A Photographic Survey for Snow Crab (Chionoecetes opilio) in Conception Bay, Newfoundland

by

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Abstract

Estimates of snow crab, Chionoecetes opilio, density in relation to bottom depth and substrate type are provided, based on a May 7-17, 1987 photographic survey in Conception Bay. Minimum density was associated with the shallowest transect over a substrate of sand, rock and mud. Higher densities at greatest depths were associated with a substrate of uniform mud. Densities were most variable among transects over a substrate of mud and rock at intermediate depths. Dense aggregations of crabs, probably females, were evident at such intermediate depths, especially in the western outer portion of the bay. Problems to be resolved for future photographic surveys are discussed.

Résumé

On présente des évaluations de la densité du crabe des neiges, Chionoecetes opilio, en foncton de la profondeur des fonds marins et du type de substrat. Les évaluations sont fondées sur un relevé photographique réalisé dans la baie Conception entre le 7 et le 17 mai 1987. La densité minimale a été observée dans les eaux les moins profondes où le fond est constitué d'un substrat sablonneux, rocailleux et vaseux. Les densités les plus grandes, observées dans les eaux les plus profondes, ont été reliées à un substrat vaseux uniforme. C'est dans le eaux de profondeur intermédiaire recouvrant un substrat rocailleux et vaseux que les densités étaient les plus variables. Des aggrégations denses de crabes, probablement des femelles, ont été aperçues à ces profondeurs intermédiaires, surtout dans la partie occidentale (extérieure) de la baie. On expose également certaines difficultés qu'il faudra résoudre avant d'entreprendre les prochains relevés photographiques.

Introduction

For most Canadian Atlantic snow crab stocks there is a need for accurate *a priori* assessments of annual recruitment and biomass. Stocks respond differently to heavy exploitation rates, apparently due to differences in levels of annual production. *A posteriori* methods currently used, such as Leslie analysis and catch rate comparisons, have no predictive capability since they do not account for variable growth and recruitment. Furthermore, Leslie analysis is inappropriate for certain stocks for a variety of reasons (CAFSAC 1987).

Bottom photography, although a slow process, appears to be the most reliable method for obtaining estimates of crab density to be used in assessing biomass (Miller 1975, Melville-Smith 1985). This paper describes a photographic survey carried out in Conception Bay, Newfoundland to assess the feasibility of estimating snow crab biomass using such techniques. Preliminary estimates of crab density are provided in relation to depth and substrate-type.

Methods and Materials

The photographic survey was carried out in Conception Bay, Newfoundland (Fig. 1) during May 7-17, 1987. A remotely operated underwater vehicle, the 'Ocean Surveyor', was towed by the 25 m research vessel MARINUS at 2.5 knots. Paired stereo images were obtained using a Photosea 2000 stereo camera mounted on the vehicle with lens axis perpendicular to bottom. The camera used flash lighting and Ektachrome 200 ASA color transparency film.

The Ocean Surveyor was flown at target altitudes of 2 m and 3 m above bottom. It was controlled by using a forward-facing Osprey SIT underwater television camera and television monitors. In total, 21 dives (transects) were executed (Fig. 1). Since the vehicle's depth sensor was not functional, depth records were obtainable only from the vessel's sounder. Therefore transects were placed in areas of relatively uniform depth.

The camera had a bulk film loader, such that a maximum of 100 pairs of exposures was possible on each transect. Exposures were taken at 30 sec intervals along each transect. Those which were poorly illuminated were discarded. The area photographed by each pair of exposures was calculated using the following equation derived for the camera:

$$Y = 0.5881049X^2$$

where Y is the area photographed and X is the altitude or distance of the lens from the subject (both in meters). While examining exposures for snow crab, qualitative observations were recorded regarding type of substrate encountered. Transects were classified as belonging to one of three substrate types: 1) sand, rock and mud, 2) mud and rock, and 3) uniform mud. Further details regarding data collected are provided in Table 1.

Results and Discussion

A summary of depth range, area photographed, substrate type and crab density is provided in Table 1 for each transect and for the survey overall. During the survey bottom depth ranged 64-271 m, 462 snow crabs were photographed in 4535 m^2 of bottom, for an overall density of 54.45 crabs/500 m^2.

