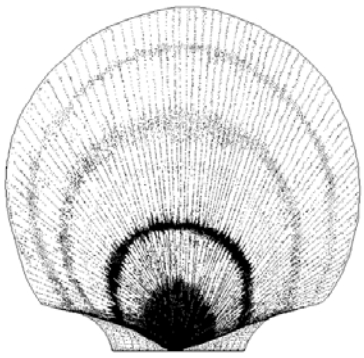
Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Maritimes Region
Canadian Science Advisory Secretariat
Science Advisory Report 2007/029

ASSESSMENT OF SCALLOPS (*PLACOPECTEN MAGELLANICUS*) IN SCALLOP FISHING AREA (SFA) 29 WEST OF LONGITUDE 65°30′W



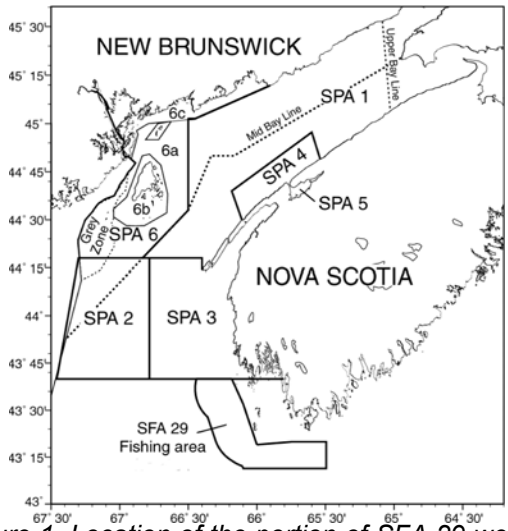


Figure 1. Location of the portion of SFA 29 west of longitude 65°30'W. Refer to full detail map in Figure 10 (last page) for locations and place names.

Context

Scallop Fishing Area (SFA) 29 encompasses a very large inshore area inside the 12-mile territorial sea, from the south of Yarmouth (latitude 43˚40'N) to Cape North in Cape Breton. This report refers to only that portion of SFA 29 west of longitude 65˚30'W continuing north to SPA 3 at latitude 43˚40'N.

Prior to 1986, the Full Bay Scallop Fleet fished in this area. Following the 1986 inshore/offshore scallop fishing agreement, fishing by the Full Bay Fleet was restricted to north of latitude 43˚40'N. A limited fishery by the Full Bay Fleet was granted from 1996–98. Access was again granted to this fleet in 2001 with a full at-sea monitoring program and with a condition of a post-season industry-funded survey. SFA 29 is within Lobster Fishing Area (LFA) 34 and, as a result, scallop fishers consulted with lobster fishers in the area to deal with potential conflicts. Lobster by-catch was minimal in 2001 despite high scallop catch rates. Lobster bycatch continues to be monitored in this fishery.

In 2002, the Minister of Fisheries and Oceans approved access to this area by the Full Bay Fleet and inshore east of Baccaro licence holders who are eligible to fish in SFA 29 west of longitude 65˚30'W. SFA 29 inshore scallop licenses were historically 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 has been prepared and was 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 has been provided annually and is based on tracking the response of survey estimates of abundance to catches in the previous year. There is no framework or reference points for the fishery in SFA 29 at this time.

A meeting of the Regional Advisory Process was held 12 April 2007 at the Bedford Institute of Oceanography (BIO), in Dartmouth, Nova Scotia to review the 2006 fishery and assess the status of the scallop stock in SFA 29 in support of the management of the 2007 fishery. Participants included DFO scientists and fishery managers, representatives of the industry and provincial governments. Specifically, the meeting was called to provide TAC advice for SFA 29 scallop fisheries by subarea using analyses of catch rate and survey biomass trends. In addition, an assessment of the potential for bycatch in each subarea was also provided. The analyses pertaining to lobster bycatch were particularly detailed as this fishery occurs within LFA 34.

SUMMARY

- For the sixth consecutive year, a fishery was conducted in the portion of Scallop Fishing Area (SFA) 29 west of longitude 65°30′W. Starting in 2002, the TAC was shared between the Full Bay Fleet and a limited number of inshore east of Baccaro licence holders who are eligible to fish in SFA 29 west of longitude 65°30′W (i.e., East of Baccaro Fleet).

- During 2006, a total of 406.1 t (307.7 t Full Bay; 98.4 t East of Baccaro) was landed against a TAC of 400 t.

- Average meat weights from the 2006 fishery ranged from 19.2 g to 23.8 g and were not appreciably different from those observed in 2005.

- Average commercial catch rates have declined since the opening of the fishery in 2001 with the rate of decline being higher for the Full Bay Fleet compared to the East of Baccaro Fleet.

- The annual survey indicates that biomass levels of commercial and recruit size scallop have declined appreciably since 2005 in all subareas and are at their lowest levels since 2002.

