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Department of Fish and Wildlife

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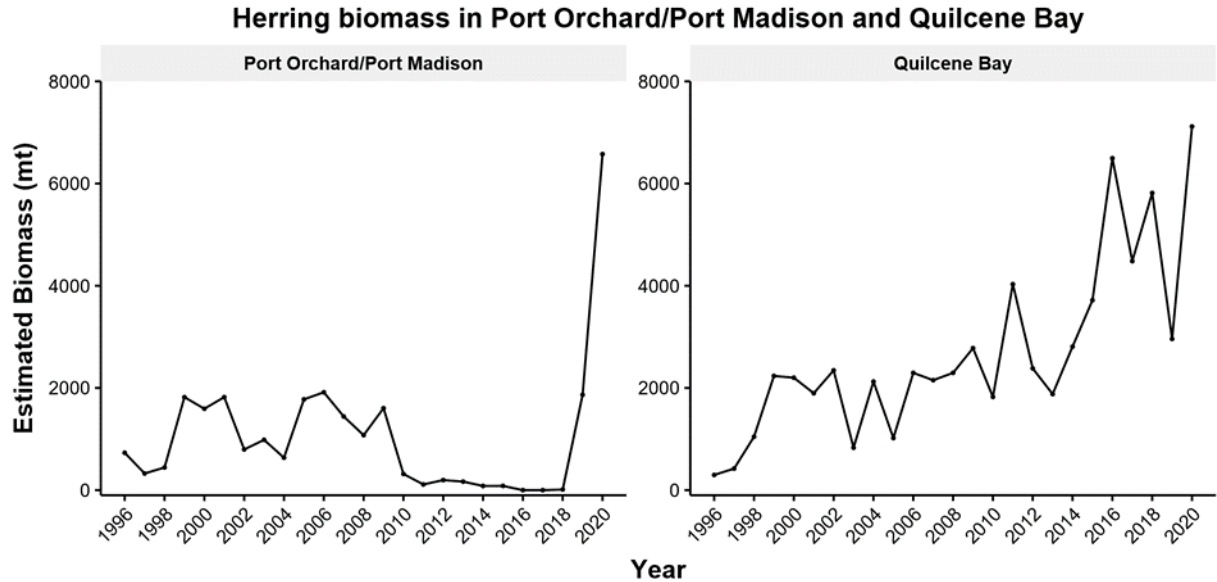
2020 Herring Biomass Summary- A Banner Year for Puget Sound!!

Forage fishes are vital components of the marine ecosystem of the Puget Sound (also known as the southern Salish Sea; SSS) and are a valuable indicator of the overall health of the marine environment. Recognizing the importance of forage fish in the SSS ecosystem, the Washington Department of Fish and Wildlife (WDFW) has monitored the abundance of key Pacific Herring stocks since 1972, and the Puget Sound Partnership (PSP) selected the spawning biomass of SSS herring as an annual [vital sign indicator](#) of ecosystem health.

WDFW monitors Pacific Herring spawning biomass from January through June each year, with 21 stocks in the southern Salish Sea monitored in 2019 (plus two stocks on the coast, Willapa Bay and Grays Harbor). In Puget Sound, most herring stocks spawn between January and April; in 2020, the survey season was closed by the COVID19 pandemic on March 16th. Despite that closure, our preliminary estimate for the herring spawning biomass is **17,635 tonnes, the highest since 1980!** (over the previous ten years, the average estimated spawning biomass (ESB) was 9,350 tonnes) [Figures 1, 2 below]. This number is clearly an underestimate due to the closure, as only six stocks had full coverage, with another six having moderate coverage and nine stocks with inadequate or no coverage at all (including Fidalgo Bay, Samish Bay, Kilisut Harbor, Sequim Bay, NW San Juan Islands, Interior San Juan Islands, Cherry Point and Point Roberts. Note that the late-spawning Cherry Point stock season is still considered open and we hope to resume boat-based survey coverage soon.)