Substrate types encountered generally comprised mostly mud with rock at intermediate depths (86-192 m) and uniform mud at greatest depths (Table 1, Fig. 2). The shallowest transect (64-96 m) was over a substrate of sand, rock, and mud, and was associated with the lowest crab density, 7.30 crabs/500 m^2 (Fig. 2). Density was quite variable among transects over substrates of mud with rock, ranging 16.30-359.10 crabs/500 m^2. Maximum crab densities for the entire survey were associated with this substrate type. Six transects were associated with densities exceeding 50 crabs/500 m^2, within a depth range of 112-192 m. At greatest depths (157-271 m) on mud substrates densities were generally lower than at intermediate depths, ranging 10.65-34.25 crabs/500 m^2.

Although crab size estimates are not yet available it was apparent in examining exposures that specimens on mud substrates at greatest depths were generally larger than those on rock and mud substrates at intermediate depths. Similarly Miller and O'Keefe (1981) found that for crabs sampled in Conception Bay in 1978 and 1979, using pots with 11.5 cm stretched mesh netting mean size increased with depth. Commercial fishing in Conception Bay is generally at depths greater than 180 m. Since large males may be concentrated at greater depths, density may be underestimated for those transects at greatest depths over mud substrates. On the television monitor crabs were occasionally seen moving rapidly away from the path of the vehicle, presumably having been startled by the light source for the television camera. Miller (1975) reported that crabs larger than 80 mm carapace width (CW) attempted to escape from the path of a submersible, whereas smaller crabs did not. It is also possible that some crabs may not have been detected if they were buried in the soft mud. However in both this study and that of Miller (1975) all partially buried crabs were easily detected as the top of the carapace and legs were exposed. The maximum density for all crabs on mud substrate in this study (34.25 crabs/500 m^2) was higher than the maximum reported by Miller (1975) for males greater than 70 mm CW (20 crabs/500 m^2). Higher values for this study are related to the inclusion of females and males less than 70 mm CW. Concurrent sampling during the survey using small mesh pots (40 mm stretched mesh) showed that at depths greater than 183 m, 6% of specimens caught were males less than 70 mm and 30% were females.

The highly variable density estimates for transects on mud-rock substrates at intermediate depths indicate that aggregations of crabs exist in that habitat. Maximum density for that substrate type (359.10 crabs/500 m^2) was similar to the maximum reported by Miller (1975) for 40-69 mm CW crabs (330 crabs/500 m^2). From trawl sampling he found that aggregation to be females, as might be the case for those transects of unusually high density in this study. The location of those transects with densities exceeding 50 crabs/500 m^2 (Fig. 3) shows that five of the six transects were within a common area in the western outer portion of the bay. However, the level of

sampling was inadequate for delineating the area occupied by the apparent aggregation of crabs in that region of the bay.

Two pairs of exposures showed a male and female in copulatory embrace. The two mating pairs were photographed on mud substrate at about 256 m, close to the maximum depth of Conception Bay. These photographs represent the first reported observations of mating pairs at such great depths and in commercial fishing areas.

In future surveys, forward-directed lighting should be avoided, as it may trigger an avoidance reaction for larger crabs causing them to escape. A vehicle which uses sonar to automatically maintain constant altitude might be more suitable than relying on an underwater television camera. Photographic transects should be compared between day and night. It appears that crabs which are buried or partially buried during the day emerge and become more active at night (Powles 1968). If, as it appears, dense aggregations of crabs exist on mud-rock substrates at intermediate depths, then future sampling should be particularly intensive within the 100-200 m depth range in Conception Bay. To estimate population size or biomass concurrent sampling with trawls is essential to predict, from mouthpart-staging techniques, the proportion of immediate prerecruits (75-94 mm CW) which would moult and recruit to the fishery during the current fishing year.

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Table 1. Summary of data collected from a May 7-17, 1987 photographic survey in Conception Bay, with calculation of crab density.

