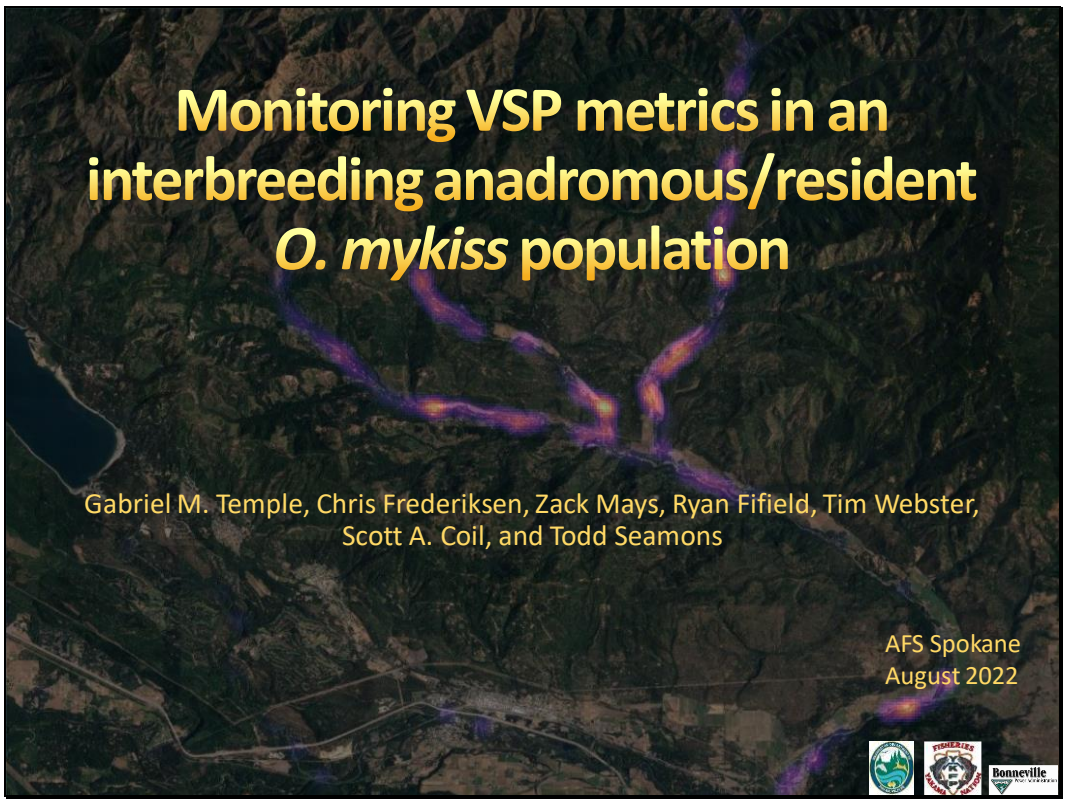
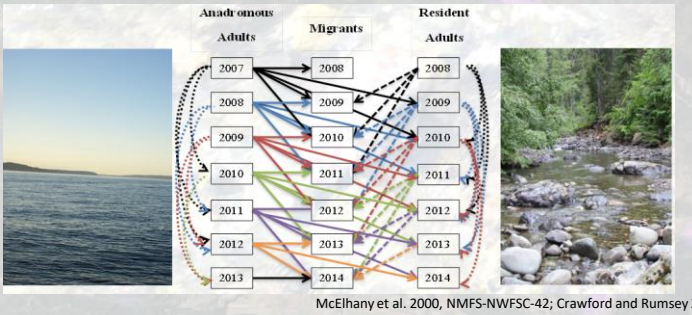


This talk is intended to provide an annual update to our Yakima Steelhead VSP project. The project was initiated in 2010 by the co-managers (Yakama Nation and WDFW), under contract with the Bonneville Power Administration, and represents our strategies for monitoring the VSP metrics for an interbreeding anadromous and resident *O. mykiss* population in the upper Yakima Basin and summarizes our observations to date.

The geographic footprint of the Yakima Basin is very large relative to the size of the State of Washington. This talk is focused on the upper Yakima which is depicted as the more northern region of the grey shaded area above. Of note is that the Yakima Basin drains a sizeable area. In fact, the Yakima River is the longest river contained entirely within the bounds of Washington State. There are 4 steelhead populations in the Yakima and we will focus only on the Upper Yakima Population in this talk.

