INCIDENTAL MORTALITY

State of the Scotian Shelf Report

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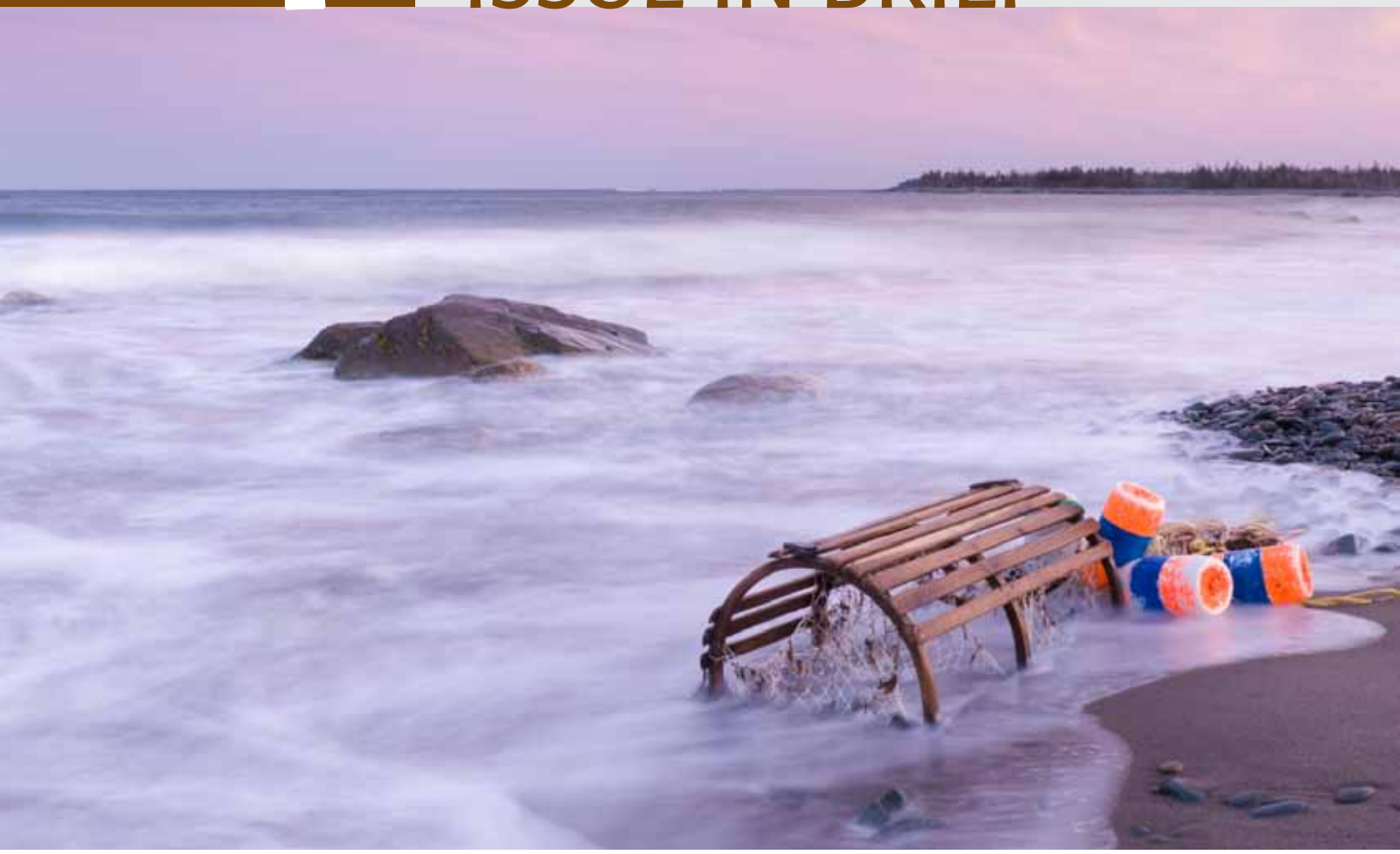
CONTENTS

1 ISSUE IN BRIEF



LINKAGES

This theme paper links to the following theme papers in the State of the Scotian Shelf Report:

- Fish Stock Status and Commercial Fisheries
- Marine Waste and Debris
- Ocean Noise
- At Risk Species
- Marine Habitats and Comminities

Human activities that occur in the marine environment often result in the unintentional mortality of marine organisms. Incidental mortality is a consequence of human activities. While incidental mortality is something that can be avoided, it is often not economically feasible to do so because it would require the cessation of whichever human activity (e.g. fishing) that was causing the mortality. The focus of this paper is on the direct causes of incidental mortality, including fisheries, transportation, oil and gas activities and marine waste and debris.

There have been and will continue to be a number of human activities occurring within or affecting the marine environment. With the knowledge that these activities will continue, it becomes important to identify the source and scale of incidental mortality in order to consider appropriate management measures and other responses. The identification of causes of incidental mortality can directly lead to improved management of human activities in the marine environment (Figure 1). In some cases, reductions in incidental mortality, e.g., through fishing gear modification, have allowed activities to expand.

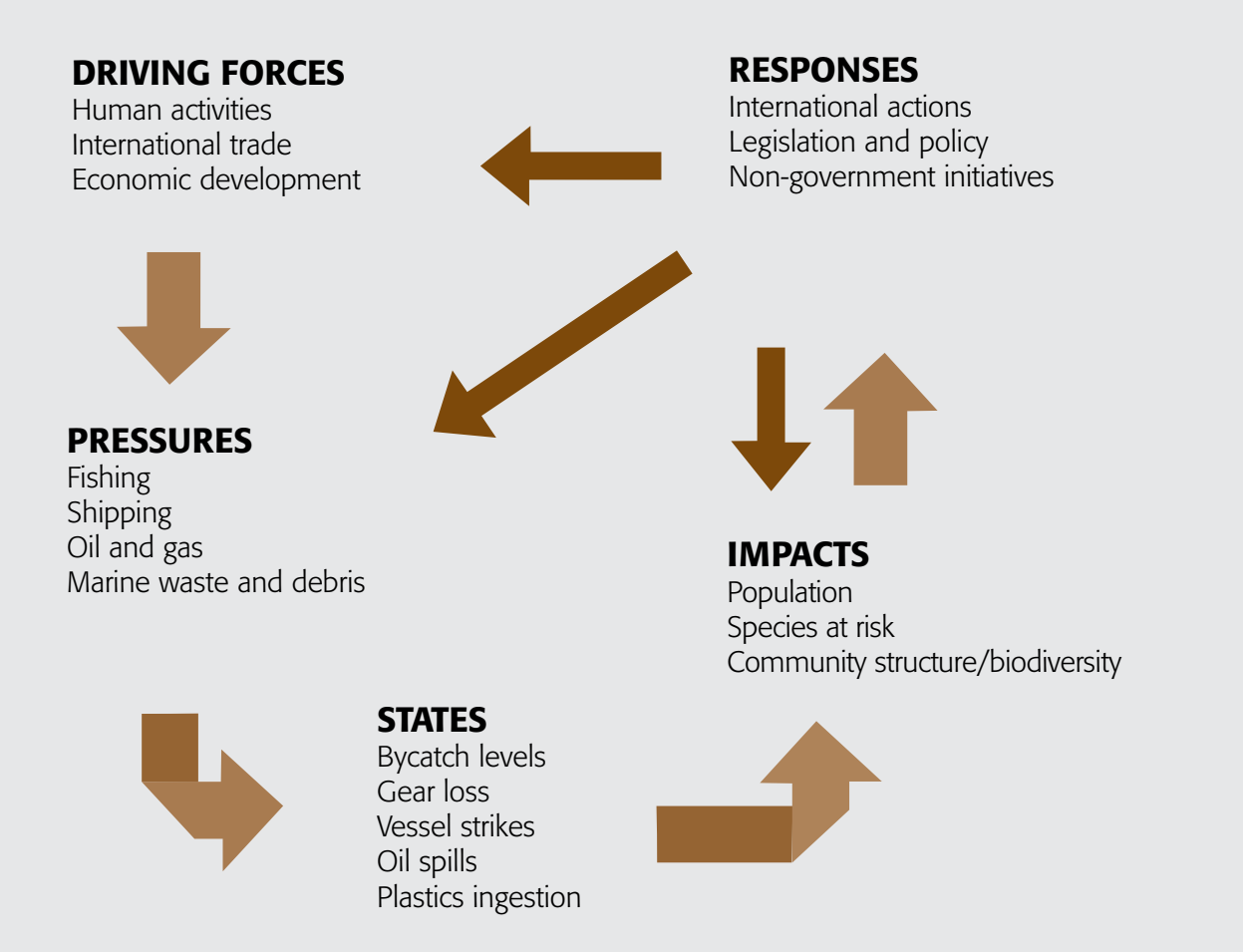


Figure 1. Driving forces, pressures, state, impacts and responses (DPSIR) to incidental mortality of marine organisms on the Scotian Shelf. The DPSIR framework provides an overview of the relation between the environment and humans. According to this reporting framework, social and economic developments and natural conditions (driving forces) exert pressures on the environment and, as a consequence, the state of the environment changes. This leads to impacts on human health, ecosystems and materials, which may elicit a societal or government response that feeds back on all other elements.

2 DRIVING FORCES AND PRESSURES

International trade, economic development and the human activities involved are some of the main driving forces that are leading to the pressures causing incidental mortality in the marine environment of the Scotian Shelf.

2.1 FISHING

Commercial fishing on the Scotian Shelf has occurred for centuries. In 1700, cod, mackerel and herring were the primary species caught for export from Nova Scotia and these species continued to be important for centuries. After peaking in the 1970s and 1980s, it became apparent that landings

for groundfish stocks, particularly cod and haddock, were beginning to decline. This resulted in some fisheries closures in the early 1990s that remain in place today. Limited fishing for some groundfish has continued, but shellfish fisheries have taken over as the dominant activity occurring on the Scotian Shelf. Shellfish fisheries include lobster, scallop, shrimp, crab, and surf clam. Additionally, large pelagic species such as swordfish, tuna and shark support fisheries throughout the Scotian Shelf (See *Fish Stock Status and Commercial Fisheries* theme paper).

With the many different fisheries occurring throughout the Scotian Shelf, there are also differences in the type of gear used. Fishing gear can be either active (i.e., mobile and physically dragged by the vessel) or passive or fixed (typically lowered to the seafloor or suspended in the water column for some period and retrieved). Both of these methods can cause injury or mortality of non-target marine species. The specific ways in which fishing causes mortality and the species most affected are listed below.

Bycatch

Bycatch is a term often used to describe non-targeted species caught through fisheries. It can also apply when undersized or juvenile forms of the targeted species are caught. Bycatch is a complex issue and rules surrounding what is discarded and what is retained vary from fishery to fishery. In general, most non-commercial species are returned to the water. Whether or not a commercial species is retained varies, and this can depend on the life-history stage and other characteristics of the species, and the nature of the fishery. Bycatch that is retained is monitored as fisheries landings, whereas bycatch that is not kept is not always recorded. While discarded species may survive post-release, actual survival rates are difficult to measure. There are a number of fisheries management measures intended to reduce the incidence of bycatch; these are outlined in law, regulations, fisheries management plans, and licence conditions.

Precatch Losses

Precatch loss is another type of incidental mortality caused by fishing. Examples of precatch losses include the incidental crushing or smothering of marine organisms that may occur from laying traps or pots or trawling. There have also been examples where a predator has eaten a fish caught on a longline (Iversen 1995). This can be considered a precatch loss because the animal may not have been consumed by the predator if fishing had not been occurring in the area (Iversen 1995).

