Baltic Waters

International role models lead the way towards sustainable fish stocks in the Baltic Sea

- great value can be created

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Executive summary

Thirty years ago, the Baltic Sea provided significant value in the form of fish for food and opportunities for recreational fishing. Today, these values have diminished to a fraction of what they once were. What remains is fishing primarily for animal feed, targeting fish stocks that continue to decline in a vicious cycle. The sparse populations and reduced size of individual fish make fishing for human consumption relatively unprofitable.

However, in several parts of the world, depleted fish stocks have successfully been restored. Based on these experiences, this report estimates the value of realistic scenarios in which the Baltic Sea's commercial fish stocks recover. This can be achieved through so-called "intensive fisheries management," implementing the necessary measures to restore fish stocks to levels that provide the best long-term sustainable outcomes for all stakeholders, including the fishing industry.

The analysis consists of four steps:

First, an overview of international examples of recovered fish stocks and the related scientific literature is presented. From a Swedish perspective, it is particularly interesting how intensive management, combined with a range of protective measures, has successfully restored viable fish stocks alongside sustainable commercial fishing, as seen in areas such as the Gulf of Riga and the waters around Iceland. There are also strong examples of the restoration of severely depleted fish stocks. For instance, the heavily reduced North Sea herring population recovered after a five-year fishing ban. The overfished Atlanto-Scandian herring took longer to recover but eventually succeeded.

The scientific literature highlights clear positive effects of strong measures such as periodic fishing bans, quotas based on the precautionary principle, effective monitoring methods, and a holistic approach to fish species and individual fish sizes. Partial measures, such as fishing bans in limited areas, generally do not appear to be sufficient to restore depleted marine ecosystems.

In a second step, two recovery scenarios are developed based on the scientific literature. Similar to successful international examples, it is assumed here that large-scale fishing is significantly restricted for the foreseeable future as part of a set of complementary measures. The main scenario assumes that sustainable fishing can be established within ten years, with large-scale trawling permitted in 25 percent of the Baltic Sea, while the remaining areas are reserved for coastal and recreational fishing - or fully protected. Here, sustainable means that commercial fishing can be conducted without jeopardizing the health of fish stocks or their ability to recover from year to year. In the second, more cautious scenario, large-scale trawling is assumed to cease entirely in favor of small-scale coastal fishing and recreational fishing.

In a third step, the economic value of fishing is calculated, including an extrapolation of current trends. The analysis updates the previous report "The Value and Potential of Baltic Sea Fisheries" which estimated the socio-economic value of the sector. The socio-economic value of large-scale fishing in the Baltic Sea remains significantly negative, with a net estimate of -205 million SEK per year.[1] A key reason for this is that large trawlers have high, subsidized fuel consumption and CO_2 emissions. As fish stocks continue to be depleted, the added value of the industry declines, inevitably leading - under current trends - to a (too) late-imposed fishing ban by 2030.

1 In this report, large-scale fishing is defined as fishing conducted by vessels using active gear (typically demersal or pelagic trawlers) and measuring over 12 meters in length. All vessels using passive gear are defined here as small-scale commercial fishing.

In the fourth step, the socio-economic value generated by the two recovery scenarios is calculated. In both scenarios, significantly greater added values and socio-economic values are created compared to what fishing generates today. A transition to the main scenario would, after recovery, lead to an annual socio-economic gain of 260 million SEK per year (and 240 million SEK for the cautious scenario). A large portion of the gain is due to the recovery of coastal commercial fishing and recreational fishing, but even large-scale fishing could fish and earn more than it does today.

The net present value of a shift in fisheries policy is calculated based on the assumption that it will take 10 years for fish stocks to gradually recover (following a linear trend), after which they will remain at a sustainable level. The net present value then amounts to a socio-economic value of 8.6 billion SEK in the main scenario and around 13.9 billion SEK if the cautious scenario occurs, over the next five decades.

This calculation does not account for a range of other benefits. For example, a larger fish stock in the Baltic Sea also serves a preparedness purpose. Fishing could become an important protein source in times of crisis. Catches of herring and cod in the main recovery scenario, compared to continuing as is, would in the 2030s correspond to 6.5 kg of cod and herring per Swede per year, which is not insignificant, and this is without factoring in the recovery of other fish species that would also occur as a result of protective measures.

Even considering the uncertainties in the statistical data, the conclusions are very clear. Both from a fiscal and socio-economic perspective, large-scale fishing in the Baltic Sea is highly unprofitable, especially when compared to the potential recovery scenarios that form the basis of the calculations in this report. The conclusion is therefore that the current fisheries policy undermines the future revenues and survival of both coastal and large-scale fisheries.

A notable observation is that large-scale fishing is estimated to be socio-economically questionable even in the main scenario, where it is assumed to be sustainable and based on larger fish stocks. The reason is that the carbon emissions from towing heavy fishing trawlers in the sea are significant in relation to the value of the fish caught for industrial purposes. This also underscores the market distortion caused by the fact that large-scale fishing receives subsidized fuel and is not subject to carbon taxes, while, for example, land-based fish farming is burdened with energy and carbon taxes. The comparison may be less relevant if land-based fish farms still use fishmeal, but many would accelerate the transition to alternative feed if the overfishing of the oceans were not so cheap.

International examples and scientific literature show that the recovery scenarios are not pipe dreams, but are actually achievable. The precautionary principle, which is a necessary tool for the recovery scenarios, is enshrined in the EU's fisheries policy but is, in practice, not being applied.

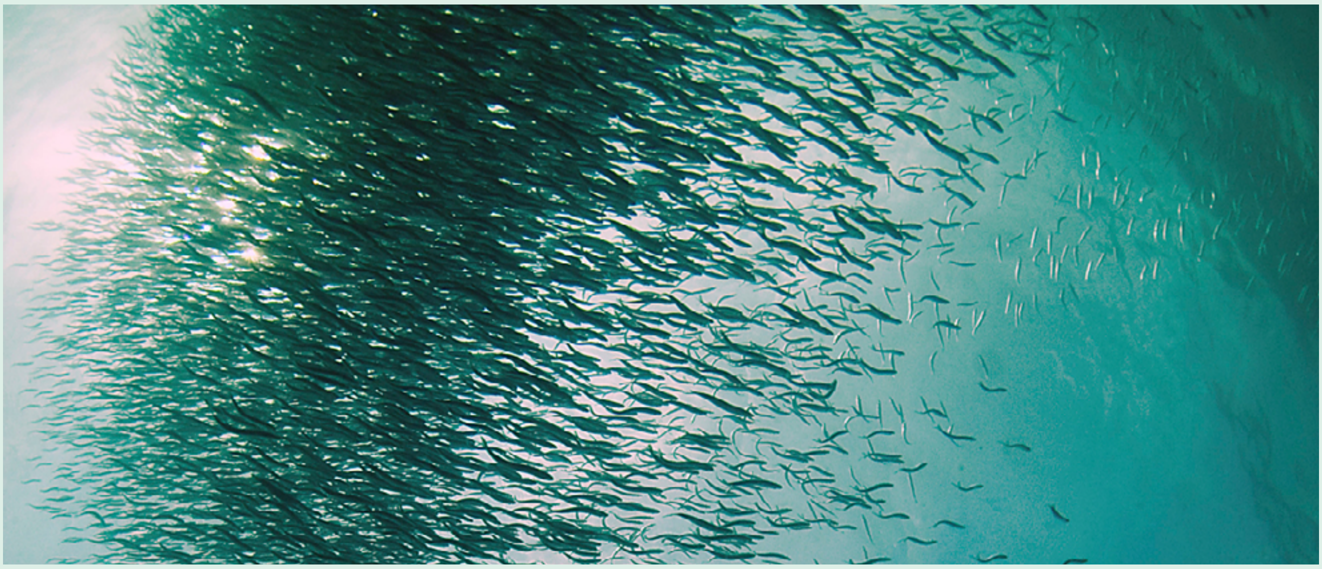


Photo: Tobias Dahlin/Azote

A vicious circle for Baltic Sea fish stocks

A former Minister for Rural Affairs, Sven-Erik Bucht (S), argued that fisheries policy ”…benefits our fishing industry, our coastal communities, and provides both us and future generations with healthy food.”[2] A similar view is also presented in the Swedish Board of Agriculture and the Swedish Agency for Marine and Water Management's joint vision 2020 for Swedish commercial fishing. But what value does Baltic Sea fishing actually add, and what does it cost society? This report analyzes the societal cost-benefit calculation of the current fisheries policy for the Baltic Sea, and the potential for a different approach to managing fish stocks.

Most of the commercial fish stocks in the Baltic Sea are in poor condition. The causes are multiple, but the only measure that seems effective in the short term is reduced fishing pressure. In many parts of the world, fish stocks have recovered significantly in this way. However, in the Baltic Sea, several fish stocks continue to decline, despite a ban on targeted cod fishing and reduced fishing quotas for all stocks in recent years, though often too late. Large-scale fishing is still allowed to continue, citing that fishing is ”an important industry.”

ishing in the Baltic Sea has thus fallen into a vicious circle. The most valuable food fish have essentially been fished out. Herring and sprat caught for human consumption now have a low market price, partly because the fish are getting smaller. At the same time, handling herring and sprat as food is costly because the fish are easily damaged. Large-scale fishing of herring and sprat for feed production is, in comparison, relatively profitable. In the feed fishing industry, prices paid for landed fish can reach five SEK per kilogram (compared to 8–12 SEK for herring used for human consumption), while fishing and handling costs are lower.[3]

Alongside this development, there has been a strong concentration of fishing quotas to a few larger vessels, most of which land their catch in foreign ports. In 2023, only just over 5,000 tons of Swedish-caught herring were used for human consumption.[4] This is only just over three percent of the 2025 quota of 150,000 tons of herring for the entire Baltic Sea, or 17 percent of the Swedish-caught herring in the Baltic Sea.

