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Rock crab off Eastern Nova Scotia: Stock Status and Evaluation of Exploratory Fishery

M.J. Tremblay and A. Reeves

Invertebrate Fisheries Division, Science Branch
Maritimes Region, Department of Fisheries and Oceans
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, N.S. B2Y 4A2

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Abstract

This document reviews fisheries for rock crab off eastern Cape Breton and the eastern shore of Nova Scotia (referred to here as Eastern Nova Scotia). Trends in landings, effort and catch rate (kg per trap haul) are examined to assess the potential effect of the fishery on the rock crab stock(s). Rock crab in this area are removed by both a directed exploratory fishery, and as a bycatch in the much larger lobster fishery. Landings by the directed fishery increased about 5-fold from 1994 to 1999 (255 mt). Assuming trap catch rate is an index of abundance, there are areas of local depletion of rock crab, but this is not a strong trend. The size composition in traps did not change from 1996-1999, suggesting exploitation has not altered rock crab size structure. In the directed fishery more fishing effort (e.g. increased participation rates, additional permits or additional traps) should be targeted to lightly fished areas to better evaluate the potential for a rock crab directed fishery.

Removals by the lobster fishery as a bycatch are under-reported if at all, since rock crab are used primarily as bait. These removals are a concern because they are difficult to quantify and could easily exceed the directed fishery. The biological sustainability of the directed fishery is difficult to evaluate without knowing the quantity of these removals, and how large they might become in the future.

Résumé

Le présent document porte sur les pêches du crabe commun sur la côte est du cap Breton et de la Nouvelle-Écosse (Est de la Nouvelle-Écosse). L'évolution des débarquements, de l'effort de pêche et du taux de capture (kg par casier levé) a été étudiée pour évaluer l'effet possible de la pêche sur le ou les stocks de crabe commun. Dans cette région, les crabes communs sont capturés par une pêche exploratoire dirigée et, en tant que prises accessoires, par la pêche du homard qui est beaucoup importante. De 1994 à 1999, les débarquements de crabes capturés dans la pêche dirigée ont augmenté par un facteur de cinq, atteignant 255 tm. Si l'on suppose que le taux de capture par casier constitue un indice d'abondance, il y aurait des zones où le crabe commun est localement surexploité, mais il ne s'agit pas d'une tendance lourde. De 1996 à 1999, la structure de taille des captures n'a pas changé, ce qui porte à croire que celle-ci n'a pas été modifiée par l'exploitation. On devrait accroître l'effort de pêche dirigée (p. ex., taux de participation accrus, permis additionnels ou davantage de casiers) dans les zones peu pêchées afin de mieux évaluer le potentiel de la pêche dirigée du crabe commun.

Les prises accessoires de crabes communs dans la pêche du homard sont sous-déclarées, sinon pas signalées du tout, car ces crabes servent surtout d'appâts. Ces prises sont préoccupantes puisqu'il est difficile de les quantifier et qu'elles pourraient dépasser les prises de la pêche dirigée. Il est difficile d'évaluer la durabilité biologique de la pêche dirigée si l'on ignore l'ampleur actuelle et éventuelle de ces prises accessoires.

Introduction

Rock crab (*Cancer irroratus*) is commonly found in shallow water less than 20 m from Labrador to Florida. Rock crab prefer sandy bottom, but can be found on all types of substrate. Molting occurs primarily in April and May and earliest maturity in the Gulf of Maine area is about 27 mm carapace width (CW) for females and 40 mm CW for males (Campbell and Eagles 1983). The size at which 50% of rock crab are physiologically mature (capable of producing eggs or sperm) occurs at about 49 mm CW for females, and 62 mm CW for males. Egg extrusion appears to occur in late October. Typically the male is larger than the female in mating pairs. A female of 60 mm CW can carry 125,000 eggs, while a 90 mm CW female may carry 500,000. The eggs hatch in the following spring or summer into larvae that are planktonic (free-floating) for 5-8 weeks depending on the temperature. Males grow larger than females with a maximum carapace width of 150 mm compared to 110 mm for females. Commercial size is reached in about 5 years; maximum longevity was estimated at 8 years for rock crab off southern New England (Reilly and Saila, 1978). Small rock crab are a common prey item for lobster (Gendron and Fradette, 1995).

Rock crab are a frequent bycatch in the Maritimes lobster fishery. From the 1960s-1980s rock crab (and its larger cousin the Jonah crab – *Cancer borealis*) were occasionally landed as a bycatch in various lobster management units, and in sporadic directed fisheries (Scarratt and Lowe 1972, DFO 1996a,b, 1998). Rock crab are currently landed by exploratory fisheries directed at rock crab in the Maritimes and Quebec and continue to be a bycatch of the lobster fishery.

This document is concerned with rock crab off eastern Cape Breton and the eastern shore of Nova Scotia (LFAs 27-32 – Fig. 1, referred to here as Eastern Nova Scotia). The directed fishery for rock crab in this area is relatively new, having been underway since 1994. The fishery occurs close to shore and thus has low costs to compensate for the relatively low dockside price for rock crab (generally < $0.80 per kg). Total landings increased about 5-fold from 1994 to 1999 in NAFO Divisions 4V and 4W (Table 1, Fig. 1b). Fisheries Management has requested advice from the Science Branch on the status of this fishery, and how to proceed with a management plan.

Landings for the directed exploratory fishery are available from logs but landings from the bycatch fishery are under-reported if at all. Here we examine trends in landings, effort and catch rate (in kg per trap haul) to assess the potential effect of the fishery on the rock crab stock(s). We also evaluate the current regulations that are in place, and assess whether more effort is advisable.

Description of the Fishery

Current regulations for the directed fishery are summarized in Table 2 and detailed in Appendix 1. The exploratory rock crab fishery for rock crab in Eastern Nova Scotia began in 1993 when one license was issued. Since then there have been two public draws for additional licenses, one in 1994 and another in 1996, bringing the total number of inshore rock and Jonah crab licenses to 28. Several First Nations have been issued communal rock crab exploratory licenses as well.

Exploratory licenses are distributed on the basis of existing Lobster Fishing Area (LFA). LFA 27 has been further subdivided to encourage exploration of the potential rock crab grounds (Fig. 1, Table 1). The 3 zones within LFA 27 are referred to here as LFA 27.1, 27.2 and 27.3. Initially the licenses issued in Eastern Nova Scotia allowed retention of either rock or jonah crab. This was not an issue for LFA 27 participants since jonah crab are absent or rare off eastern Cape Breton. In LFA's 31 and 32 jonah crab can be captured but are further from shore so by 1999 participants had to choose to direct for either rock or jonah crab. All chose rock crab.

The season for the directed rock crab fishery is outside of the spring lobster season, primarily in late summer and fall (Table 2). The number of traps per license is 150; these traps are designed to minimize retention of lobster and undersized rock crab (Appendix 1). The minimum legal size in all areas is 102 mm CW. Males only are retained and few females reach the minimum size.

Rock crab are also retained as a bycatch in the lobster fishery. Some are sold, while others are used directly as bait. As in the directed fishery, the bycatch fishery is legally prohibited from retaining males less than 102 mm CW, and all females.

Methods

Landings, effort and catch rate

Data on daily landings, effort, location and related data were obtained from the Policy and Economics Branch Catch/Effort (C/E) database. These data originate from self-reporting documents completed by fishers (Appendix 1). Copies of the original logs were used to verify the accuracy of the C/E database information, and to obtain ancillary data on trap type, bait, verbal location data etc. If errors in log entry were discovered, corrections were made prior to analyses. Due to changes in the log reporting system, data prior to 1997 are not as detailed.

The bycatch fishery records are included in the Catch/Effort database if the rock crab are sold and the lobster fisher records the landing in his self-reporting log. If the crab are used directly for bait there is no record. These logs did not have location information.

The self-reporting logs for the exploratory license holders require recording of daily catch and effort (number of trap hauls per day) and location. Landing data appear to be of good quality; effort and location data are less complete, but trap number was directly available or could be inferred for 85-95% of the logs from 1997-1999. Useable location data were provided in 48-93% of logs from 1997-99.

Catch composition

Unculled samples of the catch were used to generate carapace width frequencies of the crab catch in different areas. These were obtained by going to sea with fishermen, or arranging for them to retain the complete catch from several traps for measurement at dockside. At-sea catches were also used to measure the quantity of discards (including non-target species). Twelve unculled samples were obtained from 1996-1999; the number of crabs measured per sample averaged 323 (range 136-531). In 1998 fishers made measurements with calipers and protocols provided by us. All measurements were rounded down to the nearest mm but sizes were grouped in 5 mm intervals for display and analysis.

