Not to be cited without
permission of the author(s) [1]
Canadian Atlantic Fisheries
Scientific Advisory Committee
CAFSAC Research Document 92/24

Ne pas citer sans
autorisation des auteur(s) [1]
Comité scientifique consultatif des
Pêches canadiennes dans l'Atlantique
CSCPCA Document de recherche 92/24

Trial use of a claw gauge as an alternate measure of minimum legal size in the snow crab fishery of Eastern Cape Breton (Area 23)

by

M. J. Tremblay and M. Eagles
Benthic Fisheries and Aquaculture Division
Halifax Fisheries Research Laboratory
Biological Sciences Branch
Dept. of Fisheries and Oceans
P.O. Box 550
Halifax, Nova Scotia B3J 2S7

and

R. W. Elner
Canadian Wildlife Service
Environment Canada
5421 Robertson Rd.
P.O. Box 340
Delta, British Columbia V4K3Y3

Abstract

An alternative measure of snow crab minimum legal size based on claw height was tried on an experimental basis for 1 year in Area 23 of Eastern Cape Breton. The potential benefits of harvesting only large-clawed crabs include: (1) increased landings due to the retention of pygmy males, currently a wasted resource; (2) protection of small-clawed crabs, which are still growing; (3) possible improvement of yield per recruit; and (4) lower incidence of soft shell crab in the catch. Although fishermen were not averse to using the gauge, market forces overwhelmed its effectiveness. First, benefit (1) did not materialize because buyers discouraged the landing of pygmy crabs because of their small size and often dark shells. Second, buyers did not purchase new-shelled crabs (a change from previous years) and as a result fishermen culled their catch at sea based on shell condition. Under these conditions the claw gauge was redundant.

Résumé

On a essayé un nouveau moyen expérimental de mesurer la taille minimale réglementaire du crabe des neiges, fondé sur la hauteur de la pince, cela pendant un an dans la zone 23 de l'est du Cap-breton. La récolte sélective de crabes à grosses pinces offre les avantages suivants : 1) hausse des débarquements due aux prises de crabes pygmées, ressource actuellement rejetée; 2) protection des crabes à petites pinces, qui continuent de croître; 3) amélioration possible du rendement par recrue; 4) plus faible incidence de crabes à carapace molle dans les prises. Quoique les pêcheurs n'aient pas été défavorables à l'utilisation de cette mesure, les forces du marché l'ont emporté sur son efficacité. En premier lieu, les avantages escomptés (1) ne se sont pas concrétisés, les acheteurs ayant dissuadé les pêcheurs de débarquer des crabes pygmées en raison de la petite taille et de la carapace souvent foncée de ces derniers. En second lieu, les acheteurs ont refusé les crabes à nouvelle carapace (contrairement aux années précédentes). Les pêcheurs ont donc procédé en mer à un tri éliminatoire fondé sur l'état de la carapace. Dans ces conditions, la mesure devenait superflue.

Introduction

Harvest strategies for snow crab began to be reassessed when evidence was presented that male snow crabs in some stocks cease molting when they develop large claws (O'Halloran 1985; Conan and Comeau 1986). Suggestion that small-clawed crabs ("morphometrically immature" in the terminology of Conan and Comeau 1986 and Jamieson et al. 1988) did not mate in nature furthered the debate. While controversy remains regarding the proof of terminal molt (Dawe et al. 1991) and the significance of claw size to reproductive success (Ennis et al. 1990), most workers would agree that it is probable that large-clawed snow crabs in Atlantic stocks molt very infrequently if at all. The argument for harvesting on the basis of claw size instead of carapace size rests on the assumption of very decreased molting frequency in large-clawed crabs.

Since the current legal measure for snow crabs is on carapace width (minimum of 95 mm), the crabs that develop large claws below this size (so-called "pygmy crabs") are not harvested, and could be deemed a wasted resource. Pygmy males could provide a reproductive buffer against overfishing of larger males, but this would be at the risk of genetic selection for smaller sizes at maturity. Another problem with a carapace based measure is that crabs with small claws (but above 95 mm) are harvested---these crabs are presumably still growing, and may not have had a chance to reproduce. Elner et al. (1988) proposed an alternative strategy for harvesting crabs based on claw size. CAFSAC (Advisory Document 88/3) gave tentative support for a claw size measure given further evidence of terminal molt and the suggestions that reproductive success were related to claw size.

