

TEMPORAL AND SPATIAL SPAWNING PATTERNS OF THE PRINCIPAL SPECIES OF
FISH AND INVERTEBRATES IN THE GEORGES BANK REGION

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Fish eggs and larvae representing more than 200 taxa occur annually in coastal waters off northeastern United States. Spawning strategies vary between species but most spawn pelagic eggs. The incubation period requires anywhere from a few days to a few weeks, depending upon water temperature and the species in question. Thereafter the developing larvae are dependent upon favorable circulation patterns, water quality and food supply for a time period measured in months. It is the planktonic eggs and larvae that are the most vulnerable stages of development in the life history of marine fishes.

Although spawning continues year-round, reproduction cycles of most coastal species in the Georges Bank region are seasonal with climatic changes followed closely by changes in the species composition of the ichthyoplankton community. The role of environmental stimuli in triggering and controlling breeding cycles is poorly understood, but it is widely held that changing temperature and photoperiod are influential in determining the onset of spawning by most marine fishes in temperate and boreal latitudes.

The amount and type of information on spawning times varies widely for different species, ranging from occasional and/or localized observations to extensive time series of ichthyoplankton survey information. Furthermore, resolution of available information is often difficult to assess because adequate descriptions of geographic extent and temporal scopes are not provided.

The following synopses of spawning habits pertain to those species listed

in Table 1, which are arranged in faunal groupings that correspond to general depth and/or temperature preferences. It is evident from this tabular summary that a species occurring in different geographic regions often shows differences in spawning time and peak spawning period, even when separated by a short distance such as Georges and Browns banks. These differences provide important criteria in stock differentiation for management purposes.

I. RESIDENT SPECIES

Yellowtail flounder

Yellowtail flounder spawn from March to September (Bigelow and Schroeder, 1953) but 90% of the spawning activity in United States coastal waters occurs between mid April and late June (Royce et al., 1959). Eggs and larvae are pelagic. The period of peak spawning is temporarily offset with increased latitude, beginning in the south and progressing northward with time (Figure 1). Colton et al. (1979) reported that spawning occurs from April through August in the Middle Atlantic area, with peak activity in May. The season off southern New England and on Georges Bank is similar but the spawning peak does not begin until mid May and usually carries through mid June (Royce et al., 1959; Berrien, 1981). In coastal waters between Cape Cod and Chesapeake Bay, 98% of yellowtail flounder <4.1 mm collected by Smith et al. (1975) were taken where bottom temperatures ranged between 4.1° and 8.9°C, and over depths between 30 and 80 m. Spawning is light in the Gulf of Maine where the peak occurs in June. On the Scotian Shelf spawning begins in May and continues into August (Colton et al., 1979) with peak spawning limited to June (Scott, 1954).

Winter flounder

Winter flounder spawn demersal eggs in shallow waters in late winter and spring. South of Cape Cod, most spawning takes place in coastal estuaries from January to April, with the seasonal peak in March. However, Smith et al. (1975) caught larvae in coastal waters during spring, mostly in depths less than 20 m. In the Georges Bank-Gulf of Maine region, spawning peaks in April when bottom temperatures are between 3.3° and 5.5°C (Bigelow and Schroeder, 1953). Spawning on the Scotian Shelf is also limited mostly to shallow coastal waters, with the seasonal peak usually occurring in May (Leim and Scott, 1966).

Windowpane

Windowpane spawn in coastal waters between South Carolina and Nova Scotia over bottom temperatures between 8° and 14°C (Colton and St. Onge, 1974; Smith et al., 1975). Their eggs and larvae are pelagic. The major spawning grounds are located off the southern New England and Middle Atlantic states in depths less than 40 m. Spawning begins in May and continues into November south of Cape Cod, and runs from June through October north and east of the cape. Larvae remain in the plankton through December (Smith et al., 1975; Bolz et al., 1978). Smith et al. (1975) found recently hatched larvae most abundant off North Carolina in May and off Long Island and New Jersey in October. Spawning is interrupted during summer months if bottom temperatures exceed 15°C (Wheatland, 1956; Smith et al., 1975).

Longhorn sculpin

Little is known about the spawning cycle of longhorn sculpin. They lay demersal eggs which are adhesive, and spawn from late autumn through winter.

The spawning season from southern New England to the Scotian Shelf begins in November and continues through February. Peak spawning occurs in December and January (Bigelow and Schroeder, 1953).

Little skate

Little skate lay egg capsules throughout the year. The spawning cycle is punctuated by peak activity from November to January and again in June and July in Middle Atlantic, southern New England, and Georges Bank waters, but the summer peak is not reported for the Gulf of Maine and Scotian Shelf (Richards et al., 1963; Johnson, 1979; Waring, 1980).

Winter skate

Winter skate spawn throughout the year in southern New England and Georges Bank waters, with peaks in spring and again in autumn and winter. In the Gulf of Maine spawning reportedly occurs from August through November with a single peak in September (Bigelow and Schroeder, 1953).

Sand lance

Sand lance lay demersal eggs in sandy substrates from autumn through winter. Larvae occur in coastal waters from Cape Hatteras to Maine from November through March. Peak spawning occurs along the inner half of the shelf in December and January (Richards and Kendall, 1973). Hatching does not occur until temperatures drop below 9°C (Wheatland, 1956; Norcross et al., 1961). Larvae are most abundant during months of January and February (Figure 2).

Sea raven

Sea raven spawn from early October through late December or early January (Bigelow and Schroeder, 1953; Leim and Scott, 1966). Eggs are demersal. There is no information in the literature to suggest latitudinal differences in spawning over time.

Sea scallop

Spawning begins in July off North Carolina and Virginia, proceeds northward with time and ends in the Gulf of Maine region in October (Dickie, 1955; MacKenzie et al., 1978; Serchuk et al. 1979). Spawning times and locations have been reported as follows: Georges Bank - September (Posgay and Norman, 1958), late September and early October (MacKenzie et al., 1978); Cape Cod Bay - late September and early October (Posgay, 1950); Isle of Shoals, New Hampshire - late September (Culliney, 1974); Maine - late August (Drew, 1906), August and September (Welch, 1950), late August to early October (Baird, 1953); Bay of Fundy - August (Stevenson, 1936), late August to early September (Dickie, 1955).

Atlantic cod

The spawning season of Atlantic cod begins in autumn and continues into spring. Principal spawning grounds off northeastern United States are over the eastern part of Georges Bank (Walford, 1938; Smith et al., 1979, 1981b). Their eggs and larvae are pelagic. Although not abundant by comparative standards, cod eggs and larvae occur as far south as North Carolina from November into April or occasionally May. From southern New England, over Georges Bank and along coastal waters of the Gulf of Maine, spawning usually begins in November and may continue into June (Figure 3). Throughout this

area the period of peak spawning can vary widely from year to year and seems related to environmental conditions (Bigelow and Schroeder, 1953). In warm to moderate winters peak spawning can occur as early as December but during unusually harsh winters peak spawning can be delayed until the end of March (Smith et al., 1981b). O'Boyle et al. (1982) collected cod eggs and larvae on the Scotian Shelf from November to April. Eggs and larvae first appeared around Sable Island and along the coast of Nova Scotia. By April spawning had shifted south to Emerald, Western and Browns banks. O'Boyle et al. (1982) found no evidence of significant drift for either eggs or larvae spawned on the Scotian Shelf.

Haddock

Haddock spawn in shelf waters north and east of Nantucket Shoals. For the past 50 years the principal spawning grounds off northeastern United States have been situated over the eastern third of Georges Bank (Figure 4). Spawning is linked directly to bottom temperature with peak spawning occurring at 4° to 5°C (Colton, 1968; Marak and Livingstone, 1970). Their eggs and larvae are pelagic. Walford (1938) reported that haddock spawned on Georges Bank from February to May but Smith et al. (1981b) showed that spawning began on the bank in January during the unusually mild winter of 1980. Peak spawning occurs on the bank in March or April (Walford, 1938; Marak and Livingstone, 1970; Smith et al., 1979, 1981b). In the Gulf of Maine spawning occurs principally in nearshore coastal areas from February to May. O'Boyle et al. (1982) found significant numbers of haddock eggs on the Scotian Shelf only in April and May, with concentrations over Emerald, Western and Browns banks. However, Colton and St. Onge (1974) reported eggs on the Scotian Shelf in March. Although the onset of spawning depends upon bottom temperature

(Marak and Livingston, 1970), Grosslein and Hennemuth (1973) showed that spawning on the Scotian Shelf usually occurs about a month later than on Georges Bank.

Spiny dogfish

Spiny dogfish are ovoviviporous. Ovulation occurs in December or January and mating takes place in February and March. Thereafter the gestation period lasts 18 to 22 months (TRIGOM-PARC, 1974). Females subsequently produce 2 to 14 pups, six on average (Hisaw and Albert, 1947; Nammack, 1982). Most pupping takes place from November to February in Middle Atlantic and southern New England waters where the bulk of the population spends the late autumn and winter months. The pupping period usually peaks in January.

