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Hatcheries Division

Ford Hatchery
Annual Report

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Banks Lake Creel Survey

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We would like to thank the creel clerks, Aulin Smith, Joleen Kiesel, Jesse Schultz and others WDFW staff who assisted in the collection of data. We thank Dr. Scholz (Eastern Washington University) for helping get this project funded. We acknowledge the cooperation of Coulee Playland, the Sun Banks Resort, and the Washington State Parks for access to their properties. Thank you to all the anglers who took the time to divulge their angling information. Finally, we thank the Bonneville Power Administration for funding this project.

Executive Summary

Bonneville Power Administration's participation with the Washington Department of Fish and Wildlife, Ford Hatchery, provides the opportunity for enhancing the recreational and subsistence kokanee fisheries in Banks Lake. Funds from the BPA will improve water quality and supply at the Ford Hatchery enabling increased fingerling production for the kokanee program. Funding from BPA also allows for additional fish food, materials and supplies associated with this program, as well as an additional employee (currently, a 9-month temporary) to assist in the operation and maintenance of the program.

The Ford Hatchery will produce 11,666 lbs. (700,000) kokanee for release as fingerlings into Banks Lake in October. Ford Hatchery's production (along with Sherman Creek and the Spokane Tribal Hatchery) will contribute to a goal of one million kokanee yearlings for Lake Roosevelt and one million kokanee fingerlings and fry for Banks Lake.

While the origin of hatchery stock comes from Lake Whatcom, current objectives will increase the use of native (or, indigenous) stocks for propagation in Banks Lake and the Upper Columbia River.

The Ford Hatchery continues to produce resident trout (80,584 lb. per year) to promote the sport fisheries in trout fishing lakes in eastern Washington (WDFW Management, Region 1). Operation and maintenance funding for the increased kokanee program was implemented in FY 2001 and scheduled to continue through FY 2010. Engineering design and NEPA permits for the water improvement projects are concluding from FY 2001. A hatchery site visit by BPA and WDFW personnel associated with the improvement project on August 12, 2002 will complete the planning phase. The water projects are scheduled to begin in FY 2002.

Monitoring and evaluation of the Ford stocking programs will include existing WDFW creel and lake survey programs to assess resident trout releases in trout managed waters. BPA is also funding a creel survey to assess the harvest of hatchery kokanee in Banks Lake.

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Operations and Maintenance

Introduction

The Ford Hatchery is located at the eastern edge of the Spokane Indian Reservation, on the upper unit of the Chamokane Valley Aquifer system. The effluent flows into Chamokane Creek, a tributary of the Spokane River. The site is on land that is leased to WDFW from the Bureau of Reclamation as a mitigation agreement. The Bonneville Power Administration (BPA) constructed the hatchery in 1941. The Washington Department of Fish and Wildlife (WDFW) manages the operations and maintenance with funding provided by state fishing & regulatory revenues. Beginning in 2001, funds are provided by BPA for enhancing the kokanee production in Banks Lake.

The Ford Hatchery fish program was designed and created to provide harvest of Eastern Brook, German Brown and Rainbow trout for local public streams and lakes. The kokanee (*Oncorhynchus nerka*) production was created as mitigation in supplying harvest for the loss of anadromous fish habitat on the Upper Columbia River, due to the construction of the Grand Coulee Dam in 1941. The BPA, Spokane Indian Tribe (ST), Eastern Washington University (EWU), National Park Service (NPS) and the WDFW work together toward fishery enhancement on Lake Roosevelt and Banks Lake.

The annual production goal of the Ford Hatchery kokanee program for the Banks Lake watershed is 1,100,000. 400,000 fry (667 lbs.) are to be reared and planted into Banks Lake in early May. 700,000 fingerlings (11,666 lbs.) are to be reared and planted into Banks Lake in early October.

The role of the Ford Hatchery in this program is to: (a) create and enhance the kokanee fishery within Banks Lake; (b) establish a kokanee broodstock for future egg requirements; and (c) minimize the rate of precocity in hatchery reared kokanee using its colder water source beneficial in curtailing development in juvenile fish.

2001-2002 Annual Operating Plan

2001-2002 Banks Lake Annual Production Goal (APG)

The APG was established in FY 2001. The kokanee production increase to 700,000 fingerlings, along with 400,000 fry, for the Banks Lake watershed is reviewed by the Lake Roosevelt Hatchery Coordination Team (LRHCT). The rearing, marking and planting strategies are reviewed annually for providing program direction.

Table 1. 2001-2002 Annual Production Goal (APG) summary and time line for operations.

Unit	Fish	Operation	Number	In	Out	J	A	S	O	N	D	J	F	M	A	M	J
Ponds	KO	Rearing	69,612	300 / lb	68 / lb	X	X	O									
Ponds	KO	Rearing	402,146	300 / lb	77 / lb	X	X	X	O								
Trough	KO	Hatching	1.35 mil.	5000/lb	1800/lb						I	X	X	X	O		
Tank	KO	Rearing	425,000	1800/lb	520 / lb											O	
Ponds	KO	Rearing	700,000	280 / lb	70 / lb												X
Trough	KO	Eggs	Incubate	U													

Key: Trough= eggs and fry reared in shallow units measuring 7.5 cubic feet (44 units)
Tanks = fry reared in intermediate raceways measuring 210 cu. ft..
Ponds = rearing units measuring 2400 cu. ft.

KO = Kokanee
K = (x 1,000)
Size = per / lb.
U = Unknown

I = Received In
O = Moved or Planted Out

Note: These production numbers are included as a portion of this budget. The fish are reared during this budget cycle but some are programmed for release during the next budget cycle.

All production numbers, including fish sizes at release, are target goals. Actual size and release numbers may be different from these goals. The APG and strategies for operation are based on the anticipated egg take event at Lake Whatcom. In the event of significant circumstances or operations change, these changes will be reported to the LRHCT and BPA.

2001-2002 Annual Operation Plan (AOP) Goals

The operation and program goals from the 2001-2002 AOP were as follows:

1.1 Design and permit the improvements to the hatchery intake system.
Status: Ongoing

1.2 Rear and plant 700,000 kokanee fingerlings into Banks Lake (BY 00) (Oct. 2001).
Status: Completed (471,758 actually planted)

1.3 Construct new pond screens for rearing kokanee fry & fingerlings.
Status: Ongoing

1.4 Modify rearing strategies associated with production increase.
Status: Completed

1.5 Hire full-time temporary employee to accommodate program increase (Oct.)
Status: Completed

1.6 Receive 1.4 million kokanee eggs from Lake Whatcom (Dec.)
Status: Completed

1.7 Rear, O.T.C mark, and plant 400,000 kokanee fry at 600 fish-per-pound or larger (BY 01); (May 2002)
Status: Completed (425,000 actually planted)

1.8 Rear, O.T.C mark, and plant 700,000 kokanee fingerlings (BY01); (Oct. 2002.).
Status: Ongoing

1.9 Use of high-energy fish food in reaching planting size goals.
Status: Completed / Ongoing

1.10 Use all available means of adult kokanee collection for broodstock and program evaluation.
Status: Ongoing

2001-2002 Annual Operating Plan Objectives

The main objective for this contractual period was to design and secure the permits for the hatchery intake improvements. Other objectives include rearing and planting 1.1 million kokanee into Banks Lake and the monitoring and evaluation of the kokanee fishery through extensive creel survey.

