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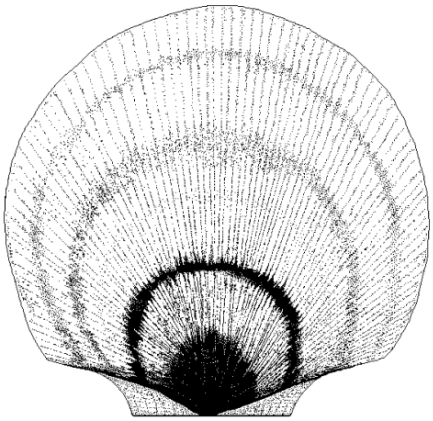
Gulf Region
Canadian Science Advisory Secretariat
Science Advisory Report 2011/039

ASSESSMENT OF THE SCALLOP FISHERY (*PLACOPECTEN MAGELLANICUS*) OF THE SOUTHERN GULF OF ST. LAWRENCE



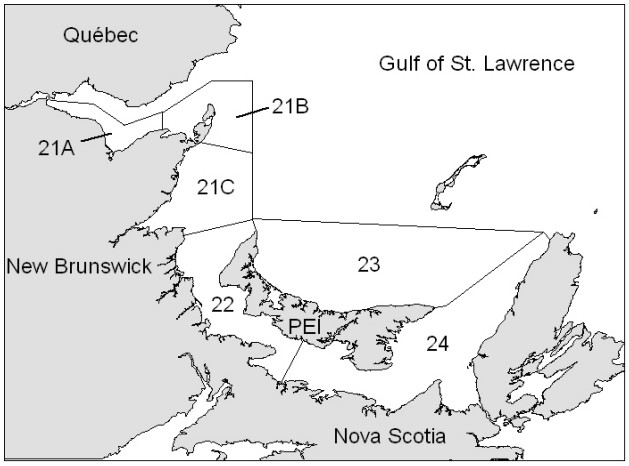


Figure 1: Scallop fishing areas in the southern Gulf of St. Lawrence.

Context

The Sea Scallop (Placopecten magellanicus) fishery in the southern Gulf of St. Lawrence has always been a complementary fishery to the lobster, herring and groundfish fisheries. Scallops are harvested with mobile gear (drag) using small vessels. In the Gulf Region there are over 700 commercial scallop fishing licences, although many are inactive. Almost all scallop fish harvesters hold more than one fishing licence.

In the Gulf Region, the scallop fishery is a relatively small fishery dispersed over a large area. The scallop grounds in the Gulf Region are divided into four Scallop Fishing Areas (SFA) with one zone (SFA 21) divided into three sub-zones. There are SFA specific management measures related to effort controls. In most SFAs, buffer zones that prohibit scallop dragging over selected habitat have been implemented mainly to protect lobster larval settling areas and surrounding habitat. First recorded landings were in the early 1900's and peak landings of 900 t annually occurred in late 1960's and early 1970's. Preliminary landings were just over 80 t in 2010.

The last assessment of the Gulf Region scallop fishery dates to 1990 (Lanteigne and Davidson 1992). The Department of Fisheries and Oceans – Gulf Region convened a workshop in 2006 to discuss the future of the southern Gulf scallop fishery (Davidson et al. 2007). The workshop was organized to identify progressive management practices for the traditional scallop fishery, while also exploring new harvesting methods.

DFO Ecosystem and Fisheries Management (EFM) has requested an assessment of the scallop fishery and of the scallop stock in the southern Gulf of St. Lawrence, with particular consideration to the effectiveness of the present management measures to protect the resource. The science peer review meeting was held on February 17 and 18, 2011 in Moncton (NB). Participants at the meeting were from DFO Oceans and Science, DFO EFM, provincial governments, industry and aboriginal associations.

SUMMARY

- Based on historical information, scallop stock abundance in the sGSL is low and only 25% of licence holders are active.

- The only index of abundance available is from the catch and effort data of the commercial fishery.

- Mandatory logbooks have been in effect since 2001 but there is incomplete compliance which adds to the uncertainty in the reliability of the landings and the effort data and the calculation and interpretation of CPUE data.

- Buffer zones were instituted for lobster conservation reasons not scallop stock rehabilitation. No new information was reviewed to assess the effectiveness of the buffer zone measures on lobster conservation.

- The benefits of area closures to scallop bed rebuilding have been documented in the literature but have not been examined in the sGSL. The closed areas in SFA 22, SFA21A, SFA21B when reopened, would be good case studies.

- In the sGSL, there was no proposal for a change in ring size so the change to population structure of the harvested scallop and consequential yield was not assessed for this document.

- Scallop dredging has little impact on habitat and on the bycatch of groundfish or crustaceans.

BACKGROUND

Biology

The sea scallop (*Placopecten magellanicus*) is a bivalve mollusc found in the Atlantic coastal waters from the north shore of the Gulf of St. Lawrence to Cape Hatteras, North Carolina. They are benthic dwellers, living at the sediment-water interface and are semi-mobile active filter-feeders ingesting phytophankton, small zooplankton, pollen grains, ciliates, detrital material and bacteria. Scallops frequently occur in dense local aggregations called beds which may be extensive enough to support commercial fisheries. They are usually found in depths ranging from about 10 to 100 m but may be found in shallower water. In the southern Gulf of St. Lawrence (sGSL), scallop beds are located at depths of 15 m to 37 m. Sea scallops seem to prefer sand-gravel or gravel-pebble substrate although they are occasionally found on sand-mud or rocky bottoms. Fishable concentrations are associated with strong tidal circulations or located in areas of persistent gyres.

Commonly reaching sizes between 100 to 150 mm, the largest sea scallop ever recorded measured 211 mm (shell height, tangential dorso-ventral measurement). In the sGSL the largest scallop commonly reached between 125 and 145 mm. Annual rings are formed on the shell each year at the time of cold water and these rings are especially pronounced in northern shallow-water populations like in the sGSL. Oxygen isotope records have confirmed that growth lines are annual events. Sea scallop growth rates are highly variable, depending on location. Growth occurs at temperature ranging from 8^{o}C to 18^{o}C while the ideal temperature for growth is 13.5^{o}C.

