Improvement of environmental security in the Black Sea Basin and national responses.

Degradation of marine ecosystems and the role of shipping

The oceans are influenced by several pressures from anthropogenic and natural sources. Maritime transport is one anthropogenic activity or so-called driving force, which has an effect on the marine ecosystem. Whereas most other driving forces like agriculture or industry have an indirect effect on marine ecosystems via revering input of hazardous substances and nutrients or atmospheric deposition, the effect of shipping is a direct one, because ships stay in the marine ecosystem.

The environmental problems caused by maritime transport are numerous:

1. **Oil pollution** is caused by tanker accidents and illegal oil discharged from ships. The oil pollutes the coastline, the sea bottom and the plants and animal living in the sea and along the shore. The amount of oiled sea birds is an indicator for the amount of oil pollution.
2. **Waste** from ships accumulates at the sea bottom in areas with high traffic density and accumulates along the shores. It hurts marine animals like seals, birds and turtles, which ingest the waste or which get captured or strangulated by plastic waste. It also affects the esthetic view of the shore and beaches.
3. **Ballast water** of ships transports marine organisms into different sea areas and its discharge into a different sea area can lead to the introduction of foreign species. The ballast water contains a lot of organisms of the water where it has been taken from. In the water of a harbor or sea area, into which it is discharged, these organisms can cause changes to the ecosystem, if they successfully reproduce and manage to build up a population.
4. **Antifouling paint** has the purpose to kill organisms, which would like to settle on the hull of a ship. It usually contains Tributyltin (TBT), which is one of the most toxic substances and has a hormone like effect in very low concentrations. It affects mollusks and especially marine snails.

There are also other toxic
substances like copper and pesticides in antifouling paint, which cause harm to marine organisms.

5. **Air pollution** by ships should also be mentioned here, although the impact of acidification is more on the terrestrial environment.

1. Introduction

1.1 About the European Environment Agency (EEA)

The aim of the European Environment Agency (EEA) is to establish a comprehensive environmental information system. This is done to assist the European Community in its attempts to improve the environment and move towards sustainability, including the EU's efforts to integrate environmental aspects into economic policies.

The EEA was initially established by the European Union. All 15 EU member states are EEA members. The EFTA countries, Iceland, Lichtenstein and Norway have also joined as full members. It is expected that the membership base will increase in the future with several of the central and eastern European countries joining.

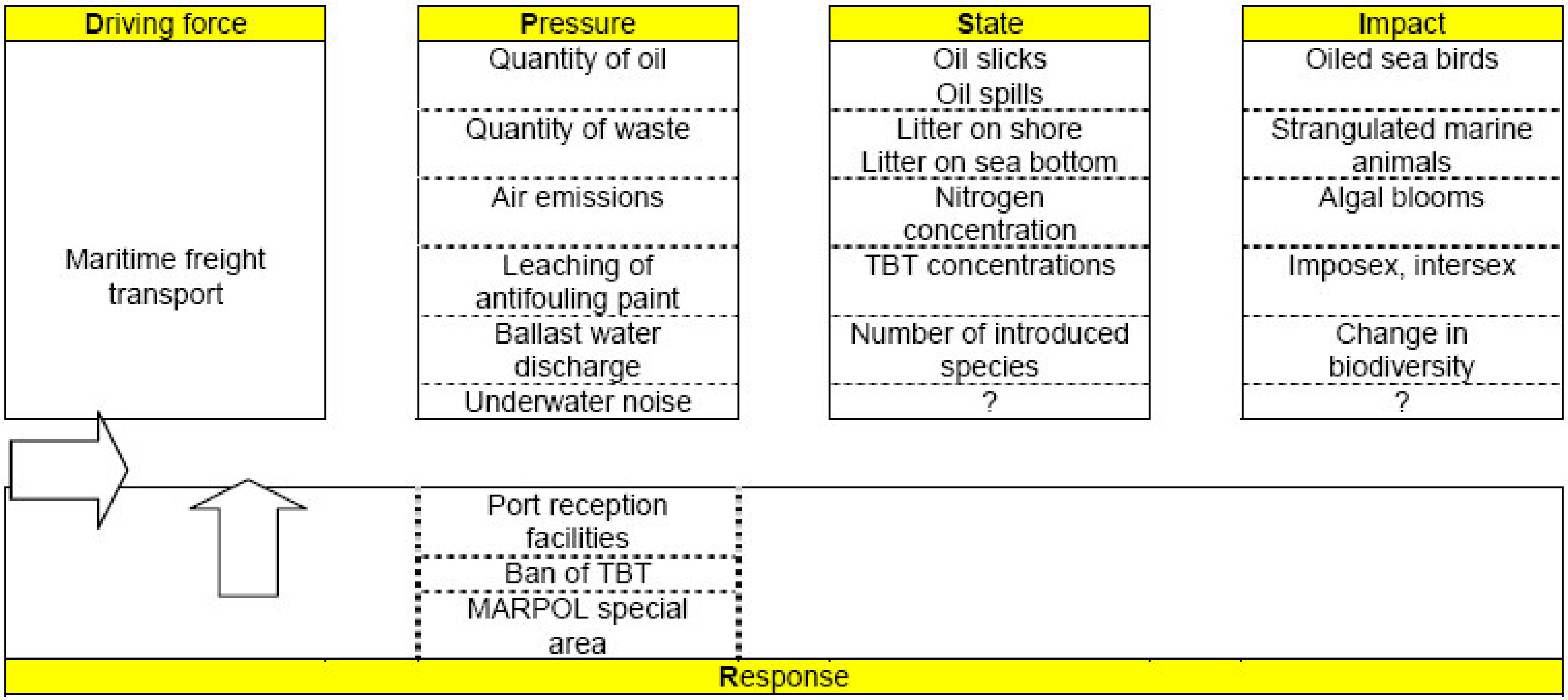
The EEA should use existing data, and its objective is to build on and improve existing capacities for monitoring and assessment. Therefore, its organizational structure is somewhat complex – covering all member countries and beyond and drawing together many different participants at local, national and trans-national level. This information network, called the Environment Information and Observation Network (EIONET), covers over 600 environmental bodies and agencies, public and private research centers across Europe. The EEA's role is to help build the network and support it in its work.

