland lakes in 2011.

Lake	Surface area (ha)	N	Number of channel catfish per length group (mm)							
			≤250	251-300	301-350	351-400	401-450	451-500	501-550	551-600
Hauser	223	503	41	168	244	45	4	3	1	0
Fernan	154	833	2	46	293	359	91	22	10	1
Cocolalla	326	2,456	120	625	1,060	566	76	3	6	0
Jewel	11.6	10	0	7	3	0	0	0	0	0

Table 6. Mean length and mean relative weight (W_r) by length category and overall W_r for channel catfish captured in four Panhandle Region lowland lakes in 2011.

Lake	Mean Length (TL)	W_r Sub-stock (<250mm)	W_r Stock (281-410mm)	W_r Quality (411-610mm)	W_r Overall
Cocolalla	359 mm	104	108	104	107
Fernan	376 mm	107	93	104	96
Hauser	308 mm	109	103	111	105
Jewel	287 mm	95	96		96

Table 7. Estimates of angler exploitation and % resident anglers for channel catfish at various Panhandle Region lakes sampled in 2011.

Lake	Year of Study	Number of Tags	Tags Returned as of 12/31	Number of different anglers	Corrected Exploitation Rate	Percent Idaho Resident
Hauser	2011	120	1	1	0%	0
Fernan	2011	105	3	3	4%	100
Cocolalla	2011	104	0	N/A	0%	N/A
Jewel	2011	10	0	N/A	0%	N/A

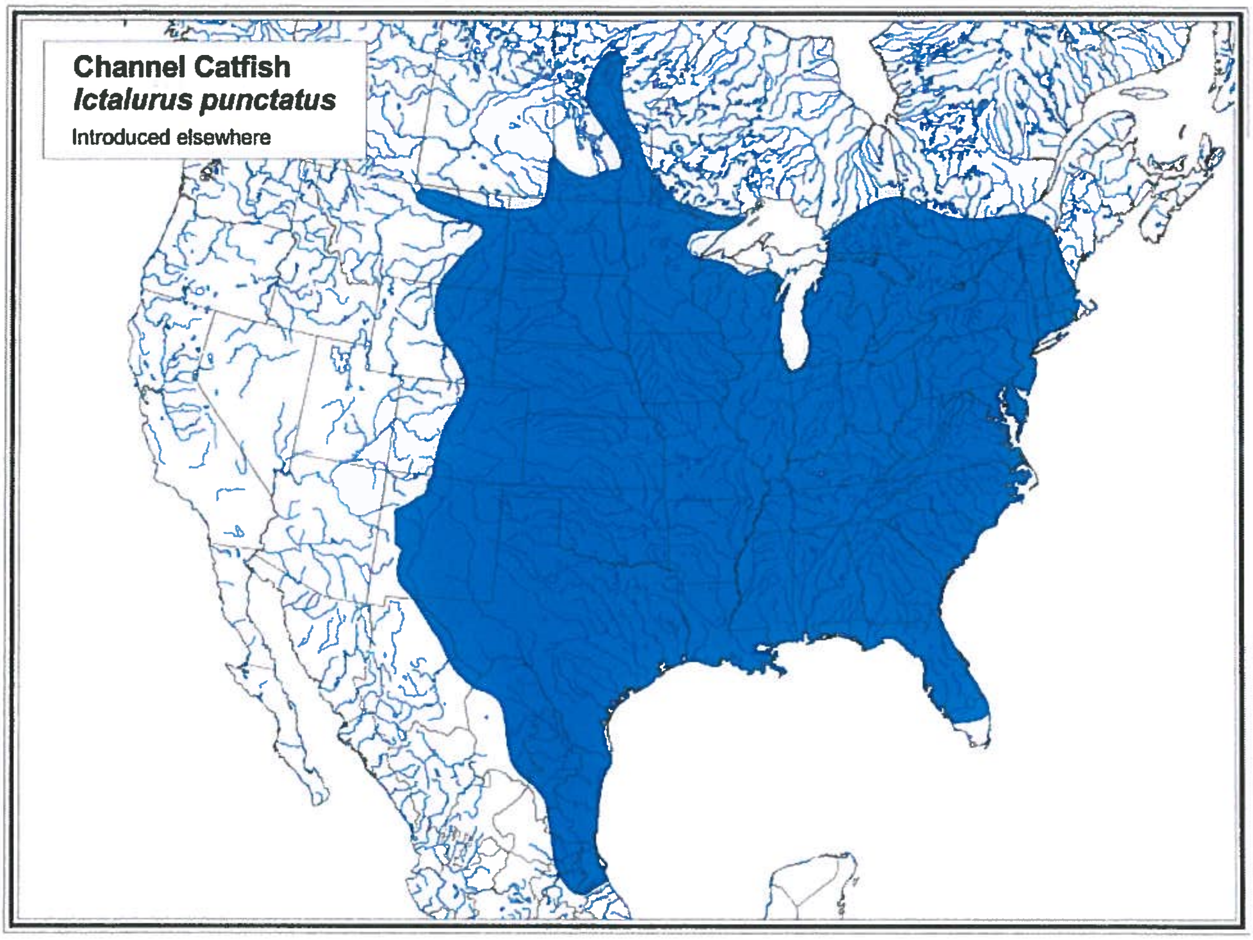


Figure 1. North American distribution of channel catfish native range (map courtesy of the Florida Museum of Natural History, Gainesville Florida).

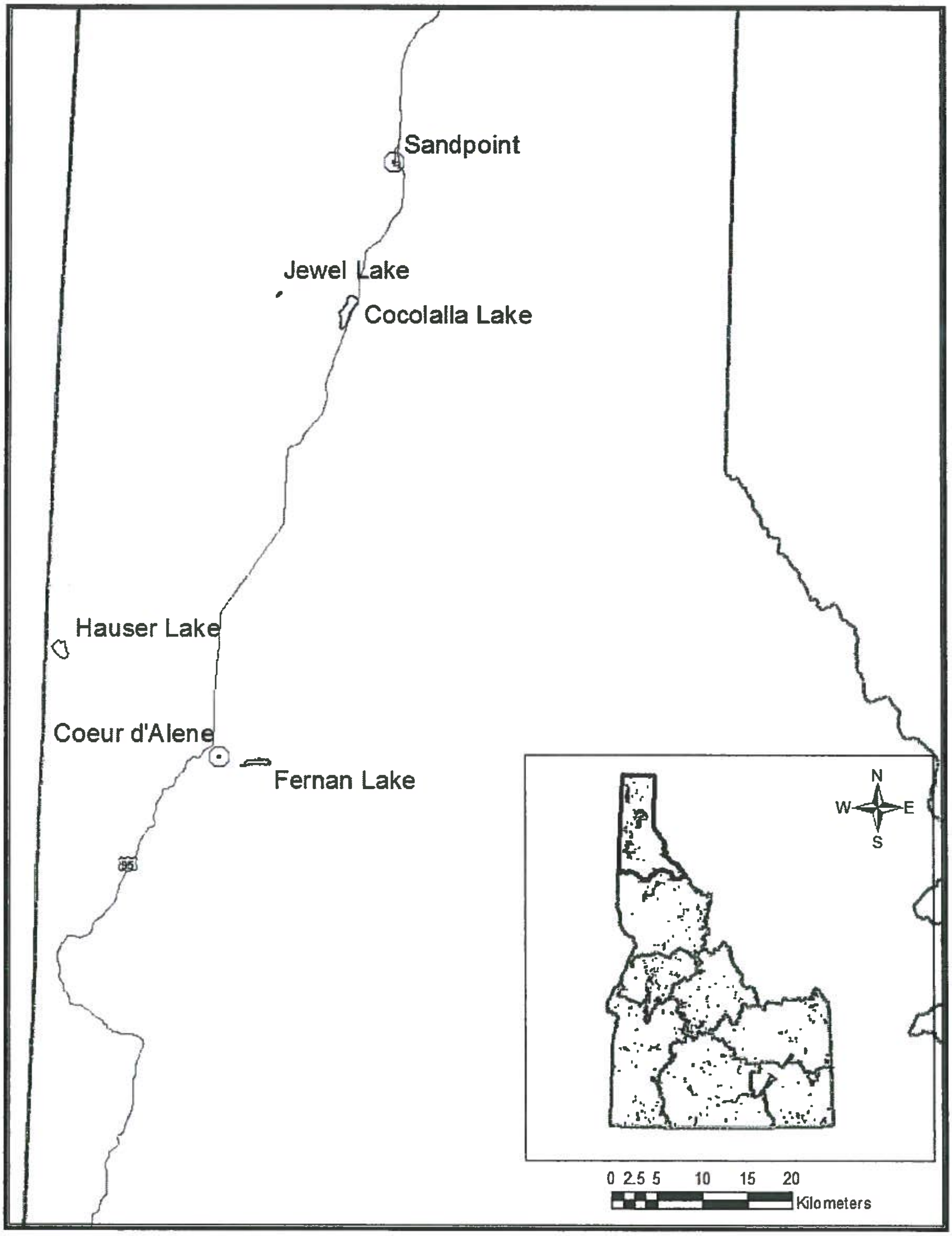


Figure 2. Map of Panhandle Region lakes included in 2011 channel catfish evaluation.

Figure 3. Illustration of typical hoop net series (HNS) used during 2011 channel catfish evaluation.

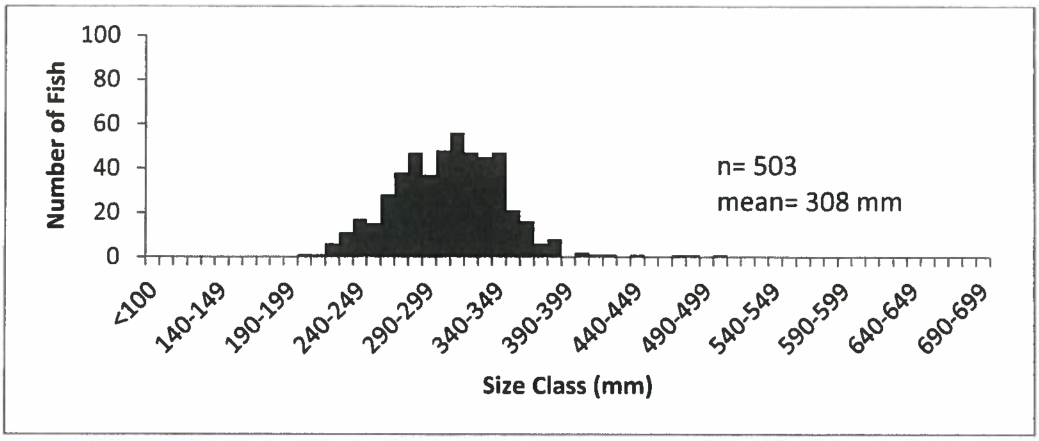


Figure 4a. Length frequency of channel catfish collected in baited hoop nets in Hauser Lake, Idaho in 2011.

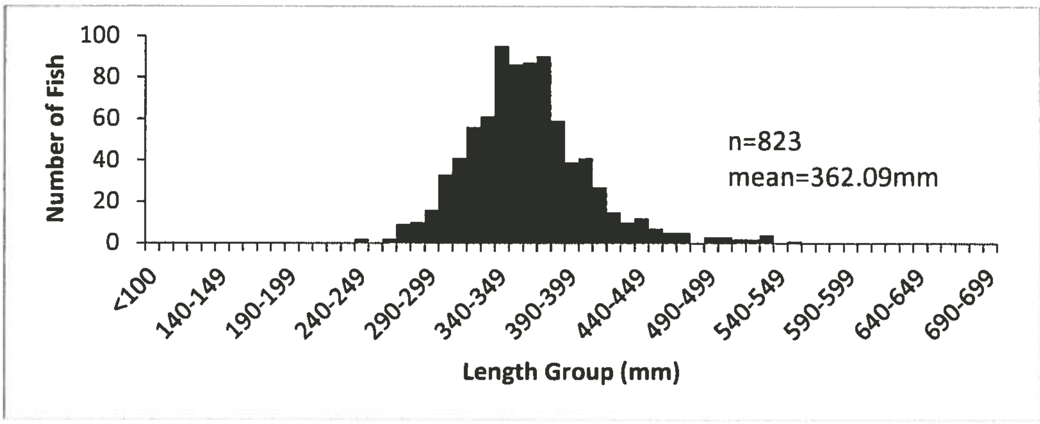


Figure 4b. Length frequency of channel catfish collected in baited hoop nets in Fernan Lake, Idaho in 2011.

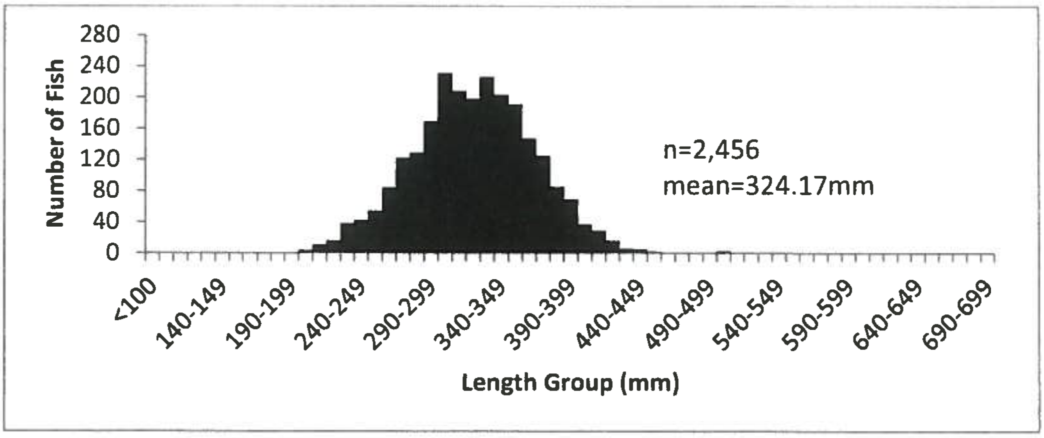


Figure 4c. Length frequency of channel catfish collected in baited hoop nets in Cocolalla Lake, Idaho in 2011.

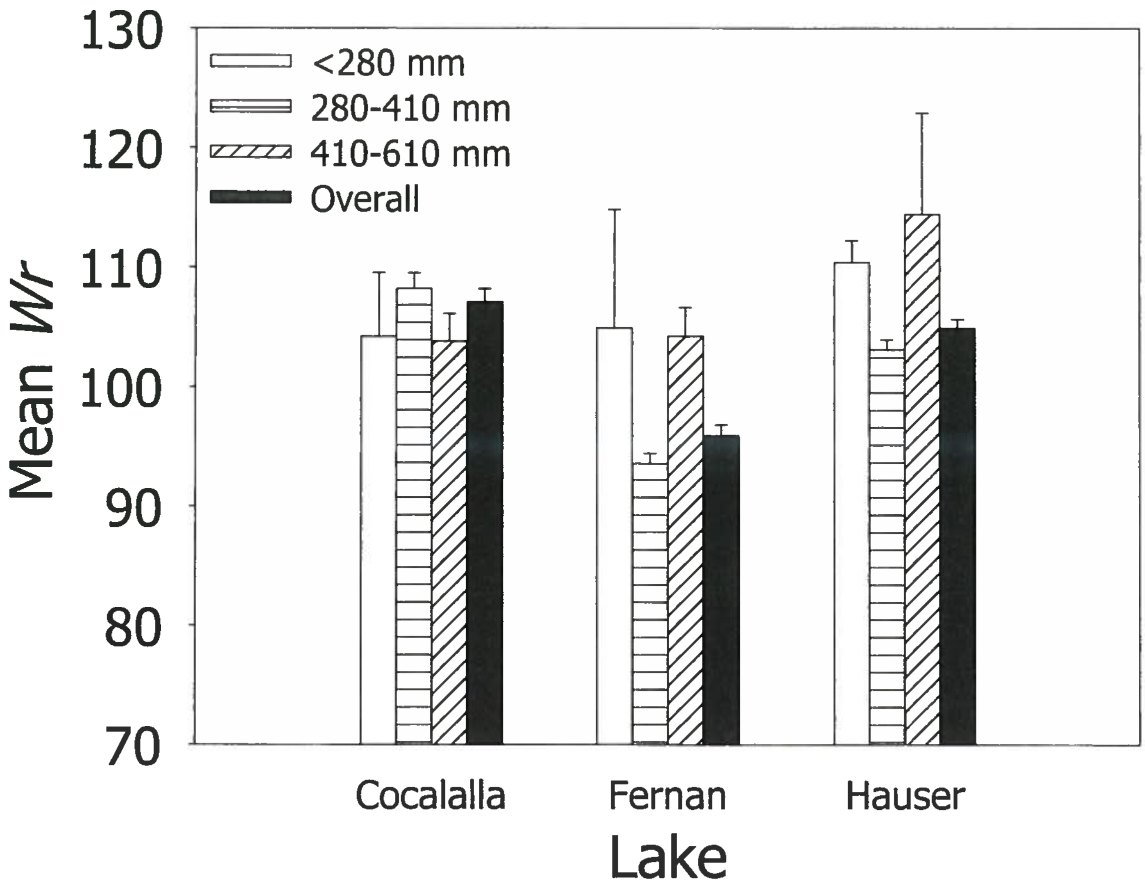


Figure 5. Mean relative weight (Wr) of sub-stock, stock to quality and quality to preferred length channel catfish in Cocolalla, Fernan and Hauser Lakes, Idaho in 2011.

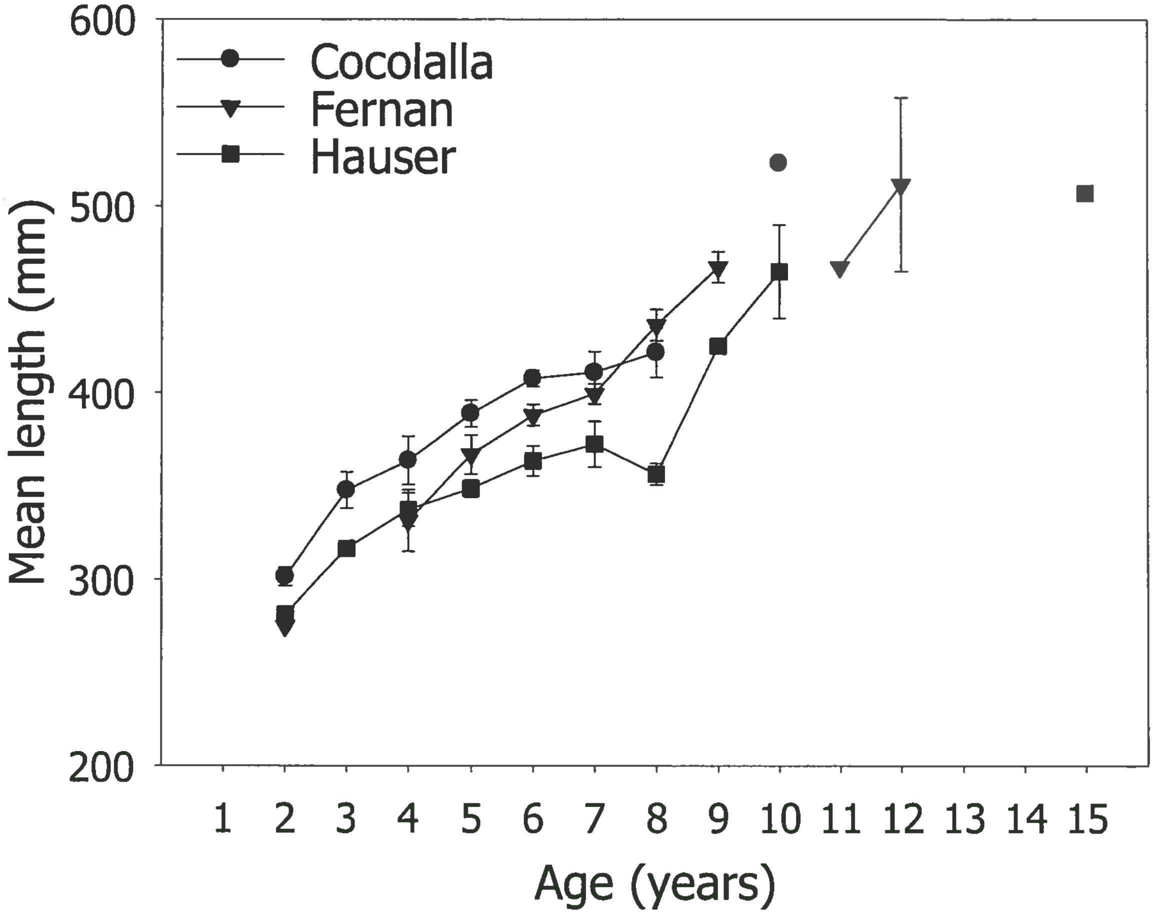


Figure 6. Mean length-at-age (at capture) of channel catfish in Cocolalla, Fernan and Hauser Lakes, Idaho in 2011.

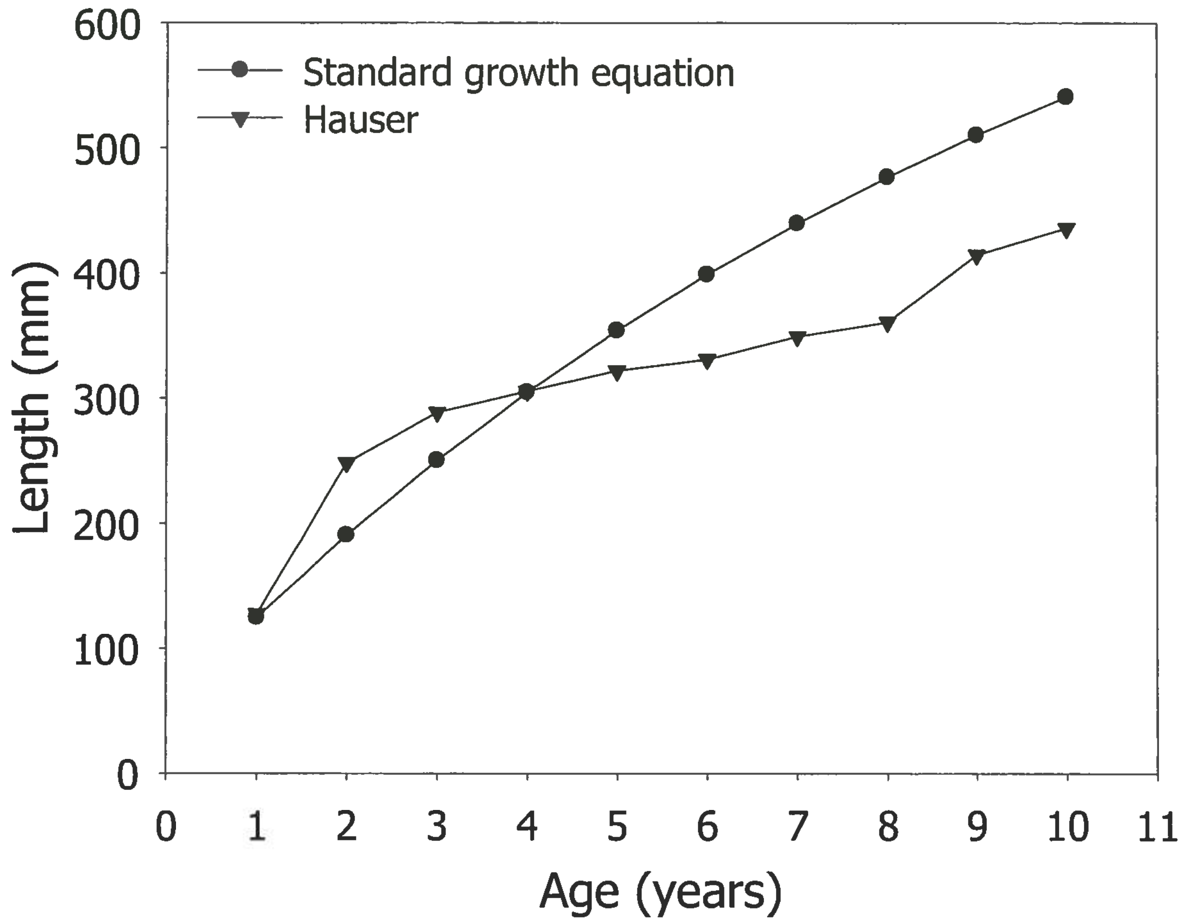


Figure 7. Back calculated length-at-age of channel catfish in Hauser Lake, Idaho in 2011 compared to predicted length-at-age (based on the Von Bertalanffy growth equation) for North American channel catfish.

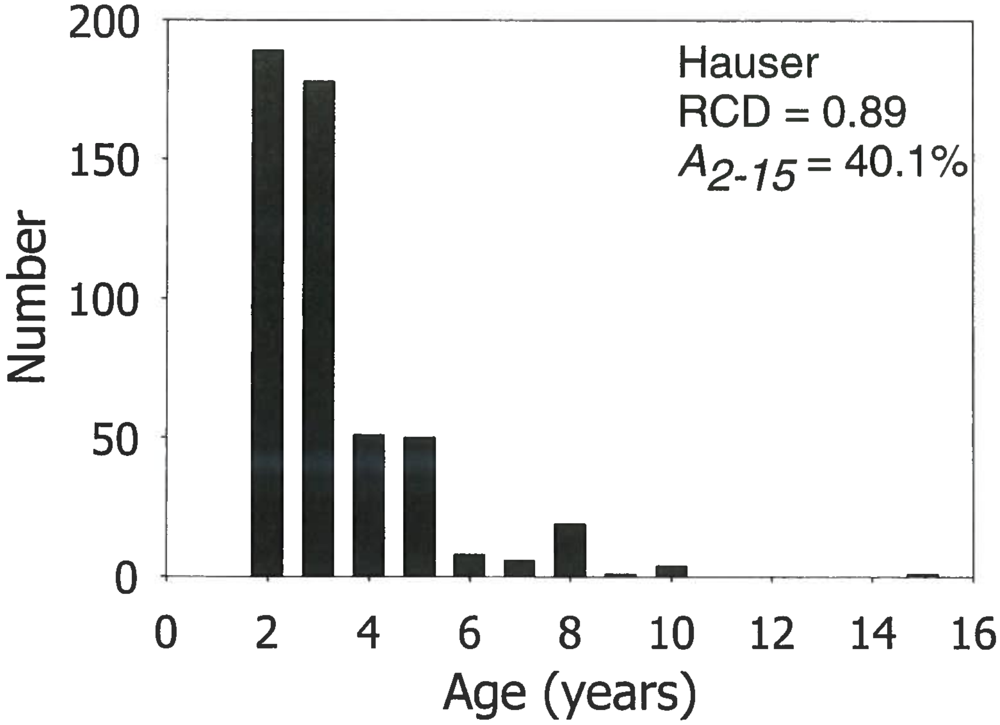


Figure 8. Weighted catch curve representing the age distribution of channel catfish in Hauser Lake, Idaho in 2011.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 2: COEUR D'ALENE LAKE FISHERY INVESTIGATIONS

ABSTRACT

Coeur d'Alene Lake provides one of Idaho's most popular kokanee *Oncorhynchus nerka* fisheries and one of its best fisheries for resident Chinook salmon *O. tshawytscha*. However between 1997 and 2008 adult kokanee density declined to critically low levels (generally < 10/ha) forcing the closure of the kokanee fishery during some falls to protect spawning fish and requiring a reduced creel limit of six kokanee/day. Steady improvements in kokanee abundance were documented in 2009, 2010, and 2011, due in part to management efforts to reduce predation. During 2011, kokanee densities increased 72% by hydroacoustics and 52% by trawling from the 2010 estimates. Kokanee densities are now the highest they have been since 1996, and should easily be able to support a year-round kokanee fishery with its current 15 fish/day limit. With the improvements in the kokanee population, we stocked 20,000 fingerling Chinook salmon into Coeur d'Alene Lake for the third straight year. All fish were marked with an adipose fin clip and a coded wire tag. No tagged Chinook salmon were recorded during fishing derbies held on the lake, although salmon stocked in 2009 may still be too small to be entered in derbies. Also, no Chinook salmon redds were destroyed and a minimum 20 inch size limit went into effect in 2011. Both of these actions may increase Chinook salmon predation on kokanee.

Authors:

Melo Maiolie
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Kokanee *Oncorhynchus nerka* are one of the most important sport fish species in the Panhandle Region. Populations have been established in all the larger lakes and several of the smaller lakes are stocked annually. Kokanee first established in Lake Pend Oreille in the 1930's by emigrating down the Clark Fork River from Flathead Lake, Montana. Kokanee were stocked into Flathead Lake in 1916 and were originally from wild stocks from Lake Whatcom, Washington. Once kokanee were established in Lake Pend Oreille, Idaho Department of Fish and Game (IDFG) transplanted them to Coeur d'Alene, Spirit, and Priest Lakes in the 1930's and 1940's. Self-sustaining populations were soon established and kokanee fisheries typically provided 50% to 90% of the angling effort in the large northern Idaho lakes. The Lake Whatcom stock of kokanee are described as "late spawners" typically using shoreline gravel rather than tributary streams and spawning from November through early January.

The kokanee fishery in Coeur d'Alene Lake peaked in 1979 with 578,000 fish harvested and remained at 120,000 to 239,000 kokanee harvested during the 1980's (Rieman and LaBolle 1980; Fredericks et al. 1997). Fall Chinook salmon *O. tshawytscha* were introduced into Coeur d'Alene Lake in 1982 as a biological tool to reduce kokanee abundance and increase their size at harvest. Fall Chinook salmon were chosen as the preferred predator for a variety of reasons: their relatively short and semelparous life cycle compared to other species (lake trout *Salvelinus namaycush*, Kamloops rainbow trout *O. mykiss*, walleye *Stizostedion vitreum*, brown trout *Salmo trutta*); ability to manage the predators numbers; and the benefit provided by a Chinook salmon fishery. Chinook salmon have established a naturally reproducing population by spawning in the Coeur d'Alene and St. Joe river systems. Both naturally produced and hatchery stocked Chinook salmon are used to achieve the desired density of these predators.

Adult kokanee densities were below the desired range of 30 to 50 fish/ha since the high run-off year of 1996. Based on trawling, age 3 kokanee densities were below 10 fish/ha in 8 of the 11 years of data between 1997 and 2008, and were at 3 fish/ha in 2006, 2007 and 2008. Our concern was that Chinook salmon predation was impacting, rather than benefiting, the kokanee fishery. Efforts to improve the predator-prey balance included not stocking Chinook salmon in 2007 and 2008, attempting to limit wild Chinook salmon spawning to 100 redds, reducing the kokanee limit to 6 fish, and closing the kokanee fishery during some falls to limit the harvest of spawning fish. In 2009 and 2010, we documented a very pronounced increase in the kokanee population as adult abundance increased to 35 and 52 adults/ha, respectively. This report covers IDFG's efforts to monitor kokanee and Chinook salmon in 2011, and manage both populations to improve the sport fishery in Coeur d'Alene Lake.

OBJECTIVES

Idaho Fish and Game's objectives for the management of Coeur d'Alene Lake are to manage "for a kokanee yield fishery and limited Chinook salmon trophy fishery" (IDFG 2008). Chinook salmon management direction is for greater catches of 1.5-9 kg fish rather than fewer but larger fish (11+ kg) (IDFG 2008).

To accomplish these objectives, we worked on several tasks. We monitored the kokanee population by both trawling and hydroacoustics to determine if kokanee were near the densities needed for a good yield fishery. We counted Chinook salmon redds in tributaries to the lake as an index of salmon abundance. We also continued our test to determine the best time to stock hatchery Chinook salmon by tagging and releasing hatchery produced fish during September and June. Our hope was to find a way to improve the initial survival of stocked

Chinook salmon. Lastly, we graphed the relationship between the number of Chinook salmon stocked and the resulting number of kokanee adults to attempt to develop a method for better balancing our stocking program with the kokanee population.

STUDY AREA

Coeur d'Alene Lake is located in northern Idaho near the town of Coeur d'Alene. It is a natural lake of 12,742 ha with 9,648 ha of pelagic habitat used by kokanee. The native sportfish within the lake are bull trout *Salvelinus confluentus*, westslope cutthroat trout, and mountain whitefish *Prosopium williamsoni*. Introduced fish species include kokanee, Chinook salmon, rainbow trout *Oncorhynchus mykiss*, brook trout *Salvelinus fontinalis*, largemouth bass *Micropterus salmoides*, smallmouth bass *Micropterus dolomieu*, pumpkinseed *Lepomis gibbosus*, bluegill *Lepomis macrochirus,* green sunfish *Lepomis cyanellus*, yellow perch *Perca flavescens*, black crappie *Pomoxis nigromaculatus*, brown bullhead *Ameiurus nebulosus*, black bullhead *A. melas*, channel catfish *Ictalurus punctatus*, and northern pike *Esox lucius*.

METHODS

Kokanee Estimates by Trawling

We used a midwater trawl, as described by Bowler et al. (1979), and Rieman (1992), and modified to a fixed-frame trawl in 2003 (Maiolie et al. 2004), to estimate the kokanee population in Coeur d'Alene Lake. The net was 2.2 m wide by 3.01 m tall by 10.5 m long and was towed through the water at a speed of 1.79 m/s by an 8.8 m boat. Twenty transects were trawled on Coeur d'Alene Lake during the dark phase of the moon on August 1 and 2, 2011. Trawl transects were in the same locations as the previous year (Figure 1), however two transects at the southern end of the lake were omitted since most kokanee were within 3 m of the lake's bottom. Data were analyzed as a stratified systematic sampling design. Densities of kokanee within each lake section were averaged to determine an arithmetic mean and multiplied by the area of that section to determine the section's abundance. Ninety percent confidence limits were placed around the estimates based on techniques for stratified systematic sampling. Kokanee total lengths were measured within a 10 mm size group, weighed, and scales were collected from representative length groups for age analysis. Whole scales were placed between glass slides with a drop of water and examined under a microscope to determine ages.

Because trawling was conducted in August and because Coeur d'Alene Lake kokanee may grow substantially between August and late November when they spawn, experimental gill nets were used to capture adults during spawning. Kokanee were netted on December 1, 2011. The gill net was set near Higgins Point for about 20 min. Potential egg deposition (PED) was estimated as the number of female kokanee spawners (half the mature population based on midwater trawling) multiplied by the average number of eggs produced per female. The average number of eggs produced per female kokanee was calculated using the length to fecundity regression in Rieman 1992.

We used the trawl estimates to calculate the mean annual mortality rate of kokanee in Coeur d'Alene Lake. A catch curve was built using trawl abundance estimates of each cohort of kokanee as it grew from age-0 to age-3. FAST software was used to calculate the average mortality rate for the specific cohort.

Kokanee Estimates by Hydroacoustics

We conducted a lake-wide, mobile, hydroacoustic survey on Coeur d'Alene Lake to monitor the kokanee population. This was the fourth hydroacoustic survey done on this lake. The survey was conducted on the nights of August 8 and 9, 2011. We used a Simrad EK60 split-beam, scientific echosounder with a 120 kHz transducer to estimate kokanee abundance. Ping rate was set at 0.2 s/ping. A pole-mounted transducer was located 0.52 m below the surface, off the port side of the boat, and pointed downward. The echosounder was calibrated prior to the survey using a 23 mm copper calibration sphere to set the gain and to adjust for signal attenuation to the sides of the acoustic axis. We used Simrad's ER60 software to determine, and input, the calibration settings.

The lake was divided into four sections for this survey. Wolf Lodge Bay was separated into its own section, like last year, since past surveys showed it contained unusually high densities of kokanee fry. We followed a uniformly spaced, zigzag pattern of 21 transects traveling from shoreline to shoreline (Figure 9). The zigzag pattern was used to maximize the number of transects that could be completed in one night. Also, this pattern follows the general rule of using a triangular design (zigzags) when the transect length is less than twice the transect spacing (Simmonds and MacLennan 2005). The starting point of the first transect in each section was chosen randomly. Boat speed was approximately 1.3 m/s at the northern end of the lake (sections 1A and 1B) and 2.2 m/s in the remained of the lake (boat speed did not affect our calculations of fish density).

We determined kokanee abundance using echo integration techniques. SonarData's Echoview software, version 4.9, was used to view and analyze the collected data. A box was drawn around the kokanee layer on each of the echograms and integrated to obtain the nautical area scattering coefficient (NASC) and analyzed to obtain the mean target strength of all returned echoes. This integration accounted for fish that were too close together to detect as a single target (MacLennan and Simmonds 1992). Densities were then calculated by the equation:

$$\text{Density (fish/ha)} = (\text{NASC} / 4\pi 10^{TS/10})\ 0.00292$$

where:

NASC is the total backscattering in m^2/nautical mile^2, and
TS is the mean target strength in dB for the area sampled.

Two methods were used to split the hydroacoustic density estimate into population estimates of each age class of kokanee. In the northern sections of the lake (sections 1A and 1B), fry were split from older age classes of kokanee based on *in-situ* target strengths. A clear break in the target strength – frequency distribution was seen at -47 dB [approximately 80 mm total length (Love 1971)] and therefore fry were defined as targets between -60 dB and -47 dB. Kokanee of age classes 1 to 3 were defined as those targets between -46.9 and -33.0 dB. The arithmetic average density of these targets in each section were split into ages 1 to 3 based on the proportions of these age classes in trawl catch for that section.

In the middle and southern sections of the lake, the arithmetic mean density estimate of all kokanee by hydroacoustics (-60 dB to -33 dB) was split into the density of each age class based on its proportion in the trawl catch for that section. Kokanee fry in these sections of the lake comprised a low percentage of the trawl catch. Using -47 dB as a maximum target strength for fry would have overestimated fry abundance. We therefore felt that using the percentage of each age class in the trawl catch times the hydroacoustic density estimate for all fish was the more appropriate technique.

To determine a total population estimate for kokanee, the density estimates of each age class of kokanee in each section, were multiplied by area of each section and summed for the entire lake.

The results of the hydroacoustic surveys in 2010 and 2011 were used to calculate a production estimate of the kokanee population by two different methods. The methods included the Summation Method and the Instantaneous Growth Rate Method as described in Hayes et al. (2007). The calculation interval for both methods was between the hydroacoustic sampling in August 2010 and the sampling in August 2011.

Chinook Salmon Stocking Tests

During 2009, 2010, and 2011 we stocked Chinook salmon during June and September as a test to determine the best stocking strategy. Eggs from Tule Fall Chinook salmon were obtained from the Big Creek Hatchery located 16 miles east of Astoria, Oregon. Eggs were hatched and reared to size at the Nampa Fish Hatchery before being transported to Coeur d'Alene Lake. All of the salmon fingerlings were given an adipose fin clip and had a coded wire tag inserted into their snout. About 10,000 fingerling Chinook salmon were stocked in each of the two months (Table 8). All of the Chinook salmon were released at the Mineral Ridge boat ramp in Wolf Lodge Bay at the northeastern side of the lake. Size at release varied with the date of release, i.e. larger fingerlings were stocked in September than in June. The test is therefore to compare the survival rate of smaller fish in June to that of larger fish in September.

Chinook Salmon to Kokanee Correlations

In past years we found a correlation between the number of adult kokanee and the number of Chinook salmon stocked 2 and 3 years earlier (Maiolie et al., 2011). Data from 2011 was added to define the correlation. We concentrated on only the recent data, since 1997, to allow for potential changes to the system such as low kokanee abundance in the post-flood years, and a potential increase in wild Chinook salmon. Data plots and correlation coefficients and were made using Window's Office PowerPoint 2007.

Chinook Salmon Redd Counts

Each year since 1990 we monitored the spawning of wild Chinook salmon in tributaries to Coeur d'Alene Lake. No Department personnel participated in the survey in 2011. Instead, we hired a pilot and co-pilot to fly a helicopter (Hughes H500 C) and count salmon redds in the Coeur d'Alene River, North Fork Coeur d'Alene River, South Fork Coeur d'Alene River, and Little North Fork Coeur d'Alene River on October 10, 2011. The St. Joe River was not counted in 2011. We also floated two sections of the North Fork Coeur d'Alene River and counted salmon redds. The total number of redds during 2011 was estimated using a proportion of the redds in the Coeur d'Alene River to the total count over the last 5 years. We estimated the natural smolt production from the redd counts by assuming an estimate of 4,000 eggs per redd, and a mean egg-to-smolt survival of 10%. No redds were destroyed in 2011 as had been done in some previous years.

RESULTS

Kokanee Estimates by Trawling

Based on trawling, we estimated Coeur d'Alene Lake contained 3,049,000 (± 71%), 1,186,000 (± 29%), 1,503,000 (± 58%), and 767,000 (± 52%) kokanee of ages 0, 1, 2, and 3, respectively (Table 9). Density of age 3 kokanee was calculated at 80 fish/ha. Standing stock was estimated at 17.4 kg/ha with a total population biomass of 168 metric tonnes (t); (Table 10). Survival rates from 2010 to 2011 were 180%, 69%, and 48% for age 0 to 1, 1 to 2 and 2 to 3, respectively, based on our trawl calculations.

Kokanee fry collected in the trawl had modal lengths of 40 mm, 110 mm, 170 mm, and 230 mm, for kokanee of ages 0, 1, 2, 3, respectively (Figure 10). Weights of the same four age groups were 0.5, 12.1,48.1, and 102.4 g. Mean weights of age-1 kokanee collected at the southern end of the lake were 36% larger than the same age class at the northern end of the lake (14.25 versus 10.46 g).

We collected 49 mature kokanee near Higgins Point in Wolf Lodge Bay in a 10 minute gillnet set on December 17, 2011. Mean length of female kokanee was 264 mm (TL), (n=29). Males averaged 273 mm (n=20). Total length of both sexes was very similar to last year, but smaller than the previous five years (Figure 11). Mean fecundity was estimated at 507 eggs per female based on their size (Rieman 1992). Most kokanee matured at age 3. Assuming a 50:50 male to female ratio, the lake contained 383,500 mature females during 2011. At this fecundity, potential egg deposition was estimated at 195 million eggs. Survival of the 117.2 million kokanee eggs laid in 2010 to the 3.0 million fry in 2011 was calculated at 2.6% based on trawling (Table 11).

Mean annual mortality rate for the cohort of kokanee that reached age-3 in 2011 was estimated at 34% (r^2=0.90, Figure 12). This was a sharp improvement from the 87% mean annual mortality of the cohort that matured in 2008, and was the lowest annual mortality rate since 1995 (Figure 12).

Kokanee Estimates by Hydroacoustics

Hydroacoustic estimates for Coeur d'Alene Lake were also calculated for 2011. We found the lake contained 10,847,000 kokanee fry (1,124/ha), 2,610,000 age-1 kokanee (271/ha), 2,868,000 age-2 kokanee (297/ha), and 1,596,000 age-3 kokanee (165/ha). Total abundance was 17,921,000 kokanee (1,857/ha) (Tables 12 and 13).

The highest densities of kokanee fry were found at the northern end of the lake particularly in Wolf Lodge Bay (Table 12). Most of the kokanee spawning is believed to occur along road fills in this bay, and it appeared that most of the fry remained in the northern sections of the lake throughout the summer. Only low densities of fry were found in the middle and southern sections.

Kokanee abundance varied by lake section. The highest abundance estimates for age-1 to age-3 kokanee were found in the middle section of the lake. We estimated this section contained 1.3 million age-1 kokanee, 2.3 million age-2 kokanee and 1.3 million age-3 kokanee (Table 12).

Target strengths of kokanee at the northern end of Coeur d'Alene Lake formed a clearly bimodal distribution (Figure 14). These data gave a clear level to break fry from older age classes of kokanee at a target strength of -47 dB. We used this decibel level to separate kokanee fry on the northern end of the lake, but used the percentage of fry in the trawl to enumerate fry in the central and southern ends of the lake.

We calculated survival rates of kokanee based on the changes between last year's and this year's hydroacoustic survey results. From age-0 to age-1, age-1 to age-2, and age-2 to age-3, we estimated survival at 64%, 93%, and 52%, respectively (Table 14). Annual mortality for the cohort that reached age-3 in 2011 was calculated at 42% based on the analysis of a catch-curve (Figure 13).

Chinook Salmon Stocking Tests

No coded wire tagged Chinook salmon were turned in by anglers during 2011. Also, during the "Big One Chinook Derby" and the "Members-Only Derby" none of the weigh masters reported seeing any Chinook salmon with adipose fin clips even though they were personally contacted and instructed to watch for them.

Chinook Salmon to Kokanee Correlations

Two regressions were described last year that had good correlations between Chinook salmon stocking and adult kokanee abundance (Maiolie et al. 2011). Our best correlation was between the number of age-3 kokanee and the number of Chinook salmon stocked 2 and 3 years previous (r^2= 0.63, based on a linear relationship) (Figure 15). Adult kokanee abundance from this year was higher than expected based on this correlation. We suspect that the relationship may change depending on the number of kokanee in other cohorts that may help to buffer predation on any year class. A second good correlation was found between the number of age-3 kokanee and the number of Chinook salmon stocked 2 years previous plus half the number of salmon stocked 3 years previous (r^2= 0.51) (Figure 16). This regression takes into account that the Chinook salmon stocked three years previous were still present in the lake, but reduced by mortality. Again the point for 2011 is higher than expected based on this correlation.

Chinook Salmon Redd Counts

Salmon redds were counted by a combination of aerial surveys and ground counts. We found 91 Chinook salmon redds in the Coeur d'Alene River between the mouth of the Little North Fork and the Cataldo boat ramp during our ground surveys (Table 15). Aerial survey found another 24 redds in this drainage. The St. Joe River drainage was not surveyed in 2011. Based on the proportion of redds seen in the St. Joe River versus the Coeur d'Alene River over the last 5 years, we estimated the total number of redds would have been about 134 (Table 15). We did not attempt to destroy any of the redds, and therefore estimated roughly 53,600 smolts would be produced naturally (Table 16). The trend in wild Chinook salmon spawning since the flood year of 1996 appeared to be increasing in a linear fashion, at a rate of nine additional redds/year (Figure 17). The trend since the redd counts began in 1990 shows a rate of increase of three redds/year (Figure 17).

DISCUSSION

Kokanee Population Estimates

Kokanee abundance in Coeur d'Alene Lake has increase greatly over the last 3 years. The pronounced change can be seen in estimates made by both trawling and hydroacoustics (Tables 9 and 13). For example, by trawling the number of age-3 kokanee increased from 3 to 35 to 52 to 80 fish/ha during the years from 2008 to 2011, respectively (Table 9). With hydroacoustics, the number of adults/ha increased from 4 to 61 to 96 to 165 over the same time span. This change has taken the population from the point where it appeared to be on the brink of collapse, to the point where kokanee now exceed our general guideline of having 30-50 kokanee adults/ha (Rieman and Maiolie 1995). The improved densities of kokanee allow us to manage for an increase in the Chinook salmon population as well as for an increase in kokanee harvest.

We attribute this pronounced increase in the population mostly to two factors. First, the lack of Chinook salmon stocking in 2007 and 2008 should have reduced predation. This fits the correlation between the numbers of Chinook salmon stocked and the resulting abundance of adult kokanee seen in Figures 15 and 16. In addition, the increase in survival of kokanee from age-2 to age-3 also suggested a decline in predation as the reduced year classes of Chinook salmon matured (Table 14).

Secondly, 2011 appeared to be an excellent year for kokanee populations in other lakes as well. Spirit Lake (see Spirit Lake chapter of this report), Priest Lake and Lake Pend Oreille all had marked improvements in kokanee abundance. The cause of these simultaneous improvements is currently unknown, however, it suggested factors such as weather or runoff conditions.

Chinook Salmon to Kokanee Correlations

The trend between Chinook salmon stocking and the abundance of adult kokanee remained reasonable good with the addition of the 2011 data (Figure 15 and 16). In both cases the 2011 kokanee data was higher than predicted. We suspect this may be due to the number of kokanee in the lake in other year classes adjacent to the one being plotted. For example, a year class of kokanee will have higher abundance at a given level of predation if other year classes of kokanee in the lake are high and help to buffer predation.

During 2009, 2010, and 2011, we tested a fall stocking of Chinook salmon that were released in Wolf Lodge Bay. To date, none of the hatchery fish have shown up in the fishery. Angler catch should be monitored over the next several years as these fish mature. This should give a clear indication of the relative proportions of hatchery and wild fish.

We recommend a moderate stocking of 20,000 Chinook salmon in 2012. Keeping the stocking level constant for several years will help us to see the amount of annual variation in the kokanee population. The moderate stocking level also seemed appropriate given that kokanee abundance was somewhat high but wild Chinook salmon appeared to be increasing (Figure 17).

MANAGEMENT RECOMMENDATIONS

1. Publicize the kokanee fishery in Coeur d'Alene Lake to see if fishing pressure can be increased on these stronger year classes of kokanee.

2. Sample the harvest of Chinook salmon in 2012 to look for adipose clipped fish and evaluate the two stocking strategies.

3. Stock a limited number (about 20,000) of Chinook salmon in Wolf Lodge Bay in 2012. Salmon should be marked with adipose fin clips and coded wire tags, and released during June and September to continue the test of stocking methods.

4. Closely monitor kokanee and Chinook salmon redds to note any indication that the wild population of Chinook salmon is increasing.

Table 8. List of tagged Chinook salmon stocked in Coeur d'Alene Lake during 2009, 2010 and 2011 as a test to determine the best month and size for stocking.

Date stocked	Number of Chinook salmon stocked	Tag Code	Fin Clip	Mean length at stocking (total length in mm)	Mean weight (g)
6/3/09	10,570	10-63-70,10-74-04	Adipose	135	28
6/3/09	127	none	Adipose		
9/9/09	10,936	10-92-71	Adipose	180	65
9/9/09	617	none	Adipose		
6/21/10	10,300	10-90-70, 10-91-71	Adipose	150	40
9/15/10	10,121	10-34-80,10-8- 72	Adipose	194	87
6/27/11	10,000	10-48-73 and 10-34-27	Adipose	178	28
10/4/11	10,132	10-01-53	Adipose	171	57

Table 9. Estimated abundance of kokanee made by midwater trawl in Coeur d'Alene Lake, Idaho, from 1979-2011. To follow a particular year class of kokanee, read right one column and up one row.

