WRIA 9 Implementation Technical Committee

Meeting Summary – June 20th, 9:00 am –12:00 am

King Street Center, 6th Floor- King/Chinook Rooms

Attendees: Joe Anderson, WDFW; Katie Beaver, King County; Lance Campbell, WDFW; Sophie Chiang, King County; Andrew Claiborne, WDFW; Jeanette Dorner, Midsound Fisheries; Larry Fisher, WDFW; Chris Gregersen, King County; Matt Goehring, WRIA 9; Kollin Higgins, King County; Josh Kahan, King County; Janne Kaje, King County; Jessica Lundin, NOAA; Ben Mann, NOAA; Amber Moore, PSP; Nate Overman, WDFW; Tyler Patterson, City of Tacoma; Mike Perfetti, City of Tukwila; Scott Pozarycki, USACE; Pete Topping, WDFW; Jennifer Quan, NOAA; Jen Rice, King County; Dennis Robertson, City of Tukwila; Laura West, King County; Meagan West, WDFW; Katie Whitlock, USACE; Debra Williston, King County. Call in: Sandra O'Neill, WDFW

Green River Chinook Otolith Study – Lance Campbell

Lance gave a presentation regarding the otolith work that WDFW has done on the Green both as part of a Puget Sound wide effort as well as specifically for WRIA 9. This project originally started with proposal to look at otoliths from several watersheds throughout Puget Sound, then continued to get multiple brood years on the Green. This first report is online and part of the Salish sea marine survival project. Looking at the last 20 or 30 years, survival has been calculated mostly with hatchery fish with results saying that larger fish generally have a higher survival rates- which lead to the thought that smaller fish don't really contribute to the population.

For Juvenile Chinook salmon migration timing, there is a trend early in the year of small fish (35-45mm size range) leaving their natal system. Then there is a second peak that occurs depending on the river, sometime between May and August, of larger size (70-100mm). We know the larger fish are coming back, but we don't know how the earlier fry are contributing to the population. This is important because it can help guide restoration because these fish have different habitat needs.

This project is reconstructing juvenile life history from adult salmon by using laser ablation on the adult salmon's otolith. The otolith serves as both a chemical and time record of the salmon- as time goes on more material goes down, so when the otolith is sectioned it creates a timeline that forms about when the fish is an eyed egg. The laser is used to look through the radius of the otolith, looking at the chemistry (particularly strontium) that occurs over the segment. Strontium is found in high concentration in the ocean, and low in freshwater, so when fish migrate to salt water there's a transition to high strontium levels which show up in the otolith chemistry. Also based on size and location of a reading on the otolith at the point where strontium levels jump up, we can reconstruct the size of the fish when they transitioned to salt water. Mass spectrometry is used to read the material to analyze it's chemistry, so the result is a nearly continuous reading across the otolith.

Lance presented two examples of the otolith microchemistry results. The first starts with elevated maternal strontium signal as the eggs are being enriched by the mother, with spring chinook having a much lower maternal signal. Then there is a decay in strontium levels down to emergence, with a low freshwater signal until the fish migrates to saltwater, in which there is then a spike in strontium levels.

This point is measured as distance from the core (in microns) to determine the fish's length at any given point. Back calculating length is fairly accurate to about 10mm bins, and results from other areas with a higher fry survival rate validate the methods. Also, how strontium is taken into the otolith isn't a linear relationship with its concentration in the water (say low salinity), and above 8 ppt is about as much of the strontium as the otolith can absorb- so even low salinity estuary environments will cause that spike in the otolith microchemistry.

In the case of the Green river, these results for all otoliths analyzed are binned into approximate lengths at outmigration. They sampled between 100 and 130 for 2015-2017. Fry were classified as 30mm to 60mm, parr above 60mm, and yearling separated by scale analysis as 1 year olds. The relatively large parr size fish are making up the majority of the returning adults. Do these small fish contribute to the population? In the case of the Green, very little. Also, the few fry returns showing up in these returns could be from another population with a higher survival and stray rate. In 2015, 36% of the population of returning adults in the Skagit were fry migrants, 28% in the Nooksack, but 0% in the cedar, 3% in the Puyallup, and 1% or less in the Green.

