



**A GENETIC ANALYSIS OF THE SUMMER  
STEELHEAD STOCK COMPOSITION IN THE  
2011 COLUMBIA RIVER TRIBAL AND  
SPORT FISHERIES**

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## ABBREVIATIONS AND ACRONYMS

BON	Bonneville Dam
BWSALM	Big White Salmon
BY	Brood Year
CI	Confidence Interval
CRITFC	Columbia River Inter-Tribal Fish Commission
CWT	Coded Wire Tag
DPS	Distinct Population Segment
EF	East Fork
GSI	Genetic Stock Identification
IDFG	Idaho Department of Fish and Game
JSR	Joint Staff Report
KLICKR	Klickitat
LOWCOL	Lower Columbia
Lci	Lower 90% Confidence Interval
MCN	McNary Dam
MFSALM	Middle Fork Salmon
MGILCS	Mid Columbia-Grande Ronde-Imnaha-Lower Snake-Lower Clearwater-Lower Salmon
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PBT	Parentage Based Tagging
PIT	Passive Integrated Transponder
PSMFC	Pacific States marine Fish Commission
SBT	Shoshone Bannock Tribes
SFCLWR	South Fork Clearwater
SFSALM	South Fork Salmon
SKAMAN	Skamania
TAC	<i>U.S. v Oregon</i> Technical Advisory Committee
Uci	Upper 90% Confidence Interval
UPCLWR	Upper Clearwater
UPPCOL	Upper Columbia
UPSALM	Upper Salmon
WDFW	Washington Department of Fish and Wildlife
YN	Yakama Nation

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## ABSTRACT

Parentage-based tagging (PBT) is an alternative to coded-wire tag (CWT) methodologies for monitoring and evaluating hatchery stocks. PBT involves the genotyping of hatchery broodstock and uses parentage assignments to identify the origin and brood year of their progeny. Beginning with Brood Year (BY) 2008, Idaho Department of Fish and Game (IDFG) initiated the tissue sampling of all steelhead used for broodstock in Idaho and several stocks in the Oregon and Washington portion of the Snake basin. The following year (BY 2009) all steelhead used for broodstock at all hatcheries in the Snake River basin were sampled. These tissue samples were genotyped by IDFG and the Columbia River Inter-Tribal Fish Commission (CRITFC), allowing their progeny to be identified with PBT methodology. Most steelhead that returned to the Columbia River in the summer and fall of 2011 spent one or two years in the ocean and most of the Snake River hatchery origin steelhead could therefore be identified using genetic methods. IDFG coordinated genetic sampling of the steelhead harvest in the lower Columbia River sport and the Zone 6 tribal fishery with Washington Department of Fish and Wildlife (WDFW), Pacific States Marine Fisheries Commission (PSMFC), Yakama Nation (YN), and CRITFC during the summer and fall of 2011. We estimated the contribution of Snake River hatcheries to steelhead harvest in these fisheries. We also sampled unclipped steelhead caught in the tribal Zone 6 fall fishery and estimated the percentage of these fish that were unclipped Snake River hatchery origin and used Genetic Stock Identification (GSI) methods developed by CRITFC to assign the putative wild steelhead into genetic reporting groups. We were able to assign 78% of the July to October lower Columbia River sport harvest to Snake River hatchery stocks. We assigned 96% of the clipped harvest and 55% of the unclipped harvest in the tribal Zone 6 fall fishery to steelhead stocks from the Snake River.

## INTRODUCTION

Steelhead are present in the Columbia River the entire year and populations contributing to returns are managed based on run timing as outlined in the *U.S. v Oregon* Management Agreement for that section of the Columbia River from the mouth to McNary Dam. All steelhead handled in fisheries downstream of Bonneville Dam from November 1 through April 30 are managed as winter steelhead. The steelhead populations of concern in this report are summer run fish. The Columbia River summer steelhead run includes populations from tributaries upstream and downstream of Bonneville Dam. The majority of the summer steelhead enter the river from May through October. All steelhead handled in fisheries downstream of Bonneville Dam from May 1 to June 30 are managed as summer run Skamania-stock steelhead. Steelhead that pass Bonneville Dam between April 1 and June 30 are counted as summer run Skamania stock steelhead. The Skamania hatchery summer steelhead stock are released in the lower Columbia tributaries, including the Willamette Basin and in some tributaries within the Bonneville pool. Wild lower river summer steelhead are present in the Kalama, Lewis, Washougal, and Wind rivers in Washington, and in the Hood River in Oregon. The lower Columbia River steelhead Distinct Population Segment (DPS) was listed as threatened by the NMFS in May 1999. The recent five-year average return (2006 – 2010) of Skamania steelhead at Bonneville Dam was 15,688 total fish of which 4,456 were wild origin (JSR 2012a).

All steelhead handled in fisheries downstream of Bonneville Dam from July 1 to October 31 are managed as summer run upriver-stock steelhead. Summer run upriver steelhead passing Bonneville Dam between July 1 and October 31 are defined to be either Group A or Group B based on fork length. Group A steelhead are destined for tributaries throughout the Columbia basin and are defined as fish <78 cm fork length. Group B steelhead are primarily bound for the rivers in Idaho and are defined as fish ≥78 cm fork length. The NMFS has divided the upriver wild summer steelhead run into three DPSs: 1) the middle Columbia DPS which includes steelhead destined for Columbia River tributaries from the Wind River in Washington and the Hood River, in Oregon, upstream to and including the Yakima River, except the Snake River basin (listed as threatened in May 1999); 2) the upper Columbia DPS which includes steelhead destined for Columbia River tributaries upstream of the Yakima River (listed as endangered in May 1999 and then changed to threatened in June 2009); and 3) the Snake River DPS which includes steelhead returning to the Snake River basin (listed as threatened in October 1997). The recent five-year average return (2006 – 2010) of Group A steelhead at Bonneville Dam was 319,407 total fish of which 99,445 were wild origin and 68,063 total Group B of which 14,420 were wild origin (JSR 2012a). In the past there was no reliable method available to segregate the steelhead run at Bonneville Dam into individual DPSs.

The run timing of summer steelhead into the Columbia River overlaps the run timing of spring, summer, and fall Chinook, sockeye, and to a lesser extent coho. Spring, summer, and fall Chinook are targeted by non-tribal commercial fisheries downstream of Bonneville Dam, tribal commercial, ceremonial, and platform fisheries upstream of Bonneville Dam, and sport fisheries downstream and upstream of Bonneville Dam. All steelhead caught in non-tribal commercial fisheries must be released. Only steelhead with a clipped adipose fin (hereafter referred to as clipped) may be kept in sport fisheries. Steelhead, both clipped and those with an intact adipose fin (hereafter referred to as unclipped) may be retained in any tribal fishery.

Steelhead harvest is estimated for all tribal and non-tribal fisheries. In sport fisheries, steelhead harvest is estimated monthly downstream of Bonneville Dam in the lower Columbia River. Sport catch upstream of Bonneville Dam is estimated from catch cards and may not be available for several years. Sport steelhead harvest is reported as the number of fish kept.

Preliminary steelhead and Chinook harvest estimates in the tribal Zone 6 fishery are made on a weekly basis beginning June 16. This allows managers to adjust seasons to keep steelhead impacts and harvest of summer and fall Chinook within the limits that are outlined in *the U.S. v Oregon* Management Agreement. Final harvest estimates are reported by *U.S. v. Oregon* Technical Advisory Committee (TAC) at the conclusion of the tribal fishery. Tribal steelhead harvest estimates are reported as the number of clipped and unclipped fish kept that were <78 cm (Group A) and ≥78 cm (Group B). Although there is some sampling for CWT, the low number of CWT recovered does not allow a precise or accurate analysis of the stock composition of the steelhead harvest in the sport or tribal fisheries (Tables 1 and 2). In addition, not all steelhead stocks are marked with a CWT.

The number of fish each hatchery and stock contributes to fisheries downstream of the Idaho border in the Snake and Columbia rivers is necessary to fully evaluate the performance of Idaho's hatchery program. The lack of an adequate number of CWT recoveries does not allow an assessment of the contribution of Idaho stocks in downriver fisheries. To address this problem, the Idaho Department of Fish and Game (IDFG) embraced the use of PBT methods to identify hatchery stocks. IDFG began sampling hatchery steelhead used for broodstock starting with Brood Year (BY) 2008 at all hatcheries in Idaho (Steele et al. 2011). The Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) began sampling BY09 hatchery steelhead used for broodstock in the Snake River basin. All samples were genotyped allowing managers to identify the origin and age of all offspring using Parental Based Tagging (PBT) methods. In 2011, IDFG coordinated the sampling of steelhead harvested in the lower Columbia River sport fishery downstream of Bonneville Dam (Figure 1) and the tribal Zone 6 fishery from Bonneville Dam to McNary Dam from early August until November (Figure 2). IDFG initiated this study because (1) there were no existing plans to use genetic data to estimate the Snake River hatchery contribution of steelhead harvest; (2) evaluation of IDFG steelhead hatchery programs requires more precise estimates of harvest contributions from specific release sites in downriver fisheries than are possible using CWTs and (3) the majority of summer steelhead smolts that are released in the Columbia River basin are from Snake River basin hatcheries (Table 3). In 2011 the primary cooperators were IDFG, Columbia River Inter-Tribal Fish Commission (CRITFC), WDFW, Yakama Nation (YN), and the Pacific States Marine Fish Commission (PSMFC).

All adipose clipped fish are known to be hatchery origin. Clipped hatchery fish from the Snake River could be assigned to a hatchery stock and release group using PBT markers. Clipped steelhead that do not assign using PBT markers are either a hatchery fish from outside the Snake River basin or a Snake River hatchery fish from a hatchery and BY that was not sampled. Steelhead with an intact adipose fin could be a wild fish or hatchery origin fish released without a clipped adipose fin. Samples from unclipped steelhead were analyzed using PBT markers to determine if the fish was of Snake River basin hatchery origin. Unclipped samples that did not assign to a Snake River hatchery (putative wild fish) were assigned to a Columbia River reporting group developed by CRITFC using Genetic Stock Identification (GSI) markers (Hess et al. 2013) These reporting groups may contain wild origin or unclipped hatchery origin steelhead.

The objectives of this project are to use the steelhead harvest estimates that the TAC and ODFW publishes for mainstem lower Columbia River sport and tribal Zone 6 fisheries and the results of the genetic analysis of collected samples to:

1. Estimate the contribution by the Snake River basin and each Snake River hatchery release group to sport harvest in the Columbia River downstream of Bonneville Dam (Sections 1 – 10).
2. Estimate the percent of the unclipped hatchery origin and wild origin steelhead caught in the Zone 6 tribal fishery.
3. Estimate the Snake River basin wild and hatchery contribution in the Zone 6 tribal harvest.
4. Estimate the contribution of each Snake River hatchery release group (clipped and unclipped) in the Zone 6 tribal harvest.
5. Assign putative wild steelhead into reporting groups using GSI and estimate the percentage of harvest from each reporting group in the Zone 6 tribal harvest.

## **METHODS**

### **Steelhead passage at Bonneville and McNary dams**

The daily count of clipped and unclipped steelhead at Bonneville Dam and McNary Dam from July 1 to October 31, 2011 was obtained from the Army Corp of Engineers website (available at <http://www.nwp.usace.army.mil/Missions/Environment/Fish/Data.aspx>). CRITFC personnel sampled steelhead at Bonneville Dam and recorded the fork length and the presence or absence of the adipose fin. Steelhead were designated as hatchery or wild origin primarily based on the presence of a fin clip or an eroded dorsal fin. If either was observed, the default designation was hatchery and if both were absent, the default designation was wild origin. However, when ageing scales a small proportion of unclipped fish initially categorized as wild were changed to hatchery origin if rapid freshwater scale growth was observed with the absence of any hard freshwater annuli checks (Jeff Fryer, CRITFC, personal communication). TAC used this data to estimate the percentage of Group A and Group B wild and hatchery fish that passed the dam between July 1 – August 25; August 26 – September 18; and September 19 – October 31. These percentages were multiplied by the total steelhead dam count in each time period to estimate the number of wild and hatchery origin Group A and Group B fish that passed the dam. The total Group A and Group B wild and hatchery passage at Bonneville Dam was the sum of the three time periods.

### **Steelhead Run-timing at Bonneville and McNary dams**

All hatchery summer steelhead stocks in the Snake River basin and several stocks in the Upper Columbia River are representatively PIT-tagged prior to release as smolts. We obtained the daily number of adult detections of each stock at Bonneville and McNary dams (detection data obtained from <http://www.ptagis.org>) from June 1, 2011 to December 31, 2011. We used the cumulative number of detections since June 1 to calculate the cumulative passage proportion by date at the dams for each Snake River stock. The run timing of each Snake River hatchery stock was calculated by combining all release groups and BYs. The Upper Columbia run-timing was calculated by combining all hatchery stocks upstream of the Yakima River.

### **Sport harvest estimates**

Sport anglers could retain two adult salmon or hatchery steelhead per day or one of each species in the Columbia River from Buoy 10 to Bonneville Dam. Only steelhead with a clipped adipose fin may be kept. Sport fisheries were allowed a 2% impact rate on wild A-run and 2% on wild B-run steelhead in July and an additional 2% impact on A-run and B-run fish from August 1 to October 31. The recreational sport fishery downstream of Bonneville Dam is divided into ten sampling sections. Personnel from ODFW and WDFW conduct random angler interviews at their respective boat ramps, beaches, and on the river to determine catch rates for each species in each section. Total number of fish caught and released for each species, month, and strata is estimated by combining total angler effort estimates derived from aerial surveys with the observed angler catch rates in each strata (Watts 2013; TAC 2008). The hatchery stock composition of the harvest is not reported.

