

## Unique northern Atlantic cod refuge in Smith Sound

Potentially Harmful Activity (X)			Potentially Harmful Stressor (X)			
Fishing	Bottom trawl		Marine pollution	Oil pollution		
	Scallop dredges			Industrial effluent		
	Clam dredges			Fishplant effluent		
	Midwater trawl			Sewage		
	Gillnets (groundfish)	X		Historic military waste		
	Gillnets (pelagic)			Long range transport of nutrients		
	Long line			Acid rain		
	Scottish seining			Persistent Organic Pollutants (POPs)		
	Purse seining			Eutrophication		
	Recreational cod fishery	X		Ghost nets	X	
	Crab pots			Litter		
	Lobster pots			Other contaminants (specify)		
	Whelk pots					
Other harvest	Otter trapping		Climate Change	Ice distribution		
	Seal hunt			Temperature change	X	
	Seabird hunt			Sea-level rise		
	Seaweed harvest			Ocean acidification		
Seabed alteration	Anchor drops/drags			Current shifts		
	Ore spill			Increased storm events	X	
	Fish offal dumping			Increased UV light		
	Finfish aquaculture			Oxygen depletion		
	Dredge spoil dumping			Changes in freshwater runoff		
	Dredging			Other (specify)		
	Mining					
Coastal alteration	Cables			Harmful species	Green crab	
	Freshwater diversion				<i>Membranipora</i>	
	Subtidal construction		Golden Star Tunicate			
	Intertidal/coastal construction		Violet Tunicate			
Other (specify)			Vase Tunicate			
			<i>Codium fragile</i>			
Disturbance			Clubbed Tunicate			
	Vessel traffic		<i>Didemnum</i>			
	Ship strikes		Toxic Algal Blooms			
	Ecotourism		Disease organisms (human waste)			
	Marine construction		Disease organisms (aquaculture)			
	Seismic surveys		Other harmful species (specify)			
	Navy sonar					
Other (specify)		Other				

We have interpreted this CP to include the physical environment, with stressors limited to changes in the physical, chemical or biological environment of Smith Sound or activities which disturb the cod in Smith Sound during the period (Nov-April) when cod form dense aggregations in the area.

**Gillnets (bottom):**

Fishing mortality is considered the greatest threat to Smith Sound cod and there is a risk that fishing inshore may impede recovery of the entire stock (Fisheries and Oceans Canada, 2008). Following the discovery of dense aggregations of cod in Smith Sound in 1995, a small (index) fishery directed at these inshore populations was introduced in 1998. Catch rates declined and the fishery was closed in 2003. Catches during 2004-2005 were limited mainly to bycatch (>600t) in the winter flounder fishery (Fisheries and Oceans Canada, 2008) and sentinel fisheries. Sentinel catch rates near Trinity Bay (southern 3K and northern 3L) have generally increased since 2002 and are currently above average for the time series. A directed stewardship fishery was reopened in the inshore in 2006 to replace the index fishery in 2006. Reported landings from the 2007 stewardship fishery were 2364t. In addition, 182t were landed in the sentinel fishery. These fisheries largely utilize gillnets. Bycatch in other directed fisheries, including winter flounder and lumpfish, which utilize gillnets, are also significant.

Total fishing mortality is estimated at 20% of the biomass (Corey Morris, Biologist, Fisheries and Oceans Canada, PO Box 5667, St. John's, NL, A1C 5X1, "pers. comm."). Stewardship fishery catch rates in 2006-07 were slightly higher than in earlier fisheries between 1998 and 2002. A pre-recruit index suggests that the strength of the 2003-2006 year-classes will be much lower than those that have supported recent fisheries (Fisheries and Oceans Canada, 2008). Gillnet fishing is clearly a major source of mortality and has been screened in for further analysis.

