Reduce coastal trawling to protect the Baltic herring

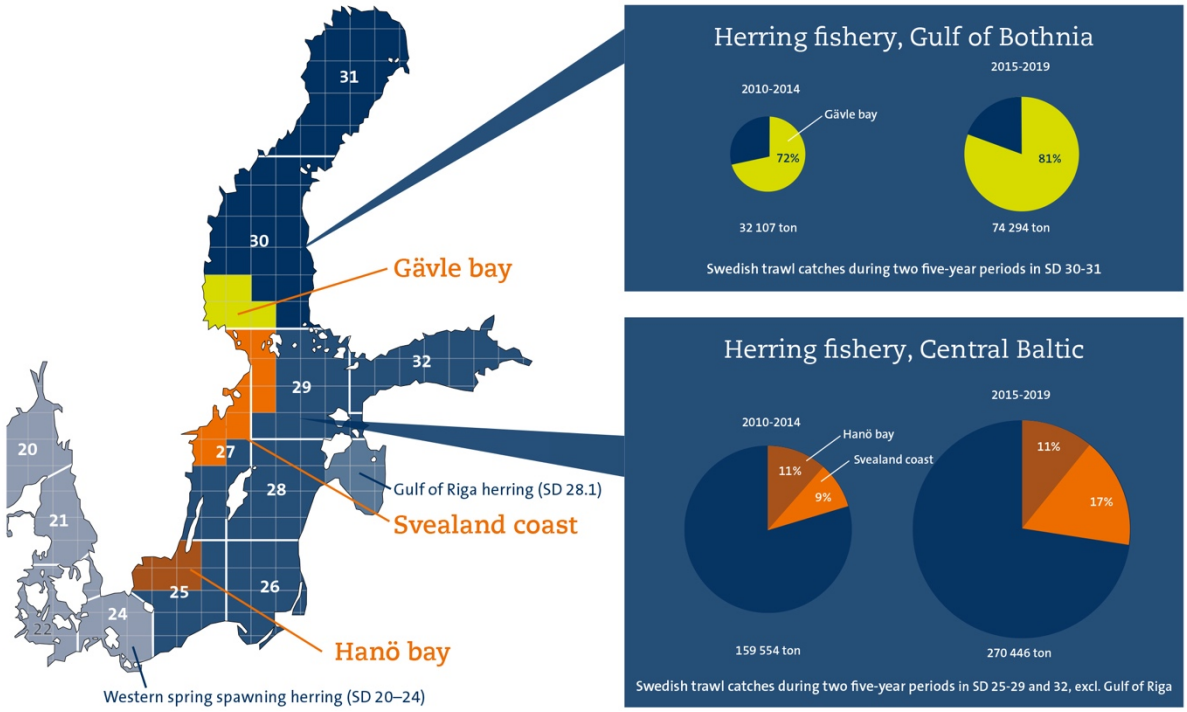
Increased herring catches close to the Swedish Baltic east coast, and the negative trend for several herring stocks accentuate the need for reduced fishing pressure and more detailed knowledge about herring subpopulation structure.

The large-scale Swedish trawling for herring in the Baltic Sea has flourished in recent years. The herring catches in the Central Baltic and the Bothnian Sea have increased by 70 percent over the past five years. At the same time, a larger proportion of the fishery has moved closer to the east coast.

There are now worrying reports about a decreased abundance of herring in several coastal areas. These concerns include depletion of local herring subpopulations, with grave consequences for coastal ecosystems and lower productivity of the whole herring stock.[1] [2]

These signals from the coast, and the overall negative trends for some of the major Baltic Sea herring stocks, call for caution. Fisheries management and stock assessment frameworks should ur- gently ensure a better and more detailed understanding of 1) the stock- and subpopulation structure of the Baltic Sea herring, and 2) how the current herring fishery affects the coastal ecosystems.

In order to halt the negative development, it is also necessary to restrict the large-scale trawling for herring close to the Swedish east coast, in line with the precautionary approach.