We need to construct a brood year analysis to see how this group of fish did over time, and with 3-4 years on average for adult chinook returns in the Green, we can partially construct that brood year with what data we have. Looking into the contribution of yearling fish, Lance suspects that based on chemistry, these fish are Newaukum creek fish. Scale and otolith chemistry confirm that these are yearling fish. Also, they do see chemistry results that shows fish moving from one area to another, such as moving from a tributary to the mainstem. These results show evidence that the yearling component is contributing to the population (2-5%). Pete mentioned that the capture efficiency for yearling Chinook at the screw trap is very low.

Doing this work, they noticed some interesting trends. From a chemical standpoint, some fish looked different than all of the others, which could possibly be different chemical signals from hatchery releases. In 2016 and 2017, they ran 30 fish that were ad clipped or CWT analysis to describe chemistry, and they were able to accurately identify 100% (55/55) hatchery fish. With the hatchery releases- Soos are released in late May and Palmer released later June/July. Within these fish, some of them had different signals and looked like they reared in the Green before they went to salt water. Approximately half of the hatchery fish 24/48 examined showed some evidence of residency in the Green River post release. Using a 3 micron/per daily growth we roughly estimated this time to be ~18 days for the fish that delayed migration.

The fish that we're describing as unmarked hatchery fish are very similar to those that we know to be hatchery fish, which further validates the methods. 2016 was the first year of thermal marks for Palmer fish, so they subsampled these. In 2017 hatchery component results dropped to 12-13% from 20%, which could be from this.

Are the fry returning as adults? Not so much in the Green, but the northern systems (Nooksack and Skagit) have much higher survival. Is this natural in the Green to have low or no fry survival rate? Why are they not showing up, what is different here? Things that they explored include: habitat differences, contaminant differences, and pathogen issues. We could explain the by saying the small fish need a particular habitat (we can't say for sure about fish rearing in tidal freshwater, which would mean that they are underestimating the fry component that migrates down to the lower river but doesn't reach salt water). So what could be the possible explanations for this? Lanced presented a graph showing the

relationship between estuary habitat quality and the proportion of adults with the fry life history type. This showed results in the 15-40% range for systems with mixed or natural estuaries. Next, they would like to look at Snohomish, since it has an estuary but also has contaminant issues, which could help separate the impacts of some of these potential explanations for differences in fry survival. Lance noted that the Tulalip tribe is interested in partnering for this work. A big question is how are the pathogens and contaminants influencing the effects of survival? Potentially the smaller rearing fish are more exposed to contaminants while larger fish move through. Kollin mentioned that we do know that the fry type life history heavily use the Duwamish in the saltwater portion.

Sandy briefly mentioned to the group that this year on the Green they've been sampling since late April to collect natural origin Chinook but it's been slow going. This year there was a flooding event in Feb which may have pushed a bunch of those fish out, so we're not getting that bump up in parr migrants that we usually do. The samples have been collected though, and they are hoping to work with Lance to get otolith chemistry done to show a relationship between time spent in estuary with contaminant body burden. Currently they don't have money to look at the otolith chemistry yet but don't think they can really interpret their data without it.

Lance mentioned that in the Chehalis, they found that the closer the fish were to their habitat, the more likely fish were to stay and reside. Use of a habitat is all about proximity to it. If we're trying to restore upper Columbia Chinook, logic says you should focus on habitat that are proximate to those locations. This work is showing that other areas are important to think about as well.

Kollin mentioned that WRIA 9 has been working to incorporating this into their recovery plan (habitat and contaminants). We as a broader group need to start separating these two primary hypothesis so we can explore these, what we can do about it, and how things like cleanup will impact Chinook. Questions like- should we by trying to restore habitat if the fish aren't going to survive? Or should we focus on habitat in the Middle green since we know from Joe's work that rearing habitat is limited? From a plan update perspective, we're working on what the best approach is.