The main directed fisheries for cod using bottom gillnet occur in the late summer or fall (September-October), including the stewardship and sentinel fisheries. Bycatch of cod may occur in other gillnet fisheries including the winter flounder fishery (August), and the turbot and lumpfish fisheries which typically take place in June-July. The turbot fishery does not take place within Smith Sound. Gillnet fishing therefore does not occur in Smith Sound during the period (November-April) when cod form dense aggregations in the area.

**Screened out.**

**Recreational cod fishery:**

Historically, cod has been an important part of the diet in Newfoundland, and access to a winter supply of fish is considered a traditional right which residents took for granted until the implementation of the groundfish moratorium. As a result, there was intense pressure to open a food/recreational fishery when dense aggregations of fish were detected in Smith Sound and adjacent coastal areas in 1995. In response to public pressure, a food fishery was opened for a number of years, but was closed again in 2003 in response to declining inshore stocks. The fishery was reopened in 2006.

Only handline and angling gear is permitted. Handlines include baited hooks, feathered hooks and artificial lures. A maximum of three (3) hooks per line may be used. The season

dates are set each year, typically 3-4 weeks in late July/early August, and an additional 1-2 weeks in late September/early October, for a total of five weeks. Recreational fishers are limited to five (5) groundfish per day (including cod), and 15 per boat trip. The recreational fishery does not occur in Smith Sound during the period (November-April) when cod form dense aggregations in the area. **Screened out.**

### **Ghost nets:**

Ghost nets are fishing gear that have been lost or discarded at sea. Fishing, legal or otherwise, involves an inherent risk of gear loss. Factors such as weather, currents, tides, sea state, depth, fishing intensity, presence of sea ice, the make up of the seafloor, the condition of the gear, equipment and vessel all contribute to the risk of lost gear (Hareide, N-R. et al., 2005; The British Ecological Society, 2000).

Since the 1960s, fishing nets have been constructed from highly durable plastic materials such as nylon, polypropylene and polyethylene, which are largely impervious to biodegradation; they are resistant to chemicals and abrasion (National Academy of Sciences, 2008). Unlike their natural predecessors, the new materials can last for years or decades in the marine environment, and lost gear or even torn fragments of netting or line floating in the sea can continue to fish for considerable periods (The British Ecological Society, 2000). Lost gillnets, traps, trawls and line fisheries are considered the most harmful (National Academy of Sciences, 2008), and of those, gillnets are generally thought to be the most problematic.

Set bottom gillnets, by virtue of their fixed, anchored framing, may remain fully deployed and fishing long after they are lost or abandoned. As nets become fouled, they become more visible, lose their vertical profile and their fishing capacity declines, but limited investigations have shown that gillnets lost in deepwater (>400m) can fish for years after they are lost because there is very little bio-fouling or water movement in depths below 400m (National Academy of Sciences, 2008). Even when nets collapse, forming balls on the sea floor, they continue to fish. Recent studies of nets on the seabed have shown that a typical pattern of capture is observed. Over the first few days, catches decline almost exponentially as the increasing weight of the catch causes the net to collapse. Then for the next few weeks, the decay of captured animals attracts a large number of scavenger species such as crabs, lobster and fish. This cycle of capture, decay and attraction continues for as long as the net retains entanglement properties. Once on the bottom, monofilament nets may, once clear of fish remains, disentangle, return to an upright position and resume fishing (The British Ecological Society, 2000).

We have no data on the number of ghost nets in Smith Sound, but data from other areas indicates that the problem is likely to be significant. The Northwest Straits Commission estimates that there are nearly 3,900 gillnet remaining in Puget Sound from domestic salmon fisheries from the 1970s and 1980s. In a recent survey of over 1,000 fish harvesters currently operating within Placentia Bay, 67% reported experiencing loss of gear (FFAW, 2007), and both DFO and industry recognized it as a major concern for Atlantic Canadian fish harvesters. A ghost net retrieval program conducted in Placentia Bay in the 1990s retrieved sixty ghost nets containing 30,000 lbs of rotting cod, as well as other species. Some 10,000

