Enumeration of Juvenile Salmonids in the Okanogan Basin Using Rotary Screw Traps

COLVILLE TRIBES/AF-2007-2 **MAY 2007**

Colville Tribes

Fish & Wildlife Department

Anadromous Fish Division – Omak Office

23 Brooks Tracts Road
Omak, WA 98841

Voice (509) 422-7434
Fax (509) 422-7428

Enumeration of Juvenile Salmonids in the Okanogan Basin Using Rotary Screw Traps

Performance Period: March 15, 2006 – July 15, 2006

BPA Project # 200302200

Prepared by:

Peter N. Johnson[1] and Michael D. Rayton[2]

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97208-3621

May 2007

[1]LGL Limited environmental research associates, PO Box 225, North Bonneville, WA 98639
[2]Colville Tribes Fish & Wildlife, 23 Brooks Tracts Road, Omak, WA 98841

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The Colville Tribes identified the need for collecting baseline census data on the timing and abundance of juvenile salmonids in the Okanogan River basin for the purpose of documenting local fish populations, augmenting existing fishery data and assessing natural production trends of salmonids. This report documents and assesses the pilot year of rotary trap capture of salmonid smolts on the Okanogan River. The project is a component of the Colville Tribes' Okanogan Basin Monitoring and Evaluation Program (OBMEP) which began in 2004.

Trapping for outmigrating fish began on 14 March 2006 and continued through 11 July 2006. Anadromous forms of *Oncorhynchus,* including summer steelhead *(O. mykiss),* Chinook (*O. tshawytscha)*, and sockeye (*O. nerka)*, were targeted for this study; all have verified, natural production in the Okanogan basin. Both 8-ft and 5-ft rotary screw traps were deployed on the Okanogan River from the Highway 20 Bridge and typically fished during evening hours or 24 hours per day, depending upon trap position and discharge conditions. Juvenile Chinook salmon were the most abundant species trapped in 2006 (10,682 fry and 2,024 smolts), followed by sockeye (205 parr and 3,291 smolts) and steelhead (1 fry and 333 smolts). Of the trapped Chinook, all fry were wild origin and all but five of the smolts were hatchery-reared. All trapped sockeye were wild origin and 88% of the steelhead smolts were hatchery-reared.

Mark-recapture experiments were conducted using Chinook fry and hatchery-reared steelhead smolts (sockeye were not used in 2006 because the peak of the juvenile migration occurred prior to the onset of the mark-recapture experiments). A total of 930 chinook fry were marked and released across eight separate release dates (numbers of marked Chinook fry released per day ranged from 34 to 290 fish). A total of 11 chinook fry were recaptured for an overall trap efficiency of 1.18%. A total of 710 hatchery-reared steelhead were marked and released across three separate release dates (numbers of steelhead released per day ranged from 100 to 500 fish). A total of 12 steelhead were recaptured for an overall trap efficiency of 1.69%.

A pooled Peterson estimator with a Chapman modification was used to produce population estimates for wild Chinook fry and hatchery-reared steelhead based on the results of the mark-recapture experiments. The 2006 populations for Chinook and steelhead were estimated to be 381,554 (95% confidence intervals: 175,731 – 587,377) and 14,164 (6,999 – 21,330), respectively. The population estimates were based on the periods in which mark-recapture experiments were initialized through the end of the trapping season (10 May for steelhead and 1 June for Chinook).

INTRODUCTION

Background

Salmon recovery within the Columbia River Basin has become a focal point in the Pacific Northwest region. Substantial amounts of time, effort and funding have been spent improving fish passage conditions, augmenting flows, enhancing and restoring critical habitats, reducing sport and commercial harvests, regulating power generation and providing spill at the hydroelectric dams, and promoting hatchery supplementation of depressed salmon stocks. The Colville Tribes are actively participating in a recovery program for salmonids in the Okanogan River Basin which include recent inventories of habitat condition and water quality, removal of fish migration barriers, and the collection and rearing of locally-adapted steelhead broodstock. Despite these efforts, many salmon populations continue to decline. Currently, there is limited quantitative information available to determine juvenile salmonid production of anadromous fish in the Okanogan River sub-basin or associated tributary streams.

Okanogan River steelhead, (*Oncorhynchus mykiss)* were listed as endangered under the U.S. Endangered Species Act (ESA) (NOAA 1997) and were upgraded to threatened in 2006. The combined five-year escapement average for the Methow and Okanogan Rivers from 1989 to 1993 was estimated at approximately 2,400 fish; 450 of which were from natural production. This population is estimated to be declining at 12% per year (NOAA 1997).

Summer/Fall Chinook salmon (*O. tshawytscha*) spawn in the Okanogan River Basin but currently are not listed as either threatened or endangered. As of 1998, these fish were classified as having a population of approximately 1,500 with the population increasing at 1%-5% per year (NOAA 1998). Washington Department of Fish and Wildlife's (WDFW)'s salmonid stock inventory program (SSI) classified summer Chinook as having a "healthy" status with an average run of 4,346 for 12 years of data (http://wdfw.wa.gov/fish/sasi). The majority of this stock spawns in the Similkameen River. Spring Chinook salmon in the Upper Columbia Evolutionary Significant Unit (ESU) are listed as endangered. However it is not certain if this run ever utilized the Okanogan River (NOAA 1999). The Okanagan Nation Alliance (ONA) is petitioning the Committee on the Status of Endangered Wildlife in Canada to list Okanogan River Chinook salmon under SARA, the Species at Risk Act of 2003.

Sockeye salmon (*O. nerka*) in the Okanogan River ESU are not listed under the ESA; however the status of Okanogan sockeye salmon is rated as chronically "depressed" by WDFW (http://wdfw.wa.gov/fish/sasi). This stock is of mutual concern to the United States and Canada as the Okanogan sockeye population is one of only two remaining populations in the Columbia River Basin. The annual escapement of sockeye salmon spawners has varied between a low of 1,600 in 1994, to a high of 60,000 in 2000, and has a 16-year mean of 25,000 (http://wdfw.wa.gov/fish/sasi, based on counts at Wells Dam). Fisheries and Oceans Canada recommends an escapement of 59,000 (http://wdfw.wa.gov/fish/sasi).

Stock size and adult escapement of anadromous fish stocks in the Okanogan River have been estimated but little is known of juvenile salmonid production in the system. In order to gain insight with regards to juvenile salmonid production, the Okanogan Basin Monitoring and Evaluation Program (OBMEP) initiated smolt trapping operations in the Okanogan River in 2006. This work is part of a larger basin-wide monitoring effort implemented by the Colville Tribes in coordination with the Washington Department of Fish and Wildlife (WDFW), National Oceanographic and Atmospheric Administration (NOAA Fisheries) and Bonneville Power Administration (BPA Project No. 200302200). The smolt trapping operations in the Okanogan River will allow for the investigation of natural production and productivity by deriving annual population estimates, egg-to-emigrant survival, and emigrant to adult survival rates for anadromous salmonids. These data will be used to evaluate the effects of supplementation programs in the Okanogan River Basin and provide information regarding spawner-recruit relationships, and inform summer spill activities at downstream hydroelectric projects.

Objectives

The primary objective of this monitoring program was collecting usable data for determining the status and trends of anadromous salmonids in the Okanogan Basin, with emphasis focused on summer Chinook and steelhead. The focus of this first year of monitoring juvenile salmonid production was obtaining population estimates for Chinook and steelhead juvenile outmigrants in the Okanogan River using rotary screw trap catch data and mark and recapture techniques.

METHODS AND MATERIALS

Study Site Location

The United States portion of the Okanogan River is a 74 mile, low gradient waterbody draining a series of natural lakes located in Canada (Figure 1). River discharges are tightly regulated in order to maintain lake heights and supply irrigation water. The elevation of Lake Osoyoos, which straddles the international border, is controlled at the outlet by Zosel Dam, located approximately five miles south of the US/Canada border. Roughly a third of the riverine habitat currently accessible to anadromous fish in the Okanogan River basin is found above this point. Inflow into Lake Osoyoos comes from natural runoff and controlled water releases from a chain-of-lakes originating from Okanagan Lake located near Kelowna, British Columbia, Canada. The Okanogan River flows in a southerly direction from Zosel Dam and is joined by the Similkameen River south of Oroville, Washington. The Okanogan River then flows south from Oroville and joins the Columbia River above Wells Dam, near Brewster, Washington.