Atlantic herring

Herring spawn demersal eggs; their larvae are pelagic. Spawning typically progresses from the Scotian Shelf and eastern Gulf of Maine region in August, where it concludes in November, to the western Gulf of Maine in September, where it ends in December (Lough and Bolz, 1979; Smith et al., 1980, 1981). The spawning period on Georges Bank prior to the collapse of the spawning stock in the mid 1970's extended from September to December with peak spawning during late September and early October. Since 1978 the spawning beds on Georges Bank have been dormant (Figure 5). The southernmost extension of significant spawning activity of Atlantic herring appears to be in the Nantucket Shoals region, where spawning occurs from October through December and peaks during October (Smith et al., 1980). The general north-to-south spawning pattern is presumably keyed to declining temperatures during autumn, although other factors such as photoperiod may play a significant role. Iles

and Sinclair (1982) proposed that stable hydrographic features define stock boundaries and serve as physical isolating mechanisms for larval stages.

Ocean pout

The period of reproduction along the Atlantic coast of the United States extends from mid September through at least late October (Olsen and Merriman, 1946); Bigelow and Schroeder, 1953). Within this time frame, there is evidence of a north-to-south progression in spawning, beginning in mid September in the Bay of Fundy and in late September in southern New England waters. Spawning occurs on rocky bottoms inside the 60-m contour, where eggs are layed in crevices and subsequently protected by one or both parents. Spawning takes place when bottom temperatures reach approximately 10°C (Olsen and Merriman, 1946).

Goosefish

Goosefish spawn from late winter through late summer, a long season that progresses northward with time. Eggs are layed in long, ribbon-like veils which drift in the water column. These veils can be more than 30 feet in length and 2 to 3 feet wide. Spawning begins in late March near Cape Hatteras, April off southern New England, as early as May at Woods Hole, and not until June north of Cape Cod (Bigelow and Schroeder, 1953). Peak spawning periods are also offset, depending upon latitude. The height of the season occurs as early as May off the Middle Atlantic states but not until July on the Scotian Shelf.

Northern lobster

Spawning of the northern lobster progresses in a south-to-north clinal gradient during late spring and early summer, apparently in response to increasing water temperature. Mating occurs for a period of up to 48 hours after molting, while the female is soft. Sperm may be stored in the seminal receptacle for as long as 15 months before spawning occurs. Thereafter, eggs are carried for 10-11 months on the female's swimmerets before hatching begins. Hatching begins in mid May and peaks about one month later (Phillips and Sastry, 1980). Statko (1980) reported lobster larvae on Georges Bank from June through October. In the Gulf of Maine the hatching season runs from June through August while on the Scotian Shelf it is limited to the July-August time period (Herrick, 1909; Templeman, 1937).

II. SEASONAL MIGRANTS

Silver hake

Silver hake begin spawning in late April off the Middle Atlantic states, and successively later to the north and east. Peak spawning is also temporally staggered from south-to-north with most eggs produced at water temperatures between 7° and 13°C (Bigelow and Schroeder, 1953). The pelagic eggs first occur in April or May in southern New England and Georges Bank waters, in May or June in the Gulf of Maine and not until July on the Scotian Shelf (Sauskan and Serebryakov, 1968; Fahay, 1974; O'Boyle et al., 1982; Berrien, 1983). Although spawning takes place as far south as Chesapeake Bay, the southernmost major spawning grounds are located off New Jersey (Silverman, 1982; Berrien, 1983). The principal spawning grounds on Georges Bank are situated along the southern slopes in depths up to 200 m, although some spawning takes place along the northern edge of the bank (Figure 6). Major

spawning areas in the Gulf of Maine include coastal waters shallower than 90 m from Cape Cod to Grand Manan Island with the Massachusetts Bay area being most important (Bigelow and Schroeder, 1953). On the Scotian Shelf the major egg concentrations occur over Browns, Emerald, Western, Banquereau and Sable Island banks (Noskov et al., 1982; O'Boyle et al., 1982).

White hake

Information on the spawning season of white hake is fragmentary, vague and, in some cases, conflicting. Colton et al. (1979) indicated that spawning occurs between October and April in the slope region of the Middle Atlantic Bight, with peak activity from December through February. Based on limited observations from southern New England to the Gulf of Maine, Bigelow and Schroeder (1953) concluded that white hake spawn from "late winter through spring to late summer." Colton and St. Onge (1974) reported larval occurrences from southern New England to the Scotian Shelf in May and June and Petrov (1973) indicated a mid summer spawning, but Leim and Scott (1966) noted that spawning occurred in early autumn off southeastern Nova Scotia. Eggs and larvae are pelagic.

Red hake

Red hake have a protracted spawning season, one that begins in March in the Middle Atlantic region, in May on Georges Bank and the Gulf of Maine and in June on the Scotian Shelf. Major spawning grounds are located in southern New England waters east of Block Island, and on the southwest part of Georges Bank (Musick, 1974) in depths of about 100-120 m. Eggs and larvae are pelagic. In the Gulf of Maine spawning occurs along the coastal region from Cape Cod to the Bay of Fundy in depths usually less than 60 m, although red

hake eggs have occasionally been taken in deep basins of the eastern gulf (Bigelow and Schroeder, 1953). Spawning on the Scotian Shelf occurs along southeastern Nova Scotia (Leim and Scott, 1966).

Fourspot flounder

The season peaks in July. Recently hatched larvae were most abundant in depths between 35 and 80 m off New Jersey and southern New England where bottom temperatures were 6° to 9°C (Smith et al., 1975). Eggs and larvae are pelagic.

Butterfish

Butterfish spawn from May through July principally off the Middle Atlantic and southern New England states. Spawning occurs largely at water temperatures between 16.3° and 22.5°C (Hildebrand and Schroeder, 1927). The spawning peak occurs in June and July off the Middle Atlantic states and in July from southern New England to the Gulf of Maine (Wilk et al., 1975; Kawahara, 1977; Sullivan, 1980). Eggs and larvae are pelagic.

Shortfin squid (Illex)

Spawning begins in August and probably continues into winter in some areas. Earliest spawning occurs along the outer part of the shelf off New Jersey. By late August or early September the spawning area extends along deep shelf waters to eastern Georges Bank (Grosslein and Azarovitz, 1982).

Longfin squid (Loligo)

The longfin squid moves to shallow inshore waters to spawn in the spring. Off the Middle Atlantic and southern New England states, spawning

begins in April and continues through the summer. The initial spawning peak occurs in June, followed by a second peak in September which is attributed to spring-spawned individuals. On Georges Bank and in the Gulf of Maine the length of the spawning season is reduced, with single peaks in June and July, respectively (Summers, 1971). No spawning is reported on the Scotian Shelf.

Pollock

Pollock spawn off northeastern United States from late October or early November into March. Peak spawning takes place in December and January (Bigelow and Schroeder, 1953; MARMAP, unpublished data). Their eggs and larvae are pelagic. The spawning season on the Scotian Shelf covers the same approximate time period but eggs are most abundant in November and December, primarily in the Emerald and Western banks area (O'Boyle et al., 1982). Unpublished MARMAP data show larvae scattered throughout coastal waters from southern New England to the Gulf of Maine in autumn and winter. Although no recurring distribution patterns emerge from year to year, larvae are most abundant in the Massachusetts Bay-Stellwagen Banks region of the Gulf of Maine and on Georges Bank (Figure 7). These observations agree with Steele (1963) who reported concentrations of larvae in the southern Gulf of Maine in January and February, and with Colton and Byron (1977) who found larvae most abundant in the Nantucket Shoals, Great South Bay Channel and Georges Bank regions between December and February.

American plaice

American plaice begin spawning on Georges Bank and in the Gulf of Maine in February and continue through June. Their eggs and larvae are pelagic. Peak spawning occurs in April and May (Bigelow and Schroeder, 1953; Colton et

al., 1979; O'Boyle et al., 1982; Sullivan, 1982). O'Boyle et al. (1982) found eggs abundant on the Scotian Shelf in April and speculated that spawning there was a month or more later than on Georges Bank. Despite O'Boyle's findings, other evidence suggests that peak spawning in Canadian waters occurs from mid April through May, or at the same time as in United States coastal waters (Powles, 1965; Pitt, 1966; MacKinnon, 1972; Nevinsky and Serebryakov, 1973).

III. COMMON MID-ATLANTIC SPECIES

Summer flounder

Summer flounder spawn from Georges Bank southward, beginning in late summer and continuing through late autumn or early winter. Their eggs and larvae are pelagic. Whereas the distributions of eggs and larvae of most spring spawning fish follow a south-to-north progression over time, eggs and larvae of most autumn spawners, e.g. summer flounder, occur first in the north and further south as the spawning season advances (Smith, 1973). North of Chesapeake Bay spawning occurs from late September to December; south of the bay from November to February. Some spawning occurs as far north as Georges Bank but the principal spawning grounds are off New York and New Jersey in October and off North Carolina in November and December. Most spawning occurs at bottom temperatures between 12° and 19°C, although both eggs and larvae seem to withstand a much wider range of temperature (Smith, 1973; Smith et al., 1975).