Table 2. 2001-2002 Annual Operating Plan (AOP) Objectives

(1.1)	Improve water quality	(1.7)	Fry planting
(1.2)	Increased fingerling planting	(1.8)	Marking / Tagging
(1.3)	New pond screens	(1.9)	Rear 700,000 fingerlings
(1.4)	Fish Health Monitoring	(1.10)	Use of high energy fish feed
(1.5)	Hire additional employee	(1.11)	Adult collection
(1.6)	Receive 1.4 million eggs	(1.12)	Training / contacts

Status: Not all of the 2001-2002 AOP Objectives were completed. The water flow and quality project is ongoing.

Kokanee Production

The kokanee production for Banks Lake derives from the stock from Lake Whatcom, a WDFW hatchery near Bellingham, Washington. Kokanee are native to Lake Whatcom and it has been the state's primary egg source since 1915. The stock is pure, having no known introductions from other kokanee sources (Crawford 1979).

Hatchery Production/Plants

The annual kokanee egg-take transfer goal from Lake Whatcom to the Ford Hatchery is 1.4 million. This goal was achieved in 2001-2002. The eggs were received on December 27, 2002.

Lot 02 Lake Whatcom BY 00

On January 23, 2001, the Ford Hatchery received 1,068,800 kokanee eggs from Lake Whatcom. The egg take was smaller than normal due to unseasonably dry weather conditions. Lot 02 was from this egg-take and incorporated into the increased fingerling

production program for Ford. No kokanee fry were planted into Banks Lake in the spring from this brood year.

Lot 01 Lake Whatcom BY 01

On December 27, 2001, the Ford Hatchery received 1,400,490 eggs from Lake Whatcom. These eggs were incubated for six weeks, prior to hatching on February 12, 2002. No health problems have existed in the rearing process. The initial planting of 401,660 fry occurred on May 17, 2002. We exceeded the fish size goal of 600 fish-per-pound by planting at a size of 517 fpp. The bigger fish provide a greater opportunity for survivability.

During our final inventory in June, we discovered a surplus of 23,747 fry. Because of the lack of space and water availability, and that these fish were given the O.T.C. feed, they were planted on June 25,2002. The total fry plant into Banks Lake for the season was 425,407.

All 700,000 fingerlings programmed for the October plant, at 60 fpp, are being reared in 18 different ponds. The pond distribution enables for low density rearing, minimizing the potential for health and environmental impacts on the fish.

Kokanee Marking

Following discussion with the Lake Roosevelt Hatchery Coordination team, it was determined the use of oxytetracycline (OTC) as the most efficient strategy for marking the fish for this brood year (2001). Studies have shown that OTC effectively provides a permanent mark to the posterior vertebrae and all ribs. When viewed under a long-wave ultraviolet light through a binocular microscope, a yellow fluorescence may be detected on the bone tissue. The caudal fin may be collected from an anglers catch to which a few of the posterior vertebrae remain. (Wiltzius)

The drawback to this marking strategy is that the lab work is more extensive and less conclusive as the fluorescent may diminish over time, becoming less detectable. All fish from this brood year were fed OTC for a 10-day period just prior to the 400,000 fry plant in May. A secondary OTC mark will be administered to the remaining 700,000 fingerlings prior to the plant in early October.

As funds and rearing strategies develop, external marking of all kokanee may be implemented. This year, 128,000 fingerlings will be left-vent clipped, along with the OTC feed, for transfer to the Banks Lake Net Pens in October. Also, 50,000 fingerlings will be adipose fin-clipped for transfer to the Lake Roosevelt Net Pen site on the Colville River. These fish will be monitored to study early maturation. The Ford Hatchery provides the coldest water temperature for the rearing cycle of the kokanee in this region and it is believed to aid in the deterrence of precocity in the juveniles. The analysis and conclusion of this study will be provided in next year's report.

Finally, the use of water temperature chiller units for providing internal band marks on the otoliths is also being proposed as a method of monitoring the fishery.

Adult Kokanee Collected

No adults were collected or trapped in Banks Lake from the 2001-2002 brood years. It is a continuing goal to establish the use of native stocks for propagation in Banks Lake and the Upper Columbia. The use of a locally adaptive stock will enhance the harvest productivity as well as supplementing future egg goals.

While all eggs currently are received from Lake Whatcom, a proposed diversion of the Nooksack River in and through the lake will all but eliminate this source. Strict WDFW disease policies do not allow transfer of eggs out of watersheds impacted by anadromous fish. The use of the Meadow Creek stock, from the Meadow Creek Spawning Channel at the north end of Kootenay Lake, British Columbia, may be a viable option. It is currently implemented in the Lake Roosevelt kokanee program, but may not meet the demands of all kokanee programs for Banks Lake and Lake Roosevelt.

The continuing development of the Lake Whatcom, Nooksack diversion proposal will be addressed in future quarterly and annual reports.

The following table is provided to show the adult kokanee collected from Lake Roosevelt (Sherman Creek Annual Report, 2001).

Table 3. 1993-2001 adult kokanee recoveries.

	Adult Kokanee Recovered			
Year	**Males**	**Females**	**Unknown**	**Total**
1993				60
1994				81
1995				10
1996				970
1997	374	22		396
1998				2,471
1999	1,292	35		1,327
2000	2,302	233	119	2,658
2001	1160	126	90	1,376

Hatchery Operations and Maintenance

Maintenance and Construction Projects

Operations and maintenance were performed according to state of Washington and WDFW policies and guidelines.

The Ford Hatchery crew was involved with a variety of projects both with fish handling and facility improvements. Some projects accomplished were: modifying and adapting rearing strategies for improving fish health and production; and building 32 new pond screens for raising kokanee fry in the round ponds (more screens are needed for the incubation building and raceways).

The WDFW Engineering Division in concluding the project plans for the water improvements. The hatchery staff has taken an active role in providing important planning information and feedback to the engineering personnel.

Equipment Purchases

Screens and Materials

The new round-pond screens and frames were made from aluminum. As well as being extremely durable, the aluminum frames and screens provide easy maintenance for routine cleaning and storage. The tube framing was purchased and the hatchery crew welded the frames together along with riveting the screen to each frame. The perforated aluminum plate, used for the screen, was picked up at the Auburn shop as surplus.

Future Modifications Identified

Complete the water increase and improvement projects.

During 2002-2003 the hatchery will need to build new screens for raceway and incubation building rearing units to accommodate the smaller kokanee fry.

With the kokanee program established and the improvement project completed, hire an additional full-time employee for accommodating the increased workload.

Cooperative Projects

The Ford Hatchery kokanee program for Banks Lake will include the Banks Lake Net Pens in 2002. 128,000 fish will be transferred in October for further enhancing the development and acclimation prior to release in April 2003. The fish will be left vent marked for distinguishing as net-pen origin, as well as OTC marked for distinguishing the hatchery rearing cycle of Ford. We look forward to the productivity and data which this part of the program can bring in the coming year.

Personnel

The Ford Hatchery was operated during 2001-2002 using three FTEs: Jon Lovrak, Fish Hatchery Specialist 4; Glenn Ward, Fish Hatchery Specialist 3; and Rex Gearhart, Fish hatchery Specialist 2. The 9-month seasonal temporary position was occupied from October through June by Adam Harris, who provided the staff with a biology background

from EWU. Administrative and complex support was provided from Mike Lewis, Complex Manager, and Cory Morrison, Fish Hatchery Specialist 4.

Fish health services for both Ford and the Spokane Tribal Hatchery were provided by Steve Roberts, Fish Health Specialist.

During the annual period the hatchery staff continued its training in kokanee production. Some of the following areas were enhanced: fish health, fish culture techniques, and fisheries management strategies.

In March, Jon Lovrak, Mitch Combs, Casey Baldwin, Jeff Korth, and Tim Peone attended the 28th Annual International Kokanee Workshop in Kalispell, Montana. This workshop is the annual inter-agency exchange of kokanee culture and management techniques between the eleven western states and Canada. This event was very informative.