The potential benefits of differential harvesting of large-clawed crabs were listed in Safran et al. (1990) as follows:

1) harvesting of pygmy males, currently a wasted resource;

2) protection of "morphometrically immature" crabs, which are still growing;

3) possible enhancement of stock fecundity;

4) possible improvement of yield per recruit;

5) lower incidence of soft shell crab in the catch.

Most of the benefits would accrue regardless of whether small-clawed males mate successfully. It is noted here that an effect opposite to (3) would result if pygmy males are currently needed to provide an adequate number of mates for the female crabs.

Safran et al. (1990) noted that a minimum chela size limit would not provide 100% separation between small- and large-clawed crabs. Complete separation would only be achieved with measurement of carapace size as well as chela size, which would be impractical as a fishery regulation. Therefore the selection of chela size for regulation purposes will be a tradeoff---the larger the gauge the lower the retention of both large small-clawed animals and small large-clawed animals.

Safran et al. (1990) recommended the use of a claw length gauge rather than a ring gauge (which measures claws height), because a ring gauge could have problems due to interference from spines. Unpublished tests (Miller and Eagles) of different claw gauges on snow crab chelae found that a ring gauge (Fig. 1) was effective at separating small- and large-clawed crabs, was easy to use, and was the most reproducible.

Elner et al. (1988) and Safran et al. (1990) recommended that the claw gauge be used on an experimental basis in the snow crab fishery of Area 23 in Cape Breton (Fig. 2). This area has long

term catch data, and supports a relatively small number of fishermen (22 active licences). A proposal to use the gauge for one season won support by fishermen at an advisory committee meeting in April of 1991. Depending upon the success of the gauge, the committee would vote on its continued use in 1992.

Assessing the effect of the claw gauge

The claw gauge could be judged successful if the following conditions were met:

1) landings increased as predicted because of the harvesting of pygmy crabs;

2) the gauge was easily used by fishermen, accepted as the legal measure and some small-clawed crabs were thus "protected";

3) there was a lower percentage of new-shelled[1] crabs in the landed catch than if a carapace width measure was used.

If there was an indication that stock fecundity was reduced because the removal of pygmy males lowered the number of available mates for females, then the claw gauge would have to be reconsidered. Criteria 1 to 3 were assessed based on port and sea samples of the catch in Area 23, and in conversations with fishermen.

To address the possibility of a change in reproductive condition as a result of the claw gauge, female crabs in Area 23 and the adjacent Area 24 were assessed for fecundity and the presence of spermatophores in the spermatheca. These data are still being analyzed and any change resulting from the claw gauge would not be expected after only one year.

Results

To assess whether the fishermen actually landed the pygmy crabs that the claw gauge allowed, the size distribution of large-clawed crabs was determined for sea samples and port samples that were obtained within 1-3 weeks of one another (Tables 1-2). If the claw gauge was used, and pygmy crabs were retained, then their proportion in sea samples should be an indicator of their proportion in the landed catch. Pygmy crabs were generally underrepresented in port samples compared to sea samples (Tables 1-2), indicating that fishermen were culling pygmy crabs from their catch. This was the result of Louisbourg crab buyers indicating they were not interested in the often very dark shells of these large-clawed crabs, particularly when they were as small as 80 mm carapace width.

Near the start of the season an inshore port sample showed that 19% of the large-clawed crabs were < 95 mm carapace width (Table 1)---this was before buyers had decided to limit their purchases of the pygmy crabs. The inshore port samples after July 23 indicate that a mean of 6% of the large-clawed crabs were pygmys, compared to 15% captured at sea. When we consider that even when the carapace gauge is used it is not unusual for 3% of the large-clawed crabs in a port sample to be pygmys (i.e. undersized crabs that are landed through error or otherwise; based on 1990 port samples), it is evident that the portion of pygmy crabs landed with the claw gauge from the inshore portion of Area 23 in 1991 was not much different than that of 1990.