Nate asked if Lance could clarify, because it looks from the graphics like there 5 times more adults returning from yearlings than fry. Lance, yes, but caution that this is a more broad scale analysis. Hatchery yearlings from icy creek are ad clipped weren't used since they were known hatchery and pulled from this analysis, so sample size is low since they were trying to quantify natural yearlings. Kollin mentioned that in the Snoqualmie, a very small proportion of juvenile Chinook are yearlings, but up to 30% of the adults are from yearlings.

Lance added that the benefit now of continuing the work will be to start matching up the brood year effects with outmigration effects. Say when we have an abnormally high parr or fry outmigration what do we see in the adult return for these years? We can then help make better predictions for smolt to adult survival as well by understanding fry/parr survival. From an otolith analysis standpoint it will cost 10-20k per year, so not a ton of money- plus some money for otolith collection.

USACE Water Storage Management- Scott Pozarycki

Scott gave us a quick overview at our last ITC meeting regarding this topic and there was such great interest in it that we asked him to come back and give a more in depth presentation. USACE works closely with Tacoma water, so there's usually some confusion about how the two interact. Scott presented a powerpoint regarding HHD and water management.

The primary purpose of HHD is flood risk reduction. Maximum flood storage capacity required from beginning of November 1st to February 20th. Beginning February 20th flood capacity decreases until 1st or 2nd week of May when flood risk capacity is not required. This is important because after February 20th we can plan on water storage for summer needs. This winter capacity protects against 140 year flood event. Beginning November 1st, they ensure that the entire reservoir is empty for flood capacity.

Scott presented the spring water storage and allocation figure which shows the groups of water storage that are contained within HHD. The turbidity pool is maintained at 1075 feet, which is basically what they call an empty reservoir. In the spring, they store 24k ac-ft for the Fish Conservation Authority, 5k ac-ft for Section 1135 Ecosystem Restoration Project (which is also water for fish), and 20k ac-ft for Tacoma municipal and industrial use (part of Additional Water Storage Project- AWSP). If they are unable to fill the pool in the spring, priority is 1st Fish Conservation Authority, 2nd is Section 1135, and 3rd is the Municipal and Industrial AWSP.

Fish Conservation Authority- when the HHD project was authorized, there was concern about low water levels and pollution in the river. Because of that there was a desire by the state and others to add water to the river. The Fish Conservation Authority adds water in the spring, summer, and fall for the benefit of fish. This program maintains a minimum flow of 110 cfs at the Palmer gage with a 95% reliability, which requires capture and storage of 24k ac ft. This was established in the 50's and has been managed in this way ever since. Water is released/conserved based on guide curve to ensure they are above the goal. If they are above the guide curve they can use the water a little differently if necessary. Kolin asked what does the 110cfs at Palmer equate to at the Auburn gage? Scott clarified that it depends on year, time of year, probably lower than 250 cfs at Auburn if it is kept at 110cfs at Palmer. This would be if the Tacoma water agreement wasn't in place, but because of that they actually maintain higher flow. Time of year matters because tribs like Soos and Newaukum aren't contributing much later in the summer. Every year since they started this in 1962 (with the exception of 1987 due to an extended drought) they were able to maintain the 110 cfs.

Following this guide curve, all of the water for this is stored by June 1st, then the use follows the curve until December to assure that the flow augmentation follows the availability to meet goals for the year. The guide curve is the management tool and default operation, so as soon as June 1st arrives they begin using this water and augmenting flow. This flow would be more than what we would expect in a natural condition. Joe asked if evaporation could be a loss of efficiency when holding the water vs releasing it sooner? Scott clarified that they don't have an answer, but they know in lake Washington that they can have 150cfs equivalent of evaporation in a single day.

Section 1135 Ecosystem Restoration- Use of this water is decided by the Corps with input from the Green River Flow Management Coordination Committee, and issued for maximum benefit to the ecosystem. The storage and release of this water is adaptively managed based on annual hydrology,

natural resources, regulatory considerations, etc. This is sponsored by Tacoma, and the use of this water is flexible.

