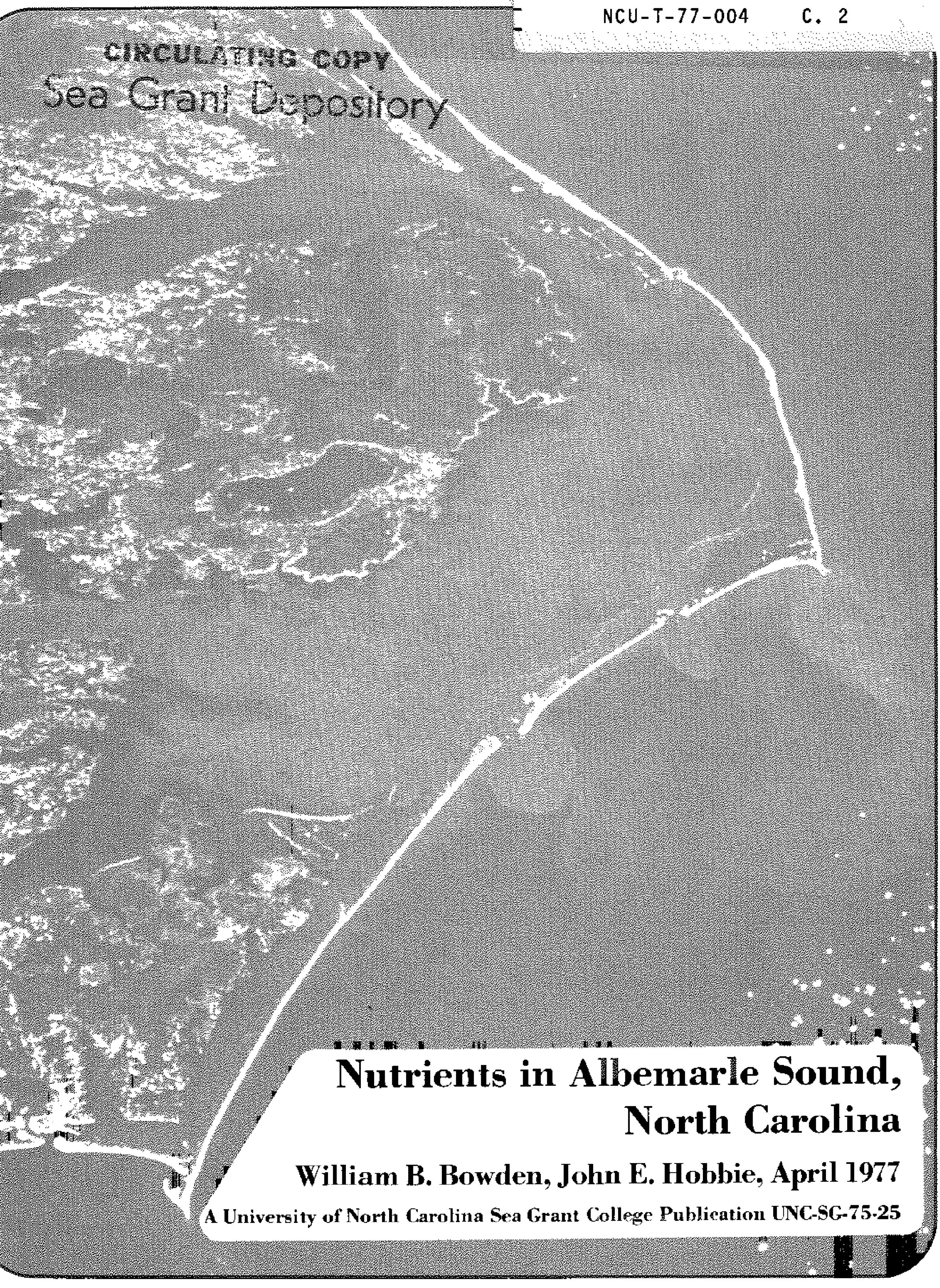

Nutrients in Albemarle Sound, North Carolina

William B. Bowden, John E. Hobbie, April 1977

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NUTRIENTS IN ALBEMARLE SOUND, NORTH CAROLINA

by

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ABSTRACT

The quality of water and degree of eutrophication were measured in Albemarle Sound, a large oligohaline sound in North Carolina. Total unfiltered phosphorus (TUP) concentrations ranged from 0.27 ug-at/liter to 12 ug-at/liter while reactive phosphorus (RP) ranged from undetectable levels to 6.1 ug-at/liter. Nitrate was the most abundant form of nitrogen ranging from 0.01 ug-at/liter to 82.7 ug-at/liter while ammonium ranged from 1.37 ug-at/liter to 35.42 ug-at/liter. Dissolved organic nitrogen (DON) ranged from 5 ug-at/liter to 20 ug-at/liter but actually may have been the largest pool of nitrogen since the digestion procedure used underestimated the actual concentration of DON. Particulate nitrogen (PN) ranged from 1 ug-at/liter to 10 ug-at/liter.

The patterns of nutrient concentration over time in Albemarle Sound were similar to those found in the near-by Tar-Pamlico and Neuse River systems, with some exceptions. Albemarle Sound exhibited a winter peak in RP that was not evident in the other two systems and the RP level in the Neuse and Albemarle systems was generally much less than in the Pamlico system. Nitrate exhibited a strong winter peak in all three systems while ammonium, DON, and PN showed no discernable patterns.

Although nutrients seem to be abundant, algal bloom conditions were surprisingly infrequent. Chlorophyll *a* concentrations ranged from less than 1 ug chl *a*/liter to 43.3 ug Chl *a*/liter. Algal productivity is apparently restricted by a combination of low light, low temperature, and high flow in the winter and low light in the summer caused by turbidity.

At present the sound is healthy with few signs of excessive eutrophication. However, the Albemarle Sound watershed is a rapidly developing region.

Increased non-point source pollution from second-home developments or reduced turbidity as a result of dams could rapidly accelerate the eutrophication process in this system.

ACKNOWLEDGMENTS

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Several people contributed to this project in different ways. Dr. B. J. Copeland, Director of the North Carolina Sea Grant Program, took an active interest in this project. Captain Henry Daniels provided boat support for all sampling cruises. James Berry, David Gossett, and Jean Dixon conducted the field and laboratory analyses. Coyla McCullough and Henri Davis performed the data reduction and composed the graphics. Judi Woodard typed and assisted in the preparation of the final report. Nathaniel W. Smith provided logistic and managerial help during the sampling phase and guided this report through various stages of final preparation.

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I. CONCLUSIONS

I. A. Summary of Results

1. Nutrients are abundant in Albemarle Sound. Nitrogen concentrations are similar to those found in the Pamlico and Neuse Rivers with dissolved organic nitrogen, nitrate, and ammonia being most abundant (in that order). Nitrate has a pronounced seasonal distribution with a strong peak in the winter; ammonia and dissolved organic nitrogen, in contrast, show no consistent seasonal pattern.

Total phosphorus is present in only half the concentration found in the Neuse and Tar-Pamlico systems. Reactive phosphate concentrations are similar in the Albemarle and Neuse systems which have about half the amount of reactive phosphate found in the Tar-Pamlico system. In addition, there is a winter peak in the Albemarle in reactive phosphorus that is not found in the other two estuaries. Therefore, these three estuarine systems are most alike with respect to nitrogen, but differ with respect to phosphorus.

2. Some of the differences in concentrations and seasonal cycles of nutrients can be explained by the greater degree of urbanization in the Neuse and Tar-Pamlico River basins than in the Albemarle basin. Although all three basins contain large areas of farmland, the Tar-Pamlico and Neuse basins appear to be more intensively cultivated than the Albemarle, or at least to have more agricultural runoff that contributes nutrients. Other differences may be found in cities--both the Neuse and Pamlico estuaries have sizeable cities at their western ends -- and in individual industries -- the Pamlico estuary is influenced by Texasgulf's phosphate mine and the Albemarle is influenced by a fertilizer plant on the Chowan River.

3. The ratios of dissolved inorganic nitrogen to reactive phosphorus are relatively high in Albemarle Sound while they are much lower in the Neuse and Pamlico estuaries. Algae on the average take up 16 atoms of nitrogen for every one of phosphorus. Therefore, phosphorus is in shorter supply in the Albemarle than in the other two estuaries where phosphorus is so abundant, relative to nitrogen, that it is never in short supply.

4. Algae are never very abundant in the Albemarle Sound; the total range of chlorophyll a is 1 to 40 ug/liter. In contrast, large blooms in the Neuse and Pamlico estuaries routinely reached concentrations of 100 to 200 ug Chl a/liter. Yet, there is an abundance of nutrients in Albemarle Sound, so it must be concluded that the nutrient concentrations are not limiting algal growth. Instead, the algal growth in winter is likely limited by a combination of temperature, light, and washout due to high amounts of water moving through this estuary. In summer, the turbidity of the estuary, which reduces the light supply, is probably the main factor keeping the algae from blooming, but flow can be important at certain times.

5. Albemarle Sound is much less saline than the Tar-Pamlico or Neuse River estuaries for two reasons. First, the Albemarle drainage basin is large (13,600 sq. miles) and the discharge is high (long-term average of about 5000 million gallons per day (mgd)). This discharge is sufficient to sweep saline water out of the system. In contrast, the Tar-Pamlico and Neuse River basins (4,300 and 6,200 sq. miles, respectively) are much smaller than the Albemarle basin and the long-term average discharges are lower (about 2000 mgd). As a result the surface salinities in these estuaries are much higher than in the Albemarle Sound.

Second, Albemarle Sound is essentially fresh because high salinity water is diluted before it can reach the sound. The closest salt-water source for Albemarle Sound is at Oregon Inlet on the opposite side of Croatan Sound. Oceanic water from Oregon Inlet is diluted in Pamlico Sound by the effluent from the Tar-Pamlico and Neuse Rivers. Effluent from the rivers emptying into Currituck and Albemarle Sounds tends to block the diluted seawater in Pamlico Sound from passing through Croatan Sound to Albemarle Sound. As a result Albemarle Sound remains essentially fresh most of the year.

6. Stratification in Albemarle Sound is weak and transitory at best. This has an important bearing on the oxygen status of bottom waters and the regeneration of nutrients from the sediments. Since the entire water column is apparently well mixed most of the time, oxygen is always present. As a result, aerobic organisms can thrive down to the bottom and aerobic decomposition which is faster than anaerobic decomposition can proceed readily. Therefore, nutrients are regenerated quickly. In addition, since the water column is well mixed, algae may be exposed to good light conditions for growth for portions of the day even though light penetration is minimal.

7. Oxygen is not only present, it is abundant throughout Albemarle Sound all year long. The percent oxygen saturation (considering temperature and salinity) is above 60% almost always and very often above 80 to 90%. Since stratification is not an important factor there is usually no substantial difference between surface and bottom oxygen concentrations. Temperature and photosynthetic activity can produce localized oxygen concentrations at or under supersaturation.

8. At the present time, Albemarle Sound is biologically healthy and shows few signs of cultural eutrophication.

I. B. Recommendations

1. This estuary is currently biologically healthy and relatively unproductive. Yet, the potential does exist for algal blooms that would

destroy recreational values and damage fisheries. For example, in the Chowan River a fertilizer industry formerly added effluent rich in nitrate and caused large blooms of blue-green algae. This could happen in the Albemarle by adding nitrate (or ammonia) from increased urban runoff, from increased agricultural runoff, or from a number of industrial effluents. Thus, if temperature or light become non-limiting or (what is more likely) if a highly productive alga begins to grow that can avoid these limitations (e.g. by floating as with the blue-green alga Amphinizomenon), then nutrient additions above some threshold value could be harmful. Although this threshold has been exceeded on occasion and localized blooms have resulted, there is no indication that the entire sound is in danger of becoming eutrophic in the near future. However, long-term planning should take this threshold into account. Albemarle Sound appears to be further from this threshold than the Pamlico or Neuse estuaries.

2. Additional upstream dams might degrade the health of Albemarle Sound. In view of the multiple uses of modern dams and reservoirs, the reservoirs will probably be held as high as possible during the summer and the flow through the sound will be reduced at these times. As a result the sound would become more like a lake than it is now and the increased flushing time would result in fewer suspended solids. Because nutrients are always relatively abundant and can be rapidly recycled, this reduced flushing time and deeper euphotic zone will allow large algal populations to build up. This might cause a shift in animal species (zooplankton, fish) and reduce the recreational value of this estuary.

II. INTRODUCTION

II. A. Background

The following report is a part of a series of papers, theses, and reports that describe the geology, chemistry, and biology of North Carolina's estuarine areas (see Hobbie 1974 for references). North Carolina has an extensive coastline (sixth in the nation, Clay et al. 1975) roughly equal to California's in length, and estuaries are an important feature of the coastline. Yet for many years North Carolina's estuaries, and coastal wetlands in general, were regarded as undesirable areas unless they were drained, filled, and developed. Gradually an awareness has grown that estuaries are self-sustaining nurseries for almost all of our important commercial and recreational shellfish and fish species. In addition, the fresh and salt water marshes that are characteristic of estuarine areas are important buffers for coastal inhabitants against storm tides. Furthermore, present investigations indicate that marshes may be efficient tertiary sewage treatment plants. Some even speculate that highly productive marsh vegatation may be an important source of organic material for fuels (e.g., methanol) in the future.