Bluefish

There are two major spawning areas for bluefish along the Atlantic coast. One is located offshore near the inner boundary of the Gulf Stream from southern Florida to North Carolina where spawning occurs largely in April

and May (Kendall and Walford, 1979). The other is located on the continental shelf between capes Hatteras and Cod where spawning occurs largely off Virginia from May through mid August (Figure 8). Norcross et al. (1974) collected eggs along the outer half of the shelf off Chesapeake Bay at surface temperatures between 18° and 26.3°C. They reported a mean temperature of 25.6°C at maximum spawning. Coastal estuaries from North Carolina to Massachusetts provide nursery grounds for young bluefish during their first summer. Although bluefish occur regularly on Georges Bank and in the Gulf of Maine in summer, there is no evidence from six years of intensive plankton surveys that they spawn north or east of Cape Cod (MARMAP, unpublished data).

Scup

Scup spawn pelagic eggs largely in shallow coastal waters off southern New England from May to August (Perlmutter, 1939; Wheatland, 1956; Herman, 1963). The principal spawning grounds include bays, sounds and nearshore ocean waters from eastern Long Island to Massachusetts. Peak spawning occurs in June (Kuntz and Radcliffe, 1918; Nichols and Breder, 1926).

IV. COMMON GULF OF MAINE SPECIES

Redfish

Unlike most fishes of the western North Atlantic, which develop from free-floating eggs cast into the sea by the female and there fertilized by the male, fertilization in redfish is internal, and the eggs develop and hatch within the oviduct of the female. Mating is thought to occur in autumn (Templeman, 1959). The Gulf of Maine represents the southern limit of significant redfish production, but adults range southward in deep shelf and/or slope waters as far as New Jersey (Bigelow and Schroeder, 1953).

Larvae occur regularly but in comparatively small numbers along the southern edge of Georges Bank from April to August (Figure 9). Larval production in the Gulf of Maine occurs from April to September, with the peak in May and June (Kelly and Barker, 1961; Colton and St. Onge, 1974). Temperatures of 3° to 4°C are the lowest in which redfish are born in the gulf, with 8° to 9°C being the maximum (TRIGOM-PARC, 1974). On the Scotian Shelf larvae are scattered along the shelf edge in April, mainly to the north and east in May and over most of the shelf by July (O'Boyle et al., 1982).

Thorny skate

Thorny skate produce egg capsules year-round. Peak spawning occurs on Georges Bank and in the Gulf of Maine from April to September. On the Scotian shelf the height of the spawning season is delayed until the October-December time period (Bigelow and Schroeder, 1953b; Templeman, 1982).

Smooth skate

Little is known about the spawning habits of this species. Eggs cases have been trawled in Canadian waters in July and August and it is considered a summer spawner in the Gulf of Maine region (Bigelow and Schroeder, 1953).

Cusk

Cusk spawn in spring and early summer in the Georges Bank-Gulf of Maine region. Eggs and larvae are pelagic. Spawning begins in April and continues through July (Bigelow and Schroeder, 1953; Colton et al., 1979). Peak spawning occurs in April and May. There is a temporal delay in spawning on the Scotian Shelf. Oldham (1972) reported finding ripe fish from May through August on the southwestern Scotian Shelf with peak activity occurring toward

the end of June.

Witch flounder

Witch flounder spawn from spring through summer in coastal waters off northeastern United States. Eggs and larvae are pelagic. In the Middle Atlantic area spawning occurs from April through August, with peak activity in May and June (Colton et al., 1979; MARMAP, unpublished data). Evseenko and Nevinsky (1973) reported eggs off southern New England in May and in the southern New England-Georges Bank region in June. Bigelow and Schroeder (1953) concluded that witch flounder spawned in the Gulf of Maine in late spring and summer, with peak activity in July and August but Colton et al. (1979) reported peak spawning in the gulf in May and June. On the Scotian Shelf spawning occurs in late spring and summer (Evseenko and Nevinsky, 1975; Leim and Scott, 1966).

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Table 1. Spawning seasons for principal coastal species in five subareas off northeastern United States and eastern Canada. Period of peak spawning in parenthesis.

	Middle Atlantic	Southern New England	Georges Bank	Gulf of Maine	Scotian Shelf
<u>Boreal (shallow) species</u>					
Sea herring	None reported	Oct-Dec (Oct)	Sep-Dec (Sep-Oct)	Aug-Dec (Sep-Oct)	Aug-Nov (Sep-Oct)
American plaice	None reported	Feb-Jun (Apr-May)**	Feb-Jun (Apr-May)	Feb-Jun (Apr-May)	Mar-Jun (Apr-May)
Atlantic cod	Nov-Apr (Mar-Apr)	Nov-May (Nov-Mar)	Nov-May (Feb-Mar)	Nov-May (Mar-May)	Nov-Mar (Mar-Apr)
Pollock	Oct-Mar (Dec-Jan)	Oct-Mar (Dec-Jan)	Oct-Mar (Dec-Jan)	Oct-Mar (Dec-Jan)	Oct-Mar (Nov-Dec)
Haddock	None reported	Jan-May (Mar-Apr)	Jan-May (Mar-Apr)	Feb-May (Mar-Apr)	Mar-May (Mar-Apr)
<u>Boreal (deep) species</u>					
Witch flounder	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)	Apr-Sep (May-Jun)
Redfish	None reported	Apr-Jul (May-Jun)**	Apr-Aug (Jun-Jul)**	Apr-Aug (Jun-Jul)	May-Sep (Jun-Jul)
Cusk	None reported	Apr-Jul (Apr-May)	Apr-Jul (Apr-May)	Apr-Jul (Apr-May)	May-Aug (Jun)
Wolfish	None reported	None reported	Nov-Jan (peak unknown)	Nov-Jan (peak unknown)	Nov-Jan (peak unknown)
Atlantic argentine	None reported	None reported	None reported	Mar-May (Mar)	Mar-May (Mar)
Thorny skate	None reported	Probably none	All year (Apr-Sep)	All year (Apr-Sep)	All year (Oct-Dec)
<u>Warm water species</u>					
Bluefish	May-Aug (Jul)	May-Aug (Jul)	None reported	None reported	None reported
Northern sea robin	Jun-Oct (Aug-Sep)	Jun-Oct (Aug-Sep)	None reported	None reported	None reported
Scup	May-Aug (May-Jun)	May-Aug (May-Jun)	None reported	None reported	None reported
Longfin squid	Apr-Sep (Jun-Sep)	Apr-Sep (Jun)	Apr-Jul (Jun)	Jul (Jul)	None reported
Fourspot flounder	May-Sep (Jul)	Jun-Aug (Jul)	Jun-Aug (Jul-Aug)	None reported	None reported
Summer flounder	Sep-Dec (Oct-Nov)	Aug-Nov (Oct)	Sep-Nov (Oct)	None reported	None reported
Butterfish	May-Sep (Jun-Jul)	May-Sep (Jul)	Jun-Sep (Jul)	Jun-Sep (Jul)	None reported
<u>Eurythermal species</u>					
Ocean pout	None reported	Sep-Oct (Oct)	Sep-Oct (Sep)	Sep-Oct (Sep)	Sep-Oct (Sep)
Longhorn sculpin	None reported	Nov-Feb (Dec-Jan)	Nov-Feb (Dec-Jan)	Nov-Feb (Dec-Jan)	Nov-Feb (Dec-Jan)
Yellowtail flounder	Mar-Aug (May)	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)	Apr-Aug (Jun)**	Jun-Aug (Jun)
Winter flounder	Mar-May (May)	Feb-May (Feb-Mar)	Mar-May (Apr)	Apr-May (Apr)	Apr-May (May)
Windowpane	May-Nov (May-Sep)	May-Nov (Sep)	Jun-Oct (Jul-Aug)	Jun-Oct (Jul-Aug)	Jun-Oct (Jul)
Little skate	All year (Nov-Jan&Jun-Jul)	All year (Nov-Jan&Jun-Jul)	All year (Nov-Jan&Jun-Jul)	All year (Oct-Jan)	All year (Oct-Jan)
Winter skate	None reported	All year (Apr-May&Nov-Feb)	All year (Apr-May&Nov-Feb)	Aug-Nov (Sep)	Aug-Nov (Sep)
<u>Stenothermal species</u>					
Red hake	Mar-Oct (Jun-Jul)	Mar-Oct (Aug-Sep)	May-Sep (Jun-Jul)	May-Sep (Jun-Jul)	Jun-Aug (July)
Spiny dogfish	Nov-Feb (Jan)	Nov-Feb (Jan)	Sep-May (Jan-Mar)**	None reported	None reported
Silver hake	Apr-Oct (Sep)	May-Oct (Jun)	May-Oct (May-Aug)	Jun-Oct (Jul-Aug)	Jul-Sep (Aug-Sep)
Sea raven	None reported	Oct-Dec (Nov-Dec)	Oct-Dec (Nov)	Oct-Dec (Nov)	Oct-Dec (Nov)
Cunner	Apr-Oct (Jun)	Apr-Oct (Jun)	May-Aug (May-Jun)	Jun-Sep (May-Jun)	Jun-Sep (Jun-Jul)
American lobster	May-Aug (May-Jun)	May-Aug (May-Jul)	Jun-Aug (Jul-Aug)	Jul-Aug (Jul-Aug)	Jul-Aug (Jul-Aug)
White hake	Oct-Apr (Dec-Feb)	Oct-Mar (Dec-Feb)	Oct-May (peak unknown)	Nov-Apr (peak unknown)	Sep-Nov (Sep)
Goosefish	Mar-Aug (May-Jun)	Apr-Aug (Jun)	Jun-Aug (Jun-Jul)	Jun-Sep (Jun-Jul)	June-Sep (Jul)
<u>Other</u>					
Alewife*	Mar-Apr (Apr)	Mar-Apr (Apr)	None reported	Apr-May (May)	May-Jun (Jun)
Blueback	Apr-Jun (May)	Apr-Jun (May)	None reported	May-Jun (Jun)	Jun (Jun)
Sand lance	Nov-Mar (Jan-Feb)	Nov-Mar (Jan-Feb)	Nov-Mar (Jan-Feb)	Dec-Apr (Feb-Mar)	Nov-Feb (Nov-Feb)
Atlantic mackerel	Apr-Jun (Apr-May)	Apr-Jun (May)	Apr-Jul (May-Jun)**	May-Jul (Jun)**	May-Jul (May-Jun)**
Gulf Stream flounder	May-Oct (Jul-Aug)	Jun-Oct (Jul-Aug)	Jun-Oct (Jul-Aug)	None reported	None reported
Rock crab	All year (Apr-Jun)	All year (Apr-Jun)	All year (Apr-Jun)	All year (Apr-Jun)	All year (Apr-Jun)
Junah crab		Jul (Jul)			
Sea scallop	Jul-Sep (Aug)	Jul-Sep (Aug)	Sep-Oct (Sep-Oct)	Aug-Oct (Aug-Sep)	Sep-Oct (Sep)
Swordfish	None reported	None reported	None reported	None reported	None reported

