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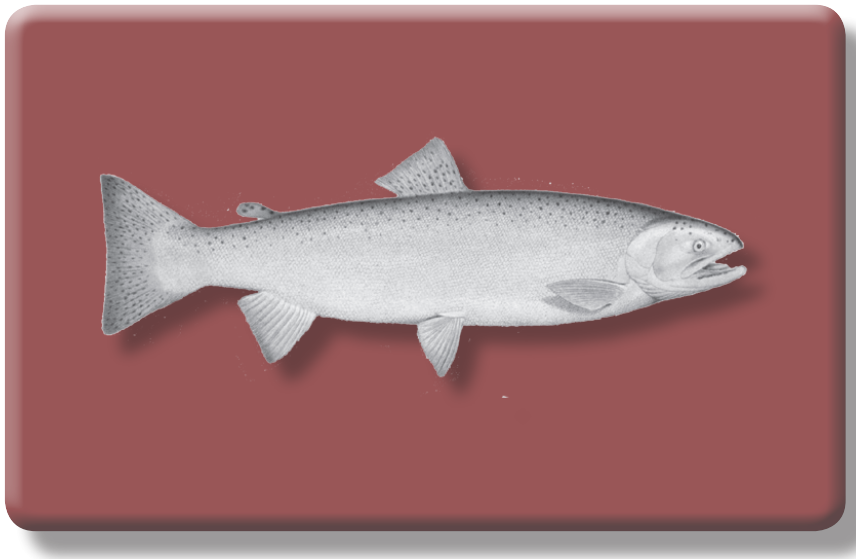
2016 Research and Monitoring of Adult *Oncorhynchus mykiss* In the Nisqually River



by Gabe Madel and
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Washington Department of
Fish and Wildlife
Fish Program

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Introduction

The Nisqually River originates from the Nisqually Glacier on the slopes of Mt. Rainier and drains 1,890 km^2 of the westslope of the Cascade Range. The Nisqually River flows west-northwest approximately 125 km before draining into south Puget Sound northeast of Olympia, Washington. Rainfall, snowmelt, and glacial melt all contribute flow to the Nisqually River. The LaGrande (river km 68.0) and Alder hydroelectric projects (river km 71.0) both influence the flow regime and LaGrande Dam is the upstream boundary of anadromous salmonids. Downstream of LaGrande Dam, the Nisqually River flows through a mix of forested, rural, and agricultural land before bordering the Fort Lewis Military Reservation (river km 31.0 downstream to 4.0) and the Nisqually Indian Reservation (river km 17.6 to 8.6).

Puget Sound Steelhead Distinct Population Segment (DPS) was listed as threatened under the Endangered Species Act in 2007 (NMFS, 2007). Recovery of Puget Sound steelhead trout *Oncorhynchus mykiss (O. mykiss)* depends on identifying factors regulating the viability of the anadromous life history strategy (WDFW 2008). *O. mykiss* can exhibit a complex array of life history strategies, including both resident and anadromous forms (Courter et al. 2013; Kendall et al. 2015). Both anadromous (steelhead) and resident *O. mykiss* life history types are present in the Nisqually River. Numerous studies outside of the Nisqually River have shown that genetic exchange between the two life history types is not uncommon in sympatric populations (Docker and Heath 2003; McPhee et al. 2007; Pearsons et al. 2007) and some endemic populations of *O. mykiss* display partial anadromy (one gene pool displaying both anadromous and resident life histories) (Olsen et al. 2006; Arakee et al. 2007; McPhee et al. 2007). Understanding the relationship and degree of interaction between resident and anadromous *O.mykiss* in Puget Sound watersheds is important in making management decisions (i.e. habitat restoration, fishery regulations, and hatchery practices) that promote recovery of the species.

Historically, monitoring and management actions in the Nisqually River have focused on the anadromous population of *O. mykiss*, however the statewide steelhead management plan provides a directive to clarify the ecological relationship between resident and anadromous *O. mykiss* (WDFW 2008). In 2015 we used otolith microchemistry to estimate the maternal contribution of anadromous and resident life histories to *O. mykiss* in the Nisqually River. Results from analysis of otoliths collected from *O.mykiss* parr, smolts, and adult rainbow trout from various locations in the Nisqually River drainage highlighted the association resident *O.mykiss* have to their anadromous counterparts in the Nisqually River and reinforced the need to monitor both life histories (WDFW, in prep). The purpose of this document is to summarize stock assessment, monitoring and research activities conducted by Washington Department of Fish and Wildlife (WDFW), Nisqually Indian Tribe (NIT), and Joint Base Lewis McCord (JBLM) associated with adult Nisqually River winter *O.mykiss* in 2016.

