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The Geographical Distribution of Capelin (*Mallotus villosus*) in the Northwest Atlantic Based on Tagging Experiments

by

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Abstract

Approximately 57,000 mature capelin were tagged with external tags from 1983 to 1988 along the southeast and east coasts of Newfoundland and approximately 23,000 offshore to determine prespawning migration patterns and to re-examine the current beliefs that two separate capelin stocks spawn on beaches on Newfoundland's east coast and that mature capelin in Div. 30, south of the Avalon Peninsula, will spawn on the Southeast Shoal. Percent recaptures were higher when marked fish were released during the fishery than released before fishing had started. Capelin released in a particular bay either were recaptured from the same bay or were returned from locations further north. Capelin released on Whale Bank, Woolfall Bank, and in the Avalon Channel were generally caught inshore. This northward distribution of tags suggests that prespawning migration of capelin was contranatant. Evidence supporting a denatant migration of larvae and juveniles is presented. Upstream migration using the Labrador Current was hypothesized as a directional clue to the prespawning migration. Clearly capelin from the Northeast Newfoundland-Labrador and Northern Grand Bank-Avalon stocks were mixing and migrating north together. Combining these two stocks into a single stock complex encompassing the entire southeast and east coasts of Newfoundland would be compatible with the distribution of tag returns and would explain why earlier studies to differentiate fish between the two areas have been unsuccessful. Tags returned from marked capelin released on Whale Bank and caught during the Newfoundland inshore fisheries in NAFO Div. 3L and Div. 3K suggest that some portion of these stocks reside in NAFO Div. 30. Regardless of the number of stocks in the area, the distribution and mixture of prespawning fish as described by tag returns has

potential implications on how capelin resources should be surveyed, assessed, and managed in the Northwest Atlantic.

Introduction

For a commercially-important species such as capelin (Mallotus villosus) how we assess and manage capelin resources is predicated on our understanding of the degree of separation among well-defined stocks. Each spring mature capelin in the northwest Atlantic Ocean undergo extensive migrations from offshore feeding areas to spawn on beaches along the coastlines of Newfoundland and Labrador (Templeman 1948, Campbell and Winters 1973) or to spawn offshore on the Southeast Shoal (Carscadden et al. 1989). The nature of the migration remains largely unknown, the inference being that once fish are near the coast or within the bay proper they tend to spawn on nearby beaches.

The evidence in support of the current stock structure used to assess and manage capelin resources on Newfoundland's east coast is tenuous and circumstantial. Based on seasonal distribution patterns observed from research vessel surveys, Campbell and Winters (1973) proposed that capelin in the northwest Atlantic were composed of three inshore spawning stocks (Northeast Newfoundland-Labrador stock in NAFO SA2 + Div. 3K, Northern Grand Bank-Avalon stock in NAFO Div. 3L, St. Pierre Bank stock in NAFO Div. 3Ps) and one offshore spawning stock (the Southeast Shoal in NAFO Div. 3NO). Recent attempts to discriminate individual fish between the Northeast Newfoundland-Labrador and Northern Grand Bank-Avalon stocks have largely been unsuccessful (Sharp et al. 1978, Carscadden and Misra 1980, Palsson 1986). Misra and Carscadden (1984) in a reanalysis of their original meristic data published in 1980 were only able differentiate fish between these two stocks using paired comparisons of very extensively analyzed data. At this point one questions whether the accepted stocks are biologically different or merely statistically different.

A tagging programme within the bays of the southeast and east coasts of Newfoundland and in offshore areas south and east of the Avalon Peninsula was designed to elucidate the migration patterns of prespawning capelin schools found in offshore areas and in the bays along the coast in May and June. I also considered the current stock designations which assume that mature capelin spawning inshore on beaches between Cape St. Mary's and Cape Freels (Fig. 1) constitute the Northern Grand Bank-Avalon stock, those spawning north of Cape Freels form the Northeast Newfoundland-Labrador stock, and capelin fished in May

on Whale Bank in Div. 3O are destined to spawn on the Southeast Shoal. Canadian acoustic surveys on the NAFO SA2 + Div. 3K, Div. 3L, and Div. 3NO capelin stocks are conducted at different times of the year and coverage assumes that each stock remains within the designated NAFO Divisions although Carscadden and Misra (1980) noted that the Northern Grand Banks may be a mixing zone for NAFO Div. 3L and Div. 3NO stocks.

Materials and Methods

TAG SELECTION

Earlier tagging experiments on capelin populations have utilized internal metal tags which rely on magnetized metal detectors for recovery (Dommasnes 1978, Dommasnes et al. 1978). This procedure is effective for a large-volume meal fishery or when catches are landed at a few known locations. However the inshore commercial capelin fishery in Newfoundland is primarily directed at roe-bearing females while males are generally discarded. In this instance fish are landed in large numbers by many vessels all over the island and sometimes transported hundreds of kilometres by truck making logistics to screen the catch for internal tags impractical. Therefore external tags were chosen as the most visible means to obtain reliable information on location and date of recapture.

Initially in 1983 I experimented with two external tag types; a short anchor (FLOY FD68BC, 20 mm tubing) and a streamer (FLOY FTSL-73, 95 mm ribbon). Owing to the small size of capelin other types of external tag beside short anchors and streamers were considered impractical to test. Since 1984 only streamer tags have been used. During the 1983 experiments we were able to apply streamer tags at a significantly faster rate than short anchor tags. Also short anchor tags caused more damage to the fish especially to females which are characteristically smaller than males (Templeman 1948). The streamers were thin yellow ribbons, each having an abbreviated return address and a sequential alpha-numeric number to keep track of individual fish. Because the sex of mature capelin in the spring can be differentiated based on external characteristics (Winters 1970), separate designations were given to male and female tags.

TAGGING METHOD

To tag capelin within the bays prior to spawning in May and June extensive searching patterns using sonars were conducted daily. From 1983 to 1986 two purse seiners and in 1987 and 1988 one purse seiner were deployed to find and catch capelin schools. In 1983 all releases were in Conception Bay; in 1984 and 1986 they were in Conception and Trinity Bays; in 1985 fish were released in Conception, Trinity, and Bonavista Bays; in 1987 capelin were tagged in St. Mary's, Trinity, Bonavista, and Notre Dame Bays; and in 1988 capelin were tagged in St. Mary's Bay (Table 1). When a school was caught in a purse seine set small numbers of capelin were carefully dipped aboard and held briefly in plastic containers (130 l) filled with seawater on deck.

To tag capelin in offshore areas in May prior to spawning, we searched for fishable concentrations of capelin using an echosounder on the Lady Hammond each May from 1988 to 1990. In 1988 capelin were tagged and released on Green Bank, Whale Bank, Woolfall Bank, and in the Avalon Channel; in 1989 marked capelin were released on Woolfall Bank and in the Avalon Channel; and in 1990 on Whale Bank, Woolfall Bank, and in the Avalon Channel (Table 2). Schools were captured in midwater trawl sets and up to 3000 fish were held on deck in insulated fish boxes (455 l) in fresh seawater. Small lots of 50 to 75 tagged fish were released gently over the side of the vessel.

Only mature fish (i.e. fish that would spawn in June or July of that year) in good condition were tagged and released. Tagging continued until fish appeared sluggish or sufficient numbers of tagged fish had been released at a particular location. To minimize initial mortalities we tagged fish in as short a time as possible (generally not more than two hours after capture), assuming that mortality increased with handling and holding time as shown for Atlantic herring (Nakashima and Winters 1984).