Trap design experiment

Lobsters are a bycatch in this fishery. Currently the trap design in the management plan (Appendix 1) requires a slot entry of at least 47.6 mm (1 7/8 inches) in modified lobster traps to reduce the catch of lobster. There is an exemption for top-entry conical traps. Experiments by Miller and Duggan (1997) reported a reduction in the catch of lobsters in conical traps with slot entries compared with those without. With this in mind an experiment was conducted with the help of a fisherman in South Bar (LFA 27.2 – Fig. 1). Twenty of his conical traps with no slot were converted to slot entry by placing a disc with a 53 by 203 mm slot in the entrance approximately 15 cm below the top of the trap. These 20 slotted traps were compared with traps with no slots by alternating the 2 types approximately 150 m apart on a line on the fisherman's normal fishing grounds. The 40 traps were hauled on 3 separate days, for a total of 60 trap hauls per trap type.

Results

Landings, effort and catch rate

From 1994 through 1998, landings increased 5-fold to 277 mt (Fig. 2). Landing figures for 1999 are unlikely complete but appear similar to 1998. Throughout the period most of the rock crab were landed in LFA 27.2 and 27.3 (70-93% of total landings). The directed fishery (as opposed to the bycatch of the lobster fishery) accounts for most of the recorded landings. In the other areas, landings reached 35 mt

only in LFA 32 (1998) and LFA 31a (1999). The seasonal pattern of landings is typified by 1998 and 1999 (Fig. 3). Landings begin in July, and are highest in August declining afterwards. Some fishing continues at low levels into December and early January.

Effort in terms of number of active licenses, number of days fished, and number of trap hauls was highest in LFA 27.2 and 27.3, and lowest in LFA's 29 and 31b (Table 3). An increase in 1996 reflects the entry of additional licenses through a draw. In several areas the effort was higher in 1999 and 1998 than 1997, partly because a minimum participation clause was instituted. In spite of this clause several license holders did not fish the minimum number of days in LFA 27 zone 1, and in LFA 31b (average number of days < 15 and 10).

Annual catch rate among LFA's ranged from 1.2-9.0 kg/th (trap haul) from 1994-1999 (Table 4); the extreme figures are based on low participation rates and are not very representative. The highest effort area (LFA 27.2) ranged from 4.4 to 7.2 kg/th; just to the south (LFA 27.3) catch rate was lower (1.5-3.7 kg/th). Annual catch rate tended to be lower in 1998-1999 than 1996-1997 but this was not a clear trend and differences are confounded to some extent with fisher and trap, since not all fishers participated each year. Within-season trends in catch rate varied. In 1998 and 1999 biweekly catch rate in LFA 27.2 initially dropped sharply, then declined more slowly or showed no trend (Fig. 4). Biweekly catch rate declined during the 6 weeks of fishing in LFA 27.1, but in other areas there was no trend. As for annual catch rate, some of the within-year differences are confounded by a fisher and trap effect since not all fishers fished the same weeks.

Fishing locations

Reported fishing locations in 1997 and 1998 (Fig. 5-6) appear more localized than 1999 (Fig. 7) but this is likely due to a lower reporting rate in 1997-98. The effort distribution in 1999 is the best reflection of areas fished over the last number of years. Much of the available coastline has had some effort, but gaps in 1999 include part of LFA 27.1, all of LFA 30, and part of LFA 29.1 and 31a. Given that some of the reported locations represent only a few hundred trap hauls, it appears that the existing participants have not fully explored for this species.

Catch composition

Male rock crabs captured in traps ranged in size from 60-142 mm CW; females from 60-104 mm CW (Fig. 8). Males outnumbered females by more than 6-fold. The size of male rock crabs varied considerably within and among areas (Fig. 9). Within LFA 27.2 rock crab captured off South Bar tended to be larger (peak 115-135 mm CW) than those captured by a fisher from an adjacent area (Alder Point, peak at 100-105 mm CW). Some of the area difference in size is likely the result of variation in trap design, rather than differences in the size of crabs on the sea-bottom.

Based on 3-4 samples per area, the size structure of males in LFA 27.1, 27.2 and 27.3 has remained consistent from 1996-1999 (Fig. 10).

Lobster bycatch

Although other crabs (e.g. toad crab, snow crab) and some fish are occasionally retained in rock crab traps, the most common bycatch is lobster. Depending on the area, lobster bycatch can be up to 12 lobsters/100 trap hauls (Table 5). The at-sea samples yielded higher estimates than the self-reporting logs, perhaps because they were completed in early September when lobsters are highly catchable, but more likely due to under-reporting in the logs.

The experiment to test how lobster bycatch is affected by the presence of a slot entry in conical traps indicated both lobster bycatch and mean lobster size were reduced in traps with slot entries (Table 6). Four lobsters were captured in the slot entry traps, while 13 were found in the unslotted traps. Lobster size ranged from 68-87 mm CL in the slotted traps, and 82-113 mm CL in the traps without slots.

Unfortunately the slot entries also reduced the crab catch. In terms of number of legal sized rock crab, the slotted entry traps caught just 58% of the unslotted traps.

Discussion

The data available to assess the status of rock crab in Eastern Nova Scotia are limited to the commercial data and comparisons with analogous fisheries. There are no fishery independent surveys. Overall the fishery appears to be having a modest to moderate effect on the rock crab standing stock. This conclusion is based on the catch rate and size composition data, together with the recognition that effort is low to moderate.

Annual catch rate data suggest there may be a decline in rock crab abundance in some areas but the trend is not strong. In LFA 27.2 the average of 1998 and 1999 (5.4 kg/th) was lower than the average of 1996-97 (6.9 kg/th) but higher than 1994 and 1995 (4.8 kg/th). In LFA 27.1 and 29 mean annual catch rates are based on a small number of fishers.

The within-season catch rate data must be interpreted with caution not only because of different fishers fishing at different times of year, but because in other areas rock crab are known to concentrate in shallow depths during fall, and because catchability will be affected by water temperature and the timing of the molt cycle (Gendron and Cyr 1994). Nevertheless the cautious interpretation of the declines in catch rate in LFA 27.1 and 27.2 is that they represent a decline in rock crab abundance.

The apparent lack of any change in the size structure from 1996 to 1999 runs counter to the above interpretation that the directed fishery has reduced fishable rock crab biomass in some areas. If the rock crab fishery (both directed and bycatch) was reducing the number of crab in the fishable sizes, it is expected there would be a shift to smaller sizes. There was no evidence of this, but as in the catch rate data, the interpretation is complicated by the fact that the data come from traps that are very selective. The within-area consistency in the size structure of the catch may be a function of trap design, since some fishers are using conical traps with 75 mm circles to allow escapement, while others are using modified lobster traps with 63.5 mm circles. If progress is to be made in interpreting catch rate data in this fishery, a small fleet of standard traps should be fished by industry in several different areas. In this way at least the inherent bias of traps will be the same throughout the fishing area.

Effort levels of the directed rock crab fishery in Eastern Nova Scotia are modest compared to the lobster fishery. Within LFA's 27-32 there are currently more than 900 lobster licenses compared to the 28 vessels that directed for rock crab in 1999. Given that the average lobster fisher within this area hauls 250-275 traps on 40-50 days, the number of trap hauls in the rock crab fishery is likely less than 2% of the lobster fishery. By comparison to the approximately 190 mt of rock crab removed by the directed rock crab fishery in LFA 27.2 and 27.3, lobster landings have been 900-1000 mt (926 in 1997, Tremblay and Eagles 1998).

A major concern with the future of the directed rock crab fishery in Eastern Nova Scotia is the unknown quantity of bycatch by the lobster fishery, for which we have only anecdotal evidence. In some areas (e.g. LFA 27.1) the retention of rock crab during the lobster fishery is apparently low to non-existent because of lower crab abundance and a more readily available bait source. In other areas (e.g. LFA 27.2 and 27.3) some lobster fishers set traps specifically for rock crab, and may use more than 20 kg per day. Some is used directly as bait, while some of the catch is sold and appears to be under-reported. This bycatch is a concern because should bait prices increase, the potential effort that could be directed at rock crab by the lobster fishery is far greater than the directed rock crab fishery. The tonnage of rock crab removed during the lobster fishery needs to be quantified.

