Emerging patterns

We have now completed 55 sets and covered both southern and northern areas of our study area. We are starting to see patterns emerge that are proving to be extremely interesting. In some cases our observations match our expectations, but in other cases we are surprised by the picture that is slowly materializing. The expected and surprising observations run across all aspects of the ecosystem we are studying, from water chemistry to plankton to fish. Here are a few of the highlights:

The over-arching objective of this study is to examine Pacific salmon immediately after the winter period, when the expectation was that prey availability would be low and only fish that had high energy reserves last fall would survive. We expected to possibly even see visual signs of this with more thin or "skinny" fish than would be typically seen in a summer survey. While there appears to be signs that this may be the case for some species of salmon, it is not, at least directly, clear for other species of salmon.

Chum salmon have been our most abundant salmon species to date, representing about half the catch of all salmon, and are widely distributed across the study area. They have the largest body size range, from small 25-cm-long fish that have just completed their first winter in marine waters, to large 55 cm-long individuals that have spent at least 3 winters in marine waters and—based on the size of the gonads—will likely spawn this coming fall.

While chum abundance is high their condition appears to be is lowest of the salmon captured. Many of the chum salmon are visually thin or what we expected to see at this time of year. Additionally, many of their stomachs are empty. We expected that prey availability in winter would be low resulting in skinny fish, and the condition of these chum certainly seem to indicate this has been the case. With the spring bloom starting, these fish should now start to increase their feeding and should grow and fatten up quickly over the coming months.

However, in stark contrast to Chum salmon, the coho and sockeye salmon which represent about 40% of our catch, appear to be in better condition. Specifically the large sockeye over 450 mm are large and fat, have full stomachs, bright red flesh and eggs and a visible layer of fat just under their skin and coating their internal organs. These larger fish are primarily found in the northern portions of our study area. Along with a different distribution than the majority of the chum salmon we have caught, the sockeye salmon eat different prey. Their diet has largely been zooplankton (copepods and krill) compared to the chum salmon that, when eating, are feeding on gelatinous prey including jellyfish, salps and comb jellies). It remains puzzling as to why their condition would be so different from the chum salmon. The discussion amongst the scientists on the ship on this topic is continuous and it is clear that further analysis from the biological samples we have collected are going to be important in providing the clues needed to untangle this puzzle.

The coho salmon and smaller sockeye salmon are more middle of the road in appearance. What is puzzling about coho salmon is they're considered to be a coastal species that remain near shore throughout their marine life. Instead, we are catching relatively large numbers of coho (our 2nd most abundant salmon) over 1000 km from land. The on-board genetic analysis of the first 30

coho we caught showed they were from a variety of rivers stretching from Puget Sound to northern British Columbia. Is the distribution of coho salmon we are observing a new phenomenon or have coho always used this part of the ocean and we simply have not been out here sampling sufficiently to know this?

Although pink salmon are the most abundant species across the North Pacific by far, less than 10% of our catch has been pink salmon. Pink salmon are also known for their strong even-odd year abundance pattern, with much larger returns to Asia, British Columbia, and Washington in odd years than even years. Since this is an odd year we expected that pink salmon would dominate our catch. So where are they? The pink salmon we have caught have all been in the southern-most part of our study each, where ocean temperatures are warmer. Reports on temperature preference of pink salmon has been varied. Published literature indicate that they possibly have a greater tolerance for higher temperatures than other salmon but they are still considered to inhabit waters to 3C. In our expedition, we have not caught pink salmon in areas with surface water lower than 6C.

A key part of the winter habitat experienced by salmon in the Gulf of Alaska is the quantity and type of zooplankton available for consumption and to support other components of the food web observed in the salmon diet, e.g., squid and small pelagic fish. To provide this information, Brian Hunt and Evgeny Pakhomov of Canada (UBC) and Alexander Slabinskii of Russia have been conducting routine zooplankton net tows at each sampling station. A part of the zooplankton catch is processed onboard while further, more detailed analyses, will be conducted when we return to land. Preliminary observations, however, are sufficient to identify substantial shifts in the zooplankton community across the survey area, and a rapid seasonal advancement with the approaching spring.

Zooplankton catches have ranged from modest to relatively large for the later winter period. The greatest difference in composition has been observed latitudinally, form south to north. The zooplankton catches in the southern part of the have been dominated by very small copepods, mainly in the size fraction <0.5 mm. However, moving north, the community shifted to being dominated by large copepods, about 7-8 mm in length, mostly *Neocalanus cristatus*. There has also been an increase in the occurrence of euphausiids (shrimp-like crustaceans), mainly *Euphausia pacifica* and *Thysanoessa spinifera*, and pelagic decapods of genera *Sergestes* from the mid-survey northward. Both of these groups are strong vertical migrators and are usually only caught in abundance during the nighttime tows when they are near the surface to feed, residing deeper than 200 m during daytime. Both large copepods and euphausiids are a valuable food for growing salmon.

Gelatinous plankton have been extremely abundant in most parts of the survey area. In the south western corner of the survey grid, the pelagic tunicate *Salpa aspera* has been highly abundant. These tunicates disappear from the catches north of 50^{o}N and are replaced by various jellyfish species. By far the most abundant of these jellyfish is *Chrysaora melanaster*, the star jellyfish. In the northern part of the survey grid this species is ever present at the ocean surface during the night, clearly observable in the ship lights during trawls. Five minute surface counts in a 20 meter window adjacent to the ship have ranged from 200 to over 3000 individuals. The

differences in the species present in the north and south of the survey area also mean differences for the food web. Salps are little open ocean “vacuum cleaners” feeding on microscopic plants (phytoplankton), while jellyfish are voracious predators feeding on small zooplankton and possibly compete with salmon for food.

Our survey is occurring during the transition from winter to spring conditions. A persistent high pressure system centered over the Gulf of Alaska has not only brought us good weather for much of our expedition, but has also provided the necessary sunlight to kick start the spring phytoplankton bloom. As our survey has progressed we have observed a steady increase in the phytoplankton biomass.

Understanding what is driving the trends we are able to readily detect is what many of the scientists on the expedition and other colleagues at home will spend time over the coming months discussing and analyzing. The patterns we’ve described here are just observations we’re making from looking at what we’re catching in our nets, our emerging sense of the “big picture.” We’ll have a much deeper understanding of emergent patterns once we’ve processed the 1000s of samples we’re collecting and start putting it all together. Stay tuned!