SEA SCALLOP FISHING IMPACT ON AMERICAN LOBSTERS IN THE GULF OF ST. LAWRENCE

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ABSTRACT

Damage to American lobsters, *Homarus americanus*, in Egmont Bay and off Miminegash, Price Edward Island, is minimal from the drags of the seasonal sea scallop, *Placopecten magellanicus*, fishery. During May 1981, when commercial sea scallop fishing was occurring, American lobster abundance was low in areas of profitable scallop exploitation. Sea bed substrate in these areas was generally smooth and most lobsters were able to avoid the gear. In the areas with and without commercial scallop fishing, 1.3% and 11.7% of observed lobsters, respectively, were injured or retained by the drag. Lobster abundance in the areas commercially exploited for scallops in May and June was significantly greater in July than in May, but whether this was a result of a natural seasonal movement of lobsters or the cessation of scallop fishing is unclear.

Sea scallop, *Placopecten magellanicus*, and American lobster, *Homarus americanus*, populations are fully exploited in Northumberland Strait, Gulf of St. Lawrence (Wilder 1947, 1965; Robinson 1979; Jamieson et al. 1981c; Campbell and Mohn 1983). Individual fishermen frequently fish both species, commonly in the same general area, although the fisheries are separated temporally (Jamieson et al. 1981c; Conan and Maynard 1983). Recently, localized low abundance of these important, commercial species has heightened long-held convictions by fishermen of the negative impact of sea scallop fishing on American lobster stocks. Fishermen's concern became acute for the Egmont Bay area during 1980, coincident with the discovery and exploitation of new nearshore scallop concentrations near West Point, Prince Edward Island (Fig. 1). Decreased scallop recruitment in recent years (Jamieson et al. 1981b, c) has resulted in a scarcity of scallops in traditional fishing areas, causing increased exploration for commercially exploitable scallop concentrations.

The magnitude of scallop gear-lobster interaction is dependent on the spatial and seasonal distributions of scallops and lobsters and the impact of scallop gear on commercial lobster abundance where the distributions of both species overlap. Scallops are widespread in Northumberland Strait (Caddy et al. 1977), but commercial concentrations are found only in limited areas. The precise locations of these areas are undocumented, and since they vary with time, they cannot be predicted with any accuracy. However, commercial log data has shown the broad distribution of scallop concentrations in Northumberland Strait during 1979-80 (Jamieson et al. 1981b, c).

The seasonal abundance and distribution of commercial-sized lobsters is largely unknown, but their general distribution overlaps that of scallops (Stasko et al. 1977; Conan and Maynard 1983). There have been few field studies conducted on lobsters in this area: Templemann (1933, 1934, 1935, 1936) reported on lobsters and the fishery in Northumberland Strait; Wilder (1963) and Wilder and Murray (1956) reported on movements and growth of tagged lobsters liberated in Egmont Bay.

Scallop and Irish moss, *Chondrus crispus*, drags can damage lobsters, although lobsters exposed on open ground tended to avoid moving drags. Most gear-induced damage has resulted from lobsters in burrows being hit or crushed by rocks disturbed by the drag (Scarratt 1973, 1975; Pringle and Jones 1980).

Investigations reported here document 1) the scallop drag/lobster interactions off Miminegash, Prince Edward Island, during August 1978 and in Egmont Bay during May and July 1981; and 2) the relative abundance and movement of lobsters trapped and tagged in Egmont Bay prior to (June-July 1981) and during the lobster fishing season (10 August-10 October 1981). Lobster abundance may change relatively rapidly because of their potential high mobility. Therefore it is important to characterize lobster microdistribution and assess the con-

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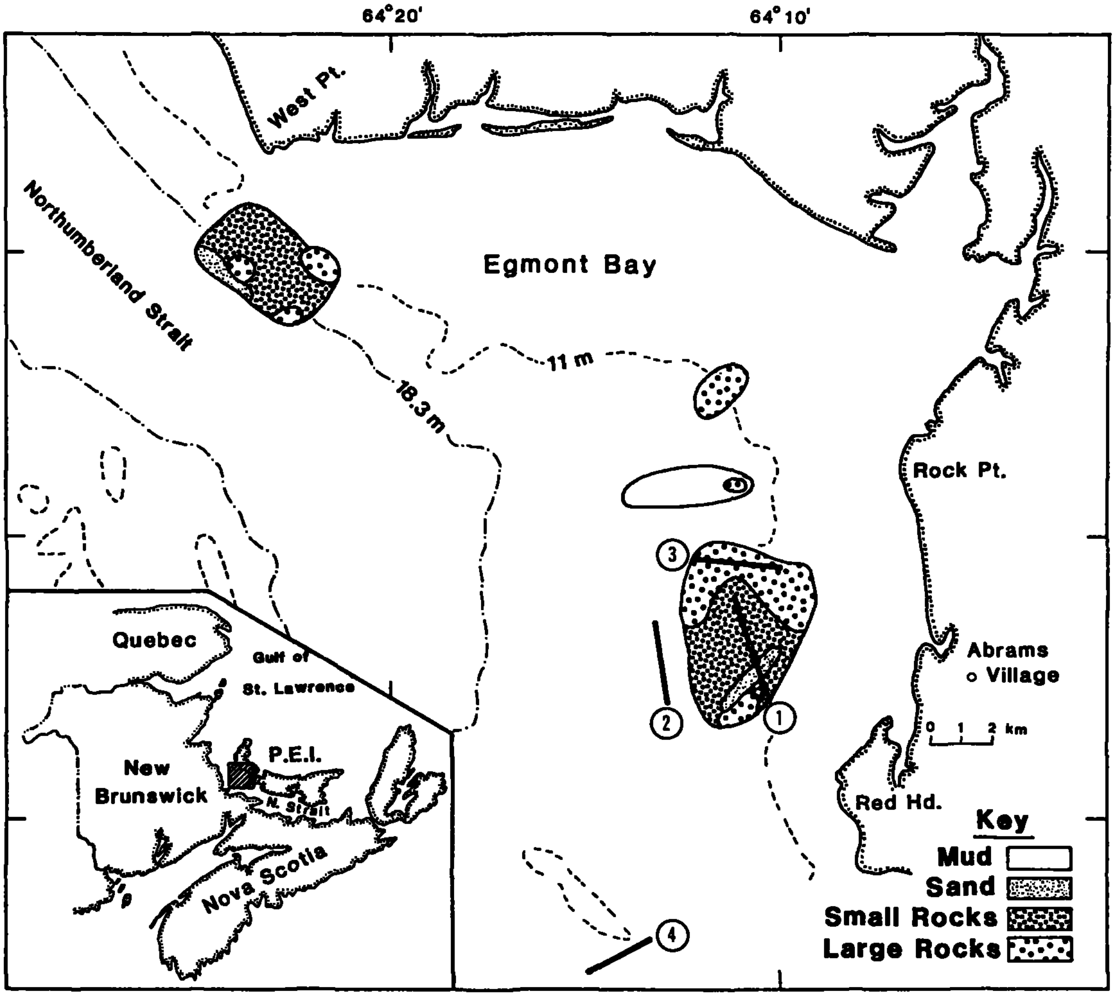