### **Tribal Zone 6 harvest estimates**

There were 26.5 days open for commercial set net fishing during a seven week period from August 22 to October 6 that primarily target fall Chinook salmon. The dates of the commercial seasons were:

- 6 AM Monday August 22 to 6 PM Thursday August 25 (3.5 days)
- 6 AM Tuesday August 30 to 6 PM Friday September 2 (3.5 days)
- 6 AM Tuesday September 6 to 6 PM Friday September 9 (3.5 days)
- 6 AM Monday September 12 to 6 PM Friday September 16 (4.5 days)
- 6 AM Monday September 19 to 6 PM Friday September 23 (4.5 days)
- 6 AM Monday September 26 to 6 PM Friday September 29 (3.5 days)
- 6 AM Monday October 3 to 6 PM Thursday October 6 (3.5 days)

These fisheries also catch significant numbers of steelhead as both species are abundant in Zone 6 during the time period the commercial seasons are open (Figure 3). In addition to the commercial seasons, platform and hook and line fisheries were open from August 1 to November 26, 2011.

The harvest rate for treaty fisheries for the fall management season (August 1 to October 31) is based on a sliding scale of the abundance of upriver fall Chinook and total B-run steelhead counted at Bonneville Dam as outlined in the *U.S. v. Oregon* Management Agreement. There is no specific harvest rate limit on A-run steelhead. In 2011, the total B-run steelhead allowable harvest rate in the treaty fishery was 20% (7,399 B-run fish).

Tribal monitors from the YN sample catch at landing points (often at in-lieu fishing sites). Data are collected on number of fish per net, number of nets sampled, numbers of times per day nets are checked and number of nets each sampled crew are fishing. Steelhead are measured (< or ≥ 78 cm) to be classified as Group A or Group B fish and presence or absence of an adipose fin-clip is noted.

WDFW crews sample the tribal catch for biological data at commercial buying stations (ticketed catch). Samplers measured the fork length and recorded the presence or absence of the adipose fin. In cases where the non-ticket catch is a large proportion of the total catch, the TAC uses information from the WDFW sampled ticketed catch combined with the YN sampling data to estimate the number of steelhead that were harvested. All tribal steelhead harvest

estimates are reviewed and then reported by TAC. Steelhead harvest is reported for clipped and unclipped Group A (<78 cm) and Group B (≥78 cm) fish (JSR 2012b; TAC 2008).

### **Sample collection from sport fishery**

Sport anglers were sampled by the WDFW creel survey crews that were used to estimate harvest from Buoy 10 upstream to Bonneville Dam. All steelhead that were encountered had a small piece of tissue removed for the genetic analysis. In addition to a tissue sample, crews also checked the fish for a CWT, PIT-tag, measured the fork length, and recorded the river section and date the fish was caught. The first samples were obtained on August 6 and the last sample was collected on October 16.

Harvest contribution by release group was estimated for two time periods: July 1 to July 31 and August 1 to October 31. To estimate the stock composition of the July harvest we used samples (n = 230) that were collected from Sections 1 – 6, during the first week of sampling from August 6 to 12. These samples were assumed to represent the stock composition in the Columbia River during the month of July. To estimate the stock contribution for the August 1 to October 31 period we drew a random subsample of 648 from the 814 samples we collected for genotyping. We allocated the subsample in proportion to the monthly August to October harvest. Ideally, we would have chosen 600 samples from August, 46 from September, and two from October. However, we only collected 39 samples in September. After we chose 600 samples from August, we then chose an additional 10 samples from the last 10 days of August to represent fish caught in September. The final sample included 610 fish from August, 36 from September, and two from October. Four of the 648 samples from the August 1 to October 31 time period were omitted from the analysis because they failed to meet the criteria used to make assignments or were determined to be a duplicate sample from the same fish.

### **Sample collection from tribal Zone 6 fishery**

Tribal harvest was sampled by WDFW crews at commercial buyers on the Washington side of the Columbia River in Bonneville Pool, The Dalles Pool, and John Day Pool. Crews randomly selected totes of steelhead during the day and sampled all fish in the tote. In addition to a tissue sample, crews also checked the fish for a CWT, PIT-tag, measured the fork length, recorded whether the fish was clipped or unclipped, and the river section and date the fish was caught. The first sample was obtained on August 11 and the last sample on October 6.

The harvest contribution by release group for clipped steelhead was estimated for two time periods: Weeks 32 to 34 and Week 35 to the end of the season. Harvest contribution by release group during Weeks 32 to 34 was estimated using samples collected in Weeks 32 to 35. We assumed that the clipped stock composition from samples obtained in Weeks 32 to 35 was representative of the stock composition for Weeks 32 to 34. We estimated the clipped stock composition for Week 35 to the end of the season using all samples that were collected in that time period. All clipped samples were genotyped; however, 19 samples were omitted from the analysis because they failed to meet the criteria used to make assignments or were determined to be duplicate samples from the same fish. The final sample size used to make assignments was 171 for the Week 32 to 35 time period and 1,444 for the Week 35 to end of season time period.

The unclipped harvest contribution of the hatchery release groups and GSI reporting groups was estimated for the entire time period from August 1 to November 26. We genotyped

all 650 samples that were collected from unclipped fish; however, two unclipped samples were omitted from the analysis because they failed to meet the criteria used to make assignments.

### **Estimating stock proportions and harvest contribution for clipped steelhead**

Clipped steelhead samples from the sport and tribal Zone 6 fisheries were analyzed using the PBT panel as described in Steele et al. 2013. Fish were assigned to a release group and BY (Table 4). Samples that were not assigned by PBT screening to a Snake River hatchery release group were put in the Other group. The Other reporting group contains fish from release groups in Snake River hatcheries whose parents were not genotyped and fish from non-Snake River hatcheries. In 2011 returning adults from Snake River hatchery stocks and BYs that were not genotyped were: 2-ocean adults (BY08) from Lyons Ferry, Wallowa, Touchet, Tucannon, and 3-ocean adults (BY07) from Dworshak. Analysis of the clipped harvest in both the sport and tribal fishery was stratified by time periods. The number of samples that were assigned to a release group and BY were expanded using the release group and BY mark rate as:

$$Cpe_{jtib} = C_{jtib} / m_{ib} \quad (1)$$

Where:

$j$  = fishery (1=sport, 2=tribal)

$t$  = sample stratum

$i$  = number of release groups (19)

$b$  = Brood Year (1=BY2008 and 2=BY2009)

$C_{jtib}$  = number of clipped fish sampled from fishery ( $j$ ) and stratum ( $t$ ) that assigned to release group ( $i$ ) and Brood Year ( $b$ )

$m_{ib}$  = the PBT mark rate for release group ( $i$ ) in Brood year ( $b$ ).

The expanded count represents the expected number of fish in the sample from each group if all groups had a tag rate = 1. The total of expanded samples from clipped fish in fishery ( $j$ ) and stratum ( $t$ ) that originate from all release groups  $i$  and both brood years  $b$  was:

$$Cpe_{jt} = \sum_{b=1}^2 \sum_{i=1}^{19} Cpe_{jtib} \quad (2)$$

The number of clipped fish sampled from fishery ( $j$ ) and stratum ( $t$ ) that did not assign to a release group was:

$$Cn_{jt} = Fc_{jt} - Cpe_{jt} \quad (3)$$

Where:

$Fc_{jt}$  = the number of clipped samples that were genotyped from fishery ( $j$ ) and stratum ( $t$ ) and used for the PBT analysis.

The proportion of the sampled clipped fish from fishery ( $j$ ) and stratum ( $t$ ) from release group ( $i$ ) and Brood Year ( $b$ ) was:

$$qc_{jtib} = Cpe_{jtib} / Fc_{jt} \quad (4)$$

The proportion of clipped fish sampled from fishery ( $j$ ) and stratum ( $t$ ) in the Other group was:

$$qu_{jt} = Cn_{jt} / Fc_{jt} \quad (5)$$

The number of harvested clipped fish by hatchery release group ( $i$ ) and Brood Year ( $b$ ) in fishery ( $j$ ) and stratum ( $t$ ) was:

$$Hc_{jtib} = Hc_{jt} * qc_{jtib} \quad (6)$$

Where:

$Hc_{jt}$  = total harvest of clipped fish from stratum ( $t$ ) in fishery ( $j$ )

The total harvest of clipped fish from release group ( $i$ ) and BY ( $b$ ) in fishery ( $j$ ) was estimated by summing all strata:

$$Hc_{jib} = \sum_{t=1}^2 Hc_{jtib} \quad (7)$$

The number of harvested clipped fish in fishery ( $j$ ) and stratum ( $t$ ) from the Other group was:

$$Hu_{jt} = Hc_{jt} * qu_{jt} \quad (8)$$

The total harvest of clipped fish in fishery ( $j$ ) from the Other group was:

$$Hu_j = \sum_{t=1}^2 Hu_{jt} \quad (9)$$

Sex ratios were calculated using the results of a genetic sex marker that was run on each sample during genotyping (Campbell et al. 2012). The percent of fish  $\geq 78$  cm fork length were calculated for all samples collected and for each release group using the actual count of each group that were identified with PBT.

### **Confidence Intervals for clipped sample percentages**

Confidence intervals for the clipped stock composition estimates in each stratum ( $t$ ) were generated using the script *Rsampit.r* (M. Ackerman, IDFG Eagle Fish Genetics Lab) performed in the R programming environment (R Development Core Team 2009). *Rsampit.r* resampled (bootstrapped) with replacement  $s$  number of times where  $s = 1$  to  $Fc_{jt}$  (number of samples in fishery  $j$  and stratum  $t$ ) from the actual data series of 'stock/brood year' assignments and

unassigned fish. Within each iteration (s) the pool of samples with known release group (*i*) and brood year (*b*) assignments were expanded to  $Cpe_{jtib}$  (Equation 1) and the sum of the expanded estimates  $Cpe_{jt}$  (Equation 2) were subtracted from the sample size  $Fc_{jt}$  and to estimate the number of fish that were not assigned  $Cn_{jt}$  (Equation 3). The expanded release group/BY assignments and estimated number of unassigned fish were divided by the sample size ( $Fc_{jt}$ ) to estimate their respective proportions  $qc_{ji}$  and  $qu_{ji}$  in the sample (Equations 4 and 5). These proportions were multiplied by the total harvest to estimate harvest contribution of each group (Equations 6 and 8). We performed 10,000 iterations and sorted the values in ascending order. The 100(1- $\alpha$ )% confidence intervals in each stratum for the proportions and harvest estimates were the (10,000 \*  $\alpha/2$ ) and (10,000 \* (1 -  $\alpha/2$ )) values of the ordered bootstrap values. The harvest CI's for a fishery with more than one stratum was found by adding the harvest estimates of each stratum for each bootstrap iteration and choosing the (10,000 \*  $\alpha/2$ ) and (10,000 \* (1 -  $\alpha/2$ )) ordered values.

### **Estimating stock proportions and harvest contribution for unclipped steelhead**

Unclipped steelhead that were harvested were composed of unclipped hatchery fish and wild fish. The unclipped samples from the tribal Zone 6 fishery were analyzed using the GSI and PBT panels (Ackerman et al. 2012; Hess et al. 2013; Steele et al. 2013). The GSI panel was used to assign all fish to a GSI reporting group (Figure 4) developed by CRITFC as described in Hess et al. 2013. The PBT panel was used to assign unclipped hatchery origin steelhead to the same release group (*i*) and Brood Year (*b*) categories as those used for clipped fish (Table 4). Unclipped fish that did not assign to a hatchery group using the PBT panel were assigned to a GSI reporting group (*k*) using the best (most likely) assignment regardless of its probability. Analysis of the unclipped harvest was not stratified by time periods. Unclipped steelhead were only harvested in the tribal Zone 6 fishery. The number of unclipped samples used in the analysis ( $F_u$ ) was:

$$F_u = U_{ib} + G_k \quad (10)$$

Where:

$U_{ib}$  = number of samples assigning to hatchery release group *i* and Brood Year *b*.  
 $G_k$  = number of samples that did not assign using the PBT panel and were assigned to a GSI report group (*k*) using the GSI panel.

The number of known hatchery origin samples was expanded by the PBT mark rate:

$$Ue_{ib} = U_{ib} / m_{ib} \quad (11)$$

Where:

$m_{ib}$  = PBT mark rate of hatchery release group (*i*) and Brood Year(*b*)

The proportion of samples in hatchery release group (*i*) and Brood Year(*b*) was:

$$qh_{ib} = Ue_{ib} / F_u \quad (12)$$

The number of fish harvested from release group (*i*) and Brood Year(*b*) was:

$$Hh_{ib} = qh_{ib} * H_u \quad (13)$$

Where:

$H_u$  = total unclipped harvest.

Since fish were added to hatchery release groups after expanding for the mark rate, an equal number of fish must be subtracted from the GSI reporting groups. The difference between the expanded and actual count of hatchery release group  $i$  and Brood Year  $b$  was:

$$D_{ib} = Ue_{ib} - U_{ib} \quad (14)$$

The difference between the expanded and actual count for each reporting group  $i$  was:

$$D_i = D_{i1} + D_{i2} \quad (15)$$

Where:

1 and 2 are Brood Year 2008 and 2009, respectively.

The number of samples to subtract from GSI reporting group  $k$  was:

$$n_k = \sum_{i=1}^{19} p_{ik} * D_i \quad (16)$$

Where:

$p_{ik}$  = the percentage of unclipped fish assigned by PBT analysis to hatchery release group  $i$  that assign to GSI reporting group  $k$  (see Table 5). Each  $p_{ik}$  represents the percentage of hatchery release group  $i$  that would assign to GSI reporting group  $k$  if PBT was not used. Release groups Upper Salmon and EF\_Salmon were combined. Release groups Sawtooth, SBT\_Yankee and, SBT\_Sawtooth were also combined.

