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This is a printable version (pdf) of the FAQ (Frequently Asked Questions) about herring published on SLU's website. https://www.slu.se/institutioner/akvatiska-resurser/radgivning/faq-om-sill/

(The website will be updated as necessary. This pdf shows the page as it looked on 2024-05-31. Links that are in the digital version are missing from the document.)

SLU answers questions about herring

There is an intense debate about herring in the Baltic Sea. Coastal and recreational fishermen testify that the occurrence of herring has declined sharply in the archipelago, and there is concern that large-scale trawling out at sea is depleting local coastal stocks. At the same time, offshore fisheries are landing normal-sized catches and the scientific experts in the International Council for the Exploration of the Sea, ICES, assess that the stocks are large enough for limited fishing to take place.

How is it connected?

Here, experts from the Department of Aquatic Resources (SLU Aqua) answer questions about herring* in the Baltic Sea. About what we know - and what we do not know - about the stocks and about the impact of fishing, about how the goals and goal conflicts of the fisheries policy affect both advice and management, and about what measures we believe are necessary for viable stocks of herring both in the high seas and in the archipelago.

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1. About herring in the Baltic Sea

Herring is the most common fish in the Baltic Sea. It lives a large part of its life out in the open sea, but during spring and summer it comes to the coast to spawn. This huge migration of fish means that the coastal ecosystem receives an addition of biomass that serves as a food base for predatory fish, birds and seals.

The spawning migration of herring to the coast has also formed the basis for the most important coastal fishing in the Baltic Sea, as well as for a lively recreational fishery. It is difficult to overestimate the importance of herring as a resource for Sweden. It is the most economically important species, and has been one of the most important sources of protein for hundreds of years.

1.1. Is the herring in the Baltic Sea running out?

Herring in the Baltic Sea is administratively divided into four main stocks: one in the Gulf of Bothnia, one in the Baltic Proper (Central Baltic Sea), one in the Gulf of Riga and one in the western Baltic Sea (including the Kattegat and Skagerrak).

According to the stock estimates made, the stocks in the Gulf of Bothnia and the Baltic Proper have a spawning biomass of 0.5 and 0.8 million tonnes each, respectively. The stocks in the Gulf of Riga and the western stock are much smaller. The size of the stocks is far from the peaks 30-50 years ago, but ICES assesses that there is still enough herring in the Baltic Sea that there is room for fishing.

The fact that many coastal fishermen and recreational fishermen have noticed that catches have decreased sharply in recent years is due to the fact that the number of individuals has decreased, but also to a changed size structure where the proportion of large herring has decreased significantly. Since coastal and recreational fishing is aimed entirely at large herring, catches have fallen sharply, despite the fact that there is still a lot of (but small) herring in terms of size.

Possible explanations behind the change in size structure

- **Fishing (and management objectives for fisheries)**
  Fishing on a stock normally reduces the number and proportion of large individuals. The objective of the current management is to fish at a level that allows for the highest possible extraction of biomass; MSY. However, fishing, even in accordance with MSY, often leads to a fish stock's size structure shifting towards smaller sizes, which has to do with the fact that we often target larger and older individuals. A general increase in mortality for all age groups will also mean that life expectancy will decrease and there will be fewer old and large individuals. (Read more about MSY and the consequences of the objectives of the fisheries policy in the section "Sustainable fishing - on conflicts of objectives in the fisheries policy".)

- **Local spawning stocks***There can be great variation in the availability of herring between different stretches of coast. Although the state of knowledge is unclear, there are probably local spawning stocks of herring within the two large management units in the Baltic Sea. High fishing pressure locally can risk greatly reducing the presence of local stocks. However, knowledge about such local spawning populations is incomplete, and current management does not explicitly take into account such local variations. Research is ongoing to improve knowledge about local stocks. (Read more about the research that is ongoing in the section "Issues of overfishing and possible measures".
  ** For a definition of spawning stock, see the fact box at the bottom of the page.*

- **Seal predationSeals take far less herring than fishing, but the seals instead selectively eat the large herring. The population of grey seals has grown sharply in recent decades, and the relative impact of the seal has thus increased.**

1.2. What does fishing look like in the Baltic Sea and how has it developed

Historically, herring was only fished in coastal areas, and then mainly with nets, traps and seines (wads). During the 1970s, trawling in the central Baltic Sea increased as a result of, among other things, reduced access to fishing waters in the North Sea and the Atlantic Ocean in connection with the countries' fishing zones being moved out to 200 nautical miles. In the Gulf of Bothnia, it took until the 1990s before trawling for herring became extensive.

Today, Sweden accounts for about 20% of the total catches in the central Baltic Sea. In the Gulf of Bothnia, the corresponding figure is around 18%, while Finland has the remainder of the total fishing opportunities.

Large-scale fishing for feed dominates

Currently, pelagic trawl fishing accounts for most of the catches, and the catch is dominated by a few large boats. The vast majority of the catch goes to the production of fishmeal. In the production of fishmeal, it is possible to remove dioxins, a type of environmental toxin of which Baltic herring has high concentrations, especially in the northern parts. The international demand for fishmeal (especially for fish farming) is high, and at the same time the demand for herring for consumption has decreased, partly due to the dioxin problem.

Coastal fishing today, whose catches are mainly taken by gillnet boats and smaller trawlers that are mainly used for human consumption, has declined continuously since the 1990s. This is partly due to a general structural change which has led to a reduction in the number of fishermen, but also to a reduction in catches per boat. The declining catches are in turn a consequence of both reduced occurrence of large herring and increased disturbance and predation by seals.

Recreational fisheries' catches of herring along the Swedish Baltic Sea coast amount to a few hundred tonnes per year. This is only a fraction of the catches of commercial fisheries, but the species is still one of the most important for recreational fishing.

Increased fishing in coastal areas

During the second half of the 2010s, there was a shift in pelagic trawling so that a larger proportion of catches were taken closer to the Swedish coast. This pattern is seen both in the southern Bothnian Sea, and along the coast from the Stockholm archipelago to Hanö Bay. In 2021, however, large-scale fishing is again shifting slightly more out to sea, but coastal catches are still at a higher level compared to the early 2010s. Pelagic trawling in the central Baltic Sea mainly takes place

during the winter, which is the time of year when the herring often accumulates before migrating to the coast for spawning. In the Bothnian Sea, pelagic trawling in the Swedish economic zone takes place for the most part during the period November-June, and then mainly concentrated in areas east and north of Finngrunden. Such concentrated fish, in time or space, risk affecting local spawning stocks.