FIGURE 1.—General substrate type as observed by divers in the areas surveyed in Egmont Bay, Northumberland Strait, Gulf of St. Lawrence. Locations of stations (heavy lines) sampled for lobsters in Egmont Bay, Northumberland Strait: 1 = recently heavily fished scallop ground, 2 = recently lightly fished scallop ground, 3 = no recent scallop fishing (large rocks), 4 = no scallop fishing (deeper water).

sequences of scallop fishing on the degree of species overlap. Scallop fishing may directly damage lobsters, or because of the disturbance of the sea bed by the drags, may cause lobsters to avoid or be attracted to the overall area.

METHODS

Scallop Gear-Lobster Interactions

1978 Study

The interaction between three types of scallop gear and lobsters was observed by divers between 15 and 30 August 1978. The study area was in 14 m of water about 1 km from shore (long. 46°52′30″W, lat. 64°14′00″N), and consisted of a sandy bottom with occasional small rocks. The gear used was a two-gang, toothed Gulf rock drag (60 cm buckets) (Fig. 2); a two-gang Digby rock drag (76 cm buckets, no teeth) (MacPhail 1954); and a 152 cm Gulf sweep chain drag. A Gulf sweep chain drag is a smaller, lighter revision of an offshore scallop drag (Bourne 1964). A hood of 38 mm stretch mesh was placed over the drags extending to a height of 81 m above the sea bottom, and one of the buckets (half the chain sweep drag) had a similar mesh hood on the outside of the back of the drag (back cover). The bucket, or portion of the drag, without a back cover had a mesh liner. Two divers hung onto each drag during tows,

