MAP 1
High seas deep-sea fishing grounds in the North West Atlantic Ocean

North West Atlantic Ocean

FAO Statistical Area 21

GEOGRAPHIC DESCRIPTION OF THE REGION

The coastal states bordering the North West Atlantic (FAO Statistical Area 21) are Canada and the United States of America on the western side, and Greenland on the eastern side (see Map 1). South of Newfoundland, the archipelago of Saint-Pierre et Miquelon is under French jurisdiction. In the north, the area includes Baffin Bay, separated from the Arctic Ocean by the Ellesmere and Devon Islands. The southern limit between the North West Atlantic and the Western Central Atlantic (FAO Statistical Area 31) is the 35°N latitude. South of Greenland, the 42°W meridian separates the North West Atlantic from the North East Atlantic (FAO Statistical Area 27).

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

The Northwest Atlantic Fisheries Organization (NAFO) is the regional fisheries management organization (RFMO) with a management mandate in this area. It was created in 1979 to replace the International Commission for the Northwest Atlantic Fisheries (ICNAF), after the extension of coastal states' jurisdiction to 200 nautical miles. Its mandate extends to all fishery resources of the Convention Area (see Map 1), except for those managed by other RFMOs, e.g. salmon (North Atlantic Salmon Conservation Organization [NASCO]), tunas and marlins (International Commission for the Conservation of Atlantic Tunas [ICCAT]), whales (North Atlantic Marine Mammal Commission [NAMMCO] and sedentary species of the continental shelf, over which, under the 1982 UN Law of the Sea Convention, Canada has sovereign rights for the purpose of exploitation (Standing Senate Committee on Fisheries and Oceans, Canada, 2007). The NAFO Convention Area encompasses a very large portion of the North West Atlantic Ocean, including the exclusive economic zones (EEZs) of coastal states, but its management mandate applies only to the areas straddling and outside the EEZs in the NAFO Regulatory Area (NRA) (see Map 1).

The NAFO Convention states that its overall objective is to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources. In 2007, NAFO adopted a revised objective that widened its mandate to include a greater focus on managing with an ecosystem approach to fisheries. There are currently 12 members of NAFO: Canada, Cuba, Denmark (in respect of Faroe Islands and Greenland), the European Union, France (in respect of Saint-Pierre et Miquelon), Iceland, Japan, the Republic of Korea, Norway, the Russian Federation, Ukraine and the United States of America.

Management and conservation measures implemented by the Fisheries Commission of NAFO currently cover 11 species (Atlantic cod [*Gadus morhua*], Atlantic redfishes nei [*Sebastes* spp.], American plaice [*Hippoglossoides platessoides*], yellowtail flounder [*Limanda ferruginea*], witch flounder [*Glyptocephalus cynoglossus*], white hake [*Urophycis tenuis*], capelin [*Mallotus villosus*], skates [*Raja* spp.], Greenland halibut [*Reinhardtius hippoglossoides*], Northern shortfin squid [*Illex illecebrosus*] and Northern shrimp [*Pandalus borealis*]), and only apply to stocks of these species present in or straddling the NRA.

The NAFO Fisheries Commission establishes Conservation and Enforcement Measures (CEM) including management and control regulations, and a monitoring scheme, as well as inspection and surveillance measures. The NAFO Scientific Council is made up of scientists from member countries. It formulates the scientific advice based on the work performed in its four Standing Committees: STACFIS (Standing Committee on Fisheries Science), which carries out fish stock assessment; STACREC (Standing Committee on Research Coordination), which keeps track of and coordinates the various national research activities; STACPUB (Standing Committee on Publications), which is responsible for Scientific Council publications; and STACFEN (Standing Committee on Fisheries Environment), which provides information on the environment. A further standing committee conducts an annual review of compliance; the Standing Committee on International Control (STACTIC).

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Directed fisheries for deep-sea species were initiated after the Second World War, with the collapse of the traditional cod fishery and other groundfish fisheries on the shelf and continental slopes. A redfish fishery was developed by the former Union of Soviet Socialist Republics (USSR) on the southern part of the Grand Banks in the 1960s. In the late 1960s, a fishery for roundnose grenadier (*Coryphaenoides rupestris*) (most abundant between 600 and 800 metres [m]) was also developed by the former USSR. Landings rapidly peaked in 1971 at over 80 000 tonnes and then declined as quickly. Since 1980, landings have remained below 10 000 tonnes and in 1997 dropped to only a few hundred tonnes (Koslow *et al*., 2000).

A few large offshore Canadian vessels began fishing for Northern shrimp in the late 1970s to early 1980s. The greatly reduced biomass of cod, an important predator of Northern shrimp, is believed to have led to a large increase in Northern shrimp biomass in the mid-1990s and Northern shrimp catches increased substantially. The fishery for Northern shrimp on the Flemish Cap was initiated in 1993 by two Canadian vessels that were granted exploratory permits to fish the species in NAFO Division 3M. (Parsons *et al*., 1998)

A small Canadian fishery for Greenland halibut has existed at least since the 1970s. In 1991, European vessels began fishing for Greenland halibut in the NAFO Regulatory Area. These vessels had to leave the fishing grounds they were previously exploiting in the South East Atlantic because of the extension of Namibia's jurisdiction to 200 nautical miles in 1990.

Exploration of the Corner Rise Seamounts by trawlers from the former USSR began in 1976–1977. Catches in 1976 were more than 10 000 tonnes, composed of mainly splendid alfonsino (*Beryx splendens*), black scabbardfish (*Aphanopus carbo*) and wreckfish (*Polyprion americanus*). Catches declined in the following year to 800 tonnes. Commercial fishing resumed again ten years later in 1987 (one to four trawlers, 2 300 tonnes) and then ceased until the mid-1990s. Since then, fishing on these seamounts has been sporadic with limited catch. The total catch of the former USSR commercial and non-commercial fleet on the Corner Rise Seamounts between 1976 and 1996 has been estimated at 19 000 tonnes (Vinnichenko, 1997).

Current fisheries

Currently, the main deep-sea demersal fisheries take place on the continental slope of the Grand Banks in international waters – the so-called "nose" and "tail" of the Grand Banks – and on the Flemish Cap in depths ranging from 200 to 1 900 m. Some limited bottom fishing also occurs on seamount clusters in the high seas of the region.

The principal target species (see Figure 1) in the high seas bottom fisheries of the North West Atlantic are the Northern shrimp, Greenland halibut, Atlantic redfishes

nei and skates. Of these, the targeted skate fishery takes place primarily on the continental shelf on the tail of the Grand Banks, but skates have a wide depth range and often are caught as bycatch in deeper water fisheries. Atlantic cod and flat fishes such as witch flounder, American plaice, Atlantic halibut (*Hippoglossus hippoglossus*) and yellowtail flounder are bycatch species in the high seas bottom fisheries of the North West Atlantic. Yellowtail flounder is targeted by the Canadians and French (Saint-Pierre et Miquelon), but this fishery takes place in shallow waters under national jurisdictions in NAFO Divisions 3N and 3O, rarely deeper than 100 m.

