Resource management in the Baltic Sea
- a background document and a summary of findings of an international workshop

Mikael Hildén, Riku Varjopuro, Heta Rousi, Milla Mäenpää
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Abstract

The management of the fishery resources of the Baltic Sea is a typical example of a socio-ecological complex in which the ecological basis for the exploitation is intimately intertwined with social and political factors. This report has explored the complex from a social science perspective by examining the nature of a set of problems and challenges, and by discussing possible solutions using the collective expertise of approximately 30 researchers and experts representing different fields.

The general conclusion is that there is a need to bring in views that can change the current constellations of the management regime, which has focused on total allowable catches as the main instrument. For political, social and practical reasons the regime has not been able to bring about significant improvement in the management of the Baltic Sea resources, notably the cod stocks. Therefore one should try to explore alternatives that can bring about changes in the management regime, at the same time realizing that what is needed is a suite of measures. There is no panacea for the resource management and therefore several approaches and measures have to be used in concert.

Contents

Executive summary

Resource management in the Baltic Sea is a socio-ecological problem. The challenge is to find solutions that create paths towards increasing sustainability, recognising that the Baltic Sea is also a dynamic system in which changes both in the ecological and social components are not only possible but likely. Seen from this perspective dealing with uncertainty and adapting to changes should be approached as every day management tasks rather than as exceptional events. Such capabilities should be enhanced in the resource management of the Baltic Sea .

The following key problems have been identified for the management of the living resources in the Baltic Sea:

1) The state of the cod stock and the cod fisheries, including illegal fishing and fishing for undersized cod.
2) The fishing for migratory fish, in particular the ban of drift net fishing and the need to restore/safeguard the remaining populations of wild salmon and sea trout.
3) The regulation of herring and sprat fisheries, especially in relation to the cod fisheries.
4) The high level of contaminants in Baltic fish, notably dioxins.
5) The increasing abundance of fish eating species, in particular cormorants and seals.
6) The deterioration of coastal waters, including hypoxia, causing losses for fisheries.

To provide viable solutions one needs to identify and understand the social and ecological factors that influence the development of the use of the resources of the Baltic Sea.
At present the management of the cod stocks is one of the most problematic issues in the Baltic Sea and this report has focused on this particular problem. The issues and problems that have been highlighted and the suggested solutions that have been examined are applicable on many other capture fisheries, when the context is properly recognized.

At present the management of the Baltic Sea fisheries is essentially based on the specification of total allowable catches (TAC). The TACs are fixed and adjusted annually in a complex process that involves scientific analysis and advice, political bargaining and the use of formulas that preserve a balance in the share of catches allocated to the EU member states and Russia. Excessive fishing capacity and failure to report actual catches, and a disregard for the consequences of a recruitment failure have maintained the stocks in a poor state. There is a lack of feed back to the fishers concerning the state of the stock, and a lack of alternative activities. Furthermore there is a perceived competition between fishers from different countries and sometimes within countries between fleets.

Different solutions haven been proposed to address issues of overfishing: Drastically reduced total allowable catches, the introduction of rights based management, reduction of effort through scrapping, enhanced community based management, influencing the markets and marine protected areas. These solutions do not exclude one another. All of them face different challenges and it is unlikely that any single measure will lead to a substantial improvement of the situation. Combinations of the alternative measures allow addressing several aspects of the socio-ecological system, even in the case that some of the measures could slightly reduce efficiency of other measures.
The overall policy determines the relative importance given to different remedial measures. So far the emphasis has been almost exclusively on a TAC-regime, and it has proven to be incapable of

solving the problems of overfishing due to structural and political difficulties, which have been aggravated by operational deficiencies such as lack of control and enforcement. Continuous efforts to improve and strengthen the TAC-regime are justified, but approaches and measures that can change the overall policy context and management situation are probably more fruitful. Social and economic analyses of the incentives and problems related to enforcement and control could in this context provide more in depth understanding of the challenges facing the TAC-implementation.

The more widespread use of rights based management is likely to change the attitudes to the resources. It is, however, important to note that there are many ways of implementing rights or privilege based management regimes and there is a need to explore different options so that the system evolves in such a way that it can achieve legitimacy among fishers and fishing communities. A rights or privilege system that simultaneously supports enhanced community based management is likely to be more successful than one which is based on a pure neoliberal economic paradigm that acknowledges only individual economic agents. Support for analyses of different solutions and evaluations of pilot systems are highly justified.

Approaches that aim at influencing the markets for fish have emerged and can potentially change the situation drastically as shown by the development in the salmon culture and fishery. The promotion of substitutes, environmental labelling and direct action can jointly affect the conditions for management. The main risks are that the measures merely rechannel the flow of fish products without influencing the exploitation levels. Careful analyses of the total markets for overexploited fish and the ways different segments of these markets can be influenced, combined with detailed monitoring of the markets is likely to enhance the effectiveness of measures that aim at influencing the markets for increasing sustainability .

Marine protected areas seek to create safe heavens for fish stocks and other marine organisms. For local stocks and populations they can be highly effective. For large stocks with wide migration patterns the challenge is to create sufficiently large areas or networks of protected areas that can have a real effect. Large protected areas introduce inequalities among fishers and can have important local or regional economic effects, which makes them politically difficult. The compatibility with the rights-based management approach can be a challenge, as well. Studies of how protected areas can contribute to the overall objectives of sustainable management, taking into account different types of regulatory regimes may contribute to a fact based debate on the use of these measures.

The direct reduction of fishing effort through scrapping programs can have desired effects but only if the reduction reaches effective fishing effort rather than formal tonnage. It is also critical that re-entry or other rebuilding of effort is excluded. Studies of how private support for scrapping could support publicly funded programs are worth support as careful legal and economic analyses should be undertaken before any private resources are devoted to this kind of activity.

The overall conclusion of this study is that there are several possible avenues for addressing the problems of the Baltic Sea resource management. These avenues should be explored in depth. The emphasis of Baltic2020 in supporting such endeavours should be determined by the measures that the foundation wishes to pursue, also taking into account the extensive research support that is channelled into fisheries research by national and European research funds.

1. Background and objectives

This document provided background information for the discussions at the Baltic Sea resource management workshop and makes a synthesis of the key findings of the workshop, which was held in Helsinki, April 3-4 2008[1]. The goals of the workshop were

- To explore the contributions that social sciences can make to the understanding of the main causes and consequences of unsustainable practices in the management of the living resources of the Baltic Sea;
- To discuss the social and economic conditions for possible solutions and approaches to the management of the resources of the Baltic Sea, taking into account governance and specific policy measures and the development of legal and economic instruments.
- To identify the main economic, legal and social challenges for an ecosystem based management of the living resources of the Baltic Sea;

The starting point for the workshop and the discussion were that resource management in the Baltic Sea can be described as a problem in a socio-ecological-complex. The challenge is to find solutions that create paths towards increasing sustainability of this complex, recognising that the Baltic Sea is also a dynamic system in which changes both in the ecological and social components are not only possible but likely.

This report is organised as follows. In section 2 we provide an overview of the general context: ecological, political and social, legal and economic. In section 3 we examine a set of general solutions that have been proposed to deal with the resource management problems. These are not in any ways unique to the Baltic Sea, but some features of the Baltic Sea affect their feasibility. In section 4 we use the cod fishery as a test case for examining different solutions. The management problems of migratory fish are noted and points are raised with respect to how their socio-ecological context differ from that of the cod. In section 5 we draw general conclusions of the analysis and discussions so far.

Our approach is based on analyses of the programme or intervention theories of the existing and proposed solutions. By intervention theories we mean all the knowledge and assumptions of relevant causal effects that the public interventions rest upon (Vedung 1997). We illustrate these intervention theories using causal loop modelling as we claim that one cannot understand the problems nor the solutions unless one recognises the complex pattern of feed-back mechanisms that exist in society and in the fisheries. Our intention is to identify, in the context of resource management

- How factors are related, and how one factor will change when another changes;
- How factors may feed back in either balancing loops or reinforcing loops;
- How external factors impact on the system governing resource use;
- How gaps in the feed-back affect the dynamics of the system;
- How time-lags affect the system;
- Key complexities in the system.

This analysis is intended to stimulate discussions on possible solutions to key problems in the resource management in the Baltic Sea.

[1] A full list of participants is given in Appendix 2

2. The context

2.1 An overview of pressing problems

For the purpose of a discussion on the resource management the relevant socio-ecological complex consists of

- The resources themselves (the fish stocks and their dynamics);
- The factors that affect the resources (environmental conditions, ecological relationships in the system);
- The factors that influence possibilities to exploit the resources, including technical, regulatory (Common Fisheries Policy, CFP, and national), and environmental factors;
- The factors that influence the possibilities to make a living of resource exploitation such as the markets for products, restrictions on the products (linked also to environmental factors, for example, Persistent Organic Pollutants (POPs) and mercury (Hg)), temporal and technical restrictions on fishing activities, and regulations concerning aquaculture;
- The actors involved in the exploitation and its regulation;
- The institutions maintaining and updating the regulatory system concerning the exploitation and factors affecting the market;
- The wider society that forms the framework for the management and exploitation of aquatic resources.

Key issues that have led to debate and international or EU-wide policy interventions in the area of resource management in the Baltic Sea include the following (see also Box 1):

1) The state of the cod stock and the cod fisheries, including illegal fishing and fishing for undersized cod.
2) The fishing for migratory fish, in particular the ban of drift net fishing and the need to restore/safeguard the remaining populations of wild salmon and sea trout.
3) The regulation of herring and sprat fisheries, especially in relation to the cod fisheries.
4) The high level of contaminants in Baltic fish, notably dioxins.
5) The increasing abundance of fish eating species, in particular cormorants and seals.
6) The deterioration of coastal waters, including hypoxia, causing losses for fisheries.

Additional concerns include the development of maritime transport and large scale infra structure development such as ports, and a gas pipeline stretching through the entire Baltic Sea from the

easternmost part of the Gulf of Finland to Germany in the SW.

Box1. Current state of the resources in the Baltic Sea (extracts from ICES reports)

"The distribution of roughly 100 fish species inhabiting the Baltic Sea is largely governed by salinity. Marine species (some 70 species) dominate in the Baltic Proper, while freshwater species (some 30-40 species) occur in coastal areas and the innermost parts. Cod, herring and sprat comprise the large majority of the fish community in both biomass and numbers."

"Cod is the main predator on herring and sprat, and there is also some cannibalism on small cod. Herring and sprat prey on cod eggs, and sprat are cannibalistic on their eggs. The trophic interactions between cod, herring and sprat may periodically exert a strong influence on the state of the fish stocks in the Baltic Sea."

"Hydrographic-climatic (i.e. low frequency of inflows from the North Sea, warm temperatures) and heavy fishing during the past three decades have lead to a shift in the fish community from cod to clupeids (herring and sprat) by first weakening cod recruitment and subsequently generating favourable recruitment conditions for sprat thereby resulting increasing clupeid predation on early stages of cod."

"Commercially important marine species are sprat, herring, cod, various flatfish, and salmon. Sea trout and eel, once abundant, are of very low population sizes."

Cod stocks

Western Baltic cod. It is biologically distinct from the Eastern stock although there is some migration between the areas. The Western Baltic cod appears to be a highly productive stock. Recruitment is rather variable and the stock is highly dependent upon the strength of incoming year classes. Spawner biomass has been below B_{pa} since 2002.

Eastern Baltic cod. Spawning is confined to deep basins where salinity is sufficiently high. The deep basins are susceptible to oxygen depletion, which can jeopardize survival of cod eggs. The spawning stock was in its historical highest level in 1982-83, but since then it has declined to the lowest level on record in the most recent years. The decline was a result of increased fishing effort and unfavourable oceanographic conditions. Since the mid-1980s reproduction has been successful only in the Bornholm basin and Slupsk Furrow. Although the stock assessments are uncertain due to misreporting, discarding and age reading problems, all available information indicates that the SSB is at very low level and the stock is considered to be below the biological reference points.

Salmon and trout

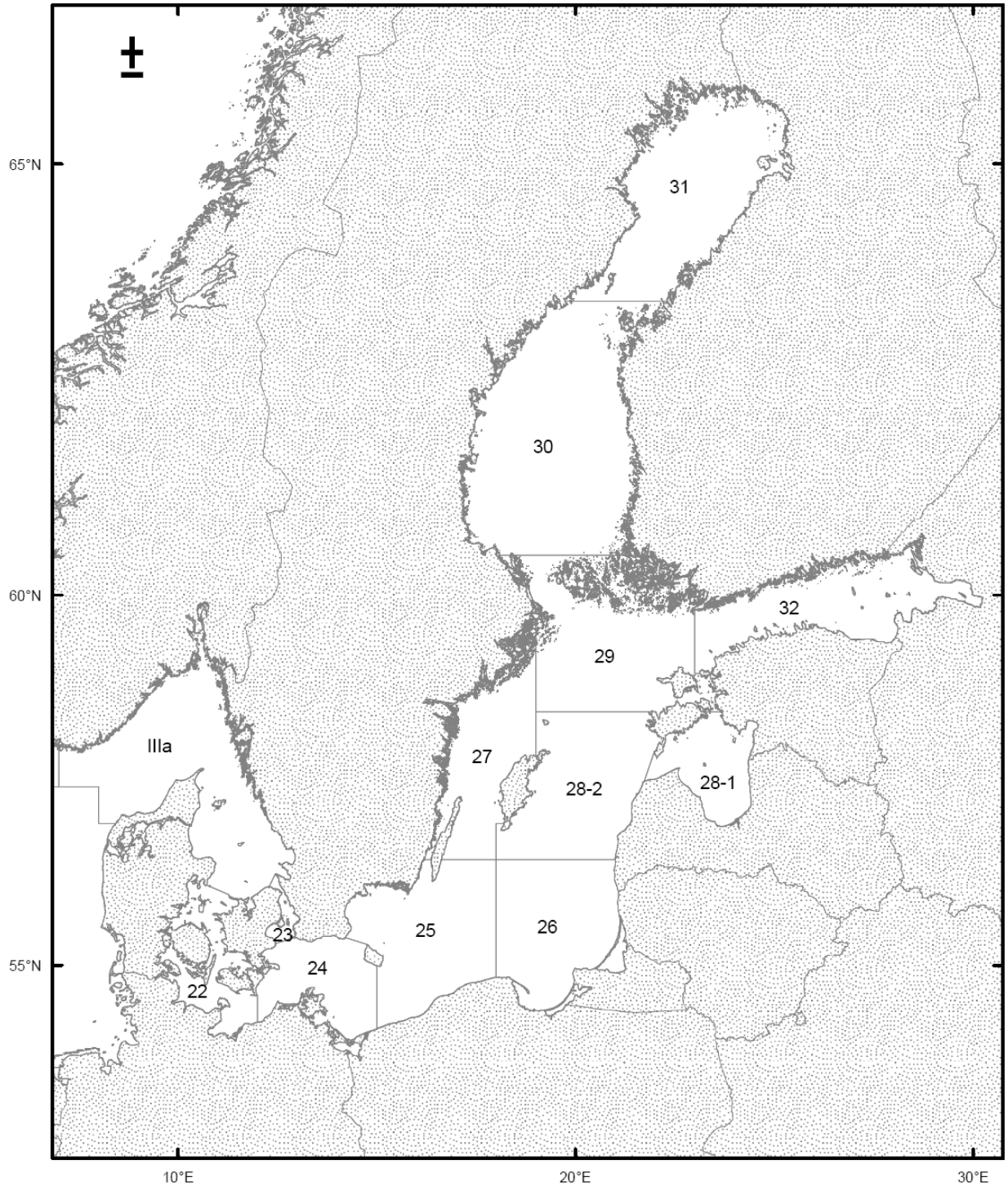
Salmon in the Baltic Proper and the Gulf of Bothnia consists of stocks in 5 different assessment units that are subjected to the same fisheries, experience the same exploitation rates, and could be managed in the same way. Wild smolt production has increased about fourfold since management action was taken in 1997. However, the post-smolt survival in the last years has been very low. This leads to decreasing numbers of feeding and maturing salmon and an advice for reduction in catches and effort is recommended.

Herring and sprat

Herring. There are several herring stocks in the Baltic Sea. Most of them have witnessed an increase in biomass since 1980s. Favourable environmental conditions, especially high temperatures have contributed to that development. On the other hand, the largest and most complex herring stock that inhabits the Baltic Proper and Gulf of Finland was declining from 1970s to 2001. Especially the southern components of the stock consisting of larger herring have declined considerably. Herring stock of the Gulf of Riga is classified to have a full reproductive capacity.

Sprat. The largest stock assessed in the Baltic Sea is considered to be exploited sustainably and to have full reproductive capacity. The stock size increased during the 1990s due to combination of strong recruitment and declining natural mortality (effect of low cod biomass).

(ICES 2007)



Map 1. The Baltic Sea and the Subdivisions used by ICES

Box 1, continued: Current state of the resources in the Baltic Sea (extracts from ICES reports)

Contamination

"The Baltic Sea is severely contaminated. Whereas DDT pollution has decreased substantially, the decline of PCB and dioxin concentrations continues, but at a slow rate, suggesting that some input of these compounds continue.