---

[1] This document uses the terminology adopted by the Invertebrates and Marine Plants Subcommittee in St. John's in Nov. 1991: New , Intermediate and Old to denote relative age of the carapace, and Soft and Hard to denote shell hardness based on durometer readings (< 68 = soft). New shells would typically be soft.

A port sample on Aug. 15 of crab caught in the offshore showed that 9% of the large-clawed crabs were pygmys (Table 2). Although pygmy crabs were relatively more important in this sample, selection against pygmys may still have occurred. The offshore is a very large area (Fig. 2) and the low percentage of pygmy crabs (3%) measured during a sea sample taken on Sept. 5 (Table 2) is unlikely to be representative of the aggregation from which the Aug. 15 port sample originated.

It was possible that fishermen would land small-clawed crabs greater than 95 mm, i.e. use both the carapace measure and the claw gauge to land more crabs. To examine this possibility, the percentages of small-clawed crabs greater than 95 mm carapace width (legal under the carapace measure) in port and sea samples were compared (Tables 3 and 4). The comparison shows that small-clawed crabs were culled at sea.

The percentage of new-shelled crabs in sea and port samples are compared in Tables 5 and 6. There was clearly a lower percentage of new shelled crabs in the port samples than the sea samples, consistent with the the use of the claw gauge. However our observations at sea and our conversations with fishermen indicate that culling at sea was based more on shell condition than on claw size.

The lack of a market for pygmy crabs indicates that the gauge might be more acceptable if the ring size was increased, thus increasing the minimum size of pygmy crabs caught. It is thought that crabs of 90-95 mm would be acceptable to processors. There is an initial disadvantage of increasing the ring size: a lower retained catch, because more crabs that are legal under the carapace measure would have to be returned to the water. However most crabs returned would be immature and would grow to legal size the following year. Changes in the retained catch that would have resulted from different claw gauge diameters are given in Table 7, based on sea samples from 1987-1991. At a ring gauge diameter of 22 mm, which corresponds to a minimum carapace width of about 88 mm, initial losses of previously legal crab would be considerable (Table 7).

Discussion

Of the predicted benefits of the claw gauge, one of the more important from the perspective of fishermen was the increased landed catch due to the retention of pygmy males. This benefit did not materialize because of an apparent lack of a market for these crabs. Some pygmy crabs were landed, but since fishermen were culling a portion of them, and since they were returning small-clawed crabs with carapace widths greater than 95 mm, landed catch was somewhat less than if they had used the carapace gauge. As a result of the poor market for pygmy crabs, fishermen in Area 23 voted to discontinue the use of the claw gauge at a meeting in April of 1992.

The poor market for pygmy crabs was disappointing. At an advisory committee meeting in February of 1991, the buyer who was present indicated he would buy crabs smaller than 95 mm carapace width. When the season opened in July this same buyer was less confident about a market and fishermen were discouraged from landing pygmy crabs. This was at least partly because some of the pygmys were quite small (ca 80 mm), and many were old with dark, epibiont-covered shells. If the pygmy crabs were actively fished, it is probable that over the course of 1-2 seasons the older shelled pygmy crabs would be removed and those remaining would tend to have newer, cleaner shells.

Another market factor that reduced the effectiveness of the claw gauge was the decision of buyers in Louisbourg to not purchase new-shelled crabs (as they did in previous years) due to their lower meat yields and tendency to spoil during transport. Although our results are consistent with the claw gauge reducing the percentage of new-shelled crabs, these results appear to be fortuitous

for 1992 since our observations indicate that fishermen culled directly on the basis of shell condition, rather than on claw size. In effect, the claw gauge was redundant under these circumstances, and in general fishermen did not use the claw gauge after they learned that pygmy crabs were not desired by buyers. The absence in port samples of small-clawed males with carapace widths greater than 95 mm is probably explained by the strong tendency of small-clawed crabs to have new shells.

