NOAA Technical Report NMFS SSRF-705

Migration and Dispersion of Tagged American Lobsters, *Homarus americanus*, on the Southern New England Continental Shelf

Joseph R. Uzmann, Richard A. Cooper, and
Kenneth J. Pecci

January 1977

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA TECHNICAL REPORTS

National Marine Fisheries Service, Special Scientific Report—Fisheries

The major responsibilities of the National Marine Fisheries Service (NMFS) are to monitor and assess the abundance and geographic distribution of fishery resources, to understand and predict fluctuations in the quantity and distribution of these resources, and to establish levels for optimum use of the resources. NMFS is also charged with the development and implementation of policies for managing national fishing grounds, development and enforcement of domestic fisheries regulations, surveillance of foreign fishing off United States coastal waters, and the development and enforcement of international fishery agreements and policies. NMFS also assists the fishing industry through marketing service and economic analysis programs, and mortgage insurance and vessel construction subsidies. It collects, analyzes, and publishes statistics on various phases of the industry.

The Special Scientific Report—Fisheries series was established in 1949. The series carries reports on scientific investigations that document long-term continuing programs of NMFS, or intensive scientific reports on studies of restricted scope. The reports may deal with applied fishery problems. The series is also used as a medium for the publication of bibliographies of a specialized scientific nature.

NOAA Technical Reports NMFS SSRF are available free in limited numbers to governmental agencies, both Federal and State. They are also available in exchange for other scientific and technical publications in the marine sciences. Individual copies may be obtained (unless otherwise noted) from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235. Recent SSRFs are:

649. Distribution of forage of skipjack tuna (*Euthynnus pelamis*) in the eastern tropical Pacific. By Maurice Blackburn and Michael Laurs. January 1972, iii + 16 p., 7 figs., 3 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

650. Effects of some antioxidants and EDTA on the development of rancidity in Spanish mackerel (*Scomberomorus maculatus*) during frozen storage. By Robert N. Farragut. February 1972, iv + 12 p., 6 figs., 12 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

651. The effect of premortem stress, holding temperatures, and freezing on the biochemistry and quality of skipjack tuna. By Ladell Crawford. April 1972, iii + 23 p., 3 figs., 4 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

653. The use of electricity in conjunction with a 12.5-meter (Headrope) Gulf-of-Mexico shrimp trawl in Lake Michigan. By James E. Ellis. March 1972, iv + 10 p., 11 figs., 4 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

654. An electric detector system for recovering internally tagged menhaden, genus *Brevoortia*. By R. O. Parker, Jr. February 1972, iii + 7 p., 3 figs., 1 app. table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

655. Immobilization of fingerling salmon and trout by decompression. By Doyle F. Sutherland. March 1972, iii + 7 p., 3 figs., 2 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

656. The calico scallop, *Argopecten gibbus*. By Donald M. Allen and T. J. Costello. May 1972, iii + 19 p., 9 figs., 1 table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

657. Making fish protein concentrates by enzymatic hydrolysis. A status report on research and some processes and products studied by NMFS. By Malcolm B. Hale. November 1972, v + 32 p., 15 figs., 17 tables, 1 app. table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

658. List of fishes of Alaska and adjacent waters with a guide to some of their literature. By Jay C. Quast and Elizabeth L. Hall. July 1972, iv + 47 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

659. The Southeast Fisheries Center bionumeric code. Part I: Fishes. By Harvey R. Bullis, Jr., Richard B. Roe, and Judith C. Gatlin. July 1972, xl + 95 p., 2 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

660. A freshwater fish electro-motivator (FFEM)-its characteristics and operation. By James E. Ellis and Charles C. Hoopes. November 1972, iii + 11 p., 2 figs.

661. A review of the literature on the development of skipjack tuna fisheries in the central and western Pacific Ocean. By Frank J. Hester and Tamio Otsu. January 1973, iii + 13 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

662. Seasonal distribution of tunas and billfishes in the Atlantic. By John P. Wise and Charles W. Davis. January 1973, iv + 24 p., 13 figs., 4 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

663. Fish larvae collected from the northeastern Pacific Ocean and Puget Sound during April and May 1967. By Kenneth D. Waldron. December 1972, iii + 16 p., 2 figs., 1 table, 4 app. tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

664. Tagging and tag-recovery experiments with Atlantic menhaden, *Brevoortia tyrannus*. By Richard L. Kroger and Robert L. Dryfoos. December 1972, iv + 11 p., 4 figs., 12 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

665. Larval fish survey of Humbolt Bay, California. By Maxwell B. Eldrige and Charles F. Bryan. December 1972, iii + 8 p., 8 figs., 1 table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

666. Distribution and relative abundance of fishes in Newport River, North Carolina. By William R. Turner and George N. Johnson. September 1973, iv + 23 p., 1 fig., 13 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

667. An analysis of the commercial lobster (*Homarus americanus*) fishery along the coast of Maine, August 1966 through December 1970. By James C. Thomas. June 1973, v + 57 p., 18 figs., 11 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

668. An annotated bibliography of the cunner, *Tautogolabrus adspersus* (Wilbaum). By Fredric M. Serchuk and David W. Frame. May 1973, ii + 43 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

669. Subpoint prediction for direct readout meterological satellites. By L. E. Eber. August 1973, iii + 7 p., 2 figs., 1 table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

670. Unharvested fishes in the U.S. commercial fishery of western Lake Erie in 1969. By Harry D. Van Meter. July 1973, iii + 11 p., 6 figs., 6 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

671. Coastal upwelling indices, west coast of North America, 1946-71. By Andrew Bakun. June 1973, iv + 103 p., 6 figs., 3 tables, 45 app. figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Continued on inside back cover

NOAA Technical Report NMFS SSRF-705

Migration and Dispersion of Tagged American Lobsters, *Homarus americanus*, on the Southern New England Continental Shelf

Joseph R. Uzmann, Richard A. Cooper, and Kenneth J. Pecci

January 1977

U.S. DEPARTMENT OF COMMERCE
Elliot L. Richardson, Secretary

National Oceanic and Atmospheric Administration
Robert M. White, Administrator

National Marine Fisheries Service
Robert W. Schoning, Director

CONTENTS

Figures

Tables

Migration and Dispersion of Tagged American Lobsters, *Homarus americanus*, on the Southern New England Continental Shelf

JOSEPH R. UZMANN, RICHARD A. COOPER, and KENNETH J. PECCI [1]

ABSTRACT

An apparently contiguous stock of American lobsters, *Homarus americanus*, is concentrated along the outer continental shelf margin and slope from Corsair Canyon westward and southward to the region of Baltimore Canyon. Between April 1968 and May 1971 we captured, tagged, and released a total of 7,326 lobsters at 52 localities between Corsair Canyon and Baltimore Canyon. As of December 1972, 945 recaptures (12.9% recovery) had been reported, providing a basis for interpretation of seasonal and long-term movements, as well as measurements of growth rate and moult frequency. A classification scheme is developed and applied to distinguish between apparently directed seasonal movements (migrations), localized movements of less than 10 nautical miles (18.5 km), and long-period (>120 days) dispersions of 10 miles or more. This last category includes point to point tracks that cannot be objectively resolved in terms of directionality and may represent random dispersal, a summation of seasonally directed tracks, or both.

We conclude from the track analyses that at least 20% of the offshore lobsters annually engage in directed shoalward migrations in spring and summer with return to the shelf margin and slope in fall and winter. This conclusion is reinforced by independent analysis of the time/depth/temperature associations of tagged lobsters at recapture which, of itself, suggests that an even larger proportion of the offshore lobsters annually effect directed migrations in response to seasonal temperature variations.

INTRODUCTION

Commercial concentrations of American lobsters, *Homarus americanus*, inhabit the outer continental shelf and slope off southern New England and the Middle Atlantic states southward to Virginia. The history, development, and recent status of this resource have been summarized in the collective studies of Firth (1940), Schroeder (1955, 1959), McRae (1960), Hughes (1963), Saila and Flowers (1968), Skud and Perkins (1969), Uzmann (1970), and Cooper and Uzmann (1971). This report is an extension of the last mentioned paper and deals further with findings and implications of seasonal and long-term movements derived from an extensive tagging program conducted over the period 1968-72.

Schroeder (1959) defined the offshore lobster population as "a population of lobsters, large enough to support commercial fishing off the east coast of the United States along the outer shelf and upper slope between the eastern part of Georges Bank and the offing of Delaware Bay. This area at depths of roughly 60-250 fm (110-450 m) is about 400 miles long and 5-10 miles wide. Lobsters are more plentiful along the eastern half of this stretch than to the west and south."

The offshore lobster fishery, so-called, has rapidly assumed a role of prominence among the major offshore fisheries of the northwest Atlantic. A brief review of its growth over the past two decades will place it in perspective relative to the long established coastal fishery and indicate its future trend.

Like the coastal stocks from Maine to New Jersey, the offshore stock has sustained a steadily increasing rate of exploitation since the mid-fifties prior to which time it ranked as a minor fishery with the majority of catches taken incidental to trawling for groundfish species. Following World War II, the coastal fishery expanded rapidly to a peak yield in 1960 of 29 million pounds (13.2 million kg) and has since declined measurably despite increased fishing effort; meanwhile, offshore lobster catches increased from nearly 2 million pounds (0.9 million kg) in 1960 to over 8 million pounds (3.6 million kg) in 1970. Ungrouped landings statistics indicate that U.S. lobster production is relatively stable at some 30 million pounds (13.6 million kg) annually, but the fact of the matter is that offshore production has annually offset the decline of coastal landings. From 1968 to 1970 offshore lobster landings averaged over 20% of the U.S. catch.

MATERIALS AND METHODS

The tagging program reported here was conducted as part of the work plan of 14 research cruises over the period 1968-71 during which time a total of 7,326 lobsters were tagged and released at 52 localities along the outer edge of the continental shelf from Corsair Canyon west

[1] Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Woods Hole, MA 02543.

and south to Baltimore Canyon (Fig. 1, Table 1). The lobsters were taken with otter trawls or traps (five localities only) at depths of 35-300 fathoms (64-549 m), then tagged and released within a day after capture and within 2.7 nautical miles (5 km) of the capture site. Tagging methodology has been described previously by Cooper (1970). Essentially, the tag consists of coded polyvinyl chloride tubing with a polyethylene monofilament leader and stainless steel anchor implanted in the right or left dorsal extensor muscle below the carapace. The anchor is inserted with the aid of a hypodermic needle through the connecting membrane between the carapace and the first abdominal segment. The membrane breaks down at ecdysis to permit withdrawal of the lobster from the old exoskeleton and the implanted tag is thus retained through successive molts.

The tagging program and its objectives were initially well advertised with letters and poster notices being sent to all New England and Middle Atlantic state fisheries commissioners, to all vessel captains known to engage in the offshore lobster fishery, and to all major buyers and wholesalers of lobsters. Port agents of the National Marine Fisheries Service were specially briefed and then maintained continuing liaison with the lobster fishermer and dealers.

In a preliminary paper Cooper and Uzmann (1971 reported 400 returns from 5,710 releases through 196 (7.0% reported recapture); in 1970 and 1971 additiona releases raised the total number tagged and released t 7,326, of which a cumulative total of 945 recoveries ha been reported to us as of 15 December 1972. Thus, the ac cumulated reported recaptures is currently 12.9% and in creasing at a decreasing rate annually by virtue o natural mortality of the tagged population, tag loss, non recognition of tags, possible emigration into areas wit little or no commercial fishery, removal and nonreportin by U.S. fishermen and various elements of the foreig fishing fleet, and possibly, increased incidence of non reporting because of fishermen apathy. We offer the las theoretical reason because renewed publicity and an in crease in the tag return reward from $1.00 to $5.00 in Oc tober 1971 failed to elicit a significant increase in the ta return rate despite a significant input (1,142) of newl tagged lobsters in that calendar year. This hypothesis i further supported by calculations of expected returns pe annum under the condition of exponential decline of th

Table 1.—Summary of offshore lobster tagging, 1968-71: station references, releases, and recaptures.[1]

Year	Composite station number	Original station number(s)	Plot position Lat. N	Plot position Long. W	Canyon or shelf region	Number of releases	Number of recaptures
1968	1	(1-3)	40°17′	68°02′	Oceanographer Canyon	42	3
	2	(4)	39°59′	69°36′	Veatch Canyon	13	3
	3	(5)	39°31′	72°13′	Hudson Canyon	146	9
	4	(6)	40°05′	71°09′	Block Canyon	52	7
	5	(7-8)	40°04′	70°27′	Atlantis Canyon	264	29
	6	(9, 11)	39°57′	69°56′	Veatch Canyon	149	22
	7	(10)	39°56′	69°41′	Veatch Canyon	99	10
	8	(12)	39°59′	70°03′	Veatch Canyon	50	4
	9	(13)	40°03′	70°17′	Atlantis Canyon	143	19
	10	(14)	40°13′	70°30′	Atlantis Canyon	39	3
	11	(15)	40°12′	70°15′	Atlantis Canyon	84	6
	12	(16)	40°12′	71°14′	Block Canyon	57	3
	13	(17-19)	40°05′	71°47′	Block Canyon	482	40
	14	(20-21)	40°05′	71°38′	Block Canyon	266	25
	15	(22)	41°42′	66°52′	Leg, Georges Bank	46	10
	16	(23-26)	40°33′	68°39′	SW Georges Bank	479	59
	17	(27-28)	40°31′	67°42′	Lydonia Canyon	223	27
Total						2,634	279
1969	18	(29, 30, 32)	39°59′	69°29′	Veatch Canyon	1,350	213
	19	(31)	40°03′	69°16′	Veatch Canyon	751	104
	20	(33-35)	40°59′	66°34′	Corsair Canyon	387	44
	21	(36)	40°32′	67°47′	Lydonia Canyon	166	23
	22	(37-38)	41°12′	66°35′	Corsair Canyon	422	46
Total						3,076	430
1970	23	(48, 50)	40°16′	68°25′	Oceanographer Canyon	301	34
	24	(49, 51)	40°26′	68°20′	Oceanographer Canyon	173	22
Total						474	56
1971	25	(57-58)	40°00′	71°12′	Block Canyon	60	10
	26	(59, 63)	39°14′	72°20′	Hudson Canyon	54	1
	27	(60-62)	37°55′	73°59′	Baltimore Canyon	194	11
	28	(64)	39°10′	72°38′	Hudson Canyon	29	3
	29	(65-66)	40°00′	69°29′	Veatch Canyon	805	155
Total						1,142	180
Grand Total						7,326	945

[1] The original releases are treated as 29; composites of two or more stations have within-group variation of less than 10 days, 10′ latitude, and 10′ longitude. Original station numbers are shown in parentheses.

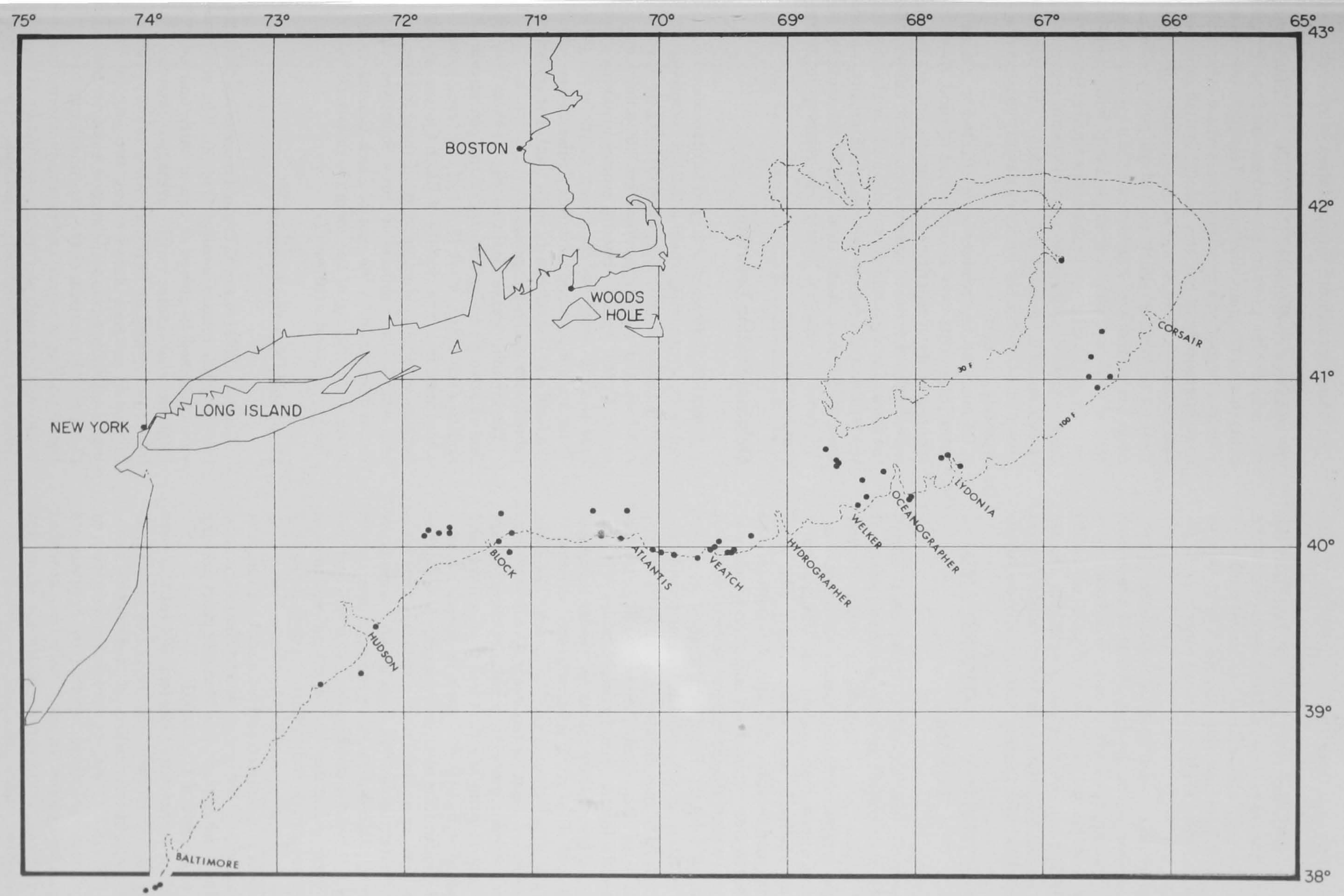


Figure 1.—Original station locations and nearby canyons.

tagged population at a theoretical summed rate of 23% per annum (12% tag loss, 6% natural mortality, 5% recapture). In calendar year 1972, for example, the theoretical number of tagged lobsters outstanding at the beginning of the year was 3,630; the expected number of returns for 1972 based on the average rate of returns (0.049) in years 1968-71 is 179, in sharp contrast to 67 actual returns.

The distribution of recaptured tagged lobsters is considered representative of the distribution of the lobster population. Fishermen search for commercial quantities of lobsters throughout the year at depths of 10-350 fathoms (18-640 m), which is a considerably greater range than the 35-300 fathoms (64-549 m) depth interval from which lobsters for tagging were initially captured.

DATA REDUCTION, PLOTTING, AND FORMAT

Data received on individual recaptures varied considerably. Data sought included date and position of recapture (latitude and longitude, or loran A coordinates), sex, carapace length, presence or absence of external eggs, cheliped configuration, and designation of any missing chelipeds and walking legs. The most critical data were location and date of recapture, and carapace length from which both migration trends and growth could be determined; this was received on 350 of the recaptured lobsters. Recapture location and date only were received on 576 individuals and provide the basis for analysis of movements.

Data was listed and keypunched in two different formats. The data format (see appendix tables) for this study includes growth increments for reader reference, but this element of the study is being treated separately; return data is listed chronologically by sex. The basic data deck provided input for computer calculation for individual recaptures of great circle distance traveled from point of release to point of recapture, days at large, and other standard computations such as mean distance traveled and mean time at large by various groupings of individuals. The same data deck served as input for a Cal-Comp Plotter, Model 663, from which release coordinates, recapture coordinates, or combinations of both were plotted in various combinations to reveal and display the overall features of dispersion within and between release groups and to show the overall monthly distribution of recaptures. The Cal-Comp Plotter was simultaneously programmed and fed a series of coastline coordinates, isobath coordinates, and titular information such that the finished plot was a Mercator chart drawing to the nominal scale of 1:1,200,000.

Among the 945 recaptured lobsters, 584 (61.8%) were reported by specific location, 183 (19.4%) by generalized location—usually by reference to a named submarine canyon, and 178 (18.8%) without location information of any kind. Those recaptures reported by approximate location are hand-plotted in distinctive fashion within the machine plots of the various subgroups of returns with specific location.

In order to facilitate interpretation of recovery data we have treated the 52 original releases as 29 according to the constraints footnoted in Table 1. This action minimized the plotter executions and gave more coherence to the individual plots. Test plots of recovery coordinates showed a number of cases where overplotting or tight grouping of recovery points resulted in a confusion of points and numbers. In these instances we used a plotting subroutine which plotted all points within or upon the eastern and southern side of a given 6-minute square (0.1° square) as a single point with collective number at the diagonal center of the square; the average displacement of any single point plotted in this manner is well under 3 nautical miles (5.6 km) which we have accepted as within the limits of navigational accuracy, reporting, or both.

Because the tag releases were effected in greater or lesser increments over a long period of time, they constitute a series of repetitive experiments and are treated accordingly; the overall presentation which follows takes the form of an atlas which provides a pictorial analysis of the results of the various releases. Additionally, we have developed a generalized treatment of the monthly distribution of offshore lobsters in relation to bottom temperature.

Original Station Locations

A total of 52 releases of tagged lobsters were made on the outer continental shelf and slope commencing in March 1968 and ending in May 1971 (Table 1). Cruise numbers and station numbers are not wholly in consecutive order because interim cruises involving coastal area tagging were also conducted in the same period. Thus, station 66 occupied during Cruise 20 was actually the 52nd and last release during a total of 14 cruises concerned with offshore tagging.

The original release localities (Fig. 1) show their location relative to major features of the continental shelf and to each other. Most (86%) of the tagging was accomplished from the vicinity of Block Canyon eastward because of more productive lobster fishing in these areas and because other aspects of cruise objectives required cruise orientation to the east of Block Canyon to maximize time sharing of the research vessels *Delaware I*, *Delaware II*, and *Albatross IV*.

Composite Station Locations

Thirteen (25%) of the 52 original releases are plotted at their original release locality (Fig. 2). The remainder were combined in groups of two or three and assigned location coordinates with averaged latitude and longitude rounded to the nearest whole minute (Table 1). Maximum distance between any two original release sites comprising a composite station was 4 nautical miles (7.4 km). The purpose of this treatment was to effect a logical pooling of release and recapture information that would expedite both plotting and evaluation of the data. Computations of distance traveled and time at large are,

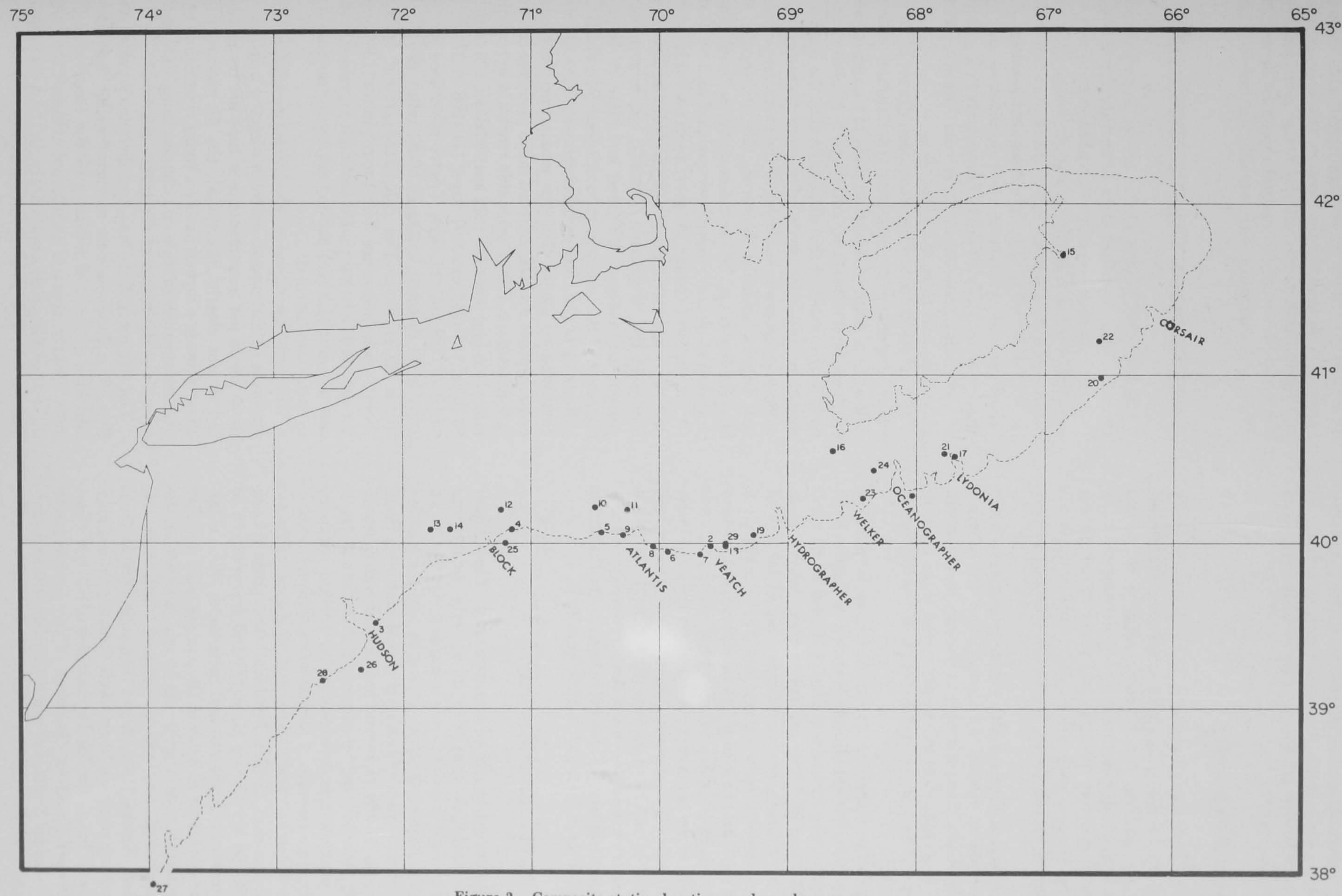


Figure 2.—Composite station locations and nearby canyons.

however, based on original release locations and dates. Details concerning individual recaptures are referenced to composite station number and listed in the appendix tables of this report.

Composite of Recoveries

Figure 3 is a precision plot of the reported recovery positions of all returns; in Figure 4 the same set of coordinates are grouped by 6-minute squares to permit readable numerical signature and to obviate overplotting of identical recovery coordinates, some of which occurred by chance, with others the result of multiple recaptures by vessels fishing a given area for one or more days.

Comparison of Figure 3 with Figure 1 (original station locations) shows overall dispersion from the original release locations along the edge of the continental shelf. Replotting of these data by release groups (Figs. 5-29) illustrates the magnitude and direction of the individual dispersions.

Straight-line dispersion (point of release to point of recovery) of individual lobsters is shown in Figures 5-29; concentric circles having a radius of 10 and 50 nautical miles (18.5 and 92.7 km) are drawn about each release locality to indicate the magnitude and variability of lobster movements from a given locality. Track lines of 50 miles (92.7 km) or greater are labeled with the return number and sex (F or M). Where two or more recaptures were made at the same reported locality, the solid circle representing the recovery point is appropriately numbered. In several instances (Figs. 20, 21, 24, 29) it was necessary to group recovery data by 6-minute squares for reasons described previously; in such cases, the nature of the plotting is included in the figure title.

Definition of Lobster Maturity

Subsequent references to maturity stage of individual lobsters assumes that the commonly prevailing minimum legal size (81 mm carapace length) is an acceptable beginning point at which both male and female lobsters attain functional sexual maturity. Skud and Perkins (1969) reported that demonstrable sexual maturity, as evidenced by external embryonated eggs or mature ovarian eggs, commenced at 80 mm carapace length in large samples of female lobsters from the same areas in which we conducted our tagging study. Stewart (1972) examined 1,018 female lobsters from western Long Island Sound and Block Island Sound for presence of spermatophores in the seminal receptacle; the median size of inseminated females in the sample (size range 53 to 106 mm carapace length) was 76 mm, and within the size class 81-82 mm (53 specimens), 81% were inseminated. Krouse (1973) found that male lobsters from the Boothbay region of Maine were virtually all sexually mature well below the legal recruit size of 81 mm; these findings were based on dissection of the genital tracts and microscopic findings of mature sperm cells and spermatophores; Krouse (1973) reiterated the observations of Templeman (1934) that significant size disparity between male and female lobsters precludes successful mating and that prerecruit size males seem unlikely to contribute materially to natural reproduction until they attain a size equality with sexually mature females.

MIGRATION VERSUS DISPERSION

Cooper and Uzmann (1971) earlier hypothesized, on the basis of a described time-temperature relationship, that the nature of the migration phenomenon was a vernal shoalward movement to warmer water with subsequent return to the edge and slope of the shelf with the onset of fall and winter. In subsequent sections of this report we will attempt to elicit qualitative and quantitative aspects of individual movements from groupings of individuals referenced to release locality, point of recapture, and time at large.

Hypothetical track lines have been drawn in all cases where dispersion or migration (definitions presented below) from point of release to point of recapture exceeded 10 nautical miles (18.5 km) (Figs. 5-29). We must concede at the outset of this discussion that the magnitude, direction, and time scale of a point-to-point track is seldom an accurate portrayal of the exact movements of any tagged animals; however, the assumption of a straight-line track, however simplistic, is tenable for the purposes of plotting, overview, analysis, and ultimately, for distinction between the short-term probable migrants and the longer-term dispersed individuals. The guiding factors in this distinction of kinds, i.e., migrant or dispersed, are distance traversed and time at large, the elements of the classical ground speed formula D/T.

Ranking of the total array of recovery data by various combinations shows that the maximum movement of any recapture was 186 nautical miles (345 km) in 71 days (2.6 miles/day). Other sesonable tracks in excess of 100 miles (185 km) were 125 (232 km)/86 days, 123 (228 km)/76 days, 118 (219 km)/107 days, 111 (206 km)/108 days, and 102 (189 km)/29 days. Twelve other lobsters made apparently directed tracks of 50-87 miles (93-161 km) within 22-41 days. The calculated ground speeds of these 31 examples range from 1 to 5.5 miles (1.8-10.2 km) per day and indicate that directional movements in excess of 1 mile (1.8 km) per day are not uncommon if not, in fact, quite normal.

We have developed a classification scheme which attempts to distinguish between directed migrants and those whose net movements over time are inconsequential or not clearly directional; the 31 examples cited above provide a logical basis for fixing constraints on the numerical values of time and distance consistent with an acceptable definition of the term "migrant."

The frequency distribution of distance traveled shows that 163 individuals were recovered within 0-9 miles (0-16.8 km) of point of release over the time range 0-950 days. Clearly, there is no internal evidence that any of these have dispersed significantly. In the time frequency interval 0-9 days, 15 of 21 recoveries were common to the

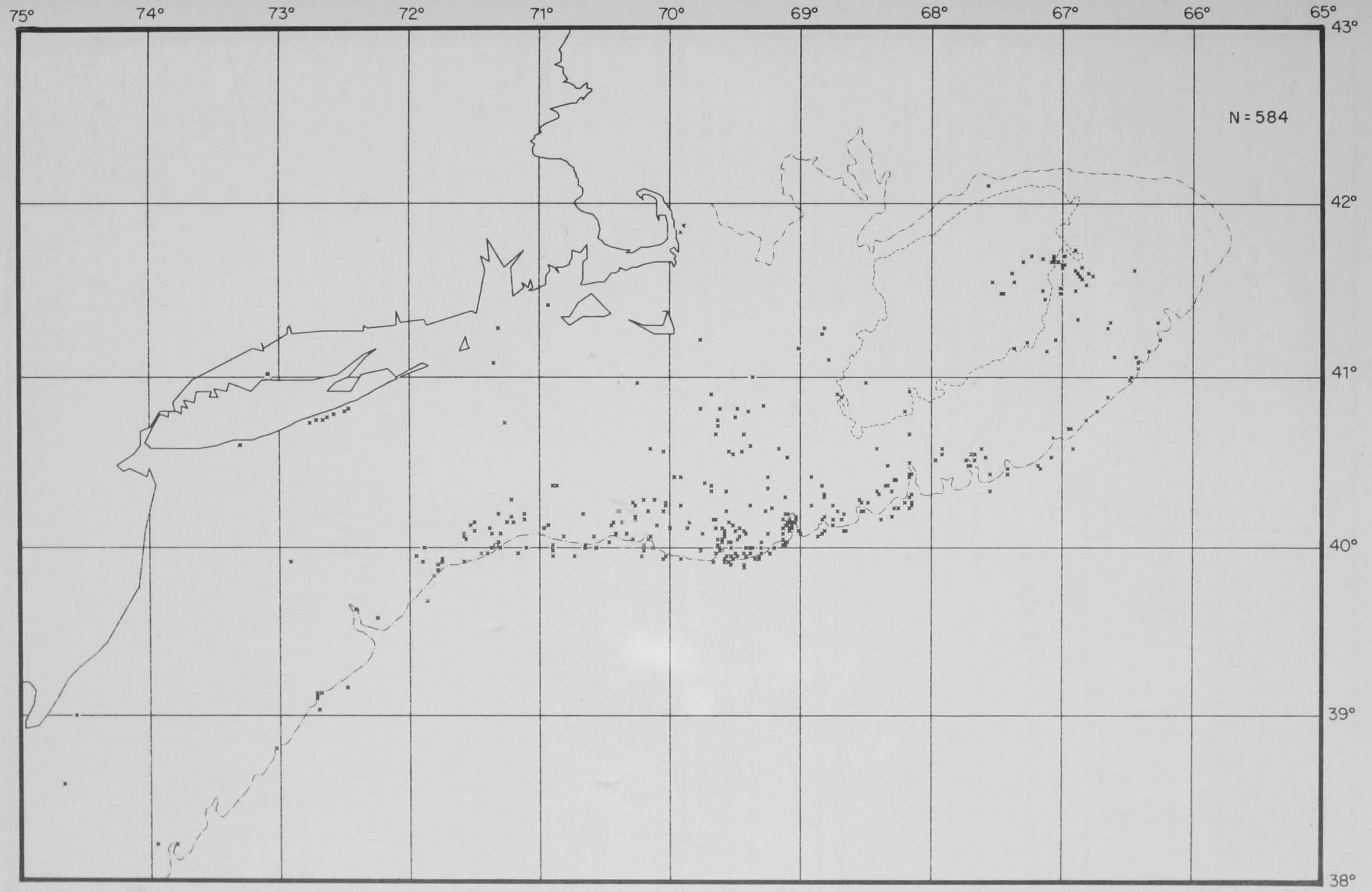


Figure 3.—Composite of tagged lobster recoveries, 1968-72.

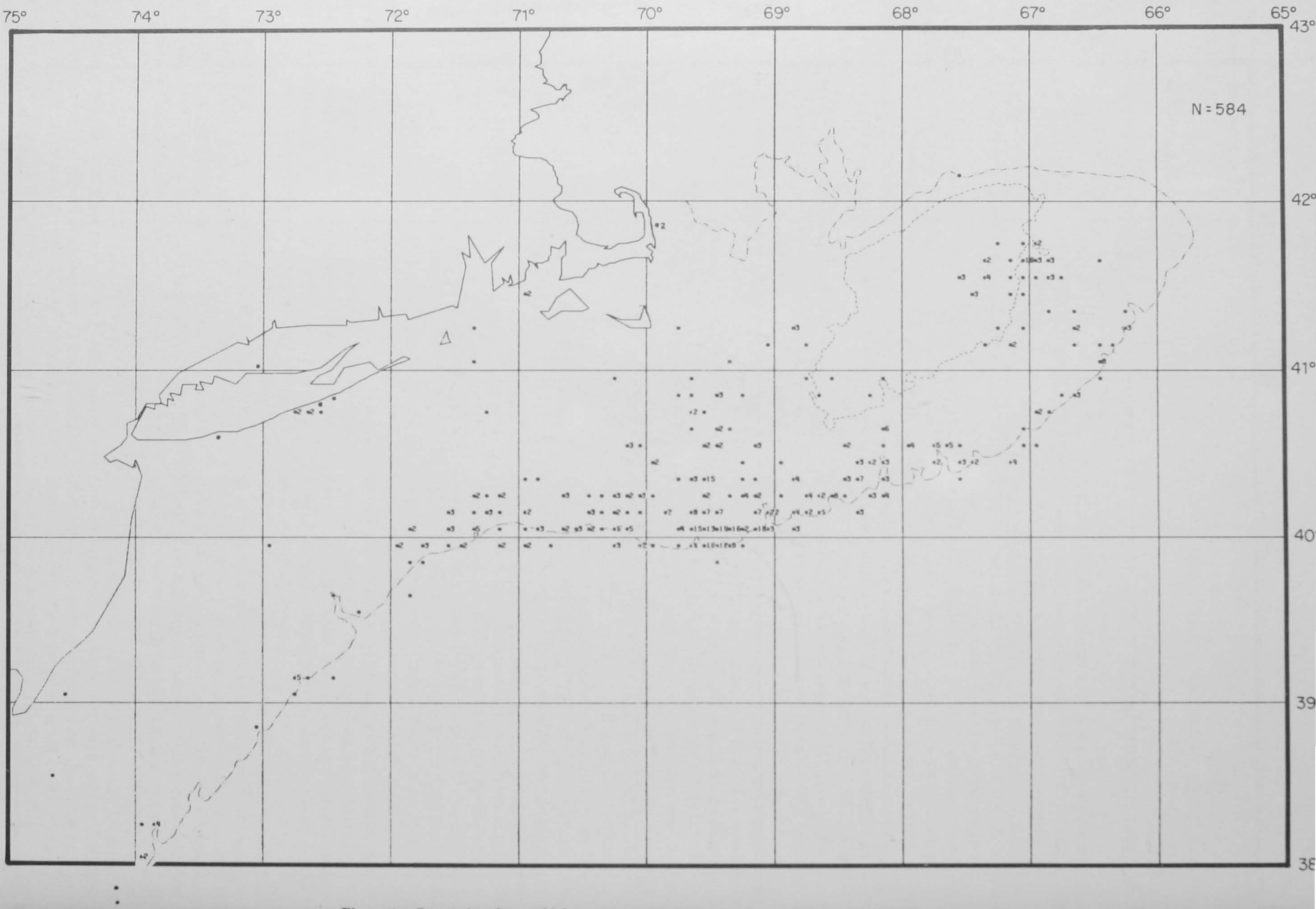


Figure 4.—Composite of tagged lobster recoveries grouped by 6-minute squares, 1968-72.

aforementioned 0.9 mile (0.16.8 km) category. Accordingly, we have adopted the premise that time or distance values under 10 preclude realistic interpretation of directionality or speed of movement.

Commercial fishing effort, monthly distribution patterns of tagged recoveries (Figs. 34-45), and supporting details (appendix tables) all combine to show that offshore lobsters are essentially aggregated along the outer edge and slope of the continental shelf during January through April (120 days) and become widely dispersed by migration or random movement in shoaler/warmer water during May through December (245 days). We have set the upper limit of duration of a directed migration at 120 days, or the theoretical half-life of a migratory season during which the migrant can move to shoaler/warmer water and return to the continental shelf margin in approximate phase with the annual shoalward and seaward migration of the bottom temperature warm front (here defined as the 10°C isotherm). Within these constraints we regarded a total of 117 individuals as migrants; ranking of these individuals by calculated ground speed shows a range of 0.1-5.5 miles (0.18-10.2 km) per day, a median speed of 0.9 miles (1.7 km) per day, and a median at 0.6 miles (1.1 km) per day. Ground speeds of defined migrants are positively correlated with distance traversed and negatively correlated with time at large.

The remainder of recaptures for which capture location and time at large are known fall into three categories of relative displacement from point of release. Our working definitions of migrant and alternative classifications are as follows:

a) Migrant by virtue of track ≥10 nautical miles (18.5 km) and time at large 10-120 days (N = 117).

b) Nonmigrant by corollary definition of track < 10 miles and time at large < 10 days (N = 15).

c) Residual nonmigrant by virtue of track < 10 miles, time at large ≥10 days (range 15-950); this classification reflects stationary behavior, or the alternative possibility of undetectable excursion(s) with homing back to release locality (i.e., within 10-mile radius of release point) (N = 147).

d) Indeterminate by virtue of track ≥10 miles (range 10-181), time at large > 120 days (range 125-1,549); movement is regarded as random dispersal, a summation of migration tracks, or a combination of both (N = 297).

Eight recaptures were reported without dates of recapture and hence could not be classified. These alternative classifications make for interesting conjecture in many cases; among the indeterminates, for example, we find many probable examples of directed migration which cannot be properly assessed because of the associated element of excessive time at large; these cases will be identified and discussed under the appropriate composite station résumés which follow this section.

Returning to the reliability of ground speed calculated from D/T, we have assumed that D is probably underestimated in most cases because a lobster track of significant distance over the bottom is unlikely to be straight-line, and also because some of the recaptures were likely on a return course relative to their original shoalward vector. Conversely, T is probably overestimated (but never underestimated) in a majority of cases because the migrant under consideration had 1) earlier arrived at destination, 2) had accumulative rest periods, and/or 3) was on a return vector. The net effect of any or all of these possible biases on calculated ground speed is to underestimate the derivation in general and to give added credence to values on the order of 4-5 miles (7.4-9.3 km) per day.

COMPOSITE STATION RÉSUMÉS

Composite Station 1 (See Appendix Table 1)

Three recaptures have been reported from a composite total of 42 releases in the vicinity of Oceanographer Canyon on 15 March 1968 (28), 16 March 1968 (5), and 30 March 1968 (9). Mean depth at first capture was 153 fathoms (280 m); mean depth at release was 175 fathoms (320 m). Only one of the recoveries was reported by location. The sex ratio of the three returns was one female to two males.

The most noteworthy feature of the recoveries from this composite release is the relatively high mean time at large (985 days = 2.7 yr) which exceeds that of all other subgroups of recoveries. The single located recovery, a mature male, was captured 13 miles (24.1 km) from its original release point and had been at large 1,342 days (3.7 yr).

Here, as in many other cases of lengthy time at large, the relatively small displacement from original release locality is indicative of either highly localized movements over time or, alternatively, a homing tendency following larger scale movements. We prefer the latter hypothesis and will attempt to sustain this view in the remainder of the text on the basis of other individual and collective returns.

