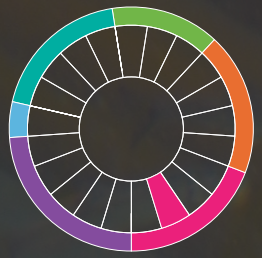


Pacific Herring

Pacific herring are one of the most abundant forage fish species in Puget Sound. Together with a few other small schooling fish species herring play a unique role in the food web: they are an essential source of food for larger fish, seabirds, and marine mammals, and as such, transfer energy from their plankton prey to these higher-level consumers.

Because they are a vital component of the marine food web, Pacific herring are one key indicator of the overall health of Puget Sound. Herring stocks require clean water and natural shorelines, so their continued survival depends on maintaining links between nearshore and open-water habitats.

The number of herring in Central and Southern Puget Sound, while variable, has shown little trend over the past 40 years. The population of the once largest and genetically unique stock of Pacific herring, the spring spawning Cherry Point stock in North Puget Sound, has declined by 90% since 1973.

Photo Credit: Anne Shaffer

Pacific Herring

INDICATOR:

Biomass of Spawning Pacific Herring

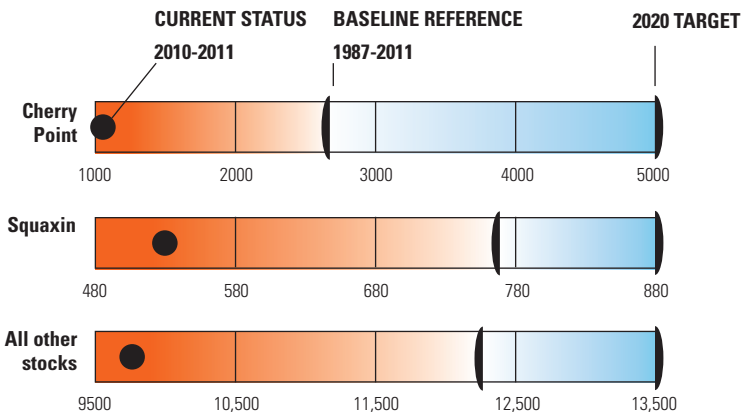
Indicator lead: Kurt Stick, Washington Department of Fish and Wildlife

TARGET:

Increase the overall amount of spawning herring throughout Puget Sound to about 19,000 tons. For each stock, the targets are: Cherry Point: 5000 tons; Squaxin Pass: 880 tons; all other stocks: 13,500 tons.

PROGRESS:

IS THE TARGET MET?	NO	IS THERE PROGRESS?	NO



Please note the different scales for each stock

The spawning biomass of all herring stocks remain below their target values as well as their baseline reference, which is defined as the 25-year mean from 1987 to 2011.

Progress Towards 2020 Target

None of the 2020 target values for individual Pacific herring stocks or groups of stocks are met, and no progress has been made. Instead, the current spawning biomass of all stocks are below both their 25-year mean baseline reference and their 2020 target values (Figure 1).

The Cherry Point herring stock in North Puget Sound, once the largest stock in the Sound, has declined by 90% since the earliest sampling date in 1973 and shows little sign of recovery.

The Squaxin Pass and other Puget Sound stocks do not exhibit the sharp decline seen in the Cherry Point stock. Although they show broad annual fluctuations, these stocks are relatively closer to their target values. In fact, in some years, these stocks have gone above their target values. However, these stocks are currently at biomass levels below their target values (Figure 1).

Predicting the future condition of herring spawning biomass is difficult. Owing simply to natural fluctuations in abundance, the Squaxin and other Puget Sound stocks in Central and South Puget Sound may reach their respective target values again over the next eight years. However, there is no evidence to suggest that herring spawning biomass at Cherry Point will increase and reach its target value by 2020, or that the biomass of all other stocks will be sustained at or above their target values. Although potential threats have been identified, there is no consensus on which threats limit the stocks or how best to manage these stocks to achieve the 2020 target.

What Is this Indicator?

The spawning biomass of Pacific herring is the estimated annual tonnage of spawning herring in Puget Sound. Herring spawning biomass is currently based on spawn deposition surveys conducted by the Washington Department of Fish and Wildlife (WDFW) to estimate the quantity of eggs deposited by herring on marine vegetation. Egg abundance is then converted to the estimated biomass of spawning herring. As measured, the indicator only reflects the status of reproductive fish rather than the status of the entire population because younger, immature age classes do not spawn.