1.2 DPSIR framework

In order to make scientific results understandable to a wider audience, the EEA is developing indicators. The work of the EEA is built around a conceptual framework of indicators known as the DPSIR assessment framework. DPSIR stands for Driving

forces, Pressures, States, Impacts and Responses. Particularly useful for policy-makers, DPSIR builds on the existing OECD model for indicators and offers a basis for analyzing the inter-related factors that impact on the environment. The aim of this approach is, to be able to provide information on all of the different elements in the DPSIR chain; to demonstrate their interconnections; and to estimate the effectiveness of Responses.
During the start-up phase of the EEA, priority has largely been given to the areas of Pressures, State and Impacts. In future, increasing attention will be given to Driving Forces and Responses, in co-operation with the Commission services, including Eurostat.
With regard to maritime transport and its impacts on the marine ecosystem, the development of indicators has just started. Indicators on Driving forces for transport are being developed within TERM (Indicator-based Transport and Environment Reporting Mechanism). Pressure indicators like air emissions of NOx , state indicators like oil spills and impact indicators like change in marine biodiversity are being developed by European Topic Centers (ETC's) under the related topic, e.g. air emissions and marine and coastal environment.
A possible system of DPSIR indicators for environmental issues related to maritime shipping is shown in figure 1
Figure 1: Possible DPSIR framework for indicators on impacts of maritime shipping on the marine environment.

DPSIR framework for indicators



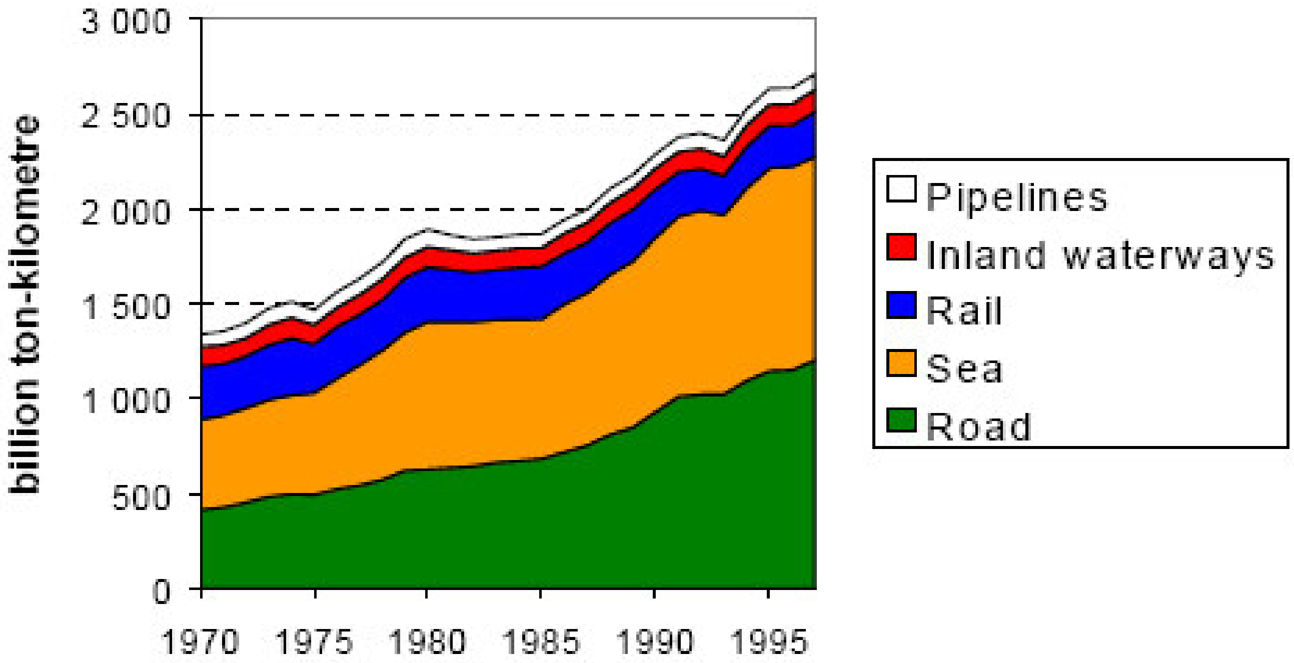
2. Driving force: Maritime transport

The Amsterdam Treaty identifies integration of environmental and sectorial policies as the way forward to sustainable development. The European Council, at its Summit in Cardiff in 1998, requested the Commission and the transport ministers to focus their efforts on developing integrated transport and environment strategies. At the same time, the joint Transport and Environment Council invited the Commission and the EEA to set up a Transport and Environment Reporting Mechanism (TERM), which will enable policy-makers to gauge the progress of their integration policies. The main output of TERM will be a series of regular and indicator-based reports through which the effectiveness of transport and environment integration strategies can be monitored.

One indicator, which has been developed within TERM is “Freight transport” (fig. 2). Maritime transport development (short-sea shipping) is one mode of transport beside road, rail, inland waterways and pipelines. Changes in production and supply systems, increasing distances and low load factors (empty runs still account for around 30 % of total vehicle-km) have resulted in a doubling of tone-km between 1970 and 1997, with the largest annual growth in road (4 % on average) and short-sea shipping (3 %). Freight transport is shifting increasingly towards road: trucking now accounts for 45 % of total freight transport (30 % in 1970).

