**Columbia River Basin Fish and Wildlife Prog****ram**

**Ocean and Plume Science Workshop – Management Implications**

February 14, 2013 8:30am – 4pm

**I. INTRODUCTION**

**Council Member Phil Rockefeller**

Welcome

Meeting objectives

Meeting logistics

Introductions

***Participants***

*In the room:* Phil Rockefeller (NPCC- WA), Bill Booth (NPCC-ID), Doug Olson (USFWS), Kurt Fresh (NWFSC), Phil Roger (CRITFC), Karl Weist (NPCC-OR), Jim Ruff (NPCC), Patty O’Toole (NPCC), Rich Carmichael (ODFW), Dave Fast (Yakima Nation), Dan Rawding (WDFW), Greg Ruggerone (ISAB), Kate Meyers(ISAB), Tom Wainwright (NOAA), Tony Grover (NPCC), Kym Jacobson (NOAA- NWFSC), Ric Brodeur (NOAA- NWFSC), Brian Burke (NOAA- NWFSC), Brian Beckman (NOAA- NWFSC), Rich Zabel (NOAA- NWFSC), Jen Zamon (NOAA- NWFSC), Bill Tweit (WDFW), Catherine Corbett (LCREP), Jan Newton (UW), Lynne Krasnow (NOAA), Liz Garr (NOAA), Craig Haskell (USGS), Erik Robinson (PEW), Cameron Sharpe (ODFW), Julie Doumbia (BPA), Cindy Studebaker (ACOE), Bill Maslen (BPA), Antonio Baptista (OHSU-CMOP), Barry Espenson (CB Bulletin), Nancy Leonard (NPCC), Erik Merrill (NPCC), John Harrison (NPCC), Dan James (PNGC), Steve Marx (PEW), Michelle DeHart (FPC), Rob Jones (NOAA), , Ritchie Graves (NOAA), Raquel Crosier (NPCC-WA), Laura Robinson (NPCC), Robert Anderson (NOAA), Jeromy Jording, Tom Cooney (NOAA), Jill Hardiman (USGS), Laurie Weitcamp (NOAA-NWFSC), Jeff Bass, Ron Costello, Doug Hatch (CRITFC), Shane Scott (PPC), David Schoellhamer (USGS), Gary Johnson (PNNL), Henry Yuen (USFWS), Jeff Gislason (BPA), Krista Jones (USGS), Marcy Foster (BPA), Rosy Mazaika (BPA), Stuart Ellis (CRITFC), Barbara Shields (BPA) Howard Schaller (USFWS).

*On the phone:* Pete Hassemer (IDF&G), Jay Hesse (Nez Perce), Ruth Howell (NWFSC), Tom Iverson (CBFWA), Charlie Petrosky (IDF&G), Jessica Miller (OSU), Stacy Horton (NPCC- WA), Paul Wagner (NOAA), Rich Alldredge (ISRP), Sara Laborde (WDFW), Colin Levings (ISAB), Marc Trudel (DFO), Lawrence Schwabe (Grande Ronde Tribe), Bill Rudolph (Northwest Fishletter), Debbie Reusser (USGS), Bernadette Graham-Hudson (ODFW), Paul Krueger (BPA), Don Campton(USFWS).Jim Geiselman (BPA), Larry Telles (USFWS), Jeff Allen (NPCC staff), Don Van Doormik (NOAA), Stephen Zylstra (USFWS), Alex McManus (PC Trask), Chris Toole (NOAA), Cheryl Morgan (OSU).

**II. Review of 2009 Columbia River Basin F&W Program Ocean Strategy, npcc Research Plan and upcoming Program Amendment process:**

**Jim Ruff, NPCC**

Provided an overview of meeting objectives:

1. Help prepare for upcoming F&WL Program Amendment process
2. Update the Council’s Research Plan
3. Integrate ocean, plume and estuary science with natural resource management in the Columbia River

Jim described the 2009 F&WL Program Ocean Strategies: Manage for ocean variability by monitoring the Columbia River plume and climate change impacts on ocean conditions and evaluate their impacts on salmon survival. Distinguish ocean effects from other effects in freshwater.