Gosselink et al. (1974) made a crude estimate of the economic value of estuaries and marshes. They argue that one way to view the worth of a coastal area is to calculate the capital investment required for an equivalent annual return at present interest rates. The value of the finfish catch in North Carolina in 1971 was about \$4 million while the shellfish catch was valued in excess of \$6 million. If we assume that these catches are wholly dependent on estuaries, estuaries were worth at least \$10 million to North Carolina in 1971. The capital investment required to get this annual return at a 6% interest rate is $167,000,000. (See Gosselink et al. (1974) for a discussion of the assumptions and simplications of this argument). In addition, the value of estuaries for recreation, development, and waste disposal must be considered. However, as Gosselink et al. (1974) pointed out, society places a much different value on coastal wetland areas than do owners.

The important problem is to determine, as a society, whether natural estuarine areas and their products are as important to us as other area use options, such as extensive condominium developments. If we are satisfied with the functions and benefits of estuaries for our society, then we should try to understand and preserve these areas. Yet, the general public, policy decision makers, and even scientists are not fully aware of all the benefits and services derived from estuarine areas. Once destroyed, these complex natural systems can not be replaced easily, if at all, and their products may be lost permanently.

The purpose of this report is to add to the baseline data and observations from other coastal systems in North Carolina. The Albemarle Sound and watershed are interesting because the sound is less saline and the watershed less urbanized than the other estuarine systems studied so far (Tar-Pamlico and Neuse). An effort has been made to point out similarities and differences between these systems.

II. B. Land Use In The Albemarle Sound Basin*

In a major stream, water quality is a function of several variables including history, geology, meteorology, demography, and economy of the

* The information presented here is a very brief condensation of sections from North Carolina Atlas: portrait of a changing southern state (1975, University of North Carolina Press, Chapel Hill, N. C.) edited by J. W. Clay, D. M. Orr, and A. W. Stuart. This book is an excellent source of social, economic, and natural data about the state of North Carolina.

associated watershed. The information in this section should be considered when studying and comparing the data in the sections that follow.

The Albemarle region of North Carolina has an extensive history of European influence. Iohn de Verrazano explored this area and the Cape Fear area in the spring of 1524 and Sir Walter Raleigh explored the Pamlico Sound, landing at Roanoke Island in 1584. In 1587 Raleigh appointed John White governor of what was to become the "Lost Colony" on Roanoke Island and it was not until the mid-1600's, after the settlement of Plymouth and Jamestown, that the area became attractive again as a site for a colony. The "Chowanock" or Chowan River was explored in 1622 by John Pory and shortly thereafter the first land grants were sanctioned. Nathaniel Batts set up a successful trading post with the Indians at the west end of Albemarle Sound in 1653 and George Durant received the Perquimans River area in a grant from Chief Kilcanen of the Yeopim Indians in 1662 (Lefler 1965). Afterwards, development spread rapidly south and west until the western mountain areas were settled in the 1820's. However, from the end of the Revolutionary War until the Civil War, North Carolina underwent a regression, dropping from fifth largest state in population in 1820 to twelfth in 1860. After the Civil War the economy and population of North Carolina grew rapidly. Today, compared to the other 49 states, North Carolina is the leading producer of tobacco and sweet potatoes, third in all crops combined, first in rural population, ninth in total manufacturing employment and tenth in value added by manufacturing.

Although the Albemarle region was the first area of North Carolina to be settled, it is presently much less urbanized than either the Tar-Pamlico River or Neuse River basins. However, there is good evidence that this is changing. From 1958 to 1967, the Albemarle Region underwent a 300% increase in urbanization - much higher than either the Tar-Pamlico or Neuse regions. Some of this increase is due to industrialization but most is due to an increase in recreational and second homes. The effects of urbanization on water quality are well documented (Leopold 1968) and it should be no surprise that as urbanization increases, the hydrology and water quality in this area will change.

Urbanization and industrialization are relatively recent processes in North Carolina. Manufacturing is dominated by three industries -- tobacco, furniture, and apparel -- with the highest concentration of industry in the "Piedmont Crescent". In the period from 1956 to 1972, manufacturing employment showed gains over most of the state with some of the largest changes occurring in the Tar-Pamlico and Neuse watersheds. Apparels, textiles, and electrical machinery account for much of the industry in this area. In contrast, manufacturing employment grew rather slowly in the Albemarle region with some counties recording a loss. Wood and paper products account for most of the industry in this area with some apparel, textile, and chemical manufacturers.

From its first settlement, North Carolina has been a largely agrarian state. Large plantations before the Civil War gave way to smaller tenant farms that are now reorganizing in "co-ops". Tobacco has always been a major cash crop; 339,000 acres yielded $549 million in 1971. Tobacco is a labor intensive crop that requires large amounts of fertilizer and pesticides that eventually affect the water quality in rivers draining the major tobacco growing regions (Tar-Pamlico, Neuse, and Cape Fear Rivers). In total acreage cultivated in North Carolina, corn leads tobacco with 1.5 million acres planted. It is used primarily as feed for cattle and hogs and is valued at $11.7 million. In the Albemarle basin, peanuts are particularly important (155,800 acres) along with soybeans and cotton.

The soil properties in this area have an important effect on agriculture and the quality of the runoff water that enters rivers. The near-surface rocks of the coastal plain are mostly of recent (Cenozoic) origin. They are sandy, shelly, or clayey soils with acidic, highly leached, well weathered characteristics (Ultisols and some Histosols). Nutrient retention in this soil is a problem because of these soil characteristics and because runoff is usually high. A mid-depth limestone strata that thickens towards the coast makes possible an extensive groundwater system with a freshwater table ranging from 200 to 600 feet thick. Wells in the coastal plain can be expected to provide from hundreds to thousands of gallons per minute.

Runoff in the Albemarle basin, where rainfall averages 45 to 55 inches per year, ranges from 0.5 to 1.0 million gallons per day per/square mile of watershed. This runoff contains from 25 to 30 mg of dissolved solids per liter in unpolluted, upstream sections and 30 to 70 mg/liter in downstream sections. The Chowan, Roanoke, Tar-Pamlico, and Neuse rivers generally carry in excess of 100 mg/liter. The water quality in the lower portion of these watersheds is generally classified as suitable for fish and wildlife (Class C). However in the upper reaches, where urbanization is most pronounced at present, water quality can range from suitable for drinking (Class A) to suitable for industrial and irrigational uses only (Class D).

II. C. Objectives

The first objective of this research project was to measure the water quality and the annual cycle of nutrients in Albemarle Sound. Second, we wished to assess the present degree of eutrophication as well as the potential for further eutrophication. The final objective was to compare the results and observations from this study to those gathered during studies in the nearby Tar-Pamlico and Neuse River estuaries. The results from all three studies are directly comparable since the same personnel, equipment, and procedures were used throughout.

III. SAMPLING AND METHODS

III. A. Study Area

Albemarle Sound is located on the North Carolina coast just below the Virginia border at approximately 36° north latitude and 76° west longitude. It is a classic drowned river valley estuary on a coastal plain characteristic of much of the coastal south east. The sound lies behind the North Carolina Outer Banks, a chain of barrier islands. The closest oceanic connection is south at Oregon Inlet through Croatan Sound, a straight-line distance of about 23 miles. Oceanic and tidal influences are therefore small. The sound itself extends about 56 miles east and west from its mouth to the Edenton bridge (N. C. route 17). A number of tributaries empty directly into the sound: the Perquimans, Little, Pasquotank, and North Rivers from the north; the Scuppernong and Alligator Rivers from the south; and the Roanoke and Chowan Rivers from the west and northwest at the head of the sound. The latter two rivers drain the largest watersheds: Roanoke about 9,700 sq. miles and Chowan about 4,900 sq. miles. Both watersheds extend well into Virginia with the Roanoke basin extending to the foothills of the Appalachian Mountains (Fig. 1).

III. B. Study Period

This study was conducted from 15 September 1970 to 29 January 1974. Samples were taken monthly except for the following months: August 1971, May and September 1972, January, February, August, and September 1973.

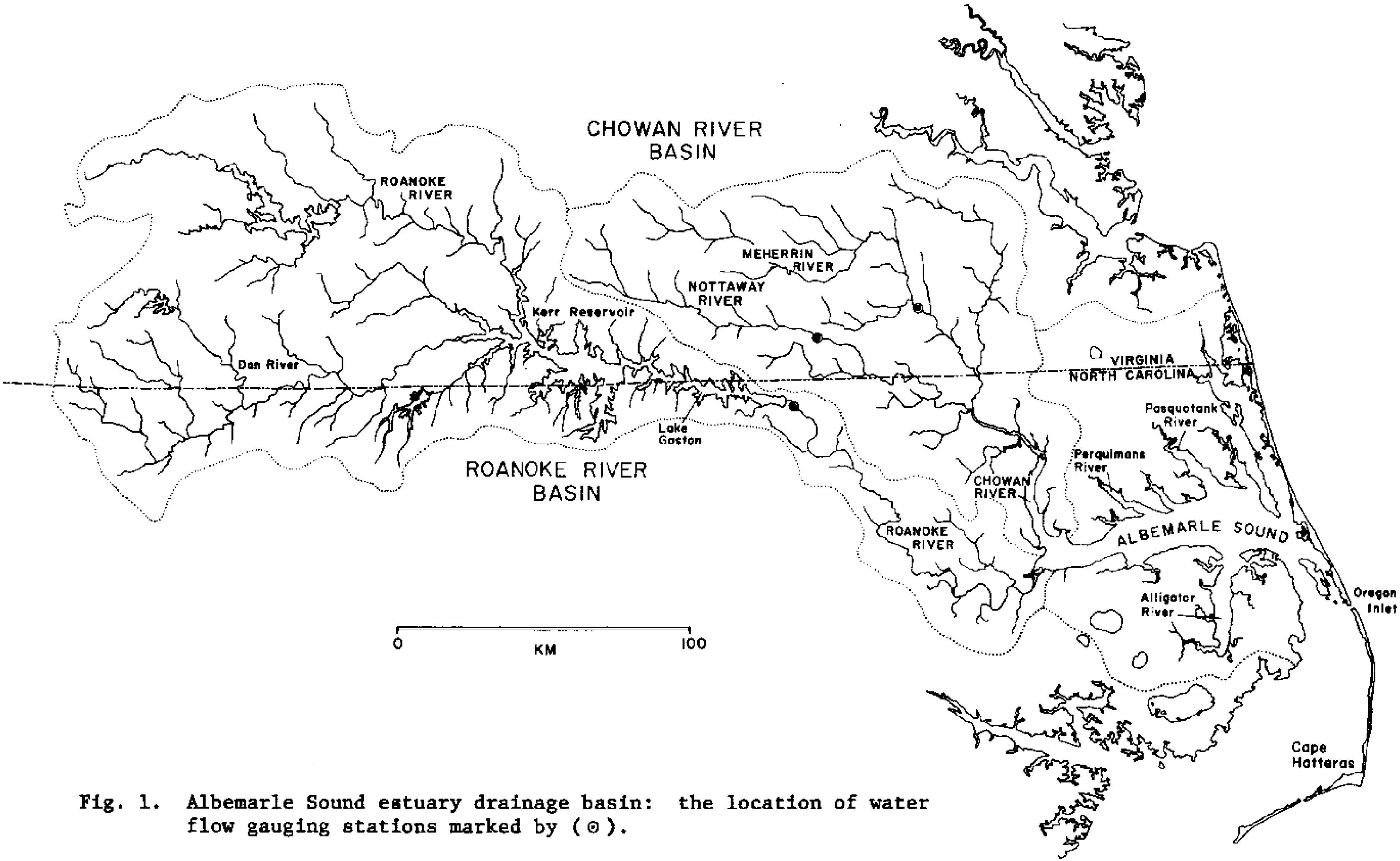


Fig. 1. Albemarle Sound estuary drainage basin: the location of water flow gauging stations marked by (⊙).

III. C. Location of Sampling Stations

Samples were taken at each of 15 stations (Fig. 2). Nine stations were located in or at the mouths of tributaries; six stations were located in the sound itself. The farthest upstream station (the Chowan River Station) was 76 miles from the mouth of the sound.

III. D. Sample Collection, Handling and Analysis

Samples were collected by boat on a two day field sampling run. Salinity and temperature were measured in the field with a Beckman RS5-3 induction salinometer. At each station, a part of the water sample was filtered through a Gelman "A" glass fiber filter and the rest of the water sample was frozen immediately in plastic bags on dry ice then transported to a field lab near Aurora, North Carolina, for later analysis.

Laboratory analyses included quantification of total unfiltered phosphorus, reactive phosphorus, nitrate, nitrite, ammonia, particulate nitrogen, dissolved organic nitrogen, and chlorophyll _a_.

Chlorophyll _a_ was measured by grinding the Gelman filters, extracting with 90% acetone, and estimating the pigment spectrophotometrically. The spectrophotometric results were corrected for phaeophytin (Strickland and Parsons 1968).

