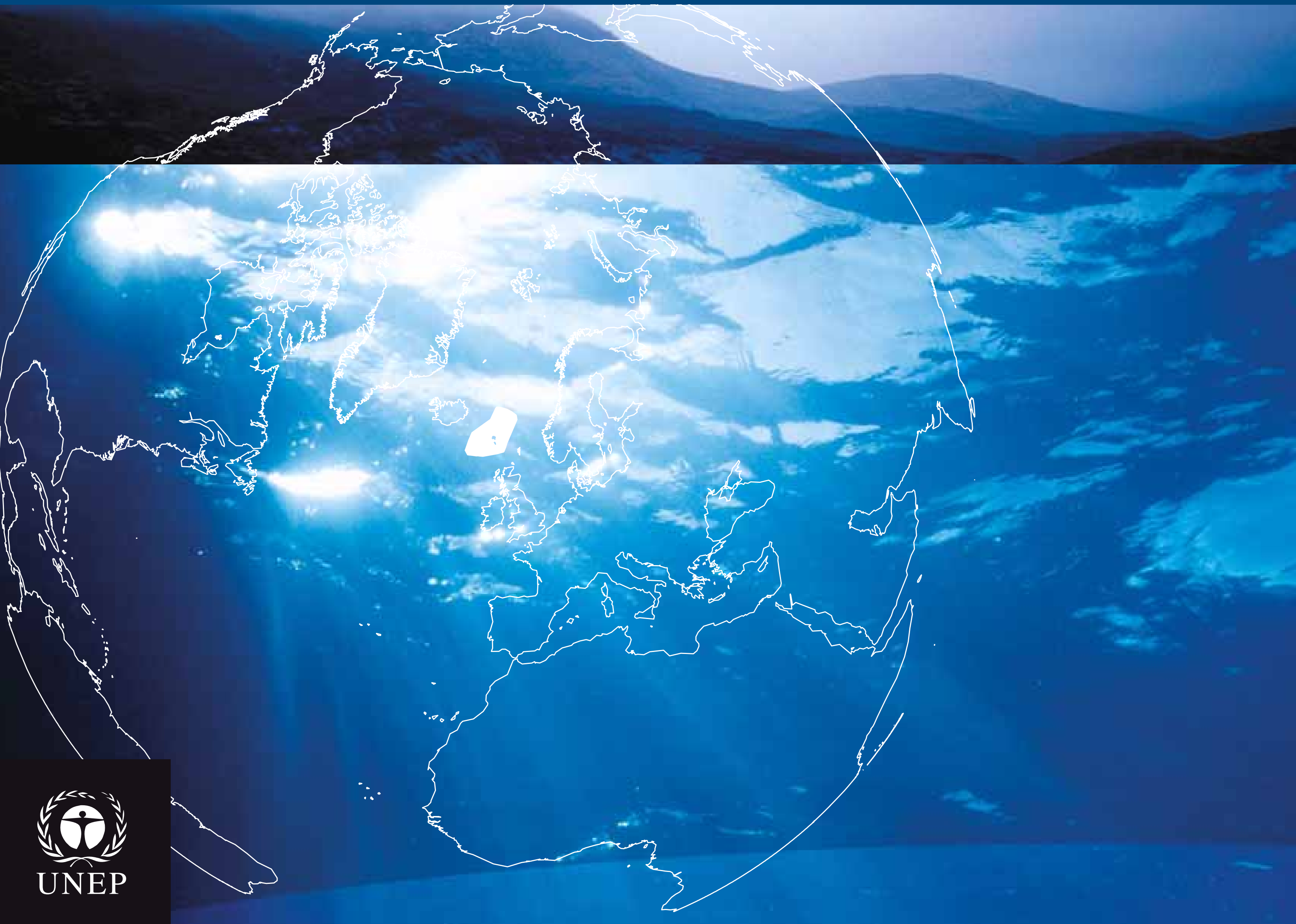
GIWA

Global International Waters Assessment



UNEP

GEF

HÖGSKOLAN KALMAR UNIVERSITY

Faroe Plateau

GIWA Regional assessment 13

Pedersen, S.A., Madsen, J. and M. Dyhr-Nielsen

Global International Waters Assessment

Regional assessments

Global International Waters Assessment

Regional assessment 13
Faroe Plateau

UNEP GEF HÖGSKOLAN KALMAR UNIVERSITY

UNEP Collaborating Centre on Water and Environment

UCC-Water UNEP DHI

National Environmental Research Institute
Ministry of the Environment · Denmark

Greenland Institute of Natural Resources

GIWA report production

Series editor: Ulla Li Zweifel

Report editor: UNEP Collaborating Centre on Water and Environment (UCC-Water)

Contributors: Søren Anker Pedersen, GINR (Compiler and editor), Jesper Madsen, NERI (Co-editor), Mogens Dyhr-Nielsen, UCC-Water (Co-editor)

Global International Waters Assessment
Faroe Plateau, GIWA Regional assessment 13

Published by the University of Kalmar on behalf of
United Nations Environment Programme

ISSN 1651-940X

University of Kalmar
SE-391 82 Kalmar
Sweden

United Nations Environment Programme
PO Box 30552,
Nairobi, Kenya

CITATIONS
When citing this report, please use:
UNEP, 2004. Pedersen, S.A., Madsen, J. and M. Dyhr-Nielsen, Faroe Plateau, GIWA Regional assessment 13. University of Kalmar, Kalmar, Sweden.

Contents

List of figures

List of tables

Preface

Globally, people are becoming increasingly aware of the degradation of the world's water bodies. The need for a holistic assessment of transboundary waters in order to respond to growing public concern and provide advice to governments and decision makers regarding management of aquatic resources has been recognised by several international bodies focusing on global environment. To compile a global overview, the Global International Water Assessment (GIWA) has been implemented by the United Nations Environment Programme (UNEP) in conjunction with the University of Kalmar, Sweden (www.giwa.net).

The importance of the GIWA has been underpinned by the UN Millennium Development Goals adopted by the UN General Assembly in 2000 and the Declaration from the World Summit on Sustainable Development in 2002. The development goals aim to halve the proportion of people without access to safe drinking water and basic sanitation by the year 2015. The Johannesburg Plan of Implementation encourages the application by 2010 of the ecosystem approach, and stresses the importance of maintaining productivity and biodiversity of marine and coastal areas, including protection of the marine environment from the impacts of land-based activities

This report presents the results of the GIWA assessment of Faroe Plateau, GIWA region 13. The report is the Faroe contribution to GIWA and it is funded by the Danish Environmental Protection Agency as part of the environmental support programme DANCEA – Danish Cooperation for Environment in the Arctic.

The report is based on the GIWA Methodology: "STAGE 1: Scaling and Scoping" and "Causal chain analyses" (see www.giwa.net).

The task team meeting was held 8 October 2003 at Fiskirannsóknarstovan (Fisheries Research Laboratory) in Tórshavn, Faroe Islands.

A number of selected experts participated in the task team meeting. Other selected experts were unable to attend to the meeting. The experts consulted for input and reviews of this report are presented in Annex 1. Jákup P. Joensen from the Food, Veterinary and Environmental Agency of the Faroe Islands was coordinator for the editorial process. The report was peer-reviewed by Dr. Henrik Sparholt and Dr. Raphael V. Vartanov.

The report has been compiled and edited by:

- Søren Anker Pedersen, GINR (Compiler and editor)
- Jesper Madsen, NERI (Co-editor)
- Mogens Dyhr-Nielsen, UCC-Water (Co-editor)

Executive summary

The Faroe Islands are situated on a shelf in the North Atlantic Ocean and surrounded by a number of important fishing grounds. The climate is strongly affected by the North Atlantic Current and frequent passage of cyclones. For a subarctic region, the Faroes enjoy fairly high winter temperature, seldom remaining below zero for any prolonged length of time.

All islands are small with very small rivers, and only the surrounding marine waters are of international significance. In the surface, the area is covered by the warm, saline Atlantic waters that flow past the Faroes into the Norwegian Sea. Only in the Northernmost part do one find cold, less saline water masses.

The waters around Faroe Islands are important nursery areas for larvae of many commercially important fish stocks. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. From 1992 onwards the conditions have returned to more normal values. A very clear relationship, from primary production to the higher trophic levels (including fish and seabirds) has been observed in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the marine waters.

The Faroe human population of a little less than 50,000 is highly dependent on the marine resources. The standard of living is comparable to the Scandinavian countries, but the economy is strongly correlated to the fishery sector, including aquaculture. Tourism is an increasingly important source of income, and there are possibilities of a future oil and gas production, similar to the oil finds in UK.

The experts have identified pollution with toxic chemical as the presently most serious international water concern. Due to bio-accumulation in the tissue of marine species, impacts on public health may be significant, due to the high reliance on traditional indigenous food sources like fish, whales and seabirds. Also, traces in the commercially important fish stocks may jeopardize this important source of income to the Faroe economy. The toxic substances are carried over far distances by water and air from the industrial areas in Europe, North America and Asia. There is an urgent need to continue to address these pollution problems in the appropriate international fora.

Another important concern is the unsustainable exploitation of fish. The severe depletion – and subsequent recovery – has been a combination of climatic/oceanographic variability, but overexploitation of an ecosystem under stress has exaggerated the problem. Due to the economic significance, there is consensus on the importance of sustainable management of marine resources, and the Faroes have introduced strict regulations to ensure sustainable fisheries.

However, basic scientific understanding of the complex interaction between climatic variability and recommended catch quotas is not complete. This problem is further compounded by the potential impacts of global warming. There is a need for the international community to promote more research focus on the Atlantic ecosystems, in order to understand, predict and adapt to the potential future changes.

This report is funded by the Danish Environmental Protection Agency and is joint effort by almost 20 experts from the Faroe universities and research institutes. The contents and views do not necessarily reflect the views and policies of the contributory organizations or the United Nations Environment Programme (UNEP)

Regional definition

This section describes the boundaries and the main physical and socio-economic characteristics of the region in order to define the area considered in the regional GIWA assessment and to provide sufficient background information to establish the context within which the assessment was conducted.

Boundaries of the region

Location and geography

The Faroe Islands are situated in the North Atlantic Ocean, between 61° 20' and 62° 24' northern latitude, and 6° 15' to 7° 41' western longitude. The islands are located approximately 430 kilometres to the south east of Iceland, and 300 kilometres to the north of Scotland.

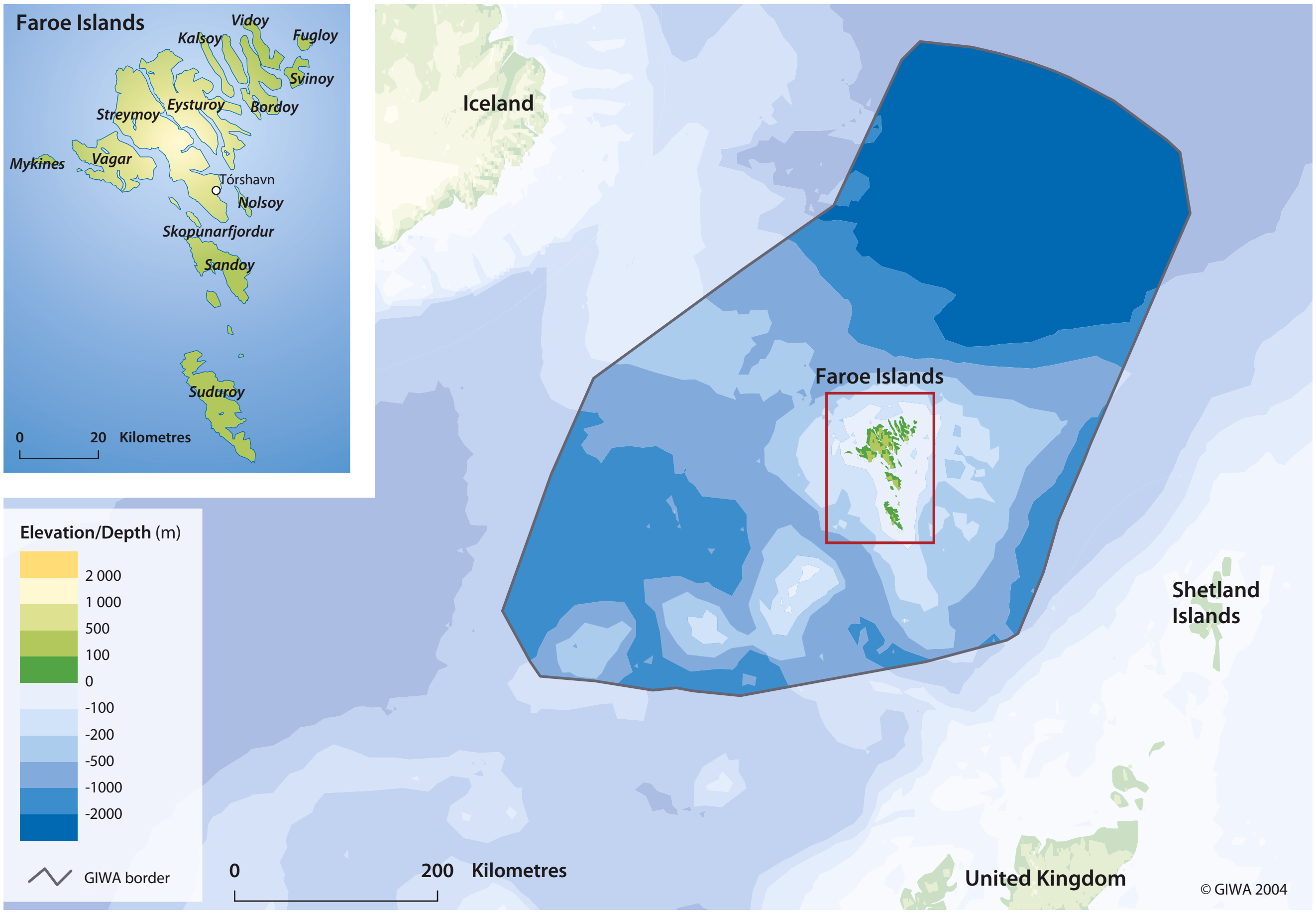


Figure 1 The Faroe Islands.

The Faroe Islands consist of 18 mountainous islands situated in the North Atlantic at about 62°N and 7°W. The islands extend over 113 km from north to south and 75 km from east to west, and the total land area is 1 399 km^2 (sea area is 274 000 km^2) (Figure 1). The highest points, almost 890 metres above sea level, are on the northern islands. Seventeen of the islands are inhabited. The capital, Tórshavn, is situated on the largest island, Streymoy (376 km^2), located in the south of the principal cluster of the northern islands.

The archipelago is volcanic in origin, forming part of the Wyville-Thompson ridge, which stretches in a north westerly direction from the British Isles to Greenland. The geological origins of the islands can be divided between the period of volcanic activity during which the basalt Plateau developed, and the subsequent period of erosion, including glacial formation during periods of ice age, which has given the islands their current distinctive features.

The Faroese fjords are oriented along a northwest to southeast trend, arising from the system of fissures through which the basalt Plateau was formed. The northern-most islands are characterised by very steep and high cliffs, with gently sloping terraces covered for the greater part by low-lying vegetation. Another distinctive feature of the Faroese coastline is the large number of gullies (gjógv), with steep walls that provide safe nesting areas for seabirds. The rapid coastal erosion on the west facing cliffs has led to the formation of stacks and skerries that are also safe nesting areas.

The majority of the Faroese shoreline is exposed to the direct action of the sea and there are few bays or sheltered lagoons. High cliffs are a dominant coastal feature and areas of sandy beach are rare, as are sand dunes, which are only present on the island of Sandoy. Safe anchorages are available in the narrow sounds between the islands and in fjords.

Physical characterstics

Climate

The climate in the Faroe Islands is strongly affected by the warm North Atlantic current and frequent passage of cyclones, which, depending on the location of the polar front, mainly come from southwest and west. The climate is characterised by mild winters and cool summers.

The high pressure over the Azores sometimes shifts towards the Faroe Islands. This can result in stable summer weather lasting several weeks, with quite high temperatures. In winter, on the other hand, the low pressure systems can move further south around the islands than normal, bringing in cold air from the north and a lengthy period of sunny winter weather.

Despite their sub-arctic location, the Faroe Islands enjoy mild winters (lows averaging 4.1°C in February) and cool summers (with average highs of 11.1°C in August).

Average air temperatures remain above zero throughout the year in all parts of the islands, and temperatures seldom remain below zero for any length of time, though there is a high incidence of frost.

The sky is typically overcast (the overcast value averages 78%) and rainfall levels are high. Precipitation is recorded on an average of 280 days annually, and rainfall averages 1 461 mm annually.

Weather patterns are subject to abrupt and violent changes, and extreme wind forces are regularly recorded. Frequent sea fogs fill the valleys and low-lying coastal zones.

The offshore waters in the Faroe Islands region are modified by the surrounding oceanic water masses, which influence ambient water temperatures. Two major surface water currents transport water into the region. The Gulf Stream carries warm Atlantic water from the southwest and divides around the north and south of the islands. The second current (the East Icelandic Current) flows from the direction of Iceland in the northwest, bringing cold, plankton-rich water. The average surface water temperature is relatively stable, averaging between 10-11°C in the summer and 6-7.5°C in the winter.

The maritime climate is also a result of the cold East Icelandic Current (polar current), which splits into two currents from eastern Iceland towards the Faroe Islands. The mixing of the water masses from this and the warm Gulf Stream causes a relatively big difference in the sea temperatures around the islands, and this in turn causes local variations in the climate.

Freshwater

The Faroe Islands hold in most places plenty of unpolluted freshwater in several lakes and streams. According to Christoffersen (2002) the Faroe Islands are inhabited by the same groups of freshwater organisms as found elsewhere in the region, because of the similar (though not identical) pre-glacial history. However, overall diversity seems to be lower than in neighbouring areas, such as Shetland and Iceland, most likely due to the presence of dispersal barriers.

Today's most important anthropogenic effects are those of untreated wastewater and the agricultural practice of fertilisation of hay fields. The few studies so far conducted on lake chemistry indicate that eutrophication does occur (Christoffersen, 2002), but not at levels observed elsewhere (e.g. in Scandinavia).

During the 20th century the water level of a number of lakes was raised by damming of outlets to produce hydroelectric power and to ensure a sufficient drinking water supply. The effects of such regulations include flooding of wetlands and changes in the aquatic food webs due to the immediate disturbances as well as to changes in catchment size and the retention time of the lake water (Jensen et al., 1983). Some of these lakes are used for aquaculture smolt production which leads to eutrophication and difficulties in controlling fish-diseases. The present-day and early historic biodiversity and ecology of Faroese streams, ponds and lakes ought therefore to be investigated and described in detail before more marked and widespread changes occur, and the results obtained will be a useful tool in the hands of water management authorities when implementing water protective measures (Christoffersen, 2002).

On the five largest islands there are some 40 mountain lakes containing brown-trout (*Salmo trutta*). Sea trout is to be found in most of the water courses from mid June. Salmon (*Salmo salar*) and sea-trout can be caught in the bigger lakes on the islands. A natural population of Arctic char (*Salvelinus alpinus*) occurs in "Leynavatn" only. Salmons, trout's and Arctic char are exploited by sports fishing only, and there are no imminent threats to these fish stocks from overfishing or pollution (A. Reinert, Fiskaaling, Faroe Islands, pers. comm.)

Oceanography and the marine ecosystem

The following description of the physical oceanography and marine ecosystem of the Faroese Plateau is from a recent comprehensive description given in Dam et al. (2000) and Jákupsstovu et al. (2003). For detailed descriptions see e.g. Hansen et al. (1998), Olsen (1998, 2001), Hansen and Østerhus (2000), Bloch et al. (2001), Gaard et al. (2002), Hoydal and Dam (2003).

Faroese waters are divided into two parts by a series of ridges that are part of the Greenland-Scotland Ridge (Figure 2). On both sides of the ridge, bottom depths exceed 1500 m while the ridge itself has typical sill depths around 500 m. The Atlantic sector, southwest of the ridge, includes a number of banks. Northeast of the ridge, the Norwegian Sea extends to depths more than 3000 m in the Faroese area.

In the surface, most of the area is covered by warm, saline Atlantic waters that flow past the Faroes into the Norwegian Sea. Only in the northernmost part are Faroese surface waters affected by cold, less saline, Arctic water masses that are carried into the area by the East Icelandic Current.

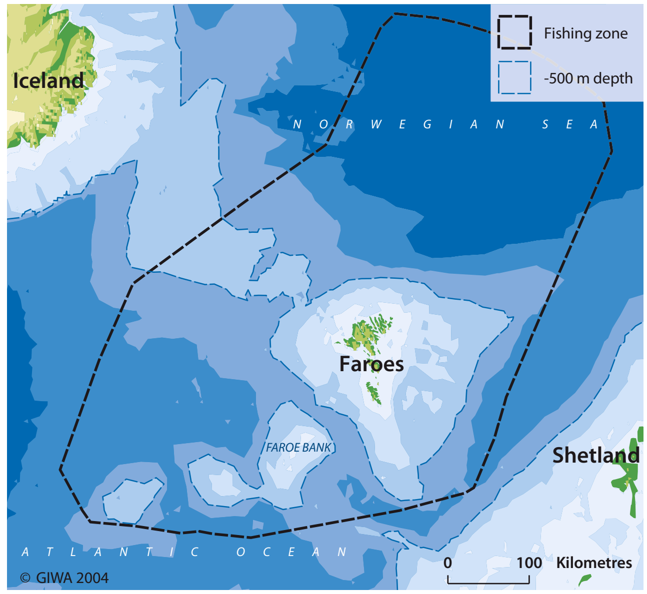


Figure 2 Faroese waters may be defined as the ocean area within the Faroese fishing zone.
(Source: Jákupsstovu et al., 2003)

The relatively homogeneous character of the surface waters disappears at greater depths. In the Atlantic sector, southwest of the ridge, warm (and saline) water extends to great depths while the northeastern sector is dominated by cold (<0°C) and less saline water from around sill level and down to the bottom. At depths below the sill, the two regions therefore exhibit quite different characteristics (Figure 3).

In mostly all directions out from the Faroes, we therefore find warm, saline Atlantic water in the upper layers and cold, less saline water at depth. In between, water from the East Icelandic Current may often be identified as a salinity minimum, especially on the eastern side of the Faroe Plateau.

This introduces an east-west asymmetry, especially at intermediate depths. The interface between the warm upper layers and the colder layers below is typically found at some 400-600 m depth, but may vary considerably which introduces large variations of the bottom temperature at these depths.