vessels, mainly small boat, inshore operations, fished monofilament gillnets in Atlantic Canada prior to the northern cod moratorium. While it is difficult to quantify the amount of lost gear, studies suggest that some 8,000 active gillnets were lost in Newfoundland waters on average each year for a number of years up to 1992. In a survey of 100 Atlantic Canada gillnet fish harvesters, losses averaged 1-3 nets per fisher per year, with the exception of two fishers with vessels greater than 65 feet that incurred an average loss of 19.2 nets per year (Memorial University of Newfoundland & Fisheries and Oceans Canada, 1995).

Gillnets are considered the most problematic gear in relation to fish mortality, and are the most common gear used in Smith Sound. Smith Sound is a small, narrow, relatively sheltered area where significant gear loss is unlikely to occur, but any lost gear is likely to end up in one of the two deep trenches where dense aggregations of cod overwinter, and significant mortalities could result. **Screened in.**

#### **Temperature change:**

Drinkwater (UNEP & UNFCCC, 2002) predicts a temperature increase of 2-4°C in Southern Newfoundland waters by 2100 based on IPCC 2001 models. Temperature rise will likely not be linear, but is expected to accelerate over time. Even given the worst case scenario, an increase in 0.4°C is likely the most we can expect over the next ten years. Many believe that temperature shifts were at least partially responsible for the poor recovery of over-fished cod stocks in the 1990s (Rose, G. A., 2007). Drinkwater (2005) states that the range of cod may extend northward with increasing temperature, and it is likely that spring migrations will occur earlier, and fall returns will be later (Drinkwater, K. F., 2005). These responses of cod to future climate changes are highly uncertain, however, as they will also depend on the changes to climate and oceanographic variables besides temperature, such as stratification, plankton production, the prey and predator dynamics, and industrial fishing. Temperature changes are not likely to be significant over the next 10 years, and a small increase of 0.4°C or less would likely be beneficial to cod in Smith Sound. **Screened out.**

#### **Increased storm events:**

Recent scientific evidence suggests a link between the destructive power, or intensity, of hurricanes and higher ocean temperatures, driven in large part by global warming. Two factors that contribute to more intense tropical cyclones, ocean heat content and atmospheric water vapour, have both increased over the past several decades. As warm, moist air rises, it lowers air pressure at sea level and draws the surrounding air inward and upward in a rotating pattern, powering the storm. As the moist air spirals in and rises to higher altitudes, it cools and releases heat as it condenses to rain (Union of Concerned Scientists, 2006).

Atlantic tropical cyclones are getting stronger on average, with a 30-year trend that has been related to an increase in ocean temperatures, and are predicted to impact the NW Atlantic at a high level of intensity relative to other areas of the globe (Elsner, J. B., Kossin, J. P., & Jagger, T. H., 2008). The years 1995-2000 experienced the highest level of North Atlantic hurricane activity in the reliable record (Goldenberg, S. B., Landsea, C. W., Mestas-Nunez, A. M., & Gray, W. M., 2001). The largest increase in hurricanes reaching categories 4 and 5 occurred in the Pacific and Indian Oceans, but the highest increase in the number of cyclones and cyclone days occurred in the North Atlantic (Webster, P. J., Holland, G. J., Curry, J. A.,

& Chang, H. A., 2005). The relationships between a warming environment and increasing storm events is complex, and research results and predictions are variable, and more research is clearly required (Emanuel, K., 2005; Emanuel, K. A., 2000; Goldenberg, S. B., Landsea, C. W., Mestas-Nunez, A. M., & Gray, W. M., 2001; Webster, P. J, Holland, G. J., Curry, J. A., & Chang, H. A., 2005).

