The Dangers of Bottom Trawling in the Baltic Sea

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The dangers of bottom trawling in the Baltic Sea
A report for Coalition Clean Baltic
by
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Introduction
This report examines the ‘dangers’ of bottom trawling, particularly with respect to the Baltic Sea. The BBC English Dictionary 1993 defines danger as the possibility for harm, hurt and killing. Although it is recognized that fishing must catch and kill fish and shellfish, the dangers of bottom trawling cannot be divorced from unwanted impacts on the commercial fishery resources they are deployed to catch, particularly when trawl design, use and ineffective regulation are implicit to a large extent in overfishing of the key target stocks. As a goal of fisheries management today is to create sustainable fisheries in sustainable ecosystems, including respond appropriately to important environmental and biodiversity concerns (IMM97; OSPAR 2000; NSC 2002) highlighted in the anticipated reform of the European Community’s Common Fisheries Policy, the dangers of bottom trawling also include their wider ecosystem impacts. In considering these aspects, it is also important to gain an estimate of the location and magnitude of bottom trawling in the Baltic Sea, as well as which national fleets are involved. Additionally, actions are needed to reduce bottom trawl impacts. This report aims to provide information on these issues.

Demersal fisheries: Declining stocks and overfishing
In the Baltic Sea, demersal1 fish (also called groundfish) stocks have traditionally provided the economically most important catches for human consumption. These demersal stocks are dominated by cod (Gadus morhua) and several flatfish species, which form the target of fisheries that today are generally conducted with fishing fleets of larger vessels. However, at the beginning of the 20th century, there was only a limited exploitation of cod in the Baltic Sea and the annual catch by the mid-1930s was less than 8 000 tonnes. The fishing mostly occurred from quite small vessels deploying passive gears such as long-lines, set-nets, and small seines towed in shallow waters. The introduction of more efficient gear from about the 1930s onwards, such as the otter trawl and the Danish seine, resulted in a continual increase in landings. This undoubtedly had consequences for the fish stocks, benthic fauna and associated habitats, especially when new trawl developments (e.g. rigging and ground gear) increased catchability and access to new fishing grounds. From the 1950’s until 1978 the landings varied between 120 000-180 000 tonnes, before increasing to a peak of nearly 450 000 tonnes in the mid-1980s. This surge in fisheries exploitation also attracted vessels from other Baltic fisheries and from fleets normally operating outside the Baltic region (Bagge et al. 1994). Thereafter, the nominal catch steadily declined by 1992 to about 50 000 tonnes and has varied since then around 100 000 tonnes (ICES 2003a).

Currently, bottom trawls, and to a much lesser extent Danish seines, are the main mobile fishing gears used to catch demersal fish in the region (ICES 2000a, 2003a). Since the 1990s, cod have accounted for about 88% of the annual landings taken from demersal stocks, and currently the dominant share (ca. 60%) of the total cod catches taken in the Baltic Sea is by bottom trawls (ICES 2003a). Thus, the overcapacity of the bottom trawling fleet, together with substantial problems with the inherent design and functioning of the bottom trawls deployed is the major contributor to the overfishing of the demersal fish stocks in the Baltic Sea (ICES 2003a).

As a result of management failures that have become more pronounced over the last 20 years, the stock size of Baltic Sea cod reached its lowest level on record in 1991 and levels since then have been

1 Species found on or near the sea bottom
close to this historic minimum. The effective fishing effort\(^2\), and thus the resulting fishing mortality\(^3\), exerted on the cod stocks have been increasing since the 1980s. As a result, the Baltic Sea cod stocks have been in a prolonged state of over-exploitation and decline, and the stock situation of both the eastern Baltic cod stock (i.e. east of Bornholm) and the western Baltic cod stock (west of Bornholm) have been 'outside safe biological limits' (i.e. outside the reference points for a sustainable fishery) for many years (Hansson 2001; ICES 2003a). In recent years, catches from the eastern Baltic stock have accounted for about 66\% of the total cod landings (ICES 2003a). Although fleet capacity and fishing effort directed at the cod stocks have been reduced to some extent, the fishing mortality has actually increased as the biomass of the stocks declined by more than the reduction in fleet capacity (ICES 2000a). Thus, stock recovery can hardly be expected with the present exploitation pattern and tendency for fishing mortality to increase (ICES 2000a).

For statistical and management recommendation purposes, the Baltic Sea has been divided into a number of sub-divisions (Fig. 1) by the International Council for the Exploration of the Sea (ICES).

**Figure 1.** ICES sub-divisions in the Baltic Sea. 21: Kattegat; 22: Belt Sea; 23: Sound; 24: Baltic – West of Bornholm; 25: Southern Coastal Baltic – West; 26: Southern Coastal Baltic – East; 27: West of Gotland; 28: Gulf of Riga; 29: Archipelago Sea; 30: Southern Bothnian Bay; 31: Northern Bothnian Bay; 32: Gulf of Finland. NB: small statistical rectangles occur within the sub-divisions.