1.3. How does pelagic fishing affect herring in the archipelago?

Although there are indications that there may be stationary spawning stocks of herring in the archipelagos, most of the fish migrate between the coast and the open sea. Spawning usually takes place on shallow, vegetation-covered hard bottoms in the coastal zone, but sometimes also on offshore shallows.

The warm and productive environment of the coast is the most important spawning and nursery area for herring, and is also an important foraging area for adult fish after spawning. For predatory fish, fish-eating birds and seals, herring is very important, and changes in the availability of herring can thus affect the entire coastal ecosystem.

The cold part of the year is spent mainly in deeper water out at sea. As a result of the migrations, fishing in the open sea affects the abundance of herring in the coastal area and can thus have an impact on the functioning of coastal ecosystems. For example, a reduced occurrence of herring can reduce the availability of prey for predatory fish such as cod, pike and perch, but also for seals. Today, a decreasing blubber thickness is seen in the grey seal in the Baltic Sea, which indicates that it suffers from a lack of food. This in turn may be one reason why seals are becoming increasingly common in the inner archipelago bays where herring spawn. In these areas, the seal can have a major impact on sensitive local stocks of predatory fish.

There are also signs that large-scale fishing may have indirectly contributed to the increase in sticklebacks in the Baltic Sea. Large herring has proven to be an important predatory fish for sticklebacks, and the reduced occurrence of large herring as a result of large-scale fishing in the open sea may thus be a reason why stickleback stocks have grown very strongly. The stickleback, in turn, has a major impact on the coastal ecosystem by eating predatory fish's eggs and larvae and can wipe out local populations of pike and perch, while at the same time reinforcing

eutrophication effects in the form of filamentous algae blooms by also eating the grazing crustaceans that normally regulate the growth of filamentous algae.

1.4. What factors determine the size of the stock?

The size of fish stocks is determined partly by recruitment, i.e. how many eggs hatch and fish that survive until they reach catchable size, and partly by the mortality of older individuals.

Factors affecting recruitment

- **The amount of mature fish**
  (especially when the amount is below the so-called carrying capacity of the stock)

- **Access to good quality spawning habitat**
  Here, for example, eutrophication can contribute to poorer survival of the eggs.

- **Variation in temperature, salinity and oxygen**
  Can affect both the survival of the eggs and the survival during the sensitive larval stage.

- **Availability of food**
  Especially during the critical larval stage.

- **Predation on eggs and larvae**
  The mortality rate in these life stages is high.

As for most of the species that are fished, the details of the processes that govern recruitment for herring are rather poorly known. However, the stock estimates show that there generally do not seem to be problems with recruitment, but that it is the mortality of older fish that determines how much herring there is.

Factors Affecting Mortality in Older/Larger Fish

- **Fishing**
  Pelagic trawl fishing accounts for the vast majority of catches. Catches from coastal and recreational fisheries account for a few per cent of the total, and therefore have less impact on stocks.

Natural mortality, including predation The grey seal's diet is often completely dominated by herring, and it eats significantly more herring than is caught in coastal fisheries. Since the seal selectively feeds on the largest individuals in the population, it helps to reduce the occurrence of large herring.
As the grey seal population has grown sharply – there are twice as many seals today than there were 15 years ago – while the availability of large herring is decreasing, there is a risk of food shortages. A sign that there is actually a food shortage today is that the blubber thickness of the seals has decreased.

At the same time, the grey seals are seen to be becoming increasingly shy and for various reasons are finding their way into the inner archipelago, where they can damage sensitive local populations of, for example, pike. It is possible that an increased access to large herring in the outer archipelago would reduce the seal's propensity to seek out the archipelagos, but we do not know for sure.

Fish-eating birds such as cormorants also contribute to the natural mortality, but to a much lesser extent than seals. Herring is also important food for other fish in the ecosystem.

In addition to predation, mortality caused by diseases and parasites and environmental factors is also included in the natural mortality.

ICES assesses that natural mortality has been on a par with, or greater than, the fishing mortality of the stock in the Gulf of Bothnia, but that fishing mortality is dominant in the central Baltic Sea.

2. Sustainable fisheries – on conflicts of objectives in fisheries policy

Is the current fishery for herring in the Baltic Sea sustainable in the long term? As in many other areas of natural resource management, the answer to the question may be different depending on how the concept of sustainability is interpreted, i.e. which management goal(s) are given the highest priority. Therefore, from their perspective, one stakeholder can condemn fishing as unsustainable, while one with a different perspective thinks the opposite.

The herring stocks in the Baltic Sea are jointly managed under the EU's Common Fisheries Policy (CFP). It is therefore the EU countries that jointly decide how much can be fished each year (quotas). Quota decisions are based on MSY (Maximum Sustainable Yield), which is the stated quantitative target for the fisheries policy. But a fishery can - even when it is compatible with MSY - for example affect the size structure of a fish stock so that there are fewer large individuals.

It is important to understand the objectives that govern the CFP. It sets the framework, both for Sweden's opportunities to influence, and for the administration's room for manoeuvre. The objectives also provide the basic conditions for scientific advice and how to advise on the extent of fishing on different stocks.

2.1. What is sustainable fishing?

The concept of sustainable fishing contains many possible interpretations depending on the perspective you have; on the importance of fishing in society and on the role of fish in the ecosystem. So there is not just one objective definition of sustainable fisheries. Examples of target categories are:

- Biological/ecological - e.g. maximum sustainable yield (MSY), quantity/proportion of large fish or intact food webs.

- Economic - e.g. profitable companies, wages of those who fish
- Social - e.g. employment in sparsely populated areas, small-scale fishing
- Food security - e.g. Sweden/EU must increase the degree of self-sufficiency in the fish we consume

All of these goals are included in some form in the Common Fisheries Policy, but parts of them are also found in, for example, the EU's Marine Environment Directive, the UN's Sustainable Development Goals, as well as in the national environmental goals. The goal formulations can vary depending on where they occur, and they are not always consistent. Different combinations of goals can therefore be difficult to reconcile. Sometimes they are even incompatible.