Fish eating species

Fish eating species of The Baltic Sea consist (excluding fish eating fish) mainly of sea birds and mammals. The fish eating mammals of the Baltic Sea are grey seal (*Halichoerus grypus*), ringed seal (*Phoca hispida*), harbor seal (*Phoca vitulina*) and a small population of harbor porpoise (*Phocoena phocoena*). The Baltic grey seal is found on the Northern Baltic Proper, the Gulf of Bothnia and the Gulf of Finland. It lives in packs; pups are born on ice in late winter. The grey seal mainly feeds on herring and cod. In the Baltic the ringed seal only occurs in the Bay of Bothnia, the Quark, the Gulf of Riga and eastern Gulf of Finland. It feeds on fish and benthic animals. The harbor seal occurs in the Baltic only in southern Sweden and the Danish straits. It lives alone or in small packs. Harbor seal feeds mainly on benthic fish, but occasionally on crustaceans and shells. Harbor porpoise resides the southern Baltic Sea but occurs regularly in the Northern Baltic. They live in pairs or small pods, always near the coast. In the Baltic Sea they mostly feed on herring.

The fish eating sea birds of the Baltic Sea consist mainly of different species of gulls, sterns, cormorant (*Phalacrocorax carbo*), mergansers, divers, common guillemot (*Uria aalge*), black guillemot (Cepphus grylle) and white-tailed eagle (*Haliaeetus albicilla*). The most important bird species with possible harmful effects on fish stocks is cormorant. The species mainly feeds on small sized fish, smaller than pursued by fishing industry. Most of its diet consists of roach species and of species with low economical value. The effects of cormorants for fish stocks are still unclear.

Recently a new alien ctenophore (comb jellyfish) species (*Mnemiopsis leidyi*) was introduced to the Baltic Sea ecosystem. The comb jellyfish feeds efficiently on zooplankton and fish offspring and eggs. It has caused considerable damage in the food chain of the Black Sea, but the effects of the species on the Baltic Sea ecosystem are still unclear. The food chain of the Baltic Sea differs considerably from the Black Sea ecosystem during the *Mnemiopsis leidyi* population explosion. Therefore it can't be necessarily assumed that *Mnemiopsis leidyi* would thrive also in the Baltic Sea as it did in the overfished conditions of the Black Sea ecosystem (Daskalov et al. 2007), as the populations of the planktivorous fish species such as herring and sprat (the most important competitors of the ctenophore species) are strong in the Baltic Sea. Demolishing of the species is practically impossible but a natural competitor can keep *Mnemiopsis leidyi* under control.

Deterioration of coastal waters

Coastal waters of the Baltic Sea are deteriorated mainly because of eutrophication by excessive nutrient loading. The external nutrient loading in the urban areas of the Gulf of Finland has decreased significantly during the last decades but the internal loading releases nutrients into the water, which slows down the recovery of the urban bays.

The coastal waters affected by agriculture and forestry show no signs of recovery yet, on the contrary the condition of coastal waters have even further deteriorated in spite of extensive environmental measures taken in agriculture. Water quality of these areas can be improved by reducing the amount of external loading, although significant improvement in oxygen conditions of the Gulf of Finland benthic environment will take several decades due to the continued effects of internal loading.

(ICES 2007; http://www.itameriportaali.fi/en [March 26 2008])

2.2 Basic issues affecting resource management problems

Political and social issues

The management of the common resources of the Baltic Sea requires joint effort of the European Community, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. In addition decisions that affect the Baltic Sea are made at a global level, for example in the IMO

concerning maritime transport. These decisions may also affect the long term sustainability of the resources of the Baltic Sea..

Decisions affecting the exploitation of the natural resources are made at the EU level (the Common Fisheries Policy and its implementation, regional development policies), nationally (specific legislation for species not covered by the CFP regulation, coastal zone management policies), in regions (regional policy and development), and locally (land use planning affecting ports, fishing harbours and fishing industry).

It is important to note that a large number of different sectors can make decisions largely independently of each other at the different levels. Furthermore fisheries are not only affected by the policies implemented by the fisheries administration. Thus infrastructure development such as fishing ports, regional development policies offering subsidies for fish based production, and decisions of the environmental and food authorities all directly affect fisheries, and many more indirectly. Policy coherence is therefore a major issue.

The Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and Belts (Gdansk 1973) was originally the basis for international management but after the enlargement of the European Union Baltic fisheries became in practice an internal affair for the EU, with limited negotiations with the Russian Federation and thus the Warsaw Commission was dismantled. The EU has established a Regional Advisory Council (RAC) (Council Decision 2004/585/EC) which has been operational since 2006. The RAC addresses key issues in the management[2] and provides a forum for debate.

The broader environmental context has been dealt with in HELCOM, which since 1974 has been a focal point for international government level discussions on the Baltic Sea. A new convention was signed in 1992 by all the states bordering on the Baltic Sea, and the European Community, and the Convention entered into force on the 17th of January 2000. The agenda of the HELCOM covers pollution from land based sources, nature conservation and shipping. The main challenges are excessive nutrient loads, pollution by harmful substances, and threats to the biological diversity. Issues of climate change are also likely to gain importance. The changing climate will have effects as such on the sea and its use, but in addition measures to mitigate climate change are likely to affect the marine environment, for example through the use of renewable energy sources.

HELCOM has acted as a strong player to sum up the scientific knowledge around the Baltic. In past decades HELCOM has released nearly hundred of recommendations that have been accepted at a ministerial level. In spite of this high level of acceptance the implementation of those recommendations in national legislation has been rather low and varies from country to another. HELCOM's ability to enforce measures is thus considerably weaker than the EU's. The EU has infringement procedures that can be used against Member States that fail to implement agreed regulation.

HELCOM is clearly trying to strengthen its role. It has developed the Baltic Sea Action Plan (BSAP) which can bee seen as basis for a more active role in implementation of the European Marine Strategy Directive and also the Maritime Policy. The challenges are documented in the BSAP, approved November 15 2007.[3] The HELCOM and BSAP is thus in many ways a precursor

[2] "The BS RAC recognises that non-compliance is one of the main barriers to maintaining a sustainable cod fishery in the Baltic Sea." Statement by the BS RAC October 25 2007. http://www.bsrac.org/archive/Dokumenter/Recommendations/2007/BSRACStatementOct2007.pdf

[3] http://www.helcom.fi/BSAP/en_GB/intro/

to the policy frame that will be developed under the Marine Strategy Directive, and covers also the broader maritime issues of the Maritime strategy. Therefore it also illustrates key challenges and tensions faced by the EU policies.

The legal basis

The basic European fisheries legislation falls under the responsibility of DG Fisheries[4]. Two important pieces of legislation for the Common Fisheries Policy (CFP) are the
1) Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy; and
2) Council Regulation (EC) No 861/2006 of 22 May 2006 establishing Community financial measures for the implementation of the common fisheries policy and in the area of the Law of the Sea. Specific Baltic Sea Regulations are 1404/2007, 1098/2007 and 2187/2005, and the Council Regulation on the EFF (1198/2006).

In addition there is EU legislation on

- Conservation
- Structures
- Common organisation of the markets
- Bilateral agreements and Regional Fisheries Organisations
- Aquaculture, Processing, Marketing
- Research
- Control and monitoring
- Fleet
- Governance
- Food hygiene

There is, in particular, specific legislation on fish products that affects the markets and the imports of fish and fish products[5]. Key issues in the EU legislation are food safety and animal welfare.

At the national level there is legislation to implement the CFP and other relevant EU-level legislation, but in addition especially coastal and fresh waters, including rivers, are subject to national legislation that may provide for very different basic rules in different countries. Thus coastal waters are largely privately or community owned in Finland and parts of Sweden, whereas access to coastal fishing grounds is not restricted based on ownership in other parts of the Baltic Sea.

Economic importance of fisheries

A recent study ordered by the European Commission has analysed employment in fisheries sector in Europe. The report "Employment in the fisheries sector: current situation" that focuses on the period 1999-2006 was published in 2006. According to the report the Baltic Sea fisheries (EU

[4] http://ec.europa.eu/fisheries/legislation_en.htm [March 20 2008]
[5] for an overview of import conditions see http://ec.europa.eu/food/international/trade/im_cond_fish_en.pdf; for aquaculture animal trade see http://ec.europa.eu/food/animal/liveanimals/aquaculture/index_en.htm; for fish and aquaculture products, see http://ec.europa.eu/food/animal/animalproducts/aquaculture/index_en.htm, for fish diseases see http://ec.europa.eu/food/animal/diseases/controlmeasures/fish_en.htm [March 21 2008]

countries) is characterised by two different demarcations. First there are large and small fishing nations in terms of catches. Second, there is a clear distinction between new and old member states that are very different in terms of their economic performance. The countries with large catches include Sweden, and Poland, while Finland and Estonia are small fishing nations. The production value of Baltic Sea fisheries has declined during the studied period. The main declining fishery has been the cod fishery and the decline has hit hardest the big countries. Poland is the country where employment in fisheries has declined especially dramatically. Still Poland hosts the highest employment in fisheries in the Baltic Sea region's EU countries.

The fisheries sector employs around 56 000 persons in the whole Baltic Sea region. The employment in capture fishery covers 31% of the total. Almost 70% of the total fisheries employment in the Baltic Sea region is in the new member states. In Latvia the fisheries sector is important in many respects: number of employed persons in capture fishery, processing and aquaculture as well as in the dependence rate on the fisheries sector. The dependence rate refers to the proportion employed by the fisheries sector relative to all employed persons (Salz et al. 2006).

3. General model solutions

In this section we describe and analyse some generally discussed and applied model solutions. They can broadly be characterised as the approaches and tools that can be used in various stock recovery plans (Caddy and Agnew 2003) or strategic multi-annual plans. Before examining proposed approaches we start with an overview of the dominant regulatory approach – the TAC regime or the setting of total allowable catches. We have chosen the TAC as a starting point because the major stocks in the Baltic Sea are regulated through TAC-regimes.

3.1 TAC

The dominant approach in fisheries resource management is to control fishing mortality by setting total allowable catches – TACs. In the EU context the TACs are set on various stocks on the European level by decisions made by the Council of (fisheries) ministers. In the decision-making process, the European Commission and ICES have important roles in preparatory and scientific advisory roles, respectively (see above).

The scientific assessments and forecasts of the state of stocks are central in the TAC based procedure. Nielsen and Holm (2007) uses the term "TAC-Machine" to describe the inseparable combination of stock assessments, forecast and quota setting in TAC management regime that functions as a cyclical routine of the construction and certification of annual TACs. Here the description of TAC regime and its inherent problems is based mainly on the paper by Nielsen and Holm (2007).

In a simplified manner the TAC machine functions as follows:

> *The scientific recommendation on the TAC for the following year (by ICES' ACFM) is based on the expert assessment of the stock based on data on, for example, catches, fishing effort, age structure of the catch that are used in a standardized modelling framework (the VPA). On*

a basis of the recommendation policy makers decide the next year's quota that will control the fishing mortality, which will then affect the status of the stock. The system has a corrective nature and therefore it can be conceived as forming a balancing loop. (Fig. 1)

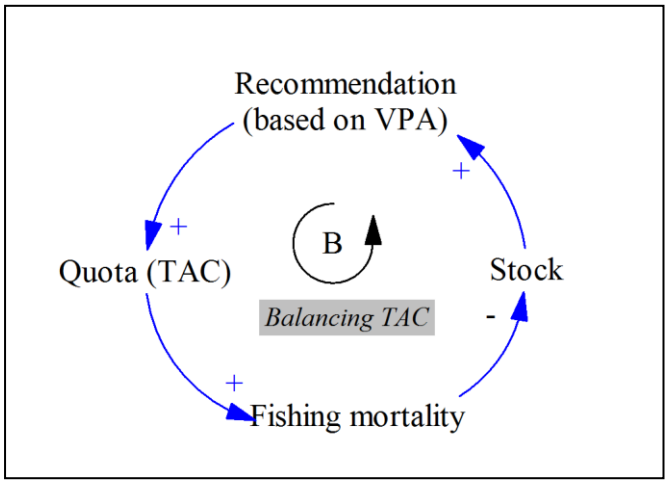


Fig. 1. The basic elements of the "TAC machine" or the simple intervention theory of a TAC regime.

Legend: The figure is applying the Causal Loop Diagram 'vocabulary'. The same is used in many of the following figures to describe the logic of various conceptual models or intervention theories of various fisheries management approaches. The Causal Loop Diagrams are based on assumed causalities. An arrow indicates that there is a causal relationship between the factors: "A is causing (or influencing) B". A plus sign indicates that the two factors are assumed to evolve to the same direction: "if A grows then B grows, too" or "if A goes down then B goes down, too". A minus sign indicates that the factors evolve in opposite directions (if A grows, the B goes down; if A goes down, B grows). See Sterman (2000).

Nielsen and Holm (2007) claim, as many other scholars before that the CFP has failed as a conservation policy. Their specific point is that it is rather the whole scheme of the TAC Machine that is prone to failure instead of only some specific weak link in it. Many writers have identified the setting of the quota as the most decisive weak link, because that is the most 'political' phase: decision makers have systematically preferred short-term socio-economic interests over the long term resource sustainability. In their paper Nielsen and Holm (2007) take an aetiological approach, analysing causes of the failure. They find several causes that affect, in fact, all relationships between the variables in the above picture.

Mis-diagnoses of stock. The Virtual Population Analysis (VPA) is a well-established stock assessment methodology and integral part of the TAC Machine. However, any individual stock assessment is open to a wide range of possible interpretations of the stock state. Calibration by using available catch or catch per unit of effort (CPUE) information is potentially biased and leads easily to overestimations. North Sea Cod assessments in 1990s function as a good example.

Intervention impotence. It is very difficult to create a solid link between intended and observed outcome for the stock. In other words, a TAC does not bring the intended results in terms of the stock state. Reasons for this may be various, e.g. failed stock assessment, non-compliance with the TAC, misreporting (that affects the assessment). Intervention impotence obscures the linkages in the TAC Machine weakening the whole TAC based regime.

Ambiguous objectives. There is a lack of clear positive objectives in EU fisheries. The present practices have become one of defining management objectives as minimum limits. Instead of aiming for positive goals, for instance Maximum Sustainable Yield (MSY), the present stated goal is to maintain stocks within safe biological limits. ICES tried to have MSY as the goal originally, but after the CFP's introduction in the 1980s that goal has been 'watered' to one of avoiding total collapse of stocks.

Policy making and quota allocation. When the 'relative stability' became one of the leading principles of CFP in determining how resources will be allocated between the member states, the importance of conservation objectives diminished. Furthermore, the TAC regime became the main management decision scheme, because the TAC thinking is rather easily converted to allocating relative shares of the member states. In addition to the paralysing effect of the relative stability principle the TAC has a tendency of keeping the fishing mortality higher than recommended by ICES. Due to a pressure from fleets of different countries, the ministers are inclined not to cut the next year's quotas.

These four weaknesses of the TAC Machine have a cascading effect that leads to knock-on effects that reinforce the problems. One example is that intervention impotence deteriorates assessment data and causes mis-diagnosis. Another is that since the assessment has weaknesses the whole management regime is vulnerable to criticism. When this is combined with the tendency of assessment biases to increase when the stocks go down the result is the system's increased weakness and indeterminacy when the strongest decision is most needed – that is when the stocks are getting depleted.

The TAC scheme becomes blurred by various external factors and by extra loops that seriously disturbs functioning of the TAC Machine. In principle the TAC machine has an auto-corrective capacity, but this has lead in practice only to "micromanagement" that is incapable to substantially address the system's weaknesses. In terms of organisational learning the TAC Machine has some capacity to operate in a single loop learning mode, but lacks the capacity of double loop learning that could provide perspectives of changing the system's norms, objectives and basic policies (Nielsen and Holm 2007)

Thus it is necessary to expand the basic picture of the TAC-machine by confounding factors (Fig. 2). The result is as follows:

The original TAC Machine scheme is in the middle of the picture (bold, underlined). But now various other factors and loops have come to make the scheme very complicated. Council 'politics' (upper left hand) is making the quota bigger than recommended on the basis of stock assessment. Another problem related to the (already spoiled) quota is that member states cannot ensure that it is followed and, therefore, the actual fishing mortality can be something very different from the quota.

A crucial problem of the TAC Machine are the difficult linkages from fishing mortality back to the population assessment. Since there is little direct access to the population the assessments are heavily dependent on fisheries data like reported landings or CPUE data (on the right). These are easily biased through misreporting. The TAC scheme has an inherent tendency to encourage quota upgrading and discarding, which further weakens quality of fisheries data used in the assessments. Misreporting, quota upgrading and discarding are encouraged when the member states' capacity to control fishing activities is weak.

Finally it is important to emphasise the role of fish markets. In the picture the markets are represented as 'demand for fish'. Demand for fish on the markets is the prime mower of the commercial fisheries. That becomes problematic when the demand is so strong that the fishery has an incentive to catch more than a long-term sustainability of the stock would allow. There can also be demand for such fish that the fishermen are not allowed to catch, e.g. undersized fish. The demand thus influences fishing mortality, but may also encourage to misreporting and quota upgrading.