ICES provides scientific information and advice on the management of fisheries, the marine environment and its associated ecosystems to its member countries and international regulatory commissions. In the Baltic Sea, the ICES Advisory Committee on Fishery Management (ACFM) provides annual scientific management advice for the individual benefit of the coastal countries.

\(^2\) A measure of the activity of fishing vessels related, for example, to numbers of vessels, fishing hours or fishing power of vessels. In bottom trawl fisheries, fishing intensity is often expressed as fishing effort per unit area of seabed.

\(^3\) The proportion of the stock or population that is killed by fishing. Fishing mortality can be expressed as a 'fishing mortality rate' or likelihood that a fish will die at any instance in time.
(Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, Sweden) as well as the Baltic Sea Fishery Commission (IBSFC). Unfortunately there has been a general lack of political and management will over the last 20 years to follow, in an effective and timely manner, the ICES advice for reducing total allowable catches (TACs) and fishing effort directed at cod, and to establish operative recovery plans for rebuilding severely depleted stocks.

**Bottom trawls and their environmental impacts**

**Trawl developments**

By far the most common mobile bottom fishing gear used today in the Baltic Sea is the otter trawl (Fig. 2), whose target species are demersal fish, primarily cod and to a lesser extent flatfish. In ICES sub-division 21 (Kattegat), on the edge of the North Sea, otter trawls modified and rigged to target pink shrimp (*Pandalus borealis*) and prawns (*Nephrops norvegicus*) are used. Although there has been a trend in some other northern European seas (e.g. North Sea) for beam trawls to replace otter trawls in fisheries for flatfish and sand shrimp (*Crangon crangon*) (Lindeboom & de Groot 1998), beam trawls are not used in the Baltic Sea.

**Figure 2.** An otter trawl showing some of the main components in its design (after Lindeboom & de Groot 1998).

Otter trawl fishers attempt to achieve as great a catch as possible for their effort and to capture anything that is legally marketable and available in the path of the trawl (Laevastu & Favourite 1988). The otter trawls used in the Baltic Sea exist in a variety of sizes and designs (Tschernij & Suuronen 2002). However, they are all cone-shaped meshed nets that have been designed to be towed along the seabed. They take their name from the rectangular trawl ‘doors’ or ‘otter boards’ that pull the wings of the net apart and keep the mouth of the net open horizontally during towing. There are numerous different trawl doors in use, but they are large and heavy structures of steel, or wood and iron, weighted on their base by a protective iron shoe. A ground-rope at the mouth of the trawl consisting of rope rounded wire or chain, often fitted with wheel-like 20-50 cm ‘bobbins’ and/or rubber discs in the central part to aid rolling, provides good contact with the bottom. Although raising the ground-rope from the bottom reduces the by-catch and subsequent discards of unwanted benthic animals, this is not practical as the higher the ground-rope the greater the number of fish that escape under it. The vertical opening is maintained by weights on the bottom and floats on the top. The towing bridles together with the wings and meshed panels of the net funnel fish into the net and along into the end of the bag-like cod end in which the fish are trapped. The contact of the otter boards and the ground rope with the
bottom, as well as the water turbulence behind the boards, generate a cloud of mud and sand that, together with the noise created, leads to a herding effect of the fish into the net (Lindeboom & de Groot 1998). Depending on the bottom conditions, one or more ‘tickler’ chains may be used to raise fish from the bottom. Otter trawls are most frequently towed over relatively flat soft-bottoms, but can also be towed over relatively rough bottoms (e.g. boulders) when fitted with ‘rock-hopper’ gear. Today, the Baltic cod demersal fishery on rocky slopes demands a very heavy and special construction to prevent gear damage and reduce the escape of fish beneath the trawl: the free space left between the rubber discs has been decreasing since the 1980s and currently averages 10 cm, and bobbins have become useless on hard bottoms and frequently totally removed (Tschernij & Suuronen 2002).

Since the start of trawling in the Baltic Sea, a general trend of escalating engine power and size of fishing vessels has allowed an increasing development in the weight, dimensions and construction of otter trawls that has made it possible for them to fish with increasing effect and impunity in more uneven bottom terrains. Since the mid-1980s, rock-hopper gear, consisting of sonar sounders and machinery to raise nets over obstacles, has permitted bottom trawls to be guided into fishing areas that previously were inaccessible. Furthermore, GPS (Global Positioning Systems), advanced echosounding and sonar, and videoplotting, have recently become standard equipment on many trawlers and have provided opportunities to fish more accurately and made previously dangerous or unreachable grounds fishable. As a result, physically undisturbed areas of seabed have become rare in areas that have been substantially fished by bottom trawls. These technological developments have made the impact of bottom trawl fisheries both on target species and on the rest of the ecosystem more widespread than before (Lindeboom & de Groot 1998).

