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Long-term Observations on Tagged Male Snow  
Crab, Chionoecetes opilio, Movements in  
Bonavista Bay, Newfoundland

by

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### Abstract

Approximately 10,000 legal-sized male snow crabs (Chionoecetes opilio) were captured, tagged and released on the commercial fishing grounds of Bonavista Bay, Newfoundland between 1979 and 1982 inclusive. The distance moved, as determined from 4255 recaptures, ranged from 0.6 to 74.1 km (mean 10.7 km, median 8.5 km). Snow crab appeared to remain within Bonavista Bay as there was no observed movement to adjacent commercial crab fishing areas over periods at liberty of up to 5 years.

### Résumé

De 1979 à 1982 inclusivement, environ 10 000 crabes des neiges (Chionoecetes opilio) mâles de taille exploitable ont été capturés, étiquetés puis relâchés dans les pêcheries commerciales de la baie Bonavista, à Terre-Neuve. Les distances parcourues, déterminées à partir des 4 255 crabes recapturés, ont varié de 0,6 km à 74,1 km (moyenne: 10,7 km, médiane: 8,5 km). Cette population de crabe des neiges ne semble pas s'éloigner de la baie Bonavista car aucune migration vers les pêcheries commerciales avoisinantes n'a été relevée au cours de la période de liberté allant jusqu'à cinq ans.

## Introduction

The snow crab, Chionoecetes opilio, fishery began in Newfoundland in 1968 and in Bonavista Bay, on the northeast coast of the Island (Fig. 1) in 1969. From 1969 to 1986 the fishery in the bay was exclusively prosecuted by 12 full time licensees utilizing vessels between 14 m and 20 m in length.

Fishermen involved in this fishery have held strong beliefs as to reasons for within-season and yearly fluctuations in abundance of snow crab, often citing such phenomena as mass inshore-offshore migrations and lunar cycles as possible explanations for dramatic shifts in catch-per-effort. Seldom have changes in effort or the effects of excessive exploitation rates within-season been considered.

Miller and O'Keefe (1981) investigated seasonal shifts in size-frequency and shell condition at given depths in a Newfoundland bay. However, there is a paucity of information regarding long-term movements of Newfoundland snow crab as determined by mark-recapture. The rationale of this study is to elucidate aspects of snow crab movement and stock structure which may be utilized on a biological basis, resulting in more realistic and pertinent advice to resource managers.

Studies of the movements of C. opilio in the Gaspé region of the Gulf of St. Lawrence by Watson (1970) and Watson and Wells (1972) have revealed that in this area snow crabs do not move extensively, averaging only 20.4 km during their time at liberty.

Tagging studies of snow crab released off Cape Breton, Nova Scotia indicated that 95% of recaptures had moved less than 20 km over periods at liberty of up to 5 years (R. W. Elnor, pers. comm., Department of Fisheries and Oceans, Halifax, Nova Scotia).

Studies on congeners, C. bairdi (Donaldson 1983) and C. tanneri (Pereyra 1966), have demonstrated similar restricted movements.

The focus of this study is concentrated on snow crab movements as determined by analysis of mark-recapture data.

## Materials and Methods

Bonavista Bay is a deep bay approximately 65 km wide and 100 km long, situated on the northeast coast of Newfoundland (Fig. 1). The commercial snow crab grounds are roughly defined by the 100 fm (183 m) depth contour and are comprised of a mud or mud/sand substrate. The snow crab fishery at the time of this study occurred from May until November annually.

Each spring, from 1979 to 1982 inclusive, tagging in Bonavista Bay began as soon as ice conditions permitted. Fishing locations were selected by means of a random design stratified by depth and were restricted to the commercial fishing grounds.

Tagging was conducted from either the CSS SHAMOOK or CSS MARINUS, steel research vessels of 27 m and 25 m LOA respectively. Trapping was carried out using Japanese-style conical traps baited with squid (Illex illecebrosus) and mackerel (Scomber scombrus) set in long-line fleets of 8-12 traps. Weather permitting, traps were hauled after a 24 h soak.

Upon hauling, crabs were carefully emptied into baskets and measured to the nearest 1.0 mm using vernier calipers. Hard-shelled, legal-sized ( $> = 95$  mm carapace width (CW)) crabs were tagged by wrapping a numbered length of No. 20 vinyl tubing (spaghetti tag), around its body between the first and second walking legs and tying the tubing in a square knot. Tagged crabs were immediately released back onto the fishing grounds. Only one trap was on deck at a time in order to minimize exposure-related mortality.