A comparison of catch rates in Eastern Nova Scotia with other rock fishing areas is useful for evaluating relative potential of these fisheries. Mean annual catch rates in the area with most effort (LFA 27.2) have ranged from 4.4-7.2 kg/th. This is markedly lower than the Baie des Chaleurs (10-18 kg/th - DFO, 1998), but similar to other areas in the southern Gulf of St. Lawrence (LFA's 23, 25 and 26a ranged from 5-8 kg/th - DFO 1996b, 1998). In LFA 26b, on the northwestern side of Cape Breton (adjacent to LFA 27.1), catch rates were only 2-3 kg/th, similar to the adjacent LFA 27.1. Determining whether these

area differences reflect differences in abundance, trap type or the quality of fishing effort would require more study.

Current regulations provide for protection of females and a portion of potentially breeding males. There is some uncertainty regarding the effect of fishing large males on reproduction (Smith and Jamieson 1991). Larger males are needed to mate larger females, and if they are reduced in number, sperm-limited female fecundity is possible (MacDiarmid and Butler 1999).

Evaluation of current regulations and management regime

Minimum size – This should not be changed unless it was to be increased for market reasons. The current size protects a portion of the mature males, as well as females. As such it provides some protection against recruitment-overfishing.

Trap design – The conical traps with slot entries tested here did reduce lobster bycatch but also reduced the catch of legal sized crab. While the current study found slotted traps to be about 60% as effective at capturing legal crab, data in Miller and Duggan (1997) indicates they were about 80% as effective. As in the current study, they noted smaller lobsters in the slotted entry traps. More experiments need to be conducted on designs that reduce lobster bycatch while maintaining (or at least not reducing substantially) legal rock crab catch rates.

At its current width of 47.6 mm (1 7/8"), the slot entry prevents some large rock crab from entering. Rock crab larger than 130 mm CW have shell depths of 47-49 mm. A width-height regression in Miller and Duggan (1997) predicts a 135 mm CW crab to be 49.8 mm in depth. Consideration should be given to a larger slot size (52-54 mm), although this may result in slightly larger lobsters gaining entry.

Effort – In the directed fishery more fishing effort (e.g. increased participation rates, additional permits or additional traps) should be targeted to lightly fished areas to better evaluate the potential for a rock crab directed fishery. Candidate areas for additional effort would be the southern portion of LFA 27.3, LFA 30, part of LFA 29 and part of LFA 31a. In LFA 27.2 and the existing fishing grounds in LFA 27.1, there are signs of within-season depletion and there should be no additional effort there.

Lobster fishery bycatch - The quantity of rock crab removed by the lobster fishery needs to be evaluated. Lobster fishermen should be encouraged to report their bycatch, whether it is used directly as bait or sold.

Potential Application of Caddy's "Traffic Light" Approach

There is currently no biological reference point for rock crab, or any guidelines as to the "right" level of effort. Caddy (1999) notes that for many fisheries, reference points specified in terms of biomass or fishing mortality are not possible because of insufficient data. Given that precautionary action cannot be delayed until data are adequate, he suggests a checklist of qualitative or semi-quantitative criteria be developed. This list would be developed by resource experts and stakeholders, and include data such as catch rate and landings, ratings of how vulnerable the species might be to exploitation, and various economic and social factors. This list could be refined to develop a resource 'traffic light', which indicates the state of the fishery and which would be used to trigger pre-negotiated management actions depending upon the number of red lights on the Limit Reference Points (LRP's) board. This approach has potential, but its application to rock crab is premature, and would require considerable development prior to use in management of any rock crab fishery.

Long-term outlook and potential interaction of rock crab with other species

Rock crab are among the most common large benthic invertebrates found on the Northwest Atlantic coast and in the Gulf of St. Lawrence, occurring on a variety of bottom types from cobble to sand and mud. They are an important component of the nearshore community, consuming polychaetes, bivalves, other crustaceans, starfish and sea urchins, and providing food for fish and other large decapods, notably lobster (Scarratt and Lowe 1972, Reilly and Saila 1978, Stehlik 1993, Gendron and Fradette 1995).

Lobster feed primarily on rock crab below the minimum legal size of 102 mm CW (reviewed by Gendron and Fradette 1995). Since the directed fishery is not taking crab at a size where they are food for lobster, it appears the rock crab fishery has the potential to adversely affect the growth and survival of lobster only if rock crab are recruitment-overfished. Recruitment overfishing is unlikely but there are some uncertainties related to mating behavior and the removal of large males, and the potential of the lobster fishery to remove large quantities of rock crab as a bycatch.

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Table 1. Rock crab landings (mt) by NAFO district on the Scotian Shelf and the Gulf of Maine 1984-1999. 4Vn and 4W comprise Eastern Nova Scotia. 1999 figures are preliminary. ENS exploratory is the tonnage accounted for by the logs of the directed fishery. In brackets is the % this represents of the total recorded landings in 4Vn and 4W.

Year	4X	4W	4Vn	Total	ENS exploratory (%)
1984	8			8	
1985			0	0	
1986	0			0	
1987	4	14	9	27	
1988	2	15	30	47	
1989	9	3	2	14	
1990	2			2	
1991	14			14	
1992	9	2		11	
1993		1		1	
1994	1	4	52	57	Not reliable
1995	74	48	115	237	Not reliable
1996	229	13	101	343	99 (87%)
1997	152	48	123	323	153 (89%)
1998	148	59	221	428	270 (98%)
1999	144	58	197	399	240 (94%)

Table 2. Summary of rock crab management measures in Eastern Nova Scotia.

Measure	All areas	Particulars by LFA
Number of licenses	28	LFA 27 – Zone 1: 4 Zone 2: 5 Zone 3: 7 LFA 29: 3 LFA 31: 5 LFA 32: 4
Trap limit	150	uniform
Season	Outside of spring lobster fishery	LFA 27: Aug. 15- Dec. 31 LFAs 29-32: Jan 1 to 1 week before lobster season (LFA 29: May 10; LFA 30: May 20; LFA 31a: Apr. 29; LFA 31b and 32: Apr 19); July 1-Dec. 31
Minimum legal size	102 mm carapace width	Uniform
Retention of females?	No	
Gear type	Modified lobster or conical, with specified escape openings	See Appendix 1.

Table 3. Indices of effort in Eastern Nova Scotia exploratory rock crab fishery for each LFA and 3 zones of LFA 27. Days fished and number of trap hauls based on landings and effort representing following percentages of total log landings: 89% (1997), 94% (1998) and 86% (1999).

	Year	27.1	27.2	27.3	29	31a	31b	32	Total
No. active vessels	1994	-	2	2	-	1	1	-	6
	1995	-	2	1	-	-	-	-	3
	1996	1	6	3	1	1	-	-	12
	1997	1	6	6	2	2	3	4	24
	1998	3	8	4	2	2	4	3	26
	1999	2	8	5	2	4	3	3	27
Mean no. days fished	1994	-	38	25	-	2	18	-	
	1995	-	57	19	-	-	-	-	
	1996	8	19	18	1	9	-	-	
	1997	10	16	17	2	21	9	13	
	1998	14	26	25	11	17	4	20	
	1999	13	32	21	10	15	5	14	
Mean no. trap hauls	1994	-	3663	1574	-	150	440	-	
	1995	-	5979	1736	-	-	-	-	
	1996	800	1835	1519	50	900	-	-	
	1997	1000	1876	1754	173	1018	700	938	
	1998	1424	3686	2962	915	1042	635	2665	
	1999	984	3716	2870	875	1001	449	1483	

Table 4. Mean annual catch rate (kg/trap haul) for each LFA and 3 zones of LFA 27. Based on total catch and total trap hauls for season.

Year	27.1	27.2	27.3	29	31a	31b	32
1994	-	5.0	3.7	-	4.5	5.4	-
1995	-	4.6	1.5	-	-	-	-
1996	4.3	6.6	3.1	4.2	9.0	-	-
1997	7.3	7.2	2.5	5.6	5.4	4.7	4.4
1998	2.2	6.4	3.1	1.2	4.5	6.6	3.6
1999	3.3	4.4	2.6	1.2	4.8	5.2	2.3

Table 5. Bycatch of lobster (no. per 100 trap hauls) in directed fishery for rock crab in Eastern Nova Scotia. In brackets is number of logs or at-sea samples upon which estimate based.