Environmental Parameters

Flow and water temperature data for the Okanogan River in 2006 were accessed via the Internet from the USGS web site (URL: http://waterdata.usgs.gov/wa/nwis/) for the USGS gauge 12447200: the Okanogan River at Malott, WA, located at river mile 17.0.

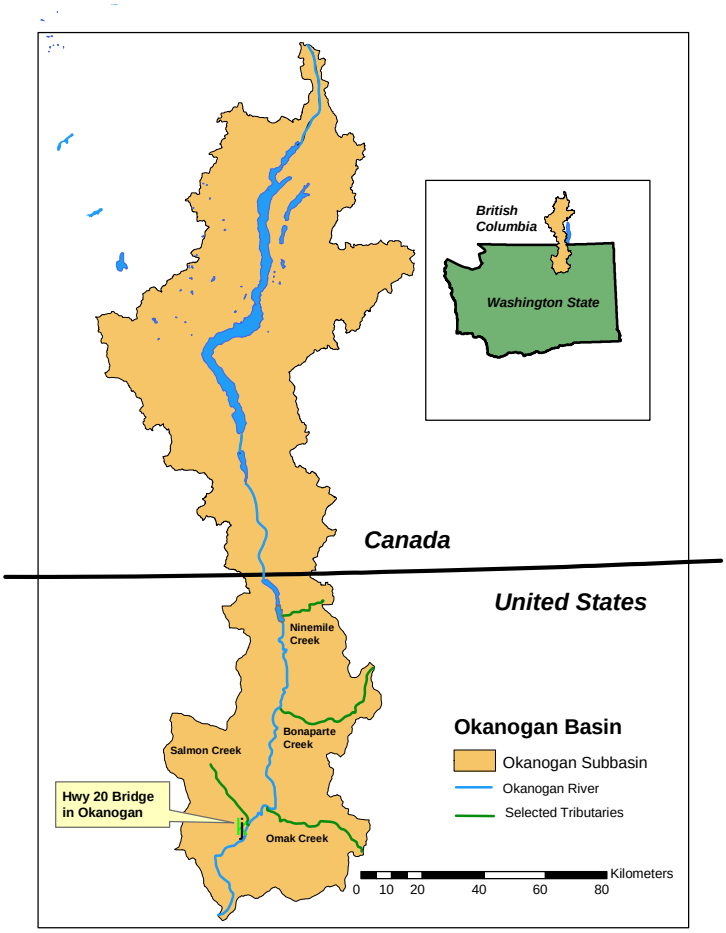

Figure 1. Map of the Okanogan River Sub-basin.

Screw Traps

Operating procedures for the 2006 study were adapted from Volkhardt and Seiler (2005) and Murdoch et al. (2000) as incorporated into a standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team for the Upper Columbia Salmon Recovery Board (Hillman 2004). Procedural details and protocols for rotary screw trap investigations in the Okanogan River are presented in the OBMEP field manual (Rayton and Wagner 2006). Daily protocols for operation of the rotary screw traps were carefully followed (Appendix A).

Selecting an appropriate site for placement of a rotary screw trap required the identification of factors affecting data capture. These included locations of current and historic runs of target fish, acceptable hydraulic conditions for solid placement of trap equipment, and the ease of access for installation, monitoring, and maintenance.

Two rotary screw traps (cone diameters of 5- and 8-ft) were initially deployed on the Okanogan River at the Highway 20 Bridge in Okanogan, Washington (Figure 1) to

estimate juvenile salmonid production. This site was conducive for locating the traps because:

- The relatively low location in the basin was below the confluences of the most productive tributary streams;
- The proximity of the trap site to the Colville Tribe's Omak Fish & Wildlife office;
- The Highway 20 Bridge presented an ideal location for anchoring rotary traps;
- The proximity of a public fishing area for crew and vehicle access;
- The availability of a fenced area at the nearby wastewater treatment plant for secure equipment storage; and
- The proximity of the USGS gauging station at Malott to infer water temperature, discharge, and gauge height at the trap site.

A single trap was placed in the main channel when flow conditions did not exceed 4,500 cfs (Position 1; Figure 2). When flows exceeded 4,500 cfs, traps were placed in both the main channel and in a secondary flow tongue near the west shore (Position 2; Figure 3). Traps in both positions could be deployed, retrieved, secured, accessed, and fished in a safe manner.

Figure 2. Photograph taken from the west bank showing the 8-ft rotary screw trap deployed in Position 1 at 2,050 cfs.

Figure 3 Photograph taken from down-stream showing the 8-ft rotary screw trap in Position 1 (right) and the 5-ft rotary trap in Position 2 (left) at 9,500 cfs.

Permitting

Installation of trapping equipment and initiation of trapping activities required several permits from various local, state, federal and tribal agencies because activities occur within the high water mark of streams. A Joint Aquatic Resources Permit Application (JARPA) was submitted to Okanogan County and the Washington State Department of Fish & Wildlife. A list of the necessary permits required for installation of the rotary trap on the Okanogan River, and their issuing agencies, is listed below:

- Section 10 Incidental Take Permit NOAA Fisheries
- Hydraulic Project Approval (HPA) Washington Dept of Fish & Wildlife
- Scientific Collection Permit Washington Dept of Fish & Wildlife
- Bridge Attachment Permit Washington State Dept of Transportation
- Shoreline Exemption City of Okanogan

Each permit carries with it various stipulations for trap deployment. Several contain language requiring periodic reporting of operations and data while others need only be kept appraised of the continuation of trapping efforts from year to year.

Of utmost concern to us was a stipulation in the NOAA Section 10 Permit which stated that "Steelhead may not be handled if water temperature exceeds 21 °C (69.8 °F)."

Fish Trapping

Traps deployed in Position 1 were fished only at night and at the edge of the main current. Fishing directly in the main channel during high flows was to be avoided as this exposure would have resulted in very high trap RPMs and the potential for significant debris impact damage.

The 8-ft trap was not equipped with a self-cleaning drum screen for the live well. The resulting accumulation of coarse particulate organic matter (CPOM) necessitated crews being on site to clear the live well. The crew checked the Position 1 trap for fish at least once every two hours, or when the cone jammed due to debris loading.

The 5-ft trap deployed in Position 2 was equipped with a self-cleaning drum screen and was located outside of the main channel and thus not subjected to the "debris train" that was inherent to Position 1. Fish in the Position 2 trap were sampled a minimum of twice per day.

All technicians involved with processing trapped fish were trained in juvenile salmonid identification (Pollard et al 1997) and accurate data collection and recording techniques. Technicians removed the fish from the live well with 16" x 9" dip nets (3/16" mesh) and placed them into large buckets. Care was taken to not overcrowd the fish. The fish were then processed by using small aquarium nets, without the use of anesthetic, to identify them to species and check for adipose fins. Fish sampled in this way were then immediately returned to the river over the edge of the trap after recording the data on the field data sheet. The data sheet included information on species, life history stage, presence of fin clips, total counts of live fish and the number of mortalities (Appendix B). Steelhead smolts were also checked for PIT tags when the PIT tag reader was on site and

operational. Fork length was measured from a sub sample of the captured fish. Fish measured or photographed were anesthetized in an MS-222 bath, processed and returned to the river after full recovery.

Trap Efficiency

The mark and recapture of juvenile salmonids provided estimates of the total number of fish passing the trap site. Valid mark recapture estimation requires the following assumptions to be true concerning trap efficiency trials:

1) All marked fish passed the trap or were captured during time period *i*;
2) The probability of capturing a marked or unmarked fish is equal;
3) All marked fish recaptured were identified; and
4) Marks were not lost between the time of release and recapture.

A sub sample of fish was marked with Bismarck Brown dye and used for trap efficiency trials. These fish were not anesthetized but were allowed to fully recover before being released about 1 km upstream of the traps at the Salmon Creek boat launch. Marked fish were transported to the release site by truck in plastic tubs equipped with portable aquarium-type aeration stones. Recaptures of these marked fish were used to generate an estimation of trap efficiency by using the following formula (Murdoch and Pevan 2005):

$$\text{Pooled trap efficiency} = E_p = \sum R / \sum M$$

Where;

E_p is the pooled trap efficiency across the emigration season,

$\sum M$ is the sum of the number of marked fish released during the sampling period, and

$\sum R$ is the sum of the number of marked fish recaptured during the sampling season.