Reflecting genetic studies that have identified three separate groupings of Puget Sound herring stocks (Figure 2), the Partnership has established three separate targets for Cherry Point, Squaxin Pass and all other stocks combined. Estimates of spawning biomass have been attempted for all known Puget Sound herring stocks by WDFW annually since 1996, and for Cherry Point herring since the early 1970s. The baseline references, the 25-year mean biomass for each stock (1987 – 2011), are intended to provide perspective for the current status of each stock (the 2-year mean of 2010 and 2011) and the targets. The baseline reference and evaluation of current stock status reported here are not based on a conventional fishery stock assessment, which takes into account growth, maturity, fecundity, and mortalities.

Spawning Biomass of Pacific Herring Stocks in Puget Sound
In tons, 1973 - 2011

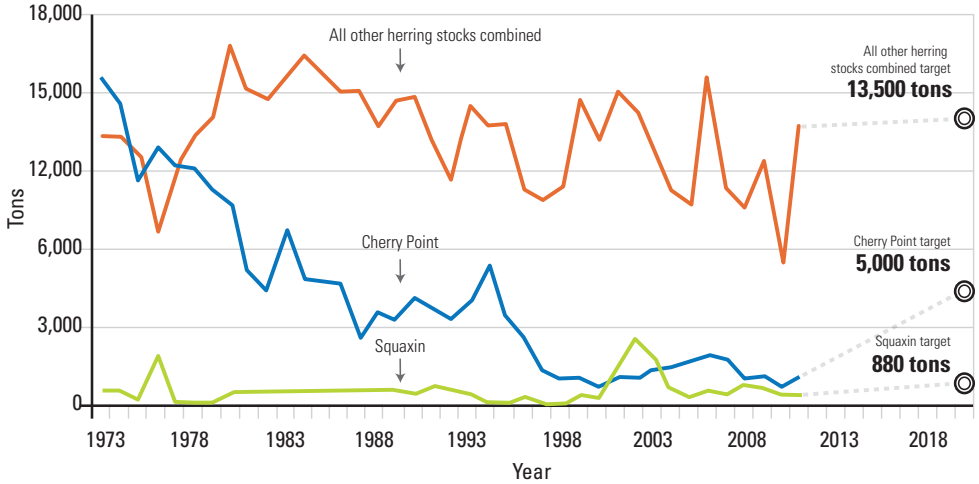


Figure 1. Annual estimates of Puget Sound herring spawning biomass, by genetic grouping with associated targets (1973 to 2011).
Source: *Washington Department of Fish and Wildlife, Fish Program*

Pacific Herring

Interpretation of Data

The Puget Sound herring data are characterized by broad year-to-year fluctuations, which is typical of Pacific herring populations and likely reflects natural environmental and demographic variability. Indeed, in Puget Sound, the bulk of the biomass of the "all other stocks" grouping is contributed by different stocks in different years, further implicating the role of site-specific variability.

The exact causes of the Cherry Point decline are unknown, but it has been variously attributed to many potential factors such as chronic pollution (e.g., PCB and PAH contaminants), oil spills, overfishing, parasites, disease and changes in abundance of predators or prey. Changes to the natural shoreline, including nearby industrial construction and operation, also may play a role. Finally, the extent to which food-web interactions may limit herring populations, and how such interactions are mediated by the effects of climate change, are not well understood. Further studies are needed to elucidate the effect of these possible pressures.

Several factors contribute to difficulties in understanding Cherry Point stock declines and in the trends of other herring stocks, including survey methods and exploitation rate analysis.

Since 1973 at Cherry Point and 1986 for the rest of the stocks, WDFW has conducted a combination of spawn deposition surveys and Acoustic-Trawl (AT) surveys to estimate herring spawning biomass. Until 1996, the spawning biomass of the larger Puget Sound stocks typically was assessed by both methods each year while the smaller stocks were surveyed by spawn deposition surveys every three years. Since 1996, the spatial coverage of both survey methods has been progressively reduced until the AT surveys were finally discontinued in 2009 due to budget reductions. Spawn deposition surveys and AT surveys each have their advantages depending on the size and type of substrate for eggs, therefore work at their best when used together.

In addition to spawning biomass, biological samples used to estimate growth, mortality, and recruitment were obtained from the AT surveys. These data which are not currently being collected, are useful for assessing the stocks' population dynamics and capacity to meet the targets, and to understand the mechanisms driving these trends.

For example, for the Cherry Point and most other Puget Sound stocks, there has been a shift in the age structure of the population since the late 1970s and early 1980s towards younger fish, which probably affected their productivity and slowed down their recovery.

