

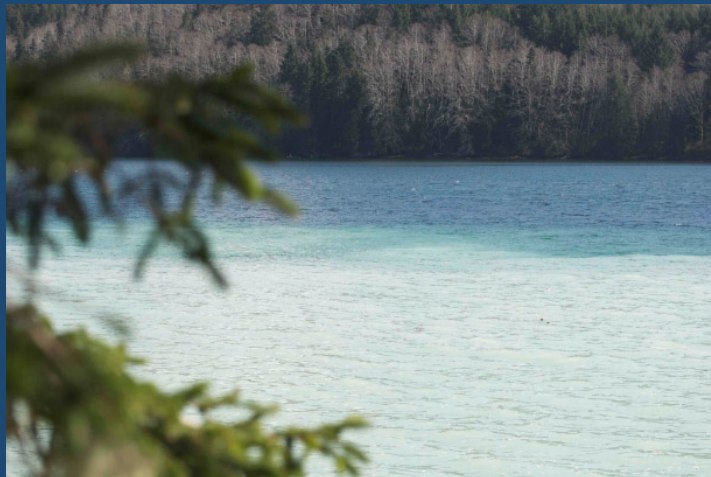
Marine, Intertidal and Terrestrial Linkages for Pacific Herring

The cross-boundary movement of energy, material and organisms provides major resource input to ecosystems and has been demonstrated to influence species abundance, diversity, trophic cascades and community structure (Polis et al. 1997). Considered a dominant subsidy to terrestrial systems (Hocking and Reimchen 2006), the marine-terrestrial transfer of salmon-derived nutrients results in multiple ecological consequences to terrestrial ecosystems (e.g. Mathewson et al. 2003, Reimchen 2000, Darimont et al. 2008). Despite its dominance, the transfer of salmon is just one of many marine-terrestrial subsidies that occur. For example, the movements of wrack and carcasses to intertidal zones also subsidize terrestrial ecosystems (Polis and Hurd 1996).



Adult Pacific herring

Formerly the most abundant commercial fish in British Columbia, Pacific herring (*Clupea pallasii*) are a cornerstone species and dominant forage fish in coastal marine ecosystems. They occur in coastal waters throughout the North Pacific Ocean and the Bering Sea and spawn in the nearshore and intertidal zones along the North American and Asian coasts. Suggestions that Pacific herring, a nearshore and intertidally spawning fish, are important prey for terrestrial consumers and act to subsidize terrestrial systems have been put forward (e.g. Willson et al. 1998, Willson and Womble 2006). Despite their ecological importance, which rivals that of Pacific salmon, the relationships between Pacific herring and intertidal and terrestrial ecosystems are almost entirely unknown.



Pacific herring spawn in Forward Inlet, Quatsino Sound in March or early April.

Pacific herring spawn annually along 450-600 km of British Columbia's coastline (Hay and McCarter 2008) in densities of up to approximately 1 million adult spawning herring per ha⁻¹ of spawn coastline. Herring spawn events provide a pulse of marine resources (eggs, milt and spawning adult fish) to nearshore and intertidal zones and attract a large diversity and biomass of marine predators and scavengers, including whales, dolphins, eagles, scoters and gulls.



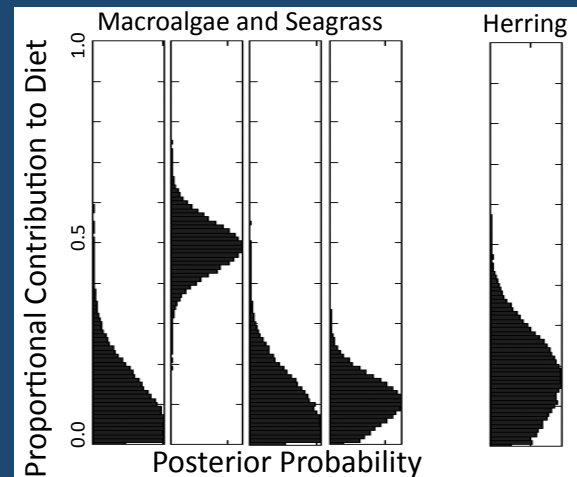
Pacific herring spawn in Quatsino Sound. Gulls are often the most conspicuous predator at spawn events. The photo on the right shows large densities of herring eggs washed up in the intertidal zone, where they are available for both intertidal and terrestrial predators and scavengers.

My research investigates ecological linkages between spawning herring and the intertidal and terrestrial ecosystems they influence. In a broad sense, I focus on (1) the activity, diet choices and subsequent nutrient transfer of herring and other intertidal resources to terrestrial ecosystems by wildlife (e.g. black bears and bald eagles) and (2) the influences of herring spatial subsidies on intertidal and terrestrial communities.

Currently, I'm using fatty acids and stable isotope signatures to trace the contribution of herring to intertidal detritivores and to identify other possible sources of production, such as macroalgae and seagrasses. We find that during spawn events, both stable isotopes and fatty acids provide corroborating evidence of a significant input of herring nutrients to intertidal detritivores. To the best of our knowledge, this is the first evidence of a spatial subsidy by Pacific herring.



Sandhoppers (*Traskorchestia* spp.), commonly the dominant detritivore of cobble/gravel beaches, benefit from herring spawn events.



Contribution of herring and other marine sources to intertidal detritivores as estimated by MixSIR.

Our work is particularly relevant because after a coast-wide population collapse in the 1960's, followed by a partial recovery, Pacific herring populations have again declined (Schweigert *et al.* 2010) and several commercial fisheries are closed. These population declines occur with concurrent reductions in spawn densities and likely, cascading consequences to marine, intertidal and terrestrial ecosystems, many of which remain undocumented.