Swedish trawl catches in the Baltic Sea have increased over the past five years – and more and more of the catch is taken near the coast. Of all herring caught by Swedish trawling vessels in the Central Baltic Sea and the Bothnian Sea, ICES subdivisions (SDs) 25-32, during the years 2010-2014, an average of 29 % was taken in the coastal areas Hanö Bay, Svealand Coast or Gävle Bay. In 2015-2019, the proportion was on average 40 percent. Illustration: Robert Kautsky/Azote

Less herring in archipelagos

Most pelagic trawl fishery for herring along the east coast takes place from January to April, and, to some extent, also during October–December. It is focused on herring that gather off the coast before spawning in the coastal zone or in shallower water.

There have been numerous warnings from local fishermen and authorities in recent years, saying that there is significantly less herring than usual in many coastal areas and archipelagos. In some areas, for instance, in the southern parts of the Bothnian Sea, the amounts of large herring have decreased over the past decade. [3] [4]

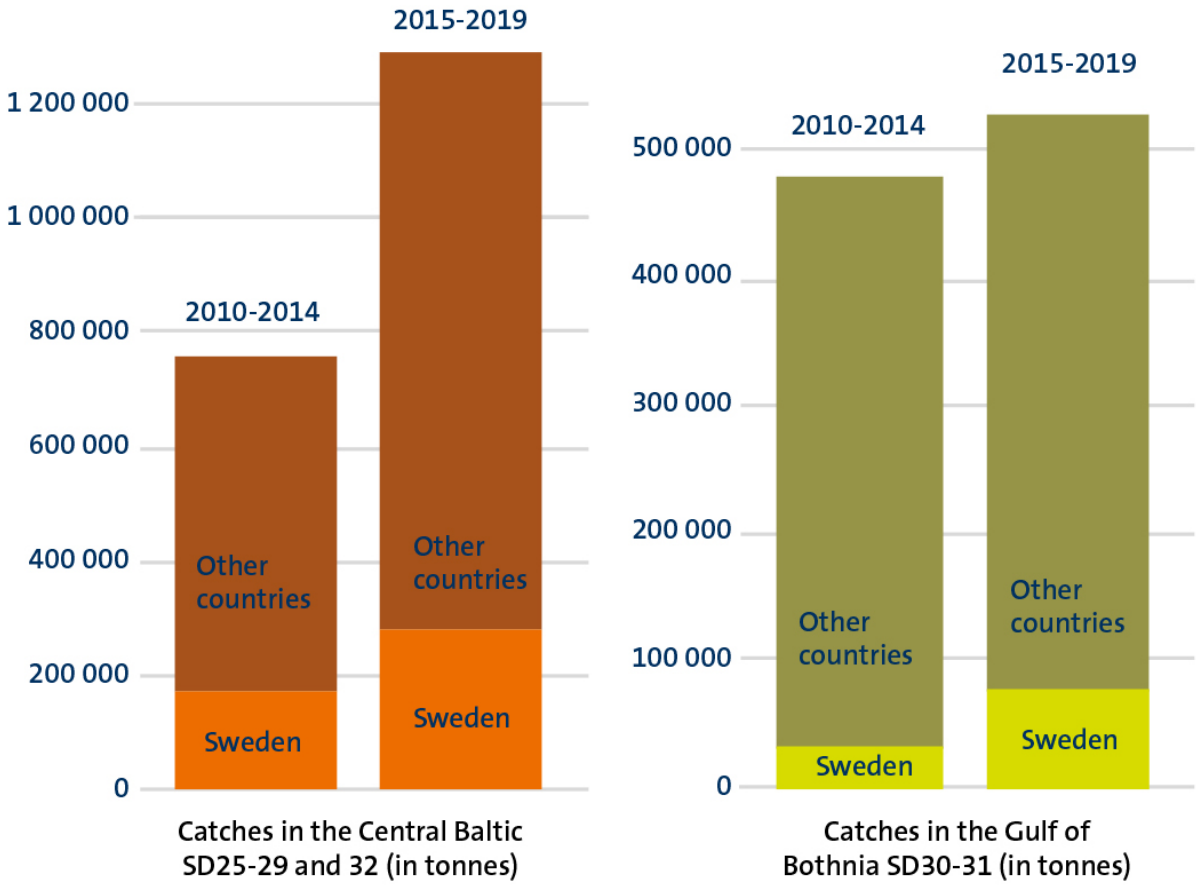
Trawl catches increase...