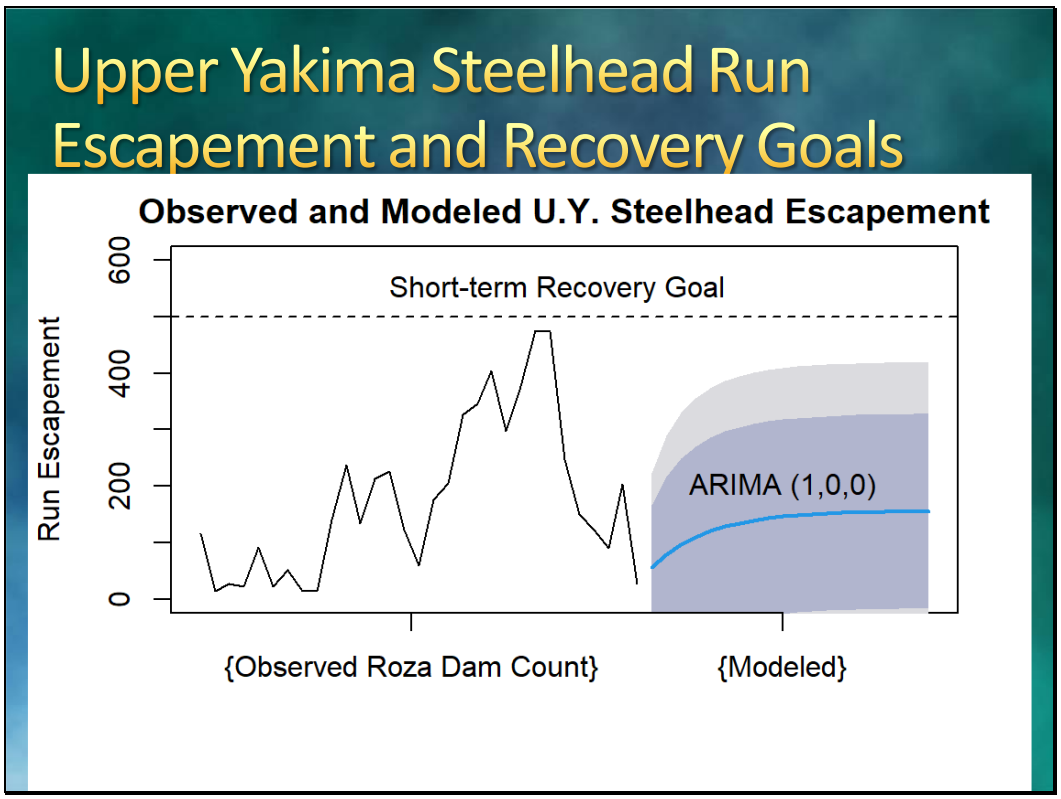
Background

- *O. mykiss* = Rainbow Trout = Steelhead Trout
- VSP = Abundance, Productivity, Spatial Structure, Diversity
- Upper Yakima Steelhead population is depressed and listed as threatened in the Yakima Basin, yet our sympatric Rainbow Trout population is robust
- Steelhead recovery objectives under ESA, but there is large uncertainty surrounding interactions between life-histories that may affect recovery



McElhany et al. 2000, NMFS-NWFSC-42; Crawford and Rumsey 2011; Guidance Document

As you may or may not know, *O. mykiss* can exhibit a multitude of life history pathways, from anadromous fish that migrate to the ocean environment for some portion of their life to resident fish which complete their entire life cycle in freshwater. To complicate things, anadromous parents can produce offspring that exhibit solely a resident life history expression, while resident fish can, and do, produce offspring that exhibit anadromy. Resident and anadromous parents can interbreed and produce offspring of either life history. Understanding these interactions is of interest because there is interest in preserving the anadromous life history, otherwise known as Steelhead Trout, which have conservation concerns under the Endangered Species Act (ESA). Our project attempts to understand these complex interactions and to generate information on the VSP metrics Abundance, Productivity, Spatial Structure, and Diversity for the interbreeding life histories.



