Coalition Clean Baltic

FOR PROTECTION OF THE BALTIC SEA ENVIRONMENT

Development of Sustainable Fisheries in the Baltic Sea

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General introduction – the ecological role of fish

Fish is very valuable food. It is tasty and holds high quality protein and valuable minerals. Fish fat is believed to counteract cardiovascular diseases – one of our main causes of illness and death. Because of these qualities, it is important that consumers can be provided with large quantities of fish. A prerequisite for this is high production of fish and for that to be possible, fish stocks must be large. In this respect, fisheries management has in general been a world-wide failure. Most of the commercially important fish stocks are depleted by too intensive exploitation. They are overfished or threatened to become overfished by being "fully exploited". In the European Union Green Paper on fisheries, published in 2001, the fishery management failure is openly acknowledged.

From the perspective presented above, fisheries management and overfishing can be seen as an economic problem for the fishing industry and a public health problem if the supply to consumers is reduced. However, the overfishing problem is much larger than this. Fish are key organisms in most aquatic ecosystems and depletion of fish stocks can thus have serious ecological consequences.

Aquatic ecosystems can be simplified and illustrated as a food chain, from plants to fish. In reasonably large lakes and in all seas, phytoplankton constitute the bulk of all plants and are quantitatively the most important *primary producers*. Primary producers are organisms that use light to produce organic substances from, basically, water and carbon dioxide. These phytoplankton are consumed by zooplankton, which are key diet components to almost all fish species. Some of the fish that eat zooplankton grow big, and their diet changes successively from zooplankton to bottom fauna or fish – they become top carnivores. Also among the top carnivores in marine ecosystems are mammals like seals and whales, but in many areas fish are quantitatively dominating. Simplified, a food chain can thus be illustrated as:

phytoplankton → zooplankton → fish → fish

Seen in this perspective, fish constitutes half the ecosystem! With this key position in the food web, it is not surprising that changes in fish community composition can result in drastic ecosystem changes. Our understanding of this is best developed for lakes, as they are more easily studied entities than the vast oceans. However, until the opposite is shown we must follow the precautionary principle and assume that the role of fish in marine ecosystems is similar to the role they have in lakes. Research results that support this are accumulating.

Fish-free lakes are generally dominated by large zooplankton (Figure 1), which are efficient grazers and keep phytoplankton concentrations at low levels. This results in clear water, which may allow bottom vegetation down to considerable depths. If zooplankton-eating fish are stocked into the lake, they will preferentially consume large zooplankton (fish are visual predators and are more likely to detect the large prey). This decreases the grazing pressure on phytoplankton and possibly enhances nutrient cycling, increasing the phytoplankton density. With increased concentration of phytoplankton, light penetration decreases and the depth of benthic vegetation is reduced. If we were unaware of the fish introduction, our impression would have been that the lake had become enriched with nutrients (eutrophied).

This process of apparent eutrophication can be partly reversed. If predatory fish are stocked, they may reduce the density of zooplanktivorous fish, which may ease the predation pressure on large zooplankton. When large zooplankton increase, their grazing on phytoplankton increases and the water transparency may increase.

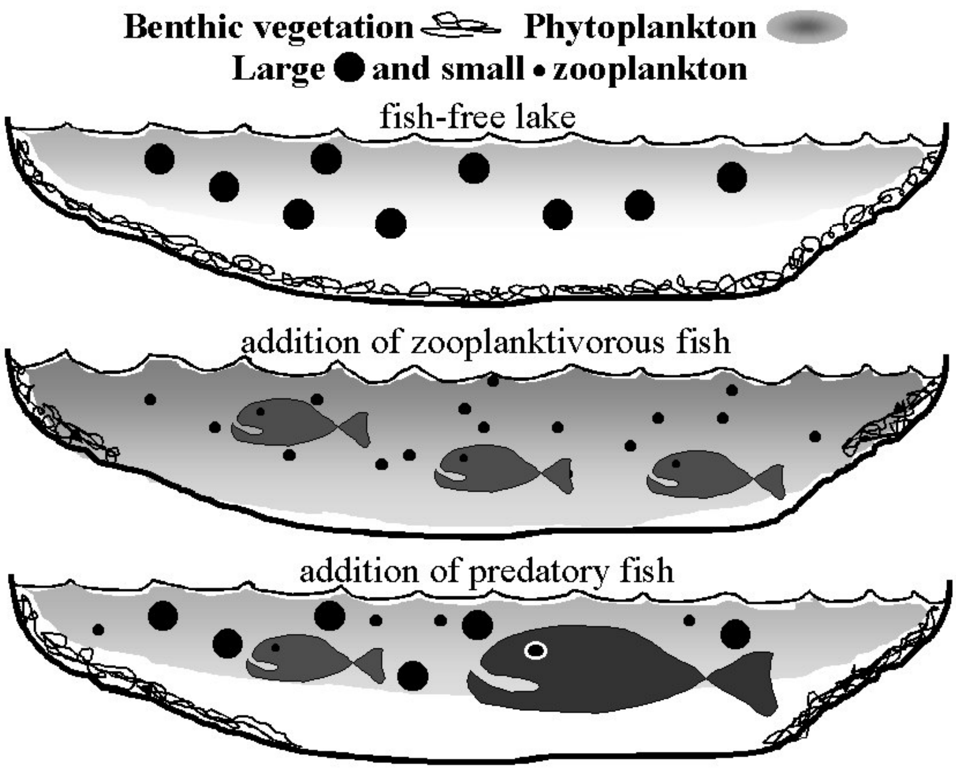


Figure 1. Fish-free lakes often have clear water and lots of large zooplankton. The water becomes richer in phytoplankton and poorer in large zooplankton if fish are introduced. The lake appears to have become eutrophied. If the density of small fish is reduced, e.g. through introduction of a fish-eating fish, the apparent eutrophication may be reversed.

In lakes, this key ecological role of fish has been used to mitigate eutrophication. By intensive fisheries for small fish and/or stockings with predatory fish, zooplankton densities have been increased, resulting in clearer water. This illustrates the critical ecosystem role that fish play, and this has to be acknowledged in fisheries management.