2016 Harvest

Since 2004 harvest of anadromous *O.mykiss* has been limited to incidental encounters during the sport and tribal winter chum fishery. In 2016 no steelhead were harvested by NIT during gillnet fisheries targeting winter chum. Steelhead mortality associated with sport fishing is assumed to be zero due to limited overlap of the fishing season with steelhead spawning period and the requirement to release wild steelhead. Harvest of resident rainbow trout by the state and Nisqually Tribe is unknown. Since 2008 sport anglers were permitted to harvest two rainbow trout over 14 inches in the lower river (river km 20.0 to the mouth) from July 1 through November 30th. Upstream of river km 20.0 where the majority of the resident rainbow trout population resides, anglers are required to release rainbow trout. Due to limited access in the upper river effort is extremely low.

Estimates of Escapement/Abundance

Anadromous *O.mykiss* (steelhead)

Methodology

Escapement of wild winter steelhead on the Nisqually River was estimated from the total number of redds observed by float and foot surveys. Between 2004 and 2014 helicopter surveys were used to account for the portion of the mainstem used by steelhead that was not surveyed by raft (approximately 40% of mainstem). In 2015, float surveys were expanded to account for the entire mainstem Nisqually River, eliminating the need for flight surveys.

In 2016 surveys were conducted by WDFW, NIT, and staff from JBLM across known steelhead spawning grounds in the Nisqually River Basin including the Nisqually River, Mashel River, Little Mashel River, Busy Wild Creek, Beaver Creek, Yelm Creek, and Ohop Creek. In an effort to physically count the total number of redds (census) staff from the NIT and WDFW sought to walk or float all available spawning habitat.

The mainstem of the Nisqually River, (river km 68.2 to 3.9), was divided into three "reaches" with differing flows and habitats. Within each reach, smaller index areas were selected for float surveys based on ease of access, ability to safely navigate the waters, and recent documented spawning activity. Consistent with previous years an index area on the Mashel River (river km 5.1 to 0) was surveyed every 7 days (weather and flow permitting). In addition, surveys were expanded in the Mashel River to better understand spawner abundance above the index area. Location of steelhead redds were recorded with GPS and marked with florescent flagging. The Mashel River above the index area was surveyed up to a falls now defined as the uppermost extent of steelhead spawning in the mainstem of the Mashel (river km 24.8, Figure 1). Associated tributaries of the Mashel such as Busy Wild Creek and Beaver Creek were also surveyed. In addition, a snorkel survey was conducted on 5/5/2016 in the La Grande bypass reach of the Nisqually River (river km 68.0-65.2) to evaluate habitat quality and potential for steelhead spawning.

Figure 1. Anadromous barrier on the Upper Mashel River. Nisqually River Drainage Pierce County, WA.

2016 steelhead escapement

Mainstem surveying effort combined with float and foot surveys conducted in the Little Mashel River, Mashel River, Busy Wild Creek, Beaver Creek, Yelm Creek, and Ohop River allowed for a conservative estimate of the total redd count in the Nisqually basin. Survey conditions were excellent in the Nisqually River and its' tributaries in 2015/16 and steelhead spawning was documented in all surveyed sections of the mainstem Nisqually with the exception of the La Grande by-pass reach upstream of the first cascade. In recent years we've observed an increased proportion of redds in the middle and lower reaches of the mainstem Nisqually River relative to the five year average (Figure 2). 178 live fish were observed in the Nisqually and Mashel Rivers. This represents the highest live fish count since live fish recording began in 2004 (2004-2015 Mean: 22.6 live fish ± 0.82 S.D.). Surveyors observed a total of 871 redds in the mainstem of the Nisqually in 2015/2016 (Figure 3). Based on the assumption that one redd represents the escapement of 1.62 adults (Mayer et al. 2005), the 2015/16 mainstem Nisqually River wild winter steelhead escapement is estimated at 1,411 adults (Figure 4). The escapement for associated tributaries of the Nisqually including Muck Creek, Yelm Creek, and Ohop Creek is estimated at 56 adults. The escapement for the Mashel River and its' tributaries is estimated at 568 adults.