The adjusted number of samples in GSI reporting group  $k$  was:

$$A_k = G_k - n_k \quad (17)$$

The proportion of samples in GSI reporting group  $k$  was:

$$qg_k = A_k / F_u \quad (18)$$

The number of fish harvested from GSI reporting group  $k$  was:

$$Hg_k = qg_k * H_u \quad (19)$$

Sex ratios were calculated using the results of a genetic sex marker that was run on each sample during genotyping (Campbell et al. 2012). The percent of fish  $\geq 78$  cm fork length were calculated for the full data set of samples collected for the unclipped fish. We estimated the sex ratio and percent of fish  $\geq 78$  cm of the unclipped fish in each release and reporting group. For the release groups (hatchery origin fish) we used the actual count of each group that

was identified with PBT. For the reporting groups, we used the best GSI assignment for those fish that were not identified with PBT.

### **Confidence Intervals for unclipped sample percentages**

Confidence intervals for the unclipped stock composition estimates were generated using the script *bootstock.r* (M. Ackerman, IDFG Eagle Fish Genetics Lab) performed in the R programming environment (R Development Core Team 2009). *Bootstock.r* resamples (bootstraps) with replacement from an original sample or set of data. The original stock assignments were resampled with replacement  $s$  number of times where  $s = 1$  to  $F_u$  (the number of unclipped samples). Within each iteration, we then calculated the expanded Hatchery release group/Brood year ( $qh_{ib}$ ) and adjusted GSI reporting group assignment ( $qn_k$ ) proportions and harvest contribution ( $Hh_{ib}$  and  $Hn_k$ ) as outlined in equations 11 through 19. We performed 10,000 iterations and sorted the values in ascending order. The  $100(1-\alpha)\%$  confidence intervals for the proportions and harvest estimates were the  $(10,000 * \alpha/2)$  and  $(10,000 * (1 - \alpha/2))$  values of the ordered bootstrap values.

## **RESULTS**

### **Steelhead passage at Bonneville and McNary dams**

During the period from July 1 to October 31, 2011 a total of 355,121 and 242,724 steelhead were counted at Bonneville and McNary dams, respectively (Figure 3). At Bonneville Dam, 230,966 of the total count were clipped fish. The 124,155 unclipped fish were a mixture of wild origin and unclipped hatchery origin fish. TAC estimated that the steelhead return at Bonneville Dam was 109,034 wild steelhead, of which 7,772 were B-run and 101,262 were A-run and 246,087 hatchery steelhead, of which 29,225 were B-run and 216,682 were A-run (Table 6).

### **Steelhead Run-timing at Bonneville and McNary dams**

The earliest arriving stock was from the Lyons Ferry hatchery. All stocks except Dworshak and the Upper Salmon attained their 50% arrival date at Bonneville Dam by mid-August. The Dworshak and Upper Salmon stocks were the latest to arrive at Bonneville Dam and did not attain the 50% arrival date until early September (Figure 5). The same general pattern was observed at McNary Dam that was seen at Bonneville Dam; however, the difference in the arrival dates from the 50% to 90% percentiles among Dworshak and the other Snake River stocks was not as large as it was at Bonneville Dam (Figure 6). The Upper Columbia steelhead passed Bonneville and McNary dams earlier than most Snake River stocks.

### **Sport harvest estimates**

ODFW estimated that 20,602 steelhead were harvested downstream of Bonneville Dam in the Columbia River from July 1 to October 31 (Table 7). Over 95% of the total harvest was caught in July and August (Watts 2013).

### **Tribal Zone 6 harvest estimates**

The total tribal steelhead harvest in Zone 6 fall fishery, from August 1 to November 26, 2011, was 18,204 clipped fish (Table 8) and 9,295 unclipped fish (Table 9). Nearly 90% of the

tribal harvest occurred during the commercial seasons that occurred from August 22 to October 6, 2011 (JSR 2012b; Roger Dick II, personal communication).

### **Estimating stock proportions and harvest contribution for clipped steelhead**

#### **Sport fishery**

We assigned 79% of the sport harvest from August 1 to October 31 in the lower Columbia River to hatcheries in the Snake River basin. The largest contribution to the harvest was from the Pahsimeroi, Oxbow, and Sawtooth (all groups combined) release groups. These three hatchery stocks made up 55% of the harvest (Table 10 and Figure 7). The contribution of the Dworshak release group was estimated to be 9%. In July, (assuming the early August samples represented the July stock composition), we assigned 76% of the harvest to hatcheries in the Snake River basin. The largest contribution to the July harvest was also from the Pahsimeroi, Oxbow, and Sawtooth release groups. These three hatchery stocks made up 58% of the July harvest (Table 11 and Figure 8). In July, the Dworshak release group contribution to harvest was estimated to be 2%. When we combined the July and August – October estimates the Snake River hatchery stocks made up 78% of the total harvest (Figure 9). The largest contribution to the total sport harvest was from the Pahsimeroi BY09 release group (4,839), Other (4,572), Sawtooth BY09 (2,146), and Oxbow BY09 (1,856). Harvest estimates and 90% CI for all release groups are shown in Table 12.

We were able to identify the sex of 644 fish using the genetic sex marker. We found that females made up 42.4% of the harvest. The percentage of female by release group ranged from 22.2% to 73.7% for groups with a sample size >10 (Table 13).

We used all samples to calculate that 8% of the harvested fish were  $\geq 78$  cm fork length. We found that nearly all the large fish were 2-ocean adults and nearly all were from the Dworshak BY08 release group. Only one fish exceeded 78 cm from all of the BY09 release groups (Table 13).

#### **Tribal Zone 6 clipped harvest**

We assigned 96% of the Zone 6 tribal clipped harvest in Weeks 35 to the end of the season to hatcheries in the Snake River basin. The Dworshak BY08 release group contributed nearly 50% of the harvest (Table 14). The next largest contribution to harvest was from the BY09 Pahsimeroi release group (nearly 12%). During the first three weeks of the season (Weeks 32 to 34) we assigned 77% of the harvest to Snake River hatcheries. Nearly 45% of the harvest came from the Pahsimeroi, Oxbow, and Sawtooth BY08 and BY09 release groups (Table 15). In Weeks 32 to 34 Dworshak BY08 only contributed 9% to the harvest. We estimate that over 50% of the total clipped harvest (8,875) came from the BY08 and BY09 Dworshak release groups followed by BY08 and BY09 Pahsimeroi (2,753), and BY08 and BY09 Sawtooth (1,503). Of the 18,204 clipped fish estimated to have been harvested from August 1 to November 26, 2011 we estimate that 94.5% of them were from hatcheries in the Snake River basin (Table 16 and Figure 10). Harvest estimates and 90% CI for all release groups are shown in Table 16.

We were able to identify the sex of 1,444 fish using the genetic sex marker. We found that females made up 43.3% of the harvest. The percentage of female by reporting group ranged from 8.3% to 76.9% for groups with a sample size >10 (Table 17).

We had 1,481 length samples to estimate that 34% of the fish were  $\geq 78$  cm fork length. We found that nearly all the large fish were 2-ocean adults from the Dworshak BY08 release group. Of the BY09 release groups only a few fish from the Dworshak and Sawtooth release groups exceed 78 cm (Table 17).

### **Estimating stock proportions and harvest contribution for unclipped steelhead**

We assigned 31.3% of the Zone 6 tribal unclipped harvest to Snake River hatchery release groups and the remaining 68.7% to GSI reporting groups. The Dworshak BY08 and BY09 made up 22.4% of the total unclipped harvest. All other hatchery release groups contributed less than 3% to the unclipped harvest (Table 18 and Figure 11). The largest contribution (36.8%) was from the geographically large GSI group MGILCS. We estimate that about 24% of the putative wild steelhead harvest came from Snake River GSI reporting groups in Idaho. The largest Snake River contributor was the SF Clearwater (SFCLWR). We estimate that 6,387 unclipped steelhead may have been wild fish (Table 19). However, it is likely that an unknown percentage of these fish were unclipped hatchery origin fish. Harvest estimates and 90% CI for all release groups are shown in Table 19.

We were able to identify the sex of 600 fish using the genetic sex marker. We found that females made up 48.7% of the harvest. The percentage of female by group ranged from 11.1% to 63.6% for groups with a sample size  $>10$  (Table 20).

We had 648 length samples to calculate that 30.6% of the sampled fish were  $\geq 78$  cm fork length. We also calculated the percentage of fish  $\geq 78$  cm by group and found that most of the large fish came from the Snake River groups: Dworshak BY08, SFCLWR, SFSALM, UPCLWR, and MFSALM (Table 20).

## **DISCUSSION**

Until now, fisheries managers have only reported the number of steelhead harvested in the lower Columbia River summer/fall sport fishery. In the tribal Zone 6 fall fishery, steelhead harvest was reported as the number of clipped and unclipped large ( $\geq 78$  cm fork length) and small fish kept. The stock composition in both the sport and tribal fisheries was not estimated or reported. This study represents the first comprehensive attempt to categorize the stock composition of the steelhead harvest in both fisheries. In the sport fishery, we were able to parse the harvest into 18 hatchery release group/Brood Year categories. The tribal harvest was parsed into 22 hatchery release group/Brood Year and 12 GSI reporting groups for a total of 34 distinct groups. The ability to parse harvest demonstrates the power of genetic technology to evaluate specific hatchery programs, assess harvest of wild stocks in the Zone 6 tribal fishery, and provide an estimate of regional contribution to the fisheries. This ability is feasible due to the relative ease, compared to CWT recoveries, of getting a representative, random sample of sufficient size to make accurate and precise estimates of stock percentages. The mark rate in the PBT baseline of Snake River hatchery stocks is high enough that most of the progeny are marked. Having a near 100% mark rate shifts the onus of a sample program to designing a representative random sample from the fishery since crews no longer need to focus on handling large numbers of fish to obtain an adequate sample size. Crews that in the past collected an average of 90 Snake River CWT per year from the sport fishery and 214 from the tribal Zone 6 fishery (Tables 1 and 2) were able to collect 814 (Table 7) and 2,150 tissue samples (Tables 8 and 9) from the sport and tribal fisheries, respectively. Additionally, GSI allows us to estimate

the origin of wild origin fish and place non-Snake River hatchery fish into geographic regions (although we did not do this in this study).

We made assumptions about the stock composition in the lower Columbia River July sport fishery and the August 1 to August 20 tribal harvest in Zone 6. Most hatchery stocks had similar run-timing at Bonneville Dam with the exception of Dworshak and Upper Salmon (a Dworshak derived stock) stocks. Only 10% of the Dworshak stock had passed Bonneville Dam by August 21 whereas all other hatchery stocks were 50% to 75% complete on this date. Dworshak attained 50% passage at Bonneville Dam on September 12, nearly 6 weeks later than most of the Snake River stocks. This supports our assumption that the Dworshak stock was a minor contributor to sport and tribal fisheries in the Columbia River until September.

We found that the majority of the steelhead harvest in sport and tribal fisheries was from Snake River hatcheries. Our estimates of Snake River contribution are a minimum estimate since several BYs from Snake River hatcheries were not in the parental baseline, hence adults from these hatcheries and BYs were assigned to the Other group in our analysis. Yet, despite missing these Snake River hatchery BYs (see Table 4 for missing stocks), we were able to assign 76% of the July sport harvest and 79% of the August – October sport harvest to Snake River hatcheries. In the tribal fishery, 94.5% of the total clipped harvest and 31% of the unclipped harvest assigned to Snake River hatcheries. An additional 24% of the tribal unclipped harvest was assigned to putative wild reporting groups within Idaho. Hence, we estimate that the minimum contribution of Snake River origin steelhead in the tribal unclipped harvest was 55%.

The tribal Zone 6 fishery is managed based on abundance of fall Chinook and the number of large (B-run) steelhead passing Bonneville Dam. Our analysis found that the majority of large hatchery origin steelhead were Dworshak 2-ocean adults. In the clipped tribal harvest 71% of the large fish were 2-ocean Dworshak fish and in the unclipped tribal harvest 32% of the large fish harvested were 2-ocean Dworshak fish. An additional 53% of the large unclipped fish assigned to GSI reporting groups in Idaho. Since we used the actual count of each group, not the expanded count, the percentage of large 2-ocean Dworshak fish is a minimum estimate. This release group had a tag rate of 67%, hence many of the large fish that were placed in the Other group for the length analysis were likely 2-ocean Dworshak fish whose parents were not sampled. Most of these fish would assign to the SF Clearwater GSI reporting group. Nearly all large hatchery origin fish were 2-ocean adults (Tables 13, 17, and 20). It is apparent from this analysis that most of the large steelhead passing Bonneville Dam during the fall management period were 2-ocean and 3-ocean Dworshak hatchery returns.

Snake River hatcheries release the most summer steelhead smolts in the Columbia River basin so it is expected that these stocks would be the largest contributor to harvest in Columbia River fisheries that occur during the summer and fall. Sixty-nine percent of all BY2008 and BY2009 summer smolt releases in the Columbia basin were from Snake River hatcheries and 82% of the smolts released upstream of Bonneville Dam were from the Snake basin. Our results suggest that the harvest contribution from Snake River hatcheries exceeded the smolt release percentages. In the lower river sport fishery from August to October, we were able to assign 79% of the harvest to hatcheries in the Snake River compared to 69% of the total smolt release. In the July sport fishery we assigned 76% of the harvest to Snake River hatcheries. Although we cannot say when the stocks enter the Columbia River, we can infer from Bonneville Dam detections which stocks arrive earlier in the season if we assume all stocks travel upriver at the same rate. Based on Bonneville Dam detections, the Lyons Ferry stock is about 7-14 days earlier than most of the other Snake River and Upper Columbia stocks with the exception

of Dworshak and Upper Salmon. The Dworshak and Upper Salmon stocks were the latest arriving stocks at Bonneville Dam (Figure 5) and both of these stocks attained their 50% arrival date in early September. We were able to detect a shift in stock composition between the July and the August through October sport harvest. The percentage of Snake River hatchery fish increased later in the season, notably the Dworshak stock (Figures 7 and 8). In the tribal Zone 6 fishery, we assigned nearly 95% of the clipped harvest to Snake River hatcheries, and 31% of the unclipped harvest assigned to Snake River hatcheries. The contribution from the Upper Columbia hatcheries (13% of the upstream of Bonneville smolt release) was at most 4% in the clipped tribal Zone 6 harvest. This lower than expected harvest contribution of Upper Columbia hatcheries in the tribal Zone 6 clipped harvest is probably due to the run-timing of these stocks. On September 1, just as the Zone 6 tribal harvest was ramping up, 80% of the Upper Columbia hatchery stocks had already passed McNary Dam and were no longer susceptible to harvest in Zone 6. In contrast, less than 10% of the Dworshak stock which was the largest contributor to the clipped Zone 6 harvest had passed McNary Dam by September 1. Only the Lyons Ferry stock had an earlier run-timing at McNary Dam than the upper Columbia stocks. The availability of Snake River hatchery stocks in Zone 6 during the peak of fishing probably explains its high contribution in the clipped harvest.

