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Canadian Atlantic Fisheries Scientific Advisory Committee

CAFSAC Research Document 88/13

Comité scientifique consultatif des pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 88/13

Lobster Size Structure and Seasonal Distribution in the Clam Bay Area of Halifax County, Nova Scotia

by

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ABSTRACT

The lobster fishery in Lobster Fishing Area 32 was in a state of collapse between 1978 and 1981. Annual landings for these years (about 5% of the high levels of the late 1800's) were the lowest ever recorded. Landings began to increase in 1982 and by 1986 were more than five times higher than 1981, prompting a group of fishermen to request a longer season. Data on most aspects of lobster ecology, specific to this area, are unavailable. A study on seasonal lobster distribution was designed to test the hypothesis that fall and spring lobsters are part of the same stock, and to provide data on seasonal size-frequencies in relation to depth and season. In October 1986 and June 1987, 1,283 and 520 lobsters, respectively, were sphyrion tagged.

The effect of the commercial fishery (April 20 to June 20) on the lobster stock in exposed outer subareas can be seen in the reduction in mean carapace length from 88.8 mm in October 1986 to 75.2 mm in late June 1987. Mean lobster size in these subareas in October 1986 increased significantly with depth, ranging from 87.5 mm carapace length (CL) at 0 to 10 m to 103.0 mm CL at 29 to 36 m. Sphyrion tag loss, for non-molted lobsters at large overwinter (6 mo), was calculated at 26%. Return rate for sphyrion-tagged lobsters was 60%, suggesting that fall lobsters constitute a major portion of the spring catch. Fifty percent of egg-bearing females were caught in a shallow, sheltered bay. The importance of these bays for mating, brooding, and larval development are discussed.

RESUME

La pêche au homard dans l'arrondissement 32 était en état d'effondrement entre 1978 et 1981. Les débarquements annuels enregistrés pendant cette période (environ 5 % des niveaux élevés de la fin des années 1800) ont été les plus bas jamais enregistrés. Les débarquements ont commencé à augmenter en 1982 et dès 1986, ils étaient plus de cinq fois plus élevés qu'en 1981, ce qui a incité un groupe de pêcheurs à demander une saison de pêche plus longue. Nous ne disposons pas de données sur la plupart des aspects de l'écologie du homard, propres à cette région. Une étude sur la répartition saisonnière du homard a été élaborée afin de vérifier l'hypothèse selon laquelle les homards de l'automne et du printemps font partie du même stock, et de fournir des données sur les fréquences saisonnières et la taille en fonction de la profondeur et de la saison. En octobre 1986 et en juin 1987, 1 283 et 520 homards, respectivement, ont été étiquetés.

L'effet de la pêche commerciale (20 avril au 20 juin) sur le stock de homards dans les sous-arrondissements extérieurs non abrités peut être observé par la réduction de la longueur moyenne de la carapace qui passe de 88,8 mm en octobre 1986 à 75,2 mm à la fin de juin 1987. La taille moyenne des homards de ces sous-arrondissements en octobre 1986 a augmenté significativement avec la profondeur, se situant entre 87,5 mm de longueur de carapace (LC) à une profondeur de 0 à 10 m, et 103,0 mm de LC pour une profondeur de 29 à 36 m. La perte d'étiquette, dans le cas des homards qui n'ont pas mué en général au cours de l'hiver (6 mois), s'établit à 26 %. Le taux de retour des homards étiquetés était de 60 %, ce qui porte à croire que les homards d'automne représentent une forte proportion des prises effectuées au printemps. La moitié des femelles oeuvées ont été capturées dans une baie abritée peu profonde. L'importance de ces baies pour la période d'accouplement jusqu'au développement des larves est analysée.

INTRODUCTION

Lobster Fishing Area (LFA) 32, formerly known as Lobster Fishing District (LFD) 5A (LFD 5 was divided into 5A and 5B in 1981 to permit different seasons for the two Districts), is located on the eastern shore of Nova Scotia, extending from Cole Harbour, east to the Halifax-Guysborough County line (Fig. 1). Annual lobster landings in LFA 32 (5A) declined steadily after 1971, and between 1978 and 1981 reached the lowest levels in the history of the fishery. The trend reversed in 1982, and landings in 1986 were five times greater than in 1981 (Fig. 2).

The enhanced annual yields spurred a group of LFA 32 lobster fishermen, in the spring of 1986, to request a fall fishery in addition to the present April 20 to June 20 season. Season changes could be accommodated through Department of Fisheries and Oceans policy, as long as there was not a concomittant increase in fishing effort. The fishermen countered by suggesting that the fall lobsters are of a different stock than the spring-fished lobsters. Although empirical data were not available, we suggested this was likely not the case. The fishermen then requested a study to resolve the spatial relationship between fall and spring lobster.

The paucity of data on most aspects of lobsters ecology in this area permitted the election of at least four hypotheses to explain the recent collapse of the fishery (Dadswell 1979; Harding et al. 1983; Wharton and Mann 1981; see a review by Ennis [1986]). The collapse was evident in 1982 when Pringle and Duggan (1984) showed that latent lobster fishing effort was about 25%. Despite this reduced effort, Pringle and Duggan (1985) showed a reduced density of lobsters in LFA 32 compared to most stocks between Queens and Victoria Counties.

Given the meagre biological data base, we initiated a study, designed to test the hypothesis that the fall and spring lobsters are part of the same stock. We, as well, present data on seasonal lobster size-frequencies in relation to depth and season.

METHODS

A local lobster fishing boat complete with gear and crew was chartered. Traps (150) were of traditional wooden construction. Fifty experimental traps with a single hoop (entrance) were constructed from 12.7 mm (½") wire mesh. Ten each had individual hoop sizes of 38 mm (1½"), 50 mm (2"), 76 mm (3"), 102 mm (4"), and 127 mm (5").

The study site in October 1986 extended east from Jeddore Head to Owl's Head and included both Jeddore and Ship Harbours. Six transects, extending south from the shoreline and spaced at intervals of 3 s of latitude, were established out to a depth of 37 m (Fig. 3). Traditional traps were set at 0.25-naut mi intervals along each transect. Additional wooden traps were set in perceived lobster abundances in an attempt to enhance the number of lobsters available for tagging. The experimental traps were rigged in trawls of five, each trap with a different hoop size. They were set at the inside, outside, and center of Transects 2 and 6, and at the inner and outer ends of Transect 4. One trawl of experimental traps was also set in each Harbour. Ryan thermographs were deployed at a depth of 15 fm (27 m) to record water temperature during the project. Traps were fished by the boat crew, and the lobsters were handed to technicians on board. Adverse weather conditions (high winds) prevented the fishing of transects every second day as originally planned.

A total of 1,504 lobsters were caught in 1,320 trap hauls; of these, 1,483 were tagged: 1,283 with only sphyrion tags (Scarratt and Elson 1965), 100 with both sphyrion and monal tags, and 100 with only monal tags. The remainder of the lobsters were judged unsuitable for tagging. Carapace length (CL), sex, egg condition of berried females, and tag number were recorded. Tagged animals were released, in most instances, within 100 m of capture.

The study site in June 1987 included the grounds between Transects 1 and 4 only (Fig. 3). Traps and trap types were as in 1986, except that ten large traps with a hoop size of 203 mm (8") were used in an attempt to catch larger lobsters, particularly egg-bearing females. A total of 785 trap hauls yielded 406 lobsters. An additional 154 lobsters were caught during initial deployment and final recovery of traps when technicians were not on board to record trap hauls. Of the total caught, 526 were tagged with sphyrion tags and released.