Appendix A

Ford Hatchery Planting Report Summary '01-'02

#	(Spc:Stk:BY:BO)	DATE	WATER NAME	SITE	NUMBER	SIZE	POUNDS	MARK
01	KO:WHAL:00:M	9-28	BANKS LAKE	STEAMBOAT ROCK	69,612	68.1	1,022	N / A
02	KO:WHAL:00:M	10-1	BANKS LAKE	STEAMBOAT ROCK	104,090	67.7	1,539	N / A
03	KO:WHAL:00:M	10-2	BANKS LAKE	STEAMBOAT ROCK	115,297	71.9	1,604	N / A
04	KO:WHAL:00:M	10-3	BANKS LAKE	STEAMBOAT ROCK	96,445	93.2	1,035	N / A
05	KO:WHAL:00:M	10-5	BANKS LAKE	STEAMBOAT ROCK	86,314	81.7	1,056	N / A
06	KO:WHAL:01:M	5-17	BANKS LAKE	STEAMBOAT ROCK	401,660	516	778	O.T.C.
07	KO:WHAL:01:M	6-25	BANKS LAKE	STEAMBOAT ROCK	23,747	245	97	O.T.C.
	TOTALS		BANKS LAKE	2001	471,758			425,407

Monitoring and Evaluation

Monitoring and Evaluation

Monitoring and evaluations are performed by the Lake Roosevelt Fisheries Monitoring Program. The angler use, harvest rates for rainbow and kokanee, and the economic value of the fishery have increased substantially. The most recent information from the monitoring program suggests that the hatchery and net pen rearing programs have been beneficial to enhancing the Banks Lake fishery while not negatively impacting wild and native stocks within the lake.

Planting and release strategies are being discussed to further enhance survivability of all kokanee going into Banks Lake. One method is the use of barging to: 1) limit predation; and 2) water temperature acclimation during transport.

The Ford Hatchery assists in the monitoring and evaluation efforts through marking coordination, data collection, and database operations. Information collected and compiled is being used to improve on operations at the Ford Hatchery and the STH. This information is available to other natural resource agencies and interested individuals. The following report details the monitoring data during this annual period.

Abstract

Hatchery kokanee and rainbow trout are stocked into Banks Lake annually; however, their status in the creel is unknown. Historically, harvest of kokanee from Banks Lake was high, but anglers have indicated few kokanee being caught since the mid 1980s. Our objective was to evaluate the Banks Lake fishery, and to determine if hatchery stocked kokanee and rainbow trout were being targeted and harvested by anglers. A non-uniform probability sampling design rove/access creel survey was used to estimate total fishing pressure, catch-per-unit-effort (CPUE), harvest-per-unit-effort (HPUE), and total harvest of fish from Banks Lake. Annual effort was 112,455 (± 363 SD) boat angler and 2,402 (± 291 SD) shore angler hours on Banks Lake. Only one kokanee was creeled from September 2001 through August 2002; however, 2,064 rainbow trout, 3,453 smallmouth bass, 6,768 walleye, and 2,300 yellow perch were harvested from Banks Lake. Banks Lake was primarily a rainbow trout/yellow perch fishery in the winter and spring and a smallmouth bass/walleye fishery in the spring, summer, and fall. Coulee Playland, Steamboat Rock State Park, Northrup and Coulee City Park were used more frequently by boat anglers than the other creel stations. Our results indicate that kokanee harvest from Banks Lake is near zero. Future study and adjustments to the creel design will potentially target anglers who are harvesting kokanee.

Introduction

Banks Lake was created as an equalizing reservoir in 1951 for the Columbia Basin Irrigation Project, which is governed by the United States Bureau of Reclamation. The primary purpose of Banks Lake is to store and deliver water for irrigation of agricultural lands in central Washington. The lake was inundated by the construction of two earth filled dams; one at the north end (North Dam) and one at the south end of the reservoir, (Dry Falls Dam) creating an 11,000-hectare (43.5 km long) reservoir.

The North Dam houses a feeder canal, which receives water that is pumped from Lake Roosevelt (FDR) through large pipes that contain six storage/power generating units. The pumps are reversible, allowing water from Banks Lake to return to FDR to provide additional energy at peak power usage times. Dry Falls Dam contains the headworks for the irrigation canals, which supply water to approximately 271,140 hectares of agricultural land (USFWS 2002). Roughly 3.2 million hectares/m of water is supplied to the Irrigation Project each year. Since the storage capacity of Banks Lake is a little over 1.3 million hectares/m, the reservoir's water volume is completely flushed out about 2.5 times during the irrigation season for an average water retention time of 146 days (USFWS 2002).

Water withdrawal can cause the elevation of Banks Lake to vary during the irrigation season, generally late March through late October. Normally, small water level fluctuations occur, but a maximum draw down of 5 m is possible. Banks Lake reaches its maximum elevation (478.5 m) in September or October, and remains in full pool status through the winter. Irrigation demand, rainfall, runoff, and power demand contribute to an alteration of this elevation cycle (Stober *et al*. 1974).

Historical Fishery

Prior to the inundation of Banks Lake, Devil's Lake (also called Steamboat Lake or Long Lake) was the largest of several small lakes in the Upper Grand Coulee including Lewis Lake, Tule Lake, Alkali Lake and Wet Weather Lake (originally called Steamboat Lake) (Wolcott 1973). These lakes were known by local anglers to contain substantial populations of largemouth bass (*Micropterus salmoides*) and pumpkinseed (*Lepomis gibbosus*). Catch records from 1952-1954 collected by state agencies indicate that the fishery consisted primarily of largemouth bass and pumpkinseed. Creel surveys performed by Spence, [Washington Department of Fish and Wildlife (WDFW), formerly called Washington Department of Game] (1965) suggested that a salmonid fishery was developing by the early 1960s. Catch records were represented mainly by yellow perch, (*Perca flavescens*), rainbow trout (*Oncorhynchus mykiss*), and kokanee (*Oncorhynchus nerka*). Duff (1973) conducted a creel survey for WDFW during 1971-1972. He found that the kokanee catch had increased, but while the total catch was evenly divided between salmonid and spiny ray fish, the effort (number of anglers) expended toward the

salmonid fishery was almost four times greater. Duff (1973) also reported that since 1965, the fishing pressure increased 3-fold and the economic value of the fishery was $1.6 million.

A yearlong creel census performed by the University of Washington (Stober et al. 1976) during 1975 and 1976 found the sport fishery to consist predominately of kokanee and yellow perch. However, by 1977 the kokanee fishery had begun to decline (Stober et al. 1979). Routine creel surveys performed by WDFW personnel during the years 1977-1978 revealed that yellow perch had to begun to dominate the sport fishery; however, kokanee were once again prevalent during 1981-1982, but the catch-per-unit-effort (CPUE) had decreased suggesting a poor or declining fishery. By the mid-1980s creel surveys indicated that anglers had ceased to target kokanee (USFWS 2002).

Significant stocking efforts of kokanee in the 1990s failed to restore a kokanee fishery in Banks Lake. Large numbers of kokanee are entrained downstream despite a barrier net at the outlet (Stober *et al*. 1976). This is substantiated by catches of kokanee at unstocked Billy Clapp Lake, downstream from Banks Lake. Stober and colleagues (1979) conducted a creel census of Billy Clapp Lake in 1978 and found the catch to consist almost entirely of kokanee. More recently, WDFW surveys have reported kokanee in the creel at Billy Clapp Lake, and since 1997, few anglers reported an improvement in the kokanee fishery (USFWS 2002).