As a whole, Faroese waters exhibit a fairly diverse and fairly variable character. Both the characteristics and the flow patterns, in the surface,

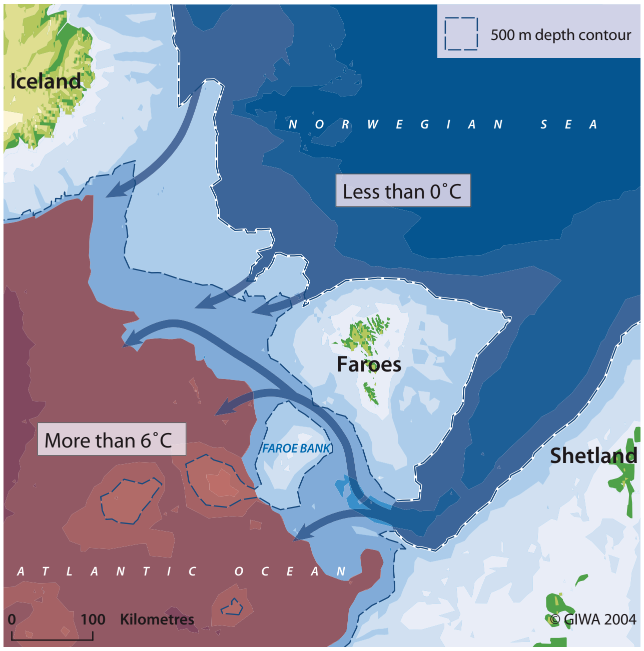


Figure 3 At depths about 600-800 m, there is a large difference in temperature (and salinity) between the two regimes on either side of the ridge. There is, however, an overflow of cold water across the ridge that influences conditions in the Atlantic sector.
(Source: Jákupsstovu et al., 2003)

as well as at depth, are determined by the thermohaline ventilation processes, occurring further north in the Arctic Mediterranean. These processes generate the cold waters that flow past the Faroes at depth and the compensating inflow of warm Atlantic water in the surface. How these processes will change with global climate change will determine the sea climate of Faroese waters in the future.

Productivity

The Faroe Islands are surrounded by a shelf, which is approximately described by its 200 m bottom contour. The 200 m bottom contour occupies about 21 000 km^2, and the width of the shelf varies greatly around the islands (Figure 2). It is only about 12 km wide east of the southernmost island and approximately 50 km wide in the northwest direction. In some areas the topography is smooth with a well-defined shelf break, and in others it is irregular or continuously sloping without a shelf break.

Because of strong tides, the on-shelf water is well mixed throughout the year, while the off-shelf water can be stratified in the summer season. In winter the cooling is on the other hand more efficient on the shelf. This creates a temperature front, not only in the summer season, but also throughout most of the year, except for the period October/November. The temperature front is most pronounced in the spring before the

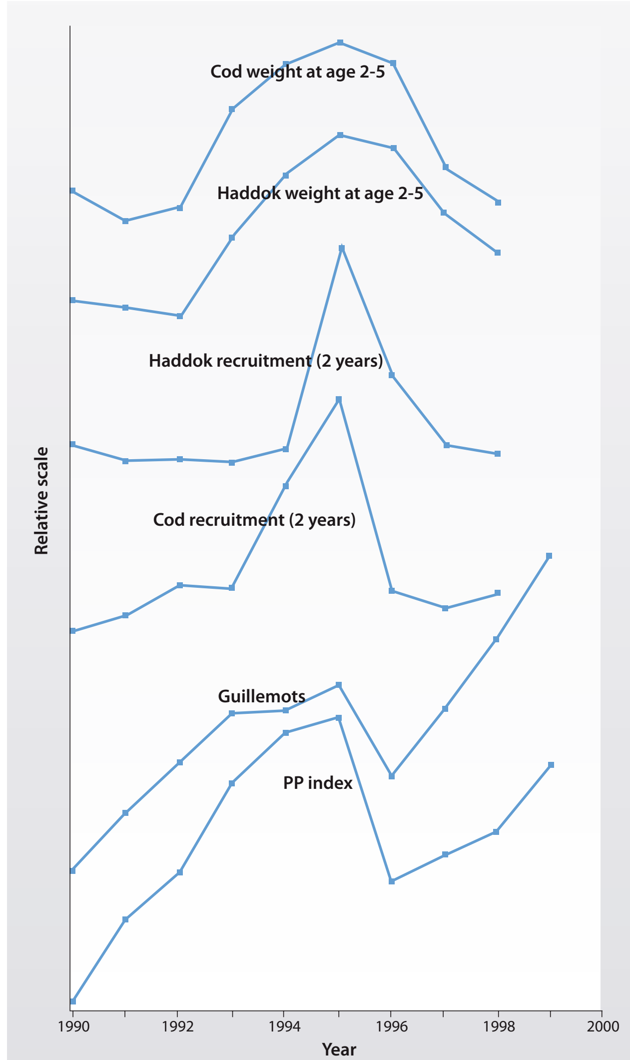


Figure 4 Relative variability in calculated new primary production, number of attending guillemots, recruitment of 2 year-old cod and haddock and mean weight of 2-5 year-old cod and haddock during 1990-1999.
(Source: Gaard et al., 2002)

onset of off-shelf stratification, and least pronounced or non-existing in the autumn, when the stratification is broken down.

The water inside the front occupies a special role in the Faroese marine ecosystem (Gaard et al., 2002) and is an important nursery area for larvae of many commercially important fish stocks. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. This applies also to the recruitment of many fish stocks, and the growth of the fish was poor as well. From 1992 onwards the conditions have returned to more normal values, which is also reflected in the fish landings. A very clear relationship, from primary production to the higher trophic levels (including fish and seabirds) has been observed in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Figure 4; Gaard et al., 2002; Steingrund et al., 2003).

Benthos

Most recently, benthos investigations were performed in Faroese waters during the BIOFAR programme initiated in 1988 to cover the EEZ at depths from 100 – 1000 m depth (Nørrevang et al. 1994, Sørensen 2003, Tendal et al. (in press)). This was a joint inter-Nordic effort with cruise-participants from Denmark, Iceland, The Faroe Islands, Norway and Sweden. The material collected was worked up mainly by specialists from these and other countries bordering the NE-Atlantic, but also by some from USA. The two main objectives were to generate a list as complete as possible of benthic invertebrate species (macrofauna), and to obtain a survey of species distribution in relation to various physical parameters, especially current, temperature, salinity and depth. In 1995, the BIOFAR programme was extended to cover also shallow waters from 0-100 m.

Both earlier literature and the more than 100 scientific papers so far published in connection with BIOFAR confirm that the fauna is mainly boreal-arctic with many distribution patterns following water mass characteristics (bibliography in Bruntse and Tendal 2001). Biologically important results are the demonstration of hyperbenthos being rich and abundant all around the Faroes, and of big concentrations of biomass dominated by one or a few large-sized species of corals or sponges in many places on or near the shelf margin (articles in Bruntse and Tendal 2001; Tendal et al. (in press)).

Fish

The fish fauna in Faroese waters is diverse mainly due to the special bottom typography and the very different water masses in the area. The fish fauna is mainly boreal but occurrence of arctic as well as of Mediterranean species illustrate the composite nature of the area (Reinert, 2003). About 18 fish species have their north westerly boundary at the Faroes. In total, about 170 different fish species have been recorded for the area. The commercially most important fish species are: cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), saithe (*Pollachius virens*), tusk (*Brosme brosme*), ling (*Molva molva*), angler fish (monkfish) (*Lophius piscatorius*), Greenland halibut (*Reinhardtius hippoglossoides*), redfish (*Sebastes* spp.), blue whiting (*Micromesistius poutassou*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*), halibut (*Hippoglossus hippoglossus*), silver smelt (*Argentina* spp.), blue ling (*Molva dypterygia*), and others.

There exist several local self-sustained fish stocks in the area (Faroe Plateau cod, Faroe Bank cod, Faroe haddock, Norway Pout, small redfish etc.); others perform limited migrations in and out of the area but are in assessments/management regarded as local stocks (saithe, halibut, ling, tusk etc.) while many others belong to stocks with a wider distribution area (golden redfish, deep-sea redfish, blue ling, Greenland halibut etc.) or are stocks migrating to and/or through Faroese waters (herring, blue whiting, mackerel, horse mackerel, salmon, blue-fin tuna etc.).

Seabirds

Nearly 2 million pairs of seabirds breed in the Faroe Islands (Olsen, 2003). As seabirds begin breeding only at 5-12 years of age there is also a very large number of sub-adult birds. In total there may be about 5 million Faroese seabirds with a total biomass around 3 000 tonnes, consuming about 300 000 tonnes/year. Four of the 21 species make up 95% of the total biomass. These are the fulmar (*Fulmarus glacialis*) (48%), puffin (*Fratercula arctica*) (21%), guillemot (*Uria lomvia*) (17%) and kittiwake (*Rissa tridactyla*) (9%). The fulmar is the most abundant and widespread species of seabird in the North Atlantic and numbers have increased dramatically over the last 250 years although the reason is unknown. It seems clear that the fulmar nested, really for the first time in the Faroes, some time between 1816 and 1839. Many of the seabirds migrate or disperse from the Faroese waters after the breeding season but the fulmar is in Faroese waters all year round (Olsen, 2003). The Fulmar in the Atlantic has shown one of the most remarkable rang expansions and population explosions known in seabirds, yet the reason for the increase are still unclear. Explanations include the provision of extra food for fulmars, first in the form of offal from whaling fleets and later as discarded fish from trawlers.

Marine mammals

During the last two centuries 27 marine mammal species have been recorded in Faroese waters: seven pinniped and 20 cetacean species (Bloch, 1998; Bloch et al., 2001). Grey seal (*Halichoerus grypus*) and harbour porpoise (*Phocoena phocoena*) are the only species occurring permanently inshore in Faroese waters.

The Faroese grey seal population seems to be related to grey seals from the Scotland-Orkney area (Mikkelsen et al., 2002). The following species are observed offshore year round as well as migrating: Fin whale (*Balaenoptera physalus*), minke whale (*B. acutorostrata*), sperm whale (*Physeter macrocephalus*), bottlenose whale (*Hyperoodon ampullatus*), long-finned pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), and white-sided dolphin (*Lagenorhynchus acutus*). Of the remaining 18 species, some migrate into and stay only temporarily in Faroese waters: Harp seal (*Phoca groenlandica*), hooded seal (*Cystophora cristata*), blue whale (*B. musculus*), sei whale (*B. borealis*), humpback whale (*Megaptera novaeangliae*), bottlenose dolphin (*Tursiops truncatus*), and white-beaked dolphin (*L. albirostris*).

The long-finned pilot whale was the topic of an international study in the period 1986-1988 where 40 pods containing 3 470 whales were examined (Desportes et al., 1994). The long-finned pilot whales around the Faroes are different in morphometry than the long-finned pilot whales around Newfoundland (Bloch and Lastein, 1993). The population size of the pilot whale in the northeastern Atlantic is around 778 000 (Buckland et al., 1993) where the hunting pressure taken by the Faroe Islands is 0.1 % on average (Bloch, 1994). From the Faroese catch statistics dating back to 1584 and unbroken from 1709 until today, both the pilot whale and the bottlenose whale are shown to have a cyclic occurrence in Faroese waters of around 100 years length and correlated with climatic variation (Bloch and Lastein, 1995; Bloch et al., 1996). Experiments with satellite tags have shown that the pilot whale dives to around 800 m. depth and can travel about 200 km/day (Heide-Jørgensen et al., 2002; Bloch et al., 2003).

The Faroe Bank area

The Faroe Bank is located approximately 75 km southwest of the Faroe Islands (Figure 2). Due to the small-size of the Faroe Bank and its position as a geographically well-defined and self-contained ecosystem surrounded by an oceanic environment, it is a very suitable area for marine biological studies. The topographic and hydrographic features on the Faroe Bank have led to the existence of a fairly isolated ecosystem. This isolation largely determines the character of the populations of fish and other organisms on the Bank (Magnussen, 2002, 2003; Reinert, 2003; Schmidt et al., 2003; Steingrund, 2003).

Bottom trawl surveys around the Faroe Islands have demonstrated that there are large differences in the distribution pattern for several of the species living on the Faroe Bank as compared to the Faroe Plateau. For example, megrim (*Arnoglossus laterna*) only occurs on the Bank, whereas squid and poor cod, which are common on the Bank, are scarce on the Plateau. In contrast, plaice is common on the Faroe Plateau but rare on the Faroe Bank.

Between 200 and 500 m the reef-forming coral *Lophelia pertusa* is present all around the slope of the bank. *Lophelia* formations themselves host about 300 associated taxa and they may function as a nursery and recruitment area within the more barren surroundings. Large sponge accumulations are found on the northeastern and on the southeastern slope of the bank. The sponge accumulations are called "ostur" (cheese-bottom) referring to the shape and consistency of the sponges and to the smell of broken specimens. Up to 50 different large sponge species have been recorded from Faroese ostur areas. Up to 242 different species, especially filter and suspension feeders have been found in association with the ostur and it is quite likely that they provide an important recruitment area for different fish species such as redfish *Sebastes* spp.

Natural resources

With very little cultivated land, sheep rising is important, and in fact, the name Faeroe Islands is said to mean "Sheep Islands". About 80 000 sheep graze on the Faroese mountainsides - free-range animals in the true sense of the word. In places difficult to access they are only in touch with humans twice in their lifetime: when they are let loose as lambs and when they are herded together as fully-grown animals. The principal natural resources consist of shellfish, fish, whales, a wide variety of bird-life, small quantities of coal, and (possibly) offshore hydrocarbon deposits.

Fisheries

The Faroe Islands are located within the International Council for the Exploration of the Sea (ICES) Fisheries Statistical Area Vb, which covers about 190 200 km^2. The fish species of major commercial value and cultural importance include demersal, deep-water and pelagic species (Table 1).

Table 1 Total Faroese catch by species in Faroese waters, ICES area Vb*, 1998-2001.

Species	**Total catch 1998-2001** (tonnes live weight)			
	1998	**1999**	**2000**	**2001**
Blue whiting	12 752	35 356	60 967	126 915
Saithe	24 148	32 439	34 353	44 500
Cod	24 987	20 157	20 684	26 768
Haddock	20 509	17 753	14 110	14 246
Greater silver smelt	17 167	8 186	6 388	9 952
Mackerel	2 171	1 270	4 790	5 888
Redfish	5 721	6 191	5 720	5 332
Other	4 134	5 159	4 102	4 740
Scallops	4 751	5 993	3 989	4 053
Greenland halibut	3 462	3 873	4 344	3 485
Ling	2 848	2 487	1 909	2 200
Monk fish	1 866	2 548	2 215	2 006
Tusk	1 346	1 676	1 282	1 787
Blue ling	1 054	1 745	1 503	1 565
Prawns	119	410	31	161
Lobster	56	79	73	51
Herring	13 825	454	0	25
Norway pout	1 515	1 511	0	0
Horse mackerel	188	132	250	0
Salmon	5	-	-	-
Total	142 624	147 419	166 710	253 674

Note: ICES area Vb = Føroya Banki and continental shelf. (From Hagstova, 2003)

Cod, haddock, saithe and other demersal stocks form the economically most important component of the Faroese fishing industry. The landings of cod, haddock and saithe, were at a historically low level during the late 1980s and early 1990s that caused a severe economic crisis for the fish industry and the entire Faroese society. The landings recovered rapidly during the mid 1990s due to improved recruitment and growth (ICES, 2003). Changes in primary production in the marine ecosystem and in the food availability for cod was most probably the driving force behind the collapse of the cod stock in 1991 as well as its rapid recovery in 1995 (Steingrund et al., 2003).

The fisheries in the Faroe area can be characterised as multigear and multispecies, targeting demersal, deep-water and pelagic species using hand lines, long lines, gillnets, purse seine and various trawl gear types (Reinert, 2001a). Before 1960, all foreign vessels were allowed to fish around the Faroe Islands outside the 3-nm zone. Since the introduction of the 200 nm fisheries zone in 1977, the demersal fishery by foreign nations has decreased and Faroese vessels now take most of the demersal catches (Table 2).

Table 2 Total catch in Faroese waters by nation, ICES area Vb*, in 2001.

Species	**Total catch in Faroese waters 2001** (tonnes live weight)						
	Faroe Islands	UK/ Germany	France	Norway	Other	Total	Faroes catch (%)
Blue whiting	126 915	-	4 537	47 340	261 134	443 211	27
Other	153 791	309	2 841	137	8 831	165 980	93
Saithe	44 500	1 303	840	56	226	46 925	95
Cod	26 768	337	11	601	20	27 736	97
Haddock	14 246	135	6	347	0	14 733	97
Tusk (Ling, Blue ling)	5 552	130	398	4 051	7	10 138	55
Redfish	5 332	168	198	16	20	5 734	93
Total	377 104	2 381	8 831	52 546	270 237	714 385	53

*Note: * ICES area Vb = Føroya Banki and continental shelf. (From Hagstova, 2003)*

The main components of the pelagic fisheries (both foreign and domestic fleets) comprise blue whiting, Atlanto-Scandian herring and mackerel. Blue whiting is caught from the Barents Sea to the Strait of Gibraltar, and the stock was perceived to be relatively constant since the early 1980s, although estimates of abundance are imprecise. Since the end of the 1990s the spawning stock biomass has increased significantly to 4.3 million tonnes in 2003, a record high value (ICES, 2004a). In Faroe waters (ICES area Vb and IIa) blue whiting is caught primarily by Russian, Icelandic, Faroese and Norwegian vessels, and Faroes caught about 27% of the 2001 catch (Table 2). The Faroese catch of blue whiting in 2002 was around 500 thousand tonnes (or 31%) of a total 1.6 million tonnes taken in the North Atlantic (ICES, 2003a).

Sea bird hunting

Seabirds are caught for local consumption. Fulmars and puffins are the most important species and it is estimated that 50 000-100 000 birds are caught each year from each of these populations.

Whale hunting

In contrast to the fishery, which has enormous economic importance, whaling is a non-commercial hunt only intended for domestic use, however still of economic value. Whaling does, however, represent a valuable food source, which in the period 2000-2003 with an annual catch of between 539 and 917 pilot whales provided on average between 2.5 and 4.5 kg of whale meat per person, the actual consumption however, is assumed to be uneven, see also Table 4, p. 26 (Museum of Natural History's archive). The catch is organised according to laws and regulations adjusted from time to time, and the conservation of marine mammals in the Faroe Islands is managed through membership in the North Atlantic Marine Mammal Commission (NAMMCO).

The average annual catch over the last 400 years of the different species is 845 pilot whales, 2 bottlenose whales and 60 white-sided dolphins as the most common and regularly taken species (Bloch, 1996a, and Faroese Museum of Natural History archive).

The pilot whale is a small toothed whale found in large schools in the North Atlantic. The Faroese pilot whale catch is a traditional, communal, non-commercial hunt aimed at meeting the community's need for whale meat and blubber. The pilot whale catch proceeds as follows: A school of pilot whales, observed near the coast, is driven into a fjord and beached, preferably on a flat stretch. Only a limited number of beaches (23) are approved for whaling and authorised by law. The whales are killed by cutting the spinal cord and in the same cut, the arteries supplying the brain are cut (Bloch, 1996b). The authorities distribute the meat and blubber according to traditional rules, the main rule being equal shares for all the inhabitants of the district.

Mariculture

The production especially of Atlantic salmon (*Salmo salar*) and to a minor extent the rainbow trout (*Oncorhynchus mykiss*) has increased rapidly during the last two decades to more than 45 000 tonnes in 2002 (Hagstova, 2003). The demand for freshwater smolt production is secured by placing the tanks in artificial streams or, less desirable, directly into natural sections of rivers. The pharmaceuticals used in the industry are regulated and subject to controls. The smolt is vaccinated and its skin disinfected before being transferred into cages, to reduce the risk of disease. In the mid 1990s, epidemics of the BKD (kidney disease) were the most severe medical problem (Dam et al., 2000). The other main indication treated with pharmaceuticals is the salmon lice (*Lepeoptherius salmonis* and *Caligus elongates*). The origin of the breed of Atlantic salmon now in production in the Faroes was roe imported from Norway in the period 1978-1984.

Socio-economic characteristics

Political structure

The Faroese descend from Norwegian and Celtic settlers, who arrived at least as early as the 9th Century A.D. Most of the legislative and executive governmental powers lie with the Faroese authorities, the Løgting (parliament) and the Landsstýri (executive branches of government) in Tórshavn, the capital. Environmental protection, including protection of the marine environment, is under Faroese jurisdiction, and is administered by the Ministry of Interior. The Faroese Maritime Authority, the Faroese coast guard and the Marine Rescue Coordination Centre (MRCC) lie with the Ministry of Fisheries and Maritime Affairs.

The Faroes as a political entity can be described as a miniature of a Nordic democracy. Being a self-governing territory under the state sovereignty of Denmark, there is a division of powers between the Faroes and Denmark within the framework of the home rule system. Some areas of relevance to the administration of marine affairs still are under Danish authority. Foreign affairs and defence are administered from Copenhagen, though the Faroese Government maintains its own Foreign Service as a department under the Faroese Prime Minister's Office. The Faroese Foreign Service maintains three missions abroad, in Brussels, Copenhagen and London. The missions in Brussels and London respectively are organised as part of the Danish embassies there. Denmark is represented by a High Commissioner in Tórshavn.

The Faroes are not a member of the European Union (EU), and decide themselves what international obligations entered by Denmark shall apply to them. In 2002 the Faroes obtained associated membership of the International Maritime Organization (IMO), and there are plans for further Faroese engagement in international relations.

Under the provisions of the Home Rule Act of 1948 Danish legislation on joint (Danish Realm) matters passed by the Danish parliament (the Folketing) must be ratified by the Faroese parliament to be applicable to the Faroes.

The fishery in the Faroese waters is regulated by the Faroese Ministry of Fisheries and Maritime Affairs which sets the quotas with reference to advice issued by ICES. Denmark is, on behalf of the Faroes and Greenland, a member of ICES, NEAFC and NAFO. Denmark has ratified the agreement on protecting the North Atlantic salmon under NASCO on behalf of both the Faroe and Greenland.

The Environmental Department at the Food and Environmental Agency is the central body of administration of the Environmental Act and the new Marine Environmental Act. The coastguard, the Faroes Inspection and Rescue Service, oversees compliance with the Marine Environmental Act.

Population

In 2002 the Faroe Islands had a population of about 47 350 – an increase of 5 500 since 1977 (Hagstova, 2003). In 2002 the capital, Tórshavn, had a population of 18 420 corresponding to slightly less than 40% of the entire population.

Recent population change has been characterised by migratory movements. In the 1970s and 1980s there was a steady immigration, largely consisting of Faroese expatriates returning because of improved employment opportunities and rising real incomes. Net immigration was relatively small up to the beginning of the 1980s but increased relatively sharply in the years 1984-89 as a consequence of a high level of economic and employment activity. In 1993 the migratory flows reversed and the population fell by 1 956 (over 4%) in two years. Since 1996 the flow has changed again, and the population level at the end of 1999 was higher than the pre-crisis level.

The characteristics of population and demographic change lie at the heart of the social and economic development. There is agreement across the Faroese political spectrum on the goal of retaining viable populations on all of the currently inhabited islands (Anon., 2001). This is not an easy task, because employment opportunities are scarce on the remote islands and the delivery of key services such as education and special health care is expensive.

Although the buoyant economic conditions of the past four to five years have encouraged net inwards migration to the Islands, within the region itself the long-term trend shows a continual move from the peripheral islands towards the centres of economic activity in urban and peri-urban areas of Tórshavn, Runavík (Eysturoy) and Klaksvík (Borðoy).

Population projections prepared by Hagstova Føroyar (the Faroese Statistical Office) for the period 2000 to 2024 indicate a potential population increase of approximately 26% over that period due to birth rate and migration. The majority of that growth is projected to occur in the urban and peri-urban areas around Tórshavn, south Esturoy and Klaksvík, and the projected growth rates for Sandoy and Suðuroy are significantly below average.

Economy and business

The Faroe Islands use the Danish currency and are part of the Danish currency area, although they have their own notes.

The Faroe Islands is an industrialised country with a standard of living comparable with the other Nordic countries. The economy is mainly founded on the fishing industry and sea farming. In addition there are subsidies from Denmark that tend to diminish in importance with the development of the Faroese economy.