The lobster fishery began April 20, 1987. Fishermen were encouraged to both report all tag returns and make the lobsters available for measurement by study staff. The study site was subdivided into six subareas (Fig. 3). Fishermen were to note the subarea in which the lobsters were captured.

To enhance tag reporting and recovery, details of awards and study-site maps (Fig. 3) were posted at all landing wharves and buying stations in the study site and beyond for 15 km. Certain lobster buyers assisted by both recording necessary information and holding tagged lobsters in tanks until study personnel could observe them. Weekly trips were made to record data and pay rewards. Rewards were also paid for information on tagged sublegal-size and egg-bearing females that could not be brought ashore.

The data were transferred to computer for analysis. The data were tested for normality using the Komolgorov-Smirnov goodness-of-fit test (Nie et al. 1975). The significance ($P \leq 0.05$) within the data was discerned with a one-way analysis of variance and/or Student's T-test (Nie et al. 1975).

RESULTS

The mean lobster size for Jeddore Harbour (Subarea 1) in 1986 (94.6 mm CL) was significantly ($P \leq 0.05$ and hereafter) larger than for lobsters caught outside (88.8 mm CL) (Table 1) and in Owl's Head (88.5 mm CL). However, mean number of lobsters per trap haul (CPTH) in Jeddore Harbour was significantly less (0.9) than outside (1.2) or at Owl's Head (1.4). Lobster mean CL in Jeddore Harbour was similar for both samples (94.6 mm in 1986 versus 92.2 mm in 1987), while outside the size fell significantly, from 88.8 mm CL in 1986 to 75.2 mm in 1987. Mean size in 1986 increased significantly with depth in the outside area (Table 2), ranging from 87.5 mm CL at 0 to 5 fm (0-10 m) to 103.0 mm CL at 16 to 20 fm (29-36 m). The significant difference in mean CL between Transects 1 and 4 is likely due to the differences in mean depth of the transects (Fig. 3). Lobster size in 1987 was similar throughout the outside area, with a mean size of 75.2 mm CL (Tables 1 and 2). The ratio of males to non-berried females in 1986 and 1987 was 1.48 and 0.95, respectively. The number of berried females captured in 1986 and 1987 was 24 and 19, respectively. The respective mean sizes were 104.3 mm CL and 104.8 mm CL (Table 3).

Mean lobster size varied directly with hoop size (Table 4). The smallest lobster captured (44 mm CL) was found in a trap with the smallest ring size. The smallest and largest lobsters caught in a traditional trap (127 mm hoop dia.) were respectively 52 mm and 149 mm CL. The latter was the largest lobster captured in the study. Traps with 203 mm entrance rings in 1987 yielded lobsters with a significantly larger mean CL (88.6 mm) than the 127 mm hooped traps (78.6 mm) (Table 4). The mean CL for the latter traps in 1986 was significantly larger at 90.5 mm. The largest lobster captured in traps with the large hoops was only 124 mm CL, but this followed the spring fishery and preceded the annual molt.

Water temperature, at 15 fm (27 m), ranged between 7.0°C and 8.5°C during the study period in October 1986. Water temperatures on June 26, 1987, at 5 fm (9 m), 15 fm (27 m), and at 0 m were 6.8°C, 9.6°C and 11.0°C, respectively.

The percentage of tag returns per subarea ranged between 37.2% and 46.7% (Table 5). Emigration between subareas varied markedly (Fig. 4 to 9). Percentage of lobsters returned from the subarea of release were higher in the inner areas (36.0% Owl's Head, 39.8% Jeddore Harbour) than the outer areas (11.3% to 16.3%). Five of the 24 berried females tagged in 1986 were recovered in the same subarea of capture in 1986. Most movements were restricted to adjacent subareas. Five recoveries were reported from just beyond the main study area: four from Jeddore Head (west), and one from Nichol Island (east). There were 12 instances where lobsters moved farther than the adjacent subarea (Fig. 4 to 9). The mean depth of capture (1986) was 11 m; the mean depth of recapture (1987) was 12.7 m.

Returns for lobsters double-tagged (100 in total) with sphyrion and monal carapace tags were as follows: 39 bearing both tags, 16 with carapace tags, and 5 with sphyrion tags. Tag loss rate was higher for sphyrion tags (26.7%) (Ennis [1986] reports 24% sphyrion tag loss for non-molted lobsters) than for carapace tags (8.3%). Overall return rates for sphyrion and carapace tags were 44% and 55%, respectively. Given these estimates for sphyrion tag loss, the real rate of tag return increases from 41% to 60%. The latter is 8% higher than the estimated exploitation rate (Miller et al. 1987).

DISCUSSION

Tag recapture studies of marine species require the cooperation of the local fishery for success. Excluding a study by Cooper (1970), which reports an exceptional 98% recovery, the percentage returned for inshore lobsters generally ranges between 7% (Campbell and Stasko 1985) and 22% (Campbell 1983). These percentage returns have been deemed acceptable in formulating concepts on lobster seasonal movement.

The percentage return of 60% in a single year is considered high for inshore lobster studies. High return rates enhance the ability to draw conclusions from the data. When one considers the total costs ($20,000) of studies such as this, the extra effort required to enhance tag returns is worthwhile. Obviously, the largest single factor is to have the fishermen "on side" prior to study start up. This can be accomplished by scientific personnel attending community meetings and explaining the study's objectives. The initial enthusiasm shown by the fishermen for the present study enhanced its success.

Another feature important for a study's success is the tagging operation. Tag insertion by inexperienced personnel may result in high mortality due to infection. Significant animal death due to tagging, married with a sphyrion tag loss of about 25% (the present study; Cooper 1970; Ennis 1986) would result in study failure.

The movement patterns observed tended to be local, with the bulk of the animals occurring in contiguous subareas of their release point (Fig. 4 to 9). A few animals moved beyond the study area. Given previous observations on lobster movement of the size studied here, it was expected that distance travelled would be minimal over 1 yr (Campbell and Stasko 1985; Campbell 1986). The longest observed distance travelled for an eastern Nova Scotia lobster was from New Harbour, Guysborough County, to Browns Bank (NAFO Subarea 4X), a distance of 440 km (D.R. Duggan, Lobster Technician, Department of Fisheries and Oceans, Halifax, N.S.). The time between release and recapture was 5 yr.

The results of the tag returns prevent rejection of the hypothesis that the fall lobsters occurring between Jeddore Head and Owl's Head Harbour are part of the stock fished in the spring. Lobsters in Subareas 2 to 5 (outside) tended to be in a different subarea upon recapture than animals in the sheltered areas of Jeddore Harbour and Owl's Head (compare Fig. 4 to 9). The animals were tagged in the fall about the time that inshore lobsters begin a seasonal migration to deeper water (Templeman 1934; Ennis 1984; Campbell 1986). It is thought that this movement permits the avoidance of turbulent shallow waters of fall and winter (Ennis 1984). As well, deeper waters are likely warmer in winter. The seaward distance moved is not known, but the lobster fishery in early spring begins in about 20 fm (37 m) of water and moves shoreward as the season progresses. Pezzack and Duggan (1987) found little evidence for the presence of lobsters between this depth and the continental slope. Experimental trapping in deep water off the study site in 1987 returned no lobsters (Stan Purdy, lobster fisherman, Eastern Passage, Halifax County, N.S.). Thus, we conclude that the bulk of the lobsters in this area range between 20 fm (37 m) and the shore. Despite this shoreward movement, the deeper waters in the fall of 1986 had significantly larger animals than the shallow waters. Either the larger animals tended to remain in deeper waters than the smaller animals, or they had begun to move to deeper waters ahead of the smaller animals.