*Anadromous species - spawn in rivers adjacent to the above subareas.

**Eggs and/or larvae scattered, spawning considered insignificant.

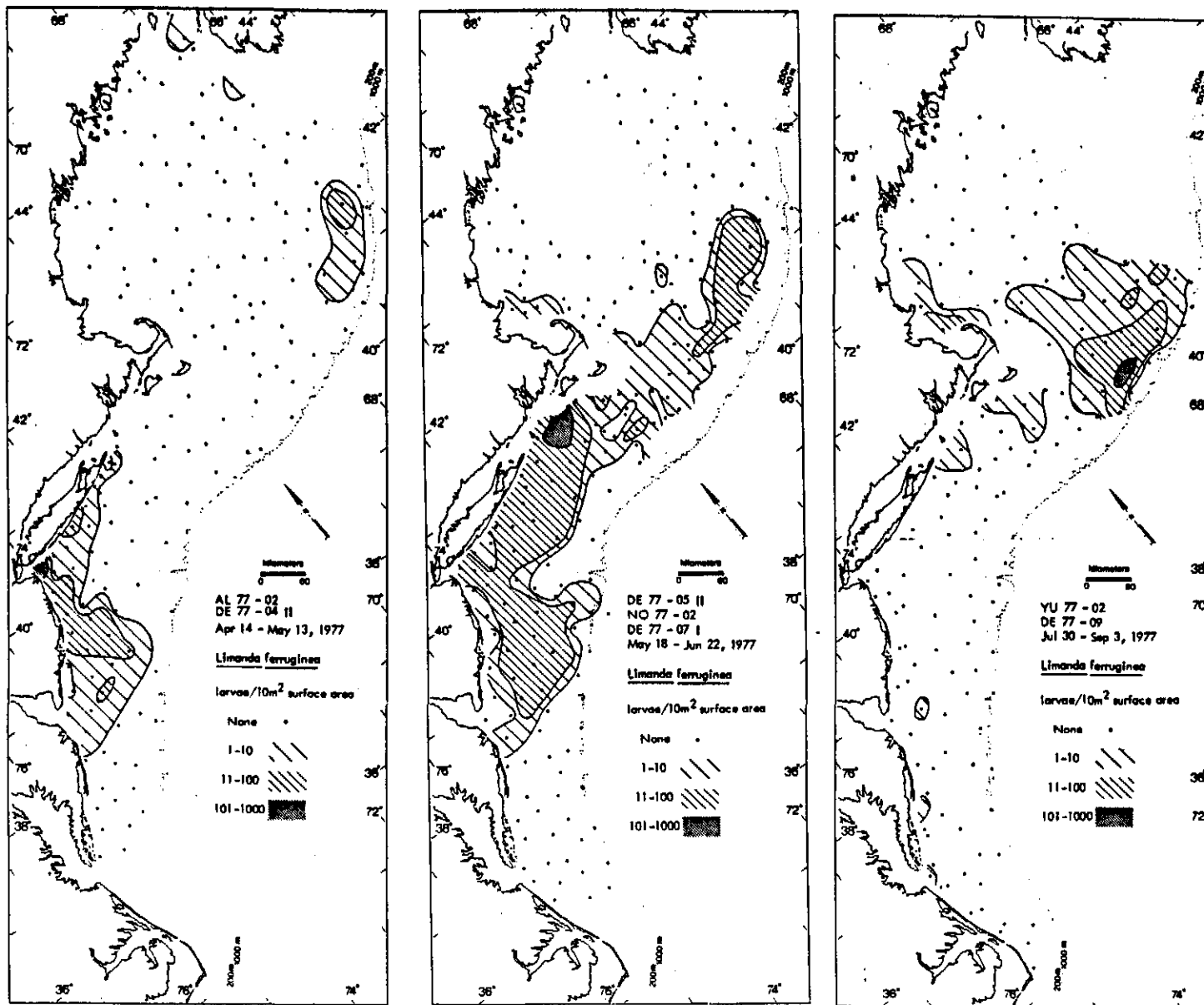


Figure 1. Distribution of yellowtail flounder larvae during spring 1977 as determined from MARMAP surveys.

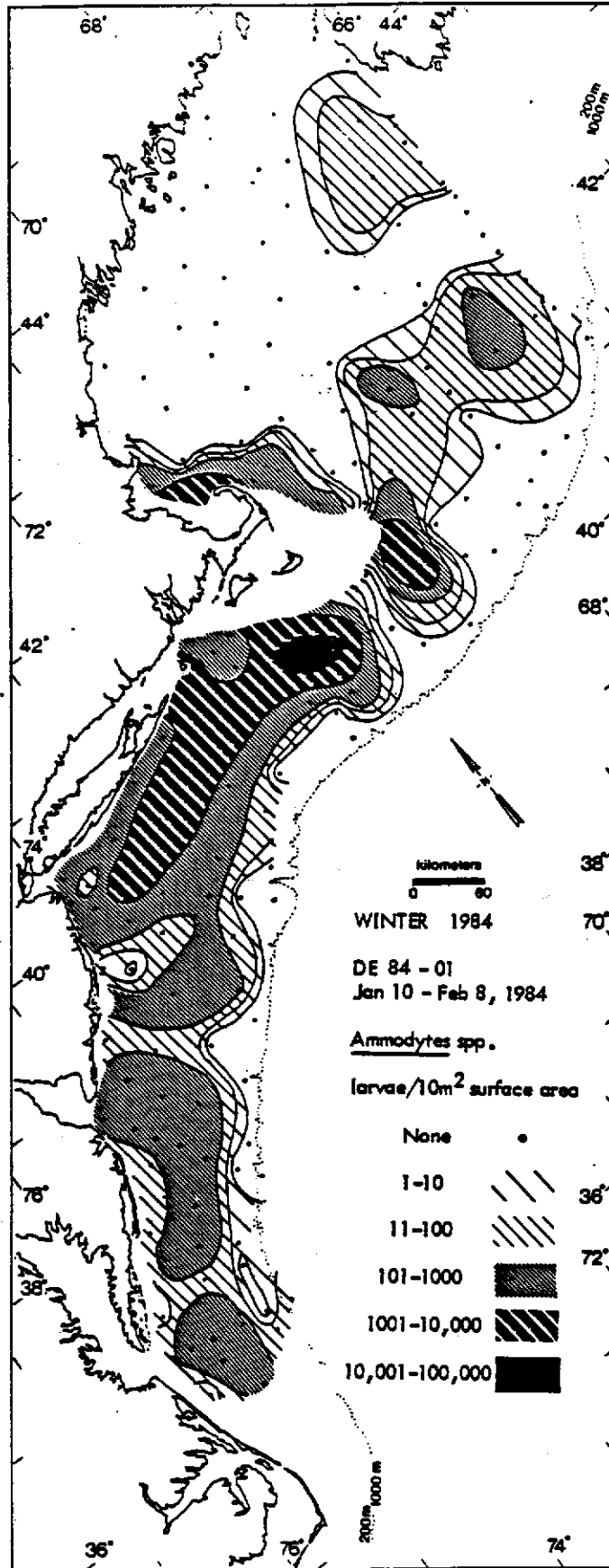


Figure 2. Distribution of sand lance larvae during winter 1984 as determined from MARMAP surveys.