Sampling Year	Age Class				Total	Age 3/ha
	Age 0	Age 1	Age 2	Age 3/4		
2011	3,049,000	1,186,000	1,503,000	767,000	6,505,000	80
2010	660,400	2,164,100	1,613,300	506,200	4,943,900	52
2009	731,600	1,611,800	2,087,400	333,600	4,764,400	35
2008	3,035,000	3,610,000	1,755,000	28,000	8,428,000	3
2007	3,603,000	2,367,000	136,000	34,000	6,140,000	3
2006	7,343,000	1,532,000	91,000	33,900	8,999,000	3
2005	-	-	-	-	-	-
2004	7,379,000	1,064,000	141,500	202,400	8,787,000	21
2003	3,300,000	971,000	501,400	182,300	4,955,000	19
2002	3,507,000	934,000	695,200	70,800	5,207,000	7
2001	7,098,700	929,900	193,100	25,300	8,247,000	3
2000	4,184,800	783,700	168,700	75,300	5,212,600	8
1999	4,091,500	973,700	269,800	55,100	5,390,100	6
1998	3,625,000	355,000	87,000	78,000	4,145,000	8
1997	3,001,100	342,500	97,000	242,300	3,682,000	25
1996	4,019,600	30,300	342,400	1,414,100	5,806,400	146
1995	2,000,000	620,000	2,900,000	2,850,000	8,370,000	295
1994	5,950,000	5,400,000	4,900,000	500,000	12,600,000	51
1993	5,570,000	5,230,000	1,420,000	480,000	12,700,000	50
1992	3,020,000	810,000	510,000	980,000	5,320,000	102
1991	4,860,000	540,000	1,820,000	1,280,000	8,500,000	133
1990	3,000,000	590,000	2,480,000	1,320,000	7,390,000	137
1989	3,040,000	750,000	3,950,000	940,000	8,680,000	98
1988	3,420,000	3,060,000	2,810,000	610,000	10,900,000	63
1987	6,880,000	2,380,000	2,920,000	890,000	13,070,000	93
1986	2,170,000	2,590,000	1,830,000	720,000	7,310,000	75
1985	4,130,000	860,000	1,860,000	2,530,000	9,370,000	263
1984	700,000	1,170,000	1,890,000	800,000	4,560,000	83
1983	1,510,000	1,910,000	2,250,000	810,000	6,480,000	84
1982	4,530,000	2,360,000	1,380,000	930,000	9,200,000	97
1981	2,430,000	1,750,000	1,710,000	1,060,000	6,940,000	110
1980	1,860,000	1,680,000	1,950,000	1,060,000	6,500,000	110
1979	1,500,000	2,290,000	1,790,000	450,000	6,040,000	46

Table 10. Kokanee population estimates and standing crop (kg/ha) in each section of Coeur d'Alene Lake based on trawl sampling on August 1 and 2, 2011.

Section	Age-0	Age-1	Age-2	Age-3	Standing Stock (kg/ha)
1	2,672,000	266,000	422,000	181,200	19.9
2	366,000	592,000	993,000	536,800	19.4
3	11,000	328,000	88,000	49,300	7.8
Whole lake total	3,049,000	1,186,000	1,503,000	767,300	17.42
90% confidence limits as a percent	71%	30%	58%	80%	

Table 11. Estimates of female kokanee spawning escapement, potential egg deposition, fall abundance of kokanee fry, and their subsequent survival rates in Coeur d'Alene Lake, Idaho, 1979-2009. All data were based on trawl sampling.

Year	Estimated female escapement	Estimated potential number of eggs ($x10^6$)	Fry estimate the following year ($x10^6$)	Percent egg to fry survival
2011	383,600	195		
2010	253,100	117	3.05	2.6
2009	48,540	25	0.66	2.6
2008	13,852	10	0.75	7.8
2007	17,100	13	3.04	23.4
2006	16,900	12	3.60	28.9
2005	-[a]	-[a]	7.34	-[a]
2004	101,000	76	-[a]	-[a]
2003	91,000	62	7.38	12.0
2002	35,000	25	3.30	13.2
2001	12,650	10	3.50	34.0
2000	37,700	32	7.10	22.2
1999	28,000	19	4.18	22.6
1998	39,000	26	4.09	15.7
1997	90,900	54	3.60	6.67
1996	707,000	358	3.00	0.84
1995	1,425,000	446	4.02	0.90
1994	250,000	64	2.00	0.31
1993	240,000	92	5.95	6.46
1992	488,438	198	5.57	2.81
1991	631,500	167	3.03	1.81
1990	657,777	204	4.86	1.96
1989	516,845	155	3.00	1.94
1988	362,000	119	3.04	2.55
1987	377,746	126	3.42	2.71
1986	368,633	103	6.89	6.68
1985	530,631	167	2.17	1.29
1984	316,829	106	4.13	3.90
1983	441,376	99	0.70	0.71
1982	358,200	120	1.51	1.25
1981	550,000	184	4.54	2.46
1980	501,492	168	2.43	1.45
1979	256,716	86	1.86	2.20

[a] No estimate could be made due to missing trawl data in 2005.

Table 12. Kokanee population estimates in each section of Coeur d'Alene Lake based on hydroacoustic sampling on August 9, 2011.

Section	Age-0	Age-1	Age-2	Age-3	Total
1A	1,799,900	37,900	109,800	29,300	1,976,900
1B	8,165,300	291,900	200,900	180,200	8,838,300
2	853,300	1,378,300	2,313,800	1,251,000	5,796,400
3	28,200	902,100	243,100	135,700	1,309,100
Total	10,846,700	2,610,200	2,867,600	1,596,200	17,920,700

Table 13. Estimated abundance of kokanee made by hydroacoustic surveys with age classes split by trawl percentages for Coeur d'Alene Lake, Idaho, from 2008-2011. To follow a particular year class of kokanee, read right one column and up one row.

Sampling Year	Age Class				Total	Age 3/ha
	Age-0	Age-1	Age-2	Age-3		
2011	10,847,000	2,610,000	2,868,000	1,596,000	17,921,000	165
2010	4,025,000	3,089,000	3,042,000	923,000	11,079,000	96
2009	3,574,000	2,467,000	3,738,000	592,000	10,371,000	61
2008	10,479,000	3,572,000	1,650,000	39,200	15,740,000	4

Table 14. Survival rates of kokanee between sampling years on Coeur d'Alene Lake, Idaho.

Year	Age-0 to Age-1	Age-1 to Age-2	Age-2 to Age-3
2011	64%	93%	52%
2010	86%	123%	25%
2009	24%	104%	36%

Table 15. Chinook salmon redd counts in the Coeur d'Alene (Cd'A) River drainage, St. Joe River and Wolf Lodge Creek, Idaho, 1990-2008.

	Coeur d'Alene River								St. Joe River					Wolf Lodge Creek	
Date	Catalaldo Mission to S.F. Cd'A River	South Fork Cd'A to L.N.F. Cd'A River	L.N.F. Cd'A to Steamboat Creek	Steamboat Creek to Steel Bridge	Steel Bridge to Beaver Creek	South Fork Cd'A River	Little North Fork Cd'A River	Coeur d'Alene River Subtotal	St. Joe City to Calder	Calder to Huckleberry Campground	Huckleberry Campground to Marble Creek	Marble Creek to Avery	St. Joe River Subtotal	Wolf Lodge Creek	Total
1990	41	10	-	-	-	-	-	51	4	3	3	0	10	--	66
1991	11	0	2	-	-	-	-	13	0	1	0	0	1	-	14
1992	29	5	3	1	-	-	-	21	18	1	2	0	21	-	63
1993	80	11	6	0	-	-	-	97	20	4	0	0	24	-	121
1994	82	14	1	0	0	13	0	110	6	0	1	1	8	-	118
1995	45	14	1	2	0	-	2	64	1	0	0	0	1	-	65
1996	54	13	13	0	0	4	0	84	59	5	7	0	71	-	155
1997	18	5	6	3	1	0	0	33	20	2	2	0	24	-	57
1998	11	3	1	0	0	0	0	15	3	1	0	2	6	4	25
1999	7	5	0	0	0	0	0	12	0	0	0	0	0	5	17
2000	16	20	3	0	0	5	1	45	5	0	0	0	5	3	53
2001	18	13	2	1	0	4	0	38	21	15	-	-	36	4	78
2002	14	10	6	0	0	3	0	33	14	4	0	0	18	0	51
2003	27	17	2	0	0	5	0	51	15	9	3	0	27	0	78
2004	24	36	4	2	0	4	1	71	15	3	0	0	18	1	90
2005	30	7	3	0	0	8	1	49	7	3	0	0	10	1	60
2006	30	80	14	7	0	10	0	141	15	1	0	0	16	-	157
2007	63	20	4	1	0	13	0	101	23	4	0	0	26	-	127
2008	79	6	1	2	0	4	0	92	13	3	1	0	17	-	109
2009	70	23	1	0	0	13	0	107	9	1	0	0	10	-	117
2010	71	16	7	9	0	8	0	112	20	0	2	0	22	-	134
2011	79[a]	12[a]	5	0	0	17	2	115	-	-	-	-	-	-	134[b]

[a] Redds counted by ground survey.
[b] Total based on a proportion of the previous 5 years.

Table 16. Number of Chinook salmon stocked and estimated number of naturally produced Chinook salmon entering Coeur d'Alene Lake, Idaho, 1982-2007. The number of Chinook salmon redds is the number left undisturbed the previous fall.

	Hatchery Produced				Naturally Produced		
Year	Number	Stock	Rearing Hatchery	Fin Clip	Previous year redd counts	Estimated Smolts	Total
1982	34,400	Bonneville	Hagerman	--	--	--	34,400
1983	60,100	Bonneville	Mackay	--	--	--	60,100
1984	10,500	L. Michigan	Mackay	--	--	--	10,500
1985	18,300	L. Michigan	Mackay	Left Ventral	--	--	18,300
1986	30,000	L. Michigan	Mackay	Right Ventral	--	--	30,000
1987	59,400	L. Michigan	Mackay	Adipose	--	--	59,400
1988	44,600	Coeur d'Alene	Mackay	Left Ventral	--	--	44,600
1989	35,400	Coeur d'Alene	Mackay	Right Ventral	--	--	35,400
1990	36,400	Coeur d'Alene	Mackay	Adipose	52	20,800	57,200
1991	42,600	Coeur d'Alene	Mackay	Left Ventral	70	28,000	70,600
1992	10,000	Coeur d'Alene	Mackay	Right Ventral	14	5,600	15,600
1993	0	--	--	--	63	25,200	25,200
1994	17,300	Coeur d'Alene	Nampa	Adipose	100	40,000	57,300
1995	30,200	Coeur d'Alene	Nampa	Left Ventral	100	40,000	70,200
1996	39,700	Coeur d'Alene	Nampa	Right Ventral	65	26,000	65,700
1997	12,600	Coeur d'Alene	Nampa	Adipose	84	33,600	46,200
1998	52,300	Priest Rapids	Cabinet G.	Left Ventral	57	22,800	75,100
1999	25,500	Big Springs	Cabinet G.	Right Ventral	25	10,000	35,500
2000	28,000	Big Springs	Nampa	Adipose	17	6,800	34,800
2001	0	--	--	--	53	21,200	21,200
2002	41,000	Big Springs	Nampa	Left Ventral	78	31,200	72,200
2003	44,800	Big Springs	Nampa	Right Ventral	51	20,400	65,200
2004	46,000	Big Springs	Nampa	Adipose	78	31,000	77,000
2005	26,300	L. Sacajawea	Nampa	Left Ventral	90	36,000	62,300
2006	47,600	L. Sacajawea	Nampa	Right Ventral	59	23,600	71,200
2007	0				100	40,000	40,000
2008	0				65	26,000	26,000
2009	21,500	Big Creek	Nampa	Adipose + coded wire tag	100	40,000	61,500
2010	20,421	Big Creek	Nampa	Adipose + coded wire tag	100	40,000	60,421
2011	20,132	Big Creek	Nampa	Adipose + coded wire tag	134	53,600	73,732

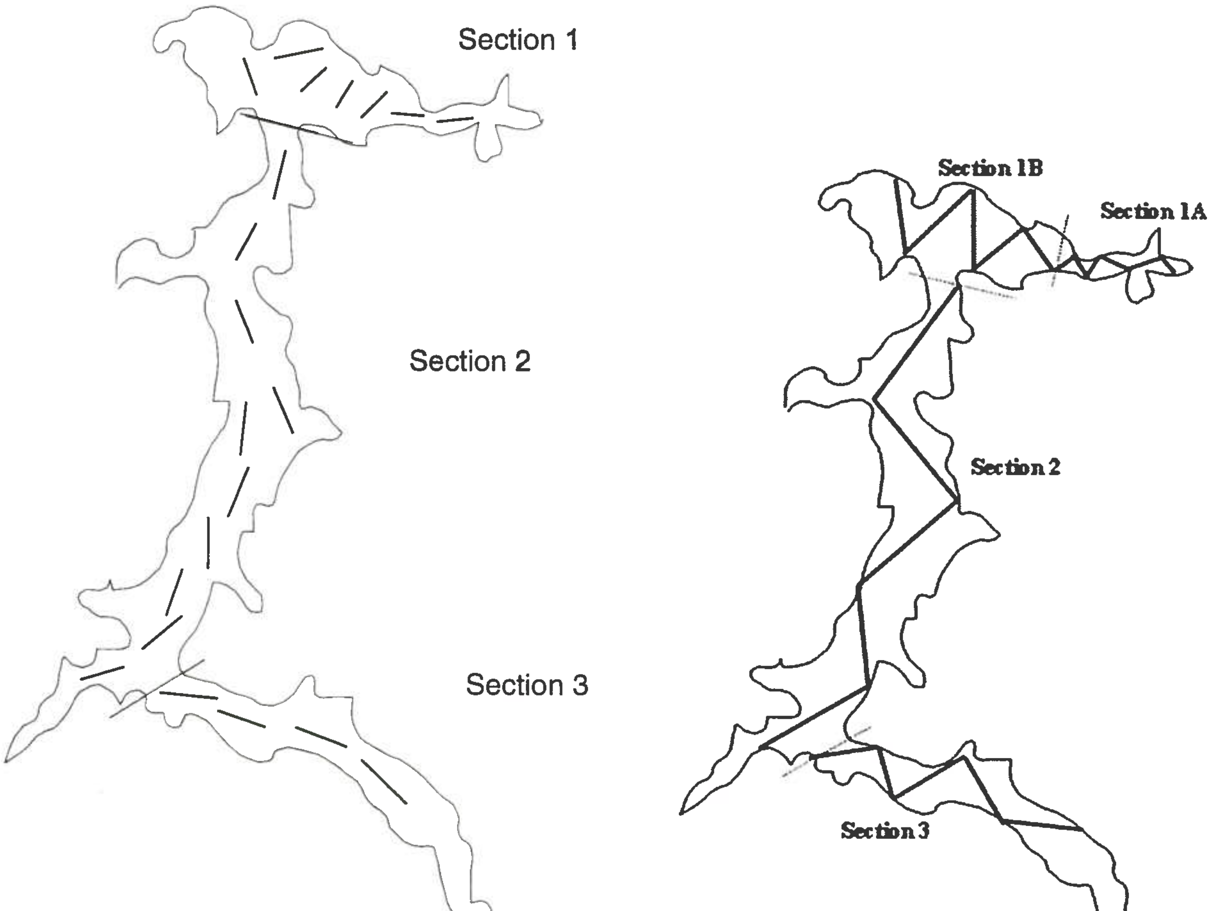


Figure 9. Location of 21 midwater trawling transects (top left), and 21 hydroacoustic transects (top right), in three sections of Coeur d'Alene Lake, Idaho, used to estimate kokanee population abundance in 2011.

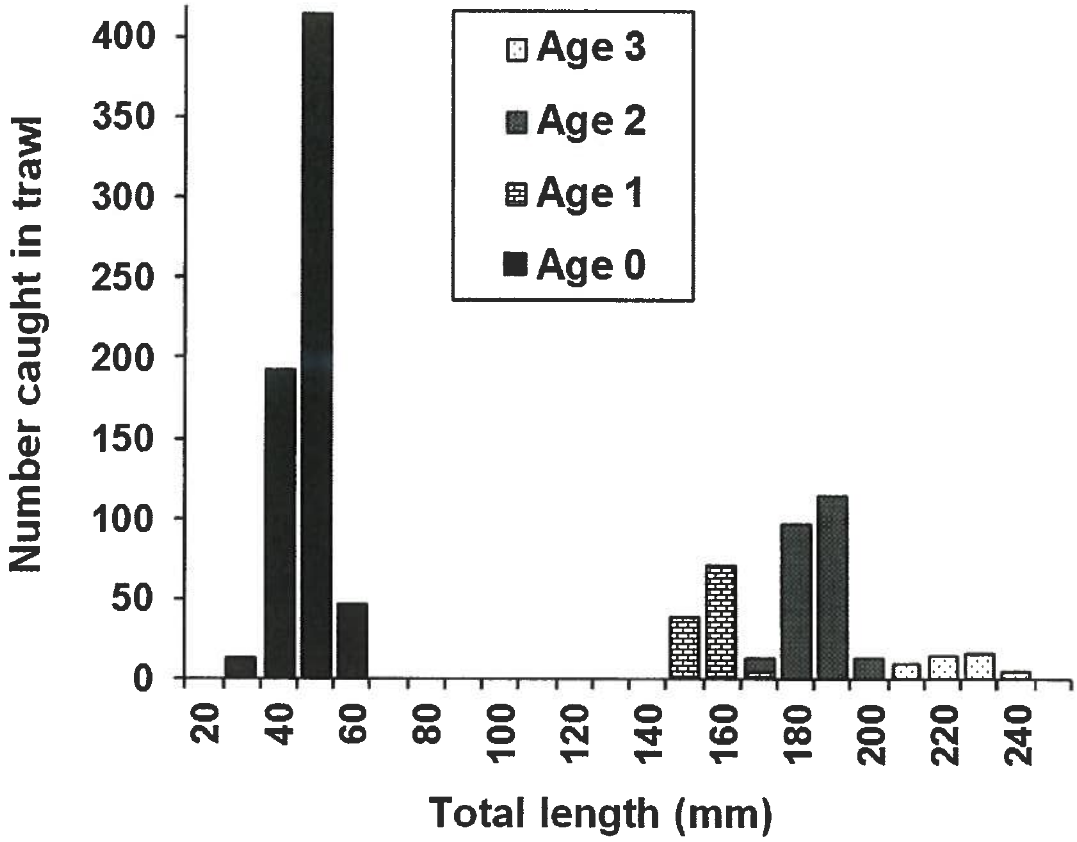


Figure 10. Length-frequency distribution of kokanee sampled in Coeur d'Alene Lake while trawling during 2011.

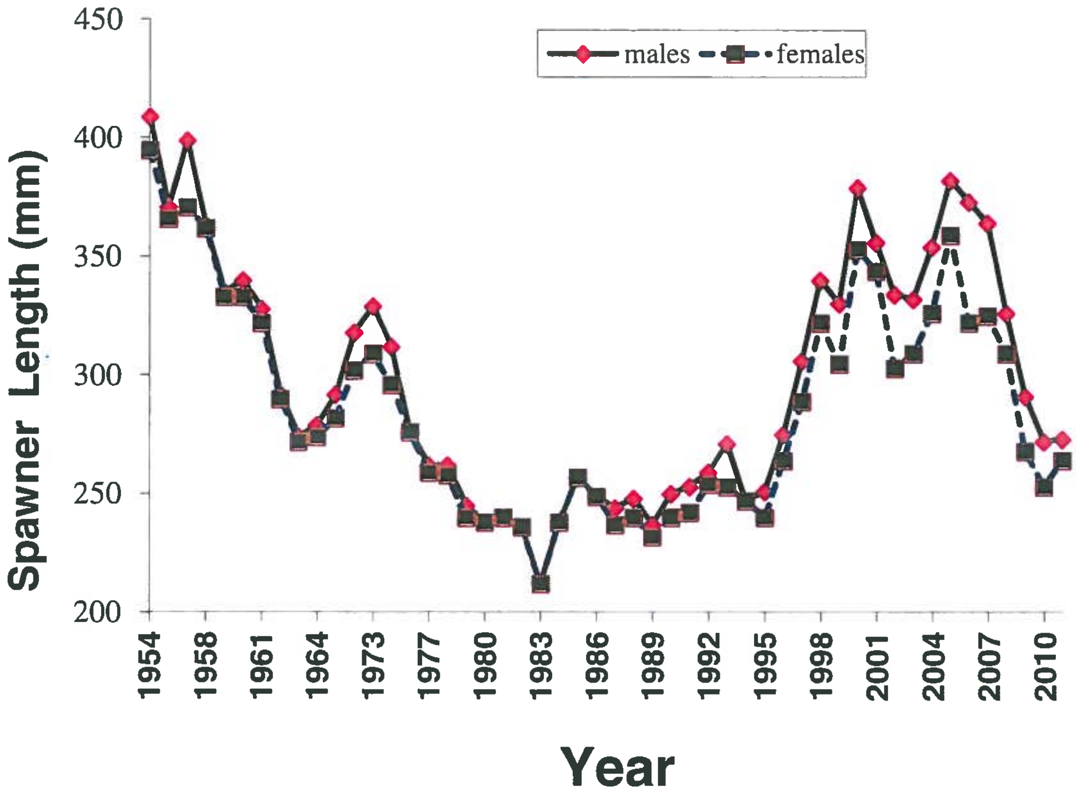


Figure 11. Mean total length of mature male and female kokanee in Coeur d'Alene Lake, Idaho, from 1954 to 2010. Years where mean lengths were identical between sexes were a result of averaging male and female lengths together.

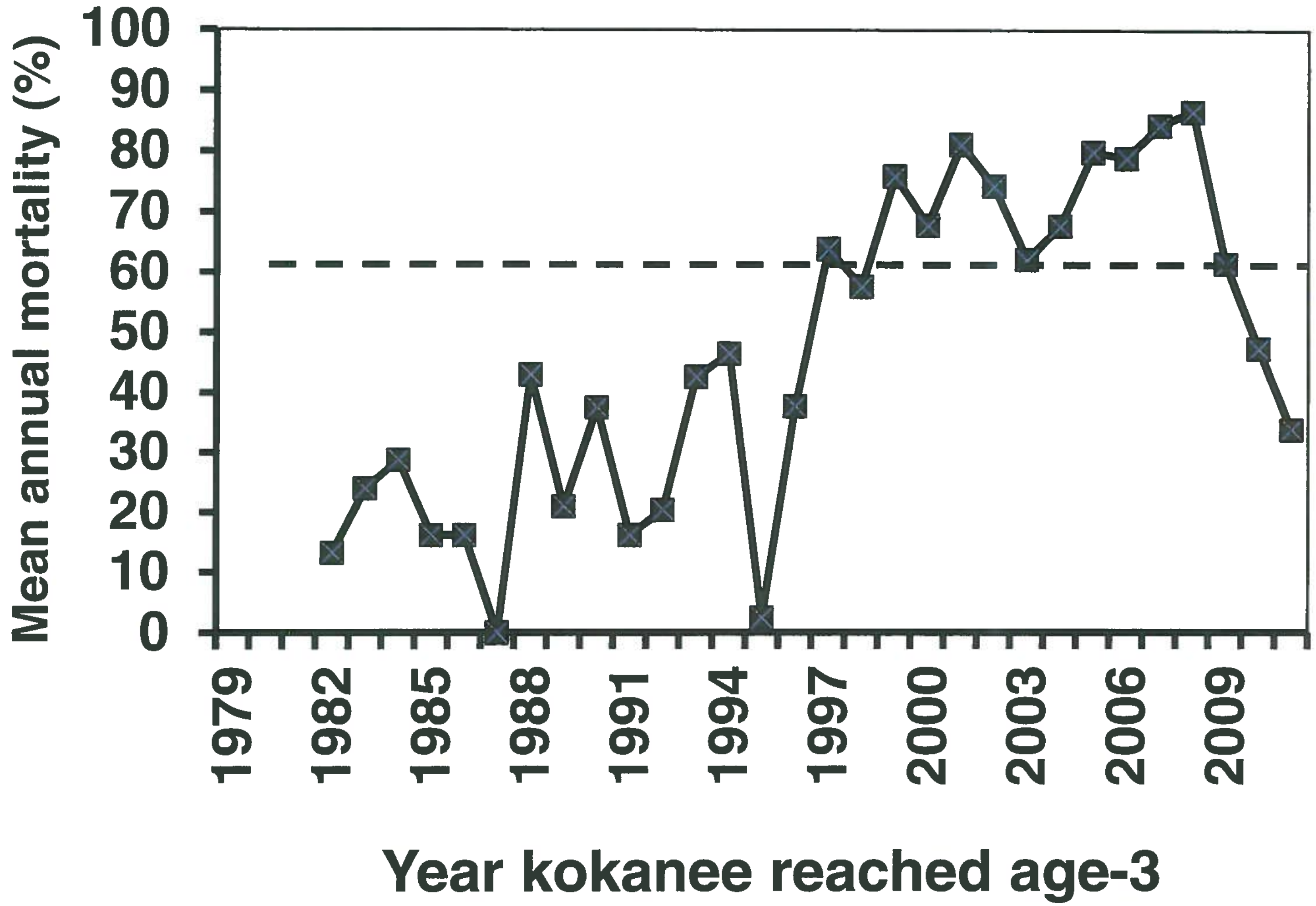


Figure 12. Mean annual mortality of a cohort of kokanee from age-0 to age-3 in Coeur d'Alene Lake. Years with mortality above 60% caused a decline in adult abundance.

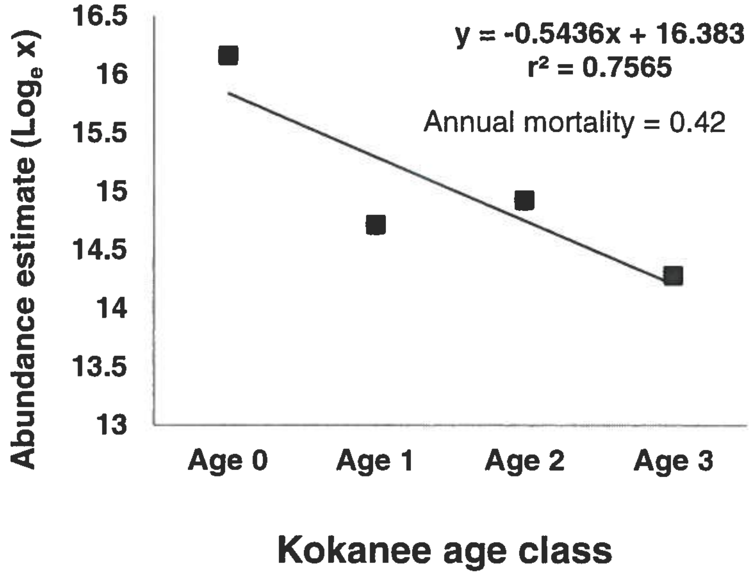


Figure 13. Catch curve for the adult year class of kokanee in Coeur d'Alene Lake during 2011. Abundance estimates were based on data collected during hydroacoustic surveys.

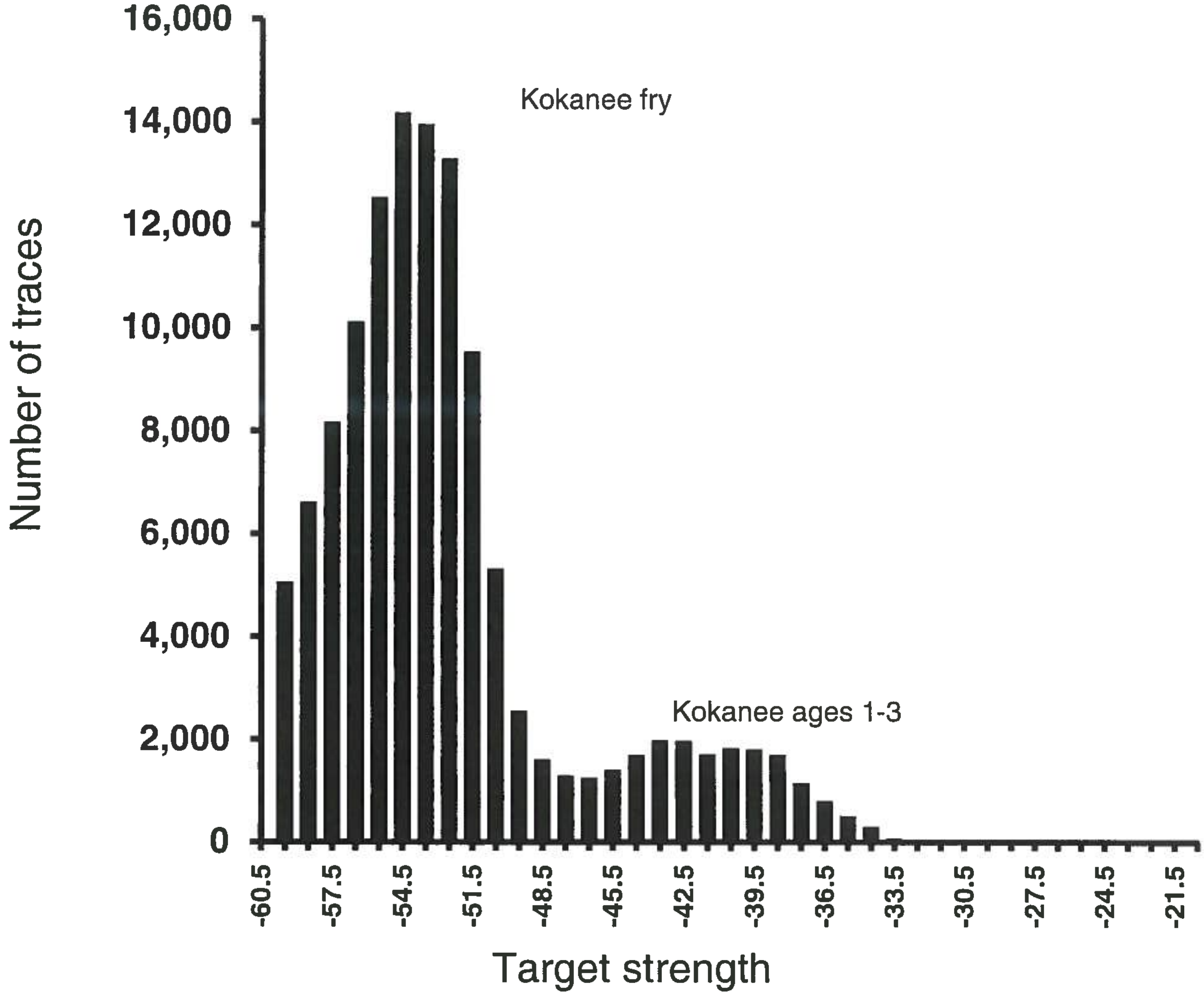


Figure 14. Target strength-frequency distribution of fish within the kokanee layer in Coeur d'Alene Lake during 2011. A trace was a single returned echo from a single fish. Fry were defined as targets between -60 dB and -47 dB, and older age classes of kokanee as targets between -47 dB and -33 dB.

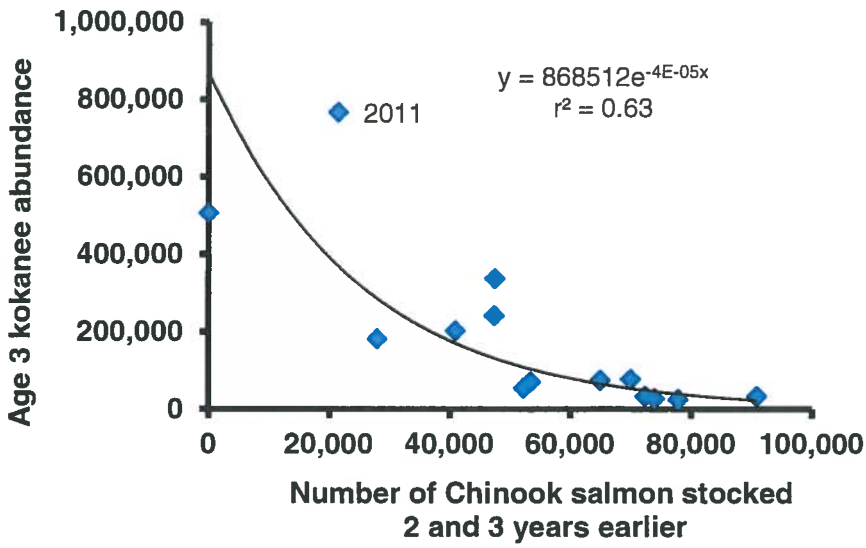


Figure 15. Relationship between the numbers of Chinook salmon stocked 2 and 3 years previous in Coeur d'Alene Lake, Idaho, and the number of age-3 kokanee. Correlation coefficient was based on a linear relationship.

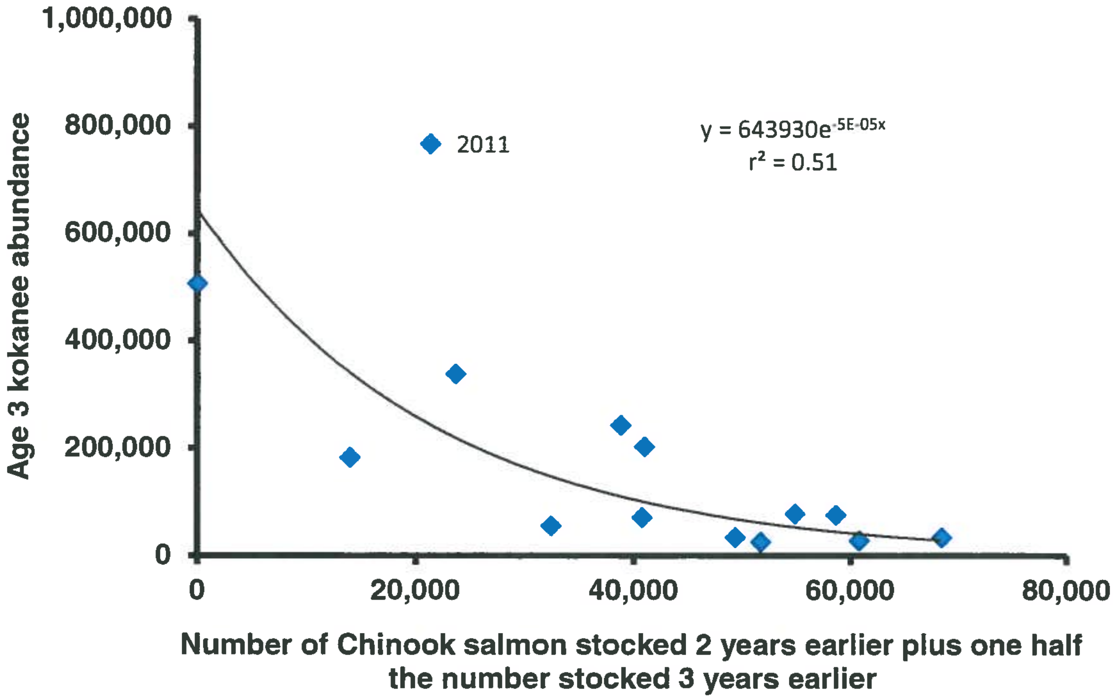


Figure 16. The relationship between the number of Chinook salmon stocked 2 years previous plus one half the number stocked 3 years previous, and the number of age-3 kokanee in Coeur d'Alene Lake as estimated by trawling. Taking one half the number stocked 3 years previous was done to account for mortality on the older cohort. Correlation coefficient was based on a linear relationship.

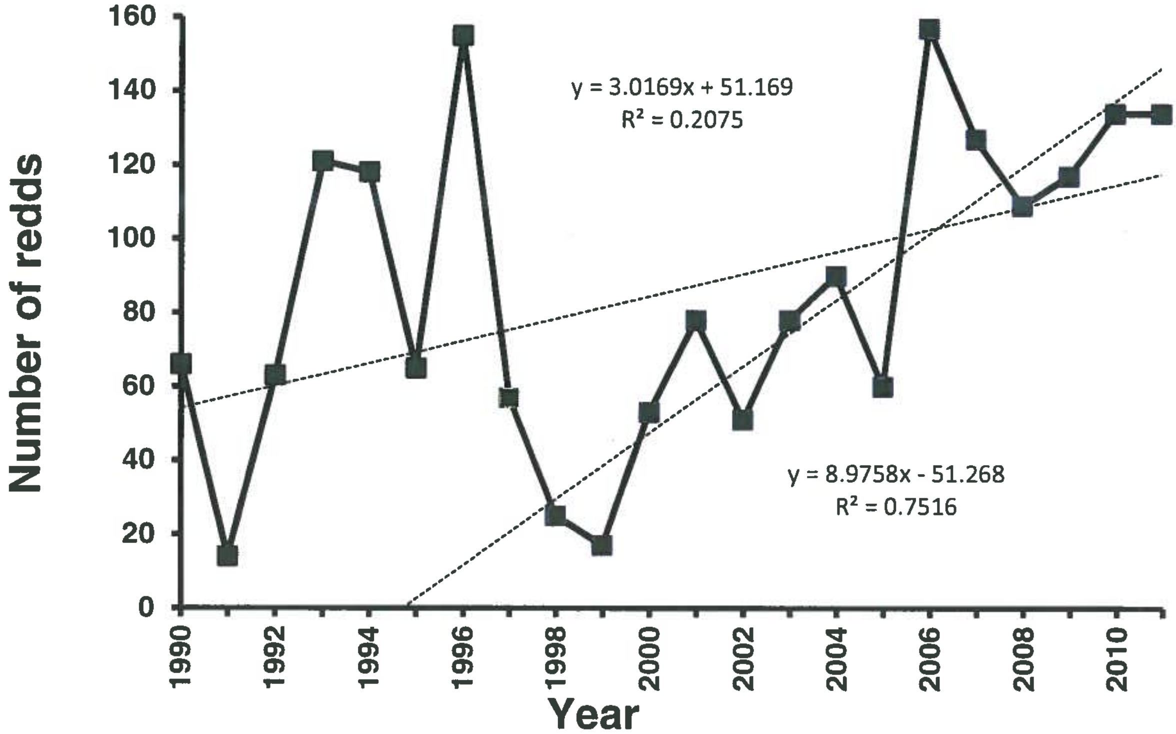


Figure 17. Numbers of Chinook salmon redds counted in tributaries to Coeur d'Alene Lake, Idaho, between 1990 and 2010. Dotted lines depict the trends from 1990 to 2011 and from 1998 to 2011.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 3: SPIRIT LAKE KOKANEE

ABSTRACT

Spirit Lake is managed for a high yield kokanee *Oncorhynchus nerka* fishery. Unlike other large kokanee lakes, Spirit Lake does not contain a large population of kokanee predators, and so illustrates kokanee population dynamics without top-down effects. During 2011 we monitored the kokanee population by midwater trawling and conducting hydroacoustic surveys. By combining both methodologies we estimated the lake contained 1,236,400 (2,100/ha) kokanee fry, 209,200 (360/ha) age-1 kokanee, 430,700 (736/ha) age-2 kokanee, and 73,800 (126/ha) age-3 kokanee. We also estimated the lake contained a standing stock of 74 kg/ha of kokanee with a production rate of 48 kg/ha/year, and a mortality of 43 kg/ha. Potential egg deposition was estimated at 13.7 million eggs. Survival from last year's eggs to this year's fry was estimated at 7.3%. Based on these results Spirit Lake had more than a sufficient number of adult kokanee in the fishery, more than adequate egg deposition and fry abundance, and continues to grow kokanee very well. No kokanee stocking appeared to be needed at this time. Age-2 kokanee abundance was exceptionally high, which should provide an outstanding ice fishery (given sufficient ice cover) in 2011-12 and may provide a good summer fishery in 2012.

Authors:

Melo Maiolie
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

OBJECTIVE

Maintain a high yield kokanee fishery in Spirit Lake.

INTRODUCTION

Spirit Lake is one of Idaho's top producers of kokanee on an area basis. In fact, Spirit Lake had the highest yield of kokanee (12.7 kg/ha) of any of the 28 kokanee fisheries in northern Idaho, Washington, Oregon, Montana, Utah, Colorado, and British Columbia listed by Rieman and Meyers (1990). It remains a regionally important fishery both summer and winter, and because of its small size and generally good ice cover, can be a particularly good ice fishery.

Spirit Lake is also northern Idaho's only large kokanee fishery which does not also support a significant population of pelagic predators. As such, Spirit Lake can be viewed as a baseline population to monitor such parameters as survival between year classes, egg-to-fry survival, production, and growth without the effects of predation.

The kokanee fishery in Spirit Lake has history of being variable. This variability has continued in recent years. Past management actions have included stocking kokanee fry in the hopes of providing more consistent recruitment and consistent angling. Monitoring, however, has generally shown high numbers of adult kokanee in most years. We continued our monitoring of kokanee in 2011 to see how kokanee are responding to the 15 fish creel limit and determine if kokanee abundance is sufficient to provide good fisheries in future years.

STUDY AREA

Spirit Lake is located near the town of Spirit Lake in the northern panhandle of Idaho. It has a surface area of 598 ha, with 585 ha of kokanee habitat. Maximum depth of the lake is about 27 m.

For northern Idaho, Spirit Lake is a fairly rich body of water. Chlorophyll 'a' was measured at 5.3 µg/l (Soltero and Hall 1984), total phosphorus was 18 µg/l, Secchi transparency was 3.9 m, conductance was 240 $\mu mhos/cm^2$, and the morphoedaphic index was 22.0 (Rieman and Myers 1990). Based on this concentration of total phosphorus the general level of lake productivity would be classed as meso-eutrophic (Wetzel 1975). This lake also was known to carry the highest standing stock of kokanee in northern Idaho at 54.5 kg/ha (Rieman and Myers 1991). More recent estimates in 2010 using hydroacoustics have raised this estimate to 67 kg/ha (Maiolie et al. in press).

Idaho Department of Fish and Game transplanted kokanee from Lake Pend Oreille to Spirit Lake in the 1930's and 1940's. These fish are genetically most similar to those from Lake Whatcom, Washington, (Winans et al 1996). Spirit Lake kokanee are "late spawners" that typically spawn during November through early January on shoreline gravel rather than in tributary streams. During the last decade, early spawning kokanee were stocked in 2000 (200,000 fry), 2001 (198,000 fry), 2004 (200,000 fry), 2007 (163,000 fry) and 2008 (169,000 fry), to insure adequate recruitment of kokanee fry. No additional kokanee were stocked in Spirit Lake in 2009 or 2010.

METHODS

Hydroacoustics

A hydroacoustic survey was conducted on the night of August 10, 2011 to determine kokanee densities. This was the sixth year that a hydroacoustic survey was conducted on this water body. Methods, equipment, and transect locations used in 2011 were the same as those used in 2010 (Maiolie et al. 2011). Similar to last year, kokanee densities were estimated by echo integration. However, in 2011 the EchoView software was up graded to version 4.90.61. Statistics such as the 90% confidence limits, biomass, production, and mortality estimates were also calculated by the methods use last year (Maiolie et al. 2011).

Trawling

We used night-time, midwater trawling to collect representative samples of kokanee and determine the percentage of each age class in the population. These percentages were used to split the hydroacoustic abundance estimate for kokanee from ages one to three. Trawling was also used to calculate its own estimate of the kokanee population based on the volume of water filtered by the net. Methods used were the same as those used last year (Maiolie 2011). Five trawl hauls were made in Spirit Lake on August 3, 2011 (Figure 18).

RESULTS

Hydroacoustics

Two size groups of kokanee were noted based on target strengths, which corresponded to fry and all other age classes (Figure 20). Based on this distribution, and the size break between fry and age-1 kokanee in the trawl catch, we divided fry from older age classes of kokanee at -47.0 dB. The modal length of fry was -50.5 dB or about 50 mm [based on Love's (1971) equation]. This agreed with the modal size of fry in the trawl catch, which was also 50 mm.

We estimated that Spirit Lake contained 1,236,400 age-0 kokanee (2,100 fry/ha) (90% CI, -24% to +31%), and 713,800 age-1 through 3 kokanee (1,200 fish/ha) (90% CI, -29% to +40%). The proportions of kokanee in the trawl catch, exclusive of fry, were: 29.3% age-1, 60.4% age-2, and 10.3% age-3. Based on these proportions we estimated the lake contained 209,200 (358 fish/ha) age-1 kokanee, 430,700 (736 fish/ha) age-2 kokanee, and 73,800 (126 fish/ha) age-3 kokanee (Table 18).

Survival rates were calculated for the years of hydroacoustic surveys (Table 19). Mean survival was 70% for age-0 to 1, 57% for age-1 to 2, and 66% for age-2 to 3. In addition egg-to-fry survival was found to range from 3.0% to 10.1% and averaged 6.3%.

Kokanee production was estimated at 28.2 tons (48.1 kg/ha/yr) using the Summation Method (Hayes et al. 2007) (Table 19), and 31.2 tons (53.3 kg/ha/yr) using the Instantaneous Growth Rate Method (Ricker 1946, Hayes et al. 2007) (Table 4). The two methods differed as to which was the most productive age class, however, both methods showed high production between age-0 and age-1, and age-1 and age-2 (Tables 20 and 21). Biomass of kokanee was 43.1 t, standing stock was 73.7 kg/ha (Table 19), and mortality by weight was 25.1 t (43 kg/ha/yr). Based on these data, the production to biomass ratio was 0.65:1. Mean NASC estimate for the lake was 600 m^2/nautical $mile^2$ (Figure 21)(Table 18) with a mean target strength of -43.99dB as an average for the 22,004 single targets recorded.

Trawling

By trawling, we estimated the lake contained 1,092,000 age-0 kokanee (±51%, 90% C.I.), 185,700 age-1 kokanee (± 55%), 382,300 age-2 kokanee (± 44%), and 65,500 age-3 kokanee (± 29%), with a total population of 1,725,400 kokanee (± 43%) (Table 17). Modal sizes of kokanee for each age class were 50 mm, 160 mm, 190 mm, and 230 mm for ages-0 to 3, respectively (Figure 19). Standing stock of the kokanee population was estimated at 65 kg/ha with a total biomass of 38.3 metric tons (t), based on trawling.

We calculate the percentage of kokanee in each age class, from age-1 to age-3, in order to partition the hydroacoustic estimate into year classes. Population estimates were 29.3% age-1, 60.4% age-2, and 10.3% age-3.

Three adult fish were collected in trawl that were thought to be early spawning kokanee based on their dark red flesh color and the beginnings of getting their spawning coloration. All were age-3 indicating they were from the last stocking of early spawning fry in 2008. They were also three of the largest fish sampled with total lengths in the 240 mm size category.

DISCUSSION

Kokanee abundance

The kokanee fishery in Spirit Lake has history of being variable. This variability has continued in recent years based on angler reports. Concerns were raised by anglers during the winter of 2007-08 and the spring of 2008 that the kokanee fishery had declined. Monitoring during July 2007 indicated a relatively low number (90/ha) of age-2 kokanee entered the fishery that year. Spirit Lake had a good, prolonged ice cover during the winters of 2008-09, and 2009-10 and the fishing was good. Groups of ice fishermen were having limit catches (15 fish/person/day) on most mornings. Summer anglers during 2009 and 2010 also appeared to be doing well. Monitoring during those years indicated a much higher abundance of age-2 kokanee entered the fishery; 340/ha in 2008 and 243/ha in 2009. The following year, during the winter of 2010-11, the fishery was poor. The lake was late to freeze and few anglers fished the lake even once the ice was established. Age-2 kokanee densities in the fall of 2010 showed a lower number of age-2 kokanee (194/ha) entered the fishery that fall.

This apparent correlation may indicate that a good way to anticipate the fishery would be to examine the density of age-2 kokanee entering the fishery in the fall. Previously we examined the density of adults and compared it to our guideline of 30-50 adult kokanee/ha that was suggested in Rieman and Maiolie (1995). These guidelines were mostly based on a summer, troll fishery. We suggest that higher densities may be needed to have a popular ice fishery. Also adult densities of kokanee were measured in Spirit Lake during the new moon between mid-July and mid-August. Substantial changes in adult abundance may occur in this lake by mortality and angler exploitation. For example, the strong year class of 198,700 age-2 kokanee in 2008 was reduced to a fairly typical 60,200 age-3 kokanee when estimated one year later as adults (Table 18). Another advantage to using the density of age-2 kokanee as an index is that they may be more accurately estimated. Their smaller size and higher abundance may make them easier to collect by trawling.

If this pattern holds, the winter of 2011-12 should have an exceptional kokanee fishery. We estimated 430,700 age-2 kokanee (736 fish/ha) should be entering the fishery this fall. This was the highest year class of age-2 kokanee ever recorded for Spirit Lake. We recommend monitoring the lake to at least qualitatively determine if exceptional year classes of fish create exceptional fisheries.

Kokanee creel limits were reduced from 25 fish to 15 fish in 2000. This seemed to have the desired effect as kokanee numbers rebounded by the next population estimate in 2005 (Table 17). During the winter of 2008-09 and the summer of 2009, Spirit Lake had a very popular sport fishery. Kokanee mortality from age-2 to age-3 was 70% based on hydroacoustics. We suspect this high mortality was at least partly due to increased angler harvest. From July 2009 to August 2010, mortality from age-2 to age-3 was a more moderate 45% by hydroacoustics (Table 18). Mortality from age-2 to 3 declined even further between 2010 and 2011 to 35%. These mortality rates seem to correlate to the variable intensity of the winter fishery. Therefore the 15 kokanee limit appears appropriate for this lake given its variable fisheries.

Two year classes of kokanee were found to be higher than normal in 2011. We estimated age-2 kokanee abundance at 430,700 fish. This was the highest estimate ever recorded for this age group and was 2 to 3 times higher than in recent years (Table 18). Kokanee fry abundance was also the highest ever recorded (Tables 17 and 18). The reason for the good egg-to-fry survival rate of 7.3% was unknown. Northern Idaho had an unusually cold and wet spring in 2011, but the connection between weather and fry survival is not well understood.