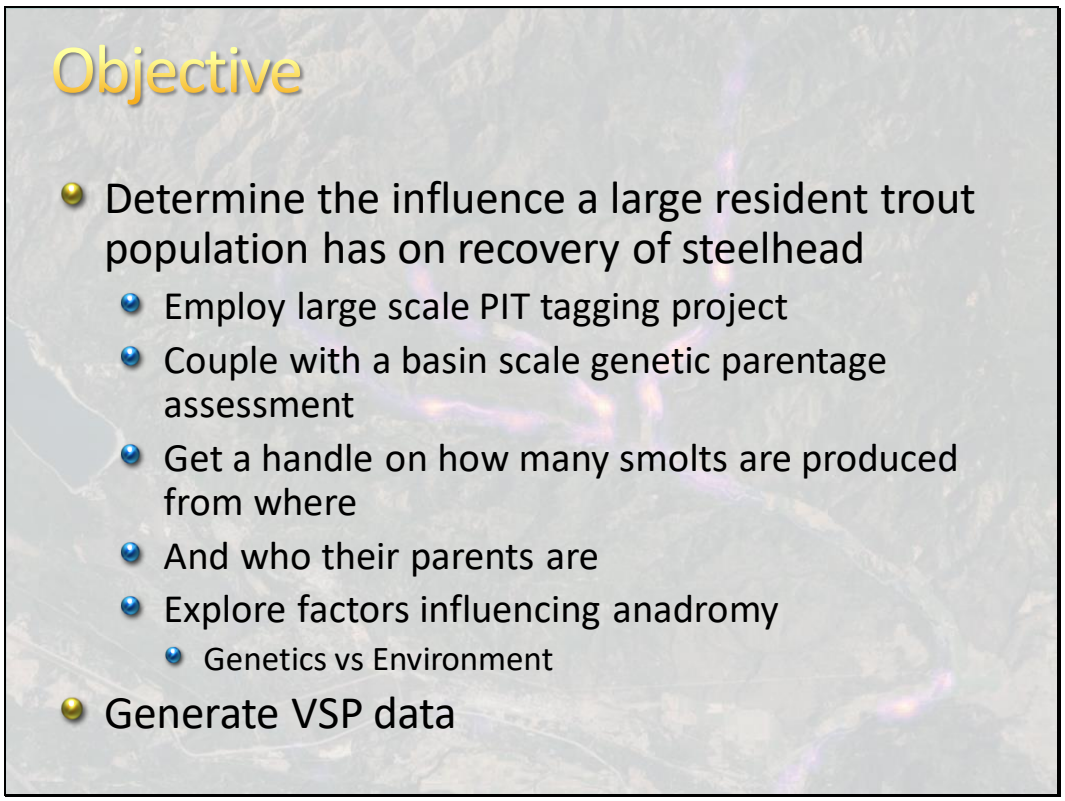
Steelhead recovery has been a concern for the upper Yakima population for some time. We have an established short term recovery goal of having an annual run escapement of greater than 500 Steelhead adults returning to the Upper Yakima for 10 consecutive years. It is evident in the graph above that current observed run escapement levels have generally been under our short-term recovery goal for the majority of the time series of data available. Formal forecasting models, although highly uncertain, produce future model estimates of run escapement that are quite low relative to our objectives. Finally, we would like to achieve a long-term recovery objective that is even greater (1500 adult returns annually).

Relevant Facts – Yakima *O. mykiss*

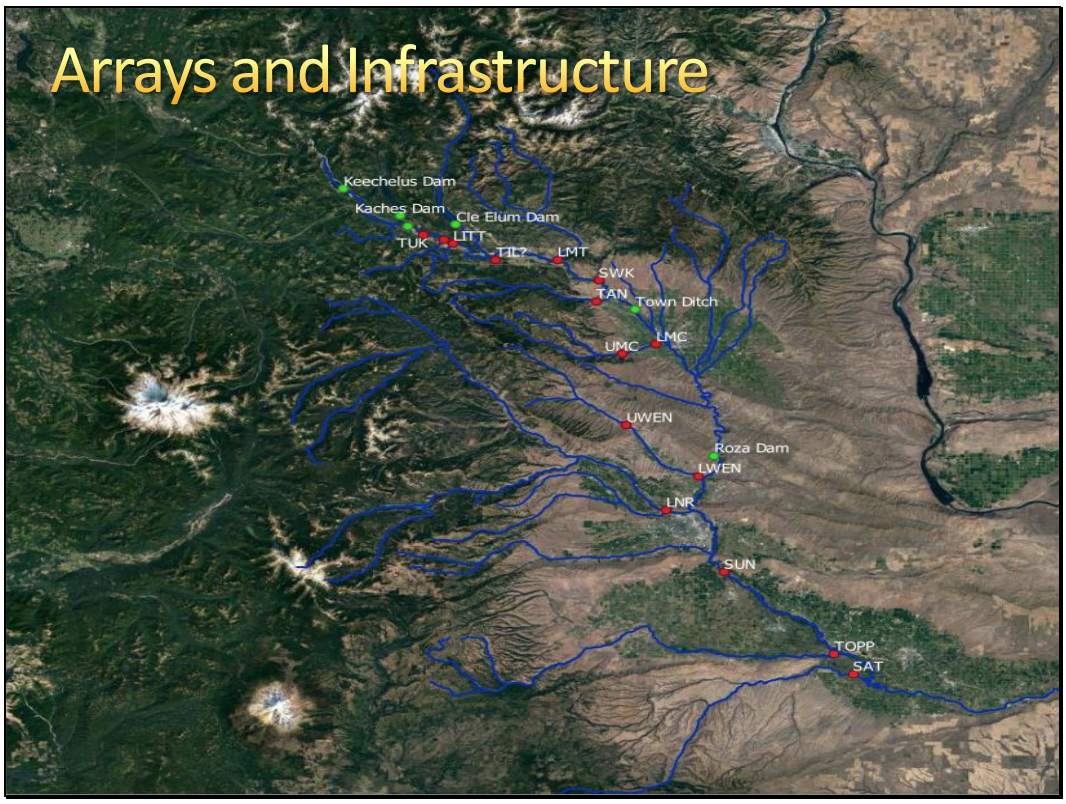
- 1) Very Little Hatchery Steelhead Influence
- 2) Historically Extensive Hatchery Trout Stocking
  - Goldendale Hatchery, South Tacoma
- 3) Genetic Admixture of Hatchery and Wild trout (Campton and Johnston 1985; our data)
- 4) Overlap in Spawn Timing and Distribution of both Resident and Anadromous *O. mykiss* (Pearsons et al. 2007)
- 5) Rainbow Trout and Steelhead Genetically More Similar in Individual Streams than the Same Life History Forms are Between Streams (Blankenship et al. 2009)
- 6) Courter et al. 2013 report up to 20% of Steelhead kelts originated from resident mothers