Any economy based on only two industries is bound to be vulnerable to the cyclical change in those industries, especially when both are related to the fishing industry. Prices and catches are volatile and these have left their mark on the economic history of the islands. This vulnerability is partly encountered by a geographically spreading of the catches all over the North Atlantic area and in other seas as well, such as the Barents Sea, which is made possible by fishery agreements between the Faroes and Norway, the EU and the Russian Federation.

The Faroese economy can be characterised as a mono-economy that is very dependent on the fishing industry. This statement is supported in the export account, of which fish products on average account for more than 95% of the export value (Anon., 2003a). The figure may be somewhat exaggerated due to incomplete export statistics for non-fish products.

Efforts to diversify the economy have been made, but so far without any notable success. Since nearly all the fish products are exported, the Faroese economy is very sensitive to the market. Consequently, the export income can fluctuate significantly from one year to the next because of changes in catch and price, and these fluctuations spread quickly throughout the economy.

The current level of reliance upon fishing and fish processing leaves the Islands exposed to external economic conditions. A variety of indicators point to the vulnerability that such exposure imposes upon the Faroe Islands, arising from (Anon., 2001):

- The high level of dependence upon foreign trade;
- The degree of dependence upon the export earnings of a narrow range of products;
- The extent to which the principal export industry (fishing) is exposed to externally controlled regulation;
- The inability of the Faroese suppliers to influence the traded prices of their principal exports;
- The possibility of risks posed to fish stocks and to the image of Faroese products by overfishing, disease and pollution.

Since 1995 the Faroese economy has grown rapidly, due particularly to strong growth in fisheries and aquaculture. From 2000 to 2001 exports increased by 12% to 4.1 billion, while imports fell by 3.5%, resulting in a surplus of DKK 211 million on the balance of trade. About 80% of exports from the Faroe Islands go to EU countries. Of this, Denmark accounts for 25% and the UK for 18%. In the last few years, the Faroe Islands have turned a net foreign debt into a net credit balance, although with a big difference between the private and the public sector. At the end of 2001 the private sector had a net credit balance of more than DKK 5 billion, while the public sector's net foreign debt stood at almost DKK 3 billion. Unemployment has fallen sharply in the last few years and is now around 3%.

The subsidy from Denmark steadily grew over the years up to 2002. During the depression years of 1991 - 1994, the Danish state transfer in percentage terms increased to almost a quarter of the Gross Domestic Product (GDP), but by 2002 it had decreased to about 8% of GDP as a result of the Faroese Government's policy to reduce economic dependency upon Danish subsidies. Prior to the economic depression, the Faroese Gross National Income (GNI) per capita was above the Danish GNI per capita, due to the Danish Government subsidy. Now the GNI per capita is lower.

More than a quarter of GDP comes from the fishing and fish processing industries. The fishing industry is also the basis for other sectors, such as shipyards and industries equipping the fishing industry.

The Faroese fishing industry

Fishing is the most important industry in the Islands and contributes over one quarter of national income. Most of the output is exported, making the industry and the Faroese economy highly susceptible to fluctuations in catch and to the world price of fish. The industry is a major employer particularly in peripheral regions.

The shipyards in the Faroes do most of the repairing of the Faroese fishing vessels. In addition the shipyards also do some repairing of vessels from Iceland and occasionally from Greenland. From time to time the shipyards also engage in constructing of fishing and special vessels. There has been a longstanding desire to diversify the Faroese economy but until now with no major effect. For the time being a committee is investigating how to establish a research environment covering biotechnology and IT with the intention to boost development in those two industrial areas.

Before the mid-1970s, the Faroese fishery was mainly based on fishing in foreign waters. The extension of national fishing boundaries, however, necessitated to a significant degree a re-organisation of the Faroese fishing industry towards exploiting the resources in Faroese territorial waters. Today, about 40% of the fish export value still comes from fishing in foreign and international waters, although most of the fishing in foreign waters is reimbursed by reciprocal rights in Faroese territorial waters.

The harvesting sector is the largest in terms of income and employment but the recent relatively high levels of profitability have been insufficient to encourage investment in modern vessels. The Faroese fishing fleet comprises around 670 vessels but the majority of the catch is taken by the 182 vessels larger than 20 GRT. The sector is considered to be overcapitalised but there is reluctance to encourage fleet reduction because this will lead to a concentration of fishing activity and a concomitant reduction of employment opportunities.

Before World War 2 subsidies to the Faroe fishing industry came from the Danish Government. After 1948 and the establishment of the Faroe Home Rule political competence and responsibility for subsidies to the fishing industry have been transferred from Danish political authorities to Faroese political authorities. From the 1950s subsidies have been given to shipbuilding and to a prize guarantee on fish for the fishing fleets. From 1998 fishing vessels do no longer receive direct support; however, they are supported indirectly by a guarantee from the "Råfiskefonden" (a Fishing Foundation established in 1975) to the fishermen of a minimum salary and daily support as well as a secured salary during illness. Beginning in the early 1970s, the fishing industry also became increasingly subsidised and this twisted the market forces in unfortunate ways. Finally in 1992, the subsidies were replaced by a capital subsidy and later in 1998, removed altogether. Now the fishing industry relies very little on subsidies, although some indirect measures have been introduced instead.

In the late 1980s, a condemnation plan was initiated whereby the ship owners were paid to give up their fishing vessels. The intent of this plan was to increase the catch for each remaining vessel and in the end, increase the competitiveness and the total catch. During the crisis in the first half of the 1990s, many vessels were sold out of the Faroese fishing fleet. This resulted in a capacity reduction of around 30%.
Approaching the mid-1990s, the cod stock turned out to be in better shape than previously estimated and the catch of cod increased gradually from 1993 to 1997. The export value, however, did not increase as much because a large portion of the export was unprocessed fish. Over a five-year period, this has changed partly because of more local processing, but more specifically because of a general increase in world market prices, especially for cod (Anon., 2003a).

Fisheries management

Quotas (TAC) were introduced by law in 1994, but by June 1996 the quotas were replaced by a new fisheries management system which regulates the fishery by "Fishing Days" and area closures (see chapter 2.4). The new system focuses on viability and takes into account the differences in fishing gear and relative size of the vessels. The number of Fishing Days in a fishing year (commencing on 1 September) is set by law on the recommendation of an advisory board, comprised of representatives from in and around the industry. The recommendation is based on estimates of the fish stocks and the level of fishing effort. Each ship within each group thus gets a certain number of fishing days in which it may fish. Fishing days are partly tradable.

The advantages of a fishing-days system compared to a quota system are mainly that vessels can take all their catch ashore rather than throwing fish overboard and furthermore curtails the fraudulent practice of landing fish under a false name. The disadvantages are mainly that the system may not be efficient in protecting specific species. Also, there is a need to take into account technological improvement over the years and reduce the number of days accordingly; this is tends to be difficult to achieve due to heavy resistance from the industry and the political system.

Although there has been significant restructuring within the fishing industry, there still is an over capacity of vessels. Other means, such as limiting the number of fishing days and encouraging fishing of other species are being used to diversify and, hence, reduce the capacity indirectly. Restrictions are also enforced by limiting and banning fishing in specific areas for longer or shorter periods. This is especially useful for the protection of spawning and young fish.

Aquaculture

The fish farming industry is a relatively new industry in the Faroe Islands. It started in the early 1980s and has since emerged into the second most important contributor to the Faroese economy. Production has been volatile over the years. In 2002, the production was around 45 000 tonnes and the export value DKK 943 million, which corresponds to 23% of total export. The production was just below the record year of 2001, but prices have remained low and hence the value was about the same.

In the early 1990s, the industry was in distress and the number of licenses went from 60 to about 15 through a series of mergers and acquisitions. Vertical integration took place such that companies now, wholly or partly, own the production from smolt to processing factory. This also allowed for larger permits and a foundation for better planning in production, less strain on the environment and a better financial result. The boom in the industry has also attracted foreign investments, but foreign ownership has hitherto been restricted by law to 33% of equity. This may now change as the political system is now reviewing the rules of ownership in this sector.

The fish farming industry conducts research to improve the quality and efficiency of production. There is also ongoing research in the farming of other species of fish, mainly cod and halibut, but so far this has not proven to be commercially viable. The public owned company P/F "Fiskaaling" gets an annual support from the Faroe Government of 1.5 to 2 million USD mainly to carry out research to develop and improve aquaculture of fish and shellfish. Thereby the aquaculture industry gets an indirect economic support being able to use the research results and improvements developed by P/F "Fiskaaling", however, this is the only public economic support to the Faroese aquaculture industry. For the time being the Aquaculture industry experiences a crisis. Nevertheless, recently more than 20% of the value of exported fish products from the Faroe Islands came from the aquaculture industry.

The tourism industry

The Faroese tourist industry is the third largest export earning activity although its contribution to employment and regional economy is small. Increasing demand for holidays in remote areas and for niche tourism activities generally demonstrate that a potential exists if facilities are improved (Anon., 2001).

For many years, efforts have been made to develop the tourist industry in order to diversify the Faroese economy (Anon., 2003a). A few years ago, a goal of 50 000 tourists per year was set. In 2002 about 44 000 tourists visited the Faroe Islands. About 17 000 of these come to visit family and friends. The direct income effect of the tourism industry is estimated to be about DKK 150 million. Given the progress that has taken place to date and anticipated in the future, tourism will slowly become a more reliable source of income for people throughout the islands (Anon., 2003a).

Agriculture

Farming in the Faroe Islands is quite insignificant. Until the end of the 19th century, farming was the Faroe Islands' main industry, but with the economic and industrial development since then, particularly within fisheries, farming today accounts for only about 1% of the Faroe Islands' gross national income at factor cost. With a view to increasing the self-sufficiency of the Faroe Islands, the government is providing grants for investments in farming.

Energy and oil expectations

The joint municipal company SEV is responsible for the production and sale of electricity on the Faroe Islands. In 2001, production amounted to about 230 million kWh. Of this, more than 30% was based on hydroelectricity, while the remainder was produced at diesel-driven plants. Recently a certain development is occurring in the field of wind generated power production. Of the electricity sold in 2001, 33% went to domestic users, 35% to industry, agriculture, and fisheries, 14% to the service sector, and the remainder to street lighting etc.

Since a number of oil finds in British territorial waters close to the Faroese border in the 1990s, there has been a reasonable presumption that there is oil in the Faroese offshore territory, and the first licensing round was held in the spring of 2000 (Anon., 2001). The first licences for exploration and production of hydrocarbons in the subsoil off the Faroe Islands were granted in August 2000.

The first three exploration wells were drilled in the summer and autumn of 2001. In one of these, oil was found. An evaluation programme is now being carried out to determine whether this find is commercially viable.

The possibility of developing an oil industry in Faroese waters has been steadily progressing since 1993. Uncertainty prevails about the type and scale of activity that will actually emerge if and when oil is found. This uncertainty breeds a variety of differing reactions, but overall there appears to be an expectation within the Islands that oil will be found, and found in sufficient quantity to exert a profound long-term impact upon Faroese society, the environment and the regional economy (Anon., 1997; 2001).

A comprehensive energy policy for the Faroe Islands, including how to increase the amount of energy produced from renewable resources such as wind and waves, is under way being formulated by a committee established by the Faroese Prime Minister. For example there has been established formal cooperation with bodies in Scotland (waves) and Iceland (hydrogen).

Transport and communications

The geography of the island group and the topography of the individual islands makes it an expensive challenge to provide good and appropriate transport and communication services. In the past access between settlements frequently involved either travel by boat or traversing precipitous mountain and cliff paths.

In recent decades the islands have developed a modern and integrated transport infrastructure. The islands have approximately 450 kilometres of paved highway. The majority of settlements are directly linked to the road network, and a number of extensive road tunnels have been constructed. The three largest islands, Vágar, Streymoy and Eysturoy, are linked by a bridge and a sub-sea tunnel. Another sub-sea tunnel is currently under construction to link the islands of Eysturoy and Borðoy. Responsibility for road maintenance is divided between the municipalities and the Faroese Ministry of Trade and Industry, the latter having charge of maintaining the arterial routes.

Some of the more remote villages and inhabited islands are provided with helicopter services for both passengers and light cargo. There are 12 helipads situated in different parts of the islands.

Many of the Islands' municipalities operate small ports for inter and intra island passenger and cargo services, and larger ports are situated at Tórshavn, Klaksvík, Tvøroyri, Runavík and Fuglafjørður. Scheduled ferry services transport passengers and cargo between settlements along the shoreline and between the islands, and 'ro-ro' ferries operate on the major inter-island routes. Chilled and frozen cargo services operate across most parts of the archipelago.

There are regular, year-round sea transport links with a variety of European ports, mainly in Denmark, United Kingdom and the Netherlands, and the Faroe Islands are used as a transit port for goods and passengers travelling to and from Iceland.

The islands have one airport situated on the island of Vágar. The airfield is managed by the Civil Aviation Administration of the Danish Ministry of Transport. The majority of international passenger arrivals on the Faroe Islands travel by air, and Vágar Airport handles approximately 4 000 incoming flights annually, the majority originating from Denmark, but scheduled services also operate from Reykjavik, Oslo, Aberdeen and London Stansted.

Constructing roads, tunnels, and harbours is costly because of the difficult topographical conditions. Since an economic downturn at the beginning of the 1990s, the number of motor vehicles has increased by almost 1 000 and now stands at 21 000 motor vehicles, of which 16 000 are cars and 3 500 lorries and vans.

Conclusion

The Faroese economy is almost totally dependent of the sea and the production in the sea. This fact, naturally, has created a great interest in the variability in the surrounding sea, and how for example climate couple to variability in the productivity of marine resources and socio-economy.

As has been the case in the past, and is evident in many other small island economies, the demographics of the Faroe Islands are subject to significant migratory flows. The most recent economic crisis led to a period of sustained net emigration from 1989 to 1995. That position has reversed and the rate of net immigration is accelerating markedly. Between 1995 and 1999 the total population increased by 2019 persons (4.7%), approximately half of this increase being accounted for by net immigration.

Assessment

Table 3 Scoring table for the Faroe Plateau region.

Assessment of GIWA concerns and issues according to scoring criteria (see Methodology chapter)

- IMPACT 0 – No known impacts
- IMPACT 1 – Slight impacts
- IMPACT 2 – Moderate impacts
- IMPACT 3 – Severe impacts

The arrow indicates the likely direction of future changes.

- ↗ Increased impact
- → No changes
- ↘ Decreased impact

Faroe Plateau	Environmental impacts	Economic impacts	Health impacts	Other community impacts	Overall Score**	Priority***
Freshwater shortage	0* →	0 →	0 →	0 →	0	5
Modification of stream flow	0					
Pollution of existing supplies	0					
Changes in the water table	0					
Pollution	2* ↗	1 →	3 ↗	1 ↗	2	1
Microbiological pollution	1					
Eutrophication	0					
Chemical	2					
Suspended solids	0					
Solid waste	0					
Thermal	0					
Radionucleid	0					
Spills	1					
Habitat and community modification	1* →	1 →	0 →	0 →	1	4
Loss of ecosystems	1					
Modification of ecosystems	2					
Unsustainable exploitation of fish	2* ↘	1 ↘	0 →	0 →	2	2
Overexploitation	2					
Excessive by-catch and discards	1					
Destructive fishing practices	2					
Decreased viability of stock	0					
Impact on biological and genetic diversity	0					
Global change	1* ↗	0 ↗	0 →	0 →	1	3
Changes in hydrological cycle	1					
Sea level change	0					
Increased UV-B radiation	0					
Changes in ocean CO_2 source/sink function	0					

* This value represents an average weighted score of the environmental issues associated to the concern.

** This value represents the overall score including environmental, socio-economic and likely future impacts.

*** Priority refers to the ranking of GIWA concerns.

This section presents the results of the assessment of the impacts of each of the five predefined GIWA concerns i.e. Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, Global change, and their constituent issues and the priorities identified during this process. The evaluation of severity of each issue adheres to a set of predefined criteria as provided in the chapter describing the GIWA methodology. In this section, the scoring of GIWA concerns and issues is presented in Table 3.

IMPACT Freshwater shortage

The Faroes holds plenty of unpolluted water in the lakes.

Environmental impacts

Modification of stream flow

Not a problem in the Faroe Islands.

Pollution of existing supplies

No pollution of existing water supplies.

Changes in the water table

No evidence that extraction of water from aquifers exceeds natural replenishment.

Socio-economic impact

Economic impacts

No known impact.

Health impacts

No known impact.

Other social and community impacts

No known impact.

Conclusions and future outlook

Freshwater shortage is not an issue of major concern for the Faroe Islands at present.

Pollution

Environmental impacts

Microbiological pollution

Microbiological pollution is connected with discharge of domestic and to a lesser degree with industrial wastewater. In most cases there are small-scale outlets draining the overflow from sewage tanks. However, at localities where this wastewater is discharged to a recipient with limited water exchange, this discharge may lead to locally significant microbial pollution, which renders the water unfit for most uses.

Eutrophication

Eutrophication can occur locally, but is considered a minor problem.

Chemical pollution

Heavy metals and Persistent Organic Pollutants (POPs)

Analyses for contaminations with heavy metals and POPs have been made as part of the Arctic Monitoring and Assessment Program (AMAP) on the Faroe Islands in the period 1997-2001 (Larsen and Dam, 2003; Olsen et al., 2003).

In the period 1997-1998 the following species were analysed from the marine environments: Blue mussel (*Mytilus edulis*), queen scallop (*Clamys opercularis*), cod (*Gadus morhua*), fulmar (*Fulmarus glacialis*), grey seal (*Halichoerus grypus*), pilot whale (*Globicephala melas*) and from freshwater environments: brown trout (*Salmo trutta*) and Arctic char (*Salvelinus alpinus*) (Larsen and Dam, 2003).

In the period 1999-2001 analyses have been made on the following species from the marine environments: Short-horn sculpin (*Myoxocephalus scorpius*), black guillemot (*Cepphus grylle*), and pilot whale, and from the freshwater environment: Arctic char (Olsen et al., 2003; Hoydal et al., 2003).

In the period 1999-2001 the analysed heavy metals were: mercury (Hg), cadmium (Cd), and selenium (Se) and the analysed POPs were: PCB and organochlorinated pesticides (14 single congeners, chlordanes, ß-HCH), DDT (o,p-isomers and metabolites) and toxaphene (incl. total toxaphene and 5 single parlars).

The highest mercury concentrations were found in pilot whale muscle, with 3 mg/kg in adult males. Next highest mercury concentrations were found in black guillemot livers, and in sculpin livers. The mercury concentrations in the three years of sculpin samples spanned a wide range from 0.1 mg/kg to almost 1.5 mg/kg varying among the age-groups but more markedly between the years. Then comes black guillemots eggs with mercury concentrations around 0.5 mg/kg, and Arctic char with a mercury level around 0.2 mg/kg.

The highest mercury concentrations exceed Danish residue guideline concentrations, as the highest guideline concentration is 1 mg/kg (Anon., 2003b).

The changes over time of environmental background concentrations of mercury for long-finned pilot whales are unknown. However, trends of increasing mercury concentrations with time has been found in museum specimens of black guillemot in the Faroe Islands (Somer and Appelquist, 1974; Appelquist et al., 1984, 1985), similar to what has been found in other seabird species foraging in the North-East Atlantic waters (Monteiro and Furness, 1995).

The mercury concentration in soft tissue from pilot whales can be traced back to 1977. The data available reveal differences in mercury concentrations between pods as well as individual differences, and a trend in the mercury concentration is not discernable (Dam and Bloch, 2000). It is assumed however, that the overall increase in anthropogenic mercury emission which may be traced in sediments and peat samples in many places on the northern hemisphere (Fitzgerald et al., 1998; AMAP, 1998) is reflected in the pilot whales as it is in for example Beaufort Sea Beluga (AMAP, 2002).

The highest concentrations of POPs were found in pilot whale blubber.

With the persistent organic pollutants there is growing evidence that the restrictions on their use that were put into action some decades ago have had an effect. There have been marked reductions in the last decade, particularly with the pesticide DDT (Dam et al., unpublished). Still, when the analysed biota is scrutinised with respect to chemical pollutants, the results are often that the concentrations of pollutants within them gives reason for concern as when compared to limits defined by food health authorities.

Dioxin is an unintended byproduct in various industrial processes and is also produced during incineration of wastes (Quass et al., 2000). Dioxin is lipid-soluble and relatively high concentrations are found in lipid-rich fish species (Leonards et al., 2001; Fiedler et al., 2000). The highest dioxin concentrations are found in areas influenced by the heavy populated and industrialised areas such as in the Baltic Sea (Robinson et al., 2000). In recent years, a decrease in dioxin in various foodstuff has been observed (Baars et al., 2004).

Solid wastes

There are two waste companies in the Faroes, which coordinate the collection, sorting and incineration, depositing or shipping to suitable processing facilities of all the wastes produced. Solid wastes are as a general rule incinerated, and incinerations are equipped with filters to hinder pollution with heavy metals. The capacity of the incineration plants is, however, becoming insufficient and new emission limits are imposed.

Waste collections from ships and fishing vessels are not functioning optimally and waste is often dumped at sea although forbidden by law.

Thermal

Approximately 60% of the electricity demand is produced at mineral oil fuelled electricity plants. These plants use seawater in the cooling system, which after use is discharged to sea. It seems unlikely that this discharge should lead to any significant thermal pollution except in the immediate vicinity of the outlets.

Radionuclide pollution

The Faroe Islands are subject to the radioactive pollution which stems from nuclear bomb-testing and the discharge to the sea and air which occurs from accidents and regular activity of for example nuclear reprocessing plants in Europe. There is no anthropogenic source of radioactivity stemming from the Faroe Islands.

According to studies by Joensen and Dahlgaard (2003), the average Caesium (^{137}Cs) activity in seawater is around 1.6 Bq/m^3 for both 1999 and 2000, with a decline from trend from 1999 to 2000 in Tórshavn/Hoyvík and Kirkjubøur. The average ^{137}Cs/^{90}Sr concentration ratio from the measurements is 1.49, which corresponds to the global fallout ratio. Results for ^{137}Cs concentrations in marine biota all show low values, with cod having the relatively highest value of around 0.2 Bq/kg fresh weight.

Due to the expected transport time of Technetium (^{99}Tc) to Faroese waters of 12-15 years, the results presented are therefore not related to the latest releases from Sellafield, but mainly to discharges in the 1970s and to global fallout from nuclear weapon tests (Joensen and Dahlgaard, 2003).

Oil spills

At present this is not considered a problem of concern. However, establishing environmental baselines to assess any future environmental pollution is important in light of the on-going exploration for offshore hydrocarbons around the Faroes (Anon., 1997, 2001). The exploitation of hydrocarbons could potentially result in adverse environmental effects.

Socio-economic impact

Economic impact

The fish oil derived from some pelagic species must at present be purified for dioxin and dioxin-like substances, a process which increases the expenses in the utilising of some pelagic fish stocks as fish feed in aquaculture. The economic will be impacted for families who have to reduce the consumption of whale products, because the whale meat is contaminated with pollutants.

Human health impact

Consumption of marine food in preference to other food is generally considered to be healthy and below the safe limits for contaminant set by the EU. However, in a few fish species levels of mercury above the EU safe limits have been found. The Faroese are known to be heavily dependent on seafood. In pilot whale the contamination levels of both POPs and mercury are above the EU safe limits. Thus the potential exposure to some pollutants is very high in the Faroe human population (Table 4).