The MGILCS is a very large genetic reporting group that ranges from Bonneville Dam upstream to the lower Clearwater and lower Salmon drainages. It also includes the Deschutes, John Day, Umatilla, Grande Ronde, Imnaha, Asotin, and Tucannon basins. This group was previously split into smaller units (Hess et al. 2012), with the Grande Ronde, Imnaha, lower Clearwater, and lower Salmon separated from the Columbia River and Tucannon basins. However, subsequent simulations found that the accuracy of the GSI assignments was improved if this group was one large unit rather than several smaller units (Hess et al. 2013). We choose to use the large MGILCS unit as defined by Hess et al. and report harvest using the same GSI units that they used to estimate passage at Bonneville Dam. Although this choice reduces the geographical distribution of the harvest, the accuracy of GSI assignments is much improved.

## REFERENCES

- Ackerman, M.W., J. McCane, C.A. Steele, M.R. Campbell, A.P. Matala, J.E. Hess, and S.R. Narum. 2012. Chinook and steelhead Genotyping for Genetic Stock Identification at Lower Granite Dam. Idaho Department of Fish and Game Report 12-15. Annual Report, BPA Project 2010-026-00.
- Campbell, M.R., C.C. Kozfkay, T. Copeland, W.C. Schrader, M.W. Ackerman, and S.R. Narum. 2012. Estimating Abundance and Life History Characteristics of Threatened Wild Snake River Steelhead Stocks by Using Genetic Stock Identification. *Transactions of the American Fisheries Society* 141(5):1310–1327.
- Hess, J.E., M.R. Campbell, A.P. Matala, and S.R. Narum. 2012. 2011 Annual Report: Genetic Assessment of Columbia River Stocks. U.S. Dept. of Energy Bonneville Power Administration Report Project #2008-907-00.
- Hess, J.E., M.R. Campbell, A.P. Matala, and S.R. Narum. 2013. 2012 Annual Report: Genetic Assessment of Columbia River Stocks. U.S. Dept. of Energy Bonneville Power Administration Report Project #2008-907-00.
- JSR (Joint Staff Report) 2012a. 2012 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and other species, and miscellaneous regulations. Joint Columbia River Management Staff. January 20, 2012.
- JSR (Joint Staff Report) 2012b. 2012 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer steelhead, and White Sturgeon. Joint Columbia River Management Staff. July 12, 2012.
- R Development Core Team. 2009. The comprehensive R archive network. Available: <http://cran.r-project.org/> (February 2013).
- Steele, C. A., M. Ackerman, J. McCane, M. Hess, N. Campbell, S.R. Narum, M.R. Campbell. 2011. Parentage Based Tagging Snake River hatchery steelhead and Chinook salmon. Annual Report. BPA (Project No. 2010-031-00 Contract Number 48348). United States Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, P. O. Box 3621, Portland, Oregon 97208.
- Steele, C.A., E.C. Anderson, M.W. Ackerman, M.A. Hess, M.R. Campbell, S.R. Narum, and M.R. Campbell. 2013. A validation of parentage-based tagging using hatchery steelhead in the Snake River basin. *Canadian Journal of Fisheries and Aquatic Sciences*. 70: 1046–1054.
- TAC 2008. *U.S. v Oregon* Technical Advisory Committee. Biological Assessment of Incidental Impacts on Salmon Species Listed Under the Endangered Species Act in the 2008-2017 Non-Indian and Treaty Indian Fisheries in the Columbia River Basin. April 21, 2008.
- Watts, James W. February 2013 (in draft). The 2011 Lower Columbia River and Buoy 10 Recreational Fisheries. Oregon Department of Fish and Wildlife. Columbia River Management. Clackamas.

Table 1. The number of CWT recovered from Snake River steelhead stocks in the Columbia River sport fishery downstream of Bonneville Dam from 2001 to 2010.

<b>Hatchery Stock</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>Average</b>
Dworshak	5	9	3	0	4	7	5	4	4	19	6
EF Salmon	0	0	0	0	0	0	0	0	0	1	<1
Imnaha	8	9	5	5	10	5	3	1	10	7	6
Lyons Ferry	11	20	3	9	6	6	5	6	17	32	12
Oxbow	12	13	2	5	3	2	5	2	25	30	10
Pahsimeroi	19	12	3	3	5	2	21	19	45	35	16
Sawtooth	16	12	1	1	4	0	14	6	15	26	10
Upper Salmon	0	0	0	0	0	0	0	1	0	3	<1
Wallowa	28	14	8	6	7	18	37	20	75	82	30
<b>Yearly Total</b>	<b>99</b>	<b>89</b>	<b>25</b>	<b>29</b>	<b>39</b>	<b>40</b>	<b>90</b>	<b>59</b>	<b>191</b>	<b>235</b>	<b>90</b>

Table 2. The number of CWT recovered from Snake River steelhead stocks in the Columbia River tribal Zone 6 fishery from 2001 to 2010.

<b>Hatchery Stock</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>Average</b>
Dworshak	54	151	62	38	38	101	81	186	28	142	88
EF Salmon	0	0	0	0	0	0	2	0	0	20	2
Imnaha	19	7	11	9	14	4	10	2	1	2	8
Lyons Ferry	32	5	5	15	12	5	5	17	3	18	12
Oxbow	25	13	11	13	8	0	6	4	13	23	12
Pahsimeroi	38	18	5	9	7	2	42	17	50	28	22
Sawtooth	70	32	10	5	2	0	35	13	25	31	22
Upper Salmon	0	0	0	0	0	0	2	8	5	7	2
Wallowa	86	35	27	19	33	23	46	44	64	84	46
<b>Yearly Total</b>	<b>324</b>	<b>261</b>	<b>131</b>	<b>108</b>	<b>114</b>	<b>135</b>	<b>229</b>	<b>291</b>	<b>189</b>	<b>352</b>	<b>214</b>

Table 3. Summer steelhead smolt releases by Region and Brood Year (BY) in the Columbia River basin. BY08 releases were the 2-ocean adult returns and BY09 were the 1-ocean adult returns in the fall 2011. Data was downloaded from Fish Passage Center website (<http://www.fpc.org>) on January 11, 2013. Clipped and unclipped refer to the adipose fin.

<b>Brood Year (BY)</b>	<b>Unclipped smolts</b>	<b>Clipped smolts</b>	<b>Total smolt release</b>
<b>BY 2009</b>	<b>1,505,658</b>	<b>10,078,215</b>	<b>11,583,873</b>
Downstream of Bonneville Dam <sup>a</sup>	14,213	1,811,609	1,825,822
Bonneville Dam to McNary Dam	2,902	482,756	485,658
Upstream of McNary Dam <sup>b</sup>	425,533	985,112	1,410,645
Snake River basin	1,063,010	6,798,738	7,861,748
<b>BY 2008</b>	<b>1,529,316</b>	<b>10,787,864</b>	<b>12,317,180</b>
Downstream of Bonneville Dam <sup>a</sup>	65,428	1,854,895	1,920,323
Bonneville Dam to McNary Dam	9,604	522,464	532,068
Upstream of McNary Dam <sup>b</sup>	327,764	874,062	1,201,826
Snake River basin	1,126,520	7,536,443	8,662,963

<sup>a</sup> Includes the Willamette River basin.

<sup>b</sup> Excluding the Snake River basin.

Table 4. Description of hatchery stocks, release groups, and tag rates for BY2008 (2-ocean adults) and BY2009 (1-ocean adults) that were included in the PBT parental baseline used to make assignments. SBT = Shoshone-Bannock Tribe. na = no fish in this BY. NS = not sampled, hence tag rate was zero.

Hatchery Stock	Release group	Tag Rate	
		BY2008	BY2009
Dworshak	Dworshak	0.6749	0.9776
EF Salmon - spawned at Sawtooth Hatchery	EF_Sawtooth	0.9615	1.0000
EF Salmon - released at weir to spawn in-river	EF Salmon	1.0000	1.0000
Imnaha	Imnaha	1.0000	1.0000
Lyons Ferry	Lyons Ferry	NS	0.9906
Oxbow	Oxbow	0.9089	0.8750
Pahsimeroi - general production	Pahsimeroi	0.9415	0.9483
Pahsimeroi - SBT Indian Creek egg box	SBT_Indian	na	0.9107
Pahsimeroi - SBT Panther Creek egg box	SBT_Panther	na	0.9540
Pahsimeroi - SBT programs (no release location data)	SBT_Pah	0.9938	na
Sawtooth - general production	Sawtooth	0.9928	1.0000
Sawtooth - SBT Basin Creek egg box	SBT_Basin	1.0000	0.9832
Sawtooth - SBT Yankee Fork egg box	SBT_Yankee_Egg	1.0000	na
Sawtooth - SBT Yankee Fork smolt release	SBT_Yankee	0.9634	1.0000
Touchet endemic	LF_Touchet	NS	0.8889
Tucannon endemic	LF_Tucannon	NS	0.8750
Upper Salmon	Upper Salmon	1.0000	1.0000
Wallowa--Cottonwood Pond release	Cottonwood	0.9647	0.9583
Wallowa--all release sites except Cottonwood Pond	Wallowa	NS	0.9094

<sup>a</sup> The Lyons Ferry stock is also released in the Walla Walla River basin.

Table 5. The percentage of unclipped hatchery fish identified with PBT that assigned to GSI reporting groups. n = number of fish identified with PBT from BY08 and BY09.

Release group	n	GSI reporting group					
		MFSALM	MGILCS	SFCLWR	UPCLWR	UPPCOL	UPSALM
Dworshak	101	0.00%	2.97%	95.05%	1.98%	0.00%	0.00%
EF_Sawtooth	14	0.00%	21.43%	21.43%	0.00%	0.00%	57.14%
Upper Salmon		0.00%	21.43%	21.43%	0.00%	0.00%	57.14%
LF_Tucannon	3	0.00%	33.33%	0.00%	0.00%	33.33%	33.33%
Oxbow	3	0.00%	33.33%	0.00%	0.00%	0.00%	66.67%
Pahsimeroi	11	0.00%	27.27%	0.00%	0.00%	9.09%	63.64%
Sawtooth	25	4.00%	20.00%	0.00%	0.00%	0.00%	76.00%
SBT_Yankee		4.00%	20.00%	0.00%	0.00%	0.00%	76.00%
SBT_Sawtooth		4.00%	20.00%	0.00%	0.00%	0.00%	76.00%

Table 6. The number of steelhead counted and sampled at Bonneville Dam (BON), and the estimated passage of Group A and Group B hatchery and wild fish from July 1 to October 31, 2011.

Time period	Sample size	Total BON count	Percentage of samples			
			A Wild	B Wild	A Hatch	B Hatch
July 1-August 25	860		34.2%	0.9%	63.4%	1.5%
August 26-September 18	230		16.1%	4.8%	59.6%	19.6%
September 19-October 31	226		10.6%	6.6%	43.4%	39.6%
<b>Total:</b>	<b>1,316</b>					
			Number of steelhead			
July 1-August 25		251,775	86,072	2,342	159,555	3,806
August 26-September 18		77,107	12,404	3,688	45,929	15,086
September 19-October 31		26,239	2,786	1,742	11,378	10,333
<b>Total:</b>		<b>355,121</b>	<b>101,262</b>	<b>7,772</b>	<b>216,862</b>	<b>29,225</b>

Table 7. Monthly steelhead harvest estimates and the number of fish sampled from July 1 to October 31 in the lower Columbia River sport fishery, 2011.

Month	Harvest	Percent of harvest	Samples collected	Percent of samples	Samples analyzed
July	8,549	41.5%	0	0	0
August	11,160	54.2%	770	94.6	606
September	848	4.1%	39	4.8	36
October	45	0.2%	5	0.6	2
<b>August to October</b>	<b>12,053</b>		<b>814</b>		<b>644</b>
<b>July to October</b>	<b>20,602</b>				

Table 8. Tribal clipped steelhead harvest and the number of samples collected in the Zone 6 fall 2011 fishery.

Week	Start	End	Clipped Harvest	Percent of harvest	Samples collected	Percent of samples
32 - 34	8/1	8/21	1,358	7.5%	39	2.6%
35	8/22	8/25	1,789	9.8%	137	9.1%
36	8/29	9/2	1,879	10.3%	145	9.7%
37	9/6	9/10	1,892	10.4%	143	9.5%
38	9/12	9/16	2,529	13.9%	316	21.1%
39	9/19	9/23	5,065	27.8%	313	20.9%
40	9/26	9/29	1,934	10.6%	231	15.4%
41	10/3	10/6	1,408	7.7%	176	11.7%
42+	10/7	11/26	350	1.9%	0	0.0%
<b>Total:</b>			<b>18,204</b>		<b>1,500</b>	

Table 9. Tribal unclipped steelhead harvest and the number of samples collected in the Zone 6 fall 2011 fishery.