Ghost Fishing

Ghost fishing can occur as a result of derelict fishing gear, which is gear that has either been discarded or lost from a fishery. Gear can be lost as a result of storms or rough waters, chafing or cutting of ropes, bottom snags, faulty gear, vandalism, human error or gear being moved unintentionally by other vessel traffic (Newman et al. 2011). It most commonly occurs as a result of gear lost from passive fishing activities such as use of nets, ropes, pots or traps. Since the materials used to construct this gear often do not degrade, the gear may continue to catch marine

species despite no longer being used by a fishery[1]. It is estimated that 52 metric tonnes of fishing gear accumulate annually (UNEP 2011). Nets can catch fish species within the water column, but can also form into a ball, at times weighing up to a tonne, and roll along the ocean floor, crushing benthic species and habitats (DFO 2010) (See *Marine Waste and Debris* theme paper).

Entanglement

Large pelagic marine organisms have the potential to get entangled in fishing gear and nets, and more than 200 species are susceptible to entanglement worldwide (UNEP 2011). In the region, the main concern of entanglement is with the endangered North Atlantic right whale (*Eubalaena glacialis*), herein after referred to as the right whale. Photographs taken in surveys in the Gulf of Maine have shown that 75% of right whales showed signs of entanglement, with lobster gear the primary source of entanglement (Myers et al. 2007). Entanglement is also a risk for endangered leatherback turtles in the region (James et al. 2005). Entanglement can lead to suffocation, starvation, drowning, restricted movement, vulnerability to predators, or other injury such as wounds from tightening material (UNEP 2011).

2.2 MARINE VESSEL TRAFFIC

The commercial shipping industry is continually growing as the global demand for goods is increasing. The marine transportation industry is responsible for over 90% of international trade (IMO 2012a) with cargo vessels and oil tankers making up the majority of the global fleet (UNCTAD 2011). As of 2006, the marine shipping sector in the Maritime Provinces contributed $0.5 billion to Canada's Gross Domestic Product (GDP) and employed approximately 10 000 people (CPCS Transcom Limited 2012). The Scotian Shelf is an area that is frequently transited by commercial shipping vessels moving between ports in Europe, the Eastern Seaboard of North America and the St. Lawrence Seaway (Figure 2).

Aside from commercial shipping vessels, there are also many passenger vessels, including ferries and cruise ships, recreational vessels, including pleasure craft, research, whale watching, and fishing vessels on the Scotian Shelf. Most of the recreational vessels occur in regions that are closer to the coast. Marine Atlantic Ferries run year round between North Sydney, Cape Breton and Port aux Basques, Newfoundland and from June to September between North Sydney and Argentia, Newfoundland (Marine Atlantic 2012). The Scotian Shelf is also a popular destination for cruise ships. In 2010, the Port of Halifax

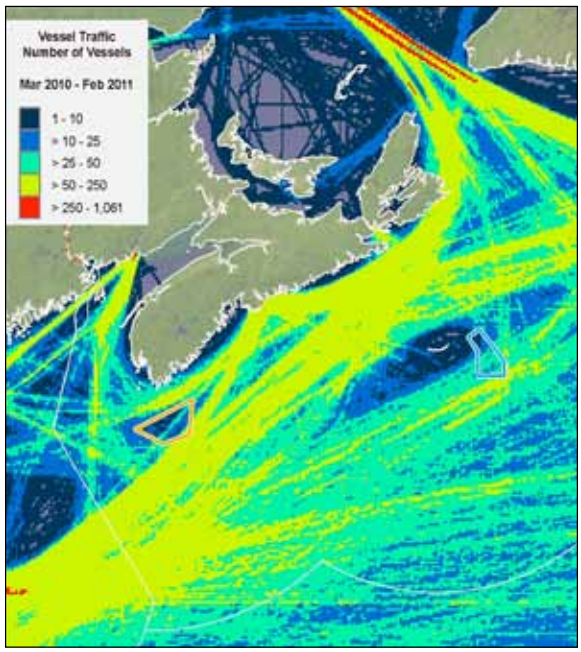


Figure 2. Composite image of vessel track counts for the Maritimes based on Long Range Identification and Tracking (LRIT) data with the Roseway Basin area to be avoided (orange polygon) and the Gully Marine Protected Area (MPA) (blue polygon) highlighted (from Koropatnick et al. 2012). Note that LRIT data only contain information for vessels of 300 gross tonnage or more on international voyages and therefore do not entirely represent the vessel activity on the Scotian Shelf.

[1] Some of the materials used in manufacturing fishing gear is now biodegradable and may eventually wear down, resulting in less mortality. However, this gear is still expected to last for at least a fishing season meaning that some mortality will still occur.

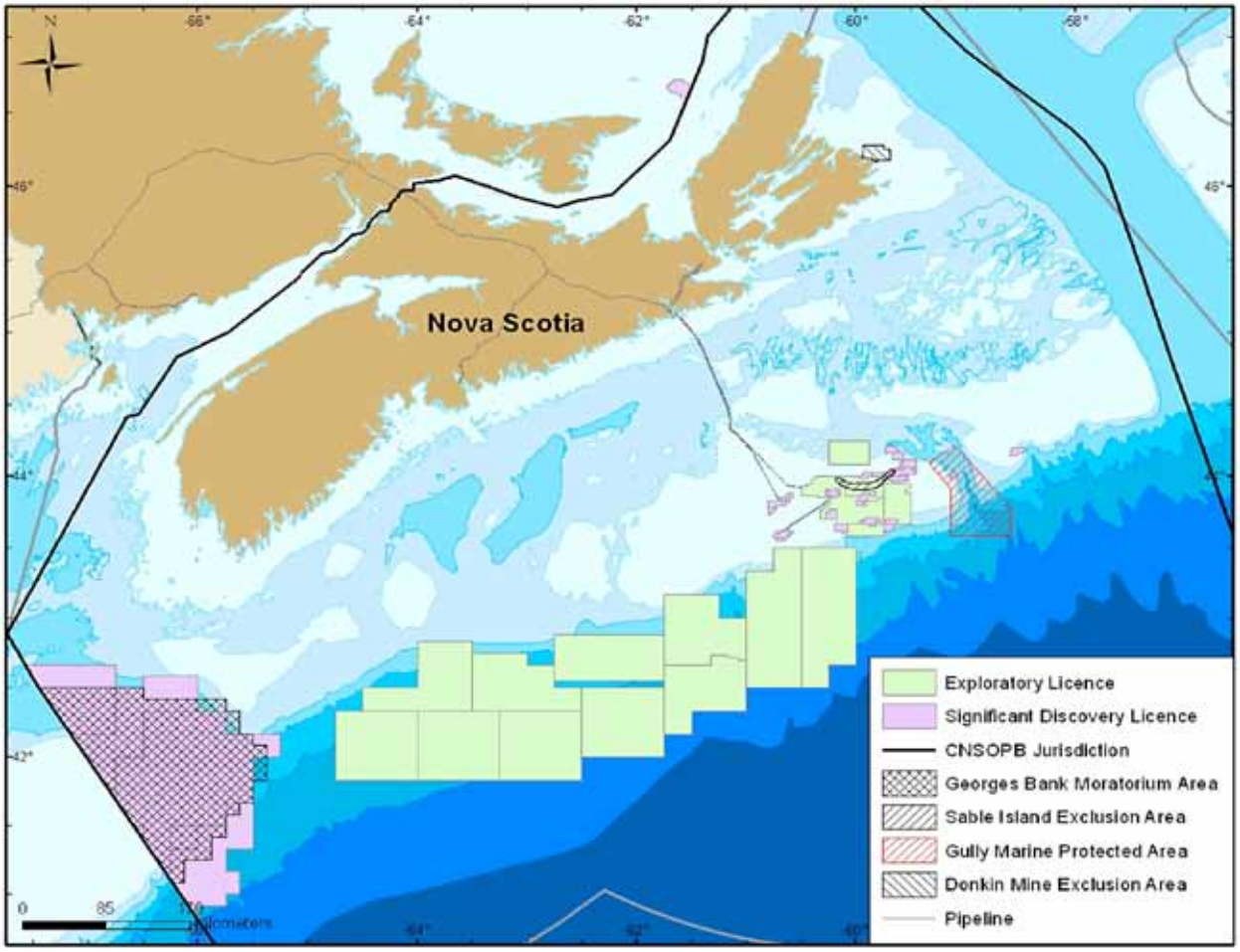


Figure 3. Nova Scotia offshore rights for petroleum exploration and development as of December 2012 (data courtesy of the Canada-Nova Scotia Offshore Petroleum Board).

alone was the port of call for over 120 cruise vessels (Cruise Halifax 2011).

Vessel traffic in the marine environment has the potential to contribute to incidental mortality through vessel strikes (to large, pelagic organisms), pollution and noise. Vessel-source pollution—including sewage, oily substances (from operational discharges or spills from accidents or leaks), garbage and hazardous and noxious substances—may result in direct mortality of marine life or have long-term health impacts. Commercial vessel traffic has raised natural ambient noise levels in some parts of the world's oceans by approximately 180 Hz (Tyack 2008). This can cause behavioural changes in marine mammals, but it is not clear if it has a direct link to incidental mortality (see also *Ocean Noise* theme paper).

2.3 OFFSHORE OIL AND GAS

The increasing need for oil and gas products has led to oil and gas exploration and drilling in the marine environment and the Scotian Shelf is thought to have large reserves of petroleum products (Breeze and Horsman 2005). There are currently two production projects in the offshore, the Sable Offshore Energy Project and the Deep Panuke project, both mainly focused on natural gas extraction (Nova Scotia Department of Energy 2012). There have also been multiple exploratory wells and areas licensed for exploration (Figure 3). In November of 2012, BP and Shell Canada Ltd. received exploratory licences for a total of eight offshore parcels and they will be conducting exploratory drilling in these areas

(CNSOPB 2012a). This will most likely result in an increase in oil and gas exploration and extraction on the Scotian Shelf in coming years.

Several aspects of oil and gas exploration and development activities can lead to incidental mortality:

Blowouts/Spills

Blowouts that result in oil being spilled in the marine environment have a low probability of occurrence, but have serious consequences if they do occur (Lee et al. 2011). If gas was released, it would most likely dissipate into the atmosphere; however, the release of oil products can create slicks on the surface of the ocean and cause the most serious environmental effects. If a spill occurs when there are larval or juvenile stages of marine life in the water column, it could cause impacts on recruitment and development of those species (Lee et al. 2011). Other marine species, such as sea birds and turtles, are also at risk from large spills. When seabirds come in contact with oil on the water's surface, it gets absorbed into the feathers of the bird and decreases their ability to thermoregulate and reduces waterproofing and buoyancy. This can result in hypothermia or starvation, leading to death (Wiese and Ryan 2003). Turtles have been found to consume oil, which can remain within their systems and the toxins get absorbed into their tissues (NOAA 2010). Oil may also cause turtles to become disoriented; it can influence the olfactory senses of the turtles and they rely heavily on these senses for navigation and orientation (NOAA 2010).

Artificial Light

Seabirds are attracted to the lights and flares on oil platforms. Some are known to fly directly into light and flares, resulting in mortality and others have been reported to circle the light until they die of starvation (Wiese et al. 2001).

Construction / Demolition

Construction of offshore oil and gas platforms, pipelines and associated structures leads to the mortality of some species (e.g., benthic invertebrates) via machinery or dredging operations and the decommission of rigs often involves the use of explosives, which could also result in incidental mortality (Lee et al. 2011). While the potential for incidental mortality to occur exists within construction and demolition procedures, the number of mortalities has not been recorded and the exact impacts remain uncertain.

