Ocean and Plume Science and Management Forum
January 19, 2017
Northwest Power and Conservation Council
Ocean Forum meeting notes
(Approved 10/26/17)

Attendees: Guy Norman (Forum Chair), Patty O'Toole, Erik Merrill, Karl Weist, Nancy Leonard, Tony Grover, Lynn Palensky, John Harrison, Kerry Berg, Jeff Allen, Kendall Farley, Stacy Horton (NPCC), Brian Burke, Laurie Weitkamp, Cheryl Morgan, Kym Jacobson, David Huff, Kurt Fresh (NOAA-NWFSC), Tim Copeland (IDFG), Doug Hatch (CRITFC), Erick Van Dyke, Cameron Sharpe (ODFW), Sam Gibbons, Nicole Czarnomski (WDFW), Lynne Krasnow, Paul Wagner (NMFS), Rudy Salakory (Cowlitz Tribe), Anne Creason (BPA), Mike Clark (USFWS), Catherine Corbett (LCEP), Kate Myers, Greg Ruggerone, Chris Wood (ISAB), Tom Iverson (Yakama Tribe rep), Shane Scott (PPC), Phil Trask (PC Trask).

1. Patty O'Toole (Council staff) welcomed everyone to the meeting and everyone in the room and on the phone introduced themselves.
2. Developments: Council staff announced that Phil Rockefeller, Washington Council member and ocean forum chair retired in 2016. Guy Norman, who was appointed to fill the Council position agreed to step into the role of Ocean Forum Chair, pending appointment by the chair of the Council. *Update: that appointment occurred February 1, 2017.

   In addition, Jim Ruff retired from the Council staff. Other retirements and staff changes have occurred within the forum membership. For several participants, this is their first forum meeting.

3. Council staff briefly reviewed forum history and the most recent meeting in March of 2016. This meeting focused on adult salmonid survival in the ocean. Thus return and survival forecasting, and the management implications were discussed. The notes from the March 4, 2016 meeting were reviewed and approved by forum participants.

4. Council staff described the Council's efforts to update its research plan. The draft research plan is currently out for public comment. The comment period lasts through March 3, 2017. Staff described some basic elements of the plan. The draft plan renews the critical uncertainties in the Fish and Wildlife Program, describes priority areas for review and possible new research as opportunities become available. The draft plan emphasizes reporting, dissemination of findings and a focus on management application of research. Staff encourages forum participants to review and comment. There are ocean and estuary critical uncertainties described in the plan.

5. Council staff summarized the purpose of the meeting today: Coupling between estuary and early ocean survival of salmonids – significance, mechanisms and opportunities.

    a. Brian Beckman, from the Northwest Fisheries Science Center presented: *Ocean-Estuary Coupling or how does freshwater/estuary history affect ocean traits*? Brian invited informal discussion as he proceeded through his presentation.

Brian began by reviewing the juvenile salmon survey by describing the survey methodology and locations. He noted that they sample only a small part of ocean salmon habitat and that in general, the sample sizes are small.

Brian described the difference in sampling results between the months of May and June.. They find more chinook in May and by June, the salmon are moving on up the coast and May appears to be very important for survival.

The research indicates there is variation in ocean entrance timing, residence time in the estuary, size, growth, residence in plume, etc. All of these add up to overall survival, with variation by stock. Different stocks utilize different places in the ocean but there is overlap.

Lynne Krasnow (NOAA) noted that most fish sampled are hatchery fish. She asked, if there is interest in hatchery stocks because of interest in managing these hatchery stocks or if there is interest because the hatchery fish are surrogates for wild fish? Brian answered it is both. He estimates they catch 95% hatchery fish.

Brian noted that they see variation in the timing of release of the fish from hatcheries, the numbers released, the distance to ocean, and the size of the fish at release. Yearling chinook salmon behavior differs from subyearlings.

Salmon abundance in the survey varies by month, stock and year. Upper Columbia and Snake spring Chinook salmon move very rapidly out of the river and up the coast, arriving in Alaska by July. Some go even further.

In May (averaged for all transects) the proportion of catch is similar to what was released from hatchery. In June, they see disproportionately more upper Columbia summer-fall fish. From May to June overall abundance changes, as well as proportions of different stocks. Migration and residence time for each stock appears to vary.

Nicole Czarnomski (WDFW) asked if size changes as well between May and June. Brian noted that the fish are different sizes at release so it gets complicated due to multiple processes going on. Survival can be size dependent and migration can be size dependent. They don't have a way yet to estimate the relative importance of each.