Composite Station 2 (See Figure 5 and Appendix Table 2)

Three recaptures, all males, have been reported from a single point release of 13 lobsters near the head of Veatch Canyon on 4 April 1968. First capture depth and release depth were at 110 fathoms (201 m). Two of the recaptures were reported by location with neither having migrated very far nor having been at large very long. The third recapture, a mature male, had been at large 741 days (2.0 yr), and was reported taken in the vicinity of Veatch Canyon without specific coordinates.

This subgroup of recoveries represents the highest rate of recapture (23%) among the 29 subgroups of releases and indicates that numerically small releases of tagged lobsters can yield significant returns.

Composite Station 3 (See Figure 6 and Appendix Table 3)

Nine recaptures have been reported from a single point release of 146 lobsters on the east side of Hudson Canyon on 26 April 1968. First capture depth was 160 fathoms (293 m); release depth was 85 fathoms (155 m). Seven of the nine recaptures were reported by location and one other from the vicinity of Hudson Canyon. Sex ratio of the nine recaptures was seven females to two males. Mean time at large was 252 days (0.7 yr). Two of the recaptures (3F, 29F) from this release, both mature females, are classified as migrants and were captured 29 and 118 days later in coastal trap fisheries off Long Island, N.Y., after having migrated 102 miles (189 km) and 77 miles (143 km), respectively. The longest outstanding recapture (660 F), an immature female at release, was at large 1,024 days (2.8 yr) during which time it increased 32% in carapace length, which is indicative of at least two moult increments (Cooper and Uzmann 1971).

Three of the recoveries (3F, 29F, 4F) were migrants within the terms prescribed in the preceding section. Return 3F was recaptured 29 days after release following a 102-mile (189-km) migration to shoal water, at 3.5 miles (6.5 km) per day. Return 29F, on the other hand, showed a net displacement of 77 miles (143 km) over the much longer period of 118 days; the calculated speed of 0.6 miles (1.1 km) per day is well below the mean speed of the collective 117 defined migrants and inconsistent with an idealized ongoing shoalward track. In the absence of any contradictory evidence, it seems logical to conclude that this individual and others, as will be seen, probably arrived in the vicinity of their recapture at considerably earlier dates. Return 11F was recaptured 13 miles (24.1 km) northwesterly in slightly deeper water than at release.

Composite Station 4 (See Figure 7 and Appendix Table 4)

Seven recaptures have been reported from a single point release of 52 lobsters several miles east of Block Canyon on 28 April 1968. First capture depth was 190 fathoms (347 m); release depth was 100 fathoms (183 m). Four of the seven recaptures were reported by location. Sex ratio of the seven recaptures was three females to four males. Mean time at large was 425 days (1.2 yr). One of the four located recaptures, a mature male, moved 71 miles (132 km) easterly over a period of 405 days at large. The longest outstanding recapture (location unreported) in this subgroup was at large 1,326 days (3.6 yr).

Composite Station 5 (See Figure 8 and Appendix Table 5)

Twenty-nine recaptures have been reported from a composite total of 264 releases west of Atlantis Canyon on 29 March 1968 (142) and 30 March 1968 (122). Mean depth at first capture was 190 fathoms (347 m); mean depth at release was 99 fathoms (181 m). Twenty of the recaptures were reported by specific location and one by approximate location.

Sex ratio of the returns was 22 females to 7 males, not significantly different from the ratio at release (212 females to 52 males).

Mean time at large for all recoveries was 284 days (0.8 yr); greatest time at large for a located individual was 774 days (2.1 yr) during which time apparent dispersion was only 10 miles (18.5 km).

Mean distance traveled by those lobsters with specific recapture locations (20) was 25.1 miles. Three individuals, all sexually mature females, made migrations in excess of 50 miles (92.7 km), the range being 56-76 miles (104-141 km).

Four of the recoveries (28F, 26F, 27F, 4F), all mature females, are classified migrants; all were recaptured in June within 36-50 days after tagging. Return 28F, an egg-bearing female at release and recapture, was taken 56 miles (104 km) northeasterly in significantly shoaler water (22 fathoms = 40.2 m) after 50 days at large; apparent speed (1.1 miles/day = 2.0 km/day) and direction are highly consistent with the vernal shoaling hypothesis.

Returns 26F and 27F (egg-bearing at release and recapture) were taken 38 miles (70.4 km) easterly near the head of Veatch Canyon at 80 fathoms (148 m) after being at large 36 and 37 days, respectively; apparent speed in each case was 1.1 miles/day (2.0 km/day). It is obvious that these tracks are not consistent with a theoretical goal of shoaler location; we will reserve comment on these and others of similar nature for later discussion. Return 4F was taken 11 miles northeasterly in significantly shoaler (64 fathoms = 117 m) water; this recovery illustrates quite well that lobsters occupying the shelf edge or slope can achieve much shoaler (or deeper) locations with relatively small excursions.

Composite Station 6 (See Figure 9 and Appendix Table 6)

Twenty-two recaptures have been reported from a composite total of 149 releases midway between Atlantis and Veatch canyons on 1 May 1968 (78) and 2 May 1968 (71). Mean depth at first capture was 190 fathoms (347 m); mean depth at release was 99 fathoms (181 m). Nineteen of the recoveries were reported by specific location and one by approximate location. Sex ratio at release was 103 females (69%) to 46 males; the ratio at recapture was 12 females (55%) to 10 males.

Mean time at large for all recoveries was 312 days (0.9 yr); greatest time at large for a located individual, an immature male at release, was 896 days (2.4 yr) during which time apparent dispersion was only 18 miles (33.4 km).

Mean distance traveled by those lobsters with specific capture locations (19) was 33.5 miles (62.1 km). Five individuals made migrations in excess of 50 miles (92.7 km), the range being 57-71 miles (106-132 km). Three of these long distance migrants were mature females, one of which (91F) was berried at recapture; the remaining two were mature males.

Six of these recaptures (9F, 10F, 1M, 18F, 19F, 20M) can be classified as migrants. Recoveries 9F and 10F moved easterly, with the latter being taken significantly shoaler (56 fathoms = 102 m) than at release. Return 1M migrated at near record speed of 5.1 miles (9.4 km) per day to a point 62 miles (115 km) westerly at a depth (120 fathoms = 219 m) significantly deeper than at release. The release depth here, as at a number of other stations, was significantly shoaler than release depth for reasons explained earlier; it is conceivable, therefore, that bottom temperature at the release site was sufficiently divergent to cause abnormal behavior. Returns 18F, 19F, and 20M were recaptured at the same point in time and space after 49 days at large; their recovery position was 18 miles (33.4 km) easterly in shoaler (69 fathoms = 126 m) water.

Composite Station 7 (See Figure 10 and Appendix Table 7)

Ten recaptures have been reported from a single point release of 99 lobsters on the west side of Veatch Canyon on 2 May 1968. Mean depth at first capture was 200 fathoms (366 m); mean depth at release was 100 fathoms (183 m). Eight of the recaptures were reported by specific location. Sex ratio at release was 77 females (77%) to 22 males; the ratio of the returns was 7 females (70%) to 3 males.

Mean time at large for all recoveries was 477 days (1.3 yr); greatest time at large for a located individual, a mature female, was 771 days (2.1 yr). This individual was recaptured 58 miles (107 km) north of the point of release in June 1970; its location in time and space is consistent with a working hypothesis of seasonal shoaling and return to home locality.

Mean distance traveled by those lobsters with specific capture locations (8) was 29.3 miles (54.4 km). Two individuals qualified as long migrants; one of these was the mature female noted above while the other was a mature male.

Among the eight located recaptures, only one (8M) is a defined migrant and is consistent with the springtime shoaling hypothesis; this individual ranged shoalward from 100 to 63 fathoms (183-115 m) at a net speed of 1.8 miles (3.3 km) per day.

Composite Station 8 (See Figure 11 and Appendix Table 8)

Four recaptures have been reported from a single point release of 50 lobsters on the east side of Atlantis Canyon on 14 June 1968. Mean depth at first capture was 70 fathoms (128 m); mean depth at release was 86 fathoms (157 m). Two of the recoveries were reported by specific location and one by approximate location. Sex ratio at release was 30 females (60%) to 20 males; the ratio at recapture was 1 female to 3 males.

Mean time at large for all recoveries was 386 days (1.1 yr); greatest time at large for a located individual, a mature male, was 734 days (2.0 yr), during which time apparent dispersion was 26 miles (48.2 km).

Maximum dispersion was attained by 156M, a mature male, which was recaptured 114 miles (211 km) easterly near the head of Lydonia Canyon. A third individual, a mature female, was reported from the vicinity of Hudson Canyon, some 100 miles (185 km) westerly of release.

Composite Station 9 (See Figure 12 and Appendix Table 9)

Nineteen recaptures have been reported from a single point release of 143 lobsters on the west side of Atlantis Canyon on 15 June 1968. Mean depth at first capture was 70 fathoms (128 m); mean depth at release was 100 fathoms (183 m). Thirteen of the recaptures were reported by specific location and two by approximate location. Sex ratio at release was 72 females (50%) to 71 males; the ratio at recapture was 11 females (58%) to 8 males.

Mean time at large for all recoveries was 623 days (1.7 yr); greatest time at large, and record high overall, for a located individual (946M), a mature male at release, was 1,549 days (4.2 yr). This individual was recaptured 118 miles (219 km) easterly at Lydonia Canyon and had increased 63% in carapace length by virtue of at least three molts.

Mean distance traveled by those lobsters with specific capture locations (13) was 36.1 miles (66.9 km). Three individuals, a mature female, an initially immature male, and the mature male cited above, surpassed the 50-mile (92.7-km) range from point of release.

Composite Station 10 (See Appendix Table 10)

Three recaptures have been reported from a single point release of 39 lobsters some 15 miles (27.8 km) northeasterly of Atlantis Canyon on 16 June 1968. Mean depth at first capture was 90 fathoms (165 m); mean depth at release was 60 fathoms (110 m). All recaptures were reported by specific location. Sex ratio at release was 25 females (64%) to 14 males; the ratio at recapture was 2 females to 1 male, all being sexually immature.

Mean time at large (48 days) and mean distance traveled (14 miles = 25.9 km) were lowest and second lowest, respectively, among all subgroups of returns. The low rate of return, and particularly the disappearance of the group after only 60 days at large, suggests that unusually high mortality occurred shortly after release.

Two of the three recoveries (34F, 41F) are migrants by definition; both were immature females and were taken only slightly shoaler than release depth. The directionality of these tracks, as with many others among the defined migrants, has not resulted in maximum shoaling for distance traversed; it seems plausible, however, that those individuals, especially immatures, captured and released well up on the shelf as late as June might, in the main, have already completed a migratory transition from colder slope water to the seasonably warmer shelf water prior to recapture. An extension of this reasoning suggests further that others captured and tagged at these midshelf depths were still en route to shoaler grounds (e.g., recapture 25F discussed under subsequent account of composite station 13).

Composite Station 11 (See Figure 13 and Appendix Table 11)

Six recaptures have been reported from a single point release of 84 lobsters 7 miles (12.9 km) north of Atlantis Canyon on 16 June 1968. Mean depth at first capture was 60 fathoms (110 m); mean depth at release was 55 fathoms (101 m). All of the recaptures were reported by specific location. Sex ratio at release was 47 females (56%) to 37 males; the ratio at recapture was 5 females (83%) to 1 male.

Mean time at large for all recoveries was 361 days (1.0 yr). Greatest time at large was 727 days (2.0 yr); the individual involved was an immature female at release and one of two females in the subgroup of returns which surpassed the 50-mile (92.7-km) range of dispersion from release point. Mean distance traveled by the six recoveries was 32.2 miles (59.7 km).

Composite Station 12 (See Figure 14 and Appendix Table 12)

Three recoveries have been reported from a single point release of 57 lobsters 10 miles (18.5 km) northeast of Block Canyon on 16 June 1968. Mean depth at first capture and at release was 60 fathoms (110 m). All three recaptures were reported by specific location. Sex ratio at release was 25 females (44%) to 32 males; the ratio at recapture was 1 female to 2 males.

Mean time at large for all recoveries was 231 days (0.6 yr); greatest time at large was 358 days (1.0 yr) during which time the record individual, a mature male at release, traveled 52 miles (96.4 km) east to the east side of Veatch Canyon. Mean distance traveled by the three recoveries was 30.3 miles (56.2 km).

Composite Station 13 (See Figure 15 and Appendix Table 13)

Forty recaptures have been reported from a composite total of 482 releases west of Block Canyon on 18 and 19 June 1968. Mean depth at first capture was 60 fathoms (110 m); mean depth at release was 47 fathoms (86 m). Twenty-three of the recaptures were reported by specific location and three by approximate location. Sex ratio at release was 256 females (53%) to 226 males; the ratio at recapture was 25 females (62%) to 15 males.

Mean time at large for all accountable (37) recoveries was 484 days (1.3 yr); greatest time at large for a located individual, a mature female at release, was 1,360 days (3.7 yr). This individual was recaptured 72 miles (133 km) southwest from point of release.

Mean distance traveled by those lobsters with specific capture locations was 52.1 miles (96.6 km), the record high average for all subgroups of returns. Twelve individuals surpassed the 50-mile (92.7-km) range; additionally, three others were reported from the vicinity of Veatch Canyon which is well beyond the 50-mile (92.7-km) range from point of release. A disproportionate number (12/15) of the long-distance migrants were females; most of the females were sexually mature at release and all were sexually mature at recapture.

Two females were recaptured in the coastal trap fishery off southern Long Island, N.Y. One of these (25F) was berried at release and at recapture after having migrated 75 miles (139 km) in 28 days (2.7 miles/day = 5.0 km/day). The short term and long distance of this movement clearly supports an hypothesis of directed migration to warmer waters. The second female (335F) taken in the coastal zone was at large 465 days (1.3 yr) and, judging from its size at release, conceivably was engaged in a second or even third seasonal inshore migration.

Three recoveries (25F, 22F, 42M) are classified migrants. Return 25F, noted above, was recaptured in a local trap fishery at Fire Island Inlet, N.Y., in 7 fathoms (12.8 m) of water; vector and ground speed well exemplify the vernal shoaling concept. Return 22F was taken 14 days after release at a point 23 miles (42.6 km) southeasterly in slightly deeper water (60 fathoms = 110 m) than depth at release (47 fathoms = 86.0 m); it is significant, perhaps, that recapture depth and original capture depth were identical. We do not imply that this individual sought to return to original depth, but given a depth/temperature constant relationship over short term, it is conceivable that this lobster sought to return to its original temperature stratum. Return 42M, an immature male, was recaptured 58 days later and 47 miles (87.1 km) northeasterly in 50 fathoms (91.4 m) of water; considering immaturity and time of year, the net track would seem biologically unproductive.

Composite Station 14 (See Figure 16 and Appendix Table 14)

Twenty-five recaptures have been reported from a composite total of 266 releases 15 miles (27.8 km) northwest of Block Canyon on 20 June 1968. Mean depth at first capture was 60 fathoms (110 m); mean depth at release was 49 fathoms (89.6 m). Twenty-two of the recoveries were reported by specific location and one by approximate location. Sex ratio at release was 146 females (55%) to 120 males; ratio at recapture was 19 females (76%) to 6 males.

Mean time at large for all accountable (24) recoveries was 401 days (1.1 yr); greatest time at large for a located individual, a mature female at release, was 1,077 days (2.9 yr). This lobster (726F) was recaptured 181 miles (335 km) easterly near the head of Oceanographer Canyon; the hypothetical straight-line track is the penultimate distance record and is exceeded slightly by that of mature female (249F) recaptured just off the north shore of Long Island, N.Y. (see Fig. 20).

Mean distance traveled by those lobsters with specific capture locations was 46.9 miles (86.9 km). Eleven individuals, fully half of the located returns, surpassed the 50-mile (92.7-km) range with a disproportionate number (9) being females. Four of the eleven, all females, were taken by a single fisherman in the seasonal trap fishery off southern Long Island; unfortunately, only the tag letter code and sex were reported and we are unable to correlate beyond date and original release station.

Among the 22 located recaptures, only one (33M) is a defined migrant; this individual moved southwesterly some 12 miles (22.2 km) and was recaptured at the same depth as at release.

Return 269M, and the four females mentioned above (347F, 348F, 349F, 350F) were taken approximately 1 yr after release in the southern Long Island trap fishery in 11-12 fathoms (20.1-21.9 m) of water; while not migrants in the strictly defined sense, these recaptures are special cases which probably represent directed migrations of the year (1969) in which captured.

Composite Station 15 (See Figure 17 and Appendix Table 15)

Ten recaptures have been reported from a single point release of 46 lobsters on the so-called Leg area of Georges Bank on 21 September 1968. Mean depth at first capture was 35 fathoms (64.0 m); release depth was 28 fathoms (51.2 m). Six of the recaptures were reported by specific location. Sex ratio at release was 23 females (50%) to 23 males; the ratio at recapture was 6 females (60%) to 4 males.

Mean time at large for all recoveries was 434 days (1.2 yr); greatest time at large for a located individual, a mature female at release, was 759 days (2.1 yr); this lobster apparently traveled only 12 miles (22.2 km), but it is evident from monthly distribution patterns developed later in this report that lobsters would not remain localized in this general area; time at large closely approximates an anniversary of the initial tagging event in this area and supports an hypothesis of seasonal revisitation to shoaler, warmer water.

Mean distance traveled by those lobsters with specific capture locations was only 16 miles (29.7 km); reference to Appendix Table 15 shows that five of the six accountable recoveries were taken 1 or 2 calendar years later during the warmest half of the year either at the shelf edge (548F), or relatively near the release area. The sixth (551F), taken in November, 44 days after release, was conceivably engaged in retreat from oncoming winter conditions to the warmer sanctuary of the shelf edge and slope. The high percentage (21.7) of recaptured lobsters from this release is second only to the slightly higher rate of recapture from Composite Station 2.

Composite Station 16 (See Figure 18 and Appendix Table 16)

Fifty-nine recaptures have been reported from a composite total of 479 releases near the southwest corner of Georges Bank on 24, 25, and 26 September 1968. Mean depth at first capture was 50 fathoms (91.4 m); mean depth at release was 40 fathoms (73.2 m). Thirty-nine of the recaptures were reported by specific location and eight by approximate location. Sex ratio at release was 196 females (41%) to 283 males; the ratio at return was 20 females (34%) to 39 males.

Mean time at large for all accountable (58) recoveries was 435 days (1.2 yr); greatest time at large for a located individual (932M), a mature male at release, was 1,407 days (3.8 yr).

Mean distance traveled by those lobsters with specific capture locations (39) was 34.8 miles (64.5 km). Nine individuals, the majority being mature, surpassed the 50-mile (92.7-km) range. Additionally, four others, two males and two females, were reported from the Veatch Canyon area, some 50 miles (92.7 km) from point of release. Maximum dispersion (107 miles = 198 km) from release point was achieved by an immature male (362M) while at large 411 days (1.1 yr).

Six of the 59 recaptures were migrants. Two of these (45F, 46M) were recaptured in October in slightly shoaler water; three (52F, 55F, 54M) were taken in November in slightly deeper (50 fathoms = 91.4 m) water, and one (75M) was taken the following January at a depth of 155 fathoms (284 m). Considering the respective dates of recapture, the tracks show a net tendency toward return to deeper water with the onset of winter season.

Composite Station 17 (See Figure 19 and Appendix Table 17)

Twenty-seven recaptures have been reported from a composite total of 223 releases near the head of Lydonia Canyon on 15 and 16 October 1968. Mean depth at first capture was 45 fathoms (82.3 m); mean depth at release was 71 fathoms (130 m). Fourteen lobsters were reported by specific location and seven by approximate location. Sex ratio at release was 138 females (62%) to 85 males; the ratio at return was 14 females (52%) to 13 males.

Mean time at large for all accountable (20) recoveries was 652 days (1.8 yr); greatest time at large for a located individual, a mature male at release, was 1,372 days (3.8 yr).

Mean distance traveled by those individuals with specific capture locations (14) was 37.4 miles (69.3 km); four individuals, three mature females and one mature male, surpassed the 50-mile (92.7-km) range as did six others which were reported from approximated canyon localities. Among this latter group, five of the six were larger, sexually mature individuals at release, thus confirming the apparent tendency of larger lobsters to migrate or disperse more so than smaller individuals. Maximum dispersion (132 miles = 245 km) was achieved by a mature male (937M) which had been at large 973 days (2.7 yr); this individual was recaptured in a coastal trap fishery on outer Cape Cod.

The single migrant of this group, a mature male (56M), moved easterly some 29 miles (53.7 km) over a period of

39 days and was recaptured at a depth of 100 fathoms (183 m); track direction and timing is consistent with hypothesized overwintering at and below the continental shelf margin. Return 357F, recaptured in October of the following year, is regarded as a migrant of the year 1969.

Composite Station 18 (See Figure 20 and Appendix Table 18)

Two hundred thirteen recaptures have been reported from a composite total of 1,350 releases some 7 miles (13.0 km) easterly of the head of Veatch Canyon on 30 April and 1 and 2 May 1969. Mean depth at first capture was 137 fathoms (251 m); mean depth at release was 71 fathoms (130 m). These subgroups, like several others, were released shoaler than capture depth to avoid the likelihood of immediate recapture by our own vessel or other commercial vessels trawling in the vicinity of initial capture. One hundred eleven of the recaptures were reported by specific location and 36 by approximate location. In Figure 20 the recoveries are grouped and plotted by 6-minute squares for reasons given earlier. Sex ratio at release was 582 females (43%) to 768 males. The ratio at return was 97 females (46%) to 116 males.

Mean time at large for all accountable (208) recoveries was 275 days (0.7 yr). Maximum time at large for a located individual (863F), a mature female at release, was 950 days (2.6 yr), during which time net displacement from release locality was only 7 miles (13.0 km).

Mean dispersion of the 111 recaptures with specific capture locations was 25.3 miles (46.9 km). Ten females and six males, the majority being mature at release, surpassed the 50-mile (92.7-km) range; among these 16, four (249F, 477F, 359M, 720M) ranged well beyond 100 miles (204 km).

Fifteen of the recoveries are defined migrants. The foremost example among these was 249F, a 90-mm female at release; this individual traveled a record 186 miles (345 km) in 71 days (2.6 miles/day = 4.8 km/day) and was recaptured in July in a trap fishery at 7 fathoms (12.8 m) depth on the north shore of Long Island. This extensive penetration into Long Island Sound might be interpreted as an initially directed shoalward vector toward Block Island Sound with unintended overrun into eastern Long Island Sound; thereafter, a southwesterly track would conceivably lead to the vicinity of recapture on the north shore of Long Island. Alternatively, once having entered the constricted eastern end of Long Island Sound, any near-southerly track would result in shoaling on the extensive north shore of Long Island and present the dilemma of choosing correctly between an easterly or westerly course for ultimate return to the open ocean. A westerly track alongshore would also, in this conjectural situation, effectively lead 249F to the point of recapture. This unforeseen situation raises the possibility that other lobsters of offshore origin may follow similar pathways and become entrapped in Long Island Sound by virtue of its confining geography.

The defined migrants within this group are listed below along with track bearing, ground speed, and depth change, and the positive values of depth change signify shoalward movement:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
249F	302°	2.6	4.8	+68	+12[illegible]
263F	348°	0.9	1.7	+50	+9[illegible]
240F	036°	2.1	3.9	+36	+6[illegible]
254F	069°	0.6	1.1	+42	+7[illegible]
271F	278°	0.3	0.6	−20	−3[illegible]
283F	073°	0.2	0.4	−20	−3[illegible]
166F	060°	0.6	1.1	0	[illegible]
158F	058°	0.5	0.9	−5	−[illegible]
221F	081°	0.2	0.4	+10	+1[illegible]
201M	072°	0.8	1.5	0	[illegible]
311M	006°	0.4	0.7	+45	+8[illegible]
199M	067°	0.7	1.3	+5	+[illegible]
266M	296°	0.2	0.4	+15	+2[illegible]
160M	066°	0.6	1.1	−12	−2[illegible]
300M	072°	0.2	0.4	−20	−3[illegible]

The initial bearing of 249F is measured to a point eas[t] of Montauk Point consistent with assumed straight-lin[e] penetration of eastern Long Island Sound; the subsequent track or tracks to point of recapture are highly conjectural as discussed above. Eight of the fifteen migrant[s] moved shoalward, two remained at release depth, an[d] five moved to deeper water. Among the five returning t[o] deeper water, three were immature females.

Composite Station 19 (See Figure 21 and Appendix Table 19)

One hundred four recaptures have been reported fro[m] a single point release of 751 lobsters some 12 miles (22.[..] km) southwesterly of Hydrographer Canyon on 4 Ma[y] 1969. Depth at first capture was 150 fathoms (274 m)[;] depth at release was 65 fathoms (119 m). Sixty-on[e] recaptures were reported by specific location and 24 b[y] approximate location. Sex ratio at release was 36[..] females (48%) to 389 males; the ratio at return was 5[..] females (55%) to 47 males.

Mean time at large for all accountable (96) recoverie[s] was 286 days (0.8 yr); greatest time at large for a locate[d] individual (673F), a mature female at release, was 74[..] days (2.0 yr).

Mean distance traveled by individuals with specifi[c] capture locations (61) was 26.7 miles (49.5 km); seven individuals (294F, 610F, 246M, 317M, 480M, 570M, 577M[)] exceeded the 50-mile (92.7-km) range from release point[.] Six of these seven long-ranging individuals were sexuall[y] mature at release; the seventh (480M) was mature a[t] recapture some 10 mo from release.

Maximum dispersion (125 miles = 232 km) wa[s] achieved by a mature male (317M) which move[d] northeasterly onto Georges Shoals at an apparent groun[d] speed of 1.4 miles (2.6 km) per day. Two others (294F[,] 570M) also exceeded the 100-mile (185-km) range; thes[e] three cases of wide dispersion from release point are goo[d] examples of the contrasting distinction between define[d] migrants (317M and 294F) and the defined indeterminate (570M): the former show ground speeds in exces[s] f 1 mile (1.85 km) per day along hypothetical track lines ıat are probably realistic approximations of actual ·acks made good; the latter (570M) was recaptured 14 ıo after release and shows a net displacement of 115 ıiles (213 km). In this situation, the track is simply a raight-line resolution of some unknown number of ıovements over long term which have resulted in a ma- ɪr westerly displacement; the timing and directionality f the component steps cannot be deduced or inferred ·om the available information.

The defined migrants (13) within this group are listed low with ground speed and depth change:

Return no.	Ground speed mi/day	km/day	Depth change fathoms	meters
255F	0.6	1.1	+45	+82
294F	1.1	2.0	+47	+86
654F	1.1	2.0	+32	+59
146F	0.4	0.7	0	0
152F	0.4	0.7	−7	−13
184F	0.4	0.7	+10	+18
191F	0.3	0.6	+15	+27
282F	0.1	0.2	−25	−46
246M	0.8	1.5	+48	+88
290M	0.5	0.9	−25	−46
317M	1.4	2.6	+38	+70
190M	0.3	0.6	+15	+27
194M	0.4	0.7	+10	+18

omposite Station 20 (See Figure 22 and ppendix Table 20)

Forty-four recaptures have been reported from a mposite total of 387 releases made 25 miles (46.3 km) uthwest of Corsair Canyon over the 3-day period, 7, 8, d 9 May 1969. Mean depth at first capture was 173 thoms (316 m) with range 160-180 fathoms (293-329); depth at release for all releases was 50 fathoms (91.4). Thirty-seven recaptures were reported by specific cation and one by approximate location. Sex ratio at ease was 274 (71%) females to 113 males; the ratio at turn was 29 (66%) females to 15 males.

Mean time at large for accountable (44) recoveries was days (0.5 yr); greatest time at large for a located in- vidual (897M), a mature male at release, was 1,075 ys (2.9 yr) with recapture 27 miles (50.0 km) from lease point.

Mean distance traveled by individuals with specific pture locations (37) was 30.4 miles (56.3 km); four in- viduals (306F, 315F, 578F, 697F), all sexually mature males, equalled or exceeded the 50-mile (92.7-km) nge from point of release. Maximum dispersion (143 iles = 265 km) was attained by 697F which was recap- red near Veatch Canyon 761 days (2.1 yr) following lease. This group of recoveries includes the second rgest number (21) and percentage (56) of definable igrants, 21 of 37. Collectively, the migrants are aracterized by relatively large size, a high proportion 6%) of females, and, among the females, a high propor- on (44%) with external eggs at release.

The defined migrants (21) within this group are listed below with track bearing, ground speed, and depth change:

Return no.	Bearing	Ground speed mi/day	km/day	Depth change fathoms	meters
148F	056°	1.0	1.9	−85	−155
161F	227°	0.8	1.5	−40	−73
244F	329°	0.5	0.9	+16	+29
252F	329°	0.5	0.9	+16	+29
259F	327°	0.7	1.3	+23	+42
276F	337°	0.5	0.9	+18	+33
277F	337°	0.5	0.9	+18	+33
306F	323°	0.5	0.9	+22	+40
314F	314°	0.6	1.1	+23	+42
315F	315°	0.6	1.1	+23	+42
171F	036°	0.3	0.6	−45	−82
198F	222°	0.4	0.7	−35	−64
209F	079°	0.2	0.4	−42	−77
228F	225°	0.2	0.4	−30	−55
239F	079°	0.2	0.4	−32	−59
247F	009°	0.3	0.6	+11	+20
149M	056°	1.0	1.9	−85	−155
150M	043°	1.0	1.9	−85	−155
200M	334°	0.8	1.5	+13	−24
285M	325°	0.5	0.9	+20	−37
210M	079°	0.2	0.4	−32	−59

It will be noted from the preceding table and Figure 22 that 10 of the 11 migrants showing shoalward displacement were recovered within a 33° arc relative to release point; the significance of this tight grouping is evident only when the recovery positions are plotted on a detailed bathymetric chart of the area encompassed from which it can be seen that the recapture locations are coincident with several areas that are heavily fished in summer months by trawlers fishing primarily for yellowtail flounders. The rugged topography of Georges Bank shoalward of 30 fathoms (54.9 m), coupled with strong tidal currents, greatly limits trawler activity and hence the incidental catch of shoaling lobsters to those areas that are topographically compatible with otter trawl fishing. The relatively large number of tagged lobsters recaptured on this shoaler part of Georges Bank (see also Fig. 24 and related discussion) indicates that this upper reach of the Bank as a whole supports a major summertime concentration of lobsters originating from the continental margin and slope from Veatch Canyon eastward.

Composite Station 21 (See Figure 23 and and Appendix Table 21)

Twenty-three recaptures have been reported from a single point release of 166 lobsters near the head of Lydonia Canyon on 6 June 1969. Depth at first capture was 70 fathoms (128 m); depth at release was 57 fathoms (104 m). Fifteen recaptures were reported by specific locations and six by approximate location. Sex ratio at release was 82 females (49%) to 84 males; the ratio at return was 7 females (30%) to 16 males.

Mean time at large for all accountable (19) recoveries was 264 days (0.7 yr); greatest time at large for a located individual (851M), a mature male at release, was 885 days (2.4 yr).

Mean distance traveled by individuals with specific capture locations (15) was 30.1 miles (55.8 km); four individuals (186F, 262F, 399F, 352M), all sexually mature at release, exceeded the 50-mile (92.7-km) range from release point.

Maximum dispersion was attained by 399F which moved a net distance of 82 miles (152 km) easterly over a period of 167 days (0.4 yr).

The defined migrants (4) within this group of recaptures are listed below with track bearing, ground speed, and depth change:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
262F	032°	1.7	3.2	+24	+44
352M	304°	0.6	1.1	+2	+4
230M	117°	0.5	0.9	−23	−42
231M	117°	0.5	0.9	−23	−42

Return 262F (44 days at large) approaches the idealized view of seasonal shoalward migration, but 352M, 230M, and 231M do not. In view of their relatively short term at large (22 days) it is possible that these last three had simply reoriented toward the depth-temperature stratum prevailing at first capture.

Recoveries 185F, 186F, and 399F fall outside the migrant classification, but represent significant dispersions with respect to time at large or distance. Both 185F and 186F were at large less than 10 days, but made seemingly directed tracks (without depth change) of 40 miles (74.1 km) and 52 miles (96.4 km), respectively, at calculated ground speeds in excess of 5 miles (9.3 km) per day. Return 399F (167 days at large) was captured at a point 82 miles (152 km) westerly and 17 fathoms (31.1 m) shoaler than point of release; this dispersion is open to interpretation, but may represent the outbound limit of a shoalward migration or simply a point on an inbound return from an even shoaler location.

Composite Station 22 (See Figure 24 and Appendix Table 22)

Forty-six recaptures have been reported from a composite total of 422 releases some 20 miles (37.1 km) southwest of the head of Corsair Canyon on 10 and 11 June 1969. Mean depth at first capture was 87 fathoms (159 m); mean depth at release was 51 fathoms (93.3 m). Thirty-nine lobsters were reported by specific location and one by approximate location. Sex ratio at release was 280 females (66%) to 142 males; the ratio at return was 28 females (61%) to 18 males.

Mean time at large for all accountable (43) recoveries was 157 days (0.4 yr); greatest time at large for a located individual (898M), a mature male at release, was 1,034 days (2.8 yr) with recapture 11 miles (20.4 km) from release point. This individual showed a 39% increase in carapace length at recapture which suggests that at least two molts occurred during its time at large.

Mean distance traveled by individuals with speci capture locations (39) was 44 miles (81.5 km); five dividuals (237F, 575F, 770F, 303M, 747M) surpassed t 50-mile (92.7-km) range from point of release by a co siderable margin (range 87-164 miles = 161-304 kr Maximum movement was attained by 747M (see Fig. which was recaptured 865 days (2.4 yr) following relea runner-up in this category was 575F, a large egg-beari female at release, which was taken in a coastal tr fishery at Truro Beach, Mass., 431 days (1.2 yr) followi release.

This group of recoveries includes the largest numb (28) and percentage (71) of definable migrants with 28 39 located recoveries meeting the "migrant" criter defined previously. The migrants here, as at station are characterized by large mean size, a high proporti (61%) of females, and, among the females, a high propo tion (59%) with external eggs at release.

Bearing, ground speed, and depth change are giv below:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change mete
236F	316°	1.7	3.2	+17	+3
237F	240°	4.4	8.2	−8	−1
238F	337°	1.5	2.8	+18	+3
251F	338°	1.0	1.9	+18	+3
260F	331°	1.0	1.9	+25	+4
284F	322°	0.5	0.9	+17	+3
287F	328°	0.6	1.1	+21	+3
288F	332°	0.6	1.1	+22	+4
293F	329°	0.6	1.1	+14	+2
307F	302°	0.7	1.3	+22	+4
308F	302°	0.7	1.3	+22	+4
309F	302°	0.7	1.3	+22	+4
316F	307°	0.9	1.7	+25	+4
336F	300°	0.5	0.9	+25	+4
337F	300°	0.5	0.9	+25	+4
339F	310°	0.5	0.9	+20	+3
208F	117°	0.8	1.5	−40	−7
222M	322°	1.0	1.9	+14	+2
242M	333°	1.4	2.6	+12	+2
243M	330°	1.4	2.6	+20	+3
248M	325°	1.3	2.4	+24	+4
258M	317°	0.9	1.7	+23	+4
261M	331°	0.9	1.7	+19	+3
278M	317°	0.7	1.3	+18	+3
303M	243°	1.6	3.0	−23	−4
310M	341°	0.6	1.1	+20	+3
341M	317°	0.4	0.7	+18	+3
342M	317°	0.4	0.7	+18	+3

All but three (208F, 237F, 303M) of the migrants ran ed significantly shoalward from point of release and we recaptured within 89 days from date of release. Migra 208F moved quickly toward deeper water approximati depth at first capture; migrant 237F, a large egg-beari female, moved rapidly some 87 miles (161 km) in 20 da to be recaptured near the head of Oceanographer Cany in only slightly deeper water; migrant 303M, a lar male, moved 123 miles (228 km) in 76 days to be reca tured on the east flank of Hydrographer Canyon significantly deeper water. These movements do not co form to a working hypothesis of springtime shoalwa migration but they illustrate the kind of exceptions that inevitably arise in attempted classification of the movements of tagged animals over a short term; the long distance traveled by 237F and 303M, both at high rates of speed, tend to infer directionality on their movements that are inconsistent with our hypothesis; the close agreement of the track bearings might well be coincidence, but a rational conclusion, nevertheless, is that the tracks are similar results of disoriented attempts to return to original release depth.

The exceptions noted above notwithstanding, the balance (25) of these migrants effected movements that were highly consistent in directionality, time at large, and distance. Inspection of Appendix Table 22 shows that all were recaptured within the range 20-89 days at net distances from point of release ranging from 22 to 48 miles (40.8-89.0 km); bearings of the net tracks are confined to the narrow range 300°-341° with effective shoaling ranging from 17 to 25 fathoms (31.1-45.7 m). This particular group of defined migrants amply supports our prevailing hypothesis and serves to illustrate better than any other the concept of the outbound (shoalward) phase of seasonal migration.

Composite Station 23 (See Figure 25 and Appendix Table 23)

Thirty-four recaptures have been reported from a composite total of 301 releases near the east flank of Welker Canyon on 19 and 20 June 1969. Mean depth at first capture was 61 fathoms (112 m); mean depth at release was 82 fathoms (150 m). Twenty-eight lobsters were reported by specific location and two by approximate location. Sex ratio at release was 139 females (46%) to 162 males; the ratio at return was 20 females (59%) to 14 males.

Mean time at large for all accountable (32) recoveries was 249 days (0.7 yr); greatest time at large for a located individual (848F), an egg-bearing female at release, was 506 days (1.4 yr) with recapture 16 miles (29.7 km) from original release point.

Mean distance traveled by individuals with specific capture locations (28) was 35 miles (64.9 km); eight individuals (576F, 728F, 771F, 562M, 564M, 767M, 769M, 797M) surpassed the 50-mile (92.7-km) range from point of release with two of these (728F, 797M) exceeding 100 miles (185 km). Maximum dispersion of 126 miles (234 km) westerly was accomplished by 728F while at large 348 days (0.95 yr); this individual bore ripe external eggs at recapture which, coupled with zero growth over the period at large, implies that egg deposition occurred shortly after release.

Only four of the recaptures qualify as migrants; all were recaptured in significantly shoaler water with at least three of the four effecting large-scale movements over relatively short term. Calculated bearing, ground speed, and depth change of these migrants are given below:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
576F	313°	1.1	2.0	+59	+108
584F	344°	0.5	0.9	+51	+93
562M	285°	5.0	9.3	+52	+95
564M	282°	5.5	10.2	+50	+91

The net tracks exhibited by 576F and 548F approach the idealized view of directed shoalward movements; the tracks of 562M and 564M are good, in the comparative sense, but less than ideal in terms of the best vector toward shoaler water. These two migrants rank first and third for calculated ground speed among the 117 defined migrants.

Probable migrations are evident in the respective locations of at least four other individuals (767F, 769M, 797M, 771F); each of these lobsters was recaptured approximately 1 yr after release at depths (20-35 fathoms = 36.6-64.0 m) consistent with hypothesized summertime distribution. It should be noted that here, as elsewhere, perambulations beyond one season cannot be approximated by a straight-line track; this simple convention is probably a valid estimator in cases of defined migrants, but where movements are summed over two or more migration cycles, the track-line can be nothing more than a measure of temporal displacement from point of release.

Composite Station 24 (See Figure 26 and Appendix Table 24)

Twenty-two recaptures have been reported from a composite release of 173 lobsters 10 miles (18.5 km) west of Oceanographer Canyon on 19 and 22 June 1970. Mean depth at first capture was 59 fathoms (108 m); mean depth at release was 57 fathoms (104 m). Fifteen lobsters were reported by specific location and four by approximate location. Three recaptures were reported without location information of any kind. Sex ratio at release was 72 females (42%) to 101 males; the ratio at return was 14 females (64%) to 9 males.

Mean time at large for all accountable (22) recoveries was 290 days (0.8 yr); greatest time at large for a located individual (883F), a mature female at release, was 512 days (1.4 yr) with recapture 18 miles (33.4 km) from release point.

Mean distance traveled by individuals with specific capture locations (15) was 24 miles (44.5 km); two individuals (569F, 648M) surpassed the 50-mile (92.7-km) radius of dispersion. Recapture 569F, the only qualified migrant among the returns, moved 74 miles (137 km) southwesterly in 16 days (4.6 miles/day = 8.5 km/day) to equivalent depth near Veatch Canyon; recapture 648M was taken 136 miles (252 km) westerly near Block Canyon following 207 days at large.

Composite Station 25 (See Figure 27 and Appendix Table 25)

Ten recaptures have been reported from a composite release of 60 trap-caught lobsters near Block Canyon on 6 and 7 January 1971. Twenty-four were captured, tagged, and released at 115 fathoms (210 m); 36 others were taken, tagged, and released at 212 fathoms (388 m). All recaptures were reported by specific location. Sex ratio at release was 30 females (50%) to 30 males; the ratio at recapture was 6 females (60%) to 4 males.

Mean time at large for the 10 recoveries was 285 days (0.8 yr); greatest time at large for a given individual (920M), a mature male at release, was 530 days (1.5 yr) with subsequent recapture 4 miles (7.4 km) from release point.

Mean distance ranged by the 10 recaptures was 15 miles (27.8 km); maximum dispersion of 54 miles (100 km) was attained by 798F while at large 163 days (0.4 yr); all other dispersions were 29 miles (53.7 km) or less with two (735F, 734M) recaptured at original release locations following some 6 mo at large.

None of the recaptures meet the migrant criteria as defined.

Composite Station 26 (See Appendix Table 26)

Only a single recapture has been reported from a composite total of 54 releases (trap-caught) southwest of Hudson Canyon on 25 January and 21 February 1971. The initial group of 50 lobsters was caught and released at 225 fathoms (412 m); the second group of four was caught and released at 300 fathoms (549 m). Sex ratio at release was 17 females (31%) to 37 males.

The single recovery (647M), a mature male at release, was at large 112 days (0.3 yr) prior to recapture at an unspecified location.

Composite Station 27 (See Figure 28 and Appendix Table 27)

Eleven recaptures have been reported from a composite release of 194 trap-caught lobsters 15 miles (27.8 km) south of Baltimore Canyon on 7, 8, 10, and 11 February 1971. Forty-seven were captured and released at 185 fathoms (338 m); 24 were captured and released at 292 fathoms (534 m); 123 were captured and released at 150 fathoms (274 m). All of the recaptures were reported by specific location. The sex ratio at release was 99 females (51%) to 95 males; the ratio at return was 6 females (54%) to 5 males.

Mean time at large for all recoveries was 452 days (1.3 yr); greatest time at large was 620 days (1.7 yr) with net displacement of only 4 miles (7.4 km).