Other species of commercial value taken in these deep-sea demersal fisheries include roundnose grenadier, roughhead grenadier (*Macrourus berglax*), wolffishes (*Anarhichas* spp.) and American angler (anglerfish) (*Lophius americanus*). In addition, there were sporadic targeted fisheries for splendid alfonsino on seamounts with bycatch of black cardinal fish (*Epigonus telescopus*), black scabbardfish and wreckfish, although the catch in these fisheries was small compared with the fisheries on the Grand Banks and the Flemish Cap. Northern shortfin squid (*Illex illecebrosus*) is considered to comprise a unit stock throughout its range in the North West Atlantic Ocean, from Newfoundland to Florida. It is mainly targeted inside the EEZ of the United States of America, but a small portion of the fishery takes place on the edge of the Grand Banks.

TABLE 1
Main commercial species landed by high seas deep-sea fisheries in the North West Atlantic

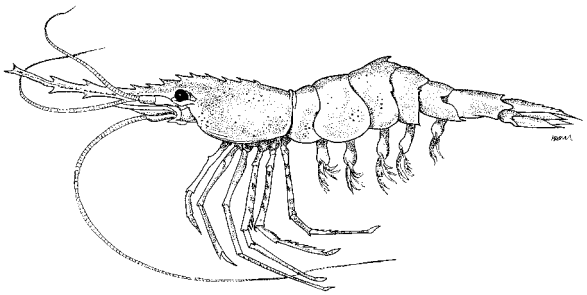
Common name	Scientific name
Main target species (Grand Banks and the Flemish Cap)	
Northern shrimp	*Pandalus borealis*
Greenland halibut	*Reinhardtius hippoglossoides*
Redfish	
Acadian redfish	*Sebastes fasciatus*
Beaked redfish (deep-sea redfish)	*Sebastes mentella*
Golden redfish	*Sebastes marinus*
Skates	*Raja* spp.
Starry ray (thorny skate)	*Raja radiata (Amblyraja radiata)*
Spinetail ray	*Bathyraja spinicauda*
Arctic skate	*Raja hyperborea*
Other species (Grand Banks and the Flemish Cap)	
Atlantic cod	*Gadus morhua*
Witch flounder	*Glyptocephalus cynoglossus*
American plaice	*Hippoglossoides platessoides*
Atlantic halibut	*Hippoglossus hippoglossus*
Yellowtail flounder	*Limanda ferruginea*
Roundnose grenadier	*Coryphaenoides rupestris*
Roughhead grenadier	*Macrourus berglax*
Wolffishes	*Anarhichas* spp.
American angler (anglerfish)	*Lophius americanus*
White hake	*Urophycis tenuis*
Northern shortfin squid	*Illex illecebrosus*
Typical seamounts species	
Splendid alfonsino	*Beryx splendens*
Wreckfish	*Polyprion americanus*
Black cardinal fish	*Epigonus telescopus*
Black scabbardfish	*Aphanopus carbo*

Table 1 lists the common and scientific names of the main species of commercial value taken in deep-sea fisheries in this region, either as targeted catch or bycatch. The table lists both true deep-sea species and those whose depth distribution extends into shallower waters. Beaked redfish (deep-sea redfish) (*Sebastes mentella*) and Acadian redfish (*Sebastes fasciatus*) have similar external characteristics, and are in general collectively reported as redfish (Ávila *et al.*, 2007). Wolffishes include Atlantic wolffish (*Anarhichas lupus*) and spotted wolffish (*Anarhichas minor*) (NAFO, 2007a). Skate species are mostly starry ray (thorny skate) (*Raja radiata*) and also to a lesser extent spinetail ray (*Bathyraja spinicauda*) and Arctic skate (*Raja hyperborea*) (González *et al.*, 2007).

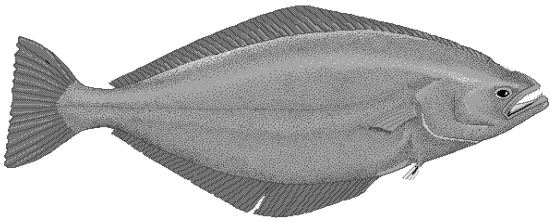
Countries known to have fleets currently participating in deep-sea fisheries in the high seas of the North West Atlantic are Canada, Estonia, Faroe Islands, Greenland,

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the North West Atlantic

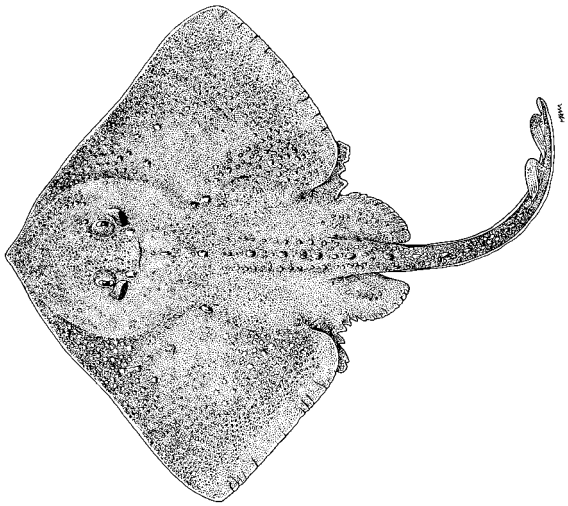
Northern shrimp (*Pandalus borealis*)



Greenland halibut (*Reinhardtius hippoglossoides*)



Starry ray (*Raja radiata*)



Source: FAO.