RECAPTURES

Recaptures of tagged fish were expected from inshore fishermen, the offshore foreign fishery, fish plant workers, and the general public. The advantage of using external yellow tags was because capelin caught in the

commercial fishery were handled to test for quality, to separate males from females, and to pack females into boxes on production lines. Posters advertising the tagging programme and offering a $5.00 reward were displayed in Department of Fisheries and Oceans offices and fish plants around the island. In addition, repeated announcements during the fishing season were made on a province-wide radio programme which focuses on fishery-related issues. Observers based on foreign vessels fishing capelin inside Canada's 200-mile fishing zone were also made aware of the tagging programme.

Recapture information was carefully scrutinized. The nature of the fishery was such that exact time and location of capture may have been difficult to determine, especially from fish plant workers. Factors which could have led to poor information were trucking of the catch to different fish plants, inability by plant workers on the production line to know where the catch was actually taken, and length of time taken from when the tag was found to when it was reported. Information from tag recoveries was verified and discrepancies were followed up either with telephone calls or in a mailed questionnaire. Time and location of capture reliability codes were assigned to each tag (1=highly reliable, 2=some doubt but acceptable, 3=unreliable). When estimating total recapture rates all returns were considered, however only those with a 'highly reliable' code were used to address questions regarding migration patterns and stock mixtures.

ANALYSIS

To examine patterns in coastal capelin migration all tag types and years of release were combined according to the bay that fish were initially captured and released. The actual number of recaptures and the number of recaptures adjusted for fishing effort (catch) were estimated for each bay. Fishing effort varied among bays and among years which would influence the number of recaptures. Because no measure of overall effort was available for every area for all years reported landings by bay provided by the Statistics Branch of the Department of Fisheries and Oceans (Table 2) were assumed to be representative of effort. Recaptures by bay were standardized to represent the number of recaptures for every 10,000 t of capelin landed. Recaptures from the offshore tagging experiments were not standardized for effort.

Results

RECAPTURES

Percent recaptures of streamer tags in 1983 and 1984 were higher when marked capelin were released after the fishery was in progress than when tagged fish were released before the fishery was well underway (Table 4). For short anchor tags in 1983 no difference was observed in percent recaptures of tagged males before and during the fishery, whereas the percent recapture of tagged males was greater before than during the fishery (Table 4). For these comparisons I assumed that fishing began in each bay (Table 1) when the first 1000 t were landed and landings continued to increase thereafter. Obviously the rate of recapture was optimal when marked fish were released during the fishery, however the information content from such releases was negligible.

Out of 57,523 fish tagged inshore from 1983-88 (Table 1) and the 22,931 tagged offshore (Table 2), 20 tagged fish were recovered the following year (Table 4) indicating that they were spawning for a second time. Of these 20 fish, 8 were originally tagged and released in Conception Bay and 12 in Trinity Bay. From the Conception Bay releases 6 were returned from Conception Bay, 1 from Trinity Bay, and 1 from the Southern Shore. From the Trinity Bay taggings, 5 tags were returned from Trinity Bay, 3 from Conception Bay, 3 from Bonavista Bay, and for one return the recapture site was unknown.

DISTRIBUTION OF RECAPTURES

Evidence from tag returns suggests that capelin spawn in the bay they are released into or they migrate northward to spawn in another area upstream from the release point. During 2 years (1987-88) of tagging in St. Mary's Bay, five marked capelin were recaptured further north on the Southern Shore and one in Conception Bay (Fig. 2). No marked capelin released in St. Mary's Bay were recaptured in St. Mary's Bay. Fish tagged in Conception Bay from 1983 to 1986 were found either in Conception Bay itself or further north in Trinity, Bonavista, and Notre Dame Bays (Fig. 3). Capelin marked in Trinity Bay from 1984 to 1987 before the fishery began in earnest were recaptured from Trinity Bay and from bays further north such as Bonavista Bay, Notre Dame Bay, and White Bay (Fig. 4). An exception to the pattern was one tag returned from Conception Bay (Fig. 4). Fish released in Bonavista Bay in 1985 and 1987 were

caught in Bonavista Bay and Notre Dame Bay (Fig. 5). Tagged capelin from a single experiment in 1987 near Fogo Island, Notre Dame Bay were recaptured in Notre Dame Bay, west of the release point (Fig. 6). The only instances of marked fish being recaptured downstream from the release area were four capelin recaptured in Conception Bay having been released near Spaniards Cove, Trinity Bay and one marked capelin caught in Conception Bay 42 days after being released near English Harbour, Trinity Bay (Fig. 4). Except for these five fish all recaptures were returned from the bay of release or from locations north of the release point.

Of the 19 recaptures from the offshore tagging experiments, 17 returns were northeast of their respective release sites (Fig. 7,8,9) and two were near the release site (Fig. 7). One tag from the 1988 tagging experiments on Whale Bank (Table 2) was returned in 1988 and another tag released in the same area in 1990 (Table 2) was returned in 1990 both from the Soviet capelin fishery operating in NAFO Div. 30 in May. Ten tags from the 1990 tagging experiments on Whale Bank were returned during the inshore capelin fishery in 1990; two from Conception Bay, four from Trinity Bay, two from Bonavista Bay, and two from Notre Dame Bay (Fig. 7). One tagged male capelin released in the Avalon Channel in 1988 was recaptured 55 days later in Bonavista Bay (Fig. 8). From the tag releases on Woolfall Bank from 1988-90, three returns were from Conception Bay, two from Trinity Bay, and one from Bonavista Bay (Fig. 9).

Discussion

The results of tagging experiments indicate that maturing capelin occurring offshore on banks south and east of the Avalon Peninsula migrate north and east towards inshore areas to spawn (Fig. 7-9). Mature capelin captured and released along coastal areas of the southeast and east coast of Newfoundland in May and June prior to spawning either remain in the same area to spawn later or migrate out of the release area to spawn on beaches further north and west (Fig. 2-6). Except for five fish released in Trinity Bay and recaptured later in Conception Bay, all other recaptures in the same year as they were released were reported from either the bay where the tagged fish were released or from sites further north. The results suggest that mature capelin were capable of migrating long distances. Furthermore, fish tagged and released from the same school did not necessarily migrate together to spawn in the same bay.

During 1983-88, 20 fish were recaptured one year after being released (Table 4). While the numbers are small compared to the numbers released, it does demonstrate that some proportion of each year's spawners consists of repeat spawners. In May 1966 Winters (1971) found repeat spawning females based on previous year's spawning zones on otoliths.

The pattern of tag returns along the east coast (Fig. 2-9) suggests a contranatant migration consisting of mature adults returning to spawning beaches from which they as capelin larvae were initially dispersed (Harden Jones 1968). Larvae emerging from intertidal sediments in June and July are rapidly advected from embayments into the open bay in as little as 6 to 8 hours (Taggart and Leggett 1987). Results of ichthyoplankton surveys in Trinity Bay (E. Dalley, Northwest Atlantic Fisheries Centre, St. John's, pers. comm.) and Conception Bay (Anderson and Penney 1991) in July and August showed that capelin larvae were displaced by the current flowing out of the southeastern side of these bays and onto the Grand Banks by late summer. Soviet prerecruit surveys in November and December have found significant concentrations of 0-group and 1-year-old capelin between 43°N and 48°N latitude on the Grand Banks (Bakanev and Oganin 1988, Bakanev et al. 1990). During annual Canadian acoustic surveys conducted on the Grand Bank in NAFO Div. 3L in May, Miller and Carscadden (1989) observed a pattern of older mature capelin occurring in the southern part of the survey area and younger, smaller fish in the north. These separate survey results taken together support a denatant migration of larval capelin from spawning beaches onto the Grand Banks with a general southerly migration as fish become older. These fish may drift into NAFO Div. 3O, as far south as the southwest part of the Grand Bank. In the spring there is a contranatant migration of prespawning adults north and east to spawn on beaches in Newfoundland completing the cycle.