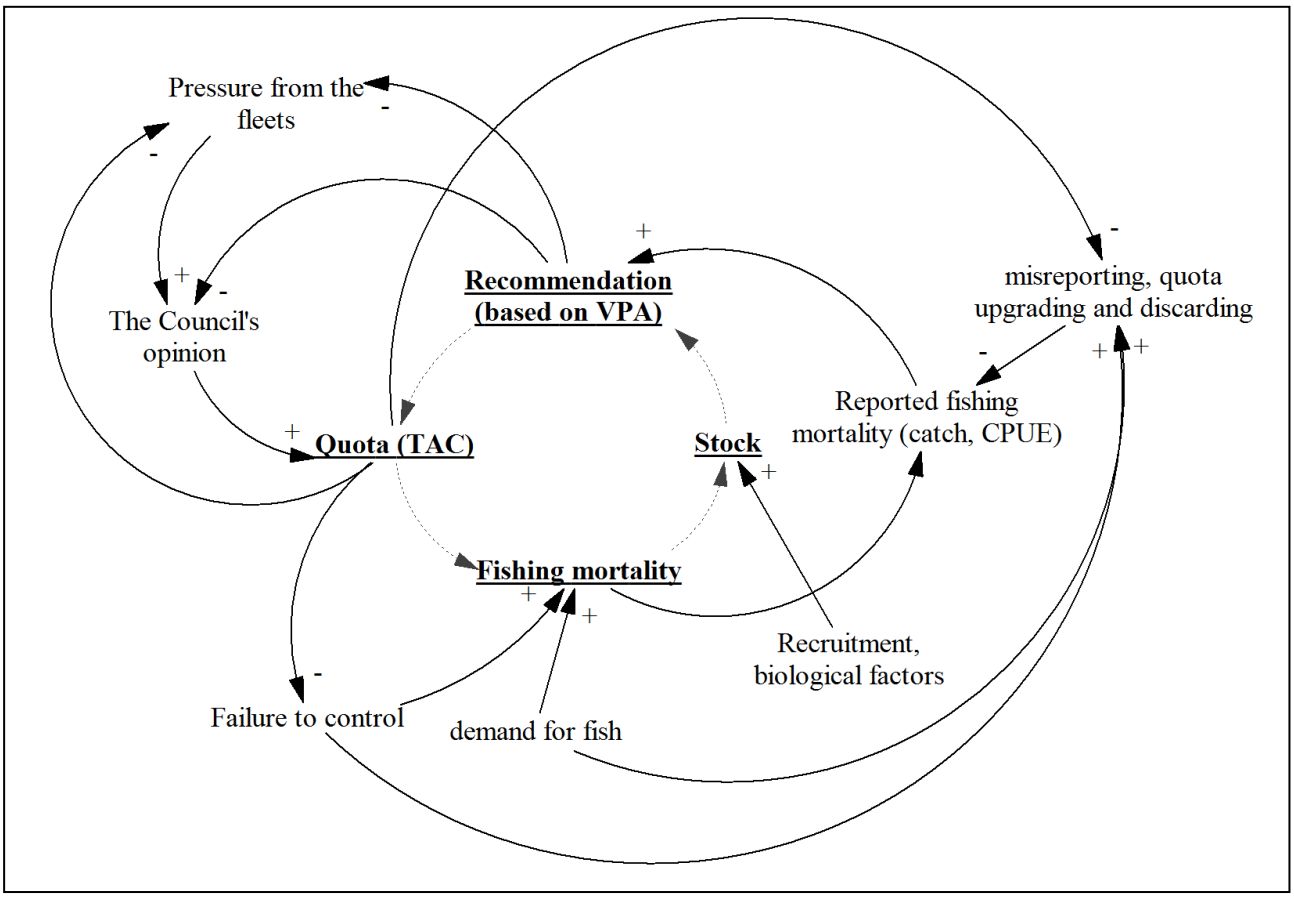


Fig. 2. The TAC machine put in the context that hinders it from functioning in the way it is intended to work. (For a legend, see Fig. 1.)

With a starting point in the more complex picture of the TAC- regime (Fig. 2) we can now turn to a further discussion on fisheries management failures and suggested solutions. Some of them are directly addressing problems of the TAC Machine and those we relate to the above discussion.

We examine how proposed solutions aim at addressing different parts of the problems. Thus some focus explicitly on the control mechanisms while others aim at raising the legitimacy of the regulatory regime.

3.2 Individual transferable quotas

Individual transferable quotas (ITQ) have been suggested as an instrument to especially solve the problem of **inefficiency** of a fishing fleet. More precisely, to combat the inefficiency that is an outcome of fisheries regulations based on TACs (Kulmala et al. 2007, Döring and Egelkraut 2008). One must notice, though, that an ITQ system is possible only as part of a TAC regime accompanied by the institutionalised stock assessments (see Holm and Nielsen 2007), since ITQ is a mechanism to allocate TAC among fishing or quota holding units in a way that leads, according to the economic theory, to more efficient use of natural resources. It is important to notice that in the ITQ literature benefits to the **society** are emphasised while assessing the rationality of use of natural resources.

ITQs are especially suggested to fisheries that are overexploited and in need of limitations on total catches, but not only in such fisheries (Brandt and McEvoy 2006). In a review from the year 2003 it was estimated that about 10 per cent of the world's fisheries are managed under an ITQ regime (Garcia and Moreno 2003 cf. Holm and Nielsen 2007). And the proportion is increasing.

According to proponents of ITQ system the TAC that regulates a total catch creates "a race for fish", in which individual fishing units try to get as large a share of the TAC as possible (e.g. Kulmala et al. 2007). A means to succeed in the race is to ensure a high catching capacity, e.g. by having powerful boats, a lot of nets or by focusing the effort on early season (Holm and Nilsen 2007). When all units try to succeed in the race the overall outcome is an overinvestment in the fishing fleet - inefficient fishing fleet that suffers from low profitability.

According to a conceptual model of ITQ, it will solve the inefficiency problem by allowing fishermen to get their individual quota that can be transferred among the quota holders. By allowing transferability the individual quotas will be bought by the most efficient units that can fully utilise their capacity. This will improve efficiency of the fleet and ensure maximum benefits to the society.

Seen in the light of the problem areas of the TAC (Fig 2.) one can argue that ITQs not only address the allocation problem but also, and in particular, part of the control problems. By creating ownership like features to the resource, the ITQ partly internalises the control and also the need for accurate assessment (Fig. 3). Thus Döring and Egelkraut (2008) hold that individual quota will increase the sense of stewardship of the resources and thus commitment to a long-term consideration of the health of the resource.

Making quotas individual has also other benefits than the increased efficiency. An important benefit is that fishermen can better choose when to fish when they have security of the catch already in the beginning of the season. Security allows considering various time-related factors like when price is the highest, when catch is the best and also when the weather is the safest. These benefits, which also increase efficiency of the fleet but to lesser extent than the main economic argument, are characteristic to all individual quotas irrespective of their transferability.

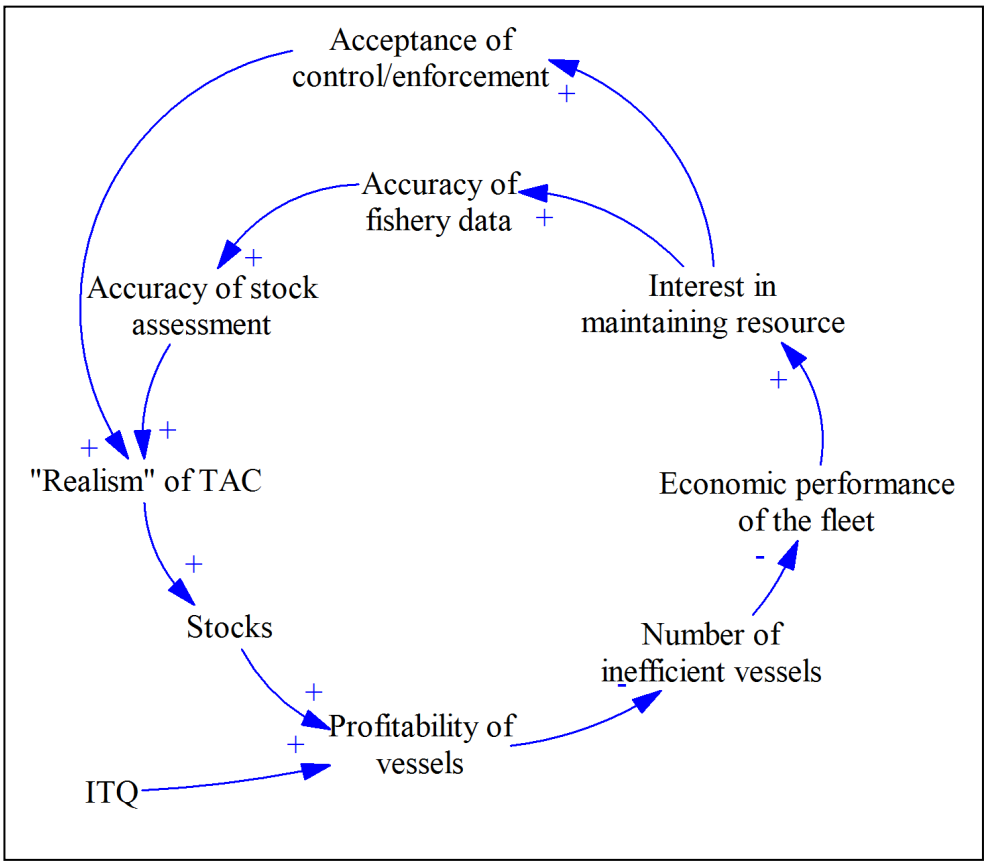


Fig. 3. The basic intervention logic of the ITQ-system as linked to a TAC regime. "Realism of TAC" indicates improved capability of obtaining information that better tracks the actual state of the stock. (For a legend, see Fig. 1.)

The intervention theory of the ITQ shows that the system is critically dependent on the TAC (Fig. 3). Therefore some scholars have emphasized further aspects that should be taken into account in building ITQ systems. One is that an ITQ regime needs to be strengthened by extra regulations to ensure sustainable utilisation of stocks: for instance technical regulations may be needed (Fig. 4). In addition further measures may be needed to control the possible increase in fishing effort. Even though the economic theory would suggest that an ITQ regime will introduce an incentive to reduce overinvestments in catching capacity, some empirical studies prove the opposite (Holm and Nielsen 2007). Therefore the Norwegian ITQ system includes extra measures to cut the capacity.

The greatest opposition against ITQ systems is probably the fear that in the end the ownership of quotas will concentrate in few hands. In the name of equity this fear is stated to be devastating for fishing communities. Therefore, in the ITQ literature it is often mentioned that an ITQ regime should include mechanisms to avoid overly concentration of the quotas (Fig. 4).

These further aspects are represented in the following picture as extra loops of external factors. These extra loops tend to reduce the strength of the ITQ system in purely economic terms, but may in the long run increase its sustainability in ecological and social terms. Special care needs to be taken, however, not to introduce counterproductive additional measures.

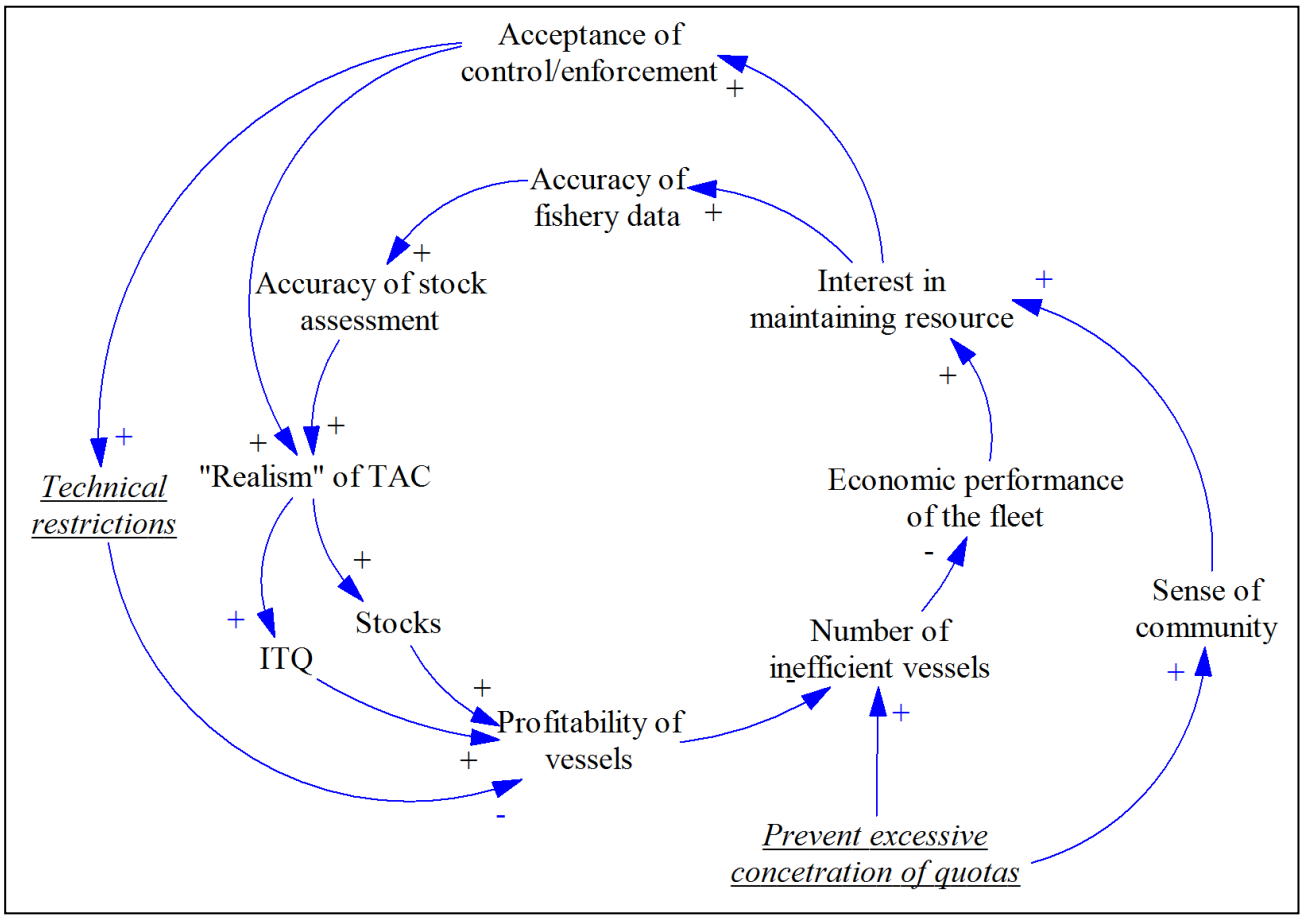


Fig. 4. The basic ITQ-intervention expanded by technical restrictions and buy-up restrictions to prevent concentration of quotas. (For a legend, see Fig. 1.)

3.3 Community based management

The starting point for community based management is the embedding of a specific resource use regime into a wider social, cultural and economic context. A key objective is to arrive at cooperative approaches (Jentoft 1985). When the resource use is concepualised in a wider context, the resource management regime would similarly be built to better fit the wider context. In practice, this would mean empowering the community that is dependent on the resource, for instance, by giving them rights to manage the resource. This would actually be a case of acknowledging the already existing, officially unrecognized and often traditional resource management practices (e.g. McCay and Acheson 1987). By empowering communities in resource management the users' commitment to commonly agreed rules is expected to increase due to a sense of stewardship over the resource (Döring and Egelkraut 2008). In addition, the community-based approach would utilize the community's own practices to enforce collectively decided rules and thus decrease the state's enforcement costs.

In its most radical form the community based approach completely rejects the present form of the "TAC-machine". The main focus is on the issue of legitimacy that is assumed to be achieved by putting the regulatory regime in a new context that stresses ownership and responsibility. A softer form that introduces only some participatory and community elements into the traditional TAC-regime is the system of Regional Advisory Councils (RACs) introduced by the EU. However, nothing would in principle hinder communities from adopting their own version of the TAC-machine, with elements of, for example, rights based management. Thus Döring and Egelkraut (2008) suggest that allocation of landings could be arranged for example by a community-based system. The community-based approach would give fishermen of certain communities rights for particular fishing areas.

A community is claimed to be an important factor in the resource use and management, but this is not recognized properly in the existing resource management thinking. For instance, Kevin St. Martin (2006) argues that the hegemonic discourse of bioeconomics[6] in the fisheries management science and practice sees a fishing unit as the sole economic actor in fisheries. In consequence, only individual (rational) economic actors are visible and comprehensible, while community and social issues are silenced. As a consequence, the community is presently silenced by the bioeconomic discourse also in economic impact assessments, social impact assessments and even in participatory processes. The communities are mapped out of the commons when they are only seen as locations where the impacts from regulation of the commons are located or seen only as profit maximizing individuals in participatory processes. This basically very Foucaultian notion tells us that the question of what kind of knowledge is recognised as useful in the resource management becomes a critical question about power, since the silencing of communities is an effect of invisibility in the hegemonic discourse. Visibility in this science-driven discourse is to large extent gained by possessing the right kind of knowledge.

Another effect of the bioeconomic perspective is that the commons that are discussed become very abstract and non-spatial resources (St. Martin 2006). An abstract resource is also detached from the community or communities that are utilizing it and the community from the resource, which is very problematic since a notion of a community is necessary for defining a commons (St. Martin 2006).

The dichotomy y of "fishing community"/"individual resource use unit" distinguishes two very different approaches to resource management. The notions "associated with the community are open to variety of (particularly community-based) economic futures while those associated with individual competitive behaviour necessitate neoliberal privatizations and a singular capitalist future" (St. Martin 2006, 170). For instance, the introduction of ITQs is a clear case of economic theory performing the economy (Holm and Nielsen 2007).

There is a large amount of literature dealing with community-based approach to natural resource management, including fisheries resources, and there are some examples of communities becoming recognised as relevant units in actual resource management. In Alaska, for instance, there have been community development quotas for eligible communities since the early 1990s and a community has become recognized as a legal construct in US also in relation to impacts of fisheries regulations (St. Martin 2006). However, some scholars have pointed out problems related to community-based natural resource management. The criticism is directed towards the (simple) concept of community and also towards an ideal of decentralized governance. For instance, Berkes (2006) lists four scale-related issues:

[6] One must notice, though, that economists argue that fisheries management thinking is mainly operating on the biological knowledge and economics does not have an equal stance (Kulmala et al 2008).