Evaluate salmonid migration and survival rates in the estuary and marine environment; evaluate impact of flow regulation, dredging and water quality on estuary and plume habitat; and improve our understanding of the relationship between estuary ecology, near-shore plume characteristics and salmonid productivity, abundance and diversity.

**Patty O’Toole, NPCC**

Patty provided a background on 1980 Northwest Power Act, Gorton Amendment to the Act, subbasin plans, and the 2013 F&WL Program amendment process and schedule.

**III.SESSION 1**

**Kate Meyers, Greg Ruggerone, ISAB**

***ISAB Program Review Recommendations for Ocean Strategies***

*Background*: This presentation was a preliminary look at the recommendations of the ISAB in their *Program Review Recommendations for Ocean Strategies*, from of a report which is soon to be released. The F&WL Program directs the Council to “consider the impact of ocean conditions of fish and wildlife populations” and states that “the program recognizes the ocean as an integral component of the Columbia river ecosystem.”

*Key recommendations*: The ISAB would like the Council to consider the Columbia River Basin and the ocean as delineated ecosystems having strong linkages. The common thinking is that we can’t really control ocean conditions. The ISAB would like to shift this thinking because we feel that ocean conditions could be changed via changes in hatchery releases, hydro system operations, pollution control, etc. The ISAB recommends expanding the primary strategy to go beyond survival and to manage for viability. Ocean conditions including temperature, prey availability, and competition, have proven to be important factors in the life cycle of the salmon. The region should continue to work on predicting future ocean conditions and begin shifting salmon recovery targets with these conditions in mind. The ISAB encourages a broader view that goes beyond salmon and steelhead to include other anadromous fish species such as lamprey, sturgeon, smelt.

The ISAB has three main recommendations concerning the ocean section of the F&WL Program. First, the Program should emphasize that productivity of anadromous populations in the Columbia Basin is affected by physical, biological and ecological conditions in the ocean. Second, the ocean strategies in Program should be revised to have three main priorities: 1) to understand and isolate effects of ocean conditions on anadromous fish survival and growth to increase the power of analyses to detect the effects of freshwater restoration actions in Basin; 2) to determine the limits of restoration potential or effectiveness of actions taken in Basin given the variability of ocean conditions affecting anadromous fish; and 3) to predict future ocean conditions with a view to adjusting actions in the basin to achieve greater benefits and/or efficiencies. Third, the Program should emphasize coordination of ocean strategies across ecosystems to maximize the benefits of our RM&E actions to the basin’s fish and wildlife.

**Bill Tweit, WDFW**: Ecosystem-based management is a good goal. The Council should consider partnering with the Pacific Fisheries Management Council (PFMC) as they are working on an ecosystem management plan which would include the NW Coast. The plan may be a useful tool for the Council as it will include information on ocean and plume ecosystem features.

NPCC F&W Committee sent a letter to PFMC last November in support of their ecosystem management plan and the protection it provides to forage fish species which are a major food source for salmon and act as alternative prey for juvenile salmon.

**Kym Jacobson, NOAA - NWFSC**

***Overview of NOAA Ocean Program***

*Brief summary:* The main objectives of the multi-agency ocean survival program include: a) to identify how Columbia River plume and ocean conditions affect the growth and survival of juvenile salmonids during their initial months at sea; b) to predict how the dynamics of plume and ocean conditions will affect juvenile salmon growth, survival and adult returns; and c) to provide information about plume and ocean conditions to inform Columbia Basin policy and management actions. From 1998 to 2012, NOAA and its partners have been: a) measuring the distribution and abundance of juvenile salmonids with metrics of growth and condition; b) measuring physical and biological conditions in the ocean; and c) providing bi-annual summaries of ocean conditions and salmon run forecasts; and d) conducting estuary channel sampling of juvenile migrants to better understand juvenile salmon marine ecology and survival by knowing the timing and species composition of fish entering the ocean. Accordingly, NOAA conducts bi-weekly ocean/ plankton sampling, juvenile salmon sampling, plume sampling, as well as studies on predators, prey and competition for juvenile salmon in the ocean and plume.