The Faroese diet is dominated by marine food, e.g. cod, haddock and halibut. Seabirds are consumed in the season, especially fulmar, puffin and guillemot.

Table 4 Conclusions and recommendations on Human Health impacts of contaminants in the Faroe Islands.

Human health
Exposure to methyl mercury and organochlorine compounds has been high in the Faroe Islands due to frequent ingestion of pilot whale meat and blubber. Cognitive deficits and other adverse effects have been demonstrated in children with prenatal exposure to these compounds in the Faroes. In August, 1998 the Faroese authorities issued an advisory that women who plan to become pregnant within three months, pregnant women, and nursing women should abstain from eating pilot whale meat. Furthermore, the best way to protect foetuses against the potential harmful effects of PCBs and other organochlorine compunds, is if girls and women do not eat blubber until they have given birth to their children. The results from a dietary survey among pregnant women in 2000 – 2001 have revealed a dramatic reduction in whale meat and blubber intake. Blood analyses showed a decrease corresponding to more than one order of magnitude with regard to mercury exposure. However, possibly because of their stability in the body, the PCB levels were still high and must be considered to be a continued potential health problem in the Faroese community. The reasons for the persistent high PCB concentrations are not fully understood, and further research is needed to elucidate this phenomenon. Because of the advantages of conducting epidemiological studies in the Faroes and because of the continuing exposure to organochlorine compounds, research should be continued to explore the health consequences of the increased exposure levels.

(Source: Deutch and Hansen, 2003)

The species of most relevance in the Faroese diet, which have been analysed in the AMAP programme are (Weihe et al., 2003a): Long-finned pilot whale, fulmar, cod, sheep (*Ovis aries*), hare (*Lepus timidus*), brown trout and Arctic char. The freshwater fish species, especially the Arctic char, though an important part of the diet in other northern communities, is of limited importance as food-item in the Faroes. First and foremost due to the limited abundance of Arctic char waters, and secondly due to the limited catch of these fishes, which are taken on a fishing rod by sports anglers only. Blue mussels and queen scallop have once been analysed for pollutants as a part of the AMAP Faroe program. These shellfish species are widely used as food. However, in the Faroes the consumption is very limited.

Most concern has been on the metals: Mercury, lead and cadmium. Most samples have been analysed for these metals. However, in some matrices selenium has also been analysed.

Marine food/traditional food provide benefits because marine mammals and fish are rich in polyunsaturated fatty acids (PUFA). A diet high with PUFA has been associated with lower risk of heart disease. Whale skin and other marine foods are rich in selenium. Selenium may increase the body's antioxidant defense. Furthermore, high levels of vitamin A are found in animal liver and blubber. In general, traditional diets therefore provide a strong nutritional base for health (AMAP, 1998, 2002).

Mercury is of both scientific and public concern due to the high concentrations in e.g. pilot whales and higher predatory fish, where up to 3 ppm Hg has been measured (Dam et al., 2000; AMAP, 1998, 2002; Olsen et al., 2003). Furthermore, it has been shown that the present levels of mercury in sea animals may have a negative effect also on the health of the local human populations, when these animals are used as food supply (Grandjean et al., 1998; Deutch and Hansen, 2003).

Realising the hazard resulting from the present contaminations and as a consequence of the findings of studies in the Faroes, new recommendations on the consumption of whale products were issued by the health authorities in 1998 (Weihe et al., 2003b). According to Weihe et al. (2003b), adults should limit their intake to one or two dinners of whale meat (corresponding to 300g whale meat) each second week. Adults should eat blubber no more than once or twice per month. Girls and women are best advised not to eat blubber at all before the end of the reproductive period. Women who intend to get pregnant during the next three months, women who are pregnant or those who are breastfeeding should not eat any whale meat at all. Livers and kidneys of whale should not be eaten by anyone at all (Heilsufrøðiliga Starvsstovan, 1998). Whale meat contains about 1.9 mg mercury/kg. i.e. much higher mercury concentrations than found in Faroese fish. The high mercury concentrations in whales are the background for the above-mentioned recommendations for the consumption of whale meat. Because of the beneficial effects of fish consumption, the long-term goal needs to be a reduction in the concentration of MeHg in seafood rather than a replacement of fish in the diet by other foods. In the interim, the best method of maintaining fish consumption and minimising Hg exposure is the consumption of fish known to have low mercury concentrations (Committee on the Toxicological Effects of Methylmercury, 2000).

Other social and community impacts

No known impact. However, the issued dietary advice by the Faroese health authorities of reduced intake of whale meat and blubber of especially young women may have socio-cultural impacts.

Conclusions and future outlook

Chemical pollution is very limited in the Faroes, a consequence of their rather remote position in the North Atlantic away from the dense populations and large industries of central Europe, and because of favorable ocean currents. This does not, however, make the Fareose people a 'reference population' with respect to environmental pollution loads, as one would expect, because the intake of pollutants from marine mammals is marked.

Dietary advice to limit the consumption of pilot whale meat was first issued in 1977, and this was apparently also the first time mercury was ever measured in Faroese pilot whale meat. Since then, heavy metals and persistent organic pollutants in these mammals have been measured. The best-studied species is probably the long-finned pilot whale. Measurements of contaminants in long-finned pilot whales and in the marine fauna of the Faroe Islands need to be continued in the future to keep the natural resources healthy and below the safe limits for contaminants in human food set by for example the EU.

Habitat and community modification

Environmental impacts

The overall judgment by the task team experts of issue 12, losses of ecosystem or ecotones was a slight impact. However, certain coral-reefs of the reef-forming corals (e.g. *Lophelia pertusa*) were regarded as moderately impacted (score 2) by bottom trawling. The ecological value of these habitats is, however, poorly understood. Probably there is no loss of entire ecosystems due to bottom trawling. However, this has not been investigated and little data exists. Issue 13, modification of bottom habitats and community structures, was assessed to be moderately impacted, mainly due to bottom trawl fishery.

Benthic communities

The damaging impact of bottom-trawling on the benthic fauna, e.g. reef-forming coral and large sponge accumulations, are by killing the animals both directly by crunching and indirectly by stirring up the bottom sediment and making it impossible for the benthic animals to respire and feed (Rogers, 1999; Hall-Spencer et al., 2001; Thiel and Kowlow, 2001). On the Faroe Plateau, two known localities are inhabitated by the slow growing eight armed corals of genus *Paragorgia* spp. and *Primnoa* spp. these are in particular sensitive to trawling. In the fjords and along the edge of the plateau at around 90 m depth there are mussel beds, which are sensitive to dredging and trawling (O. Tendal, Zoological Museum, University of Copenhagen, pers. comm.).

The Faroe Bank is an important fishing ground for the Faroese fishery accounting for approximately 10 % of the total annual catch within the Faroese fisheries zone. The bank supports a unique ecosystem of ecological and economic importance. Many of the species like the corals and sponges are very sensitive to physical damage and disturbance, as it is often caused by activities like trawling without proper management (Schmidt et al., 2003).

Sea birds

The increasing tourism in recent year has increased the pressure on some local sea bird breeding locations (Olsen, 1998, 2001), but a new law is being prepared to better protect these bird colonies from disturbance.

Socio-economic impacts

Economic impacts

No known impact

Health impacts

No known impact

Other social and community impacts

No known impact

Conclusions and future outlook

The benthic community is moderately impacted mainly by bottom trawling.

IMPACT Unsustainable exploitation of fish and other living resources

Environmental impacts

Important resources of fish, sea birds and marine mammals have large distribution areas, involving the waters of several nations. This means that fishery, hunting and other influences on one part of a population will eventually affect the rest of it, within as well as outside of Faroes waters. International cooperation on conservation and management of marine resources is thus essential. The Faroes participate actively in a number of international organisations which give advice on a sustainable use of marine resources of the Faroe Islands, e.g. International Council for the Exploration of the Sea (ICES), North East Atlantic Fishery Commission (NEAFC), North Atlantic Salmon Conservation Organisation (NASCO), North Atlantic Marine Mammal Commission (NAMMCO), International Whaling Commission (IWC), Northwest Atlantic Fishery Organization (NAFO), and International Marine Organization (IMO).

Overexploitation

Fishery

The Faroese fishing fleet has been regulated since the declaration of the fishing zone (FFZ) around the islands in 1977, initially through technical measures (e.g. limitations on gear size, closed areas, etc). A system of licences introduced in 1987 restricted entry into the fishery (Reinert, 2001a; ICES, 2003). This was accompanied by a limited buy-back scheme aimed at reducing the total level of fishing effort in the fishery. In 1994, following the sharp decline in cod catches, a series of individual transferable quotas (ITQs), effective for ten years, were imposed on the remaining fleet and a restrictive total allowable catch (TAC) was adopted to enable cod stocks to recover. This system was abandoned in 1996 and replaced by a system (valid for 8 years) whereby individual boats were allocated a permissible number of fishing days-at-sea. This individual effort quota system was supplemented by spatial control, the Faroe fishing zone (ICES Division Vb) being subdivided into three concentric zones within which access for particular kinds of fishing vessels was clearly defined (Figure 5)(Reinert, 2001a).

In recent years the Faroe Islands have built up a reputation of being foremost in fisheries management and sustainable fishing. In two international reports prepared in 2001, the Faroes fishing industry came out on top of the league for its fisheries management (Chuenpagdee and Alder, 2001) and also on the question of profitability the Faroes came out on top (EEC, 2002). This positive evaluation of the Faroes fishing performance is based on the successful new fishing regulation system started in 1996 including individual transferable effort quotas in days within fleet categories. However, the fishing system, as with

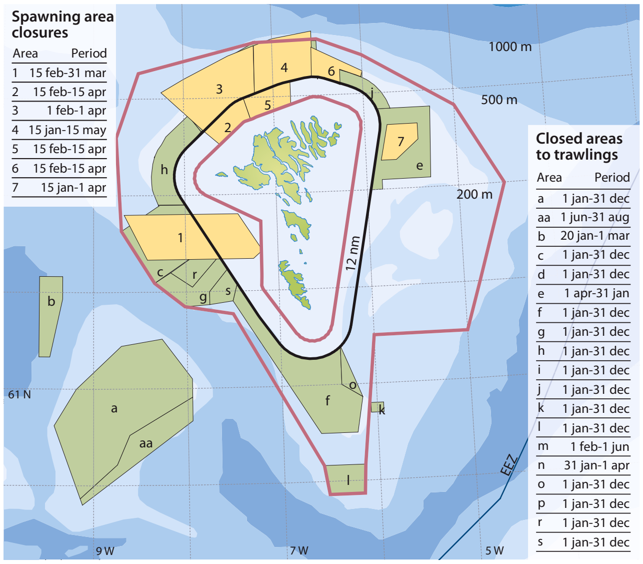


Figure 5 Fishing area regulations in Division Vb.

Allocation of fishing days applies to the area inside the outer thick line on the Faroe Plateau. Holders of effort quotas who fish outside this line can tripple their number of days. Long liners larger than 110 GRT are not allowed to fish inside the inner thick line on the Faroe Plateau. If long liners change from long line to jigging, they can double their number of days. The Faroe Bank shallower than 200 m depths (a. aa) is regulated seperate from the Faroe Plateau. It is close to trawling and the long line fishery is regulated by individual day quotas.

any other system, must be regularly updated. Fisheries research has shown that effectiveness in fishing fleets generally increases with 2-3% per year. With the Faroe fishing day system, the aim is to fish as much as possible on a permitted day, therefore huge investments are made to increase efficiency. This can be as much as 5% per year. Although widely accepted, there is a risk for collapse of the Faroe fishing day system if agreement cannot be reached as to how the system should be updated.

The key elements in the Faroese fisheries management of the demersal stocks are:

1. A separation of the fishing vessels into fleet segments that are based on physical vessel attributes, mainly size (GRT and HP) and vessel types (trawlers, long liners etc.). The fleet segmentation is a central element in controlling capacity, effort and the fishing pattern.
2. A capacity policy aiming at maintaining the fleet capacity at the 1997 level. The capacity is in principle maintained within each fleet segment, but there are rules for allowing vessel transfers between groups (e.g. in conjunction with vessel replacement). The capacity policy is based on vessel licenses.
3. An effort system that allots a total number of fishing days for the coming fishing year to each of the fleet segments. The total fleet segment effort is subsequently divided between the individual vessels. Except for the small-scale coastal fishery the general rule is that all vessels within the fleet segment gets an equal share. The small-scale coastal fishery (fleet segment 5B) fishes on a common effort quota. The fishing days may be traded within fleet segments and with some restrictions between segments. The effort regulation is maintained through a fishing license system.
4. A complex system of area closures that regulates access to the fishing grounds for the various fleet segments. The main restrictions are: The trawlers are generally not allowed to fish within the 12 nautical mile limit and within other areas closed to trawlers, implying that large areas shallower than 200 m are closed to trawling. There are exceptions for small trawlers that are allowed a summer fishery for flatfish on the plateau. The nearshore area (inside the 6 nm line) is closed to the larger long liners. Gill netters are only allowed to fish at depths deeper than 350 m.
5. A number of supplementary technical regulations such as: Spawning area closures, minimum mesh sizes, sorting grids, real-time closures to protect small fish, and minimum landing sizes. The Faroe Bank shallower than 200 m is closed to trawling.
6. According to Faroese legislation, all discarding is banned.

The single trawlers that target deepwater resources (redfish, saithe, blue ling, Greenland halibut, and others) are not covered by the effort regulation, and catches of cod and haddock are limited by maximum by-catch allocation. Similarly, the gill netters that target monkfish and Greenland halibut are not included in the effort system their catch of cod, haddock, and saithe is almost nil due to the depth of fishing and the large mesh sizes. One fishing day by long liners is considered equivalent to two fishing days for jiggers in the same size category. Long liners could therefore double their allocation by converting to jigging. Holders of individual transferable effort quotas who fish outside this line can fish for 3 days outside for each day allocated inside the line.

The Faroese effort management system links fishing mortality on the demersal stocks, i.e. that the effort level (number of fishing days) concurrently determines the fishing mortality on all three demersal stocks. The fishery for haddock and cod are closely linked. The fishery for saithe is a more directed fishery, albeit with by-catch of cod and haddock. According to ICES (2004b) fishing mortality for the Faroe Plateau cod in 2003 was more than twice the level that was recommended based on precautionary principles. For haddock and saithe the present fishing mortality was also above the precautionary level. Therefore, ICES recommends a reduction of the fishing effort directed at cod and haddock in the neighbourhood of 2/3. For the saithe fisheries ICES recommends that effort be reduced by around 30%. This effort is predicated on the present low by-catch of cod and haddock in the saithe fisheries. If the by-catch of cod or haddock is observed to increase in the saithe fishery, then effort will have to be reduced proportional to the increase in by-catch rate. For Faroe Bank cod effort should be reduced to the 1996-2002 level.

The stock of Greenland halibut in the Faroe Islands area (a stock shared between Greenland, Iceland and Faroe Islands) is considered at low levels, and catches have routinely exceeded ICES advice (ICES, 2003). The status of other demersal stocks is not so well known but deep-water species like blue ling and redfish are considered to be overexploited and are presently at low levels.

All the pelagic stocks entering the Faroese waters are widely migrating stocks and the proportion that enters the Faroese area might be affected by the size of the stocks. Therefore the Faroes will benefit from large stock sizes. Currently the Norwegian spring-spawning herring, blue whiting and mackerel are considered stable stocks in generally good shape, but they are fished at or above the recommended level (ICES, 2003a,b). The reason for overfishing on the latter stocks is inability to reach an agreement of political reasons. For blue whiting all parties want to catch as much as possible to have a good argument for getting a large quota when agreement is reached sometime in the future.

Sea birds hunting

No serious overexploitation is known, and the hunting has been regulated for centuries (Nørrevang, 1986).

Marine mammals hunting

The grey seal population may be overexploited locally (Bjarni Mikkelsen, Museum of Natural History, Faroe Islands, pers. comm.).

The pilot whale is an abundant species. As a small cetacean the whale is not covered by the regulations of the IWC. Working through NAMMCO, Faroese and international scientists keep a close watch on the size of the whale population. The most recent scientific abundance estimate based on regular sightings surveys is that there are approximately 780 000 animals in the North East Atlantic. The annual catch fluctuates with oceanic conditions, but the long-term average catch is approximately 1 000 animals, corresponding to only a small fraction of the annual natural rate of increase. Hence the catch is regarded as sustainable (Bloch, 1994; Weihe et al., 2003a).

Excessive by-catch and discards

Fish

Discarding is forbidden by law. However, in some fisheries, especially deep-water fisheries there are some discarding of non-commercial species. The management system in Faroese waters is based on number of fishing days and several technical measures (Reinert, 2001a,b); this means that there should be no incentives to discard fish in order to maximise profit (as is often seen in TAC based management systems).

Seabirds

Seabirds are occasionally taken as by-catch especially fulmars which takes bait on long lines (Dunn and Steel, 2001). The number of seabirds taken as by-catch in long line fisheries at the Faroe Islands is unknown. However, the fulmar population is increasing and the fishermen try to get as few fulmars as possible. Therefore by-catch of seabirds is not considered a problem of concern.

Marine mammals

Some seals and whales may be lost due to sinking. However, this is not of conservation concern for pilot whales (see above on whaling). Some seals are shot by salmon farmers. There is no significant by-catch of marine mammals in fishing gear.

Destructive fishing practices

There will always be some impact from trawl fishing on the bottom habitat. However, there are large areas on the Faroe Plateau closed to all trawl fisheries (Reinert, 2001a; ICES, 2003). During the late 1970's and in the 1980's when the trawl fishery expanded to deeper waters, there were severe impacts on the bottom habitat especially coral reefs. In recent years this problem is regarded as minor, and some areas with corals are closed to trawling.

Decreased viability of stock through pollution and disease

No known impact.

Impact on biological and genetic diversity

No known impact.

Socio-economic impacts

Economic impacts

The system for management of the Faroes fisheries has worked well and been a benefit for the economy, but more experience with system is needed to draw conclusions.

Health impacts

No known impact.

Other social and community impacts

No known impact.

Conclusions and future outlook

The task team experts found unsustainable exploitation of fish and other living resources to have moderate impact. Overexploitation was assessed to have moderate impact. By-catch and discards were considered to have slight impact, while bottom trawling was assessed to have moderate impact on the bottom habitat especially corals. In recent years the problem with corals was regarded minor because closing of areas with corals.

IMPACT Global change

Environmental impacts

Changes in oceanography

Direct current meter observations since 1995 shows that the volume transport of Norwegian Deep Water from the Greenland and Norwegian Seas into the North Atlantic is decreasing. Extrapolation back to 1950 using ocean hydrography at a weather ship station in the Norwegian Sea indicates that the decreasing trend has lasted at least over the last half century, with acceleration in the decreasing trend over the last decade (Hansen et al., 2001).

Although it is suggested that this change in the ocean currents may have some effect on the ecosystem, there is no evidence for a direct link between observed variations in the ecosystem and the decrease in the deep water overflow.

The possible impact of global changes in climate and hydrological cycles on marine biota and contaminant pathways in the Faroe Islands have been described in Heide-Jørgensen and Johnsen (1998), Gaard et al. (2002), OSPAR Commission (2000), and Macdonald et al. (2003).

The oceanographic conditions around Faroe Islands are linked to climate variability and the changes in the distributions of atmospheric pressures on the northern hemisphere, for example the North Atlantic Oscillation Index (NAO-index) and the Arctic Oscillation Index (OA-index) (e.g. Macdonald et al., 2003). Changes are expected at sea, although the uncertainty is also greatest here as long as the fate of the North Atlantic Current has not been clarified. Warmer deep water could result in a redistribution of pelagic and benthic communities. Impacts on plankton are unknown for the time being.

Productivity in marine natural resources are highly dependent on climate, sea currents, primary productivity and plankton distributions, which are linked (Figure 4; Gaard et al., 2002; Steingrund et al., 2003; Jacobsen et al., 2002; Jákupsstovu et al., 2003).

Effects on marine mammals and seabirds are expected mainly to concern spatial shifts in areas of food production and primary productivity (changes in upwelling sites), nesting and rearing sites, and increases in diseases and oceanic biotoxin production (from both temperature increase and current changes).

Sea level change

Analyses of tidal gauges for long time changes have not been carried out, but significant changes are not observed in available material.

Increased UV-b radiation as a result of ozone depletion

No known impact – no observations.

Changes in ocean CO_2 source/sink function

No known impact – no observations.

Socio-economic impacts

Economic impacts

No known impact.

Health impacts

No known impact.

Other social and community impacts

No known impact.

Conclusions and future outlook

Changes in oceanography were assessed to have slight impact now and in 2020. However, from the history it is known that even small changes in climate and ocean currents can influence the productivity in the marine resources and their distribution. Therefore, better understanding and predictions of the impact of global changes on climate, ocean circulation and marine productivity have high priority for the Faroese Fisheries Laboratory now and in the future (Jákupsstovu et al., 2003).

Priority concerns for further analysis

The Task Team agreed to prioritise the issues of concern as given in Table 3. Hence, the major concern themes were Pollution, Unsustainable exploitation of fish and other living resources, and Global change including their links.

Causal chain analysis

This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involves a step-by-step process that identifies the most important causal links between the environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis also recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. In order to ensure that the final outcomes of the GIWA are viable options for future remediation, the Causal chain analyses of the GIWA adopt relatively simple and practical analytical models and focus on specific sites within the region. For further details, please refer to the chapter describing the GIWA methodology.

Introduction

During the task team meeting it was decided to make causal chain analyses for the impact issues chemical pollution and overexploitation.

Chemical pollution, the other prioritised GIWA issue no. 6, was found to have moderate impact in Faroe Plateau mainly due to the impact on human health through consumption of marine food. Overexploitation, the prioritised GIWA issue no. 14, has been reported for cod, haddock, saithe, Greenland halibut, redfish, blue ling, and blue whiting. However, the task team considered the impact to be moderate.

Immediate causes

Chemical pollution

The Faroese health authorities have issued dietary advice in relation to the utilisation of pilot whales as food (Weihe et al., 2003b). The major concern is the heavy metal mercury which occurs in such high concentrations in the whale liver that it gives cause for concern for the pilot whale (there are no indications of its impact on a population level, i.e., reproductive capacity etc), and these high mercury concentrations also mean that liver should not be used as food. Also, on the average, the concentration of mercury in pilot whale muscle tissue exceeds the EU limit for fish for consumption, and dietary advice to limit consumption has been issued. There is also particular concern regarding the persistent, lipid soluble pollutants such as PCB, DDT etc. as they occur in whale blubber which is also normally used as food, in concentrations which are above threshold levels in European countries. Therefore dietary advice to limit the utilisation of pilot whale meat and blubber as food has been given and with a special regard to the developing foetus, females have been advised as a safeguard to abstain from eating pilot whale blubber.

In addition to these considerations which are limited to the utilisation of one particular species from the marine environment, there is cause for concern about the present level of dioxin and PCB with dioxin-equivalent toxicity in especially lipid rich pelagic fish in the North-East Atlantic Ocean. The concentration of these substances is a problem for the utilisation of these species in the fish feed which is produced for the aquaculture market (Hites et al., 2004).

A special concern has arisen the last few years during monitoring of pollutants in seabirds because some of these species also carry high levels of persistent organic pollutants. The levels are such that the safety of continuing the utilisation of some of these seabird species for human food may be questioned.

Overall, there is a problem with the long-range transported pollutants in the Faroese environment. This problem is severe because such pollutants are biomagnified in the marine food chain which the Faroese populations are dependent of. Fish exports are vital for the Faroese economy as is hunting of marine mammals and seabirds for the Faroese culture.