- Large numbers of clappers (paired empty shells) were reported by fishermen during the 2006 fishery in Subarea D. While it is acknowledged that clapper ratios are higher in Subarea D for reasons unknown, there is no evidence to indicate that an epidemic was occurring during the fishery.

- Very few scallops with shell heights less than 100 mm were found by the survey in Subarea A. Continued fishing in Subarea A in 2007 will probably be limited to scallops ages 6 and older due to limited recruitment.

- The population model estimates have a high degree of uncertainty associated with them and may represent a lower bound for possible TACs (25 t in each of subareas B, C, and D). While commercial catch rates, which are not used in the model, have declined in SFA 29, they suggest a higher biomass than that estimated by the model.

- There was not enough survey information to recommend catch levels for Subarea E. This subarea appears to offer marginal habitat for scallop.

- Continuing with a TAC at the 2006 level (400 t) for SFA 29 may not be sustainable in the future given that the survey indicates low recruitment for the next three or more years.

- Bycatch of lobster by the SFA 29 scallop fishery in 2006 was estimated at approximately 0.12% of the number of lobsters landed by the Lobster Fishing Area (LFA) 34 lobster fishery in the SFA 29 area. Of this 0.12%, less than a third of lobsters were dead or injured.

BACKGROUND

Species Biology

The sea scallop (*Placopecten magellanicus*) occurs only in the northwest Atlantic Ocean from Virginia north to Labrador. Within this area, scallops are concentrated in persistent, geographically discrete aggregates or "beds", many of which support valuable commercial

fisheries. Scallops in different beds, and in different areas of large beds, show different growth rates and meat yields.

Unlike many commercial scallop species, the sea scallop has separate sexes. Male scallops develop a white gonad in the summer months, while female gonads are bright red. Eggs and sperm are released into the water and fertilization takes place in the sea. Spawning begins in late August to early September, and the larvae drift in the water for almost a month before settling to the bottom in October.

Fishery

The 2006 fishery in subareas A, B, and E opened 0600h 19 June, while that in Subarea C and Subarea D opened at 0600h on 26 June and 4 July, respectively (Figure 10). The fishery continued until 18 August with the exceptions of Subarea D which was closed at 0559h 7 July (reopened 17 July for a 12 hour period) and subareas A, C, and E which were closed 2 August. During 2006, a total of 406.1 t (307.7 t Full Bay; 98.4 t East of Baccaro) was landed against a TAC of 400 t (Table 1). Prior to 2004, Subarea D had been closed to fishing because of a large number of young scallops present. The western half of Subarea D (west of longitude 65˚40′W) was opened for the 2004 season after it was determined from the 2003 survey that there were enough commercial size scallops for a fishery. All of Subarea D was open for the 2005 and 2006 fisheries.

Many fishermen reported large catches of clappers (paired empty shells) during the 2006 fishery in Subarea D. This subarea is known to have higher densities of clappers than other areas of SFA 29 but the reports from the 2006 fishery indicated that they were higher than the10–30% observed in earlier years and more widespread in distribution. The fishery in Subarea D was closed 7 July pending updates to the quota report. The fishery was reopened for a 12 hour period 17 July so that the two fleets could complete fishing their quotas. At the same time, the F/V Royal Fundy agreed to perform a survey of the area with a DFO technician on board. An analysis was presented to representatives of both fleets at BIO on 4 August 2006 where a number of representatives asked that more quota be allocated in anticipation of continued high mortality. The request for additional quota was not supported and the fishery in Subarea D remained closed. The issue of clappers will be discussed in more detail later in this document.

Average meat weights from the 2006 fishery ranged from 19.2 g to 23.8 g and were not appreciably different from those observed in 2005. Percentages of small meats (less than 8 g) continued to be extremely low.

Table 1. Scallop landings (meats, t) for SFA 29.

		Fleet					
		Full Bay		East of Baccaro		Total	
Year	Subarea	TAC	Landings	TAC	Landings	TAC	Landings
2001	Total	400	400			400	400
2002	29A	75	1	25	4	100	5
	29B	150	193	50	75	200	268
	29C	375	334	125	106	500	440
	Total	600	528	200	185	800	713
2003	29A						
	29B	150	114	51	38	201	152
	29C	188	33	63	32	251	65
	29E		2		2		4
	Total	338	149	114	72	452	221
2004	29A	150.0[1]	70.2	50.0[1]	9.9	200	80.1
	29B		33.1		46.8		79.9
	29E		0.2		3.4		3.6
	29C	187.5	123.8	62.5	35.2	250	159.0
	29D	112.5	148.6	37.5	40.0	150	188.6
	Total	450.0	375.9	150.0	135.3	600	511.2
2005	29A	45.0	2.5	15.0	2.2	60	4.7
	29B	30.0	22.7	10.0	26.3	40	48.9
	29C	75.0	91.9	25.0	23.4	100	115.3
	29D	41.25	63.2	13.75	10.7	55	73.9
	29E		8.8		1.7		10.5
	Total	191.25	189.1	63.75	64.3	255	253.3
2006[2]	29A	18.75[3]	20.4	6.25[3]	1.1	25	21.5
	29E		0.8		1.0		1.8
	29B	93.75	87.8	31.25	27.8	125	115.6
	29C	75.00	85.7	25.00	25.6	100	111.3
	29D	112.50	113.0	37.50	42.9	150	155.9
	Total	300	307.7	100	98.4	400	406.1

[1] TAC for 29A, B and E combined.
[2] Preliminary landings.
[3] TAC for 29A and E combined.