Sea scallops prefer salinities of 30 to 32 ppt but they can tolerate salinities as low as 25 ppt. In the sGSL, scallops must often face temperatures ranging from -2°C to 20°C. The sea scallop is stressed at temperatures between 20°C to 23°C yet will survive if acclimated. Mortality will occur at temperatures of 23.5°C or greater and mass mortality of scallops has occurred historically in portions of the southern Gulf.

The sexes are separate, with males and females being identified by the colour of the gonad when it is ripening: the male gonad is white and the female gonad is orange to brick red. Sexual differentiation occurs at an age of 1+, however, most sea scallops do not effectively release their gametes until they reach a shell height > 70 mm (approximately 3 years old in the sGSL). In the sGSL the sea usually spawns at the end of August. Scallops are considered to have reached the adult stage when their shell height are >81mm. However, it has been demonstrated that the adult stage may actually only be reached at 95 mm shell height. Fecundity is exponentially related to the shell height and can vary annually. During the spawning period the males and females release their gametes synchronously and fertilisation occurs in the water column. The larvae are planktonic for 4 to 5 weeks after which time they metamorphose and settle on suitable substrates to begin their benthic life.

An at-sea sampling program was conducted from 2001 to 2005 to collect biological information on scallops from representative beds in the southern Gulf of St. Lawrence. Biological data collected included length distributions, age structure and meat yields.

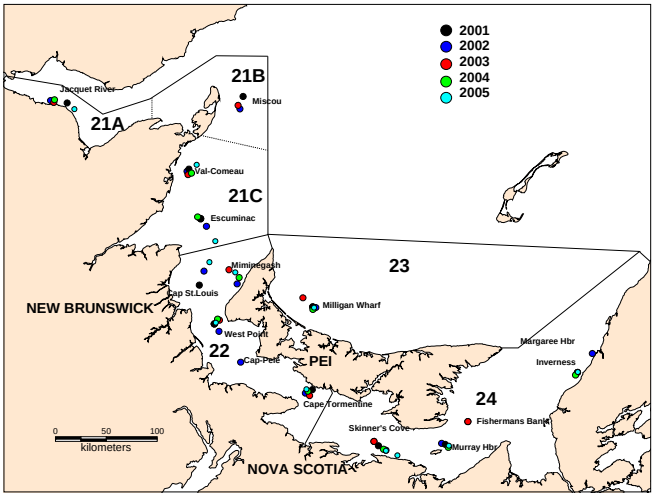


Figure 2: Sea sampling sites in the southern Gulf of St. Lawrence in 2001, 2002, 2003. 2004 and 2005 in each Scallop Fishing Area (SFA) 21A, 21B and 21C, 22, 23 and 24.

Scallops sampled and aged during the at-sea program in 2001 to 2005 ranged in age from 3 to 17 years old (Figure 3). The 80 mm “adult” stage scallops range in age are about 4 to 6 years old whereas the 100 mm shell height scallops range in age from 7 to 8 years or older in most areas of the southern Gulf. The maximum growth in shell length for sea scallops from the southern Gulf occurs at ages 3 to 6 years.

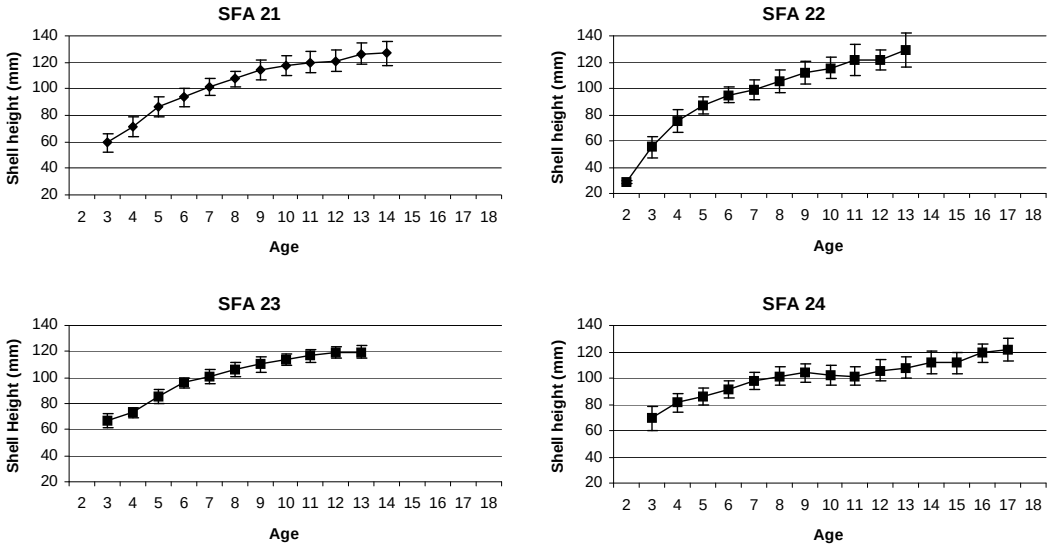


Figure 3: Estimated shell height at age of sea scallop by SFA based on at sea sampling, 2001 to 2005.

The meat weight / shell height relationships vary within a season, among SFAs and among years (Figure 4).