Otter trawls are, owing to their inherent construction characteristics, notoriously poor at selecting between the target fish species, and the sizes of the individuals of these that should be retained, and non-target species. Thus, these limitations frequently result in their use being associated with substantial amounts of by-catch and discards. Part of this problem is due to most of the fish that are directly in front of the trawl—and are unable to evade the large opening—swimming actively and/or being driven along the middle length of the net until they are exhausted and eventually finish in the cod end. Although there is a large mesh size in the wings and a substantial portion of the front part of the trawl net, the sharp angle of attack of the meshes during towing results in the retention of most of the fish and other animals entering the mouth. In traditionally designed trawls, most of the selectivity occurs in the cod-end. Unfortunately, the long duration of commercial trawl tows (up to 10 hrs or more), together with exhaustion and damage to the fish as it passes along the trawl and is concentrated and compacted with other fish in the cod end, results in limited escape of younger under-sized fish through the cod-end meshes, and reduced survival of escapees. The majority of the under-sized fish in the cod end are typically dead when hauled on deck at the end of the tow, and the under-sized fish are sorted out and discarded at sea. The poor size selectivity of the trawl can result in the discarded by-catch of undersized cod accounting for up to about 20% by number and 6% by weight of the total fish catch (Tschernij & Suuronen 2002). Discards increase the mortality caused by a fishery (ICES 2003b).

The Baltic Sea demersal cod fishery is largely based on recruiting year classes, and discarding is substantial (ICES 2003a). Technical measures, primarily intended to improve the selectivity of trawl fisheries—and thereby reduce the by-catch and discarding of young cod—were introduced by the 2002 IBSFC Fishery Rules requiring either an increase in the minimum mesh size (130 mm) in the cod end of ordinary trawls or the use of BACOMA exit windows in modified trawls (Tschernij & Suuronen 2002). However, ICES (2003a) has warned that technical manipulations of the gear are being used to negate their effectiveness, and during the early part of 2003 there have been consistent reports from the fishing industry of high discards of cod, which are below the minimum landing size. The retention (i.e. reduced selectivity) of these small cod by the gear is not consistent with the experimentally estimated selectivity characteristics of the new trawl gears. The reports indicate that the selectivity is

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4 The part of the catch that is made up of marine organisms that are not the primary target of the fishing effort. This may include – depending on the fishing gear used – both unwanted commercial species as well as non-target (i.e. non-commercial species of fish, benthos, seabirds and marine mammals)

5 The part of the catch that is returned to the sea as a result of legal, economic or personal reasons
being reduced either by fishing with the BACOMA gear with the escape windows roped shut, or fishing with the diamond mesh equivalent using thick, inflexible twine so that the meshes remain closed. It has been concluded that the change in gear regulations has not improved the effective selectivity of the gears, and it may even have made the gears less selective, due to non-compliance by the fishing industry. ICES (2003a) has reiterated that gear regulations should not be used as a substitute for reduction in fishing mortality, i.e. by reducing fishing effort.

Traditionally, modifying bottom trawling gear to enable greater catches of the target fish and shellfish has resulted in the subsequent increase in the by-catch of non-target invertebrates and fish (Lindeboom & de Groot 1998). Although nets have been refined to reduce the by-catch of non-target and undersized fish species, little progress has been made in reducing the by-catch and subsequent discards of invertebrate benthic species (Nilsen et al. 2002).

As a result of the variability of trawl sizes, constructions, designs, and riggings, and the engine power of the fishing vessels, the catching properties of different fleets vary. Today over 70% of the active fleet in the Baltic Sea are side trawlers, but almost all new vessels are stern trawlers. A common vessel size today in the bottom trawling fleets fishing in the Baltic Sea is 16-18 m length overall (LO), with an engine of 200-250 KW, but some reach about 30 m LO and 750 KW (Lindebo 2001; Tscherni & Suuronen 2002). The otter boards used often range from about 250-500 kg or more each, and the horizontal opening between the otter boards often lies from 15-20 m.

**Impacts of bottom trawls on the seabed and bottom habitats and communities**

Marine ecosystems can be affected by fishing activities in several ways (ICES 2000a, 2003), including:

1. Mortality effects on the abundance and composition of the target fish and shellfish populations (e.g. number of cod in a particular stock, their size distribution and their genetic make-up);
2. By-catch and discard related mortality effects on the abundance and composition of the non-target populations, including under-sized individuals of commercial fish and shellfish populations, and populations of non-commercial fish, benthic invertebrates, seabirds, and marine mammals;
3. Alterations to the seabed and associated habitats of bottom living fish and invertebrates;
4. Changes in the structure, function and integrity of ecosystems, including effects on the food web and multispecies predator prey relationships.