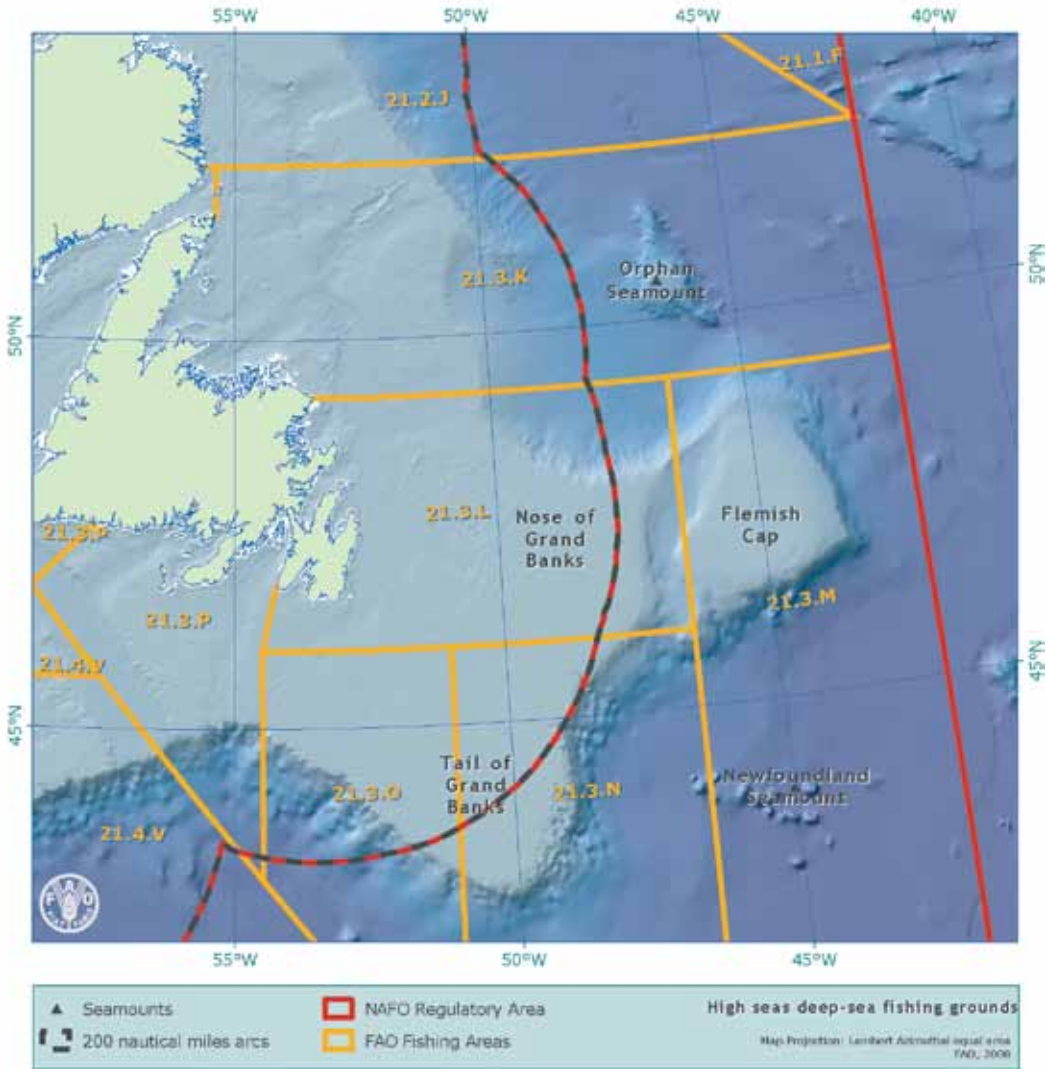
Iceland, Japan, Latvia, Lithuania, Norway, Poland, Portugal, the Russian Federation, Spain and Ukraine. The Russian Federation, Spain and Estonia take the majority of the catch. A brief description of fisheries targeting deep-sea demersal species in areas that are either straddling or lie exclusively in the high seas, is presented in the following sections by main fishing ground and NAFO subregion. Through the analysis of current management regimes, responses to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A) and consultations with NAFO, it is concluded for the purposes of this review that all non-Canadian catches after the beginning of the 1990s can be considered to have been taken exclusively in the high seas. Similarly all Canadian catches can be considered to have been taken within the Canadian EEZ, although a very small percentage may have been taken outside the Canadian EEZ.

Grand Banks of Newfoundland and the Flemish Cap

The main high seas fishing grounds for deep-sea demersal species in the North West Atlantic are on the slopes of the Grand Banks of Newfoundland in NAFO Divisions 3L, 3N and 3O and on those of the Flemish Cap in NAFO Division 3M (Map 2). Most of the Grand Banks is located inside the Canadian EEZ, but the northeastern and the southeastern parts, respectively known as the "nose" and the "tail" of the Grand Banks, are in international waters. The Flemish Cap is entirely in the high seas, about 120 nautical miles east of Canada's 200 miles limit.

Bottom trawl fishery targeting Northern shrimp (nose of the Grand Banks and the Flemish Cap; NAFO Divisions 3L and 3M)

The high seas shrimp fishing grounds are distributed around the Flemish Cap in NAFO Division 3M and on the slopes of the Grand Banks, mainly in Division 3L. The main part of the shrimp stock (between 75 and 80 percent) is exploited by Canadian vessels within the EEZ (Orr *et al.*, 2005). Fishing grounds are distributed between 150 and 600 m depth, although some fishing operations might be performed deeper down



MAP 2
Deep-sea fishing grounds of the Grand Banks and the Flemish Cap

to at least 900 millimetres (m) (Casas, 2007). Some of the larger vessels tow two trawls simultaneously (Parsons *et al*., 1998).

Bycatch consists of redfish and, to a lesser extent, species such as Greenland halibut, skates, wolffish, roundnose grenadier or hake. Gear requirements to reduce bycatch include a minimum mesh size of 40 mm and the use of sorting grids.

Since 1993, the number of vessels involved in the NRA shrimp fishery has ranged from 40 to 110, from as many as 19 nations (Skúladóttir, 2006). Both catch and effort have decreased markedly from 2004 to 2006 (see Table 2). Supplementary information from the fishery suggests that economic considerations (price of fuel and market prices for shrimp) may be affecting participation (NAFO, 2006).

Table 2 illustrates combined effort and total catch of all countries participating in the high seas fishery for Northern shrimp in both Divisions 3M and 3L. Canada's participation in the shrimp fishery is mostly inside Canada's EEZ. The data reported in Table 2 only refer to their participation on the high seas fishing ground. NAFO reported two days of fishing by two Canadian trawlers in 2006. In its answer to the FAO Questionnaire, Canada also reported the activity of one shrimp trawler in 2003 (27 fishing days, 132 tonnes). Greenland also has a sizeable Northern shrimp fishery taking place in areas under national jurisdiction. In recent years (2004–2006), Estonia has been the main flag state involved in the Northern shrimp fishery. The fisheries for Northern

TABLE 2
Reported catches of Northern shrimp in the high seas by country in NAFO Divisions 3M and 3L for the period 2004–2006

Flag state	Number of vessels[1]			Number of fishing days[1]			Total catch (tonnes)[2]					
Year	2004	2005	2006	2004	2005	2006	2004		2005		2006	
							3M	3L	3M	3L	3M	3L
Canada	0	0	1	0	0	2	0	0	0	0	10	0
Cuba	0	0	0	0	0	0	969		964	136	1 126	239
Estonia	9	7	4	1 740	1 511	638	13 444	144	12 009	281	5 651	485
Faroe Islands	6	6	4	680	535	260	4 952	1 050	2 457	1 055	1 150	1 809
France*	/	/	/	/	/	/	423	106	487	147	183	245
Greenland	1	1[3] – 2	2[3] – 4	7	24	73	0	294	10	302	793	451
Iceland	1	1	1	308	262	156	3 567	104	4 014	140	2 099	85
Latvia	4	2	1	580	320	177	3 059	143	2 112	144	1 330	244
Lithuania	3	2	1	662	384	172	4 802	144	3 652	216	1 246	486
Norway	7	2	1	999	31	34	11 738		223	74	461	245
Poland	1	1	1	75	41	36	1 158	144	458	129	224	245
Portugal	0	0	0	0	0	0	50	0	0	0	0	0
Russian Fed.	/	/	/	/	/	0	654	141	266	146	46	248
Spain	/	4	2 – 7[4]	/	450	138	1 134	140	1 384	154	877	251
Ukraine	1	0	1	49	0	90	315	145	0	0	282	121
United States of America	0	0	0	/	/	/	952	0	1 235	136	1 258	245
Total	33	26–27	19–26	5 100	3 558	1 776	47 217	2 555	29 271	3 060	16 736	5 399
							49 772		32 331		22 135	