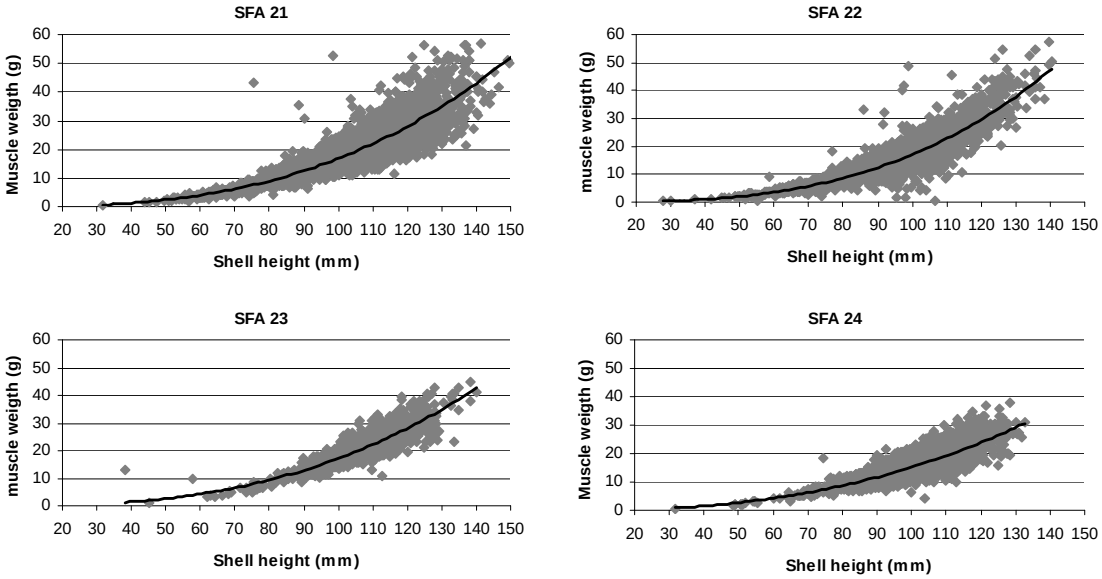


Figure 4: Meat weight to shell height relationships of scallops by SFA based on at-sea samples during 2001 to 2005.

Fishery

The scallop grounds in the Gulf Region are divided into four Scallop Fishing Areas (SFA) with one zone (SFA 21) divided into three sub-zones (Fig. 1). Fish harvesters in SFA 21 accepted in 1996 to be sub-divided to facilitate the management of a scallop enhancement project conducted by the Maritime Fishermen's Union. Each SFA has its own management strategies.

Scallop fishing occurs with fishing vessels less than 14 m (45'). Most of the industry uses a Digby-type dredge (Fig. 5). A sweep chain drag is sometimes used. The buckets of the dredge are constructed with steel rings linked with a maximum of 8 steel washers (2 per side) with chaffing gear or only 1 rubber washers on the vertical (Fig. 5). Rubber washers, like chaffing gear, prevents the wear and tear of the rings (Fig. 6). Prior to 2000, the minimum ring size in all SFAs was 76.2 mm (3"). The ring size increased to 82.6 mm (3 ¼") in 2000. However, the first row of rings attached to the bucket frame may have a diameter not less than 76.2 mm. When using a chain sweep, the mesh used must create an opening equal in size to the 82.6 mm rings. The total length of the dredge (Table 2), the ring size, type and number washers and tow bar are described in the condition of licence for each SFA.

Figure 5: Digby-type dredge commonly used in the Gulf Region showing tow bar and steel ring buckets.

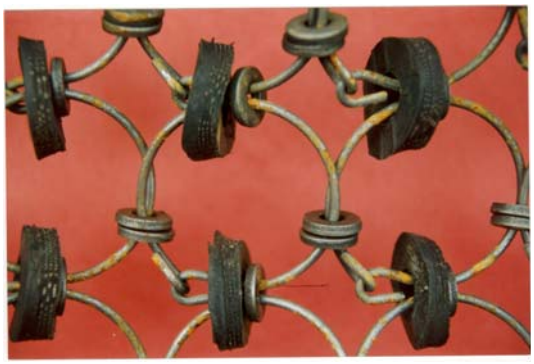


Figure 6: Configuration of the bucket showing rings linked with steel washers and vertically placed rubber washers.

Fishing effort is controlled by limits on fishing season, fishing hours, and day closures within the week (Table 1). The fishing season of other commercial stocks such as lobsters often influence the establishment of the scallop fishing season. In some cases, shortened fishing seasons were proposed when their catch per day decreased. There are no minimum sizes for scallop harvesting, but the size of the scallops harvested are regulated by a maximum number of scallop meats per 500 grams unit. The meat count value varies among the SFAs (Table 1).

There were 774 commercial scallop fishing licences in 2010 (Table 2). Half the licences are in SFA 24, 27% are in SFA 22, 13% are in SFA 21 and 10% are in SFA 23. Active licences were estimated from records of landings in statistics and / or from logbooks. During 2002 to 2009, between 25% and 34% of the licence holders were active (i.e. had recorded landings). The highest percentage of active participants has been in SFA 21A (43% to 100% during 2002 to 2009; in 2010 the area was closed to scallop fishing) and the lowest percentage of active participants has been in SFA 23 (range of 0% to 4% in 2002 to 2009) (Table 2). Thirteen First Nation communities have commercial access to the scallop resource.

Table 1. Scallop fishery seasons, open daily fishing periods, within season closed days, and regulatory meat count by SFA for 2008 to 2010.

		Scallop Fishing Area (SFA)					
		21A	21B	21C	22	23	24
Max. length of dredge (m)		6	6	6	4.88	6	5
Other gear regulation					with 50.8 mm runners		
Season open	2008	June 23 – July 25	May 19 to Aug. 9	June 23 to Aug. 30	May 1 – June 5	July 4 – Sept. 3 Nov.7 – Dec. 3	Oct. 29 – Dec. 12
	2009	June 29 – July 24	May 11 to Aug. 7	June 22 – Aug. 29	May 4 – June 6	July 2 – Sept. 1 Nov. 5 – Nov. 30	Nov 2. – Dec. 15
	2010	Closed	May 10 – Aug. 6	June 28 – July 31	May 3 to June 5	July 2 – Sept. 1 Nov. 1 – Nov. 27	Nov. 1 – Dec. 15
Time open		6:00 to 18:00	5:30 Monday to 14:00 Friday	5:30 to 20:00	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00
Days closed		Saturday & Sunday	Saturday & Sunday	Sunday	Sunday	Sunday	Sunday
Meat count		39	39	39	44	33	52

Table 2. Distribution of commercial scallop fishing licences and estimates of active fishing licences by SFA in 2002 to 2010.