Short-sea shipping rose from 35 to 39 % and is beside road transport the only other mode of transport, which has increased its share. Increasing intra-EU trade and internationalization has led to this increase in the share of international freight tone-km, mainly by sea and road transport. International transport accounts for 50 % of total tone-km (and 10 % of total transported tones). While the Community’s freight transport action plans have resulted in a better performance of short-sea shipping, they have not yet reversed the decline in shares of rail and inland waterways.

Figure 2: Annual freight transport performance by mode (EU)



Sources: DG Transport, Eurostat

3. Environmental Issues related to maritime transport

Quite a few environmental problems in the marine environment are caused by shipping. These issues are oil pollution, toxic antifouling paints, air pollution, waste and litter, ballast water, noise and others. Shipping might not be the only source for the environmental problems listed, but contributes heavily to the problem. In the following, the most important environmental shipping issues are described and an actual overview of the situation is given. Since indicators on Pressures, State and Impact are still under development for these issues, the presented information has been taken from EEA's assessment reports and the various assessments of international bodies like Bonn Agreement, Helsinki Commission (HELCOM), OSPAR Commission, UNEP/MAP, EMEP, International Maritime Organization (IMO), International Council for the Exploration of the Seas (ICES), as well as from national and international research projects.

3.1 Oil pollution

The main sources of marine oil pollution are:

- land based run-off and discharges;
- marine shipping;
- offshore oil and gas exploitation;
- atmospheric deposition;
- accidental oil spills;

The relative importance of these sources differs from one sea to another. For the North Sea, the major sources of oil input are

- accidental or illegal discharges from shipping (15 000 – 60 000 tones per year),
- offshore oil and gas production (20 000 – 30 000 tones per year)
- rivers/land run-off (16 000 – 46 000 tones per year) (OSPAR, 1993).

It has been proven extremely difficult to gather full information on the scale of discharges from shipping. Such discharges fall into two categories: accidental and operational (legal and illegal). Control of operational discharges falls within the mandate of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78).

3.1.1 Oil pollution accidents

Environmental damage caused by marine accidents can vary considerably, depending where they occur. Dramatic oil spills, like the ERIKA accident at the French coast or the PALLAS accident at the German coast, gain the public's attention, but the size of the spill is no indicator of final impact. Actual impacts can vary considerably, depending on whether or not the oil is released in coastal waters which are ecologically sensitive, prevailing weather conditions and the type of oil spilled.

Worldwide, between 1970 and 1996, there were 1 082 reported spills of 7-700 tones of spilt oil and 384 spills of more than 700 tones. Of about 10 000 total reported incidents, the vast majority (83%) fall into the smallest category, i.e. <7 tones. The number of major oil spills (<700 tones) has decreased significantly: by the end of the 1980s the average number of major oil spills each year dropped to one third of that in the previous decade. There has been a remarkable decline in the annual number of major spills worldwide in the past decade (EEA, 1998).

At European level, the annual number of major oil spill was falling till 1996 (figure 3), but not as rapidly as the global figure. The number of oil spills exceeded 700 tones in European waters resulting from accidents involving tankers, combination carries and barges between 1970 and 1996. The number of marine accidents, that have occurred in the regional seas of Europe since 1987 are shown in figure 4 and their geographical distribution is shown in figure 5.