Thus, there are conflicts of objectives. For example, it can be difficult to combine an economic goal of maximizing the profitability of fishing with a social goal of maximizing the level of employment in fishing.

Correspondingly, it may be difficult to reconcile the biological objective of MSY (Maximum Sustainable Yield) fisheries with ensuring good access to large herring along the coast.

2.2. What does the management objective mean as maximum sustainable yield (MSY)?

Maximum sustainable yield (MSY) originates from the first half of the 20th century and is primarily a theoretical concept of how catch harvest can be maximized in the long term without risking the regrowth of stocks.

The concept is based on the fact that the growth of a population is density-dependent: when the number of fish in a population decreases as a result of fishing, the growth rate of the remaining individuals will increase. And as long as you make sure that a sufficiently large amount of mature fish remains, regrowth is guaranteed.

Important to know about MSY

- MSY aims to maximize the harvest of individual fish stocks from the sea, without risking the stock's long-term reproductive capacity (spawning biomass).

- Fishing at MSY normally means that the size of the stock is less than half the size of a completely unfished stock.

- MSY depends on the size selectivity of the fishery, i.e. how the fishing affects different age groups. When calculating MSY for a specific fish stock, the starting point is the current harvest and the size selection that takes place in the fishery today.

- The MSY value is not static, but is affected by several factors that change over time, such as ecosystem and species productivity (growth), mortality factors in addition to the fishing itself (predators, diseases, etc.), interactions between species in the ecosystem, and the extent to which future regeneration is dependent on the amount of adult fish. These factors can change over time and need to be regularly reviewed.

- Another factor that affects how large a fishery can be in MSY is a stock's reference values. A stock's reference values are also affected by the productivity of the ecosystem and species (growth), mortality factors in addition to the fishing itself (predators, diseases, etc.), interactions between species in the ecosystem. Therefore, the reference values for a stand can also change over time, and the included parameters need to be reviewed regularly.

- Fishing at MSY often means that a stock's size structure is shifted towards smaller sizes, which has to do with the fact that increased mortality generally reduces the chance of getting old, but is also due to the fact that fishing is often aimed at larger and older individuals.

- The MSY concept in itself does not provide any guidance on whether fishing should take place on juvenile fish or adult fish, i.e. the concept does not include any unbiased optimisation of how a stock should be taxed. This means that fishing that only takes place on juvenile fish may well take place within the framework of MSY as well as fishing that only taxes adult fish. However, the difference between these two MSY scenarios is that they are characterised by different optimal fishing mortality, different stock sizes, different stocks/size structures and different long-term catch levels.

- In practice, however, most fishing is done in a way that causes mortality to increase with the size of the fish (for example, catching juvenile fish is

often avoided), which means that the proportion of large fish in the stocks is reduced. A consequence of today's MSY-based management of herring (and most other commercial species) is thus that the amount of large fish decreases.

2.3. What are the objectives of today's fisheries policy?

MSY (Maximum Sustainable Yield) is an interpretation of biological sustainability that has had a major impact, especially after the UN World Summit on Sustainable Development in Johannesburg in 2002. As a result of the Johannesburg Declaration, the EU and its member states, along with many other countries around the world, committed to maintaining and restoring fish stocks at levels capable of producing MSY by 2015.

The Common Fisheries Policy (CFP) in force at the time lacked specific objectives other than 'ensuring the sustainable exploitation of living aquatic resources in economic, environmental and social terms' and the application of the precautionary approach (Council Regulation (EC) 2371/2002). A couple of years later, the European Commission proposed a plan for how MSY should be applied in management plans within the EU, and starting in 2007, the MSY target gradually began to be applied in connection with the European Commission's proposal for management plans for different stocks and areas.

In 2013, in the context of the last reform, MSY became a central and stated objective of the CFP (Article 2(2) of Regulation (EU) No 1380/2013 of the European Parliament and of the Council)

SLU Aqua (Swedish Board of Fisheries) advocated other sustainability goals

SLU Aqua, which at the time was the Swedish Board of Fisheries' R&D department, pointed out in its opinion on the Commission's proposal that the MSY concept had shortcomings. Instead, they wanted to see alternative sustainability goals, such as MEY (Maximum Economic Yield) or the more conceptual ESY (Ecologically Sustainable Yield), both of which include lower fishing mortality and larger stock sizes than MSY. Lower fishing mortality also increases the proportion of larger/older fish in the stocks. The fact that fish stocks are characterized by a high proportion of large and older fish is a central management goal within the Marine Environment Directive, which is currently not implemented in fish management.

But the R&D department still saw the proposal as a step on the way out of the EU's dismal history, where the lack of clear management goals continuously led to more or less arbitrary decisions on allowable catches that were regularly far greater than the scientific advice - and also far above MSY.

And it has still gotten better. In 2004, it was estimated that 76% of EU stocks were overfished in relation to MSY, and that mortality from fishing was usually twice as high as it should be under MSY. Although problems remain, the overall situation of EU stocks is much better today (around 32% of stocks were overfished in 2022).

MSY - the operational biological target

The Common Fisheries Policy (CFP) also contains more general objectives on environmental sustainability, such as achieving economic, social and employment benefits, and contributing to food security. In practice, while these general objectives have an impact on the actual fisheries policy and management, MSY is the operational objective in terms of biological objectives.

The EU's fisheries policy also specifies the ecosystem approach as one of the sub-goals (Article 2.3) in addition to MSY. This means that the negative impact of fishing on marine ecosystems must be minimized. Reference is made here primarily to other environmental directives, such as the Marine Environment Directive, which specifies objectives and criteria for what is required for the sea to achieve good environmental status.

The Marine Strategy Framework Directive's sub-criteria for commercial fish species:

- Fishing mortality (the amount of fish caught by fisheries) must be sufficiently low (below an MSY limit; Fmsy) to prevent the stock from becoming too small

- The spawning biomass, i.e. the amount of mature fish in the stock, must be sufficiently high to ensure regrowth (above a limit value for Bmsy).

- Fish stocks must have a healthy age and size distribution

The first two of these criteria and calculations of fishing mortality and spawning biomass are standard deliveries in the ongoing advice on catch thread (quotas) that the International Council for the Exploration of the Sea (ICES) produces for the European Commission and the member states.

When goals are difficult to integrate...

