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Vignette 10: Biological Repercussions from Microplastics in the Salish Sea

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10 BIOLOGICAL REPERCUSSIONS FROM MICROPLASTICS IN THE SALISH SEA

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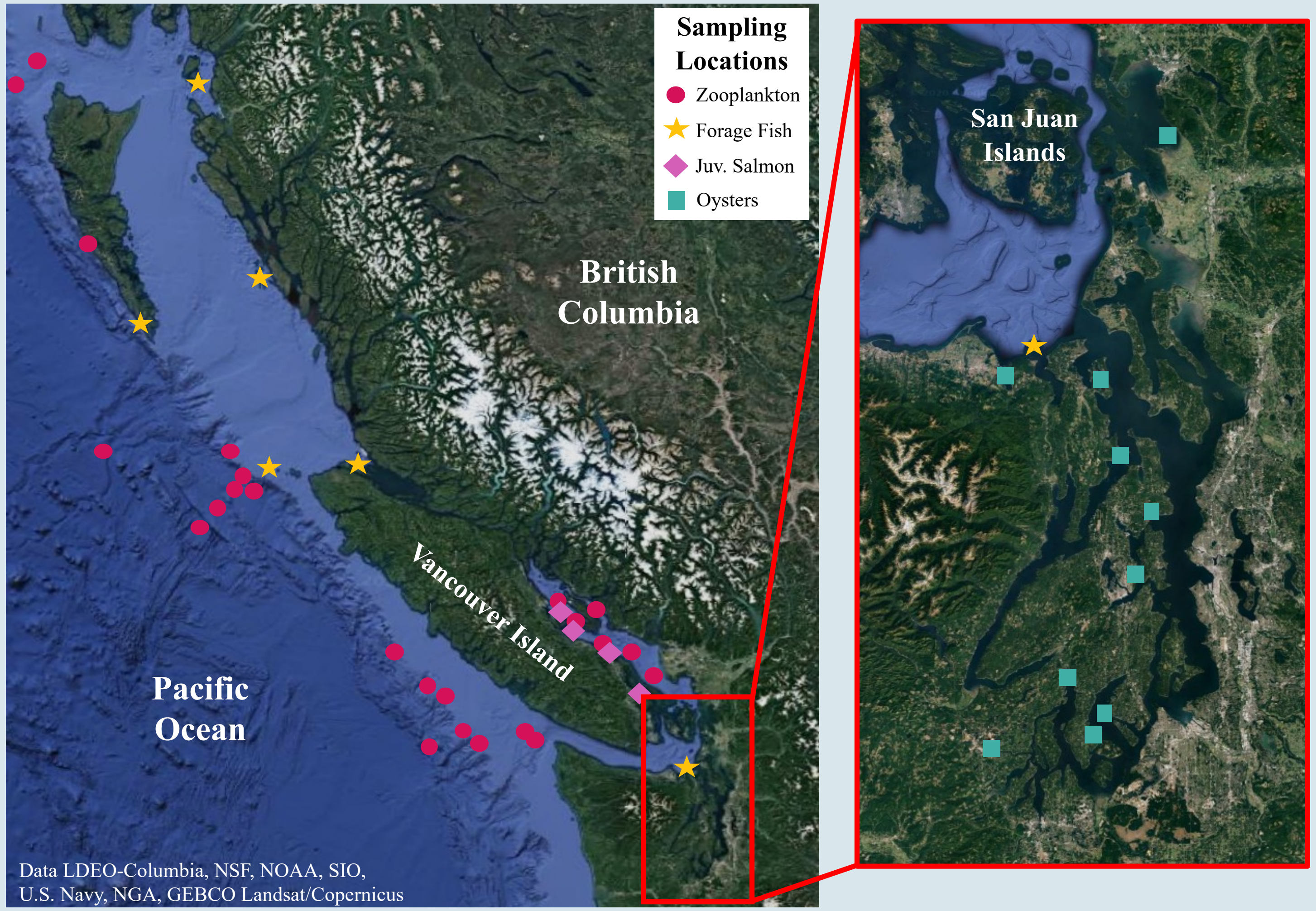
Microplastic (< 5 mm) consumption and the movement of microplastic through the marine food web is an emerging concern in the Salish Sea. Upon consumption, marine plastics can physically and chemically affect marine organisms. Physical effects from eating it include obstructing an organism's mouth and/or throat, blocking its digestive tract, artificially filling its stomach, and absorbing into other parts of its body (Cedervall et al. 2012; Cole et al. 2013; Rochman et al. 2013; Desforges et al. 2014, 2015). Chemical pollutants in seawater can bind to microplastic particles and "hitchhike" their way into marine organisms only to leach after consumption. This can cause: (1) male fish to produce proteins commonly found in female fish, a process known as feminization; (2) endocrine disruption, which can lead to developmental malformations or disturbances in the immune and nervous systems; and (3) bioaccumulation within an organism (Tian et al. 2021). It is important to note that effects from plastics may be unique among species, types of contaminants, and types and sizes of plastics (Desforges et al. 2015; Ašmonaite et al. 2018).