The total Nisqually River Drainage escapement for 2015/16 (with all tributaries included) is estimated at 2,035 adults.

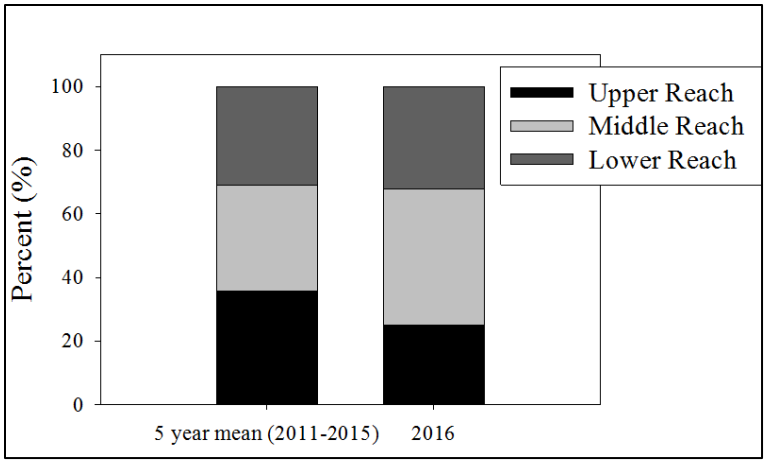

Figure 2. Proportion of redds in the upper reach (river km 42.2-68.2), lower reach (river km 3.9-20.3), and middle reach (river km 20.3-42.2) of the Nisqually River for 2011 through 2015 (average), and 2016, Thurston County, WA.