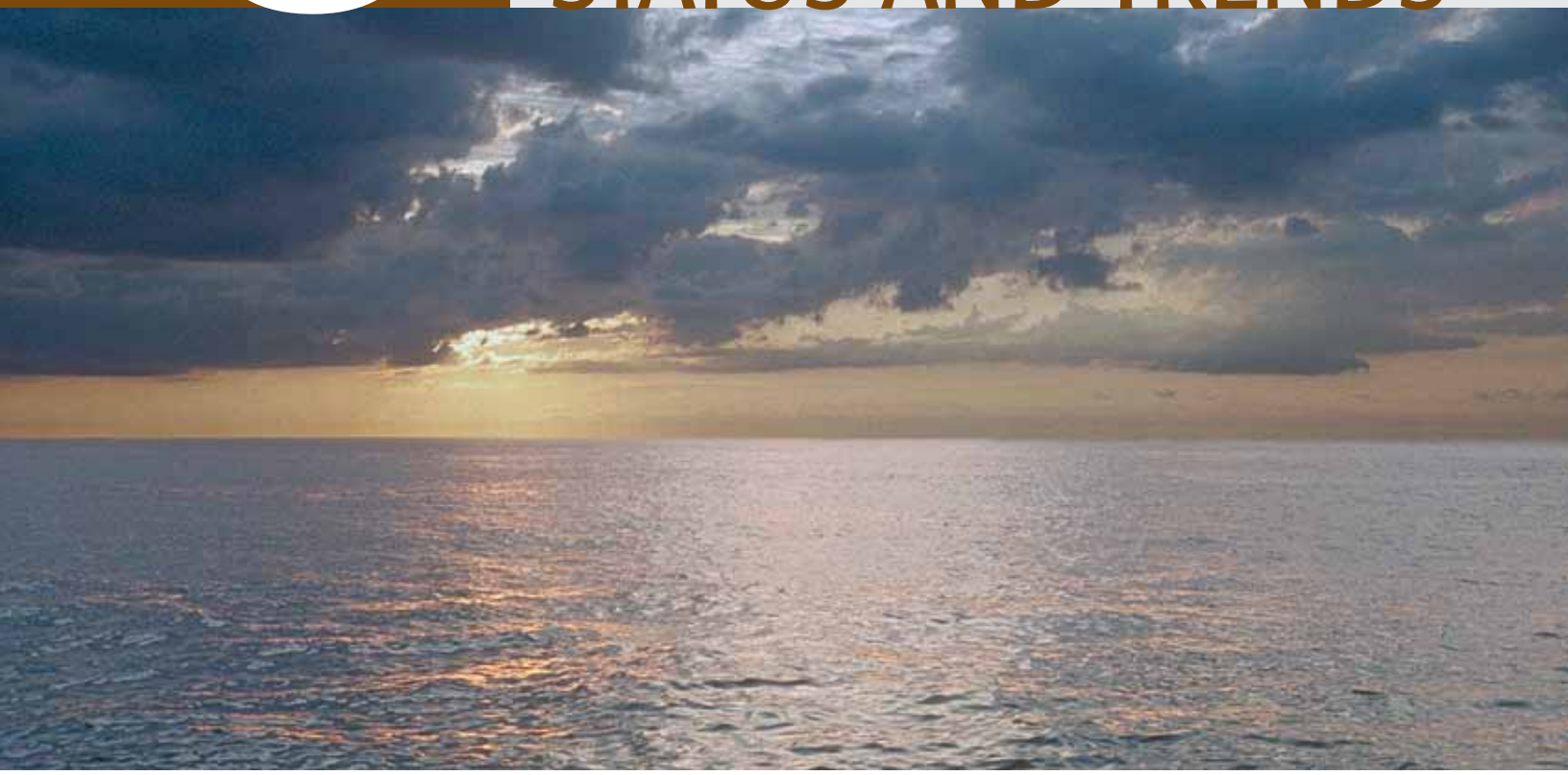
Seismic Testing

Seismic testing involves releasing sound waves into the marine environment in order to produce an image of the subsurface geology of an area (Hurley 2009). High levels of seismic noise can cause mortality, development abnormalities or injuries in the early life stages of fish and invertebrates, i.e., eggs and larvae, with most problems occurring within 5 metres of the air gun (Lee et al. 2011). While studies have found evidence that seismic noise can cause egg and larval fish mortality, the exact impacts in the natural environment remain unknown (DFO 2004).

2.4 MARINE WASTE AND DEBRIS

Marine waste or debris can be defined as any manufactured or processed solid material that enters the ocean either through direct or indirect means (UNEP 2011; USEPA 2011; NOAA 2011). Marine waste and debris includes almost all types of litter present in the ocean, ranging in size from micromillimetres (e.g., microplastics) to hundreds of metres (e.g., fishing gear). It can cause deaths of marine organisms directly through ingestion and entanglement as well as indirectly, such as through the transportation of invasive species that may outcompete indigenous species (see the *Marine Waste and Debris* theme paper). Seabirds and sea turtles are particularly vulnerable to ingestion of plastic materials such as bags or rope. Leatherback turtles mistake plastic bags for their prey, jellyfish. Plastic can cause suffocation, digestive tract blockage or starvation of seabirds and sea turtles.

3 STATUS AND TRENDS



The status and trends related to various sources of incidental mortality are difficult to determine because for most causes of incidental mortality, there is no baseline information for the Scotian Shelf. Available information is provided below and can provide a baseline for future work.

3.1 FISHERIES BYCATCH

Most fisheries occurring on the Scotian Shelf have some form of bycatch and there have been targeted measures to reduce incidental mortality in most of those fisheries, including groundfish, scallop, shrimp, herring purse seine, and pelagic longline. Even where there

have been efforts to document bycatch, it is difficult to be sure how much mortality actually occurs (See Section 4 on Impacts for more information). Some recent studies, discussed below, have examined bycatch in particular commercial fisheries in an attempt to measure impacts and provide a better understanding of the status and trends of bycatch. Readers should be aware that information is not available for all fisheries and that the availability of information does not necessarily mean that bycatch is a greater problem in that fishery than in others for which information is not available. See Section 5 for Actions and Responses to some of the trends discussed below.

Scallop Fishery

The sea scallop (*Placopecten magellanicus*) fishery is one of the more economically important shellfish fisheries in Nova Scotia. In 2009, the total value of the offshore scallop fishery was $85 million and the majority of the catch was exported to the United States and European markets (DFO 2011a). On the Scotian Shelf, the fishery mainly occurs on Browns, Sable Island and Western banks. The gear used to fish scallops is a large dredge or rake, ranging in width from 3.96 to 5.18 metres and trailed by a large chain net that drags along the bottom and a mesh net on top that collects the catch (Walsh 2008). There are no overall bycatch estimates for the Scotian Shelf; however, yellowtail flounder (*Limanda ferruginea*), cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), skates (*Raja* spp.), monkfish (*Lophius americanus*), other species of flounder, and miscellaneous fish and invertebrates are caught as bycatch in the nearby Georges Bank fishery (see e.g., Gavaris et al. 2007; Walsh 2008). A recent assessment of fisheries observer data found that approximately 94% of organisms caught in the fishery on Georges Bank are scallops with the majority (by weight) of the remaining organisms caught being fish (Caddy et al. 2010).

Between 2001 and 2007 the most abundant bycatch species (by weight) in scallop fishing area 29 west were Jonah crab (*Cancer borealis*), Atlantic rock crab (*Cancer irroratus*), hermit crabs (Paguroidea), longhorn sculpin (*Myoxocephalus octodecimspinosus*) and the thorny skate (*Amblyraja radiate*) (Smith et al. 2009). Many other species of skates, benthic invertebrates and groundfish have also been caught as bycatch in this area.

Swordfish and Tuna Longline Fishery

Swordfish is caught by pelagic longline and harpoon gear. The harpoon fleet is allocated 10% (up to 150 t) of the Canadian swordfish quota, while the longline fishery accounts for 90%. The offshore tuna fishery and the exploratory porbeagle shark fisheries also use pelagic longline gear. The pelagic longline gear used by Canadian fishermen consists of a backline that may be up to 64 kilometres long. Styrofoam floats ensure that the line is supported in the water column and there may be as many as 2000 baited hooks attached to the line (Stone and Dixon 2001). Since the gear does not allow for targeting of a specific species, bycatch occurs. Species with the most concerning incidences of bycatch are sharks (blue, porbeagle, and shortfin mako) and sea turtles (loggerhead and leatherback) (Gilman et al. 2006; Gavaris et al. 2010; Carruthers et al. 2011; Table 1).

Table 1. Bycatch species (including alive, dead and unable to determine) by number and weight from the Eastern Canadian pelagic longline fishery from 2004-2009, based on observer data and including both retained and discarded animals. Most bycatch is discarded. Adapted from Devitt et al. 2012.

		YEAR					
BYCATCH SPECIES	**NUMBER/ WEIGHT**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**
FISH							
Cutless Fishes	Number					7	
	Weight (kg)					16	
Sea Lamprey	Number		14				
	Weight (kg)		14				
Longnose Lancetfish	Number	9	8	11	26	10	4
	Weight (kg)	46	19	46	100	60	19
Monkfish	Number		4		1		
	Weight (kg)		13		3		
Oilfish	Number			1	4		
	Weight (kg)			5	114		
Opah	Number				7		
	Weight (kg)				116		
Atlantic Manta Ray	Number	3			1		
	Weight (kg)	455			500		
Manta Ray	Number		1				
	Weight (kg)		200				
Remora	Number	2	9				
	Weight(kg)	5	9				
Blue Shark	Number	2398	2367	1267	1692	836	1138
	Weight (kg)	112764	78661	30759	67267	35208	44145
Hammerhead Shark	Number	1					
	Weight (kg)	15					
Sand Shark	Number					1	
	Weight (kg)					75	
Thresher Shark	Number	1	2	4	2	3	1
	Weight (kg)	90	350	266	682	195	200
Tiger Shark	Number	5	7	2	2	7	1
	Weight (kg)	576	2080	130	450	356	100
Pelagic Stingray	Number	54	17	148	98	113	4
	Weight (kg)	296	41	437	266	306	8
Ocean Sunfish	Number	2		3	3	1	1
	Weight (kg)	260		1120	495	200	80
Blackfin Tuna	Number					1	
	Weight (kg)					20	
Striped Bonito/Skipjack Tuna	Number	1		1			
	Weight (kg)	8		5			
BIRDS							
Great Black-Backed Gull	Number	1					2
	Weight (kg)	2					4
Greater Shearwater	Number	3	1				2
	Weight (kg)	4	1				2
TURTLES							
Leatherback Turtle	Number	8	1	4	10	11	9
	Weight (kg)	1569	91	779	2884	2392	1350
Green Turtle	Number					22	1
	Weight (kg)					870	20
Kemp's Ridley Turtle	Number					1	2
	Weight (kg)					100	60
Loggerhead Turtle	Number	16	31	37	77	90	5
	Weight (kg)	482	958	1476	3127	2803	270
Hardshelled Turtles (unsp.)	Number	12				2	1
	Weight (kg)	494				58	30
MARINE MAMMALS							
Seal (unsp.)	Number						1
	Weight (kg)						135

Table 2. Average annual retained catch in the haddock-directed fishery, by gear, on the western Scotian Shelf and Bay of Fundy (4X5Y), 2002-2008, from logbook data. Fish harvesters were considered to be directing for haddock when it made up more than 50 percent of the catch. Percentage is percentage of total catch (adapted from Cox et al. 2010).

RETAINED SPECIES	BOTTOM OTTER TRAWL		BOTTOM LONGLINE	
	Weight (t)	Percentage	Weight (t)	Percentage
Haddock	3063	82.2	400	63.3
Pollock	130	3.5	2	0.3
Redfish	66	1.8	1	0.2
Cod	263	7.1	126	19.9
Monkfish	49	1.3	3	0.5
Silver hake	0	0	0	0
Winter flounder	49	1.3	0	0
Dogfish	0	0	0	0
Cusk	5	0.1	32	5.1
Halibut	0	0	9	1.4
White hake	40	1.1	54	8.5
Yellowtail flounder	1	0	0	0
Others	60	1.6	5	0.8

Table 3. Total discarded catch in the haddock-directed fishery, by gear, on the western Scotian Shelf and Bay of Fundy (4X5Y), 2004-2008, as estimated from observer data. Fish harvesters were considered to be directing for haddock when it made up more than 50 percent of the catch. Percentage is percentage of total catch. Invertebrates (other than commercial species) were not included (adapted from Cox et al. 2010).