The third sub-criterion, that of size distribution, on the other hand, has proved to be more difficult to apply. In 2017, ICES assessed that the relationship between stand status and size structure is not satisfactorily elucidated. Following a new series of meetings, ICES again concluded in 2024 that it had not been able to identify science-based indicators and thresholds for when a stock transitions from a healthy/desired to an unhealthy/undesirable age and size structure.

This is the background to the fact that the issue of the size structure of stocks is currently neither requested by the EU nor handled by ICES in the ongoing scientific advice, despite the fact that the Marine Environment Directive was adopted by the EU as early as 2008.

The implementation of a broader and more ecosystem-based approach in fisheries policy has thus been initiated, and there are defined management objectives. However, since the goals are not fully integrated into the established advice, the European Commission, like the decision-makers in the individual countries, focuses on the MSY goal.

2.4. Who decides the goals and what can Sweden decide on itself?

In general, legislation on fisheries and the marine environment in the EU is decided jointly by the EU Council (the ministers of the countries) and the EU Parliament on the basis of legislative proposals from the European Commission.

But there is one important exception; the annual fishing opportunities (quotas) are decided by the EU Council alone on the basis of the Commission's proposal, which in turn is based on the requirements of the jointly agreed legislation.

For Sweden, this means that the government (the Minister for Rural Affairs) is ultimately responsible for Sweden's positions when the fishing quotas are negotiated in the EU Council. Sweden's positions are based, among other things, on documentation from the Swedish Agency for Marine and Water Management (HaV), which in turn is based on ICES advice but sometimes also on additional biological knowledge and advice from SLU Aqua. SwAM also evaluates other knowledge and views and makes its own assessments in its documentation to the Government Offices.

MSY - a goal that is difficult to change

Since detailed formulations in jointly decided legal acts are very controlling, there is limited room for other language interpretations than MSY at present. The MSY target has also been decided in the usual democratic order through the latest reform of the EU's fisheries policy. A change or adaptation of the MSY target must therefore also take place via political decisions in the EU.

Sweden's control is limited

The Common Fisheries Policy (CFP) is an area in which the EU has exclusive competence, which means that the EU has the exclusive right to legislate. Member States can then only apply the legislation, unless the EU has given them permission to adopt certain laws themselves. This means that Sweden alone cannot determine important aspects of how the stocks are to be managed.

In order to have a real effect on stocks that are jointly managed (such as herring in the Baltic Sea), decisions must be taken jointly by the EU. Somewhat simplified; Sweden cannot therefore decide on its own how much can be fished, what gear rules apply or what minimum size a certain species must have. On the other hand, Sweden alone decides who can use Sweden's quotas.

Sweden also has some extended powers closer to the coast. Here, Sweden can introduce certain rules, but they must not be less far-reaching than the EU-wide regulatory framework. The rules must also not discriminate against fishermen from neighbouring countries who have the right to fish there.

There are thus opportunities for Sweden to determine its own rules for fishing in coastal waters (within 12 nautical miles of the coast), but this would require a review of the agreements with the neighbouring countries that currently have the right to fish there. SwAM is the expert authority for these issues.

3. From politics to advice

Based on the objectives of the Common Fisheries Policy (CFP), the European Commission commissions scientific advice from the International Council for the Exploration of the Sea (ICES). ICES is an intergovernmental organization with 20 member countries around the North Atlantic (Europe and North America).

The recurring agreed assignments include the annual advice on catch line (quotas) for internationally managed fish stocks. This advice is normally given once a year, at the end of May for the Baltic Sea.

Since MSY is the explicit operational biological target within the EU (and in Sweden), it is also explicitly scientific advice in accordance with MSY that the European Commission commissions from ICES.

3.1. On what knowledge base are the quota decisions based?

The catch thread is based on models that estimate the number of fish of different ages in each management area and the level of spawning biomass and fishing mortality in relation to the established reference points for these.

For these stock estimates, information is used both from commercial fisheries (quantity, size and age of the fish in different sub-areas) and from scientific sonar surveys and test trawls. These fisheries-independent surveys estimate the presence of fish of different sizes and ages throughout the management areas. All countries around the Baltic Sea contribute to this data collection and to the stock estimates that are then made jointly by researchers from the various countries under the auspices of ICES.

3.2. How does ICES work and how quality-assured is the advice?

Within the framework of the ICES cooperation, around a hundred different working group meetings, workshops and conferences take place annually on various themes and tasks. Many working groups are of a temporary nature while some are more permanent. Some working groups have more open tasks, while others have much more precise tasks with clearer delivery requirements. An example of permanent groups with clear delivery requirements is those that handle orders for catch wire for different stocks (stock estimate groups).

WGBFAS - keeps track of the Baltic Sea stocks

The catch thread for herring is developed by the Baltic Sea stock working group called WGBFAS (Baltic Fisheries Assessment Working Group), which consists of scientific experts from all Baltic Sea countries. For Sweden, it is mainly experts from SLU Aqua who participate, but over the years other universities have sometimes also participated. Staffing of ICES working groups is decided by each country. All work within ICES is funded by the respective country.

WGBFAS meets in April each year and during the meeting, a stock estimate is made, based on previously agreed and quality-assured methodology, data from fishery catches, from standardized joint annual scientific surveys and from available research.

Comprehensive review by independent experts

The stock estimate results in a draft catch wire for the following year. This advice from the stock working group (including all methodology and calculations behind it) is in turn reviewed by independent experts in a so-called ADG (Advisory Drafting Group). The ADG's opinion is then forwarded to the ICES Advisory Committee (ACOM) for final quality review and approval. ACOM consists of a permanent group of senior experts from the member states and is chaired by a chairperson employed by ICES.

In addition to this annual advisory process, regular reviews (3-5 year intervals or more frequent if need is identified) of knowledge and data bases and methods are also carried out in special so-called benchmark meetings. These aim to constantly improve and ensure the quality of the advice and to determine which methods and data are to be used in the future. The benchmarking process is also reviewed by independent experts.

ADG meetings and benchmark meetings are open to external observers.

3.3. How are fishing quotas set and distributed between and within EU countries?

After the process of developing advice within ICES, the prison thread is published. For the Baltic Sea stocks, this normally takes place at the end of May each year. (West Sea stocks about a month later.)