	Status	2002	2003	2004	2005	2006	2007	2008	2009	2010
SFA 21A	Total	26	26	26	26	26	28	28	28	28
	Active	25	26	25	24	25	26	20	12	0
SFA 21B	Total	28	27	27	27	27	27	27	27	27
	Active	10	6	7	11	8	5	8	10	4
SFA21C	Total	46	48	48	48	48	48	48	48	48
	Active	24	16	13	17	8	6	4	2	1
SFA 22	Total	197	200	203	203	203	203	203	203	203
	Active	101	100	77	103	94	96	103	108	105
SFA 23	Total	75	78	78	78	78	78	78	78	78
	Active	3	0	1	2	0	1	1	2	4
SFA 24	Total	389	390	390	390	390	390	390	390	390
	Active	95	99	82	89	75	71	62	58	73
Southern Gulf	Total	761	769	772	772	772	774	774	774	774
	Active	258	247	205	246	210	205	198	192	187

Buffer zones were implemented to prevent the scallop fishery dragging over habitat of immature lobsters and to protect sensitive habitat (Fig. 7). Buffer zone criteria vary from one SFA to another. In SFA 21A the buffer zones represent areas of depths less than approximately 15 m. In SFA 21B, the largest portion of the buffer zone is in place in Chaleur Bay and there are no buffer zones in SFA 21C. In SFA 22, the buffer zone consists of all habitats in water less than 11 m. In SFA 23, there are no official buffer zones but there is an agreement not to fish in waters less than 27.4 m. In SFA 24, a large portion of the habitats in water less than 9 m is not protected but other areas of deeper water are protected.

In 2005, an area west of the Confederation Bridge was closed by variation order at the request of the fish harvesters in SFA 22 as a measure to allow the scallop stock to rebuild. Similarly, in 2010, the entire SFA 21A was closed (Fig. 7). Small closed areas in the eastern section of SFA 21B are not identified in Figure 7.

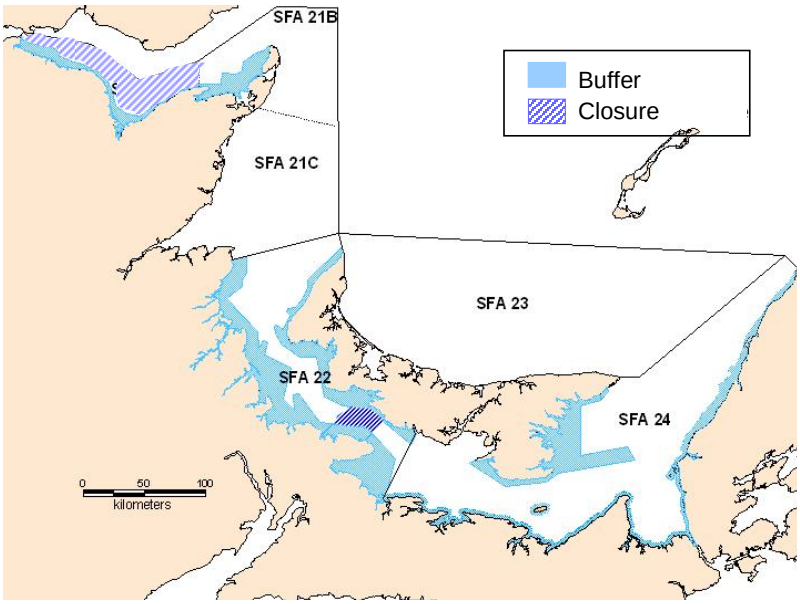


Figure 7: Buffer zones and closed areas in the Gulf Region in 2010.

ASSESSMENT

The assessment information for the scallop fishery is primarily derived from commercial fishery logbooks. Since 1998, mandatory logbooks were included as a condition of licence however usable data are only available since 2001. The logbook data used includes landings (sales to buyers and local sales), effort (hours of fishing per day), and fishing positions. Effort (hr per m of drag) is standardized using the recorded hours and the width of the drag used.

Presently, in the Gulf Region fish harvesters land only the meat. In the past, the meat with roe was occasionally landed. The fisheries statistics identify three types of scallop landings: meat weight, meat with roe weight and live weight. Meat weight is converted to live weight using a multiplier of 8.3 while roe and meat is considered as live weight landings and a conversion factor is not applied.

Scallop landings, in terms of meat weight available from the landings statistics, are obtained from commercial sale transaction slips and since 2001 additionally from logbooks. Fish harvesters are required to record in their logbooks the amount of scallops that is sold to non-registered buyer as “local sales”. Prior to 1998, local sales were estimated by DFO fishery officers and were recorded as supplementary B forms. Commercial sale transaction slips that are given by registered buyer are recorded in DFO’s statistics.

The vessel registration number (VRN) number has been recorded on each sale transactions slip since 1985-1986. Since 1986 a rough estimate of the number of fishing days (Fig. 8), and of the number of active fishing vessels can been derived from landing data assuming that the landed

quantity recorded on one sale slip is the catch of one fishing day and that each VRN represents one active fish harvesters.

First recorded landings from the scallop fishery in the southern Gulf date to the early 1900's. From 1923 to the early 1980's, fish harvesters were allowed to fish the entire Gulf of St. Lawrence. In the early 1980's scallop fishing activities of individual fish harvesters were identified to specific SFAs. The maximum recorded landings occurred in the late 1960s and early 1970s at about 900 t annually (Fig. 8). Periods with lesser peaks were recorded in the early 1980s and again during 1996 to 1998 at less than 400 t. Since 2001, the average annual landing has been less than 100 t, the preliminary value for 2010 is 80 t (Fig. 8).