An increase in storm surges can potentially contribute to super-cooling events during severe winter storms where the motion keeps seawater in a liquid state at temperatures well below -2°C and can lead to mass mortalities. A super-cooling event in Smith Sound several winters ago resulted in mass mortality (~500,000 fish) of over-wintering cod. **Screened in.**

**Key Activities/Stressors:**

- Ghost nets
- Increased storm events

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## **Unique northern Atlantic cod refuge in Smith Sound**

### **Ghost nets (derelict fishing gear)**

#### **Magnitude of Interaction**

##### **Areal extent:**

- Deep (200m) narrow trenches in Smith Sound provide refuge habitat for dense aggregations of overwintering cod. In 2001, these aggregations were estimated at 20,000t or 10,000,000 fish (Rose, 2007).
- We have no data on the areal extent of ghost nets in Smith Sound, but gillnets are the most common gear used in Smith Sound, and lost gillnets are considered the most problematic gear in relation to fish mortality.
- Since inshore gillnet losses average 1-3 nets per fish harvester each year (Memorial University of Newfoundland & Fisheries and Oceans Canada, 1995), significant loss of gear in Smith Sound is likely to have occurred over the years.
- As a result of the steep bathymetry, any lost nets are likely to accumulate in the deep trenches where cod aggregate in winter, and the area of overlap is likely to be in the high range, but lower than the areal extent of active gillnet fisheries. We have therefore selected a score at the lower end of the high range (7.5).

#### **Score 7.5**

##### **Contact:**

- Lost nets snag on a bottom feature with the free ends floating in the water column, or form a ball on the sea floor, with folds of netting moving with the motion of the water. These ghost nets appear to attract a range of marine species as they provide attractive but deadly structural habitat and a constant food supply for predators, scavengers and decomposers. In inshore waters of the LOMA, cod is often the most common species captured in lost nets retrieved from the ocean floor - sixty ghost nets retrieved in Placentia Bay in the 1990s were found to contain 30,000 lbs of rotting cod, as well as other species.
- Contact is therefore considered to be high.

#### **Score 8**

##### **Duration:**

- Since the 1960s, fishing nets have been constructed from highly durable plastic materials such as nylon, polypropylene and polyethylene, which do not biodegrade. When exposed to the sun for a period of years, photo-degradation will weaken these materials releasing fragments of plastic (see marine litter). On the sea bottom, however, where they are protected from UV radiation, there is no evidence that these nets weaken or degrade over time. As a result, lost nets accumulate in the environment, and are present 100% of the time.

#### **Score 10**

### Intensity:

- Since we have no data on the density of ghost nets or the frequency of gear loss within the EBSA, we have based our intensity score on data related to **sources** of ghost nets (gillnet fishing) and environmental factors (rough bottom, wind speed, wave action).
- Global maps (Halpern et al., 2007) for demersal non-destructive fisheries, with high bycatch, which include gillnets, shows a medium (yellow) intensity relative to global levels for a score range of 40% to 60% for the LOMA.

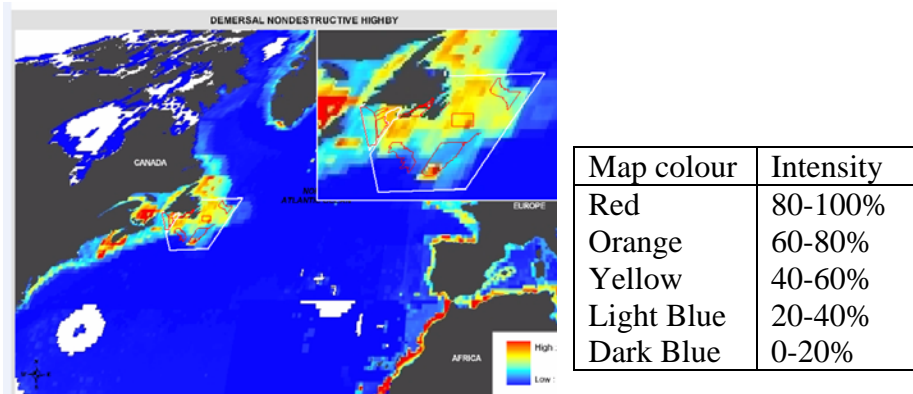


Figure 1. Global intensity of bottom gillnets (adapted from (Halpern et al., 2008)).