These advice is then applied by the European Commission, which produces a proposal for the coming year's fishing opportunities, which in turn are discussed within and between the member states. During October's meeting of the EU Council for Agriculture and Fisheries, next year's fishing opportunities (quotas) for the Baltic Sea stocks (in December for the North Sea) will be negotiated and determined.

The agreed quotas are then distributed among the countries according to a fixed percentage per stock. This proportion is fixed between years and is usually referred to as relative stability.

3.4. What is done when the state of knowledge is weak?

Although knowledge about the functioning of marine ecosystems is continuously evolving, there are still major knowledge gaps, including issues related to commercial fish and shellfish stocks.

For example, in the case of herring, we have poor knowledge about the occurrence and distribution of local spawning stocks and the migration patterns of these stocks. Governance takes place, largely for practical reasons, at the sea basin level, where, for example, the entire central Baltic Sea is one administrative unit and the Gulf of Bothnia is another. Thus, we do not know how fishing pressure affects such local stocks, even if fishing pressure at sea level is considered to be at a sustainable level.

All member states can use ICES for advice

In Sweden and the EU, fish stocks must be managed on the basis of the best available scientific advice. The main instruments for this advice are through the EU-wide data collection (DCF - where countries collect data via coordinated expeditions as well as from fisheries catches and reporting), in combination with an agreement between the European Commission and ICES on ongoing scientific advice.

ICES also provides one-off advice, both to the European Commission and other clients. All ICES member countries, including Sweden, can use ICES for advice based on their own issues. Sweden can thus give ICES the task of continuing to work to integrate concrete goals regarding the size structure of fish stocks with today's MSY-based management.

It would also require Sweden to prioritise this nationally, including the research support needed, and to participate in the work required. ICES is a cooperative organization with extremely limited analytical and human resources of its own. It is the ICES member states that finance their own experts' participation, and the practical work is therefore largely guided by the member states' priorities and commitment.

What is the precautionary approach?

In this context, the precautionary approach means that management that can affect nature and natural resources includes a margin for lack of knowledge, for example about how fishing affects a stock.

A lack of knowledge cannot be taken as an excuse for not doing something, for example if there is a suspicion that the impact of fishing is negative on the stock in question (or in relation to some other aspect). At the same time, decisions on measures normally involve a trade-off of risks. It is therefore important to analyse that a proposed measure based on a precautionary approach does not risk having other equally serious or more serious effects on other parts of the ecosystem.

It is the administration (risk manager) that must apply the precautionary approach when the state of knowledge is uncertain. The role of the research (risk evaluator) is to investigate and communicate such uncertainties and trade-offs and their consequences, as well as to seek funding for and carry out research and development work to broaden the knowledge base on which the administration rests.

4. Questions about ICES advice

According to ICES' latest assessments, the herring in the Baltic Proper has been fished too hard for a few years and the catches there have had to be reduced. ICES now assesses that the stock has increased in 2023 and 2024. It is estimated to have increased so much that fishing opportunities for 2025 may increase.

The ICES catch advice for the Gulf of Bothnia has been postponed in time when the reference levels will be updated based on the current ecological situation and the state of knowledge about the stock.

In the questions below, you can read more about the reference values in the ICES advice, as well as explanations of the ICES latest catch thread for herring.

4.1. What is what in ICES prisoner wire?

The concept of maximum sustainable yield (MSY) originates from the first half of the 20th century and is primarily a theoretical concept of how the harvest of catch can be maximized in the long term without risking the regrowth of the stocks.

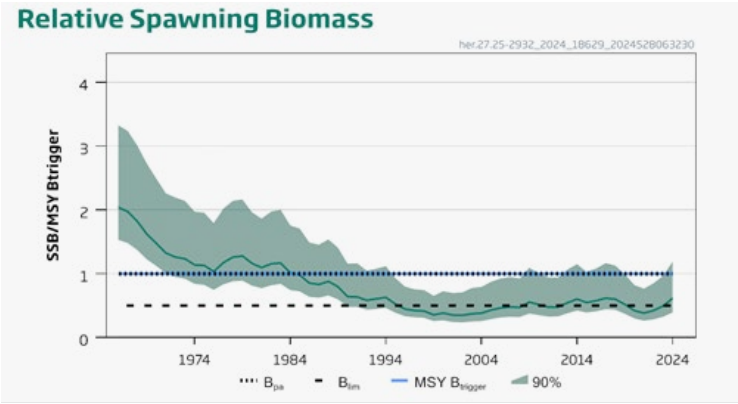
The concept is based on the fact that the growth of a population is density-dependent: when the number of fish in a population decreases as a result of fishing, the growth rate of the remaining individuals will increase. As long as you ensure that a sufficient amount of mature fish remains, regrowth is guaranteed.

To ensure that the spawning stock biomass (SSB; the total weight of all fish that reproduce in a stock) is large enough, minimum levels are used. The minimum levels have two reference points: one called the biomass limit Blim and one called the precautionary biomass limit Bpa.

The biomass limit, Blim, is the lowest level to which a stand can be allowed to fall. Below this level, the stock is assumed to be so small that its ability to produce juveniles is greatly reduced. In the long run, this means that the future of the entire stock is in danger. In the worst case, the stock can be fished out to the point that it can never recover to previous levels.

Estimates of stocks are always uncertain and this is also the case when it comes to setting the biomass limit, Blim. To take into account the natural uncertainty and create a buffer, a precautionary limit is set above the biomass limit, Bpa. Linked to Bpa, another precautionary limit is used, Btrigger (often Btrigger is the same as Bpa), which is the spawning biomass level where fishing should be reduced. To avoid that the spawning biomass decreases to levels below Blim, fishing must be reduced already when the spawning biomass is assessed to be lower than Btrigger.

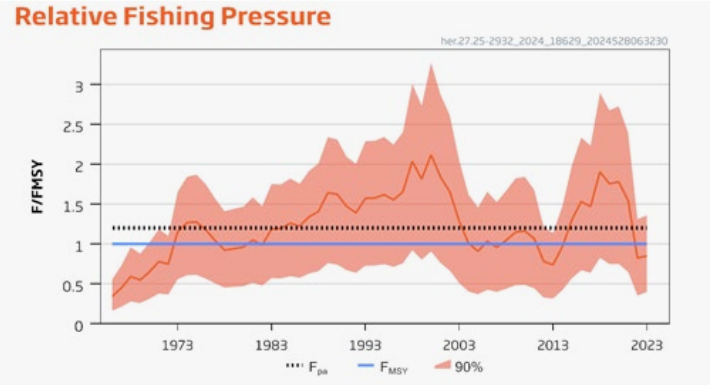
Below is an example of how a diagram of the development of a spawning population's size over time can look like. In this case, the herring appears in the central Baltic Sea.