The weight of fish caught in the ocean varies by more than 2 times by stock. The changes from May to June could be growth or could be variations in survival being reflected in the samples. The size of fish in the ocean is correlated to size of fish at release so Brian posed the question: how can this information be used by managers? Data suggests that hatchery managers could change the size of fish released and that would effectively change the size of fish in the ocean, 1-2 months after release.

Paul Wagner (NOAA) suggested that it depends on goals of the hatchery program. Sometimes the goal is to mimic wild fish, sometimes it is to maximize survival. Size at release may be constrained by facilities, temperature of water or other things. Typically the size at released is targeting maximum survival.

Brian Burke (NWFSC) noted a challenge in that the range of sizes within a stock is less than the range between stocks. Different stocks are doing different things in the ocean, so differences in survival could be based on where they go, when they go and size when they go. A possible experiment would be to release a wider range within a stock and look at how they do.

Paul Wagner asked why the disparity between the proportion of hatchery fish seen in the ocean (95% hatchery) and what is thought to be the proportion of 80% hatchery fish (generally) in the river.

Brian Beckman noted that wild fish tend to be smaller and may be in closer towards shore and may not be sampled in the surveys. Brian thought it may be useful to look at the hatchery/wild proportion in the samples and compare against the hatchery/wild proportion of adults coming back.

Laurie Weitkamp (NWFSC) described seeing similar proportions in the estuary sampling program. They compared sampling in the mainstem and along the edges of estuary (shallow water habitats). They see some fall chinook subyearlings right along the shore, but generally the proportion of hatchery fish seen moving through the estuary looks the same as the samples in the ocean.

Doug Hatch (CRITFC) asked about the typical sample size. Brian Beckman said that for yearlings it can vary from 20 fish in bad years to a few hundred. The May catch can be in the hundreds.

Laurie Weitkamp noted that often “wild” fish are often actually unmarked fish. She noted that in 2016 she caught some unmarked fish that were unmarked and turned out (using parental based tagging) to be Dworshak hatchery fish.

Kym Jacobson (NWFSC) suggested that be the surveys might be missing some fish – in particular subyearlings, because of location. Subyearlings may be in closer to shore. Sampling gear is generally thought to favor yearlings over subyearlings.

Brian Beckman presented biomass data for Snake River spring chinook. Biomass (abundance x weight) varies by stock, month and year, but reflect annual patterns. These data are helping researchers understand density dependence. In poor ocean conditions, they have observed an increase in mean fish size. While counter intuitive, this can be explained by the fact that in poor ocean conditions, overall mortality is higher, and this tends to affect small fish more due to size-dependent predation, so size and growth of survivors can be relatively strong. Conversely, in years of good ocean conditions, growth can be lower because more fish survival, including small and slow-growing fish. Moreover, this increase in abundance can increase competition for food resources, further decreasing growth rates.

Brian Burke noted that there are some correlations between biomass and forage fish, but reminded the group that the surveys focus on salmon. The researchers are interested to see if they can better address the lower trophic levels. They have some data on chlorophyll, but very little on salmon prey. They would like to be able to describe prey field dynamics better but do not want to compromise the main sampling program. Brian suggested that they need to think about hake, sardine and anchovy. They feed at similar trophic level as salmon. Density dependence is very complicated and is something the ocean research community needs to consider more in the future.

Brian Beckman presented data on growth and survival in the ocean. Levels of IGF1 (Insulin-like growth factor) act as a good index of relative growth. For Snake River spring chinook, growth rates varies in the ocean across years as food supplies vary. In food limited years, less competitive fish die earlier, and growth can be better for the survivors versus years where all of the fish survive, creating more competition for food, so that growth may be slower. But it varies over time. In 2008, IGF levels indicated growth was good, and 2011 and 2012 were really good.

b. Laurie Weitkamp (NWFSC) presented *The Columbia River Estuary half of estuary-ocean coupling: more going on that we thought*.

Laurie described the methods and locations of sampling in the estuary. Sampling occurs during the spring out-migration, on incoming tides in the lower estuary. Results indicate that outmigration peaks in May in the estuary for yearlings, later in June for subyearlings.

Similar to the ocean sampling, catch of hatchery fish is very high, generally 85-95% hatchery fish. The “wild” fish often turn out to be unmarked hatchery fish. She observes stock-specific movement patterns through the estuary with some overlap and she observes similar patterns each year. The overlap of hatchery and wild fish and of many stocks in the estuary presents the opportunity for interaction, such as competition.