Marine ecosystems have for many decades been impacted by means of fisheries and mammal hunting. This exploitation has substantially increased the mortality of

ecologically important groups like predatory fish (Figure 2). To illustrate the magnitude of this, an analogy could be relevant:
Assume that a ship with chemicals capsized in the Baltic Sea, and these chemicals killed every second adult cod. This would reasonably be classified as one of the major environmental catastrophes to have happened in this sea area, and even one of the worst in a world-wide perspective. Fortunately, this environmental tragedy with toxic substances has not happened. However, we have a massive fishery, which unlike the one-time event of a wrecked ship, goes on continuously killing every second adult cod every year!

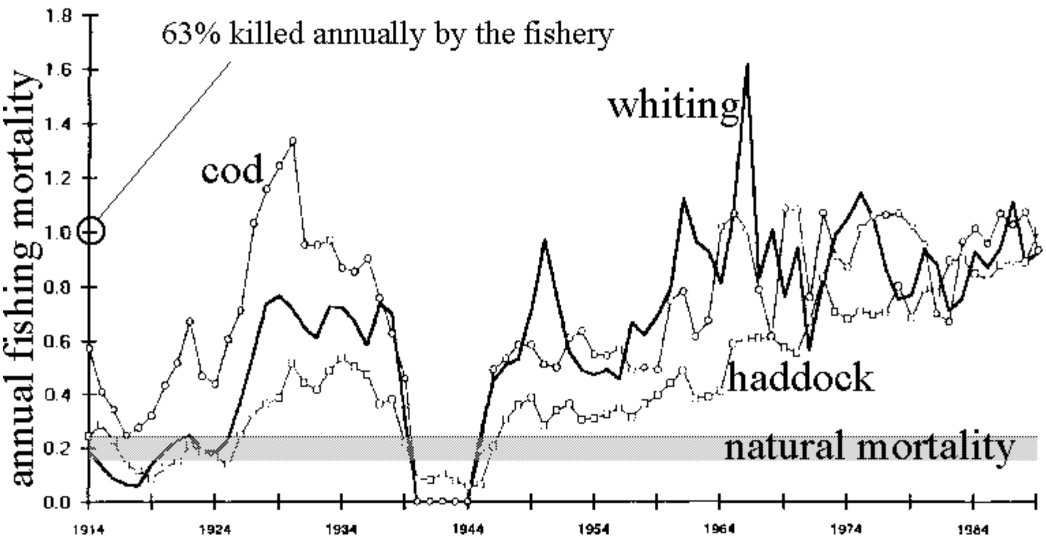


Figure 2. Annual fishing mortality of some key species in the North Sea. The natural fishing mortality is 10-20% and for these species the fishery has increased the mortality rate 4-5 times. Modified from *Anon (1992) Report of the study group on ecosystem effects of fishing activities. ICES Cooperative Research Report 200:1-120.*

Another way to illustrate the impact of fishing is to analyse how much of the production is required to produce the fish that are caught. Just some hundred years ago, significant human impacts on aquatic life were generally limited to small lake ecosystems and the fauna and flora in shallow, coastal regions. Now we are claiming ~¼ of the production in large areas of the world's ocean (Table 1).

That exploitation influences fish stocks has been long realised. In 1785, Johan Fischerström, a member of the Swedish Royal Academy of Sciences, reported from Lake Mälaren: "There is a general complaint that the catches of fish have been declining seriously. However, as more people fish today than before, … and when too large and fine-meshed seine nets are used, removing the sexually immature fish and fish fry, the cause of these changes are easily identified". During World War II, fishing activities decreased, resulting in an increase of fish densities and size. For a long time, we have known that **the fishery has the capacity to reduce fish stocks** and hence to impair long term fishing yields. Problems with overfishing have been one of the key issues addressed within the ICES scientific community (ICES = International Council for Exploration of the Seas, an international organisation that deals with environmental and fisheries issues of the North East Atlantic). The ecological impacts of fishing are also politically acknowledged. In Sweden, the government presented a bill to Parliament in 2001 (Prop. 2000/01:130), where **fishing** is stressed as **the human activity that has had the strongest impact on marine ecosystems**. Despite this knowledge, the **decision-makers have hitherto generally failed to manage fisheries in a sustainable manner,** and the result is a **serious depletion of marine fish resources.**

Ecosystem type	Mean %
Open ocean	1.8
Upwelling areas	25.1
Tropical shelves	24.2
Non-tropical shelves	35.3
Coastal/reef systems	8.3
Rivers and lakes	23.6

Table 1. Estimated proportions of the primary production required to produce the fish that are caught in the fishery. From: *Pauly and Christensen (1995) Primary production required to sustain global fisheries. Nature 374:255-257.*

In addition to these direct effects of fishing, other negative environmental impacts occur. Fishing gears like bottom trawls have serious **effects on benthic organisms**. All gears are to some extent non-selective, catching also non-targeted animals. Such **bycatches** may be a very serious threat to organisms like **small whales and sea birds**. In the Baltic Sea, the harbour porpoise has declined dramatically during the last half-century and it is in danger of becoming extinct. Bycatch in fisheries is widely recognised as the single most important explanation to this decline[1]. Fishing impacts on bottoms and on bycatch species may certainly constitute serious problems, but disproportionately much of the focus on the ecological effects of fishing have been on these issues. **The generally most serious impact of fishing is the massive killing of targeted fish species.** For many species in the top of the food web (e.g. cod, haddock, whiting, salmon, sharks and rays), fishing is the most important of all mortality factors (Figure 2).

Sustainable management

Two key elements in fisheries management are **sustainability** and the **precautionary approach**. By sustainability, we mean that today's fishery must not restrict the possibility for future generations fisheries. In other words, we must not reduce the fish stock to such an extent that reproduction is hampered. The background to this is that the number of offspring is non-linearly related to the size of the adult population, simplified in Figure 3.