The consequence is that, in the short term, it appears most profitable to fish for animal feed, which commands a higher market price. At the same time, the overfishing resulting from large-scale feed fishing, including bycatch of fish species that are actually subject to fishing bans, is so significant that fishing for human consumption becomes increasingly difficult and nearly ceases. This creates a vicious circle, resulting in lower profitability for the entire fishing industry than what would be possible.

The vicious circle makes it profitable to squeeze out the last of what is left

To begin with, current fishing quotas are not sustainable or stable in the long term, but are decreasing over time. Figure 1 below shows how fishing quotas have had to be gradually reduced, often belatedly. If the trend of the past thirty years continues, there will be a fishing ban on herring around 2030.

Secondly, a reduction in fishing for feed purposes today could lead to an increase in herring stocks within a few years. Figure 1 shows how herring and sprat quotas have decreased over time due to, among other factors, overfishing. It indicates that herring quotas in the 1990s were set at levels roughly eight times higher than those today. A wiser fisheries management approach might have been able to sustainably maintain stocks at the levels of the 1990s with quotas four times the current levels, instead of the actual eight times higher quotas. Both large-scale and coastal fishing would have generated significantly higher revenues than they do today. At the same time, herring stocks would have been large enough to continue substantial herring fishing for human consumption. The profitability for all parts of the fishing industry would, therefore, have been much higher.

2 After the fisheries ministers' quota decisions on the Baltic Sea fishery in 2018.

3 Compare with the situation a few years ago, when it was considered relatively more profitable to fish herring for human consumption, perhaps partly because the fish were larger at that time. https://balticwaters.org/wp-content/uploads/2023/05/policydokument_Mer-lonsamt_2023.pdf

4 According to information from Statistics Sweden and the Swedish Agency for Marine and Water Management.

Thirdly, herring and sprat were naturally processed by serving as food for more valuable fish species such as cod and salmon in large quantities as recently as the 1990s. However, the cod quota was set much higher than what was sustainable. With halved quotas, it would likely have been possible to maintain a cod fishery with significantly higher profitability than today's feed fishing. A stable herring stock could also have helped slow down the dramatic decline of cod and its current difficulties in recovering.

How others have managed to restore fish stocks

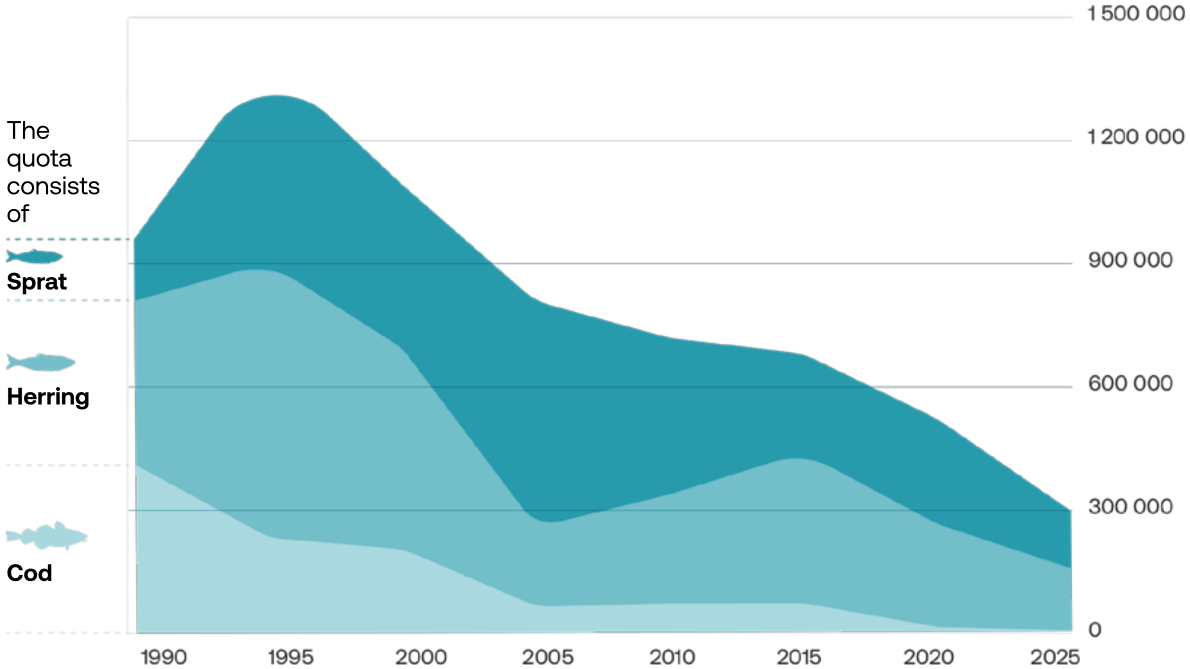
A key question is whether it is possible to rebuild the stocks. This will be addressed in the next section, which explores international experiences and scientific literature on the effects of wiser fisheries management.

A number of studies have established that areas that have implemented so-called ”intensive fisheries management” have, to varying degrees, succeeded in allowing depleted stocks to recover.[5] In some cases, the stocks are on their way to levels classified as ”abundance” (healthy stocks). Intensive fisheries management involves the application of a range of measures and restrictions aimed at preserving or restoring stocks to sustainable levels. When fish stocks are low, intensive fisheries management in practice means fishing bans until some recovery has occurred.

A study published in the prestigious PNAS (Hillborn et al., 2020) examines, for example, the relationship between fishing pressure and changes in fish stock abundance, as well as between management intensity and fishing pressure, across more than 632 fishing waters in 29 countries. Intensive fisheries management is reflected in high ”fish management index” (FMI) scores, which are calculated for 70 fishing nations or regions around the world based on responses to 46 questions for over 1,000 fish stocks. According to the study, higher FMI scores are associated with better stock status. In regions where fish are managed intensively, the amount of fish generally increases or remains close to the goals of fisheries management.

In several countries, the reduction in fishing pressure can be directly linked to legislative changes and subsequent management. This often requires real opportunities to monitor

Figure 1. Fishing quotas TACs in the whole Baltic Sea over the last 30 years



Source: https://ices-library.figshare.com/collections/ICES_Advice_2024/6976944/20. According to the table ”agreed TAC” under the council for herring in the Baltic Sea, pages 24–32, cod (eastern) and sprat, as well as a few pages into the advice, a table with figures per year. Illustration: Sofie Handberg.

5 See for example Lotze et al. (2011).

fishing catches. Within the EU, several studies have shown that inadequate monitoring has likely allowed up to twice the catch levels to occur compared to those reported.[6]

The following section describes a number of examples, from which a selection will then serve as a reference point for the recovery scenarios.

Herring in the Gulf of Riga

In the Gulf of Riga, Estonia and Latvia have successfully reversed the decline of herring stocks through fishing regulations, including the establishment of protected areas and seasonal closures.[7] Of the four managed herring stocks in the Baltic Sea, three are at risk of the same collapse that has already occurred with cod, while the herring in the Gulf of Riga is thriving and has been stable or even increased over the past two decades. Several fisheries management measures are applied in the area:

- No large trawlers are allowed in the Gulf of Riga, and bottom trawling is prohibited.[8]
- In addition, there are restrictions on the types of fishing gear allowed.
- The allocated fishing quota is divided equally between coastal fishermen and trawlers, which results in a relatively high proportion of coastal fishing. Interestingly, the coastal fishermen use nets that do not prevent the herring from spawning in the trap.

To protect spawning fish, several areas are completely closed to fishing at sea, as well as almost all areas deeper than 20 meters.[9] Certain periods of the year are also closed: in both Latvia and Estonia, fishing is prohibited for 30 days in the spring, and Estonia also has a ban on trawling from mid-June to mid-September. Fishing is conducted year-round, but trawling is prohibited when the herring gather in schools for spawning, which is a significant difference compared to how trawl fishing occurs, for example, in the Gulf of Bothnia.

The scope and accuracy of the joint Estonian-Latvian acoustic survey are several times more intensive than for other herring stocks in the Baltic Sea, and the sampling from commercial landings is also high.[10] This is also a major difference compared to the monitoring of herring stocks in the rest of the Baltic Sea.

The herring in the Gulf of Riga is fished exclusively by Latvia and Estonia, and the consumption of herring for human consumption is relatively high in these two countries compared to others around the Baltic Sea. The herring stock in the Gulf of Riga is therefore an excellent case study of what more intensive fisheries management can achieve.

Photo: Lance Anderson/Unsplash

6 See for example https://www.fishsec.org/app/uploads/2011/03/1226500209_46529.pdf
7 FishSec (2023).
8 The size is limited by a cap on engine power, which must not exceed 221 kW.
9 See for example https://www.su.se/stockholm-university-baltic-sea-centre/news/baltic-breakfast-fisheries-regulations-and-environmental-factors-behind-the-strong-riga-herring-1.694536
10 Sepp et al. (2022).

North Sea herring recovered in five years

As a result of heavy overfishing, the spawning biomass of herring in the North Sea declined from over 5 million tons in the 1950s to less than 50,000 tons in the 1970s.[11] During this time, the stock was fished by vessels from at least 14 countries. In January 1977, the North Sea countries extended their exclusive economic zones to 200 nautical miles from the coast. Shortly after, the United Kingdom introduced a complete fishing ban on all directed herring fishing in its North Sea zone.

The other North Sea countries stopped all targeted fishing for North Sea herring in 1977. The ban lasted for six years, until June 1983, and had significant short-term consequences. Some ship owners went bankrupt, and both commercial fishermen and processing industries disappeared, which of course was largely due to the shrinking stocks rather than the fishing ban.

But in the long term, the fishing ban became both an ecological and economic success. The North Sea herring responded positively to the reduced fishing pressure. The trend reversed, and the spawning biomass grew to nearly two million tons around 1990. Since then, the spawning biomass has fluctuated between one and two million tons, and is now above both the precautionary level (Bpa) and the critical level (Blim), where the stock's ability to reproduce is considered seriously threatened.