For chinook and steelhead there is high diet overlap. Specific stocks show a diet overlap of 60-80 % (amphipods & insects). If prey is limited, it appears that there is

competition for food. This could make a difference in survival if fish go to the ocean hungry versus well fed.

Based on preliminary data, it appears that when there are more fish together in the estuary, there tends to be reduced stomach content. There is more work to be done with this data for a more complete picture.

In terms of other behavioral interactions, if bigger fish have an advantage over smaller wild fish, wild fish may be at a disadvantage for food. There is a size difference between hatchery and wild chinook, and it is even more pronounced with steelhead. This could impact early (and thus overall) survival as well fed fish are more likely survive the early ocean and early ocean survival is important for overall survival in the ocean.

Laurie indicated that there are stock-specific differences for timing of ocean entry. The Willamette stocks tend to be very early, up to a month ahead of some other stocks and they grow very rapidly. Growth rates tend to even out in June. In 2016 outmigration was extremely early for all stocks.

Additional research, funded by the Corps of Engineers in the upper estuary is looking at the conceptual model that the estuary functions as a pipe, moving juvenile salmon out to the ocean with no or little feeding and growth. This new research is looking at estuary habitat restoration effectiveness at the landscape scale. Laurie's team is sampling out-migrating salmon at various locations in the estuary and looking for differences. They use a two boat tow-net and sample in April, May, June and July, at three sites. They look at species composition, density, genetic stock, and stable isotopes.

The hypothesis is that if the estuary were functioning primarily as a pipe, sample data would be uniform, with no significant differences. Results from the first year of the study show that there are big catches in May of yearling chinook and sockeye. Subyearling salmon appear in the samples later during June and July. Downstream sites exhibit great stock diversity. Different species assemblages were observed at each location, even between sites that are close to each other

Differences in diet for chinook (dominated by Snake River Chinook salmon) are seen at each site. The fish are definitely eating, and the data shows they are eating different diets at different locations.

Researchers are looking at stable isotopes in fish fin tissues. Stable isotopes reflect what was eaten recently. This information can show the source and trophic level of prey. Researchers were very surprised that the data are so different at each site. Very clearly, the source of prey is different.

Erick Van Dyke asked if they are looking into prey assemblages. Laurie said yes, they are working with OHSU to do additional work with stable isotopes.

IGF (Insulin like growth factor- indicator of growth) data shows a clear progression of increasing values which indicate eating and growth as the fish move from site to site through the estuary. Laurie said the data suggest that the estuary is not just a pipe.

Lynne Krasnow (NOAA) asked if fish have to be eating to be growing. Laurie replied that smoltification is definitely an issue. Studies show that even if fish are starved, they still grow in *length*. IGF, however, reflects true overall growth in that the fish are eating. Brian Beckman added that condition factor (length/weight) typically goes down during smoltification. This is similar to 15 year old boys eating burgers and milkshakes but staying skinny. They are growing in length and getting skinnier. The same hormones are at work with smoltification. For this reason, condition factor is a poor indicator of nutrition in smolting fish. Fasting fish will not have a high IGF level. Differences between sites shows there are differences in feeding but the relationship of IGF to growth may be different in the estuary versus the ocean, after smolting. Researchers are looking at gut contents and eDNA from gut contents to clarify the story. This may end up being a new tool for understanding survival mechanisms through the river.

Paul Wagner asked why IGF levels in the hatchery were low. Brian Beckman noted that these fish are sampled in March when the water is cold and that fish don't grow as fast in hatcheries as they grow in the ocean. Quality of food is different also.

The data for steelhead show differences between stocks and has varying results. Once again, different stocks appear to be doing different things. Generally, steelhead don't seem to eat as much and researchers are saw more empty stomachs. The Clearwater stock shows some feeding. This work will continue next year.

Tim Copeland (IDFG) noted that if they are sampling fish at Lower Granite Dam, this is in some cases, hundreds of miles downstream from the hatchery of origin. He suggested that if the researchers sample directly at the hatcheries, they might see similar results as chinook. Lower Granite is over 100 miles or more downstream of the hatchery for some stocks.

Laurie noted that researchers are trying to piece together the bigger story about how and where salmon are finding prey and how it links to wetland restoration. Various researchers are looking at different pieces to the story.

Guy Norman asked that if, indeed the estuary is not a pipe, is there an opportunity to look at residence times for different stocks? Laurie said yes, they can by using

tagged fish to determine release dates. Interior fish move faster than lower river fish. She also noted that otoliths might help to determine residence time. Otoliths will pick up different chemical signals as they pass different areas. Guy noted that could be important as estuary restoration continues, to evaluate how salmon utilize estuary habitat over time. Laurie agreed and said they plan to look at estuary residence time next year.