Mean distance traveled by the 11 recaptures was 24 miles (44.5 km); two individuals (740F, 917F) exceeded the 50-mile (92.7-km) range. Maximum dispersion was attained by 917F which was taken in a coastal trap fishery near Cape May, N.J., some 71 miles (132 km) from release location.

None of the recaptures meet migrant criteria.

Composite Station 28 (See Appendix Table 28)

Three recaptures have been reported from a single point release of 29 trap-caught lobsters 25 miles (46.3 km) southwest of Hudson Canyon on 22 February 197[illegible] Capture and release depth was 250 fathoms (457 m); s[illegible] ratio at release was 14 females (48%) to 15 males.

Mean time at large for the three recoveries was 1[illegible] days (0.5 yr); greatest time at large was 479 days (1.3 y[illegible] with only 9 miles (16.7 km) displacement from relea[illegible] locality.

Mean distance ranged by the three recoveries was on[illegible] 7.6 miles (14.1 km), the range being 7-9 miles (13.0-16[illegible] km).

None of these recaptures meet the migrant criteria [illegible] defined.

Composite Station 29 (See Figure 29 and Appendix Table 29)

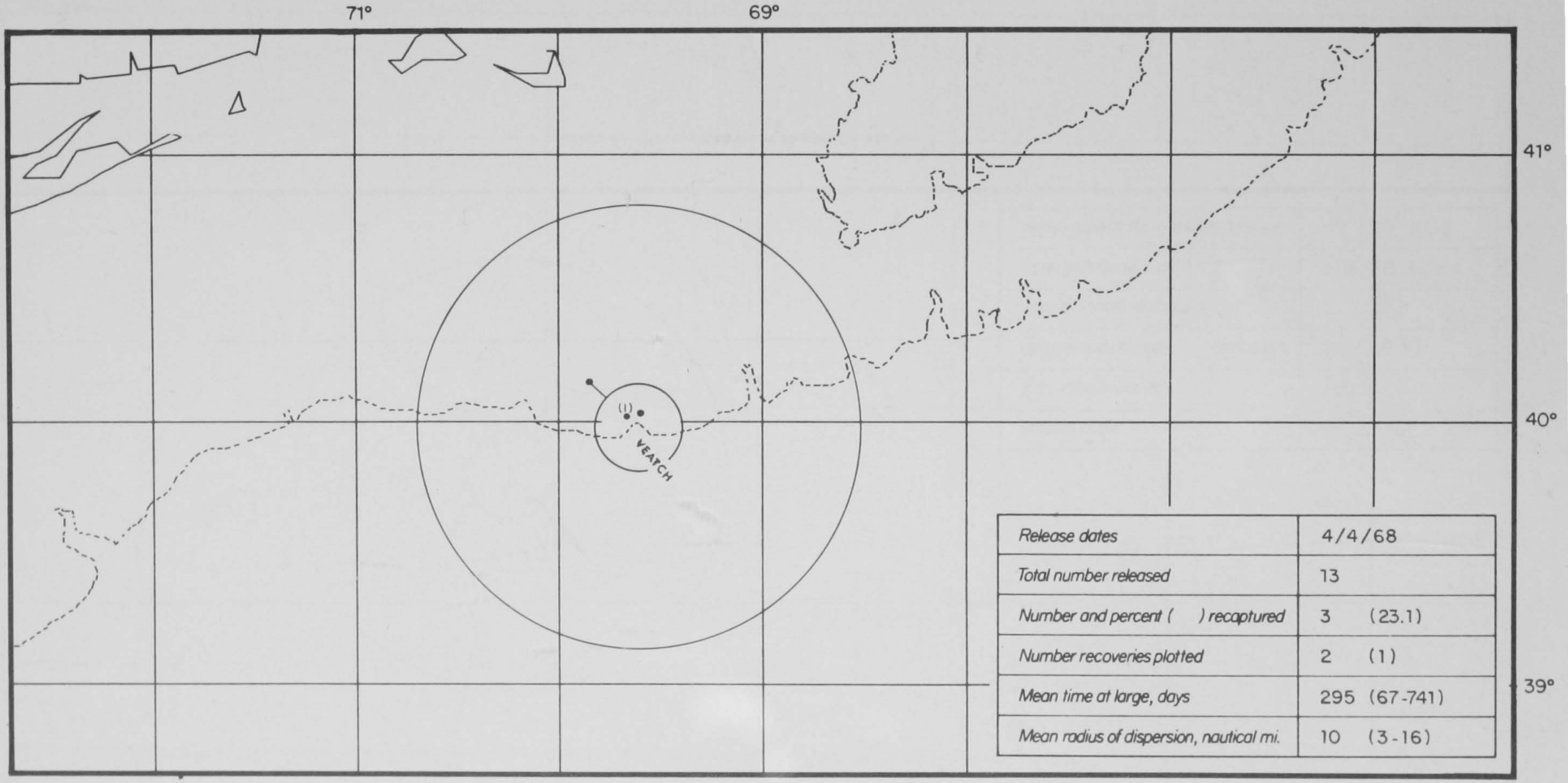
One hundred fifty-five recaptures have been report[illegible] from a composite release of 805 trap-caught lobsters [illegible] Veatch Canyon on 9 and 10 May 1971.

This series of releases was made by one of us (Richa[illegible] A. Cooper) while participating as scientific observer du[illegible] ing commercial trap-fishing operations of the FV *W[illegible] Fox* owned and operated by the Prelude Lobster Corpor[illegible] tion of Westport, Mass. The lobsters that were tagg[illegible] were, for the most part, either sublegal by size, or eg[illegible] bearing females, and would normally have been discar[illegible] ed as the traps were hauled and emptied. This taggi[illegible] strategy was not used on any other cruise. All oth[illegible] lobsters were trawl-caught or trapped (composi[illegible] stations 25, 26, 27, 28) by research vessels previous[illegible] named; among these trap-caught lobsters all that we[illegible] viable at capture were tagged and released with the e[illegible] ception of those which were dead or moribund (<1[illegible] after the posttagging holding period.

One hundred fifty of the tagged lobsters were captur[illegible] and released at 60 fathoms (110 m); the second group [illegible] 655 was captured and released at 55 fathoms (101 m[illegible] Sixty-three of the recaptures were reported by speci[illegible] location, 83 by approximate location, and 9 without loc[illegible] tion information of any kind. Sex ratio at release was 6[illegible] females (77%) to 184 males; the ratio of recaptures w[illegible] 105 females (68%) to 50 males.

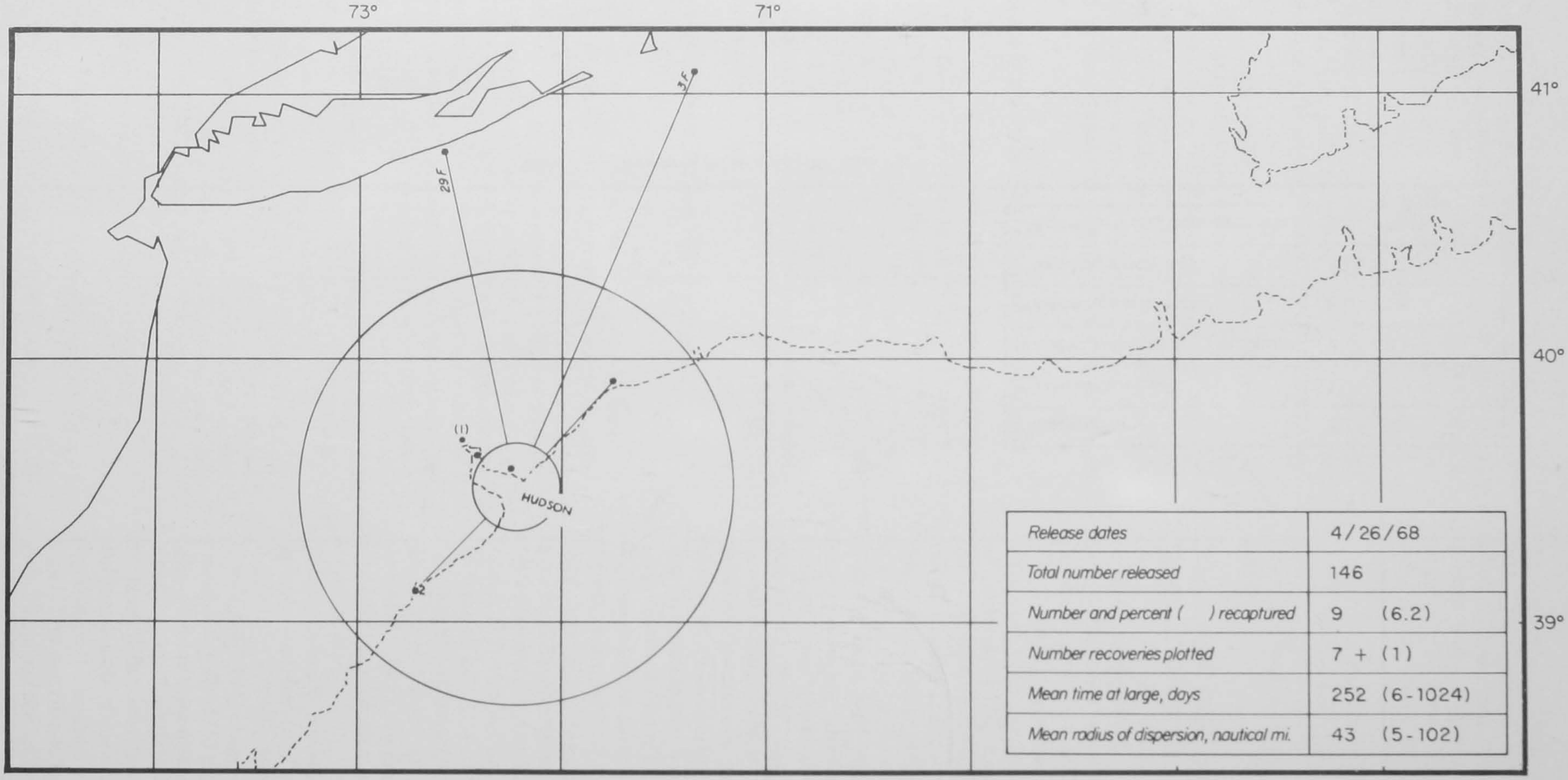
Mean time at large for all accountable (154) recoveri[illegible] was 183 days (0.5 yr); greatest time at large for a locat[illegible] individual (953F), an immature female at release, w[illegible] 492 days (1.3 yr) with recapture 18 miles (33.4 km) fro[illegible] release point.

Mean distance traveled by individuals with speci[illegible] capture locations (63) was 15 miles (27.8 km); fi[illegible] lobsters (721F, 738F, 926F, 758M, 895M) surpassed t[illegible] 50-mile (92.7-km) range with each of the two males e[illegible] ceeding 100 miles (185 km). Maximum dispersion of 1[illegible] miles (206 km) northerly to Cuttyhunk Island was a[illegible] tained by 758M while at large 108 days; this migrati[illegible] (by prior definition) into the coastal trap fishery is [illegible] further example of the evident, but unmeasured, annu[illegible] recruitment to coastal stocks by lobsters of offsho[illegible] origin. The net dispersion of 895M over 221 days to [illegible] point 102 miles (189 km) westerly could conceivably ha[illegible] been the summation of a shoalward migration such [illegible]



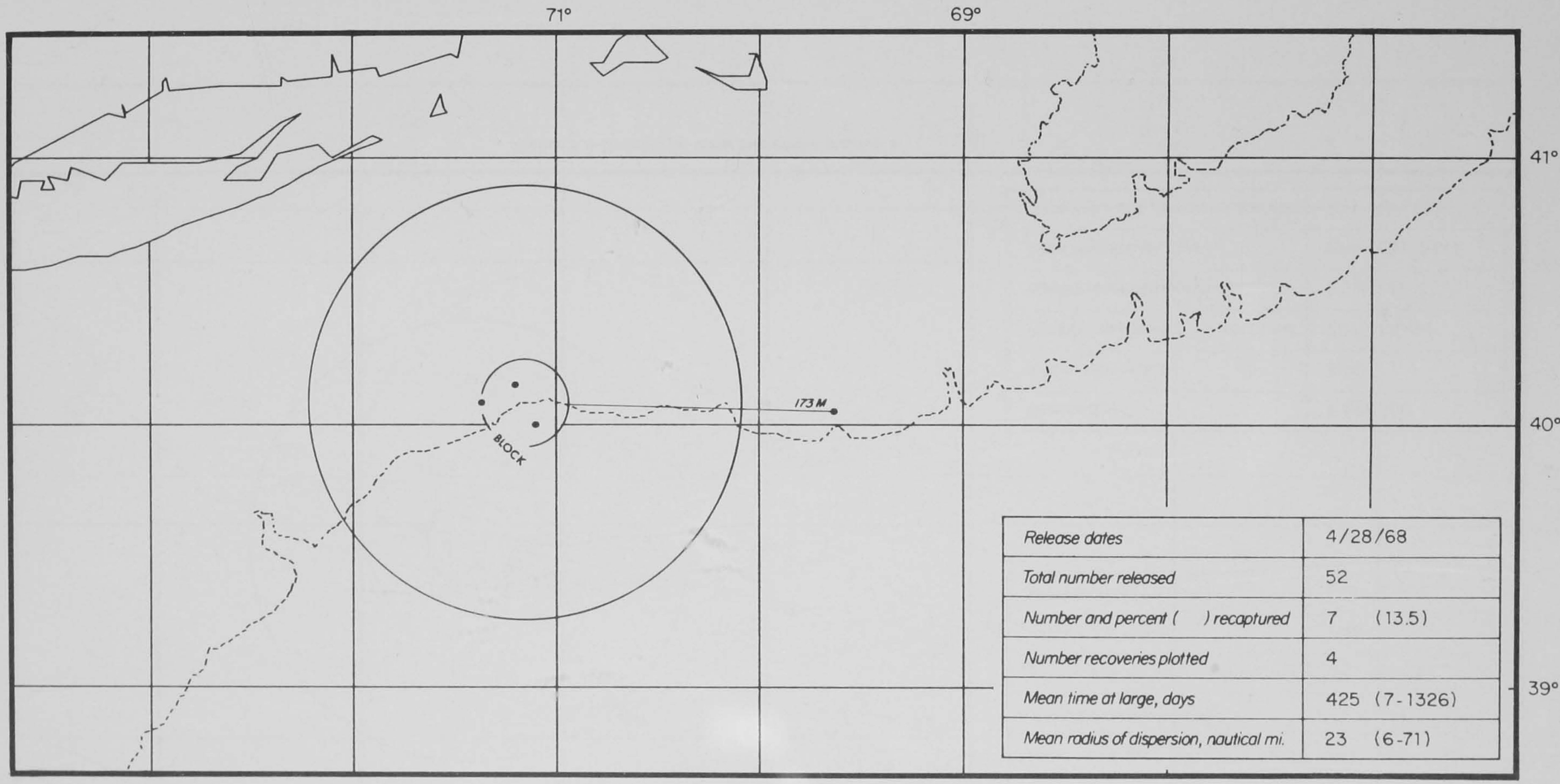
Release dates	4/4/68
Total number released	13
Number and percent ( ) recaptured	3 (23.1)
Number recoveries plotted	2 (1)
Mean time at large, days	295 (67-741)
Mean radius of dispersion, nautical mi.	10 (3-16)

Figure 5.—Recoveries from composite station 2.



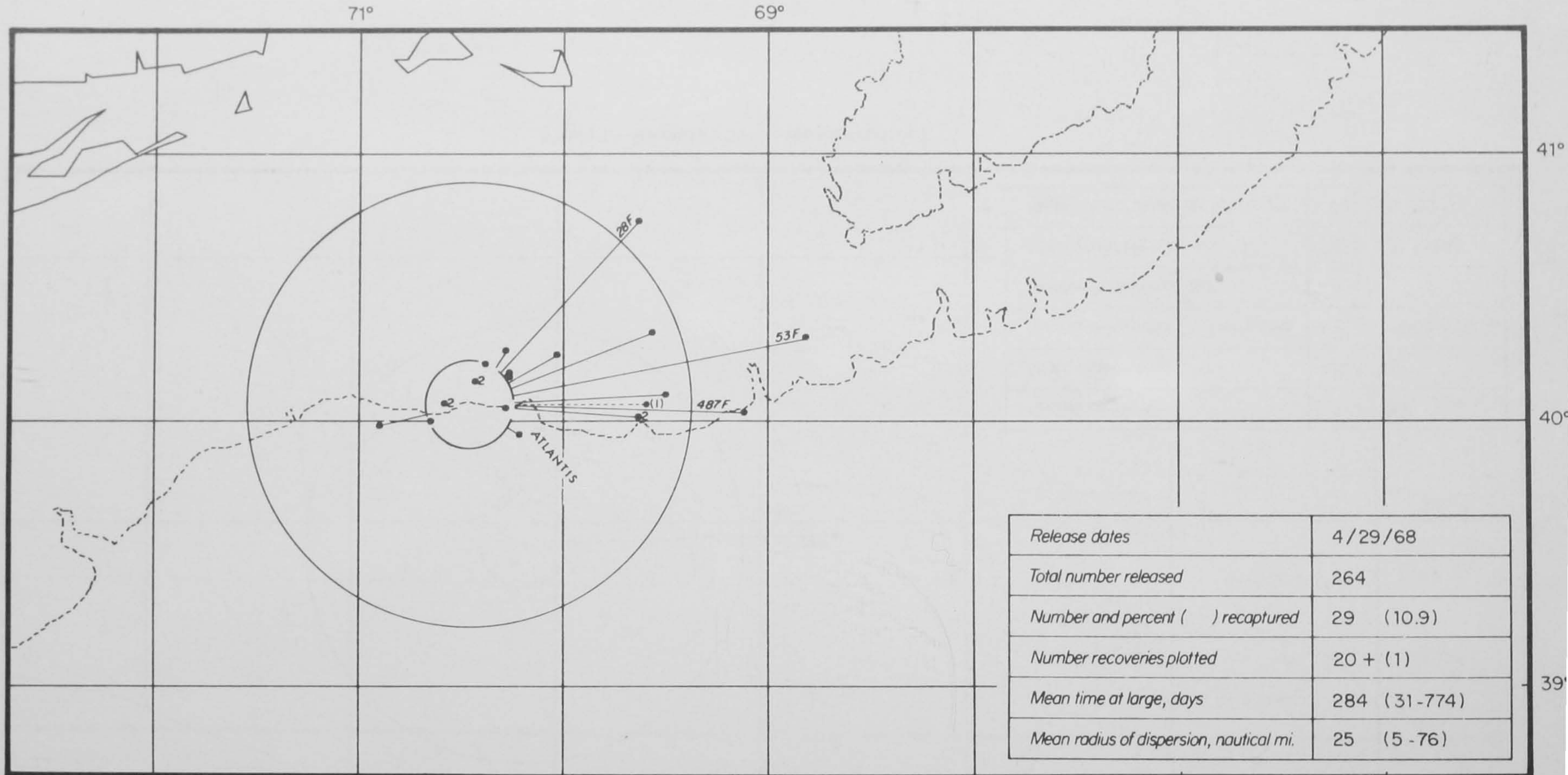
Release dates	4/26/68
Total number released	146
Number and percent ( ) recaptured	9 (6.2)
Number recoveries plotted	7 + (1)
Mean time at large, days	252 (6-1024)
Mean radius of dispersion, nautical mi.	43 (5-102)

Figure 6.—Recoveries from composite station 3.



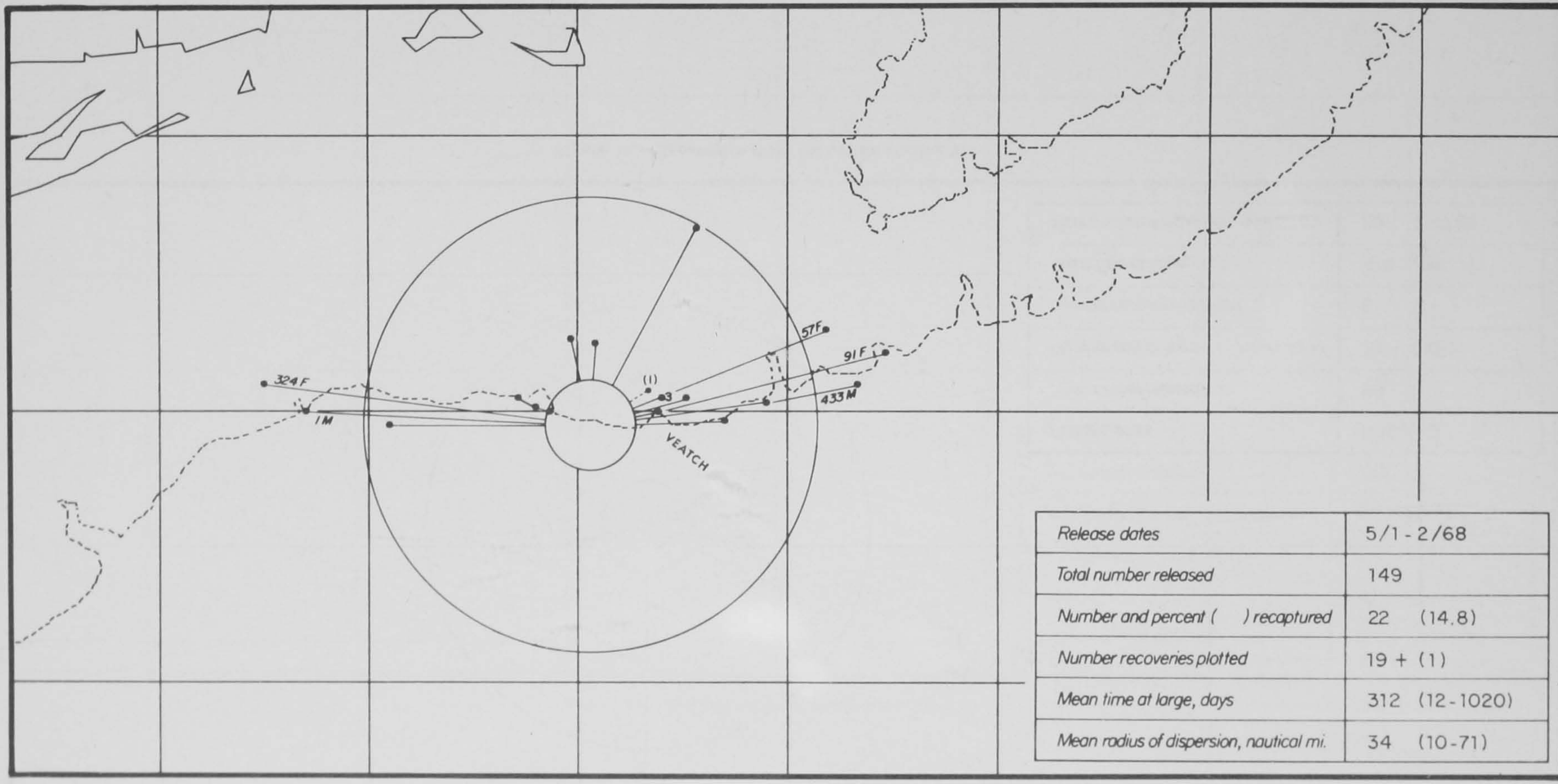
Release dates	4/28/68
Total number released	52
Number and percent ( ) recaptured	7 (13.5)
Number recoveries plotted	4
Mean time at large, days	425 (7-1326)
Mean radius of dispersion, nautical mi.	23 (6-71)

Figure 7.—Recoveries from composite station 4.



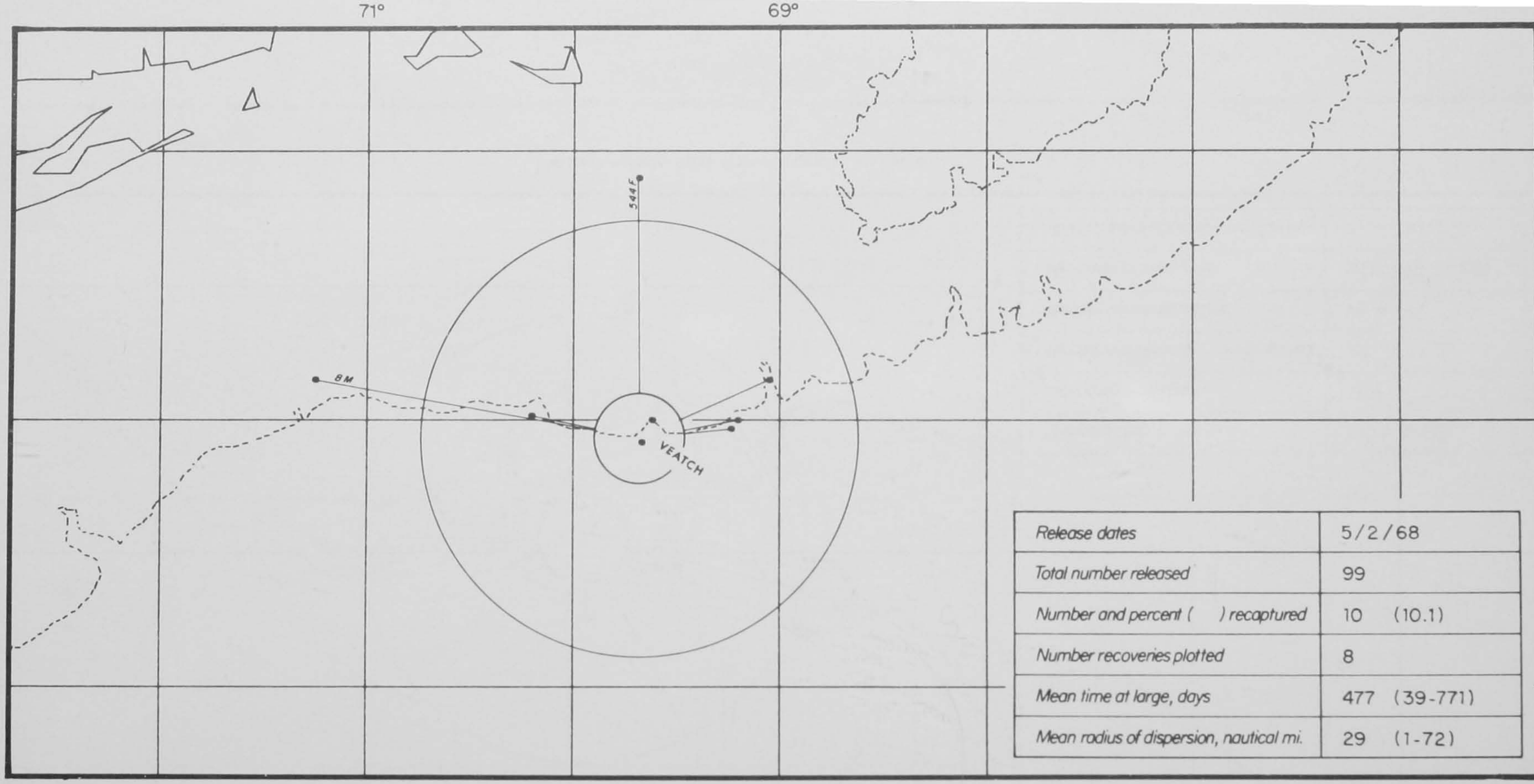
Release dates	4/29/68
Total number released	264
Number and percent ( ) recaptured	29 (10.9)
Number recoveries plotted	20 + (1)
Mean time at large, days	284 (31-774)
Mean radius of dispersion, nautical mi.	25 (5-76)

Figure 8.—Recoveries from composite station 5.



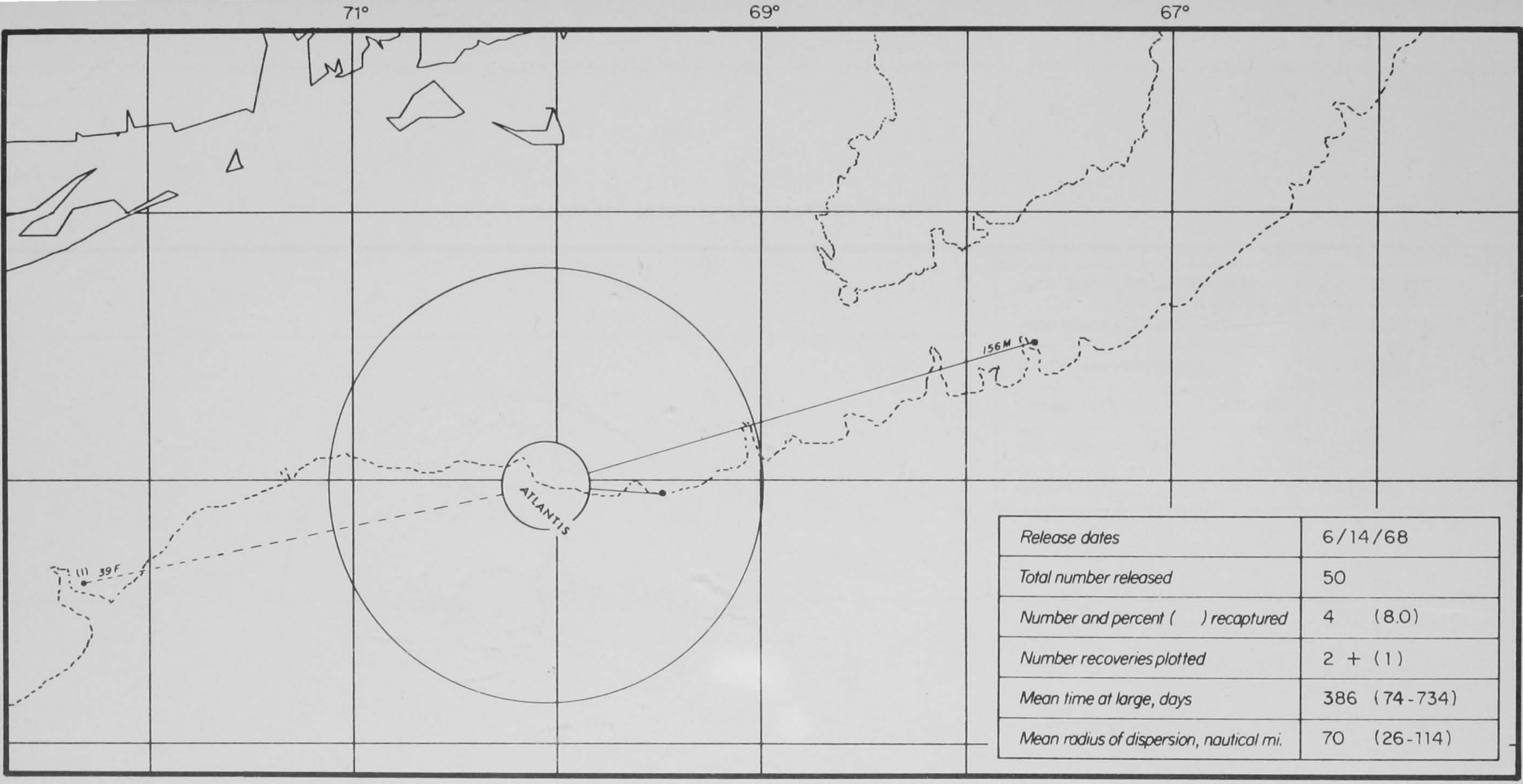
Release dates	5/1 - 2/68
Total number released	149
Number and percent ( ) recaptured	22 (14.8)
Number recoveries plotted	19 + (1)
Mean time at large, days	312 (12-1020)
Mean radius of dispersion, nautical mi.	34 (10-71)

Figure 9.—Recoveries from composite station 6.



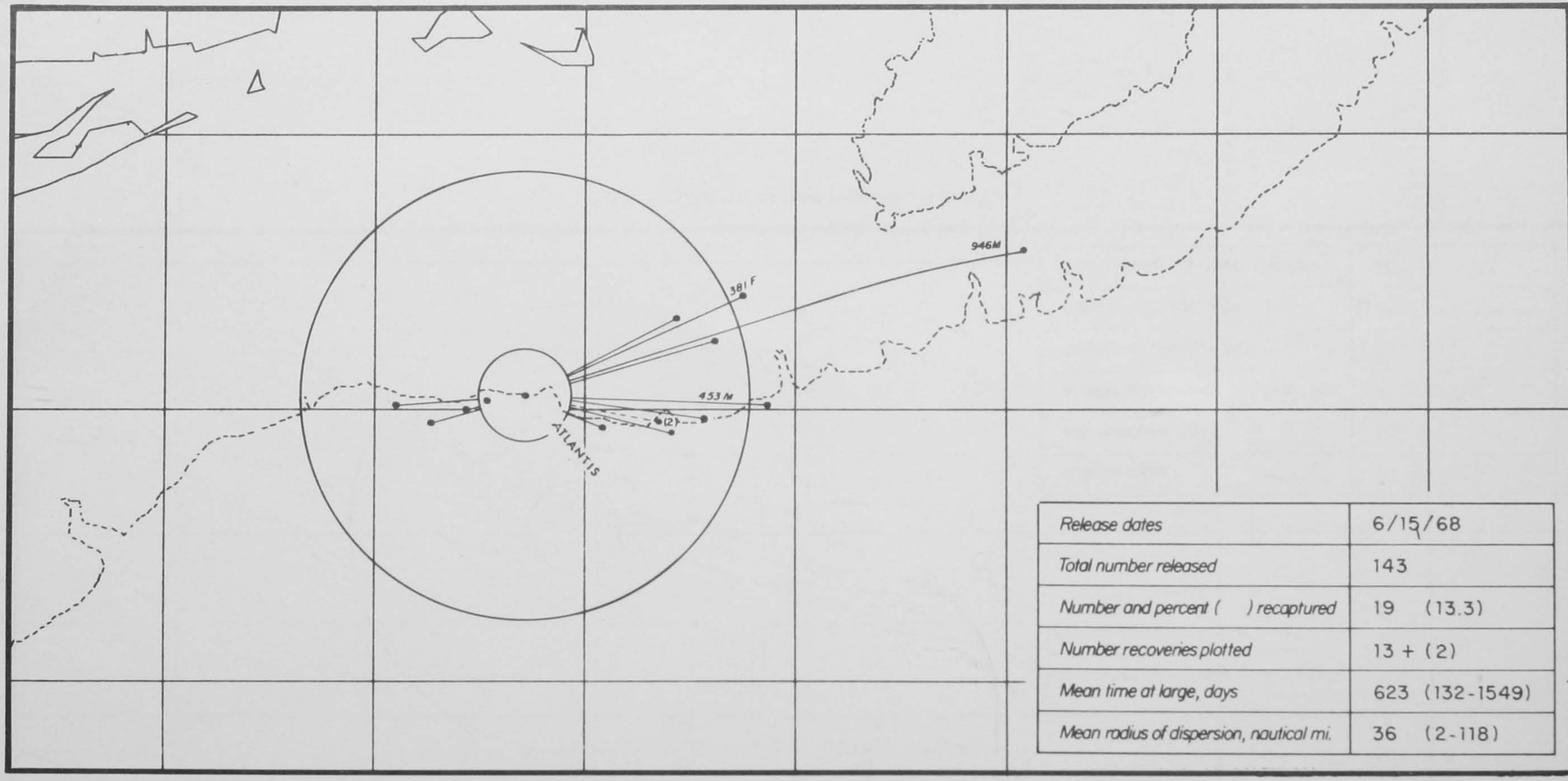
Release dates	5/2/68
Total number released	99
Number and percent ( ) recaptured	10 (10.1)
Number recoveries plotted	8
Mean time at large, days	477 (39-771)
Mean radius of dispersion, nautical mi.	29 (1-72)

Figure 10.—Recoveries from composite station 7.



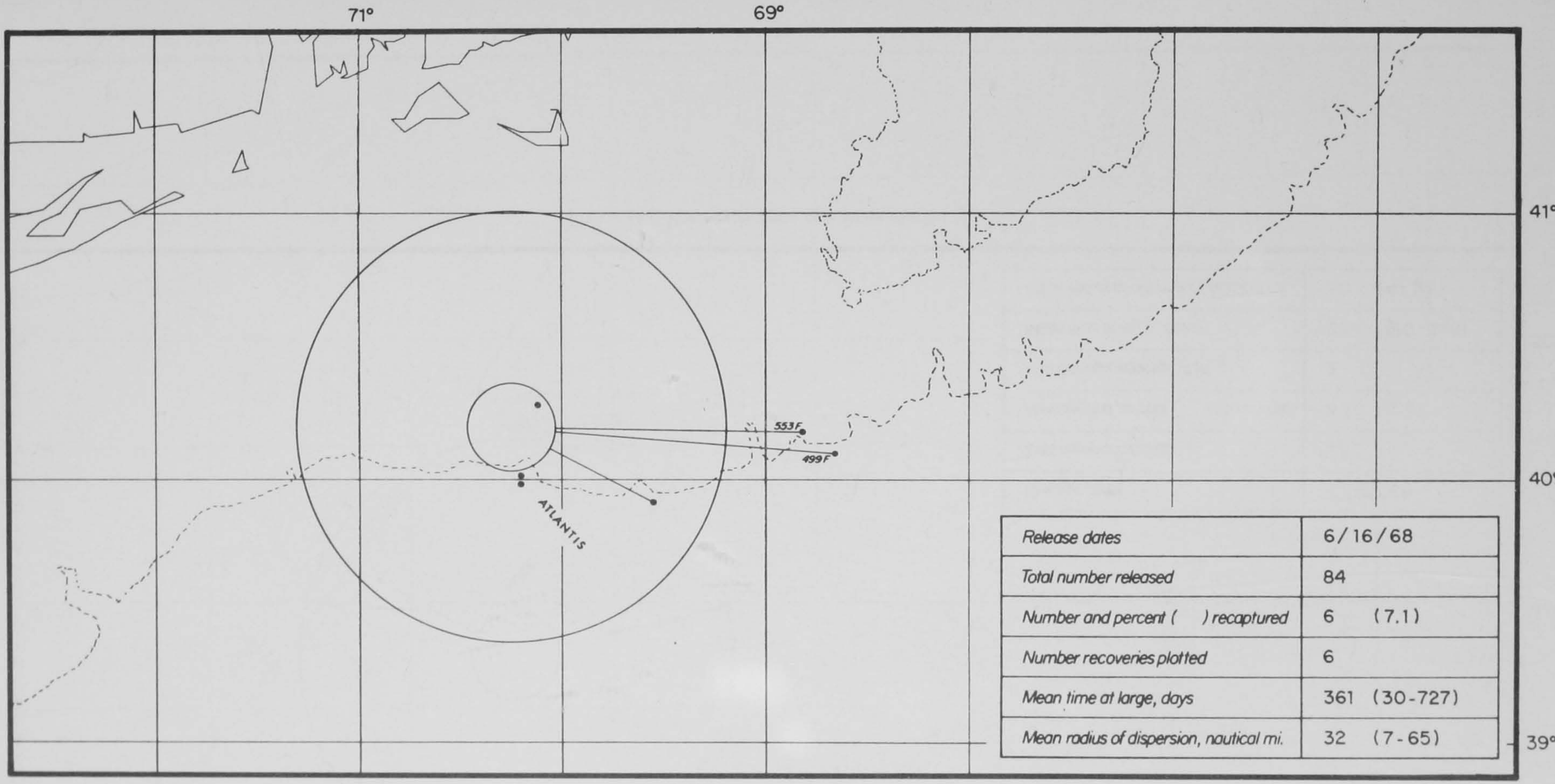
Release dates	6/14/68
Total number released	50
Number and percent ( ) recaptured	4 (8.0)
Number recoveries plotted	2 + (1)
Mean time at large, days	386 (74-734)
Mean radius of dispersion, nautical mi.	70 (26-114)

Figure 11.—Recoveries from composite station 8.



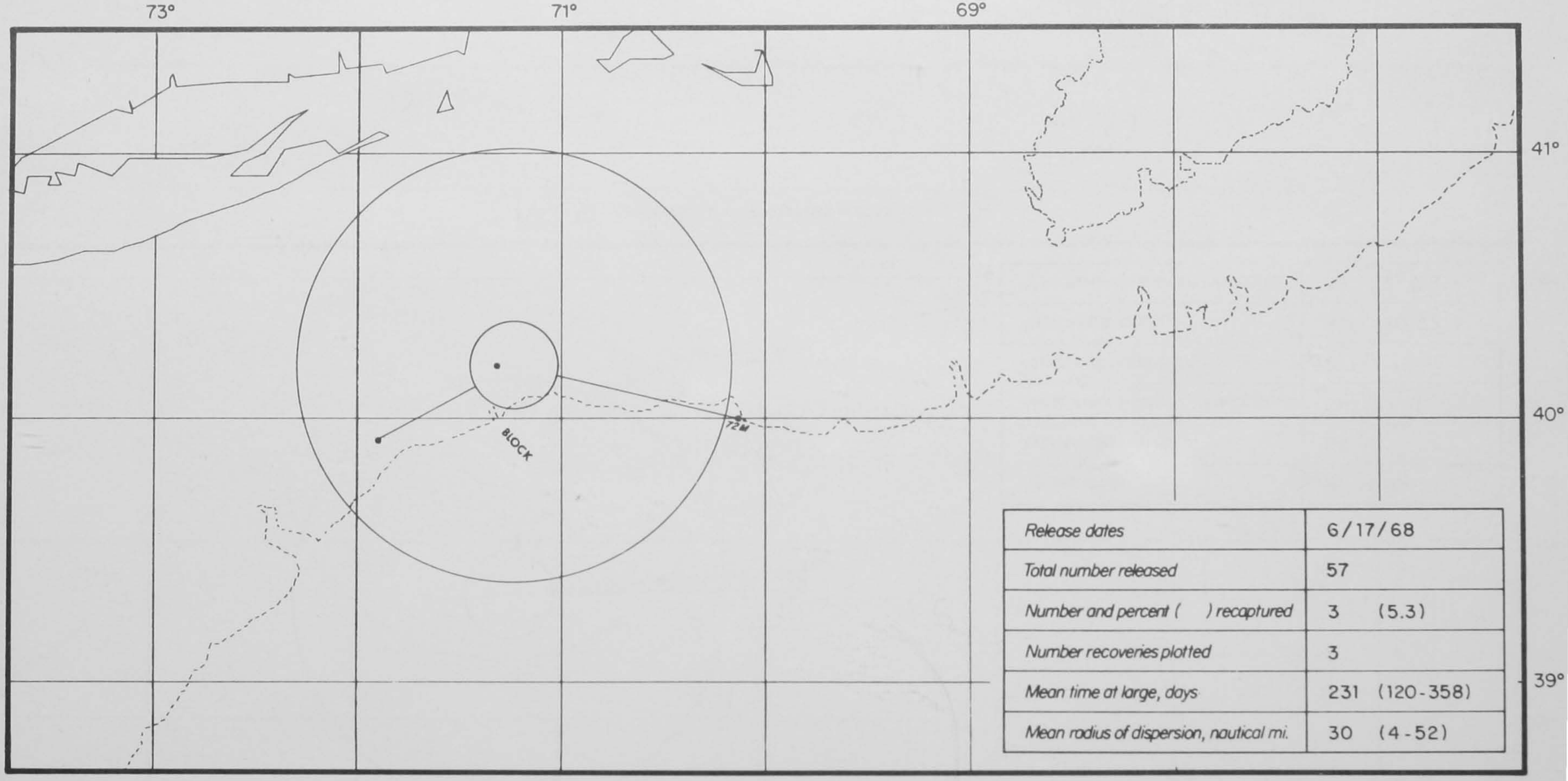
Release dates	6/15/68
Total number released	143
Number and percent ( ) recaptured	19 (13.3)
Number recoveries plotted	13 + (2)
Mean time at large, days	623 (132-1549)
Mean radius of dispersion, nautical mi.	36 (2-118)

Figure 12.—Recoveries from composite station 9.



