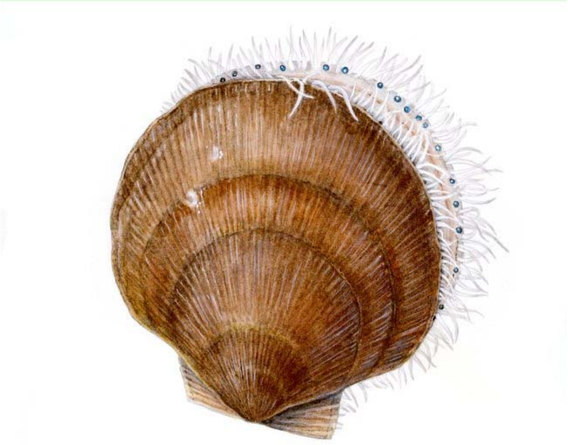
Seafood Watch
Seafood Report

Scallop
Placopecten magellanicus



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Atlantic Canada

July 7, 2011

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Independent Contractor

About SeaChoice, Seafood Watch® and the Seafood Reports

This report is a joint product of SeaChoice and the Monterey Bay Aquarium Seafood Watch® program. Both organizations evaluate the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. In doing so, SeaChoice applies the definition of sustainable seafood and the method for its evaluation and presentation developed by the Seafood Watch program at the Monterey Bay Aquarium. Seafood Watch defines sustainable seafood as originating from species, whether wild-caught or farmed that can maintain or increase production into the long-term without jeopardizing the structure or function of affected ecosystems.

SeaChoice is a comprehensive seafood markets program with the primary goal of realizing sustainable fisheries in Canada and abroad. **SeaChoice** uses the best available science, strategic communications and partnerships to mobilize sustainable seafood markets via six main programs: (1) research, (2) industry outreach, (3) public education, (4) retail partnerships, (5) strategic communications, and (6) dialogue with government. More information on **SeaChoice** can be obtained at www.SeaChoice.org

Seafood Watch makes its science-based recommendations available to the public on our website (www.SeafoodWatch.org), print materials, an iphone app and other media. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans. Each sustainability recommendation is supported by a Seafood Report. Each report synthesizes and analyzes the most science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid". The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

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SeaChoice, Seafood Watch and the seafood reports are made possible through grants from the David and Lucile Packard Foundation.

Table of Contents

I. Executive Summary

This report is an evaluation of the Canadian sea scallop (*Placopecten magellanicus*) fishery. The Canadian scallop fishery is conducted both offshore (including the Eastern Scotian Shelf, Georges Bank Banquereau, Middle Bank, Sable and Western Banks, Browns Bank, German Bank and St Pierre Bank) and inshore (Bay of Fundy and Quebec). Depending on the area, scallop fishing occurs year-round. Fishermen target both inshore and offshore sea scallops with gear towed behind a vessel dragging large wire-mesh bags along the seafloor (dredge). The offshore dragger fishery uses both wet and freezer trawlers.

Sea scallops are inherently resilient to fishing due to their high intrinsic population growth rate, high individual growth rate, low age at first maturity and high fecundity.

The stock status of scallops varies by area. The offshore fishery has reduced its effort considerably in the last decade while maintaining high catch levels. Despite a long fishing record, offshore sea scallop stocks in Canada are not considered overfished. Recruitment in the Bay of Fundy fishery is low. Stocks in Quebec are considered low in abundance with the exception of the North Shore area where catches have remained constant. In all areas, catches have been in decline since the opening of the fisheries. Department of Fisheries and Oceans (DFO) stock assessment reports cover one region at a time; stocks and data are not always reported in the same manner. Knowledge of the overall population abundance of Canadian wild scallop stocks is fragmentary. Overall, stock status is considered to be a moderate conservation concern for all stocks.

Scallop dredges are known to catch many species in addition to their intended targets. Although there has been recent research into some bycatch species (winter skate) and discards, historically, there is either limited or no long-term analysis. Bycatch may include some species listed as a conservation concern by COSEWIC, such as winter skate and Atlantic cod. However, management has implemented measures to constrain bycatch of these species. When data are available, these bycatch events have not shown any increase and, in some cases, have shown a decrease in recent years. In addition, recent data have shown high post-catch survivorship for winter skate, and some measures have been implemented to reduce bycatch. Nevertheless, there is a general lack of research on the quantity of bycatch and its impact on populations. Bycatch from the Canadian scallop fishery is rated as a moderate conservation concern.

Scallop dredging impacts benthic habitats by altering physical and biological structures. Ecosystem effects have been detected but few studies have adequate controls comparing an impacted area to an area that has never been fished. Dredging can also impact populations of scallops and result in both direct and indirect mortality (e.g., by altering important habitat) of the target species. Dredging for scallops is deemed to be a high conservation concern.

The Department of Fisheries and Oceans (DFO) provides routine stock assessments with fishery dependent and fishery-independent data. Management has implemented good practices such as limiting entry, restricting gear types, and establishing fishing areas, seasons, and buffer zones. Catches are monitored by an industry-funded dockside monitoring program, and several fisheries require vessel monitoring systems. Historically, Canadian fisheries management has been faulted for being slow to respond to benthic habitat destruction caused by scallop dredging. Recent seabed mapping (facilitated by industry and DFO cooperation) has led to a reduced footprint for the dredge fishery but has also allowed vessels to target older brood stocks and access areas previously protected because of the potential for gear hang-ups. Overall, management of the Canadian scallop fishery is deemed a moderate conservation concern.

Overall, the Canadian scallop fishery is considered a **Good Alternative**.

The Eastern Canada offshore scallop fishery (St Pierre Bank, the Eastern Scotian Shelf, Browns and German Bank, and Georges Bank) has been certified as sustainable to the Marine Stewardship Council (MSC) standard. The MSC is an independent non-profit organization, which has developed an environmental standard for sustainable and well-managed fisheries. It uses a product label to reward environmentally responsible fishery management and practices (http://www.msc.org/).

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Nature of Bycatch		√		
Habitat & Ecosystem Effects			√	
Management Effectiveness		√		

About the Overall Seafood Recommendation:

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation:

Best Choice 🟩

Good Alternative 🟨

Avoid 🟥

II. Introduction

This report is an evaluation of the Canadian sea scallop (*Placopecten magellanicus*) fishery. The Canadian scallop fishery is conducted both offshore (including the Eastern Scotian Shelf, Georges Bank Banquereau, Middle Bank, Sable and Western Banks, Browns Bank, German Bank and St Pierre Bank) and inshore (Bay of Fundy and Quebec). This report does not cover the Gulf Region as this area accounts for only 2% of the total scallop landings in Canada (Mallet *et al.* 2010).

Biology

The sea scallop (*Placopecten magellanicus*) is distributed in the northwest Atlantic from North Carolina north to Labrador. Within this area, scallops are found in large concentrations known as geographically discrete beds. Sea scallops are single-sexed, bivalve mollusks. Both males and females reach sexual maturity at age four. Male scallop gonads are white and milky while female gonads are bright red, both developing in the Canadian summer months. Fertilization is external with eggs and sperm released into the water column between August and October. Fertilized eggs develop into larvae (veliger) in a few days and continue to develop through four larval stages that feed on phytoplankton in the water column. This period of growth continues for 30 to 60 days before the larvae settle on the bottom. The sea scallop prefers sandy, gravel bottoms and depths of 35 to 120 m. Once settled, the postlarvae undergo a series of morphological changes before developing into juvenile scallops. The persistence of scallop aggregations (beds) in localized areas suggest that the spatial distribution of scallop beds is determined by available substrate types and local hydrographic conditions that persist from year to year, such as gyres, upwelling and vertical mixing. These hydrographic features affect temperature, primary productivity, bottom currents and retention of scallop larvae. The growth of scallops is estimated from annual rings on the shell. Growth rates vary geographically and according to time of year, depth and water temperature.

Fishery

The Canadian sea scallop (*Placopecten magellanicus*) fishery is conducted in both inshore and offshore waters. The main types of bottom gear used are Digby drags, ‘miracle gear’ drags (used inshore) and New Bedford dredges (used offshore).

Offshore

After Canada declared a 200-mile fishing zone in 1977, disputes occurred over access to Georges Bank between Canada and the USA. This dispute was settled in 1984 through the International Court of Justice (ICJ) confirming and establishing an international boundary in the Gulf of Maine referred to as the "ICJ line" or "Hague line." Canada was awarded the northeastern portion of Georges Bank. The Canadian offshore scallop fishery includes: Georges Bank, the Eastern Scotian Shelf (Banquereau, Middle Bank, Sable and Western Banks (fished periodically), Browns Bank, German Bank and St Pierre Bank. In 1989, an Enterprise Allocation (EA) program for the management of the offshore scallop fishery was introduced to fix the percentage of shares for each of the enterprises involved in the fishery. The Offshore Scallop Advisory Committee (OSAC) is the management body for the offshore scallop fishery, composed of the major stakeholders and DFO. The OSAC makes recommendations on annual Total Allowable Catches (TACs), administration of the EA program and other management measures. Scallop resource on Georges Bank, which is the primary area fished, are assessed annually.

The fleet consists of wet fish and freezer-trawler vessels. Both types of vessels use dual New Bedford dredges, from 4 to 6.1 m in width, one towed on each side of the vessel. Prior to 1998, Georges Bank was managed as a single unit but has since been managed as two distinct zones: 'Zone A' (a shallower and more productive fishery) and 'Zone B' (deeper marginal habitat) with the latter having a separate management plan (Fig. 1). Georges Bank 'Zone A' is managed with a TAC and a meat count of 33 meats per 500 g. In the Canadian scallop fishery, meat counts (which specify the number of meats allowed per unit weight; as average scallop meat size goes up, the meat count declines) were introduced in 1973 in an effort to maximize yield per recruit (Shumway and Parsons 2006). The scallop resource on Georges Bank 'A' are assessed annually on the recommendation of a 2009 framework assessment (Jonsen *et al.* 2009). Other offshore banks are currently assessed on an ad-hoc basis. In the past, the determination of need for an assessment for these other areas has come through dialogue between the offshore fishing industry and DFO. Currently, DFO intends to start a biannual assessment of Georges Bank and the other offshore banks, but this has not been implemented to date. Prior to 2008, Georges Bank 'B' was managed with a rolling TAC allocated in 200 t increments for a specified fishing period and a meat count of 40 meats per 500 g. In January 2008, the management system was changed: the TAC was switched to a conventional model while the meat count per gram stayed the same. In November 2004, to increase the yield of juvenile scallops, the offshore scallop industry introduced voluntary closures of fishery areas on Georges Bank. Currently, there are three closures for Zone 'A' on Georges Bank and three on Browns Bank.

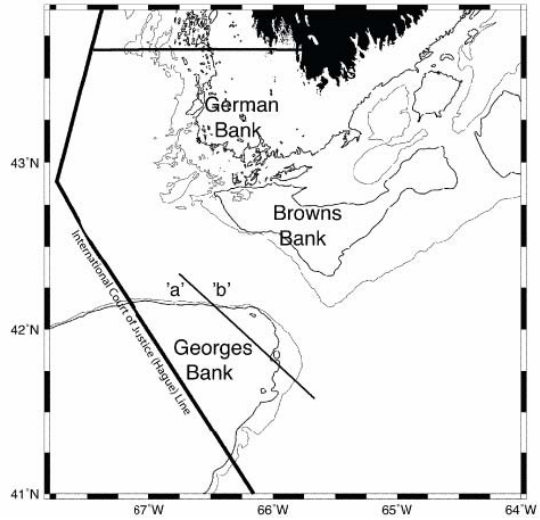


Figure 1. Location of Georges Bank 'A' and 'B' (from DFO, 2009a).

In 2008, the TAC for Zone 'A' was 5,500 t (with reported landings of 5,498 t) while Zone 'B' had a smaller TAC of 400 t (with landings of 358 t). Prior to 2002, the fleet consisted mostly of wet fish vessels but freezer-trawlers were then introduced. In 2008, ten wet fish and six freezer-trawlers fished a portion of the season. The landings from freezer-trawlers have increased since their introduction from 775 t during the first year (12% of the total landings) to 3,776 t from Zone 'A' (69% of total landings) and 265 t (74% of total landings) from Zone 'B' in 2008.

The Bay of Fundy

The Bay of Fundy scallop fishery is managed as six scallop production areas (SPA 1–6) and has three fishing fleets: Full Bay Fleet, Mid Bay Fleet and the Upper Bay Fleet. The Full Bay Fleet (with vessels of 45' to 60') has access to the entire Bay of Fundy, the Mid Bay Fleet (with vessels of 30' to 45') is permitted to fish only those areas north of the Mid Bay line, and the Upper Bay Fleet (also with vessels of 30' to 45') is restricted to the upper reaches of the Bay (Fig. 2). The fishery is regulated through limited entry, gear size limits, seasonal closures, minimum shell height, meat counts, and individual meat weight restrictions (Smith and Lundy 2002a; Smith and Lundy 2002b). Gear width is restricted to 5.5 m (and a ring size of < 82 mm, inside diameter). The Mid and Upper Fleets operate under a competitive quota while the Full Bay Fleet operates under an Individual Transferable Quota (ITQ) system. Landings from all three fisheries are reported by adductor muscle weight (referred to as the 'meat'). Scallops are assessed annually according to a framework completed in 2002 (Smith and Lundy 2002a; Smith and Lundy 2002b).