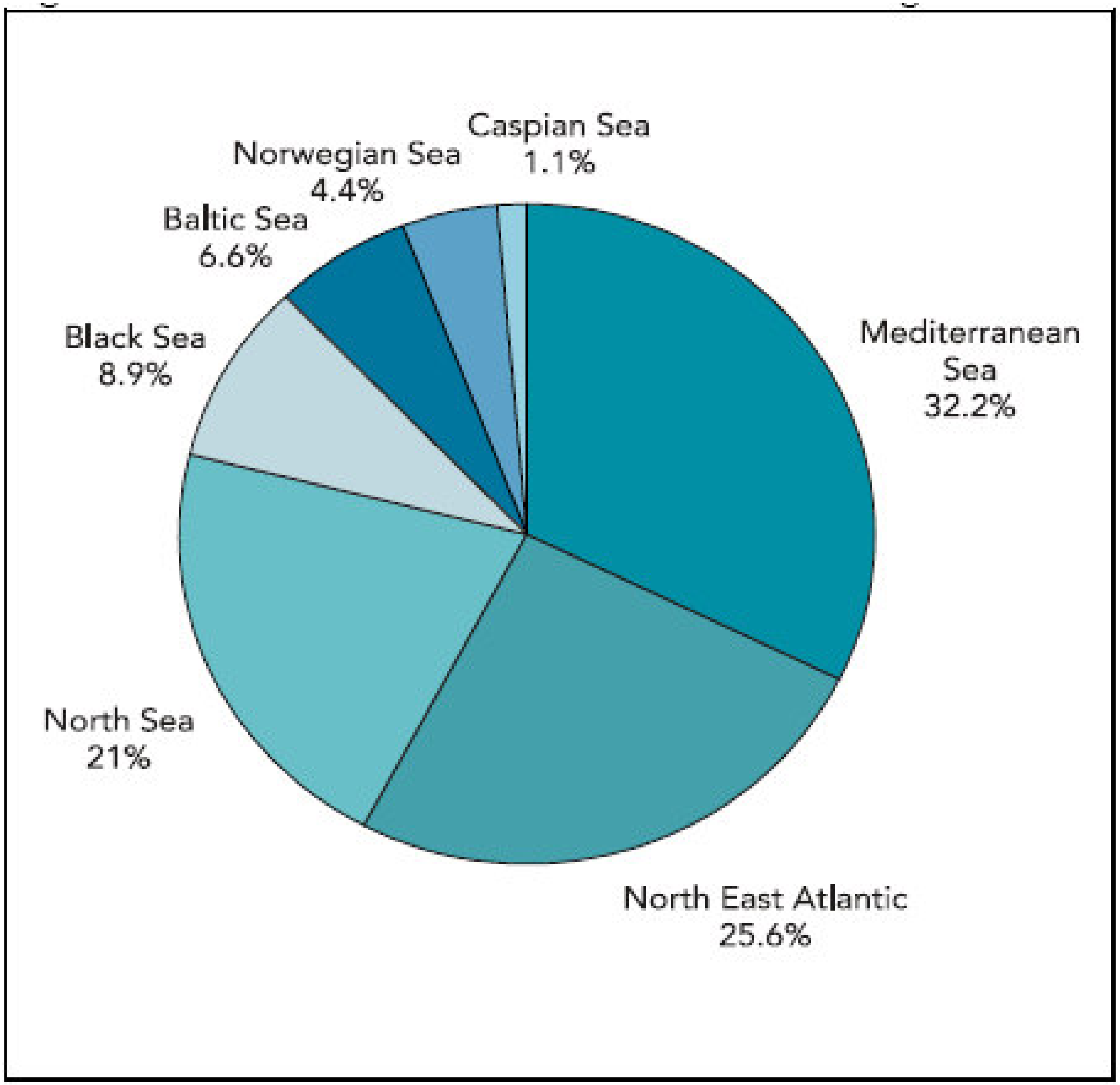


Figure 5: Large tanker spills in Europe, 1970 – 96 (EEA, 1998).

ERIKA accident (2000)

The Maltese tanker ERIKA of 19,666 GT and 37,283 DWT broke in two during a severe gale off Brittany, France in the Bay of Biscay in the early morning of 12 December 1999. The tanker was traveling with a cargo of approximately 30,000 tones of Heavy Fuel Oil, about an estimated 14,000 tones of its heavy fuel oil cargo was spilled into the sea. Aerial surveillance was carried out by the French authorities to monitor the drift of the two halves of the tanker as well as the spilled oil. The oil polluted a huge area of the French Atlantic coast.

The removal of accumulations of bulk oil was carried out during the following weeks, followed by

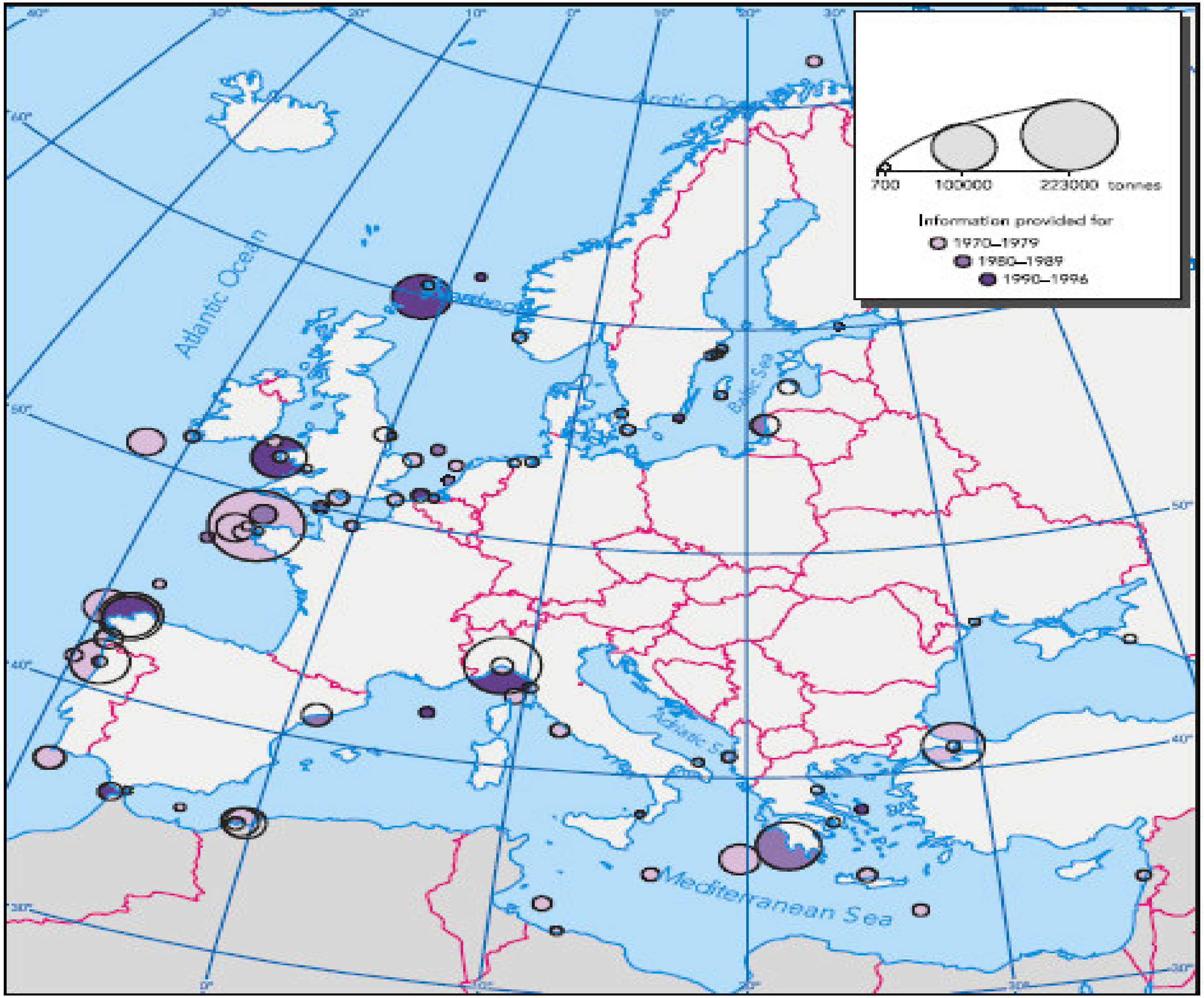
secondary cleaning of stained rocks and the removal of remaining tar balls from sandy areas. Small-scale high pressure hot water washing was used at a limited number of locations.