Point 1 has historically been the main focus of fisheries management, while the new ecosystem-based fisheries management also aims to focus on the other 3 points in order to create sustainable fisheries in sustainable ecosystems.

As an intensive and widespread fishing activity, bottom trawling in the Baltic Sea has made various contributions to the above-mentioned points. These include: a) the overfishing of cod, the main demersal target species, causing the stocks to be outside safe biological limits, b) depleted stocks of cod have reduced the predation on the stocks of small pelagic fish (e.g. herring and sprat) and allowed expansion of pelagic and industrial fisheries, and c) the decreased abundance of larger fish has resulted in a shift towards smaller fish communities (ICES 2000a; Hopkins et al. 2001).

Numerous recent reviews (e.g. Lindeboom & de Groot 1998; Jennings & Kaiser 1998; Watling & Norse 1998; Hall 1999; ICES 2000b; Nilsen et al. 2002; Ojaveer 2002; Huse et al. 2003; Thrush & Dayton 2002) of the impacts of bottom trawling have recognized the following basic and ubiquitous effects prevalent in continental shelf seas that have experienced intense levels of fishing effort:

- **Effects on habitats**: removal of major physical features, reduction of structural biota, reduction in habitat complexity, changes in sea floor structure;

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Habitat: the place where an organism lives, as characterized by the physical features. Particular animal and plant species and communities depend on specific habitat characteristics.
- Effects on species: reduction in geographic range, decrease in species with low turn-over rates, changes in relative abundance of species, fragile species more affected, surface-living species more affected than burrowing species, sub-lethal effects on individuals, increase in species with high turn-over rates, increase in scavenger populations.

The conservation of habitats is a precondition for conserving the species that are associated with and depend on the habitats for their viability (Nilsen et al. 2002). Degradation, fragmentation and eventually complete loss of habitat caused by physical alteration (e.g. bottom trawling) as well as water quality impairment (e.g. pollution including eutrophication) represent the most serious threats to marine biodiversity, especially if contiguous but different habitats forming landscape diversity are lost (GESAMP 1997).

Otter trawls used to catch species that live on or near to the bottom are designed to maximize contact with the seabed and scrape, scour and plough the seabed. Impacts result from the heavy trawl doors digging into the bottom sediment (e.g. mud and sand) and crashing into hard structures. Additionally, substantial abrasion of the bottom may be generated by the ground-ropes fitted with weighty bobbins and rubber discs, and the belly and cod end of the trawl, especially when the latter becomes heavy with fish and even rocks and boulders. Thus, trawling degrades and reduces the complexity of seabed substrates and structures that form essential habitats, and also kills and injures bottom living and feeding species of invertebrates and fish, which either pass into the net or are left behind in the trawl path after it has passed. The impacts often cause severe and long-lasting effects on bottom communities, particularly where the return interval—the time between consecutive trawling events—is shorter than the time it takes for the disturbed and degraded habitat with its impacted communities to recover (Watling & Norse 1998). In particular, slow growing species of bottom fish with low fecundity (e.g. rays, skates and sharks) are particularly prone to local extinction from bottom trawling, even at relatively low levels of fishing mortality (Nilsen et al. 2002). Many marine species, including juvenile fish, use rock-based and biogenic7 structures as refuges to avoid predation, so degradation and loss of these structures by bottom trawls may contribute to the decline of demersal fish stocks.

The effects of bottom trawling have been compared with the consequences of major terrestrial disturbances such as agricultural ploughing and forest clearcutting in reducing biodiversity, and converting ecosystems dominated by disturbance-intolerant equilibrium species to ones dominated by disturbance-tolerant opportunistic species (Watling & Norse 1998; Thrush & Dayton 2002).

Numerous reviews, including quite contemporary ones, of the effects of bottom trawling tend to reiterate that otter trawl doors have only a limited ability to dig into soft bottom substrates (e.g. 20 cm). However, recent studies (Lundälv & Jonsson 2001; Andersson & Jonsson 2003) using ROV8-mounted video-camera and side scanning sonar in Swedish areas of ICES sub-division 21 and 25 have shown images of substantial trawl door impacts over most of the investigated areas including many rocky areas, and in numerous cases their imprints in muddy bottoms at about 60 m were between 0.5-1.0 m deep and 1.0-1.5 m wide along direction of the tow (Fig. 3). Thus, the impacts of otter trawl doors on both benthic surface living and burrowing invertebrates has probably been underestimated in many earlier reviews.