Maximum levels are also set for fishing mortality (F; the amount of fish caught and killed by fishing), with reference values. If a stock is fished above the Flim level, there is a high probability that the spawning biomass of the stock will be greatly reduced and the recruitment of juveniles is at risk. There is also a precautionary limit for fishing mortality, Kela.

Below is an example of what a diagram of how the development of fishing mortality over time can look like. Also In this case, the herring appears in the central Baltic Sea.

This text has been machine-translated, the Swedish version is authentic



Abbreviations

MSY = Maximum sustainable yield: The maximum amount of fish that can be fished from a stock while leaving enough fish for the stock to develop sustainably.

SSB = spawning biomass: The amount of fish that are sexually mature and can produce juveniles

B = biomass: The total weight of a fish stock

Recruitment = Influx of new fish

MSY Btrigger = If the biomass reaches this level, ICES must recommend measures to restore the spawning biomass to a level that is sustainable in the long term.

Bmsy = A stand's biomass cannot be infinitely large. Bmsy is the biomass that provides maximum sustainable yield.

Blim = If the stock biomass falls below this level, there is a high risk of reduced recruitment.

Bpa = Precautionary level to avoid Blim. As long as the stock biomass is above Bpa, the risk of reduced recruitment is considered low.

F = fishing mortality: The proportion of the stock killed by fishing.

Fmsy = The fishing pressure that in the long term can provide maximum sustainable yield, MSY. Fishing at this level is considered sustainable.

Flim = If a stock is fished above this level, the stock's biomass will be greatly reduced and end up below Blim.

Fpa = Precautionary level to avoid ending up on Flim. If fishing pressure reaches Kela, management measures must be taken to protect the stock.

4.2. What is behind the large increase in the council for herring in the central Baltic Sea?

Several factors are the reason for the advice on increased fishing opportunities for 2025 for the herring stock in the Baltic Proper. All in all, this is due to a combination of an increasing spawning biomass and an upscaling of the spawning biomass compared to last year's assessment.

The increase in spawning biomass is the result of reduced fishing in the last two years and relatively large incoming year classes (juveniles) in 2022 and 2023. In last year's assessment, the litter of juveniles born in 2022 was slightly underestimated. This, plus the fact that the herring overall had a higher weight at a specific age in 2023 than was assumed last year, has led to an upscaling of the biomass.

This slightly larger year class of herring that was born in 2022 leads to an increased spawning biomass in 2025, which in turn results in an increased catch opportunity. Since the starting point for the stock's biomass is at a low level, and last year's advice was 52 549 tonnes, which was the lowest since 1988, an increase in the advice to 125 344 tonnes will be a percentage high. The advice of 125,344 tonnes is the highest since 2021, when it was 173,395 tonnes.

It should be noted that what is assumed for juvenile fish production in 2023 and 2024 in the future projections is uncertain because factual information is lacking, but like everything in ICES' work, it is based on the best available science.

That there is room for increased fishing in the central Baltic Sea may seem contradictory, when many at the same time testify that herring has declined sharply in the archipelago. The fact that coastal and recreational fisheries report that catches have decreased is partly due to the fact that the occurrence of large individuals has decreased, which is also still visible in ICES' latest analyses. The ICES framework for advice on fishing opportunities also does not currently give the stock biomass time to recover from fishing after it has been at a low level (Blim).

4.3. ICES suspends the Council for Baltic Herring in the Gulf of Bothnia. Why?

In the Gulf of Bothnia, the stock is generally considered to have declined over the past 30 years since the peak in the mid-90s, in parallel with increased fishing. From an MSY perspective, Baltic herring in the Gulf of Bothnia has historically not been fished very hard, so a decreasing spawning biomass in line with increased fishing is an expected result of management against MSY.

In recent years, however, catches and fish mortality have decreased, without any positive response in increased spawning biomass. The ICES catch advice for the Gulf of Bothnia has therefore been postponed as the reference levels (see section 4.1) are to be updated based on the current ecological situation and the state of knowledge about the stock. Since the ICES catch thread is based on the assessed spawning biomass level in relation to the reference levels, the catch advice cannot be given until the reference levels are established.

5. Questions about possible measures

SLU's comments on possible measures that can contribute to viable populations, as well as ongoing projects and research to increase knowledge.

5.1. Can a relocated trawl limit increase the amount of large herring in the coastal zone?

As a general rule, trawling is prohibited closer to the coast than 4 nautical miles outside the baseline in the Swedish part of the Baltic Sea. Restricting fishing closer to the coast by moving the trawl limit, or establishing closed areas, can help protect local spawning stocks by protecting herring in the areas where it accumulates for spawning. It would therefore not primarily be possible to reduce catches from fisheries, but to protect fish when they are in particularly sensitive areas.

Since knowledge about the migration patterns of herring is limited, it is unclear how well such a measure would protect the fish in practice and what effect an exodus can be expected to have on the amount of large herring. The greatest effect of a trawl limit migration can be expected if local stocks have limited dispersal into the open sea, while the measure would have less effect if the herring make longer annual migrations, as they can then be caught outside the trawl limit during autumn and winter.

Limited wintering in the coastal zone

The herring overwinters mainly in deep water, under the halocline, which is found at a depth of about 50-60 m, where the water is a little warmer in winter. Access to such areas inside the current trawl limit (4 nautical miles) is limited. This means that most of the herring stocks are outside the immediate coastal zone in winter, and are thus exposed to trawl fishing.

A more extensive fishing currently takes place in winter in the deep areas outside the archipelagos, within and outside the territorial limit (12 nautical miles), where the herring overwinter and accumulate before spawning.

This fishing thus risks affecting local spawning stocks. However, the lack of knowledge about the geographical distribution of local spawning stocks and how the distribution of these spawning stocks looks like in the open sea (and in the fisheries' catches there) makes the degree of risks and how these vary spatially difficult to assess.