Week	Start	End	Unclipped Harvest	Percent of Harvest	Samples collected	Percent of samples
32 - 34	8/1	8/21	882	9.5%	14	2.2%
35	8/22	8/25	890	9.6%	57	8.8%
36	8/29	9/2	994	10.7%	84	12.9%
37	9/6	9/10	993	10.7%	50	7.7%
38	9/12	9/16	1,128	12.1%	126	19.4%
39	9/19	9/23	2,474	26.6%	102	15.7%
40	9/26	9/29	949	10.2%	81	12.5%
41	10/3	10/6	809	8.7%	136	20.9%
42+	10/7	11/26	176	1.9%	0	0.0%
<b>Total:</b>			<b>9,295</b>		<b>650</b>	

Table 10. The number of PBT assignments, expanded assignments, and the percentage of each hatchery release group and brood year used to estimate sport harvest for the period from August 1 to October 31, 2011. ns = not sampled, na = BY specific assignment not possible.

Release group	PBT Assignments						Percent of expanded assignments		
	Actual Count			Expanded for Tag rate			BY2008	BY2009	Na
	BY2008	BY2009	Total	BY2008	BY2009	Total			
Dworshak	35	6	41	51.86	6.14	58	8.05%	0.95%	9.01%
Cottonwood	7	7	14	7.26	7.3	14.56	1.13%	1.13%	2.26%
Imnaha	3	11	14	3	11	14	0.47%	1.71%	2.17%
Lyons Ferry	ns	40	40	-	40.38	40.38	-	6.27%	6.27%
Oxbow	36	57	93	39.61	65.14	104.75	6.15%	10.11%	16.27%
Pahsimeroi	19	130	149	20.18	137.08	157.26	3.13%	21.29%	24.42%
Sawtooth	15	65	80	15.11	65	80.11	2.35%	10.09%	12.44%
SBT_Basin	0	1	1	0	1.02	1.02	0.00%	0.16%	0.16%
SBT_Yankee	0	9	9	0	9	9	0.00%	1.40%	1.40%
Upper Salmon	1	0	1	1	0	1	0.16%	0.00%	0.16%
Wallowa	ns	27	27	-	29.69	29.69	-	4.61%	4.61%
<b>Snake River total</b>	<b>116</b>	<b>353</b>	<b>469</b>	<b>138.02</b>	<b>371.75</b>	<b>509.77</b>	<b>21.43%</b>	<b>57.73%</b>	<b>79.16%</b>
Other	na	na	175			134.23			20.84%
<b>Total</b>			<b>644</b>			<b>644</b>			

Table 11. The number of PBT assignments, expanded assignments, and the percentage of each hatchery release group and brood year used to estimate sport harvest for the period from July 1 to July 31, 2011. ns = not sampled, na = BY specific assignment not possible.

Release group	PBT Assignments						Percent of expanded assignments		
	Actual Count			Expanded for Tag rate			BY2008	BY2009	Total
	BY2008	BY2009	Total	BY2008	BY2009	Total			
Dworshak	3	1	4	4.44	1.02	5.46	1.93%	0.44%	2.37%
Cottonwood	3	0	3	3.11	0	3.11	1.35%	0.00%	1.35%
Imnaha	1	4	5	1	4	5	0.43%	1.74%	2.17%
Lyons Ferry	ns	19	19		19.18	19.18		8.34%	8.34%
Oxbow	13	15	28	14.3	17.14	31.44	6.22%	7.45%	13.67%
Pahsimeroi	6	58	64	6.37	61.16	67.53	2.77%	26.59%	29.36%
Sawtooth	6	25	31	6.04	25	31.04	2.63%	10.87%	13.50%
SBT_Yankee	0	3	3	0	3	3	0.00%	1.30%	1.30%
Wallowa	ns	8	8		8.8	8.8		3.83%	3.83%
<b>Snake River total</b>	<b>32</b>	<b>133</b>	<b>165</b>	<b>35.27</b>	<b>139.3</b>	<b>174.57</b>	<b>15.33%</b>	<b>60.57%</b>	<b>75.90%</b>
Other	na	na	65			55.42			24.10%
<b>Total:</b>			<b>230</b>			<b>230</b>			

Table 12. Estimated stock percentages, 90% bootstrap CI's, and harvest contribution in the lower Columbia River sport fishery, July 1 to October 31, 2011. lci = lower 90% CI; uci = upper 90% CI.

Release Group	BY	July						August - October						Total		
		point estimate	lci	uci	harvest estimate	harvest lci	harvest uci	point estimate	lci	uci	harvest estimate	harvest lci	harvest uci	harvest estimate	harvest lci	harvest uci
Dworshak	2008	1.9%	0.6%	3.9%	165	55	330	8.1%	6.0%	10.4%	971	721	1,248	1,136	832	1,467
Dworshak	2009	0.4%	0.0%	1.3%	38	0	114	1.0%	0.3%	1.6%	115	38	191	153	57	267
Cottonwood	2008	1.4%	0.5%	2.7%	116	39	231	1.1%	0.5%	1.9%	136	58	233	251	135	405
Cottonwood	2009	0.0%	0.0%	0.0%	0	0	0	1.1%	0.5%	1.9%	137	59	234	137	59	234
Imnaha	2008	0.4%	0.0%	1.3%	37	0	112	0.5%	0.0%	0.9%	56	0	112	93	19	186
Imnaha	2009	1.7%	0.4%	3.0%	149	37	260	1.7%	0.9%	2.6%	206	112	318	355	205	522
Lyons Ferry	2009	8.3%	5.3%	11.4%	713	450	976	6.3%	4.7%	7.8%	756	567	945	1,469	1,149	1,789
Oxbow	2008	6.2%	3.8%	9.1%	532	327	777	6.2%	4.6%	7.9%	741	556	947	1,273	966	1,600
Oxbow	2009	7.5%	4.5%	10.4%	637	382	892	10.1%	8.0%	12.2%	1,219	963	1,476	1,856	1,494	2,239
Pahsimeroi	2008	2.8%	0.9%	4.6%	237	79	395	3.1%	2.0%	4.3%	378	239	517	615	416	833
Pahsimeroi	2009	26.6%	21.5%	31.6%	2,273	1,842	2,705	21.3%	18.7%	24.1%	2,566	2,250	2,901	4,839	4,308	5,389
Sawtooth	2008	2.6%	0.9%	4.4%	225	75	374	2.3%	1.4%	3.3%	283	170	396	507	338	696
Sawtooth	2009	10.9%	7.8%	14.3%	929	667	1,227	10.1%	8.2%	12.0%	1,217	992	1,441	2,146	1,791	2,519
SBT_Basin	2009	0.0%	0.0%	0.0%	0	0	0	0.2%	0.0%	0.5%	19	0	57	19	0	57
SBT_Yankee	2009	1.3%	0.4%	2.6%	112	37	223	1.4%	0.6%	2.2%	168	75	262	280	149	429
Upper Salmon	2008	0.0%	0.0%	0.0%	0	0	0	0.2%	0.0%	0.5%	19	0	56	19	0	56
Wallowa	2009	3.8%	1.9%	6.2%	327	163	531	4.6%	3.2%	6.1%	556	391	741	883	637	1,148
<b>Snake River total</b>		<b>75.9%</b>			<b>6,489</b>			<b>79.2%</b>			<b>9,541</b>			<b>16,030</b>		
Other	--	24.1%	18.9%	29.4%	2,060	1,619	2,510	20.8%	17.6%	24.0%	2,512	2,126	2,892	4,572	3,979	5,166
<b>Total</b>					<b>8,549</b>						<b>12,053</b>			<b>20,602</b>		

Table 13. Percent of female and large fish (fork length  $\geq 78$  cm) by release group in the sport harvest. The percent large - all samples column is the percent the total large fish sampled from each release group. The percent large within group column is the percent of large fish within each release group. For example, 48.1% of all large fish came from the BY2008 Dworshak group and 71.4% of the BY2008 Dworshak release group were large.

Release Group	Sample size (sex)	Percent Female	Sample size (length)	Percent Large - all samples	Percent Large within group
<b>All samples</b>	<b>644</b>	<b>42.4%</b>	<b>644</b>	<b>8.1%</b>	--
<b>Other</b>	175	42.9%	175	42.3%	12.6%
<b><u>Brood Year 2008</u></b>					
Dworshak	35	54.3%	35	48.1%	71.4%
Cottonwood	7	42.9%	7	0.0%	0.0%
Imnaha	3	66.7%	3	0.0%	0.0%
Oxbow	36	58.3%	36	1.9%	2.8%
Pahsimeroi	19	73.7%	19	3.8%	10.5%
Sawtooth	15	66.7%	15	0.0%	0.0%
Upper Salmon	1	0.0%	1	1.9%	100.0%
<b><u>Brood Year 2009</u></b>					
Dworshak	6	0.0%	6	0.0%	0.0%
Cottonwood	7	28.6%	7	0.0%	0.0%
Imnaha	11	27.3%	11	0.0%	0.0%
Lyons Ferry	40	45.0%	40	0.0%	0.0%
Oxbow	57	22.8%	57	0.0%	0.0%
Pahsimeroi	130	43.8%	130	1.9%	0.8%
Sawtooth	65	38.5%	65	0.0%	0.0%
SBT_Basin	1	100.0%	1	0.0%	0.0%
SBT_Yankee	9	44.4%	9	0.0%	0.0%

Table 14. The number of PBT assignments, expanded assignments, and the percentage of each hatchery release group and brood year used to estimate Zone 6 tribal clipped harvest for the period from Week 35 to the end of the season. ns = not sampled, na = BY specific assignment not possible.

Release group	PBT Assignments						Percent of expanded assignments		
	Actual Count			Expanded for Tag rate			BY2008	BY2009	Total
	BY2008	BY2009	Total	BY2008	BY2009	Total			
Dworshak	485	30	515	718.6	30.7	749.3	49.76%	2.13%	51.89%
EF_Sawtooth	0	2	2	0	2	2	0.00%	0.14%	0.14%
Cottonwood	12	36	48	12.4	37.6	50	0.86%	2.60%	3.46%
Imnaha	3	12	15	3	12	15	0.21%	0.83%	1.04%
Lyons Ferry	ns	17	17		17.2	17.2		1.19%	1.19%
Oxbow	56	57	113	61.6	65.1	126.7	4.27%	4.51%	8.77%
Pahsimeroi	46	159	205	48.9	167.7	216.6	3.39%	11.61%	15.00%
Sawtooth	29	86	115	29.2	86	115.2	2.02%	5.96%	7.98%
SBT_Pah	2	0	2	2	0	2	0.14%	0.00%	0.14%
SBT_Basin	0	1	1	0	1	1	0.00%	0.07%	0.07%
SBT_Yankee	2	18	20	2.1	18	20.1	0.14%	1.25%	1.39%
Upper Salmon	10	0	10	10	0	10	0.69%	0.00%	0.69%
Wallowa	ns	54	54		59.4	59.4		4.11%	4.11%
<b>Snake River total</b>	<b>645</b>	<b>472</b>	<b>1,117</b>	<b>887.8</b>	<b>496.6</b>	<b>1384.4</b>	<b>61.48%</b>	<b>34.40%</b>	<b>95.87%</b>
Other	na	na	327			59.6			4.13%
<b>Total</b>			<b>1,444</b>			<b>1,444</b>	<b>61.48%</b>	<b>30.28%</b>	<b>4.13%</b>

Table 15. The number of PBT assignments, expanded assignments, and the percentage of each hatchery release group and brood year used to estimate Zone 6 tribal clipped harvest for the period from Week 32 to Week 34. ns = not sampled, na = BY specific assignment not possible.

Release group	PBT Assignments						Percent of expanded assignments		
	Actual Count			Expanded for Tag rate			BY2008	BY2009	Total
	BY2008	BY2009	Total	BY2008	BY2009	Total			
Dworshak	10	2	12	14.82	2.05	16.86	8.66%	1.20%	9.86%
EF_Sawtooth		2	2	0.00	2.00	2.00	0.00%	1.17%	1.17%
Cottonwood	3	11	14	3.11	11.48	14.59	1.82%	6.71%	8.53%
Imnaha	1		1	1.00	0.00	1.00	0.58%	0.00%	0.58%
Lyons Ferry		5	5		5.05	5.05		2.95%	2.95%
Oxbow	9	16	25	9.90	18.29	28.19	5.79%	10.69%	16.48%
Pahsimeroi	9	18	27	9.56	18.98	28.54	5.59%	11.10%	16.69%
Sawtooth	4	16	20	4.03	16.00	20.03	2.36%	9.36%	11.71%
SBT_Yankee	1	4	5	1.04	4.00	5.04	0.61%	2.34%	2.95%
Wallowa		9	9		9.90	9.90		5.79%	5.79%
<b>Snake River total</b>	<b>37</b>	<b>83</b>	<b>120</b>	<b>43.45</b>	<b>87.73</b>	<b>131.19</b>	<b>25.41%</b>	<b>51.31%</b>	<b>76.72%</b>
Other			51			39.81			23.28%
<b>Total</b>	<b>37</b>	<b>83</b>	<b>171</b>			<b>171</b>			

Table 16. Estimated stock percentages, 90% bootstrap CIs, and harvest contribution in the tribal Zone 6 clipped steelhead harvest August 1 to November 27, 2011. lci = lower 90% CI; uci = upper 90% CI.