I hypothesize that the most likely mechanism employed by prespawning capelin is to migrate upstream against a detectable current. The Labrador Current flows southward along the Labrador Coast and east coast of Newfoundland (Petrie and Anderson 1983). In the vicinity of Cape Bonavista the Labrador Current divides into an offshore and an inshore branch with the inshore branch proceeding south near the coastline following the Avalon Channel (Petrie and Anderson 1983). A counter-clockwise current was observed by Bailey (1958) in Trinity Bay in September 1956. Based on current mooring data collected from

June to October 1984, Yao (1986) showed that the alongshore component of the current into Trinity Bay was on the northwest side and out of the Trinity Bay it was on the southeast side. Therefore, the southward flow of the Labrador Current, especially the inshore branch and the counter-clockwise current flow inside the long bays may provide the directional clue that capelin could use to follow a northward counter-current migration route. The northward displacement of recaptures presented in Figures 2-9 strongly supports a contranatant migration pattern. When searching each bay for capelin to tag schools were consistently located in areas where capelin could take advantage on the northwest side of the current flow into Trinity (Fig. 4) and possibly Conception Bays (Fig. 3), the inshore branch through the Avalon Channel (Fig. 2,7,8,9), and the Labrador Current itself flowing from the northern tip of the island southward onto the Grand Banks (Fig. 5, 6). The same currents possibly used in a contranatant migration of adults could also be employed during the denatant migration phase. The actual migratory path was not observed, however the recapture data along with known current patterns in the northwest Atlantic provide sufficient evidence to advance the hypothesis that prespawning capelin follow a contranatant migration pattern, possibly employing current direction as a clue. Other fish species such as herring, salmon, cod, eels, and plaice have been observed to respond to water currents with rheotactic swimming movements (e.g. Harden Jones 1968, Arnold 1974, 1981, Westerberg 1979, 1984). Unfortunately recapture data contain no information on the way capelin arrived at their destination. A counter-current mechanism seems intuitively appealing, however some other clue such as water temperature or olfactory signals may eventually be discovered as the true mechanism.

Tag return data show that capelin from two stock areas, the Northeast Newfoundland-Labrador and Northern Grand Bank-Avalon, intermingle for some time period before and throughout their offshore and inshore prespawning migrations. Two possible interpretations exist. The two stocks are distinct at spawning but mix extensively at some point in their life history prior to spawning or else capelin populations along the southeast and east coast of Newfoundland constitute one stock complex. Either interpretation has profound consequences for the manner in which acoustic biomass surveys and fisheries management decisions are undertaken. If two distinct stocks exist as is the present basis for management (Campbell and Winters 1973), then the results from the tagging experiments demonstrate that capelin from the Northeast Newfoundland-Labrador stock migrate as far south as Whale Bank in Div. 30 mixing with the Northern Grand Bank-Avalon stock before migrating north to spawn on beaches in Notre Dame

Bay and White Bay. Canadian acoustic surveys designed to assess the two stocks as separate entities may not be covering the total area where each stock is distributed because the surveys assume that stocks do not overlap and that the entire stock is distributed within the NAFO-defined stock areas. It is conceivable that some portion of the Northeast Newfoundland-Labrador stock may be distributed south of the fall Canadian acoustic survey which currently operates from Hamilton Bank to Cape Freels (Fig. 1).

The second possibility is that capelin from St. Mary's Bay to Cape Bauld are from a single stock complex based on the general distribution of tag returns of tagged capelin released in St. Mary's, Conception, Trinity, and Bonavista Bays (Fig. 2-5) and on Whale Bank, Woolfall Bank, and the Avalon Channel (Fig. 7-9). These results would explain the difficulty encountered in differentiating capelin samples from the Northeast Newfoundland-Labrador and Northern Grand Bank-Avalon areas as coming from two distinct stocks (Sharp et al. 1978, Carscadden and Misra 1980, Misra and Carscadden 1984, Palsson 1986). Acceptance of a single capelin stock extending from Whale Bank in NAFO Div. 30 to Cape Bauld would require changes to the biological sampling scheme, the timing and coverage of acoustic biomass surveys, and the basis of catch and TAC assignments. The evidence presented herein supports a needed review of the structure of capelin stocks in the northwest Atlantic based on the known distribution and migration of various life history stages.

Inshore tag return data to date cannot conclusively distinguish between the notion of one or two stocks of capelin along the southeast and east coasts of Newfoundland. However, the data demonstrate that during the annual spawning migration of capelin along the coast capelin populations from disperse spawning sites co-occur in the same schools. Fish caught within the bays prior to spawning can consist of two types: 1) individuals maturing and waiting in the area for the right environmental conditions to initiate spawning and 2) individuals intercepted during their migration to spawn on beaches further north. The limited returns from offshore tagging experiments in May support the overall pattern indicated by inshore tag returns. There is also sufficient evidence to conclude that some proportion of the maturing capelin observed and caught in NAFO Div. 30 on Whale Bank in May are from the Northeast Newfoundland-Labrador stock (NAFO SA2 + Div. 3K) and the Northern Grand Bank-Avalon stock (NAFO Div. 3L).

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Table 1. Location, date when inshore commercial fishing began, date of release, and number of capelin tagged and released during inshore tagging experiments.

Year	Bay	Date fishing began	Location	Release date	No. tags released	
					Males	Females
1983	Conception	Jun 14	Upper Island Cove	May 29	1275	350
			Salmon Cove	May 31	525	1025
			Harbour Grace Islands	Jun 2	600	825
			Salmon Cove	Jun 21	1850	1350
			Salmon Cove	Jun 23	600	2650
			Bacon Cove	Jun 27	1125	2075
			Harbour Grace Islands	Jun 28	1800	1775
1984	Conception	Jun 11	Port de Grave	May 23	800	900
			Broad Cove	May 24	600	200
			Salmon Cove	May 25	700	300
			Upper Island Cove	May 26	600	400
			Bacon Cove	May 26	300	300
			Western Bay	May 29	1100	1300
	Trinity	Jun 13	East Random Head	Jun 6	600	600
			Horse Chops	Jun 14	900	300
			Spaniards Cove	Jun 21	1800	300
1985	Conception	Jun 27	Lower Island Cove	May 27	700	800
	Trinity	Jun 27	Southwest Arm	Jun 1	300	300
			Southwest Arm	Jun 18	400	500
			Bonaventure Head	Jun 25	700	400
			Melrose	Jun 26	400	400
			Horse Chops	Jun 26	500	400
			Trinity	Jun 27	300	600
	Bonavista	Jun 28	Greenspond	Jun 29	500	500
			Bessie's Island	Jul 1	400	600
			Bessie's Island	Jul 2	700	700
			Sandy Cove	Jul 3	400	300
1986	Trinity	Jun 5	Trinity	May 24	400	700
			Bonaventure Head	May 24	600	600
	Conception	Jun 13	Broad Cove	Jun 7	300	600
1987	St. Mary's	Jun 18	Colinet Island	May 29	600	600
			Little Salmonier Point	May 30	600	600
			Harricot Point	May 31	500	500
			Colinet Island	May 31	400	400
			Colinet Island	Jun 1	300	300
	Trinity	Jun 19	Trinity	Jun 10	600	600
			Smith Sound	Jun 11	500	500
	Bonavista	Jun 19	Sandy Cove	Jun 13	300	300
			Greenspond	Jun 14	400	400
			Fair Island	Jun 19	250	600
			Bloody Bay Reach	Jun 20	450	400
			Bessie's Island	Jun 20	400	400
			Long Island	Jun 21	50	500
	Notre Dame	Jun 19	Cape Fogo	Jun 17	700	700
1988	St. Mary's	Jun 15	Colinet Island	Jun 13	449	499

Table 2 . Location, date of release, and number of capelin tagged and released during offshore tagging experiments.