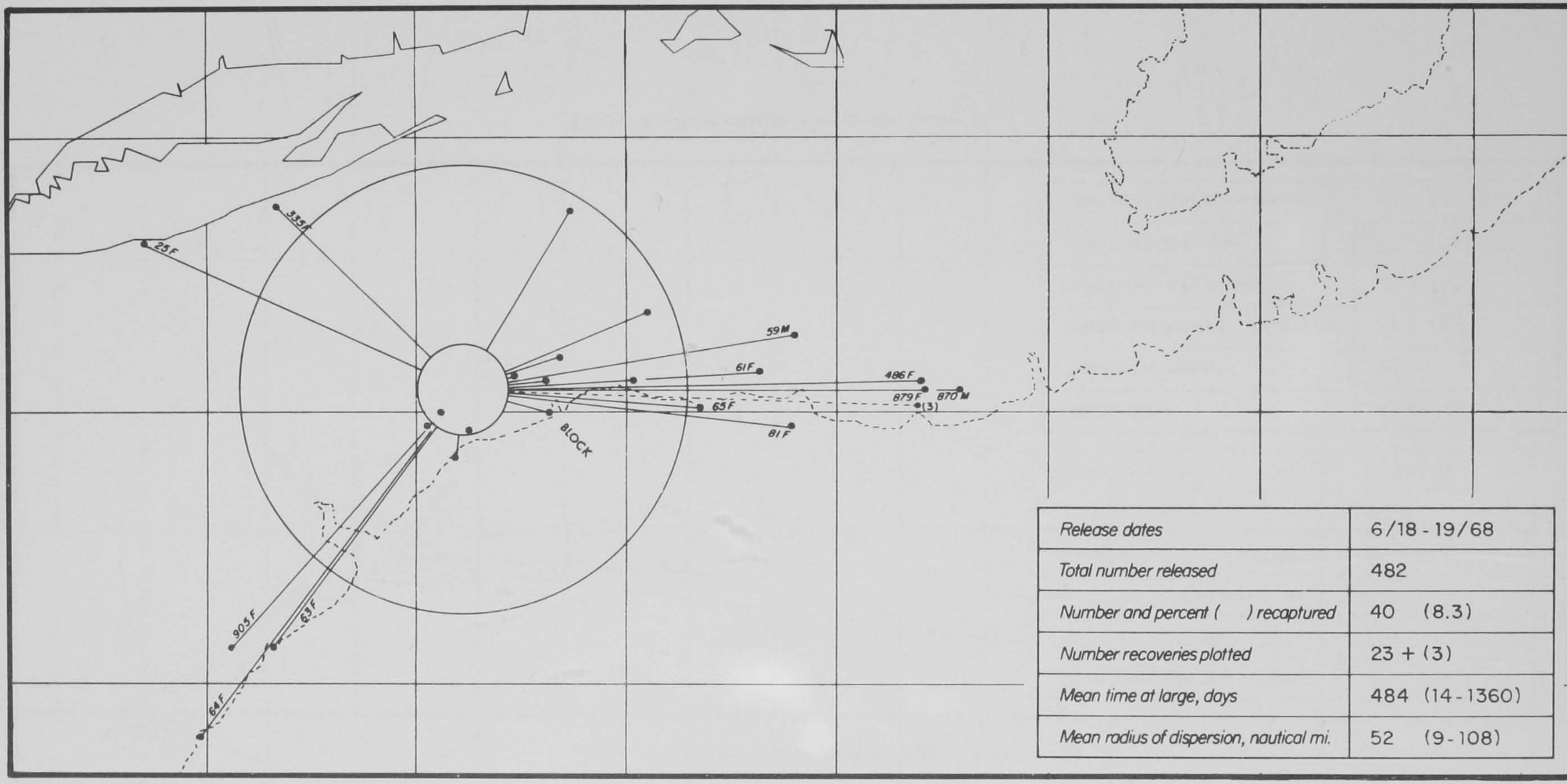
Release dates	6/16/68
Total number released	84
Number and percent ( ) recaptured	6 (7.1)
Number recoveries plotted	6
Mean time at large, days	361 (30-727)
Mean radius of dispersion, nautical mi.	32 (7-65)

Figure 13.—Recoveries from composite station 11.



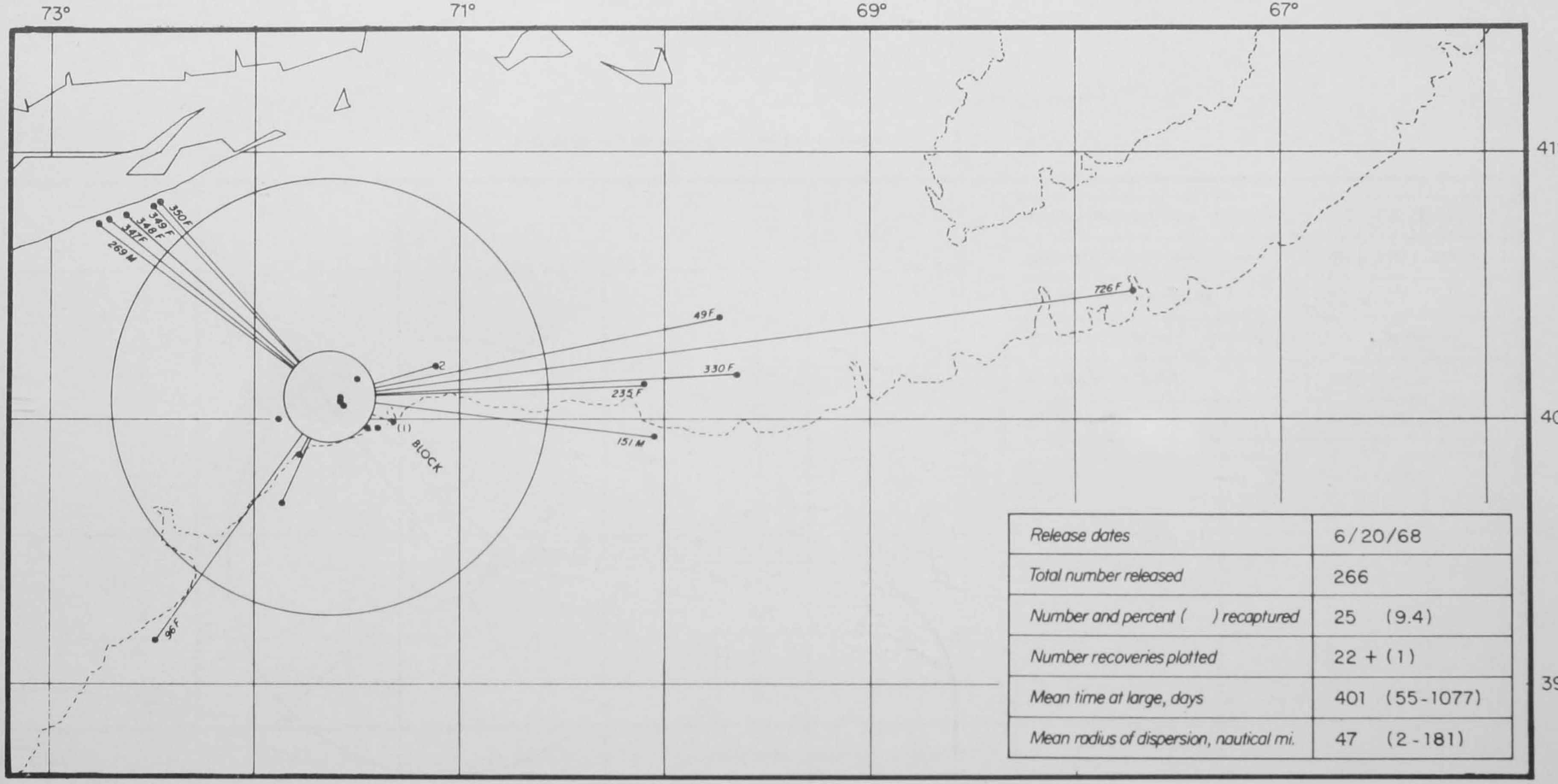
Release dates	6/17/68
Total number released	57
Number and percent ( ) recaptured	3 (5.3)
Number recoveries plotted	3
Mean time at large, days	231 (120-358)
Mean radius of dispersion, nautical mi.	30 (4-52)

Figure 14.—Recoveries from composite station 12.



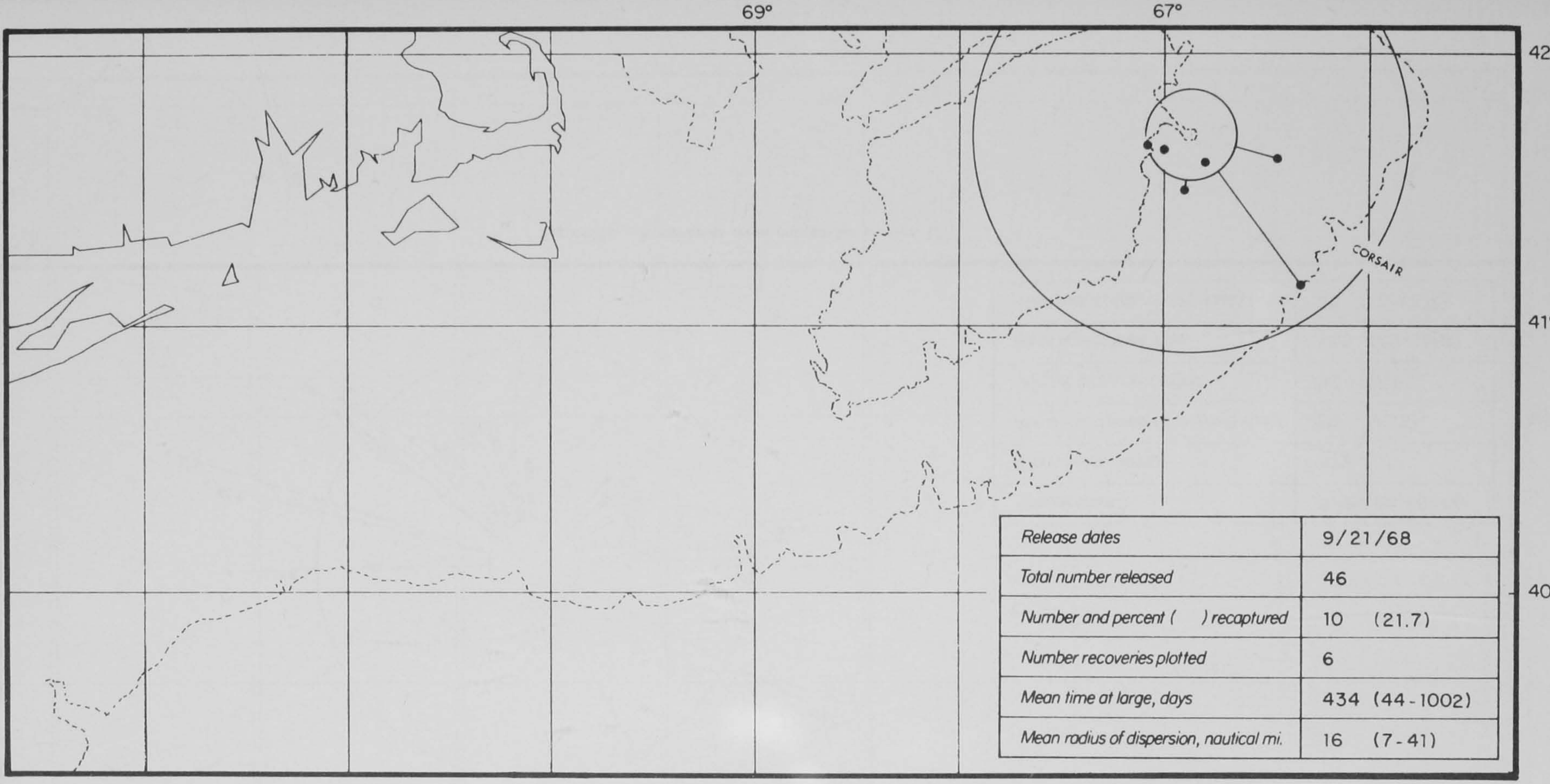
Release dates	6/18 - 19/68
Total number released	482
Number and percent ( ) recaptured	40 (8.3)
Number recoveries plotted	23 + (3)
Mean time at large, days	484 (14 - 1360)
Mean radius of dispersion, nautical mi.	52 (9 - 108)

Figure 15.—Recoveries from composite station 13.



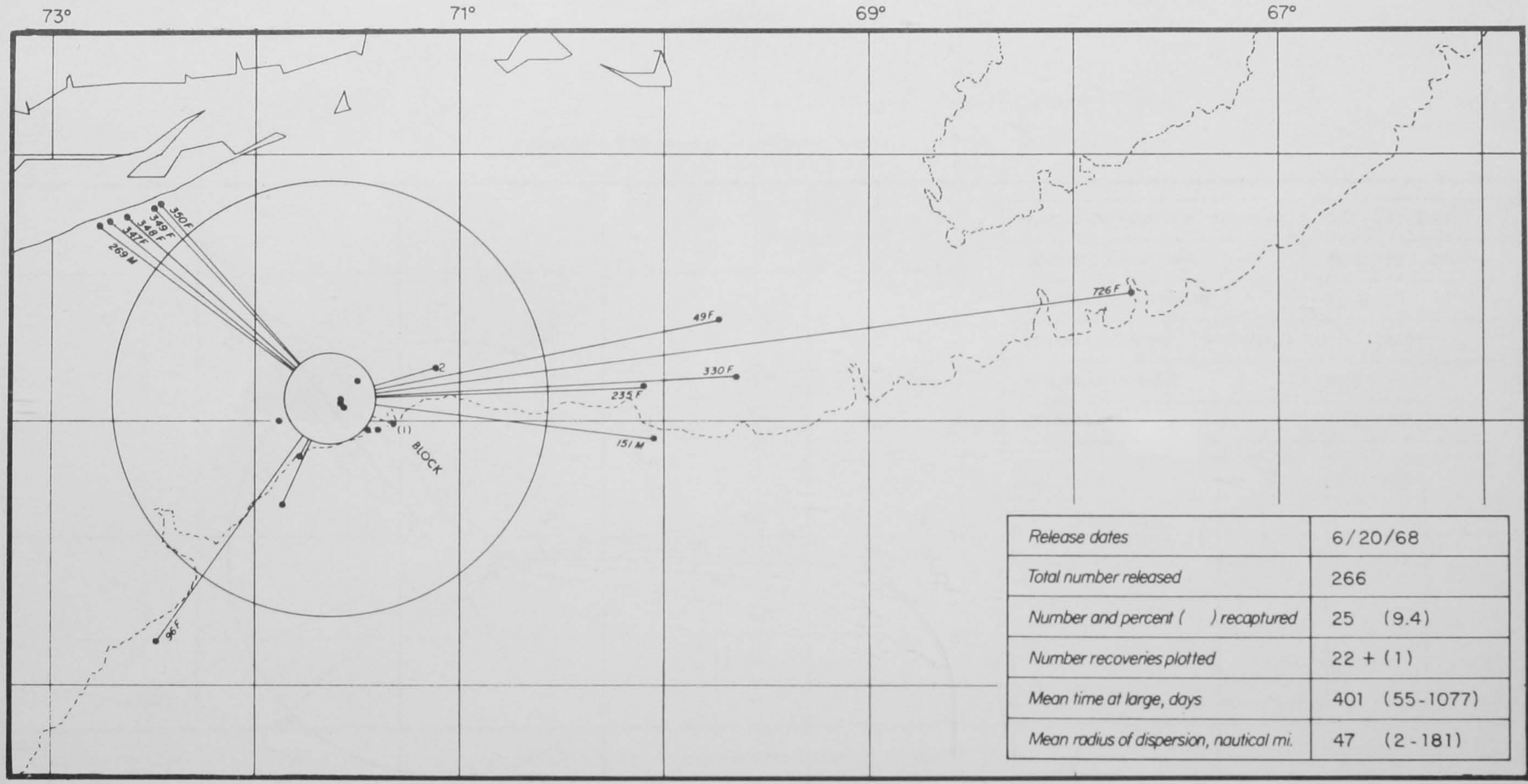
Release dates	6/20/68
Total number released	266
Number and percent ( ) recaptured	25 (9.4)
Number recoveries plotted	22 + (1)
Mean time at large, days	401 (55-1077)
Mean radius of dispersion, nautical mi.	47 (2-181)

Figure 16.—Recoveries from composite station 14.



Release dates	9/21/68
Total number released	46
Number and percent ( ) recaptured	10 (21.7)
Number recoveries plotted	6
Mean time at large, days	434 (44-1002)
Mean radius of dispersion, nautical mi.	16 (7-41)

Figure 17.—Recoveries from composite station 15.



Release dates	6/20/68
Total number released	266
Number and percent ( ) recaptured	25 (9.4)
Number recoveries plotted	22 + (1)
Mean time at large, days	401 (55-1077)
Mean radius of dispersion, nautical mi.	47 (2-181)

Figure 16.—Recoveries from composite station 14.

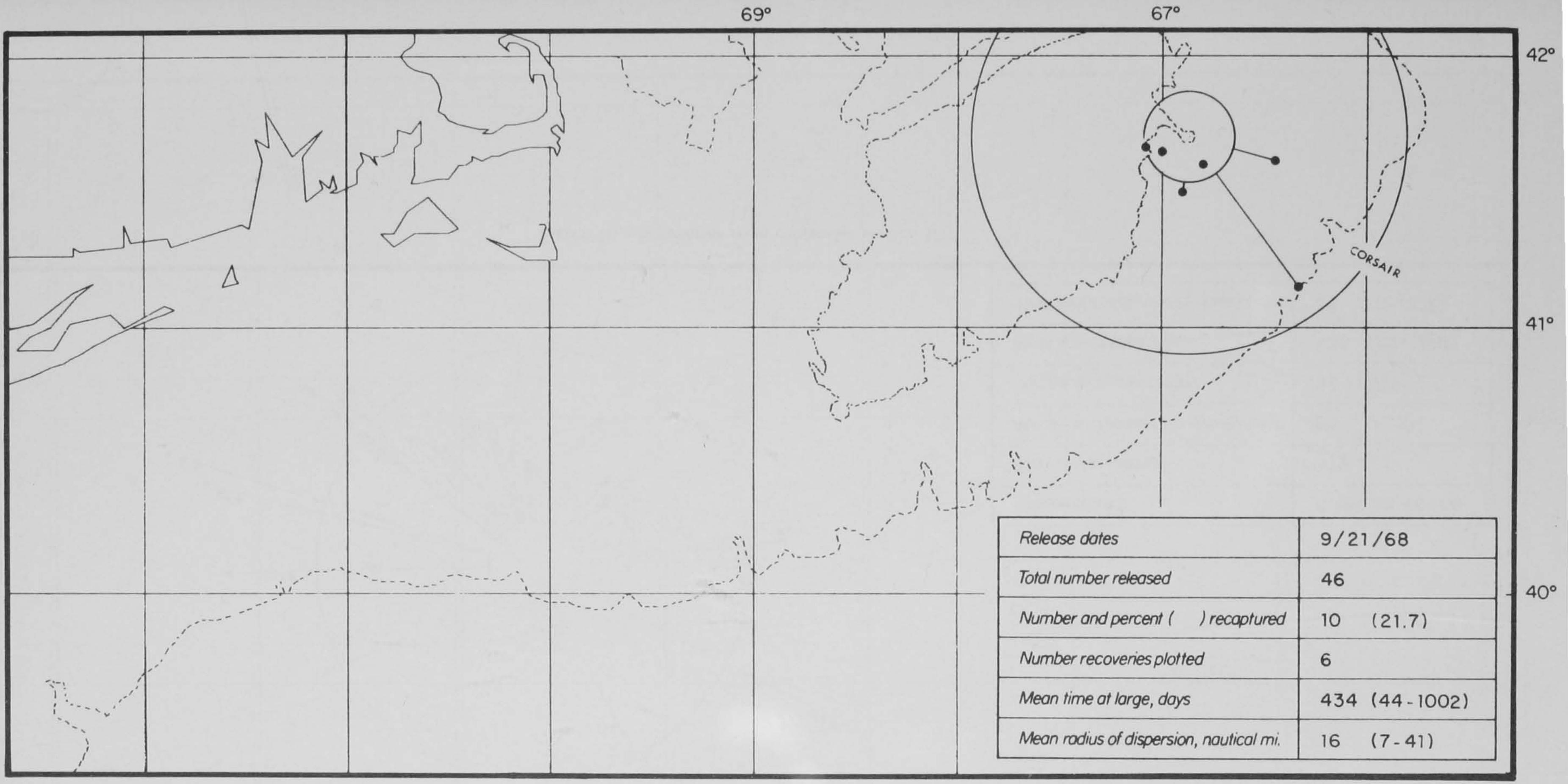
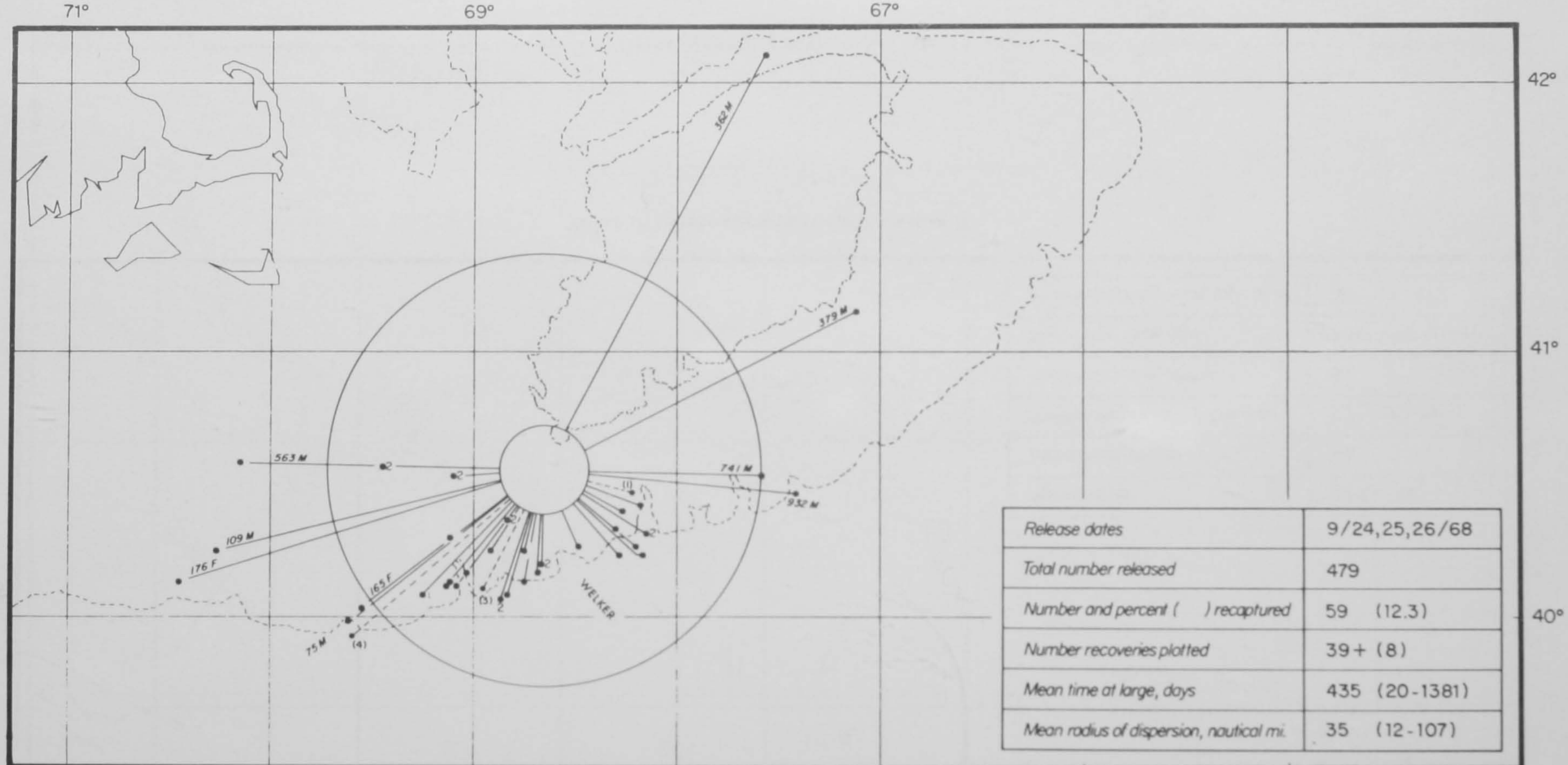
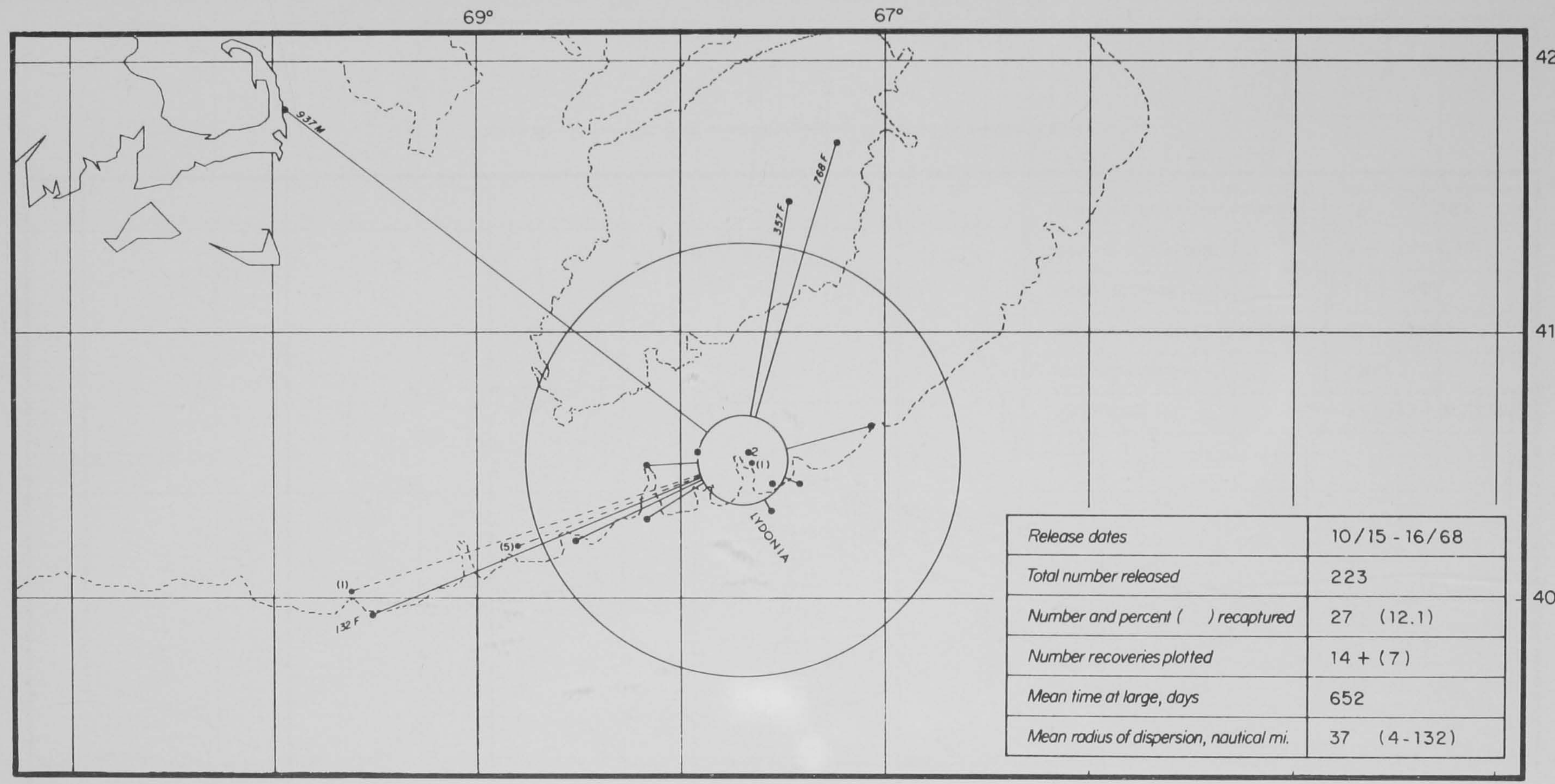


Figure 17.—Recoveries from composite station 15.



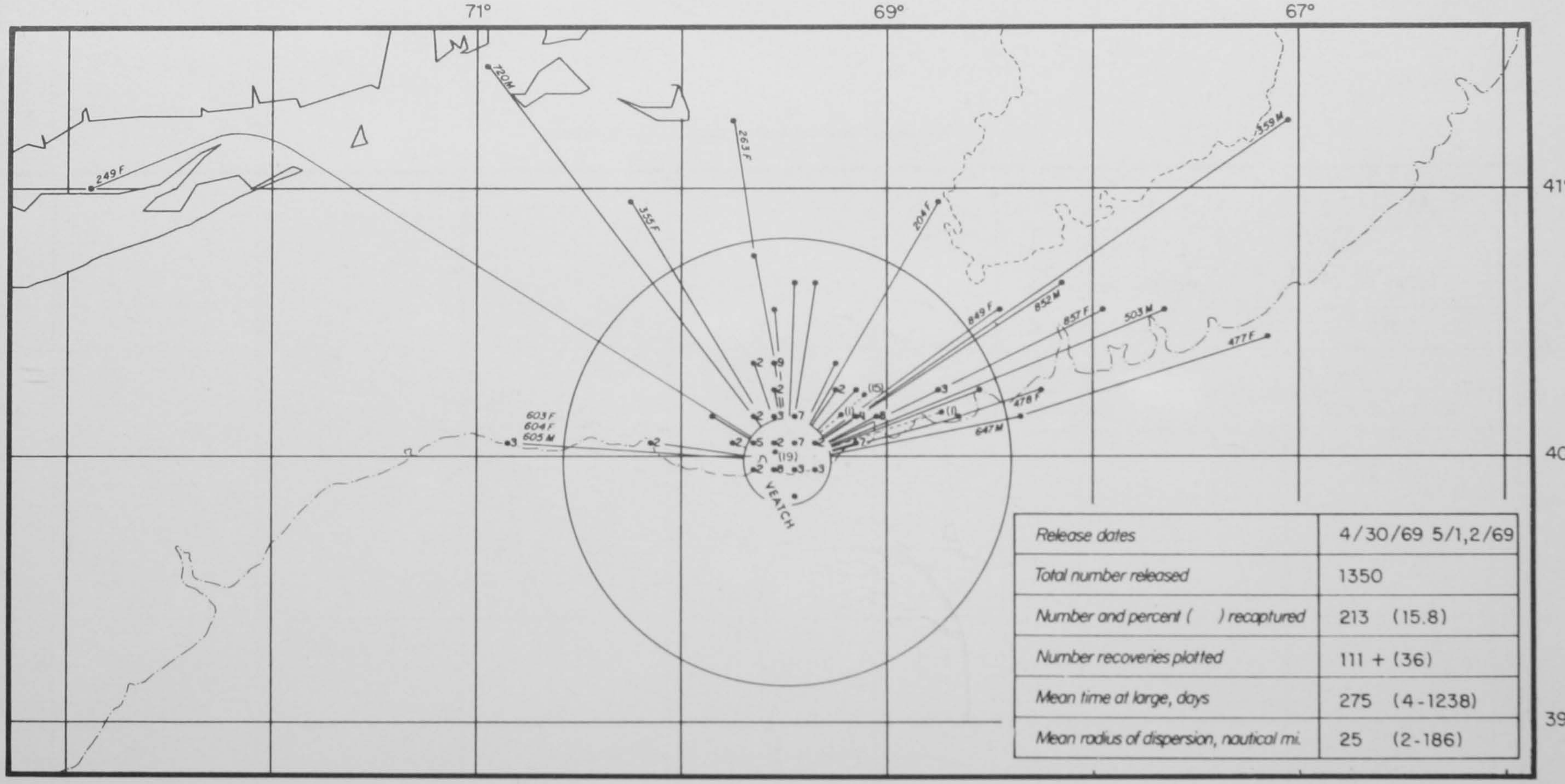
Release dates	9/24,25,26/68
Total number released	479
Number and percent ( ) recaptured	59 (12.3)
Number recoveries plotted	39 + (8)
Mean time at large, days	435 (20-1381)
Mean radius of dispersion, nautical mi.	35 (12-107)

Figure 18.—Recoveries from composite station 16.



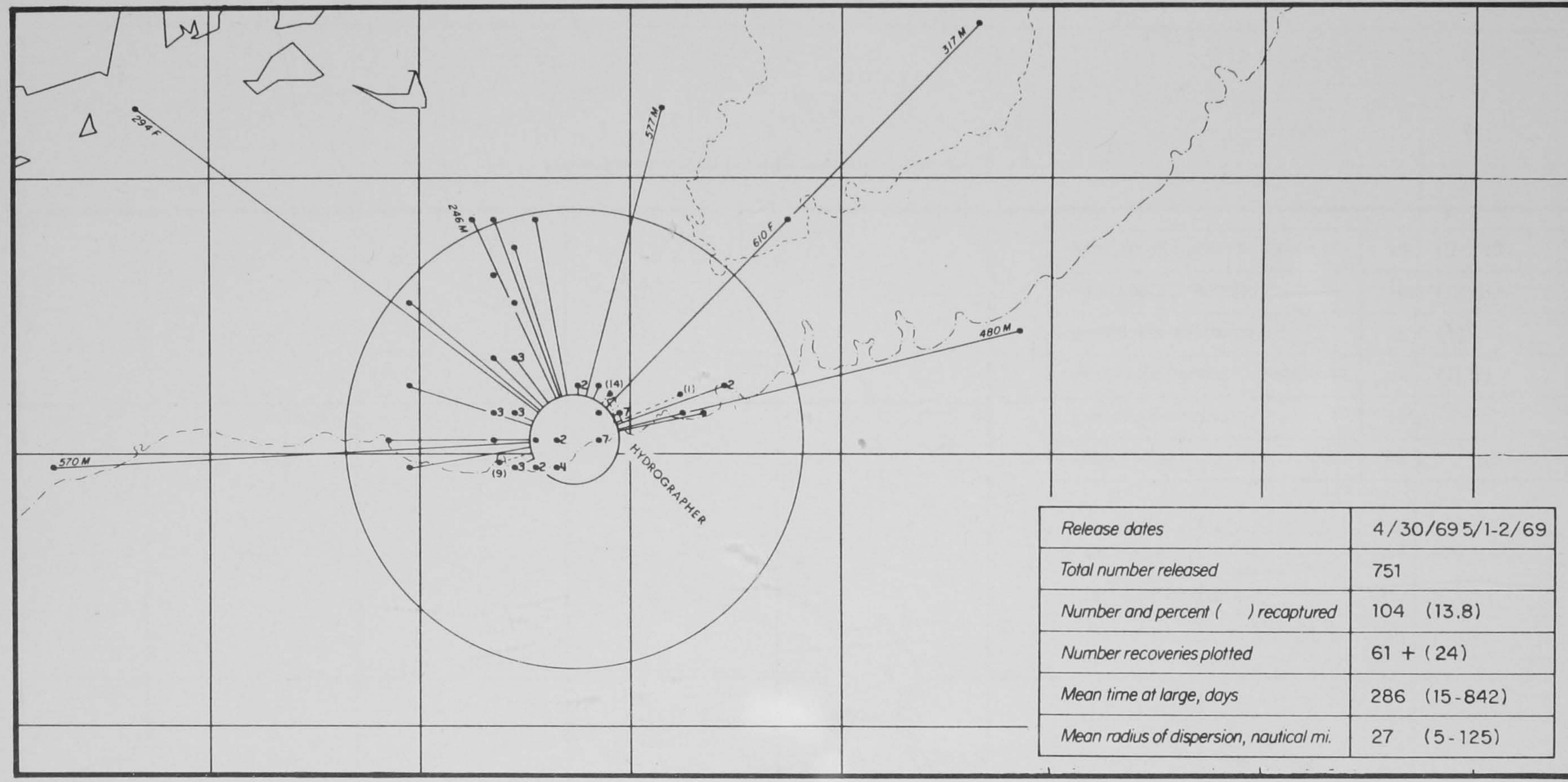
Release dates	10/15 - 16/68
Total number released	223
Number and percent ( ) recaptured	27 (12.1)
Number recoveries plotted	14 + (7)
Mean time at large, days	652
Mean radius of dispersion, nautical mi.	37 (4-132)

Figure 19.—Recoveries from composite station 17.



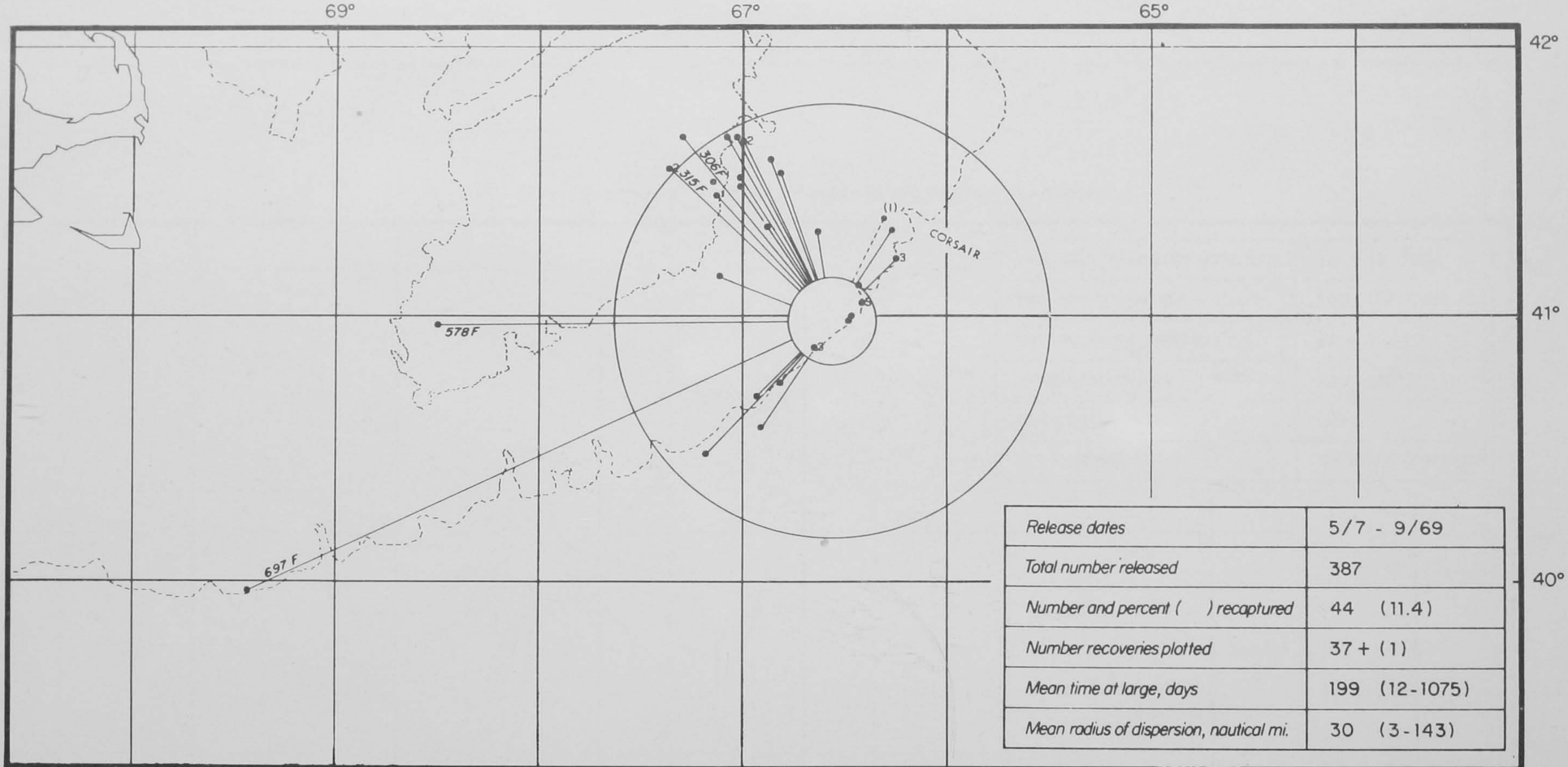
Release dates	4/30/69 5/1,2/69
Total number released	1350
Number and percent ( ) recaptured	213 (15.8)
Number recoveries plotted	111 + (36)
Mean time at large, days	275 (4-1238)
Mean radius of dispersion, nautical mi.	25 (2-186)

Figure 20.—Recoveries from composite station 18 plotted by 6-minute squares.



Release dates	4/30/69 5/1-2/69
Total number released	751
Number and percent ( ) recaptured	104 (13.8)
Number recoveries plotted	61 + (24)
Mean time at large, days	286 (15-842)
Mean radius of dispersion, nautical mi.	27 (5-125)

Figure 21.—Recoveries from composite station 19 plotted by 6-minute squares.



Release dates	5/7 - 9/69
Total number released	387
Number and percent ( ) recaptured	44 (11.4)
Number recoveries plotted	37 + (1)
Mean time at large, days	199 (12-1075)
Mean radius of dispersion, nautical mi.	30 (3-143)

Figure 22.—Recoveries from composite station 20.