[1] Briefing Book, from ASCOBANS Workshop on Drafting a Recovery Plan for Harbour Porpoises in the Baltic Sea, Jastarnia, Poland, 9 - 11 January 2002. ASCOBANS = The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas

As long as the spawning stock biomass (SSB) is above ***SSB_{lim}*** (the spawning stock biomass that ***lim****its* recruitment) in Figure 3, the recruitment will be at maximum. Other factors, like food competition and cannibalism, limit the recruitment at a larger stock size. This means, that when SSB exceeds ***SSB_{lim}***, we can fish without compromising future catches by reducing reproduction. Provided, of course, the fishery does not reduce SSB to below ***SSB_{lim}***. If SSB is below ***SSB_{lim}***, the recruitment is reduced and the fishing intensity must be cut to allow SSB to rebuild to above ***SSB_{lim}***. In practice, it is often difficult to assess the spawning stock biomass and estimates may be wrong. To account for that, a precautionary approach is taken. To substantially reduce the risk that the actual SSB falls below ***SSB_{lim}***, the fishery should be managed so that the estimated SSB is above ***SSB_{pa}*** (***pa*** for ***p***recautionary ***a***pproach). When the estimated SSB is above ***SSB_{pa}***, the risk that the actual SSB is below ***SSB_{lim}*** is small and hence both the sustainability and the precautionary approach are met.

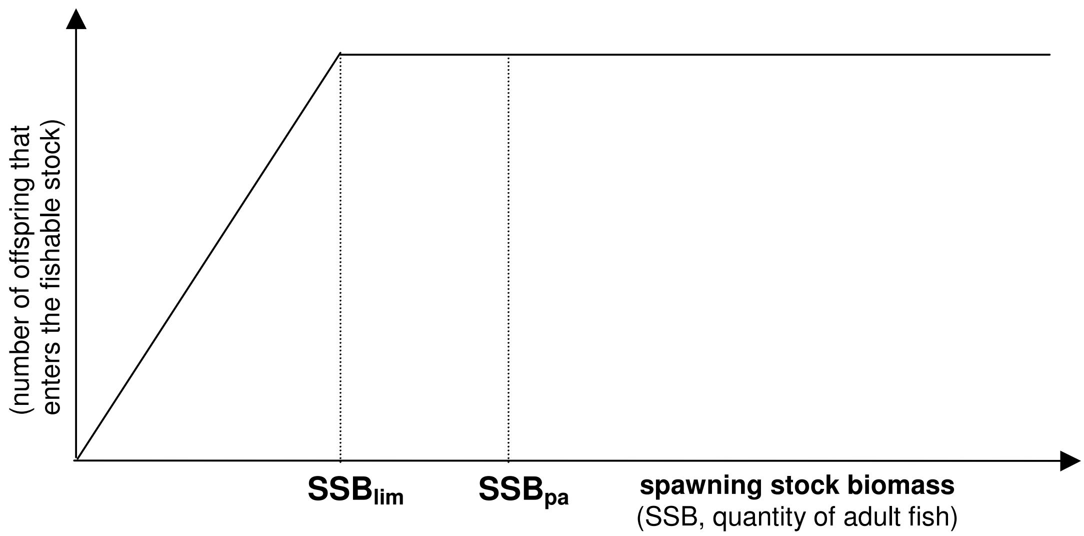


Figure 3. The relationship between the amount of adult fish (spawning stock biomass, SSB) and recruitment (number of offspring that survive long enough to be included in the fishable stock). If the spawning stock is decreased below ***SSB_{lim}***, the recruitment will be reduced (violation of the sustainability principle). Assessments of fish densities are however difficult, and to decrease the risk of reducing the stock below ***SSB_{lim}*** (applying the precautionary approach), the spawning stock biomass should not be reduced below ***SSB_{pa}***.

The fishery management can not only focus on keeping a fish stock above a certain minimum biomass in a short time perspective. In a long time perspective, the fishing fleet must be managed, so that its capacity matches the production of fish. One aspect of this is to keep the fishing mortality at a sustainable level, i.e. that today's fishing capacity/intensity must not be so high that it will reduce SSB to such an extent that it forces us to reduce fishing in the future. The level of the sustainable fishing intensity varies among species. Fish like herring and sprat, which suffer high mortality rates from predation, may not stand high additional mortalities from fisheries.

In the same way as there are difficulties in estimating SSB, we have difficulties in assessing the fishing mortality (F)[2]. Errors in F are caused by errors in SSB, discards (dead fish thrown back into the sea), illegal fishing and misreporting. To handle this uncertainty, a similar approach is taken as with SSB. To be reasonably sure that the actual fishing mortality is below a certain maximum ($\boldsymbol{F_{lim}}$), the estimated mortality must be less than $\boldsymbol{F_{pa}}$.

When a spawning stock biomass is below $\boldsymbol{SSB_{pa}}$ or the fishing intensity exceeds $\boldsymbol{F_{pa}}$, the fish stock is outside safe limits. More on fisheries management are found in the publication "The Status of Fisheries and Related Environment of Northern Seas", published by the Nordic Council of Ministers. The report can be downloaded from "http://www.norden.org/fisk/sk/publikationer.asp?lang=1"

Eco-labelling of fish

Based on the approach outlined above, it is possible to analyse the stock and fishery situation for a fish population (Figure 4). This can be a major tool when eco-labelling fish. Provided that a fishery has acceptable by-catches and other side effects, the landed catch can be eco-labelled if the spawning stock biomass exceeds $\boldsymbol{SSB_{pa}}$ and the fishing mortality is below $\boldsymbol{F_{pa}}$. If the spawning stock biomass is below $\boldsymbol{SSB_{pa}}$ but still above $\boldsymbol{SSB_{lim}}$, or the fishing mortality is between $\boldsymbol{F_{pa}}$ and $\boldsymbol{F_{lim}}$, eco-labelling could be considered if prompt and strong actions are taken to build up biomasses above $\boldsymbol{SSB_{pa}}$ and/or reduce the fishing mortality below $\boldsymbol{F_{pa}}$. Catches from fish stocks that are below $\boldsymbol{SSB_{lim}}$ or fished above $\boldsymbol{F_{lim}}$ should never be eco-labelled.