The Atlanto-Scandinavian herring took longer to recover. During the first half of the 20th century, the Atlanto-Scandinavian herring (also known as the Norwegian spring-spawning herring) was Europe's largest population of vertebrates.[12] But in just 20 years, from the 1950s to the 1970s, the stock was fished down to the bottom. The spawning biomass fell from over 10 million tonnes to less than 10,000 tonnes. In 1971, a fishing ban was introduced.

The recovery took longer than for the North Sea herring – it wasn't until 1983 that the first strong age class appeared. This age class was considered exceptionally strong given the low spawning biomass of the stock. At the end of the 1980s, a small and strictly controlled fishery was resumed, and during the first half of the 1990s, new strong age classes emerged, further contributing to the recovery. Fishing was gradually resumed, the spawning biomass continued to grow, and by the end of the 1990s, annual catches were back to between 500,000 and one million tonnes.

Islandic cod

The Icelandic cod population continues to grow. The biomass of the cod stock is now larger than it has been since 1985, when the current systematic measurements began.[13] Older fish are also larger and heavier than in previous measurements, further indicating that the cod stock is in good condition.

The good condition of the Icelandic cod population is the result of a sustainable fisheries policy introduced in the 1980s. According to the final report from the measurements conducted by the Icelandic Marine Research Institute on the status of several key commercial fish stocks, the biomass of the cod population is now larger than at any time since systematic measurements began in 1985.[14] The population's biomass has increased every year since 2007. The distribution of cod in Icelandic waters was also greater than in previous measurements.

The stocks of other important commercial fish species, including haddock and pollock, are also increasing and are close to historical highs. The stocks collapsed during the post-war period, similar to many other commercial fish stocks in the Atlantic, as fishing increased with larger and more powerful vessels. In response to this crisis, Iceland introduced a system of total allowable catch quotas in 1984. These quotas were later made transferable, allowing fishermen to trade their shares of the total allowable catch. This has led to the concentration of quotas in fewer boats.

However, the total fishing quotas have been kept low enough to successfully strengthen the fish stocks. During the system's early years, the total quotas did exceed the advice from marine biologists, but more recently, the recommendations from the International Council for the Exploration of the Sea (ICES) have been taken more seriously. Over the past eight

11 See Dickey-Collas et al. (2010) for a detailed analysis of this measure, as well as Hamrén (2023).

12 See Hannesson (2022) for a description.

13 See https://icelandinsider.is/uncategorized/thanks-to-sustainable-fisheries-icelands-cod-stock-now-larger-than-at-any-time-since-1985/

14 https://www.hafogvatn.is/en/about/news-announcements/mfris-advise-for-the-fishing-year-20242025-f

years, ICES has provided particularly cautious recommendations with the aim of increasing the number of mature, spawning cod.

United States and Canada

In the United States, amendments to the Magnuson-Stevens Act in 1996 required the development of recovery plans and catch limitations, which resulted in a significant reduction in fishing pressure on overfished stocks.[15] Since 2000, the number of overfished stocks has decreased by 60% in federal waters, and better management now contributes to more stable fisheries and increased revenues for commercial fishing.

Where conservation requirements have been fully implemented, many depleted fish stocks have fully recovered, while other fish populations have made remarkable progress towards recovery. Since 2000, 50 U.S. fish stocks have been restored to healthy levels.[16] Among these are red snapper (Gulf red snapper), bluefish (Mid-Atlantic bluefish), scallops (New England scallops), Pacific lingcod, and summer flounder (Mid-Atlantic summer flounder).[17] NOAA Fisheries published the report "Fisheries Economics of the United States" in 2022. According to the latest figures, commercial and recreational fishing in the U.S. supports 2.3 million jobs and generates $321 billion in sales in 2022. These levels have been maintained since the reporting began in 1992.[18] The U.S. commercial fishing and seafood industry continues to have a significant and positive impact on the economy, as does recreational fishing.

However, Atlantic cod fared worse. In eastern Canada and the U.S., fishing catches dropped sharply in the 1990safter the collapse of bottom-dwelling fish stocks, such as cod, in Newfoundland.[19] Until 1977, both foreign and domestic Atlantic fleets had access to valuable bottom-dwelling fish species such as cod and haddock. With the introduction of Canada's 200 nautical mile exclusive economic zone in 1977, foreign fleets were excluded from the largest fishing areas. Between 1978 and 1985, many species saw a recovery, but domestic fleets increased fishing pressure again between 1986 and 1993. From 1992 to 1993, cod stocks were overfished in a large part of the fishing areas around Newfoundland, resulting in extensive cod fishing bans in the early 1990s across much of the region. By 2024, after 32 years of cod fishing bans, cod in Newfoundland was considered to have recovered somewhat, and fishing was therefore reopened at a cautious level.

Photo: Joakim Odelberg

15 National Research Council (2014).
16 See for example https://www.noaa.gov/news-release/status-of-stocks-record-low-number-of-stocks-on-overfishing-list-in-2023
17 According to https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2012/03/16/rebuilding-us-fisheries-success-stories
18 See for example https://s3.amazonaws.com/media.fisheries.noaa.gov/2024-07/FEUS-2022-v04-0.pdf
19 According to https://en.wikipedia.org/wiki/Collapse_of_the_Atlantic_northwest_cod_fishery

In other areas where more limited fishing bans were implemented, protecting fish only in designated areas, the situation worsened. For example, most cod stocks and other fish species off eastern Nova Scotia (Scotian Shelf) in the Atlantic off Canada collapsed in the early 1990s, while the fish grew more slowly and the fishing individuals remained smaller.

Similarly, other Atlantic-based cod stocks in the United States have not recovered significantly. A full-scale fishing ban was not implemented there either, and the restrictions have only applied to certain areas and time periods.[20] The populations of Atlantic cod have declined despite significantly reduced catches in fishing and a range of management measures over several decades in U.S. waters. This decline has raised increasing awareness that current management measures have not sufficiently accounted for the biological population structure of cod, which has contributed to the weak recovery.[21]

According to Shackell et al. (2021), restricted areas that are closed to fishing are insufficient. At Nova Scotia, where cod stocks also collapsed in the early 1990s, certain areas with effective protection and conservation (OECM) were established to promote the recovery of bottom-dwelling fish species. Using long-term data series, the study shows that three long-standing fishing bans in restricted areas have barely improved recovery for most of the 24 most common bottom-dwelling fish species. At the regional level, 10 out of 24 species today have less than 50 percent of their biomass from before the collapse (1979–1992).

The results reflect the situation with Baltic cod, where recovery is hindered by factors such as bycatch and heavy fishing of its prey - herring and sprat. Additional factors hindering the recovery of cod include recurring permits to fish as soon as the stock increases marginally, inaccurate stock assessments, increased amount of small fish eating cod larvae, and larger seal populations.

Rebuilding the U.S. marine fish stocks, according to one estimate, would yield several benefits.[22] Recovering fish populations create jobs, support coastal economies, repair damaged marine ecosystems, and increase recreational fishing opportunities. Additionally, it would re-establish the sale of locally caught fresh fish for human consumption, resulting in an additional $31 billion in annual sales and creating 500,000 new jobs in the U.S.

Other fishing closures

Another interesting example is Indonesia, where fish stocks in Karimunjawa National Park increased significantly in the years following the ban on the use of coral-damaging nets. The total biomass of herbivorous fish species in the national park more than doubled between 2012 and 2013, compared to the period 2006–2009. This was made possible by a complete ban on muroami fishing in 2011. Muroami fishing is a common fishing method throughout Southeast Asia, where large nets are used in combination with striking tools that hit coral reefs to scare fish into the nets.[23] Several similar examples are reported in the scientific literature.[24]

In 1997, Japan implemented total allowable catch (TAC) limits for several species. Following this, TAC-managed stocks improved more rapidly than others.[25] Furthermore, New Zealand introduced similar restrictions in 2008, and Chile implemented extensive legal and regulatory reforms in 2013 to address overfishing. This led to a remarkable recovery of mackerel stocks, which are now considered to be at a sustainable level.[26]

Trawling ban in the Öresund and elsewhere

Trawling has been banned in Öresund for a long time, which makes it an important reference point). Fish stocks there have generally developed better than in the rest of the Baltic Sea.[27] Copenhagen Economics (2018) studied the trawling ban in the Öresund region, estimating that small-scale commercial fishing

20 https://www.fisheries.noaa.gov/species/atlantic-cod
21 https://repository.library.noaa.gov/view/noaa/48082/noaa_48082_DS1.pdf
22 Ecotrust (2011). Also see https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report
23 See for example https://news.mongabay.com/2019/11/destructive-fishing-muroami-indonesia-ban-reefs-recovery-karimunjawa/
24 Sheehan et al.. (2013).
25 For example Ichinokawa et al. (2017).
26 See for example https://www.msc.org/what-we-are-doing/fishery-features/chilean-jack-mackerel
27 From 2024, the cod fishing ban will also apply to all recreational fisheries.

(around 160 vessels) landed approximately 2,000 tons with a landing value of 36 million DKK. This shows that even a relatively small fishing area can generate significant value if well-managed.[28]

Another strand in the scientific literature shows that trawling bans often enable the recovery of fish stocks, resulting in larger individual sizes, higher biomass, and greater species diversity.[29] In the Bay of Biscay (western France), predatory fish higher up the food chain benefitted from a four-year trawling ban, and more generally, the average trophic level (how high the fish are in the food chain) of fish stocks increased after the ban.[30] However, a trawling ban within a designated area of a Dutch offshore wind farm showed only moderate recovery after five years.[31]

Other studies in the waters around Hong Kong have also shown that the size and average trophic level of crustaceans increased, and that greater diversity in benthic crustacean communities was observed following the trawling ban.[32]

Fishing bans in international waters

A particularly interesting thread in this literature concerns fishing bans in international waters. Daniel Pauly, a professor of fisheries science at the University of British Columbia, who has studied open-ocean fishing for many years, concludes that global catch could actually increase with a ban on open-ocean fishing, and the catch would be more evenly distributed.[33] A few nations today catch the majority of fish in the open ocean, particularly China, Japan, South Korea, Taiwan, and Spain.

