Pink salmon and their plankton prey

Image: National Oceanic and Atmospheric Administration/Department of Commerce.

Data from the Continuous Plankton Recorder survey has highlighted an unusual control on plankton populations in the North Pacific. By **Sonia Batten**, **Greg Ruggerone** and **Ivonne Ortiz**.

Pink salmon are the most abundant of the Pacific salmon species and have a fixed two-year life cycle between hatching in the rivers, migrating to the open ocean to feed and mature and then returning to their native river to spawn and die. In some regions, alternate years have very different numbers of pink salmon, often referred to as the odd-year and even-year runs, which are almost entirely genetically separate from each other. The parts of the ocean where they go to feed and grow may also experience the same high and low densities in alternating years.

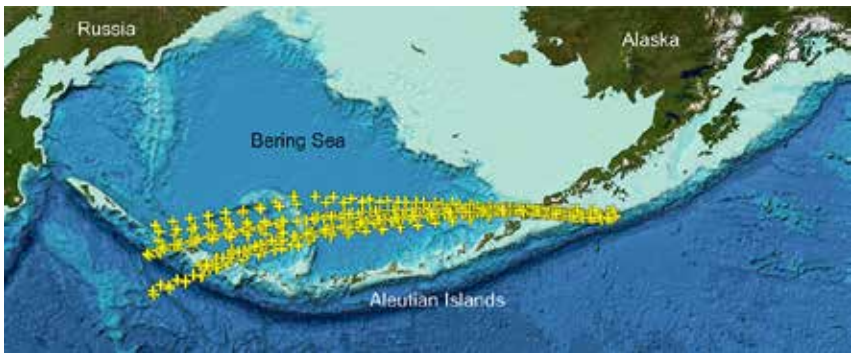

Figure 1. Map showing the study region in the southern Bering Sea and around the Aleutian Islands. The locations of the plankton samples are shown by yellow crosses and fall along the North Pacific Great Circle Route used by commercial ships.

A monitoring programme to sample and record plankton has been running in the North Pacific since 2000, using continuous plankton recorders towed behind commercial ships. Plankton are the tiny free-floating plants (phytoplankton) and animals (zooplankton) that form the base of marine food chains. When looking at the summer samples collected from around the Aleutian Islands and the southern Bering Sea (Fig. 1) we noticed that some of the plankton groups showed a strong alternating year-to-year pattern in numbers. In addition, the phytoplankton pattern was opposite to the zooplankton pattern (in this case diatoms and large copepods, respectively). This suggested that impacts from pink salmon, which feed on zooplankton, were moving *down* the food chain, also known as a 'trophic cascade' effect. When numbers of pink salmon were high (in odd years) the numbers of copepods

were low because they were being eaten by the salmon. The reduction in copepods meant that their phytoplankton food, the diatoms, could grow unchecked and so numbers were high. We saw the reverse pattern in even years: fewer salmon leading to more copepods and so fewer diatoms (Fig. 2). What was also interesting was that while the pattern persisted from 2000 to 2012, the 2013 odd-year run of pink salmon was unexpectedly low and the plankton numbers responded. It was clear there was a strong relationship between predator and prey.

This finding is highly unusual because most of the time the changes we see in plankton numbers are caused by changes in ocean climate (temperature, currents and so on). That is, environmental or climate control of plankton populations is a much more common result and we expect these impacts to be passed up the food chain to the fish, birds and mammals that feed on them, not to see impacts on plankton at the base of the food chain by a single predator. Our unique findings further suggest that in this region, in years when pink salmon are very abundant, there may not be enough plankton around for other species to feed and grow as much as they potentially could. Pink salmon are found in many rivers around the North Pacific rim. The stocks feeding in our region of interest were likely wild fish from East Kamchatka, Russia, but in many places the numbers of pink salmon are increased by releasing fry from hatcheries into rivers. Our result implies that hatchery production may not lead to more pink salmon returning as adults if food in the ocean is limited, and in fact may impact other species of salmon, fish and seabirds that feed in the same area.