A few relevant facts include, 1) although there have been hatchery origin Steelhead released in the Upper Yakima, there is currently very little hatchery Steelhead influence. However, decades of extensive hatchery Rainbow Trout stocking led some of the early genetic researchers to describe the populations as being a genetic admixture of hatchery and native origin O. mykiss. Ecological and genetic evidence supports the observation that the life histories are interacting.

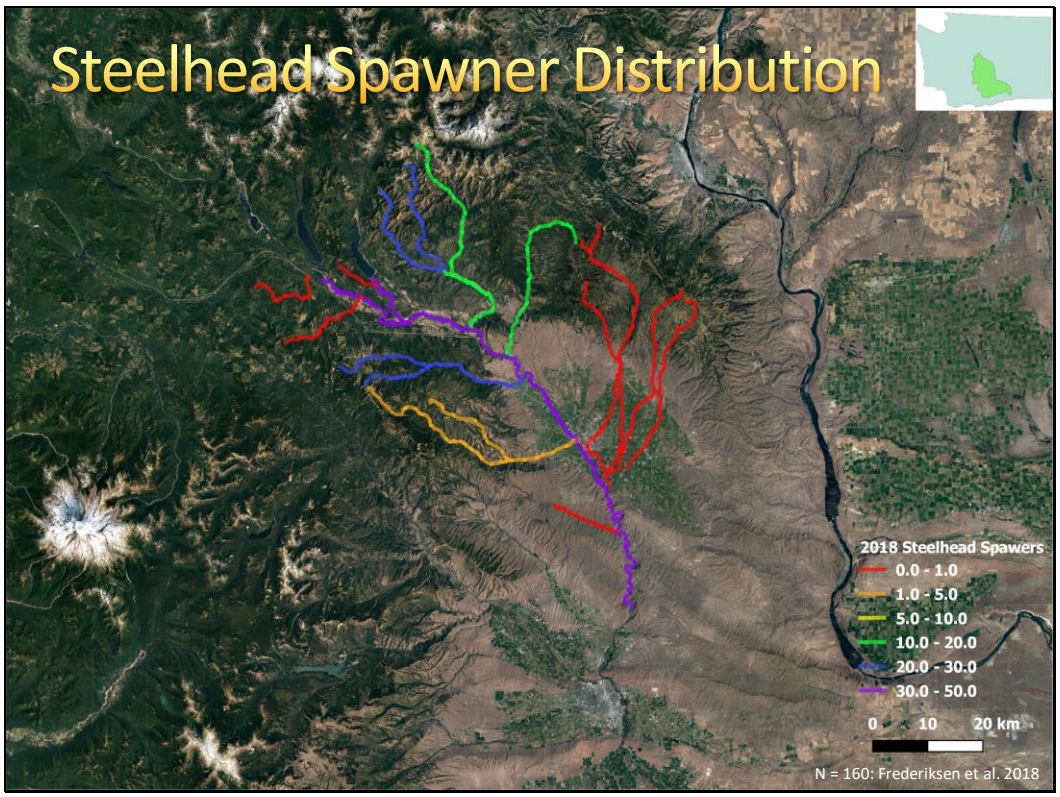
The video above illustrates interactions between and anadromous steelhead trout female and numerous smaller resident trout males on the spawning grounds (the video plays during live in-person meetings but does not work in this PDF version).



