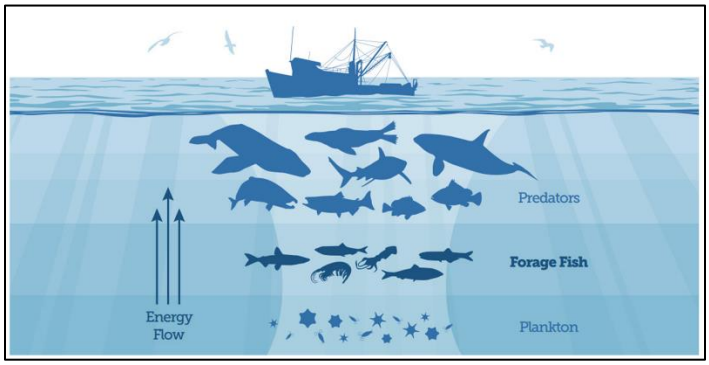
Forage Fish Backgrounder

The term 'forage fish' refers to a group of small, schooling fishes, which are a critical component of the marine ecosystem and fisheries. There are 7 species that reside along the BC coast, includeing Pacific herring (*Clupea pallasii*), Pacific sardine (*Sardinops sagax*), Northern anchovy (*Engraulis mordax*), eulachon (*Thaleichthys pacificus*), surf smelt (*Hypomesus pretiosus*), capelin (*Mallotus villosus*), and Pacific sand lance (*Ammodytes hexapterus*). Fish species are designated 'forage fish' based on their ecological role, rather than by taxonomic relationships; therefore, this group of species are very diverse in their life histories and global ranges. Regardless of their extensive variation, they are all remarkably influential in the overall health and productivity of the marine ecosystem, as they provide resources to an extensive list of predator species. In particular, Pacific sand lance are prey to 45 species of sport and commercial fishes, 40 seabird species, and 12 marine mammal species, some of which are listed as threatened or endangered under the Canadian Species at Risk Act. With such a lengthy list of predators it is not difficult to conceive that forage fish species account for 30% of the global fisheries landings, by weight; they are primarily used to make fish oil and fish meal.

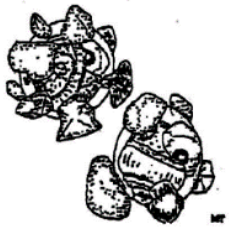


Forage fish are an integral part of the marine food web as they influence both predator and prey populations; they are a key linkage between the lower and higher trophic level species, transferring energy throughout the food web. These intermediate trophic level species has influence on species' abundance of their predators and prey, directly and indirectly. Forage fish sustain many 'dependent predators', in that the majority of these predators' annual diet is composed of forage fish. There is significant evidence that dependent predator populations mirror forage fish population fluctuations, increasing and decreasing as a result of resource availability. A 2009 study showed that along the coast of BC, 34% of the coho salmon (*Oncorhynchus kisutch*) diet is forage fish. On North Vancouver Island, Pacific sand lance consist of 65% of the diet of an adult chinook salmon (*Oncorhynchus tshawytscha*).

The influence forage fish have on the food web is critical to acknowledge when considering human actions with regards to fisheries. Forage fish populations undergo natural fluctuations in response to marine cycles, such as Pacific Decadal Oscillation, the variation in sea surface temperature shifting between warmer and cooler temperatures every 50 to 70 years. Due to their schooling behaviour, forage fish are generally easy to catch by industrial fishing methods. Added pressure from fisheries, specifically in years that forage fish populations are naturally low, can have detrimental impacts on their populations if proper management and policy are not enforced.

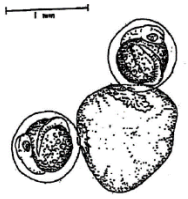
Forage fish and their spawning habitats are protected under Section 35 of the Federal Fisheries Act. However, there is minimal data available regarding location of forage fish spawning habitat along the coast of BC. Generally, Pacific sand lance (PSL) and surf smelt use intertidal zones of beaches on Vancouver Island for spawning and embryonic development. The BC Land Act prevents modifications being made in areas below high tide, with exceptions made when leases or licenses are obtained. Without a database revealing spawning habitats in BC, shoreline owners and property owners are not informed when pursuing development, rendering conservation efforts difficult. Some modifications to management methods acknowledge research that has been done; however, there are still significant limitations with regards to policy and management of forage fish and their habitats.