Recovered oily wastes were collected mainly at Donges, and reported to a total of 115 000 tones. A large number of samples of cultivated shellfish were taken along the affected area to monitor the possible effects of oil on mar culture. Whilst most areas have been found not to have been contaminated, bans are in place in certain places.

PALLAS accident (Reineking, 1999)

The most recent oil pollution accident in the German Bight happened on 28 October 1998, when the Italian owner general cargo M/V PALLAS (27 years old) stranded two nautical miles of the island of Amrum in Schleswig-Holstein, Germany after a having caught fire. In total, about 244 tones of fuel oil and oil sludge spilled into the North Sea. The oil polluted the beaches of the islands Amrum, Föhr and Sylt. It is estimated that about 26 000 birds, mainly eider ducks and common scoters were oiled and, in total, about 16 000 of them, at minimum, died during the Pallas accident.

Figure 4: Number of accidents in the different regional seas of Europe EA,



700
100000
223000 tonnes
Information provided for
1970–1979
1980–1989
1990–1996
Atlantic Ocean
Arctic Ocean
Baltic Sea
Adriatic Sea
Mediterranean Sea

3.1.2 Oil slicks from operational discharges

Legal operational discharges of oil from shipping cannot usually be detected by eye or remote-sensing techniques, and they are not likely to present problems, since the oil discharged is dissolved or dispersed in water and amenable to further dispersion and degradation process. The legal discharge in the North Sea has been estimated to be 0.5 – 2% of the total oil inputs (OSPAR, 1993).

Illegal operational discharges can usually be detected. Regular national and international aerial surveillance flights are carried out under the Bonn Agreement 2000.

3.1.3 Environmental effects of oil spills

The environmental effects of oil spills are:

- Oiled birds, mammals and vegetation
- Oiled recreational beaches, loss of tourism income
- Impact on mar culture.

The magnitude of the effect is governed by a number of spill characteristics and environmental conditions, i.e. spill characteristics (spilled quantity, type of oil, evaporation, dispersion, emulsification) and environmental conditions (open sea or sheltered archipelagos, sea state, wave exposure, biological season - spawning/breeding, shoreline sensitivity, weather conditions, temperature, ice.

The small spills from illegal discharges dominate the frequency of ship-generated spills, while large accidental spills are relatively infrequent events.

Large spills are often associated with a wide range of spectacular environmental effects, including oiled birds, massive beach clean up operations and local destruction of the marine fauna and flora. The impacts of such occasional spills are generally naturally restored within 2-5 years. In especially sensitive and protected waters the impact of the spilled oil may remain up to 20 years.

The majority of the small operational spills are not possible to combat or recover at sea. The spills are often dispersed naturally and do not require any spectacular beach-clean up operations but never the less such small scale spills may cause significant oiling of birds.

Experience from the Baltic Sea has shown that an illegal spill may kill 30 - 40 000 birds. For the most frequent species of birds, such losses are not considered to affect the population in the long run. For rare species with locally restricted habitats the population may however be significantly reduced by impact from oil spills.
The increasing frequency of operational spills is concentrated to the main transportation routes and oil terminal areas. In order to avoid long-term biological impact from chronic oil pollution in such areas, it is important to prevent and reduce the number of illegal spills.

3.1.3.4 Oiled sea birds

Birds are the most remarkable victims and reliable biological indicators for oil pollution on sea. Standardized, long-term registrations of beached birds and pollution at representative coastal strips are very suitable to document the extent of the chronicle oil pollution (figure 7). In several North Sea countries, Beached Bird Surveys (BBSs) have been carried out for about 20 - 30 years with the help of volunteers. The rate of oil pollution - the share of oiled beached birds among all dead birds found - has revealed itself as a valuable indicator for the intensity of oil pollution of the seas.
The chemical analysis of the oil from polluted feathers serves as identification of the substance, its origin and its cause. Fuel residues from shipping are still mainly responsible for the pollution along the Danish-German-Dutch North Sea coast. With the help of the Beached Bird Surveys and the oil analysis the efficiency of measures taken to reduce the contamination caused by oil, such as e.g. providing reception facilities and air bone surveillance, can be determined.
Guidelines for monitoring of oiled birds and chemical analysis of oiled feathers have been established by the OSPAR commission. Regular monitoring of beached birds is at present carried out only by few countries. It would be quite useful to develop an European indicator for oiled birds in order to show the effects of oil accidents and oil spills on sea bird populations.

3.2 Litter

Attention has focused recently on the increasing amounts of man-made debris littering the world oceans and coastlines. However, the studies made on this problem are very limited and the available information does not allow to provide a quantitative assessment of litter input, level and decay.

The main sources of litter are:

- litter which reaches the beach and the sea via rivers;
- litter which is left on the beach by tourists who come to the beach for recreation and by construction contractors who at times dump building debris there;
- litter which is discarded from ships directly into the sea.

Investigations have shown, that waste can be transported around the world oceans by currents and wind. Factors which control the distribution of litter are: Proximity to the litter source which may be shipping lanes at sea or population concentration on land, winds and currents which disperse the litter from its source, and waves which drive the litter from the front of the beach to its back and in case of storms even beyond it, landward.

