Shore Stewards News
GUIDELINES AND RESOURCES FOR LIVING NEAR WATER | ESTABLISHED 2003

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Puget Sound's Favorite Food: Forage Fish

From 2008 newsletter written by past Hood Canal Shore Stewards Coordinator Cammy Mills, with additional content and editing by Doris Small, Washington Department of Fish & Wildlife. Updated and added to by Scott Chase, Shore Stewards Coordinator, WSU Extension Island County.

When we think of fish in Puget Sound, the images that first come to mind may include a silvery Chinook salmon dancing at the end of a fisherman's line, or a brightly colored Sockeye making its epic journey up the river where it hatched, to spawn. But there is another kind of fish that we should think of, too. While forage fish may not be as glamorous as some of our other local fauna, they fill a critically important niche in our local ecosystem.

Forage fish get their name not because of their own foraging behavior, but because they are forage for other fish, birds, and marine mammals. Washington's waters are home to six different species of forage fish (Pacific sardines, surf smelt, northern anchovies, eulachon, Pacific sand lance and Pacific herring). Of these species, three rely on nearshore waters of the Puget Sound for their survival. Surf smelt and sand lance rely on the upper beach habitat exclusively as spawning grounds, and Pacific herring spawn in subtidal eelgrass and macroalgae beds.

Because healthy forage fish populations are so vital to the stability of salmon populations (and other species) the Department of Fish and Wildlife has a "no net loss" policy for forage fish spawning habitat.

A Critical Link in the Food Chain

Most of you are probably familiar with the idea of a food chain, wherein smaller species become food for progressively larger species. If we use this food chain idea, then forage fish can be thought of as a vulnerable link in the chain. At the bottom of the food chain in Puget Sound are phytoplankton (microscopic plants), tiny zooplankton (microscopic animals) and small invertebrates. These are then consumed by forage fish, which in turn become food for various other fish-consuming animals, or piscivores (see diagram below). It's important to note how few species are at the middle level of our chain, especially in comparison to the relatively large number of species that rely on the middle level of the chain for food. It's also important to note that if the population levels in the middle of the chain are

insufficient to support all the piscivores (fish eaters) at the top, the piscivores cannot "choose" to feed on the species at the bottom of the food chain.

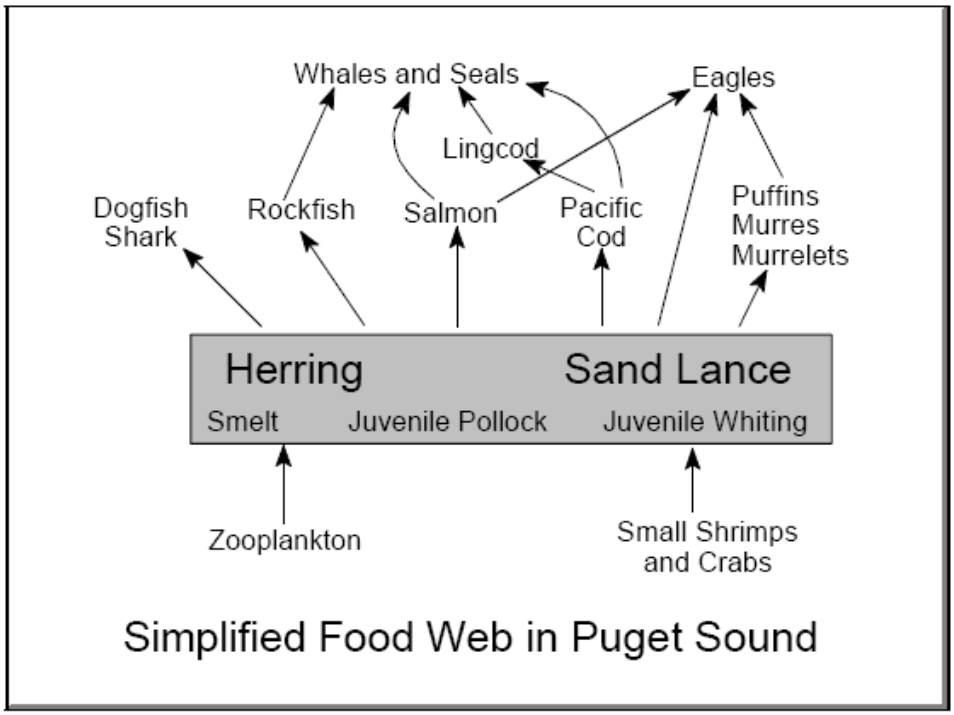


Figure 1. Simplified food web of piscivores in Puget Sound. Source: *Forage Fish Management Plan: A plan for managing the forage fish resources and fisheries of Washington.*