Details of the methods of phosphorus analysis are given in Hobbie (1970). Gelman A glass fiber filters were used for filtration, a part of the sample was oxidized with potassium persulfate (Menzel and Corwin 1965), and the final measurements made on a DU II Spectrophotometer after addition of a mixed reagent (Strickland and Parsons 1968). Three fractions were calculated as reactive P (no pre-treatment), as total unfiltered P (not filtered, but oxidized), and as total filtered P (filtered, oxidized).

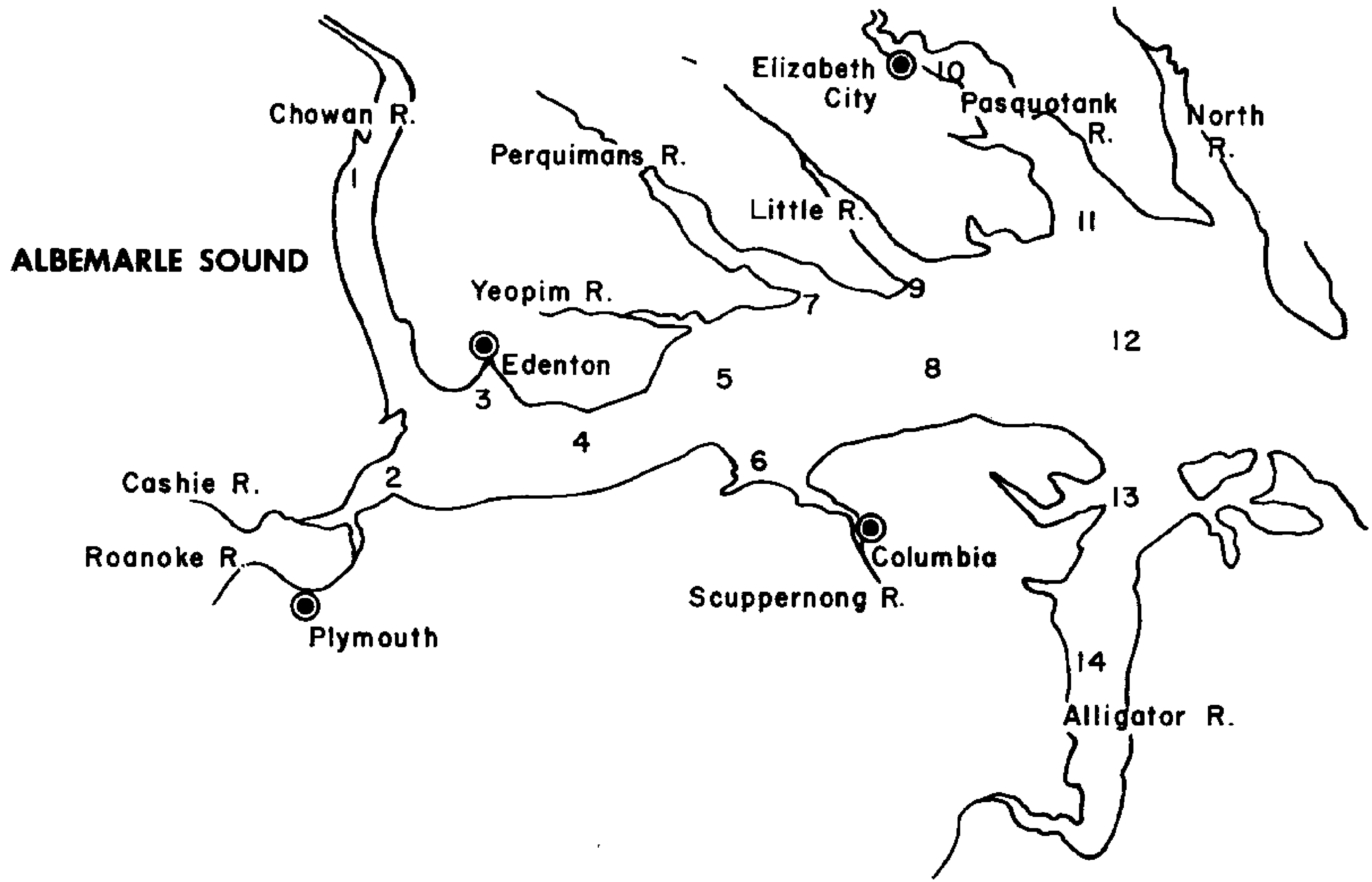


Fig. 2. Location of sampling stations. (⊙)

Nitrogen was analyzed as five different fractions. Most of the analyses consisted of various pre-treatments of a sample followed by analysis as nitrite. The nitrite was analyzed (Strickland and Parsons 1968) as an azo dye produced by sulphanilamide plus N- (1-napthyl)-ethylenediamine. The nitrate was analyzed as nitrite following reduction in a copper-cadmium column. Ammonia was also analyzed as nitrite by oxidization of the sample with alkaline hypochlorite, but this procedure (Strickland and Parsons 1968) really gives ammonia plus amino acids (the error is small). Two other analyses were also carried out for organic nitrogen using oxidation by strong UV light to convert organic forms to a mixture of nitrate and nitrite (Strickland and Parsons 1968). Both total unfiltered nitrogen (TUN) and total filtered nitrogen were measured (TFN). TUN minus TFN gives particulate nitrogen (PN). TFN minus the sum of nitrate, nitrite, and ammonia gives dissolved organic nitrogen (DON).

IV. RESULTS

The salinity and chemical data are presented in several forms. First, the data from 15 September 1970 to 5 June 1972 are presented as hand drawn surface contour maps. Second, beginning with 17 July 1972, the surface contour maps were constructed by a SYMAP computer program. The same program was also used to construct a map giving the depth profile of salinity at the stations along the middle of the sound. Third, the data for an entire year were summarized in isopleth graphs of average values as a function of river location and date. Finally, the data are presented in tables in appendices.

IV. A. Hydrography

IV. A. 1. Flow and Precipitation

Hydrological conditions varied throughout the study period (Fig. 3) (Water Resources data for North Carolina. Part 1: surface water records. 1970 to 1974. USGS). The 1970 water year (a water year starts in October and ends the following September) was exceptionally dry. Streams in the Coastal Plain reached lowest flow levels in August and September just prior to the commencement of this study. The dry period ended with rains starting on 27 and 28 September 1970. However, the estimated runoff deficiency for the year was 5.3 inches. The 1971 water year was characterized by a return to normal flow conditions. However, on the last day of the 1971 water year (30 September) Hurricane Ginger hit Morehead City traveling northwest and left from 6.0 to 9.2 inches of rain in 24 hours. Flooding was most notable in the Tar-Pamlico and Neuse River regions. The rest of the 1972 water year was characterized by a full return to normal flow conditions. Rain in late October, May, and late June 1972 (from tropical storm Agnes) caused additional heavy flow periods. The 1973 water year was an exceptionally wet year. Significant flooding occurred in early February and again in late June extending through August. Flow in the Neuse River index station was 179% above normal. The remainder of the study period (from October 1973 to January 1974) started with very low flows but ended with near normal flows after rains in late December. Flow in the Roanoke River can be regulated at the Kerr and Roanoke Rapids Reservoir dams to mitigate floods and insure adequate flow during droughts. This explains the abrupt topping of the high flow peaks on the Roanoke River (Fig. 3).

Discharge into Albemarle Sound is much higher than into the Tar-Pamlico or Neuse estuaries. The Roanoke River alone discharges from 400 to 150,000

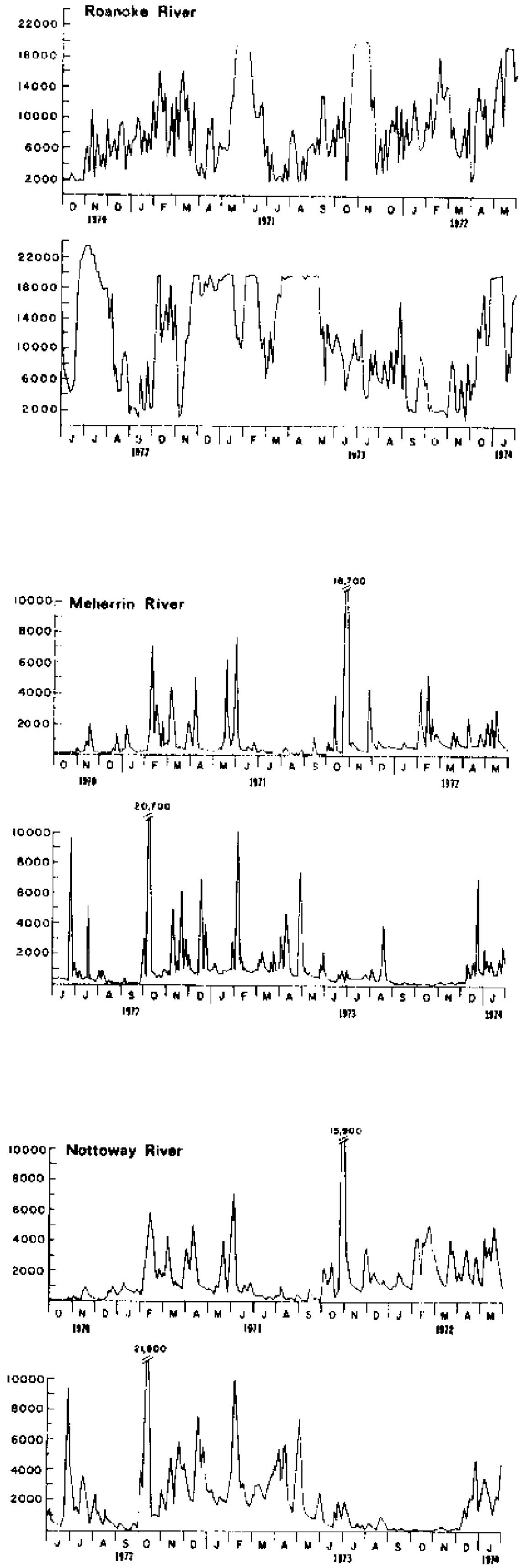


Fig. 3. Stream flow (cfs) for the Roanoke River, Meherrin River, and Nottaway River.

mgd with a long-term average of 5,000 mgd. While the Roanoke River is the major stream entering Albemarle Sound, it is not the only large stream. On the other hand, the Tar and Neuse Rivers are the only major streams entering their respective estuaries; their discharges are much lower than the Roanoke and range from about 30 or 35 mgd to about 15,000 or 20,000 mgd with a long-term average of 2,000 mgd (Clay et al. 1975).

IV. A. 2. Salinity

Salinity was quite high in Albemarle Sound in late 1970 (Fig. 4) when this study began. High salinity water entered the sound as a consequence of the very dry summer of 1970 and the below normal flows that resulted. When rainfall increased in early 1971 (Fig. 5) the surface salinities retreated as freshwater flowed into the sound. This situation continued through the middle of the year until a dry period in late July and August allowed saline water to enter again (Fig. 6). After Hurricane Ginger in October 1971, freshwater flushed the sound (Fig. 7) causing low surface salinities. Salinity remained low during early and mid 1972 (Fig. 8) but began to increase slightly thereafter. It is interesting that tropical storm Agnes in late June and July 1971 did not exert a noticeable influence on salinity (Fig. 9). However, unlike Ginger, Agnes was centered in the western part of the state, away from the coastal plain. Heavy rains in the coastal plain in late 1972 and the first half of 1973 kept flow high (Fig. 3) and salinity low throughout the sound (Fig. 10, 11, 12). The return of a dry period in summer 1972 caused an increase in salinity (Fig. 13 and 14) which was broken by rains as this study ended in January 1974 (Fig. 15).