Should economic conditions change and a market develops for pygmy crabs, or if buyers offer to purchase new-shelled crabs, a claw gauge may again be supported by fishermen. Most fishermen realize the importance of returning new-shelled crabs to the sea, but in the past if a buyer offered to purchase them, fishermen felt pressure to retain and sell new-shelled crabs. A claw gauge provides an enforceable mechanism for decreasing the landings of new-shelled crabs. Since fishermen were neutral to positive on the ease of use of the claw gauge, future trials should have support if the conditions so warrant.

Consideration of larger diameter gauges shows the increased proportion of small-clawed crabs that would be returned to the water (Table 7). This should increase yield-per-recruit according to the model of Mohn and Elner (1988), but initially the retained catch of fishermen would be less. Two potential benefits of the claw gauge still exist: increased yield-per-recruit and a mechanism that decreases the proportion of new-shelled crabs in the landings. These benefits should be examined more rigorously if a larger claw diameter gauge were to be advocated.

Acknowledgements

R. Miller directed the study to determine the size and type of claw gauge. We thank him for his advice during the implementation of the claw gauge trial, and for reviewing this manuscript.

References

Conan, G. Y. and M. Comeau. 1986. Functional maturity and terminal molt of male snow crab, *Chionoecetes opilio*. Can. J. Fish. Aquat. Sci. 43: 1710-1719.

Dawe, E. G., D. M. Taylor, J. M. Hoenig, W. G. Warren, G. P. Ennis, R. G. Hooper, W. E. Donaldson, A. J. Paul, and J. M. Paul. 1991. A critical look at the idea of terminal molt in male snow crab (*Chionoecetes opilio*). Can. J. Fish. Aquat. Sci. 48: 2266-2275.

Elner, R. W., Semple, R. E. and E. M. Lachance. 1988. Assessment of the 1987 fishery for snow crab, *Chionoecetes opilio*, around the Atlantic Coast of Cape Breton Island. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 88/11.

Ennis, G. P., R. G. Hooper, and D. M. Taylor. 1990. Changes in the composition of snow crab (*Chionoecetes opilio*) participating in the annual breeding migration in Bonne Bay, Newfoundland. Can. J. Fish. Aquat. Sci. 47: 2242-2249.

Jamieson, G. S., R. Bailey, G. Y. Conan, R. W. Elner, W. D. McKone and D. M. Taylor. 1988. I. Workshop Report. *In*: Jamieson, G. S. and McKone W. D. (eds) Proceedings of the International Workshop on Snow Crab Biology, Dec. 8-10, 1987, Montréal, Québec. Can. MS Rep. Fish. Aquat. Sci. 2005: 163 p.

Mohn, R. K., and R. W. Elner. 1988. Consideration of snow crab yield per recruit incorporating terminal molt and a differential harvesting strategy. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 88/14. 11 p. + appendix.

O'Halloran, M. J. 1985. Moult cycle changes and the control of moult in male snow crab, *Chionoecetes opilio*. M. Sc. thesis, Dalhousie University, Halifax, Nova Scotia. 183 p.

Safran, E. B., T. P. Foyle, and R. W. Elner. 1990. Prospects for distinguishing morphometrically mature and immature crabs: an alternate management strategy for the snow crab fishery. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 90/30. 31 p.

Taylor, D. M. and W. G. Warren. 1989. The effect of shell condition on male snow crab, *Chionoecetes opilio*, weight-width relationships. p. 145-152, *In*: Proc. Int. Symp. King & Tanner Crabs, Nov. 89, Anchorage Alaska.

Table 1. Carapace size distribution of large-clawed crabs (claw >= 19.5 mm): July 26 sea sample vs port samples (Louisbourg). N large-claw is number of large-clawed crabs in sample; Total N is total number of crabs in sample. Pygmy crabs are in the first 2 size ranges. OS = sample of catch from > 20 miles offshore.