Plastic materials constitute most of the material. This is crucial because plastics are not degraded easily. The remaining litter consists of metal, glass, lumber and wood, Styrofoam and others. Floating litter consists almost entirely of plastics, Styrofoam and wood, whereas seabed litter consists mostly of wood and then plastics, metal and glass in the same abundance.

Field observations along European shores give the impression that the container fraction of the coastal litter in the Mediterranean consists mostly of those used for beverages, food and cosmetics. This is in contrast to containers of household detergents and cleansers which are the most abundant on the European coastline of the Atlantic. It has been proposed that most of the Mediterranean coastal litter is left by beach goers and therefore should be considered as land-based litter whereas that of the Atlantic beaches of Europe is mostly discarded from ships and therefore marine-based (UNEP/IOC/FAO, 1991).

The impacts of litter on the marine environment and human activities are:

- damage to fish, marine mammals and birds through entanglement and ingestion of small pellets;
- damage to free navigation through entanglement in ship propellers and clogging intakes of cooling water systems, and
- damage to shores and beaches by deterioration of their aesthetics.

Entanglement in litter can cause the drowning of marine mammals and hindrance of food uptake. The ingestion of small plastic particles affects the feeding behavior of birds, since they accumulate in the gizzard and cause false feelings of satiation. Although there are many records of seabirds, turtles, mammals and large fish being entangled in pieces of fishing line or being choked with plastic, the true scale of this problem is unclear.
Litter along shores and beaches is a problem especially in areas, where currents and wind directions cause the accumulation of litter. Despite several local studies, no quantitative figures are available at European level.

3.3 Ballast water

International shipping has been recognized as a major vector for the introduction of no indigenous and harmful organisms through the transportation of species in ballast water and hull fouling. During the last decades ballast water discharges have increased throughout the world in and near most of the major ports worldwide causing an increasing probability of successful transfer and establishment of self-sustaining populations of exotic species. The ballast water transfer with ships has been recognized as a major vector for the introduction of non-indigenous and harmful organisms.
Globally, it is estimated that about 10 billion tones of ballast water is transferred each year.
The water taken on board for ballasting a vessel may contain aquatic organisms, including dormant stages of microscopic toxic aquatic organisms - such as din flagellates, which may cause harmful algal blooms after their release. In addition, pathogens such as the bacterium (cholera), have been transported with ballast water. As ships travel faster and faster, the survival rates of species carried in ballast tanks have increased. As a result, many introductions of non-indigenous organisms in new locations have occurred, often with disastrous consequences for the local ecosystem - which may include important fish stocks or rare species.

It has been assumed that on average 3,000 to 4,000 species are transported by ships intercontinental on a daily basis (Gollasch 1996).

Over 100 non-indigenous species have been reported in the North-east Atlantic. Among the 112 species known or thought until now to be non-native in the Baltic and Black Sea (93 and 36, consequently), the exact routes of introduction are in many cases unknown.
It is very difficult to predict the impact of an introduction. Some species have out competed indigenous species, while others have caused no adverse effects. One
example for an introduced species, which had very severe adverse effects on the marine ecosystem and fisheries is the comb jelly *Mnemiopsis leidyi*:
The ctenophore *Mnemiopsis leidyi,* endemic to the North American Atlantic coast, has been introduced by ballast water into the Black Sea and is spreading there. After its first record in the Black Sea in 1982 by SCUBA divers, additional findings were reported in 1986. Nowadays the comb jelly is well established and occurs in masses. It has played a major role in the profound decline of the local anchovy industry. Up to 300 – 400 specimens have been found per one cubic meter of water. It was estimated that up to one billion tones of biomass at the end of the 1980s was formed by this species. No other species showed a higher biomass in the Black Sea. The population of native ctenophores has almost been completely removed by the American comb jelly *Mnemiopsis leidyi*. The fishing harvest of the Anchovies fishery in the Black Sea decreased to 10% compared with fisheries of the times before the comb jelly invaded the Black Sea. In 1989–1990 700,000 t of fish were caught. This was reduced to 80 t annually after the occurrence of the invader.
Current options for preventing the spread of harmful aquatic organisms in ballast water include exchanging the ballast water in deep ocean, where there is less marine life and where organisms are less likely to survive. Other options include various (filtration, thermo, chemical, radiation) treatments of the ballast water en route to kill the living organisms.
These control methods have generally been ineffective. The means of preventing such introductions have been under review by an IMO/MEPC working group, which is preparing regulations for ballast water management.

3.4 TBT-Antifouling paint

Exposure to Tributyltin (TBT), originating from anti-fouling paints, produces distinctive responses in a number of organisms, including shell thickening in Pacific oysters and sex change (imposex) in marine snails.

Antifouling paints are used to coat the bottoms of ships to prevent sea life such as algae and mollusks attaching themselves to the hull - thereby slowing down the ship and increasing fuel consumption. In the early days of sailing ships, lime and later arsenic was used to coat ships' hulls, until the modern chemicals industry developed effective antifouling paints using metallic compounds.

The compounds slowly "leach" into the sea water, killing barnacles and other marine life that have attached to the ship – but studies have shown that these compounds persist in the water, killing sea life, harming the environment and possibly entering the food chain. One of the most effective antifouling paints, developed in the 1960s, contains the 1organotin tributyltin (TBT), which has been proven to cause deformations in oysters and sex changes in whelks.

TBT belongs to the most toxic substances released into the environment. On account of ite strong ecotoxicity and the relatively high levels in the water column as well as port sediments, negative ecological effects are very probable. An analysis of the stock development of marine snails on the German North Sea coast reveals for a plurality of species decreases in abundance. To some extent, this decrease can be attributed to TBT. A positive stock development is listed for none of these species (Nehring, 1999).