Kokanee stocking continues annually into Banks Lake by the Ford Hatchery (WDFW) and the Spokane Tribal Hatchery; however no creel studies have been conducted since the early 1980s to quantify the Banks Lake fishery. The lack of a creel study and information from anglers indicated the reduction and disappearance of kokanee from the creel. In September 2001, the Bonneville Power Administration (BPA) allocated funds to WDFW through the Ford Hatchery Renovation Project to conduct a 10-year creel study on Banks Lake. The objective of the creel study was to evaluate the Banks Lake fishery, and to determine if hatchery stocked kokanee and rainbow trout were being targeted and harvested by anglers.

Methods

The study design was based on standard protocols from Malvestuto (1983) and Pollock et al. (1994). A non-uniform probability sampling design rove/access creel survey was used to estimate total fishing pressure, catch-per-unit-effort (CPUE), harvest-per-unit-effort (HPUE), and total harvest of fish from Banks Lake. Ten permanent creeling stations were surveyed from September 2001 through August 2002. The creeling stations were established by including all major boat ramps, and were named as follows (north to south orientation): 1) Coulee Playland Resort; 2) Sun Banks Resort; 3) Osborne Bay Park; 4) Jones Bay; 5) Northrup; 6) Steamboat Rock State Park; 7) Paynes Gulch; 8) the Pass; 9) Coulee City Park; and 10) Dry Falls Junction (Figure 1). Creel survey days were randomly chosen from a set number of weekdays and weekend/holidays each month, which varied depending on season. Each survey lasted eight hours and consisted of a rove (generally two hours) and two access site visits (generally six hours). Rove surveys

were used to estimate the total fishing pressure, while access site visits provided information on catch and harvest rates. During the rove surveys, each station was visited to count the total number of boat trailers and shore anglers and to interview anglers. The start time of the rove survey was randomly selected (the beginning vs. end of the 8-hour creel survey). The access surveys were conducted at two randomly selected stations per creel day, and were designed to collect completed trip information from anglers as they left the lake. Creel clerks asked anglers for information regarding party size, recreational activity and if their trip was completed, start and end times of activity, species targeted, species-specific catch and harvest, and satisfaction with the fishing experience. Access randomization was based on the proportional use of each boat ramp from the previous month. The creel survey start time was randomly selected with equal probability and based on eight hours after sunrise or eight hours prior to sunset.

Aerial flights were conducted during one weekday and one weekend day during June and August to establish a correction factor for the total angling effort (pressure) between fishing and recreation boats. The airplane traveled north along the east shoreline and south along the west shoreline, while a creel clerk recorded the total number of boat trailers at the access creel stations and the number of fishing boats, non-fishing boats, and shore anglers on and around the lake. A creel clerk simultaneously conducted a standard creel survey from the ground. Due to the cost we only conducted an aerial flight in June and August and made the assumption that all trailers counted from September 2001 to May 2002 were associated with fishing boats. The correction factor for July was an average between June and August.

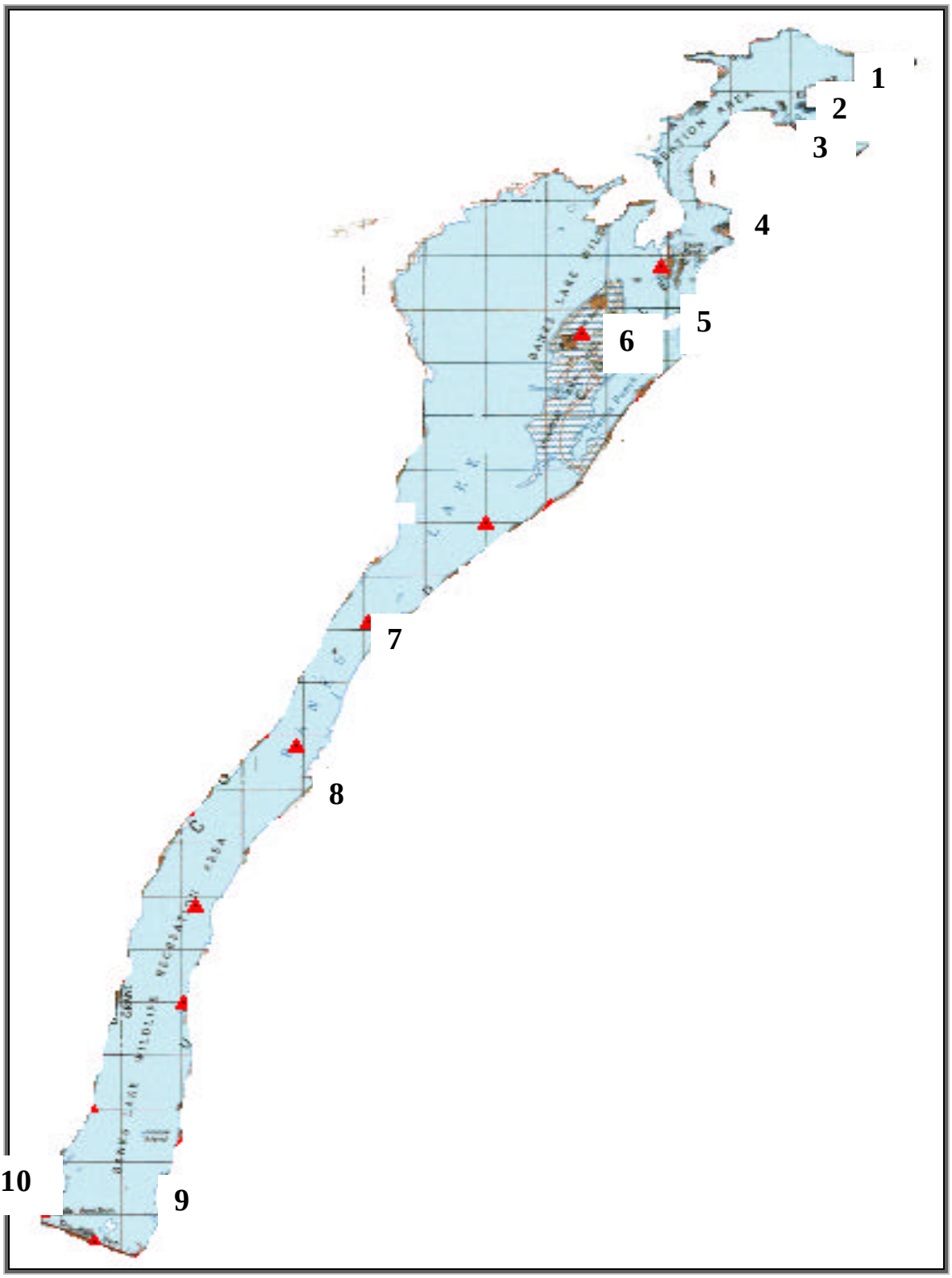

Figure 1. Creel sites on Banks Lake, Washington. 1) Coulee Playland, 2) Sun Banks Resort, 3) Osborn Bay, 4) Jones Bay, 5) Northrup, 6) Steamboat Rock State Park, 7) Paynes Gulch, 8) the Pass, 9) Coulee City Park, and 10) Dry Falls.

Data Analysis

Monthly estimates of catch and harvest were stratified by: weekend days vs. weekdays; and boat anglers vs. shore anglers. Values were then combined to determine monthly and annual totals. The following equations were modified from Cichosz et al. (1997), McLellan (2000), Pollock et al. (1994), and Malvestuto (1983) to estimate catch/harvest rates and total harvest.