In food chains such as this, population size is not controlled from the top up, or the bottom down, but rather from the middle out. That is to say, if there is an abundance of organisms at the mid-level (in this case, forage fish), then there will be an expansion in the population size at the upper level (because there is more food for them) and a decrease in population size at the bottom of the food chain (because they're being eaten by the forage fish). Conversely, a shortage of organisms at the mid-level will mean a population decrease at the top level and increase at the bottom level.

Much study has been devoted to the Pacific Herring and it is known that Pacific herring comprise a large percentage of the diet for many marine species, including Chinook, Coho, Pacific cod, whiting, lingcod, halibut and harbor seals. Other species, including California sea lions, Stellar sea lions, harbor porpoises, Dall's porpoises, Minke whales, pelicans, terns, gulls and auks all use forage fish for a significant part of their diet.

Forage fish populations naturally show rapid and wide fluctuations in size. This natural variability means that no management plan the humans devise can create a stable population, but it also means that we must be quite careful to preserve enough high-quality habitat so that when there is a population crash, the species can recover. Once a population crash occurs, it may take decades for it to recover.

Forage Fish in Puget Sound

Pacific Herring

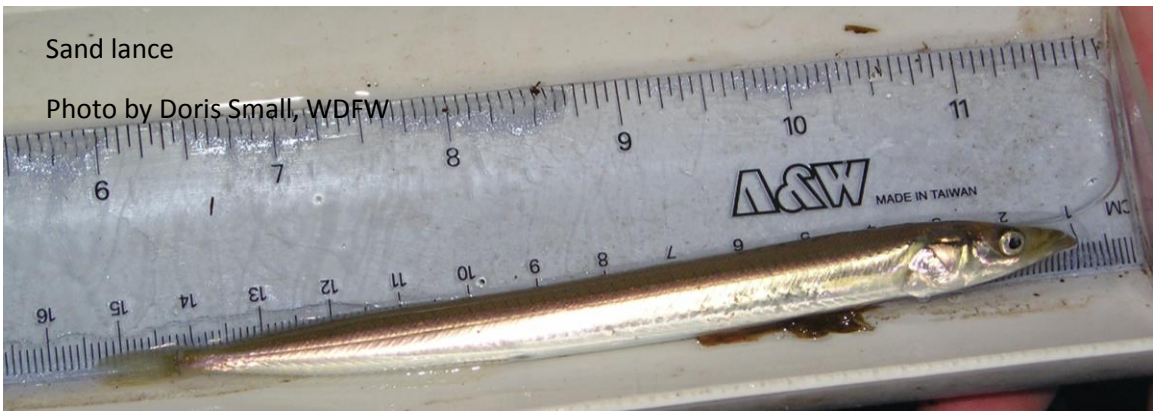
Pacific herring can grow to be nine inches long, are bluish to olive green on their back and have silvery sides. Herring spawn on eelgrass and macroalgae beds around Puget Sound. Herring tend to return to spawn in the same area as they were hatched, though their homing is not as precise as that of salmon. Herring originating from different spawning grounds are considered to be from a different stock. They spawn from late January through early April, with the exception of the Cherry Point stock in Whatcom County which spawns from early April through early June.

Pacific Herring

Photo by Doris Small, WDFW

Pacific Sand Lance

Sand lance (sometimes called candlefish) can grow to be eight inches long, have a gray to green back and silver sides. Their dorsal fin stretches almost the full length of their back and they have an elongated body. Sand lance feed in the open water during the daytime, and then bury themselves in the sand at night to avoid being eaten. Sand lance spawn on mixed sand and gravel beaches between the elevation of mean high tide and mean tide. They are obligate intertidal spawners, which means that if their preferred habitat is unavailable, they cannot spawn successfully elsewhere. Sand lance spawn from November through February. Sand lance are very small and their eggs are miniscule, so even if you have them spawning on your beach, you may not see them.