Overexploitation

The Faroe Plateau cod and Faroe haddock were reduced to low levels during the mid-1980s to mid-1990s, due to the combined effect of poor recruitment and high fishing effort. In the period 1993–1995, ICES considered the populations to be well below minimum biologically acceptable levels and consequently advised no fishing (ICES, 2003). Both stocks have since increased due to improved recruitment and growth (Figure 6). The Faroe Bank cod stock seems to be at or slightly above average. The Faroe saithe has been increasing from the record low in 1992 to above biologically safe limits in 1998–2002.

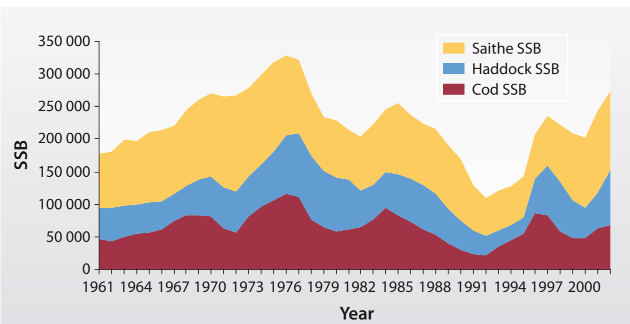


Figure 6 The Faroe demersal spawning stock biomasses (SSB) of cod, haddock, and saithe.
(Source: ICES, 2003)

Root causes

Chemical pollution

Long-range transport

The heavy metals assessment in AMAP focuses on mercury, lead, and cadmium (AMAP, 1998, 2002). Of the metals mercury pollution generate the greatest concern because levels in the Arctic are already high, and are not declining despite significant emissions reductions in Europe and North America (Macdonald et al., 2003). Coal burning, waste incineration and industrial processes around the world emit mercury to the atmosphere, where natural processes transport the metal.

Gaseous Elemental Mercury (GEM) has been measured on the Faroe Islands from May 2000 through March 2001 (Hoydal and Dam, 2003). The air concentration time series shows periods with elevated mercury concentrations (>1.5 ngHg/m3, the generally accepted global background average) which were attributed to two potential causes: local sources and long range transport. However, detailed analysis determined that local sources were not responsible for the elevated levels observed, and it was further determined that the elevated levels were caused by long-range transport from Europe, most notably from the UK.

Likewise, POPs mainly originate from the industrialised world from where POPs are transported to the Faroe Islands by air and ocean currents.

Overexploitation

An overall difficulty in fisheries assessment is to assess changes in the stocks due to both overfishing and environmental changes (e.g. changes in climate and ocean currents). For the Faroe assessment the collapse mid-1990s was also a result of fish leaving the area where neither the research vessels nor the commercial fishermen could find the fish and later on the fish came back. This is a very unusual event, which have never so clearly been seen before and which was only recognisable in retrospect. Faroe fish stocks can disappear again and growth can be reduced due to environmental changes. These changes can be difficult to detect soon enough to be of use in the management.

According to Steingrund et al. (2003) changes in primary production in the marine ecosystem and in the food availability for cod was most probably the driving force behind the collapse of the cod stock in 1991 as well as its rapid recovery in 1995.

Changes in primary production and the coupling to higher trophic levels (fish, sea birds, and marine mammals) are to a large extent coupled to changes in climate and ocean circulation (Figure 4; Gaard et al., 2002; Steingrund et al., 2003). Hence, climate is a driving force for production of marine resources and commercial harvesting on Faroe Plateau.

Conclusions

The vast majority of chemical pollution in Faroe Islands is due to long-range transported contaminants from outside the Islands.

The root causes for overexploitation are: inadequate management and increasing fishing take (mortality) due to new catch technology, which are to be solved within Faroe Islands and they are strictly not of

GIWA concern. However, climate change greatly influences the natural resources and is a very important factor for Faroese ability to manage the natural resources and the consequences for socio-economics.

Hence, the main problems for the Faroe Plateau, the biota and the society, are chemical pollution and unpredictable effects of climate change. These problems are caused by the industrialised world, and the lack of knowledge to predict and manage the effects of climate change. These problems are global international problems to be solved in international cooperation.

Policy options

This section aims to identify feasible policy options that target key components identified in the Causal chain analysis in order to minimise future impacts on the transboundary aquatic environment. Recommended policy options were identified through a pragmatic process that evaluated a wide range of potential policy options proposed by regional experts and key political actors according to a number of criteria that were appropriate for the institutional context, such as political and social acceptability, costs and benefits and capacity for implementation. The policy options presented in the report require additional detailed analysis that is beyond the scope of the GIWA and, as a consequence, they are not formal recommendations to governments but rather contributions to broader policy processes in the region.

Definition of the problem

Pollutants are transported to the Faroe Islands by the atmosphere and by the marine currents. Main sources of marine pollution are the industrialised areas in Europe. Local sources of pollutants in the marine environment at the Faroe Islands play a minor role.

Situated far from the European continent, the Faroe Islands environment is generally characterised by low levels of industrial pollutants. As a result, the Faroes can provide a useful baseline reference for other regions exposed to higher levels of pollution. Establishing environmental baselines to assess any future environmental damage is especially important in light of the on-going exploration for offshore hydrocarbons around the Faroes. The exploitation of hydrocarbons could result in adverse environmental effects.

Because pilot whales, which contain high concentrations of environmental pollutants such as mercury and polychlorinated biphenyls (PCBs), also make up an important part of the Faroese diet, the health effects of exposure to these chemicals is an important topic for research and for dietary advice.

Research in ecosystems and natural resources is important for several reasons. The ocean surrounding the Faroe Islands borders on the prime areas for deep-water formation in the North Atlantic. It is therefore of major importance for the global ocean circulation, and hence for the regional and global climate. In addition, the currents that result from the exchange of huge volumes of warm and cold water in this part of the ocean mean that the area is also important in terms of marine fauna.

The recent near collapse of the Faroese fishing industry highlights the importance of carrying out studies of the dynamics of the marine ecosystem. It also emphasises the importance of conducting surveys of the commercial fish species and the environment to foresee changes in the fish productivity and geographic distributions.

Establishing of policy option

Chemical pollution

The main conclusion of the Human Health Programme in AMAP phase 2 was that the current human exposure at the prevailing levels and mixtures of contaminants influences the health of Arctic populations in a negative way (Deutch and Hansen, 2003). Subtle effects have been demonstrated to be present at a sub-clinical level. In consideration of the potential effects on future generations, efforts to reduce the entry of persistent substances into the ecosystems of the world should be accelerated. Furthermore, the process initiated through the AMAP under phase 1 and 2 should be continued and expanded to involve all relevant disciplines with the goal of pursuing a more holistic assessment of the health of the Arctic Peoples.

Overexploitation

Sustainable fishing

In 1987 the Brundtland Report, also known as Our Common Future (World Commission on Environmental and Development, 1987), alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. The report provided a key statement on sustainable development, defining it as: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

In the North Atlantic considerable investments have been and continue to be made to manage fisheries. Yet, despite these substantial investments, the fishery management processes, including scientific advice, can hardly be described as successful, particularly for the important cod fisheries that have been the backbone of demersal fisheries in the North Atlantic (Maguire, 2001). However, at present the Faroes fisheries management system started in 1987 are considered be one of the best in the world today (Reinert, 2001a; Chuenpagdee and Alder, 2001).

Fishery management has neglected the influence of the environment. According to Maguire (2001) it would benefit from a more humble evaluation of what it can reasonably expect to achieve, recognising the large role of oceanographic and hydrographic variability. Fishery management should formally and explicitly incorporate the social, economic and environmental components of fishery management in addition the presently dominating stock assessment component. This should help put back the fishermen as one of the component of the ecosystem whose functions fishery management is trying to protect.

Steele and Hoagland (2003) have recently discussed the concept of sustainability in fisheries. One of the main difficulties in fisheries management is the "ratchet" effect (Ludwig et al., 1993). When the abundance of a stock increases, the fishing capacity goes up. But when later the stock decreases, the effort stays the same, usually with disastrous consequences for the stock and the economy. This general sequence occurs on top of a trend for "improved" gear technology. The critical scientific problem is to distinguish between these two causes: natural environmental variability and changes in effort, fishing boats and gear. According to Steele and Hoagland (2003) the time scale of natural changes in the sea (a few decades) is comparable to the economic scales of human adaptation; specifically the "lifetime" of a fishing vessel. It is this resonance in time scales that makes the attribution of cause to the quasi-cycles in stock abundance more than a purely scientific problem. There is a need to understand the natural physical and ecological causes of these "cycles" in marine ecosystems. And then devise sufficiently long-term management to ameliorate rather than amplify the economic consequences (Steele and Hoagland, 2003).

Recently FAO has given technical guidelines for responsible fisheries and fisheries management using an Ecosystem Approach to Fisheries (EAF) (FAO, 2001, 2003). These guidelines have been adopted to reflect the merging of two different but related and – it is hoped – converging paradigms. The first is that of ecosystem management, which aims to meet its goal of conserving the structure, diversity and functioning of ecosystems through management actions that focus on the biophysical components of ecosystems (e.g. introduction of protected areas). The second is that of fisheries management, which aims to meet the goals of satisfying societal and human needs for food and economic benefits through management actions that focus on the fishing activity and the target resource. Up until recently, these two paradigms have tended to diverge into two different perspectives, but the concept of sustainable development (Brundtland Report, Our Common Future) requires them to converge towards a more holistic approach that balances both human well-being and ecological well-being. EAF is, in effect, a way to implement sustainable development in a fisheries context (FAO, 2003).

Identification of the recommended policy option

Chemical pollution

The pollution stemming from the industrial regions of Northern Europe, America and Asia is caused by a complex of causes and the solution is to stop/reduce the chemical pollution which leads to problems for the biota and human population on the Faroe Plateau. The latter calls for international cooperation and action such as AMAP and OSPAR (AMAP, 2002; OSPAR Commission, 2000). It may be an important target area for GEF projects.

Heavy metals

Current international actions on metals

In addition to national regulations concerning emissions and use of heavy metals, some significant steps have recently been taken internationally to address the heavy metals. The United Nations Economic Commission for Europe (UN ECE) Convention on Long-Range Transboundary Air Pollution adopted a Protocol on Heavy Metals in 1998. The protocol targets mercury, lead, and cadmium. Countries that are party to the protocol will have to reduce total annual emissions to below the levels they emitted in 1990.

As of June 15th, 2002, there were 36 signatories to the protocol, including all the Arctic countries except Russia. Of these, 10 had ratified it, including Canada, Denmark, Finland, Norway, Sweden, and the United States. For the protocol to enter into force, sixteen countries must ratify it. At its meeting in 2000, the Arctic Council called on the United Nations Environment Programme (UNEP) to initiate a global assessment of mercury that could form the basis for appropriate international action. This request was based on the findings of AMAPs first assessment.

In 2001, the UNEP Governing Council agreed to undertake such a study. The study on mercury will summarise available information on the health and environmental impacts of mercury, and compile information about prevention and control technologies and practices and their associated costs and effectiveness. In addition, the UNEP Governing Council requested, for consideration, an outline of options to address any significant global adverse impacts of mercury. These options may include the reduction and/or elimination of the use, emissions, discharges, and losses of mercury and its compounds; improving international cooperation; and enhancing risk communication.

POPs

Several important steps have already been taken to address the threats POPs pose to the North Atlantic environment, such as the Stockholm Convention and the UN ECE POPs Protocol. The AMAP (2002) assessment shows the continued need to bring Arctic concerns about POPs to the attention of these international policy fora to ensure continued emphasis on Arctic needs.

Conventions regulate some POPs

At a national level, the use and emissions of many POPs have been restricted since the 1970s. In 1998, the United Nations Economic Commission for Europe (UN ECE) negotiated a regional protocol on POPs under the Convention on Long-range Transboundary Air Pollution, the Aarhus POPs Protocol, which covers Europe, all states of the former Soviet Union, and North America. All AMAP countries except Russia are signatories to this convention. As of August 1, 2002, the following AMAP countries had ratified the POPs Protocol: Canada, Denmark, Norway, and Sweden.

The regional UN ECE agreement paved the way for global negotiations on banning POPs under the auspices of the United Nations Environment Programme. The Stockholm Convention on Persistent Organic Pollutants was opened for signature in May 2001. All AMAP countries have signed the Stockholm Convention. As of July, 2002, Canada, Iceland, Norway, and Sweden had ratified it.

Both agreements identify a number of specific POPs to be banned or whose use or emissions are to be restricted. They include industrial chemicals and by-products, such as PCBs, dioxins, furans, and hexachlorobenzene. Also included are a number of organochlorine pesticides: aldrin, chlordane, dieldrin, DDT, endrin, heptachlor, mirex, and toxaphene. Together, these are often called the 'dirty dozen'. Some POPs, most notably the pesticide hexachlorocyclohexane (HCH), are covered in the UN ECE Protocol but not the Stockholm Convention. For several of the listed substances, some limited use is allowed, for example DDT for fighting malaria.

The conventions also define criteria for including new chemicals based on their persistence, bioaccumulation, potential for long-range transport, and adverse effects. The Arctic is well suited as an indicator region for long-range transport. Monitoring data that provide information about the fate of chemicals in the Arctic will therefore be critical in identifying new POPs to be considered under the agreements.

Overexploitation

The high dependency in the Faroe Islands of the marine resources requires proper resource assessments and management. The advice on management of the resources has so far been based solely on fisheries and fishery independent survey data. However, the great variability in individual growth and recruitment to the fish stocks in the area makes an ecosystem approach to resource management relevant for the Faroe Islands.

A preliminary work by Zeller and Reinert (2004) is an example of how an ecosystem approach to fisheries may be useful in fisheries management in the Faroes:

The Faroe Islands utilise a spatial- and effort-based system of fisheries management, explicitly incorporating ecosystem considerations in their policies. This management system was introduced relatively recently (mid-1990s) (Reinert, 2001a,b). Given the exceptional importance of marine resources to the Faroese culture and economy, effective and sustainable fisheries management is of paramount importance to the Faroes. Of particular interest in this regard at the present are ecosystem-level evaluations of the effects of the seasonal and gear-specific closure systems. By spatially explicit simulations using an ecosystem model of the Faroese waters, Zeller and Reinert (2004) found that the current area closures could be considered beneficial in conserving major stocks of demersal species, with biomass for cod, haddock and other demersal species increasing over the 10-year simulation period. Simulated removal of the closure system reduced the effect of the projected stock increases considerably. Greenland halibut, one of the major deep-water species, and blue whiting, one of the main pelagic species, did not benefit from the existing spatial management. Simulated additional offshore closures of at least 20% of habitats deeper than 200 m benefited Greenland halibut only. Both Greenland halibut and blue whiting stocks benefited from drastic reductions in fishing effort (between 20-50% reductions from 1997 effort levels). According to Zeller and Reinert (2004) the simulation results suggest that the current management regime, which limits effort and spatial access by certain gears (trawls) is likely to be effective for demersal stocks. Furthermore, the simulations were also in line with single-species assessment advice, which indicated that the deep-water fisheries for Greenland halibut and the pelagic fisheries for blue whiting are being heavily overfished. The simulations suggest that significant management changes would be required to halt the current declining biomass trend for Greenland halibut and blue whiting, including considerations for extensive spatial closures for deep-water fisheries, as well as drastic reductions in real effort for both pelagic and deep-water fisheries.

To improve fisheries resource management there is a need for better understanding and predictions of the impact of global climate changes on the Faroe Plateau marine ecosystem. Therefore, modeling the coupling between climate, ocean circulation and marine productivity has high priority for the Faroese Fisheries Laboratory (Jákupsstovu et al., 2003).

Global climate change

The Kingdom of Denmark comprises Denmark, Greenland and the Faroe Islands. The UN Framework Convention on Climate Changes has been ratified on behalf of all three parts of the Kingdom (Anon., 2003c).

In the Faroe Islands there is no energy policy or plan in place (Anon., 2001). The Islands' lack of a specific legislative framework on energy use is recognised as an impediment to promoting energy efficiency measures throughout the Faroese economy. According to Anon. (2001), necessary measures that will in part demand an extended regulatory regime may include:

- Establishing a regulatory framework for energy production and use and setting clear targets on renewable energy sources. Establishing realistic CO_2 emission reduction targets for the different sectors of the Faroe Islands economy.
- Promotion of fleet reduction and rejuvenation measures in an effort to improve the long-term sustainability and fuel efficiency of the fishing fleet.
- Promoting energy efficiency measures and the use of cleaner fuels in the fishing sector.
- Promoting wind energy schemes and eliminating barriers to third party access to the electricity grid.
- Promoting cooperation between the joint municipal company, SEV, the Faroe Islands Government and the oil sector regarding energy production on offshore installations.
- Investigating ways of reducing CO_2 emissions associated with offshore energy production.
- Improving and enlarging the available range of energy and environmental indicators and statistics, and including regular figures for CO_2 emissions, broken down by sector.

It is evident that global climatic change, in particular related to ocean temperature, salinity and currents, may have a potential very severe impact on the fisheries resources and the economy of the Faroes. However, the main causes for these effects shall be found outside the Faroes, and only determined international action by the large emittants of greenhouse gases will be able to address this issue efficiently. Here, The Faroes share fate with the cause of Small Island Development States (SIDS)

Conclusions

Climate change and chemical pollution from outside the Islands impact the natural resources on the Faroe Plateua by increasing the risks of overexploitation and by contaminating the natural resources to levels above the safe limits for human consumption. Both chemical pollution and climate change are caused by the industrialised world and they are global international problems to be solved in international cooperation. It is important for Faroe Islands to inform the UN and the world about the impact of chemical pollution and climate change and to take active part in solving the root causes to the problems. The Faroese are very aware of the threats to habitats, biota, human health due to climate change, chemical pollution and overexploitation through its membership and active participation in international organisations concerned with resource management (e.g. ICES, NAFO, NEAFC, NAMMCO, Arctic Council) and pollution (e.g. AMAP and OSPAR).

References

Appelquist, H., Asbirk, S. and Drabæk I.1984. Mercury Monitoring: Mercury stability in bird feather. Mar. Poll. Bull. 15 (1) 22-24.

Appelquist, H., Drabæk I. and Asbirk, S. 1985. Variation in mercury content of Guillemot feathers over 150 years. Mar. Poll. Bull. 16 (6) 244-248.

Anonymous, 1997. Preparation for Oil Exploration. Report of the Hydrocarbon Planning Commission to the Faroese Government. 524 pp.

Anon., 2001. Study of the impact of the development of hydrocarbon resources in the Faroe Islands. Menas Associates Limited in association with Fróðskaparsetur Føroya (University of Faroe Islands). A study commissioned by BP Amoco Exploration.

Anon., 2003a. Information Memorandum, Faroe Islands, September 2003, Landsbanki Føroya, Governmental Bank. 22p.

Anon., 2003b. Bekendtgørelse om visse forureninger i fødevare. Fødevaredirektoratet, bekendtgørelse nr. 860, 22.10.2003.

Anon., 2003c. Denmark´s third national communication on climate change. Under the United Nations Framework Convection on climate change. Danish Environmental Protection Agency, Danish ministry of the Environment. 212 pp.

AMAP, 1998. AMAP Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. Xii+859 pp.

AMAP, 2002. Arctic Pollution 2002. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. Vii + 112 pp. www.amap.no.

AMAP, 2003. AMAP 2002: Human Health in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. Xiv + 137 pp.

Baars,A.J., M. I. Bakker, R. A. Baumann, P. E. Boon, J. I. Freijer, L. A. P. Hoogenboom, R. Hoogerbrugge, J. D. van Klaveren, A. K. D. Liem, W. A. Traag and J. de Vries, 2004. Dioxins, dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs: occurrence and dietary intake in The Netherlands. Toxicology Letters Volume 151, Issue 1 , p.51-61.

Bloch, D. 1994. Pilot whales in the North Atlantic. Age, growth and social structure in Faroese grinds of the long-finned pilot whale, Globicephala melas. PhD thesis, the University of Lund, Sweden.

Bloch, D. 1996a. Whaling in the Faroe Islands, 1584-1994, an overview. In: Holm, P., Starkey, D.J. and Thór, J. Th. (eds.). The North Atlantic Fisheries, 11-1976. National perspectives on a common resource. Studia Atlantica 1: 49-61.

Bloch, D. 1996b. Færøernes grindefangst med en tilføjelse om døglingefangsten. 2001. 6th revised edition. Føroya Náttúrugripasavn.

Bloch, D. 1998. A review of marine mammals observed, caught or stranded over the last two centuries in Faroese Waters. Shetland Sea Mammal Report, 1997: 15-37.

Bloch, D., Desportes, G., Zachariassen, M. and Christensen, I. 1996. The Northern Bottlenose Whale in the Faroe Islands, 1584-1994. J. Zool. London 239: 123-140.

Bloch, D., Heide-Jørgensen, M.P., Stefansson, E., Mikkelsen, B., Ofstad, L.H., Dietz, R. and Andersen, L.W. 2003. Short-term movements of pilot whales around the Faroe Islands. Wildlife Biology 9,1: 71-82.

Bloch, D. and Lastein, L. 1993. Morphometric segregation of long-finned pilot whales in eastern and western North Atlantic. Ophelia 38: 55-68.

Bloch, D., and Lastein, L. 1995. Modelling the school structure of pilot whales in the Faroe Islands, 1832-1994. In: Blix, A.S., Walløe, L. and Ulltang, U. (eds.). Whales, seals, fish and man: 499-508. Elsevier. Amsterdam - Lausanne - New York - Oxford - Shannon - Tokyo.

Bloch, D., Mikkelsen, B. and Ofstad, L.H. 2001. Marine Mammals in Faroese Waters with special attention to the south-south-eastern Sector of the region. GEM Report to Environmental Impact Assessment Programme: 1-40.

Bruntse G. and O.S. Tendal (eds.), 2001: Marine biological investigations and assemblages of benthic invertebrates from the Faroe Islands. - Kaldbak Marine Biological Laboratory. 80 pp.

Buckland, S.T., Bloch, D., Cattanach, K.L., Gunnlaugsson, T., Hoydal, K., Lens, S. and Sigurjónsson, J. 1993. Distribution and abundance of long-finned pilot whales in the North Atlantic, estimated from NASS-1987 and NASS-89 data. Rep. int. Whal. Commn (special issue 14): 33-49.

Christoffersen, K. 2002. Previous Studies of Freshwater Biota in Faroese Lakes. Ann. Soc. Scient. Færoensis Suppl. 36: 7-13

Chuenpagdee R. and J. Alder, 2001. Sustainability Ranking of North Atlantic Fisheries. In: Tony Pitcher, Ussif Rashid Sumaila and Daniel Pauly. (eds) Fisheries impacts on North Atlantic ecosystems: Evaluations and Policy Exploration. Fisheries Centre Research Reports 9(5): 49-54.

Committee on the Toxicological Effects of Methylmercury, 2000. Board on Environmental Studies and Toxicology, Commission on Life Sciences, National Research Council. Toxicological effects of methylmercury. Washington, DC: National Academy Press, 2000. Online-version: (http://books.nap.edu/books/0309071402/html, accessed on April 30, 2001).

Dam, M. and D. Bloch, 2000. Screening of mercury and persistent organochlorine pollutants in long-finned pilot whale (Globicephala melas) in the Faroe Islands. Marine Pollution Bulletin 2000, Vol. 40, 1090 - 1099.