**Antonio Baptista, OHSU**

***Managing to timing, thresholds and change—a view from estuarine and plume physics***

*Brief summary:* River management definitely does have an impact on the plume. In fact, a large percentage of plume variability (44%) is explained by changes in river discharge. Thus, FCRPS operations affect important physical aspects of the plume, the estuary and their connectivity. Both the estuary and plume are important to biology. We have ability to predict estuary and plume characteristics at different temporal and spatially detailed scales. Therefore, we have the potential to make in-season and long-term adjustments in how we manage anadromous fish and the ecosystem to affect success of recovery efforts. For example, we could time hatchery and barge releases to occur under better plume and ocean conditions based on forecasts to improve salmon survival. FCRPS river management operations can be used to locally control estuary/plume thresholds and benefit salmon; a flow threshold of at least 250 Kcfs is necessary for favorable habitat conditions in the estuary and plume. The time is right to get the fish managers, project operators and scientists to work together – we may now have the motivation and tools to make such a joint effort productive and transformative.

**Ric Brodeur, NOAA- NWFSC**

***Predator-prey interactions of salmon in plume and near-shore, implications for density dependence***

*Brief summary:* Competition can occur between different species or the same species. Salmon populations, rearing types and species overlap in distribution and diet in ocean. There is spatial overlap between wild and hatchery spring Chinook, as well as wild and hatchery steelhead. Juvenile fish don’t seem to be utilizing food sources in the estuary but move quickly to the ocean to feed. There is a large variability in forage fish density off of the Columbia River plume. An example of density dependence was presented which shows Chinook survival is 62% lower off Alaska when migrating to ocean in even years when there are large numbers of pink salmon present. There is some evidence of density dependence for Columbia River spring Chinook. Large releases of hatchery Chinook may compete with wild salmon, particularly when ocean conditions are poor. If fish are moving quickly through the river then they are more dependent upon ocean nutrients (which are variable). Juvenile salmon mostly eat krill and copepods. Coho, Chinook and jack mackerel are all feeding within a similar trophic level in the ocean. There is growing evidence that hatchery and wild salmon compete for prey at sea, leading to reduced growth and survival. But competition with other fish species is difficult to prove; more investigation is needed. Juvenile salmon are minor constituents of ocean shelf communities in the California Current and food web interactions must be considered to understand variation in salmon productivity and survival. Large numbers of jelly fish could potentially be competing for food with, and potentially impacting, salmon feeding. Juvenile salmon have many other predators; mackerel, sea birds, etc. Predation rates on salmon are difficult to quantify but are likely important to survival and may be related to availability of alternate prey. In years with low prey base, salmon can become alternate prey for predator species.

*Information gaps:* We don’t yet know where and when (temporal and spatial scales) density dependence occurs. We don’t know how do within and between population effects interact? Can we measure the carrying capacity of the ocean for salmon and other species? Even if we could measure it, how would we manage differently for density dependent effects if we find them? For example, could hatchery releases be adjusted in consideration of poor ocean conditions, predator migratory patterns, etc.?

**MANAGERS PERSPECTIVE ON SESSION 1**

**Dave Fast, Yakima Nation Fisheries**: From what I heard from Richard Brodeur, I understand that there are more forage fish in May than June. This type of information about abundance of prey could certainly have an important impact on release times and survival.

**Julie Doumbia, BPA:** How far in advance could you make run predictions?

**Antonio Baptista, OHSU:** Forecasts could be done two weeks in advance.

**Dan Rawding, WDFW:**The F&WL Program focuses on ecosystem concepts, and implementation should also integrate these concepts. Healthy ecosystems help all species. Partnerships are key for success in the ocean and in the Program’s work overall. We need to foster existing partnerships and extend partnerships. I’m excited about opportunities for adaptive management in the lower river, estuary and plume. It seems there is a need for some kind of forum to highlight a process for decision making and facilitate decision-making in real time.

**Rich Carmichael, ODFW**: Collaboration is the key for practical application. Teams could be developed to determine how to put fish in the right place at the right time to improve survival.

**Doug Olsen, USFWS:**US v OR hasn’t been mentioned yet, but it is an important part of how harvest and hatchery release decisions are made. Decisions about release timing, size, and rearing densities would have to be proven within existing models and would have to occur outside of US v OR. We talk about changes to river operations and hatchery release times but we need to look at the risk of changing these operations as well. Some pilot studies are needed before large-scale changes in hatchery release measures should be taken.