Community is a complex phenomenon. Communities are seldom simple. They may be heterogeneous, with different interests by gender, age, class, socioeconomic group or ethnic group.

Community-based systems are influenced by external drivers. External drivers such as central government policies or global markets are those key factors that cause change in socio-ecological systems.

Resource boundaries rarely match institutional boundaries. Ecological processes may operate on various levels and similarly there are many relevant institutional levels.

Most cases of natural resource management are cross level. Because cross-level linkages are so pervasive in the resource systems, attention to community level alone is never likely to be sufficient.

Berkes (2006) suggests that because of the cross-scale nature of natural resource problems the emphasis of inquiry should be on understanding the linkages, their nature and dynamics, rather than on focusing on one scale. The most challenging forms of community governance are those which operate and recognise multiple levels of governance. Such approaches are particularly necessary for international waters and resources (Berkes et al. 2006). In the US a number of different collaborative fisheries have, however, also appeared for "difficult" species such as cod (Pinto da Silva and Kitts 2006).

The concept of fishing community is thus recognised in some jurisdictions as a relevant unit, but at the same time it has been recognised as a problematic concept. In political terms, the concept could be an important opening towards integrating social and cultural considerations into fisheries decision-making stronger than in the present prominent bioeconomic discourse. In fact, it would allow also more multiple handling of the coastal economies in fisheries management (St. Martin 2006). At the same time the concept of community has important political consequences on the communities. A particularly tricky question is which communities are valid fisheries communities and which are not? In other word, which are the communities that are given this status and which communities (still) remain silenced? What are the criteria for separating coastal communities into fisheries communities and non-fisheries communities? One way around these problems is not to predefine communities, but rather to create opportunities for co-operatives to emerge (Kitts and Edwards 2003).

3.4 Marine Protected Areas

The fourth type of fisheries management approach that has been discussed extensively in recent years is to protect a certain part of marine environment from fishing to protect habitats. These areas are called marine protected areas – MPAs. At first, they were not discussed mainly as a fisheries management tools, but were more focused on protection of marine habitats and especially to protected them from harmful physical effects of fishing activities. Later discussions addressing MPAs have stressed their potential as fisheries management tools among the other more established ones. In fact, MPAs are seen as additional management tools that on the one hand can strengthen the effectiveness of other tools and on the other hand need other tools (Sumaila et al. 2000).

Several reviews on the benefits of MPAs have been conducted. Below findings of some reviews are summarized (review for a PROTECT project 2006; Sumaila et al. 2000; Carter 2003). With reference to the problem context of the TAC-regime (Fig. 2), one can argue that the MPA solution aims at creating a security check against failures of the TAC by simply removing a sufficient part of the fishing grounds from access. An MPA can thus be completely independent of the yearly stock estimate and the political compromises surrounding the setting of TACs. Also enforcement is relatively simple, on the condition that the MPAs are sufficiently large. The argument is that the MPA will "pay back" the investment through spill over effects and general improvement of the health of the system.

The ecological reasoning behind MPAs emphasise the broader ecosystem considerations in fisheries management. Reserving an area outside fishing activities "restore, at least partially, pre-industrial exploitation patterns" (Sumaila et al. 2000, 753), which will let the marine ecosystem recover and function as in their "natural" state (PROTECT 2006, 31). By letting the ecosystem function without disturbance in an area that is critical for the species, the reproduction potential of the stocks will increase. For the areas outside the MPA this can mean spill over effects that will eventually increase the amount of fish available outside the MPA (e.g. through migration of larvae or adult fish). But it is not only the improved reproduction that brings the ecological benefits. MPAs can reduce the by-catch of undersized fish that have an escape area inside MPAs. Furthermore, the protection of benthic communities will improve the ecosystem integrity that is in the long run beneficial also for the commercial fish species. As the MPA improves state of the protected ecosystem it will function as an insurance against management failures and other shock effects that fish stocks may face.

The scheme of MPA:

> *The MPAs are considered as a tool for recovery of an overfished stock. In other words, there is initially a big difference between the observed state of the stock and the preferred 'healthy' state. By designating a MPA managers can reduce fishing effort totally or partially by allowing only certain type of fisheries that are not considered harmful. This will a) eliminate or reduce the catch in MPA, b) eliminate or reduce by-catch of juvenile fish, c) stop disturbance in the reproduction area (spawning and nursery area) and d) protect the habitats (e.g. benthic communities). All these will improve a reproduction potential of the stock and consequently the stock in MPA will grow and lead to spillover effects. Predation of fish in the MPA may reduce the stock. The spillover effect is a link to the fisheries management goals outside a MPA: it can help to correct the overfishing problems created by a TAC regime .*

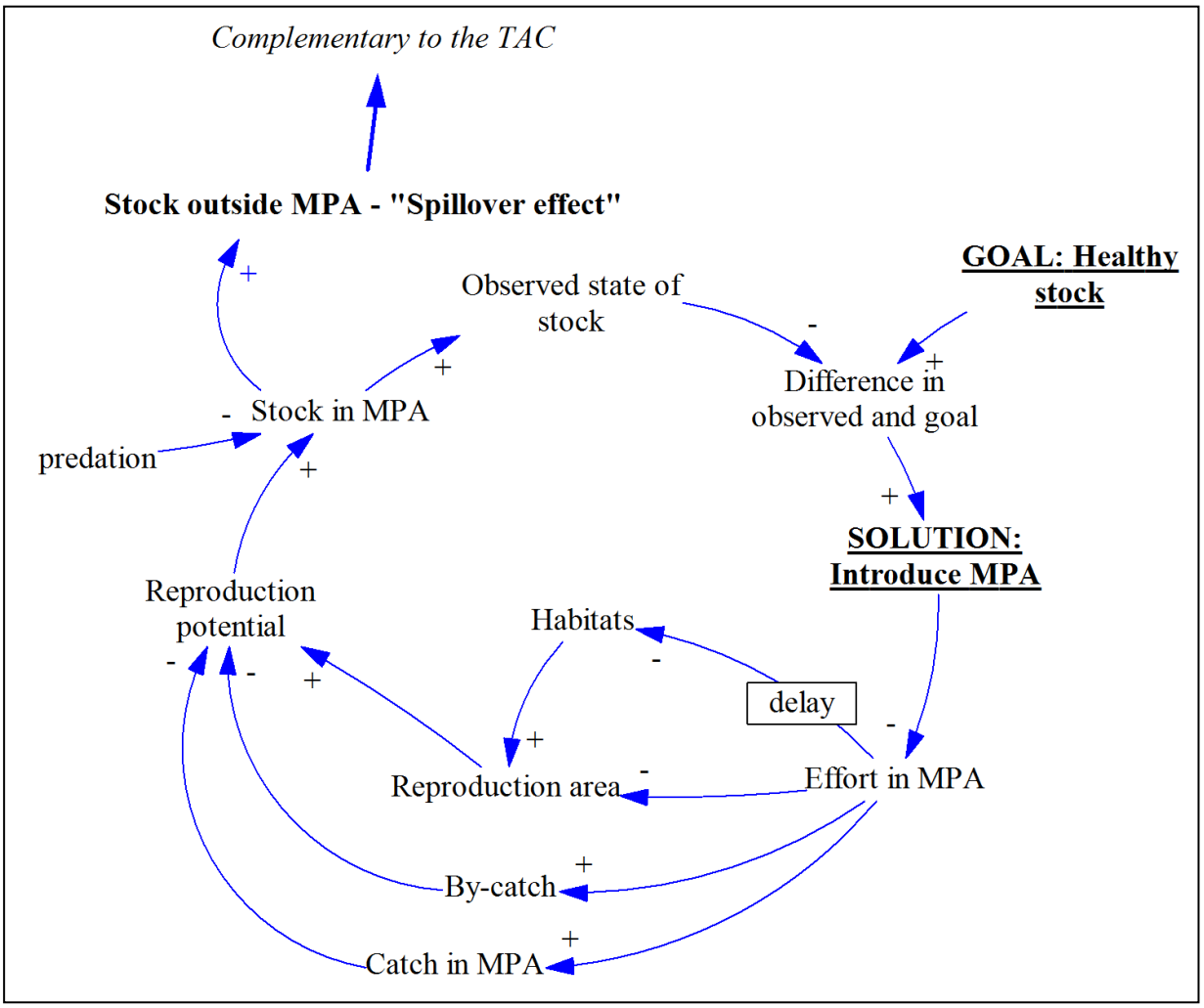


Fig. 5. MPAs as helping fish stocks and critical habitats to recover. MPAs are complementary to a TAC regime. ***(For a legend, see Fig. 1.)***

There are many uncertainties related to ecological effects of MPAs. For instance the PROTECT review (2006) points out that the actual effects are dependent on at least the proportion of fish within the marine reserve, biological characteristics of the species in question as well as on fishing effort and its spatial distributions outside the MPA. Similar observations are made by Röckmann et al. (2007). The PROTECT review indicates also that controlling the fishing effort that is redirected from the MPA is important, since it may lead to significant increase of fishing effort in some other areas. In fact, the potential complementary effects to support a TAC regime may be lost as a result.

Fishers have often protested against the plans of establishing MPA on the basis of the fear of loosing important fishing grounds. Seen from the ITQ perspective the loss of fishing grounds will decrease the efficiency of a fishing fleet, if fishermen have to choose less productive fishing grounds. (Gibbs 2007).

Proponents of MPAs argue that in the long run the MPAs will bring social and economic benefits that, in fact, will be lost if the short-term economic interests are allowed to dominate. This protection of future jobs by allowing recovery of fish stocks is seen as the direct long-term economic benefit to the fishery. In addition to the benefits to fisheries, other economic benefits can

be expected, namely from non-consumptive uses of the protected marine areas (Sumaila et al. 2000) although this effect is seen uncertain in many studies (PROTECT 2006, 115).

Studies of social and economic impacts of MPAs are scarce compared to the ecological studies. Since even the ecological benefits are more often based on theoretical modeling studies than empirical studies of the actual effects, the socio-economic benefits that are indirect and mediated effects are even more difficult to detect. Carter (2003) has analysed the potential economic benefits from the MPAs. He separates the consumptive and non-consumptive uses as the two large categories of potential benefits. He points out that short-term benefits from (consumptive use of) the rebuilt stock depends on connectivity of the marine environment (that the spill-over effect actualizes), the availability of alternative fishing grounds and the predator-prey relationships in the environment. He also reminds that the long-term benefits will be lost if the overall effort is not reduced.

Regarding the overall cost-effectiveness of MPAs Carter (2003) observes that MPA is a drastic fisheries management measure. In cases that stock management is possible by more traditional fisheries management tools, MPAs are not worth the effort, if only fisheries are considered. The non-consumptive benefits as well as other consumptive uses of MPAs than capture fisheries may change the outcome, though. Furthermore, the institutional aspects and respective costs of MPAs must not be forgotten in assessments of costs and benefits of MPAs.

Further points regarding considerations of MPAs is for instance that there are different types of MPAs. There exist 'real' marine reserves that are strictly protected from fishing and even from most anthropogenic pressures such as tourism. In these areas the benefits of MPAs are most likely to actualize. For instance, increase of tourism in MPAs may actually disturb the ecosystem and prevent the expected benefits. Most of the MPAs are such that only some fishing is prohibited. Quite often small-scale fishing is allowed, which has created a situation that fishing effort has increased in that fraction of fishery. The reviews show that such partial MPAs are not very effective in terms of stock conservation.

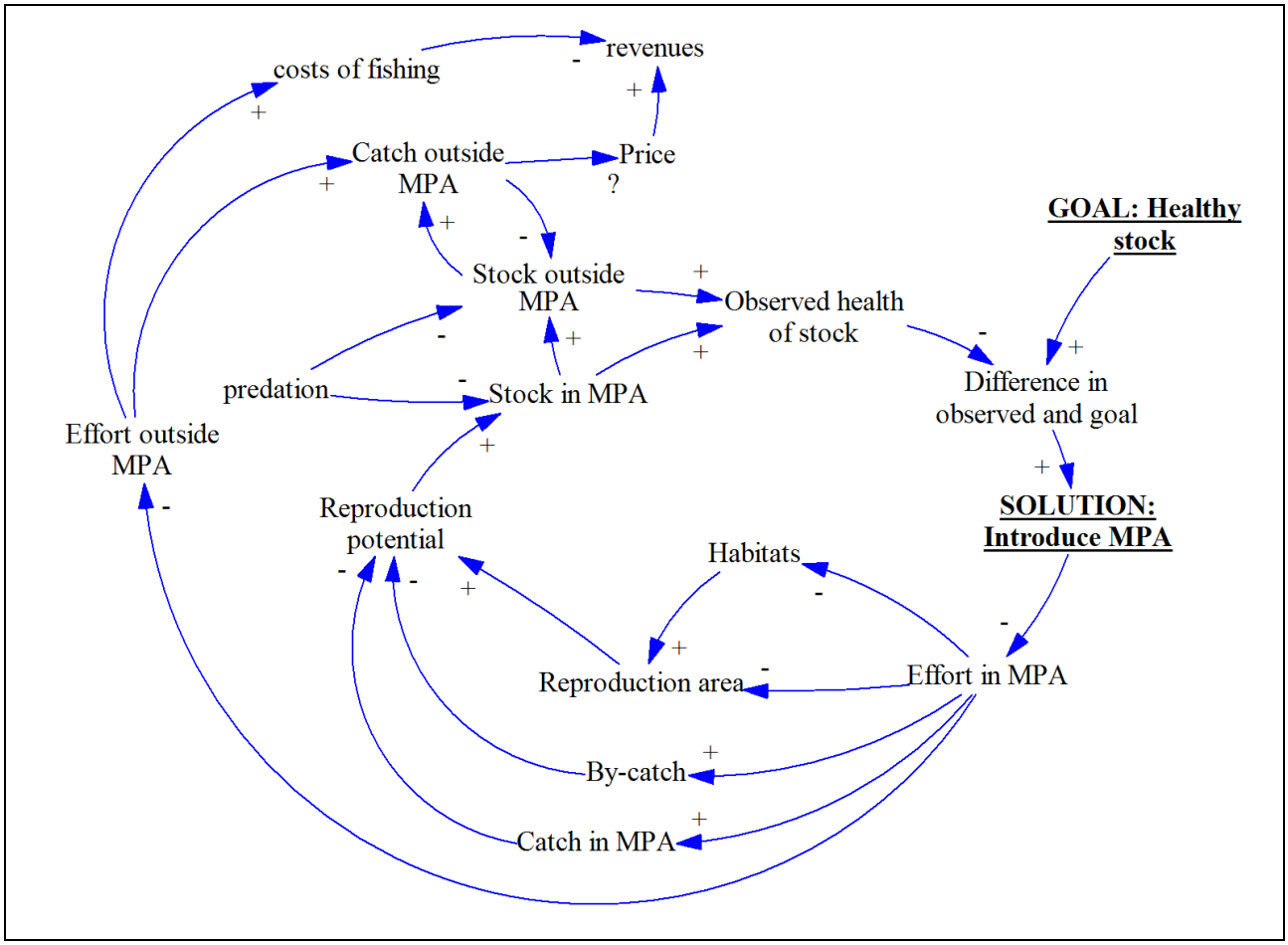


Fig. 6. Scheme of MPA with broader effects on fishery outside an MPA. The potential complementary effects to support a TAC regime may be lost if effects of an MPA on fishing outside it is not taken into account. ***(For a legend, see Fig. 1.)***

4. Pressing problems in the Baltic Sea and their possible solutions

4.1 The state of the cod stock and the cod fisheries, including illegal fishing and fishing for undersized cod

Baltic Sea cod stocks are heavily exploited. According to the ICES' stock assessment ofMay 2007[7] the cod in the Baltic proper (Subdivisions 25-32) is in a precarious state: "The stock is at a historical low level and no increase in the spawning-stock biomass could be observed in recent years. Based

[7] http://www.ices.dk/committe/acom/comwork/report/2007/may/cod-2532.pdf [March 22 2008]

on the most recent estimates of SSB [spawning stock biomass] and fishing mortality ICES classifies the stock as suffering reduced reproductive capacity and being harvested unsustainably." For the cod in the western Baltic (ICES Subdivisions 22-24) "ICES classifies the stock as being at risk of reduced reproductive capacity. […] At the present exploitation rate the stock is dependent upon the strength of incoming year classes. The three latest year classes are estimated to be well below average." In the following we will focus on the cod of the eastern Baltic Sea (Subdivisions 25-32), which is the larger of the stocks. These statements have not been changed substantially in the published ICES advice 2007[8].

Heavy fishing combined with varying and low reproduction success compared with historical conditions causes the problem. The success of the reproduction for Baltic Sea cod is a very important, but complex factor, since the cod recruitment in the Baltic Sea cannot be reliably described with a simple stock-recruit relationship. The reproduction rate of the cod in the Baltic Sea is limited due to environmental conditions – salinity and oxygen concentration (e.g. Döring and Egelkraut 2008; Röckmann et al. 2007; ICES 2007). Salinity changes depending on occasional flows of ocean water from the North Sea 'the major Baltic inflow', while the oxygen depletion is caused by breakdown of organic material below the halocline. The latter effect is strengthened by anthropogenic pollution of the sea (nutrient discharges) that increase primary production in the ecosystem, while inflow of saline, well-oxygenated water from the North Sea can temporarily ease the oxygen depletion (ICES 2007). Reproduction rate is also affected by predation on cod eggs and larvae mainly by sprat.