Sand lance

Photo by Doris Small, WDFW

Surf Smelt

Surf smelt can grow to be nine inches long and have an olive green back with a silver or yellow band on their side. Surf smelt spawn on mixed sand and gravel beaches in the upper intertidal zone. In fact, both sand lance and surf smelt use the same stretches of beach at the same times of year. However, unlike sand lance, surf smelt have been found to spawn year round on some beaches. Surf smelt also use more of the upper beach than sand lance, spawning from the elevation of mean high tide to mean higher high water (the annual average of every day's highest tide). Surf smelt eggs develop a small stalk that attaches them to the grains of sand on which they're laid. This keeps the eggs from being washed away until they're buried in the sand. This helps protect the eggs from predators.

Surf smelt

Photo by Doris Small. WDFW

Forage Fish Spawning Maps

If you would like to see a map of forage fish spawning locations in Puget Sound, click here. (You can enlarge or shrink map by using plus and minus signs. Use legend tab to see which species are indicated.)

What You Can Do

The areas in which our local forage fish spawn make them especially vulnerable to impacts from shoreline development, and there is no known way to replace lost forage fish spawning grounds. Additionally, not all forage fish spawning habitat may be known. Surveys for surf smelt spawning habitat are incomplete, so it is important to protect not only the known spawning beaches, but other beaches as well. Fortunately, there are steps you can take to help prevent degradation of forage fish spawning habitat, and in some cases, you may even be able to improve habitat.

Eelgrass beds can easily be damaged by boats that are anchored or moored over them. Anchors and attached chains can clear large patches of eelgrass when they scrape along the bottom as the boat they're attached to moves about on the water's surface. If you must moor or anchor your boat in an area with eelgrass, do so in deeper waters where there is no eelgrass (this has an added benefit as it also prevents the possibility that your boat will become grounded at low tide.) Additional information can be found in the Guideline 7 of the Guide for Shoreline Living, which can be seen here.

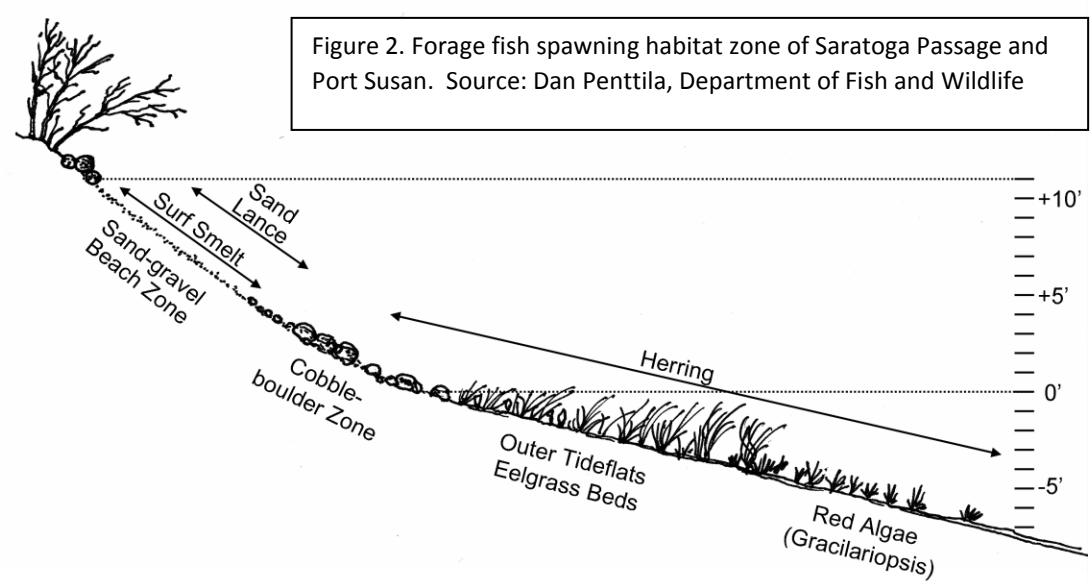


Figure 2. Forage fish spawning habitat zone of Saratoga Passage and Port Susan. Source: Dan Penttila, Department of Fish and Wildlife

Eelgrass is a plant, and as such, it needs sunlight. Docks and piers can make it too shady for eelgrass to grow. If you are thinking about installing or replacing such a structure, consider doing so in a way that permits light to pass through. For instance, when the Department of Transportation expanded the Clinton ferry terminal, they used glass bricks in the passenger walkway to permit light to pass through to eelgrass beds below. Installing glass bricks is potentially expensive. Less expensive techniques include using grating or limiting the width of your dock to 4-6 feet. Instead of building a new dock, you might also want to consider sharing a dock with a neighbor.