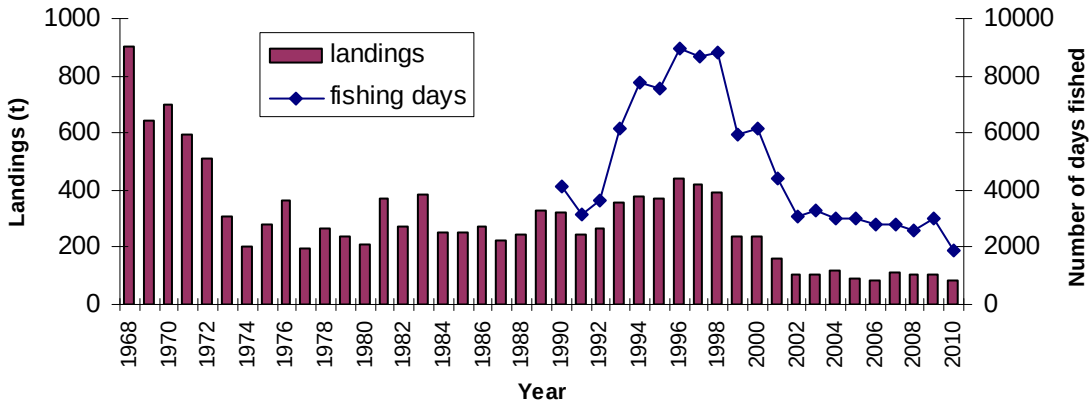


Figure 8: Recorded sea scallop landings (t of meat weight) and the number of days fished in the southern Gulf of St. Lawrence, 1968 to 2010.

The highest landings during 2001 to 2010 are registered in SFA 22 and the lowest values in SFA 23. Effort (in days fished) follows closely the variations in landings in the southern Gulf and by SFA. The highest effort in the past decade occurred in SFA 22 and the least effort in SFA 23. Prior to 2001, effort was higher in SFA 21 and SFA 24 and landings in SFA 21 and SFA 24 were more important than those of SFA 22 (Fig. 9).

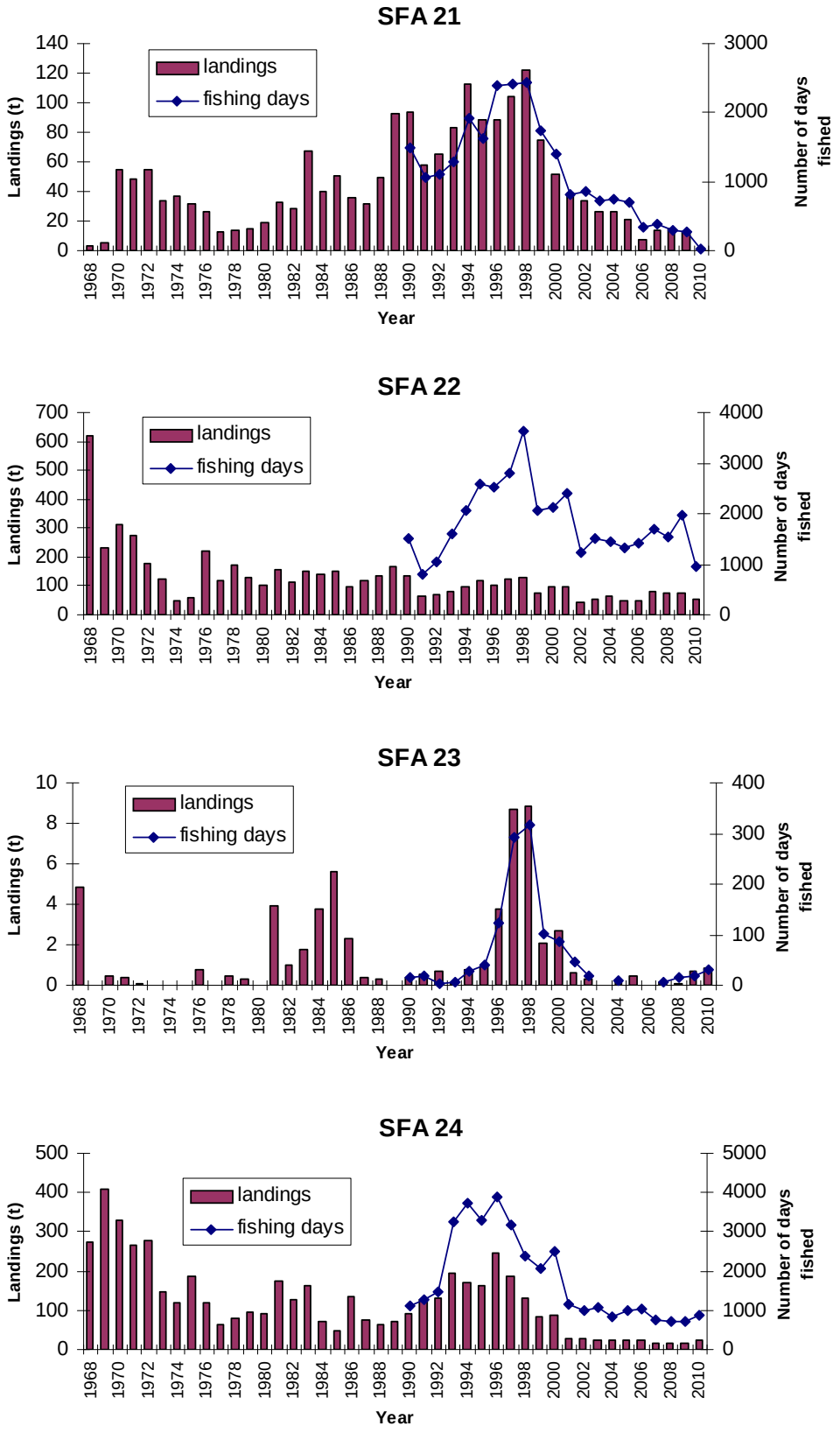


Figure 9: Recorded sea scallop landings (t of meat weight) and the number of days fished by SFA, 1968 to 2010.

CPUE as Index of Abundance

The only index of abundance available is from the catch and effort (CPUE) data of the commercial fishery. The assumption is that the catch rates are proportional to abundance. The logbook data provides the best information but the usable time series begins in 2001. The effort data from logbooks was standardized to hour per metre of dredge. When effort was not recorded in logbooks or for landings data for which no logbooks were returned, the total effort is estimated using the CPUE corrected by the total reported landings. The percentage of the fishing days tabulated from logbooks relative to the fishing days estimated from the purchase slips data decreased after 2004 in most SFAs with the exception of SFA 24 where the percentage has been high (> 95%) over the entire time period (Fig. 10). The consequence of missing logbook data is added uncertainty in the reliability of the landings and the effort data and the calculation and interpretation of CPUE data.