* Saint-Pierre et Miquelon.
/ = Unknown.
Sources:
[1] Response from NAFO to FAO Questionnaire, except where otherwise noted.
[2] NAFO, 2008a.
[3] Siegstad, 2004; 2005.
[4] Casas, 2007.
Note: some countries fish under charter agreements/arrangements which explains some of the discrepancies between the lack of vessels fishing and reported catch.

shrimp in NAFO Divisions 3LNO and in Division 3M are managed separately. In 2006, the total allowable catch (TAC) was 22 000 tonnes with the Canadian 83 percent allocation to be fished within the Canadian EEZ and the remaining 17 percent of the TAC allocated to all other contracting parties to be fished in the NRA (NAFO, 2008c). In 2004, Denmark, in respect of Faroe Islands and Greenland, lodged a formal objection to the TACs for shrimp in NAFO Division 3L and set unilateral quotas of 1 344 tonnes of shrimp in NRA 3L in 2004 and 2005, and 2 274 tonnes for 2006. In NAFO Division 3M, a number of fishing days is allocated to each fishing nation. For the 2004–2006 period covered by this report, the United States of America, Cuba, the Russian Federation, France and Portugal had a quota for shrimp in the NAFO Regulatory Area. Catches have been reported by these countries, but no information concerning the number of vessels was found. Some charter arrangements might explain why these countries report catch but have no fishing vessels involved in this fishery. In the case of the United States of America, one Estonian vessel has been fishing the United States shrimp quota in recent years. According to the NAFO STATLANT 21A database[8] (hereinafter referred to as the STATLANT database), Japan reported catches in the high seas Northern shrimp fishery from 2000 to 2003 in Division 3M, but has since ceased its activities. Portugal also reported catches in this fishery in 2004 (50 tonnes). The catches of these two countries also correspond to charter arrangements.

[8] The NAFO STATLANT database contains information on annual catches by species, subareas, country and year.

TABLE 3
Number of bottom trawlers and number of fishing days in the high seas fishery by the main flag states for redfish and Greenland halibut by flag state for the period 2004–2006

Flag state	Number of vessels[1]			Number of fishing days[1]			Catch (tonnes) in 3MLNO	
							Greenland halibut (mainly 3L)	Redfish (mainly 3M and 3O)
Year	2004	2005	2006	2004	2005	2006	2006	
Russian Federation	8	5	6	951	571	476	1 531[2]	1 834[2]
Spain	32	27	23	6 196	3 832	2 842	5 859[2]	2 033[2]
Portugal	12	10	10	1 812	1 493	1 799	2 327[2]	7 802[2]
Japan	2	1	13	349	347	221	1 324[3]	419[3]
Estonia	2	2	2	462	415	328	278[3]	1 155[3]
Latvia	0	1	1	0	8	37	18[4]	250[4]
Lithuania	/	15	15	/	/	/	57[4]	397[4]
Total	56	47	44	9 770	6 666	5 703	11 394	13 890

/ = Unknown.
Sources:
[1] Response from NAFO to FAO Questionnaire, except where otherwise noted.
[2] Annual reports submitted to NAFO by respective country: Spain (González *et al.,* 2007; González *et al.,* 2006; González *et al.*, 2005); Russian Federation (Vaskov *et al.,* 2007; Vaskov *et al.*, 2006; Vaskov *et al.,* 2005); Portugal (Vargas *et al*., 2007; Vargas *et al.,* 2006; Vargas *et al.,* 2005).
[3] Returned questionnaires to FAO by respective country.
[4] NAFO, 2007b.
[5] Information provided by Lithuanian expert.

A recent assessment of fishing effort in the NRA has been performed by the NAFO Secretariat (Campanis, 2007). This study, based on the analysis of vessel monitoring systems (VMS) data, confirms that 98 percent of the time spent fishing for shrimp in the high seas was in NAFO Divisions 3M and 3L (respectively 62 and 36 percent).

Greenland halibut and redfish bottom trawl fishery (off the Grand Banks and the Flemish Cap; NAFO Divisions 3M, 3L, 3N and 3O)

This fishery targets Greenland halibut or redfish (mainly *Sebastes fasciatus*). The directed deep-sea bottom fishery for Greenland halibut commenced in 1990, whereas the bottom fishery for redfish has been a target of commercial interest for over 40 years in this region (NAFO, 2007a). Vessels engaged in this fishery switch depth and target species with the season, sometimes fishing for skate as well (see following section). The fishery for redfish is mainly conducted in Divisions 3M and 3O. Since 1998, no directed fishery for redfish has been authorized in 3L and 3N. Greenland halibut is mainly fished in Divisions 3M and 3L. The redfish fishery is conducted at shallower depths (150–800 m) than the Greenland halibut fishery (600–1 900 m), but the gear type remains roughly the same (e.g. 135-mm bottom trawls) (Power, 2005; NAFO, 2007a).

The catch composition varies with the target species, but both species are important bycatch when the other is the target (González *et al*., 2007; Vargas *et al*., 2007; Vaskov *et al.*, 2007). Roundnose and roughhead grenadier are important bycatch in the Greenland halibut fishery but are almost completely absent from fisheries for redfish in shallower depths. Other common bycatch species are American plaice, skates, witch flounder, Atlantic halibut, anglerfishes and wolffishes.

This fishery is conducted by Spain, Portugal and the Russian Federation and, to a lesser degree, Canada, Japan, Estonia, Latvia and Lithuania. Table 3 illustrates the number of vessels and effort by countries that are participating in the fishery. Spain and Portugal have, by far, submitted the most comprehensive information on fishing activity to NAFO in the form of annual reports, although the table is a compilation of information from various sources. When national reports to NAFO were used, effort was sometimes estimated because of the different reporting units used by country and/

TABLE 4
Directed skate fishery on the tail of the Grand Banks (catch and effort) for the period 2004–2006

Flag state	Number of vessels			Number of fishing days			Catch (tonnes) of skate		
	2004	2005	2006	2004	2005	2006	2004	2005	2006
Russian Federation	2[2]	2[2]	No direct fishery for skate[2]	110[2]	3[2]	0	2 835 in 3N[2] 3 415 in 3LMNO[2]	70 in 3N[2] 79 in 3LMNO[2]	0
Spain	/	/	/	247[2]	389[2]	302[2]	5 117 in 3N 6 340 in 3LMNO[2]	2 985 in 3N 3 788 in 3LMNO[2]	3 353 in 3N 3 870 in 3LMNO[2]
Portugal	/	/	/	/	/	/	967 in 3N 1 542 in 3LMNO[2]	444 in N 575 in 3LMNO[2]	535 in 3N 1 003 in 3LMNO[2]
Estonia	/	2[3, 6]	2[3, 6]	/	/	/	680[1]	424[1]	175 in 3N[3]
Lithuania	/	1[4, 6]	1[4, 6]	/	/	/	/	48 in 3LMNO[5]	135 in 3LMNO[5]
Total (3LMNO)	2	5	3	357	392	302	11 977	4 914	5 183

/ = Unknown.
Sources:
1 The STATLANT database.
2 Annual reports submitted to NAFO by respective country: Spain (González *et al.*, 2007; González *et al.*, 2006; González *et al.*, 2005); Russian Federation (Vaskov *et al.*, 2007; Vaskov *et al.*, 2006; Vaskov *et al.*, 2005); Portugal (Vargas *et al.*, 2007; Vargas *et al.*, 2006; Vargas *et al.*, 2005).
3 Returned questionnaires to FAO by respective country.
4 Information provided by Lithuanian expert.
5 NAFO, 2007b.
6 These vessels are likely to be the same vessels listed in Table 3.

or by year. For example, the data below on fishing effort for the Spanish fleet have been converted to days fished from reported hours fished based on the information provided in the annual reports to the NAFO Scientific Council. Canada is not included in Table 3 because the catch was reported from within the EEZ. For 2006, catch of both target species in 3L, 3M, 3N and 3O has been included to highlight their relative importance.