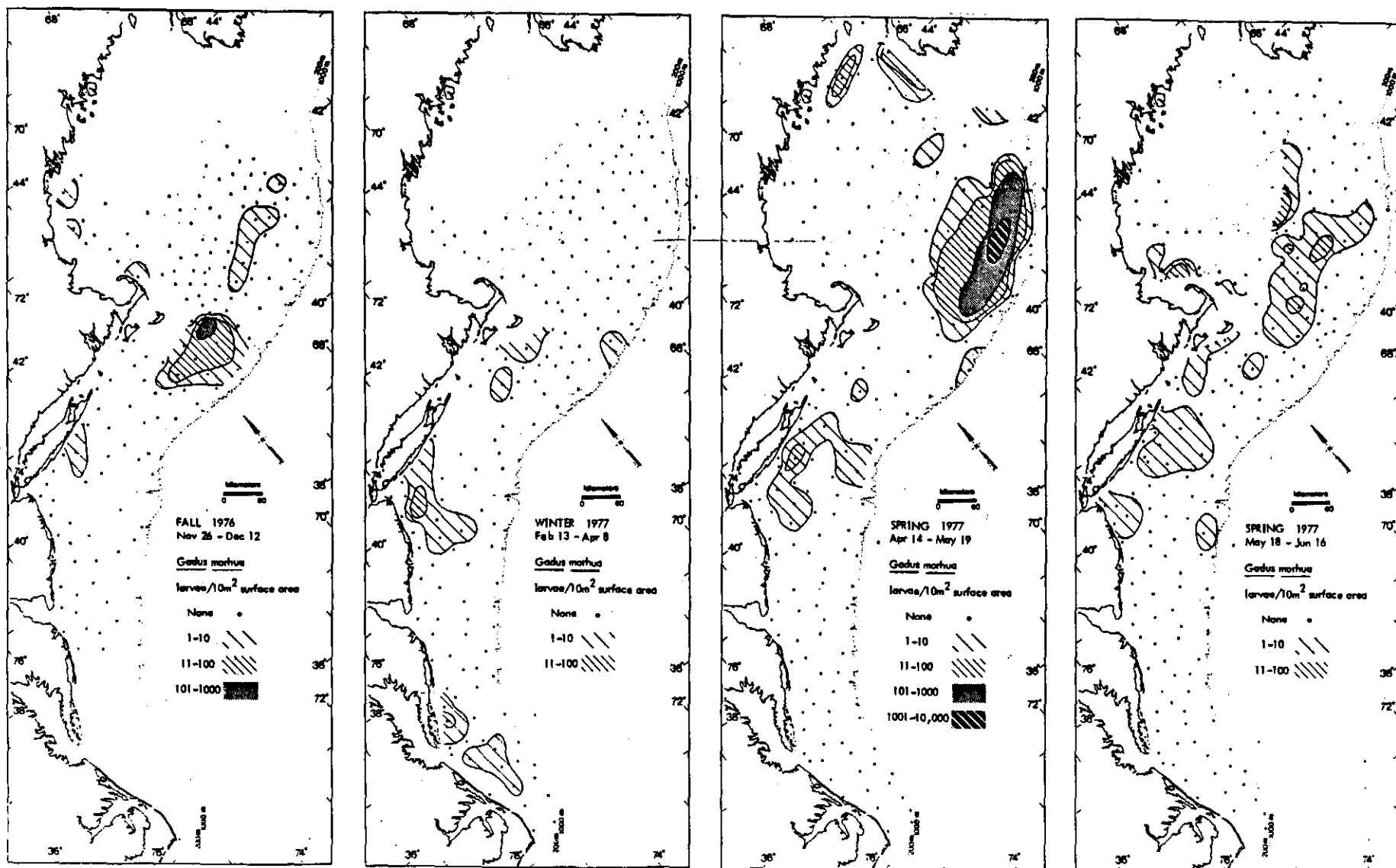


Figure 3. Distribution of Atlantic cod larvae during autumn through spring spawning season of 1976/77 as determined from MARMAP surveys.

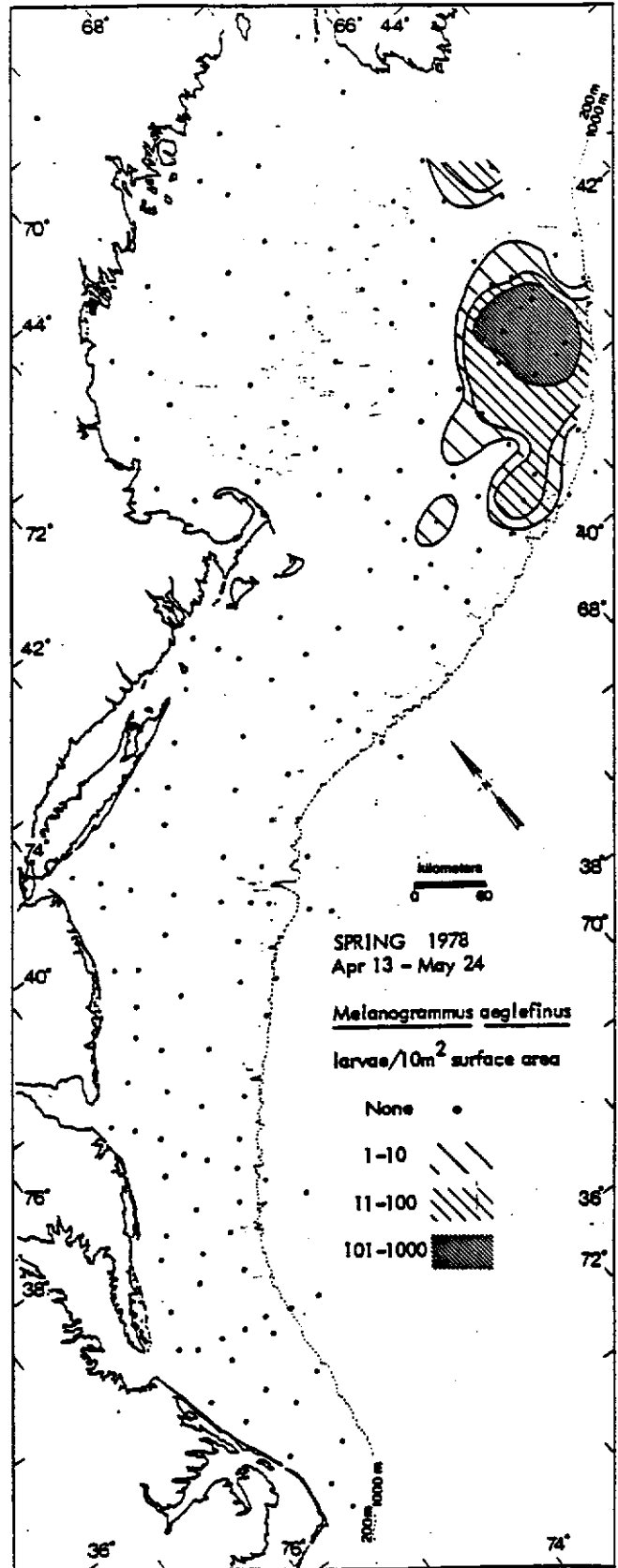
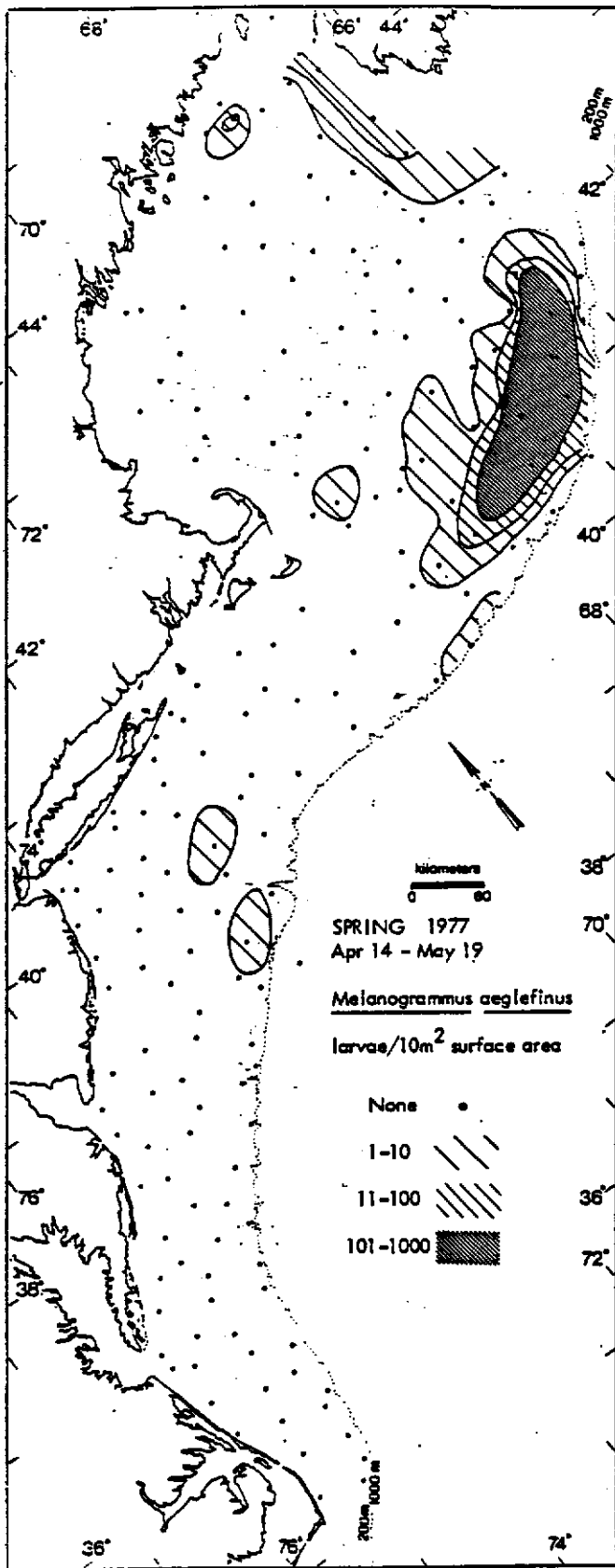


Figure 4. Distribution of haddock larvae during spring of 1977 and 1978 as determined from MARMAP surveys.