Baltic Sea Centre's analysis of national official catch data from the past ten years show that herring catches by Swedish trawl fisheries have increased in three areas near the Swedish east coast:

- **Gävle Bay:** Along the southwest coast of the Bothnian Sea, the catches started increasing in 2013/2014. During 2015-2019 the catches tripled compared with the previous five-year period – and the average annual catch went from around 4 600 tonnes to about 12 000 tonnes per year.
- **Svealand coast:** Outside the Stockholm archipelago and in the Åland Sea, the catches more than tripled in 2015-2019 compared with the previous five-year period, with a significant increase in 2015 – and the average annual catch went from around 2 800 tonnes to about 9 000 tonnes per year.

- In **Hanö Bay**, outside the Blekinge archipelago, the catches increased by 60 percent during 2015-2019 compared with the previous five-year period – and the average annual catch went from around 3 600 tonnes per year to around 5 800 tonnes.

These three areas attract large amounts of spawning herring each year. The local small-scale fishery in the two northernmost areas has had decreasing catches during the past ten years.



The Swedish share of the total catches of herring (all countries) in the Central Baltic Sea (SD 25-29 and 32) has been relatively constant, around 29%, during the last ten years, while the Swedish share of the total catches in the Gulf of Bothnia (SD 30-31) has doubled in the last five years, from an average of 7% in 2010-2014, to 15% in 2015-2019. Illustration: Robert Kautsky/Azote