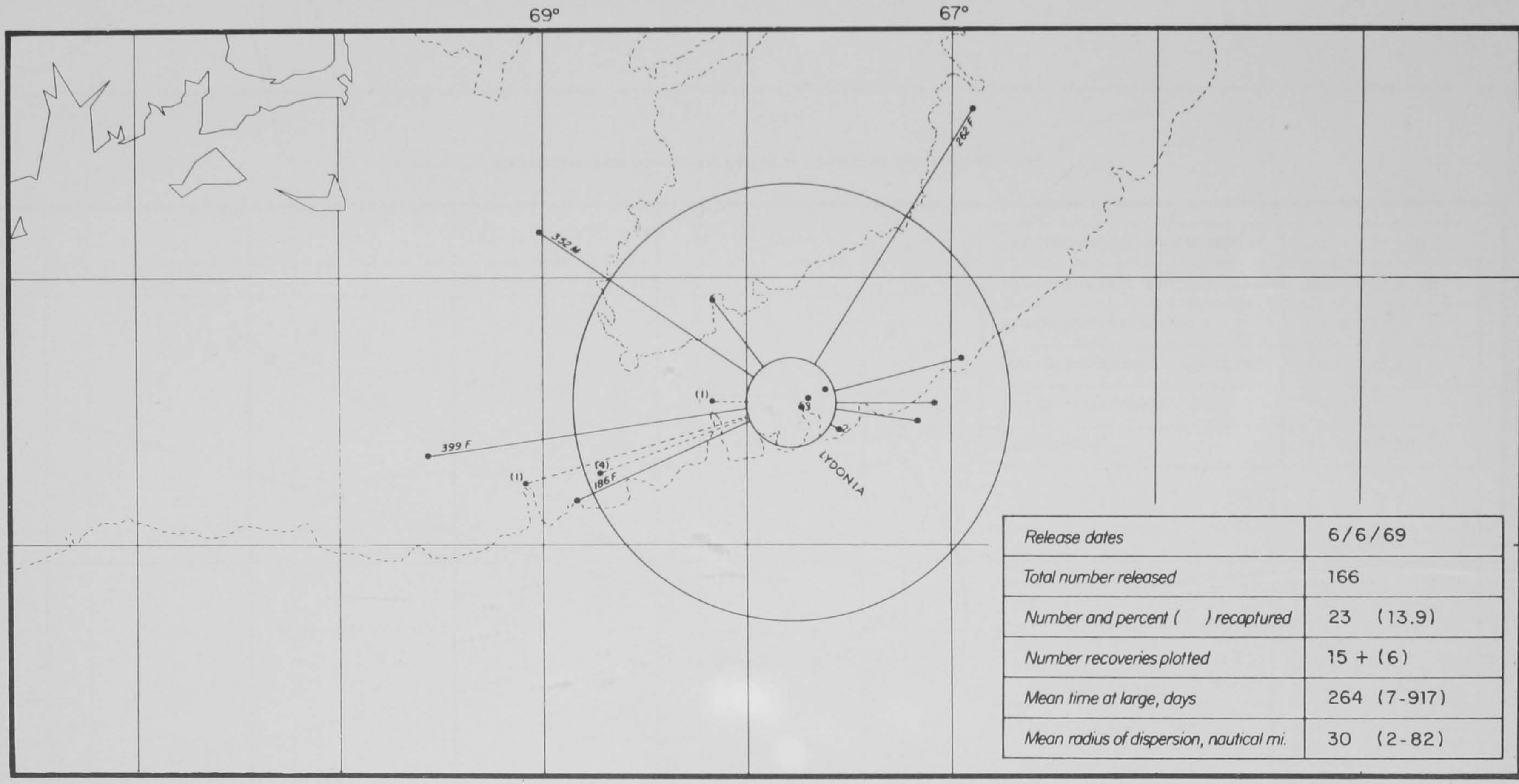
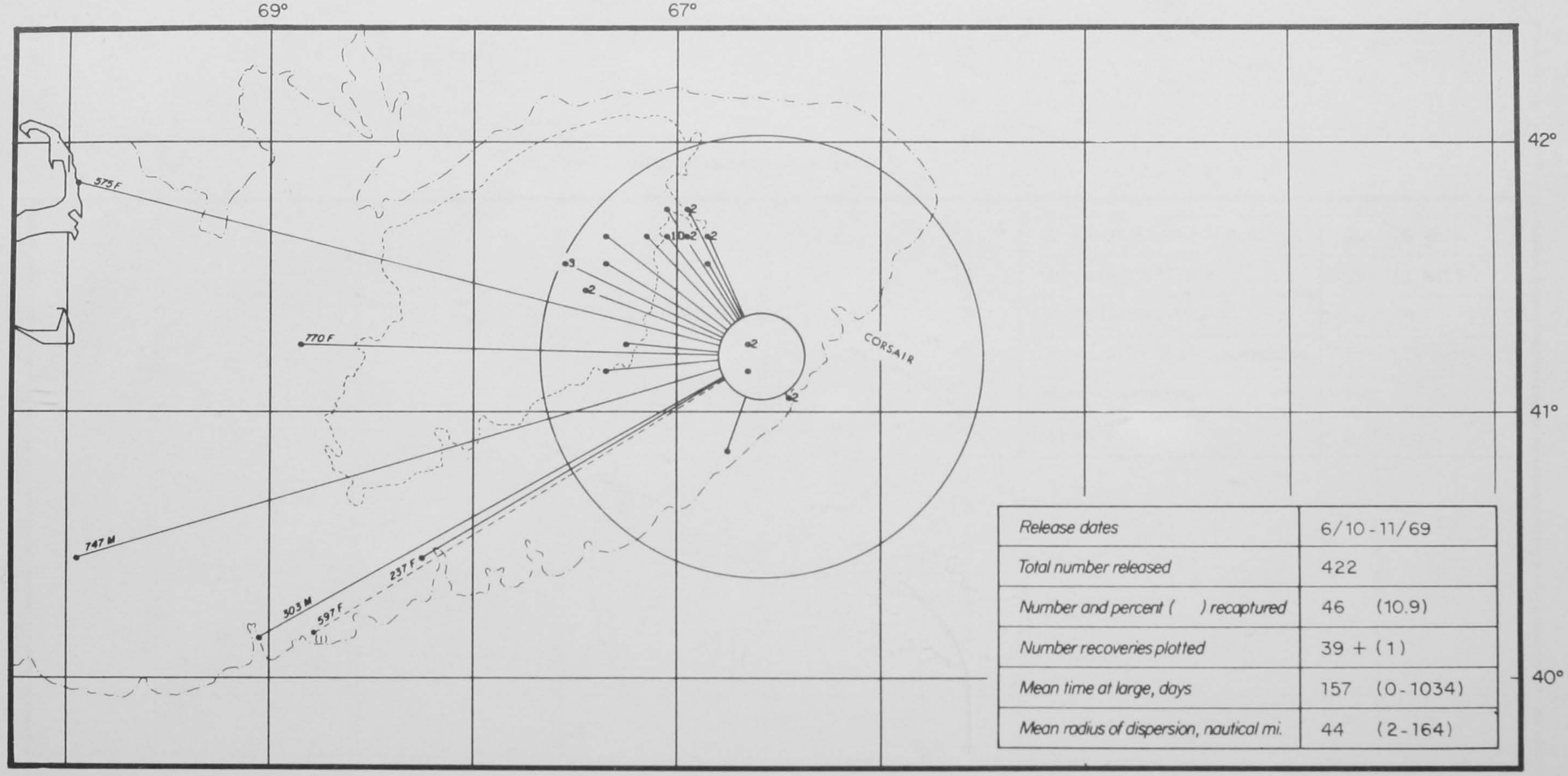
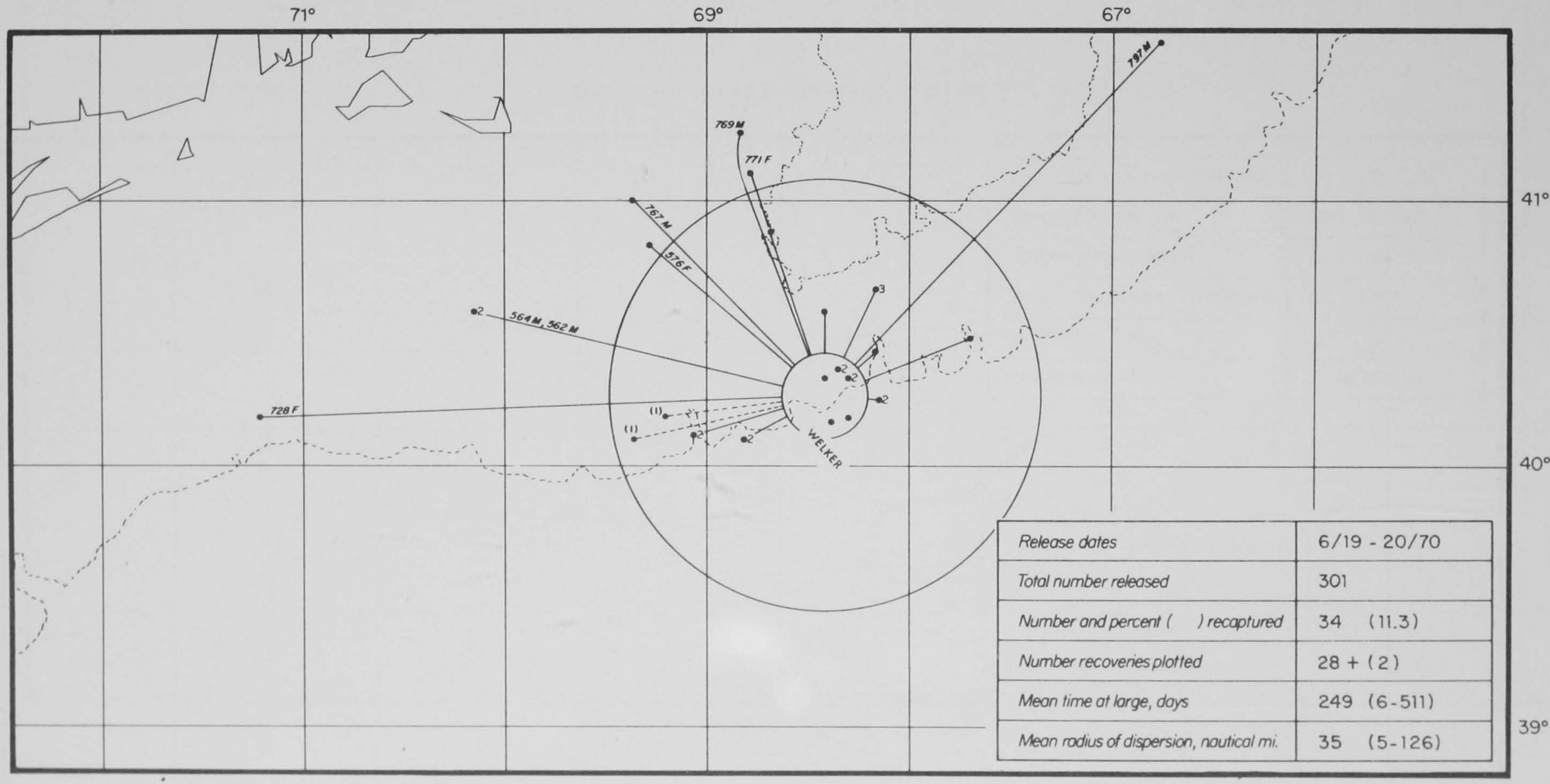


Figure 23.—Recoveries from composite station 21.



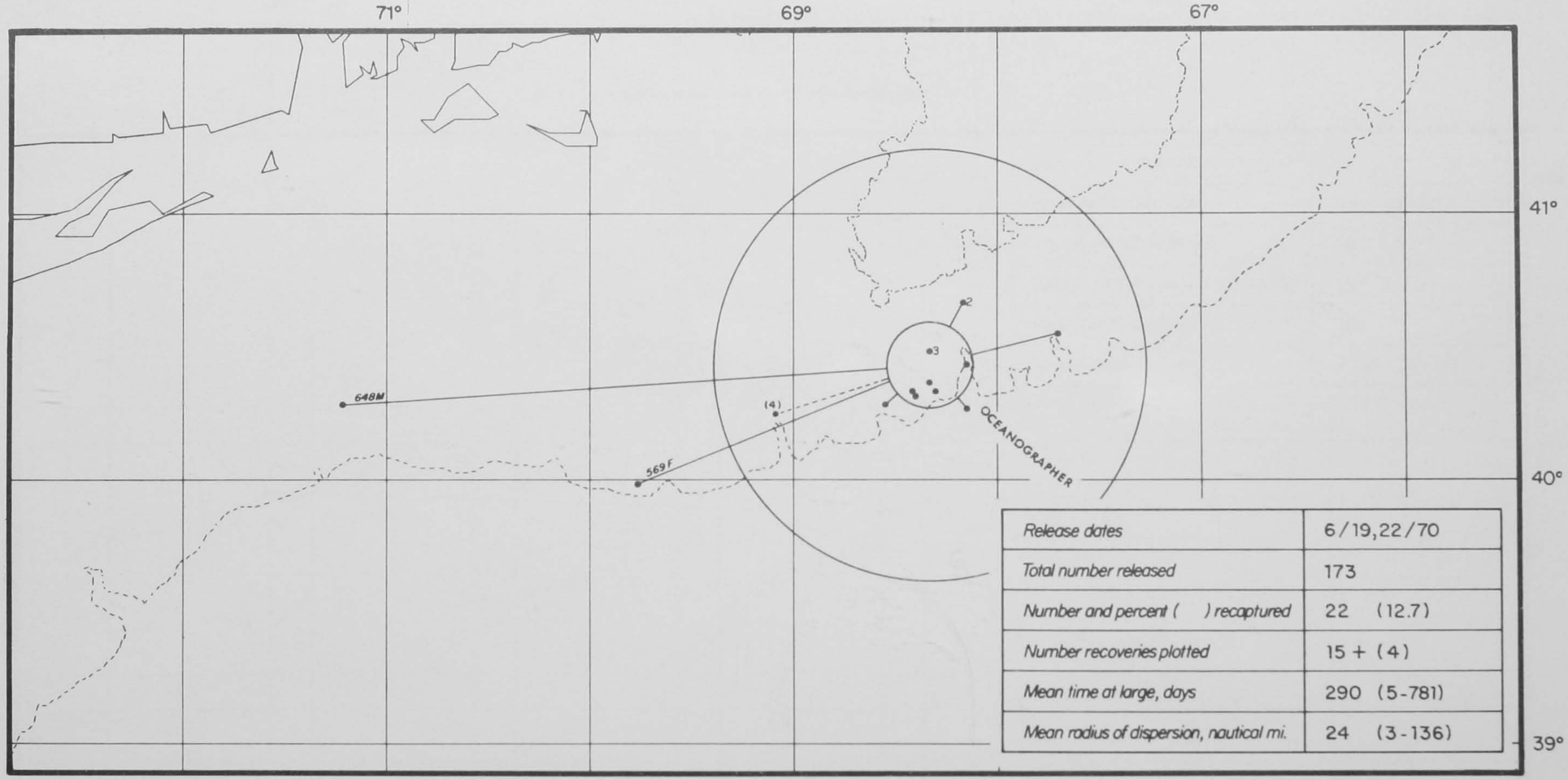
Release dates	6/10 - 11/69
Total number released	422
Number and percent ( ) recaptured	46 (10.9)
Number recoveries plotted	39 + (1)
Mean time at large, days	157 (0 - 1034)
Mean radius of dispersion, nautical mi.	44 (2 - 164)

Figure 24.—Recoveries from composite station 22 plotted by 6-minute squares.



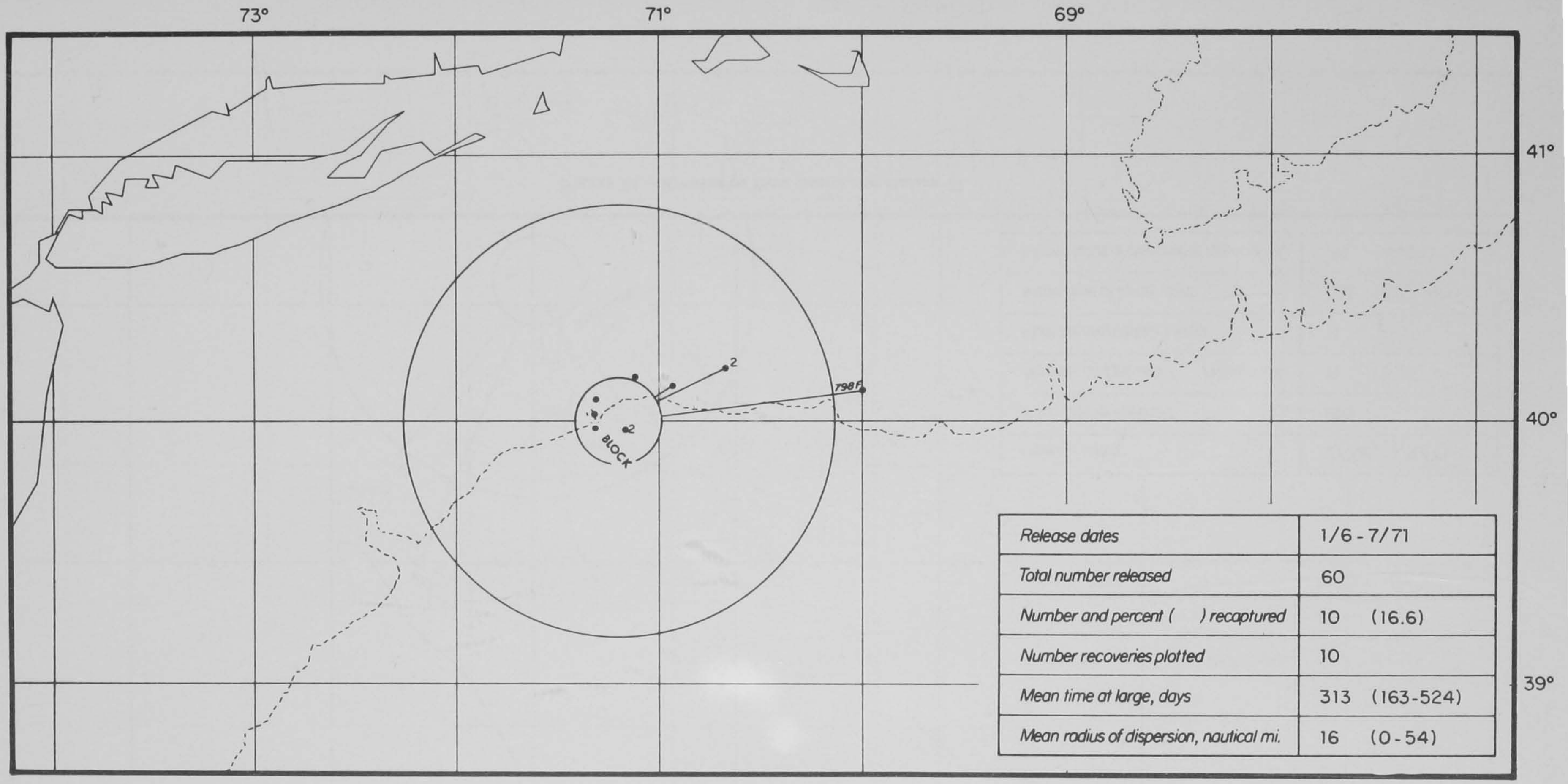
Release dates	6/19 - 20/70
Total number released	301
Number and percent ( ) recaptured	34 (11.3)
Number recoveries plotted	28 + (2)
Mean time at large, days	249 (6-511)
Mean radius of dispersion, nautical mi.	35 (5-126)

Figure 25.—Recoveries from composite station 23.



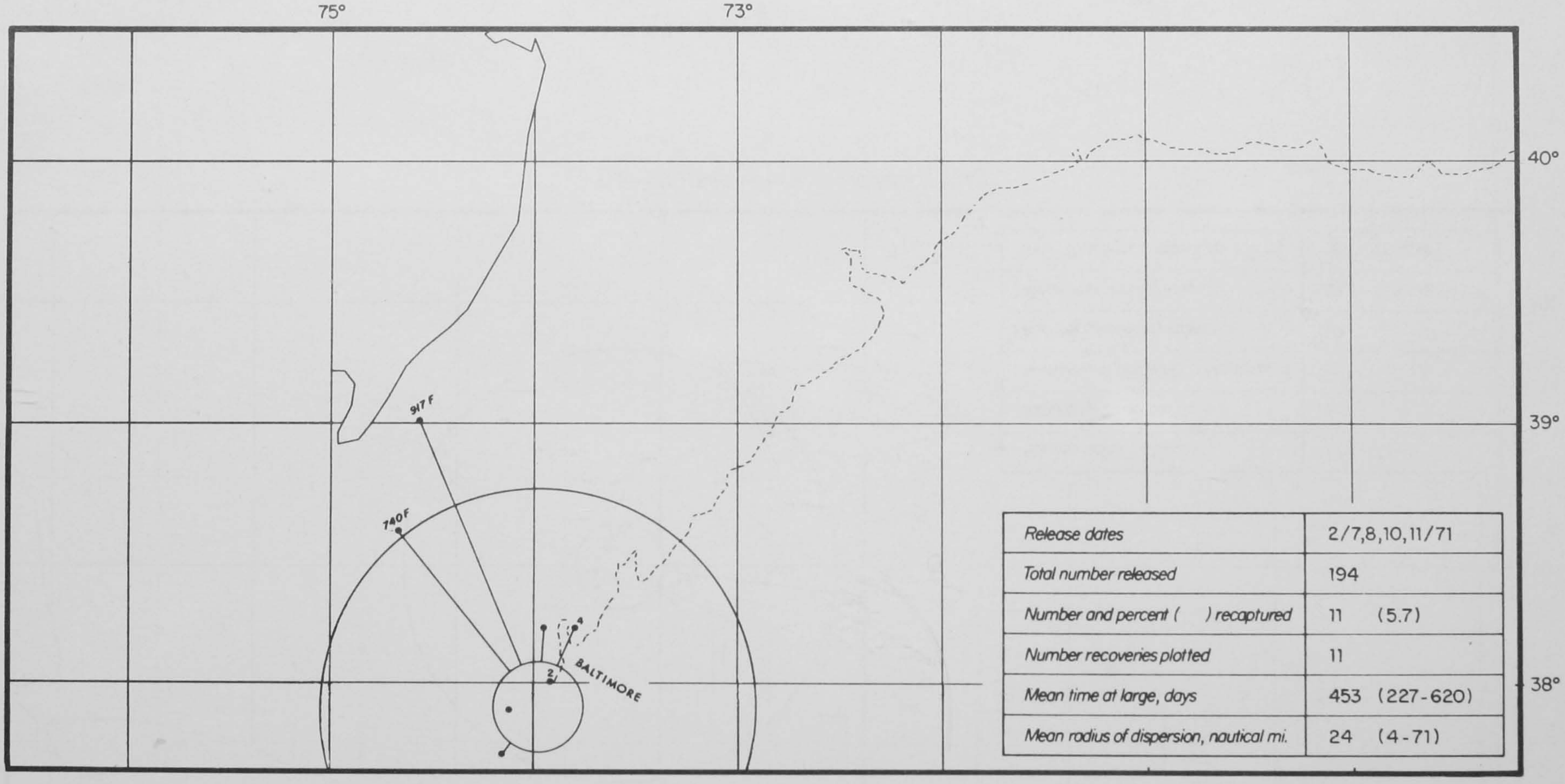
Release dates	6/19,22/70
Total number released	173
Number and percent ( ) recaptured	22 (12.7)
Number recoveries plotted	15 + (4)
Mean time at large, days	290 (5-781)
Mean radius of dispersion, nautical mi.	24 (3-136)

Figure 26.—Recoveries from composite station 24.



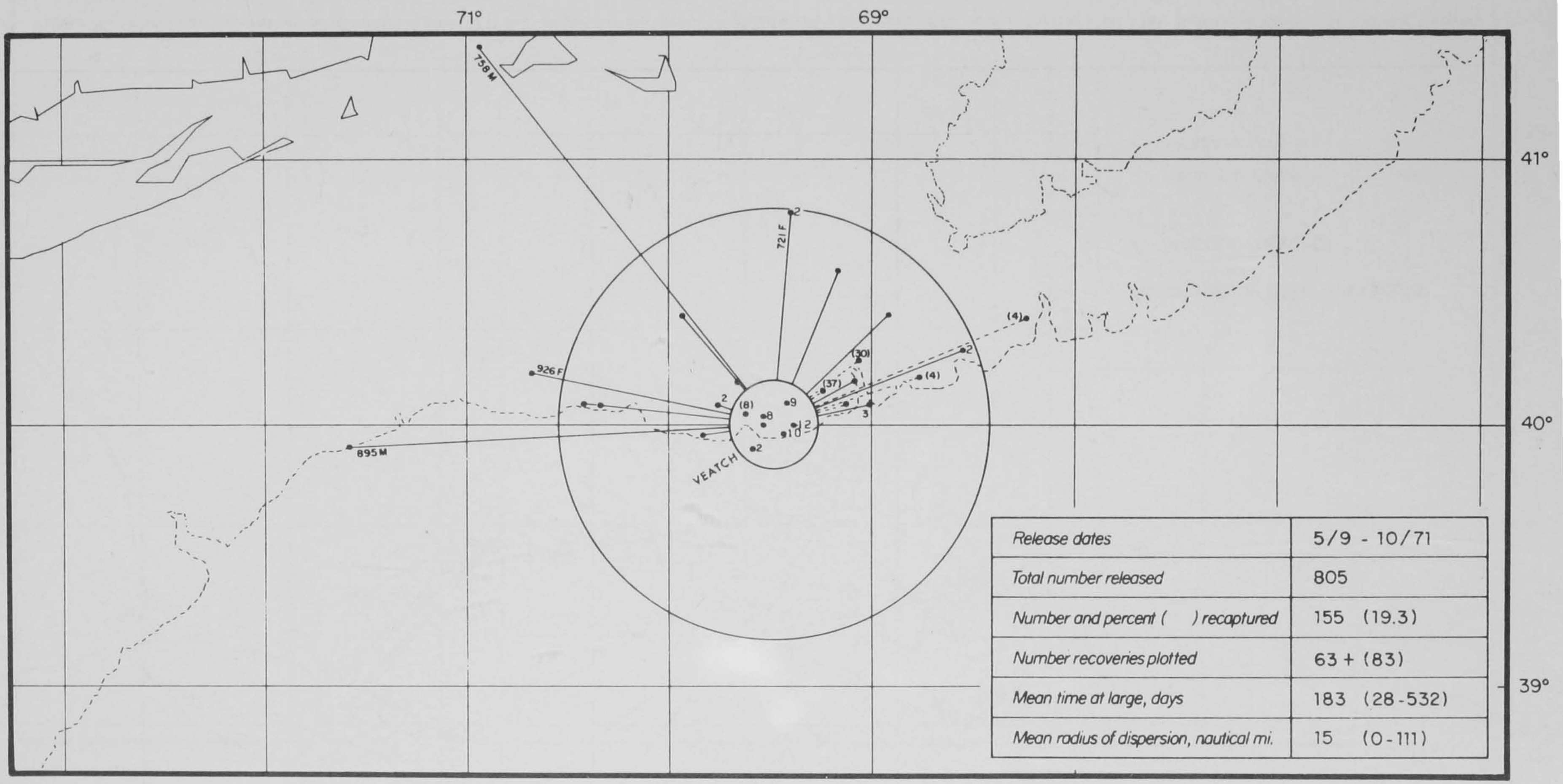
Release dates	1/6 - 7/71
Total number released	60
Number and percent ( ) recaptured	10 (16.6)
Number recoveries plotted	10
Mean time at large, days	313 (163-524)
Mean radius of dispersion, nautical mi.	16 (0-54)

Figure 27.—Recoveries from composite station 25.



Release dates	2/7,8,10,11/71
Total number released	194
Number and percent ( ) recaptured	11 (5.7)
Number recoveries plotted	11
Mean time at large, days	453 (227-620)
Mean radius of dispersion, nautical mi.	24 (4-71)

Figure 28.—Recoveries from composite station 27.



Release dates	5/9 - 10/71
Total number released	805
Number and percent ( ) recaptured	155 (19.3)
Number recoveries plotted	63 + (83)
Mean time at large, days	183 (28-532)
Mean radius of dispersion, nautical mi.	15 (0-111)

Figure 29.—Recoveries from composite station 29 plotted by 6-minute squares.

Figure 30.—Shoalward migrations of 60 nautical miles (111 km) or greater and probable shoalward migrations of 50 nautical miles (92.7 km), Baltimore Canyon to Corsair Canyon.

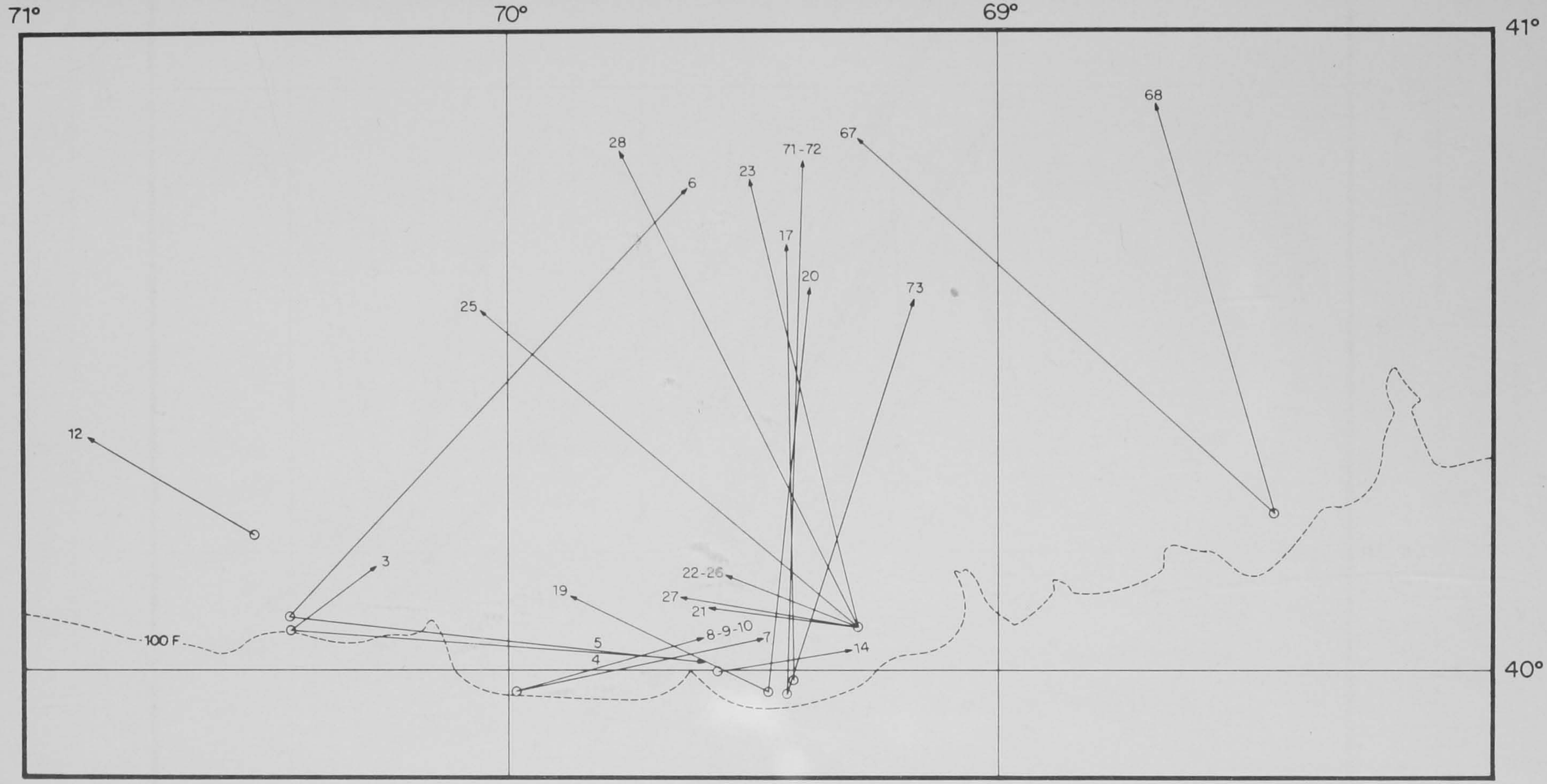
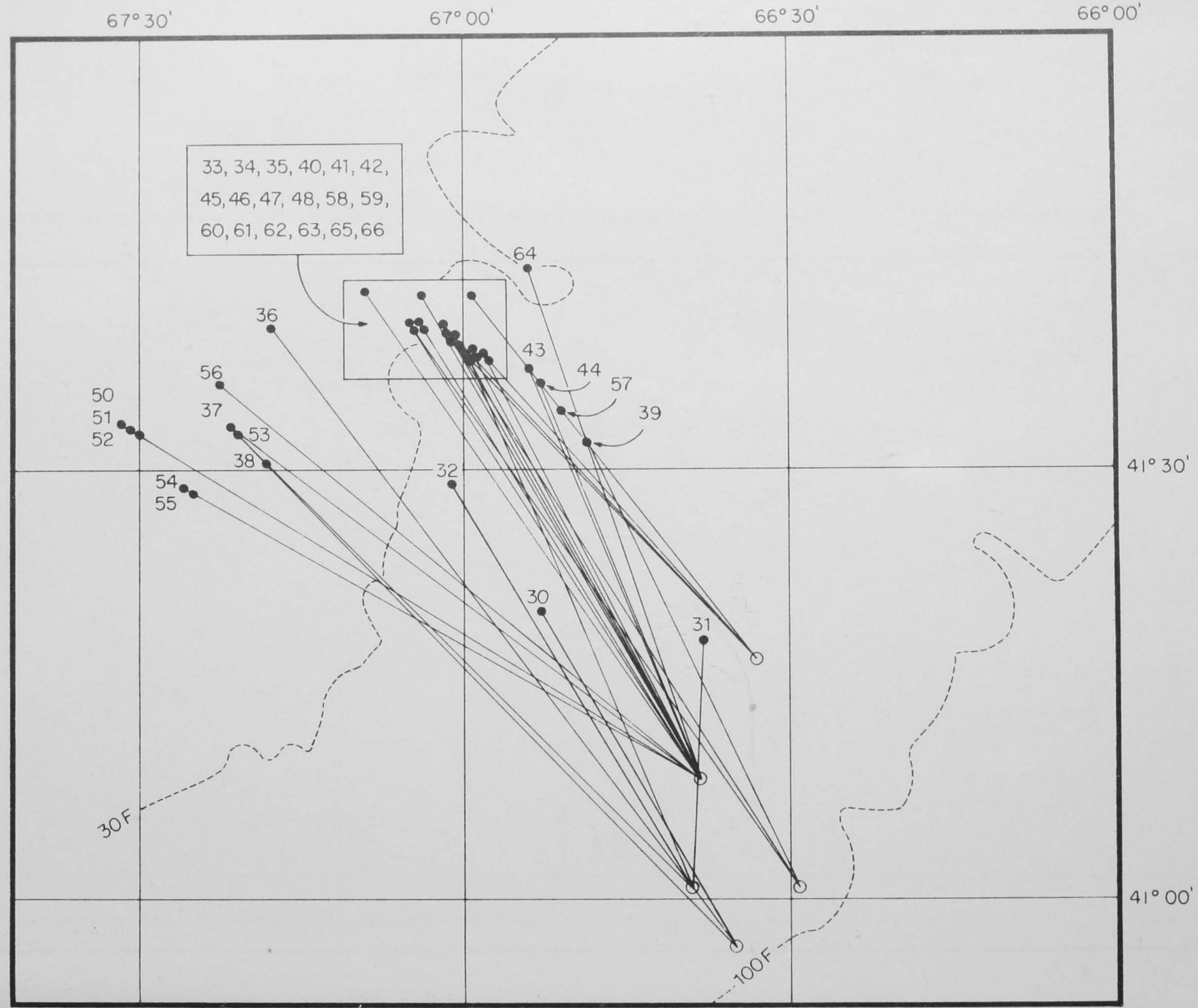


Figure 31.—Shoalward migrations greater than 10 nautical miles (18.5 km) but less than 60 nautical miles (111 km), Block Canyon to Oceanographer Canyon.


67° 30'
67° 00'
66° 30'
66° 00'
41° 30'
41° 00'
33, 34, 35, 40, 41, 42,
45, 46, 47, 48, 58, 59,
60, 61, 62, 63, 65, 66
64
36
43
44
57
39
56
50
51
52
37
53
38
32
54
55
30
31
30F
100F

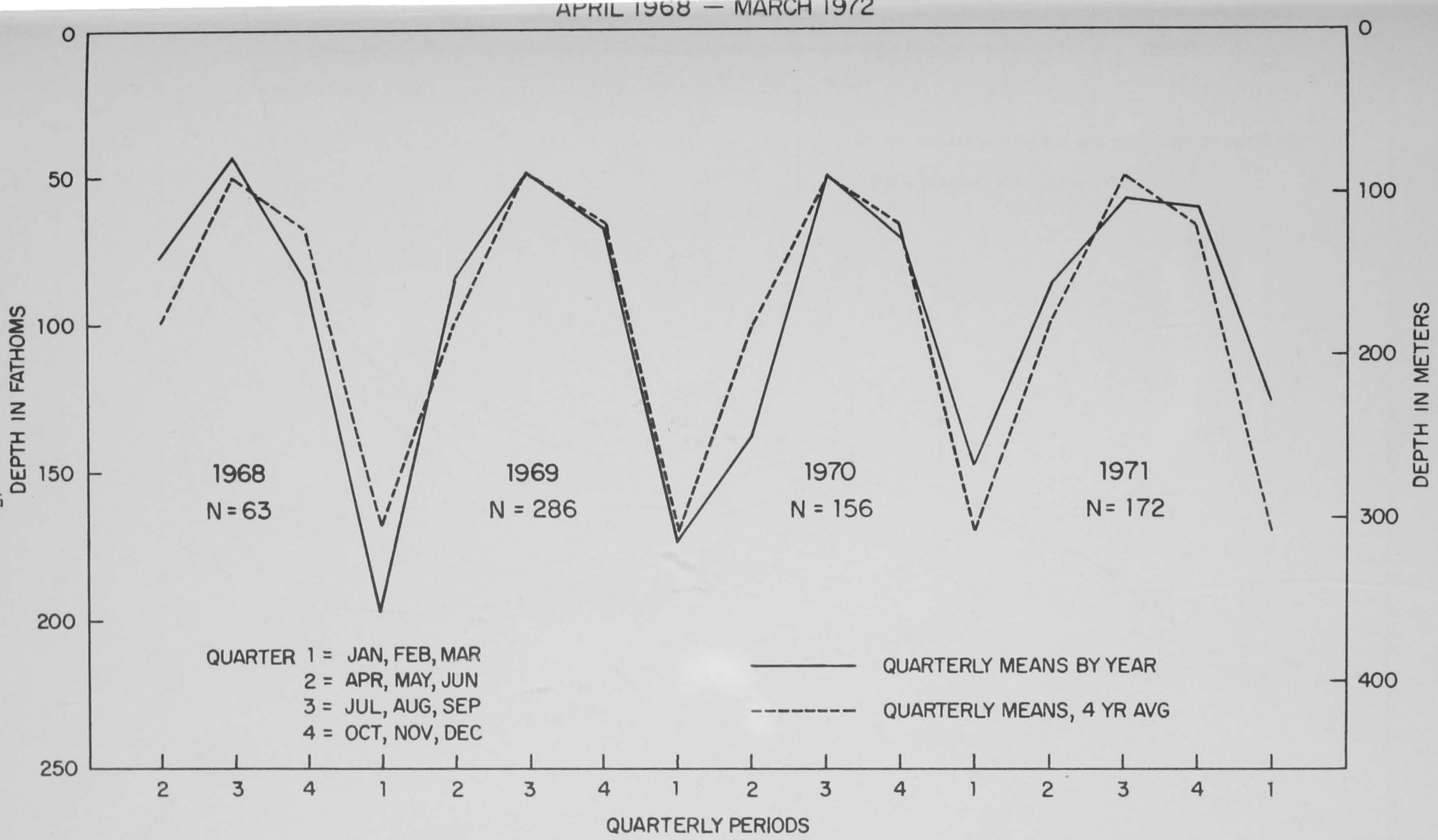


Figure 33.—Mean depth of recapture of tagged lobsters by quarterly periods, 1968-71.

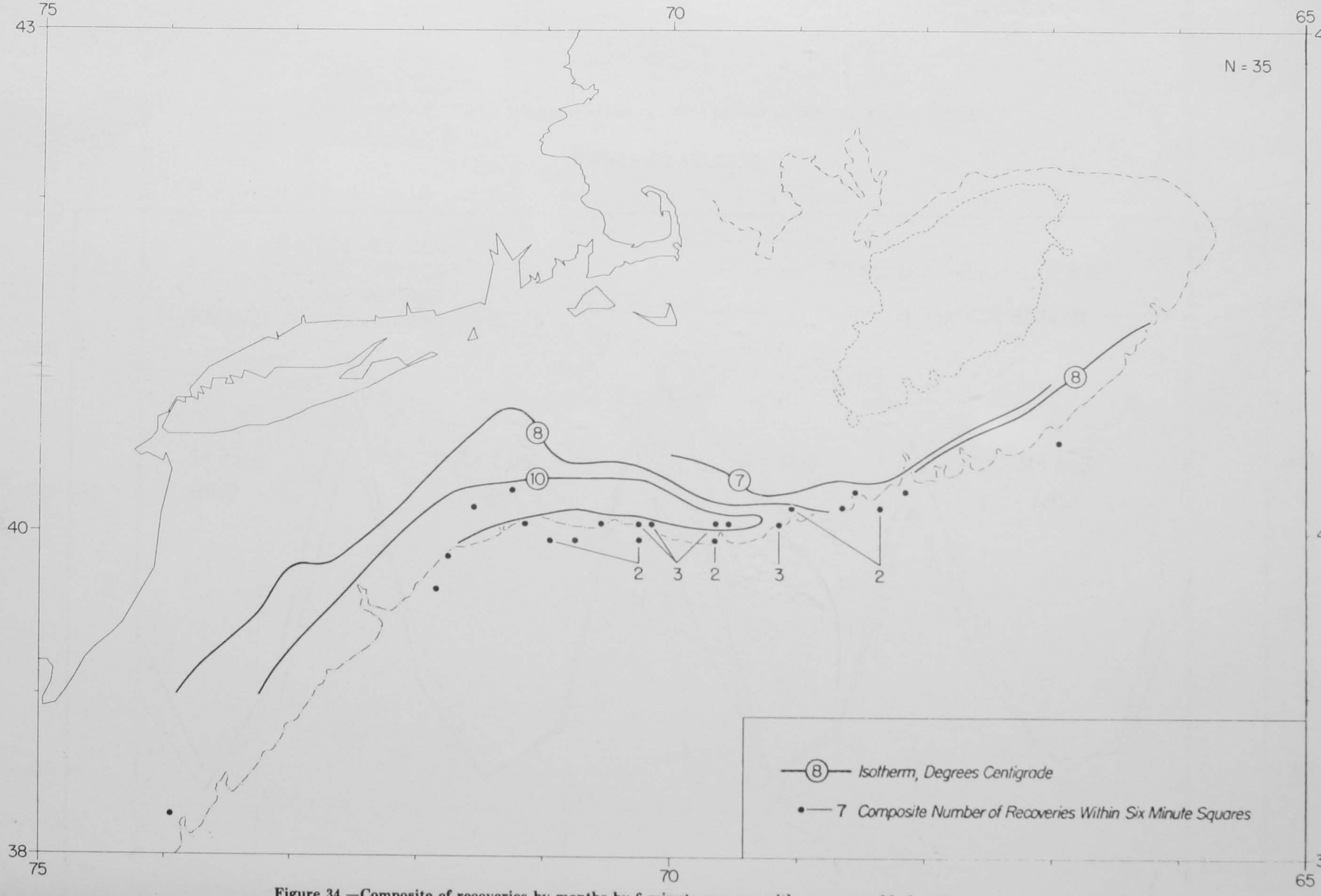


Figure 34.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—January.