ICES (2007) has concluded that there has been extensive underreporting of catches, which demonstrates a poor enforcement of the TAC regulation. The so called unallocated catches amount to almost 30 % of the estimated total catch. As such the problems of the Baltic cod stocks are not new. During the 15 years between 1978 and 1993 ICES recommended 12 times to reduce fishing, 9 times substantially and twice a complete ban (Hildén 1997). It is thus fairly evident that the regulatory regime has been incapable of achieving sustainable cod fishing. The agreed TACs have consistently been higher than those recommended by ICES, and when unallocated catches are taken into account, the actual catches have probably exceeded even the inflated TACs

In their recent article Döring and Egelkraut (2008) describes the problem dynamics. They also take as a starting point the weakness of the TAC system to reduce fishing effort. They argue that to secure economic interests of the harvesting sector governments decide on higher annual quotas on the cod than is recommended by ICES. Too high quota leads to overfishing and too small spawning stock. Furthermore, catching juvenile fish reduces quality of the spawning stock. As a result the stock is depleted.

Döring and Egelkraut (2008) look at the dynamic in a frame of wider ecosystem by conceiving the cod as 'a natural capital'. They describe a knock-on effect that actually becomes a vicious circle caused by low reproduction and overfishing (see Fig. 7). As the cod stock becomes depleted, the predation on the sprat declines. This means that more sprats eat more zoo plankton and then algae is saved from predation by zoo plankton. As a result more algae can grow and eventually more dead algae sink to the bottom. A mass of dead algae decomposes and consumes oxygen. Oxygen depletions becomes worse and further lowers the cod reproduction rate. Lower reproduction rate combined with overfishing results in ever smaller cod stock.

[8] ICES Advice 2007, Book 8.
http://www.ices.dk/products/icesadvice/2007/ICES%20ADVICE%202007%20Book%208.pdf

The vicious circle has an extra loop that may reinforce it. This is caused by the sprat's predation on cod egg and larvae. Due to decreasing cod stock there is more sprat that further reduces the cod's reproduction rate (ICES 2007).

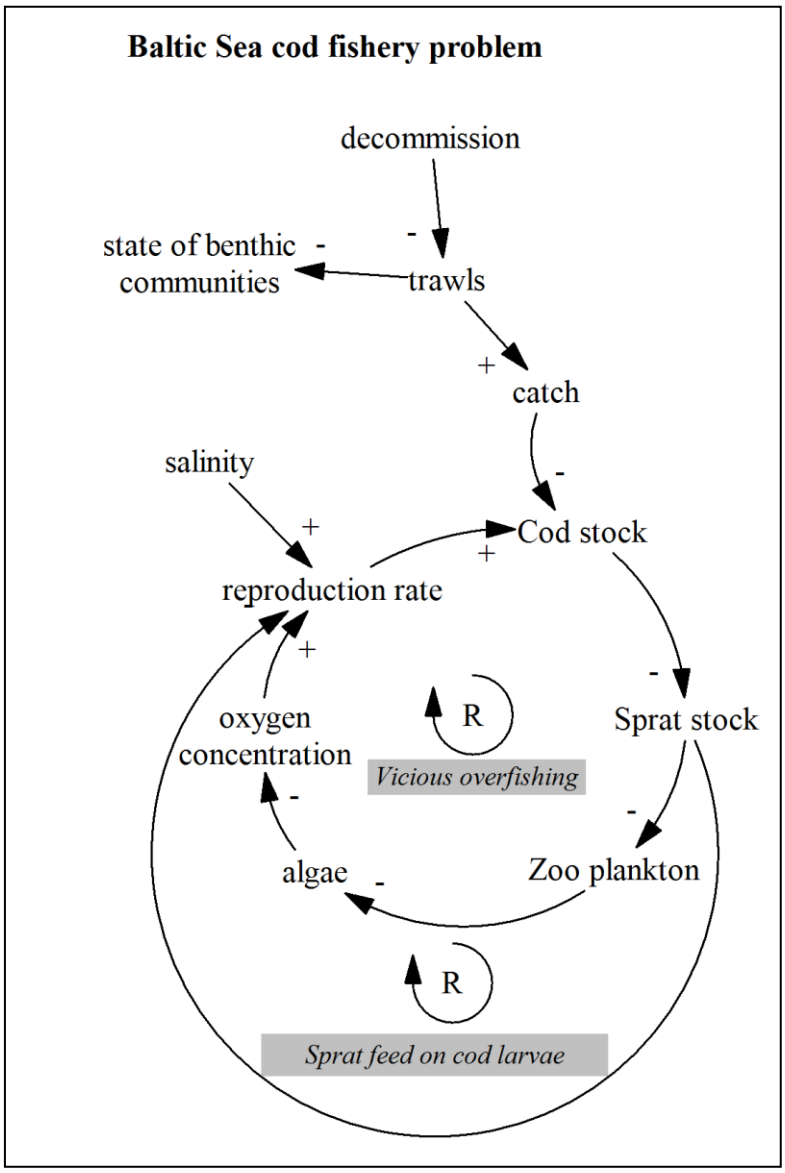


Fig. 7. The cod fishery problem in the Baltic Sea (Döring and Egelkraut 2008; ICES 2007). ***(For a legend, see Fig. 1.)***

4.2 How to deal with the Baltic Sea cod problems?

The problems have clearly been recognised. The Commission has recently adopted a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks.[9] The Baltic Sea Regional Advisory Council has in a statement of October 25 2007 urged for more efficient

[9] COUNCIL REGULATION (EC) No 1098/2007 of 18 September 2007 establishing a multiannual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 779/97. Official Journal of the European Union 22.9. 2007. L248/1.

measures to achieve sustainable fishing for cod.[10] The persistence of the problems indicates, however, that there are structural or systemic features in the socio-ecological complex that hinder an improvement of the state of the cod stocks and a development towards more sustainable fisheries.

The Commission paints a fairly rosy picture of its proposed multi-annual plan (COM (2006) 411) [11], according to which: "The proposed measures would, if implemented, result in:
a) for the cod stocks
• rebuilding of the Baltic cod stocks to sustainable levels and maintenance of those levels thereafter
• change in the age composition towards older and larger fish
b) for other stocks
• the fishing mortality on stocks (mainly flatfish stocks) caught together with cod in the demersal fisheries will be reduced
• no analytical assessment is available for these associated stocks and the impact of reduced fishing mortality on the stock development and catches can not be assessed
c) for the fishing effort
• a general reduction in the fishing effort in the fleet segments exploiting demersal species in the Baltic Sea
d) for the impact of fishing on the environment
• reduced impact of the demersal fisheries on the environment
e) for the catching sector
• stable catches of cod in the recovery period followed by increased catches
• increased catch per unit effort"

The multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks focuses on a TAC based regime, with additions of technical measures and temporal area closures. The fact that previous attempts to improve the state of the Baltic cod problem have failed suggests, however, that several impasses have to be broken and also more radical solutions than the multi-annual plan should be considered. Suggested solutions based on the following general interventions theories or combination of them can be forwarded:

1) Increase control and enforcement: This aims at solving the basic failures of the present TAC regime, by ensuring that it is implemented. This is largely the position adopted by the Baltic Sea RAC and the multi-annual plan.
2) Introduce novel technical measures that are justified by an ecosystem based approach. This is an approach advocated by among others Döring and Egelkraut (2008).
3) Close the cod fishery to allow recovery of the cod stock. This is the position ICES has taken several times (ICES 2007) and has earlier also been advocated by Swedish fisheries authorities and experts.
4) Remove direct and indirect subsidies that maintain non-sustainable fishing practices and excessive fleet capacity. At a general level EU and OECD has recognised that subsidies are part of the problem of the fisheries sector (OECD 2005).
5) Create large enough protected areas that support the recovery of the cod even if the TAC regime fails. (Röckmann et al. 2007)
6) Influence the market for cod so that present cod fishing becomes unprofitable until the stock has been built up. This idea is implicitly embedded in the Swedish campaign for

[10] Statement by the BS RAC on compliance and the sustainability of the Baltic cod fishery October 25 2007. http://www.bsrac.org/archive/Dokumenter/Recommendations/2007/BSRACStatementOct2007.pdf [March 22 2008]
[11] EC 2006. Proposal for a Council Regulation establishing a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks. Brussels, 24.7.2006 COM(2006) 411 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0411:FIN:EN:PDF [March 23 2008].

boycotting cod as food[12] and is closely related to the approach used by the Marine Stewardship Council.[13]

In the following we will discuss several of the solutions in order to make judgements of their feasibility and outline conditions for their effectiveness.

Increasing control and enforcement

An increase of the control and enforcement is in a sense an easy solution. About 90 % of the legally reported catches of eastern Baltic cod are caught by, in order of catch levels in 2006, Poland Denmark, Sweden, Latvia, Russia and Lithuania. It is probably fair to assume that the unallocated (illegal) catches also find their way to the markets primarily through these countries.

Improved enforcement and control require little modification of the existing socio-ecological complex, and it does not question the present management regime. It is therefore politically fairly uncontroversial. The legal framework also basically exists. Thus Poland, which catches about 30 % of the legally reported catch of cod in the eastern Baltic Sea has introduced a specific control program.[14]

The economic aspects of increased enforcement and control are a potential stumbling stone. The cost of enforcement is relatively high and the marginal costs increase rapidly with the attempted coverage. The Polish program includes 165 inspection days but there are altogether more than 800 vessels and 59 harbours, fishing ports and other places for landing of the fishery products on the Polish coast of the Baltic Sea. The ability to detect actual infringements are thus limited, unless there is a widespread support for the control in the fishing community. The social acceptance and legitimacy are therefore critical for the effectiveness of increased control. The situation is similar in other countries of the Baltic Sea.

Even if the enforcement and control would be fully effective, their effects on the cod stock would be limited. They would mainly reduce the unreported catches, and possibly increase the effectiveness of some technical restrictions. According the assessment of ICES this is far from enough to achieve sustainable cod fisheries in the Baltic Sea. As the discussion on the TAC-Machine above shows, the enforcement problem is just one the regime's weaknesses.

The multi-annual program aims at an annual 10 % decrease of fishing mortality, but additional provisions have been included that in practice means avoiding the full benefit of incoming strong year classes. Thus the TAC can be raised by up to 15 % whenever the 10 % reduction of fishing mortality seems to be reached. Given the uncertainty of the assessments and the high level of illegal

[12] The Swedish consumers campaign against frozen and then also fresh cod was initiated in 2006. http://www.konsumentsamverkan.se/11verk/kampanj/fiske/bojktorsk.htm [March 22 2008]. In February 2008 the campaign against fresh cod was discontinued and replaced by demands to have identified origins of the cod http://www.konsumentsamverkan.se/press/upphavdbojkott.htm [March 22 2008].

[13] As of September 2007 there are 857 MSC-labelled seafood products sold in 34 countries worldwide. Over 7% of the world's edible wild-capture fisheries are now engaged in the program, either as certified fisheries or in full assessment against the MSC standard for a sustainable fishery. http://www.msc.org/html/content_462.htm [March 22 2008].

[14] Polish national control action program for cod in the Baltic Sea in year 2008 implementing the Council Regulation (EC) No 1098/2007. http://www.minrol.gov.pl/DesktopDefault.aspx?TabOrgId=1210&LangId=1 [March 20 2008]

fishing this will cause a deliberate lag in the recovery process for little good. This possibility of delaying recovery has already been used by the Baltic Sea RAC. [15]

An ecosystem and community approach

A management programme based on the concept of natural capital (Döring and Egelkraut 2008) focuses on the health of the spawning stock and measures to ensure it without actually stopping the fishing.

> *The key to turn the vicious circle (Fig. 7) into a positive one is a selective fishing of cod that does not catch juvenile fish (Fig. 8). Fishery would target only such age classes of cod that have already spawned at least once. The selective fishing thus allows higher reproduction rate. After three years' delay the cod stock will become healthier. Decisive will be that there will be several younger year classes that are not caught, which will increase the stock , but also that fishery is not dependent on a single year class' recruitment success as it is now. The latter increases resilience of stock and fishery. Selective fishing that catches bigger cod means also that the catches will be bigger in tons even though the number of caught fish is lower.*
>
> *However, saving the Baltic Sea cod stocks will require drastic measures in the beginning. The management programme would start by reducing the allowable catch by half to 25 000 tons and changing to selective trawls. After five years the catch could be increased back to 50 000 tons and increased annually after that. The final phase after ten (or twenty years depending on the scenario) would be the change to long lines. At this point the average size of cod has increased enough so that long line would give enough catch. An additional benefit of long lines will be their much less severe effects on the Baltic Sea ecosystem (effects on sea bed, bycatch).*
>
> *The approach would also require reducing the number of fishing units. Acceptability of these drastic measures is enhanced by securing long-term licences to the remaining fishermen, which will create the necessary trust in the system.*

[15] Recommendations on the TACs for the Baltic Sea fish stocks in 2008 http://www.bsrac.org/archive/Dokumenter/Recommendations/2007/BS%20RAC%20recommendation%20on%20TACs%20in%202008.pdf [Marc 23 2008]

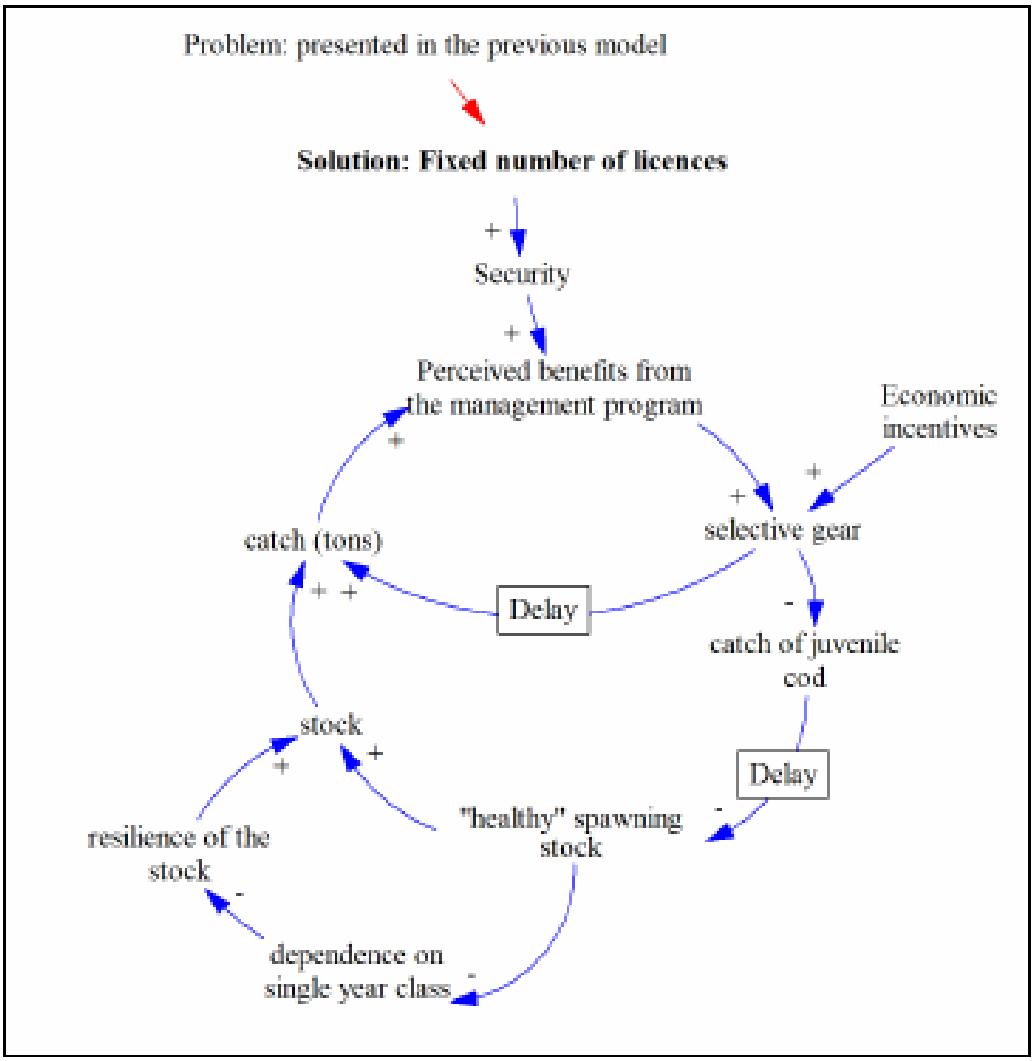


Fig. 8. A recovery programme for the Baltic Sea cod as suggested by Döring and Egelkraut (2008). ***(For a legend, see Fig. 1.)***

Political considerations

The new approach outlined by Döring and Egelkraut (2008) would require drastic measures and radical political decisions. They suggest "a shift away from the current system of setting politically manipulable quotas to permanently fixing the number of fishing licences". Fixing the fishing licences combined with guaranteed share of the (increasing) natural capital – the (growing) cod stock – will give the fishermen a sense of security of their future. In other words, the writers suggest abandoning the TAC system and replacing it with fixed number of fishing units (and at the same time reducing a number of the fishing units). This would be a major political and institutional

change in the Baltic Sea fishery requiring international negotiations and agreement on the new management approach.

Döring and Egelkraut do not much discuss how the initial reduction in number of fishermen will be executed, althought that is a major political and economic issue. As noted above there are five to six countries with substantial interest in cod fisheries (ICES 2007) and it is not simple to find allocation mechanisms that would be politically accepted. There is, however, a certain willingness to consider changes. The EU has clearly adopted a positive attitude to rights based management, and it is likely that changes may become feasible[16]. Thus the Polish review "Agriculture and food economy in Poland 2007"[17] notes that "Limits on the use of fishing potential (number of days at sea) may be replaced by individual catch limits in the near future."