Through a simulation based on empirical data, White and Costello (2014) show that a complete fishing ban on the open ocean would increase the total biomass of certain species by 150 percent, raise catches in coastal waters by 30 percent, and double the profit margins for fishermen.

A fishing ban on the open ocean would not worsen global food security, argue Laurence Schiller et al. (2018). They show that fish catches on the open ocean account for only 4.2 percent of total marine catch and just 2.4 percent of the world's total seafood harvest, including freshwater fishing and aquaculture.

Recovery scenarios for the Baltic Sea

Based on international experiences, we describe two scenarios, with the assumption that large-scale fishing in the Baltic Sea will pause or stop in the coming years. The recovery time for fish stocks is uncertain. Some data and experiences from cod in the U.S. and other countries suggest that recovery could take anywhere from 10 to 30 years.[34] As noted, this has occurred after partial fishing bans on species at the top of the food chain. Where management measures have been more consistent, faster recovery has typically been observed.[35] Species lower in the food chain, like herring, have recovered more quickly.

In particular, five Northern European scenarios serve as models for the recovery scenarios in this report:

1. The herring recovery in the Gulf of Riga
2. The recovery of cod around Iceland
3. The trawl ban in Öresund
4. The recovery of North Sea herring
5. The recovery of the Atlanto-Scandinavian herring

28 See also County Administrative Board of Skåne (2015). https://www.lansstyrelsen.se/download/18.4e0415ee166afb59324214dc/1713432663118/Havsplanering%20Öresund%20-%20Planeringsförutsättningar%20Öresund.pdf
29 For example Murawski et al. (2000).
30 Serrano et al. (2011), Pauly et al. (1998), Shannon et al. (2014).
31 Bergman et al. (2015).
32 Studies on the potential recovery of fish communities after trawling bans in Hong Kong are limited and yield mixed results. See, for example, Mak et al. (2021).
33 See https://www.npr.org/sections/thesalt/2018/09/14/647441547/could-a-ban-on-fishing-in-international-waters-become-a-reality
34 Sewell, B. et al. (2013).
35 Hillborn et al. (2020).

To assess how realistic these scenarios are, one can compare them with the drastic reduction in part of the Baltic Sea fishery analyzed here – namely the cod fishery. In the entire Baltic Sea, cod fishing was about ten times larger in the early 1980s, depending on the years being compared.[36] If only a fraction of the cod stocks were to recover, it would easily allow for a much larger increase in small-scale fishing than assumed in the following.

To be clear, the calculation in this report refers not only to cod fishing but to all commercial species. The calculation is based on the total value-added for fishing, with the assumption that the distribution between species remains the same throughout the recovery period as it was between 2000 and 2015. Based on these assumptions, two scenarios are described, and their values are calculated.

Main scenario: Recovery of fish stocks to a level where fishing can take place in a sustainable manner

With some support from a scenario described by Fishsec (2022), it is assumed that a more thorough recovery of cod takes 20 years. A limited fishery may then take place after 10 years. Fishsec outlines how such cautious fishing can be achieved. The proposed measures are:

- Allocate only 25 percent of the Baltic Sea for demersal and pelagic trawl gear, as well as other active gear, which must, however, be selective with very minimal bycatch of cod;
- Allocate 35 percent of the Baltic Sea for small-scale fishing using passive gear;
- Protect 40 percent of the Baltic Sea through marine protected areas (MPAs) where no fishing is allowed, except for recreational fishing. However, recreational fishing can only take place if a permit is issued based on an environmental impact assessment confirming that the fishing does not harm the conservation values established in the MPA management plan.[37]

Photo: Tobias Dahlin/Azote

Intensive fisheries management may also require additional measures beyond fishing restrictions. An important factor affecting fishing opportunities in the Baltic Sea is, for example, seals and cormorants. Seal damage to catches was estimated to amount to about 30 million SEK for the fishing industry as a whole in 2006. Since then, seal populations have increased while nearshore fishing has declined. These costs can be seen as lost revenue, meaning the landing value is 30 million SEK lower than it would have been without seal damage. In addition, there are costs for repairing and replacing fishing gear. Therefore, seals should also be managed in a way that ensures their populations are sustainable in the long term, in harmony with sustainable fish stocks.

For cod, an annual catch of approximately 20,000 tons could be achievable after another 10 years of fishing ban until 2034. Cod catches from trawl fisheries in the Baltic Sea, for all countries' fishing fleets, ranged between 100,000 and 200,000 tons from the 1960s until the late 1970s. Catches increased and peaked at 400,000 tons in 1984, before declining to under 30,000 tons by 2016.[38] Between 2000 and 2015 (used here as the reference period), cod fishing quotas and landings averaged around 70,000 tons per year (ICES, 2017, 2021). A similar recovery for herring would imply that a cautious return to catch levels of approximately 300,000 tons per year could be possible after 2035 (compared to around 600,000 tons fished between 2000 and 2015).[39] It is assumed that Sweden's share could be up to 20 percent of the total catch for the entire Baltic Sea, even with the recovery of the stocks.

36 According to the Swedish Agency for Marine and Water Management's catch statistics for the Baltic Sea coastal segment, landings in 2017 or 2018, at approximately 20,000 tons, were 20 times larger than in the early 1980s.
37 See Tunca et al. (2019).
38 ICES (2017).
39 See ICES (2021).

The calculation includes all fish species expected to benefit from restricted or halted large-scale trawling. With sustainable cod stocks and the protective measures mentioned above, small-scale coastal and recreational fishing could see significant improvement, even if catches in tons remain a small fraction of large-scale fishing yields.

Cautious scenario: Fish stocks recover slowly and quota is only allocated to small-scale fisheries

In this scenario, no pelagic trawling is conducted, and stocks recover slowly. The recovery would only support Swedish small-scale commercial fishing, allowing an increase in catch by approximately 10,000 tons across all species (compared to around 1,000 tons in 2023). This means Swedish small-scale commercial fishing could expand significantly. Similar calculations and assumptions apply to recreational fishing.[40]

The value of Swedish large-scale fishing in the Baltic Sea

The Swedish fishing fleet consists of many small vessels using passive gear and a smaller number of larger vessels primarily engaged in trawling. In 2006, a total of 1,564 Swedish vessels were licensed for commercial offshore fishing.[41] By 2023, the number had decreased to 936.[42] The number of individuals holding a fishing license (previously called a professional fishing license before 2014) was 1,880. By 2023, this number had dropped to 724.[43] However, not all of these individuals are active. For the baseline calculation in this report, it is assumed that the declining trend continues, approaching zero by 2030.

Few trawlers are based on the east coast, except for vendace trawlers in the north. In contrast, vessels using passive gear are more evenly distributed along the west, south, and east coasts. Additionally, vessels from Denmark, Estonia, Finland, Latvia, Lithuania, Russia, Poland, and Germany also fish in the Baltic Sea.

Target species are primarily herring, sprat, and cod. Cod fishing in the Baltic Sea has mainly been conducted through large-scale bottom trawling. In recent years, however, cod has become so small and weak that significant portions were not sold as food fish to retailers but instead exported for fishmeal production. The crisis of Baltic cod led the EU Commission to impose an immediate fishing ban in late July 2019 for the remainder of the year. In 2019, the International Council for the Exploration of the Sea (ICES) recommended a complete fishing ban on the eastern stock for 2020.

Due to the cod fishing ban, large-scale fishing is now primarily focused on herring and sprat. Most landings are directed to the fishmeal and fish oil industry, partly due to the dioxin content in fatty fish.

The dramatic decline of cod stocks previously led to an increase in its natural prey, herring and sprat, but these species are now also under heavy fishing pressure. In the calculation below, it is assumed that herring and sprat stocks, along with their fishing quotas, will continue their negative trend, approaching zero by 2030.

In rough terms, the total landing value of all Baltic Sea fisheries was just under 1.8 billion SEK (156 million euros) in 2021, with a decrease thereafter.[44] Herring and sprat (= industrial fishing) account for just over 1.2 billion SEK (107.1 million euros) of this total.[45] In the Baltic Sea, small-scale fishing accounts for the vast majority of vessels (about 95 percent), but only around 22 percent of the landing value.[46]

The total landing value for commercial fishing in Sweden is estimated to be approximately 1.274

40 It is assumed that small-scale fishing along the entire Swedish Baltic Sea coast (which is 15 times longer than Öresund) could catch six times as much as is currently caught in Öresund in the absence of competition from large-scale fishing. Öresund offers better conditions for small-scale and recreational fishing, both due to the favorable bottom conditions for fish and its proximity to a larger group of potential recreational fishermen.
41 The Swedish Board of Fisherie (2008).
42 According to The Swedish Agency for Marine and Water Management. Swedish sea-fisheries during 2023.
43 According to data requested from the Swedish Agency for Marine and Water Management in October 2024, the total employment is slightly higher, as not all individuals working aboard fishing vessels need to hold a license.
44 The 2023 annual economic report on the EU fishing fleet (STECF 23-07), p. 104. Based on statistics from 2021.
45 The 2023 annual economic report on the EU fishing fleet (STECF 23-07), p. 104. Based on statistics from 2021.
46 According to STECF (2024), p. 100. https://stecf.jrc.ec.europa.eu/documents/d/stecf/stecf_24-07_aer

billion SEK (110 million euros) in 2023.[47] The value added produced by Swedish commercial fishing in total is reported to be 615 million SEK in 2021, with only 11 percent coming from small-scale fishing using passive gear.[48] Of the Swedish fishing in the Baltic Sea, small-scale fishing using passive gear accounts for only 6.63 percent.[49] Overall, large-scale commercial fishing in the Baltic Sea accounts for about 37 percent of the total Swedish landing value in the entire country.[50] This share, or quota, is used in several sections below to roughly allocate public expenditures and administrative efforts that are not sufficiently broken down. However, based on a trend projection of the stocks until 2030, it is assumed that the Swedish landing value for large-scale fishing in the Baltic Sea will be zero by then.