When each cruise was completed, the 12 full-time crab fishermen in the Bay were individually contacted, informed of the tagging program and its purpose, and what should be done with recaptured tags. In addition, reward posters were placed in conspicuous locations at local crab processing facilities in order to inform production workers who might encounter tags what information was required of them when returning tags.

Persons returning tags were requested to include with the tag, information which detailed as precisely as possible the date, depth, and position of recapture. To facilitate this procedure, all crab fishermen and each "first-time" person who returned tags were sent tag-return information sheets that were to be completed as accurately as possible and returned.

Prior to 1981, Bonavista Bay was divided into two management areas and the pattern of tagging illustrated in Figures 1a and 1b reflect this division. By common agreement amongst the local fishermen there was a "buffer zone" which was not fished, and no tags were released in this area during this time period. In 1981 fishermen from both management areas began to fish outside the bay and across the buffer zone resulting in tagging activities being extended over the whole bay.

Analysis of tag return data included calculation of days free and distance moved. Recapture positions provided by fishermen were either obtained by radar, Decca "A" or by dead reckoning. These positions were plotted on navigation charts in relation to release sites, and the distance moved by the crabs calculated to the nearest 0.2 of a kilometer. Direction of movement in relation to the tagging site was estimated at the same time by dividing a compass into 8 units (North, Northeast, East...) and by means of a parallel rule, simply assigning the direction that most closely fit a direct path between release and recapture positions.

In order to test the null hypothesis that tagged snow crabs move randomly in terms of direction during their time at liberty, a Chi-square test was conducted.

### Results

During the 4 cruises undertaken between 1979 and 1982, 10,118 legal-sized (95-140 mm CW; mean = 107.6 mm) male snow crab were tagged and released at 104 locations (Fig. 1). 5871 tags (58.0%) were returned between April 1979 and September 1987. 4255 (72.5%) were accompanied with sufficient information to enable a calculation of distance and direction moved and 4792 (81.6%) had data suitable for a calculation of days free. A summary of yearly releases and recaptures is provided in Table 1.

Mean distance moved by tagged crabs during the study was 10.6 km. Mean distance moved during the first year at liberty varied from 7.6-11.5 km with year tagged. Crabs tagged in 1979 and recaptured within one year moved an average of 11.5 km while those tagged in the years following moved an average of 11.1, 7.6, and 10.0 km respectively during the first year following release (Table 2). Distance moved increased only

marginally with increasing days free. The maximum distance moved was 74.1 km (Table 2), but mean distance moved by those animals tagged in 1979 for instance, was 11.5, 16.3, 10.6, 14.5, 12.4 and 7.8 km for each successive year of freedom. These data for 1979 roughly mirror the results from the other three tagging periods except for 1981 when the mean distance moved during the first two years at liberty was substantially less than for other release years (Table 2).

Results of the Chi-square test indicate that movement is non-random (Chi-square 1027.84 with 7 df,  $p < 0.001$ ), and our null hypothesis must be discounted. Overall, most crabs appeared to move away from the mouth of the bay from the time they were tagged until recapture, which generally occurred during the same fishing season.

#### Discussion

The results of this study are similar to those obtained by Watson and Wells (1972) for snow crab tagged in the Gulf of St. Lawrence. While their study only looked at movements for a period of one year, the mean distance moved of 20.3 km is approximately twice as great as the overall mean distance moved in this study of 10.6 km irrespective of the time at liberty. It is noteworthy, however, that their study area was different in that potential movement of crabs in Bonavista Bay was constrained by the configuration of the depth contours of the bay, whereas the Gulf of St. Lawrence study area provided a much larger area for potential movement. Never the less results of this study confirm that snow crab on the east coast of Canada are relatively sedentary, moving only short distances over several years.

The high tag return rate experienced in this study is consistent with the high exploitation rates found in the commercial fishery (Taylor and O'Keefe 1985). The results of this study indicate snow crab in Bonavista Bay move relatively short distances in any given year and the fact that not a single tagged crab was recovered from outside the confines of the bay confirms that the fishery is probably dependent on discreet local concentrations of crabs population for a fishing season. Therefore, the practice of managing the fishery as a discrete stock unit is probably warranted. Yearly fluctuations in abundance are likely reflections of changes in recruitment and fishing pressure. At the mouth of Bonavista Bay there is an extremely steep sill which may act as a barrier to emigration, entrapping the local crab population within the confines of a comparatively small area. Therefore, emigration out of the bay resulting in reduced commercial catch rates is not a viable explanation for within-season reductions in landings. Rather, fishermen and others concerned with the viability of this fishery should examine factors such as excessive fishing effort in attempting to explain and deal with within-season reductions in catch rates.