Pooled trap efficiency rates (E_p) were calculated for each species and life history stage throughout the season. Trap efficiency trials were conducted beginning mid-season and lasted until the end of the smolt emigration period. Hatchery steelhead smolts raised at the Cassimer Bar hatchery were used at the outset to estimate trap efficiency for hatchery-reared steelhead. Wild steelhead smolts collected at the trap site were not used for trap efficiency trials due to their low abundance. Year 0 Chinook smolts collected from the traps, marked and released upstream, were used to estimate total trap efficiency of Chinook due to their abundance. Efficiency rates were not determined for sockeye smolts because the peak of the run occurred prior to implementation of the trap efficiency trials.

Production Estimation

The Stratified Population Analysis System (SPAS) software (Arnason et al. 1996) was used to generate mark-recapture estimates and 95% confidence intervals for wild Chinook fry and hatchery-reared steelhead. The approximately unbiased estimate of the

population size using a pooled Peterson estimator with a Chapman modification (Chapman 1954; Seber 1982) includes the following statistics:

$$\hat{N} = \frac{(M+1)(C+1)}{R+1} - 1$$

Where;

C = total number of fish caught (including recaptures),

M = number of fish marked and released,

N = population estimate, and

R = number of recaptures throughout the season.

An approximately unbiased estimate of the variance of the population is:

$$\hat{V}\left[\hat{N}\right] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

The standard error can be calculated as follows:

Standard Error = Square root of Variance of N

RESULTS

Environmental Parameters

The Okanogan River discharge pattern throughout the fish trap sampling period of 2006 was characterized initially by flows less than 2,000 cfs before a gradual increase in flows through most of May (Figure 4). A sharp increase to a peak flow of 17,600 cfs occurred on 22 May. Generally high flows of between 12,800 and 11,200 cfs were sustained through the first half of June before discharge steadily decreased throughout the remainder of the sampling period. Mean daily water temperature in the Okanogan River had an inverse pattern relative to daily discharge for a majority of the sampling season (Figure 4). In general, as discharge increased water temperature decreased and as discharge decreased water temperature was observed to increase. Water temperatures steadily increased through late June, and peaked on 27 July at 27.7 ^{o}C.

Trap Operations

The 8-ft trap was in operation from 14 March through 8 June (Figure 5) and the 5-ft trap was in operation from 22 April through 11 July (Figure 6). A second 5-ft trap was deployed and fished simultaneously with the first 5-ft trap during the latter part of June. The 8-ft trap was fished in positions 1 and 2 for 414 and 27.5 hours, respectively. The 8-ft trap was typically fished in positions 1 and 2 from 8 pm to 6 am Sunday through Thursday. However, for some days in March and April, the 8-ft trap was fished up to 24 hours per day. The 5-ft traps were fished in positions 1 and 2 for 162.25 and 721.5 hours, respectively. The 5-ft trap in position 1 was generally fished from 8 pm to 6 am Sunday through Thursday, and in position 2 the smaller trap was fished 24 hours per day.

Fish Trapping

Chinook

Chinook salmon were the most abundant species of fish trapped in 2006. The Chinook fry catch totaled 10,682 fish and the Chinook smolt catch totaled 2,024 (Tables 1 and 2, Figure 7). No fry were adipose-fin-clipped and all but five of the smolts were adipose-fin-clipped. Almost 78% of the Chinook fry were caught in the 5-ft trap while 78% of Chinook smolts were caught in the 8-ft trap. The overall mortality for Chinook fry was 9.5%, with a peak mortality event occurring on 18 May when 225 fry were found dead in the 8-ft trap (Table 1). Over 85% of the Chinook smolt mortality occurred in the 8-ft trap. Total Chinook smolt mortality was 32.7%, largely due to a high mortality event occurring on 21 April when 614 smolts were found dead in the 8-ft trap (Table 2). Less than 1% of smolt mortalities occurred in the 5-ft trap. Catch per effort for Chinook fry across the combinations of trap size and trap position ranged from 4.4 (8-ft trap, position 1) to 20.5 fish / hour (8-ft trap, position 2; Table 3). Catch per effort for hatchery-reared smolts ranged from 0.02 (5-ft trap, position 2) to 3.8 fish / hour (8-ft trap, position 1; Table 3).

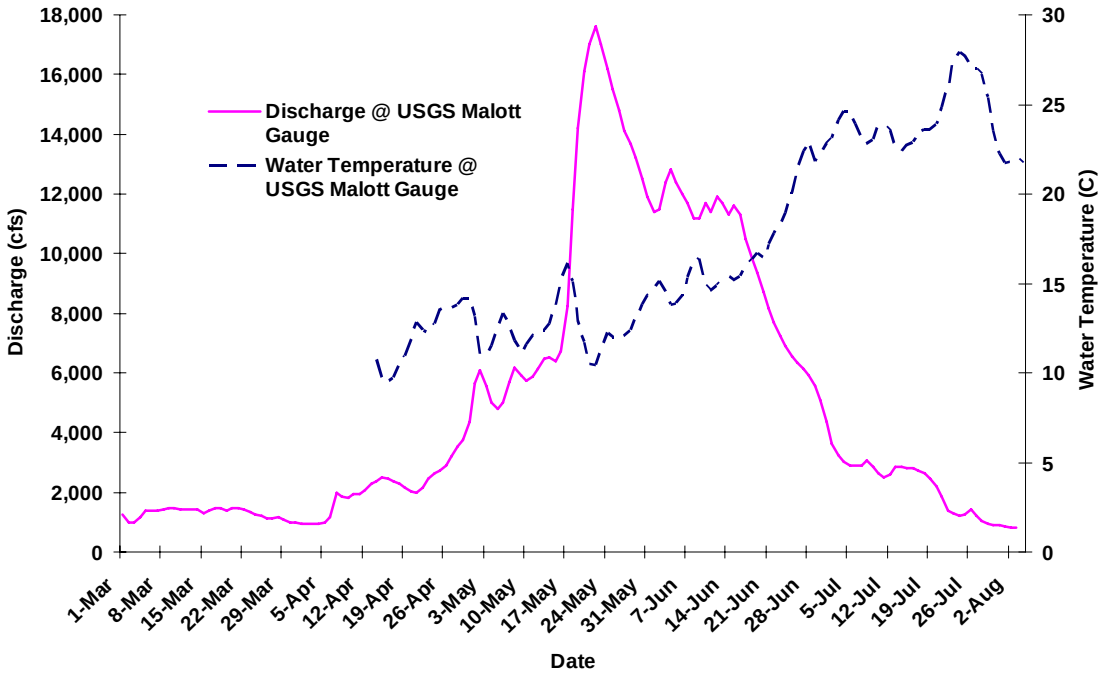

Figure 4. Daily mean discharge and water temperature in the Okanogan River throughout the 2006 sampling season. Water temperature data were not available prior to 14 April.

The run timing of Chinook based on daily trapping shows that the smolt migration occurred earlier than the fry migration (Tables 1 and 2, Figure 7). Smolts were first observed 11 April and catches peaked on 21 April when 690 were counted in the traps.

This corresponds to fish releases from the WDFW Similkameen rearing ponds and the Colville Tribes' St. Mary's and Bonaparte rearing and acclimation ponds. Few Chinook smolts were caught after 17 May. Chinook fry were first seen in the traps on 27 March but the fry emigration period did not get underway in earnest until the second week in May when counts exceeded several hundred per day. The peak daily count for fry occurred on 18 May when 888 were caught in the traps. The fry migration was multi-modal with distinct peaks apparent in early and mid-May, early June, and late June/early July.

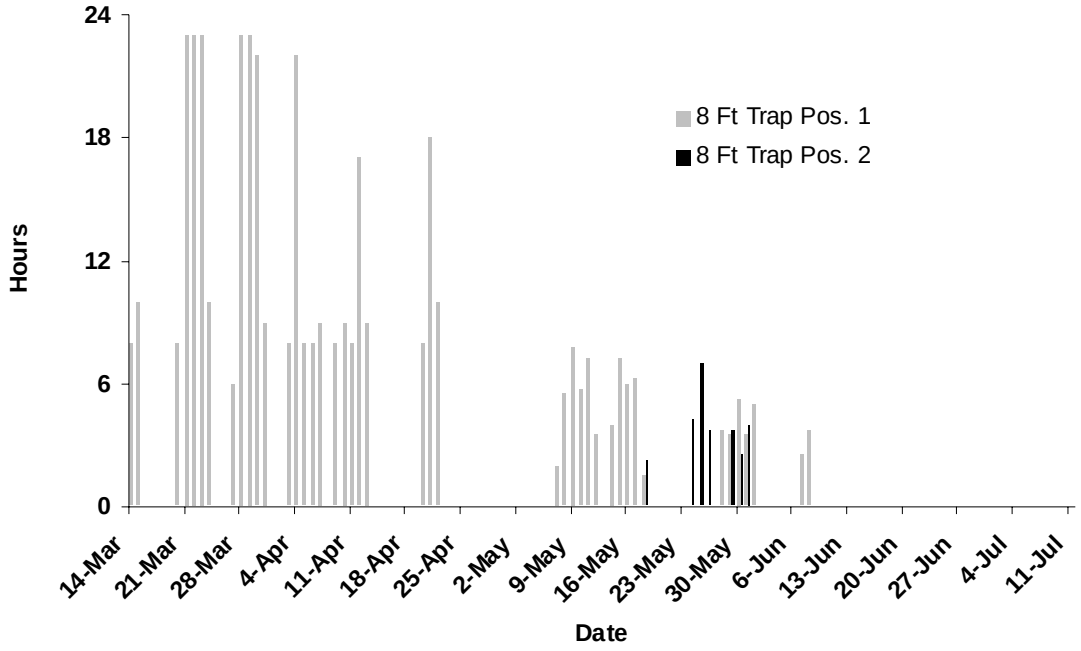

Figure 5. Operational time for the 8-ft rotary screw trap by trap position on the Okanogan River in 2006.