Bottom trawl fishery targeting starry ray (tail of the Grand Banks; NAFO Division 3N)
A small percentage of the total effort of the vessels involved in the redfish and Greenland halibut fishery is directed towards skates on the tail of the Grand Banks. The target species is starry ray and the most common bycatch is American plaice. The main participants in this fishery are Canada, Spain, Portugal and the Russian Federation (NAFO, 2008b). In its answer to the FAO Questionnaire, Estonia also reported some activity in the fishery. The Lithuanian bottom trawler fishing for Greenland halibut and redfish on the Grand Banks has also been involved in the fishery during the period covered by this review (48 tonnes in 2005 and 135 tonnes in 2006) (NAFO, 2007b). Mesh size of the trawls is changed from 135 to 280 mm when fishing for skates (González *et al.*, 2006; Vargas *et al.*, 2007; Vaskov *et al.*, 2006). Catch and fishing effort developed by flag states of vessels involved in the fishery during the period 2004–2006 are presented in Table 4.

Seamount areas

In addition, there are a number of seamounts in the high seas of the North West Atlantic, grouped by NAFO in four major areas or groups (Map 3): Orphan Knoll (in Division 3K), Newfoundland Seamounts (in Division 3N and 3M), New England Seamounts (in Division 6E and 6F) and the Corner Rise Seamount complex (in Divisions 6G and 6H). These are made up of a total of 43 seamount peaks, and most of the area lies in waters deeper than 1 800 m. Fishing has occurred on some of the seamounts in the Corner Rise complex and New England Seamount areas, particularly in the shallowest seamounts in the Corner Rise, but there is no evidence of demersal fishing in the other

TABLE 5
Spanish trawl experimental survey in the North West Atlantic – catch and effort, 2004

	NAFO Div. 4Vs, 4W, 4X	New England Seamounts (NAFO Div. 6E, 6F)	Corner Seamounts (NAFO Div. 6G, 6H)	South NAFO (FAO Statistical Area 31)
		Pelagic trawl		
Fishing effort (hours)	83.4 hours	115.1 hours	102 hours	48 hours
		Catch (kg)		
Splendid alfonsino	0.2 kg	2.2 kg	2 476.3 kg	2.9 kg
Lanternfishes	3.7 kg	46.1 kg	300.0 kg	118.0 kg
Deep-sea hooked squid		60.0 kg	255.0 kg	145.0 kg
Total	**3.9 kg**	**108.3 kg**	**3 031.3 kg**	**265.9 kg**
		Bottom trawl		
Fishing effort (hours)		5.25 hours	104.25 hours	
		Catch (kg)		
Splendid alfonsino			414 811 kg	
Black cardinal fish			12 338 kg	
Black scabbardfish			9 273 kg	
Total			**436 422 kg**	

Source: Durán Muñoz *et al.,* 2005.

TABLE 6
Spanish fleet fishing effort and catches in the Corner Rise complex, from 2005 to March 2007

		Year		
		2005	**2006**	**2007**
Fishing effort	Total hauls	90	22	13
	Total hours	160	43	38
Catch (kg)	Splendid alfonsino	1 125	63.7	52.1
	Wreckfish	24.7		
	Black scabbardfish	9.3	81	
	Other species	22.3	3.9	2
	Total catch	**1 181.3**	**148.6**	**54.1**

Source: González-Costas and Lorenzo, 2007.

two areas – Orphan Knoll and Newfoundland Seamounts (Kulka *et al.*, 2007). The Newfoundland seamounts have no peaks shallower than 2 500 m.

Deep-sea species fishery on seamounts

As already mentioned in the section on History of fisheries, fishing for deep-sea species on the seamounts of the NAFO Regulatory Area was initiated in the 1970s by research vessels from the former USSR. It was followed by commercial exploitation by a Russian fleet until 1996. In 2000, a United States of America research vessel made 20 trawl hauls on and over Bear Seamount, which is part of the New England Seamounts complex (in NAFO Divisions 6E and 6F) (Kulka *et al.*, 2007).

In 2004, a Spanish trawler conducted an experimental fishing survey, using pelagic and bottom trawls (Durán Muñoz *et al.*, 2005). The area of the survey included seamounts of the New England and Corner Rise regions, as well as adjacent areas in NAFO Divisions 4VWX and in the Western Central Atlantic (FAO Statistical Area 31). The catch of the main species and the effort data from this survey are summarized in Table 5. Splendid alfonsino was the main species caught by bottom trawls.

Since 2004, four Spanish vessels have been fishing with pelagic trawl gear in the Corner Rise Seamounts area. Fishing effort and catches by species have been reported to the NAFO Scientific Council by seamount (González-Costas and Lorenzo, 2007). Over the 2005–2007 period, the three main species in the landing composition were splendid alfonsino, black scabbardfish and wreckfish. A summary is presented in Table 6.

Kulka *et al.* (2007) mentioned additional fishing activity in the region by a Canadian trawler in 2005 (three fishing trips). On-board observers sighted other vessels fishing in the area, including one Russian vessel.

In its reply to the FAO Questionnaire, Estonia also reported the activity of one trawler in Division 6G in 2006 (six fishing days, for a total catch of 2.82 tonnes). The catch consisted of 1 186 kg of alfonsino, 1 162 kg of black scabbardfish, 168 kg of black cardinal fish, and 312 kg of Mediterranean slimehead.

Some of the seamounts in the Corner Rise complex are outside the NAFO Regulatory Area and instead are located within the area covered by the Western Central Atlantic Fishery Commission (WECAFC). This has been addressed at the 2007 meeting of the NAFO Scientific Council and it was agreed that efforts will be made to contact WECAFC and explore possibilities of protecting these seamounts (NAFO, 2007a). Although fished by the former USSR in the 1970s, in recent years fishing on these seamounts has been sporadic, with limited catch (Clark *et al.*, 2007).

NAFO regulations have prohibited the use of bottom gear on the four seamounts areas (Map 3) of the NRA since 1 January 2007: Orphan Knoll, and the Newfoundland, New England and Corner Rise Seamounts (see section on Conservation and management measures). The NAFO Secretariat (Thompson and Campanis, 2007) presented at the 2007 NAFO Scientific Council Meeting a study of fishing activity on and around these four seamounts areas. The results confirm that the Corner Rise Seamounts have been regularly fished in recent years, with an estimate of 20 days per year. Sporadic fishing (two to three days per year) has been observed on the New England Seamounts, few exploratory tows on the Newfoundland Seamounts, and no evidence of fishing on the Orphan Knoll.