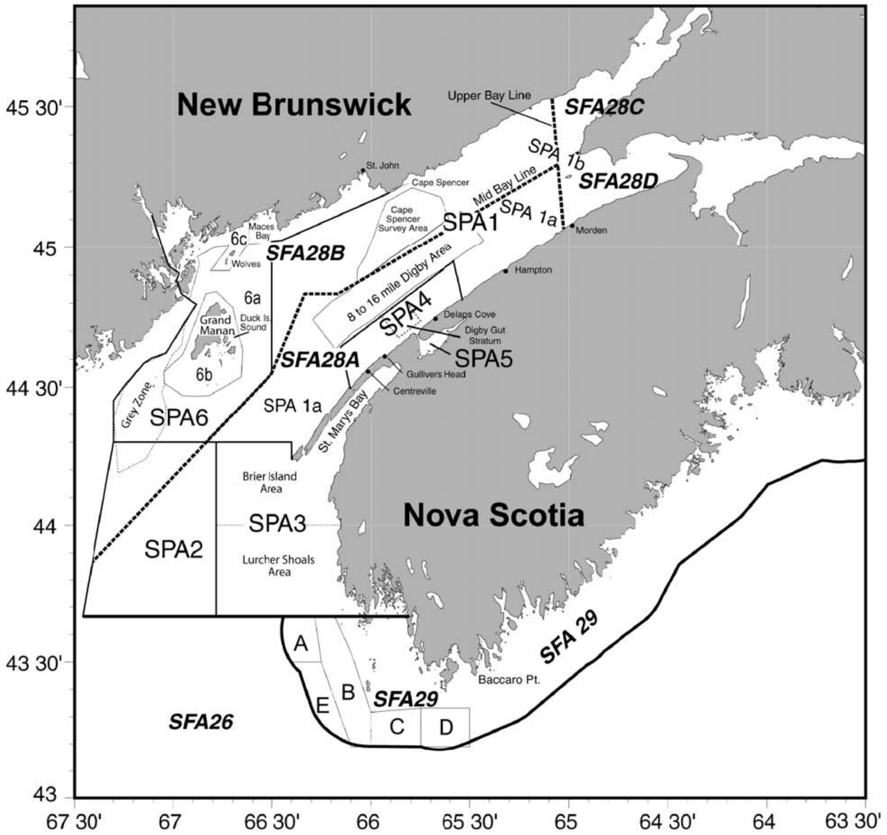


Figure 2. Locations and place names for inshore scallop grounds (from DFO, 2009b).

Scallop Fishing Area 29

Scallop Fishing Area (SFA) 29 stretches from the inshore area (inside the 12-mile territorial sea) south of Yarmouth (latitude 43°40′N) to Cape North in Cape Breton (Fig. 2). It lies within Lobster Fishing Area 34, and the two fisheries consult with each other to minimize conflict. Lobster fishermen have expressed concern about the impacts of scallop fishing as LFA 34 is one of the best lobster fishing areas in Atlantic Canada. Lobster bycatch was minimal in 2001 despite high scallop catch rates. The impact on the lobster fishery is measured only by lobster bycatch, which continues to be monitored in this fishery.

The Full Bay Scallop Fleet fished in this area until 1986, after which it was restricted to the area north of latitude 43° 40′ N in accord with the 1986 inshore/offshore scallop fishing agreement. From 1996 to 1998, a limited fishery for this fleet was approved. In 2001, the Full Bay Fleet was granted access once again with a full at-sea monitoring program and the condition of a post-season industry-funded survey. In the following year, access was granted to this fleet and to license holders who are eligible to fish inshore in SFA 29 east of Baccaro and west of longitude 65°30′W. Historically, SFA 29 inshore scallop licenses were restricted to east of Baccaro (east of longitude 65° 30′ W). A joint project agreement was signed with the fishing fleets, Natural

Resources Canada, and Fisheries and Oceans Canada with all parties providing funds to conduct multi-beam acoustic mapping of the seafloor and other scientific work. A map showing bottom features for the entire area was prepared and distributed to the fishermen for the 2004 fishery. Work continues on analyzing surficial geology and the spatial distribution of scallops. Advice on TACs for this area is provided annually based on tracking the response of survey estimates of abundance to catches in the previous year. There are no framework or reference points for the fishery in SFA 29 at this time. Landings have ranged from 221 t to 713 t.

Inshore Quebec

The inshore commercial scallop fishery in Quebec began in the late 1960s and targets the two species of scallop in the area interchangeably (the sea scallop and Iceland scallop, *Chlamys islandica*). These two species are found mainly on gravel, shell or rocky bottoms, generally at depths of 20–60 m.

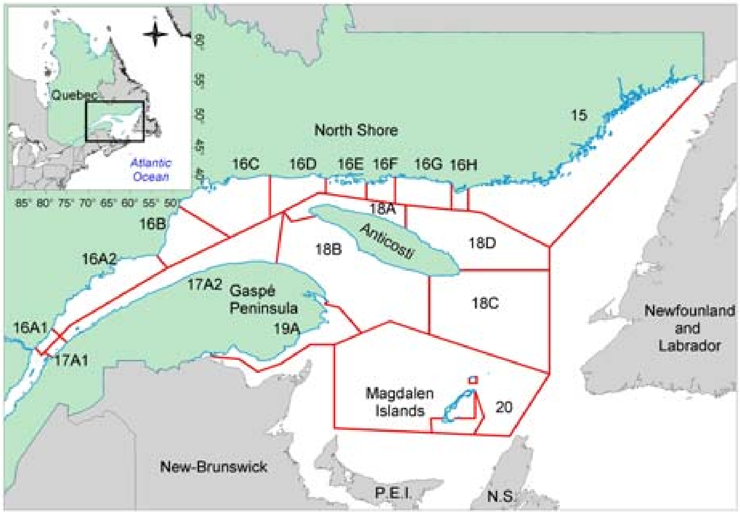


Figure 3. Inshore scallop fishing areas in Quebec (DFO, 2007b).

Over the years, there has been a substantial increase in fishing effort, primarily as a result of the fleet's increased capacity and efficiency, but since 2007 there has been an overall 29% decline in effort for the inshore Quebec fishery (DFO 2010).

The region is divided into 18 management units grouped into three sectors: the North Shore, the Gaspé and the Magdalen Islands. There are 80 permanent fishing licenses and two exploratory licenses as of 2006 (DFO, 2007b; Fig. 3). Fishing effort is controlled in all units. Most units on the North Shore and around Anticosti Island are also governed through quotas. The North Shore region has posted the largest scallop landings in Quebec since 1985 (DFO 2005c). In 2004, landings totaled more than 127 t of meat, down by 21% from 2003. The North Shore accounted for 82% of the landings, followed by the Magdalen Islands with 14%, and the Gaspé with 4%. Fishing effort also decreased by 34% in 2004 (DFO 2005c).

Availability of Science

Science is readily available and accessible in the form of regular stock assessments and scientific reports (DFO 2006; Smith *et al.* 2007). In the offshore fishery, the industry provides vessels and crew as a cost-sharing agreement with DFO to conduct annual surveys and mapping of the sea floor (DFO 2006). In addition, some independent investigations have been conducted into the impacts of the scallop fishery on the sea floor (Kenchington *et al.* 2007). More research is required to fully assess the impacts of these extensively used gear types. Some data on bycatch are from government reports but are generally either limited to certain regions or not consistently released (Benoît *et al.* 2010; Gavaris *et al.* 2010). In addition, independent fishery observer data are not easily accessible. Previous reliance on logbooks (not intended to provide bycatch information) has resulted in poor historical data, but increases in observer coverage have improved recent data collection.

Market Availability

The adductor muscle, referred to as the 'eye', is the main edible part of the scallop, although several regions in the world prefer whole scallops with gonads attached. Given that scallops are active swimmers and use this muscle to open and close their shell generating a motion that propels them through the water, the muscle is more developed in the scallop than in other shellfish such as oysters and clams. The color of the raw meat varies from creamy white to slightly orange due to the algae they consume.

Prices fluctuate depending on the market and size. Scallops can sell for $13 USD per lb. The landed value of scallops in Eastern Canada in 2005 was over $88 million, making it the fourth most valuable fishery in Atlantic Canada after lobster, snow crab and shrimp. Major importers of Canadian scallops are the US and France with 52% and 26%, respectively, of the 2009 total Canadian exports value (Mallet *et al.* 2010). In 2010, the United State imported over 3,000 tons, valued at over $52 million USD, which represents approximately 14% of the scallop imports into the United States (NMFS 2011).

Common and market names: scallop, sea scallop, digby scallop, pétoncles

Seasonal availability: Available year round in North America

Product forms: Scallops come fresh or frozen. In Quebec, whole scallops (with roe attached) are an aquaculture product and can be purchased, but the majority of the seafood product is the adductor muscle.

III. Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

The commercial value of the scallop fishery as well as its relatively sedentary lifestyle has resulted in significant research on assessing life history characteristics relevant to fisheries management. There is information on growth parameters, reproductive potential, and recruitment. Less attention has been paid to intrinsic rates of increase or maximum age. Research on juveniles and habitat preferences has also been conducted. Difficulty assessing juveniles has made year-class estimates challenging.

Sea scallops are single-sexed, releasing eggs or sperm in the water column where external fertilization takes place. Other benthic invertebrates with this mode of reproduction have been shown to be vulnerable to the Allee effect, where reproduction is reduced or eliminated below a certain population density, although this has not been directly observed in sea scallops. Similarly, higher population densities would be expected to enhance recruitment as fertilization success increases, but evidence for strong stock-recruitment relationships is equivocal. McGarvey *et al.* (1992) documented an exponential increase in the recruitment of sea scallops with stock size. In contrast, more recent data analyzed by the Northeast Fisheries Science Center (NEFSC) found little indication of recruitment driven by biomass (NEFSC, 2004). A better understanding of stock-recruitment relationships is necessary to more precisely determine density and population size effects on recruitment at both high and low densities.

Sea scallops grow quickly, reaching maturity at age four, although individuals less than five years of age may contribute a small amount to the population gamete pool (McGarvey *et al.* 1993). Scallops continue to grow quickly during their first few years of life, increasing in length by 50–80% between the ages of three and five years. The scallops' von Bertalanffy coefficient for Canada is 0.375. (Palomares and Pauly 2011) There is a positive relationship between fecundity and shell height (Langton *et al.*, 1987b). Maximum egg production is not reached until several years after maturity. Maturity is reached at age four (85–90 mm) when a female may release up to two million eggs with maximum egg production closer to 270 million eggs (Langton *et al.*, 1987b). However, only approximately 1–6 % of these will be fertilized, survive the planktonic larval phase, and reach maturity (Barber and Blake 1991; McGarvey *et al.* 1992). This estimate is highly variable and reflects the density dependent stock-recruitment relationship. Scallops are relatively long lived; estimates of life-span range from 18–29 years (Bricelj and Shumway, 1991). They prefer a sandy gravel bottom, which is unlimited in the North Atlantic and has not been impacted by disturbance other than fishing (DFO, 2009a). Scallops exhibit two behaviors that may make them more vulnerable to fishing pressure: (1) they form aggregations, known as beds, and (2) they have a patchy distribution (Langston *et al.* 1987b).

Table 1. Life history characteristics of the sea scallop (Langton *et al.*, 1987b, Thouzeau *et al.*, 1991, Hart and Chute, 2004; NEFSC, 2007).

Intrinsic rate of increase	Median age at maturity yrs	Growth rates, von Bertalanffy k	Max. age yrs	Max. size cm	Fecundity	Species range	Special behavior
Unknown	4	0.375	18 to 29	14.2 to 15.3	up to 270 million	North Carolina to Newfoundland	Its aggregate, patchy distribution

Synthesis

Scallops' inherent vulnerability to fishing pressure is considered a low conservation concern due to their high individual growth rate, low age at first maturity and high fecundity.

Inherent Vulnerability Rank:

[✓ **Resilient** 🟩] Moderately Vulnerable 🟨 Highly Vulnerable 🟥

Criterion 2: Status of Wild Stocks

Factors 1, 2 & 3: Management classification status, abundance thresholds and occurrence of overfishing

Generally, the Canadian stock assessment process does not specify stock status in terms of B_{MSY}. The scallop fishery is not assessed according to reference points (although DFO will be formulating reference points for some scallop stocks in the future) that would characterize it as overfished or demonstrate whether overfishing was occurring. Standard groundfish assessment approaches have been found to be inappropriate for sea scallops due to their sedentary lifestyle, which shows non-random aggregations of both biomass and age (MSC 2010). Although uncertain, it does not appear that scallop stocks are overfished or experiencing overfishing. However, current population abundance relative to B_{MSY} and fishing pressure relative to Fmsy are unknown, and each of these three factors receives a yellow ranking.

Offshore

The scientific advice on TAC for the offshore scallop fisheries is based on abundant scientific information (Table 2). Georges Bank (the main fished area) has seen relatively stable TAC and landings since 1990. The 2008 TAC was set at 5500 t based on evidence from the survey and commercial catch data showing a recent steady increase in the stock and above average incoming recruitment (DFO 2008b). In addition, scallop catch for all offshore areas has been relatively stable over time, although less than during the 1970's (Figure 4).