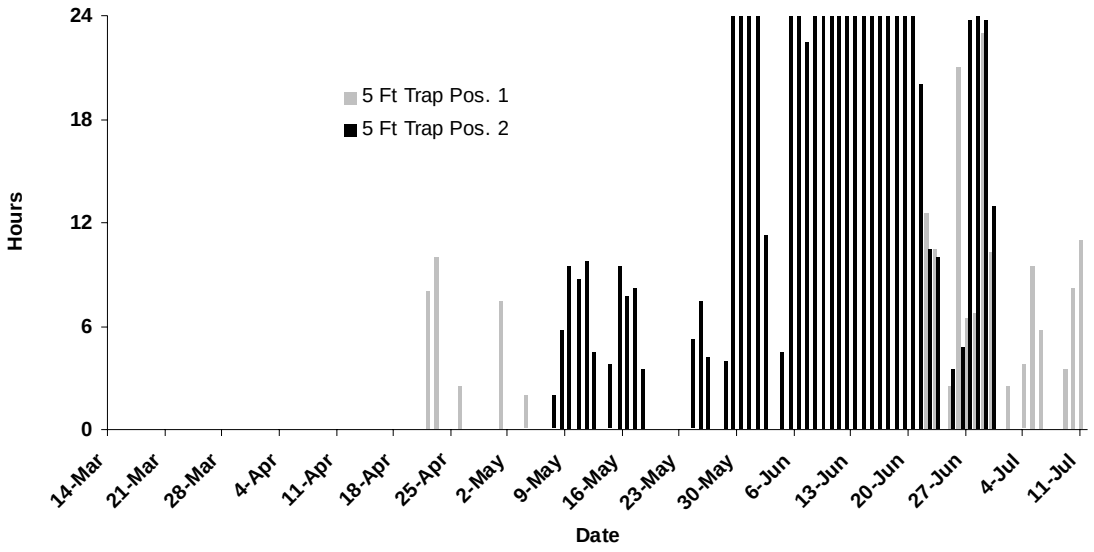

Figure 6. Operational time for the 5-ft rotary screw trap by trap position on the Okanogan River in 2006.

Table 1. Daily number of Chinook fry, mortalities and percent mortality caught in the rotary screw traps in the Okanogan River in 2006. Only dates in which Chinook fry were captured are listed. Trap effort includes total number of hours per day that the 5-ft and 8-ft traps were in operation.

Date	Fish Count	Trap Effort (hrs)	Mortality Count	Percent Mortality	Date	Fish Count	Trap Effort (hrs)	Mortality Count	Percent Mortality
27-Mar	2	6	0	0.0%	1-Jun	561	29	172	30.7%
28-Mar	1	23	0	0.0%	4-Jun	335	4.5	1	0.3%
29-Mar	2	23	0	0.0%	5-Jun	304	24	0	0.0%
30-Mar	3	22	0	0.0%	6-Jun	280	24	1	0.4%
3-Apr	33	8	21	63.6%	7-Jun	619	25	138	22.3%
4-Apr	39	22	0	0.0%	8-Jun	428	27.75	4	0.9%
9-Apr	67	8	0	0.0%	9-Jun	178	24	0	0.0%
11-Apr	22	8	0	0.0%	10-Jun	168	24	0	0.0%
20-Apr	37	8	37	100.0%	11-Jun	47	24	0	0.0%
21-Apr	42	18	0	0.0%	12-Jun	56	24	0	0.0%
22-Apr	13	18	0	0.0%	13-Jun	79	24	1	1.3%
26-Apr	50	2.5	0	0.0%	14-Jun	33	24	0	0.0%
4-May	12	2	0	0.0%	16-Jun	176	24	1	0.6%
7-May	162	4	2	1.2%	19-Jun	36	24	0	0.0%
8-May	416	11.25	0	0.0%	20-Jun	39	24	0	0.0%
9-May	626	17.25	0	0.0%	21-Jun	132	20	68	51.5%
10-May	460	14.5	9	2.0%	22-Jun	174	23	46	26.4%
11-May	282	17	2	0.7%	23-Jun	232	20.5	4	1.7%
12-May	118	8	0	0.0%	25-Jun	130	6	1	0.8%
14-May	137	7.75	0	0.0%	26-Jun	375	25.75	0	0.0%
15-May	152	16.75	2	1.3%	27-Jun	188	30.25	4	2.1%
16-May	279	13.75	13	4.7%	28-Jun	131	30.75	0	0.0%
17-May	738	14.5	79	10.7%	29-Jun	147	46.75	0	0.0%
18-May	888	7.25	225	25.3%	30-Jun	34	23.25	1	2.9%
24-May	90	9.5	11	12.2%	2-Jul	16	2.5	0	0.0%
25-May	120	14.5	10	8.3%	4-Jul	14	3.75	0	0.0%
26-May	21	8	2	9.5%	5-Jul	3	9.5	0	0.0%
28-May	38	7.75	4	10.5%	9-Jul	1	3.5	0	0.0%
29-May	273	31.25	40	14.7%	10-Jul	1	8.25	0	0.0%
30-May	350	31.75	62	17.7%					
31-May	292	31.5	56	19.2%	Total	10,682		1,017	9.5%

Sockeye

A total of 205 and 3,291 sockeye parr and smolt, respectively, were caught in the rotary screw traps in 2006 (Tables 4 and 5, Figure 8). None of the trapped sockeye were observed to have adipose clips. The 8-ft trap caught 78% of all sockeye parr and 96% of all smolts observed. The overall trapping mortality for sockeye parr was 5.9% (Table 4), the result of a single mortality event on 20 April when 12 dead parr were counted in the 8-ft trap. The trapping mortality for sockeye smolts was 7.3%, due in large part to several mortality events that occurred in mid-May when between 43 and 71 fish were found dead per day (Table 5). Over 97% of all smolt mortalities occurred in the 8-ft trap. Catch per unit effort for sockeye parr and smolts were highest with the 8-ft trap in position 1 (Table 3).

Daily trapping run timing indicates that the majority of the sockeye migration was more condensed in time relative to what was observed for Chinook (Tables 4 and 5, Figures 7 and 8). Daily counts for both sockeye parr and sockeye smolts peaked on 9 May with counts of 117 and 1,296, respectively. Over 90% of the sockeye counts were reported during the second two weeks in May.

Table 2. Daily number of Chinook smolt, mortalities and percent mortality caught in the rotary screw traps in the Okanogan River in 2006. Only dates in which Chinook smolt were captured are listed. Trap effort includes total number of hours per day that the 5-ft and 8-ft traps were in operation.