The lower than average number of fry seen last year has turned into a weak year class of age-1 kokanee. These alternating strong and weak year classes between ages-0 and 2 should give a good opportunity to see their effects on the fishery. Knowing their year class strengths may help us explain to anglers why the fishery is rather dynamic.

Three adult kokanee of the early spawning strain were collected in 2011. All were age-3 indicating that a few fish of this strain may mature a year later than most. Any of the early spawning strain in the lake now would be from natural reproduction. We recommend looking for these fish in future years to determine if they are becoming established in the system.

Kokanee production for Spirit Lake was estimated at 48 kg/ha/yr between 2010 and 2011 (Tables 21 and 22). For comparison, this is about 4 to 6 times the kokanee production of Lake Pend Oreille (8 to 11 kg/ha/yr between 1995 and 2007, agency files). Standing stock of kokanee was cited in Rieman and Myers (1991) at 54.5 kg/ha. In our study it was estimated at 73.7 kg/ha, which is up from last year's estimate of 67.5 kg/ha (Table 22). Spirit Lake therefore remained a very productive lake for growing kokanee and has been increasing in kokanee biomass for at least the last 5 years (Table 22).

NASC (nautical area scattering coefficients) values are a sum of the areal backscattering of fish in the analyzed kokanee layer (Simmonds and MacLennan 2005). Figure 4 compares NASC values for kokanee surveys for several lakes in Idaho. These data indicated Spirit Lake had a relatively high abundance of kokanee for waters in northern Idaho. Only Anderson Ranch Reservoir in southern Idaho had a higher NASC value during our recent surveys. NASC values are a measurement of area of the targets, and so may not directly correlate with fish biomass when comparing bodies of water. It does however show that Spirit Lake had considerably more kokanee than some of these other systems.

MANAGEMENT RECOMMENDATIONS

1. Publicize the information that an exceptional year class of kokanee will be entering the Spirit Lake fishery this winter and promote the ice fishery. We also recommend at least qualitative monitoring to determine if good fisheries correlate to the high density of age-2 kokanee.

2. Monitor the contribution of early spawning kokanee in the trawl catch during future years to see if a self-sustaining population is developing. If early spawning kokanee are reproducing, we recommend breaching the beaver dams in Brickle Creek as needed.

3. No supplemental stocking of kokanee is recommended at this time.

Table 17. Kokanee population estimates based on midwater trawling from 1981 through 2009 in Spirit Lake, Idaho.

Year	Age Class				Total	Number Age-3/ha
	Age-0	Age-1	Age-2	Age-3		
2011	1,092,000	185,700	382,300	65,500	1,725,400	112
2010	138,200	459,900	88,800	61,600	748,500	105[a]
2009	260,700	182,600	75,900	30,000	549,200	51[a]
2008	281,600	274,400	188,800	56,400	801,200	96
2007	439,919	210,122	41,460	20,409	711,910	35
2006	-	-	-	-	-	-
2005	508,000	202,000	185,000	94,000	989,100	161
2001-04	-	-	-	-	-	-
2000	800,000	73,000	6,800	7,800	901,900	13
1999	286,900	9,700	50,400	34,800	381,800	61
1998	28,100	62,400	86,900	27,800	205,200	49
1997	187,300	132,200	65,600	6,500	391,600	11
1996	--	--	--	--	--	--
1995	39,800	129,400	30,500	81,400	281,100	142
1994	11,800	76,300	81,700	19,600	189,400	34
1993	52,400	244,100	114,400	11,500	422,400	20
1992	--	--	--	--	--	--
1991	458,400	215,600	90,000	26,000	790,000	45
1990	110,000	285,800	84,100	62,000	541,800	108
1989	111,900	116,400	196,000	86,000	510,400	150
1988	63,800	207,700	78,500	148,800	498,800	260
1987	42,800	164,800	332,800	71,700	612,100	125
1986	15,400	138,000	116,800	35,400	305,600	62
1985	149,600	184,900	101,000	66,600	502,100	116
1984	3,300	16,400	148,800	96,500	264,900	168
1983	111,200	224,000	111,200	39,200	485,700	68
1982	526,000	209,000	57,700	48,000	840,700	84
1981	281,300	73,400	82,100	92,600	529,400	162

[a] Does not include similar- sized age 2 early spawners.

Table 18. Kokanee population estimates based on hydroacoustic surveys in Spirit Lake, Idaho. NASC is the nautical area scattering coefficient and TS is the target strength.

	Age Class								
Year	Eggs	Age-0	Age-1	Age-2	Age-3	Total Kokanee	Age 3/ha	Mean NASC	Mean TS
2011	13,700,000	1,236,400	209,200	430,700	73,800	1,950,200	126	600	-43.99
2010	17,000,000	366,800	587,000	113,400	78,600	1,145,800	134[b]	646	-41.34
2009	12,400,000	567,500	345,100	142,400	60,200	1,115,200	103[b]	448	
2008	11,300,000	553,500	292,500	198,700	60,700	1,105,400	103	505	
2007	5,490,000	495,900	266,900	52,500	25,900	841,200	44	494	
2005-06		-	-	-	-	-	-	-	
2004		279,000	-[a]	-[a]	-[a]	916,800	-	458	

[a] No trawling was conducted in 2004 to delineate kokanee in age classes 1 to 3.
[b] Does not include mature age 2 kokanee that were of similar-size to age 3 late spawners.

Table 19. Survival rates of kokanee based on hydroacoustic estimates for Spirit Lake, Idaho.

	Age Class			
Year	Egg-0	0-1	1-2	2-3
2011	7.3%	57%	73%	65%
2010	3.0%	103%	32%	55%
2009	5.0%	62%	48%	30%
2008	10.1%	59%	74%	115%
Mean	6.3%	70%	57%	66%

Table 20. Calculations of kokanee production for Spirit Lake between 2010 and 2011 using the Summation Method (Hayes et al. 2007). Biomass was estimated by multiplying the 2011 weight times the 2011 abundance for each cohort.

Age class	2010 weight (g)	2011 fry weight (g)	2011 weight (g)	Weight gain (g)	2010 abundance	2011 abundance	Mean abundance	Production (t)	Biomass of age class in 2011 (t)
Emergent Fry – Age 0	0.15		1.05	0.90	4,121,323	1,236,397	2,678,860	2.4	1.3
0 to 1	1.20		37.79	36.59	366,795	209,231	288,013	10.5	7.9
1 to 2	36.29		60.63	24.34	586,981	430,748	508,865	12.4	26.1
2 to 3	75.51		105.63	30.12	113,392	73,808	93,600	2.8	7.8
3 to 4	116.61		116.61	0	78,628	0	39,314	0.0	0.0
Total (t)								28.2	43.1
Total (kg/ha)								48.1	73.7

Table 21. Calculation of kokanee production for Spirit Lake, Idaho, between 2010 and 2011 using the Instantaneous Growth Rate Method (Ricker 1946, Hayes et al. 2007).

Life stage	Mean weight (g)	Biomass (t)	Mean biomass	Instantaneous growth	Production (t)
Emergent fry- Age-0					
2011(emergence)	0.15	0.618	0.956	1.946	1.859
2011 (fall fry)	1.05	1.293			
Age 0-1					
2010	1.2	0.440	4.173	3.450	14.397
2011	37.79	7.907			
Age 1-2					
2010	36.29	21.302	23.709	0.513	12.169
2011	60.63	26.116			
Age 2-3					
2010	75.51	8.562	8.179	0.336	2.746
2011	105.63	7.796			
Total production					31.171

Table 22. Production, standing stock, and mortality of the kokanee population in Spirit Lake.

Year	Production by Summation method (kg/ha/yr)	Production by Instantaneous Growth Rate method (kg/ha/yr)	Standing stock (kg/ha)	Mortality by weight (kg/ha/yr)
2011	48.1	53.3	73.7	43.0
2010	60.6	-	67.5	43.7
2009	54.9	-	48.8	49.2
2008	22.4	-	41.6	12.6
2007	-	-	32.7	-

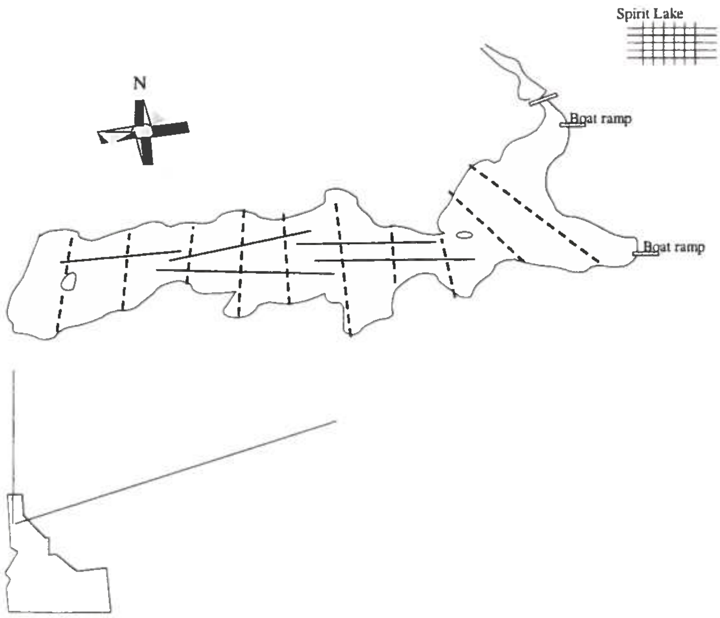


Figure 18. Location of five midwater trawling transects (solid lines) and ten hydroacoustic transects (dashed lines) used to estimate kokanee population abundance in Spirit Lake, Idaho during 2011.

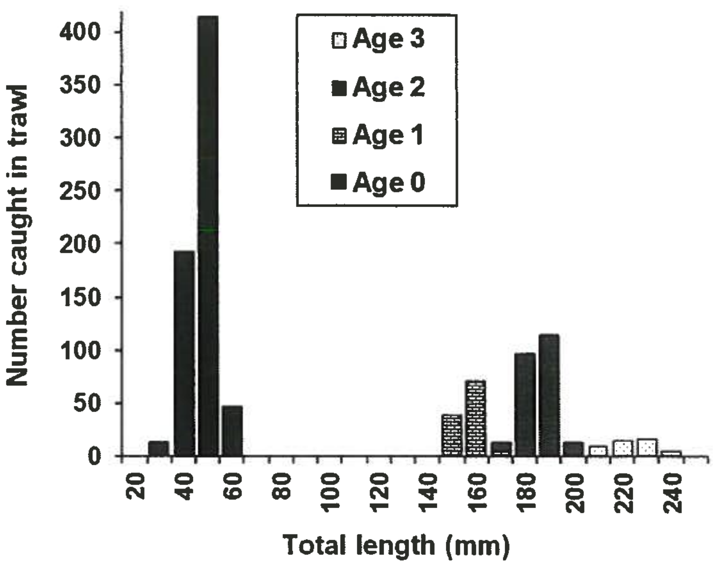


Figure 19. Length-frequency distribution of kokanee caught while trawling Spirit Lake, Idaho, August 3, 2011.

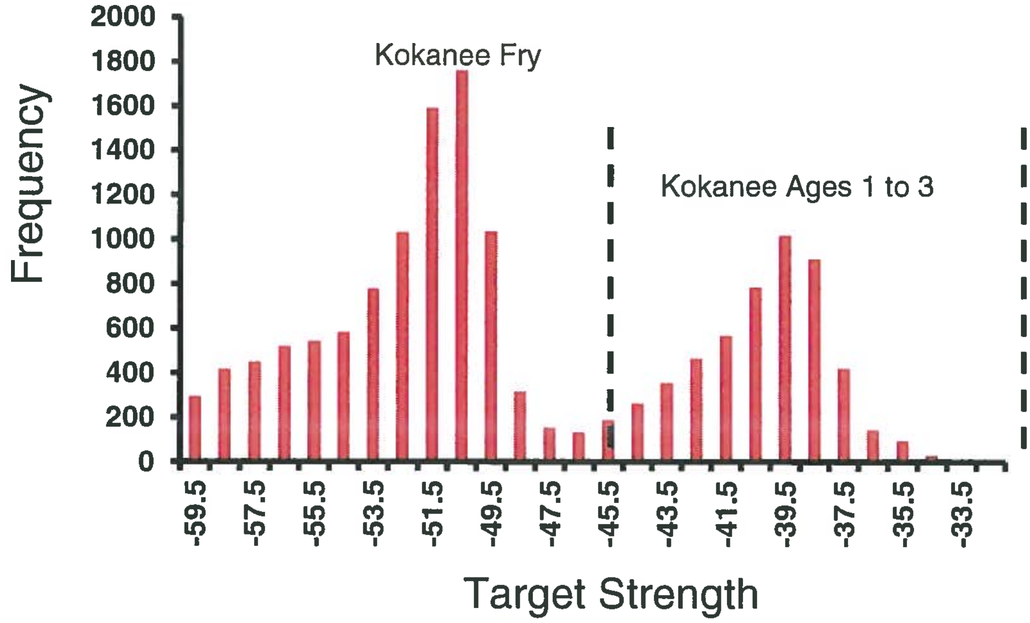


Figure 20. Target strength-frequency distribution of kokanee in Spirit Lake, Idaho, on August 10, 2011. Based on this figure and lengths of kokanee in the trawl catch, kokanee fry were separated from older age classes at a target strength of -47.0.

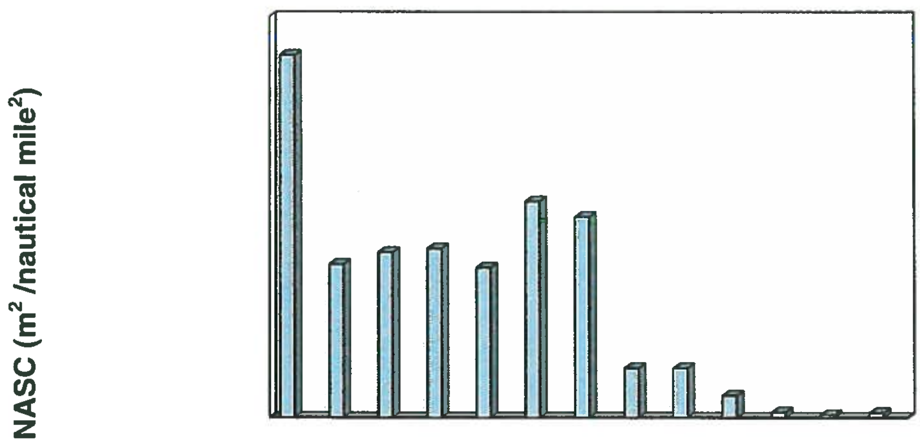


Figure 21. Nautical area scattering coefficients (NASC) for several lakes and reservoirs in Idaho.

CHAPTER 4: UPPER PRIEST LAKE AND THOROFARE LAKE TROUT CONTROL

ABSTRACT

Hickey Bros. Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to use gill nets to remove lake trout *Salvelinus namaycush* from Upper Priest Lake in 2011 using their 36 foot commercial gill net boat with funding from the U. S. Fish and Wildlife Service (USFWS). Gill nets were fished from May 24 through June 1, 2011. We fished a total of 65.6 km of gill net (40.7 mi) averaging 7,283 m net/day. A total of 4,996 lake trout were caught and removed. Based on a Leslie Depletion Model (Ricker 1975) we estimated lake trout population abundance at the beginning of the effort to be 5,967 fish which suggests we removed approximately 84% of the population.

With funding from USFWS, Kalispell Tribe, and U. S. Forest Service (USFS), Idaho Department of Fish and Game (IDFG) contracted with Hickey Bros. Fisheries, Inc. in 2011 to continue evaluation of trap nets to minimize lake trout movement into Upper Priest Lake from Priest Lake. From September 12 through November 3, 2011, we used trap nets to capture fish in the Thorofare. Trap nets were placed approximately 200 m and 300 m upstream of Priest Lake. We caught 355 lake trout and seven bull trout *Salvelinus confluentus* during this effort. Lake trout ranged from 395 mm to 920 mm (TL) Lake trout movement through the Thorofare increased as surface water temperatures neared 11°C. Peak movement was observed from October 12 through October 31 when 289 (81%) of all lake trout were captured.

Authors:

Mark Liter
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

It has been well documented that introduced lake trout *Salvelinus namaycush* have the tendency to suppress other native and non-native species through predation and/or competition (Donald and Alger 1993, Fredenberg 2002, Hansen et al. 2008.) Historically native bull trout *Salvelinus confluentus* provided a trophy fishery in Upper Priest Lake with an annual catch of 1,800 fish in the 1950's (Bjorn 1957). Bull trout harvest was eliminated in 1984, but no positive response in the population ensued (Mauser et al. 1988). The bull trout population in Priest Lake is considered functionally extinct while the population in Upper Priest Lake is severely depressed (DuPont et al. 2007).

Native westslope cutthroat trout *Oncorhynchus clarkii lewisi* were also historically abundant in Priest Lake and Upper Priest Lakes with 30 fish limits common in the 1940's (Mauser et al. 1988). Over harvest, interspecific competition, predation and degradation of spawning habitat all led to the decline of cutthroat trout in the Priest Lakes. Cutthroat trout were closed to harvest in 1988

In Upper Priest Lake the lake trout population appears to have grown rapidly in the past 25 years. Lake trout were not known to be present in Upper Priest Lake until mid-1980s at which time they were thought to have begun migrating from Priest Lake (Mauser 1986). In 1998 the Upper Priest Lake lake trout population was estimated at 859 fish (Fredericks and Vernard 2001). In an effort to reduce threats to dwindling bull trout and cutthroat populations, Idaho Fish and Game (IDFG) has been using gill nets to reduce lake trout abundance in Upper Priest Lake since 1998. Between 150 and 2,500 lake trout have been removed nearly every year from Upper Priest Lake (Liter et al. 2010 in press). The netting efforts demonstrated that Upper Priest Lake is not a closed system. It has become increasingly evident that without a migration barrier in the Thorofare to limit immigration from Priest Lake, Upper Priest Lake will likely be dominated by lake trout (Fredericks and Vernard 2001).

METHODS

Lake Trout Removal

Hickey Bros. Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to use gill nets to remove lake trout from Upper Priest Lake in 2011 using their 36 foot commercial gill net boat. Funding for this contract was provided by the United States Fish and Wildlife Service (USFWS). Gill nets used in Upper Priest Lake were 91 m long by 2.7 high designed with multiple panels of graded mesh sizes ranging from 44 mm to 89 mm randomly arranged in each net. Individual gill nets were tied together end to end to create a continuous net ranging from 1,645 m to 6,644 m.

Gill nets were fished from May 24 - June 1, 2011. Nets were set throughout the lake and were moved based on catch rates at a particular site and the discretion of the netting crew. Gill nets were set perpendicular to shore when fishing shoreline areas and at various angles when fishing deeper offshore areas. Nets were fished from around 5 A.M. to 7 P.M. and averaged 9.7 hrs of soak time daily. Nets were set on the bottom at depths ranging from 10-31 m. A concerted effort was made to avoid incidental bull trout captures by avoiding areas known to hold concentrations of bull trout.

Fish were measured (TL) and all fish greater than 300 mm in length were cleaned, packed on ice and sent to local food banks for distribution. Fish less than 300 mm were returned as biomass to the lake bottom.

Thorofare Netting Evaluation

With funding from USFWS, Kalispell Tribe, and U. S. Forest Service (USFS), IDFG contracted with Hickey Bros. Fisheries, Inc. in 2011 to continue evaluation of commercial trap nets to minimize lake trout movement into Upper Priest Lake from Priest Lake. From September 12 through November 3, 2011, we used trap nets to capture fish in the Thorofare.

Because the trap net leads were designed to span the entire width of the Thorofare, posing navigation obstacles to boaters, an 8-10 m wide section of float line was submerged to create a passage-way near the thalweg to allow boat traffic movement. Large signs alerted boaters well in advance that research nets were ahead. Multiple orange floats spaced 6 m apart were attached to the top of the leads to help boaters recognize and avoid the trap nets. Additionally, signs with arrows and "boat passage" guided boaters through the passage way.

Trap nets were placed in the Thorofare approximately 200 m and 300 m upstream of Priest Lake. These sites were selected due to their narrow width, relatively flat streambeds and lack of debris. Leads constructed of thick 200 mm mesh extended from the trap net to the shoreline on each side, extending from the bottom to the surface. These visible leads divert fish into an enclosure called the heart. The heart has wings or net sections that form a V-shape and are supported by floats and anchors. Once inside the heart, fish swim through a tunnel and become trapped in a boxlike receptacle called a pot (Figure 22). Fish trapped in the pot remain alive, until it is raised up to the boat where lake trout are dipped out with a long handled net and removed. Captured lake trout were enumerated; measured (mm total length) and stage of sexual maturity and ripeness were recorded. Captured bull trout and cutthroat trout were measured and transported away from the net site before release.

RESULTS

Lake Trout Removal

During our nine day effort we averaged 7,283 m net/day. A total of 4,996 lake trout were caught and removed. Daily catch of lake trout ranged from 179-1,261 fish. Lake trout ranged from 136-906 mm with a mean of 307 mm total length (Figure 23).

Catch rates of lake trout varied among locations and days in Upper Priest Lake during this effort. Catch rates were generally higher along shorelines and lower in deeper mid-lake sets. Daily catch was generally higher at the start of the effort and tapered off over the 9 day effort (Figure 25).

Using a Leslie Depletion Model (Ricker 1975) we estimated the lake trout population to be 5,967 fish at the beginning of the effort (Figure 26). Assuming equal catchability of all lake trout, our removal efficiency would be approximately 84%.

A total of 41 bull trout were captured and 29 were released alive (Figure 24). Bull trout ranged from 180-680 mm with a mean length of 369 mm. Other species caught include 18 pygmy whitefish *Prosopium coulteri,* 153 longnose sucker *Catostomus catostomus*, 20 largescale sucker *C. macrocheilus*, 280 northern pikeminnow *Ptychocheilus oregonensis*, 64 peamouth chub *Mylocheilus caurinus*, one yellow perch *Perca flavescens* and 7 kokanee salmon *Oncorhynchus nerka.*

Thorofare Netting Evaluation

We caught 355 lake trout and seven bull trout during this effort. Lake trout ranged from 395 mm to 920 mm (TL) (Figure 6); 95% were sexually mature and 52% (183) were females. Seven bull trout were captured with one mortality occuring. Bull trout ranged from 350 mm to 872 mm. We also captured 34 cutthroat trout ranging from 315 to 567 mm (Table 23). Other species caught include smallmouth bass *Micropterus dolomieu*, rainbow trout *Oncorhynchus mykiss*, kokanee salmon, brook trout *S. fontinalis*, largescale and longnose suckers *Catostomus spp*, mountain whitefish *Prosopium williamsoni*, northern pikeminnow, and tench *Tinca tinca*. A total of 653 fish were captured (Table 23).

Lake trout movement through the Thorofare increased as surface water temperatures neared 11°C. This observation is consistent with other studies that suggest lake trout begin to arrive at spawning sites when surface water temperatures near 12°C (Dux 2005; Gunn 1995). Peak movement was observed from October 12 through October 31 when 289 (81%) of all lake trout were captured. In 2010 we reported lake trout catch was at its highest from October 12 through October 26. From this we can conclude that lake trout spawning was initiated in late-October when water temperatures approached 11°C and likely ended early to mid-November based on an average spawning duration for lake trout of 2-3 weeks (MacLean et al. 1981).

Trap nets were removed on November 3 when water levels reached low-pool, eliminating access for our 28.5' boat. Large boat traffic through the Thorofare is eliminated as water depth is reduced to less than ½ m the first 100 m above Priest Lake at the completion of draw-down.

DISCUSSION

Lake Trout Removal

In 2011 we captured and removed 4,996 lake trout from Upper Priest Lake and using a Leslie Depletion Model estimated the lake trout population abundance to be 5,967 fish at the start of our removal effort. The past five years of lake trout removal has demonstrated that we are effective at removing a significant portion of the lake trout population in a very short amount of time, but that Upper Priest Lake is being re-populated annually by mature fish from Priest Lake, as well as juvenile fish recruiting to the population from within Upper Priest Lake.

In 2011 we captured and removed more lake trout than any other year, however, we believe this is a function of gillnet mesh size. Mean length of lake trout removed from Upper Priest Lake in 2007 was 421 mm TL (Figure 28) and has decrease each year (Table 26). Mean length of lake trout removed in 2011 was 307 mm TL. In 2010 we included 50 mm (2 inch) mesh and 2011 we included 50 mm and 44 mm (1 ¾ inch) mesh whereas in previous years our smallest mesh size was 63 mm (2.5 inch). Of the 4,996 lake trout captured in 2011, 30% (1,494) were captured in 50 mm mesh and 38% (1,897) were captured in 44 mm mesh (Table 25). It should also be noted that the two small mesh sizes combined accounted for 68% of the total lake trout catch and only 43% of our netting effort. The length frequency histogram in Figure 28 illustrates the increased catch of juvenile lake trout in 2011 and a notable shift in lake trout size structure and mean length since 2007. This is indicative of a population being heavily exploited.

A total of 41 bull trout were captured in 2011 compared to 22 in 2010, 22 in 2009, 13 in 2008 and 7 in 2007. Bull trout ranged from 180 - 680 mm. The 180 mm bull trout is the smallest collected in recent years. Eighteen of the bull trout collected (44%) in 2011 were ≤ 305 mm compared to 32% in 2010. The fact that we continue to see a reduction in adult lake trout numbers and increases in juvenile bull trout numbers suggests that we are improving bull trout recruitment in Upper Priest Lake, however, bull trout redd counts in the Upper Priest Lake drainage were down from the record high count in 2010 (Table 26).

Thorofare Netting Evaluation

In 2011, IDFG worked with the Idaho Water Resource Board to modify the Outlet Structure Operation guidelines specified in the Priest River Basin Plan Amendment to delay the drawdown of Priest Lake to mid-November, 2011. By delaying the drawdown we where able to access the Thorofare and continue netting until November 3 whereas in 2010, low water levels resulted in cessation of netting on October 26. This additional nine days of netting appears to have been advantageous as 163 lake trout or 46% of our total catch occurred after October 26. A total of seven bull trout were captured in the Thorofare in 2011 compared to 3 in 2010. Although a small sample size this doubling of bull trout catch is similar to results of our spring netting effort where we saw 41 bull trout captured compared to 22 in 2010.

Results of this study continue to indicate the Thorofare is a passage corridor for lake trout as well as westslope cutthroat, bull trout, mountain whitefish, and other species. These results are consistent with other studies suggesting extensive fish movement between the lakes, especially in the fall (Fredericks 1999; Fredericks and Vernard 2001). A total blocking of fish movement between the lakes could be detrimental to native fish, and any migration barrier will have to be evaluated relative to negative impacts to species other than lake trout.

Over the past few years IDFG has researched the use of strobe lights and an electric weir as a means of minimizing immigration by lake trout to Upper Priest Lake. Effectiveness, financial constraints, and social implications make either of these options unrealistic. In addition to initial costs, as well as maintenance and operating costs, variable flows, floating debris, and limited access for maintenance are factors needing consideration when discussing potential fish barriers. Additionally, any structure inhibiting boat passage would conflict with the popular use of the Thorofare by boaters.

A seasonal, passive fish barrier, such as large trap nets, may be a temporary means of minimizing lake trout immigration through the Thorofare. Fredericks and Vernard (2001) reported lake trout movement through the Thorofare is greatest during October and November, coinciding with the timing of spawning. Trap nets set at either end of the Thorofare from September through mid- November could significantly reduce movement of lake trout while not barring native fish migrations. It's our observation that boat traffic is greatly reduced during the fall months, and this project demonstrated that trap nets could be effectively used to block fall migrations of lake trout through a low gradient river channel, while with proper signage, still provide passage for watercraft.

MANAGEMENT RECOMMENDATIONS

1. Continue annual netting to reduce lake trout abundance through current State Fish Management Plan period.

2. Continue to investigate methods to minimize lake trout immigration from Priest Lake to increase effectiveness of annual suppression efforts.

Table 23. Total number of fishes captured in trap nets, total length ranges and mean lengths during Priest Lake Thorofare netting evaluation 2011.

	Total Captured	Range TL mm	Mean TL mm
Lake trout	355	395-920	597
Bull trout	7	350-872	626
Westslope cutthroat	34	315-567	401
WSCXRBT	1		
Rainbow trout	1		435
Brook trout	1		
Kokanee	13		
Mountain whitefish	39		
Smallmouth bass	8		
Tench	64		
Largescale sucker	75		
Longnose sucker	6		
Northern pikeminnow	49		

Table 24. Total number of lake trout captured by date, net location and water temp °C during Priest Lake Thorofare netting evaluation 2011.

Date	Lower Net	Upper Net	Total Captured	Water temp °C
9/12/2011	0	0	0	18
9/17/2011	1	0	1	16.4
9/19/2011	2	0	2	15.9
9/22/2011	0	0	0	14.4
9/26/2011	2	1	3	14.6
9/30/2011	9	3	12	13.8
10/4/2011	0	6	6	12.8
10/12/2011	19	29	48	10.8
10/13/2011	9	3	12	12.2
10/14/2011	19	6	25	11.8
10/17/2011	6	1	7	10.6
10/19/2011	2	3	5	10.3
10/21/2011	4	0	4	10.7
10/24/2011	6	17	23	8.3
10/26/2011	28	16	44	7.5
10/28/2011	53	9	62	6.1
10/31/2011	53	6	59	
11/1/2011	22	0	22	
11/3/2011	17	3	20	

Table 25. Number of lake trout captured in each gill net mesh size in Upper Priest Lake, Idaho from May 24 through June 1, 2011.

Mesh size	# Caught	Mean Length (mm)	Range (mm)	% of Catch	% of Effort
44mm (1.75")	1897	263	164-836	38.0	21.3
50mm (2")	1494	296	168-772	30.0	21.3
56mm (2.25")	318	335	235-757	6.8	7.1
63 mm (2.5")	586	371	189-765	11.7	21.3
75 mm (3")	368	351	142-831	7.8	13.4
89 mm (3.5")	326	416	136-906	6.5	14.2
101 mm (4.0")	0	N/A	N/A	N/A	0.8
Experimental	7	205	168-257	0.14	0.4

Table 26. Results from commercial lake trout removal and Upper Priest River and tributaries bull trout redds count 2007-2011.

	Lake Trout				Bull Trout		
	Lake Trout Removed	Estimated Population	Mean TL (mm)		Bull Trout Captured	Mean TL (mm)	Upper Priest River Redd Counts
2007	1,982	2,307	421		7	588	7
2008	2,207	2,278	390		13	511	22
2009	1,353	1,348	388		22	408	34
2010	2,551	3,346	310		22	358	42
2011	4,996	5,967	307		41	372	31

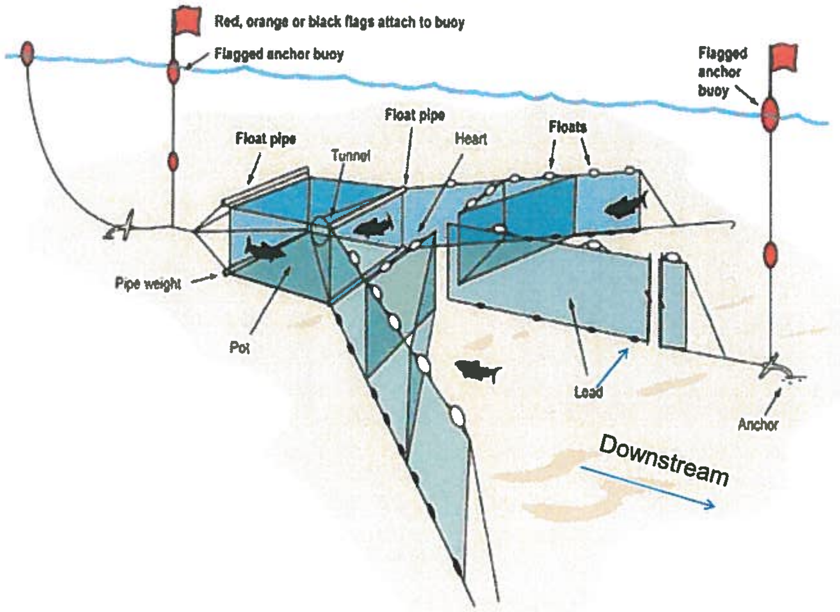


Figure 22. Illustration of a trap net used in Priest Lake Thorofare. Image redrawn from one provided by the University of Wisconsin Sea Grant Advisory Services.

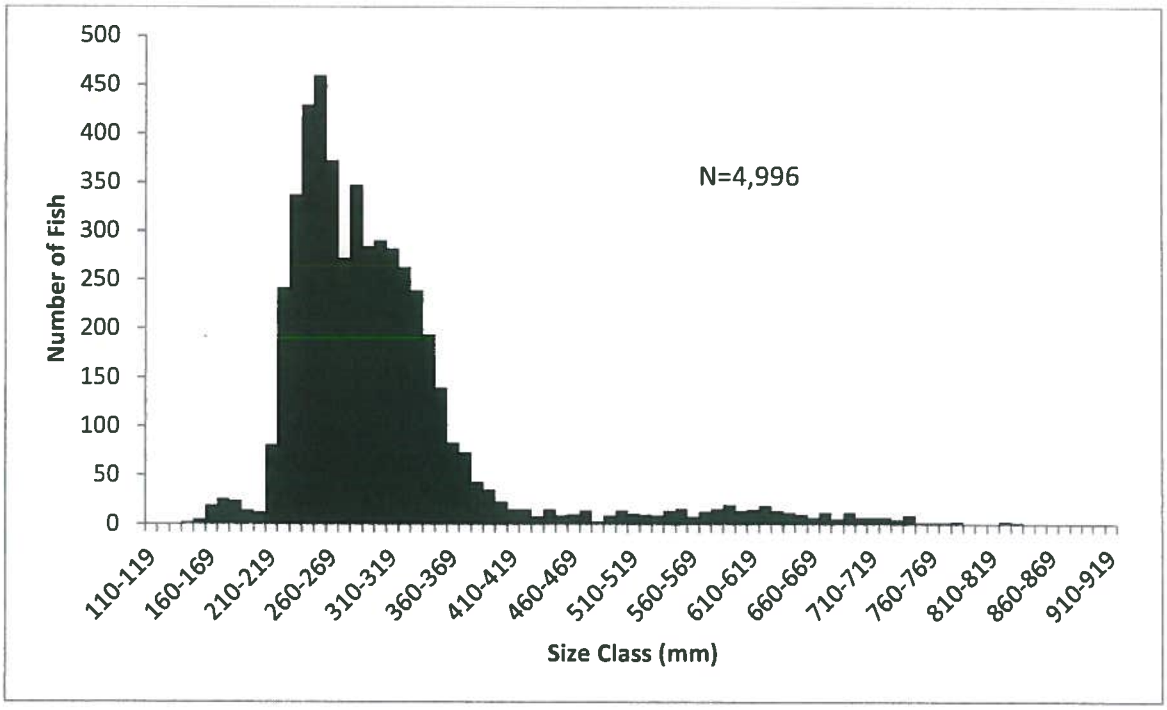


Figure 23. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, from May 24 through June 1, 2011.

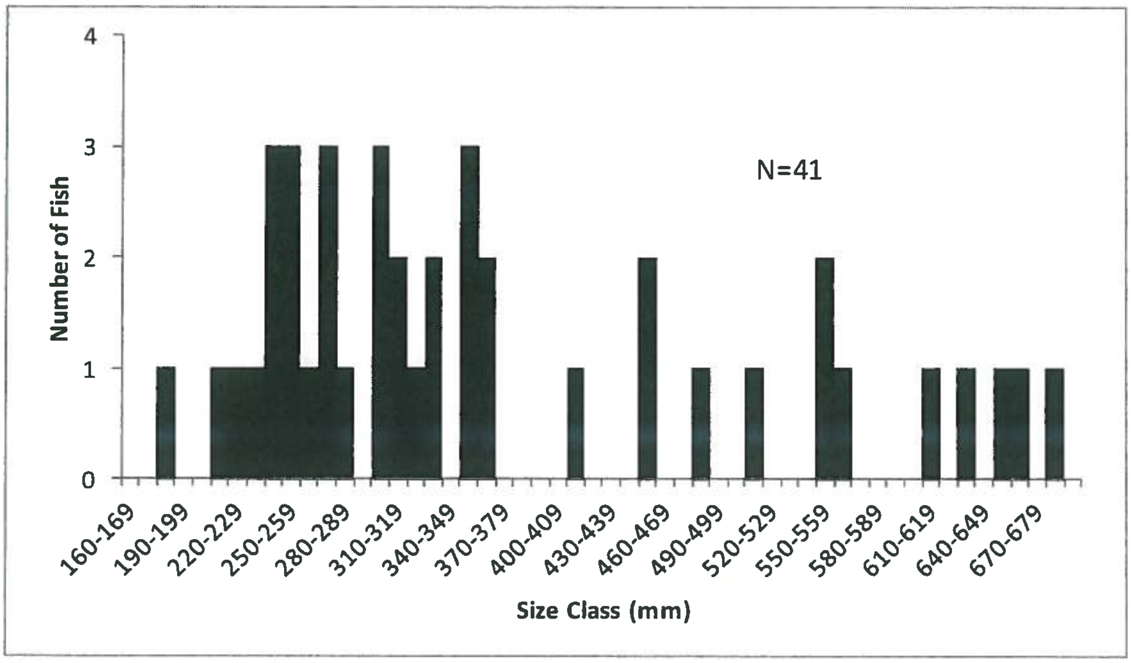


Figure 24. Length frequency of bull trout caught in gill nets in Upper Priest Lake, Idaho, from May 24 through June 1, 2011.

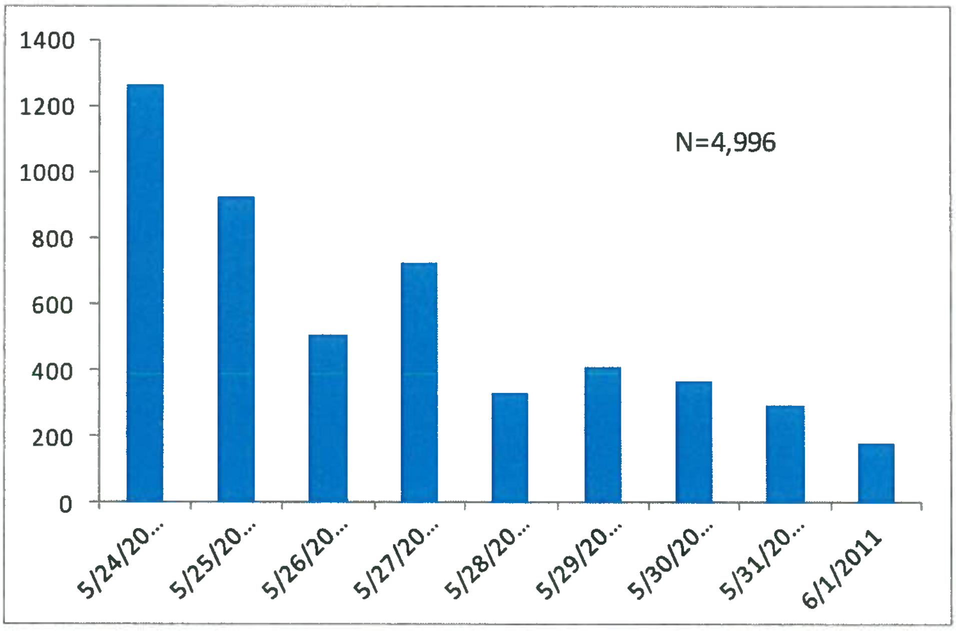


Figure 25. CPUE of lake trout caught per day over 9 days of sampling by gill nets in Upper Priest Lake, Idaho from May 24 through June 1, 2011.

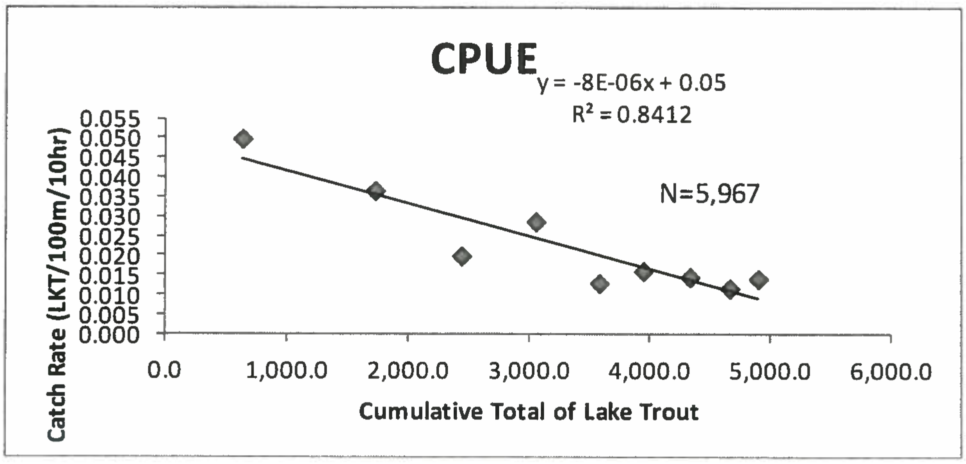


Figure 26. Leslie Depletion Model (Ricker 1975) abundance estimate for lake trout captured by gill nets in Upper Priest Lake, Idaho from May 24 through June 1, 2011.

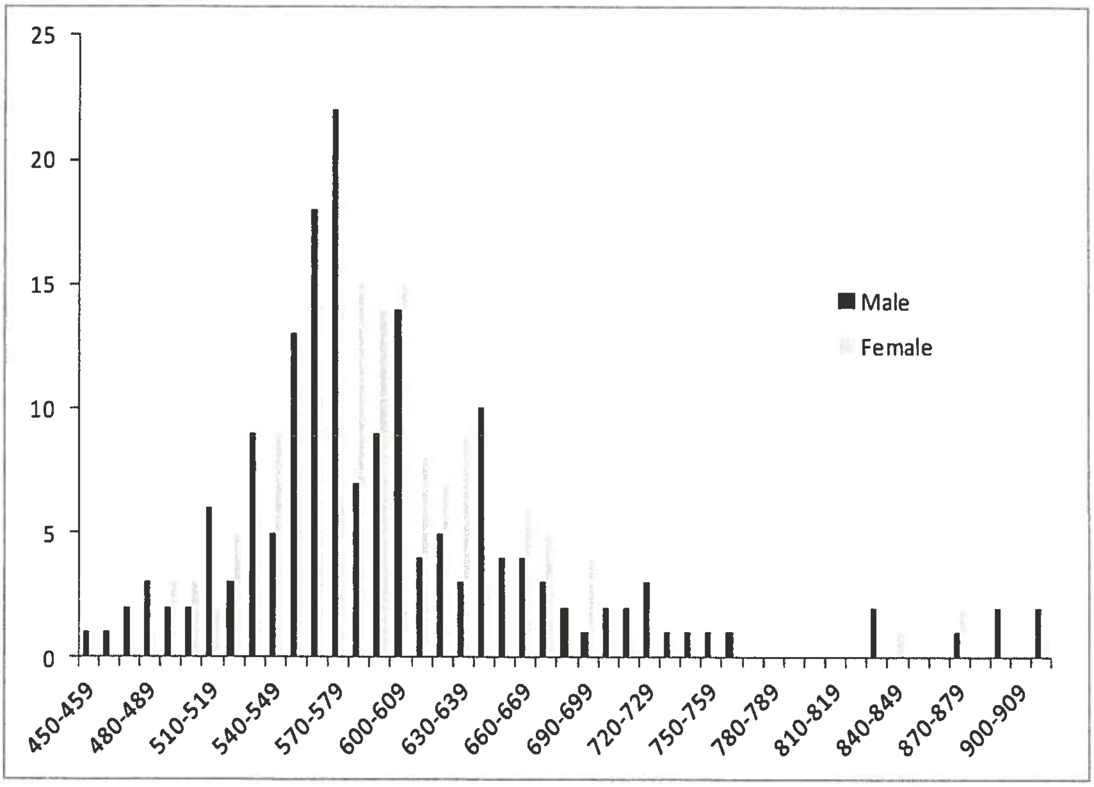


Figure 27. Length frequency of lake trout caught in trap nets during Priest Lake Thorofare netting evaluation during September 12 – November 3, 2011.

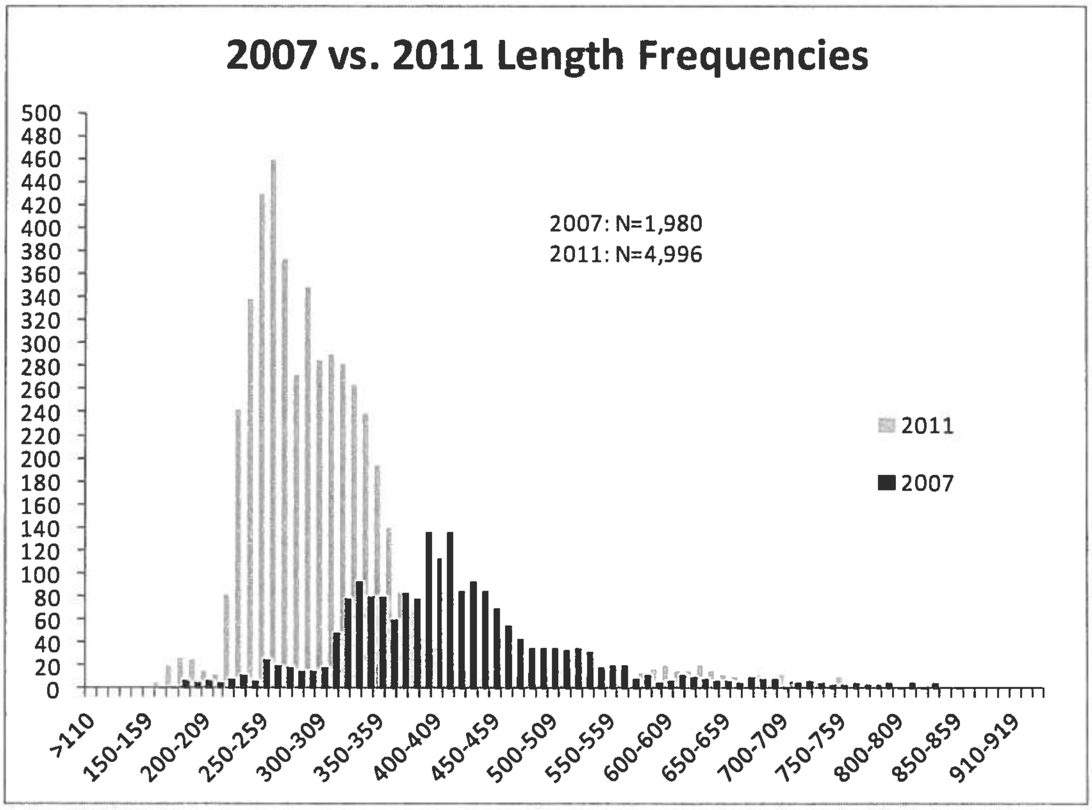


Figure 28. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, May, 2010 and 2007.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 5: STATUS OF PYGMY WHITEFISH IN SPIRIT AND PRIEST LAKES

ABSTRACT

Staff surveyed two of the four lakes in Idaho known to contain pygmy whitefish *Coregonus coulteri* as an effort to determine their population status. Based on bottom trawling we estimated Spirit Lake contained a minimum estimate of 43,000 pygmy whitefish. Fish ranged in size from 104 mm to 190 mm. Ages ranged from 2 to 6 years old and all collected fish were mature. In Priest Lake, we were unable to get good density estimates of pygmy whitefish by either bottom trawling or hydroacoustics. However, pygmy whitefish were caught in each bottom trawl sample. Based on these studies, we concluded that pygmy whitefish were still abundant in Spirit Lake, and appear widespread in the northern section of Priest Lake.

Authors:

Melo Maiolie
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Pygmy whitefish are a native species in Idaho. They are listed by the state as a "species of greatest conservation need". Within this listing they are categorized as "a species lacking essential information pertaining to status". ". Little information on this species exists. To our knowledge, no estimates of their abundance or densities have ever been made in Idaho. We have also not seen any information on their age and growth. They have been incidentally collected while sampling for other species, but even this information was rarely documented.

Prior to our work, pygmy whitefish were known to exist in four lakes in Idaho; Upper Priest Lake, Priest Lake, Spirit Lake, and Lake Pend Oreille. It was not uncommon to catch several small pygmy whitefish while conducting the annual mid-water trawling in Lake Pend Oreille, and some were collected while gillnetting in Upper Priest Lake (Personal communication, Mark Liter and Bill Harryman, Idaho Department of Fish and Game, 2011). However, no pygmy whitefish were seen in recent years in Spirit Lake or Priest Lake. These four lakes have gone through many changes in their recent history. Exotic species have been introduced to each lake, and changes in water quality have occurred. Thus, the current status of pygmy whitefish remained in question.

During 2010 we conducted hydroacoustic surveys and bottom trawling on Upper Priest Lake (Maiolie and Fredericks 2011). The methodology worked well and we estimated a population of about 150,000 pygmy whitefish in Upper Priest Lake. During 2011, we attempted to use the same methodology on Spirit Lake and one section of Priest Lake to determine the feasibility of estimating whitefish abundance in these waters.

OBJECTIVES

The objective for our work on pygmy whitefish was to "ensure the long-term survival of native fish ..." (Idaho Fish and Game 2005). A strategy listed for accomplishing this objective was to "inventory, monitor, and assess the status of native fish, wildlife, and plants and the habitats upon which they depend" (Idaho Fish and Game 2005).

STUDY AREA

The native range for pygmy whitefish in Idaho includes four lakes in the northern panhandle of the state. These lakes are Upper Priest Lake (570 ha), Priest Lake (9,500 ha), Spirit Lake (600 ha), and Lake Pend Oreille (34,800 ha). All of these lakes were near the southern terminus of the continental glaciers during the Wisconsin glacial episode. Two of these lakes were surveyed in this study: Priest Lake and Spirit Lake.