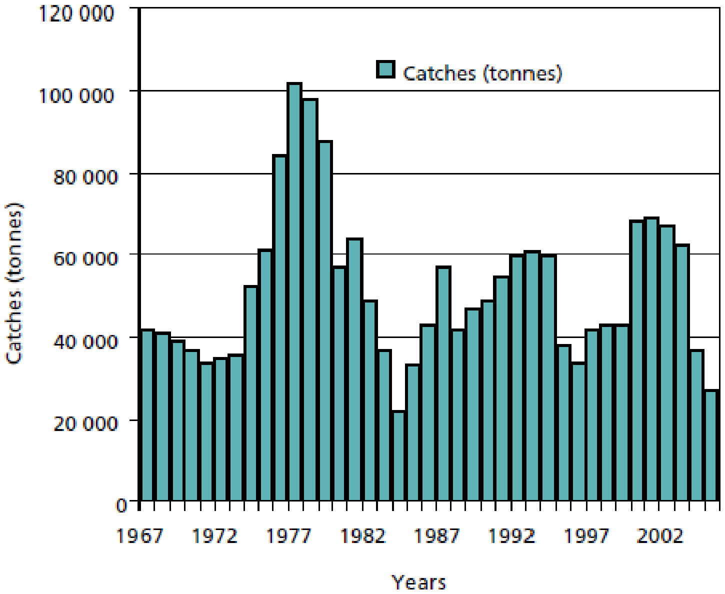
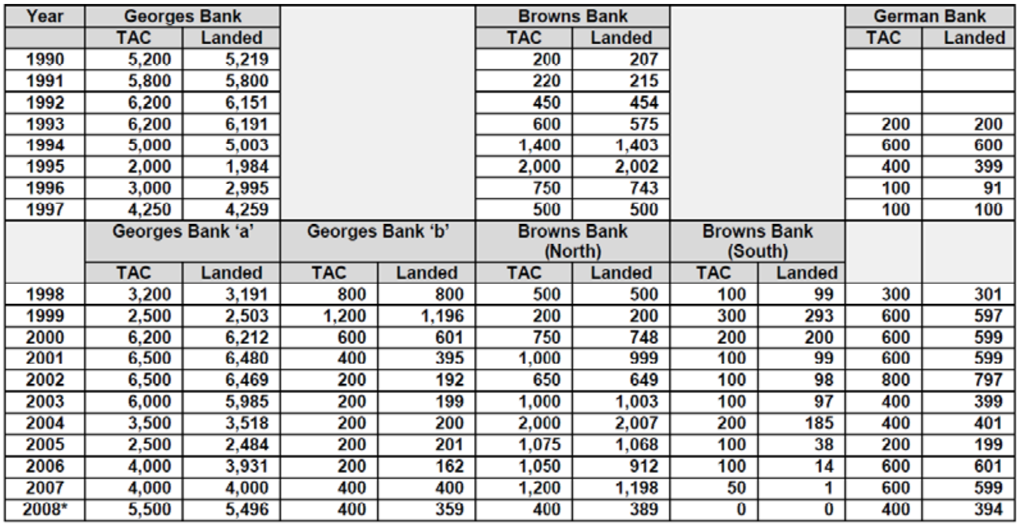
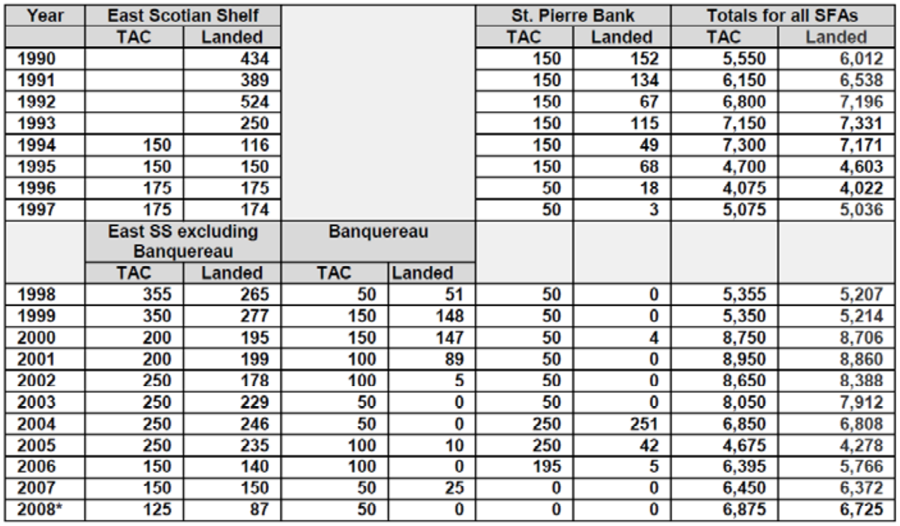


Figure 4. Scallop catches for all offshore areas, 1996–2006. Figure from Stevens *et al.* 2009.

Table 2. Annual TAC and catch for offshore scallop stocks. * 2008 data are preliminary (from MSC 2010).



Year	Georges Bank				Browns Bank				German Bank	
	TAC	Landed			TAC	Landed			TAC	Landed
1990	5,200	5,219			200	207				
1991	5,800	5,800			220	215				
1992	6,200	6,151			450	454				
1993	6,200	6,191			600	575			200	200
1994	5,000	5,003			1,400	1,403			600	600
1995	2,000	1,984			2,000	2,002			400	399
1996	3,000	2,995			750	743			100	91
1997	4,250	4,259			500	500			100	100
	Georges Bank 'a'		Georges Bank 'b'		Browns Bank (North)		Browns Bank (South)			
	TAC	Landed	TAC	Landed	TAC	Landed	TAC	Landed		
1998	3,200	3,191	800	800	500	500	100	99	300	301
1999	2,500	2,503	1,200	1,196	200	200	300	293	600	597
2000	6,200	6,212	600	601	750	748	200	200	600	599
2001	6,500	6,480	400	395	1,000	999	100	99	600	599
2002	6,500	6,469	200	192	650	649	100	98	800	797
2003	6,000	5,985	200	199	1,000	1,003	100	97	400	399
2004	3,500	3,518	200	200	2,000	2,007	200	185	400	401
2005	2,500	2,484	200	201	1,075	1,068	100	38	200	199
2006	4,000	3,931	200	162	1,050	912	100	14	600	601
2007	4,000	4,000	400	400	1,200	1,198	50	1	600	599
2008*	5,500	5,496	400	359	400	389	0	0	400	394



Year	East Scotian Shelf				St. Pierre Bank		Totals for all SFAs	
	TAC	Landed			TAC	Landed	TAC	Landed
1990		434			150	152	5,550	6,012
1991		389			150	134	6,150	6,538
1992		524			150	67	6,800	7,196
1993		250			150	115	7,150	7,331
1994	150	116			150	49	7,300	7,171
1995	150	150			150	68	4,700	4,603
1996	175	175			50	18	4,075	4,022
1997	175	174			50	3	5,075	5,036
	East SS excluding Banquereau		Banquereau					
	TAC	Landed	TAC	Landed				
1998	355	265	50	51	50	0	5,355	5,207
1999	350	277	150	148	50	0	5,350	5,214
2000	200	195	150	147	50	4	8,750	8,706
2001	200	199	100	89	50	0	8,950	8,860
2002	250	178	100	5	50	0	8,650	8,388
2003	250	229	50	0	50	0	8,050	7,912
2004	250	246	50	0	250	251	6,850	6,808
2005	250	235	100	10	250	42	4,675	4,278
2006	150	140	100	0	195	5	6,395	5,766
2007	150	150	50	25	0	0	6,450	6,372
2008*	125	87	50	0	0	0	6,875	6,725

Bay of Fundy

Landings in the southwest Bay of Fundy (SPA 1A) were 225 t for the Full Bay Fleet during the 2007/2008 fishing year with a TAC of 216 t (Fig. 5). Commercial catch rates were relatively stable during the 1995/1996 to 2007/2008 period. Fishing effort decreased from 2003/2004 to 2005/2006 as the strong 1998 year-class was fished. The TAC has increased since 2006/2007 but remains below levels from previous years in the series (Smith *et al.*, 2009b).

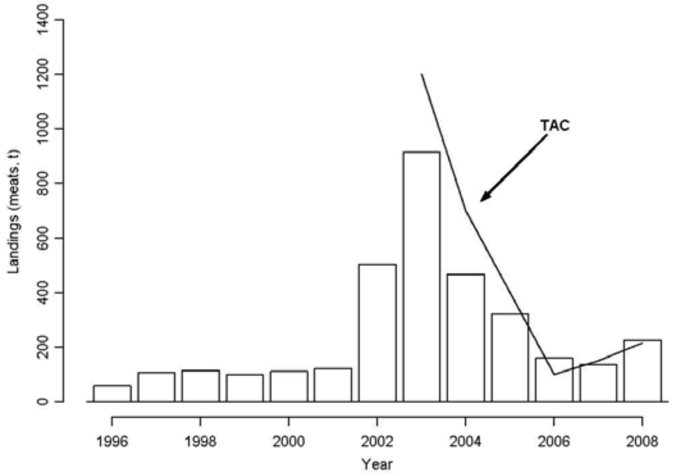


Figure 5. Landings (t) and TAC for scallops in SPA 1 (from Smith *et al.*, 2009b).

Landings from the Northern/Upper Bay of Fundy (SPA 1B) were 210 t from the Full Bay Fleet with a TAC of 206.25 t and 155 t and 87 t from the Mid and Upper Bay fleets with TACs of 148.28 and 85.47 t, respectively (Fig. 6). With improved recruitment, catch rates have been increasing since 2006 (Smith *et al.* 2009b).

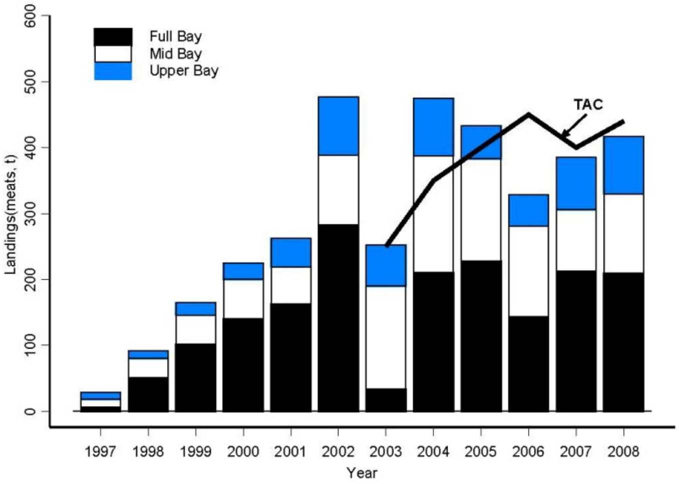


Figure 6. Landings (t) and TAC for scallops in SPA 1B (from Smith *et al.*, 2009b).

In the Brier Island, Lurcher Shoals and St Mary's Bay area (SPA 3), landings were at 80 t with a TAC of 70 t, which represents the second lowest landing since the early 1990s (Fig. 7). Since 2006, the commercial catch for this area has been stable and close to the median while the exploitation rate has been high from 1996–2008.

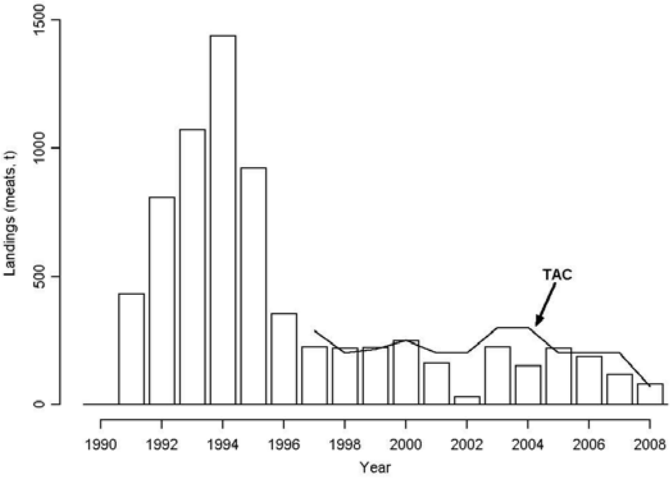


Figure 7. Landings (t) and TAC for scallops in SPA 3 (from Smith *et al.*, 2009b).

In SPA 4 (Digby) in 2008, landings totaled 79 t against the TAC of 100 t (Fig. 8). Both catch rates and effort have been in decline since 2002 and are below the series median. The fishery in the Annapolis Basin (SPA 5) is small with landings between 2 t and 20 t in recent years (Fig. 9). The commercial catch rate and effort are close to the long-term average.

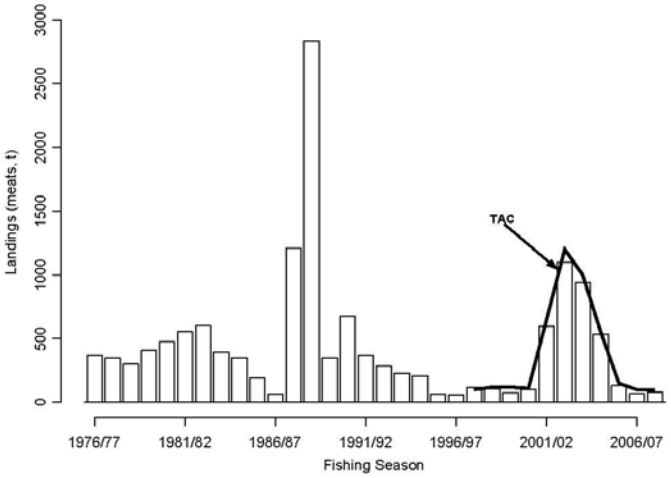


Figure 8. Landings (t) and TAC (began in 1997) for scallops in SPA 4 (from Smith *et al.*, 2009b).

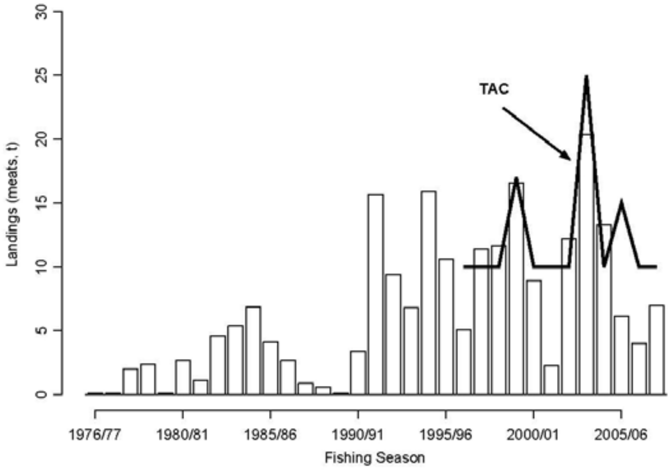


Figure 9. Landings (t) and TAC for scallops in SPA 5 (from Smith *et al.*, 2009b).

In SPA 6 (Grand Manan and SW New Brunswick), the catch rates have been stable for the past four years (Fig. 10). Sixty-eight tons of scallop meat was landed in 2008 against a TAC of 140 t.

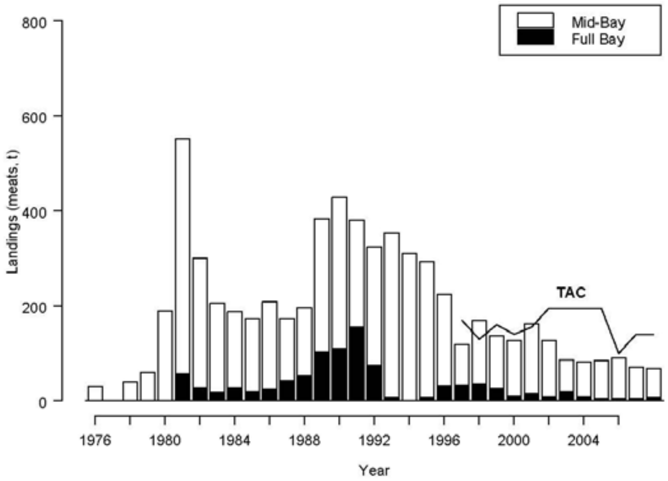


Figure 9. Landings (t) and TAC for scallops in SPA 6 (from Smith *et al.*, 2009b).