Year	Data source	27.1	27.2	27.3	29	31a	31b	32
1997	Log	0.3 (1)	1.0 (2)	0.7 (1)	-	1.2 (1)	0.4 (2)	0.4 (1)
1998	Log	-	1.9 (3)	-	-	-	-	-
1999	Sea sample	-	11.7 (2)	2 (1)	-	2.5 (1)	-	-

Table 6. Results of trapping experiment to assess effect of a slot in a top entry conical trap. Shown is catch (in number). Experiment based on a total of 60 trap hauls per type (20 traps of each type hauled on each of 3 different days).

	no slot	with slot
N lobster < 80 mm CL	0	2
N lobster > 80 mm CL	13	2
Min lobster CL (mm)	82	68
Max lobster CL (mm)	113	87
N crab < 102 mm CW	111	107
N crab > 102 mm CW	275	160
Max crab size	140	134

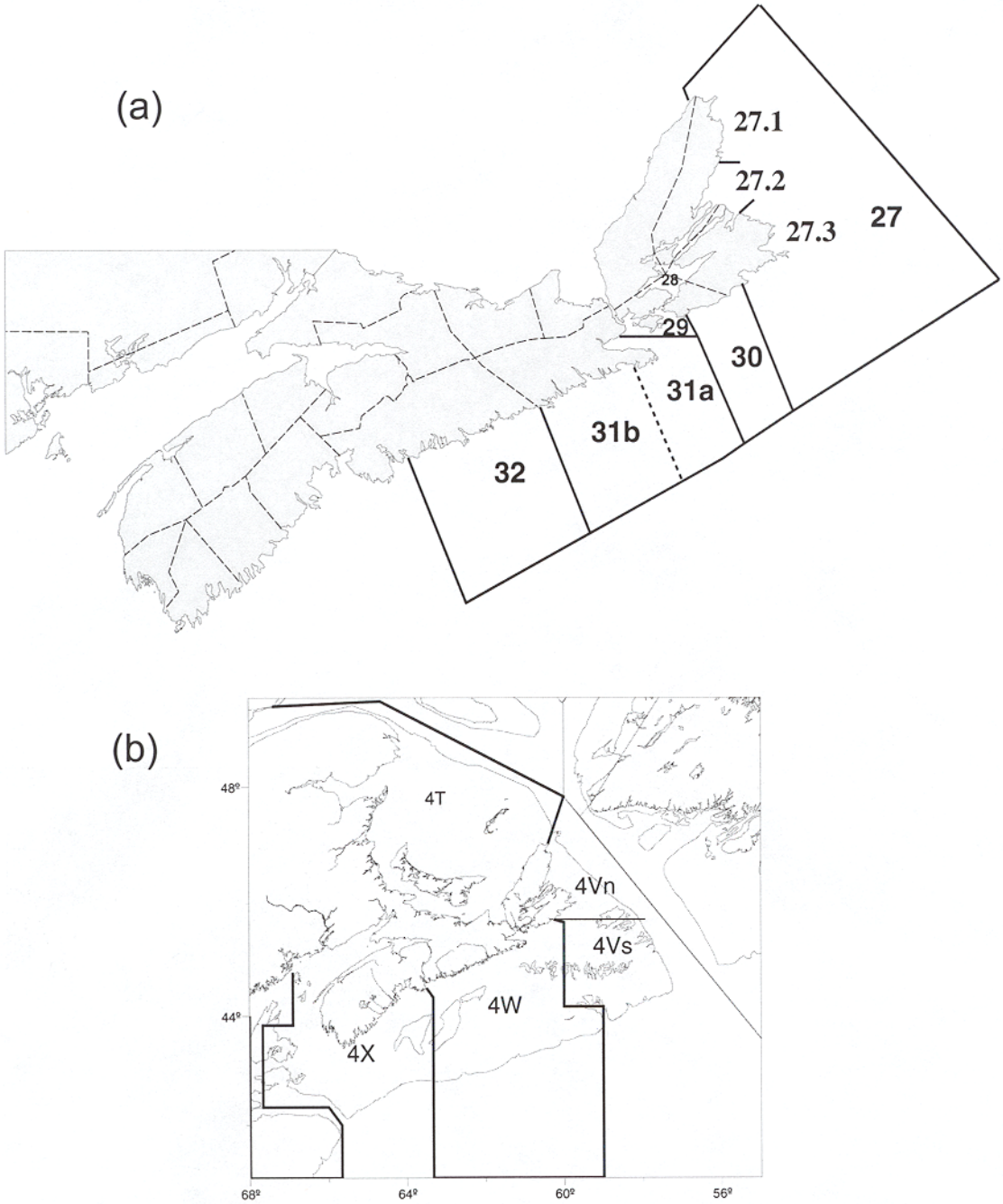

Fig. 1. Maps showing areas for which rock crab landings are provided.
(a) Lobster Fishing Areas (LFA's) in Eastern Nova Scotia (LFA 27-32). Rock crab licenses for the exploratory directed fishery are allocated on the basis of LFA. LFA 27 is further divided into 3 areas (27.1, 27.2 and 27.3) to encourage a wider distribution of fishing effort.
(b) NAFO subareas

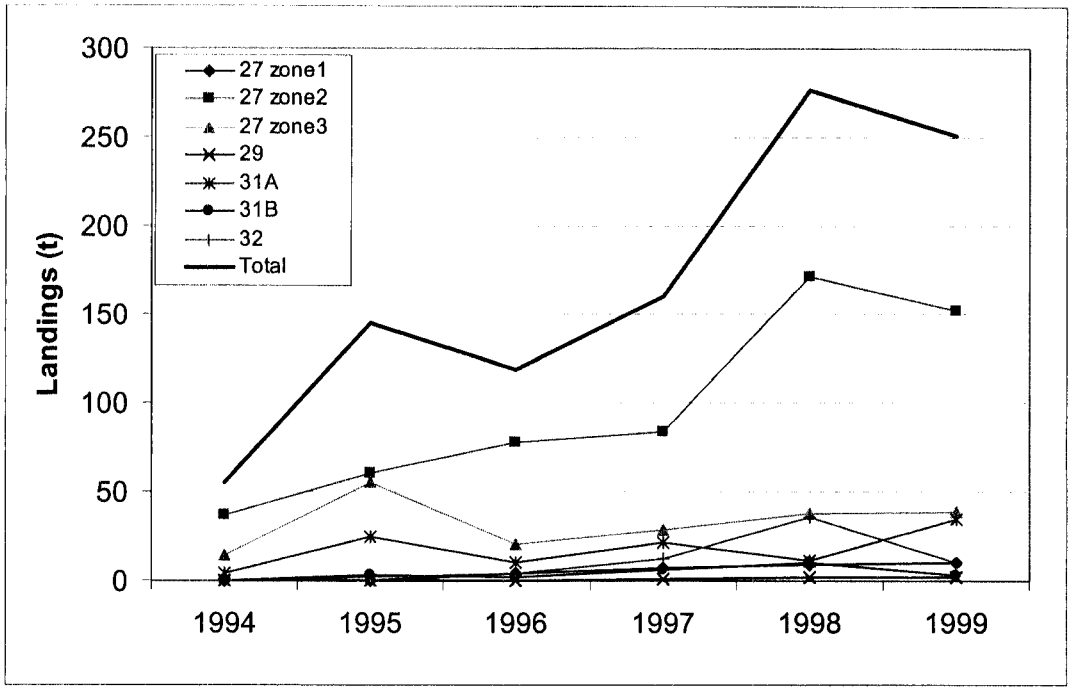

Fig. 2. Total rock crab landings recorded for Eastern Nova Scotia since the beginning of the directed fishery. 1999 landings are not finalized. Bycatch landings during the lobster fishery are underestimated.