Catherine Corbett (LCEP) described LCEP sampling in the backwater habitats that are relevant to the discussion. They sample six sites throughout the lower river and find consistent patterns of species, timing and sizes of fish that use these habitats although it does shift over the year. LCEP also uses stable isotopes to evaluate feeding and growth. They look at prey to see what the fish are eating and what makes it into the tissues of the fish. They see similarities with the information presented today. Catherine suggested coordinating their studies and information. Laurie agreed and described various research efforts underway in addition to the landscape scale study. PNNL is working on a site scale study, looking at restoration and reference sites and how at the site scale, restoration projects benefit fish. Another study is looking at the food web and how food and nutrients move out of wetlands and into the mainstem river.

Greg Ruggerone remarked that it was interesting to see the high proportion of hatchery fish-95% in the presentations. He asked how that ratio of hatchery to wild changes in the ocean and compares to adult returns. Laurie noted they are seeing more wild steelhead than in past years. Perhaps the improvements being made at dams are be helping but hatchery/wild ratio between the estuary and ocean are almost identical. She also noted that the numbers of wild subyearling Chinook salmon were up in 2016. She said that wild fish tend to move out later, and their sampling tends to be earlier in the season when hatchery fish are migrating. The study probably has a bias towards hatchery fish.

More discussion

Paul Wagner noted that in terms of managing flow, reservoir management is a tool. The basic idea is to shape water into late April and early May for migrating smolts. Is this still right? Laurie suggested that May is really prime time.

Nicole asked about timing and how it relates to temperature and prey base. Different prey are available depending on water and air temperatures, and how it relates to timing is interesting and important. As we are trying to provide habitat and thinking about how fish can access these habitats, timing is really important. If flow peaks, but water temperatures are too warm, it does not help. In 2015 this was an issue and will be again someday. We need to plan restoration for today, but also 10 and 50 years out.

Brian Burke noted they have been working on a timing model and it is still evolving. They are interested in migration timing and how it effects Bonneville to Bonneville survival. We have a couple of metrics in the model that represent river flow and temperature. This gets at the idea that the experience the fish have in the river can influence their experience and survival in the ocean. There might be more data that we can incorporate from LCEP's work. We are very interested in that.

Laurie noted that flow does not just influence what is going on in the river, but also where fish end up in the ocean. In 2011 we found no salmon within 20 miles of shore because flow was high and like a hose, transported the fish further out. In 2001 we had low flow and the fish were very close to shore.

Paul Wagner asked if turbidity/or chlorophyll could be used as an indicator of conditions to influence timing, water management or other actions? That information appears readily available. Brian Burke said that he has looked at chlorophyll and distribution and it holds up ok, but they are unsure of the mechanism. Does more turbidity mean increased safety from predators or is it something else? Is not clear. They are considering creating a diagram of the primary mechanisms that influence survival and growth in ocean. At this point, chlorophyll does not seem to have a clear related survival benefit.

Brian Beckman observed that ocean conditions seem to be changing and are unpredictable. Instead of always thinking about trying to hit the best conditions, it maybe be better to look at average conditions over time and try to avoid the worst conditions.

Nicole suggested that residence time in the estuary is important but so is location where fish are spending time. Looking at prey - it seems available but is that always true and where is prey coming from? It would be helpful to know more about where food is coming from to better target restoration work, given it is so challenging and expensive.

Laurie noted that Curtis Roegner's flux study will estimate what is coming out of marsh habitats. Combined with the landscape scale study, it should provide a good idea of food inputs as the fish go downstream.

Guy asked if there are more advantages to restoring habitat in the lower estuary besides just utilization such as the potential to improve food supply. Laurie confirmed this. Snake River spring chinook are moving 60 km per day. They don't have time to hang around to feed very long. They would like to know how much is the indirect benefit of marsh habitat contributing towards their survival? It looks like the fish are getting drift insects. Not like in the marshes where they feed on other

species. Instead, it looks as if some food is getting transporting into the main channel. Guy observed that the fish don't really need to go to the restaurant if they are getting home delivery. Laurie confirmed this point.

Cam Sharpe (ODFW) noted that he is very interested in there are differences in transit time for Willamette fish released at different times? His interest is that if there is a risk of negative interaction between hatchery and wild in the estuary, can we release hatchery fish to make sure we have the fastest possible transit time to minimize interactions with wild fish? Laurie said they will be out in March this season and will let him know if they get any Willamette fish. She suggested that he be mindful that too early might mean more bird predation. One advantage of a large group of fish moving out together is increased protection from predators. Research on bird predation suggests that during peak outmigration the predation rate on individual fish is lower. Laurie noted that there is a need to balance risks and benefits in any strategy.

