A Distributional Assessment of Cetaceans in Shelf/Shelf-Edge and Adjacent Slope Waters of the Northeastern United States Based on Aerial and Shipboard Surveys, 1978-1988

By
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A DISTRIBUTIONAL ASSESSMENT OF CETACEANS IN SHELF/SHELF-EDGE AND ADJACENT SLOPE WATERS OF THE NORTHEASTERN UNITED STATES BASED ON AERIAL AND SHIPBOARD SURVEYS, 1978-1988

BY

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INTRODUCTION

The shelf/shelf-edge and adjacent slope waters of the northeastern United States contain several important habitats for feeding aggregations of marine mammals (CeTAP 1982; Payne et al. 1984; Kenney and Winn 1986; Hain et al. 1985; MBO 1988). Recent National Marine Fisheries Service/Northeast Fisheries Center (NMFS/NEFC) research has emphasized an integrated, multispecies approach to management of fisheries resources (Sherman 1980; Sissenwine et al. 1982). The NMFS/NEFC also acts as legal custodian for all endangered and protected species of marine mammals in the shelf/shelf-edge waters of the northeastern United States. Given their ecological approach to fisheries management and legal responsibilities, NMFS/NEFC requires data on the distribution of cetaceans compatible with existing NMFS/NEFC databases in order to examine trophic interactions between these consumers and potential prey species.

Since 1978 there have been two large-scale surveys of cetaceans throughout shelf/shelf-edge and adjacent slope waters of the northeastern United States; the Department of the Interior, Bureau of Land Management sponsored Cetacean and Turtle Assessment Program (CeTAP), and the NMFS/NEFC sponsored Cetacean and Seabird Assessment Program (hereafter these latter surveys are referred to as NMFS/NEFC surveys). Cetacean sighting data collected during these two surveys provided the most comprehensive sighting effort throughout the study area.

The major objectives of CeTAP were to provide a spatial overview of cetacean distribution (Hain et al. 1981; CETAP 1982; Kenney and Winn 1986), and to estimate the absolute abundance of cetaceans in the study area (Scott et al. 1981; CETAP 1982; Kenney et al. 1985). These data were to be used by federal agencies making decisions about potential development of oil- and gas-lease sale tracts (Edel et al. 1981a); therefore special attention was

paid to these areas (Sorensen et al. 1984). The CeTAP aerial surveys also provided the first absolute estimates of cetacean abundance in the shelf waters of the northeastern United States from line-transect surveys.

The collection of the NMFS/NEFC shipboard sighting data also followed line-transect procedures (as described by Seber 1973; Burnham et al. 1980) but have been used, thus far, only to describe relative densities or abundance of cetaceans rather than absolute densities as were generated by CeTAP. These data have been used to monitor small-scale temporal changes in the distribution and relative abundance of these taxa (Powers 1983; Powers and Payne 1983; Powers and Brown 1986; Payne et al. 1984, 1989, 1990a, 1991a, 1990b); to determine physical oceanographic factors influencing cetacean distributions (Selzer and Payne 1988); and to describe trophic interactions between cetaceans and/or seabirds and potential prey (Payne et al. 1986; Powers and Backus 1986; Smith et al. 1988, 1990; Overholtz et al. 1991).

Despite differences in platform and objectives, both programs provided parallel information on the distribution of cetaceans in shelf waters of the northeastern United States (Payne et al. 1984; Hain et al. 1985; Kenney and Winn 1986, 1987; Selzer and Payne 1988; MBO 1988). In this paper we examine the spatial distribution of cetacean sightings in shelf/shelf-edge and adjacent slope waters of the northeastern United States for the period 1978-1988 which were collected during the CeTAP surveys (November 1978-January 1982) and the NMFS/NEFC surveys (May 1980-January 1988).

Study Area

The study area consisted of shelf/shelf-edge <200f (183m) in depth and adjacent slope waters 183-1830m (200-2000f) off the northeastern United States between Cape Hatteras, North Carolina and Nova Scotia, Canada (Fig. 1a). Four major oceanographic regions (Gulf of Maine, Georges Bank, southern New England and mid-Atlantic) occur within the shelf boundary of the study area. Slope water occurs over the entire length of the study area seaward of the shelf

edge.

The Gulf of Maine is bounded on the northwest by the USA coastline, and on the northeast by the Bay of Fundy and Nova Scotia (Fig. 1a). The oceanographic character of the Gulf of Maine is influenced by relatively cold, low-salinity surface water from the Scotian Shelf (Sutcliffe et al. 1976; Hopkins and Garfield 1979; Smith 1983; Flagg 1986) and deep basins. The maximum depth is 377m in Georges Basin located inside the Northeast Channel north of Georges Bank. The Gulf of Maine is insulated from the warmer waters of the offshore Atlantic on the east and south by two relatively shallow banks, Browns Bank (Scotian Shelf) and Georges Bank respectively, essentially making the Gulf a closed basin. The Northeast Channel (depths to 270m) divides Browns Bank and Georges Bank, and is the largest passage for warm, Atlantic waters entering into the Gulf of Maine from offshore.

Georges Bank is a broad, relatively shallow area noted for high primary productivity (Cohen and Grosslein 1986; O'Reilly et al. 1986). The northern half of the bank has numerous, shallow shoals (minimum depth about 4m). Water on the central part of the Bank (<60m in depth) is nearly homogeneous due to strong tidal mixing (Bumpus 1976; Hopkins and Garfield 1981; Sherman et al. 1988). The northern edge of the Bank has a very steep slope into the Gulf of Maine, and the southern edge deepens to the continental shelf-edge which is cut by several submarine canyons (Fig. 1a). Offshore of Georges Bank lie waters of the continental slope (Wright 1976. The Great South Channel separates the western boundary of Georges Bank from broad, gently sloping Southern New England and Mid-Atlantic shelf regions (Fig.1a).

The combined southern New England and mid-Atlantic regions form a broad shelf at the Great South Channel (northern end) but becomes quite narrow toward the southwest to Cape Hatteras (Fig. 1). The southern New England and mid-Atlantic regions are characterized by a broad, gently sloping shelf from

the coast to the shelf-edge. Two principal water masses are found in these regions: relatively cool, low-salinity shelf water, which extends 50-70km seaward of the continental shelf-edge; and slope water which is found seaward of shelf water throughout the region (Sherman et al. 1988). The Hudson Canyon, an important submarine feature, cuts across the southern New England shelf. The mid-Atlantic also includes the mouths of the Delaware and Chesapeake Bays (Fig. 1a).

Several submarine canyons cut the seaward edge of the entire study area at the continental shelf-edge (Fig. 1a). Shelf and slope waters meet in a narrow region of sharp temperature and salinity gradients at the shelf-edge/slope front (Wright 1976). The front generally intersects the bottom near the 50m contour (Sherman et al. 1988).

Partitioning of the Survey Area

The NMFS/NEFC study area (212,686 km^2) consisted of all shelf/shelf-edge and adjacent slope waters between Cape Hatteras and Nova Scotia <910m (<500f), although most of the NMFS/NEFC surveys were conducted in shelf waters <183m (<100f). The CeTAP surveys (from CeTAP 1982) also encompassed the entire U.S. outer continental shelf seaward to the 1820m (2000f) isobath (278,350 km^2). Therefore the NMFS/NEFC study area was comparable in scope (but functionally smaller in area due largely to a decrease in slope area being surveyed) to the CeTAP study area (described in Scott and Gilbert 1982).

The NMFS/NEFC stratified the study area into individual stratum (Grosslein 1969) based principally on depth and latitude. These strata have been combined into ecological subregions (Fig. 1b) in a manner consistent with Payne et al. (1984, 1986, 1989, 1990a). The combined subregions comprise each of the four major shelf regions used by NMFS/NEFC. We refer to these subregions, the four shelf regions defined by NMFS/NEFC, to coastal waters (water depth <15f) and to slope waters which extend seaward of the continental shelf

(water depth >100f).

METHODS

Collection of Whale Sighting Data

Aerial Surveys-CeTAP

The CeTAP aerial surveys were conducted from November 1978 to January 1982. Throughout the three-year CeTAP study, a number of sampling schemes and time intervals for data collection and analyses were employed, and each year a number of refinements and changes were incorporated into the database management (Edel et al. 1981a; Scott et al. 1981; Scott and Gilbert 1982; CETAP 1982). During 1979, dedicated, random-transect aerial surveys were conducted during each of 8 time periods throughout the year (Edel et al. 1981a). During 1980 and 1981, four dedicated surveys were flown each year, usually one per season (CeTAP 1982). The observer crew consisted of either two sets of two observers which alternated observation periods, or two observers who sat and observed out side windows, depending upon aircraft used (CeTAP 1982).

The CeTAP dedicated aerial surveys provided the first absolute estimates of cetacean abundance in the shelf waters of the northeastern United States. Only the data collected during the dedicated aerial surveys were used by CeTAP in estimating absolute abundance. CeTAP sighting data which could not be corrected for level of effort comparable to that obtained during the dedicated aerial surveys (therefore were not used by CeTAP to estimate abundance, but which were incorporated into the combined database and used in this study to describe distributions of cetaceans) were also collected during the following surveys.

Also during each year of the CeTAP study, special aerial surveys were conducted emphasizing endangered species not adequatly sampled by the dedicated surveys (Winn et al. 1981), or to characterize species occurrence and abundance in specified lease sale areas. During May 1979, a special right whale (Eubalaena glacialis) survey was conducted over the entire Gulf of Maine

and OCS regions immediately south of the Gulf of Maine (Winn et al. 1981). Also, during 1980 and 1981, several surveys were conducted during spring and late-summer of each year to Lease Sale 52 Nomination Area (east of Cape Cod south through the Great South Channel and eastward over Georges Bank, and to the northern Gulf of Maine and southwestern Scotian Shelf (CeTAP 1982). Sighting data from these surveys were used in this paper.

Special Shipboard Surveys-CeTAP

During May 1980 and 1981, behavioral data on dive duration and frequency by baleen whales were collected during two cruises to waters adjacent to Cape Cod (CeTAP 1982). Sighting data from these surveys were also used in this paper.

Surveys of Opportunity-CeTAP

During 1979 and 1980, CeTAP placed observers on aircraft and vessels-of-opportunity operating within the study area (CeTAP 1982). The U.S. Coast Guard and NMFS/NEFC provided the majority of vessel platforms. These platforms were supplemented by several institutional research vessels. The aerial portion of this effort was generally provided by the U.S. Coast Guard, Cape Cod, Massachusetts, and continued through 1981. The shipboard component of this effort was discontinued in 1980.

NMFS/NEFC Shipboard Surveys

A long-term series of bottom trawl surveys were begun by NMFS/NEFC in 1963 (see Grosslein 1969; Azarovitz 1981). Between 1976 and 1987 plankton surveys were conducted and NMFS/NEFC initiated the Marine Monitoring Assessment and Prediction Program (MARMAP) to provide annual and seasonal monitoring of the distribution, biomass, and population structure of principal biota, and the physical environment on a broad geographical scale (Sherman 1980). In May 1980 NMFS/NEFC extended the MARMAP strategy by placing a dedicated observer on each NMFS/NEFC survey to monitor the distribution and abundance of cetaceans and seabirds, and to a lesser extent, turtles. These standardized shipboard surveys were conducted by the Manomet Bird Observatory from May 1980 through

December 1988.

The NMFS/NEFC shipboard surveys were designed to provide a near-continuous assessment of cetacean/seabird populations in shelf/shelf-edge waters (generally <200m) of the northeastern United States. Data collection procedures have been described previously (Powers et al. 1980; Payne et al. 1984; 1986; Selzer and Payne 1988; Smith et al. 1990). Generally, observers were placed on NMFS/NEFC research vessels, principally the R/V ALBATROSS IV and R/V DELAWARE II, on a non-interference basis and did not alter the track-line of the vessel during the survey. Cetacean observations were recorded continuously by the observer along the predetermined trackline between ramdonly placed NMFS/NEFC sampling stations as long as the vessel moved on a straight course and at a uniform speed. The NMFS/NEFC sampling stations were randomly placed within each stratum (roughly in proportion to the size of each stratum, Grosslein, 1969); therefore the extent of cetacean sighting effort (the spatial and temporal coverage) and the stratified random component of the NMFS/NEFC cetacean surveys were dependent entirely on the design of the NMFS/NEFC fisheries/oceanographic surveys.

Observer effort was quantified in 15-minute periods (where each period was considered a transect). Initially, the amount of time spent obtaining cetacean and seabird sighting data within NMFS/NEFC strata was considered proportional to the size of each stratum. However, Payne et al. (1990a) found that the observer effort per NMFS/NEFC strata was inversely related to the size of the stratum, the larger strata being undersampled in these surveys. Although data collection of NMFS/NEFC shipboard sighting data followed line-transect procedures (as described by Seber 1973; Burnham et al. 1980) they are biased by uneven effort allocation relative to strata size; therefore do not, at present, provide a basis for the estimation of absolute cetacean abundance.

Non-NMFS/NEFC Shipboard Surveys

During each year cetacean/seabird sightings were also conducted from research vessels for government agencies other than NMFS/NEFC. The Environmental Protection Agency (EPA) provided the vessel for most of these additional surveys. The EPA surveys focused on the distribution and assessment of endangered or threatened species in waters which included, or adjacent to, designated deepwater dumpsites or proposed incineration-at-sea locations. Although these surveys did not follow the stratified-random survey design prescribed by NMFS/NEFC, the sighting data were collected in a manner comparable to that collected on standardized NMFS/NEFC surveys. Therefore these sightings data were also incorporated into the combined database and used in this paper.

Treatment of the Sighting Data

All cetacean sightings collected during the CeTAP aerial surveys (Nov 1978-Jan 1982) and by MBO onboard shipboard surveys (May 1980-Dec 1988) were combined and treated as one dataset. The distribution of each cetacean species was examined, generally, by initially grouping the sighting data into six, 2-month time-periods (i.e. January-February, March-April, May-June, July-August, September-October, and November-December). Each sighting in the database was then weighted by group-size per sighting (i.e. 1-10, 11-30, 31-300 or 301->1000 individuals per sighting) and overlayed onto a basemap of the study area (following Payne et al. 1989, 1990a, 1990b).

Relative densities (sighting data corrected to some measure of standardized effort) could not be used to describe species distributions with the combined database because of differences in survey types and platforms, within and between programs, and because of uneven effort allocation within the study area between, and within, surveys. Therefore, these sighting data do not provide a basis for quantitative, cetacean abundance estimates for the study area. Despite this bias, the number of individuals per sighting approach (unweighted by effort) provided the most detailed, qualitative account of the

spatial and temporal distribution of cetaceans throughout shelf/shelf-edge and adjacent slope waters of the northeastern United States.

All base maps were digitized and sighting data overlayed onto the base maps using the PC based mapping-program CAMRIS (Computer Aided Mapping and Resource Inventory System) (Ford 1989).

Exceptions to the above 2-month data groupings include the presentation of sighting data for species which predictably occur throughout the study area in low numbers (therefore we have very few sightings over the 10-year study period). For these few species sighting data were either combined into one figure (i.e. not partitioned into 2-month intervals) or sighting locations were given and a discussion followed without presentation of a distribution map. Also, for several species movement patterns (generally within a season, not for the entire year) could be explained in more detail by presenting the sighting data by month (rather than in 2-month periods). Any further changes in the temporal presentation of the data are explained throughout the text.

SPECIES ACCOUNTS-RESULTS AND DISCUSSION

Bottlenose Dolphin (Tursiops truncatus)

The sighting distribution of coastal and offshore bottlenose dolphins combine to form a distinctive J-shaped distribution (described by Hain et al. 1981; CeTAP 1982) in shelf/shelf-edge and slope waters of the northeastern United States. Coastal and offshore Tursiops can be hematologically differentiated by the type and concentration of hemoglobin present, the packed cell volume and red blood cell count (Duffield et al. 1983; Hersh and Duffield 1990) and indirectly distinguished by parasite load (Mead and Potter 1990). The coastal form (ecotype, from Hersh and Duffield 1990) has a seasonal distribution north of Cape Hatteras to Delaware Bay and southern New Jersey (Fig. 2). The sighting distribution of offshore Tursiops occurred in shelf-edge and adjacent slope waters generally seaward of the 50f contour between Cape Hat-

teras and the Northeast Channel, Georges Bank (Fig. 2). All bottlenose dolphin sightings which occurred in slope waters (n = 543/1,073 or approximately 50% of all Tursiops sightings, Table 1) were considered the offshore ecotype.

Generally, the number of sightings were low during winter. Only four percent (n = 48/1073) of all bottlenose dolphin sightings occurred during January-February (Table 1). Seventy-seven percent (n = 822/1073, Table 1) of bottlenose dolphin sightings throughout the year occurred May-August. Also, the number of Tursiops sightings in May-June and July-August were very comparable (Table 1) indicating similar levels of abundance (Scott et al. 1981; CeTAP 1982). Approximately 73% of all shelf sightings occurred in mid-Atlantic waters (n = 389/530, Table 1).

Small groups of Tursiops occasionally follow warmwater intrusions through the Great South Channel or the Northeast Channel into coastal and nearshore Gulf of Maine waters. However this species is considered uncommon in Gulf of Maine waters (n = 6 sightings, Table 1). Strandings also occur periodically within the Gulf of Maine north to eastern Canada (Miller and Kellogg 1955; Sergeant and Fisher 1957; Mairs and Scattergood 1958, 1959).

Seasonal Distribution and Movements

Shelf Sightings of Bottlenose Dolphin

During January-February all but one shelf sighting occurred in mid-Atlantic waters (n = 31/32, Table 1, Fig. 2a). The number of sightings increased north of Cape Hatteras during March-April (Fig. 2b) primarily along the mid-Atlantic shelf-edge/slope interface (n = 62/120, Table 1). During the 4-month period, January-April all known sightings of the inshore bottlenose dolphin ecotype occurred below Cape Hatteras, their sighting distribution remaining spatially disjunct (from the offshore ecotype) even over the narrow shelf southeast of Cape Hatteras (Figs. 2a-2b).

Inshore sightings of Tursiops increased significantly north of Cape Hatteras during May-June, primarily in mid-Atlantic shelf waters (n = 116/160,

Table 1). The sighting distribution extended in a patchy continuum from Cape Hatteras north to the mouth of Delaware Bay (Fig. 2c). The number of shelf sightings in the mid-Atlantic during May-June and in July-August were comparable (Table 1), indicating similar levels of abundance (CeTAP 1982) and little change in distribution. During summer, bottlenose dolphins also entered lower Chesapeake and Delaware Bays (Fig. 2d) where, historically, a bottlenose dolphin fishery existed (Mead 1975a).

The number of sightings in mid-Atlantic shelf waters decreased during September-October (Table 1) and the coastal distribution of Tursiops sightings again occurred south of the Chesapeake Bay (Fig. 2e). An even greater decrease in the number of bottlenose dolphin sightings occurred throughout the study area during November-December (Table 1). Approximately seventy-seven percent (n = 64/83, Table 1) of all Tursiops sightings in November-December again occurred in mid-Atlantic waters. Inshore sightings were clustered only at Cape Hatteras (Fig. 2f) indicating a southward shift in the distribution of bottlenose dolphin during late-autumn. Numerous sightings of coastal Tursiops also occur below Hatteras during winter (Caldwell and Golly 1965; Caldwell et al. 1971a; CeTAP 1982; Burn et al. 1987).

Most nearshore or coastal populations of Tursiops have seasonal range expansions similar to those which occur along the eastern United States north of Cape Hatteras (Shane 1980, 1990; Irvine et al. 1981, 1982; Leatherwood 1982; Wells et al. 1980, 1981; Shane et al. 1986). The seasonal movements of coastal Tursiops may result from changes in water temperatures (Gaskin 1968; Mead and Potter 1990), changes in prey density or composition affecting prey availability (Leatherwood et al. 1978; Barros and Odell 1990; Shane 1990; Scott et al. 1990) or may be related to their minimum seasonal reproductive requirements (as suggested by Scott et al. 1990; Wells et al. 1980; Irvine et al. 1981) which may occur only below Cape Hatteras.

Offshore sightings of Bottlenose Dolphin

The offshore Tursiops occurred in shelf-edge and adjacent slope waters from Cape Hatteras to Georges Bank throughout the year with seasonal shifts in abundance. Sightings in slope waters during mid-winter were reduced in number (Table 1) but occurred from Cape Hatteras north to, and including, Georges Bank (Fig. 2a). The largest shelf-edge/slope concentration of bottlenose dolphin sightings during January-February occurred east of Cape Hatteras (Fig. 2a).

The number of slope sightings from Cape Hatteras north to the Northeast Channel increased during March-April (Fig. 2b). Fifty-three percent of all March-April sightings (n = 64/120) occurred in slope waters (Table 1). During May-June and July-August the number of slope sightings were very comparable (approximately 45%-47% of the bottlenose dolphin sightings occurred in slope waters during these months, Table 1), also indicating similar levels of abundance (CeTAP 1982). The number of bottlenose dolphin sightings from the Great South Channel north to the Northeast Channel (Georges Bank shelf/shelf-edge and slope waters) peaked during May-August (Table 1). By September-October the number of Georges Bank shelf-edge/slope water sightings decreased (Table 1) and the sighting distribution extended north on Georges Bank only to Lydonia Canyon (Fig. 2e).

Fifty-four percent (45/83) of all sightings during November-December occurred in slope waters of the mid-Atlantic (Table 1) and the largest concentrations of shelf-edge/slope bottlenose dolphin sightings generally occurred south of Hudson Canyon seaward of the 50f contour (Fig. 2f).

Ecological and Management Considerations

From June 1987 through June 1988, over 700 Tursiops stranded from New Jersey south to Florida (Scott et al. 1988), apparently due to a disease epidemic. Scott et al. (1988) suggested that the mortality affected mid-Atlantic coastal Tursiops (rather than the offshore ecotype) and that the

coastal population was reduced by as much as 53%. Further, assuming a constant rate of mortality equal to pre-epidemic estimates, Scott et al. (1988) estimated recovery time to range from 18 to >100 years (median value = 50.5 years).

The offshore bottlenose dolphin also occurs in slope waters seaward of the 500f contour. Kenney (1990) reported sightings in slope waters considerably away from the shelf-edge and bottlenose dolphins were a dominant member of the cetacean fauna observed along the northern edge of the Gulf Stream on a recent (August 1990) NMFS/NEFC survey into slope waters (NMFS/NEFC, unpublished sighting data).

Between 1977-1988 nine offshore Tursiops were reported taken incidental to foreign fishing efforts for squid (long-finned Loligo pealei or short-finned squid Illex illecebrosus) and Atlantic mackerel (Scomber scombrus) (Waring et al. 1990). The offshore Tursiops are also taken during the drift-gillnet fishery for swordfish Xiphius xiphius (Earle 1990). This fishery occurs in slope waters between Cape Hatteras and Corsair Canyon, Georges Bank primarily from May-November. The extent of the incidental take relative to the offshore Tursiops population is not yet known.

Rough-Toothed Dolphin Steno bredanensis

Rough-toothed dolphins are associated with water temperatures >25°C (Leatherwood et al. 1976, 1983), likely prefering tropical-Gulf Stream influenced waters south of (and possibly seaward of) the study area. They have been reported from Virginia south to Florida, the Gulf of Mexico and the Caribbean (Layne 1965; Caldwell and Caldwell 1974; Leatherwood et al. 1976; Schmidly 1981; Perkins and Miller 1983).

Strandings of this species in cold temperate waters are considered vagrant. Therefore, sightings of the rough-toothed dolphin north of Cape Hatteras are considered rare. One sighting (coded as "sure" by CeTAP 1982) was

recorded on 21 September 1979 in slope water (depth >1500f) seaward of the study area (CeTAP 1982).

Atlantic Spotted Dolphin Stenella frontalis

Two species of spotted dolphin are recognized in the North Atlantic, the pantropical Stenella frontalis and the endemic S. attenuata (Caldwell et al. 1971b; Perrin 1975; Perrin et al. 1987). In the western North Atlantic the distribution of S. frontalis extends farther north than S. attenuata (Gunter 1954; Caldwell 1955; Caldwell and Caldwell 1966, 1974; Fritts and Reynolds 1981; Perrin et al. 1987). The range of each species overlaps in the western North Atlantic south of Cape Hatteras (Katona et al. 1978; Schmidly 1981; Perrin et al. 1987), then S. frontalis is replaced by S. attenuata in the Caribbean (Caldwell et al. 1971b; Caldwell and Caldwell 1973). Although S. attenuata occasionally strand in the study area, S. frontalis is considered to be the spotted dolphin species which commonly occurs in shelf-edge/slope waters north of Cape Hatteras. The now-established vernacular name for S. frontalis is the Atlantic spotted dolphin (Perrin et al. 1987).

The preference by this species for mid-Atlantic shelf/shelf-edge and slope waters was apparent throughout the year. Eighty-three percent (n = 148/179 of all spotted dolphin sightings) occurred in the mid-Atlantic region (Table 2) and, although the spotted dolphin has stranded north of 40°00'N lat, there were no spotted dolphin sightings recorded in the Gulf of Maine during these surveys (Table 2, Fig. 3).

Seasonal Distribution and Movements

There were no sightings of spotted dolphin north of 35°00'N during January-February (Table 2) although one spotted dolphin sighting was reported off Cape Fear, North Carolina (below 35°00'N lat). This species is generally considered absent in the study area from December-February. Furthermore, during March-April only nine sightings were reported from the study area

(Table 2). Most of these sightings occurred during April and all but one were reported from mid-Atlantic shelf-edge or slope waters (Table 2, Figs. 3a-3b). The number of spotted dolphin sightings increased between 35°00'N-39°30'N lats (mid-Atlantic waters) during May-June (Fig. 3c). Ninety-one percent (n = 32/35) of the sightings during this two-month period occurred in the mid-Atlantic region. The number of spotted dolphin sightings peaked during July-August (n = 72, Table 2) although the distribution did not vary markedly from the previous 2-month period, still being centered in the mid-Atlantic (Fig. 3d).

The sighting distribution of spotted dolphin was the most widespread during September-October (Table 2, Fig. 3c), extending north of the mid-Atlantic in slope waters to Georges Bank. Only thirty-one sightings (approximately 17% of the total) occurred north of the mid-Atlantic throughout the year. Thirty percent of these sightings (n = 13/43) occurred in southern New England/Georges Bank shelf-edge (n = 3) and slope (n = 10) waters during September-October (Table 2).

All but one November-December sighting occurred in southern New England or mid-Atlantic slope waters (south of 39°00'N lat) (Table 2, Fig. 3f) indicating a distributional shift southward to warmer, Gulf-stream influenced waters during winter.

Ecological and Management Considerations

The spotted dolphin was taken in slope waters of the southern New England and mid-Atlantic regions during the drift-gillnet fishery for swordfish Xiphius xiphius during 1989-1990 (IWC 1990). The full extent of the incidental take is not yet known.

Striped Dolphin Stenella coerueoalba

In the western North Atlantic striped dolphin are known mainly from warm-temperate and tropical waters (Leatherwood et al. 1976, 1983).

North of Cape Hatteras (35°00'N lat) striped dolphin were distributed in

slope (rather than shelf/shelf-edge) waters from Cape Hatteras to Georges Bank (Fig. 4). Eighty-three percent (n = 90/115) of all striped dolphin sightings occurred in slope waters (Table 3). In southern New England-Georges Bank slope waters (between the Great South Channel and Hydrographers Canyon) striped dolphin sightings occurred during all seasons and during each 2-month period (Figs. 4a-4f) except January-February (Table 3). Between 37°00'N-39°00'N lats. striped dolphin were observed during all seasons (generally seaward of the 500f depth contour, Figs. 4a-4f). CeTAP (1982) suggested that striped dolphin occupied this area throughout the year, with shifts in their sighting distribution to the southwest in winter and spring, and eastward in summer and autumn.

The preference of these dolphins for offshore, slope and Gulf Stream-influenced waters throughout the year was reflected in the average depth-at-sighting (>1000f, Edel et al. 1981b; CeTAP 1982), the deepest of any regularly occurring delphinid species in the study area.

Seasonal Distribution and Movements

Only 11 striped dolphin sightings occurred during January-February, all in mid-Atlantic shelf-edge/slope waters (Table 3) north to approximately 38°30'N lat (Fig. 4a). The number of striped dolphin sightings increased during March-April (Table 3). Eighty-eight percent of all March-April sightings (n = 31/35) also occurred in mid-Atlantic waters. The remainder occurred in slope waters north to Lydonia Canyon, Georges Bank (Fig. 4b).

From May through August (Figs. 4c-4f) sixty-four percent of all sightings (n = 28/44) were in mid-Atlantic slope waters (Table 3). All but three of the remaining sightings occurred in a slope water-patchy continuum from the Great South Channel northeast through Hydrographers Canyon to 41°00'N lat (approximately Corsair Canyon). During late-summer and autumn Mansfield (1967) and Sergeant et al. (1970) also reported striped dolphin from Nova Scotia suggest-

ing a continued movement north and northeast of Georges Bank at this time.

From September-December the number of striped dolphin sightings decreased steadily throughout the study area to January-February levels (Table 3). Eighty-four percent of all September-December sightings (n = 21/25) occurred south of the Hudson Canyon in southern New England/mid-Atlantic slope waters (Table 3).

Striped dolphin are considered stragglers within the Gulf of Maine during any season (n = 2 sightings, Table 3). They are most often recorded in this region from late-autumn through winter as a stranding event. Mid-winter strandings have also been reported from Sable Island, Nova Scotia (Sergeant et al. 1970).

Ecological and Management Considerations

Striped dolphin have been taken in slope waters from the mid-Atlantic north to Corsair Canyon during the pelagic drift-gillnet fishery for swordfish Xiphius xiphius (Earle 1990). The full extent of the incidental take is not yet known.

Spinner Dolphin Stenella Longirostris

Spinner dolphins have been reported from tropical Atlantic waters south of Cape Hatteras (Taruski and Winn 1976; Caldwell et al. 1971b) into the Gulf of Mexico (Fritts and Reynold 1981; Schmidly 1981; Loehefner et al. 1989; Fritts et al. 1983). They were recorded rarely during these surveys (Fig. 9).

Seasonal Distribution and Movements

Hain et al. (1981) reported 2 sightings of spinner dolphin (19 April 1979 and 30 August 1979) in slope water (>1000f) considerably beyond the seaward limits of the study area. Two other sightings (suggested by CeTAP as possibly the same group of dolphins) were reported in slope waters below Nantucket ($39^{o}70'N-69^{o}95'W$ and $39^{o}67'N-69^{o}83'W$ respectively) during August 1979 (Fig. 5). Another sighting was reported south of Cape Hatteras.

Several sightings of spinner dolphins were also observed seaward of the

shelf-edge along the northern edge of the Gulf Stream in August, 1990 during the NMFS/NEFC Gulf Stream/slope water survey (NMFS/NEFC, unpubl. data, not plotted here). Two of these dolphins (one sighting) were seen with a small group of sperm whales Physeter macrocephalus in waters >2000f in depth and surface water temperatures exceeding 28°C.

Spinner dolphins are generally considered absent in shelf waters of the study area.

Common or Saddleback Dolphin Delphinus delphis

Common dolphin were widespread in mid-shelf/shelf-edge and adjacent slope waters (Fig. 6) from 36°00'N lat northeastward to the Northeast Channel (42°00'N lat) during all seasons. They are strictly an outer-shelf/slope species west of 72°00'W long (Fig. 6). Their distribution east of 70°00'W long followed the perimeter of Georges Bank, although they were not as abundant on the northern edge (Fig. 6). They were the most frequently sighted dolphin in southern New England/Georges Bank shelf waters throughout the year. The only near-shelf incursions occurred in the southern New England region (Fig. 6).

Common dolphin regularly occur, but are not considered abundant, in Gulf of Maine waters.

Seasonal Distribution and Movements

During January-February common dolphin occurred from Cape Hatteras to the eastern edge of Georges Bank, with a conspicuous gap in the southern New England region between 71°00'W and 72°00'W long (Fig. 6a). Scattered sightings occurred along the shelf-edge; however the largest concentrations occurred between Norfolk and Baltimore Canyons, and below the Great South Channel (Fig. 6a). CeTAP (1982) found the abundance of this species greatest during winter.

Sightings were concentrated along the shelf-edge and adjacent slope waters south of 39°00'N lat during March-April (Fig. 6b). Eighty-three per-

cent of all sightings during this two month period (n = 122/147) occurred in southern New England/mid-Atlantic waters (Table 4). The large cluster of sightings which occurred below the Great South Channel in January-February (Fig. 6a) no longer occurred during March-April. Rather, another sighting concentration formed below Georges Bank from Oceanographer to Lydonia Canyons (Fig. 6b). This sighting distribution indicates that common dolphin move northeast along the outer edge of Georges Bank during March-April with little movement onto mid- or near-shelf waters at this time.

The sighting distribution continued to shift northeastward along the shelf-edge during May-June (Fig. 6c). The large concentrations along the 50-100f contours in the mid-Atlantic decreased significantly, shifting northeast along the shelf-edge and into slope waters (Fig. 6c). The number of sightings also increased in near- to mid-shelf waters of the southern New England region (common dolphin moved up the Hudson Canyon to form a distinct "spike", Fig.) and on Georges Bank from the Great South Channel to the Northeast Peak (Table 4, Fig. 6c).

The southern limit of sightings in July-August was approximately 38°00'N lat indicating a continued movement northeast throughout the study area during summer. Hain et al. (1981) also suggested that summer and autumn sightings are greatest north of 37°30'N lat. Approximately fifty percent (n = 54/109) of all sightings during July-August occurred on Georges Bank (Table 4). The northeast progression of sightings is more apparent when July sightings north of 39°00'N lat (Fig. 6d) are examined separately from those which occurred in August (Fig. 6e). The sighting distribution shifted from southern New England waters in July (Hudson Canyon to the Great South Channel) onto northeastern Georges Bank in August. In contrast, <10% of all common dolphin sightings, July-October, occurred in mid-Atlantic waters, a regional minimum.

Sixty-seven percent (n = 89/132) of all common dolphin sightings during

September-October occurred on Georges Bank, a regional maximum (Table 4). However most of these sightings occurred during October, rather than September. During September (Fig. 6f) common dolphin sightings (and abundance, from CeTAP 1982) decreased throughout the study area as this species moves over the Northeast Channel and become abundant on the Scotian Shelf (east of Nova Scotia) (Sergeant and Fisher 1957; Sergeant et al. 1970; Leatherwood et al. 1976). Also, Whitehead and Glass (1985) reported sightings of common dolphin on the southeast shoals of the Grand Banks (approximately 44°00'N lat) during late summer-autumn. The combined sightings suggest a widespread movement, inshore and northward throughout the North Atlantic by common dolphin at this time.

During October (Fig. 6g) common dolphin again move southward across the Northeast Channel onto central Georges Bank, and along the shelf-edge of Georges Bank to the Great South Channel. The number of sightings on Georges Bank increased significantly over the previous month. Payne et al. (1984) found that the greatest densities of this species on Georges Bank occurred in autumn. Selzer and Payne (1988) suggested that the widespread movement of this species onto Georges Bank at this time was due, possibly, to increased water temperatures and increased densities of squid, a known prey species-group of common dolphin in this region (Major 1986; Waring et al. 1990). Sightings of common dolphin west of 70°00'W long during September-October (Figs. 6f-6g) are nearly absent.

Eighty percent of all sightings during November-December (n = 139/174) occurred in Georges Bank/southern New England waters which suggests a continued movement southwest from the Scotian Shelf into southern New England shelf waters. The center of the sighting distribution at this time extended from the Northeast Peak of Georges Bank to the Hudson Canyon (Fig. 6h).

Hain et al. (1981) indicated that common dolphin are most abundant on

Georges Bank May-June, then again from October-December. Also, the lack of sightings in Georges Bank/southern New England slope waters at this time (n = 13) further indicate a common dolphin movement onto Georges Bank/southern New England shelf waters from the Canadian shelf (rather than an onshelf movement from slope waters below Georges Bank). Common dolphin remain abundant on Georges Bank throughout the winter. In contrast only three percent (n = 6 sightings) occurred in mid-Atlantic waters during November-December (Table 4). These sightings were scattered south to 37°00'N lat (Fig. 6h). However, by January the distribution of common dolphin again becomes widespread in a mid-shelf-to-shelf-edge band from Georges Bank south to Cape Hatteras.

The Gulf of Maine is not considered preferred habitat for this species. Occasional sightings did occur from the Scotian shelf (over the Northeast Channel) southwest along the northern edge of Georges Bank from October-December (Figs. 6g-6h). At this time local water temperatures exceeded 10°C due to warm-water intrusions through the Northeast Channel into the Gulf.

Ecological and Management Considerations

Between March 1977 and December 1988, 203 common dolphin were reported taken incidental to foreign fishing activities off the northeastern United States (Waring et al. 1990). Most of these (68%) were taken along the southern New England/mid-Atlantic shelf-edge primarily during December-February (Waring et al. 1990). From 1977-1986 most were captured in the Loligo squid fishery. This fishery was discontinued following the 1986 season (Waring et al. 1990). During 1987 and 1988, fifty common dolphin were taken in the expanded fishery for Atlantic mackerel (Waring et al. 1990).

During 1989-1990 common dolphin were also taken in slope waters during the pelagic drift-gillnet fishery for swordfish (Earle 1990). The full extent of the incidental take is not yet known.

Atlantic White-Sided Dolphin (Lagenorhynchus acutus)

The white-sided dolphin is the most abundant dolphin in the Gulf of Maine. Seventy-seven percent of all sightings throughout the study area (n = 826/1067) occurred in Gulf of Maine waters (Table 5). This species was present throughout the year north of 40°30'N lat from the Great South Channel/western Georges Bank region, northwest along the 50f contour outside of Cape Cod throughout the western half of the Gulf of Maine (Fig. 7). Several areas north of 40°00'N lat where white-sided dolphin sightings were noticeably absent at all times included the mid-shelf region from the Hudson Canyon north to Long Island, and the shallow-water shoals below Nantucket and on Georges Bank.

South of 40°00'N lat, their sighting distribution was restricted, generally, to southern New England waters with Hudson Canyon being their only known area of concentration (Fig. 7). Only 4 white-sided dolphin sightings (<1.0% of the total number) occurred in mid-Atlantic shelf waters (Table 5).

Seasonal Distribution and Movements

The white-sided dolphin has been characterized as a shelf-species with no tendencies for shelf-edge concentrations (Hain et al. 1981). However, the number of sightings during January-February does not support the hypothesis that white-sided dolphin necessarily remain on the shelf throughout the year. Only 20 white-sided dolphin sightings were reported throughout the study area during January-February (Table 5), significantly fewer than at other periods of the year. These sightings were reported from the southwest Gulf of Maine and waters adjacent to the Hudson Canyon (Fig. 7a).

During March-April the number of white-sided dolphin sightings increased significantly in the Gulf of Maine (Table 5). The distribution of these sightings was concentrated in the southwest Gulf of Maine along the 50f contour from the Great South Channel to the northern edge of Stellwagen Bank (Fig. 7b). The observed increase in the number of March-April white-sided dolphin sightings (from the scattered number of sightings observed in

January-February) is not understood, but it is not considered an artifact of sampling. The differences between the number and concentration of sightings during these two time periods suggest rapid movement into the study area during late-February/early-March.

The number of sightings continued to increase during May-June (Table 5) but the distribution still remained centered from the Great South Channel northwest along the 50f contour (Fig. 7c). A few shifts in the sighting distribution suggest a movement pattern toward the Great South Channel/southern Gulf of Maine from southern New England waters. The dolphin sightings which occurred in southern New England shelf-edge waters during March-April are reduced in number by May. Another sighting concentration was observed from Montauk Point east to below Martha's Vineyard, Massachusetts (Fig. 7c). Also, white-sided dolphin sightings extended north from Stellwagen Bank to Jeffreys Ledge in May-June further indicating a northward shift in their distribution into the Gulf of Maine (Fig. 7c).

A significant concentration of white-sided dolphin sightings occurred on the Northeast Peak of Georges Bank during May-June (Fig. 7c). White-sided dolphins occurred on Georges Bank throughout the year in low numbers (n = 145 sightings, from Table 5), however most of these sightings occurred on southwest Georges Bank (near the Great South Channel where sightings occurred throughout much of the year). The white-sided dolphin sightings on the Northeast Peak of Georges Bank during mid-summer (Figs. 7c-7d) occurred primarily during 1986-1987 in response, we suggest, to a shift in the distribution and density of prey during those years.

A noticeable shift in the sighting distribution occurred during July-August (Fig. 7d). White-sided dolphins occurred in a patchy continuum from the southwestern Gulf of Maine-Great South Channel region north into the western and north-central areas of the Gulf of Maine (Fig. 7d). Sightings

were concentrated from northern Stellwagen Bank/Jeffreys Ledge northeast, and from Cashes Ledge/Basin north to the central Gulf of Maine below Mt. Desert Island (Fig. 7d). White-sided dolphin sightings also occurred in Northeast Channel/Browns Bank (Scotian Shelf) waters during July-August (Fig.) indicating movement from Georges Bank northeast out of the study area. Although sightings of white-sided dolphin were widespread during mid-summer, their greatest densities extended from the Great South Channel north along the 50f contour around the western rim of the Gulf (as opposed to the central basins).

White-sided dolphins have been reported in group sizes >2000 individuals on Jeffreys Ledge during mid-summer (Mercer 1985). Group sizes >1000 individuals are not uncommon throughout the southwest Gulf of Maine. White-sided dolphin sightings have also been reported from the Bay of Fundy (north of the present survey effort) from mid-summer through autumn (Kraus and Prescott 1981, 1982).

Summer sightings below 39°00'N lat are considered south of the present seasonal range for this species. Rowlett (1980) did not observe any white-sided dolphin between 37°00'N-39°00'N lats from 1971 to 1977 during his summer surveys.

Between September-December the white-sided dolphin sighting distribution changed little (Figs. 7e-7f). Sightings were concentrated, generally, in the southwestern Gulf of Maine from Jeffreys Ledge to east of Nantucket. There were more sightings at the base of the Great South Channel during November-December (Fig. 7f), however there was little indication that white-sided dolphin continued to move below the Great South Channel during this period. Despite the large number of November-December sightings (n = 98, Table 5) and no indication of a significant or rapid change in their distribution, white-sided dolphin sightings were absent (or significantly reduced in number) from the study area by January. A possible interpretation of these sighting data

is that white-sided dolphin move off-shelf mid-December to early-January.

Ecological and Management Considerations

The abundance and distribution of white-sided dolphin in shelf waters of the northeastern United States have changed considerably during the past several decades. A lack of sightings during the 1950's and 1960's suggest that it was not a particularly abundant species at that time (Schevill 1956; Sergeant and Fisher 1957). The first confirmed report of white-sided dolphin from Cape Cod occurred in 1954 (Schevill 1956). However, sighting-effort has increased significantly in the study area since the mid-1970's; therefore a lack of white-sided dolphin sightings prior to then does not suggest that they were completely absent. Available data does indicate, however, that they were not as abundant in coastal and near-shelf waters during that period as they are at present. Also, the increased number of sightings, combined with a rapid and concurrent increase in the number of strandings from the Gulf of St. Lawrence to the Gulf of Maine (Katona et al. 1976; Sergeant et al. 1980; Mitchell 1981; Sergeant 1982) strongly suggest that the absolute abundance of white-sided dolphin has increased in shelf waters north of Cape Cod in recent decades.

During the mid- 1970's several white-sided dolphin sightings were reported from Georges Bank slope waters (Katona 1976; Ramsdell 1978; Testaverde and Mead 1980). The white-sided dolphin has also been reported from Newfoundland over deep waters (Mercer 1973), from slope waters (>500f) south of Iceland (Sigurjonsson et al. 1989) and from the shelf-edge of southwest Norway and northwest Europe (Jonsgaard and Nordli 1952). Since they were considered uncommon during the 1960's and so little is known regarding the distribution of white-sided dolphin prior to the mid- 1970's, it is not unreasonable to consider that their distribution was different, possibly mid-shelf to shelf-edge/slope, rather than strictly a shelf-based distribution as recent sighting

data indicate. Generally, it is difficult to explain deep-water sightings and a concurrent increase in shelf sightings and strandings from the Chesapeake Bay to Newfoundland without considering that white-sided dolphin have recently entered near-shelf waters in the study area from offshore. The near complete lack of sightings during January-February, 1978-1988 also suggest that at least a part of the white-sided dolphin population of the northeastern United States may move beyond the seaward boundary of the study area at that time.

One possible explanation for a shift in the distribution of white-sided dolphin sightings during recent decades might be a response to a change in the distribution and abundance of prey. Since the mid-1970's sandlance Ammodytes spp. abundance increased significantly in the study area (Meyer et al. 1979; Sherman et al. 1981; Morse 1982). In Gulf of Maine-Georges Bank waters white-sided dolphin have been frequently observed in close association with humpback Megaptera novaeangliae and fin Balaenoptera physalus whales (Hain et al. 1981; Mayo 1982) which were observed feeding on sandlance. White-sided dolphin might also have been feeding on sandlance in these mixed-species associations.

The shelf-wide increased sandlance abundance followed the depletion of offshore stocks of Atlantic herring (Sherman et al. 1981). The decreased biomass of offshore herring coupled with increased sandlance abundance near-shelf could have precipitated the suggested offshore-to-nearshore shift in the distribution of white-sided dolphin during recent decades. Such a recent distribution shift into the Gulf of Maine (in response to increased prey densities) would also explain the lack of confirmed white-sided dolphin sightings near Cape Cod during the 1950's and 1960's, and a subsequent increase in sightings since the 1970's.

The close predator-prey relationship between sandlance and white-sided dolphin in the southwest Gulf of Maine can be demonstrated further by examin-

ing the sighting distribution (data from NMFS/NEFC survey vessels only) in the southwestern Gulf of Maine in 1984-1985 (Fig. 7g) to comparable data collected during 1986-1987 (Fig. 7h). The sighting distribution in 1986-1987 shifted southeastward from Stellwagen Bank into the Great South Channel and onto Georges Bank (Fig. 7h). This shift occurred concurrently with a decreased abundance of sandlance on Stellwagen Bank during 1986 (sandlance data from Nelson and Ross 1991). The concentrations of white-sided dolphin on Georges Bank during 1986 were the largest reported since 1978-1979 (those reported by CeTAP 1982). A similar shift in distribution away from Stellwagen Bank (in response to decreased prey densities at that location) was observed for humpback, and to a lesser extent, fin whales during 1986 (Payne et al. 1990c).

Strandings of white-sided dolphin and mortality due to gillnet entanglement have been reported from the Gulf of Maine (Katona et al. 1976; Mead 1979; Sergeant et al. 1980; Sergeant 1982; Gilbert and Wynne 1988). Waring et al. (1990) also reported the incidental capture of white-sided dolphin in the southern New England mid-shelf/shelf-edge (Hudson Canyon region) fisheries for squid and Atlantic mackerel between March and early-May. Neither form of incidental take seem to have a significant impact on the population.

White-Beaked Dolphin Lagenorhynchus albirostris

The distribution of white-beaked dolphin sightings in the northwest Atlantic presently extends in temperate and sub-arctic waters from at least 41°00'N lat (below Cape Cod) north to Greenland, the Davis Straits and Iceland (Sergeant 1958; Sergeant and Fisher 1957; Leatherwood et al. 1976, 1983; Katona et al. 1983; Whitehead and Glass 1985; Alling and Whitehead 1987; Sigurjonsson et al. 1989). However, they are far more numerous in shelf waters between Canada and Iceland than off the northeastern United States.

White-beaked dolphin are considered regular, but uncommon, throughout the study area. Thirty-five sightings were recorded 1978-1988 (Table 6).

Seasonal Distribution and Movements

Only one white-beaked dolphin sighting was recorded in the study area between September-February (Table 6). White-beaked dolphin are presently considered to be rare in the study area during that period. Most white-beaked dolphin sightings have occurred between March and August (Table 6) in southwest Gulf of Maine shelf-waters from the western boundary of the Great South Channel northwest over Stellwagen Bank to Jeffreys Ledge and Basin (Fig. 8). The largest recorded sighting of this species (@200 individuals) in the study area occurred on 8 July 1979 near Jeffreys Ledge (Stone et al. 1983). Several sightings have also occurred below Cape Cod, and CeTAP (1982) reported three shelf-edge sightings (Fig. 8). Only one sighting has been reported south of 39°30'N latitude.

CeTAP (1982) considered southern New England waters to be the southern range limit for this species in the northwest Atlantic.

Ecological and Management Considerations

The white-beaked dolphin was the Lagenorhynchus species most often reported in the Gulf of Maine as recently as the early 1970's (Katona 1976). It is generally accepted that white-beaked dolphin were more abundant around Cape Cod in the 1950's-1960's than at present (Katona et al. 1983).

Sigurjonsson et al. (1989) suggested that white-beaked dolphins displace the smaller white-sided dolphin in cooler, nearshore Icelandic waters. Katona et al. (1983) also suggested that the two Lagenorhynchus species segregate spatially by water temperature, and ecologically by diet. However, this warm water/cool water distinction between the two Lagenorhynchus species does not adequately explain the recent decline in white-beaked dolphin sightings throughout the Gulf of Maine. Although available data do not provide for a causal explantation, a qualitative examination does indicate several ecological changes in the Gulf of Maine food-web which may be relevant to the decline of white-beaked dolphin.

The preferred prey of white-beaked dolphin in Canada and Iceland are schooling fish, respectively Atlantic herring and capelin Mallotus villosus, or squid (Sergeant and Fisher 1957). Between the mid-1960's and mid-1970's a >50% reduction in herring and mackerel biomass occurred in the Gulf of Maine-Georges Bank regions (Clark and Brown 1977; Anthony and Waring 1980; Grosslein et al. 1980). White-beaked dolphin abundance may have declined following the removal of their preferred prey despite the subsequent appearance of a super-abundant, ecologically similar prey in sandlance. The white-sided dolphin (a species which preys extensively on sandlance in the southwest Gulf of Maine) may have then replaced the white-beaked dolphin in this region.

Incidental catches of white-beaked dolphin in the northeastern United States have not been reported.

Grampus or Risso's Dolphin Grampus griseus

Grampus are widespread in slope waters throughout the western North Atlantic. It has been reported from the Lesser Antilles (Caldwell et al. 1971b), the southeastern United States/Gulf of Mexico (Gunter 1954; Paul 1968; Fritts and Reynolds 1981; Schmidly 1981; Dorf 1982; Jennings 1982; Fritts et al. 1983; Loehoefner et al. 1989) north to eastern Newfoundland (Leatherwood et al. 1976, 1983).

Grampus have a three season distribution in the study area centered from 36°00'N to 41°00'N lats (Fig. 9). Eighty-three percent of all sightings (n = 460/552, Table) occurred in southern New England/mid-Atlantic shelf-edge and adjacent slope waters (Table 7). Typically, grampus were not observed inshore of the 50f contour.

Jennings (1982) recorded grampus throughout the year in slope waters off eastern Florida. Sixty-three percent of all the grampus sightings (n = 349/552, Table 7) occurred in slope waters, approximately one-half of these (n = 170) in the mid-Atlantic (Table 7). It is possible, therefore, that grampus

also occur north of Cape Hatteras during mid-winter, but in slope waters seaward of the study area and nearer Gulf-stream influenced water.

Seasonal Distribution and Movements

Only 16 sightings of grampus were reported during January-February (Table 7). Approximately eighty percent of the grampus sightings during this 2-month period (n = 13/16, Table 7) occurred in mid-Atlantic slope waters below the Baltimore-Wilmington Canyons (Fig. 9a). During March-April 70% of the grampus sightings (n = 32/46, Table 7) were still observed in mid-Atlantic slope waters between 36°30'N-39°00'N lats, Fig. 9b). Scattered sightings also occurred in shelf-edge waters northeast of the Hudson Canyon (Fig. 9b).

The sighting distribution extended north into southern New England slope waters to the base of the Great South Channel by May-June (Fig. 9c). Grampus also extended their distribution into shelf-edge waters. One-third of all sightings during May-June occurred in shelf-edge waters (n = 33/103, from Table 7) from 36°30'N to the Great South Channel.

The peak abundance for this species in shelf-waters occurred during summer (CeTAP 1982). Fifty-four percent of all shelf sightings (n = 104/193, Table 7) occurred during July-August and the sighting distribution shifted northeast (Fig. 9d). Also, the number of grampus sightings more than doubled over May-June levels (Table 7) and were near-equally divided between shelf-edge and adjacent slope waters during this period (Table 7). Seventy-eight percent (n = 22/28, Table 7) of all Georges Bank sightings throughout the year occurred during this 2-month period. The largest concentrations of grampus sightings at this time extended along the shelf-edge/slope interface from 38°00'N lat to the Hudson Canyon, and west of 71°00'W to Lydonia Canyon, Georges Bank (Fig. 9d). Occasional slope sightings also occurred along the Northeast Peak of Georges Bank.

The number of sightings decreased dramatically during September-October (Table 7) and their distribution shifted northeast (Fig. 9e), becoming cen-

tered in southern New England waters. During this 2-month period approximately seventy percent of all shelf sightings (n = 34/45), and sixty percent of the total number of sightings throughout the study area (n = 66/113) occurred in southern New England waters (Table 7) generally along the shelf-edge/slope interface. Throughout September-October grampus continued to move along the shelf-edge/slope interface northeast and offshore out of the study area.

By November (Fig. 9f) there were few grampus sightings north of 40°00'N lat. All but two November-December sightings in the study area (n = 34/36, Table 7) occurred in slope waters, generally from Hudson Canyon south into the mid-Atlantic region. Therefore, the distribution of grampus shifted back into slope waters seaward of the study area (based on the absence of sightings) during late-autumn.

This species is generally considered absent from the Gulf of Maine (n = 8/552 sightings, Table 7). However sightings near Cape Cod or inside the Northeast Channel do occur, generally, during late-sumnmer and autumn following warm water intrusions into the Gulf of Maine from offshore. Mercer (1985) reported grampus on Fippennies Ledge (42°45'N, 69°18'W) and in Ipswich Bay, Massachusetts during August 1985. Surface water-temperatures at these sighting exceeded 27°C (from Mercer 1985). Several shore-based sightings have been reported and Gulf of Maine strandings occur but they are considered uncommon.

Ecological and Management Considerations

The incidental capture of grampus in foreign-fishing activities were reported on 4 occasions between 1977 and 1988 (Waring et al. 1990). They have also been taken incidental to the drift-gillnet fishery for swordfish (Earle 1990).

Killer Whale Orcinus orca

Killer whale sightings are widespread (and sporadic) throughout the western North Atlantic from pack-ice to the Lesser Antilles, and into the Gulf

of Mexico (see Sigurjonsson and Leatherwood 1988 for a complete discussion of killer whale sightings in the North Atlantic).

Seasonal Distribution and Movements

Killer whale sightings in the study area occurred April through September (Table 8) primarily in mid-shelf to shelf-edge waters (Fig. 10). Katona et al. (1983, 1988) suggested that killer whale sightings increased in the Gulf of Maine during late-summer following the appearance of bluefin tuna Thunnus thynnus, a preferred prey of killer whales in this region.

Killer whale sightings (from sources other than the NMFS/CeTAP surveys) have been reported most frequently from Cape Cod Bay-Stellwagen Bank throughout the western Gulf of Maine (regions of considerable whalewatch and vessel effort). A summary of known sightings in the study area are provided by Katona et al. (1988) and Mitchell and Reeves (1988).

False Killer Whale Pseudorca crassidens

False killer whale sightings and strandings are widely distributed in warm temperate and tropical waters (Brimley 1937; Caldwell et al. 1970, 1971a, 1971b; Mitchell 1975a, 1975b; Leatherwood et al. 1976, 1983; O'dell et al. 1980; Schmidly 1981; Loehoefner et al. 1989), but rarely reported from shelf waters north of Cape Hatteras.

Seasonal Distribution and Movements

One "possible" sighting (reliability code from CeTAP 1982) of 7 individuals was reported in slope waters southeast of Cape Hatteras (>500m depth) on 30 August 1980. Generally, they are considered absent from the study area.

Pygmy Killer Whale Feresa attenuata

The pygmy killer whale is distributed widely in deeper, warm-temperate to tropical waters (Caldwell and Caldwell 1971c; Nishiwaki 1966; Ross and Leatherwood 1988) but no where has been described as abundant (Leatherwood et al. 1983).

Seasonal Distribution and Movements

A single pygmy killer whale sightings was reported by CeTAP (1982) on 1

August 1981 in slope water (depth >1000f) south of Georges Bank. Because of the unsure identification of this species (sighting reliability reported by CeTAP), the occurrence of this species in the study area is questionable (CeTAP 1982).

Pilot Whale Globicephala melaena and G. macrorhynchus

The Atlantic or long-finned pilot whale (G. melaena) is commonly observed in the northwest Atlantic from at least Cape Hatteras, North Carolina (Leatherwood et al. 1976; Hain et al. 1981; CeTAP 1982; Payne et al. 1984) north to the Scotian Shelf, eastern Canada and Newfoundland (Sergeant 1962, 1968; Sergeant and Fisher 1957; Sergeant et al. 1970; Geraci and St. Aubin 1977; Mercer 1975; Mitchell 1975a, 1975b; Hay 1982); Greenland (Kapel 1975), Iceland and the Faeroe Islands (Sigurjonnson et al. 1989; Bloch et al. 1989a, 1989b, 1990).

The short-finned pilot whale (G. macrorhynchus) is sympatric with G. melaena in the northern portion of its western North Atlantic range. The short-finned pilot whale is considered a more tropical species, common south of Cape Hatteras into Caribbean waters (Caldwell and Erdman 1963; Caldwell and Golley 1965; Caldwell et al. 1971b; Caldwell and Caldwell 1975; Erdman 1970; Erdman et al. 1973; Leatherwood et al. 1976) into the Gulf of Mexico (Gunter 1954; Schmidly 1981; Fritts and Reynolds 1981; Dorf 1982; Fritts et al. 1983; Loehoefner et al. 1989) and south to Venezuela (Leatherwood et al. 1976, 1983).

There are few confirmed records of G. macrorhynchus in the study area. Rowlett (1980) reported a sighting of G. macrorhynchus seaward of the Baltimore Canyon (38°6'N, 73°45'W) during September 1977, and strandings have been reported as far north as New Jersey (Mead 1975b; Katona et al. 1978). Leatherwood et al. (1976) suggested that they probably range as far north as Virginia during late-summer and autumn. CeTAP (1982) also proposed the occur-

rence of two Globicephala species in the study area during fall based on the occurrence of calves in both spatially separated northern and southern pilot whale concentrations.

In the waters of the northeastern United States, pilot whales constitute a significant percentage of the entire cetacean biomass for the shelf-edge/slope community (Hain et al. 1985; Kenney and Winn 1987). Because the range of each species potentially overlaps in southern New England/mid-Atlantic shelf/shelf-edge and slope waters between 35°00'N (Cape Hatteras) and 38°00'N-39°00'N, and because of difficulties in separating these two species in the field, both have been considered together in recent distributional and abundance analyses (CeTAP 1982; Powers and Payne 1983; Payne et al. 1984; Hain et al. 1985; Kenney and Winn 1987). However, Payne et al. (1989) considered their distributions to be seasonally disjunct in the shelf waters of the northeastern United States. This paper provides separate discussions of the two species whenever possible.

Seasonal Distribution and Movements

The distribution of pilot whale Globicephala spp. sightings off the northeastern coast of the United States generally followed the shelf-edge/slope region from Cape Hatteras (35°00'N lat) to the northeastern portion of Georges Bank and onto the Scotian shelf (Fig. 11). Sightings of pilot whales also extended from the V-shaped basin of the Great South Channel along the northern edge of Georges Bank to the Northeast Channel (Fig. 11).

Pilot whale sightings were observed frequently during every 2-month period except January-February (Table 9) when they were infrequent (n = 26) and loosely distributed along the shelf-edge/slope region of the study area (Fig. 11a). Only 3 sightings occurred on Georges Bank and throughout the Gulf of Maine during this 2-month period (Table 9). Based on the sighting distribution, all near- and mid-shelf areas were sparsely occupied by pilot whales

at this time.

The number of sightings increased along the shelf-edge/slope interface from Norfolk Canyon to the Northeast Channel during March (Fig. 11b) and April (Fig. 11c). Ninety-three percent of all shelf sightings (n = 52/56, Table 9) occurred in southern New England/mid-Atlantic waters during March-April. Only 2 sightings occurred on Georges Bank during this period. However, most sightings at this time occurred in slope waters (n = 82 sightings, 63% of total number of sightings). The sighting distribution in slope waters extended from the mid-Atlantic to the Northeast Channel, Georges Bank.

A significant increase in the number of pilot whale sightings in the Gulf of Maine occurred during May and June (Table 9). During May pilot whale sightings north of 40°0'N lat increased from the Great South Channel northeast around the outer edge of Georges Bank and onto the Scotian Shelf (Fig. 11d). During June (Fig. 11e) the sighting distribution extended into the deeper, central Gulf of Maine.

The number of pilot whale sightings in mid-Atlantic slope waters also increased dramatically during May-June over the previous four months (Table 9). Although the May-June sighting distribution extended from 35°00'N (Cape Hatteras) north along the entire shelf-edge/slope interface of the study area, there was an obvious gap in the distribution of sightings located west of the Great South Channel between 40°00'N-38°40'N lat (centered on the Hudson Canyon, Fig. 11e). This resulted in two separate groups of pilot whale sightings-a northern group occurred from the Great South Channel northeast to the Scotian Shelf, and into the Gulf of Maine (predominantly north of 40°00'N lat) and a second group of pilot whale sightings which occurred in mid-Atlantic slope waters (not shelf waters, see Table 9) from 39°00'N lat (Wilmington Canyon) south to the southern edge of the study area (Fig. 11e).

The number of pilot whale sightings on Georges Bank during July-August

more than doubled from the previous 2-month period (Table 9). Also, these sightings were concentrated nearer the Northeast Channel (Fig. 11f) than were Georges Bank sightings in May-June. Another large concentration of sightings occurred in the mid- to upper reaches of the Great South Channel (Fig. 11f).

Seventy percent (n = 55) of all pilot whale sightings in slope waters during July-August occurred in the mid-Atlantic (Table 9). This large number of mid-Atlantic-slope sightings first occurred during May-June, peaked in July-August, then remained high throughout the remainder of the year. Eighty-seven percent of all mid-Atlantic sightings from May through December (n = 183/211, from Table 9) occurred in slope waters. The northernmost range of these sightings extended to 39°00'N lat (east of Delaware Bay), and more importantly, remainded spatially segregated from those north of 40°00'N lat. throughout the year.

During September-October eighty-three percent (n = 92/111) of all pilot whale sightings on the shelf occurred in the Georges Bank/Gulf of Maine regions (Table 9). Shelf waters west of 70°00'W long were unoccupied by pilot whales, generally, from September through December (Figs. 11g-11i). There was also a decrease in the number of pilot whale sightings on the central-northeast areas of Georges Bank, concurrent with an increase in the number of pilot whale sightings concentrated in the lower Gulf of Maine (western Georges Bank to the Great South Channel). Most pilot whales observed in the Great South Channel at this time were moving southwestward out of the Gulf of Maine (from observers notes and personal observations).

By November-December, the only noticeable concentration of pilot whale sightings on the shelf (<200m) was at the Great South Channel (Fig. 11i). However, the distribution of pilot whale sightings in slope waters again extended throughout the study area (Table 9) with a noticeable gap in southern New England waters. A major concentration of slope sightings at this time (n

=50/67, Table 9) occurred in Mid-Atlantic waters east of Cape Hatteras (Fig. 11i). These sightings were not present in January.

Distribution and Movements of the Long-finned Pilot Whale Based on the Distribution of Sighting Data.

From January throughout April there was little evidence of a disjunct distribution of pilot whale sightings north of 37°00'N lat suggesting that only one species G. melaena (the northernmost and most commonly observed) was present in the study area during that period. By March-April most shelf/shelf-edge sightings occurred in southern New England waters, while slope sightings extended from the northern mid-Atlantic northeastward along the outer perimeter of Georges Bank.

The distribution of G. melaena was most widespread during May-June. During this period sightings occurred on Georges Bank and in the deeper basins of the Gulf of Maine. The sighting data indicate movement onto shelf and nearshore waters from late-spring through early-summer, a movement pattern also described for G. meleana throughout Canada (Sergeant and Fisher 1957; Sergeant et al. 1970; Mercer 1975). These movements may be related to an inshore movement of the short-finned squid (Illex illecebrosus) during the warmer months (Sergeant 1961, 1962; Mercer 1975).

The distribution of those G. melaena remaining on the shelf (Georges Bank/Gulf of Maine regions) during September-December shifted southward. By the end of December G. melaena were not abundant north of 40°0'N lat, and were infrequent in southern New England/mid-Atlantic waters indicating a large-scale movement out of the study area into slope waters during late-autumn/winter. Pilot whales moving into slope waters complete a clockwise gyre to the mid-Atlantic/southern New England regions by the following spring when they again move northward along the shelf-edge/slope interface.

Distribution and Movements of the Short-finned Pilot Whale Based on the Distribution of Sighting Data.

By May-June two distinct groups of pilot whale sightings occurred in the

study area-one whose distribution occurred throughout shelf and shelf-edge/slope waters north of 40°00'N lat (G. melaena) and another which remained in mid-Atlantic slope waters below 38°30'N lat. We believe the increased number of pilot whale sightings in mid-Atlantic slope waters between May-December (from Table 9) followed an incursion of G. macrorhynchus into the study area during a northward, seasonal extension of the their more tropical range south of Cape Hatteras.

Sightings of G. macrorhynchus occurred in Mid-Atlantic/southern New England slope waters at three locations during July-August (Fig. 11f)- one east of Cape Hatteras, another east of the mouth of Chesapeake Bay, and the northernmost at approximately 39°0'N lat (east of Delaware Bay). The latter concentration potentially represents the northernmost known range extension of any large numbers of G. macrorhynchus in the study area. Strandings of the short-finned pilot whale have occurred as far north as New Jersey (Mead 1975b; Katona et al. 1978).

The short-finned pilot whale was most abundant (and most separated from concentrations of G. melaena) during May-December. Based on this sighting distribution, the short-finned pilot whale did not move onto the shelf (as did the long-finned pilot whale). Rather, G. macrorhynchus remained in the deeper, Gulf Stream influenced slope waters of the mid-Atlantic region. Only 23 pilot whale sightings occurred in shelf/shelf-edge waters of the mid-Atlantic during May-December (from Table 9). However a total of 145 sightings (86% of all mid-Atlantic sightings during these months) occurred in mid-Atlantic slope waters.

The northern limit of G. macrorhynchus sightings continually shifted southward toward Cape Hatteras throughout autumn. By December pilot whale sightings in the mid-Atlantic occurred in slope waters east of Cape Hatteras and by January G. macrorhynchus again moved south of the study area.

We believe that G. macrorhynchus are disjunct, both ecologically and seasonally from G. melaena in the mid-Atlantic. Payne et al. (1989) suggested that G. macrorhynchus are an abundant, regularly occurring seasonal component of the pilot whale community in mid-Atlantic/slope waters.

Ecological and Management Considerations

Two causes of G. melaena mortality are known to occur in shelf/shelf-edge waters of the northeastern United States, strandings and incidental take in foreign fishery operations.

Between 1973 and 1990, approximately 400 G. melaena stranded throughout New England (north of Long Island, data courtesy of Greg Early, New England Aquarium, Boston, MA). Most of these strandings occurred in nine separate 'mass-stranding' events at a limited number of locations in the southwestern Gulf of Maine adjacent to Cape Cod between October and December (Greg Early, New England Aquarium Stranding Network, pers. comm.). The seasonal distribution of G. melaena likely facilitates the timing and location of mass-stranding events in this region. Although strandings of individual animals have occurred between Cape Hatteras and Long Island, the mass-strandings north of Long Island represent 95% of the total number of pilot whales which have stranded along the eastern United States since 1973. The overall impact of the mass-strandings on the pilot whale population (based on abundance estimates from CeTAP 1982) appears minimal (Waring et al. 1990).

It is of ecological interest that between 1900 and 1980 approximately fifty percent of known stranding (or potential drive-fishery) events in Massachusetts occurred from June through September (n = 38/71, data courtesy of F. Wenzel, Plymouth Marine Mammal Research Center, Plymouth, Massachusetts). These summer strandings included several mass-strandings of >100 individuals. There have been no mass-stranding events during summer since 1973 (F. Wenzel, pers. comm.).

At present, individual pilot whale strandings in Massachusetts are rare

during summer. Near-shore sightings of the magnitude necessary to create a mass-stranding or "drive" fishery have not been recorded in recent decades. A comparison of available historical, stranding or "drive fishery" information (Clark 1887) to the present sighting data suggest that the summer distribution of pilot whales, and possibly the abundance, in southern New England/southwest Gulf of Maine waters (those waters adjacent to Massachusetts and Cape Cod) has changed considerably during the latter-half of this century.

The long-finned pilot whale was the most frequently caught marine mammal in east-coast foreign fishing activities between 1977-1988 (Fairfield and Waring 1991; Waring et al. 1990). Most of the pilot whale captures occurred in mid-Atlantic/southern New England shelf-edge waters during March-July (Waring et al. 1990). Since 1984 ninety-three percent of the incidental take has occurred in the Atlantic mackerel fishery (Waring et al. 1990). Based on the co-occurrence of G. melaena and mackerel, the number caught in the nets and examination of stomach contents from several pilot whales caught in the fishery, Waring et al. (1990) suggested that mackerel was an important prey species (not alternate prey as has been suggested for other finfish species, Sergeant 1962; Mercer 1967; Mitchell 1975b) of pilot whales (likely G. melaena) during winter and early-spring.

The long-finned pilot whale has been caught incidental to the pelagic drift-gillnet fishery for swordfish (Earle 1990). The full impact of the incidental take is not yet known.

Harbor Porpoise Phocoena phocoena

Seventy-five percent of all harbor porpoise sightings in the study area (n = 688/921) occurred in the Gulf of Maine between March-October (Table 10). These sightings were distributed into two seasonally disjunct clusters north of 40°00'N lat (Fig. 12). One cluster of sightings occurred, generally, in the upper Gulf of Maine from 42°30'N lat north during late summer-early au-

tumn. The second occurred in the southwestern Gulf of Maine/western Georges Bank waters between 42°30'N and 42°00'N lats from autumn through early spring.

Sightings south of 40°00'N lat were few in number during any season and widely scattered.

Seasonal Distribution and Movements

The winter distribution of harbor porpoise is poorly known when compared to other seasons. The number of sightings during January-February (n = 9, Table 10) was significantly less than the numbers which were reported spring through autumn. Prescott and Fiorelli (1980) suggested that harbor porpoise winter on 'offshore' banks. However, no large wintering harbor porpoise concentrations were offshore during the CeTAP/NMFS surveys. Several January-February sightings along the northeastern edge of Georges Bank (Fig. 12a) were individuals possibly moving south from the Bay of Fundy/Scotian Shelf region.

Mid-winter sightings of harbor porpoise in the Gulf of Maine have been reported previously from the Bay of Fundy (Neave and Wright 1968, 1969) to Cape Cod Bay (Mayo 1982). Also, anecdotal sightings in coastal waters south of 42°0'N lat increase during winter and early-spring indicating a southward movement during winter. Harbor porpoise have been observed at the mouth of Delaware Bay (south of Cape May) and inside Chesapeake Bay during winter. Rowlett (1980) also reported harbor porpoise in small numbers from Baltimore Canyon during the winter 1977-1978.

Winter strandings of harbor porpoise have also occurred from New England to Cape Hatteras, and rarely to Florida (reported in Polacheck and Wenzel 1990). Despite the large numbers of harbor porpoise which stranded on Cape Hatteras during a 'severe' 1977 winter (SEAN 1975-1978), Rowlett (1980) considered sightings to North Carolina as being rare. Therefore, at present, we believe that significant concentrations of harbor porpoise occur north of 35°00'N lat (Chesapeake Bay) but that the southern limit of dispersed sight-

ings continues below Cape Hatteras during winter.

The number of harbor porpoise sightings in southern New England/Gulf of Maine waters adjacent to the Great South Channel increased significantly during March-April from the previous 2-month period (Table 10). The largest single sighting (300+ individuals) was reported from the west side of the Great South Channel on 31 March, 1978 (Stone et al. 1983). The distribution of sightings also extended north along the outside of Cape Cod to Cape Cod Bay-Stellwagen Bank, and into the deeper basins of the central Gulf of Maine (Fig. 12b). The general movement of harbor porpoise was northeast through the Great South Channel and into the Gulf of Maine by April, further indicating that a large percentage of the New England harbor porpoise population winters south of the Gulf of Maine.

A total of 691 sightings (seventy-five percent of all harbor porpoise sightings) occurred May-August (Table 10). By May the sightings were distributed, generally, north of 40°30'N lat (most sightings occurred between 40°30'N and 42°30'N, Fig. 12c) indicating that most of the population no longer occurred below the Great South Channel. During June the sighting distribution shifted northward (Fig. 12d). Mercer (1985) stated that harbor porpoise sightings off New Hampshire (Jeffreys Ledge) occurred rarely after June (animals being farther north at that time). By July-August ninety-seven 97% of all harbor porpoise sightings (n = 380/388, Table 10) occurred north of 43°00'N lat in the northern Gulf of Maine/Bay of Fundy (Fig. 12e). Sightings throughout the southwestern Gulf of Maine (Jeffreys Ledge to Stellwagen Bank) and Cape Cod Bay are rare at this time (Fig. 12e). Therefore, the distribution of porpoise completely shifted from the southwest Gulf of Maine-western Georges Bank (spring) to north of 43°0'N lat by July.

Gaskin (1977) indicated that (at this time) the northern Gulf of Maine and the Bay of Fundy might support as much as 80% of the total summer popula-

tion of harbor porpoise south of the Gulf of St. Lawrence. Approximately half of this known population feeds within a radius of 20 miles from the mouth of Head Harbour Passage (western Bay of Fundy). The movements of harbor porpoise into the Bay of Fundy are correlated quite closely with increased water temperatures to 8°C (Gaskin 1977) and with increased abundance of Atlantic herring and mackerel (Smith and Gaskin 1974; Gaskin et al. 1975; Smith et al. 1983; Gaskin and Watson 1985; Read and Gaskin 1985; Recchia and Read 1989).

The distribution of porpoise in the Bay of Fundy was also related to subsurface topography (Gaskin et al. 1975; Watts and Gaskin 1985) particularly the margins of basins and channels in areas of restricted water flow (areas of fish accumulation which the porpoises exploit, Read and Gaskin 1985).

The largest concentrations of porpoise are still north of 43°30'N during September (Fig. 12f), however a significant decrease in the number of sightings occurred throughout the Gulf of Maine/Bay of Fundy during September-October (Table 10) as harbor porpoise moved south during autumn. Sightings became widespread with local concentrations found only near Jeffreys Ledge and Basin (Fig. 12g). Mercer (1985) stated that harbor porpoise were again seen along the coast of New Hampshire from mid-October to late-December. The number of porpoise observed between September-December (Figs. 12f-12h) in the Gulf of Maine do not account for the numbers observed during July-August north of 43°00'N (Table 10). Harbor porpoise possibly move south from the Bay of Fundy-Scotian shelf along the Georges Bank shelf/slope interface, as well as along the western edges of the Gulf of Maine.

Ecological and Management Considerations

It is possible that the distribution and seasonal occurrence of harbor porpoise throughout the study area has shifted in recent decades. Connor (1971) and (Ulmer 1977) reported harbor porpoise (in small groups) in the summer months (during the 1940's) in Lower New York Bay. It is difficult to determine what 'a small number' implied, however harbor porpoise, at present,

are rarely observed in the study area outside the upper Gulf of Maine/Bay of Fundy during summer. Such a seasonally reduced sighting distribution generally implies an overall reduction in abundance, a shift in the distribution, or both.

Also, 120 sightings of harbor porpoise were reported from Georges Bank primarily during May-June (Table 10). All but one of these sightings occurred between 1978-1981. There are several possible explanations for the lack of sightings on Georges Bank during the latter part of the survey period. Between 1981-1988 all Georges Bank survey data were reported from NMFS/NEFC vessels, rather than from aircraft used by CeTAP, 1978-1980. The differences between these two platforms (i.e. height of the observer off the water, angle of observations) would account, at least in part, for the observed differences in the number of sightings (Kraus et al. 1983). Therefore we might expect a possible reduction in the number of harbor porpoise sightings during the shipboard surveys. However, given the thousands of observer days (in suitable sea state to observe porpoise) conducted on Georges Bank during 1981-1988, we cannot accept a complete reduction to zero in the number of reported sightings due solely to platform bias.

Another possibile explanation is that harbor porpoise have shifted their distribution inshore (away from Georges Bank) to southern New England/Gulf of Maine waters since the late 1970's-early 1980's. There was a 75% reduction in herring biomass on Georges Bank between 1967-1976 (Sissenwine et al. 1984) and in 1977 the commercial fishery for herring failed completely. There was virtually no evidence of a Georges Bank herring population between 1977-1983, despite hundreds of days of research vessel trawl operations and ichthyoplankton sampling (Sissenwine et al. 1984). We know that harbor porpoise movements are closely correlated with herring. It follows that in response to the complete collapse of a Georges Bank herring stock, harbor porpoise may have

shifted their distribution. We suggest that in response to the complete collapse of a Georges Bank herring stock harbor porpoise shifted their distribution nearshore during the early 1980's (away from Georges Bank) and into coastal southern New England/Gulf of Maine waters.

Several sources of anecdotal or opportunistic sightings also support this hypothesis. Several cases of shipboard surveys to Nantucket Shoals during the winter 1991 resulted in more harbor porpoise sightings than were reported in the combined CeTAP/NMFS database for the months January-February, 1978-1988 (D. Wiley, International Wildlife Coalition, Falmounth, Massachusetts and A. Read, Woods Hole Oceanographic Institue, Woods Hole, Massachusetts, pers. comm.). Conversely, CeTAP (1982) reported few sightings from the same region during the aerial overflights. Also, nearshore Gulf of Maine fishermen have suggested that harbor porpoise numbers have increased in recent years. A shift in the distribution of porpoise to coastal/nearshore Gulf of Maine waters would result in an increased density (individuals per unit area) and local increases in the abundance of porpoise.

The recent harbor porpoise 'awareness' by fishermen has also been the direct result of increased interactions between the harbor porpoise and the Gulf of Maine/Bay of Fundy bottom-gillnet fishery. It is possible that the number of sightings and the rate of incidental take in this fishery observed by the fishermen have increased as a result of the decreased herring stocks on Georges Bank in the late 1970's followed by a shift in the distribution (and an increased density) of harbor porpoise to nearshore waters of the Gulf of Maine.

The current number of harbor porpoise taken incidental to the gillnet fishery in the Gulf of Maine seems, initially, to be large (Payne et al. 1990b) relative to available estimates of the harbor porpoise Gulf of Maine/Bay of Fundy subpopulation (subpopulation as described by Gaskin 1984).

Read and Gaskin (1988) suggested that harbor porpoise in the Bay of Fundy/Gulf of Maine may be in the initial stages of a decline. Woodley and Read (in press) further suggested that the Gulf of Maine/Bay of Fundy harbor porpoise cannot continue to sustain even moderate levels of incidental mortality. Because of this known (Prescott and Fiorelli 1980; Prescott et al. 1981; Gaskin 1984; Gilbert and Wynne 1983, 1984, 1985, 1988; Read 1990; Read and Gaskin 1988, 1990), but not yet quantified by-catch of harbor porpoise, the Gulf of Maine/Georges Bank gillnet fisheries for Atlantic mackerel (Scomber scombrus) and groundfish spp. were classified as "Category 1" fisheries under the 1988 reauthorization of the Marine Mammal Protection Act (MMPA) (Federal Register 1989). The NMFS/NEFC is presently providing observers to this fishery to determine the extent of the incidental take. Also, comprehensive surveys to estimate abundance of this subpopulation are in progress (Polacheck 1989a, 1989b; Polacheck and Smith 1989; Polacheck and Thorpe 1990) as present estimates of harbor porpoise in the Gulf of Maine (CeTAP 1982; Kraus et al. 1983) are dated and considered inadequate.

Harbor porpoises are also taken in herring weirs in the Bay of Fundy (Smith et al. 1983). However, the apparent impact of this fishery on harbor porpoise appears minimal relative to the gillnet fishery (Smith et al. 1983).

Beluga DELPHINAPTERUS LEUCAS

The distribution of beluga is north circumpolar (Sergeant and Brodie 1975; Reeves and Mitchell 1989; Brodie 1990). Although considered rare in the study area at least 24 "extralimital " sightings of beluga have been observed from the Canadian maritimes south to New Jersey (Connor 1971; Fisher and Sergeant 1954; Goode 1884; Mairs and Scattergood 1958; Sergeant and Fisher 1957; Waters and Rivard 1982; Reeves 1976b) since the early-1900's (summarized in Reeves and Katona 1980). Many of these sightings involved several individuals who remained in the sighting area for extended periods of time (several

days to nearly 2 months).

Seasonal Distribution and Movements

There were five sightings (four of these are possibly the same individual) of beluga reported by CeTAP (1982). Most of these occurred off the southern coast of Long Island between March and June.

The southernmost subpopulation of beluga occur in the St. Lawrence (Finley et al. 1982; Pippard 1985; Sergeant and Hoek 1988; Sergeant 1986). Sergeant and Brodie (1975) and Sergeant et al. (1970) suggested that beluga from this isolated subpopulation enter the Gulf of Maine/Bay of Fundy region by following the cold Gaspe Current around the coast of Cape Breton, Nova Scotia.

Ecological and Management Considerations

A large proportion of beluga sightings in New England were of individuals captured in herring wiers (Reeves and Katona 1980) suggesting that, at least for the period of time they were in New England waters, beluga may have been feeding on schools of herring or mackerel.

There have been no strandings of beluga along the eastern seaboard (Reeves and Katona 1980) inspite of the numerous inshore sightings south of the expected ranged of this species. Therefore, Reeves and Katona (1980) suggested that beluga need not be adversely affected by extended stays in New England, considerably southward of their normal range.