Scallop Fishing Area 29

In 2008, 249 t of scallop meat was landed with a TAC of 250 t (Fig. 11). During the last two years in subareas A and E (Fig. 2) the fishery has been sporadic and commercial catch rates have increased. Catch rates in subarea B have either declined (Full Bay fleet) or remained stable (East of Baccaro fleet) while in subarea C the Full Bay fleet catch rates have been stable for the last three years. The East of Baccaro fleet catch rates have increased since 2006. Both fleets in subarea D have experienced declines in catch rates since 2005. Between 2007 and 2008 exploitation has fallen in subarea B but remained stable in subarea C and increased (possibly doubled) in subarea D.

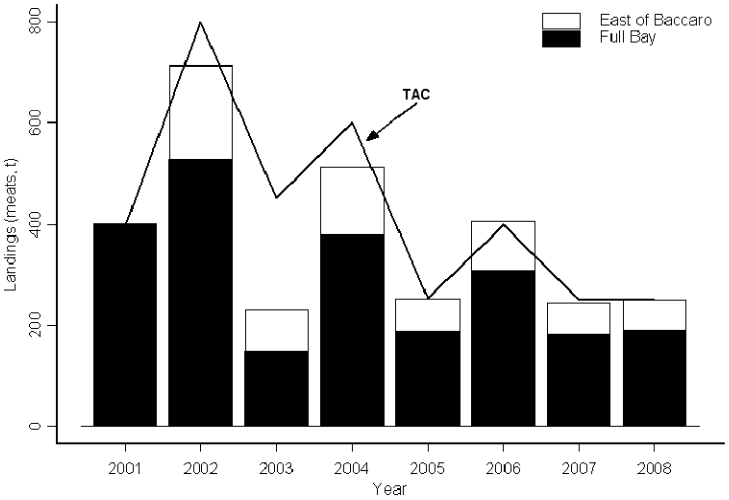


Figure 11. Landings (t) of scallops (meat) by fleet and total TAC for Scallop Fishing Area 29 (from DFO, 2009b).

Inshore Quebec

Landings in the inshore fishery in Quebec peaked in the early 1970s, and again in 1990 and have declined throughout the region since that time. Catches in 2004 were the lowest in more than a decade (Fig. 4). Landings in 2006 reached 120.3 t, a fall of 15% from 2005. Effort also fell by 11%. For the three sectors, the North Shore accounted for 79% of the landings, the Magdalen Islands 15% and the Gaspé for 6%.

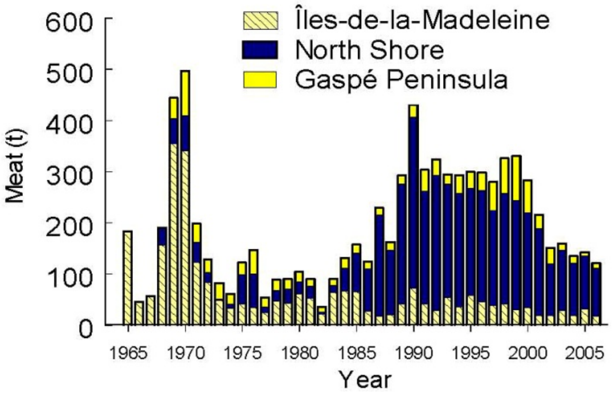


Figure 12. Scallop landings in the inshore fishery in Quebec. Landings include sea scallop and the Iceland scallop (Figure from DFO, 2007b).

Catch per unit effort for the North Shore area is variable by subarea: some experienced a fall (16E and 16F), others stability (18A) or an increase (15). There is the potential for overexploitation in subareas 15 and 16 if all fishers were to exercise a sustained and high fishing effort (DFO, 2007b).

The Gaspé fishing area is composed of three subareas: the St. Lawrence Estuary, Anticosti Island and Chaleur Bay. Landings from the Gaspé showed a gradual rise from 1993, peaking in 1999 at 80 t of meat (Fig. 13). However, since 1999 landings have fallen and reached a record low in 2004 at 5.5 t. Since then, landings have increased steadily each year.

There are numerous concentrations of sea scallop beds around the Magdalen Islands, namely Étang du Nord (Pointe-du-Ouest), Dix-Milles, Chaîne-de-la-Passe, Sud-Ouest, Île Brion and Banc de l'Est. Two of these beds, the Chaîne-de-la-Passe and a section of the Étang du Nord seabeds, are aquacultural sites dedicated for scallop seeding. A management plan incorporates both a fishery and scallop seeding. In 2006, fishing effort was 325 days with landings totaling 18 t, a fall of 39% compared with the previous year. Further, the CPUE in 2006 was one of the weakest in this fishery (0.58 kg/hm) and represents a 25% fall from levels of the previous 10 years.

Factor 4: Overall degree of uncertainty in status of stock

Due to the wealth of long term fishery-dependent and independent data (annual population surveys) for Georges Bank scallops, Bay of Fundy scallops, SFA 29, and inshore Quebec scallops there is relatively little uncertainty in stock status. Scientific surveys are completed for the offshore fishery through cooperation with industry. Nevertheless, some uncertainty remains specific to each region. Uncertainty regarding the status of the stock relative to reference points remains because they are not used.

Offshore

The distribution of scallop age groups is not homogeneous, and as fishing fleets target specific size classes, fishing effort is aggregated. As a result, the commercial catch rate index may not be proportional to the abundance or biomass of scallops (DFO, 2009a). The use of voluntary closure areas could accentuate the issue of non-proportionality. In common with other stock assessment models, the model used to predict biomass tends to under-predict biomass as biomass increases and over-predict as biomass declines. This error needs to be taken into account when providing harvesting advice. Confidence in the growth rate of scallops is undermined by the lack of recent age data, which are also used in the assessment model and could further bias estimates of biomass.

Scallop Fishing Area 29

The model used to estimate the exploitation of scallops in this area makes several assumptions (i.e., no recruitment, natural mortality, equal vulnerability of commercial-size scallops to fishing gear and minimal growth during the period of the fishery) that have not been verified. In addition, there is an absence of long-term population dynamics data (data are only from 2001–2009), which are required to validate the analysis of the commercial catch rate data (DFO, 2009b). However, a recent paper by Smith *et al.* (2010) made some validations for area 29 using survey data.

Inshore Quebec

Knowledge of exploitation rates is lacking, which makes application of quotas or exploitation strategies difficult (DFO, 2007b). Further, little is known about recruitment or total mortality of scallops in this area.

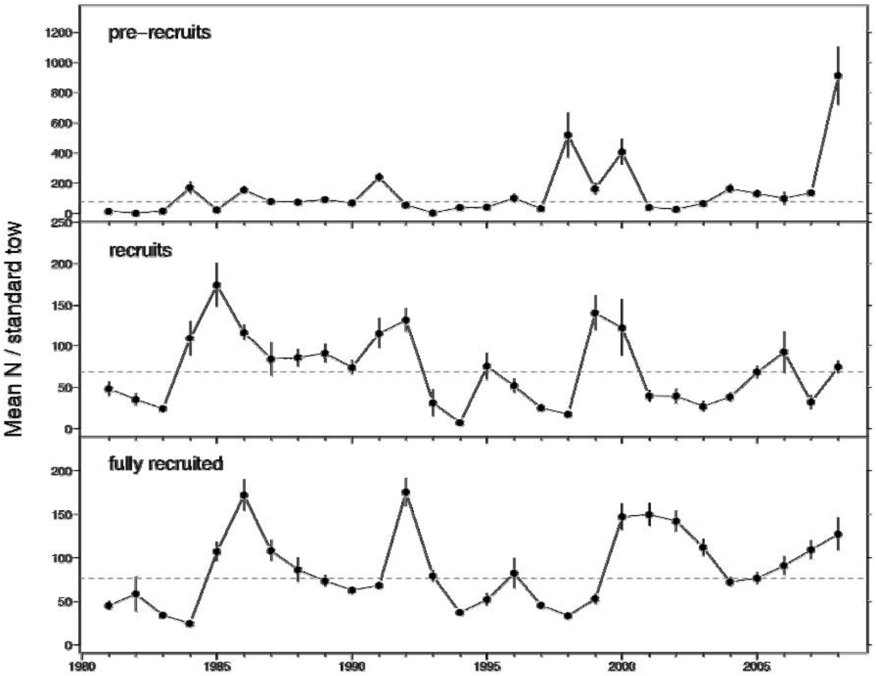


Figure 10. Indices of abundance (mean number/standard tow) for Georges Bank Zone 'A' scallops: pre-recruit (< 75 mm), recruit (75–94 mm) and fully recruited (≥ 95mm). Dashed lines represent the 27-year median abundance level for each size class (from DFO, 2009a).

Factors 5, 6 & 7: Short- and long-term trends in abundance and the current age, size, or sex distribution

Offshore

The Georges Bank scallop resource is assessed annually through joint DFO–industry surveys. Since 1981, survey catch rates for all Georges Bank Zone 'A' scallop size classes (pre-recruits, < 75 mm; recruits, 75–94 mm; and fully recruited, ≥ 95 mm) have fluctuated but with three main peaks (DFO, 2009a; Figure 13). In 2008, all size classes were either equal to or greater than their respective 27-year median abundances (Fig. 14).

The 2008 abundance of pre-recruit scallops was at the highest level observed since 1981 (Fig. 14). This is due to the large 2006 year-class (25–65 mm range) in the northern part of the region. High densities (300–1,000 per tow) were also found in the extreme southern part of the region. The recruits are currently at their 27-year median level of abundance (Fig. 14). The majority of these scallops are 90–94 mm in size and found primarily in the northwestern and eastern regions of Georges Bank. Since 2005, fully recruited scallops have been increasing in abundance and are approaching the peak observed between 2000 and 2002 (Fig. 13). The mid-northern region, which straddles the two zones ('A' and 'B'), holds the highest densities of fully recruited scallops. The mean meat weight of fully recruited scallops (21.1 g) is well above the 27-year mean (18 g) as it has been since the late 1990s (Fig. 14).

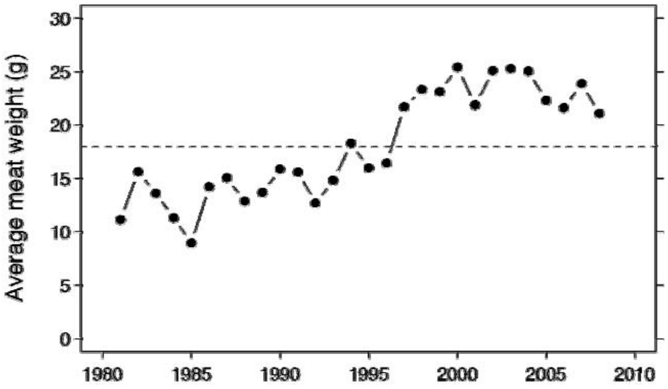


Figure 14. Mean meat weight of fully recruited Georges Bank Zone 'A' scallops. The dashed line represents the 27-year mean (from DFO, 2009a).

The abundance of scallops in the offshore region appears to be fluctuating in the long-term and increasing in the short-term. Age, size and sex distributions relative to a natural condition are unknown.

Bay of Fundy

Stock status for scallops in all areas of the Bay of Fundy is determined using estimates from the annual drag survey. In 2008, there were 754 stations used for the survey, which is higher than the number of stations used in previous years (520–702; DFO, 2009c).

For SPA 1A (southwest Bay of Fundy), the abundance (mean numbers/tow) of commercial size scallops in the 8–16 mile area has been increasing since 2005, but declining in the other two areas (Fig. 15). The average meat weight-at-shell height for the 2008 survey remains above the lows observed in 2005 and 2006. The estimated population biomass of meats was 1,426 t, which is higher than the previous year and the median biomass of 1,246 t for the 1997–2007 series.

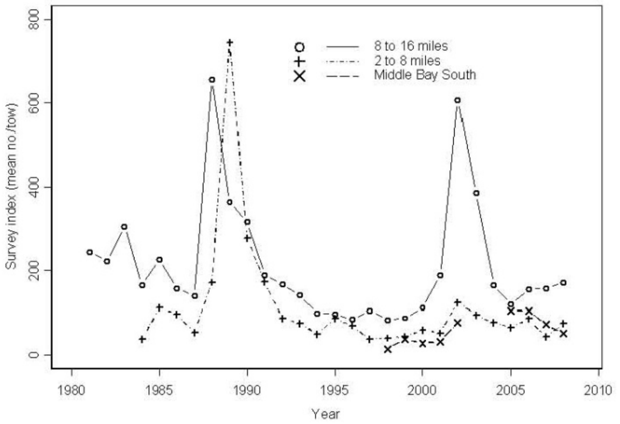


Figure 11. Abundance index (mean numbers per tow) for commercial sized (≥ 80 mm) scallops in the 8–16 mile area, 2–8 mile area and Middle Bay South area of SPA 1A (from DFO, 2009c).

In SPA 1B (Northern/Upper Bay of Fundy), the distributions of shell height have exhibited moderate and regular recruitment, and thus there is a stable abundance of commercial-sized scallops in this area. In 2008, the abundance (mean numbers per tow) of commercial-sized scallops decreased from 2007 for all areas except for Minas/Scots Bay (Fig. 16), although recruitment is expected to improve in most areas. The mean meat weight-at-shell height decreased from 2007 in the majority of survey areas. The population biomass is estimated at 1,890 t meats for 2008, which is above the median biomass of 1,638 t for the 1997 to 2007 series.