Other related fisheries

Longline multispecies fishery (off the Grand Banks and the Flemish Cap; NAFO Divisions 3M, 3N, 3L and 3O)

In its response to the FAO Questionnaire, Canada reported a small multispecies longline fishery (one to three vessels), targeting deep-sea species such as Greenland halibut, Atlantic halibut and redfish, which operates in part on the high seas (see Table 8). This fishery is conducted over a wide bathymetric range (50–1 500 m), and also targets shallower water species such as white hake, yellowtail flounder and skates (see Table 7).

TABLE 7
Canadian longline fleet in NAFO Divisions 3N, 3L and 3O – depth range by target species

Species	Depth range (m)
Atlantic halibut	300–700
Greenland halibut	700–1 500
Redfish	300–700
White hake	50–200
Skate	50–200
Yellowtail flounder	60–100

Source: response from Canada to FAO Questionnaire.

TABLE 8
Canadian longline fleet in NAFO Divisions 3N, 3L and 3O – catch and effort data, 2004–2006

Year	Number of vessels	Number of fishing days	Total catch (tonnes)
2003	1	3	20
2004	3	34	120
2005	3	21	80
2006	0	0	0

Source: response from Canada to FAO Questionnaire.

Snow crab pot fishery

A directed fishery for queen crab (snow crab) (*Chionoecetes opilio*) is conducted by Canada in NAFO Divisions 2J, 3K, 3L, 3N and 3O, with a total catch of 49 400 tonnes reported in 2006 (Wells *et al.*, 2007). This species is considered sedentary by Canada and as such is managed solely by Canada (Fisheries Resource Conservation Council [FRCC], Canada, 2005). A portion of this fishery takes place on the high seas, but Canada has not created special reporting requirements based on catches taken either inside or outside its EEZ. Other countries have not reported catch of snow crab in recent years. One vessel fishing with crab pots on the high seas in the Corner Rise Seamounts complex has been mentioned in a document presented at the 2007 NAFO Scientific Council Meeting (Kulka *et al.*, 2007).

TABLE 9A
Number of vessels and fishing days of the main bottom fisheries in the NRA, 2004–2006 Regulatory Area

	Number of vessels			Number of fishing days		
	2004	2005	2006	2004	2005	2006
Northern shrimp (3M and 3L)	33	27	21	5 100	3 558	1 776
Redfish (3M and 3O)/Greenland halibut	56	47	44	9 770	6 666	5 703
Skates (3LNO)	2	5	3	357	392	302

Note:
– The numbers listed in this table only includes information from the main flag states in the major areas of each fishery and may include vessels that are fishing in more than one fishery.
– The numbers of vessels in each fishery do not equal the total number of vessels as shown in Table 9B because updated data broken down by country are not yet available and the information for each fishery is intended to give an overview of the involvement of each fishing nation.

TABLE 9B
Overall number of vessels and fishing days in the main fisheries in the NRA, 2004–2006

	Number of vessels			Number of fishing days		
	2004	2005	2006	2004	2005	2006
Northern shrimp	33	27	21	5 100	3 558	1 776
Groundfish	63	50	45	9 966	6 948	5 908
Pelagic Fishery						
Redfish (*Sebastes mentella*)	48	53	42	1 414	1 784	979

Source: NAFO Secretariat

TABLE 9C
Reported catch of the main deep-sea target species in the NAFO Regulatory Area

	Catch of main target species (tonnes)		
	2004	2005	2006
Northern shrimp (3M and 3L)	49 772	32 331	22 135
Redfish (3M and 3O)	6 973	12 826	13 774
Skates (3LNO)	11 476	2 853	5 255
Greenland halibut (3LMNO)	11 125	11 141	11 334
Total	**79 346**	**59 151**	**52 498**

Source: NAFO, 2008d.
Notes:
– All numbers have been taken from the above-mentioned source (except for Northern shrimp) for the sake of an appropriate time series and consistency. However, the total catch for each fishery presented in the tables of this document generally correspond to the numbers presented here.
– Minor catches are not included and therefore these numbers represent only the major part of each fishery.
– Catch by Canada is excluded from these numbers as the majority of its catch is from within its EEZ.

Trawl fishery targeting redfish (NAFO Divisions 1F and 2J)

Although this fishery is conducted with pelagic gear, the redfish species targeted (*Sebastes mentella*) is considered to be a deep-sea species. Bycatch in this fishery is minimal (Paramonov, 2007). Fishing takes place both inside and outside the EEZ of Greenland and outside the EEZ of Canada with a total catch of some 20 000 to 30 000 tonnes over the past few years. It is unknown how much of this is taken on the high seas. This species is also fished in adjacent areas in the North East Atlantic (Greenland EEZ and ICES Areas XII and XIV). Several nations are involved in this fishery, including the Russian Federation, Iceland, Lithuania, Germany, Poland, Latvia, Portugal, Faroe Islands and Spain.

Catch and effort summary

Catch and fishing effort of the four main deep-sea species targeted in the high seas of the NAFO Regulatory Area during the period 2004–2006 are presented in Tables 9A,

9B and 9C. Table 10 gives an overview of other species caught in bottom fisheries in the NAFO Regulatory Area in 2006.

Illegal, Unreported and Unregulated (IUU) fishing

NAFO maintains a list of vessels recognized as having participated in IUU fishing in the NAFO Regulatory Area. This list, available on the NAFO Web site, currently includes 19 vessels (accessed on 11 June 2008). NAFO collaborates with other RFMOs such as the North East Atlantic Fisheries Commission (NEAFC), the South East Atlantic Fisheries Organisation (SEAFO) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in order to share IUU information.

TABLE 10
Other species caught in bottom fisheries in the NAFO Regulatory Area (2006)

Species	Catch (tonnes)
Roundnose grenadier[a]	1139
American plaice[b]	882
Roughhead grenadier[a]	524
Yellowtail flounder[b]	410
Cod[b]	393
White hake[b]	251
Witch flounder[b]	158
Wolffish[a]	105
Northern shortfin squid[b]	75
Atlantic halibut[a]	53
American angler[a]	35
Total	**4 025**

Sources:
[a] FAO, 2008.
[b] NAFO, 2008d.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

In 2006, the NAFO Scientific Council adopted the Fisheries Reporting Monitoring System (FIRMS) classification to describe the status of stocks. The current classification of NAFO stocks is presented in Table 11. Target stocks of the fisheries presented in the previous section are given in bold. The status of the stock is described by letters defined below the table.