The significant difference in mean lobster size between October 1986 and late June 1987 likely reflects the impact of the seasonal (April-June) fishery. A recent stock assessment of LFA 31/32 suggested that effort increased threefold between 1980 and 1986; exploitation rates were about 52% (Miller et al. 1987). Further evidence of high exploitation can be seen by comparing the size-frequencies between October 1986 and June 1987 (Fig. 10 and 11). The mean size in June suggests that this fishery is dependent on annual recruitment.

Despite the high exploitation rate, the mean lobster size inside Jeddore Harbour was significantly larger than outside (Table 1). Two fishermen, at least, actively trap this Harbour; thus, this phenomenon was not due to a lack of fishing, although there could have been a differential in fishing pressure between the Harbour and the outside. We examine the hypothesis that this was due to the Harbour being a refuge for large berried females. Nearly one-half of the berried females (21 of 43 [16 of 24 in 1986 and 5 of 19 in 1987]) were indeed captured inside Jeddore Harbour. However, the mean lobster size was reduced only slightly (from 94.6 mm CL to 93.7 mm CL in

1986, and from 92.2 mm CL to 90.7 mm CL in 1987), with the exclusion of the berried females. Thus, the mean size of the males (96.7 mm CL in 1986 and 93.2 mm CL in 1987) and non-berried females (88.0 mm CL in 1986 and 87.8 mm CL in 1987) inside the Harbour must, as well, be larger than outside the Harbour.

The occurrence of a high incidence of large berried females inside Jeddore Harbour (mean size for berried females outside the Harbour in 1986 was 101 mm CL; one berried female in Owl's Head was 77 mm CL) is of extreme interest. Regular at-sea sampling has recovered few berried females (Campbell and Robinson 1984), which suggests that recruitment comes from elsewhere or the sampling technique underestimates their numbers. It appears that their distribution may be highly contagious. Harding et al. (1983) hypothesized that the warm, shallow bays along this coast may be important for larval maturation. The presence of large berried females in June, prior to larval hatch, supports this hypothesis. Their presence in these bays in October suggests that the bays are "brood" areas as well. Temperature data will be analysed to determine if higher temperatures in the bays, over the outside areas, can, in part, explain this behaviour pattern.

The high incidence of large males and berried females in Jeddore Harbour suggests that these shallow bays may also be a mating site.

ACKNOWLEDGEMENTS

Thanks are extended to all fishermen and lobster buyers in the study site for their cooperation; without their assistance this study would not have been a success. We give special thanks to R. Baker, President of the Eastern Shore Fisherman's (SIC) Protective Association, who represented the fishermen well when interfacing with the researchers. D.R. Duggan did an excellent job of lobster tagging.

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Table 1. Mean size (carapace length in mm.) and mean catch per trap haul (CPTH) per subarea during 1986 and 1987.

		1986		1987	
	Subarea	Size	CPTH	Size	CPTH
#1	Jeddore Harbour	*94.6	0.90	92.2	0.55
#2-5	Sub-areas outside harbours	88.8	1.20	75.2	0.51
#6	Owl's Head area	88.5	1.40	-	-
	Totals	89.7	1.10	76.9	0.52

* significantly larger ($P \leq 0.05$)

Table 2. Mean size (carapace length in mm) and mean catch (number) of lobsters per trap haul by depth in subareas 2-5 (areas outside harbours) for 1986 and 1987.

Year	0-5 fath		6-10fath		11-15 fath		16-20 fath	
	Size	CPTH	Size	CPTH	Size	CPTH	Size	CPTH
1986	85.7	1.3	90.0	1.4	94.3	1.0	103.0	0.1
1987	75.1	0.7	76.3	0.5	72.5	0.2	75.8	0.1

Table 3. Mean size (carapace length in mm.) per transect for 1986 and 1987 and grand mean size per sex for 1986 and 1987.

Transect Number	1986	1987
1	100.1	71.3
2	91.2	74.2
3	94.8	71.6
4	90.3	73.9
5	95.0	-
6	93.2	-
Total Males	91.4 (n=885)	77.4 (n=263)
Total Females	86.7 (n=597)	75.0 (n=278)
Berried Females	104.3 (n=24)	104.8 (n=19)

Table 4 Mean size (carapace length in mm) and mean catch (number) per trap haul (CPTH) by trap type for 1986 and 1987. Standard errors are given for mean sizes.

		1986.			1987		
Trap Type	Hoop Diameter	Size	(S.E.)	CPTH	Size	(S.E.)	CPTH
Experimental traps	38 mm.(1.5")	46.0	(n.a.)	0.02	47.0	(0.8)	0.08
	50 mm (2")	66.7	(4.2)	0.25	58.0	(7.6)	0.08
	76 mm (3")	76.2	(1.7)	0.60	72.6	(1.0)	0.19
	102 mm.(4")	82.0	(2.7)	0.50	74.9	(7.0)	0.29
	127 mm.(5")	83.2	(2.4)	0.36	77.0	(2.8)	0.33
Traditional traps	152 mm.(6")	90.5	(0.4)	1.40	78.6	(2.8)	0.58
Large traps	203 mm.(8")	-		-	88.6	(4.4)	0.38

Table 5 Number of tagged lobsters released in 1986 and number and percent recovered in 1987 per subarea.

Subarea	# Released 1986	#Recovered 1987	% Recovered 1987
1	261	122	46.7
2	412	168	40.8
3	129	48	37.2
4	109	49	45.0
5	336	128	38.1
6	236	95	40.2