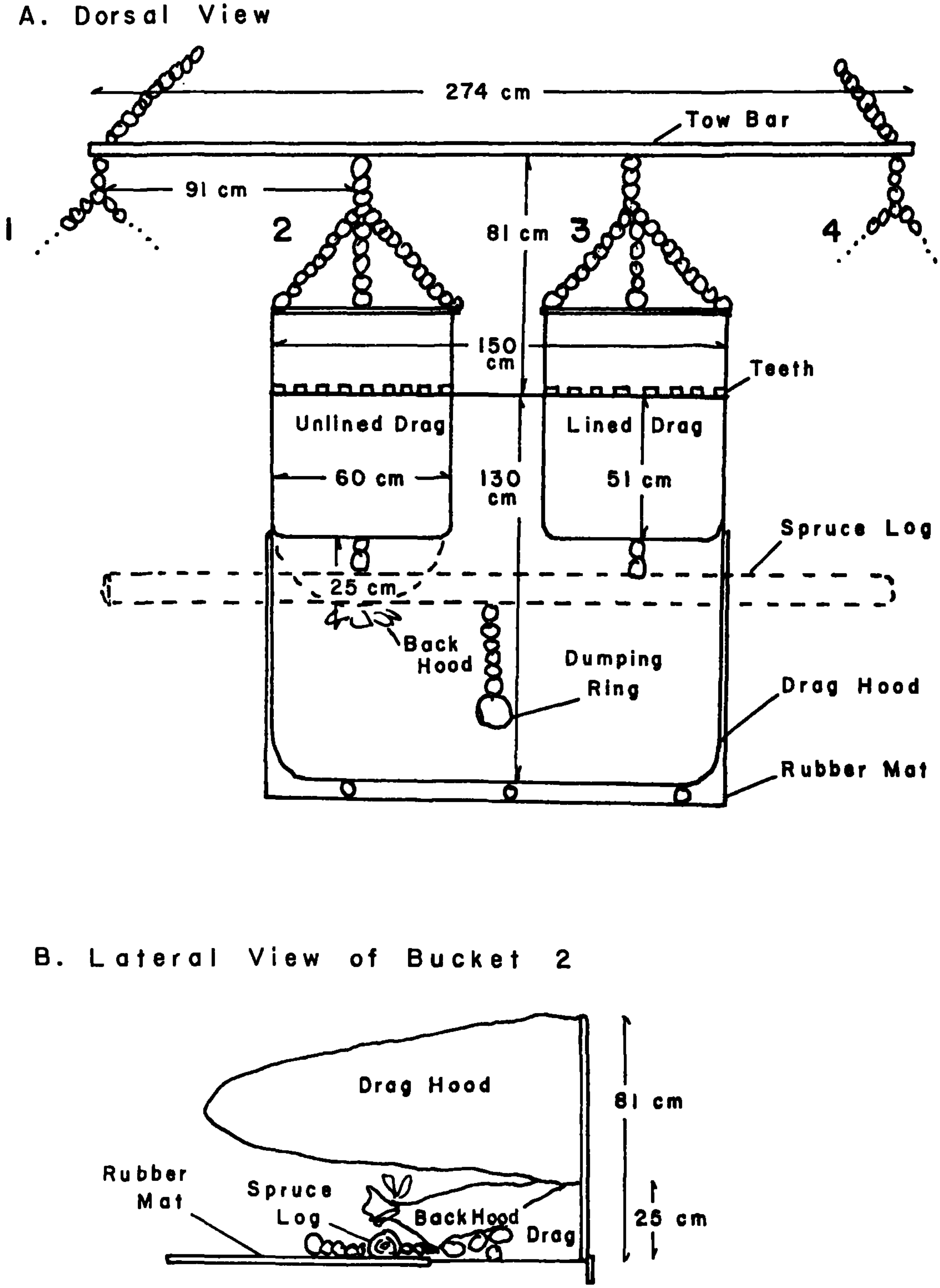

FIGURE 2.—Schematic drawings of a four-gang Gulf rock drag: (A) hood and liner arrangements used with buckets 2 and 3 in 1978 (buckets 1 and 4 were removed). In 1981, 4 unmodified buckets were used. (B) Lateral view of bucket 2 used in 1978.

noting lobster behavior and the physical effect of the drag on lobsters; carapace lengths (CL, back of eye socket to posterior carapace margin) of fished lobsters were measured. Tow velocities, established by engine rpm, were similar to commercial operations and tow duration was 5 min.

1981 Study

Dragging was conducted during 14-22 May and 27-31 July 1981. Four general areas (Fig. 3) were surveyed in both periods. Scallops and lobsters were known by fishermen to exist in areas A and A′ but scallop fishing had not occurred for several years; five research tows were conducted in May and three tows in July. Areas B and C were reported by fishermen to be prime lobster ground where scallop fishing had occurred recently or was in progress during the study; 30 research tows were conducted in May and 25 tows in July. Tow locations were randomized within an area and the number per area was arbitrarily assigned according to the apparent distribution of commercial effort in the scallop fishery. Bottom water temperatures averaged 8.8° and 18.4°C in May and July, respectively. A four-gang Gulf rock drag (Fig. 2) with 51 cm buckets was used throughout the study. Scallop rings had 69-75 mm and 80-84 mm inside and outside diameters, respectively. Lead ropes 30 m long were attached to each end of the 2.36 m club stick at the back of the drag to define an area behind the drag to be surveyed by divers. Before the drag was dropped, the lines were let out while the vessel was steaming or drifting to establish an unfished control area for survey