Dam, M. G. Bruntse, A. Reinert, and J.P. Joensen. 2000. Chapter 3: The Faroe Islands. In C. Sheppard (Editor). Seas at The Millennium: An Environmental Evaluation. PERGAMON, Elsevier Science Ltd.:31-41.

Deutch B. and J.C. Hansen (Editors). 2003. AMAP Greenland and the Faroe Island 1997-2001. Vol. 1: Human Health. DANCEA. Ministry of Environment, Denmark. 234pp.

Desportes, G., Bloch, D., Andersen, L.W. and Mouritsen, R. 1994. The international research programme on the ecology and status of the long-finned pilot whale off the Faroe Islands: Presentation, results and references. Fróðskaparrit 40 (1992): 9-29.

Dunn, E and C. Steel, 2001. The impact of longline fishing on seabirds in the north-east Atlantic: recommendation for reducing mortality. RSPB, NOF, JNCC and Birdlife International. 2001, 107 pp)

EEC, 2002. Economic performance of selected European fishing fleets. European Commission.

FAO, 2001. What is the code of conduct for responsible fisheries? FAO Rome, 2003. 13pp.

FAO, 2003. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome, FAO. 2003. 112p.

Fiedler, H., Hutzinger, O., Welsch-Pausch, K. and Schmiedinger, A. 2000. Evaluation of the occurrence of PCDD/PCDF and POPs in wastes and theri potential to enter the foodchain. Univ. Bayreuth, Germany, pp.117.

Fitzgerald, W.F., Engstrom, D.R., Mason, R.P., Nater, E.A.1998. The case for atmospheric mercury contamination in remote areas. Env. Sci. Technol. 32(1) 1-7.

Gaard, E., Hansen, B., Olsen, B., and Reinert, J. 2002. Ecological Features and Recent Trends in the Physical Environment, Plankton, Fish Stocks, and Seabirds in the Faroe Shelf Ecosystem. In K. Sherman and H.R. Skjoldal (editors), p 245-265, Large Marine Ecosystem of the North Atlantic 449 pp. Elsevier..

Grandjean, P., Weihe, P., White, R.F., and Debes, F., 1998. Cognitive performance of children prenatally exposed to "safe" levels of methylmercury. Env. Res. Sec A. 77, 165-172.

Hagstova, 2003. 'Statistics Faroe Islands': www.hagstova.fo .

Hall-Spencer, S. et al., 2001. Trawling damage to Northeast Atlantic coral reefs. - Proc. R. Soc. Lond. B 269: 507-511.

Hansen, B. and Østerhus, S. 2000. North Atlantic - Nordic Seas exchanges. Progress in Oceanography, 45, 109-208.

Hansen, B., Stefánsson, U., and Svendsen, E.1998. Iceland, Faroe and Norwegian Coasts. In The Sea, Volume 11, 733-758, edited by A.R.Robinson and K.H.Brink, John Wiley & Sons, Inc.

Hansen, B., W. R. Turrell and S. Østerhus, 2001. Decreasing overflow from the Nordic seas into the Atlantic Ocean through the Faroe Bank Channel since 1950. Nature, 198, 520-528.

Heide-Jørgensen, H.S. and Johnsen, I., 1998: Ecosystem Vulnerability to Climate Change in Greenland and the Faroe Islands. Miljønyt no. 33, Danish Environmental Protection Agency, 266 pp.

Heide-Jørgensen, M.P., Bloch, D., Stefansson, E., Mikkelsen, B., Ofstad, L.H. and Dietz, R. 2002. Diving behaviour of long-finned pilot whales Globicephala melas around the Faroe Islands. Wildlife Biology 8,4: 307-313.

Heilsufrøðiliga Starvsstovan, 1998. Landslæknin og Deildin fyri Arbeiðs- og Almannaheilsu [Hygienic Institute, Chief Medical Officer, and Department for Occupational and Public Health]. Kosttilmæli um grind [Dietary recommendations about pilot whale consumption]. Tórshavn, Faroe Islands: Heilsufrøðiliga Starvsstovan, 1998.

Hites, R.A., J. A. Foran, D. O. Carpenter, M. C. Hamilton, B. A. Knuth, and S. J. Schwager, 2004. Global Assessment of Organic Contaminants in Farmed Salmon. Science, Vol. 303, Issue 5655, 226-229.

Hoydal, K. and M. Dam (Editors), 2003. AMAP Greenland and the Faroe Islands1997- 2001. Vol. 3: The Environment of the Faroe Islands. DANCEA. Ministry of Environment, Denmark: 265p.

Hoydal, K., J. Olsen, and M. Dam, 2003. 7 AMAP Faroe Islands 1999-2001 POPs. In: Hoydal, K. and M. Dam (Editors), 2003. AMAP Greenland and the Faroe Islands1997- 2001. Vol. 3: The Environment of the Faroe Islands. DANCEA. Ministry of Environment, Denmark: 221-265..

ICES, 1998. Report of the northern pelagic and blue whiting fisheries working group. ICES CM 1998/ACFM:18, pp. 282.

ICES, 2001. Report of the northern pelagic and blue whiting fisheries working group. ICES CM 2001/ACFM:17, pp. 243.

ICES, 2003. Report of the North-Western Working Group. Advisory Committee on Fishery Management ICES CM 2003/ACFM:24. Part 1 and 2 (www.ices.dk).

ICES, 2003a. Report of the Northern pelagic and blue whiting fisheries Working Group. ICES CM 2003/ACFM: 23, 229 pp.

ICES, 2003b. Report of the Working Group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 2003/ ACFM: 07, 572 pp.

ICES, 2004a. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group, 27 April 4 May 2004 (ICES CM 2004/ACFM:24).

ICES, 2004b. Report of the North-Western Working Group. Advisory Committee on Fishery Management (www.ices.dk).

Jacobsen, J.A., Guðmundsdóttir, Á., Heino, M., Holst, J.C., Krysov, A., Melle, W., Mork, K.A., Røttingen, I., Tangen, Ø. & Vilhjálmsson, H. 2002. Report of the Planning Group on Surveys on Pelagic Fish in the Norwegian Sea 2002. ICES CM 2002 (D:06): 1-68.

Jákupsstovu, H. I. (ed.), 2003. Workshop on Ecosystem Modelling of Faroese Waters Tórshavn 24-26 September 2002. Fiskirannsóknarstovan 2003.

Jensen, J.K., Mortensen. S.M., and Langgaard, L. 1983. Biologiske effekter af vandudnyttelse ved Vestmanna og Eiði, Færøerne. Rapport til Overfredningsnævnet på Færøerne. Vandkvalitetsinstituttet, ATV, Hørsholm, Danmark.

Joensen, H.P. and H. Dahlgaard, 2003. 4 Radionuclides. In: Hoydal, K. and M. Dam (Editors), 2003. AMAP Greenland and the Faroe Islands1997-2001. Vol. 3: The Environment of the Faroe Islands. DANCEA. Ministry of Environment, Denmark: 57-69.

Larsen, R.B. and M. Dam, 2003. 5 AMAP Faroe Islands 1997-1998. Hoydal, K. and M. Dam (Editors), 2003. AMAP Greenland and the Faroe Islands1997- 2001. Vol. 3: The Environment of the Faroe Islands. DANCEA. Ministry of Environment, Denmark: 71-153.

Leonards, Pim E. G.; Traag, Wim A.; de Boer, Jacob, 2001. Polychlorinated dibenzo-p-dioxins (PCDD), dibenzofurans (PCDF) and biphenyls (PCBs) in Dutch fishery products. Organohalogen Compounds (2001), 52(Dioxin 2001), 161-164.

Ludwig, D., Hilborn, R., Walters, C., 1993. Uncertainty, resource exploitation and conservation. Science 260, 17–26.

Magnussen, E. 2002. Demersal fish assemblages of the Faroe Bank: Species composition, distribution, biomass spectrum and diversity. Mar.Ecol.Prog.Ser. 238:211-225.

Magnussen, E. 2003. Demersal fish assemblages of Faroe Bank. In: Jákupsstovu, H.I. (ed.) 2003. Workshop on the Ecosystem Modelling of Faroese Waters Tórshavn 24-26 September 2002. Fiskirannsóknarstovan 2003. pp 95.

Maguire, J-J. 2001. Fisheries Science and Management in the North Atlantic. Pages 36-48 in Pitcher, T.J., Sumaila, U.R. and Pauly, D. (eds) (2001) Fisheries Impacts on North Atlantic Ecosystems: Evaluations and Policy Exploration. Fisheries Centre Research Reports 9 (5): 94 pp.

Mikkelsen, B., Haug, T. and Nilssen, K.T. 2002. Summer diet of grey seals (Halichoerus grypus) in the Faroese waters. Sarsia. 87: 462-471.

Monteiro, L.R. and Furness, R.W. 1995. Seabirds as monitoris of mercury in the marine environment. Water , Air and Soil pollution 80, 851-870.

Nørrevang, A., 1986. Tradition of sea bird fowling in the Faroes: An ecological basis for sustained fowling. Ornis Scandinavica 17: 275-281.

Nørrevang, A., T. Brattegard, A.B. Josefson, J.-A. Sneli and O.S. Tendal, 1994: List of BIOFAR stations. - Sarsia 79: 165-180.

Olsen, B. 1998. Changes in Faroese Seabird Populations and Human Impact. Fróðskaparrit 46. bók p 167-168.

Olsen, B. 2001. Burðardygg ferðavinna og fuglurin. Frágreiðing frá Føroya Fuglafrøðifelag p 8-10

Olsen, B. 2003. Seabird-data that can be used in modelling the ecosystem of the Faroese waters. In: Jákupsstovu, H.I. (ed.) 2003. Workshop on the Ecosystem Modelling of Faroese Waters Tórshavn 24-26 September 2002. Fiskirannsóknarstovan 2003. pp 95.

Olsen, J., K. Hoydal, and M. Dam, 2003. AMAP Faroe Islands 1999-2001 Heavy Metals. In: Hoydal, K. and M. Dam (Editors), 2003. AMAP Greenland and the Faroe Islands1997- 2001. Vol. 3: The Environment of the Faroe Islands. DANCEA. Ministry of Environment, Denmark: 155-220.

OSPAR Commission, 2000. Quality Status Report 2000, Region I – Arctic Waters. OSPAR Commission, London. 102 + xiv pp. (www.ospar.org)

Reinert, J. 2001a. Faroese Waters: Environment, Biology, Fisheries and Management. In: Zeller, D., R. Watson, and D. Pauly (eds.). Fisheries Impacts on North Atlantic Ecosystems: Catch, Effort and National/ Regional Data Sets. Fisheries Centre Research Reports 9(3): 110-125.

Reinert, J. 2001b. Faroese Fisheries: Discards and Non-mandated Catches. In: Zeller, D., R. Watson, and D. Pauly (eds.). Fisheries Impacts on North Atlantic Ecosystems: Catch, Effort and National/Regional Data Sets. Fisheries Centre Research Reports 9(3): 126-129.

Reinert, J. 2003. Fishes in Faroese Waters – a brief overview. In: Jákupsstovu, H.I. (ed.) 2003. Workshop on the Ecosystem Modelling of Faroese Waters Tórshavn 24-26 September 2002. Fiskirannsóknarstovan 2003. pp 95.

Robinson, Clive; Rose, Martin; White, Shaun; Gem, Martin; Gleadle, Alison; Harrison, Nigel, 2000. PCDDs, PCDFs and PCBs in fish and fish fingers on sale in the UK. Organohalogen Compounds (2000), 47 334-337.

Rogers, A.D., 1999: The biology of Lophelia pertusa (Linnaeus, 1758) and other deep-water reef-forming corals and impacts from human activities. - Internat. Rev. Hydrobiol. 4: 315-406.

Schmidt, S. F., O. S. Tendal, and E. Magnussen. 2003. The Faroe Bank – A Potential MPA. WWF's Showcase Examples for the OSPAR System of Marine Protected Areas (MPAs). www.ngo.grida.no/wwfneap/Projects/MPAmap.htm

Somer, E. and Appelquist, H., 1974. Changes and differences in mercury level in the Baltic and Kattegat compared to the North Atlantic using Uria sp. (Guillemot sp.) and Cepphus grylle (Black guillemot) as indicators. 9the Conference of the Baltic oceanorgraphers, Paper no. 30, 379-387.

Steele, J. and P. Hoagland, 2003. Are fisheries "sustainable"?. Fisheries Research 64 (2003) 1–3

Steingrund, P. 2003. Relationship between primary production, food abundance and fish production on Faroe Plateau. In: Jákupsstovu, H.I. (ed.) 2003. Workshop on the Ecosystem Modelling of Faroese Waters Tórshavn 24-26 September 2002. Fiskirannsóknarstovan 2003. pp 95.

Steingrund, P., L.H. Ofstad, and D.H. Olsen, 2003. Effect of recruitment, individual weights, fishing effort, and fluctuating longline catchability on the catch of Faroe Plateau cod (Gadus morhua L.) in the period 1989-1999. ICES Marine Science Symposia, 219: 418-420.

Sørensen, J., G. Bruntse, K. Gunnarsson and R. Nielsen, 2001: List of BIOFAR 2 stations. - Fróðskaparrit 48: 61-85.

Sørensen, J. 2003. Benthos in modelling the Faroe Shelf ecosystem. In: Jákupsstovu, H.I. (ed.) 2003. Workshop on the Ecosystem Modelling of Faroese Waters Tórshavn 24-26 September 2002. Fiskirannsóknarstovan 2003. pp 95.

Tendal, O.S., T. Brattegard, A. Nørrevang and J.-A. Sneli: The BIOFAR 1 programme: background, accomplishment, and some outcome from inter-Nordic investigations around the Faroe Islands (NE Atlantic). – Frođskaparrit (In press)

Thiel, H. and A. Kowlow (eds.), 2001. Managing risks to biodiversity and the environment on the high sea, including tools such as marine protected afras - Scientific requirements and legal aspects. - Proceedings of the expert workshop held at the International Academy for Nature Conservation, Isle of Vilm, Germany, 27 February - 4 March 2001. 216 pp. (Her særligt A.J. Grahan: Deep-water coral conservation. Pp 67-74)

Quass, U., Fermann, M. and Broker, G., 2000. The European Dioxin emission inventory Stage II. Vol I.North Rhine Westphalia State Environment Agency, pp. 54.

Weihe, P, M. Dam, and Á. Olafsson., 2003a. Chapter 5. The Faroe Islands. Sociocultural environment, lifestyle, health and contaminant exposure. In: Deutch B. and J.C. Hansen (Editors), 2003. AMAP Greenland and the Faroe Island 1997-2001. Vol. 1: Human Health. DANCEA. Ministry of Environment, Denmark: 123-134.

Weihe, P, Steuerwald, U, Taheri S, Færø O, Veyhe AS, Nicolajen D, 2003b. Chapter 6. The Human Health programme in the Faroe Islands 1985-2001. In: Deutch B. and J.C. Hansen (Editors), 2003. AMAP Greenland and the Faroe Island 1997-2001. Vol. 1: Human Health. DANCEA. Ministry of Environment, Denmark: 135-212.

World Commission on Environment and Development. 1987 - Our common future. Oxford, UK; Oxford University Press: 398 pp.

Zeller, D. and Reinert, J. 2004. Modelling spatial closures and fishing effort restrictions in the Faroe Islands marine ecosystem. Ecological Modelling, 172: 403-420.

Annexes

Annex I
List of contributing authors

Faroe plateau task team experts – meeting participants and contributors:
The Scaling and Scoping meeting held 8. October 2003 at the Fiskirannsóknarstovan (Faroese Fisheries Laboratory)

Name	Country	Field of work
Jákup Reinert	Faroe Islands	Fisheries research
Jan Arge Jacobsen*	Faroe Islands	Fisheries Research
Andrias Reinert*	Faroe Islands	Fish Research Freshwater
Dorete Bloch	Faroe Islands	Habitat and community modification, marine mammals, and other issues
Bjarni Mikkelsen	Faroe Islands	Marine mammals
Bergur Olsen	Faroe Islands	Seabirds
Arne Nørrevang	Faroe Islands	Benthic community modification, and other issues
Jákup P. Joensen*	Faroe Islands	Pollution and other environmental issues
Pál Weihe	Faroe Islands	Biomagnification of pollutants, human health
Eyðfinn Magnusson*	Faroe Islands	Marine Ecology
Eilif Gaard	Faroe Islands	Marine Ecology
Sámal Johansen	Faroe Islands	Socio-economy
Maria Gunnleivsdóttir Hansen*	Faroe Islands	Pollution
Johanna Olsen	Faroe Islands	Pollution
Maria Dam*	Faroe Islands	Pollution, AMAP
Knud Simonsen*	Faroe Islands	Oceanography and Climate
Sigmundur Ísfeld*	Faroe Islands	(Advicer on political structure), Department of Foreign Affairs, Faroe Prime Minister's Office

The Global International Waters Assessment

This report presents the results of the Global International Waters Assessment (GIWA) of the transboundary waters of the Faroe Plateau region. This and the subsequent chapter offer a background that describes the impetus behind the establishment of GIWA, its objectives and how the GIWA was implemented.

The need for a global international waters assessment

Globally, people are becoming increasingly aware of the degradation of the world's water bodies. Disasters from floods and droughts, frequently reported in the media, are considered to be linked with ongoing global climate change (IPCC 2001), accidents involving large ships pollute public beaches and threaten marine life and almost every commercial fish stock is exploited beyond sustainable limits - it is estimated that the global stocks of large predatory fish have declined to less that 10% of pre-industrial fishing levels (Myers & Worm 2003). Further, more than 1 billion people worldwide lack access to safe drinking water and 2 billion people lack proper sanitation which causes approximately 4 billion cases of diarrhoea each year and results in the death of 2.2 million people, mostly children younger than five (WHO-UNICEF 2002). Moreover, freshwater and marine habitats are destroyed by infrastructure developments, dams, roads, ports and human settlements (Brinson & Malvárez 2002, Kennish 2002). As a consequence, there is growing public concern regarding the declining quality and quantity of the world's aquatic resources because of human activities, which has resulted in mounting pressure on governments and decision makers to institute new and innovative policies to manage those resources in a sustainable way ensuring their availability for future generations.

Adequately managing the world's aquatic resources for the benefit of all is, for a variety of reasons, a very complex task. The liquid state of the most of the world's water means that, without the construction of reservoirs, dams and canals it is free to flow wherever the laws of nature dictate. Water is, therefore, a vector transporting not only a wide variety of valuable resources but also problems from one area to another. The effluents emanating from environmentally destructive activities in upstream drainage areas are propagated downstream and can affect other areas considerable distances away. In the case of transboundary river basins, such as the Nile, Amazon and Niger, the impacts are transported across national borders and can be observed in the numerous countries situated within their catchments. In the case of large oceanic currents, the impacts can even be propagated between continents (AMAP 1998). Therefore, the inextricable linkages within and between both freshwater and marine environments dictates that management of aquatic resources ought to be implemented through a drainage basin approach.

In addition, there is growing appreciation of the incongruence between the transboundary nature of many aquatic resources and the traditional introspective nationally focused approaches to managing those resources. Water, unlike laws and management plans, does not respect national borders and, as a consequence, if future management of water and aquatic resources is to be successful, then a shift in focus towards international cooperation and intergovernmental agreements is required (UN 1972). Furthermore, the complexity of managing the world's water resources is exacerbated by the dependence of a great variety of domestic and industrial activities on those resources. As a consequence, cross-sectoral multidisciplinary approaches that integrate environmental, socio-economic and development aspects into management must be adopted. Unfortunately however, the scientific information or capacity within each discipline is often not available or is inadequately translated for use by managers, decision makers and policy developers. These inadequacies constitute a serious impediment to the implementation of urgently needed innovative policies.

Continual assessment of the prevailing and future threats to aquatic ecosystems and their implications for human populations is essential if governments and decision makers are going to be able to make strategic policy and management decisions that promote the sustainable use of those resources and respond to the growing concerns of the general public. Although many assessments of aquatic resources are being conducted by local, national, regional and international bodies, past assessments have often concentrated on specific themes, such as biodiversity or persistent toxic substances, or have focused only on marine or freshwaters. A globally coherent, drainage basin based assessment that embraces the inextricable links between transboundary freshwater and marine systems, and between environmental and societal issues, has never been conducted previously.

International call for action

The need for a holistic assessment of transboundary waters in order to respond to growing public concerns and provide advice to governments and decision makers regarding the management of aquatic resources was recognised by several international bodies focusing on the global environment. In particular, the Global Environment Facility (GEF) observed that the International Waters (IW) component of the GEF suffered from the lack of a global assessment which made it difficult to prioritise international water projects, particularly considering the inadequate understanding of the nature and root causes of environmental problems. In 1996, at its fourth meeting in Nairobi, the GEF Scientific and Technical Advisory Panel (STAP), noted that: *"Lack of an International Waters Assessment comparable with that of the IPCC, the Global Biodiversity Assessment, and the Stratospheric Ozone Assessment, was a unique and serious impediment to the implementation of the International Waters Component of the GEF"*.

The urgent need for an assessment of the causes of environmental degradation was also highlighted at the UN Special Session on the Environment (UNGASS) in 1997, where commitments were made regarding the work of the UN Commission on Sustainable Development (UNCSD) on freshwater in 1998 and seas in 1999. Also in 1997, two international Declarations, the Potomac Declaration: Towards enhanced ocean security into the third millennium, and the Stockholm Statement on interaction of land activities, freshwater and enclosed seas, specifically emphasised the need for an investigation of the root causes of degradation of the transboundary aquatic environment and options for addressing them. These processes led to the development of the Global International Waters Assessment (GIWA) that would be implemented by the United Nations Environment Programme (UNEP) in conjunction with the University of Kalmar, Sweden, on behalf of the GEF. The GIWA was inaugurated in Kalmar in October 1999 by the Executive Director of UNEP, Dr. Klaus Töpfer, and the late Swedish Minister of the Environment, Kjell Larsson. On this occasion Dr. Töpfer stated: *"GIWA is the framework of UNEP´s global water assessment strategy and will enable us to record and report on critical water resources for the planet for consideration of sustainable development management practices as part of our responsibilities under Agenda 21 agreements of the Rio conference"*.

The importance of the GIWA has been further underpinned by the UN Millennium Development Goals adopted by the UN General Assembly in 2000 and the Declaration from the World Summit on Sustainable

The Global Environment Facility (GEF)

The Global Environment Facility forges international co-operation and finances actions to address six critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, ozone depletion, land degradation, and persistent organic pollutants (POPs).

The overall strategic thrust of GEF-funded international waters activities is to meet the incremental costs of: (a) assisting groups of countries to better understand the environmental concerns of their international waters and work collaboratively to address them; (b) building the capacity of existing institutions to utilise a more comprehensive approach for addressing transboundary water-related environmental concerns; and (c) implementing measures that address the priority transboundary environmental concerns. The goal is to assist countries to utilise the full range of technical, economic, financial, regulatory, and institutional measures needed to operationalise sustainable development strategies for international waters.

United Nations Environment Programme (UNEP)

United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system. The mission of UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP work encompasses:

- Assessing global, regional and national environmental conditions and trends;
- Developing international and national environmental instruments;
- Strengthening institutions for the wise management of the environment;
- Facilitating the transfer of knowledge and technology for sustainable development;
- Encouraging new partnerships and mind-sets within civil society and the private sector.