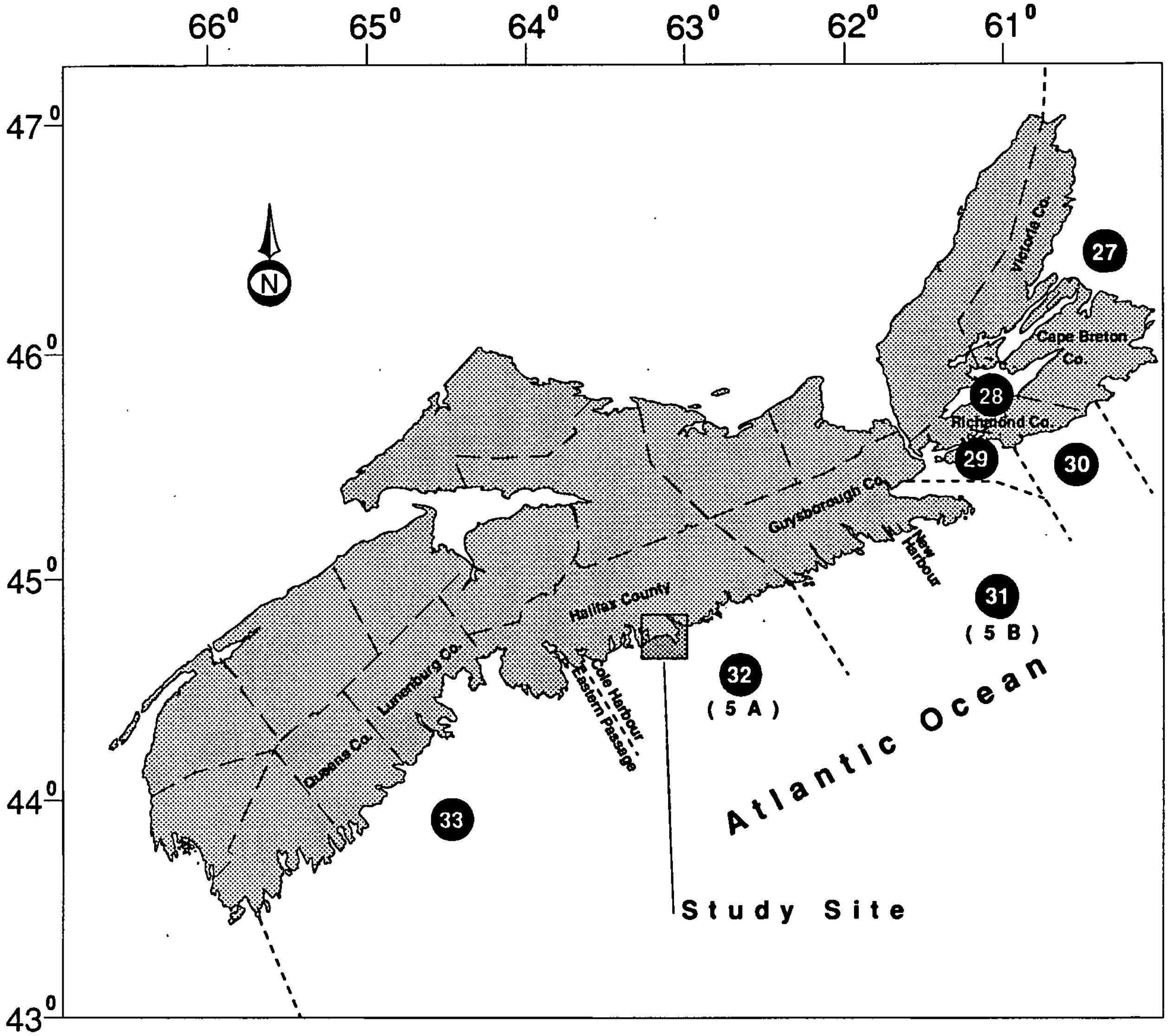

Figure 1. Study site (see Fig. 3) and Lobster Fishing Areas on Atlantic Coast of Nova Scotia .

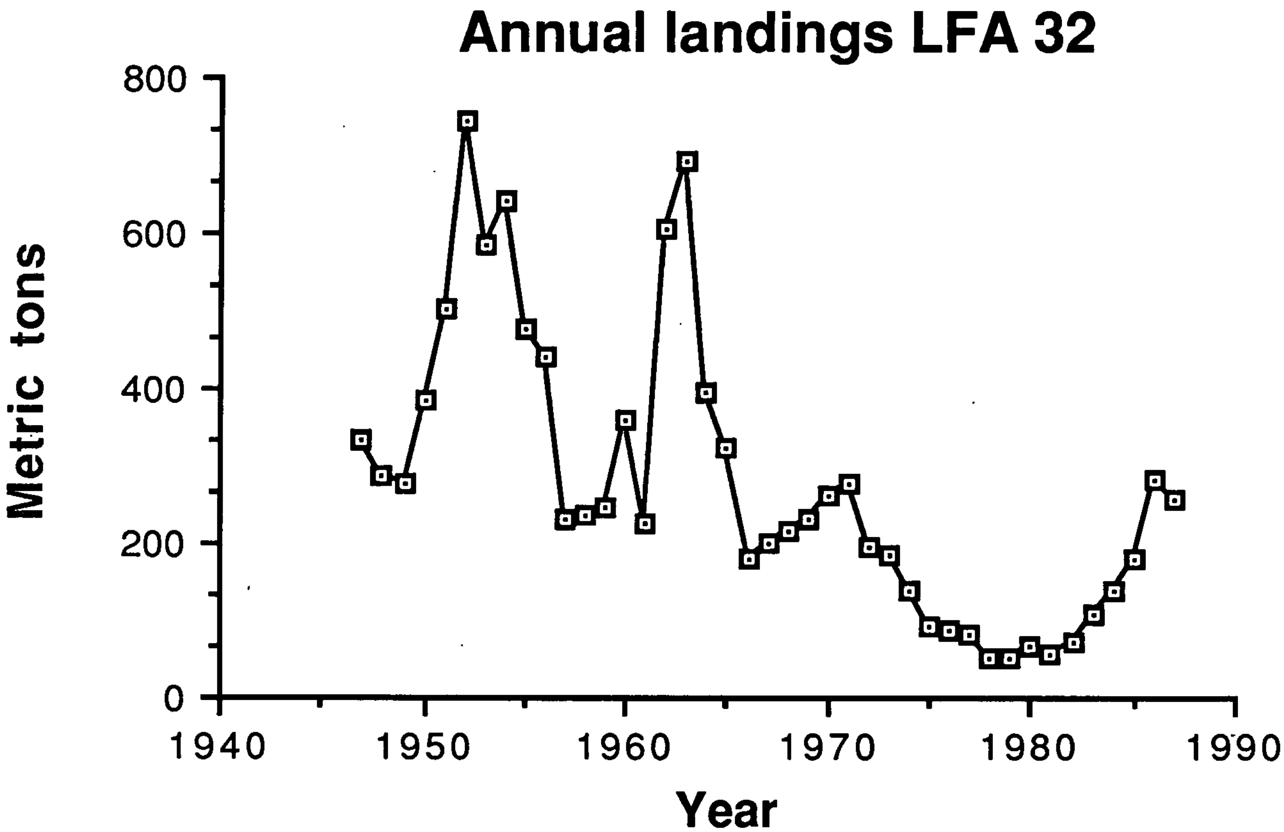

Figure 2. Annual lobster landings (t) for lobster fishing area 32.