If fisheries management followed these rules, the situation for many fish stocks, and also for considerable sections of the fishing industry, would be much better than today. There are thus very good reasons to put strong pressure on the decision-makers to follow recommendations based on these analyses, in particular as the analyses are based on the generally acknowledged principle of sustainability and the precautionary approach. Yet, it must be recognised that this approach to fisheries management is based on the very assumption that fish mainly swim in the sea to be caught by fishermen. As discussed in the beginning of this paper, the contrary is true. Fish are important components in aquatic ecosystems, and as we learn more about this it is possible that limits for minimum spawning stock biomasses will be increased. An example of this is increased SSB target levels for cod in the Baltic Sea, as this may be needed to get the species distributed over larger geographical areas (e.g. into the coastal zone and up to the Bothnian Sea).

Baltic Sea

The Baltic Sea ecosystem is strongly dominated by three species of fish: herring, sprat and cod. The cod population can be divided into to separate groups (one population east and one west of Bornholm), that should be managed separately. Catches have varied substantially over the last century (Figure 5). Much of the increased catches are

[2] The fishing mortality is expressed as the annual mortality rate:

$$N_{y+1}=N_y \times e^{-(M+F)}$$

where $\boldsymbol{N_y}$ and $\boldsymbol{N_{y+1}}$ are numbers of fish at a given date and one year later respectively, while $\boldsymbol{M}$ and $\boldsymbol{F}$ are natural and fishing mortalities.

explained by an intensified fishery, but it is also possible that decreased predation from seals and an increased productivity due to eutrophication have made this increase possible. Fish catches does not necessarily reflect the amount of fish in the sea, as technological equipment have made it possible for fishermen to efficiently find the fish and in a short term perspective get good catches even from weak populations.

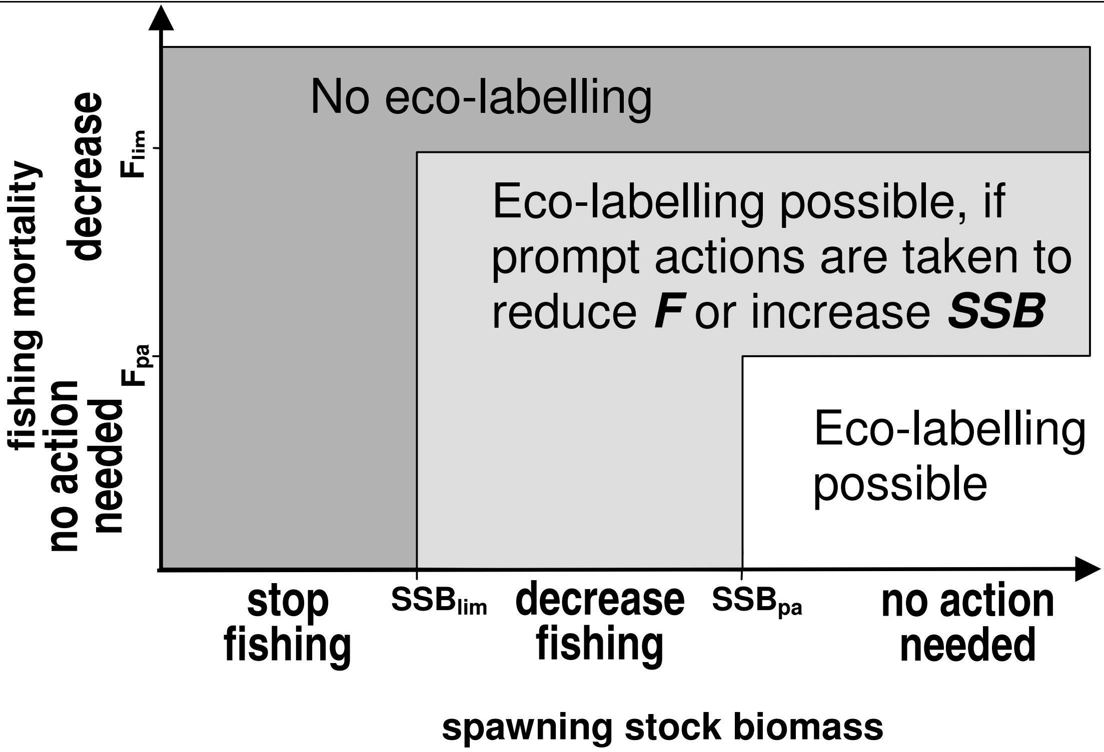


Figure 4. Possible decision rules for eco-labelling fish. No particular management actions are needed if SSB exceeds $\boldsymbol{SSB_{pa}}$ or the fishing mortality is below $\boldsymbol{F_{pa}}$.

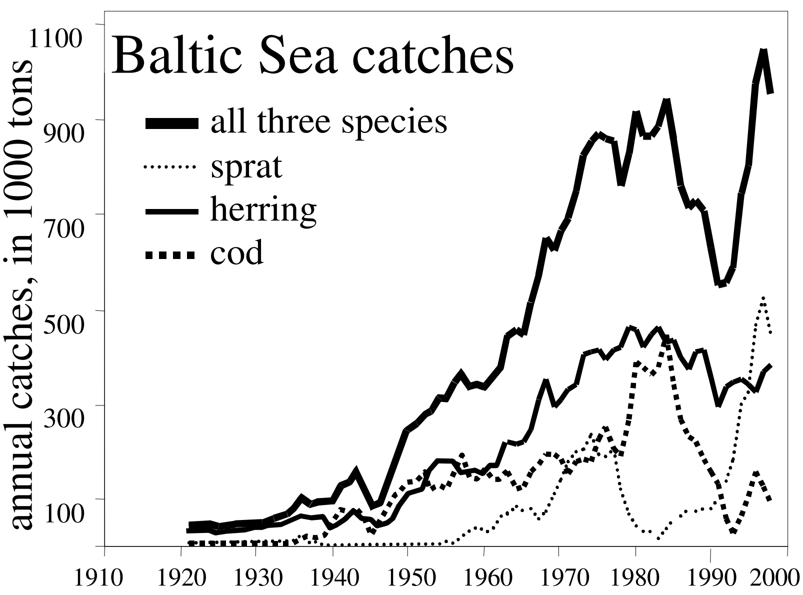


Figure 5. Catches of the three main fish species in the Baltic during the 20th century. Various sources.