TABLE 11
Updated classification of NAFO stocks

	NAFO stock classification	
Stock	**Stock abundance status**	**Exploitation rate status**
American plaice Div. 3LNO	D	3
American plaice Div. 3M	D	1
Capelin Div. 3NO	E	0
Atlantic cod Div. 3M	D	1
Atlantic cod Div. 3NO	D	3
Thorny skate (starry ray) Div. 3LNO	**C**	**0**
Greenland halibut SA 0+1 offshore+1B-F	E	0
Greenland halibut Div. 1A inshore	E	0
Greenland halibut SA 2 + Div. 3KLMNO	**D**	**3**
Redfish Div. 3O	**E**	**0**
Redfish Div. 3LN	**B**	**1**
Redfish Div. 3M	**A**	**1**
Redfish SA1	D	0
Roughhead grenadier SA 2+3	E	0
Roundnose grenadier SA 0+1	D	0
Roundnose grenadier SA 2+3	E	0
Northern shortfin squid SA 3+4	C	1
Witch flounder Div. 2J+3KL	E	0
Witch flounder Div. 3NO	D	0
Yellowtail flounder Div. 3LNO	A	2
White hake Div. 3NO	D	0
Northern shrimp Div. 3LNO*	**A**	**1**
Northern shrimp SA 0+1*	**A**	**2**
Northern shrimp 3M*	**A**	**0**
Northern shrimp in Denmark Strait*	E	1

* Status not updated.
A = virgin or high abundance; B = intermediate abundance; C = low abundance; D = depleted; E = uncertain, not assessed.
1 = no or low fishing mortality; 2 = moderate fishing mortality; 3 = high fishing mortality; 0 = not assessed.
Source: NAFO, 2007a.

Status of target stocks

Greenland halibut stock is at a low biomass and is under a recovery plan. The latest stock assessments conclude that, despite the current management measures, the exploitable biomass estimates are declining and are at their lowest level. Catches exceed TACs and consist mainly of juvenile immature fishes. (NAFO, 2008b)

Starry ray has been under quota regulation since 2004. TACs during 2005–2007 were set to 14 500 tonnes. During that period, the average annual catch has been 5 580 tonnes. Biomass estimates have increased in recent years, but are much lower compared with the mid-1980s. The NAFO Scientific Council is recommending that TACs for 2009 and 2010 should not exceed 6 500 tonnes. (NAFO, 2008b)

Estimates of Northern shrimp stocks on the Flemish Cap and Grand Banks indicate high abundance in

recent years. The annual quota was increased between 2005 and 2006 from 13 000 to 22 000 tonnes, with 83 percent of the quota allocated to the Canadian fleet within their EEZ.

The abundance of redfish in NAFO Area 3O is considered unknown. This stock has been under TAC regulation since 2004, when an annual quota of 20 000 tonnes was adopted for the period 2005–2007. The same quota has been set for 2008 (NAFO, 2008b). In NAFO Divisions 3M and 3LN, the redfish stock abundance has been assessed as "high" and "intermediate", respectively. No directed fishery for redfish is authorized in NAFO Divisions 3NL. In Division 3M, the quota for redfish in 2006 and 2007 was 5 000 tonnes, and has been increased to 8 000 tonnes for 2008. (NAFO, 2008c)

Status of bycatch stocks

Stocks such as Atlantic cod and witch flounder in NAFO Divisions 3N and 3O (southwestern slopes of the Banks), or American plaice in 3M (Flemish Cap) are considered to be depleted, and are no longer subject to directed fishing (see section on Conservation and management measures).

Impacts on Vulnerable Marine Ecosystems (VMEs)

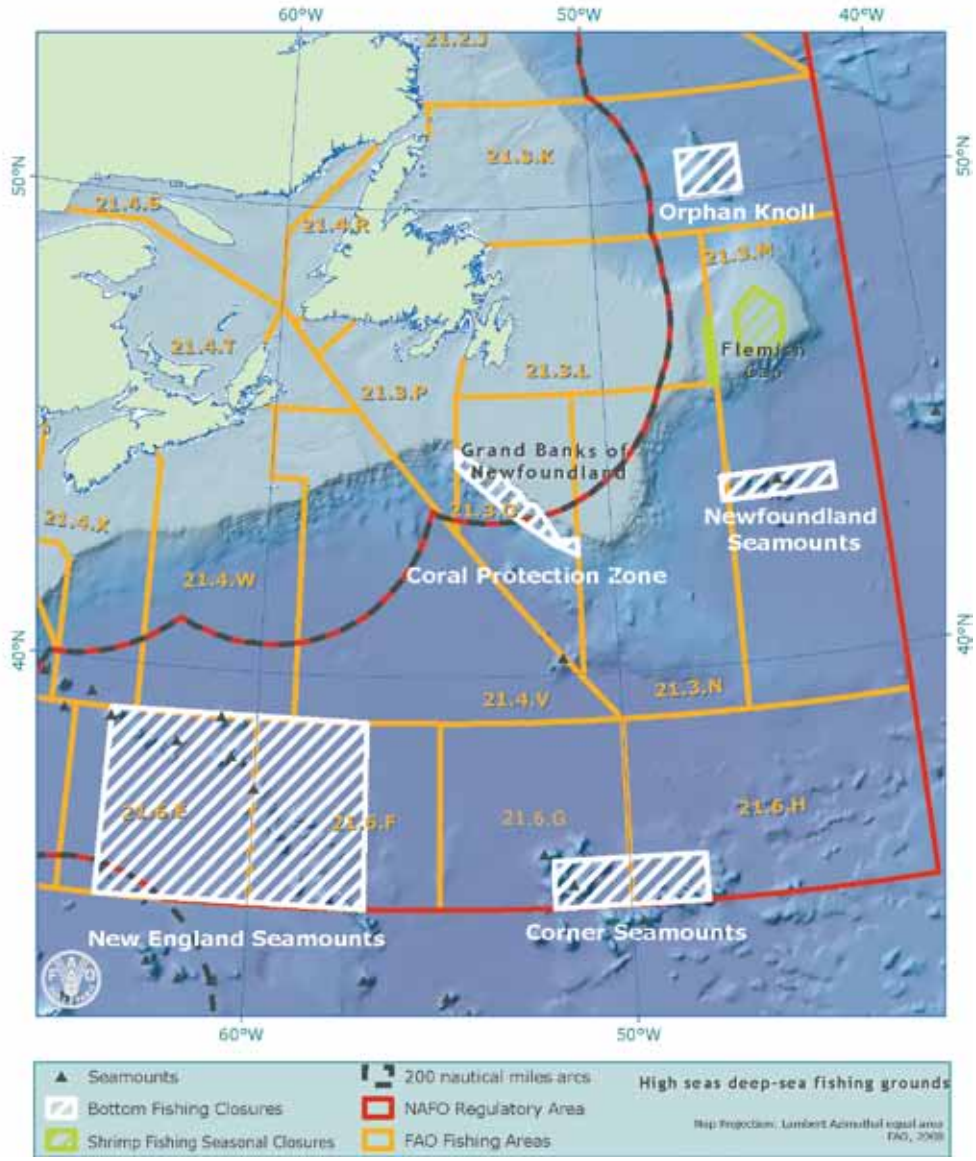
Deep-sea corals, sponges and vulnerable fish species are known to be present in the NAFO Regulatory Area. In 2005, a scientific study on deep-sea corals of the North Atlantic was conducted on two seamounts of the Corner Rise complex using a remotely operated vehicle (ROV). Evidence of impact of bottom fishing was observed, including scar marks, broken corals and crusts, displaced boulders, metallic waste or absence of sessile fauna present on other peaks in the same area (Waller *et al.*, 2007). Preliminary results of the NAFO Scientific Council and associated working groups (WGEAFM[9], WGDEC[10]) in identifying ecosystems vulnerable to deep-sea fishing are presented in the report of the June 2008 Scientific Council Meeting (NAFO, 2008b). A first list of species (including benthic taxa and fish species) sensitive and likely vulnerable to deep-sea fisheries has been established. Candidate VME sites have been identified within the NAFO Regulatory Area, including the four seamounts areas and the coral protected area for which measures have already been adopted by NAFO in 2006 and 2007 (see following section).