DISCARDED SPECIES	OTTER TRAWL		LONGLINE	
	Weight (t)	Percentage	Weight (t)	Percentage
Dogfish	5035	6.4	2129	7.3
Skates (unsp)	1256	1.6	1145	3.9
Lobster	1138	1.2	-	-
Sharks	583	0.7	-	-
Halibut	208	0.3	104	0.4
Sculpin	87	0.1	-	-
Cusk	-	-	368	1.3
Haddock	-	-	33	0.1
Wolffish	-	-	27	0.1
Others	190	0.2	49	0.2

Groundfish Fishery

Groundfish fisheries across the Scotian Shelf include pollock, halibut and other flatfish (such as American plaice and yellowtail flounder), silver hake, and redfish. As well, there are cod and haddock fisheries that occur on the western Scotian Shelf (DFO 2011b). The groundfish fishery is managed as a multi-species fishery which means one or more species are caught using the same gear and contribute toward landings. In some ways, the simultaneous targeting of species reduces incidences of bycatch since most of the catch is in fact targeted. A groundfish licence holder must adhere to licence conditions which identify certain groundfish species as targeted. This condition makes the fishery different from other fisheries, where discards may be permitted, since incidental catch of other groundfish species must be retained. Most groundfish are caught using mobile gear such as otter or other types of trawlers, but longline, gillnet, seine and handlines are also used (Breeze and Horsman 2005). The catch in the haddock-directed fishery on the western Scotian Shelf and Bay of Fundy was documented by Cox and others (2010) and includes both targeted commercial species and non-targeted, non-commercial species (Tables 2 and 3). It is likely that the catch mix on the eastern shelf would be different.

The Northwest Atlantic is divided into divisions and subdivisions set by the Northwest Atlantic Fisheries Organization (NAFO). These divisions are used to manage most groundfish fisheries in the Northwest Atlantic (Figure 4).

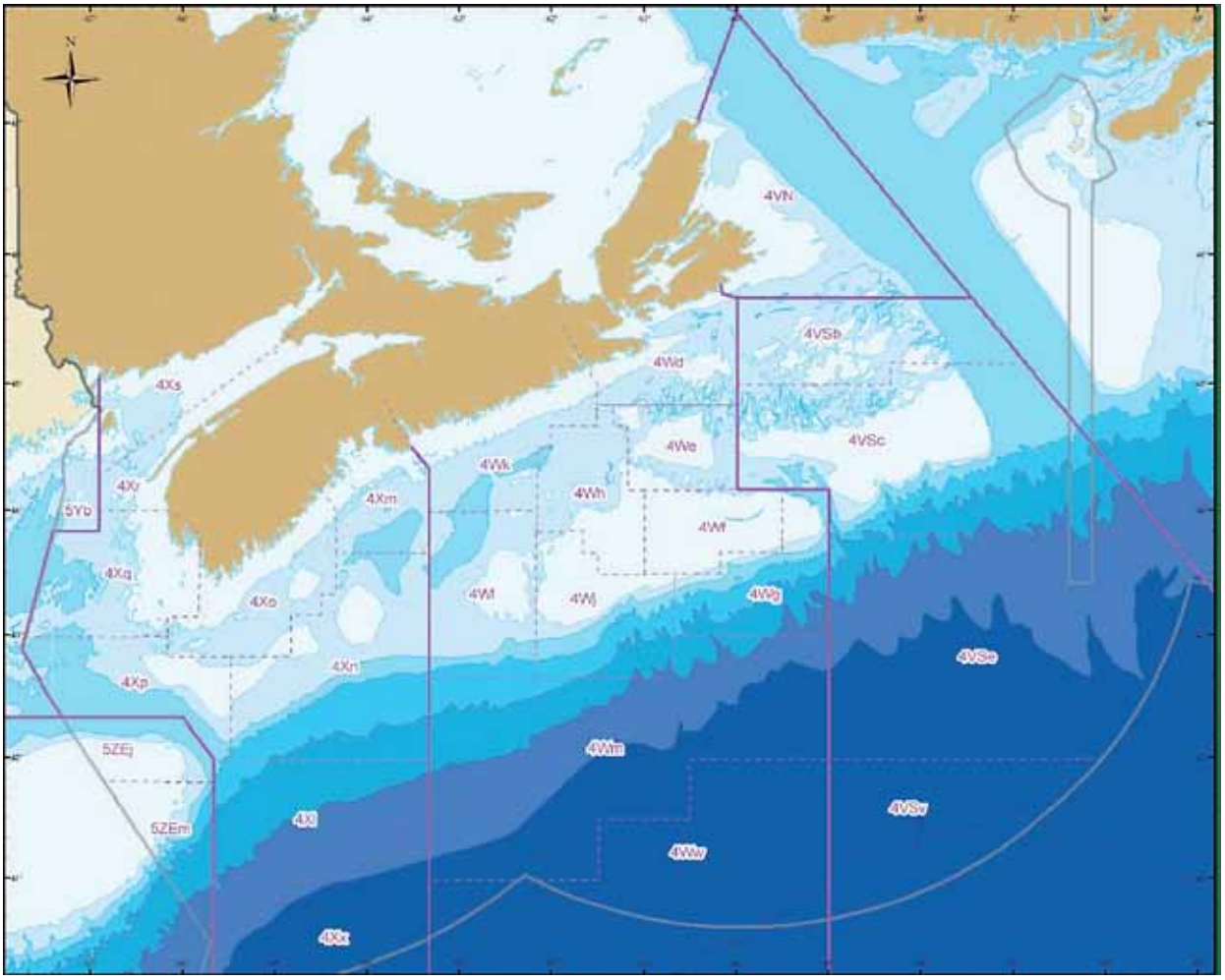


Figure 4. Fisheries management areas for the Maritimes Region (from DFO 2011b).

Fishing Area: 4VW	Groundfish longline	Groundfish bottom trawl	Groundfish bottom trawl offshore	Silver hake bottom trawl	Redfish bottom trawl	Redfish bottom trawl offshore
Snow crab						
Halibut						
Swordfish						
Jonah crab						
Blue shark						
Other sharks						
Herring						
Winter skate						
Other flounders						

Table 4. Summary of discards of licensed species in 4VW fishing region (Eastern Scotian Shelf). Lighter coloured cells indicate lower amounts of discards, while darker colours indicate high amounts. White cells indicate that there is no contribution to discards by that particular fishery (adapted from Gavaris et al. 2010).

Fishing Area: 4VW	Groundfish longline	Groundfish bottom trawl	Groundfish bottom trawl offshore	Groundfish midwater trawl offshore	Silver hake bottom trawl	Redfish bottom trawl	Redfish bottom trawl offshore
Northern wolffish							
Thorny skate							
Porbeagle							
Spiny dogfish							
Basking shark							

Table 5. Summary of discards of species of potential concern in 4VW (Eastern Scotian Shelf). Lighter coloured cells indicate lower amounts of discards, while darker colours indicate high amounts. White cells indicate that there is no contribution to discards by that particular fishery (adapted from Gavaris et al. 2010).

Fishing Area: 4X5Y	Groundfish gillnet	Groundfish longline	Groundfish bottom trawl	Groundfish bottom trawl offshore	Silver hake bottom trawl	Redfish bottom trawl	Redfish bottom trawl offshore	Sculpin bottom trawl
Herring								
Scallop								
American lobster								
Jonah crab								
Snow crab								
Halibut								
Spiny dogfish								
Sea cucumbers								
Atlantic rock crab								
Sculpin								
Blue shark								
Sea urchins								
Clam								
Other flounders								

Table 6. Summary of discards of licensed species in 4X5Y (Western Scotian Shelf and Bay of Fundy). Lighter coloured cells indicate lower amounts of discards, while darker colours indicate high amounts. White cells indicate that there is no contribution to discards by that particular fishery (adapted from Gavaris et al. 2010).

Fishing Area: 4X5Y	Groundfish gillnet	Groundfish longline	Groundfish bottom trawl	Groundfish bottom trawl offshore	Silver hake bottom trawl	Redfish bottom trawl	Redfish bottom trawl offshore	Sculpin bottom trawl
Thorny skate								
Barndoor skate								
Winter skate								
Smooth skate								
White hake								
Porbeagle								
Shortfin mako								
Cusk								
Basking shark								

Table 7. Summary of discards of species of potential concern in 4X5Y (Western Scotian Shelf and Bay of Fundy). Lighter coloured cells indicate lower amounts of discards, while darker colour indicate high amounts. White cells indicate that there is no contribution to discards by that particular fishery (adapted from Gavaris et al. 2010).

Tables 4-7 show the various species that are caught by type of groundfish fishery for fisheries divisions in the Scotian Shelf and the Bay of Fundy. The tables are divided by fishing zone as well as by those species that are discarded but licensed, and those that are discarded but are of potential concern. The data are based on observations of discards by fisheries observers and the shaded cells are determined based on amount, consistency and reliability of the estimates (Gavaris et al. 2010)[2].

Shrimp Fishery

There are two managed shrimp fishing areas (SFA) on the Scotian Shelf, SFA 13-15 and SFA 16 (DFO 2011c); most shrimp is caught on the eastern Scotian Shelf. The shrimp trawl fishery was historically known for the amount of groundfish bycatch associated with it. Between the 1970s and the 1990s, shrimp stocks in the region were underutilized. The gear used in the fishery resulted in a high amount of bycatch and the bycatch was counted toward the total allowable catch for the fishery. However, the fishery is active today because there have been gear modifications that have significantly reduced the amount of bycatch associated with this fishery (Figure 5). Koeller et al. (2009) show that total bycatch is from about 50 to 400 t per year, a relatively small proportion of total catches; however, there is a lot of variability (Figure 6). Parsons and others (2011) documented bycatch in the northern shrimp fishery on the Scotian Shelf (Table 8). Only shrimp may be retained in this fishery, all non-target species are discarded.

3.2 FISHERIES PRECATCH LOSSES AND GHOST FISHING

Information on precatch losses and ghost fishing on the Scotian Shelf is limited, but some studies have been done on the Gulf of St. Lawrence snow crab (*Chionoecetes opilio*) fishery. This was the first snow crab fishery to be established in Eastern Canada when it began in the mid-1960s (Gardner Pinfold 2006). A study by Hébert et al. (2001)

[2] The findings from the Gavaris et al. (2010) study are coarse and the authors acknowledge more investigation is needed to perform a detailed analysis. The purpose of the study was to identify gaps in monitoring and consider the estimates of discards as the first stage in a triage to prioritize potential conservation risks that may be associated with higher discard amounts.

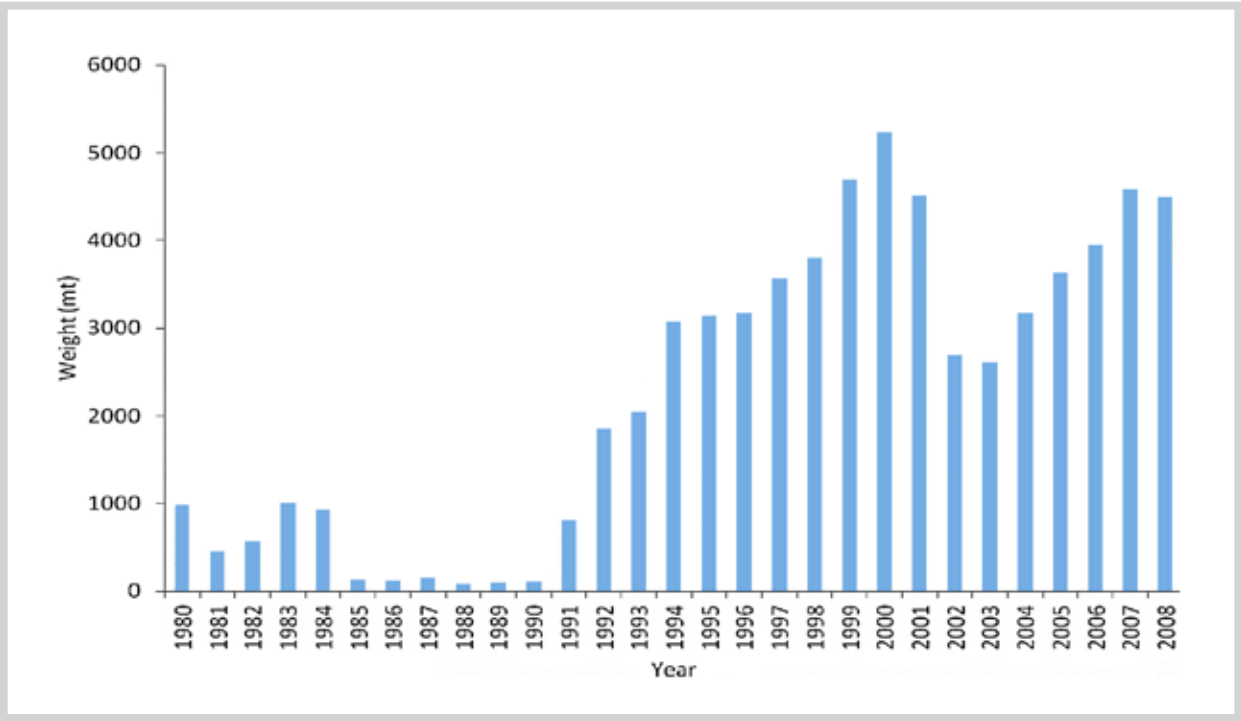


Figure 5. The total catches of shrimp on the eastern Scotian Shelf (SFAs 13 to 15) from 1980 through 2008 (adapted from Koeller et al. 2009).