Sperm Whale Physeter macrocephalus

Sperm whales have the most extensive distribution of any large whale (Gosho et al. 1984; Rice 1990). In the northwest Atlantic they are found in deepwater basins of the Caribbean and Gulf of Mexico (Schmidly 1981; Gunter 1954; Collum and Fritts 1985; Watkins et al. 1985) north to northern Canada, the Davis Straits, Iceland and waters west of Jan Mayan and Norway (Mitchell 1975c; Sigurjonnsson et al. 1989; Leatherwood et al. 1976; Reeves et al. 1986; Winn et al. 1979; Rice 1990). Their upper latitudinal limit is age/sex relat-

ed and is roughly 40°00'N during mid-winter with seasonal shifts north in summer. Their winter distribution (and summer distribution of females with calves) corresponds approximately with the 15°C sea surface isotherm (Rice 1990). During summer the large males move the farthest north (to approximately 70°00'N lat, Gosho et al. 1984). Large males were the only whales taken by shore stations in Nova Scotia (Mitchell and Kozicki 1984).

The distribution of sperm whale sightings in the study area was centered in slope waters between 35°00'N-39°00'N lats throughout the year (Fig. 13). Eighty-two percent (n = 340/413 sightings, Table 11) occurred in slope waters. The shelf-edge/slope interface represented the nearshore distributional limit of sightings for this species throughout much of the year. Limited shelf-sightings occurred in southern New England waters (Table 11) between Hudson Canyon and the Great South Channel, and in deep Gulf of Maine basins inside the Northeast Channel (Fig. 13).

Sperm whale sightings in slope waters beyond the seaward limits of the study area are considered common. However, sperm whale sightings in slope waters are not randomly distributed. During the NMFS/NEFC Gulf Stream survey, August 1990, sperm whales were abundant along the northern edge of the Gulf Stream in 27-29°C waters. There was a noticeable gap in the distribution of sightings between the shelf-edge/slope interface and the northern edge of the Gulf Stream during this survey.

Seasonal Distribution and Movements

Sperm whales sightings were sporadic in slope waters along the outer edge of the study area during January-February (Fig. 13a). Only five percent (n = 22/413) of the sperm whale sightings occurred during this 2-month period (21 of these occurred in slope waters, Table 11). The largest concentration of sightings occurred in slope waters east of Cape Hatteras (Fig. 13a). The greatest abundance for this species at this location throughout the year also

occurred during January-February (CeTAP 1982). These sightings indicate that during January-February most sperm whales are still in slope waters seaward of the study area and movement into the study area occurs at that location at that time.

The number of sperm whale sightings increased significantly during March-April (Table 11). Eighty-two percent (n = 71/87) of all March-April sightings occurred in southern New England/mid-Atlantic slope waters (Table 11) in 2 noticeable concentrations-one from Cape Hatteras north to Hudson Canyon, and another in slope waters below the Great South Channel (Fig. 13b). An obvious gap in the sperm whale sighting distribution existed between these two concentrations (Fig. 13b) and only 4 sperm whale sightings occurred in Georges Bank slope waters at this time. Shelf sightings during March-April were limited to the mid-Atlantic shelf/edge (n = 11/12 shelf sightings, Table 11).

From May-August 48 sperm whale sightings occurred in Georges Bank slope waters (Table 11) indicating a northward shift in the distribution of sperm whales during summer (Figs. 13c-13e). This was approximately 21% of the total number of sperm whale sightings during this period, and 83% of all sightings which occurred in Georges Bank slope waters throughout the year (n = 48/58, Table 11). Correspondingly, the maximum abundance of sperm whales below Georges Bank was recorded by CeTAP (1982) during this period.

There was also an increase in mid-Atlantic slope sightings during July-August (Table 11). The largest concentrations of sperm whale sightings during July occurred in slope waters between 37°00'N and 39°00'N lats (Fig. 13d). Sperm whales still appeared to be entering the study area as far south as Cape Hatteras. By August the slope water distribution of sperm whales extended northward towards Corsair Canyon, Georges Bank (Fig. 13e).

During September-October the number of sperm whale sightings in mid-

Atlantic and Georges Bank slope waters decreased from September-October levels (Fig. 13f, Table 11). Approximately sixty-seven percent (n = 27/44 of the total number of sightings, Table 11) occurred in southern New England waters indicating, we believe, a continued clockwise movement of sperm whales east/northeast from the mid-Atlantic into southern New England waters, and east from Georges Bank slope waters out of the study area.

Sperm whale sightings were most numerous on the shelf from July-October. Approximately 87% of all shelf sightings of sperm whales (n = 34/39) occurred during this period primarily in southern New England waters (Table 11) between Montauk Point, Long Island and the Great South Channel (Figs. 11d-11f). Sperm whales occurred predictably in this location during these months. The greatest abundance of sperm whales in southern New England shelf waters also occurred at this time (CeTAP 1982). Sperm whales may move onto the southern New England shelf in response to warmwater intrusions, followed by increased prey (squid spp.) densities.

Sperm whale sightings also occurred predictably in the Gulf of Maine (Georges Basin) and in the Northeast Channel along the southern edge of Browns Bank from late-summer through November. Ninety percent of all Gulf of Maine sperm whale sightings (n = 10/11, Table 11) occurred inside the Northeast Channel from July-December. Historically a whaling fishery based out of Nova Scotia targeted on sperm whales in slope waters seaward of the Northeast Channel, May to December (Mitchell 1975c; Sutcliffe and Brodie 1977; Mitchell and Kozicki 1984). Sperm whale sightings in the upper Bay of Fundy are considered rare (McAlpine 1985).

During November-December sightings were reduced in number and occurred either in mid-Atlantic slope waters, or in southern New England shelf waters (Table 11, Fig. 13g).

Pygmy and Dwarf Sperm Whales KOGIA SPP.

The ranges of the pygmy sperm whale Kogia breviceps and the dwarf sperm whale K. simus completely overlap in waters of the eastern United States and the Gulf of Mexico (Handley 1966; Schmidly 1981; Caldwell and Caldwell 1990). Neither species are known from polar waters and strandings do not indicate any seasonal shifts in distribution (Caldwell and Caldwell 1990). These have been considered rare, offshore species but the stranding records indicate otherwise. Most strandings occur in Florida and strandings of K. breviceps outnumber those of K. simus by a factor of several times (O'dell et al. 1985). However Schmidly (1981) suggested that, due to misidentifications, some of the old records of K. breviceps are likely to be K. simus. Sightings are rare however available sighting data suggests that the Gulf of Mexico and Caribbean may constitute significant proportions of the range of the pygmy K. breviceps and dwarf sperm whales K. simus (Leatherwood et al. 1976; Loehoefner et al. 1989).

Only one sighting of Kogia spp. occurred within the study area during the standardized surveys. This sighting occurred in slope waters (>1000f) on 8 June 1981 east of Delaware Bay (CeTAP 1982). Strandings of Kogia have occurred north to at least Nova Scotia (Sergeant et al. 1970).

Beaked Whales Spp.

Four species of Mesoplodon beaked whales (True's beaked whale M. mirus, Antillean beaked whale M. europaeus, Blainville or dense-beaked whale M. densirostris, and North Sea beaked whale M. bidens) are known from strandings between Cape Hatteras and Newfoundland (Allen 1906, 1939; Andrews 1914; True 1910, 1913; Raven 1937, 1942; Ulmer 1941; Brimley 1943, 1945; Moore 1966, 1968; Sergeant and Fisher 1957; Sergeant et al. 1970; Mead 1975b, 1990a; Leatherwood et al. 1976; Reeves and Ulmer 1976; Banefield 1977; Ulmer 1977; Katona et al. 1978; Dix et al. 1986; Houston 1990a, 1990b; Mead 1990a; Lien and Barry 1990; Lien et al. 1990). The Antillean beaked whale is the species

which strands most commonly along the eastern coast of North America, primarily south of Cape Hatteras (Mead 1990a). The dense-beaked whale has the widest distribution (based on stranding data) of these Mesoplodon species (Houston 1990a; Mead 1990a). Most of these beaked whale species extend their range south into the Gulf of Mexico and Caribbean (Ulmer 1947; Gunter 1954, 1955; Moore 1953, 1958, 1966; Golley 1966; Caldwell 1964; Erdman et al. 1973; Schmidly 1981).

The goose-beaked whale or Cuvier's beaked whale Ziphius cavirostris is the most cosmopolitan of the beaked whales (from stranding records, Heyning 1990; Mead 1990a). It occurs within the study area (True 1910; Backus and Schevill 1961; CeTAP 1982) south into the Caribbean and Gulf of Mexico (Caldwell and Caldwell 1971; Erdman et al. 1973; Schmidly 1981; Mead 1990a).

All beaked whale species are known to prey upon squid spp. (Mitchell 1975a; Mead 1990a) and, although seasonal movements not well known, it is likely that they move in slope waters which seasonally get progressively warmer (Carter et al. 1981; Price and Fairfield 1985). The considerable stranding data and limited sighting data indicate that beaked whales are abundant in slope waters generally seaward of the study area.

Seasonal Distribution and Movements

Forty beaked whale sightings (recorded primarily Mesoplodon spp.) were observed (Table 12, Fig. 14). Seventy-seven percent (n = 31) occurred in slope waters (average depth at-sighting >1000f, from CeTAP 1982) during summer and autumn. One sighting (3 individuals) was photographed from a NMFS research vessel on 9 June 1979 south of Hudson Canyon at 39°19'N lat-72°09'W long (reported in Hain et al. 1981). These individuals were tentatively identified (from the photographs) as M. densirostris.

CeTAP (1982) also reported 6 sightings (16 individuals) of the goosebeaked or Cuvier's beaked whale. All but one of the sightings were reported from

shelf-edge/slope waters between the Great South Channel and Cape Hatteras (average depth >500f, from CeTAP 1982). Two sightings, one on 23 October 1979 along the shelf edge east of Cape Hatteras (reported in Hain et al. 1981) and the second on 9 July 1988 below Lydonia Canyon, consisted of a mother and a calf/juvenile (author PMP, personal observation). The locations and average at-sighting water temperature of 24.5°C for three of the Ziphius sightings (CeTAP 1982) are consistent with the slope and known temperate to tropical water distribution of this species.

CeTAP (1982) also recorded two rare sightings of the Northern bottlenosed whale Hyperoodon ampullatus in the study area, one on 30 May 1980 along the shelf edge east of Georges Bank and another on 12 June 1981 east of Delaware Bay in waters >1000f and >700f respectively, consistent with their known deepwater distribution. However, the distribution of H. ampullatus in the western North Atlantic generally extends in deepwater from just south of Sable Island, Nova Scotia in an area called the "Gully" to northern Labrador and Greenland (Benjamin and Christensen 1979; Mead 1990b). Mitchell and Kozicki (1975a) also reported a bottlenose whale stranding in the Bay of Fundy.

Ecological and Management Considerations

Twelve beaked whale were killed incidental to the swordfish driftnet fishery of the eastern United States during the summer 1989 (Earle 1990). These were later identified as North Sea beaked whale M. bidens from lower jaw specimens. During August 1990 NMFS/NEFC initiated a series of surveys to the northern edge of the Gulf Stream to monitor the occurrence of beaked whale spp. relative to the extent of the incidental take in the driftnet fishery. Beaked whales (several Mesoplodon species and Ziphius) were observed frequently along the northern edge of the Gulf Stream (sea surface temperatures 28°-29°C and depths >2000f) during that survey.

Minke Whale Balaenoptera acutorostrata

Minke whale sightings occurred over wide regions of the shelf but were

most abundant north of 40°00'N lat in regions of high bottom-relief (Fig. 15). This tendency for minke whales to concentrate near edges of banks, or rapidly changing bottom topography is characteristic of this species throughout the northwest Atlantic (Sergeant 1963; Winn and Perkins 1976; Perkins and Whitehead 1977; Larsen 1981; Lynch and Whitehead 1984; Stewart and Leatherwood 1985; Piatt et al. 1989). Over ninety percent of all minke whale sightings in the study area occurred in shelf waters north of the mid-Atlantic region (n = 712/758, Table 13).

CETAP (1982) suggested that minke whale densities were greatest in a U-shaped area which extended east from Montauk Point, Long Island, southeast of Nantucket Shoals to the Great South Channel, then northward along the 50f contour outside Cape Cod to Stellwagen Bank and Jeffreys Ledge (Fig. 15). Most minke whale sightings occurred in the Gulf of Maine (n = 497, Table 13). Minke whale sightings were also abundant from the Great South Channel northeast along the northern edge of Georges Bank. Minke whale sightings below below Hudson Canyon (below 40°00'N lat) were infrequent. Only 22 sightings (<1% of all sightings) occurred in mid-Atlantic shelf waters (Table 13). Minke whale sightings inside, and east of Chesapeake Bay, have been reported (Schwartz 1962; Rowlett 1980) but were considered uncommon.

Seasonal Distribution and Movements

During January-February minke whale sightings were rare (Table 13). Several occurred in southern New England nearshore waters (<15f) and in mid-Atlantic waters (Table 13), generally from mid-shelf to the 50f contour (Fig. 15a). The paucity of sightings during January-February suggest that minke whale shelf abundance is possibly reduced during that period.

The number of minke whale sightings increased in southern New England shelf waters (Table 13) east of Long Island during March-April (Fig. 15b). Eighty-three percent of all minke whale sightings in slope waters during

March--April (n = 10/12, Table 13) also occurred in southern New England waters (Fig. 15b) suggesting a seasonal movement onshelf between the Hudson Canyon and Georges Bank. An increased number of sightings also occurred in the Gulf of Maine generally along the 50f contour from the western flank of the Great South Channel to Jeffreys Ledge (Fig. 15b).

The number of minke whale sightings increased significantly west of 72°00'Long during May-June (Fig. 15c). The sighting distribution in the Gulf of Maine shifted northwest from Stellwagen Bank/Jeffreys Ledge along the 50f contour into the northern Gulf of Maine. Also, the number of sightings in southern New England/Georges Bank waters (near the Great South Channel) increased significantly during May-June (Table 13). Most May-June sightings below 40°00'N lat were concentrated in shelf/shelf-edge waters near Hudson Canyon (Fig. 15c).

By July-August (Fig. 15d) the sighting distribution in the western Gulf of Maine extended north into the Bay of Fundy. The scattered sightings on Georges Bank (during May-June) congregated on the Northeast Peak in July-August (Fig. 15d). Also the May-June southern New England/Georges Bank shelf-edge sightings were fewer in number at this time. Instead a string of mid-shelf sightings extended from Montauk Point,Long Island below Nantucket Shoals and the Great South Channel (Fig. 15d). These sighting data indicate that movement onto the shelf during July-August was complete, and that minke whales continued a clockwise movement east-northeast from southern New England waters throughout the Gulf of Maine.

From September-October to November-December there was a significant decrease in the number of sightings throughout the Gulf of Maine/Bay of Fundy (Table 13). CeTAP (1982) considered winter sightings southeast of Nantucket (south of 40o00'N) as rare further indicating an overall decrease in abundance throughout shelf waters of the study area. Sightings outside the Gulf of

Maine at this time were uncommon. Approximately ninety percent (n = 167/188, Table) of all September-December sightings occurred in a patchy continuum along the western margins of the Gulf (Figs. 15e-15f). Throughout the year minke whales were sympatric with fin whales B. physalus. During winter minke whales may move offshore into deeper shelf-edge/slope waters (a seasonal movement pattern suggested for fin whales by Leatherwood et al. 1976) resulting in the decreased seasonal abundance observed by CeTAP (1982) .

Ecological and Management Considerations

Minke whales are the only baleen whale for which partitioning of habitat (exclusive adjoining feeding ranges in individually identified whales) has been demonstrated (Dorsey 1983; Dorsey et al. 1990). The distribution of minke whales in the northwest Atlantic has often been related to their prey (Jonsgard 1951, 1982; Sergeant 1963; Mitchell 1974a, 1975b; Mitchell and Kozicki 1975b; Whitehead and Carscadden 1985). Edds and MacFarlane (1987) thought that habitat partitioning may also be a function of prey density or overall prey abundance.

Fin Whale Balaenoptera physalus

Fin whales are a wide-ranging species throughout the North Atlantic summering from the eastern coast of North America north to the Arctic, Greenland, Iceland and northeast above Norway to the Barents Sea and Spitzbergen (Jonsgard 1966a, 1966b; Mitchell 1974b, 1975d; Leatherwood et al. 1976; Sergeant 1966, 1977; Mizroch et al. 1984a; Gambell 1985a). In the western North Atlantic they winter from the ice-edge south into the Gulf of Mexico and Caribbean (Schmidly 1981; Gambell 1985a).

Fin whales were present during all seasons (at some level of abundance) in southern New England shelf waters from Delaware Bay to the shelf-edge, from the New York Bight southeast to the Hudson Canyon/slope interface and from Montauk Point east to Cox Ledge (and below Martha's Vineyard). Fin whale densities were the greatest in the Gulf of Maine primarily from the base of

the Great South Channel (including inside the V-shaped basin of the Great South Channel formed by the 50f contour) northwest along the 50f contour into the southwestern Gulf of Maine over Stellwagen Bank to Jeffreys Ledge (Fig. 16). Sixty-nine percent (n = 2,259/3,291 sightings) of all the sightings occurred within the Gulf of Maine (Table 14) primarily in the latter area. The distribution of sightings shifted clockwise from the Great South Channel-Stellwagen Bank region in spring, to the northern Gulf of Maine-Bay of Fundy region mid-summer, then onto the Scotian Shelf and northeast peak of Georges Bank from mid-summer through November. These seasonal movements have also been demonstrated for individual fin whales (Mattila et al. 1983; Agler et al. 1990; Seipt et al. 1990).

Concentrations of fin whales (with seasonal shifts in abundance from region to region) also occurred along the shelf-edge (between the 50-100f contours) from 36°00'N lat north around the 50f perimeter of Georges Bank (Fig. 16). However, only 4% of all fin whale sightings (n = 128/3,291) occurred in slope waters, approximately one-half of these (n = 63) occurring seaward of the southern New England shelf-edge (Table 14).

Fin whales were conspicuously absent (or sightings are very much reduced in numbers) in coastal waters below 40°00'N lat (except the mouth of Chesapeake Bay) and directly east of Cape Hatteras (Fig. 16). Approximately 6% (n = 197) of all sightings occurred in mid-Atlantic waters (Table 14). Fin whale sightings were also recorded in low numbers from the central portion of the Gulf of Maine and the central, shoals-portion of Georges Bank, Nantucket Shoals (Figure 16).

Seasonal Distribution and Movements

Only 2% of all fin whale sightings (n = 70/3,291 from Table 14) occurred during January-February. Although reduced in number, these sightings were widely distributed, generally occurring in local concentrations within each

region of the study area (Fig. 16a). Noticeable concentrations were located in mid-Atlantic/southern New England waters. Relative abundance levels outside Delaware Bay increased winter and early spring (CeTAP 1982). CeTAP (1982) suggested that this area was very important to fin whales during winter.

During January-February fin whales also occurred in the southwestern Gulf of Maine from Stellwagen Bank to Jeffreys Ledge, and along the northern edge of Georges Bank (Fig. 16a). Mid-winter densities of fin whales were greatest in the southwest Gulf of Maine, principally on Stellwagen Bank and in the Great South Channel (MBO 1988).

The number of fin whale sightings throughout the study area during March-April was significantly greater than that observed during January-February (Table 14). These increases occurred along the shelf-edge from Norfolk Canyon north to Lydonia Canyon, and in southern New England (east of Montauk Point) and Gulf of Maine waters. The number of mid-Atlantic sightings peaked during March-April then decreased steadily throughout the remainder of the year, Table 14). The largest concentrations of fin whales at this time occurred in the southwest Gulf of Maine along the 50f contour (Fig. 16b).

During May-June the distribution of sightings shifted northward away from the mid-Atlantic (Fig. 16c). Between Cape Hatteras and 40°00'N lat (generally north of 37°30'N lat) fin whale concentrations occurred only southeast of the Delaware Bay (mid-shelf inside the 50f contour), along the Hudson Canyon (inside the 50f contour) and east of Montauk Point, Long Island (Fig. 16c). Rowlett (1980) also noticed an increase in the abundance of fin whales during early-spring outside the Chesapeake Bay in response, he believed, to increased mackerel densities.

By May-June, seventy-seven percent of all fin whale sightings (n = 903/1,170, Table 14) occurred in the Gulf of Maine primarily from the Great

South Channel northwest to Jeffreys Ledge. The distribution of fin whale sightings continued to shift northeast during July-August (Fig 16d). There was a large increase in the number of sightings in the southern New England region during July-August (Table 14) from Montauk Point east to below Martha's Vineyard (Fig. 16d) concurrent with a continued decrease in the number of sightings in the mid-Atlantic. The southern limit of noticeable concentrations during July-August occurred along the shelf-edge southeast of Delaware Bay.

Fin whale sightings also increased in the northern Gulf of Maine-Bay of Fundy during July-August. The cluster of fin whale sightings which occurred along the 50f contour of northwest Georges Bank during May-June (Fig. 16c) dispersed, either shifting northwest along the western margin of the Gulf of Maine, or east along the northern edge of Georges Bank to the Northeast Peak/Scotian Shelf (Fig. 16d).

A significant decrease in the number of fin whale sightings (by approximately 50%) occurred throughout the study area during September-October (Table 14). During this period only 33 fin whale sightings occurred in the southern New England region, a decrease of nearly 85% in this region from July-August. At this time most fin whale sightings occurred northeast of a line extending from the New York Bight to the Hudson Canyon (Fig. 16e). The large concentration of fin whale sightings which occurred east of Montauk Point from March through August was no longer present. Also, the concentration of sightings in the Bay of Fundy was no longer present. The northern limit to large fin whale aggregations in the Gulf of Maine extended north only to Jeffreys Ledge (Fig. 16e).

Fin whale abundance decreased dramatically during autumn (CeTAP 1982). Sightings were limited, generally, to the southwest Gulf of Maine and the northern edge of Georges Bank by November (Fig. 16f). The large number of fin

whale sightings which occurred from the Northeast Peak south along the Georges Bank shelf-edge mid-summer through October (Figs. 16d-16e) were no longer present (Fig. 16f). Leatherwood et al. (1976) suggested that many fin whales may move offshore during late-autumn and winter.

Ecological and Management Considerations

The most obvious ecological and management consideration with regards to fin whales in shelf waters of the northeastern United States is their potential impact as predators, and/or competitors, in the system. In terms of biomass, fin whales are the dominant cetacean species within the study area comprising between 31% (autumn) and 47% (winter) of the total cetacean biomass (Scott et al. 1983; Kenney et al. 1985). Since the largest aggregations of fin whales are found north of 40°00'N lat (generally in the southwest Gulf of Maine and southwestern Georges Bank), and since the Gulf of Maine-Georges Bank systems are distinguished from the southern New England-mid-Atlantic regions by the relatively high-use of the Gulf of Maine by baleen whales, these biomass estimates (therefore consumption estimates) are much greater in the Gulf of Maine (exceeding 50% of total whale biomass during several seasons) than for the entire study area.

During 1986-1987 the number of fin whale sightings in mid-shelf/shelf-edge waters from the northern edge of Georges Bank to the Hudson Canyon was greater (as compared to a more typical pattern of abundance in 1984-1985) (Figs. 16g-16h). Concurrent to this increase the number of fin whale sightings in the southwest Gulf of Maine (Stellwagen Bank) declined during 1986 and 1987 (Payne et al. 1990c)Concurrent to the mid-summer decrease in the number of fin whales in the southwest Gulf of Maine, the number of fin whale sightingsWe believe that the increased number of sightings in southern New England waters during 1986-1987 were the result of a noticeable decline in sandlance on Stellwagen Bank (Bowman et al. 1984; Nelson and Ross 1989, 1991) during the same period and a subsequent small-scale shift in the distribution of fin

whales to the south and southeast. During 1988 sandlance abundance on Stellwagen Bank was at a regional maxima (data from Nelson and Ross 1989) and fin whale numbers on Stellwagen Bank were comparable to pre-1986 levels (Payne et al. 1990c).

Blue Whale Balaenoptera musculus

In the western North Atlantic blue whales occur regularly from the Gulf of St. Lawrence, and off eastern Nova Scotia and southern Newfoundland (Mansfield 1985; Sergeant 1953, 1966; Mitchell 1975d; Sears et al. 1987, 1990).

Historical records of blue whale strandings in the study area (many now re-identified as fin whales) were reported by Allen (1916). Neave and Wright (1968) reported blue whale sightings from the Bay of Fundy. However the validity of these sightings was questioned by Schevill (1968) indicating the rarity of the species in the Gulf of Maine.

Seasonal Distribution and Movements

During August 1980 CeTAP (1982) reported 2 blue whales on the Scotian shelf-edge 70 miles southeast of Cape Sable, Nova Scotia. However the first confirmed sighting of a blue whale in the Gulf of Maine occurred north of Race Point, Cape Cod (42°07'N-70°22'W on 4 October 1986 (Wenzel et al. 1988). This whale was also reported the following day approximately 10km north of the original position (Fig. 17).

The following spring, on 18 May 1987, three blue whales were observed at 41°18'N-68°42'W from a NMFS/NEFC research vessel on northwest Georges Bank (Fig. 17). On 29 July 1987 another blue whale was observed on southwest Georges Bank at 40°38'N-68°04'W. The latter whale was observed near several right whales Eubalaena glacialis and basking sharks Cetorhinus maximus. A blue whale reported southeast of Cape Ann, Massachusetts on 9 August 1987 was resighted on 11 August north of Race Point, Massachusetts (42°14'N-70°20'W). Yet another blue whale was observed east of Nauset Beach, Cape Cod (41°48'N-

69° 45'W) on 30 August 1987. There were no blue whales sighted in the study area between 1988-1990.

Ecological and Management Considerations

Blue whales feed almost exclusively on euphausiids (Jonsgard 1955, 1966a; Nemoto 1957, 1959; Mitchell 1975d; Mizroch et al. 1984b; Yochem and Leatherwood 1985); however they also take copepods of the genus Calanus (Nemoto 1970; Kawamura 1980). The influx of blue whale sightings throughout the southern Gulf of Maine during the summer 1986 and 1987 co-occurred with an increased abundance of C. finmarchicus and an increased number of right and sei whale B. borealis (Payne et al. 1990c) sightings in the Gulf of Maine, species which feed in a similar manner and on similar prey types.

The blue whale sightings during 1986-1987 indicated a dramatic change in the distribution of this species. It confirmed the hypothesis of CeTAP (1982) that seasonal movements of blue whales occurred in near proximity to the study area, likely in slope waters. Also, the whale identified on 9 and 11 August was photographed previously in the Gulf of St. Lawrence (from comparisons of photographs taken at-sighting with those found in Sears et al. 1987, 1990) further suggesting a single population in the northwest Atlantic.

Sei Whale Balaenoptera borealis

Sei whales in the northwest Atlantic may consist of two stocks (Mitchell and Chapman 1977; Mizroch et al. 1984c; Gambell 1985b), one centered in the Labrador Sea and another with its center of abundance off eastern Nova Scotia. Southern New England shelf-edge/slope waters are presently considered the southern limit of the feeding range for the latter stock of this species.

Sei whale sightings generally occurred north of 40°00'N lat (Fig. 18). The sighting distribution centered around the perimeter of Georges Bank from the base of the Great South Channel between the 50f-1000f contours, north along the shelf-edge/slope interface through the Northeast Channel into the deeper basins of the Gulf of Maine (Fig. 18). Also eighty-two percent of all

sei whale sightings reported during these surveys occurred April-August, indicating a strong seasonal movement onto the southern New England/Georges Bank shelf-edge at that time. Sightings throughout the remainder of the study area were scattered and infrequent.

Occasional strandings have also been reported (Mead 1977).

Seasonal Distribution and Movements

Mid-winter sei whale sightings are rare. There there were no sightings of sei whales reported in the study area from November through January 1978-1988, and only four sightings February-March. The number of sei whale sightings increased in April, and then only at the base of the Great South Channel (Fig. 18a).

Most May-August sei whale sightings occurred north of 40°00'N lat along the Georges Bank shelf-edge/slope interface northeast to the Northeast Peak and Scotian shelf (Fig. 18b). The number of sei whale sightings increased throughout southern New England shelf regions, indicating a movement onto the shelf north of Hudson Canycn during this period (Fig. 18b). Sei whale sightings were generally absent from mid-Atlantic shelf/slope waters (n = 4/86 sightings, Table 15).

Sei whales arrived on Georges Bank during May-June, then move into the Gulf of Maine through the Great South Channel and the Northeast Channel. Also, sei whales moved northward from Georges Bank shelf-edge/slope waters onto the Scotian Shelf in June (Mitchell 1974b; Mitchell and Chapman 1977). This sighting distribution followed the intrusion of warmwater around the northern edge of Georges Bank and onto the Scotian Shelf.

By September the number of shelf sightings decreased significantly (Table 15). The largest concentrations of sei whales at this time generally occurred from the Northeast Channel northeast onto the Scotian Shelf (Fig. 18c). From mid-September to mid-November the number of sei whales on the Scotian Shelf

also decreased as the whales moved offshore and southward (Michell and Chapman 1977).

Sei whales have been reported from the Bay of Fundy (Neave and Wright 1968) although they are not considered common in this region (Mitchell and Chapman 1977; Kraus and Prescott 1981; 1982).

Ecological and Management Considerations

Sightings of sei whales in the southwestern Gulf of Maine and Cape Cod Bay are very rare during any season (Mayo et al. 1988). Watkins and Schevill (1979) reported sei whales feeding off Cape Cod in 1975, and Mayo et al. (1988) recorded only a single whale in thousands of survey cruises conducted in Cape Cod Bay and on Stellwagen Bank between 1978 and 1985. Mercer (1985) reported multiple sightings of 3 sei whales in Ipswich Bay (western Gulf of Maine) during September, and another sei whale on Jeffreys Ledge in October 1985. Then, during the summer 1986, sei whale numbers increased dramatically in the southwest Gulf of Maine (Weinrich et al. 1986; Mayo et al. 1988; Payne et al. 1990c), moving through the Great South Channel and onto Stellwagen Bank. Mayo et al. (1988) reported 351 sightings of 38 individually identified sei whales between June-October 1986 (not reported from NMFS/NEFC surveys) and mother-calf pairs were commonly observed (Weinrich et al. 1986). The occurrence of sei whales in 1986 was followed by an equally dramatic decline during 1987 and 1988.

Sei whales will prey on small schooling fishes, but feed principally on Calanus species in all oceans (Omura and Nemoto 1955; Nemoto 1959; Kawamura 1973, 1974; Rice 1977; Gambell 1985b). The increased sei whale abundance in the Gulf of Maine co-occurred with a regional maximum abundance of C. finmarchicus (Payne et al. 1990c), a preferred prey of sei and right whales in the northwest Atlantic (Mitchell 1975d, 1975e; Jonsgard and Darling 1977; Mitchell and Chapman 1977; Watkins and Schevill 1979; Winn et al. 1986) and a regional low level of sandlance, a potential competitor with sei (and right whales) for

copepods.

Jonsgaard and Darling (1977) described "invasion years" where unusually large numbers of sei whales occur in an area. Kapel (1985) also described an "invasion year" by sei whales which was associated with an increase in surface water temperatures. These years are generally followed by an equally sharp decrease in the number of whales in the same area. An invasion year in response to increased prey abundance accurately describes the ocurrence of sei whales on Stellwagen Bank during 1986.

Payne et al. (1990c) hypothesized that competition between sei whales and plantiverous finfish for similar prey in the Gulf of Maine (copepods) has influenced the present distribution of the sei whale in the study area. Although sei whales have the ability to forage on fish (Nemoto 1959; Nemoto and Kawamura 1977) they have not exploited the superabundant sandlance in the Gulf of Maine. By remaining at the shelf-edge/slope interface sei whales subsist, possibly, on planktonic (euphausiids and copepods) and possibly fish prey, they might minimize the effect of competition from sandlance for copepods which could occur in Gulf of Maine shelf waters.

Bryde's Whale Balaenoptera edeni

Bryde's whales prefer warmer water temperatures than fin whales (Tershy et al. 1990) and have a more tropical and subtropical distribution than other Balaenoptera species (Best 1975; Ivashin 1980; Cummings 1985a). They possibly follow warm-water currents (Nishiwaki 1967; Omura 1977) and are limited by the 20°C isotherm (Omura 1977). Ivashin (1980) considered a western Atlantic population to occur in the Gulf of Mexico, Caribbean Sea and waters of the southwest North Atlantic.

Seasonal Distribution and Movements

There have been no Bryde's whale sightings reported from the study area. Mead (1977) reported one stranding from within the Chesapeake Bay (incorrectly

reported by Miller (1927) as a sei whale). Otherwise, strandings and sightings along the eastern coast of the United States have occurred south of Cape Hatteras (south of 33°00'N lat, Mead 1977) and into the Gulf of Mexico (Schmidly 1981).

Humpback Whale Megaptera novaeangliae

Several reasonably discrete summer-feeding stocks of humpbacks have been identified in the northwest Atlantic (Johnson and Wolman 1984; Kapel 1979; Katona 1986; Katona and Whitehead 1981; Katona and Beard 1990; Katona et al. 1979, 1980, 1984; Martin et al. 1984; Mitchell and Reeves 1983; Perkins et al. 1982, 1984, 1985; Whitehead 1981, 1982, 1983; Whitehead and Glass 1985; Whitehead et al. 1980, 1982, 1983). Humpback whales which feed in the shelf waters of the northeastern United States are considered part of the Gulf of Maine-Nova Scotia feeding stock.

Although discrete stocks have been suggested in feeding areas of the northwest Atlantic, Mattila et al. (1989) and Mattila and Clapham (1989) present evidence for both spatial and genetic mixing of these different feeding stocks in the wintering grounds. The major winter concentrations of humpback whales in the northwest Atlantic occur along the Antillean chain in the West Indies, principally on Silver and Navidad Banks, north of the Dominican Republic (Winn et al. 1975; Balcomb and Nichols 1978; Whitehead and Moore 1982; Hay 1985a; Mattila and Clapham 1989; Mattila et al. 1987, 1989). Smaller concentrations of whales are scattered from Mona Passage, Puerto Rico (Mattila 1983, 1984; Martin et al. 1984), Samana Bay, Dominican Republic (Mattila and Clapham 1989) throughout the Lesser Antilles, from Virgin Bank in the northwest to the Gulf of Paria in the southeast (Erdman et al. 1973; Levenson and Leapley 1978; Mattila and Clapham 1989).

The migratory route between regions of winter breeding and summer feeding in the northwest Atlantic occurs in deeper, slope waters off the continental

shelf. Several possible offshore routes between these winter and summer areas have been suggested (Katona et al. 1980; Martin et al. 1984; Stone et al. 1987). Furthermore, Stone et al. (1987) identified individuals from Bermuda which are members from all the feeding and wintering grounds occurring in proportions relative to the size of the feeding and wintering samples; thus some of the whales that winter together on Silver Bank and at Puerto Rico are still together during spring migration past Bermuda. Therefore the summer feeding stock identities might develop only after humpbacks have passed Bermuda on their migration north (Stone et al. 1987). Stone et al. (1987) further suggested that Bermuda might be an opportunistic feeding area as humpbacks move north to preferred feeding areas.

Seasonal Distribution and Movements

Within the shelf waters of the northeastern United States humpback whales have a restricted distribution (Fig. 19). Although a few sightings occurred in the mid-Atlantic (n = 12/1,472, Table 16), this species generally occurred north of 40°00'N lat in several well-defined concentrations. The largest number of humpback whale sightings occurred in the Gulf of Maine (Table 16) along a patchy continuum from the V-shaped 50f contour of the Great South Channel-northwest Georges Bank, northeast outside Cape Cod over Stellwagen Bank to Jeffreys Ledge (Fig. 19). Humpback whales were present throughout the year in this area with seasonal shifts in abundance. Smaller concentrations of humpbacks also occurred from the southern edge of Grand Manan Island-mouth of the Bay of Fundy south along the western Scotian Shelf-Briers Island region to the perimeter of Georges Bank, and in southern New England waters from Montauk Point, Long Island east to Cox's Ledge and south to the shelf-edge (Fig. 19). Humpback whales were infrequent on Georges Bank (n = 64, Table 16) throughout the study period.

The number of humpback whale sightings in the study area were significantly less during January-February (as compared to other periods, Table 16,

Fig. 19a). Only 10 January-February sightings were reported (only 6 in the study area, Table 16). During January-February humpbacks have been observed overwintering in the Great South Channel, near the mouth of Chesapeake Bay and on the shelf as far south as Cape Hatteras (Fig. 19a). They have also been reported in Cape Cod Bay during winter (Payne et al. 1984; Geraci et al. 1989).

The total number of sightings during March-April (n = 151, Table 16) was significantly greater than during January-February. Only 14 of these sightings occurred during March; therefore during April humpback whales appeared along the southern New England shelf-edge between Hudson Canyon and the Great South Channel (generally below the Great South Channel), then moved through the Great South Channel into the southwestern Gulf of Maine (Fig. 19b). For the Gulf of Maine stock, the Great South Channel has been suggested as the major exit/entry between the Gulf of Maine feeding area and the deeper, offshore migration route (Kenney et al. 1981). There were few slope sightings reported for humpback whales during the 1978-1988 study period (n = 11, Table 16). Therefore, it is apparent that humpbacks do not spend any length of time in slope waters once they have reached the shelf-edge/slope interface below the Great South Channel.

During May-June the number of humpback whale sightings increased dramatically (Table 16). Humpbacks were located in southern New England waters from Montauk Point, Long Island east to Cox's Ledge (Fig. 19c). Although a few whales remained in southern New England/Georges Bank shelf waters throughout summer, most humpbacks in the study area were found in the Gulf of Maine during May-June (n = 541/592, Table 16). The distribution of humpback whales in the Gulf of Maine occurred in several discrete clusters between 41°00'N and 43°00'N lats within a narrow corridor extending from the Great South Channel north to Jeffreys Ledge along the 50f contour (Fig. 19c). These clusters

generally occurred east of Cape Cod-Nantucket along the western flank of the Great South Channel, on Stellwagen Bank and on Jeffreys Ledge.

The number of humpback whale sightings in the northern Gulf of Maine-Bay of Fundy and western Scotian Shelf continued to increase during July-August as whales moved north from the southwestern Gulf of Maine-Georges Bank regions (Fig. 19d). Several concentrations of whales also occurred along the shelf-edge/canyon region of Georges Bank. Increased densities of humpback whales during late summer have been previously reported from the Bay of Fundy (Neave and Wright 1968; Kraus and Prescott 1981; 1982).

Ninety-three percent of the humpback whale sightings during September-October (n = 232/250) occurred in the Gulf of Maine (Table 16). The number of sightings on the southern New England shelf decreased during this period (Table 16) and the whale sightings east of Montauk Point were no longer present (Fig. 19e).

Humpback whales remained in the southwest Gulf of Maine through December (Fig. 19f), however there was a significant decrease in the number of sightings (Table 16) and overall abundance during November-December. Humpbacks moved southwest from the northern Gulf-Bay of Fundy regions and northeast Georges Bank during this period. Reports of humpback whales from the southwest Gulf of Maine to the Great South Channel were also reduced in number at this time. Based on the lack of sightings throughout the remainder of the study area, most humpbacks must migrate south to wintering grounds in slope waters seaward of the study area.

Ecological and Management Considerations

During the mid 1970's the center of the humpback whale feeding distribution in the Gulf of Maine shifted southward in response to increased densities of sandlance in the lower Gulf of Maine (Mullane and Rivers 1982; Payne et al. 1986). When considered with previous sighting data and observations of feed-

ing humpbacks (Overholtz and Nicolas 1979; Kenney et al. 1981; Mayo 1982, 1983; Hain et al. 1982; Weinrich et al. 1985; Winn and Reichley 1985; Mayo et al. 1988) there is little doubt that sandlance has been the most important prey of humpbacks in the Gulf of Maine since the mid-1970's.

This predator-prey relationship was further emphasized during 1986 when sandlance abundance on Stellwagen Bank declined. Between 1982-1985 the number and distribution of humpback whale sightings in the southwest Gulf of Maine remained fairly stable (Figs. 19g-19h). Then during 1986 sandlance abundance declined to near-zero (based on NMFS/NEFC spring and autumn bottom trawl surveys data, presented in Nelson and Ross 1991) and humpbacks evacuated this area (Fig. 19i) for the first time since the sandlance population explosion in 1975 (Payne et al. 1990c). Most of the humpbacks relocated to the Great South Channel (Fig. 19i) or moved northeast over Georges Bank to the western Scotian Shelf. During 1987 a small increase in sandlance abundance on Stellwagen Bank resulted in the return of a few humpback whales to the area (Fig. 19i). A regional maximum abundance of sandlance on Stellwagen Bank in 1988 (from Nelson and Ross 1991) was followed by an increased abundance of humpbacks on Stellwagen to pre- 1986 levels (Payne et al. 1990c). Similar shifts in the distribution of humpback whales in response to changes in the distribution and abundance of prey have been described elsewhere (Lien et al. 1979; Perkins and Beamish 1979; Bryant et al. 1981; Whitehead and Lien 1982; Whitehead 1983; Lynch and Whitehead 1984; Whitehead and Carscadden 1985).

During winter humpbacks have also been observed feeding on Atlantic mackerel in Cape Cod Bay and east of Nantucket. The most significant die-off of baleen whales in the study area occurred during November-December 1987 and January 1988, when 14 humpbacks died in Cape Cod Bay after eating Atlantic mackerel containing a dinoflagellate neurotoxin (Geraci et al. 1989).

Humpbacks have been entangled in gillnet fishing gear on several occa-

sions in the southwest Gulf of Maine (Kraus 1990a).

Northern Right Whale Eubalaena glacialis

Despite the rarity of this species, right whale aggregations within the Gulf of Maine-Bay of Fundy regions have been well defined (Fig. 20). Approximately ninety-percent of all right whale sightings (n = 625/700, Table 17) occurred in the Gulf of Maine. The large number of sightings was due largely to increased sighting effort as a result of dedicated right whale surveys (see METHODS-Collection of Whale Sighting Data). There have been no large aggregations of right whales found in the study area south of 40°00'N lat.

From March to at least mid-October right whales move between several locations north of 41°00'N lat. During late-winter through spring most sightings occurred in a patchy distribution from the Great South Channel (generally in the V-shaped basin formed by 50f contour) north throughout the southwest Gulf of Maine (including Cape Cod Bay) to Jeffreys Ledge and Basin (Fig. 20). During late summer-autumn right whale sightings north of 40°00'N lat are concentrated in the lower Bay of Fundy, and on the Browns Bank-southern Scotian shelf (Fig. 20). Right whale occurrence in these two areas are temporaly disjunct, generally, from those in the southwest Gulf of Maine.

Right whales also have a seasonal occurrence (January-April) in the mid-Atlantic (Table 17) near Cape Hatteras (Fig. 20). A winter (January to early-March) right whale fishery occurred, historically, from South Carolina-Georgia north to Cape Hatteras (Holder 1883; Earll 1887a, 1887b; Brimley 1894; summarized in Reeves and Mitchell 1986, 1988). The coastal coves from South Carolina to Florida (and possibly the Gulf of Mexico, Moore and Clark 1963) have also been well documented as historical calving areas (Reeves et al. 1978). At least part of the North Atlantic population still overwinters along the coast from North Carolina to Florida (Kraus et al. 1986, 1989; Winn 1984) and relatively newborn calves have been observed in the Georgia-Florida Bight

(Kraus et al. 1986). This wintering group has been tied with those whales that move into the Gulf of Maine-lower Bay of Fundy during the spring and summer (Kraus et al. 1986).

Right whale sightings north and northeast of the Scotian Shelf are considered rare (Lien et al. 1989; Sigurjonsson et al. 1989). However, a right whale observed between Iceland and eastern Greenland in July 1987 (Sigurjonsson et al. 1989) was later photographed at 42°11'N-65°43'W (south of Nova Scotia) during June 1989 (S. Kraus, pers. comm.) extending the range of a potential single population of right whales in the western North Atlantic from Georgia-Florida to Greenland-Iceland.

Seasonal Distributon and Movements

Right whale sightings are extremely limited north of Cape Hatteras during January-February (Fig. 20a). Nine of the 13 sightings during this 2-month period occurred in the mid-Atlantic/southern New England regions (Table 17). Right whales were observed east of Cape Hatteras in five different years of the study period primarily from January through April (Figs. 20a-20b). During January-February right whale sightings also occurred in the southern Gulf of Maine-Cape Cod Bay (Fig. 20a).

The present sighting data, combined with historical information south of Long Island (True 1904; Ulmer 1961; Reeves 1976a; Reeves et al. 1978; Reeves and Brownell 1982; Reeves and Mitchell 1986) indicate a progressive northward movement through the mid-Atlantic/southern New England regions during mid-winter. This loosely structured northward movement coalesces in in the lower Gulf of Maine-Great South Channel region (Figs. 24a-24c) between February and May (Allen 1908; Allen 1916; Mayo 1982; Watkins and Schevill 1982; Scott et al. 1985; Schevill et al. 1986; Mayo et al. 1988; Kenney et al. 1986; Wishner et al. 1988; Brown and Winn 1989; Hamilton and Mayo 1990).

During March-April right whale sightings increased north of 40°00'N lat from the shelf-edge below the V-shaped 50f contour of the Great South

Channel/western Georges Bank north to Cape Cod Bay and Stellwagen Bank (Fig. 20b). Right whales in Cape Cod Bay have been observed skim feeding, socializing and courting since the early 1950s (Watkins and Schevill 1976, 1979; Mayo et al. 1985, 1987; Mayo and Marx 1990; Schevill et al. 1986; Hamilton and Mayo 1990). Mayo et al. (1985) suggested that Stellwagen Basin-eastern Stellwagen Bank are also important areas for social activity.

Right whale sightings increased significantly during May-June (Table 17) due not only to a movement of right whales into the area but also, at least in part, to increased survey effort throughout the lower Gulf of Maine/Great South Channel. By May-June right whale sightings occurred from the lower Gulf of Maine-Great South Channel into the lower Bay of Fundy and Scotian shelf regions (Fig. 20c). A few right whales sometimes remained in the southern Gulf of Maine-Great South Channel regions throughout summer. However from July through October the number of sightings in the Gulf of Maine decreased dramatically (Table 17) and the right whale distribution moved northward (Figs. 20d-20e) and becomes centered in the lower Bay of Fundy and on the southern Scotian shelf (CeTAP 1982; Reeves et al. 1983; Cummings 1985b; Kraus 1985; Kraus and Prescott 1982; Kraus et al. 1984, 1986, 1989; Hay 1985b; Mitchell et al. 1986; Winn et al. 1986, 1987; Gaskin 1987; Stone et al. 1988; Murison and Gaskin 1989). This seasonal pattern was generally repeated in all years between 1978 and 1988, except 1986 when right whales were observed on Stellwagen Bank virtually every day throughout the summer (Hamilton and Mayo 1990; Payne et al. 1990c). Right whale activity in the Bay of Fundy continues through October, however most of the whales disperse southward by November (Fig. 20f).

During November-December only 26 right whale sightings occurred in the study area (Table 17), 85% of these (n =22) occurred in the Gulf of Maine. Some right whales migrate southward from the Bay of Fundy-Scotian Shelf re-

gions through the Gulf of Maine (Figs. 20e-20f). However, much of the right whale southward migration route is unknown. The few individuals observed November-December in the southwestern Gulf of Maine from Jeffreys Ledge to Cape Cod Bay (Fig. 20f) do not account for the numbers observed throughout mid-summer in the Bay of Fundy-Scotian Shelf regions. There were no right whale sightings in the eastern Bay of Fundy-Browns Bank and Scotian Shelf during November-December (Fig. 20f). Right whales may move southward outside of Georges Bank along the shelf-edge, or in slope waters seaward of the study area. Winn et al. (1986) suggested that right whales do not pause for any protracted time in shelf/slope waters during their southward migration, but rather move offshore eventually appearing off Georgia-Florida or near Cape Hatteras, completing the annual cycle.

Ecological and Management Considerations

The commercial "extinction" of right whales represents one of the most serious depletions of a large whale species in the western North Atlantic (Reeves and Mitchell 1986). Despite decades of protection Schevill et al. (1986) suggested that right whale numbers around Cape Cod Bay have not changed significantly since the 17th century. Possible reasons speculated for the non-recovery of this species include the combined effects of ship traffic, marine pollution and coastal development in North Atlantic calving grounds (Reeves 1982; Braham and Rice 1984; Hay 1985b), competition for available prey with other copepod-feeding whales (Mitchell 1975d; Mitchell et al. 1986) and finfish (Kenney et al. 1986; Payne et al. 1990c) and human induced mortality through entanglement and collision with vessels (Kraus 1990b). NOAA/NMFS (1990) considered the latter to be the most important impact on right whales at the present.

Recovery actions recommended by NOAA/NMFS (1990) included a reduction in the risk of ship collisions through education and enforcement, regulation of

certain fishing gear types which entangle right whales, the regulation of recreational whale watching activities directed at right whales and the designation of certain areas as critical habitat for right whales.

LITERATURE CITED

Agler, B. A., J. A. Beard, R. S. Bowman, H. D. Corbett, S. W. Frohock, M. P. Hawvermale, S. K. Katona, S. S. Sadove and I. E. Seipt. 1990. Fin whale (Balaenoptera physalus) photographic identification: methodology and preliminary results from the western North Atlantic. Rept. int. Whal. Commn. (Spec. Issue 12): 349-356.

Allen, G. M. 1906. Sowerby's whale on the American coast. Amer. Naturalist 40: 357-370.

Allen, G. M. 1916. The whalebone whales of New England. Mem. Boston Soc. Nat. Hist. 8: 107-322.

Allen, G. M. 1939. True's beaked whale in Nova Scotia. J. Mammal. 20: 259-260.

Andrews, R. C. 1914. Notice of rare Ziphioid whale, Mesoplodon densirostris, on the New Jersey coast. Proc. Acad. Nat. Sci. (Philadelphia) 66: 437-440.

Allen, J. A. 1908. The North Atlantic right whale and its near allies. Bull. Amer. Mus. Nat. Hist. 24: 277-329.

Alling, A. K. and H. P. Whitehead. 1987. A preliminary study of the status of white-beaked dolphins, Lagenorhynchus albirostris, and other small cetaceans off the coast of Labrador.

Anthony, V. A. and G. Waring. 1980. The assessment and management of the Georges Bank herring fishery. Rapp. P.-v. Reun. Cons. int. explor. Mer. 177: 72-111.

Azarovitz, T. R. 1981. A brief historical review of the Woods Hole Laboratory trawl survey time series. pp. 62-67 in W. G. Doubleday and D. Rivard (Eds.), Bottom Trawl Surveys. Can. Spec. Publ. Fish. Aquat. Sci. 58.

Backus, R. H. and W. E. Schevill. 1961. The stranding of a Cuviers beaked whale (Ziphius cavirostris) in Rhode Island, USA. Norsk Hval. 50: 177-181.

Balcomb, K. C. and G. Nichols. 1978. Western North Atlantic humpback whales. Rep. int. Whal. Commn 28: 159-164.

Banefield, A. W. F. 1977. The mammals of Canada. Univ. Toronto Press, Toronto, Canada.

Barros, N. B. and D. K. Odell. 1990. Food habits of bottlenose dolphins in the southeastern United States. pp. 309-328 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Benjamin, T. and I. Christensen. 1979. The natural history of the bottlenose whale, Hyperoodon ampullatus Forster. pp. 143-164 in H. E. Winn and B. L. Olla (Eds.), Behavior of Martine Mammals, Plenum Press, New York.

Best, P. B. 1975. Status of the Bryde's whale (Balaenoptera edeni). FAO Advis. Commn on Mar. Resources Res., Marine Mammal Symposium, August 1975, Bergen, Norway.

Bloch, D., T. Gunnlaugsson, K. Hoydal, and J. Sigurjonsson. 1989a. Distribution and abundance of pilot whale (Globicephala melas) in the northeast Atlantic in June-August 1987, based on shipboard sightings survey. Rep. int. Whal. Commn, Sci. Comm. SC/41/SM10 (to be published as Rep. Int. Whal. Commn, Spec. Issue on pilot whales in the North Atlantic: in press).

Bloch, D., Desports, G., Mouritsen, R., Debes Dahl, M., Skaaning, S. and Stefansson, E. 1989b. Study on the ecology and status of the long-finned pilot whale (Globicephala melas Traill) off the Faroe Islands in the period 1986 to 1988. Rep. int. Whal. Commn, Sci. Comm. SC/41/SM (to be published as Rep. Int. Whal. Commn, Spec. Issue on pilot whales in the North Atlantic: in press).

Bloch, D., G. Desportes, K. Hoydal and P. Jean. 1990. Pilot whaling in the Faroe Islands, July 1986-July 1988. North Atlantic Studies 2 (No. 1 + 2): 36-44.

Bowman, R., J. Warzocha and T. Morris. 1984. Trophic relationships between Atlantic mackerel and American sandlance. Int. Counc. Exp. Sea (ICES), Document C.M. 1984/H:27. 10 pp.

Braham, H. W. and D. W. Rice. 1984. The right whale, Balaena glacialis. Mar. Fish. Rev. 46(4): 38-44.

Brimley, H. H. 1894. Whale fishing in North carolina. Bull. N. C. Dep. Agric. 14(7): 4-8.

Brimley, H. H. 1937. The false killer whale on the North Carolina coast. J. Mammal. 18: 71-73.

Brimley, H. H. 1943. A second specimen of True's beaked whale, Mesoplodon mirus True, from North Carolina. J. Mammal. 24: 199-203.

Brimley, H. H. 1945. Kogia breviceps and Mesoplodon mirus in the neighborhood of the Oregon Inlet, North Carolina. J. Mammal. 26: 434.

Brodie, P. F. 1990. The White Whale-Delphinapterus leucas (Pallas, 1776), pp. 119-144 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.4, River Dolphins and the large Toothed whales), Academic Press, London.

Brown, C. W. and H. E. Winn. 1989. Relationship between the distribution pattern of right whales, Eubalaena glacialis, and satellite-derived sea surface thermal structure in the Great South Channel. Cont. Shelf Res. 9: 247-260.

Bryant, P. J., G. Nichols, T. B. Bryant and K. Miller. 1981. Krill availability and the distribution of humpback whales in southeastern Alaska. J. Mammal., 62: 427-430.

Bumpus, D. F. 1976. Review of the physical oceanography of Georges Bank.

Int. Comm. Northw. Atl. Fish. Bull. 12: 119-134.

Burn, D. M., G. P. Scott, R. E. Owen and L. J. Hansen. 1987. Bottlenose dolphin (Tursiops truncatus) distribution patterns in the southeastern United States. pp. 8 in Abstracts of the Seventh Bienniel Conference on the Biology of Marine Mammals, 5-9 December, Miami, Florida.

Burnham, K.P., D.R. Anderson, and J.F. Laake. 1980. Estimation of density from line transect sampling of biological populations. Wildl. Monogr. No. 72. 202 pp.

Caldwell, D. K. 1955. Notes on the spotted dolphin, Stenella plagiodon, and the first record of the common dolphin, Delphinus delphis, in the Gulf of Mexico. J. Mammal. 36: 467-470.

Caldwell, D. K. 1964. A new record for the beaked whale, Mesosplodon europaeus, from Jamaica. Carib. J. Sci. 4: 547.

Caldwell, D. K. and M. C. Caldwell. 1966. Observations on the distribution, coloration, behavior and audible sound production of the spotted dolphin, Stenella plagiodon (Cope). Contr. in Science 104, Los Angeles county Museum of Natural History,, 27 pp.

Caldwell, D. K., H. Neuhauser, M. C. Caldwell and H. W. Coolidge. 1971a. Recent records of marine mammals from the coasts of Georgia and South Carolina. Cetology 5: 1-12.

Caldwell, D. K., M. C. Caldwell, W. F. Rathjen, and J. R. Sullivan. 1971b. Cetaceans from the Lesser Antillean island of St. Vincent. Fish. Bull. 69: 303-312.

Caldwell, D. C. and M. C. Caldwell. 1971c. The pygmy killer whale, Feresa attenuata, in the western Atlantic, with a summary of world records. J. Mammal. 52: 206-209.

Caldwell, D. K. and M. C. Caldwell. 1973. Marine mammals of the eastern Gulf of Mexico. pp. 1-23 in J. I. Jones, R. E. Ring, M. O. Rinkel and R. E. Smith (Eds.), A summary of knowledge of the eastern Gulf of Mexico. State University System of Florida Institute of Oceanography, Vol. III-1.

Caldwell, D. K. and M. C. Caldwell. 1974. Marine mammals from the southeastern United States coast: Cape Hatteras to Cape Canaveral. pp.704-772. in: A socio-economic environmental baseline summary for the south Atlantic region between Cape Hatteras, North Carolina and Cape Canaveral, Florida. Virginia Institute of Marine Science, Gloucester Point, Virginia.

Caldwell, D. K. and M. C. Caldwell. 1975. Dolphin and small-whale fisheries of the Caribbean and West Indies: occurrence, history and catch statistics-with special reference to the Lesser Antillean island of St. Vincent. J. Fish. Res. Board Canada 32: 1105-1110.

Caldwell, D. K. and M. C. Caldwell. 1990. Pygmy Sperm Whale-Kogia breviceps (de Blainville, 1838): Dwarf Sperm Whale-Kogia simus Owen, 1866. pp. 235-260 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of

Marine Mammals: (Vol.4, River Dolphins and the large Toothed whales), Academic Press, London.

Caldwell, D. K. and D. S. Erdman. 1963. The pilot whale in the West Indies. J. Mammal. 44: 113-115.

Caldwell, D. K. and F. B. Golley. 1965. Marine mammals from the coast of Georgia to Cape Hatteras. J. Elisha Mitchell Sci. Soc. 81: 24-32.

Caldwell, D. K., M. C. Caldwell, and C. M. Walker. 1970. Mass and individial strandings of false killer whales, Pseudorca crassidens, in Florida. J. Mammalogy 51: 634-636.

Carter, G. R., F. M. Fairfield and H. E. Winn. 1981. Occurrence of beaked whales (Ziphiidae) in the western North Atlantic. (no page numbers) in Abstracts of the Fourth Bienniel Conference on the Biology of Marine Mammals, 14-18 December, San Francisco, California.

Cetacean and Turtle Assessment Program (CeTAP). 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U. S. outer continental shelf, Final Report of the Cetacean and Turtle Assessment Program. H. E. Winn (Ed.), U.S. Dept. of the Interior, Bureau of Land Management, Final Report. Contract No. AA551-CT8-48, Washington D. C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Ref. No. PB83215855]. 538 pp.

Clark, A. H. 1887. The Blackfish and porpoise fisheries. Part XVI, pp. 297-310 in G.B. Goode (Ed.), The Fisheries and Fishery Industries of the United States. Section II. A geographical review of the fisheries industries and fishing communities for the year 1880. U. S. Government Printing Office, Wash. D.C., 788 pp.

Clark, S. H. and B. E. Brown. 1977. Changes in biomass of finfishes and squid from the Gulf of Maine to Cape Hatteras, 1963-1974, as determined from research vessel survey data. Fish. Bull. 75: 1-21.

Cohen, E. B. and Grosslein, M. D. 1986. Production on Georges Bank compared with other shelf ecosystems. pp. 382-393. In R. H. Backus and D. W. Bourne (Eds.) Georges Bank and its surroundings, MIT Press, Cambridge, Massachusetts.

Collum L. A. and T. H. Fritts. 1985. Sperm whales (Physeter catadon) in the Gulf of Mexico. Southwest Nat. 30: 101-104.

Connor, P. F. 1971. The mammals of Long Island, New York. New York State Museum and Science Serv. Bull. 416: 1-78.

Cummings, W. C. 1985a. Bryde's Whale-Balaenoptera edeni, pp. 137-154 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic Press, London.

Cummings, W. C. 1985b. Right Whales, pp. 275-304 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic Press, London.

Dix, L., J. Lien and D. E. Sergeant. 1986. A North Sea beaked whale, Meso-

plodon bidens, in Conception Bay, Newfoundland. Canadian Field-Naturalist 100: 389-391.

Dorf, B. A. 1982. Oceanographic factors and cetacean distributions in the Gulf of Mexico. Ms. Thesis, Texas A & M University, Galveston, Texas. 122 pp.

Dorsey, E. M. 1983. Exclusive adjoining ranges in individually identified minke whales (Balaenoptera acutorostrata) in Washington State. Can. J. Zool. 61: 174-181.

Dorsey, E. M., S. J. Stern, A. R. Hoelzel and J. Jacobsen. 1990. Minke whales (Balaenoptera acutorostrata) from the west coast of North America: individual recognition and small-scale site fideltiy. Rept. int. Whal. Commn. (Spec. Issue 12): 357-369.

Duffield, D. A., S. H. Ridgway and L. H. Cornell. 1983. Hematology distinguishes coastal and offshore forms of dolphins (Tursiops). Can. J. Zool. 61: 930-933.

Earle, M. 1990. Observations on tuna and swordfish driftnet fisheries. Paper SC/090/G42 presented to the IWC Workshop on mortality of cetaceans in passive fishing nets and traps, 22-25 October 1990, LaJolla, California, 3 pp.

Earll, R. E. 1887a. North Carolina and its fisheries. Part XII, pp. 475-97 in G.B. Goode (Ed.), The Fisheries and Fishery Industries of the United States. Section II. A geographical review of the fisheries industries and fishing communities for the year 1880. U. S. Government Printing Office, Washington, D.C. 788 pp.

Earll, R. E. 1887b. South Carolina and its fisheries. Part XIII, pp. 499-518 in G.B. Goode (Ed.), The Fisheries and Fishery Industries of the United States. Section II. A geographical review of the fisheries industries and fishing communities for the year 1880. U. S. Government Printing Office, Washington, D.C. 788 pp.

Edel, R. K., M. A. M. Hyman and M. F. Tyrell. 1981a. Introduction to 1979 Annual Report. pp. I-1-66 in A Characterization of marine mammals and turtles in the Mid- and North- Atlantic areas of the U.S. Outer Continental Shelf, Ann. Report for 1979. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Ref. No. PB81243289].

Edel, R. K., M. Cagan, J. H. W. Hain, P. W. Sorensen. 1981b. Correlations between cetacean sightings and selected environmental variables. pp. VII-1-140 in A Characterization of marine mammals and turtles in the Mid- and North- Atlantic areas of the U.S. Outer Continental Shelf, Ann. Report for 1979. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Ref. No. PB81243289].

Edds, P. L. and J. A. F. MacFarlane. 1987. Occurrence and general behavior of balaenopterid cetaceans summering in the St. Lawrence Estuary, Canada. Can. J. Zool. 65: 1363-1376.

Erdman. 1970. Marine mammals from Puerto Rico to Antiqua. J. Mammal. 51: 636-639.

Erdman, D. S., J. Harms and M. M. Flores. 1973. Cetacean records fromthe northeastern Caribbean region. Cetology 17: 1-14.

Fairfield, C. P. and G. T. Waring. 1989. Co-distribution and interactions of pilot whales and the foreign Atlantic mackerel fishery in the mid-Atlantic Bight, 1984-88. Rept. Int. Whal. Commn Doc. SC/41/SM19, presented to the IWC Scientific Committe, June 1989. Available Rept. int. Whal. Commn (Spec. Issue), in press.

Federal Register. 1989. Taking of marine mammals incidental to commercial fishing operations; Interim exemption for commercial fisheries; notice. pp. 16072-16086 in NOAA/Department of Commerce, Washington, D.C., Fed. Reg., Vol. 54 (No. 75-Part III), 20 April 1989.

Finley, K. J., G. W. Miller, M. Allard, R. A. Davis. and C. R. Evans. 1982. The belugas (Delphinapterus leucas) of northern Quebec: Distribution, abundance, stock identity, catch history and management. Canadian Tech. Rept. Fish. and Aquatic Sci., No.1123. 57 pp.

Fisher, H. D. and D. E. Sergeant. 1954. A white whale in the Bay of Fundy. Can. Field-Naturalist 68: 138-139.

Flagg, C. N. 1986. Hydrographic structure and variability. pp. 108-124 In R. H. Backus and D. W. Bourne (Eds.) Georges Bank and its surroundings. MIT Press, Cambridge, Massuchusetts.

Ford, R. G. 1989. CAMRIS-Computer Aided Mapping and Resource Inventory System, 64 pp. (Available Ecological Consulting, Inc., Portland, Oregon).

Fritts, T. H. and R. P. Reynolds. 1981. Pilot study of the marine mammals, birds and turtles in OCS areas of the Gulf of Mexico. U.S. Fish and Wildl. Service, Office of Biol. Serv., Publ. FWS/OBS-81/36, September 1981. 150 pp.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collumn, W. Hoffman and M. A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U. S. Fish and Wildl. Service, Office of Biol. Serv., Publ. FWS/OBS-82/65, July 1983. 455 pp.

Gambell, R. 1985a. Fin Whale-Balaenoptera physlaus, pp. 171-192 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic Press, London.

Gambell, R. 1985b. Sei Whale-Balaenoptera borealis, pp. 155-170 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic Press, London.

Gaskin, D. E. 1968. The Distribution of Delphinidae (Cetacea) in relation to sea surface temperatures off eastern and southern New Zealand. New Zealand J. Mar. Freshwater Res. 2: 527-534.

Gaskin, D. E. 1977. Harbour porpoise Phocoena phocoena (L.) in the western approaches to the Bay of Fundy. Rep. int. Whal. Commn 27: 487-492.

Gaskin, D. E. 1984. The harbour porpoise Phocoena phocoena (L.): Regional populations, status, and information on direct and indirect catches. Rep. int. Whal. Commn 34: 569-586.

Gaskin, D. E. 1987. Updated status of the right whale, Eubalaena glacialis. Can. Field-Naturalist 101: 295-309.

Gaskin, D. E. and A. P. Watson. 1985. The harbor porpoise, Phocoena phocoena, in Fish Harbour, New Brunswick, Canada: Occupancy, distribution, and movements. Fish. Bull. 83: 427-442.

Gaskin, D. E., G. J. D. Smith, and A. P. Watson. 1975. Preliminary study of harbor porpoises (Phocoena phocoena) in the Bay of Fundy using radiotelemetry. Can. J. Zool. 53: 1466-1471.

Geraci, J. R. and D. J. St. Aubin. 1977. Mass-stranding of the long finned pilot whale, Globicephala melaena, on Sable Island, Nova Scotia. J. Fish. Res. Board Can. 34: 2196-2199.

Geraci, J. R., D. M. Anderson, R. J. Timperi, D. J. St. Aubin, G. A. Early, J. H. Prescott and C. A. Mayo. 1989. Humpback whales (Megaptera novaeangliae) fatally poisoned by dinoflagellate toxin. Can. J. Fish. Aquat. Sci. 46: 1895-1898.

Gilbert, J. R. and K. M. Wynne. 1983. Harbor seal populations and marine mammal-fisheries interactions, 1982, 2nd Annual Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NA-80-FA-C-00029. 43 pp.

Gilbert, J. R. and K. M. Wynne. 1984. Harbor seal populations and marine mammal-fisheries interactions, 1983, 3rd Annual Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NA-80-FA-C-00029. 52 pp.

Gilbert, J. R. and K. M. Wynne. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. Annual Report, National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole, Massachusetts, Contract No. NA-84-EA-C-00070, 15 pp.

Gilbert, J. R. and K. M. Wynne. 1988. Marine mammal interactions with New England gillnet fisheries. Final Report, National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole, Massachusetts, Contract No. NA-84-EA-C-00070, 21 pp.

Golley, F. B. 1966. South Carolina Mammals. Charleston Museum, Charleston, S. Carolina.

Goode, G. B. (Ed.). 1884. The whales and porpoises, in Natural History of Useful Aquatic Animals, Section 1. U.S. Commn Fish and Fisheries. Washington, D.C.

Gosho, M. E., D. W. Rice and J. M. Breiwick. 1984. The sperm whale, Physeter macrocephalus. Mar. Fish. Rev. 46(4): 54-64.

Grosslein, M. D. 1969. Groundfish survey program of BCF Woods Hole. Commer. Fish. Rev. 31 (8-9): 22-35.

Grosslein, M. D., R. W. Langton, and M. P. Sissenwine. 1980. Recent fluctuations in pelagic fish stocks of the northwest Atlantic, Georges Bank region, in relation to species interactions. Rapp. P. - v. Reun. Cons. Int. Explor. Mer. 177: 374-404.

Gunter, G. 1955. Blainsville's beaked whale, Mesoplodon densirostris, on the Texas coast. J. Mammal. 36: 573-574.

Gunter, G. 1954. Mammals of the Gulf of Mexico. pp. 543-551 in P. S. Galtsoff (Ed.), Gulf of Mexico. Its origin, waters, and marine life. U. S. Fish and Wildlife Surv., Fish. Bull. 55(89).

Hain, J. H. W., G. R. Carter, S. D. Kraus, C. A. Mayo, H. E. Winn. 1982. Feeding behavior of the humpback whale, Megaptera novaeangliae, in the western North Atlantic. Fish. Bull. 80: 259-268.

Hain, J. H. W., R. K. Edel, H. E. Hays, S. K. Katona, and J. D. Roanowicz. 1981. General distribution of cetaceans in the continental shelf waters of the northeastern United States. pp. II-1-345 In A characterization of marine mammals and turtles in the Mid- and north Atlantic areas of the U. S. outer continental shelf, Annual Report for 1979, U.S. Dept.of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C.

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985. The role of cetaceans in the shelf edge region of the western North Atlantic. Mar. Fish. Rev., 47: 13-17.

Hamilton, P. K. and C. A. Mayo. 1990. Population characteristics of right whales (Eubalaena glacialis) observed in Cape Cod and Massachusetts Bays, 1978-1986. Rep. int. Whal. Commn (Spec. Issue 12): 203-208.

Handley, C. O. 1966. A synopsis of the genus Kogia (pygmy sperm whale). pp. 62-69 in K. S. Norris (Ed.), Whales, Dolphins, and Porpoises. Univ. of California Press, Berkeley, California.

Hay, K. A. 1982. Aerial line-transect estimates of abundance of humpback, fin, and long-finned pilot whales in the Newfoundland-Labrador area. Rep. int. Whal. Commn 32: 475-486.

Hay, K. A. 1985a. Status of the humpback whale, Megaptera novaeangliae, in Canada. Canadian Field-Naturalist 99: 425-432.

Hay, K. A. 1985b. Status of the right whale, Eubalaena glacialis, in Canada Canadian Field-Naturalist 99: 433-437.

Hersh, S. L. and D. A. Duffield. 1990. Distinction between Northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. pp. 129-139 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Heyning, J. E. 1990. Cuvier's beaked whale-Ziphius cavirostris G. Cuvier,

Grosslein, M. D. 1969. Groundfish survey program of BCF Woods Hole. Commer. Fish. Rev. 31 (8-9): 22-35.

Grosslein, M. D., R. W. Langton, and M. P. Sissenwine. 1980. Recent fluctuations in pelagic fish stocks of the northwest Atlantic, Georges Bank region, in relation to species interactions. Rapp. P. - v. Reun. Cons. Int. Explor. Mer. 177: 374-404.

Gunter, G. 1955. Blainsville's beaked whale, Mesoplodon densirostris, on the Texas coast. J. Mammal. 36: 573-574.

Gunter, G. 1954. Mammals of the Gulf of Mexico. pp. 543-551 in P. S. Galtsoff (Ed.), Gulf of Mexico. Its origin, waters, and marine life. U. S. Fish and Wildlife Surv., Fish. Bull. 55(89).

Hain, J. H. W., G. R. Carter, S. D. Kraus, C. A. Mayo, H. E. Winn. 1982. Feeding behavior of the humpback whale, Megaptera novaeangliae, in the western North Atlantic. Fish. Bull. 80: 259-268.

Hain, J. H. W., R. K. Edel, H. E. Hays, S. K. Katona, and J. D. Roanowicz. 1981. General distribution of cetaceans in the continental shelf waters of the northeastern United States. pp. II-1-345 In A characterization of marine mammals and turtles in the Mid- and north Atlantic areas of the U. S. outer continental shelf, Annual Report for 1979, U.S. Dept.of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C.

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985. The role of cetaceans in the shelf edge region of the western North Atlantic. Mar. Fish. Rev., 47: 13-17.

Hamilton, P. K. and C. A. Mayo. 1990. Population characteristics of right whales (Eubalaena glacialis) observed in Cape Cod and Massachusetts Bays, 1978-1986. Rep. int. Whal. Commn (Spec. Issue 12): 203-208.

Handley, C. O. 1966. A synopsis of the genus Kogia (pygmy sperm whale). pp. 62-69 in K. S. Norris (Ed.), Whales, Dolphins, and Porpoises. Univ. of California Press, Berkeley, California.

Hay, K. A. 1982. Aerial line-transect estimates of abundance of humpback, fin, and long-finned pilot whales in the Newfoundland-Labrador area. Rep. int. Whal. Commn 32: 475-486.

Hay, K. A. 1985a. Status of the humpback whale, Megaptera novaeangliae, in Canada. Canadian Field-Naturalist 99: 425-432.

Hay, K. A. 1985b. Status of the right whale, Eubalaena glacialis, in Canada Canadian Field-Naturalist 99: 433-437.

Hersh, S. L. and D. A. Duffield. 1990. Distinction between Northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. pp. 129-139 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Heyning, J. E. 1990. Cuvier's beaked whale-Ziphius cavirostris G. Cuvier,

1823. pp. 289-308 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.4, River Dolphins and the large Toothed whales), Academic Press, London.

Holder, J. B. 1883. The Atlantic right whales: a contribution. Bull. Amer. Mus. Nat. Hist. 1: 99-113.

Hopkins, T. S. and Garfield III, N. 1979. Gulf of Maine intermediate water. J. Mar. Res. 37: 103-139.

Hopkins, T. S. and N. Garfield, III. 1981. Physical origins of Georges Bank water. J. Mar. Res. 39: 465-500.

Houston, J. 1990a. Status of Blainville's beaked whale, Mesoplodon densirostris, in Canada. Canadian Field-Naturalist 104:117-120.

Houston, J. 1990b. Status of True's beaked whale, Mesoplodon mirus, in Canada. Canadian Field-Naturalist 104:135-137.

International Whaling Commission (IWC). 1990. Report of the Workshop on mortality of cetaceans in passive fishing nets and traps, 22-25 October, La Jolla, California (to be published as a Special Issue of the IWC).

Irvine, A. B., M. D. Scott, and R. S. Wells, and J. H. Kaufmann. 1981. Movements and activities of Atlantic bottlenose dolphins, Tursiops truncatus, near Sarasota Florida. Fish. Bull. 79: 671-688.

Irvine, A. B., R. S. Wells, and M. D. Scott. 1982. An evaluation of techniques for tagging small odontocete cetaceans. Fish. Bull. 80: 135-143.

Ivashin, M. V. 1980. On the populations of Bryde's whale (Balaenoptera edeni Anderson, 1878). Rep. int. Whal. Commn 30: 233-235.

Jennings, R. 1982. Pelagic sightings of Risso's dolphin, Grampus griseus, in the Gulf of Mexico and Atlantic Ocean adjacent to Florida. J. Mammal. 63: 522-523.

Johnson, J. H. and A. A. Wolman. 1984. The humpback whale, Megaptera novaeangliae. Mar. Fish. Rev. 46(4): 30-37.

Jonsgard, A. 1951. Studies on the little piked whale or minke whale (Balaenoptera acutorostrata Lacepede). Nor. Hvalfangst-Tid. 40: 209-232.

Jonsgard, A. 1955. The stocks of blue whales (Balaenoptera musculus) in the North Atlantic Ocean and adjacent Arctic waters. Norsk. Hvalf.-Tid.,44: 505-519.

Jonsgard, A. 1966a. The distribution of Balaenopteridae in the North Atlantic Ocean. pp. 114-124 in K. S. Norris (Ed.), Whale, dolphins, and porpoises, Univ. of California Press, Berkley and Los Angeles.

Jonsgard, A. 1966b. Biology of the North Atlantic fin whale Balaenoptera physalus (L.). Taxonomy, distribution, migration and food. Hval.-Skrifter, Sci. Results of Mar. Biol. Res., No. 49. Oslo, Norway. 62 pp.

Jonsgard, A. 1982. The food of minke whales (Balaenoptera acutorostrata) in

northern North Atlantic waters. Rep. int. Whal. Commn. 32: 259-26.

Jonsgard, A. and K. Darling. 1977. On the biology of the eastern North Atlantic Sei whale, Balaenoptera borealis Lesson. Rept. int. Whal. Commn (Spec. Issue 1): 124-129.

Jonsgaard, A. and O. Nordli. 1952. Concerning a catch of white-sided dolphins (Lagenorhynchus acutus) on the west coast of Norway, winter 1952. Norsk Hvalfangst.-tid., 5: 229-232.

Kapel, F. O. 1975. Preliminary notes on the occurrence and exploitation of smaller cetaceans in Greenland. J. Fish. Res. Board Can. 32: 1079-82.

Kapel, F. O. 1979. Exploitation of large whales in West Greenland in the 20th century. Rep. int. Whal. Commn. 29: 197-214.

Kapel, F. O. 1985. On the occurrence of sei whales (Balaenoptera borealis) in West Greenland waters. Rep. int. Whal. Commn 35: 349-352.

Katona, S. K. 1976. Whales in the Gulf of Maine: 1976, Final Report. Marine Mammal Commn, Washington, D.C., Contract No. MM6AC-018. [Available College of the Atlantic, Bar Harbor, Maine].

Katona, S. K. 1986. Biogecgraphy of the humpback whale Megaptera novaeangliae, in the North Atlantic. in A. C. Pierrot-Balts, S. vanderSpoel, B. J. Zahuranec and R. K. Johnson (Eds.) Pelagic Biogeography, UNESCO Tech. Paper Mar. Sci. 49.

Katona, S. K. and J. A. Beard. 1990. Population size, migrations and feeding aggregations of the humpback whale (Megaptera novaeangliae) in the western North Atlantic ocean. Rept. int. Whal. Commn. (Spec. Issue 12): 295-306.

Katona, S. K. and H. P. Whitehead. 1981. Identifying humpback whales using their natural markings. Polar Rec. 20: 439-444.

Katona, S., B. Baxter, O. Brazier, S. Kraus, J. Perkins and H. Whitehead. 1979. Identification of humpback whales by fluke photographs. pp. 33-34 in H. E. Winn and B. L. Olla (Eds.) Behavior of Marine Animals, Vol. 3. Plenum Press, New York.

Katona, S. K., J. A. Beard and K. C. Balcomb, III. 1984. The humpback whale fluke catalogue, Final Report. National Marine Fisheries Service/Northeast Fisheries Center Contract No. NA-81-FA-C-00027, Woods Hole, Massachusetts.

Katona, S. K., J. A. Beard, P. E. Girton, and F. Wenzel. 1988. Killer whales (Orcinus orca) from the Bay of Fundy to the Equator, including the Gulf of Mexico. pp. 205-220 in J. Sigurjonsson and S. Leatherwood (Eds.), North Atlantic Killer Whales, Rit Fiskideildar, Vol. XI.

Katona, S., Harcourt, P. M., J. S. Perkins, and S. Kraus. 1980. Humpback whales in the Western North Atlantic: a catalogue of identified individuals (2nd Ed.). College of the Atlantic, Bar Harbor, Maine.

Katona, S. K., V. A. Rough and D. T. Richardson. 1983. A field guide to the

whales, porpoises and seals of the Gulf of Maine and eastern Canada-Cape Cod to Newfoundland. Scribner's Sons, New York. pp. 255.

Katona, S., W. Steiner and H. E. Winn. 1978. Marine Mammals pp. XIV- 1-165 in Center for Natural Areas. A summary and analysis of environmental information on the continental shelf from the Bay of Fundy to Cape Hatteras, Vol. 1, Book 2 , Final Report. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA550-CT6-45, Washington, D.C.

Katona, S. K. , S. A. Testaverde, and B. Barr. 1976. Observations on a white-sided dolphin , Lagenorhynchus acutus, probably killed in gill nets in the Gulf of Maine. Fish. Bull. 76: 475-476.

Kawamura, A. 1973. Food and feeding of sei whales caught in the waters south of 40°N in the North Pacific. Sci. Rep. Whales Res. Inst. 25: 219-236.

Kawamura, A. 1974. Food and feeding ecology in the southern sei whale. Sci. Rep. Whales Res. Inst. 26: 25-144.

Kawamura, A. 1980. A review of food of Balaenopterid whales. Sci. Rep. Whales Res. Inst. 32: 155-197.

Kenney, R. D. 1990. Bottlenose dolphins off the northeastern United States. pp. 369-386 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Kenney, R. D. and H. E. Winn. 1986. Cetacean high-use habitats of the north-east U. S. continental shelf. Fish. Bull., 84: 345-357.

Kenney, R. D. and H. E. Winn. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. Cont. Shelf Res., 7: 107-114.

Kenney, R. D., D. R. Goodale, G. P. Scott, and H. E. Winn. 1981. Spatial and temporal distribution of Humpback Whales in the CETAP study area. pp. V-1-32 In A Characterization of marine mammals and turtles in the Mid- and North- Atlantic areas of the U.S. Outer Continental Shelf, Ann. Report for 1979. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Ref. No. PB81243289].

Kenney, R. D., M. A. M. Hyman, R. E. Owen, G. P. Scott and H. E. Winn. 1986. Estimation of prey densities required by western north Atlantic right whales. Mar. Mamm. Sci. 2: 1-13.

Kenney, R. D., M. A. M. Hyman, and H. E. Winn. 1985. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States outer continental shelf. NOAA Tech. Memo. NMFS-F/NEC-41. 99 pp.

Kraus, S. D. 1985. A review of the status of right whales (Eubalaena glacialis) in the western North Atlantic with a summary plan for research and management, Final Report. U.S. Marine Mammal Commn, Washington D.C., Contract No. MMC-84/08. 61 pp. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Report No. PB86-154143].

Kraus, S. D. 1990a. Incidental take of cetaceans by fishing activities in the nearshore waters of the northeastern U.S., 1975-1989. Paper SC/090/G?? presented to the IWC Workshop on mortality of cetaceans in passive fishing nets and traps, 22-25 October 1990, LaJolla, California, 3 pp.

Kraus, S. D. 1990b. Rates and potential causes of mortality in North Atlantic right whales. Mar. Mamm. Sci. 6: 278-291.

Kraus, S. D. and J. H. Prescott. 1981. Distribution, abundance and notes of the large cetaceans of the Bay of Fundy, summer and fall 1980, Final Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NA-80-FA-2-00048, Woods Hole, Massachusetts. 66 pp.