The serious combined effects of bottom trawling and eutrophication have been focused on in several semi-enclosed seas, including the Baltic Sea and the North Sea. Since about the beginning of the 20th century, human-caused physical impacts (e.g. mortality and bottom disturbance from towed demersal fishing gears) and excessive organic input (e.g. from increased biomass enhancement via eutrophication and discarded by-catch and offal from fisheries) have increased (Svelle et al. 1997; OSPAR QSR 2000; Hopkins et al. 2001; Nilsen et al. 2002). These impacts have favoured opportunistic species with flexible life history traits and eliminated vulnerable ones with conservative life histories. The resulting changes in the benthic fauna and flora in heavily trawled and more eutrophic areas such as the Baltic Sea have changed towards non-fragile fast growing and mobile scavengers, predators, and sediment or suspension feeders such as polychaetes, amphipods, and starfish. These shifts have occurred at the expense of slow-growing and longer-lived organisms such

7 Structures formed from living material, e.g. reefs of cold-water coral, colonial corals and mussel beds.
8 Remote Operated Vehicle.
as many of the larger, sessile and frequently fragile filter-feeding bivalves, reef forming polychaete worms, maërl and corals. These human-caused impacts have jointly resulted in more biomass and productivity, and the transformed structure of the demersal and benthic communities. Among the sources of human and natural disturbance (e.g. sediment movements caused by storm exposing or burying organisms) affecting the benthos, none produce as far-reaching effects as demersal trawl fisheries, by physically crushing and damaging benthic species and habitats (Nilsen et al. 2002).

Figure 3. Remotely operated vehicle (ROV) ‘Sea Owl’ recordings made in 2002 at about 60 m depth of a trawl mark near Karlskrona, southern Baltic Sea. The mark near the camera is about 0.5 m deep and almost one metre wide, disappearing away from the camera. Source: Department of Engineering Geology, Lund University, Lund, Sweden.

Substantial attention has been focused on the impacts of fishing on nutrient enriched ecosystems, such as the Baltic Sea, reflecting the combined impact of increasing fishing intensity and nutrient run-off on marine food webs, and bottom oxygen depletion, leading inter alia to a relative decrease in the landings of demersal fish (e.g. cod) compared with pelagic species (e.g. herring and sprat) and an associated decline in mean trophic level of the fisheries (Bagge 2000; Caddy 2000; Hopkins et al. 2001). Thus, the joint effects of increased eutrophication and increased fishing pressure have resulted in a change in the structure of the fish community and the fisheries regime that has been pursued. Baltic Sea cod appears to be close to its limits of ecological tolerance, as reflected in the increase in pelagic/demersal catch ratio from about 2 in 1976 to over 10 in 1993 (Caddy 2000). The economic yield per unit biomass of the fishery has declined, with a smaller proportion of the catch being directed for human consumption and food security (Hansson 2001; Hopkins et al. 2001). Besides these effects, bottom trawling in the Baltic Sea can remobilize substantial amounts of bottom sediments, including associated nutrients and contaminants (e.g. heavy metals), smothering some filter-feeders, and adding to the pollution load and biological oxygen demand (Caddy 2000).
The location and magnitude of bottom trawling activities

There is a lack of readily available information regarding the abundance and size distribution of the national fishing vessels taking part in the various fisheries, and their respective catches in the Baltic Sea on a geographically meaningful basis. In many cases, this information is found in national databases, but it is generally neither worked up and published nor made available for wider use. This places major constraints on being able to conduct precise and accurate analyses of the status and trends of fishing fleet operations, and to determine more exactly where and how frequently the different fishing gears are used. In the case of bottom trawling, such data is of fundamental importance for considering the impacts on target commercial stocks as well as on other parts of the ecosystem.

In response to a request from IBSFC, ICES recently provided information on cod landings broken down by gear and areas (ICES 2003a). A reworking of the data tabulated by ICES enables one to obtain a relative index of where in ICES sub-regions 22-32 of the Baltic Sea most of the bottom trawl effort is deployed and by which country (Fig. 4). No data was provided for ICES sub-region 21 (Kattegat) as this sub-region is not in the IBSFC area. The information provides an approximate indication of the relative contact and, by association, interactions with the seabed and benthic habitats that takes place in different areas of the Baltic Sea. It is evident that about 45% of the bottom trawling occurs in sub-division 25 (Southern Coastal Baltic – West), followed by about 20% each in sub-regions 22 (Belt Sea) and 26 (Southern Coastal Baltic – East), with about 10% in sub-region 24 (Baltic – West of Bornholm). About 84% of the bottom trawling is carried out by the fishing fleets of Denmark, Germany, Sweden and Poland, which each contribute about 19-26%.

In sub-division 23 (Sound, encompassing the territorial waters of Sweden and Denmark), a total ban on towed fishing gears such as bottom trawls has been operative since 1932. This ‘trawl-free’ area has probably been the major contributory factor accounting for the improved status (e.g. relatively high abundance and presence of more larger individuals) of the cod population in the Sound compared with those in other near-lying areas (Svedång et al. 2002).

It is noteworthy that the catch per unit effort (CPUE) of trawling in the Baltic Sea as a whole has fallen markedly since the mid-1980s as the peak landings declined considerably while the fishing effort has hardly diminished (data in ICES 2003). As fishing effort has not been effectively reduced during this process, the recurrent impact on the seabed and benthic ecosystems is unlikely to have diminished substantially.