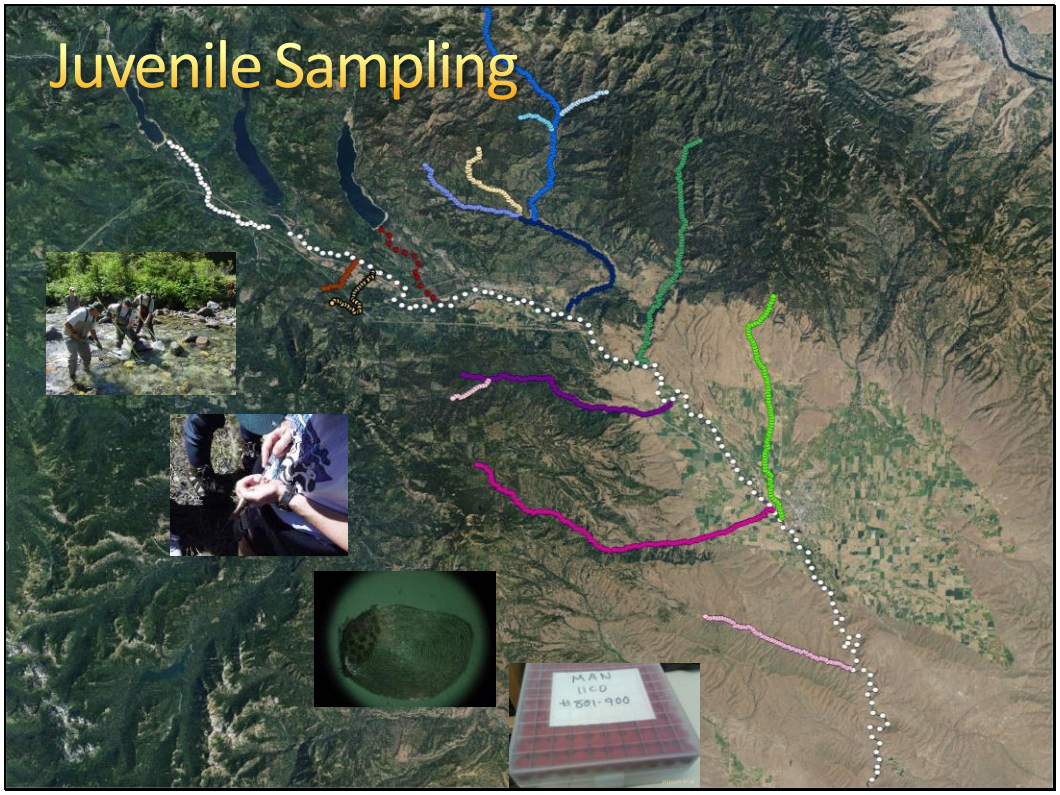
Our objectives are to develop an understanding of how the relatively robust resident trout population may influence recovery efforts of the anadromous form, given that we know they are interacting ecologically and genetically. We are attempting to better our understanding using a large-scale tagging project coupled with a basin scale genetic parentage assessment get a handle on how many smolts are produced from various geographic areas of the basin, and to understand how the parent crosses contribute to production. We believe this will help us disentangle the genetic versus environmental factors that influence anadromy. We are also generating an understanding the VSP metrics while performing this work in order to monitor status and trends in the comingled population.



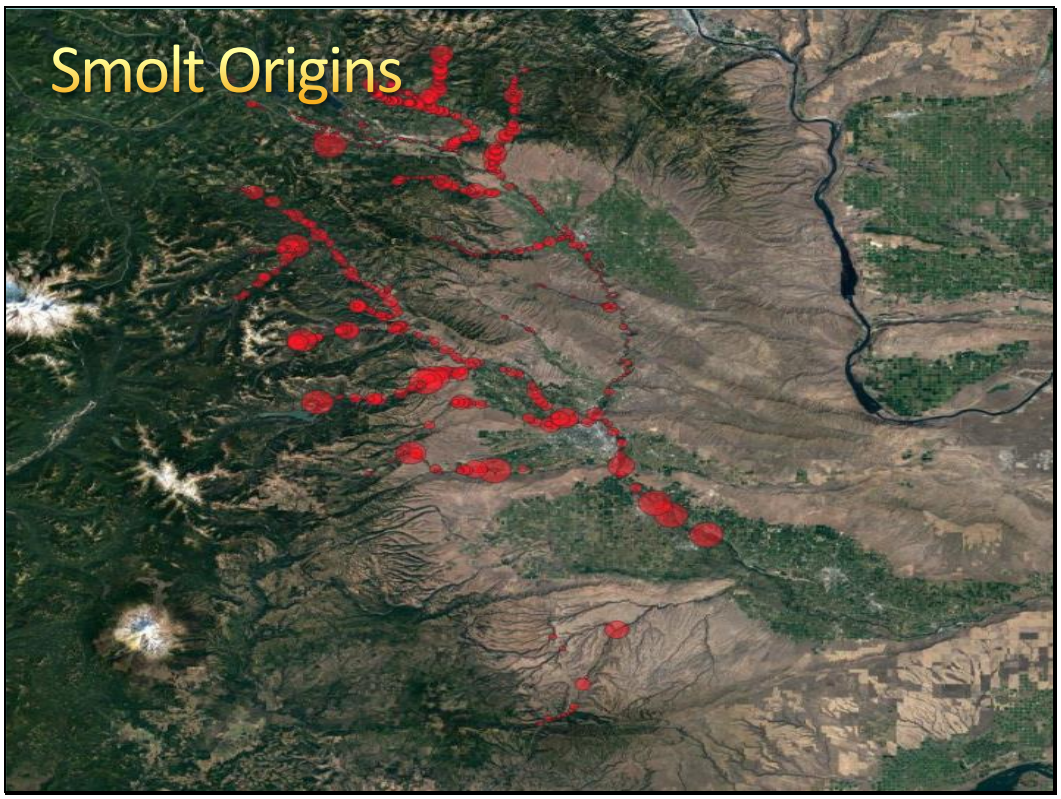
We have been strategically developing an instream tag detection network which allows us to partition tributary and main stem habitat use and movement of tagged fish. The lower end of the majority of the major spawning tributaries have been outfitted with an instream tag detection system.