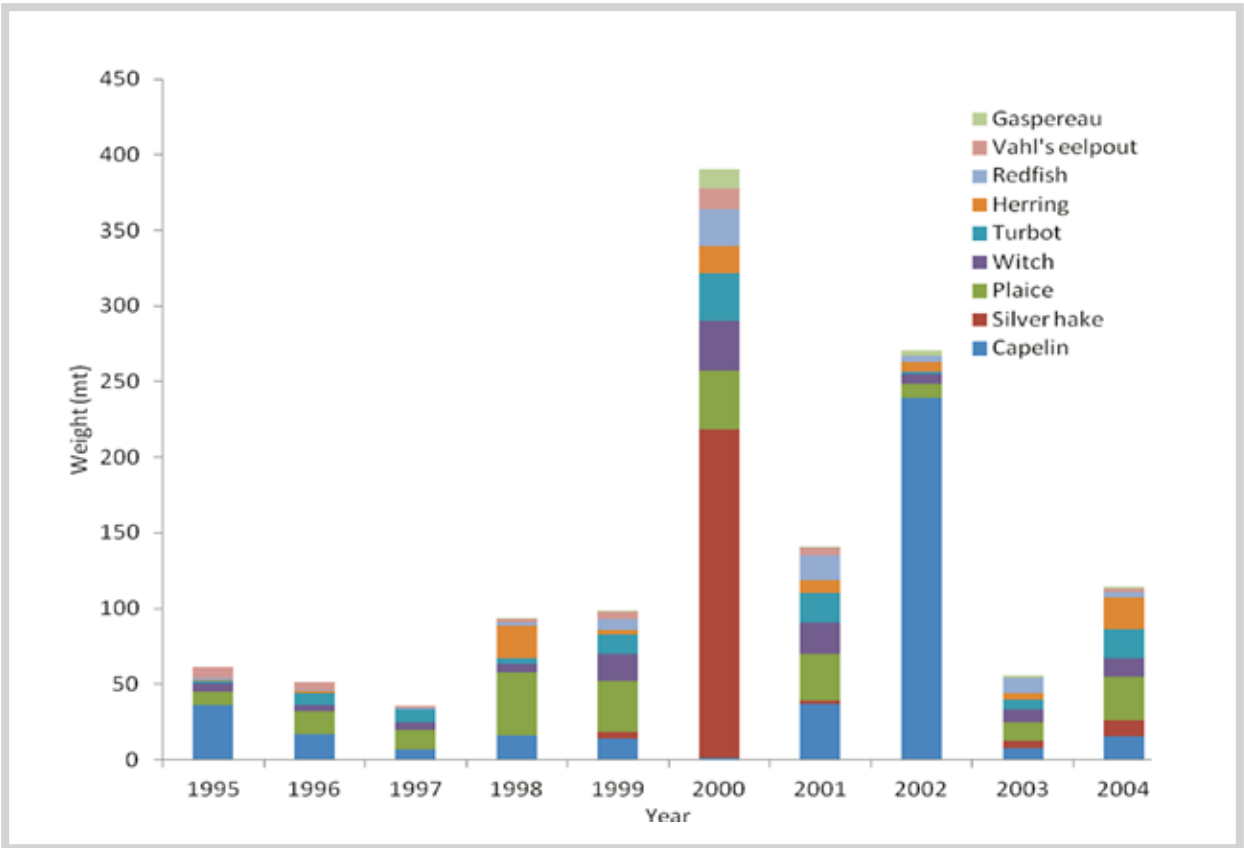


Figure 6. The estimated weight (mt) of bycatch (by species) from the Eastern Scotian Shelf shrimp fishery from 1995 through 2004 (adapted from Koeller et al. 2006).

Table 8. Discards as a percentage of total catch for the years 2002, 2004, 2005, 2006, 2008, 2009 in the northern shrimp (*Pandalus borealis*) trawl fishery on the eastern Scotian Shelf, from observed trips (adapted from Parsons et al. 2011).

Common Name	Percentage of catch
Northern shrimp	0.19
Redfish	0.33
Silver hake	0.31
Witch flounder	0.23
Greeland halibut	0.20
American plaice	0.12
Capelin	0.10
Atlantic herring	0.08
Winter flounder	0.05
Snake-blenny	0.04
Short-fin squid	0.02
Ocean pout	0.02
Eelpout (unsp.)	0.01
Thorny skate	0.01
American eel	0.01
Alligator fish	0.01
Alewife	0.01
Longfin hake	0.01
Red hake	0.01
Atlantic sea poacher	0.01
Shorttailed (Vahl's) eelpout	0.01
Snow crab	0.01
Striped wolfish	0.01
TOTAL	**1.72**

designed to understand the effects of ghost fishing from the Gulf of St Lawrence snow crab fishery predicted that 1000 lost conical traps would kill 84 194 snow crabs per year. With a snow crab fishery now occurring on the Scotian Shelf, it could be assumed that some snow crab fatalities are occurring through ghost fishing in this region as well. Numbers are likely not as high as suggested by Hébert et al. (2001) because changes have been made to the conical traps (including the use of galvanic time releases and biodegradable twine) that may reduce mortalities caused by ghost fishing, but further studies are needed to verify. While the focus of this study was primarily on snow crab mortalities, there were also findings of toad crabs being caught and other studies have suggested that fish can get caught in the traps, starve, die and create bait for crustaceans resulting in a cyclical pattern (FAO 2012a).

3.3 VESSEL STRIKES – ALL SECTORS

The species that are most commonly killed by vessel strikes include fin whales (*Balenoptera physalus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter catodon*), grey whales (*Eschrichtius robustus*) and right whales (*Eubalaena spp.*) (Laist et al. 2001). Though whales are more commonly struck, marine turtles are also at risk of vessel strikes in their summer feeding areas, which include the Scotian Shelf. Not all vessel strikes of marine mammals and turtles are reported on the Scotian Shelf—in some cases, the captain may not be aware that an animal has been hit. However, causes of right whale deaths are monitored and approximately 20% of the right whale mortalities from vessel strikes have occurred in Canadian waters (Brown et al. 2010). Of the known whale-vessel collisions off North America, most have occurred off the U.S. east coast (about 50%), followed by the U.S. west coast (about 20%) and then eastern Canada (about 10%), with the remainder occurring along the Alaskan and Hawaiian coasts and in the Gulf of Mexico (Jensen and Silber 2004).

3.4 OIL SPILLS AND DISCHARGES

Vessel-source Oil Spills and Discharges

Accidental or deliberate releases of petroleum from vessels can be a serious cause of seabird mortality in the offshore. Transport Canada's

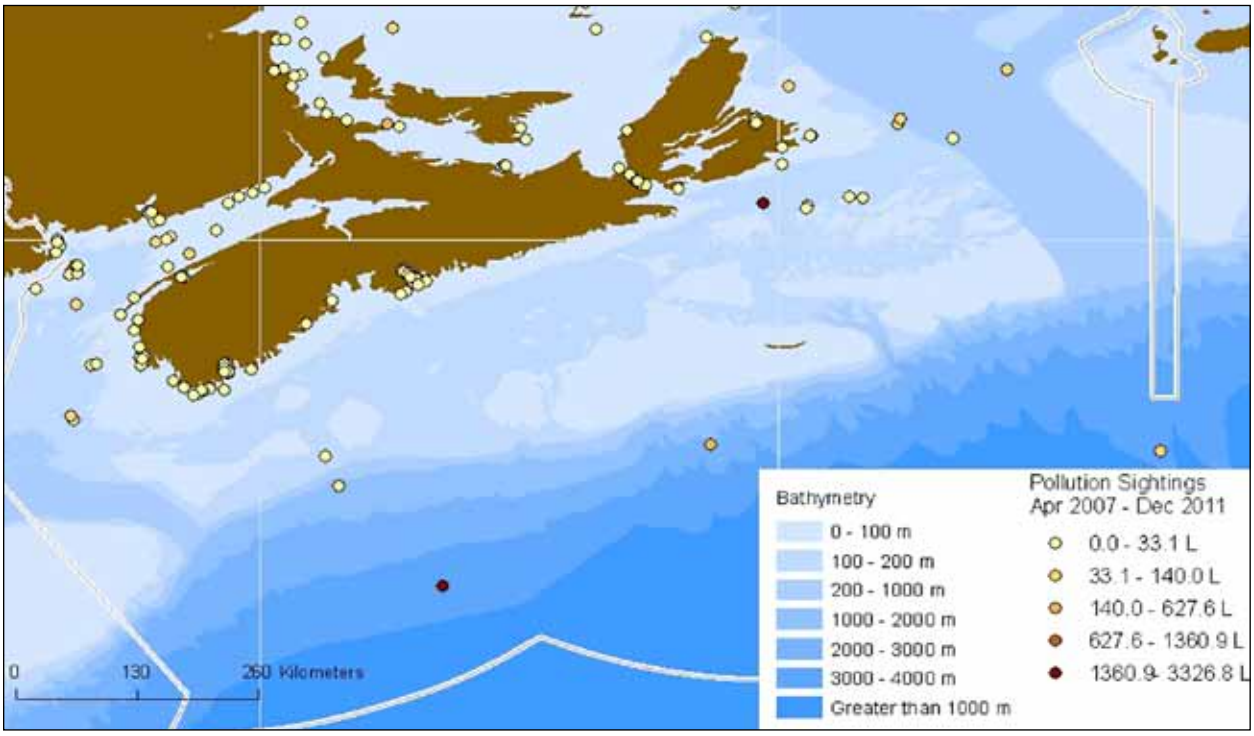


Figure 7. Locations and estimated volume (litres) of spills detected by Transport Canada's National Aerial Surveillance Program in the Bay of Fundy and Scotian Shelf from April 2007 to December 2011.

National Aerial Surveillance Program (NASP) is the main method of oil pollution detection in the region's marine environment (Figure 7). NASP plans and conducts surveillance flights daily, weather and equipment permitting, and it can detect anomalies using on-board remote sensing equipment. Pollution incidents can also be detected by satellite (e.g. through Environment Canada's Integrated Tracking of Pollution program), other vessels at sea, and concerned citizens in port areas.

Petroleum Industry Oil Spills and Blowouts

The offshore oil and gas sector is in a growth phase on the Scotian Shelf and the Province of Nova Scotia is encouraging developers to take advantage of the resources that lie beneath the Scotian Shelf (Government of Nova Scotia 2012). To date there have been no major incidents involving blowouts or spills. However, the Canada-Nova Scotia Offshore Petroleum Board tracks the release of petroleum products into the marine environment from offshore oil and gas development and there have been 51 spills ranging in size from less than 1 litre to greater than 150 litres (Table 9).