ASSESSMENT

Average **commercial catch rates** over the whole area have declined since the opening of the fishery in 2001 with the rate of decline being higher for the Full Bay Fleet compared to the East of Baccaro Fleet (Figure 2). Trends for each of the subareas A to C indicate similar patterns, however the changes between 2005 and 2006 for Subarea D are very different for the two fleets (Figure 3). Only the western half of Subarea D was opened in 2004 and while the whole subarea was opened briefly in 2005, all fishing by both fleets was concentrated in the eastern half of the subarea.

Catch rates in Subarea D for the Full Bay Fleet declined in 2006 after the high in 2005 to be below the estimate for 2004 while the East of Baccaro catch rates have remained level over the three years that Subarea D has been open. Catch rates for this subarea continue to be higher than the other four subareas.

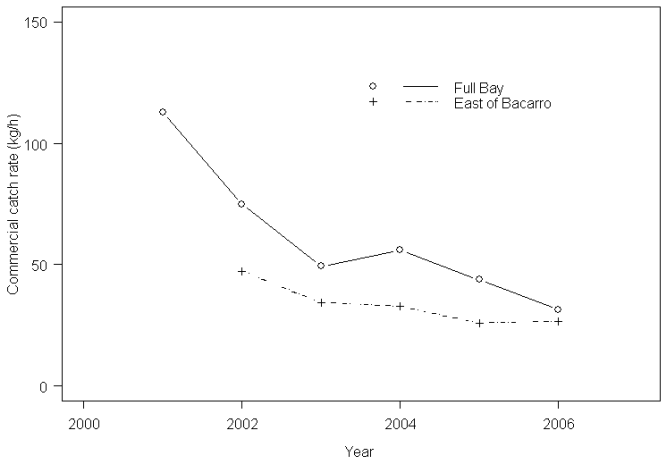


Figure 2. Mean commercial catch rate (kg/h) trends for SFA 29 scallop fishery for all subareas by fleet.

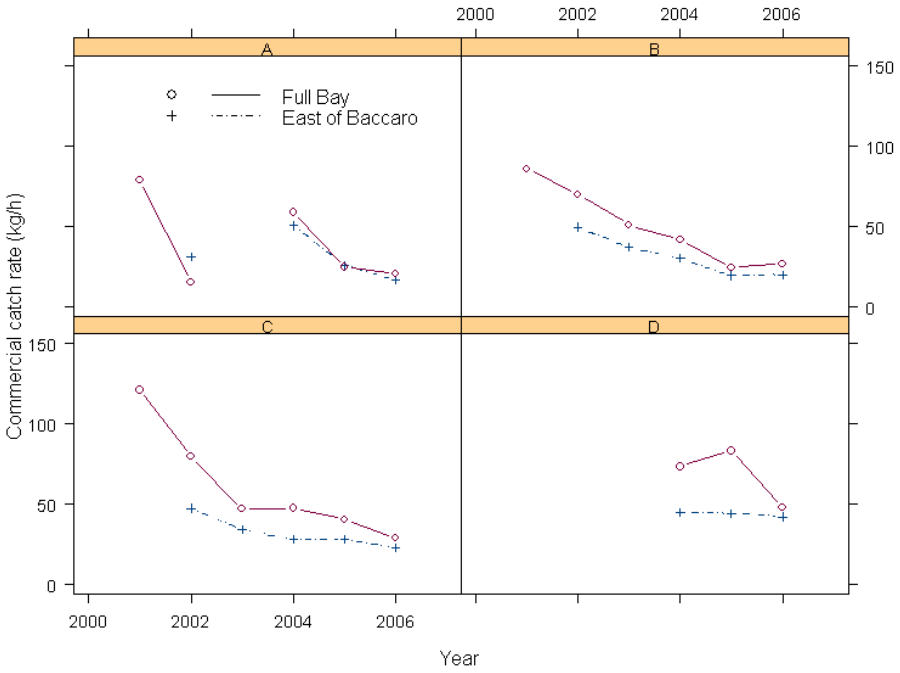


Figure 3. Mean commercial catch rate (kg/h) trends for SFA 29 scallop fishery for each subarea by fleet.