- Gillnet are among the most common gear types used inshore, and since Smith Sound is known for its dense aggregations of fish, intensity is likely higher than average.
- Based on these factors we have selected the highest score within the range indicated for the LOMA.

### Score 6

**Magnitude of Interaction:**  $(7.5 \times 8 \times 10 \times 6) / 1000 = 3.6$

### Sensitivity

#### **Sensitivity of the CP to acute impacts:**

- Set gillnets, by virtue of their fixed, anchored framing (held in position by buoys on top and lead rope on bottom), may remain fully deployed and fishing long after they are lost or abandoned. As nets become fouled, they become more visible and lose their vertical profile, and their fishing capacity declines (National Academy of Sciences, 2008). Even when nets collapse, forming balls on the sea floor, they have been observed to self bait such that predators and scavengers attracted to entangled animals are themselves entangled, thereby perpetuating the cycle of destruction.
- Based on available data, impacts are considered significant, but relative to fishing mortality are likely minor, so we have selected a medium score with in the low range.

### Score 2

### **Sensitivity of the CP to chronic impacts:**

- Although overall mortality of cod from ghost nets may be relatively minor in Smith Sound, the chronic, cumulative nature of the threat is a greater concern. Fishing activity can be reduced as required to conserve stocks, but once ghost nets are lost, retrieval is very difficult and expensive, and mortalities can continue for decades and therefore chronic impacts may be minor, but long term so we have selected a score at the high end of the low range (3).
- Atlantic cod are listed in the CP document as a ‘depleted and rare species’, and will therefore rank higher on this scale than other CPs because they are already in need of recovery (**add one point**).

### **Score 4**

#### **Sensitivity of ecosystem to harmful impacts to the CP:**

- Smith Sound cod belong to the Newfoundland and Labrador population of Atlantic cod, one of two major cod stocks within the LOMA.
- Cod have historically had a huge influence on the ecosystem of the LOMA, mainly because of their large biomass and broad distribution compared to other species, and their significant role as both predator and prey at all trophic levels as they grow and move from one trophic level to another. Even though they are currently at less than one percent of their former biomass, they still represent a significant component of the total groundfish population.
- Since the sharp decline in cod biomass in the 1990s, stocks of invertebrates such as shrimp and crab have expanded to record highs in what has been termed a trophic cascade. These changes have been blamed on over-fishing resulting in perturbations to the predator-prey systems, and although environmental change may have had a contribution, it is clear that the role of Atlantic cod in the ecosystem is highly significant to its structure and function.
- Smith Sound is an important overwintering area for the severely depleted population of Northern cod. Much of the currently known spawning that occurs along the northeast coast appears to originate from migrating subgroups of cod which overwintered in Smith Sound (Templeman, 2007). Smith Sound cod aggregations may be critical to the recovery of the population (Templeman, 2007), although the potential role of bay stocks such as those in Smith Sound in rebuilding the offshore stocks is unknown (Rose, 2007).
- Given the importance of this population to one of the two major stocks within the LOMA, we have selected a score of 6.
- Atlantic cod are listed in the CP document as an ‘ecologically significant species’ (**add one point**).

### **Score 7**

**Sensitivity:**  $(2 + 4 + 7)/3 = 4.3$

**Risk of Harm:**  $MoI \times S = 3.6 \times 4.3 = 15.5$

## **Certainty Checklist**

Answer yes or no to all of the following questions. Record the number of NO's to the 9 questions, and record certainty according to the scale provided below:

- 1 No's = High certainty
- 2- 3 No's = Medium certainty
- ≥ 4 No's = Low certainty

### **Y/N**

- N Is the score supported by a large body of information?
- N Is the score supported by general expert agreement?
- N Is the interaction well understood, without major information gaps/sources of error?
- N Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
- N Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic)?
- Y Is the score supported by recent data or research (the last 10 years or less)?
- N Is the score supported by long-term data sets (ten years or more) from multiple surveys (5 years or more)?
- Y Do you have a reasonable level of comfort in the scoring/conclusions?
- N Do you have a high level of confidence in the scoring/conclusions?