3.5 PLASTIC INGESTION

There is little data specific to the Scotian Shelf on plastics at sea and their ingestion by marine life. One study looked at plastics collected in plankton net tows from 1986 to 2008 in the North Atlantic, including parts of the Scotian Shelf (Law et al. 2010). It found that that the highest concentrations of plastic debris were found in a subtropical region surrounding Bermuda, with concentrations diminishing at higher and lower latitudes (Figure 8); data from latitudes equivalent to the Scotian Shelf show the lowest concentrations. Between the 1960s and the 1980s, a global study found that 37% of studied leatherbacks had plastic in their stomachs (Mrosovsky et al. 2009). A study focusing specifically on the Scotian Shelf has not yet been completed.

Table 9. The number of spills from offshore oil and gas activity by approximate volume and product type from April 2006 to March 2012 (adapted from CNSOPB 2012b).

Substance	Less than 1L	1-10L	11-150L	Greater than 150L	Total number of spills
Hydraulic oil	8	5	6	1	20
Diesel	6	1			7
Chemicals		1	1	3	5
Condensate	2	1	2		5
Light oil	1				1
Water based mud				1	1
Oil (unclassified)	5	2			7
Lubricating oil	3				3
Mineral oil		2			2
Total	25	12	9	5	51

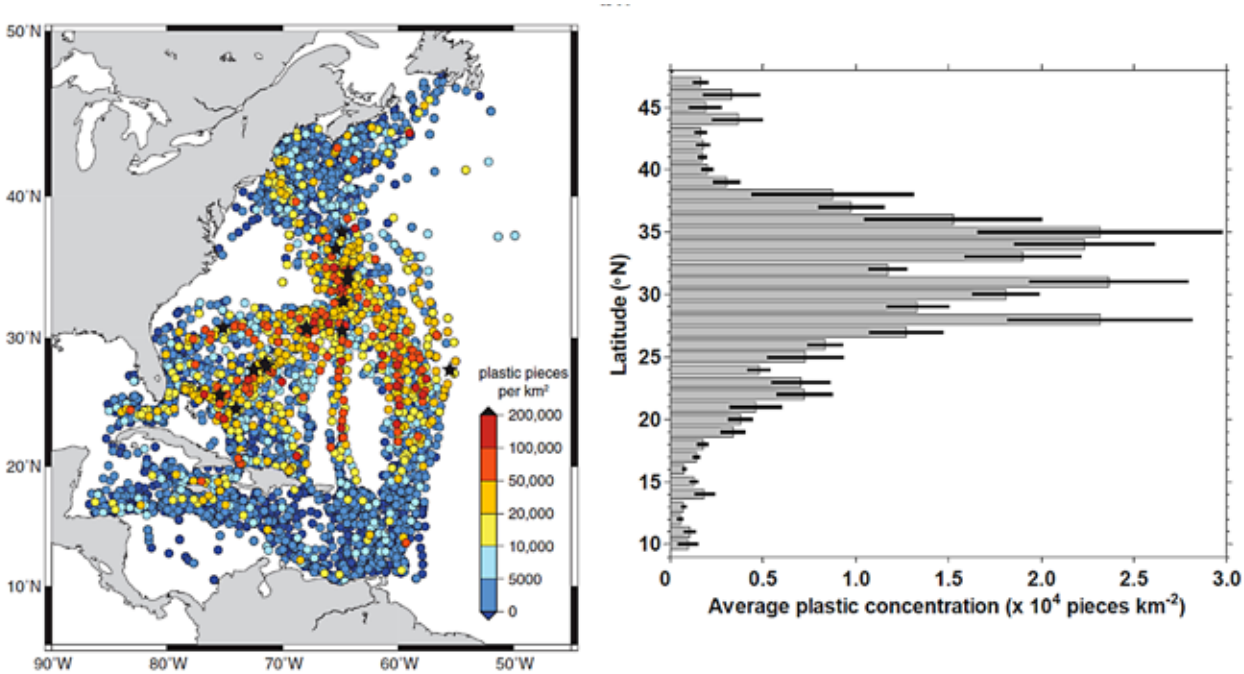
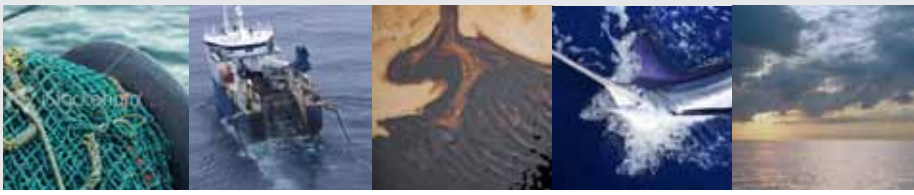


Figure 8. Left: Distribution of plastic marine debris collected in 6136 surface plankton net tows in the western North Atlantic. Black stars indicate tows with measured concentrations greater than 200 000 pieces/km² and symbols are layered from low to high concentration. Right: Average plastic concentration as a function of latitude. Averages were calculated by one-degree latitude groupings; black lines indicate standard error. The highest plastic concentrations were observed in subtropical latitudes (22-38°N). The Scotian Shelf and Slope are found at approximately 41 to 46°N (from Law et al. 2010).

4 IMPACTS

Many occurrences of incidental mortality can go unreported and therefore can be difficult to measure. It is even more difficult to then understand the impacts of incidental mortality on the marine ecosystem. Though the impacts are difficult to understand, information about the impacts on populations from incidental mortality caused by the fishing industry is starting to be gathered. In many cases bycatch and entanglement etc. are reported and can be measured and therefore this section is heavily concentrated on fishing impacts.



4.1 POPULATION

Globally, fisheries bycatch has been identified as one of the leading factors for population declines, particularly of sea turtles, seabirds and cetaceans (Lewison et al. 2004). Studies have demonstrated that impacts of bycatch on seabirds on the Scotian Shelf are not a concern, however, sea turtles and cetaceans are being impacted, though more research is needed to confirm numbers specific to the Scotian Shelf (Anderson et al. 2011; Wallace et al. 2008; Moore and van der Hoop 2012). A concern related to such population declines is that they tend to go undetected before significant declines occur (Lewison et al. 2004). This becomes an issue, particularly with megafauna because they have long life spans and low reproductive output, meaning that their populations take a longer time to recover from depletion. If populations of these high order species decline, there will likely be consequences on other species populations that interact with the megafauna. For example, it is surmised that on average a leatherback turtle consumes between 65-260 kilograms of jellyfish per day (Mrosovsky et al. 2009) and thus, a decline in leatherback turtle populations may increase jellyfish populations. Similarly, it is believed that declines in shark populations result in increased seal populations, thus having a further trickle-down effect impacting herring and pollock populations (Heithaus et al. 2008).

The amount of incidental mortality and impacts of bycatch on these populations are difficult to calculate but analysis of data collected by at-sea observers and research is helping to provide a clearer picture and to help guide management measures that may be required to reduce these impacts.

Sharks and Skates

Populations of sharks and skates have declined due to directed fisheries as well as incidental catches. Blue sharks are the most frequently caught shark species in longline fishing gear and have declined in abundance by 5-6% annually between 1995 and 2005 (Campana et al. 2006; Campana et al. 2011), and were assessed as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2006 (COSEWIC 2011). Blue sharks are highly migratory across the Atlantic and therefore, the decline in abundance cannot be attributed primarily to fisheries in Canada's Atlantic waters; however, they do contribute to the overall reduction (Campana et al. 2006). Using satellite pop-up tags, post-release mortality for blue sharks has been measured at around 19% (Campana et al. 2011). Extrapolating these results to the entire Canadian fishery by using observer reports, Campana and others (2011) estimated that 500 t of discarded blue shark can be expected to die annually from activities associated with commercial fishing. The same study found that 30 t of discarded porbe-

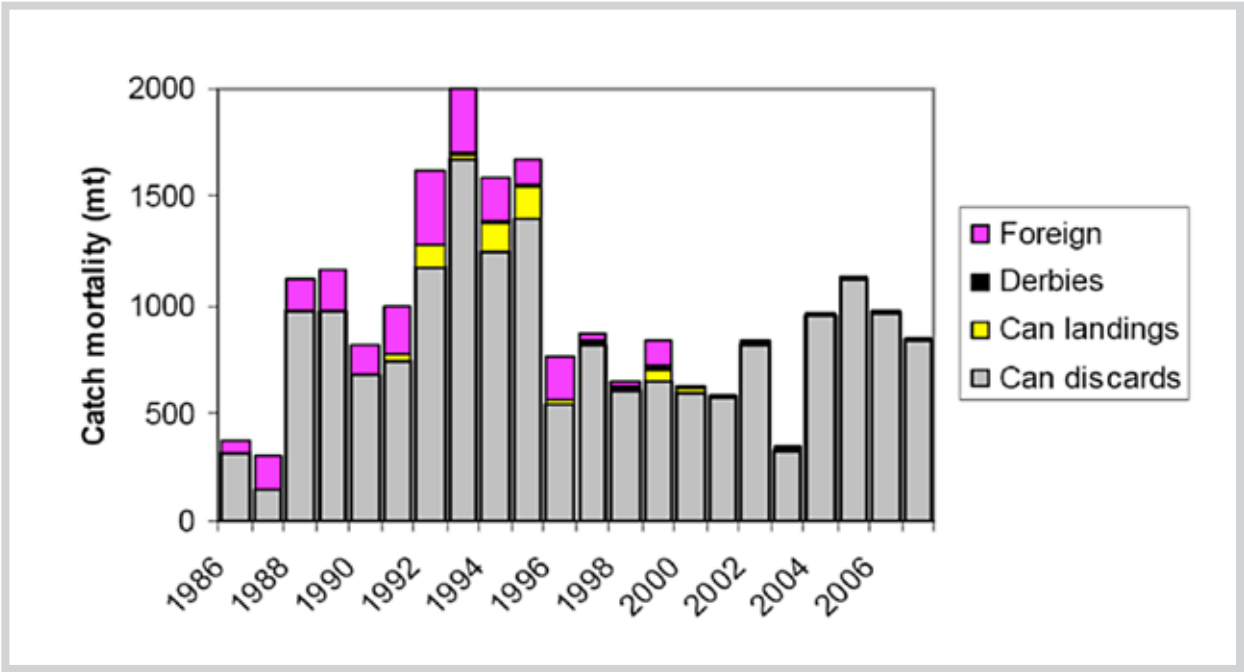


Figure 9. Total catch mortality by source for blue sharks caught in Atlantic Canadian waters (from Fowler and Campana 2008).

agle and 10 t of discarded mako would also be expected to die. Figure 9 provides a summary of total catch mortality by source for blue sharks caught in Atlantic Canadian waters.

Cetaceans and Other Marine Mammals

The Scotian Shelf provides habitat for a number of marine mammals, many of which are threatened or endangered. These include the right whale, blue whale (*Balaenoptera musculus*), northern bottlenose whale (*Hyperoodon ampullatus*), minke whale (*Balaenoptera acutorostrata*), fin whale (*Balaenoptera physalus*), dolphins (*Delphinus* spp., *Lagenorhynchus* spp.), and the grey seal (*Halichoerus grypus*). Both fixed and mobile gear can have impacts on these species. Whales, in particular, are of concern with respect to impacts caused by fishing gear. While the exact mortality rates and impacts are difficult to measure, examples of mortality caused by drowning, emaciation, increased drag, infections from tissue damage, and other impacts of entanglement have been observed in populations of many whale species (Moore and van der Hoop 2012). Through photographic surveys, Knowlton et al. (2012) estimated that the average rate of entanglement of right whales was 19% in 2009. Vessel strikes have had the greatest impact on the right whale. Overfishing of this species in the early 1900's had reduced the population greatly and vessel strikes are hindering the ability for the population to grow. Between 1970 and 2007, vessel strikes accounted for 37% of the known right whale mortalities (Brown et al. 2009).