CONSERVATION AND MANAGEMENT MEASURES

The main management measures for deep-sea fisheries in the NAFO Regulatory Area include the following (NAFO, 2008c).

- TACs are set for all stocks under NAFO's jurisdiction and allocated to countries. These TACs are reviewed on an annual basis.
- Minimum authorized mesh sizes to be used in the NRA are as follows:
  a) 40 mm for shrimps and prawns;
  b) 60 mm for shortfin squid (*Illex*);
  c) 280 mm in the codend and 220 mm in all other parts of the trawl for skate;
  d) 130 mm for groundfish;
  e) 100 mm for pelagic *Sebastes mentella* in Subarea 2 and Divisions 1F and 3K; and
  f) 90 mm for redfish in the fishery using mid-water trawls in Division 3O.
- The shrimp fishery is managed separately in NAFO Divisions 3M and 3L. In addition to TACs, fishing effort limits are set by the contracting party in Division 3M. Time and spatial restrictions are applied in both management units. Fishing

[9] NAFO Working Group on Ecosystem Approach to Fisheries Management.
[10] ICES/NAFO Working Group on Deep-Water Ecology.



MAP 3
NAFO seamount closures, including the "Coral Protection Zone" adopted in 2007

for shrimp is prohibited from June to December in 3M and from April to June in 3L, and there are two closed areas for shrimp on the Flemish Cap (Division 3M) during certain times of the year (Map 3). In Division 3L, shrimp fishing is prohibited at depths below 200 m and limited at any one time to one vessel per flag state. Finally, the use of a sorting grid to reduce bycatch of fish is mandatory for all fleets in the 3LMNO fisheries for shrimp.

- Greenland halibut is currently under a 15-year rebuilding plan that contracting parties are obliged to uphold. The objective of this programme is to reach an exploitable biomass (age five and older) of 140 000 tonnes which should allow more stable yield over the long term. The TAC from 2008 onwards may be adjusted by Scientific Council advice, but by no more than 15 percent less or greater than the TAC of the preceding year. Within Canadian waters the

minimum fish size for Greenland halibut is 45 cm, whereas the minimum fish size in the NRA is 30 cm. In 2008, NAFO further tightened the monitoring scheme for these fisheries (NAFO, 2008c, Article 8).

Over the past three years, NAFO has started to take precautionary measures in order to protect VMEs from the adverse impact of bottom fisheries in the NRA. In 2006, NAFO members agreed to protect four seamount areas from high seas bottom trawling for a four-year period based on the ecosystem approach to fisheries (2007–2010) (see Map 3) (NAFO, 2007a), two additional seamount areas south of the Grand Banks (Fogo seamount 1 and 2) were closed in 2008 (NAFO, 2008c, Article 15). In NAFO Division 3O, a coral protection zone was established in 2007 and is closed to all fishing activity involving bottom contact gear (NAFO, 2008c). In May 2008, a special session of the NAFO Fisheries Commission adopted specific measures regarding bottom fisheries and their potential impacts on vulnerable ecosystems. In 2008, contracting parties will have to collaborate on the assessment of existing fished areas (the footprint), and from 2009, the development of bottom fisheries in new areas will have to follow a protocol, including the execution of a preliminary impact assessment. The complete set of measures is described in Chapter I bis of the 2008 NAFO *Conservation and Enforcement Measures* (NAFO, 2008c). In addition, there are specific requirements for all regulated species which can not be targeted (bycatch species) (NAFO, 2008c, Article 12).

INFORMATION AND REPORTING GAPS

Catch data publicly available are aggregated by NAFO Divisions. There is no separation of high seas and EEZ catch. This is currently a minor shortcoming because only Canada and France fish within EEZs, but this has not always been the case, and there is no guarantee that it will continue to be the case in the future.

There is some inconsistency between STATLANT data and data available from other sources, including NAFO documents. The catch estimates produced by NAFO STACFIS are often higher than the catches declared by countries in STATLANT. In addition, the data of some countries are not available and in the national reports submitted by parties to NAFO, fishing effort is reported in various units, such as fishing hours, number of fishing operations or number of fishing days. This makes it difficult to complete a comprehensive analysis.

NAFO's Secretariat has initiated some analysis of VMS data to investigate the usefulness of this type of information to assess fishing effort spatial distribution (Campanis, 2007). If the results of the study are promising, the author's conclusion was that enhancement of VMS data quality would ensure more accurate estimates. The NAFO Scientific Council recommended that positions be reported at time intervals shorter than the current two hours, and that the instantaneous speed and the course of the vessel be included in the VMS position messages transmitted (NAFO, 2008b).

SOURCES OF INFORMATION

In their reply to the FAO Questionnaire, Canada, Estonia, Germany, Japan and Ukraine included information regarding participation of some vessels in the high-seas deep-sea fisheries in the North West Atlantic. In addition, NAFO answered the FAO Questionnaire, which provided a comprehensive review of the number of vessels active and fishing effort deployed in the high seas of the NRA for the last four years. The STATLANT database contains catch data reported to NAFO up to 2005, along with research and summary documents, which are available on the NAFO Web site, and provide a valuable source of information.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Canada, Denmark (in respect of Faroe Islands and Greenland), France (Saint-Pierre et Miquelon), Germany, Iceland, Japan, Latvia, Lithuania, Norway, Poland, Portugal, Russian Federation, Spain and Ukraine
Estimated total number of vessels	67
Total reported catch of main target species (tonnes)	52 498
Total reported catch of other bottom species (tonnes)	4 025

Main fisheries				
Gear	**Main target species**	**Fishing ground**	**Regional Area**	**Remark**
Bottom trawl	Northern shrimp	Nose of the Grand Banks and the Flemish Cap	NAFO Div. 3L and 3M Div.	
Bottom trawl	Greenland halibut and redfish	Grand Banks and the Flemish Cap	NAFO Div. 3M, 3L, 3N and 3O	
Bottom trawl	Starry ray	Tail of the Grand Banks	NAFO Div. 3N	
Bottom and pelagic trawl	Splendid alfonsino, black scabbardfish, black cardinal fish and wreckfish	NAFO Seamounts zones		Closed with some provision for fishable areas
Bottom longline	Greenland halibut, Atlantic halibut and redfish	Off the Grand Banks and the Flemish Cap	NAFO Div. 3M, 3N, 3L and 3O	
Trap	Snow crab	Off the Grand Banks and the Flemish Cap	NAFO Div. 2J, 3K, 3L, 3N, 3O, 3P and 4R	

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