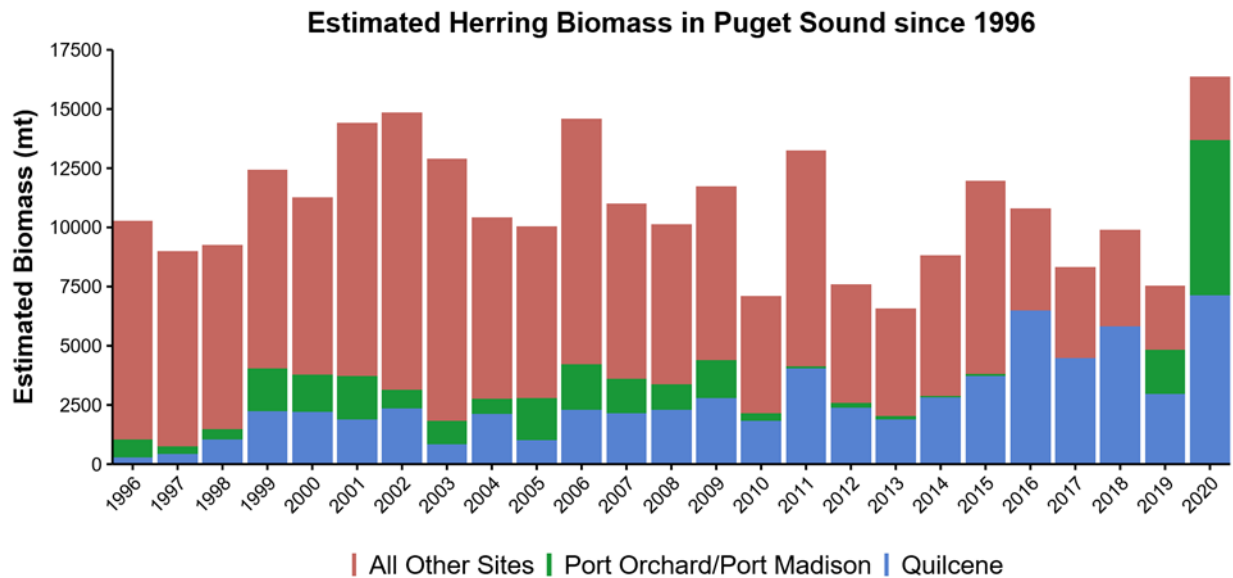
The biggest increases occurred at Purdy (884 mt; South Sound), Quilcene Bay (7,118 mt; Hood Canal) and Port Orchard-Port Madison (6,577 mt; Central Basin); *these were the largest spawning events ever recorded at these sites.*

Figure 1: Estimated spawning biomass at the two sites with the largest increases in 2020 (1996 was the first year with good survey coverage of nearly all stocks)



These two stocks made up majority of herring spawn in 2020, as seen below:

Figure 2: Estimated spawning biomass at the two sites with the largest increases in 2020 (1996 was the first year with good survey coverage of nearly all current stocks). Note the figure does not include all of the unusual spawning activity noted in 2020 and thus does not exceed 17,000 mt).



There were also large spawning events at Elliott Bay (this year, spawning occurred south of Alki Point, with credible reports- and estimates- of spawning biomass) and off the NW corner of Bainbridge Island (after the PO-PM spawn) captured by citizen reports that

were not surveyed due to the closure: (The “whitewater” in the foreground is the herring milt coloring the water; photo credit: Dylan Tomine)



In this photo by Brian Whitlock, a Bald Eagle feasts on the herring spawn at low tide (the vegetation in the foreground is covered with herring eggs):



Another spawning event took place at Greenbank, north of Holmes Harbor (Whidbey Island) outside of the previously documented spawning area of this stock. Photo credit: Randy Schroder.



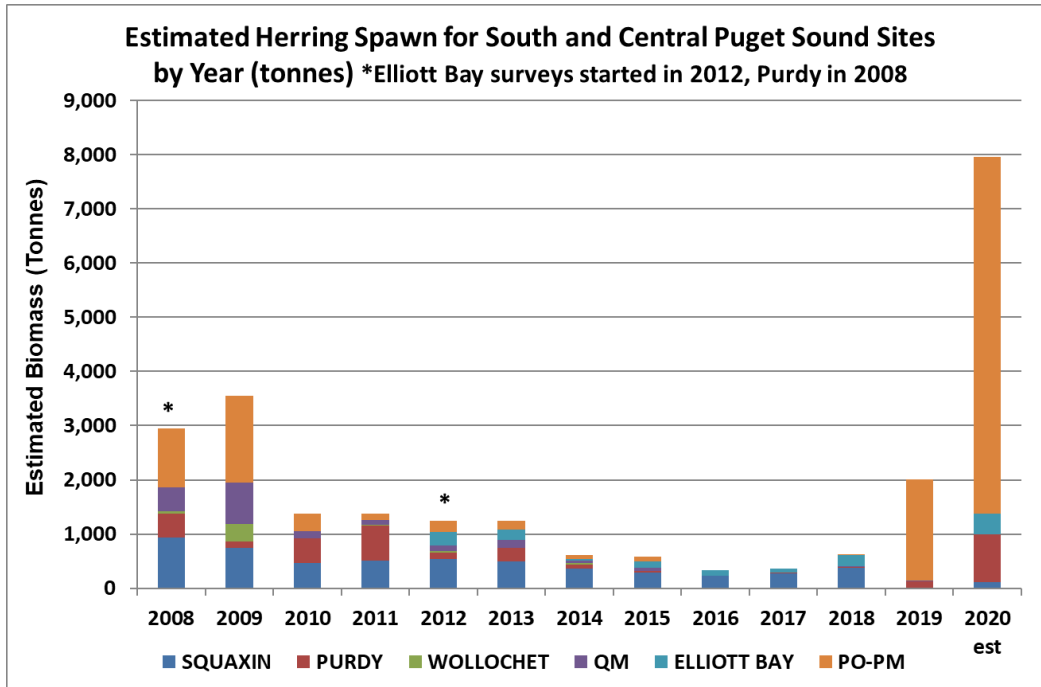
An additional spawning event at McCurdy Point, in the Strait of Juan de Fuca, was reported on March 28th, east of our previously known herring spawning areas. Photo credit: Roy Clark, WDFW.