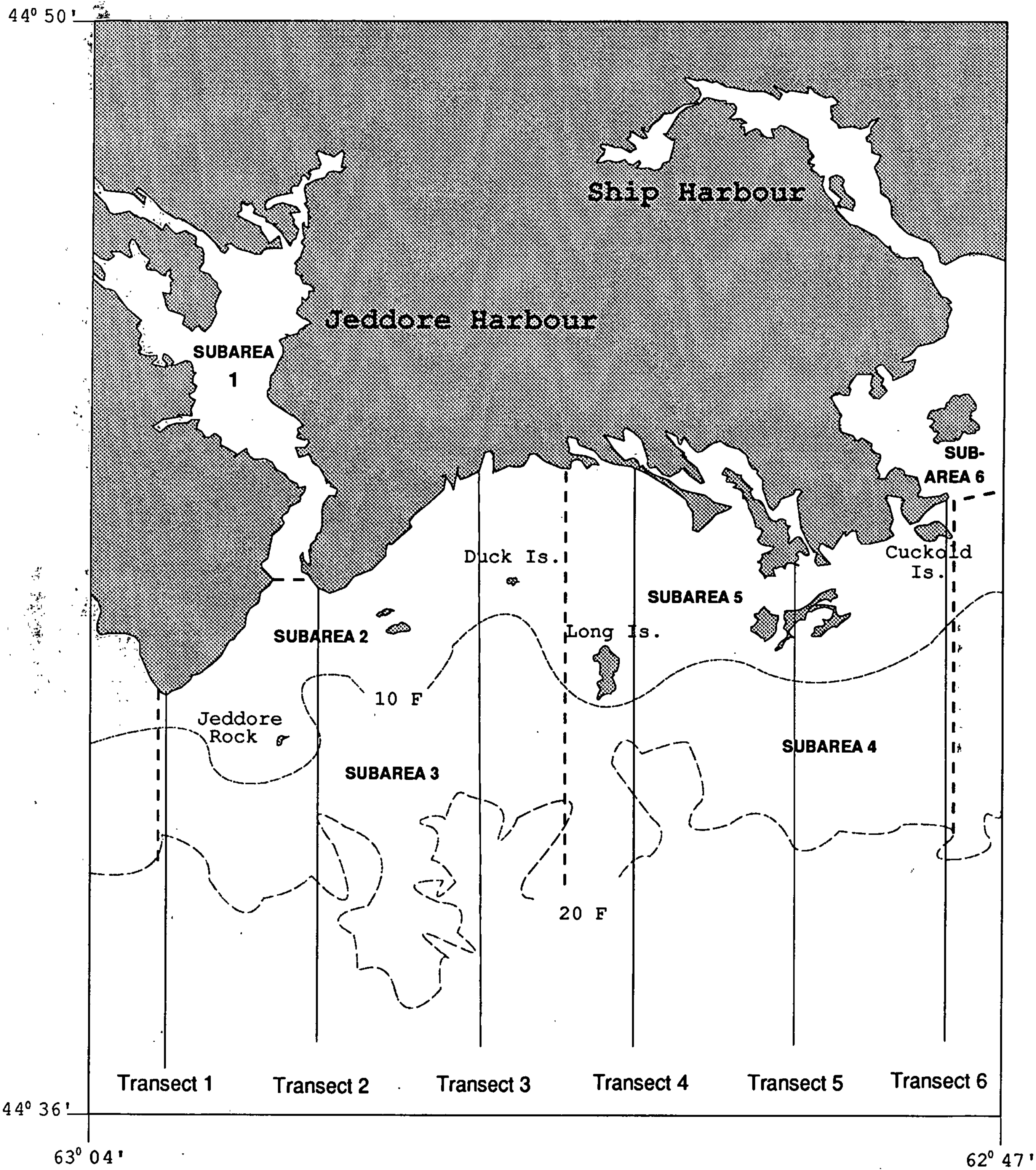

Figure 3. Research site sub-areas and survey transects. Dashed lines and depth contours are boundaries for sub-areas 2-5.

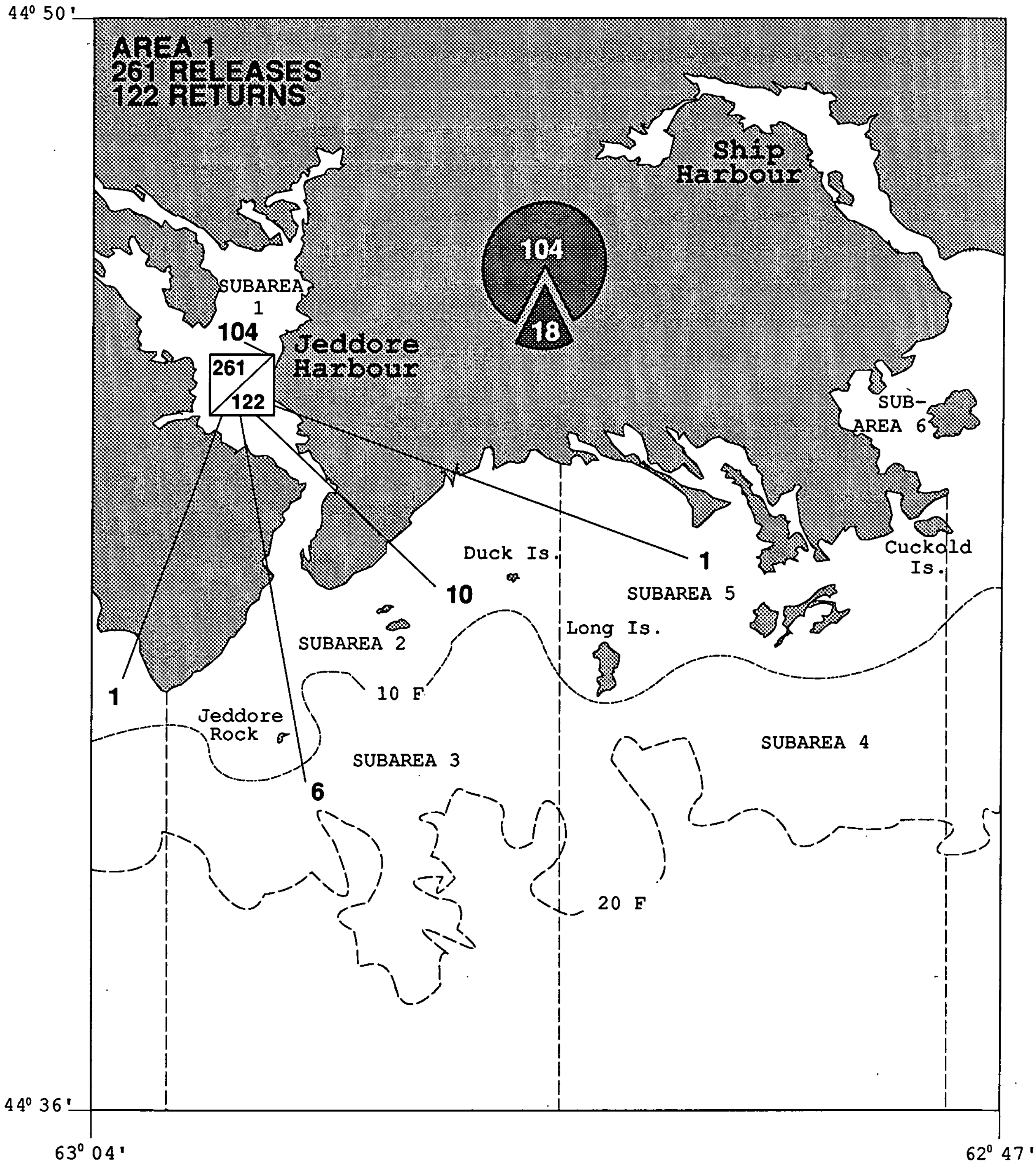

Figure 4. Locations of recaptures of lobsters released in area 1.