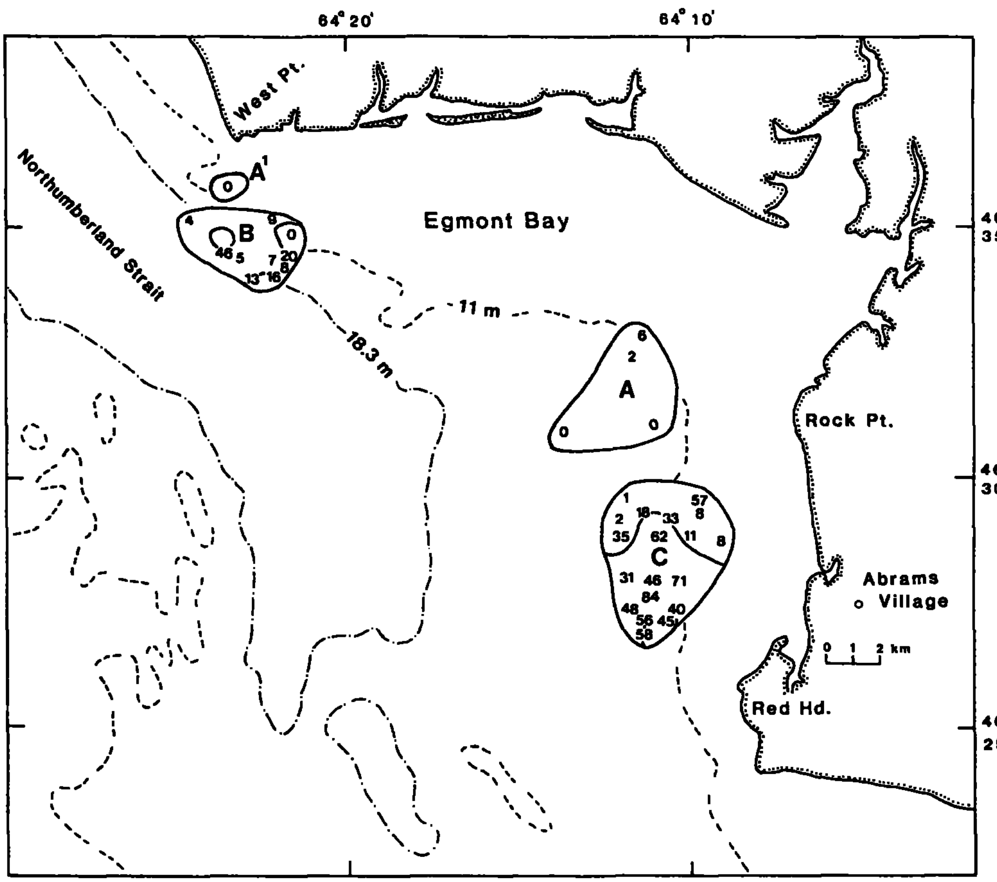

FIGURE 3.—Number of scallops fished/tow (average length = 975 m) by the gear in May in Egmont Bay, Northumberland Strait, Gulf of St. Lawrence. Identified areas are where both scallops and lobsters exist in commercial densities: A and A′ were areas where no scallop fishing had occurred for several years (= unfished control); B and C were areas where scallop fishing had recently occurred or was in progress during the study. Substrate type is shown in Figure 1.

by the divers when the drag was finally lowered. When the drag was on the bottom, divers swam along the outside edge of each lead line with a 2 m rod, noting all scallops and lobsters encountered in the 2 m wide unfished "path" (120 m^2). The divers then positioned themselves on the drag and noted the number of lobsters in the drag path during the tow, which covered on average 975 m (SD = 221). When the tow terminated, the divers searched the drag path between the lead lines (70.8 m^2) and collected the scallops and lobsters encountered. Scallop height (edge of hinge to distal edge of the valves) and lobster carapace lengths were measured to the nearest millimeter with a measuring board and vernier calipers, respectively. Location (loran C readings), bottom type (Fig. 1), water temperature, and marine plant presence were noted. Tow distance and speed were calculated from loran C readings (Jamieson 1982) and averaged 4.6 kn (SD = 1.9) in May and 4.3 kn (SD = 1.7) in July. Average tow duration was 6.9 min.

Lobster Abundance and Distribution

Four study areas (Table 1; Fig. 1) were located by loran C and were selected after bottom types were characterized from scuba diving observations. The areas were 1) recently heavily fished scallop ground, 2) recently lightly fished scallop ground, 3) ground with large rocks with no recent scallop fishing, and 4) typical lobster ground in waters deeper than areas 1-3 with no scallop fishing. Fifty, three bow, single kitchen and parlor design lobster traps with 121 mm diameter entrance ring and 31-34 mm lath spaces were set in each area. Each trap was baited with salted gaspereau (or alewife), *Alosa pseudoharengus*, and/or Atlantic herring, *Clupea harengus harengus*. The traps were set in groups, two traps per buoy, within a 1 km radius of the center of the area (Table 1). The mean interval between trap hauls from 22 June to 30 July was 3 d (1-7 d range). Each trap was reset as close as possible to the original site of each trap set.

The sex and carapace length (CL in mm) of each trapped lobster was recorded. Once a week, the terminal quarter of a pleopod endopodite was removed with scissors from each of 70-140 lobsters of various size groups, and placed in a vial containing seawater. The pleopod method described by Aiken (1973) was used to determine the molt stage of each lobster.

The bottom and surface water temperatures were recorded for each area and time fished. To observe lobster movement and growth, a total of 2,002 lobsters (ca. 500 lobsters/area) were measured and tagged (Table 1) with a sphyrion tag (Scarratt and Elson 1965) and returned to the water within 10 min and 0.5 km of the capture site. During the 10 August-10 October fishing season, lobster samples were obtained at-sea from commercial lobster fishing boats at a number of locations within and near areas 1-4.

One-way analysis of variance was used to compare the mean number of lobsters per trap haul in each area during a 1-wk sampling period and to compare the mean distance moved for lobsters from the different study areas.

From tagged lobsters recaught during the study, movement and direction statistics of tagged lobsters were analyzed by methods Jones (1959) and Saila

TABLE 1.—Summary of Egmont Bay lobster tagging experiment, 22 June-30 July 1981.

Details	Area 1 Heavily fished scallop ground	Area 2 Lightly fished scallop ground	Area 3 Scallop ground with rocks[1]	Area 4 Lobster ground[1]
Location				
Latitude (°N)	46°28′	46°27′	46°28′	46°23′
Longitude (°W)	64°10′	64°13′	64°12′	64°15′
Bottom type	mud, small rock (<10 cm)	mud, small rock (<10 cm)	mud, rocks (>10 cm)	mud, rocks (>10 cm)
Mean depth (m)	11	13	11	18
No. of traps	50	50	50	50
Trap soak-over (days) (range)	2-5	1-7	2-5	1-5
No. of trap hauls	489	568	500	591
No. of lobsters caught	2,507	1,967	2,568	2,330
Total tags released	500	501	500	501
Total tags returned[2]	182	162	234	162
% of total tags released in area[2]	36.4	32.3	46.8	32.3

[1]No scallop fishing.
[2]Number of tags returned up to 30 October 1981 including tags without recapture locations.

and Flowers (1968) have reported, using a computer program by Campbell et al. (1983).

RESULTS

Scallop Gear-Lobster Interactions

1978 Study

No scallops were present but lobsters were numerous and were observed by divers to be frequently foraging in the open. Average carapace length of 22 diver-collected lobsters was 61.3 mm (SD = 26.8). While the microdistribution of substrate type was patchy, tows were of sufficient duration to cover all substrate types. Under the assumption of an average uniform lobster density during tows, lobster catches made by the Gulf sweep-chain drag over sand and rock-sand were highest. Average catches in the lined and unlined portion of the drag were 0.53 and 0.07 lobsters/m of drag width fished per min ($m^{-1}min^{-1}$), respectively (Table 2).