Sea Turtles

The two sea turtle species known to inhabit Scotian Shelf waters are the leatherback (*Dermochelys coriace*) and the loggerhead (*Caretta caretta*), although there are also a small number of reports of green turtle (*Chelonia mydas*) sightings (James et al. 2004). For sea turtles, the fishing gears that pose the largest threat are gillnet, longline and trawl (Wallace et al. 2010). On the Scotian Shelf, sea turtle bycatch has been observed mainly in the swordfish longline fishery. While it is possible that sea turtles may be released live resulting in some survival, generally it is believed that loggerheads have a post-release mortality rate between 17 and 42% (Wallace et al. 2008). Figure 10 shows bycatch estimates for loggerhead turtles in the entire eastern Canadian pelagic

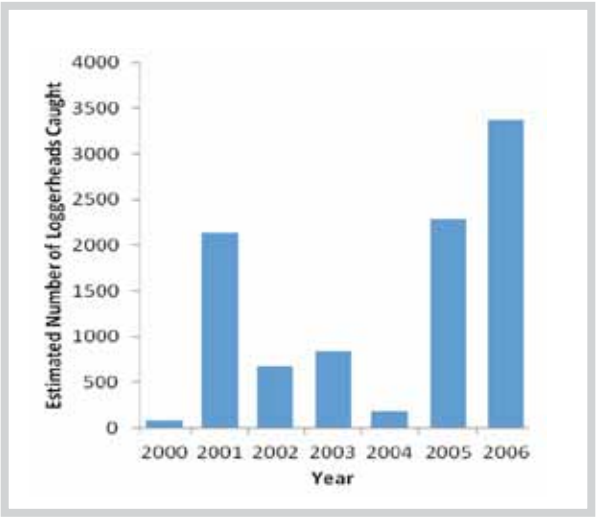


Figure 10. Estimated number of loggerheads captured through the eastern Canadian pelagic longline fishery, which includes an area beyond the Scotian Shelf (adapted from Brazner and McMillan 2008).

longline fishery. There is some variability in the number of turtles caught each year which could suggest a gap in data collection or reflect changing numbers of vessels in the longline fishery.

Corals and Sponges

There are several areas on the Scotian Shelf that have been identified as areas of high density and distribution of cold-water corals and sponges. The Northeast Channel and Lophelia Coral Conservation Areas and the Gully Marine Protected Area were designated to protect cold water corals. However, the locations of corals are not well understood and certain species are more sensitive than others to bycatch and precatch loss. Trawling is considered most damaging as it can clear entire coral colonies in one drag, but some passive gear can result in smothering or partial breakages (Freiwald et al. 2004; Hall-Spencer et al. 2002). In the waters off Nova Scotia's coast, trawling, bottom-set gillnet, bottom-set longline, and pot and trap fisheries pose the greatest threat to coral populations.

Seabirds

The threats that fishing activities, particularly longlining, pose to seabird populations have been deemed to be a large problem throughout the world's oceans. The Scotian Shelf hosts seasonally important habitats for global populations of thick-billed murres (*Uria lomvia*), common murres (*Uria aalge*), dovekies (*Alle alle*), shearwaters (*Puffinus* spp.) and storm-petrels (*Oceanodroma* spp.) (Hedd et al. 2011). Some studies have been done to better understand the impact that pelagic longline fisheries are having on global bird populations. The seabirds are attracted to the baited longline hooks and discharged offal (Tuck et al. 2011). Seabirds can die as a result of swallowing hooks and drowning. However, seabird mortalities can be avoided if the baited hooks are sunk before they are visible to birds or if the hooks are deployed in such a way that seabirds are unable to access the hooks (Bull 2007). While some seabird mortality does occur on the Scotian Shelf as a result of pelagic longline fisheries, the impact on bird populations is relatively minimal when compared to other countries (Anderson et al. 2011).

Estimates of seabird mortality as a result of vessel-source discharges in Atlantic Canada are as high as 300 000 birds per year (Weise 2002). A long term study on Sable Island conducted 93 surveys for bird carcasses from April of 1996 to May of 2005 (Figure 11). The majority of the alcids

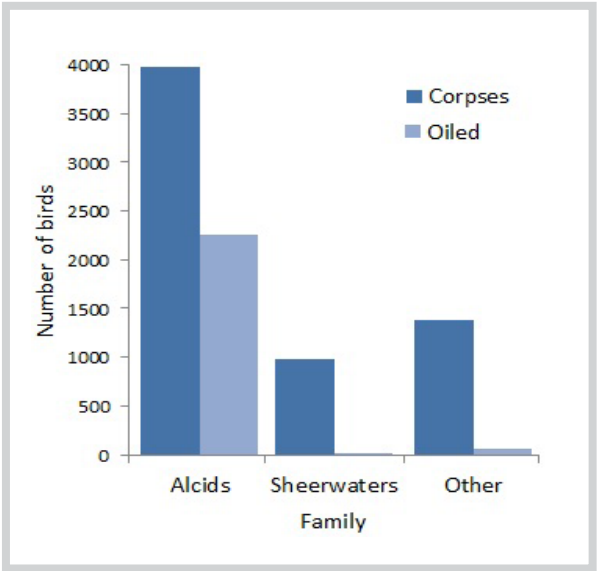


Figure 11. The number of bird carcasses found on Sable Island and the number of those carcasses that were oiled from April 1996 to May 2005 (adapted from Lucas and MacGregor 2006). The "other" category included gulls, loons, gannets, and other bird species.

(e.g., murres and puffins) were found between December and April and the majority of the shearwaters were found between June and August. The artificial light produced by oil platforms has the greatest impact on seabird populations during migration periods. While it is known that artificial lights on the platforms does cause incidental mortality, the actual number of birds that are killed has not yet been investigated (Weise et al. 2001).

4.2 SPECIES AT RISK

Incidental mortality is considered a key threat to the recovery of some species listed under the *Species at Risk Act* (SARA), as well as others that are considered "at risk" by COSEWIC. Incidental mortality is considered a threat to the recovery of several species found on the Scotian Shelf, such as the right whale (vessel strikes, entanglement in fishing gear), blue whales (vessel strikes, entanglement in fishing gear), and wolffish (bycatch). Leatherback turtles are a summer resident on the Scotian Shelf and are listed as endangered under the SARA. While the main threat to endangered leatherback turtles is damage to their tropical beach nesting sites, they are susceptible to entanglement in fishing gear (ALTRT 2006), vessel strikes and often ingest plastic bags.

Several species of sharks and skates found on the Scotian Shelf have been assessed as species at risk by COSEWIC, including the basking shark, blue shark, porbeagle shark, six-gill shark, smooth skate, spiny dogfish, spinytailed skate, white shark, and winter skate (DFO 2007a) (see the *At Risk Species* theme paper). All these species are or have the potential to be caught as bycatch in fisheries. Other fish species considered to be depleted are discussed in the population section above.

4.3 COMMUNITY STRUCTURE AND BIODIVERSITY

When a specific species is targeted, either directly or indirectly, through human activities, there can be significant impacts to the specific species population if the activities are not managed, but there can also be impacts on the community structure and environment with which that species may interact. While such impacts are difficult to measure, research on the issue is resulting in a better understanding of the changes that may occur. For example, the incidental mortality of leatherback turtles on the Scotian Shelf could result in a decrease in the population that feeds in the summer months. If the number of turtles feeding on jellyfish is reduced, it is possible that the jellyfish populations could increase and outcompete other pelagic species.

Ecosystems may also be impacted from habitat alteration, disturbance or destruction that can be caused by bottom-contacting fishing gear, oil and gas activity and submarine cables. Habitat loss can lead to indirect mortality of species that were reliant on that habitat (see the *Marine Habitats and Communities* theme paper). For example, a direct impact of incidental mortality is the loss of coral from fishing efforts. Coral is bycatch in many fisheries, but also provides habitat for many species and again, loss of habitat can lead to mortality or reduced productivity of species that were reliant on that habitat.

5 ACTIONS AND RESPONSES

International organizations, the federal government, industry groups and other organizations have worked to reduce levels of incidental mortality in various marine activities. The following provides an overview of some of the responses to incidental mortality that are occurring at an international, national and local or non-governmental level.

5.1 INTERNATIONAL COMMITMENTS

Bycatch

Within the past decade or so, the international community has begun to address incidental mortality due to fisheries bycatch. The Food and Agriculture Organization of the United Nations (FAO) has developed

International Guidelines on Bycatch Management and Reduction of Discards (FAO 2011) but generally, responses to this issue tend to be species-specific. For example, as the global populations of sharks has declined, the FAO developed the International Plan of Action for the Conservation and Management of Sharks (IPOA – Sharks) which was implemented in 1999 (Techera and Klein 2011; FAO 2012b). The IPOA-Sharks is a voluntary strategy whereby countries who sign on commit to developing national plans to reduce levels of shark bycatch (FAO 2012b). In response to the FAO's initiative, Canada developed a National Plan of Action for the Conservation and Management of Sharks in 2007 (DFO 2007a). Along with providing an overview of shark and skate populations and status in Canadian Atlantic, Pacific and Arctic waters, the Plan identifies ways in which efforts will be made to reduce shark and skate bycatch levels including improving regulatory frameworks and enhancing reporting measures (DFO 2007a). In addition to the IPOA – Sharks, the FAO has also developed an International Plan of Action for Seabirds (IPOA – Seabirds) (FAO 2012c). Canada has joined this initiative as well through the development of the National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (DFO 2007b). International regulatory frameworks, even if they are voluntary, can be effective in encouraging the development of management plans on a national scale.

In addition to the FAO, regional fishery management organizations (RFMOs) have taken steps toward developing guidelines to reduce incidences of bycatch. For example, international tuna fisheries have been identified as one of the main sources of bycatch for seabirds, sea turtles, sharks, marine mammals and young or undersized targeted fish (Gilman 2011). As a result, several RFMOs including the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Western and Central Pacific Fisheries Commission (WCPFC) have identified and encouraged the use of best practices through gear modification and changes in fishing methods (Gilman 2011). While these are important changes, some researchers have suggested that these methods only prevent bycatch of particular species but do not reduce bycatch of others (Gilman 2011), suggesting there is still much work to be done through RFMO regulatory measures.

Precatch Losses and Ghost Fishing

The exact effects and extent of precatch losses and ghost fishing are yet to be understood. Due to this lack of information, international measures directly addressing precatch losses and ghost fishing are somewhat limited. FAO's International Guidelines on Bycatch Management and Reduction of Discards (FAO 2011) recommend that nations and/or RFMOs should adopt measures for reducing precatch losses and ghost fishing through the development of technologies, adoption of gear modifications and improved retrieval procedures (FAO 2011). The FAO acknowledges that much more information and research is needed to understand the full effect of these activities and encourages nations to complete such research.

Entanglement

There have been some initiatives to help reduce entanglement in the region. The World Wildlife Fund (WWF) works with fishermen and other non-governmental organizations (NGOs) in Atlantic Canada to raise awareness about the impacts of fishing gear on the right whale and has held workshops with fishermen to help develop methods of setting gear that are likely to have the lowest impact on right whales (WWF 2010). Additionally, the Canadian Sea Turtle Network has developed a partnership with fishermen throughout Nova Scotia to help raise awareness about leatherback turtles and provide instruction on how to free a leatherback from gear safely.

Vessel Strikes

The International Maritime Organization (IMO) is the main regulatory body for international marine transportation. The IMO has the capacity to facilitate and implement changes to vessel traffic

to reduce the risk of vessel strikes on whales in response to applications put forward by member governments. Canada is a member government of the IMO and has had successful applications through the IMO to designate North Atlantic right whale habitat in the Roseway Basin on the Scotian Shelf as an Area to be Avoided by vessels (Vanderlaan and Taggart 2009). The IMO has also produced a document that provides guidance to mariners on how to reduce the risk of vessel strikes on whales (IMO 2009).

Vessel-Source Discharges

The International Convention for the Prevention of Pollution from Ships (MARPOL), of which Canada is a signatory, sets standards for discharges from ships and also deals with ship-source pollution from accidents. This convention prohibits the discharge of bilge water into the marine environment that contains oil concentrations over 15 parts per million (Gard 2011).