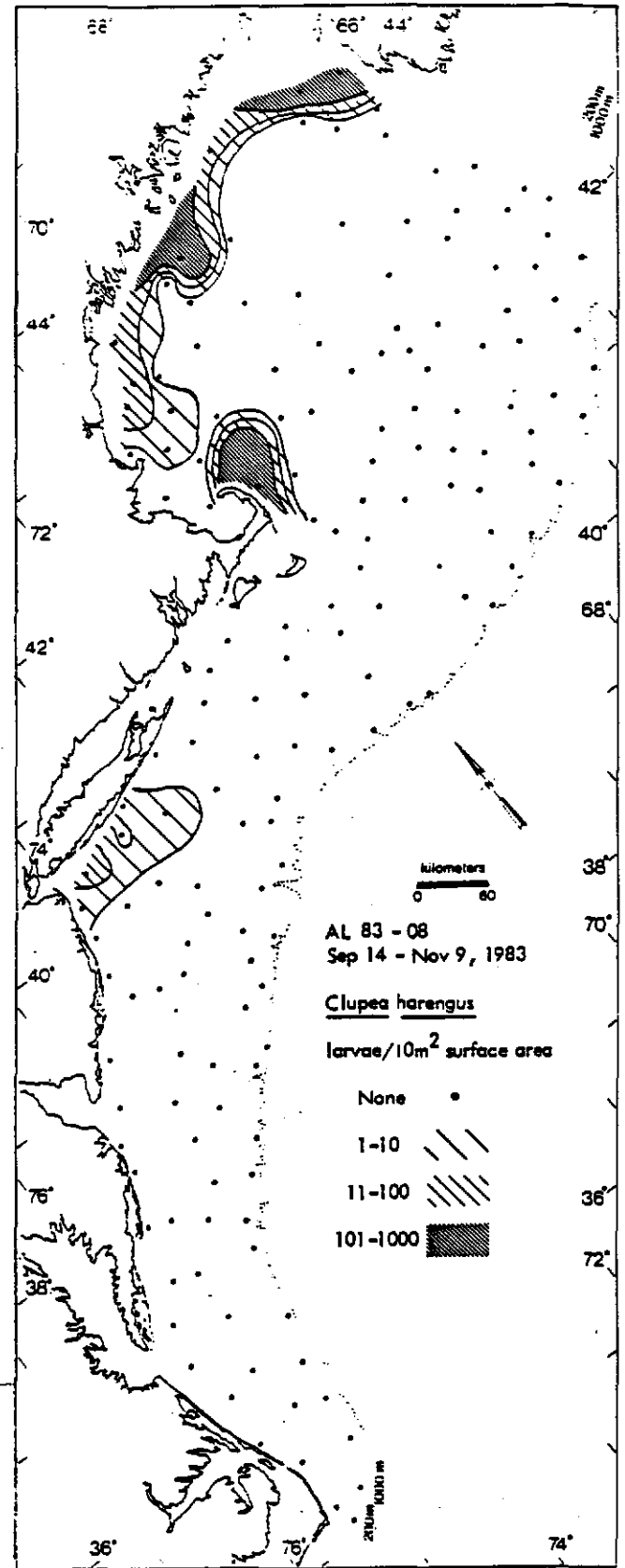
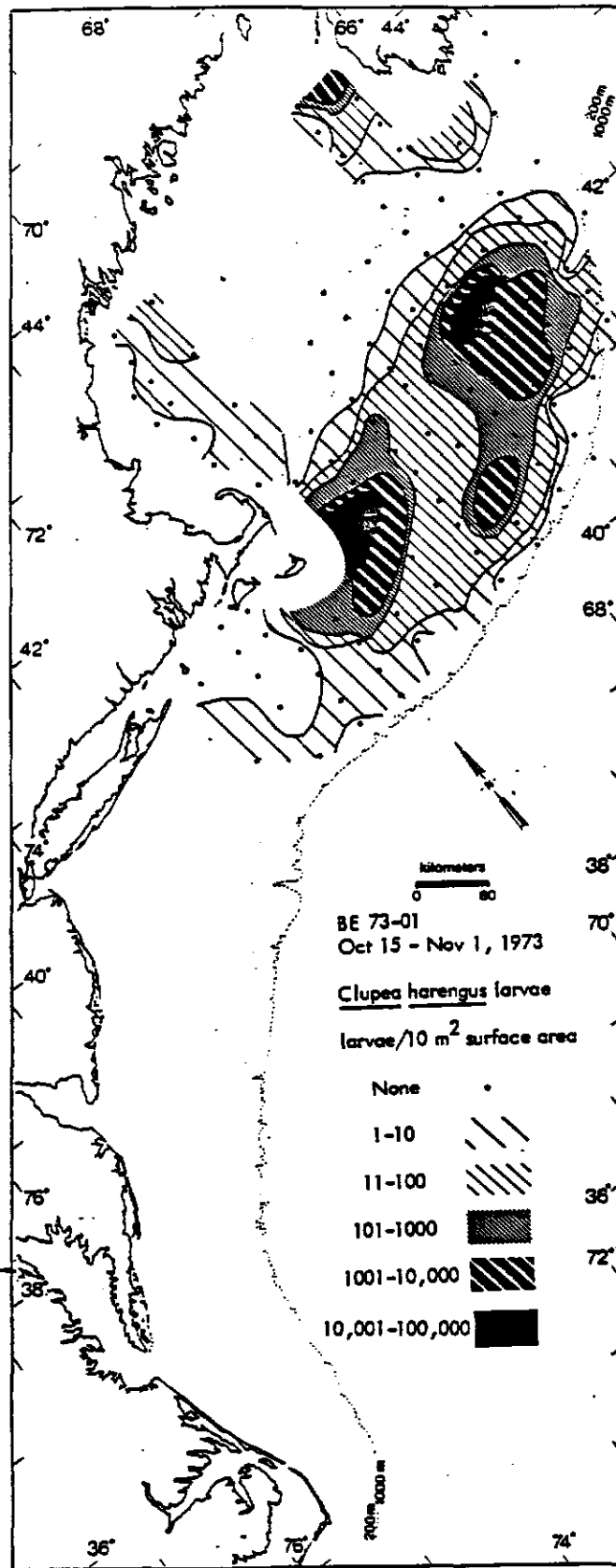


Figure 5. Distribution of herring larvae in autumn 1973 and 1983 showing differences in spawning activity on Georges Bank.