No lobsters were retained by the unlined rock drags, but since they were retained in the back cover of the drag, lobsters were entering the drag and passing through the rings. These lobsters did not show any external evidence of damage. The hoods of all three drag types contained lobsters, indicating that lobsters can escape by swimming over the advancing drag.

TABLE 2.—Average number of lobsters caught $m^{-1}min^{-1}$ of drag width in the hoods and linings of the scallop gear used in 1978. Each drag type was hauled over both sand and sand-rock substrates off Miminegash, Prince Edward Island. L = lined gear; UL = unlined gear; H = hood; B = back cover.

Drag type	No. tows	Lobster catch L	UL	H	B
Gulf sweep chain	5	0.53	0.07	0.15	0.31
Gulf rock drag	5	0.11	0.00	0.06	0.11
Digby rock drag	6	0.02	0.00	0.07	0.04

1981 Study

RELATIVE SCALLOP AND LOBSTER ABUNDANCE.—Catch results and sightings per tow (Jamieson et al. 1981a) indicated that for each study area, considerable variation existed in abundance of both scallops (Fig. 3) and lobsters (Fig. 4). Substrate type was variable over the distance of a single tow, and this appeared to be a major factor influencing relative scallop and lobster abundance.

Scallop and lobster densities in the two areas (B and C) fished for scallops varied significantly on some dates (Table 3) from those densities in the nonfished areas (A and A[1]); fished grounds had a greater number of scallops, but fewer lobsters, than did the nonfished ground. Between the two fished areas, the only significant (P < 0.05) difference was in the scallop drag catch in May, but study area C off Red Head generally yielded more of both species than did study area B off West Point (Figs. 3, 4).

There were no significant differences (P > 0.05) in the densities of either scallop or lobster in the nonfished area between the two sampling periods. Lobster sightings per tow in both fished areas were significantly greater (P < 0.05) in July than in May, but the number of sightings averaged less than in the unfished area. Although not always significant, the general seasonal trend of lobster abundance, as indicated by the control sampling procedures, increased between May and July in all areas. Scallop catch decreased significantly (P < 0.01) in the ground off Red Head between May and July. On fished ground, average scallop density decreased whereas scallop density on the nonfished ground increased during this time period.

TABLE 3.—Average scallop and lobster catch in a 4-gang Gulf rock drag in 1981, and the abundance per 1,000 m^2 in each study area before the scallop drag was towed (control) and in the drag path behind the drag. Values with asterisks are significantly different from the corresponding value in the nonfished scallop location. * = P < 0.05; ** = P < 0.01; n = number of tows.

Location	Month	Control density n	Scallop	n	Lobster	Drag n	No. scallop caught	n	No. lobsters observed	Drag path n	Scallop	n	Lobster
Nonfished area	May	4	6.25	4	2.08	5	0.87	4	3.03	2	0.0	2	0.00
	July	2	12.50	2	16.67	3	0.15	3	4.62	3	4.71	3	4.71
West Point	May	4	56.23	4	0.00	11	7.59*	11	0.48	8	24.70*	8	1.76
	July	3	22.21	3	2.78*	7	10.10	7	1.48*	5	127.08	5	5.65
Red Head	May	9	99.03**	9	0.93	19	16.38**	19	0.87	12	68.25**	12	1.18
	July	9	58.31	9	5.55	18	8.34**	18	1.98*	10	52.24	10	1.41