As mentioned above, not all spawning grounds/stocks have been surveyed every year. To complete the time series depicted in Figure 1, data gaps were filled in with the long-term average for the stocks with missing data. Given the importance of this indicator to the recovery of the Sound, monitoring methods and analysis should be reviewed and improved to more completely and accurately report status and trends.

Commercial exploitation of Puget Sound herring is limited to a bait fishery, which is allowed to take up to 10% of the cumulative Puget Sound spawning biomass of Central and South Puget Sound stocks. Landings in the past 10 years have ranged from 3 to 5% of this total and are not expected to increase significantly in the near future. This is a conservative exploitation rate, compared to a typical global exploitation rate of 20%. Although a 10% exploitation rate is precautionary, a more rigorous analysis of an appropriate exploitation rate, that accounts for current population dynamics (including age composition) and ecosystem needs (e.g., the extent of predator dependency on forage fish), is desirable to ensure sustainability of the Puget Sound herring stock.

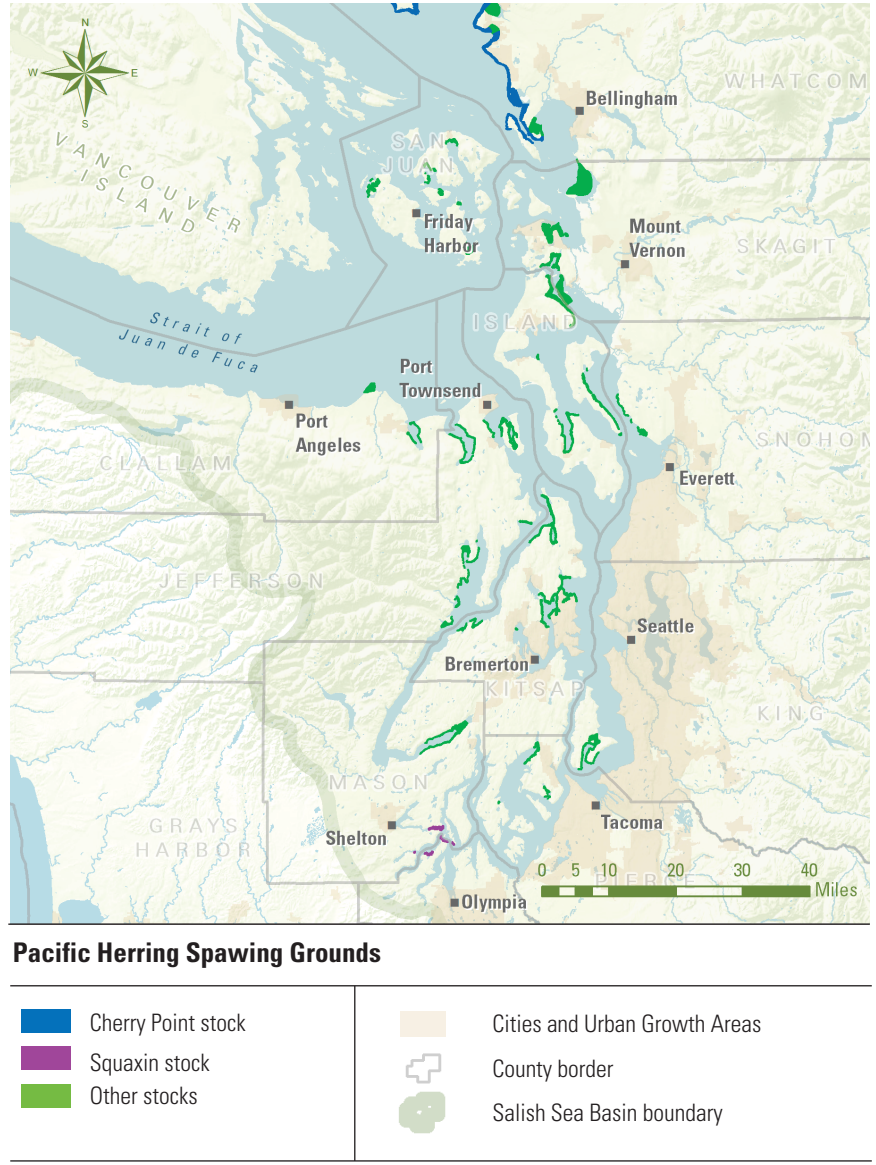


Figure 2. Distribution of Pacific herring spawning grounds in Puget Sound.
Source: Washington Department of Fish and Wildlife, Fish Program.