Transect	Depth range (m)	Altitude (m) $\bar{x}$	Altitude (m) Range	No. exposures	Bottom type[1]	No. snow crab	Area photographed (m^2)	Density (no. crabs/ $500m^2$)
A3	181-232	3.00	2.70-3.60	79	M	10	418.14	11.95
A7	124-141	2.90	1.50-3.50	62	MR	10	306.65	16.30
A8	64-96	2.04	1.50-3.20	84	SRM	3	205.59	7.30
C2	212-271	3.02	2.80-3.40	76	M	9	407.65	11.05
C3	174-260	2.04	1.00-2.70	88	M	10	215.38	23.20
C4	86-121	2.08	1.50-4.20	87	MR	8	221.36	18.05
C5	130-254	2.00	1.40-3.40	91	MR	13	214.07	30.35
C6	260-269	1.97	1.20-2.30	92	M	14	209.98	33.35
C7	161-256	1.99	1.70-2.30	96	M	9	223.58	20.15
C8	220-229	1.99	1.20-2.50	69	M	11	160.70	34.25
C9	157-166	1.96	1.70-3.00	77	MR	24	173.97	69.00
E1	121-154	2.09	1.30-4.00	77	MR	39	197.81	98.60
E2	186-192	2.01	0.80-2.70	86	MR	24	204.34	58.75
E3	172-179	1.92	1.10-2.30	85	MR	59	184.28	160.10
E4	198-205	1.93	0.80-4.40	83	M	5	181.82	13.75
E5	129-140	1.98	1.30-2.30	93	MR	154	214.42	359.10
E6	234-241	1.95	1.80-2.20	42	M	2	93.92	10.65
E7	99-126	2.03	1.30-4.30	80	MR	12	193.88	30.95
E8	139-150	1.93	1.10-2.40	81	MR	12	177.44	33.80
E9	157-179	2.04	1.20-3.40	67	M	6	163.98	18.30
F1	112-135	2.07	1.80-4.00	66	MR	28	166.32	84.20
Overall	64-271	-	0.80-4.40	1,661	-	462	4535.28	54.45