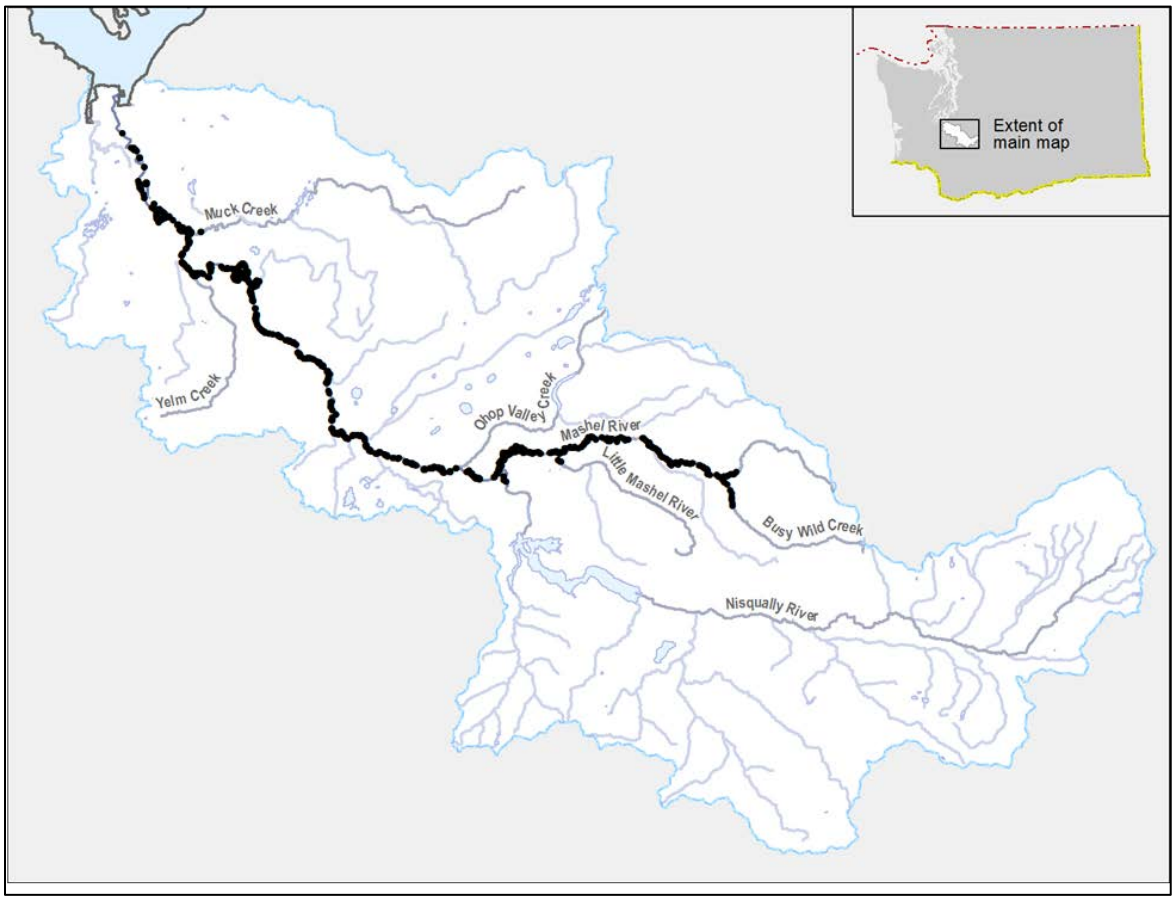

Figure 3. Steelhead redd locations in the Nisqually River Drainage, Thurston County, WA. Each black dot represents the geo-referenced location of an individual redd.

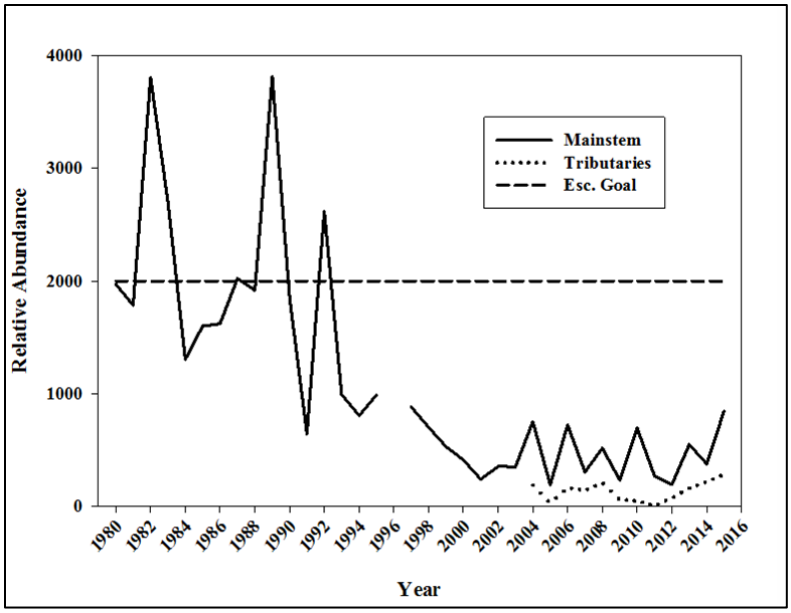

Figure 4. Nisqually River steelhead escapement estimate (1980 to current) Thurston County, WA.

Fluvial/Resident *O.mykiss* (Rainbow Trout)

Methodology

Resident *O. mykiss* were sampled in the Nisqually River from river km 63.7 downstream to river km 35.1 as a pilot project to develop a long term approach to monitor size, age, gender and abundance of resident *O.mykiss*. Adult rainbow trout were sampled in 2016 (n=99) from 4/8/2016 through 6/23/2016 using hook and line surveys. Numerous studies have documented sampling bias associated with hook and line methods (Hetrick and Bromaghin 2006; Losee and Phillips 2016) where larger rainbow trout are disproportionately captured relative to what is present in the population. To evaluate sampling bias associated with hook and line methods we used South Prairie Creek, Pierce County, a tributary of the Puyallup River as a proxy to compare the size and species composition of fish observed while snorkeling versus those sampled using hook and line surveys. In summary, fork length of rainbow trout was not significantly different between fish observed while snorkeling versus those captured via hook and line (Livingood-Schott and Losee 2016, Figure 5).