**OPEN DISCUSSION**

**Steve Marx, PEW Environmental Trust:**The conversation I heard today confirms for me that large harvest levels of forage species will have a huge impact on the recovery of Pacific salmon.

**Greg Ruggerone, ISAB:**What do we know about the plume residence time of salmon by species? Do some species stay in the plume as a refuge while others move out of the plume quickly?

**Ric Brodeur, NOAA- NWFSC:**The plume is important for all species because it is where all juvenile salmon learn about new ocean prey. We think all juvenile salmonid species probably stay a few days. That said, there are clear variances by species. Steelhead don’t seem to be utilizing the plume as much as salmon and are found moving northwest faster while smaller Chinook reside in the plume for longer periods of time. Studies have shown that the turbidity in the plume may be a benefit to juvenile salmonids because it is a less preferable environment for larger predator species.

**IV.SESSION 2**

**Brian Beckman, NOAA- NWFSC**

***Marine growth of hatchery Chinook salmon***

*Brief summary:* There may be a management conflict between hatchery fish production for treaty trust obligations and wild fish abundance to meet ESA obligations, and not all hatchery fish are equivalent. Competition may occur between stocks within a salmon species. Food demand is dependent upon fish biomass.

Some questions raised include: Are there too many hatchery fish in ocean depressing survival of wild fish? Is there a carrying capacity issue? Salmon populations in wild experience both compensatory and depensatory effects; density dependence is shown primarily at the extremes. What are the management linkages? There may be density dependence within-species, including overproduction or underproduction. There may also be trophic interaction dependence, including ecosystem-based harvest policies or smolt timing management.

Growth hormone (IGF1) of yearling CR Chinook during late June differs between years and areas; most fish are found in BC offshore waters (although some are in SE Alaska). We found that fish growth and distribution is “patchy” in ocean. There are some big differences in hatchery release timing and fish sizes at release in the CRB. For example, Willamette River spring Chinook represent about 36% of potential consumptive demand in May, but represent only 16% of release numbers by abundance, whereas SR spring Chinook represent only 17% of potential consumptive demand in May, but represent 35% of release numbers by abundance. That is, WR spring Chinook were shown to have the highest growth rates in May, whereas upriver spring Chinook have the lowest growth rates. But in June these growth differences disappear, e.g., they have similar growth rates. Does the presence of larger lower CR and Willamette spring Chinook in estuary and near ocean affect the growth rates of the smaller, upriver spring Chinook?

*Information gaps:* Food abundance hasn’t been measured in plume and ocean due to difficulties with finding an appropriate net. We don’t know when or where food is limiting growth and how this may vary in hatchery vs. wild stocks. We need better data on wild fish distribution, abundance, size and growth.

*Management options:* Could we change food demand by changing abundance and mean size of hatchery release by stock? Could we change spatial and temporal overlap by changing release timing by stock? We should also consider how river management options (such as spill, barging, spillway weirs) increase or decrease the spatial and temporal overlap in ocean by stock.

**Rich Zabel, NOAA - NWFSC**

***Examples of management applications that include ocean components***

*Brief summary:* The NOAA Science Center staff has been working with the federal Columbia River Treaty Team to run life cycle models as to how alternative storage and flow release schedules could impact fish migration rates and survival. The Science Center is also evaluating which factors influence within-season and year-to-year variability in smolt-to-adult return rates. One of the common principles is that if you get fish to the estuary sooner, they do better. Seasonal transport study has shown that in-river survival has increased in recent years. The Science Center is also involved in forecasting short-term risks of decline in listed salmon populations using an age-structured Bayesian approach. We are also working on life cycle modeling of salmon populations located in the interior Columbia River Basin. Broad scale climate indices such as PDO and ENSO on the ocean need to be considered.

*Information gaps:* Some key information needed to improve future life cycle modeling efforts include: a) better resolution of fish survival in the estuary, plume and ocean; b) a better understanding of the role of the ocean in population dynamics; c) better predictions of how local ocean conditions will respond to climate change; d) a better understanding of how fish condition after leaving the hydropower system interacts with ocean conditions; and e) a better understanding of potential density dependent effects in the estuary, plume, and ocean.

**MANAGERS PERSPECTIVES ON SESSION 2**

**Cameron Sharpe, ODFW:** How can we parse out the ocean survival of different run releases (i.e., Willamette hatchery vs. SAFE)?