[1] S - sand, R - rock, M - mud

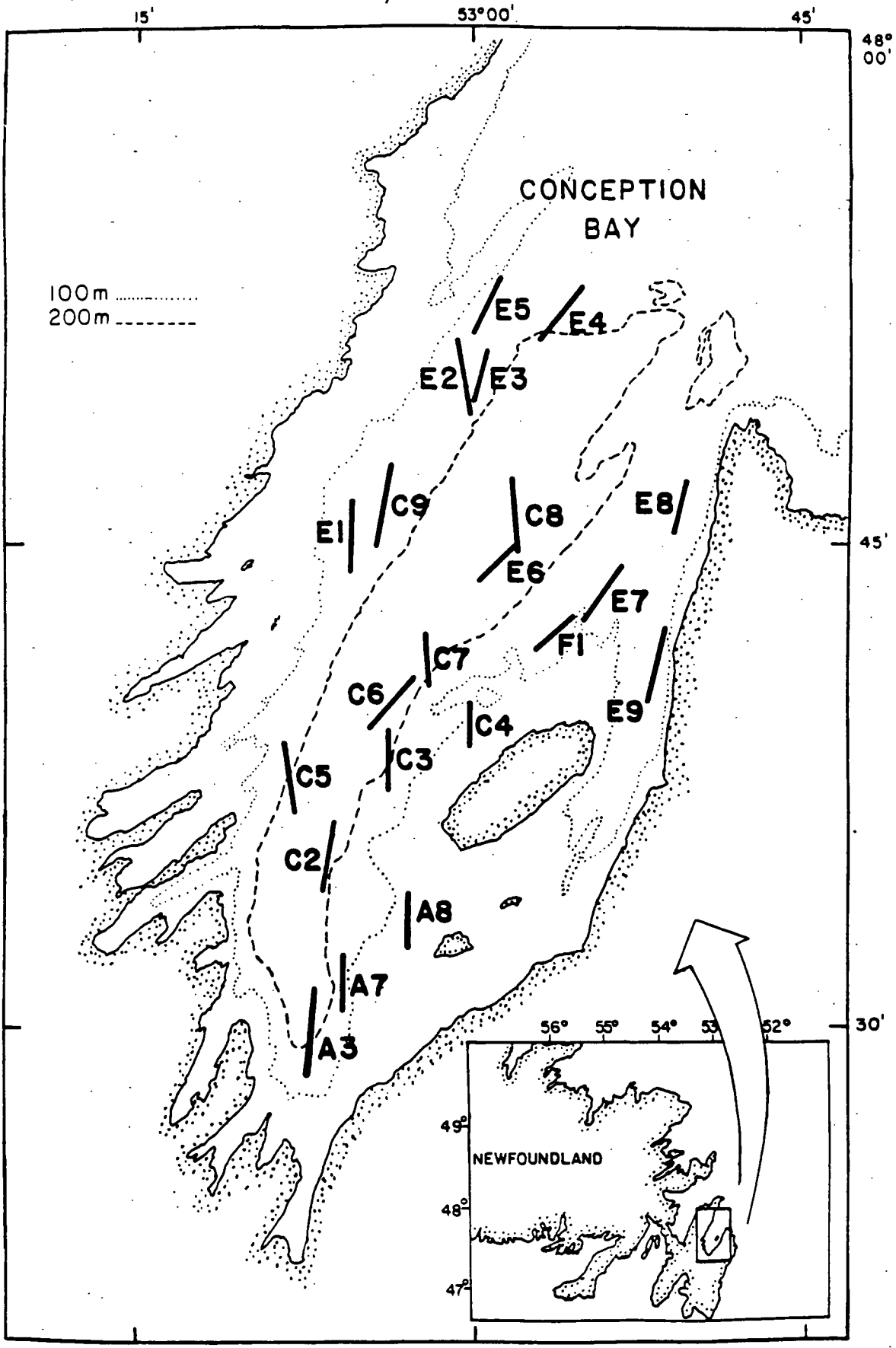

Fig. 1. Location map showing transects occupied during a May 7-17, 1987 photographic survey in Conception Bay, Newfoundland.

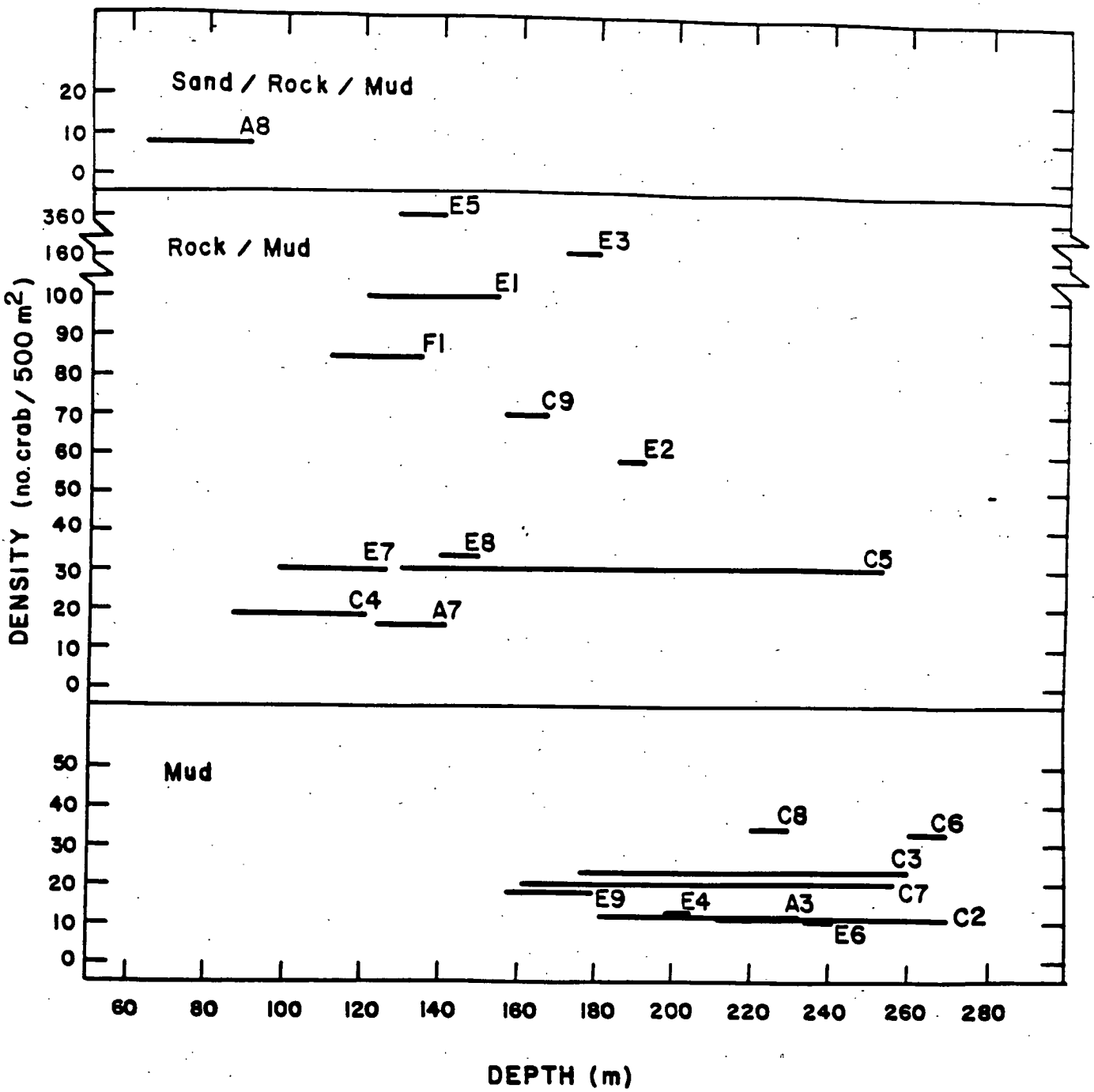

Fig. 2. Snow crab density estimates in relation to substrate-type and depth range for all transects occupied during the photographic survey.