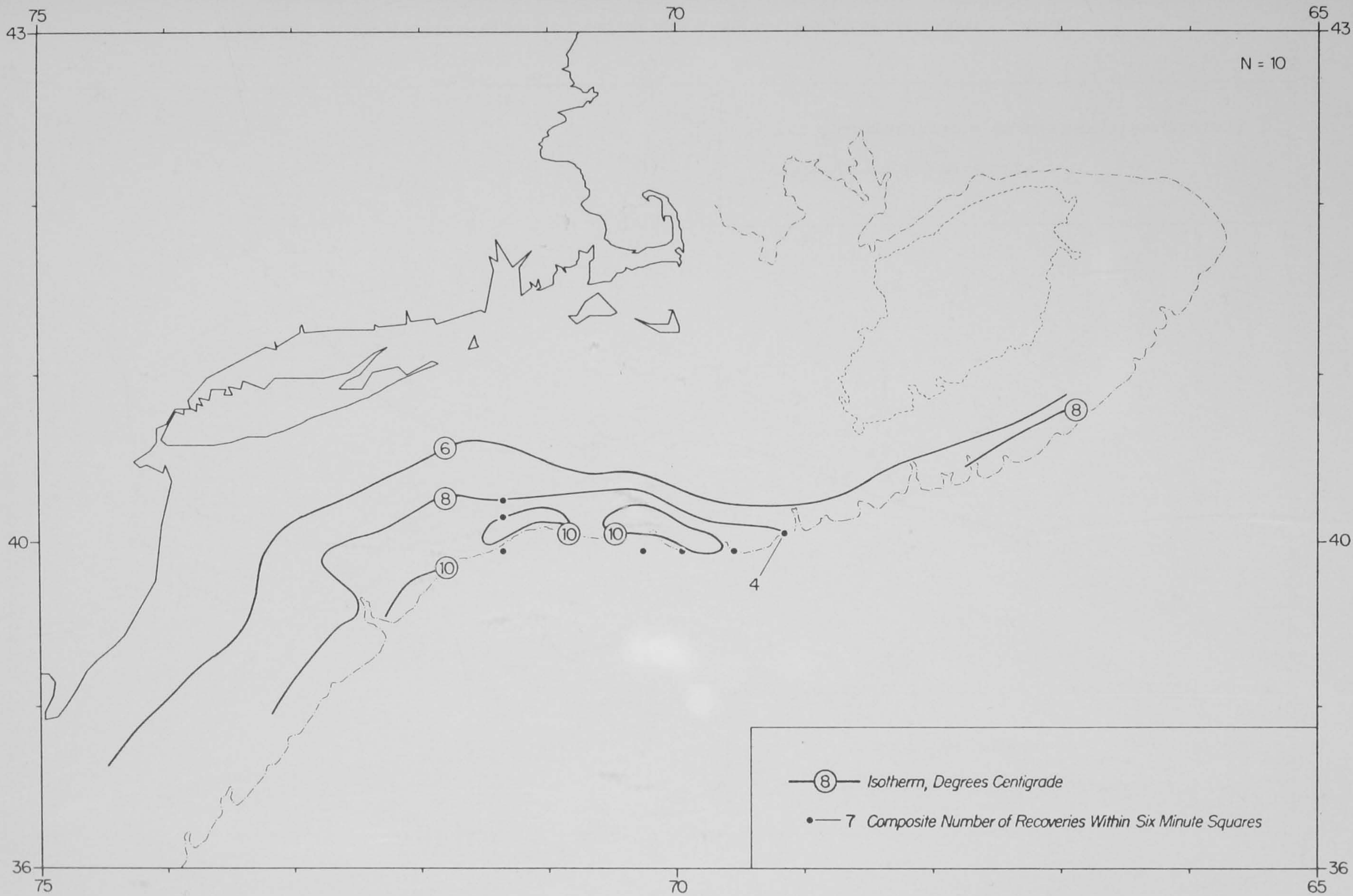


Figure 35.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—February.

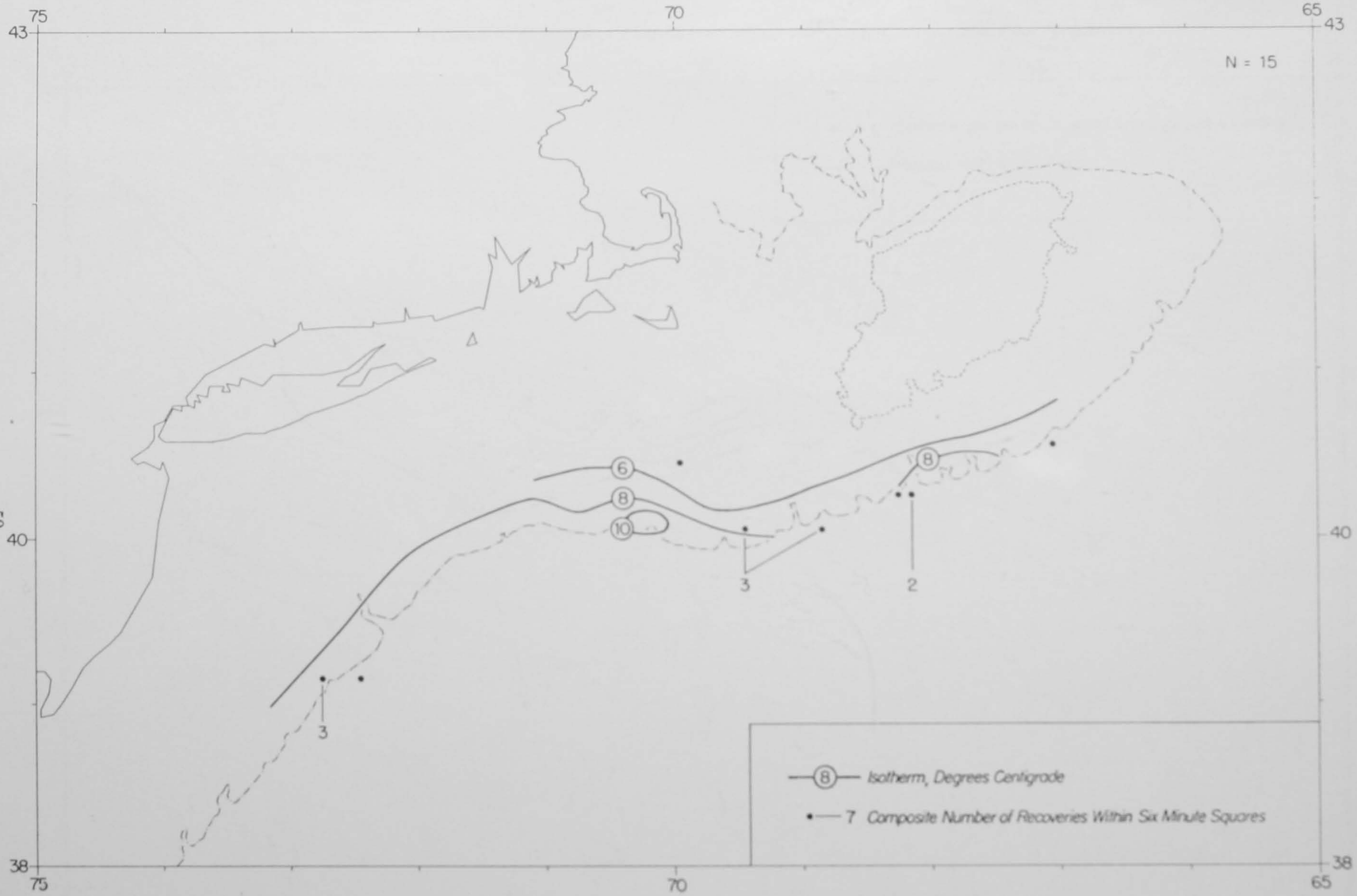


Figure 36.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—March.

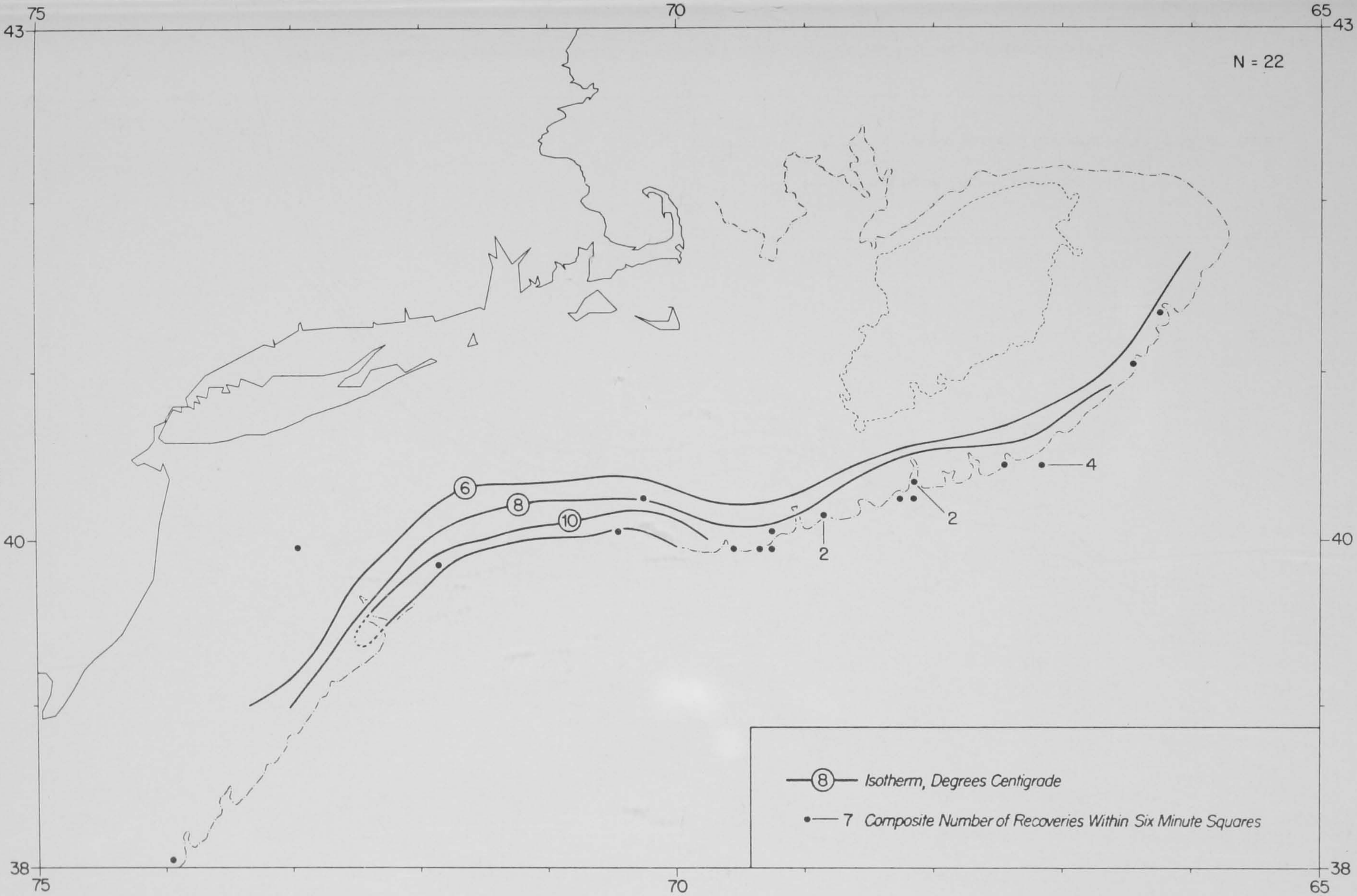


Figure 37.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—April.

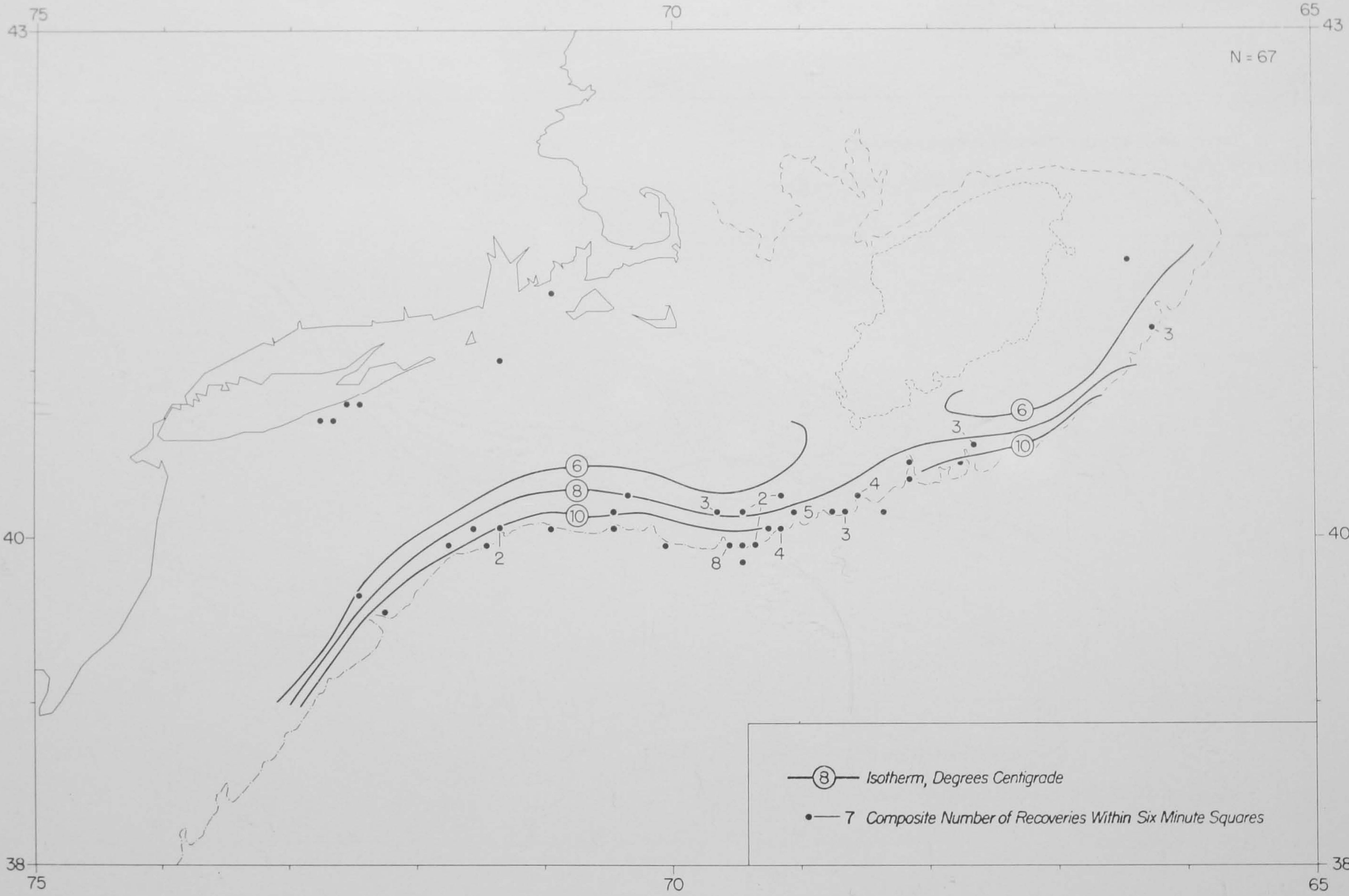


Figure 38.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—May.

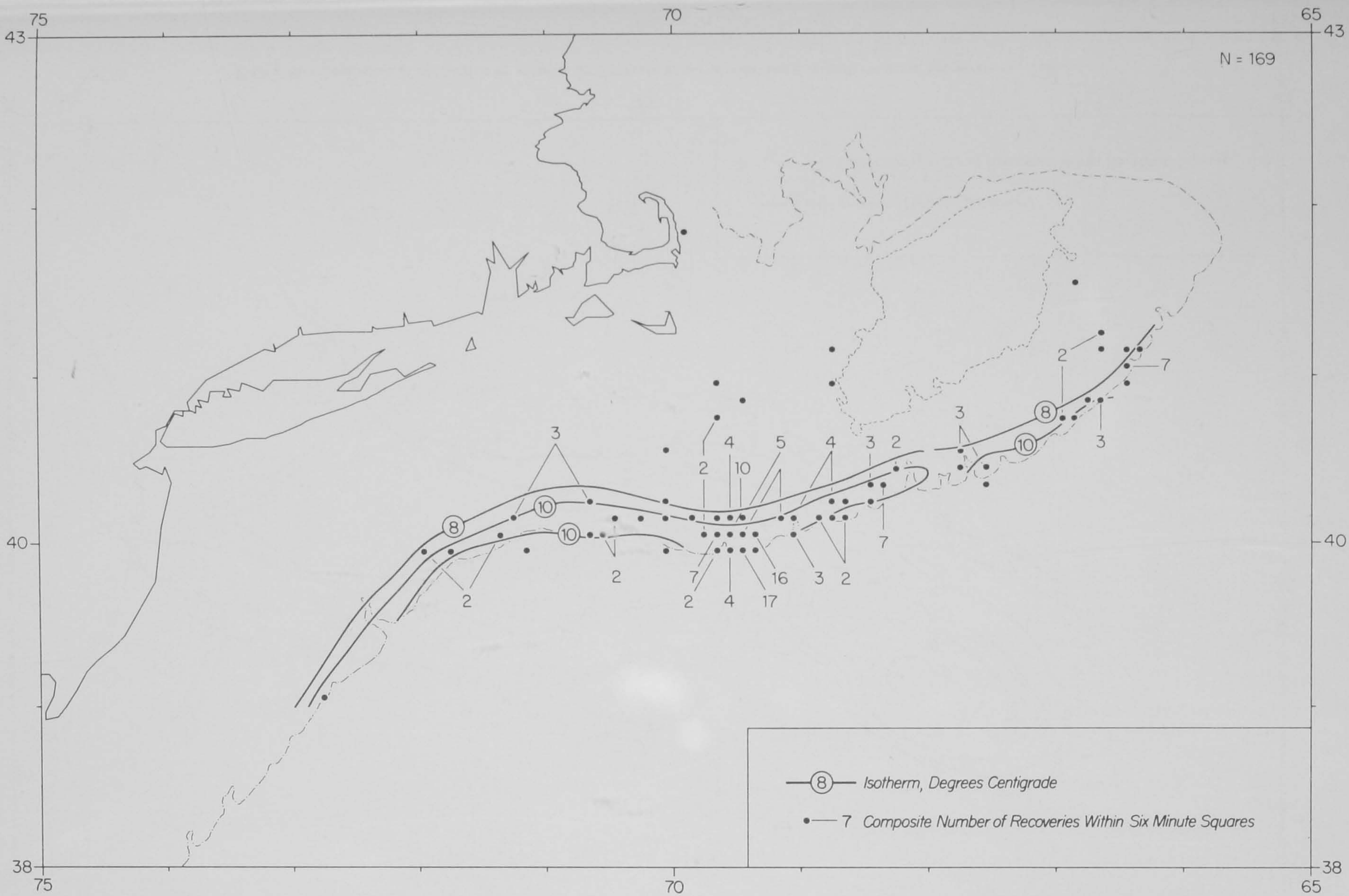


Figure 39.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—June.

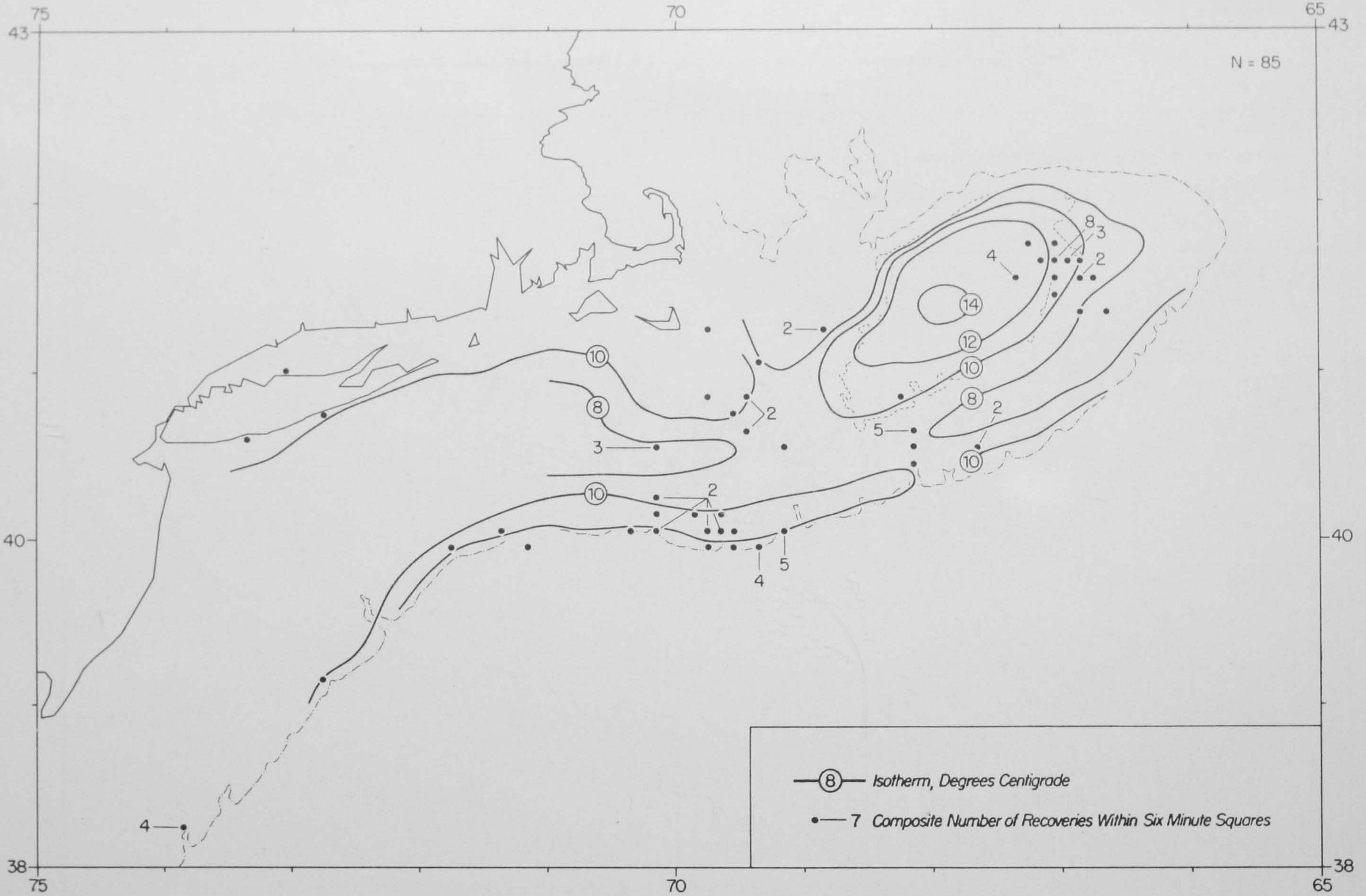


Figure 40.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—July.

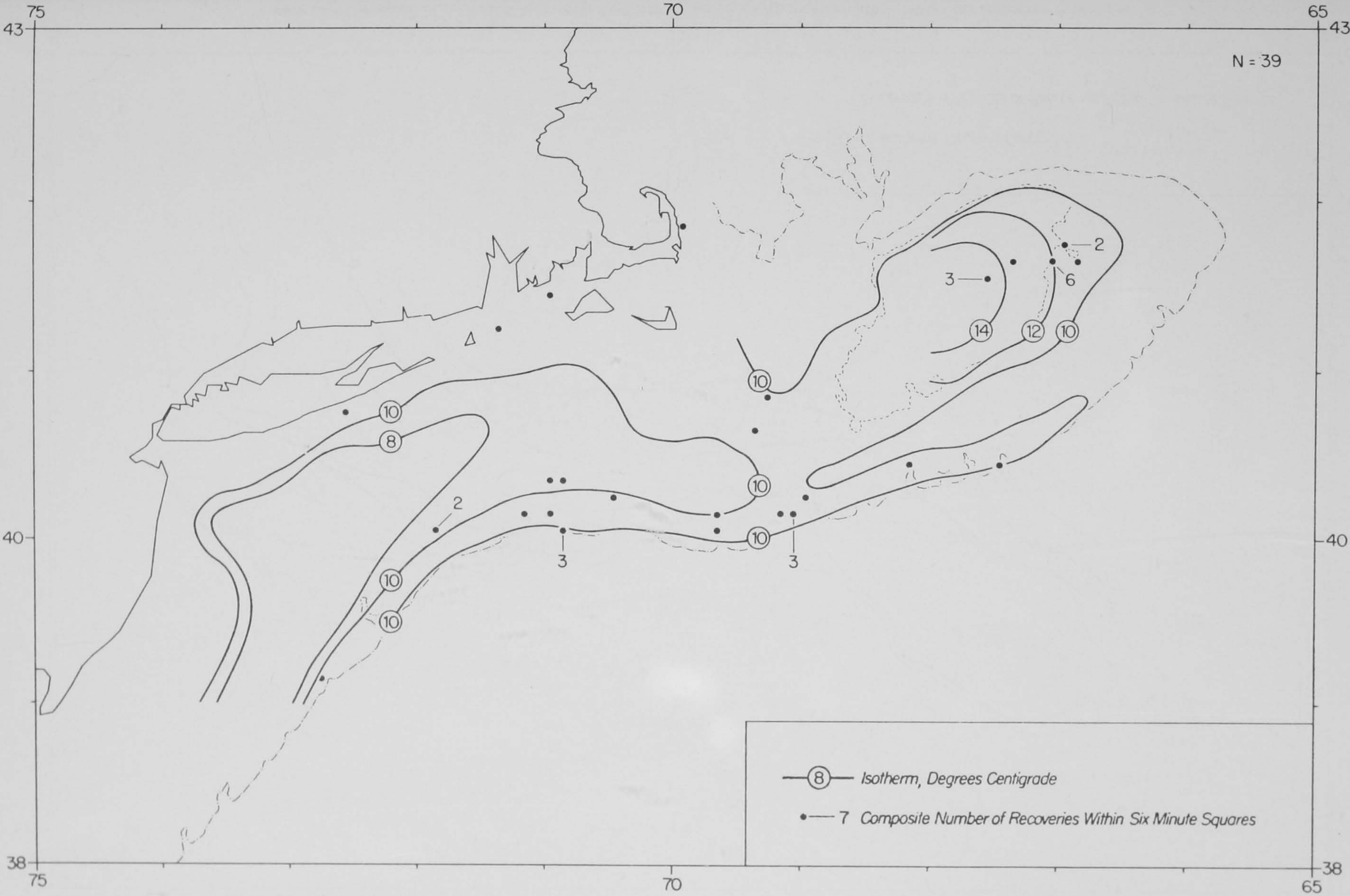


Figure 41.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—August.

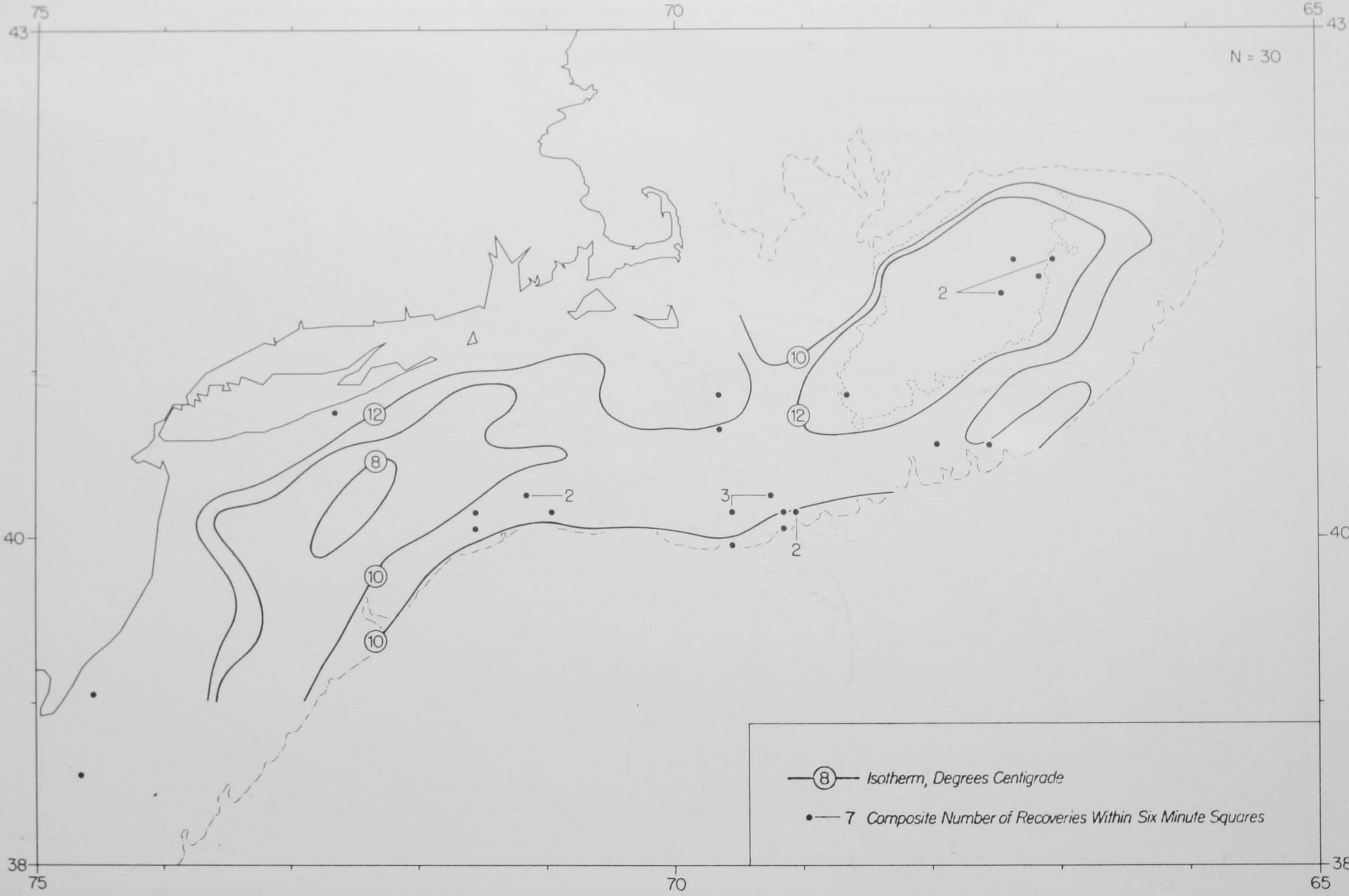


Figure 42.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—September.

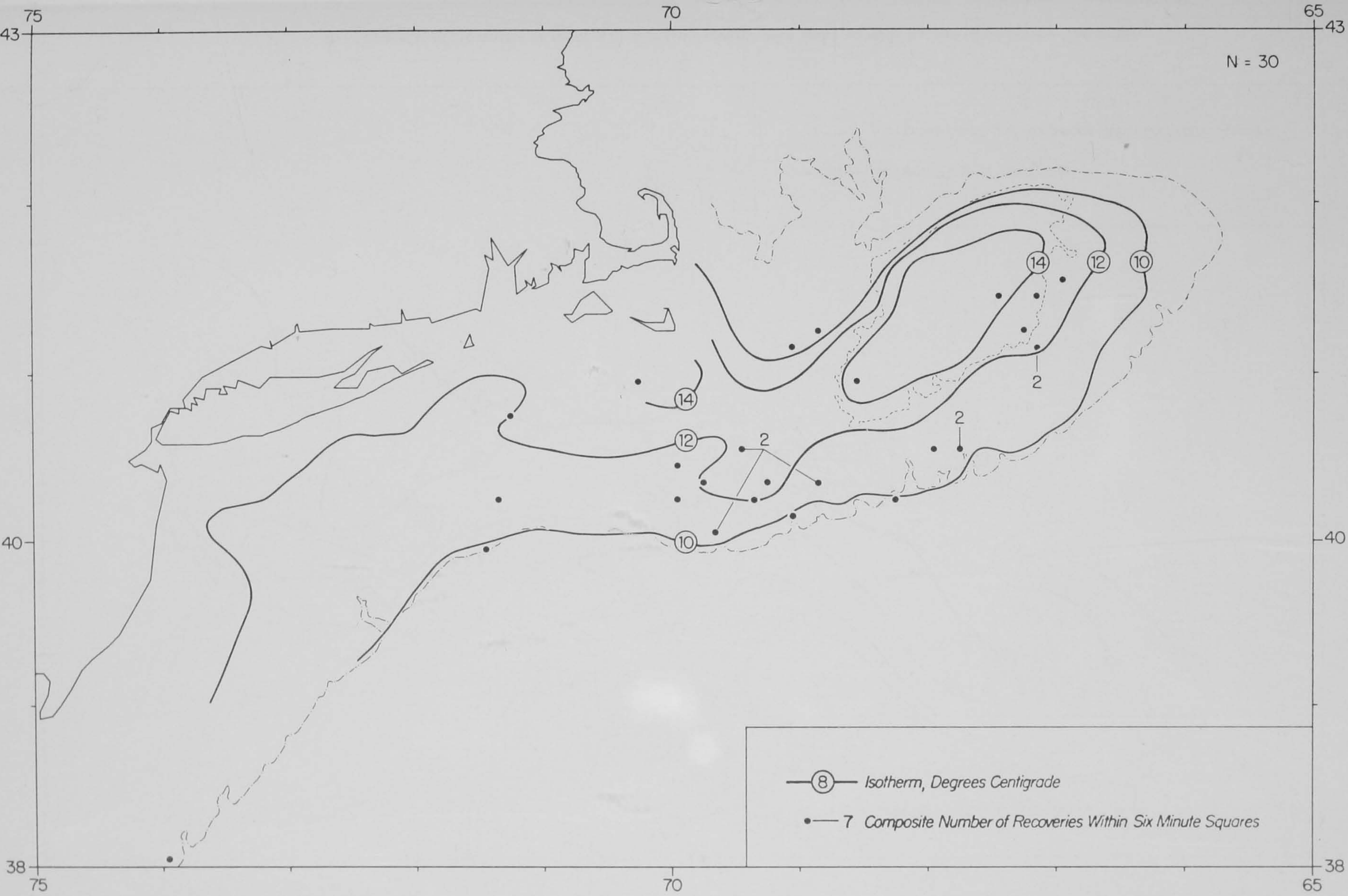


Figure 43.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—October.

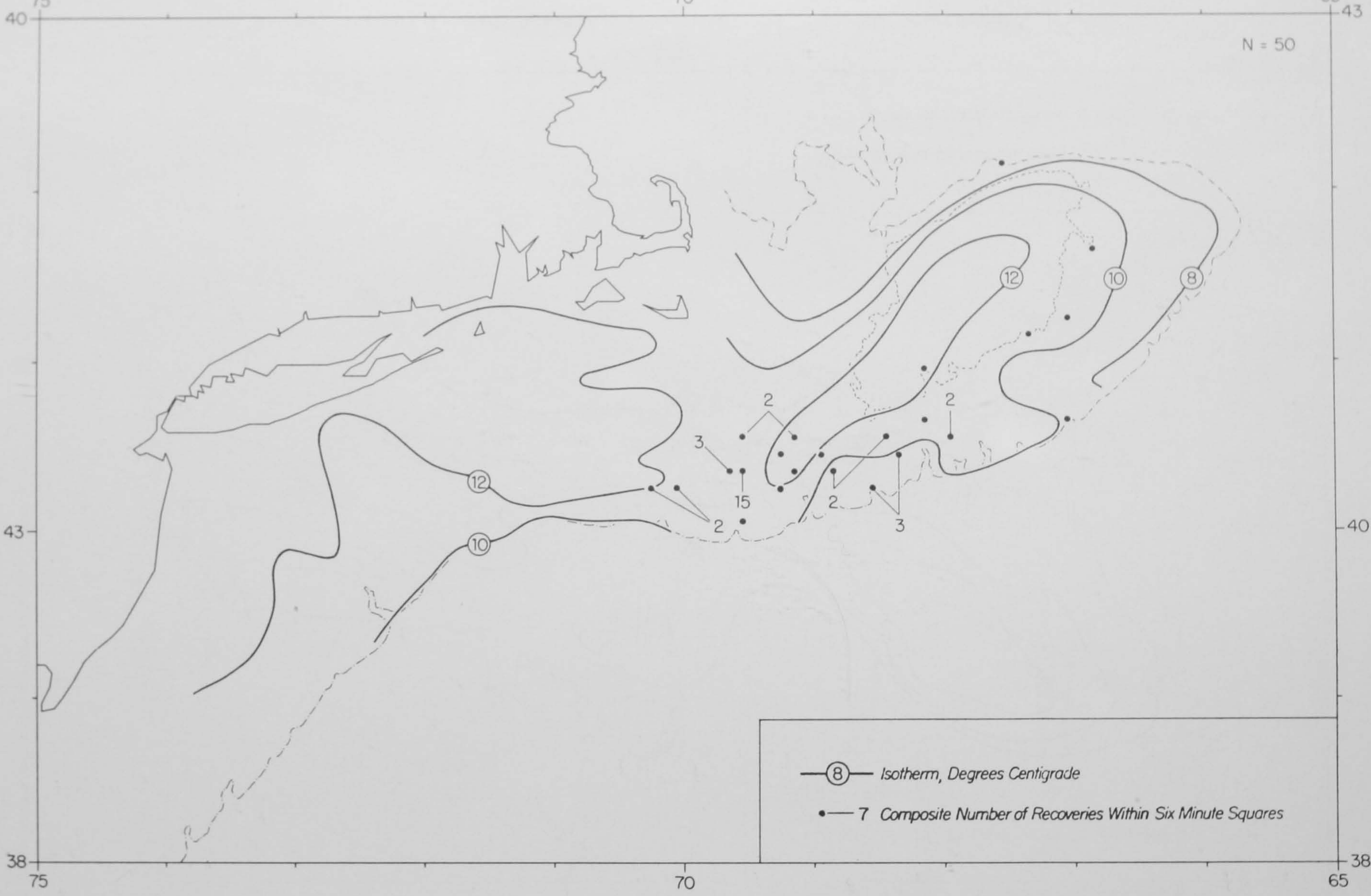


Figure 44.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—November.

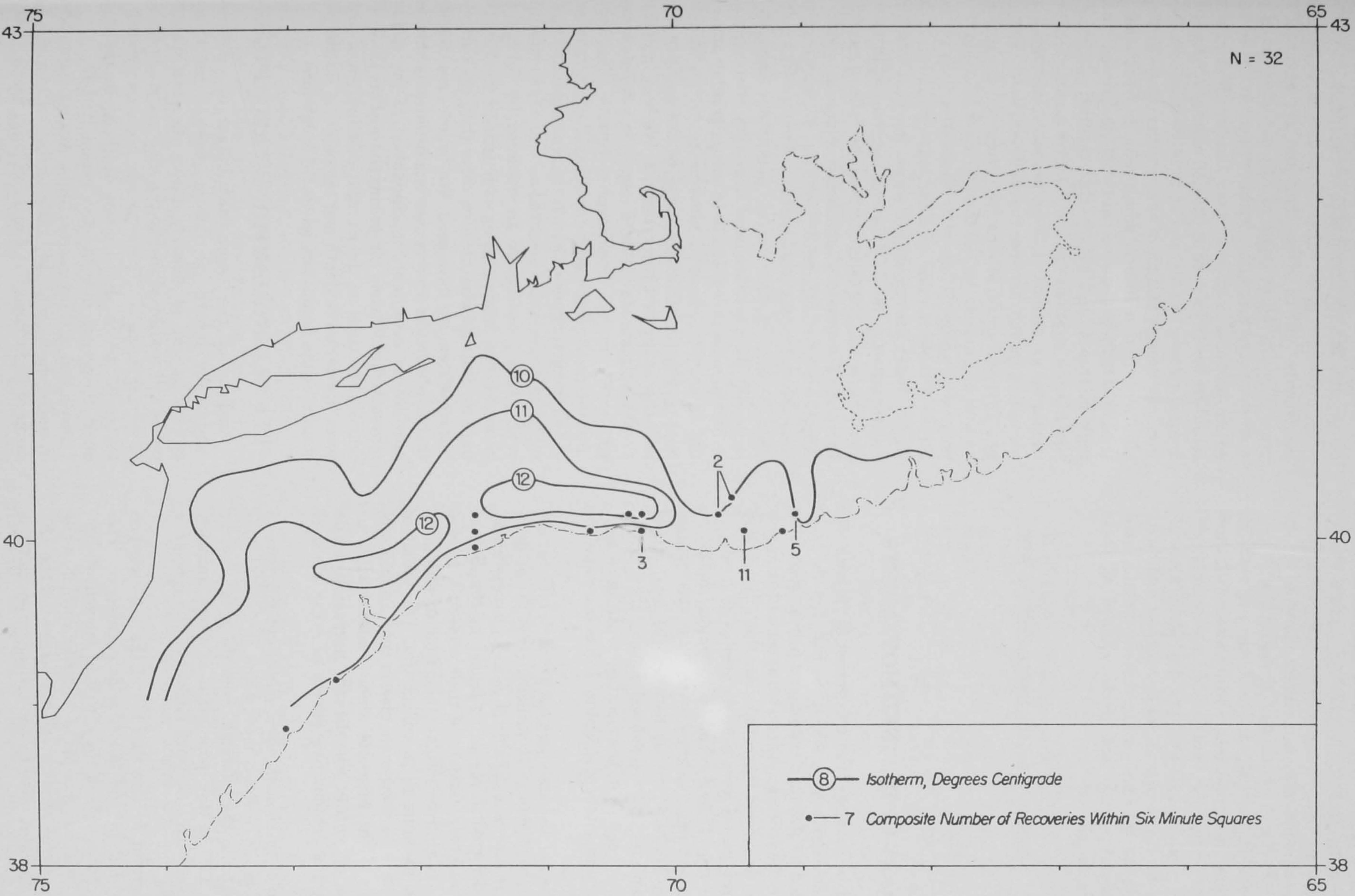


Figure 45.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—December.

that of 758M followed by an equal, but nonreciprocal return leg leading back to the point of capture west of Block Canyon; we believe that this hypothetical kind of two-stage movement could account for many of the apparently directed easterly or westerly movements.