Mean number of anglers per day of fishing was estimated:

$$X_b = (A_d)(B_f)$$

Where:

X_b = the mean number of anglers per boat per day for each stratum,
A_d = mean number of anglers per boat for each stratum per month, and
B_f = mean number of boats fishing for each stratum per month.

Number of hours available for fishing (sunrise to sunset) was estimated:

$$N_s = (D_s)(H_d)$$

Where:

N_s = number of hours per weekend or weekday per month,
D_s = number of days per month (weekday or weekend), and
H_d = average number of hours per day for each stratum per month.

The number of hours sampled for each stratum per month was estimated:

$$n = \sum_{i=1}^{Ds} (H_{ci})$$

Where:

n = the total number of hours sampled for each stratum per month,
D_s = the number of days per month within each stratum per month, and
H_{ci} = mean number of hours creeled per day for each stratum per month.

The number of shore anglers per day for each stratum per month was estimated:

$$X_a = \sum_{i=1}^{Pd} S_{pi}$$

Where:

X_a = the mean number of shore anglers per day for each stratum per month from rove surveys,
P_d = the number of rove surveys conducted for each stratum per month, and

S_{pi} = the total number of shore anglers counted during rove surveys for each stratum per month.

The mean number of anglers ($boat_b$ or $shore_a$) for each stratum per month was estimated:

$$X_s = (X_{a,b})(D_s)$$

Where:

X_s = the mean number of anglers for each stratum per month,
$X_{a,b}$ = mean number of anglers for each stratum per day,
D_s = number of days per month.

The standard deviation of angler hours (boat or shore) for each stratum per month was estimated:

$$S_s = (S_d)(D_s)$$

Where:

S_s = the standard deviation of mean number of angler hours for each stratum per month,
S_d = the standard deviation of mean trip length per day for each stratum per month,
D_s = the number of days per month for each stratum per month.

The mean trip length for each stratum per month was estimated:

$$H_a = [T_h / (A_i * P_i)]$$

Where:

H_a = the mean trip length for each stratum per month,
T_h = the total hours spent fishing for each stratum per month,
A_i = the total number of parties interviewed for each stratum per month, and
P_i = the mean party size for each stratum per month.

Total angler pressure for each stratum per month was estimated:

$$PE_t = (N_s / n)(X_s)(H_a)$$

Where:

PE_t = the total pressure estimate for each stratum per month,
N_s = the number of hours for each stratum per month,
n = the number of hours sampled for each stratum per month,
X_s = the mean number of anglers for each stratum per month, and
H_a = the mean trip length for each stratum per month.

The species-specific pressure was calculated:

$$PE_{ss} = PE_t * (\sum spp_i / \sum spp_t)$$

Where:

PE_{ss} = the species specific pressure estimate for each stratum per month
PE_t = the total pressure estimate for each stratum per month,
spp_i = the total number of anglers who targeted a specific fish species for each stratum per month,
spp_t = the total number of anglers who targeted a specific fish species for each stratum per month

The variance of the pressure estimate for each stratum per month was calculated:

$$VPE_{ss} = (N_s / n)(S_s^2)$$

Where:

VPE_{ss} = the variance of the pressure estimate for each stratum per month,
N_s = the number of hours for each stratum per month,
n = the number of hours sampled for each stratum per month, and
S_s = the standard deviation of the mean number of angler hours for each stratum per month.

The ninety-five percent confidence intervals for each stratum per month were calculated:

$$C.I. = PE_{ss} \pm (\sqrt{VPE_s} * 1.96)$$

Where:

C.I. = 95% confidence intervals for each stratum per month,
PE_{ss} = pressure estimate for each stratum per month, and
VPE_s = variance of the pressure estimate for each stratum per month.

Both complete and incomplete trips were used to calculate CPUE for each fish species for each stratum per month. CPUE was calculated from all caught fish, whereas HPUE was calculated only from fish that were kept by anglers.

$$CPUE = \frac{F_{c+h}}{T_h} \textit{ and } HPUE = \frac{F_h}{T_h}$$

Where:

CPUE = catch-per-unit-effort of a particular fish species for each stratum per month,
HPUE = harvest-per-unit-effort of a particular fish species for each stratum per month,
F_{c+h} = the number of fish captured (includes harvest) for each stratum per month,
F_h = the number of fish harvested per each stratum per month, and
T_h = the total hours spent fishing for each stratum per month.

Harvest of each fish species for each stratum per month was calculated:

$$H_s = (HPUE)\ (PE_{ss})$$

Where:

H_s = harvest of a particular species of fish for each stratum per month,
HPUE = the number of fish harvested of a particular fish species for each stratum per month, and
PE_{ss} = species specific pressure estimate for each stratum per month.

The total economic value of the fishery was estimated:

$$EV = \frac{PE_t}{H_a} * (\$)$$

Where:

EV = the total economic value,
PE_t = the total pressure estimate for each stratum per month,
H_a = the mean angler trip length for each stratum per month, and
$ = average dollar amount spent per angler trip.

Data compiled by the U.S. Fish and Wildlife Service in 1996 (USDI 1996) determined that the average inland Washington angler spent $25.00 per angling trip. This value was multiplied by the inflation rate from 1996 to 2002 (1.15) to determine the current dollar amount spent per angler trip (U.S. Department of Labor 2002).

Results

Coulee Playland, Steamboat Rock State Park, Northrup and Coulee City Park were used more frequently by boat anglers than the other creel stations from September 2001 through August 2002 (Figure 2). Shore anglers used the Coulee City Park 57% of the time, and almost never used Jones Bay or Northrup. Annual effort was 112,455 (± 363 SD) boat angler and 2,402 (± 291 SD) shore angler hours on Banks Lake. Weekday angling accounted for 58% of the total angling pressure. Walleye, smallmouth bass, and rainbow trout angling accounted for 49%, 34%, and 11% of the total pressure, respectively. Angling pressure was highest in July and lowest in November (Figure 3). During the winter months, both boat and shore anglers primarily targeted rainbow trout and yellow perch. Boat anglers shifted efforts to walleye and smallmouth bass during the summer months, while shore anglers continued to target rainbow trout or any species (Figure 4). One kokanee was caught from the shore in November.

A total of 1,047 parties were interviewed for catch data. Boat and shore anglers caught one or more fish 72% and 39% of the time, respectively. Anglers indicated that they caught a total of 488 rainbow trout, 1,873 smallmouth bass, 512 walleye, and 312 yellow perch. The total CPUE was 0.42 (± 1.11 SD) for rainbow trout, 0.59 (± 0.79 SD) for smallmouth bass, 0.22 (± 0.32 SD) for walleye, and 0.85 (± 1.26 SD) for yellow perch (Table 4). Smallmouth bass anglers released a majority of the fish they caught (92%), resulting in harvest rates that were a minimum of five times less than catch rates.