### **Certainty Score: Low**

For interactions with Low certainty, underline the main factor(s) contributing to the uncertainty

- Lack of comprehensive data
- Lack of expert agreement
- Predictions based of future scenarios which are difficult to predict
- Other (provide explanation)

Suggest possible research to address uncertainty:

**Improved reporting and data analysis related to lost nets**

## Reference List

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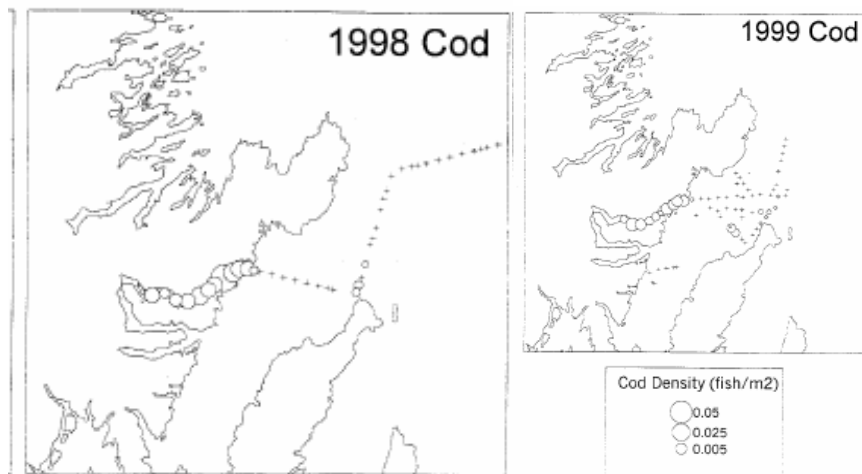
## Unique northern Atlantic cod refuge in Smith Sound

### Increased storm events

#### Magnitude of Interaction

##### Areal extent:

- Smith Sound is a small area which supports a very dense aggregation of over-wintering cod. A deep (200m) trench provides over-wintering habitat for pre-spawning fish, and as deep waters cool in the spring, warming surface layers provide above zero waters if deep water should fall below optimal temperatures for spawning and survival of cod. Thus, during the spawning season, cod may be seen throughout Smith Sound.



- Increased storm events are an escalating stressor related to climate change which is predicted to impact the LOMA.

### Score 10

#### Contact:

- Storm events affect the entire water column in shallow coastal areas, and therefore contact will be high for CPs associated with coastal areas (100%)

### Score 10

#### Duration:

- Although some fish remain in the sound year-round, the majority of cod take refuge in Smith Sound during the winter from November to April- (6 months).
- Super-cooling events resulting from storm mixing are most likely in the spring of the year when ice cover (which prevents wind related mixing) is gone, but surface waters are below 0°C (March-April)- but these events are not expected to occur annually.
- Chronic stressors which are unlikely to occur annually are scored in the **low** range. We have selected a score at the low end of the range to reflect the anticipated low frequency and duration of the stressor.