With an average towing speed of the trawl relative to the bottom of about 3.5 knots and an average horizontal opening between the otter boards of about 18 m, and taking into account that about 15% of the fishing time is used for hauling and setting the gear, a bottom trawler will fish a surface area of about 0.1 km$^2$ in one fishing hour. Information regarding fishing hours by otter trawls is not available for the Baltic Sea, but it is plausible that the annual fishing hours for heavily fished areas in the Baltic Sea and North Sea are roughly comparable, particularly when it is evident that there are similar fishing mortality rates for the same demersal target species (i.e. cod). Thus, the range of 50 000-150 000 fished hours for otter trawls per heavily fished statistical rectangle (1.0 ° longitude by 0.5 ° latitude) recorded in the late 1990s for the mid to northern North Sea (Lindeboom & de Groot 1998) may also be used to provide rough estimates for the Baltic Sea. Based on these data, and assuming 0.1 km$^2$ trawled per hour, intensely trawled regions of the Baltic Sea experience about 5 000-15 000 km$^2$ trawled per year within a statistical rectangle (at 57.5° N = ca. 60 km x 60 km = 3 600 km$^2$). In turn, this provides an estimate of about 1-4 trawl tows per unit seabed per year in intensely fished areas. It is interesting to note that in the intensely fished Kiel Bight (Germany), Krost et al. (1990) estimated the substrate area disturbed by bottom trawling at 140 km$^2$, but repeated trawling of 4.5 times during the year elevated the estimated total trawled area to about 630 km$^2$ per year. Such levels of trawling intensity undoubtedly have brought about major impacts over time on the seabed and its associated demersal fish and benthic invertebrate communities.
**Figure 4.** Relative total landings (tonnes) in 2002 of Baltic Sea cod caught by bottom trawl by country and ICES sub-division (100% = 42 985 tonnes) (data source: ICES 2003). NB: Data was not provided by Estonia, but historical landings of cod by Estonia are generally similar to those of Latvia.

A)

**Bottom trawl landings (%) by sub-division and country**

![Bottom trawl landings graph](image)

B)

**Proportion of total bottom trawl landings by country**

![Proportion graph](image)
International instruments emphasize that sustainable fisheries depend on sustainable ecosystems

Numerous international instruments (Table 1) have promoted the need to implement the precautionary principle and the ecosystem approach to management with a view to the prudent conservation and management of biodiversity including living marine resources, and especially the need to integrate fisheries and environmental issues.

A major impending development is the planned accession in 2004 to the European Community (EC•European Union) by Estonia, Latvia, Lithuania and Poland, leaving the Russian Federation as the sole coastal Baltic Sea country outside the Community. The enlargement of the EC will have significant effects on the coastal and marine policies of the countries of the Baltic Sea region, especially regarding the application of different EC policies and strategies concerning *inter alia* environment, fisheries, water resources and scientific research.

Important EC policy documents regarding the Common Fisheries Policy (CFP) and its awaited reform to improve environmental protection and biodiversity conservation include:

- Article of the Treaty of Rome (1957), establishing the European Community, which requires the integration of environmental protection into all Community policies and activities, including the Common Fisheries Policy, with a view to promoting sustainable development;
- The 1997 Amsterdam Treaty of the European Community, which sets environmental policy objectives;
- Fisheries Management and Nature Conservation in the Marine Environment (COM(1999)363);
- Application of the Precautionary Principle and Multi-annual Arrangements for Settings TACs (COM(2000)803);
- Elements of a Strategy for the Integration of Environmental Protection Requirements into the Common Fisheries Policy (Doc. No. 7885/01 Pêche 78, Env 188);
- Communication from the European Commission to the Council and the European Parliament: Elements of a Strategy for the Integration of Environmental Protection Requirements into the Common Fisheries Policy (COM(2001)143 final), which recommends as a priority ‘the adoption of an ecosystem-based approach to fisheries management’;
- Sixth Environmental Action Programme of the European Community (Decision 1600/2002/EC) of the European Parliament and Council, which illustrates as a goal the establishment of marine protected areas;
  - Halting biodiversity decline by 2010 as set out in the 6th Environmental Action Plan;
  - Integration of environmental concerns into the CFP, including recognition that heavy fishing pressure and use of inappropriate fishing techniques threatens marine biodiversity and long-term sustainability of the European fisheries sector;
  - Use of targeted reductions in fishing pressure as the most important management measures in order to achieve sustainable development taking into account the precautionary principle;
  - The need to establish a sustainable balance between fishing effort and available fish resources, and development of a fleet policy that secures appropriate targeted reductions in fishing effort;
  - Greater involvement of a wide range of relevant stakeholders in fisheries management with a view to improving living marine resources conservation and securing sustainable use of these resources; promotion of sustainable management and environmental integration in regional fisheries organizations;
  - Establishment of a strategy and concrete proposals for the integration of environmental protection and sustainable development into the CFP, including priority actions such as
reduction in fishing pressure and increased selectivity of fishing gear, measurable targets, timetables, improved protection of marine biodiversity and progress towards an ecosystem-based management;

- The requirement to monitor and evaluate the process of integration of environment and sustainable development into the CFP.
- Communication from the European Commission to the Council and the European Parliament: Towards a Strategy to Protect and Conserve the Marine Environment (COM(2002)539 final), drawing attention to the need to implement the ecosystem approach to management regarding human activities including fisheries.

