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Foraging strategy, prey preferences and limited competition among forage fishes in the San Juan Islands: implications for Chinook recovery

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Introduction
Puget Sound Chinook remain at historically low levels despite harvesting restrictions and efforts to protect, reconnect, and restore their spawning habitat. Concern is shifting to bottom-up factors, in particular the marine diet of juvenile Chinook. Juvenile Chinook out-migrants eat less fish than a decade ago. This may reflect shrinking stocks of Pacific herring, and other forage fishes, which in turn may be due to the impacts of pollution and climate change on their zooplankton prey.

The extent to which herring compete with other forage fishes for limited prey opportunities in the Salish Sea is poorly understood.

Materials and methods
Forage fish and juvenile salmon were collected by 80- and 120-foot beach seines set in 2-3 fathoms by small powerboat at Watmough Bay (Waldron) in the course of a community monitoring program launched in 2009. Forage fish were rinsed in 95 percent ethanol in the field and refrigerated prior to dissection. Gut contents of 295 forage sampled in 2021 were processed. Fish with fewer than 65% of prey items identifiable were excluded from analysis.

Zooplankton and large diatoms were collected by oblique tows using a bongo net with 60-cm long, 335-μm mesh socks, conducted on the same dates and tides as seines at each study site, as part of the Puget-Sound-Wide Zooplankton Monitoring Program.

Results
When multiple species co-occur in a confined habitat, comparing their gut contents with an independent measure of what was available to eat (the prey field) can reveal differences in foraging strategy and preferred targets. Overlaps in prey choice under these circumstances suggest that limited resources can result in prey limitation on growth and survival.

On this date, for example, herring and Pacific sand lance targeted euphausiids (krill), crab larvae, hyperiid amphipods, and the largest calanoid copepods. Juvenile Chum salmon were present as well and largely targeted the same prey. Separately, we have found that juvenile Chinook target the same crustaceans in their migration through the islands.

Juvenile Chinook in the San Juan islands compete with their principal prey (herring and sand lance) and juvenile Chum salmon for crab larvae, krill, large calanoids, and hyperiids. Selectivity and competition make them highly vulnerable to changing conditions in the Salish Sea.

Unlike herring or sand lance, anchovies feed indiscriminately and as a result often feed at a lower trophic level than other forage fish. Anchovies may therefore be more resilient and sustainable prey for salmon in the long term.

In 2021, juvenile anchovies arrived at our study sites near the end of the Chinook outmigration, and were predated by Chinook.

Implications for salmon recovery
Juvenile Chinook in the San Juan islands compete with their principal prey (herring and sand lance) and juvenile Chum salmon for crab larvae, krill, large calanoids, and hyperiids. Selectivity and competition make them highly vulnerable to changing conditions in the Salish Sea.

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Literature cited

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