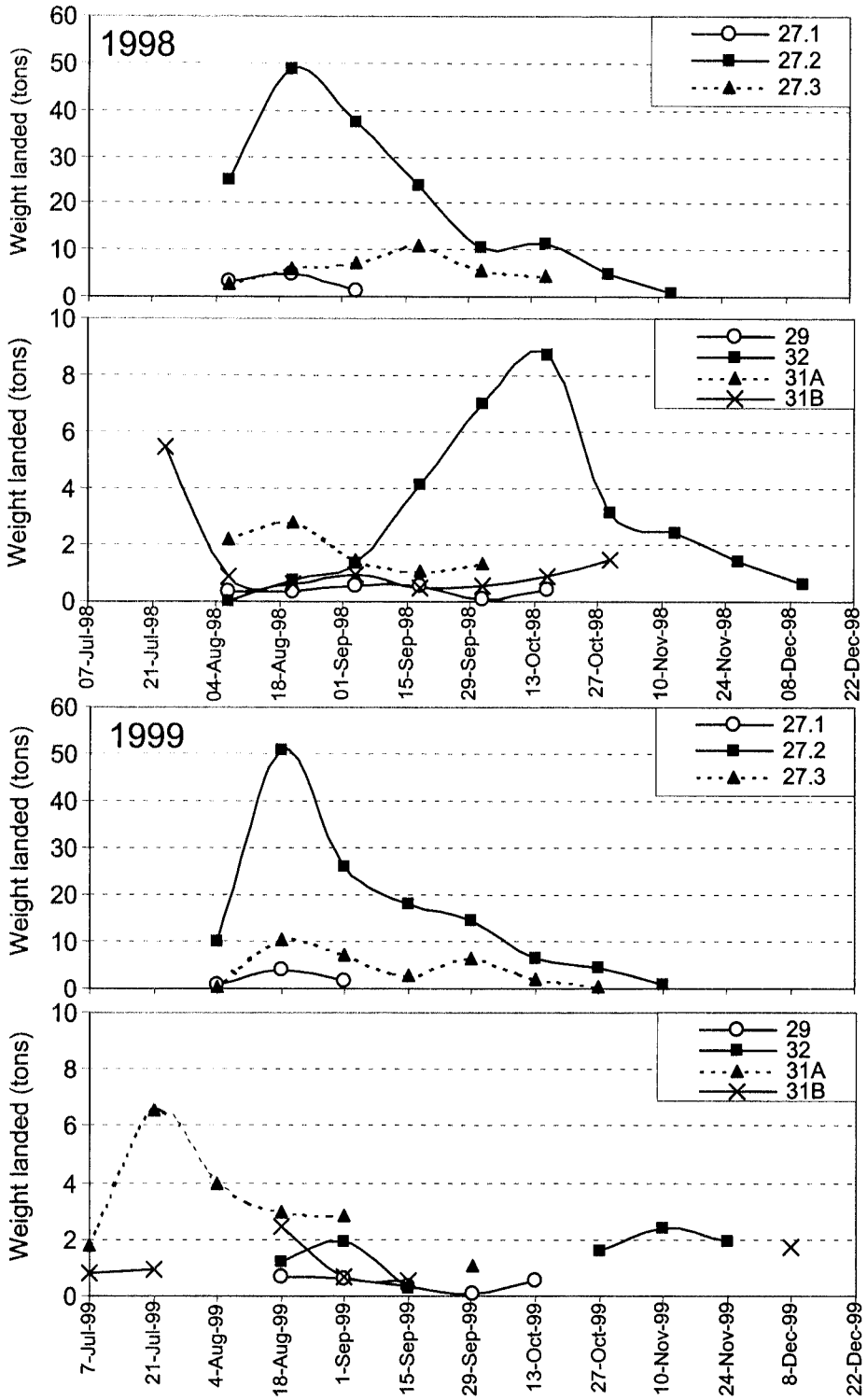

Fig. 3. Seasonal trends in biweekly landings in 1998 and 1999.
Figures represent 85-95% of the recorded rock crab landings for Eastern Nova Scotia in the 2 years. Some of directed fishery landings are not included because of missing effort data.

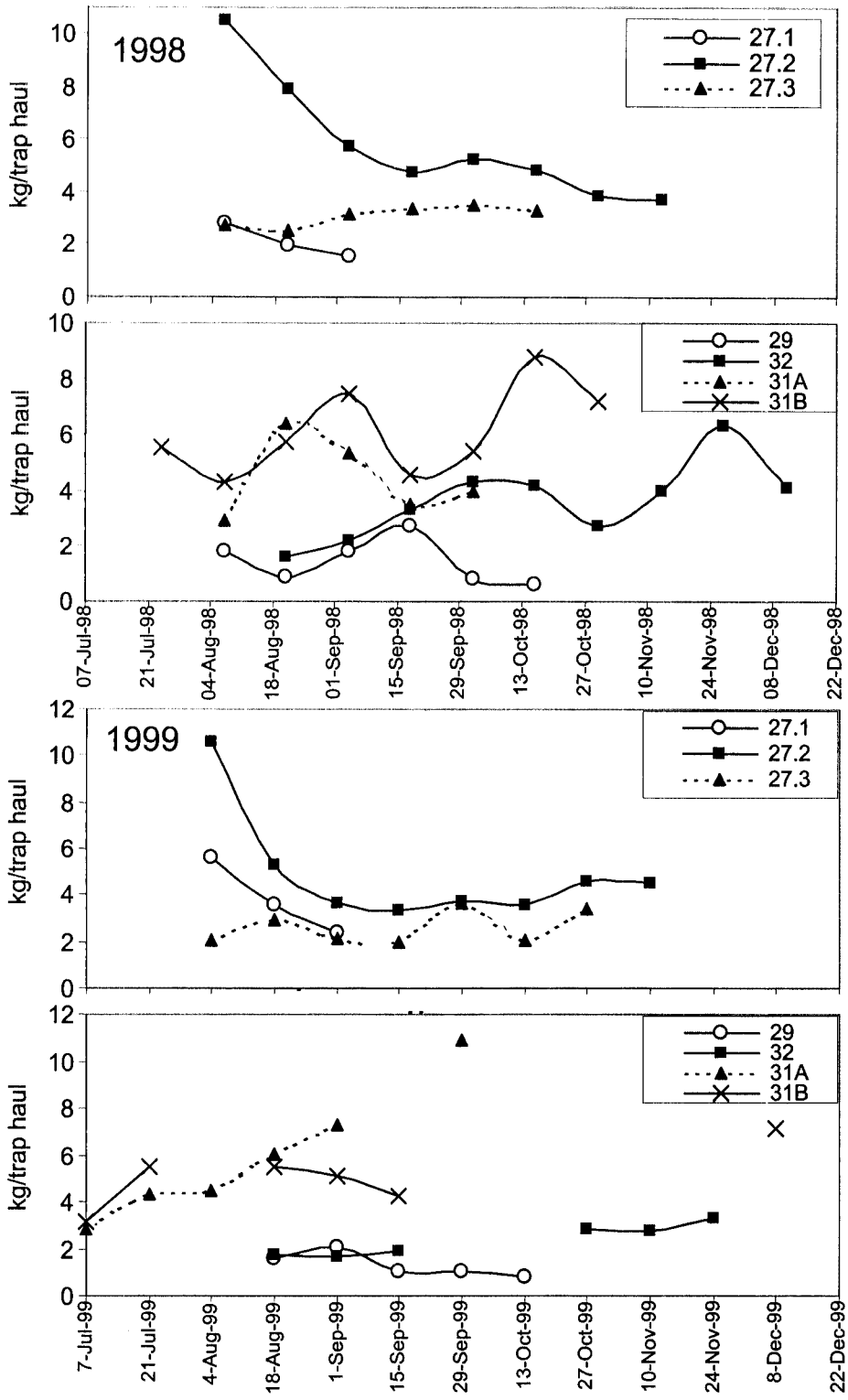

Fig. 4. Seasonal trends in biweekly catch rate in 1998 and 1999.
Figures represent 85-95% of the recorded rock crab landings for Eastern Nova Scotia in the 2 years. Some of directed fishery landings are not included because of missing effort data.