Few surveys of microplastics in marine organisms in the Salish Sea have been conducted to date (see map figure, adjacent page). Zooplankton, bivalves, forage fish, salmon, and orcas are species of concern for direct microplastic consumption or secondary consumption via trophic transfer. Species at the base of the food web, like zooplankton, are likely to pass consumed microplastics on to their predators. Feeding behavior and physical characteristics influence the quantity and size of microplastics eaten by zooplankton (Cole et al. 2013). A field study in British Columbia determined encounter rates were one particle per every 34 copepods and one particle per every 17 euphausiids, but found that exposure and consumption were not correlated (Desforges et al. 2015).

Filter-feeding bivalves can retain microplastics directly from the water or indirectly by consuming zooplankton that have eaten microplastics. Oysters appear to have low retention time of microplastics, and a recent observational study determined only 2% of particles found in wild Pacific oysters were identified as plastic (Martinelli et al. 2020). Mussels treated with microplastics and algae under laboratory conditions had inhibited clearance rates when high concentrations of microplastics were present; however, the concentrations of microplastics observed in the Salish Sea likely do not negatively affect mussel clearance rate (Harris & Carrington 2020).

Research on microplastic consumption in forage fish, salmon, and orcas is limited. Observational research has shown that low percentages of sand lance (1.5%) and herring (2.0%) on the coast of British Columbia consumed microplastics and that consumption varied according to body size, with larger forage fish less likely to consume microplastic (Hipfner et al. 2018). This study concluded it is unlikely forage fish are a conduit for microplastic consumption in predatory species, like salmon. Another observational study in the Salish Sea discovered the average microplastic concentration per juvenile Chinook salmon was 1.15 pieces, which is unlikely to cause direct mortality (Collicutt et al. 2019). A laboratory study by the United States Geological Survey (USGS) concluded most juvenile Chinook that consumed microfibers—thread-like fibers less than 5 mm in diameter—were able to excrete them and that the fish did not experience altered digestion rates (A. Spanjer, USGS, personal communication). Scientists with the National Oceanic and Atmospheric Administration and University of Washington are examining fecal samples to determine microplastic consumption by southern resident orcas. Preliminary results reveal microfibers and small microparticles in the feces. This research is important in furthering our understanding of the chemical effects associated with microplastic consumption.

The existing body of research suggests that current microplastic concentrations within the Salish Sea are not a significant threat to marine organisms. However, factors such as increasing urbanization and climate change may create or exacerbate microplastics impacts on Salish Sea species, and microplastic exposure and consumption rates across local and regional spatial scales and seasonal and interannual timescales remain largely unquantified.



Approximate sampling locations for zooplankton, forage fish, salmon, and wild Pacific oysters within Salish Sea and coastal waters (left) and Puget Sound waters (right) representing surveys conducted by Desforges et al. (2015), Hipfner et al. (2018), Collicutt et al. (2019), and Martinelli et al. (2020). Four sampling locations outside this geographic area were excluded from visualization.