In addition to these key international and EC policies and measures aimed at mitigating the environmental impacts of fisheries, it is noteworthy that environmental impact assessments regarding fisheries, including bottom trawling, have not been conducted in European waters despite the EC’s environmental impact directives. Environmental Impact Directive (85/337/EEC amended by 97/11/EC), requires a developer to provide information to the competent authority about likely significant environmental effects, and the EC Strategic Environmental Impact Assessment (SEA, 2001/42/EC), requires a formal environmental assessment by appropriate authorities of a wide range of public plans and programmes with significant effects on the environment. SEAs are mandatory for all plans or programmes which set the framework for development consents for individual projects (as listed in the EIA Directive), including when they are in the fields of fisheries, or where they have been determined to require an assessment under the Habitats Directive (92/43) in view of their likely effect on Natura 2000 sites.

The coastal Baltic Sea countries must be seen to be actively committed to carrying out their obligations as Contracting Parties to these important international instruments contributing to the conservation, restoration and protection of the marine environment and its biodiversity, including fisheries. Unfortunately, as evidenced by the serious and deplorable overfishing of the main demersal stocks in the Baltic Sea and the substantial ecosystem effects of demersal fisheries—especially the dominant contributory role of bottom trawling in these impacts—it is clear that there has been a lack of political will for several decades to follow these policies and take effective restorative actions.

Table 1. Some of the key international instruments relevant to the Baltic Sea, promoting the prudent management and conservation of the marine environment and its biodiversity, including fisheries.

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<th>Instrument</th>
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<tr>
<td>Gdansk Convention (1973)</td>
<td>Under the International Baltic Sea Fishery Commission (IBSFC), cooperation ‘with a view to preserving and increasing the living resources of the Baltic Sea and the Belts and obtaining the optimum yield, and, in particular to expanding and coordinating studies towards these ends’.</td>
</tr>
<tr>
<td>Helsinki Convention (1974, revised 1992)</td>
<td>Under the Helsinki Commission – Baltic Marine Environment Protection Commission (HELCOM), the Convention on the Protection of the Baltic Sea Area, in addition to combatting pollution, it aims to conserve natural habitats and biological diversity and to promote ecosystem approaches for the sustainable use and management of coastal and marine natural resources.</td>
</tr>
<tr>
<td>CITES (1975)</td>
<td>The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provides a framework for regulating trade in animals and plants that are or may become threatened with extinction.</td>
</tr>
<tr>
<td>Bonn Convention (1979)</td>
<td>Conservation of migratory species of wild animals, including ASCOBANS 1991 to protect and conserve small cetaceans in North Sea and Baltic Sea.</td>
</tr>
<tr>
<td>Bern Convention (1979)</td>
<td>Conservation of European wildlife (fauna and flora) and natural habitats.</td>
</tr>
<tr>
<td>Convention on Biological Diversity (1992)</td>
<td>Establishes three main goals: 1) the conservation of biological diversity, 2) the sustainable use of its components, and 3) the fair and equitable sharing of the benefits from the use of genetic resources.</td>
</tr>
<tr>
<td>Precautionary Principle (1992)</td>
<td>As set out in the Rio Declaration of 1992, the principle states that ‘where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation’.</td>
</tr>
</tbody>
</table>

FAO Code of Conduct on Responsible Fisheries (1995) | Provides international standards for responsible fishing practices. It aims to ensure the conservation, effective management, & sustainable development of fish stocks while promoting the precautionary principle & respecting the ecosystem and marine biodiversity. The precautionary principle is also acknowledged as an important element of the Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks (UN 1995)

UN Convention on Straddling & Highly Migratory Stocks (1995) | The Convention establishes principles for the conservation of such species, and provides guidelines for their management based on the precautionary principle and the best available scientific information. Straddling stocks refer to stocks of migratory species that spend part of their lifecycle in two or more jurisdictions, especially those that migrate between ’Exclusive Economic Zones’ (EEZs) and international waters. The Agreement outlines minimum international standards for cooperation regarding for the conservation & management of such stocks. The Agreement came into force in December 2001 & includes the European Community amongst the Contracting Parties.

| EC Water Framework Directive (2000/60/EC) establishes a framework for the protection of various waters including near shore coastal waters for inter alia preventing further deterioration and protects and enhances the status of ecosystems via application of the ecosystem approach.