Possible effects of out-migration vary between areas

In subareas 27 and 29 (the stretch from Kalmar Sound to Öregrund), the area between 4 and 12 nm is largely suitable wintering areas with depths greater than 50 m, which means that a relocation of the trawl limit here would probably have positive stock effects locally in the form of increased occurrence of large herring in these coastal areas.

At the same time, a relocation of the trawl limit along only part of the coastline would probably lead to a relocation of fishing to adjacent areas and thus to locally higher fishing pressure there instead.

In the southern Bothnian Sea, where much of the fishing in the Bothnian Sea takes place, most wintering areas with depths greater than 50 metres are found outside Swedish territory (12 nm), which means that a relocation of the trawl limit to 12 nm would probably not be sufficient to provide positive stock effects.

Regulation for both Swedish and foreign boats

It should be added that a relocated trawl limit based on national legislation can create incentives to compensate for lost fishing by Swedish vessels via Finnish and Danish vessels, through cooperation with these Swedish stakeholders. This would also risk nullifying the effectiveness of the regulation. To counteract this, a regulation of herring fishing between 4 and 12 nautical miles should therefore also include foreign vessels.

Furthermore, the greatest biological effect of a relocated trawl limit would be achieved if no boat size exceptions were allowed. Exempting vessels smaller than, for example, 24 m is estimated to reduce the positive effects of a relocated trawl limit significantly more in subarea 27 than in subarea 29, based on the fact that these smaller vessels have fished an average of 24% and 0.6% of all herring in the two subareas in recent years, respectively.

Evaluation programme

On behalf of SwAM, SLU Aqua has developed an overall program to be able to evaluate a relocation of the trawl limit/closed areas. SLU Aqua has based its work on existing monitoring and data collection activities. To this have been added a number of work packages. The follow-up programme is made up of 6 work packages (Wp) with monitoring and analysis of:

Wp1. Abiotic Information
Wp2. Pelagic fish (herring, sprat and stickleback)
Wp3. Genetics and Otolithic Chemistry
Wp4. Pelagic Fishing
Wp5. Seals and cormorants
WP6. Other ecosystem effects

Parts of these work packages have been initiated in 2024.

Most effective: reducing fishing mortality

If you want to get a higher proportion of large herring back in the stock, a safer measure is to reduce the general fishing mortality, i.e. to lower the catch quotas. However, it is more difficult to implement and requires common understanding with other countries concerned, as such a decision must be taken at EU level.

5.2. Can closed areas increase the amount of herring in the coastal zone?

In the same way that a relocation of the trawl limit has the potential to have locally positive stock effects (see 4.4) on herring in the coastal zone, properly designed closed areas, i.e. closed areas that are not linked to the trawl limit, can also result in an increased occurrence of large herring. However, such a closed area must be designed in a way that takes into account the herring's wintering areas and migration behaviour in order for such a closed area to have the desired effects. A misplaced or too small conservation area will not be able to produce the desired local effects.

However, just as with a local relocation of the trawl limit, the introduction of a closed area would lead to a relocation of fishing to other areas and thus to a higher impact on the local sub-stocks there instead. As with a relocated trawl limit, the access of other nations to the areas should also be regulated.

Most effective: reducing fishing mortality

If you want to get a higher proportion of large herring back in the stock, a safer measure is to reduce the general fishing mortality, i.e. to lower the catch quotas. However, it is more difficult to implement and requires common understanding with other countries concerned, as such a decision must be taken at EU level.

5.3. How does fishing affect the size distribution of the stock in the Gulf of Bothnia?

On behalf of the Swedish Agency for Marine and Water Management, SLU Aqua has analysed the effect of different fishing mortality on the age/size composition of herring in the Gulf of Bothnia.

The analyses show that fishing mortality has a major impact on the size structure and that the sharp increase in fishing in the Gulf of Bothnia from 2005 coincides with a reduced occurrence of large herring. In just a few years, the proportion of herring who are five years old or older has fallen by just over 30 percent if you compare the years 2015-2021 with the years 1980-2014.

Analyse shows that if we continue to fish in accordance with today's MSY target (f-MSY*), the proportion of large herring will continue to decrease. If you want to regain a size distribution similar to that before the expansion of the fishery in 2015, fishing mortality needs to be reduced to significantly lower levels than f-MSY for several 10-year years.

In summary, the analyses show that when fishing increases, the decline of large individuals on a lightly fished stock (as the herring in the Gulf of Bothnia was all the way into the 2000s) can be rapid, but that the reconstruction requires large reductions in mortality and takes a long time.

The magnitude of the necessary reduction in fishing mortality also suggests how challenging it is likely to be to achieve a similar effect by moving the trawl limit, or by introducing closed areas - unless they are large enough to significantly reduce fishing mortality or are located in a way that clearly reduces mortality on

local stocks.

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* f-MSY = The fishing pressure that in the long term can provide maximum sustainable yield, MSY. MSY (Maximum Sustainable Yield) is primarily a theoretical concept of how to get as large catches as possible out of a fish stock without risking the stock's regrowth in the long term. The concept is based on the fact that the growth of a population is density-dependent, so that when the number of fish in a population decreases as a result of fishing, the growth rate and reproduction of the remaining individuals will increase. In addition, a sufficient amount of mature fish must be left in the sea to guarantee regrowth.

5.4. Herring fishing is done with fine-mesh trawls, how does that affect?

An increase in mesh size in fishery trawls has been proposed as a strategy to avoid catching juveniles of pelagic species, but small pelagic species such as herring have a particular susceptibility to skin damage/scale loss and suffering from exhaustion. This makes them vulnerable to the physical contact with fishing gear, especially trawls and waders. Oxygen deficiency is also considered to be an important factor, especially when fishing with seines. This means that a fish that comes into physical contact with a trawl is often injured, and that only a small percentage (10-20%) survive.

For this reason, increasing the mesh size is not considered an unproblematic strategy to avoid catching juveniles of pelagic species. It is different with most demersal fish species (e.g. cod) because they are more robust and exhibit negligible selection mortality. For example, there are calculations that suggest that the (hidden) selection mortality for 0-1 year old herring in the Baltic Sea may be greater than that caused by fishing and that this may affect the outcome of the stock estimates.

Protection of juvenile pelagic fish via mesh size regulation is therefore generally inappropriate. In that case, protection is better achieved through other measures, e.g. by minimising fishing during times or in places with accumulations of juveniles.