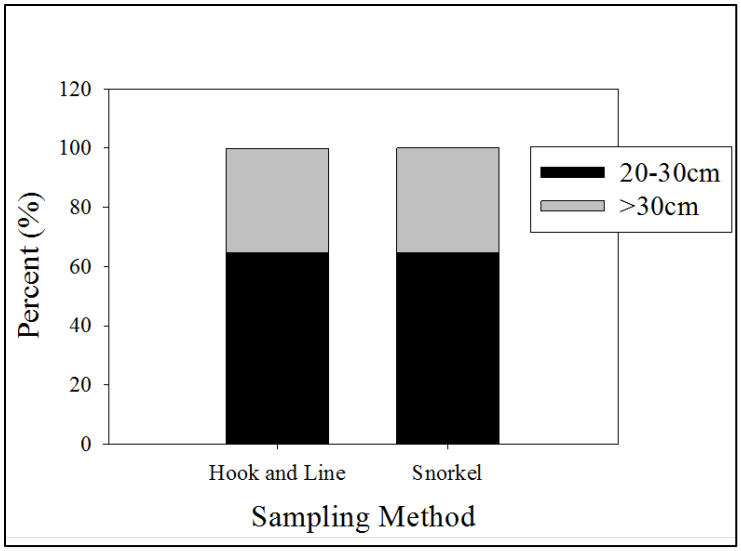

Figure 5. Fork length of fish sampled via hook and line versus those observed while snorkeling in South Prairie Creek, a tributary of the Puyallup river, Pierce County WA.

Age data and fork lengths were collected from all individuals captured and compared to samples collected in the spring of 2013 and 2015. Scales were used to age individuals as described by Peven et. al. (1994). In 2016, efforts were made to determine gender from resident *O.mykiss* sampled using morphological characteristics and the expression of milt by males.

To evaluate interannual variability in abundance of the resident *O.mykiss* population we conducted a two-day test fishery on June 27th and 28th, 2016 made up of nine volunteer anglers. Anglers floated the Nisqually River from river km 63.7 to river downstream to km 53.0 using artificial unbaited lures (flies, spoons, spinners) with barbless hooks. We divided this area into two "sub-indexes". From these data we calculated catch per unit effort (CPUE, fish/hour) and compared between sub-indexes.

2016 resident *O.mykiss* age, size, gender and abundance

In 2016, the majority of rainbow trout sampled were 3 years old (53%, 35/66) however 2 and 4 year olds were also common (Figure 6). This is in contrast to rainbow trout sampled in 2014 and 2015 where 2 year olds made up the largest proportion of sampled fish.

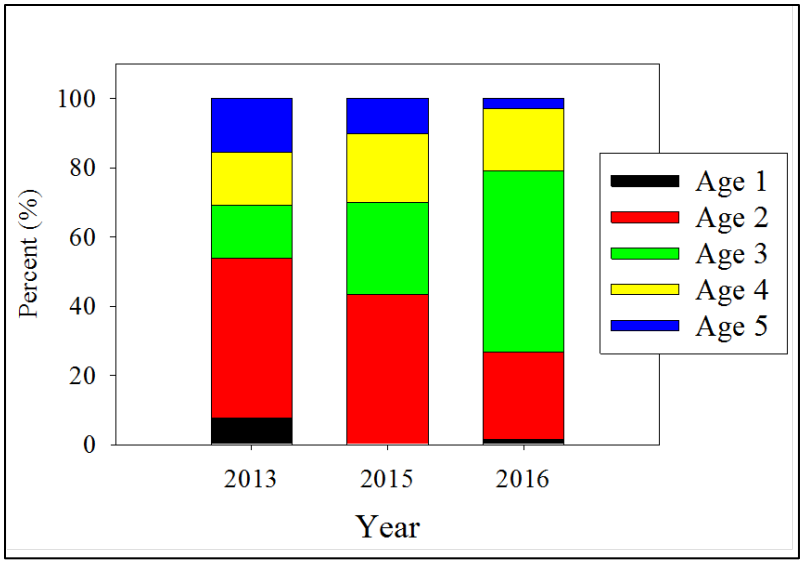

Figure 6. Age composition of resident *O. mykiss* sampled in 2013, 2015, and 2016 in the Nisqually River, Thurston County WA.