Carapace width (mm)	Sea sample July 26	Port samples			
		July 23	July 29	July 23 (OS)	July 29 (OS)
80-90	7%	6%	1%	0%	0%
90-95	7%	13%	6%	5%	3%
95-100	7%	5%	9%	9%	3%
100-110	20%	20%	25%	18%	9%
110-120	29%	31%	29%	36%	26%
> 120	30%	26%	30%	32%	59%
N large-claw	260	131	69	44	74
Total N	334	135	70	44	74

Table 2. Carapace size distribution of large-clawed crabs (claw >= 19.5 mm): late August and early September sea samples vs port samples (Louisbourg). See Table 1 caption.

Carapace width (mm)	------Sea samples----- Aug. 22	Sept 5 (OS)	------Port samples (Louisbourg)----- Aug. 13	Aug 15 (OS)	Aug 21 (OS)
80-90	7%	1%	1%	3%	0%
90-95	9%	2%	4%	6%	3%
95-100	11%	2%	8%	4%	7%
100-110	29%	10%	17%	8%	11%
110-120	24%	29%	41%	23%	26%
> 120	21%	55%	29%	56%	54%
N large-claw	123	299	133	117	74
Total N	195	313	133	118	74

Table 3. Proportion of crabs >= 95 mm carapace width with small claws: July 26 sea sample vs port samples (Louisbourg). CW = carapace width.

	Sea sample July 26	----------Port samples---------- July 23	July 29	July 23 (OS)	July 29 (OS)
Proportion small-clawed	6%	0%	2%	0%	0%
Tot N > 95 mm CW	237	106	65	42	72

Table 4. Proportion of crabs >= 95 mm carapace width with small claws: late August and early September sea samples vs port samples (Louisbourg). CW = carapace width.

	------Sea samples----- Aug. 22	Sept. 5 (OS)	----------Port samples---------- Aug. 13	Aug. 15 (OS)	Aug. 21 (OS)
Proportion small-clawed	25%	5%	0%	0%	0%
Tot N >= 95 mm CW	139	296	127	106	72

Table 5. New shelled crabs as % of total number of crabs: July sea sample vs port samples.

July 26	Sea sample July 23	Port samples July 29	July 23	July 29 (OS)	(OS)
New (Stage 1)	13%	2%	13%	7%	5%
Total N	334	135	70	44	74

Table 6. New shelled crabs as % of total number of crabs: late season sea samples vs port samples.

Shell condition	Sea samples Aug. 22	Sept. 5 (OS)	Port samples Aug. 13	Aug. 15 (OS)	Aug. 21 (OS)
New (Stage 1)	27%	5%	9%	3%	3%
Total N	195	313	133	118	74

Table 7. Effect of different claw gauge sizes on landings based on previous sea samples. Δ Wt is the percentage change in weight of the landings compared to the 95 mm carapace width gauge. Min LC is the minimum carapace width of large-claw crabs that would be retained. Max SC is the maximum carapace width of small-claw crabs that would be returned to the water. Weight of catch calculated from length frequency from sea sample; and width-weight relationship for new hard shell crabs in Taylor and Warren (1989).

Sea Sample (%)	Claw gauge size: 19.5 mm Δ Wt	Min LC	Max SC	20 mm Δ Wt	Min LC	Max SC	21 mm Δ Wt	Min LC	Max SC	22 mm Δ Wt	Min LC	Max SC
July 1991	3	83	106	1	83	112	-4	88	112	-7	90	115
Aug 1991	-11	86	109	-14	86	109	-20	87	109	-26	91	125
Sept. 1991	0	89	101	0	89	110	-2	90	110	-3	95	110
July 1990	13	83	101	13	83	101	8	84	107	-1	89	107
Aug. 1989	-9	81	112	-17	85	112	-30	86	124	-37	89	124
Aug. 1988	-2	76	106	-7	76	106	-12	76	112	-22	88	115
July 1987 OS	13	77	110	7	83	110	1	84	110	-3	84	122
July/Aug. 87	28	71	99	15	71	111	3	78	111	-13	82	111
Aug. 87	28	80	95	15	80	96	1	86	97	-11	87	100
MEAN	7	83	105	1	82	107	-6	84	110	-14	88	114

Figure 1. The claw gauge used in the Area 23 snow crab fishery during the 1991 fishing season. Crabs were kept if one claw did not fit through the 19.5 mm diameter ring (the smaller ring is to fix a small cord).