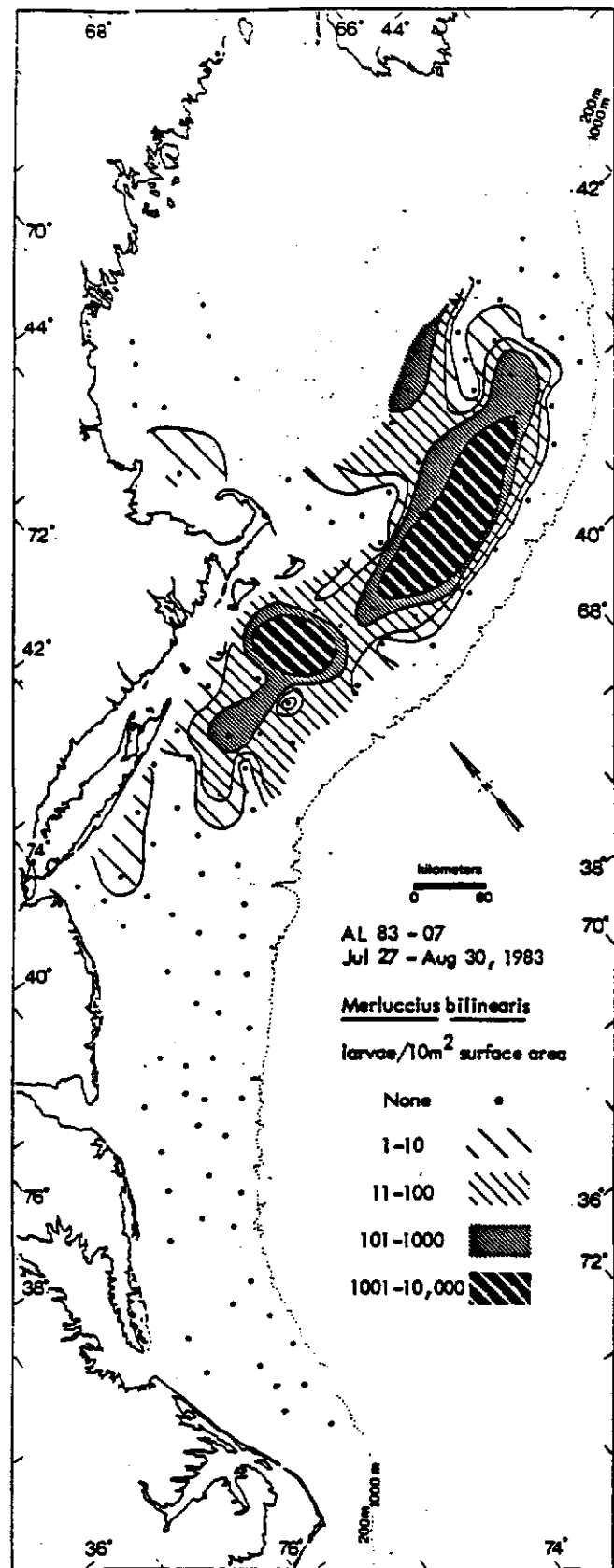
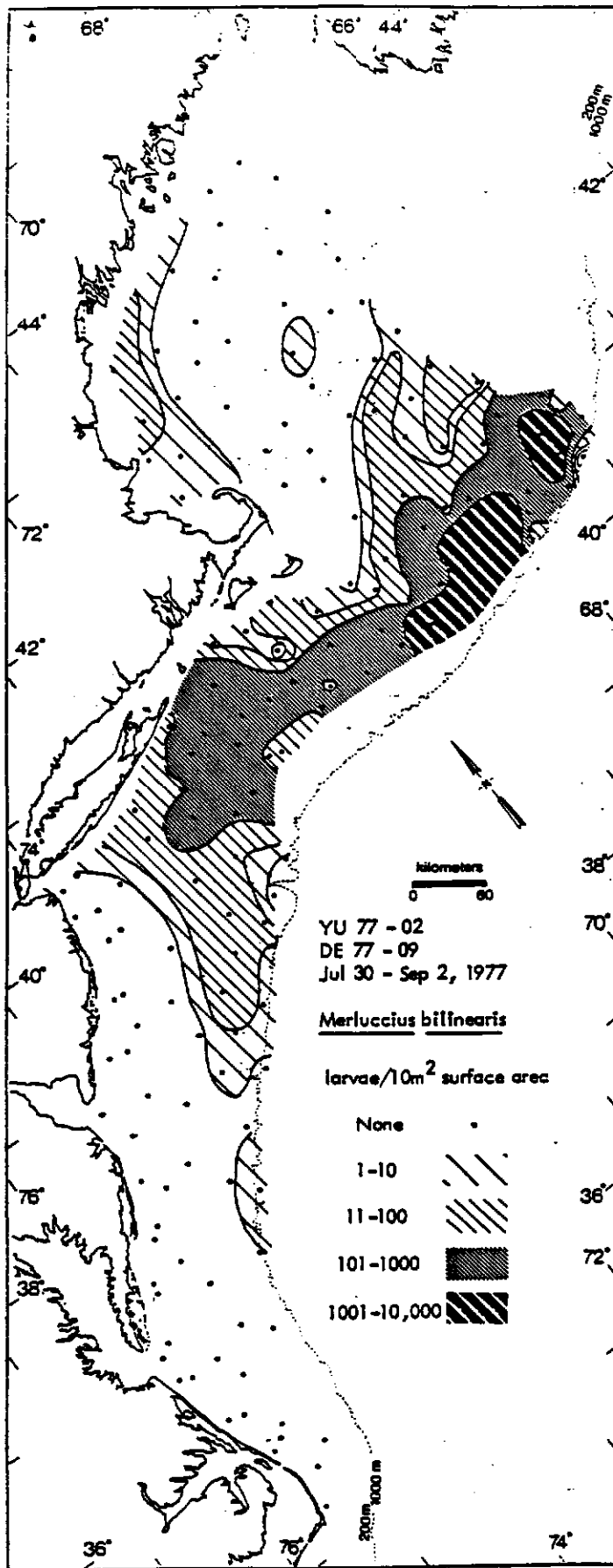


Figure 6. Distribution of silver hake larvae during summer of 1977 and 1983 as determined from MARMAP surveys.

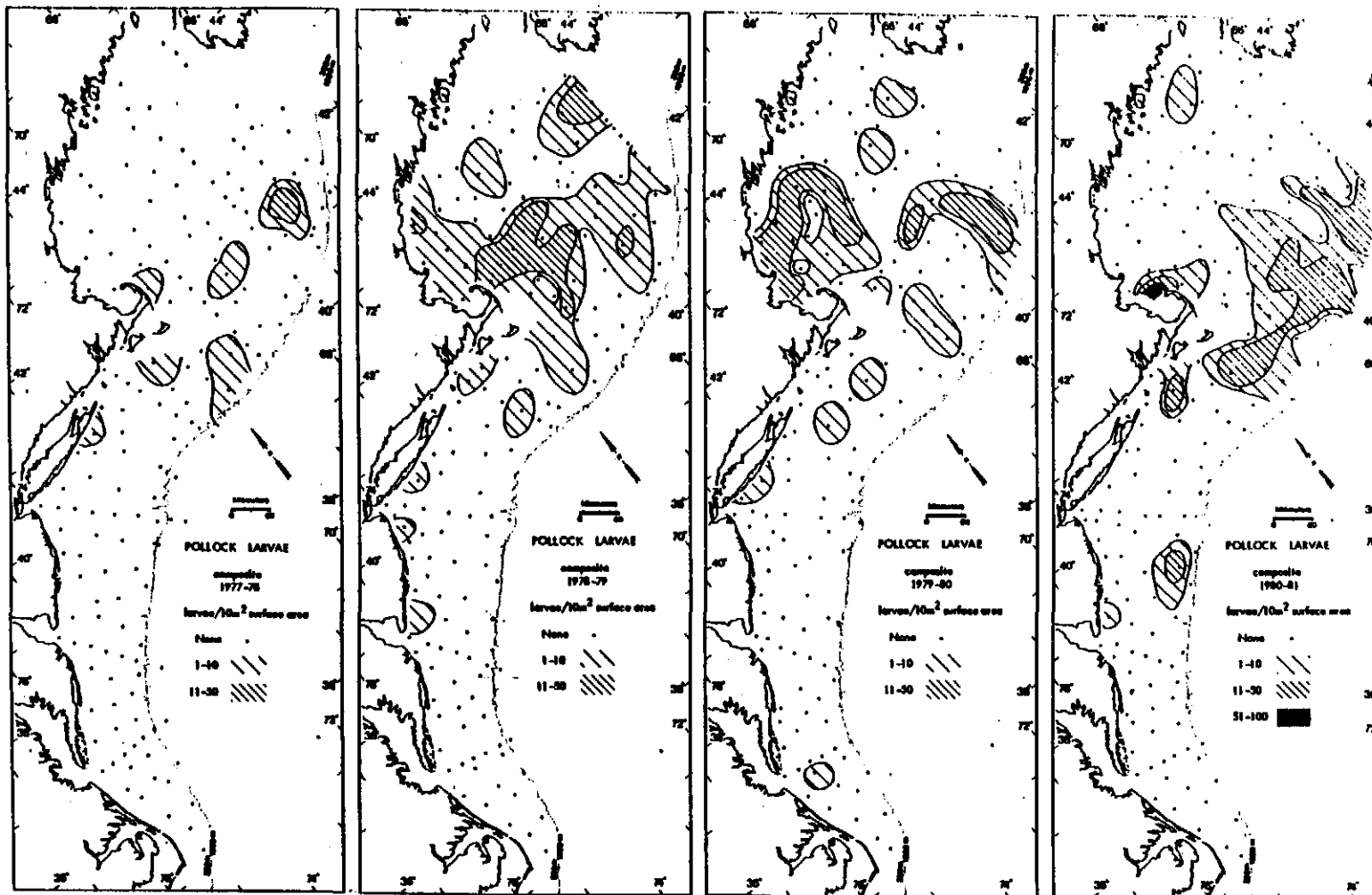


Figure 7. Distribution of pollock larvae as determined from MARMAP surveys, 1977-78 through 1980-81. Maps are composite of larvae taken on autumn through spring surveys.