Salinity in the Albemarle Sound is low compared to other coastal estuaries. Estuarine water is arbitrarily defined as water with a salinity

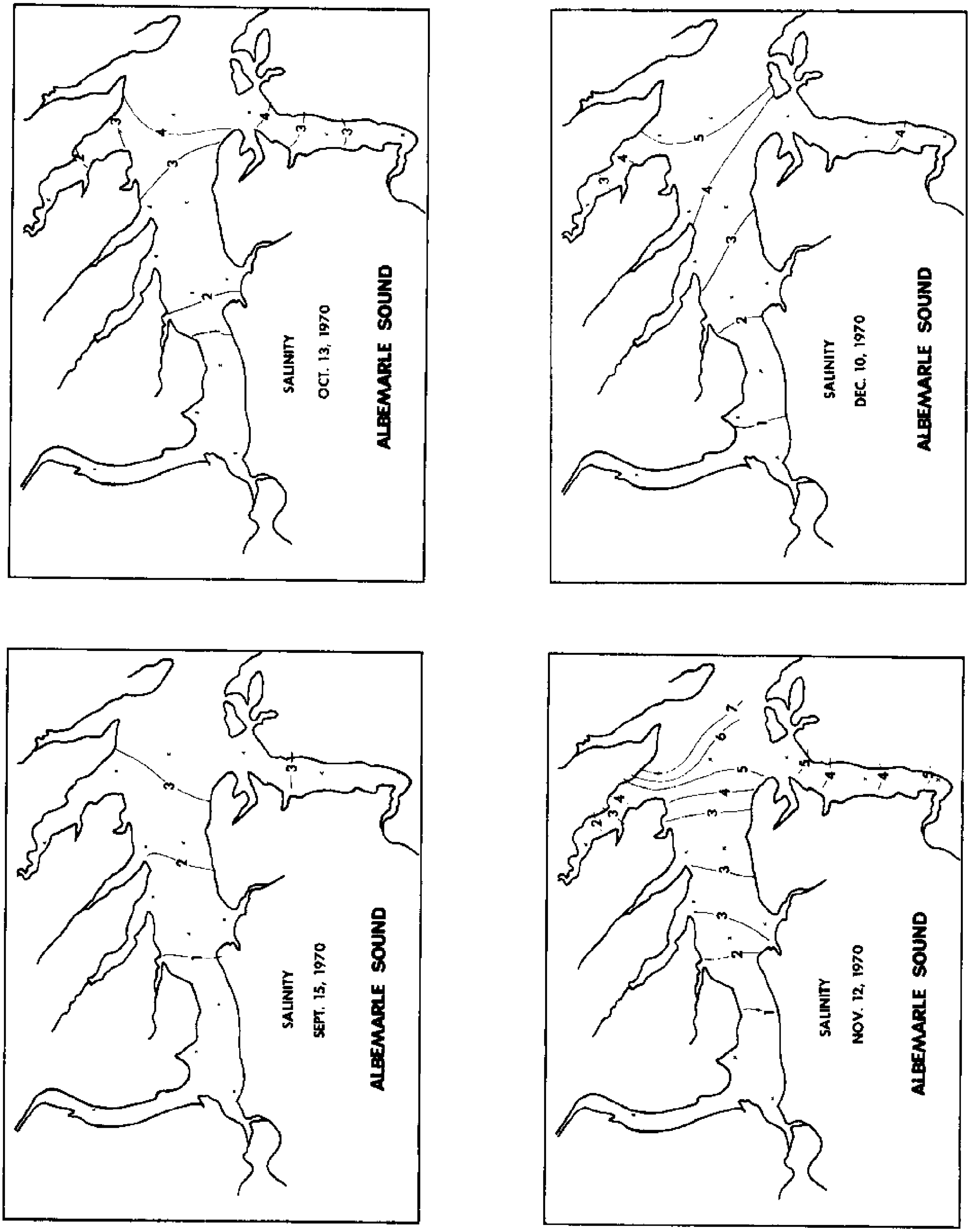


Fig. 4. Surface salinities (ppt) for 15 September, 13 October, 12 November and 10 December 1970 in the Albemarle Sound.

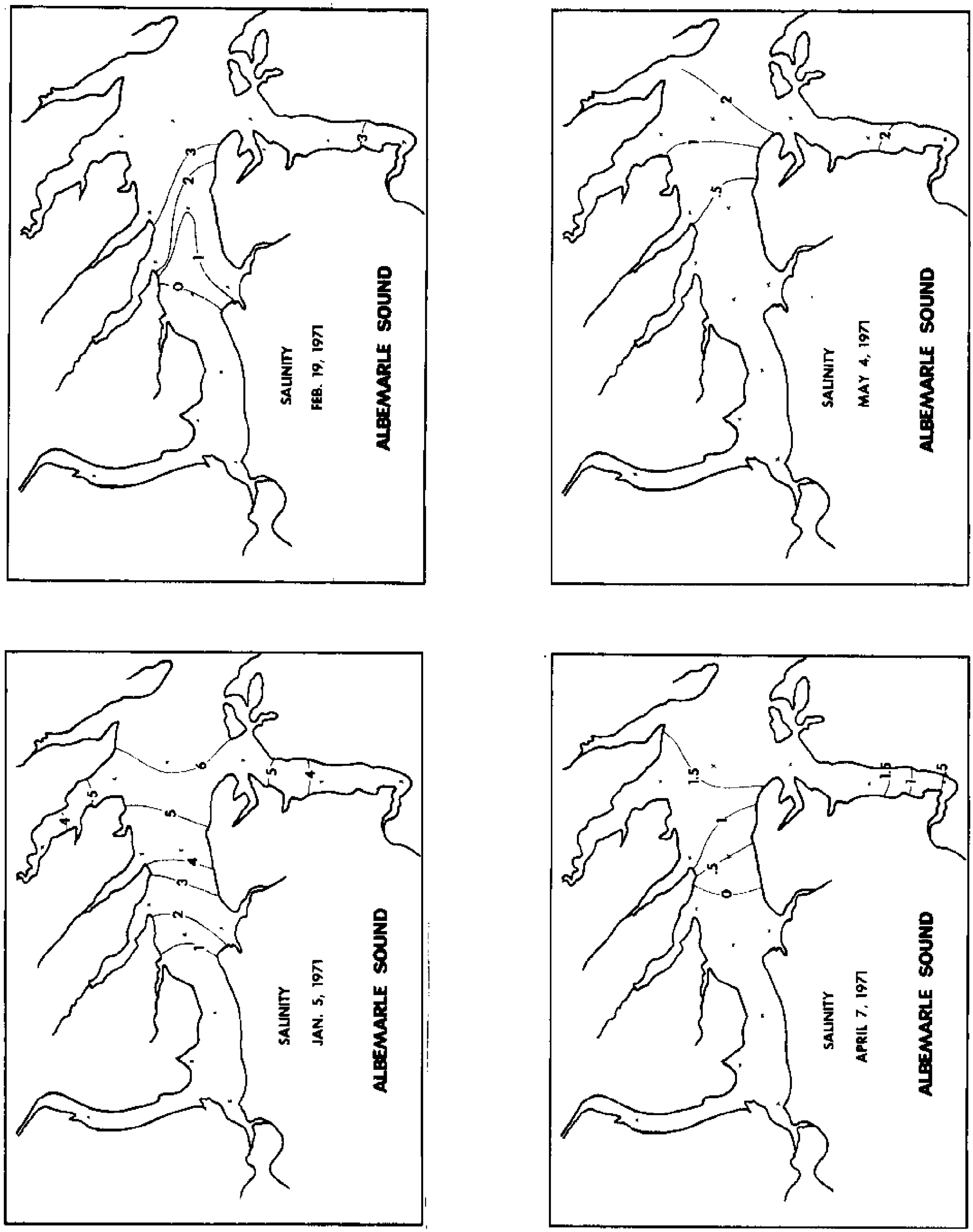


Fig. 5. Surface salinities (ppt) for 5 January, 19 February, 7 April and 4 May 1971 in the Albemarle Sound.

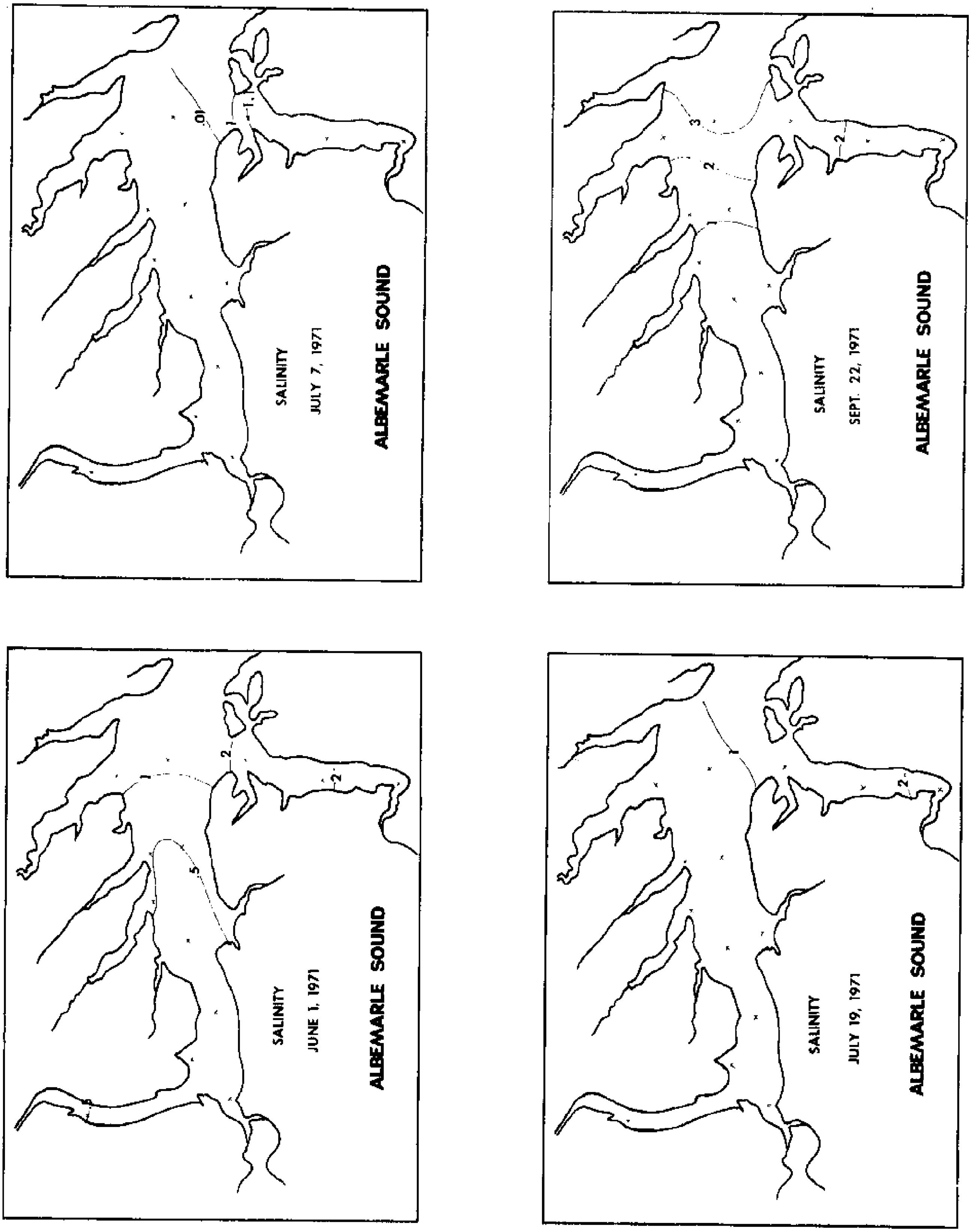


Fig. 6. Surface salinities (ppt) for 1 June, 7 July, 19 July and 22 September 1971 in the Albemarle Sound.