Year	NAFO Div.	Location	Release date	No. tags released	
				Males	Females
1988	3Ps	Green Bank	May 10	1069	719
	3O	Whale Bank	May 11	630	969
	3L	Avalon Channel	May 7	435	350
			May 12	500	600
			May 13	459	600
			May 14	488	450
		Woolfall Bank	May 14	953	850
			May 16	323	399
			May 19	778	600
1989	3L	Avalon Channel	May 9	178	200
			May 10	600	540
			May 11	424	400
		Woolfall Bank	May 9	822	799
			May 10	1000	660
1990	3O	Whale Bank	May 9	1797	1173
			May 10	500	424
	3L	Avalon Channel	May 11	200	200
		Woolfall Bank	May 11	200	300
			May 12	700	500
			May 13	100	42

Table 3. Inshore capelin landings (t) by area for the Northern Grand Bank-Avalon and Northeast Newfoundland-Labrador stocks, 1983-88.

Year	St. Mary's Bay	Southern Shore	Conception Bay	Trinity Bay	Bonavista Bay	Notre Dame Bay	White Bay
1983	1000	7	12015	8849	3203	3714	50
1984	1901	689	13522	11257	5891	5471	1646
1985	1417	390	10664	8985	3994	4697	2671
1986	6056	1451	17176	16795	6719	6075	5718
1987	712	771	4521	8617	4355	5359	3422
1988	4469	3447	17860	19856	7781	16106	10208

Table 4. Annual release and recapture data for streamer (S) and anchor (A) tag experiments conducted in 1983-88.

Year released	No. tags released	Tag type	Sex	Year recaptured		Percentage recaptured
				Same	Second	
Before Fishery						
1983	375	A	M	7		1.9
	1100	S	M	30		2.7
	125	A	F	4		3.2
	3000	S	F	45	2	1.6
1984	5600	S	M	96	1	1.7
	4300	S	F	93	1	2.2
1985	5300	S	M	102		1.9
	5500	S	F	62		1.1
1986	1300	S	M	23	1	1.8
	1900	S	F	21	1	1.2
1987	6050	S	M	41	2	0.7
	6800	S	F	45		0.7
1988	449	S	M	3		0.7
	499	S	F	3		0.6
During Fishery						
1983	3075	A	M	55	1	1.8
	2400	S	M	75		3.1
	950	A	F	9		1.0
	6700	S	F	217	3	3.3
1984	1800	S	M	169	8	9.8
	300	S	F	14		4.7

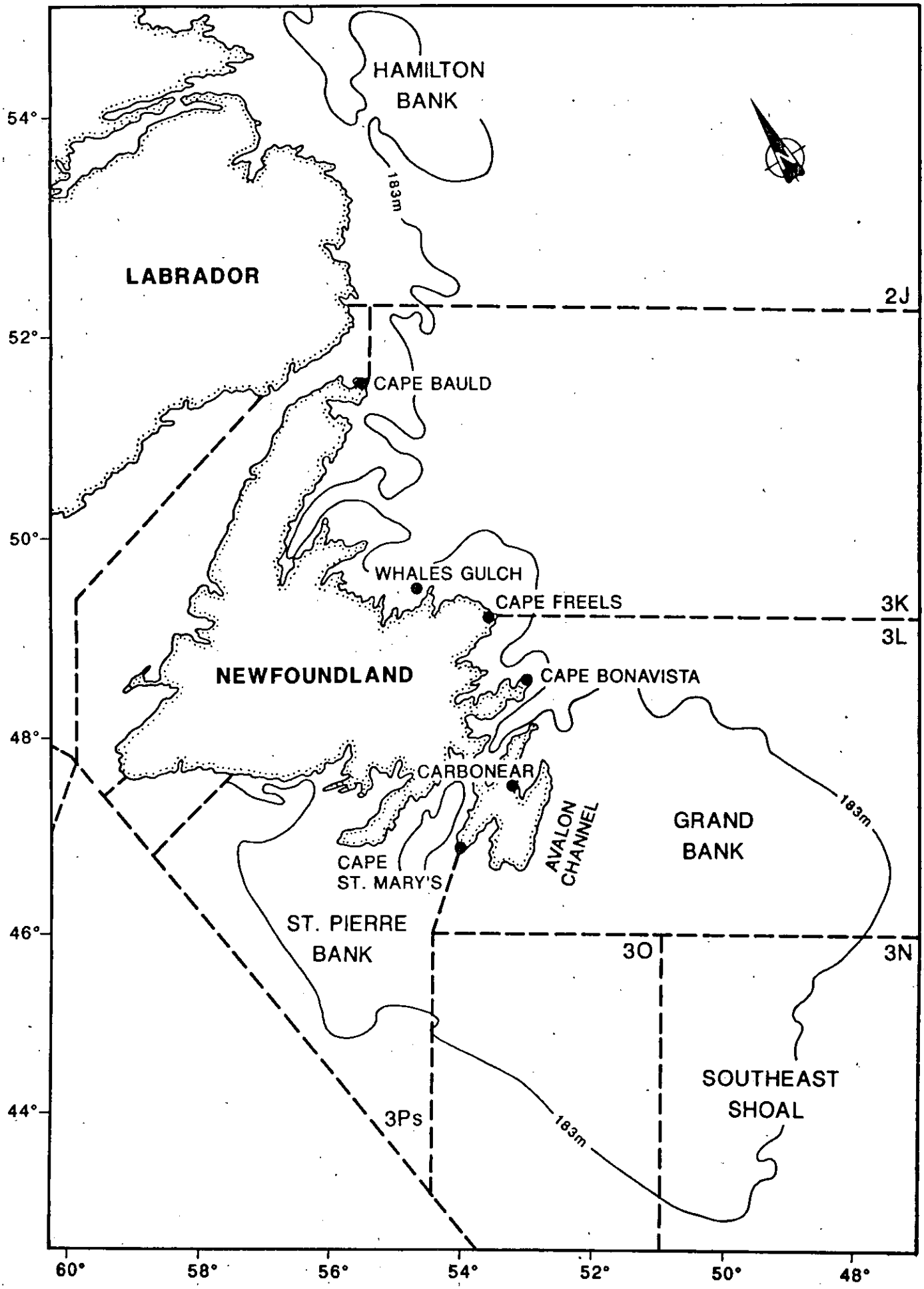

Figure 1. NAFO Divisions on the east and southeast coasts of Newfoundland.