Marine Waste and Debris

The impacts that marine waste and debris have on marine ecosystems are slightly different from those of other activities mentioned throughout this report since they generally occur over an extended period of time. MARPOL directly addresses and prohibits the disposal of plastics and garbage from ships in Annex V (IMO 2012b). Despite this international regulation, it is estimated that ships still discard approximately 6.5 million tons of plastic per year (Derraik 2002).

5.2 FEDERAL AND PROVINCIAL POLICY AND LEGISLATION

Bycatch

Aside from the national action plans discussed previously, Canada employs other policies and legislation in an effort to reduce bycatch. Section 33 of the Fishery (General) Regulations (FGR) (1993) requires that any fish caught

incidentally must be returned to the place where it was retrieved, but states that exceptions can be made where specified (e.g., Atlantic Fishery Regulations). Furthermore, in an effort to prevent high-grading, Section 34 of the FGR states that the dumping of fish caught in accordance with the *Fisheries Act* is prohibited. Measures such as the mandatory release of incidental catch and the mandatory retention of target species are designed to reduce the incidences of bycatch and are explicitly outlined in the FGR. Some examples of other measures used in specific fisheries to reduce bycatch are described below.

There are a number of strategies for specific fisheries that have been implemented to reduce bycatch. Integrated fisheries management plans (IFMPs) have been created by DFO in an effort to "guide the conservation and sustainable use of marine resources" (DFO 2012a). Many IFMPs describe measures to prevent bycatch in a particular fishery and improve post-release survival. For example, in the IFMP for Canadian Atlantic Swordfish and Other Tunas, a management measure for maintaining species diversity is to minimize incidental mortalities on non-targeted species. Other measures within the swordfish and tuna fishery that are used to reduce bycatch include size requirements, proper handling and release of species at risk (such as leatherback

turtles), the use of circle hooks, and practicing live release (DFO 2012b). While there are numerous measures in place to reduce bycatch, more research is needed to fully understand the impacts of this fishery.

Lastly, gear modifications and licence conditions for specific fisheries have been designed to promote sustainable fishing, and in some cases, minimize incidences of bycatch. For example, undersized crab and small non-target species have been identified as the bycatch species for the snow crab fishery. As a result, a condition of snow crab fishing licences is that undersized or non-target species be subject to a mandatory release and gear must conform to size restrictions in order to prevent undersized catch. There have also been gear modifications in the scallop fishery that have resulted in a reduction of groundfish bycatch while maintaining the same amount of scallop catch (DFO 2009). Several other fisheries throughout the Scotian Shelf are required to follow similar regulations and gear modifications.

Precatch Losses and Ghost Fishing

Nationally, there are no policies directly related to the regulation of precatch losses and ghost fishing. However, there are some that indirectly address these issues. For example, the Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas was developed by DFO in an effort to reduce impacts from fisheries on benthic marine ecosystems. Protection of these ecosystems is achieved through such measures as fisheries closures, gear restrictions and gear modifications (DFO 2012c). In addition, some IFMPs and national management plans require fish harvesters to label their gear and in some cases, fish harvesters may be fined for lost gear. Biodegradable panels or materials are also required for the gear in particular fisheries (e.g., snowcrab) so that if gear is lost, it does not ghost fish for much longer than a regular fishing season.

Vessel Strikes

A right whale recovery strategy has been developed through SARA that addresses the many threats to right whales, including vessel strikes (Brown et al. 2009). The objective is to reduce vessel strikes by obtaining a better understanding of the risks associated to right whales from vessels and creating management strategies that help to reduce those risks through collaboration with the shipping industry (Brown et al. 2009). An example of one of these collaborative management strategies is the Coast Guard "Notice to Mariners," which provides information on the Roseway Basin Area to be Avoided.

Vessel-Source Discharges

Canadian law and regulations implement the marine pollution provisions of MARPOL. Transport Canada enforces the Vessel Pollution and Dangerous Chemicals Regulations (2012) under the *Canada Shipping Act*, which prohibits vessels within Canadian waters and Canadian vessels in other waters from releasing bilge water that contains oil concentrations above 5 parts per million.

Large Oil Spills

The *Emergency Management Act* assigns the Minister of Public Safety the responsibility for managing response efforts during an environmental emergency. The minister is also responsible for assessing environmental response management plans and strategies. The Federal Emergency Response Plan works to harmonize the response efforts between all organizations and parties involved in environmental emergency response (Government of Canada 2011). The Canadian Coast Guard is one of the first responders in the event of an oil spill and they have stores of equipment across the region. There are also private companies, such as the Eastern Canadian Response Corporation (ECRC) that are fully equipped to respond to a spill event to aid the Canadian Coast Guard. In the Maritimes Region, a group of federal, provincial and non-governmental departments and organizations, known as the Regional

Environmental Emergencies Team (REET), are called together in the event of a spill to share information and plan the response activities (Environment Canada 2012).

In addition to the emergency response described above, the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) and associated legislation and regulations are responsible for environmental protection during all phases of offshore petroleum activities. The CNSOPB requires all offshore operators to have an Environmental Protection Plan in place and be able to demonstrate that they are able to respond to an environmental emergency, if one were to occur (DFO 2011d). They set standards for environmental protection during offshore oil and gas development and conduct environmental assessments for offshore projects (CNSOPB 2012c).

Other Petroleum Industry initiatives

The provincial and federal government agencies that are involved in offshore oil and gas activities have worked together to develop the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (Government of Canada 2007). This statement is targeted mainly towards marine mammals, and while it is known that seismic activity causes behavioural changes in marine mammals, it still remains unknown whether it actually causes incidental mortality. However, this initiative is a precautionary approach to conducting this activity and lowers the overall impact on marine mammals.

Marine Waste and Debris

In addition to MARPOL Annex V, which Canadian vessels are also expected to adhere to in an effort to reduce waste and plastics from entering the oceans, Section 98 of the *Vessel Pollution and Dangerous Chemicals Regulations* (2012) under the *Canada Shipping Act* (2001) addresses marine debris. Additionally, the *Canadian Environmental Protection Act* also regulates vessel pollution. While both laws address various aspects of marine waste and debris disposal, there are concerns with enforcement and compliance (Derraik 2002).

5.3 INDUSTRY AND COMMUNITY LED INITIATIVES

Bycatch

The fishing industry itself is engaging in activities to lessen bycatch. These measures range from being somewhat formal to informal (e.g., avoiding areas where they have experienced a lot of bycatch). There are also initiatives between DFO and the fishing industry to work together on research projects to examine bycatch patterns in an attempt to mitigate the issue (DFO 2012c). Within the swordfish/tuna fishery, licence holders must take a turtle handling certification course and have dehooking gear on board their vessel in order to reduce post-release mortality.

In 2013, the groundfish fishing industry in the Maritimes Region implemented a conservation strategy for skate species. This strategy includes the development of a laminated card providing fish harvesters with best practices for handling live skates, a skate identification guide to improve accurate reporting of discarded

skate species and a recommended move-away protocol when encountering large quantities of thorny skate. The industry has also implemented a measure requiring the mandatory release of thorny skates by all groundfish vessels.

Some international NGOs are attempting to develop creative solutions to encourage a reduction in bycatch levels. WWF International launched the International Smart Gear Competition in 2004 which encourages fishermen and industry to develop cost-effective and innovative ways to modify fishing gear or practices to reduce bycatch (WWF 2012). WWF then works with industry and other relevant parties to test and begin implementation of winning ideas.

Ghost Fishing

In an effort to eliminate impacts from ghost fishing caused by derelict lobster traps, DFO staff and local fish harvesters came together to recover more than 500 "ghost" lobster traps from Saint John Harbour in New Brunswick (Recchia 2010). The fish harvesters helped to identify areas where they suspected traps would have been lost. They were then collected by the harvesters themselves and fisheries officers. Harvesters do not want to lose their gear because it can be costly to them, so they are willing to adhere to regulations to reduce the loss of gear and may also develop measures of their own. Transmitting devices can be attached to gear to allow for retrieval if it is lost.

Vessel Strikes

The voluntary area to be avoided on the Scotian Shelf set up by the IMO is largely complied with by industry and the majority of vessels now avoid the Roseway Basin (Vanderlaan and Taggart 2009).

Large Oil Spills

Response to large oil spills that occur as a result of a tanker accident are in part the responsibility of the International Tanker Owners Pollution Federation (ITOPF) (ITOPF 2010). Members of ITOPF pay a fee and in the case of an accident, members receive response aid in the form of funding or physical response efforts from the federation.

For offshore oil and gas operations, the International Petroleum Industry Environmental Conservation Association (IPIECA) provides information to operators on best practices for the industry (IPIECA 2012). Nationally, the Canadian Association of Petroleum Producers (CAPP) works to prevent spills through responsible operations, but also responds to spill events (CAPP 2012).

Marine Waste and Debris

Some local initiatives aim to reduce marine waste and debris on the Scotian Shelf. For example, the Ship to Shore program developed by Clean Nova Scotia works with Nova Scotian fishermen to encourage them to transport garbage back to shore instead of throwing it overboard (Clean Nova Scotia 2012).

INDICATOR SUMMARY

INDICATOR	DPSIR ELEMENT	STATUS	TREND
Number of oil and gas developments on the Scotian Shelf	Pressure	Good – Currently 7 offshore platforms operating on the Scotian Shelf.	No trend – Less activity than there has been in the past; however, it is expected to increase.
Amount of commercial vessel traffic on the Scotian Shelf	Pressure	Fair – A large number of vessels currently transit the Scotian Shelf, potentially causing incidental mortality.	Unknown – Systems for tracking and analysing the number of vessels transiting the shelf have only recently been put in place.
Vessel discharges of oily substances	State	Good – Discharges and spills are monitored by NASP	Unknown – Difficult to track; likely less oil entering the environment in the last 10 years because of regulations and monitoring.
Non-target fish species as percent of total catch (groundfish fishery)	State	Fair – Non-target fish species make up about 12% of the total catch in the western Scotian Shelf haddock fishery	Unknown – Needs to be tracked over a longer time period.
Non-target species as percent of total catch (shrimp fishery)	State	Good – Bycatch is currently estimated at less than 2% in the Scotian Shelf shrimp fishery.	Improving – Before the early 1990s, there were high levels of bycatch.
Number of depleted species and species at risk where a threat to recovery is incidental mortality	Impact	Poor – Currently 17 marine species listed under SARA; many other species are considered depleted.	Worsening – No species have recovered and others have been assessed by COSEWIC as "at risk."
Number of oiled seabirds in beach surveys	Impact	Poor – More than 2000 oiled birds were collected in Sable Island beach surveys, 1996-2005.	Unknown – No information over a long time period.
Changes to community structure of marine ecosystems due to incidental mortality	Impact	Unknown – Difficult to attribute observed changes to incidental mortality; however, changes have been seen elsewhere and may be occurring on the Scotian Shelf.	Unknown
Integrated fisheries management plans	Response	Good – There are IFMPs which address incidental mortality for most Scotian Shelf fisheries.	Improving – Efforts to reduce incidental mortality are included in most IFMPs.

Data Confidence:

- For commercial fisheries, landings of target and bycatch species are recorded in fishing logs; fisheries observer data is a good source of information on a variety of species that are returned to the water.
- The Canada-Nova Scotia Offshore Petroleum Board tracks discharges by offshore oil and gas operations.

Data Gaps:

- Much of the knowledge of non-retained bycatch is from observer data. Fish harvesters may change their fishing practices when observers are aboard, thus it is not clear if observer data represents a "true" picture of bycatch. Determining how much mortality is actually occurring is difficult.
- Enforcement of vessel discharges and other sources of pollution is difficult; NASP data is patchy and has more effort where there have been incidents (e.g., grounding of vessels, known accidental discharges).
- Information on impacts of many of the pressures addressed in this report is patchy; there are no regular systematic surveys, e.g., of oiled seabirds or animals entangled in marine debris.
- Vessel strikes sometimes go unreported.

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