Kraus, S. D. and J. H. Prescott. 1982. The North Atlantic right whale (Eubalaena glacialis) in the Bay of Fundy, 1981, with notes on the distribution, abundance, biology and behavior, Final Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NA-81-FA-C-00030, Woods Hole, Massachusetts, and to the World Wildlife Fund-U.S., Washington, D.C. 105 pp.

Kraus, S. D., Gilbert, J. R. and Prescott, J. H. 1983. A comparison of aerial, shipboard, and land-based survey methodology for the harbor porpoise, Phocoena phocoena. Fish. Bull, (U.S). 81: 910-913.

Kraus, S. D., M. J. Crone and A. R. Knowlton. 1989. The North Atlantic Right Whale. pp. 685-698 In Audubon Wildlife Report 1988/1989, The National Audubon Society, New York.

Kraus, S. D., J. H. Prescott, A. R. Knowlton and G. S. Stone. 1986. Migration and calving of right whales (Eubalaena glacialis) in the western North Atlantic. Rep. int. Whal. Commn (Spec. Issue 10): 139-144.

Kraus, S. D., J. H. Prescott and G. S. Stone. 1984. Right whales (Eubalaena glacialis) in the western North Atlantic: A summary of research conducted from 1980 to 1984, Final Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NA-81:FA-C88830, Woods Hole, Massachusetts,.

Larsen, F. 1981. Observations of Large whales off West Greenland, 1979. Rep. int. Whal. Commn 31: 617-623.

Layne, J. N. 1965. Observations on marine mammals in Florida waters. Bull. Fla. State Mus. Biol. Sci. 9: 131-181.

Leatherwood, S. J. 1982. Size of bottlenose dolphin population(s) in Indian River, Florida. Rept. int. Whal. Commn. 32: 567-568.

Leatherwood, S., D. K. Caldwell, and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U. S. Dept. of Commerce, NOAA Tech. Rept. NMFS Circ. 396. 176pp.

Leatherwood, S., M. W. Deerman and C. W. Potter. 1978. Food and reproductive status of nine Tursiops truncatus from the northeastern United States coast. Cetology 28. 6 pp.

Leatherwood, S., R. R. Reeves and L. Foster. 1983. The Sierra Club Handbook of Whales and Dolphins. Sierra Club Press, San Francisco, California. 302 pp.

Levenson, C. and W. T. Leapley. 1978. Distribution of humpback whales (Megaptera novaeangliae) in the Caribbean determined by a rapid acoustic method. J. Fish. Res. Board Can. 35: 1150-1152.

Lien, J. and F. Barry. 1990. Status of Sowerby's beaked whale, Mesoplodon bidens, in Canada. Canadian Field-Naturalist 104: 125-130.

Lien, J., S. Johnson and B. Merdsoy. 1979. Whale distribution in Newfoundland during 1979. The Osprey 11(2): 21-32.

Lien, J., R. Sears, G. B. Stenson, P. W. Jones and I-Hsun Ni. 1989. Right whale, Eubalaena glacialis, sightings in waters off Newfoundland and Labrador and the Gulf of St. Lawrence, 1978-1987. Can. Field-Naturalist 103: 91-93.

Lien, J., F. Barry, K. Breeck and Ul Zuschlag. 1990. Multiple strandings of Sowerby-s beaked whales, Mesoplodon bidens, in Newfoundland. Canadian Field-Naturalist 104: 414-420.

Loehoefner, R., K. Mullin, W. Hoggard, C. Roden, C. Rogers and B. Taggart. 1989. Distribution, relative abundance, and seasonality of Outer Continental Shelf cetaceans in the north-cental Gulf of Mexico: A pilot study, Contract Report. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisianna. 9 pp.

Lynch, K. and H. Whitehead. 1984. Changes in the abundance of large whales off Newfoundland and Labrador, 1976-1983, with special reference to the finback whale. Rept. int. Whal Commn, Sci. Doc. SC/36/02: 8pp.

Mairs, D. F. and L. W. Scattergood. 1958. Recent Maine records of the bottlenose porpoise and the beluga. Maine Field-Naturalist 14(4): 78-80.

Mairs, D. F. and L. W. Scattergood. 1959. Three Maine cetacean records. Maine Field-Naturalist 12(4): 111-113.

Major, P. F. 1986. Notes on a predator-prey interaction between common dolphins (Delphinus delphis) and short-finned squid (Illex illecebrosus) in Lydonia submarine canyon, western North Atlantic Ocean. J. Mammal. 67: 769-770.

Manomet Bird Observatory (MBO). 1988. Cetacean and Seabird Assessment Program-Effort Evaluation, Final Report. National Marine Fisheries Service/Northeast Fisheries Center Contract No. 50-EANF-6-00028. 172 pp.

Mansfield, A. W. 1967. The mammals of Sable Island. Can. Field- Naturalist 81: 40-49.

Mansfield, A. W. 1985. The status of the blue whale, Balaenoptera musculus, in Canada. Canadian Field-Naturalist 99: 417-420.

Martin, A. R., S. K. Katona, D. Mattila, D. Hembree and T. D. Waters. 1984.

Migration of humpback whales between the Caribbean and Iceland. J. Mammal. 65: 330-333.

Mattila, D. K. 1983. Humpback whales off Puerto Rico: Population composition and habitat use. pp. 63 in Abstracts of the Fifth Conference on the Biology of Marine Mammals, 27 November-1 December 1983, Boston, Massachusetts.

Mattila, D. K. 1984. Humpback whales in Mona Passage, Puerto Rico: a summary, Unpubl. Report. [Available Center for Coastal Studies, Provincetown, Massachusetts].

Mattila, D. K. and P. J. Clapham. 1989. Humpback whale, Megaptera novaeangliae, and other cetaceans on Virgin Bank and in the northern leeward Islands, 1985 and 1986. Can. J. Zool. 67: 2201-2211.

Mattila, D. K., C. A. Carlson, P. J. Clapham and C. A. Mayo. 1983. Resightings of individually identifiable fin whales in the waters of Stellwagen Bank and Cape Cod Bay, Massachusetts. pp. 64 in Abstracts of the Fifth Bienniel Conference on the Biology of Marine Mammals, 27 November - 1 December, Boston, Massachusetts.

Mattila, D. K., P. J. Clapham, S. K. Katona, and G. S. Stone. 1989. Population composition of humpback whales, Megaptera novaeangliae, on Silver Bank, 1984. Can. J. Zool. 67: 281-285.

Mattila, D. K., P. J. Clapham, G. S. Stone, H. Corbett and S. K. Katona. 1987. Humpback whales on Virgin Bank: Population composition and habitat use. p. 45 in Abstracts of the Seventh Bienniel Conference on the Biology of Marine Mammals, 5-9 December 1987, Miami, Florida.

Mayo, C. A. 1982. Observations of cetaceans: Cape Cod Bay and southern Stellwagen Bank Massachusetts 1975-1979. U.S. Marine Mammal Commn Report MMC-80/07 [Available as Natl. Tech. Information Service, Report No.PB82-186263, 5285 Port Royal Road, Springfield, Virginia]. 68 pp.

Mayo, C. A. 1983. Patterns of distribution and occurrence of humpback whales in the southern Gulf of Maine. pp. 64 in Abstracts of the Fifth Bienniel Conference on the Biology of Marine Mammals, 27 November-1 December, Boston, Massachusetts.

Mayo, C. A. and M. K. Marx. 1990. Feeding behaviour of northern right whales, Eubalaena glacialis, in Cape Cod Bay, and associated zooplankton characteristics. Can. J. Zool. 68:

Mayo, C. A., C.A. Carlson, and M. K. Gilmore. 1985. Food and feeding of right whales on Cape Cod Bay, Massachusetts. pp. 52 in Abstracts of the Sixth Biennial Conf. on the Biology of Marine Mammals, 22-26 November 1985, Vancouver, B.C., Canada.

Mayo, C. A., M. K. Marx and B. H. Letcher. 1987. Estimated zooplankton consumption rate and caloric intake of the North Atlantic right whale, Eubalaena glacialis. pp. 46 in Abstracts of the Seventh Bienniel Conf. on the Biology of Marine Mammals, 5-9 December, Miami, Florida.

Mayo, C. A., D. K. Mattila, S. Pittman, P. Christian, and L. Baraff. 1988.

Abundance, distribution and habitat use of large whales in the southern Gulf of Maine, May 1-September 30, 1986, Interim Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. 50-EANF-6-00059, Woods Hole, Massachusetts.

McAlpine, D. F. 1985. First records of the sperm whale (Physeter macrocephalus) from New Brunswick and the Bay of Fundy. Naturaliste Can. (Rev. Ecol. Syst.) 112: 433-434.

Mead, J. G. 1975a. Preliminary report on the former net fisheries for Tursiops truncatus in the western North Atlantic. J. Fish. Res. Board Can. 32: 1155-1162.

Mead, J. G. 1975b. Distribution of cetaceans along the Atlantic and Gulf coasts of the United States, Unpubl. manuscript. Marine Mammal Commission, Contract No. MMC-MM4AC007, Washington, D.C.

Mead, J. G. 1977. Records of sei and Bryde's whales from the Atlantic coast of the United States, the Gulf of Mexico, and the Caribbean. Rep. int. Whal. Commn (Spec. Issue 1): 113-116.

Mead, J. G. 1979. An analysis of cetacean strandings along the eastern coast of the AUnited States. pp. 54-68 in J. R. Geraci and D. J. St. Aubin (eds.), Biology of marine mammals: insights through strandings. Mar. Mamm. Commn, Washington, D.C., Final Report. 343 pp. [Available as Natl. Tech. Information Service, Report No.PB-293890, 5285 Port Royal Road, Springfield, Virginia].

Mead, J. G. 1990a. Beaked whales of the genus Mesoplodon. pp. 349-432 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.4, River Dolphins and the large Toothed whales), Academic Press, London.

Mead, J. G. 1990b. Bottlenose whales-Hyperoodon ampullatus (Forster, 1770) and Hyperoodon planifrons Flower, 1882. pp. 321-348 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.4, River Dolphins and the large Toothed whales), Academic Press, London.

Mead, J. G. and C. W. Potter. 1990. Natural history of Tursiops truncatus along the central Atlantic coast of the U.S. pp. 165-195 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Mercer, M. S. 1975. Modified Leslie-DeLury population models of the the long-finned pilot whale (Globicephala melaena) and annual production of the short-finned squid (Illex illecebrosus) based upon their interaction at Newfoundland. J. Fish. Res. Board Can. 32: 1145-1154.

Mercer, M. C. 1967. Wintering of pilot whales, Globicephala melaena, in Newfoundland inshore waters. J. Fish. Res. Board Can. 24: 2481-2484.

Mercer, M. C. 1973. Observations on distribution and intraspecific variation in pigmentation patterns of Odontocete Cetacea in the western North Atlantic. J. Fish. Res. Board Can. 30: 1111-1130.

Mercer, S. 1985. Observations of cetaceans on Jeffreys Ledge and in Ipswich

Bay in Spring, summer and autumn 1985 including references to previous seasons, Unpubl. manuscript. New England Whale Watch, Inc., Hampton, New Hampshire. 18 pp.

Meyer, T. L., R. A. Cooper and R. W. Langton. 1979. Relative abundance, behavior, and food habits of the American sandlance, Ammodytes americanus, from the Gulf of Maine. Fish. Bull. 77: 243-253.

Miller, G. S. 1927. The pollack whale on the east coast of Virginia. Proc. Biol. Soc. Wash. 40: 111-112.

Miller, G. S. and Kellogg. 1955. List of North American recent mammals. U.S. Natl. Hist. Mus. Bull., No. 205. 954 pp.

Mitchell, E. 1974a. Preliminary report on Newfoundland fishery for minke whales (Balaenoptera acutorostrata). Rep. int. Whal. Commn 25: 218-225.

Mitchell, E. 1974b. Present status of northwest Atlantic fin and other whale stocks. pp. 108-169 In The whale problem; a status report. W. E. Schevill (Ed.), Harvard Univ. Press, Cambridge, Massachusetts.

Mitchell, E. D. 1975a. Review of biology and fisheries for smaller cetaceans: A report of the meeting of the Int. Whaling Commission Sub-committee on smaller cetaceans, 1-11 April 1974, Montreal, Quebec, Canada. J. Fish. Res. Board Can. 32: 889-983.

Mitchell, E. D. 1975b. Porpoise, dolphin and small whale fisheries of the world. Status and problems. Int. Union Cons. Nat. Natural Res., Morges, Switzerland, Monogr. 3. 129 pp.

Mitchell, E. 1975c. Preliminary Report on Nova Scotia fishery for Sperm Whales (Physeter catadon). Rept. Int. Whal. Comm. 25:226-235.

Mitchell, E. D. 1975d. Trophic relationships and competition for food in northwest Atlantic whales. pp. 123-133 In Proc. of the Canadian Soc. of Zoologists, Ann. Meeting, 2-5 June 1974. Downsview, Ontario, Canada.

Mitchell, E. D. 1975e. Preliminary report on Nova Scotia fishery for sei whales (Balaenoptera borealis). Rep. int. Whal. Commn 25: 218-225.

Mitchell, E. D. 1981. Canada Progress Report on Cetacean Research, June 1979-May 1980. Rep. int. Whal. Commn 31: 174-175.

Mitchell, E. and D. G. Chapman. 1977. Preliminary Assessment of Stocks of Northwest Atlantic Sei Whales (Balaenoptera borealis). Rept. int. Whal. Commn (Spec. Issue 1): 117-120.

Mitchell, E. and V. M. Kozicki. 1975a. Autumn stranding of the northern Bottlenose whale (Hyperoodon ampullatus) in the Bay of Fundy, Nova Scotia. J. Fish. Res. Bd. Canada 32: 1019-1040.

Mitchell, E. D. and V. M. Kozicki. 1975b. Supplementary information on minke whale (Balaenoptera acutorostrata) from Newfoundland fishery. J. Fish. Res. Bd. Canada 32: 985-994.

Mitchell, E. and V. M. Kozicki. 1984. Reproductive condition of male sperm

whales, Physeter macrocephalus, taken off Nova Scotia. Rept. int. Whal. Commn (Spec. Issue) 6: 243-252.

Mitchell, E. and Reeves, R. R. 1983. Catch history, abundance, and present status of northwest Atlantic humpback whales. Rep int. Whal. Commn (Special Issue 5): 153-212.

Mitchell, E. and R. R. Reeves. 1988. Records of killer whales in the western North Atlantic, with emphasis on eastern Canadian waters. pp. 161-193 in J. Sigurjonsson and S. Leatherwood (Eds.), North Atlantic Killer Whales, Rit Fiskideildar, Vol. XI.

Mitchell, E. D., V. M. Kozicki and R. R. Reeves. 1986. Sightings of right whales, Eubalaena glacialis, on the Scotian Shelf, 1966-1972. Rep. int. Whal. Commn (Spec. Issue 10): 83-107.

Mizroch, S. A., D. W. Rice and J. M. Breiwick. 1984a. The fin whale, Balaenoptera physalus. Mar. Fish. Rev. 46(4): 20-24.

Mizroch, S. A., D. W. Rice and J. M. Breiwick. 1984b. The blue whale, Balaenoptera musculus. Mar. Fish. Rev. 46(4): 15-19.

Mizroch, S. A., D. W. Rice and J. M. Breiwick. 1984c. The sei whale, Balaenoptera borealis. Mar. Fish. Rev. 46(4): 25-29.

Moore, J. C. 1953. Distribution of marine mammals to Florida waters. Amer. Midl. Nat. 49; 117-158.

Moore, J. C. 1958. A beaked whale from the Bahamas Islands and comments on the distribution of Mesoplodon densirostris. Amer. Mus. Nat. Hist., Novitates 1897: 1-12.

Moore, J. C. 1966. Diagnoses and distribution of beaked whales of the genus Mesoplodon known from North American waters. pp. 32-61 in K. S. Norris (Ed.) Whales, Dolphins and Porpoises, Univ. Calif. Press, Berkeley, California.

Moore, J. C. 1968. Relatlionships among the living general of beaked whales, with classification, diagnoses and keys. Fieldiana Zool. 53: 206-298.

Moore, J. C. and E. Clark. 1963. Discovery of right whales in the Gulf of Mexico. Science (Wash., D.C.) 141(3577): 269.

Morse, W. 1982. Spawning stock biomass estimates of sandlance, Ammodytes sp., off northeastern United States determined from MARMAP plankton surveys, 1974-1980. Int. Cons. Explor. Seas, CM 1982/G:59. 11 pp.

Mullane, S. J. and A. Rivers. 1982. Mt. Desert Rock, Maine, Annual Report. Allied Whale, College of the Atlantic, Bar Harbor, Maine. 27 pp.

Murison, L. D. and D. E. Gaskin. 1989. The distribution of right whales and zooplankton in the Bay of Fundy, Canada. Can. J. Zool. 67: 1411-1420.

Neave, D. J. and B. S. Wright. 1968. Seasonal migrations of the Harbor Porpoise (Phocoena phocoena) and other Cetacea in the Bay of Fundy. J. Mammal. 49: 259-264.

Neave, D. J. and B. S. Wright. 1969. Observations of Phocoena phocoena in the Bay of Fundy. J. Mammal. 50: 653-654.

Nelson, G. A. and M. R. Ross. 1989. The population dynamics of sand lance,)(Ammodytes dubius) in the northwest Atlantic: Abundance and Distribution. M.S. Thesis, Univ. of Massachusetts, Dept. of Forestry and Wildl. Management, Amherst, Massachusetts. 66 pp.

Nelson, G. A. and M. R. Ross. 1991. Biology and population changes of northern sand lance (Ammodytes dubius) from the Gulf of Maine to the Middle Atlantic Bight. J. Northw. Atl. Fish. Sci. 11: 11-27.

Nemoto, T. 1957. Foods of baleen whales in the North Pacific. Sci. Rep. Whales Res. Inst. 12: 33-89.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Sci. Rep. Whales Res. Inst. 14: 149-290.

Nemoto, T. 1970. Feeding patterns of baleen whales in the ocean. pp. 241-252 in J. H. Steele (Ed.) Marine Food Chains, Univ. California Press, Berkeley.

Nemoto, T. and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. Rept. int. Whal. Commn (Spec. Issue 1): 80-87.

Nishiwaki, M. 1966. A discussion of rarities among the smaller cetaceans caught in Japanese waters. pp. 192-204 in K. S. Norris (Ed.), Whales, Dolphins and Porpoises, Univ. California Press, Berkeley, CA.

Nishiwaki, M. 1967. Distribution and migration of marine mammals in the North Pacific area. pp. 1-64 in Bull. Ocean. Res. Inst., Univ. of Tokyo, Japan.

NOAA/NMFS. 1990. U.S. Dept. of Commerce, NOAA/NMFS, Draft Natl. Recovery Plan-Northern right whale Eubalaena glacialis, Washington, D.C., February 1990. 77 pp.

Odell, D. K., E. D. Asper, J. Baucom, and L. H. Cornell, 1980. A recurrent mass stranding of the false killer whale Pseudorca crassidens, in Florida. Fish. Bull. 78: 171-176.

Odell, D. K., D. M. Burn, D. B. Olson and E. D. Asper. 1985. Strandings of dwarf and pygmy sperm whales (Kogia spp.) on the east coast of Florida. Sixth Bienniel Conf. on the Biology Marine Mammals, (Abstract), Nov. 1985, Vancouver, British Columbia, Canada.

Omura, H. 1977. Review of the occurrence of Bryde's whale in the northwest Pacific. Rep. int. Whal. Commn (Spec. Issue 1): 88-91.

Omura, H. and T. Nemoto. 1955. Sei whales in the adjacent waters of Japan, relation between movement and water temperature of the sea. Sci. Rep. Whales Res. Inst. 10: 79-87.

O'Reilly, J. E., Evans-Zetllin, C. and Busch, D. A. 1986. Primary Production. pp. 218-232 In R. H. Backus and D. W. Bourne (Eds.) Georges Bank and its surroundings. MIT Press, Cambridge, Massachusetts.

Overholtz, W. J. and J. R. Nicolas. 1979. Apparent feeding by the fin whale, Balaenoptera physalus, and humpback whale, Megaptera novaeangliae, on the American sand lance, Ammodytes americanus, in the northwest Atlantic. Fish. Bull. 77: 285-287.

Overholtz, W. J., S. A. Murawski and K. L. Foster. 1991. Impact of predatory fish, marine mammals, and seabirds on the pelagic fish ecosystem of the Northeastern USA. in Daan, N. and M. Sissenwine (Eds.), Symposium on multispecies models relevant to management of living resources, October 1989, The Hague, Netherlands. Rapp. P.-V. Reun. Cons. Int. Explor. Mer., (in press).

Paul, J. R. 1968. Risso's dolphin, Grampus griseus, in the Gulf of Mexico. J. Mammal. 49: 746-748.

Payne, P. M., L. A. Selzer, and A. T. Knowlton. 1984. Distribution and density of cetaceans, marine turtles and seabirds in the shelf waters of the northeastern United States, June 1980-Dec 1983, from shipboard observations, Final Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NA-81-FA-C-00023. 246 pp.

Payne, P. M., J. R. Nicolas, L. O'Brien, and K. D. Powers. 1986. The distribution of the humpback whale Megaptera novaeangliae on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel Ammodytes americanus. Fish. Bull. 84: 271-277.

Payne, P. M., D. W. Heinemann and G. T. Waring. 1989. Distribution of pilot whales (Globicephala spp.) in shelf/shelf-edge and slope waters of the northeastern United States, 1978-1988. Int. Whaling Commn Doc. SC/41/SMM18, presented to the IWC Scientific Committee, June 1989. Available Rept. Int. Whal. Commn (Spec. Issue), in press.

Payne, P. M., Heinemann, D. W. and Smith, T. D. 1990a. Seasonal distribution of minke whales in the shelf and shelf-edge waters of the northeastern U.S. Paper SC/42/NHMi32 presented to the IWC Scientific Committee, June 1990.

Payne, P. M., G. Power and C. T. Yustin. 1990b. Interactions between the New England sink-gillnet fishery and the harbor porpoise Phocoena phocoena. Int. Whaling Commn Sci. Doc. SC/090/G41, presented at the IWC Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps, 22-25 October 1990, LaJolla, California. Available Rept. Int. Whal. Commn (Spec. Issue), in press.

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham and J. W. Jossi. 1990c. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. Fish. Bull. 88: 687-696.

Perkins, J. S. and G. Winston Miller. 1983. A mass stranding of Steno bredanensis in Belize. Biotropica 15: 235-236.

Perkins, J. S. and P. C. Beamish. 1979. Net entanglements of baleen whales in the inshore fishery of Newfoundland. J. Fish. Res. Board Can. 36: 512-528.

Perkins, J. S. and H. Whitehead. 1977. Observations on three species of baleen whales off northern Newfoundland and adjacent waters. J. Fish. Res. Board Can. 34: 1436-1440.

Perkins, J. S., K. C. Balcomb, G. Nichols and M. DeAvilla. 1984. The abundance and distribution of humpbacks whales off West Greenland. Can. J. Fish. Aquat.Sci. 41: 533-536.

Perkins, J. S., K. C. Balcomb, G. Nichols, A. Tilghman Hall, M. Smultea and N. Thumser. 1985. Status of the West Greenland hupback whale feeding aggregation, 1981-83. Rept. int. Whal. Commn 35: 379-383.

Perkins, J. S., P. J. Bryant, G. Nichols and D. R. Patten. 1982. Humpback whales (Megaptera novaeangliae) off the west coast of Greenland. Can. J. Zool. 60: 2921-2930.

Perrin, W. F. 1975. Variation of spotted and spinner porpoise (genus Stenella) in the eastern tropical Pacific and Hawaii. Bull. Scripps Inst. Oceanography, Univ. of California, No. 21. 206 pp.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, M. C. Caldwell, P. J. H. vanBree and W. H. Dawbin. 1987. Revision of the spotted dolphins, Stenella spp. Mar. Mamm. Sci. 3: 99-171.

Piatt, J. F., D. A. Methven, A. E. Burger, R. L. McLagan, V. Mercer and E. Creelman. 1989. Baleen whales and their prey in a coastal environment. Can. J. Zool. 67: 1523-1530.

Pippard. L. 1985. Status of the St. Lawrence River populationof beluga. Dephinapterus leucas. Canadian Field-Naturalist 99: 438-450.

Polacheck, T. 1989a. Harbor porpoises and the gillnet fishery. Oceanus 32(1): 63-70.

Polacheck, T. 1989b. Results of field tests of line transect methods for shipboard sighting surveys for harbor porpoises. Int. Whaling Commn Doc. Sc/42/SM38, presented to the IWC Scientific Committee, June 1989. 15 pp.

Polacheck, T. and T. D. Smith. 1989. A proposed methodology for field testing line transect theory for shipboard surveys of cetaceans. Rep. int. Whal. Commn 39: 341-345.

Polacheck, T. and L. Thorpe. 1990. The swimming direction of harbor porpoise in relation to a survey vessel. Rep. int. Whal. Commn 40: 463-470.

Polacheck, T. and F. W. Wenzel. 1990. What do stranding data say about harbor porpoise (Phocoena phocoena). Int. Whaling Commn Doc. SC/42/SM39 presented to the IWC Scientific Committee, June 1990. 13 pp.

Powers, K. D. 1983. Pelagic distributions of marine birds off the northeastern United States. NOAA Tech. Memo. NMFS-F/NEC-27, 201 pp.

Powers, K. D. and E. H. Backus. 1986. Estimates of consumption by seabirds on Georges Bank. pp. 372-374 In R. H. Backus and D. W. Bourne (Eds.)Georgés Bank and its surroundings. MIT Press, Cambridge, Massachusetts.

Powers, K. D. and R. G. B. Brown. 1986. Seabirds. pp. In R. H. Backus and D. W. Bourne (Eds.) Georges Bank and its surrounding. MIT Press, Cambridge, Massachusetts.

Powers, K. D. and P. M. Payne. 1983. Distribution of marine mammals, birds and turtles near the Deepwater Dumpsite 106 (DWD-106) and the Philadelphia Dumpsite (PDS). Chap. 11, In J. B. Pearce et al. (Eds.) Northeast Monitoring Program, 106-Mile Characterization Update, NOAA Tech. Memo. NMFS-F/NEC-26.

Powers, K. D., P. M. Payne, and D. S. Miller. 1980. A Marine Observer Training Program, Final Report. National Marine Fisheries Service/Northeast Fisheries Center, Contract No. NAA80-FA-D-0004, Woods Hole, Massachusetts. 73 pp.

Prescott, J. H. and P. M. Fiorelli. 1980. Review of the harbor porpoise (Phocoena phocoena) in the U.S. Northwest Atlantic, Final Report. Marine Mammal Commission, Report MMC-78/08, Washington, D.C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Report No. PB80-176928]. 55 pp.

Prescott, J. H., S. D Kraus, D. E. Gaskin, G. J. D. Smith and M. Brander. 1981. Harbor porpoise (Phocoena phocoena): Distribution, abundance, survey methodology and preliminary notes on habitat use and threats, Final Report. National Marine Fisheries Service/ Northeast Fisheries Center, Contract NA-80-FA-00009, Woods Hole, Massachusetts. 61 pp.

Price, C. A. and F. M. Fairfield. 1985. Use of satellite data to correlate beaked whale and squid distribution with the shelf/slope thermal front. (no page numbers) in Abstracts of the Sixth Bienniel Conference on the Biology of Marine Mammals, 22-26 November, Vancouver, British Columbia, Canada.

Ramsdell, K. 1978. Whales in the Gulf of Maine 1977. Annual Report of the Gulf of Maine Whale Sighting Network. College of the Atlantic, Bar Harbor, Maine. 39 pp.

Raven, H. C. 1937. Notes on the taxonomy and osteology of two species of Mesoplodon (M. europaeus Gervais, M. mirus True). Amer. Mus. Nat. Hist., Novitates 905.

Raven, H. C. 1942. On the structure of Mesoplodon densirostris, a rare beaked whale. Bull. Amer. Mus. Nat. Hist. 80: 23-50.

Read, A. J. 1990. Gillnet and trap fisheries in the Northwest Atlantic. Int. Whal. Commn Doc. SC/090/G6, presented at the IWC Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps, 22-25 October 1990, LaJolla, California.

Read, A. J. and D. E. Gaskin. 1985. Radio tracking the movements and activi-

ties of harbor porpoises, Phocoena phocoena (L.), in the Bay of Fundy, Canada. Fish. Bull. 83: 543-552.

Read, A. J. and D. E. Gaskin. 1988. Incidental catch of harbor porpoises by gill nets. J. Wildl. Manage. 52: 517-523.

Read, A. J. and Gaskin, D. E. 1990. The effects of incidental mortality on harbour porpoises (Phocoena phocoena) in the Bay of Fundy and Gulf of Maine. Int. Whaling Commn Doc. SC/42/SM21, presented to the IWC Scientific Committee, June 1990. 18 pp.

Recchia, C. A. and A. J. Read. 1989. Stomach contents of harbour porpoises, Phocoena phocoena (L.), from the Bay of Fundy. Can. J. Zool. 67: 2140-2146.

Reeves, R. R. 1976a. New Jersey's great whales, Occ. Paper 122, New Jersey Audubon Soc. 2(1): 7-14.

Reeves, R. R. 1976b. New Jersey's dolphins and porpoises. New Jersey Outdoor 3(4): 2-5.

Reeves, R. R. 1982. What hope for North Atlantic right whales? Oryx XVI(3): 255-262

Reeves, R. R. and R. L. Brownell. 1982. Baleen whales-Eubalaena glacialis and allies. pp. 415-444, in: Wild Mammals of North Am,erica. Biology, management, and economics. J. A. Chapman and G. A. Feldhamer (Eds), The Johns Hopkins University Press, Baltimore, 1147 pp. review of statis.

Reeves, R. R. and S. K. Katona 1980. Extralimital records of white whales (Delphinapterus leucas) in eastern North American waters. Canadian Field-Naturalist 94: 239-247.

Reeves, R. R. and E. Mitchell. 1986. The Long Island, New York, Right Whale fishery: 1650-1924. Rep. Int. Whal. Commn (Spec. Issue 10): 201-220.

Reeves, R. R. and E. Mitchell. 1988. History of whaling in and near North Carolina. NOAA Tech. Report NMFS 65. 28 pp.

Reeves, R. R. and E. Mitchell. 1989. Status of white whales, Delphinapterus leucas, in Ungava Bay and eastern Hudson Bay. Canadian Field-Naturalist 220-239.

Reeves, R. R. and F. A. Ulmer. 1976. New Jersey's medium-sized whales, Occ. Paper No. 126, New Jersey Audubon Soc. 2(12): 7-18.

Reeves, R. R., S. K. Kraus, and P. Turnbull. 1983. Right Whale Refuge? Nat. Hist. 92(4): 40-45.

Reeves, R. R., J. G. Mead and S. Katona 1978. The right whale, Eubalaena glacialis, in the western North Atlantic. Rep. int. Whal. Commn 28: 303-312.

Reeves, R. R., K. J. Finley, E. Mitchell and J. MacDonald. 1986. Strandings of sperm whales, Physeter catadon, in Ungava Bay, northern

Quebec. Canadian Field-Naturalist 100: 174-179.

Rice, D. W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. Rept. int. Whal. Commn (Spec. Issue 1): 92-97.

Rice, D. W. 1990. Sperm Whale Physeter macrocephalus Linnaeus, 1758. pp. 177-234 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.4, River Dolphins and the large Toothed whales), Academic Press, London.

Ross, G. J. B. and S. Leatherwood. 1988. Pygmy killer whale Feresa attenuata Gray, 1874. pp. In Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol. 4, River Dolphins and the large Toothed whales), Academic Press, London.

Rowlett, R. A. 1980. Observations of marine birds and mammals in the northern Chesapeake Bight. U.S. Fish and Wildlife Service/Biological Services Program, FWS/OBS-80/04. 87 pp.

Schevill, W. E. 1956. Lagenorhynchus acutus off Cape Cod. J. Mammal. 37: 128-129.

Schevill, W. E. 1968. Sight records of Phocoena phocoena and cetaceans in general. J. Mammal. 49: 794-796.

Schevill, W. E., W. A. Watkins and K. E. Moore. 1986. Status of Eubalaena glacialis off Cape Cod. Rep. int. Whal. Commn (Spec. Issue 10): 79-81.

Schmidly, D. J. 1981. Marine mammals of the southeastern United States coast and Gulf of Mexico. U.S. Fish Wildl. Serv., Biol. Serv. Program, FWS/OBS-80/41. 165 pp.

Schwartz, F. J. 1962. Summer occurrence of an immature little piked whale, Balaenoptetra acutorostrata, in Chesapeake Bay, Maryland. Chesapeake Sci. 3: 206-209.

Scott, G. P. and J. R. Gilbert. 1982. Problems and Progress in the U.S. BLM-sponsored CeTAP surveys. Rept. int. Whal. Commn 32: 587-600.

Scott, G. P., D. M. Burn and L. J. Hansen. 1988. The dolphin dieoff: Long-term effects and recovery of the population. OCEANS' 88 Conf., Proc. of Unusual Environmental Events Symposium, IEEE Cat. No. 88-CH2585-8, Vol. 3: 819-823.

Scott, G. P., R. D. Kenney, J. R. Gilbert, and R. K. Edel. 1981. Estimates of cetacean and turtle abundance in the CeTAP study area with an analysis of factors affecting them. pp. IV-1-70 In A Characterization of marine mammals and turtles in the Mid- and North- Atlantic areas of the U.S. Outer Continental Shelf, Annual Report for 1979. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Ref. No. PB81243289].

Scott, G. P., R. D. Kenney, R. E. Owen, M. A. M. Hyman and H. E. Winn. 1985. Biological and physical oceanographic correlatives to cetacean density

distribution in the Great South Channel. Int. Council Expl. Seas (ICES), Doc. C.M. 1985/N:6/Ref L. 36 pp.

Scott, G. P., R. D. Kenney, T. J. Thompson, and H. E. Winn. 1983. Functional roles and ecological impacts of the cetacean community in the waters of the northeastern U. S. continental shelf. Int. Cons. Explor. Sea (ICES), Doc. C.M. 1983/N:Ref L. 12 pp

Scott, M. D., R. S. Wells and A. B. Irvine.. 1990. A long-term study of bottlenose dolphins on the west coast of Florida. pp. 235-244 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Sears, R., F. W. Wenzel and J. M. Williamson. 1987. The blue whale: A catalogue of individuals from the western North Atlantic (Gulf of St. Lawrence). Mingan Island Cetacean Study (MICS Inc.), Saint-Lambert, Quebec, Canada. 64 pp.

Sears, R., J. M. Williamson, F. W. Wenzel, M. Berube, D. Gendron and P. Jones. 1990. Photographic identification of the blue whale (Balaenoptera musculus) in the Gulf of St. Lawrence, Canada. Rept. int. Whal. Commn. (Spec. Issue 12): 335-342.

Seber, G. A. F. 1973. The estimation of animal abundance. Hafner Publ. Co., Inc. New York. 506 pp.

Seipt, I. E., P. J. Clapham, C. A. Mayo and M. P. Hawvermale. 1990. Population characteristics of individually identified fin whales Balaenoptera physalus in Massachusetts Bay. Fish. Bull. 88: 271-278.

Selzer, L. A. and P. M. Payne. 1988. The distribution of white-sided (Lagenorhynchus acutus) and common dolphins (Delphinus delphis) versus environmental features of the continental shelf of the northeastern United States. Mar. Mamm. Sci., 4: 141-153.

Sergeant, D. E. 1953. Whaling in Newfoundland and Labrador waters. Norsk Hvalfanst-Tidende 1953. 1489-1504.

Sergeant, D. E. 1958. Dolphins in Newfoundland waters. Can. Field-Naturalist 72: 156-159.

Sergeant, D. E. 1961. Whales and dolphins of the Canadian east coast. Fisheries Board of Canada, Circ. 7. 17 pp.

Sergeant, D. E. 1962. The biology of the pilot or pothaead whale Globicephala melaena (Traill) in Newfoundland waters. Bull. Fish. Res. Board Can. 132: 1-84.

Sergeant, D. E. 1963. Minke whales, Balaenoptera acutorostrata Lacepede, of the western North Atlantic. J. Fish. Res. Board Can. 20: 1489-1504.

Sergeant, D. E. 1966. Populations of large whales in the western North Atlantic with special reference to the fin whale. Fish. Res. Bd. Canada, Circ. 9: 1-13.

Sergeant, D. E. 1968. Sightings of marine mammals. Int. Commn. Northw. Atl.

Fish., Spec. Publ. No. 7: 241-244.

Sergeant, D. E. 1977. Stocks of fin whales Balaenoptera physalus L. in the North Atlantic Ocean. Rept. int. Whal. Commn 27: 460-473.

Sergeant, D. E. 1982. Mass strandings of toothed whales (Odontoceti) as a population phenomenon. Sci. Rep. Whales Res. Inst. 34: 1-47.

Sergeant, D. E. 1986. Present status of white whales, Delphinapterus leucas, in the St. Lawrence estuary. Naturaliste can. (Rev. Ecol. Syst.) 113: 61-81.

Sergeant, D. E. 1990. Present status of white whales Delphinapterus leucas in the St. Lawrence estuary. Naturaliste can. (Rev. Ecol. Syst.) 113: 61-81.

Sergeant, D. E. and P. F. Brodie. 1975. Identity, abundance and present status of populations of white whales, Delphinapterus leucas, in North America. J. Fish. Res. Bd. Canada 32: 1047-1054.

Sergeant, D. E. and H. D. Fisher. 1957. The smaller Cetacea of eastern Canadian waters. J. Fish. Res. Bd. Canada 14: 83-115.

Sergeant, D. E. and W. Hoek. 1988. An update of the status of white whales Delphinapterus leucas in the Saint Lawrence Estuary, Canada. Biol. Cons. 45: 287-302.

Sergeant, D. E., D. J. St. Aubin and J. R. Geraci. 1980. Life history and northwest Atlantic status of the Atlantic white-sided dolphin, Lagenorhynchus acutus. Cetology 37: 1-12.

Sergeant, D. E., A. W. Mansfield and B. Beck. 1970. Inshore records of Cetacean for eastern Canada, 1949-1968. J. Fish. Res. Board Can. 27: 1903-1915.

Shane, S. S. 1980. Occurrence, movements, and distribution of bottlenose dolphin, Tursiops truncatus, in southern Texas. Fish. Bull. 78: 593-601.

Shane, S. S. 1990. Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. pp. 245-265 In S. Leatherwood and R. R. Reeves (Eds.), The Bottlenose Dolphin, Academic Press, Inc., San Diego, California.

Shane, S. S., R. S. Wells and B. Wursig. 1986. Ecology, behavior, and social organization of the bottlenose dolphin: a review. Mar. Mammal Sci. 2: 34-63.

Sherman, K. C. 1980. MARMAP, a fisheries ecosystem study in the northwest Atlantic: Fluctuations in ichthyoplankton-zooplankton components and their potential for impact on the system. pp. 9-37 in F. P. Diemer, F. J. Vernberg and D. Z. Mirkes (Eds.), Advanced concepts inocean measurements for marine biology. Belle W. Baruch Institute for Marine Biology and Coastal Research. Univ. South Carolina Press, Columbia, South Carolina.

Sherman, K., C. Jones, L. Sullivan, W. Smith, P. Berrien and L. Ejsymont. 1981. Congruent shifts in sand eel abundance in western and eastern North Atlantic ecosystems. Nature 291: 486-489.

Sherman, K., Grosslein, M., Mountain, D., Busch, D., O'Reil ly, J. and Theroux, R. 1988. The continental shelf ecosystem off the northeast coast of the United States. pp. 279-337. In H. Postma and J. J. Zijlstra (Eds.). Ecosystems of the World 27. Elsevier Press, Amsterdam.

Sigurjonsson, J. and S. Leatherwood (Eds). 1988. North Atlantic killer whales. Rit Fiskideildar, Vol. XI. 316 pp.

Sigurjonsson, J., T. Gunlaugsson and P. M. Payne. 1989. NASS-87: Shipboard sighting surveys in Icelandic and adjacent waters, June-July 1987. Rep. Int. Whal. Commn 39: 395-409.

Sissenwine, M. P., B. E. Brown, J. E. Palmer, and R. J. Essig. 1982. Empirical examination of population interactions for the fishery resources off the northeastern USA. In M. C. Mercer (Ed.) Multispecies approaches to fisheries management advice. Can. Spec. Publ. Fish. Aquat. Sci., 59: 82-94.

Sissenwine, M. P., W. J. Overholtz, and S. H. Clark. 1984. In search of density dependence. pp. 119-138 In B. R. Melteff (Ed.) Proceedings of the workshop on Marine Mammal-Fishery Interactions of the East Bering Sea, 18-21 October 1983, Anchorage, Alaska. Univ. of Alaska Sea Grant Publ., Fairbanks, Alaska. 300 pp.

Smith, G. J. D., and D. E. Gaskin. 1974. The diet of harbour porpoises (Phocoena phocoena (L.)) in coastal waters of eastern Canada, with special reference to the Bay of Fundy. Can. J. Zool. 52: 777-782.

Smith, G. J. D. , A. J. Read, and D. E. Gaskin. 1983. Incidental catch of harbor porpoise, Phocoena phocoena (L.), in herring weirs in Charlotte County, New Brunswick, Canada. Fish. Bull. 81: 660-662.

Smith, P. C. 1983. The mean and seasonal circulation off southwest Nova Scotia. J. Phys. Oceanogr. 13: 1034-1054.

Smith, T., P. M. Payne, D. Heinemann, G. Waring, and A. Lange. 1988. Utility of cetacean and seabird sighting surveys conducted during fishery surveys. Int. Cons. Explor. Seas (ICES) Doc. C.M. 1988/N: 5. 40 pp.

Smith, T., Payne, P. M., Heinemann, D. W., Waring, G. T. and Lange, A. 1990. Simultaneous fishery resource and seabird and cetacean sighting surveys:Advantages and disadvantages. North Atlantic Studies 2 (No. 1 + 2): 90-103.

Sorensen, P. W., Medved, R. J., Hyman, M. A. M. and Winn, H. E. 1984. Distribution and abundance of cetaceans in the vicinity of human activities along the continental shelf of the northwestern Atlantic. Mar. Environ. Res. 12: 69-81.

Stewart, B. S. and S. Leatherwood. 1985. Minke Whale-Balaenoptera acutorostrata, pp. 91-136 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic

Press, London.

Stone, G., S. Katona and J. Beard. 1983. Whales in the Gulf of maine, 1978-1981:Report of the Gulf of Maine Sighting Network. College of the Atlantic, Bar Harbor, Maine 04609. 24 pp.

Stone, G. S., S. D. Kraus, J. H. Prescott, and K. W. Hazard. 1988. Significant aggregations of the endangered right whale, Eubalaena glacialis, on the continental shelf of Nova Scotia. Canadian Field-Naturalist 102: 471-474.

Stone, G. S., S. K. Katona and E. B. Tucker. 1987. History, migration and present status of humpback whales Megaptera novaeangliae at Bermuda. Biol. Cons. 42: 133-145.

Sutcliffe, W. H., Jr. and P. F. Brodie. 1977. Whale distributions in Nova Scotia waters. Tech. Rep. Rish. Mar. Serv. (Can.) 722. 83 pp.

Sutcliffe, W. H., Loucks, R. H. and Drinkwater, K. F. 1976. Coastal circulation and physical oceanography of the Scotian Shelf and Gulf of Maine. J. Fish. Res. Board Can. 33: 98-115.

Taruski, A. G. and H. E. Winn. 1976. Winter sightings of odontocetes in the West Indies. Cetology 22: 1-12.

Tershey, B. R., D. Breese and C. S. Strong. 1990. Abundance, seasonal distribution and population composition of balaenopterid whales in the Canal de Ballenas, Gulf of California, Mexico. Rept. int. Whal. Commn (12):349-376.

Testaverde, S. A. and J. G. Mead. 1980. Southern distribution of the Atlantic whitesided dolphin Lagenorhynchus acutus in the western North Atlantic. Fish. Bull. 78: 167-169.

True, F. W. 1904. The whalebone whales of the western North Atlantic compared with those occurring in European waters with some observations on the species of the North Pacific. Smithson. Contribution Knowledge 33. 332 pp.

True, F. W. 1910. An account of the beaked whales of the family Ziphiidae in the collection of the United States National Museum, with remarks on some specimens in other American museums. Bull. U.S. Natl. Mus. 73.

True, F. W. 1913. Description of Mesoplodon mirus, a beaked whale recently discovered on the coast of North Carolina. Proc. U.S. Natl. Mus. 45: 651-657.

Ulmer, F. A. 1941. Mesoplodon mirus in New Jersey, with additional notes on the New Jersey M. densirostris, and a list and key to the Ziphioid whales of the Atlantic coast of North America. Proc. Acad. Nat. Sci. (Philadelphia) 93: 107-122.

Ulmer, F. A. 1947. A second Florida record of Mesoplodon europaeus. J. Mammal. 28: 184-185.

Ulmer, F. A. 1961. New Jersey's whales and dolphins. New Jersey Nature News

(New Jersey Audubon Soc.) 16(3): 80-93.

Ulmer, F. A. 1977. New Jersey's dolphins and porpoises. Occ. Paper No. 137, New Jersey Audubon Soc 3: 1-11.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast USA, 1977-1988. Fish. Bull. 88: 347-360.

Waters, J. H. and C. J. Rivard. 1962. Terrestrial and marine mammals of Massachusetts and other New England states. Standard-Modern Printing Co., Inc., Brockton, Massachusetts. 119 pp.

Watkins, W. A. and W. E. Schevill. 1976. Right whale feeding and baleen rattle. J. Mammal. 27: 58-66.

Watkins, W. A. and W. E. Schevill. 1979. Aerial observations of feeding behavior in four baleen whales: Eubalaena glacialis, Balaenoptera borealis, Megaptera novaeangliae, and Balaenoptera physalus . J. Mammal. 60: 155-163.

Watkins, W. A. and W. E. Schevill. 1982. Observations of right whales, Eubalaena glacialis, in Cape Cod waters. Fish. Bull. 80: 875-880.

Watkins, W. A., K. E. Moore, and P. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology 49: 1-15.

Watts, P. and D. E. Gaskin. 1985. Habitat index analysis of the harbor porpoise (Phocoena phocoena) in the southern coastal Bay of Fundy, Canada. J. Mammal. 66: 733-744.

Weinrich, M., C. R. Belt, M. R. Schilling, and M. Marcy. 1986. Behavior of sei whales in the southern Gulf of Maine, Summer 1986. Whalewatcher, J. Am. Cetacean Soc. 20(4): 4-7

Weinrich, M. T., C. R. Belt, H. J. Iken, and M. R. Schilling. 1985. Individual variation in feeding patterns of humpback whales (Megaptera novaeangliae) in New England, pp.28-40; in Humpback Whales of the southern Gulf of Maine: Recent findings on habitat use, social behavior, and feeding patterns. Cetacean Research Unit, Gloucester Fishermen's Museum, Gloucester, Massachusetts. 41 pp.

Wells, R. S., A. B. Irvine, and M. D. Scott. 1980. The social ecology of inshore odontocetes. pp. 263-317 In L. M. Herman (Ed.), Cetacean Behavior: M echanisms and Functions, Wiley (Interscience), New York, New York.

Wells, R. S., M. D. Scott and A. B. Irvine. 1981. Repeated patterns of occurrence, dirstribution and social associations of marked bottlenose dolphins, Tursiops truncatus. pbserved from 1970-1981. pp. 12 In Abstracts of the Fourth Bienniel Conference on the Biology of Marine Mammals, 14-18 December, San Francisco, California.

Wenzel, F., D. K. Mattila and P. J. Clapham. 1988. Balaenoptera musculus in the Gulf of Maine. Mar. Mamm. Sci. 4: 172-175.

Whitehead, H. 1981. The baleen whales off the northeast coast of Newfoundland. Rep. int. Whal. Commn 31: 1-8.

Whitehead, H. 1982. Populations of humpback whales in the northwest Atlantic. Rep. int. Whal. Commn 32: 345-353.

Whitehead, H. P. 1983. Structure and stability of humpback whale groups off Newfoundland. Can. J. Zool. 61: 1391-1397.

Whitehead, H. P., and J. Carscadden. 1985. Predicting inshore whale abundance-whales and capelin off the Newfoundland coast. Can. J. Fish. Aquat. Sci. 42: 976-981.

Whitehead, H. and C. Glass. 1985. The significance of the Southeast Shoal of the Grand Bank to humpback whales and other cetacean species. Can. J. Zool. 63: 2617-2625.

Whitehead, H. and J. Lien. 1982. Changes in the abundance of whales and whale damage, along the Newfoundland coast 1973-1981. Rep. int. Whal. Commn, Scientific Comm. 34/01 : 6pp.

Whitehead, H. and M. J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. Can. J. Zool. 60:L 2173-2179.

Whitehead, H., K. Chu, J. Perkins, P. Bryant, G. Nichols. 1983. Population size, stock identity, and distributionof the humpback whales off West Greenland-summer 1981. Rep. int. whal. Commn. 33: 497-501.

Whitehead, H., P. Harcourt, K. Ingham and H. Clark. 1980. Migration of the humpback whales past the Bay de Verde Peninsula, Newfoundland. Can. J. Zool. 58: 687-692.

Whitehead, H. P., R. Silver and P. Harcourt. 1982. The migration of humpback whales along the northeast coast of Newfoundland. Can. J. Zool. 60: 2173-2179.

Winn, H. E. and P. J. Perkins. 1976. Distributions and sounds of the minke whale, with a review of mysticete sounds. Cetology 19: 1-12.

Winn, H. E., R. K. Edel and A. G. Taruski. 1975. Population estimate of the humpback whale in the West Indies by visual and acoustic techniques. J. Fish. Res. Bd. Canada 31: 499-506.

Winn, H. E., D. R. Goodale, M. A. M. Hyman, R. D. Kenney, C. A. Price and G. P. Scott. 1981. Right whale sightings and the right whale minimum count. pp. VI-1-37 In A Characterization of marine mammals and turtles in the Mid- and North- Atlantic areas of the U.S. Outer Continental Shelf, Ann. Report for 1979. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA552-CT8-48, Washington D.C. [Available Natl. Tech. Inform. Service, Springfield, Virginia, Ref. No. PB81243289].

Winn, H. E., J. H. W. Hain, M. A. M. Hyman and G. P. Scott. 1987. Whales, Dolphins, and Porpoises. pp. 375-382 in R. H. Backus and D. W. Bourne (Eds.) Georges Bank and its surroundings. MIT Press, Cambridge, Massachusetts.

Winn, H. E., C. A. Price and P. W. Sorensen. 1986. The distributional biology of the right whale (Eubalaena glacialis) in the western North Atlantic. Rep. int. Whal. Commn (Spec. Issue 10): 129-138.

Winn, H. E. 1984. Development of a right whale sighting network in the southeastern United States, Final Report. Marine Mammal Commn, Washington, D.C., Report No. MMC-82/05. 16 pp. [Available National Tech. Inform. Service, Ref. No. PB84240548, Port Royal Road, Springfield, Virginia].

Winn, H. E. and N. E. Reichley. 1985. Humpback Whale-Megaptera novaeangliae, pp. 141-274 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic Press, London.

Winn, L. K., H. E. Winn, D. K. Caldwell, M. C. Caldwell and J. L. Dunn. 1979. Marine Mammals. pp. XII.1-XII. 117, Vol. I (Book 2) in A summary and analysis of environmental information on the continental shelf and Blake plateau from Cape Hatteras to Cape Canaveral, Final Report. Center for Natural Areas, Contract AA550-CT2-39, Bureau of Land Management, Washington, D.C.

Wishner, K., E. Durbin, A. Durbin, M. Macaulay, H. Winn and R. Kenney. 1988. Copepod patches and right whales in the Great South Channel off New England. Bull. Mar. Sci. 43: 825-844.

Woodley, T. H. and Read, A. J. 1991. Potential rates of increase of a harbor porpoise Phocoena phocoena population subjected to incidental mortality in commercial fisheries. Can J. Fish. Aquat. Sci., in press.

Wright, W. R. 1976. The limits of shelf water south of Cape Cod, 1941 to 1972. J. Mar. Res. 34: 1-14.

Yochem, P. K. and S. Leatherwood. 1985. Blue Whale-Balaenoptera musculus, pp. 193-240 in Ridgway, S. H. and R. Harrison (Eds.), Handbook of Marine Mammals: (Vol.3, The Sirenians and Baleen Whales), Academic Press, London.

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TABLE 1. The number of bottlenose dolphin sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	0	1	1	1	2	1	6
GB	1	0	17	25	4	5	52
SNE	0	8	26	30	15	4	83
MA	31	47	116	113	63	19	389
SL-gb	4	20	27	46	17	3	117
SL-sne	3	19	52	37	32	6	149
SL-ma	9	25	50	68	80	45	277
TOTAL	48	120	289	320	213	83	1073

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = Southern New England, MA = Mid-Atlantic and SL = Slope
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 2. The number of spotted dolphin sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	0	0	0	0	0	0	0
GB	0	1	0	0	1	1	3
SNE	0	0	0	2	2	0	4
MA	0	5	22	46	18	0	91
SL-gb	0	0	0	1	5	0	6
SL-sne	0	0	3	5	5	5	18
SL-ma	0	3	10	18	12	14	57
TOTAL	0	9	35	72	43	20	179

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = Southern New England, MA = Mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 3. The number of striped dolphin sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	0	0	1	0	0	1	2
GB	0	0	0	0	0	0	0
SNE	0	0	1	0	1	0	2
MA	6	7	0	1	0	1	15
SL-gb	0	3	2	4	1	0	10
SL-sne	0	4	4	3	3	6	20
SL-ma	5	21	10	18	7	5	66
TOTAL	11	35	18	26	12	13	115

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = Southern New England, MA = Mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 4. The number of common dolphin sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	4	5	8	6	18	7	48
GB	51	9	39	54	89	75	317
SNE	68	18	46	20	10	64	226
MA	31	56	15	12	0	6	120
SL-gb	4	11	20	5	4	7	51
SL-sne	2	20	29	7	8	6	72
SL-ma	14	28	41	5	3	9	100
TOTAL	174	147	198	109	132	174	984

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 5. The number of white-sided dolphin sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	15	86	190	346	105	84	826
GB	1	13	33	75	17	6	145
SNE	4	15	13	22	3	6	63
MA	0	1	2	0	1	0	4
SL-gb	0	5	2	3	2	0	12
SL-sne	0	5	6	1	0	2	14
SL-ma	0	2	1	0	0	0	3
TOTAL	20	127	247	447	128	98	1067

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

Table 6. The number of white-beaked dolphin sightings used in the plots of distribution by two-month period.

JAN-FEB	MAR-APR	MAY-JUN	JUL-AUG	SEP-OCT	NOV-DEC	TOTAL
1	16	11	7	0	0	35

TABLE 7. The number of grampus or Risso's dolphin sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	0	3	0	3	2	0	8
GB	0	1	11	11	5	0	28
SNE	1	3	9	60	34	0	107
MA	0	1	13	30	4	2	50
SL-gb	0	5	4	18	12	7	46
SL-sne	2	1	36	56	32	6	133
SL-ma	13	32	30	50	24	21	170
TOTAL	16	46	103	228	113	36	552

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

Table 8. The number of killer whale sightings used in the plots of distribution by two-month periods.

JAN-FEB	MAR-APR	MAY-JUN	JUL-AUG	SEP-OCT	NOV-DEC	TOTAL
0	3	4	2	4	0	13

TABLE 9. The number of pilot whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	1	2	87	94	45	39	268
GB	2	2	21	46	47	30	148
SNE	6	36	76	18	16	19	171
MA	2	16	5	16	3	4	46
SL-gb	8	34	40	18	3	12	115
SL-sne	5	31	24	5	13	5	83
SL-ma	2	17	39	55	39	50	201
TOTAL	26	138	291	253	166	159	1,033

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 10. The number of harbor porpoise sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	5	62	173	380	73	18	711
GB	2	18	95	2	2	1	120
SNE	2	37	30	4	3	0	76
MA	0	2	0	1	0	0	3
SL	0	4	5	1	1	0	11
TOTAL	9	123	303	388	79	19	921

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.

TABLE 11. The number of sperm whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	0	0	1	3	4	3	11
GB	0	0	8	2	0	0	10
SNE	1	1	4	11	14	8	39
MA	0	11	2	0	0	0	13
SL-gb	3	4	14	34	3	0	58
SL-sne	4	18	25	12	13	3	75
SL-ma	14	53	47	65	10	18	207
TOTAL	22	87	101	127	44	32	413

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 12. The number of beaked whale spp. sightings used in the plots of distribution by regions for all seasons.

Region[1]	GOM	GB	SNE	MA	SL-gb	SL-sne	SL-ma
	1	0	4	4	10	7	14

TABLE 13. The number of Minke whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	1	37	112	180	153	14	497
GB	1	5	55	41	9	1	112
SNE	1	13	46	37	4	2	103
MA	3	9	2	5	2	1	22
SL-gb	0	1	3	3	0	0	7
SL-sne	0	10	1	0	0	0	11
SL-ma	0	1	2	1	1	1	6
TOTAL	6	76	221	267	169	19	758

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 14. The number of fin whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	27	262	903	615	325	127	2259
GB	6	21	86	57	55	21	246
SNE	16	69	103	225	33	15	461
MA	18	64	55	41	10	9	197
SL-gb	2	13	8	7	7	2	39
SL-sne	1	21	8	15	14	4	63
SL-ma	0	7	7	10	1	1	26
TOTAL	70	457	1170	970	445	179	3291

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region;
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 15. The number of sei whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Apr	May-Aug	Sep-Dec	Total
GOM	2	11	5	18
GB	11	9	0	20
SNE	10	7	1	18
MA	1	2	0	3
SL-gb	5	16	0	21
SL-sne	3	2	0	5
SL-ma	0	1	0	1
TOTAL	32	48	6	86

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 16. The number of humpback whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	3	121	541	331	232	56	1284
GB	1	9	28	15	6	5	64
SNE	0	14	17	51	10	9	101
MA	2	3	3	2	2	0	12
SL-gb	0	0	2	2	0	1	5
SL-sne	0	2	1	0	0	1	4
SL-ma	0	2	0	0	0	0	2
TOTAL	6	151	592	401	250	72	1472

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
SL-sne = slope waters seaward of the southern New England region,
SL-ma = slope waters seaward of the mid-Atlantic region.

TABLE 17. The number of right whale sightings used in the plots of distribution by regions and two-month period.

Region[1]	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
GOM	4	61	307	143	88	22	625
GB	0	11	10	1	1	0	23
SNE	4	22	3	3	0	2	34
MA	5	5	3	0	0	2	15
SL-gb	0	0	1	0	0	0	1
SL-sne	0	2	0	0	0	0	2
SL-ma	0	0	0	0	0	0	0
TOTAL	13	101	324	147	89	26	700

[1] GOM = Gulf of Maine, GB = Georges Bank, SNE = southern New England, MA = mid-Atlantic and SL = slope.
SL-gb = slope waters (200 -2,000m in depth) seaward of Georges Bank,
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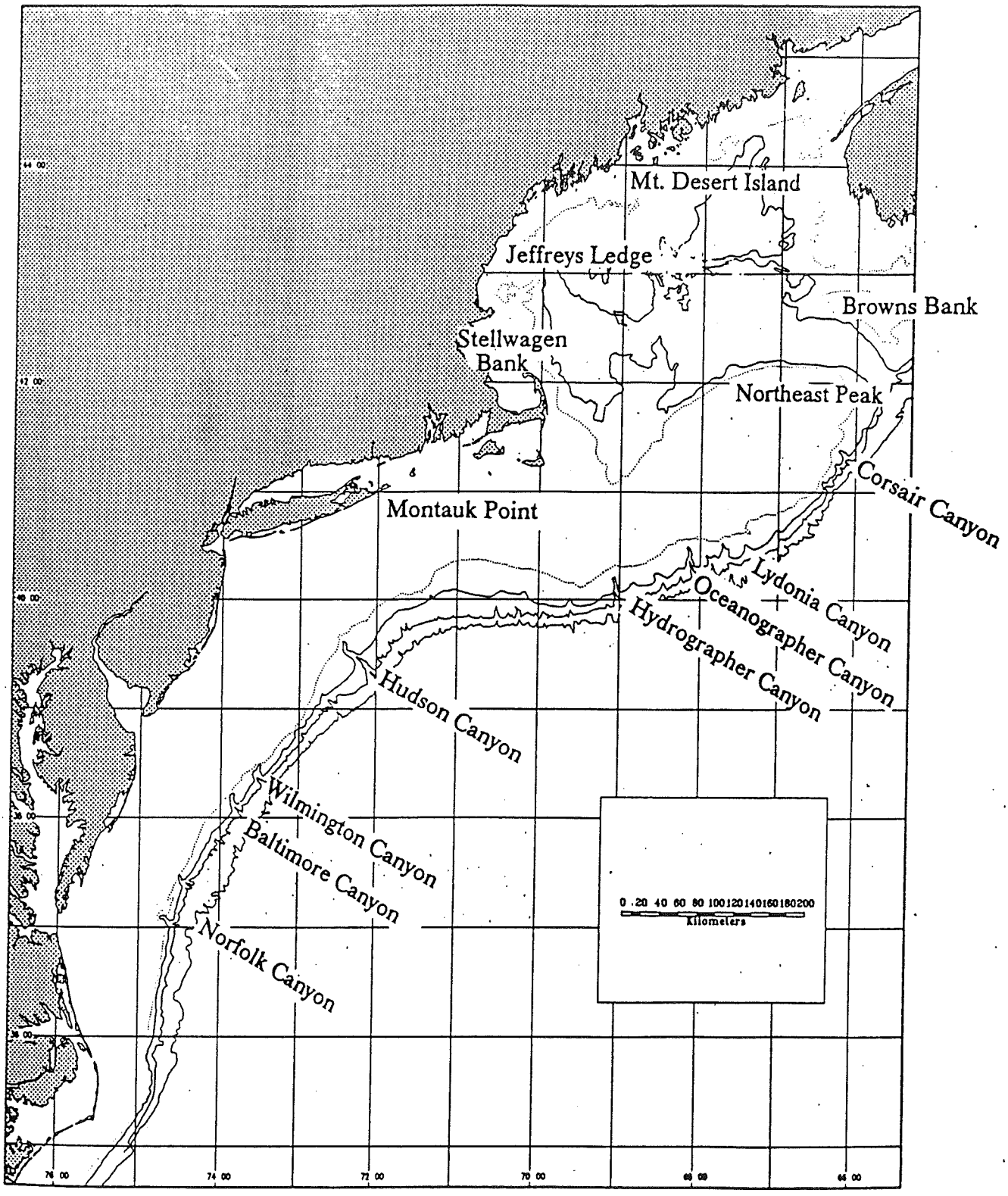

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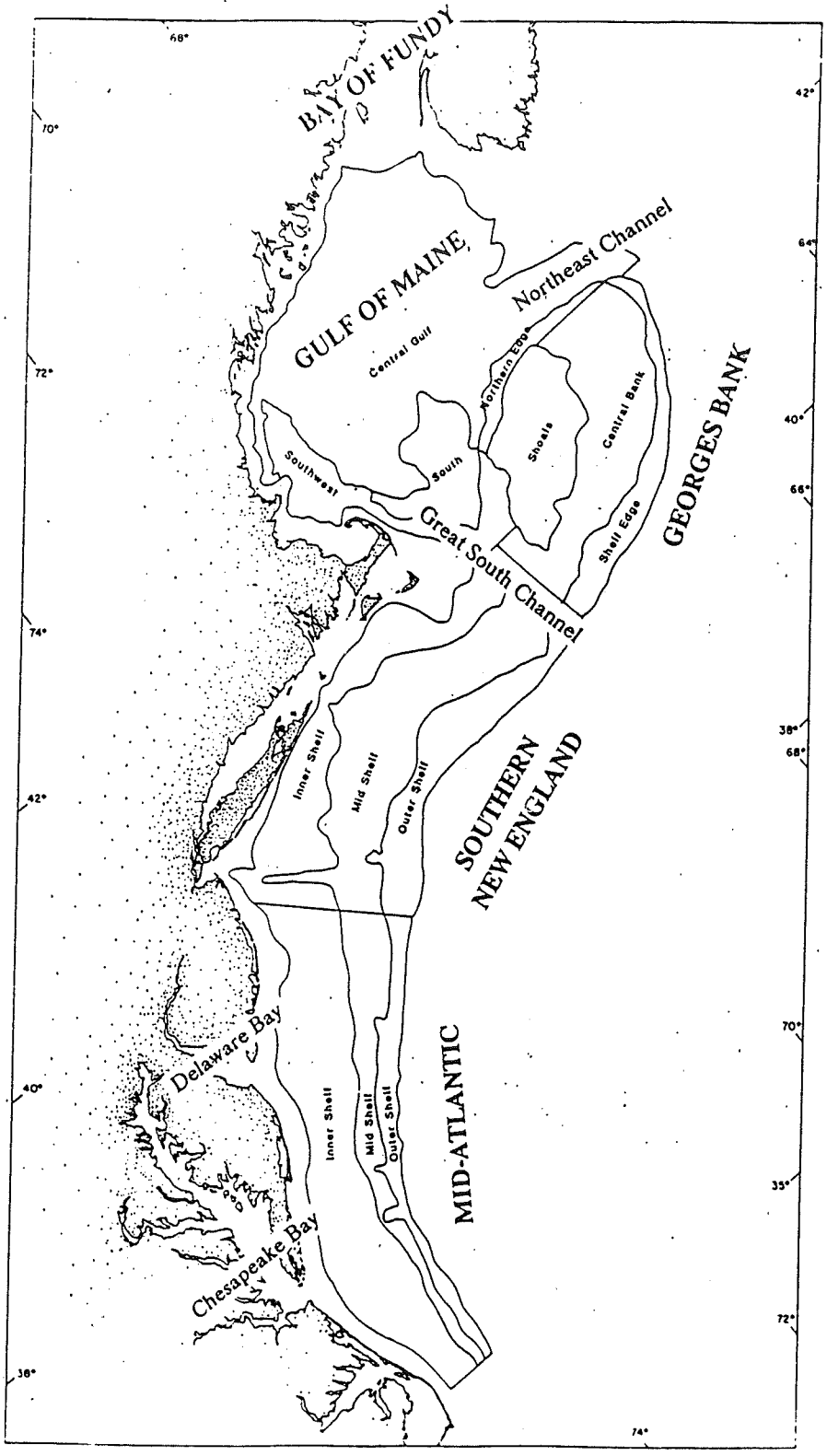

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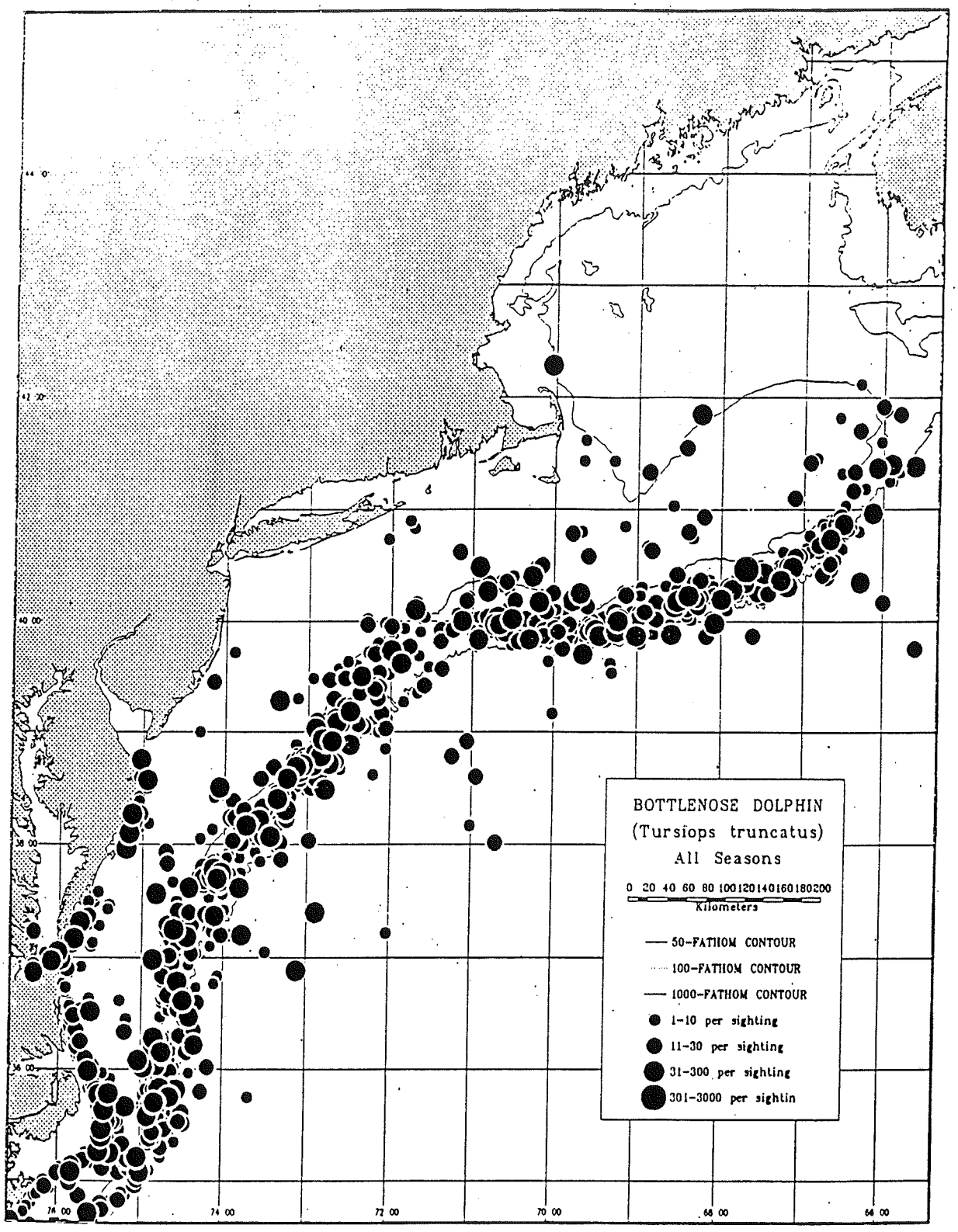

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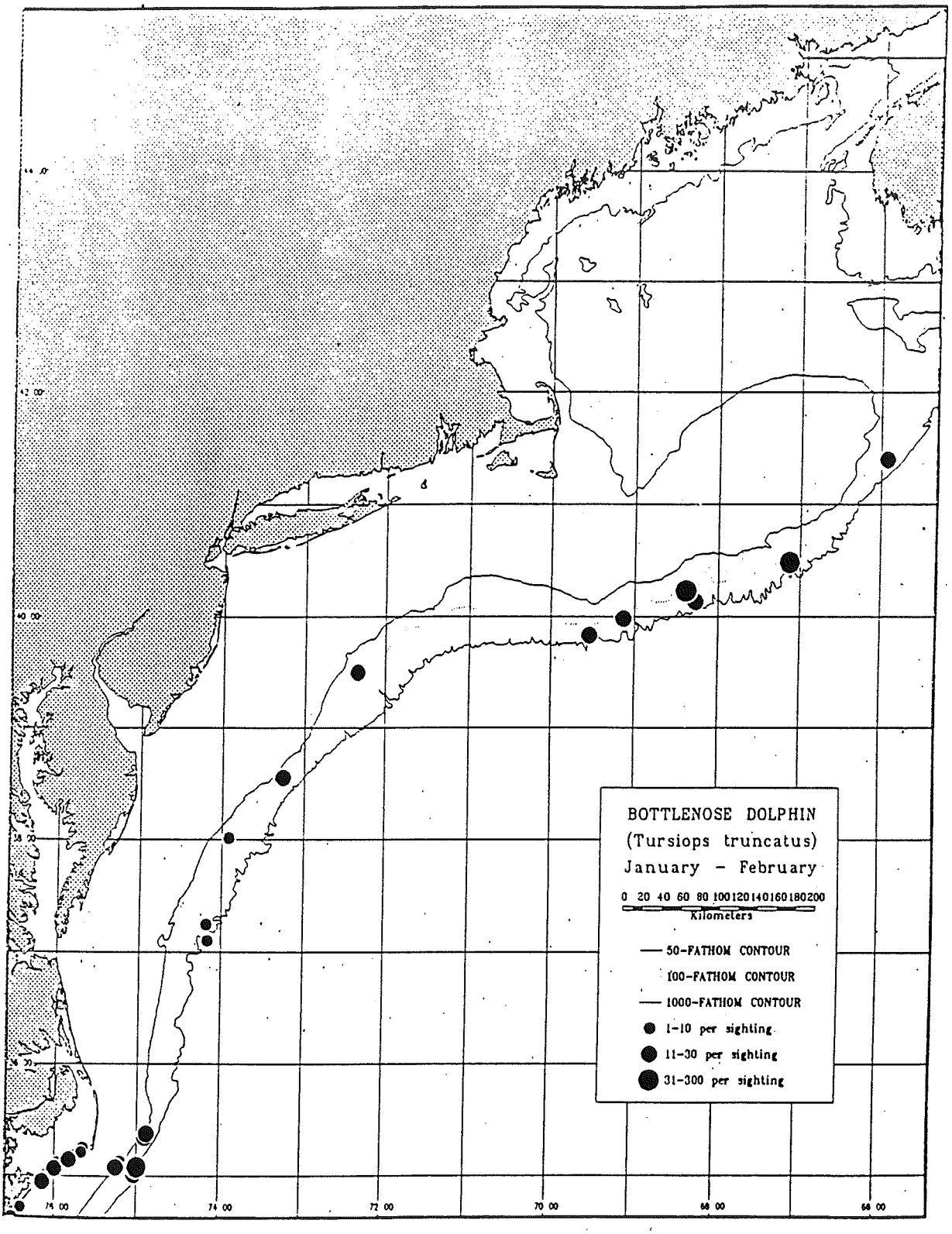

Figure 2a. Distribution of bottlenose dolphin Tursiops truncatus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

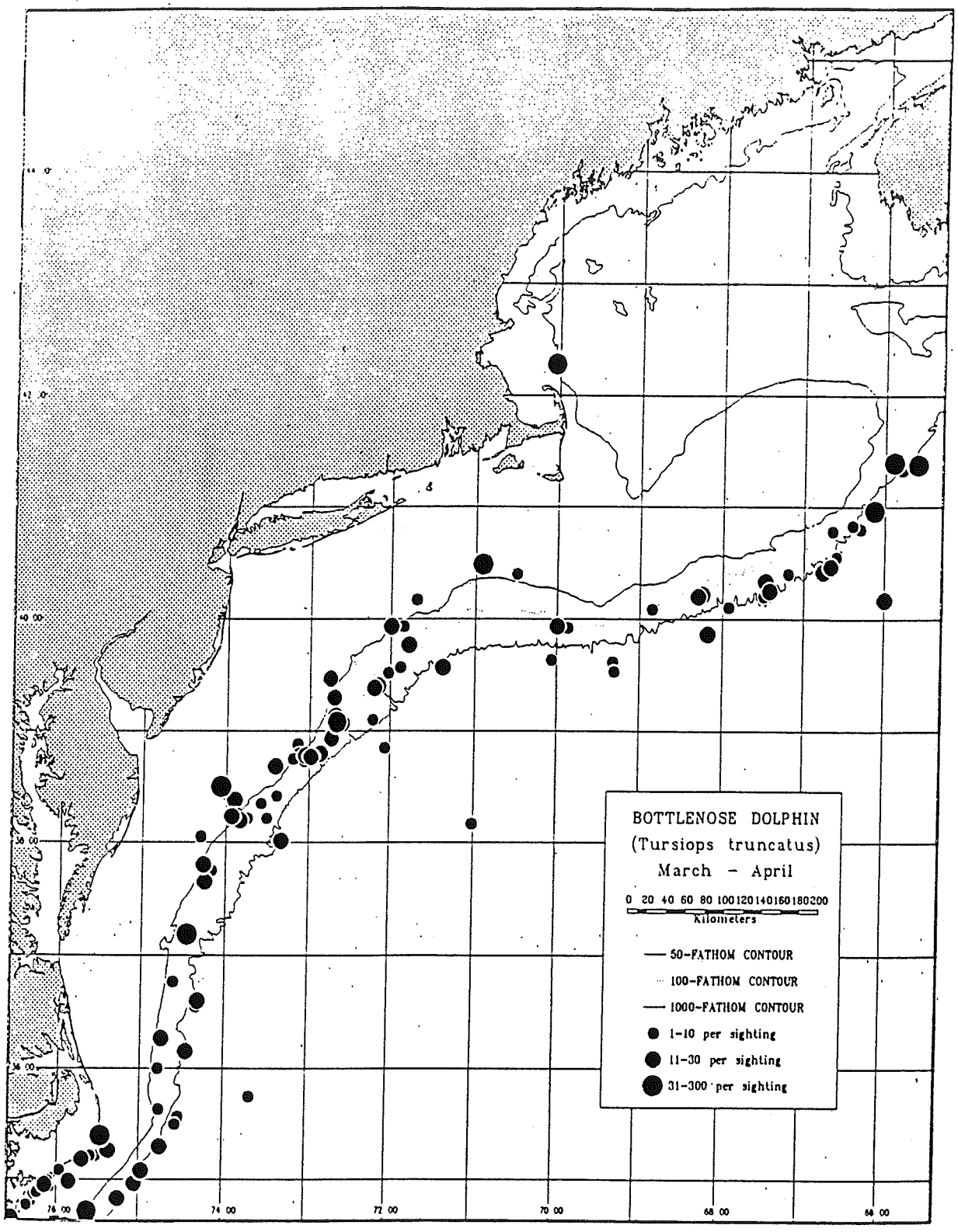

Figure 2b. Distribution of bottlenose dolphin Tursiops truncatus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

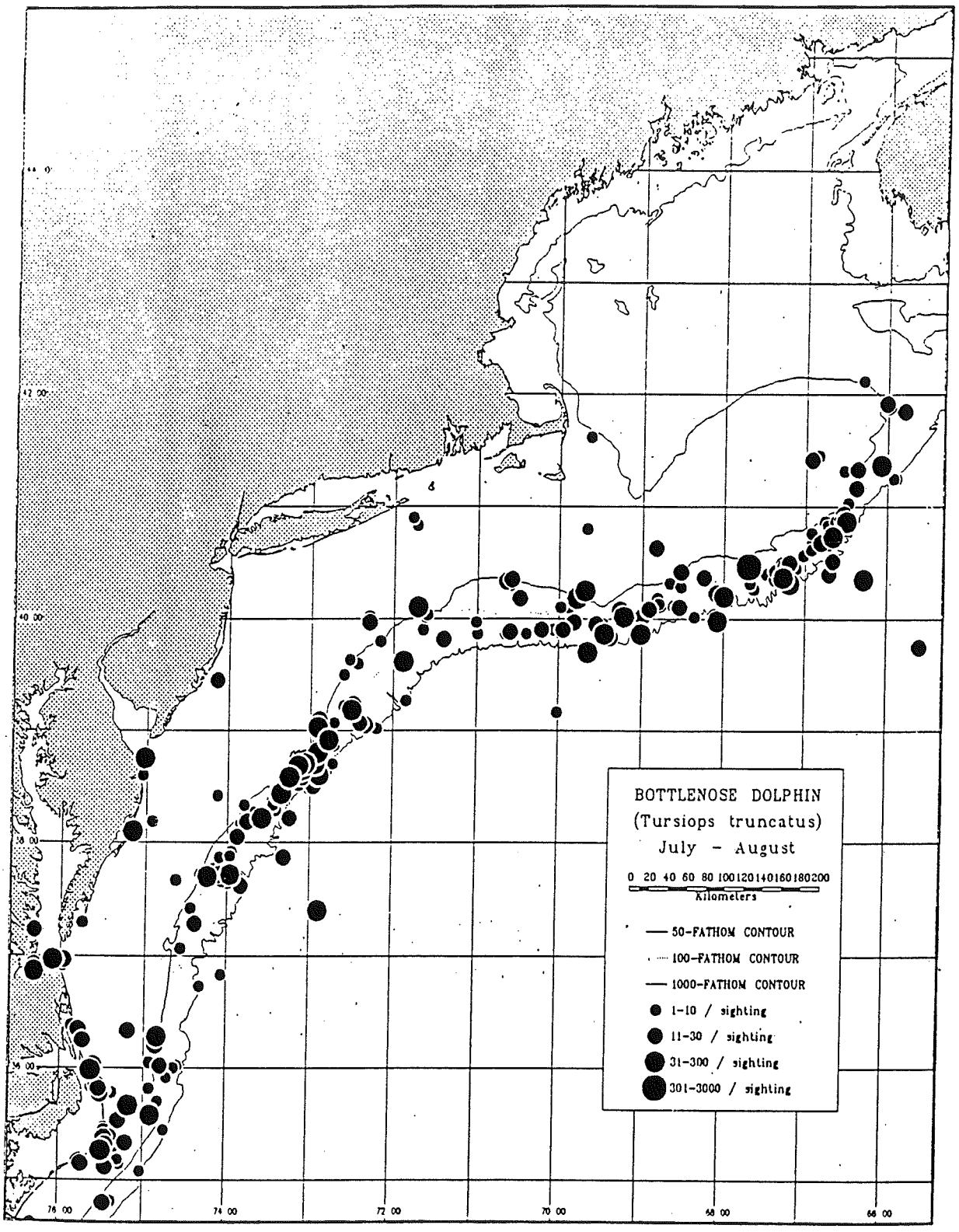

Figure 2d. Distribution of bottlenose dolphin Tursiops truncatus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