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Table 1. Summary of Bonavista Bay mark-recapture data, 1979-1982

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Year Sites	No. of Tagging	No. Released (%)	No. Recaptured
1979	32	3082	2108 (68.4)
1980	22	3028	1684 (55.6)
1981	22	1835	909 (49.5)
1982	28	2173	1170 (53.8)
Totals	104	10118	5871 (58.0)

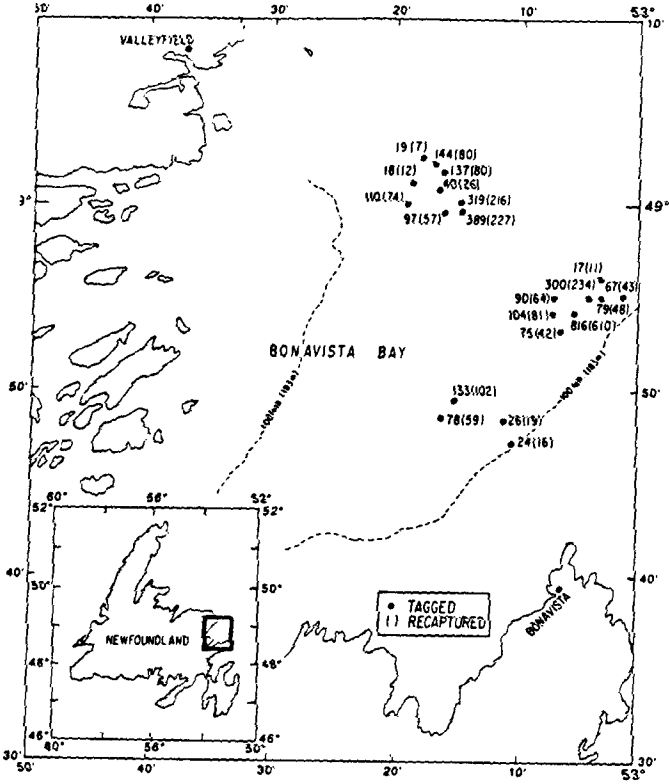
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Table 2. Summary of yearly movements of recaptured tagged male snow crab *Chionoecetes opilio*.

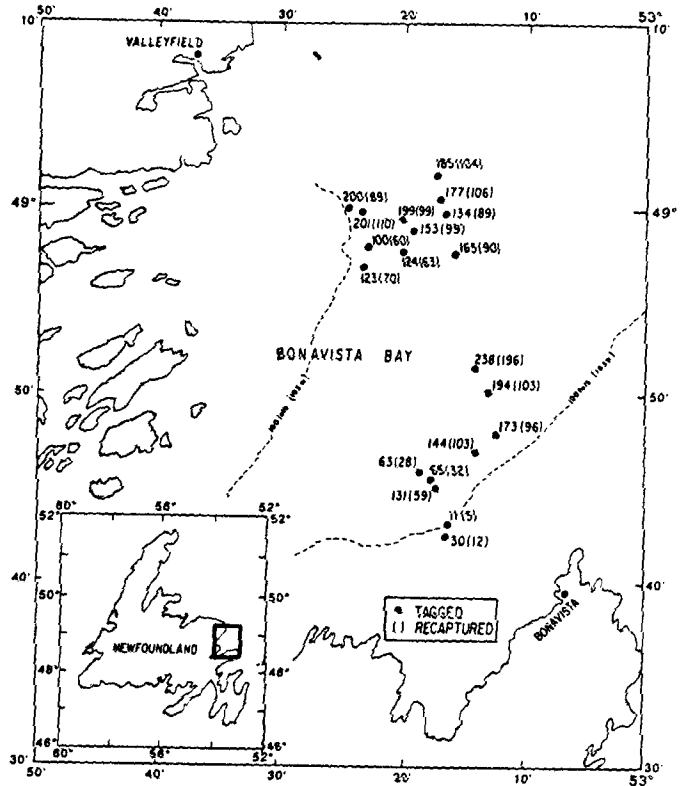
Year Released	Years at Liberty	No. Returned	$\bar{X}$ Distance Moved (km.)	Max. Dist Moved (km.)
1979	1	715	11.5	74.1
	2	96	16.3	47.3
	3	14	14.5	27.8
	4	3	12.4	16.7
	5	1	7.8	7.8
1980	1	1082	11.1	59.5
	2	81	18.3	38.4
	3	22	15.2	26.1
	4	9	16.7	30.0
	5	5	14.8	26.9
1981	1	579	7.6	29.6
	2	44	8.3	25.0
	3	42	10.4	30.4
	4	7	12.6	36.9
1982	1	535	10.0	34.8
	2	367	14.1	42.6
	3	57	9.6	25.6
	4	2	7.4	10.6