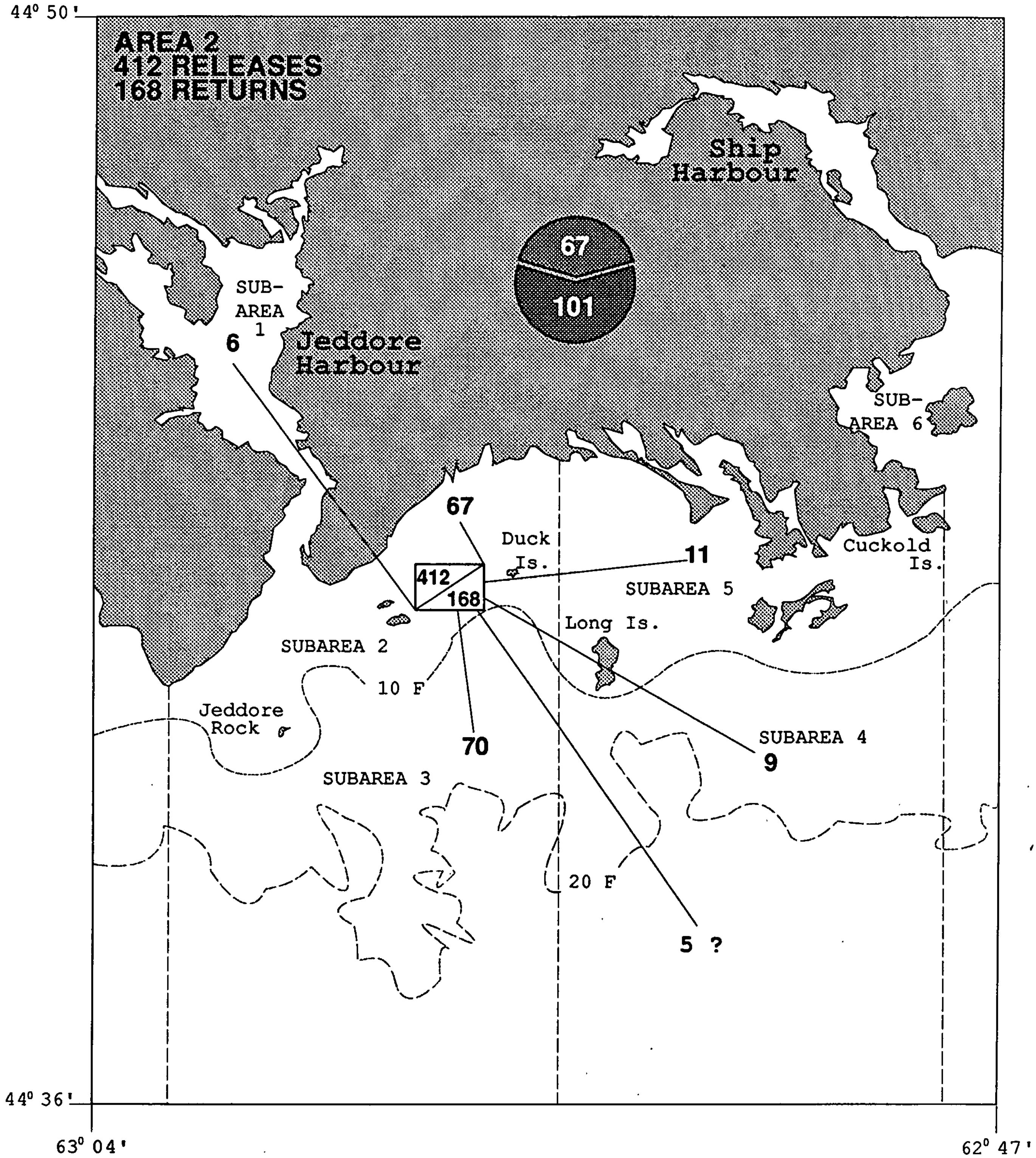

Figure 5. Locations of recaptures of lobsters released in area 2.

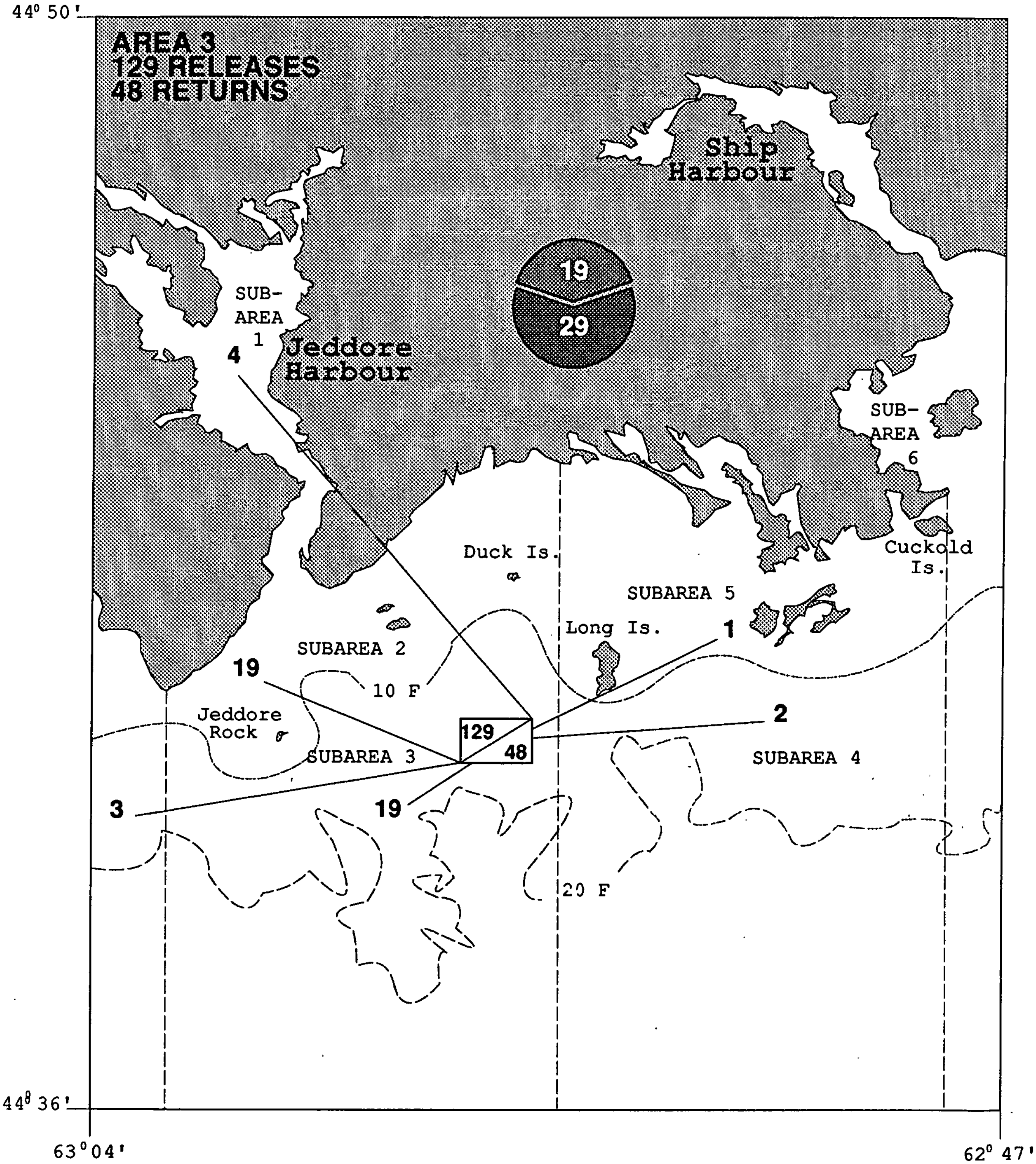

Figure 6. Locations of recaptures of lobsters released in area 3.