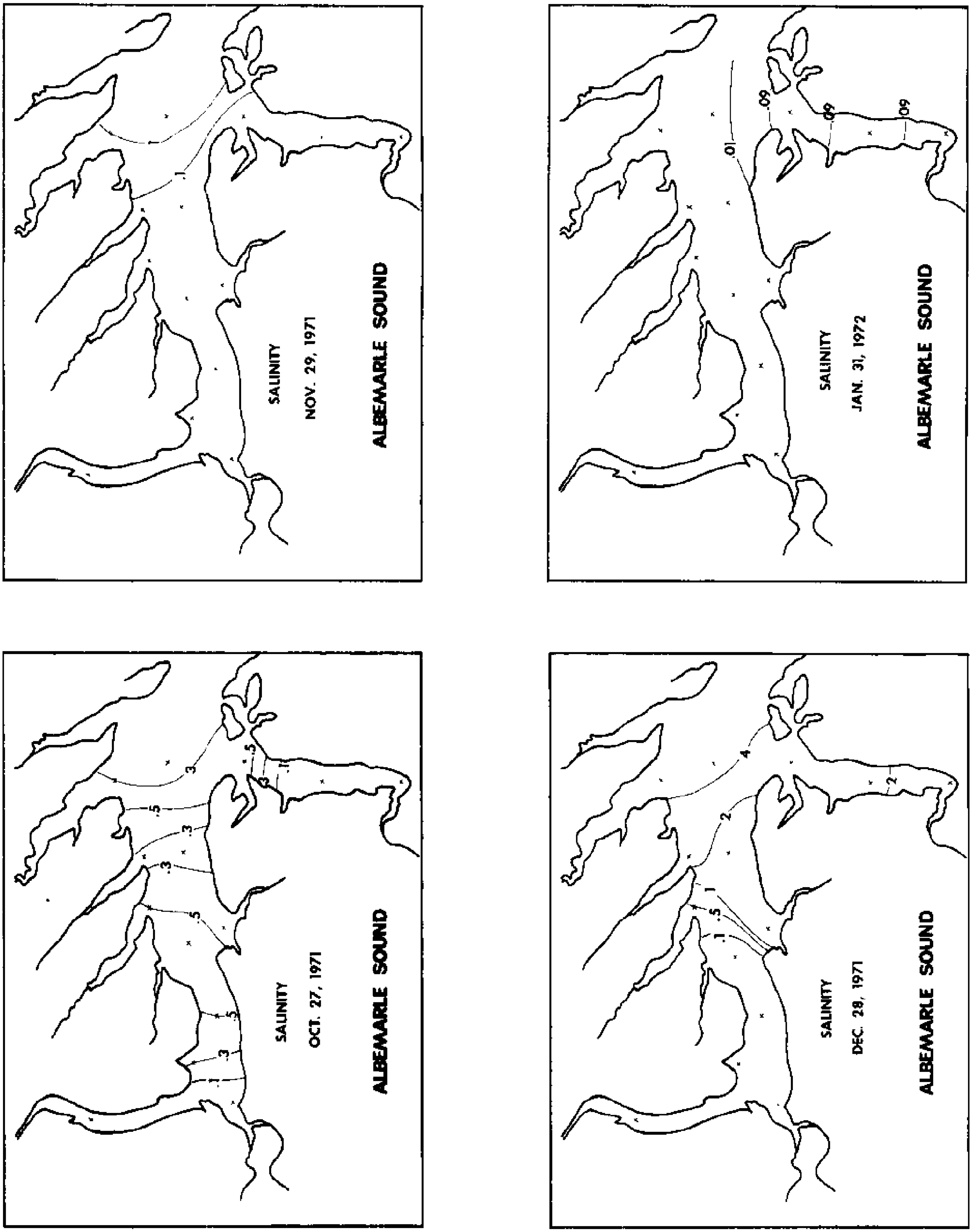
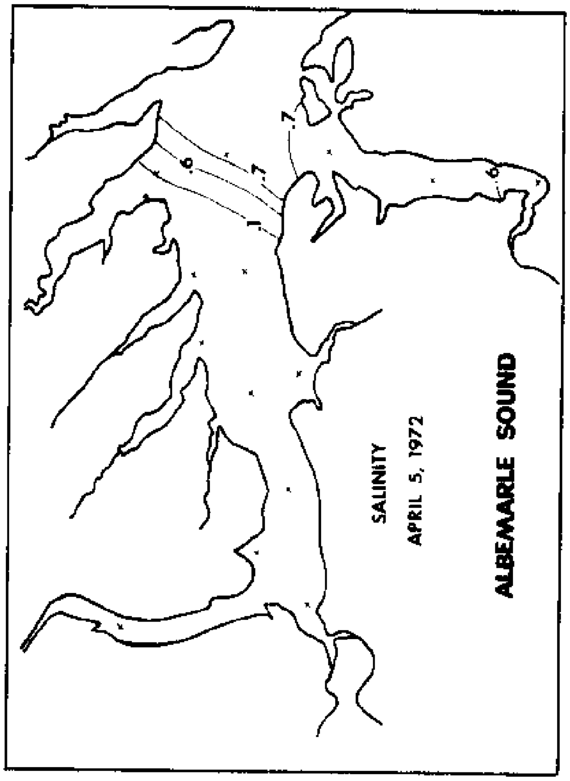
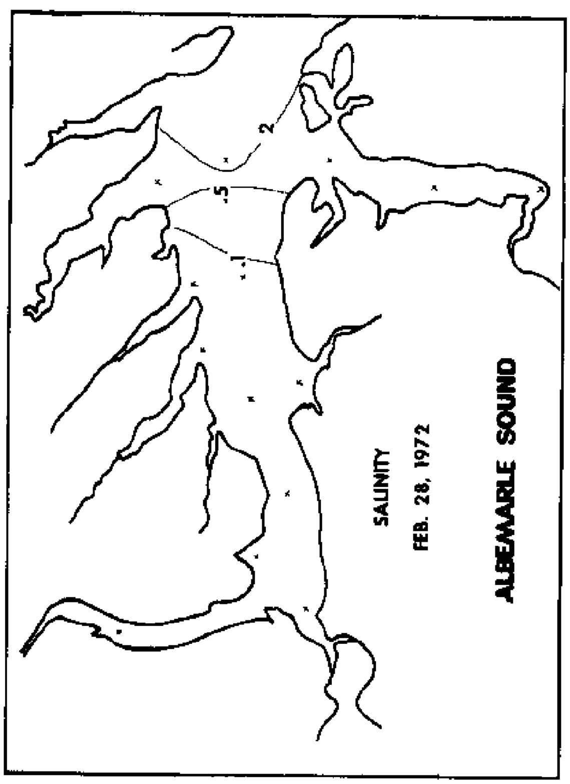


Fig. 7. Surface salinities (ppt) for 27 October, 29 November, 28 December 1971 and 31 January 1972 in the Albemarle Sound.





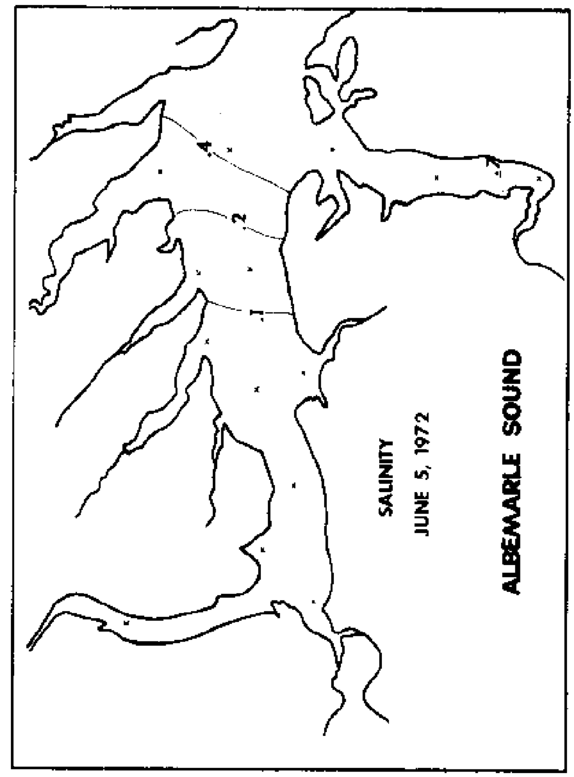


Fig. 8. Surface salinities (ppt) for 28 February, 5 April and 5 June 1972 in the Albemarle Sound.

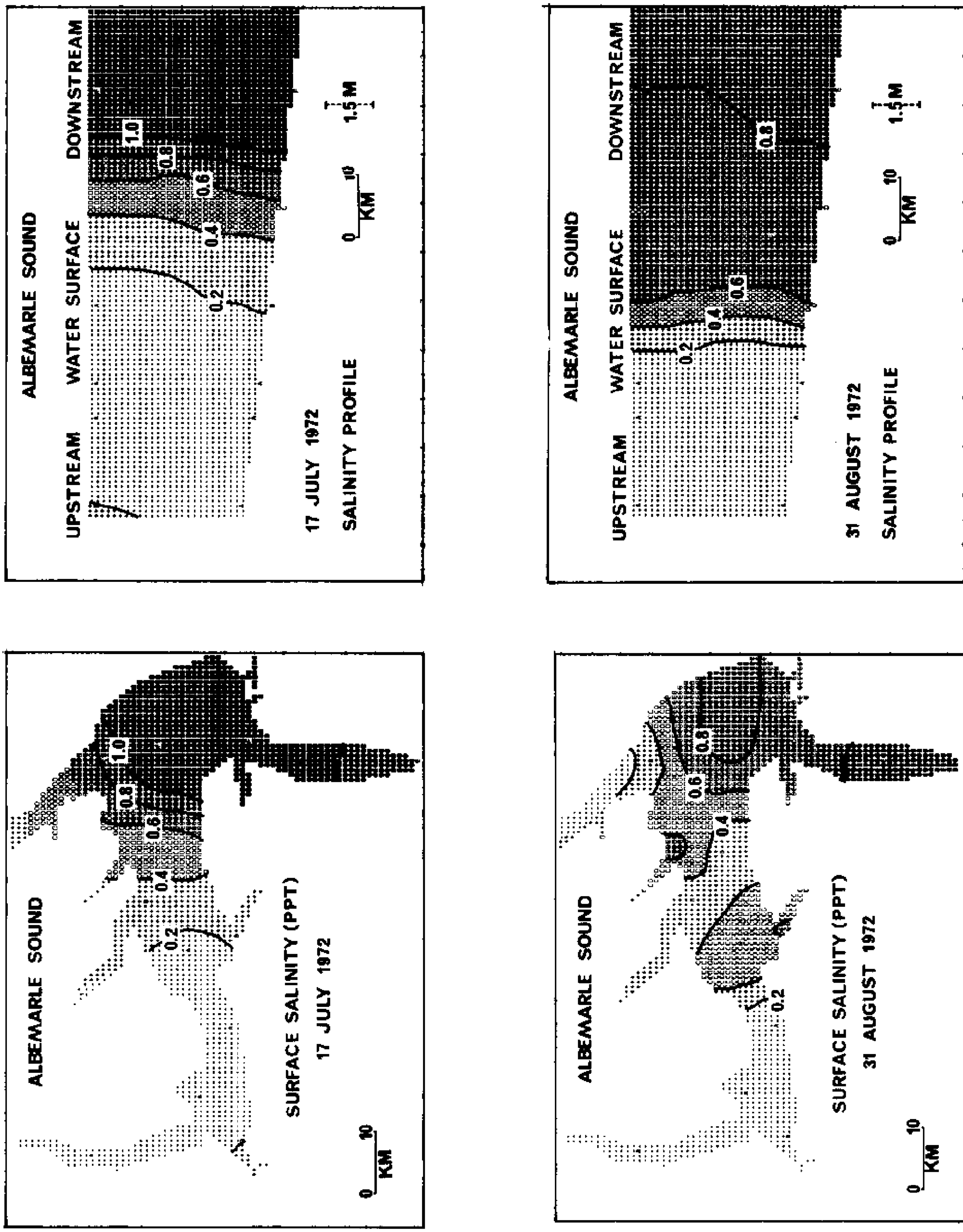


Fig. 9. Surface salinities and depth profiles of salinity for 17 July and 31 August 1972 in the Albemarle Sound.

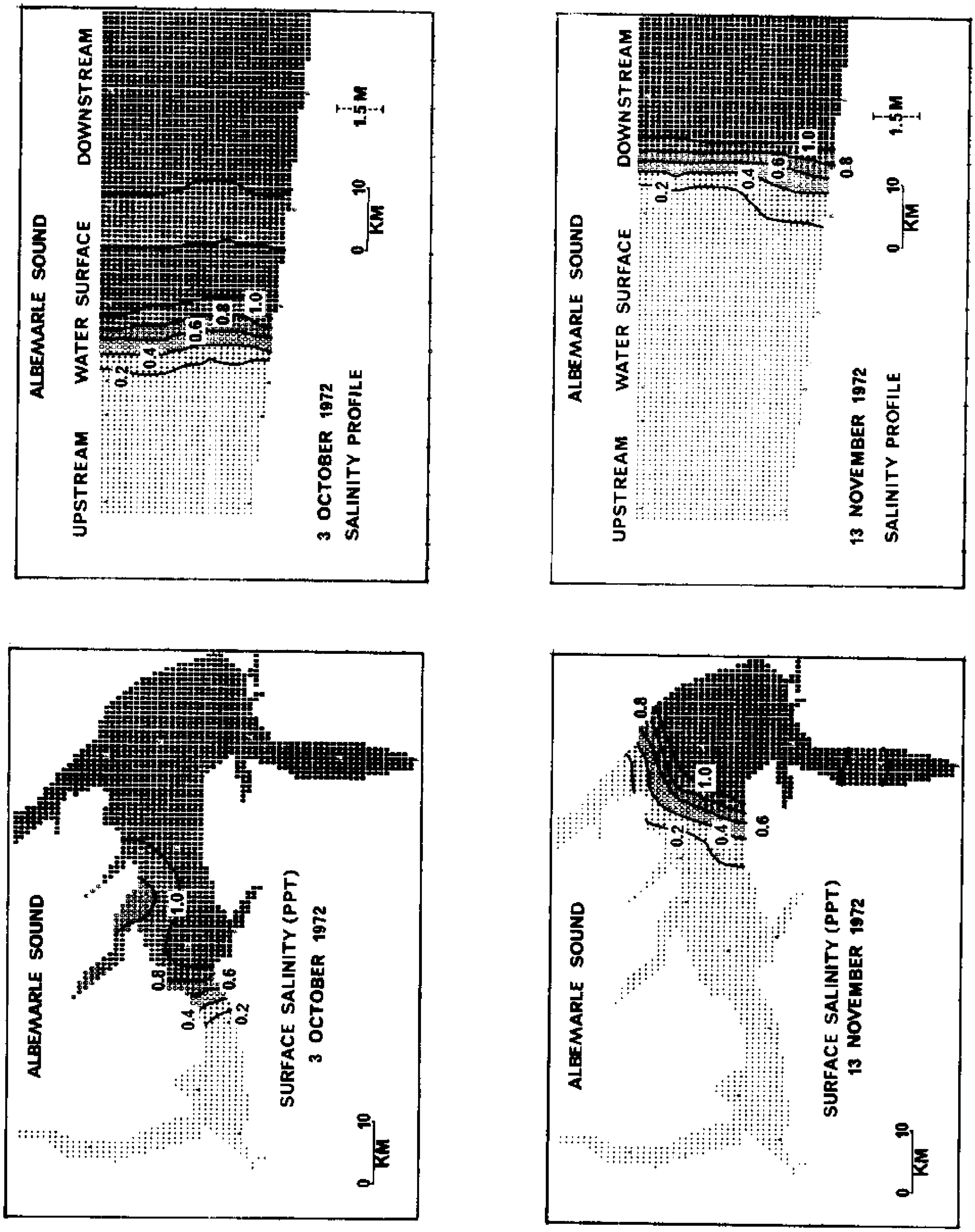


Fig. 10. Surface salinities and depth profiles of salinity for 3 October and 13 November 1972 in the Albemarle Sound.

