Apr 26th, 4:30 PM - 5:00 PM

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

Russel Barsh
Kwiaht

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

Russel Barsh, Madrona Murphy, Alex Assaf, and Brianna Bjordahl, Kwiaht (info @Kwiaht.org)

Introduction

Puget Sound Chinook remain at historically low levels despite harvesting restrictions and efforts to protect, reconnect, and restore their spawning habitat.[1] 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.[2] This may reflect shrinking stocks of Pacific herring,[3] 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 (Lopez) and Cowlitz 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 fish sampled in 2021 were processed. Fish with fewer than 65% of prey items identifiable were excluded from analysis.

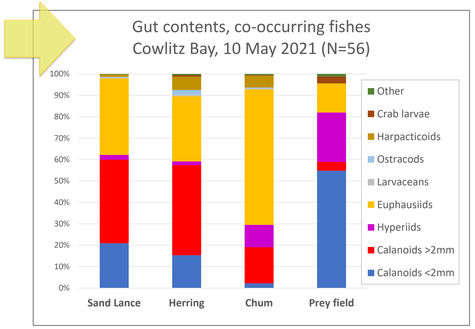
Zooplankton and large diatoms were collected by oblique tows using a bongo net with 60-cm long, 335-µm mesh socks, conducted on the same dates and tides as seines at each study site, as part of the Puget-Sound-Wide Zooplankton Monitoring Program.

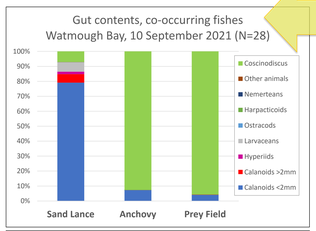
Results

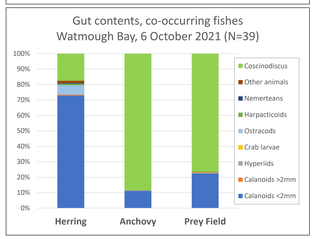
When multiple species co-occur in a confined habitat, comparing their gut contents with an independent measure of what was available to eat (the prey field) can reveal differences in foraging strategy and preferred targets. Overlaps in prey choice under these circumstances suggest that limited resources 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.[4]







While herring and sand lance appear to forage selectively and "peck" at high-value prey items, Northern Anchovy gut contents tend to match the prey field, as seen in these two examples of anchovies co-occurring with other forage fishes at Watmough Bay in fall 2021.

Nonselective feeding by anchovies is confirmed by a significant gut burden of both woody debris and microplastic fibers, which were rarely found in herring or sand lance. By comparison, herring gut contents often included tiny sand grains and benthic organisms such as nemerteans absent in sand lance meals.

Large discoid diatoms (*Coscinodiscus spp*) comprised a large part of the diet of juvenile anchovies, a level of herbivory that we never observed in several years of study of the diets of sand lance and herring in the islands.

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.

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.

Literature cited

1. R. Barsh, M. Murphy and E. Fisher, "Juvenile Chinook", P. 59 *in* PSEMP Marine Waters Workgroup. 2020. *Puget Sound marine waters: 2019 overview*, J. Apple, et al. (Eds).

2. R. Barsh, M. Murphy, M. Howard, and E. Fisher, "Juvenile Chinook ", P. 49 *in* PSEMP Marine Waters Workgroup. 2021. *Puget Sound marine waters: 2020 overview*, J. Apple, et al. (Eds).

3. T. Sandell, A. Lindquist, P. Biondo, K. Olson, and P. Dionne, "Pacific herring", P. 57 *in* PSEMP Marine Waters Workgroup. 2020. *Puget Sound marine waters: 2019 overview*, J. Apple, et al. (Eds).

4. Chamberlin, J., Gamble, M., Connelly, K., Gardner, J., Barsh, R., Keister, J., Beauchamp, D., Schmidt, M., Beckman, B., and Warheit, K. 2017. *Assessing early marine growth in juvenile Chinook salmon: factors affecting variability in individual growth in Northern Puget Sound*. Seattle: Long Live the Kings.

Acknowledgments

We are indebted to Dr. Julie Keister and Amanda Winans at the University of Washington School of Oceanography for their prey-field analyses. This study was made possible by a grant from the National Fish and Wildlife Foundation Killer Whale Research & Conservation Program grant. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government or the National Fish and Wildlife Foundation and its funding sources.