A post-season joint industry/departmental **research survey** has been conducted each year since 2001. During this time, there have been four industry vessels involved. Full analysis of the available comparative data is still pending.

In 2001, the survey was based upon a simple random sampling design over the whole area. From 2002 to 2004, subareas A–E were defined to be strata, with random sampling within strata. Subarea E has not been consistently covered in the survey due to time limitations; this subarea is considered to be marginal habitat for scallops and, as a result, has been less of a survey priority. In 2005, stratification was based upon the bottom types identified from the multi-beam mapping and surficial geology groundtruth analysis in SFA 29. In 2006, tows were allocated randomly to surficial strata within subareas.

Estimates of survey total biomass (meats, t) in each subarea for **commercial size** (100+ mm shell height) and **recruit size** scallops (90–99 mm shell height) indicate that the biomass for

both of these size classes in 2006 have declined appreciably since 2005 and are at their lowest levels since 2002 (Figure 4). Based on ageing information, the recruit size range represents age 5 scallops that will recruit to the fishery in 2007. At present, almost all recruits and **pre-recruits** (80–89 mm shell height, expected to recruit to the fishery in 2 years) are in C and D.

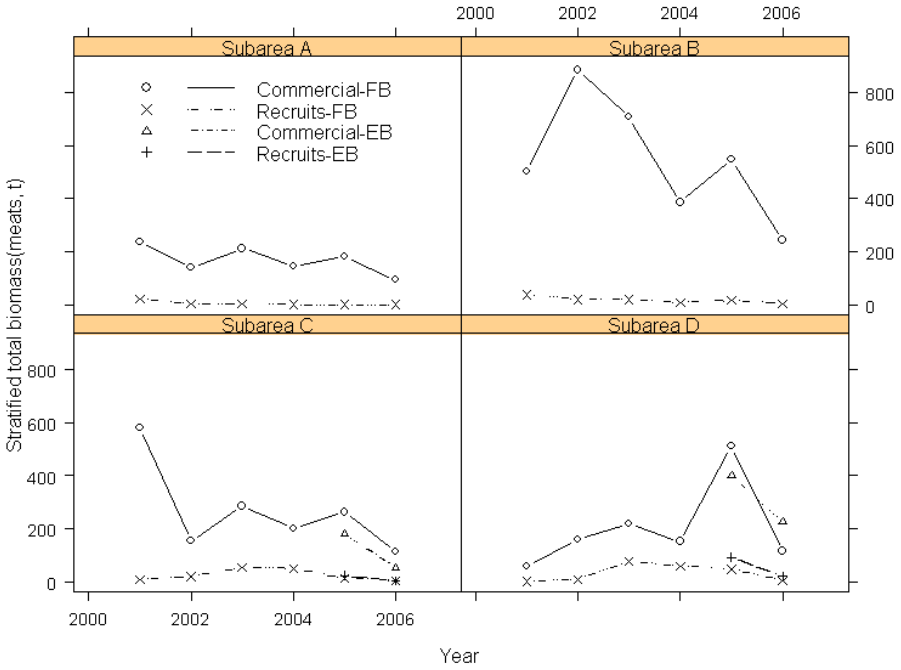


Figure 4. Annual trends of fully recruited (100+ mm) and recruit (90–99 mm) size scallop biomass (meats, t) from research surveys by subarea in SFA 29. Commercial-FB and Recruits-FB estimated from the Full Bay (FB) industry vessels: F/V Julie Ann Joan (2001–2003,2005–2006) and F/V Branntelle (2004). Commercial-EB and Recruits-EB estimated from the East of Baccaro (EB) industry vessels: F/V Overton Bay (2005) and F/V Faith Alone (2006).

In response to the report of large numbers of clappers by fishermen during the 2006 fishery in Subarea D, a survey was conducted on 18 July 2006. The proportion of clappers in the survey tows ranged from 0 to 0.41 with a mean of 0.15. There did not seem to be an obvious spatial pattern for the proportion of clappers. Shell height frequencies over all tows indicated that the mode for the clappers may be 5–10 mm below that for the live scallops (Figure 5) suggesting that the scallops died 6–12 months earlier. A sample of live scallops from the survey tow with the highest proportion of clappers was examined by a pathologist at the Atlantic Veterinary College at University of Prince Edward Island and the scallops were found to be in good condition with no evidence of infectious agents or disease.

The observer data base contained reports from three vessels that had observers onboard in Subarea D during 4–7 July. Shell height frequencies and counts were only available for a total of three positions for two of the boats. Clapper ratios were 0.10, 0.21 and 0.36 for these positions.

High catches of clappers have been common in survey tows in Subarea D since at least 2002. In fact, the ratios of clappers to live scallops have been much higher in the past in all four subareas than they are now (Figure 6). The ratio for Subarea D is the highest overall for surveys in 2002 to 2006. It is unknown why subareas differ in clapper ratios or what process is underlying annual trends.