**Brian Beckman, NOAA- NWFSC:** It would take a lot of tags, CWT or acoustic, sampling in May-September and a no catch regulation in September. In November there are tags collected off of Kodiak Island. Most of the larger spring-run Chinook likely head north quickly. Three tags have been caught in June from net pen facilities which leads us to believe that they are being released later. Dave Teal (NOAA) is now using *SNIPS* genetic markers for his analyses.

**Kurt Fresh, NOAA – NWFWS:** NOAA’s sampling is focused in May and June and clearly some Willamette Basin fish are in the ocean or estuary previous to their sampling. To really get answers on those fish, we would need to alter our salmon program to start in April. 160 mm hatchery fish have been caught over the last month at the estuary (at the mouth). They all have CWTs and are trying to determine where these fish are coming from.

**Dan Rawding, WDFW:** Is the early warning stock risk assessment modeling ready for prime time?

**Rich Zabel, NOAA – NWFSC:** Yes and no. The biggest issue is getting the needed data. The tool is ready to use but to use it predicatively we need river data in real-time. We also need ocean condition data in real time.

**Rich Carmichael, ODFW:** How do Willamette Basin spring Chinook salmon grow in comparison to Snake River fish?

**Brian Beckman, NOAA- NWFSC:** Willamette fish will have been in the ocean up to 6 weeks before the Snake River fish arrive. The Snake River fish are typically about half the size of the Willamette fish. Snake River fish are smaller at release and smaller when surveyed in the ocean. But because the Willamette fish are released earlier, they have more time to forage and grow in the plume before going out to the ocean.

**Pete Hassemer, IDFG:** It would be useful to have some of the ocean, estuary and plume science integrated into the F&WL Program. From a management perspective it is hard to tell the fish when to leave the hydropower system. Plus we have no control over migration timing for wild fish. An important question is how will plume and ocean conditions after the fish leave the hydropower system affect their survival? We are hopeful that the tributary habitat actions are improving their freshwater conditions, but without much of any control on wild stock travel times and entrance into the plume and ocean we have limited opportunities to alter migration timing.

**Jay Hesse, Nez Perce Tribe:** In the upper basin we use adult run forecasting for hatchery operations to plan for broodstock management for the coming year. Application of ocean conditions, or indicators, is becoming an important part of our run forecasting for management. Yearlings only account for about 20% of the annual release. It would be useful to hear about what is known about the sub yearling age class.

**Brian Beckman, NOAA- NWFSC:** There is limited data on the sub yearling age class.

**OPEN DICSUSSION**

**Catherine Corbett, LCREP:** It would be great to have more workshops on ocean research work and management. In the lower Columbia River and estuary, we are finding lipid content differences between hatchery and wild fish. As you go down stream the lipid content in hatchery fish goes down. However, the unmarked fish aren’t showing this trend. This type of information sharing is key to better ecosystem management. Low lipid levels make fish more susceptible to toxic contaminants.

**Lynne Krasnow, NOAA fisheries:** Hatchery fish have a lot of fat when they leave the hatchery while wild fish do not. We are not sure what the implications are but the trend is noteworthy.

**V. SESSION 3**

**Brian Burke, NOAA - NWFSC**

***Ocean Indicators-Current Knowledge and Future Directions***

*Brief Summary:* While inriver survival for yearling Chinook through the hydropower system dams is about 50%, the survival in the ocean is much lower (around 1-2%). Our ocean indicator work could help improve salmon managers’ preseason adult run forecasting process. NOAA is using a Maximum Covariance Analysis method (MCA) to do all of its run forecasts.  It allows us to include a large number of ocean indicators into one annual metric, but weights them according to how well they relate to salmon returns (a weighted average indicator). NOAA is working with salmon managers from ODFW and Nez Perce Tribe to develop pre-season run forecasts for hatchery Chinook in the Imnaha River and with ODFW on forecasts for wild Chinook from the John Day River. NOAA is also developing pre-season run predictions for steelhead. Instead of looking at the big picture, we should be looking at all the various direct impacts on ocean survival (from large-scale climate effects, river flow, coastal winds and ocean currents, to larval fish biomass, sea nettle biomass, copepod biomass). NOAA is using network analysis for that effort.