At the same time, the general description of the problem for Baltic herring does not show that it is juvenile fish but large herring that has primarily shown a

negative development over time. These large individuals can also not be expected to be very well protected with a change in mask size for the same reason.

5.5. Hav has developed a package of measures for the protection of herring. Is that enough?

In 2021, the Swedish Agency for Marine and Water Management presented a package of measures aimed at improving the situation of herring. This package of measures is not entirely current at the time of writing, but we still choose to leave our comments on the package of measures here in the FAQ for the sake of continuity and transparency.

In general, the proposals in the Swedish Agency for Marine and Water Management's package of measures rest heavily on national measures to solve the problem of reduced occurrence of large herring along the coast.

What we are communicating here is that the connection between the presence of local stocks and their connection to stocks and fishing off the coast are central issues. There is a lack of knowledge about these issues.

National measures can be expected to have the greatest impact if the local sub-stocks are clearly coast-bound for a large part of their life cycle. Despite the fact that there are uncertainties about the effects of, for example, moving the trawl limit, such a measure can still be seen as a precautionary measure given the current state of knowledge.

If the decline in large herring along the coast, and the sub-stocks are more mixed, national measures in the coastal zone are likely to be less effective and a change in EU joint management is necessary. More knowledge about the use of the coastal zone by herring would improve the knowledge base and the effectiveness of different measures.

5.6. How does SLU work to improve knowledge?

For herring, we have poor knowledge about the occurrence and distribution of local spawning stocks* and the migration patterns of these stocks. The management takes place, largely for practical reasons, at the sea level where, for example, the entire central Baltic Sea is one management unit for herring and the Gulf of Bothnia is another. Thus, we do not know how fishing pressure affects at a more local level, even if fishing pressure at sea area level is considered to be at a sustainable level.
** For a definition of spawning stock, see the fact box at the bottom of the page.*

Genetics can show local spawning populations

To improve knowledge about local spawning stocks, the Swedish Agency for Marine and Water Management has initiated a project in which SLU and Stockholm University jointly collect herring along the entire east coast.

By performing genetic analyses, it is then possible to describe the presence of local spawning populations. Preliminary genetic analyses indicate that there are local spawning populations along the coast, but we do not know whether these populations are stable over time. The greatest genetic differences are found between spring and autumn spawning herring in the Baltic Sea.

Play areas and size structure

SLU also maps the spawning areas of herring along the coast and investigates changes in the size structure of herring to improve the knowledge base for ecosystem-based fish management. In these analyses, we see downward trends, especially for large herring in the Baltic Sea.

There is also an ongoing project on ecosystem-based ocean management in the southern Bothnian Sea, where issues related to herring are examined in a broad ecosystem perspective.

SLU Aqua is also currently starting up a new EU-funded project called 'Improfish' with the Natural Resources Institute Finland (LUKE) in Finland, with the aim of increasing the knowledge and quality of the scientific basis for stock estimation of herring in the Gulf of Bothnia through improved cooperation. Within this project, SLU's genetic analyses of local spawning populations will be expanded with samples from the Finnish coast. This type of information about possible local spawning stocks is currently lacking in ICES' stock estimation models of herring in the Baltic Sea.

Knowledge base for management

SLU also conducts other surveys and compiles knowledge on behalf of SwA, in order to provide the administration with a supplementary knowledge base. Examples of such studies that have been carried out recently are compilations of fisheries and population structure for herring along the Swedish coast and an on-board sampling of catches in the large-scale pelagic fishery in order to follow up how, when and where the different stocks are caught in the fishery and estimate the mixture of herring and sprat and the amount of by-catches.

SLU contributes to the extensive work of producing scientific data for the annual stock analyses of herring (and many other species), as well as to ICES' work to carry out these stock estimates.

6. Published knowledge base

Reports and scientific knowledge base that SLU Aqua has produced regarding herring in the Baltic Sea.

The compilation was last updated in 2022, and will be supplemented in June 2024.

- Size structure of herring in the Gulf of Bothnia SD 30-31. An analysis of how reduced fishing mortality for herring can recreate a better size distribution of the stocks in the area. Knowledge base for the Swedish Agency for Marine and Water Management (2022-09-14).

- Trends in biomass for herring in SD 25-30. A compilation of trends in BIAS (Baltic International Acoustic Survey) and in the net sampling fishery that show declines in herring densities in the area. Knowledge base for the Swedish Agency for Marine and Water Management, (2022-02-18)

- Preliminary reporting on the question: are there genetic differences among spring-spawning herring in ICES areas 27 and 29? from ongoing collection and genetic analyses of individuals from different spawning groups along the Swedish east coast (Stockholm University, Uppsala University in collaboration with SLU Aqua). (2022-02-15)

- How can fisheries regulations be developed to protect coastal spawning stocks of herring in the northern Baltic Proper (SD 27 and 29) Knowledge base for the Swedish Agency for Marine and Water Management (2022-02-04)

- Comment regarding the coastal fishermen's proposal for a conservation area in the Gulf of Bothnia, memorandum with SLU Aqua's response to the Swedish Agency for Marine and Water Management (2021-09-03).

Fact box

* **Herring and herring** are the same species – *clupea harengus*. What the fish is called depends on where it was caught. The name herring was used for herring caught in the Baltic Sea north of Kalmar, further south and on the West Coast the name herring is used. Although the species is the same, the fish changes appearance the further north in the Baltic Sea you go, and the lower the salinity of the water becomes. A herring from the West Coast, for example, has a shorter head and is fatter than a Baltic herring. There are also some genetic differences between herring and herring due to the fact that the fish have adapted to local environmental conditions.

*** Local spawning populations, populations and populations**
By population, we mean a group of individuals of the same species who share the same ecological and genetic characteristics. In theory, few individuals immigrate or emigrate from or to a population and it is thus self-contained/self-sufficient.

By stock, we mean a group of individuals from a population that are either spatially separated, or share migration patterns, and spawning grounds, and that are taxed by a defined fishery. For management purposes, however, a "stock" can be equal to a part of a stock, as long as the results of the stock analysis and management reflect sufficiently well the results that would have been if the entire stock were taken into account.

When we talk about possible local spawning populations in our text, we mean that there may be a group of individuals that today are incorrectly managed as part of an already defined population, but that should be managed separately. The group of individuals can be spatially separated from other individuals in the population, at least during spawning, in separate spawning areas.

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