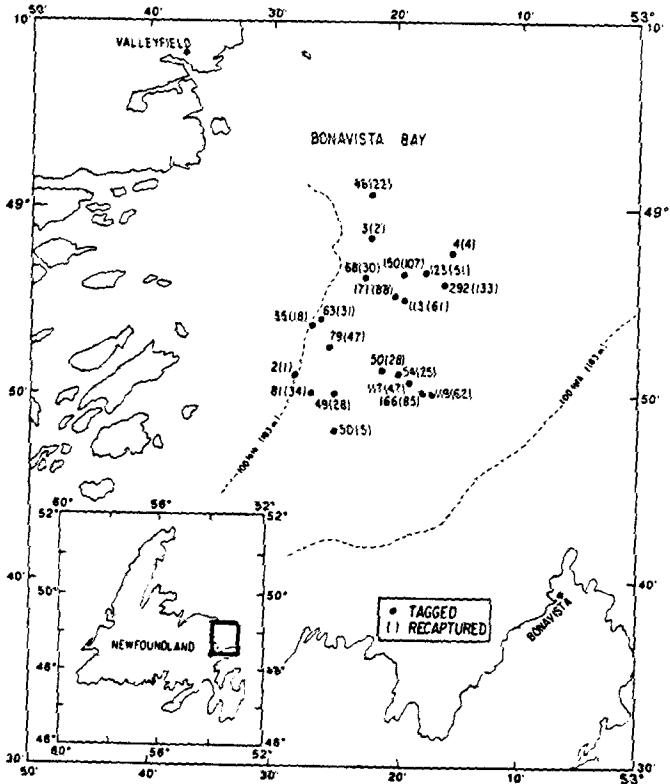
A



B



C



D

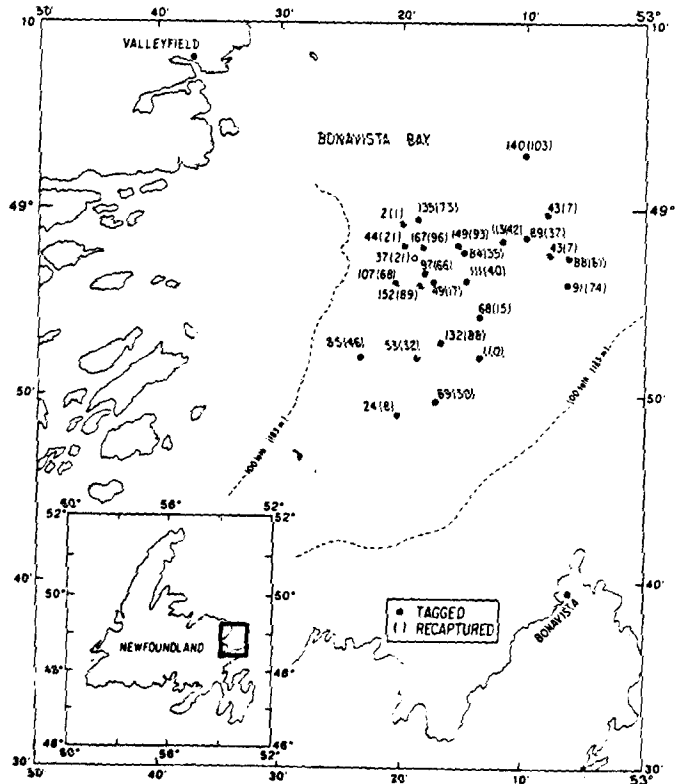


Fig. 1. Bonavista Bay tag release stations 1979-82: A - 1979; B - 1980; C - 1981; D - 1982. Bracketed numbers represent recaptured animals.