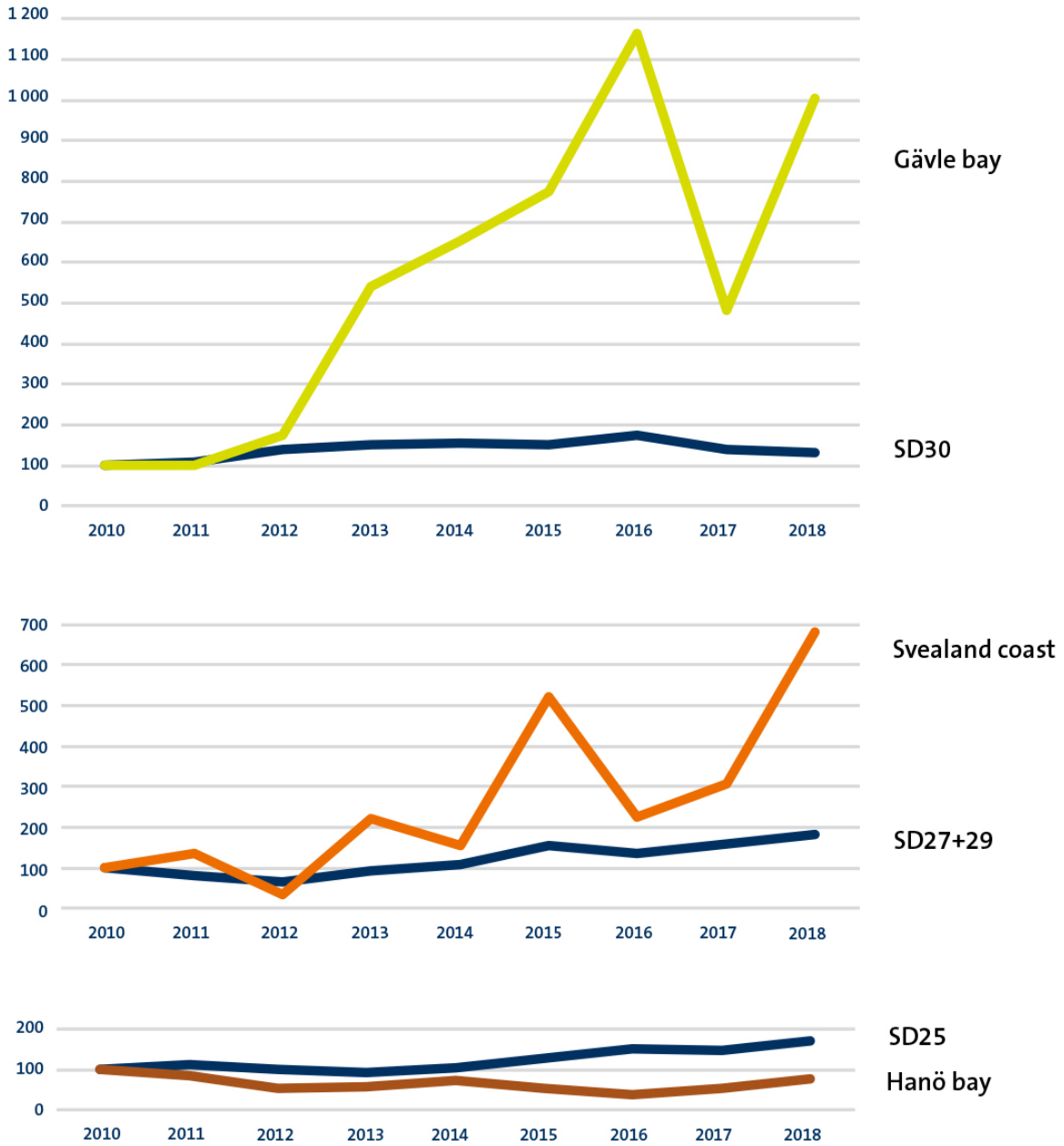
...and more is caught near the coast

At the same time as both Swedish and foreign trawl vessels catch more herring in the Central Baltic Sea and the Bothnian Sea, a larger proportion of the Swedish yield is caught near the coast:

- **Bothnian Sea:** The total catches increased by an average of 131 percent during 2015-2019, while the catches off the Gävle Bay increased by 161 percent. The proportion caught off the Gävle Bay increased from 72 to 81 percent over the past five years compared with the previous five-year period.
- **Central Baltic Sea:** While total Swedish trawl catches increased by an average of 70 percent during 2015-2019 compared to 2010-2014, the coastal-near catches off the Svealand coast increased by an average of 218 percent. The proportion caught in the area Svealand coast almost doubled, from 9 to 17 percent, over the compared five-

year periods. Catches in Hanö Bay also increased during 2015-2019, but in proportion to the increase in total yield.

Of all herring caught by Swedish trawling vessels in both the Central Baltic Sea and the Bothnian Sea (SD 24-32) during 2010-2014, an average of 29 percent were caught in areas close to the east coast (Hanö Bay, Svealand coast and Gävle Bay). For 2015-2019, the proportion of coastal-near catches went up to an average of 40 percent.



The relative development of Swedish herring catches in three coastal "hot spots" along the Swedish east coast, and their adjoining subdivisions (SDs), between 2010 and 2018. Note that each time series is normalised at 100 % in 2010. Illustration: Robert Kautsky/Azote

Managing the big picture

The question is how increased large-scale trawl fisheries close to the east coast might affect the distribution of herring in archipelagos and other coastal areas – and what consequences

it might have for coastal ecosystems and the Baltic Sea herring population as a whole. One obvious risk is that overly intensive fishing of offshore aggregations of herring near the coast can deplete or even wipe out local subpopulations, leading to, in general, lower productivity in coastal habitats.

Current fisheries management fails to take into account the complex subpopulation structure of herring. Instead, it focuses on the big picture, based on four management units, also called stocks: Central Baltic herring, Western spring spawning herring, Gulf of Riga herring, and Gulf of Bothnia herring.

Each management unit annually gets a politically agreed catch quota (TAC) based on scientific stock assessments. Where and when, within the management unit, the fish is later caught, is up to the fishermen themselves to decide.

Subpopulations – a scientific controversy

Many of today's concerns about the risks associated with large-scale herring fisheries along the Swedish east coast boils down to an old scientific controversy; that of herring subpopulations.

Should the current management units for Baltic herring be regarded as a relatively homogenous stock, with similar migration and spawning behaviours? Is it sufficient to manage all herring trawl fishery in the Central Baltic Sea as fishing on a single stock, regardless of where and when the catches take place?

Or does each management unit, in fact, consist of several genetically and behaviourally different subpopulations and local components, with more or less specific learned and/or genetically driven migration and spawning patterns?