*Information Gaps:* We do not have information on direct predation rates in the plume or ocean.

*Management Applications:* Pre-season adult run forecasts are important to assist salmon managers in managing stocks for diversity. These run forecasts are also important for harvest management, estimating hatchery egg take, estimating escapement (hatchery and wild returns), and run timing diversity.

**NPCC Council Member Booth:** Thank you all for attending. I was struck by how much the ocean genre has advanced since I’ve been on the Council. Not only has the science advanced but it is advancing in the right direction such as looking for ways to apply the knowledge to survival and improve returns. Mortality in the ocean is huge. If we can get a handle on the key ocean indicators, we may be able to use the information in a practical way to develop better management tools.

**Jan Newton, University of Washington**

***Emerging Ocean Issues***

Brief Summary: There are three major risks to the ocean environment posed by climate change; 1) temperature change, 2) hypoxia; and 3) ocean acidification. Elevated temperatures in PNW waters are very likely, model estimates predict an increase of 1.2 degrees C (2.2 degrees F) by the 2040s, which could influence species ranges in ocean. Temperatures may be further affected by upwelling (or downwelling), weather events, mixing, stratification, and will certainly be increased seasonally over the baseline.

Hypoxia is the term used for an ocean condition with decreased oxygen and increased carbon dioxide which limits survival of many marine species. Dissolved oxygen levels in NE Pacific Ocean are expected to decrease as the upper ocean warms and becomes more stratified. Long-term declines in dissolved oxygen have been observed at numerous locations in the NE Pacific. For example, since 2002, hypoxia conditions have occurred off the Oregon coast every summer, including many years with severe hypoxia. Hypoxia conditions are expected to increase under climate change. Changes in the strength and pattern of upwelling winds and the oxygen and nutrient content of offshore waters can impact the likelihood and severity of hypoxia events.

Ocean acidification is caused by a prolonged reduction in pH, which is driven by increasing levels of carbon dioxide in seawater. Principal cause of it at the global scale is carbon emissions from human activities being absorbed by oceans. Ocean acidity has increased 30% since the start of the industrial era and is projected to rise 100- 150% by 2100. The current rate of acidification is nearly ten times faster than at any period over the past 50 years. Ocean acidification will impact marine food web health because many life processes are sensitive to small changes in pH. Acidification has implications for slower growth and higher mortality for shell-forming organisms (calcifiers). We also expect increased mortality among some species of pteropods, a type of plankton and a salmon food source. Washington near-shore waters are particularly vulnerable to pH decline because regional drivers can combine with global atmospheric CO2 contribution to exacerbate the acidification process. There are a lot of opportunities for partnerships with current ocean research (NANOOS, NOAA, UW, etc).

*Information gaps:* How much will seasonal ocean temperatures change in the future and how might those changes influence species ranges? What will be the future spatial definition of ocean temperature changes in the future? How can we better predict the onset and duration of upwelling in the near ocean environment, or even changes in SST? How can we predict the likelihood, severity and spatial patterns of future hypoxia events? How can we predict changes in ocean stratification? Don’t yet know how important local drivers are and species specific impacts of acidification. We need more information on the various carbon sources, sinks, and mechanisms driving spatial distribution and temporal variation in regional ocean acidification, and what is the relative magnitude of these drivers? What are the effects of regional land use on seawater dissolved organic carbon and pH levels? What is the effect of the Columbia River discharge and plume on ocean carbon dioxide and pH levels? How does freshwater input affect total alkalinity variation?

**MANAGERS PERSPECTIVES/OPEN DISCUSSION ON SESSION 3**

**Council Member Rockefeller, NPCC:** Are there issues with hypoxia and acidification in the plume as well as in the ocean?

**Jan Newton, University of Washington:** At this point we are unsure.Curtis Roegner and Antonio Baptista did a study that found hypoxia moving into the plume. When you have conditions for a hypoxia event you also have the right conditions for an acidification event. The Fraser River and Columbia River plumes seem to have opposite effects in regards to hypoxia. This has to do with the chemistry of the river water which could result from land use, nutrient content, etc.

**Catherine Corbett, LCREP:** hypoxia episodes are found in the estuary, and decreasing trends in pH in some places (Beaver Army Terminal). Some hypoxia and pH tracing will be occurring with F&WL Program funding through LCREP.