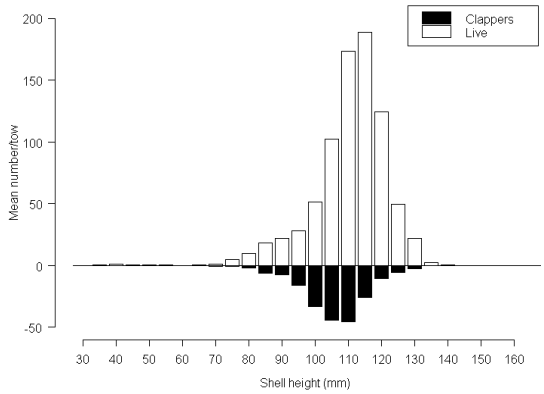


Figure 5. Shell height frequencies for live scallops and clappers in the July 2006 survey of SFA 29D.

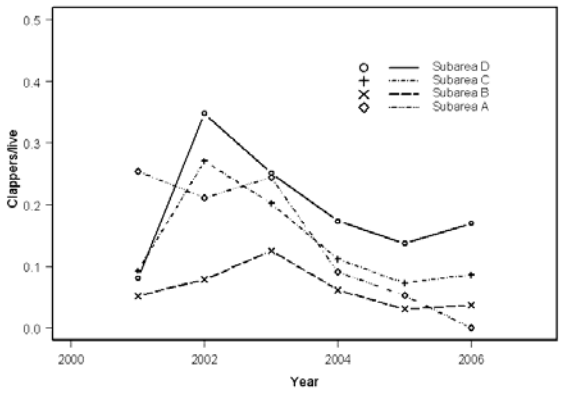


Figure 6. Ratio of mean number of clappers to mean number of live scallops of commercial size from annual survey in SFA 29.

Many of the positions where clappers were reported during the 2006 fishery were in the southern part of D, much of which was fished for the first time in 2006. It is possible that the distribution appeared to be more widespread than observed previously because while clappers were found in this area by the survey in previous years, the fishermen had little or no experience with what to expect in this area. While it is acknowledged that clapper ratios are higher in Subarea D, there is no evidence to indicate that an epidemic was occurring during the fishery.

Lobster Bycatch

Similar to previous years, most lobsters were caught in subareas A and B during the 2006 survey (Figure 7). In Subarea B, the catch rate increased to the highest level of the series (3.6 lobsters per tow) while it was less than 1.3 lobsters per tow in subareas A, C, and D. In Subarea C, there has been an increase in the proportion of sets with lobsters during the last 2 years. The SFA 29 survey was conducted in September during 2001–2003 and in October during 2004–2006; the impact of survey timing on lobster bycatch is unknown.

The regular monitoring by onboard observers of lobster bycatch from this fishery is unique relative to other scallop fisheries. Observer coverage was required for both fleets at a rate of one observed day per active vessel per fishing season. The resulting coverage was that 7.5% of the trips were observed in 2006. Lobsters were observed in all subareas but the highest catch rates were in Subarea B (Figure 8). The total number of lobsters caught in the 2006 scallop fishery was estimated to be 7107. Regulations required that all lobsters caught be returned to the water. Of those caught, 8% were dead and 19% were injured. Assuming that observed trips are representative of the whole fishery, 2174 lobsters are estimated to have been returned to the water either dead or injured in 2006. This level of bycatch may be considered quite low given that lobster fishery landings in the areas corresponding to SFA 29 approximated 3468 mt (approximately 5,780,000 lobsters) in the 2005–2006 season.

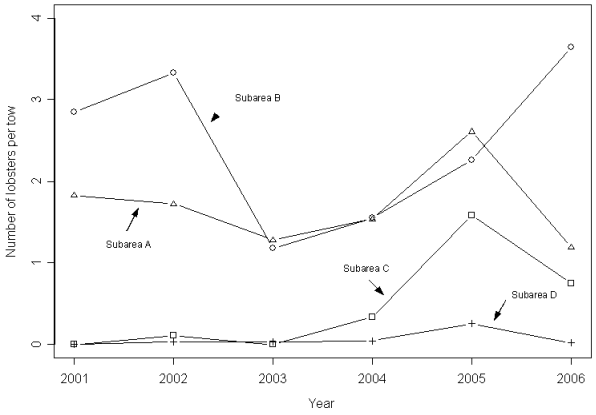


Figure 7. Mean number of lobsters per tow from annual scallop surveys of SFA 29.