Date	Fish Count	Trap Effort (hrs)	Mortality Count	Percent Mortality
11-Apr	22	8	0	0.0%
12-Apr	4	17	0	0.0%
20-Apr	67	8	35	52.2%
21-Apr	690	18	614	89.0%
22-Apr	107	18	0	0.0%
26-Apr	262	2.5	2	0.8%
1-May	66	7.5	2	3.0%
4-May	1	2	0	0.0%
7-May	24	4	0	0.0%
8-May	73	11.25	0	0.0%
9-May	105	17.25	0	0.0%
10-May	61	14.5	0	0.0%
11-May	35	17	1	2.9%
12-May	34	8	0	0.0%
14-May	113	7.75	0	0.0%
15-May	150	16.75	2	1.3%
16-May	181	13.75	5	2.8%
17-May	17	14.5	0	0.0%
18-May	4	7.25	0	0.0%
28-May	1	7.75	1	100.0%
30-May	2	31.75	0	0.0%
1-Jun	1	29	0	0.0%
5-Jun	1	24	0	0.0%
7-Jun	2	25	0	0.0%
28-Jun	1	30.75	0	0.0%
Total	2,024		662	32.7%

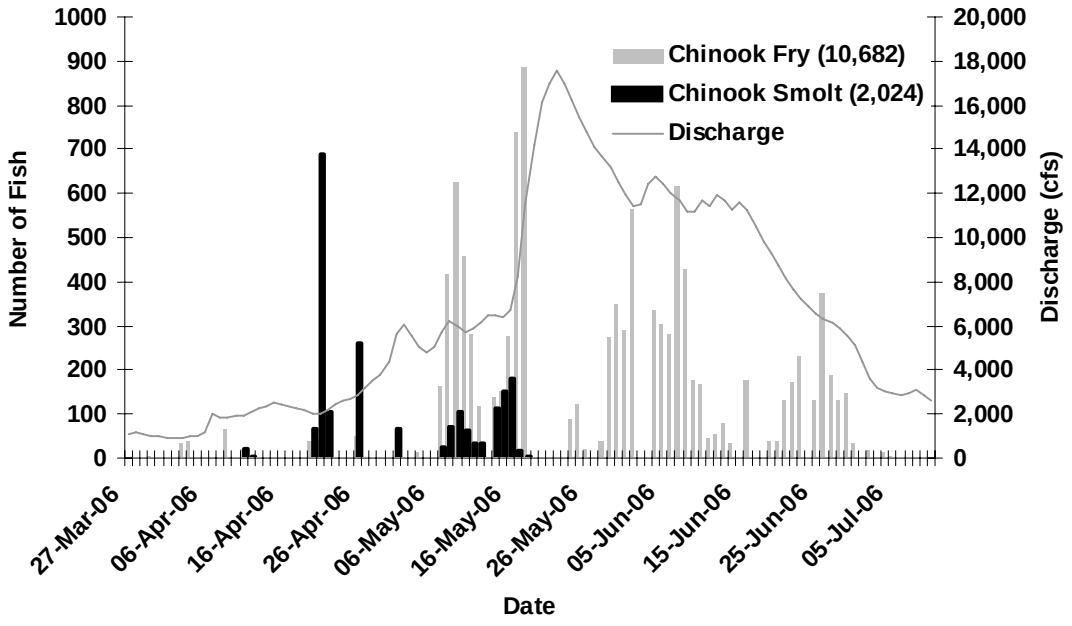

Figure 7. Daily discharge and counts of Chinook fry and smolt caught in rotary screw traps on the Okanogan River in 2006. Mean daily discharge data from USGS gauge at Malott, WA.

Table 3. Catch per unit effort (number of fish / hour) for all anadromous species, life history stage, and origin across all combinations of trap size and trap position for the rotary screw traps in the Okanogan River in 2006.

	Life History		CPUE					
Species	Stage	Origin	5 Ft Pos. 1	5 Ft Pos. 2	5 Ft (Total)	8 Ft Pos. 1	8 Ft Pos. 2	8 Ft (Total)
Chinook	Fry	Wild	9.36	9.41	9.40	4.38	20.51	5.38
Chinook	Smolt	Hatchery	2.69	0.02	0.51	3.78	0.11	3.55
Chinook	Smolt	Wild	0.01	< 0.00	< 0.00	n/a	0.04	< 0.00
Sockeye	Parr	Wild	0.28	n/a	0.05	0.38	0.04	0.36
Sockeye	Smolt	Wild	0.79	0.01	0.15	7.61	0.15	7.15
Steelhead	Fry	Wild	n/a	< 0.00	< 0.00	n/a	n/a	n/a
Steelhead	Smolt	Hatchery	n/a	< 0.00	< 0.00	0.70	n/a	0.66
Steelhead	Smolt	Wild	0.02	0.01	0.01	0.08	n/a	0.07

Steelhead

A total of 333 steelhead smolts, one steelhead fry, and one adult steelhead were caught in the rotary screw traps in 2006 (Table 6, Figure 9). Of the steelhead smolts, 88% were adipose-clipped as hatchery fish. Trapping mortality was low for smolts, as only two fish (0.6%) were found dead in the 8-ft trap. The lone steelhead fry was a mortality found in the 5-ft trap. Catch per effort for steelhead smolts was highest in the 8-ft trap in position 1 (Table 3) as over 97% of all trapped smolts were caught in that trap.

Steelhead smolts were first caught in the traps on 20 April and the last ones were caught on 30 June (Table 6, Figure 9). Despite the range of time in which smolts were trapped, the majority of the steelhead run timing occurred in mid-May with a single primary mode of passage. Daily counts peaked on 11 May when 94 smolts were counted in the traps.

Table 4. Daily number of sockeye parr, mortalities and percent mortality caught in the rotary screw traps in the Okanogan River in 2006. Only dates in which sockeye parr were captured are listed. Trap effort includes total number of hours per day that the 5-ft and 8-ft traps were in operation.

Date	Fish Count	Trap Effort (hrs)	Mortality Count	Percent Mortality
11-Apr	1	8	0	0.0%
20-Apr	15	8	12	80.0%
22-Apr	3	18	0	0.0%
26-Apr	30	2.5	0	0.0%
1-May	10	7.5	0	0.0%
8-May	1	11.25	0	0.0%
9-May	117	17.25	0	0.0%
10-May	5	14.5	0	0.0%
11-May	7	17	0	0.0%
12-May	1	8	0	0.0%
14-May	1	7.75	0	0.0%
15-May	4	16.75	0	0.0%
16-May	3	13.75	0	0.0%
29-May	3	31.25	0	0.0%
30-May	1	31.75	0	0.0%
31-May	1	31.5	0	0.0%
26-Jun	2	25.75	0	0.0%
Total	205		12	5.9%

Non-Target Fish

Fifteen non-target fish species and several other unidentified species were caught in the rotary screw traps in 2006 (Table 7). Non-target fish totaled 3,275 individuals, with mountain whitefish (1,825) and carp (661) being the most abundant species.

Effects of Flow on Catches

Examination of catch data relative to daily Okanogan River flows indicates that peak catches of Chinook fry and smolt, sockeye smolt and parr, and steelhead smolt all occurred prior to the peak flows observed in the latter part of May (Figures 7 – 9). During the period in which flows decreased after the peak, Chinook fry were still being caught in considerable numbers, but few sockeye or steelhead were observed.

Table 5. Daily number of sockeye smolt, mortalities and percent mortality caught in the rotary screw traps in the Okanogan River in 2006. Only dates in which

sockeye smolt were captured are listed. Trap effort includes total number of hours per day that the 5-ft and 8-ft traps were in operation.

Date	Fish Count	Trap Effort (hrs)	Mortality Count	Percent Mortality
29-Mar	1	23	0	0.0%
9-Apr	2	8	0	0.0%
20-Apr	2	8	2	100.0%
21-Apr	18	18	15	83.3%
22-Apr	4	18	0	0.0%
26-Apr	65	2.5	0	0.0%
1-May	57	7.5	2	3.5%
7-May	24	4	0	0.0%
8-May	31	11.25	1	3.2%
9-May	1,296	17	18	1.4%
10-May	149	14.5	9	6.0%
11-May	55	17	12	21.8%
12-May	22	8	4	18.2%
14-May	171	7.75	4	2.3%
15-May	577	16.75	9	1.6%
16-May	495	13.75	46	9.3%
17-May	183	14.5	43	23.5%
18-May	71	7.25	71	100.0%
28-May	9	7.75	0	0.0%
29-May	22	31.25	0	0.0%
30-May	23	31.75	3	13.0%
31-May	11	31.5	0	0.0%
1-Jun	1	29	0	0.0%
21-Jun	1	20	1	100.0%
26-Jun	1	25.75	0	0.0%
Total	3,291		240	7.3%

Marked Fish Releases

A total of 710 hatchery steelhead smolts were marked and released across three release dates in May of 2006 (Table 8). Steelhead releases numbered between 100 and 500 fish. A total of 930 young-of-the-year (YOY) wild Chinook fry were marked and released across eight release dates from 31 May through 29 June (Table 8). Chinook releases numbered between 34 and 290 fish.