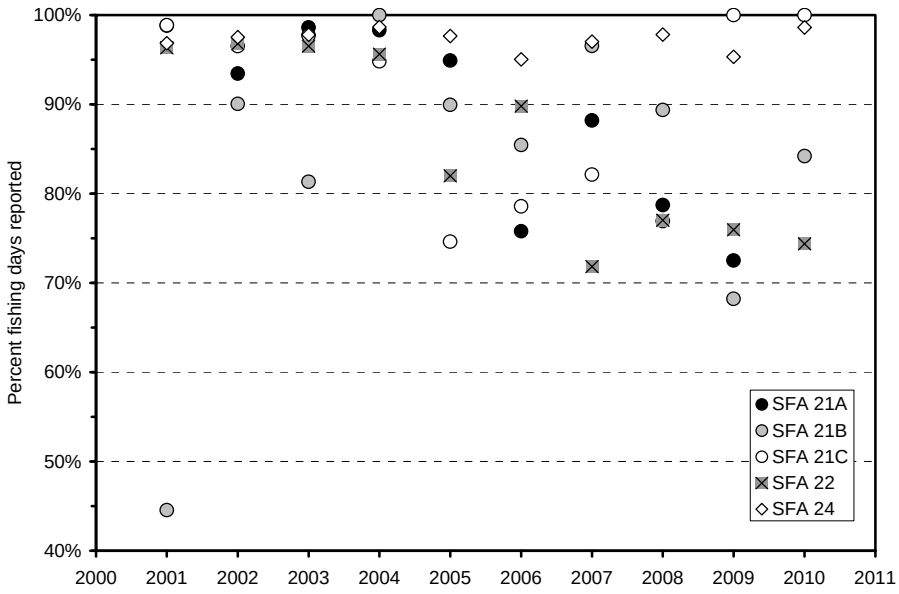


Figure 10: The percentage of the fishing days recorded in logbooks versus the fishing days estimated from purchase slips by SFA for 2001 to 2010.

The CPUEs have generally been highest in SFA 22, mean values around 0.75 to 1.00 kg per hr per m, and lowest in SFA 21A and 21C (Fig. 11). The regulatory meat weight count is lower in SFA 24 (highest meat count per 500 g regulation; see Fig. 4) and in approx. numbers of animals, the catch rate in SFA 24 would be closer to those of SFA 22 and above those in SFAs 21 and 23 (Fig. 11). The CPUE within SFAs show high variability within years but without a trend in most of the SFAs over the ten year period (Fig. 11). In SFAs 21A and 21C, there was no trend in CPUE during a time when estimated effort declined substantially, by more than 50% in SFA 21A and by 98% in SFA 21C (Fig. 11). This differs from SFA 22 where there is no temporal trend in either CPUE or effort during 2001 to 2010. In SFA 24, effort has declined by about 25% over the time period with no trend in CPUE. Declining efforts even though the recorded catch rates have not decreased is often consistent with low or even declining abundance of the resources because fish harvesters voluntarily stop fishing when it is no longer profitable.

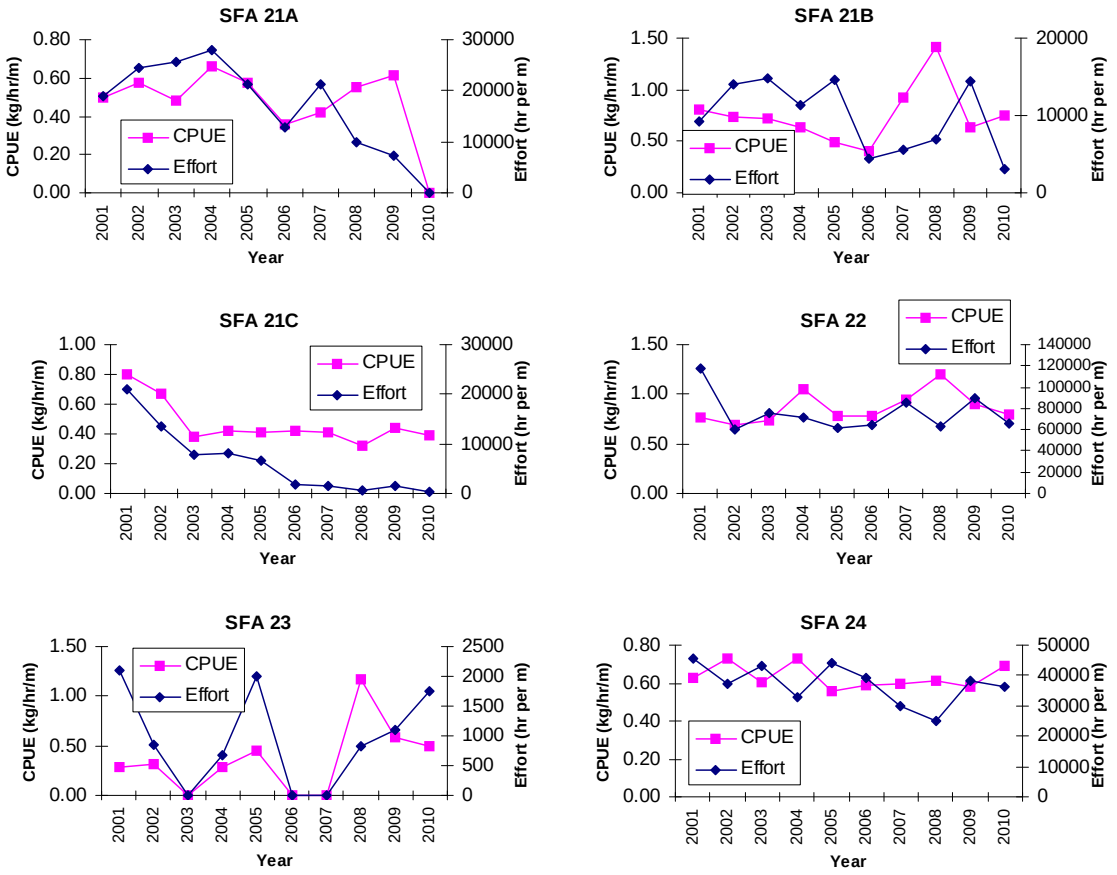


Figure 11: CPUE (kg per hr per m of dredge) and estimated effort (hr per m of dredge) for the six SFAs in the southern Gulf of St. Lawrence based on logbook data. Effort not recorded in logbooks is estimated from the CPUE values corrected for the total landings.