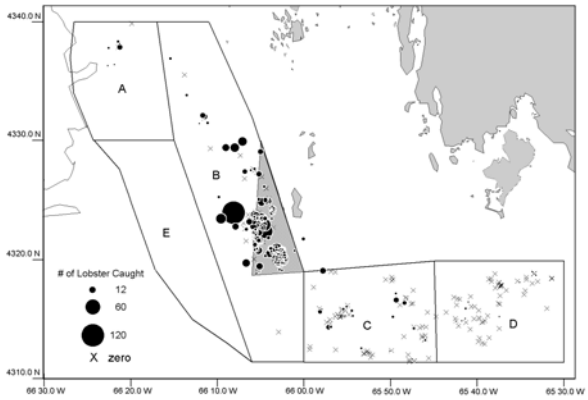


Figure 8. Location and number of lobsters caught per set in SFA 29 during 2006 from observed scallop fishing trips. Shaded triangle indicates area closed during fishery for high bycatch of lobster.

Other Bycatch

All fish and invertebrate species are monitored by observers. A preliminary analysis of the observed catch was conducted for the 2001–2005 data to examine linkages between the presence/absence of each bycatch species and bottom type, depth, associated catch of scallops, and the amount of catch of stones and garbage, etc. All covariates (except scallop catch and stones in 2001) were significantly related to the presence of many of the species. In particular, the probability of bycatch of monkfish increased with depth, while yellowtail and winter flounder decreased with depth. The probability of bycatch of lobster showed the strongest relationship with bottom type with the lowest probability associated with till/silt. Monkfish had the second highest probability of being present as bycatch. Yellowtail flounder was most likely to be caught in tows on till/silt while winter flounder was least likely to be caught on this bottom type but more likely to be caught on thin sand. Winter skate was also less likely to be caught on till/silt sediments although skate species identification is uncertain.

Sources of Uncertainty

The traditional interpretation of commercial catch rate (catch-per-unit effort or CPUE) data is that assuming catchability is constant, catch rate should track population abundance over time. This is a very simplistic model and even if catchability was constant over time, it does not take into account the spatial distribution of the animals being fished. In SFA 29, scallops are known to be more abundant in specific habitats with conditions favouring high densities of scallops being relatively rare. Fishing experience, information about survey catch rates, and multibeam maps have also resulted in fishermen having a good knowledge of scallop distribution in this area. As a result of these factors, analyses suggest that declines in catch rate will, in part, reflect a decline in stock abundance but may also be confounded by fishing behaviour. As of yet, there has been no development of catch rate indices that overcome these problems and papers on the subject tend to suggest relying on a survey index for monitoring stock size.

During 2001–2006, the survey design for SFA 29 was modified from simple random sampling over the whole area (2001), to random sampling within strata defined as subareas A–E (2002-2004), to random sampling within strata defined based upon surficial geology (2005), to random allocation of tows to surficial strata within subareas (2006). While changes in survey design do

not appear to have changed the interpretation of the overall trends in biomass of commercial size scallops and seem to have improved the precision of abundance estimates, the impact of these changes on the scientific advice requires further evaluation.

Little is known about the recruitment or total mortality dynamics in this area.

CONCLUSIONS AND ADVICE

There are three indicators of stock size for SFA 29 scallop: commercial catch rates for the Full Bay Fleet, commercial catch rates for the East of Baccaro Fleet, and the annual research survey. The commercial catch rates are poorly correlated with the survey biomass estimates.

Analysis of the spatial dynamics of the catch rate series suggests that effort rather than catch rate is matching the spatial density of the stock for the most recent three to four years. If this is true then the commercial catch rates are not directly measuring the change in stock biomass and are confounded by fishing behaviour. According to other studies on similar situations, this condition is particularly problematic for medium and low population densities. Therefore, it is likely that the decline in population biomass in subareas B and C is more severe than the commercial catch rates indicate.

The survey biomass estimates (Figure 4) for all of the subareas indicate more rapid declines from 2005 to 2006 than indicated by the commercial catch rates (Figure 3). However, the lack of strong population dynamics signals in the survey data makes it difficult to model the population. Comparing predicted population biomass for 2006 from the last assessment with the current estimate for 2006 shows that all subareas declined but these estimates have very large confidence intervals (Figure 9).