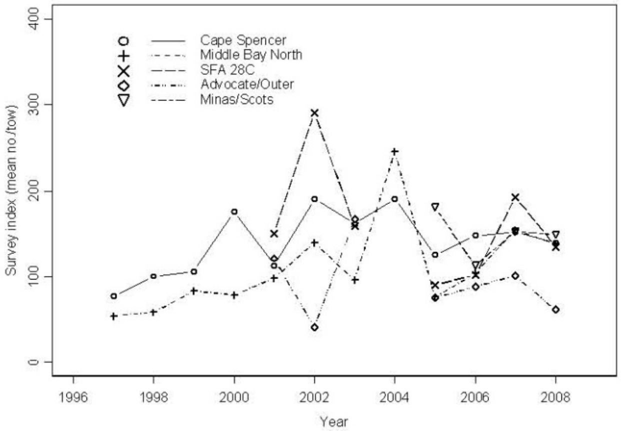


Figure 16. Abundance index (mean numbers per tow) for commercial sized (≥ 80 mm) scallops in the Cape Spencer area, Middle Bay North area, and Upper Bay areas of SPA 1B (from DFO, 2009c).

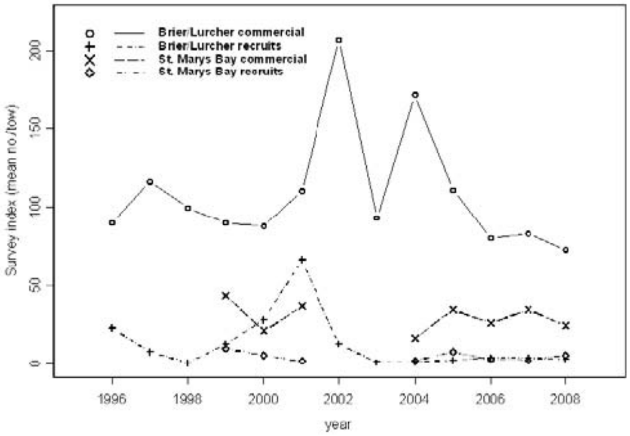


Figure 12. Abundance (mean numbers per tow) for commercial sized (≥80 mm) and recruit (65–79 mm) scallops in the Brier Island, Lurcher Shoals and St. Mary's Bay portions of SPA 3 (from DFO, 2009c).

In SPA 3 (Brier Island, Lurcher Shoals and St Mary's Bay), surveys conducted in 2007 and 2008 show declines in both the numbers of recruits and mean weights of scallops (Fig. 17). In 2008, the estimated biomass was below that for 2007 and the median biomass for the 1996–2007 series.

In SPA 4 (Digby) since 2006, the population has been stable with low recruitment, and this trend is expected to continue for the next two years. The population biomass estimate of 779 t is above that for 2007 and just below the long-term average for the 1983–2007 series (Fig. 18).

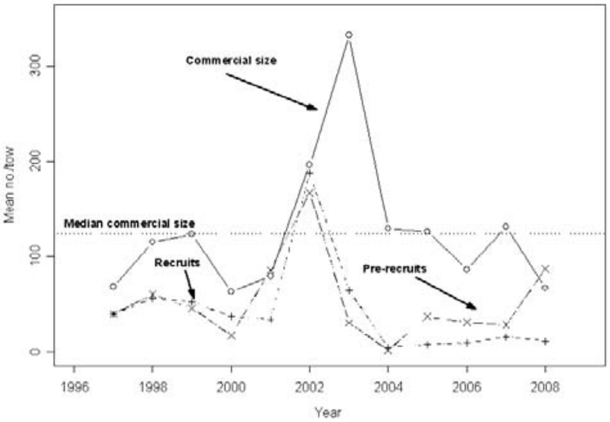


Figure 18. Estimates of biomass (meats, t) of commercial sized (≥80 mm) and recruit (65–79 mm) scallops from SPA 4 (from DFO, 2009c).

In SPA 5 (Annapolis Basin), frequencies of shell heights suggest that the 2007 year class may be the strongest since the 1999 and 2000 year classes. Recent surveys indicate that abundance (numbers per tow) is below the long-term average and indeed the lowest in the series (Fig. 19).

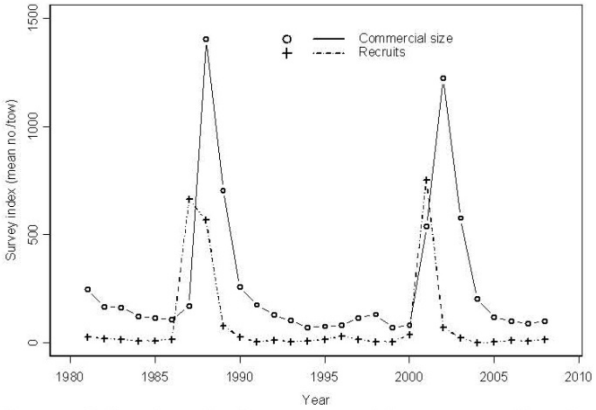


Figure 19. Survey abundance index (mean no./tow) for commercial size (≥80 mm shell height), recruit (65–79 mm shell height), and pre-recruit (<65 mm shell height) scallops in SPA 5.

In SPA 6 (Grand Manan and southwest New Brunswick) in 2008, pre-recruits (40–64 mm) were more widely distributed compared with the previous year (DFO, 2009c). The abundance (mean catch per tow) of commercial-sized scallops fell in the Duck Island Sound area in 2008 but is expected to increase in 2009. The frequencies of shell height in subareas 6A, 6B, and 6C suggest small increases in the abundance of < 80 mm scallops relative to recent years. From 2007 to 2008, annual trends in the abundance (mean numbers per tow) of commercial-sized scallops and recruits suggest little change for areas 6A, 6B or 6C.

Overall, long and short-term trends in this region are variable (across both time and area), while distributions relative to a natural condition are unknown.

Scallop Fishing Area 29

Since 2001, annual assessments of the stock for this fishing area have been conducted through a joint industry/departmental research survey. The abundance of commercial-sized (≥100 mm) scallops in subarea A suggests an increase in 2008 relative to the previous year (Fig. 20). However, there is some concern over the patchy occurrence of scallops in subarea A and the poor recruitment observed during the time series; the survey trends may not be a true reflection of population trends. In subarea B, the abundance index suggests a decline after 2002 and little change after 2006. Recruitment remains low in this subarea. In subarea C after 2002, stronger than average year classes have contributed little to changes in the abundance of commercial-sized scallops up to the decline observed from 2005 through 2006. Since 2006, recruitment has remained low. The Full Bay survey suggests a stable commercial-sized population while the East of Baccaro survey suggests abundance is increasing over the same time period. In subarea D, peaks in abundance were observed in 2005. Between 2007 and 2008, the Full Bay survey index suggests an increase in the abundance of commercial-sized scallops while the East of Baccaro survey suggests a fall after 2005. For both series, recruitment remains low. Overall, long and short-term trends appear to be flat or variable, while age, size and sex distributions are unknown.

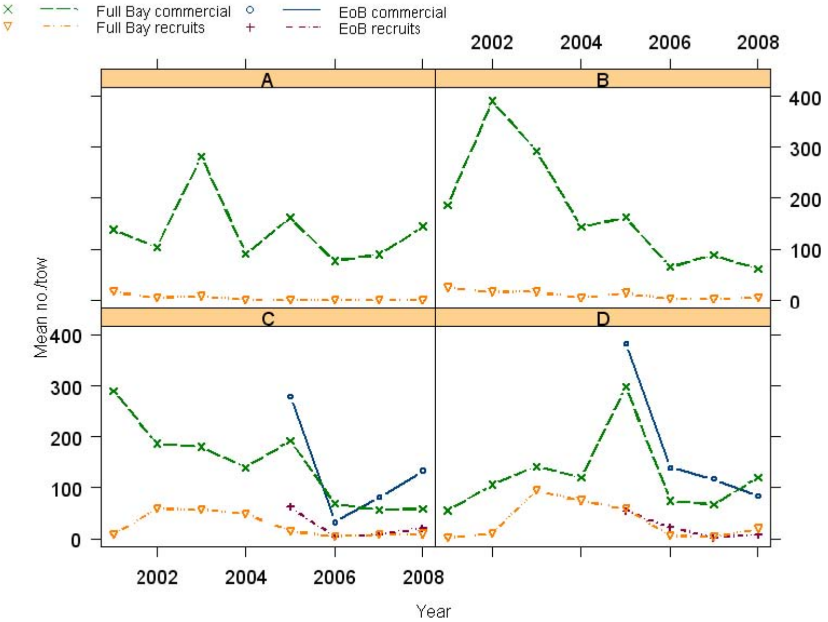


Figure 20. Abundance index of fully recruited (≥100 mm) and recruit (90–99 mm) sized scallop from research surveys by subarea (A to D) in SFA 29 (from DFO, 2009b).

Inshore Quebec

The status of scallop populations is based mostly on analyses of commercial indices calculated from logbooks or from sampling activities at sea or dockside (DFO, 2007b). Scallop beds in the Mingan sector and the Magdalen Islands are surveyed periodically and the results are incorporated into the indices (DFO 2010d).

For the middle North Shore management area, the modal size of scallops and the mean muscle weight from dockside landings are below the previous ten-year average. Data from the 2005 research survey indicates that the density of commercial-sized scallops is slightly below the 1990–2004 average and that the density of non-commercial-sized scallops is above this average (Fig. 21). In the lower shore management area, the muscle weight of scallops from dockside landings and the modal size of harvested scallops have increased significantly since 2003. This is due to a new fishing strategy where scallop beds with higher meat yields were preferentially targeted ahead of scallop beds with higher densities but lower meat yields.

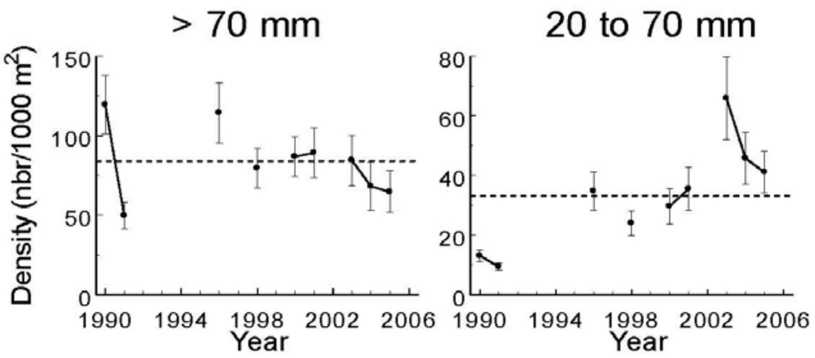


Figure 21. Density index for commercial (> 70 mm) and non-commercial (20–70 mm) sized scallops. The dotted line represents the mean for the 1990–2004 series (from DFO, 2007b).

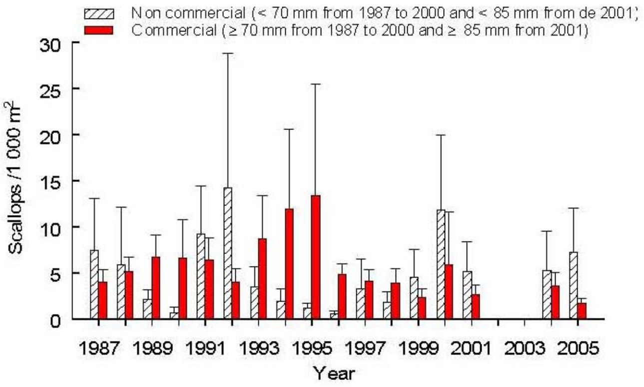


Figure 22. Density (scallops per 1000 m^2 ± 2 standard errors) for scallops sampled in research surveys in the Magdalen Islands (from DFO, 2007b).

In the Gaspé region, the size of scallops and the average muscle weight of commercial catches fell in 2006. The abundance of pre-recruits from research surveys around the Magdalen Islands was low in the mid-1990s, but since 1999 it has been equal to or greater than the average (DFO, 2007b; Fig. 22). The abundance of commercial-sized scallops remains relatively low.

Synthesis

The stock status of scallops depends on the area. The offshore fishery has reduced its effort (in regions other than Georges Bank) in the last decade but maintained high catch levels. Despite a long fishing record, offshore sea scallop stocks in Canada are currently not considered overfished, although biomass relative to B_{MSY} and fishing pressure relative to F_{MSY} remain unknown. Recruitment in the Bay of Fundy fishery is low in several areas while in Quebec stocks are considered low (with the exception of the North Shore area where catches have remained constant). In all areas, catches have declined from when the fisheries first began. The DFO stock assessment reports cover one region at a time, and stocks and data are not always reported in the same manner. Consequently, knowledge of the population abundance of Canadian wild scallop stocks is fragmentary. Overall, stock status is considered to be in moderate condition due to many unknown factors.

Status of Wild Stocks Rank:

Healthy 🟩 **Moderate/Rebuilding** 🟨 Poor 🟥 Critical ⬛

Criterion 3: Nature and Extent of Bycatch

Bycatch is defined as species that are caught but subsequently discarded (injured or dead) for any reason. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for and/or managed in some way.