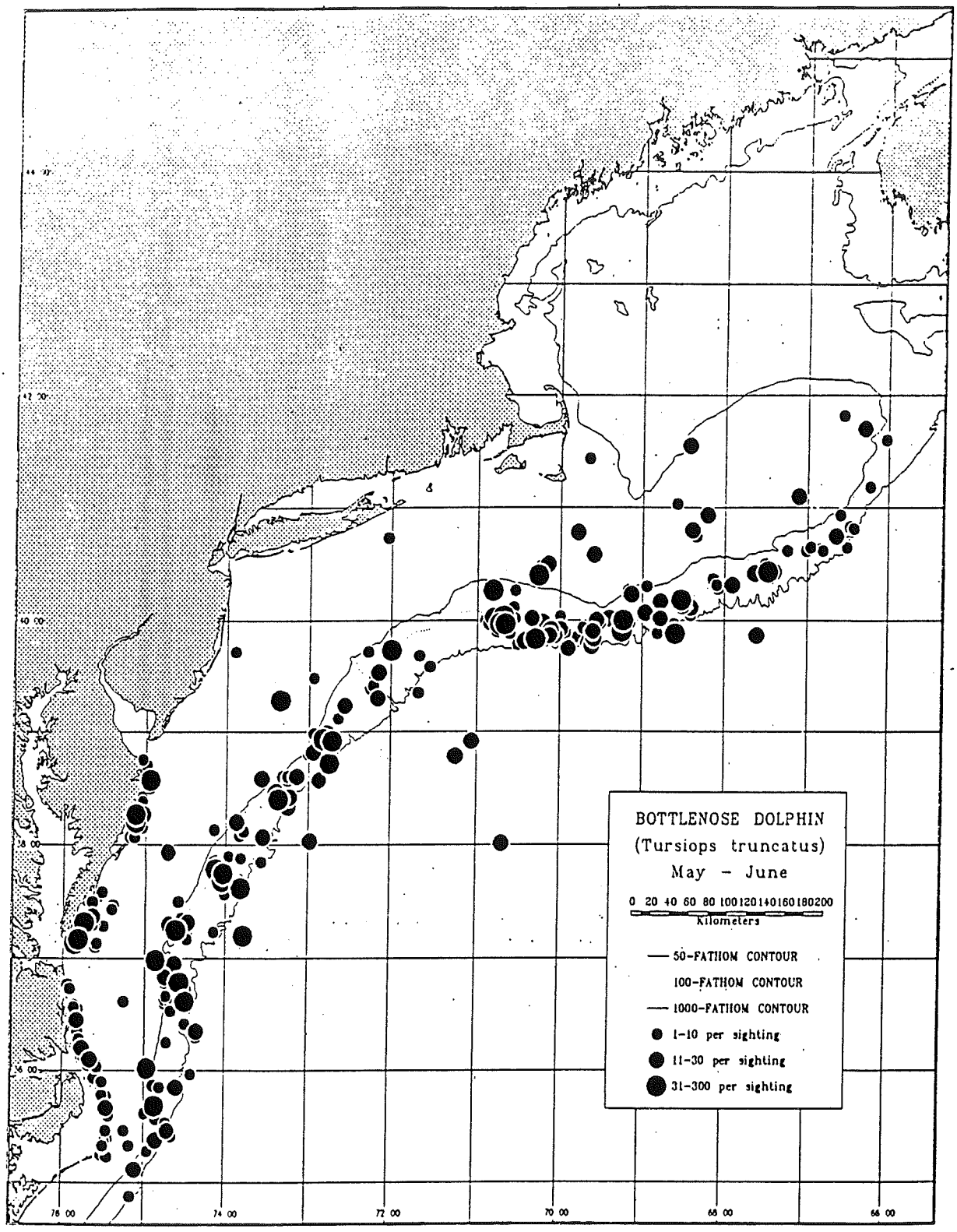

Figure 2c. Distribution of bottlenose dolphin Tursiops truncatus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

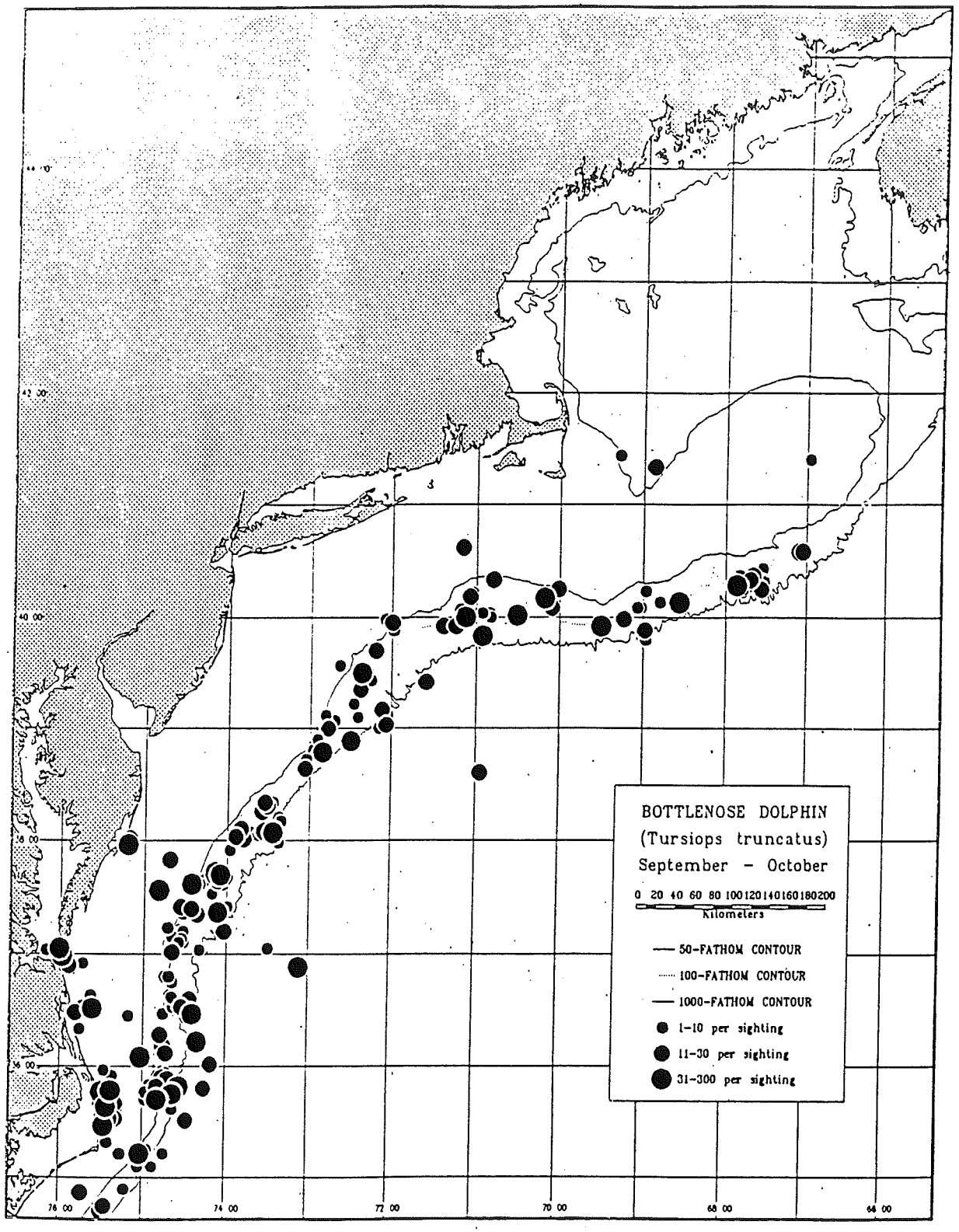

Figure 2e. Distribution of bottlenose dolphin Tursiops truncatus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

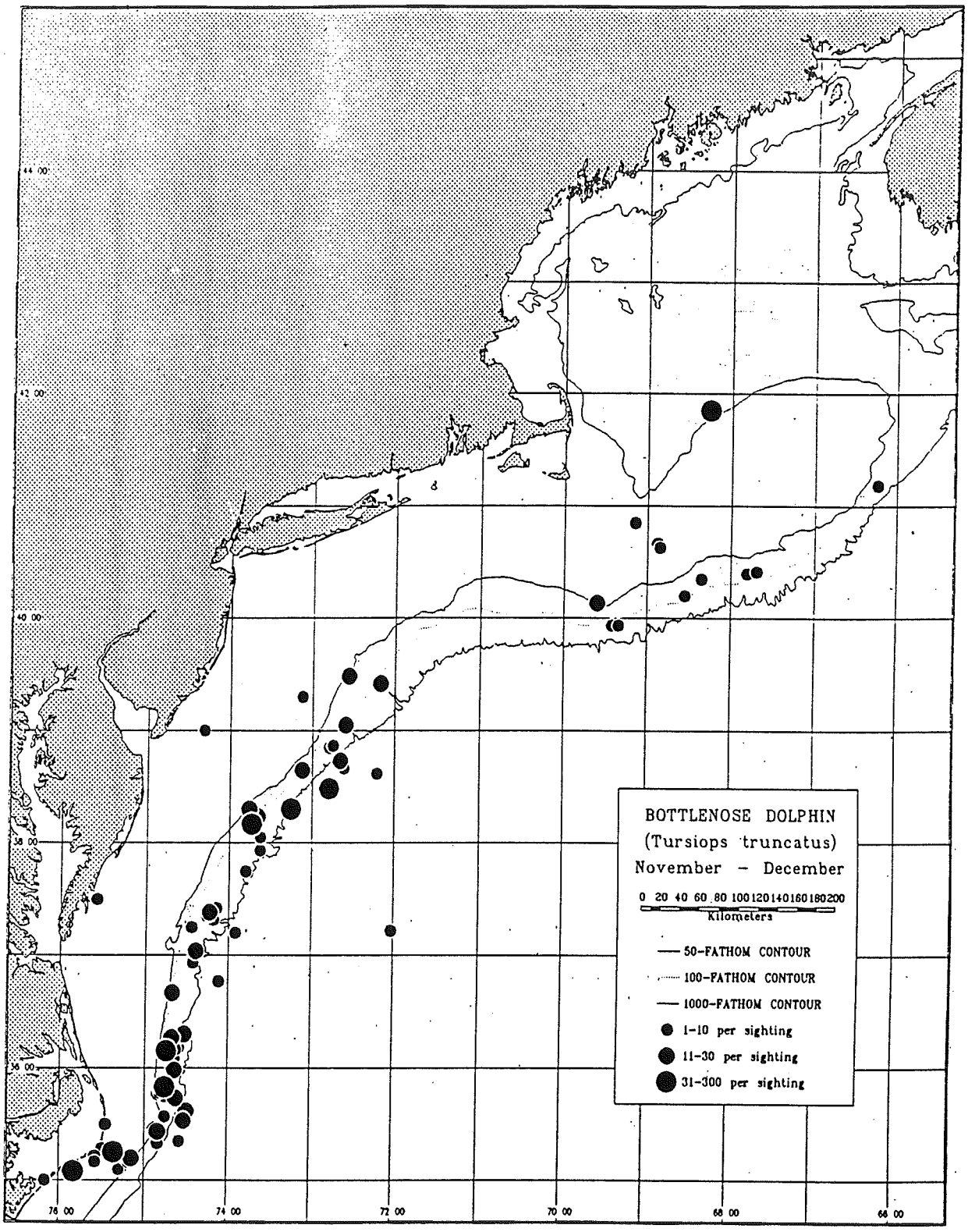

Figure 2f. Distribution of bottlenose dolphin Tursiops truncatus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

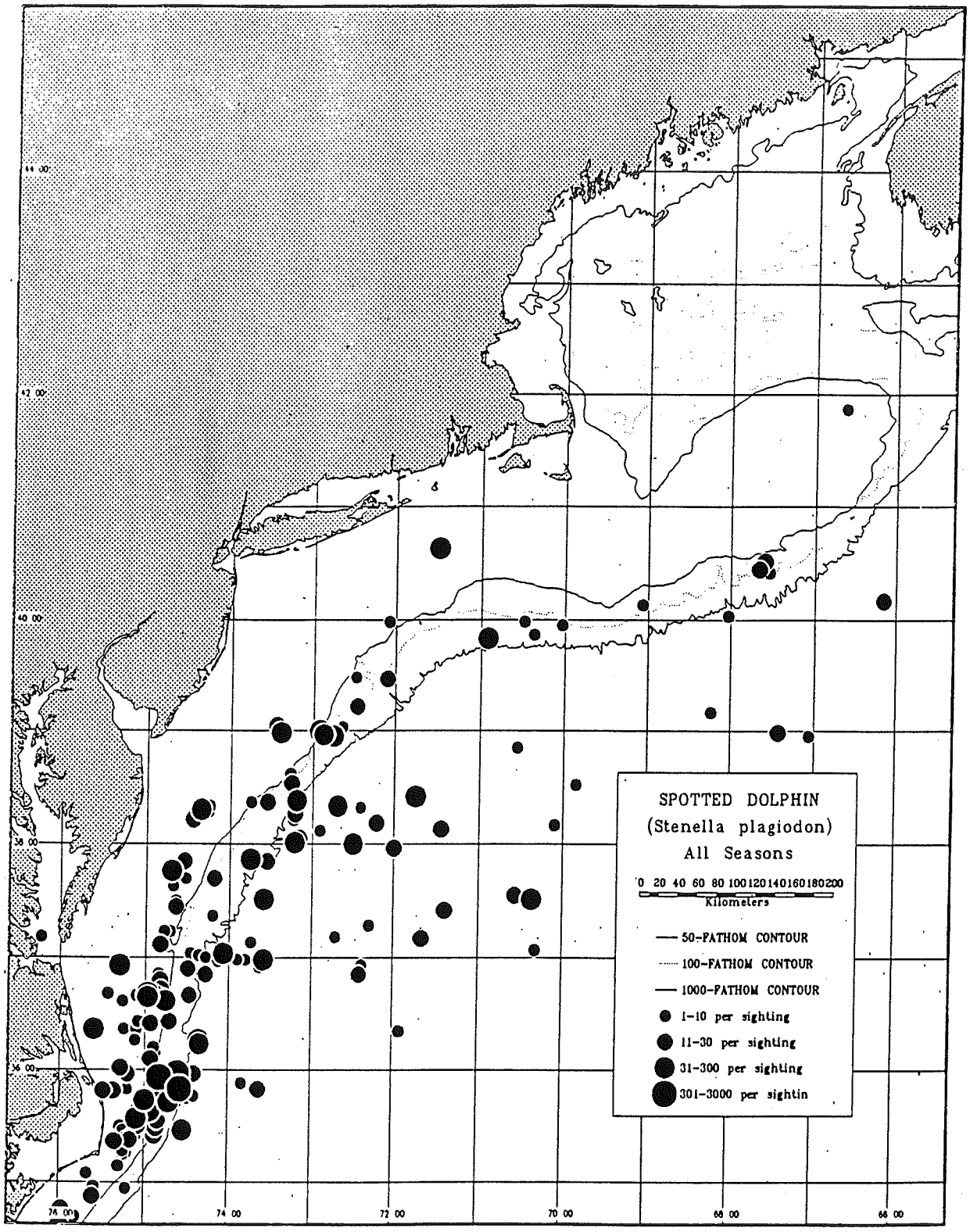

Figure 3. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

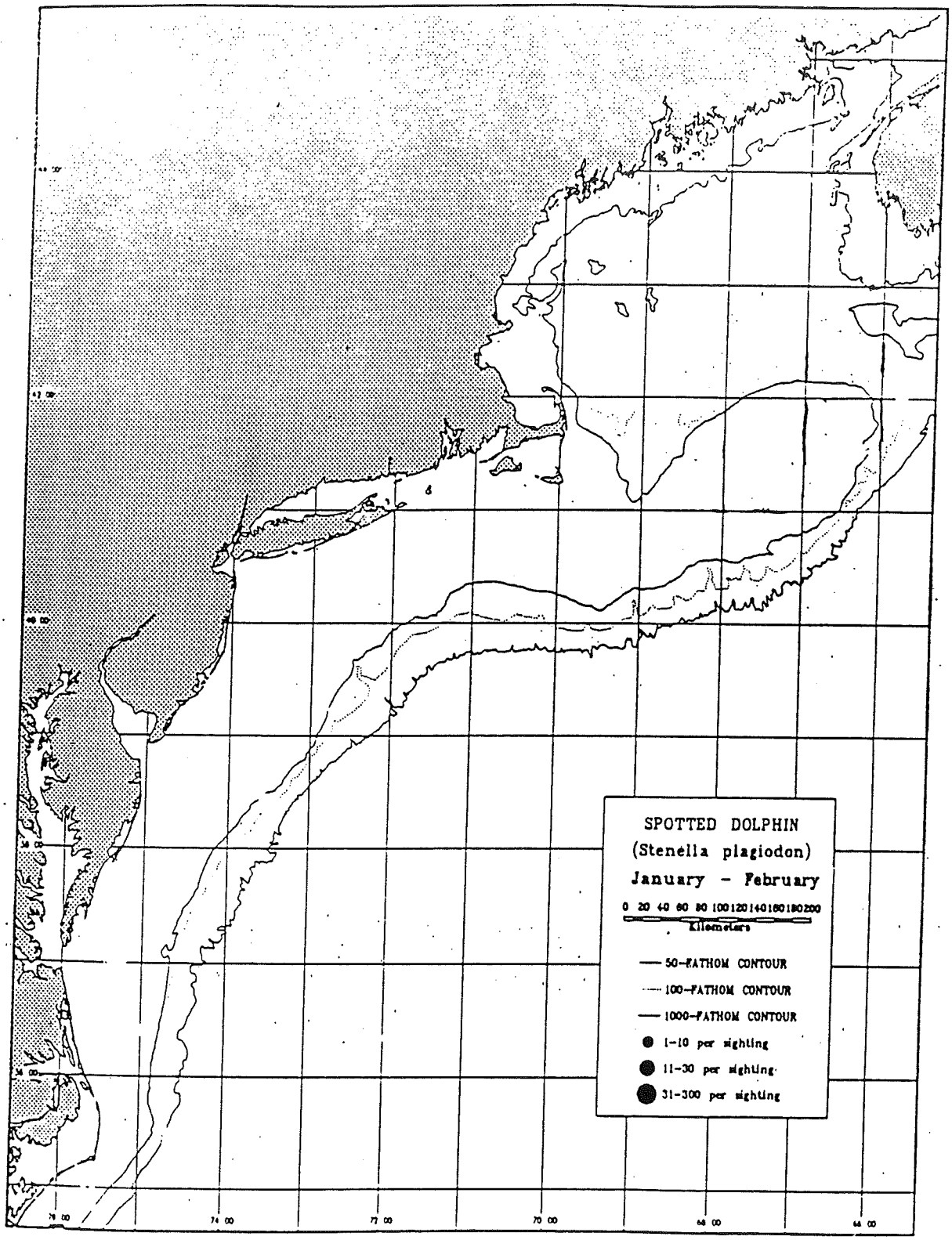

Figure 3a. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

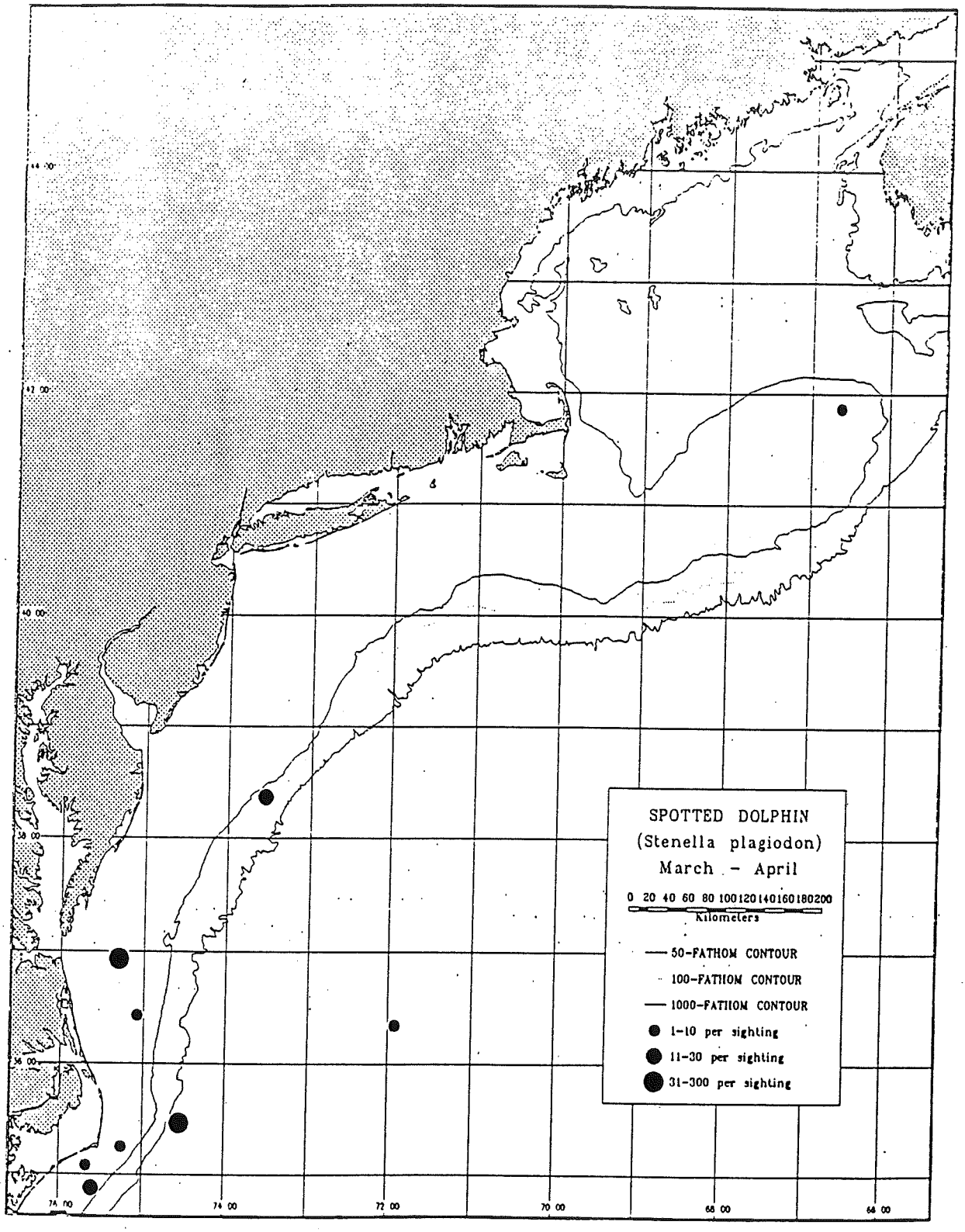

Figure 3b. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

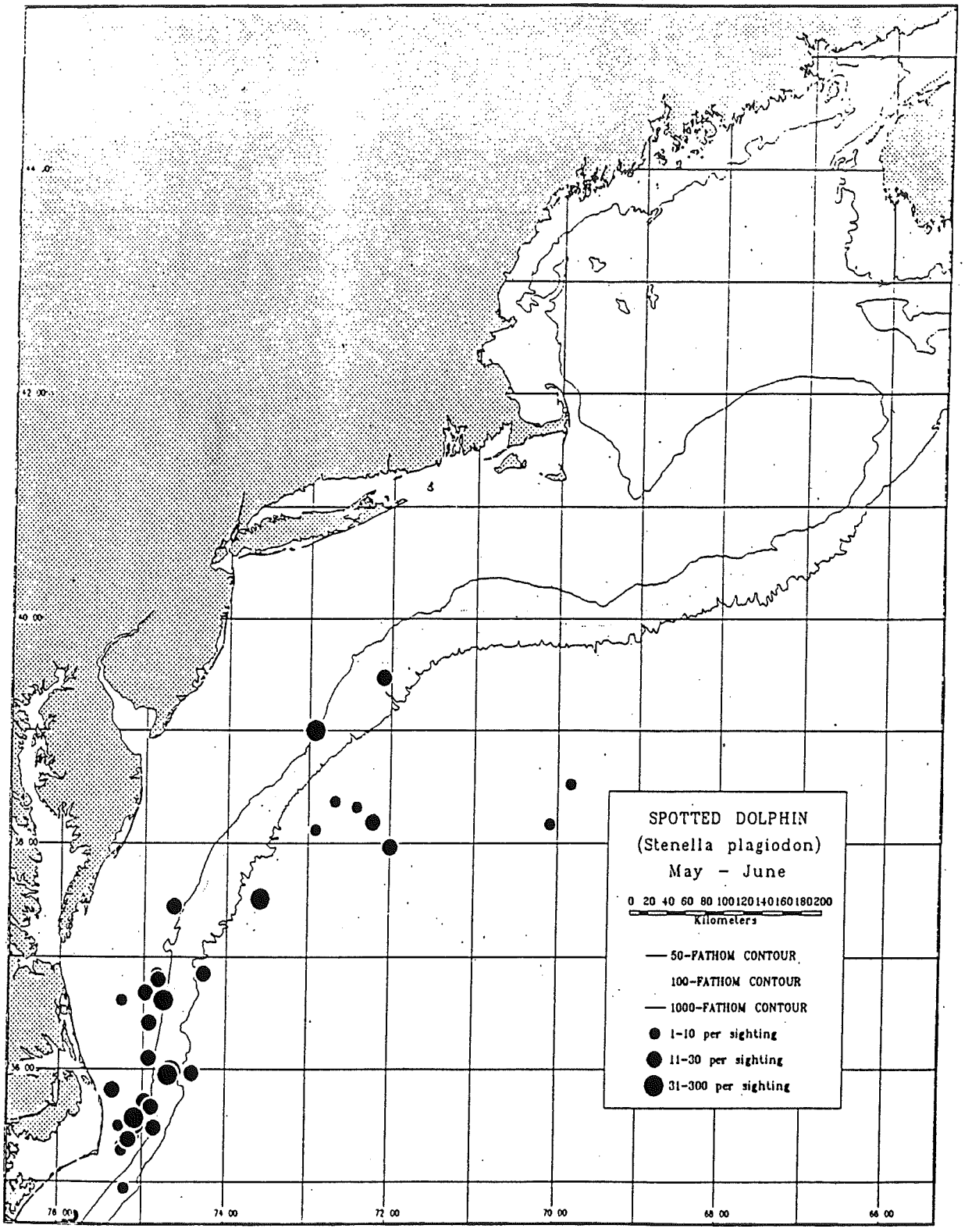

Figure 3c. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

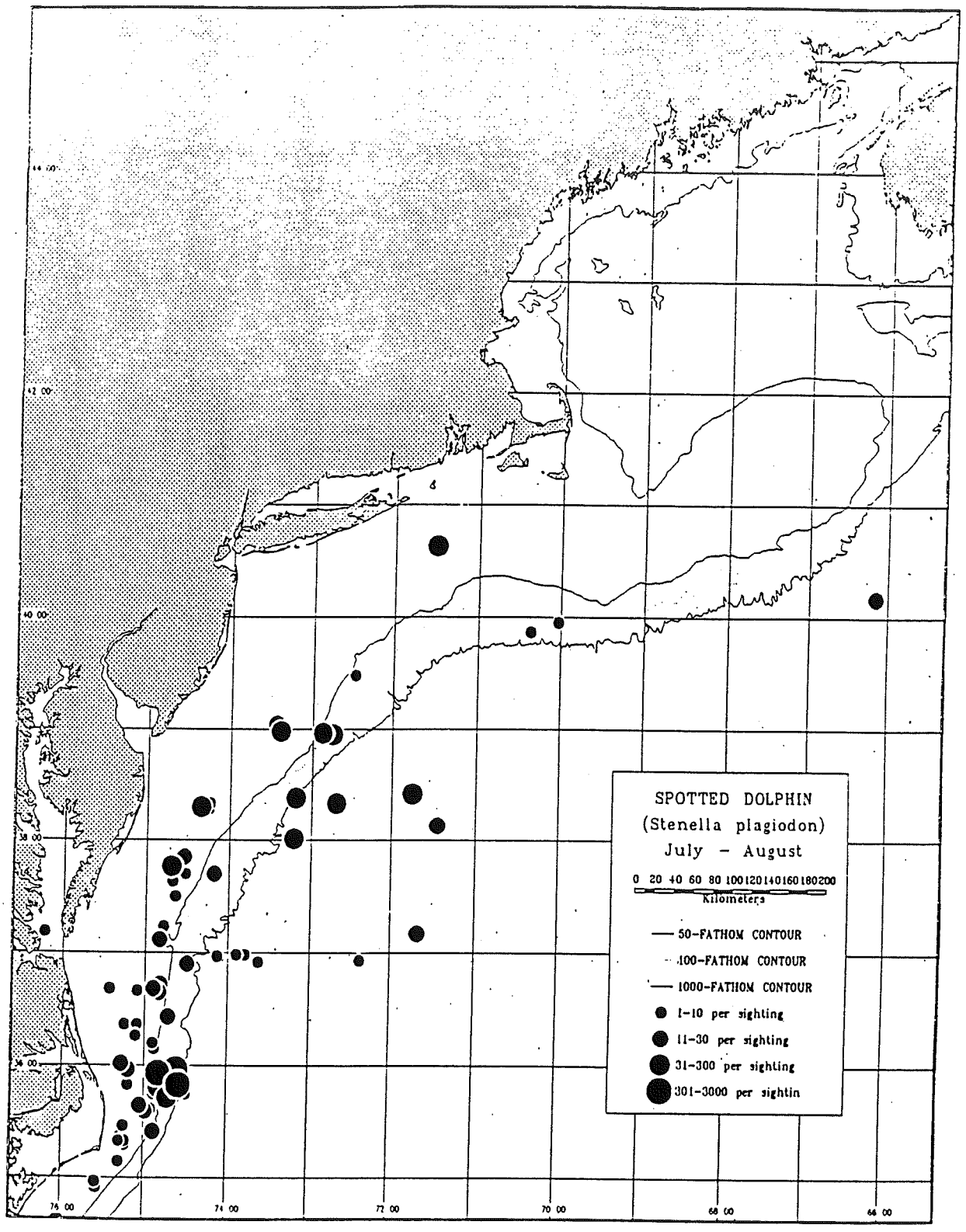

Figure 3d. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

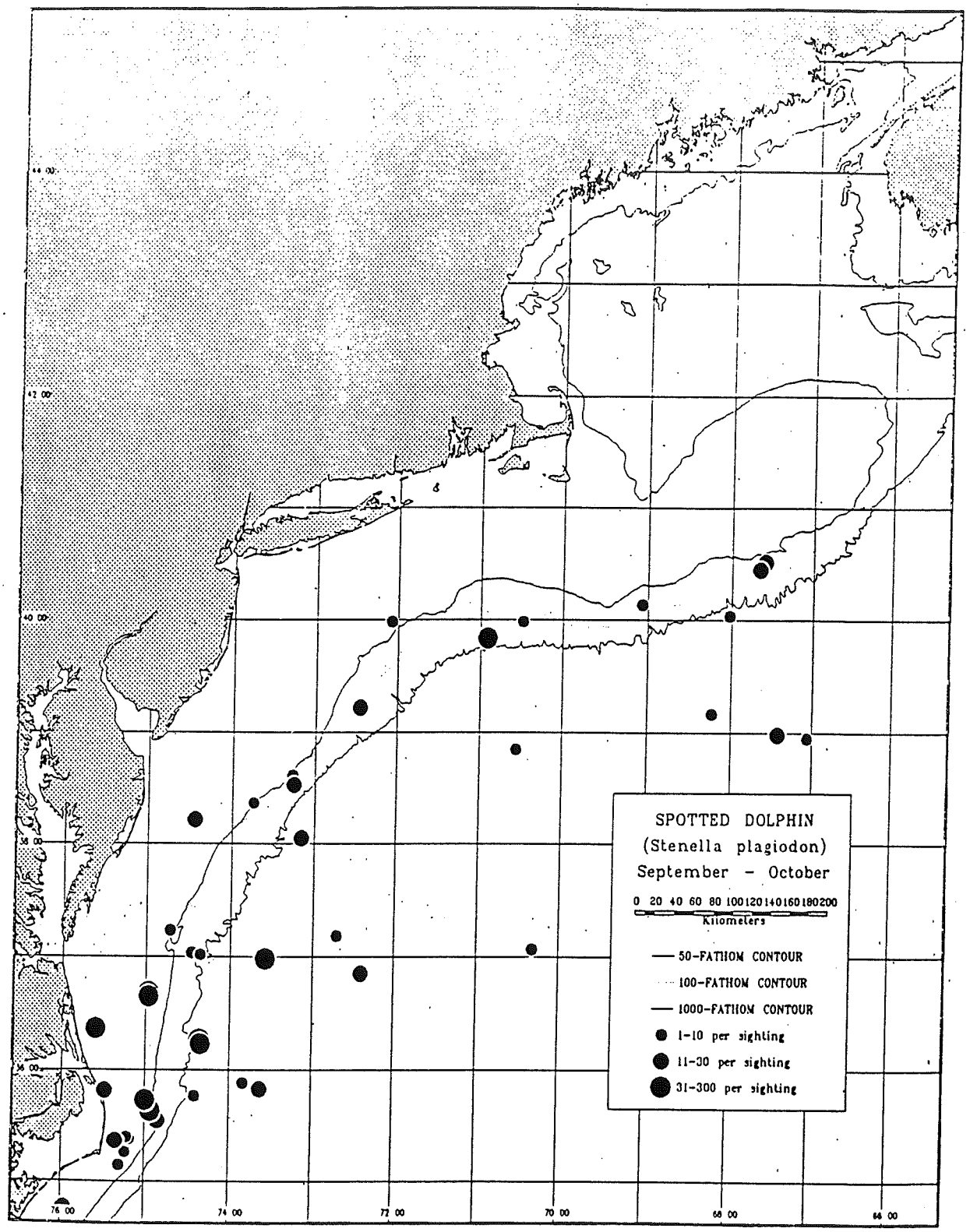

Figure 3e. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

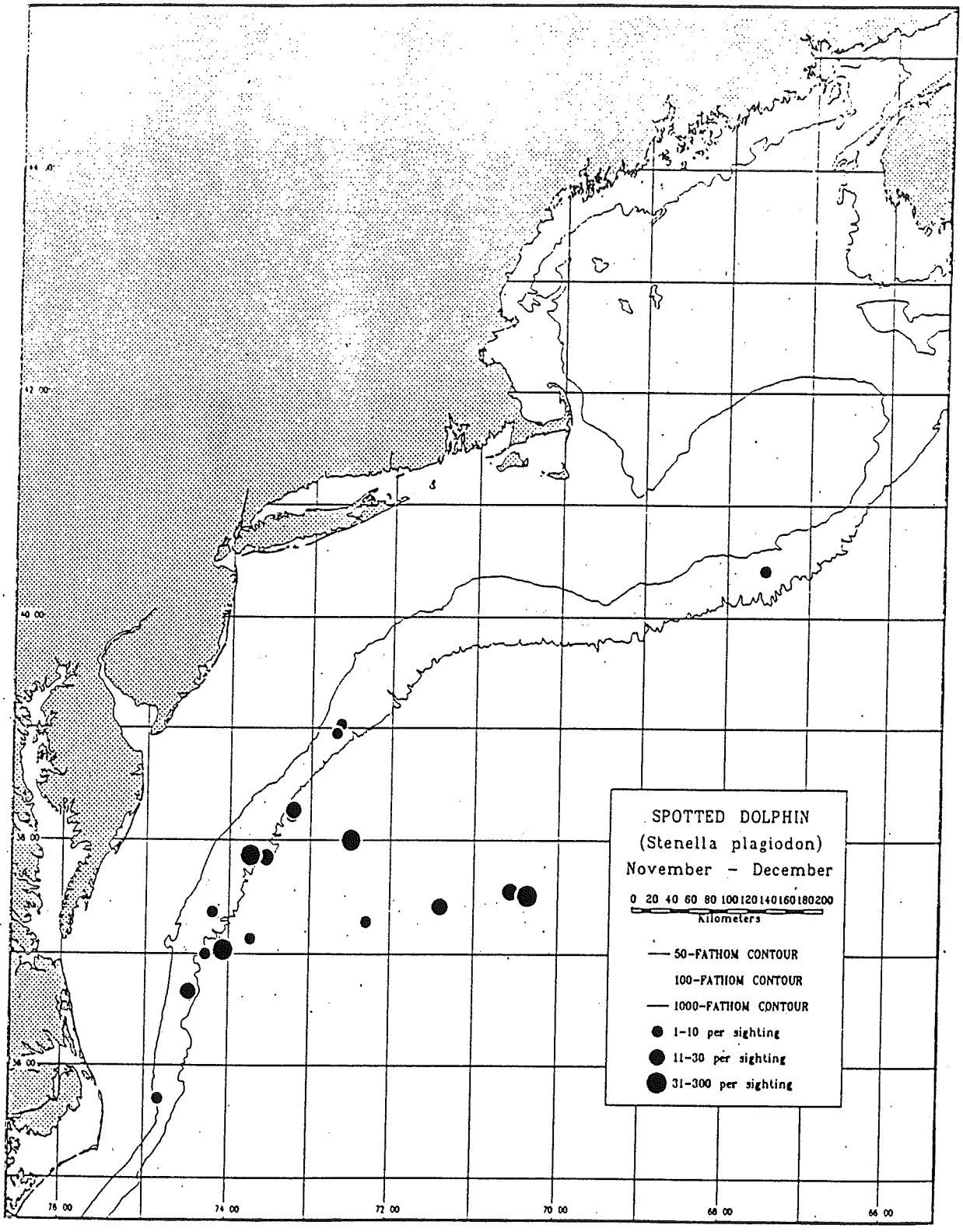

Figure 3f. Distribution of spotted dolphin Stenella frontalis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

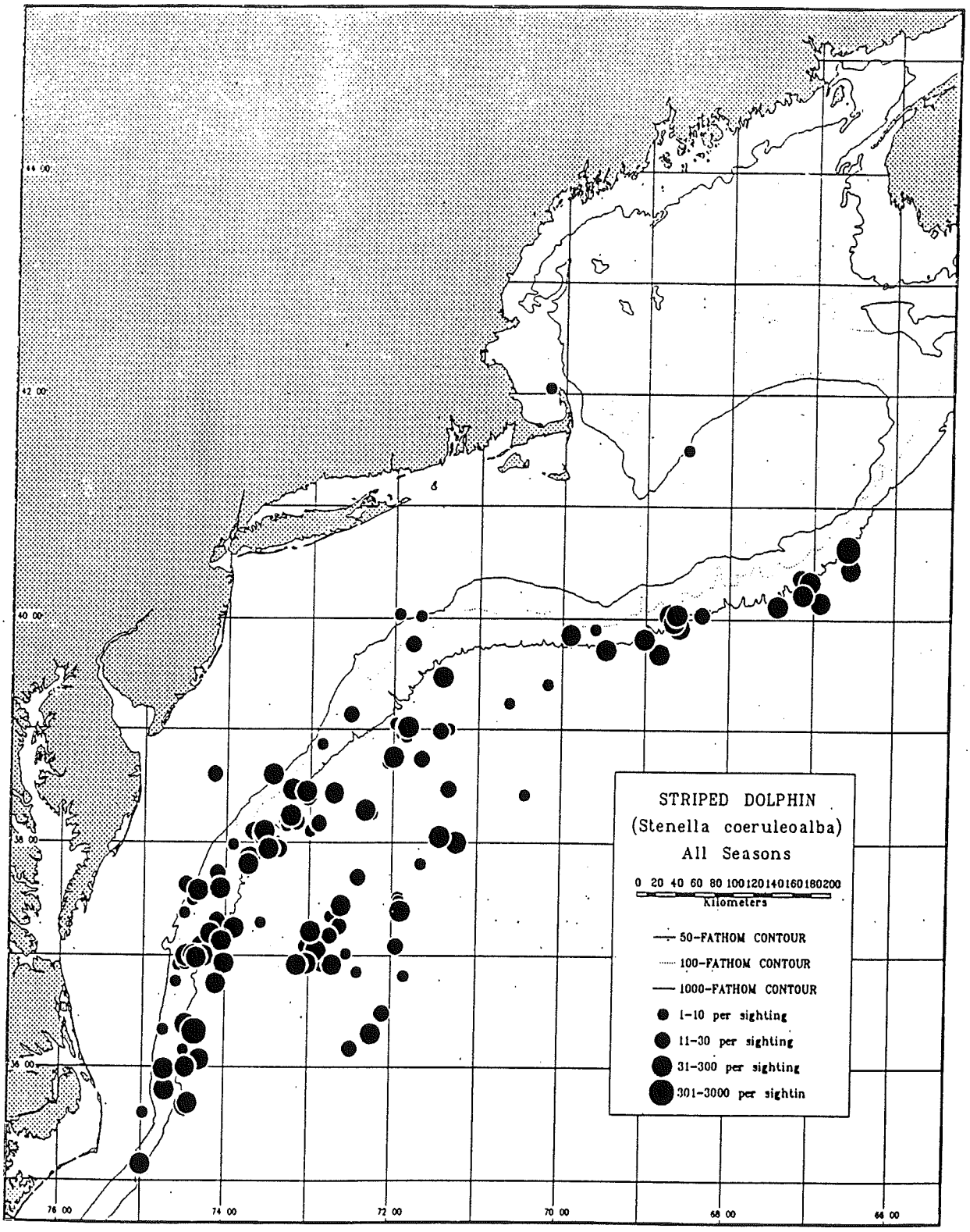

Figure 4. Distribution of striped dolphin Stenella coerueoalba sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

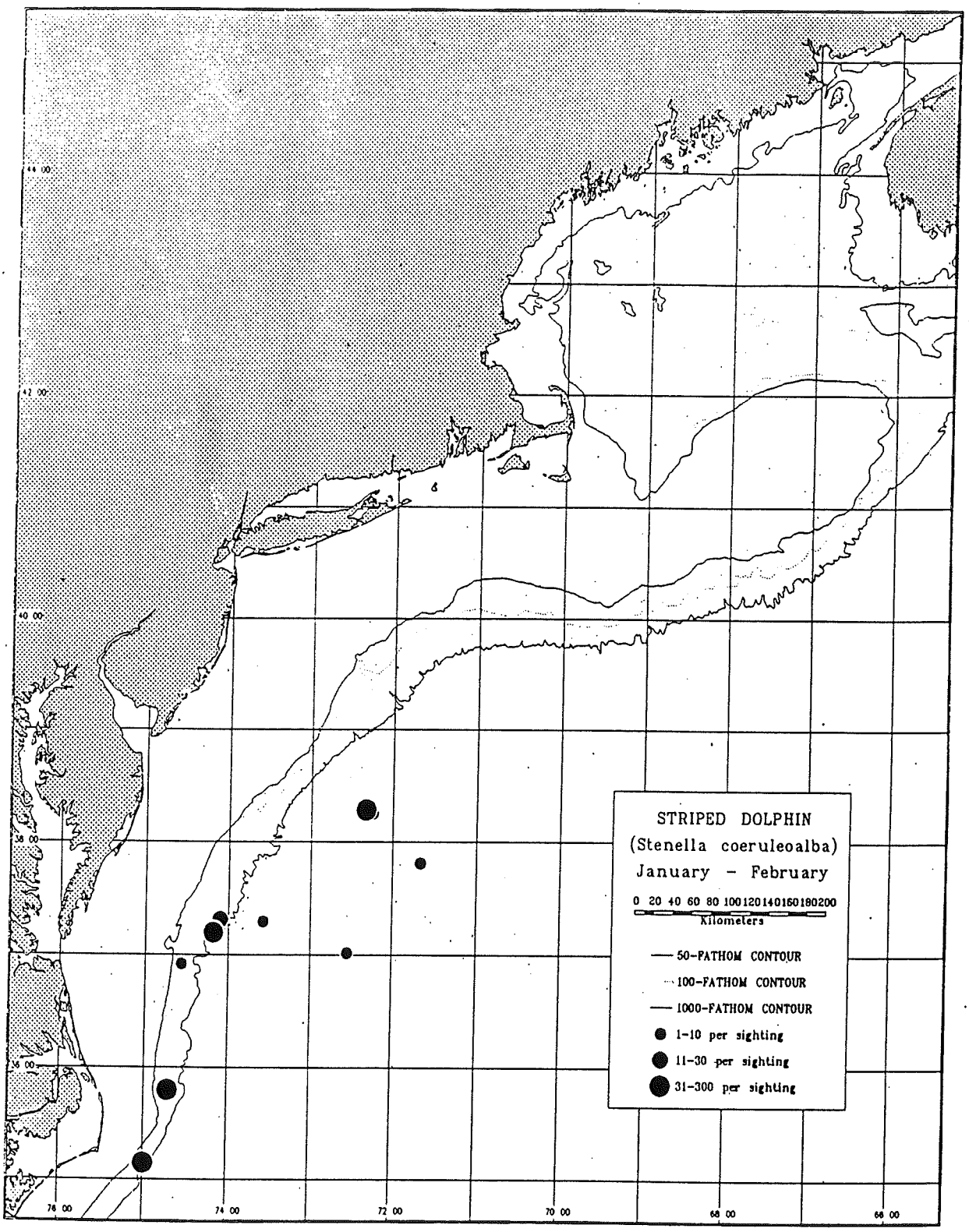

Figure 4a. Distribution of striped dolphin Stenella coerueoalba sigtings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

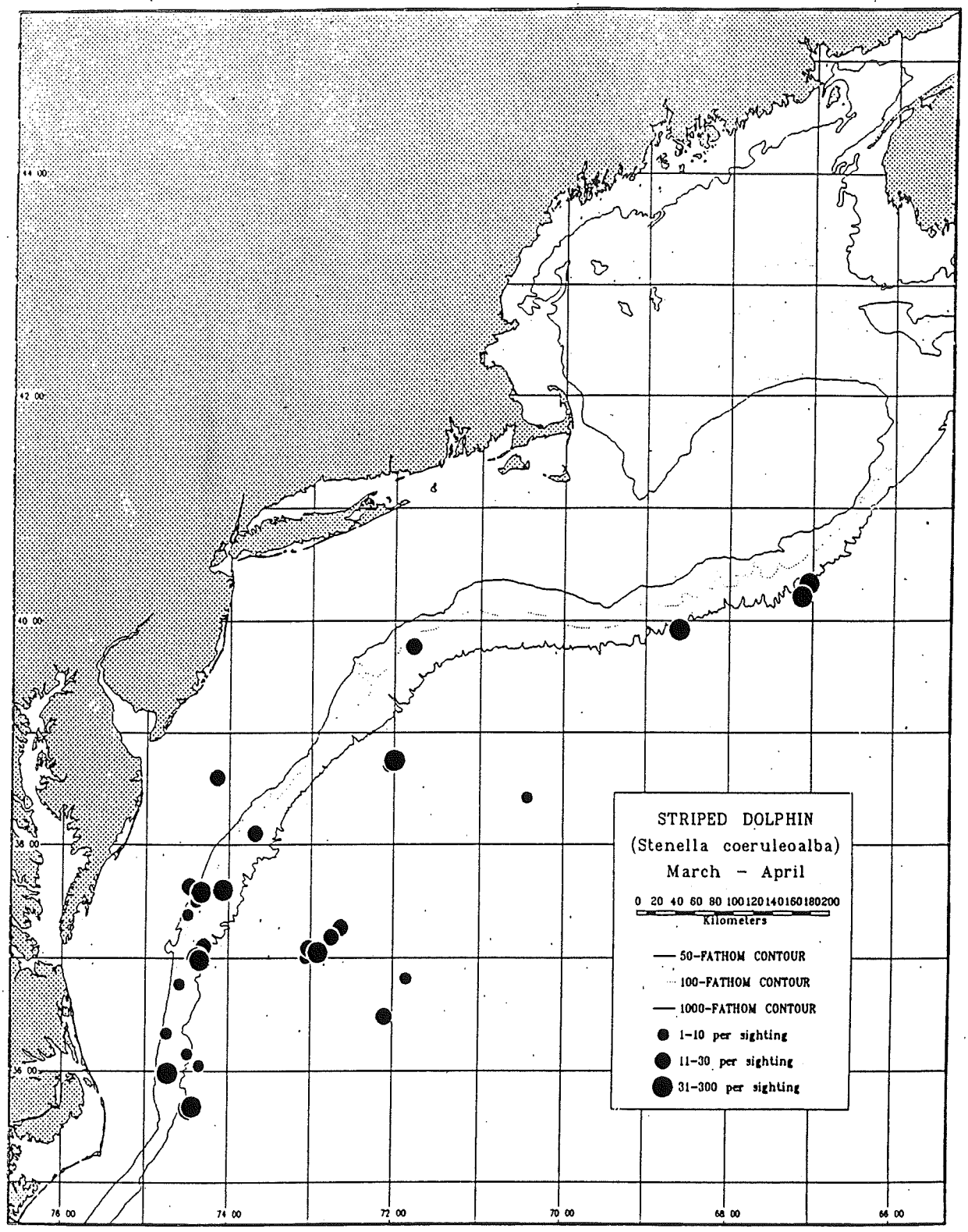

Figure 4b. Distribution of striped dolphin Stenella coeruleoalba sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

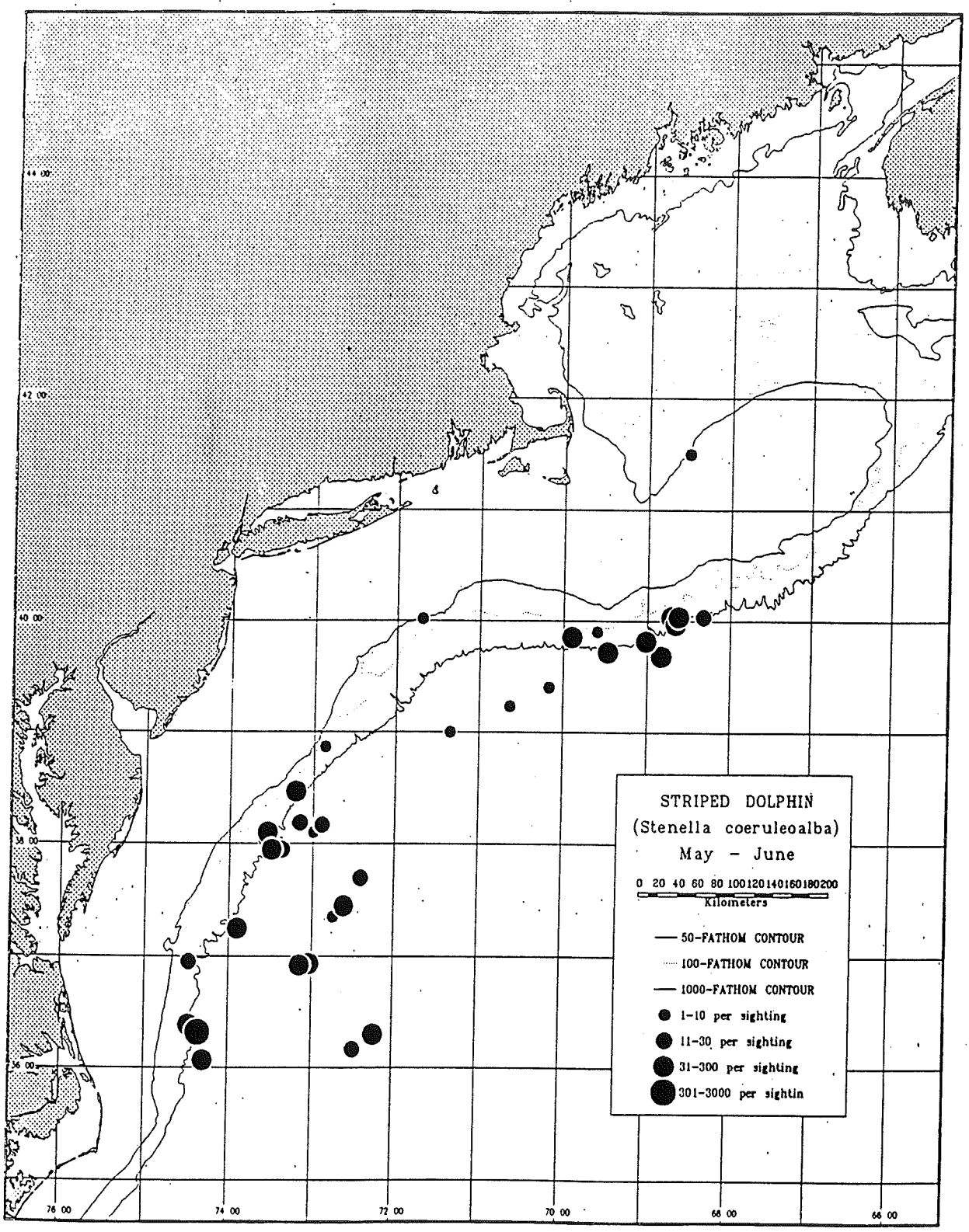

Figure 4c. Distribution of striped dolphin Stenella coeruleoalba sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

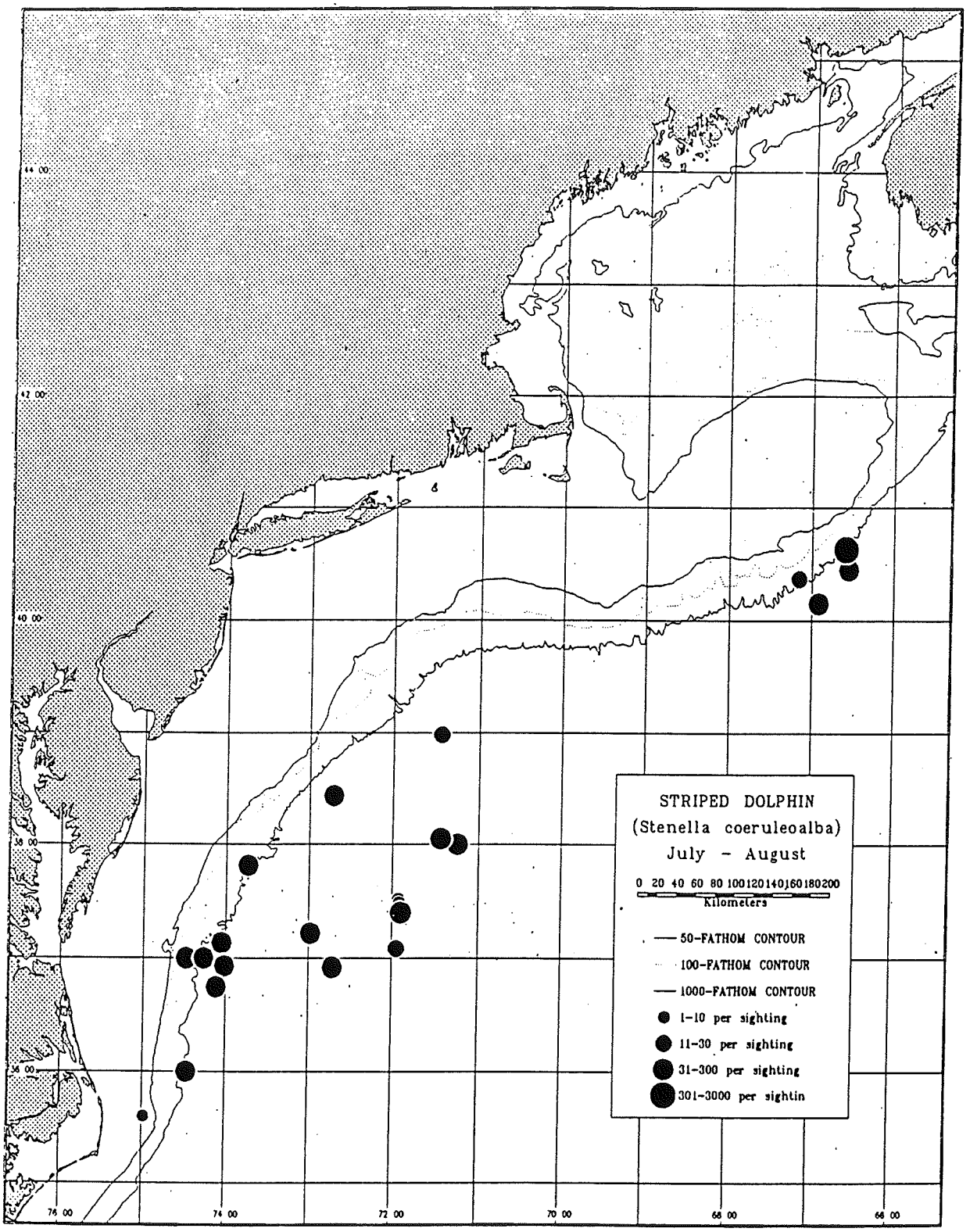

Figure 4d. Distribution of striped dolphin Stenella coerueoalba sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

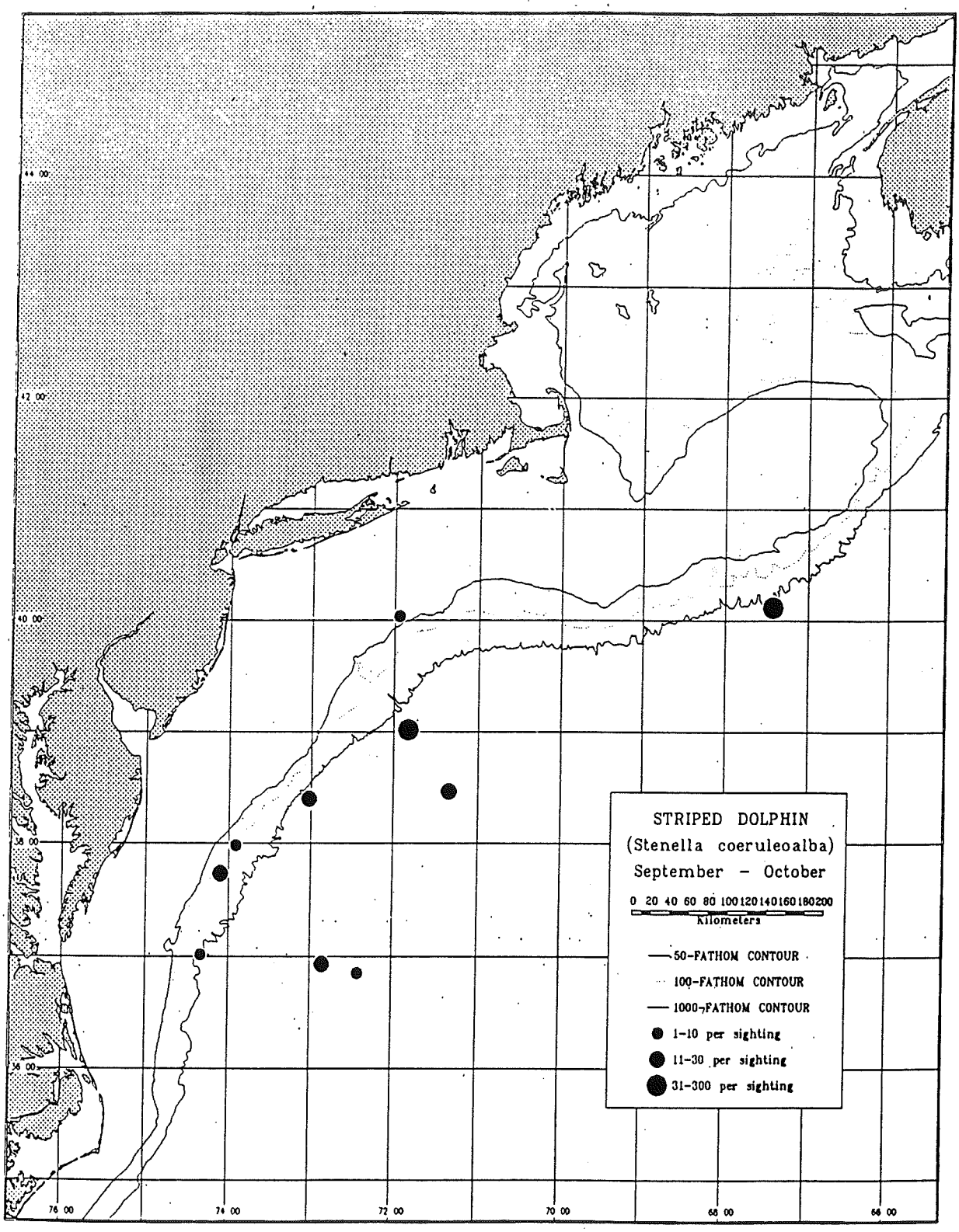

Figure 4e. Distribution of striped dolphin Stenella coerueoalba sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

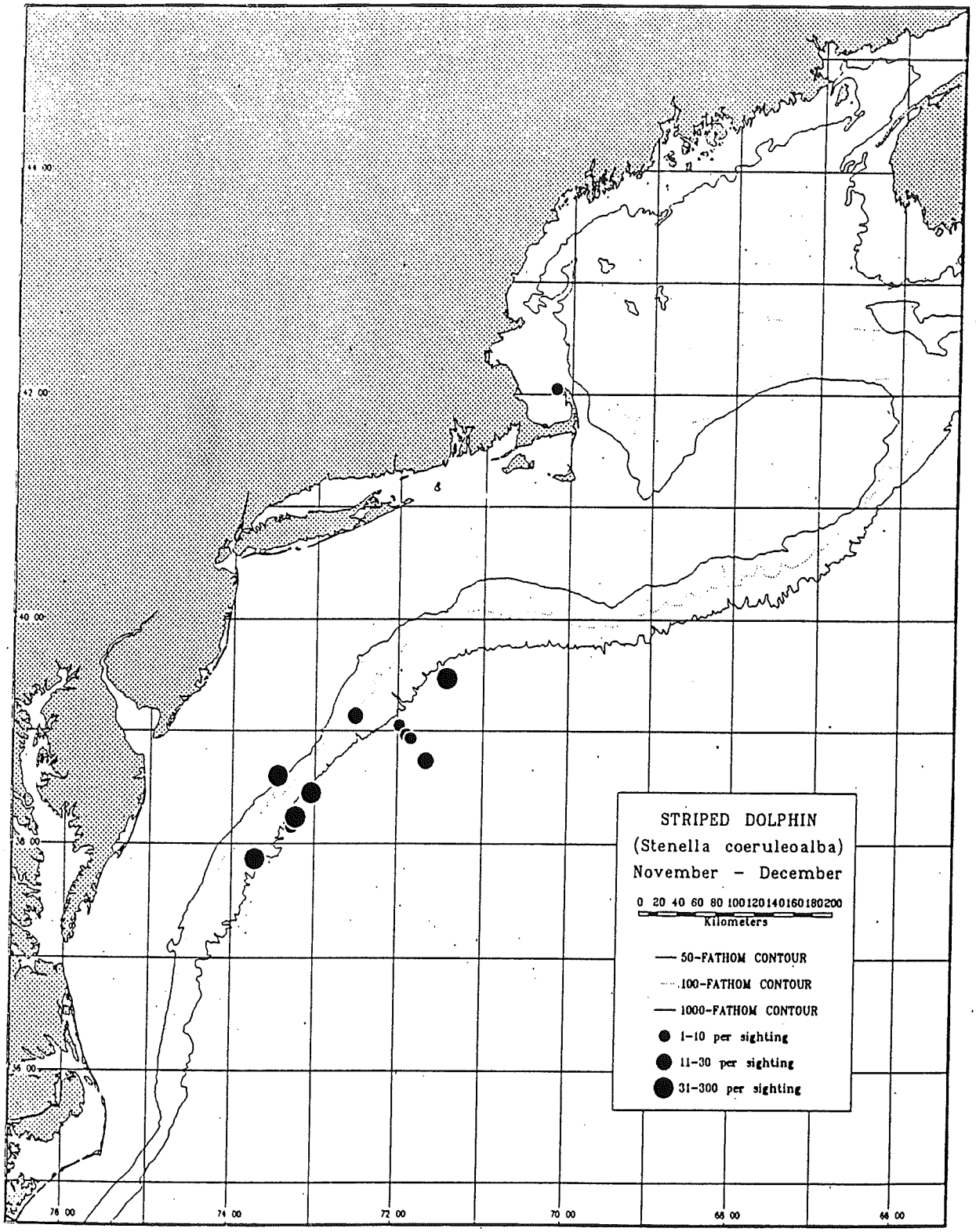

Figure 4f. Distribution of striped dolphin Stenella coerueoalba sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

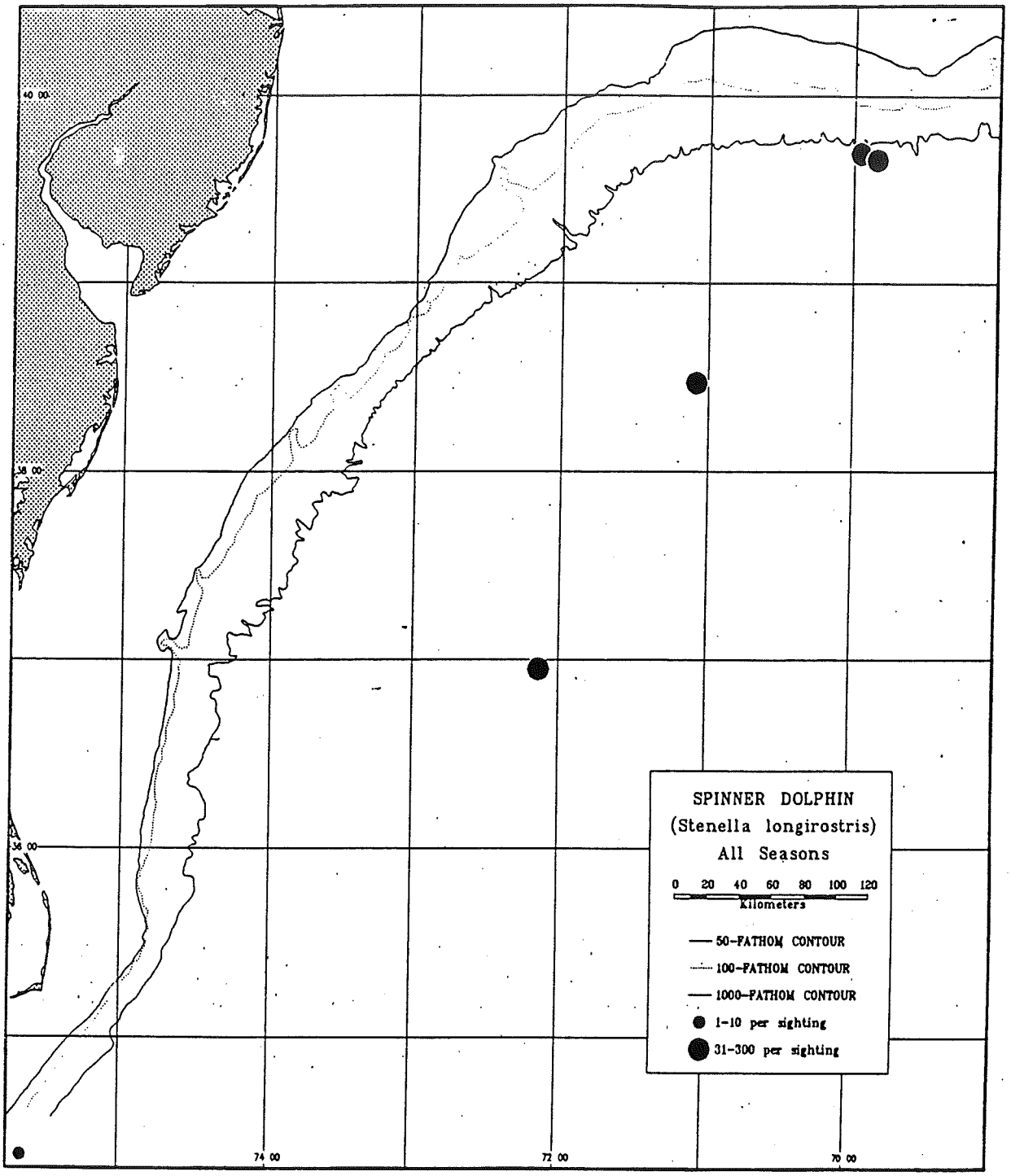

Figure 5. Distribution of spinner dolphin Stenella longirostris sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

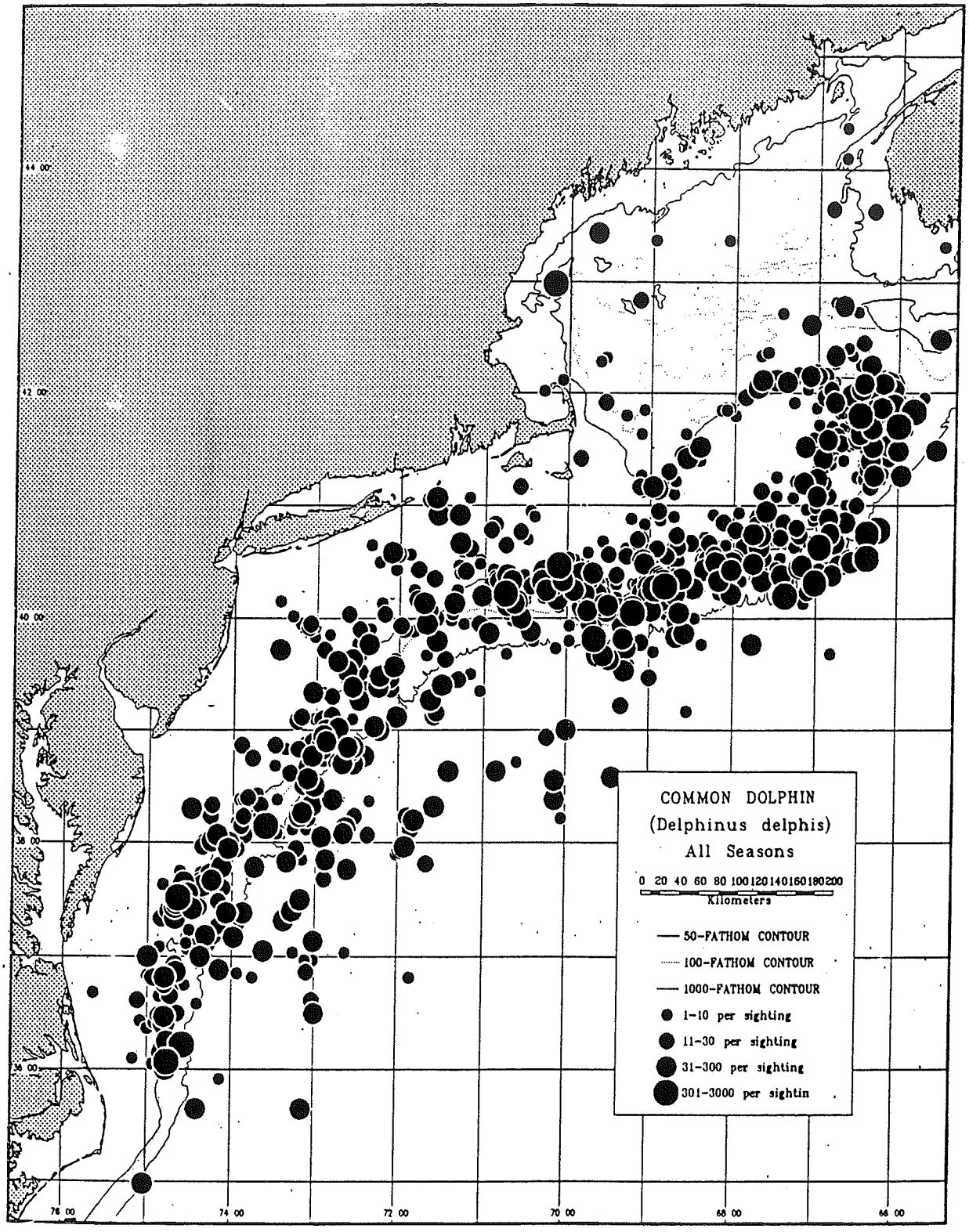

Figure 6. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

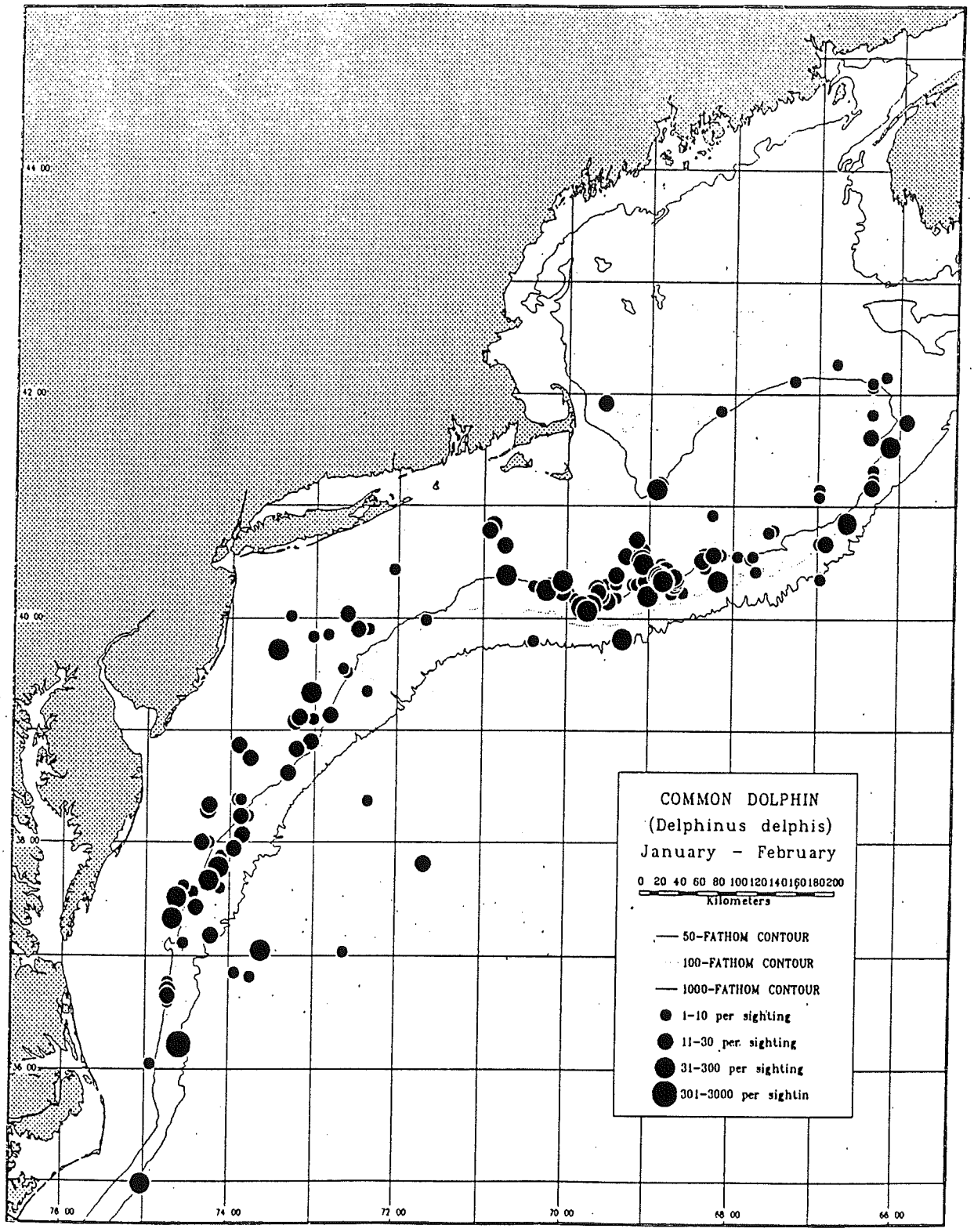

Figure 6a. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

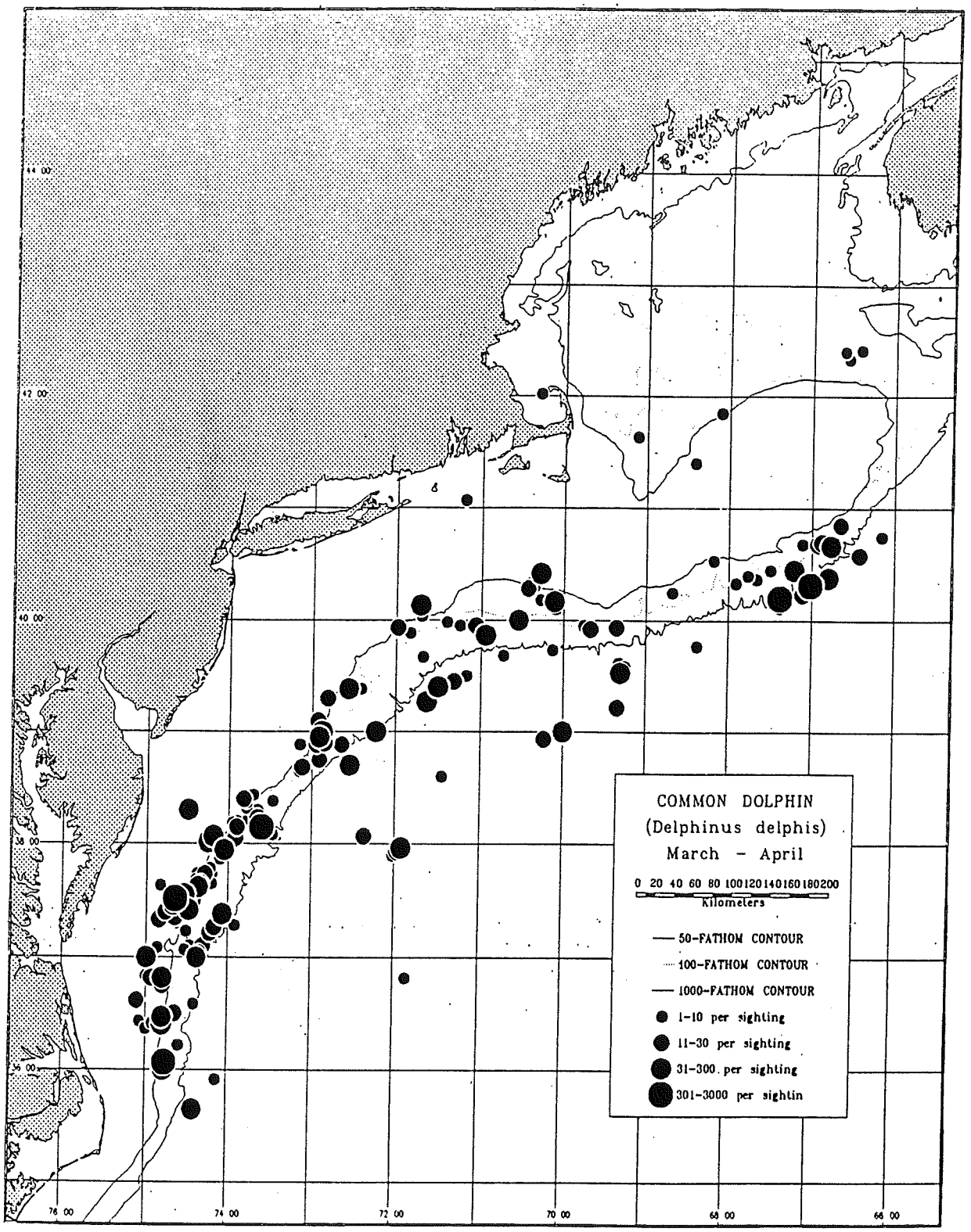

Figure 6b. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

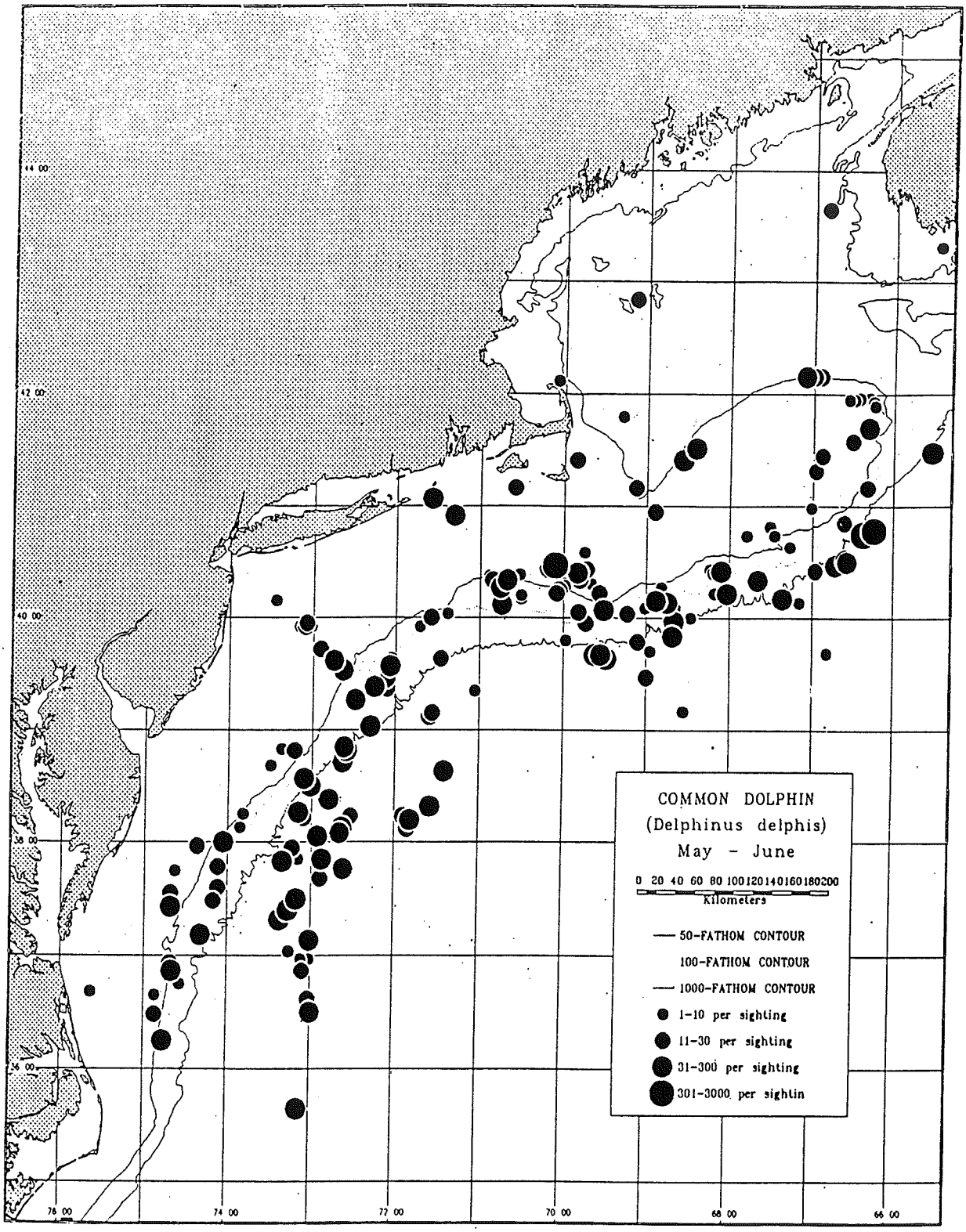

Figure 6c. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

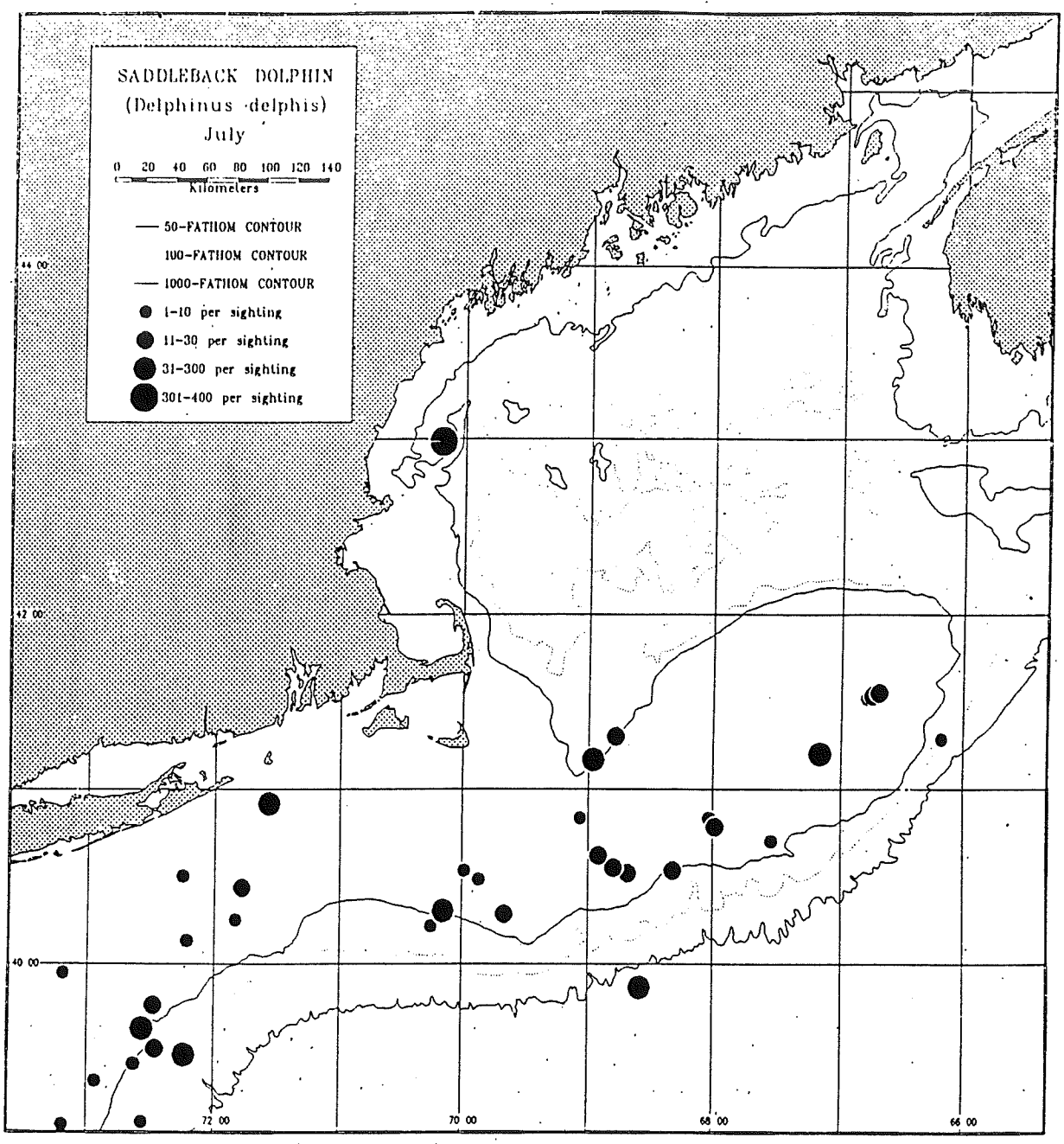

Figure 6d. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July, 1978-1988.