Today's fisheries management is organised according to the previous model. In practice, that presupposes that all herring fished close to specific spawning areas will automatically be replaced by herring from the same or neighbouring management units the following year.

However, both historical and new research shows that the latter model is closer to how fish populations are structured.

It is known that different herring spawning subpopulations are to some extent separated from each other based on when and where they reproduce and that they possibly adapt to the environment during the egg and larval phases.[5]

For instance, tagging and genetic studies suggest that Western spring spawning herring has a complex mixture of several different subpopulations (e.g. Rügen herring, Fehmarn herring, herring from the Kattegat and Inner Danish waters. They predominantly spawn during spring, but there are also local spring-, autumn- and winter spawning stock components – each of which has different contributions to the fishery and ecosystem.[6]

During summer, these subpopulations migrate to feeding grounds as far away as Skagerrak and the North Sea before returning to their different spawning grounds to reproduce (i.e. similar to the homing behaviour observed in salmon).

DNA reveal genetic "toolbox"

In a recent study[7] lead by a research team at Uppsala University, new DNA-techniques were used to map the entire genome of At- lantic and Baltic Sea herring. The results revealed a large number of genetic variations between herrings sampled at different locations in the Baltic Sea. Genetic differences were also discovered between herrings caught in the same area but spawning at other times of the year.

The most significant genetic differences between different populations are related to season of spawning and the local environmental conditions (salinity, temperature, light conditions, etc.) during spawning and early larval development.

Since herring also have a well-documented homing behaviour (i.e. spawns in the same place, or at least area, as it was once hatched)[8] [9] [10], it is highly probable that the herring's choice of spawning grounds is not made randomly but is largely genetically controlled or learned.

The scientists behind the study conclude that the Baltic herring population has a "toolbox" of different genetic variations linked to different reproduction strategies, and that the extensive genetic characterization of herring populations has established highly informative genetic markers that can be used for cost-effective monitoring of herring populations.

A more finely calibrated fisheries management

It is not yet apparent how and where the genetic variations occur and exactly how they divide the Baltic herring into different sub-populations.

The depleted state of several herring stocks, combined with increased catches and reports of decreasing herring quantities along the east coast, are clear warning signs. At the same time, existing knowledge about the herring population structure shows that the management goal of maximum sustainable yield (MSY) can be assumed to be very different between different subpopulations.

Reducing fishing pressure on stocks that are currently below sustainable levels is a given. The same applies to measures to reduce coastal trawling in areas where severe herring shortages are reported in coastal ecosystems.

But it is also time to further safeguard the herrings' genetic variation by taking greater account of subpopulation structure within each current management unit. The work of providing fisheries management with detailed knowledge about the herring's population dynamics in relation to coastal ecosystems and the impact of fisheries should begin immediately.

Knowing which herring are caught where, and when, may help remedy the mismatch between management and biological reality – and reduce the risk of further depleting the Baltic Sea herring.

***

POLICY RECOMMENDATIONS

- **Move the trawling border** along the Swedish east coast further out (e.g. to 12 nautical miles from the baseline) to secure herring spawning sites and over-wintering areas.
- **Conduct a more detailed survey** of the stock and subpopulation structure and migratory patterns of the Baltic Sea herring, using historical knowledge and new DNA-techniques, cross-checked with other techniques, such as otolith chemistry.
- **Use the survey results** to revise the current structure of management units for Baltic Sea herring to better account for herring subpopulations in fisheries management.
- **Reduce annual catches** to well below Fmsy for Central, Western, and Gulf of Bothnia herring – to safeguard the preservation of stocks, subpopulations, and genetic diversity.
- **Restrict large-scale herring trawling** in times and places with particular risks for coastal ecosystems and local subpopulations, in line with the precautionary principle.

FACTS

The importance of herring

Herring is an important ”engine” of the Baltic Sea marine ecosystem. It constitutes an important food source and links the transfer of nutrients, energy, and other substan- ces between the plankton community and the larger sea animals.
Herring also play a crucial role for many coastal areas, supporting local fisheries and having several important ecosystem functions:

- transfer of nutrient from the high sea to the coastal areas
- food for larger predatory fish, seabirds, and seals
- herring egg and larvae are important food for many fish species (e.g. pike, perch, trout).