This report analyzes the current fishing situation focusing on its socio-economic profitability, and alternative scenarios where intensive fisheries management is applied in the form of a ban on large-scale fishing in the Baltic Sea, combined with measures that allow for fish stock recovery. The numerical data is primarily based the most recent available years, but in several cases, averages over multiple years are used when differences between years are significant. In the first step, the fiscal effects of large-scale fishing in the Baltic Sea are calculated.

Fiscal impact of large-scale fishing in the Baltic Sea

The fiscal effects of large-scale fishing consist of the government's direct subsidies, indirect subsidies such as fuel subsidies and more favorable conditions for unemployment insurance, as well as costs for administration and oversight. These costs are offset by tax revenues from the industry. The following sections describe and summarize these components. A similar calculation was presented in Fölster (2020) but has been updated in this report. The subsequent sections present and explain both the previous calculation and the revised figures.

Direct subsidies

Under the EU's Common Fisheries Policy during the structural program period (2014–2020), Sweden's program budget was nearly 1.5 billion SEK. A wide range of subsidies was distributed, including support for investments in fishing gear, market promotion, and compensation for income loss due to the cod fishing ban. Payouts were relatively low in 2016 and 2017, prompting the Swedish Board of Agriculture to prioritize and accelerate disbursements from 2018 onward. To avoid misleading conclusions from annual fluctuations, the 2020 calculation used the average annual amounts budgeted for 2014–2020. This support totaled 183 million SEK per

47 According to STECF (2024), p. 506. https://stecf.jrc.ec.europa.eu/documents/d/stecf/stecf_24-07_aer. The Swedish Agency for Marine and Water Management provides slightly different figures. https://www.havochvatten.se/download/18.5a0c1a2c18fa6d6097b78f51/1717146059469/officiell-statistik-JO55SM2401.pdf
48 According to the Swedish Agency for Marine and Water Management's annual report 2023, p. 41.
49 Data requested from the Swedish Agency for Marine and Water Management, October 2024.
50 The Swedish Agency for Marine and Water Management. Swedish sea-fisheries during 2023. (p. 6). In their report, (the source for 37%), the term "fodder fishing" is used, which has been equated with large-scale commercial fishing here.

year in subsidies for the fishing industry, of which 66 million SEK was allocated to large-scale fishing in the Baltic Sea.[51]

This calculation was criticized by Ministry of Agriculture officials, who claimed the share of subsidies allocated to large-scale fishing in the Baltic Sea was lower. However, they were unable to present any alternative figures or substantiate their claims. Coincidentally, the Ministry of Agriculture's annual reports became much less detailed, making it difficult to determine the size of the subsidy allocations within the fishing sector.[52] Thus, a standardized allocation is made based on the total subsidy amount reported as expenditures in the Ministry of Agriculture's 2023 annual report.[53] The expenditures for support measures for fisheries and aquaculture are stated as 121 million SEK, of which 37 percent, or 45 million SEK, is allocated to large-scale fishing in the Baltic Sea. Our forecast assumes that a fishing ban will be implemented from 2030 due to continued overfishing, leading to the cessation of this support.

Direct costs also include public research funding aimed at preventing or mitigating overfishing impacts. These funds support research, driven by overfishing, rather than directly subsidizing the fishing industry. Research funding is distributed by several agencies, including the Swedish Research Council, the Swedish Environmental Protection Agency, the Swedish Agency for Marine and Water Management, the Swedish Board of Agriculture, the National Veterinary Institute, the Swedish Food Agency, and the Mistra Foundation. According to a previous estimate, fisheries-related research funding from these entities amounted to approximately 50 million SEK per year, of which half (25 million SEK) is assumed to be related to overfishing.[54] Again, the distribution key of 37 percent for the large-scale Baltic Sea fishery, as previously described, is applied, which amounts to 9.25 million SEK. This is likely an underestimation since much of the research is focused on the consequences caused by overfishing and its ongoing effects. By 2030, it is assumed that these costs will remain at the same level, even if large-scale fishing has ceased – for example, some fishing operations may receive subsidies to be left fallow, and research focusing on managing the consequences of overfishing will likely be needed for a long time to come.

Unemployment benefits during a fishing ban

An indirect subsidy to the fishing industry is represented by unemployment benefits, which are granted under more generous rules than the standard unemployment insurance allows. To qualify, it is required that the individual engages in professional fishing as their primary source of income. During temporary interruptions in fishing, which may be caused by weather conditions or ice obstructions, the individual is considered unemployed. The unemployment insurance for professional fishermen was at risk of bankruptcy but was saved at by being integrated into the Commercial Employees' Union, which became part of the Union's unemployment insurance fund in 2019.

As a result, there is no longer any simple statistics on fishermen's unemployment days. Instead, the number of days and costs are estimated based on the number of fishermen and the previously more detailed statistics. In 2006, the number of paid days was reported as 10,090 for approximately 2,400 professional fishermen. By 2018, this figure had decreased to about 1,400 professional fishermen and approximately 700 in 2023. If the same conditions apply now, the number of paid days would be about 3,000 per year. The highest unemployment benefit is 1,200 SEK per day before taxes. Since we calculate the net financial costs to the state, we can use the amount after an average tax rate of 28 percent on unemployment benefits, and after taking into account the fishermen's contributions through membership fees, the total cost to the state would be 2.3 million SEK per year. According to the previous allocation method, 0.9 million SEK can be attributed to large-scale Baltic Sea fishing, which is expected to remain the same in 2030.

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51 According to the Swedish Board of Agriculture's annual report 2018.

52 Previously, the subsidy allocations were distributed to areas such as promoting environmentally sustainable, resource-efficient, innovative, competitive, and knowledge-based fishing; promoting the implementation of the Common Fisheries Policy; increasing employment and territorial cohesion; promoting marketing and processing; promoting the implementation of the integrated maritime policy; and technical support.

53 https://www2.jordbruksverket.se/download/18.7e82796818dc47e64f48513/1708585071868/ovr678.pdf

54 According to a survey covering the period 1990-2004. Formas (2004).

Fuel subsidies

Similar to other maritime sectors, registered fishing vessels are exempt from fuel taxes. Most vessels purchase fuel tax-free, while others receive a refund of the tax at a later stage.

The calculation here is based on an indirect estimate. Fishing released an average of 113,000 tons of CO2 equivalents between 2016 and 2018, and in proportion to the number of vessels, it is assumed to have decreased to 68,000 tons of CO2 equivalents.[55] One liter of diesel produces approximately 2.5 kg of carbon dioxide emissions. This means that the fishing industry is likely to consume about 27 million liters per year. The reduction in energy and carbon dioxide taxes in 2024 was 3,926 SEK per cubic meter. The value of fuel subsidies for the entire Swedish commercial fishing sector is therefore 106 million SEK. Of this, 37 percent, or 39 million SEK, is allocated to large-scale fishing in the Baltic Sea. The main reason for the decrease compared to previous calculations is the reduction in the diesel fuel tax, making the tax exemption less valuable. By 2030, this tax exemption is expected to decrease to zero under the scenario that large-scale fishing has ceased.

Administrative costs for fishing

The administrative costs for fishing primarily arise at the Swedish Agency for Marine and Water Management, which is responsible for regulating and managing fishing, preparing data for quota negotiations, and overseeing much of the fisheries control, including landing inspections. The Swedish Coast Guard is also responsible for fishing control, including offshore inspections. Additionally, the Swedish Board of Agriculture's administrative costs for distributing subsidies are estimated at 7 percent of the subsidy amount, which amounts to 8.5 million SEK (for all fisheries).[56] The Swedish Environmental Protection Agency, County Administrative Boards, ministries, and Sweden's EU delegation also incur administrative costs for fisheries, which are cautiously estimated at 7 million SEK.

The Swedish Agency for Marine and Water Management (HaV) reports its costs for fisheries control, landing inspections, as well as costs related to regulations and permits in its 2018 annual report.[57] For 2018, the costs for these four categories are reported to total 88.3 million SEK. However, the 2019 annual report does not provide sufficient details, and these costs were further affected by the cod fishing ban. HaV claims that its actual administrative costs are lower. If this is the case, it raises the question of whether all reported inspections were truly carried out, especially considering the recurring criticism about insufficient controls. In the 2023 annual report, the line item ”Improving work on supervision, fisheries monitoring, and fisheries control” is stated as 55 million SEK.

The Coast Guard stated that their average cost per fisheries control intervention was 9,000 SEK in 2018.[58] The number of actions in the form of inspections and checks was reported to be 12,500. This brought the total cost to 112 million SEK. According to the 2023 annual report, the number of inspections has decreased by about 30 percent since then. At the same time, inflation has been high. Therefore, it is estimated that the cost is roughly at the same level as before, approximately 110 million SEK.

55 According to data compiled from various authorities by the Swedish Environmental Protection Agency. See also the Swedish Society for Nature Conservation (2018).

56 Based on the Swedish Board of Agriculture's reported operational costs in relation to the grant amounts managed, according to the 2023 annual report.

57 These costs are not sufficiently detailed in the 2019 annual report.

58 In the 2018 annual report, the cost per control measure was reported, but in the 2019 report, this method changed, and no cost per measure was provided. Since the Coast Guard's operations are stable, the 2018 figures are used here. For reference, the Coast Guard reported a total maritime surveillance cost of 515 million SEK in 2019.

Table 1. Summary of public financial costs and revenues from large-scale Baltic Sea fishing (million SEK per year)

	Calculation 2020	Updated calculation for 2023	Projection for 2030
Direct subsidies	- 75	- 54,25	- 9,25
Unemployment benefits	- 1	- 1	- 1
Exemptions from fuel taxes	- 106	- 39	0
Administrative costs	- 69	- 66	-66
Tax revenue	22	23	0
Total	**- 229**	**- 137**	**- 76**

Note: Rounded figures. Direct subsidies include both those reported by the Swedish Board of Agriculture and research grants related to overfishing as previously described.

