Chinook migrations across the North Pacific Ocean

One species of Pacific salmon that has been in the news a lot lately are Chinook salmon, the "King" of salmon. As the largest Pacific salmon, Chinook are prized as a recreational fish, are important to First Nations in the U.S. and Canada, and get the highest price on a per weight basis of any salmon for commercial fishermen. Management of Chinook salmon is extremely complex because of the large number of ocean fisheries that target Chinook from Alaska to California and because many Chinook populations are subjected to multiple fisheries in both countries. Chinook salmon are also the preferred prey of Resident Killer whales. The Southern Resident Killer Whales reside from southern BC to California. They are the group that feeds on Chinook salmon during summer in the Strait of Juan de Fuca, Strait of Georgia, and San Juan Islands. Recent declines in this population of killer whales have been tied to declines in Chinook salmon abundance. At the same time, many Chinook salmon populations in Washington, Oregon, Idaho, and California receive protection under the U.S. Endangered Species Act because of concerns that rapidly declining populations may go extinct in the near future.

Because of both management and conservation concerns, Chinook salmon are the focus of substantial research to understand where and when they go in the ocean and the factors that determine their survival. Most of this marine research focused on Chinook salmon as they return home as adults with more recent research focused on the early marine period as they enter the ocean as juveniles. Both focal periods occur when Chinook salmon are close to shore and concentrated, and therefore relatively easy to catch by both fisheries as adults or with research nets as juveniles.

One fascinating outcome of this research is the realization that Chinook salmon appear to follow "ancestral feeding routes" during their time in marine waters. Every generation of fish migrate to the same areas at the same time in their life cycle, regardless of whether that area will provide abundant prey, and each stock has its own unique migration pattern. These patterns likely developed over thousands of generations because they were successful at producing returning adults. This fixed migration pathway has been observed by researchers working with juvenile salmon in both U.S. and Canadian waters, and with adults caught by ocean fisheries in both countries.

While we are learning where Chinook salmon stocks are during their early and late ocean migrations, where they go during the 1-4 years in between is poorly understood. Tagging studies conducted since the 1950s by high seas programs have shown that Chinook salmon originating from North America are caught in the Gulf of Alaska, central North Pacific and Bering Sea. However, there isn't enough data to determine if Chinook salmon maintain these ancestral feeding routes on the high seas, or let prey abundance determine their pathway: they move when prey is low and stay when prey is high. Even less is known about the location and migratory patterns of Chinook salmon on the high seas during winter, when we suspect that prey resources are low and abundant prey simply are not available anywhere. Additionally, we suspect that the conditions the juveniles encounter during their early marine period in the nearshore area can impact their subsequent success, especially during their first marine winter in the high seas. The intent of this expedition was to shed light on this winter period, examine the

distribution, abundance, and condition of salmon in the Gulf of Alaska, and to determine if our expectations were correct.

While our catches of Chinook salmon on this expedition are too low to say much about stock-specific distributions, we can say something about the condition of the salmon we caught and what they're eating. Our initial impressions are that all Chinook salmon looked very healthy without obvious signs of disease, injury, or starvation. All fish also had very full stomachs filled with deep sea squid and fish, both of which should be high quality prey. This suggests that these fish have encountered good feeding conditions, at least during this February and March, in the Gulf of Alaska. The fish were of mixed age classes and scales will be used to verify age and determine if any, especially the smallest individuals, were experiencing their first winter at sea. We will have a better sense of how healthy the Chinook were at a cellular level once back on shore when we can examine and analyze the numerous tissues we collected. We think all Chinook we caught originated from Washington and British Columbia, which will be confirmed with analyses on shore.

Because of their fixed migration pathway, there are concerns that Chinook salmon will not deviate from their feeding routes, even when conditions are poor and survival is low. Laurie Weitkamp, a salmon biologist with NOAA Fisheries who is on this expedition, has examined the recovery locations of millions of Chinook salmon caught in ocean fisheries over 1 ½ decades. She found that even when conditions were extremely poor, due to El Niño or other climate events, Chinook salmon still went to the same places, even when it wasn't a good place to be.

Clearly, for salmon to have survived for millions of years--experiencing ice ages, warming events, and everything in between--they have been flexible enough to adapt to changing conditions over time. Chrys Neville a biologist with Fisheries and Oceans Canada and another participant on the expedition, notes that various stocks have differing strategies including the time of year they enter the ocean. In BC, the Chinook salmon from the South Thompson region of the Fraser River, mostly enter the ocean in mid-summer rather than the spring with other Chinook salmon entering the Strait of Georgia. Over the last decade this group of fish have had improving escapements in contrast to most other stocks. This variability may be the strength of Chinook salmon. However, it may also mean that as managers we need to recognize that the Chinook and other salmon stocks that have been dominant in the last 20-40 years, may not be the same ones that are successful in the future.

Laurie and Chrys both note that this is further complicated by climate change which is increasing the rate of change in our oceans and extreme events such as "the blob" occur suddenly and without warning. How well Chinook and other Pacific salmon can adapt to such rapid changes is not known. However, by understanding the factors that regulate the survival we will be better informed to be able to successfully manage and sustain this species for years to come.