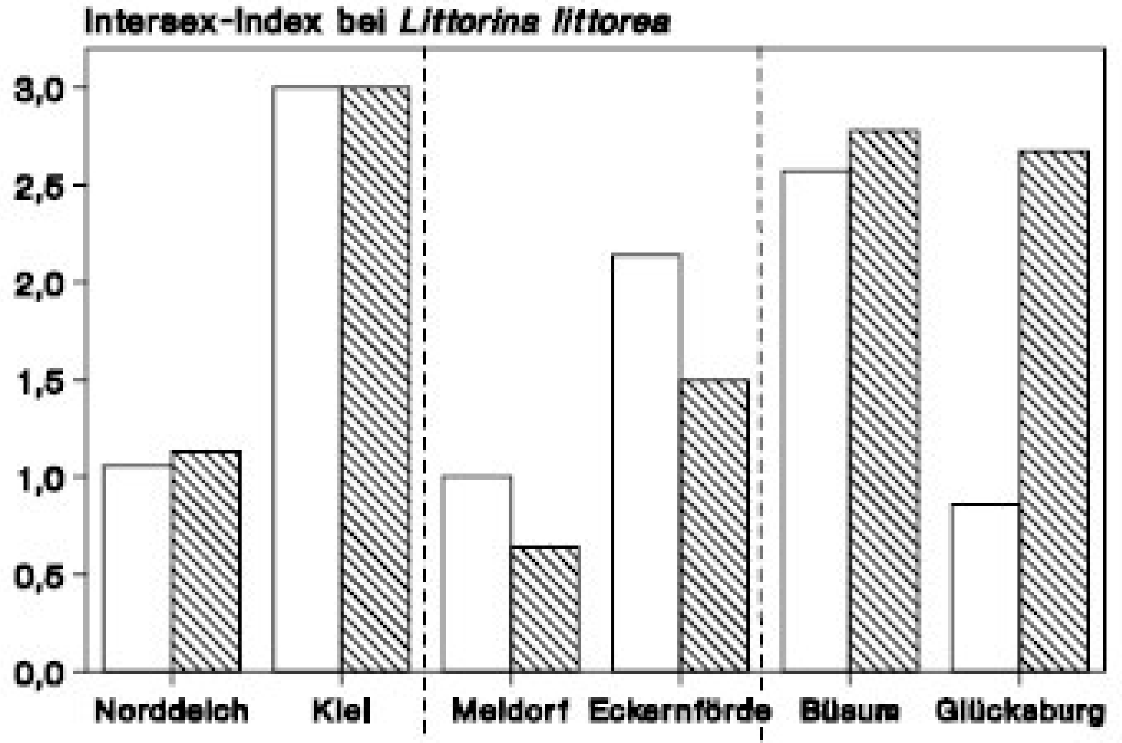
The sensitivity to TBT of marine snails differs between species. The most sensitive species is the dog whelk *Nucella lapillus*, which shows imposex effects already at concentrations of 0.5 ng TBT-Sn/l in water, whereas the edible periwinkle *Littorina littorea* intersex effects only at concentrations of about 5 ng TBT-Sn/l in water shows.

The level of imposex and intersex is correlated to the level of TBT in the environment. Generally, TBT concentrations in offshore waters and sediments are generally less than the detection limit, whereas much higher values are found in harbors and marinas and major shipping routes. Significant levels of imposex/intersex in dog whelks and edible periwinkle are found in those estuarine and coastal areas with the heaviest concentrations of shipping and ship related activity (fig 8,9).

Figure 8.

Imposex index for populations of *Nucella lapillus* in 1987 (white column) and 1993 (shaded column) at different sites in Ireland (from left to right: reference stations, salmon farms, marinas, ports) (Oehlmann, 1998).

Figure 9: Intersex index for populations of *Littorina littorea* in 1995 for old females (white column) and young females (shaded column) at different harbors in Germany (Oehlmann, 1998).



There is presently a lack of controls on the application of TBT to ships larger than 25 m (use on smaller vessels was banned in 1990). There is a positive correlation between shipping intensity and TBT levels in biota/sediments and the occurrence of imposex. This suggests that vessels with a length of more than 25 m represent the main source of TBT for the marine environment . The IMO has agreed a mechanism for a general ban on the use of organ tin compounds in anti-fouling paints, aimed at prohibiting their application from 2003 and requiring the removal of TBT from ships' hulls by the year 2008.

Alternatives to TBT paint include copper-based coatings and silicon-based paints, which make the surface of the ship slippery so that sea life will be easily washed off as the ship moves through water. Further development of alternative anti-fouling systems is being carried out. Underwater cleaning systems avoid the ship having to be put into dry dock for ridding the hull of sea life, while ultrasonic or electrolytic devices may also work to rid the ship of foulants.