The total administrative costs for commercial fishing in Sweden amount to 180 million SEK, with 66 million SEK attributable to large-scale Baltic Sea fishing. These costs are expected to remain at the same level in 2030, as controls will need to be carried out to ensure compliance with anticipated fishing bans.

Tax revenue from the Swedish large-scale fishing and processing industry

The state not only incurs costs from large-scale fishing but also potentially tax revenues. To estimate these, the value added for vessels with active gear over 12 metres in length, published by the Swedish Agency for Marine and Water Management in its annual report, is used here. They are summarised at SEK 528 million for 2020 and SEK 515 million in 2021.[59] The average value of these two years is SEK 521.5 million, of which 193 is attributed to large-scale Baltic fishing. For the business sector as a whole, taxes on profits, payroll taxes and social security contributions, as well as VAT, amount to around 40 per cent of value added. By 2030, tax revenues are assumed to have fallen to zero based on our assumption that a fishing ban is introduced after increasingly depleting stocks.

However, the question here is to what extent fishermen would be working elsewhere if they were not fishing. According to the standard methods developed for social investment (ASEK 6.1, 7), it should normally be assumed that all jobs and investment would take place elsewhere in the economy if large-scale fisheries existed. Exceptions can be made if a concrete market failure can be demonstrated that prevents employment and capital from becoming productive in other industries. In this case, it may be that a small proportion of fishermen are approaching retirement, or for other reasons are unlikely to be productive elsewhere. Similarly, some capital is tied up for a number of years in vessels that may not have as much opportunity value. A conservative assumption is that the majority of workers, and capital in the long run, would still find other areas of activity. It is therefore assumed that 70 per cent of the tax would have been collected anyway. The calculation is then that the net tax revenue amounts to SEK 23 million for Swedish large-scale fishing in the Baltic Sea.

In Sweden, the large-scale fish processing industry is dominated by a few large companies not dependent on Swedish quotas and landings. Raw materials are largely sourced from outside the EU and import dependency is estimated at around 80 per cent by value. The large-scale processing industry is mainly located in Västra Götaland. The dependence and link to Swedish landings from the Baltic Sea is small. Most of the catches from large-scale fishing in the Baltic Sea do not become food for humans, but animal feed in the form of fishmeal. The conclusion drawn from this is that the effects on tax revenues from the processing industry, which currently processes fish from large-scale Baltic Sea fishing, should be disregarded.

The state's costs associated with large-scale Baltic Sea fishing are thus estimated at SEK 137 million net per year. This can be put in relation to an estimated value added of SEK 193 million, or to our calculation of the proportion of value added, SEK 58 million, that could not be replaced by labour and investment in other parts of the

59 According to the Swedish Agency for Marine and Water Management's annual report 2023, p. 41 . In comparison, vessels with passive gear have added values of SEK 64 million and SEK 67 million in 2020 and 2021 respectively.

economy.[60] By 2030, large-scale fishing is assumed to have ceased, but consequential costs remain. Some of the figures are subject to some uncertainty. At the same time, few industries are as statistically detailed as the fishing industry. Even if the estimate of government costs for Baltic Sea fishing were 50 per cent over- or underestimated, it would not change the conclusion that the net costs to taxpayers are significantly higher than the value added created by large-scale Baltic Sea fishing.

Socio-economic value of Swedish large-scale fishing in the Baltic Sea

The socio-economic value of large-scale fisheries inclydes three elements: the economic value of production, the socio-economic cost of public intervention, and various externalities. A summary of these is presented at the end.

The economic value

The calculation mirrors the approach used above to estimate tax revenues. Value added for vessels over 12 metres with active gear is published in the Swedish Agency for Marine and Water Management's annual report.[61] The average for the years 2020 and 2021 was reported as 521.5 million SEK, of which 193 million SEK can be attributed to large-scale Baltic Sea fishing. As descibed, it is likely that most fishermen would find work in other sectors if fishing did not exist. Therefore, it is assumed here that 70 percent

Photo: Amanda Öberg

of the value added would have been created anyway. Based on this, the net contribution from large-scale fishing in the Baltic Sea is estimated at 58 million SEK. By 2030, this value is expected to decrease to zero.

The socio-economic value of government interventions

For this calculation, government interventions fall into two categories: first, interventions that draw actual resources, such as control and administration; second, subsidies that redistribute from taxpayer money to fishermen without drawing resources. These subsidies do not create a socio-economic cost in themselves. However, they lead to efficiency losses due to taxation, reduced incentives to work and invest, and administrative costs. A commonly used calculation is that the efficiency loss corresponds to 30 per cent of public expenditure. The calculations are summarised in Table 2. By 2030, large-scale fishing is assumed to cease, but many public costs remain, such as monitoring and subsidies to restore damage from depletion.

External effects of the fishing industry

Among the external effects, only carbon dioxide emissions are quantified. Impacts on other industries discussed, but not quantified. In the alternative scenarios, later presented, small-scale fishing and recreational fishing grow at the expense of today's large-scale fishing. Profits for these industries are presented there and should not be double counted by being deducted here as well. Regional and other societal effects are also addressed in the alternative scenarios.

Carbon dioxide emissions are an external effect of fishing that burdens other people today and in the future. According to previous reasoning, fishing boats are estimated to emit 68,000 tonnes of carbon dioxide equivalents. According to the ASEK 7 standard used in many industries for socio-economic calculations, one kilogram of emissions should be valued at SEK 7. The socio-economic cost of fishing as a whole is then SEK 476 million, of which we estimate the share of large-scale Baltic Sea fishing at SEK 176 million per year.[62]

60 Based on an accepted assumption that 70 percent of investment and labour would be productive in other parts of the economy if the industry in question did not exist.

61 According to the Swedish Agency for Marine and Water Management's annual report 2023, p. 41.

62 See also Waldo and Paulrud (2017) who estimate that carbon dioxide emissions in Swedish fisheries could be reduced by 30-60 per cent if fisheries were managed more efficiently.

Table 2. The socio-economic cost of government interventions related to large-scale fishing in the Baltic Sea (million SEK per year)

	2023	Projection for 2030
Resource cost	66	66
Transfers (only efficiency loss of net transfer)	21	14
Total	**87**	**80**

Note: Rounded figures.

Table 3. Summary of the socio-economic value of large-scale fisheries in the Baltic Sea (million SEK per year)

	2023	Projection for 2030
Contribution to GDP	58	0
Contribution via public finances	- 87	- 80
Carbon dioxide emissions	- 176	0
External impact on other industries (not valued here but estimated in the next section)		
Total	**- 205**	**- 80**

Note: Rounded figures.

The value of healthier fish stocks in the Baltic Sea

The effects on other industries of a halt to large-scale fishing were not assessed in the previous chapter. Instead, the fiscal and socio-economic value of two alternative scenarios is calculated here, where small-scale small-scale fishing and recreational fishing are allowed to increase instead. Similar calculations have previously been made by Fishsec (2022).[63]

Description of two alternative scenarios

The starting point is that large-scale fishing in the Baltic Sea is significantly restricted in the main scenario or ceases entirely in the cautious scenario. The time required for fish stocks to recover is uncertain, but the following two scenarios are based on international experiences and the scientific literature previously presented.

In the main scenario, coastal and recreational fishing are assumed to recover to some extent, while large-scale fishing is limited to a quarter of the Baltic Sea. For cod, a cautious estimate after recovery suggests a sustainable annual catch of around 20,000 tons. As recently as 2000–2015, fishing quotas and cod landings averaged approximately 70,000 tons per year.[64] A sustainable future catch of 20,000 tons is therefore significantly higher than what has been possible in recent years. For herring, this would mean a cautious return to catch levels of around 300,000 tons per year for the entire Baltic Sea, compared to approximately 600,000 tons per year caught between 2000 and 2015.[65] It is also assumed that fishing for other species will recover in a similar way.

The other cautious scenario assumes that no large-scale fishing is possible, but that fishing opportunities for small-scale and recreational fishing may increase in the same way as in the main scenario.

A key question for the calculation of the alternative scenarios here is how much small-scale and recreational fisheries combined can increase their catches. One important aspect is the discarding of unwanted species and sizes of fish and shellfish, known as discards. Discarded fish rarely survive. Much work has been done in the 1990s to develop more selective gear,

63 BalticStern in HELCOM (2013); Döring and Egelkraut (2008); Blenckner et al. (2011).
64 ICES (2017; 2021).
65 ICES (2021).

but trawl fishing is non-selective in nature - all species that cannot pass through the mesh are caught in the trawl. The Swedish Board of Fisheries' observer programme has previously shown that in the trawl fishery for cod in the Baltic Sea, 28 percent of the catch by weight was thrown overboard.[66] Since targeted fishing for cod in the Baltic Sea was banned in 2019, cod is only present as by-catch. According to ICES, around 12 tonnes of cod in the Baltic Sea were discarded in 2023.[67] The conclusion is that stopping large-scale fishing can significantly increase the availability of fish for small-scale commercial fisheries.

How much can small-scale commercial fishing increase?

In essence, the recovery scenarios are based on the previous review of international experience. The size of fish has shrunk significantly but can be expected to increase again with more restrictive fisheries management.[68] Another possible reference point is the Öresund, where trawling has long been banned. In a study, Copenhagen Economics (2018) found that small-scale commercial fishing harvested around 2,000 tons, with a landing value of 36 million DKK and approximately 160 vessels. The Öresund is only one-fifteenth the length of Sweden's Baltic Sea coast. It is thus reasonable to assume that small-scale fishing along the Swedish Baltic coast could catch six times as much once fish stocks recover and large-scale fishing is halted or restricted. This assumption applies in both the main and cautious scenarios. However, Öresund has more favorable conditions for small-scale and recreational fishing, both in terms of seabed characteristics that support fish populations and a larger number of potential recreational fishers.

From the estimated increase in fishing under the recovery scenarios, the catch from today's small-scale commercial fishing must be deducted. In 2023, this amounted to only 1,011.3 tons [69]. That is, just over one percent (1.36 percent) of the total Swedish commercial fishing in the Baltic Sea, which amounts to 74,131.7 tons[70], the vast majority of which is caught by the large-scale pelagic fleet.[71] The increase in small-scale commercial fishing could then reach approximately 10,000 tons in both scenarios, increasing many times over while still remaining much less dense than fishing in, for example, the Öresund.