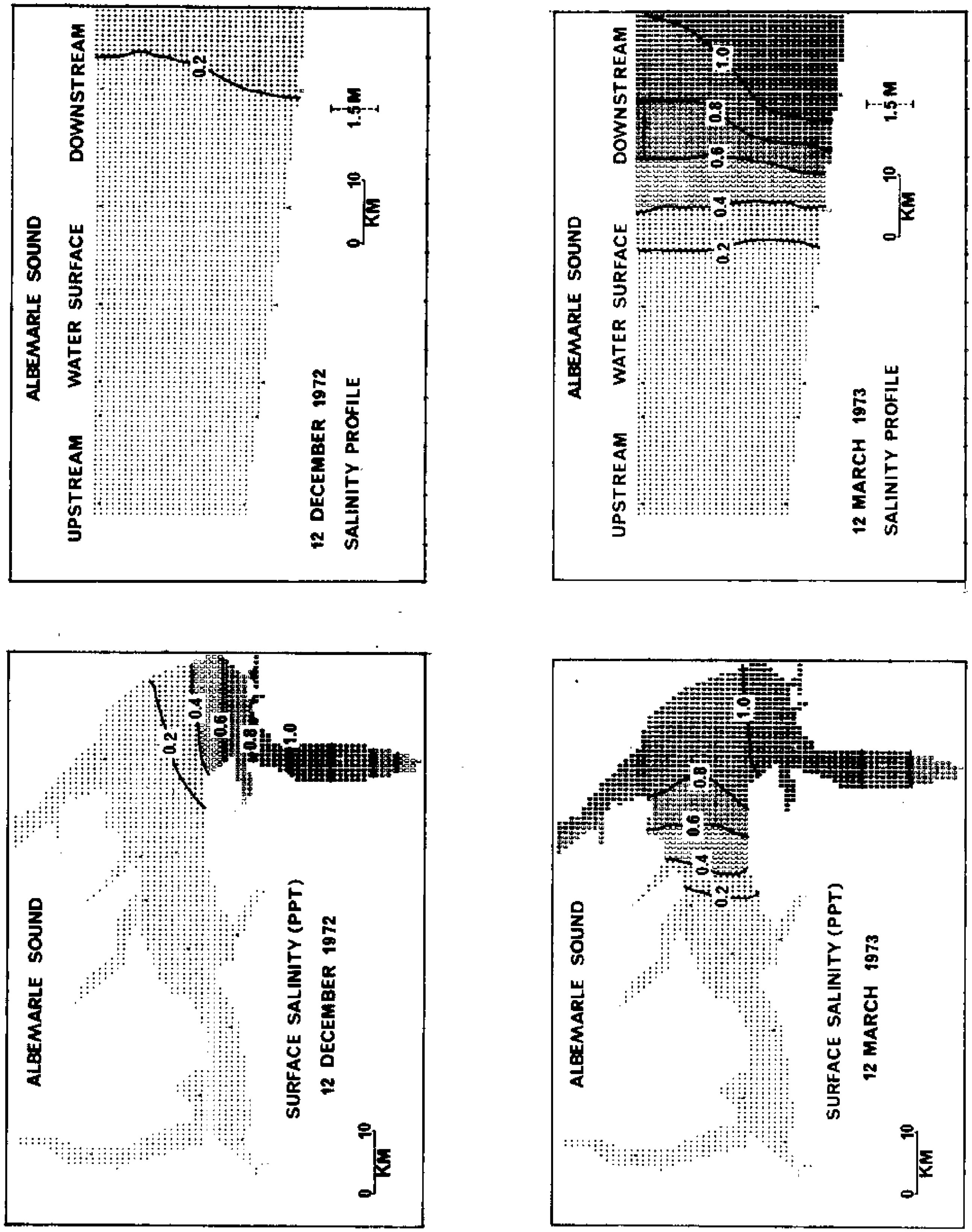


Fig. 11. Surface salinities and depth profiles of salinity for 12 December 1972 and 12 March 1973 in the Albemarle Sound.

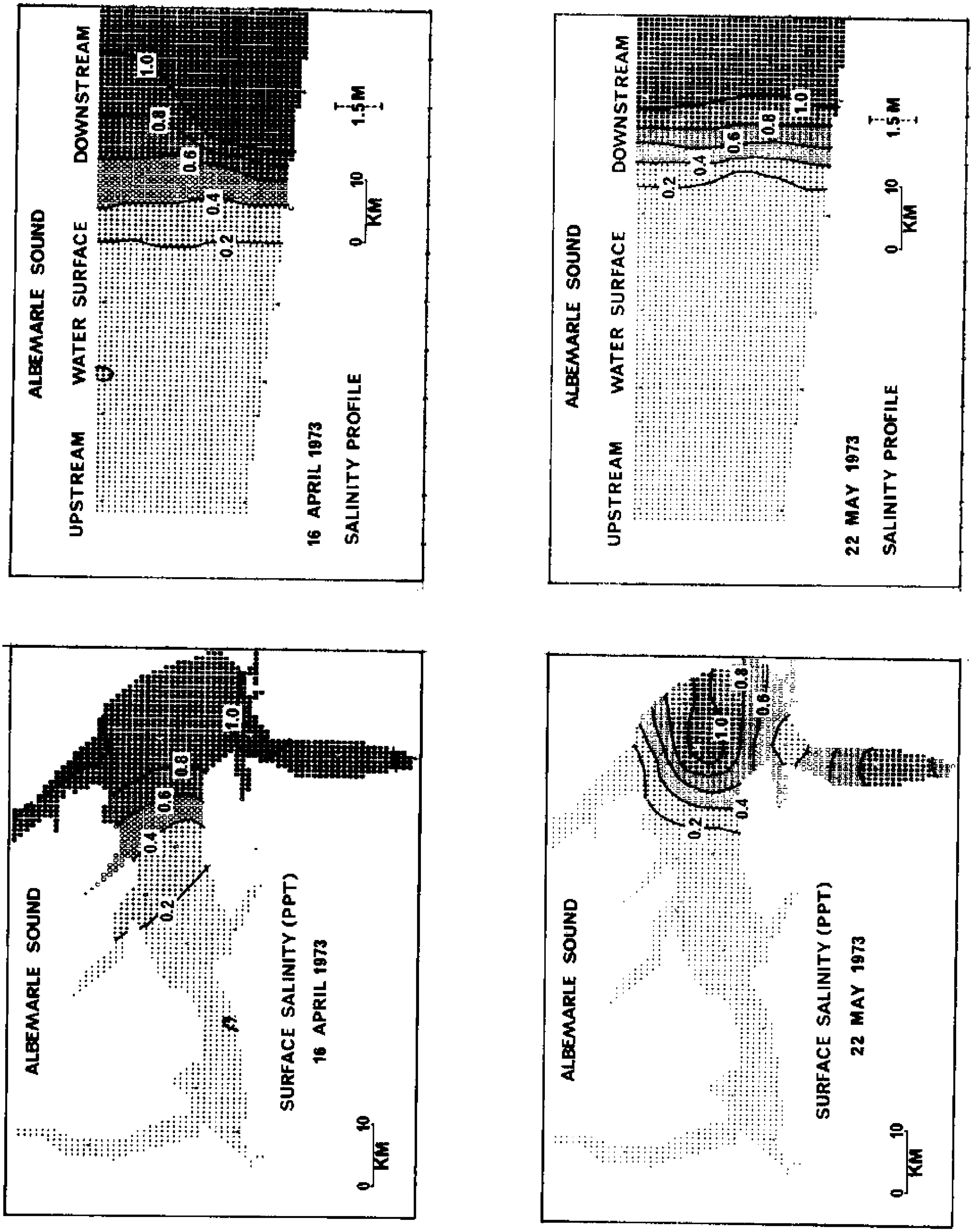


Fig. 12. Surface salinities and depth profiles of salinity for 16 April and 22 May 1973 in the Albemarle Sound.

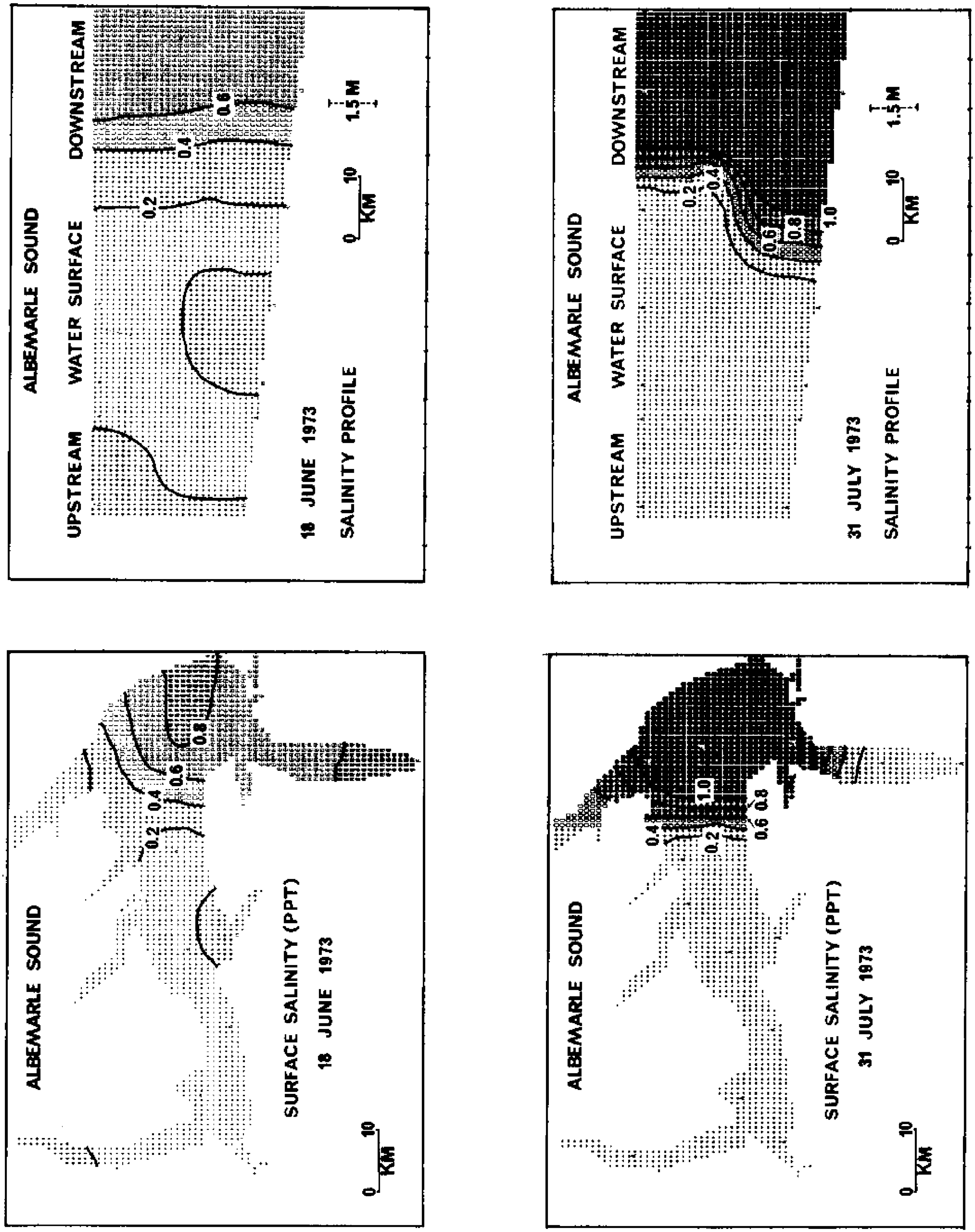


Fig. 13. Surface salinities and depth profiles of salinity for 18 June and 31 July 1973 in the Albemarle Sound.