Evaluation of Management Measures

Buffer Zones

Buffer zone criteria vary from one SFA to another. Buffer zones have been implemented to prevent the scallop dragging over selected habitat, mainly aimed at protecting the habitat of immature lobsters. The fishing industry from each SFA and DFO managers collaborated to establish buffer zones, but for the most part the focus was on lobster conservation principles not scallop stock rehabilitation. No new information was reviewed to assess the effectiveness of the buffer zone measures on lobster conservation. Historically, the scallop fishery did not operate in the buffer zone areas unless fish harvesters were exploring because high density scallop aggregations have generally been in deeper water.

Area closures

In the sGSL, some areas where scallop beds are located were closed to scallop dragging to allow natural recruitment to increase the scallop density. The benefits of area closures to scallop bed rebuilding have been documented in the literature but have not been examined in the sGSL. Information on growth rates as well as size and age at maturity of sea scallops in the sGSL are available but size distribution of the sea scallop populations prior to the areas

closures are not fully documented. The closed areas in SFA 22 SFA21A, SFA21B when reopened, would be good case studies. Periodic closures allow scallop beds to rebuild but fishing effort may be displaced to other areas which could result in increased exploitation rates on those beds.

Ring size restrictions

The construction of the buckets of the dredge is regulated in the sGSL; minimum ring size of 82.6 mm (3 ¼") linked with a maximum of 8 steel washers (2 per side) with chaffing gear or only 2 rubber washers (1 on the top and 1 on the bottom) on the vertical (Fig. 5). Previous studies have shown that the size distribution of scallops retained by the gear is determined by the ring size, the larger ring size retains fewer small scallops (DFO 2007). According, to limited sea sampling, the shell height size distribution in the sGSL fishery ranges from an extreme low of 31 mm to as large as 151 mm and most (approximately 85%) of the sampled scallops were between 80 and 120 mm. The modal size in most areas of the sGSL was usually greater 90 mm. Any increase in ring size would result in an upward shift in the size distribution of retained scallops (DFO 2007). The benefits of such a measure are associated principally with a reduced risk of growth overfishing, shifting the harvest from smaller animals with large annual growth increments to larger animals of lower growth rates and higher meat yield. In the sGSL, there was no proposal for a change in ring size so the change to population structure of the harvested scallop and consequential yield was not assessed for this document.

Sources of Uncertainty

Mandatory logbooks have been in effect since 2001 but there is incomplete compliance. Landings from purchase slips are recorded from Vessel Registration Numbers for which logbooks have not been returned to DFO. The completeness of the data provided in logbooks is also unknown. The effort information is reported variously from hours the dredge was fishing to hours the vessel was at sea. These uncertainties confuse the status indicators based on these fishery dependent data.

Indices of abundance for this resource are limited to CPUE data from logbooks, and only since 2001. Declining effort may result in sustained CPUE despite a decline in abundance of the resource.

In the sGSL, there are no fishery-independent indicators of abundance for sea scallop. A number of periodic surveys conducted in SFA 22 between 1967 and 1997 have shown that abundance has generally declined. It is not possible to link these abundance indicators to the commercial fishery catch per unit effort indicators because reliable commercial catch and effort data are not available for the corresponding years.

The requirement that scallop must be shelled at sea makes it difficult to reconstruct the landings in terms of shell height (as a surrogate for age) based on sampling of scallop meats. In the absence of sampling for shell height harvested or specific meat weight distributions (with corresponding shell height to meat weight relationships), it is impossible to reconstruct the size distribution of the fished component of the stock. The variation in meat weight per shell height by season and among beds also makes it difficult to estimate the number of animals harvested within an area and overall in the sGSL.

CONCLUSION

In the sGSL, sea scallop landings and recorded effort have declined and remained low since 2002. Only 25% of licence holders are active in the fishery. The majority of the license fish harvesters have chosen not to fish. The index of fishing performance (CPUE from logbooks) has generally been unchanged between 2001 to 2010 while effort has declined in several SFAs. Sustained catch rates with declining effort is more consistent with low or even declining abundance.

Based on historical information, scallop stock abundance in the sGSL is presently considered to be low. Periodic surveys in between 1967 and 1997 have shown that abundance over that time period decreased (Caddy 1968; Worms and Chouinard 1984; Lanteigne and Davidson 1989; Hanson 1998). Present management measures are respected (i.e. season, meat count regulation), but fishing power has also changed, as the size and weight of the dredge has increased over time to the current limits allowed under regulations. Exploitation rates have not been estimated in any of the SFAs although logbook data in some areas may be sufficient to estimate these using depletion estimation models. This requires further analysis.

There are no reference points against which to assess the status of the resource at this time. CPUE specific reference points have been developed to guide the management of the scallop fishery in Magdalen Islands (DFO 2010). CPUE from the commercial fishery are classified into high range (> 1.5 kg/hm), a medium range (between 0.85 and 1.5 kg/hm) and a low range (less than 0.85 kg/hm). The reference levels were based on an analysis of variations in CPUE from 1965 to the present, CPUE having declined from the highest levels at the start of the series to the lowest levels between 1998 to 2006 (DFO 2010). Such a CPUE classification for the sGSL could not presently be developed from the fish harvesters' logbooks because the time series is too short and the stocks are presently considered to be at low abundance.