In ICES assessment and management recommendations, suggestions are often given separately for different geographic areas. Geographically, the basis for this is a division of the Baltic into subdivisions (SD, Figure 6) and for different species the recommendations covers different areas, based on the biology of the species.

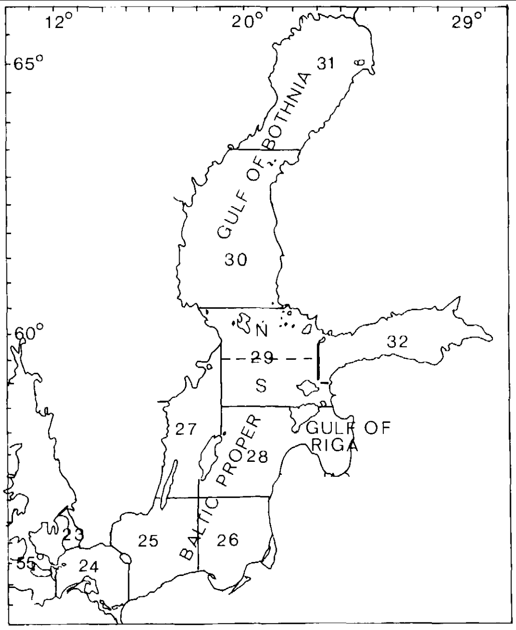
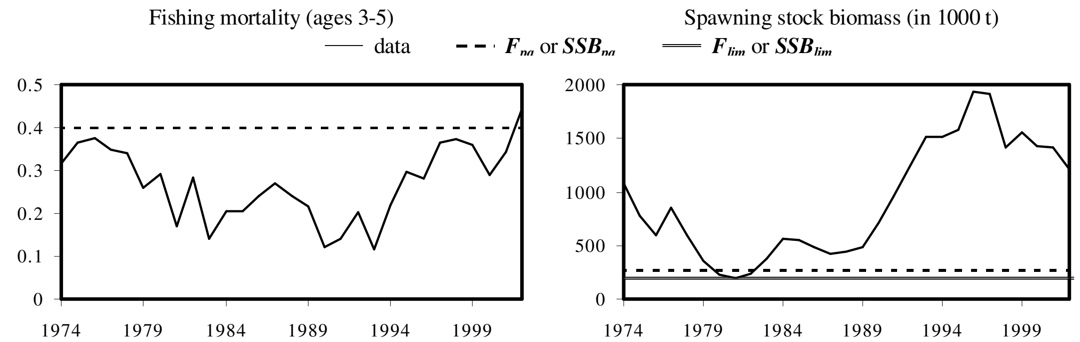


Figure 6. ICES division of the Baltic Sea into subdivisions (SD), which are used in assessment and management recommendations.

The fisheries in the Baltic are managed by the International Baltic Sea Fishery Commission (IBSFC), which today has six member nations (Russia, Estonia, Latvia, Lithuania, Poland and EU). The commission requests scientific management advice from ICES. As seen below, not all *reference limits* (***SSB**$_{lim}$*, ***SSB**$_{pa}$*, ***F**$_{lim}$*, ***F**$_{pa}$*) have been defined and this mirrors the high scientific level of much of the work within ICES. If scientific data are insufficient, reference limits or similar parameters are not defined. In the section below, reference limits are given for each management unit, together with graphs of the development of fishing mortality and spawning stock biomass. Management decisions by IBSFC for 2001 – 2004 are also reported. Data are from an ICES report (ACFM, May 2003).

Sprat in SD 22-32 (whole Baltic Sea)

ICES considers that:	*ICES proposes that:*
SSB$_{lim}$ is 200,000 tons	***SSB$_{pa}$*** be set at 275,000 tons
F$_{lim}$ is not yet defined	***F$_{pa}$*** be set at 0.40

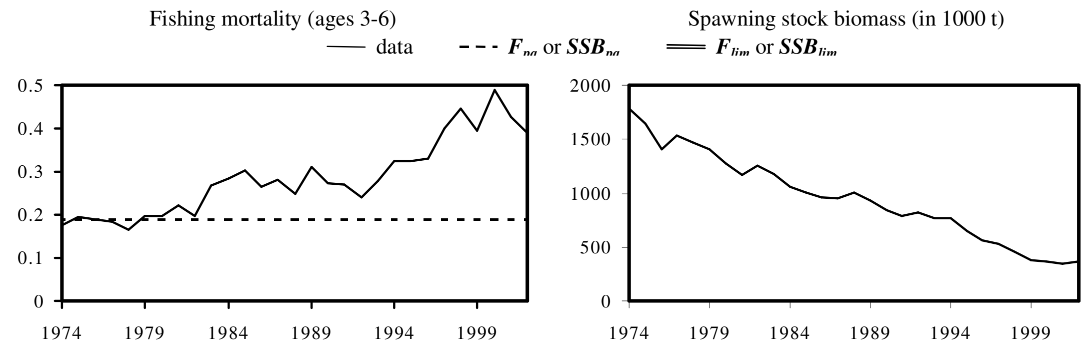


	ICES catch recommendation	IBSFC decision	Note
2001:	314,000 tons	355,000 tons	difference +13%
2002:	369,000 tons	380,000 tons	difference +3%
2003:	300,000 tons	310,000 tons	difference +3%
2004:	474,000 tons	420,000 tons	difference -11%

The population is fished within safe biological limits.