Both lakes have seen many changes since the last ice age that could affect pygmy whitefish. Priest Lake now has a strong population of non-native lake trout and Spirit Lake has high densities of non-native kokanee with densities currently exceeding 3,000 kokanee/ha (Spirit Lake chapter of this report). Water quality may also be an issue for pygmy whitefish in Spirit Lake. Oxygen in the hypolimnion was found to drop below 4 mg/l during mid-summer (Maiolie et al. 2009).

METHODS

Both lakes were surveyed using a bottom trawl and hydroacoustic techniques. The transects used in each survey, with each technique, are shown in Figure 29. Both methodologies were used only at night. On Spirit Lake the hydroacoustic survey was conducted on June 23, 2011 to avoid the period when hypolimnetic oxygen would be low. Trawling on Spirit Lake was conducted one week later on June 30, 2011. On Priest Lake the hydroacoustic survey was conducted on June 22, 2011 and the bottom trawling on June 29, 2011.

Hydroacoustic surveys used the same format as the ones done for kokanee on Spirit Lake and Coeur d'Alene Lake in 2011 (see those chapters in this report). A Simrad split beam echosounder with a 6.5° cone was used in a down-scanning orientation at a ping rate of 0.3 to 0.4 s/ping. The boat traveled at 5-6 km/h.

We conducted bottom trawling on both lakes to determine fish species composition. Mouth of the trawl was 2.5 m wide by 56 cm high with the net being 6.5 m long. The net had a bar mesh of 2.5 cm in the front section with a 2 mm woven stretched mesh in the cod end. Bottom trawling was conducted at depths of 12 to 23 m in Spirit Lake with tows of 10 to 20 min. In Priest Lake trawl depths ranged from 25 to 46 m with tows lasting 19 to 21 min. The net was towed at a speed of 4.8 km/h with the engine running at 1,000 rpms. Netted fish were placed on ice until the next morning and measured to length. Later, otoliths from a sample of fish were removed, potted in epoxy, sectioned, polished, and later aged.

RESULTS

Spirit Lake

Hydroacoustic Survey

There was no clear separation in the vertical distribution between pelagic kokanee and the more benthic pygmy whitefish in Spirit Lake (Figure 30). Therefore we could not define a bottom layer to calculate the density of benthic fish.

Bottom Trawling

We netted 105 pygmy whitefish in the five bottom tows in Spirit Lake. Kokanee, slimy sculpins and yellow perch were also collected. The percentage of each species in the trawl was 64% pygmy whitefish, 35% kokanee, and 1% yellow perch. Proportions do not include the four slimy sculpins collected, since they would not be visible by hydroacoustics.

Density estimates were calculated directly from four of the five bottom trawls. One trawl caught a 5 m long tree limb and so was not used in the estimate. Mean density was 73 pygmy whitefish/ha, for a population estimate of 42,900 pygmy whitefish with a 90% CI of +/- 68% (Table 27).

Pygmy whitefish in Spirit Lake ranged from 104 mm to 199 mm (Figure 31). Ages ranged from 2 to 6 years old (Figure 32). Forty seven of the collected pygmy whitefish between 113 mm and 174 mm were examined and all were found to be mature. Two of the smallest fish we examined were 113 mm in total length. Both of these fish were males and both were mature at age-2. The two smallest females that were examined from Spirit Lake were 122 mm and 123 mm and both were also mature.

Priest Lake

Hydroacoustic Survey

The hydroacoustic survey in Priest Lake found small fish in deep water that were scattered in the bottom 20 m (Figure 33). Since there was no bottom "layer" of small fish that could be identified to species by our bottom trawling, we did not use the density estimates from the hydroacoustic survey.

Bottom Trawling

We netted 10 pygmy whitefish in the five bottom tows in Priest Lake. Four lake trout and 17 slimy sculpin were also collected. The percentage of each species in the trawl was 71% pygmy whitefish and 29% lake trout. Proportions do not include the slimy sculpin collected, since they would not be visible by hydroacoustics.

Density estimates were calculated directly from four of the five bottom trawls. One trawl filled with mud and so was not used in the estimate. Mean density was 6.5 pygmy whitefish/ha (Table 28). This density estimate, however, likely underestimated the density of pygmy whitefish since hydroacoustic surveys showed numerous small fish well above the lake bottom. Pygmy whitefish caught in the bottom trawl ranged in total length from 73 mm to 128 mm (Figure 34).

DISCUSSION

The methodology of using hydroacoustics and bottom trawling to estimate the densities of pygmy whitefish in Upper Priest Lake did not work well for either Spirit Lake or Priest Lake. In Spirit Lake it appeared kokanee and pygmy whitefish mixed together for considerable distance above the bottom. We did not feel the bottom trawl's species proportions would be appropriate to describe the fish community in a hydroacoustic layer that was more than several meters above the bottom. In Priest lake, we could have used the hydroacoustic survey to obtain a density estimate of small fish in the lower 20 m, but again we doubt if the bottom trawl catch would apply to the species proportions. We felt the catch of pygmy whitefish in the bottom trawl, without the hydroacoustics, would at least give a conservative estimate of the fish for future comparison. In both lakes it is quite likely that pygmy whitefish densities were considerably higher than indicated since fish more than three quarters of a meter above the bottom may not have been sampled by the trawl net.

There was a sharp contrast in the sizes of pygmy whitefish in Spirit and Priest lakes (Figures 31 and 34). Many pygmy whitefish in Spirit Lake were between 150 and 190 mm in length. In Priest Lake, no pygmy whitefish were collected over 120 mm. We hesitate to attribute this difference predation or lake productivity. It is possible that the larger pygmy whitefish in Priest Lake moved further off of the bottom and were missed by the bottom trawling.

Pygmy whitefish are known to mature at a young age and small size. Eschmeyer and Bailey (1955) found that male pygmy whitefish matured at age-2 in Lake Superior with females maturing at age-3. It was therefore not surprising that fish we collected all appeared to be mature.

MANAGEMENT RECOMMENDATIONS

1. Conducting bottom trawling on Spirit Lake at 5 to 10 year intervals to monitor the health of the pygmy whitefish population.

2. In Priest Lake, develop a method to estimate the proportions of various species of small fish in deep water (30-50 m bottom depths) that may be 10 to 20 m above the lake's bottom.

3. Test the effectiveness of small-mesh gill nets as an easier method to collect pygmy whitefish and obtain samples for evaluating these populations.

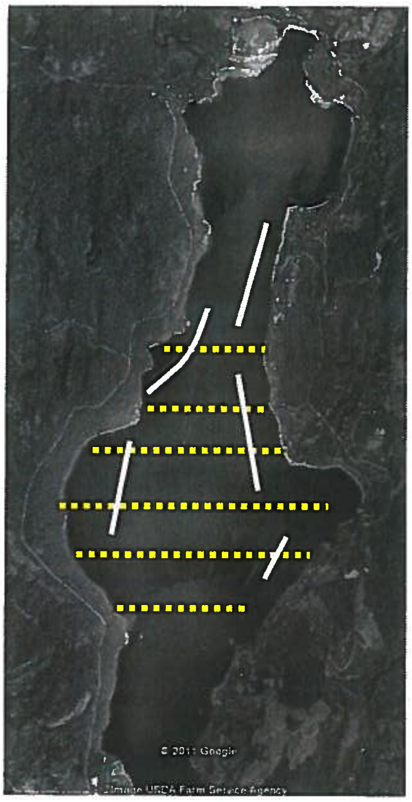
Table 27. Results of bottom trawling for pygmy whitefish in Spirit Lake June, 2011. Haul number 1 caught a 5 m long limb and was therefore not used in the mean density estimate.

Bottom haul number	Length of tow (m)	Width of net (m)	Area sampled (m^2)	Number of pygmy whitefish caught	Density of pygmy whitefish (fish/ha)
1	1,320	2.5	3,300	6	18.18
2	1,513	2.5	3,783	19	50.23
3	1,481	2.5	3,703	13	35.11
4	789	2.5	1,973	15	76.05
5	1,577	2.5	3,943	52	131.90
Mean density for hauls 2-5					73.32

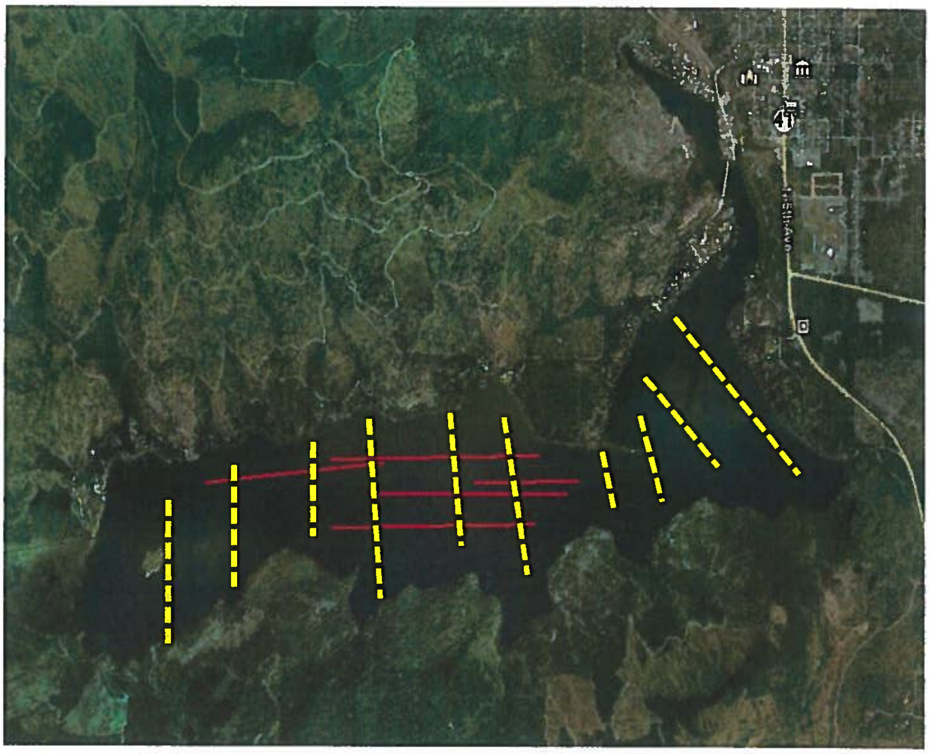
Table 28. Results of bottom trawling in Priest Lake June, 2011. Haul number 1 filled with mud and was therefore not used in the mean density estimate. Note that hydroacoustic surveys conducted at same location show many smaller fish were well above the lake bottom and so density is likely underestimated.

Bottom Haul number	Length of tow (m)	Width of net (m)	Area sampled (m^2)	Number of pygmy whitefish caught	Density of pygmy whitefish (fish/ha)
1	676	2.5	1,690	-	-
2	1,770	2.5	4,425	2	4.52
3	1,529	2.5	3,823	1	2.62
4	1,400	2.5	3,500	1	2.86
5	1,513	2.5	3,783	6	15.86
Mean density for hauls 2-5					6.46

Figure 29. Location of hydroacoustic transects (dotted lines) and bottom trawling (solid lines) on Priest Lake (left figure) and Spirit Lake (right figure) during the pygmy whitefish surveys in 2011.

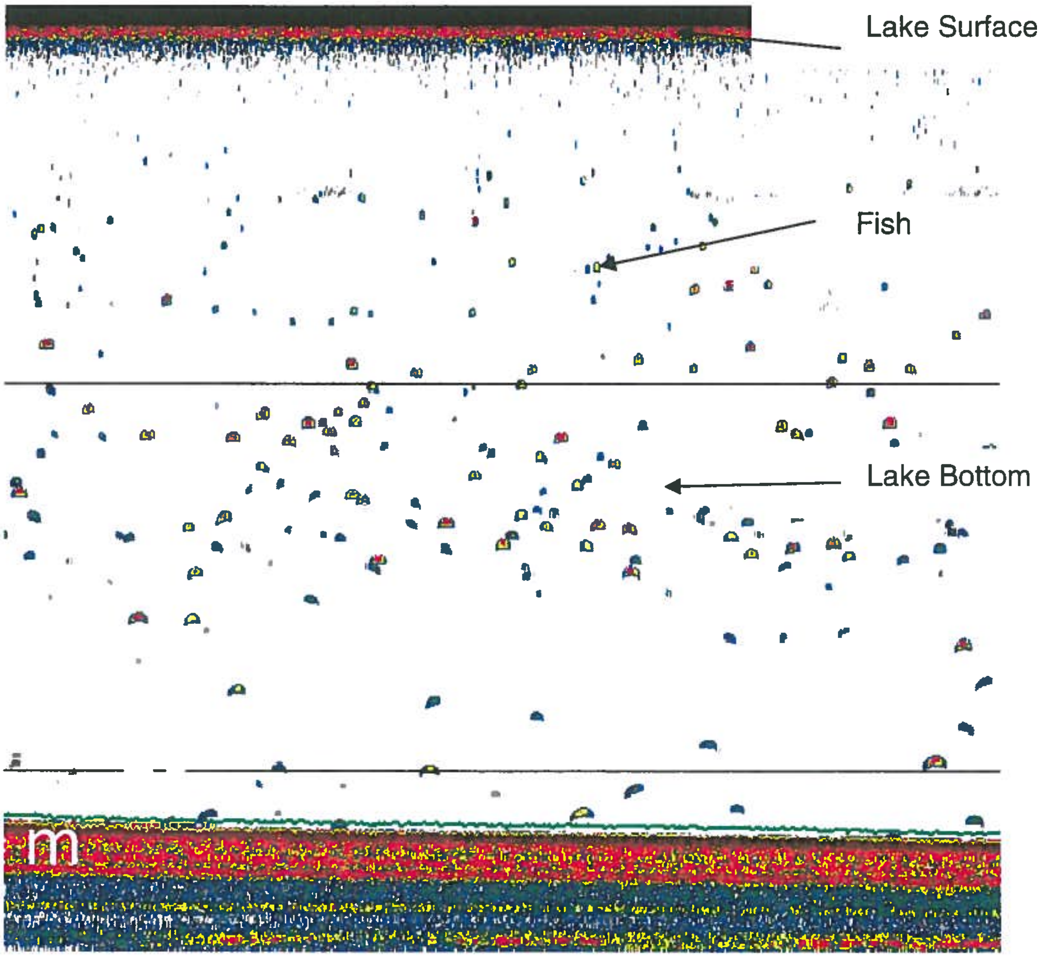


Priest Lake



Spirit Lake

Figure 30. Section of an echogram recorded on Spirit Lake on June 23, 2011. Note the continuous distribution of fish from the lake's bottom to the center of the lake.



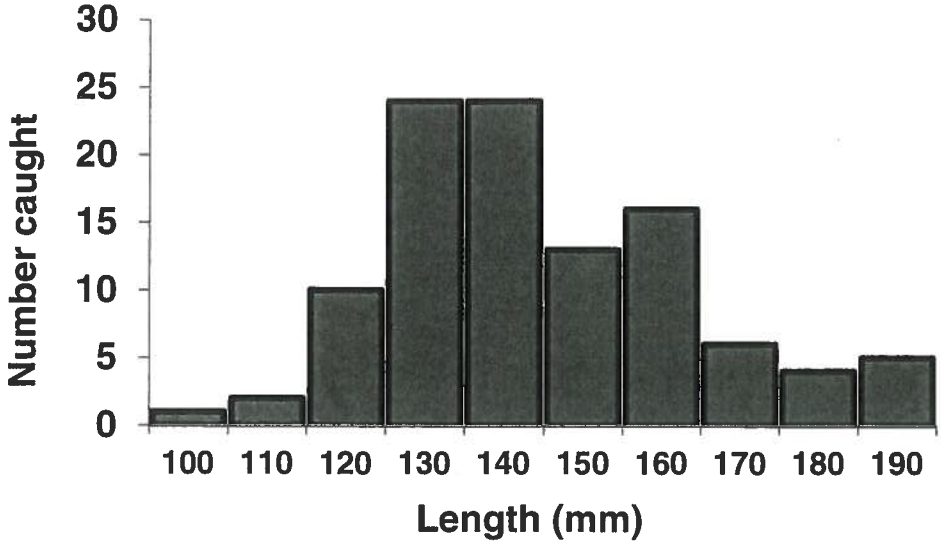


Figure 31. Length frequency distribution of pygmy whitefish collected in Spirit Lake, Idaho, 2011.

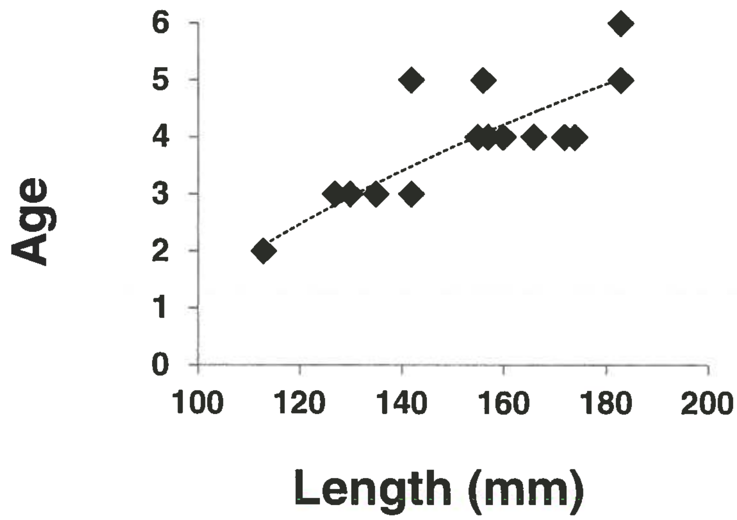


Figure 32. Ages of pygmy whitefish from Spirit Lake, Idaho, during 2011.

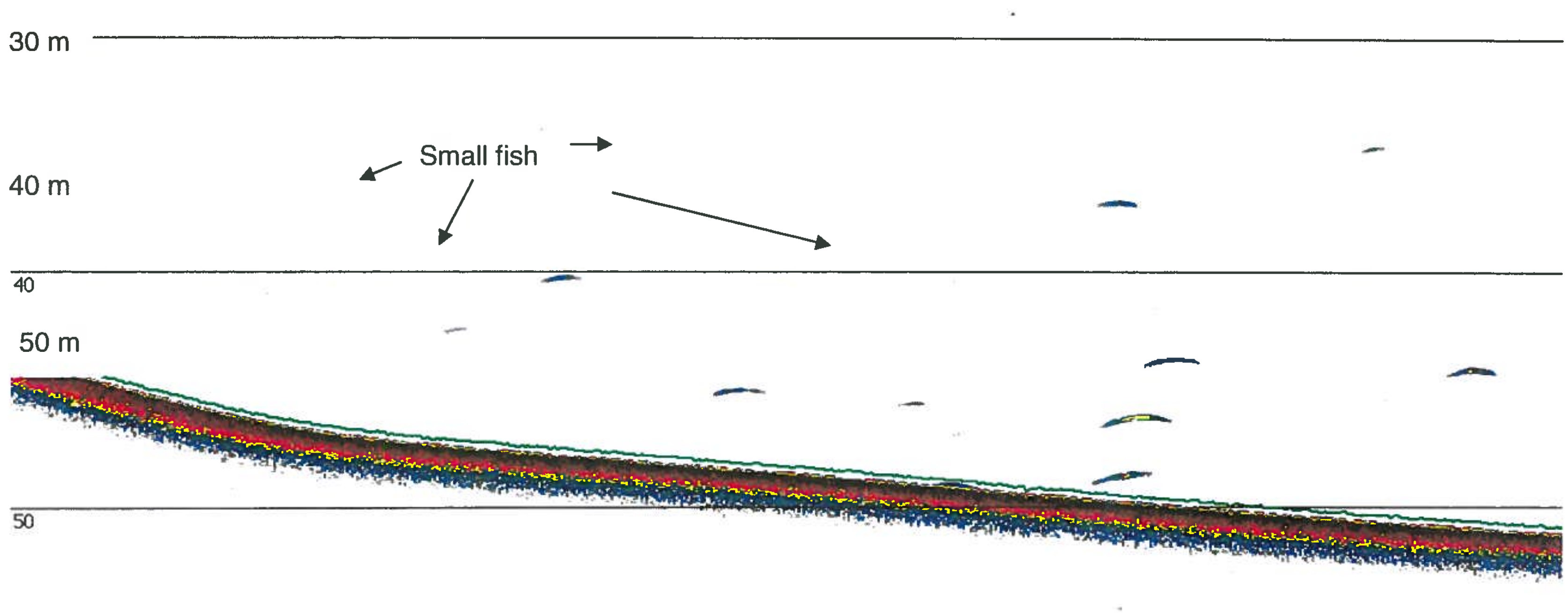


Figure 33. Section of an echogram recorded on Priest Lake on June 22, 2011. Note the distribution of small fish well above the lake's bottom.

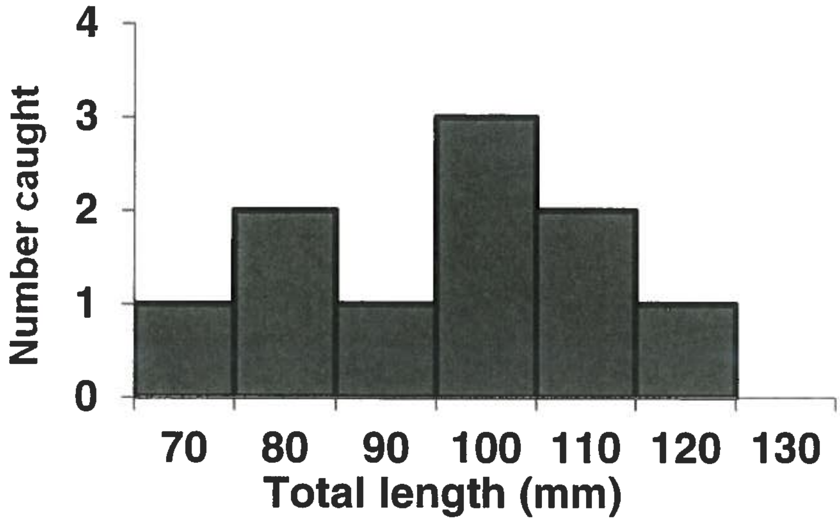


Figure 34. Length frequency distribution of pygmy whitefish collected in Priest Lake Idaho, during 2011.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 6: PEND OREILLE WALLEYE MONITORING

ABSTRACT

Non-native fish colonization has been recognized as a threat to native fish communities across the west and specifically in the Pend Oreille drainage. Walleye, a non-native fish in the Pend Oreille basin, were first documented in this system during a fishery survey of the Pend Oreille River in 2005. A description of walleye abundance and distribution in Lake Pend Oreille and the Pend Oreille River was important for fisheries managers to understand how this new introduced piscivorous species may impact native fish and kokanee in this system. In 2011, we completed a survey of walleye abundance and distribution in Lake Pend Oreille and the Pend Oreille River following standardized Fall Walleye Index Netting (FWIN) protocols. We completed 40 net nights among all sampled areas resulting in a total capture of 57 walleye and a catch rate of 1.4 ± 0.66 walleye per net. Walleye represented five age classes with 88% of all walleye estimated at two years of age. Survey results suggested walleye were present in low abundance, but demonstrated characteristics such as fast growth, good condition, and early maturity consistent with a potentially expanding population. If walleye abundance continues to increase, sensitive native fish and important sportfish are likely to be impacted especially where habitat preferences overlap as in the Pend Oreille River.

Authors:

Robert Ryan
Regional Fisheries Biologist

Jim Fredericks
Regional Fisheries Manager

INTRODUCTION

Non-native fish colonization has been recognized as a threat to native fish communities across the west and specifically in the Pend Oreille drainage (PBTAT 1998). Case studies throughout the intermountain west have clearly demonstrated that introduced lake trout *Salvelinus namaycush* threaten the persistence of native fish assemblages including bull trout *Salvelinus confluentus* and cutthroat trout (Donald and Alger 1993; Fredenberg 2002; Martinez et al. 2009). Walleye *Sander vitreus* have also been demonstrated to negatively impact salmonid fish assemblages where these populations overlap (Baldwin et al. 2003). Lake trout in Lake Pend Oreille (LPO) are heavily studied and currently being suppressed in an effort to enhance kokanee *Oncorhynchus nerka* and associated native fish assemblages. Walleye are also present in LPO, but little is known about their abundance, distribution, and associated impacts on desired fish communities.

Walleye, a non-native to the Pend Oreille basin, were first documented in the system during a fishery survey of the Pend Oreille River (POR) in 2005 (Schoby et al. 2007). Subsequently, walleye were also documented in LPO near the Pack River since 2007 (IDFG, unpublished data). Walleye were illegally established in the lower Clark Fork River, Montana within the Noxon Reservoir reach in the early 1990's and continue to persist (Huston 1994, Horn et al. 2009). This upstream population is believed to be the source of primary introduction into LPO and the POR. Two walleye were collected in the lower Clark Fork River, Idaho in 2002 (Downs and Jakubowski 2003), suggesting walleye have likely been present downstream of Noxon Reservoir in small numbers for some time.

In addition to documenting the presence of walleye in 2007, LPO lake trout netting efforts have provided a crude measure of relative walleye abundance. Walleye have been collected at one sample site near the Pack River in a repeated spring net set since 2007 (IDFG, unpublished data). Most walleye caught at this site since 2007 have been mature adults. However, in 2011 juvenile production was first documented by the capture of multiple younger age classes. IDFG fisheries surveys of the POR in 2010 also documented walleye of multiple age classes distributed throughout the system (Maiolie et al. 2011). POR samples demonstrated a relative increase in walleye abundance from 2005. Results from these efforts suggested walleye were likely expanding in both abundance and distribution.

A limited target fishery for walleye in LPO and the POR has been reported by anglers for several years. However, in 2011 anglers first began reporting consistent catches of walleye primarily in the POR. IDFG maintains policy against introduction or management for walleye in open systems (IDFG 2007). As such no harvest restrictions have been placed on Pend Oreille basin waters.

A description of walleye abundance and distribution in LPO and the POR is essential for fisheries managers to understand how this new introduced piscivorous species may impact native fish and kokanee in the Pend Oreille system. Our objective was to initiate a walleye monitoring program that provided an understanding of current abundance, distribution, and potential impacts of walleye in LPO and the POR. Establishment of a monitoring survey would also allow for standardized comparisons to monitor changes in abundance, distribution, and potential impacts over time.

METHODS

We completed a survey of walleye abundance and distribution in LPO and the POR following standardized Fall Walleye Index Netting (FWIN) protocols described in the FWIN Manual of Instructions (Morgan 2002). FWIN sampling was conducted between September 30 and October 7, 2011. Sample locations were randomly selected, but were focused within the northern portion of LPO (Clark Fork River delta to POR mouth) and the POR (Appendix A). These areas contained water depths consistent with FWIN protocol. Much of LPO was not compatible with the selected sampling protocol due to existing bathymetry. Selected sample zones were defined within the 25 m depth contour. We also excluded two areas from sampling due to concerns with overlapping bull trout distribution and associated potential by-catch. Excluded areas included the Pack River mouth and the lower most portion of the Pend Oreille River in Idaho from the historic community of Thema downstream. The total area included in the survey was approximately 10,000 ha. We set a total of 36 nets based on sample size recommendations described in FWIN protocol. In addition to survey effort in the northern portion of the basin we sampled a limited portion of the southernmost tip of LPO (Idlewilde and Scenic Bays) to assist in describing distribution on a larger scale. Bathymetry also limited available sample locations in this zone. In addition, shoreline development and boating traffic limited sample locations. Due to these challenges sample locations were not randomly selected, but rather chosen on availability.

We used monofilament experimental gill nets described in the FWIN protocol to sample fish. Nets were eight panel monofilament nets 1.8 m deep, 61.0 m long, with 7.6 m panels measuring 25 mm, 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 127 mm, and 152 mm stretched mesh. Net sets were equally divided between two depth strata including 2 – 5 m and 5 – 15 m depths. All nets were placed perpendicular to the shoreline. Netting was conducted at water temperatures between 10 °C and 15 °C. Net sets were approximately 24 hour in length. Catch-per-unit-effort (CPUE) calculated as catch-per-net was used to describe relative abundance of walleye. The arithmetic mean of CPUE was used to describe average relative abundance among all samples.

Upon removal from gill nets physical metrics were collected from fish. We measured total length (mm,TL) and weighed (g) all walleye. All non-target species were measured, with a sub-sample weighed. We collected otoliths from all walleye for estimation of age. We estimated age by examining otoliths under a dissecting microscope in whole view or by breaking centrally, browning, sanding, and viewing the cross section. Growth patterns were evaluated using estimated fish ages to determine mean length at age by sex.

Condition indices were generated from collected walleye to describe the general health of the population. To estimate condition indices, we removed and weighed visceral fat. Visceral fat weights were used in calculating a visceral fat index as a measure of condition. We calculated the visceral fat index as the ratio of visceral fat weight to total body weight and described as a percentage. Gonads were also removed and weighed to estimate a gonadal somatic index value for each fish. We calculated the gonadal somatic index value as the ratio of gonad weight to body weight and described as a percentage. We calculated relative weights and summarized them by size groups labeled as stock, quality, preferred, trophy, and memorable as defined in FAST (Fisheries Analyses and Simulation Tools, version 2.1; Anderson and Neumann 1996).

We estimated rates of sexual maturity by examining all walleye and ranking each individual as mature or immature (Duffy et al. 2000). Maturation rates are inversely related to growth rate and may reflect changes in population dynamics (Gangl and Pereira 2003, Schneider et al. 2007). We determined total length and age at 50% maturity using logistic regression (Quinn and Deriso 1999). We also calculated a female diversity index value based on the Shannon diversity index to describe the diversity of the age structure of mature females (Gangl and Pereira 2003). The female diversity index has been shown to be sensitive to changes in population structure (Gangl and Pereira 2003).

No attempt was made to evaluate stomach contents of collected walleye. Diet samples collected from fish caught in overnight gill net sets are generally considered to poorly represent actual consumed items or quantities as fish tend to regurgitate stomach contents when entangled.

RESULTS

We completed 40 net-nights among all sampled areas. A total of 57 walleye were collected comprising 2.7% of the total catch. Walleye CPUE ranged from zero to 18 walleye per net. Walleye were captured at 16 of 40 sample sites. Relative abundance measured as arithmetic mean CPUE for walleye of all age classes was 1.4 fish/net (± 0.66, 80% CI). Although we did not capture walleye in every net, we did capture walleye in representative samples throughout LPO and the POR (Figure 35). However, POR net sets represented a disproportionate percentage of the total walleye sample at 68% of all walleye captured and 28% of sampled sites.

We collected 20 other species at varying relative proportions in the by-catch associated with walleye netting including: black bullhead *Ictalurus melas* (1.9%), black crappie *Pomoxis nigromaculatus* (1.8%), brown trout *Salmo trutta* (0.7%), kokanee (0.6%), largemouth bass *Micropterus salmoides* (0.1%), longnose sucker *Catostomus catostomus* (3.9%), largescale sucker *Catostomus macrocheilus* (2.4%), lake whitefish *Coregonus clupeaformis* 9.9%), mountain whitefish *Prosopium williamsoni* (0.9%), northern pikeminnow *Ptychocheilus oregonensis* (14.6%), peamouth *Mylocheilus caurinus* (12.6%), pumpkinseed *Lepomis gibbosus* (1.0%), rainbow trout *Oncorhynchus mykiss* (0.2%), redside shiner *Richardsonius balteatus* (< 0.1%), smallmouth bass *Micropterus dolomieui* (3.3%), tench *Tinca tinca* (6.9%), westslope cutthroat trout *Oncorhynchus clarkii lewisi* (0.3%), westslope cutthroat x rainbow trout hybrids (0.2%),and yellow perch *Perca flavescens* (35.9 %) (Table 29). Mean length and weight of collected species were listed in Table 29. Sensitive native species (bull trout and westslope cutthroat trout) and sport fish including rainbow trout and kokanee were caught in association with walleye at only three of 40 sample locations. In contrast, yellow perch were captured at all but three of 16 locations walleye were sampled.

Mean total length of sampled walleye was 426 mm (± 13 mm, 80% CI) and ranged from 307 mm to 718 mm (Figure 35). Mean weight of sampled walleye was 885 g (± 122 g, 80% CI). PSD of the sampled population was 77.19 (66.3 – 88.1, 95% CI). Walleye of stock size (at least 249 mm) and greater made up 100% of the sampled population. Nine percent of the sampled walleye were of preferred length (at least 509 mm) or greater (Figure 36).

Walleye collected in sampling efforts had a mean gonadal somatic index of 0.8 and 2.1(± 0.43, 0.23; 80% CI) for males and females, respectively. Mean visceral fat indices were 3.5 and 4.5 (± 0.65, 0.26; 80% CI) for male and female walleye, respectively. Relative weight (Wr) ranged from 96 to 106 for males and from 90 to 108 for females.

Five age classes were present in the collected samples representing fish of age classes one, two, three, four, and eight (Figure 37). The majority of walleye sampled (88%) were two years old. Age classes one and three were represented by only one sample. Missing cohorts observed in age frequencies were also observed in walleye length frequencies (Figure 36).

Growth rates of sampled walleye varied by sex. Female growth described by length at age was greater than comparable male growth when viewed over all age classes (Figure 38). Mean length at age-2 was 403 mm and 415 mm for males and females, respectively.

Male walleye were more abundant in the catch (72%) than females (28%) (Figure 39). Seventy eight percent of sampled males were mature, while only 19% of females were mature. Age and length at 50% maturity for female walleye were estimated at 3 years and 525 mm, respectively. Age and length at 50% maturity for male walleye were estimated at less than one year and 192 mm, respectively. Seventy five percent of age-2 males were mature. Although we estimated maturation rates, it is likely our estimates were inaccurate due to sample size limitations and limited representation by most age classes. We sampled only three female walleye estimated at greater than three years of age of which all were mature. Female diversity index was valued at 0.28.

DISCUSSION

Catch rates observed in our survey of walleye in the Pend Oreille basin (CPUE, 1.4 ± 0.66) suggested abundance is low, but walleye were well distributed throughout the system with fish captured at 16 different sample locations across all major regions sampled. Comparable surveys of other established walleye populations in Idaho and Washington provided a reference of relative abundance for walleye in the Pend Oreille basin. Average CPUE from FWIN surveys in southern Idaho reservoirs with established walleye populations were considerably higher than the Pend Oreille basin, ranging from 19 to 34 walleye per net (Ryan et al. 2009, IDFG unpublished data). A similar scale of catch rates were identified in Washington walleye populations using the FWIN survey protocol, with a mean catch rate reported from across multiple waters of 19 walleye per net (WDFW 2005). More closely comparable were catch rates reported from FWIN surveys of Ontario walleye waters ranging from 2.8 to 10.7 fish per net (Ministry of Natural Resources (MNR) 2005). The 2011 survey provided a baseline condition to which walleye abundance and distribution may be compared in the future.

Our observations of walleye in this system were consistent with a newly established population. Sampled walleye represented only five age classes spread over nine years. Walleye often experience variable recruitment affected by multiple biotic and abiotic factors (Muth and Wolfret 1986, Quist et al. 2003b, Schneider et al. 2007). The absence of numerous age classes combined with low abundance in most present age classes suggested walleye have been present at most in only a very limited capacity prior to the 2009 recruitment year, represented by the abundant age-2 year class. It is feasible females in the 2003 year class, represented in the 2011 sample as age-8 walleye, were the founding population demonstrating consistent recruitment between 2007 and 2010. Maturation of female walleye between ages three and four as observed in our collections was consistent with this timeline. Previous surveys of species composition in the Pend Oreille River confirm walleye were undocumented in that system prior to 2005 (Schoby 2007, Karchesky 2002, Dupont 1994). However, Schoby et al. (2007) reported collecting walleye in the Pend Oreille River in 2005 representing not only the 2003 year class, but also fish recruited in 2002 and 2001 and Downs and Jakubowski (2003) collected walleye in 2002 in the lower Clark Fork River, suggesting some contribution was possible from age classes present prior to 2003 and not represented in our 2011 sample. Open downstream passage from lower Clark Fork River reservoirs likely contribute walleye downstream to Idaho waters making interpretation of recruitment dynamics complex. We are uncertain what walleye recruitment will be like in the Pend Oreille basin looking forward. However, we expect, given a strong maturing age-2 year class, population expansion is likely. We expect female walleye in this year class will largely be mature within the next two years, resulting in a significant increase in spawning potential. Consistent recruitment over the previous four years provides some evidence spawning habitat is available.

Although, we are uncertain what the long term projection of walleye in the Pend Oreille basin will be, survey results suggest walleye demonstrated physical characteristics such as elevated growth rate and early maturity that allow for population expansion. Walleye commonly demonstrate variable growth across a latitudinal gradient (Quist 2003a). However, observed walleye growth in sample fish comparatively evaluated as length at age-2 demonstrated rapid initial growth beyond that experienced in other regional waters of similar latitude. Ryan et al. (2009) reported walleye length at age two of 276 mm to 350 mm for male walleye and 287 mm to 369 mm for female walleye from two southern Idaho reservoirs with established walleye populations. Horn et al. (2009) compared length at age-2 from several waters of the northwest and great lakes regions of the United States and found a wide variation from 295 mm to 396 mm. Age-2 walleye of combined sexes from Noxon Reservoir, Montana, up-stream of LPO, averaged 320 mm in the same comparison. With estimated walleye total length at age-2 above 400 mm for male and female, our study represents greater average growth than most comparable waters. Although, we likely failed to accurately estimate the timing associated with maturity due to few representative samples, it was clear early maturity in male walleye is occurring with 75% of age-2 males being mature. Maturation of male walleye has been generally described as initiating at a range of 2 to 9 years of age or beyond a threshold of 34cm (Kerr et al. 2004). In contrast, female walleye typically mature one to two years later than males at total lengths of 440 to 480 mm, consistent with our limited sample of mature female walleye. If walleye abundance increases in the Pend Oreille basin we expect declining growth and maturation rates may be detectable in monitoring efforts.

Consistent with our observations of rapid growth, Pend Oreille basin walleye also demonstrated above average condition. Relative weight values above 90 for all size classes sampled indicated walleye had average to above average weight. Visceral fat content of walleye from all size classes was also observed to be high at 3.5 to 4.5. In comparison, visceral fat indices from southern Idaho waters have been reported to range from 1.26 to 3.75 (Ryan et al. 2009). These measures of physical condition suggested forage was readily available. Reported by-catch demonstrated several species dominated the fish community within the areas sampled and were readily available as forage. Although dominant species in this survey did not include sensitive native species they did include yellow perch, a popular sportfish. It should be noted sampling nets were sinking bottom oriented nets that were not likely efficient at capturing pelagic oriented fishes such as westslope cutthroat and kokanee. In addition, sampling criteria were not intended to identify forage preferences. However, continued monitoring of walleye condition should provide some insight into the availability of forage in the system and consequently impacts to other species in the present fish community.

The primary concern related to the presence of walleye in the Pend Oreille Basin is the potential for negative impacts to native fish and other sportfish. We observed few sensitive native fish species such as bull trout and cutthroat trout in the by-catch in our survey, which suggested interactions between walleye and these species may be limited. However, sampling methods were designed to capture walleye and may not accurately represent the larger fish community. It is anticipated an increasing walleye population could negatively impact existing fish communities where known habitat preferences of native fishes overlap with the described walleye distribution. For example, the POR is a seasonal travel corridor for bull trout using the Priest River system for spawning and rearing (Dupont et al. 2007). In the POR walleye were well distributed among samples and demonstrated the highest catch rates among all areas representing 68% of all walleye sampled. Other scenarios where walleye may impact sportfish in LPO may also be plausible although less definitive. Walleye commonly conflict with management of salmonid fisheries including kokanee and rainbow trout around the west (Baldwin et al. 2003, Yule et al. 2000). These conflicts typically occur where habitat preferences overlap. LPO differs from most western lentic waters given its significant expanse of deep pelagic water. It is unclear to what extent a more littoral oriented fish species such as walleye might utilize this large pelagic zone.

MANAGEMENT RECOMMENDATIONS

1. Continue FWIN surveys on a three-year rotation to evaluate changes in relative abundance and distribution as well as corresponding shifts in non-target species.

2. Consider development of a comparative evaluation to better describe future impacts to the present fish community that may result from expanding walleye abundance.

Table 29. Catch summary of fish collected in the 2011 FWIN survey of Lake Pend Oreille and the Pend Oreille River, Idaho. Summary statistics included catch (N) and percent catch by species, average total length (Avg TL), standard deviation of measured total lengths (Stdev TL),average weight (Avg WT), and standard deviation of measured fish weights (Stdev WT).

Species	N	% Catch	Avg TL	Stdev TL	Avg WT	Stdev WT
Redside shiner	1	0.0%	NA	NA	NA	NA
Largemouth bass	3	0.1%	212	98	290	170
Rainbow trout	4	0.2%	379	54	480	170
Cutthroat x rainbow hybrid	5	0.2%	359	71	420	266
Bull trout	6	0.3%	363	65	439	288
Westslope cutthroat trout	6	0.3%	347	69	472	179
Kokanee	12	0.6%	240	89	104	106
Brown trout	15	0.7%	482	123	1368	1057
Mountain whitefish	18	0.9%	305	62	362	47
Pumpkinseed	20	1.0%	133	26	62	37
Black crappie	37	1.8%	185	52	132	133
Black bullhead	39	1.9%	267	40	306	145
Largescale sucker	50	2.4%	435	103	1129	764
Walleye	57	2.7%	426	76	885	719
Smallmouth bass	68	3.3%	295	82	493	435
Longnose sucker	81	3.9%	326	63	349	210
Tench	144	6.9%	435	48	1190	313
Lake whitefish	206	9.9%	297	93	244	184
Peamouth	262	12.6%	245	67	116	97
Northern pikeminnow	304	14.6%	312	92	372	307
Yellow perch	749	35.9%	172	41	76	88

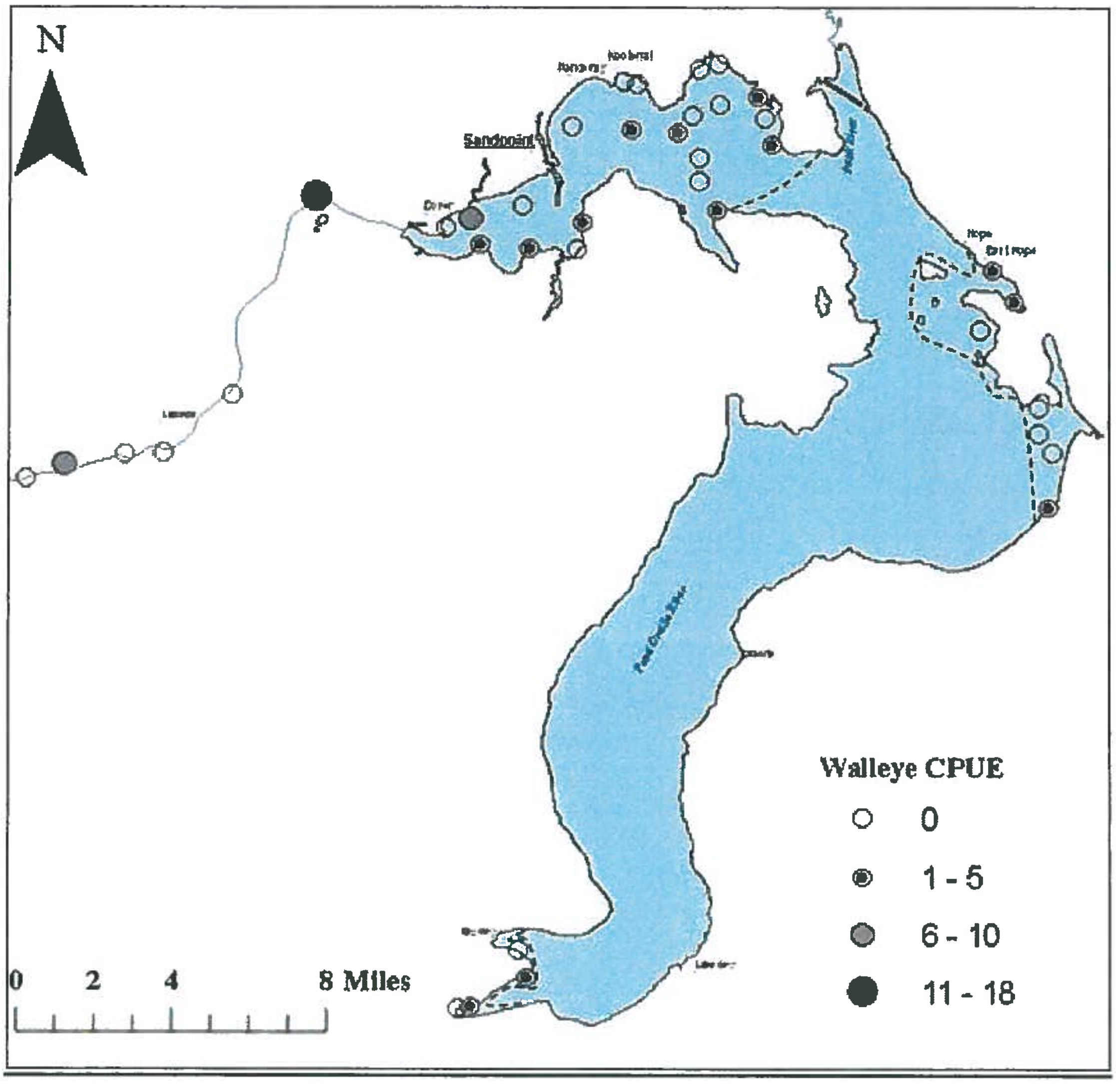


Figure 35. Fall walleye index netting sample locations in the Pend Oreille Basin, Idaho 2011. Sample sites displayed by catch per unit effort (CPUE, net night). Dashed lines represent approximated sample boundaries primarily defined by 25 m depth contours.

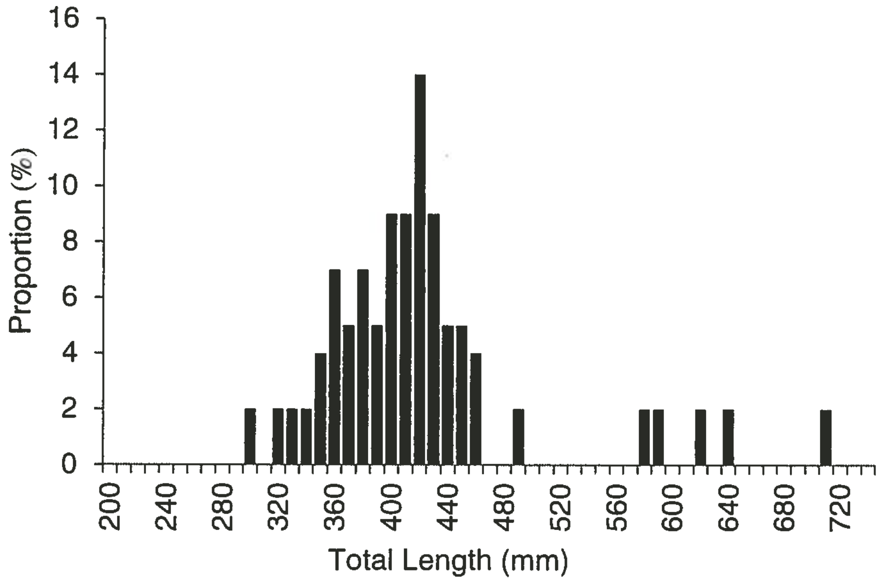


Figure 36. Proportion of sampled walleye by total length collected in 2011 FWIN sampling of Lake Pend Oreille and the Pend Oreille River, Idaho.

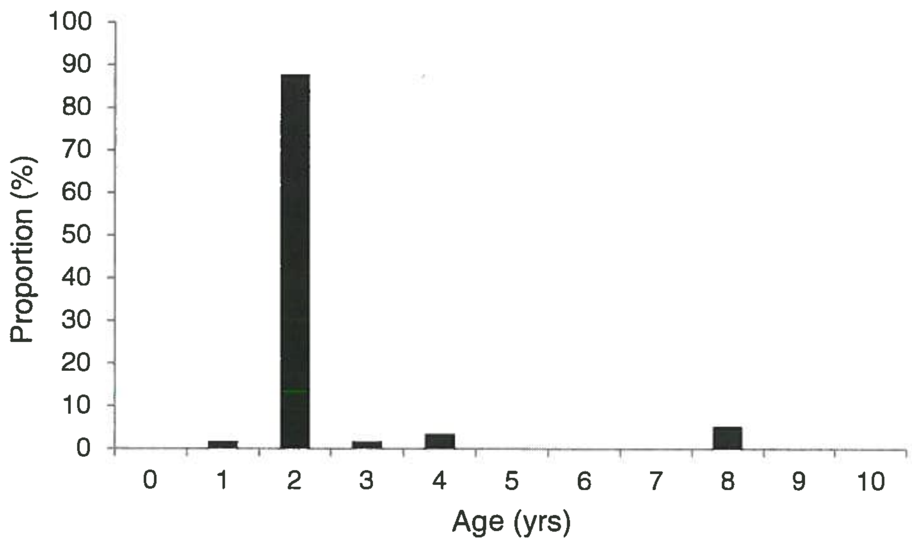


Figure 37. Proportion of sampled walleye by age collected in 2011 FWIN sampling of Lake Pend Oreille and the Pend Oreille River, Idaho.