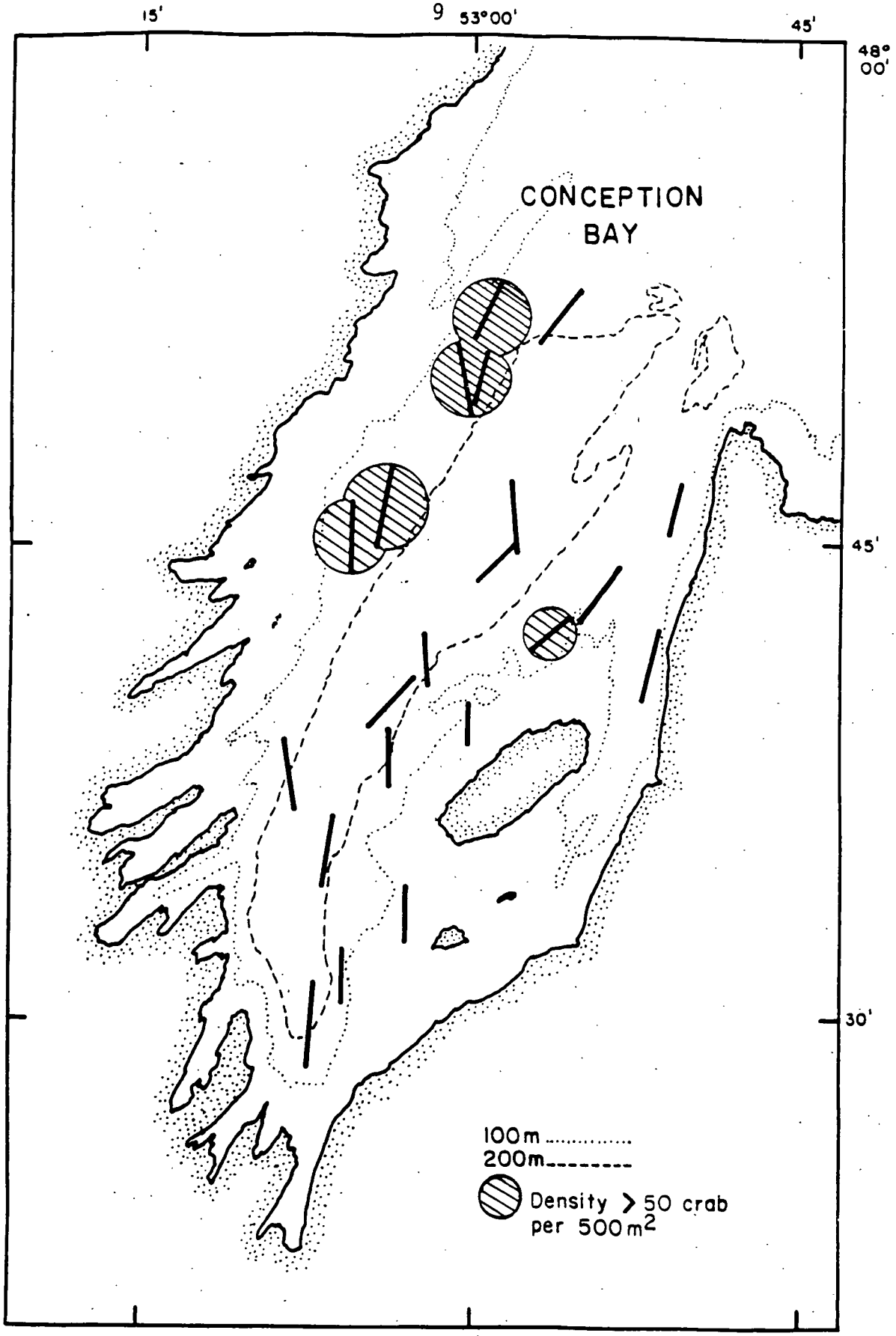

Fig. 3. Location of transects of greatest snow crab density (cross-hatched) within Conception Bay.