## Score 1

### Intensity:

- Atlantic tropical cyclones are getting stronger on average, with a 30-year trend that has been related to an increase in ocean temperatures, and are predicted to impact the NW Atlantic at a high level of intensity relative to other areas of the globe (Elsner, J. B., Kossin, J. P., & Jagger, T. H., 2008).
- The years 1995-2000 experienced the highest level of North Atlantic hurricane activity in the reliable record (Goldenberg, S. B., Landsea, C. W., Mestas-Nunez, A. M., & Gray, W. M., 2001).
- The largest increase in hurricanes reaching categories 4 and 5 occurred in the Pacific and Indian Oceans, but the highest increase in the number of cyclones and cyclone days occurred in the North Atlantic (Webster, P. J, Holland, G. J., Curry, J. A., & Chang, H. A., 2005). The relationships between a warming environment and increasing storm events is complex, and research results and predictions are variable, and more research is clearly required (Emanuel, K., 2005; Emanuel, K. A., 2000; Goldenberg, S. B., Landsea, C. W., Mestas-Nunez, A. M., & Gray, W. M., 2001; Webster, P. J, Holland, G. J., Curry, J. A., & Chang, H. A., 2005).
- Based on the available information we have selected a score at the low end of the high range.

## Score 7.5

**Magnitude of Interaction:**  $(10 \times 10 \times 1 \times 7.5) / 1000 = 0.75$

### Sensitivity

#### **Sensitivity of the CP to acute impacts:**

- It is not clear exactly what factors contribute to making Smith Sound a unique refuge area for northern Atlantic cod, but the abundance of prey, particularly capelin, refuge from the intense fishing effort that led to the decline of offshore stocks, as well as the deep (200m) trench within a sheltered sound which offers over-wintering habitat for pre-spawning aggregations, are likely important factors.
- Spawning in Smith Sound begins in early April and continues into the summer, with spawning observed as late as July in some years (Rose, G. A., 2007). Some fish appear to remain in Smith Sound all year, but the majority migrate seasonally in and out of the bay. In a normal year, migrating cod return to Smith Sound in late fall or early winter when deep waters in the trench are warm (3-5°C). As spring approaches, deep waters cool, but temperatures are still above 0°C when cod begin to spawn in early April. By late May, temperatures in deep waters may dip below 0°C and the fish either move up into the warming surface waters or out into adjacent areas (Rose, G. A., 2007).
- Increased storm surges can potentially lead to super-cooling events during severe winter storms where the motion keeps seawater in a liquid state at temperatures well below -2°C and can lead to mass mortalities.
- In the spring of 2003, the normal cooling of the deep waters accelerated quickly in early April, trapping the cod in sub-zero waters deep in the Sound, and about 5% (500,000

fish) froze to death in the super-cooled water (Rose, G. A., 2007). This type of event is rare, occurring when specific environmental conditions coincide, and may never occur again, but increased storm events may increase the risk of reoccurrence, although the additional risk is considered low (3).

### Score 3

#### Sensitivity of the CP to chronic impacts:

- Smith Sound cod belong to the Newfoundland and Labrador population of Atlantic cod which was assessed by COSEWIC in 2003 and designated **endangered**. The Status Report lists fishing (including legal, illegal, and unreported catches) and fishing-induced changes to the ecosystem as key threats to cod recovery.
- Inshore components of the stock appear more productive than offshore components. Stewardship fishery catch rates in 2006-07 were slightly higher than in earlier fisheries between 1998 and 2002, and sentinel fisheries catch rates near Trinity Bay (southern 3K and northern 3L) have generally increased since 2002 and are currently above average for the time series.
- A pre-recruit index suggests that the strength of the 2003-2006 year-classes will be much lower than those that have supported recent fisheries (Fisheries and Oceans Canada, 2008).
- Mortality from the 2003 super-cooling event were significant (500,000 fish), but are sustainable (5% of biomass) provided other mortality sources are adjusted in consideration of the loss for the year in which the event occurred (2).
- Atlantic cod are listed in the CP document as a 'depleted and rare species', and will therefore rank higher on this scale than other CPs because they are already in need of recovery (**add one point**).