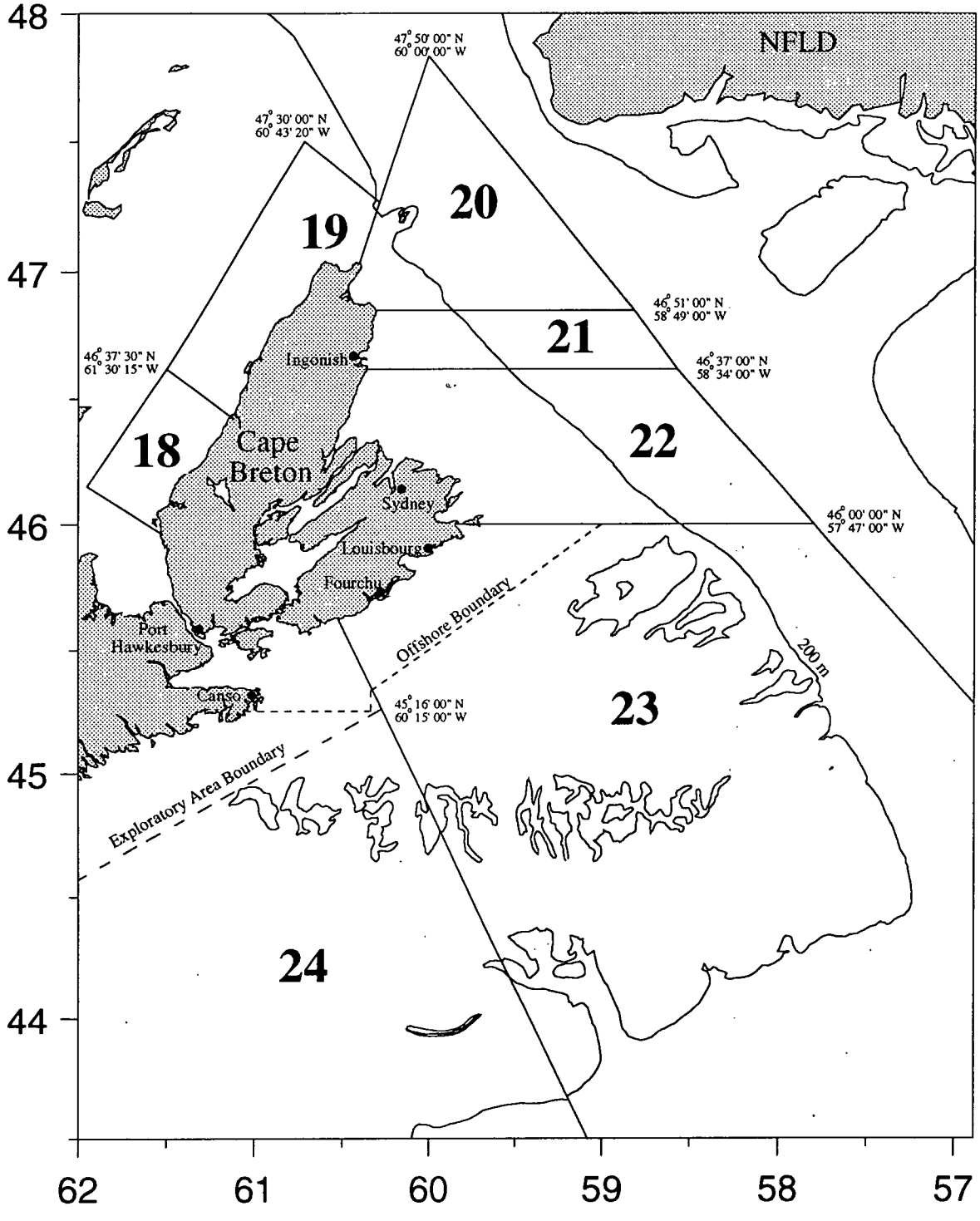

Figure 2. Snow crab areas off Cape Breton. Dashed line in Area 23 dividing inshore from offshore is used for assessment purposes only.