In 2016 resident rainbow trout ranged in size from 177mm to 450mm fork length. Pairwise comparisons of mean fork length revealed that size of resident *O.mykiss* captured in 2016 (N=121) were not significantly different than those captured in 2015(N=57) or 2013 (N=14) (Dunn's Method, P<0.05) however those captured in 2011(N=26) were significantly smaller than those captured in other years of the study (Dunn's Method, P>0.05; Figure 7). In 2016, average length of resident *O.mykiss* increased with age but there was large overlap in length between the different age classes (Figure 8).

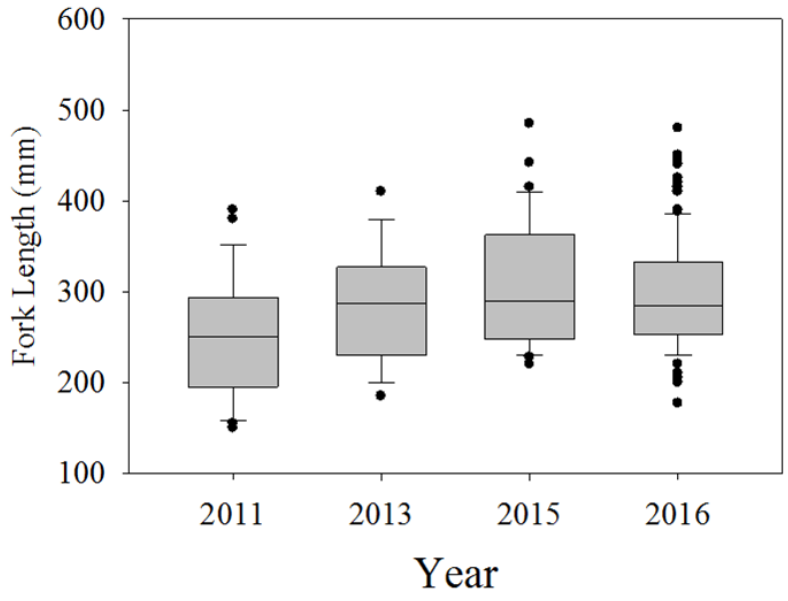

Figure 7. Box plots represent the median, 10th, 25th, 75th, and 90th percentile fork length of resident *O. mykiss* sampled each year from 2011-2016 in the Nisqually River, Thurston County WA.

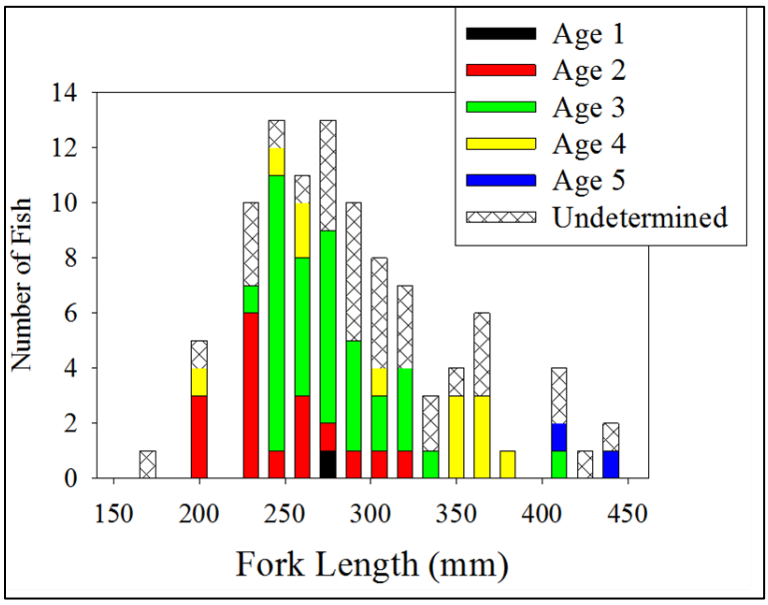

Figure 8. Length frequency distribution and age composition of resident *O. mykiss* sampled in the Nisqually River, Thurston County WA.