Release group	BY	Weeks 32 - 34						Weeks 35 - 42						Total		
		point estimate	lci	uci	harvest estimate	harvest lci	harvest uci	point estimate	lci	uci	harvest estimate	harvest lci	harvest uci	harvest estimate	harvest lci	harvest uci
Dworshak	2008	8.7%	4.3%	13.0%	118	59	177	49.8%	46.7%	52.8%	8,384	7,865	8,902	8,502	7,976	9,026
Imnaha	2008	0.6%	0.0%	1.8%	8	0	24	0.2%	0.1%	0.4%	35	12	70	43	12	82
Cottonwood	2008	1.8%	0.6%	3.6%	25	8	49	0.9%	0.5%	1.3%	145	85	218	170	101	246
Oxbow	2008	5.8%	3.2%	9.0%	79	44	122	4.3%	3.4%	5.2%	719	565	873	798	639	961
SBT_Pah	2008	0.0%			0			0.1%	0.0%	0.3%	23	0	59	23	0	59
Pahsimeroi	2008	5.6%	2.5%	8.7%	76	34	118	3.4%	2.6%	4.2%	570	434	706	646	509	791
Sawtooth	2008	2.4%	0.6%	4.7%	32	8	64	2.0%	1.4%	2.7%	341	235	447	373	267	482
SBT_Yankee	2008	0.6%	0.0%	1.8%	8	0	25	0.1%	0.0%	0.4%	24	0	61	32	0	69
Upper Salmon	2008	0.0%			0	0	0	0.7%	0.3%	1.0%	117	58	175	117	58	175
Dworshak	2009	1.2%	0.0%	3.0%	16	0	41	2.1%	1.6%	2.8%	358	263	465	374	271	485
EF_Sawtooth	2009	1.2%	0.0%	2.9%	16	0	40	0.1%	0.0%	0.3%	23	0	58	39	8	75
Imnaha	2009	0.0%			0			0.8%	0.5%	1.2%	140	82	210	140	82	210
Cottonwood	2009	6.7%	3.7%	9.8%	91	50	133	2.6%	2.0%	3.3%	438	329	560	529	407	656
Lyons Ferry	2009	3.0%	1.2%	5.3%	40	16	72	1.2%	0.8%	1.7%	200	130	283	240	161	330
Oxbow	2009	10.7%	6.7%	14.7%	145	91	200	4.5%	3.6%	5.5%	760	600	933	905	740	1,083
Pahsimeroi	2009	11.1%	7.4%	15.4%	151	100	209	11.6%	10.2%	13.1%	1,956	1,722	2,202	2,107	1,869	2,353
Sawtooth	2009	9.4%	5.8%	13.5%	127	79	183	6.0%	4.9%	7.0%	1,003	828	1,178	1,130	951	1,311
SBT_Basin	2009	0.0%			0			0.1%	0.0%	0.2%	12	0	36	12	0	36
SBT_Yankee	2009	2.3%	0.6%	4.1%	32	8	56	1.2%	0.8%	1.7%	210	128	292	242	160	328
Wallowa	2009	5.8%	3.2%	9.0%	79	43	122	4.1%	3.3%	5.0%	693	552	847	772	618	933
<b>Snake River total</b>		<b>76.7%</b>			<b>1,043</b>			<b>95.9%</b>			<b>16,151</b>			<b>17,194</b>		
Other		23.3%	16.9%	29.6%	315 <sup>a</sup>	230	402	4.1%	1.7%	6.5%	695	294	1,098	1,011	602	1,427
<b>Total</b>					<b>1,358</b>						<b>16,846</b>			<b>18,204</b>		

<sup>a</sup> Subtract one fish to account for rounding error.

Table 17. Percent of female and large fish (fork length  $\geq 78$  cm) by release group in the clipped tribal Zone 6 harvest. The percent large - all samples column is the percent the total large fish sampled from each release group. The percent large within group column is the percent of large fish within each release group. For example, 70.6% of all large fish came from the BY2008 Dworshak group and 73.2% of the BY2008 Dworshak release group were large.

<b>Release group</b>	<b>Sample size (sex)</b>	<b>Percent Female</b>	<b>Sample size (length)</b>	<b>Percent large- all samples</b>	<b>Percent large within group</b>
<b>All</b>	<b>1,444</b>	<b>43.3%</b>	<b>1,481</b>	<b>34.0%</b>	
Other	325	57.1%	336	26.8%	40.2%
<b><u>Brood Year 2008</u></b>					
Dworshak	473	45.0%	485	70.6%	73.2%
Cottonwood	13	76.9%	14	0.2%	7.1%
Imnaha	2	50.0%	3	0.0%	0.0%
Oxbow	57	47.4%	58	0.6%	5.2%
Pahsimeroi	46	67.4%	46	0.2%	2.2%
Sawtooth	29	48.3%	30	0.0%	0.0%
SBT_Pah	2	100.0%	2	0.0%	0.0%
SBT_Yankee	2	50.0%	2	0.0%	0.0%
Upper Salmon	9	33.3%	10	1.2%	60.0%
<b><u>Brood Year 2009</u></b>					
Dworshak	30	10.0%	30	0.2%	3.3%
EF_Sawtooth	2	50.0%	2	0.0%	0.0%
Cottonwood	41	29.3%	41	0.0%	0.0%
Imhaha	12	8.3%	12	0.0%	0.0%
Lyons Ferry	19	15.8%	19	0.0%	0.0%
Oxbow	64	31.3%	64	0.0%	0.0%
Pahsimeroi	155	36.1%	161	0.0%	0.0%
Sawtooth	88	39.8%	90	0.2%	1.1%
SBT_Basin	1	100.0%	1	0.0%	0.0%
SBT_Yankee	17	17.6%	18	0.0%	0.0%
Wallowa	57	35.1%	57	0.0%	0.0%

Table 18. Actual, expanded, adjusted, and percent of samples that assigned to hatchery (above dashed line) release groups and GSI (below dashed line) reporting groups that were used to estimate the unclipped harvest contribution in the Tribal Zone 6 fishery. ns = not sampled. Total harvest of unclipped steelhead was 9,295 fish.

Group	PBT Assignments									Percent of adjusted assignments		
	Actual Count			Expanded for Tag rate			Adjusted count					
	BY2008	BY2009	Total	BY2008	BY2009	Total	BY2008	BY2009	Total	BY2008	BY2009	Total
Dworshak	91	10	101	134.83	10.23	145.06	134.83	10.23	145.06	20.81%	1.58%	22.39%
EF_Sawtooth	1	12	13	1.04	12.00	13.04	1.04	12.00	13.04	0.16%	1.85%	2.01%
LF_Tucannon	0	3	3	0.00	3.43	3.43	0.00	3.43	3.43	0.00%	0.53%	0.53%
Oxbow	1	2	3	1.10	2.29	3.39	1.10	2.29	3.39	0.17%	0.35%	0.52%
Pahsimeroi	9	2	11	9.56	2.11	11.67	9.56	2.11	11.67	1.48%	0.33%	1.80%
Sawtooth	3	2	5	3.02	2.00	5.02	3.02	2.00	5.02	0.47%	0.31%	0.77%
SBT_Yankee	3	17	20	3.11	17.00	20.11	3.11	17.00	20.11	0.48%	2.62%	3.10%
Upper Salmon	0	1	1	0.00	1.00	1.00	0.00	1.00	1.00	0.00%	0.15%	0.15%
<b>Hatchery total:</b>	<b>108</b>	<b>49</b>	<b>157</b>	<b>152.66</b>	<b>50.05</b>	<b>202.72</b>	<b>152.66</b>	<b>50.05</b>	<b>202.72</b>	<b>23.56%</b>	<b>7.72%</b>	<b>31.28%</b>
BWSALM			1						1.00			0.15%
KLICKR			15						15.00			2.31%
LOWCOL			3						3.00			0.46%
MFSALM			20						20.00			3.09%
MGILCS			240						238.21			36.76%
SFCLWR			85						43.02			6.64%
SFSALM			29						29.00			4.48%
SKAMAN			5						5.00			0.77%
UPCLWR			36						35.13			5.42%
UPPCOL			23						22.87			3.53%
UPSALM			31						30.06			4.64%
YAKIMA			3						3.00			0.46%
<b>GSI total:</b>			<b>491</b>						<b>445.28</b>			<b>68.72%</b>

Table 19. Estimated stock percentages, harvest contribution, and 90% confidence intervals in the tribal Zone 6 unclipped steelhead harvest August 1 to November 27, 2011. The hatchery release groups identified with PBT are above the dashed line. GSI reporting groups are below the dashed line. lci = lower 90% CI. uci = upper 90% CI. Total unclipped harvest was 9,295 fish.

Release/Report group	BY	point estimate	lci	uci	harvest estimate	harvest lci	harvest uci
Dworshak	2008	20.81%	17.61%	24.24%	1,934	1,637	2,253
Dworshak	2009	1.58%	0.79%	2.37%	147	73	220
EF_Sawtooth	2008	0.15%	0.00%	0.46%	14	0	43
EF_Sawtooth	2009	1.85%	1.08%	2.78%	172	100	258
LF_Tucannon	2009	0.53%	0.18%	1.06%	49	16	98
Oxbow	2008	0.17%	0.00%	0.51%	16	0	47
Oxbow	2009	0.35%	0.00%	0.88%	33	0	82
Pahsimeroi	2008	1.48%	0.66%	2.29%	137	61	213
Pahsimeroi	2009	0.33%	0.00%	0.81%	30	0	76
Sawtooth	2008	0.47%	0.00%	0.93%	43	0	87
Sawtooth	2009	0.31%	0.00%	0.77%	29	0	72
SBT_Yankee	2008	0.48%	0.16%	0.96%	45	15	89
SBT_Yankee	2009	2.62%	1.70%	3.70%	244	158	344
Upper Salmon	2008	0.00%			0		
Upper Salmon	2009	0.15%	0.00%	0.46%	14	0	43
<b>All Snake River hatchery</b>		<b>31.28%</b>			<b>2,907</b>		
BWSALM	na	0.15%	0.00%	0.46%	14	0	43
KLICKR	na	2.31%	1.39%	3.40%	215	129	316
LOWCOL	na	0.46%	0.15%	0.93%	43	14	86
MFSALM	na	3.09%	2.01%	4.32%	287	186	401
MGILCS	na	36.76%	33.63%	39.89%	3,418	3,126	3,708
SFCLWR	na	6.65%	4.13%	9.19%	618	384	855
SFSALM	na	4.48%	3.24%	5.86%	416	301	545
SKAMAN	na	0.77%	0.31%	1.39%	72	29	129
UPCLWR	na	5.42%	4.01%	6.97%	504	373	648
UPPCOL	na	3.52%	2.31%	4.76%	327	214	442
UPSALM	na	4.64%	3.27%	6.05%	431	304	562
YAKIMA	na	0.46%	0.00%	0.93%	43	0	86
<b>All GSI reporting groups</b>		<b>68.72%</b>			<b>6,388</b>		

Table 20. Percent of female and large fish (fork length  $\geq 78$  cm) by group in the unclipped tribal harvest. Hatchery origin fish identified with PBT are above the dashed line. The hatchery groups and GSI groups are the actual count identified with PBT and GSI analysis. GSI groups (notably the SFCLWR) include fish that were moved to hatchery release groups after the actual counts were expanded for tag rate.

Release/Report group	BY	Sample size(sex)	Percent Female	Sample size (length)	Percent Large - all samples	Percent Large within group
<b>All</b>	--	<b>600</b>	<b>48.7%</b>	<b>648</b>	<b>30.6%</b>	
Dworshak	2008	85	41.2%	91	31.8%	69.2%
EF_Sawtooth	2008	1	100.0%	1	0.0%	0.0%
Oxbow	2008	1	100.0%	1	0.0%	0.0%
Pahsimeroi	2008	9	33.3%	9	0.0%	0.0%
Sawtooth	2008	3	33.3%	3	0.0%	0.0%
SBT_Yankee	2008	3	66.7%	3	0.0%	0.0%
Dworshak	2009	9	11.1%	10	0.0%	0.0%
EF_Sawtooth	2009	12	33.3%	12	0.0%	0.0%
LF_Tucannon	2009	3	33.3%	3	0.0%	0.0%
Oxbow	2009	2	0.0%	2	0.5%	50.0%
Pahsimeroi	2009	2	0.0%	2	0.0%	0.0%
Sawtooth	2009	2	50.0%	2	0.0%	0.0%
SBT_Yankee	2009	15	13.3%	17	0.0%	0.0%
BWSALM	--	--	--	1	0.0%	0.0%
KLICKR	--	15	53.3%	15	2.0%	26.7%
LOWCOL	--	3	33.3%	3	0.5%	33.3%
MFSALM	--	18	38.9%	20	3.5%	35.0%
MGILCS	--	226	58.0%	240	11.6%	9.6%
SFCLWR	--	75	38.7%	85	29.8%	69.4%
SFSALM	--	25	48.0%	29	9.6%	65.5%
SKAMAN	--	5	100.0%	5	0.0%	0.0%
UPCLWR	--	33	63.6%	36	8.1%	44.4%
UPPCOL	--	21	47.6%	23	1.0%	8.7%
UPSALM	--	28	46.4%	31	1.5%	9.7%
YAKIMA	--	3	100.0%	3	0.0%	0.0%