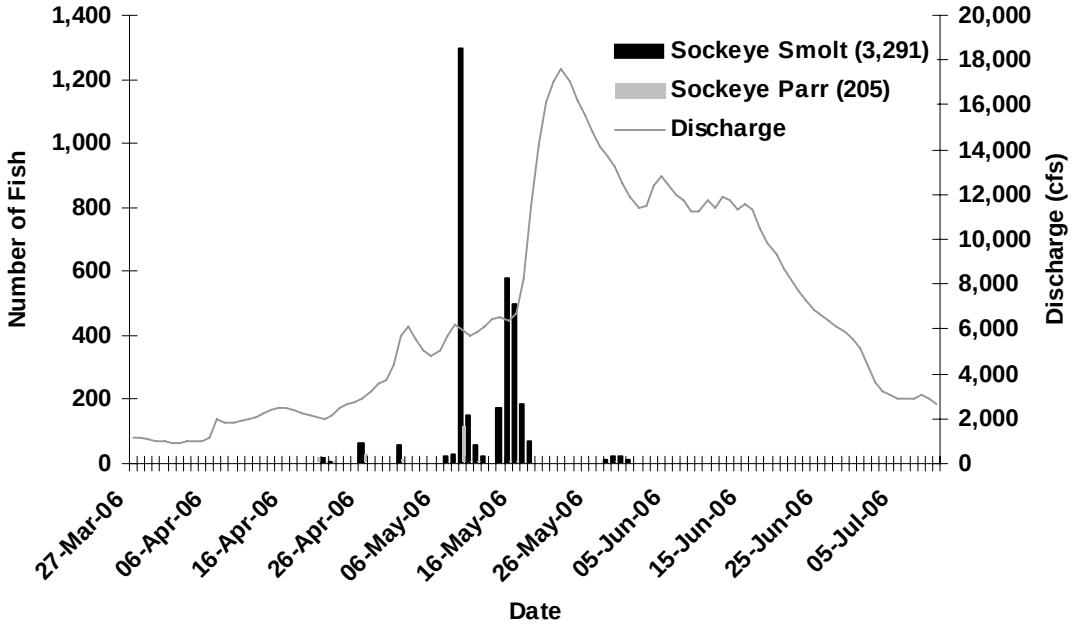

Figure 8. Daily discharge and counts of sockeye parr and smolt caught in rotary screw traps on the Okanogan River in 2006. Mean daily discharge data from USGS gauge at Malott, WA.

Fish Recaptures and Trap Efficiency

Trap efficiency estimates of hatchery-reared steelhead per release group ranged from 1.2 to 3.0%, with overall trap efficiency for steelhead estimated at 1.7% (Table 9). The discharge in the Okanogan River during the days in which marked steelhead were recaptured ranged from 5,720 to 16,200 cfs and trap efficiency was observed to decrease with increasing flows across the three steelhead releases. For wild Chinook fry, efficiency estimates ranged from 0.0 to 3.3% across the eight release groups, with overall efficiency estimated at 1.2% (Table 9). The discharge during the days in which marked Chinook were recaptured ranged from 5,560 to 11,700 cfs. Based on the combination of trap size and trap position, efficiency estimates ranged from 0.4 to 1.0% for steelhead and 0.2 to 0.5% for Chinook (Table 10).

Population Estimates

The population estimates for hatchery-reared steelhead and wild Chinook based on the mark and recapture experiments in 2006 were 14,164 and 381,554 fish, respectively (Table 11). The population estimates are based on catch data collected during the period after which the trap efficiency trials began (1 June through 11 July for Chinook and 10 May through 26 June for steelhead). The population estimate for steelhead included only the catch data for hatchery-reared fish.

Table 6. Daily number of steelhead smolt, mortalities and percent mortality caught in the rotary screw traps in the Okanogan River in 2006. Only dates in which steelhead smolt were captured are listed. Trap effort includes total number of hours per day that the 5-ft and 8-ft traps were in operation.

Date	Fish Count	Trap Effort (hrs)	Mortality Count	Percent Mortality
20-Apr	1	8	0	0.0%
21-Apr	5	18	2	40.0%
22-Apr	1	18	0	0.0%
7-May	5	4	0	0.0%
8-May	22	11.25	0	0.0%
9-May	19	17.25	0	0.0%
10-May	38	14.5	0	0.0%
11-May	94	17	0	0.0%
12-May	54	8	0	0.0%
14-May	14	7.75	0	0.0%
15-May	32	16.75	0	0.0%
16-May	31	13.75	0	0.0%
17-May	8	14.5	0	0.0%
29-May	1	31.25	0	0.0%
4-Jun	1	4.5	0	0.0%
5-Jun	1	24	0	0.0%
7-Jun	2	25	0	0.0%
26-Jun	1	25.75	0	0.0%
27-Jun	1	30.25	0	0.0%
30-Jun	2	23.25	0	0.0%
Total	333		2	0.6%

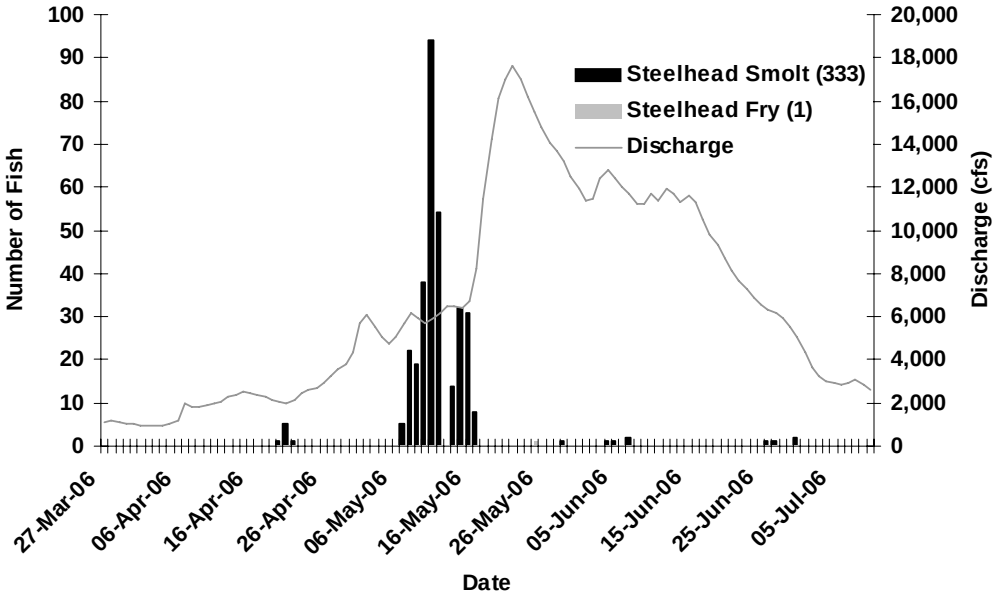

Figure 9. Daily discharge and counts of steelhead fry and smolt caught in rotary screw traps on the Okanogan River in 2006. Mean daily discharge data from USGS gauge at Malott, WA.

Table 7. Non-target species and numbers of fish caught in the rotary screw traps in the Okanogan River in 2006.

Species	Number
Bluegill	30
Bridgelip Sucker	35
Brown Bullhead	20
Carp	661
Chiselmouth	1
Cottid (unknown)	2
Fish (unknown)	16
Largemouth Bass	2
Largescale Sucker	2
Mountain Whitefish	1,825
Northern Pikeminnow	30
Pacific Lamprey	220
Percid (unknown)	2
Redside shiner	16
Smallmouth Bass	147
Sucker (unknown)	22
Three-spine Stickleback	15
White Crappie	62
Yellow Perch	167
Total	3,275

Table 8. Number of marked fish released by date and species for rotary screw trap efficiency trials on the Okanogan River in 2006.

Release Number	Date	Species	Number Marked and Released
1	9-May	Steelhead	100
2	17-May	Steelhead	110
3	24-May	Steelhead	500
		Total	710
1	31-May	Chinook	34
2	5-Jun	Chinook	74
3	7-Jun	Chinook	215
4	9-Jun	Chinook	290
5	12-Jun	Chinook	47
6	14-Jun	Chinook	68
7	19-Jun	Chinook	112
8	28-Jun	Chinook	90
		Total	930

Table 9. Trap efficiency estimates and number of recaptured marked fish by release number, species, and date for the rotary screw trap efficiency trials on the Okanogan River in 2006. Okanogan River discharge is also listed for each recapture date. For recaptures where two dates are listed, the discharges shown are averages across the two dates.