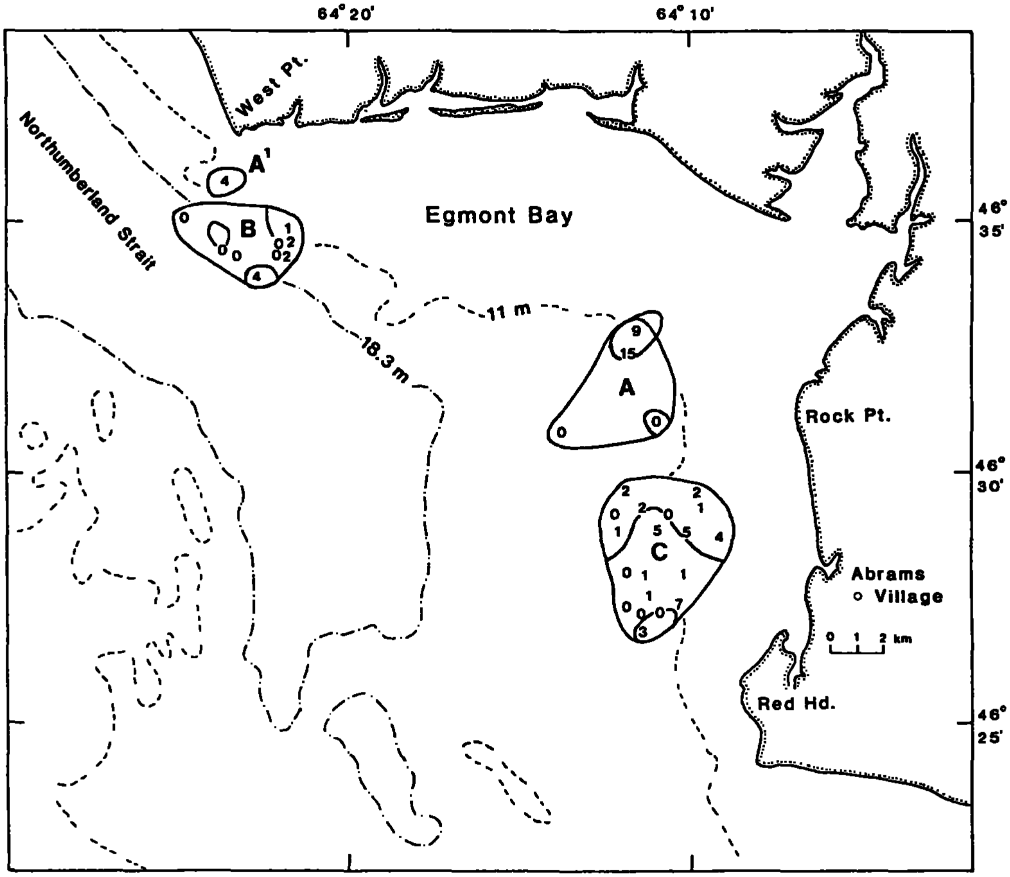

FIGURE 4.—Number of lobsters observed by divers in May during each tow in Egmont Bay, Northumberland Strait, Gulf of St. Lawrence. Substrate type is shown in Figure 1. Area designations are explained in Figure 3.

SCALLOP GEAR: LOBSTER INTERACTION.—No relation was found between the two sample periods and the number of lobsters injured or retained during a tow (Table 4). The weighted percentage of lobsters injured or retained was 11.7 and 1.3, for the nonfished and combined fished areas, respectively. Injured lobsters were not found in the drag path, although occasionally lobsters were observed to retreat into burrows in front of a moving drag. Whether they subsequently became damaged or trapped in their burrows is unknown, but the absence of damaged lobsters in the drag path suggests that the frequency of lobster damage is low on commercial scallop ground especially where there is a general lack of large rocks and boulders. However, 14 of the 30 locations surveyed had occasional large rocks.

Most lobsters encountered were too small (mean CL = 72 mm) (Table 5) to be retained by the scallop gear unless the steel rings making the drag were partially blocked by debris. All lobsters <92 mm CL can pass through a 70 mm inside diameter scallop ring (Stasko 1975). Several lobsters were seen by the divers entering the drag and passing through the rings apparently unscathed. In 63 tows, 11 lobsters were affected directly by the scallop gear: four were retained by the drag (the ring openings were block-

TABLE 4.—Frequency by month and location of lobster reduction and/or injury during dragging.

Details	Month	Nonfished areas	Fished areas: West Point	Fished areas: Red Head
No. lobsters observed	May	28	10	35
	July	32	24	82
No. lobsters injured/retained	May	3	1	0
	July	4	1	0
% injured/ retained	May	11	10	0
	July	13	4	0

TABLE 5.—Summary of lobster catches during closed fishing season (June-July 1981) and during the fishing season (August-October 1981) in Egmont Bay. Shorts = prerecruits <63.5 mm CL; legals = recruits ≥63.5 mm CL.

					Prerecruits			Recruits		
Week no.	Time period	Area	No. of lobsters sampled	No. of trap hauls	% total lobsters	No. per trap haul	% females of total shorts	No. per trap haul	% females of total legals	Mean CL (mm)
1	22-26 June	2	2	104	0	0	0	0.02	0	81.0
		4	2	96	50.0	0.01	0	0.01	100.0	72.0
2	29 June-3 July	1	3	100	33.3	0.01	100.0	0.02	100.0	71.0
		2	17	102	29.4	0.05	80.0	0.12	33.3	68.8
		3	2	100	50.0	0.01	100.0	0.01	100.0	66.0
		4	11	100	45.5	0.05	40.0	0.06	50.0	67.3
3	6-10 July	1	141	98	9.2	0.13	53.9	1.31	20.3	71.4
		2	114	102	12.3	0.14	35.7	0.98	35.4	71.5
		3	99	100	11.1	0.11	72.7	0.88	21.6	70.9
		4	35	100	25.0	0.09	22.2	0.27	30.8	72.6
4	13-17 July	1	503	94	17.7	0.95	42.7	4.40	31.9	71.0
		2	542	104	10.4	0.59	54.1	5.06	33.8	72.1
		3	550	100	12.2	0.67	41.8	4.83	33.3	71.3
		4	395	100	9.4	0.38	45.9	3.65	31.6	72.6
5	20-24 July	1	794	99	13.7	1.10	55.0	6.92	33.9	69.9
		2	708	104	9.0	0.62	51.6	6.19	36.3	71.6
		3	840	100	10.7	0.90	47.8	7.50	36.6	70.4
		4	792	98	6.3	0.51	58.0	7.57	33.8	72.4
6	27-30 July	1	1,066	98	15.7	1.70	44.3	9.17	29.1	70.3
		2	584	52	9.3	1.04	57.4	10.19	31.0	71.6
		3	1,077	100	9.2	0.99	44.4	9.78	29.6	70.9
		4	1,095	97	6.2	0.70	39.7	10.59	32.0	73.3
8	10-14 Aug.	(1)	1,582	488	24.5	0.79	44.9	2.40	33.1	71.9
9	17-21 Aug.	(1)	155	125	47.7	0.59	46.2	0.65	(2)	(2)
10	24-28 Aug.	(1)	501	240	44.7	0.93	48.5	1.13	31.8	73.2
11	13 Aug.-4 Sept.	(1)	458	245	42.5	0.80	42.6	1.07	34.4	73.0
13	14-18 Sept.	(1)	496	237	51.6	1.08	50.8	0.99	44.2	71.5
15	28 Sept.-2 Oct.	(1)	129	74	7.7	1.18	53.4	0.57	(2)	(2)

[1]All fishing areas during fishing season.
[2]Size and sex not recorded

ed with *Laminaria longicruris*), four passed under the drag and were possibly injured, and three were struck during the course of one tow (in May) resulting in claw loss or a cracked carapace. In the latter instance, strong currents impeded the escape of lobsters.