Greg Sieglitz (NOAA) asked if is there a way to intersect the status of primary indicators of habitat conditions in the estuary and corresponding juvenile fish use or trends. For instance, could residence time could be associated with quality and extent of habitat? Lynne noted that the work this far is a pilot effort from a landscape perspective. The idea being that if the estuary is a pipe to get them to the ocean quickly, then perhaps habitat restoration in estuary is not as important. This is the first year to see what we can find out to help put together hypotheses about the contributions of estuary habitat for fish coming out of the Snake River.

Greg commented that if the fish go out quickly, could that be because the quality habitat is lacking? He suggested that if the fish are only there short time it is possible that the behavior may be a derivative of what is available to them and perhaps it might be different if there was higher quality and quantity of habitat available. It may be important to consider key indicators of estuarine health to better understand relationship between juvenile fish and trends of those indicators, as opposed to just looking at the fish and deriving what is important in terms of habitat.

Catherine Corbett (LCEP) described their habitat change analysis (2009). They found that about 50% of available habitat in the estuary has been lost. But the big question remains, how much habitat is enough? If we recover to 60% that is a lot of money and effort. Is that enough to recover and sustain salmon in the estuary?

Guy said that coordination and collaboration of research and monitoring efforts could help. Lynne agreed and noted that the NW Fish Science Center also coordinates with the science centers in the California and Alaska to put the story together for the whole coast.

Kurt Fresh (NWFSC) reminded the group that we tend to think that all fish from a stock use habitat the same way, but as we add more habitat we are allowing more and more fish to utilize that habitat and increase the benefits to a more diverse group of fish. Just because we only see 2% of a population doing something does not mean it is not important. We need to look at different indicators to maximize diversity.

Cam Sharpe suggested that increasing the certainty about whether fish sampled are hatchery or wild is important. He noted that all Willamette fish are thermally marked and as long as otoliths are collected, unmarked hatchery Willamette stock fish can be identified. Unmarked Willamette hatchery fish levels can vary but it can be up to 30% at times. This could improve sampling. The hatchery fish have been 100% thermally marked since 1998. It is even possible to distinguish between different Willamette stocks and hatcheries. Cam suggested contacting Jeff Grimm in the WDFW otolith lab for more information. Laurie said that was helpful information and would do so.

Kate Myers (ISAB) was interested in coordination between managers and researchers to come up with the best types of experimental studies to improve survival of hatchery stocks. She asked if there are any ongoing studies where there is direct coordination between researchers and hatchery managers.

Brian Beckman said no, not for any one hatchery release. The chance of sampling fish from any one hatchery release is low due to low sampling numbers. Pit tags would be the best way to do this.

Guy Norman noted there are a lot of hatchery studies (diet, release strategies, etc.) but he is not aware of any that specifically connects to the estuary or ocean. Lynne reiterated the earlier comment it would be like searching for a needle in a haystack. It would require a very large release. Plus some of the best study ideas would have a large social consequence thus is not very appealing or feasible.

Laurie agreed. The sample sizes are very small. They only sampled 12 pit-tagged fish last year. The estuary and ocean studies are good at answering some questions, but not all. They don't sample enough fish.

Greg Ruggerone asked about when sampling occurs. Laurie said that samples are all day-time samples and the seine is only fished on an incoming tide. The tow-netting occurs on both incoming and outgoing tides. Brian Beckman noted that the ocean sampling occurs during the day only. They tried sampling at night but catch of salmon is better during day time sampling. Predators are out at night so salmon tend to stay really high in water column and they don't have gear to sample the surface. Logistically it is very hard to sample nights.

Rudy Salakory (Cowlitz Tribe) commented that these were compelling studies. He noted that it is good to know that we may be able to assess the value of habitat restoration in the estuary. He agreed with earlier comments that long term data sets are important.

Staff and Guy Norman thanked Brian and Laurie for their presentations and the discussion turned to the next Forum meeting. July would be the next opportunity for a meeting. Possible topics for the next meeting include:
relationship between DD and the amount of quality habitat in the estuary, an update on ocean indicators with data from 2016 (estuary indicators), hearing more from the managers about their needs, research objectives for FY 2018 and beyond, replicating the original full day workshop from 2013, improvements to forecasting, life cycle modeling, improvements to how we understand the PDO, etc.

End

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