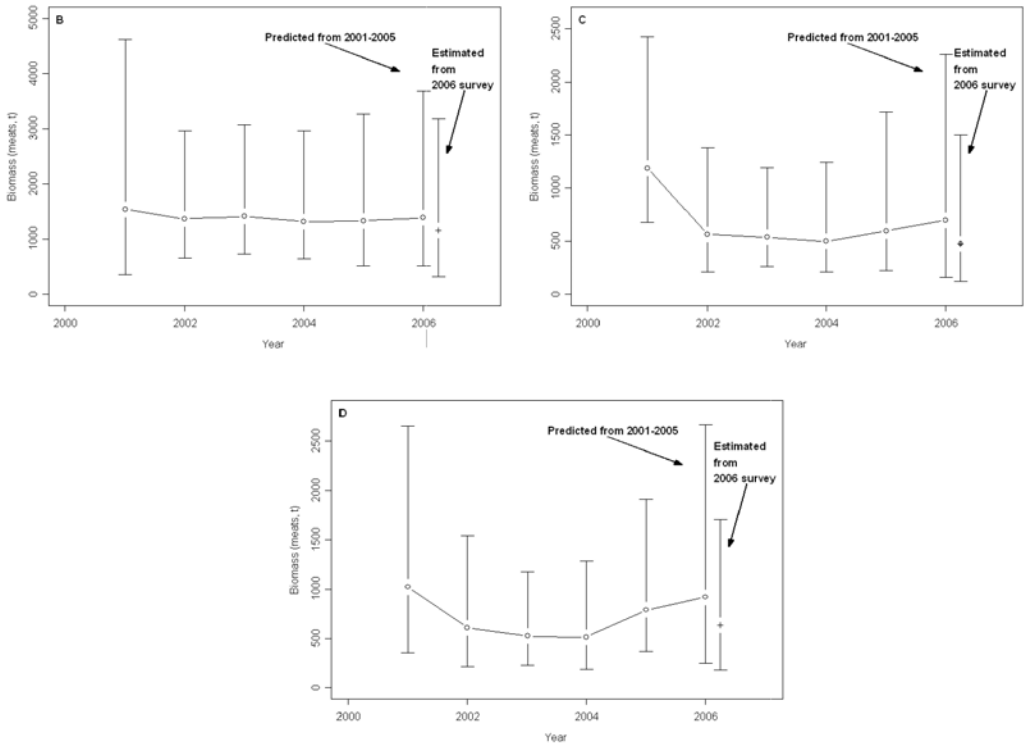


Figure 9. Comparison of predicted biomass of commercial size scallops in 2006 from model used in 2005 assessment and estimate of 2006 biomass after survey and fishery in 2006. Top left panel: SFA 29 B, Top right panel: SFA 29 C, Bottom centre panel: SFA 29 D.

Last year's model predicted that for the catch levels chosen for the 2006 fishery, the probability of the population biomass declining for all subareas exceeded 50–60%. These estimates still stand despite the changes to survey series estimates. The expected decline was less than 10% but estimated declines from the current model are more in the order of 13% for Subarea B and 31% for subareas C and D. The current model predicts that catches of 25 t in each of subareas B, C, and D will all result in a greater than 50% chance of population decline (Table 2). The expected decline is on the order of 10% or less. The population model estimates have a high degree of uncertainty associated with them and may represent a lower bound for possible TACs. While commercial catch rates, which are not used in the model, have declined in SFA 29, they suggest a higher biomass than that estimated by the model.

Table 2. Predicted probability of post-fishery population biomass (100+ mm shell height) in SFA 29 in 2007 being less than in 2006 in relation to different catch levels.

	Subarea		
Catch in 2007 (t)	B	C	D
25	0.53	0.52	0.55
50	0.56	0.59	0.57
75	0.60	0.70	0.59

The population model did not fit the data for Subarea A. Very few scallops with shell heights less than 100 mm were found by the survey in this subarea. Continued fishing in Subarea A in 2007 will probably be limited to scallops ages 6 and older due to limited recruitment.

There was not enough survey information to recommend catch levels for Subarea E. This subarea appears to offer marginal habitat for scallop.

Continuing with a TAC at the 2006 level (400 t) for SFA 29 may not be sustainable in the future given that the survey indicates low recruitment for the next three or more years.

OTHER CONSIDERATIONS

Bycatch of lobster by the SFA 29 scallop fishery in 2006 was estimated at approximately 0.12% of the number of lobsters landed by the LFA 34 lobster fishery in the SFA 29 area. Of this 0.12%, less than a third of lobsters were dead or injured. Based upon comparisons of lobster landings among SFA 29, areas adjacent to SFA 29, and LFA 34 (as a whole), there does not appear to be any immediate impact of the scallop fishery on lobster landings. However, the impact of the scallop fishery on juvenile lobsters and lobster habitat were not evaluated and if there is any impact, it may not be apparent in the lobster fishery for a number of years.

During the July–October molting period, lobsters are less mobile, more prone to injury, and involved in mating. Measures have been taken to avoid scallop fishing in areas where, or at times when, lobsters are in high concentrations or are soft-shelled. The closure of a portion of Subarea B in previous years due to high lobster bycatch has been an example of the type of measure that could be employed.

Continued mandatory observer coverage of lobster bycatch with details on the condition of lobsters caught should be continued in 2007.

SOURCES OF INFORMATION

Smith, S.J., M.J. Lundy, S. Rowe, D. Pezzack, and C. Frail. 2006. Scallop Fishing Area 29: Stock Status and Update for 2006. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/033.

Smith, S.J., S. Rowe, M.J. Lundy, J. Tremblay, and C. Frail. 2007. Scallop Fishing Area 29: Stock Status and Update for 2007. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/029.