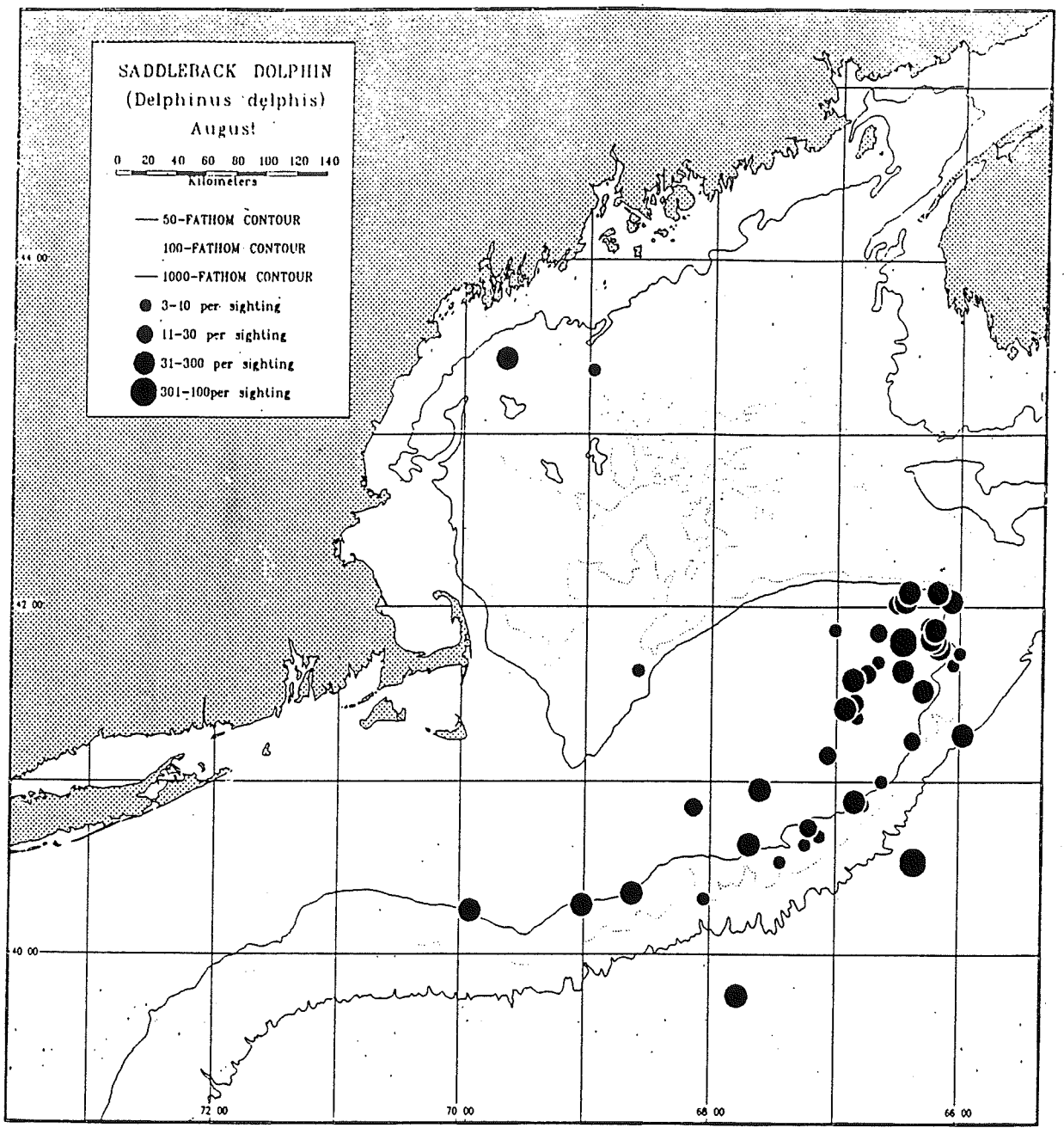

Figure 6e. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during August, 1978-1988.

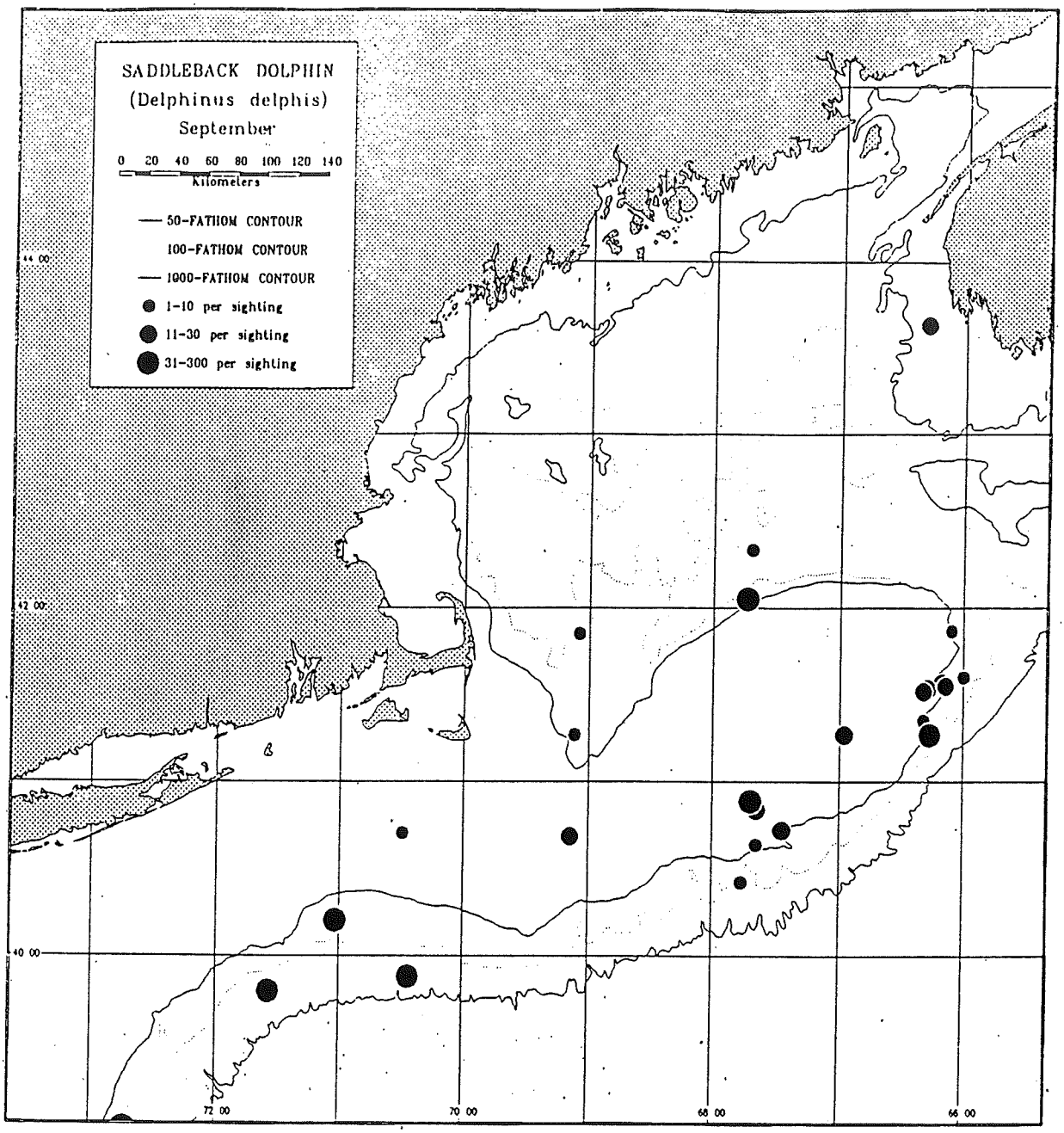

Figure 6f. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September, 1978-1988.

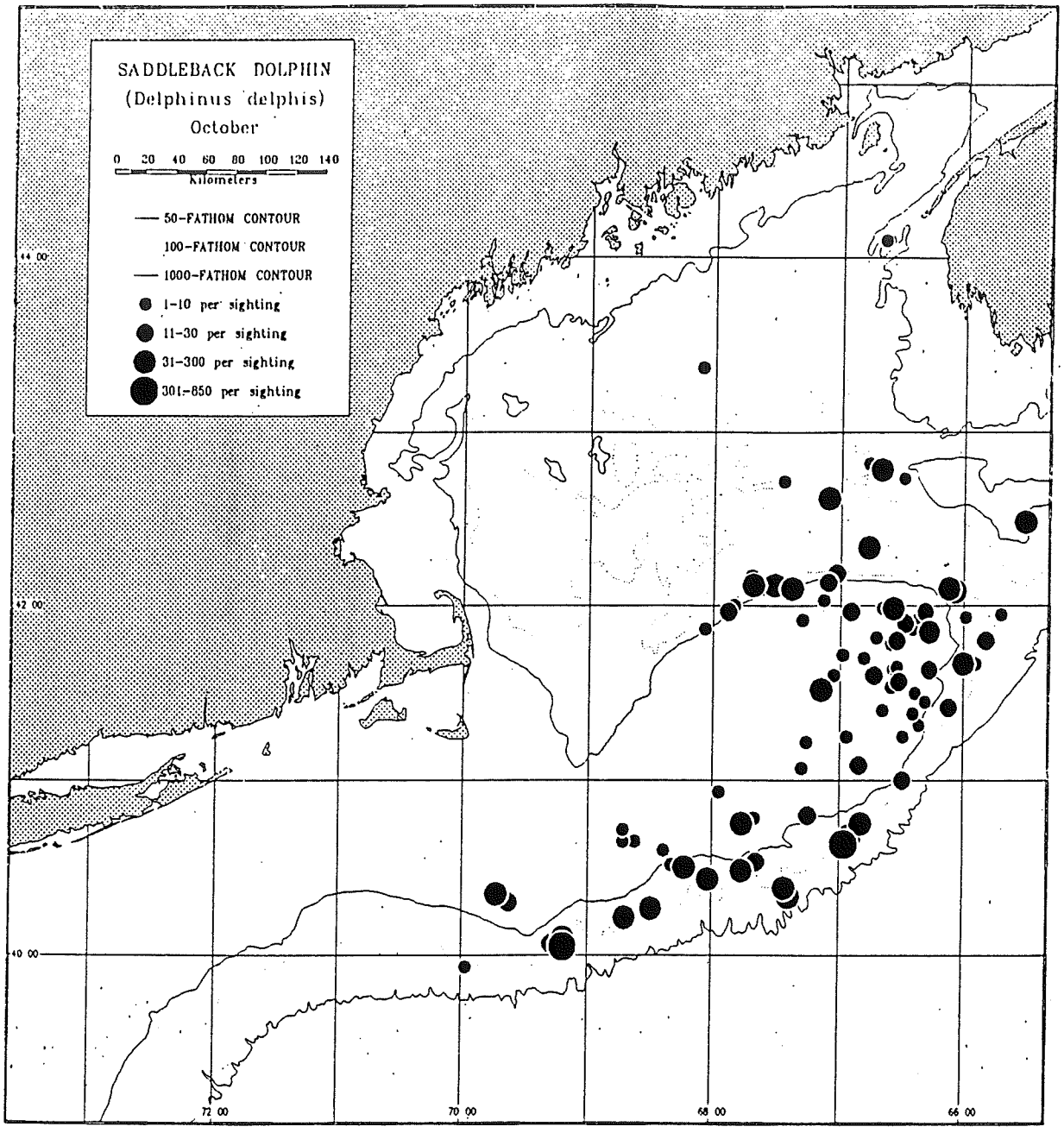

Figure 6g. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during October, 1978-1988.

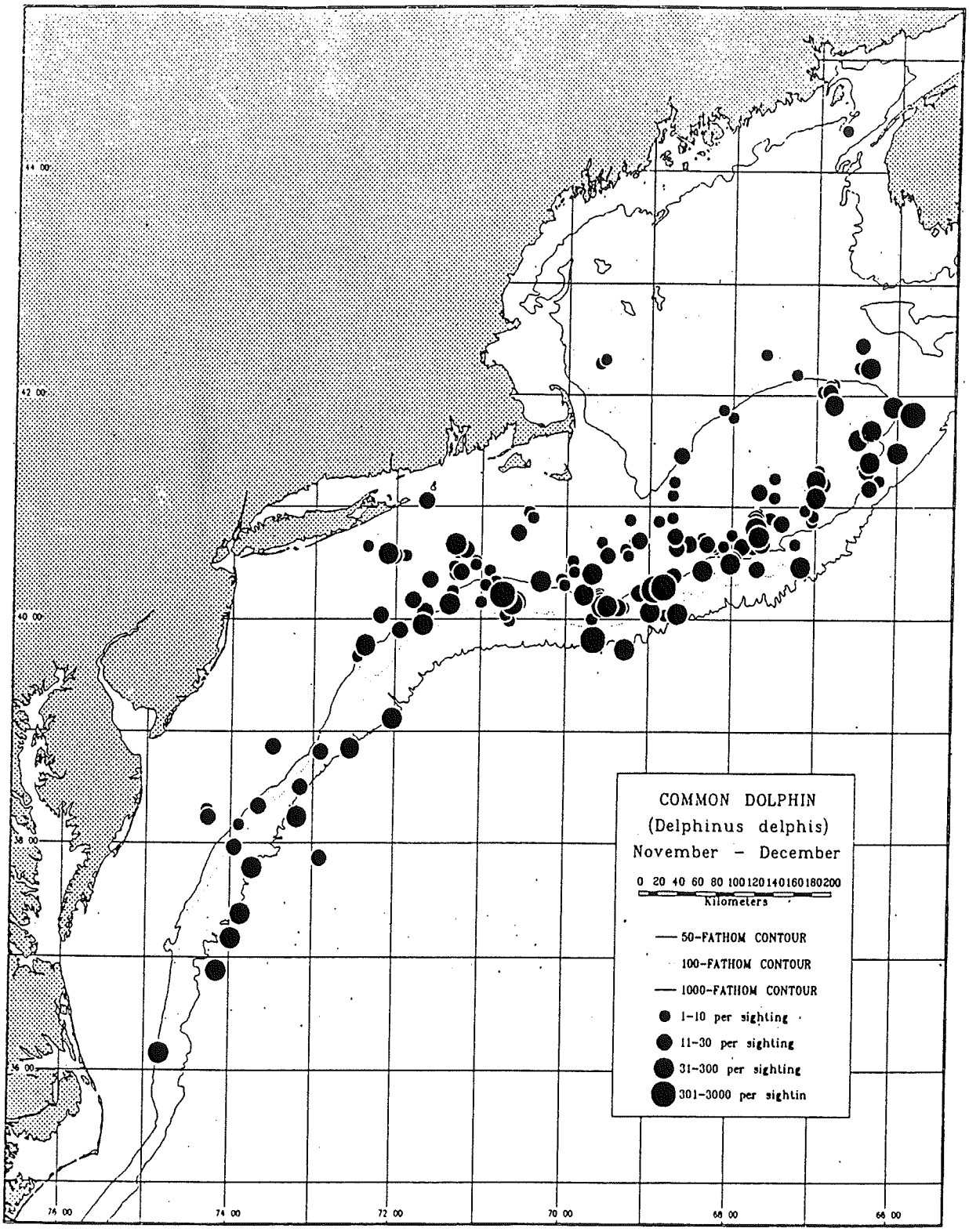

Figure 6h. Distribution of common or saddleback dolphin Delphinus delphis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

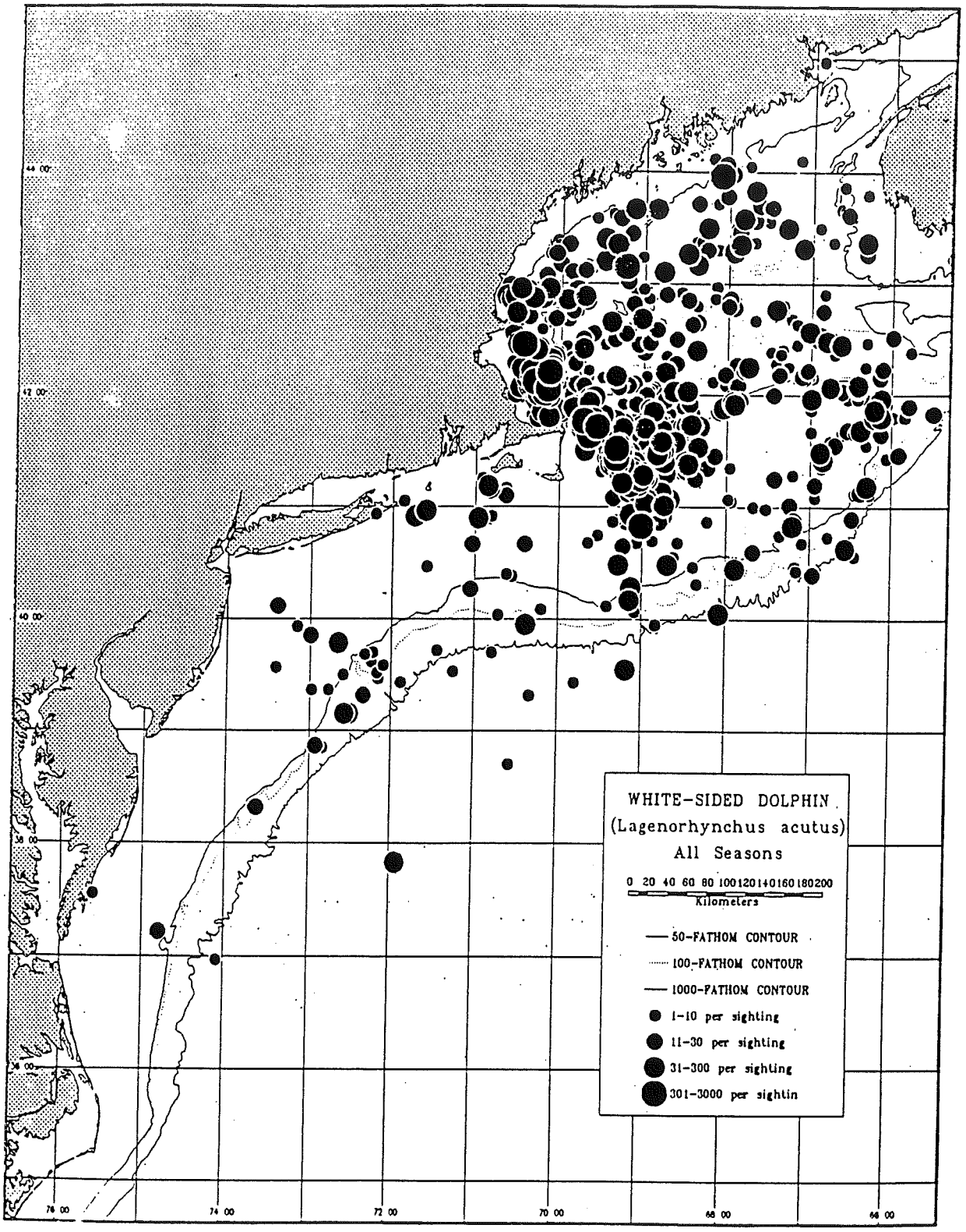

Figure 7. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

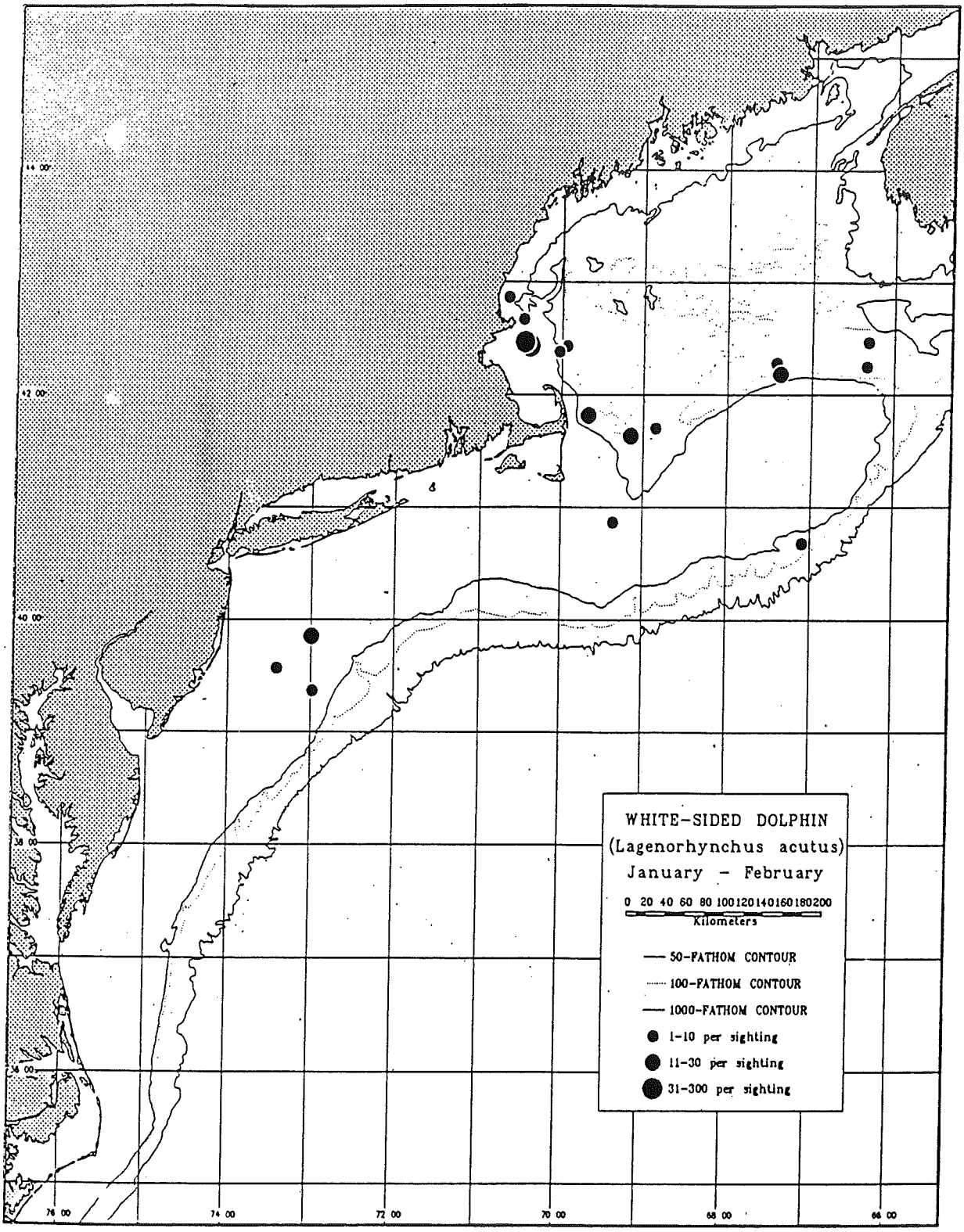

Figure 7a. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

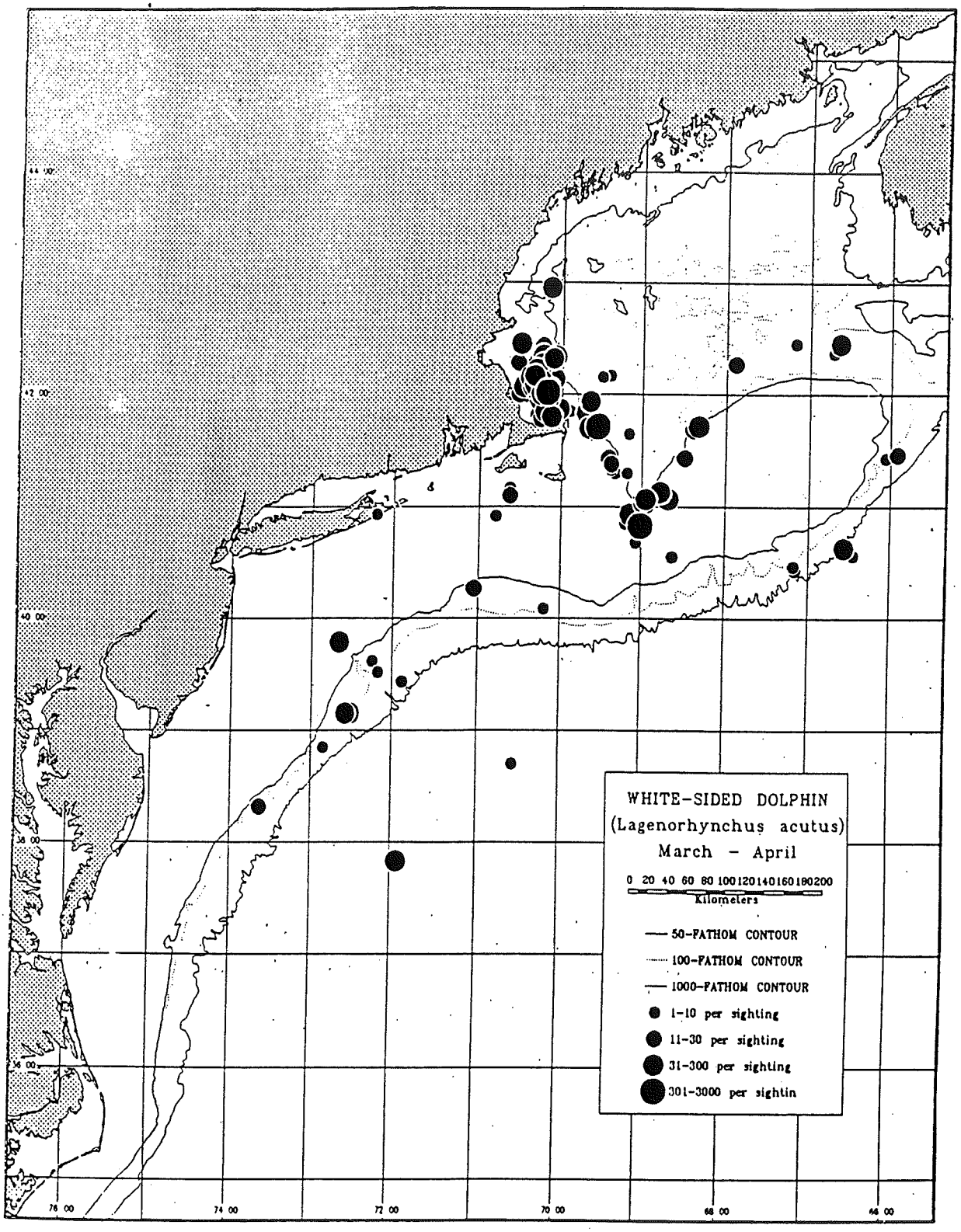

Figure 7b. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April,

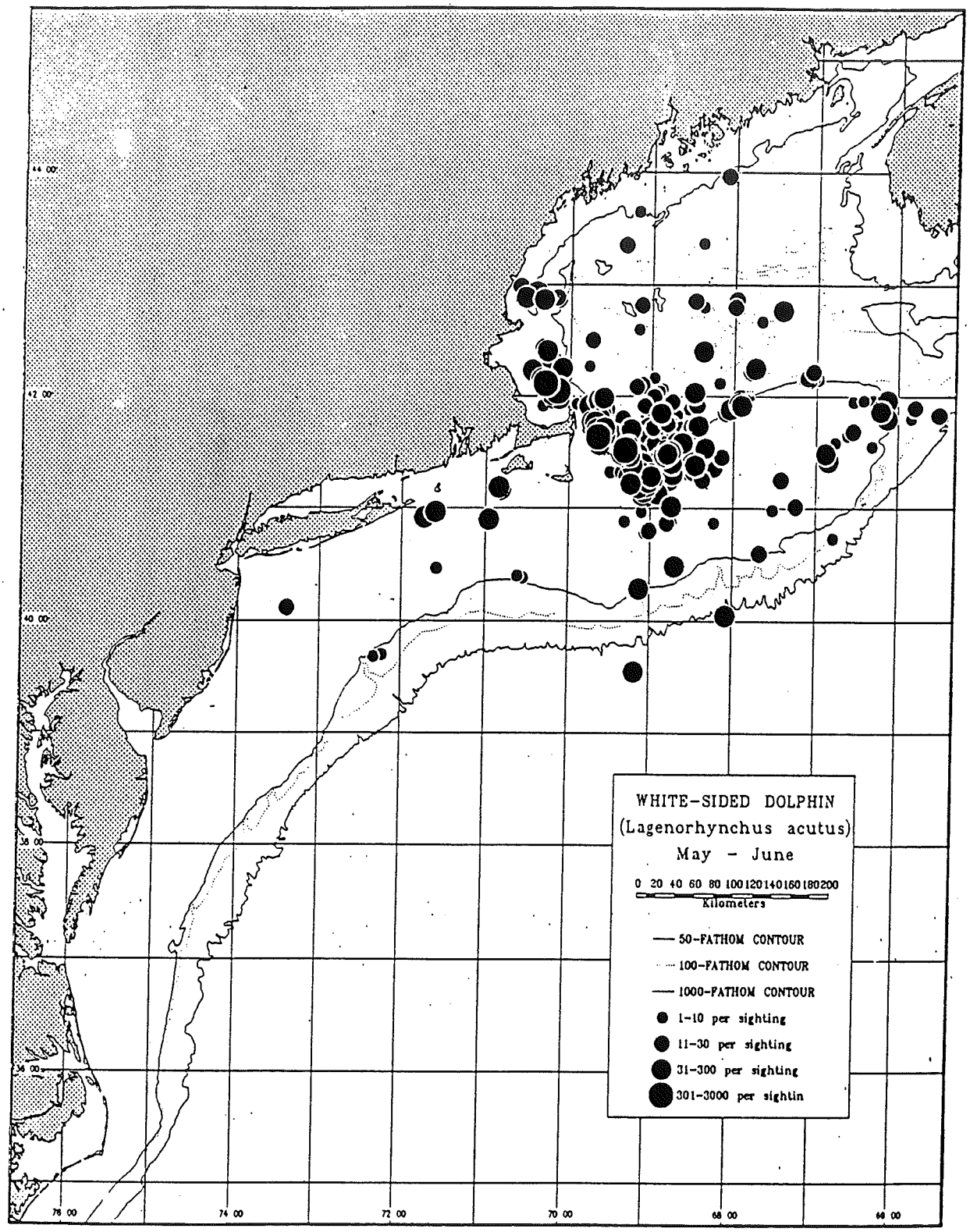

Figure 7c. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

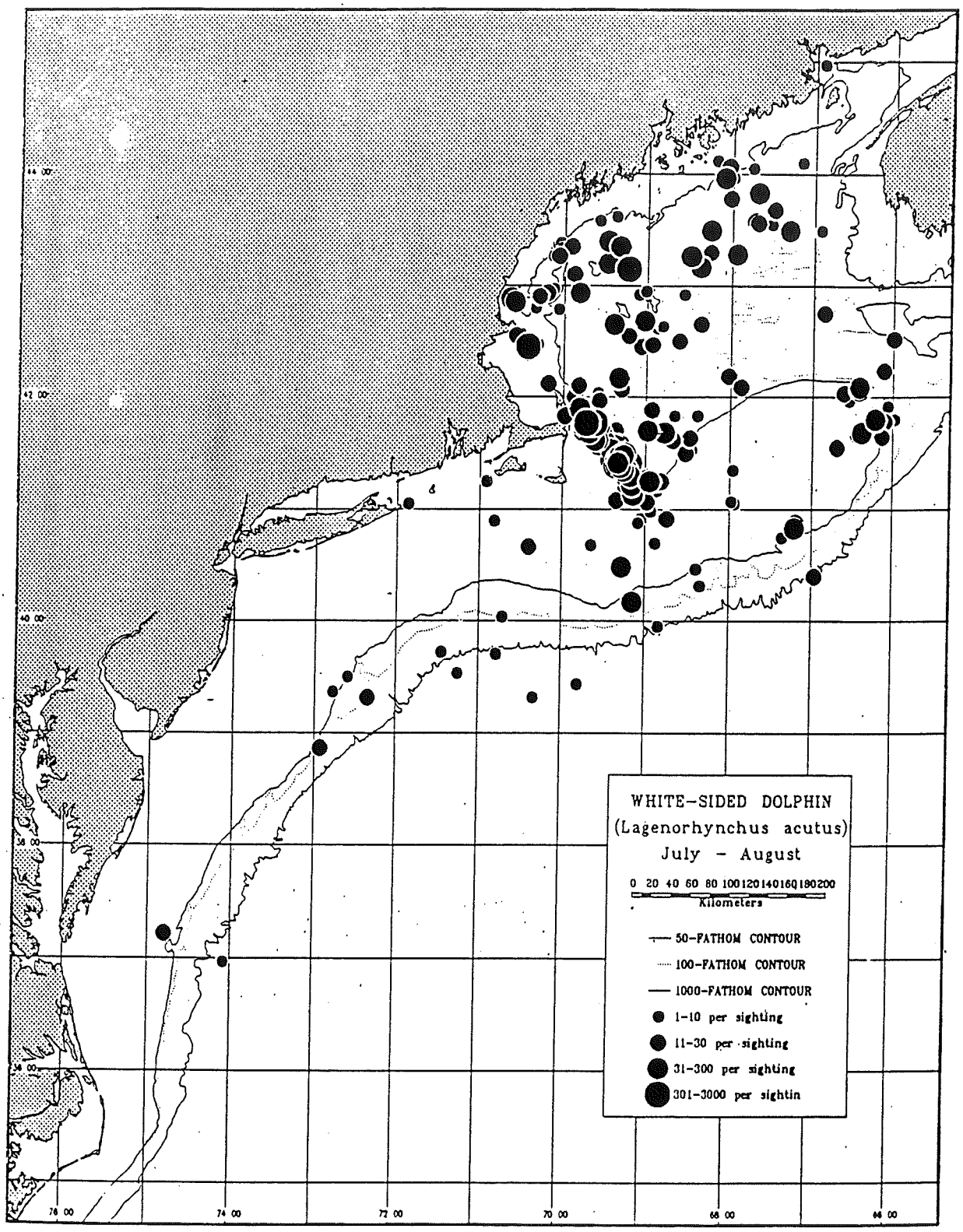

Figure 7d. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

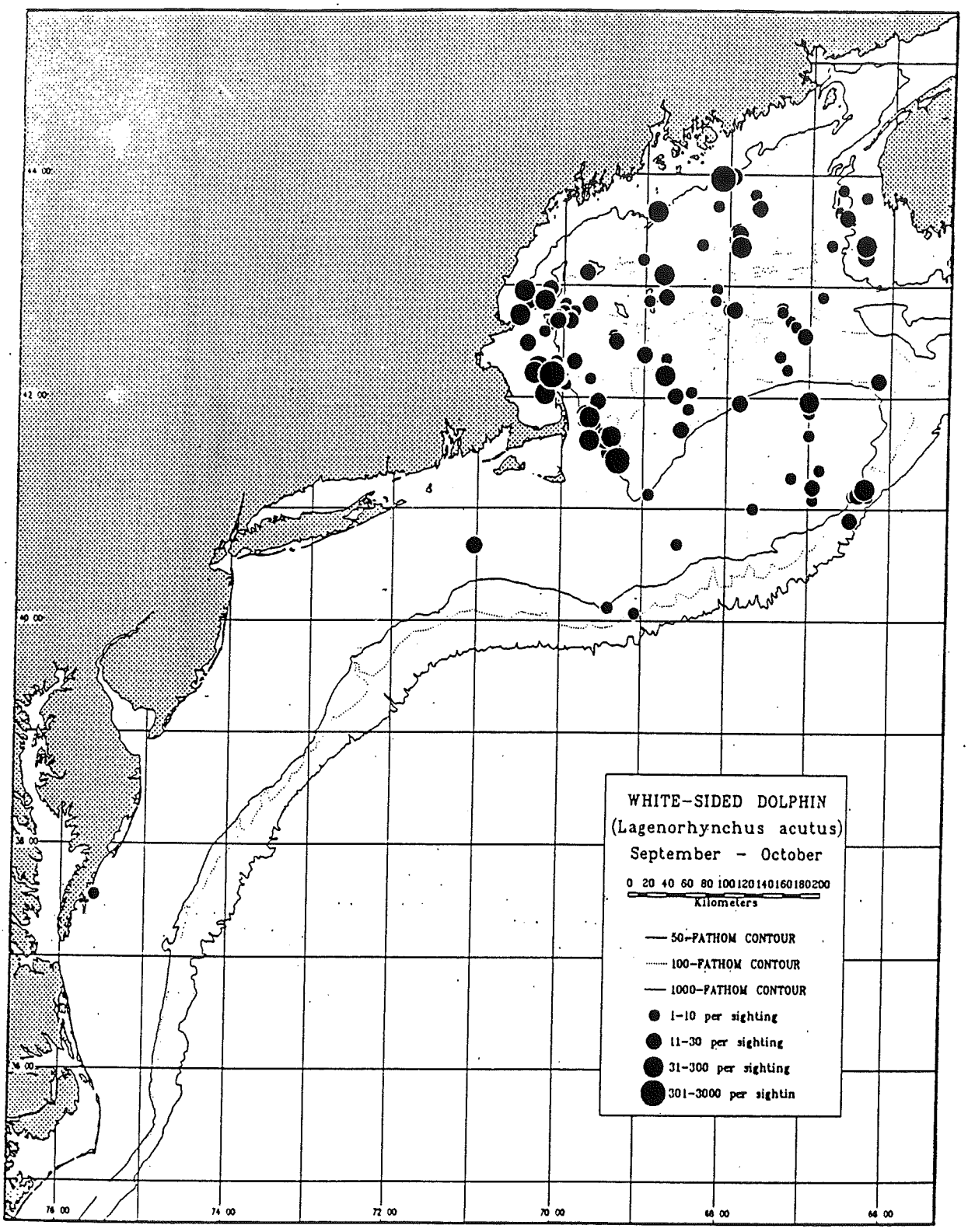

Figure 7e. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

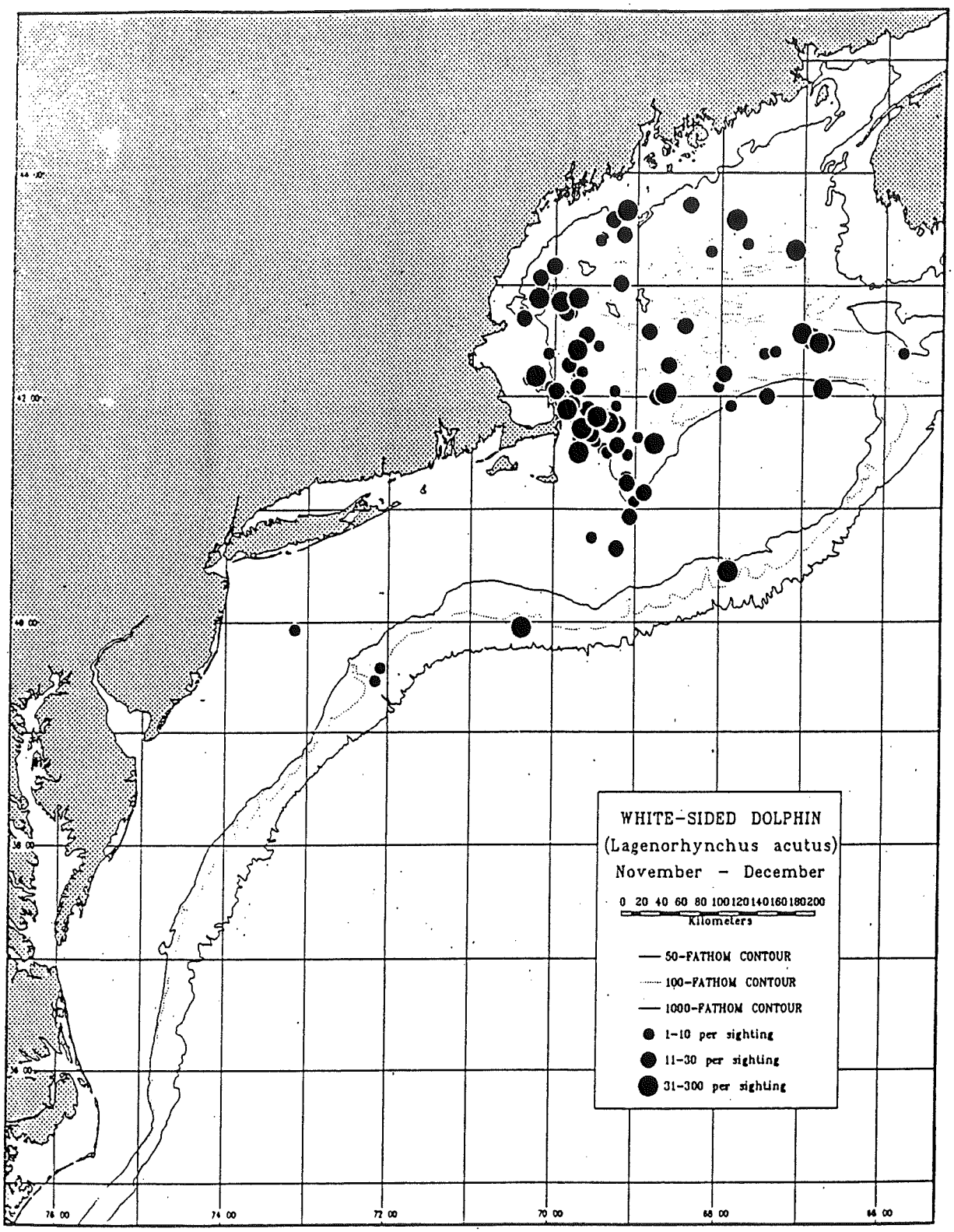

Figure 7f. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

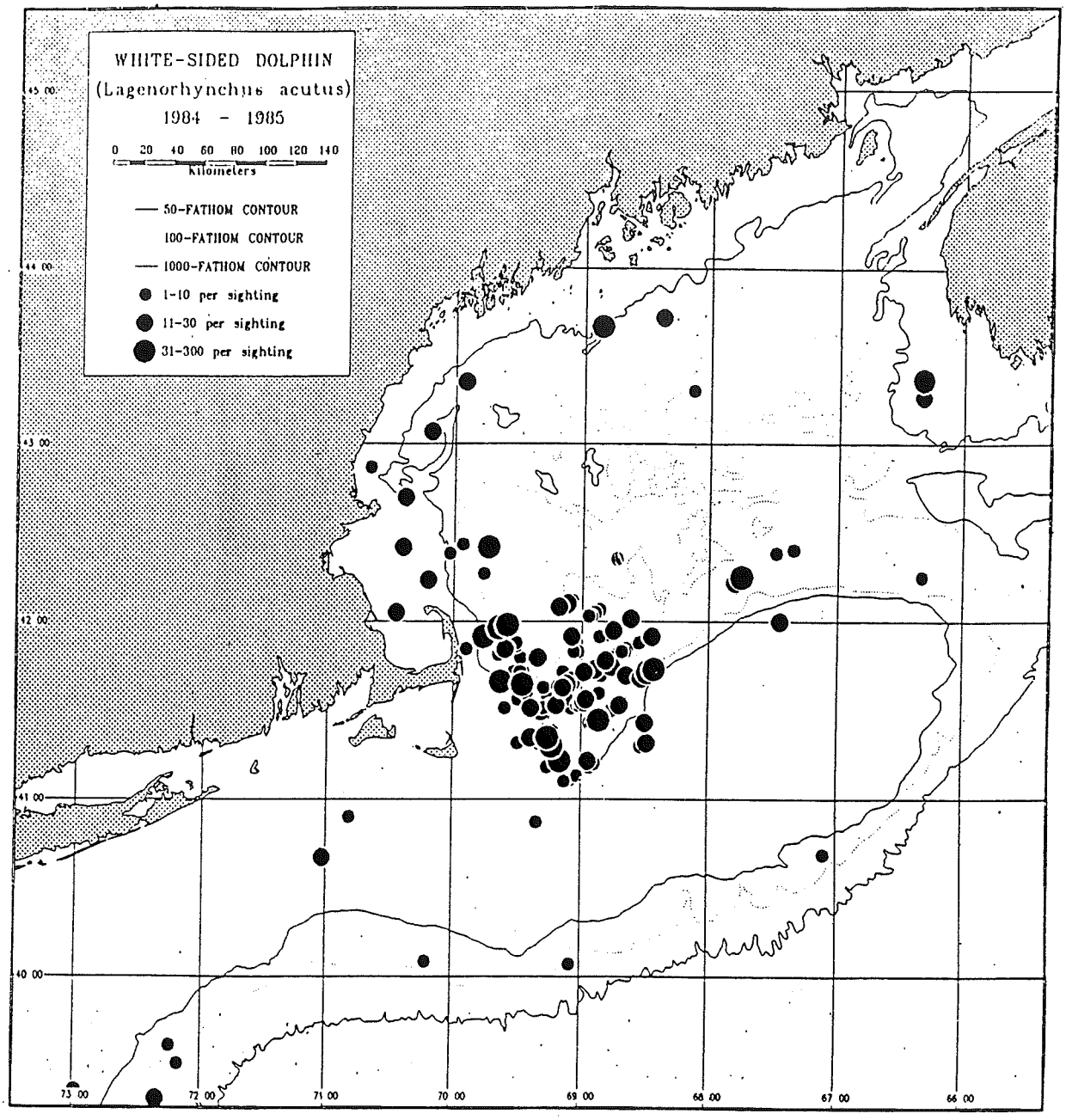

Figure 7g. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings during shipboard surveys, for all seasons 1984-1985, in shelf waters of the southwest/ south Gulf of Maine and the Great South Channel regions.

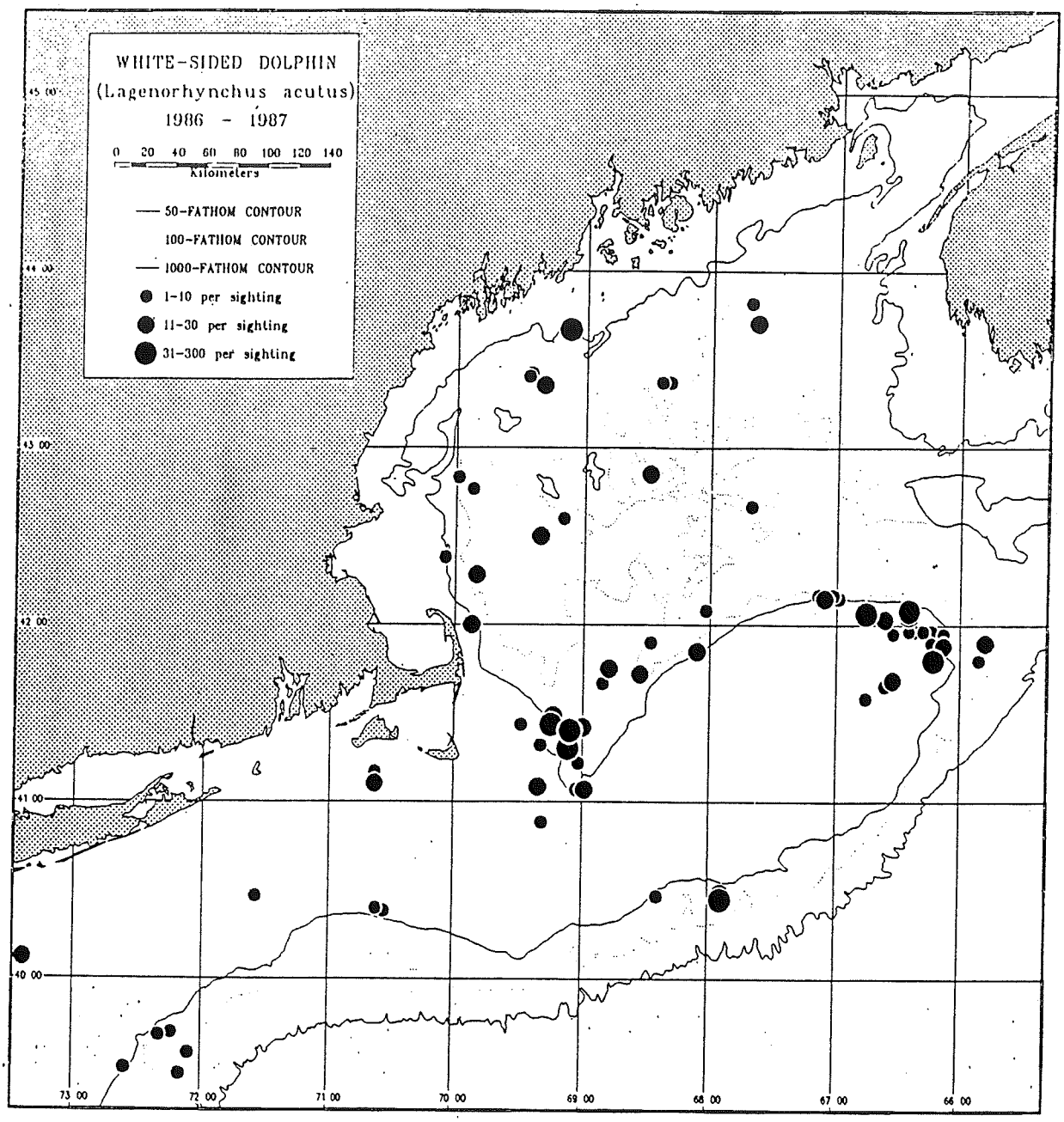

Figure 7h. Distribution of Atlantic white-sided dolphin Lagenorhynchus acutus sightings during shipboard surveys, for all seasons 1986-1987, in shelf waters of the southwest/ south Gulf of Maine and the Great South Channel regions.

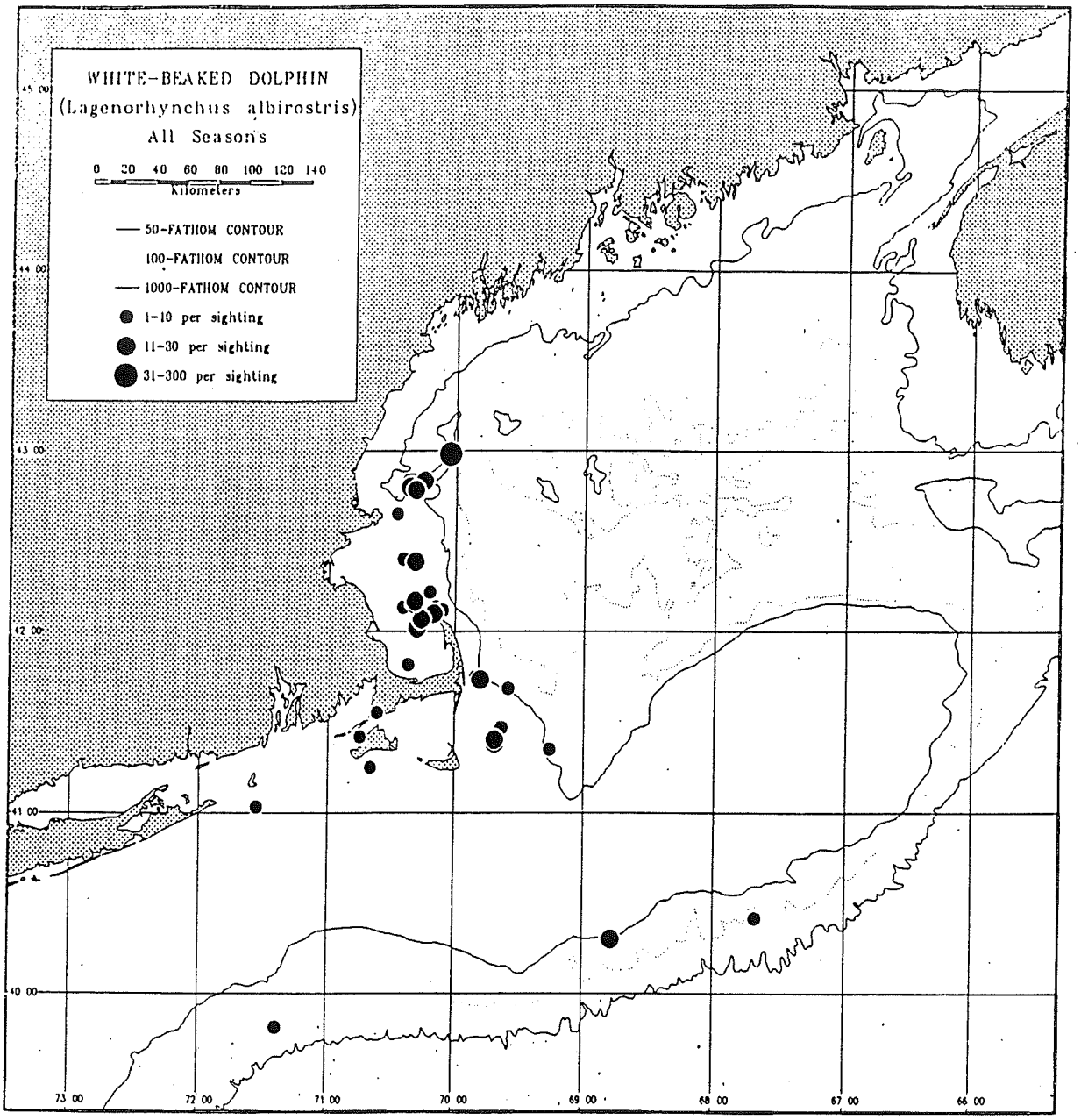

Figure 8. Distribution of white-beaked dolphin Lagenorhynchus albirostris in the shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

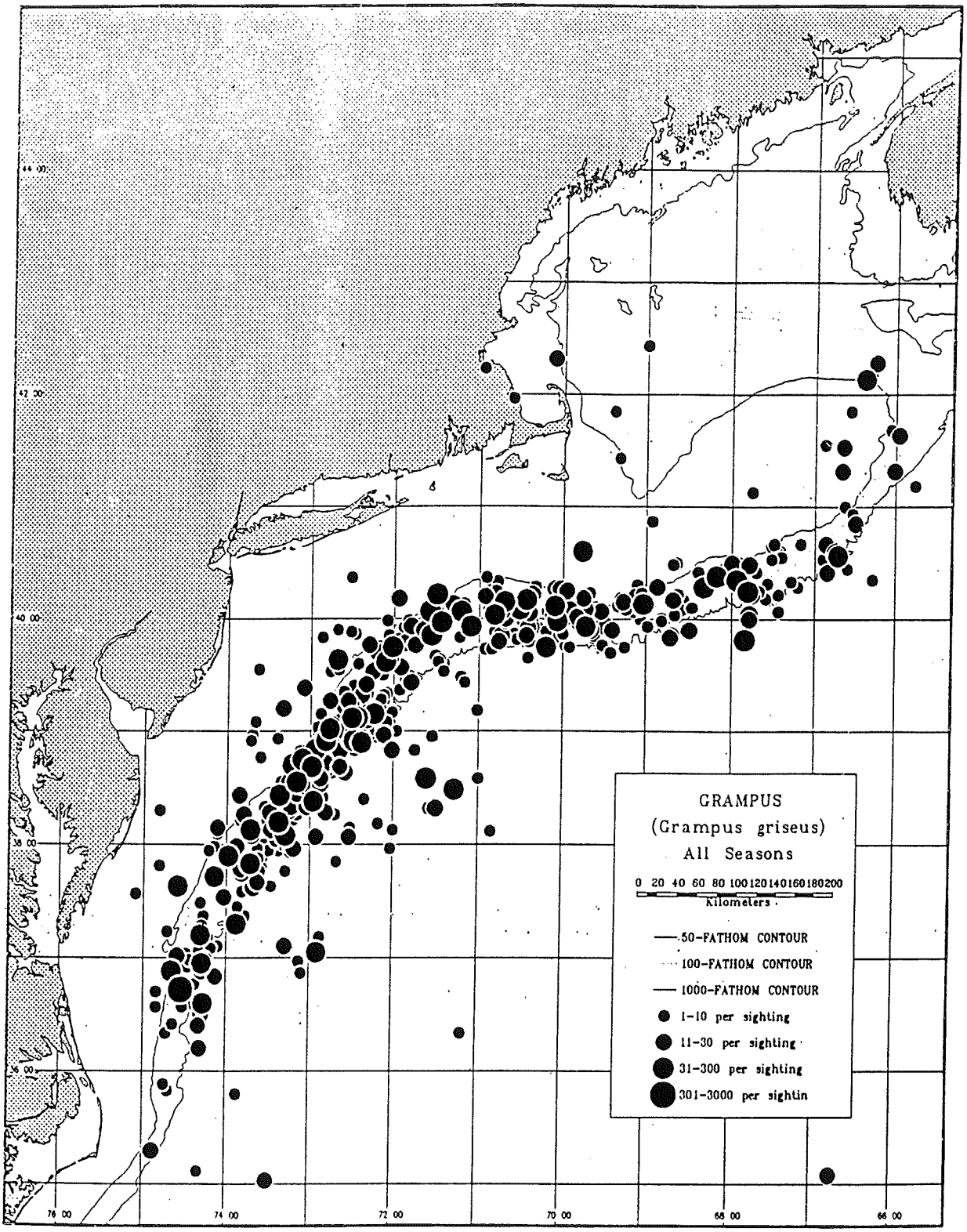

Figure 9. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

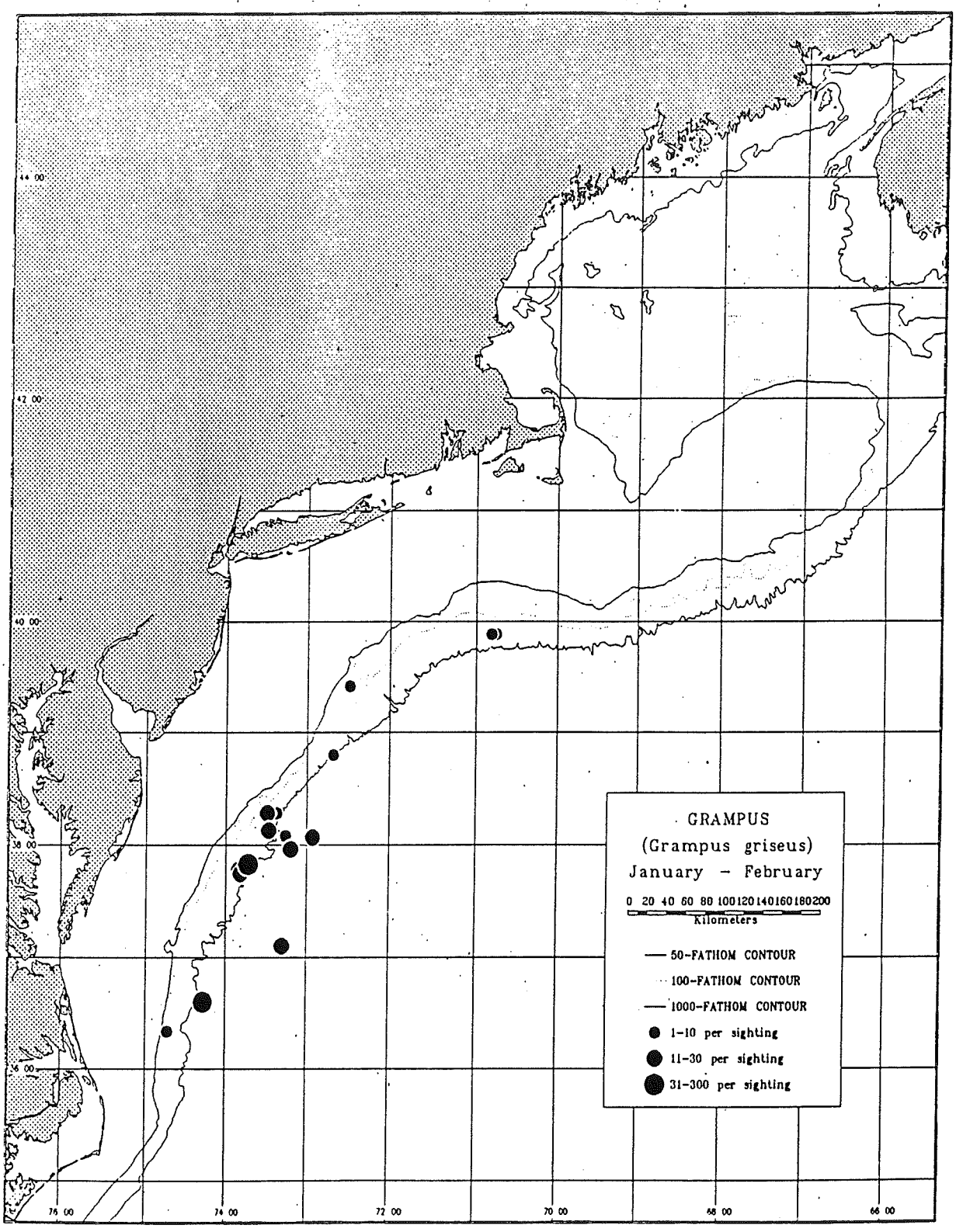

Figure 9a. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

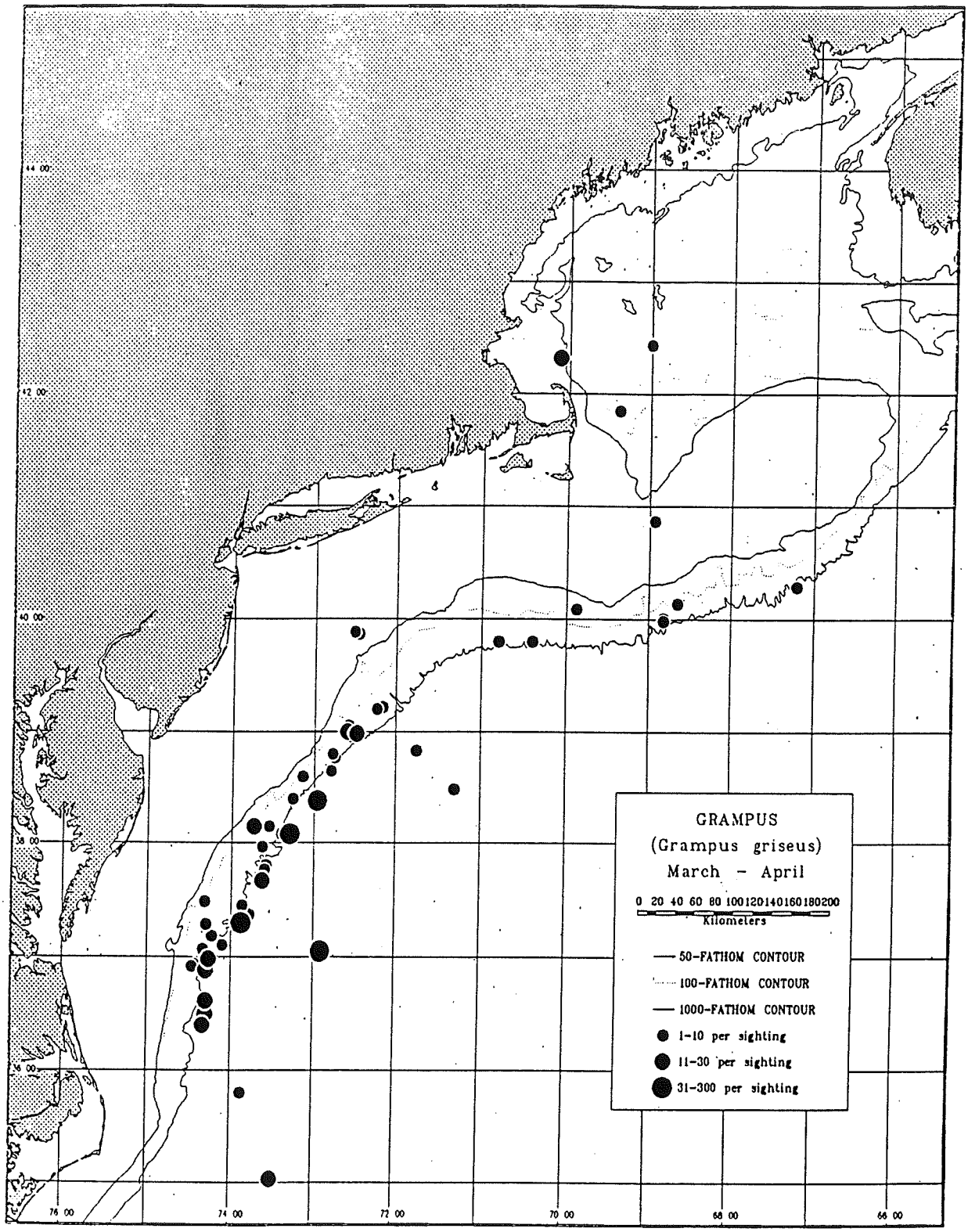

Figure 9b. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

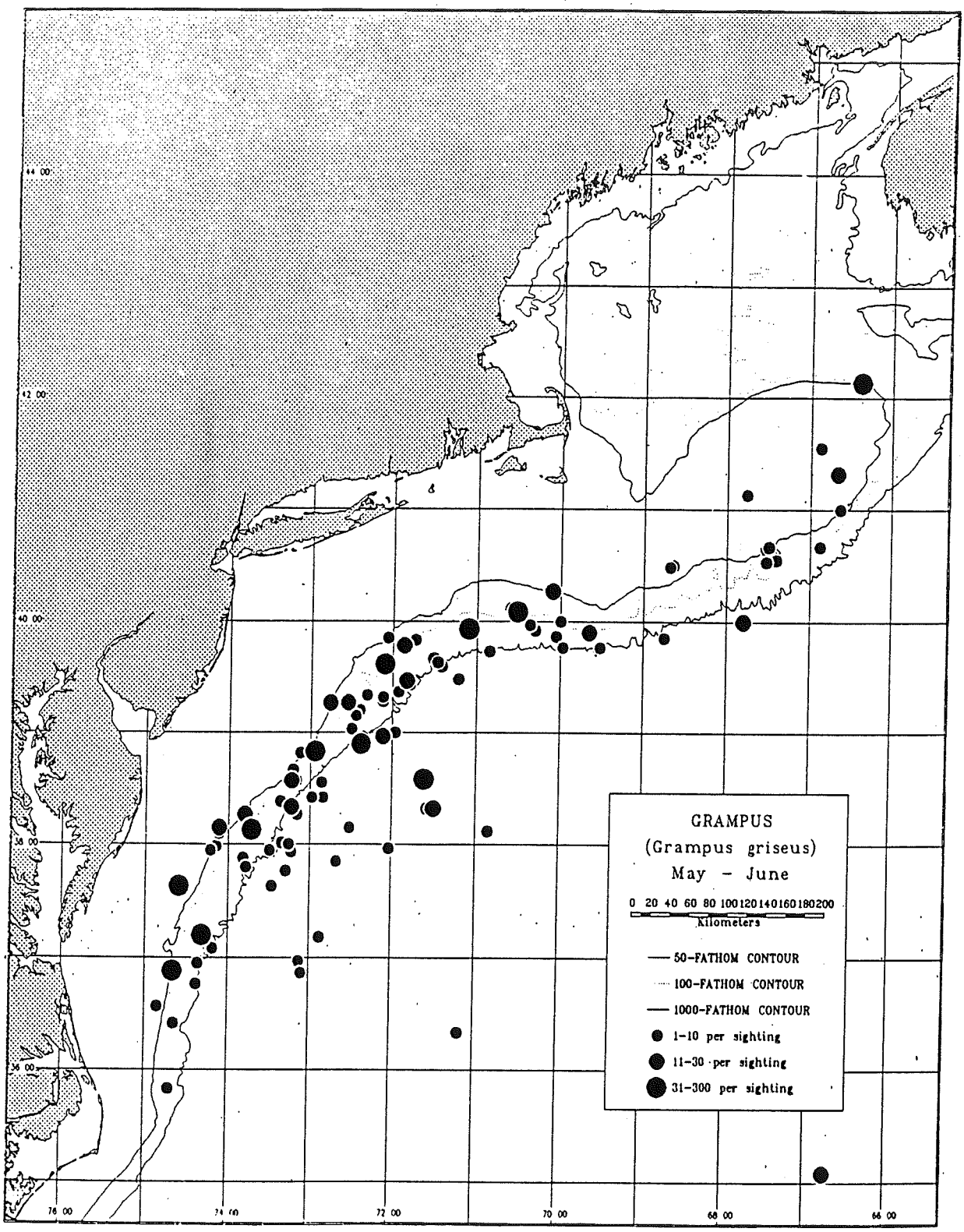

Figure 9c. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

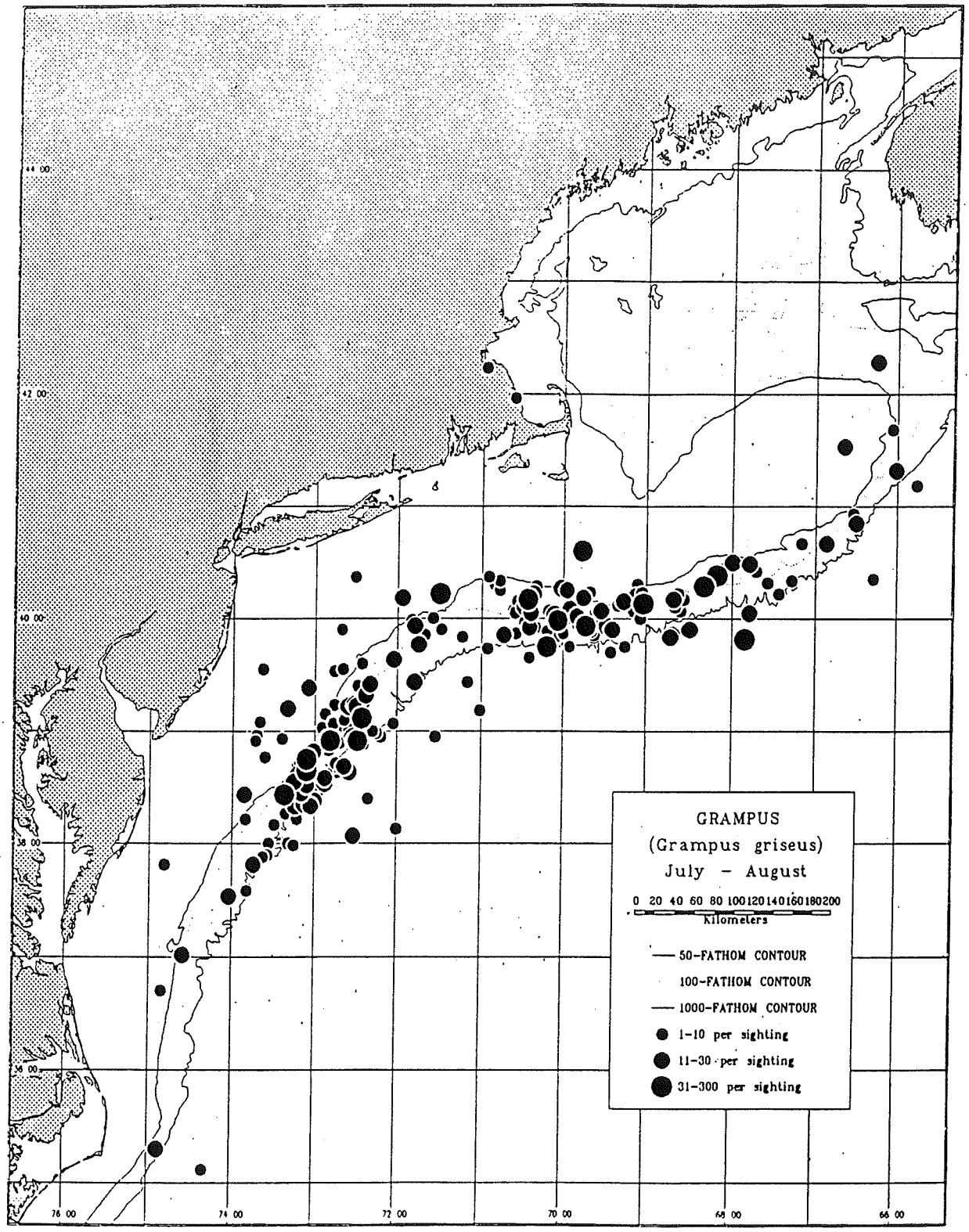

Figure 9d. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

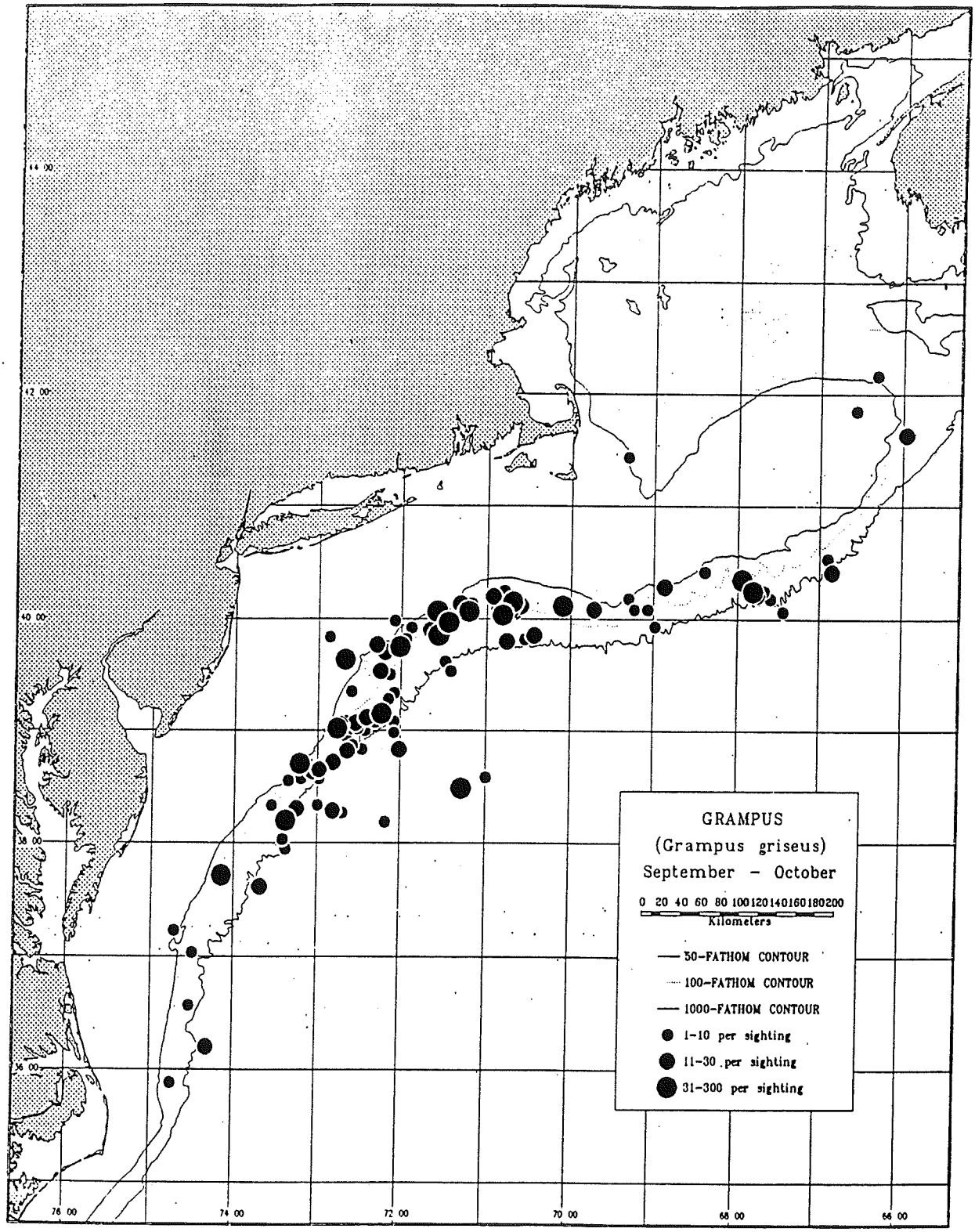

Figure 9e. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

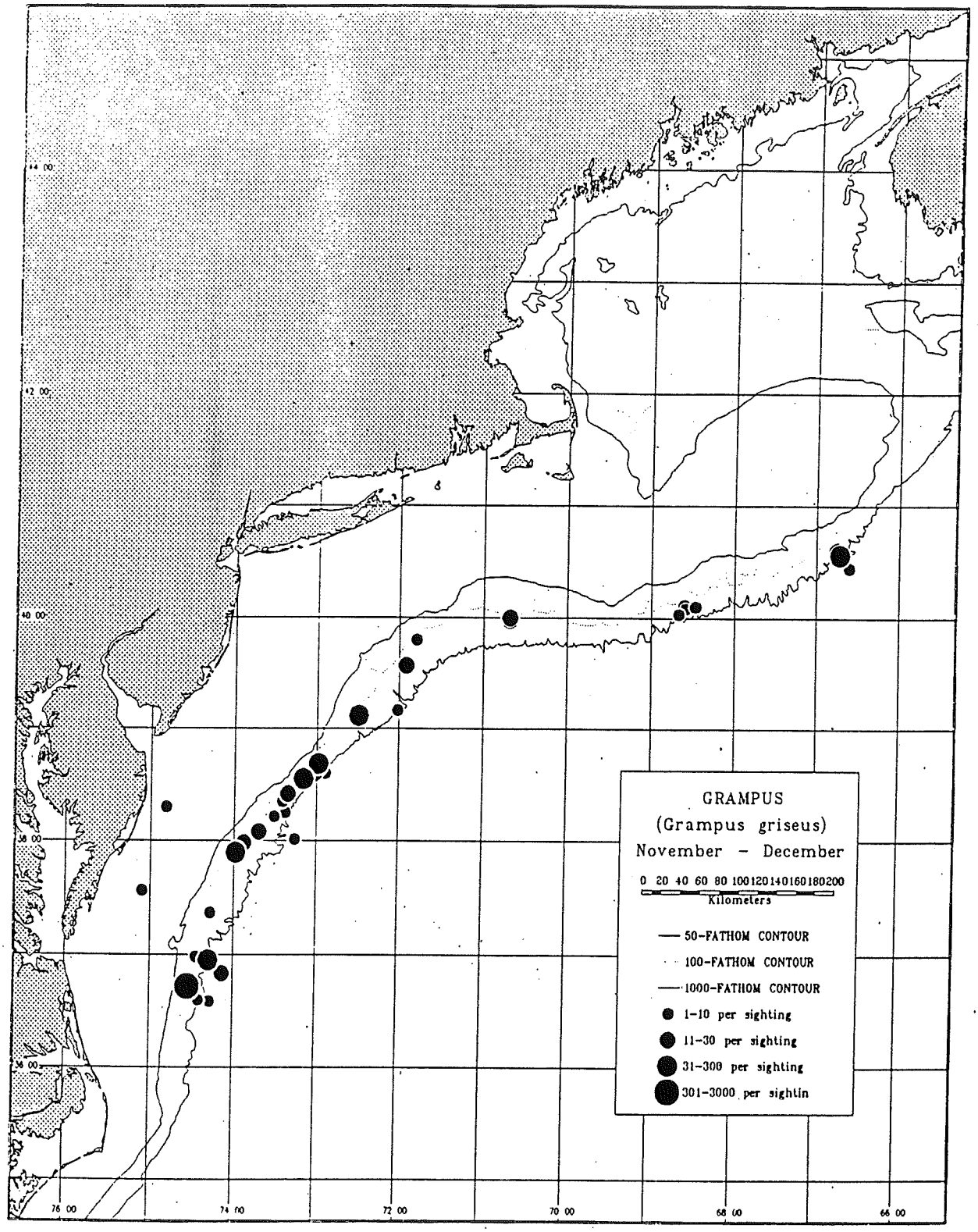

Figure 9f. Distribution of grampus or Risso's dolphin Grampus griseus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