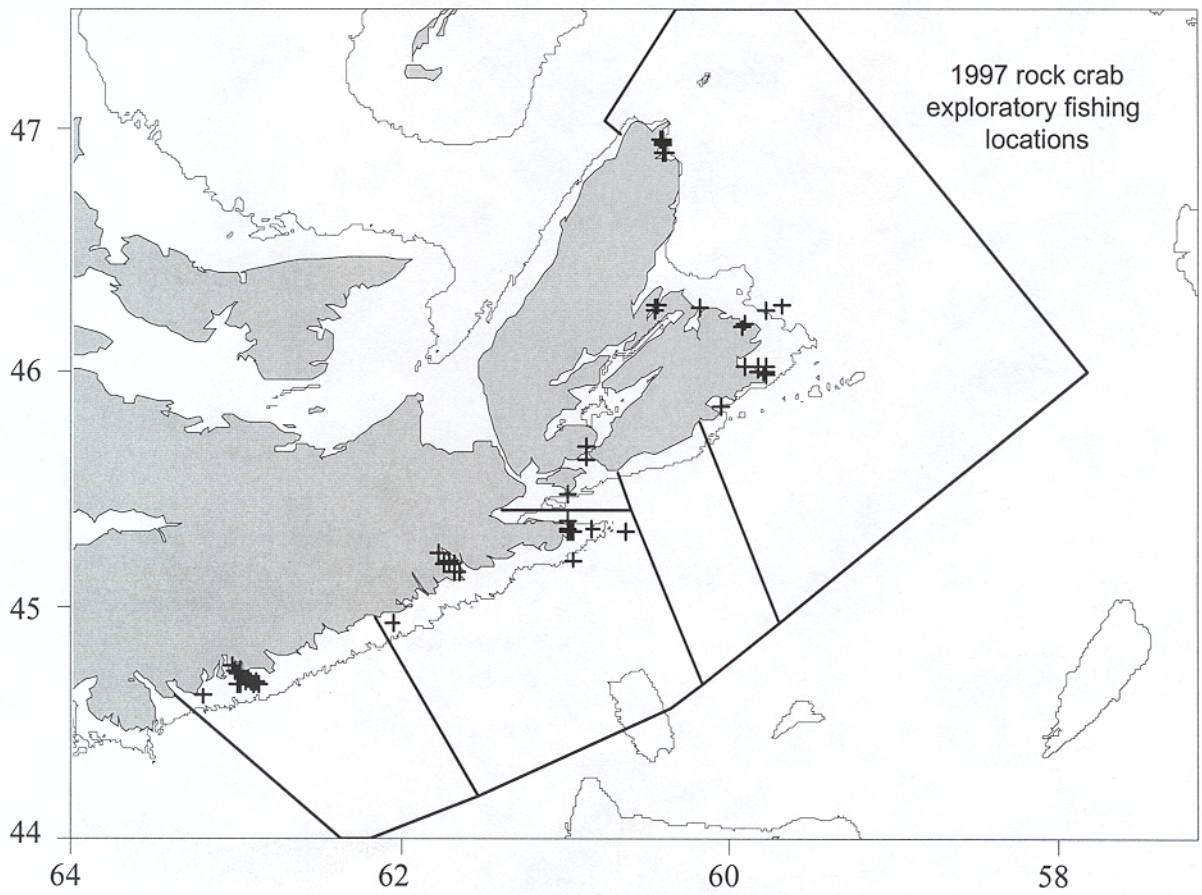

Fig. 5. Fishing locations off Eastern Nova Scotia directed rock crab fishery in 1997. Represents 77 mt or 45% of the total recorded landings (171 mt)

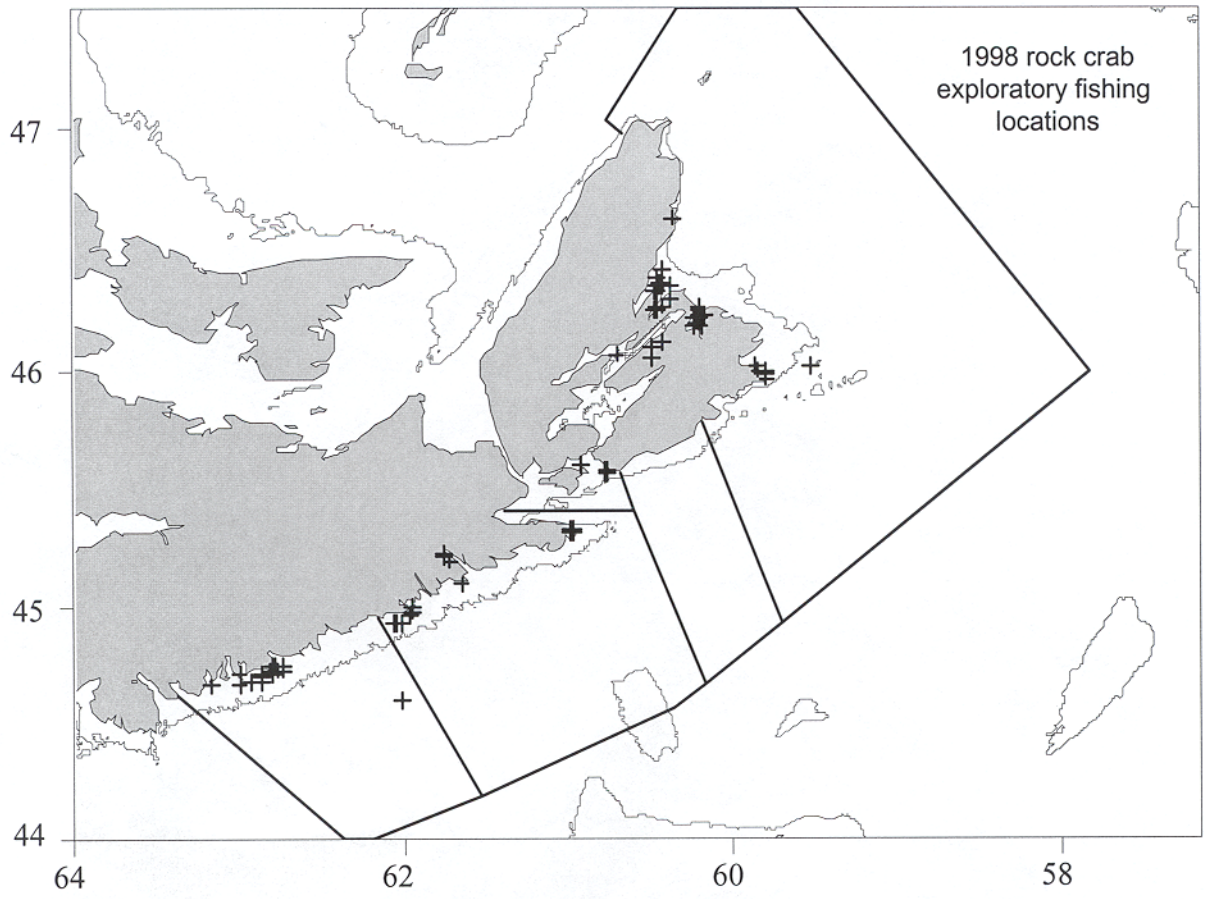

Fig. 6. Fishing locations off Eastern Nova Scotia directed rock crab fishery in 1998. Represents 133 mt or 48% of the total recorded landings (280 mt)

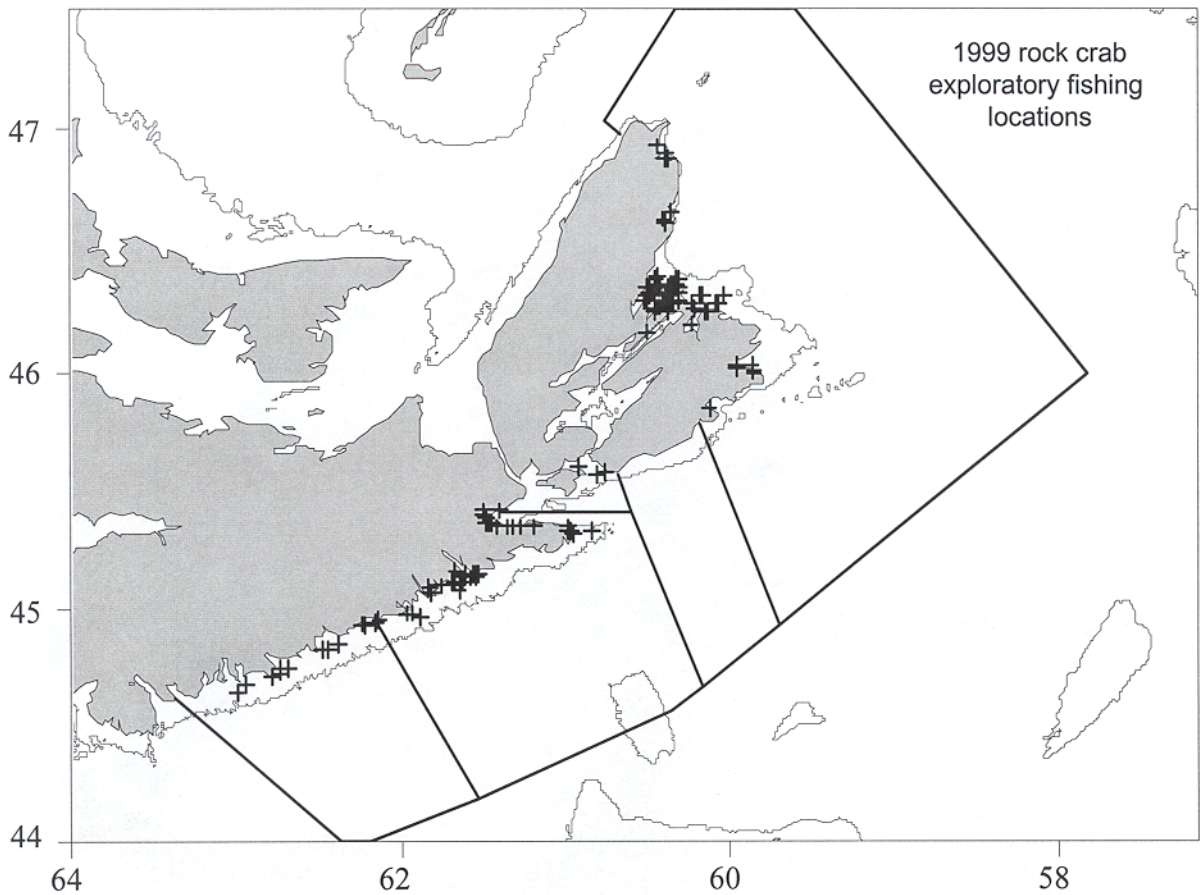

Fig. 7. Fishing locations off Eastern Nova Scotia directed rock crab fishery in 1999. Represents 223 mt or 87% of the total recorded landings (255 mt)