FOR MORE INFORMATION

Contact: Stephen Smith, Mark Lundy, and Sherrylynn Rowe
Population Ecology Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography
P.O. Box 1006, Dartmouth
Nova Scotia B2Y 4A2

Tel: (902) 426-3317 / 426-3733 / 426-8039
Fax: (902) 426-1862
E-Mail: smithsj@mar.dfo-mpo.gc.ca
lundym@mar.dfo-mpo.gc.ca
rowes@mar.dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice,
Maritimes Region and Gulf Region
Department of Fisheries and Oceans
P.O. Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2

Phone number: 902-426-7070
Fax: 902-426-5435
e-mail address: XMARMRAP@mar.dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1480-4913 (Printed)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO, 2007. Assessment of Scallops (*Placopecten magellanicus*) in Scallop Fishing Area (SFA) 29 West of Longitude 65°30'W. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/029.

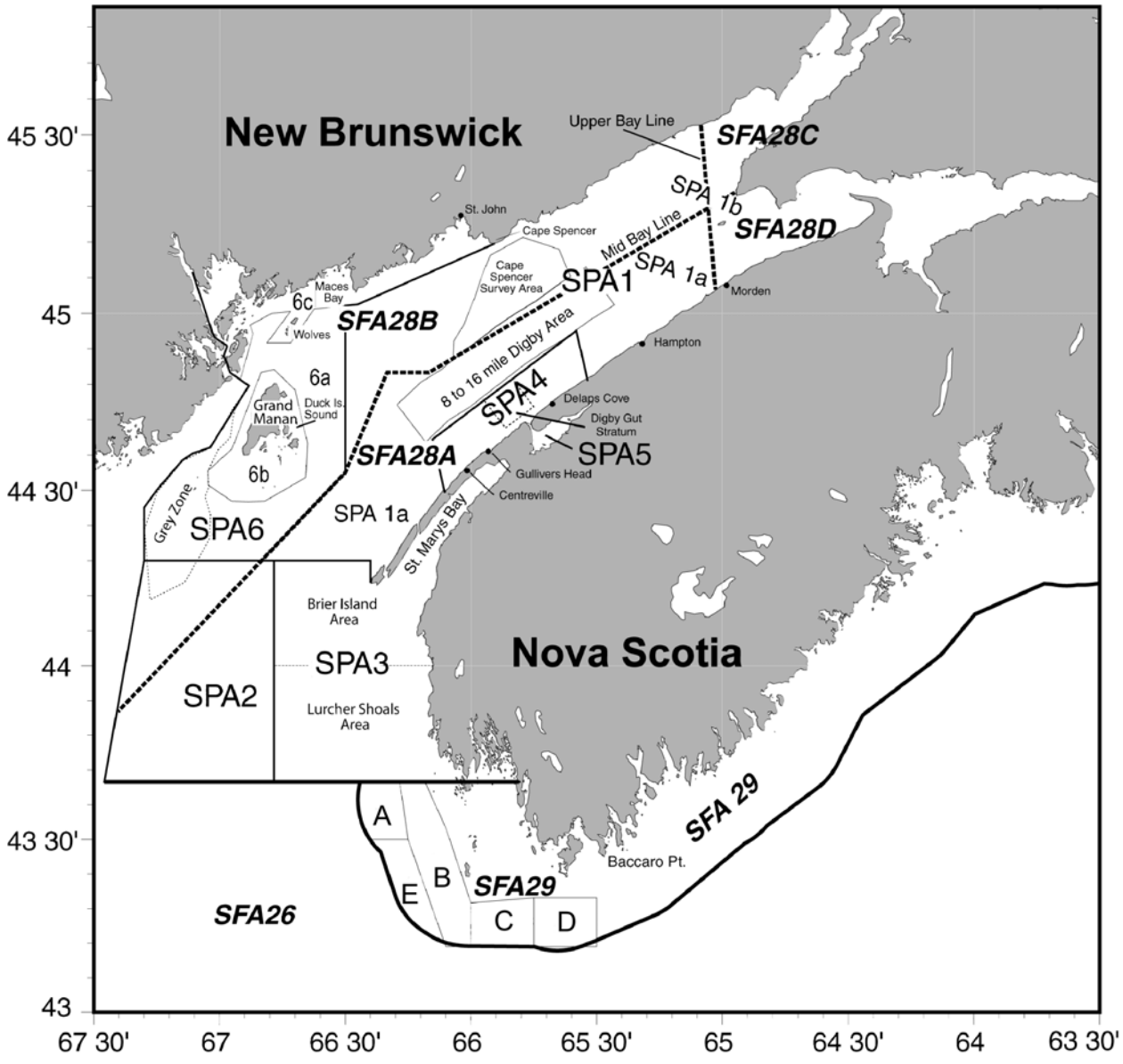


Figure 10. Locations and place names used in this Science Advisory Report.