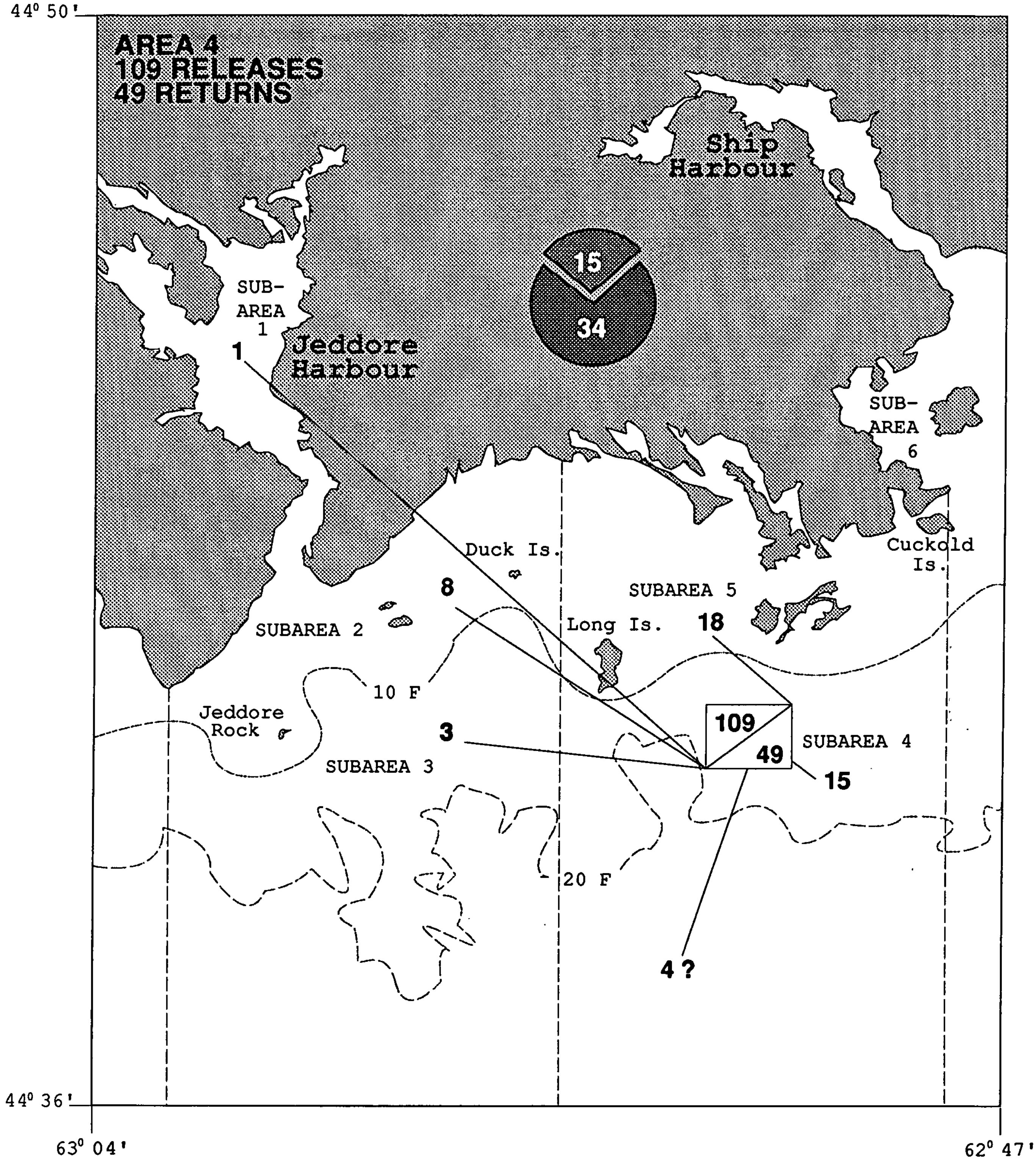

Figure 7. Locations of recaptures of lobsters released in area 4.

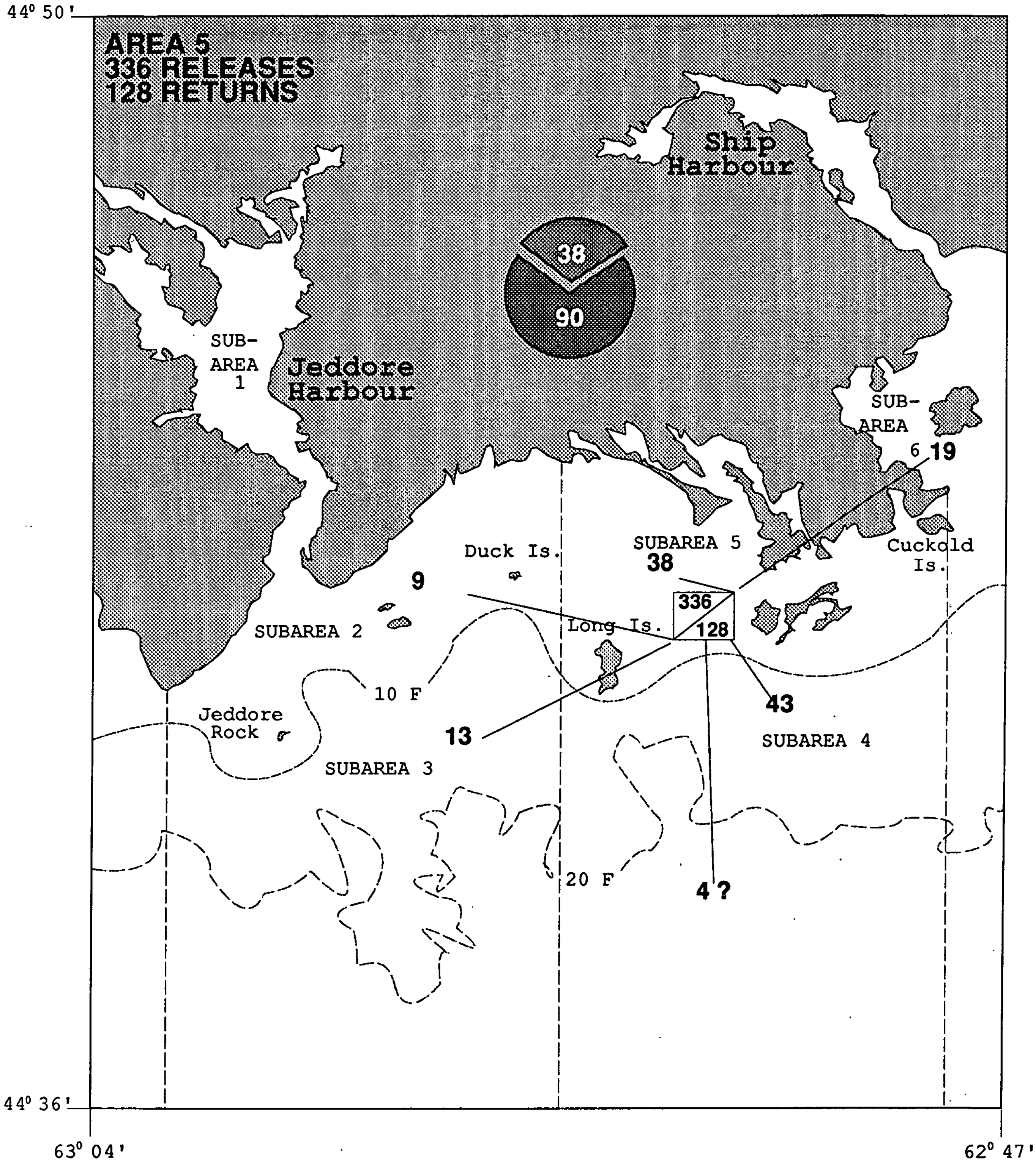

Figure 8. Locations of recaptures of lobsters released in area 5.