Poor water quality can also damage eelgrass beds. Runoff contaminated with fertilizer from gardens and farms is detrimental to eelgrass. There are many things you can do to reduce your use of fertilizer. These include testing your soil prior to fertilizing to determine how much (if any) fertilizer your plants need; calibrating your spreader to make sure you only put down as much fertilizer as needed; amending your soils with compost to help boost soil health; and using organic or slow-released fertilizer. A buffer of plants between the water's edge and your lawn or garden will help eliminate nutrients in runoff before it enters the water. Runoff containing pesticides can also damage eelgrass beds. There are many ways to eliminate weeds and pests without having to resort to harmful chemicals. For instance, you can pull weeds by hand and use mulch on garden beds to prevent their return. Slug traps work well to eliminate slugs, and a strong spray of water is often enough to eliminate an aphid infestation on a plant.

Eelgrass beds also benefit tremendously from shorelines that are left natural. Bulkheads can increase wave energy and change a beach's substrate so that the habitat is no longer suitable for eelgrass. If you are considering installing or replacing a bulkhead, consider soft armoring techniques instead and make sure that any structures you do build are set back as far as possible from the water's edge. Not only does minimizing shoreline hardening help eelgrass beds, it also helps preserve the spawning habitat of sand lance and surf smelt. The increased wave energy and subsequent changes to a beach's substrate and slope can eliminate both the type of substrate sand lance and surf smelt like to use to spawn and the tidal elevation at which they spawn.

One of the easiest things you can do to protect the area where sand lance and surf smelt spawn is to provide shade on your beach. The eggs of both of these fish are vulnerable to drying out in warm

temperatures. Studies have shown that the temperature on a beach is significantly lower where it is shaded by overhanging vegetation and that mortality rates for forage fish eggs on shaded beaches are much lower.

Creating a buffer of vegetation along your beach will help shade the habitat that is so vital for forage fish. Not only is this practice good for our local forage fish and eelgrass beds, it has the added benefit of helping stabilize slopes. Even if you don't have a natural shoreline, planting a buffer along your bulkhead can help shade your beach.

Development and Jellyfish Threaten Herring and Smelt

New research by scientists from NOAA Fisheries' Northwest Fisheries Science Center, the University of Washington and the Washington Department of Fish and Wildlife has found big increases in the catch of jellyfish, sticklebacks and sand lance, and declines in smelt and herring in Puget Sound over the last 40 years. Although this decline in forage fish can be attributed in part to rising human population with associated pollution and development, there has also been a significant rise in jellyfish blooms, which may divert energy from forage fish species. In sub-basins where smelt and herring populations declined, jellyfish-dominated catches increased from three to nine-fold, in many cases dominating the catches of trawl survey nets in recent years. In some densely populated parts of Central and South Puget Sound, surrounded by Tacoma, Seattle, Bremerton, and other cities, herring catches were 1 percent or less of what they were in the 1970s.

Using data from trawl surveys of Puget Sound fish species in the 1970s and 1980s, along with handwritten data and records found in old files, the scientists compared these early results to information from surveys done in 2003 and 2011, looking for changes in location and abundance of jellyfish and forage fish. Surf smelt and Pacific herring, the 2 most abundant forage fish, showed significant declines in the more heavily populated areas of Puget Sound. Three-spine stickleback and sand lance populations increased in these locations. Being smaller in size, these fish offer less prey for birds, larger fish and marine mammals. (Pacific herring serve as an indicator of the health of Puget Sound's ecosystem, according to the Puget Sound Partnership.)

Looking at multiple factors that might affect the decline in Pacific herring and surf smelt, climate change and commercial fishing were implicated in the changes, but were not seen to be as dominant as the dense population centers nearby. As human population increased in certain areas of Puget Sound, bringing with it human-driven changes such as polluted runoff and increased shoreline hardening, the resulting declines in smelt and herring may benefit opportunistic jellyfish, which compete with forage fish for food, and in some instances feeding on their larvae and eggs. Jellyfish have far less nutritional value to species higher in the food chain, reducing their food and energy. This may also affect juvenile salmon survival in Puget Sound. Forage fish serve as prey for salmon, and are also eaten by predators such as seals, who will consume the salmon in absence of abundant forage fish.

One course of action suggested by researchers is to focus on protecting and restoring areas of Puget Sound that are less disturbed, and remain important forage fish habitat. It is also important to understand how human pressures may drive changes in marine ecosystems that are not yet recognized.