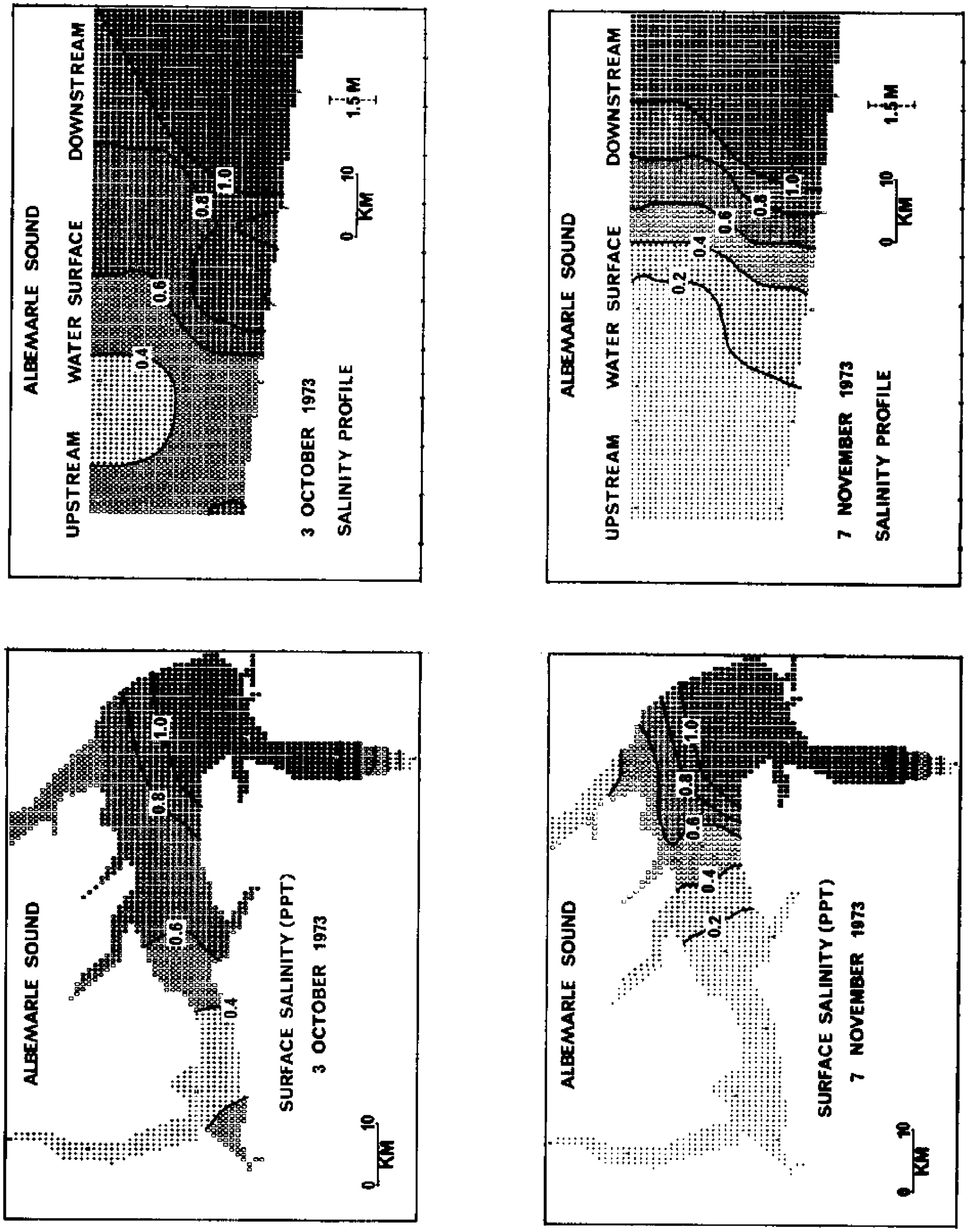


Fig. 14. Surface salinities and depth profiles of salinity for 3 October and 7 November 1973 in the Albemarle Sound.

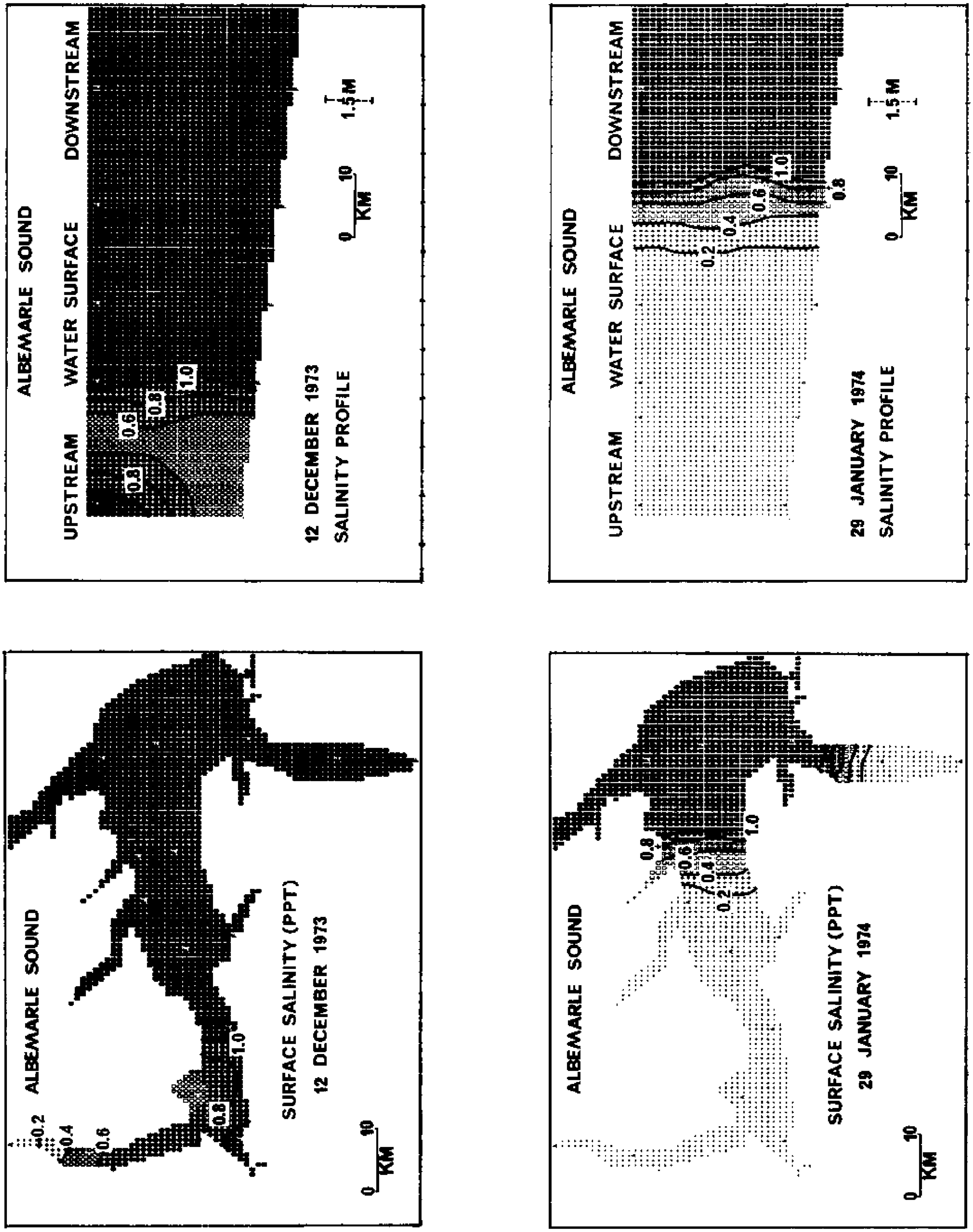


Fig. 15. Surface salinities and depth profiles of salinity for 12 December 1973 and 29 January 1974 in the Albemarle Sound.

greater than 0.5 ppt. During the study period, salinities ranged from 0 to 7 parts per thousand (ppt). Above the mouth where salinity is highest, virtually the entire estuary is less than 1 ppt for a major portion of the year. In comparison, salinities in the Neuse River range from 1 to 20 ppt with highest salinities during summer low flows and lowest salinities during storms and winter high flows (Hobbie and Smith 1975). The pattern is similar but less distinct in the Pamlico where salinities vary from 2 to 15 ppt (Hobbie 1974). Salinity is usually well above 1 ppt throughout these estuaries all year long.

In Albemarle Sound salinity is inversely related to a river flow. Low surface salinities in the sound seem to follow peaks of river flow by 2 weeks to a month with long lag periods during low flow. This inverse relationship and the evidence of lag times are evident when comparing the flow diagrams (Fig. 3) with the surface salinity summary isopleths (Fig. 5 and 16).

There are two pecularities with the computer generated summary (annual) isopleths that should be mentioned. First, the computer does not consider missing data when drawing an isopleth. It averages the available data to fill in blanks. Therefore for the months in which data are missing (and even between sampling dates) short term events of significant impact could go unnoticed. Consequently, the observation that the salinity data (Fig. 16) do not fit the flow data on some dates (Fig. 3, Roanoke River, January to February 1973) may be a computer and sampling artifact. The same months of data are missing for all variables.

Second, the summary isopleths are plots of concentrations at various locations (miles along the sound) versus time. Consequently, values from stations running across the sound are averaged to get a single value. This is not particularly significant for salinity. However, in later graphs for

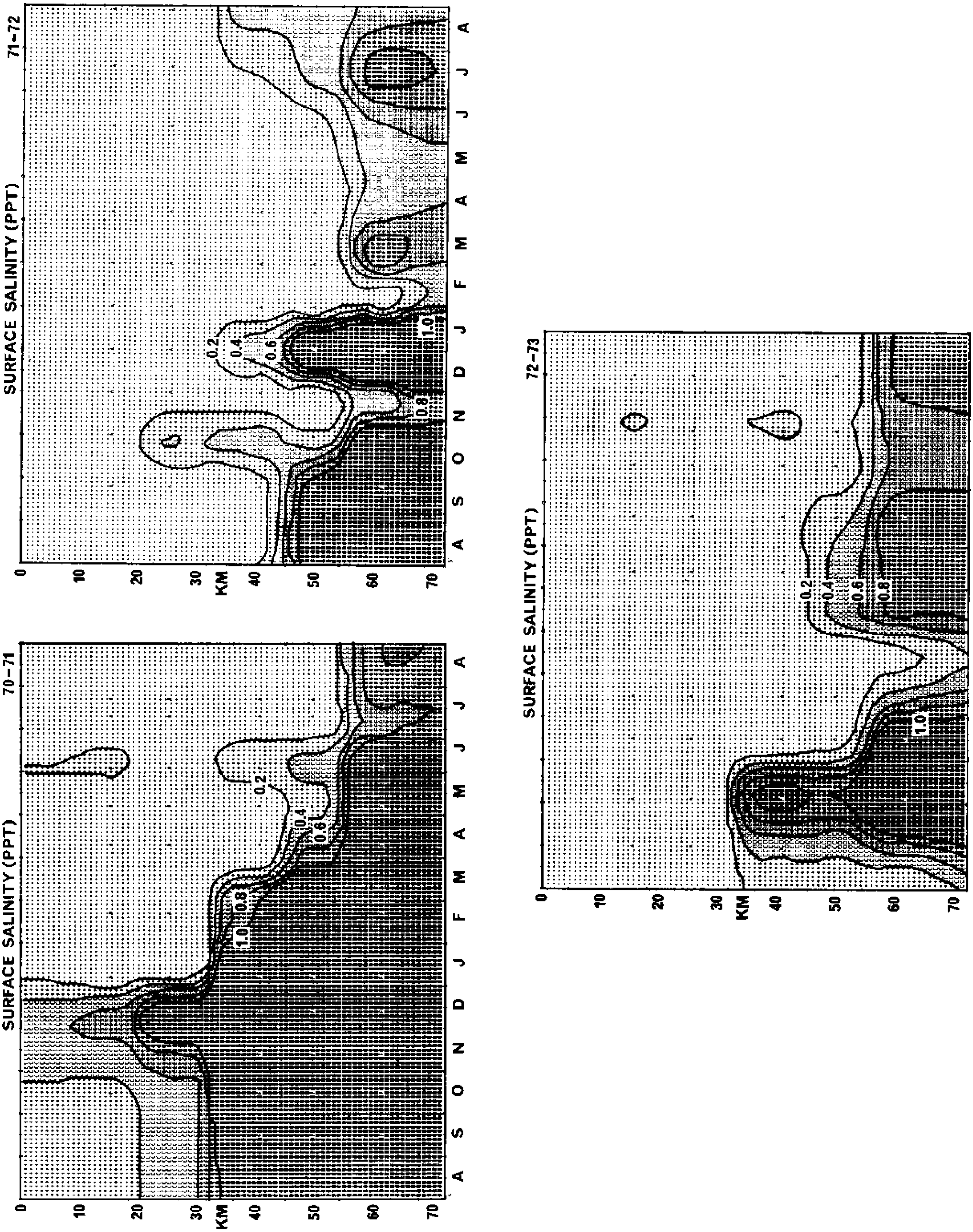


Fig. 16. Yearly maps of the seasonal distribution of salinity (ppt) in the Albemarle Sound 1970-1973.

nutrients, tributaries are often significant sources of nutrients ($PO_4^{\equiv}$, NH_4^+, NO_3^-) and their effects might be overlooked when averaged with low concentration sound water to give a single value at a particular river mile. In addition, note that the value associated with a degree of shading may change from graph to graph, especially for the nutrient summary isopleths. These problems should be kept in mind when considering the nutrient reports that follow.

There is very little evidence for salinity stratification in Albemarle Sound. Generally stratification does not occur if tidal influences exceed river flow by a factor or about 10 or in shallow water (Dyer 1973). Albemarle Sound averages 4.5 m deep and a very crude estimate of the ratio of tidal input to river flow (sum of the Roanoke, Nottoway, and Meherrin rivers) ranges from 11 to 18. Thus, tidal (and wind) influences, though small, are still greater than river influences most of the time and stratification should be unlikely.

This fact is evident in the salinity depth profiles (Fig. 9 to 15). Even in the profiles that appear to have some stratification (e.g., Fig. 13: 31 July 1973) the salinity gradient is only about 0.5 ppt/m depth. (Note that there is an extreme horizontal contraction in these profiles.) Both the profiles of salinity and the ratio of the river flow to tidal input indicate that Albemarle Sound is partially to well mixed. Under these circumstances, stratification should be at best weak and transitory.