Scallop size frequencies were similar in May and July in each of the two commercially fished areas and all scallop age classes were exploited about equally.

Lobster Abundance and Distribution

Abundance

The number of lobsters caught per unit of effort (trap haul; CPUE) increased during the experimental fishing period in all areas (Table 5). During the commercial fishing period, CPUE of prerecruits increased but CPUE of legal-sized lobsters decreased presumably as a result of fishing mortality. Number of lobsters per trap haul was not significantly different between areas observed during the experimental period (Table 5). The use of CPUE is unreliable in the quantitative estimation of lobster abundance as many factors affect trapability, including water temperature, lobster behavior, molting, relative trap and lobster densities, and bait attractiveness (Elner 1980).

Lobster Movement

Of the 740 tagged lobsters recaptured (37%), 658 had recapture location data (Tables 1, 6). In areas 1, 2, and 3, the majority (65-78%) of tagged lobsters were recaptured within 10 km of release, but in area 4, 50% were caught 11-18.5 km from release (Table 6). The mean distance moved was not significantly different for tagged lobsters released in areas 1, 2, or 3, but lobsters from area 4 moved a significantly ($P < 0.01$) greater mean distance than those of the other three areas.

Direction statistics (according to Saila and Flowers 1968) summarize the nature of lobster movement

TABLE 6.—Summary statistics of distance travelled and direction moved by tagged lobsters released at four areas in Egmont Bay during June-July 1981, and recaptured up to 30 October 1981. (Direction statistics calculated according to Jones [1959] and Saila and Flowers [1968] are $\bar{\Theta}$ = mean vector angle from true north; V and V′ = directed movement along north-south and east-west plane, respectively, negative values of V and V′ indicate net southerly and westerly movement, respectively; *R* and *Z* = Rayleigh test statistics for randomness or uniform distribution of points about a circle; * = significant at $P < 0.01$ indicates a non-uniform distribution.) SD = Standard deviation.

Details	Release area 1 Heavily fished scallop ground	2 Lightly fished scallop ground	3 Scallop ground with rocks[1]	4 Lobster ground[1]
% of total recaptures moved 0-10 km	65.2	70.3	78.2	35.3
% of total recaptures moved 11-18.5 km	28.1	16.2	19.8	49.7
% of total recaptures moved >18.5 km	6.7	13.5	2.0	15.0
Total recaptures	164	148	207	139
Mean distance moved, km (±1 SD)	9.2 (0.5)	10.1 (0.6)	8.3 (0.4)	[2]12.9 (0.6)
Maximum distance moved, km	25.0	45.0	38.9	49.7
$\bar{\Theta}$	247.3	289.3	310.5	344.4
V (km/d)	−0.055	0.026	0.062	0.213
V′ (km/d)	−0.132	−0.075	−0.073	−0.059
R	74.9	26.3	64.9	63.5
Z	34.2*	4.7*	20.4*	29.0*

[1]Light or no scallop fishing.
[2]Value for mean distance travelled significantly different ($P < 0.01$); other values not significantly different ($P > 0.05$).

(Table 6). The Rayleigh test statistic, *Z*, indicated a non-uniform distribution of tag returns ($P < 0.01$) for each area of release. Results of the Rayleigh test should be treated with caution (Batschalet 1965) since there is some evidence of bimodality. In general, the returns exhibited three main directions of movement for lobsters: south-west for area 1, north-west for areas 2 and 3, and north for area 4 (Table 6). V and V′, the north-south and east-west coefficients of directed movement, measure the mean daily travel of the group. Lobsters from areas 1-3 showed little dispersion in a north-south direction in contrast to lobsters from area 4, which moved the greatest in a northward direction (0.213 km/d). Lobsters from all areas generally moved west, but lobsters from Area 1, the heavily fished scallop ground, tended to disperse furthest west per day (0.132 km/d). Dispersion to the west is perhaps largely the result of the relative proximity of the release areas to the western shore of Prince Edward Island, which restricted lobster movement to the east.

Lobster Growth

Determinations of molt stage from pleopod examinations indicated that lobsters may have molted as early as 6-12 July (Table 7). Trapability of lobsters is affected by molt stage, with late molt stages (e.g., $D_{4.0}$; Aiken 1973) being difficult to trap. The high percentage of D_3 to D_4 animals (stages just before molting) in mid-August indicated that considerable molting was imminent, and this probably affected CPUE at this time. Many tagged lobsters (47.8%, $N = 46$) recaptured during the period 24 August-26 September had molted.

DISCUSSION

The results of this study are probably area and

TABLE 7.—Percentage of pleopod stages of lobsters sampled from Egmont Bay, July-September 1981. Pleopod stages 3.0-3.5 and 4.0-5.5 predict lobsters molting within 1.9-4.0 wk and 0.3-2.4 wk, respectively, at 15°-19°C (Aiken 1973). Prediction of molting time for pleopod stage 1.0-2.5 is unreliable but usually exceeds 4.0-10.3 wk.