The increase in landing value for small-scale commercial fishing in the Baltic Sea is estimated at 180 million SEK in both scenarios based on

Photo: Tobias Dahlin/Azote

66 The Swedish Fisheries Agency (2007).

67 Baltic Fisheries Assessment Working Group (WGBFAS) 2024. (p. 22). Due to data shortages, the figure is very uncertain.

68 At the October 2022 Council of Ministers, the European Commission, Finland, Latvia, Lithuania, Poland and Sweden signed a statement expressing concern about the size and age distribution of Baltic herring. The International Council for the Exploration of the Sea (ICES) was therefore asked to identify the reasons for the decline in stock size and to propose measures. In spring 2024, ICES published an action plan, but since then there has been silence.

69 Data from the Swedish Agency for Marine and Water Management, filtered by catch area "Baltic Sea" and vessel segment "Coastal segment.".

70 Data from the Swedish Agency for Marine and Water Management, filtered by catch area "Baltic Sea." In 2019, small-scale commercial fishing accounted for only 2,106 tons, or nearly two percent of the total Swedish commercial fishing in the Baltic Sea, which amounted to 121,000 tons.

71 According to the catch statistics from the Swedish Agency for Marine and Water Management.

these assumptions.[72] The generated value-added for small-scale commercial fishing in the Baltic Sea would increase by 72 million SEK in both scenarios. Assuming, as in previous sections, that tax revenue equals 40 percent of the value-added, but that 70 percent of this would have been created in other sectors if fishing did not exist, the net increase in tax revenue amounts to 8.6 million SEK in both scenarios.

Moreover, most current subsidies for commercial fishing are assumed to be discontinued, except for small-scale fishing, which retains fuel subsidies and unemployment benefits. However, these costs are not expected to increase proportionally with landing value, as larger catches are anticipated per fishing trip or distance traveled. Fuel subsidies are halved relative to landing value when today's large-scale Baltic Sea fishing is replaced by small-scale fishing, as passive gear consumes significantly less fuel. This estimate is indirectly supported by an SLU study suggesting that carbon dioxide emissions in Swedish fisheries could decrease by 30 to 60 percent with more efficient management and fleet adjustments to sustainable stock levels.[73] In this case, the thought experiment assumes that large-scale fishing continues as before but with fewer and more efficient vessels.

How much can recreational fishing increase?

Recreational fishing in Sweden catches a total of 11,000 tons of fish. About 8,000 tons of this occurs in lakes and rivers, while the remaining 3,000 tons are caught along the coasts and in the sea.[74] The poor situation for cod in coastal waters has led to a significant reduction in opportunities for recreational fishermen to catch cod in recent years. The charter boat fishery for cod, which existed in the southern Baltic Sea and around Öland and Gotland during the 1970s and 1980s, no longer exists. By comparison, recreational fishing in Öresund is estimated to have ranged between 500 and 1,000 tons.[75] It is assumed here that recreational fishing along the entire Baltic Sea coast is of a similar magnitude, at 750 tons. With this as a reference point, and in line with previous assumptions, recreational fishing in the Baltic Sea could increase to 6,000 tons (1,000 tons x 6), meaning the increase from the current level would be 5,250 tons. The values created in recreational fishing per kilogram of fish do not necessarily mean that the fish die. Some recreational anglers practice catch-and-release, where the same fish can be caught multiple times.

According to SCB, recreational fishermen spend as much as 1,200 SEK per kilogram of fish when including costs for investments such as boats, and 380 SEK per kilogram without investments. In comparison, Copenhagen Economics estimates that recreational fishermen around resund spend as much as 400 million DKK annually on goods and services, equivalent to 200–400 DKK per kilogram of fish. Additionally, fish prices are generally higher in Öresund due to higher quality of the fish. Recreational fishing is roughly the same size as commercial fishing and is carried out by 40 to 50 turbats, which have almost disappeared elsewhere in the Baltic Sea.

Based on this, it is cautiously assumed that recreational fishermen's purchases of goods and services currently amount to 400 SEK per kilogram of fish in the Baltic Sea, but that this decreases to 300 SEK per kilogram in the alternative scenarios, which is closer to the average for Öresund according to Copenhagen Economics. The reasoning is that easier fish catching allows more to be caught with the same equipment or on the same fishing trip, thereby lowering the cost or price of equipment per kilogram of fish. At the same time, more people may fish more often and buy more goods and services. These assumptions about decreased price or cost per kilogram of fish are among the most uncertain figures in the calculation and are thus cautiously estimated.

The increase in recreational fishermen's purchases is calculated as:

(Fish caught in the alternative scenario in kg x price/cost for purchases per kg) - (Fish caught in the baseline scenario x price/cost for purchases per kg)

72 This equals 18 SEK per kg, which aligns with calculations from Copenhagen Economics (2018). It refers to a weighted average for all fish species, where, for example, cod may fetch a higher price and herring a lower one.

73 Waldo and Paulrud (2017).

74 https://www.havochvatten.se/data-kartor-och-rapporter/data-och-statistik/officiell-statistik/officiell-statistik---fiske/fangststatistik-for-fritidsfisket.html

75 Based on Copenhagen Economics (2018).

This amounts to 1.5 billion SEK in both scenarios. A common assumption is that the added value equals 40 percent of the revenue. As previously stated, 70 percent of this added value would have occurred in other industries regardless, leaving 178 million SEK in increased added value. Tax revenue is assumed to be 40 percent of the added value. Therefore, the net tax revenue from increased purchases by recreational fishers is estimated at 71 million SEK in both scenarios. Any potential administrative costs for recreational fishing are assumed to be fully covered by fishing licenses or fees and are thus excluded from the calculation.

Large-scale fishing in the Baltic Sea is only allowed in the main scenario and is expected to increase compared to today after the recovery of fish stocks, which is also reflected in increased fuel subsidies and carbon dioxide emissions by 25 percent. However, no increase in other public subsidies and administrative costs is assumed, as these largely consist of fixed costs or are governed by government budgets, which are not expected to increase. For example, the costs for monitoring by the Coast Guard are not assumed to increase as fishing rises. Tax revenues, on the other hand, increase in proportion to the increased landing values..

The calculation of the increased added value for small-scale fishing has been described as 72 million SEK in both scenarios. As before, it is assumed that 70 percent of this added value would have been created in elsewhere if fishing did not exist. This leaves a net contribution to GDP of 22 million SEK in both scenarios.

The socio-economic value resulting from increased fishing opportunities for recreational fishing consists of two parts. First, the producer surplus corresponding to the value for businesses that fully or partially sell goods or services to recreational fishermen. The calculation of this has been described above as a basis for calculating the effect on tax revenues. Part of the sale of goods and services related to recreational fishing is considered export,

Table 4. Summary of fiscal effects resulting from the recovery scenarios compared to 2023 (million SEK per year)

	Main scenario	Cautious scenario
Small-scale fishing:		
Subsidies	Not considered	
Unemployment benefits	0	0
Exemption from fuel taxes (a fraction of today's fishing as small-scale fisheries do not haul heavy trawling nets)	-3	-3
Administrative costs	0	0
Tax revenue	9	9
Recreational fishing:		
Subsidies	None	
Unemployment benefits	None	
Exemption from fuel taxes	None	
Administrative costs	Self-financing through fishing fees	
Tax revenue	71	71
Large-scale fishing:		
Direct subsidies	0	-
Unemployment benefits	0	-
Exemption from fuel taxes	- 10	-
Administrative costs	0	-
Tax revenue	23	-
Total	**90**	**77**

Note: Rounded figures. The calculation of the socio-economic value follows the same template as before, but with some important additions.

as it is sold to fishing tourists. At least that portion would not have been directed towards the purchase of other goods and services in Sweden.[76]

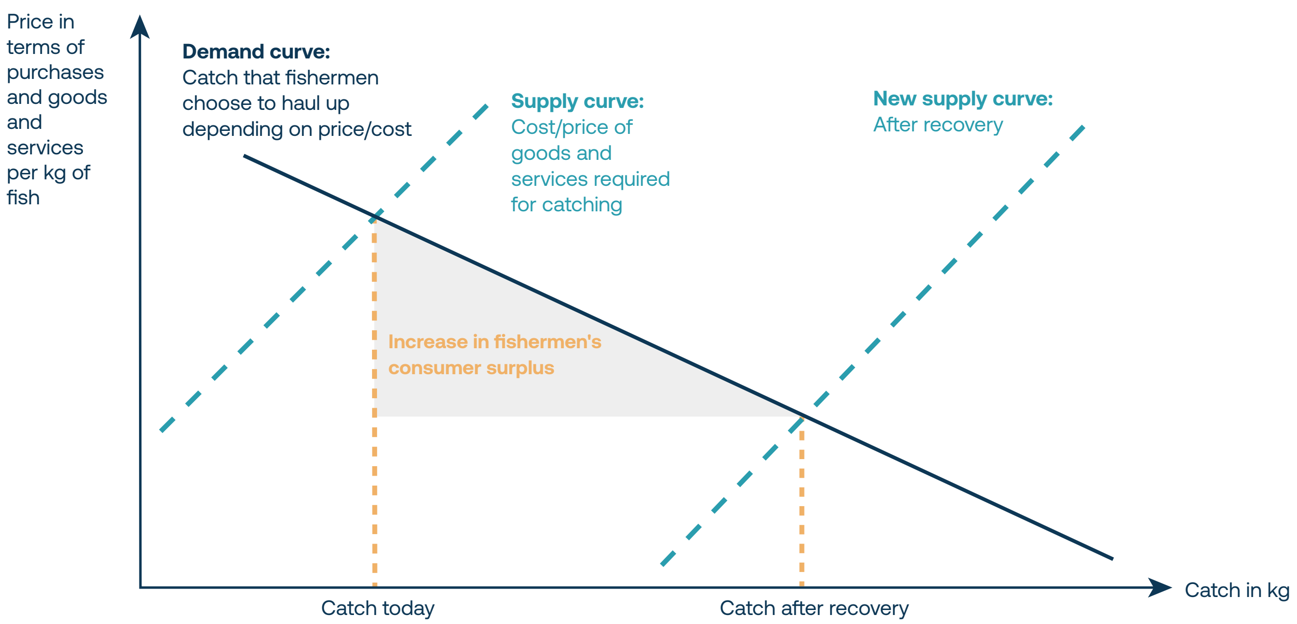
The second part is the consumer surplus (see Figure 2), which is the difference between what the consumer is maximally willing to pay for the product and what they actually have to pay for it, in this case, the experience of fishing and the catch. In economic terms, consumer surplus can be seen as analogous to the profit (producer surplus) generated by a business activity. Over the years, several attempts have been made to estimate consumers' willingness to pay for fishing. Many studies first estimate how better access to fish, catch per fishing trip, affects the number of fishing days and how much consumers are willing to spend per additional fishing day, as well as the consumer surplus. A typical study might find, for example, that a 50 percent increase in catch per trip increases the number of fishing days by 150 percent.[77]