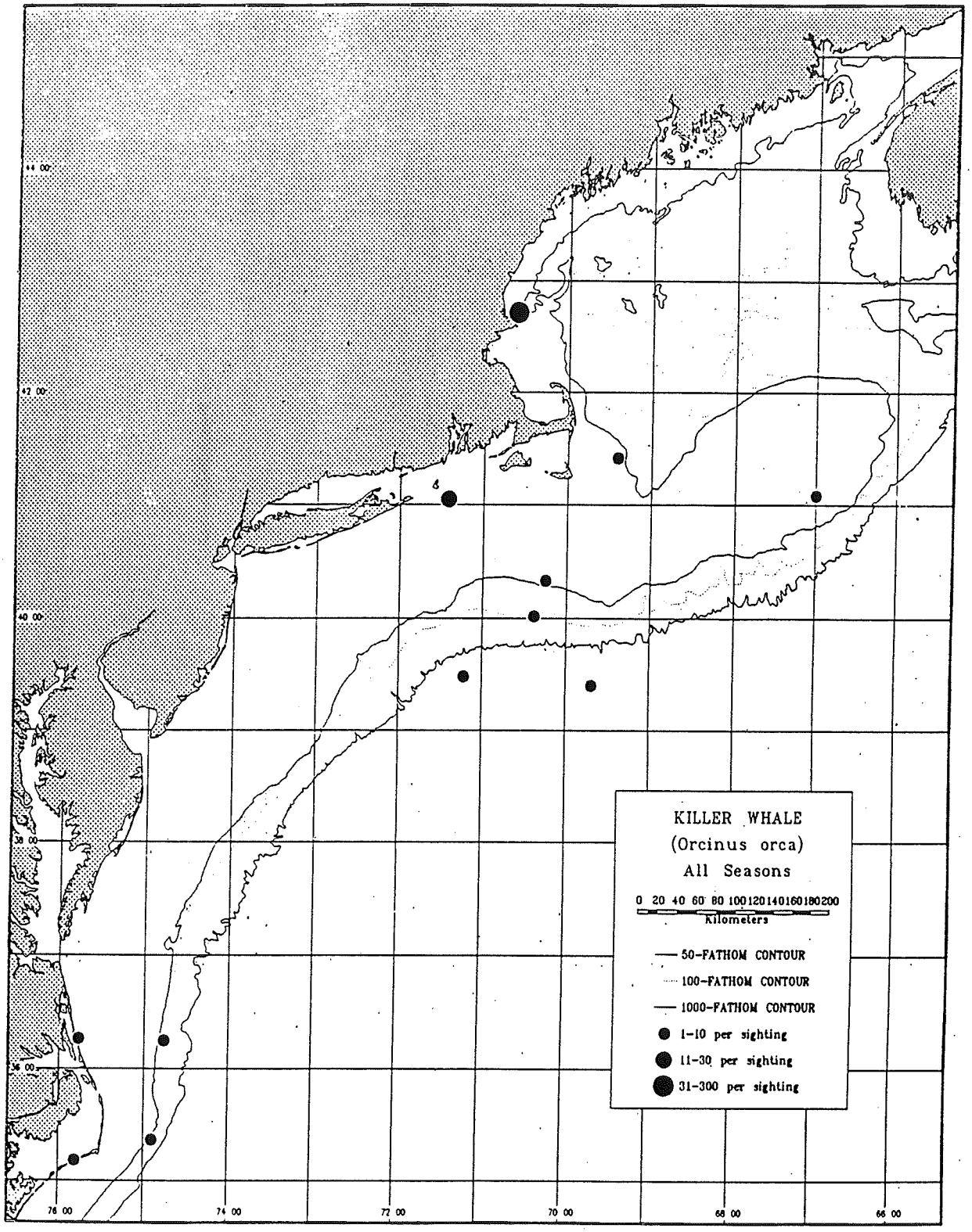

Figure 10. Distribution of killer whale Orcinus orca sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

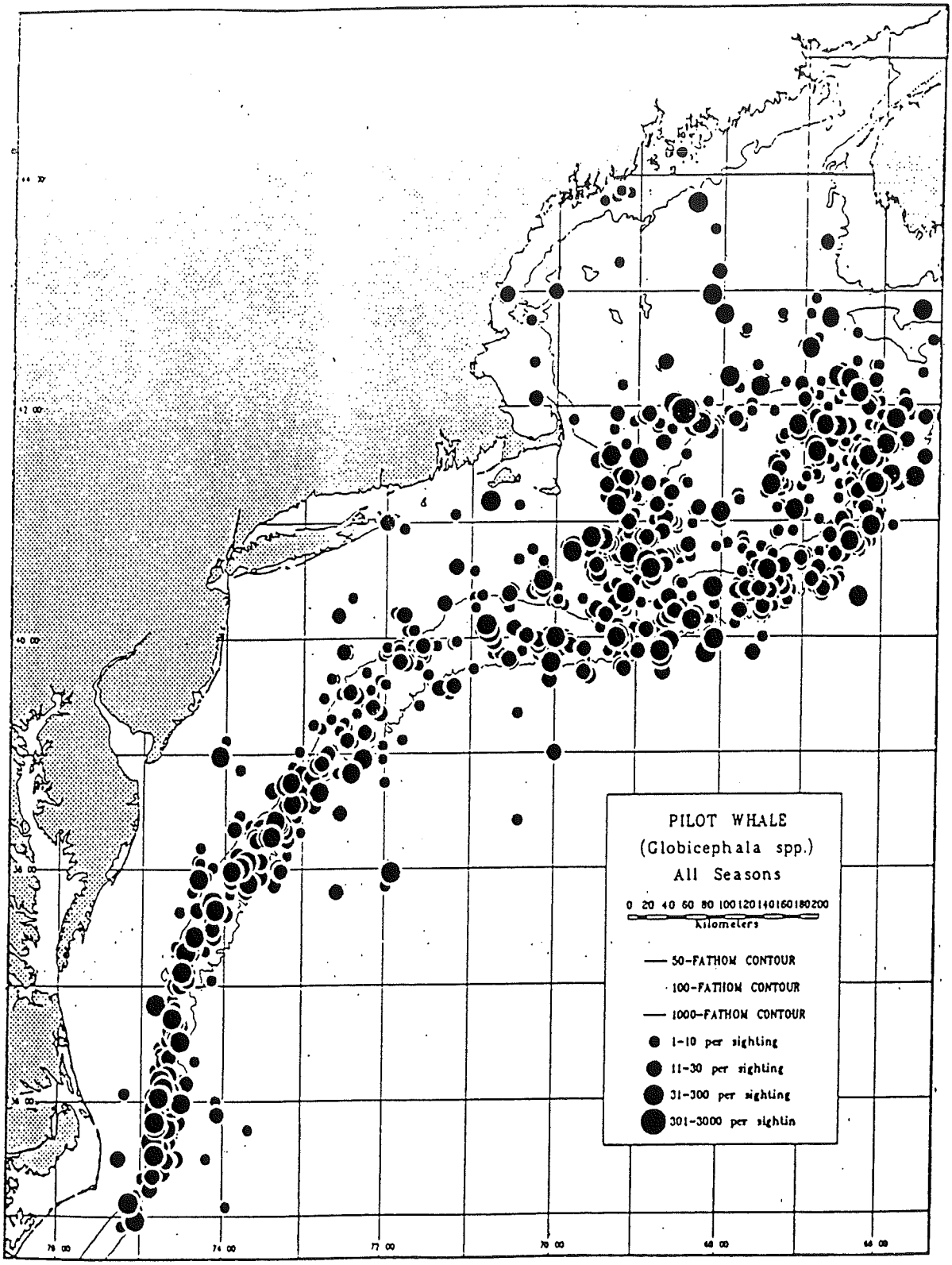

Figure 11. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

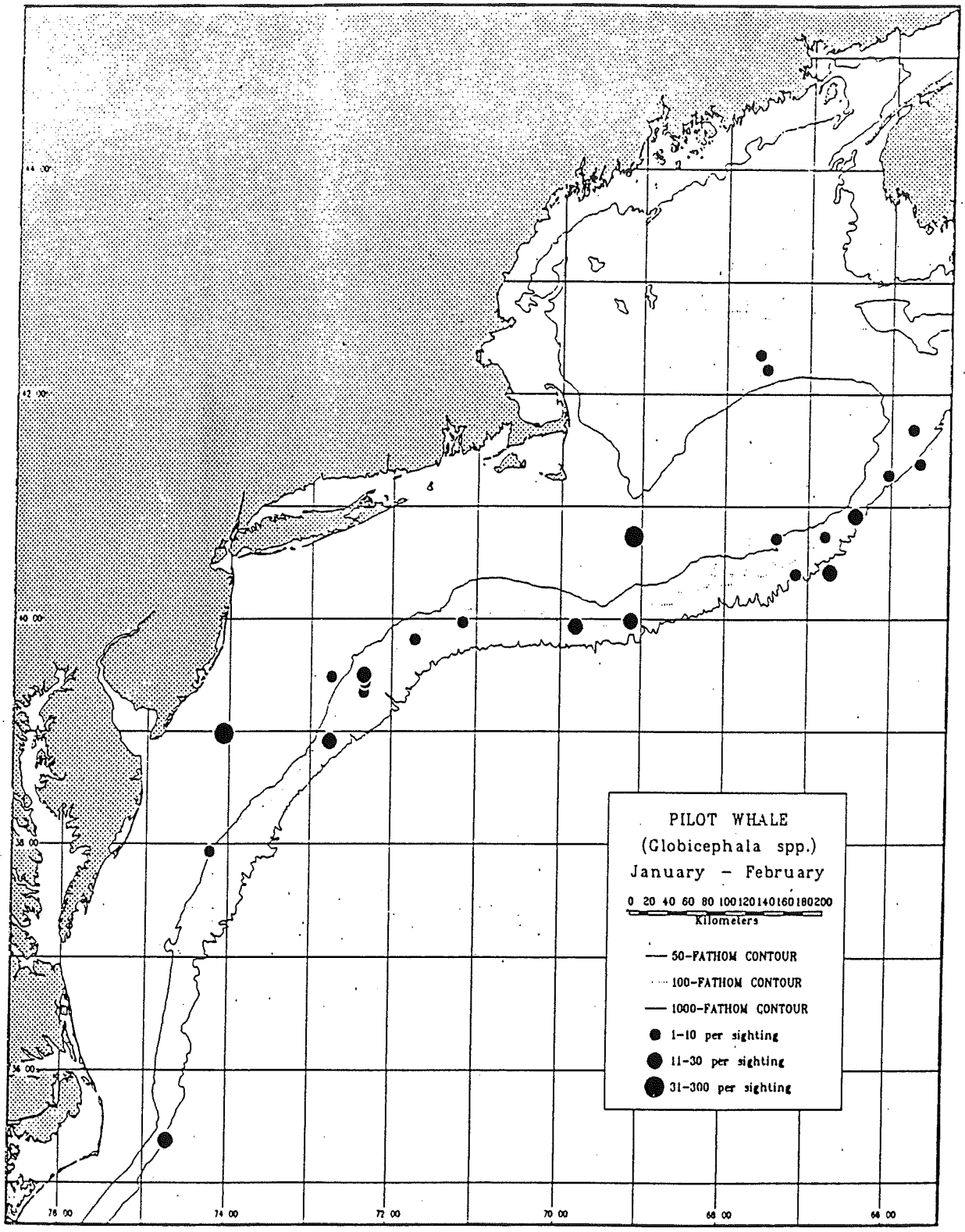

Figure 11a. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

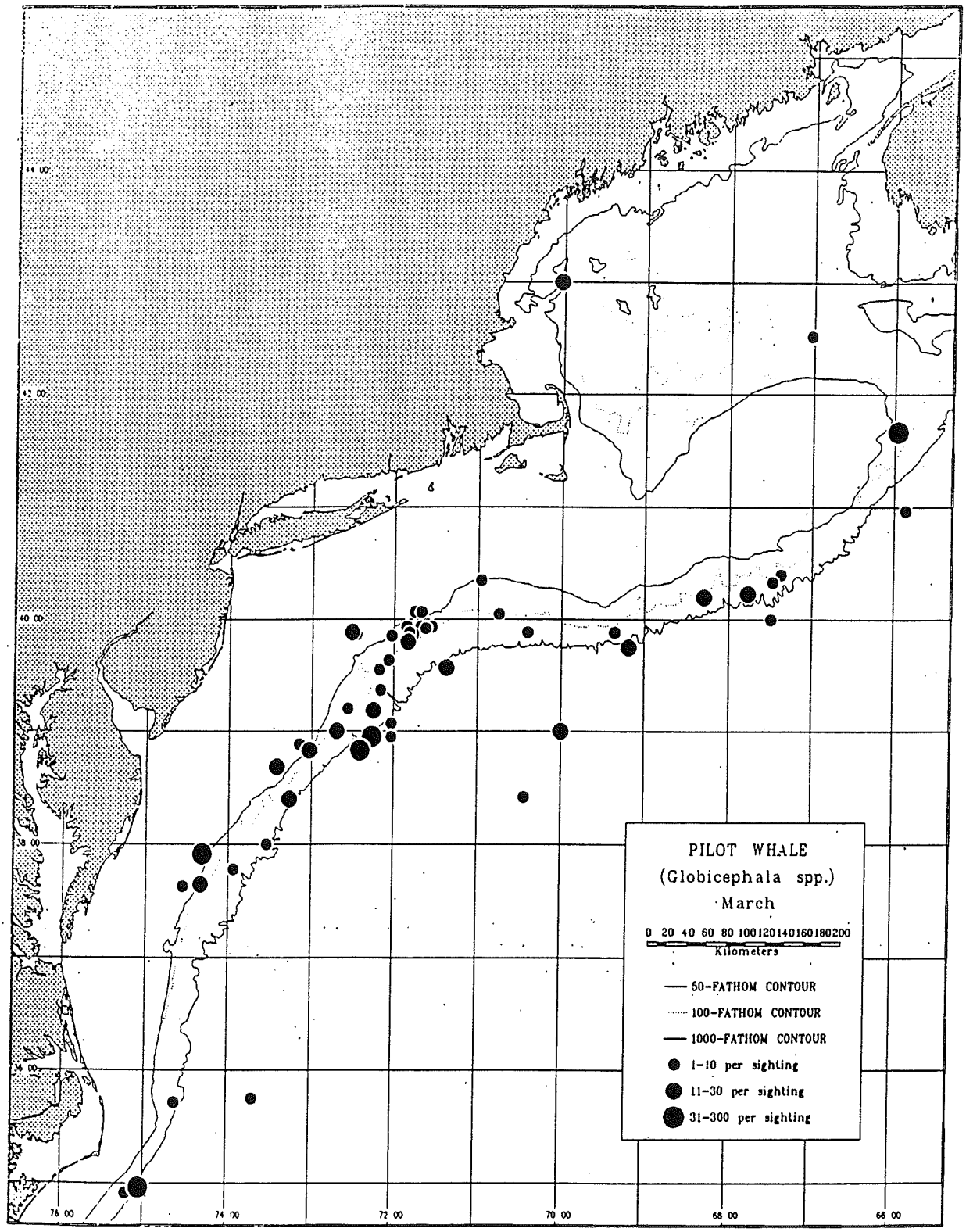

Figure 11b. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March, 1978-1988.

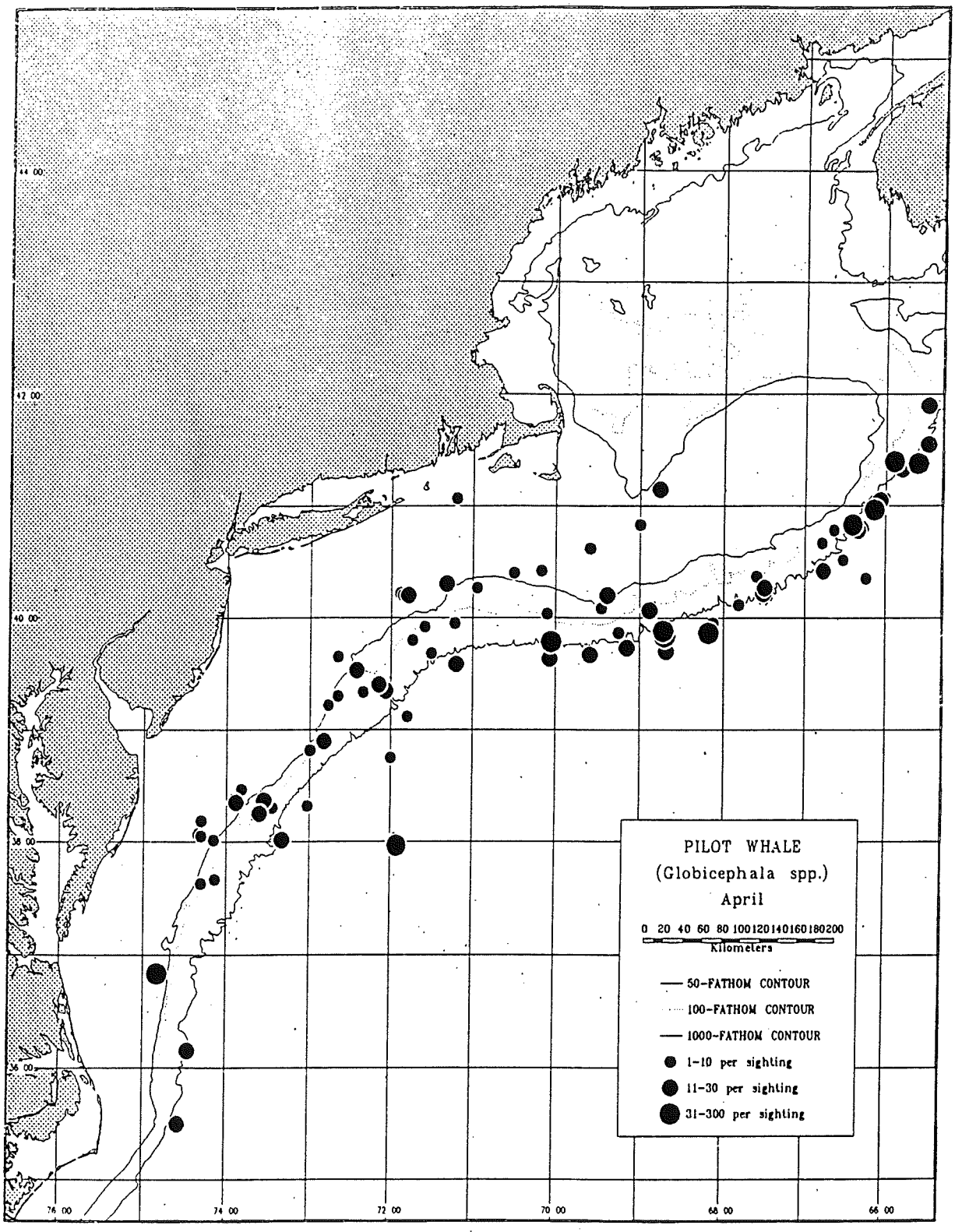

Figure 11c. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during April, 1978-1988.

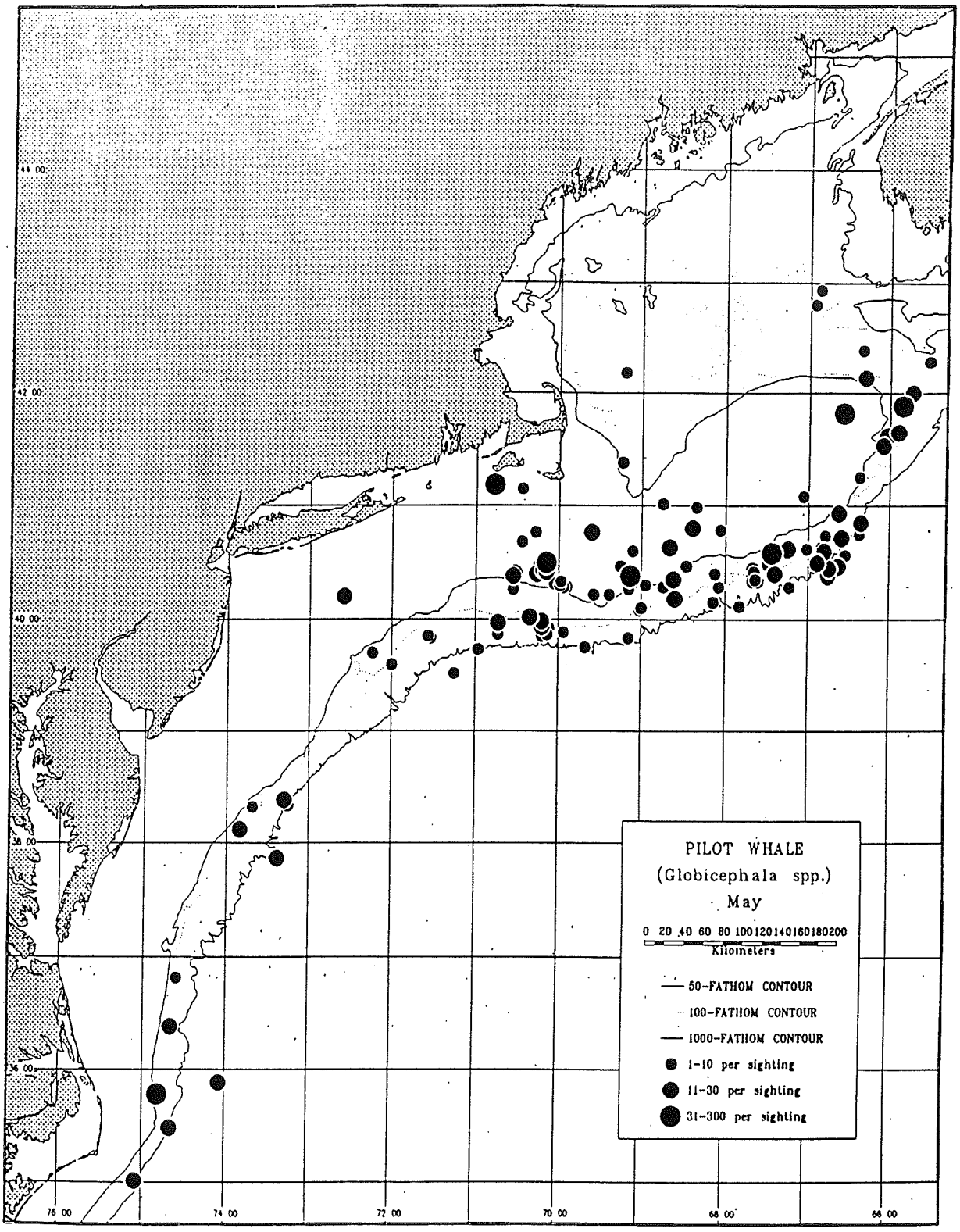

Figure 11d. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May, 1978-1988.

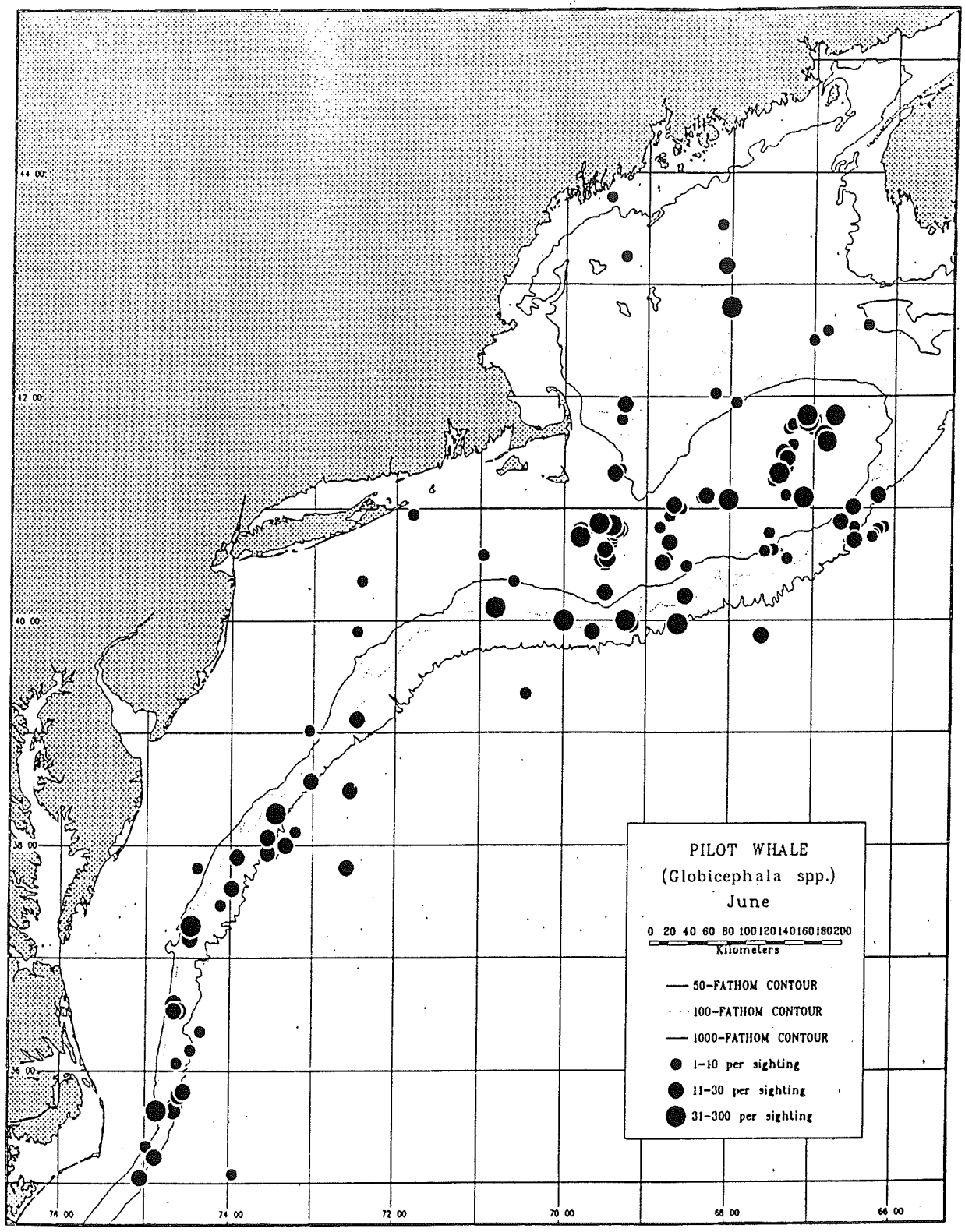

Figure 11e. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during June, 1978-1988.

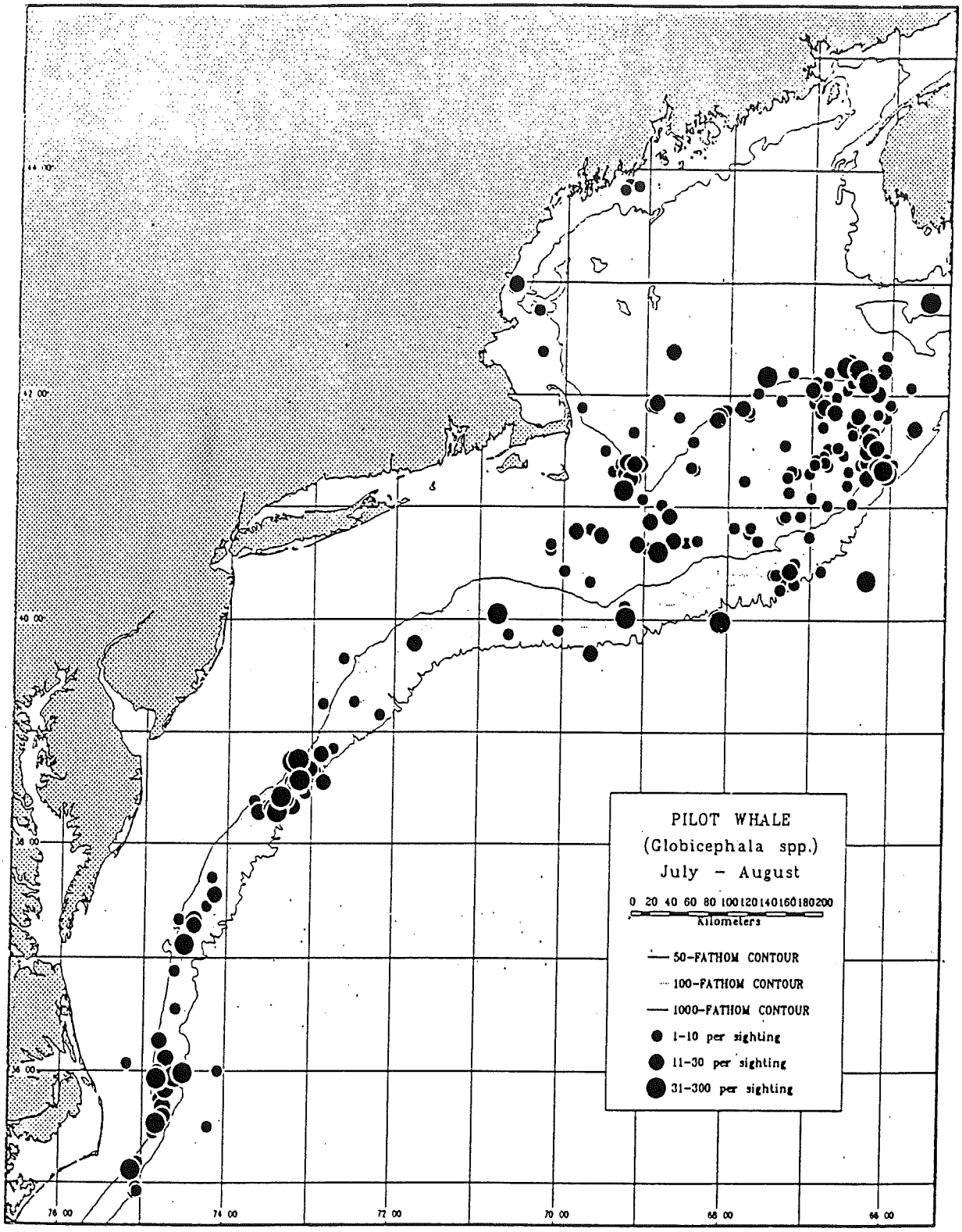

Figure 11f. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

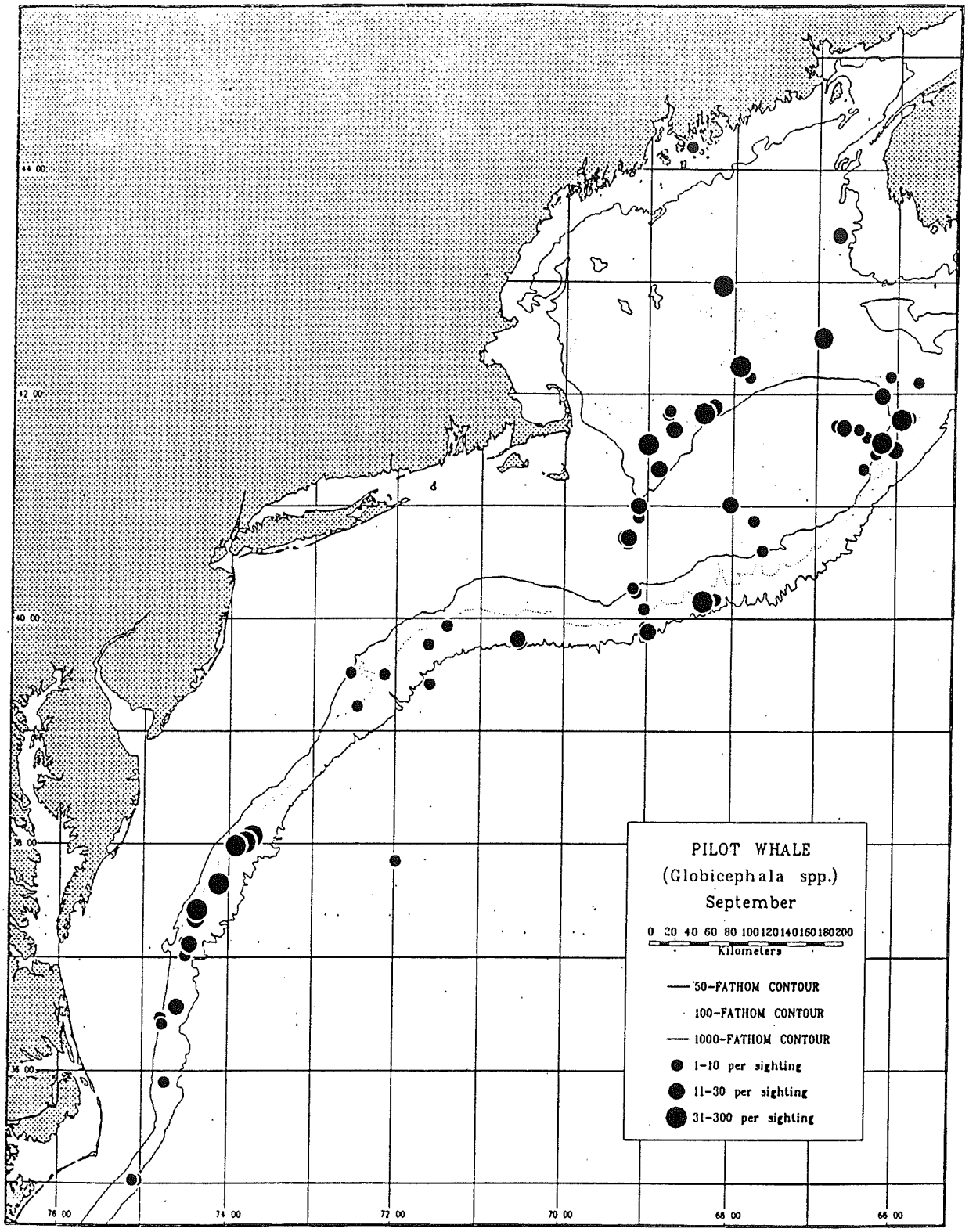

Figure 11g. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September, 1978-1988.

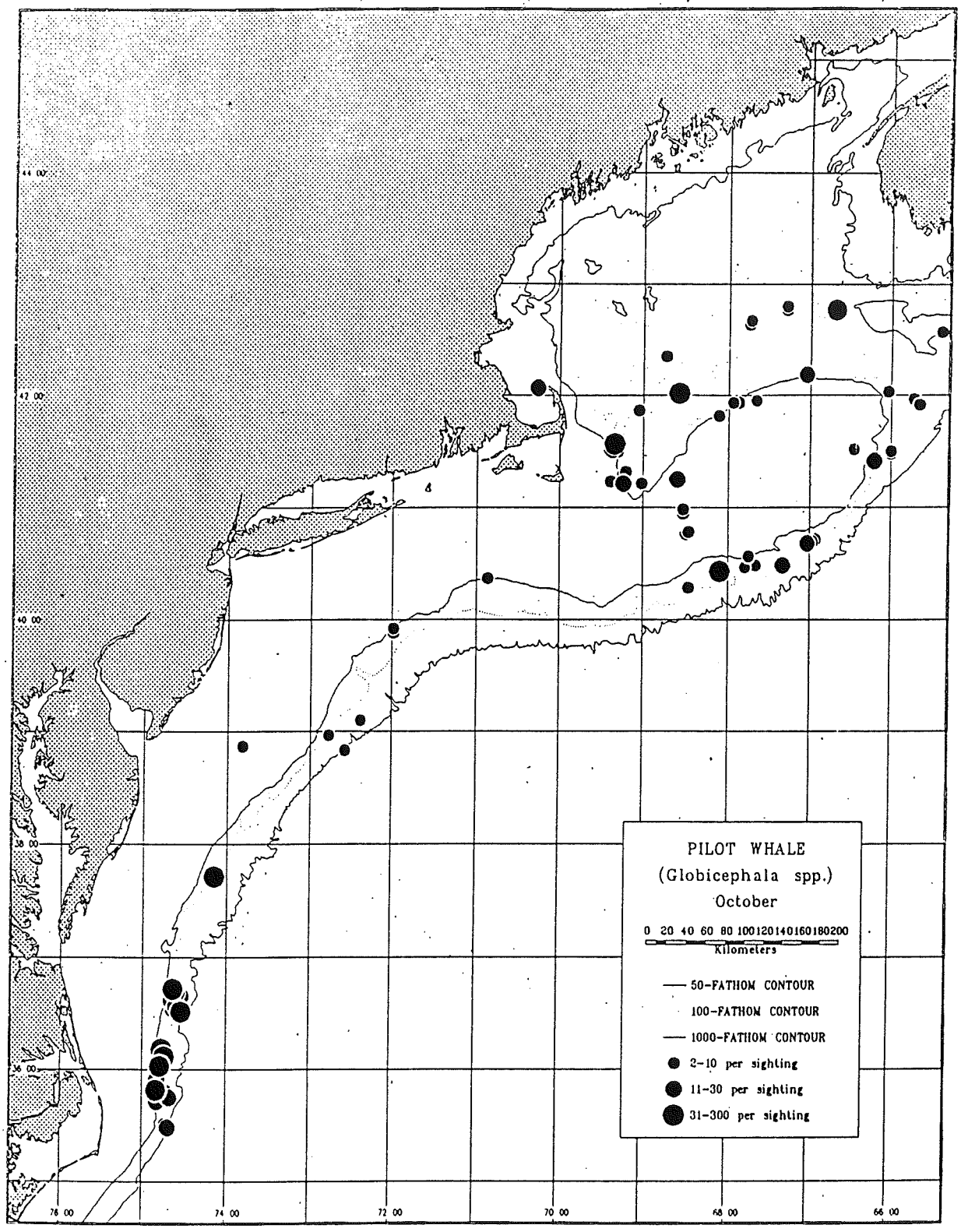

Figure 11h. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during October, 1978-1988.

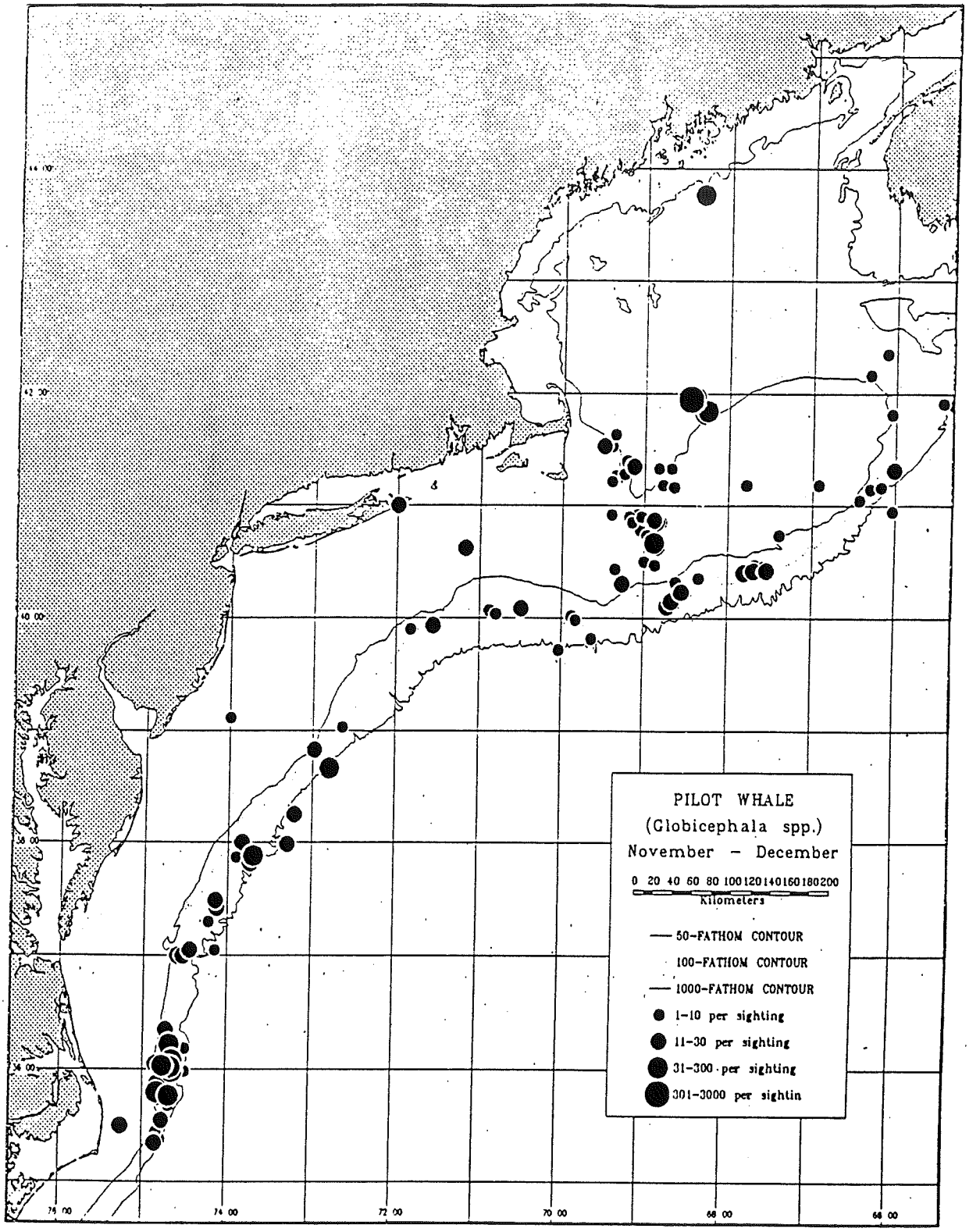

Figure 11i. Distribution of pilot whale Globicephala spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

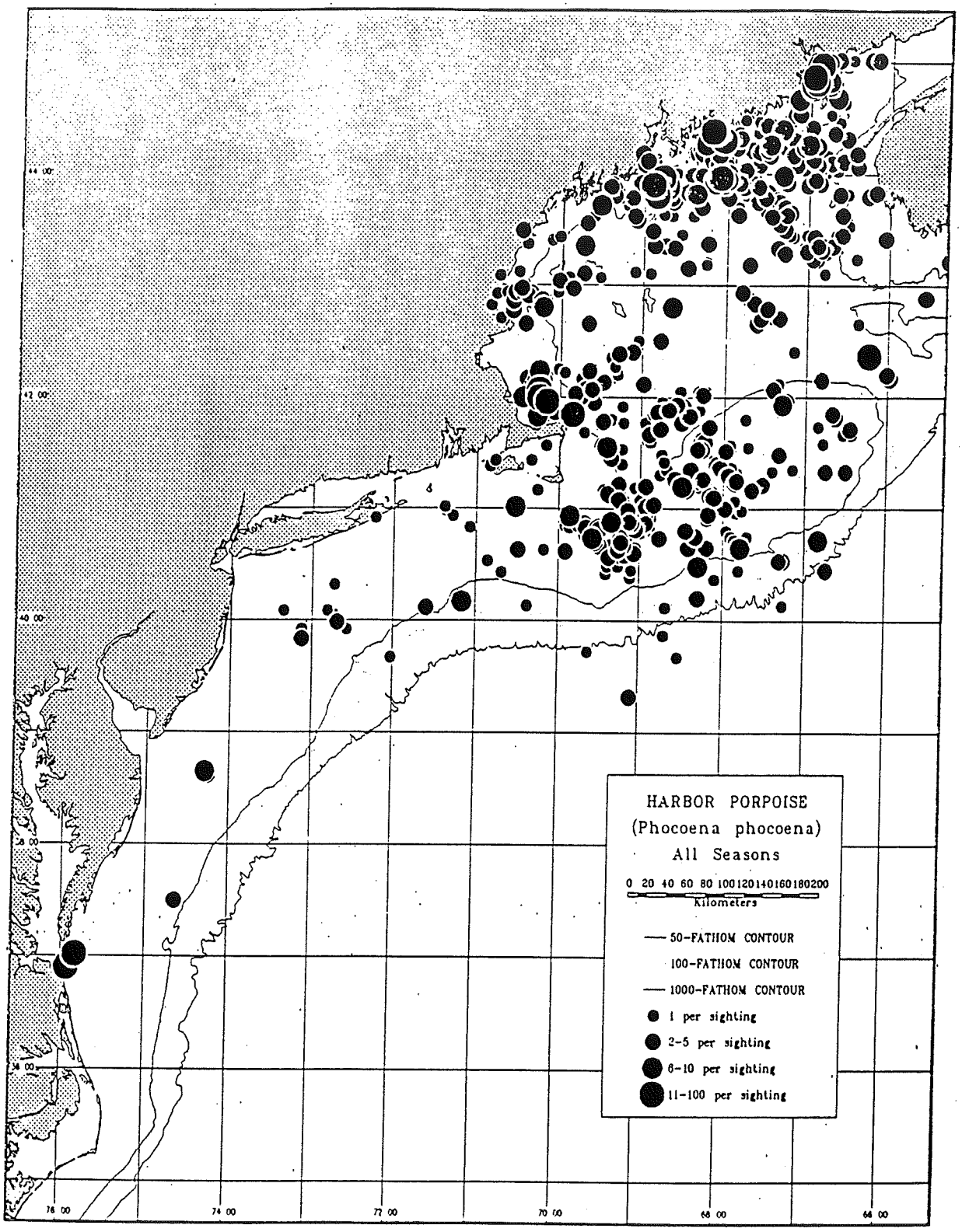

Figure 12. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

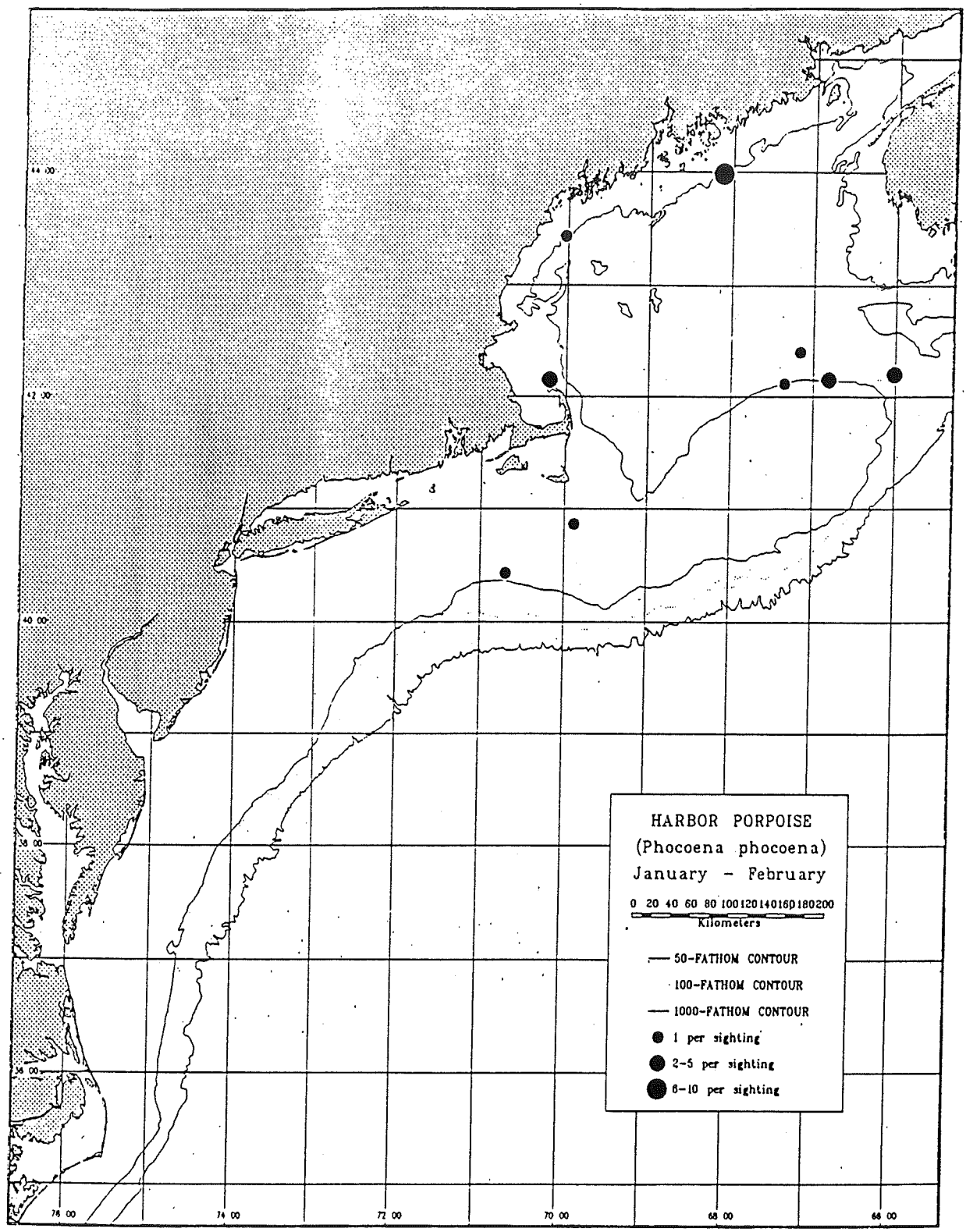

Figure 12a. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

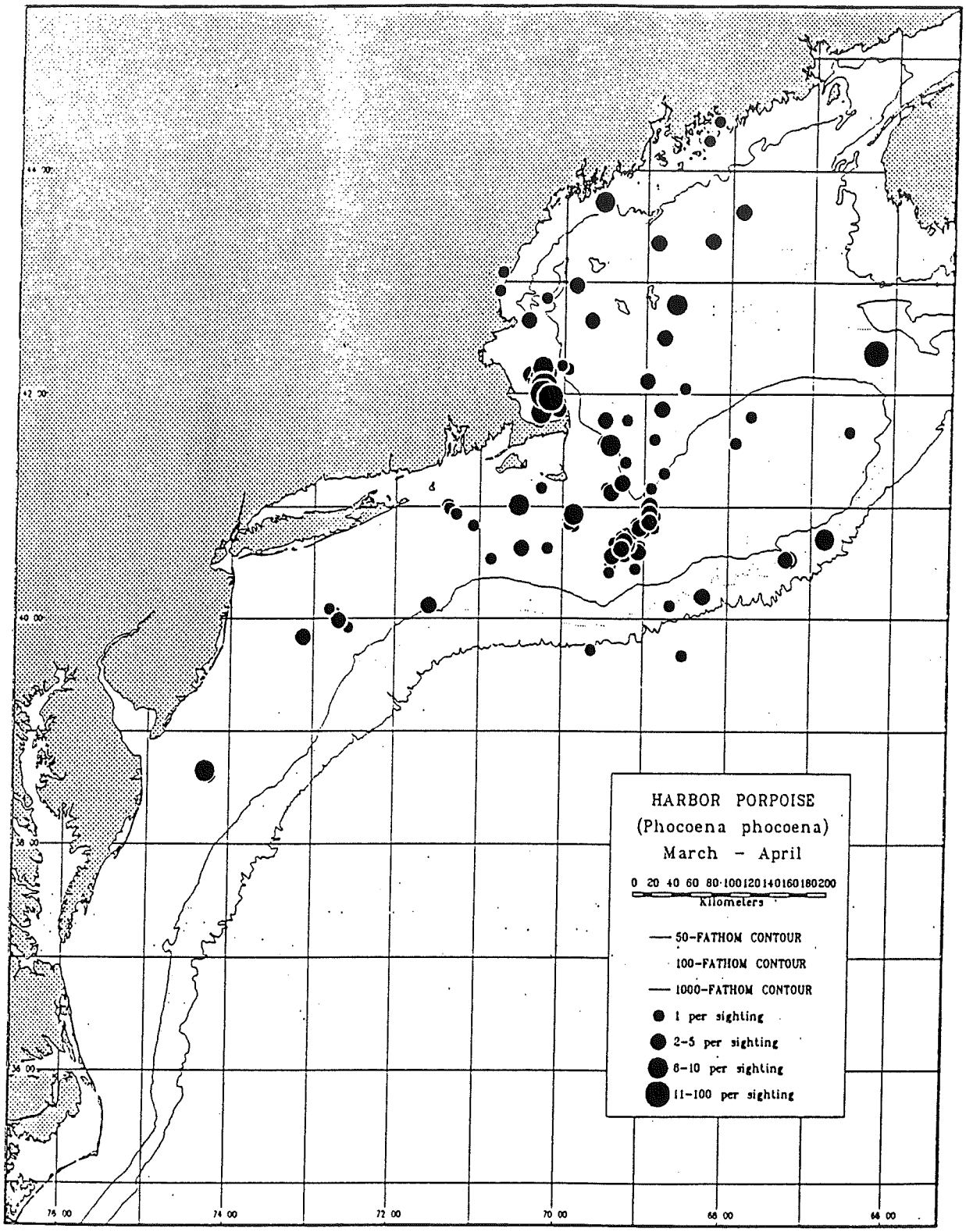

Figure 12b. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

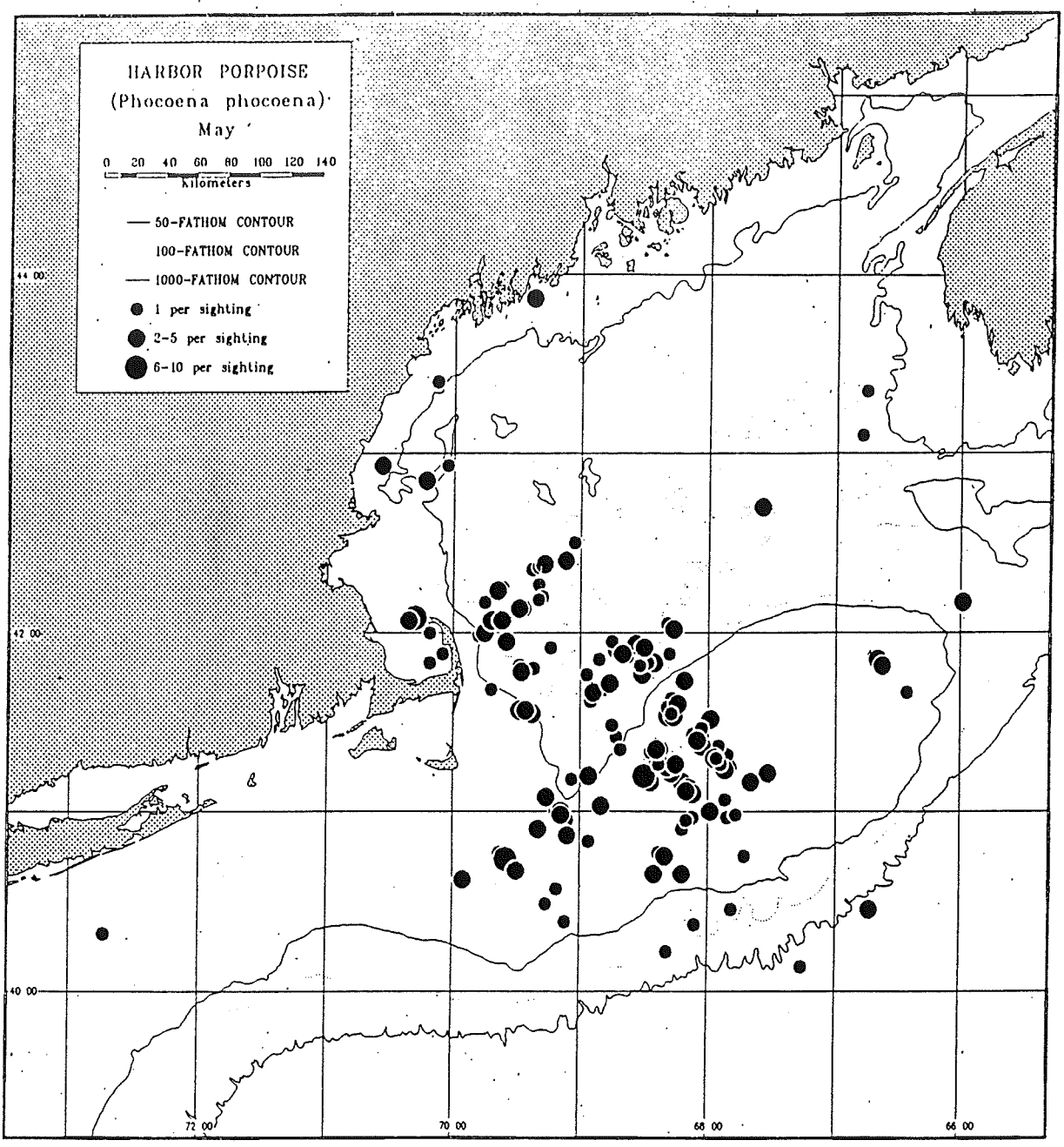

Figure 12c. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May, 1978-1988.

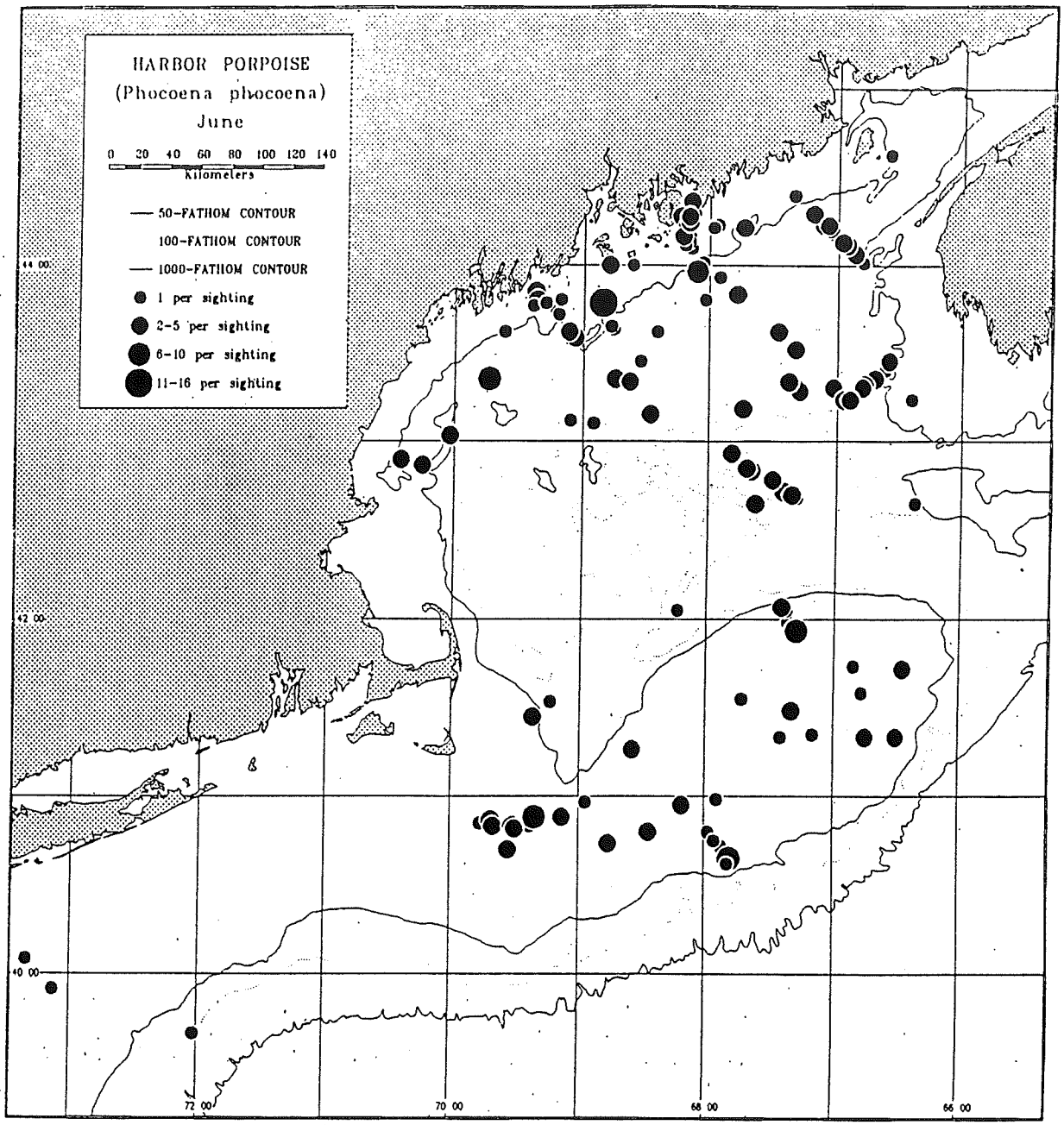

Figure 12d. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during June, 1978-1988.

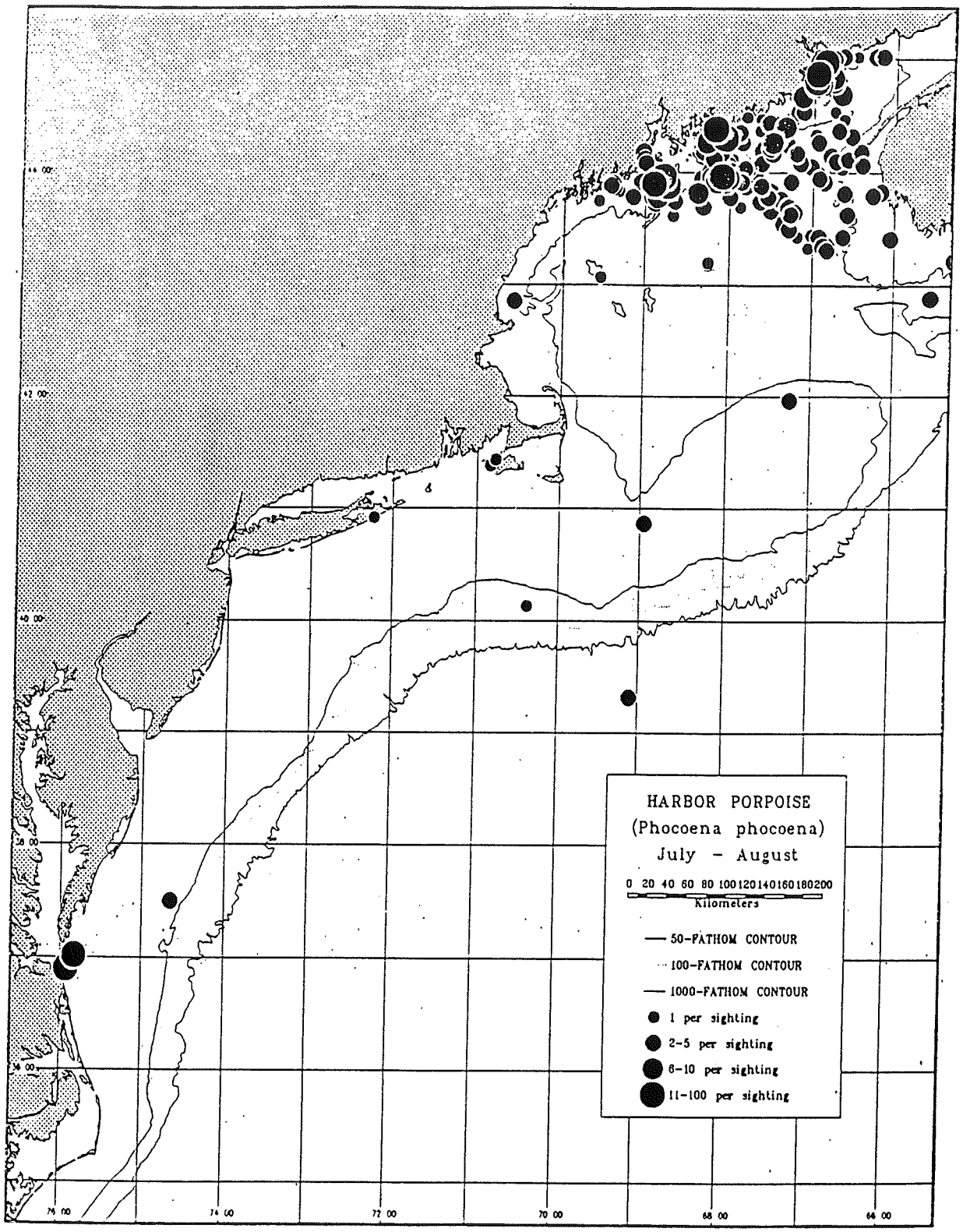

Figure 12e. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

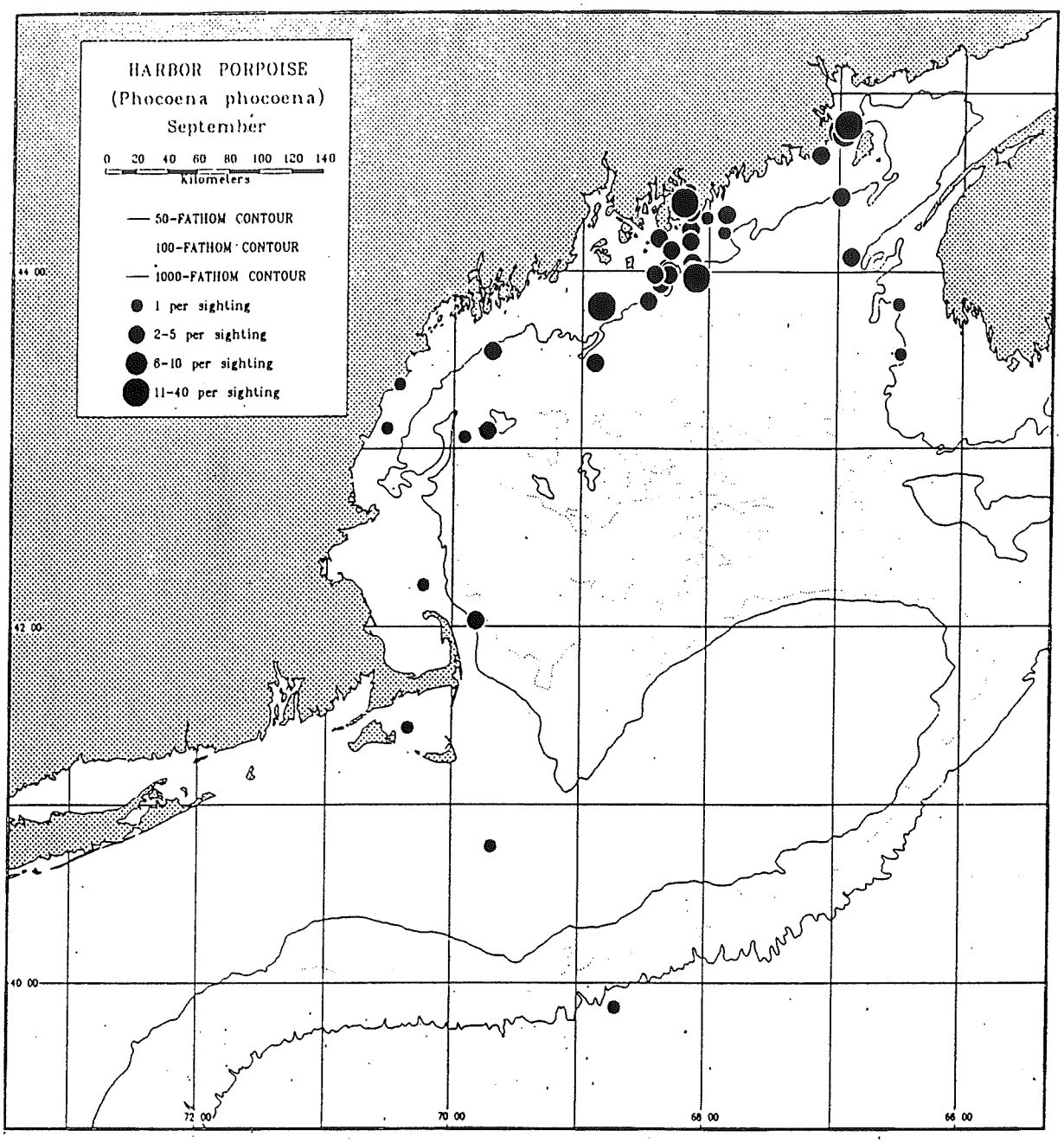

Figure 12f. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September, 1978-1988.

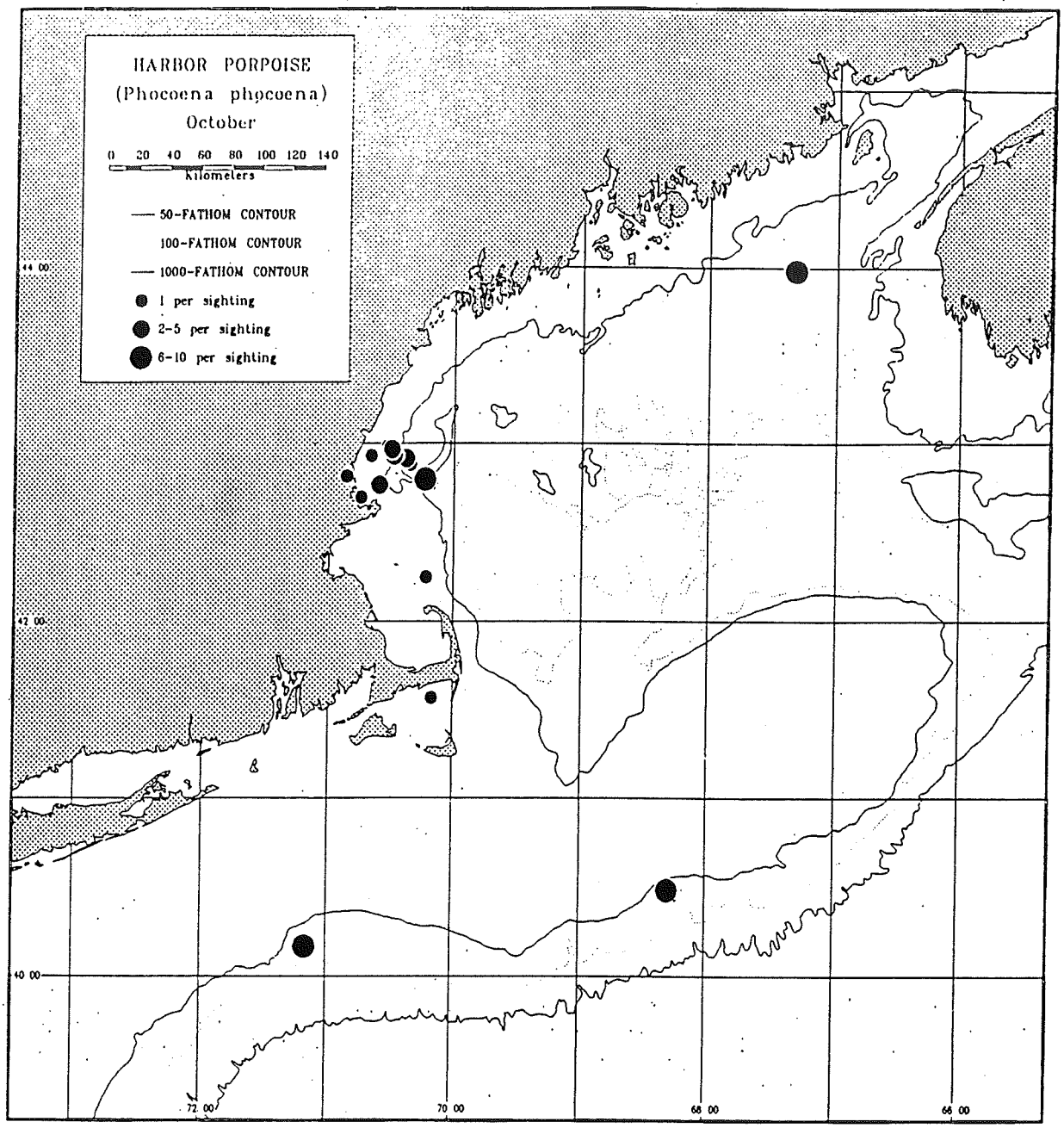

Figure 12g. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during October, 1978-1988.