Herring in SD 25-29 and 32 (Baltic proper east of Bornholm + Gulf of Finland. Gulf of Riga not included)

ICES considers that:	*ICES proposes that:*
SSB$_{lim}$ not defined	***SSB$_{pa}$*** not defined
F$_{lim}$ is not defined	***F$_{pa}$*** be set at 0.19

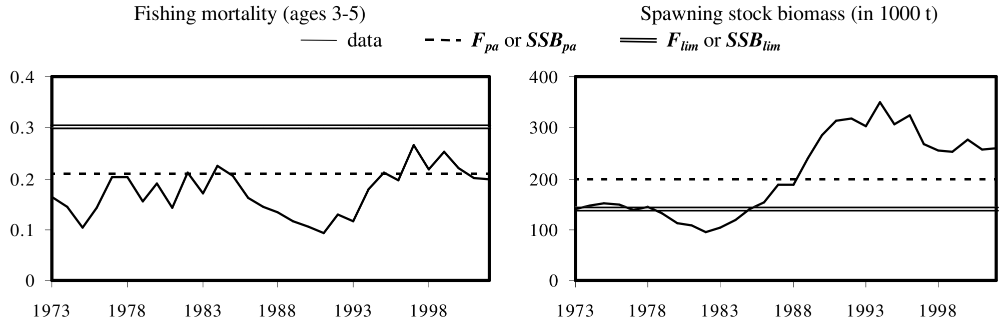


	ICES catch recommendation	IBSFC decision	Note
2001:	60,000 tons	300,000 tons	decisions for the area south of Åland Sea, SD 22-29S+32
2002:	73,000 tons	200,000 tons	
2003:	72,000 tons	143,349 tons	
2004:	80,000 tons	176,626 tons	

The stock is currently fished outside safe biological limits.

Herring in SD 30 (Bothnian Sea)

ICES considers that:	*ICES proposes that:*
$\boldsymbol{SSB_{lim}}$ is 145,000 tons	$\boldsymbol{SSB_{pa}}$ be set at 200,000 tons
$\boldsymbol{F_{lim}}$ is 0.30	$\boldsymbol{F_{pa}}$ be set at 0.21



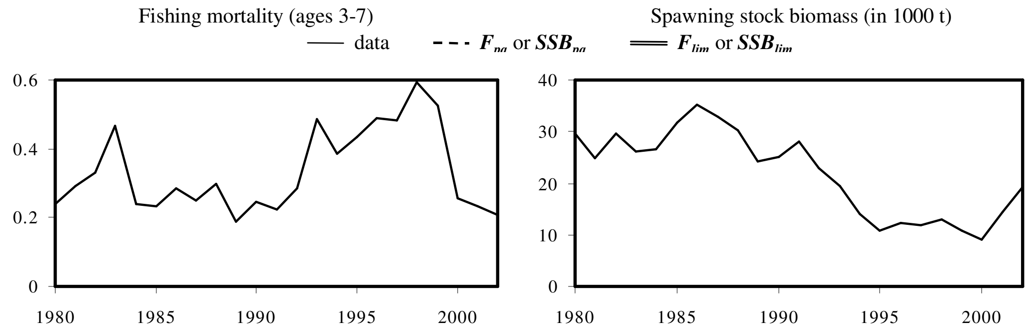
	ICES catch recommendation	IBSFC decision	Note
2001:	36,000 tons	72,000 tons	decisions for the area north of Åland Sea, SD 29N-31
2002:	40,000 tons	60,000 tons	
2003:	<50,000 tons	60,000 tons	
2004:	<50,000 tons	61,200 tons	

The exact stock status is uncertain, but it is considered to be fished outside safe biological limits.

Herring in SD 31 (Bothnian Bay)

ICES considers that: *ICES proposes that:*

There are no reference points for this stock



	ICES catch recommendation	IBSFC decision	Note
2001:	Exploitation should not be increased	72,000 tons	decisions for the area north of Åland Sea SD 29N-31
2002:	Exploitation should be decreased	60,000 tons	
2003:	<3,000 tons	60,000 tons	
2004:	<3,000 tons	61,200 tons	

The status of the stock is uncertain, but since the mid-1990s the stock size has been at a very low level.

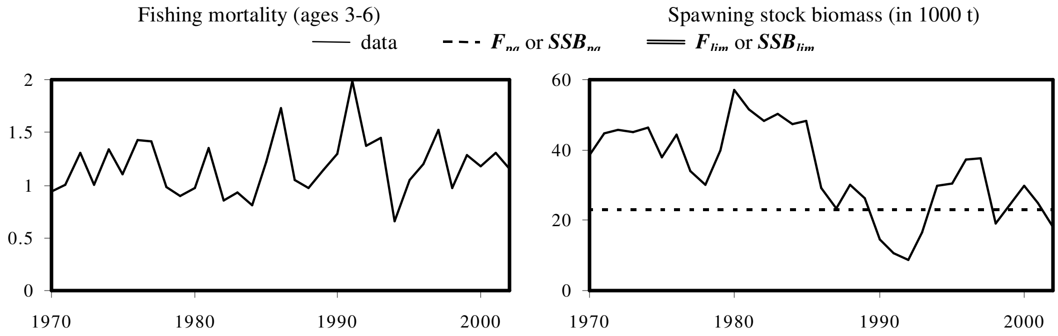
Herring in general

As seen above, ICES and IBSFC refer to slightly different areas, which makes comparisons of recommendations and decisions difficult. However, combining all data from SD 22-32 gives the following:

	ICES catch recommendation	IBSFC decision	Note
2001:	166,000 tons	372,000 tons	difference +125%
2002:	165,500 tons	260,000 tons	difference +58%
2003:	168,000 tons	203,349 tons	difference +21%
2004:	264,000 tons	232,826 tons	difference -12%

Cod in SD 22-24 (west of Bornholm)

ICES considers that:	*ICES proposes that:*
SSB_{lim} is not yet defined	***SSB_{pa}*** be set at 23,000 tons
F_{lim} is not yet defined	***F_{pa}*** is not yet defined