This indicates that the suggestion of Döring and Egelkraut (2008) according to which the future landings could be allocated either through ITQ system or by establishing community rights on specific fishing grounds is not completely out of the question. The intervention theory of the ITQ (Fig. 3) suggests an "automatic" reduction of the number of fishing units when the ownership of quotas will concentrate in fewer units.

Legal considerations

Allocating fishing resources to a fixed number of fishing units means a change in the property rights. An ITQ system can avoid some of the allocation problems by letting the markets gradually take care of the redistribution. The initial distribution can be based on grandfathering in order to avoid controversies related to the different economic status of fishers in the different countries of the Baltic Sea.

In a case that the cod is transferred from a common property to community ownership major legal hurdles can be expected as the cod stock is not confined to a well defined geographical area that could correspond to an easily identifiable community or communities. The Baltic Sea RAC is about the closest one that comes to a community and its size, diversity and geographical distribution means that it differs fairly little from government driven negotiations in terms of diversity of participants and material interests. It may, however, contain elements that lead to greater acceptance of the measures. Without this acceptance it is unlikely that the multi-annual plan for cod or any other attempt to improve sustainability will be achieved.

The transfer of rights can in itself lead to multi-level governance. As Kitts and Edwards (2003) note, part of the restricted access may open up opportunities for the emergence of collectives of various sorts. Any legislation that governs a (re)distribution of rights would need to pay attention to the possibility of "private multi-level governance" in addition to the multi-level government processes.

Economic considerations

Döring and Egelkraut (2008) anticipate that in order for the fishery to survive over the recovery period of the stock, the industry needs government subsidies either as direct payments or as loan guarantees. This will facilitate the commitment of fishermen to the system. The writers argue that

[16] EC 2007. Communication from the Commission on rights-based management tools in fisheries. Brussels, 26.2.2007 COM(2007) 73 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0073:FIN:EN:PDF [March 23 2008].
[17] http://www.minrol.gov.pl/DesktopDefault.aspx?TabOrgId=1210&LangId=1 [March 22 2008]

eventually the benefits of the system will be higher that the initial phase's costs of 187.5 million euros. However, the states' capability to invest such amounts depends heavily on the political will and trust in the proposed approach's future benefits.

One major challenge will thus be the distributional effect of the scheme. A convincing demonstration that Pareto efficient solution can be achieved not just within a single country but across all relevant cod fishing countries in the Baltic Sea is a very tall order.

Closure of the cod fishery

In 2007 ICES recommended to stop the fishery completely or reduce catches drastically from the Eastern Baltic cod stock. Similar recommendations have been given earlier, too, but the fishery has continued. Reluctance to close a fishery is seen as the TAC system's weakness to make drastic decisions. The main reason for not closing the fishery is the economic and social concerns of present fishers and fishing communities (Döring and Egelkraut 2008; Nielsen and Holm 2007; Sumaila et al. 2000). Closing a fishery is a drastic measure, and the strength of its impacts is highly dependent on alternative opportunities. Momtaz and Gladstone (2008) report that in a case where no alternative fisheries were available the social impacts were dramatic, consisting of lost jobs, wider impacts on community, loss of lifestyle, loss of cultural heritage and loss of pride.

Political considerations

The expected dramatic social consequences of a closure make the solution next to impossible to implement, unless a collapse of the stock has actually occurred. In those countries of the Baltic Sea in which the cod is an important part of the catch the alternatives are relatively few. A temporary closure would require subsidies for the fishers and communities to overcome the temporary hardship caused by a closure.

The present political infeasibility of a closure is clearly expressed by the Baltic Sea RAC, which concluded "The BS RAC recommends a TAC of 50,945 tonnes (+15%) based on ICES's interpretation of the proposed Multi-annual plan for cod stocks in the Baltic Sea. A minority of RAC members recommends a decrease of the TAC by 15% based on the fact that the stock is still below the limit reference point for the spawning stock biomass."[18] The statement of the BS RAC neglected the fact that ICES actually proposed a closure or strict reduction (ICES 2007).

Legal considerations

The Council Regulation (EC) No 1098/2007 of 18 September 2007 establishing a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks includes Article 7, according to which " By way of derogation from Article 6, the Council may, where it considers this appropriate, adopt a TAC that is below the TAC that follows from applying Article 6." Thus a closure is legally possible, but it requires a Council level decision.

In 2002 there were initiatives in Sweden that a unilateral Swedish closure should be adopted. An agreement between the Social Democrats, the Leftist (socialist) Party and the Green Party aimed at unilateral closure from 1 January 2003. The possibility of such a unilateral closure was ruled out by

[18] Recommendations on the TACs for the Baltic Sea fish stocks in 2008 http://www.bsrac.org/archive/Dokumenter/Recommendations/2007/BS%20RAC%20recommendation%20on%20TACs%20in%202008.pdf [Marc 23 2008]

the Commission on the grounds that this would interfere with the Common Fisheries Policy (Lövin 2007).

Economic considerations

The closure of a fishery is a costly action, but several calculations have indicated that the costs may not be all that great in comparison with the subsidies that maintain the present unacceptable situation. The time it takes to build up the cod stock is also surprisingly short 3 to 4 years. The obvious difficulty is re-channelling the subsidies from supporting a build up of fishing effort to a reduction of effort. The time needed for adjustment also has to be taken into account and this can, in theory be achieved through buy back schemes, provided that new vessels can be kept from entering the fishery.

In 2008 the Ministry of Agriculture of Sweden launched a buy-back programme to reduce the fishing fleet drastically: one third of the big boats and half of the middle size boats will be decommissioned.

Removing subsidies and adjusting fleet capacity to resources

It is obvious that the fishery for cod in the Baltic Sea would be different if there would be no or had not been any subsidies that have contributed to a large fishing capacity. The EU has focused on the issue, but the action is relatively slow. Thus Horbowy and Kuzebski (2006) conclude: "Between the years 1994 and 2005, FIFG [the EU Financial Instrument for Fisheries Guidance] co-financed withdrawal from operation of vessels in eight EU states fishing on the Baltic Sea (Germany, Denmark, Sweden, Finland, Poland, Lithuania, Latvia and Estonia). The total tonnage of those vessels amounted to 58 thousand GT, whilst the total power to 204 thousand kW. At the same time, the Fund supported construction of vessels with the total tonnage of 25 thousand GT and power of 72 thousand kW. Therefore, the net balance of the reduction of the fleet capacity equalled – 33 thousand GT and -132 thousand kW, which is tantamount to more or less the size of the whole Polish Baltic fleet at the end of 2004. Such a reduction has undoubtedly contributed if not to improvement of the state of the resources then at least to halting of their further degradation."

Political considerations

Elaborated systems of direct and indirect subsidies are part and parcel of policies affecting fisheries and the Baltic Sea is no exception. It is challenging to trace these subsidies that support fisheries, because they do not all come under clear headings in state budgets. A rough and polemic, but transparent, calculation by Lövin (2007) suggests that the amount of subsidies in Sweden are close to the value of the commercial catch.

The Commission has recognised the problem and initiated studies that may provide information helping to overcome some political obstacles (MegaPesca 2000). For the Baltic Sea cod fishery more detailed information on the role of subsidies and on the structure of the fisheries is likely to provide information on how and where to focus measures.

Legal considerations

Restrictions on state aid have, since the expansion of the EU hindered countries from indiscriminately subsidising their own fishing fleets. There are, however, still many legal ways of

subsidising fisheries as show by the development of the fishing fleet. Since the subsidies for removing vessels will probably mostly be used by those vessels who in practice fish little, whereas the subsidies for renewal will be used by those aiming at as high effort as possible the actual effect on the fishing pressure may be small (as in fact has been observed). A legal solution to this would be to introduce still more strict criteria on the subsidies for renewal of the fleet.

Economic considerations

It is likely that many of the present subsidies are far from efficient in economic terms. They are maintained due to political agreement. Cost-benefit, or cost-effectiveness analyses, taking into account the side effects, are likely to provide further insights into the economics of the overfishing for cod in the Baltic Sea. Such studies are also likely to support the targeting of decommissioning activities aiming at an adjustment of the fleet.

Marine protected areas

Röckmann et al. 2007 modelled the effect of permanent or temporary closures of important reproduction areas of cod in the Baltic Sea. They used five management scenarios:

- Fishing mortality 'as usual' over the 50 year simulation period
- Overall reduction of fishing mortality by 70% in all three ICES subdivision (SD 25, 26 and 28)
- Seasonal closure of SD 25 in quarters 1 and 2; quarters 3 and 4 open to reduced (-50%) fishing
- Permanent closure of SD25
- Total closure of fishery in all three subdivisions

In addition to the management scenarios different environmental scenarios plausible in the Baltic Sea environmental context were taken into account. The main conclusions were:

- MPAs would be beneficial for cod stock under both favourable and unfavourable environmental conditions and can reduce the impacts of variable environmental conditions on the stock
- MPA can improve the age structure of initially overexploited fish stocks serving as positive feedback

The critical assumption is the very drastic reduction of the fishing mortality in line with other studies.

Political considerations

A major closure such as SD 25, which in practice means most of the area between Poland, Bornholm, Sweden and Gotland, faces serious political obstacles. It will not affect Baltic fishers equally and it will be easy to argue that it would seriously upset the "traditional" distribution of fishing rights. Therefore the whole distribution key concerning not only the cod fishery but also all other fisheries would need to be reopened. This is in line with Kaiser's (2005) observation that "[] the scale of MPAs required to ensure sustainable fisheries of wide-ranging, long-lived species, such as cod and plaice, may be both impractical and equally prone to the same political horse-trading that has neutered many current management systems".

Legal considerations

Limited restricted areas have been used in the Baltic Sea both nationally and internationally. The legal basis does thus exist, for example in the multi-annual program for the cod. However, MPAs

that aim at whole sale closure of all significant fisheries is a different matter and the areas that exist are very small. At a national level this can be achieved through the creation of aquatic strict nature conservation areas based on nature conservation legislation.

Economic considerations

The establishment of MPA is likely to lead to demands for compensation from fishers excluded from the areas. There are distributional effects that may be significant. If non-commercial fishing is allowed within the areas, the recreational fishers may benefit from a higher proportion of prize fish (Blyth-Skyrme et al. 2006). In the case of cod in Baltic Sea this is not likely to be of high significance, although observations have been made on the Swedish west coast that near shore populations of cod have probably been severely depleted, and this has been observed by recreational fishers. At any rate, the distributional issues are an issue that needs to be taken into account, which requires detailed socio-economic data for potential areas and their use (Richardson et al. 2006).

Influencing the market for cod

Although fisheries management and issues of fisheries and aquaculture products reside within the same DG in the European Commission, the two worlds are still largely separated. The Commission has recognised the potential and sees "eco-labelling schemes as a means of integrating environmental protection concerns into the fisheries sector"[19]. The Commission refers extensively to development work that has been conducted by the FAO (2005).

The markets for fish and fish products, reflected in the price of the fish, are driving forces underlying unsustainable fisheries (Fig. 9). This simple fact has yet made no trace in the multi-annual program for the cod management in the Baltic Sea. If markets could be influenced in such a way that demand for cod would drop, many of the other measures for stock recovery would become easier to implement. If, on the other hand, the demand for cod increases, management measures will be increasingly difficult to enforce.

Consider the herring and sprat fisheries in the Baltic Sea. They appear to be sustainably exploited but one can argue that the sustainable management is the result of a modest demand (price) for these fish relative to the cost of catching them. The salmon fishery in the Baltic also illustrates the importance of markets. The expansion of salmonid aquaculture has reduced the price of wild salmon in the Baltic Sea to modest levels. The number of salmon fishers has declined "naturally" and it has therefore become easier to implement restrictions of the fisheries and to get positive response on buy back schemes.

Political considerations

In 2006 Swedish consumer organisations initiated a boycott of frozen cod, following revelations that the Barents Sea cod fishery included substantial illegal activities and that part of these illegally fished cod ended up in Swedish super markets. [20] The idea of a boycott also spread to fresh cod. In 2007 a book was published on the mismanagement of the fish stocks in the Baltic Sea and

[19] http://ec.europa.eu/fisheries/cfp/market_policy/ecolabel/community_en.htm [March 24 2008]
[20] The Swedish consumers campaign against frozen and then also fresh cod was initiated in 2006. http://www.konsumentsamverkan.se/11verk/kampanj/fiske/bojktorsk.htm [March 22 2008].

elsewhere (Lövin 2007). It gave further impetus to public debate on using consumer power to affect fisheries.

The discussion has continued in a lively way. The worries of citizen actualized as a boycott on cod that WWF Sweden also supported. Some well known restaurants stated that they have stopped serving cod or are only serving cod that is not from the Baltic Sea. Municipalities also joined the boycott by not using cod in the meals served in municipal facilities.

The boycott has raised debate in the country and not all accept it. The latest turn in the discussion is, though, that consumers are encouraged to buy certified fish instead of boycotting cod totally.[21] The argumentation is that not all cod is coming from endangered stocks and not all fishing of cod is unsustainable. In other words, the debate has become more detailed and differentiated. A consumer organisation in Sweden is supporting more qualified decision making by consumers, which means stronger emphasis on traceability of fish products: consumers must have a possibility to know the origin of the fish. Certification is a proactive means to influence the harvesting sectors. The organisation's argument goes that if consumers just stop buying the fish, the fish will be caught anyway and sold abroad. But if the consumers have a possibility to choose a certified fish, the message to producers is clear.

The case of the Swedish cod boycott and the turn toward eco-labelled fish is an interesting case of consumer activism. Another possible path to create a disincentive to overfishing is the introduction of substituting products. The substitutes could come from stocks that are not overfished or they could come from fish farming. In the Swedish debate pangasus fillets imported from Vietnam were mentioned as one possible substitute and there are some examples of restaurants substituting cod with pangasus.

The wider political question is to what extent public bodies should support or take part in efforts to influence markets in a sustainable way. Two main routes are available:

- Support or endorse eco-labelling schemes such as the Marine Stewardship Council (MSC), which follow the FAO guidelines (2005) to specify products from "sustainable fisheries".
- Apply and use sustainability criteria in public procurement of fish and fish products.

In addition, trade policies and their implementation can be developed in such a way that they do not put undue restrictions on the products from sustainable fisheries. In extreme cases restrictions on trade of endangered fish stocks are also conceivable through the CITES-agreement. Today 95 species of ray finned fish and 10 species of elasmobranchs are listed in the CITES database[22] but the Baltic cod does not belong to these.

Legal considerations

The Commission has outlined three possible positions on ecolabelling ranging from no action to a community wide single unified eco-labelling scheme (cf EMAS) to general support for voluntary

[21] In February 2008 the consumer organisations's campaign against fresh cod was discontinued and replaced by demands to have identified origins of the cod http://www.konsumentsamverkan.se/press/upphavdbojkott.htm [March 22 2008].

[22] http://www.cites.org/eng/resources/species.html [March 24 2008]

eco-labelling approaches.[23] A unified system is clearly the most demanding legally speaking. The European Economic and Social Committee has adopted a position according to which the establishment of minimum requirements for voluntary eco-labelling should be the preferred route.[24]

A European framework would in principle make it possible for the Baltic countries to support the development of a specific eco-labelling scheme for Baltic fish. However, the demand for fish in Baltic countries exceeds the sustainable production of Baltic fish and therefore issues of imported products would arise. The import of fish products are controlled by EU-legislation, which so far has not paid particular attention to sustainability issues.

In the case of procurement care will have to be taken not to breach competition legislation. For Baltic cod this is not likely to be a serious issue. The amounts procured by any one public body are likely to be small.

Economic considerations

If eco-labelling and sustainability oriented procurements become successful they could provide additional profits to those who exploit resources in a sustainable way. If the systems are operated by markets the input needed from public resources are minimal, beyond ensuring that the criteria are fair and actually implemented.

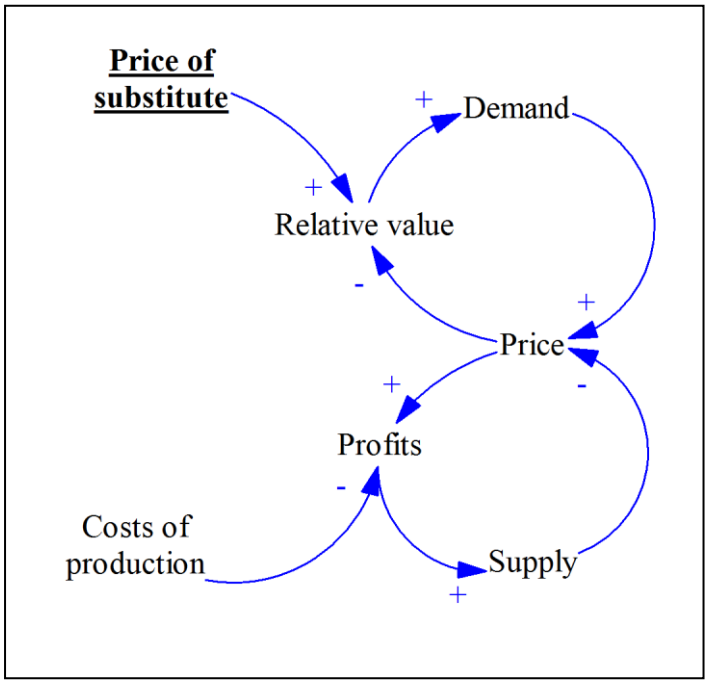


Fig. 9. The classic economic view of how the price of a substitute influences the relative value of a supplier's good (Sterman 2000, 170). A lower priced substitute to Baltic Sea cod would reduce demand for the Baltic Sea cod.