### Score 3

#### Sensitivity of ecosystem to harmful impacts to the CP:

- Smith Sound cod belong to the Newfoundland and Labrador population of Atlantic cod, one of two major cod stocks within the LOMA.
- Cod have historically had a huge influence on the ecosystem of the LOMA, mainly because of their large biomass and broad distribution compared to other species, and their significant role as both predator and prey at all trophic levels as they grow and move from one trophic level to another. Even though they are currently at less than one percent of their former biomass, they still represent a significant component of the total groundfish population.
- Since the sharp decline in cod biomass in the 1990s, stocks of invertebrates such as shrimp and crab have expanded to record highs in what has been termed a trophic cascade. These changes have been blamed on over-fishing resulting in perturbations to the predator-prey systems, and although environmental change may have had a contribution, it is clear that the role of Atlantic cod in the ecosystem is highly significant to its structure and function.
- Smith Sound is an important overwintering area for the severely depleted population of Northern cod. Much of the currently known spawning that occurs along the northeast

coast appears to originate from migrating subgroups of cod which overwintered in Smith Sound (Templeman, N. D., 2007). Smith Sound cod aggregations may be critical to the recovery of the population (Templeman, N. D., 2007), although the potential role of bay stocks such as those in Smith Sound in rebuilding the offshore stocks is unknown (Rose, G. A., 2007).

- Given the importance of this population to one of the two major stocks within the LOMA, we have selected a score of 6.
- Atlantic cod are listed in the CP document as an ‘ecologically significant species’ (**add one point**).

**Score 7**

**Sensitivity:**  $(3 + 3 + 7)/3 = 4.3$

**Risk of Harm:**  $MoI \times S = 0.75 \times 4.3 = 3.2$

## **Certainty Checklist**

Answer yes or no to all of the following questions. Record the number of NO's to the 9 questions, and record certainty according to the scale provided below:

- 1 No's = High certainty
- 2- 3 No's = Medium certainty
- ≥ 4 No's = Low certainty

### **Y/N**

- N Is the score supported by a large body of information?
- Y Is the score supported by general expert agreement?
- N Is the interaction well understood, without major information gaps/sources of error?
- Y Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
- N Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic)?
- N Is the score supported by recent data or research (the last 10 years or less)?
- N Is the score supported by long-term data sets (ten years or more) from multiple surveys (5 years or more)?
- Y Do you have a reasonable level of comfort in the scoring/conclusions?
- N Do you have a high level of confidence in the scoring/conclusions?

### **Certainty Score: Low**

For interactions with Low certainty, underline the main factor(s) contributing to the uncertainty

- Lack of comprehensive data
- Lack of expert agreement
- Predictions based of future scenarios which are difficult to predict
- Other (provide explanation)

Suggest possible research to address uncertainty:

## Reference List

1. Fisheries and Oceans Canada (2008). *Stock Assessment of Northern (2J3KL) Cod in 2008* (Rep. No. 2008/034). Canadian Science Advisory Secretariat Science Advisory Report, Newfoundland and Labrador Region.
2. Rose, G. A. (2007). *Cod: The Ecological History of the North Atlantic Fisheries*. Breakwater Books.
3. Templeman, N. D. (2007). *Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas* (Rep. No. 2007/052). Canadian Science Advisory Secretariat Research Document, Fisheries and Oceans Canada.

**Summary Table: Unique Northern Atlantic cod Refuge in Smith Sound**

<b>Key Activity/Stressor</b>	<b>a</b>	<b>c</b>	<b>d</b>	<b>i</b>	<b>MoI</b> $\frac{(a \times c \times d \times i)}{1000}$	<b>as</b>	<b>cs</b>	<b>es</b>	<b>S</b> $\frac{(as+cs+es)}{3}$	<b>Risk of Harm</b>	<b>Certainty</b>
Ghost nets	7.5	8	10	6	<b>3.6</b>	2	4	7	<b>4.3</b>	<b>15.5</b>	<b>Low</b>
Increased storm events	10	10	1	7.5	<b>.75</b>	3	3	7	<b>4.3</b>	<b>3.2</b>	<b>Low</b>
<b>Cumulative CP Score</b>										<b>18.7</b>	