State of the herring

- **The Central Baltic herring** is in poor shape. Since 1974 the estimated spawning stock biomass has shrunk by 77%. The spawning stock biomass (the part of a fish stock that has reached sexual maturity) is below the target level of MSY B-trigger, and the fishing pressure is above sustainable levels.
- **Western Baltic spring spawning herring** has decreased since 2006 and has been fished above sustainable levels for many years. The spawning stock biomass has reached historically low levels, currently below the limit reference point (Blim) and the precautionary reference point (Bpa).

- **Gulf of Bothnia herring** has issues with data collection and stock assessment. Hence, the status of the stock is by and large unknown.
- **Gulf of Riga herring** has been fished in line with the Baltic multiannual management plan and is doing well. However, biomass is expected to decline during 2022.

Genetic diversity strengthens the species

The preservation of the subpopulation structure is essential for the fish stock productivity and strengthens the whole species. A fish population complex composed of several subpopulations appears to be more resilient and more stable in terms of reproducing itself than one that is not. Stability occurs when the subpopulations within the population can respond in different ways to the same environmental conditions. At the same time, losses of individual subpopulations can pass unnoticed, leading to the stock's total production capacity becoming lower until a recolonisation of lost spawning sites occurs.[11] [12] [13] [14]

---

[1] https://balticeye.org/sv/hallbart-fiske/strommingsfisket/

[2] https://balticeye.org/sv/hallbart-fiske/regeringen-soker-bevis-om-strommingsfisket/

[3] https://www.lansstyrelsen.se/blekinge/om-oss/nyheter-och-press/nyheter---blekinge/2019-10-07-landshovdingar-foreslar-stopp-for-storskaligt-foderfiske-i-sodra-ostersjon.html

[4] https://www.havet.nu/forskare-och-fiskare-kraver-stopp-for-tralfiske-efter-stromming-i-ostersjon

[5] Limborg et al: *Environmental selection on transcriptome-derived SNPs in a high gene flow marine fish, the Atlantic herring (Clupea harengus)* (Molecular ecology, 2012) https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-294X.2012.05639.x

[6] Herring Assessment Working Group for the Area South of 62ºN (HAWG) (ICES 2019a) Stock Annex https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2019/HAWG/01%20HAWG%20Report%202019.pdf

[7] Fan Han et al: *Ecological adaptation in Atlantic herring is associated with large shifts in allele frequencies at hundreds of loci* (eLife, 2020) https://elifesciences.org/articles/61076

[8] Gaggiotti et al: *Disentangling the effects of evlolutionar, demographic, and environmental factors influencing genetic structure of natural populations: Atlantic herring as a case study* (International Journasl of Organic Evolution, 2009) https://onlinelibrary.wiley.com/doi/full/10.1111/j.1558-5646.2009.00779.x

[9] Ruzzante et al: *Biocomplexity in a highly migratory pelagic marine fish, Atlantic herring* (The Royal Society, 2006) https://royalsocietypublishing.org/doi/10.1098/rspb.2005.3463

[10] Stephenson, R. L., Melvin, G. D., and Power, M. J. 2009. *Population integrity and connectivity in Northwest Atlantic herring: a review of assumptions and evidence*. – ICES Journal of Marine Science, 66: 1733–1739.

[11] ICES Baltic Fisheries Assessment Working Group (WGBFAS), Volume 2 Issue 45, 2020 http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WGBFAS_2020.pdf

[12] Schindler et al: *Population diversity and the portfolio effect in an exploited species* (Nature, 2010) https://www.nature.com/articles/nature09060

[13] Smedbol, et al: *The importance of managing within-species diversity in cod and herring fisheries of the north-western Atlantic* (Journal of Fish Biology, Volume 59, Issue sA, 2005) https://doi.org/10.1111/j.1095-8649.2001.tb01382.x

[14] Larkin: *An Epitaph for the Concept of Maximum Sustained Yield* (Transactions of the American Fisheries Society, Volume 106, Issue 1, 1977) https://doi.org/10.1577/1548-8659(1977)106<1:AEFTCO>2.0.CO;2