Release Number	Species	Release Date	Recapture Date(s)	Number Recaptured	Trap Efficiency	Trap Size (ft)	Trap Position
1	Steelhead	9-May	9 and 10 May	1		5	2
1	Steelhead	9-May	10-May	1		8	1
1	Steelhead	9-May	10-May	1		5	2
1					3.00%		
2	Steelhead	17-May	17 and 18 May	1		5	2
2	Steelhead	17-May	17-May	1		8	1
2	Steelhead	17-May	18-May	1		5	2
2					2.73%		
3	Steelhead	24-May	24-May	1		8	2
3	Steelhead	24-May	24 and 25 May	2		8	2
3	Steelhead	24-May	25-May	2		5	2
3	Steelhead	24-May	25 and 26 May	1		5	2
3					1.20%		
Overall Total				12	1.69%		
1	Chinook	31-May	1-Jun	1	2.94%	5	2
2	Chinook	5-Jun		0	0.00%		
3	Chinook	7-Jun	7-Jun	5		8	2
3	Chinook	7-Jun	7 and 8 Jun	1		5	1
3					2.79%		
4	Chinook	9-Jun	9 and 10 Jun	1	0.34%	5	2
5	Chinook	12-Jun		0	0.00%		
6	Chinook	14-Jun		0	0.00%		
7	Chinook	19-Jun		0	0.00%		
8	Chinook	28-Jun	28 and 29 Jun	1		5	1
8	Chinook	28-Jun	29-Jun	2		5	2
8					3.33%		
Overall Total				11	1.18%		

Table 10. Trap efficiency estimates for steelhead and Chinook by trap size and trap position.

Species	Trap Size (ft)	Trap Position	Number Recaptured	Trap Efficiency
Steelhead	5	2	7	0.99%
Steelhead	8	1	2	0.28%
Steelhead	8	2	3	0.42%
Chinook	5	1	2	0.22%
Chinook	5	2	4	0.43%
Chinook	8	2	5	0.54%

Table 11. Population estimates and 95% confidence limits for hatchery-reared steelhead and wild Chinook based mark and recapture experiments with rotary screw traps on the Okanogan River in 2006.

Species	Life History Stage	Origin	Population Estimate	Standard Error	Lower 95% CI	Upper 95% CI
Steelhead	Smolt	Hatchery	14,164	3,656	6,999	21,330
Chinook	Fry	Wild	381,554	105,012	175,731	587,377

DISCUSSION

Population Estimates

The population estimates reported here for wild Chinook fry and hatchery steelhead (Table 11) should be viewed cautiously as the timing of efficiency trials, and rotary screw trap operations were not consistent through the sampling period. The initial trap efficiency trials for steelhead were conducted on 9 and 10 May (Table 9), a point in time in which 12% of the migrating hatchery steelhead had already been trapped. As a result, the population estimate for hatchery steelhead could only be generated for the portion of the migration passing the trap after 9 May since the probability of trapping fish prior to 10 May is unknown (the assumption that the probability of capturing a marked or unmarked fish is equal during the period prior to 10 May is invalid since there were no marked and released fish during that time period). Similarly, trap efficiency trials for wild Chinook fry were not initially conducted until 1 June, a date in which 54% of the Chinook fry had already been trapped (Figure 7). As with steelhead, the Chinook population estimate could only be generated for the portion of the migration that passed the trap after the efficiency trials began. As a consequence, the Chinook population estimate, and to a lesser extent the steelhead population estimate, underestimate actual production of these species.

Also confounding the validity of the population estimates was the small number of efficiency trials conducted across a combination of trap sizes and trap positions. Steelhead efficiency trials were based on only three separate releases and steelhead recaptures occurred in the 5-ft trap in position 2, and in the 8-ft trap in positions 1 and 2 (Table 9). Chinook efficiency trials were based on eight releases and recaptures occurred in the 5-ft trap in positions 1 and 2, and in the 8-ft trap in position 2 (Table 9). Although combination trap-size and position-specific efficiency estimates were calculated (Table 10), production estimates were not produced for each trap size / position combination given the small sample sizes. Despite the variation in catch probabilities associated with the trap size / trap position conditions, the pooled Peterson estimator was used to estimate overall production. Ideally, given a large enough sample size for efficiency trials, trap size and position specific efficiencies, a reliable mark recapture estimate could be generated. If the trap efficiency estimates differed significantly by trap size or position, a more accurate population estimate could be produced by further stratifying the mark recapture estimates.

The effect of discharge on production estimation is another caveat that should be acknowledged when considering the trap efficiency and population estimates reported here. The mark-recapture efficiency trials for hatchery steelhead and wild Chinook fry were conducted across a wide range of Okanogan River flows (5,720 to 16,200 cfs for steelhead and 5,560 to 11,700 cfs for Chinook; Table 9). The population estimates derived by using the modified Peterson pooled model distills the inherent differences in catch probabilities across the range of flows, resulting in likely biased production estimates (bias would occur if the pooled efficiency estimate was not representative of the pooled flow across the migration). Given increased sample sizes for efficiency trials during discreet time periods, more accurate population estimates could be produced that account for differential catch probabilities associated with variable river flow. Although sample sizes were too low in 2006 to generate discharge specific productions estimates, the effect of variable discharge on trap efficiency was apparent for steelhead across the three releases: trap efficiency was observed to decrease with increasing flow (Table 9).

Despite the first-year pilot nature of this effort, the 2006 rotary screw trap monitoring in the Okanogan River was successful in that methodologies for trap deployment and operation were developed and valuable experiences were gained in the process. Lessons learned in 2006 will lead to more rigorous mark-recapture efforts and more accurate smolt production estimates in future years.

RECOMMENDATIONS

Based on the efforts and results from this study, we offer the following recommendations to further enhance the effectiveness and reliability of continued assessment of smolt production with rotary trapping in the Okanogan River Basin. Following these recommendations would allow for refined efforts to determine accurate population estimates for juvenile salmonids in the Basin.

Purchase and Use of an 8-ft Trap Equipped with a Self-Cleaning Drum Screen

The most significant cause of mortality in captured fish was the use of an antiquated "California style" screw trap. Constructed in 1993, the 8-ft trap used in the 2006 sampling season was not equipped with a self-cleaning drum screen for small debris removal from the live well. Furthermore, the discharge end of the cone was located approximately 12" above the water level of the live well. Debris accumulating in the live well created a floating mat on the surface of the water that was impenetrable to captured fish. Fish trapped after the formation of this debris mat suffocated and led to the high mortality rate. Therefore, in order to reduce mortality of captured fish we recommend the purchase and use of a new 8-ft trap with self-cleaning drum screen for the 2007 trapping season.

Early Initiation of Mark-Recapture Efforts

One of the largest limitations in the 2006 juvenile salmonid production monitoring and the resulting population estimates was the timing in which mark-recapture experiments were conducted. Initial mark-recapture efforts did not occur until 9 and 10 May for steelhead and 1 June for Chinook. This was especially problematic with Chinook since the catch data indicates that over half the total number of trapped Chinook was observed prior to the onset of the trap efficiency trials (Figure 9). As discussed above, the

consequence of delaying the mark-recapture effort is that those fish trapped early on cannot be included in the population estimate since the assumption of equal probability of capture of marked and unmarked fish is violated. Therefore, in order to obtain more accurate estimates of population levels we recommend initializing mark-recapture efforts for key species at the earliest possible date within the migration period.

Establish Consistent Trap Operations

Ideally, screw traps would be deployed in position and maintained in that position for the duration of the monitoring period. This would simplify data analysis by eliminating the need for stratifying production estimates based on trap position. However, if increased discharge conditions prevent consistent trap operation as in 2006, then inconsistent trap positioning cannot be avoided. Whether traps are moved during the monitoring period or not, we recommend consistent trap operation with regards to hours fished and data collected on a daily basis. Frequent and consistent data collection will minimize the time in which fish are held in the traps and likely result in lower rates of mortality than were seen in 2006.

Increased Frequency of Mark-Recapture Efforts

To better reflect variable discharge and screw trap operational effects on trap efficiency and population estimates, we recommend mark-recapture trials be conducted more frequently than what was done in 2006. We suggest trials be conducted at least once every five days. In this way, trap efficiency estimates could be obtained more frequently across changes in flow and combinations of trap size and position, allowing for stratification of production estimates by flow or trap size and position if trap efficiency estimates differ significantly among flow or trap configurations. More frequent and numerous releases would also increase confidence in the pooled population estimate.