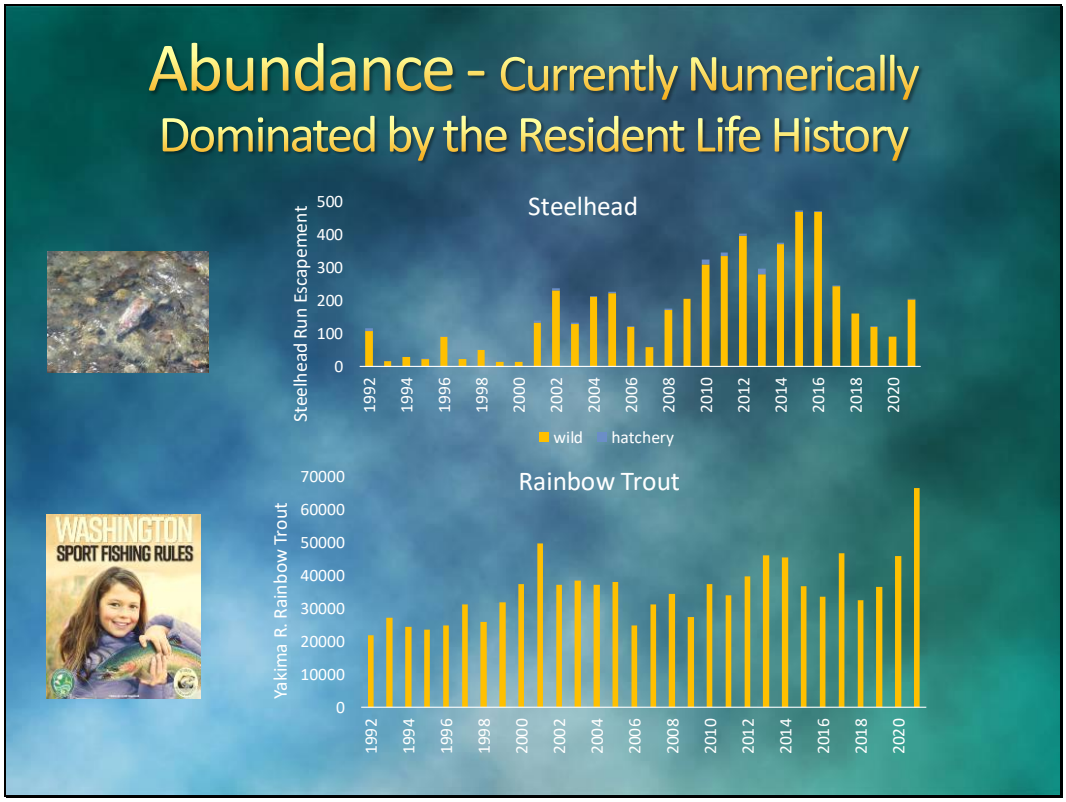
All adult Steelhead are tagged at Roza Dam by Yakima Nation Biologists as they move upstream on their spawning migration. Each fish is tagged with a passive integrated transponder (PIT) tag, and genetically sampled to facilitate the genetic parentage assessment. The instream tag detection network allows us to enumerate spawner abundance within the tributaries as fish move upstream to their spawning areas, and in the main stem river by subtraction.



Juvenile *O. mykiss* are sampled throughout their rearing streams in the upper Yakima (and we are now replicating this in the Naches Basin as well). Fish are captured using electrofishing methods, PIT tagged in their natal streams, scale samples are collected for cohort tracking, and genetic samples are collected from each fish sampled. This facilitates our parentage analysis as nearly all anadromous parents, and their anadromous offspring are sampled.