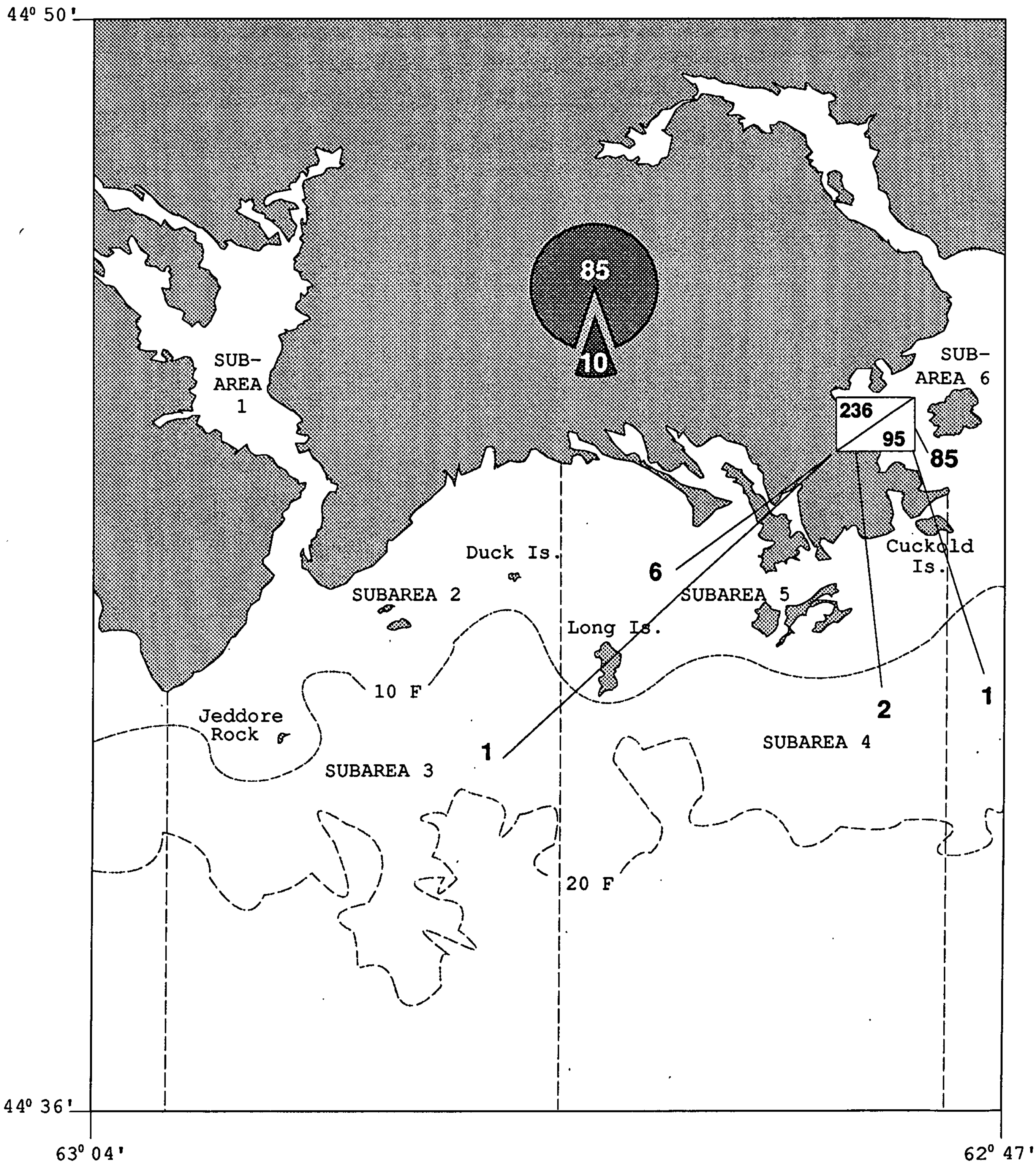

Figure 9. Locations of recaptures of lobsters released in area 6.

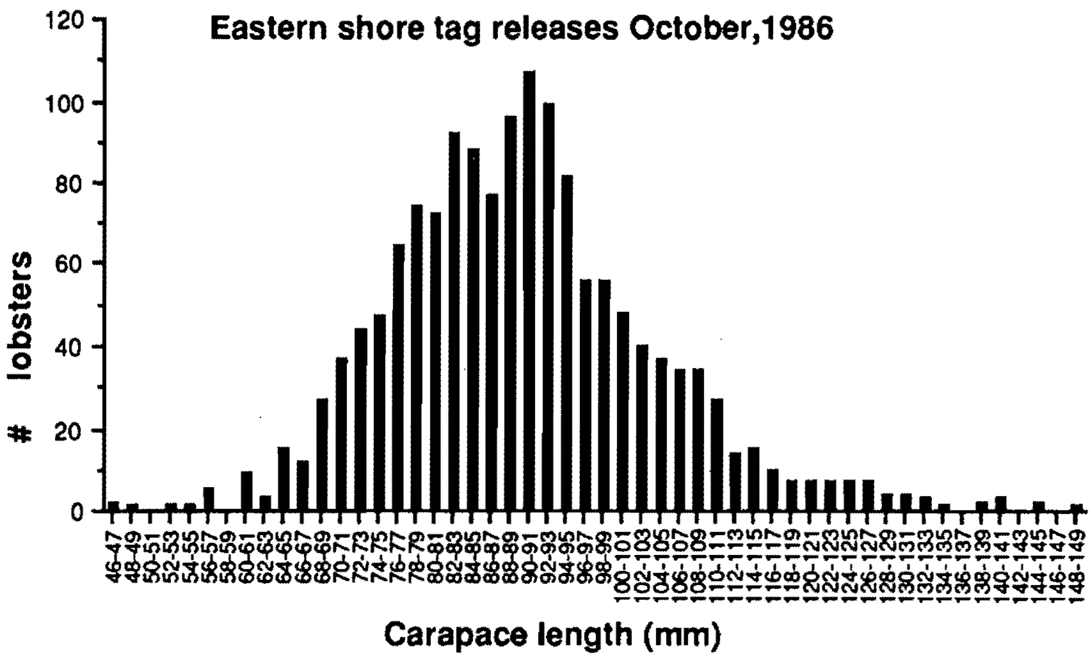

Figure 10. Size frequency, tagged lobster releases, Eastern shore 1986

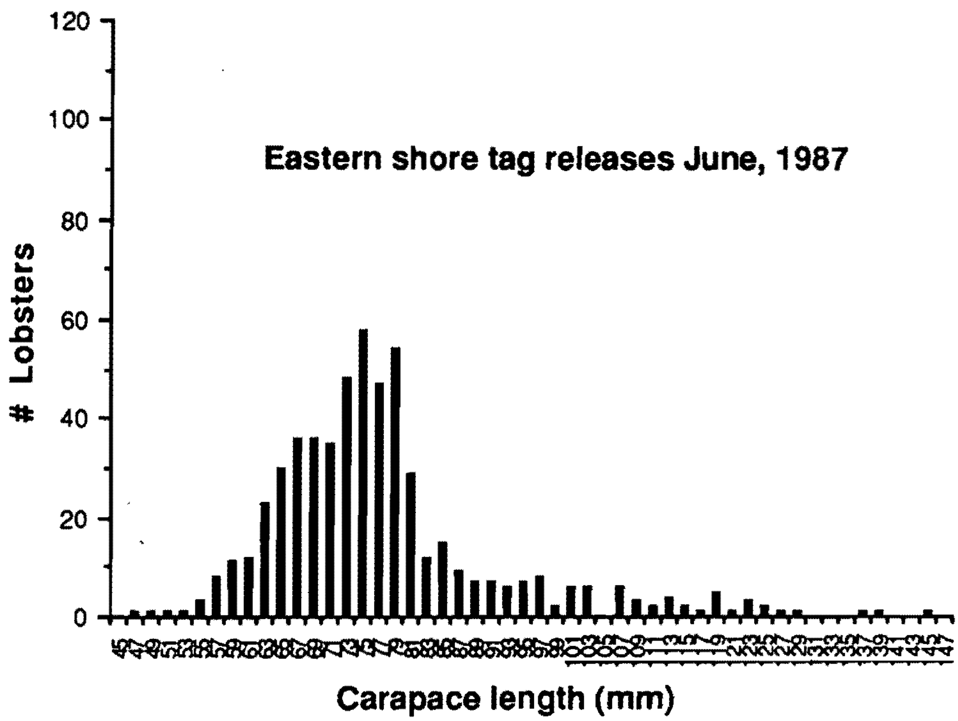

Figure 11. length frequency, tagged lobster releases Eastern shore 1987