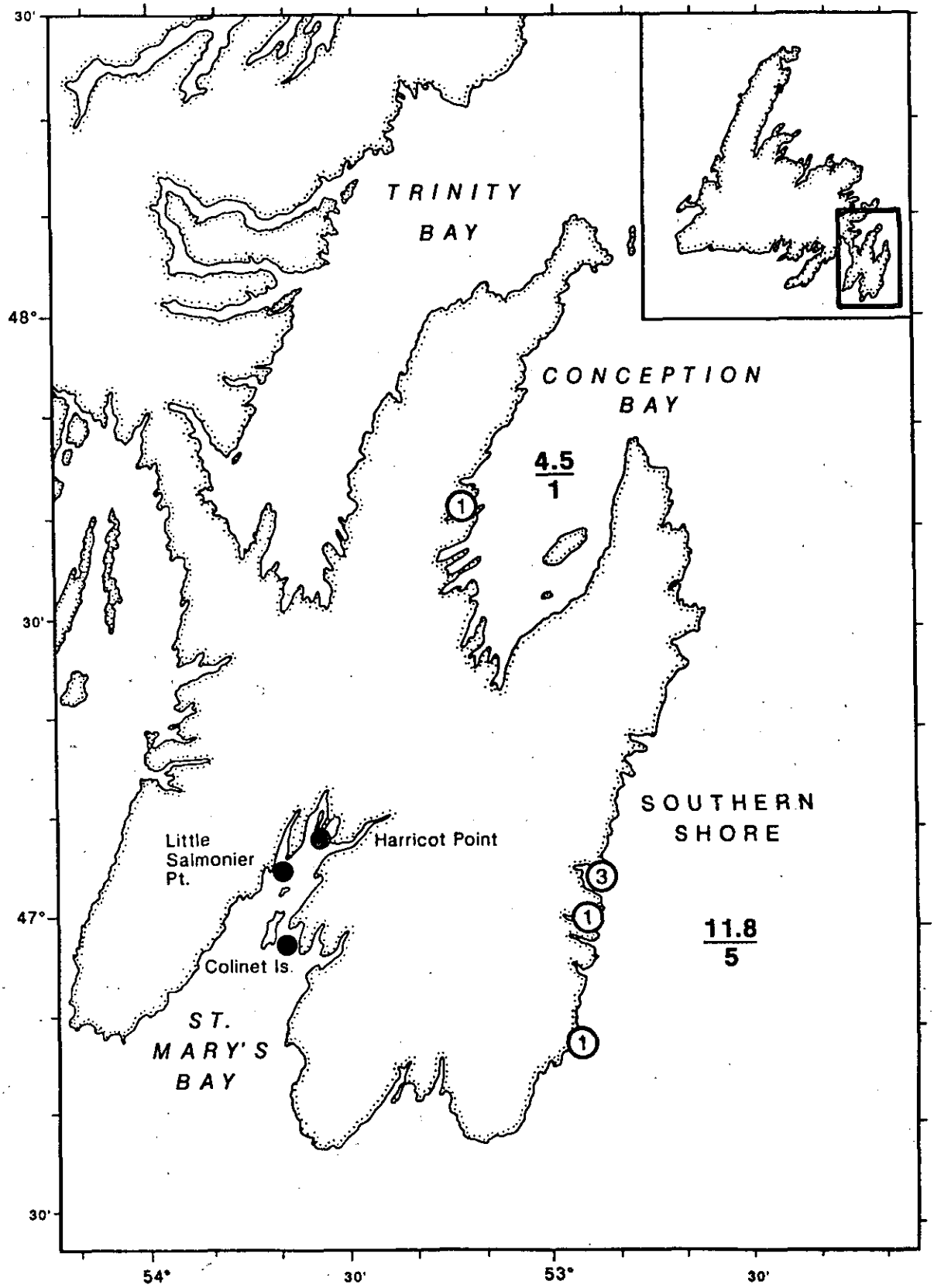

Figure 2. Locations where tagged capelin were released in St. Mary's Bay in 1987 and 1988 prior to the start of the fishery (●) and the recapture sites (○). The fraction has the standardized returns in the numerator and the actual returns in the denominator.

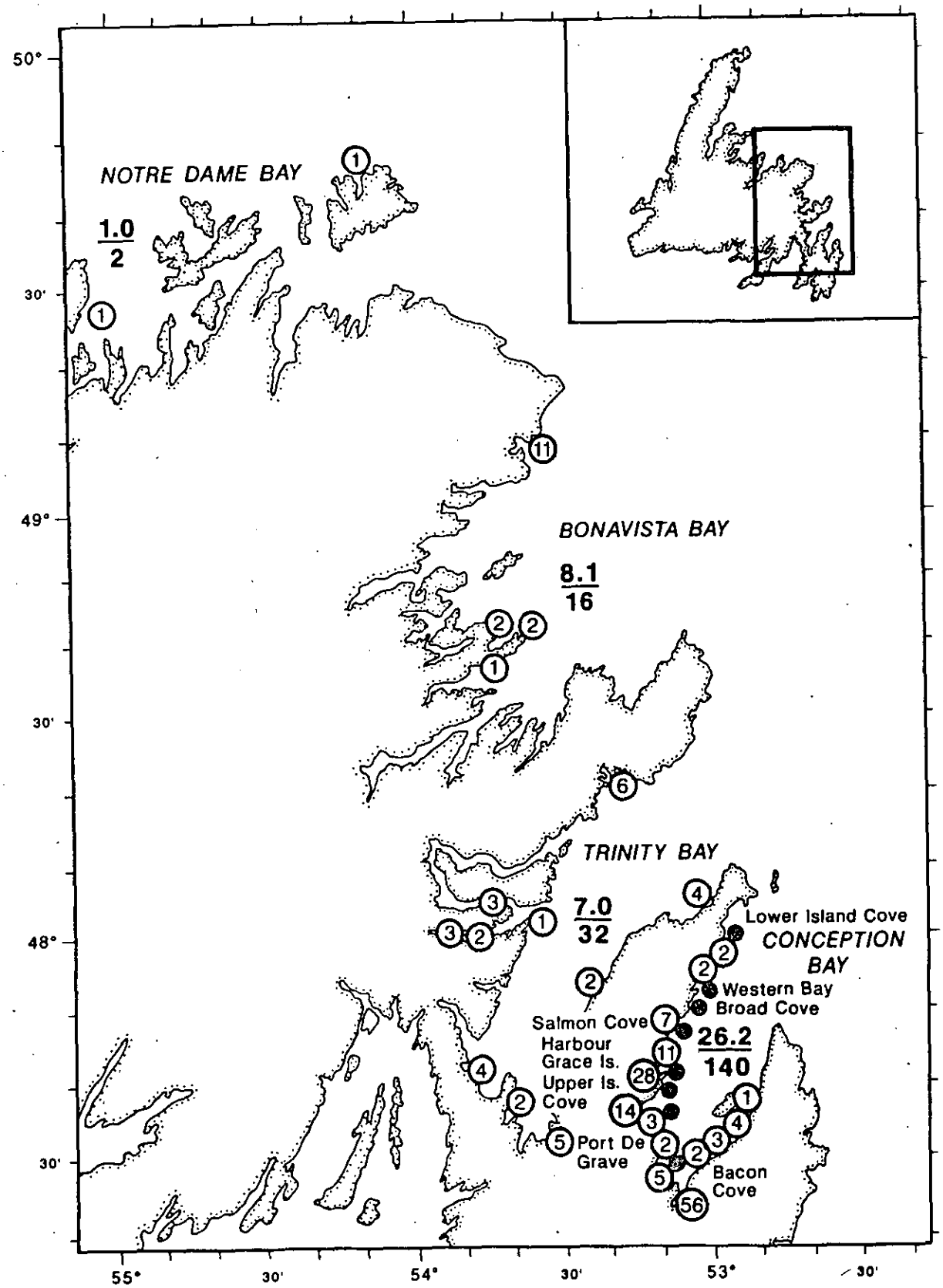

Figure 3. Locations where tagged capelin were released in Conception Bay from 1983 to 1986 prior to the start of the fishery (●) and recapture sites (○). The fraction has the standardized returns in the numerator and the actual returns in the denominator.