Tacoma Municipal and Industrial (part of AWSP phase 1) - This hasn't been fully implemented, but corps captures and stores 20k ac-ft for Tacoma use. Tacoma determines the release schedule. In recent years, half of this has been used for flow augmentation as determined by the Green River Flow Management Coordination Committee. Water for this was first captured and stored in 2007, though this program has not yet been fully implemented. A 2nd phase would involve storing more water in the reservoir.

Spring refill objectives- The Corps tries in the spring to store water for all these 3 purposes minimizing impacts to natural resources, and store water adaptively. They try to mimic the natural hydrograph, but remain flexible for when that water is needed. For example in 2015, they decided that they would capture all water for refill since they knew availability later on would be very limited.

What do they do with the water? Typical augmentation objectives include the following:

- Ensure instream mimium flows
    - 110 cf at palmer (Corps objective)
    - 250cfs at auburn (GRFMCC objective)
- Minimize steelhead redd dewatering in the spring and early summer. We use data collected by the Muckleshoots to identify individual redds that are at risk to be dewatered, and measuring water depth and estimate flow needed for protection which serves as a management objective for spring water augmentation.
- Maximize summer rearing habitat – often this is related to the instream minimum flows, if they feel they have excess water they can try to maintain a higher summer flow, though they can't do this every year.
- Support Chinook salmon adult migration and spawning. The bulk of the water is reserved for Chinook salmon, which begins in mid-September. They try to bump the flows up to ~500cfs for this.

Nate asked if any thought to model guide curves to suit particular life history types? Scott- the curve was developed in the 50's so not specific to life history. Could be value to re-evaluating this, the fish conservation authority says this is managed for the best benefit for fish, so the corps would be open to this. Tyler mentioned that the Muckleshoots are very concerned about the best benefit to fish, so the steelhead spawning, summer rearing, and fall spawning are very important. Scott mentioned that typically baseflow is met around late July.

Lance- is the timing of the parr outmigration is related to how the flows are managed? Joe added that they do see the parr timing later in some systems like the Nisqually, though Scott mentioned that we don't have the colder water with glacial input. Kollin added that the trap counts show just the middle Green, but there's a big gap below this as to how fish are rearing in the lower river. Pete- do you capture water during the summer, say storm in July? This has happened before in August, and what typically happens is that at this time of year the dam is bypassing flows on a 48" pipe which can only pass a certain flow, so any additional input would mostly be stored. Occasionally we can have flows at 1000cfs into July if it's cooler and there is a higher snowpack- so in those years they spread out the storage phase and may not even have it at full refill at June 1st to spread out the impact of refilling.

The group asked for the Corps perspective on authority to be flexible on changing storage refill curves. Scott- the authority is fairly flexible, some uncertainty if this could include something other than low flow augmentation- but the low flow augmentation regime could be looked at. This would have to go through a NEPA process, since this would be a major change to the basin. Tacoma's HCP is not something that governs what the Corps does. The Corps has become more adaptive in how they store water. At one period, there was fish above HHD so there was a goal to pass fish before storage. They would pass inflow until mid-May or June, then go straight to minimum flow then store water in a short 1 to 2 week period. This regime ended with the EIS written in the late 90's, when they decided that fish in the lower river were probably not benefitting. The EIS helped incorporate more adaptive management. Nate- are there ramping rate guidelines? Scott- Yes, there are guidelines, they don't come into play much in the summer- they do though in the winter. The guidelines were established by WDFW to avoid stranding fish.