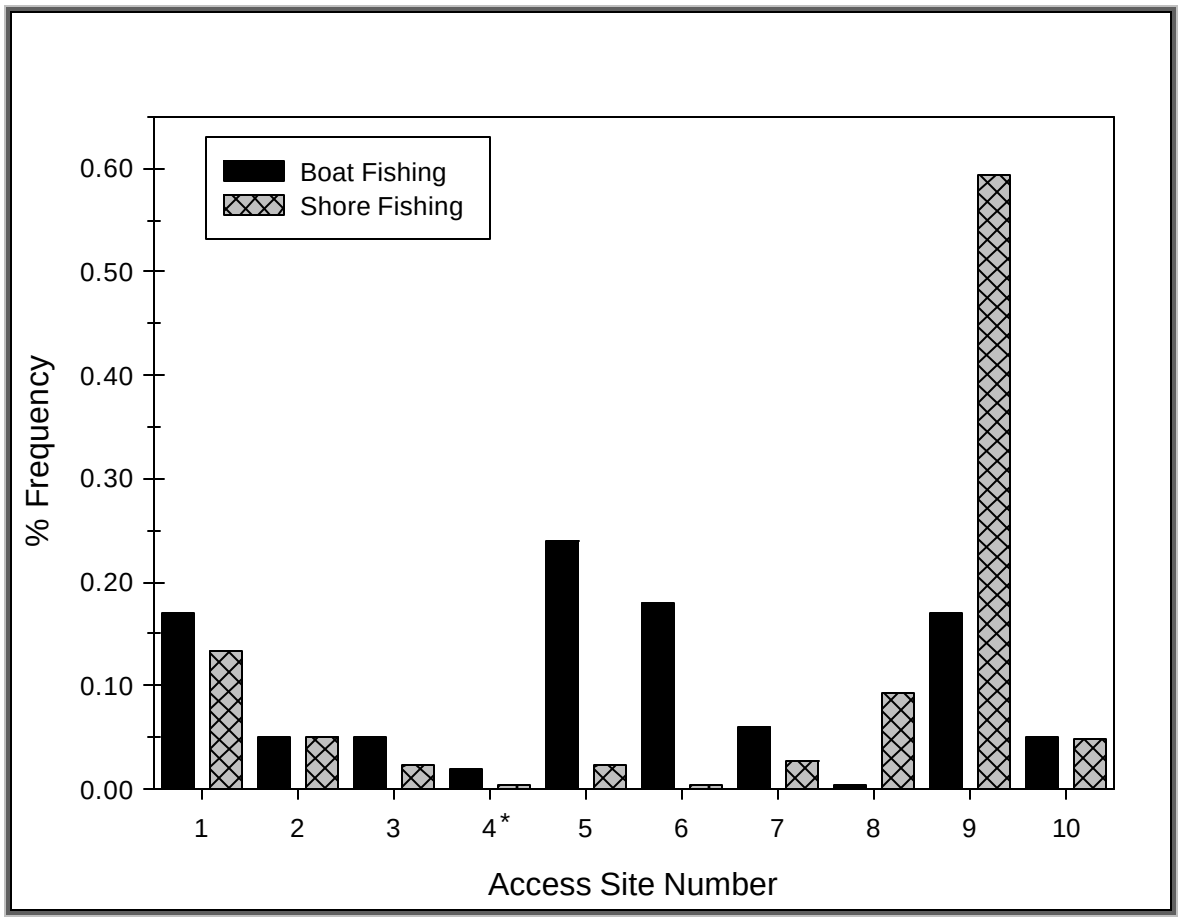

Figure 2. The frequency of site use by boat and shore anglers on Banks Lake, Washington from September 2001 through August 2002. Access site numbers correspond to site names as follows: 1) Coulee Playland; 2) Sun Banks Resort; 3) Osborn Bay; 4) Jones Bay; 5) Northrup; 6) Steamboat Rock State Park; 7) Paynes Gulch; 8) the Pass; 9) Coulee City Park; and 10) Dry Falls. *Jones Bay (4) was closed for fishing access until May 2002.

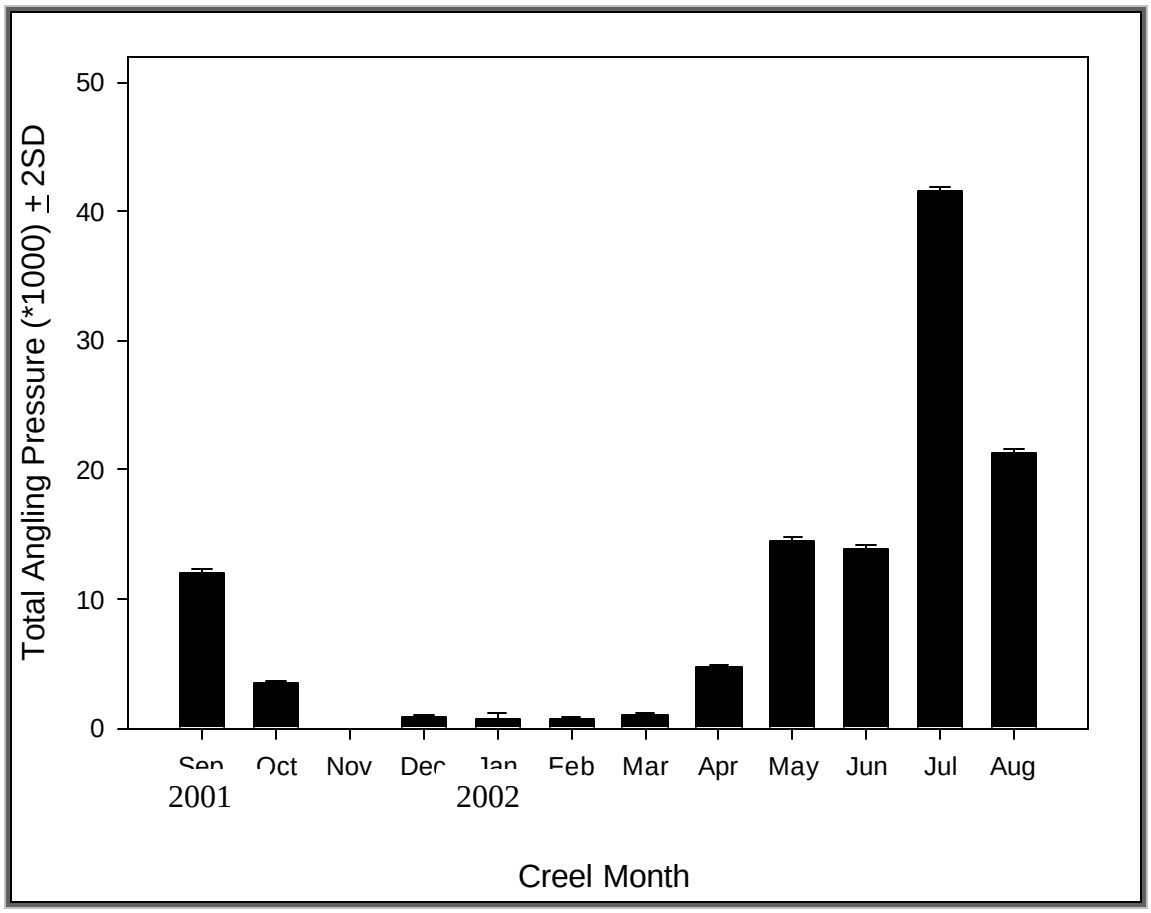

Figure 3. The monthly estimated angling pressure (± 2 SD) on Banks Lake, Washington from September 2001 through August 2002. The monthly pressure estimates include both boat and shore anglers.