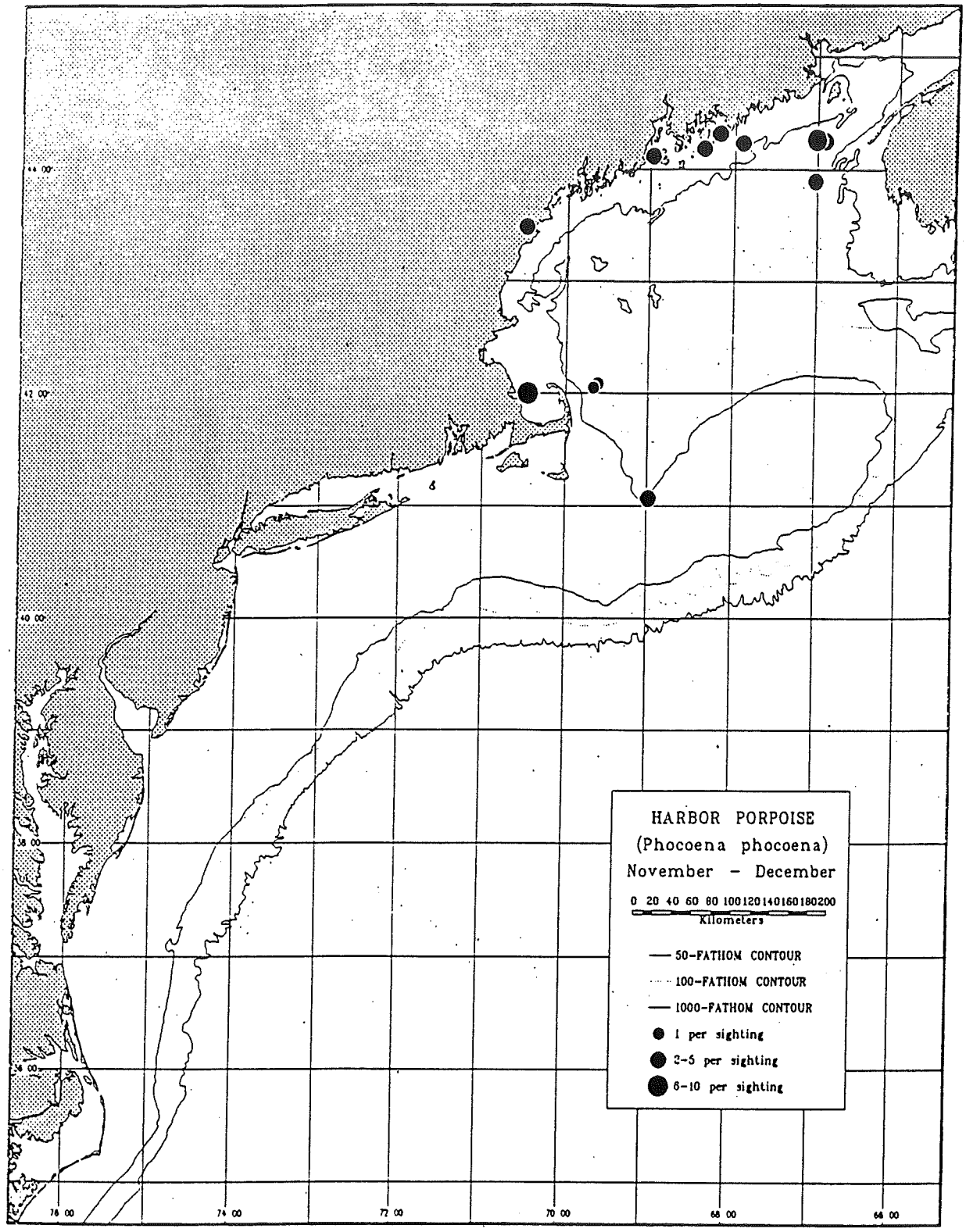

Figure 12h. Distribution of harbor porpoise Phocoena phocoena sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

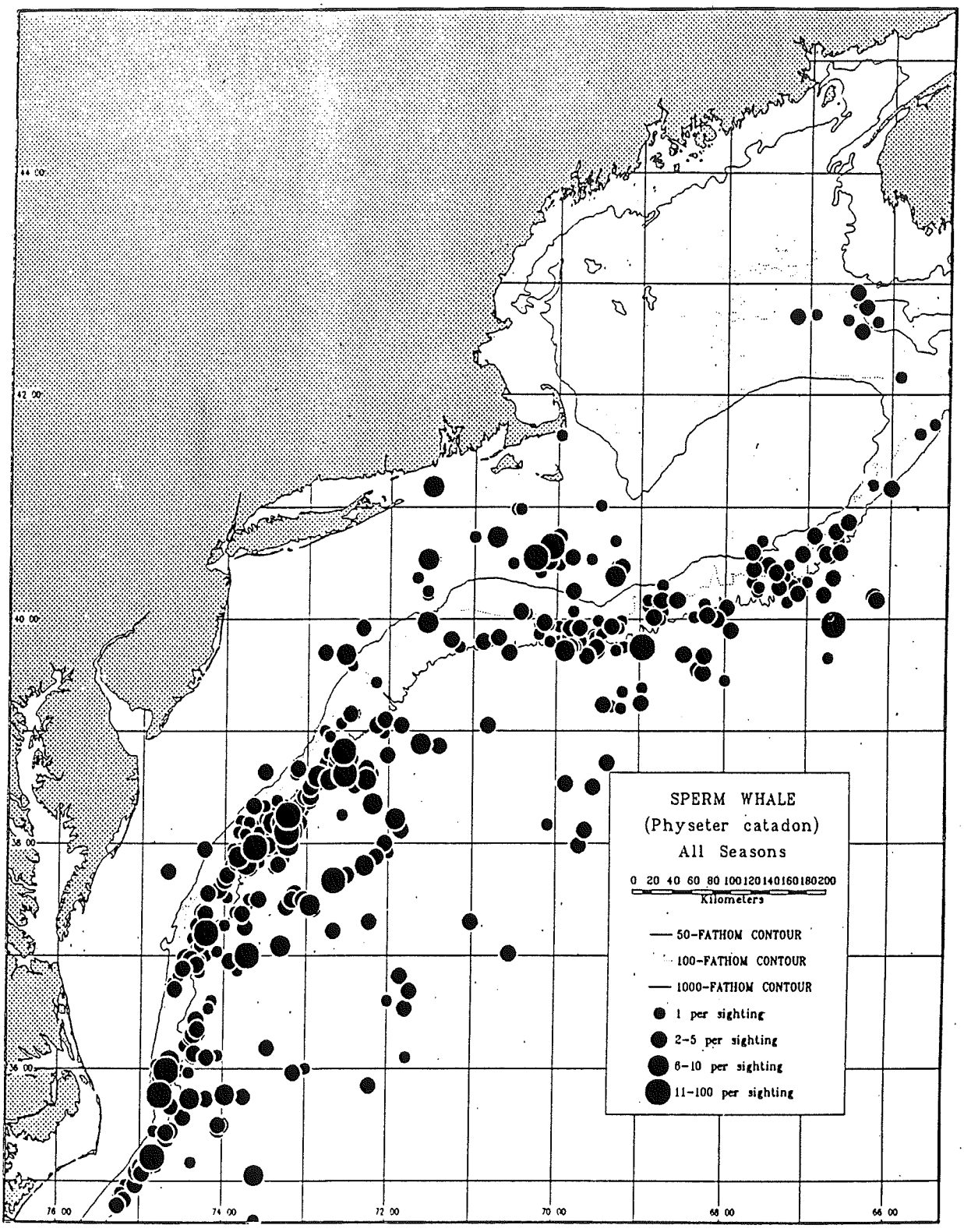

Figure 13. Distribution of sperm whale Physeter macrocephalus in the shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

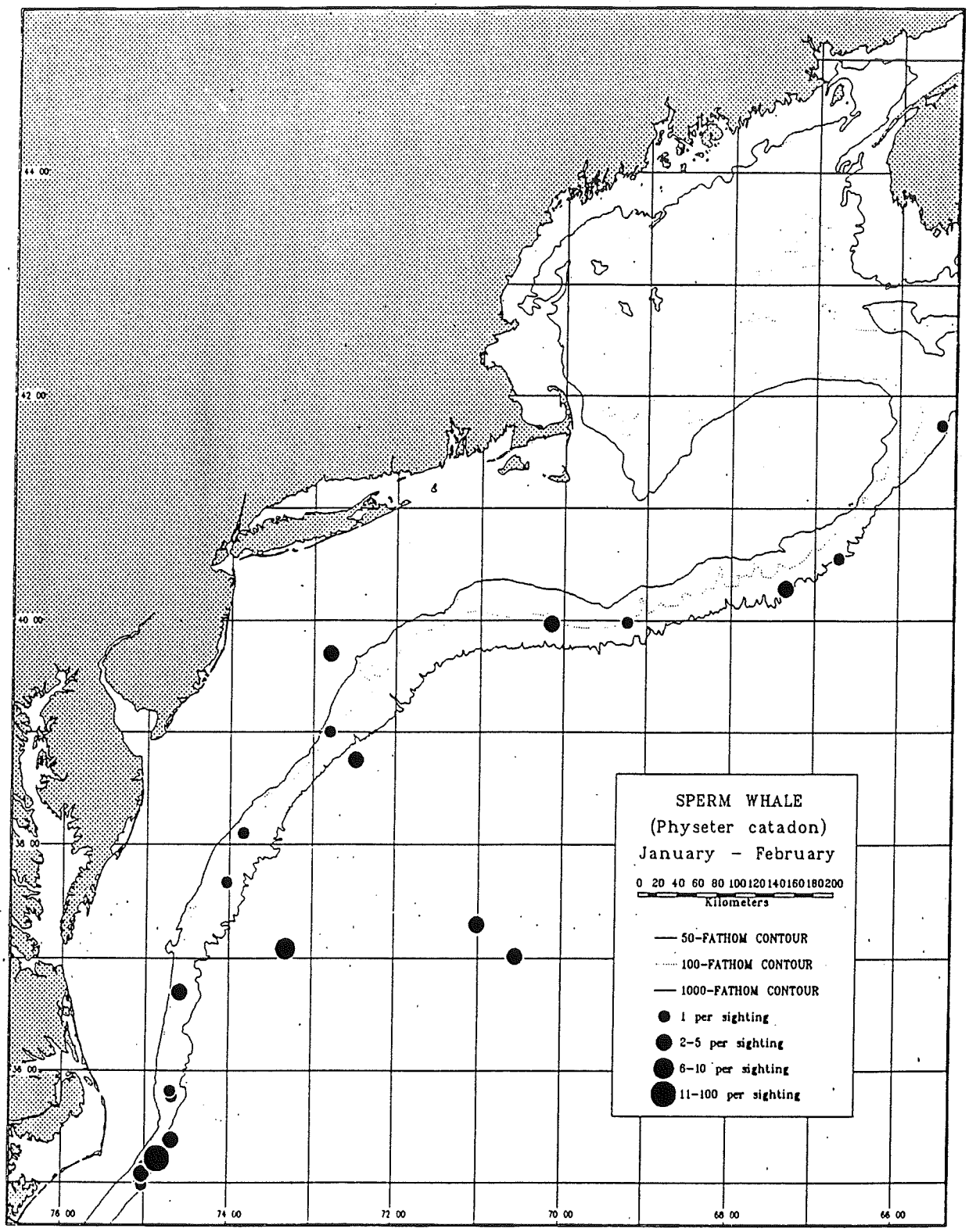

Figure 13a. Distribution of sperm whale Physeter macrocephalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

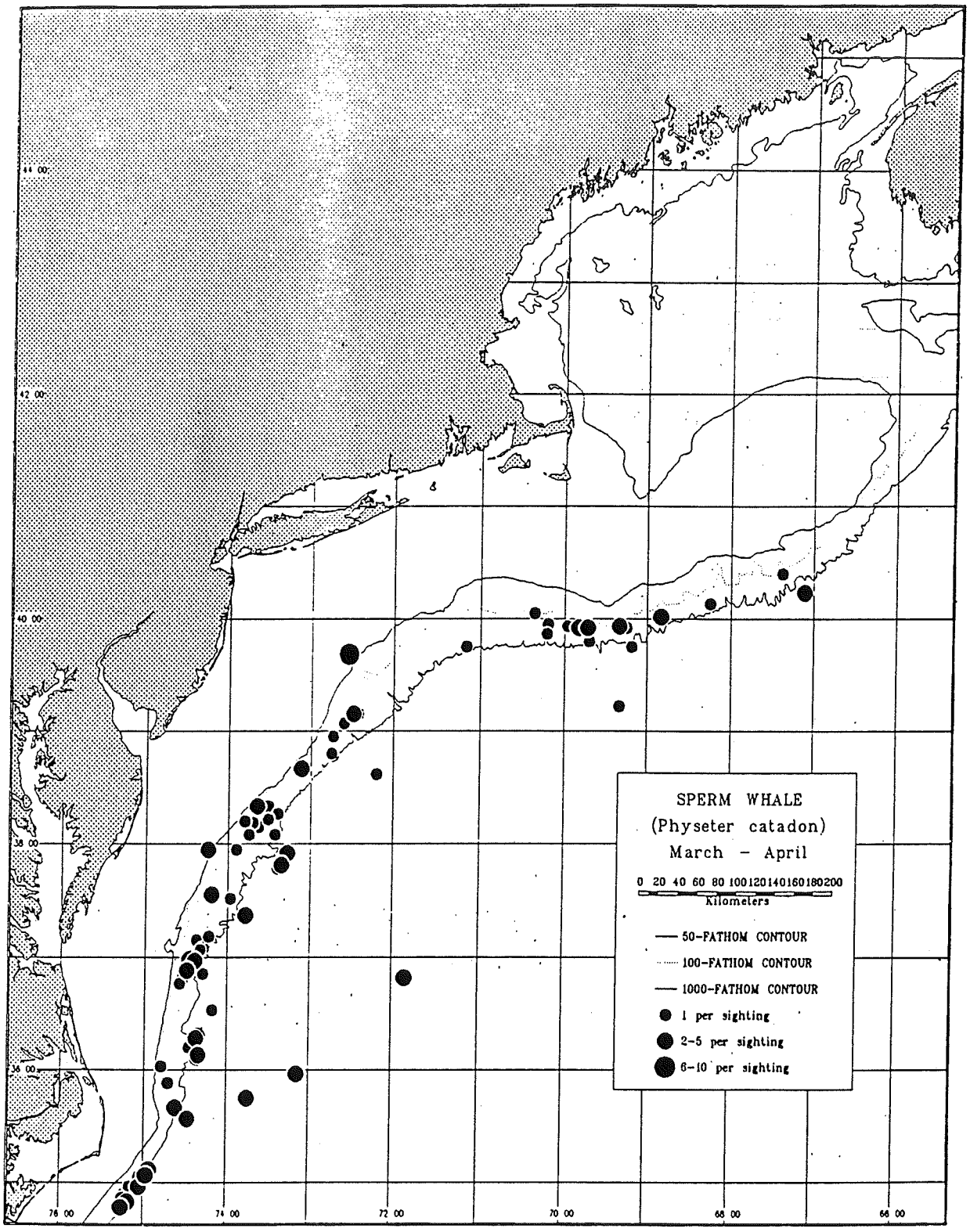

Figure 13b. Distribution of sperm whale Physeter macrocephalus in the shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

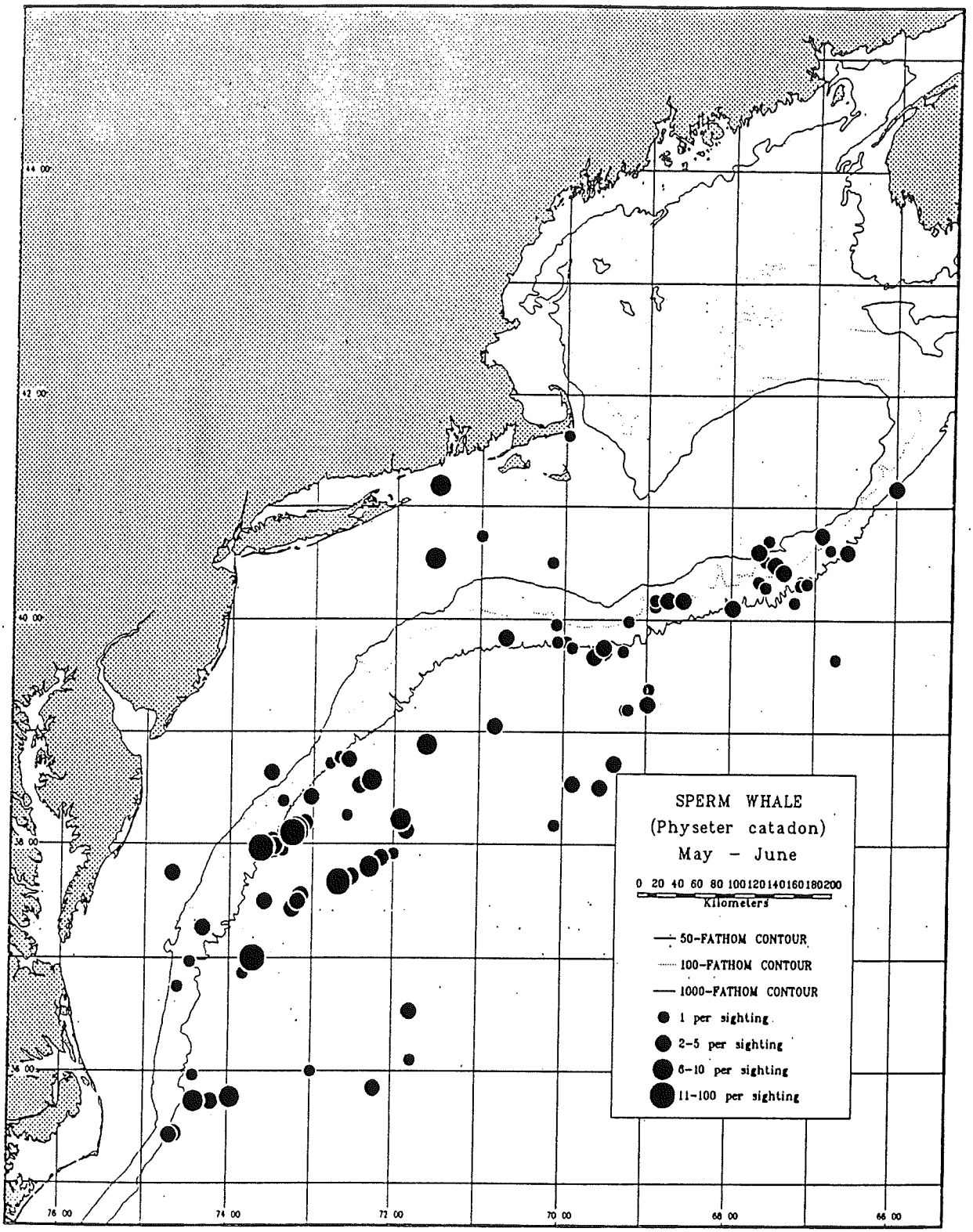

Figure 13c. Distribution of sperm whale Physeter macrocephalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

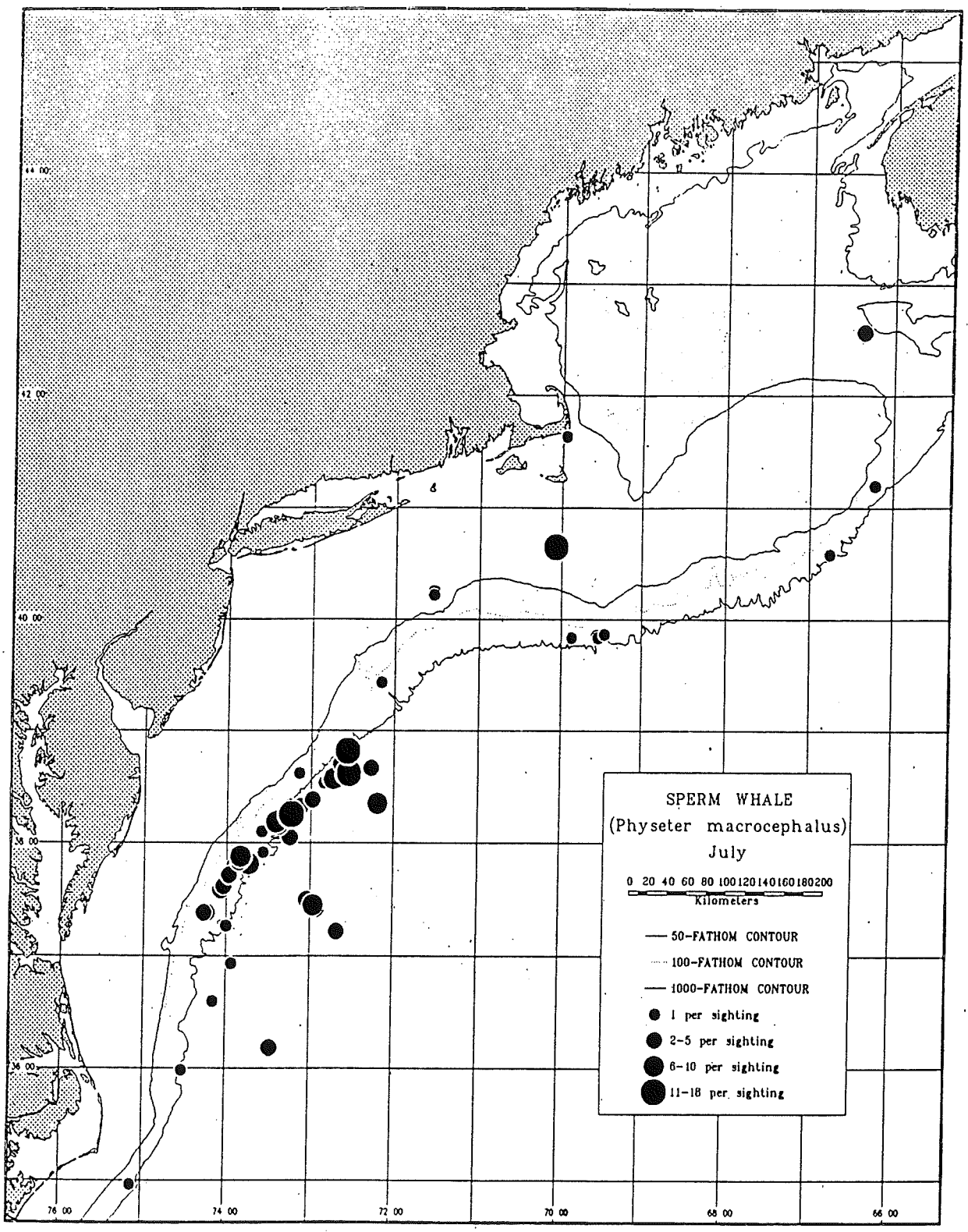

Figure 13d. Distribution of sperm whale Physeter macrocephalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July, 1978-1988.

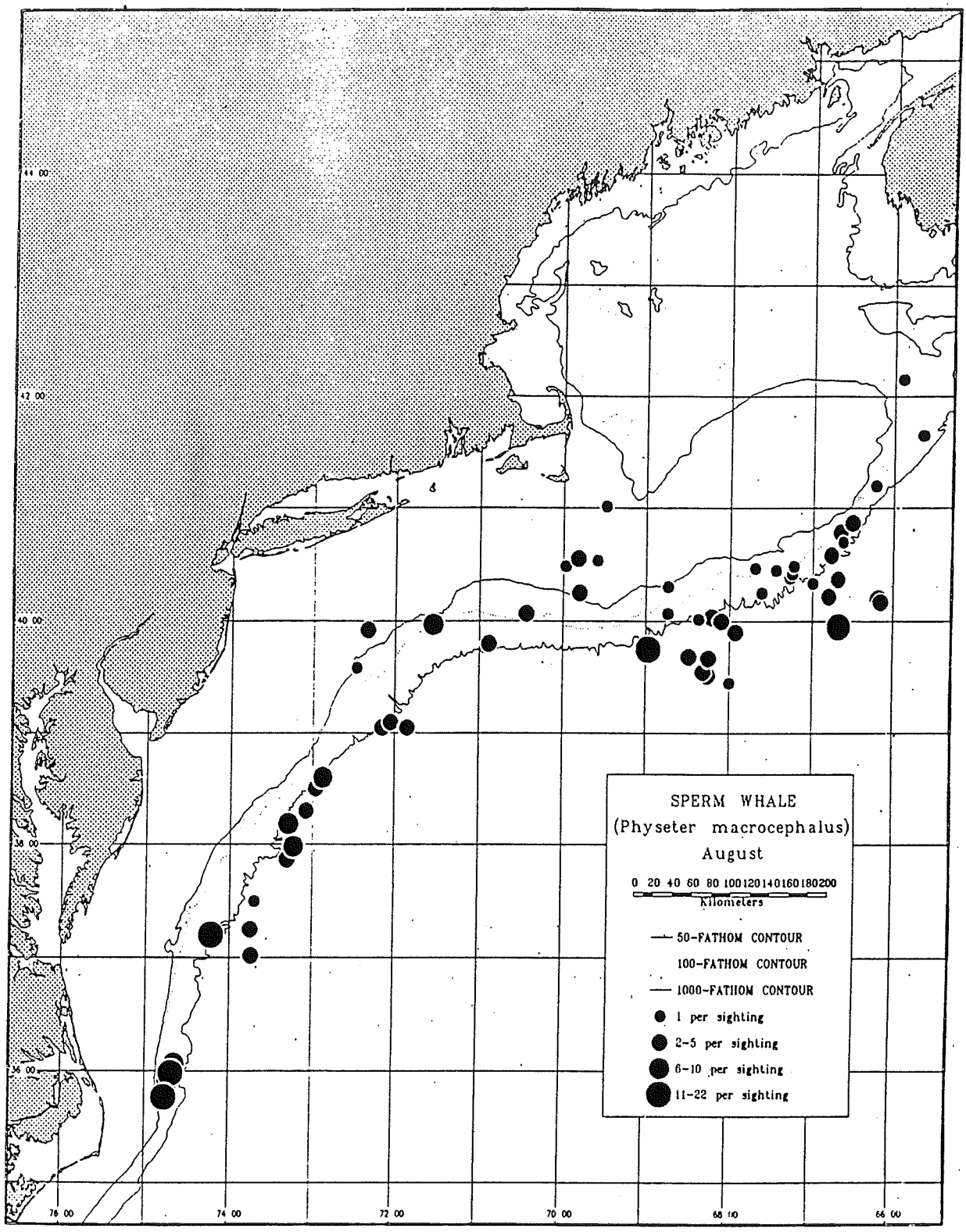

Figure 13e. Distribution of sperm whale Physeter macrocephalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during August, 1978-1988.

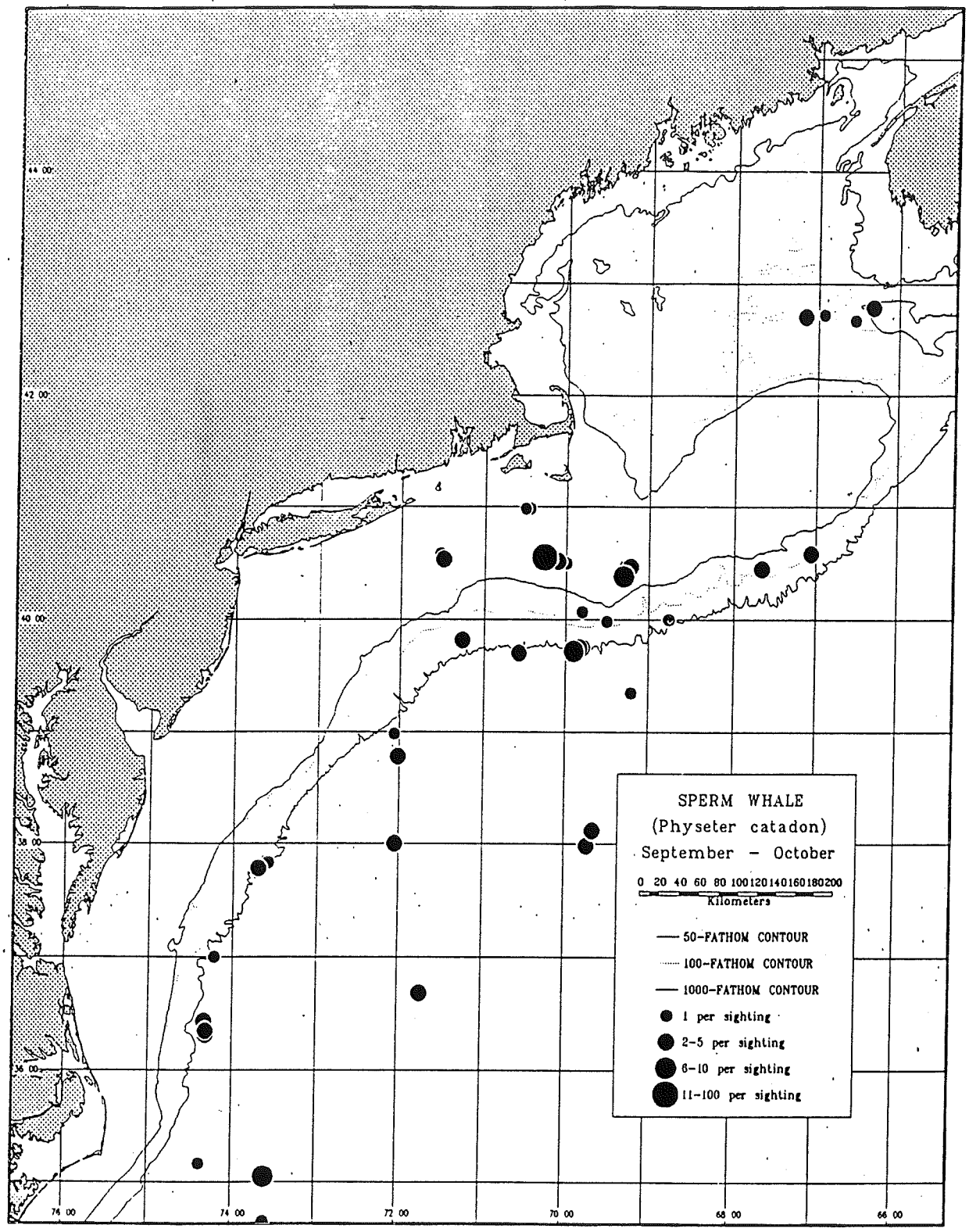

Figure 13f. Distribution of sperm whale Physeter macrocephalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

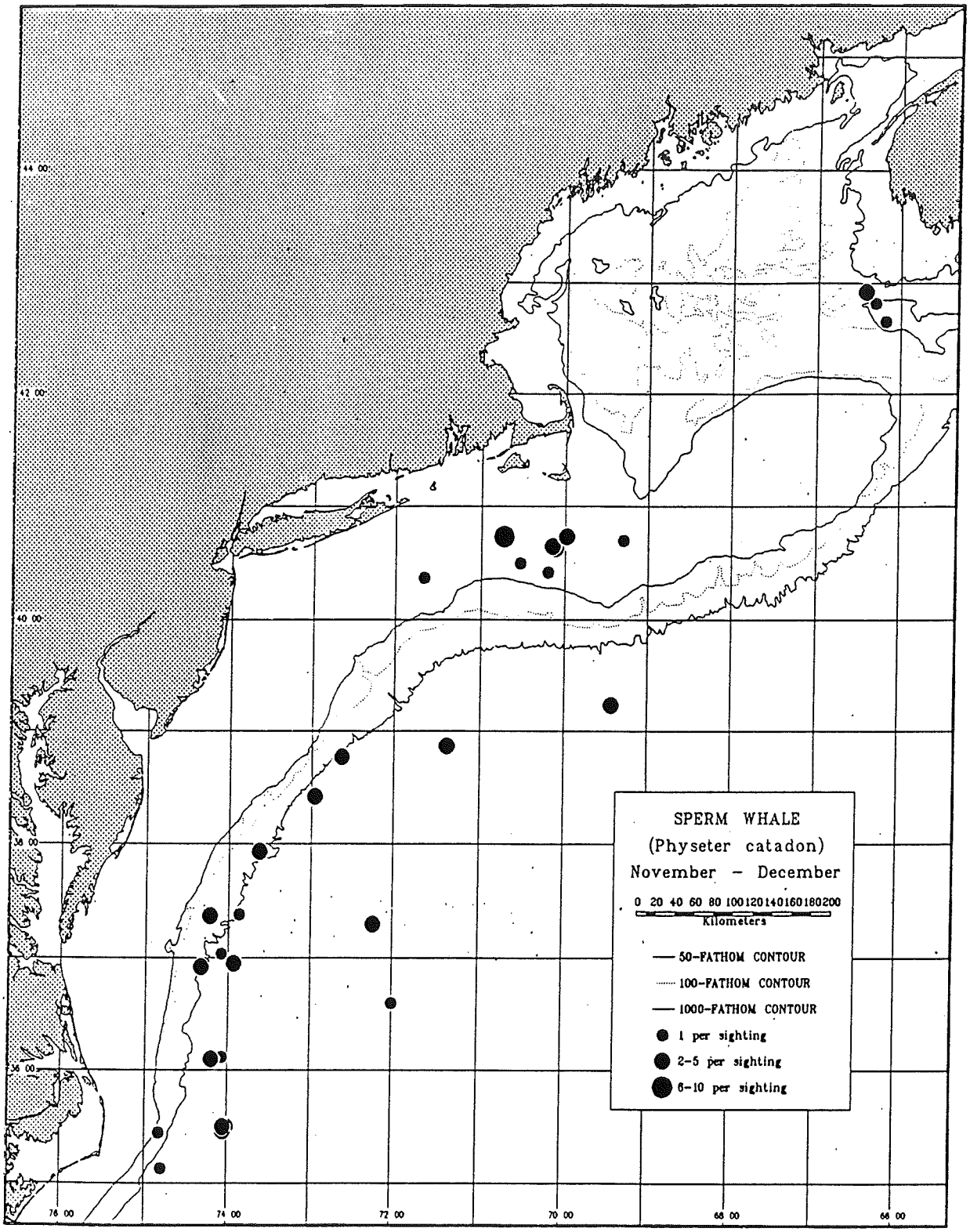

Figure 13g. Distribution of sperm whale Physeter macrocephalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

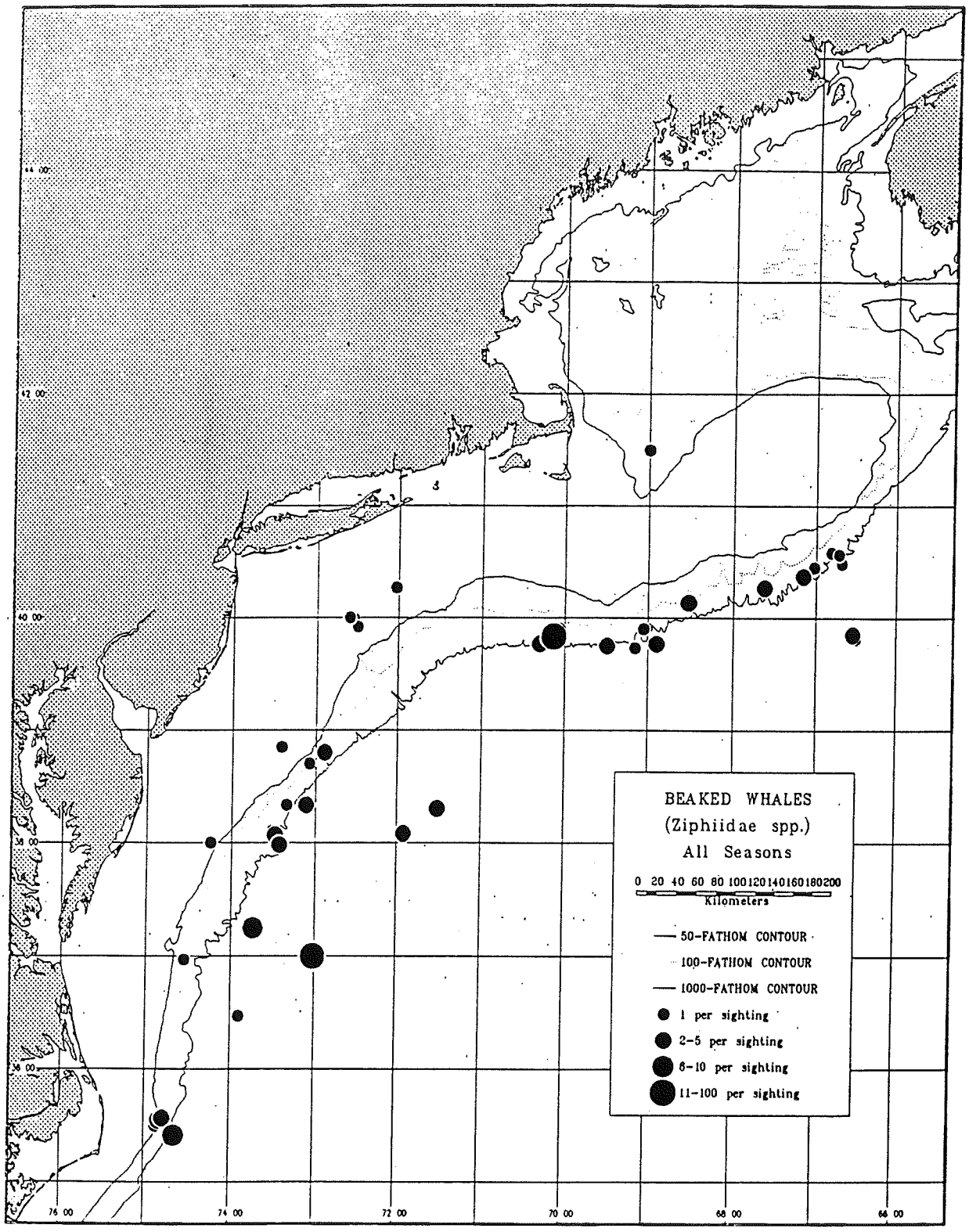

Figure 14. Distribution of beaked whale Ziphiidae spp. sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

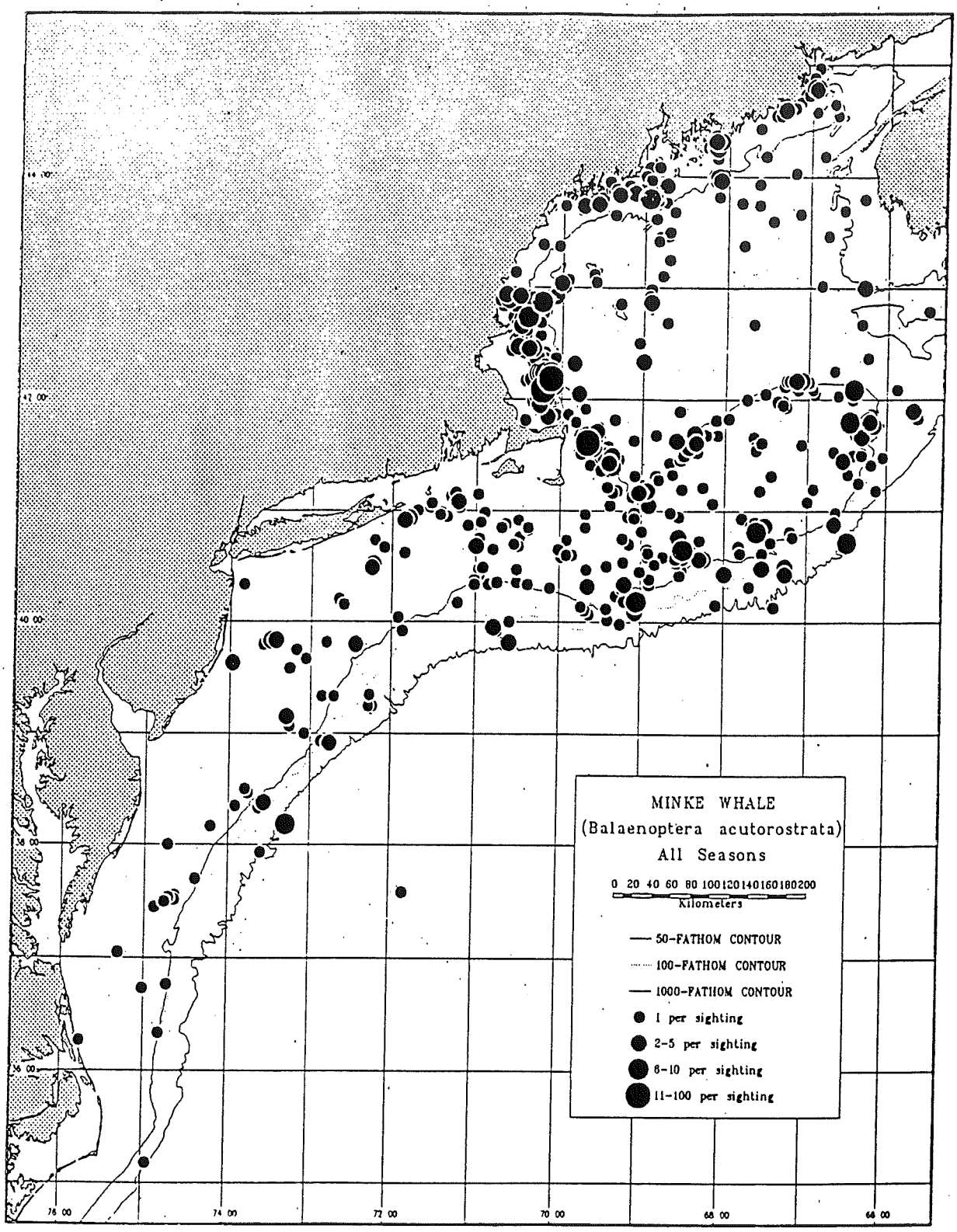

Figure 15. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

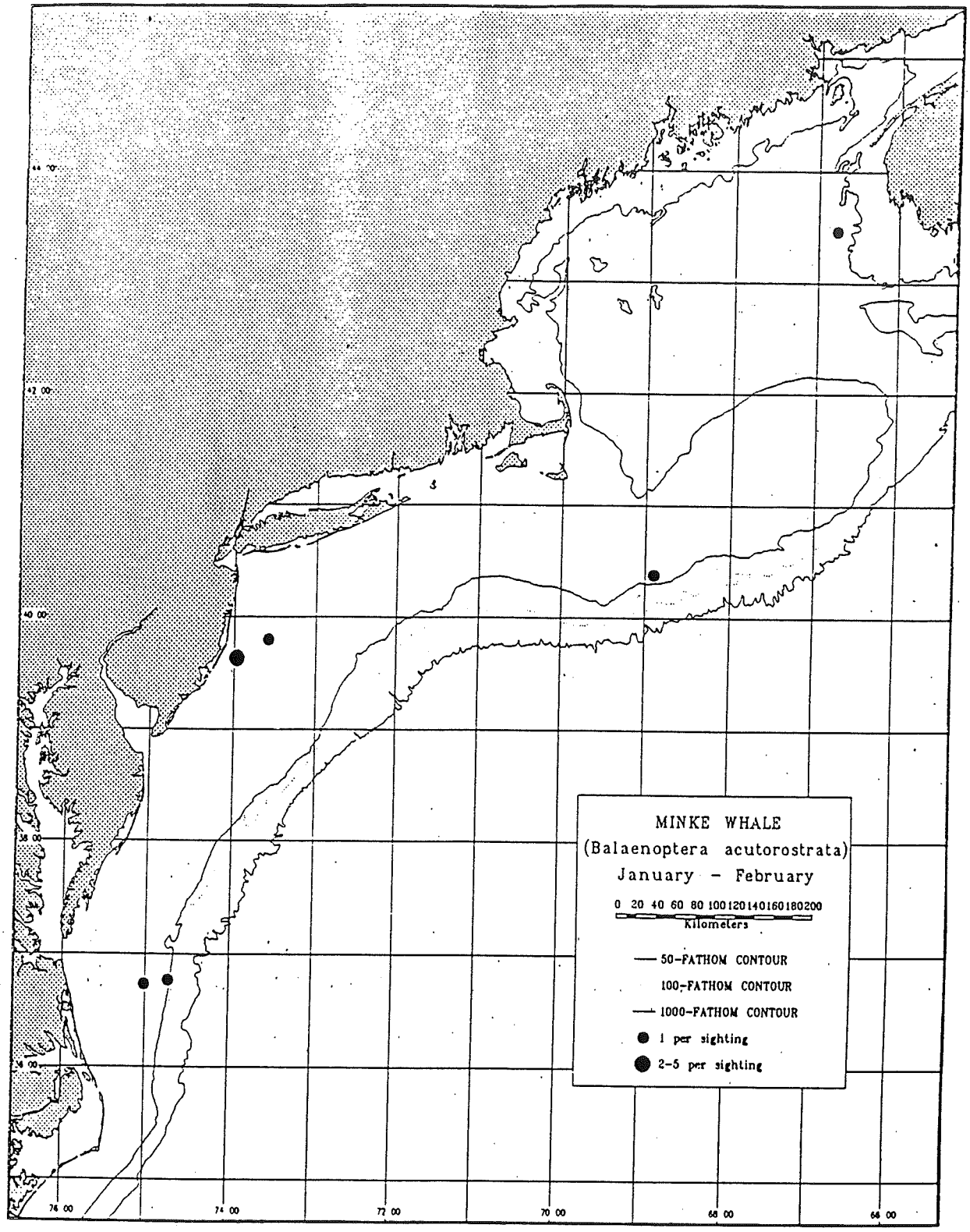

Figure 15a. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

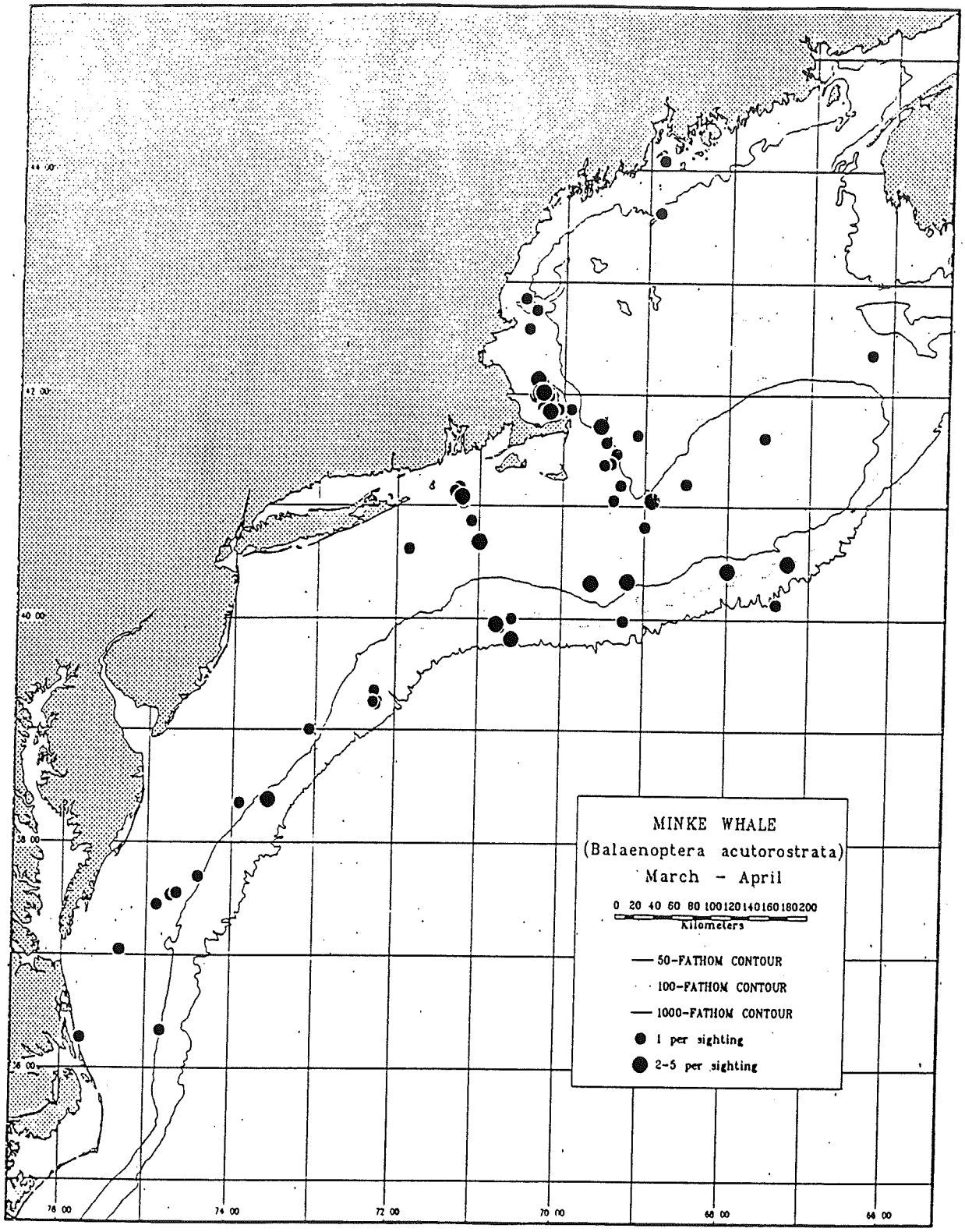

Figure 15b. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

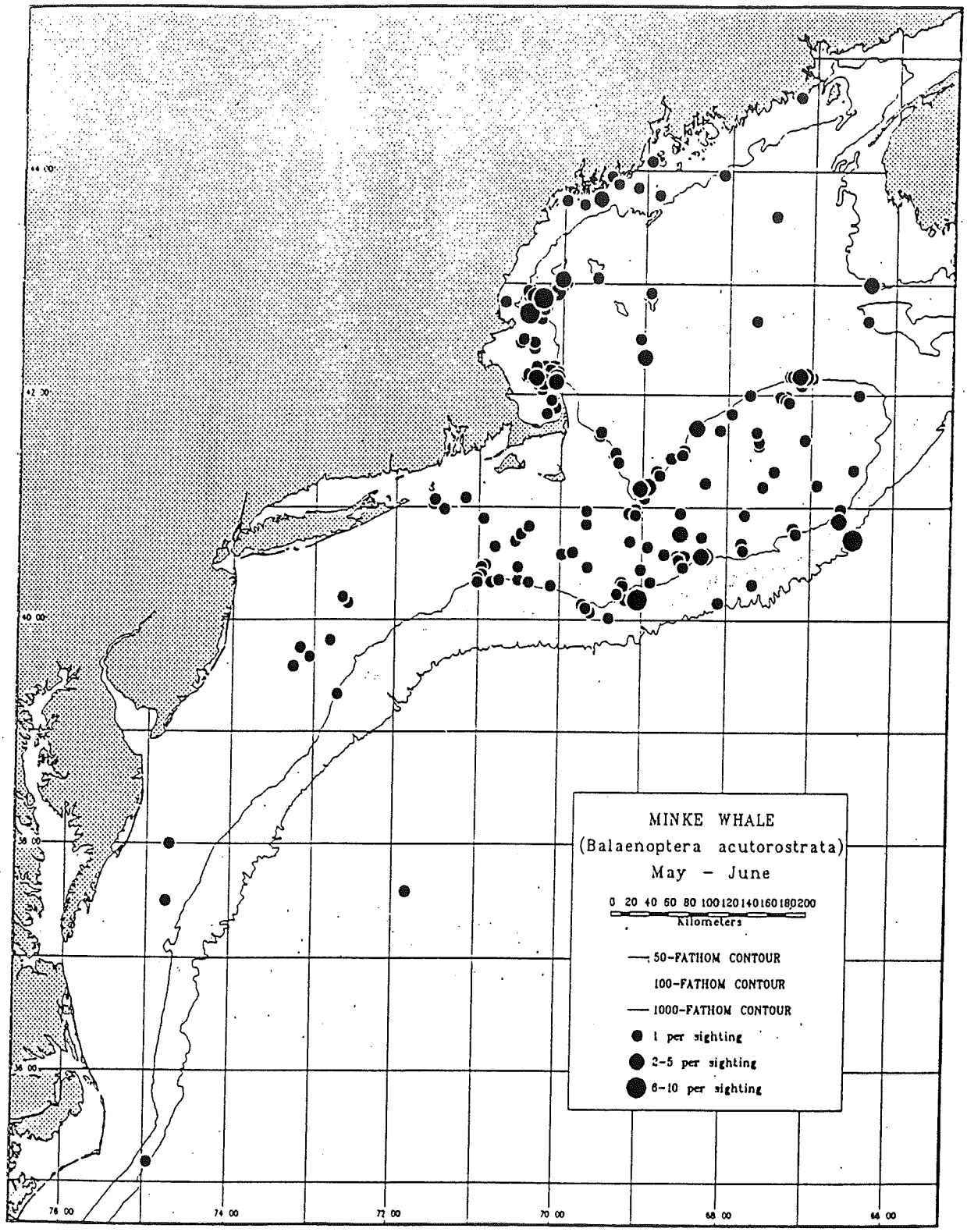

Figure 15c. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

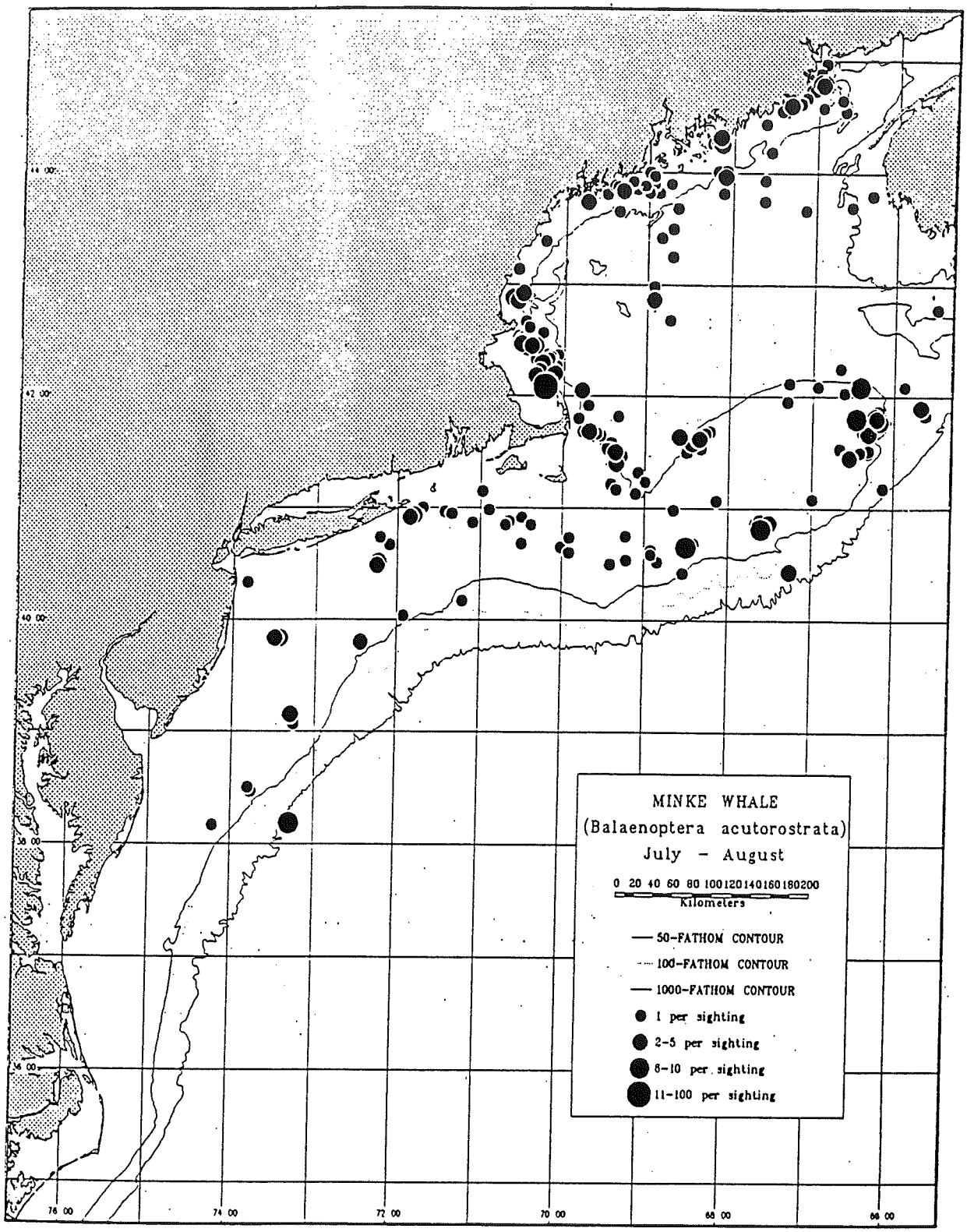

Figure 15d. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

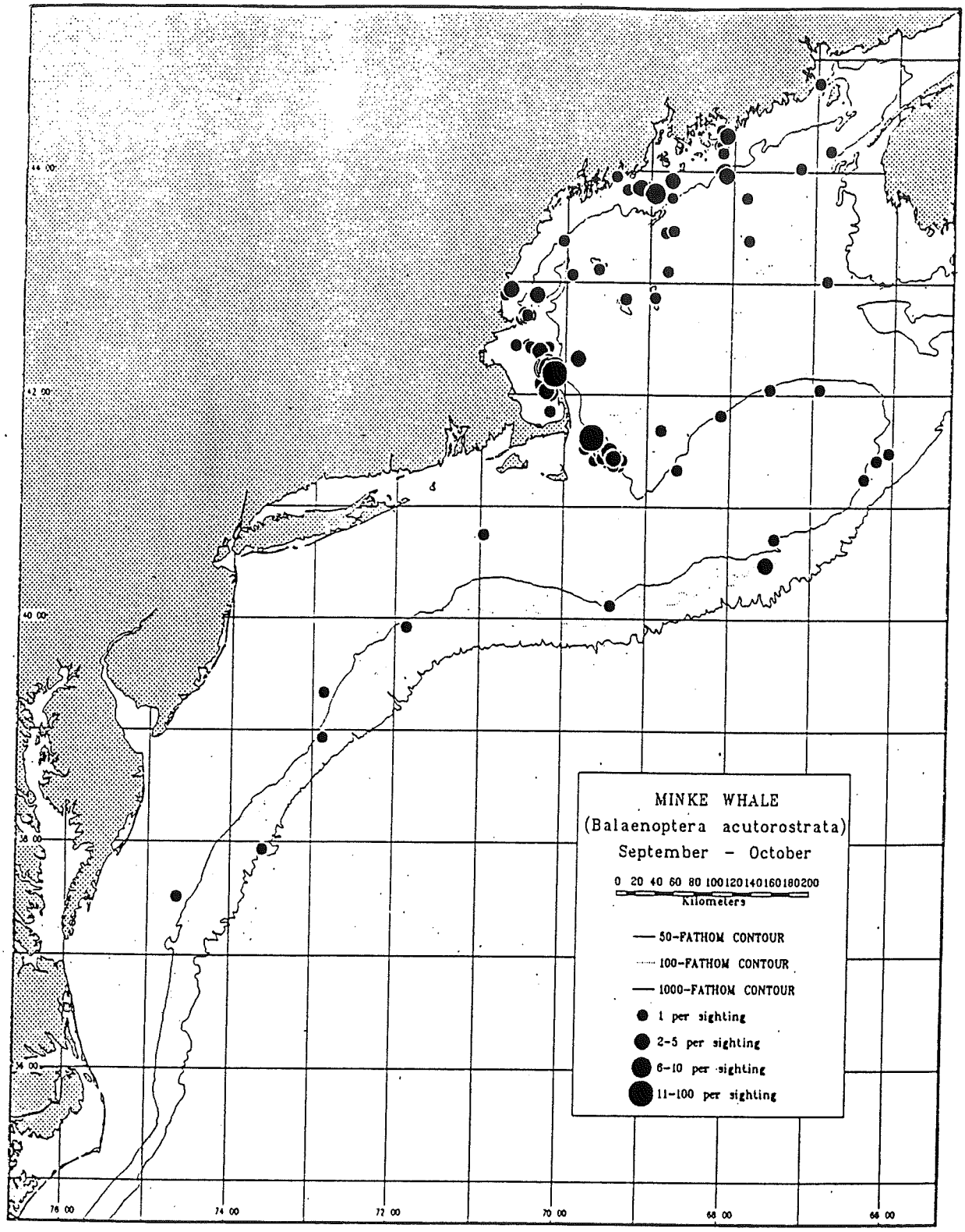

Figure 15e. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

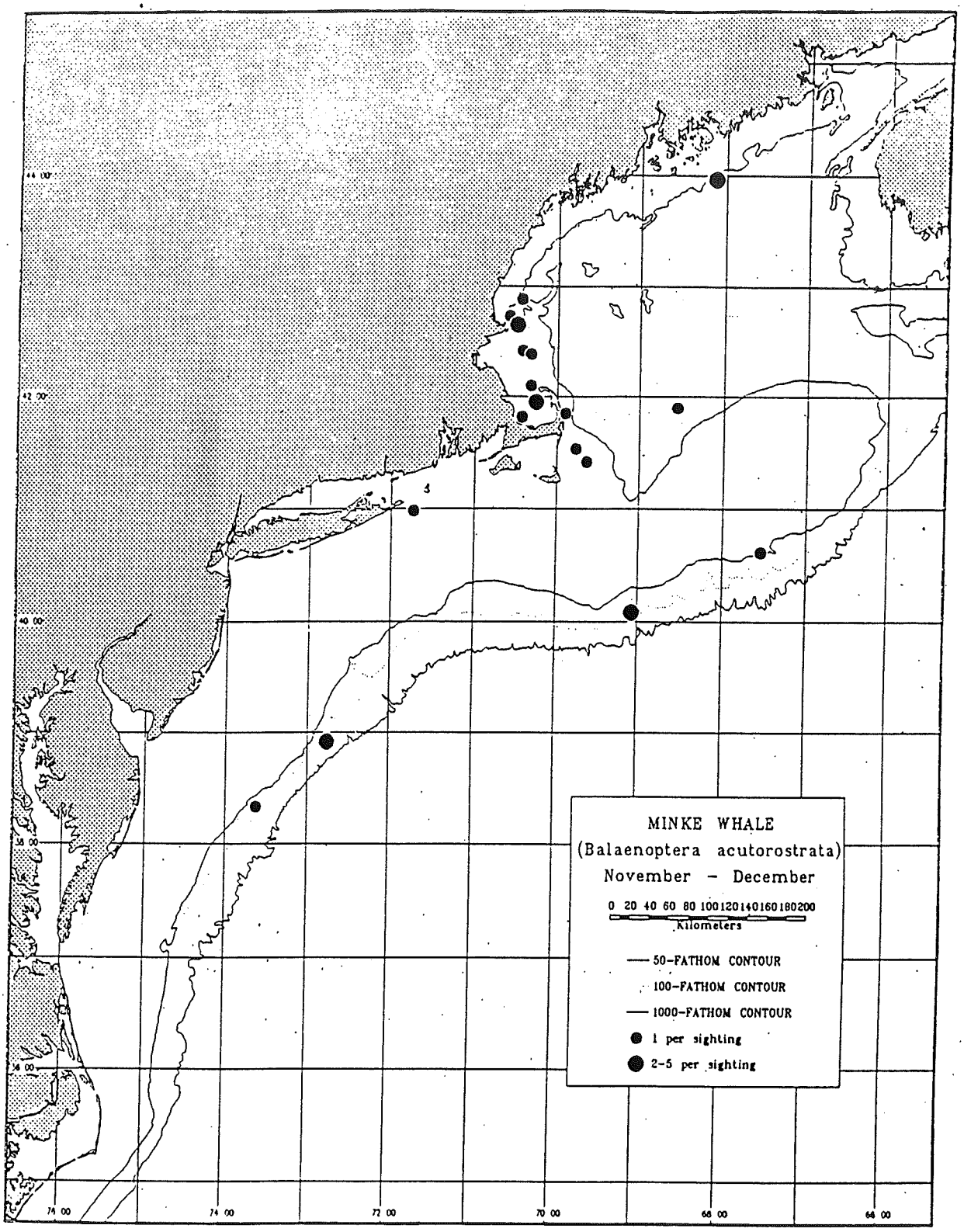

Figure 15f. Distribution of minke whale Balaenoptera acutorostrata sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

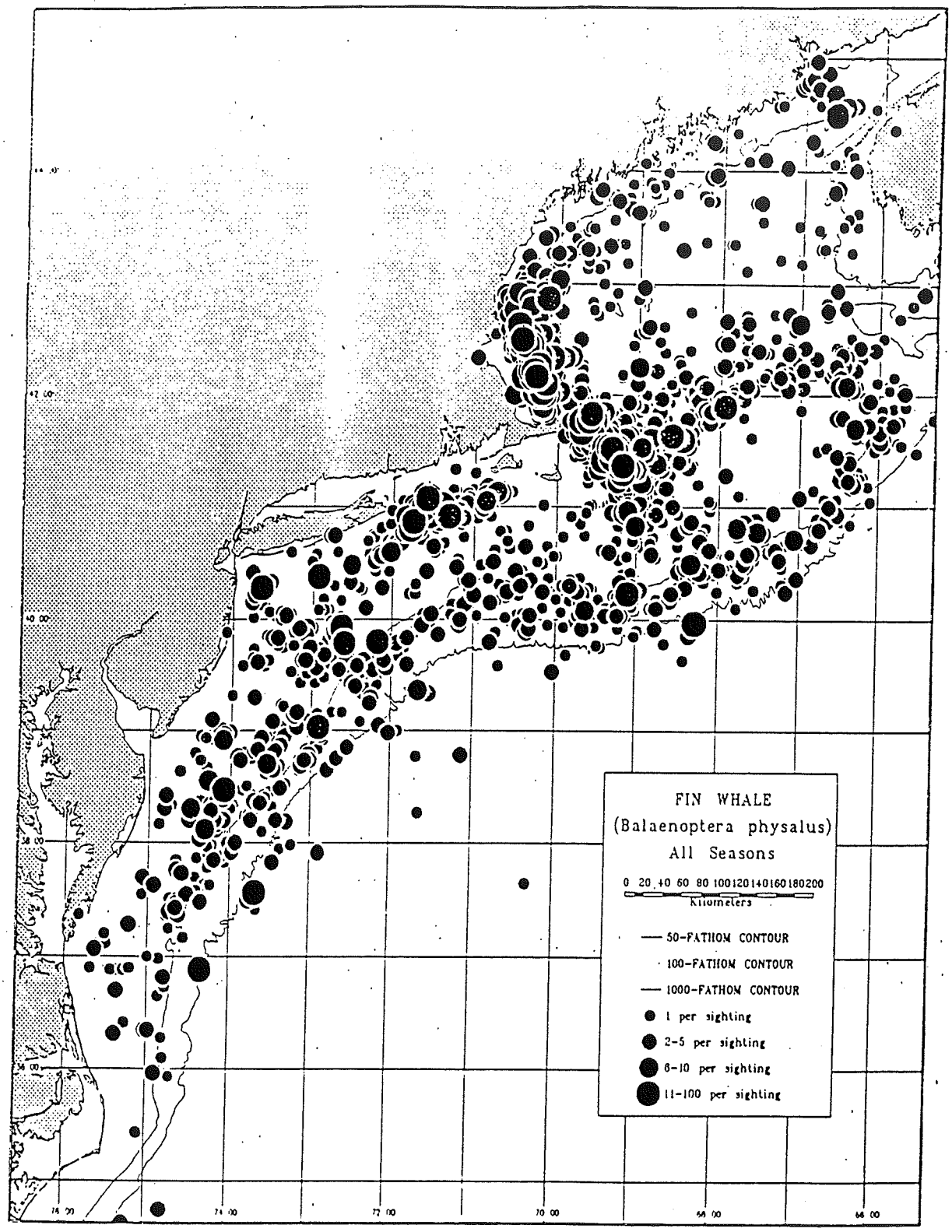

Figure 16. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

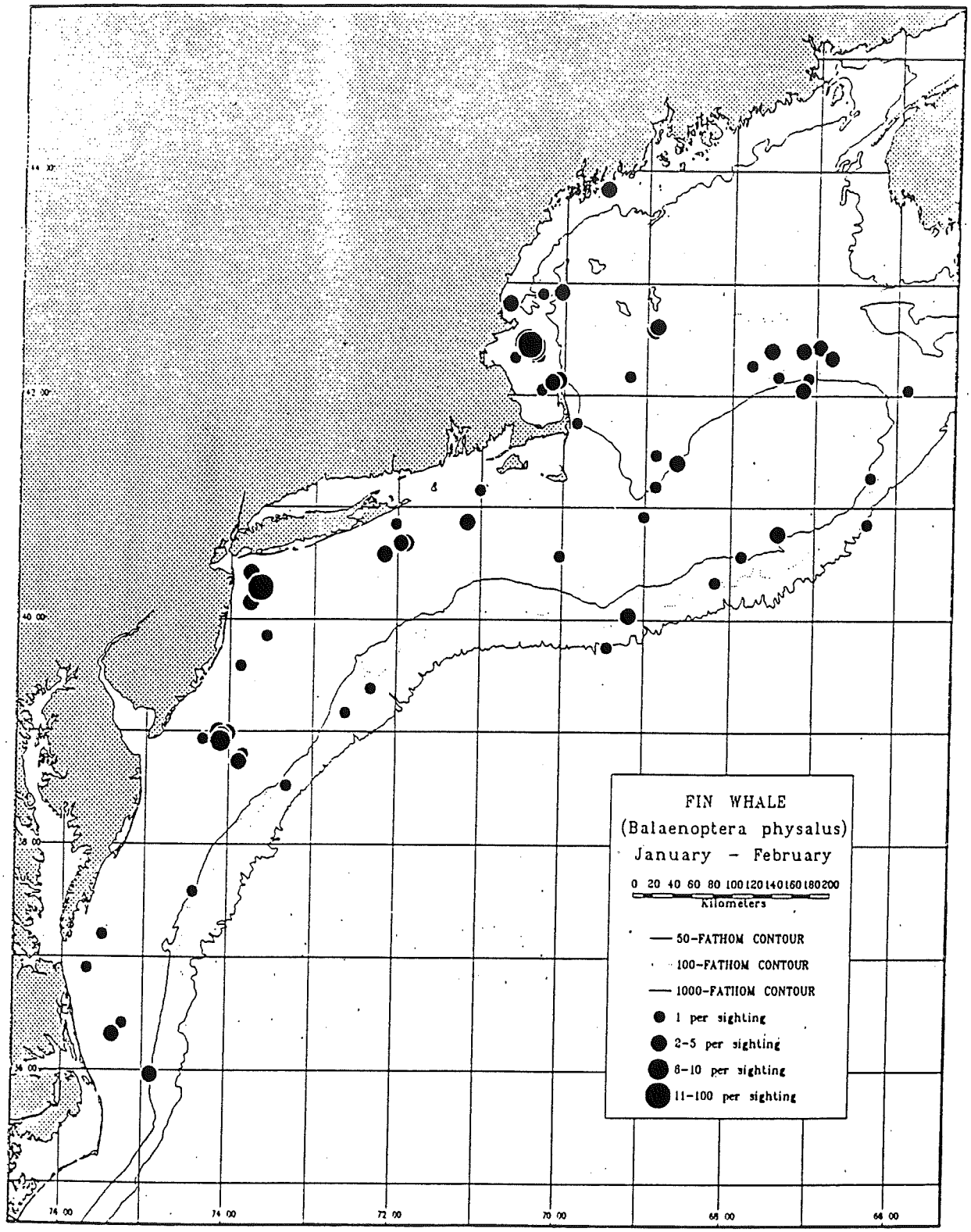

Figure 16a. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

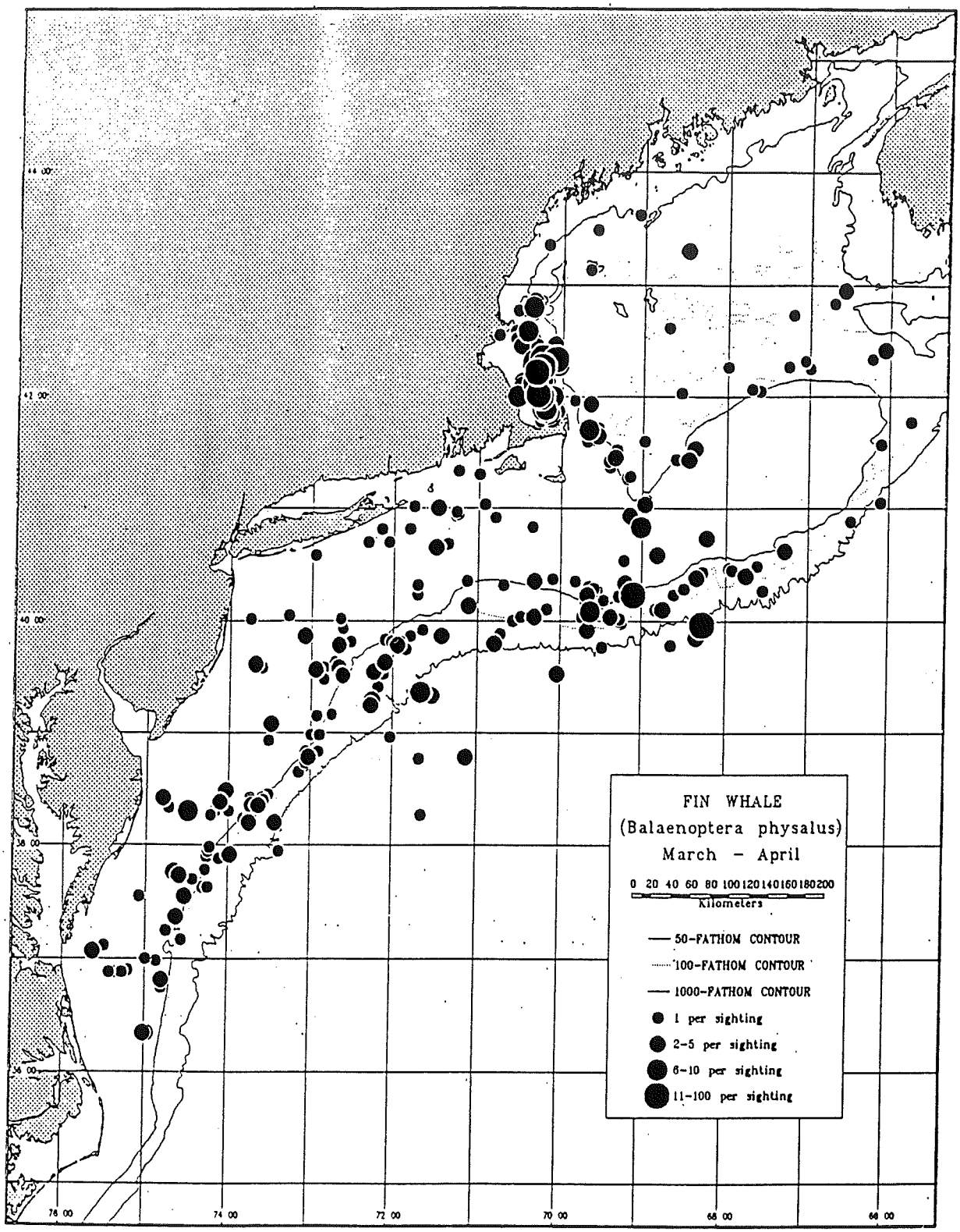

Figure 16b. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

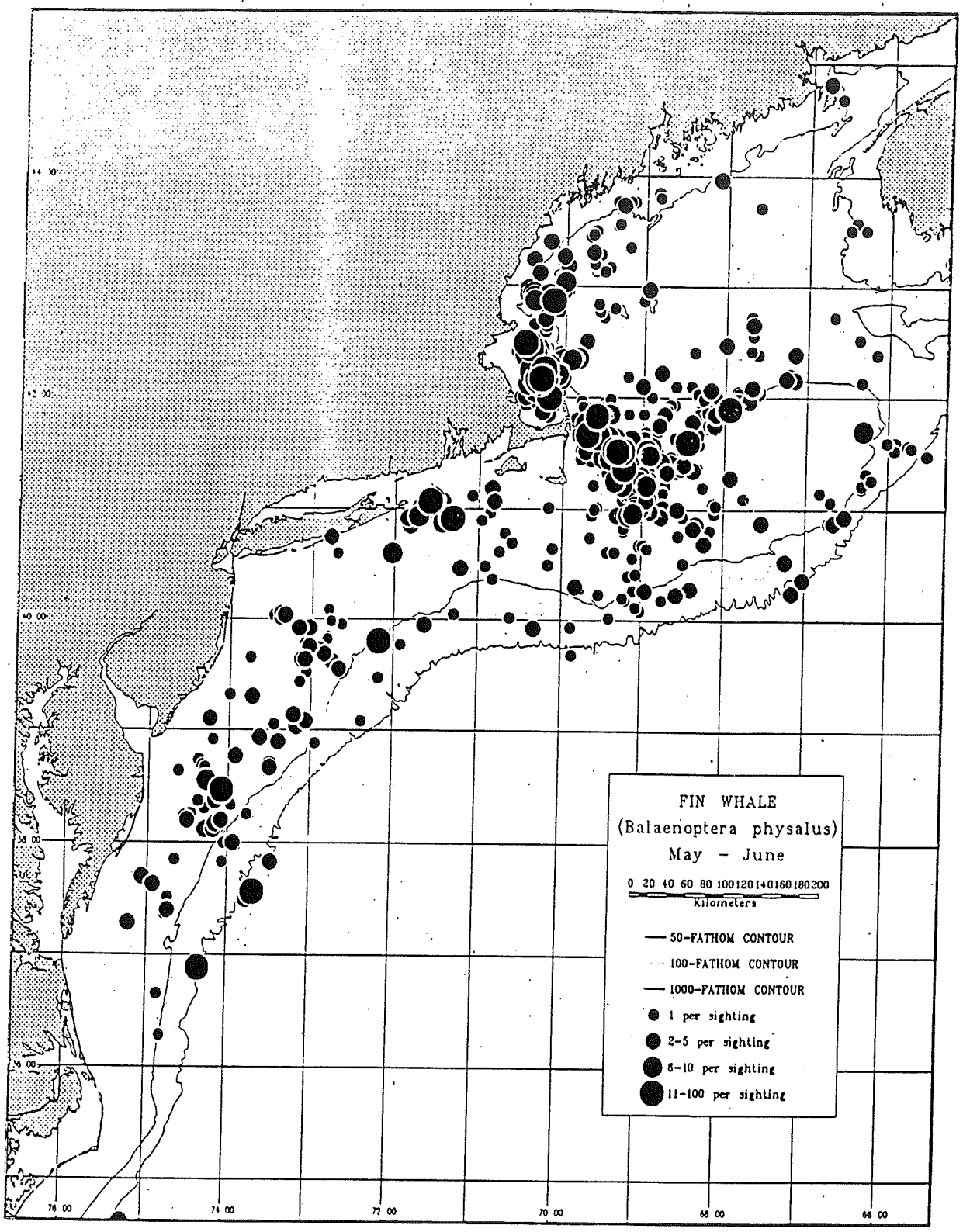

Figure 16c. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

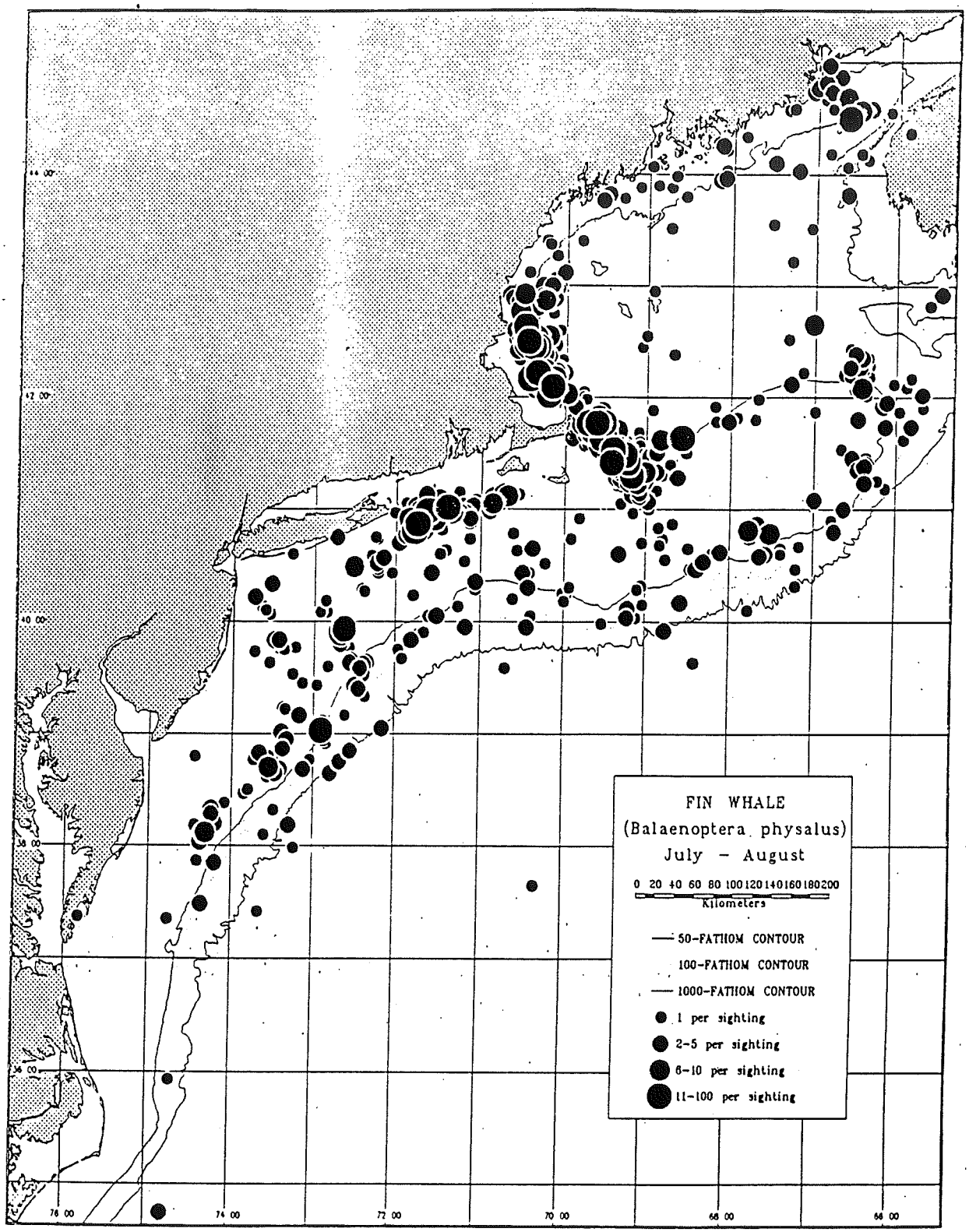

Figure 16d. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

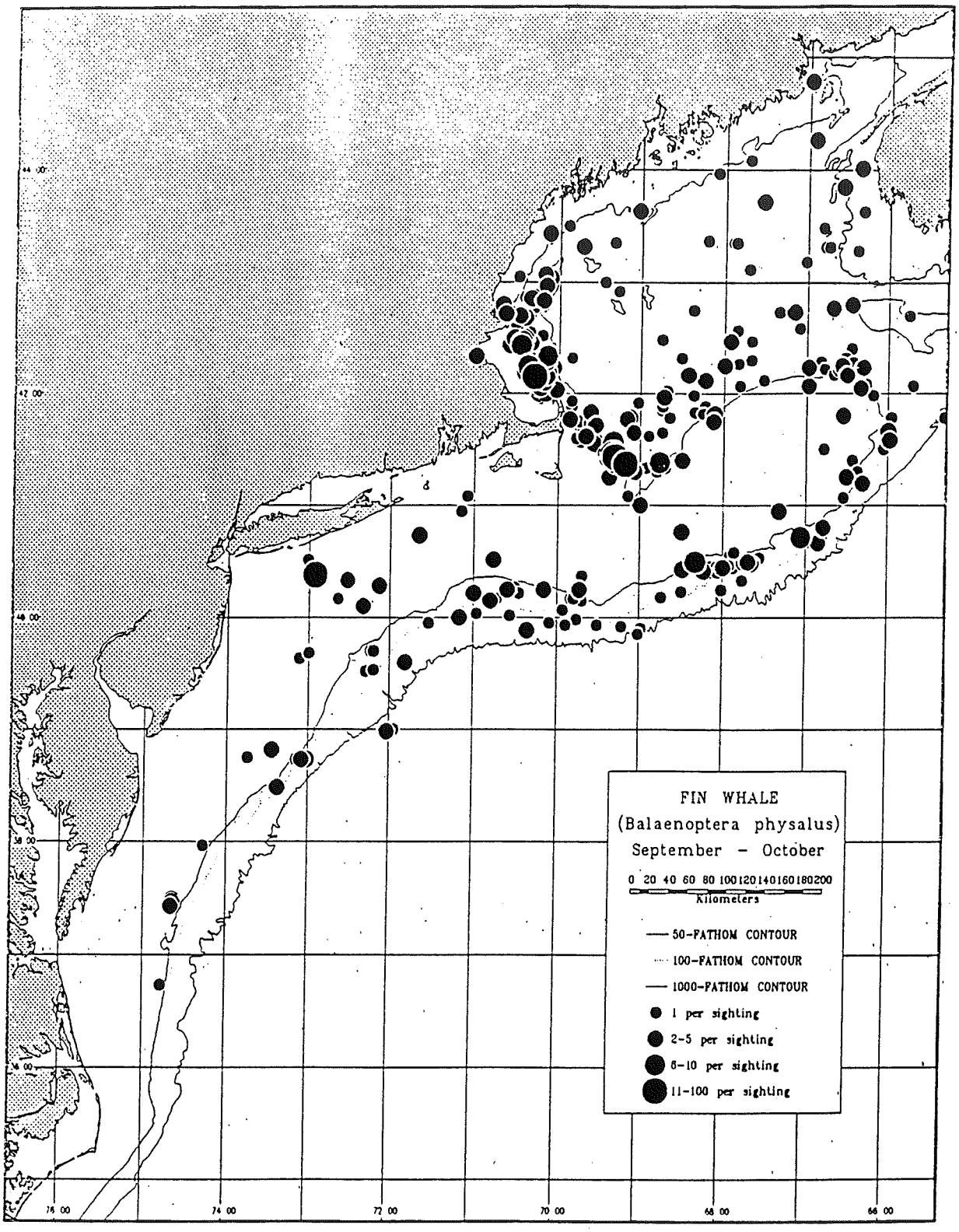

Figure 16e. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

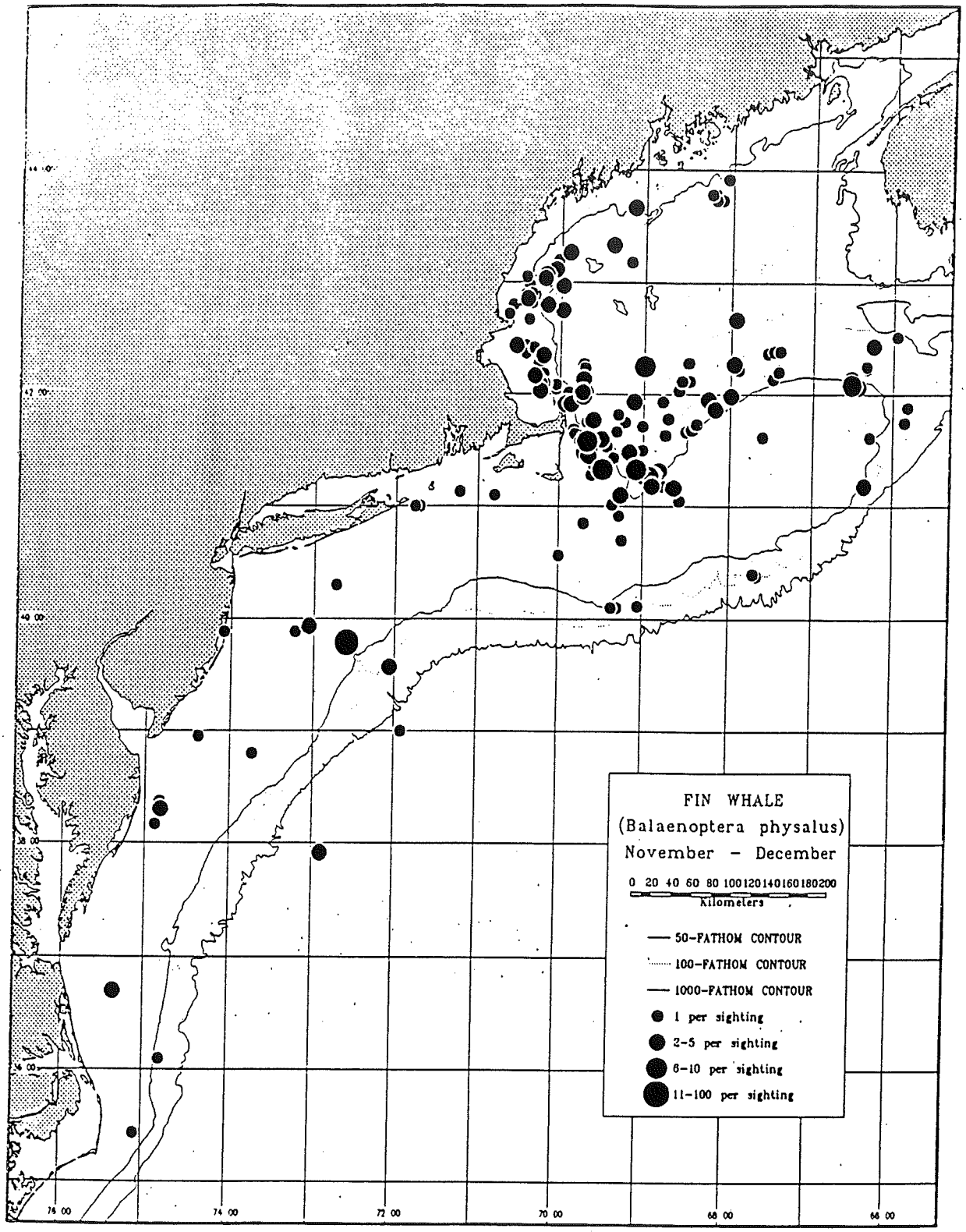

Figure 16f. Distribution of fin whale Balaenoptera physalus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

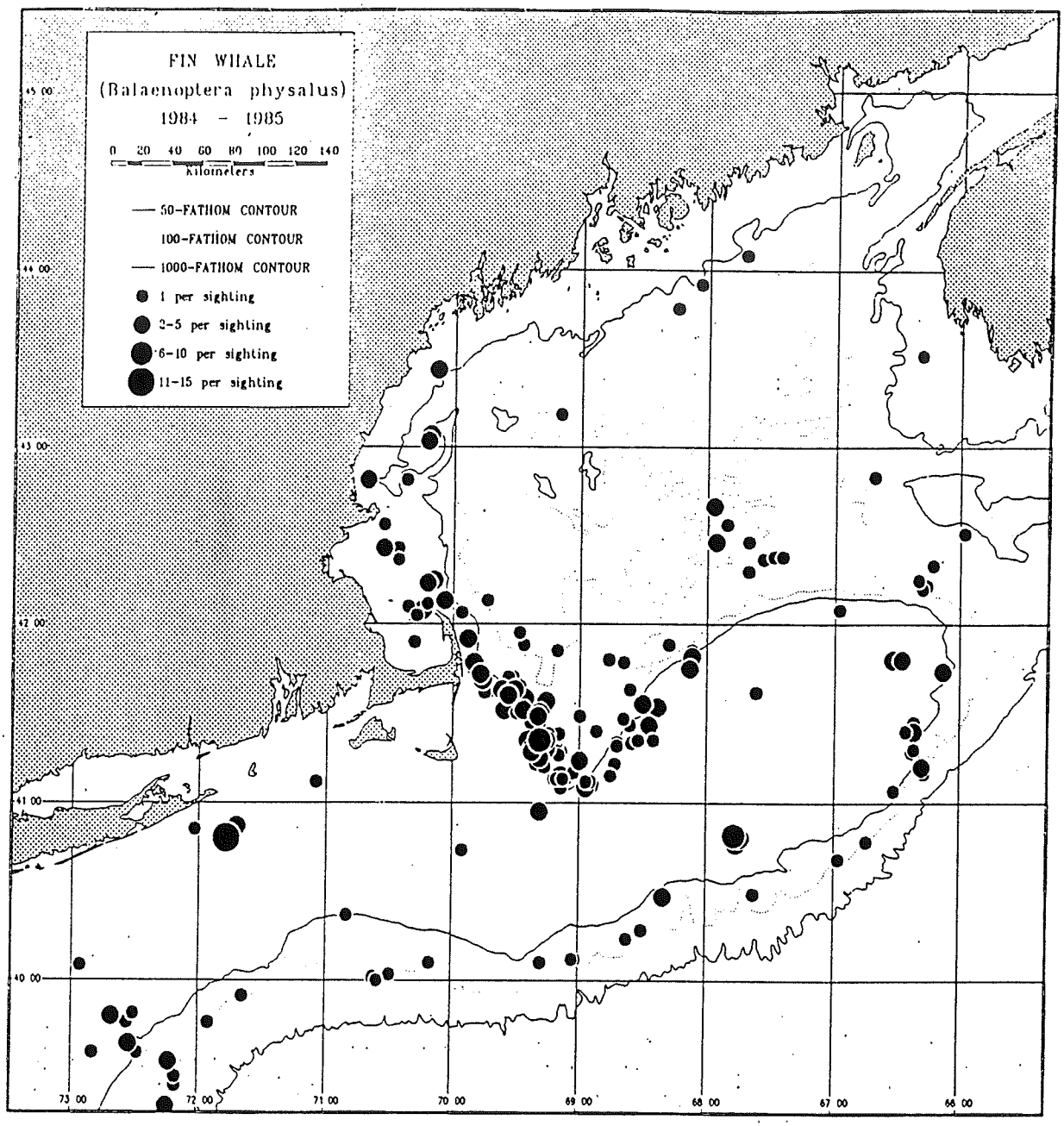

Figure 16g. Distribution of fin whale Balaenoptera physalus sightings during shipboard surveys, for all seasons 1984-1985, in shelf waters of the southwest/ south Gulf of Maine and the Great South Channel regions.