3.5 Air pollution

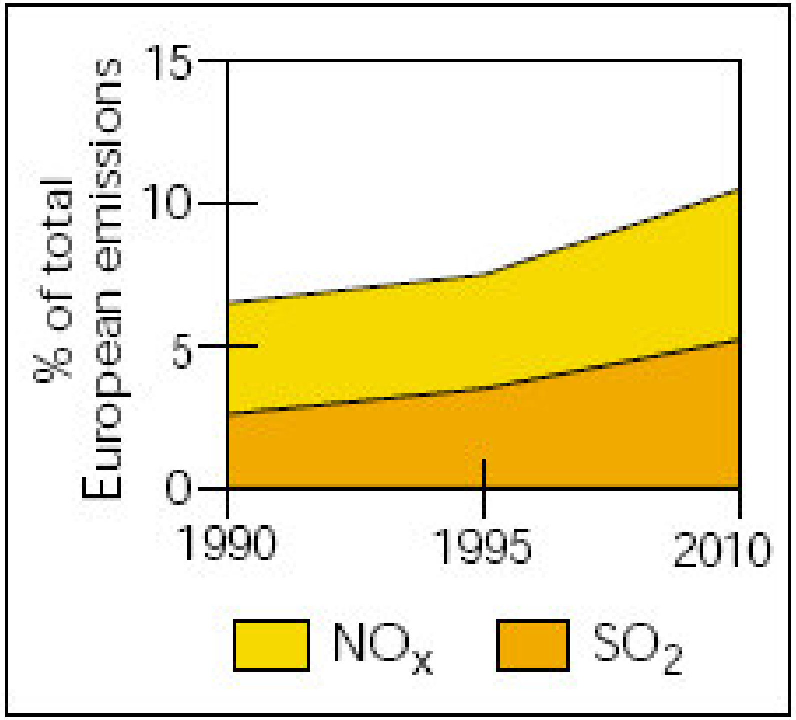
Emissions of NOx from ships are one source for atmospheric nitrogen and its deposition into the seas. Increase nitrogen concentrations in marine waters cause eutrophication problems like algal blooms.

The emissions of SO2 and NOx from international ship traffic in 1995 were similar in magnitude to the contribution of land-based emissions of individual large countries. The contribution of emissions from international ship traffic sources to the total deposition over western Europe is about 10-15% (EEA, 1998).

The spatial distribution of NOx emissions used in model calculations for 1997 over Europe shows clearly the emissions along major shipping routes (EMEP, 1999).

The relative importance of international ship traffic emissions will increase if no measures are taken to control this type of emission. Since the total reported emissions of SO2 and NOx in European countries decreased markedly from 1990 to 1995, the relative contribution of international ship traffic increased in the period to 3.5% for SO2 and 7.5% for NOx. If no further reductions are accomplished, it is expected that the relative contribution of emissions from international ship traffic will have doubled by the year 2010 (Figure 10).

Figure 10: Contribution from international shipping in the North Sea and north-east Atlantic Ocean to total European acidifying emissions Nitrogen compounds and sylph compounds each contribute about 50% to ongoing acidification. *Source: EMEP*



As a consequence, reductions of emissions from international ship traffic would translate into considerable reductions of the pressures/depositions in western European countries and seas, with the additional advantage of reducing the costs for reaching the established environmental targets.

In 1997, the International Convention for the Prevention of Pollution from Ships (MARPOL) proposed a new protocol to reduce pollution from ships' exhaust emissions. Reducing emission from international ship traffic could be more cost-effective than reducing land-based sources. The estimated savings are about 1 000 million euros/year

3.6 Noise

Sources of underwater noise are:

- ship propellers
- offshore drilling
- ice breakers
- seismic underwater explosions.

Marine animals are threatened by underwater noise: Loud and sudden bursts of noise such as underwater explosions during seismic exploration can deafen animals. Noise can disturb and upset animals and scare them away from their natural domiciles and feeding areas.

Another important impact may be the interference of noise with marine mammal communication. Marine mammals possess a complex communication system serving a large variety of functions. For some species, vocalizations have been related to excitement, alarm, fright, threat, traveling, resting and copulation. Masking of these communication signals to the point of incomprehensibility can have fatal results.

Models for protecting marine mammals from noise have been suggested that are analogous to human noise criteria, specifically (1) weighting functions that model species-specific auditory threshold functions (analogous to A-weighting); (2) threshold models for predicting the proportion of individuals that avoid a noise; and (3) the equal energy hypothesis for predicting hearing loss. Models for reducing sleep interference, speech interference, and attention deficits might also be applicable. Unfortunately, human noise criteria do not apply to a number of effects that could occur in free-ranging marine mammals. Noise could affect non-auditory physiology. Noise could also mimic natural sounds (e.g., seismic impulses that are similar to tail beats), or attract marine mammals into dangerous areas (e.g., attracting killer whales to fishing gear).

Especially whales could be severely affected by underwater noise from sources such as ship propellers and underwater drilling. Sophisticated sonar techniques used by oil exploration companies as well as drilling are just part of the man-made problem causing havoc to whales' breeding and feeding patterns.

The International Whaling Commission (IWC) believes more research should be done on the effects on whales which could lead them to put pressure on offshore operators to limit the noise they produce underwater.

The short-term reaction can be seen but it is unclear,
whether this will have long term repercussions, changing migration routes and moving animals away from their preferred feeding and breeding grounds. It is necessary to take a precautionary approach to the problem to insure the least disruption to marine mammals. Long-term studies should be done to discover if shipping and drilling are affecting the creatures.

4. Conclusion

An overview on the environmental effects of shipping has been given in this paper. A lot of information is available on oil spills and also on other issues a several studies have been carried out. No European picture of the problems has been drawn so far, except for oil accidents. It is important that the information available at regional sea level is made comparable at European level. Especially data on oiled birds, litter and TBT effects need to be collected for all sea areas in order to show the European aspect of the problem and to assess, if different measures are necessary for different sea areas.
Our knowledge on the effects of underwater noise is so scarce, that research is needed to better understand, if this issue is a real problem and what we need to do to reduce negative effects.
Measures
–on ballast water to avoid introduction of alien organisms,
–on oil pollution to avoid accidents and illegal spills,
–to reduce air pollution by ships and
–to ban the use of TBT
are necessary to avoid the described adverse effects on the marine environment.
Activities on all items are already ongoing, but they are not sufficient or effective enough.
It has to be monitored and assessed, if further measures are effective