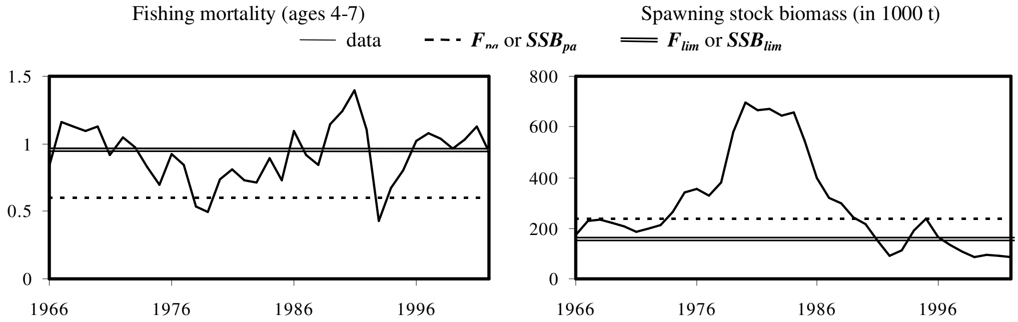


	ICES catch recommendation	IBSFC decision	Note
2001:	48,600 tons	105,000 tons	IBSFC decisions for SD 22-32
2002:	36,300 tons	76,000 tons	
2003:	28,800 tons	75,000 tons	
2004:	29,600 tons	61,600 tons	

*The 2002 fishing mortality was estimated to 1.16, which is above the F of 1.0 agreed by IBSFC. SSB is estimated to 18,300 tons, which is below **SSB_{pa}**.*

Cod in SD 25-32 (east of Bornholm)

ICES considers that:	*ICES proposes that:*
SSB_{lim} is 160,000 tons	***SSB_{pa}*** be set at 240,000 tons
F_{lim} is 0.96	***F_{pa}*** be set at 0.6



ICES catch recommendation		IBSFC decision	Note
2001:	39,000 tons	105,000 tons	IBSFC decisions for SD 22-32
2002:	0 ton	76,000 tons	
2003:	0 ton	75,000 tons	
2004:	13,000 tons[3]	61,600 tons	

*The stock is outside safe biological limits, with a SSB in 2002 well below **SSB_{pa}**. The fishing mortality is well above **F_{pa}**. In the most recent years the stock has been below **SSB_{lim}** and the fishing mortality has been around **F_{lim}**. IBSFC have adopted a long-term management strategy and ICES considers that **the agreed management plan is consistent with the precautionary approach, provided the reference limits are used as upper bounds on F and lower bounds on SSB, and not as targets**.*

Cod in general

As seen above, **IBSFC decides on a common catch quota for the entire Baltic, despite significant biological differences between the two populations.[4] ICES consistently points out that the stocks should be managed separately.** Combining recommendations and decisions for the entire Baltic gives the following:

	ICES catch recommendation	IBSFC decision	Note
2001:	87,600 tons	105,000 tons	difference +20%
2002:	36,300 tons	76,000 tons	difference +109%
2003:	<28,800 tons	75,000 tons	difference +160%
2004:	<42,600 tons	61,600 tons	difference +45%

[3] The biological justification for advising no fishing on the eastern cod stock remains, but based on the assumption that the IBSFC cod recovery plan will be implemented effectively in the future, fishing mortality should be reduced by 90% (F>0.10) to rebuild the SSB above SSB_{lim}. Hence, TAC in 2004 must be less than 13,000 tons.

[4] In June 2003, IBSFC agreed to implement two management areas, one for the Western cod stock and one for the eastern cod stock. This decision was not followed, however, when the IBSFC decided on one common catch quota for both stocks for 2004 in September 2003.

Summary of the last four years management

The data given above, on the last four years of ICES recommendations and IBSFC decisions, are summarised in Table 2.

Advice and decisions for 2001

Species	*ICES recommendation*	*IBSFC decision*	*Difference*
Cod east of Bornholm	<39.000	}105.000	}+20%
Cod west of Bornholm	<48.600		
Herring	<166.000	372.000	+125%
Sprat	<314.000	355.000	+13%

Advice and decisions for 2002

Species	*ICES recommendation*	*IBSFC decision*	*Difference*
Cod east of Bornholm	0	}76.000	}+109%
Cod west of Bornholm	<36.300		
Herring	<164.500	260.000	+58%
Sprat	<369.000	380.000	+3%

Advice and decisions for 2003

Species	*ICES recommendation*	*IBSFC decision*	*Difference*
Cod east of Bornholm	0	}75,000	}+160%
Cod west of Bornholm	<28,800		
Herring	<168,000	203,349	+21%
Sprat	<300,000	310,000	+3%

Advice and decisions for 2004

Species	*ICES recommendation*	*IBSFC decision*	*Difference*
Cod east of Bornholm	<13,000[3]	}61,600	}+ 45%
Cod west of Bornholm	<29,600		
Herring	<264,000	232,826	-12%
Sprat	<474,000	420,000	-11%

Table 2. Summaries of catch recommendations from ICES and the resulting decisions taken by IBSFC.

Of the three major fish species in the Baltic, the eastern cod stock has the greatest economic potential, at the same time as it has an ecological key role. Under natural conditions it is the dominant fish eating species in the Baltic proper, exerting a substantial predation pressure on both herring and sprat. Despite its ecological importance, the fishing pressure on cod has been allowed to reach devastating levels and the fishing mortality is only rarely below $\boldsymbol{F_{pa}}$. The three black dots in Figure 7 show fishing mortalities 2000-2002. Despite that the stock size was much below $\boldsymbol{SSB_{lim}}$ (i.e. when a total closure of the fishery should be considered), the fishing

[3] The biological justification for advising no fishing on the eastern cod stock remains, but based on the assumption that the IBSFC cod recovery plan will be implemented effectively in the future, fishing mortality should be reduced by 90% (F>0.10) to rebuild the SSB above SSB_{lim}. Hence, TAC in 2004 must be less than 13,000 tons.