University of Kalmar

University of Kalmar hosts the GIWA Co-ordination Office and provides scientific advice and administrative and technical assistance to GIWA. University of Kalmar is situated on the coast of the Baltic Sea. The city has a long tradition of higher education; teachers and marine officers have been educated in Kalmar since the middle of the 19th century. Today, natural science is a priority area which gives Kalmar a unique educational and research profile compared with other smaller universities in Sweden. Of particular relevance for GIWA is the established research in aquatic and environmental science. Issues linked to the concept of sustainable development are implemented by the research programme Natural Resources Management and Agenda 21 Research School.

Since its establishment GIWA has grown to become an integral part of University activities. The GIWA Co-ordination office and GIWA Core team are located at the Kalmarsund Laboratory, the university centre for water-related research. Senior scientists appointed by the University are actively involved in the GIWA peer-review and steering groups. As a result of the cooperation the University can offer courses and seminars related to GIWA objectives and international water issues.

Development in 2002. The development goals aimed to halve the proportion of people without access to safe drinking water and basic sanitation by the year 2015 (United Nations Millennium Declaration 2000). The WSSD also calls for integrated management of land, water and living resources (WSSD 2002) and, by 2010, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem should be implemented by all countries that are party to the declaration (FAO 2001).

International waters and transboundary issues

The term "international waters", as used for the purposes of the GEF Operational Strategy, includes the oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries, as well as rivers, lakes, groundwater systems, and wetlands with transboundary drainage basins or common borders. The water-related ecosystems associated with these waters are considered integral parts of the systems.

The term "transboundary issues" is used to describe the threats to the aquatic environment linked to globalisation, international trade, demographic changes and technological advancement, threats that are additional to those created through transboundary movement of water. Single country policies and actions are inadequate in order to cope with these challenges and this makes them transboundary in nature.

The international waters area includes numerous international conventions, treaties, and agreements. The architecture of marine agreements is especially complex, and a large number of bilateral and multilateral agreements exist for transboundary freshwater basins. Related conventions and agreements in other areas increase the complexity. These initiatives provide a new opportunity for cooperating nations to link many different programmes and instruments into regional comprehensive approaches to address international waters.

The conceptual framework and objectives

Considering the general decline in the condition of the world's aquatic resources and the internationally recognised need for a globally coherent assessment of transboundary waters, the primary objectives of the GIWA are:

- To provide a prioritising mechanism that allows the GEF to focus their resources so that they are used in the most cost effective manner to achieve significant environmental benefits, at national, regional and global levels; and
- To highlight areas in which governments can develop and implement strategic policies to reduce environmental degradation and improve the management of aquatic resources.

In order to meet these objectives and address some of the current inadequacies in international aquatic resources management, the GIWA has incorporated four essential elements into its design:

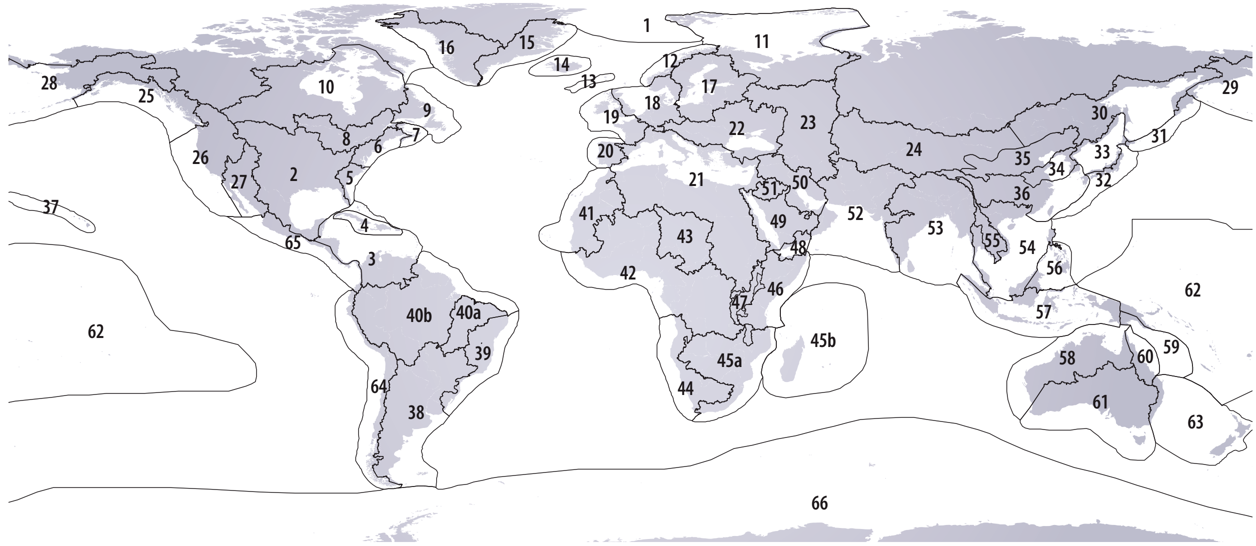
- A broad transboundary approach that generates a truly regional perspective through the incorporation of expertise and existing information from all nations in the region and the assessment of all factors that influence the aquatic resources of the region;
- A drainage basin approach integrating freshwater and marine systems;
- A multidisciplinary approach integrating environmental and socio-economic information and expertise; and
- A coherent assessment that enables global comparison of the results.

The GIWA builds on previous assessments implemented within the GEF International Waters portfolio but has developed and adopted a broader definition of transboundary waters to include factors that influence the quality and quantity of global aquatic resources. For example, due to globalisation and international trade, the market for penaeid shrimps has widened and the prices soared. This, in turn, has encouraged entrepreneurs in South East Asia to expand aquaculture resulting in the large-scale deforestation of mangroves for ponds (Primavera 1997). Within the GIWA, these "non-hydrological" factors constitute as large a transboundary influence as more traditionally recognised problems, such as the construction of dams that regulate the flow of water into a neighbouring country, and are considered equally important. In addition, the GIWA recognises the importance of hydrological units that would not normally be considered transboundary but exert a significant influence on transboundary waters, such as the Yangtze River in China which discharges into the East China Sea (Daoji & Daler 2004) and the Volga River in Russia which is largely responsible for the condition of the Caspian Sea (Barannik et al. 2004). Furthermore, the GIWA is a truly regional assessment that has incorporated data from a wide range of sources and included expert knowledge and information from a wide range of sectors and from each country in the region. Therefore, the transboundary concept adopted by the GIWA extends to include impacts caused by globalisation, international trade, demographic changes and technological advances and recognises the need for international cooperation to address them.

The organisational structure and implementation of the GIWA

The scale of the assessment

Initially, the scope of the GIWA was confined to transboundary waters in areas that included countries eligible to receive funds from the GEF. However, it was recognised that a truly global perspective would only be achieved if industrialised, GEF-ineligible regions of the world were also assessed. Financial resources to assess the GEF-eligible countries were obtained primarily from the GEF (68%), the Swedish International Development Cooperation Agency (Sida) (18%), and the Finnish Department for International Development Cooperation (FINNIDA)



1 Arctic
2 Gulf of Mexico (LME)
3 Caribbean Sea (LME)
4 Caribbean Islands
5 Southeast Shelf (LME)
6 Northeast Shelf (LME)
7 Scotian Shelf (LME)
8 Gulf of St Lawrence
9 Newfoundland Shelf (LME)
10 Baffin Bay, Labrador Sea, Canadian Archipelago
11 Barents Sea (LME)
12 Norwegian Sea (LME)
13 Faroe plateau
14 Iceland Shelf (LME)
15 East Greenland Shelf (LME)
16 West Greenland Shelf (LME)
17 Baltic Sea (LME)
18 North Sea (LME)
19 Celtic-Biscay Shelf (LME)
20 Iberian Coastal (LME)
21 Mediterranean Sea (LME)
22 Black Sea (LME)
23 Caspian Sea
24 Aral Sea
25 Gulf of Alaska (LME)
26 California Current (LME)
27 Gulf of California (LME)
28 East Bering Sea (LME)
29 West Bering Sea (LME)
30 Sea of Okhotsk (LME)
31 Oyashio Current (LME)
32 Kuroshio Current (LME)
33 Sea of Japan/East Sea (LME)
34 Yellow Sea (LME)
35 Bohai Sea
36 East-China Sea (LME)
37 Hawaiian Archipelago (LME)
38 Patagonian Shelf (LME)
39 Brazil Current (LME)
40a Brazilian Northeast (LME)
40b Amazon
41 Canary Current (LME)
42 Guinea Current (LME)
43 Lake Chad
44 Benguela Current (LME)
45a Agulhas Current (LME)
45b Indian Ocean Islands
46 Somali Coastal Current (LME)
47 East African Rift Valley Lakes
48 Gulf of Aden
49 Red Sea (LME)
50 The Gulf
51 Jordan
52 Arabian Sea (LME)
53 Bay of Bengal S.E.
54 South China Sea (LME)
55 Mekong River
56 Sulu-Celebes Sea (LME)
57 Indonesian Seas (LME)
58 North Australian Shelf (LME)
59 Coral Sea Basin
60 Great Barrier Reef (LME)
61 Great Australian Bight
62 Small Island States
63 Tasman Sea
64 Humboldt Current (LME)
65 Eastern Equatorial Pacific
66 Antarctic (LME)

Figure 1 The 66 transboundary regions assessed within the GIWA project.

(10%). Other contributions were made by Kalmar Municipality, the University of Kalmar and the Norwegian Government. The assessment of regions ineligible for GEF funds was conducted by various international and national organisations as in-kind contributions to the GIWA.

In order to be consistent with the transboundary nature of many of the world's aquatic resources and the focus of the GIWA, the geographical units being assessed have been designed according to the watersheds of discrete hydrographic systems rather than political borders (Figure 1). The geographic units of the assessment were determined during the preparatory phase of the project and resulted in the division of the world into 66 regions defined by the entire area of one or more catchments areas that drains into a single designated marine system. These marine systems often correspond to Large Marine Ecosystems (LMEs) (Sherman 1994, IOC 2002).

Large Marine Ecocsystems (LMEs)

Large Marine Ecosystems (LMEs) are regions of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margin of the major current systems. They are relatively large regions on the order of 200 000 km^2 or greater, characterised by distinct: (1) bathymetry, (2) hydrography, (3) productivity, and (4) trophically dependent populations.

The Large Marine Ecosystems strategy is a global effort for the assessment and management of international coastal waters. It developed in direct response to a declaration at the 1992 Rio Summit. As part of the strategy, the World Conservation Union (IUCN) and National Oceanic and Atmospheric Administration (NOAA) have joined in an action program to assist developing countries in planning and implementing an ecosystem-based strategy that is focused on LMEs as the principal assessment and management units for coastal ocean resources. The LME concept is also adopted by GEF that recommends the use of LMEs and their contributing freshwater basins as the geographic area for integrating changes in sectoral economic activities.

Considering the objectives of the GIWA and the elements incorporated into its design, a new methodology for the implementation of the assessment was developed during the initial phase of the project. The methodology focuses on five major environmental concerns which constitute the foundation of the GIWA assessment; Freshwater shortage, Pollution, Habitat and community modification, Overexploitation of fish and other living resources, and Global change. The GIWA methodology is outlined in the following chapter.

The global network

In each of the 66 regions, the assessment is conducted by a team of local experts that is headed by a Focal Point (Figure 2). The Focal Point can be an individual, institution or organisation that has been selected on the basis of their scientific reputation and experience implementing international assessment projects. The Focal Point is responsible for assembling members of the team and ensuring that it has the necessary expertise and experience in a variety of environmental and socio-economic disciplines to successfully conduct the regional assessment. The selection of team members is one of the most critical elements for the success of GIWA and, in order to ensure that the most relevant information is incorporated into the assessment, team members were selected from a wide variety of institutions such as universities, research institutes, government agencies, and the private sector. In addition, in order to ensure that the assessment produces a truly regional perspective, the teams should include representatives from each country that shares the region.

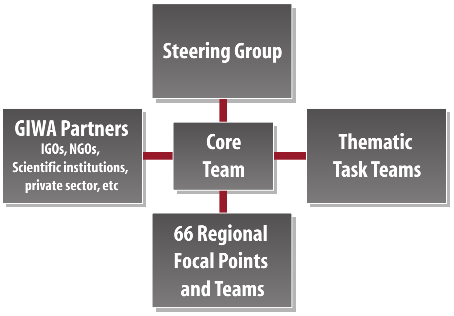


Figure 2 The organisation of the GIWA project.

In total, more than 1 000 experts have contributed to the implementation of the GIWA illustrating that the GIWA is a participatory exercise that relies on regional expertise. This participatory approach is essential because it instils a sense of local ownership of the project, which ensures the credibility of the findings and moreover, it has created a global network of experts and institutions that can collaborate and exchange experiences and expertise to help mitigate the continued degradation of the world's aquatic resources.

GIWA Regional reports

The GIWA was established in response to growing concern among the general public regarding the quality of the world's aquatic resources and the recognition of governments and the international community concerning the absence of a globally coherent international waters assessment. However, because a holistic, region-by-region, assessment of the condition of the world's transboundary water resources had never been undertaken, a methodology guiding the implementation of such an assessment did not exist. Therefore, in order to implement the GIWA, a new methodology that adopted a multidisciplinary, multi-sectoral, multi-national approach was developed and is now available for the implementation of future international assessments of aquatic resources.

UNEP Water Policy and Strategy

The primary goals of the UNEP water policy and strategy are:

(a) Achieving greater global understanding of freshwater, coastal and marine environments by conducting environmental assessments in priority areas;

(b) Raising awareness of the importance and consequences of unsustainable water use;

(c) Supporting the efforts of Governments in the preparation and implementation of integrated management of freshwater systems and their related coastal and marine environments;

(d) Providing support for the preparation of integrated management plans and programmes for aquatic environmental hot spots, based on the assessment results;

(e) Promoting the application by stakeholders of precautionary, preventive and anticipatory approaches.

The GIWA is comprised of a logical sequence of four integrated components. The first stage of the GIWA is called Scaling and is a process by which the geographic area examined in the assessment is defined and all the transboundary waters within that area are identified. Once the geographic scale of the assessment has been defined, the assessment teams conduct a process known as Scoping in which the magnitude of environmental and associated socio-economic impacts of Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, and Global change is assessed in order to identify and prioritise the concerns that require the most urgent intervention. The assessment of these predefined concerns incorporates the best available information and the knowledge and experience of the multidisciplinary, multi-national assessment teams formed in each region. Once the priority concerns have been identified, the root causes of these concerns are identified during the third component of the GIWA, Causal chain analysis. The root causes are determined through a sequential process that identifies, in turn, the most significant immediate causes followed by the economic sectors that are primarily responsible for the immediate causes and finally, the societal root causes. At each stage in the Causal chain analysis, the most significant contributors are identified through an analysis of the best available information which is augmented by the expertise of the assessment team. The final component of the GIWA is the development of Policy options that focus on mitigating the impacts of the root causes identified by the Causal chain analysis.

The results of the GIWA assessment in each region are reported in regional reports that are published by UNEP. These reports are designed to provide a brief physical and socio-economic description of the most important features of the region against which the results of the assessment can be cast. The remaining sections of the report present the results of each stage of the assessment in an easily digestible form. Each regional report is reviewed by at least two independent external reviewers in order to ensure the scientific validity and applicability of each report. The 66 regional assessments of the GIWA will serve UNEP as an essential complement to the UNEP Water Policy and Strategy and UNEP's activities in the hydrosphere.

Global International Waters Assessment

References:

AMAP (1998). Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway.

Barannik, V., Borysova, O. and Stolberg, F. (2004). The Caspian Sea Region: Environmental Change. Ambio, 33:45-51.

Brinson, M.M. and Malvárez, A.I. (2002). Temperate freshwater wetlands: types, status, and threats. Environmental Conservation, 29:115-133.

Daoji, L. and Daler, D. (2004). Ocean Pollution from Land-based Sources: East China Sea, China. Ambio, 33:98-106.

FAO (2001). Reykjavik conference on responsible fisheries in the marine ecosystem. Iceland, 1-4 October 2001.

IOC (2002). IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs). Fourth Session, 8-9 January 2002, Paris, France.

IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. In: Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson, C.A. (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kennish, M.J. (2002). Environmental threats and environmental future of estuaries. Environmental Conservation, 29:78-107.

Myers, R.A. and Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. Nature, 423:280-283.

Primavera, J.H. (1997) Socio-economic impacts of shrimp culture. Aquaculture Research, 28:815-827.

Sherman, K. (1994). Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. Marine Ecology Progress Series, 112:277-301.

United Nations conference on the human environment (1972). Report available on-line at http://www.unep.org

United Nations Millennium Declaration (2000). The Millennium Assembly of the United Nations, New York.

WHO-UNICEF (2002). Global Water Supply and Sanitation Assessment: 2000 Report.

WSSD (2002). World Summit on Sustainable Development. Johannesburg Summit 2002. Key Outcomes of the Summit, UN Department of Public Information, New York.

The GIWA methodology

The specific objectives of the GIWA were to conduct a holistic and globally comparable assessment of the world's transboundary aquatic resources that incorporated both environmental and socio-economic factors and recognised the inextricable links between freshwater and marine environments, in order to enable the GEF to focus their resources and to provide guidance and advice to governments and decision makers. The coalition of all these elements into a single coherent methodology that produces an assessment that achieves each of these objectives had not previously been done and posed a significant challenge.

The integration of each of these elements into the GIWA methodology was achieved through an iterative process guided by a specially convened Methods task team that was comprised of a number of international assessment and water experts. Before the final version of the methodology was adopted, preliminary versions underwent an extensive external peer review and were subjected to preliminary testing in selected regions. Advice obtained from the Methods task team and other international experts and the lessons learnt from preliminary testing were incorporated into the final version that was used to conduct each of the GIWA regional assessments.

Considering the enormous differences between regions in terms of the quality, quantity and availability of data, socio-economic setting and environmental conditions, the achievement of global comparability required an innovative approach. This was facilitated by focusing the assessment on the impacts of five pre-defined concerns namely; Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources and Global change, in transboundary waters. Considering the diverse range of elements encompassed by each concern, assessing the magnitude of the impacts caused by these concerns was facilitated by evaluating the impacts of 22 specific issues that were grouped within these concerns (see Table 1).

The assessment integrates environmental and socio-economic data from each country in the region to determine the severity of the impacts of each of the five concerns and their constituent issues on the entire region. The integration of this information was facilitated by implementing the assessment during two participatory workshops that typically involved 10 to 15 environmental and socio-economic experts from each country in the region. During these workshops, the regional teams performed preliminary analyses based on the collective knowledge and experience of these local experts. The results of these analyses were substantiated with the best available information to be presented in a regional report.

Table 1 Pre-defined GIWA concerns and their constituent issues addressed within the assessment.

Environmental issues	Major concerns
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radionuclide 11. Spills	**II Pollution**
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**
14. Overexploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	**IV Unsustainable exploitation of fish and other living resources**
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**

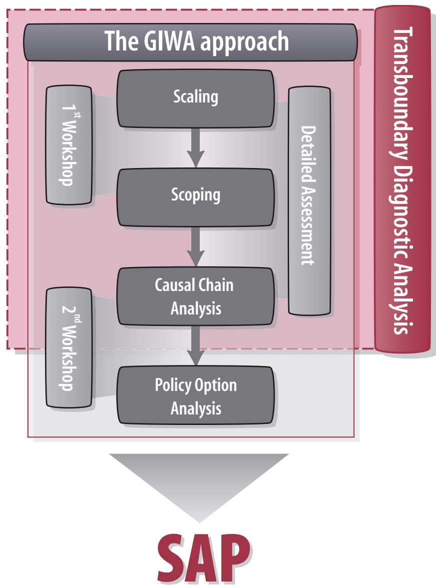


Figure 1 Illustration of the relationship between the GIWA approach and other projects implemented within the GEF International Waters (IW) portfolio.

The GIWA is a logical contiguous process that defines the geographic region to be assessed, identifies and prioritises particularly problems based on the magnitude of their impacts on the environment and human societies in the region, determines the root causes of those problems and, finally, assesses various policy options that addresses those root causes in order to reverse negative trends in the condition of the aquatic environment. These four steps, referred to as Scaling, Scoping, Causal chain analysis and Policy options analysis, are summarised below and are described in their entirety in two volumes: *GIWA Methodology Stage 1: Scaling and Scoping*; and *GIWA Methodology: Detailed Assessment, Causal Chain Analysis and Policy Options Analysis*. Generally, the components of the GIWA methodology are aligned with the framework adopted by the GEF for Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programmes (SAPs) (Figure 1) and assume a broad spectrum of transboundary influences in addition to those associated with the physical movement of water across national borders.

Scaling – Defining the geographic extent of the region

Scaling is the first stage of the assessment and is the process by which the geographic scale of the assessment is defined. In order to facilitate the implementation of the GIWA, the globe was divided during the design phase of the project into 66 contiguous regions. Considering the transboundary nature of many aquatic resources and the transboundary focus of the GIWA, the boundaries of the regions did not comply with political boundaries but were instead, generally defined by a large but discrete drainage basin that also included the coastal marine waters into which the basin discharges. In many cases, the marine areas examined during the assessment coincided with the Large Marine Ecosystems (LMEs) defined by the US National Atmospheric and Oceanographic Administration (NOAA). As a consequence, scaling should be a relatively straight-forward task that involves the inspection of the boundaries that were proposed for the region during the preparatory phase of GIWA to ensure that they are appropriate and that there are no important overlaps or gaps with neighbouring regions. When the proposed boundaries were found to be inadequate, the boundaries of the region were revised according to the recommendations of experts from both within the region and from adjacent regions so as to ensure that any changes did not result in the exclusion of areas from the GIWA. Once the regional boundary was defined, regional teams identified all the transboundary elements of the aquatic environment within the region and determined if these elements could be assessed as a single coherent aquatic system or if there were two or more independent systems that should be assessed separately.

Scoping – Assessing the GIWA concerns

Scoping is an assessment of the severity of environmental and socio-economic impacts caused by each of the five pre-defined GIWA concerns and their constituent issues (Table 1). It is not designed to provide an exhaustive review of water-related problems that exist within each region, but rather it is a mechanism to identify the most urgent problems in the region and prioritise those for remedial actions. The priorities determined by Scoping are therefore one of the main outputs of the GIWA project.

Focusing the assessment on pre-defined concerns and issues ensured the comparability of the results between different regions. In addition, to ensure the long-term applicability of the options that are developed to mitigate these problems, Scoping not only assesses the current impacts of these concerns and issues but also the probable future impacts according to the "most likely scenario" which considered demographic, economic, technological and other relevant changes that will potentially influence the aquatic environment within the region by 2020.

The magnitude of the impacts caused by each issue on the environment and socio-economic indicators was assessed over the entire region using the best available information from a wide range of sources and the knowledge and experience of the each of the experts comprising the regional team. In order to enhance the comparability of the assessment between different regions and remove biases in the assessment caused by different perceptions of and ways to communicate the severity of impacts caused by particular issues, the results were distilled and reported as standardised scores according to the following four point scale:

- 0 = no known impact
- 1 = slight impact
- 2 = moderate impact
- 3 = severe impact

The attributes of each score for each issue were described by a detailed set of pre-defined criteria that were used to guide experts in reporting the results of the assessment. For example, the criterion for assigning a score of 3 to the issue Loss of ecosystems or ecotones is: "*Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.*" The full list of criteria is presented at the end of the chapter, Table 5a-e. Although the scoring inevitably includes an arbitrary component, the use of predefined criteria facilitates comparison of impacts on a global scale and also encouraged consensus of opinion among experts.