Regarding use of stored water, they try to be empty by Nov 1st, though try to hold onto 5k ac-feet in case there's a drought that persists into November in order to maintain minimum flows throughout November. Lance- are there scouring dumps of water after Chinook spawning that could have a negative impact? Late fall, if there's still stored water and a big storm comes in they would have to release some water since later in the year flood storage becomes the primary goal. Kollin- based on some of Josh Latterell's work, some high flow events have occurred in the fall around 6000cfs, but noted flows that do scour redds without being high enough to have habitat forming processes. Scott- not sure about the 6000cfs, may have been before the HCP. They manage the water and store it so that by the end of the fall the water is used and they don't have to dump any water. Lance- there is a concern about shift in earlier adult return time, which could stress water needs more. Maybe by pushing timing back later. Scott- this flow timing could be supporting the earlier adult return time instead of selecting for later timing when there's more water. There may be benefits to looking at the timing, which could mean we don't need to use as much water which could be used at other times. Kollin- historic run timing has shifted roughly 3 weeks sooner since pre-dam time. From standard practice of getting egg take early it has shifted timing, even before flow management started. Scott- the flow regime probably supports this.

Nate- 2013 was a very wet September, how were things different with water storage since things were so much different? Not sure, but several years lately we've have a lot of water in the fall- in these cases they use this water by releasing about 800 or 900 cfs. There wasn't a "dump", and since they knew they had the water they were able to use it rather than just dump it.

Scott gave a brief overview of the Green River Flow Management Coordination Committee. These are biweekly conference calls during the refill and augmentation period that occurs from late Feb to November. Any agency individual can participate. This is generally a discussion of environmental resource conditions, water supply, and water needs. WDFW and Muckleshoots also contribute fish data from spawner surveys and the screw trap. They also discuss the current status of water in the watershed, weather, and needs of the water for fish. They will then formulate a strategy for the next 2 week period, and use these to adjust water usage throughout the season for their capture and release strategy. Scott also presented a couple hydrographs to show reservoir elevation and how this water is used along with the average daily inflow and average daily outflow.

Kollin- Has the Corps been tracking temperature from top to bottom of reservoir or match the temperature outflow to inflow? Scott- there's a thermocline that builds up. Historically before new regime in 2007 where we were storing to 1167 feet, we would typically be augmenting cold water from the bottom (since the outlet is on the bottom), and they would run out of cold water in August or early September. Since they've started storing more water, that cold water has lasted longer because the thermocline us up higher. Now the cold water is probably lasting closer to mid-September (depends on the year). Kollin- are there requirements on temperature? There are on the Tolt, where they must match inflow. Scott- there is no ability to control outflow temperature. During the summer they use a small outlet low in the reservoir, which is at 1069 feet. The larger 19 foot tunnel is at 1035. So basically the outlet is below all of the water storage and below 1075 which is an "empty reservoir". With that said they have looked at temperature downstream. The effects of cold vs hot water release is really only limited to about 4 miles of the river below the dam, below that the ambient temperature and riparian conditions have more of an effect on stream temperature than the outflow temperature. So even if they were to match the inflow temp to outflow temp, the benefit would be limited to the short reach below the dam. Much of this is in the area where there aren't fish, but there is some benefit of the colder water below the headworks dam. Tyler added that this can be as high as 20 deg C coming into the reservoir, 16-17 coming out of the reservoir, then it's back up to 20 degrees very quickly.

Tacoma Water- Water Storage and Management - Tyler Patterson

Tyler presented an overarching view of Tacoma water management for those who aren't familiar. Tacoma has been using water for the city (of Tacoma) since 1913. The first diversion water right was established in 1912 for up to 113cfs, and is primarily for Tacoma and other wholesale customers along the pipeline. The second diversion water right was acquired in 1986 for up to 100 cfs. This pipeline (Pipeline 5) was used for the first time in 2006. This line has some connections with partner connections for Kent, Federal Way, and Covington. Other water is for environmental mitigation in the Green river. Looking at the watershed, Tacoma does not own the entire basin. They only own about 11% or 16k acres within the watershed which is primarily land associated with the mainstem and lower tributaries.