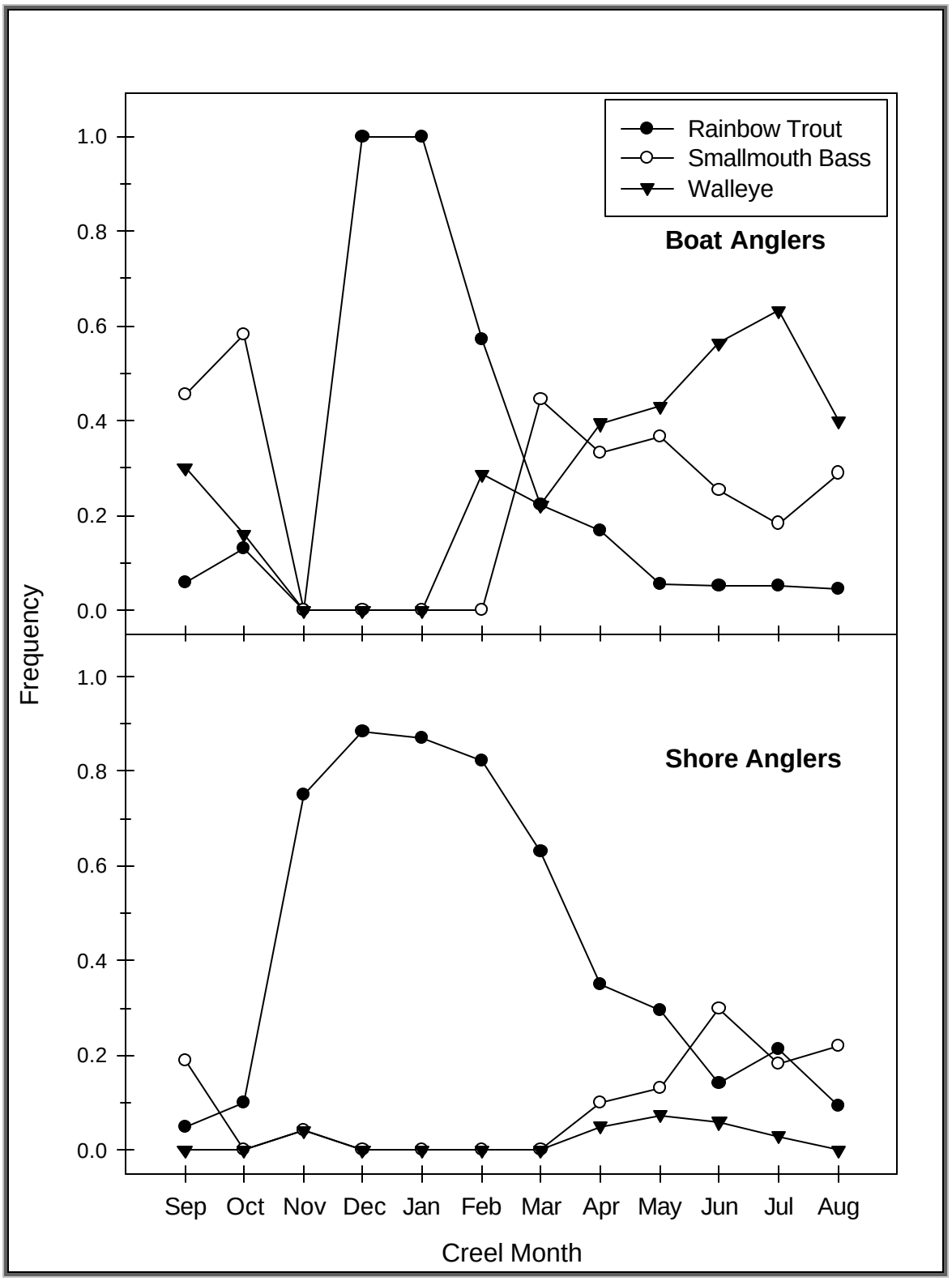

Figure 4. The relative proportion of anglers who indicated they were targeting rainbow trout, smallmouth bass, or walleye each month on Banks Lake, Washington.

Rainbow, walleye, and yellow perch anglers released 39%, 41%, and 49% of the fish they caught, respectively. An estimated 2,064 (± 189 SD) rainbow trout, 3,453 (± 106 SD) smallmouth bass, 6,768 (± 87 SD) walleye, and 1,598 (± 163) yellow perch were harvested (Table 5), while an estimated 4,622 (± 11 SD) rainbow trout, 26,218 (± 424 SD) smallmouth bass, 12,070 (± 161 SD) walleye, and 2,300 (± 194) yellow perch were caught from Banks Lake from September 2001 through August 2002 (Table 6). Anglers who targeted rainbow trout and yellow perch were the most satisfied with the fishery, while walleye anglers were the least satisfied (Table 7).

Aerial creel flights in June indicated that an average of 76% of the boats on Banks Lake were associated with fishing activities, while only 33% were fishing boats in August (Table 8).

We estimated the value of the Banks Lake fishery to determine the economic benefit to the local economy. We determined that the average dollar amount spent per angler trip was $28.75, which yields a total economic value of the Banks Lake fishery from September 2001 through August 2002 of $1,325,490.

Table 4. Monthly catch and release totals, catch and harvest per unit effort (± 1SD), and mean size of the most abundant fish species reported in the creel on Banks Lake, Washington. Fish species codes are as follows: rainbow trout (RBT); smallmouth bass (SMB); walleye (WAL); and yellow perch (YP). All data is summarized from angler interviews.

Month	Species*	Total # Caught	Total # Released	CPUE ± SD (fish/hr)	HPUE± SD (fish/hr)	Mean Size (mm) ± SD
September	RBT	48	19	0.40 ± 0.44	0.18 ± 0.05	381 ± 100
	SMB	532	488	0.70 ± 0.73	0.11 ± 0.04	343 ± 55
	WAL	101	47	0.34 ± 0.52	0.15 ± 0.04	486 ± 56
	YP	105	47	1.45 ± 1.37	1.11 ± 2.34	214 ± 49
October	RBT	46	11	0.47 ± 0.45	0.35 ± 0.21	353 ± 57
	SMB	247	227	0.72 ± 0.48	0.08 ± 0.02	399 ± 70
	WAL	1	1	0.03 ± 0.05	0.00	--
	YP	62	17	2.00 ± 2.62	1.32 ± 8.66	162 ± 8
November	RBT	15	0	0.35 ± 0.56	0.35 ± 0.31	433 ± 59
	SMB	0	0	--	--	--
	WAL	0	0	--	--	--
	YP	4	4	3.03 ± NA	0.00 ± NA	--
December	RBT	19	1	0.20 ± 0.21	0.19 ± 0.04	447 ± 37
	SMB	0	0	--	--	--
	WAL	0	0	--	--	--
	YP	0	0	--	--	--
January	RBT	37	11	0.23 ± 0.48	0.10 ± 0.02	443 ± 59
	SMB	0	0	--	--	--
	WAL	0	0	--	--	--
	YP	11	10	0.58 ± 0.79	0.04 ± 0.01	173 ± NA

Table 4. Monthly catch and release totals, catch and harvest per unit effort (± 1SD), and mean size of the most abundant fish species reported in the creel on Banks Lake, Washington (continued).