**Antonio Baptista, OHSU:** When you have a hypoxic event, you have the elements for an acidic event.

**Dan Rawding, WDFW:** It doesn’t look like the ocean indicators work is scaled down to the individual population scale. Will it be scaled down in the future?

**Brian Burke, NOAA – NWFSC:** The hope is that the work would continue on and look deeper at the population scale.

**Doug Olson, USFWS:** Much of the information presented has hatchery management implications. However, managers will need to weigh the benefits and risks of changing hatchery release schedules. The USFWS could use the help from Columbia River managers to identify data sets that can be applied to ocean indicators. Are there data sets that observe farther back in time to be able to understand ocean cycles more clearly? What is the uncertainty with all this ocean research data?

**Dave Fast, Yakima Nation Fisheries**: This ocean research is becoming very valuable, unfortunately the salmon life cycles are very complex and sometimes the science becomes conflicting.

**Jan Newton, University of Washington:** NANOOS is set up to bring coastal ocean data to decision makers and to work on data products that are going to make it more accessible to make the best decisions. NANOOS would be happy to work with the managers in the region.

**Brian Burke, NOAA – NWFSC:** Teasing apart the ocean vs. river effects would be good work. This hasn’t occurred yet due to time constraints. Some work has shown that there are 5-6 variables in the freshwater that directly correlate with PDO. Network analyses can model relationships as long as data is available – it allows one to infer from the times that you *do* have data what might have occurred in the portions of time that you *do not* have data.

**Howard Schaller, USFWS:** There is a need to combine ocean and freshwater variables together. The ocean indicators are fine, but we need to integrate the ocean indicators with freshwater indicators. What happens in freshwater appears to be very influential on what happens in the ocean. These are mixed independent variables with a short time series. Look at biological measures back through a longer period of time – try to get a better sense of what indicators really influence survival, they might be different variables.

**Rich Carmichael, ODFW:** We are taking ocean information into account in run forecasting. There were some really good examples of both how we are using this information now and how we might be able to use ocean information in the future. One is flow management and its influence on time fish spent in the plume. We could use some of the indices to adjust fish transport times in this regards. We need to think about how we can continue to have this type of dialogue between managers and scientists in the future. Forcing the forum to occur is necessary or people will get focused back in on their own work and the opportunity for collaboration will be missed.

**Phil Rogers, CRITFC:** I agree that we need to continue this dialogue. We need some setting to discuss ocean science/ management application and a methodology before people take action. Can data be applied to other stocks and populations?

**Brian Burke, NOAA – NWFSC:** Fall Chinook have been examined but the lack of age structure data has led to poor modeling. It’s easier to get age structure data on spring Chinook.

**Marc Trudel, DFO:** We have been conducting a study on Redfish Lake sockeye smolt migration from Lower Granite Dam on the Snake River to the ocean. This data is non-existent prior to 1998.

**VI. WRAP-UP DISCUSSION (***highlights***)**

**Council Member Rockefeller, NPCC:** One of the main ideas today was how we ensure a continuing open and ongoing dialogue between mangers and ocean researchers as a community. There appears to be support for this.

**Bill Tweit, WDFW:** In thinking of the importance of the offshore waters in WA state, our discussion today made me realize that it is really a two-way street; what goes on in the Columbia River has impacts on what goes on in the ocean and what goes on in the ocean has impacts on the Columbia. The Council should look into tracking some of the various other ocean forums: PFMC, West Coast Governors Alliance, and NANOOS. This would help the Council in gathering and sharing information, and in making policy recommendations. Council partnership would be mutually beneficial to these groups, especially NANOOS. NANOOS will look better in the eyes of their federal funders with support from NPCC and its stakeholders. Working in the ocean requires such partnerships.

**Kym Jacobson, NOAA- NWFSC:** We are here because of the idea of re-scoping ocean projects. What we need to hear from inland managers is that they are willing to follow-through on the management level implications. It is important to have management commitment and partnership in ocean research. We need to know that there is the interest from managers to try some experiments in adjusting hatchery releases or fish transport timing.