So the next time you think about fish in Puget Sound, feel free to think of that beautiful silver Chinook, or brightly colored Sockeye. But then think about the forage fish that very likely fed those beautiful salmon, and know how we all play a role in keeping those populations healthy.

References/Resources

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2017 Bull Kelp "Snapshot" for Island County

Shore Stewards: following is a survey submitted by Linda Rhodes, PhD, who is a longtime member of the Island County Marine Resources Committee and encourages you to take take part in an important survey regarding the health of bull kelp in Island County and Puget Sound. Thank you in advance for your interest and participation!

You have seen it offshore, waving in the swell and streaming with the current. Sometimes it's washed up on the beach in a slippery tangle. Bull kelp (*Nereocystis leutkeana*) is one of the largest algae in the Salish Sea. It can form underwater forests, providing physical habitat for animals and other algae while supporting critical food webs from bacteria through mammals and birds. The growing awareness of the role of bull kelp beds in ecosystem function is focusing more attention on where beds occur, how beds change through the seasons, and who inhabits the beds.


Fish under bull kelp at Ebey's Landing

Several years ago, the Island County Marine Resources Committee (MRC) initiated a bull kelp project in collaboration with the Northwest Straits Initiative and other regional MRCs. (Read more about the MRC's bull kelp project here.) Because bull kelp are annual plants, beds can disappear from view during the winter, and may or may not reappear the following spring. Washington Department of Natural Resources has evidence of declines of bull kelp beds in Central and South Puget Sound, and there are anecdotal reports of bull kelp bed disappearances in San Juan County. Although Island County supports robust beds in the Smith and Minor Island Aquatic Reserve, there is poor documentation of kelp beds County-wide.

In 2017, the MRC bull kelp project is trying to capture a "snapshot" of bull kelp locations along Island County's shoreline and nearshore. With sightings from the beach or from boats, you can report bull kelp locations on-line. The best data would include GPS coordinates to allow better mapping (there are free smart-phone GPS applications), but all reports are important. And redundancy in reporting is good – multiple reports of a bed increases the confidence the bed truly exists. We'll be comparing reports with aerial photographs, and will post a final map of locations after the season's end.

The on-line survey form is located here:
https://docs.google.com/a/noaa.gov/forms/d/e/1FAIpQLSc9XcrzLk7fP0oKlOoKVgTtjw2Lg7B6szu8EQ45Gm_ER9Z5RQ/viewform?c=0&w=1

A few short instructions are on the next page.

Thanks for helping with the 2017 "snapshot" of bull kelp in Island County, and spread the word!

How bull kelp looks from the shore,

and from the water

Brief instructions on collecting GPS coordinates

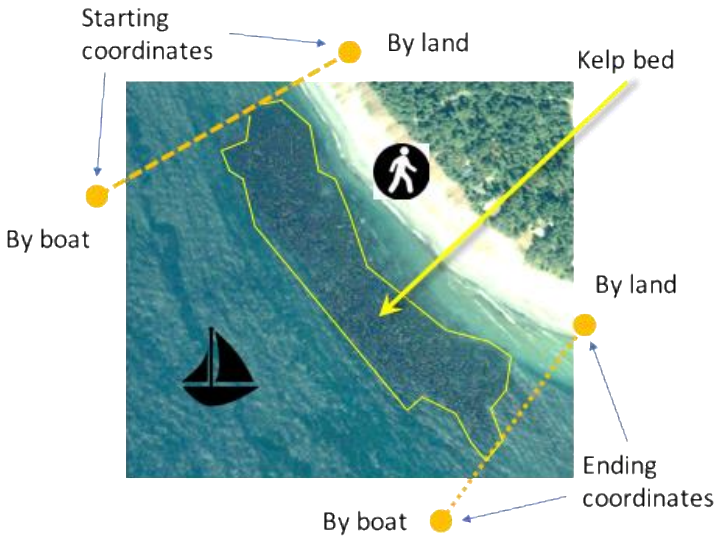
Don't forget to record the time & date.

Starting coordinates:

- Position yourself & the end of the kelp bed in a perpendicular line to the shore (yes, this is subjective).
- Record these coordinates (latitude & longitude – any format).

Ending coordinates:

- Travel to the farthest end of the bed, & repeat the alignment for the starting coordinates.
- Record these coordinates (latitude & longitude – any format).



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