Pacific Sand Lance (*Ammodytes hexapterus*)



All adult PSL are silver, elongated, and narrow, growing up to 20cm long and living 5 – 7 years. Their distribution spans the length of the Pacific Northwest coastline, across the Beaufort Sea to the Sea of Okhotsk and Hokkaido. PSL spend their days feeding in the water column (<10m) and their nights buried in sandy sediment in the intertidal/subtidal regions in order to avoid predation. From November to mid-February, PSL choose sandy or gravel/pebbled beaches to spawn on, targeting the high tide line to mid-intertidal zone. They haphazardly spawn, releasing 0.6 – 0.8mm in diameter eggs; therefore, the eggs are vulnerable to dispersal by wind and wave action. Each egg attaches to multiple sand grains and will incubate for approximately 4 weeks.

Surf Smelt (*Hypomesus pretiosus)*



A silvery-coloured fish that grows from 20 – 25cm in length and is found from Alaska to California. Surf smelt are sexually dimorphic, with the males showing a brown dorsal side and a yellow ventral side, and the females showing a green ventral side and white ventral side. Surf smelt spawn year-round, with peak spawning seasons varying regionally, but most commonly occurring June through September. They prefer beaches with small gravel and close to broadcast spawn near the high tideline. Regardless of the season, surf smelt spawning has been found to be linked to tidal and lunar cycles, having the greatest abundance of spawning individuals present on high evening tides accompanied by a full moon. Soon after fertilization, a small distinctive fold in the egg's membrane forms and it attaches to one piece of substrate. Eggs incubate for 2 – 4 weeks.

Cultural Importance

PSL were known by coastal First Nations as prey to a large number of species; therefore, areas known to contain PSL were utilized as 'hotspots' for hunting larger fish species. Surf smelt have been used by First Nations for generations in the Pacific Coast for a variety of purposes including ceremonial, food, and social. North of Vancouver Island the Haida First Nations of Massett and Skidegate have historically harvested surf smelt.

Existing Stressors

Modified shorelines and coastal development threatens nearshore habitats, including forage fish spawning habitat. Critical marine fish habitat is degraded or destroyed when structural modifications are built in; these include seawalls, boulder structures (riprap), boat ramps, groins, ferry and port construction and other coastal developments. Hard armouring can alter the state and flow of sediments, increase beach exposure to wave action, and introduce environmental/human activities into the area that damage/prevent spawning activity.

Vegetation removal increases the intertidal zone's exposure to solar radiation, resulting in the area experiencing significant temperature fluctuations throughout the day. Further, the increased temperatures experienced subsequently result in greater evaporation, leading to egg desiccation, which the eggs rarely recover from.

Human actions, such as sewage dumping, vehicles or ATVs driving into the area, storm water runoff, oil spills and other contaminants spills from surrounding vessels, can have detrimental impacts on the beaches condition, ultimately impacting the potential for forage fish to spawn there.

Climate change is resulting in dramatic changes to the marine ecosystem, specifically with regards to temperature. Increasing ocean temperatures can have a devastating impact on forage fish as they heavily depend on both zooplankton and phytoplankton as food sources. Regime shifts due to climate change may have impacts on the abundance of both zoo- and phytoplankton, therefore impacting the range in which different forage fishes can survive. Further, sea level rise may increase structural modifications to shorelines from homeowners, reducing the number of potential forage fish spawning beaches.

Commercial and recreational fisheries exist for surf smelt, but not PSL. Commercial fisheries for surf smelt began in the mid 1800's and peaked in 1904 with over 230 tonnes harvested from BC, and since the 1960's commercial catch has not gone over 10 tonnes. However, recreational fishery for surf smelt does not require reporting of catch, and with increase appears to be growing which leaves open questions about the sustainability of the stock.

Rehabilitation/Enhancement Activities

Modified shoreline and coastal development impacts can be reduced by implementing shoreline development policies and enforcing effective setbacks. Also, hard armouring can be removed and replaced with soft shoreline engineering options to stabilize the shoreline. Further, beach nourishment, replenishing the beach with large volumes of suitable sediment, could occur in those locations that have lost sediment or experienced coarsening of sediment as a result of the structures.

Vegetation removal can be reversed by replanting native species to enhance shoreline stability. Additionally, future considerations by residents could be to trim vegetation, as opposed to removing it entirely.

Human actions and climate change can be countered with education. Informing the public with regards to what actions they are undertaking that may be harming the intertidal zone, both directly and indirectly (climate change) could prevent these actions from occurring in the future. Further, monitoring of areas that humans have a heavy influence in can advise restorative efforts.

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