Implement Different Marking Strategy

Increased frequency of mark-recapture efforts would necessitate a different fish marking strategy than used in 2006 if accurate production estimates stratified by flow or trap configuration are to be obtained. We recommend the use of a variety of different colored dyes or visible implant elastomer tags (or non-debilitating fin clips) in order to differentiate among marked fish released among different time periods, a technique successfully used in rotary screw trap mark-recapture investigations of juvenile salmonids on the Coldwater and Alouette rivers, British Columbia (Humble et al. 2006; Murray et al. 2006; Mathews et al. 2007). We suggest using a stratified design with three different dyes used in alternating five-day blocks (e.g., day 1 - 5 brown dye; day 6-10 red dye; day 11-15 green dye). By using this marking strategy, bias associated with delayed migration and consequent trapping of individual fish marked and released during prior time periods should be minimized. If the same mark was used throughout the migration season, as was done in 2006, then the bias associated with recapturing marked fish from prior time periods would be unknown.

ACKNOWLEDGEMENTS

We wish to thank the following individuals for their efforts on this project:

John Arterburn for valuable insight in the drafting of this report;

Edward Berrigan and Fred Jordan for diligence in trap tending and data collection;

Bryan Nass from LGL Limited and Ed Zapel from Pacific Hydraulic Engineers & Scientists for technical expertise in trap rigging design and initial trap deployment;

Dorothy Baker from LGL Limited for formatting the document;

Andy Petersen from Petersen Welding & Machine in Omak whose welding skills kept our traps fishing in spite of the debris;

And all the other individuals who helped make the 2006 trapping season a success.

REFERENCES CITED

Arnason, A.N., C.W. Kirby, C.J. Schwarz and J.R. Irvine. 1996. Computer analysis of data from stratified mark-recovery experiments for estimation of salmon escapements and other populations. Canadian Technical Report of Fisheries and Aquatic Sciences, 2106.

Chapman, 1954. The estimation of biological populations. Annals of Mathematical Statistics. 25:1-15.

Hillman, T. W. 2004. Monitoring strategy for the Upper Columbia Basin: Draft Report. Prepared for the Upper Columbia Regional Technical Team, Wenatchee, Washington.

Humble, S.R., A.C. Blakely and R.C. Bocking. 2006. Field trials to assess steelhead smolt migration success through the Alouette Reservoir, 2006. Technical report prepared for the BC Hydro Bridge Coastal Fish and Wildlife Restoration Program, November, 2006.

Mathews, M., R. Bocking, T. Sampson and D. Coutlee. 2007. Coldwater River smolt emigration (2006) assessment project. Technical report prepared for the Pacific Salmon Endowment Fund Society, February, 2007.

Murdoch, A., K. Petersen, T. Miller, M. Tonseth and T. Randolph. 2000. Freshwater production and emigration of juvenile spring Chinook from the Chiwawa River in 1999. Prepared for Public Utility District Number 1 of Chelan County, Wenatchee, WA.

Murdoch, A. and C. Pevan. 2005. Conceptual approach to monitoring and evaluating the Chelan County Public Utility hatchery programs. Prepared for Chelan County PUD Habitat Conservation Plan's Hatchery Committee.

Murray, B., R. Bocking, N. Todd, T. Sampson and J. Ferguson. 2006. Coldwater River smolt emigration (2005) assessment project. Technical report prepared for the Pacific Salmon Endowment Fund Society, February, 2006.

NOAA (National Oceanic and Atmospheric Administration). 1997. 50 CFR Parts 222 and 227. Endangered and Threatened Species: Listing of several Evolutionary Significant Units (ESUs) of West Coast Steelhead. US Federal Register.

NOAA (National Oceanic and Atmospheric Administration). 1998. 50 CFR Parts 222, 226 and 227. Endangered and Threatened Species: West Coast Chinook Salmon; Listing Status Change; Proposed Rule. US Federal Register.

NOAA (National Oceanic and Atmospheric Administration). 1999. 50 CFR Parts 223 and 224. Endangered and Threatened Species Threatened Status for Three Chinook Salmon Evolutionary Significant Units in Washington and Oregon, and Endangered Status of One Chinook Salmon ESU in Washington; Final Rule. US Federal Register.

Pollard, W.R., G.F. Hartman, C. Groot and P. Edgell. 1997. *Field Identification of Coastal Juvenile Salmonids.* Published by Harbour Publishing for Department of Fisheries and Oceans, Canada and Weyerhauser Ltd. Madeira Park, British Columbia, Canada.

Rayton, M.D. and P. Wagner 2006. Field Manual: Okanogan Basin Monitoring and Evaluation Program Rotary Screw Trap Protocols. Internal report prepared for the Colville Tribes adapted from trapping protocols by Murdock et al. (2001) and Seiler and Volkhardt (2005). http://nrd.colvilletribes.com/obmep/Reports.htm

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters (2nd ed.). London: Griffin.

Volkhardt, G.C. and D.E. Seiler. 2005. Scoop and rotary traps: Measuring juvenile anadromous salmonid production in boatable river systems. In: D.H. Johnson, B.M. Shrier, J.S. O'Neal, J.A. Knutzen, X. Augerot, T.A. O'Neil and I.G. Cowx (eds.) Measuring and monitoring biological diversity – standard methods for freshwater fishes. Smithsonian Institution Press.

APPENDICES

Appendix A**.** Daily Operational Guidelines for Trap Tenders.

Before any work is performed on site, make sure that:

1. At least two people are on site
2. All rigging equipment is sound and safety equipment is in good working order
3. When on the trap, everyone wears a PFD
4. Conditions are within safe operational parameters
5. Date, time, trap rotation and temperature are recorded.
6. All needed sampling equipment is available and fully functional
    - PFD
    - Throw bags
    - Waders
    - Tools & hardware (wrenches, sockets, shackles, clips, etc.)
    - Fish measuring board and balance
    - Data sheets, clipboard and pencil(s)
    - Brush for cone cleaning. Use trash pump when needed
    - Nets
    - Buckets
    - MS-222
    - Bismarck Brown 'Y' Certified Dye
    - Headlamp and fresh batteries
    - *Appropriate Clothing*!!

When fishing:

1. Check the screw trap a minimum of once daily. During periods of high flow, check trap repeatedly.
    - things to look for:
        1. debris in the cone and trap box
        2. worn bushings and seals
        3. missing rivets or screws
        4. worn or broken parts
        5. damage to straps, cables, blocks and other trap rigging
    - make sure trash screens are clean
    - look for means by which fish can escape the trap box

- make sure pontoons and cone are not rubbing on rocks
- make sure live boxes are secure
- check for the presence of predator fish in the trap box
- collect and dispose of man-made trash

2. Work up all fish in the AM
   a. fill out the trap notes in Rite-In-Rain notebook
      1. participants
      2. trap RPM
      3. discharge from USGS website (Malott, WA)
         http://waterdata.usgs.gov/wa/nwis/uv?format=html&period=2&site no=12447200
      4. water temperature (°C)
      5. non-target fish
      6. trap operation (general notes)
   b. make sure to separate the large fish from the small fish
   c. work up steelhead first. Steelhead MAY NOT be handled if water temperature exceeds 21°C (69.8°F)
   d. avoid overloading five-gallon buckets with fish
3. Hold fish until fully recovered. Record water temperature (°C) and time (24 hour) at release.

4. Make sure equipment is kept neat and orderly.
   a. equipment is dried off and put away
   b. do not leave any equipment where the public can get to it.
   c. chemical bottles are to be kept full (use refill containers)

5. DON'T FORGET TO NOTE TIME AND TEMPERATURE WHEN RELEASING FISH.

6. Complete the LOG SHEET daily.

Appendix B. Daily rotary screw trap data sheet used on the Okanogan River in 2006.

	Julian	24h Time	Discharge	Trap RPM	Collectors	Date		Weather		
2006	Date	Start	at Malott	at Start						
OKANRT		End								
	Redeploy Start Time:		TRAP NOTES:						Pos 1	Pos 2
	Redeploy RPM:							8 foot		
RKM 858.040								5 foot		
"558 Miles to	Number Dyed	Recaps								
the Pacific"										
	CHINOOK		SOCKEYE		STEELHEAD		OTHER			
	Unmarked	AD Clip	Skaha Lake	(Year 2)	Unmarked	AD Clip				
			Lake Osoyoos	(Year 1)						
Captured										
&										
Released										
			Mountain Whitefish							
YOY										
Trap										
Morts										
	Unmarked	AD Clip	Skaha	Osoyoos	Unmarked	AD Clip				
	CHINOOK		SOCKEYE		STEELHEAD		OTHER			