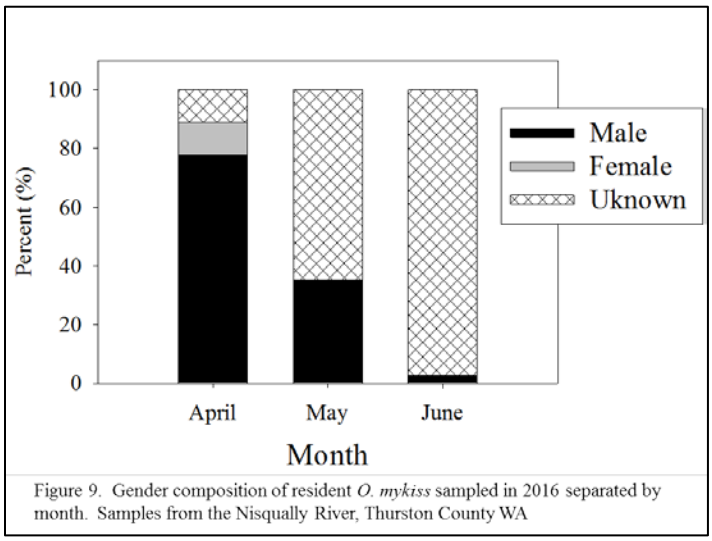

Figure 9. Gender composition of resident O. mykiss sampled in 2016 separated by month. Samples from the Nisqually River, Thurston County WA.

In 2016, gender was not determined for 83.3% of fish sampled due to the lack of milt expression or clear morphological characteristics. Of the individuals that were identified to gender we observed 15 males and 1 female. It appears that the ability to sex fish was driven in large part by the time of sampling (Figure 9). Of the 9 samples collected in April, we positively identified gender for 88.9% (8/9). This period coincides with the peak spawn timing of anadromous *O.mykiss* occurring between April 15th and May 1st and provided the best estimate of sex ratio in

2016. It is worth mentioning that in 2016 we observed ripe males as young as 2 years old and as small as 177 mm fork length.

Catch per unit effort on June 27th and 28th was higher in the uppermost sub area (river km 60.2-63.7, Table 1). This was the first year to assess relative abundance therefore no comparisons were made to other years.

Table 1. CPUE and number of resident *O. mykiss* caught in each Nisqually River sub-index in 2016.

Date	River Kilometer	Number *O. mykiss* Caught	Hours Fished	CPUE (fish/hr)
6/27/16	60.2-63.7	43	69	0.623
6/28/16	53.0-60.2	27	63	0.429

Discussion and Future Work

The 2015/2016 steelhead escapement (2,035 spawners) represents the highest number observed in over a decade (Figure 4) and represents the first time the escapement goal (2000 steelhead) has been met since 1992. In addition, 2016 represents the first year co-managers attempted to conduct a census of all available spawning habitat for steelhead in the Nisqually River Drainage. Steelhead were observed spawning in tributaries of the Nisqually River that were not surveyed in recent years such as Busy Wild Creek. Additional years accounting for these previously unsurveyed reaches will provide important insight into total distribution and abundance of anadromous *O. mykiss* and allow for the creation of a correction factor to strengthen historical steelhead estimates for tributaries of the Nisqually River. While these new reaches provide valuable data on total distribution and abundance of winter steelhead the mainstem of the Nisqually River provides the best estimate of relative abundance when evaluating interannual variability in steelhead runsize (Figure 4).

Early marine survival of juveniles during outmigration has been identified as a critical period for steelhead where survival is low relative to other life stages (Moore et al. 2015). In addition, river conditions during freshwater rearing have been shown to have a significant effect on ultimate survival rates of a cohort (Petrosky and Schaller 2010). In order to fully understand factors that affect variability in abundance of anadromous *O.mykiss* in the Nisqually River additional work needs to be done to compare survival at various life stages. In line with these efforts, WDFW has operated a smolt trap at river kilometer 19.0 since 2009. These data will be used in conjunction with spawning ground survey data in future years to improve our understanding of the factors driving steelhead abundance in the Nisqually River.

In 2016 WDFW personnel took the first steps toward developing a monitoring approach for resident *O. mykiss* in the Nisqually River Drainage. Work completed in 2016 should be viewed as a pilot project to build a foundation for collecting metrics to monitor the resident life history of this species. In order to evaluate interannual variability associated with length, age, and CPUE and maximize identification of gender, sampling efforts should be concentrated at the beginning of the spawning period (first two weeks of April). While valuable data was collected on resident *O. mykiss* in 2016, the strength of this research will result from long term, consistent, monitoring of resident *O. mykiss* as they relate to the overall *O. mykiss* complex in the Nisqually River Basin.

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