Factor 1: Quantity & composition of bycatch

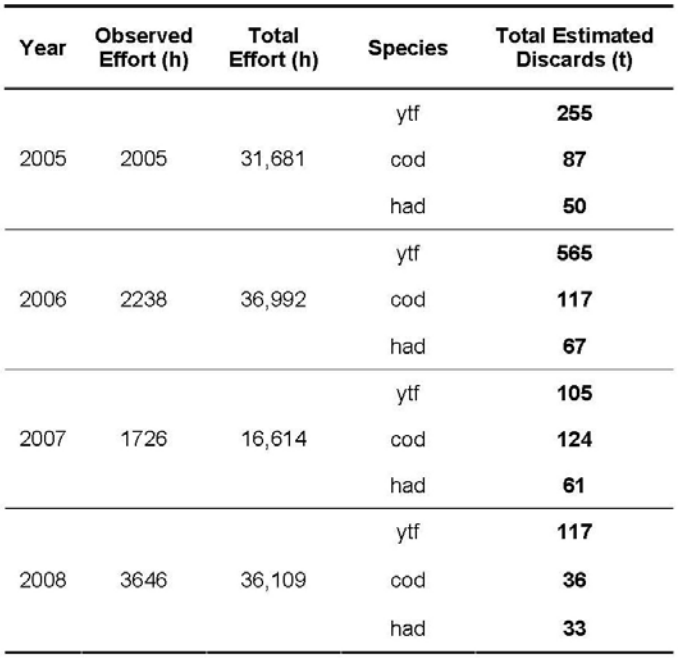
Offshore

Bycatch in the Georges Bank scallop fishery is recorded by independent observers with an observer coverage target of two trips per month. In 2008, this represented 10% of the total hours fished (DFO, 2009a). Other than monkfish (*Lophius americanus,* which may be landed and retained), the Canadian scallop fishery has been required since 1996, "to return to the water in a manner that causes the least possible harm all other species of fish caught incidentally while fishing for scallops" (DFO, 2008). In accordance with the bilateral agreement between Canada and the USA, the bycatch of commercial finfish species in the USA and Canada Georges Bank scallop fisheries must be included as catch in their respective groundfish quotas. Further, estimates of mortality of key bycatch species, such as those listed below, are to be used in stock assessments (DFO, 2007a). In preparation for the Canadian offshore scallop fishery to be certified as a Marine Stewardship Council fishery, a preliminary analysis was conducted on bycatch data from the Georges Bank scallop fishery (Caddy *et al*., 2009). Approximately 25% of the contents of scallop dredges were rocks, sand, foreign articles, garbage and shells. The remainder consisted of organisms including approximately 150 identified taxa; of this catch, 94% were scallops by weight. Fish bycatch accounted for 5.4% of the total weight, the most common of which were, in decreasing abundance: monkfish, winter skate (*Leucoraja ocellata*), little skate (*Raja erinacea*), yellowtail flounder (*Limanda ferruginea*), longhorn sculpin (*Myoxocephalus octodecemspinosus*), sea raven *spp*., winter flounder (*Pseudopleuronectes americanus*), cod (*Gadus morhua*), thorny skate (*Raja radiata*), haddock (*Melanogrammus aeglefinus*), barndoor skate (*Dipturus laevis*), spiny dogfish (*Squalus acanthias*), ocean pout (*Zoarces americanus*) and American plaice (*Hippoglossoides platessoides*). COSEWIC (2011) lists winter skate as endangered in the Gulf of St Lawrence, threatened on the Eastern Scotian Shelf, and as a species of concern on Georges Bank and in the Bay of Fundy. In addition, COSEWIC (2011) designates spiny dogfish as a species of special concern and American plaice as threatened in the Maritime region. Invertebrates accounted for the remaining 0.6%, of which the most common were, in decreasing abundance: starfish, hermit crabs, lobster, razor clams, crabs, sponges, sea urchins, gastropods and shrimp (Caddy *et al*., 2009).

Data analysis of bycatch by DFO has focused on yellowtail flounder, cod and haddock. Atlantic cod from the Maritimes region (which includes Georges Bank) are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered. The bycatch of yellowtail flounder has fallen in recent years from an estimated 565 t in 2006 to 117 t in 2008 (DFO, 2009a; Table 3). The bycatch of cod and haddock fell from

124 t in 2007 to 36 t in 2008 for cod, and from 67 t in 2006 to 33 t in 2008 for haddock, despite a two-fold increase in fishing effort between 2007 and 2008 (Table 3). Yellowtail flounder, cod and haddock bycatch is monitored through the Transboundary Resources Assessment Committee (TRAC). Since 1994, changes in management of the haddock fishery have led to good recovery on the eastern Georges Bank (Brodziak *et al.*, 2006). Stocks of both yellowtail flounder and cod, however, remain depressed with low recruitment and productivity (TRAC, 2008b, TRAC, 2008a).

Table 3. Estimated bycatch of yellowtail flounder (ytf), cod, and haddock (had) in the Georges Bank ('A' and 'B') scallop fishery for the years 2005 to 2008 (from DFO, 2009a).



Year	Observed Effort (h)	Total Effort (h)	Species	Total Estimated Discards (t)
2005	2005	31,681	ytf	**255**
			cod	**87**
			had	**50**
2006	2238	36,992	ytf	**565**
			cod	**117**
			had	**67**
2007	1726	16,614	ytf	**105**
			cod	**124**
			had	**61**
2008	3646	36,109	ytf	**117**
			cod	**36**
			had	**33**

Bycatch of winter skate in the offshore scallop fishery may have been substantial prior to observer coverage, as observed in the US fishery, however, bycatch and discard data have not been publicly available until a recent publication by Gavaris *et al.* (2010) (DFO, 2005a). Routine observer coverage in the scallop fishery did not occur until 2005, so long-term bycatch records are not available.

A recent analysis by Benoît *el al.* (2010) estimated the number of winter skate captured annually in the Southern Gulf of St Lawrence scallop fishery during the 2006 to 2008 fishing seasons. They found that bycatch was small relative to the estimated total population size and the survival rate for discarded winter skate appeared relatively high (DFO 2010). Based on observed catches and estimates of discard survival, Benoît *et al.* (2010) estimated the mean annual exploitation rate (percentage of the population killed) between 2006 and 2008 at 0.14% for juvenile winter skate and 0.06% for adults (Benoît *et al.* 2010). Benoît *et al.* (2010) concluded that fishing-induced mortality for winter skate is minimal when compared to mortality from other sources.

For the period 1986 to 2007 in NAFO Subdivision 5Zc, relative to other fisheries in the area, the scallop fishery has the lowest bycatch rates for barndoor skate (0.07%) but has the highest total removals (11–40 t; Simon *et al.*, 2009). The total annual bycatch estimates of barndoor skate for all fisheries combined for the same area and time period range from 26 to 100 t. Wolffish (northern wolffish, *Anarhichas denticulatus,* spotted wolffish, *A. minor* and Atlantic wolffish, *A. lupus*) bycatch occurred in the Canadian scallop fishery during the late 1980s and through the 1990s but has since greatly declined (Fig. 23, Kulka *et al.*, 2008). All three species are listed by COSEWIC (*A. denticulatus* and *A. minor* as 'Threatened' and *A. lupus* as of 'Special Concern') and in Schedule 1 of the *Species at Risk Act* (SARA) (Kulka *et al.*, 2008; COSEWIC 2011).

There are no long-term data on the bycatch of marine mammals, turtles or sea birds in the Canadian sea scallop fishery, with the exception of one seal (species unknown) in 2005 (Gavaris *et al.* 2010). Marine mammal bycatch has not been documented in the Atlantic US scallop fishery. However, turtle bycatch has been recorded in the US fishery and includes four species, namely, loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*) and leatherback (*Dermochelys coriacea*). It has been estimated that during the period 1989–2005 in the US Atlantic scallop fishery, 619 loggerhead turtles were caught (Merrick and Haas, 2008). Turtle bycatch has not been consistently recorded in the Canadian fishery (MSC 2010). Greater shearwater (*Puffinus gravis*), herring gull (*Larus argentatus*) and common loon (Greater Northern loon, *Gavia immer*) have also been documented as bycatch in the Atlantic US scallop fishery (Zollett, 2009). Recently, fishery observers in Canada have been required to report all catches of turtles and seabirds, although none were reported between 2002 and 2006 (Anonymous 2011).

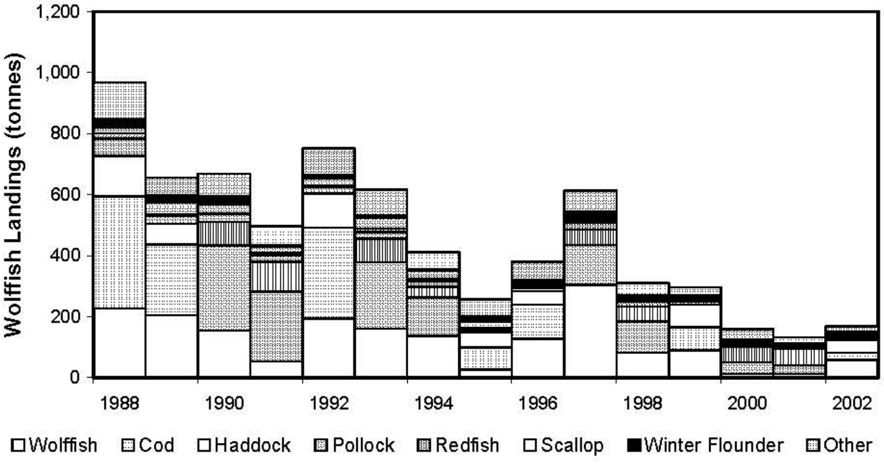


Figure 23. Annual wolffish landings for the Scotia-Fundy Region for the period 1986–2002 (figure indicates main species landed when wolffish were caught) (from Kulka *et al.*, 2008).

Bay of Fundy

There is no observer coverage for the scallop fishery in SPAs 1–6 and thus no data on bycatch. However, in 2008, DFO funded observer coverage of the fishery to examine bycatch; these data are not yet available. In the lower Bay of Fundy scallop fishery, over 150 additional species have been recorded from dredge hauls (Fuller *et al.*, 1998). The majority of these were not commercial species, but rather benthic fauna including sponges, hydroids, tunicates and bryozoans, all of which form structural habitat on the sea floor. In some areas, horse mussel beds were also impacted.

Scallop Fishing Area 29

In this fishery, the number of observed vessel days must equal the number of active vessels. In 2008, 63 vessel days were observed for 61 vessels. Due to the high bycatch of lobster, observer coverage focuses on subarea B (Fig. 24).

As in previous years, subarea B had the highest bycatch of lobster compared with other fished areas. Bycatch of lobsters in subareas C and D was very low. In 2008, 1,473 lobsters were caught as bycatch on observed vessels, of which 936 were classified as uninjured (and released), 411 as injured and 116 as dead (condition not noted for ten others). The estimated number of lobsters bycaught for the entire scallop fishery in SFA 29 in 2008 was 4535. This represents 2.3 t by weight, equivalent to < 0.1% of the lobsters landed by the LFA 34 lobster fishery in the area corresponding to SFA 29 for 2007/2008. In addition to lobsters, rock crabs (*Hemigrapsus sexdentatus*), sculpins and Jonah crabs (*Cancer borealis*) were also dominant in bycatch from the 2008 fishery (DFO, 2009b).

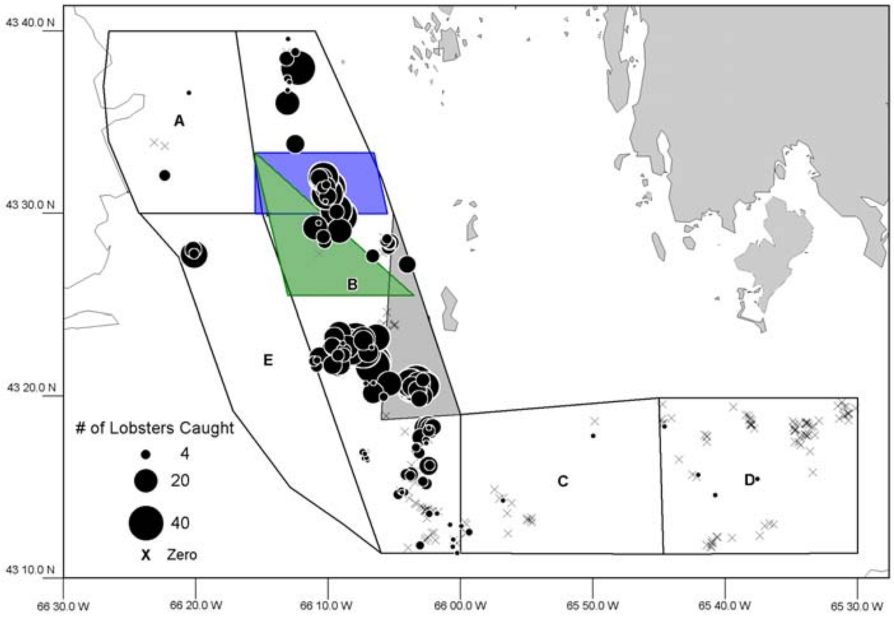
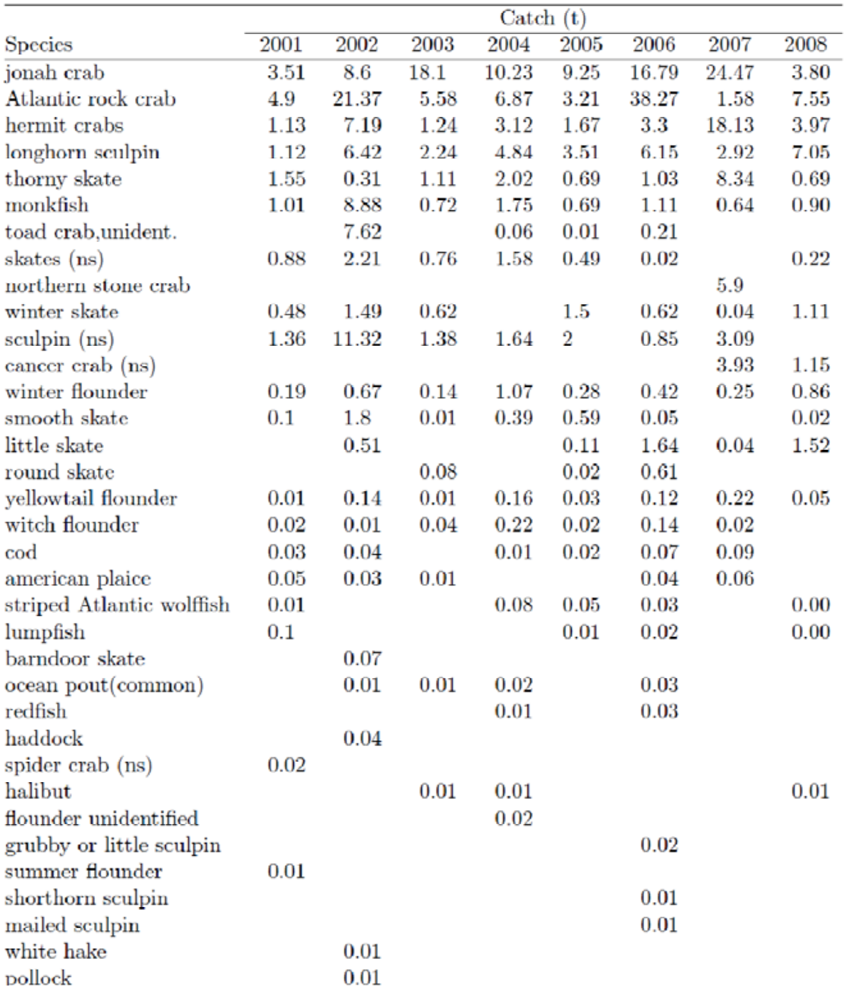


Figure 24. Number and location of bycaught lobsters from observed scallop fishing trips in the scallop SFA 29 fishery for 2008. Closed fishing areas in subarea B are indicated by blue and green polygons. The gray triangle refer to areas used in previous years to monitor lobster bycatch (from DFO, 2009b).