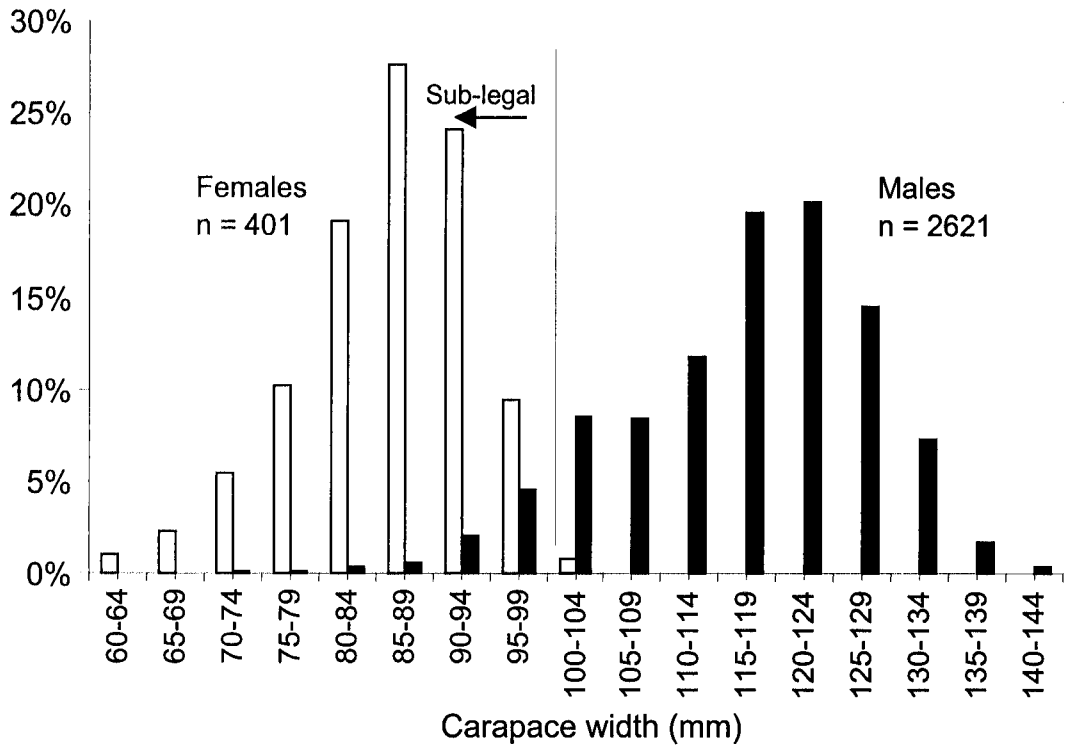

Fig. 8. Male and female carapace width measurements at sea in LFA 27 (zones 2 and 3) from 1996-1999. Total N = 3022 in 10 samples.

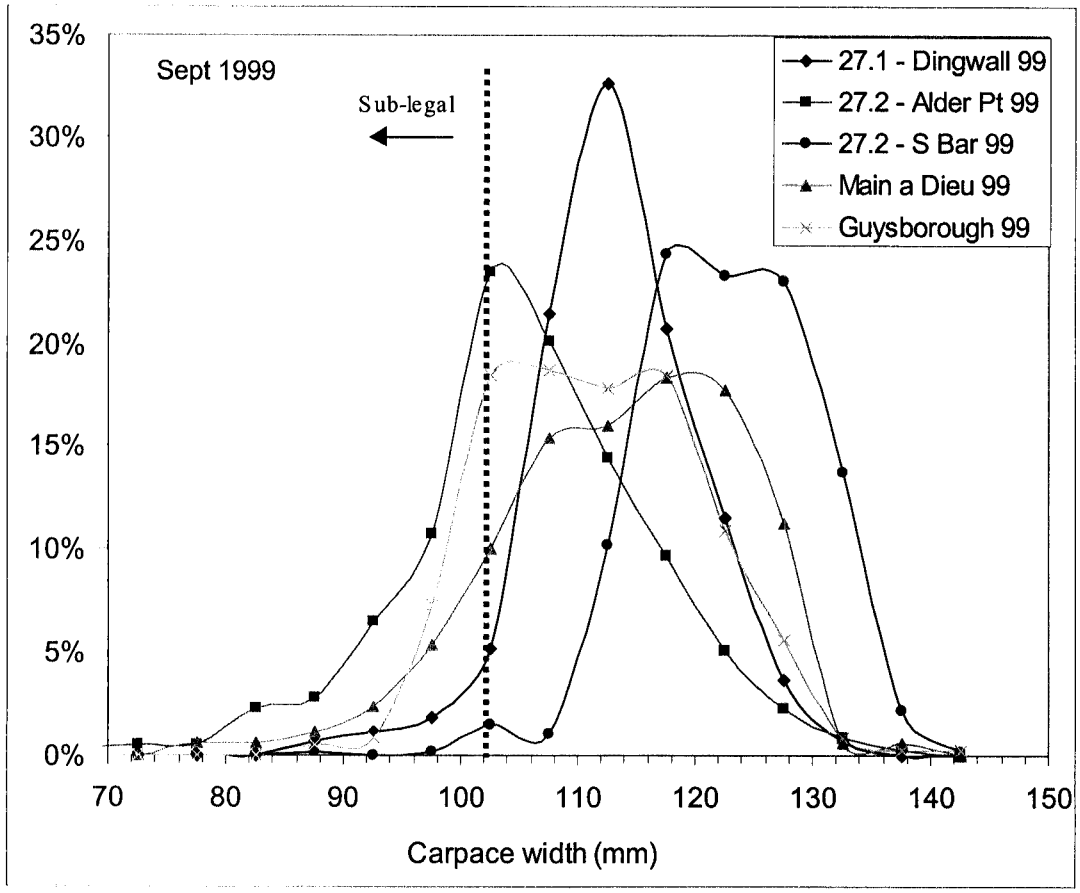

Fig. 9. Male carapace width measurements of unculled catches in September 1999. Numbers measured were 270 (Dingwall), 353 (Alder Pt.), 460 (South Bar), 169 (Main-a-Dieu), and 358 (Guysborough)