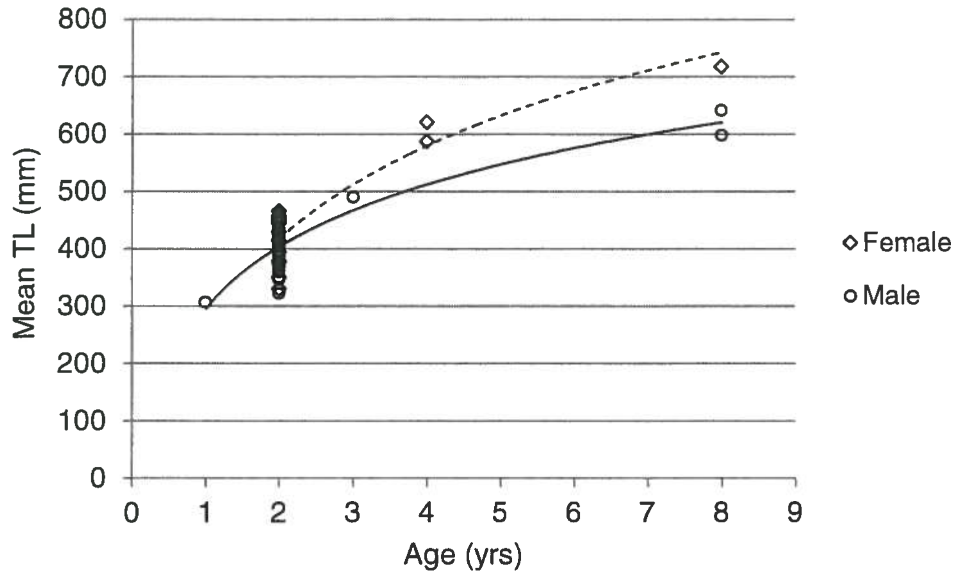


Figure 38. Mean total length at age of male and female walleye collected in 2011 FWIN sampling of Lake Pend Oreille and the Pend Oreille River, Idaho.

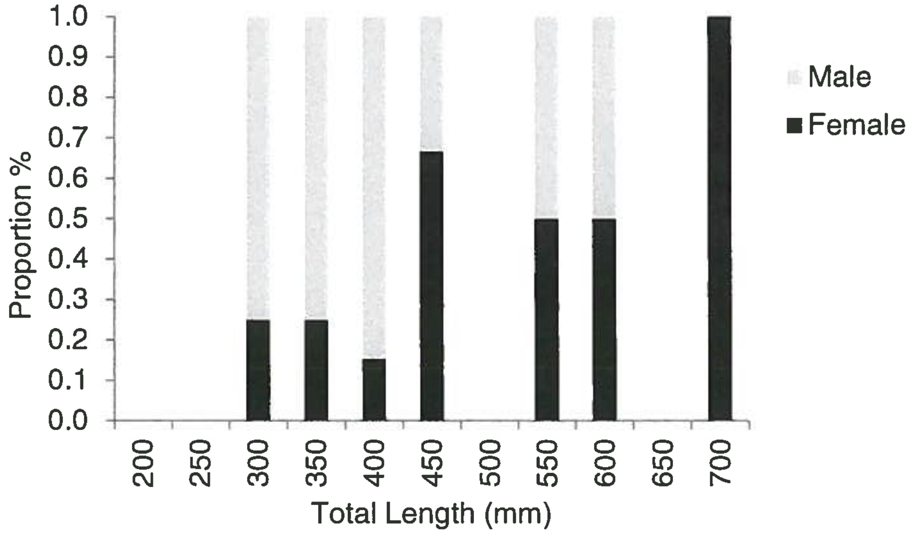


Figure 39. Proportions of male and female walleye collected in 2011 FWIN sampling of Lake Pend Oreille and the Pend Oreille River, Idaho.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 7: FERNAN AND HAUSER LAKE CREEL SURVEYS

ABSTRACT

Creel surveys on Fernan and Hauser lakes were conducted from May 1 to October 1, 2011. We interviewed a total of 736 anglers on Fernan Lake and estimated effort was approximately 50,219 hours; compared to 97,490 hours in 1993. The majority of anglers were targeting rainbow trout (31.9%) followed by "anything" (30.4%), channel catfish (18.9%) and largemouth bass (6.5%). Anglers caught an estimated 33,703 fish in Fernan Lake, and catch was comprised of 9,920 bluegill, 5,031 black crappie, 4,429 rainbow trout, 4,415 yellow perch, 4,294 largemouth bass, 2,406 channel catfish, 1,687 pumpkinseed, 1,260 smallmouth bass, 250 tench, and 10 northern pike. We interviewed a total of 682 anglers on Hauser Lake. Angler effort was estimated to be 37,442 hours on Hauser Lake. Overall, angler effort was down 60-65% from our 1993 surveys. This effort was spread out between several species with the majority of anglers targeting "anything" (32%), channel catfish (21.3%), rainbow trout (20.9%) and largemouth bass (10.4%). Anglers caught an estimated 37,121 fish in Hauser Lake during the five month survey. Estimated catch in Hauser Lake was comprised of 22,351 bluegill, 4,654 rainbow trout, 3,692 channel catfish, 2,587 largemouth bass, 2,008 black crappie, 778 pumpkinseed, 648 yellow perch, 278 smallmouth bass, 53 tench, 38 kokanee salmon and 34 tiger musky. In 2011, angler effort and catch rates for channel catfish were higher than were seen in past surveys. The increase in estimated catch and effort is likely due to modifications made to the 2011 creel survey methods which included nighttime counts and interviews; the period when channel catfish are most heavily targeted.

Authors:

Mark Liter
Regional Fishery Biologist

Kelly Carter-Lynn
Fishery Technician

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Hauser and Fernan lakes provide year-round fishing opportunity for a variety of species and are popular fisheries for residents and non-residents. Since the 1970's both lakes have been primarily rainbow trout *Oncorhynchus mykiss* fisheries. In 1993 Idaho Department of Fish and Game (IDFG) conducted a fishery survey and angler survey to assess the Fernan Lake fishery (Nelson et al. 1996). Seven species of gamefish were reported caught with hatchery rainbow trout being the most common (33%). Yellow perch *Perca flavescens* and black crappie *Pomoxis nigromaculatus* were the most abundant warmwater species captured by anglers in 1993 consisting of 21% and 18% of the creel respectively. With its close proximity to Coeur d'Alene, Fernan Lake is heavily fished year-round receiving an estimated 97,000 hours of effort in 1993. In 1993, IDFG also conducted a fishery survey and angler survey to assess the Hauser Lake fishery (Nelson et al. 1996). Six species of gamefish were reported caught with black crappie being the most common species harvested (42%). Hatchery rainbow trout were the second most harvested species comprising 29% of angler harvest.

Two to six thousand channel catfish *Ictalurus punctatus* have been stocked in Hauser and Fernan lakes annually since their initial introduction in 1989. Stocking rates ranged from 21 to 25 channel catfish/ha in Hauser and Fernan lakes in 2011 representing a substantial investment. The cost of production and distribution averaged $.90 per channel catfish fingerling stocked in the Panhandle Region in 2011 (Tom Frew IDFG Resident Hatchery Manager, Personal Communication). Because cooler water temperatures in northern Idaho are not conducive to successful channel catfish reproduction, channel catfish numbers are controlled by stocking and angler harvest. Current Idaho regulations set no bag limit, size or possession limits on channel catfish; and exploitation rates have not been estimated for most Idaho catfish fisheries. Previous creel surveys estimated little angler effort toward channel catfish in Hauser and Fernan lakes, however, no nighttime interviews were conducted during those surveys.

In 2011, approximately 15,000 hatchery catchable rainbow trout were stocked into Hauser and Fernan lakes each. We implemented an assessment of catchable rainbow trout return-rates and a channel catfish assessment in Hauser and Fernan lakes in 2011 to ensure proper management and use of limited hatchery resources. Additionally, these surveys allow us an opportunity to document increasing effort directed at warmwater species on each lake. We conducted creel surveys on Hauser and Fernan lakes in 2011 to evaluate characteristics of the fisheries today including the contribution of hatchery fish (catchable rainbow trout and channel catfish) to the fishery.

OBJECTIVE

Assess fishing effort, catch, and harvest on Fernan and Hauser lakes fisheries through a five month-long creel survey.

STUDY AREA

Fernan Lake

Fernan Lake is located in Kootenai County, just east of Coeur d'Alene, Idaho (Fig. 40). The watershed is approximately 4,872 ha. with 102 ha. inside the Coeur d'Alene city limits. Fernan Lake has a surface area of 121 ha, a mean depth of 3.7 m and a max depth of 7.6 m. Water quality studies conducted by Idaho Department of Health and Welfare Division of Environmental Quality classifies Fernan Lake as mesotrophic (Mossier 1993). Most of the

Fernan Lake shoreline is forested while the northwest corner of the lake lies within the Fernan Lake Village corporate limits. Public access is limited to two boat ramps, one on the east and another on the west end of the lake and several newly created roadside access points.

Fernan Lake is stocked annually with 15,000 - 19,000 triploid Kamloops rainbow trout catchables, 5,000-7,000 westslope cutthroat trout fingerlings *O. clarkii,* and approximately 3,000 catchable size channel catfish. Fernan Lake is managed as a Family Fishing Water.

Hauser Lake

Hauser Lake is located in Kootenai County, 24 km northwest of Coeur d'Alene, Idaho (Fig. 40), and covers approximately 223 ha. The western and northern shorelines are blanketed in macrophytes whereas the eastern shoreline has rock outcrops and riprap along a roadside with steep bank slopes. Inflow to the lake includes several small tributaries and ground water and outflow is minimal, eventually flowing into the Rathdrum aquifer. Mean depth is 6.4 m with a maximum depth of 12.2 m. Public boating access to Hauser Lake is limited to a single boat launch, operated by Kootenai County Parks and Waterways, located on the southwest end of the lake. This ramp is utilized extensively by pleasure boaters and anglers. About 50% of the shoreline is developed with seasonal and year-round residences. Numerous roadside access points are scattered along the perimeter.

Hauser Lake is stocked with 15,000-17,000 thousand triploid rainbow trout catchables and 60,000 kokanee *O. nerka* fingerlings each year. Additionally, 33,781 early spawner kokanee fingerlings, 15,125 westslope cutthroat fingerlings and 14,348 rainbow trout fingerlings were stocked in Hauser Lake in 2011. Approximately 5,000 channel catfish of catchable size are stocked on an annual basis. Beginning in 1989, tiger musky *E. masquinongy* X *E. lucius* were stocked in Hauser Lake, however, annual stocking of tiger muskies has not been possible due to a lack of disease free fish in recent years. The Idaho state record tiger musky was captured in Hauser Lake in 2001, weighing 17.4 kg and measuring 123 cm. Hauser Lake is managed under general fishing regulations.

METHODS

We conducted a five month-long roving-roving creel survey on Fernan and Hauser lakes between May 1 and October 1, 2011. Randomly selected creel counts were performed on 2 weekdays and 2 weekend days for each two week interval. Count times (3 replicates per count day) were also randomly selected and split into a.m., p.m. and night shifts. The p.m. and night shifts were six hours long (noon to six p.m. and six p.m. to midnight) with the a.m. shift length depending on day length (sunrise to noon). Sunrise was defined by the official 2011 NOAA calendar. To obtain specific creel information, we conducted interviews of anglers in conjunction with angler counts. We boated the lake, waited at boat ramps, or traveled by vehicle to interview fishermen at roadside access points. Calculations of fishing pressure, harvest, and catch rates were made following methods outlined in Pollock et al. (1994).

RESULTS

Fernan Lake

We interviewed a total of 736 anglers on Fernan Lake (Table 30). The month with the highest number of interviews was June (Table 30). Anglers from 15 different states were interviewed, with the majority (92%) being Idaho residents (Table 31). Total estimated effort over the 5 month period was approximately 50,219 hours (Table 32) with the highest amount of angler effort during the month of May (Table 30). Effort was spread out between several species with the majority of anglers targeting rainbow trout (31.9%) followed by anglers targeting "anything" (30.4%) channel catfish (18.9%) (Table 33). Anglers caught an estimated 33,703 fish in Fernan Lake during the survey (Table 32), with an estimated 9,332 fish harvested (Table 34). Catch rates were highest for bluegill followed by yellow perch and largemouth bass *Micropterus salmoides* while harvest rates were highest for bluegill followed by yellow perch and black crappie (Table 35). The percentage of anglers (73%) fishing from shore remained unchanged from 1993.

Hauser Lake

We interviewed a total of 682 anglers on Hauser Lake (Tables 30 and 31). The month with the highest number of interviews was June (Table 30). Anglers from 9 different states were interviewed on Hauser Lake, with the majority (77%) being Idaho residents (Table 31). Total estimated effort over the 5 month period was approximately 37,442 hours (Table 36) with the highest amount of angler effort during the month of June (Table 30). Effort was spread out between several species with the majority of angler effort (32%) targeting "anything", followed by channel catfish (21.3%) (Table 33). Anglers caught an estimated 37,121 fish in Hauser Lake during the survey (Table 36), with an estimated 18,298 fish harvested (Table 37). Catch rates were highest for bluegill followed by rainbow trout, largemouth bass and black crappie while harvest rates were highest for bluegill followed by rainbow trout and black crappie (Tables 35 and 36). As with Fernan Lake, the percentage of anglers fishing from shore was unchanged from 1993 at 67%.

DISCUSSION

Fernan Lake

Anglers caught an estimated 33,703 fish from Fernan Lake between May 1 and October 1, 2011 compared to 46,974 in a similar time-period in 1993. Our 1993 creel survey reported 97,490 angler hours compared to 50,219 hours in 2011 (Table 32). Fernan Lake has seen a considerable reduction in rainbow trout harvest since the early 1990's. Approximately 32% of angler effort was directed at hatchery rainbow trout and rainbow trout made up 30% of harvest in 2011 (Table 33 and Table 34). Nelson et al. (1996) reported that in 1993, rainbow trout comprised 47% of species caught. Anglers harvested 2,828 trout in 2011 compared to 7,775 in 1993 (Table 32). While estimated effort has decreased since 1993, catch rates and angler exploitation rates for hatchery rainbow trout have varied little. Catch rates near 0.1 fish/hr are consistent with those reported by Nelson et al. (1996).

Similar to Hauser Lake, harvest of warmwater species in Fernan Lake in 2011 was considerably higher than previous surveys. The Fernan Lake fish community now contains bluegill which was not present during previous creel surveys and we speculate that they are the result of an illegal introduction. Bluegill, channel catfish and yellow perch were the warmwater fish species harvested most frequently in 2011 accounting for 54% of the fish caught (Table 34). Approximately 37% of angler effort in Fernan Lake during 2011 was targeted at warmwater species, primarily channel catfish and largemouth bass (Table 33). Additionally, we estimated that anglers caught 2,406 channel catfish representing 7% of the fish caught in 2011 and 18.9% of the angler effort (Table 33 and Table 34). We conducted an angler exploitation study on channel catfish on Fernan Lake in 2011. Through December 31, 2011, 3 of 105 tagged channel catfish in Fernan Lake were returned. After correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation for channel catfish was estimated at 4% in Fernan Lake.

One additional tag was returned in February, 2012 but not included in this estimate. Results of this study are reported in our 2011 Regional Fisheries Management Report, channel catfish evaluation.

In 2009 we evaluated the harvest rates of stocked, catchable-sized trout in Fernan Lake and estimated angler exploitation to be 39%. Additionally, from Fernan Lake we received 5 catchable trout tag returns after December 31, 2009 indicating some "hold-overs". As budgets continue to shrink, the use of limited hatchery rainbow trout continues to be closely scrutinized. With its close proximity to Coeur d'Alene, Fernan Lake is heavily fished year-round receiving more than 50,000 hours of effort in 2011. With an estimated 31.9% of angler effort directed toward rainbow trout and an estimated angler exploitation of 39%, Fernan Lake should be given priority when decisions are made relative to reductions in hatchery rainbow trout stocking.

Hauser Lake

Hauser Lake has seen a reduction in hatchery rainbow trout catch and harvest since the early 1990's. Hatchery rainbow trout harvest on Hauser Lake has declined from 8,153 to 3,855 since 1993 (Table 36) and angler exploitation has dropped significantly. Nelson et al. (1996) reported angler exploitation to be 57% in 1993. In 2010 and 2011 we evaluated the harvest rate of stocked, catchable-sized rainbow trout in Hauser Lake. After correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation was estimated to be 2% in 2010 and 6% in 2011. Hatchery rainbow trout are no longer the most sought after species in Hauser Lake and in 2011 rainbow trout made up only 21% of the harvest and 12% of the catch compared to 34% of the catch in 1993 (Table 33 and Table 37). Additionally, no hold-overs were reported either year. We speculate this low exploitation rate may be explained by water-specific influences; specifically differences in productivity, thermal and oxygen refugia, and depth. Hauser Lake is relatively shallow with a mean depth of 6.4 m and a maximum depth of 12.2 m with suitable trout habitat in late August being limited to the metalimnetic zone approximately 4-7 m from surface because of high epilimnetic temperatures and low hypolimnetic oxygen levels (Fredericks et al. 2002).

Angler effort and harvest of warmwater species in Hauser Lake in 2011 increased compared to 1993 (Table 36). During 2011 approximately 44% of the total fishing effort was spent to catch warmwater species, primarily channel catfish, largemouth bass, bluegill, black crappie and smallmouth bass *M. dolomieui* which in turn accounted for 87% of the total catch (Table 37). Anglers harvested an estimated 18,298 warm water fish compared to 14,300 fish in 1993 (Table 36).

Yellow perch and black crappie were the most abundant warmwater fish harvested in the 1993 however, several changes in the Hauser Lake fish community have occurred in the past 20 years. Channel catfish and tiger musky were introduced into Hauser Lake in 1989 to increase angler opportunity and may have had an adverse effect on the yellow perch population. Additionally, bluegill and smallmouth bass were documented in Hauser Lake in the early 2000's, both illegal introductions. Schneider (1997) reported the addition of bluegill to a Michigan lake resulted in a doubling of biomass of which 52% was bluegill and a decrease in yellow perch biomass by 20%. Additionally, he reported the abundance of large yellow perch (>178 mm) decreased 76%. The biomass loss by yellow perch, mainly by fish >126 mm was attributed to competition with bluegill for large zooplankton and benthic invertebrates. It is likely that a combination of predation and competition resulted in the reduction of harvestable size yellow perch in Hauser Lake. Approximately 6% of angler effort in Hauser Lake in 2011 was targeted toward bluegill and smallmouth bass combined and bluegill made up 60% of angler catch (Table 33 and Table 37).

Like Fernan Lake, channel catfish were present but seldom reported caught in the 1993 Hauser Lake creel survey as no angler interviews were conducted after dark. Parrett et al. (1999) found that over 50% of channel catfish effort and harvest occurred at night in two Ohio impoundments. Anglers caught an estimated 3,692 (+/- 282 95% CI) channel catfish in Hauser Lake in 2011 (Table 36) with 21% of angler effort targeting channel catfish (Table 33). Similar to Fernan Lake we conducted an angler exploitation study on channel catfish on Hauser Lake in 2011. Through December 31, 2011, 1 of 120 tagged channel catfish in Hauser Lake were returned and after correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation for channel catfish was estimated at 1% in Hauser Lake. We assumed a 53% reporting rate, which is typical of non-reward tags for various species (Meyers et al. 2010) and adjusted the return rate accordingly to provide an exploitation estimate. The discrepancy between our creel survey channel catfish catch estimate and our exploitation study is not easily explicable. While Meyers et al. 2010 reported a 53% reporting rate for non-reward tags, channel catfish were not included and perhaps this is an over-estimate and not applicable to channel catfish anglers. We are confident that the discrepancy is not related to tag loss as Travnichek 2004 and Holley 2006 both estimated tag loss at 0% with Carlin dangler tags. Also, tagging mortality was assumed to be a conservative 3% based on work conducted on rainbow trout by Meyer et al. (2010). In addition to potential inaccuracies in reporting rate, most of the inconsistency likely lies within a variety of factors including; the creel survey estimate, 3,692 (+/- 282 95% CI) due to variability in number of channel catfish caught per angler surveyed and misidentification of species or misreporting due to language barriers between anglers and creel survey personnel. A follow up study could include the use of $50 reward tags to further refine channel catfish angler exploitation estimates. Meyers et al. 2010 concluded that $50 reward tags would result in a 92-95% reporting rate.

We estimate anglers caught 34 tiger musky in Hauser Lake in 2011. Tiger musky have been stocked in Hauser since 1989 and for a number of years was an extremely popular fishery, however, disease issues have resulted in a near elimination of tiger musky stocking and in 2011 less than 3% of angler effort was spent targeting tiger musky.

Our hatchery rainbow trout tagging studies in 2010 and 2011 indicate that angler exploitation for hatchery rainbow trout in Hauser Lake is extremely low (2-6%) and as hatchery rainbow trout allocations dwindle and we begin to make decisions relative to reductions in stocking numbers it will be increasingly difficult to justify stocking 14,000 catchable rainbow trout and 15,000 fingerling cutthroat trout per year into Hauser Lake.

MANAGEMENT RECOMMENDATIONS

1. Reduce hatchery rainbow trout catchable and fingerling stocking numbers in Hauser Lake and continue to evaluate angler satisfaction and participation.

2. Periodically evaluate return-to-creel rates of catchable trout in Fernan Lake.

Table 30. Number of angler interviews per work period, angler effort and percent of estimated total effort on Fernan and Hauser Lakes, Idaho during the 2011 creel surveys.

Work Period Start Date	Fernan Lake			Hauser Lake		
	# of Interviews	Hours of Effort	% Effort	# of Interviews	Hours of Effort	% Effort
5/1/2011	144	11,954	23.8	108	6,707	17.9
6/1/2011	242	11,329	22.6	219	9,457	25.3
7/1/2011	103	10,152	20.2	148	8,045	21.5
8/1/2011	104	9,585	19.1	88	8,230	22.0
9/1/2011	143	7,200	14.3	119	5,002	13.4
Total	736	50,219	100.0	682	37,442	100.0

Table 31. State of residency of anglers fishing Fernan and Hauser Lakes, Idaho during the 2011 creel surveys.

State of Residency	Fernan		Hauser	
	Number of Anglers	% of total	Number of Anglers	% of total
Idaho	679	92.3	524	76.6
Washington	27	3.7	141	20.7
California	6	0.8	5	0.7
Arizona	4	0.5	1	0.1
Florida	3	0.4	-	-
Minnesota	3	0.4	-	-
Utah	3	0.4	-	-
Iowa	2	0.3	-	-
Louisiana	2	0.3	-	-
Oregon	2	0.3	5	0.7
Arkansas	1	0.1	-	-
Montana	1	0.1	3	0.4
Non Resident	1	0.1	-	-
North Dakota	1	0.1	-	-
Wisconsin	1	0.1	-	-
Colorado	-	-	-	-
Michigan	-	-		-
Wyoming	-	-	1	0.3
Nevada	-	-	1	0.1
Tennessee	-	-	1	0.1
Total	736	100	682	100.0

Table 32. Comparison of creel survey results (+/- 95% CI) from Fernan Lake, Idaho by survey year.

Estimate	1984*	1985*	1986*	1993**	2011****
Survey Period	April-Sept	April-Sept	April-Sept	April 1-Sept 30	May 1-Oct 1
Residents	--	--	--	80%	92%
Angler hours	63,000	67,742	72,000	97,490 (8,693)	50,219 (1,040)
Rod hours	63,000	67,742	72,000	97,490 (8,693)	54,739
Interviewed anglers	592	532	273	1,946	736
Total Catch	--	--	--	46,974 (8,119)	33,703 (2,063)
Trout					
Catch	--	--	--	--	4,429 (277)
Harvest	--	--	--	7,775 (1,908)	2,828 (164)
Catch rate (fish/h)	0.1	0.3	0.1	0.1	0.21
Harvest rate (fish/h)	--	--	--	--	0.15
Warm Water Species* **					
Catch	--	--	--	--	29,014 (2,096)
Harvest	--	--	--	--	6,505 (603)
Catch rate (fish/h)	0.2	0.6	0.3	0.2	0.58
Harvest rate (fish/h)	--	--	--	--	0.23
Channel Catfish					
Catch	--	--	--	--	2,406 (187)
Harvest	--	--	--	236 (217)	1,644 (142)
Catch rate (fish/h)	--	--	--	--	0.09
Harvest rate (fish/h)	--	--	--	--	0.05
Largemouth bass					
Catch	--	--	--	6,204	4,294 (204)
Harvest	--	--	--	1,329 (604)	642 (52)
Catch rate (fish/h)	--	--	--	--	0.36
Harvest rate (fish/h)	--	--	--	--	0.01

* Catch rates are reported for all salmonids

** Catch rates represent put-and-take rainbow trout

*** Included under warm water species were largemouth bass, channel catfish, pumpkinseed, yellow perch, black crappie, bluegill, smallmouth bass and bullhead.

**** Catch and harvest were computed for all anglers; catch and harvest rates were computed for anglers targeting the specified species.

Table 33. Estimated total fishing effort (angler hours) by species targeted during the Fernan and Hauser Lake, Idaho 2011 creel surveys.

	Fernan		Hauser	
Species Sought	Estimated Effort (h)	Percent of total effort	Estimated Effort (h)	Percent of total effort
Trout Sp.	16,035	31.9	7,816	20.9
Anything	15,284	30.4	11,971	32.0
Channel Catfish	9,484	18.9	7,980	21.3
Largemouth bass	3,275	6.5	3,881	10.4
Bass Sp.	2,593	5.2	711	1.9
Black Crappie	1,706	3.4	1,694	4.5
Bluegill	682	1.4	1,749	4.7
Smallmouth bass	409	0.8	437	1.2
Northern Pike	341	0.7	-	-
Yellow Perch	205	0.4	-	-
Pumpkinseed	205	0.4	219	0.6
Tiger Musky	-	-	820	2.2
Kokanee	-	-	164	0.4
Total	50,219	100	37,442	100.0

Table 34. Number of fish caught, number of fish harvested and percent catch composition by species during the 1993 and 2011 Fernan Lake, Idaho creel surveys.

Species	Number Caught 2011	Number Harvested 2011	Percent of Catch 2011	Percent of Catch 1993
Bluegill	9,920	2,143	29	-
Black Crappie	5,031	498	15	10
Rainbow Trout	4,429	2,828	13	47
Yellow Perch	4,415	1,247	13	25
Largemouth Bass	4,294	642	13	6
Channel Catfish	2,406	1,644	7	1
Pumpkinseed	1,687	144	5	7
Smallmouth Bass	1,260	186	4	-
Tench	250	0	1	-
Northern Pike	10	0	0	0
Other	-	-	-	3
Total	33,703	9,332	100	100

Table 35. Catch and harvest (+/- 95% CI) of warmwater species in Fernan and Hauser lakes, Idaho during the 2011 creel surveys.

Species	Total Catch	Total Harvest	Targeted Catch Rate (fish/hr)	Targeted Harvest Rate (fish/hr)
	Fernan			
Bluegill	9,920 (865)	2,143 (309)	1.16	0.82
Black crappie	5,031 (1,154)	498 (74)	0.32	0.21
Yellow perch	4,415 (381)	1,247 (287)	0.44	0.44
Largemouth bass	4,294 (204)	642 (52)	0.36	0.01
Channel catfish	2,406 (187)	1,644 (142)	0.09	0.05
Pumpkinseed	1,687 (154)	144 (26)	0.00	0.00
Smallmouth bass	1,260 (105)	186 (31)	0.34	0.00
	Hauser			
Bluegill	22,351 (1,141)	11,153 (551)	3.57	3.10
Channel catfish	3,692 (282)	1,907 (135)	0.18	0.12
Largemouth bass	2,587 (240)	57 (13)	0.44	0.02
Black crappie	2,008 (176)	679 (69)	0.44	0.25
Pumpkinseed	778 (82)	326 (41)	0.18	0.18
Yellow perch	648 (49)	258 (28)	-	-
Smallmouth bass	278 (52)	0.00	0.00	0.00

Table 36. Comparison of creel survey results (+/- 95% CI) from Hauser Lake, Idaho by survey year.

Estimate	1984*	1985*	1986*	1992	1993	2011
Survey Period	April-Sept	April-Sept	April-Sept	April 1-Sept 11	April 1-Sept 30	May 1 -Oct 1
Residents	--	--	--	82%	82%	77%
Angler hours	49,500	75,210	66,710	35,392 (5,467)	60,670 (6,643)	37,442 (862)
Rod hours	49,500	75,210	66,710	35,392 (5,467)	60,670 (6,643)	40,437
Interviewed anglers	375	554	385	430	1,270	682
Total Catch	--	--	--	18,192 (8,458)	47,575 (17,246)	37,121 (1,373)
Trout						
Catch	--	--	--	--	--	4,654 (367)
Harvest	--	--	--	5,166	8,153	3,855 (343)
Catch rate (fish/h)	0.3	0.2	0.3	--	--	0.45
Harvest rate (fish/h)	--	--	--	--	--	0.37
Warm Water Species**						
Catch	--	--	--	--	--	32,343 (1,248)
Harvest	--	--	--	7,128***	14,300	18,298 (731)
Catch rate (fish/h)	0.2	0.1	0.4	--	--	0.92
Harvest rate (fish/h)	--	--	--	--	--	0.54
Channel Catfish						
Catch	--	--	--	--	0	3,692 (282)
Harvest	--	--	--	518	0	1,907 (135)
Catch rate (fish/h)	--	--	--	--	--	0.18
Harvest rate (fish/h)	--	--	--	--	--	0.12

Historical data were taken from Horner, N., L. LaBolle and C. Robertson. 1987. Davis, J., L. Nelson and N. Horner. 1996. and Nelson, L., J. Davis, and N. Horner.1996.

* Catch rates are reported for all salmonids

** Included under warm water species were largemouth bass, channel catfish, pumpkinseed, yellow perch, black crappie, bluegill and smallmouth bass.

***Does not include pumpkinseed.

****Catch and harvest are reported for all anglers; catch rates and harvest rates are computed for anglers targeting the specified species.

Table 37. Number of fish caught, number of fish harvested and percent catch composition by species during the 1992, 1993 and 2011 Hauser Lake, Idaho creel surveys.

Species	Number Caught 2011	Number Harvested 2011	Percent of Catch 2011	Percent of Catch 1993	Percent of Catch 1992
Bluegill	22,351	11,153	60.21	-	-
Rainbow Trout	4,654	3,855	12.54	34	35
Channel Catfish	3,692	1,907	9.95	0	2
Largemouth Bass	2,587	57	6.97	3	2
Black Crappie	2,008	679	5.41	14	26
Pumpkinseed	778	326	2.10	6	-
Yellow Perch	648	258	1.75	38	21
Smallmouth Bass	278	0	0.75	-	-
Tench	53	53	0.14	-	-
Kokanee	38	10	0.10	-	-
Tiger Muskie	34	0	0.09	-	-
Other	-	-	-	5	12
Total	37,121	18,298	100	100	100

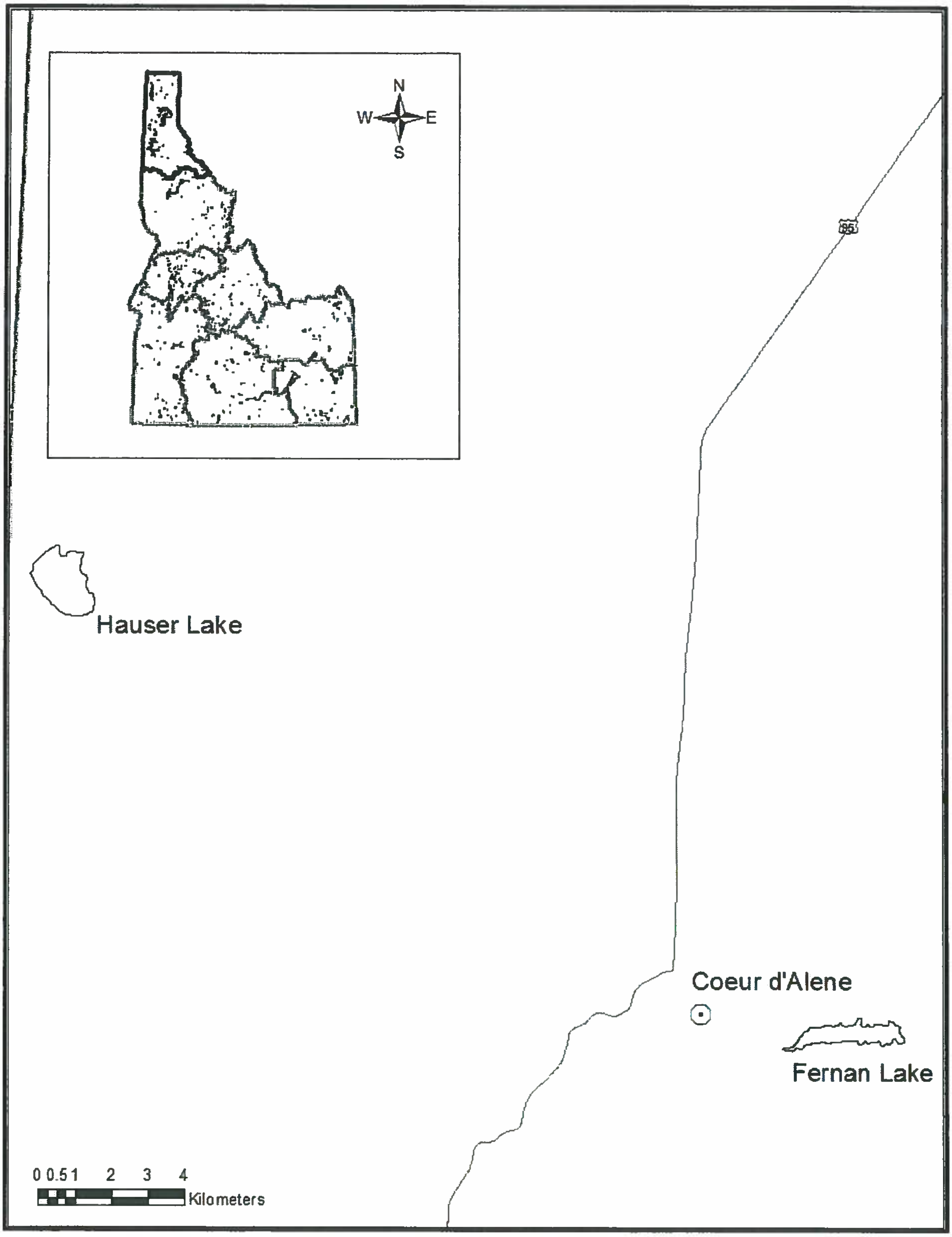


Figure 40. Locations of lakes sampled during the 2011.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 8: PRIEST LAKE KOKANEE SPAWNER SURVEY

ABSTRACT

We counted kokanee *Oncorhynchus nerka* spawners at five historic shoreline sites in Priest Lake. A total of 19,333 kokanee spawners were counted on November 4, 2011. This is up from 1,845 in 2010 and the highest number recorded since surveys began in 2001.

Authors:

Mark Liter
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

A self-sustaining population of kokanee was established in Priest Lake in the early 1940's, and they soon became the most abundant game fish. Harvest of kokanee in 1956 was estimated at 100,000 fish (Bjornn 1957). Kokanee in Priest Lake are classified as "late spawners" typically using shoreline gravel rather than tributary streams and spawn from November through early January. From the early 1950's to the early 1970's kokanee provided most of the fishing in Priest Lake with an annual harvest of 30,000-100,000 fish. The introduction of opossum shrimp *Mysis diluviana* in the early 1960's lead to dramatic increases in lake trout numbers and collapse of the kokanee population in the late 1970's.

Until around 2000 the Priest Lake kokanee population had been considered all but extirpated. Around that time we began receiving reports of aggregations of spawning kokanee at several locations around the lake, indicating a depressed, but persistent population. We have been counting kokanee spawners at five historic sites since 2001, averaging 2,875 fish per year until this year when we counted 19,333.

OBJECTIVE

Provide a limited consumptive harvest of kokanee in Priest Lake.

METHODS

Kokanee spawner counts were conducted in fives historic spawning areas on Priest Lake on November 4, 2011. Surveys were conducted using a boat with two observers standing on the bow while a third person drove the boat contouring the shoreline at a depth of about 3 m. Each observer counted spawners and an average of the two counts was used as the estimate for each of the five sites. Our efforts were concentrated on the area between the Granite Creek delta and Copper Bay, Indian Creek campground and marina, Cavanaugh Bay Marina, Hunt Creek delta and Huckleberry Bay (Figure 41).

RESULTS

Approximately 20,000 kokanee spawners were counted at five shoreline sites in Priest Lake (Table 38). Number of kokanee spawners observed at each of the five sites on Priest Lake were as follows; Copper Bay 750, Huckleberry Bay 90, Cavanaugh Bay 1,300, Hunt Creek beach 16,000, and Indian Creek beach 1,050 (Table 38). Few dead kokanee were observed and most were too deep to retrieve, therefore, no mean length of spawners was obtained. Mean lengths of spawners appeared to be similar to past years, however it appeared to observers that there may have been a bimodal size distribution with a peak around 325 mm and a larger group around 400 mm.

DISCUSSION

In 2011 Priest Lake spawning kokanee numbers were at the highest number counted since surveys began in 2001 and well above the previous 10 year average of 2,875 spawners. The number of spawners counted was up at all five shoreline sites with the largest increases observed at Indian Creek and Hunt Creek, both deeper water spawning areas. Since 2007 the majority (68%) of Priest Lake kokanee spawned near the mouth of Hunt Creek in water as deep as six meters. This is in contrast to 2001-06 when the majority of kokanee were spawning in Cavanaugh Bay and Copper Bay in water 15 cm to 0.5 meters deep. In 2012 we will collect otoliths from Priest Lake kokanee to determine if the spawning population consists of age 3+ and/or age 4+ fish.

MANAGEMENT RECOMMENDATION

1. Continue to monitor kokanee spawner age structure and numbers on Priest Lake.

Table 38. Counts of shoreline spawning kokanee salmon in Priest Lake, Idaho, 2001- 2011.

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Copper Bay	588	549	1237	1584	906	1288	308	223	400	37	750
Cavanaugh Bay	523	921	933	1673	916	972	463	346	550	331	1340
Huckleberry Bay	200	49	38	359	120	43	38	0	37	18	90
Indian Crk Bay	222	0	0	441	58	0	40	27	15	50	1050
Hunt Crk Mouth	232	306	624	2060	2961	842	1296	884	1635	1410	16103
Total	1775	1825	2832	6117	4961	3145	2145	1480	2637	1835	19333

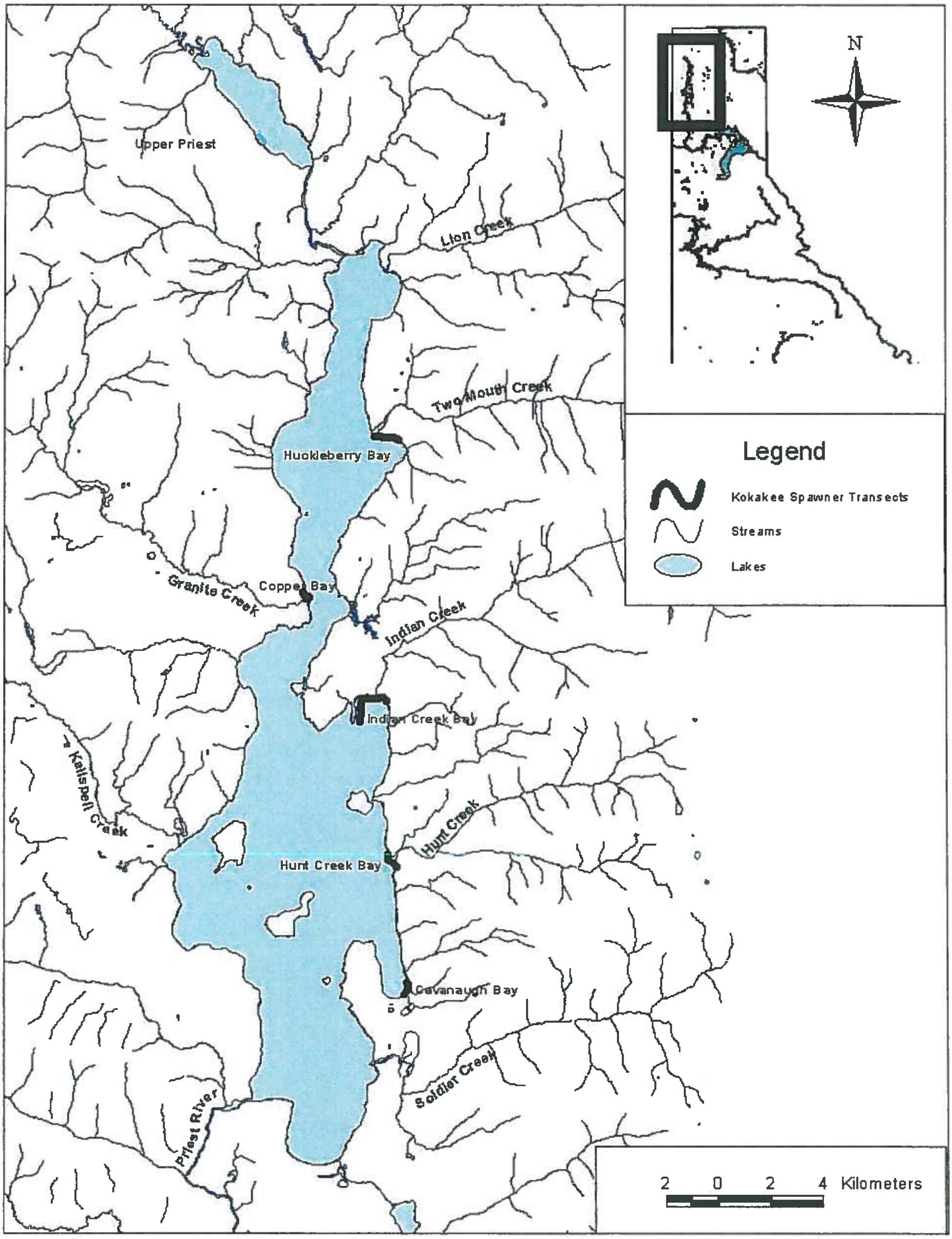


Figure 41. Location of kokanee spawner counts on Priest Lake, Idaho, 2009.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 9: UPPER PRIEST LAKE PURSE SEINE EVALUATION

ABSTRACT

We examined the feasibility of using purse seine gear to sample and estimate westslope cutthroat trout population size in Upper Priest Lake and compare our results to those in mid-1980. A 9.1-m-deep purse seine with a circumference of approximately 0.27 ha was used to sample open water areas of Upper Priest Lake over a two-day period from September 25-26. Eleven hauls were made capturing 19 westslope cutthroat trout. No westslope cutthroat trout were captured in 4 of the 11 purse seine hauls and no recaptures were collected. Westslope cutthroat trout ranged in size from 198 to 362 mm with a mean size of 282 mm. A total of 3 kokanee and 33 mountain whitefish were also sampled. Mountain whitefish ranged from 206 to 363 mm and averaged 304 mm. Considering the man-hours expended and number of cutthroat captured per haul we concluded that purse seine gear alone is not an efficient or cost effective technique to sample westslope cutthroat trout in north Idaho's oligotrophic lakes.

Authors:

Mark Liter
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Fishing for native westslope cutthroat trout *Oncorhynchus clarkii lewisi* cutthroat trout was the primary attraction at Priest and Upper Priest Lakes in the early days of the fishery with 30 fish limits common in the 1940's. By the first creel survey in 1956 (Bjornn 1957) annual cutthroat harvest had already declined to 3,500 fish and catch rate to 0.5 cutthroat per hour. Opossum shrimp *Mysis relicta* were introduced from Kootenay Lake, British Columbia in 1965 to improve the kokanee fishery. Their establishment resulted in a dramatic increase in lake trout *Salvelinus namaycush* numbers which eliminated popular fisheries for kokanee *Oncorhynchus nerka,* and bull trout *Salvelinus confluentus* (Rieman and Lukens 1979, Mauser et al. 1988). Over harvest, interspecific competition, predation and degradation of spawning habitat all led to the decline of cutthroat trout in the Priest Lakes. In 1982, major nursery streams were closed and a minimum size limit of 38 cm was implemented for cutthroat trout in Priest and Upper Priest lakes, however, cutthroat numbers in the lakes failed show a documented improvement. Mauser et al. (1988) reported that by1983 the cutthroat fishery declined to a total catch of 929 fish at 0.21 per hour and in 1988 westslope cutthroat trout were closed to harvest.

Purse seine gear was used to sample westslope cutthroat trout and estimate population size and determine the contribution of hatchery-reared cutthroat trout fingerling stocking in Priest and Upper Priest Lake in 1985 and 1986 (Mauser et al. 1985 and 1986). The estimated abundance of wild cutthroat 300 mm and larger was 1,440 fish in Priest Lake in 1986.

Our objective was to examine the feasibility of using purse seine gear to sample and estimate westslope cutthroat trout population size in Upper Priest Lake and compare our results to those in mid-1980s.

METHODS

A 9.1-m-deep purse seine was used to sample open water areas of Upper Priest Lake. The purse seine was constructed with square mesh of 10 mm and encircled an area of approximately 0.27 ha, assuming the 184-m net was set in an approximately circular fashion. Crews of 5-7 people using two boats (20' towing boat with 150 hp outboard and 20' purse seine barge with 90 hp outboard) set, pursed, and hauled the net in approximately 55 minutes. Although the net was 9.1 m deep, we fished the net in waters as shallow as 8 m. Over a two day period from September 25-26, 2011, 11 hauls were made. We did not attempt to randomly sample throughout Upper Priest Lake as our primary goal was to evaluate the effectiveness of purse seine gear to capture wild cutthroat trout. Sample location were limited to areas with water depths exceeding 8 m and were dictated somewhat by wind velocity and direction as nearly one hour was required from set to completion. Captured fish were loaded onto one of the boats and sorted into live wells. All cutthroat trout were measured, marked with a caudal fin hole-punch and released.

RESULTS

We conducted 11 purse seine hauls and sampled 19 cutthroat trout in Upper Priest Lake during Sept 2011 averaging 1.7 cutthroat/haul. No westslope cutthroat trout were captured in 4 of the 11 purse seine hauls and no recaptures were collected. Westslope cutthroat trout ranged in size from 198 to 362 mm with a mean size of 282 mm. A total of 3 kokanee and 33 mountain whitefish *Prosopium williamsoni* were sampled with purse seine gear. Mountain whitefish ranged from 206-363 mm and averaged 304 mm.

Upper Priest Lake has a surface area of 567 ha and assuming 80% of the surface area is >9 m deep, the depth of the purse seine, there would be 453 ha of available habitat for seining. Our seine encircled an area of approximately 0.27 ha. In 453 ha of available habitat for seining there would be 1,677 potential seine hauls (453/0.27). Recognizing the limitations of this effort, averaging 1.7 cutthroat per/haul (1.7 x 1,677), we estimated 2,852 adult cutthroat trout in Upper Priest Lake.

DISCUSSION

Purse seine gear was used in 1985 and 1986 to estimate the cutthroat population in Priest and Upper Priest Lakes. Mauser (1988) reported that in 43 purse seine hauls he captured 122 wild westslope cutthroat trout or a rate of 2.8 fish per haul in Priest Lake. Most of their effort was concentrated on the northern portion of Priest Lake as their primary objective was to evaluate the performance of hatchery-raised fingerlings released into Tango and Granite Creeks. In 2011 we caught 19 cutthroat trout in 11 hauls from Upper Priest Lake, averaging 1.7 fish/haul. Size of westslope cutthroat trout appears to be similar to fish collected in 1986. In 2011 westslope cutthroat trout ranged in size from 198 to 362 mm with a mean size of 282 mm compared to 216 to 318 mm with a mean size of 279 mm in 1987 (Mauser et al. 1988). Mean length of cutthroat trout captured in 1986 was 294 mm with 43% larger than 300 mm. 2011 sampling efforts found 42% where larger than 300 mm.

In Priest Lake the population was estimated at 6,000 fish with wild cutthroat comprising 58% (3,480) of the catch in 1985 and 3,000 in 1986, showing a slow but steady decline in their total abundance.

Since we captured so few westslope cutthroat trout, we recognize the limitations and accuracy of this abundance estimate. It was our observation that purse seine gear alone is not an efficient or cost effective technique to sample westslope cutthroat trout in north Idaho's oligotrophic lakes. Catch rates could be influenced by time of day and weather conditions. Catch rates are probably highest in the evening when westslope cutthroat are near the surface feeding. Additionally, catch rates are probably higher when wind conditions are quiet, allowing for sampling areas close to shore without fear of being blown into the shoreline. Maneuverability of the towing boat (changes of course require a lot of space) and difficulty of communication between the boats are issues in windy conditions. As for labor costs, purse seine gear is expensive as it required 5-6 people, 2 on the towing boat and 3-4 on the purse seine barge. With each set requiring 2 hours (including set, haul, fish work-up and transport time to the next site) this equates to 10-12 man/hrs/haul. With a catch rate of 1.7 fish/haul, we feel that hook and line sampling or electrofishing may be better alternatives.

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 10: LOWLAND LAKES HATCHERY TROUT EXPLOITATION

ABSTRACT

In 2011 we evaluated the harvest rate of stocked, catchable-sized rainbow trout *Oncorhynchus mykiss* in Freeman, Jewel, Robinson, Smith lakes and Bull Moose Pond. Two hundred rainbow trout were tagged with Floy T-bar anchor tags and released in each lake with each lake receiving 100 fish in April and 100 in May. Bull Moose Pond received 100 tagged fish in May only. As of December 31, 2011, angler harvest rates for hatchery rainbow trout were estimated to range from a low of 17% in Freeman Lake to a high of 71% in Jewel Lake.

Authors:

Mark Liter
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

In Idaho, approximately 15 million trout are produced per year in 13 hatcheries by Idaho Department of Fish and Game (IDFG) for resident trout angling. Rainbow trout *Oncorhynchus mykiss* and cutthroat trout *O. clarkii* are most often stocked in Idaho's lakes and reservoirs and in 2011, 16% were of catchable size (≥150 mm). Hatchery trout are used primarily in habitats not capable of supporting wild production sufficient to meet angler demand (IDFG 2007). Catchable rainbow trout raised for put-and-take use in the Panhandle Region are usually Trout Lodge or Hayspur strain raised at Mackey, Grace or Nampa Hatcheries. The fish are transported to either Sandpoint or Mullan Hatchery, and then distributed throughout the spring and summer. The Trout Lodge strain is used throughout the Panhandle Region for a variety of reasons including availability, growth, feed conversion and disease resistance. Only triploid (i.e. sterile) rainbow trout were stocked in the Panhandle Region in 2011. The cost of production and distribution averaged $1.41 per catchable trout stocked from the Mullan Hatchery and $0.83 per catchable stocked from the Sandpoint Hatchery in the Panhandle Region in 2011.