In 1920's- the water treatment facility would take raw water from the intake, then put chlorine gas in and send it off through a wood stave pipe. Today, they use a filtration facility that was completed in 2014 which was built based on the Department of Health's focus on cryptosporidium issues. It's common to have one or two detects of this per year but very very rarely to have it at lethal levels. With these concerns though, they had two options for ratepayers. Either spend $50m for UV treatment but may have to build filtration later down the road, or spend $200m and not have to worry about it again (which was the option they chose). The total cost was around $185m. They have raw surface water coming in from the intake, which goes through filtration and gets treated at the plant. They also have raw surface water coming in from the intake, which goes through the filtration plant and gets treated. Also, they have intake coming in from north fork well field- originally because of dirty water coming into the plant for which the Department of Health has a turbidity standard. The well field from Oct 31 into spring smelt provided buffering clear water so they could blend the turbidity to acceptable levels. This well field does not get used between July 1st and October 31st.

Tacoma water Habitat Conservation Plan (HCP)- over 800 pages completed in 2001 as a result of the listing of Chinook salmon. IN order to get a permit to continue to take water, they had to create and

adhere to the HCP. This is a 50 year commitment from 2001 to 2051. 32 species are covered by it including animals, birds, and fish. There are 66 conservation measures to follow to make sure that they are doing the right things for flow management, forestry, and wildlife with an emphasis on fish. Part of this is on the water rights. The right is for 113 cfs for pipeline 1, and 110 cfs right for NF well field which is for augmenting the pipeline 1 water. Doug- how rigid is the HCP for changes? Say if we get fish above the dam? Tyler- it would take working with NOAA, US fish, regulating agencies for any changes. The HCP is all the mitigations that have been identified, required, and signed. This document is a legal document under ESA. Kollin- was the possibility of Chinook above the dam taken into account when the HCP was written? Tyler- yes, this sets the target for the rate of draw down in the north fork, as well as the dates in which water is not drawn out of the well field to prevent de-watering. The flow in the North Fork already goes hyporheic for up to the lower mile of the river anyways, so they would not want to introduce fish to that regardless of well withdrawals. There are augmentation wells at the South Tacoma Way wellfield that they use so that they can reduce withdrawal in the Green in order to maintain the instream flows in really bad years. They go elsewhere for this water in these cases. So to go below 250cfs in the river there has to be a governor declared drought, in which case 225 is the lowest flow allowed at Auburn.

Tyler presented example graphic of flows for each of the pipelines. For example, on June 18, 2018, pipeline 1 had 41cfs, the NW well field 0 cfs, pipeline 5 at 81 cfs, coming out to 122 cfs total. For much of the spring, the water from the middle river helps meet the required flow at Auburn. For pipeline 1, it requires some pumping so they have to maintain it at 50cfs peak day demand, whereas for the newer pipeline 5 it's all gravity feed so they can run 117-136cfs peak day demand. Water demand peaked around 1979 and has decreased since then due to increases in efficiencies.

First diversion water right instream flow commitments- This is what is required of Tacoma under the HCP, as well as the 1995 Muckleshoot tribe agreement (rolled into HCP). This is to maintain the minimum flow of 225 at Auburn (for example in the summer of 2015 they did not pull any flow from the Green in order to meet this flow level)

Additional water storage project (AWSP) - Tacoma water needed more water for its second supply project pipeline, but they looked at the numbers for how much water that would take and they didn't have enough water to maintain flows in the river to meet these needs. This project in coordination with the corps raised HHD spring pool by 20ft in 2017, creating 20k acre feet of municipal and industrial water storage for Tacoma. They are currently donating 10k ac-ft of this annually for fish conservation, which is in lieu of there not being downstream passage at HHD. This water is available for fish flows in the summer, specifically for summer low flow to meet that 225/250 cfs. This 10k goes into ecosystem restoration program because it's more flexible than the fish conservation which follows the curve that Scott discussed. After fish passage is established, they won't need to donate this 10k annually. If they reach a point in the fall if they know that of the 10k not for fish (the other 10k) there will be plenty of water leftover, they will use that water for fish as well as the 10k donated. Another piece is that if we're pushing this limit for fish in the long term, there's phase II of the AWSP that hasn't been implemented. Under this they could raise the HHD full pool another 10 feet for the AWSP. At this point it's conceptual, and would require new mitigations. This water could be stored in the reservoir currently as there is capacity over full pool. Under phase I of the AWSP, they have the right to 20k ac feet, but because downstream passage hasn't been completed, they will donate the 10k to fish once they get to full pool. If they don't get to full pool, it's less. Matt- would require no modification, but would require operation

changes to store more water? Yes, would need to have higher capture rate and would have impact on the river downstream. Scott- may or may not need changes to the reservoir. The corps would need to look at the dam's ability to hold that water and if there would be some structural changes required hard to say at this point. Storage of water for flood is different than holding water at full pool.