Actions needed to reduce bottom trawling impacts

1) Several changes will contribute to significant reductions in the effects of bottom trawls on the seabed and its associated bottom living fish and benthic invertebrates, and accordingly reduce the ecosystem effects of fishing. The most serious effects could be mitigated, without unduly reducing the possibilities of catching commercially important species, through the following priorities (ICES 2000b):

   a) a major reduction in fishing effort;
   b) establishing closed areas;
   c) making gear substitution and modifying gear to a) reduce physical impact on the seabed and vulnerable species and habitats, and b) minimize by-catches and discards;
   d) habitat restoration;
   e) governance changes.

2) A number of changes to fisheries management systems are under review that would greatly facilitate major reductions in the effects of fishing on marine ecosystems, e.g. reform of the CFP. However, ICES (2000b) has emphasized that the precautionary approach requires that immediate action be taken, to ensure that conservation is not compromised while greater knowledge bases are being built.

3) TACs have not been effective in reducing fishing mortality on demersal fish stocks: the primary step to redress overfishing and to remove the main obstacle to the environmental integration of fisheries, continues to be excessive fishing effort (ICES 2003a). Technological improvements (e.g. gear regulations and modifying bottom trawls) to reduce the environmental impact of fishing will not be sufficient if this is not addressed as the first priority (ICES 2003a). Large closed areas and seasons may contribute to the stock recovery of demersal fish species, but only if accompanied by major reductions in effort or catch.

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9 ICES has defined the ecosystem approach to management as the ‘integrated management of human activities based on knowledge of ecosystem dynamics to achieve sustainable use of ecosystem goods and services, and maintenance of ecosystem integrity’.
4) It is necessary to reduce excessive fishing effort, particularly in the bottom trawling fleet, fleet overcapitalization and perverse subsidies. As the overcapacity of the bottom trawling fleet is the main cause of the long-standing excessive fishing effort causing the drastic declines of cod—the most valuable demersal fish in the Baltic Sea—and associated degradation of seabed habitats and impacts on vulnerable benthic species of fish and invertebrates, priority should be given to measures that substantially and effectively reduce the annual fishing hours of vessels deploying otter trawls. This can be achieved by an appropriate combination of effective ‘tie-up’ and decommissioning schemes, as well as a limited partial reallocation of fishing effort to vessels using passive gear having low levels of by-catch and discards. Because of the almost insurmountable problems required to make bottom trawls environmentally friendly, substantial areas of the Baltic Sea should be designated as permanently ‘trawl-free’ areas while also ensuring that the fishing effort using bottom trawls in approved areas is strictly limited and controlled. Substantial financial support and incentives are required to help the fishing industry to meet these objectives.

5) Concern about the high incidence of by-catch and discards in the bottom trawl fisheries requires that adequate data and information—including monitoring and reporting—on by-catch and discards are collected in order to allow improvement of the selectivity of fishing gears, improvements towards a sustainable management of fisheries and an enhancement of the basis for the multispecies and ecosystem approaches. Measures must be developed for harmonization of regulations for by-catch and discards, joint and coordinated control measures both at sea and at landing of catch, and closure of areas with a high incidence of by-catch and/or discards. Effective systems for vessel monitoring, control and inspection must be established to enforce compliance with gear- and access-related regulations.

6) It is paramount to establish networks of Marine Protected Areas (MPAs) of significant size, with clearly defined management goals, including undisturbed areas having ‘no-take/no trawl zones to enhance the protection of juvenile fish, spawning areas and vulnerable benthic species and habitats. In this context it is important to devise and implement effective habitat classification and mapping programmes for constructing spatially orientated inventories, coupled with restoration schemes to enhance the recovery of substantially degraded seabed environments.

7) Radical governance changes must be implemented. The actors in fisheries management issues have so far been almost exclusively from institutions that represent those who exploit the resource, e.g. Ministry of Fisheries and the fishing industry. They have failed to apply appropriately prudent, precautionary and effective fisheries management measures as evidenced by critically depleted target and non-target resources, unabated use of inappropriate fishing practices, seriously changed ecosystems, and substantially disturbed and degraded seabed environments. Based on this poor performance, there is little reason to expect that major improvements will occur to create sustainable fisheries without actively establishing more inclusive stakeholder forums at all levels for the purpose of setting proper objectives and making co-management decisions. The extended legitimate stakeholders include Ministries of the Environment and a range of non-governmental organizations such as local authorities, and institutions connected with nature conservation, consumer affairs, recreational fishing and tourism.

Acknowledgements
The author is grateful to Coalition Clean Baltic for proposing this task, and thanks Kjell Andersson and Peter Jonsson (Dept. of Engineering Geology, Lund University) for providing Fig. 3.

References