OBJECTIVE

To optimize use of hatchery produced trout.

STUDY SITE

Freeman Lake

Freeman Lake is a 16 ha natural lake located in Bonner County, Idaho on the Idaho/Washington border. The lake is relatively shallow, with a mean depth of 1.8 m and a maximum depth of 5.2 m. The shallow nature of Freeman Lake is very conducive to rooted aquatic vegetation and there is a distinct vegetation line around the lake at about 3 m depth. Public access to Freeman Lake is limited to a single boat launch on the southwest side where IDFG owns approximately 540 m of shoreline.

Freeman Lake is a two-story fishery supporting both warm and coldwater fisheries. The rainbow trout fishery in Freeman is supported by an annual stocking of 4,000-5,000 catchable triploid Kamloops rainbow trout *Oncorhynchus mykiss.* Tiger muskie *Esox lucius x E. masquinongy* were first introduced to Freeman Lake 1989, however, has not been stocked since 2007 due to the lack of a disease free source. The intent was to utilize the abundant forage base (mainly pumpkinseeds and yellow perch) to produce a limited trophy fishery for tiger muskies. Management of the fishery is under general statewide regulations, with the exception of an electric motors only provision.

Jewel Lake

Jewel Lake is located in Bonner County 5.6 kilometers southeast of Laclede, Idaho. The lake covers an area of 12 ha. Maximum depth is approximately 10 m. Most of the land around the lake is owned by a single landowner (Hulquist) who has allowed public access since 1951. Currently, IDFG maintains the access site in exchange for public use. There is a boat ramp maintained by IDFG located on the southwest shoreline. Management of the fishery is under general statewide regulations and the lake is managed as an "Electric Motors Only" waterbody.

Jewel Lake is stocked with 6,000 catchable triploid Kamloops rainbow trout annually. Beginning in 2001, 350 channel catfish have been stocked in Jewel Lake on an annual basis. In 2000, approximately 300 bluegill were transplanted from Rose Lake.

Robinson Lake

Robinson Lake is a shallow, eutrophic, 24 ha natural lake located in northeastern Boundary County, 2.5 km south of the Canadian border. The U.S. Forest Service (USFS) operates a fee campground facility on the southwestern side of the lake and a free boat launch on the northeastern side of the lake.

Robinson Lake provides both cold and warmwater fisheries. Six to ten thousand catchable triploid Kamloops rainbow trout have been stocked annually since the 1980's. Fingerling brook trout *Salvelinus fontinalis* were stocked in 1995 and 1997. Gillion Creek supports some natural reproduction of brook trout (Fredericks and Horner 1998). Largemouth bass and pumpkinseed *Lepomis gibbosus* provided the warmwater fishery until 1989, when bluegill *L. macrochirus* were stocked.

Robinson Lake is managed as a quality bass lake which allows for six bass, only two may be largemouth bass with no largemouth under 16 inches. The lake is managed under statewide general bag and possession limits for all other species and is managed as "Electric Motors Only" lake under IDFG fishing regulations

Smith Lake

Smith Lake is located approximately 8 km north of Bonners Ferry, Idaho. The USFS developed a camping and picnic area including a boat launch and fishing dock. Smith Lake is one of a series of small lakes located about 300 m above the Kootenai Valley floor at an elevation of 914 m. The lake has a surface area of 15.4 ha, a maximum depth of 11 m, and a mean depth of 6.7 m. The south end of the lake has a small area of marl bottom with extensive growths of aquatic vegetation while the remainder to the lake shoreline is mud or sand.

IDFG stocking records dating back to 1967 indicate extensive fish stocking in Smith Lake over the years. Various stocks of rainbow trout including domestic Kamloops, Eagle Lake, Hayspur triploid, Hayspur rainbow, Mt. Lassen, Trout Lodge triploid and several unspecified stocks of rainbow have been stocked since 1967. Rainbow trout stocking rates have varied from 3,000 to 8,000 fingerlings per year. Westslope cutthroat were stocked from 1989 to present at rates ranging from 150 to 10,000 fingerlings each year. Smith Lake has been stocked with kokanee, however, kokanee stocking rates and frequency have varied considerably over the last ten years due to availability of kokanee fry. Early spawning kokanee were stocked through the mid 2000's at a rate of 1,000 to 2,500 fry each year. In 2011, 1,100 early spawning kokanee fingerling were stocked in Smith Lake. Management of the fishery is under general statewide regulations and the lake is managed as an "Electric Motors Only" waterbody.

Bull Moose Lake

Bull Moose Lake is a shallow 0.5 ha manmade pond 23 km north of Coolin, Idaho on the east side or Priest Lake. In 1991, IDFG entered into an MOU with the Huckleberry Bay Company to create a fishing pond for use by the public on private property. The goal was to provide improved fishing opportunity and a consumptive fishery for users of the north east side of Priest Lake, Bonners County, Idaho. Originally a small borrow pit, (1-2 ac) was flooded with diverted water from an unnamed tributary of Two Mouth Creek. A diversion structure and water supply pipeline maintain year round water levels in the pond.

Two to three thousand catchable triploid Kamloops rainbow trout have been stocked annually. Management of the Bull Moose Lake fishery is under general statewide regulations.

METHODS

Eight hundred Trout Lodge strain rainbow trout were tagged with Floy T-bar anchor tags and released in Freeman, Jewel, Robinson, and Smith Lakes with each waterbody receiving 100 fish in April and 100 in May. Bull Moose Lake received 100 tagged fish in May only. Rainbow trout reached an average weight of 2.5 fish per pound and a mean length of 250 mm at the time fish were stocked.

All fish used in this study were raised at the IDFG Nampa Hatchery, then transferred to and distributed by the Sandpoint Hatchery. On the day of stocking, trout were crowded, randomly removed from the raceway, and loaded into the fish transport truck for stocking. Rainbow trout were tagged with orange Floy T-bar anchor tags with the tag inserted just below the dorsal fin. Tags were labeled on two sides with one side stating "IDFG 1-866-258-0338" and the other side with a tag number. IDFG operates a toll free automated hotline and website through which anglers could report tags, although some tags were mailed in or dropped off at the Panhandle Regional Office. Additionally IDFG distributes posters and stickers to license vendors, regional offices and sporting goods outlets that publicize the tagging efforts and explain how to report tags and what the information is used for.

To determine angler exploitation, the number of fish harvested by anglers (determined by tags returns) was divided by the number of fish we tagged. We assumed a 53% reporting rate, which is typical of non-reward tags (Meyer et al. 2010), and adjusted the return rate accordingly to provide an exploitation estimate. Tag loss was assumed to be 8.2% while tagging mortality was assumed to be 3% based on work conducted on rainbow trout by Meyer et al. (2010).

RESULTS

Through December 31, 2011, the number of tag returns per lake ranged from 13 at Bull Moose Lake to 60 from Jewel Lake. Through the same time period, anglers reported catching 29, 30, and 15 of the 200 tagged rainbow trout stocked in Smith, Robinson and Freeman Lakes, respectively. After correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation was estimated to range from a low of 17% for hatchery rainbow trout in Freeman Lake to a high of 71% in Jewel Lake in 2011 (Table 39). Statewide, in 2009 tags were returned using the tag return 1-800 hotline (48%), website (45%), by mail (2%) returned to the Regional office in person (5%) Meyer et al. (2010).

Our study indicates a high percentage of hatchery rainbow trout catchables in the Panhandle Region are caught by Idaho residents. Idaho residents returned 87-97% of the tagged rainbow trout in 2011 from Jewel, Smith, Robinson and Freeman Lakes (Table 39). Idaho residents returned 46% of the tagged rainbow trout from Bull Moose Lake. This may be a function of the lakes' proximity relative to Priest Lake and the high percentage of out-of-state anglers recreating at Priest Lake in the summer. The mean number of days between stocking and capture or days-at-large ranged from 32 days in Freeman and Bull Moose Lakes to 45 days in Smith Lake. A total of 131 people caught and reported 147 tags in 2011 with 16 anglers reported catching more than one tagged trout

DISCUSSION

Angler tag return rates for Robinson, Smith and Bull Moose lakes to date are estimated at 32%, 32% and 31% respectively with each of the lakes in the upper end of values reported for other Idaho lakes and reservoirs. On average, exploitation for hatchery rainbow trout across Idaho lakes and reservoirs from 2006-10 was 15.9%, and ranged from 0-79% (Meyer et al. 2010). It is important to note that harvest estimates for the four lake sampled in 2011 do not reflect season-long estimates and as more tags are reported we will refine our angler exploitation estimates.

In 2010 we evaluated the harvest rates of stocked, catchable-sized trout in Stoneridge Reservoir, Lower Twin, Hauser and Fernan Lakes. Our 2011 hatchery trout evaluation revealed some “hold-overs” in three of these lakes. From Fernan Lake we received 6 catchable trout tag returns after December 31, 2010. From Lower Twin Lake and Stoneridge Reservoir we received 4 and one “hold-over” tag returns respectively (Table 39). No ‘hold-overs’ were reported from Hauser Lake.

In 2012, we will continue our systematic assessment of catchable rainbow trout return-rates in Panhandle Region lakes and adjust planting priorities based on established stocking criteria which include impacts to native fish, accessibility, return to creel rates, catch rates and the ability of a water body to provide a fishery without stocking. This may require eliminating lightly fished lakes or increase the frequency of stocking in heavily fished lakes.

MANAGEMENT RECOMMENDATIONS

1. Continue lowland lakes stocking evaluations with evaluation of Steamboat Pond, Gold Creek Pond, Clee Creek Pond, Calder Pond, Day Rock Pond, Lower Glidden and Elsie Lakes in 2012.

Table 39. Estimates of angler exploitation, % resident anglers, and days-at-large for hatchery rainbow trout at various Panhandle Region lakes sampled in 2009-2011.

Lake	Year of Study	Number of Tags	Tags Returned as of 12/31	Tags Returned w/in 1 year	Number of different anglers	Corrected Exploitation Rate	Percent Idaho Resident	Mean Days at Large *
Round	2009	200	29	36	34	36%	91	103
Kelso	2009	200	67	73	58	79%	86	50
Hauser	2010	199	3	3	3	2%	100	8.3
Fernan	2010	198	35	40	31	39%	100	90
LTwin	2010	193	14	18	13	20%	85	52
Stoneridge	2010	199	33	33	22	33%	77	49
Freeman	2011	200	15	N/A	14	17%	87	32
Jewel	2011	200	60	N/A	47	71%	93	36
Robinson	2011	200	30	N/A	26	32%	97	33
Smith	2011	200	29	N/A	28	32%	90	45
Bull Moose	2011	100	13	N/A	13	31%	46	32

*mean days @ large as of 12/31

2011 Panhandle Region Annual Fisheries Management Report

CHAPTER 11: HAYDEN LAKE INVESTIGATIONS

ABSTRACT

We surveyed Hayden Lake with a scientific echosounder to serve as a baseline from which to evaluate the pelagic fish community. Currently the only age class of kokanee in the lake were the newly stocked age-0 fish. We noted the presence of a low density of small, fry-sized targets in the pelagic area (29 fish/ha), and a very low density of targets that could be confused with older aged kokanee (3 fish/ha). Future hydroacoustic surveys should be able to estimate kokanee densities without much interference from other fish populations within the lake. As a second investigation we monitored zooplankton abundance throughout the growing season to determine a good time for stocking hatchery produced trout and kokanee. Zooplankton biomass, and the index of larger plankton abundance (ZQI), showed increases in early June that may indicate a good time for stocking kokanee and trout fingerlings.

Authors:

Melo Maiolie
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Hayden Lake provides very popular fisheries for both warm and coldwater species and provided 74,000 hours of fishing effort in 2010 (Hardy et al. 2011). However in recent years the harvest rates and fishing pressure for coldwater species has declined (Hardy et al. 2011). In an effort to increase the open water fishery for coldwater species, Hayden Lake was stocked in 2011 with 100,000 kokanee fry of the early spawning strain.

During 2011, we conducted what we believe to be the first ever hydroacoustic survey of Hayden Lake. The purpose of this work was to examine the open-water (pelagic) community to note sizes and abundance of fish. This would serve as a baseline for future hydroacoustic work that may be done as more kokanee are stocked into this lake. Our baseline work would show if there were many pelagic fish that could be confused with kokanee. Prior to 2011, the last recorded stocking of kokanee in Hayden Lake was 43,000 fry 1989. These fish did not appear to establish a reproducing population and are likely gone from the system. Survivors of this year's stocking (2011) should be visible as large fry during the hydroacoustic survey.

We also examined zooplankton abundance in Hayden Lake. Hayden Lake is annually stocked with trout, and our hope was to maximize trout survival by stocking when zooplankton is at an optimal level, while considering other factors such as temperature and discharge from the lake.

STUDY AREA

Hayden Lake is a 1,520 ha lake that is located 7 km north of Coeur d'Alene, Idaho. It is a natural lake created during the last ice age. Hayden Lake is managed for a diversity of warm, cool, and coldwater species of fish (IDFG 2007).

Warm and cool water species include largemouth bass *Micropterus salmoides*, northern pike *Esox lucius*, smallmouth bass *Micropterus dolomieu*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, pumpkinseed *Lepomis gibbosus*, and brown bullhead *Ameiurus nebulosus*. These species are naturally reproducing, and are typically fished in the near-shore areas. Coldwater species include rainbow trout, cutthroat trout, and in 2011, kokanee. Angling for coldwater species is typically by trolling the open water areas of the lake. Trout are annually stocked in Hayden Lake. For example, in 2011 Hayden Lake was stocked with 309,000 triploid Kamloops rainbow trout along with 100,000 kokanee fry.

OBJECTIVES

Our objective for this work on Hayden Lake was to "maintain a diversity of fishing opportunity" (Idaho Fish and Game 2005). We hoped to do this by improving the fishery in the pelagic area of the lake that would provide a troll fishery for kokanee and rainbow trout.

METHODS

Hydroacoustic Survey

Hydroacoustic methodology was similar to that used on Coeur d'Alene Lake in 2011 (see the chapter on Coeur d'Alene Lake in this report for the details). We surveyed along nine transects that were perpendicular to the long axis of the lake (Figure 42). The location of the first transect (nearest the dam) was chosen at random and the other transects were spaced evenly up the lake until the water became too shallow to be considered kokanee habitat. Survey was conducted at night on August 11, 2011.

We analyzed the echograms from Hayden Lake to define the pelagic fish community. The seven southernmost transects in Hayden were conducted in water that reached depths of 30 m or more. Densities were estimated for fish in three size categories for each 10 m depth interval. The size categories were for targets -60 to -46 dB, -46 dB to -33 dB and -33 to -20 dB. These categories corresponded to kokanee size classes of fry, kokanee that were age-1 to age-3, and fish larger than kokanee; based on our results in other lake systems (see Coeur d'Alene and Spirit Lake chapters in this report).

We also plotted depths versus target strengths of all targets encountered during the survey and compared this to a similar plot made from an echogram at the center of Coeur d'Alene Lake. Coeur d'Alene Lake has an abundance of kokanee and therefore illustrates the sizes and depths of a pelagic community dominated by kokanee.

Zooplankton Sampling

Zooplankton was sampled bi-weekly from April 28, 2011 to October 14, 2011. Three sampling locations were selected representing the southern, middle and northern sections of Hayden Lake. The sites were located at Clark Point (N47°45.623, W116°44.270), Yellowstone Point (N47°45.941, W116°42.470) and Lee's Point (N47°46.443, W116°41.527). At each of the three sampling sites vertical tows to a depth of 10 m were made using 153 µm, 500 µm and 750 µm mesh nets. Collection and analysis of the samples followed the Zooplankton Quality Index (ZQI) protocol from Teuscher (1999).

Samples were preserved in denatured ethyl alcohol at a 1:1 sample volume to alcohol ratio. After a minimum of two and a maximum of ten days samples were re-filtered through a 153 µm sieve to remove phytoplankton. Samples were then blotted with paper towel and weighed to the nearest 0.1 g.

Zooplankton sample data were analyzed using the zooplankton productivity ratio (ZPR) which Teuscher (1999) described as the ratio of preferred to usable zooplankton (ZPR=biomass in the 750 µm net/biomass in the 500 µm net). Additionally, to account for both zooplankton abundance and size we calculated the ZQI where ZQI = ((500 µm biomass+ 700 µm biomass)*ZPR).

Teuscher (1999) outlined stocking criteria for specific values of the ZQI recommending that only catchables be stocked in waters with ZQI ≤ 0.10, 75-100 fingerlings/acre for ZQI between 0.10-0.60 and 150-300 fingerlings/acre in waters with ZQI >0.60.

RESULTS

Hydroacoustic Survey

We calculated the density of fish targets seen in our survey of Hayden Lake by 10 m depth strata. The highest densities of fish were found in the top 10 m of the water column (Table 40). Densities were estimated at 3,200 fish/ha in this layer, however, most targets were very small. These targets were likely larval fish, and due to their low target strengths, could have included non-fish biota such as amphipods or aquatic insects (Figure 43).

In the pelagic region where kokanee were typically found (depths from 10 to 30 m and target strengths of -60 to -33 dB), only very low densities of fish were recorded. Analyzing these depths and target strengths, we found only 29 fish/ha in the size range of kokanee fry, 3 fish/ha in the size range of age-1 to age-3 kokanee, and 0.6 fish/ha in the size range of fish too large to be a 250 mm kokanee (>-33)(Table 40).

The two northern most transects were not included because of the shallower water depth.

Zooplankton Survey

Zooplankton biomass ranged from 0.1 g/m on 4/28/2011 to 0.66 g/m on 6/24/2011 at Clark Pt., from 0.11 g/m on 4/28/2011 to 1.02 g/m on 7/7/2011 at Yellowstone Pt., and from 0.19 g/m on 10/14/2011 to 0.65 g/m on 7/7/2011 at Lee's Pt. (Table 41).

ZQI values for all three sites fell mostly within the 0.1-0.6 range indicating that a stocking density of 30-40 fingerlings/ha is appropriate for Hayden Lake (Teuscher 1999). The highest observed ZQI value for Clark Pt. occurred on 7/7/2011. ZQI values at Yellowstone Pt. and Lee's Pt. were highest during the month of August (Table 41). At all three sites, ZQI values increased from April through the sampling on June 24.

DISCUSSION

Hydroacoustic Survey

Hydroacoustic survey of Hayden Lake showed a very low density of fish in the pelagic areas of the lake at depths below 10 m. Kokanee would be expected to occupy the open water at depth of 10-30 m and have target strengths from -60 to -33 dB (Figure 43). This area in Hayden Lake, particularly in the larger fish sizes, was nearly devoid of fish. Future hydroacoustic surveys to estimate kokanee abundance should have little interference from other fish species within the lake.

Of interest in Hayden Lake were the many small "fry" near the surface. We estimated the densities of these small targets at 3,200 fish/ha. Sizes were recorded between -60 and -55 dB; approximately 15 to 30 mm based on Love (1971). These could be small fish fry or invertebrates. We recommend several tows of a larval fish net to determine the species composition. Surface oriented "fry" were not seen in Coeur d'Alene and Spirit Lakes.

Zooplankton Survey

Based on the ZQI values we recommend stocking kokanee or rainbow trout fingerlings in Hayden Lake in early June. By this date, zooplankton was increasing from the lows recorded in the early spring. We also suggest giving strong consideration to whether or not water is flowing over the outlet on the Hayden Lake dike before stocking at the south end of the lake.

MANAGEMENT RECOMMENDATIONS

1. Conduct hydroacoustic surveys for kokanee in Hayden Lake similar to the standard methodology and analysis used in Coeur d'Alene Lake.

2. Conduct fry tows in the top 10 m of the lake to determine species composition of the small targets recorded in this study.

3. Stock hatchery-produced rainbow trout in early June to coincide with the beginning of the zooplankton blooms.

Table 40. Results from a hydroacoustic survey of Hayden Lake conducted on August 11, 2011. Only transects 1 – 7 were included since they had water depths exceeding 30 m (Figure 42). Transects were divided into six depth strata and three sizes of fish. Note the low densities of fish at depths below 10 m.

Depth strata (m)	Number of single targets	Number of Pings	NASC	Mean TS	Total Density (fish/ha)	Percent Fry (-60 to -46 dB)(%)	Fry Density (fish/ha)	Percent small fish (-46 to -33 dB)	Density small fish (fish/ha)	Percent large fish (> -33 dB)	Density of large fish (fish/ha)
0 -10	1280	43538	29.13	-56.8	3,232	99.2	3,207	0.78	25	0	0.00
10-20	35	42726	3.94	-39.0	7	57.1	4	34.29	3	8.6	0.62
20-30	2	42259	0.18	-57.4	25	100	25	0	0	0	0.00
30-40	32	42020	0.07	-59.2	14	100	14	0	0	0	0.00
40-50	131	40598	0.04	-59.1	8	100	8	0	0	0	0.00
50-60	4	34675	0.10	-59.4	20	100	20	0	0	0	0.00

Table 41. Zooplankton density (g/m), zooplankton productivity ratio (ZPR) and zooplankton quality index (ZPR) from samples collected in Hayden Lake, Idaho between April and October, 2011.

	Clark Point			Yellowstone Point			Lee's Point		
Date	Biomass g/ma	ZPR	ZQI	Biomass g/ma	ZPR	ZQI	Biomass g/ma	ZPR	ZQI
4/28/2011	0.10	0.43	0.05	0.11	1.20	0.19	0.22	0.83	0.10
5/27/2011	0.19	1.75	0.21	0.18	1.33	0.21	0.23	1.00	0.20
6/8/2011	0.35	0.83	0.30	0.27	0.94	0.34	0.37	0.89	0.43
6/24/2011	0.66	1.18	0.79	0.31	0.95	0.41	0.62	0.94	0.53
7/7/2011	0.42	0.68	0.31	1.02	0.52	0.49	0.65	0.53	0.30
7/24/2011	0.31	0.81	0.34	0.34	0.58	0.26	0.36	0.69	0.41
8/12/2011	0.14	0.50	0.05	0.30	0.50	0.07	0.46	1.22	0.54
8/31/2011	0.34	1.25	0.62	0.55	0.94	0.70	0.57	0.71	0.51
9/15/2011	0.34	0.95	0.43	0.36	1.03	0.69	0.41	0.73	0.51
10/14/2011	0.22	1.00	0.46	0.22	1.00	0.42	0.19	1.43	0.53

[a] Biomass reported for samples collected using the 153 m mesh net.

Figure 42. Map of Hayden Lake, Idaho, showing the location of nine hydroacoustic transects used in the current study to estimate the densities of pelagic fish. Transects 1-7 contained water over 30 m deep and were analyzed separately.

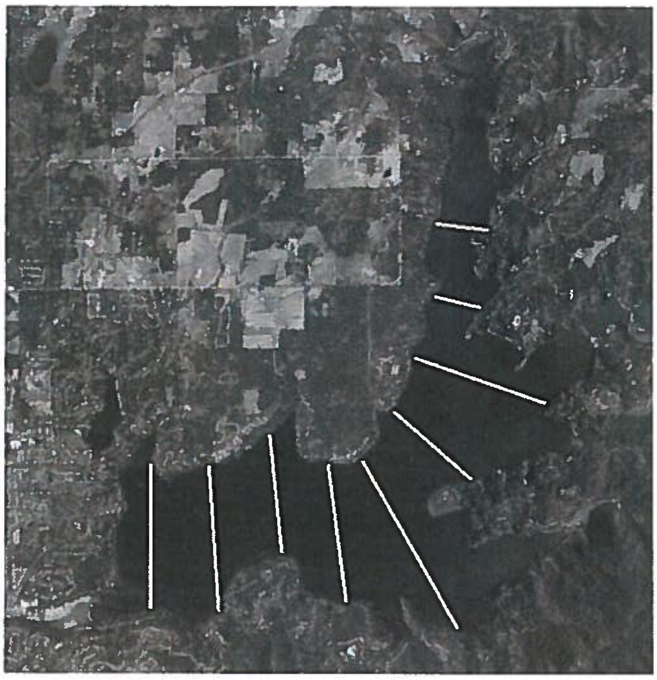
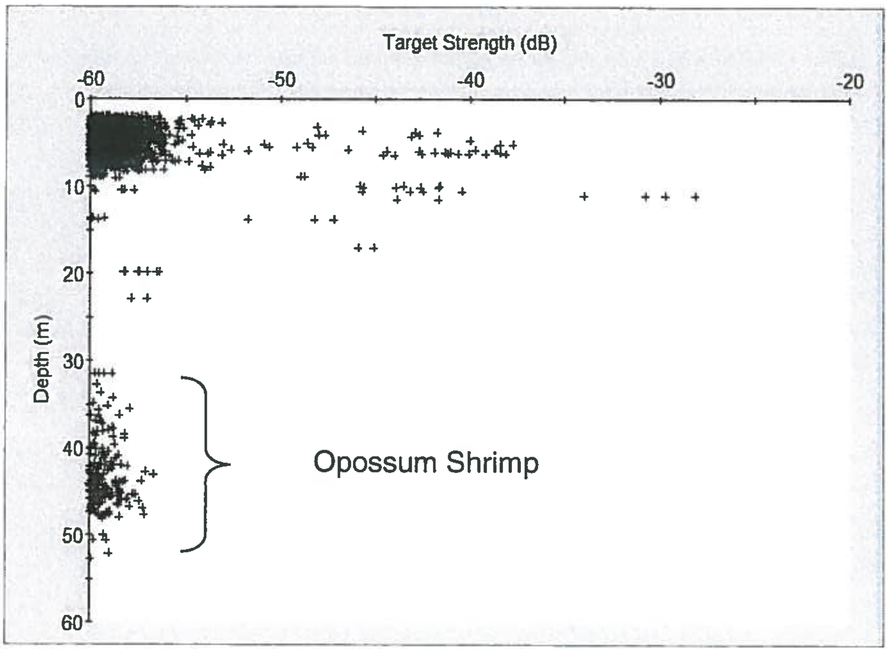
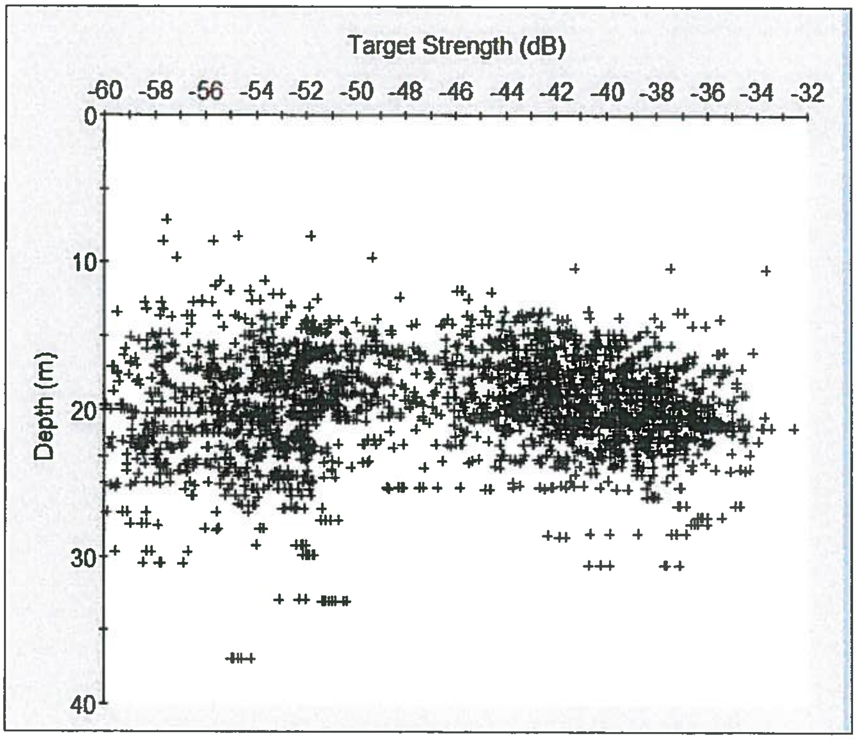


Figure 43. Depth and target strength distribution of fish and shrimp in Hayden Lake (top) during a hydroacoustic survey on August 11, 2011, and Coeur d'Alene Lake (bottom) on August 9, 2011. Kokanee would be expected at depths of 10 to 30 m and target strengths of -60 to -33 dB depending on adult sizes. Targets under the 2 m depth were eliminated to remove noise.





CHAPTER 12: BULL TROUT REDD COUNTS

ABSTRACT

Bull trout redds were counted in 2011 as an index of the abundance of bull trout in each major drainage in northern Idaho. In six index streams in the Pend Oreille drainage, 474 redds were counted. This was an increase from last year, but slightly below average. In the Upper Priest Lake drainage, 13 redds were counted in 7 index streams, which was a decline from the last 2 years but better than during the period from 2005 to 2008. In the Kootenai drainage, 82 redds were counted, which represents the lowest total count was since 1994. In the St. Joe drainage, 43 redds were counted in three index sections, which was the lowest count since 2001. In the Little North Fork Clearwater River, 26 redds were found in five index streams, which was the lowest count since 2002. These surveys indicated particularly low populations of bull trout in the Upper Priest and St. Joe drainages.

Authors:

Melo Maiolie
Regional Fisheries Biologist

Rob Ryan
Regional Fisheries Biologist

Mark Liter
Regional Fisheries Biologist

Cathy Gidley
Regional Fisheries Biologist

Jim Fredericks
Regional Fisheries Manager

INTRODUCTION

Bull trout redd counts are conducted in each of the core recovery areas to monitor long term trends in these populations. Redd counts not only allow us to evaluate the status of the populations in these areas as they pertain to each of the recovery criteria, but they also help in directing future management and recovery activities.

STUDY SITES

Bull trout redds were counted in headwater streams within the Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork (LNF) Clearwater River drainages where bull trout are known to spawn. These watersheds make up all or part of five different core areas that occur in the IDFG Panhandle Region (USFWS 2002). These core areas are Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and NF Clearwater River. The boundaries of the Kootenai River and NF Clearwater River core areas extend outside of the Panhandle Region.

OBJECTIVES

Our objective in conducting these surveys was to ensure the continuing existence of bull trout in several drainages in northern Idaho. Minimum population criteria for each drainage were specified in the U.S. Fish and Wildlife Service's draft recovery plan for bull trout (USFWS 2002).

METHODS

To reduce observer variability in counting bull trout redds, we held a training class on September 19, 2011 at Trestle Creek, a tributary to Lake Pend Oreille. The objective of the training was to maintain and enhance consistency in bull trout redd counts by standardizing survey techniques and familiarizing new surveyors in bull trout redd identification. Research has demonstrated the level of observer training and experience may influence the accuracy of redd counts (Bonneau and LaBar 1997; Dunham et al. 2001). Attendees represented IDFG, USFS, and USFWS. These individuals also participated in bull trout redd surveys around the region.

We counted bull trout redds in selected tributaries of the Priest Lake, Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and LNF Clearwater basins where bull trout were known or believed to occur. We summarized counts in each of these basins for the core areas. Redd counts in the Middle Fork (MF) East River and Uleda Creek (tributaries of Priest River) were added to the Pend Oreille Lake Core Area in 2003 when bull trout were documented to spend their adult life in Pend Oreille Lake (Dupont et al. 2009). We counted all redds at similar times (late September and October) as had occurred in the past. Survey techniques and identification of bull trout redds followed the methodology described by Pratt (1984). To add to our knowledge on preferred bull trout spawning areas and to help evaluate recovery efforts, the location of redds was recorded on maps and/or GPS units during redd counts. Sections of the Kootenai River and NF Clearwater core areas occurred outside the Panhandle Region. We obtained redd count data for these areas from the personnel from partner agencies responsible for conducting these surveys.

To estimate the spawning escapement or population abundance (depending on recovery area) of bull trout in streams, we used Downs and Jakubowski (2006) findings that an average of 3.2 adult bull trout entered tributaries of Lake Pend Oreille for each redd that was counted during annual redd count surveys. We decided to use this adult to redd ratio because this estimation came from one of the core areas in the Panhandle Region and because it is consistent with that found in the Flathead Lake system (Fraley and Shepherd; 1998). See Dupont et al. (2009) for further justification.

RESULTS AND DISCUSSION

Pend Oreille Core Area

We counted redds in the Pend Oreille core area between October 6 and 24, 2011. A total of 815 bull trout redds were counted in the surveyed streams (Table 42). A total of 474 redds were counted in the six index streams that were consistently surveyed since 1983 (Table 42). The total count and the index count were below the previous ten year average. However, both counts showed an increase from last year's count. Total counts included 37 bull trout redds from Caribou Creek, a Pack River tributary. This represented the first survey of bull trout spawning in this stream and a significant local population. In addition, 16 bull trout redds were counted in approximately 2.5 km of Grouse Creek downstream of the standard count reach boundary at the Flume Creek confluence and were included in the total and index counts in 2011.

A total of 37 bull trout redds were counted in the MF drainage on October 6, 2011. Twenty-eight redds were in the mainstem of the river with nine in Uleda Creek. Six redds in Uleda Creek were above a barrier that had been removed by blasting in 2004 (Figure 44). During summer 2011 a log barrier on the upper end of the MF was opened. Six redds were counted above this barrier (Figure 44).

Priest Lake Core Area

We counted a total of 31 bull trout redds in the Upper Priest River basin on October 3, 2011 (Table 4). Surveys were also conducted in tributaries of Priest Lake, in the lower Priest Lake basin, including the NF and SF Granite Creek. No bull trout redds were observed in these two tributaries. By expanding the number of redds observed by 3.2 fish/redd, we estimated a spawning escapement of 99 bull trout for the Upper Priest Lake basin.

Kootenai River Core Area

We surveyed three tributaries (North Callahan, South Callahan, and Boulder creeks) on October 17 and 20, 2011 for bull trout redds in the Idaho portion of the Kootenai River Core Area. A total of 2 redds were counted (Table 44). Personnel from Montana counted 2 redds in South Callahan Creek and 1 redd in North Callahan Creek. This was the tenth year surveys were conducted in all three tributaries. No bull trout redds were counted in Boulder Creek. By expanding the number of redds observed by 3.2 fish/redd, we calculated the spawning escapement of bull trout for the Idaho portion of the Kootenai River Core Area to be 6 fish. The long term trend in bull trout redds counts in the Kootenai River basin has declined over the past 10 years (Table 44).

Coeur d'Alene Lake Core Area

Five streams were surveyed in St. Joe River drainage on September 21, 2011, with Medicine Creek, Wisdom Creek and the upper St. Joe River being the index streams. A total of 52 redds were counted in the drainage with 43 redds counted in the three index streams (Table 45). The count in the index streams was the lowest recorded in the past 9 years. Medicine Creek contained most of the redds in this drainage (Figure 45). To our knowledge no spawning or rearing of bull trout occurred in the Coeur d' Alene River drainage.

North Fork Clearwater River Core Area

We counted 46 bull trout redds in the surveyed section of the North Fork Clearwater River drainage on September 22, 2011 (Table 46). The five index areas that included Lund Creek, Little Lost Lake Creek, Lost Lake Creek, Little North Fork Clearwater River between Lund and Lost Lake creeks, and the Little North Fork Clearwater River between its headwaters and Lost Lake Creek contained a total of 26 redds. The number of redds in the index streams was the lowest in the last 9 years.

MANAGEMENT RECOMMENDATION

1. Continue to monitor bull trout spawning escapement at two to five year intervals in the Priest Lake, Pend Oreille Lake, Kootenai River, St. Joe River and Little North Fork Clearwater River watersheds.

Table 42. Number of bull trout redds counted per stream in the Pend Oreille Lake, Idaho, Core Area, from 1983 to 2011. Index streams have an asterisk by their name.

Stream	Avg 1983-2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Clark Fork R.	8	7	8	1	0	3	2	0	1	0	0
Lightning Cr.	10	8	8	9	22	9	3	10	11[b]	0	20
East Fork Cr. *	50	58	38	77	50	51	34	38	85	26	64
Savage Cr.	7	15	7	15	7	25	0[b]	8	5	6	1
Char Cr.	11	8	7	14	15	20	1	5[e]	1[e]	4[e]	9[e]
Porcupine Cr.	10	0	5	10	14	8	8	8	15	11	13
Wellington Cr.	9	7	8	7	6	29	9	10	4[b]	7	6
Rattle Cr.	19	33	37	34	34	21	2	24	62[b]	43	65
Johnson Cr. *	19	31	0	32	45	28	32	40	47	57	54
Twin Cr.	9	8	3	6	7	11	0	4	0	0	1
Morris Cr.	1	7	1	1	3	16	0	6	6	9	0
Strong Cr.	2	0	--	0	--	--	--	7	6	2	11
Trestle Cr. [a] *	249	333	361	102[b]	174	395	145	183	279	188	178
Pack R.	22	22	24	31	53	44	16	11	4	0	1
Grouse Cr. *	37	42	45	28	77	55	38	31	51	27	116
Granite Cr.	32	57	101	149	132	166	104	52	106[c]	75[c]	129[c]
Sullivan Springs Cr.	16	15	12	14	15	28	17	7[c]	2[c]	9[c]	11[c]
North Gold Cr. *	29	24	21	56	34	30	28	17	28[c]	28[c]	6[c]
Gold Cr. *	112	203	126	167	200	235	179	73	107[c]	130[c]	56[c]
W. Gold Cr.	NA	--	--	--	--	4	0	7	5	4	0
M.F. East R.	NA	8[d]	21	20	48	71	34	36	25	22	28
Uleda Cr.	NA	4[d]	3	7	4	7	2	7[b]	16	6	9
N.F. East R.	NA	--	--	1	0	0	--	0	--	0	--
Caribou Creek	NA	--	--	--	--	--	--	--	--	--	37
Total 6 index streams	493	691	591	462	580	794	456	382	597	456	474
Total of all streams	611	890	836	781	940	1256	654	584	866	654	815

[a] Additional apprx. 0.5 km reach immediately upstream of index reach on Trestle Creek added in 2001
[b] Impaired observation conditions (ice, high water, ect)
[c] Abundant early spawning kokanee made identification of bull trout redds in lower reaches difficult
[d] Partial Count
[e] Barrier excluded bull trout from accessing typical spawning habitat

Table 43. Number of bull trout redds counted in the Priest River drainage, Idaho, 1985 to 2011.

Stream	Transect Description	Length (km)	1985	1986	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Upper Priest River	Falls to Rock Cr.	12.5	--	--	--	--	--	--	15	4	15	33	7	7	17	8	5	13	21	5	14	5	17	10
	Rock Cr. to Lime Cr.	1.6	--	--	--	2	1	1	2	0	3	7	0	2	0	0	0	0	1	0	0	2	4	1
	Lime Cr. to Snow Cr.	4.2	12[a]	5[a]	--	3	4	2	8	1	10	9	9	5	1	16	12	3	4	1	5	10	3	1
	Snow Cr. to Hughes Cr.	11.0	--	--	--	0	0	--	0	3	7	4	2	8	3	13	2	10	0	1	2	4	0	7
	Hughes Cr. to Priest Lk	2.3	--	--	--	0	0	--	0	--	--	0	0	--	--	--	--	--	--	--	--	--	0	0
Rock Creek	Mouth to F.S. trail 308	0.8	--	--	0	0	--	--	2	1	0	--	0	0	0	--	1	0	0	0	0	0	1	0
Lime Creek	Mouth upstream 1.2 km	1.2	4[b]	1[b]	0	0	--	--	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cedar Creek	Mouth upstream 3.4 km	3.4	--	1	--	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruby Creek	Mouth to waterfall	3.4	--	--	0	0	--	--	--	0	0	--	--	--	0	--	--	0	--	0	0	0	0	--
Hughes Creek	Trail 311 to trail 312	2.5	1	17	7	3	2	0	1	4	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	F.S. road 622 to Trail 311	4.0	35[c]	2[c]	2	0	7	1	2	0	0	0	0	0	0	1	2	1	1	0	0	5	0	7
	F.S. road 622 to mouth	7.1	4[d]	0[d]	--	1	--	--	2	3	1	0	2	6	1	0	1	1	1	0	0	3	11	3
Bench Creek	Mouth upstream 1.1 km	1.1	1	2	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jackson Creek	Mouth to F.S. trail 311	1.8	--	--	4	0	0	0	0	0	0	--	--	--	0	0	0	0	1	0	0	0	0	0
Gold Creek	Mouth to culvert	3.7	24	23	5	2	6	5	3	0	1	1	9	5	2	2	0	1	0	0	1	5	6	2
Boulder Creek	Mouth to waterfall	2.3	--	--	0	0	0	--	0	0	0	--	0	--	--	--	--	0	--	0	0	0	0	--
Trapper Creek	Mouth upstream 5.0 km upstream from East Fork	5.0	--	--	--	4	4	2	5	3	8	2	0	1	0	0	0	0	--	0	0	0	0	--
Caribou Creek	Mouth to old road crossing	2.6	--	--	--	1	0	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	0	--
All stream reaches combined		70.5	80[e]	50[e]	18	18	28	12[f]	41	22	45	58	29	34	24	41	23	29	29	7	22	34	42	31
Only those stream reaches counted during 1985 and 1986		23.8[g]	80	50	14[h]	11	21[h]	8[f]	17	10	12	12	20	16	4	20	15	6	6	1	6	23	20	13

[a] Redds were counted from Lime Creek to Cedar Creek, which was about half the distance that is currently counted.
[b] Redds were counted from the mouth to Forest Service road 1013, which was about one quarter of the distance that is currently counted.
[c] About 2/3 of the distance was counted that is currently counted.
[d] Redds were counted from Forest Service road 622 to Forest Service road 1013, which is about 1/3 of the distance that is currently counted.
[e] Redds were counted in about 20% of the stream reaches where they are currently counted.
[f] Observation conditions were impaired by high runoff.
[g] During 1985 and 1986 about 15 km of stream reach was counted.
[h] Two of the index sites were not counted.

Table 44. Number of bull trout redds counted in tributaries to the Kootenai River, 1990 to 2011. North and South Callahan creeks are the counts for the Idaho sections of these streams.

Stream	Length (km)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
IDAHO																							
Boulder Creek	1.8	--	--	--	--	--	--	--	--	--	--	0	2	2	0	0	1	0	0	0	0	0	0
North Callahan Creek	3.3	--	--	--	--	--	--	--	--	--	--	--	--	13	32	17	10	29	3	17	10	9	2
South Callahan Creek	4.3	--	--	--	--	--	--	--	--	--	--	--	--	3	10	8	5	4	0	0	0	1	0
MONTANA																							
Quartz Creek	16.1	76	77	17	89	64	67	47	69	105	102	91	154	62[d]	55	49	71	51	35	46	31	39	37
O'Brien Creek	6.9	--	25	24	6	7	22	12	36	47	37	34	47	45	46	51	81	65	77	79	40	27	32
Pipe Creek	12.9	6	5	11	6	7	5	17	26	34	36	30	6[a]	11	10	8	2	6	0	4	9	16	2
Bear Creek	6.9	--	--	--	--	--	6	10	13	22	36[b]	23	4[c]	17	14	6	3	14	9	14	6	8	3
West Fisher Creek	16.1	--	--	--	2	0	3	4	0	8	18	23	1	1	1	21	27	4	18	6	8	12	3
Idaho Total	9.4	0	0	0	0	0	0	0	0	0	0	0	2	19	42	25	21	33	3	17	10	10	2
Montana Total	58.9	82	107	52	103	78	103	90	144	216	229	201	212	136	126	135	184	140	139	149	94	102	80
Quartz/O'Brien/Pipe	35.9	82	107	52	101	78	94	76	131	186	175	155	207	118	111	108	154	122	112	129	80	82	71
Total all streams	68.3	82	107	52	103	78	103	90	144	216	229	201	214	154	168	160	200	173	142	166	104	112	79

Table 45. The number of bull trout redds counted in the St. Joe River drainage, Idaho, between 1992 and 2011. The Idaho Department of Fish and Game has counted the index streams since 1995. All other stream reaches were counted by the U.S. Forest Service and/or volunteers. Index streams include Medicine Creek, St. Joe River from Heller Creek to St. Joe Lake, and Wisdom Creek.

Stream Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Aspen Cr.	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--
Bacon Cr.	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--
Bad Bear Cr.	--	0	0	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Bean Cr.	14	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
Beaver Cr.	2	2	0	0	0	0	1	0	--	0	0	0	0	0	0	0	0	0	3	--
Bluff Cr.- East Fork	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
California Cr.	2	4	0	2	3	0	--	--	0	0	0	0	0	0	0	0	0	2	--	--
Copper Cr.	--	--	0	--	0	--	--	--	--	--	0	0	0	--	--	0	0	--	--	--
Entente Cr.	--	--	--	--	--	--	--	0	--	--	1	0	--	--	--	--	--	--	--	--
Fly Cr.	1	--	--	0	0	0	2	0	--	--	1	0	0	0	--	0	2	1	0	--
Gold Cr. Lower mile	--	0	--	--	--	0	--	0	--	--	--	0	--	--	--	--	--	--	--	--
Gold Cr. Midde	--	--	--	0	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
Gold Cr. Upper	--	2	--	--	1	1	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Gold Cr. All	--	--	--	--	--	--	--	--	--	1	0	--	0	--	--	--	--	--	--	--
Heller Cr.	0	0	0	0	--	1	0	0	0	--	0	0	7	1	5	0	0	3	9	5
Indian Cr.	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Medicine Cr.	11	33	48	17[a]	23[a]	13[a]	11[a]	48[a]	43	16	42	28	52	62	71	55	71	41	48	35
Mosquito Cr.	0	--	0	0	4	0	2	--	--	--	--	--	0	0	--	--	--	--	--	--
Quartz Cr.	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--
Red Ives Cr.	--	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	1	--	2	4
Ruby Cr.	0	1	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sherlock Cr.	0	3	0	2	1	1	0	1	0	--	--	0	0	0	0	0	3	--	1	--
Simmons Cr. - Lower	--	0	0	0	--	--	--	--	--	0	--	--	--	--	--	--	1	0	--	--
Simmons Cr. - NF to Three Lakes	--	5	0	--	--	--	--	--	--	--	--	--	--	--	0	--	--	0	--	--
Simmons Cr. - Three Lakes to Rd 1278	--	3	5	5	0	0	0	0	--	--	--	--	--	--	0	--	--	0	--	--
Simmons Cr. - Rd 1278 to Washout	--	0	0	0	1	0	1	0	--	--	--	--	--	--	--	--	--	0	--	--
Simmons Cr. - Upstream of Washout	--	0	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	0	--	--
Simmons Cr. - East Fork	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--
St. Joe River - below Tento Creek	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Spruce Tree CG to St. Joe Lodge	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 45. continued

Stream Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
St. Joe River - St. Joe Lodge to Broken Leg	--	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Broken Leg Cr upstream	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Bean to Heller Cr.	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Heller to St. Joe Lake	10[b]	14[b]	3[b]	20	14	6	0	10	2	11	3	9	9	10	0	6	8	1	5	7
Three Lakes Creek	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Timber Cr.	--	0	1	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Wampus cr	--	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Washout cr.	--	3	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Wisdom Cr	1	1	4	5	1	0	4	11	3	13	9	9	11	19	12	32	27	8	1	1
Yankee Bar	1	0	--	--	--	0	--	--	1	0	0	0	0	0	3	0	0	--	--	--
Total - Index Streams [c]	22	48	55	42	38	19	15	69	48	40	54	46	72	91	83	93	106	50	54	43
Total - All Streams	42	71	62	64	48	23	21	70	49	41	56	46	79	93	91	94	113	57	69	52

[a] These counts differed from what the U.S. Forest Service counted.

[b] These counts did not include from California Creek to Medicine Creek, a reach where bull trout spawning typically occurs.

[c] Index streams include Medicine Creek, St. Joe River from Heller Creek to St. Joe Lake, and Wisdom Creek.

Table 46. Number of bull trout redds counted in the Little North Fork Clearwater drainage between 1994 and 2011. Trend sites include Lund Creek, Little Lost Lake Creek, Lost Lake Creek, Little North Fork Clearwater River between Lund and Lost Lake creeks, and the Little North Fork Clearwater River between its headwaters and Lost Lake Creek.

Stream	Length (km)	1994	1996	1997	1998	1999	2000	2001	2001[a]	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Buck Creek	4.8	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--
Canyon Creek	5.5	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Butte Creek	1.2	--	--	--	--	--	--	--	5	0	--	--	--	--	--	--	--	--	--
Rutledge Creek		--	--	--	--	--	--	--	--	--	1	1	6	0	--	--	--	--	--
Rocky Run Creek	1.5	--	--	--	--	--	--	--	--	5	1	3	21	13	6	--	8	10	1
Lund Creek	3.9	0	7	2	2	1	1	13	5	7	7	5	19	7	30	22	11	6	1
Little Lost Lake Creek	3.9	0	1	1	1	7	3	1	--	2	4	15	1	34	31	14	5	19	2
Lost Lake Creek	3.0	0	0	0	0	--	1	--	--	0	--	1	--	10	13	8	9	7	6
Little North Fork Clearwater River																			
1268 Bridge to Lund Cr.	7.0	--	--	--	--	--	--	--	17	6	13	8	16	18	20	13	3	6	19
Lund Cr. to Lost Lake Cr.	3.8	--	--	3	1	9	8	3	12	5	7	5	8	16	21	9	11	9	11
Lost Lake Cr. to headwaters	5.4	0	2	0	0	--	5	1	--	5	5	5	11	13	8	20	14	7	6
All stream reaches surveyed	40.0	0	10	6	4	17	18	18	39	30	43	43	82	111	129	86	61	64	46
Trend sites (five streams)	20.0	0	10	6	4	17	18	18	17	25	28	32	39	84	108	73	50	48	26

[a] Streams were surveyed between 9/16/1994 and 9/19/1994, one week earlier than surveys in following years.