intensity exceeded $\boldsymbol{F_{lim}}$ (a fishing pressure that would have been too high even if the cod stock had been in good condition, i.e. spawning stock > $\boldsymbol{SSB_{pa}}$)! Following the development of fishing mortality over time (Figure 7), indicate that IBSFC has not learned from earlier mistakes or has been unable to apply good fisheries management practices. **Data clearly show that IBSFC has failed in the management of this important fish population.**

As the result of years of continuous management failure, ICES had to recommend a total closure of the cod fishery east of Bornholm for 2002 and 2003. IBSFC dismissed this recommendation and decided (also against clear scientific advice) to have a common TAC (76,000 tons for 2002 and 75,000 tons for 2003) for the eastern and the western cod stocks. In June 2003, IBSFC adopted a management plan for the Baltic cod stock (which replaces the previous recovery plan for the eastern cod stock). According to this plan, the fishing mortality (F) for the eastern stock should always be below $F_{pa} = 0.6$.[5] A fishing intensity of $F = F_{pa} = 0.6$ is what the eastern cod stock is assumed to be able to carry if the stock size exceeds 240.000 tons (>$\boldsymbol{SSB_{pa}}$), but now stock size is only about 1/3 of that. This will result in a continuous intensive fishery on the very weak eastern cod stock. **By not following the advice from leading scientists, IBSFC plays Russian roulette with the eastern cod stock, the Baltic Sea ecosystem and the commercial fishery.**

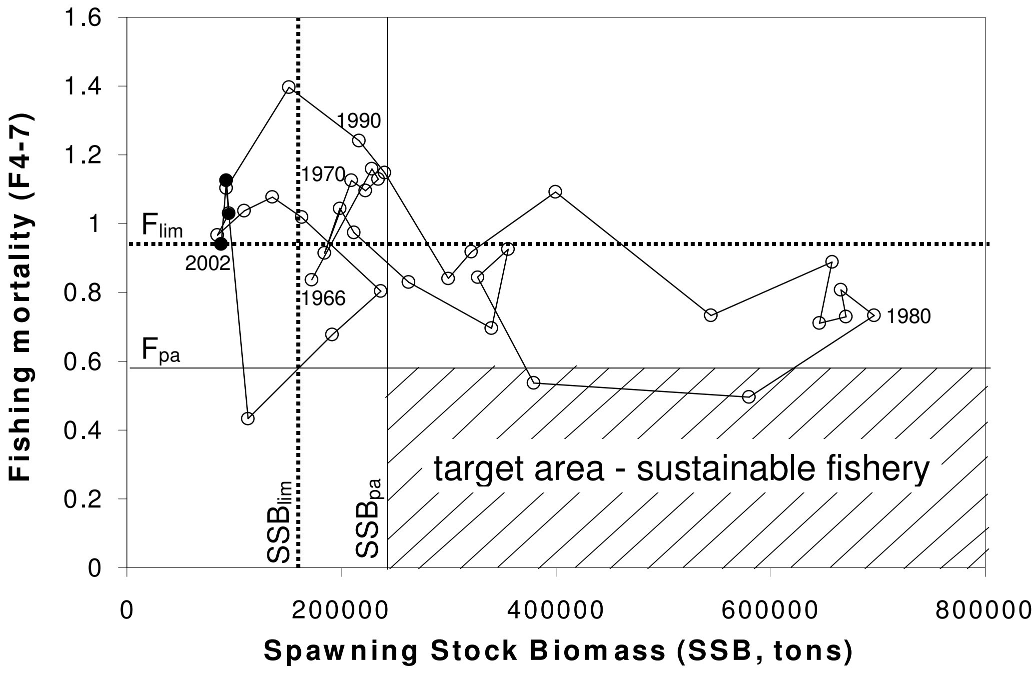


Figure 7. The spawning stock biomass of the eastern cod stock (SSB), and annual fishing mortality rate of adult fish (age 4-7). The three black dots represent the three last years from which there are data (2000-2002). The dots are connected, so that the development over time can be followed.

[5] The IBSFC management plan for Baltic cod stocks also states that if the spawning stock biomass decreases below SSB_{pa}, TACs should be set at levels that results in $SSB > SSB_{pa}$ and an increase in SSB of at least 30% at the end of the year. If that is not possible, TACs should be set as low as possible. So far, this cod management plan has not been implemented.

Conclusions

- Fish are key organisms in aquatic ecosystems
- Fisheries constitute the most important human impact on marine ecosystems. No other factor, such as nutrients and toxins, has had more far reaching impacts.
- The most serious impact of fisheries is the massive killing of targeted fish species.
- To avoid overfishing and obey international agreements on the principles of sustainability and precaution, management procedures have been developed.
- Today's management is based on securing sustainable fisheries, but with the ecological key role of fish, other aspects may also become important.
- For the Baltic Sea fishery to become sustainable, it must be managed according to the principles of sustainability and precaution.
- By seriously dismissing the advice from their own national experts in the International Council for Exploration of the Sea (ICES), the Baltic Sea Region governments (through the International Baltic Sea Fishery Commission, IBSFC) does not obey to the principles of sustainability and precaution.
- Catch quotas adopted by IBSFC have regularly been much higher than recommended by ICES. Quotas have been 100 – 160% higher for cod and up to 125% higher for herring.
- The result is serious mismanagement of common fish resources, damaging the fish stocks, the environment and both commercial and recreational fisheries.
- There are so far no convincing signs that IBSFC have learned from passed mistakes and that the management has improved substantially with time.
- With the ecological key role of fish, and the environmental impact of fisheries, Baltic region Ministries of Environment should get the main responsibility in decisions on catch quotas and bycatch related issues.
- All legitimate stakeholders (commercial fishermen, anglers, environmentalists and consumers) have the same right to influence the management.
- Eco-labelling of fish must be scientifically based and should follow the advice from ICES.
- Managers and fishermen must acknowledge the limitations set by Nature. Baltic cod reproduction problems, caused by irregular saltwater influxes, must not be used as an excuse to refrain from actions to reduce fishing pressure