Only four of the recaptures qualify as migrants; all were recaptured in significantly shoaler water with three of the four effecting large-scale movements approximating 1 mile (1.85 km) per day while at large. Each of the tracks show optimal or near optimal directionality relative to the shoaling objective. Calculated bearing, ground speed, and depth change of these migrants are as follows:

Return no.	Bearing	Ground speed mi/day	km/day	Depth change fathoms	meters
721F	004°	1.0	1.9	+38	+70
738F	004°	0.9	1.7	+30	+55
779F	018°	0.5	0.9	+35	+64
758M	322°	1.0	1.9	+55	+101

SUMMARY OF DEFINED MOVEMENTS

It should be recalled that this report deals with 945 recaptured lobsters among which 584 (62%) of the total were reported by specific location and hence classifiable according to the scheme outlined in the section on migration versus dispersion. According to the criteria laid down, 117 recaptures have been defined as migrants, 15 as nonmigrants, 147 as residual nonmigrants, and 297 as indeterminates, thus yielding a total of 576 defined movements. The discrepancy between the total of 584 located recaptures and 576 defined movements is due to the fact that eight of the located recaptures were reported without a date of recapture and hence could not be classified.

Among the 117 defined migrants, 74 (63%) effected net shoalward movements of 10 fathoms (18.3 m) or more beyond the release point (Table 2). Although these tracks have been depicted in preceding figures as elements of the overall recovery patterns of their respective release group, it is instructive to isolate them from their original cohorts and examine them collectively. The intent of Figures 30-32 is to show more clearly the variability of performance of the migrants which conform with our hypothesis of vernal shoalward migration while eliminating the confounding effects of other kinds of movements.

The ratio of these conforming (shoaling) migrants to the sum total of defined movements is 74:576. This grouping permits the inference from these tag returns that some 13% of the population at large annually engages in seasonal shoalward migration to a greater or lesser degree.

It is important to note that 297 of the 576 classified movements fall in the indeterminate category. This group constitutes 51% of the classified movements and includes a significant number of dispersions which, while failing to meet the migrant criteria because of the 120-day time constraint, may be subjectively interpreted as migrants on the basis of relative dislocation from the continental margin and month of recapture.

In order to give fuller consideration to these movements, and to assess their additive effect on the previously derived estimate of 13% participation in annual shoalward migration, we have selected and redefined as probable migrants those indeterminates whose recapture locations were at least 50 miles (92.7 km) from original release locality and at least 50 miles (92.7 km) from the nearest margin of the continental shelf. These highly restrictive criteria admit only 22 additional entries (Table 2) to the asserted list of conforming (shoaling) migrants and raises the theoretical ratio of shoalward migrations to 17%. We have assumed that the shoalward excursions of these probable migrants commenced in springtime from the shelf margin in the vicinity of first capture or, alternatively, from some other point on the shelf margin no less than 50 miles (92.7 km) from point of recapture. These restrictions effectively exclude a considerable number of other indeterminates of only slightly lesser performance. If we assume that 13% of the indeterminates, or 39 lobsters, demonstrated vernal shoaling, as was the estimate from the defined migrants, the revised estimate of shoalward migration would be 20% (74 + 39 = 113, or 20% of 576). We can conclude from this review and reassessment of movements that at least 17-20% of the tagged population engaged in seasonally directed shoalward migration, that some 25% remained more or less localized (nonmigrants), and that the balance of classified movements (indeterminates) might, by more definitive criteria, be assignable to one or the other of the first two categories. We believe that the 17-20% estimate of shoalward migration is highly conservative. The major impediment to correct allocation of the movements observed is our unsatisfactory knowledge of 1) homing tendencies and 2) the realistic limits on the radius of dispersion of localized movements in any given year. Until these issues are resolved by further experimentation (sonic tagging with periodic tracking), we have no basis for classification other than the partly arbitrary system we have used. We believe, nevertheless, that the deductive process used is substantially valid and provides an acceptable interpretation of the seasonal movements of lobsters comprising the offshore stock. The following sections on the monthly distribution of recaptures in relation to depth and temperature further substantiates the arguments advanced heretofore.

DEPTH DISTRIBUTION AT RECAPTURE

Analysis of the depth distribution of recaptured lobsters by month of capture shows a pronounced cyclical pattern of shoaling during the shelf warming period followed by retreat to the shelf margin and slope in winter months. These trends are summarized in Figure 33 which shows mean depth at recapture by quarterly periods over the 4-yr period 1968-72.

Inspection of third quarter (July, August, September) averages shows relatively little deviation from the 4-yr mean of 50 fathoms (91.4 m); similarly, fourth quarter le 2.—Recapture data for 74 shoalward migrating lobsters demonstrating shoaling of 10 fathoms (18.3 m) or more and 22 probable migrants ose recapture location was at least 50 nautical miles (92.7 km) from release and at least 50 miles from nearest margin of continental shelf.

Figures 30-32 vector no.	Return no. and composite station no.	Nautical miles	Days at large	Average speed (mi/day)	Depth change (fathoms)
1	3F-3	102	29	3.5	60
2	29F-3	77	118	0.6	75
3	4F-5	11	36	0.3	34
4	26F-5	38	37	1.0	18
5	27F-5	38	37	1.0	20
6	28F-5	56	50	1.1	78
7	10F-6	24	33	0.7	42
8	18F-6	18	49	0.4	29
9	19F-6	18	49	0.4	29
10	20M-6	18	49	0.4	29
11	8M-7	72	39	1.8	37
12	41F-10	20	60	0.3	10
13	25F-13	75	28	2.7	38
14	221F-18	12	54	0.2	10
15	240F-18	66	32	2.1	36
16	249F-18	186	71	2.6	68
17	254F-18	41	71	0.6	42
18	263F-18	76	80	0.9	50
19	266M-18	21	85	0.2	15
20	311M-18	39	106	0.4	45
21	184F-19	15	40	0.4	10
22	191F-19	14	43	0.3	15
23	255F-19	45	70	0.6	45
24	294F-19	118	107	1.1	47
25	654F-19	47	41	1.1	32
26	190M-19	14	43	0.3	15
27	194M-19	17	42	0.4	10
28	246M-19	51	67	0.8	48
29	317M-19	125	86	1.4	38
30	244F-20	27	60	0.4	16
31	247F-20	18	62	0.3	11
32	252F-20	32	66	0.5	16
33	259F-20	47	70	0.7	23
34	276F-20	41	79	0.5	18
35	277F-20	41	79	0.5	18
36	306F-20	54	100	0.5	22
37	314F-20	45	81	0.5	23
38	315F-20	50	82	0.6	23
39	200M-20	35	43	0.8	13
40	285M-20	48	94	0.5	20
41	262F-21	76	44	1.7	24
42	236F-22	33	20	1.6	17
43	238F-22	32	21	1.5	18
44	251F-22	32	32	1.0	18
45	260F-22	37	38	1.0	25
46	284F-22	32	60	0.5	17
47	287F-22	38	59	0.6	21
48	288F-22	38	59	0.6	22
49	293F-22	38	60	0.6	14
50	307F-22	48	72	0.7	22
51	308F-22	48	72	0.7	22
52	309F-22	48	72	0.7	22
53	316F-22	41	48	0.9	25
54	336F-22	42	89	0.5	25
55	337F-22	42	89	0.5	25
56	339F-22	44	86	0.5	20
57	222M-22	22	23	0.9	14
58	242M-22	35	25	1.4	12
59	243M-22	40	28	1.4	20
60	248M-22	41	31	1.3	24
61	258M-22	32	37	0.9	23
62	261M-22	35	41	0.8	19
63	278M-22	30	45	0.7	18
64	310M-22	38	67	0.6	20
65	341M-22	32	89	0.3	18
66	342M-22	32	89	0.3	18
67	576F-23	52	48	1.1	59
68	584F-23	39	84	0.5	51
69	562M-23	80	16	5.0	52
70	564M-23	83	15	5.5	50
71	721F-29	50	49	1.0	38
72	738F-29	50	53	0.9	30
73	779F-29	39	79	0.5	35
74	758M-29	111	108	1.0	55
75	544F-7	58	771		
76	335F-13	56	465		
77	347F-14	65	365		
78	348F-14	62	365		
79	349F-14	59	365		
80	350F-14	59	365		
81	269M-14	65	392		
82	357F-17	58	353		
83	768F-17	76	1,010		
84	937M-17	132	973		
85	355F-18	70	166		
86	720M-18	110	761		
87	610F-19	66	443		
88	577M-19	78	522		
89	578F-20	87	519		
90	575F-22	155	431		
91	770F-22	103	750		
92	767M-23	62	389		
93	769M-23	60	377		
94	771F-23	54	361		
95	740F-27	52	227		
96	917F-27	71	230		

rages are in good agreement with the 4-yr mean of 66 oms (121 m). In contrast, the first quarter averages v an almost straight-line cline ranging from 197 oms (360 m) in 1969 to 127 fathoms (232 m) in 1972; implication of this trend is not clear because of the tively small numbers and large range of observations n which these means were derived. If, however, the d is real, it suggests that slope waters became gressively warmer over the 4-yr period to the degree optimal overwintering conditions (discussed below er Average Monthly Bottom Temperatures) were met rogressively shoaler levels. The sum of deviations of nd quarter means from the 4-yr averages are almost as great as those of the first quarter; here, however, the major source of deviation stems from a disproportionate number of deep-running recaptures taken in April 1970.

Despite the shortcomings of the data, the clearly cyclical nature of seasonal depth change seems, independent of net track analyses, adequate evidence of the tendency of offshore lobsters to optimize their year-round temperature regime. The consequences of this behavior are manifold in that metabolic rates and related life processes are doubtless accelerated relative to the coastal zone populations which tend to remain highly localized and hence subject to wider seasonal extremes and significantly lower mean annual temperature.

AVERAGE MONTHLY BOTTOM TEMPERATURES

The distribution of recaptured tagged lobsters by month and grouped by 6-minute squares against average bottom water temperatures (°C) from Colton and Stoddard (1973) are presented in Figures 34-45. Bottom isotherms are plotted from data collected during the period 1940-66. Only recaptures whose month and location of recapture are known (N = 584) are plotted.

Relating lobster distribution to average bottom water temperatures, it is apparent that the offshore lobster population generally maintains itself within a temperature regime of 8°-14°C. The two apparent exceptions to this generalization, evident in Figures 36 (March) and 37 (April), are predictable. Bottom isotherms represent average temperature conditions for a 26-yr period, and the temperature conditions for a given month vary considerably from year to year and within a given month (Colton and Stoddard 1973; and Chamberlin[2]).

During the first quarterly period, January through March, offshore lobsters are distributed along the outer continental shelf and upper slope (Figs. 34-36). Bottom water temperatures during this period ranged from 8° to 12°C (Colton and Stoddard 1973; Chamberlin[2]). In contrast, the inshore, shallow-water lobster populations are in a state of reduced activity in coastal waters of 0°-4°C (Cooper et al. 1975).

During the second quarterly period, April through June, the onset of shoalward migration has begun, occurring first (April and May) in the western half of the shelf (Figs. 37, 38) and next (June) in the eastern half of the shelf (Fig. 39). Bottom water temperatures in the latter half of May along southern Long Island, Block Island Sound, and Buzzards Bay are 8°C and warmer (Colton and Stoddard 1973). An intensive fishery for lobsters occurs along southern Long Island from late May through mid-July, directed primarily toward the onshore migrants emanating from Hudson to Veatch Canyon (Cooper and Uzmann, unpubl. studies). Lobster migrations into the southern Long Island coastal waters are evident from Figures 6, 15, and 16.

Figures 40-43 (July-October) demonstrate that the offshore lobster population is widely distributed over the southern New England continental shelf, including the shoal waters of Georges Bank and the coastal waters of Long Island, Rhode Island, southern Massachusetts, and Cape Cod. Bottom water temperatures in areas of apparent lobster abundance during July-September are 8°-14°C.

The return migration to the outer shelf-upper slope waters probably begins in August (Fig. 41) and continues through September, October, and November (Figs. 42-44). Migration to deep water first occurs in the western half of the shelf and then in the eastern half.

During the first month (October) of the last quarter (October-December) there are still some lobsters distributed over the shoals of Georges Bank and immediately south of Nantucket Island (Fig. 43) with bottom water temperatures of 10°-14°C. By December the offshore lobster population is again distributed along the outer continental shelf and upper slope waters (Fig. 45) where bottom temperatures are 8°-12°C.

CONCLUSIONS

The distribution of tag returns from a 4-yr tagging and recapture study has demonstrated that at least 20% of the offshore lobster population moves into shoal water in the spring and summer and returns to the outer shelf and upper slope by early winter. This migratory behavior appears to be motivated by temperature, as the seasonal distribution of tagged lobsters according to depth is well correlated with bottom temperature. The extensive seasonal migrations undertaken by offshore lobsters contrast sharply with the localized movements of coastal stocks. This apparent difference may be partially explained by the very high exploitation rate inshore such that most lobsters of recruit size are quickly harvested within the bounds of locally intensive fisheries.

Whether the offshore stocks are genetically distinct from the coastal stocks has not been established, but it is evident that the shelf edge and upper slope is a permanent habitat from which small- and large-scale excursions are made with seasonal regularity. We believe that the continental slope habitat lacks sufficiently high temperatures during the summer to promote extrusion of eggs, molting, and subsequent mating, and that this deficiency is compensated by seasonal shoalward migration to warmer water. In situ observations of offshore lobsters from the research submersible *Nekton Gamma* at Corsair, Lydonia, Oceanographer, Hydrographer, and Veatch canyons during June-July of 1973 and 1974 substantiate this belief. Evidence of lobster molting (shed exoskeleton) was observed only at depths shoaler than 100-110 fathoms (183-201 m), whereas lobsters were distributed to depths of at least 170 fathoms (311 m).

The magnitude of variation in depth at recapture by month suggests that the migration toward shoal water is not a total population response, nor is it likely a well-coordinated one. We hypothesize that some lobsters migrate early, some late, and some not at all. Superimposed upon these variations in migratory behavior is an apparent tendency of some lobsters to move laterally east or west along the outer shelf and upper slope. Hence, the concept of discrete canyon populations is unlikely.

SUMMARY

1. This report has presented the results of an offshore lobster tag and recapture study to define the seasonal

[2]Chamberlin, J. L. Bottom temperatures on the continental shelf and slope south of New England during 1974. *In* J. Goulet (editor), Environment of the United States living marine resources—1974, p. 18-1 to 18-7, figs. 18.1-18.6 (NMFS unpubl. manuscr.)

[3]Research submersible operations provided by NOAA's Manned Undersea Science and Technology Office.

migratory behavior and population distribution of the offshore lobster population ranging from Corsair Canyon and the southeastern extremes of Georges Bank to Baltimore Canyon off the coast of Virginia. A total of 7,326 offshore lobsters were tagged and released at 52 localities, grouped into 29 composite release stations to effect a logical pooling of release and recapture information and expedite the plotting and evaluation of the data.

Cooper and Uzmann (1971) hypothesized, on the basis of a described time-temperature relationship, that the nature of the offshore lobster migration phenomenon was a vernal shoalward movement to warmer water with subsequent return to the outer edge of the shelf and upper slope with the onset of fall and winter. In this report we attempt to elicit qualitative and quantitative aspects of individual movements from groupings of individuals referenced to release locality, point of recapture, and time at large.

Among the 945 recaptured lobsters, 584 (62%) were reported by specific location, 183 (19%) by generalized location, and 178 (19%) without location information of any kind. A classification scheme is presented which distinguishes between directed migrants and those whose net movements over time are inconsequential or not clearly directional. We have defined a migrant as an individual that has moved a distance of 10 miles or more in 10-120 days from time of release to time of recapture. A total of 117 (20% of 584) lobsters meet our requirements of defined migrants.

Between 17 and 20% of the 576 recaptured lobsters whose net movements were definable (classified movements) demonstrated seasonal shoalward migration. The highly restrictive criteria used herein for defining shoalward migrants have probably excluded a considerable number of other recaptures that had, in fact, migrated into shoaler water. Therefore, the estimate of 17-20% annual shoalward migration is probably an underestimate. Approximately 25% of the tagged population remained localized (nonmigrants) and some portion of the remaining 55-58% of the classified movements (indeterminates) might, through more definitive criteria of classification, be assignable as shoalward migrants or nonmigrants.

Forty-three (37%) of the defined migrants (117) moved laterally along the outer edge of the continental shelf. There is no apparent reason for this lateral movement easterly or westerly during spring and summer. Discrete submarine canyon populations seem unlikely in view of these lateral movements. In contrast, 63% of the defined migrants moved into shoal water.

Analysis of the depth distribution of recaptured lobsters by month of capture shows a pronounced cyclical pattern of shoaling during March-August followed by a return to the shelf margin and upper slope during October-December. These cyclical changes in depth by season, independent of net track analyses, provides additional support for the hypothesis of Cooper and Uzmann (1971) of inshore-offshore movements of the offshore lobster population.

7. The distribution of recaptured lobsters by month of capture and mean bottom water temperature demonstrates that the offshore lobster population, through random and/or directed movements, maintains itself within a temperature regime of 8°-14°C.

ACKNOWLEDGMENTS

We thank National Marine Fisheries Service port agents John V. Mahoney, Churchill T. Smith, Fred C. Blossom, Paul P. Swain, and Dennis E. Main for invaluable assistance in locating, collecting, and reporting tagged lobsters taken by the commercial fishing fleet. Special thanks are due to John P. Laird, National Marine Fisheries Service, Woods Hole, for assistance with programming and execution of computer and plotter runs. The laboratory draftsmen, John R. Lamont and James A. Rollins, have our deep appreciation for their patient craftsmanship with our many requirements. Likewise, we sincerely thank Gwendolyn L. Kelley, staff typist, and Gareth W. Coffin, staff photographer, for their essential services in the final production of this report.

LITERATURE CITED

COLTON, J. B., and R. R. STODDARD.
1973. Bottom-water temperatures on the continental shelf, Nova Scotia to New Jersey. U.S. Dep. Commer., NOAA Tech. Rep. NMFS CIRC-376, 55 p.

COOPER, R. A.
1970. Retention of marks and their effects on growth, behavior, and migrations of the American lobster, *Homarus americanus*. Trans. Am. Fish. Soc. 99:409-417.

COOPER, R. A., R. A. CLIFFORD, and C. O. NEWELL.
1975. Seasonal abundance of the American lobster, *Homarus americanus*, in the Boothbay Region of Maine. Trans. Am. Fish. Soc. 104:669-674.

COOPER, R. A., and J. R. UZMANN.
1971. Migrations and growth of deep sea lobsters, *Homarus americanus*. Science (Wash., D.C.) 171:288-290.

FIRTH, F. E.
1940. Giant lobsters. New Engl. Nat. 9:11-14.

HUGHES, J. T.
1963. Report of the investigation and study of the deep sea lobster fishery. Commonw. Mass., House Doc. 3190:1-13.

KROUSE, J. S.
1973. Maturity, sex ratio, and size composition of the natural population of American lobster, *Homarus americanus*, along the Maine coast. Fish. Bull., U.S. 71:165-173.

McRAE, E. D., JR.
1960. Lobster explorations on the continental shelf and slope off northeast coast of the United States. Commer. Fish. Rev. 22(9):1-7.

SAILA, S. B., and J. M. FLOWERS.
1968. Movements and behaviour of berried female lobsters displaced from offshore areas to Narragansett Bay, Rhode Island. J. Cons. 31:342-351.

SCHROEDER, W. C.
1955. Report on the results of exploratory otter-trawling along the continental shelf and slope between Nova Scotia and Virginia during the summers of 1952 and 1953. Pap. Mar. Biol. Oceanogr., Deep Sea Res., Suppl. Vol. 3:358-372.

1959. The lobster, *Homarus americanus*, and the red crab, *Geryon quinquedens*, in the offshore waters of the western North Atlantic. Deep Sea Res. 5:266-282.

SKUD, B. E., and H. C. PERKINS.

1969. Size composition, sex ratio, and size at maturity of offshore northern lobsters. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 598, 10 p.

STEWART, L. L.

1972. The seasonal movements, population dynamics and ecology of the lobster, *Homarus americanus* (Milne-Edwards), off Ra Island, Conn. Ph.D. Thesis, Univ. Connecticut, Storrs, 152 p

TEMPLEMAN, W.

1934. Mating in the American lobster. Contrib. Can. Biol. Fish New Ser. 8:421-432.

UZMANN, J. R.

1970. Use of parasites in identifying lobster stocks. (Abstr.) Parasitol. 56, Suppl. Sec. II, p. 349.

APPENDIX TABLES

Key to Column Headings

RET - Return number plus F (female) or M (male) suffix on column entries
CS - Composite station number
OS - Original station number
MO - Month of recapture
RLAT - Release latitude
RLON - Release longitude
CLAT - Recapture latitude
CLON - Recapture longitude
DATL - Days at large
MIL - Miles (nautical)
CL1 - Carapace length at release
CL2 - Carapace length at recapture
EC - External egg code; first digit is egg code at release, second digit is egg code at recapture:
- 1 - no eggs
- 2 - new eggs
- 3 - mature eggs
- 4 - unreported
- 5 - eggs, stage unreported

Appendix Table 1

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
28F	1	1	5	4017	6803			421		118	118	11
23M	1	2	6	4017	6803			1191		185	212	
56M	1	1	11	4017	6803	4031	6758	1342	13	119		

Appendix Table 2

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
13M	2	4	6	3959	6936	4009	6951	67	16	80	80	
17M	2	4	6	3959	6936	4002	6936	76	3	102	102	
66M	2	4	4	3959	6936	VEAT		741		97	135	

Appendix Table 3

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
3F	3	5	5	3931	7213	4105	7121	29	102	96		14
11F	3	5	5	3931	7213	3938	7225	26	13	78	78	11
23F	3	5	5	3931	7213	3955	7145	6	33	90	90	11
29F	3	5	8	3931	7213	4047	7235	118	77	94	94	11
45F	3	5	8	3931	7213	3907	7243	470	34	70		14
46F	3	5	7	3931	7213	3907	7243	460	34	72		14
60F	3	5	2	3931	7213			1024		79	104	11
2M	3	5	5	3931	7213	3935	7215	15	5	74	74	
38M	3	5	8	3931	7213	HUDS		125		73		

Appendix Table 4

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
87F	4	6	1	4005	7109	4000	7106	254	6	85	99	1
462F	4	6	4	4005	7109			344		92		5
875F	4	6	12	4005	7109			1326		69	88	4
7M	4	6	6	4005	7109	4009	7112	43	5	103		
12M	4	6	5	4005	7109	4005	7122	7	10	79	79	
173M	4	6	6	4005	7109	4003	6938	405	71	100		
409M	4	6	12	4005	7109			597		73	108	

Appendix Table 5

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
4F	5	8	6	4004	7027	4010	7016	36	11	87		14
5F	5	8	5	4004	7027	4009	7026	31	6	103	103	55
6F	5	7	5	4005	7027	4013	7023	27	8	80	80	11
14F	5	7	6	4005	7027	4009	7026	34	5	81	81	11
15F	5	7	6	4005	7027	4004	7035	43	7	78	78	11
21F	5	8	7	4004	7027			83		82		11
26F	5	8	6	4004	7027	4001	6938	36	38	100	100	12
27F	5	7	6	4005	7027	4001	6938	37	38	107	107	5
28F	5	7	6	4005	7027	4045	6938	50	56	124	124	5
36F	5	7	8	4005	7027			93		67		1
37F	5	8	8	4004	7027			92		169		1
43F	5	7	9	4005	7027	4006	6930	127	44	93		1
44F	5	7		4005	7027					94		1
53F	5	7	11	4005	7027	4019	6849	191	76	111		14
58F	5	8	11	4004	7027	4015	7002	199	23	111		1
60F	5	7	12	4005	7027	4011	7016	216	10	110		14
82F	5	8	1	4004	7027	3957	7013	274	14	89	103	12
377F	5	8	11	4004	7027	4016	7017	564	15	73		14
456F	5	7	2	4005	7027			657		87	100	11
487F	5	7	5	4005	7027	4002	6907	735	61	99	112	11
498F	5	8	5	4004	7027	VEAT		740		79		14
551F	5	7	6	4005	7027	4000	7039	774	10	88		14
16M	5	8	6	4004	7027	4004	7035	42	7	76	76	
40M	5	8		4004	7027					99	99	
68M	5	7	12	4005	7027	4003	7017	236	7	80	96	
76M	5	8	1	4004	7027	3959	7054	257	22	77	77	
398M	5	8	11	4004	7027	4020	6934	569	44	93	108	
521M	5	7	5	4005	7027			747		72		
535M	5	8	6	4004	7027			767		98	116	

Appendix Table 6

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
9F	6	11	6	3957	6953	3958	6918	36	27	79	79	11
10F	6	9	6	3958	6959	4003	6929	33	24	88		11
18F	6	9	6	3958	6959	4003	6936	49	18	84	84	11
19F	6	9	6	3958	6959	4003	6936	49	18	99	99	11
57F	6	9	11	3958	6959	4018	6849	197	57	123		14
67F	6	9	12	3958	6959	4003	7017	234	15	119	119	11
71F	6	11	1	3957	6953	4000	7008	259	10	92	92	12
73F	6	9	1	3958	6959	4002	6906	259	41	113	127	31
86F	6	9	1	3958	6959	3957	7054	252	42	102	102	31
91F	6	11	1	3957	6953	4013	6832	266	63	83	83	12
324F	6	9	9	3958	6959	4006	7130	496	71	84		14
436F	6	9	11	3958	6959	VEAT		563		114		31
1M	6	9	5	3958	6959	4000	7118	12	62	101	101	
20M	6	9	6	3958	6959	4003	6936	49	18	86	86	
50M	6	9	11	3958	6959	4016	7002	187	19	83	99	
70M	6	9	1	3958	6959	4000	6937	262	17	89		
85M	6	9	1	3958	6959	4001	7012	274	11	104	104	
253M	6	11	7	3957	6953	4040	6926	435	47	96	115	
279M	6	11	7	3957	6953			425		74		
33M	6	11	1	3957	6953	4006	6840	616	58	87	102	
33M	6	9	10	3958	6959	4015	6955	896	18	67		
56M	6	9	2	3958	6959			1020		99		

Appendix Table 7

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
74F	7	10	1	3956	6942	3955	6940	256	1	100	114	31
84F	7	10	1	3956	6942	4001	7012	272	23	83	98	11
104F	7	10	4	3956	6942	4000	6912	336	23	100	100	11
112F	7	10	4	3956	6942	3958	6914	354	21	132	132	11
38F	7	10	1	3956	6942			624		109	127	11
95F	7	10	5	3956	6942	4009	6903	739	31	96	109	11
44F	7	10	6	3956	6942	4054	6941	771	58	90	103	11
8M	7	10	6	3956	6942	4009	7115	39	72	111	111	
37M	7	10	1	3956	6942	4000	6937	626	5	71	101	
38M	7	10	5	3956	6942			753		86		

Appendix Table 8

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
39F	8	12	8	3959	7003	HUDS		74		84		14
156M	8	12	5	3959	7003	4031	6740	350	114	91		
245M	8	12		3959	7003					100	120	
546M	8	12	6	3959	7003	3957	6929	734	26	111	130	

Appendix Table 9

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
47F	9	13	10	4003	7018	4015	6923	132	43	89	104	11
62F	9	13	12	4003	7018	VEAT		178		88	101	14
69F	9	13	1	4003	7018	3957	7044	204	22	83		14
105F	9	13	4	4003	7018	4002	7028	298	8	93	93	11
381F	9	13	11	4003	7018	4025	6915	533	51	86	99	11
413F	9	13	12	4003	7018			545		75	100	11
429F	9	13	1	4003	7018			561		94	108	11
439F	9	13	1	4003	7018	4000	7034	592	13	76	102	11
693F	9	13	6	4003	7018	3958	6926	1087	40	76		14
713F	9	13	2	4003	7018	3956	6955	975	19	72		14
908F	9	13	6	4003	7018	3955	6935	1453	34	76	100	44
66M	9	13	12	4003	7018	4003	7017	189	2	140	140	
389M	9	13	11	4003	7018	4020	6934	533	37	74	104	
406M	9	13	12	4003	7018	VEAT		547		87	103	
420M	9	13	12	4003	7018			548		72		
453M	9	13	2	4003	7018	4001	6908	605	54	73		
457M	9	13	2	4003	7018			610		91	130	
515M	9	13	5	4003	7018	4001	7054	704	28	82		
946M	9	13	3	4003	7018	4035	6755	1549	118	101	165	

Appendix Table 10

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
34F	10	14	7	4013	7031	4013	7010	39	16	76	76	11
41F	10	14	8	4013	7031	4022	7052	60	20	76		14
30M	10	14	8	4013	7031	4013	7024	46	6	69		

Appendix Table 11

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
31F	11	15	7	4013	7015	4017	7007	30	7	71		14
83F	11	15	1	4013	7015	4001	7012	227	12	87	99	12
90F	11	15	2	4013	7015	3959	7012	231	14	72	83	11
99F	11	15	5	4013	7015	4006	6839	695	74	93	107	11
53F	11	15	6	4013	7015	4011	6849	727	65	98		14
94M	11	15	2	4013	7015	3955	6933	253	37	117	117	

Appendix Table 12

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
96F	12	16	6	4012	7114	3955	7154	358	35	97	97	11
48M	12	16	10	4012	7114	4012	7119	120	4	113	113	
72M	12	16	1	4012	7114	4000	7008	214	52	102	120	

Appendix Table 13

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
22F	13	17	7	4004	7150	4000	7122	14	23	91		14
24F	13	17		4004	7150					91	91	55
25F	13	17	7	4004	7150	4037	7318	28	75	97	97	55
32F	13	19	8	4005	7143	4000	7153	56	9	78	90	11
61F	13	19	12	4005	7143	4009	7022	174	63	88	103	14
63F	13	18	12	4006	7148	3908	7241	178	70	79	103	11
64F	13	18	12	4006	7148	3848	7302	183	96	99	99	11
65F	13	18	12	4006	7148	4001	7039	182	52	79	93	11
78F	13	19		4005	7143					83		14
81F	13	19	1	4005	7143	3957	7013	224	71	88	88	11
99F	13	17	3	4004	7150			259		95	109	31
115F	13	19		4005	7143					68		14
164F	13	19	5	4005	7143			345		92	107	11
267F	13	18	7	4006	7148			397		98		51
270F	13	19	6	4005	7143	3956	7145	375	9	85	85	11
297F	13	17	6	4004	7150			350		87		14
335F	13	18	9	4006	7148	4045	7240	465	56	92	105	11
353F	13	19	10	4005	7143	4044	7116	484	45	65	83	11
407F	13	17	12	4004	7150	VEAT		544		87	101	31
486F	13	19	5	4005	7143	4007	6936	681	98	90	102	11
615F	13	19	8	4005	7143			792		85	98	11
618F	13	18	9	4006	7148			824		89	102	11
772F	13	17	7	4004	7150	VEAT		1121		79	109	44
879F	13	17	11	4004	7150	4005	6935	1228	104	97		54
905F	13	18	3	4006	7148	3908	7243	1360	72	88		44
42M	13	17	8	4004	7150	4022	7054	58	47	72		
59M	13	17	11	4004	7150	4017	7012	158	76	86	103	
92M	13	17	1	4004	7150	VEAT		227		89		
95M	13	17	2	4004	7150	4012	7119	235	25	87		
106M	13	17	4	4004	7150	3950	7149	302	14	97		
108M	13	17	2	4004	7150	4007	7123	238	21	94		
175M	13	18	6	4006	7148	3957	7157	353	11	85	97	
250M	13	18	7	4006	7148			381		86		
268M	13	18	7	4006	7148			378		107		
325M	13	17	8	4004	7150			434		103		
472M	13	17	4	4004	7150			655		94	132	
585M	13	18	9	4006	7148	4007	7058	816	39	98	137	
649M	13	17	1	4004	7150	4008	7132	941	15	98	137	
742M	13	18	10	4006	7148			1215		75		
870M	13	18	12	4006	7148	4005	6925	1267	108	89		

Appendix Table 14

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
35F	14	21	9	4005	7138	4003	7134	79	6	82		14
49F	14	21	10	4005	7138	4023	6944	129	89	94	108	11
80F	14	20	1	4007	7138	3952	7147	224	16	89	102	11
93F	14	21	2	4005	7138	BLOC		235		77		14
96F	14	20	3	4007	7138	3910	7229	262	69	87	87	12
147F	14	20	5	4007	7138	3958	7127	341	12	79	93	11
174F	14	20	6	4007	7138					80		14
235F	14	20	7	4007	7138	4008	7006	376	71	91		15
322F	14	21	9	4005	7138	4012	7107	441	26	74		14
323F	14	20	9	4007	7138	4012	7107	441	25	95		12
330F	14	20	7	4007	7138	4010	6939	378	91	87		14
347F	14	21	5	4005	7138	4045	7243	365	65			
348F	14	21	5	4005	7138	4046	7238	365	62			
349F	14	21	5	4005	7138	4048	7230	365	59			
350F	14	21	5	4005	7138	4049	7228	365	58			
430F	14	21	1	4005	7138			556		88	101	11
446F	14	21	12	4005	7138	4004	7135	546	4	81	93	12
504F	14	21	5	4005	7138	4005	7135	689	2	82	96	13
726F	14	20	6	4007	7138	4029	6743	1077	181	91	121	14
33M	14	21	8	4005	7138	4000	7153	55	12	98	98	
79M	14	21	1	4005	7138	3941	7152	222	26	92	107	
151M	14	20	5	4007	7138	3956	7003	328	73	95		
269M	14	20	7	4007	7138	4044	7246	392	65	100	117	
422M	14	20	12	4007	7138	4009	7130	556	7	104	126	
634M	14	21	10	4005	7138	3958	7124	836	13	123		

Appendix Table 15

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
51F	15	22	11	4142	6652	4136	6648	44	7	117		14
107F	15	22	5	4142	6652	4137	6627	227	19	136		14
289F	15	22	8	4142	6652	4139	6700	321	7	86	86	11
548F	15	22	6	4142	6652	4109	6620	640	41	157		14
607F	15	22	7	4142	6652			666		151	163	11
620F	15	22	10	4142	6652	4130	6654	759	12	107	121	11
77M	15	22	1	4142	6652			132		141	141	
130M	15	22	5	4142	6652			231		142	142	
286M	15	22	8	4142	6652	4140	6705	321	10	156	156	
724M	15	22	6	4142	6652			1002		167		

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
45F	16	23	10	4031	6837	4034	6927	20	38	98	98	11
52F	16	25	11	4029	6837	4018	6907	38	25	86		14
55F	16	26	11	4035	6842	4032	6906	55	18	85		14
98F	16	25	3	4029	6837	4004	6852	173	27	96	96	31
100F	16	26	3	4035	6842	4014	6817	171	28	105	105	11
114F	16	24	4	4030	6836			215		90	100	11
165F	16	24	6	4030	6836	4002	6933	250	52	104	104	11
176F	16	26	6	4035	6842	4008	7027	257	84	92	92	31
241F	16	24	6	4030	6836	4024	6816	250	15	103	103	11
367F	16	26	11	4035	6842			415		83	100	11
434F	16	26	12	4035	6842	HYDR		447		94		14
449F	16	23	2	4031	6837	VEAT		514		102		31
539F	16	26	5	4035	6842			231		115		14
559F	16	25	6	4029	6837	4020	6818	640	17	120		14
616F	16	26	9	4035	6842	VEAT		719		108		24
629F	16	26	10	4035	6842	HYDR		735		105	117	31
731F	16	23	6	4031	6837			981		84	110	14
732F	16	26	6	4035	6842			980		85	120	14
749F	16	26	8	4035	6842	4015	6855	1062	21	86	100	44
762F	16	25	7	4029	6837	OCEA		1034		98		44
46M	16	24	10	4030	6836	4034	6927	20	39	123	123	
54M	16	25	11	4029	6837	4032	6906	56	22	96		
75M	16	25	1	4029	6837	3959	6937	113	54	92	92	
88M	16	26	10	4035	6842	4022	6850	7	14	98		
89M	16	25	10	4029	6837	4022	6850	8	12	85		
97M	16	26	3	4035	6842	4004	6852	172	31	90	90	
101M	16	24	3	4030	6836	4005	6850	177	27	107	107	
102M	16	26	4	4035	6842	4019	6809	189	29	128	128	
103M	16	24	4	4030	6836	4019	6809	191	23	92	92	
109M	16	25	4	4029	6837	4015	7016	194	77	101		
110M	16	25	4	4029	6837	4014	6810	203	26	120	120	
113M	16	24	4	4030	6836			215		100	100	
116M	16	25	5	4029	6837	VEAT		237		137		
139M	16	24	5	4030	6836	4007	6905	237	32	79	89	
145M	16	23		4031	6837					99	99	
157M	16	26	6	4035	6842	4007	6908	248	34	109	109	
159M	16	26	6	4035	6842	4008	6845	252	26	83	83	
170M	16	25	6	4029	6837			249		116		
195M	16	26	6	4035	6842	4012	6840	269	23	131	131	
197M	16	25	6	4029	6837	4012	6840	269	17	122	122	
220M	16	25	6	4029	6837	4010	6841	272	19	93	93	
223M	16	23	6	4031	6837	4016	6829	275	15	104	104	
224M	16	24	6	4030	6836	4008	6907	275	32	109	109	
257M	16	25	7	4029	6837			290		107	107	
296M	16	25	6	4029	6837			251		86		
362M	16	25	11	4029	6837	4206	6734	411	107	76		

Appendix Table 16 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
79M	16	23	10	4031	6837	4109	6707	384	79	90		
01M	16	25	12	4029	6837	4010	6902	439	27	74	86	
73M	16	25	4	4029	6837	VEAT		557		84	99	
29M	16	24	6	4030	6836			620		80	95	
40M	16	25	5	4029	6837	4005	6915	612	38	156		
52M	16	25	6	4029	6837	4015	6845	641	16	94		
63M	16	25	7	4029	6837	4035	7009	648	70	76	96	
28M	16	25	10	4029	6837	HYDR		736		106	125	
741M	16	26	9	4035	6842	4032	6735	1077	51	126		
759M	16	25	10	4029	6837	4016	6812	1103	23	83	147	
18M	16	23	7	4031	6837	4025	6810	1380	21	117	165	
32M	16	25	8	4029	6837	4028	6725	1407	55	96	143	
33M	16	25	7	4029	6837			1381		105		

Appendix Table 17

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
131F	17	28	5	4033	6745			206		156	156	11
132F	17	27	5	4029	6739	3956	6931	201	92	132	132	11
140F	17	27	5	4029	6739	4018	6810	208	26	130	130	11
232F	17	27	6	4029	6739	4026	6733	256	5	81		11
234F	17	28	7	4033	6745	4033	6740	259	4	105	105	31
357F	17	28	10	4033	6745	4129	6728	353	58	140	140	11
481F	17	27	4	4029	6739	4026	6725	560	10	126	126	11
508F	17	28	5	4033	6745	4013	6831	577	41	100	115	11
590F	17	27		4029	6739	HYDR	WELK			100		14
591F	17	27		4029	6739	HYDR	WELK			97		14
768F	17	27	7	4029	6739	4142	6714	1010	76	117		44
784F	17	28	10	4033	6745	LYDU		1107		104		44
786F	17	27		4029	6739					119		14
940F	17	27	7	4029	6739			1367		108		54
56M	17	27	11	4029	6739	4039	6704	39	29	199		
117M	17	28	5	4033	6745	VEAT		216		121		
144M	17	27		4029	6739					109	109	
167M	17	28	6	4033	6745			229		98	98	
233M	17	28	7	4033	6745	4033	6740	259	4	116	116	
587M	17	28		4033	6745	HYDR	WELK			118		
588M	17	27		4029	6739	HYDR	WELK			74		
589M	17	28		4033	6745	HYDR	WELK			107		
744M	17	27	10	4029	6739	4033	6755	1091	12	132		
934M	17	27	7	4029	6739	4030	6810	1372	24	119		
937M	17	27	6	4029	6739	4150	6957	973	132	109		
938M	17	27	6	4029	6739	4020	6733	1338	11	114		
943M	17	28	8	4033	6745			1413		108	120	

Appendix Table 18

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
25F	18	29	5	3958	6928			15		71		14
26F	18	29	5	3958	6928			15		79		14
33F	18	29	5	3958	6928	3956	6931	4	4	103	103	55
55F	18	29	5	3958	6928			19		75		14
58F	18	30	6	3959	6925	4007	6908	31	16	72	72	11
63F	18	29		3958	6928					84	84	41
66F	18	29	6	3958	6928	4007	6908	32	18	91	91	11
80F	18	32	6	4000	6934	4007	6928	41	9	80	80	11
82F	18	29	6	3958	6928	4007	6928	43	9	77	77	11
83F	18	32	6	4000	6934	4007	6928	41	9	80	80	11
11F	18	29	6	3958	6928			56		80	80	11
21F	18	32	6	4000	6934	4002	6918	54	12	109	109	11
40F	18	32	6	4000	6934	4054	6843	32	66	101	101	11
49F	18	29	7	3958	6928	4059	7305	71	186	90		11
54F	18	30	7	3959	6925	4040	6926	71	41	121	121	31
56F	18	30	7	3959	6925			72		86	86	11
63F	18	30	7	3959	6925	4113	6946	80	76	116	116	11
71F	18	32	7	4000	6934	4004	7009	85	27	68	68	11
83F	18	32	8	4000	6934	4007	6905	102	25	71		14
91F	18	32	8	4000	6934	VEAT		91		82	82	11
95F	18	29	6	3958	6928			34		86		14
18F	18	29	8	3958	6928	4000	6937	122	7	80	93	11
19F	18	32	8	4000	6934			118		83	83	11
29F	18	29	7	3958	6928			64		92		14
40F	18	29	9	3958	6928	3957	6932	129	3	68	82	11
43F	18	32	10	4000	6934			156		87		14
55F	18	30	10	3959	6925	4058	7015	166	70	97	113	11
58F	18	29	10	3958	6928	4008	6904	181	21	74		14
61F	18	29	10	3958	6928	4003	6936	175	8	86	115	11
69F	18	29	11	3958	6928			199		76	91	11
71F	18	30	11	3959	6925			198		72	86	11
75F	18	29	11	3958	6928	4022	6941	207	24	73	89	11
76F	18	32	11	4000	6934	4022	6941	205	21	76	89	11
80F	18	32	11	4000	6934	HYDR		199		68	82	11
92F	18	32	11	4000	6934	4020	6934	212	20	75	90	11
95F	18	29	12	3958	6928	4013	6934	221	16	79	93	11
05F	18	29	12	3958	6928	VEAT		233		72		14
10F	18	29	12	3958	6928			226		97	112	31
17F	18	29	12	3958	6928			229		70		14
21F	18	32	12	4000	6934			227		69		14
27F	18	29	1	3958	6928			259		69	82	11
28F	18	32	1	4000	6934			257		83	98	11
31F	18	30	1	3959	6925			258		81	96	11
40F	18	29	1	3958	6928	4001	6908	275	15	73	86	11
45F	18	32	1	4000	6934	4003	7010	258	28	88		14
48F	18	32	2	4000	6934	VEAT		295		88	102	11
50F	18	30	1	3959	6925			274		75	88	11
54F	18	32	2	4000	6934	4001	6908	284	20	92		14
55F	18	30	2	3959	6925			290		71	85	11
61F	18	29	6	3958	6928	4000	6925	41	2	87		14