In addition to lobster, there are several other bycatch species in SFA 29; the highest catch in terms of weight are the crab species (Table 4). Many other of these species are caught in low quantities such as winter skate and yellowtail flounder (Smith *et al.* 2009a).

Table 4. Estimated catches of bycatch species in the SFA 29 scallop fishery. Table from Smith *et al.* 2009a.



	Catch (t)							
Species	2001	2002	2003	2004	2005	2006	2007	2008
jonah crab	3.51	8.6	18.1	10.23	9.25	16.79	24.47	3.80
Atlantic rock crab	4.9	21.37	5.58	6.87	3.21	38.27	1.58	7.55
hermit crabs	1.13	7.19	1.24	3.12	1.67	3.3	18.13	3.97
longhorn sculpin	1.12	6.42	2.24	4.84	3.51	6.15	2.92	7.05
thorny skate	1.55	0.31	1.11	2.02	0.69	1.03	8.34	0.69
monkfish	1.01	8.88	0.72	1.75	0.69	1.11	0.64	0.90
toad crab,unident.		7.62		0.06	0.01	0.21		
skates (ns)	0.88	2.21	0.76	1.58	0.49	0.02		0.22
northern stone crab							5.9	
winter skate	0.48	1.49	0.62		1.5	0.62	0.04	1.11
sculpin (ns)	1.36	11.32	1.38	1.64	2	0.85	3.09	
cancer crab (ns)							3.93	1.15
winter flounder	0.19	0.67	0.14	1.07	0.28	0.42	0.25	0.86
smooth skate	0.1	1.8	0.01	0.39	0.59	0.05		0.02
little skate		0.51			0.11	1.64	0.04	1.52
round skate			0.08		0.02	0.61		
yellowtail flounder	0.01	0.14	0.01	0.16	0.03	0.12	0.22	0.05
witch flounder	0.02	0.01	0.04	0.22	0.02	0.14	0.02	
cod	0.03	0.04		0.01	0.02	0.07	0.09	
american plaice	0.05	0.03	0.01			0.04	0.06	
striped Atlantic wolffish	0.01			0.08	0.05	0.03		0.00
lumpfish	0.1				0.01	0.02		0.00
barndoor skate		0.07						
ocean pout(common)		0.01	0.01	0.02		0.03		
redfish				0.01		0.03		
haddock		0.04						
spider crab (ns)	0.02							
halibut			0.01	0.01				0.01
flounder unidentified				0.02				
grubby or little sculpin						0.02		
summer flounder	0.01							
shorthorn sculpin						0.01		
mailed sculpin						0.01		
white hake		0.01						
pollock		0.01						

Inshore Quebec

Bycatch in the inshore Quebec scallop fishery is currently unknown and not collected by observers but does represent a source of mortality for commercial species (Benoît, 2006). For example, the scallop fishery in the southern Gulf takes place in the area occupied by winter skate (listed as Endangered by COSEWIC) in the summer (Swain *et al.*, 2006). Although winter skate are on occasion observed in scallop dredge catches, no historical estimates of bycatch rates are available (Swain *et al.*, 2006). However, recent work by Benoît *et al.* (2010) provides estimates of discard survival for the southern Gulf of St Lawrence that estimated mean annual exploitation rate (percent of population killed by scallop dredges) for winter skate at 0.14% for juvenile winter skate and 0.06% for adults. They conclude that fishing-induced mortality is very small for winter skate in the scallop dredge fishery compared to mortality from other sources (Benoît *et al.* 2010).

Overall, this factor receives a red ranking. Although bycatch data from some regions are unavailable, data from other regions suggest that bycatch regularly includes species of concern, including cod and winter skate.

Factor 2: Population consequences of bycatch

A complete picture of bycatch effects in the Canadian scallop fishery is lacking. Fishermen note the gradual extension of "lemonweed", the bryozoan *Flustra foliacea*, from the Upper Bay to off Yarmouth and suggest that this change is a result of the scallop fishery (Fuller and Cameron, 1998). The extent to which scallop dredging might be preventing the recovery of stocks such as cod and yellowtail flounder is unknown. The impacts on winter skate appear low given that a recent study found most winter skates captured in the scallop fishery were released alive and in very good condition, indicating high post-release survival. For winter skate, mean annual exploitation rate (percent of population killed by scallop dredges) was 0.14% for juvenile and 0.06% for adults (Benoît *et al.* 2010).

There are no data available on how the scallop fishery in SFA 29 either directly or indirectly (from impacts of gear on lobster habitat) affects the lobster population (Smith *et al.*, 2009a). A recent study found that lobsters are more evident on coarse bottoms than on the gravel pavements favored by scallops (Tremblay *et al.*, 2009). Lobster catches in SFA 29 do not suggest an adverse impact from the scallop fishery as lobster landings in this area in 2007/08 were higher than those in the previous year and five years earlier (Smith *et al.*, 2009a). However, it is understood that landing trends are not wholly representative of the population size.

Most analysis of bycatch on species of concern in the scallop dredge fishery has focused on cod, haddock, and yellowtail flounder (Figure 25). Haddock populations were previously depressed but are now rebounding to healthier levels. Populations of cod and yellowtail and flounder, on the other hand, remain low. It is unknown how the scallop fishery has impacted these populations. It is considered unlikely that the scallop fishery has led to declines in these species because scalloping effort has declined in the last decade, and declines are believed to be due to directed trawl fishing and environmental change instead (MSC 2010). Even so, the extent to which current bycatch levels in the scallop fishery are impeding recovery of these species is unknown. The fishery has taken measures to reduce and constrain bycatch of these species, including the sort of time and area closures that have been shown to be effective at reducing cod bycatch and have recently been implemented to reduce yellowtail flounder bycatch. Other approaches include "bycatch reserves" that set aside part of the annual TAC for each species for bycatch based on an assumption of 100% discard mortality rates, and changes in gear designs and towing procedures. Because the impact of the fishery on species of special concern is not known, but management is taking measures to reduce or constrain bycatch, this factor receives a yellow ranking.

Factor 3: Trends in interaction bycatch rates

Due to the lack of long term and/or systematic research on bycatch, there are no long-term data on trends in bycatch interaction rates in most areas, but when data do exist for the offshore fishery and SFA 29, bycatch rates in the short-term trends are flat or down (in terms of weight by species) with a slight increase between 2007 and 2008 in SFA 29 for winter skate (Tables 3 and 4).

Fishing-induced mortality for winter skate has been shown to be very small in scallop dredges compared to mortality from other sources (Benoît *et al.* 2010). However, due to past changes in the scallop fishery, such as gear modifications and the introduction of areas closures, it is not possible to use recent findings to evaluate the total contribution of mortality in the scallop fishery to total mortality from previous years (Benoît *et al.* 2010).

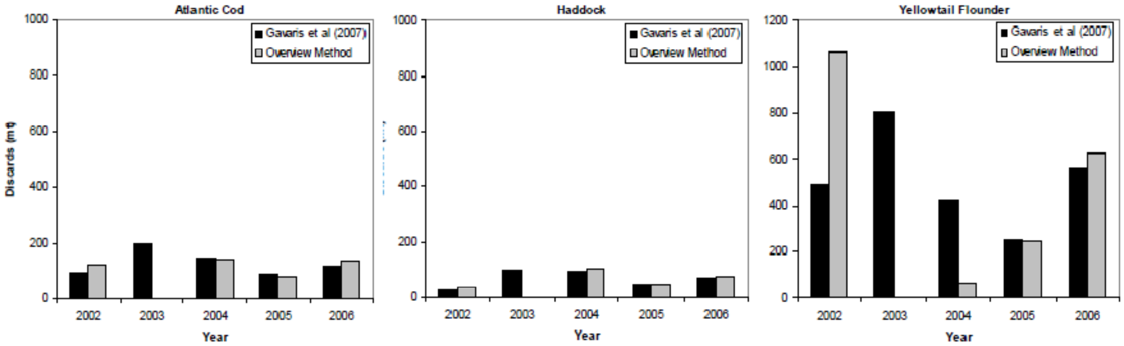


Figure 25. Discard estimates (mt) for Atlantic cod, haddock, and yellowtail flounder from the 5Z region of Georges Bank (2002–2008). Black and grey bars represent two different estimation methods. Figure from Gavaris *et al.* 2010.

For the offshore fishery, DFO established bycatch reserves in the groundfish management plan for yellowtail, cod and haddock on Georges Bank to account for the discards by the offshore scallop fleet (MSC 2010). These are expressed as a percentage of the total TACs and are 30%, 12 % and 1.03 % for yellowtail, cod and haddock, respectively (MSC 2010).

In addition, a bycatch protocol for the offshore scallop fleet includes: (Clearwater 2008 in MSC 2010)

1. All groundfish bycatch will be returned to the water in a manner that causes least harm to the fish. No vessel is to leave any tows on deck awaiting processing. No more than one tow will be permitted in the hopper, rail, dump table, deck, etc. at a time.
2. In order to facilitate communication of bycatch areas among the fleet, a grid system will be used to identify catch location. This grid is labeled, numbered and provided to all vessels in the fleet.
3. It is the responsibility of the Captain to ensure yellowtail flounder, cod and haddock bycatch (by number of fish) is monitored on a tow-by-tow basis 24 hours per day. Fish will be accounted for in the grid of the greatest % of the tow.
4. Avoidance measures will be taken if a vessel encounters a yellowtail flounder catch that exceeds 25 lbs per watch, or a maximum 100 lbs per day, and/or a cod catch of 15 lbs per watch, or a maximum 60 lbs per day.

Bycatch reduction techniques for the scallop fleet include: gear modifications, area/time closures to protect spawning stocks and bycatch restrictions as mentioned above (MSC 2010). All of these measures are unique to the area and season of fishing. As a result of these bycatch reduction measures, bycatch trends are believed to be either flat or declining for most species. Therefore, this factor receives a yellow ranking.

Factor 4: Ecosystem impacts

There are insufficient data to assess impacts on the ecosystem from bycatch in the Canadian scallop fishery. However, a recent study examined changes to a benthic ecosystem after 30 years of scallop dredging (Kenchington *et al.*, 2007). The study showed that the benthic community changed from one dominated by sessile, long-lived species (e.g., boring sponges *Cliona spp*., horse mussel *Modiolus modiolus*, the scallop *Chlamys islandica*) to one domination by mobile, short lived species (e.g., whelks *Buccinum undatum* and *Colus spp*., bivalves *Astarte spp*. and *Cyclocardia borealis*, and the brittle stars *Ophiurida*; Kenchington *et al*., 2007). The study suggests that the primary cause for these changes is physical impacts by fishing gear. As this study relates strictly to benthic species and their habitats and not the ecosystem consequences of bycatch such as cod, this factor remains unknown and will be addressed in the habitat and ecosystem impacts section.

Synthesis

Scallop dredges may catch many species in addition to their targeted species. However, there is either limited or no long term or systematic analysis of this bycatch from the Canadian scallop fishery. Some of these bycatch species are listed as a conservation concern by COSEWIC, such as winter skate and Atlantic cod (endangered in some regions). However, when data are available, these bycatch events are sporadic, flat or in decline, and it has recently been shown that winter skate have a high post-release survival rate. In addition, there are several measures in place to help reduce bycatch such as gear modifications, area/time closures to protect spawning stocks and bycatch restrictions.

However, these measures have not been in place long enough to know how effective they are. Historically, there has been a lack of research on the quantity of bycatch and its impact on populations, but new reports on bycatch trends have been made available recently. Bycatch from the Canadian scallop fishery is rated as a moderate conservation concern.

Nature of Bycatch Rank:

Low 🟩 **Moderate** 🟨 High 🟥 Critical ⬛

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Factor 1, 2 & 3: Impacts of fishing gear on habitat, resilience of the habitat fished and spatial extent of the impact

Scallop dredges have impacts on benthic populations, communities, and habitats by damaging or reducing structural biota and habitat complexity and by altering seafloor structure and large habitat features (DFO, 2006a). In an international review that examined studies investigating the impacts of fishing methods on habitats, scallop dredging was shown to have the highest impact on seafloor ecology of any mobile fishing method (Kaiser *et al.*, 2006). Scallop dredging was listed as the third most severe fishing method in terms of bycatch and habitat impact in a study that examined the assessment of fishing methods by a range of user groups, including fishermen (38%), scientists (27%) and marine conservationists (25%) (Fuller *et al.*, 2008). Scallop dredging may impact the benthic community by reducing densities and shifting spatial distribution of macrofaunal populations (Langton *et al.*, 1987a, Langton and Robinson, 1990, Thrush *et al.*, 1995, Kenchington, 2000, Bradshaw *et al*. 2002), by removing colonial epifauna, reducing habitat complexity (Dayton *et al.*, 1995, Auster *et al.*, 1996, Collie *et al.*, 1997, Collie and Escanero, 2000, Hall-Spencer and Moore, 2000, Stokesbury and Harris, 2006) and by redistributing the grain sizes of sediments and increasing silt in the water column (Caddy, 1989, Mayer *et al.*, 1991, Grant, 2000, MacDonald, 2000). In the lower Bay of Fundy, scallop dredging has been shown to alter the seafloor community with a marked shift from sessile, longer lived species to those that are mobile and fast growing (Magee *et al.*, 1999).