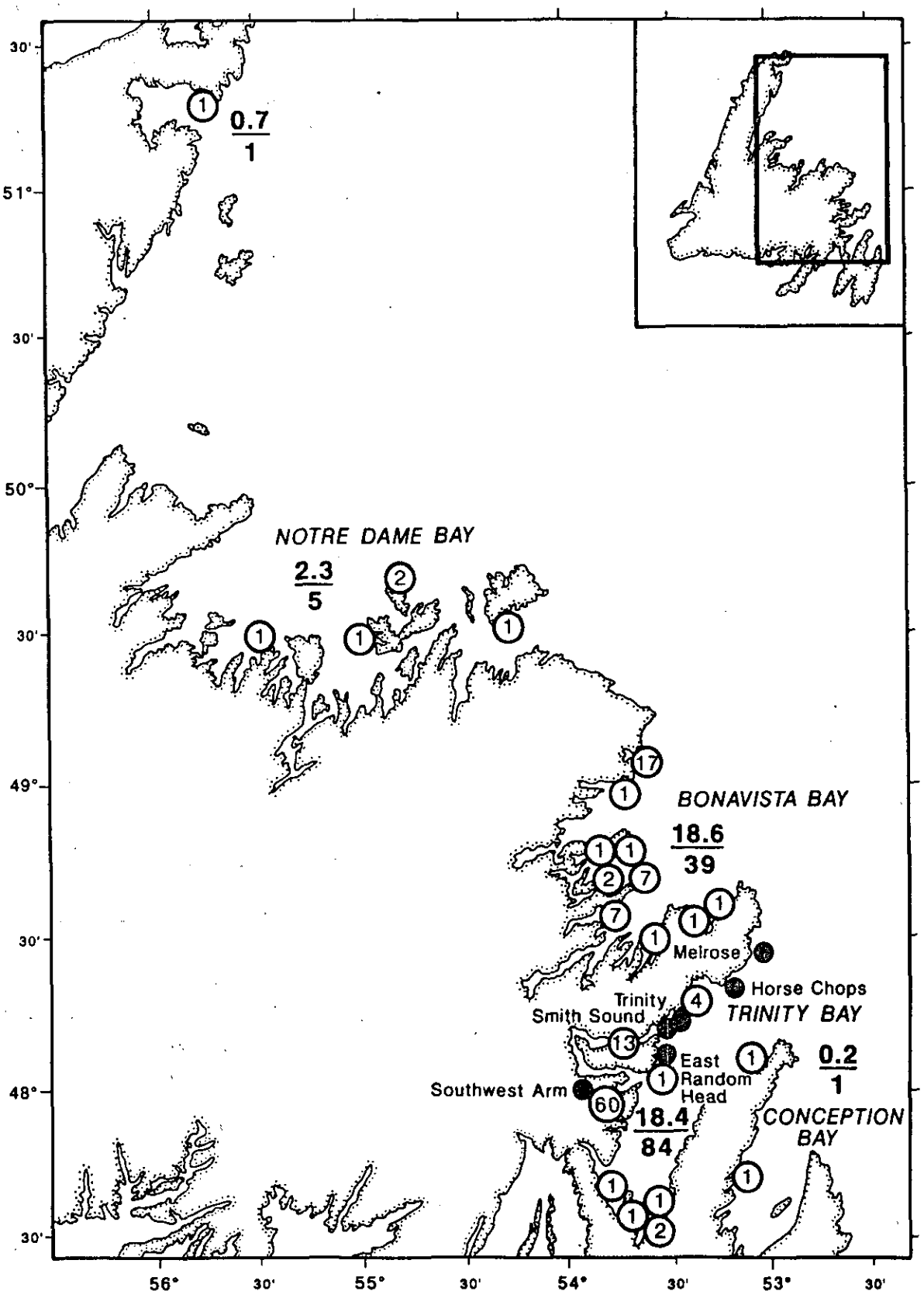

Figure 4. Locations where tagged capelin were released in Trinity Bay from 1984 to 1987 prior to the start of the fishery (●) and recapture sites (○). The fraction has the standardized returns in the numerator and the actual returns in the denominator.

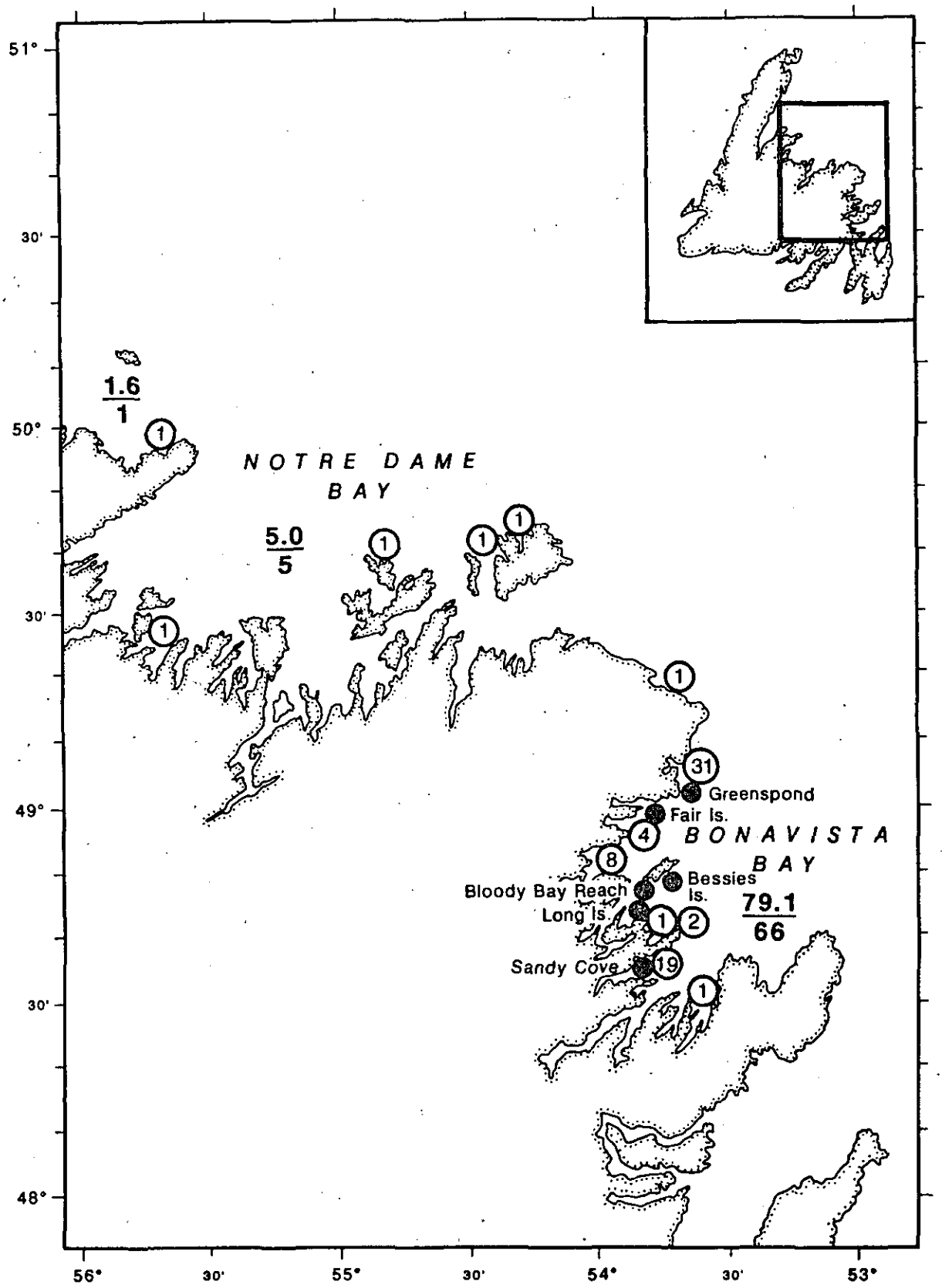

Figure 5. Locations where tagged capelin were released in Bonavista Bay in 1985 and 1987 prior to the start of the fishery (●) and the recapture sites (○). The fraction has the standardized returns in the numerator and the actual returns in the denominator.