Appendix Table 18 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
468F	18	29	4	3958	6928			336		89		14
469F	18	32	4	4000	6934			334		107		14
470F	18	32	4	4000	6934			334		77		14
471F	18	32	4	4000	6934			334		72		14
476F	18	32	4	4000	6934	VEAT		340		82	82	11
477F	18	29	4	3958	6928	4028	6710	344	110	140	154	51
478F	18	32	4	4000	6934	4014	6815	352	60	74	86	11
483F	18	30	5	3959	6925	3953	6926	367	5	85	102	11
485F	18	29	5	3958	6928	4007	6936	366	11	88	100	11
494F	18	29	5	3958	6928	4009	6903	376	21	86	93	11
500F	18	29	5	3958	6928	4006	6839	377	38	88	112	11
509F	18	29	5	3958	6928	4013	6831	381	46	101		14
513F	18	32	5	4000	6934	3956	6935	383	4	60	71	11
516F	18	32	6	4000	6934	4005	6945	395	9	91	91	11
518F	18	30	6	3959	6925	3957	6925	396	2	83		14
520F	18	32	6	4000	6934	3957	6925	395	8	71		14
525F	18	32	6	4000	6934	HYDR		402		77	91	11
533F	18	32	6	4000	6934			400		61	75	11
537F	18	32	5	4000	6934			388		97	97	11
547F	18	29	6	3958	6928	4043	6938	416	45	75	90	11
560F	18	29	7	3958	6928	4004	6935	430	9	68		14
572F	18	29	6	3958	6928	VEAT		411		73		14
573F	18	30	7	3959	6925	VEAT		428		75	90	11
596F	18	29		3958	6928	HYDR	WELK			86		14
599F	18	32	8	4000	6934	4010	6908	474	22	90	104	11
603F	18	30	8	3959	6925	4004	7049	462	64	73		14
604F	18	29	8	3958	6928	4004	7049	463	62	85		14
608F	18	32	7	4000	6934			433		73	82	11
609F	18	32	6	4000	6934	3957	6934	409	3	88		14
612F	18	29	3	3958	6928	4004	6928	319	6	75		14
622F	18	29	10	3958	6928	HYDR		519		86	99	51
623F	18	30	10	3959	6925	HYDR		518		88	103	11
632F	18	32	11	4000	6934	4033	6931	548	32	59	85	11
667F	18	32	4	4000	6934	3956	6919	701	12	80	94	11
669F	18	29	3	3958	6928			688		75	92	14
676F	18	32	5	4000	6934	4012	6906	750	25	103	116	31
678F	18	32	6	4000	6934	HYDR		409		75	105	14
679F	18	32	6	4000	6934	HYDR		409		81		14
730F	18	32	6	4000	6934	4015	6845	773	41	65	91	13
800F	18	29	6	3958	6928	VEAT		42		77		14
801F	18	29	6	3958	6928	VEAT		42		82		14
803F	18	32	6	4000	6934	VEAT		40		90		14
804F	18	32	9	4000	6934	VEAT	HYDR	866		61	97	11
849F	18	30	11	3959	6925	4035	6825	921	59	85	116	11
857F	18	29	11	3958	6928	4031	6758	931	78	102		14
863F	18	30	12	3959	6925	4005	6925	950	7	81		44
894F	18	32	12	4000	6934			957		77		14
944F	18	29	9	3959	6925			1238		75	100	14

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
22M	18	30	5	3959	6925	VEAT		19		81		
23M	18	29	5	3958	6928	VEAT		20		71		
24M	18	29	5	3958	6928	VEAT		20		83		
27M	18	29	5	3958	6928			10		94	94	
29M	18	30	5	3959	6925			9		90	90	
34M	18	29	5	3958	6928	3956	6931	4	4	87	87	
35M	18	29	5	3958	6928	3956	6931	4	4	100	100	
36M	18	29	5	3958	6928	3956	6931	4	4	70	88	
43M	18	29		3958	6928					91	91	
53M	18	30	5	3959	6925			18		81		
54M	18	29	5	3958	6928			19		73		
60M	18	29	6	3958	6928	4006	6905	36	20	102	102	
79M	18	30	6	3959	6925	4007	6928	42	9	99	99	
81M	18	29	6	3958	6928	4007	6928	43	9	75	75	
92M	18	32	6	4000	6934	4009	6933	45	9	92		
93M	18	32		4000	6934					90	90	
99M	18	29	6	3958	6928	4013	6843	52	37	153	153	
01M	18	32	6	4000	6934	4013	6843	50	41	174	174	
13M	18	30	6	3959	6925			55		82	82	
14M	18	32	6	4000	6934			54		90	90	
16M	18	32	6	4000	6934	3958	6939	54	5	161		
17M	18	29	6	3958	6928	3958	6939	56	9	130		
18M	18	29	6	3958	6928	4000	6922	58	6	88	88	
26M	18	29	6	3958	6928			60		71	82	
64M	18	29	7	3958	6928	4000	6937	81	7	101	101	
65M	18	29	7	3958	6928	4000	6937	81	7	65	88	
66M	18	29	7	3958	6928	4007	6952	85	21	89	89	
72M	18	29	7	3958	6928	3958	6923	62	3	94	94	
75M	18	30	7	3959	6925	3958	6923	62	1	85		
32M	18	29	8	3958	6928	VEAT		93		94	107	
00M	18	29	7	3958	6928	4003	6908	82	16	86		
1M	18	29	8	3958	6928	4036	6923	106	39	96	96	
2M	18	30	9	3959	6925	4008	6931	125	10	74	90	
3M	18	32	9	4000	6934	4008	6931	124	8	96	96	
26M	18	30	6	3959	6925			55		96		
27M	18	30	7	3959	6925			63		97		
28M	18	29	7	3958	6928			64		90		
33M	18	29	9	3958	6928	4014	6913	143	20	87		
59M	18	32	11	4000	6934	4113	6703	190	137	66		
60M	18	32	10	4000	6934	4003	6936	173	3	81	110	
64M	18	32	11	4000	6934	4013	6916	191	20	71	87	
68M	18	32	11	4000	6934			197		78	91	
73M	18	32	11	4000	6934			197		68	83	
74M	18	29	11	3958	6928			199		78		
32M	18	32	11	4000	6934	4020	6934	212	20	85	102	
33M	18	32	11	4000	6934	4020	6934	212	20	103	124	
37M	18	32	11	4000	6934	4020	6934	212	20	100	100	
38M	18	32	11	4000	6934	4020	6934	212	20	98	98	
90M	18	32	11	4000	6934	4020	6934	212	20	91	107	
91M	18	29	11	3958	6928	4020	6934	214	22	75	84	

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
393M	18	29	11	3958	6928	4020	6934	214	22	87	107
394M	18	29	12	3958	6928			219		103	
396M	18	32	12	4000	6934	4013	6934	219	13	66	78
397M	18	29	11	3958	6928	4020	6934	204	22	76	89
400M	18	32	12	4000	6934	4006	6901	222	25	64	75
402M	18	32	12	4000	6934	4009	6904	220	24	110	110
404M	18	30	12	3959	6925	4009	6904	223	19	81	99
408M	18	30	12	3959	6925			225		81	101
411M	18	32	12	4000	6934			224		79	79
412M	18	29	12	3958	6928			226		82	100
414M	18	30	12	3959	6925			225		71	87
415M	18	32	12	4000	6934			224		86	102
416M	18	29	12	3958	6928			229		77	
418M	18	30	12	3959	6925			228		91	
419M	18	32	12	4000	6934			227		126	
425M	18	32	1	4000	6934			257		79	92
426M	18	32	1	4000	6934			257		63	76
435M	18	29	12	3958	6928	HYDR		231		117	
442M	18	29	1	3958	6928			260		71	
443M	18	32	12	4000	6934	4001	6907	236	19	92	
447M	18	29	11	3958	6928			199		95	112
451M	18	30	2	3959	6925	4001	6908	285	13	74	
452M	18	30	2	3959	6925	4001	6908	285	13	81	
458M	18	29	6	3958	6928	4000	6925	41	2	100	
459M	18	32	6	4000	6934	4000	6925	39	6	112	
460M	18	30	6	3959	6925	4000	6925	40		81	
464M	18	30	4	3959	6925	VEAT		348		72	90
474M	18	32	4	4000	6934	VEAT		339		61	90
475M	18	30	4	3959	6925	VEAT		340		67	81
484M	18	32	5	4000	6934	4007	6936	364	7	92	106
488M	18	32	5	4000	6934	4002	6907	365	22	80	97
492M	18	29	5	3958	6928	VEAT		368		81	97
503M	18	29	5	3958	6928	4035	6737	374	92	120	120
514M	18	32	5	4000	6934	3956	6935	383	4	67	90
517M	18	29	6	3958	6928	4005	6945	397	14	68	92
519M	18	29	6	3958	6928	3957	6925	397	2	90	
523M	18	29	5	3958	6928			394		80	95
526M	18	32	6	4000	6934	HYDR		402		94	94
531M	18	32	6	4000	6934			400		80	95
536M	18	29	5	3958	6928			390		191	191
541M	18	29	5	3958	6928	4006	6926	371	8	85	100
542M	18	30	5	3959	6925	4006	6926	370	7	84	98
555M	18	32	6	4000	6934	4009	6905	422	23	92	110
571M	18	32	6	4000	6934	VEAT		409		91	112
582M	18	30	9	3959	6925	4009	6906	512	17	67	
583M	18	32	9	4000	6934			487		70	
605M	18	29	8	3958	6928	4004	7049	463	62	86	
613M	18	29	3	3958	6928	4004	6928	319	6	106	
617M	18	30	9	3959	6925			507		108	118
619M	18	32	10	4000	6934	4021	6915	528	25	76	112

Appendix Table 18 Cont.

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
1M	18	29	10	3958	6928	HYDR		519		65	85	
5M	18	30	10	3959	6925	HYDR		518		92	110	
7M	18	32	10	4000	6934	HYDR		517		83	115	
9M	18	32	11	4000	6934			572		83	121	
7M	18	29	1	3958	6928	4010	6823	620	50	66	96	
8M	18	29	2	3958	6928			656		86		
4M	18	29	1	3958	6928	4005	6935	620	8	97		
0M	18	29	5	3958	6928	4125	7056	761	110	82		
8M	18	32	8	4000	6934	HYDR		840		73	102	
5M	18	32	11	4000	6934	HYDR		920		68	131	
9M	18	29	6	3958	6928			48		95		
2M	18	32	6	4000	6934	VEAT		40		146		
5M	18	30	4	3959	6925	HYDR		703		73	104	
2M	18	32	11	4000	6934	4040	6810	927	75	69	118	
3M	18	30		3959	6925	HYDR				105		

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
137F	19	31	5	4004	6917	3957	6919	15	6	96	96	1
146F	19	31	5	4004	6917	4012	6907	24	11	77	77	1
152F	19	31	6	4004	6917	3958	6930	29	11	94		1
162F	19	31	6	4004	6917	VEAT		30		85	85	1
184F	19	31	6	4004	6917	4006	6935	40	15	87	87	1
191F	19	31	6	4004	6917	4009	6933	43	14	90		5
212F	19	31	6	4004	6917			52		78	78	1
219F	19	31	6	4004	6917	4000	6922	55	5	76	76	1
225F	19	31	6	4004	6917			56		80	80	1
255F	19	31	7	4004	6917	4046	6930	70	45	115	115	1
273F	19	31	7	4004	6917	3958	6923	58	7	82	82	1
274F	19	31	7	4004	6917	3958	6923	59	7	88		3
282F	19	31	8	4004	6917	4007	6905	100	10	87		1
294F	19	31	8	4004	6917	4117	7119	107	118	92	92	1
298F	19	31	7	4004	6917	4003	6908	78	7	67		1
299F	19	31	7	4004	6917	4003	6908	78	7	73		1
301F	19	31	7	4004	6917	4003	6908	78	7	75		1
302F	19	31	7	4004	6917	4003	6908	78	7	87		1
320F	19	31	9	4004	6917	4010	6905	136	11	79		1
321F	19	31	9	4004	6917	4010	6905	136	11	95		1
332F	19	31	9	4004	6917	4014	6913	139	11	68		1
334F	19	31	9	4004	6917	4049	6937	137	48	95	95	1
372F	19	31	11	4004	6917			195		68	83	1
386F	19	31	11	4004	6917	4020	6934	210	22	68	82	1
423F	19	31	1	4004	6917					88	99	3
424F	19	31	1	4004	6917					85	98	1
467F	19	31	4	4004	6917	VEAT		347		94	94	1
490F	19	31	5	4004	6917	4002	6907	363	9	70	93	1
505F	19	31	5	4004	6917	4009	6904	376	12	86	101	1
507F	19	31	5	4004	6917	4010	6845	379	25	60	80	1
510F	19	31	5	4004	6917	4013	6831	377	36	94		1
524F	19	31	5	4004	6917	HYDR		390		80		1
527F	19	31	6	4004	6917	HYDR		400		72	98	1
528F	19	31	6	4004	6917	HYDR		400		69	83	1
534F	19	31	6	4004	6917			398		68	82	1
543F	19	31	6	4004	6917	4013	7003	401	37	104	104	1
545F	19	31	6	4004	6917	3957	6929	410	12	85	100	1
554F	19	31	6	4004	6917	4009	6905	420	10	84	93	1
586F	19	31	9	4004	6917	4040	6939	504	41	86	97	1
602F	19	31	6	4004	6917	4008	6906	393	8	68		1
610F	19	31	7	4004	6917	4048	6812	443	66	97	111	5
614F	19	31	3	4004	6917	4004	6928	315	9	71		1
626F	19	31	10	4004	6917	HYDR		515		71	96	1
638F	19	31	11	4004	6917	4034	6933	563	33	70	86	1
640F	19	31	12	4004	6917	4007	6939	576	18	63	91	1
641F	19	31	12	4004	6917	4007	6939	576	18	87	98	1
643F	19	31	1	4004	6917			607		76		1
654F	19	31	6	4004	6917	4034	7003	41	47	77		1
655F	19	31	2	4004	6917			658		84	97	1
668F	19	31	4	4004	6917	3954	6932	699	14	98	112	3

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
671F	19	31	5	4004	6917	4016	6832	736	35	60	90	14
673F	19	31	5	4004	6917	3956	6921	744	8	96	111	11
717F	19	31	1	4004	6917	HYDR		251		72	93	14
729F	19	31	6	4004	6917	HYDR		767		60		14
757F	19	31	8	4004	6917	HYDR		842		90	102	14
891F	19	31		4004	6917	HYDR				57		14
892F	19	31		4004	6917	HYDR				86		14
118M	19	31	5	4004	6917	VEAT		16		85		
119M	19	31	5	4004	6917	VEAT		17		86		
120M	19	31	5	4004	6917	VEAT		16		72		
121M	19	31	5	4004	6917	VEAT		16		76		
141M	19	31		4004	6917					96	96	
142M	19	31		4004	6917					109	109	
168M	19	31	6	4004	6917	VEAT		29		80		
188M	19	31	5	4004	6917			16		95		
190M	19	31	6	4004	6917	4009	6933	43	14	76		
194M	19	31	6	4004	6917	4007	6939	42	17	88	88	
215M	19	31	6	4004	6917	4000	6918	51	3	76		
246M	19	31	7	4004	6917	4049	6946	67	51	99	99	
290M	19	31	7	4004	6917	4004	7009	83	40	78		
317M	19	31	7	4004	6917	4133	6722	86	125	147		
331M	19	31	9	4004	6917	4014	6913	139	11	81		
344M	19	31	10	4004	6917			154		78		
356M	19	31	10	4004	6917			164		85		
363M	19	31	11	4004	6917	HYDR		195		90		
365M	19	31	11	4004	6917	4020	6941	199	26	115	133	
366M	19	31	11	4004	6917			195		103	125	
370M	19	31	11	4004	6917			195		73	89	
384M	19	31	11	4004	6917	4020	6934	210	22	107	125	
385M	19	31	11	4004	6917	4020	6934	210	22	78	96	
403M	19	31	12	4004	6917	4009	6904	220	10	69	84	
441M	19	31	1	4004	6917	4005	6908	270	7	78	91	
444M	19	31	1	4004	6917	4000	6937	255	16	115		
480M	19	31	4	4004	6917	4029	6711	335	98	74	89	
482M	19	31	5	4004	6917	3954	6926	364	11	75		
489M	19	31	5	4004	6917	4002	6907	363	9	81	97	
491M	19	31	5	4004	6917	VEAT		364		87	106	
496M	19	31	5	4004	6917	4009	6903	372	11	113	128	
501M	19	31	5	4004	6917	4006	6839	373	28	109		
512M	19	31	5	4004	6917	3956	6935	381	16	75	113	
530M	19	31	6	4004	6917			398		119	127	
532M	19	31	6	4004	6917			398		80	96	
561M	19	31	7	4004	6917	4049	6929	426	47	89	106	
570M	19	31	7	4004	6917	3954	7147	425	115	98	118	
574M	19	31	6	4004	6917	3957	7002	394	35	83		
577M	19	31	10	4004	6917	4117	6849	522	78	86	125	

Appendix Table 19 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
598M	19	31		4004	6917	HYDR	WELK			76	
601M	19	31	8	4004	6917	VEAT		461		73	88
624M	19	31	10	4004	6917	HYDR		515		95	111
642M	19	31	1	4004	6917			607		56	
677M	19	31	6	4004	6917	HYDR		407		73	
715M	19	31	4	4004	6917	HYDR		710		67	101
756M	19	31	8	4004	6917	HYDR		842		63	99
884M	19	30		3959	6925					81	

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
48F	20	34	5	4101	6639	4113	6615	22	22	159	159	31
61F	20	33	6	4057	6635	4042	6656	27	22	121	121	31
69F	20	34	6	4101	6639			25		123		14
71F	20	33	6	4057	6635	4107	6626	34	11	146	146	11
72F	20	34	6	4101	6639	4059	6629	32	8	119	119	55
98F	20	33	6	4057	6635	4045	6649	42	16	115	115	31
07F	20	35	6	4101	6629	4103	6625	46	3	128	128	55
09F	20	34	6	4101	6639	4103	6625	46	10	129		55
28F	20	35	6	4101	6629	4053	6639	50	11	153	153	11
39F	20	34	6	4101	6639	4103	6625	48	10	133		11
44F	20	33	7	4057	6635	4120	6653	60	27	111	111	11
47F	20	34	7	4101	6639	4119	6638	62	18	130	130	55
52F	20	34	7	4101	6639	4129	6701	66	32	129	129	11
59F	20	35	7	4101	6629	4140	6702	70	47	145		14
76F	20	34	7	4101	6639	4139	6700	79	41	139	139	11
77F	20	34	7	4101	6639	4139	6700	79	41	157	157	11
81F	20	35	7	4101	6629			79		123	123	11
06F	20	33	8	4057	6635	4140	6718	100	54	161	161	11
14F	20	34	7	4101	6639	4133	6722	81	45	117		31
15F	20	33	7	4057	6635	4133	6722	82	50	182		31
38F	20	33	9	4057	6635	4130	6709	138	42	112		14
65F	20	34	4	4101	6639	CORS		350		147	147	11
97F	20	33	5	4057	6635			368		112	112	14
06F	20	33	4	4057	6635			348		162		14
78F	20	33	10	4057	6635	4058	6830	519	87	128		11
79F	20	34	10	4101	6639	4127	6708	517	34	188		11
11F	20	34	7	4101	6639	4131	6701	436	34	158		14
37F	20	33	6	4057	6635	3958	6926	761	143	136		34
35F	20	33	1	4057	6635	4035	6655	995	27	135	147	14
38M	20	33	5	4057	6635			12		163	163	
49M	20	34	5	4101	6639	4113	6615	23	22	134	134	
50M	20	33	5	4057	6635	4113	6615	23	22	139	139	
00M	20	35	6	4101	6629	4132	6649	43	35	177	177	
02M	20	33	6	4057	6635	4100	6628	44	6	195	195	
06M	20	33	6	4057	6635	4103	6625	48	9	171		
10M	20	34	6	4101	6639	4103	6625	48	10	141		
27M	20	34	6	4101	6639	4053	6639	51	8	125	125	
29M	20	33	6	4057	6635	4053	6639	52	6	136	136	
85M	20	35	8	4101	6629	4140	6705	94	48	176	176	
51M	20	34	10	4101	6639	4109	6707	157	23	156		
79M	20	33	4	4057	6635	4029	6711	329	40	148	148	
68M	20	34	7	4101	6639	4135	6652	429	35	146	170	
25M	20	34	6	4101	6639			773		109		
97M	20	33	4	4057	6635	4119	6616	1075	27	159		

Appendix Table 21

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
185F	21	36	6	4032	6748	4042	6657	7	40	132	132	1
186F	21	36	6	4032	6748	4010	6850	9	53	103	103	1
262F	21	36	7	4032	6748	4137	6654	44	76	120	120	1
399F	21	36	11	4032	6748	4020	6934	167	82	122	122	1
463F	21	36	4	4032	6748	4028	6710	308	29	170	170	1
502F	21	36	5	4032	6748	4035	6737	337	9	92	106	1
592F	21	36		4032	6748	HYDR	WELK			106		1
187M	21	36	6	4032	6748			9		103	103	
203M	21	36	6	4032	6748	4031	6744	16	2	157		
204M	21	36	6	4032	6748	4031	6744	16	2	101		
205M	21	36	6	4032	6748	4031	6744	16	2	98		
230M	21	36	6	4032	6748	4026	6733	22	12	112	112	
231M	21	36	6	4032	6748	4026	6733	22	12	114	114	
352M	21	36	10	4032	6748	4110	6901	117	67	117		
493M	21	36	3	4032	6748	4032	6705	295	32	126		
581M	21	36	9	4032	6748			478		171	183	
593M	21	36		4032	6748	HYDR	WELK			117		
594M	21	36		4032	6748	HYDR	WELK			93		
595M	21	36		4032	6748	HYDR	WELK			122		
630M	21	36	10	4032	6748	HYDR		482		122	143	
745M	21	36	10	4032	6748	4033	6742	859	5	189		
851M	21	36	11	4032	6748	4055	6810	885	28	133	160	
861M	21	36	12	4032	6748	OCEA		917		105	125	

Appendix Table 22

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
177F	22	38	6	4117	6633	4117	6639		4	177	177	11
178F	22	37	6	4108	6638	4117	6639	2	9	136	136	55
189F	22	37	6	4108	6638	4107	6636	4	2	164		11
208F	22	37	6	4108	6638	4103	6625	13	10	102		11
236F	22	38	7	4117	6633	4141	6704	20	33	141	141	11
237F	22	37	6	4108	6638	4024	6817	20	87	149	149	55
238F	22	37	7	4108	6638	4137	6654	21	32	157	157	11
251F	22	37	7	4108	6638	4136	6653	32	32	138	138	55
260F	22	37	7	4108	6638	4140	6702	38	37	117		54
280F	22	37	7	4108	6638			22		132		14
284F	22	38	8	4117	6633	4142	6659	60	32	134	134	31
287F	22	37	8	4108	6638	4140	6705	59	38	144	144	31
288F	22	37	8	4108	6638	4139	6700	59	38	122	122	11
293F	22	37	8	4108	6638	4140	6704	60	38	157	157	31
307F	22	37	8	4108	6638	4133	6732	72	48	114	114	31
308F	22	37	8	4108	6638	4133	6732	72	48	127	127	31
309F	22	37	8	4108	6638	4133	6732	72	48	101	101	11
316F	22	37	7	4108	6638	4133	6722	48	41	126		31
336F	22	37	9	4108	6638	4129	6727	89	42	124	137	32
337F	22	37	9	4108	6638	4129	6727	89	42	142	142	11
339F	22	37	9	4108	6638	4136	6723	86	44	133	133	11
432F	22	38	1	4117	6633			218		164	164	31
575F	22	37	8	4108	6638	4152	6956	431	155	122		51
597F	22	37		4108	6638	HYDR	WELK			139		14
600F	22	38	8	4117	6633	4138	6651	427	25	151	162	51
606F	22	38	9	4117	6633			451		150		54
770F	22	38	7	4117	6633	4115	6850	750	103	127	140	14
787F	22	37		4108	6638					172		14
222M	22	38	7	4117	6633	4134	6651	23	22	170	170	
242M	22	37	7	4108	6638	4139	6659	25	35	128	159	
243M	22	37	7	4108	6638	4142	6704	28	40	139	139	
248M	22	37	7	4108	6638	4141	6709	31	41	130	130	
258M	22	38	7	4117	6633	4140	6702	37	32	143	143	
261M	22	37	7	4108	6638	4138	6700	41	35	157	157	
278M	22	38	7	4117	6633	4139	6700	45	30	166	166	
303M	22	37	8	4108	6638	4011	6902	76	123	154	154	
305M	22	38	8	4117	6633			62		148	148	
310M	22	37	8	4108	6638	4144	6654	67	38	170	170	
341M	22	38	9	4117	6633	4140	6702	89	32	132		
342M	22	38	9	4117	6633	4140	6702	89	32	156		
354M	22	37	10	4108	6638	4112	6716	126	29	95	95	
378M	22	37	11	4108	6638	4110	6722	167	33	162	186	
652M	22	37	1	4108	6638					195		
722M	22	38	6	4117	6633	4048	6644	737	29	148	163	
747M	22	38	10	4117	6633	4025	6958	865	164	154		
898M	22	37	4	4108	6638	4105	6625	1034	11	121	168	

Appendix Table 23

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
565F	23	50	6	4018	6823	4022	6821	8	5	97	97	1
567F	23	48	6	4015	6827	4022	6821	9	8	118	118	1
576F	23	48	8	4015	6827	4050	6917	48	52	122	122	3
584F	23	48	9	4015	6827	4053	6841	84	39	85	97	1
646F	23	48	1	4015	6827	4010	6823	205	7	116	127	3
650F	23	48	1	4015	6827	4007	6904	198	29	111		5
651F	23	48	1	4015	6827	4007	6904	198	29	110		5
661F	23	48	3	4015	6827	4015	6809	266	15	88	101	1
662F	23	50	3	4018	6823	4015	6809	266	12	102	112	3
670F	23	48	5	4015	6827	4029	6742	337	37	90	103	1
672F	23	50	5	4018	6823	4011	6818	326	8	96	96	1
675F	23	48	4	4015	6827			311		90	104	3
728F	23	48	6	4015	6827	4011	7113	348	126	116	116	1
737F	23	48	7	4015	6827	4040	6810	377	28	110		3
739F	23	48	8	4015	6827	4026	6810	408	17	115		1
771F	23	48	6	4015	6827	4106	6847	361	54	88	102	1
775F	23	50	7	4018	6823	4040	6810	376	24	101		5
788F	23	50		4018	6823					103		1
842F	23	48	11	4015	6827	VEAT	HYDR	511		124	140	1
848F	23	50	11	4018	6823	4035	6825	506	16	103		3
550M	23	48	6	4015	6827	4020	6825	6	6	132	132	
556M	23	48	6	4015	6827	4020	6818	8	8	115		
557M	23	48	6	4015	6827	4020	6818	8	8	95		
562M	23	48	7	4015	6827	4035	7009	16	80	86	86	
564M	23	50	7	4018	6823	4035	7009	15	83	117	117	
659M	23	48	2	4015	6827			241		143		
665M	23	48	4	4015	6827	4006	6849	286	18	114	134	
666M	23	48	4	4015	6827	4006	6849	291	18	110	128	
736M	23	48	7	4015	6827	4040	6810	377	28	104		
767M	23	48	7	4015	6827	4100	6922	389	62	135	158	
769M	23	48	7	4015	6827	4115	6850	377	60	88	102	
774M	23	48	7	4015	6827	HYDR		404		90		
789M	23	48		4015	6827					90		
797M	23	48	7	4015	6827	4135	6646	404	112	104		

Appendix Table 24

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
549F	24	49	6	4024	6825	4020	6825	6	6	103	103	55
558F	24	51	6	4027	6815	4020	6818	5	7	102		14
569F	24	51	7	4027	6815	3959	6946	16	74	116		14
580F	24	49	9	4024	6825			100		116	116	54
631F	24	49	10	4024	6825	HYDR		104		81	93	11
636F	24	51	11	4027	6815	4029	6820	149	3	110	123	31
719F	24	51	6	4027	6815	4019	6824	361	11	110	110	14
727F	24	51	5	4027	6815	4026	6809	343	6	90	103	14
765F	24	51	11	4027	6815	HYDR		498		73	73	44
776F	24	51	7	4027	6815	4040	6810	383	14	97		54
778F	24	51	7	4027	6815	HYDR		379		85		44
883F	24	51	11	4027	6815	4017	6833	512	18	98		11
936F	24	51	7	4027	6815			766		157	163	14
947F	24	51	8	4027	6815			781		145		54
566M	24	51	6	4027	6815	4022	6820	6	7	98	98	
635M	24	49	11	4024	6825	4029	6820	152	8	111	129	
637M	24	49	11	4024	6825	4029	6820	152	8	107	107	
648M	24	51	1	4027	6815	4017	7113	207	136	136	136	
653M	24	49	1	4024	6825	4016	6809	220	16	99	115	
746M	24	49	10	4024	6825	4033	6742	481	34	95		
773M	24	51	7	4027	6815	HYDR		383		107		
777M	24	51	7	4027	6815	4040	6810	383	14	123		

Appendix Table 25

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
718F	25	57	2	4002	7115	3959	7119	38	5	82		14
735F	25	58	6	3958	7110	3958	7110	169		109		11
791F	25	58	8	3958	7110	4010	7107	209	12	108	108	44
798F	25	58	6	3958	7110	4007	7000	163	54	113		31
827F	25	57	6	4002	7115	4012	7040	412	29	76	90	14
828F	25	57	6	4002	7115	4012	7040	412	29	75	92	14
734M	25	58	7	3958	7110	3958	7110	184		90		
792M	25	58	8	3958	7110	4008	7056	210	15	107		
920M	25	57	6	4002	7115	4002	7119	530	4	104	125	
921M	25	57	6	4002	7115	4005	7118	524	5	83		

Appendix Table 26

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
674M	26	59	5	3914	7220			112		103	103	

Appendix Table 27

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
740F	27	62	9	3756	7356	3835	7440	227	52	125		1
914F	27	60	6	3754	7402	3744	7409	494	12	124		1
915F	27	60	7	3754	7402	3813	7348	526	22	141		1
916F	27	60	7	3754	7402	3813	7348	526	22	129		1
917F	27	61	9	3755	7358	3900	7434	230	71	98		1
935F	27	60	4	3754	7402	3800	7355	448	9	150		1
880M	27	60	1	3754	7402	3813	7357	329	20	121		
911M	27	60	7	3754	7402	3813	7348	526	22	72		
912M	27	62	7	3756	7356	3752	7407	516	8	97		
913M	27	60	7	3754	7402	3813	7348	536	22	130		
954M	27	62	10	3756	7356	3800	7355	620	4	101		

Appendix Table 28

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
906F	28	64	6	3910	7239	3902	7242	479	9	123		[illegible]
663M	28	64	3	3910	7239	3906	7243	36	7	161	161	
664M	28	64	3	3910	7239	3906	7243	36	7	146	146	

Appendix Table 29

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
682F	29	66	6	4002	6932	4002	6932	28		76		11
684F	29	66	6	4002	6932	4002	6932	28		95	95	33
685F	29	65	6	3958	6926	3958	6926	30		100	100	33
686F	29	66	6	4002	6932	4002	6932	28		87	87	33
687F	29	65	6	3958	6926	3958	6926	30		81		14
689F	29	66	6	4002	6932	4002	6932	28		76		14
690F	29	65	6	3958	6926	3958	6926	30		73		14
691F	29	65	6	3958	6926	3958	6926	30		78		14
695F	29	65	6	3958	6926	3958	6926	30		66		11
698F	29	66	6	4002	6932	4002	6932	28		77		14
699F	29	66	6	4002	6932	4002	6932	31		76		14
701F	29	65	6	3958	6926	4000	6923	44	3	80	95	14
702F	29	66	6	4002	6932	4000	6923	42	7	103		34
703F	29	65	6	3958	6926	4000	6923	44	3	76		14
705F	29	65	6	3958	6926	4000	6923	44	3	71		11
710F	29	65	6	3958	6926	4000	6923	44	3	74		14
712F	29	66	6	4002	6932	4000	6932	42	7	76		14
721F	29	65	6	3958	6926	4048	6924	49	50	108	108	33
738F	29	65	7	3958	6926	4048	6924	53	38	102		33
743F	29	65	7	3958	6926			80		92		14
750F	29	65	8	3958	6926	HYDR		108		117	117	34
751F	29	65	8	3958	6926	HYDR		108		72	72	14
752F	29	65	8	3958	6926	HYDR		108		72	86	14
753F	29	65	8	3958	6926	HYDR		108		84	105	34
755F	29	65	8	3958	6926	HYDR		108		68	82	14
760F	29	66	10	4002	6932	HYDR		152		78	78	14
761F	29	65	10	3958	6926	HYDR		154		76	92	14
763F	29	65	11	3958	6926	HYDR		178		104	115	34
764F	29	65	11	3958	6926	HYDR		178		77	90	14
779F	29	65	7	3958	6926	4035	6910	79	39	81	91	14
780F	29	65	11	3958	6926			185		75	90	14
781F	29	65	11	3958	6926			186		74	87	14
782F	29	65	11	3958	6926	HYDR		184		101	116	14
783F	29	65	11	3958	6926	HYDR		184		116	130	14
790F	29	65	8	3958	6926			96		93	93	14
793F	29	65	8	3958	6926	VEAT		87		105	105	14
794F	29	66	8	4002	6932	VEAT		85		70	85	14
795F	29	65	8	3958	6926	VEAT		87		114	114	14
796F	29	65	8	3958	6926	VEAT		87		117	117	31
805F	29	65	9	3958	6926			130		75	88	11
807F	29	65	9	3958	6926	VEAT	HYDR	130		99	114	31
808F	29	65	9	3958	6926	VEAT	HYDR	130		72	85	11
809F	29	66	9	4002	6932	VEAT	HYDR	128		85	100	31
810F	29	66	9	4002	6932	VEAT	HYDR	128		75	90	14
811F	29	65	9	3958	6926	VEAT	HYDR	130		104	116	31
813F	29	65	9	3958	6926	VEAT	HYDR	130		72	88	14
814F	29	65	9	3958	6926	VEAT	HYDR	130		102	115	31
815F	29	65	9	3958	6926	VEAT	HYDR	130		105	122	31
816F	29	65	9	3958	6926	VEAT	HYDR	130		76	93	11
817F	29	65	9	3958	6926	VEAT	HYDR	130		72	87	14

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
818F	29	65	9	3958	6926	VEAT	HYDR	130		77	95	14
820F	29	65	9	3958	6926	VEAT	HYDR	130		71	86	14
821F	29	65	9	3958	6926	VEAT	HYDR	130		70	85	14
822F	29	65	9	3958	6926	VEAT	HYDR	130		73	87	14
826F	29	65	11	3958	6926	HYDR		196		81	95	14
827F	29	65	11	3958	6926	HYDR		196		106	115	31
829F	29	65	11	3958	6926	VEAT		181		96		34
830F	29	65	11	3958	6926	VEAT		181		75		14
832F	29	65	11	3958	6926	VEAT	HYDR	188		72	88	14
833F	29	65	11	3958	6926	VEAT	HYDR	188		73	90	14
835F	29	65	11	3958	6926	VEAT	HYDR	188		77	91	31
837F	29	66	11	4002	6932	VEAT	HYDR	186		87	98	31
838F	29	66	11	4002	6932	VEAT	HYDR	186		103	116	31
839F	29	65	11	3958	6926	VEAT	HYDR	188		74	87	14
840F	29	65	11	3958	6926	VEAT	HYDR	188		99	109	31
841F	29	65	11	3958	6926	VEAT	HYDR	188		113	125	31
844F	29	65	11	3958	6926	VEAT	HYDR	188		71	86	14
845F	29	66	11	4002	6932	VEAT	HYDR	186		94	107	31
846F	29	65	11	3958	6926	VEAT	HYDR	188		99	112	31
847F	29	65	11	3958	6926	VEAT	HYDR	188		95	108	31
850F	29	65	11	3958	6926	4025	6855	178	35	87	104	31
853F	29	65	10	3958	6926	OCEA		173		93	104	31
855F	29	65	11	3958	6926	HYDR		204		87	100	31
858F	29	65	11	3958	6926	OCEA		200		78	90	11
859F	29	65	12	3958	6926	HYDR		211		102	115	31
862F	29	65	12	3958	6926	OCEA		211		91	105	11
867F	29	65	12	3958	6926	4005	6925	213	7	92		34
871F	29	65	12	3958	6926	4005	6925	213	7	71		14
872F	29	65	12	3958	6926	4005	6925	213	7	113		34
874F	29	65	12	3958	6926			221		77	93	14
876F	29	65	12	3958	6926	VEAT	HYDR	210		100	115	34
878F	29	65	12	3958	6926	VEAT	HYDR	210		103	116	34
881F	29	66	11	4002	6932	4017	6833	190	47	67		14
882F	29	65	11	3958	6926	4017	6833	192	45	72		14
886F	29	65	1	3958	6926	HYDR	WELK	242		70	83	11
888F	29	65	1	3958	6926	HYDR	WELK	242		76	91	14
889F	29	65	1	3958	6926	HYDR	WELK	242		74	86	14
890F	29	65	1	3958	6926	3955	6935	250	8	114	130	34
902F	29	66	2	4002	6932	HYDR		267		98		14
907F	29	65	6	3958	6926	3955	6935	396	8	104	118	14
910F	29	65	7	3958	6926	VEAT		428		80	93	14
919F	29	65	6	3958	6926			407		77		14
922F	29	65	6	3958	6926	4005	6900	416	21	92		14
923F	29	66	6	4002	6932	4005	6900	414	25	94		34
924F	29	65	6	3958	6926	4005	6900	416	21	95		34
926F	29	65	6	3958	6926	4012	7040	414	58	81	97	14
929F	29	65	7	3958	6926	4005	7020	428	42	78	90	14
930F	29	65	7	3958	6926	4005	6945	438	16	75	89	14
931F	29	65	7	3958	6926	4005	6945	432	16	78	108	14
941F	29	65	10	3958	6926	HYDR		532		72	100	14

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
348F	29	65	7	4001	6930	HYDR		420		110		34
349F	29	65	7	4001	6930	HYDR		429		69		14
350F	29	66	7	4002	6932	HYDR		421		101		34
351F	29	65	6	4001	6930	HYDR		419		117		34
353F	29	65	9	4001	6930	4005	6908	492	18	63		14
680M	29	66	6	4002	6932	4002	6932	28		74		
681M	29	65	6	3958	6926	3958	6926	30		72		
683M	29	65	6	3958	6926	3958	6926	30		77		
688M	29	66	6	4002	6932	4002	6932	28		77		
692M	29	65	6	3958	6926	3958	6926	30		80		
694M	29	65	6	3958	6926	3958	6926	30		79		
696M	29	65	6	3958	6926	3958	6926	30		79		
700M	29	65	6	3958	6926	4000	6923	44	3	80		
704M	29	65	6	3958	6926	4000	6923	44	3	72		
706M	29	65	6	3958	6926	4000	6923	44	3	78		
707M	29	65	6	3958	6926	4000	6923	44	3	78		
708M	29	65	6	3958	6926	4000	6923	44	3	69		
709M	29	65	6	3958	6926	4000	6923	44	3	74		
711M	29	66	6	4002	6932	4000	6923	42	7	79		
754M	29	65	8	3958	6926	HYDR		108		74	90	
758M	29	65	8	3958	6926	4125	7056	108	111	76	91	
766M	29	65	7	3958	6926	HYDR		81		72		
806M	29	65	9	3958	6926	VEAT	HYDR	130		80	98	
812M	29	65	9	3958	6926	VEAT	HYDR	130		77	95	
819M	29	65	9	3958	6926	VEAT	HYDR	130		80	95	
823M	29	65	9	3958	6926	VEAT	HYDR	130		75	94	
824M	29	65	9	3958	6926	VEAT	HYDR	130		77	94	
828M	29	65	11	3958	6926	VEAT		181		78		
831M	29	65	11	3958	6926			188		70	85	
834M	29	65	11	3958	6926	VEAT	HYDR	188		78	95	
836M	29	65	11	3958	6926	VEAT	HYDR	188		81	98	
843M	29	65	11	3958	6926	VEAT	HYDR	188		80	96	
854M	29	66	11	4002	6932	HYDR		202		73	89	
860M	29	65	11	3958	6926	HYDR		186		74		
864M	29	65	12	3958	6926	4005	6925	213	7	66		
865M	29	65	12	3958	6926	4005	6925	213	7	81		
866M	29	65	12	3958	6926	4005	6925	213	7	68		
868M	29	65	12	3958	6926	4005	6925	213	7	70		
869M	29	65	12	3958	6926	4005	6925	213	7	74		
873M	29	65	12	3958	6926	4005	6925	213	7	72		
877M	29	66	12	4002	6932	VEAT	HYDR	208		70	86	
887M	29	65	1	3958	6926	HYDR	WELK	242		78	91	
895M	29	65	12	3958	6926	3955	7135	221	102	81		
896M	29	65		3958	6926	HYDR				72		
899M	29	65	4	3958	6926	3958	6950	354	18	83	101	
900M	29	65	3	3958	6926	4025	6955	308	35	77	94	