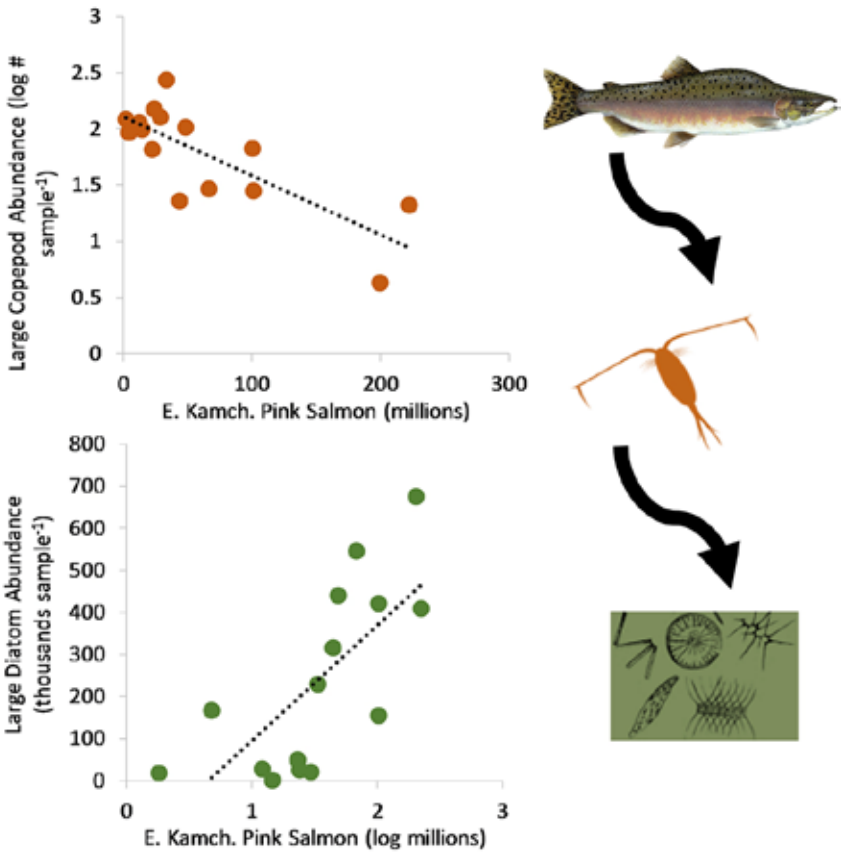

Figure 2. The trophic cascade effect – the relationship between East Kamchatka pink salmon (data from Ruggerone and Irvine, 2018) and plankton around the eastern Aleutian Islands. In years with high pink salmon abundance, there are fewer large copepods (upper) and more diatoms (lower).

Box 1. Pink salmon facts

Pink salmon (*Oncorhynchus gorbuscha*), also called Humpies in Alaska, are at the highest abundance in the North Pacific since records began in 1925. Pink salmon represent nearly 70% of all Pacific salmon. Pink salmon are especially abundant in odd years (600 million per year) compared with even years (312 million per year). Hatchery pink salmon production in Alaska and Asia is tremendous (82 million per year), exceeding total abundance of wild chum salmon (53 million per year) and nearly equal to wild sockeye salmon abundance (85 million per year).

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Further reading:

Batten, S.D., Ruggerone, G.T. & Ortiz, I. (2018). Pink Salmon induce a trophic cascade in plankton populations in the southern Bering Sea and around the Aleutian Islands. *Fisheries Oceanography*. https://doi.org/10.1111/fog.12276

Ruggerone, G.T., & Irvine, J.R. (2018). Number and biomass of natural- and hatchery-origin pink, chum, and sockeye salmon in the North Pacific Ocean, 1925-2015. *Mar Coast Fish*: 10:152-168. https://doi.org/10.1002/mcf2.10023