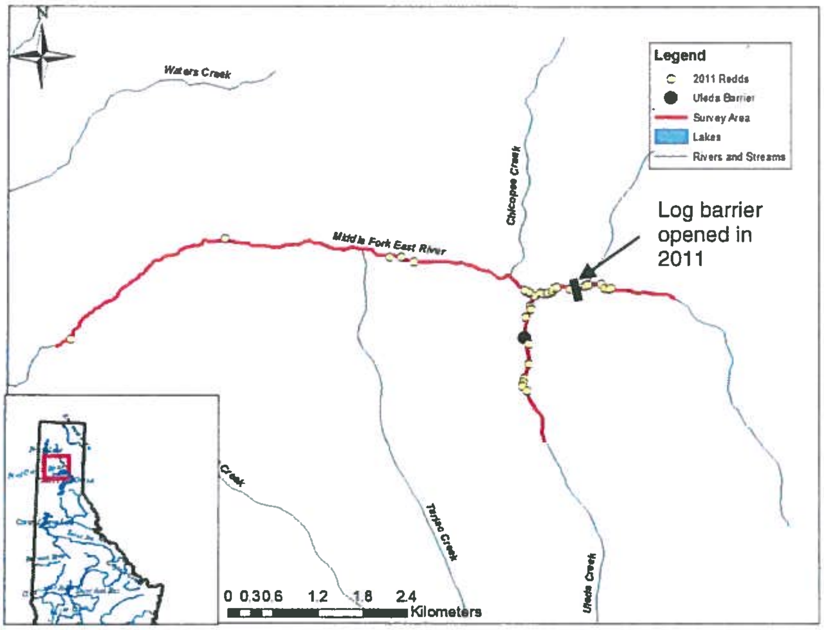


Figure 44. Location of bull trout redds in the Middle Fork East River drainage during surveys in 2011.

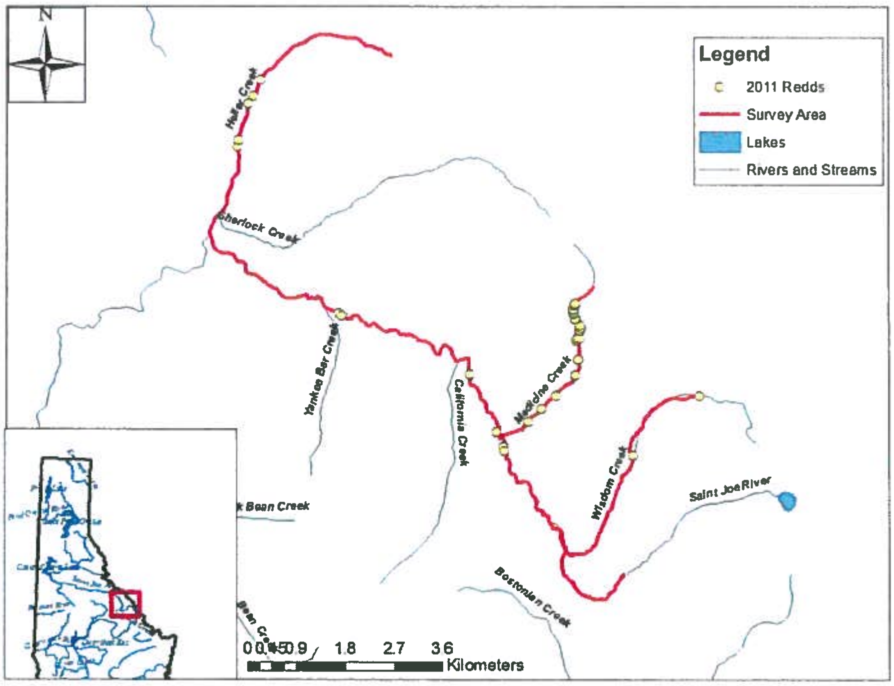


Figure 45. Location of bull trout redds in the upper St Joe River drainage during surveys in 2011.

CHAPTER 13: CUTTHROAT TROUT X RAINBOW TROUT HYBRIDIZATION IN THE NORTH FORK OF THE COEUR D'ALENE RIVER

ABSTRACT

Tissue samples from 170 trout collected throughout the North Fork Coeur d'Alene River that were analyzed at seven diagnostic nuclear DNA markers. Of these specimens, 79% were pure cutthroat trout, 11% were pure rainbow trout and 9% were cutthroat x rainbow hybrids. Of the hybrid trout, 15 out of 16 were greater than F1 hybrids. This data should serve as a baseline to determine future changes in hybrid composition. Prior to genetic analysis, biologists or officers classified each trout as a cutthroat, rainbow, or hybrid trout based on phenotypic traits. All fish classified as rainbow trout were genetically rainbow trout or hybrids, with 0% pure cutthroat trout. Fish classified as cutthroat trout were genetically cutthroat trout 96% of the time, hybrids 4% of the time, and rainbow trout 0% of the time. Trout that were genetically hybrids were misidentified 100% of the time, being called cutthroat trout 38% of the time, and misidentified as rainbow trout 62% of the time. These data illustrate the difficulty of phenotypically identifying hybrid trout in the North Fork Coeur d'Alene River.

Authors:

Melo Maiolie
Regional Fishery Biologist

Matthew Campbell
Geneticist

Ryan Hardy,
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Westslope cutthroat trout *Oncorhynchus clarkii lewisi* were historically found in most waters of Idaho north of, and including, the Salmon River drainage (Behnke 1972, Rieman and Apperson 1989). One of the threats facing the continued existence of the species is their tendency to hybridize with rainbow trout (Leary et al. 1984). IDFG ceased stocking diploid rainbow trout in the Coeur d'Alene River in 1998 and began stocking triploid rainbow trout in 2001. All stocking of rainbow trout ceased in 2002. These actions were done to protect the genetically pure stocks of westslope cutthroat trout.

Previous work has been done to examine the genetic makeup of trout in the Coeur d'Alene River. Samples were collected randomly at four sites in the North Fork (NF) Coeur d'Alene River and mainstem Coeur d'Alene River in 2004. The sample of trout was found to be 85% cutthroat trout, 7.5% rainbow trout, and 7.5% hybrids of the two species (n=67)(Dupont et al. 2004). An additional analysis from the Eagle Genetics Lab, completed in 2005, examined samples from 18 trout collected from the Little North Fork Coeur d'Alene River. This study detected no hybrids, although one rainbow trout was detected and hybrids were detected elsewhere in the drainage (Campbell and Cegelski 2005).

Our current study was to accomplish two purposes. It was first to establish a better baseline for the extent of hybridization in the in the N.F. Coeur d'Alene River by increasing the sample size of analyzed fish. Secondly, we wanted to retest the ability of field personnel to accurately differentiate westslope cutthroat trout, rainbow trout, and hybrids using phenotype-based procedures.

STUDY SITE

Trout were collected for this study from the North Fork of the Coeur d'Alene River between the Big Hank Campground and the Cataldo boat ramp. (Figure 46). This section of the Coeur d'Alene River currently allows the harvest of six rainbow trout and rainbow x cutthroat hybrids, but allows no harvest of cutthroat trout.

OBJECTIVES

The objective of this study was to "ensure the long-term survival of native fish" and to "maintain or improve game populations to meet the demand for fishing" (Idaho Fish and Game 2005). Specifically our results were meant to help protect westslope cutthroat trout in the North Fork of the Coeur d'Alene River. We hope to better define a baseline of the amount of hybridization that was occurring within the drainage. Future studies can then determine if hybridization is increasing or decreasing. We also tested the ability of field personnel to be able to identify a cutthroat trout, a rainbow trout, or hybrids of the two species. If phenotypic classification is possible, then a number of options become available that may help accomplish the above objectives. These may include selective removal of fish or continuing regulations that allow selective angler harvest of non-cutthroat trout.

METHODS

Trout were collected for this study by electrofishing the North Fork of the Coeur d'Alene River from Big Hank Campground to Cataldo between July 6 and July 20, 2012 (Figure 46). Efforts were made to collect trout fairly evenly throughout the study reach. The location of capture, a fin tissue sample, a photograph of each fish, its total length, and a decision on whether the trout was a cutthroat trout, a rainbow trout, or a hybrid was made for each fish. In addition, tissue samples of trout, photographs and lengths, were collected by enforcement officers from angler caught fish between July 10 and August 21, 2012.

Successful genetic analyses on 170 trout samples collected from the N.F. Coeur d'Alene River drainage (2 samples failed) was completed for this study. To assess hybridization and introgression, all samples were screened with seven diagnostic nuclear DNA (nDNA) markers (OM55, Occ34, Occ35, Occ36, Occ37, Occ38, and Occ42). These markers are co-dominant, Simple Sequence Repeat (SSR) markers which are diagnostic based on size differences in the Polymerase Chain Reaction (PCR) products between rainbow trout and cutthroat trout (Ostberg and Rodriquez 2002).

Prior to genetic analysis, we examined the phenotypic characteristics of the trout to classify them as a cutthroat trout, a rainbow trout, or a hybrid. The traits used were the presence, absence, or the completeness of the red slash under the jaw, and the spotting pattern on the sides of the fish. Enforcement officers also contributed fish and classified them based on their best professional judgment.

RESULTS

Of the 170 samples that were extracted and successfully genotyped, 134 had genotypes indicative of cutthroat trout (homozygous for cutthroat trout alleles at all loci examined), and 20 had genotypes indicative of rainbow trout (homozygous for rainbow trout alleles at all loci examined) (Table 47). The remaining 16 samples were identified as hybrids. Of these, 15 were identified as $>F_1$ hybrids, and 1 was identified as an F_1 hybrid (heterozygous with a rainbow trout allele and a cutthroat trout allele at each locus examined). Hybridization, calculated as the total number of hybrids detected out of the total samples genotyped was 9.3%. Rainbow trout introgression within the sample was 5.6% and was calculated as the number of rainbow trout alleles detected in samples with genotypes indicative of cutthroat trout and $> F_1$ hybrids (119) divided by the total alleles examined in those samples (2114). Because introgression is the actual incorporation of alleles from one taxa into another, samples with genotypes indicative of F_1 hybrids and rainbow trout were not included in this calculation. The identification of many fish within this sample exhibiting genotypes indicative of the pure parental species (rainbow trout and westslope cutthroat trout), indicates that we are not sampling a hybrid swarm. As expected, a test for Hardy Weinberg Equilibrium (HWE) performed using the software program GENPOP confirmed this. All seven loci were significantly out of HWE ($p<.0001$) when tested on all samples, rejecting the null hypothesis that samples were collected from a single population.

Phenotypic identification of hybridized trout proved to be difficult. Observers (officers and biologists) were 100% correct in identifying rainbow trout (20 out of 20) (Table 48). Observers were 0% correct in identifying a hybrid trout (0 out of 16) (Table 48 and Figure 47). Lastly, observers were 98% accurate in identifying a genetically pure cutthroat trout (131 out of 134) (Table 48). The three errors occurred by calling pure cutthroat trout a hybrid (Table 48 and Figure 48).

Location of the hybrid and rainbow trout were mostly in the lower stretches of the river (Figures 49 and 50).

DISCUSSION

This screening detected more rainbow trout and hybrids than the previous two studies within the N.F. Coeur d'Alene River drainage, and higher levels of hybridization and introgression (Campbell and Cegelski 2005, Dupont et al. 2004). However, our sample sizes from the earlier studies were probably too low to make confident inferences about changes in hybridization and introgression levels and rates over this time period. It is important to mention though, that it has been hypothesized that once non-native rainbow trout establish self-reproducing populations, they may expand in numbers and distribution over time, displacing and interbreeding with cutthroat trout. This is believed to occur due to a combination of the superior competitive ability of rainbow trout in particular environments and the lack of isolating mechanisms that are present in naturally sympatric populations (Robinson 2007).

Studies in other drainages in the Columbia River basin have documented increases in the hybridization and introgression of westslope cutthroat trout populations over time in areas where non-native rainbow trout have been introduced. This is a result of the establishment of self-reproducing populations and the dispersal of hybrids into areas containing pure cutthroat populations (Rubidge and Taylor 2004; Hitt et al. 2003). In response to these types of findings, one management strategy that has been suggested is the selective removal of non-native rainbow trout and hybrids. One obvious requirement of this strategy is the ability to accurately differentiate rainbow trout, cutthroat trout, and their hybrids. This study indicates that if the phenotype-based identifications employed by samplers were used to identify rainbow trout for removal, they would have been successful in removing all rainbow trout handled and 10 of the 16 hybrids handled (62.5%) (Table 48). One potential concern is that of the 3 samples identified in the field as hybrids (1 sample failed), all 3 had genotypes indicative of cutthroat trout (Table 48). This suggests that the use of current phenotype-based identifications may inadvertently remove a small number of pure cutthroat trout. These results will have to be considered carefully as managers assess strategies to limit the spread and rate of introgression within the drainage.

A second way to describe the results was to look at whether or not the observer was correct once the genotype was determined. For example, 100% of the 20 genotypic rainbow trout were correctly identified by observers as rainbow trout (Table 48). Of the 134 genotypically pure cutthroat trout, 131 were identified as cutthroat trout and 3 were called hybrids (2% error rate). Of the trout that genetically were found to be hybrids, none were correctly identified as hybrids (100% error) (Table 48).

Errors made in these identifications were consistent with a past study in this drainage. Work by Dupont et al. (2004) also misidentified all five trout that were genotypically found to be hybrids. In their study, three of the hybrids were classed as rainbow trout and two were classed as cutthroat trout. They also classified two trout as hybrids that were genotypically found to be pure cutthroat trout. These results indicate the difficulty with identifying hybrid cutthroat trout. Previous research by Leary et al. (1984) demonstrated that westslope cutthroat trout with low levels of rainbow trout alleles may be phenotypically undistinguishable from pure westslope cutthroat trout.

MANAGEMENT RECOMMENDATION

Curtail the practice of trying to explain to anglers the characteristics that define a hybrid westslope cutthroat trout.

Table 47. Number of samples examined (N), number of samples successfully genotyped (N^G), total numbers of alleles examined (A^E), total number of rainbow trout alleles observed (RBT^A), total number of cutthroat trout alleles observed (CUT^A), total number of alleles examined in samples with genotypes indicative of cutthroat trout and >F1 hybrids (CUT^A + $>F_1{}^A$), total number of RBT alleles observed in those samples (RBT^A), number of samples with genotypes indicative of cutthroat trout (CUT), rainbow trout (RBT), F1 hybrids ($F_1{}^{HYB}$), and >F1 Hybrids ($>F_1{}^{HYB}$), total hybrids detected (HYB^T), and percentage hybridization (HYB%) and introgression (INT%) observed in samples.

N	N^G	A^E	RBT^A	CUT^A	CUT^A + $>F_1{}^A$	RBT^A	CUT	RBT	F_1 HYB	$>F_1$ HYB	HYB^T	HYB%	INT%
174	172	2406	406	2000	2114	119	136	20	1	15	16	9.3%	5.6%

Table 48. Comparisons of phenotype-based identifications of rainbow trout (RBT^P), westslope cutthroat trout (WCT^P), and hybrids between the two (RBT X CUT^P) and genotype based identifications. For example, of the 30 fish identified as rainbow trout (RBT), 20 had genotypes indicative of RBT^G, and 10 had genotypes indicative of greater than F_1 hybrids ($>F_1$ HYB^G).

Genotype of sampled trout	Phenotypic identification of sampled trout		
	RBT^P	WCT^P	RBT X CUT^P
RBT^G	20		
CUT^G		131	3
F_1 HYB^G		1	
$>F_1$ HYB^G	10	5	
Number in sample	30	137	3

Figure 46. Map of the Coeur d'Alene River showing the location of the section where genetic samples were collected.

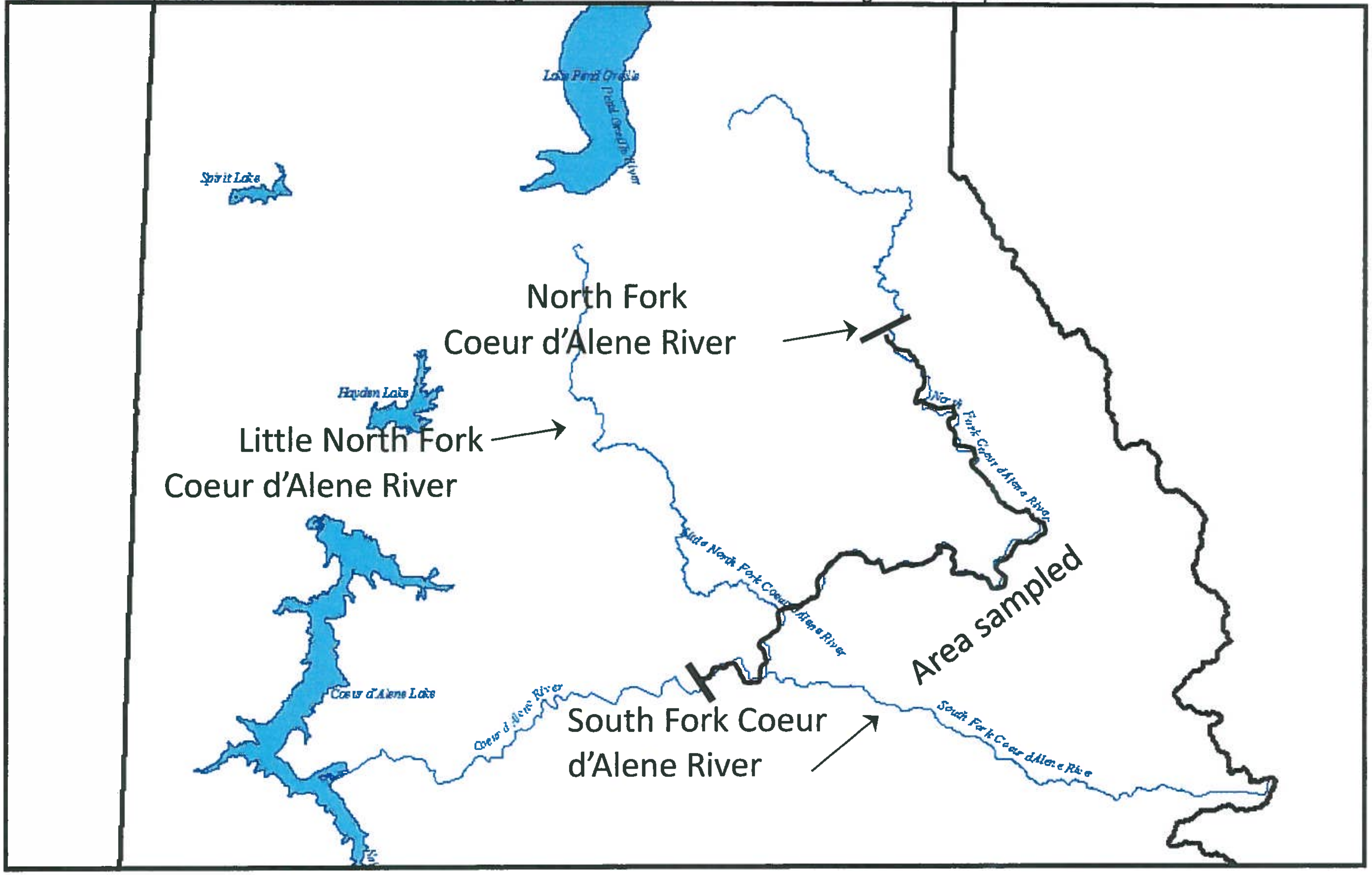
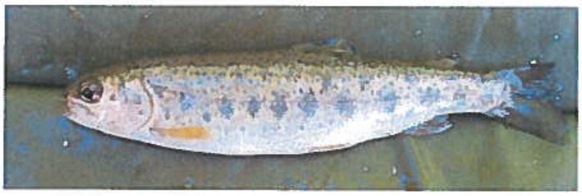
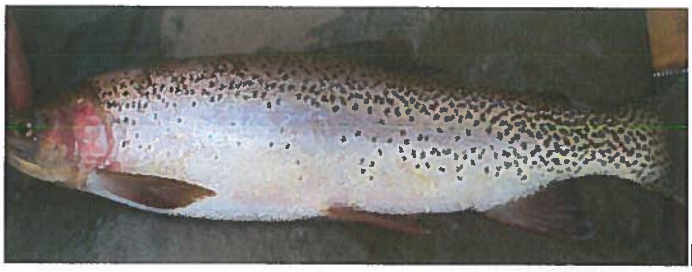


Figure 47. Photographs of hybrid cutthroat trout misidentified during study.


Misidentified as a rainbow trout.


Misidentified as a rainbow trout.


Misidentified as a cutthroat trout.


Misidentified as a cutthroat trout.


Misidentified as a cutthroat trout.

Figure 48. Photographs of three pure cutthroat trout that were misidentified as hybrids.

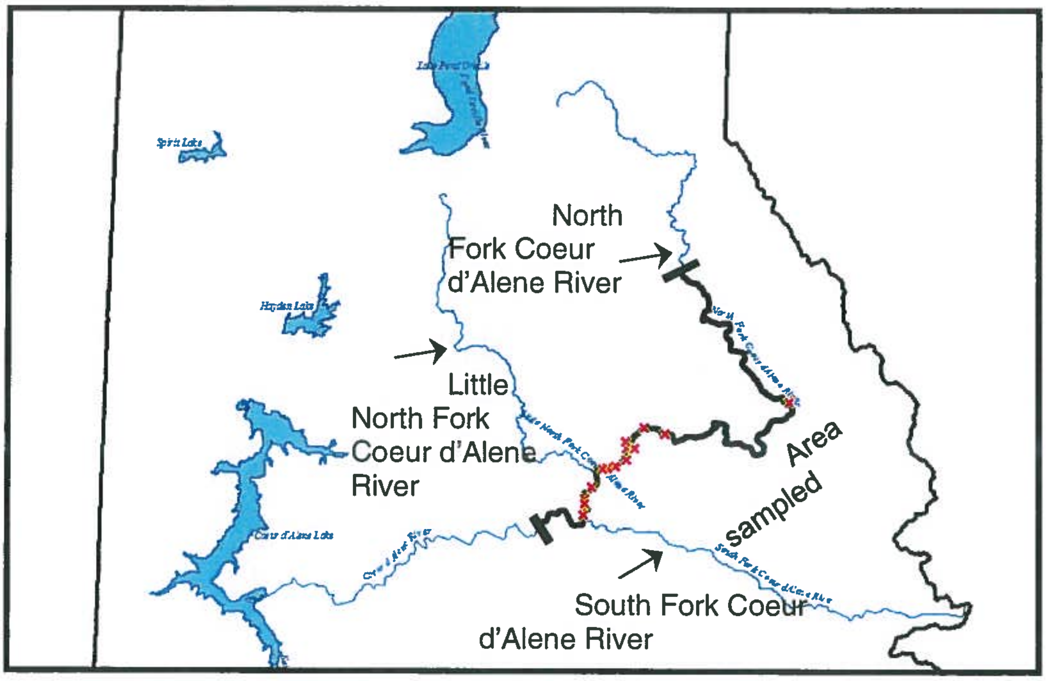


Figure 49. Map of the Coeur d'Alene River drainage showing the locations where cutthroat trout x rainbow trout hybrids (red Xs) were collected.

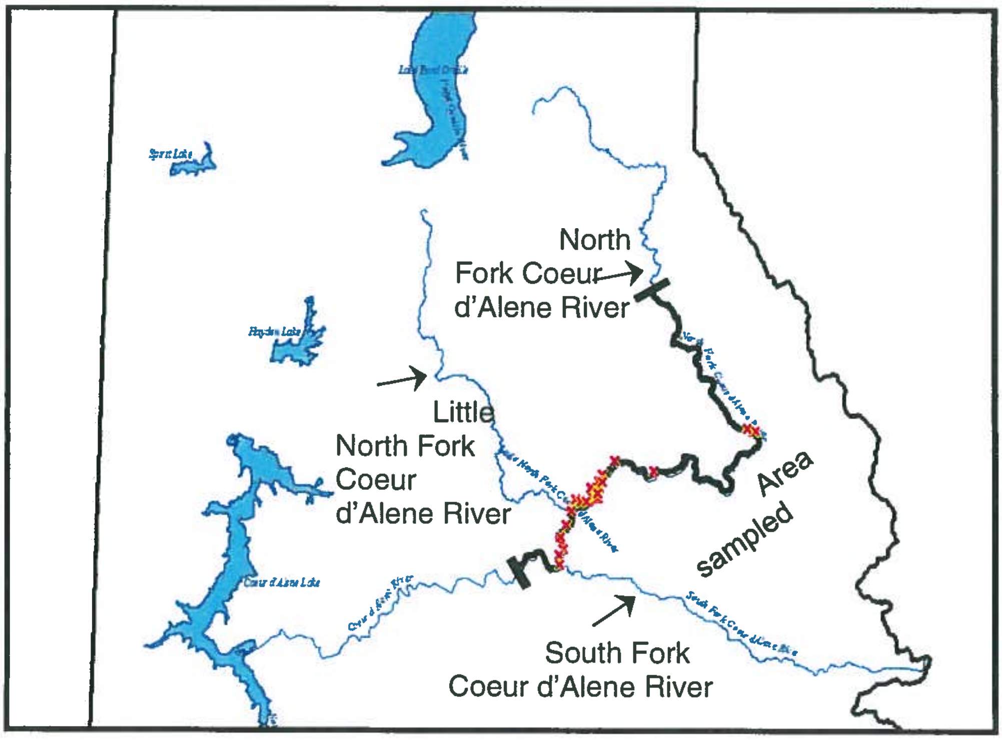


Figure 50. Map of the Coeur d'Alene River drainage showing the locations where genetically pure rainbow trout (red Xs) were collected.

CHAPTER 14: TROUT SURVEYS IN THE COEUR D'ALENE, ST. MARIES AND PRIEST RIVERS

ABSTRACT

We estimated fish densities at established transects in three river systems as part of a long term data set to evaluate a variety of fishery management and habitat improvement efforts. Twenty-eight transects were snorkeled in Coeur d'Alene River, 15 in the St. Maries River, and 12 in the Priest River. Total densities of age-1 and older westslope cutthroat trout *Oncorhynchus clarkii lewisi* were 1.93 fish/100 m^2 in the Coeur d'Alene River drainage, 0.02 fish/100 m^2 in Priest River, and 0.10 fish/100 m^2 in the St. Maries River. Densities of cutthroat trout ≥ 300 mm in length were 0.29 fish/100 m^2 in the Coeur d'Alene River, 0.001 fish/100 m^2 in the Priest River, and 0.03 m^2 in the St. Maries River. Cutthroat trout in the North Fork Coeur d'Alene River were at record high densities and appeared to be responding to restrictive regulations and habitat improvements. Densities of larger cutthroat trout have increased by 574% from the densities seen during the period from 1991 to 2002. In addition, 5 sites were sampled in the Priest River by electrofishing. Species composition showed low cutthroat abundance and an increasing population of smallmouth bass *Micropterus dolomieu*.

Authors:

Melo Maiolie
Regional Fisheries Biologist

Ryan Hardy
Regional Fisheries Biologist

Jim Fredericks
Regional Fisheries Manager

INTRODUCTION

Past researchers found declines in the Coeur d'Alene River fishery were directly related to over harvest, habitat degradation, and toxic mine wastes (Rankel 1971; Bowler 1974; Lewynsky 1986; Rabe and Sappington 1970; Mink et al. 1971). Efforts such as habitat improvements and fishing regulation changes have been on going to try to mitigate these impacts. As a result, westslope cutthroat trout populations have increased significantly and now support a very popular fishery.

Snorkel transects for monitoring fish abundance were established in the North Fork (NF) Coeur d'Alene River in 1973 (Rankel 1971; Bowler 1974), and the South Fork (SF) Coeur d'Alene River in 2006 (Dupont et al. 2009). The long-term data sets collected from these snorkel transects were important in documenting how changes in fishing regulations, habitat, and weather patterns influence trends in fish populations. During 2011, monitoring in the North Fork Coeur d'Alene River was continued. In addition we began monitoring in the Priest River and St. Maries River to establish trend data for these waters.

OBJECTIVE

These surveys were conducted to monitor the progress on three main objectives for their respective drainages including: 1) maintain or improve fish populations to meet the demand for fishing; 2) ensure the survival of native fish; and 3) increase the capacity of habitat to support fish (Idaho Fish and Game 2005).

STUDY SITES

Fish abundance was estimated in three separate drainages during 2011; the North Fork Coeur d'Alene River, the Priest River below Priest Lake, and the St. Maries River. The North Fork Coeur d'Alene River and the St. Maries River are in the Spokane River drainage. Both of these rivers eventually flow into Coeur d'Alene Lake. Priest River is a tributary to the Pend Oreille River, which then flows into the Columbia River north of the Canadian border. Historically, the primary sportfish in these three watersheds was cutthroat trout (Rieman and Apperson, 1989).

METHODS

Snorkeling was used to evaluate trends in fish abundance following standardized methods described by DuPont et al. (2009). We snorkeled transects on the NF Coeur d'Alene River from August 1-4. In the NF Coeur d'Alene River, 24 snorkel transects were located in the main river system (85 river km), 13 were in the Little North Fork (LNF) Coeur d'Alene River (45 river km) and 7 were in Tepee Creek (8 river km) (Figure 51). Sampling on the NF Coeur d'Alene River was consistent with previous year's sampling times. Some of the transect locations on the Coeur d'Alene River have been changed over the years as the river has shifted positions and pools have filled (see DuPont et al. 2009).

Snorkeling in the Priest River and St. Maries River were being done for the first time. In the Priest River snorkeling was conducted from August 16-18, along 12 transects (Figure 52). In addition the Kalispel Tribe snorkeled 13 transects at the upper end of the Priest River closer to Priest Lake. Snorkeling took place on August 22, 23 and 30. In the St. Maries River snorkeling was conducted July 26-27 along 15 transects (Figure 53).

Electrofishing was also used to monitor fish populations in the Priest River. A drift boat mounted electrofishing unit was used to survey July 12 to 15. Five sites were electrofished with two passes; once down each bank at river km 2, 13, 24, 27, and 34. Total sampling time for all electrofishing was 148 minutes. In addition, the Kalispell Tribe electrofished five sites at river km 43, 45, 50, 57, and 64, on July 12 to 14. They sampled for a total time of 158 minutes.

We attempted to monitor angler exploitation of cutthroat trout on the St. Maries River by tagging fish over 300 mm. Only 12 fish were caught due to high water during the spring. Floy tags were inserted into the dorsal musculature of the fish after they were caught by hook and line. Tags contained the phone number for IDFG so anglers could report the catch of tagged fish. Exploitation was estimated after correcting for a one year tag loss of 8.9%, a non-reporting rate of 52.9%, and assuming no mortality due to fish tagging.

RESULTS

North Fork Coeur d'Alene River

A total of 2,980 cutthroat trout, 662 rainbow trout, 73 brook trout *Salvelinus fontinals*, and 6,927 mountain whitefish *Prosopium williamsoni* were counted in the NF Coeur d'Alene River transects (Table 49). Densities of cutthroat trout in all size classes on all transects averaged 1.93 fish/ha. Density of cutthroat over 300 mm averaged 0.29 fish/100 m^2. Densities of both size groups were higher than previously recorded (Tables 50 and 51). Density of cutthroat trout over 300 mm was an increase of 574% from a mean of 0.043 fish/100 m^2 during the period from 1991 to 2002 (Figure 52).

The amount of improvement in cutthroat trout densities varied in different sections of the Coeur d'Alene River. In areas of the river where cutthroat trout were previously allowed to be harvested (the section of the North Fork Coeur d'Alene River below Yellowdog Creek and the section of the Little North Fork below Laverne Creek) densities of larger cutthroat trout have been steadily increasing since 2002 (Figure 54). In areas of the river where cutthroat trout were previously made catch and release (the North Fork above Yellowdog Creek after 1986, and the Little North Fork above Laverne Creek after 1988), densities of larger cutthroat trout improved after 2001 and have remained high for the last seven years.

Rainbow trout densities were highest at snorkel transects NF7 (2.24 rainbow trout/100 $m^{2)}$, and NF8 (3.77 rainbow trout/100 m^2) (Table 49 and Figure 57). Almost no rainbow trout were identified in Tepee Creek, the upper sections of the NF Coeur d'Alene River, and the upper end of the Little NF Coeur d'Alene River.

St. Maries River

Low numbers of fish were found in the St. Maries River. We counted a total of 44 cutthroat trout, 0 rainbow trout, 64 mountain whitefish, 84 largescale sucker *Catostomus macrocheilus*, 30 northern pikeminnow *Ptychocheilus oregonensis*, and 1 brook trout in the 15 transects that covered 45.11 ha (Table 51). Cutthroat density was estimated at 0.10 fish/100 m^2. Thirty-two percent of the cutthroat trout seen were larger than 300 mm. We found no mountain whitefish in most of the surveyed transects, however, one transect had 51 mountain whitefish (transect 35.5) (Table 51). Northern pikeminnow and largescale suckers were also aggregated in a few transects and were missing from most. Temperatures at the time of the survey ranged from 19.5° C at the lowest transect to 13.5° C at the uppermost transect.

Anglers reported catching 1 tagged cutthroat trout out of the 12 tagged fish in the St. Maries River. Exploitation was estimated at 14% after correcting for tag loss and non-reporting. Because of the low sample size, little confidence was placed in this estimate.

Priest River

IDFG personnel surveyed the lower river at river km 10.5 to 39.5 (Figure 52). A total of 18 cutthroat trout, 12 rainbow trout, 475 mountain whitefish, 389 largescale sucker, 10 northern pikeminnow, 19 smallmouth bass *Micropterus dolomieu* and 21 brown trout *Salmo trutta* were counted during the snorkeling survey of the Priest River (Table 50). Trout densities were very low at 0.02 cutthroat trout/100 m^2, 0.01 rainbow trout/100 m^2 and 0.02 brown trout/100 m^2. Only 6% of the cutthroat trout seen were larger than 300 mm (1 out of 18). The most numerous fish was the mountain whitefish, however, the density of mountain whitefish was only 11% of the density seen in the Coeur d'Alene River. Smallmouth bass were observed in 6 of the 12 transects. Density was estimated at 0.02 smallmouth bass/100 m^2 (Table 50). Temperature at the time of the survey ranged from 16° C at the lower end (transect 10.5) to a high of 19° C at transect 36 (Figure 50).

Personnel from the Kalispel Tribe surveyed the upper river at river km 42 to 68.5 (Figure 50). They counted a total of 14 cutthroat trout, 90 rainbow trout, 582 mountain whitefish, 4 smallmouth bass, 13 largescale sucker, 5 northern pikeminnow, and 2 brown trout during their snorkeling survey on the upper section of the Priest River (Table 50). Trout densities were very low at 0.01 cutthroat trout/100 m^2, 0.08 rainbow trout/100 m^2, and 0.002 brown trout/100 m^2. The most numerous fish seen in the upper river was the mountain whitefish. Smallmouth bass were seen on three of the 13 transects in the upper sections, with a density of 0.004 bass/100 m^2. A maximum temperature of 21.5 °C was recorded during the survey on August 23 at river km 50.

Electrofishing results were similar to the results from snorkeling (Tables 52 and 53). Mountain whitefish were the most numerous species collected. After whitefish, cutthroat trout were the most numerous game fish in the lower river and smallmouth bass (1) in the upper sections. All trout species were in low abundance.

DISCUSSION

North Fork Coeur d'Alene River

Cutthroat trout densities have increased since we began surveys in the early 1970's. This year densities of both cutthroat trout >300 mm, and cutthroat trout of all sizes combined, were at record high levels (Figures 52 and 53). Much of this increase can be attributed to regulation changes and improved timber management policies throughout the basin. A detailed breakdown of basin wide changes and how they may correlate to changes in fish densities were presented in DuPont et al. (2009). It would be very difficult to separate improvements due to habitat changes from improvements due to fishing regulation changes since the effects are occurring simultaneously.

The greatest improvement in cutthroat trout densities in 2011 occurred in areas that were open to harvest before 2008, but then became catch and release. Densities of cutthroat trout over 300 mm in these areas were approaching the densities recorded in areas of the Coeur d'Alene River that had been catch and release for more than the last 20 years (Table 52 and Figure 56). Overall cutthroat densities in the North Fork Coeur d'Alene River (1.93/100 m^2)

were higher in 2011 than those recorded in the St. Joe River in 2010 (1.24/100 m^2) (Hardy and Fredericks 2011). Number of large cutthroat trout over 300 mm still remains higher in the St. Joe River (0.40/100 m^2 versus 0.29/100 m^2) (Hardy and Fredericks 2011).

Priest River

This year's snorkeling effort was the first such survey for the Priest River. Compared to the Coeur d'Alene River, trout densities were very low. Snorkeling found density of all sizes of cutthroat trout averaged 0.015 trout/100 m^2 (upper and lower sections combined) compared to 1.92 cutthroat trout/100 m^2 in the Coeur d'Alene River (Tables 49 and 50). All sites sampled with electrofishing equipment by IDFG and the Kalispell Tribe showed very few sportfish in either the upper or lower river sections (Tables 54 and 55). Possible factors worth investigating in the future include warm, mid-summer temperatures and the dam on Priest Lake being a barrier to migrating cutthroat trout during the spawning season.

Location of the specific transects used in this study were provided in Figure 52. We suggest that future surveys use these same transects so that direct comparisons can be made to the current data.

St. Maries River

To our knowledge this is the first systematic snorkeling survey done in the St. Maries River. Cutthroat densities were very low compared to the Coeur d'Alene River, 0.1 cutthroat trout/100 m^2 compared to 1.92 cutthroat trout/100 m^2 (Tables 49 and 51). A number of possible factors could contribute to the low densities. These include the possibility that cutthroat trout stocks in this basin may be adfluvial and move down to Coeur d'Alene Lake as they grow. However, we would still have expected to see more small cutthroat trout residing in the river. A second possibility was that mid-summer temperatures in the river may be too warm for cutthroat trout.

MANAGEMENT RECOMMENDATIONS

1. Investigate the mid-summer temperatures in the St. Maries and Priest rivers to see if an explanation can be found for the low densities of trout.

2. Continue habitat improvement work and restrictive regulations in the Coeur d'Alene River to determine if cutthroat trout densities will continue to improve.

ACKNOWLEDGEMENTS

The authors would like to thank Jason Connor, Jason Olson, Shane Harvey, and Cy Rosenthal of the Kalispel Tribe for their help with snorkeling and electrofishing on the Priest River.

Table 49. Numbers and density of fishes observed while snorkeling transects in the Coeur d'Alene River, Idaho, during August 1-4, 2011.

Transect	Area (m^2)	Cutthroat trout: Number counted <300 mm	Cutthroat trout: Number counted >300 mm	Cutthroat trout: Total	Cutthroat trout: Density (fish/100 m^2)	Rainbow trout: Total	Rainbow trout: Density (fish/100 m^2)	Mountain whitefish: Total	Mountain whitefish: Density (fish/ 100 m^2)	Large-scale sucker: Total	Northern Pike-minnow: Total	Brook trout: Total	Sal-monid: Density (fish/ 100 m^2)
Lower North Fork													
NF1	5,049	17	3	20	0.40	10	0.20	250	4.95	260	120	0	5.55
NF1slough	1,927	8	10	18	0.93	9	0.47	80	4.15	0	0	35	7.37
NF2	7,640	29	3	32	0.42	10	0.13	200	2.62	55	0	0	3.17
NF3	10,500	32	0	32	0.30	10	0.10	132	1.26	105	255	0	1.66
NF4	7,656	60	9	69	0.90	27	0.35	350	4.57	150	600	0	5.83
NF5	6,355	95	26	121	1.90	32	0.50	350	5.51	0	550	0	7.92
NF6	6,278	63	17	80	1.27	91	1.45	450	7.17	0	15	0	9.89
NF7	6,030	139	15	154	2.55	135	2.24	1100	18.24	250	100	0	23.03
NF8	5,696	610	58	668	11.73	215	3.77	1200	21.07	30	0	0	36.57
NF9	7,778	81	4	85	1.09	2	0.03	36	0.46	0	0	0	1.58
NF10	8,505	425	63	488	5.74	64	0.75	1380	16.23	0	10	0	22.72
NF11	7,475	98	13	111	1.48	0	0.00	80	1.07	0	0	0	2.56
NF12	5,695	21	8	29	0.51	2	0.04	0	0.00	0	0	0	0.54
NF13	2,404	18	3	21	0.87	0	0.00	1	0.04	0	0	0	0.92
North Fork													
NF14	4,133	62	22	84	2.03	0	0.00	312	7.55	0	0	0	9.58
NF15	3,062	65	9	74	2.42	0	0.00	330	10.78	0	0	0	13.19
NF16	4,496	19	7	26	0.58	0	0.00	10	0.22	0	0	0	0.80
NF17	8,261	101	10	111	1.34	0	0.00	150	1.82	0	0	0	3.16
NF18	2,288	64	22	86	3.76	0	0.00	240	10.49	0	0	0	14.25
NF19	431	37	8	45	10.45	0	0.00	2	0.46	0	0	0	10.91
NF20	921	0	3	3	0.33	0	0.00	2	0.22	0	0	0	0.54
NF21	965	7	3	10	1.04	0	0.00	3	0.31	0	0	0	1.35
NF22	1,460	50	33	83	5.69	0	0.00	20	1.37	0	0	0	7.06
NF23	603	3	1	4	0.66	0	0.00	0	0.00	0	0	0	0.66

Table 49. Continued.

Transect	Area (m^2)	Cutthroat trout: Number counted <300 mm	Cutthroat trout: Number counted >300 mm	Cutthroat trout: Total	Cutthroat trout: Density (fish/ 100 m^2)	Rainbow trout: Total	Rainbow trout: Density (fish/100 m^2)	Mountain whitefish: Total	Mountain whitefish: Density (fish/ 100 m^2)	Large-scale sucker: Total	Northern Pike-minnow: Total	Brook trout: Total	Sal-monid density (fish/ 100 m2)
Little North Fork													
LNF1	1,200	13	0	13	1.08	1	0.08	0	0.00	0	0	0	1.17
LNF2	3,343	53	1	54	1.62	14	0.42	0	0.00	0	0	22	2.69
LNF3	2,949	7	2	9	0.31	2	0.07	37	1.25	0	0	0	1.63
LNF4	782	78	12	90	11.51	26	3.32	0	0.00	0	0	15	16.75
LNF5	2,967	10	5	15	0.51	6	0.20	10	0.34	0	0	1	1.08
LNF6	1,553	19	5	24	1.55	4	0.26	0	0.00	0	0	0	1.80
LNF7	1,285	20	3	23	1.79	0	0.00	0	0.00	0	0	0	1.79
LNF8	3,672	38	9	47	1.28	1	0.03	0	0.00	0	0	0	1.31
Little North Fork													
LNF9	1,183	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
LNF10	1,752	39	4	43	2.46	1	0.06	0	0.00	0	0	0	2.51
LNF11	1,398	10	3	13	0.93	0	0.00	0	0.00	0	0	0	0.93
LNF12	1,228	8	8	16	1.30	0	0.00	0	0.00	0	0	0	1.30
LNF13	889	6	1	7	0.79	0	0.00	0	0.00	0	0	0	0.79
Teepee Creek													
TP01	1,598	39	8	47	2.94	0	0.00	45	2.82	0	0	0	5.76
TP02	5,109	0	3	3	0.06	0	0.00	0	0.00	0	0	0	0.06
TP03	1,505	31	6	37	2.46	0	0.00	35	2.33	0	0	0	4.78
TP04	2,442	4	5	9	0.37	0	0.00	2	0.08	0	0	0	0.45
TP05	1,283	19	1	20	1.56	0	0.00	120	9.35	0	0	0	10.91
TPR1	1,536	19	7	26	1.69	0	0.00	0	0.00	0	0	0	1.69
TPR2	1,388	20	10	30	2.16	0	0.00	0	0.00	0	0	0	2.16
TOTALS	154,624	2,537	443	2,980	1.93	662	0.43	6927	4.48	850	1650	73	

Table 50. Numbers and density of fishes observed while snorkeling transects in Priest River, Idaho, during August 16-18, 2011.

		Cutthroat trout				Rainbow trout		Mountain whitefish		Small-mouth bass		Large-scale sucker	Northern pike-minnow	Brown trout	Salmonid density
		Number counted			Density		Density		Density		Density				
Transect	Area (m^2)	<300 mm	>300 mm	Total	(fish/ 100 m^2)	Total	(fish/ 100 m^2)	Total	(fish/ 100 m^2)	Total	(fish/10 0 m^2)	Total	Total	Total	(fish/ 100 m^2)
Lower Section Priest River															
P10.5	8,764	1	0	1	0.01	1	0.01	99	1.13	3	0.03	0	1	0	1.15
P13.5	5,273	3	0	3	0.06	3	0.06	78	1.48	0	0.00	0	2	6	1.71
P23	11,100	0	0	0	0.00	0	0.00	62	0.56	3	0.03	55	6	1	0.57
P23.5	13,325	0	0	0	0.00	3	0.02	97	0.73	7	0.05	161	0	0	0.75
P26	5,830	0	0	0	0.00	0	0.00	83	1.42	0	0.00	0	1	13	1.65
P28.5	7,608	0	1	1	0.01	0	0.00	0	0.00	0	0.00	0	0	0	0.01
P30.5	10,206	1	0	1	0.01	0	0.00	53	0.52	3	0.03	170	0	1	0.54
P33	8,116	0	0	0	0.00	1	0.01	0	0.00	0	0.00	0	0	0	0.01
P36	8,362	1	0	1	0.01	0	0.00	0	0.00	2	0.02	1	0	0	0.01
P37.5	4,833	0	0	0	0.00	0	0.00	0	0.00	1	0.02	0	0	0	0.00
P39	7,297	6	0	6	0.08	0	0.00	0	0.00	0	0.00	2	0	0	0.08
P39.5	6,729	5	0	5	0.07	4	0.06	3	0.04	0	0.00	0	0	0	0.18
Total	97,442	17	1	18	0.02	12	0.01	475	0.49	19	0.02	389	10	21	0.54
Upper Section Priest River															
P42	8,764	0	0	0	0.00	0	0.00	0	0.00		0	0	0	0	0.00
P43	10,605	0	0	0	0.00	0	0.00	0	0.00		0	0	0	0	0.00
P45.5	7,800	8	0	8	0.10	3	0.04	3	0.04	1	0.013	0	0	1	0.19
P49	7,167	0	0	0	0.00	4	0.06	0	0.00	1	0.014	4	0	0	0.06
P50	9,100	0	0	0	0.00	0	0.00	0	0.00		0	0	0	1	0.01
P51.5	10,800	0	0	0	0.00	0	0.00	1	0.01		0	1	0	0	0.01
P54.5	10,502	0	0	0	0.00	3	0.03	0	0.00		0	0	0	0	0.03
P58	11,460	2	0	2	0.02	2	0.02	0	0.00		0	0	0	0	0.03
P58.7	7,471	0	0	0	0.00	4	0.05	90	1.20	2	0.027	6	0	0	1.26
P63	7,120	0	0	0	0.00	5	0.07	81	1.14		0	2	5	0	1.21
P63.5	10,524	3	1	4	0.04	7	0.07	351	3.34		0	0	0	0	3.44
P67.5	4,980	0	0	0	0.00	24	0.48	15	0.30		0	0	0	0	0.78
P68.5	5,333	0	0	0	0.00	38	0.71	41	0.77		0	0	0	0	1.48
Total	111,626	13	1	14	0.01	90	0.08	582	0.52	4	0.004	13	5	2	0.62

Table 51. Numbers and density of fishes observed while snorkeling transects in the St. Maries River, Idaho, during July 26-27, 2011.

Transect	Area (m^2)	Cutthroat trout: Number counted <300mm	Cutthroat trout: Number counted >300mm	Cutthroat trout: Total	Cutthroat trout: Density (fish/100 m^2)	Rainbow trout: Total	Rainbow trout: Density (fish/ 100 m^2)	Mountain whitefish: Total	Mountain whitefish: Density (fish/ 100 m^2)	Largescale sucker: Total	Northern pikeminnow: Total	Brook trout: Total	Sal - monid Density (fish/ 100 m^2)
SM9	2,386	1	1	2	0.08	0	0.00	0	0.00	0	5	1	0.13
SM10	3,948	0	0	0	0.00	0	0.00	0	0.00	3	1	0	0.00
SM12	2,347	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
SM13	2,099	1	2	3	0.14	0	0.00	0	0.00	7	8	0	0.14
SM15.5	1,720	2	0	2	0.12	0	0.00	0	0.00	0	0	0	0.12
SM17	1,680	0	0	0	0.00	0	0.00	0	0.00	1	3	0	0.00
SM24	4,027	1	2	3	0.07	0	0.00	0	0.00	12	12	0	0.07
SM27.5	5,100	2	3	5	0.10	0	0.00	0	0.00	2	0	0	0.10
SM28	5,673	2	0	2	0.04	0	0.00	0	0.00	0	0	0	0.04
SM35.5	4,084	5	4	9	0.22	0	0.00	51	1.25	39	0	0	1.47
SM37	3,177	11	2	13	0.41	0	0.00	8	0.25	20	po0	0	0.66
SM38	3,103	0	0	0	0.00	0	0.00	1	0.03	0	0	0	0.03
SM40	1,751	2	0	2	0.11	0	0.00	4	0.23	0	0	0	0.34
SM41.5	1,851	3	0	3	0.16	0	0.00	0	0.00	0	0	0	0.16
SM42.5	2,169	0	0	0	0.00	0	0.00	0	0.00	0	1	0	0.00
Total	45,114	30	14	44	0.10	0	0.00	64	0.14	84	30	1	0.24

Table 52. Electrofishing catch in the Priest River, Idaho, during July 12 to 15, 2011 at sites sampled by Idaho Department of Fish and Game. Sample size was five sites with a total of 148 minutes of electrofishing.