Table 2 Example of environmental impact assessment of Freshwater shortage.

Environmental issues	Score	Weight %	Environmental concerns	Weight averaged score
1. Modification of stream flow	1	20	Freshwater shortage	1.50
2. Pollution of existing supplies	2	50		
3. Changes in the water table	1	30		

Table 3 Example of Health impacts assessment linked to one of the GIWA concerns.

Criteria for Health impacts	Raw score	Score	Weight %
Number of people affected	Very small – Very large 0 1 2 3	2	50
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Health impacts		**2**	

The trade-off associated with assessing the impacts of each concern and their constituent issues at the scale of the entire region is that spatial resolution was sometimes low. Although the assessment provides a score indicating the severity of impacts of a particular issue or concern on the entire region, it does not mean that the entire region suffers the impacts of that problem. For example, eutrophication could be identified as a severe problem in a region, but this does not imply that all waters in the region suffer from severe eutrophication. It simply means that when the degree of eutrophication, the size of the area affected, the socio-economic impacts and the number of people affected is considered, the magnitude of the overall impacts meets the criteria defining a severe problem and that a regional action should be initiated in order to mitigate the impacts of the problem.

When each issue has been scored, it was weighted according to the relative contribution it made to the overall environmental impacts of the concern and a weighted average score for each of the five concerns was calculated (Table 2). Of course, if each issue was deemed to make equal contributions, then the score describing the overall impacts of the concern was simply the arithmetic mean of the scores allocated to each issue within the concern. In addition, the socio-economic impacts of each of the five major concerns were assessed for the entire region. The socio-economic impacts were grouped into three categories; Economic impacts, Health impacts and Other social and community impacts (Table 3). For each category, an evaluation of the size, degree and frequency of the impact was performed and, once completed, a weighted average score describing the overall socio-economic impacts of each concern was calculated in the same manner as the overall environmental score.

After all 22 issues and associated socio-economic impacts have been scored, weighted and averaged, the magnitude of likely future changes in the environmental and socio-economic impacts of each of the five concerns on the entire region is assessed according to the most likely scenario which describes the demographic, economic, technological and other relevant changes that might influence the aquatic environment within the region by 2020.

In order to prioritise among GIWA concerns within the region and identify those that will be subjected to causal chain and policy options analysis in the subsequent stages of the GIWA, the present and future scores of the environmental and socio-economic impacts of each concern are tabulated and an overall score calculated. In the example presented in Table 4, the scoping assessment indicated that concern III, Habitat and community modification, was the priority concern in this region. The outcome of this mathematic process was reconciled against the knowledge of experts and the best available information in order to ensure the validity of the conclusion.

In some cases however, this process and the subsequent participatory discussion did not yield consensus among the regional experts regarding the ranking of priorities. As a consequence, further analysis was required. In such cases, expert teams continued by assessing the relative importance of present and potential future impacts and assign weights to each. Afterwards, the teams assign weights indicating the relative contribution made by environmental and socio-economic factors to the overall impacts of the concern. The weighted average score for each concern is then recalculated taking into account

Table 4 Example of comparative environmental and socio-economic impacts of each major concern, presently and likely in year 2020.

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.3	2.3	2.7	2.8	2.6	3.0	1.8	2.2	**2.3**
Pollution	1.5	2.0	2.0	2.3	1.8	2.3	2.0	2.3	**2.0**
Habitat and community modification	2.0	3.0	2.4	3.0	2.4	2.8	2.3	2.7	**2.6**
Unsustainable exploitation of fish and other living resources	1.8	2.2	2.0	2.1	2.0	2.1	2.4	2.5	**2.1**
Global change	0.8	1.0	1.5	1.7	1.5	1.5	1.0	1.0	**1.2**

the relative contributions of both present and future impacts and environmental and socio-economic factors. The outcome of these additional analyses was subjected to further discussion to identify overall priorities for the region.

Finally, the assessment recognises that each of the five GIWA concerns are not discrete but often interact. For example, pollution can destroy aquatic habitats that are essential for fish reproduction which, in turn, can cause declines in fish stocks and subsequent overexploitation. Once teams have ranked each of the concerns and determined the priorities for the region, the links between the concerns are highlighted in order to identify places where strategic interventions could be applied to yield the greatest benefits for the environment and human societies in the region.

Causal chain analysis

Causal Chain Analysis (CCA) traces the cause-effect pathways from the socio-economic and environmental impacts back to their root causes. The GIWA CCA aims to identify the most important causes of each concern prioritised during the scoping assessment in order to direct policy measures at the most appropriate target in order to prevent further degradation of the regional aquatic environment.

Root causes are not always easy to identify because they are often spatially or temporally separated from the actual problems they cause. The GIWA CCA was developed to help identify and understand the root causes of environmental and socio-economic problems in international waters and is conducted by identifying the human activities that cause the problem and then the factors that determine the ways in which these activities are undertaken. However, because there is no universal theory describing how root causes interact to create natural resource management problems and due to the great variation of local circumstances under which the methodology will be applied, the GIWA CCA is not a rigidly structured assessment but should be regarded as a framework to guide the analysis, rather than as a set of detailed instructions. Secondly, in an ideal setting, a causal chain would be produced by a multidisciplinary group of specialists that would statistically examine each successive cause and study its links to the problem and to other causes. However, this approach (even if feasible) would use far more resources and time than those available to GIWA[1]. For this reason, it has been necessary to develop a relatively simple and practical analytical model for gathering information to assemble meaningful causal chains.

Conceptual model

A causal chain is a series of statements that link the causes of a problem with its effects. Recognising the great diversity of local settings and the resulting difficulty in developing broadly applicable policy strategies, the GIWA CCA focuses on a particular system and then only on those issues that were prioritised during the scoping assessment. The starting point of a particular causal chain is one of the issues selected during the Scaling and Scoping stages and its related environmental and socio-economic impacts. The next element in the GIWA chain is the immediate cause; defined as the physical, biological or chemical variable that produces the GIWA issue. For example, for the issue of eutrophication the immediate causes may be, inter alia:

- Enhanced nutrient inputs;
- Increased recycling/mobilisation;
- Trapping of nutrients (e.g. in river impoundments);
- Run-off and stormwaters

Once the relevant immediate cause(s) for the particular system has (have) been identified, the sectors of human activity that contribute most significantly to the immediate cause have to be determined. Assuming that the most important immediate cause in our example had been increased nutrient concentrations, then it is logical that the most likely sources of those nutrients would be the agricultural, urban or industrial sectors. After identifying the sectors that are primarily

[1] This does not mean that the methodology ignores statistical or quantitative studies; as has already been pointed out, the available evidence that justifies the assumption of causal links should be provided in the assessment.

responsible for the immediate causes, the root causes acting on those sectors must be determined. For example, if agriculture was found to be primarily responsible for the increased nutrient concentrations, the root causes could potentially be:

- Economic (e.g. subsidies to fertilisers and agricultural products);
- Legal (e.g. inadequate regulation);
- Failures in governance (e.g. poor enforcement); or
- Technology or knowledge related (e.g. lack of affordable substitutes for fertilisers or lack of knowledge as to their application).

Once the most relevant root causes have been identified, an explanation, which includes available data and information, of how they are responsible for the primary environmental and socio-economic problems in the region should be provided.

Policy option analysis

Despite considerable effort of many Governments and other organisations to address transboundary water problems, the evidence indicates that there is still much to be done in this endeavour. An important characteristic of GIWA's Policy Option Analysis (POA) is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overexploitation of living resources and habitat destruction are very complex phenomena. Policy options that are grounded on a better understanding of these phenomena will contribute to create more effective societal responses to the extremely complex water related transboundary problems. The core of POA in the assessment consists of two tasks:

Construct policy options

Policy options are simply different courses of action, which are not always mutually exclusive, to solve or mitigate environmental and socio-economic problems in the region. Although a multitude of different policy options could be constructed to address each root cause identified in the CCA, only those few policy options that have the greatest likelihood of success were analysed in the GIWA.

Select and apply the criteria on which the policy options will be evaluated

Although there are many criteria that could be used to evaluate any policy option, GIWA focuses on:

- Effectiveness (certainty of result)
- Efficiency (maximisation of net benefits)
- Equity (fairness of distributional impacts)
- Practical criteria (political acceptability, implementation feasibility).

The policy options recommended by the GIWA are only contributions to the larger policy process and, as such, the GIWA methodology developed to test the performance of various options under the different circumstances has been kept simple and broadly applicable.

Global International Waters Assessment

Table 5a: Scoring criteria for environmental impacts of Freshwater shortage

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 1: Modification of stream flow "An increase or decrease in the discharge of streams and rivers as a result of human interventions on a local/ regional scale (see Issue 19 for flow alterations resulting from global change) over the last 3-4 decades."	■ No evidence of modification of stream flow.	■ There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin > 40 000 km²); or ■ There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or ■ There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of estuarine salt wedge or mixing zone; or ■ Change in the occurrence of exceptional discharges (e.g. due to upstream damming.	■ Significant downward or upward trend (more than 20% of the long term mean) in annual discharges in a major river or tributary draining a basin of >250 000 km²; or ■ Loss of >20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or ■ Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or ■ Significant saline intrusion into previously freshwater rivers or lagoons.	■ Annual discharge of a river altered by more than 50% of long term mean; or ■ Loss of >50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or ■ Significant increased siltation or erosion due to changing in flow regime (other than normal fluctuations in flood plain rivers); or ■ Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing.
Issue 2: Pollution of existing supplies "Pollution of surface and ground fresh waters supplies as a result of point or diffuse sources"	■ No evidence of pollution of surface and ground waters.	■ Any monitored water in the region does not meet WHO or national drinking water criteria, other than for natural reasons; or ■ There have been reports of one or more fish kills in the system due to pollution within the past five years.	■ Water supplies does not meet WHO or national drinking water standards in more than 30% of the region; or ■ There are one or more reports of fish kills due to pollution in any river draining a basin of >250 000 km².	■ River draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion ■ Severe pollution of other sources of freshwater (e.g. groundwater)
Issue 3: Changes in the water table "Changes in aquifers as a direct or indirect consequence of human activity"	■ No evidence that abstraction of water from aquifers exceeds natural replenishment.	■ Several wells have been deepened because of excessive aquifer draw-down; or ■ Several springs have dried up; or ■ Several wells show some salinisation.	■ Clear evidence of declining base flow in rivers in semi-arid areas; or ■ Loss of plant species in the past decade, that depend on the presence of ground water; or ■ Wells have been deepened over areas of hundreds of km²;or ■ Salinisation over significant areas of the region.	■ Aquifers are suffering salinisation over regional scale; or ■ Perennial springs have dried up over regionally significant areas; or ■ Some aquifers have become exhausted

Table 5b: Scoring criteria for environmental impacts of Pollution

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 4: Microbiological pollution "The adverse effects of microbial constituents of human sewage released to water bodies."	■ Normal incidence of bacterial related gastroenteric disorders in fisheries product consumers and no fisheries closures or advisories.	■ There is minor increase in incidence of bacterial related gastroenteric disorders in fisheries product consumers but no fisheries closures or advisories.	■ Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries product consumers; or ■ There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.	■ There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or ■ There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.
Issue 5: Eutrophication "Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes."	■ No visible effects on the abundance and distributions of natural living resource distributions in the area; and ■ No increased frequency of hypoxia[1] or fish mortality events or harmful algal blooms associated with enhanced primary production; and ■ No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and ■ No evident abnormality in the frequency of algal blooms.	■ Increased abundance of epiphytic algae; or ■ A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets; or ■ Measurable shallowing of the depth range of macrophytes.	■ Increased filamentous algal production resulting in algal mats; or ■ Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.	■ High frequency (>1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms; or ■ Significant changes in the littoral community; or ■ Presence of hydrogen sulphide in historically well oxygenated areas.

Issue 6: Chemical pollution "The adverse effects of chemical contaminants released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic or persistent or bioaccumulating."	■ No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and ■ No fisheries closures or advisories due to chemical pollution; and ■ No incidence of fisheries product tainting; and ■ No unusual fish mortality events. If there is no available data use the following criteria: ■ No use of pesticides; and ■ No sources of dioxins and furans; and ■ No regional use of PCBs; and ■ No bleached kraft pulp mills using chlorine bleaching; and ■ No use or sources of other contaminants.	■ Some chemical contaminants are detectable but below threshold limits defined for the country or region; or ■ Restricted area advisories regarding chemical contamination of fisheries products. If there is no available data use the following criteria: ■ Some use of pesticides in small areas; or ■ Presence of small sources of dioxins or furans (e.g., small incineration plants or bleached kraft/pulp mills using chlorine); or ■ Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or ■ Presence of other contaminants.	■ Some chemical contaminants are above threshold limits defined for the country or region; or ■ Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures; or ■ High mortalities of aquatic species near outfalls. If there is no available data use the following criteria: ■ Large-scale use of pesticides in agriculture and forestry; or ■ Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or ■ Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or ■ Presence of considerable quantities of other contaminants.	■ Chemical contaminants are above threshold limits defined for the country or region; and ■ Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by area closures of fisheries; or ■ Large-scale mortalities of aquatic species. If there is no available data use the following criteria: ■ Indications of health effects resulting from use of pesticides; or ■ Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or ■ Known contamination of the environment or foodstuffs by PCBs; or ■ Known contamination of the environment or foodstuffs by other contaminants.
Issue 7: Suspended solids "The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities"	■ No visible reduction in water transparency; and ■ No evidence of turbidity plumes or increased siltation; and ■ No evidence of progressive riverbank, beach, other coastal or deltaic erosion.	■ Evidently increased or reduced turbidity in streams and/or receiving riverine and marine environments but without major changes in associated sedimentation or erosion rates, mortality or diversity of flora and fauna; or ■ Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.	■ Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or ■ Extensive evidence of changes in sedimentation or erosion rates; or ■ Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.	■ Major changes in turbidity over wide or ecologically significant areas resulting in markedly changed biodiversity or mortality in benthic species due to excessive sedimentation with or without concomitant changes in the nature of deposited sediments (i.e., grain-size composition/redox); or ■ Major change in pelagic biodiversity or mortality due to excessive turbidity.
Issue 8: Solid wastes "Adverse effects associated with the introduction of solid waste materials into water bodies or their environs."	■ No noticeable interference with trawling activities; and ■ No noticeable interference with the recreational use of beaches due to litter; and ■ No reported entanglement of aquatic organisms with debris.	■ Some evidence of marine-derived litter on beaches; or ■ Occasional recovery of solid wastes through trawling activities; but ■ Without noticeable interference with trawling and recreational activities in coastal areas.	■ Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or ■ High frequencies of benthic litter recovery and interference with trawling activities; or ■ Frequent reports of entanglement/suffocation of species by litter.	■ Incidence of litter on beaches sufficient to deter the public from recreational activities; or ■ Trawling activities untenable because of benthic litter and gear entanglement; or ■ Widespread entanglement and/or suffocation of aquatic species by litter.
Issue 9: Thermal "The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body."	■ No thermal discharges or evidence of thermal effluent effects.	■ Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.	■ Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or ■ Evidence of reduced migration of species due to thermal plume.	■ Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or ■ Marked reduction in the migration of species due to thermal plumes.
Issue 10: Radionuclide "The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities."	■ No radionuclide discharges or nuclear activities in the region.	■ Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.	■ Minor releases or fallout of radionuclides under poorly regulated conditions that do not provide an adequate basis for public health assurance or the protection of aquatic organisms but without situations or levels likely to warrant large scale intervention by a national or international authority.	■ Substantial releases or fallout of radionuclides resulting in excessive exposures to humans or animals in relation to those recommended under the Basic Safety Standards; or ■ Some indication of situations or exposures warranting intervention by a national or international authority.
Issue 11: Spills "The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities."	■ No evidence of present or previous spills of hazardous material; or ■ No evidence of increased aquatic or avian species mortality due to spills.	■ Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects one aquatic or avian species.	■ Evidence of widespread contamination by hazardous or aesthetically displeasing materials assumed to be from spillage (e.g. oil slicks) but with limited evidence of widespread adverse effects on resources or amenities; or ■ Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.	■ Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or ■ Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.

Table 5c: Scoring criteria for environmental impacts of Habitat and community modification

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 12: Loss of ecosystems or ecotones "The complete destruction of aquatic habitats. For the purpose of GIWA methodology, recent loss will be measured as a loss of pre-defined habitats over the last 2-3 decades."	■ There is no evidence of loss of ecosystems or habitats.	■ There are indications of fragmentation of at least one of the habitats.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by up to 30 % during the last 2-3 decades.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.
Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition "Modification of pre-defined habitats in terms of extinction of native species, occurrence of introduced species and changing in ecosystem function and services over the last 2-3 decades."	■ No evidence of change in species complement due to species extinction or introduction; and ■ No changing in ecosystem function and services.	■ Evidence of change in species complement due to species extinction or introduction	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure; and ■ Evidence of change in ecosystem services[2].

[2] Constanza, R. et al. (1997). The value of the world ecosystem services and natural capital, Nature 387:253-260.

Table 5d: Scoring criteria for environmental impacts of Unsustainable exploitation of fish and other living resources

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 14: Overexploitation "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	■ No harvesting exists catching fish (with commercial gear for sale or subsistence).	■ Commercial harvesting exists but there is no evidence of over-exploitation.	■ One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits.	■ More than one stock is exploited beyond MSY or is outside safe biological limits.
Issue 15: Excessive by-catch and discards "By-catch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refers to dead fish or other animals that are returned to the sea."	■ Current harvesting practices show no evidence of excessive by-catch and/or discards.	■ Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.	■ 30-60% of the fisheries yield consists of by-catch and/or discards.	■ Over 60% of the fisheries yield is by-catch and/or discards; or ■ Noticeable incidence of capture of endangered species.
Issue 16: Destructive fishing practices "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	■ No evidence of habitat destruction due to fisheries practices.	■ Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or ■ Trawling of any one area of the seabed is occurring less than once per year.	■ Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or ■ Trawling of any one area of the seabed is occurring 1-10 times per year; or ■ Incidental use of explosives or poisons for fishing.	■ Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or ■ Trawling of any one area of the seabed is occurring more than 10 times per year; or ■ Widespread use of explosives or poisons for fishing.
Issue 17: Decreased viability of stocks through contamination and disease "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	■ No evidence of increased incidence of fish or shellfish diseases.	■ Increased reports of diseases without major impacts on the stock.	■ Declining populations of one or more species as a result of diseases or contamination.	■ Collapse of stocks as a result of diseases or contamination.
Issue 18: Impact on biological and genetic diversity "Changes in genetic and species diversity of aquatic environments resulting from the introduction of alien or genetically modified species as an intentional or unintentional result of human activities including aquaculture and restocking."	■ No evidence of deliberate or accidental introductions of alien species; and ■ No evidence of deliberate or accidental introductions of alien stocks; and ■ No evidence of deliberate or accidental introductions of genetically modified species.	■ Alien species introduced intentionally or accidentally without major changes in the community structure; or ■ Alien stocks introduced intentionally or accidentally without major changes in the community structure; or ■ Genetically modified species introduced intentionally or accidentally without major changes in the community structure.	■ Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or ■ Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).	■ Extinction of native species or local stocks as a result of introductions (intentional or accidental); or ■ Major changes (>20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).

Table 5e: Scoring criteria for environmental impacts of Global change

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 19: Changes in hydrological cycle and ocean circulation "Changes in the local/regional water balance and changes in ocean and coastal circulation or current regime over the last 2-3 decades arising from the wider problem of global change including ENSO."	■ No evidence of changes in hydrological cycle and ocean/coastal current due to global change.	■ Change in hydrological cycles due to global change causing changes in the distribution and density of riparian terrestrial or aquatic plants without influencing overall levels of productivity; or ■ Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.	■ Significant trend in changing terrestrial or sea ice cover (by comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or ■ Extreme events such as flood and drought are increasing; or ■ Aquatic productivity has been altered as a result of global phenomena such as ENSO events.	■ Loss of an entire habitat through desiccation or submergence as a result of global change; or ■ Change in the tree or lichen lines; or ■ Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or ■ Changing in ocean or coastal currents or upwelling regimes such that plant or animal populations are unable to recover to their historical or stable levels; or ■ Significant changes in thermohaline circulation.
Issue 20: Sea level change "Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change."	■ No evidence of sea level change.	■ Some evidences of sea level change without major loss of populations of organisms.	■ Changed pattern of coastal erosion due to sea level rise has became evident; or ■ Increase in coastal flooding events partly attributed to sea-level rise or changing prevailing atmospheric forcing such as atmospheric pressure or wind field (other than storm surges).	■ Major loss of coastal land areas due to sea-level change or sea-level induced erosion; or ■ Major loss of coastal or intertidal populations due to sea-level change or sea level induced erosion.
Issue 21: Increased UV-B radiation as a result of ozone depletion "Increased UV-B flux as a result polar ozone depletion over the last 2-3 decades."	■ No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.	■ Some measurable effects of UV/B radiation on behavior or appearance of some aquatic species without affecting the viability of the population.	■ Aquatic community structure is measurably altered as a consequence of UV/B radiation; or ■ One or more aquatic populations are declining.	■ Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.
Issue 22: Changes in ocean CO_2 source/sink function "Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO_2 as a direct or indirect consequence of global change over the last 2-3 decades."	■ No measurable or assessed changes in CO_2 source/sink function of aquatic system.	■ Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO_2.	■ Some evidences that the impacts of global change have altered the source/sink function for CO_2 of aquatic systems in the region by at least 10%.	■ Evidences that the changes in source/sink function of the aquatic systems in the region are sufficient to cause measurable change in global CO_2 balance.

GIWA

The Global International Waters Assessment (GIWA) is a holistic, globally comparable assessment of all the world's transboundary waters that recognises the inextricable links between freshwater and coastal marine environment and integrates environmental and socio-economic information to determine the impacts of a broad suite of influences on the world's aquatic environment.

Broad Transboundary Approach

The GIWA not only assesses the problems caused by human activities manifested by the physical movement of transboundary waters, but also the impacts of other non-hydrological influences that determine how humans use transboundary waters.

Regional Assessment - Global Perspective

The GIWA provides a global perspective of the world's transboundary waters by assessing 66 regions that encompass all major drainage basins and adjacent large marine ecosystems. The GIWA Assessment of each region incorporates information and expertise from all countries sharing the transboundary water resources.

Global Comparability

In each region, the assessment focuses on 5 broad concerns that are comprised of 22 specific water related issues.

Integration of Information and Ecosystems

The GIWA recognises the inextricable links between freshwater and coastal marine environment and assesses them together as one integrated unit.

The GIWA recognises that the integration of socio-economic and environmental information and expertise is essential to obtain a holistic picture of the interactions between the environmental and societal aspects of transboundary waters.

Priorities, Root Causes and Options for the Future

The GIWA indicates priority concerns in each region, determines their societal root causes and develops options to mitigate the impacts of those concerns in the future.

This Report

This report presents the results of the GIWA assessment of the marine waters around The Faroes – one of the important national and international fishing grounds in the North Atlantic. Toxic contamination of the tissue of marine fish, birds and mammals is causing human health problems, but may also affect the economically important fisheries sector. The cause is long-distance transport of pollutants by ocean currents and air from industrial areas in Europe, North America and Asia. Improved international cooperation is needed to address this issue. The marine resources are also threatened by unsustainable exploitation, in particular because the fish stocks are stressed by climatic and oceanographic variability. The need for efficient governance and management frameworks is acknowledged, but lack of scientific documentation impede the actual implementation. Comprehensive international research efforts, supporting the Faroe research community, is needed.

UNEP

GEF

HÖGSKOLAN KALMAR UNIVERSITY