Restoring fish passage- Diversion dam in 1920's was about 3 feet shorter than it is now. Changes were made to make the dam more sinusoidal so it can be safer for downstream fish passage. Prior to Howard Hanson, downstream flow minimum was around 87cfs. Today, intake is subsurface and the diversion dam backs up about a half mile. Water goes through a trash rack into stilling basin. This has 120ft long stainless screen to keep fish out of intake which has to meet NMFS guidelines, then the fish are diverted back to the river. Going upstream, the fish ladder entrance at the base of dam goes up 18 cells into adult trap and haul facility. This was constructed and operational in 2007, allowing fish to be trucked above both dams. Fish condition assessment on was done on coho in 2014 to look at abrasion, descaling, and contusions for fish using the ladder multiple times, and they didn't find any detrimental effects.

For downstream passage, Tacoma is about a 1.5% sponsor for the cost of downstream passage. For the first year they operated the upstream passage, took 1400 pink salmon upstream into the upper watershed to get a boost in nutrients and study their spawning. As they went forward it became clear that the downstream passage facility was getting delayed, so they held off on the work. Since then, they've done some coho releases upstream to see where they're actually going and making sure their spawning in the river and not falling back into the reservoir. Based on that, they did not find significant fallback into reservoir. From that point on, co-managers (WDFW and Muckleshoot) have been having some wild fish taken from the ladder for broodstock. This was recently discontinued this because of the unclipped Palmer fish which we can't tell apart from the wild fish, so many of these fish can be thermally marked and you can't tell for hatchery purposes.

In the upper watershed, there are some culverts that are hindering fish passage. Tacoma has been working on replacing these. They have done 30 of these since 2001, which has opened up over 23 miles of habitat for a shared cost of 4.2 million (calculation based on how much an owner owns within an area above the culver and they pay that percentage of the cost, though Tacoma does the management and construction). Based on this, Tacoma's cost is more like 1.3 million of the 4.2 million. Kollin mentioned that there are somewhere between 40-160 miles of spawning habitat above the dam. For the AWSP phase II, there may be around a mile of additional inundation of the river.

Fish habitat restoration in the upper Green- since late 1800's forestry practices have been logging all the way to the river. This has had many effects on the river, so Tacoma has worked with the USACE throughout the last decade to do instream wood additions in the mainstem and tributary streams. 1300 individual pieces of woods were placed out there in these structures as well as individual un-anchored logs. They are obligated to do this under the HCP for the life of the plan. Currently they are delaying this to time it better with fish introduction. Right now Tacoma is on a 5 year cycle mapping all the mainstem and floodplain habitat that exists. This is done at baseflow using ipads/iphones and ESRI collector with GPS receivers. They're looking to see increases in residual pool depth as well as pool volume with the wood structures.

Forest land management- Tacoma needs to make sure that the land is being managed for the benefit of fish wildlife and water quality as well. To accomplish this, their property is divided up into the following three "zones":

- The natural zone- these are proximate to most sensitive areas for water quality areas like riparian areas or even groundwater zones. They do not touch these natural zones, other than maybe management for improving a younger stand like thinning.
- The conservation zone- the target for this zone is for bringing a stand into a multi-story late successional type stand. Can do thinning, but not even age harvest. Once the stand is 100 years old they do not touch them again.
- The commercial zone- this area is for even age harvest work like clearcutting. With commercial zones, they are allowed to do thinning and harvest but on a 70 year rotation, while nearby landowners are on a 30 or 40 year rotation. These are done under FPA's, as well as bridge work. The 70 year rotation is much better for river baseflow conditions than the 30/40 year rotation cycle.