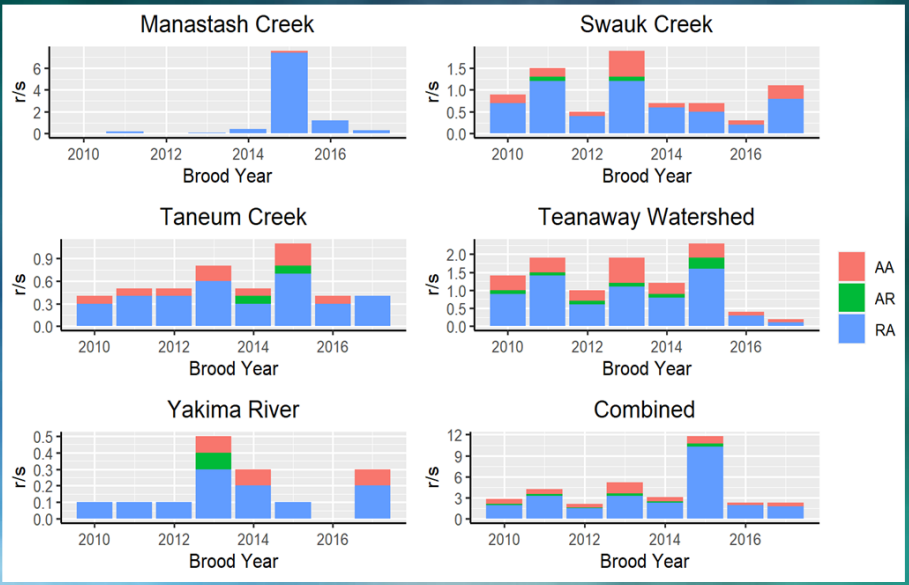


Tagged individuals are defined as steelhead smolts when they are observed exhibiting a migratory life history when they are detected leaving the Yakima and observed on the detection system throughout the Columbia River hydrosystem. Smolt production hotspots in the Yakima are identified as the ratio of the number of migrants detected to the total number tags deployed, corrected for the year they were tagged.

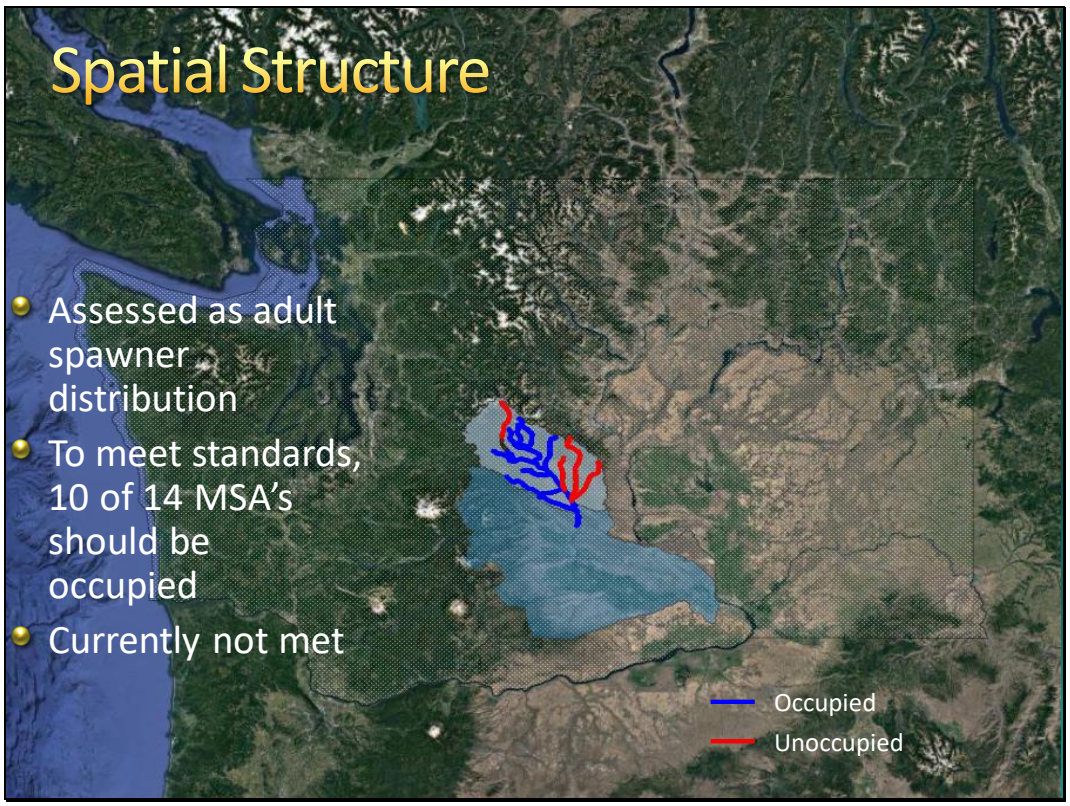


It is easily apparent that the *O. mykiss* population is dominated by a resident life history by looking at the Y axis scales in the graphs above. The resident trout population is currently managed as a popular catch and release sport fishery, while steelhead persist at very low abundance.