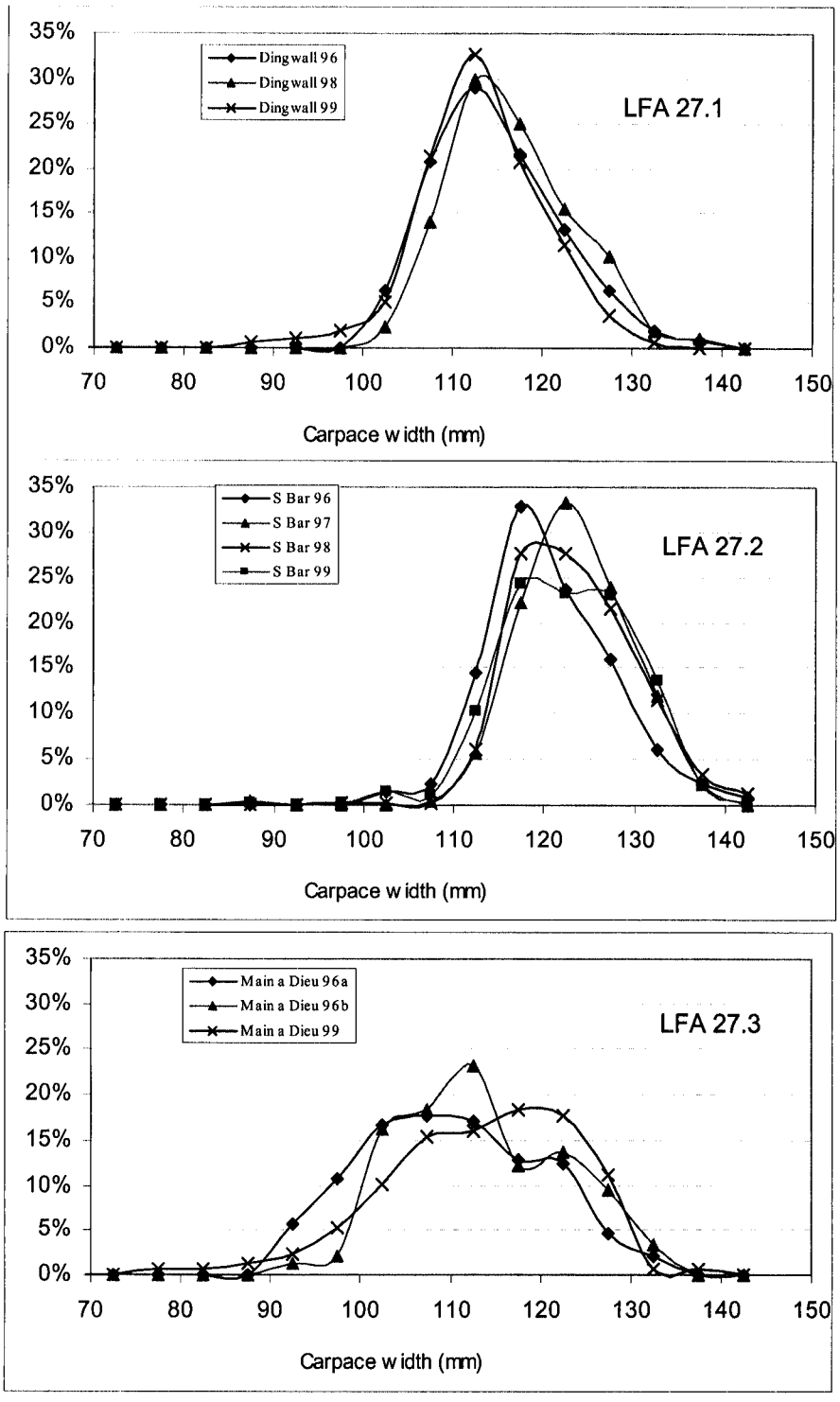

Fig. 10. Male carapace width measurements of unculled catches in different years for 3 ports in LFA 27. Samples were from late August through early November.

Appendix 1 – Extract from The 1998 Rock and Jonah Crab Integrated Fishery Management Plan for Eastern Nova Scotia

Table 1: Summary of Rock and Jonah crab exploratory fishery management measures for Eastern Nova Scotia, 1998

Management Measure	LFA 27	LFA 29	LFA 31A, 31B, 32
Licence Designation	Rock only	Rock only	Rock and Jonah*
Season	Aug. 15 - Dec. 31	Jan. 1 - 1 wk<lobster season July 1 - Dec. 31	Jan. 1 - 1 wk<lobster season July 1 - Dec. 31
Carapace Size	102 mm	102 mm	Rock: 102mm Jonah: 130 mm
Trap limit	150	150	150
Trap design	Conicals or modified lobster - (minimum 2 escape gaps ≤ 76mm from floor and side panels minimum 3"X5" with degradable material) rectangular opening ≤1 7/8" wide, escape gaps 2 1/2" wide	Conicals or modified lobster - (minimum 2 escape gaps ≤76mm from floor and side panels minimum 3"X5" with degradable material) rectangular opening ≤1 7/8" wide, escape gaps 2 1/2" wide	Conicals or modified lobster (minimum 2 escape gaps ≤ 76mm from floor and side panels minimum 3"X5" with degradable material) Rock: rectangular opening ≤1 7/8" wide, escape gaps 2 1/2" wide Jonah: rectangular opening ≤3" wide, escape gaps 3 1/2" wide
DMP	100% hail, + 20% dockside monitoring or 100% if floating car storage	100% hail, + 20% dockside monitoring or 100% if floating car storage	100% hail, + 20% dockside monitoring or 100% if floating car storage
Participation Requirement	5000 lbs landed/sold and 15 days of fishing	1000 lbs landed/sold and 10 days fishing	1000 lbs landed/sold and 10 days fishing

***Fishers will have until 1999 to declare species designation.**

4.2 Trap Design

Traps shall be of the following design:

- **Conicals or modified lobster traps** (top entry preferred but not required in 1998); all traps to include at least two, and preferably three or four, lobster escape gaps to be located no higher that 76mm from the floor of the trap if a "parlor" type trap is used, i.e. a trap with two compartments, the escape gap or gaps must be in the "parlor"; all traps to include side panels of at least 3" X 5" made of or held on by degradable materials such as sisal, hemp or corrodable metal which will release the panel and help to prevent "ghost fishing" of lost traps;

- **When directing for rock crab**: trap entrance should be rectangular with opening no more than 1 $^{7}/_{8}$" wide, with no limit on the length of this opening. Escape gaps shall be 63.5mm (2 $^{1}/_{2}$ ") in diameter. Rectangular opening requirement exempt for conical traps.

- **When directing for Jonah crab**: unless fishing with conicals, trap entrance should be rectangular with opening no more than 3" wide with no limit on the length of this opening. Lobster escape gaps shall be 91mm (3 $^{1}/_{2}$ ").

4.3 Dockside Monitoring Program (DMP)

Under this plan, all exploratory licence holders must participate in an approved monitoring and reporting program at their own expense. For 1998, there will be 20% full DMP coverage or 100% if a floating car method of storage is used and 100% data entry of fishing log data. Dockside monitoring and data entry to be provided at licence holders' expense by an approved dockside monitoring company. A new crab monitoring document has been designed for the 1998 season, booklets of which can be obtained from DFO (**Appendix 5**). For those trips that do not require an observer at dockside, fishers will be required to supply copies of all documents within 72 hours after the offloading of the crab. Copies of monitoring documents should be maintained on board the vessel for a period of one year after the end of the fishing year for verification purposes.

Licence holders may be requested to carry, at their own expense, an at-sea monitor to collect data relevant to the fishery.

4.4 Licence Distribution

Appendix 1 cont'd

The licenses are distributed along the following geographic lines as indicated in the following table.

Table 2: Licence distribution in LFA 27

Rock Crab LFA 27		
Zone	**Location in LFA 27**	**Number of Licenses**
Zone 1	Northern Portion	4
Zone 2	Central Portion	5
Zone 3	Western Portion	7
Total		**16**

Further information on the distribution of licence holders within the LFA 27 harvesting zones is included in **Appendix 1**.

Licence distribution for rock and Jonah crab are indicated in the following table.

Table 3: Licence distribution for rock and Jonah crab

Rock and Jonah Crab	
LFA Number	**Number of Licenses**
LFA 29	3*
LFA # 31A	2
LFA # 31B	3
LFA # 32	4
Total	**12**

***LFA 29 licenses are already designated for rock crab. Remaining licence holders must declare a species designation by 1999.**

4.5 Participation Requirements

In order to ensure that a minimum of exploration activity is conducted in each of these fisheries on an annual basis, minimum participation requirements have been set in consultation with the respective ad hoc advisory groups. The minimum requirements are summarized in Table 1. If these requirements are not met, the matter is tabled before the Developing Species Advisory Board for a recommendation on redistribution of the inactive licence. Likewise, if other terms and conditions of the licence are not met (such as DMP and reporting requirements) a similar review process occurs. Licenses are redistributed based on an eligibility list or a public draw in the absence of a list.

CRAB (1997 - 01)

CRAB MONITORING DOCUMENT

GENERAL INFORMATION

Crab License Number: _____ NAFO Area: _____

Vessel Name: _____ Vessel Registration Number: _____ Crab Area or LFA: _____

Date Sailed: _____ Date Landed: _____ Port Landed: _____

LOG INFORMATION Trap type Top entry lobster ☐ Lobster ☐ Conical ☐ Other (Specify) ☐ _____

Species codes Jonah 703 Red 706 Snow 705 Trap Size _____

Rock 704 Stone 708 Toad 701 Other 707

(Please fill in one line per trap string)

Date (M/D)	Location Latitude / Longitude	Depth (fath.)	# of Traps	Soak time (days)	Spec. code	Catch kept (pounds)	Spec. code	Catch kept (pounds)	Spec. code	Catch kept (pounds)	Comments

HAIL INFORMATION

Estimated time of arrival: _____ (24 hr. clock) H H M M Total pounds on board: _____

Confirmation number: _____

WEIGHOUT SLIP

Date	Species	Weight (Lbs)	Price per lb	Buyer

DFO use only

Dockside monitor's name _____

Dockside monitor's signature _____

Captain's name _____

Captain's signature _____

Note: One Document is to be completed for each fishing trip.