A: Coastal and Ocean Ecosystems – Current Findings Linking Plume and Ocean Conditions to Salmon Growth and Survival

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It is now recognized that throughout most of the 1980's and 1990's, ocean conditions in the Pacific Northwest region were poor, and ocean survival of Columbia River salmon was significantly affected. New insights now demonstrate that variations in salmon abundance are linked to phenomena on spatial and temporal scales that biologists and managers have not previously taken into account (the entire North Pacific Basin and decadal time scales). Over the past eight years we have demonstrated that the distribution, abundance, condition, and survival of juvenile Columbia River salmon vary synchronously with ocean conditions. Ocean conditions, in the context of salmon ecology, may be defined as that set of factors that control the growth and survival of salmonids during their life at sea. Those factors include for example ocean circulation, water temperature, upwelling, and the quality and quantity of the salmonid prey base. Ocean conditions affect the abundance of piscine and avian predators of salmon and pathogens which can in turn affect salmon populations. Each of these factors varies in linear and non-linear ways at seasonal, interannual and decadal time scales. These findings have given us new insights into the climate-ocean linkages and mechanisms which influence marine survival of coho and Chinook salmon and steelhead.

Pearcy in 1992 proposed several mechanisms that might account for interannual variations in salmon survival in the plume habitat when they first enter the sea. He suggested that low river inflow is unfavorable for juvenile salmonid survival because of: a) reduced turbidity in the plume (leading to increased foraging efficiency of birds and fish predators), b) increased residence time of the fish in the estuary and near the coast where predation is high, and c) decreased incidence of fronts with concentrated food resources for juvenile salmonids. This has led to testable hypotheses of mechanisms that control salmon growth and survival in the sea. These include 1) salmon growth and survival is controlled by quantity and quality of prey resources (bottom-up control), 2) predators and diseases impact salmon survival (top-down control), 3) interactions across trophic levels affect salmon survival (top-down, bottom-up control), and 4) interactions of river flow with the coastal ocean (plume structure) affect salmon growth and survival.

I will provide examples of how integrating physical and biological assessments of the coastal ocean environment of Oregon and Washington improves our understanding allowing us to test the hypotheses of how both "bottom-up" and "top-down" factors control juvenile salmon abundance, distribution, growth and survival and eventual adult salmon returns. I will further show how this information can be used to forecast how changing ocean conditions and future climate change will affect salmon. Understanding how ocean conditions affect juvenile salmon survival and eventual adult returns are necessary in order to manage and assess the benefit of freshwater actions taken to recover and rebuild endangered salmon populations.