Month	Species*	Total # Caught	Total # Released	CPUE ± SD (fish/hr)	HPUE± SD (fish/hr)	Mean Size (mm) ± SD
February	RBT	27	13	0.38 ± 0.90	0.09 ± 0.02	396 ± 67
	SMB	0	0	--	--	--
	WAL	3	1	0.14 ± 0.19	0.09 ± 0.02	--
	YP	21	16	0.68 ± 0.90	0.20 ± 0.10	215 ± 48
March	RBT	11	0	0.14 ± 0.26	0.14 ± 0.07	411 ± 72
	SMB	0	0	--	--	--
	WAL	4	4	0.39 ± 0.43	0.00	--
	YP	0	0	--	--	--
April	RBT	98	43	0.26 ± 0.36	0.10 ± 0.02	399 ± 68
	SMB	66	55	0.27 ± 0.42	0.03 ± 0.01	369 ± 37
	WAL	20	9	0.07 ± 0.18	0.04 ± 0.01	496 ± 44
	YP	6	1	0.09 ± 0.07	0.06 ± 0.00	271 ± 12
May	RBT	107	60	1.22 ± 2.72	0.26 ± 0.14	378 ± 56
	SMB	293	271	0.59 ± 0.48	0.10 ± 0.06	318 ± 61
	WAL	41	9	0.28 ± 0.29	0.21 ± 0.09	498 ± 98
	YP	6	2	0.44 ± 0.34	0.15 ± 0.01	296 ± NA
June	RBT	60	27	0.43 ± 0.39	0.24 ± 0.12	392 ± 50
	SMB	466	454	1.13 ± 1.36	0.11 ± 0.10	387 ± 67
	WAL	244	111	0.30 ± 0.31	0.13 ± 0.03	486 ± 39
	YP	79	48	0.67 ± 1.08	0.27 ± 0.12	289 ± 23
July	RBT	11	3	0.13 ± 0.21	0.08 ± 0.01	330 ± 54
	SMB	118	95	0.56 ± 0.83	0.08 ± 0.02	327 ± 28
	WAL	80	22	0.13 ± 0.15	0.09 ± 0.01	479 ± 43
	YP	5	0	0.61 ± NA	0.61 ± NA	281 ± 32
August	RBT	9	1	0.14 ± 0.14	0.10 ± 0.02	358 ± 39
	SMB	151	125	0.51 ± 0.61	0.06 ± 0.01	266 ± 70
	WAL	18	8	0.23 ± 0.34	0.12 ± 0.03	506 ± 49
	YP	10	7	0.31 ± 0.33	0.12 ± 0.10	245 ± 37
Totals	RBT	488	189	0.42 ± 1.11	0.17 ± 0.08	400 ± 67
	SMB	1873	1715	0.59 ± 0.79	0.08 ± 0.03	328 ± 70
	WAL	512	212	0.22 ± 0.32	0.11 ± 0.03	488 ± 49
	YP	312	153	0.85 ± 1.26	0.45 ± 1.34	222 ± 54

* Other species caught included: 2 bluegill; 3 burbot; 11 bullhead; 8 carp; 1 kokanee; 23 largemouth bass; and 6 whitefish.

Table 5. Monthly harvest estimates (± 1SD) for rainbow trout, smallmouth bass, walleye and yellow perch from Banks Lake, Washington.

Month	Rainbow Trout	Smallmouth Bass	Walleye	Yellow Perch
September	235 ± 8	686 ± 16	574 ± 9	571 ± 26
October	263 ± 21	147 ± 9	0	711 ± 95
November	0*	0	0	0
December	163 ± 15	0	0	0
January	70 ± 29	0	0	1 ± 1
February	49 ± 7	0	0	11 ± 5
March	75 ± 23	0	0	0
April	132 ± 26	46 ± 6	70 ± 8	0
May	374 ± 20	606 ± 23	1,317 ± 26	41 ± 1
June	353 ± 29	585 ± 31	1,453 ± 20	54 ± 12
July	258 ± 5	899 ± 12	2,256 ± 11	0
August	91 ± 34	486 ± 9	1,063 ± 13	209 ± 22
Total	2,064 ± 189	3,453± 106	6,768 ± 87	1,598 ± 163

* Rainbow trout fishermen were observed harvesting rainbow trout, however, the number of fishermen was so low in November that creel pressure counts missed those individuals.

Table 6. Monthly catch estimates (± 1SD) for rainbow trout, smallmouth bass, walleye and yellow perch from Banks Lake, Washington.

Month	Rainbow Trout	Smallmouth Bass	Walleye	Yellow Perch
September	522 ± 23	4,529 ± 58	1,292 ± 25	750 ± 23
October	357 ± 10	1,333 ± 35	12 ± 1	711 ± 85
November	1 ± NA	0	0	0
December	173 ± 4	0	0	0
January	168 ± 4	0	0	11 ± 7
February	209 ± 2	0	53 ± 1	43 ± 14
March	75 ± 2	0	57 ± 5	0
April	163 ± 21	426 ± 30	123 ± 24	0
May	1,796 ± 53	3,715 ± 44	1,742 ± 25	116 ± 4
June	617 ± 11	5,929 ± 133	3,397 ± 35	136 ± 37
July	417 ± 1	5,921 ± 68	3,324 ± 17	0
August	124 ± 1	4,365 ± 55	2,071 ± 28	533 ± 23
Total	4,622± 111	26,218 ± 424	12,070 ± 161	2,300 ± 194

Table 7. The percent of anglers who indicated they were satisfied or dissatisfied with the fishery on Banks Lake. Data was only used if the angler specified their target fish species.

Species Targeted	% Satisfied	% Dissatisfied
ANY	57.3	42.7
Rainbow Trout	83.8	16.2
Smallmouth Bass	76.9	23.1
Walleye	54.5	45.5
Yellow Perch	81.5	18.5

Table 8. The percent of fishing boats vs. recreation boats (water skiers, jet skiers, etc.) during weekdays and weekend days in June and August, determined from aerial creel flights. These percentages were used to correct for the number of boat trailers associated with fishing boats or other recreating boats.

Flight Date	Day Strata	Total # of Boats Counted	Fishing Boats (%)	Recreational Boats (%)
6/19/2002	Weekday	29	86	14
6/21/2002	Weekend	118	60	40
8/23/2002	Weekday	69	35	65
8/25/2002	Weekend	128	32	68

Discussion

The Banks Lake creel study is the primary tool used by the Banks Lake Fishery Evaluation Project (another BPA project that is examining the limiting factors of kokanee and panfish in Banks Lake) to quantify the total number of kokanee returning to the creel and estimate exploitation by using harvest numbers. We established a non-uniform probability sampling regime to maximize the number of angler interviews and used stratified random sampling to take into account all daily time periods when anglers were using the lake. Since we only have one year of creel data, it is impossible for a comparative discussion; therefore, this discussion section will highlight some of the creel results and nuances of the creel study on Banks Lake.

Only one kokanee was observed in the creel from September 2001 through August 2002, and the relative abundance of kokanee during limnetic gill net surveys in the spring of 2002 was 1.3% (Polacek et al. 2002). Fifteen kokanee were collected in the fall 2000 during a WDFW lakewide fish survey (239-498 mm), and several sexually mature kokanee were collected during lakewide gill net surveys in the fall of 2001; however, it is not known if those fish were of wild or hatchery origin. Local fishermen and guides have indicated that there are a few anglers who target and catch kokanee from boats; however, creel clerks have never encountered those individuals. It is possible that the 2001 netting survey sampled a strong year class of age 3 or 4 kokanee and that subsequent year class survival was poor; however, several years of creel data, in conjunction with data from the BLFEP, will be required to quantify abundance and harvest of kokanee in Banks Lake.

The fishery for walleye and smallmouth bass was very good during the early fall, spring, and summer. The highest amount of pressure was from those anglers targeting walleye (59,443 ± 226 SD angler hours) and smallmouth bass (40,890 ± 225 SD angler hours). Banks Lake became almost exclusively a rainbow trout fishery during the winter months. The jetty at Coulee City Park is where most anglers targeted rainbows during the winter. Yellow perch were targeted sporadically, but ice cover was not consistent, thereby limiting ice fishing opportunity that may drastically increase pressure (J. Korth, personal communication). Anglers who were trying to catch anything harvested a variety of other fish species.

Total harvest of rainbow trout for this study is conservative. Due to the low numbers of anglers and short trip lengths during the winter months, the pressure counts are likely to miss many or all of the anglers using the lake. In November, the pressure estimate was zero, even though we knew that rainbow trout were being targeted and harvested. We believe that harvest underestimates of rainbow trout also occurred during December and January. Hourly pressure counts during the access visits may be the only way to correct for the deficiency in the pressure rove count method. The 2002-03 survey will include more visits to the lake in an effort to observe more anglers.

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