Species	Number caught	Catch rate (fish/h)
Brook trout	2	0.81
Bull trout	2	0.81
Brown trout	5	2.03
Largescale sucker	21	8.51
Mountain whitefish	129	52.30
Northern pikeminnow	19	7.70
Rainbow trout	1	0.41
Redsided shiner	2	0.81
Smallmouth bass	10	4.05
Westslope cutthroat trout	13	5.27
Longnose dace	1	0.41
Peamouth	3	1.22

Table 53. Electrofishing catch in the Priest River, Idaho, during July 12 to 14, 2011, at sites sampled by the Kalispel Tribe. Sample size was five sites with a total of 158 minutes of electrofishing.

Species	Number caught	Catch rate (fish/h)
Brook trout	0	0
Bull trout	0	0
Brown trout	0	0
Largescale sucker	5	1.90
Mountain whitefish	51	19.39
Northern pikeminnow	0	0
Rainbow trout	0	0
Redsided shiner	0	0
Smallmouth bass	1	0.38
Westslope cutthroat trout	0	0
Longnose dace	2	0.76
Peamouth	0	0

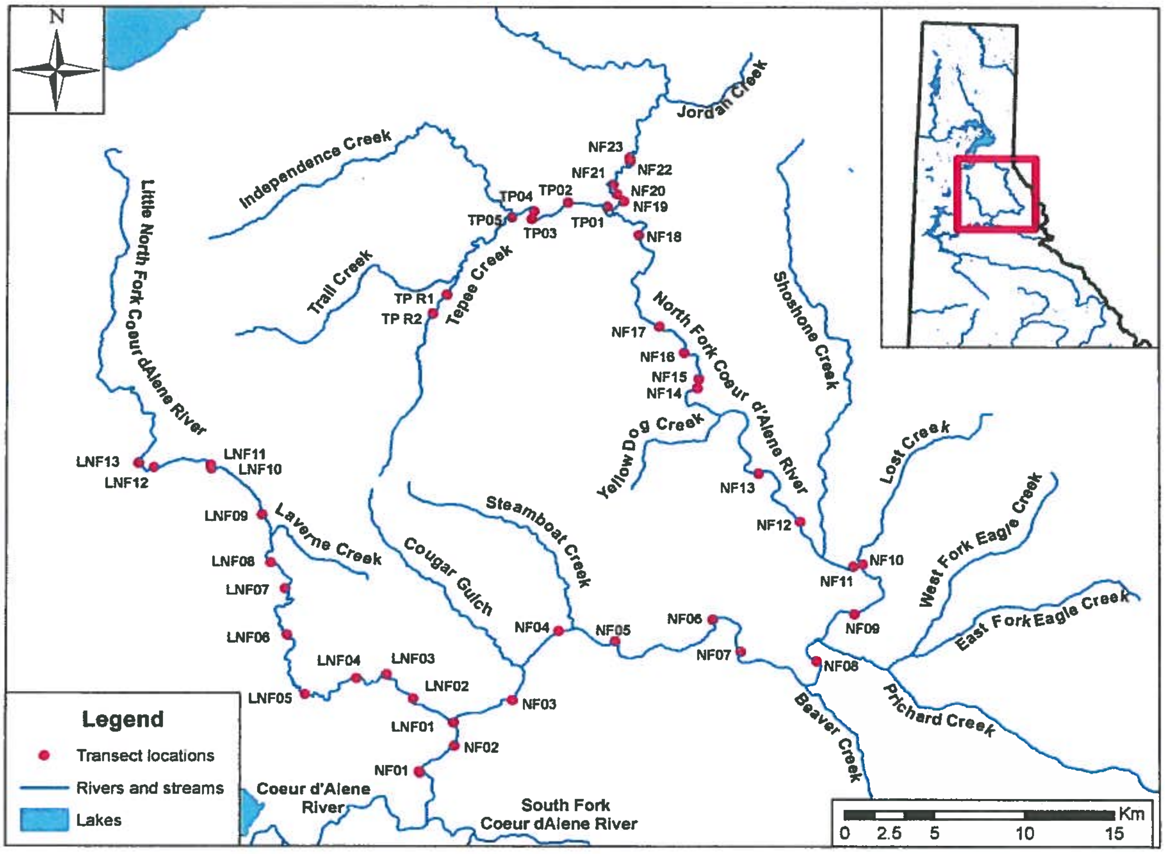
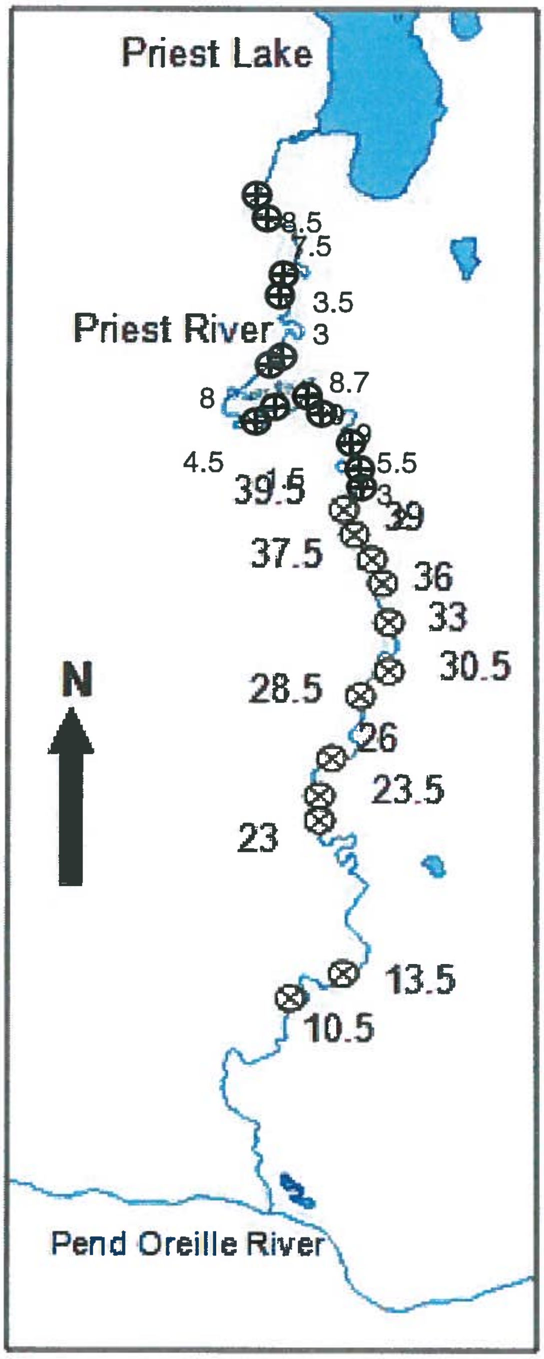
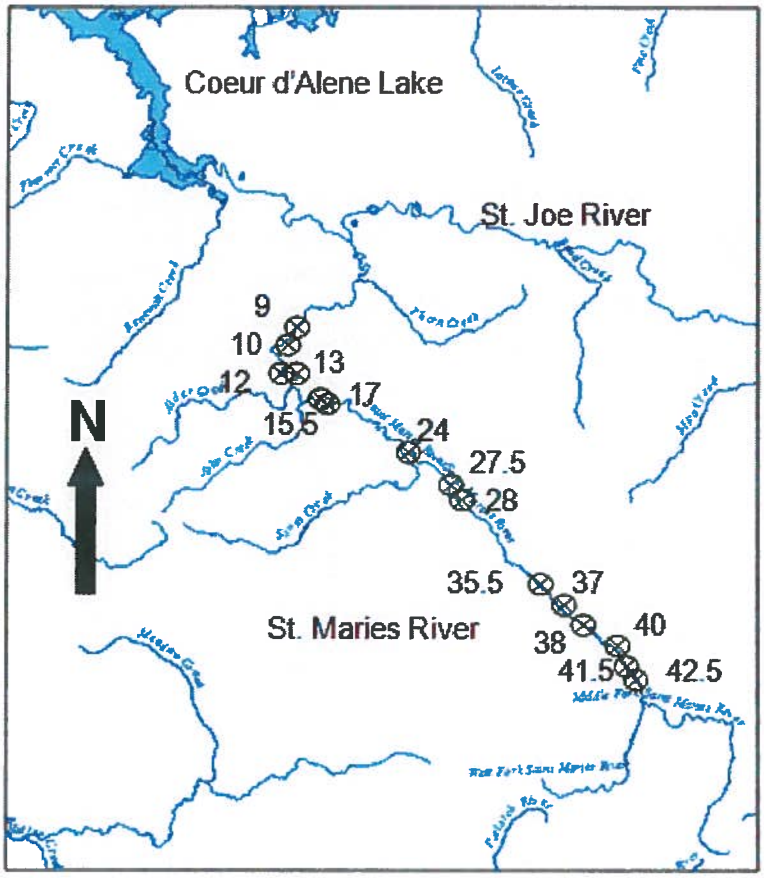


Figure 51. Location of 42 transects snorkeled on the Coeur d'Alene River, Idaho, during August 1-4, 2011.



Transect number	Latitude	Longitude
10.5	48.235650	-116.887465
13.5	48.241546	-116.866619
23	48.286883	-116.876539
23.5	48.290208	-116.873347
26	48.306969	-116.873432
28.5	48.322377	-116.861268
30.5	48.334653	-116.848140
33	48.346269	-116.851913
36	48.364273	-116.858066
37.5	48.368565	-116.861657
39	48.374749	-116.867724
39.5	48.378263	-116.870172
42	48.38898	-116.86670
43	48.39373	-116.86809
45.5	48.40141	-116.87116
49	48.40971	-116.88548
50	48.41539	-116.89053
51.5	48.41160	-116.90309
54.5	48.40630	-116.91340
58	48.42261	-116.90928
58.7	48.42595	-116.90192
63	48.44555	-116.90520
63.5	48.45058	-116.90366
67.5	48.46846	-116.91401
68.5	48.47371	-116.91638

Figure 52. Locations of 24 transects snorkeled on the Priest River, Idaho, during August, 2011. Transect number refers to the kilometers from the mouth of the river. Circles with an "X" were surveyed by Idaho Fish and Game, and circles with a cross were surveyed by the Kalispel Tribe.



Name	Latitude	Longitude
SM9	47.25228	-116.61035
SM10	47.24494	-116.62009
SM12	47.22527	-116.61997
SM13	47.22494	-116.60271
SM15.5	47.20979	-116.58631
SM17	47.20608	-116.57623
SM24	47.17559	-116.49393
sm27.5	47.14864	-116.45001
SM 28	47.14355	-116.44190
SM35.5	47.07887	-116.34501
SM37	47.06907	-116.32574
SM38	47.06354	-116.31136
SM40	47.04968	-116.28557
SM41.5	47.03535	-116.27106
SM 42.5	47.02872	-116.26142

Figure 53. Locations of 15 transects snorkeled on the St. Maries River, Idaho, during August 26-27, 2011.

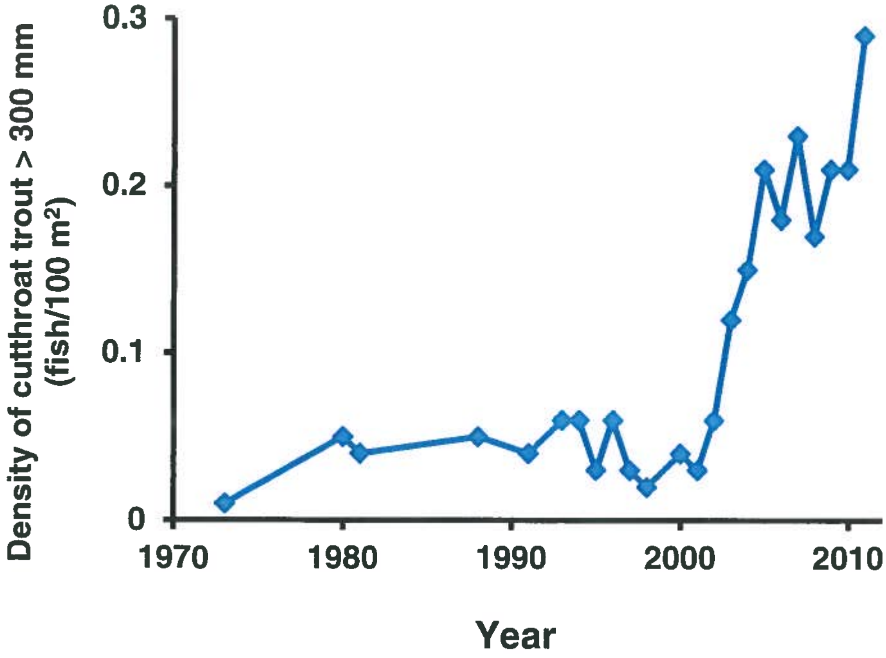


Figure 54. Densities of cutthroat trout >300 mm in the North Fork of the Coeur d'Alene River, Idaho.

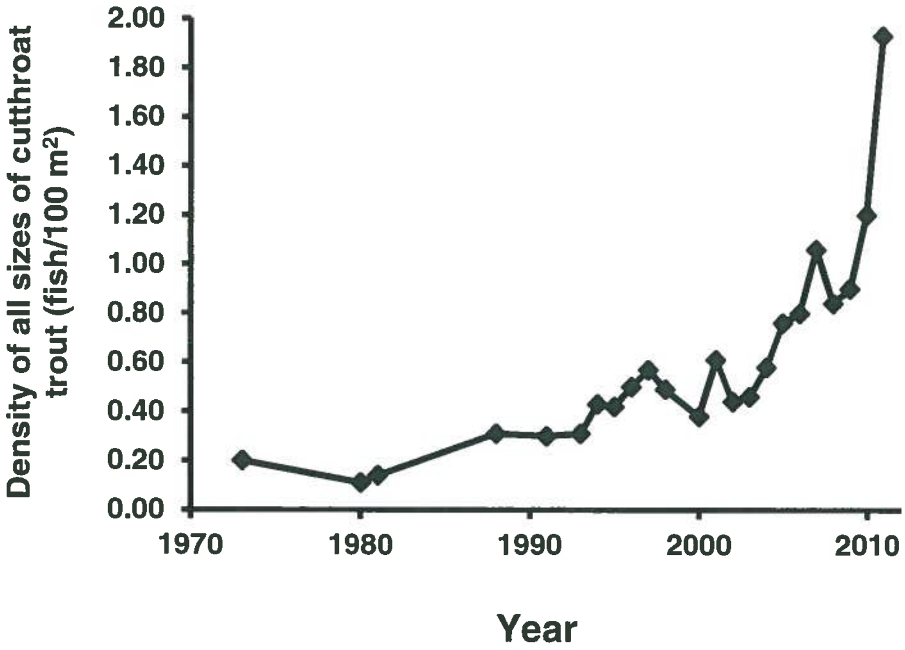


Figure 55. Densities of cutthroat trout of all sizes in the North Fork of the Coeur d'Alene River, Idaho.

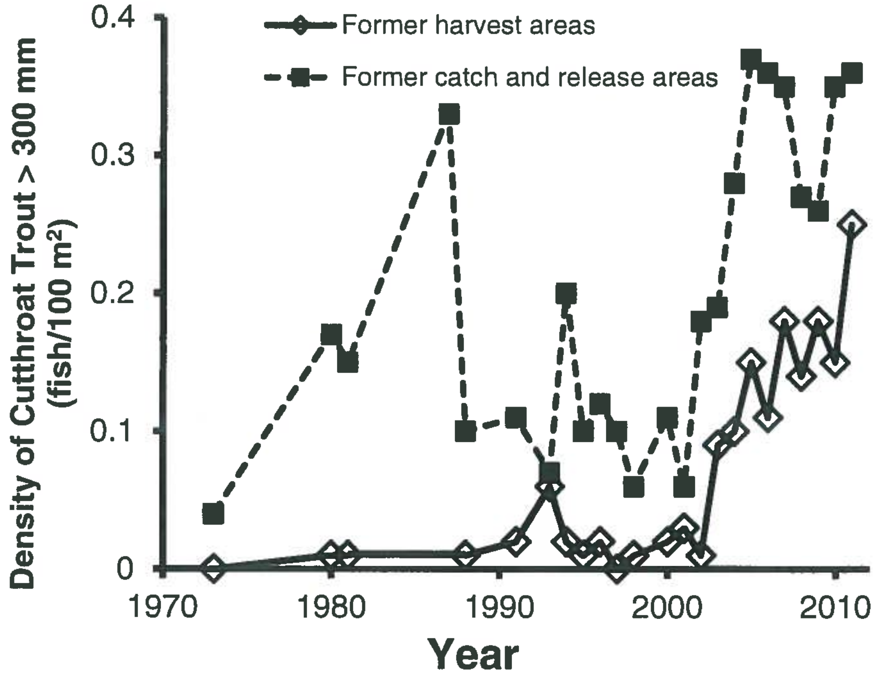


Figure 56. Densities of cutthroat trout in sections of the North Fork of the Coeur d'Alene River that previously allowed harvest compared to areas that were previously catch and release.

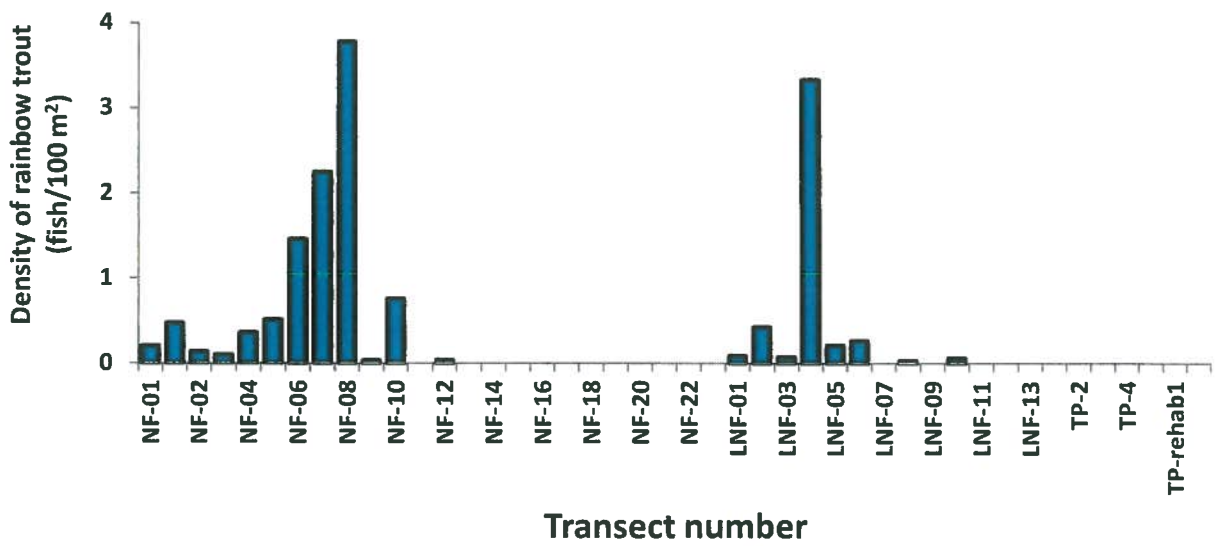


Figure 57. Densities of rainbow trout recorded during the surveys of the North Fork (NF) and Little North Fork (LNF) Coeur d'Alene rivers during 2012. Transect locations are given in Figure 51.

Appendix A. Densities (fish/100 m^2) of all sizes of cutthroat trout observed in various reaches of the Coeur d'Alene River.

	North Fork Coeur d'Alene River				Little North Fork Coeur d'Alene River		Other River Sections									
Year	South Fork Coeur d'Alene to Prichard Creek	Prichard Creek to Yellowdog Creek	Yellowdog Creek to Tepee Creek	Tepee Creek to Jordan Creek	Mouth to Laverne Creek	Laverne Creek to Deception Creek	Tepee Creek	Entire North Fork Coeur d'Alene River	Entire Little North Fork Coeur d'Alene River	All Transects	Former limited harvest areas [a]	Former catch and release areas [b]	Tepee Creek Rehabilitation Area	North Fork Coeur d'Alene upstream of Jordan Cr.
1973	0.06	0.05	0.24	1.48	0.33	0.79	0.00	0.13	0.38	0.20	0.10	0.51		
1980	0.02	0.00	0.31	0.68	0.04	1.03	0.14	0.10	0.15	0.11	0.02	0.41		
1981	0.02	0.02	0.28	0.74	0.02	1.95	0.43	0.11	0.24	0.14	0.02	0.53		
1987	--	--	1.05	2.34	--	--	0.24	--	--	--	--	1.09		
1988	0.05	0.02	1.10	0.46	0.10	0.90	0.12	0.33	0.27	0.31	0.04	0.81		
1991	0.18	0.14	1.18	0.11	0.09	0.66	0.24	0.32	0.20	0.30	0.15	0.76		
1993	0.56	0.08	0.35	0.27	0.18	0.03	0.19	0.35	0.15	0.31	0.32	0.25		
1994	0.31	0.28	1.70	1.31	0.03	0.47	0.12	0.54	0.13	0.43	0.25	0.94		
1995	0.47	0.19	1.57	0.46	0.04	0.22	0.13	0.53	0.09	0.42	0.31	0.72		
1996	0.51	0.06	1.71	1.17	0.12	0.90	0.02	0.63	0.35	0.50	0.28	0.90		
1997	0.35	0.44	1.70	1.87	0.22	0.00	0.45	0.69	0.17	0.57	0.35	1.08		
1998	0.32	0.41	0.63	1.18	0.39	0.65	1.24	0.44	0.45	0.49	0.36	0.89		
2000	0.41	0.13	0.63	1.49	0.36	0.79	0.25	0.38	0.45	0.38	0.28	0.65		
2001	0.53	0.51	1.74	1.02	0.28	0.12	0.24	0.76	0.25	0.61	0.46	1.05		
2002	0.28	0.49	0.54	2.40	0.13	0.98	0.84	0.43	0.31	0.44	0.29	0.89	0.87	0.51
2003	0.41	0.30	0.78	1.22	0.30	0.69	0.44	0.47	0.39	0.46	0.36	0.73	0.00	
2004	0.60	0.33	0.88	1.27	0.22	0.97	0.85	0.58	0.44	0.58	0.45	0.92	1.09	
2005	0.65	0.66	1.38	1.78	0.21	1.35	0.54	0.82	0.56	0.76	0.59	1.23	0.48	
2006	0.49	0.67	1.71	2.92	0.14	0.56	1.00	0.86	0.27	0.80	0.51	1.56	0.55	
2007	0.92	0.58	1.48	4.12	0.53	2.26	1.14	1.05	1.06	1.06	0.76	1.75	0.36	
2008	1.01	0.46	1.23	1.56	0.59	1.07	0.53	0.89	0.72	0.84	0.78	1.03	0.29	
2009	0.92	0.50	1.50	1.67	0.79	0.64	0.69	0.95	0.76	0.90	0.77	1.22	0.62	
2010	1.31	0.77	1.70	1.31	1.03	1.84	0.68	1.23	1.27	1.20	1.10	1.42	0.73	
2011	2.09	2.30	1.71	3.31	1.55	1.23	1.16	2.01	1.46	1.93	2.06	1.62	1.92	

[a] Prior to 2008 some cutthroat trout harvest was allowed in the North Fork Coeur d'Alene River below Yellowdog Creek and in the Little North Fork Coeur d'Alene River below Laverne Creek.

[b] "Former catch and release areas" refers to the North Fork Coeur d'Alene River above Yellow Dog Creek and the Little North Fork Coeur d'Alene River above Laverne Creek. The former was restricted to catch and release fishing since 1986 and the latter was restricted to catch and release fishing since 1988.

Appendix B. Densities (fish/100 m^2) of cutthroat trout >300 mm observed in various reaches of the Coeur d'Alene River.

	North Fork Coeur d'Alene River				Little North Fork Coeur d'Alene River		Other River Sections							
Year	South Fork Coeur d'Alene to Prichard Creek	Prichard Creek to Yellowdog Creek	Yellowdog Creek to Tepee Creek	Tepee Creek to Jordan Creek	Mouth to Laverne Creek	Laverne Creek to Deception Creek	Tepee Creek	Entire North Fork Coeur d'Alene River	Entire Little North Fork Coeur d'Alene River	All transects	Former limited harvest areas[a]	Former catch and release areas[b]	Tepee Creek rehabilitation area	North Fork Coeur d'Alene upstream of Jordan Cr.
1973	0.00	0.00	0.02	0.07	0.02	0.18	0.00	0.01	0.03	0.01	0.00	0.04		
1980	0.02	0.00	0.12	0.35	0.02	0.37	0.03	0.05	0.05	0.05	0.01	0.17		
1981	0.01	0.00	0.04	0.20	0.00	0.18	0.43	0.02	0.02	0.04	0.01	0.15		
1987	--	--	0.12	1.25	--	--	0.20	--	--	--	--	0.33		
1988	0.01	0.01	0.08	0.23	0.05	0.09	0.06	0.04	0.06	0.05	0.01	0.10		
1991	0.01	0.03	0.13	0.06	0.05	0.00	0.18	0.04	0.04	0.04	0.02	0.11		
1993	0.08	0.02	0.04	0.23	0.06	0.03	0.08	0.06	0.06	0.06	0.06	0.07		
1994	0.01	0.04	0.31	0.37	0.00	0.00	0.09	0.08	0.00	0.06	0.02	0.20		
1995	0.01	0.01	0.07	0.29	0.00	0.00	0.09	0.03	0.00	0.03	0.01	0.10		
1996	0.04	0.01	0.14	0.30	0.01	0.05	0.00	0.07	0.02	0.06	0.02	0.12		
1997	0.00	0.01	0.11	0.21	0.00	0.00	0.08	0.03	0.00	0.03	0.00	0.10		
1998	0.00	0.03	0.02	0.18	0.00	0.00	0.08	0.02	0.00	0.02	0.01	0.06		
2000	0.01	0.01	0.07	0.38	0.04	0.06	0.05	0.04	0.04	0.04	0.02	0.11		
2001	0.03	0.06	0.07	0.09	0.00	0.00	0.04	0.05	0.00	0.03	0.03	0.06		
2002	0.01	0.04	0.12	0.44	0.00	0.11	0.22	0.05	0.02	0.06	0.01	0.18	0.05	0.15
2003	0.10	0.09	0.21	0.24	0.05	0.15	0.16	0.12	0.07	0.12	0.09	0.19	0.00	
2004	0.13	0.09	0.25	0.43	0.04	0.18	0.34	0.15	0.08	0.15	0.10	0.28	0.04	
2005	0.13	0.24	0.52	0.69	0.08	0.16	0.05	0.24	0.10	0.21	0.15	0.37	0.04	
2006	0.07	0.21	0.36	0.74	0.03	0.07	0.29	0.19	0.04	0.18	0.11	0.36	0.19	
2007	0.20	0.19	0.32	0.81	0.06	0.22	0.30	0.24	0.11	0.23	0.18	0.35	0.14	
2008	0.13	0.18	0.22	0.54	0.08	0.04	0.32	0.17	0.07	0.17	0.14	0.27	0.10	
2009	0.17	0.17	0.25	0.60	0.24	0.11	0.22	0.20	0.21	0.21	0.18	0.26	0.31	
2010	0.10	0.20	0.36	0.48	0.26	0.21	0.33	0.19	0.25	0.21	0.15	0.35	0.56	
2011	0.25	0.29	0.31	1.10	0.21	0.25	0.27	0.30	0.22	0.29	0.25	0.36	0.58	

[a] Prior to 2008 some cutthroat trout harvest was allowed in the North Fork Coeur d'Alene River below Yellowdog Creek and in the Little North Fork Coeur d'Alene River below Laverne Creek.

[b] "Former catch and release areas" refers to the North Fork Coeur d'Alene River above Yellow Dog Creek and the Little North Fork Coeur d'Alene River above Laverne Creek. The former was restricted to catch and release fishing since 1986 and the latter was restricted to catch and release fishing since 1988.

LITERATURE CITED

Anderson, R.O. 1976. Management of small warm water impoundments. Fisheries 1(6):5-7, 26-28.

Ashley K. W., and D. L. Garling, Jr. 1980. Improved method for preparing pectoral spine sections of channel catfish for age determination. Progressive Fish-Culturist 42:80-81.

Bjornn, T.C. 1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries, Idaho. Master's Thesis. University of Idaho, Moscow.

Bonneau, J.L. and G. LaBar. 1997. Inter-observer and temporal bull trout redd count variability in tributaries of Lake Pend Oreille, Idaho. Department of Fish and Wildlife Resources, University of Idaho, Moscow.

Bowler, B. 1974. Coeur d'Alene River Study. Idaho Department of Fish and Game, Federal Aid in Fish Restoration, F-53-R-9, 1974 Job Performance Report, Boise.

Bowler, B., B.E. Rieman, and V.L. Ellis. 1979. Pend Oreille Lake fisheries investigations. Idaho Department of Fish and Game, Job Performance Report, Project F-73-R-1, Boise.

Brown, M.L., F. Jaramillo, Jr., D. M. Gatlin, III, and B. R. Murphy. 1995. A revised standard weight (*Ws*) equation for channel catfish. Journal of Freshwater Ecology 10:295-302.

Campbell, M.R. and C.C. Cegelski. 2005. Native Species Investigations, Project 2. Idaho Department of Fish and Game. Annual performance report, Grant # F-73-R-25, Report Number 05-19.

Davis J., L Nelson, and N. Horner. 1993. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. Lowland Lake Surveys. Job Performance Report 1993 F-71-R-18. Boise.

Davis, J., L. Nelson and N. Horner. 1996. Region 1 Lowland Lakes Investigations. Idaho Department of Fish and Game, Job Performance Report, Project F-71-R-17, Job 1-b, Boise.

Donald, D. B., and Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71: 238-247.

Downs, C. C. and R. Jakubowski. 2003. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring. Avista Corporation. Spokane, Washington.

Downs, C.C., and R. Jakubowski. 2006. Lake Pend Oreille/Clark Fork River fishery research and monitoring, 2005 Progress Report. Project 1, 2005 Lake Pend Oreille bull trout counts progress report. Avista Corporation. Spokane, Washington.

Duffy, M. L., J. L. McNulty, and T. E. Mosindy. 2000. Identification of sex, maturity, and gonad condition of walleye (*Stizostedian vitreum*). Ontario Ministry of Natural Resources Northwest Science and Technology, Thunder Bay, Ontario, NWST FG-05.

Dunham J.B., B.E. Rieman, and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fish Management 21:343-352.

DuPont, J. M. 1994. Fish habitat associations and the effects of drawdown on fishes in the Pend Oreille River, Idaho. Master's thesis. University of Idaho, Moscow, Idaho.

Dupont, J. M., R. S. Brown, and D. R. Geist. 2007. Unique allacustrine migration patterns of a bull trout population in the Pend Oreille River drainage, Idaho. North American Journal of Fisheries Management. 27:1268-1275. Gangl, R. S. and D. L. Pereira. 2003. Biological performance indicators for evaluating exploitation of Minnesota's large-lake walleye fisheries. North American Journal of Fisheries Management. 23: 1303-1311.

DuPont, J., M. Liter, and N. Horner. 2007. Regional fisheries management investigations. Idaho Department of Fish and Game, Federal Aid in Fish Restoration, Upper Priest River Bull Trout Redd Surveys, 2005 Job Performance Report, Boise.

DuPont J., M. Liter, and N. Horner. 2009. Regional fisheries management investigations. Idaho Department of Fish and Game, Federal Aid in Fish Restoration, IDFG 09-109, 2006 Job Performance Report, Boise.

Dupont, J., M.R. Campbell, and C. Cegelski. 2004. Testing phenotype-based identifications of westslope cutthroat trout, rainbow trout, and hybrids in the Coeur d'Alene River basin, ID: a pilot study. Idaho Department of Fish and Game, Eagle Fish Genetics Lab, Lab Report 04-1, Eagle.

Dux, A. 2005. Distribution and population characteristics of lake trout in Lake McDonald, Glacier National Park: Implications for suppression. Masters of Science Thesis. Montana State University, Bozeman, Montana.

Eschmeyer, P.H. and R.M. Bailey. 1955. The pygmy whitefish, *Coregonus Coulteri*, in Lake Superior. Transactions of the American Fisheries Society, 84:161-199.

Elliott, J.M. 1983. Some methods for the statistical analysis of samples of benthic invertebrates. Freshwater Biological Association, Scientific Publication number 25, Ambleside, United Kingdom.

Fraley, J., and B. Shepard. 1998. Life history, ecology, and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Montana Department of Fish, Wildlife, and Parks, Kalispell.

Fredenberg, W. 2002. Further evidence that lake trout displace bull trout in mountain lakes. Intermountain Journal of Sciences 8(3).

Fredericks, J. 1999. Exotic fish species removal: Upper Priest Lake and Lightning Creek drainages. Annual Progress Report, Grant Number:E-20, Segment Number:1. Idaho Department of Fish and Game, Coeur d'Alene, Idaho.

Fredericks, J. and J. Vernard. 2001 Bull Trout Exotic Fish Removal Project Completion Report. Threatened and Endangered Species Report, Project E-20, Segments 1-3. Idaho Department of Fish and Game, Coeur d'Alene, Idaho.

Fredericks, J., J. Davis, and N. Horner. 1997. Lowland lake investigations. Idaho Department of Fish and Game, 1996 Annual Performance Report, Report number IDFG 99-21, Boise.

Fredericks, J., M. Liter, N. Horner and C.Corsi. 2002. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. Lowland Lake Surveys. 1999 Job Performance Report IDFG F-71-R-24. Boise.

Gabelhouse, D.W., Jr. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Gunn, J.M. 1995. Spawning behavior of lake trout: effects on colonization ability. Journal of Great Lakes Research 21 (Supplement 1):323-329.

Guy C. S. and M. L. Brown. 2007. Analysis and Interpretation of Freshwater Fisheries Data 6:232-246.

Hansen, M.J., N.J. Horner, M.D. Liter, M.P. Peterson, and M.A. Maiolie 2008. Dynamics of an Increasing Lake Trout Population in Lake Pend Oreille, Idaho, USA. North American Journal Fisheries Management.

Hardy, R. and J. Fredericks. 2011. Spokane River drainage cutthroat trout surveys. Pages 138-166 *in* Fishery Management Annual Report, Panhandle Region, Idaho Department of Fish and Game, report number IDFG 11-117, Boise.

Hardy, R., K. Carter-Lynn, and J. Fredericks. 2011. Hayden Lake fishery investigations. Pages 29-43 in M. Maiolie, R. Hardy, M. Liter, R. Ryan, K. Carter-Lynn, and J. Fredericks, Fishery Management Annual Report, Panhandle Region 2010, Idaho Department of Fish and Game, Report IDFG 11-117, Boise.

Hayes, D.B., J.R. Bence, T.J. Kwak, and B.E. Thompson. 2007. Abundance, Biomass, and Production. Pages 327-374 *in* C.S. Guy and M.L. Brown editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Education Section, Bethesda, Maryland.

Hesse, L. W., G. Zuerlein, B. Newcomb, and L. A. Devore (Retelsdorf). 1982. The relationship of hoop-net size to channel catfish catches. Page 40-43 *in* L.W. Hesse, editor. The Missouri River channel catfish. Nebraska Game and Parks Commission, Nebraska Technical Series Number 11, Lincoln.

Hitt, N. P., C. A. Frissel, C. C. Muhlfeld, and F. A. Allendorf. 2003. Spread of hybridization between native westslope cutthroat trout, Oncorhynchus clarki lewisi, and nonnative rainbow trout, Oncorhynchus mykiss. Canadian Journal of Fisheries and Aquatic Science 60:1440-1451.

Holley, M.P 2006. An evaluation of the catfish fishery in Wilson Reservoir, Alabama Master's Thesis. Auburn University. Auburn, Alabama.

Horner, N., L. LaBolle, and C. Robertson. 1987. Region 1 Lowland Lakes Investigations. Idaho Department of Fish and Game, Job Performance Report, Project No. F-71-R-11, Job 1-b, Boise.

Hubert, W. A. 1999*b*. Standards for assessment of age and growth data for channel catfish. Journal of Freshwater Ecology 14:313-326.

Idaho Department of Environmental Quality (DEQ) 1997 Beneficial Use Reconnaissance Project Survey of Fernan Lake. Field notes from DEQ, Coeur d'Alene.

Idaho Department of Fish and Game. 2005. The compass. Idaho Department of Fish and Game, Boise.

Idaho Department of Fish and Game. 2007. Fisheries Management Plan 2007-2012. Idaho Department of Fish and Game, Boise.

Karchesky, C. M. 2002. Effects of winter drawdown on fish community structure and behavior in the Pend Oreille River, Idaho. Master's thesis, University of Idaho, Moscow, Idaho.

Kerr, S. J., A. J. Dextrase, N. P. Lester, C. A. Lewis, H. J. Reitveld. 2004. Strategies for managing walleye in Ontario, Walleye Management Strategies Working Group, Percid Community Synthesis. Ontario Ministry of Natural Resources.

Koch, J. D., and M. C. Quist 2007. A Technique for Preparing Fin Rays and Spines for Age and Growth Analysis. North American Journal of Fisheries Management 27:782-784, 2007.

Krummrich, J.T. and R.C. Heidinger. 1973. Vulnerability of channel catfish to largemouth bass predation. Progressive Fish-Culturist 35:173-175.

Leary, R.F., F.W. Allendorf, S.R. Phelps, and K.L. Knudsen. 1984. Introgression between westslope cutthroat and rainbow trout in the Clark Fork River drainage, Montana. Proceedings of the Montana Academy of Sciences 43:1-18.

Lewynsky, V.A. 1986. Evaluation of special angling regulations in the Coeur d'Alene River trout fishery. Master's Thesis, University of Idaho. Moscow.

Liter M., K. Carter, and J. Fredericks 2011 in-press. Regional fisheries management investigations. Idaho Department of Fish and Game, Federal Aid in Fish Restoration, Low lakes evaluations, 2011 Job Performance Report, Boise, Idaho.

Liter, M., R. Hardy, M. Maiolie. and J.Fredericks.2010 In Press. Regional fisheries management investigation, Idaho Department of Fish and Game, Federal Aid in Fish Restoration, Lowland Lake Surveys. IDFG , 2010 Job Performance Report, Boise.

Love, R. H. 1971. Dorsal-aspect target strength of an individual fish. Journal of the Acoustic Society of America, 49:816-823.

MacLean, J.A., D.O. Evans, N.V. Martin, and R.L. DesJardine. 1981. Survival, growth, spawning distribution, and movement of introduced and native lake trout (*Salvelinus namaycush)* in two inland Ontario lakes. Canadian Journal of Fisheries and Aquatic Sciences 38: 1685-1700.

Maiolie, M. A. and J. Fredericks. 2011. Pygmy whitefish investigations in Upper Priest Lake. Pages 84-94 *in* M. Maiolie, R. Hardy, M. Liter, R. Ryan, K. Carter-Lynn, and J. Fredericks, editors. Fishery Management Annual Report. Report number IDFG 11-117, Idaho Department of Fish and Game, Boise.

Maiolie, M. A., M. Liter, and J. Fredericks. 2009. Spirit Lake kokanee population studies. Pages 16-31 *in* J. Fredericks, M. Liter, M. Maiolie, R. Hardy, R. Ryan, D. Ayers, and C Gidley, editors. Fishery Management Annual Report, Panhandle Region. Report number IDFG 09-125, Idaho Department of Fish and Game, Boise.

Maiolie, M.A., W. Harryman, and W.J. Ament. 2004. Lake Pend Oreille Fishery Recovery Project. Idaho Department of Fish and Game, Annual Performance Report, Report number 04-40, Boise.

Maiolie, M.A., M. Liter, R. Hardy, and J. Fredericks. 2011. Coeur d'Alene Lake fishery investigation. Pages 1-28 *in* M. Maiolie, R. Hardy, M. Liter, R. Ryan, K. Carter-Lynn, and J. Fredericks, editors. Fishery Management Annual Report. Report number IDFG 11-117, Idaho Department of Fish and Game, Boise.

Mauser, G.R, 1986. Enhancement of trout in large, north Idaho lakes. Federal Aid in Fish Restoration; Job Performance Report, Project F-73-R-6. Idaho Department of Fish and Game, Boise.

Mauser, G.R, R.W. Vogelsang, and C.L. Smith. 1988. Lake and Reservoir Investigations: Enhancement of trout in large north Idaho lakes. Federal Aid in Fish Restoration; Job Performance Report, Project F-73-R-9. Idaho Department of Fish and Game, Boise.

Meyer. K. A., A. Butts, F. S. Elle, and J. A. Lamansky, 2010. Lake and Reservoir research; subproject #3: Angler exploitation evaluations. Project F-73-R-29. Idaho Department of Fish and Game. Boise.

Michaletz P. H. and K. P. Sullivan 2002. Sampling Channel Catfish with Tandem Hoop Nets in Small Impoundments. North American Journal of Fisheries Management 22:870-878, 2002.

Ministry of Natural Resources (MNR). 2005. Walleye state of the resource report for southern region. http://mrn.gov.on.ca.

Mink, L.L., R.E. Williams, and A.T. Wallace. 1971. Effects of industrial and domestic effluents on the Coeur d'Alene River basin. Idaho Bureau of Mines and Geology. Pahphlet 140. Moscow.

Morgan, G.E. 2002. Manual of instructions – fall walleye index netting (FWIN). Percid community synthesis, diagnostics, and sampling standards working group. Cooperative Freshwater Ecology Unit. Sudbury, Ontario.

Mossier, J. 1993. Idaho Lake Water Quality Assessment Report. Water Quality Status Report No. 105. Idaho Department of Health and Welfare, Division of Environmental Quality, Coeur d'Alene.

Mosher, T.D. 1999. Characteristics of channel catfish in Kansas state fishing lakes: Effects of watershed on growth. Pages 353-360 *in* E.R. Irwin, W.A. Hubert, C,F, Rabeni, H.L. Schramm, Jr. and T. Coon, editors. Catfish 2000: proceedings of the international ictalurids symposium. American Fisheries Society, Symposium 24, Bethesda, Maryland.

Muth, K. M. and D. R. Wolfret. 1986. Changes in growth and maturity of walleyes associated with stock rehabilitation in western Lake Erie, 1964-1983. North American Journal of Fisheries Management. 6:168-175.

Nelson, L., J. Davis, and N. Horner. 1996. Lowland lakes investigations. Idaho Department of Fish and Game, Annual Performance Report, Project I Surveys and Inventories, Job b, Boise.

Newman, R.M., and F.B. Martin. 1983. Estimation of fish production rates and associated variances. Canadian Journal of Fisheries and Aquatic Sciences 40:1729-1736.

Ostberg, C. O., and R.J. Rodriguez. 2002. Novel molecular markers differentiate Oncorhynchus mykiss (rainbow trout and steelhead) and the O. clarki (cutthroat trout) subspecies. Molecular Ecology Notes. 2 (3), 197-202.

Parrett, T. P., J. A. Marshall, and D.J. Bright. 1999. An investigation in the applicability of length limits on channel catfish populations in two small Ohio reservoirs. Pages 447-454 *in* E.R. Irwin, W.A. Hubert, C.F. Rabeni, H.L. Schramm, Jr. and T. Coon, editors. Catfish 2000: proceedings of the international ictalurids symposium. American Fisheries Society, Symposium 24, Bethesda, Maryland.

Pollock, K.H., C.M. Jones, and T.L. Brown. 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society Special Publication 25.

Pratt, K.L. 1984. Pend Oreille trout and char life history study. Idaho Department of Fish and Game, Boise.

Quinn, T. J., II, and R. B. Deriso. 1999. Quantitative fish dynamics. Oxford University Press, New York.

Quist, M.C., C. S. Guy, R. D. Schultz, and J. L. Stephens. 2003a. Latitudinal comparisons of walleye growth in North America and factors influencing growth of walleye in Kansas reservoirs. North American Journal of Fisheries Management. 23:677-692.

Quist, M.C., C. S. Guy, and J. L. Stephens. 2003b. Recruitment dynamics of walleyes (Stizostedion vitreum in Kansas reservoirs: generalities with natural systems and effects of a centrarchid predator. Canadian Journal of Fisheries and Aquatic Science. 60:830-839.

Rabe, F.W. and C.W. Sappington. 1970. Biological productivity of the Coeur d'Alene rivers as related to water quality. Water Resources Research Institute. Technical Completion Report, Project A-024-IDA. University of Idaho. Moscow.

Rankel, G.L. 1971. An appraisal of the cutthroat trout fishery of the St. Joe River. Master's Thesis, University of Idaho, Moscow.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 191:382. Ottawa, Ontario.

Ricker, W. E. 1946. Production and utilization of fish populations. Ecological Monographs, 16:373-391.

Rieman, B.E. 1992. Status and analysis of salmonids fisheries: kokanee salmon population dynamics and kokanee salmon monitoring guidelines, Idaho Department of Fish and Game, Job Performance Report, Project F-73-R-14, Boise.

Rieman, B.E. and D. Meyers. 1990. Status and analysis of salmonid fisheries. Idaho Department of Fish and Game, Job Performance Report, Federal Aid in Fish and Wildlife Restoration, F-73-R-12, Subproject II, Study No.1, Boise.

Rieman, B.E. and D. Meyers. 1991. Kokanee population dynamics. Idaho Department of Fish and Game. Job Completion Report, Project F-73-R-13, Boise.

Rieman, B.E. and K.A. Apperson. 1989. Status and analysis of salmonid fisheries. Idaho Department of Fish and Game, Project F-73-R-11, Subproject II, Job number 1, Boise.

Rieman, B.E. and L. LaBolle. 1980. Coeur d'Alene Lake Creel Census. Idaho Department of Fish and Game. Federal Aid in Fish and Wildlife Restoration, F-73-R-2, Study number V, Job I. Job Performance Report. Boise.

Rieman, B.E., and J.R. Lukens. 1979. Priest Lake creel census. Idaho Department of Fish and Game, Job Completion Report, Project F-73-R-1, Job 2, Boise.

Rieman, B.E. and M.A. Maiolie. 1995. Kokanee population densities and resulting fisheries. North American Journal of Fisheries Management 15: 229-237.

Robinson, M.D. 2007. Ecological consequences of hybridization between introduced rainbow trout (Oncorhynchus mykiss) and native westslope cutthroat trout (O. clarki lewisi) in the Upper Oldman River, Alberta. M.Sc. thesis, University of Lethbridge, Lethbridge, Alberta.

Rubidge, E. and E.B. Taylor. 2004. Hybrid zone structure and the potential role of selection in hybridizing populations of introduced rainbow trout (Oncorhynchus mykiss) and native westslope cutthroat trout (O. clarki lewisi). Molecular Ecology. 13: 3735-3749.

Ryan, R. G., E. Gutknecht, and D. J. Megargle. 2009. Regional fisheries management investigations, Magic Valley Region 2007, IDFG 08-114. Boise.

Schneider J.C. Michigan Department of Natural Resources Fisheries Research Report No. 2020, 1997. Ann Arbor.

Schneider, J. C., R. P. O'Neal, and R. D. Clark, Jr. 2007. Ecology, management, and status of walleye, sauger, and yellow perch in Michigan. Michigan Department of Natural Resources, Fisheries Special Report 41, Ann Arbor.

Schoby, G. P. T. P. Bassista, and M. A. Maiolie. 2007. Effects of higher winter water levels on the Pend Oreille River fish community, Lake Pend Oreille Fishery Recovery Project. Report 07-15. Idaho Department of Fish and Game, Boise.

Scott, W.B., and E.J. Crossman. 1998. Freshwater Fishes of Canada. Galt House Publications Ltd. Oakville, Ontario.

Simmonds, J. and D. MacLennan. 2005. Fisheries Acoustics Theory and Practice. Second edition. Blackwell Publishing, Oxford, United Kingdom.

Soltero, R.A., and J.A. Hall. 1984. Water quality assessment of Spirit Lake, Idaho. Eastern Washington University, Cheney.

Storck, T. and D. Newman. 1988. Effects of size at stocking on survival and harvest of channel catfish. North American Journal of Fisheries Management 8:98-101.

Sullivan, K.P., and C. M. Gale.1999. A comparison of channel catfish catch rates, size distributions, and mortalities using three different gears in a Missouri impoundment. Pages 293-300 in Irwin et al. (1999).

Teuscher, D. 1999. Hatchery Trout Evaluations. Idaho Department of Fish and Game, Job Performance Report, Grant F-73-R-21, Boise.

Travnichek, V.H. 2004. Movement of flathead catfish in the Missouri River: examining opportunities for managing river segments for different fishery goals. Fisheries Management and Ecology 11:89-96.

USFWS (U.S. Fish and Wildlife Service). 2002. U.S. Fish and Wildlife Service Bull Trout (*Salvelinus confluentus*) Draft Recovery Pan. Portland, Oregon.

Vokoun, J. C., C.F. Rabeni, and J.S. Stanovick. 2001. Sample-size requirement for evaluating population size structure. North American Journal of Fisheries Management 21:660-665.

Washington Department of Fish and Wildlife (WDFW). 2005. Results of the 2005 WDFW fall walleye index netting (FWIN) surveys, Sprague Lake, Scooteny Reservoir, Moses Lake, Potholes Reservoir, Banks Lake, and Lake Roosevelt. http://wdfw.wa.gov.

Wetzel, R.G. Limnology. 1975. W.B. Saunders Company, Philadelphia, Pennsylvania.

Winans, G.A., P.B. Aebersold, and R.S. Waples. 1996. Allozyme variability of Oncorhynchus nerka in the Pacific northwest, with special consideration to populations of Redfish Lake, Idaho. Transactions of the American Fisheries Society, 125:645-663.

Yule, D. L., R. A. Whaley, and P. H. Mavrakis. 2000. Use of strain, season of stocking, and size at stocking to improve fisheries for rainbow trout in reservoirs with walleyes. North American Journal of Fisheries Management. 20:10-18.

Prepared by:

Jim Fredericks
Regional Fishery Manager

Melo Maiolie
Regional Fishery Biologist

Ryan Hardy
Regional Fishery Biologist

Rob Ryan
Regional Fishery Biologist

Mark Liter
Regional Fishery Biologist

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

Edward B. Schriever, Chief
Fisheries Bureau

Jeff Dillon
State Fishery Manager