The consumer surplus is calculated here using a method widely used and recommended by ASEK, which in Sweden formulates standards for calculating socio-economic values in infrastructure contexts. This method is called ”The Rule of Half.” The consumer surplus is then calculated as 0.5*(the increased amount of fish recreational fishermen catch in kg)*(the change in price/cost per kg catch). This is illustrated in the diagram below. The price/cost per kg catch is cautiously assumed to decrease from 400 to 300 SEK per kg, as a fisherman may catch more fish on each trip compared to today. The increase in consumer surplus is then calculated to be 262 million SEK. However, the same assumption applies to consumer surplus—that at least some domestic fishermen would likely have bought other products that also generate consumer surplus if they hadn't purchased fishing experiences. Therefore, we follow our earlier assumptions that 70 percent of the consumer surplus would have occurred anyway. The net increase in consumer surplus is thus 78 million SEK in both scenarios.

The socio-economic effect of government subsidies and interventions is calculated using the same method as for large-scale fishing.

Only actual resource consumption is counted as a socio-economic cost, not transfers that simply redistribute resources. Both are, however, burdened by an efficiency loss of 30 percent, which arises when the money needs to be collected as tax elsewhere in the economy. The socio-economic cost of carbon dioxide emissions is also calculated as before, except that it is assumed that small-scale commercial fishing causes half the emissions relative to the landing value, and that recreational fishing emits the same amount as small-scale commercial fishing per kilogram of fish.

Figure 2. Illustration of consumer surplus of recreational fishermen



76 See also Pluntke, J., T. Brynteson and K. Livsey Berg (2025), on maritime tourism.
77 Lupi and Hoehn (1997).

Photo: Ebba Rosendahl

Qualitative values

Four values are only presented qualitatively as they are very difficult to estimate.

The first of these is the value of a stronger regional economy. Fishing-based cultural environments are often important for local identity and attract tourists to coastal regions. Regional policy considerations are one of the reasons why small-scale fishing is prioritized in Swedish fisheries policy.[78] Many of the cultural environments that attract tourists are based around a local fishing harbor, and the fact that fishing keeps harbors open, thereby attracting tourists to an area, is a positive external effect. However, these harbors are often associated with small-scale and local fishing, whereas large-scale fishing can instead have a negative impact on opportunities for swimming and recreation.

Large-scale fishing in the Baltic Sea is rarely based along the Baltic coast. In a few ports, such as Simrishamn, it is argued that large-scale fishing helps maintain essential infrastructure like ice machines and landing facilities. However, in many other ports, such as those on Gotland, a different perspective is given, where small-scale reception capacity is considered sufficient. Overall, the conclusion is that a shift to the alternative scenarios would have positive regional effects along the Baltic coast, even if they are difficult to quantify.

Secondly, the value of healthy food. Cod is not significantly affected by toxins that have impacted fatty fish such as salmon and herring. To the extent that the alternative scenarios would allow for the recovery of cod stocks, access to healthy food in Sweden would also increase.

The third value, is the public's valuation of having more fish in the sea. The mere existence of a functioning ecosystem in the Baltic Sea holds value - even for those who do not directly use it. While this may seem obvious, economic studies in other areas have shown a willingness to pay to preserve natural assets. In the TemaNord (1999) study, Swedes were estimated to be willing to pay a total of 2.4 billion SEK per year, for example, through higher taxes, to keep Sweden's fish populations viable. However, as these estimates vary significantly, the value is not quantified here.

A fourth factor is that larger fish stocks in the Baltic Sea also serve a preparedness function. Fishing can be an important source of protein in times of crisis. The increase in catches of herring and cod in the main scenario would, by the 2030s, correspond to 6.5 kilograms of herring and cod per Swede per year, not including the increase in other fish species, which is also significant.[79]

Altogether, there is a significant improvement in the economic profitability of fishing in the recovery scenarios. Large-scale fishing, however, remains only slightly less unprofitable, even if recovery occurs at a level that does not deplete stocks. Economic profitability would improve from -205 million SEK per year, according to previous calculations, to -181 million SEK. The main reason is the high greenhouse gas emissions caused by dragging heavy trawls through the sea. This calculation refers to pelagic trawling. In recent years, it has also emerged that bottom trawling releases large amounts of greenhouse gases from the seabed.[80]

78 See also Waldo and Blomquist (2020).
79 Calculated on the basis that Sweden's fisheries account for 20 per cent of the catch in the Baltic Sea.
80 Atwood et al. (2024).

Table 5. Summary of the increase in socio-economic value of the alternative scenarios compared to 2023 (million SEK per year)

	Main scenario	Cautious scenario
Small-scale fishing:		
Contribution to GDP	22	22
Contributions via public finances	None	
Transfers	- 1	- 1
Resource consumption	0	0
Carbon dioxide emissions	- 5	- 5
Recreational fishing:		
Contribution to GDP	178	178
Consumer surplus	79	79
Contributions via public finances	None	
Carbon dioxide emissions	- 34	- 34
Large-scale fishing:		
Contribution to GDP	60	-
Contributions via public finances	None	-
Resource costs	0	-
Transfers (only efficiency loss of net transfers)	4	-
Carbon dioxide emissions	- 44	-
Qualitative values:		
Value of better regional economy	Positive, but not quantified	
Healthier food supply	Positive, but not quantified	
Public valuation of healthier seas	Positive, but not quantified	
Better crisis preparedness	Positive, but not quantified	
Total	**259**	**239**

Note: Rounded figures.

Final compilation

In the previous sections, the question was divided into two parts. First, the socio-economic impact of large-scale fishing in the Baltic Sea in recent years and going forward was calculated, without considering what could develop if it were limited. In the second calculation, the socio-economic value of fishing in total, including small-scale fishing and recreational fishing, was estimated if appropriate protective measures were implemented and large-scale fishing was restricted. In this concluding section, these two calculations are combined to determine the net effect of restricting large-scale fishing and managing fisheries in line with successful international examples, compared to continuing fishing as it is today. The results are shown in Tables 6 and 7 on the next page.

An important aspect in combining the calculations is the time dimension. The calculation for the scenario of continuing as before shows the socio-economic values for the year 2023, but also projects the trend, which would result in continued declining fishing until 2030. After that, it is assumed that fishing will continue at the low levels of 2030 due to overfishing and the implementation of zero quotas for herring and sprat, as already has been done with cod. The recovery scenarios, on the other hand, represent net present values for future years when fish stocks may have recovered, which is assumed to happen from the year 2035.[81] The combination of the total effect should therefore be interpreted so that the sums show the net effect of the different scenarios for the year indicated and thereafter.

Instead of calculating on an annual basis, the net present value arising over the next five decades is calculated. Assume that, in the absence of measures, fish stocks follow the current trend and decrease until 2030, and then remain at the minimal level described above, while in the recovery scenarios, fish stocks gradually recover and from 2035 give rise to the sustainable fishing described above. This creates a series of 50 annual values that are then summed. As explained earlier, discounting of future values is implicitly done by not adjusting wages and other prices in future years.

The net present value of the societal economic value of switching to the main scenario is 8.6 billion SEK, and around 13.9 billion SEK for switching to the cautious scenario.

81 The net present value calculation in the analysis is implicit. No discounting of future values is applied, nor are they adjusted for real wage growth and other expected real price increases. Implicitly, it is assumed that the discount rate is equal to the inflation-adjusted annual increase in wages and the relevant prices.

Table 6: Value added of Swedish fisheries in the Baltic Sea in 2023 and future years according to the scenarios (million SEK per year)

	2023 Continued overfishing	From 2035 Main scenario	From 2035 Cautious scenario
Large-scale fishing	193 (decreased to zero by 2030)	393	0
Small-scale fishing	7 (decreased to zero by 2030	79	79
Recreational fishing	120 (decreased to 60 by 2030)	603	603

Note: Rounded figures.

Table 7: Socio-economic valuation of Swedish fisheries in the Baltic Sea in 2023 and 2035 according to the scenarios (million SEK per year)

	2023 Continued overfishing	From 2035 Main scenario	From 2035 Cautious scenario
Large-scale fishing	- 205 (decreased to - 80 by 2030)	- 185	- 80
Small-scale fishing	2 (decreased to zero by 2030)	18	18
Recreational fishing	51 (decreased to 26 by 2030)	279	279
Total	**- 152 (decreased to - 52 by 2030)**	**112**	**217**

Note: Rounded figures.

BalticWaters is an independent foundation with a single goal: to keep our sea alive. The foundation carries out environmental projects and applied research to identify measures that can contribute to a healthier Baltic Sea and sustainable fish stocks. BalticWaters also works to develop and share knowledge about the sea with the public, authorities, and decision-makers. The goal is to raise awareness of the challenges facing the sea and to build public support for action and policy decisions.

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