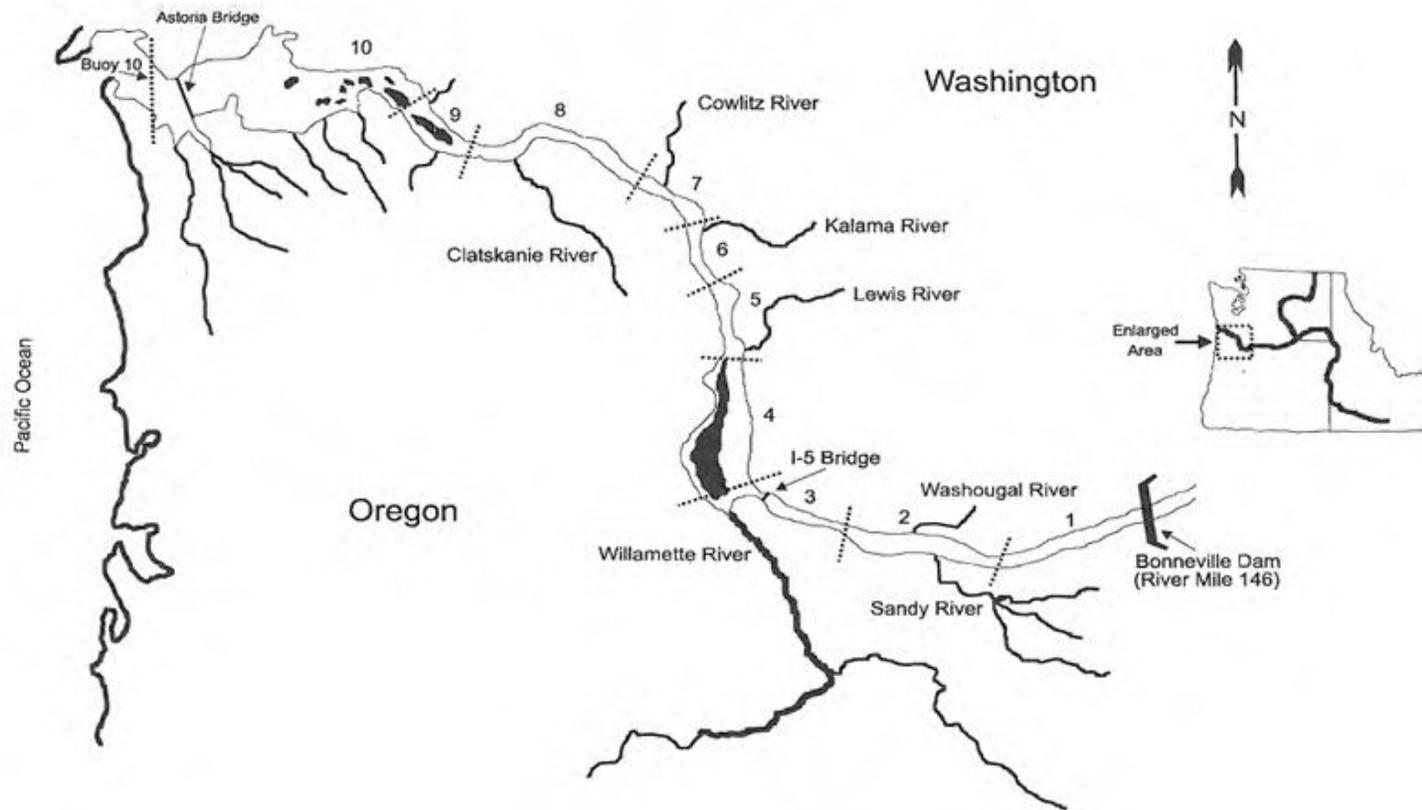


Figure 1. Map of the Columbia River, downstream of Bonneville Dam, showing the sport fishing sections used for creel surveys.

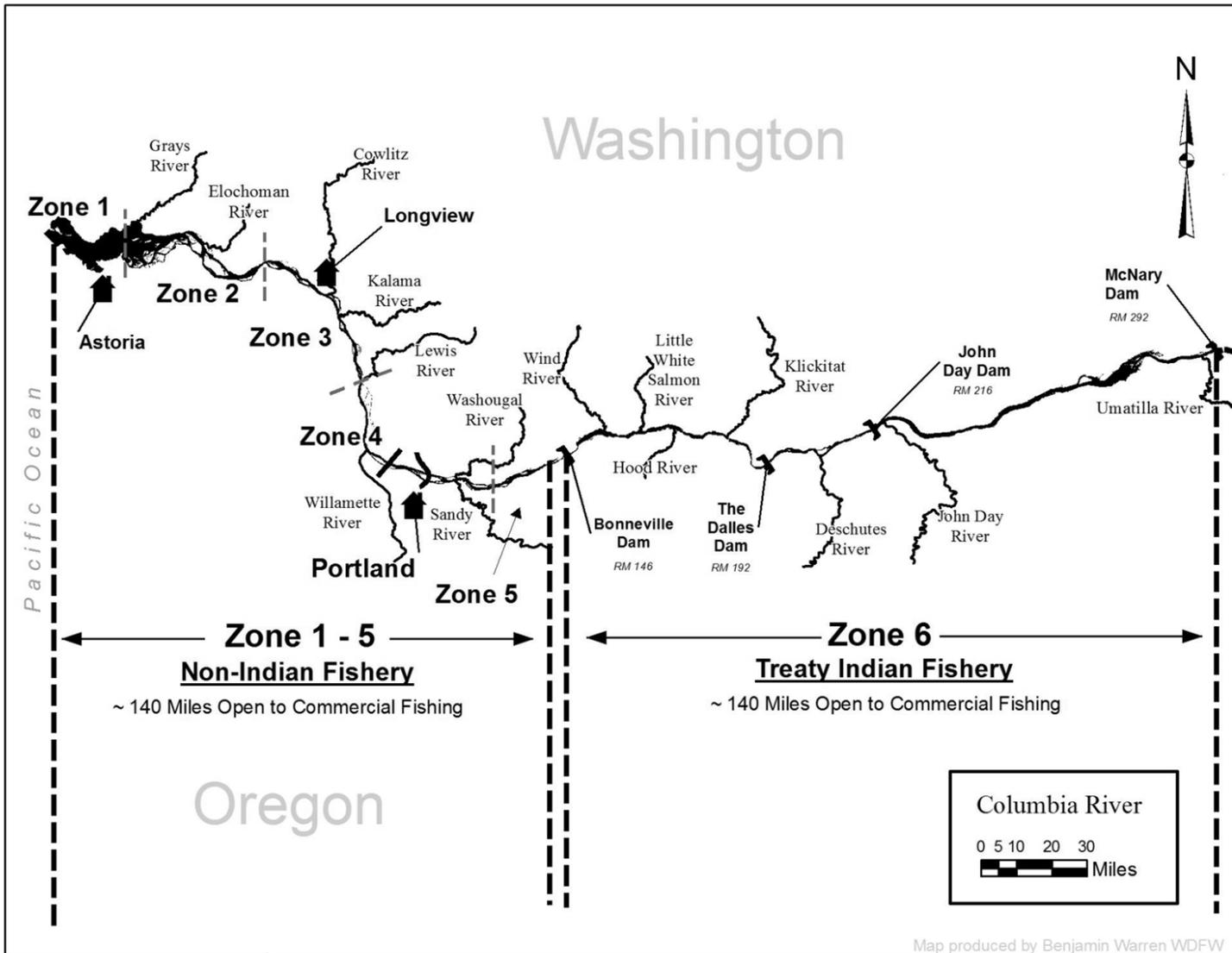


Figure 2 Map of the Columbia River, downstream of McNary Dam, showing the commercial fishing areas.

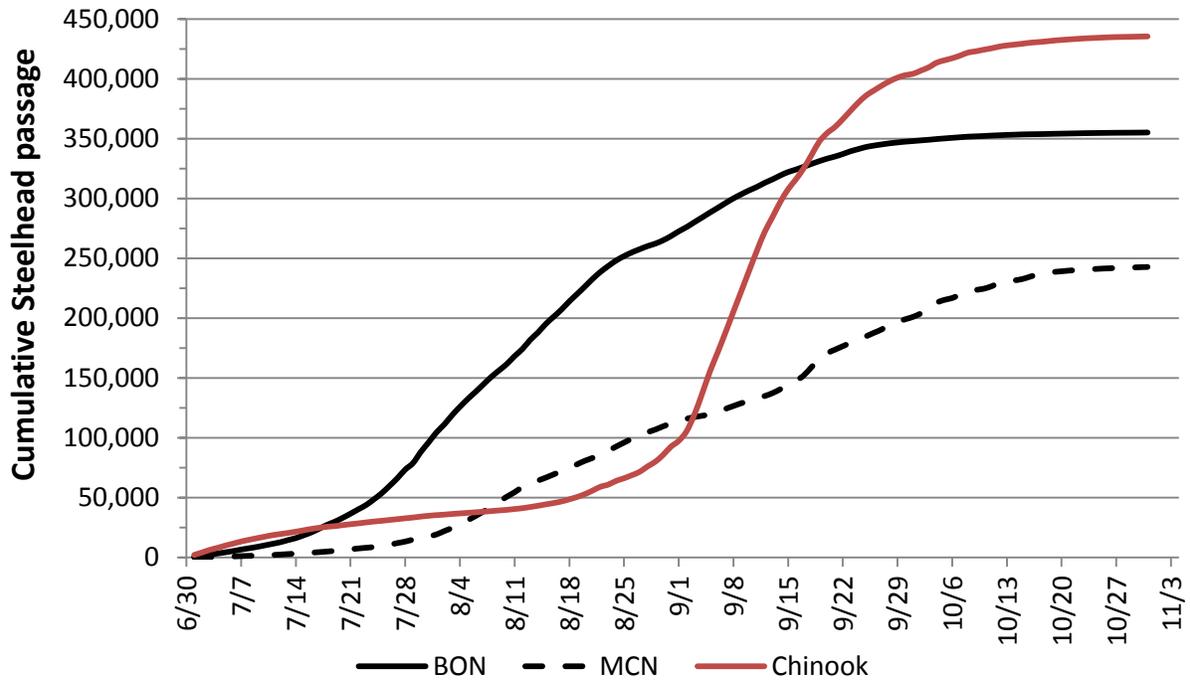


Figure 3. Total cumulative steelhead passage at Bonneville Dam (BON), steelhead at McNary Dam (MCN), and adult Chinook at Bonneville Dam (Chinook) from July 1 to October 31, 2011.

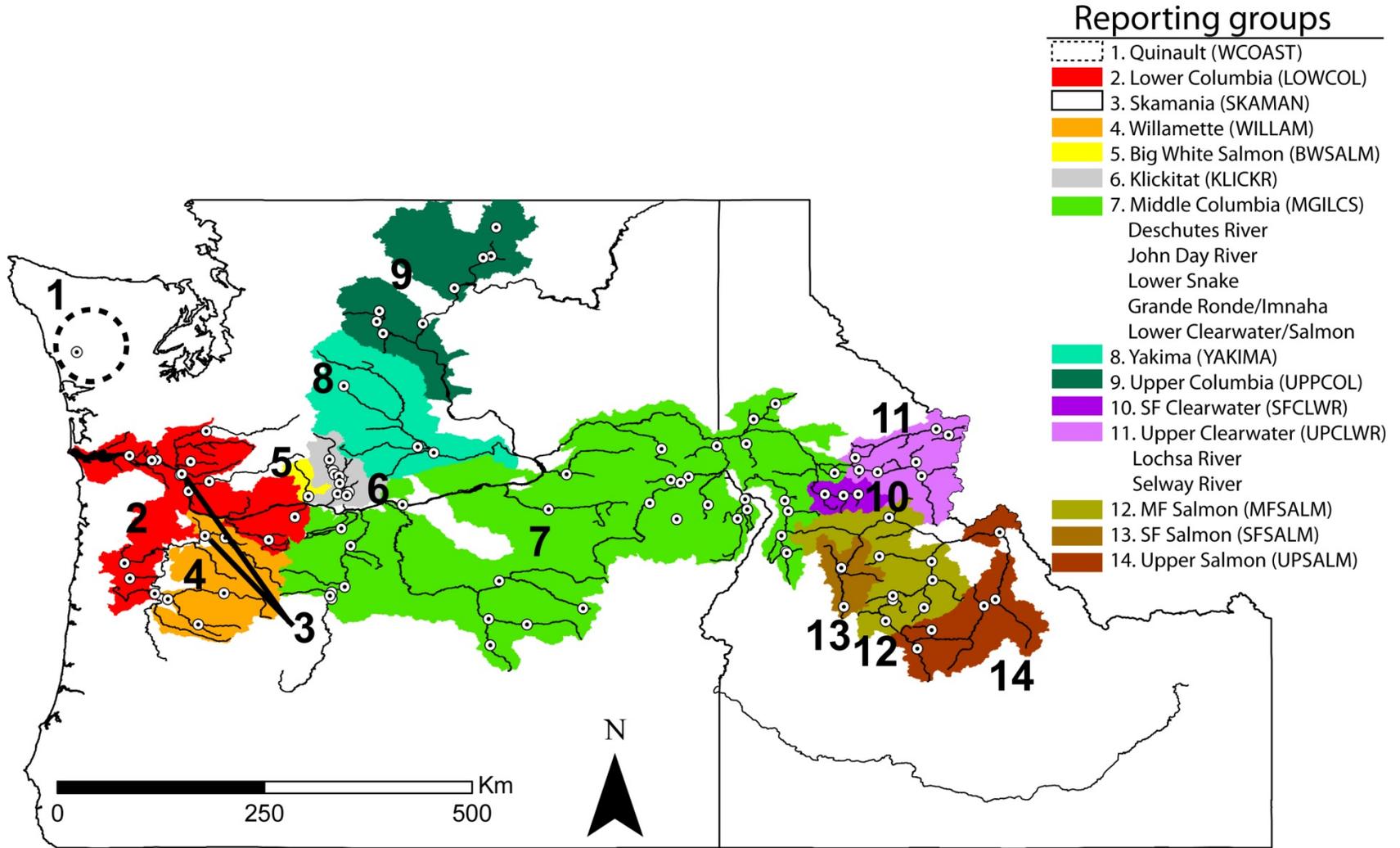


Figure 4. Map showing the GSI reporting groups that have been developed by CRITFC. These groups were used to assign unclipped steelhead that were not identified with PBT.