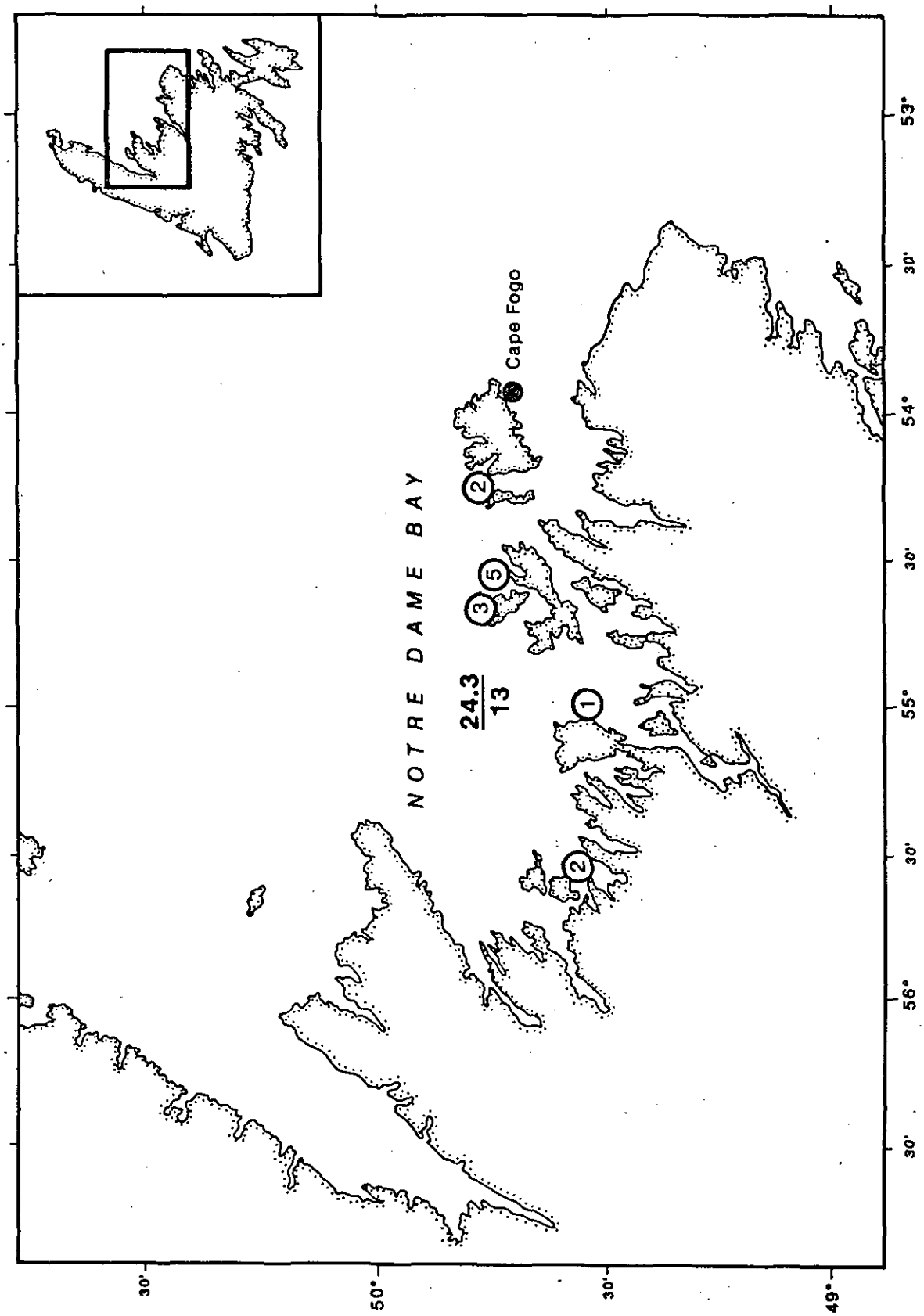

Figure 6. Location where tagged capelin were released in Notre Dame Bay on June 17 1987 prior to the start of the fishery (●) and the recapture sites (○). The fraction has the standardized returns in the numerator and the actual returns in the denominator.

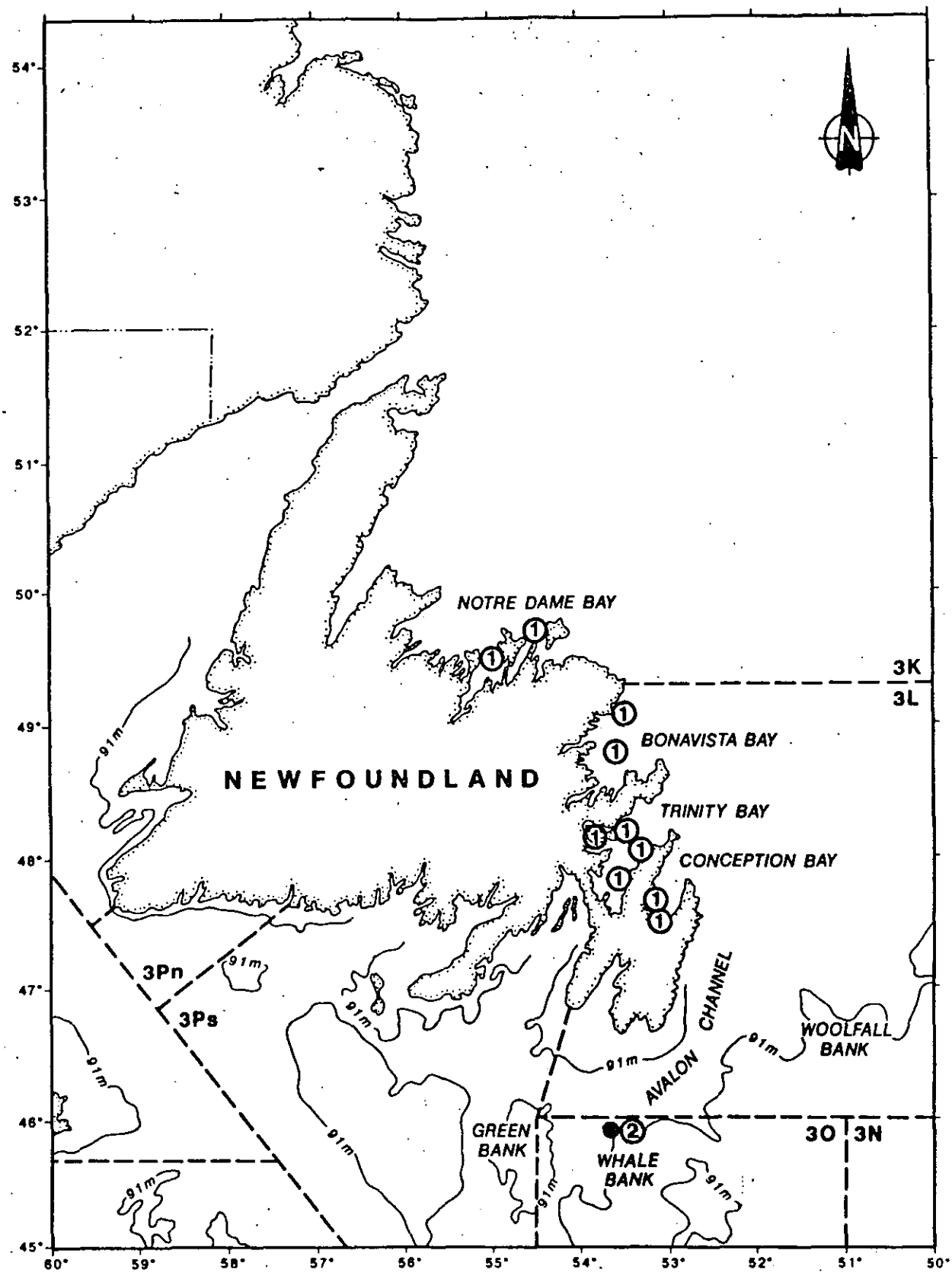

Figure 7. Location where tagged capelin were released on Whale Bank in 1988 and 1990 (●) and recapture sites (○).