Period	% of lobsters, Pleopod stage 1.0-2.5	3.0-3.5	4.0-5.5	No. of lobsters	Temperature (°C)
6-10 July	97.1	1.5	1.4	69	15.5
13-17 July	98.2	0.9	0.9	113	16.0
20-24 July	96.5	3.5	0.0	142	16.5
27-30 July	89.9	6.6	3.5	117	19.0
10-14 Aug.	76.3	21.1	2.6	76	18.1
31 Aug.-4 Sept.	91.1	5.9	3.0	101	17.5

time specific. Nevertheless the extent of sea scallop gear damage to American lobsters in Egmont Bay was measured, and this permits estimation of the damage to lobsters on similar substrate types in other locations. In the nonfished area there was no significant difference in the lobster abundance between the May and July observations, whereas there were significant differences in relative seasonal lobster abundance in the fished areas. In western Northumberland Strait at the time of this study, scallop fishing occurred primarily between late April and late June, with a minor amount of fishing between mid-October and winter freeze-up (Jamieson et al. 1981c). There was limited scallop fishing during July. If lobsters were displaced by scallop dragging during May and June, normal seasonal lobster densities could be reestablished by late July. It is unclear whether the greater density of lobsters in the fished areas in July was due to normal seasonal migration onto these grounds or to the absence of scallop fishing. Data from tagged lobsters suggested that some immigration may have occurred from the deeper water areas of the Strait, but it also appeared that overall abundance on the scallop grounds may have been reduced by scallop dragging activity. Predators have been reported to be attracted to the disturbed substrate in a drag's path (Caddy 1973), but how this relates to lobsters is unclear.

The trapability of lobsters is a function of many variables (Elner 1980), making the quantification of lobster abundance difficult in the four trap study areas. There was a lower percentage of short lobsters and a larger mean carapace length in Area 4 than in the other areas (Table 5). When large lobsters were trapped there were generally fewer small lobsters in the traps (Table 5), but this may have resulted from agonistic behavior (Cobb and Tamm 1975) rather than relative density. Water temperature increases may also have affected behavior and possibly had major modifying effects on lobster growth and/or movement. McLeese and Wilder (1958) documented an increase in lobster rate of movement with increasing temperature, but what effect this had on the average direction of movement during the study period is unclear. The mean movement rate of lobsters in our study (Table 7) was similar to that reported by Saila and Flowers (1968) for mature lobsters off Rhode Island. Saila and Flowers (1968) showed that the coefficients of directed movement, V and V', are sensitive to changes in movement patterns at various life history stages, and hence are a possible function of lobster maturity level and the sex ratio used in their calculation. These potential influences were not considered here because of limited duration of the study and the relative close proximity of release and recapture areas which were probably not optimal to permit extensive data analysis.

There probably was a directed movement of tagged lobsters from area 4 (deeper water) into Egmont Bay. This may have contributed to the increased CPUE during July-October. Templeman (1936) found there was some movement during the summer with lobsters congregating in the relatively shallow inshore water areas of Northumberland Strait and that some lobsters moved offshore in the fall. The disproportionate sex ratio of legal-sized lobsters observed in the present study suggested a geographic distributional difference between the sexes of lobsters after maturity during July-August.

Lobster trapability, and hence estimated abundance, can be influenced by molt stage. Many legal-sized lobsters appeared to have molted between August and September, and while the data are insufficient to support the fact that a molt may have occurred prior to or during the experimental fishing period (late June-July), other investigations have presented evidence in the literature that lobsters in this area do molt in late spring (Templeman 1934, 1936; Wilder 1963). If, in fact, two molts did occur during the study period, this along with increased water temperature increasing lobster movement (McLeese and Wilder 1958) could partially explain the rapid increase in CPUE during July. However, no soft-shelled lobsters were observed during July, while soft-shelled lobsters were quite frequently encountered in fishermen's traps during the August-September fishing season.

The seasonal nature of the fisheries minimizes the impact of scallop gear on lobsters because lobsters are in low abundance on scallop ground at the time of greatest scallop fishing activity. Commercial concentrations of scallops and lobsters also appear to be largely separated spatially (Figs. 2, 3). What then is the likely economic impact in Egmont Bay of scallop fishing on lobsters, and how does this compare to the value of the exploited scallop resource? No reported commercial scallop fishing was reported in 1980 off Red Head, but vessel logs recorded that 1,509.4 kg of adductor muscle meat were taken near West Point (scallop log areas 77 and 78 combined, Jamieson et al. 1981c). Average CPUE was about 2.4 kg/h$\cdot$m^{-1}, indicating that 629 h$\cdot$m of effort was expended. In our study, a total of 8.2 h$\cdot$m of research effort was expended in May on the fished grounds and 22 lobsters were observed behind the drag in the drag path. Drag velocities over the bottom in both commercial fishing operations and in our study are assumed to be similar. If 2.6% of the lobsters observed are retained or injured, with 50% of these lobsters killed, then the total number of lobsters estimated to be destroyed by commercial scallop fishing in 1980 was 22 lobsters. If each lobster weighed 0.5 kg and was valued at \$6.60 kg^{-1}, then the loss would be about \$73. In comparison, at \$8.27 kg^{-1} of scallop meat in May, 1980 (Jamieson et al. 1981c), the scallop landings from these two fished areas had an estimated value of \$12,483.

If lobster abundance was as high as that in the unfished area, i.e., 3.03 lobsters/1000 m^2, then 139 lobsters, with a value of \$460, would have been destroyed. In both instances, this loss is negligible in comparison to the values of the lobster and scallop fisheries. These conclusions are in agreement with the observations of Scarratt (1973) and Pringle and Sharp (1980) in their assessments of the impact of Irish moss raking on lobster populations.

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