The decline of the scallop stocks is most likely attributed to growth overfishing resultant of high exploitation rates; the scallops are not given the time to grow to the size at which the maximum sustainable yield would be obtained from the stock. Limited sea sampling undertaken in 2001 to 2005 from several locations indicates that there were very few animals greater than 120 mm (10 to 11 years) in the fishery, this for an animal that can live to greater than 15 years and sizes of 140 mm or more. Growth overfishing could be controlled by increasing the size of animals harvested through changes in gear selectivity (for example increases in ring size) or the introduction of minimum sizes for harvesting. Exploitation rates could be reduced through a number of measures including changes in seasons and restrictions on daily and weekly fishing periods. The high proportion of inactive licences which could potentially become active at any time could counteract such effort control initiatives.

It is unknown if recruitment is being constrained by reduced abundance of spawners. Scallop recruitment, measured by spat collectors in 1997 to 2001, occurred throughout the sGSL although the amount of spat expected from an abundant scallop resource is not known.

The buffer zones, with exception of a sector in SFA 24, were never intended to protect the scallop resource. Buffer zones in place in most SFAs in the sGSL preclude scallop fishing to protect lobster habitat but these areas were historically not intensively used by the scallop fishery. They are expected to have minimal benefit to the scallop resource. Closed areas on the other hand were initiated with the intent to rebuild scallop stocks. To date, there has not been any analysis of the status of scallops in these areas and the benefits of closed areas to rebuilding objectives. Population structure and abundance prior to closure was not fully assessed and it would therefore be difficult to evaluate the changes in the population due to the

closure. However, commercial CPUE data could be used to assess the changes in the commercial exploited portion of the stock when any of these closed areas are reopened.

ECOSYSTEM CONSIDERATIONS

Scallop fishing activities can impact the ecosystem is two ways: the effect on the benthic habitat, and the effect on bycatch species.

Since the implementation of the logbook program, the distribution of scallop dredging effort can be mapped. Even though, the fish harvesters are only reporting one position per day in their logbook, mapping each position delineate the location of scallops beds that are similar to the location reported in the early '80's. The location of effort is quite similar among years.

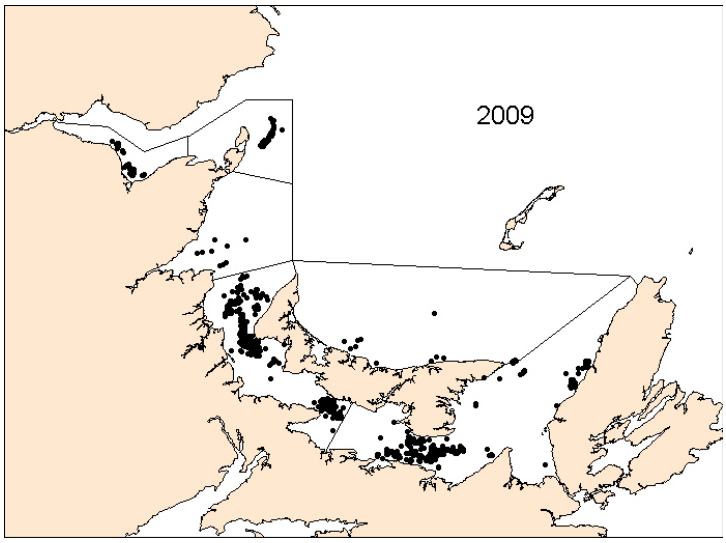


Figure 12: Map of fishing effort positions reported in the 2009 fish harvesters' logbook.

The effects of scallop dredging on benthic habitat are related to the bottom type, the benthic community and the environmental conditions of the site. Benthic communities in naturally dynamic environments (such as shallow water depths where the bottom is susceptible to frequent disturbance by storms) are likely more resilient to disturbances, including those from scallop dredging. In a number of studies, the effects of scallop dredging on community structure were expressed as a decrease in the number of species and reduced abundance for certain species (DFO 2006). Typically, scallop bed habitat is not structurally complex and usually subjected to natural perturbations. Sea scallops are found most often on sand-gravel or gravel-pebble bottom although they are occasionally found on sand-mud or rocky bottoms. Fishable concentrations are associated with strong tidal circulations or located in areas of persistent gyres. In the sGSL, the sea scallop bottom type preference is generally considered to be poor habitat for juvenile and adult lobster (simple habitat composed of soft material such as gravel, sand and mud or hard bottom such as sandstone or granite) such that the impact of fishing activities on lobster habitat are considered minimal. Buffer zones have been established mainly to protect the habitat of immature lobsters.

In the sGSL there is considerable spatial-temporal overlap between the scallop fishery and the distribution of winter skate (*Leucoraja ocellata*). Most winter skate captured in the scallop fishery were released alive and in very good condition. The estimated fishing-induced mortality on

winter skate is very small compared to mortality from other sources (Benoît et al. 2010; DFO 2010).

The bycatch of other aquatic organisms in the scallop fishery of the sGSL is diverse. In a limited study in the sGSL, the bycatch diversity included 19 fish species, 5 crustacean species, 9 mollusk species/groups, 5 echinoderm species/groups, as well as sponges and sea aneomones. Numerically, echinoderms (primarily starfish and sand dollars) were the most abundant bycatch followed by Atlantic rock crab and whelks. The most abundant fish bycatch was winter flounder (*Pseudopleuronectes americanus*). In general, incidentally captured fish had generally sustained only minor injuries and were considered to have a very high likelihood of post-release survival. Most incidentally-captured rock crab and lobster were in good to excellent vitality when they were discarded. Catches of lobster in the scallop fishery are considered to represent a miniscule fraction of the population in the sGSL.

The impacts on organisms which are contacted by the gear but not retained has not been assessed. Animals which pass through the dredge rings can incur injuries and become more susceptible to predation than might otherwise occur. As well, if scallops settle preferentially on scallop shells / beds, then disruption of the beds by dredging may impact scallop settlement and survival, effects which have not been studied.

SOURCES OF INFORMATION

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ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)
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La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2011. Assessment of the scallop fishery (*Placopecten magellanicus*) of the southern gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/039.