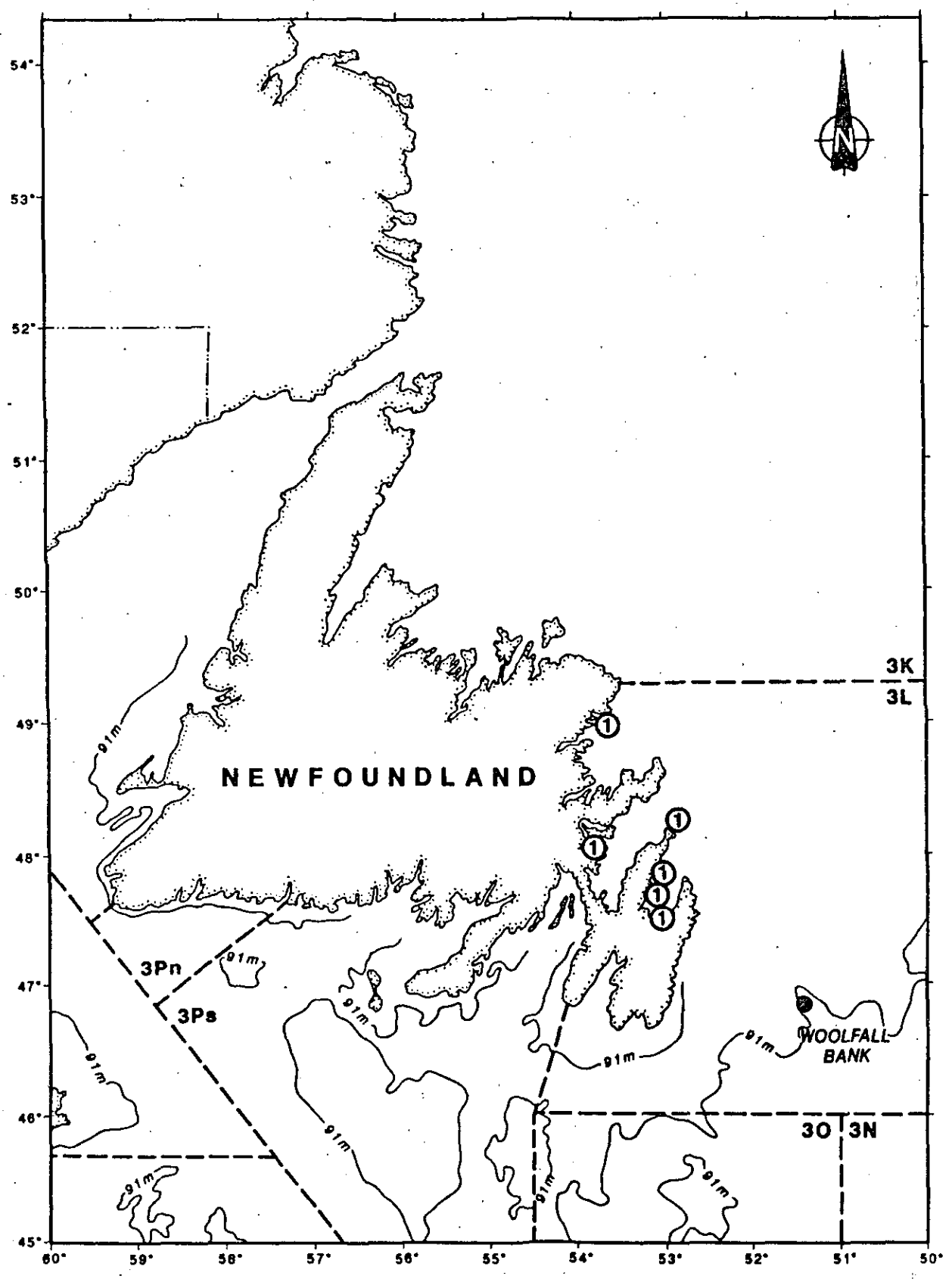

Figure 8. Location where tagged capelin were released in the Avalon Channel in 1988 (●) and recapture sites (0).

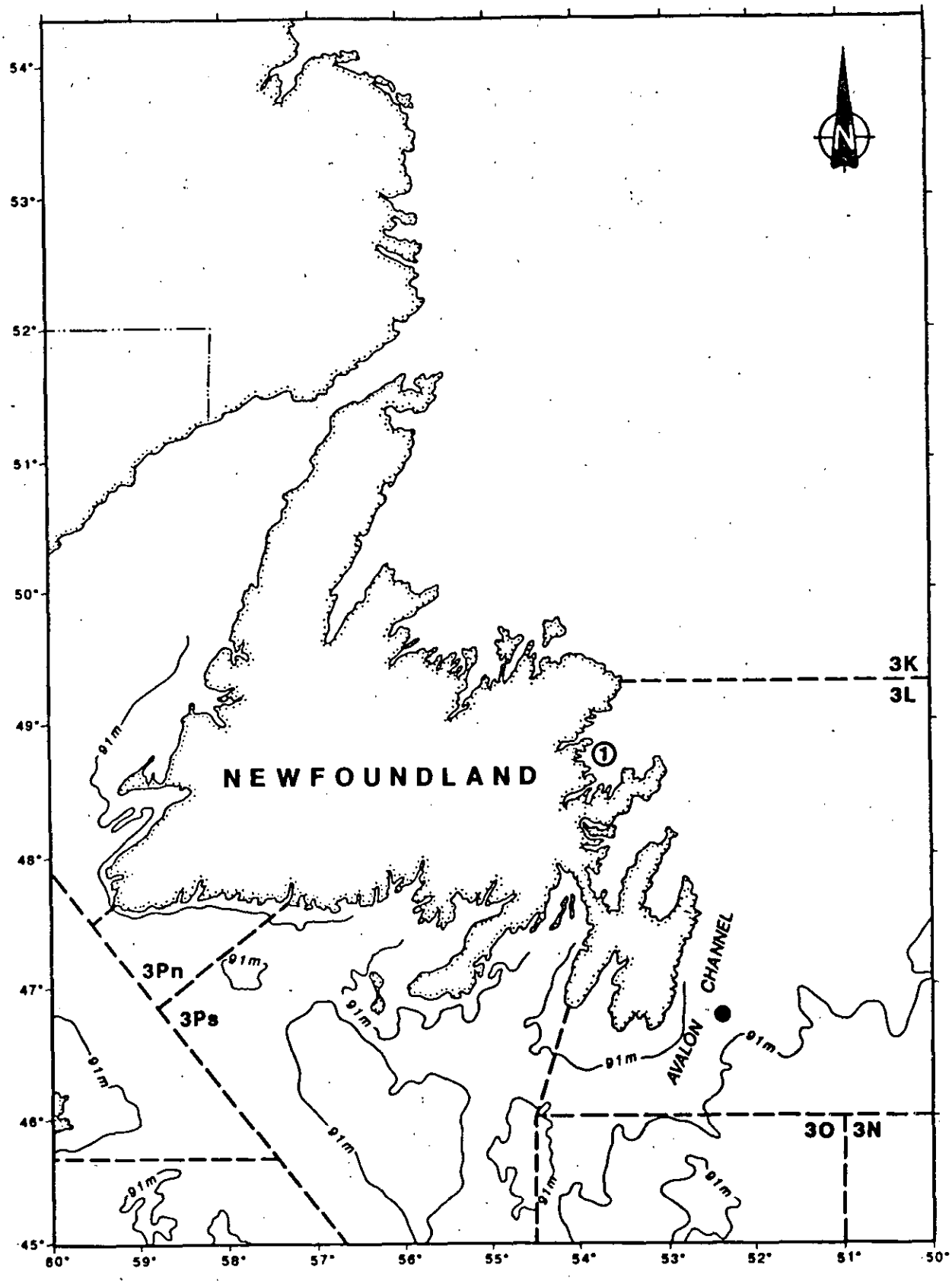

Figure 9. Location where tagged capelin were released on Woolfall Bank in 1988-90 (●) and recapture sites (○).