On the offshore banks, scallops prefer a sandy gravel bottom in depths of 35–120 m (DFO, 2009a). Stokesbury and Harris (2006) suggest that a limited short-term sea scallop fishery on Georges Bank alters the epibenthic community less than the natural dynamic environmental condition. Lindholm *et al.* (2004) suggest that sand habitats on Georges Bank exposed to natural disturbance may recover from fishing gear impact in a relatively short period of one year. Both studies were conducted in a high-energy area and stress the importance of closed areas to allow recovery from fishing impacts, but these are not representative of all scallop-fishing areas. A study on the effects of scallop dredging on benthic communities in an ecosystem dominated by high velocity currents, upwelling zones, etc., showed that the habitat recovered in a few months from the impacts of dredging gear (Archambault and Goudreau, 2006) while Bradshaw *et al.* (2002) suggest that the period of recovery from fishing gear is determined by the duration of fishing rather than the intensity. Thus, the nature of the habitat and duration of fishing influence the temporal extent of the impact from scallop dredges. The moderate to deep water, gravel and sand bottom habitat of the scallop is considered moderately resilient to disturbance, while the fishery's spatial scale is considered moderate (i.e., a modern industrialized fishery, but of limited geographic scope).

Primary Ecosystem Factors

Factor 4 & 5 Disruption of Food Webs and Changes in Ecosystem State

In the lower Bay of Fundy, a recent study has examined changes to a benthic ecosystem after 30 years of scallop dredging (Kenchington *et al.*, 2007). It shows that the benthic community changed from one dominated by sessile, long lived species (e.g., boring sponges *Cliona spp*., horse mussel *Modiolus modiolus*, the scallop *Chlamys islandica*) to one domination by mobile, short lived species (e.g., whelks *Buccinum undatum* and *Colus spp*., bivalves *Astarte spp*. and *Cyclocardia borealis*, and the brittle stars *Ophiurida*; Kenchington *et al.*, 2007). The study suggests that the primary cause for these changes is physical impacts by fishing gear.

The extent to which changes in habitat structure by scallop dredging throughout Canada might affect the survival of juvenile fish is unknown at present. However, the reduction of habitat complexity and structure through scallop dredging could have negative impacts on commercial fish species. Lindholm *et al.* (1999) have demonstrated that seabed habitat disturbance can reduce the survivorship of juvenile cod. In addition, recent research on the Scotian Shelf has indicated that juvenile haddock prefer seabed habitats that are more rugged and complex (Anderson *et al.*, 2005).

Overall, while it is unknown whether the removal of the target species and/or baitfish post any disruption to the food web, it is believed that the physical impacts of dredging in the area have resulted in ecosystem state changes.

Synthesis

Scallop dredging impacts habitats by changing their physical and biological structure. Dredging is a fishing method that causes great damage, and the scallop dredge fishery occurs in moderately resilient habitat over a moderate spatial scale. Ecosystem effects have been detected; however, there are few studies with adequate controls comparing impacted areas to those that have never been fished. Dredging can also impact populations of scallop and result in indirect mortality of the target species by altering the size structures and resilience of the species. As a result, the effects of fishing practices on habitats and ecosystems are considered severe.

Effect of Fishing Practices Rank:

Benign 🟩 Moderate 🟨 [✓ **Severe** 🟥] Critical ⬛

Criterion 5: Effectiveness of the Management Regime

Factor 1: Stock assessments

The majority of offshore scallop beds are surveyed on an annual basis by DFO in collaboration with the fishing industry. The exceptions are Banquereau and St Pierre Banks, which are considered to be marginal fisheries and are only fished and assessed periodically. DFO provides funding for the sole annual (August) survey to assess the Georges Bank scallop stock. In addition, the fishing industry provides funding (on a shared cost basis with DFO) and logistical support for yearly surveys of all other offshore scallop stocks (German, Browns, Middle, Sable Island/Western Banks). Surveys conducted by DFO provide advice and abundance and distribution estimates for commercial-sized and pre-recruit (ages 3+) scallops. Although surveys cover both Georges Bank Zones A and B, assessments are only conducted using data from Zone A. An assessment of the fishery is also conducted using changes in CPUE obtained from logbook and observer data, a meat weight index for commercial-sized scallops (100 mm), and from meat counts and 100% landings coverage by dockside observers.

Scallops in the Bay of Fundy are assessed annually (DFO 2009c). Assessment of the SFA 29 scallop fishery is provided annually with advice on the TAC based on survey estimates of abundance and commercial catch rates (DFO 2009b). The inshore Quebec fishery is assessed every three years (DFO 2007b). This assessment is used to determine whether changes in stock status require adjustments to the conservation approach and management plan. Statistical fishery data, sampling of commercial catches and research surveys are all used to generate these assessments.

Survey results are published through Science Advisory Reports (SAR). Periodically, DFO produces peer-reviewed scientific assessments of scallop stocks with recommendations for fishery management.

Factor 2: Scientific monitoring

Management is based on regular collection of both fishery-independent data (e.g., abundance surveys) and fishery-dependent data (including catch and CPUE).

Factor 3: Scientific advice

Scientific advice is provided annually for the offshore scallop industry through stock assessment reports from the DFO surveys on Georges Bank. Scallops in the Bay of Fundy are assessed annually and the results are provided along with scientific advice. Advice on TACs for the scallop fishery in SFA 29 is provided annually based on survey estimates of abundance and commercial catch rates. The inshore Quebec fishery is assessed every three years to determine whether changes in stock status require adjustments to the conservation approach and management plan. There is no indication that scientific advice is not followed in the Canadian scallop fishery.

Factor 4: Management plans to control bycatch

The offshore Canadian scallop fishery has implemented measures to minimize the catch of non-scallop species with a focus on Atlantic cod, haddock and yellowtail flounder. These measures include the proper release and handling of bycatch, identification of areas of high bycatch, adjusting the spacing and location of ropebacks in the scallop dredge, reducing tow time and speed, directional changes and, finally, leaving a high bycatch grid area for a 12-hour period. On Georges Bank, there are two time-area closures to protect cod (January–March) and yellowtail flounder (June) during their spawning periods. Scallop dredges use a minimum of three inch rings to allow small scallops to escape, although little is known about their survival. Four inch ring sizes are being investigated as well as various ropeback configurations to avoid finfish bycatch (although there are no set gear restrictions in the offshore fishery). Although bycatch is monitored on observed trips, bycatch figures for species other than Atlantic cod, haddock and yellowtail flounder, e.g., non-commercial and habitat-forming species, are recorded but were not reported until a recent report by Gavaris *et al.* (2010) that listed these species for 2002–2008. Bycatch is not recorded in the inshore Quebec scallop fishery or the scallop fishery in SPAs 1–6, although some observer coverage was funded by DFO for 2008 and part of 2009 (the data were not yet available for inclusion in this report; DFO, 2009c). Although there are some measures in place to control and reduce bycatch, their effectiveness remains unknown.

In SFA 29, measures have been taken to avoid scallop fishing in areas where, or at times when, lobsters are in high concentration or are soft shelled (DFO, 2009b). For example, lobsters molt in July–October and are less mobile, more prone to injury and involved in mating during this part of the season. In previous years, a portion of Subarea B was closed due to high lobster bycatch. It has been suggested that moving the start date of the fishery earlier in June may avoid overlap with the lobster molting period (DFO, 2009b).

Factor 5: Management plans to control habitat impacts from fishing practices

To minimize the impact of scallop dredging on seafloor habitats and be able to target mature scallop beds for fishing, five of the seven offshore scallop license holders formed the Canadian Offshore Scallop Industry Mapping Group (COSMIG). This group formed a partnership with the Canadian Hydrographic Service of Canada and the Geological Survey of Canada with the aim of acoustically mapping the ocean floor to create sediment maps of commercial scallop fishing areas. This work would also include benthic habitat interpretation. Using these maps, the industry has been able to more efficiently target scallop beds and reduce their impact on the environment (Table 5a & b, Robert, 2001; DFO, 2004a). Although seabed mapping has occurred through industry and DFO cooperation and led to a decrease in the dredge fishery footprint, it has also allowed vessels to target older brood stocks and access areas previously protected because of the potential for gear hangups. It is important to note that the industry currently owns benthic habitat maps of Georges Bank but has not made these available to DFO for management and stock assessment purposes (Anonymous 2010). These maps would be important for reducing habitat damage and ecosystem impacts from scallop dredging.

Table 5a. The amount of fishing effort required to capture one ton of scallop meat with and without the use of map imagery (from Robert, 2001).

	Without imagery	With imagery	Reduction
Fishing effort	6.37 hours	2.41 hours	62%

Table 5b. The amount of time scallop gear is on the sea bottom, the area of sea bottom towed and the fuel usage for fishing 13,640 kg of scallop with and without the use of map imagery (from Robert, 2001).

	Before imagery	With imagery	Reduction
Time gear on bottom	162 hours	43 hours	73%
Area of bottom towed	1,176 km²	311 km²	74%
Fuel usage	27,697 liters	17,545 liters	36%

Rotational fishing may aid in habitat recovery for offshore scallops beds (Gulf Region). In the Southern Gulf of St Lawrence region, through collaboration between DFO and the scallop industry, buffer zones have been established to avoid dredging specific habitat (Davidson *et al.*, 2007). These zones are designed primarily to protect lobster larval settlement areas. Other measures have been proposed but have not been implemented to date. For example, since scallops spawn in late summer and juveniles settle on the seabed in the fall, a halt in fishing during the spawning and settlement periods (August to November) would limit the adverse effects of dragging on the substrate and favor the survival of young scallops; a rotational fishing strategy would also reduce the mortality rate of pre-recruits (DFO, 2005b; DFO, 2007b). Because habitat maps developed by the fishing industry have not been made available to DFO to properly manage habitat impacts from scallop dredges, this factor receives a red ranking.

Factor 6: Catch monitoring and enforcement

For Canadian scallop fisheries, exploitation of the stock is restricted by establishing TACs for each SFA. The OSAC forwards recommendations to DFO on TACs for approval based on scientific advice, marketing and other information. OSAC is conservative in setting the TAC level, which is usually approved by DFO. Monitoring and enforcement measures for the offshore fishery include license conditions, TACs and individual EA limits on catch, bycatch reserves and protocols, hail-in/hail-out requirement, mandatory satellite vessel monitoring equipment on all fishing vessels, on-board observers, an industry funded 100% dockside monitoring to weigh all scallop meats landed, an industry-funded port sampling program to monitor the meat count regulation, daily hailing of catch, random at-sea boarding by Fishery Officers, aerial surveillance and mandatory completion of logbooks. In addition, compliance is very high in the offshore scallop fishery. In SFA 29 during 2000, all Full Bay Fleet fishing vessels were required by DFO to install electronic monitoring devices to monitor vessel activity after reports of fishing occurring in areas that had been closed to protect scallop broodstocks (Anonymous).

Commencing in 1997, consistent with Fisheries and Oceans Canada's approach in other Enterprise Allocation (EA) fisheries, all scallops landed by offshore vessels must be monitored by a dockside observer and recorded against the EA of the appropriate company. Prior practice where crews were permitted to take small predetermined quantities of scallops ashore without the benefit of dockside monitoring and without having weights counted against EA quotas, was prohibited by license conditions effective January 1, 1997. Real time electronic monitoring has been in place in SFA 29 since 2002 and is now active aboard all offshore scallop vessels regardless of the area being fished.

The inshore scallop fishery fleets also participate in dockside monitoring and meat sampling programs (DFO, 2004a). In addition, the fleets of SFA 29 are required to financially contribute to a sea-bed mapping project in the area that was completed in 2006 (DFO, 2004a; DFO). There has been little regular or routine monitoring of bycatch species (restricted to the offshore scallop and SFA 29 fisheries) or changes in bycatch over time, but there have been some recent bycatch analyses (Gavaris *et al*. 2010; Smith *et al*. 2009; Smith *et al*. 2007).

Factor 7: Management track record

Management's effectiveness at maintaining stock productivity is uncertain, as there are no assessments of stock abundance relative to reference points; however, landings appear to have been stable over time, and the stock is not believed to be overfished or experiencing overfishing. As a result, this factor receives a yellow ranking.

Synthesis

DFO provides routine stock assessments with both fishery-dependent and fishery-independent data. Management has implemented good practices such as limited entry, gear restrictions, establishment of fishing areas and seasons, and meat counts. Catches are monitored through an industry-funded dockside monitoring program. In addition, all offshore and Maritime Region vessels are required to carry vessel monitoring systems. Canadian management has been faulted for failing to address habitat impacts but overall has implemented the good management practices mentioned above. Measures are in place to address bycatch of commercial and non-commercial species, but further improvement is needed. Although some habitat maps completed by the fishing industry have not been released for management purposes, some seabed mapping has occurred, leading to a decreased footprint for the dredge fishery. However, these maps have also allowed vessels to target older brood stocks and access areas previously protected due to the potential for gear hang-ups.

Effectiveness of Management Rank:

Highly Effective 🟩 [✓ Moderately Effective 🟨] Ineffective 🟥 Critical ⬛

IV. Overall Evaluation and Seafood Recommendation

Scallops are relatively resilient to fishing pressure, although there is concern about the indirect impacts of fishing on natural populations. Stock status is variable throughout the Atlantic Region with pulsed reproduction resulting in strong year classes and inconsistent catches from year to year. There are some concerns about bycatch and the impact of the fishery on the marine ecosystem and habitats. Bycatch impacts on commercial and non-commercial species have received little study in Atlantic Canada, despite some species being listed under COSEWIC and SARA. However, there are several measures in place to reduce bycatch, and bycatch rates have not shown increases in recent years. Scallop dredges are one of the most destructive fishing gear types, and there are concerns over benthic habitat damage caused by scallop dredging. Management practices have been effective at maintaining stocks, although little has been done to mitigate impacts on habitat. The Canadian scallop dredge fishery receives a recommendation of **Good Alternative**.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Nature of Bycatch		√		
Habitat & Ecosystem Effects			√	
Management Effectiveness		√		

Overall Seafood Recommendation:

Best Choice 🟩 **Good Alternative** 🟨 Avoid 🟥

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