[23] EC 2005. Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee Launching a debate on a Community approach towards eco-labelling schemes for fisheries products. Brussels, 29.06.2005 COM(2005)275 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0275:FIN:EN:PDF [March 24 2008]
[24] EESC 2006. Summary of opinions adopted. http://www.eesc.europa.eu/activities/press/summaries_plenaries/2006/grf_ces26-2006_d_en.pdf [March 24 2008]

4.3 The fishing for migratory fish

Approaches to cod management are applicable to many fisheries and therefore we will not repeat them here. Fishing for migratory fish raise, however, some specific issues that need separate consideration. There are fishers who target the stock in various geographical regions, but they are also targeting different life stages of the stocks. Salmons in the Baltic Sea have various life stages that typically are also geographically differentiated between rivers and the sea: the salmon may spawn in the rivers of the northernmost part of the Baltic Sea drainage and migrate to the southern parts of the Baltic proper. The harvest of salmons is with several small salmon fisheries characterised by different timing, gear, catchability, fishing costs and prices. However, the differentiated fisheries are interdependent through their cumulative effect on the spawning stock. (see Kulmala et al 2008.)

Migration on wide areas and different salmon fisheries' interdependencies necessitate coordinated, international actions in management. While regarding the cod fishery the necessity for coordinated actions stems especially from the cod's economic importance to several Baltic Sea states, in the case of salmon the main focus is perhaps on the biological factors that connect several countries along the migration routes.

As almost all of the Baltic Sea states are EU member states, EU decision-making is important in guiding the commercial fisheries. The Baltic Sea RAC has taken a proactive role in the discussions about future management of the Baltic Sea salmon fisheries[25].

Earlier coordination of salmon management was mainly done through the IBSFC (International Baltic Sea Fisheries Committee). In 1997 the IBSFC launched a Salmon Action Plan 1997-2010. The programme emphasised especially the recovery of reproduction success of various (river-specific) salmon stocks. The goal was "to attain by 2010 for each Salmon river a natural production of wild Baltic Salmon of at least 50% of the best estimated potential". The Salmon Action Plan has been quite successful in improving the natural production of wild salmon. According to a recent ICES assessment (ICES 2007) "wild smolt production is now estimated to be around two thirds of the potential smolt production". There is though great variability between salmon rivers regarding the recovery of the reproduction success (ICES 2007).

The most important measures that have been taken to implement the action plan are reduction of TAC (from 650 000 salmons in 1993 to 410 000 in 1997 and back to 460 000 in 2003), limiting of fishing seasons during the spawning migrations and area closures in river mouths. Also some technical measures have been introduced.

The EU Commission has taken initiatives to develop a management plan for the Baltic Sea salmons to continue the work started by the Salmon Action Plan.

In spite of the increased smolt production of the rivers, low post-smolt survival in the sea is hindering recovery of the stocks. For wild salmons the survival rate has crashed from approx. 20% in early 1990s to less than 5% in recent years. The number of spawners is, in fact, predicted to decrease in 2007-2008 and, therefore, the ICES recommends taking a precautionary approach and to further reduce salmon catches and fishing effort. Reasons for the decrease in post-smolt survival are still unclear (ICES 2007). In addition, a 'natural' survival rate is unknown.

[25] BS RAC RECOMMENDATION ON A SALMON MANAGEMENT PLAN FOR THE BALTIC SEA (http://www.bsrac.org/archive/Dokumenter/Recommendations/2007/RecommendationSalmon010307.pdf)

The latest change in the Baltic Sea salmon fisheries is that the ban on drift nets came into force in 2008. This technical restriction aimed primarily at reducing by-catches in various European fisheries, but it does have, of course, consequences for the target species. In the case of salmon fishery in the Baltic Sea the technical regulation will reduce fishing mortality of salmon in open sea fishery to very low levels. However, the low post-smolt survival can still mean that the drift net ban has relatively little effect on salmon stocks (see ICES 2007).

In sum, the Baltic Sea salmon fishery management shows that reproduction success can be increased through measures to protect spawners. The protection of spawners may be easier compared to species with less distinctive migration habits. With such species even more effort needs to be put on reduction of overall fishing mortality and on selectivity of fishing to protect spawners. However, the post-smolt mortality of the salmon has diminished the success of the Salmon Action Plan. This emphasises the complexities population dynamics that are not only governed by anthropogenic fishing mortality.

5. Conclusions

5.1 The persistence of the problems

A top down TAC-based regulatory regime is used in the Baltic sea fisheries that can be classified as unsustainable. One can somewhat cynically argue that the present regulatory regime, including the multi-annual program for cod, will appear to "solve" the problems only if external conditions change so much that the root causes of the problems are dissolved. Such changes can arise almost in any part of the socio-ecological fishery complex: a collapse of the stocks following prolonged recruitment failure, a disappearance of the market for fish from the Baltic Sea following the detection of new persistent pollutants in the products, a drastic decline in the profitability of the capture fisheries as a consequence of cheap substitutes or increasing costs of fishing, or a lack of recruitment of fishers due to changing preferences and development of alternative forms of employment in coastal communities. In the salmonid fisheries some of these changes have already occurred.

It is evident that 'politics' will play an important role also in the future, since coastal economies are partly dependent on the exploitation of living aquatic resources. The resource management problems of the Baltic Sea will certainly not be solved by research only. The idea that one could develop scientific fisheries management free of politics is simply ill-informed. By recognizing the necessary political element also research may be better focused. By accepting the political dimension researches may, somewhat paradoxically, be able to deliver more neutral research that different parties may regard as relevant.

5.2 Does the EU-funded research support solutions?

The EU spends significant resources on research related to fisheries. One could hope that this research will provide answers to many of the pressing questions. The likelihood of obtaining meaningful answers can be critically evaluated with reference to the component of the socio-

ecological complex that exploits the living resources of the Baltic Sea. As argued in the introduction the socio-ecological complex consists of

- The resources themselves (the fish stocks and their dynamics);
- The factors that affect the resources (environmental conditions, ecological relationships in the system);
- The factors that influence possibilities to exploit the resources (technical, regulatory (Common Fisheries Policy, CFP, and national), environmental);
- The factors that influence the possibilities to make a living of resource exploitation (The markets for the products, restrictions on the products (linked also to environmental factors: Persistent Organic Pollutants (POPs), mercury (Hg), others), temporal and technical restrictions on fishing activities, regulations concerning aquaculture;
- The actors involved in the exploitation and its regulation;
- The institutions maintaining and updating the regulatory system concerning the exploitation and factors affecting the market;
- The wider society that forms the framework for the management and exploitation of aquatic resources.

The research that has been initiated under FP6 and that has immediate relevance for the problems at hand (for details see appendix 1) have covered issues such as

- Data management
- The ecological basis for ecosystem management
- The social, economic and ecological basis for MPAs
- Ecological modeling tools
- The basis for technical regulation
- Multi objective analysis supporting CFP
- Social & psychological aspects of fishery regulation
- Economic aspects of regulation
- Governance
- Aquaculture
- Conflict resolution between fisheries and nature conservation

As such the objectives and foci of the project appear to cover reasonably well the elements of the socio-ecological complex. The balance between different efforts can always be debated and it is not obvious that all of the projects serve, or should serve, an instrumental purpose.

What is clearly missing or only addressed in an oblique way is research that would foster understanding of the fishery in a wider societal frame and the politics that is related to this position. Nearly all the research aims at addressing the fisheries problems as “fisheries problems” with the implicit assumption that problems can be solved when sufficient knowledge has been gained of the ecological basis of the fisheries, the way fish is caught and sold, and of the way fishers like to be governed or react to regulation.

5.3 Possible ways forward

There is no disagreement among researchers and fisheries managers that the state of the fish stocks and the fisheries of the Baltic Sea could and should be greatly improved. This view is not, however,

necessarily shared by all fishers. Some feel that the researchers and the administration lack a full view of the situation. On the other hand there is at least in some countries surrounding the Baltic Sea a growing public awareness that something should be done. Yet very little has happened in practice although the basic problems have been well known for more than two decades as evidenced by, for example, ICES reports and recommendations. This raises the following questions:

- Where one should focus attention in the future, and
- Which measures could succeed, where past measures have failed?

The most pressing problems are those related to the cod stocks and cod fisheries. Some herring stocks are also exploited above what has been considered sustainable, and salmon fisheries should be restricted to allow for low post smolt survival, but in comparison with the problems of the cod fisheries these are less acute (ICES 2007). ICES (2007) has proposed a complete cod closure, but the multiannual plan[26] for the cod in the Baltic effectively excludes such a measure, unless there is a stock collapse. It therefore appears that the present EU-management has negotiated itself into a dead end. That is, only modest action is possible since fisheries interests are reluctant to accept any new measures. The situation is thus locked and the risk of a collapse is obvious. A collapse would materialize if recruitment falls two to three years in a row.

The basic premise is that the present "TAC machine" is unable to solve the problems as long as one fails to implement sufficiently strict control (Anon. 2007). Such control is virtually impossible to build up. It would be prohibitively expensive to achieve "full control" over all relevant fishing operations. It thus appears futile to try to lower fishing pressure through the present TAC regime in the Baltic Sea unless one is able to introduce new elements and perspectives. No amount of lobbying is likely to change the mindset of those responsible for setting the TAC unless a collapse actually occurs. There is very strong lobbying for status quo, as shown by the Baltic RAC proposal to increase TAC at the first instance of a slight improvement in cod recruitment. This is in line with the reasoning built into the multiannual plan.

5.3.1 General remarks

The workshop approached fisheries management from a social science point of view. This means that the status of the stocks was treated as a starting point, but not a primary issue of debate. Instead the focus was on fisheries and fish management as social and economic activities and the factors that affect their evolution. Some key observations were:

The management of fisheries is not primarily about managing fish stocks but about managing people, or creating conditions for people to manage themselves. This is also true, and perhaps even more so of "ecosystem management", because it widens the range of stakeholders. Therefore key issues that the workshop addressed and that should be considered in developing any management regime include the following:

- Trust between actors such as fishers, researchers, fish traders and consumer organisations and factors affecting possibilities to maintain the trust in the fairness of the governance;
- Legitimacy and acceptability – ways to increase buy-in into the management and management measures?

[26] Council Regulation (EC) No 1098/2007 of 18 September 2007 establishing a multiannual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 779/97. Official Journal of the European Union 22.9. 2007. L248/1.

- Transparency and openness at all levels – in particular, is the present Regional Advisory Council (RAC) appropriate for maintaining openness concerning the basis of its positions and decisions if it would be entrusted with greater responsibility for the stocks ?
- Development of common language between stakeholders;
- Organizational and legal aspects of management: which values and whose values does the management regime reflect?
- Distributional issues and social justice: who bears the consequences, who has responsibility?
- Top-down vs bottom up approaches in decisions concerning the regulation of the fisheries;
- What networks between actors such as fishers, fish traders and environmental NGOs and administrators are created and maintained, who influences what?
- Evaluation of management and management measures to increase learning and adaptation among both fishers and managers;
- Understanding incentives that exist and that management systems create;
- The role of uncertainty in management. Uncertainties restrict not only what can be known of fish stocks and fisheries. The fact that all knowledge is uncertain is also used as a key argument, both in advocating precaution and in arguing for status quo. Robustness is therefore a key issue.

A notion which can broadly be characterised as governance for adaptive management was central to the discussions. There is a recognition that not only the ecological system but in particular the social components of the socio-ecological complex is likely to change. Therefore one should look for adaptive approaches that avoid strong administrative closures in the governance, so that one does not replace the dysfunctional "TAC machine" with other types of "machines". Strong closures, for example in the form of heavy top down decision processes create external effects, but more importantly, make the regime incapable of dealing with external changes affecting the system. A key problem lies in the control mechanism. If there is little acceptance of the need for restrictions, fishers will easily find ways of making any management system function poorly. If the need to restrict fishing pressures to levels that are lower than the present ones is generally accepted one can partly rely on and develop internal control mechanisms.

5.3.2 A broader view of the fisheries

The workshop discussed extensively approaches that could broaden the view of fisheries. Instead of narrowly focusing on fishing operations (how much fish; catching techniques; effort; etc.) and regulation of them, an important aspect is to think of external factors that create incentives for overfishing. If one is able to identify and understand the nature of the external factors, they may offer new ways of influencing the fisheries indirectly, but more efficiently than through traditional management structures. For example, influencing markets by raising consumer awareness and removing barriers to the introduction of substitutes can be more efficient than attempts to reduce the TAC. This could be achieved by supporting the development of eco-labelling, finding and marketing substitutes of cod. By forcing the fisheries to internalise the risks of stock collapse in the form of insurances that are not covered by public funding one could also affect the pricing of stocks that face a clear risk of collapse.

Research implications:

- Studies of the incentive structures and socio-economic drivers of commercial fisheries in the Baltic Sea. The fisheries are not homogenous but the variability is not displayed by aggregate data. Especially relevant seem to be value chains and fish markets, since these

may provide opportunities in addition to a greater understanding of the roots of the persistent problem of overfishing.

- Studies of the markets for cod from the Baltic Sea may lead to the identification of substitutes that could be actively promoted as such. The analogy with the salmon fishery is obvious. One of the factors that facilitated the introduction of the Baltic Salmon Action Plan was the introduction of substitutes that lowered the prices of salmon and reduced the profitability of fishing in the open sea.
- By analysing the potential of market-oriented measures, like eco-labelling, one could find ways of increasing consumer awareness especially in those countries which have not seen overfishing as an issue.
- Research that supports the internalization of factors that are presently external to the TAC approach should provide analyses of the system to be governed and its scope and characteristics. The present TAC-machine includes no appreciation or understanding of the diversity of the fisheries. Research should explore how the roles of the managers and the managed could be changed so that one could respond to illegal practices by other means than simply demanding more and expensive external control. The types and levels of disincentives should also be examined so that one could identify the most efficient ways of responding to different illegal activities. The research needs to analyse multiple scales and multiple sectors in management regime.

5.3.3 Rights or privilege based management as a solution

The introduction of Rights Based Management (RBM) was one of the issues discussed extensively at the workshop. RBM in the form of Individual Transferable Quota (ITQ) have been introduced in Denmark and there are indications that the approach will be adopted in other countries around the Baltic Sea as well. The introduction of ITQs is based on the TAC thinking, but the implementation failures of a 'normal' TAC system should be reduced. If Rights Based Management is introduced throughout the Baltic Sea the following actions are possible:

1) Ensure that the ITQ is designed in such a way that it allows a broad range of stakeholder to participate in the market for fishing rights. With broad participation, conservation interests may buy rights to fish and thereby lower the fishing pressure below the TAC. At the same time attention needs to be paid to those sectors that are exempted from the Rights Based Management such as recreational and subsistence fisheries. These sectors contribute to a large proportion of the catch in several regions, and could provide a loophole past any regulation.
2) Develop new versions of RBM, for example by providing the rights to communities rather than to vessels or companies. Such approaches may reduce the economic efficiency, but may help to maintain and develop new fishing communities.
3) Consider shifting to privilege-based management (used in some fisheries in the US, Andrew Kitts, pers. comm.), which are conceptually different from rights based management (but attempt to mimick important aspects of RBM) in that the fish resources remain public property, and vessels, communities and others are only granted a privilege to exploit these resource under certain conditions. If conditions are violated loss of the privilege would follow without any compensation.

Research implications:

- Analyses of different legal models for the ITQ that can be used in debates on the design of the system(s). A particular issue is whether ITQs remain national (or even regional within a country) or whether rights can be bought and sold freely between member states. A social and economic analysis of its consequences for the fisheries in the Baltic Sea under complete transferability would provide information on the feasibility of a general ITQ for the whole Baltic Sea. A general ITQ would inevitably over time reduce the role of individual Member States in the quota negotiations.
- Analyse potential consequences of paying attention to discards and ways of avoiding discarding (including regulatory incentives);
- Provide an overview of present fishing communities and their role in the Baltic Sea fisheries and analyse which communities could appropriately obtain quota.
- Carry out analyses of what privilege based management would entail in practice in the Baltic Sea. Comparative analyses of the conditions in selected US fisheries and Baltic Sea fisheries from a social, economic and legal point of view are likely to yield a better understanding of the feasibility of privilege-based solutions and their likely consequences.

5.3.4 Ecosystem based management

Ecosystem based management has been raised as a potential solution to the management of marine resources. ICES will, for example, provide management advice that includes different aspects of the marine system.[27] However, scientific advice will not bring change in the Baltic Sea on its own merits since there is a long tradition for disregarding advice from the scientific community. Ecosystem management and the extended use of instruments such as marine protected areas or other ways to carry out marine spatial planning will require detailed analysis of their practicality.

Research implications:

- An analysis of the political feasibility of an alternative management regime. It is likely that there will be fierce opposition against major changes but there may also be some support and so it is essential to understand the relevant political processes if one tries to initiate such changes.
- An analysis of alternative goal setting procedures: how are the goals set in a multi-level governance structure?
- Conflict analysis, arbitration and resolution: what mechanisms can be used?
- Studies of alternative ways of ensuring participation.
- Analysis of the role of valuation and values in directing management.
- Examination of cost curves of learning how to manage the system in the face of external change driven by, for example, climate.

5.3.5 Buying out fishing capacity

Scrapping programmes have been in place in the Baltic Sea. In principle they are the most direct route to reducing fishing effort and they have reduced the fleet in terms of tonnage, but the fishing effort for cod has not been significantly reduced. An explanation is that scrapping tends to take out vessels that have little active effort, while at the same time the active vessels improve their technology and efficiency. Thus, if a reduction of the active effort, i.e. the fishing mortality, is the

[27] Council 2008 extra meeting on Advice/ Doc. C.M. 2008 Del-04 .
http://www.ices.dk/iceswork/bulletin/ACOM/Resolutions/ [11.5. 2008]

primary goal, buy out programmes must focus on the active part of the fleet and must ensure that effort from other fisheries do not “backfill” into what was removed. One way of avoiding the recruitment of new vessels to the fishery is to combine buy out schemes with rights based management that regulates the entry. Potential loop holes include the "recreational" fishery, which can become semi-professional unless there are strict regulations on, for example, permissible gear.