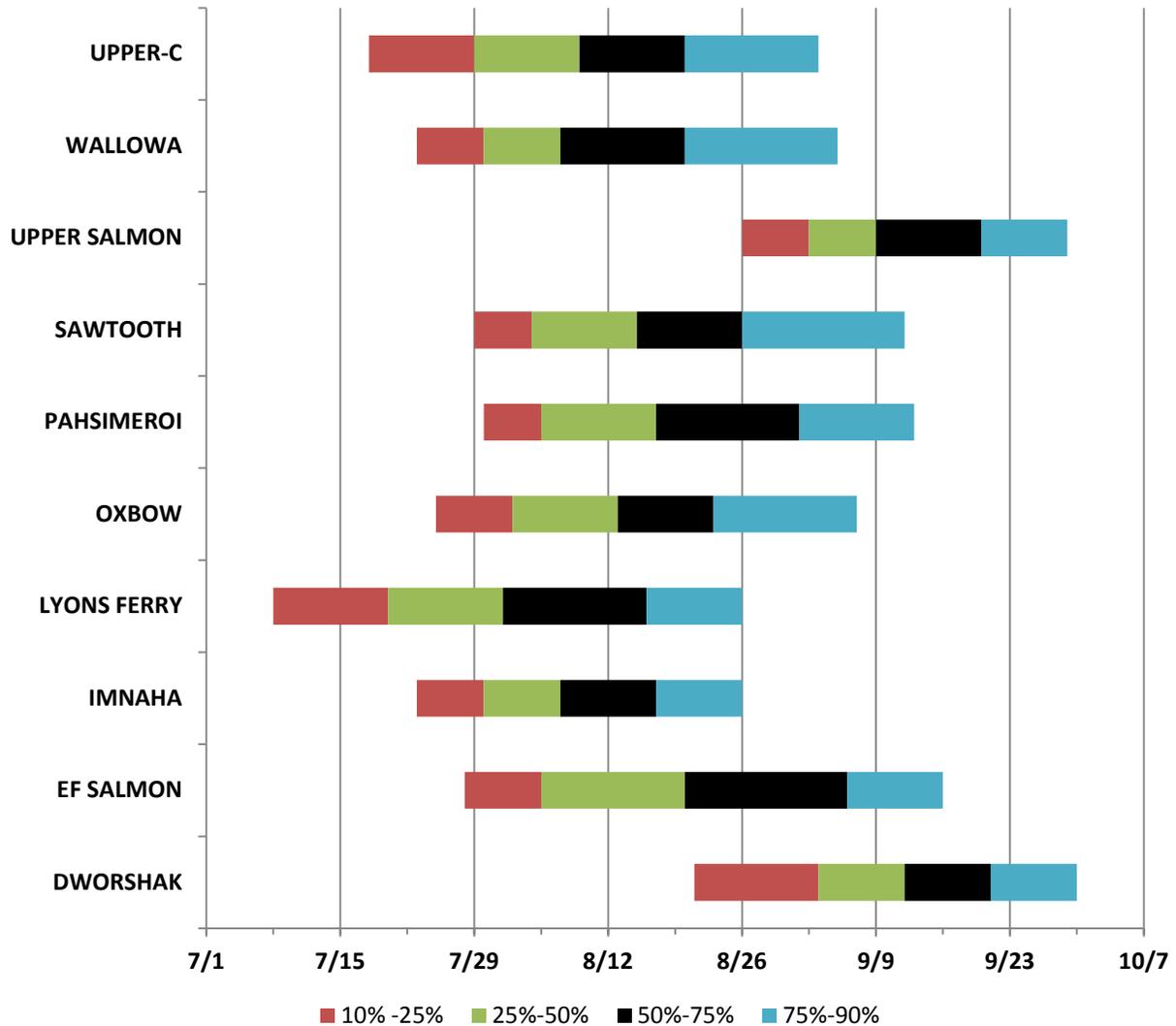


Figure 5. The date that 10%, 25%, 50%, 75%, and 90% of the adult steelhead detections at Bonneville Dam was attained for Snake River and Upper Columbia hatchery stocks in 2011. The left edge of each block is the date that the lower quantile of the block was reached. UPPER-C is all hatchery stocks upstream of the Yakima River combined.

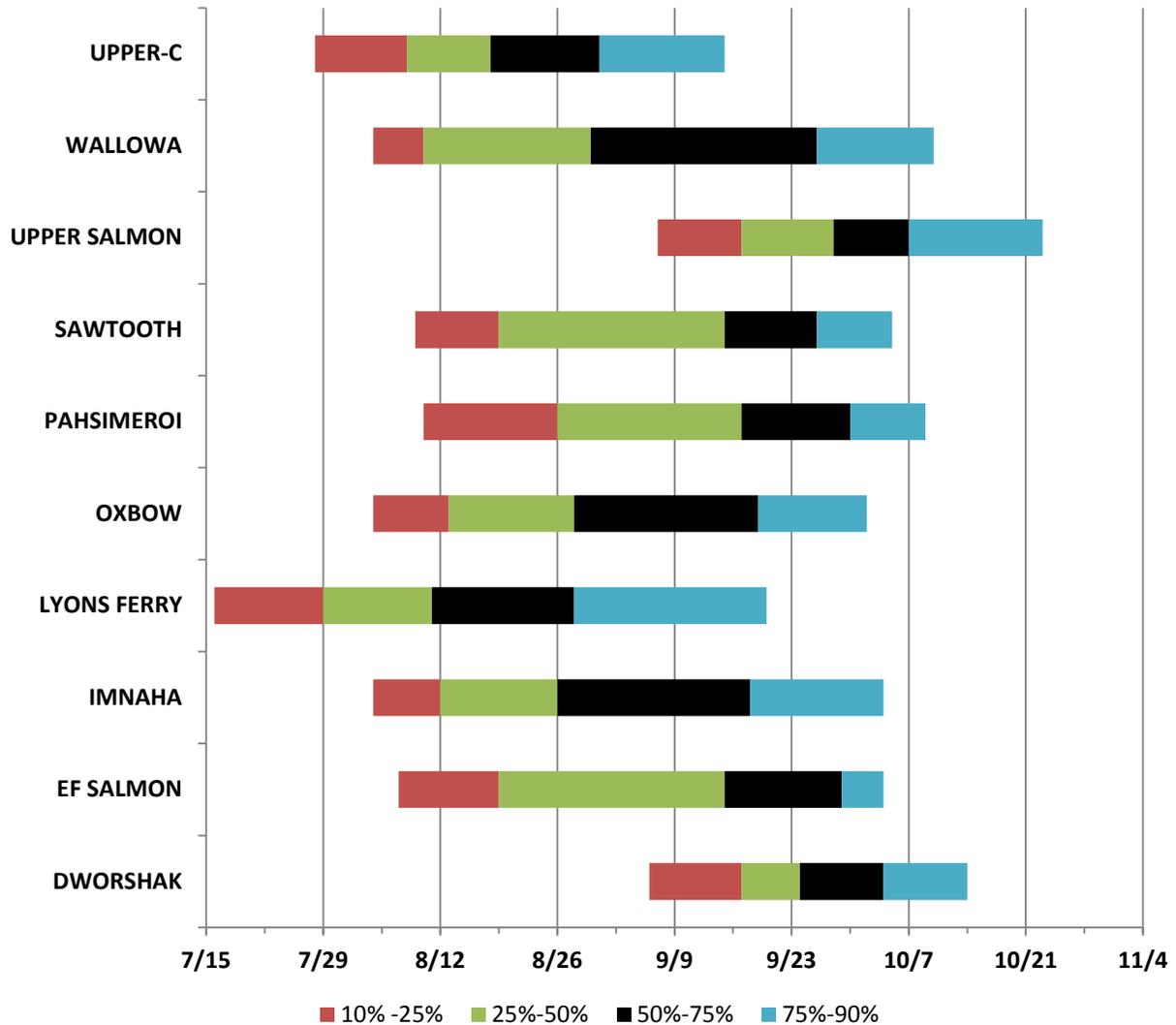


Figure 6. The date that 10%, 25%, 50%, 75%, and 90% of the adult steelhead detections at McNary Dam was attained for Snake River and Upper Columbia hatchery stocks in 2011. The left edge of each block is the date that the lower quantile of the block was reached. UPPER-C is all hatchery stocks upstream of the Yakima River combined.

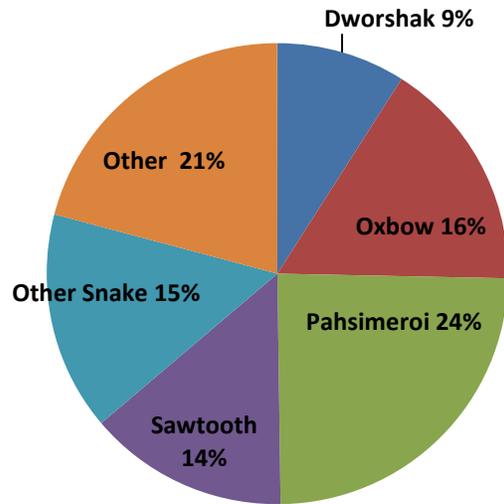


Figure 7. Contribution to sport harvest by hatchery stock in the lower Columbia River from August 1 to October 31, 2011. Other Snake are Snake River hatchery stocks from Washington and Oregon that were in the PBT baseline. Other category includes the Snake River Lyons Ferry and Wallowa stocks from BY08 and non-Snake River hatchery stocks.

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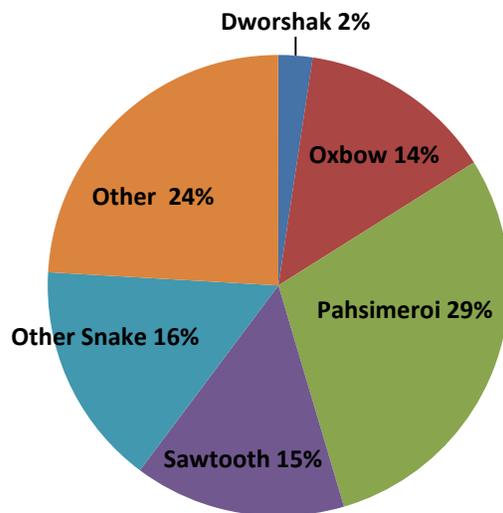


Figure 8. Contribution to sport harvest by hatchery stock in the lower Columbia River in July 2011. Other Snake are Snake River hatchery stocks from Washington and Oregon that were in the PBT baseline. Other category includes the Snake River Lyons Ferry and Wallowa stocks from BY08 and non-Snake River hatchery stocks.

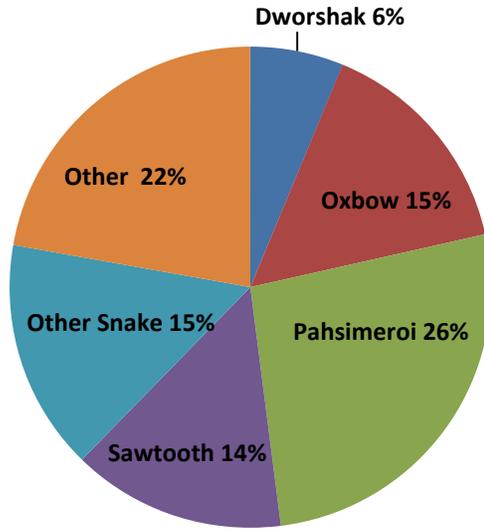


Figure 9. Contribution to the total sport harvest from July 1 to October 31, 2011 by hatchery stock in the lower Columbia River. Other Snake are Snake River hatchery stocks from Washington and Oregon that were in the PBT baseline. Other category includes the Snake River Lyons Ferry and Wallowa stocks from BY08 and non-Snake River hatchery stocks.

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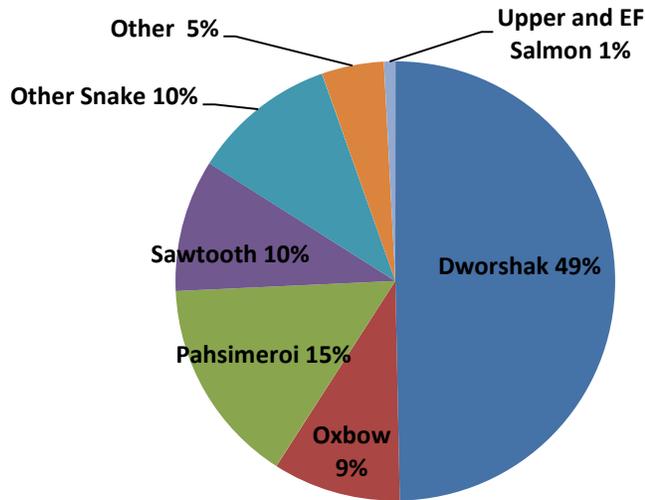


Figure 10. Contribution to the total clipped tribal harvest by hatchery stock from August 1 to November 26, 2011 in the Zone 6 tribal fishery. Other Snake are Snake River hatchery stocks from Washington and Oregon that were in the PBT baseline. Other category includes the Snake River, Lyons Ferry, and Wallowa stocks from BY08 and non-Snake River hatchery stocks.

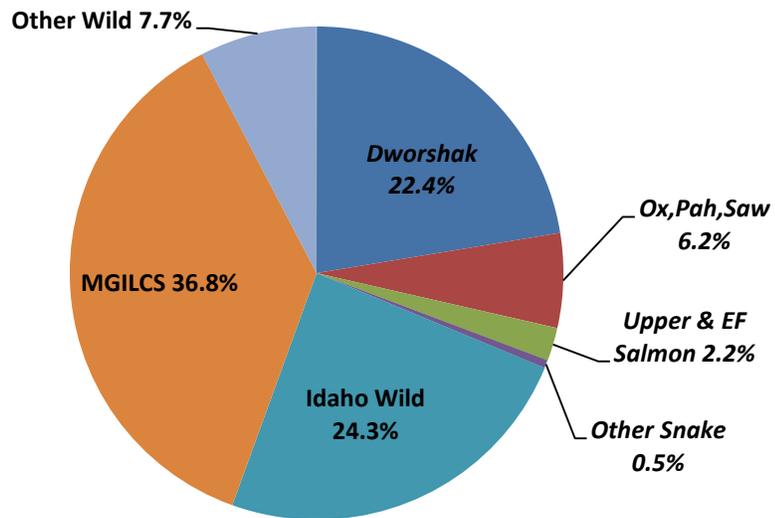


Figure 11. Contribution to the unclipped tribal harvest by hatchery stock and GSI reporting groups from August 1 to November 26, 2011 in the Zone 6 tribal fishery. Hatchery stocks are shown in italic font. Ox,Pah,Saw = Oxbow, Pahsimeroi, and Sawtooth hatchery stocks combined. Other Snake = Snake River hatchery stocks from Washington and Oregon. The MGILCS reporting group includes rivers in the Snake basin and the Columbia basin downstream of the Snake River.

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