**Tony Grover, NPCC:** We need to develop the third leg to the stool, that is find a place for managers and researchers to come together. I invite Catherine Corbett to explore with us how to develop the third leg. We don’t want to tell the researchers and managers how to do their business but we would like to find a place where everyone can come together and have those conversations. LCREP could be such a place.

**Catherine Corbett, LCREP:** LCREP brings together inland, ocean and estuary folks and is willing to help coordinate an ongoing collaborative process between the ocean scientists and salmon managers. Everyone is stretched thin at this time so having clear objectives for the forum would help.

**Marc Trudel, DFO:** What does BPA think of this? Would an ongoing process provide BPA useful information for both the short- and long-term?

**Bill Maslen, BPA**: This is an overdue conversation. We are looking for information that informs management decisions in the freshwater; how the fish transportation system is operated, how to operate flow at dams, etc. We have talked about these issues in concept but not in any realistic or applied sense. The work has shown that the ocean is a variable environment; different stocks have different consequences of their environment. BPA feels that we have reached our BiOp requirements in ocean exploration. We need traction in real management decisions that can help improve salmon survival rates. It would be great if LCREP and NPCC could work together to bring together science and management to keep this information sharing process going and identify ways to get more out of the investment in ocean research.

**Jay Hesse, Nez Perce Tribe:** Partnership is key. Scientists need help looking at the right questions and salmon managers need help getting their hands on the most current science. I suggest a structured decision making process.

**NPCC Council Member Rockefeller:** We have identified many remaining ocean uncertainties today. Can we recap some of these critical uncertainties that may be useful to Columbia River managers?

*(The group did a round robin exercise to identify the critical uncertainties presented and discussed throughout the workshop. Staff has produced a list of these uncertainties on the following page).*

**UNCERTAINTIES:**

PLUME/ OCEAN CONDITIONS AND FOOD WEBS

* Are there predictable patterns in forage fish abundance in the plume?
* Can food abundance in the plume be measured? Is food abundance an issue for wild salmonids?
* Why do some juvenile salmonid species spend longer times in the plume while others move quicker north? Is fish health a factor in this?
* Can we predict the year-to-year variations in conditions? Seasonal ocean/plume/estuary conditions? And their impacts on fish?
* What are the major predators in the ocean? What are the major predators in the plume? How do these vary by species? What are predation rates in the plume/ocean?
* Where and when does density dependence occur? Could hatchery releases be adjusted to consider poor ocean years, predator migratory patterns, etc?
* Does density dependence within and between populations interact?
* Can we measure carrying capatcity in the ocean? Is it an issue for wild salmonids?
* What is the role of the ocean in population dynamics?

HATCHERY/ MAINSTEM/ RELEASE TIME

* Does hatchery fish diet have an effect on in-river and ocean survival?
* How good are hatchery fish as a proxy for wild fish?
* What are the on-site and off-site effects on the condition of fish as they exit the river and enter the ocean? How does this compare to data on survival in the first year?
* How can release times, transport times be optimized to benefit juvenile salmonids?
* What are the mechanisms of survival?
* How might alternative storage and flow release schedules impact fish?
* What is the role of large woody debris in the estuary and ocean, especially now that there is no longer much input because of the dams on the mainstem?
* Are hatchery fish having an impact on wild fish in the plume/ocean?

CLIMATE CHANGE IMPACTS ON OCEAN CONDITIONS

* How will ocean conditions such as acidification, hypoxia impact the survival of salmonids and salmon food sources?
* How do salmon but also other anadromous species function in changing ocean conditions?
* How does hypoxia impact the migratory patterns of salmon and their predator and prey species?
* Are the impacts of hypoxia and acidification just as prevalent in the plume?
* Why does upwelling not work anymore?
* Are there things we can be doing to alter or mitigate for acidification/ hypoxia? Can we predict the rate of progress of these climate related ocean issues?
* How can we offset the impacts of climate change?

**QUESTIONS FOR MANAGERS:**

* If we had information on ocean conditions in real time, how would we change our management methodologies?
* How are we going to translate science into a practical tool for management?
* For every fish benefit and potential management application, how do we evaluate risk of changing the current methodology?
* How can we shift management to focus at the ecosystem scale? While also looking at individual species and population variations?
* How much leeway do managers need to shift their management methodologies? And can scientists turn around ocean condition data to fit this need?
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