Buying out the active part of the fleet means higher costs per tonnage, but increasing effectiveness in terms of reducing fishing effort. In principle a private foundation can be created to supplement the publicly funded programmes, but there should be close linkages and careful analyses to direct the activity and to ensure that it does not, for example, increase costs of the whole scheme by driving up price expectations.

Research implications:

- Analyses of the willingness to sell capacity and of the factors that influence this willingness in different fleets, possibly linked with rights based management.
- Studies of the optimal efficiency of the use of resources in reducing effective effort rather than total tonnage.

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Appendix 1.

European research projects related to Resource management. The projects mentioned in the list cover the following themes 1) Data management, 2) The ecological basis for ecosystem management, 3) The social, economic and ecological basis for MPAs 4) Ecological modelling tools, 5) Basis for technical regulation, 6) Multi objective analysis supporting CFP, 7) Social & psychological aspects of fishery regulation, 8) Economic aspects of regulation, 9) Governance,10) Aquaculture, 11) Conflict resolution between fisheries and nature conservation (the theme is mentioned in parentheses before project description).

Project	**Objectives**
Cod spatial dynamics and vertical movements in European waters and implications for fishery management CODYSSEY	(2) Main objectives of the project are identifying the key environmental forces of horizontal movements of cod, reconstructing movements of cod in relation to spawning / feeding grounds, describing patterns and mechanisms of vertical movements in relation to environmental parameters and developing predictive models of vertical distribution of cod.
Effects of changes in fishery discarding rates on seabird communities DISCBIRD	(2) The objective of the project is quantification of the impacts of changes in fishery discarding rates on seabird communities.
Managing fisheries to conserve ground fish and benthic invertebrate species diversity MACFONS	(2) The objective of the project is to provide the scientific advisors to fisheries managers with mathematical tools for the quantification of ground fish & benthic invertebrates to achieve particular fisheries objectives
Research on effective cod stocks recovery measures RECOVERY	(5) The objective of the project is to develop selective demersal fishing methods
Costing the impact of demersal fishing on marine ecosystem processes and biodiversity COST-IMPACT	(5) The primary objective of the project is to research the impacts of demersal fishing for the biodiversity of marine benthos
Value of exclusion zones as a fisheries management tool in Europe: A strategic evaluation and the Development of an Analytical framework VALFEZ	(4) The objectives of the project are the evaluation of the ecological and socio-economic value of exclusion zones as tools of fisheries management and development of robust analytical frameworks and models for use in the evaluation and development of exclusion zones
Multiple objectives in the management of EU fisheries MOFISH	(6) The objectives of the project are: 1) development of a framework for the analysis of fisheries management, 2) defining of objectives to the fisheries management process and the CFP, 3) defining preference of interest groups in the EU fisheries management, 4) development of case studies of EU fisheries, 5) Analyzing results and trade offs for all case studies to investigate an optimally managed fishery from the perspective of interest groups individually
Technical efficiency in EU fisheries: implications for monitoring and management through effort control TEMEC	(5) The objective of the project is determination of the most appropriate methodology for the estimation of efficiency of used inputs in a number of EU fisheries
Development and testing of	(5) The main objective of the project is to build and test a new mesh gauge

an objective mesh gauge OMEGA	suitable for fisheries research and industry
Margins along the European seafood value chain – impact of the salmon industry on market structures SALMAR	(8) The objectives of the project are understanding of the dynamics of the seafood value chain over the last 20 years in Europe, explaining of the price-cost margins in a dynamic way and achieving of a better knowledge of fish markets
Mutualisation on fisheries and aquaculture of European research institutes MUTFISHARE	(10) The objective of the project is organising and coordinating of research programs and facilities to support the CFP.
Fishery regulation and the economic responses of fishermen: perceptions and compliance FISHREG	(7) The project will develop and employ a methodology to investigate fishermen's responses to fishery regulations; aims at improving the effectiveness of management.
Economic assessment of European fisheries EAEF	(8) The aim of the project is to integrate and analyze the available economic information in order to contribute to effective management of fisheries.
Modelling fishermen's behaviour under new regulatory regimens MFBUNRR	(7) The objective of the project is determination of most appropriate methodologies for modelling fishermen's behaviour under regulatory schemes with individual quotas.
A coordinated approach towards development of a scientific basis for management of wild Atlantic salmon SALMODEL	(1) The objective of the project is to advance the scientific basis upon which advice is given to managers of local, national and international salmon fisheries (North Atlantic Salmon Conservation Organization 1998 Accord on salmon management).
European fisheries ecosystem plan EFEP	(1) The aim of the project is to provide a description and understanding of the basic environmental and human context in which a fishery is managed; it directs the use of the information for fisheries management and defines strategies for development and implementation of management objectives.
Establishing traceability for cod (Gadus morhua): determining location of spawning and harvest CODTRACE	(6) The objectives of the project are differentiation between cod spawned in different basins, identification of their harvest location and placing the results in a context of EU common Fisheries Policy and law.
Policy and knowledge in fisheries management: The North Sea cod case PKFM	(9) The overall objectives of the project are to identify and understand specific problems in the European Common Fisheries Policy and its implementation, which have contributed to the problems in several European fisheries and devising of means for European fisheries management.
Framework for the evaluation of management strategies FEMS	(1) The objectives of the project are development of a simulation framework to evaluate management strategies, development of an understanding of the impact of processes related to environmental fluctuations and quantification of benefits of including such processes in stock management and where appropriate, develop alternative management strategies.
Estimation of the reproduction capacity of	(2) The objectives of the project are studying of the capacity of the silver eel to swim to the spawning grounds, development of a silvering index and

European eel: enhancing the biological basis for sustainable fisheries and aquaculture EELREP	development of a maturation index.
Aquaculture and coastal economy and social sustainability AQCESS	(10) The objectives of the project are analysis of the impact of labour market conditions for aquaculture and fisheries in five different EU countries.
Reducing the conflict between cormorants and fisheries on a pan-European scale REDCAFE	(2) The objectives of the project are to resolve cormorant conflict issues (e.g. location, financial cost, magnitude), to study cormorant ecology and aspects leading to conflicts and to develop cormorant management techniques across Europe.
European lifestyles and marine ecosystems ELME	(7) The objectives of the project are to assess the consequences of current human lifestyles on Europe's regional seas, to create a predictive model of the following key environmental problems: destruction of habitats and species and to form an integrated vision of the future state of Europe's seas.
Safety intelligent fisheries product traceability management throughout the supply chain SAMANTHA	(8) The objectives of the project are to provide a system which will enable the traceability of fishing products, based on the ability to identify them uniquely at any point within the supply chain. The batches are identified uniquely thanks to a RFID tag containing the required information.
Ecosystem approach to sustainable management of the marine environment and its living resources ECOSUMMER	(2) A consortium of eight internationally-recognized universities and marine science institutes in UK, Spain and Greece offers early stage training with particular emphasis on ecosystem approach to sustainable management of living resources.
Integrated ecological coastal zone management system ECOMANAGE	(2) The objectives of the project are to develop integrated tools to help decision makers in the integrated coastal zone management.
Integrating multiple demands on coastal zones with emphasis on aquatic ecosystems and fisheries INCOFISH	(11) The project provides information on aquatic plants preferred as food by herbivorous fishes in a given country or ecosystem. The tool is meant to assist conservationists and managers in ecosystem-based fisheries management.
Discovery modelling mediation deliberation: interface tools for multi-stakeholder knowledge partnerships for the sustainable management of marine resources and coastal zones PASARELAS	(2) The project aims to increase coastal and marine fisheries resources with the aim of maximizing research impact through the development of stakeholder dialogue between science and society.
Ecosystems, societies, consilience, precautionary principle: development of an assessment method of the societal cost for best fishing practices and efficient public policies ECOST	(11) The main aim of the project is to develop a new approach to assess the societal cost of fishing activities to the ecosystem.

Cost and benefit of the control strategies COBECOS	(6) The project will estimate which factors amount to the cost-benefit analysis of management strategies relevant to common fisheries policy (CFP).
Welfare and health in sustainable aquaculture WEALTH	(10) The project aims to gain an understanding of the factors affecting the health of farmed fish. It will e.g. identify the development stages in which fish are most vulnerable to stress induced infections and help improve health and welfare of farmed fish.
Incorporating the extrinsic drivers into fisheries management IN EX FISH	(11) The project aims to improve the response of fishery management to anthropogenic and natural factors in four European seas: The North Sea, The Baltic Sea, The West Iberian Sea and the Mediterranean Sea.
Restoration of the European eel population: pilot studies for a scientific framework in support of sustainable management SLIME	(4) The project identifies options and uses the available information for a coherent European fisheries management strategy by e.g. describing suitable models for the evaluation of the eel stock and formulating advice for a scientific framework based on the outcomes from the various models.
Comparative evaluations of innovative solutions in European fisheries management CEVIS	(8) The project aims to assess innovations for EU fishery management. The target management objectives are biological robustness, economic efficiency, cost-effectiveness and social robustness.
European platform for the communication of European research and technical development results to stakeholders in fisheries and aquaculture PROFET POLICY	(5) The project improves communication between EU-funded research projects in fisheries and aquaculture by employing modern communication methods, organizing workshops and distributing widely the workshop proceedings.
European marine protected areas as tools for fisheries management and conservation EMPAFISH	(3) The project evaluates the effectiveness of marine protected areas in protecting sensitive and endangered species, habitats and ecosystems from the effects of fishing and makes proposals for establishing marine protected areas.
Improve scientific and technical advice on fisheries management ISTAM	(1) The project develops training systems that strengthen the basis for fishery assessment, management and conservation by improving the quality and quantity of data used for assessments.
Catch, effort and discard estimates in Real-time CEDER	5) The project aims to reduce uncertainty in fisheries management by exploring the opportunities for exploiting new technology and making management more responsive e.g. by producing a harmonized database for six representative fisheries across EU.
Development of fishing gears with reduced effects on the environment DEGREE	(5) The project develops new fishing gear that reduces the adverse effects on the seabed and benthic communities, quantifies the potential reduced affect on habitats and benthic communities and assesses the socio-economic consequences of introducing these gears in established fisheries.
A framework for fleet and area based fisheries management AFRAME	(7) The objective of the project is to develop a framework for fleet and area-based fishery management through case studies.
Operational evaluation tools	(4) The project develops a framework for the simulation and

for fisheries management options EFIMAS	evaluation of biological & socio-economic consequences of range of fishery management options & objectives.
Probabilistic assessment, management and advice model for fishery management in the case of poor data availability POORFISH	(1) The project gathers information for utilisation within a probabilistic assessment, management and advice model in data poor fisheries.
Indicators for fisheries management in Europe IMAGE	(11) The project develops environmental indicators for assessing the effectiveness of management measures of ecosystem based fisheries management.
Critical interactions between species and their implications for a precautionary fisheries management in a variable environment- a modelling approach BECAUSE	(11) The project investigates the long-term dynamics of the marine ecosystem (interaction between predator and prey & the effects of fishing into the balance of the marine food chain) in order to protect the biodiversity of our seas.
Scientific advice for fisheries management at multiple scales SAFMAMS	(2) The project draws insights from existing research projects and management processes and communicates them to scientists and decision makers.
Sustainable options for people, catchment and aquatic resources SPEAR	(11) The project uses natural and social sciences to develop coastal zone structure and dynamics in areas where communities depend on marine resources (watershed interactions, ecological structure and human activities).
Facilitating innovation for sustainable fisheries and marine resources FISH	(5) The project supports the participation of small and medium-size enterprises in EC FP6 research activities in fisheries and marine resources and uses research and technological development to ensure their sustainability.
Effects of environmental and habitat characteristics on condition and reproduction of exploited marine fish populations FISH CONDITION	(2) The project aims to analyze the influence of productive and structurally complex habitats on the condition and reproductive potential of two exploited fish species. The fish condition is utilized as an explanatory variable of reproductive potential in order to improve future stock assessments.
Marine protected areas as a tool for ecosystem conservation and fisheries management PROTECT	(3) The project aims at providing EU policy-makers with tools for the identification, design and management of marine protected areas and developing scientific methods to evaluate the effect of marine protected areas to protect sensitive habitats and species against the effect of fishing.
Developing indicators of environmental performance of the common fisheries policy INDECO	(6) The project aimed at ensuring a coherent approach to the development of indicators at EU level, in support of environmental integration within the CFP and in the context of international work on indicators.
To investigate sustainable biological carrying capacities of key European coastal zones KEYZONES	(11) The project aims to help increase the quality of commercial production of bivalve shellfish whilst reducing waste in terms of human, financial and natural resources.
Monitoring compliance with	(1) The main objective of the project is to improve compliance monitoring of

EU fisheries regulations	EU fisheries by making it more effective and more efficient. (e.g. developing and assessment of systems incorporating space borne synthetic aperture radar imagery for fisheries monitoring).
Measurement of capacity, effort and fishing mortality CAFÈ	(8) The aim of the project is to carry out a comprehensive study of capacity and effort metrics and model their relationships to fishing mortality, and the economic drivers for capacity development.
Commitment to tailor-made long-term fishery management strategies COMMIT	(8) The project aims to improve the scientific basis for the long-term sustainable planning of fishery management, while identifying any short-term biological and socio-economic consequences.
Environmental and socio-economic effects of aquaculture ECASA	(10) The project Identifies quantitative indicators of aquaculture effects on ecosystems and develops a range of methods and protocols that encapsulate current understanding of ecosystem processes.
Better fishery management through meta-research IBEFish	(2) The project prepares a synthesis of results and theoretical understandings gained in past projects with regard to the ecosystem approach in fisheries management. The project focuses on the roles and challenges involved in management.
Modified fishing gear and practices to reduce by-catch in trawl fisheries NECESSITY	(5) The project develops ways of modifying trawls to enable by-catch species to escape from the trawl unharmed.
Offshore aquaculture on the horizon OATP	(10) The project collects, collates and validates data and opinions from a diverse range of sources on the opportunities and requirements of offshore aquaculture in Europe.
Assessing risk in fishery advice and management decisions PRONE	(4) The project tests current risk analysis theory on four fisheries subject to different management regimes: the Faroe Islands, Greece, Iceland and North Sea.
Developing more effective stock-recovery programmes UNCOVER	(11) The purpose of the project is to develop recovery strategies for EU fish stocks that are outside safe biological limits.

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Appendix 2:

Participants in the workshop April 3-4 2008

Surname	First name	email	Affiliation
Aps	Robert	apsrobert824@gmail.com	UT ESTONIAN MARINE INSTITUTE
Cassner	Daniella	Daniella.cassner@jklgroup.com	Baltic 2020
Chabay	Ilan	Ilan.chabay@sts.gu.se	Gothenburg University
Eggert	Håkan	Hakan.Eggert@economics.gu.se	Gothenburg University
Fordham	Sonja	SFordham@oceanconservancy.org	Ocean Conservancy
Gezelius	Stig S	stig.gezelius@nilf.no	Norwegian agricultural economics research institute (NILF)
Gipperth	Lena	Lena.Gipperth@law.gu.se	Gothenburg University
Haapasaari	Päivi	paivi.haapasaari@oulu.fi	University of Oulu
Heikinheimo	Outi	outi.heikinheimo@rktl.fi	Finnish game and Fisheries Research Institute
Hildén	Mikael	mikael.hilden@ymparisto.fi	Finnish Environment Institute
Jakobsson	Britt-Marie	bjakobss@abo.fi	Åbo Akademi University
Jentoft	Svein	sveinje@nfh.uit.no	Tromsö University
Juntunen	Teppo	teppo.juntunen@helsinki.fi	University of Helsinki
Kitts	Andrew	andrew.kitts@noaa.gov	U.S. National Marine Fisheries Service/Northeast Fisheries Science Center
Kuzebski	Emil	emil@mir.gdynia.pl	Sea Fisheries Institute Gdynia, dept of fishery economics
Levring Andersen	Jesper	jla@foi.dk	Institute of Food and Resource Economics, Denmark
Lindroos	Marko	marko.lindroos@helsinki.fi	University of Helsinki
Marciniak	Boguslaw	bmarciniak@mir.gdynia.pl	Sea Fisheries Institute in Gdynia
Mikelenaite	Jurgita	jurgita@corpi.ku.lt	Chalmers University
Molander	Sverker	Sverker.Molander@chalmers.se	Chalmers University
Mäkinen	Timo	timo.makinen@rktl.fi	Finnish game and Fisheries Research Institute
Owen	Daniel	daniel.owen@fennerschambers.co.uk	Fenners Chambers, UK
Rousi	Heta	heta.rousi@ymparisto.fi	Finnishe Environmen Institute
Peltonen	Heikki	Heikki.peltonen@ymparisto.fi	Finnish Environment Institute
Strehlow	Harry	harry.strehlow@vti.bund.de	Federal Research Centre for Fisheries, Institute for Baltic Sea Fisheries
Stöhr	Christian	christian.stohr@sts.gu.se	Gothenburg University
Waldo	Staffan	staffan.waldo@sli.lu.se	SLI, Lund, Sweden
Varjopuro	Riku	riku.varjopuro@ymparisto.fi	Finnish Environment Institute
Virtanen	Jarno	jarno.virtanen@rktl.fi	Finnish game and Fisheries Research Institute