With these additional, un-surveyed spawning events, plus the Cherry Point ESB, the annual total ESB is clearly much higher. However, despite all the good news, herring stocks in South Puget Sound (besides Purdy, a relatively small stock) continue to do

poorly, with no spawn detected at two sites even with moderate survey coverage (Wollochett and Quartermaster Harbor)- see Figure 3:

Figure 3: Estimated spawning biomass in South Puget Sound since 2008 (value for 2020 is an estimate and is not yet complete)



Why do we think this happened ?

Forage fish populations are notorious for having extreme annual variations in population abundance and recruitment, but the increase seen in 2020 is striking. Some possible explanations include:

- During the anomalously warm “Blob” years (~2015-17), when surface waters in the NE Pacific Ocean were much warmer than average (<https://jisao.uw.edu/2018/09/16/climatologist-talks-el-nino-the-blob-and-climate-change/>), surface waters in the SSS were also higher and we had more sunlight than normal in the region. This led to increased phytoplankton and zooplankton blooms that created a larger food supply for larval fish. Research by Julie Keister’s lab at the University of Washington (https://marinesurvivalproject.com/research_activity/list/zooplankton-establishing-puget-sound-wide-zooplankton-sampling-program//) showed the increases in zooplankton abundance were particularly large in the Main Basin of Puget Sound (which includes the PO-PM/Bainbridge Island area) and Hood Canal (Quilcene Bay) (Figure 4). As a result, there may have been “jackpot recruitment” years for herring in 2016-17 due to increased zooplankton abundance. Herring return to spawn at age 2-3, so this may explain the abundance of spawning fish in 2020 (this also suggests that the dramatic increase in herring spawn is unlikely to persist for more than 2-3 years).

Figure 4: Average Total Zooplankton Biomass by Month in the southern Salish Sea (as determined by mg carbon/m³ in samples; figure courtesy of J. Keister)



- “Predator swamping”: Increased numbers of Northern Anchovy (and possibly other forage fish) during and since the Blob years may have reduced predation on herring, leading to an increase in adult spawners in 2020. Anchovy are more abundant during warmer periods and may have multiple spawning events during the summer months; they have been particularly abundant in south Puget Sound in recent years. However, this does not explain why the big increases in spawning herring were in the Main Basin of Puget Sound and Hood Canal (although, as previously mentioned, there was also an increase at Purdy, in South Sound—though two other stocks there had no detectable spawn in 2020). It remains to be seen if this effect also reduced predation on juvenile Pacific salmon with longer life cycles; examination of the smolt-to-adult (SAR) survival rates may provide evidence.

- Other possibilities include the benefits of habitat restoration, better ocean conditions for herring stocks that feed in the Pacific during the summer (many stocks in the Southern Salish Sea emigrate to the West coast of Vancouver Island during the summer months, although some stocks in South Sound are resident year-round), changes in predator abundance/behavior, etc. Reports of good herring returns all the way to Alaska in 2020 lend credence to the hypothesis that ocean conditions are partly responsible. However, there are still a lot of things we don't understand regarding what governs forage fish abundance...

For more information on herring in Puget Sound/SSS, see:

<https://wdfw.wa.gov/publications/02105>

For a broader summary of the many factors influencing Pacific Herring in the Salish Sea as a whole, this SeaDoc funded report is a good resource:

<https://static1.squarespace.com/static/5b071ddea2772cebc1662831/t/5c18489e032be4b073ad9d86/1545095350054/frances-et-al-herring-assessment-management-of-salish-sea.pdf>

We wish to thank the many citizens (including Laura James, Jen Strongin, Brian Whitlock, Kollin Higgins, Dylan Tomine, Martha Kongsgaard, Brian Allen, Randy Schroder, Nancy Partlow and others who help us track forage fish activity by sending reports and pictures via email (Todd.Sandell@dfw.wa.gov or Adam.Lindquist@dfw.wa.gov).

We also wish to thank private pilot and biologist Mike MacKay, as well as Christine Steele, Lane Gormley, Mark Gaponoff and the other pilots at LightHawk, a non-profit conservation flying group (<https://www.lighthawk.org/about/what-we-do/>) for assisting with aerial surveys of the Cherry Point/Birch Bay region.

Finally, we want to acknowledge our DFW seasonal herring surveyors (Roy Clark, Paul Clarke, Kris Costello, George Peterson) and forage fish crew (Adam Lindquist, Patrick Biondo, Eric Bruestle, Stephanie Lewis, Aidan Coyle, Todd Sandell and Phill Dionne) for the thousands of hours they spend on the water, as well as colleagues at the Coastal Watershed Institute (<http://www.coastalwatershedinstitute.org/>), WWU, DNR, PSEMP, DOE, UW, USGS, PSP, and NOAA. The southern Salish Sea is a big place and it's a challenge to cover it all. Thank you!