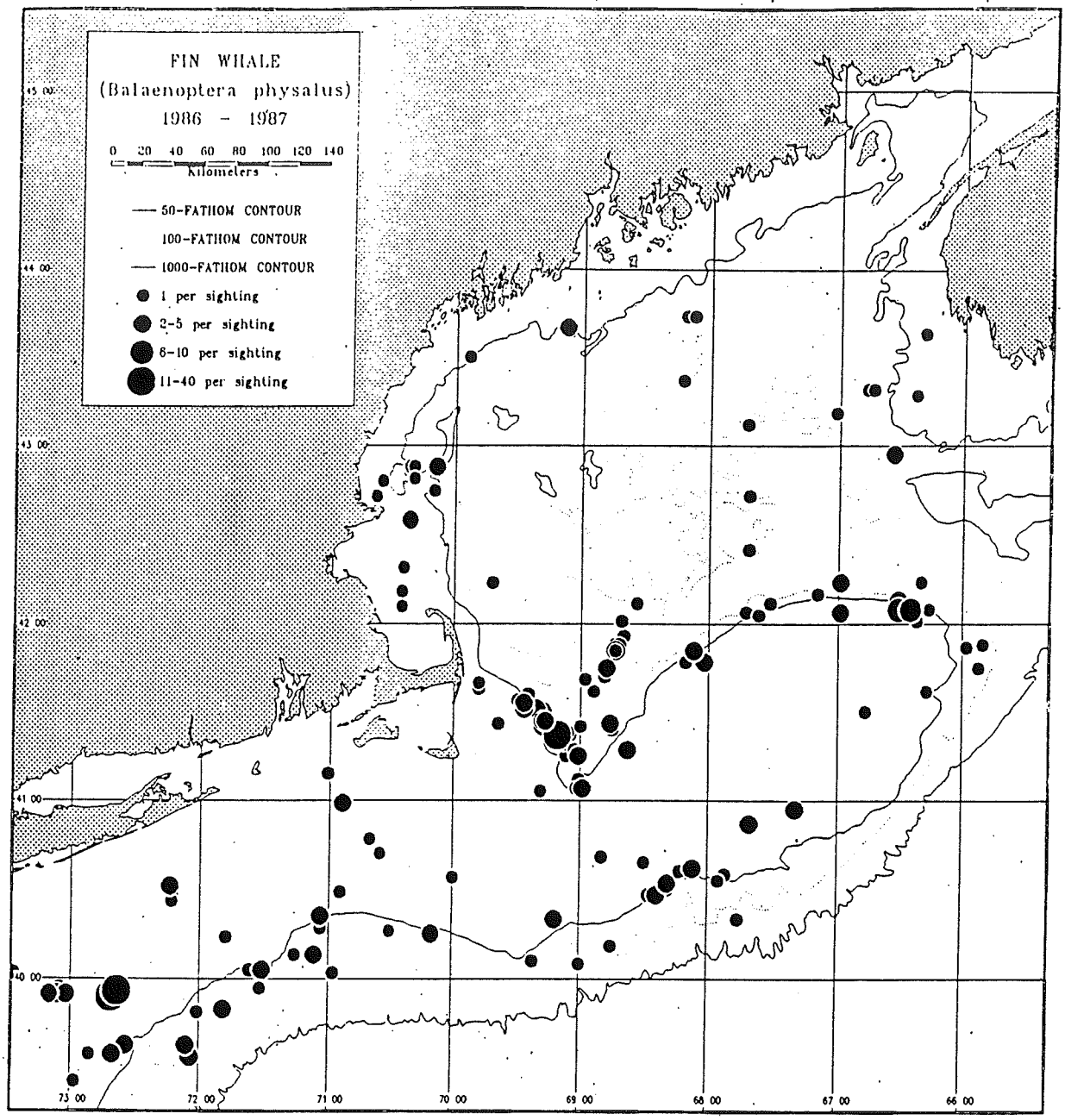

Figure 16h. Distribution of fin whale Balaenoptera physalus sightings during shipboard surveys, for all seasons 1986-1987, in shelf waters of the southwest/ south Gulf of Maine and the Great South Channel regions.

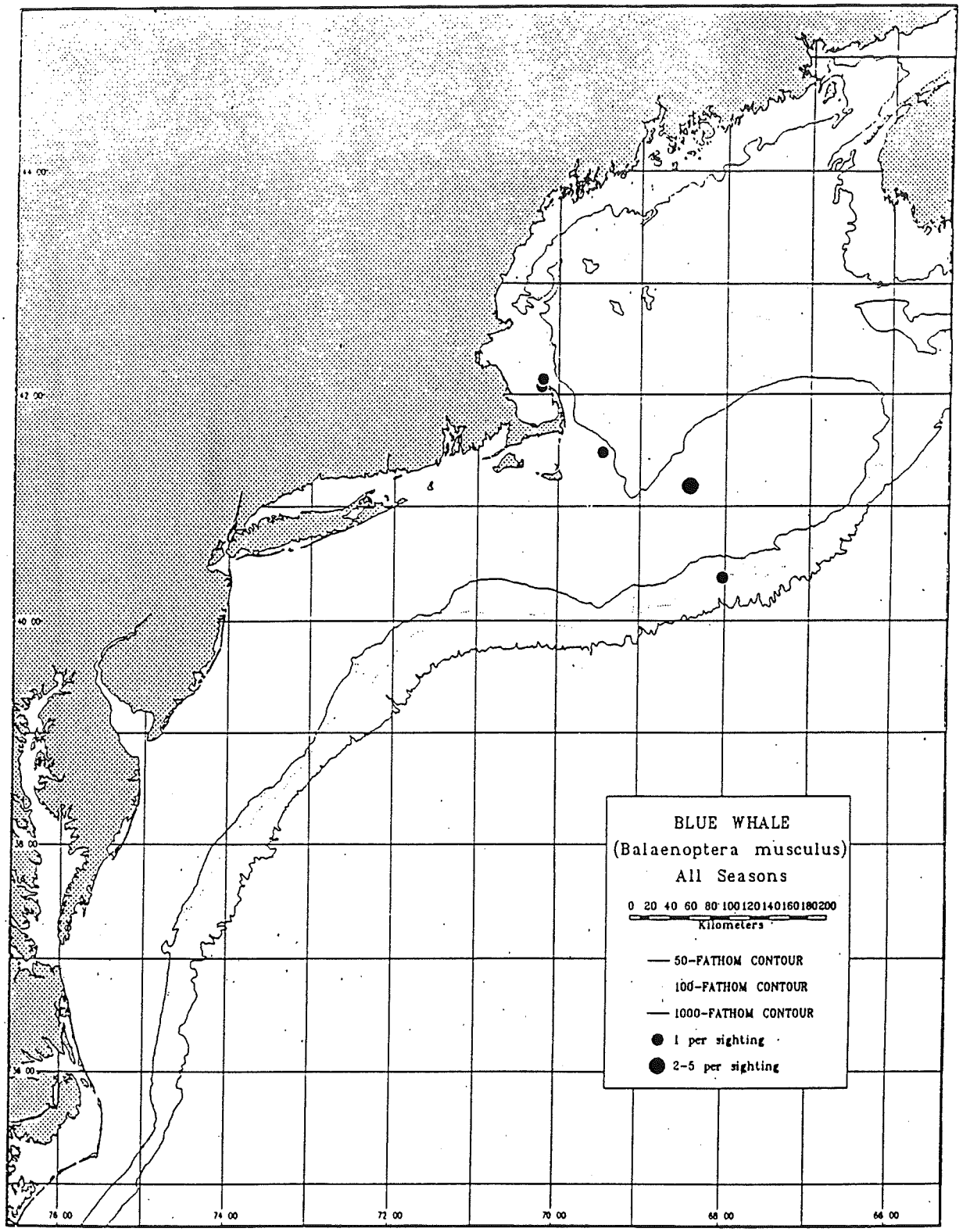

Figure 17. Distribution of blue whale Balaenoptera musculus sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

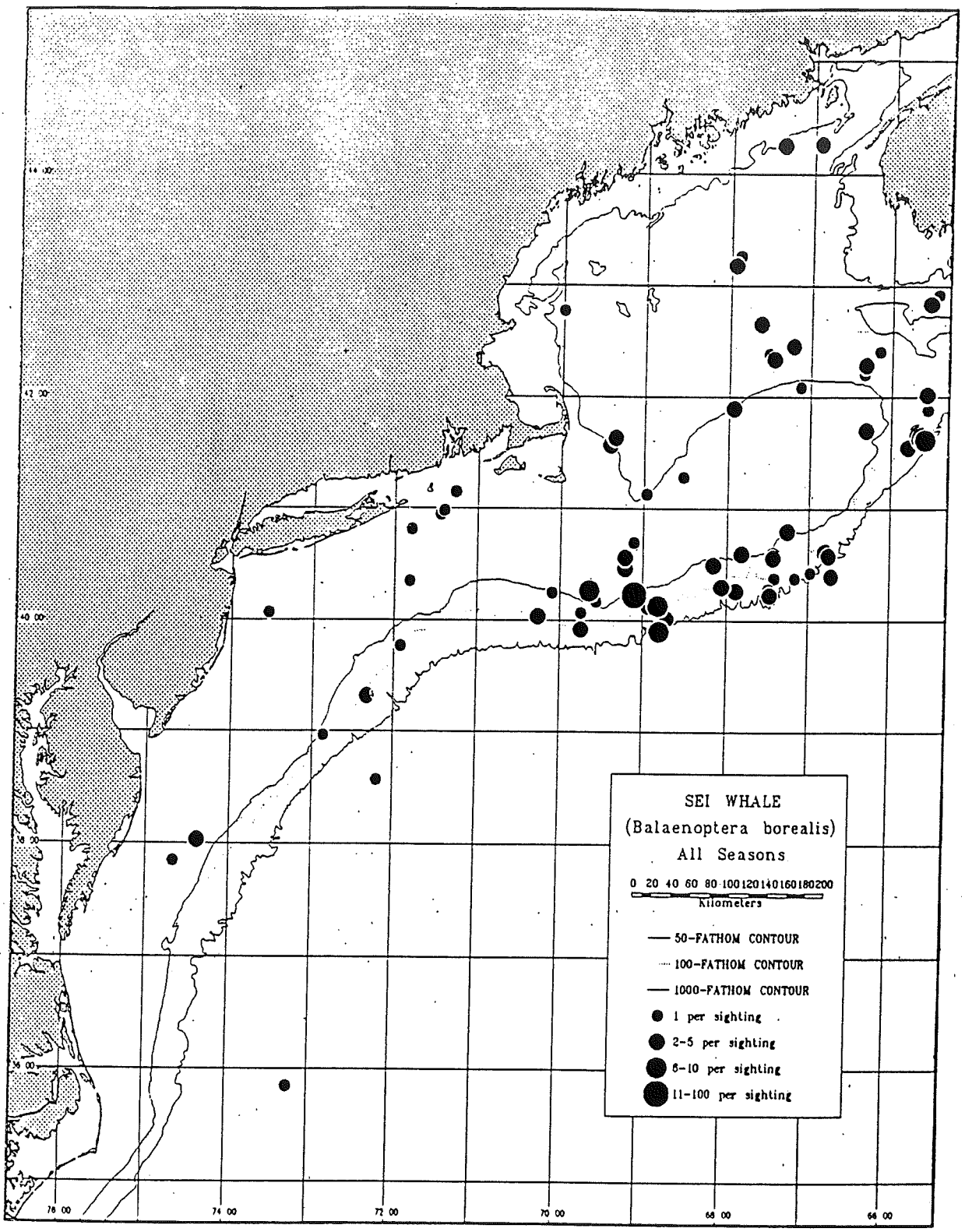

Figure 18. Distribution of sei whale Balaenoptera borealis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

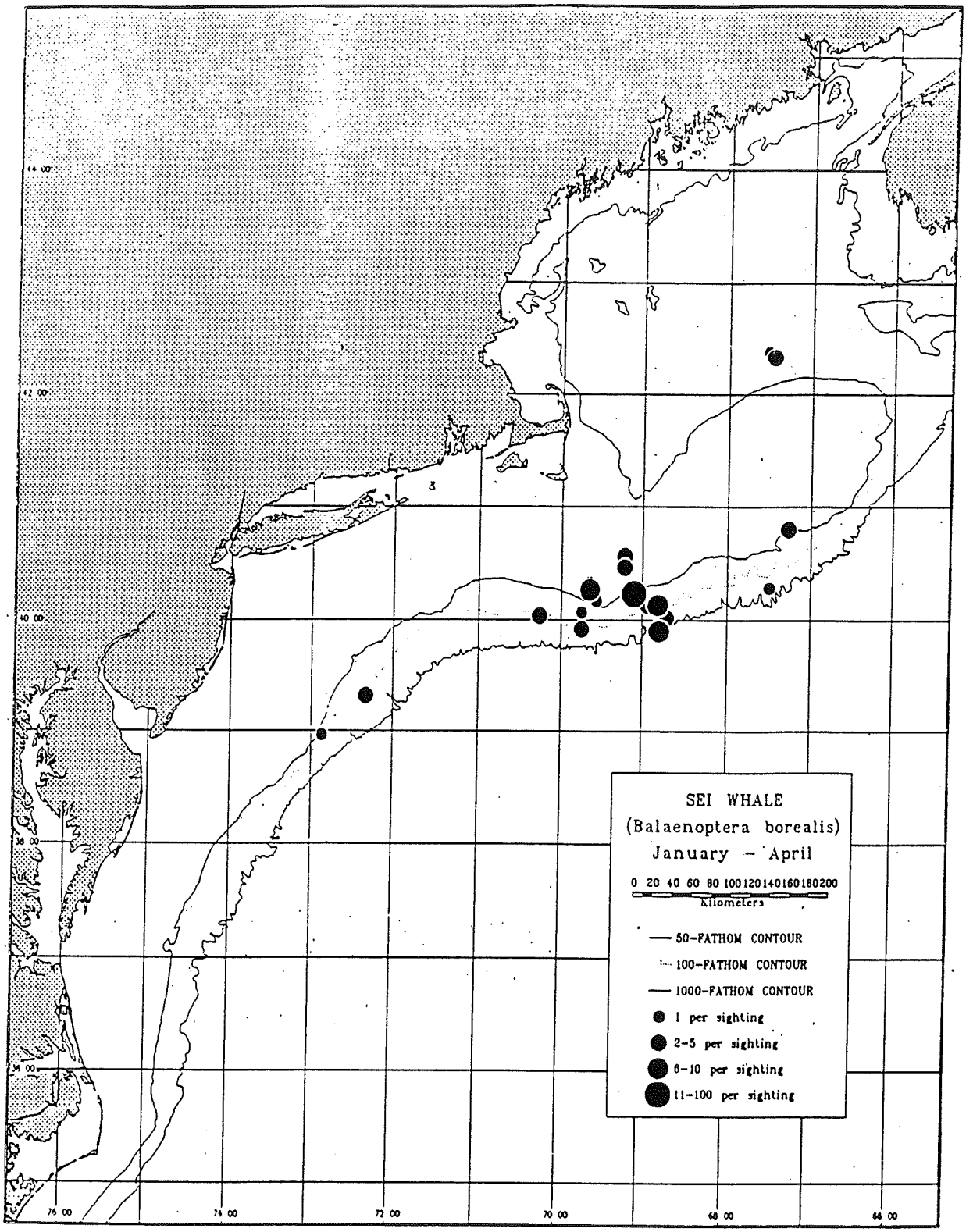

Figure 18a. Distribution of sei whale Balaenoptera borealis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-April, 1978-1988.

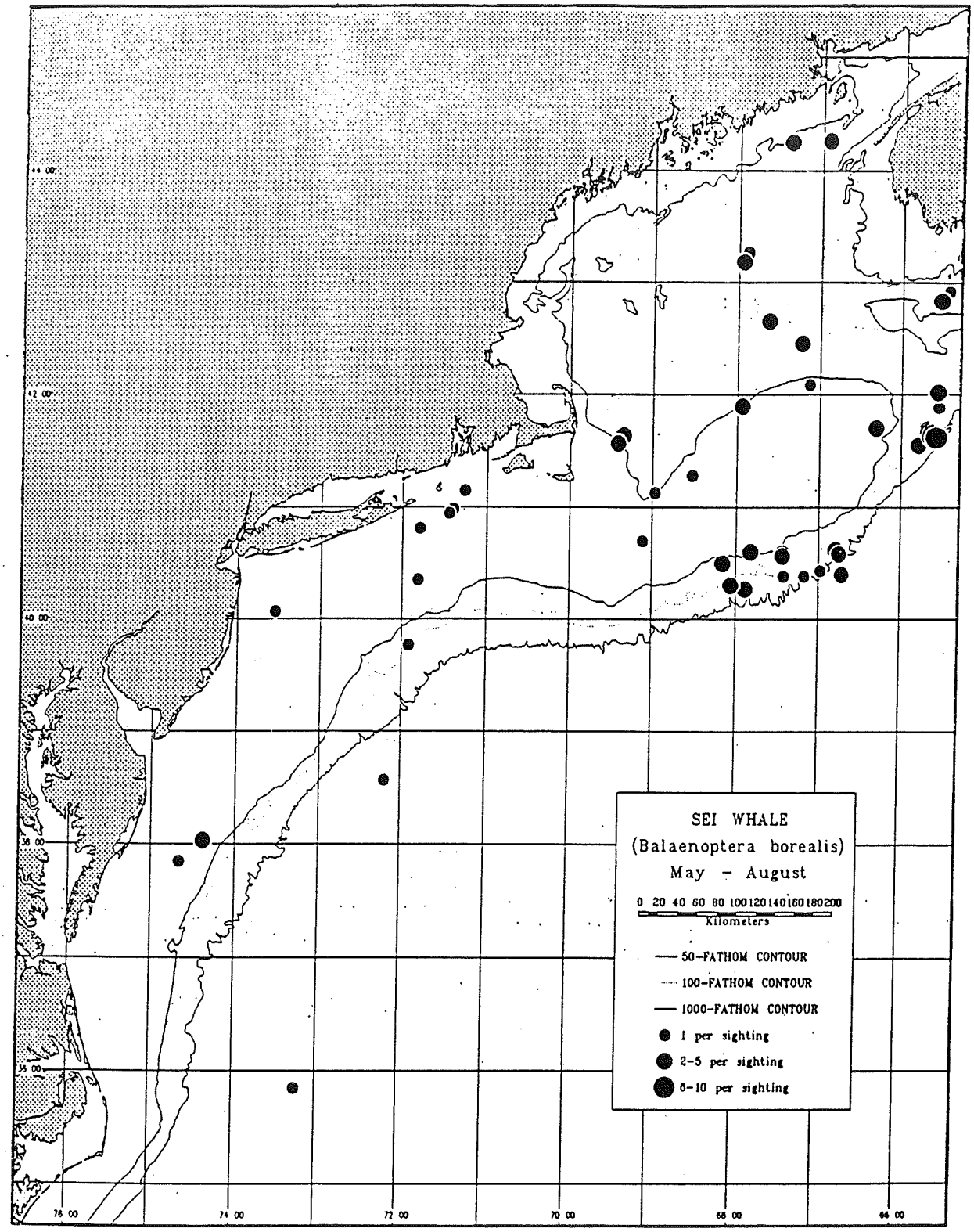

Figure 18b. Distribution of sei whale Balaenoptera borealis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-August, 1978-1988.

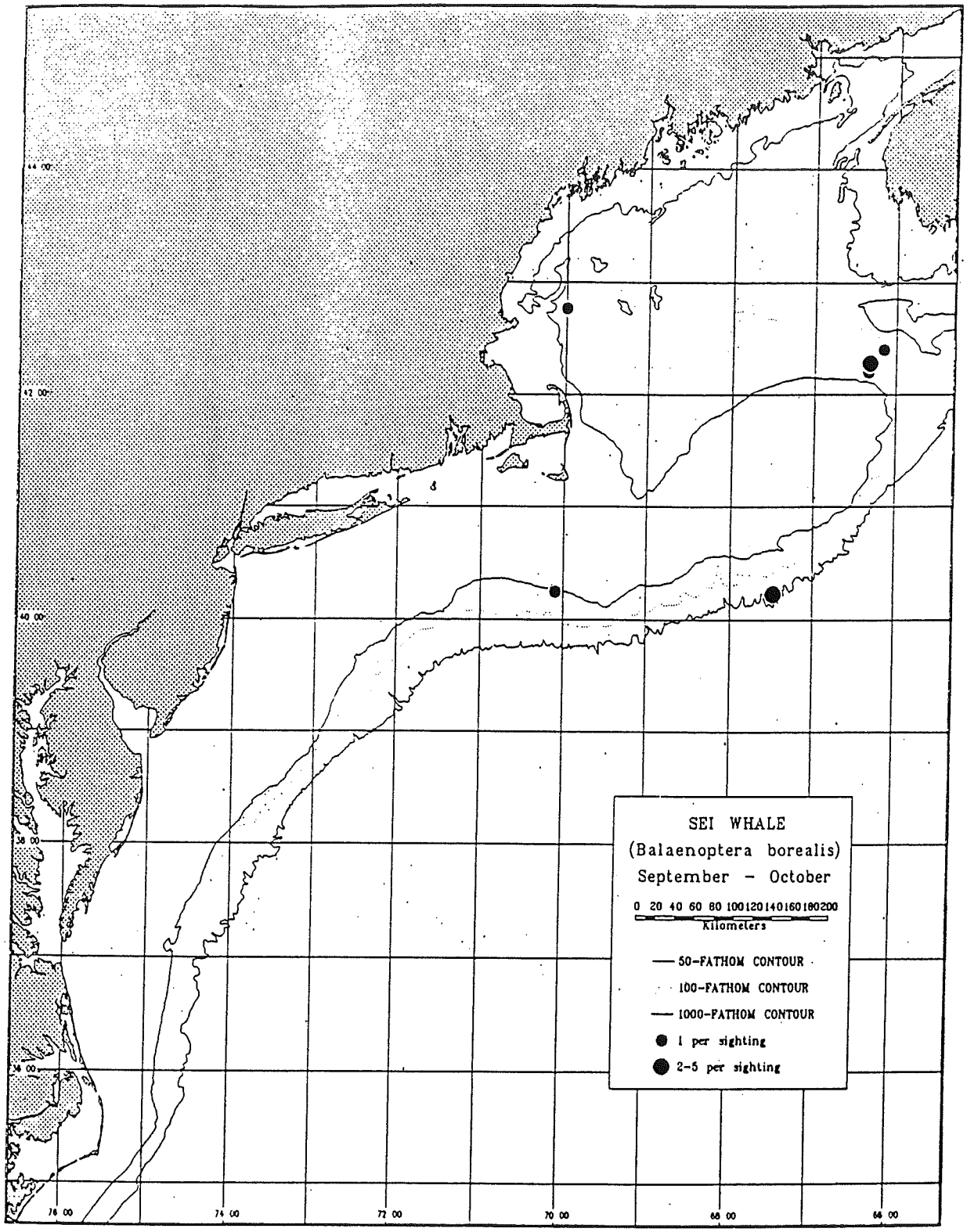

Figure 18c. Distribution of sei whale Balaenoptera borealis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-December, 1978-1988.

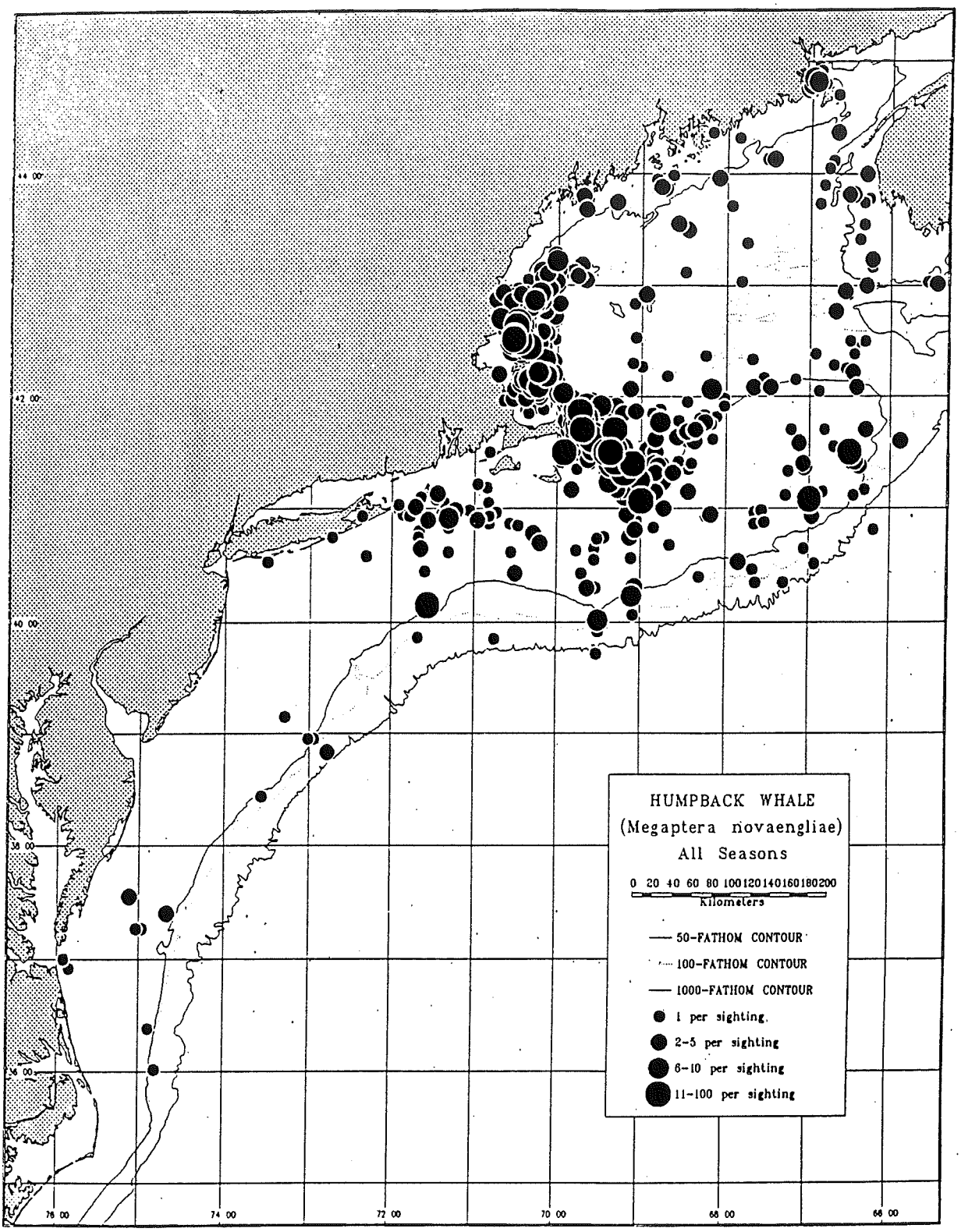

Figure 19. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

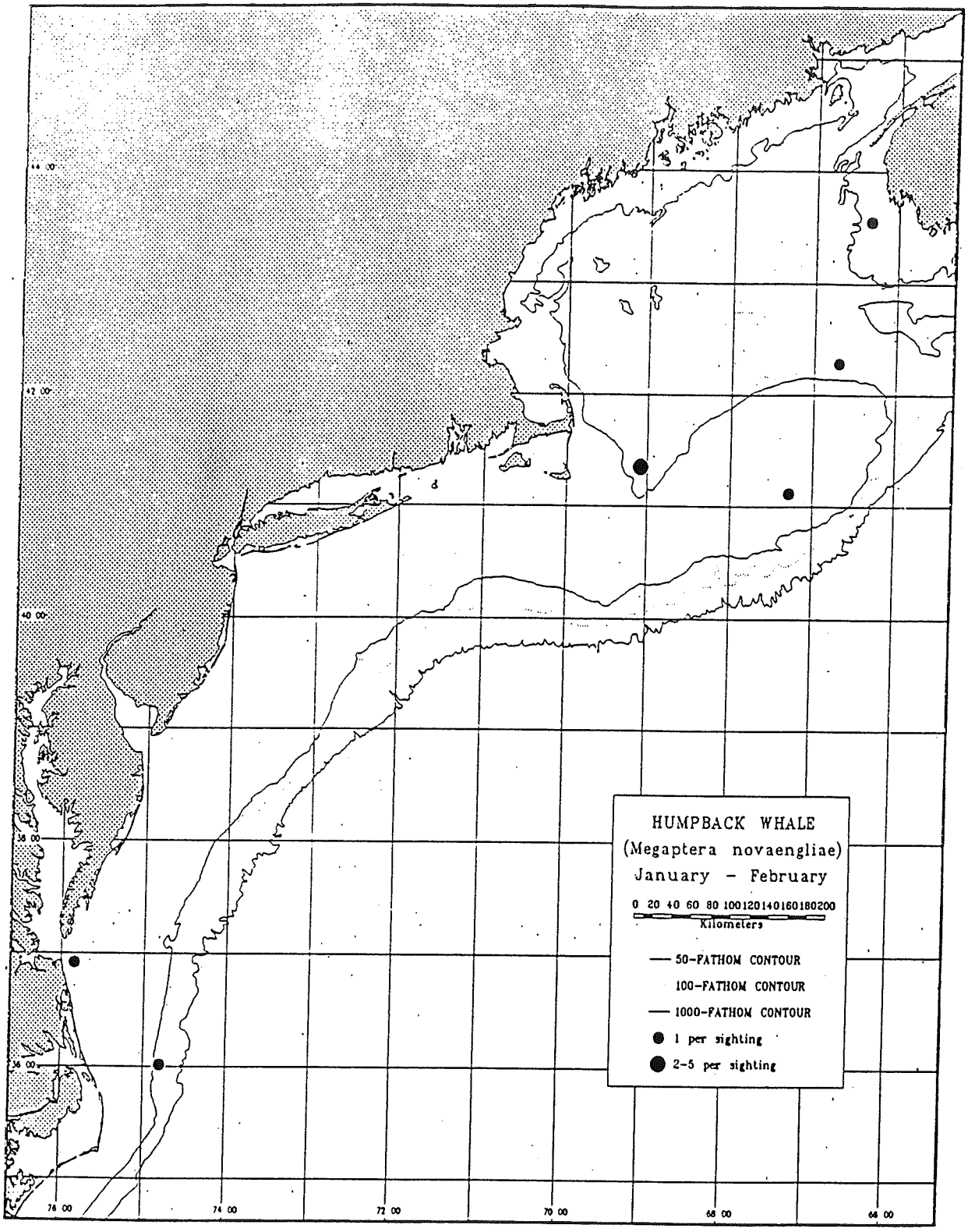

Figure 19a. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

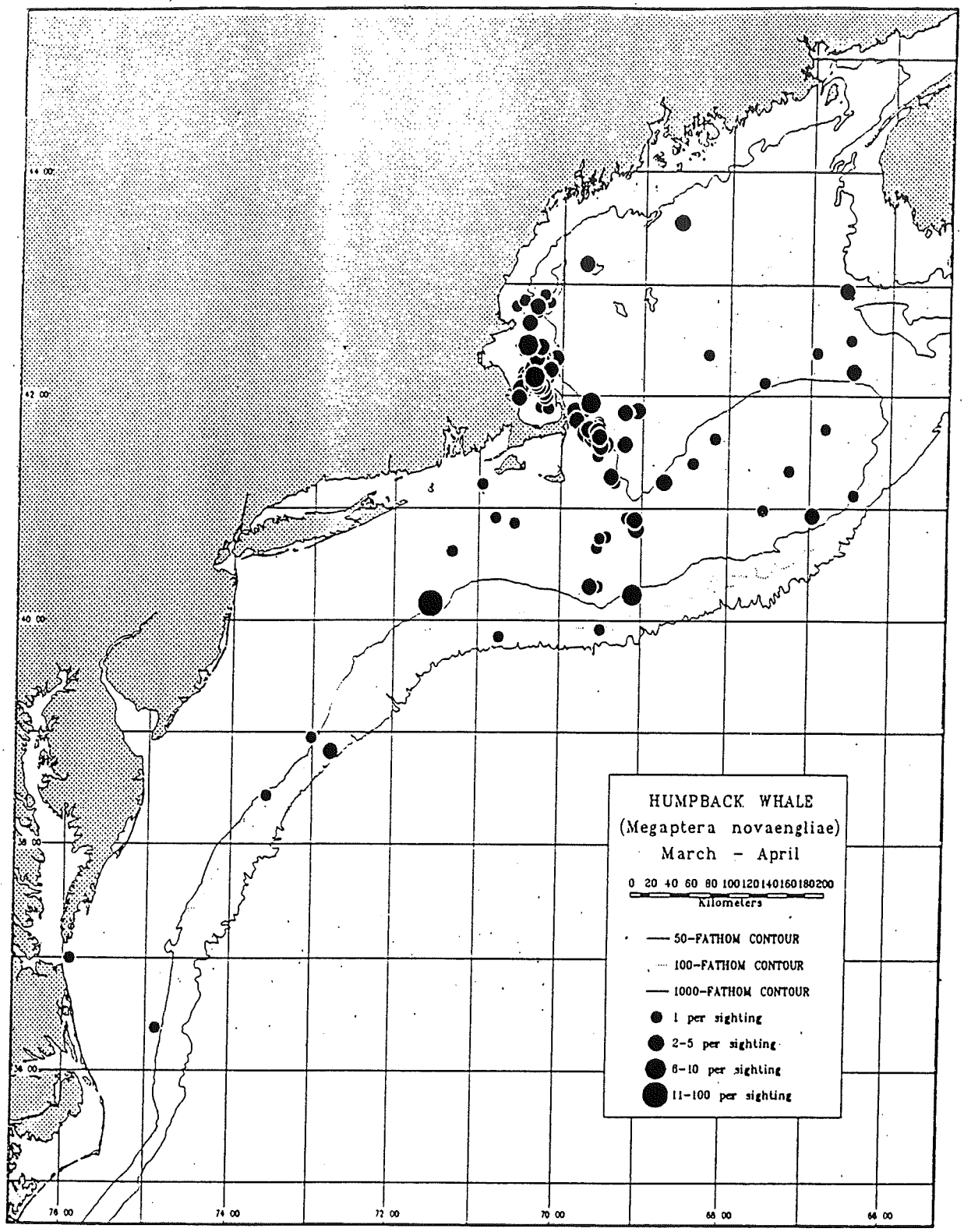

Figure 19b. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

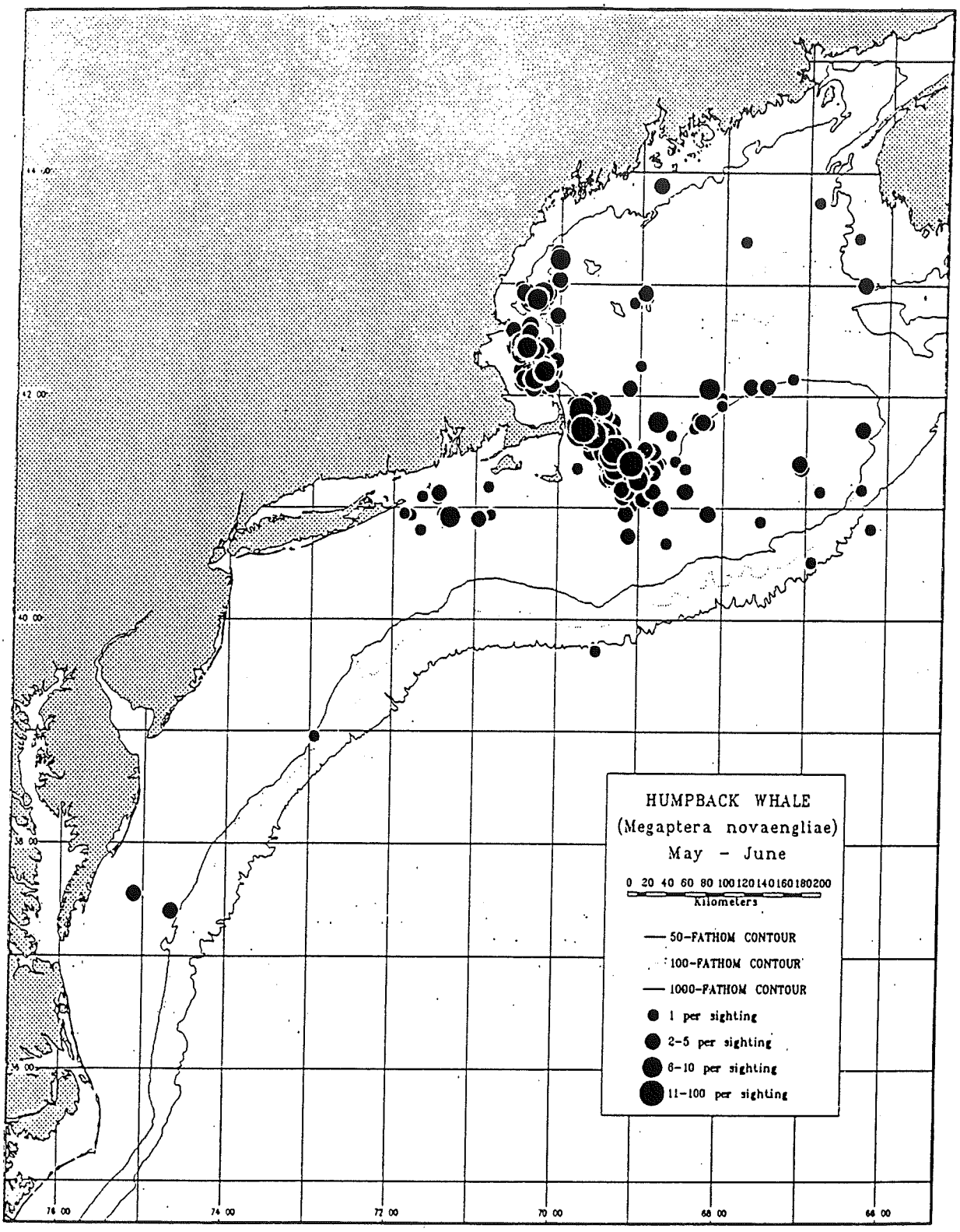

Figure 19c. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

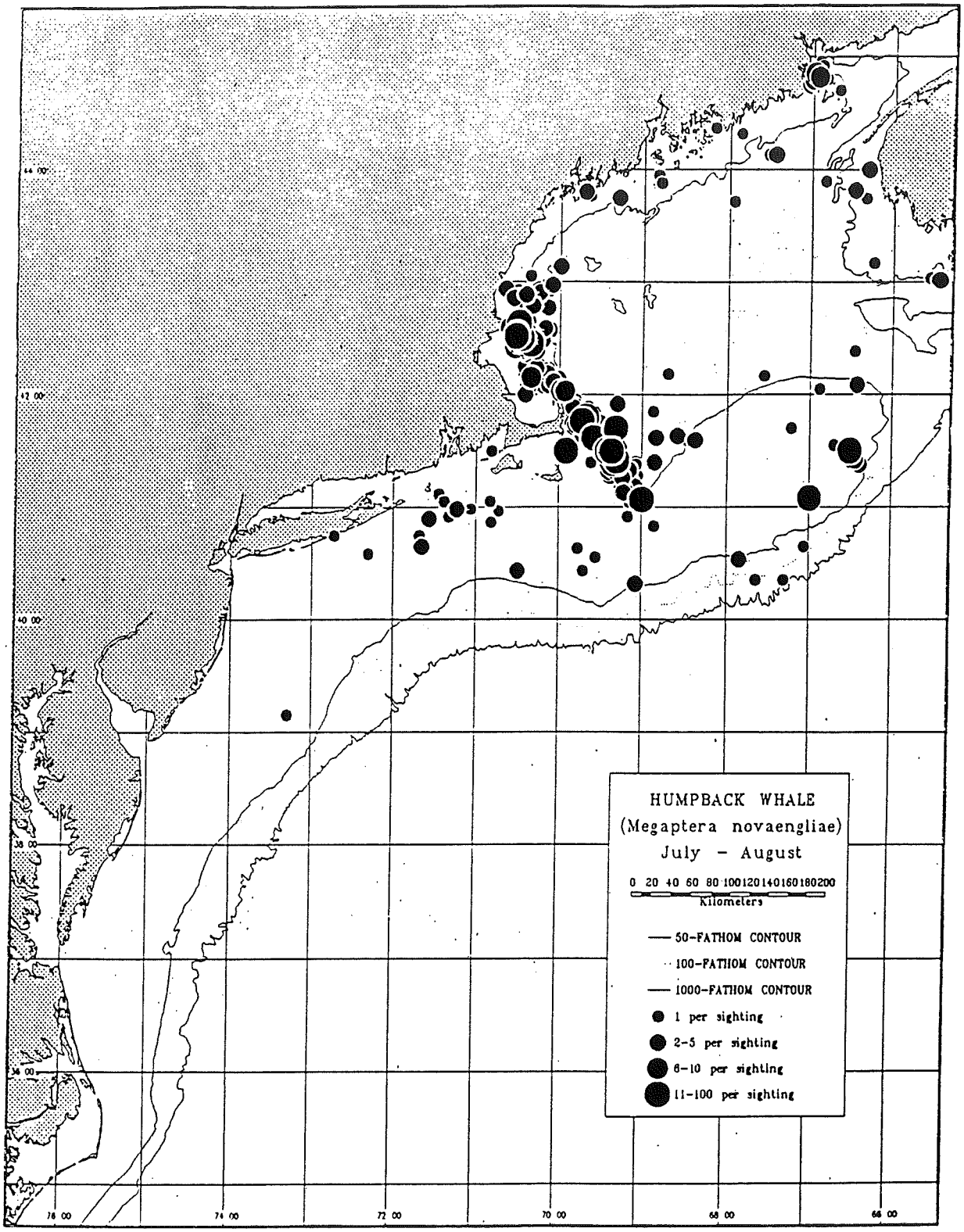

Figure 19d. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

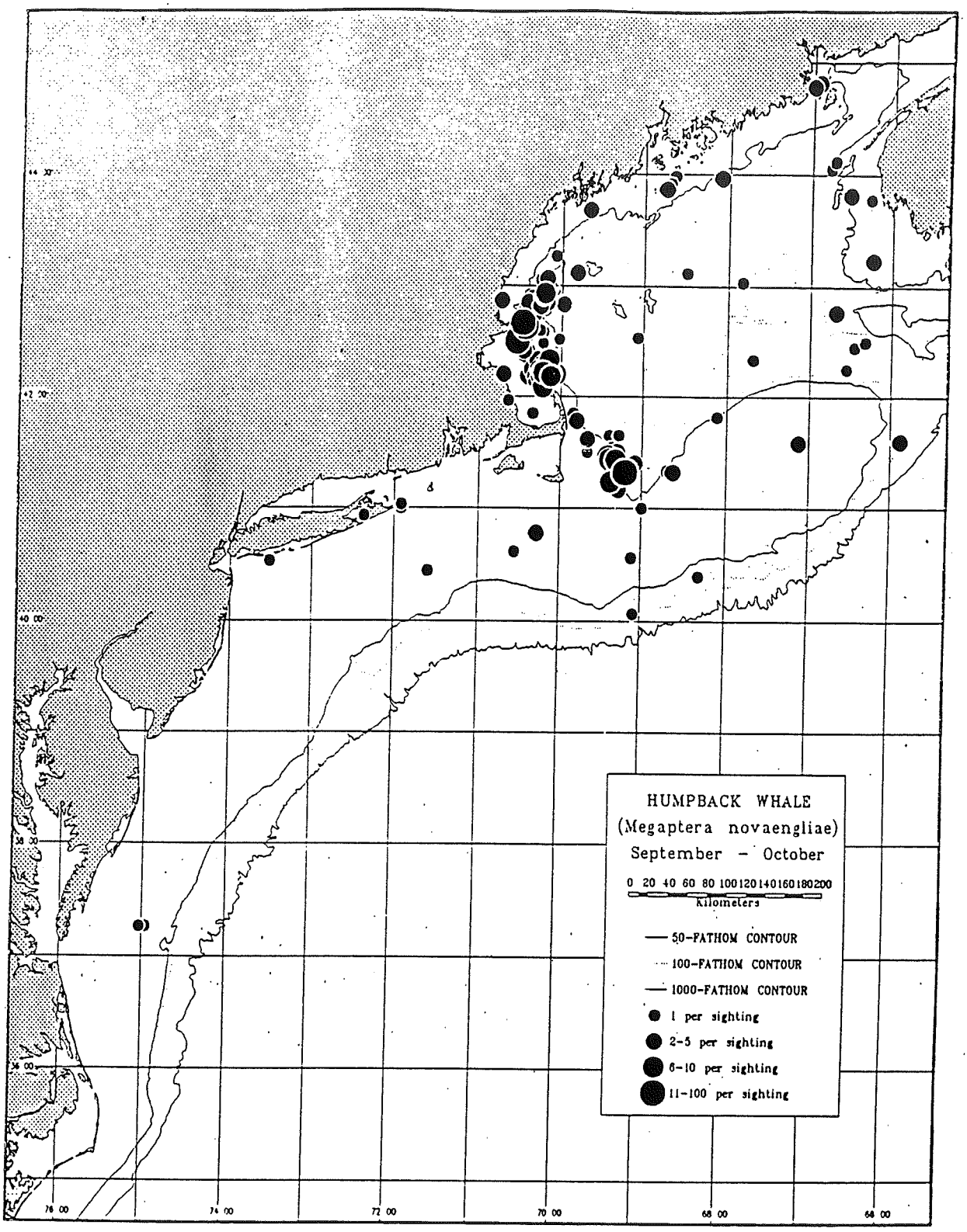

Figure 19e. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.

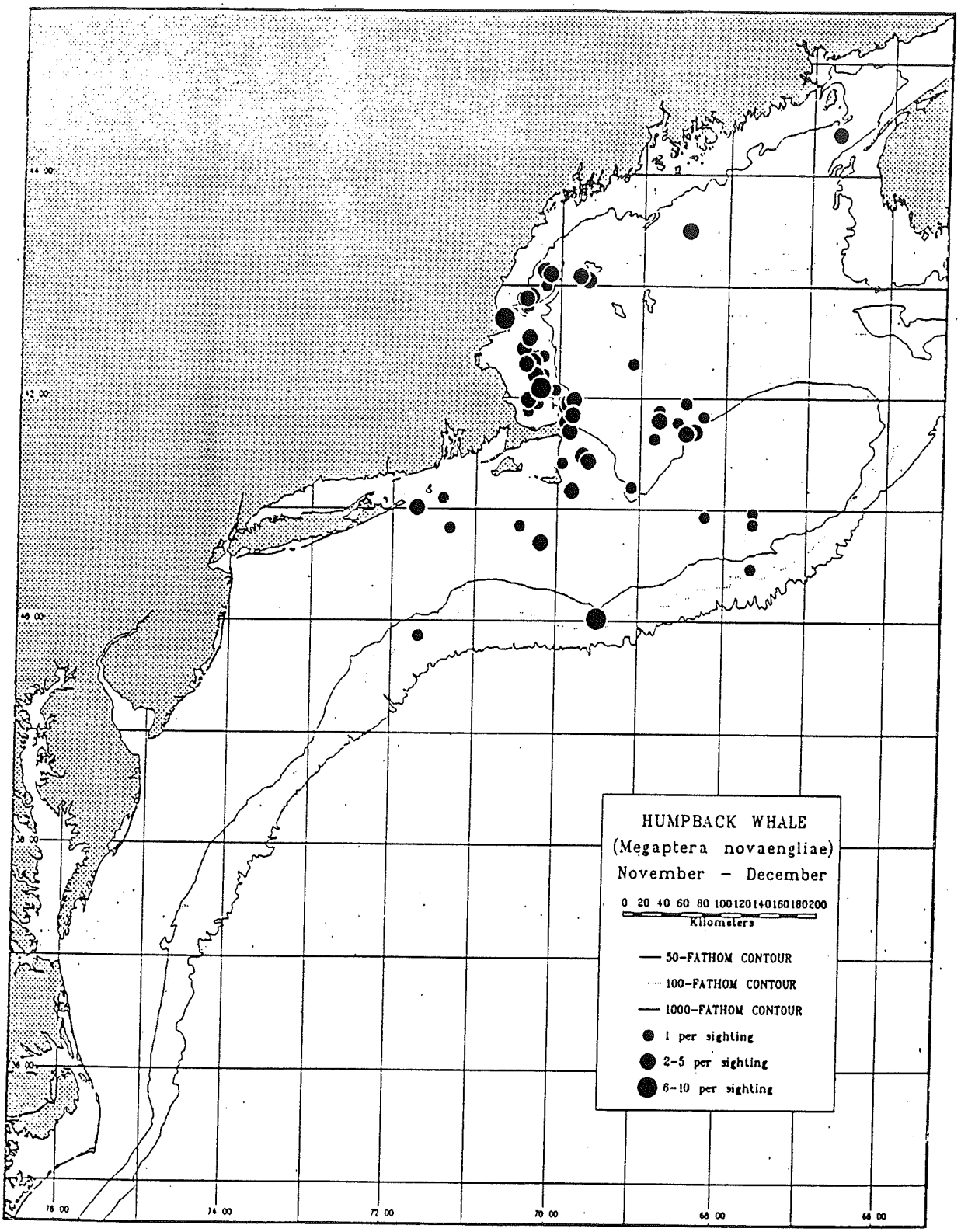

Figure 19f. Distribution of humpback whale Megaptera novaeangliae sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during November-December, 1978-1988.

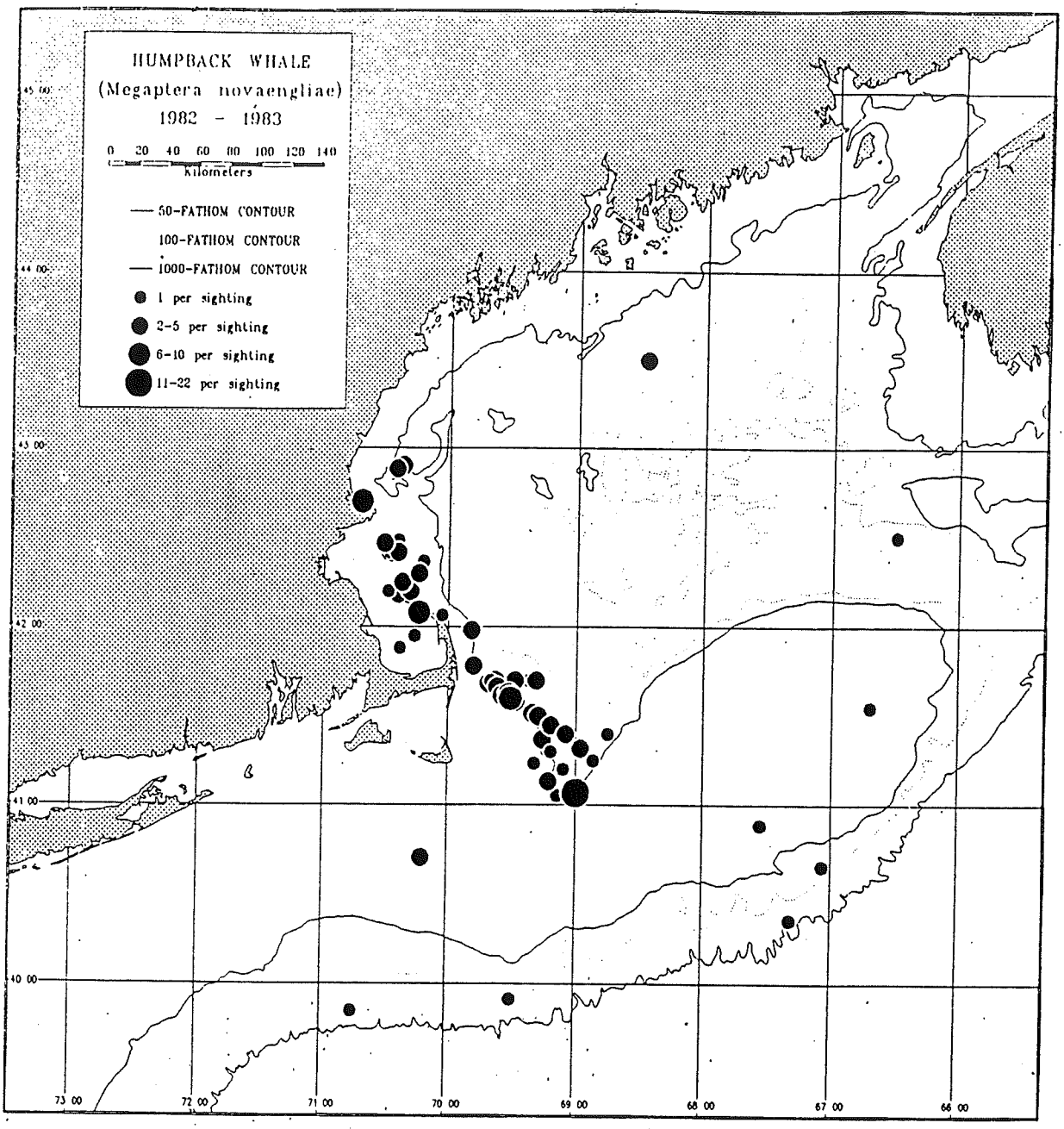

Figure 19g. Distribution of humpback whale Megaptera novaeangliae sightings during shipboard surveys, for all seasons 1982-1983, in shelf waters of the southwest/ south Gulf of Maine and the Great South Channel regions.

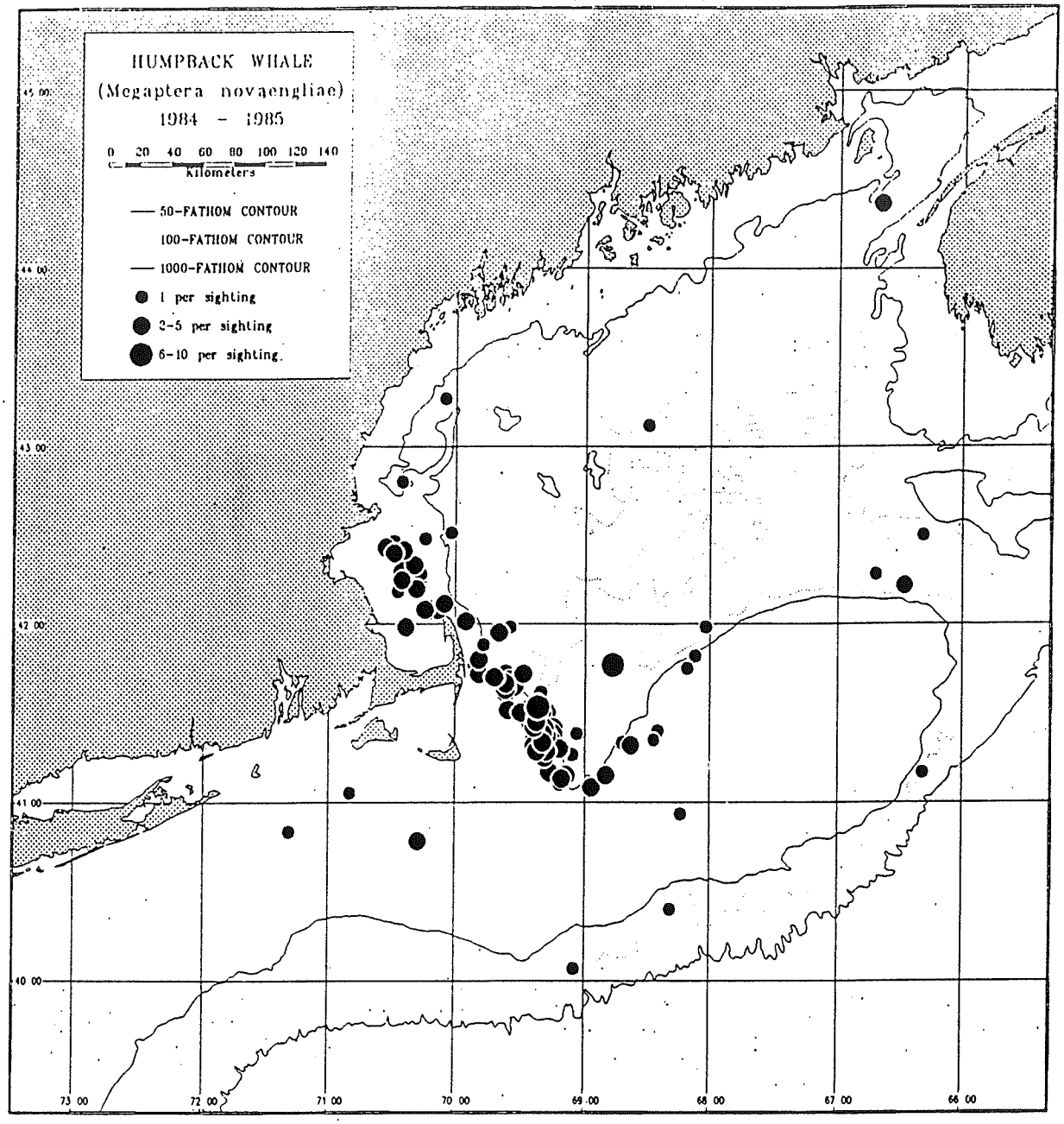

Figure 19h. Distribution of humpback whale Megaptera novaeangliae sightings during shipboard surveys, for all seasons 1984-1985, in shelf waters of the southwest/ south Gulf of Maine and the Great South Channel regions.

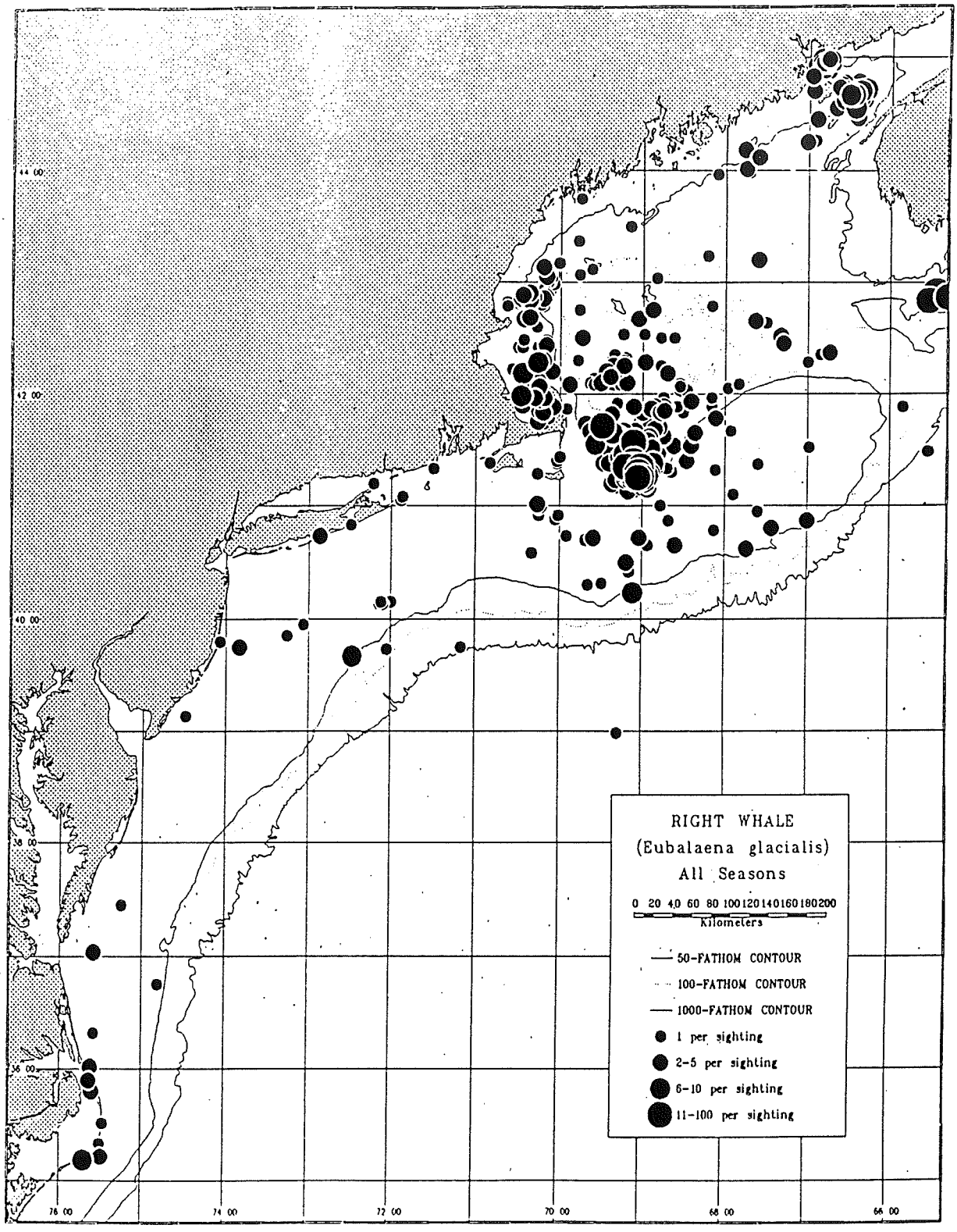

Figure 20. Distribution of Northern right whale Eubalaena glacialis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during all seasons, 1978-1988.

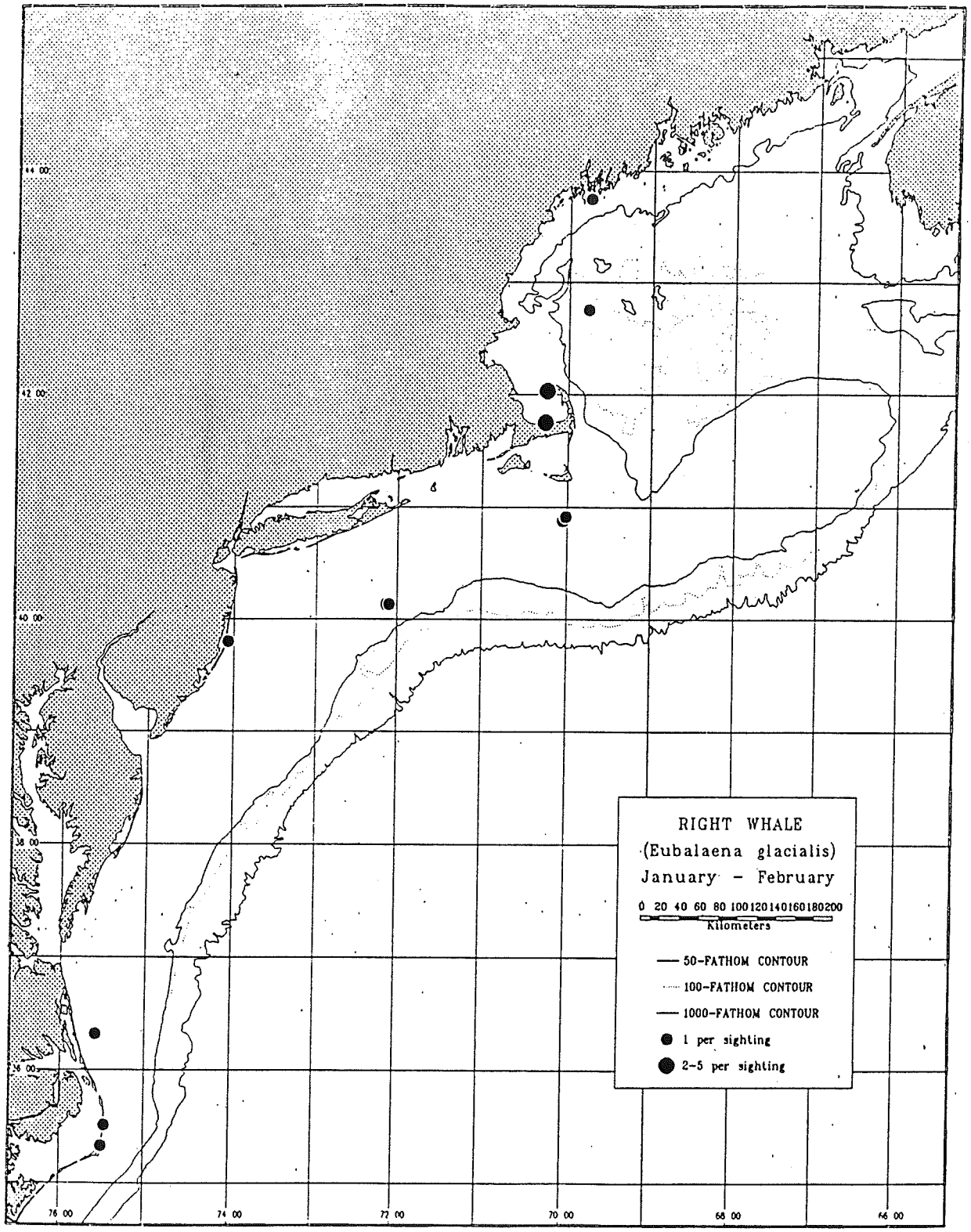

Figure 20a. Distribution of Northern right whale Eubalaena glacialis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during January-February, 1978-1988.

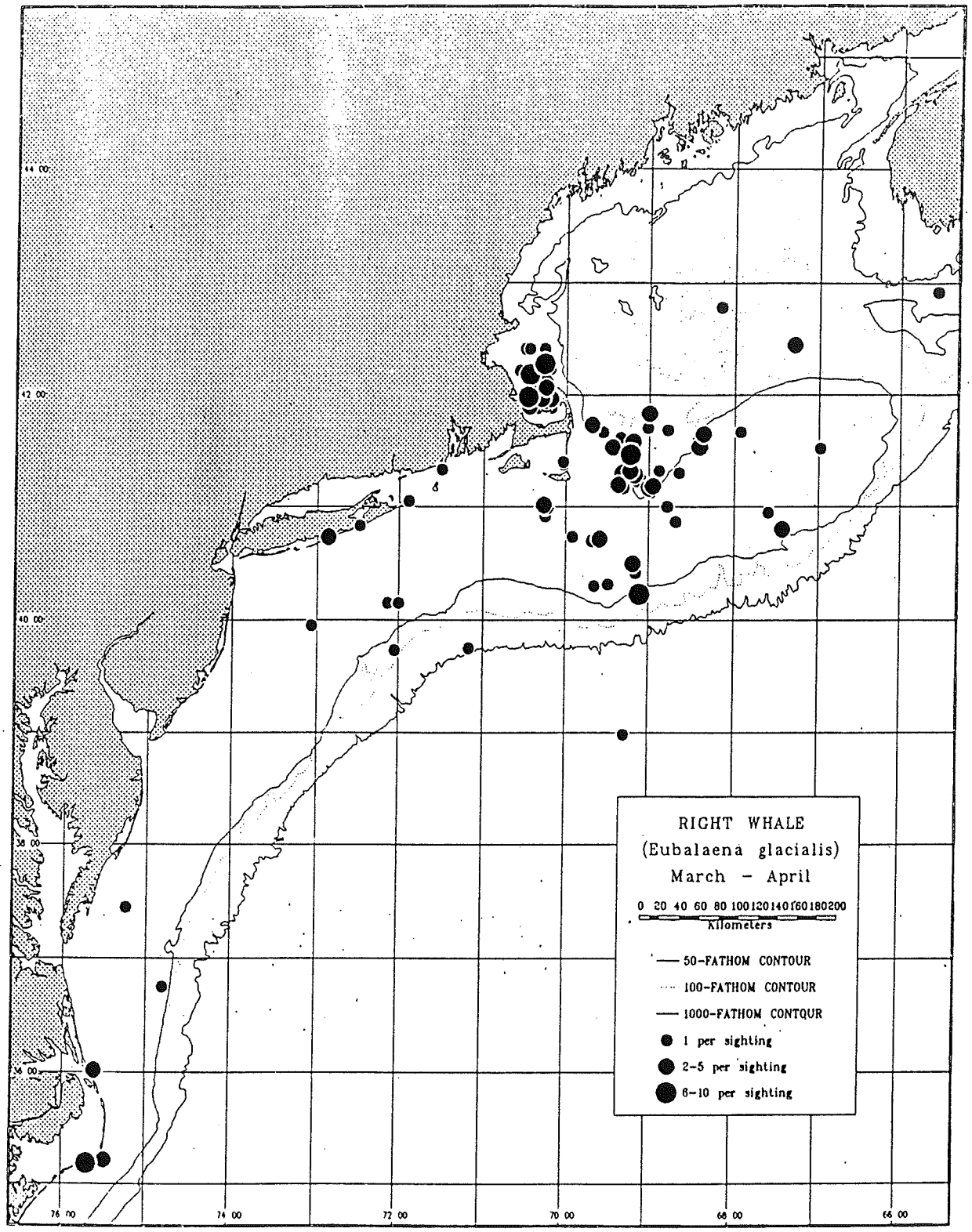

Figure 20b. Distribution of Northern right whale Eubalaena glacialis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during March-April, 1978-1988.

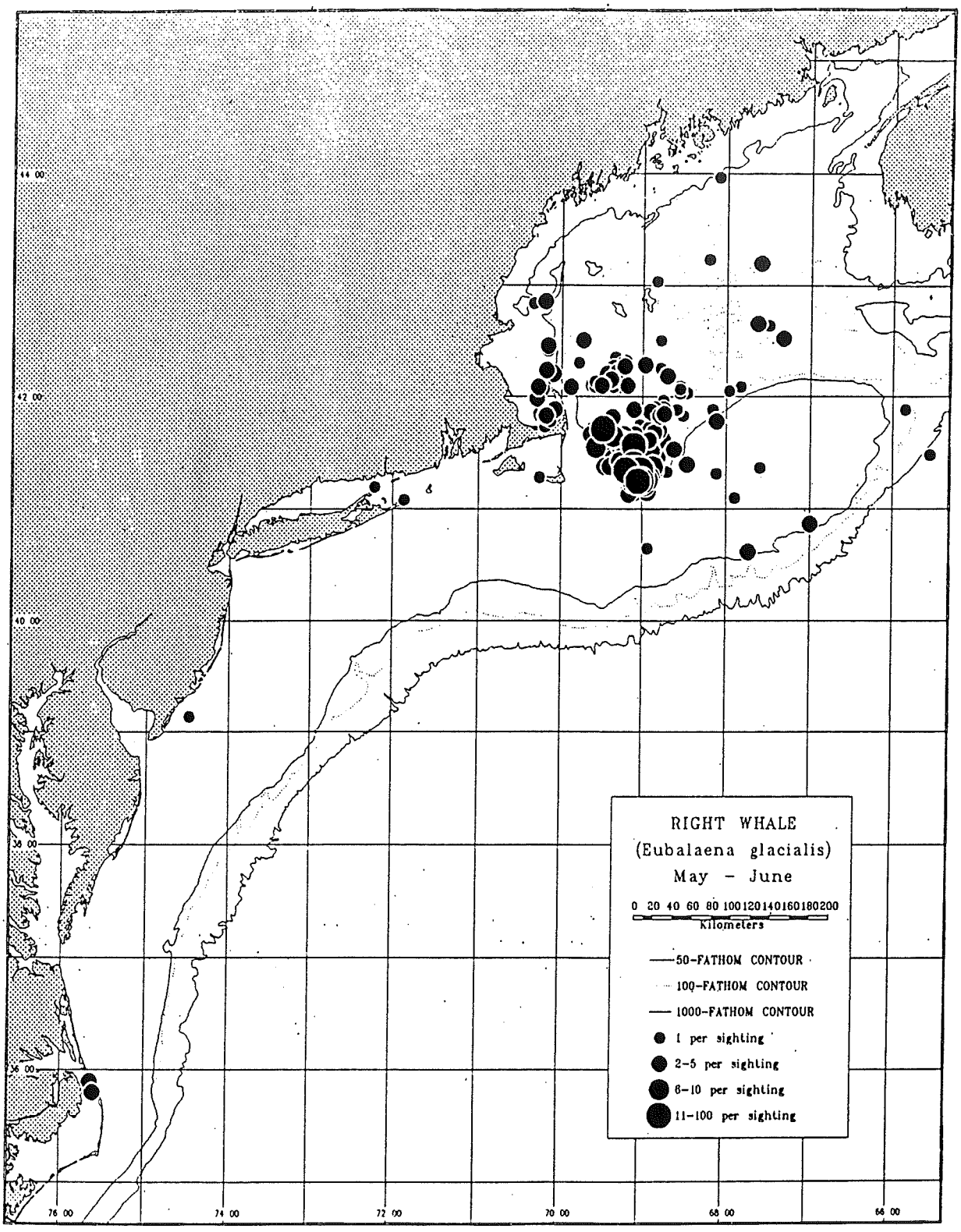

Figure 20c. Distribution of Northern right whale Eubalaena glacialis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during May-June, 1978-1988.

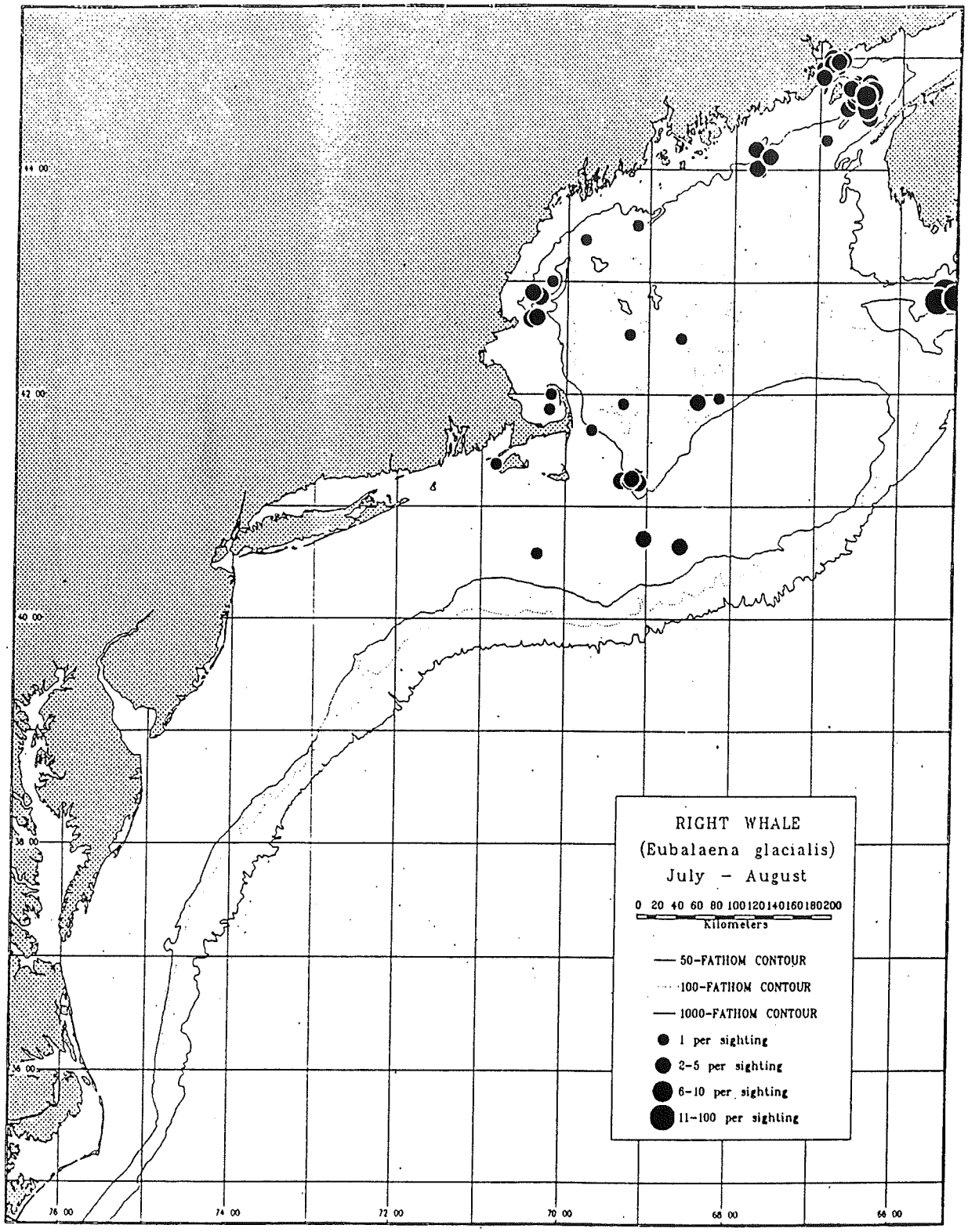

Figure 20d. Distribution of Northern right whale Eubalaena glacialis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during July-August, 1978-1988.

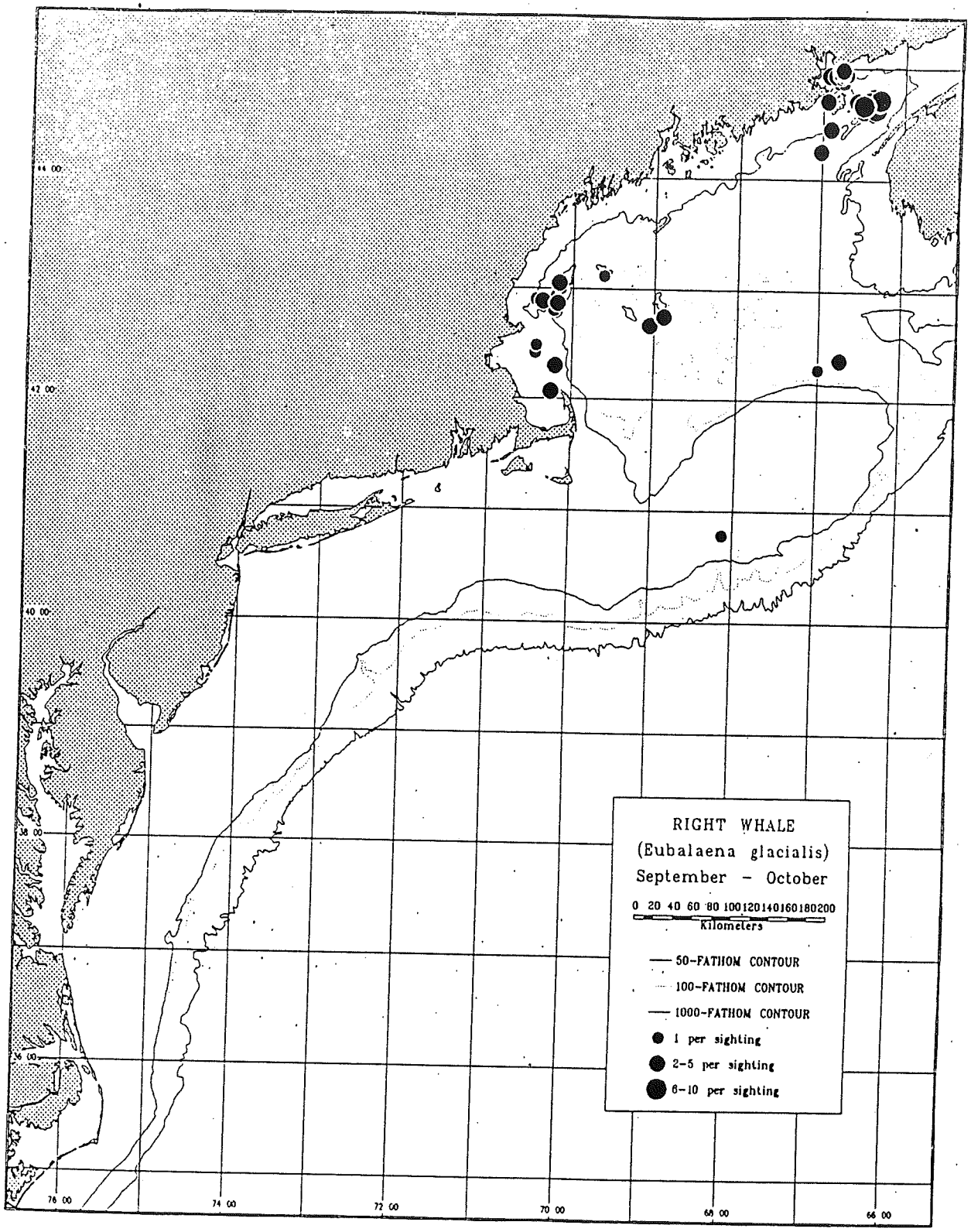

Figure 20e. Distribution of Northern right whale Eubalaena glacialis sightings in shelf/ shelf-edge and adjacent slope waters of the northeastern United States during September-October, 1978-1988.