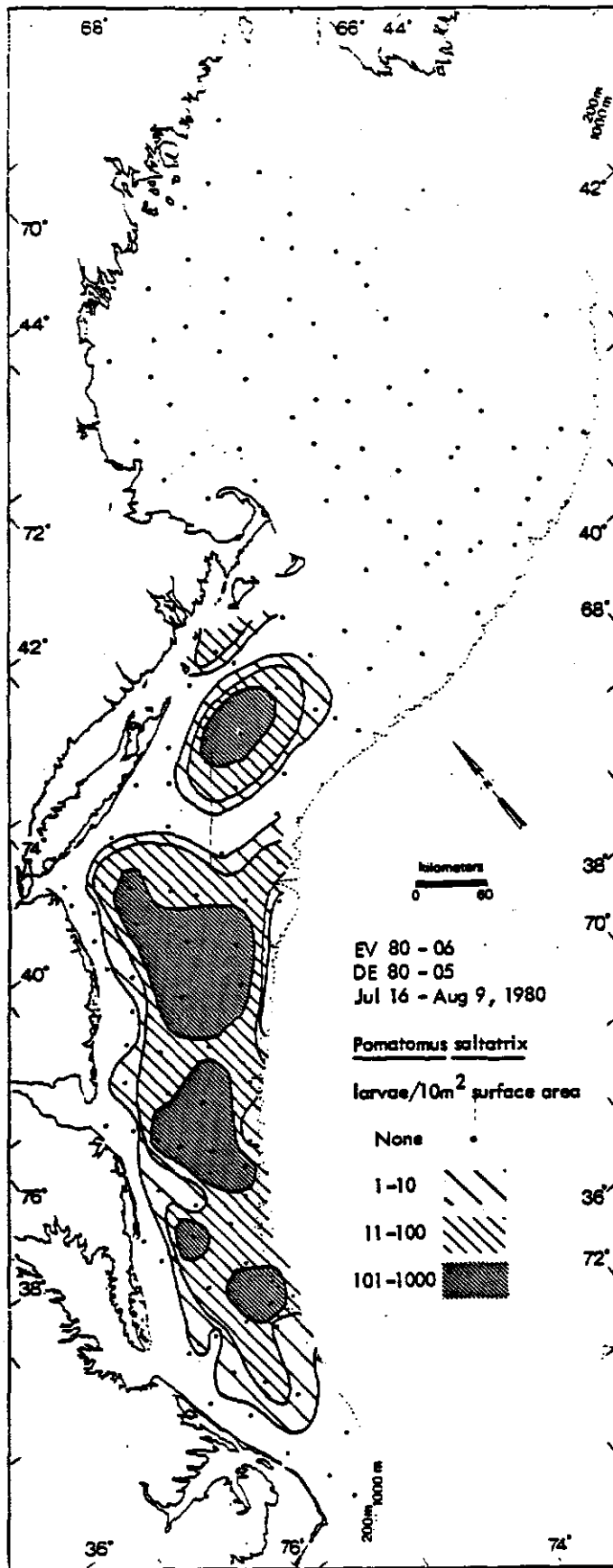


Figure 8. Distribution of bluefish larvae during summer 1980 as determined from MARMAP surveys.

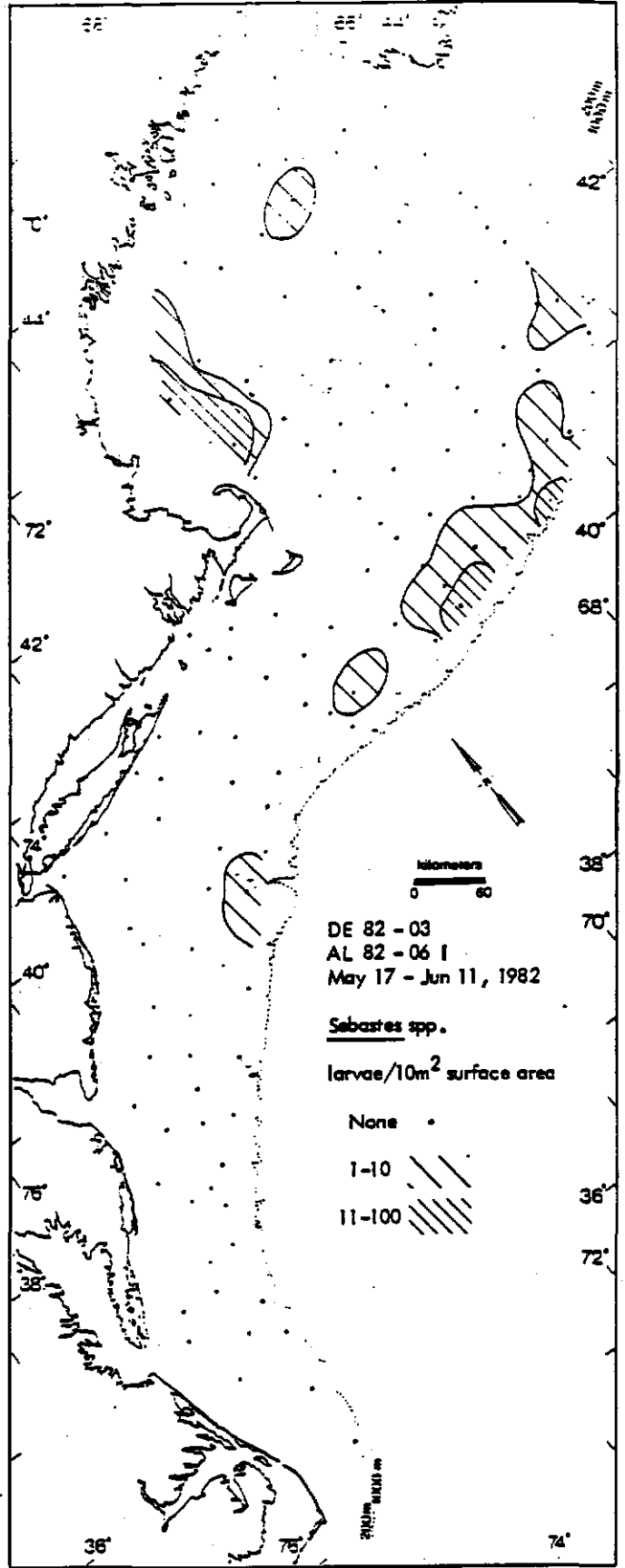
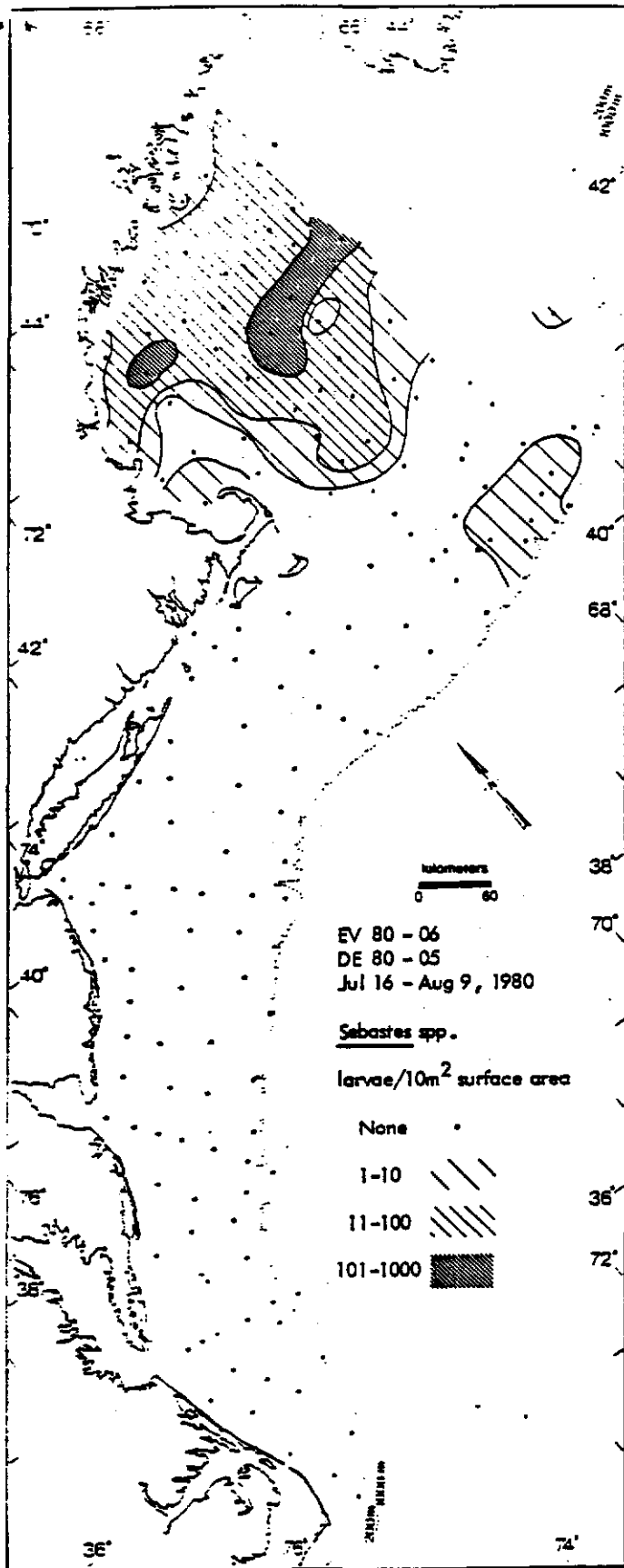


Figure 9. Distribution of redfish larvae as determined from MARMAP surveys.