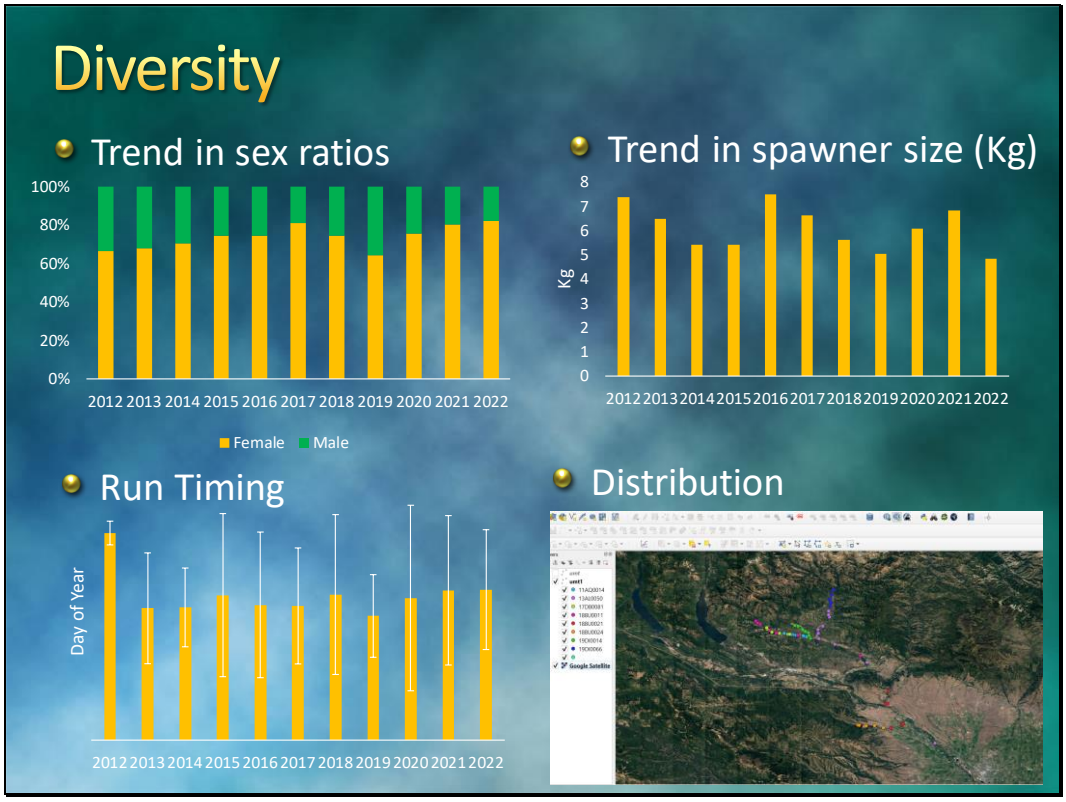
Productivity



We have developed productivity indices for the parental crosses by enumerating anadromous offspring produced per steelhead spawner.



Spatial structure standards have been established for the upper Yakima. Ten of the 14 major spawning areas should be occupied by steelhead adult spawners to be considered occupied. Currently these standards are not being met.



We are also monitoring diversity metrics to identify temporal trends that may indicate divergence in the diversity metrics monitored. We are monitoring things such as sex ratios, spawner size, run timing, and the spawning distribution.

Summary

- Upper Yakima *O. mykiss* may currently be genetically predisposed to a resident life history and current conditions appear to favor that life-history pathway
- Likely different environmental drivers of life-history expression in different geographical areas of the basin
- Generating VSP metrics for populations with co-mingled life histories is not at all straightforward
- Managing for life history diversity may be a good strategy to maintain phenotypic diversity under an uncertain future
- *O. mykiss* life history interaction stuff is complicated

To summarize our observations, it is likely that our *O. mykiss* population is predisposed to express a resident life history due to current hatchery trout genetic legacy of the population coupled with current environmental conditions. We do know that there appear to be different regions of the upper Yakima that are likely influenced by a suite of environmental conditions favoring anadromy, or more so that other areas in the basin. Generating abundance, productivity spatial structure, and diversity metrics is not at all straightforward given the interaction between the life history forms throughout the Upper Yakima Basin. Knowing that the climate is is likely to change into the future, and that there is large interaction between residency and anadromy, it makes sense that managing for diversity may be a good strategy to maintain phenotypic diversity, or the ability of this co-mingled population to respond to shifting environmental conditions into the future. Finally, we would just add that this work is ongoing and we continue to learn new and exciting things about this unique population with each additional year of data collection.