IV. A. 3. Temperature

Surface temperatures were quite high in early September 1970 when this study began, but quickly cooled through the latter part of the year (Fig. 17). Temperatures remained cool in early 1971 and began to warm in

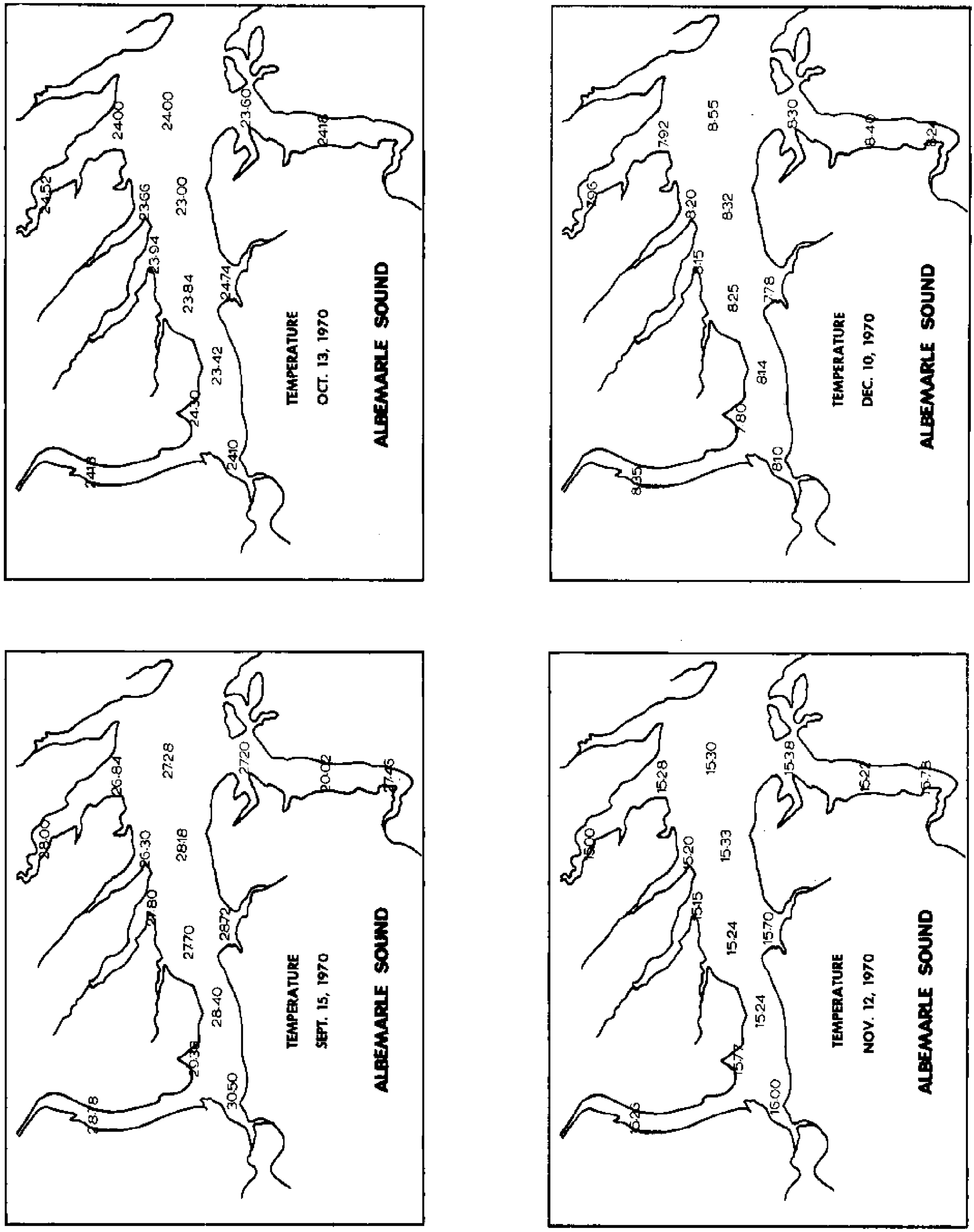


Fig. 17. Surface temperatures (^{o}C) for 15 September, 13 October, 12 November and 10 December 1970 in the Albemarle Sound.

early May (Fig. 18). Maximum temperatures were reached in July and August (Fig. 19) and began to fall again in the latter third of the year (Fig. 20). This pattern -- a summer temperature maximum, a cooling period at the end of the year, and a temperature minimum in the first of the year followed by a warming trend -- is evident each year with slight variations in temperature maxima and minima (Fig. 21 to 26).

In general temperatures are higher in the upstream tributary stations than in the mid-sound stations. The difference in temperature can be from less than $1^{\circ}C$ to greater than $7^{\circ}C$. However, when laterally averaged, temperature down the sound is relatively homogeneous (Fig. 26).

Surface temperatures in Albemarle Sound ranged from $6.1^{\circ}C$ on 5 January 1971 (Fig. 18) to $30.5^{\circ}C$ on 15 September 1970 (Fig. 17). This temperature range is well within those for the Neuse River (Hobbie and Smith 1975) and the Pamlico River (Hobbie 1974) where the long-term range may be from about 0.5 to $35^{\circ}C$.

As with salinity, there is no evidence for strong stratification of temperature. Although there are no temperature-depth profiles, bottom temperature data are presented in Appendix I. The difference between surface and bottom temperatures is rarely more than 2 to $3^{\circ}C$ and is generally less. It is interesting that on days when salinity stratification might have existed (by the loosest definition of stratification)(e.g., Fig. 13: 31 July 1973) there is little evidence for temperature stratification. For example, on 31 July 1973 surface temperatures ranged from 0.0 to $0.5^{\circ}C$ higher than bottom temperatures at all stations. Therefore, neither temperature nor salinity stratification appear to be important factors affecting this sound.

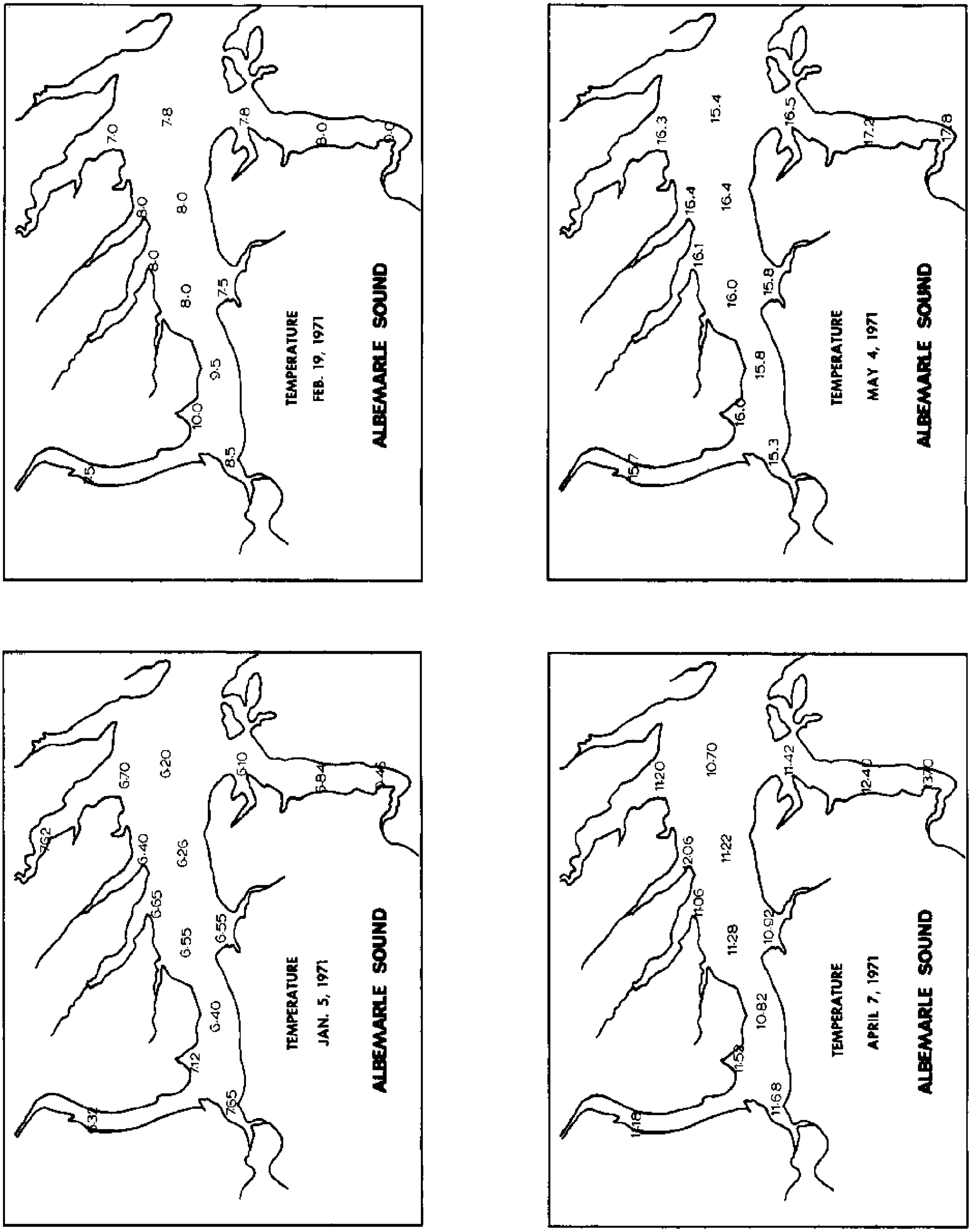


Fig. 18. Surface temperatures (°C) for 5 January, 19 February, 7 April and 4 May 1971 in the Albemarle Sound.

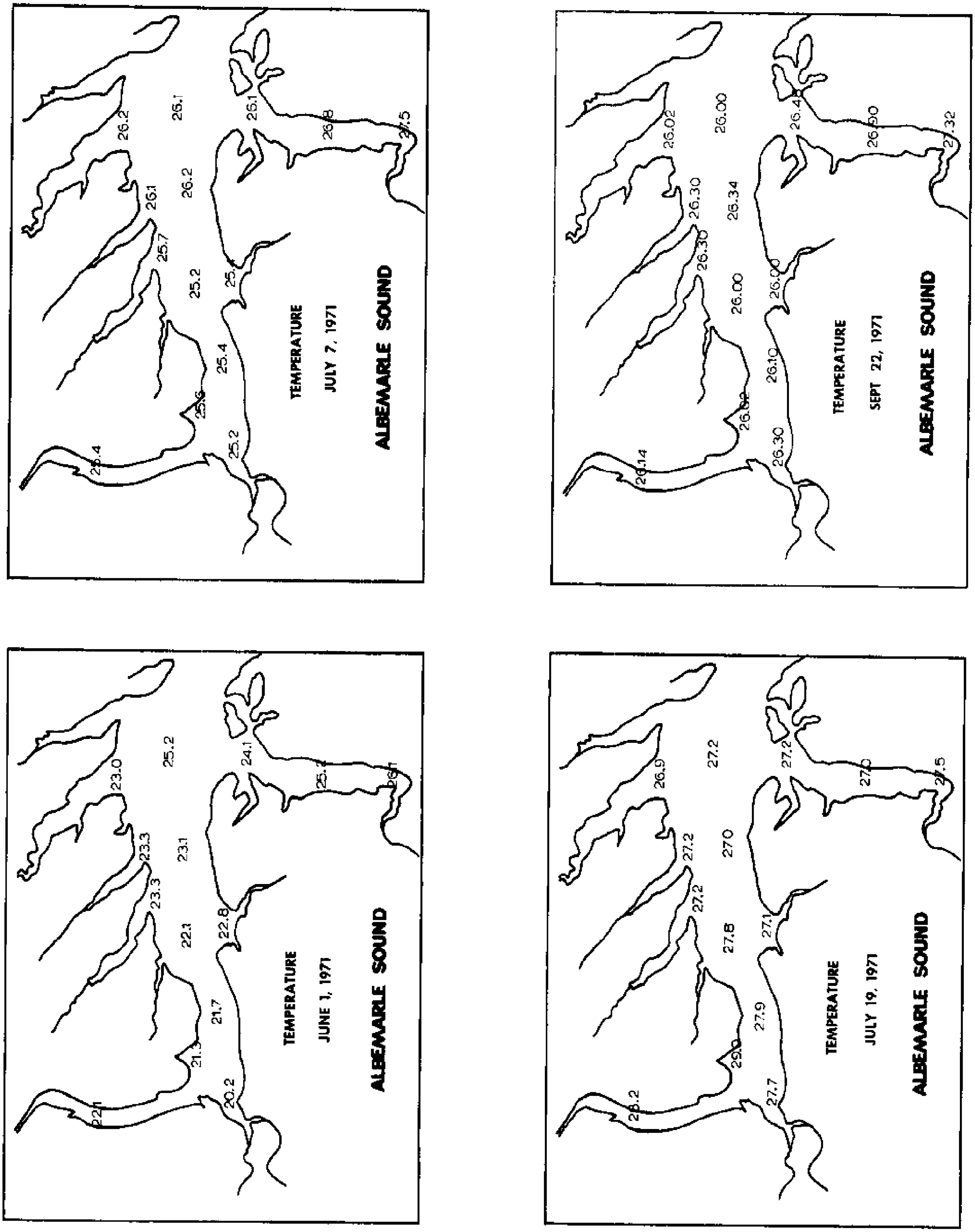


Fig. 19. Surface temperatures (^{o}C) for 1 June, 7 July, 19 July and 22 September 1971 in the Albemarle Sound.

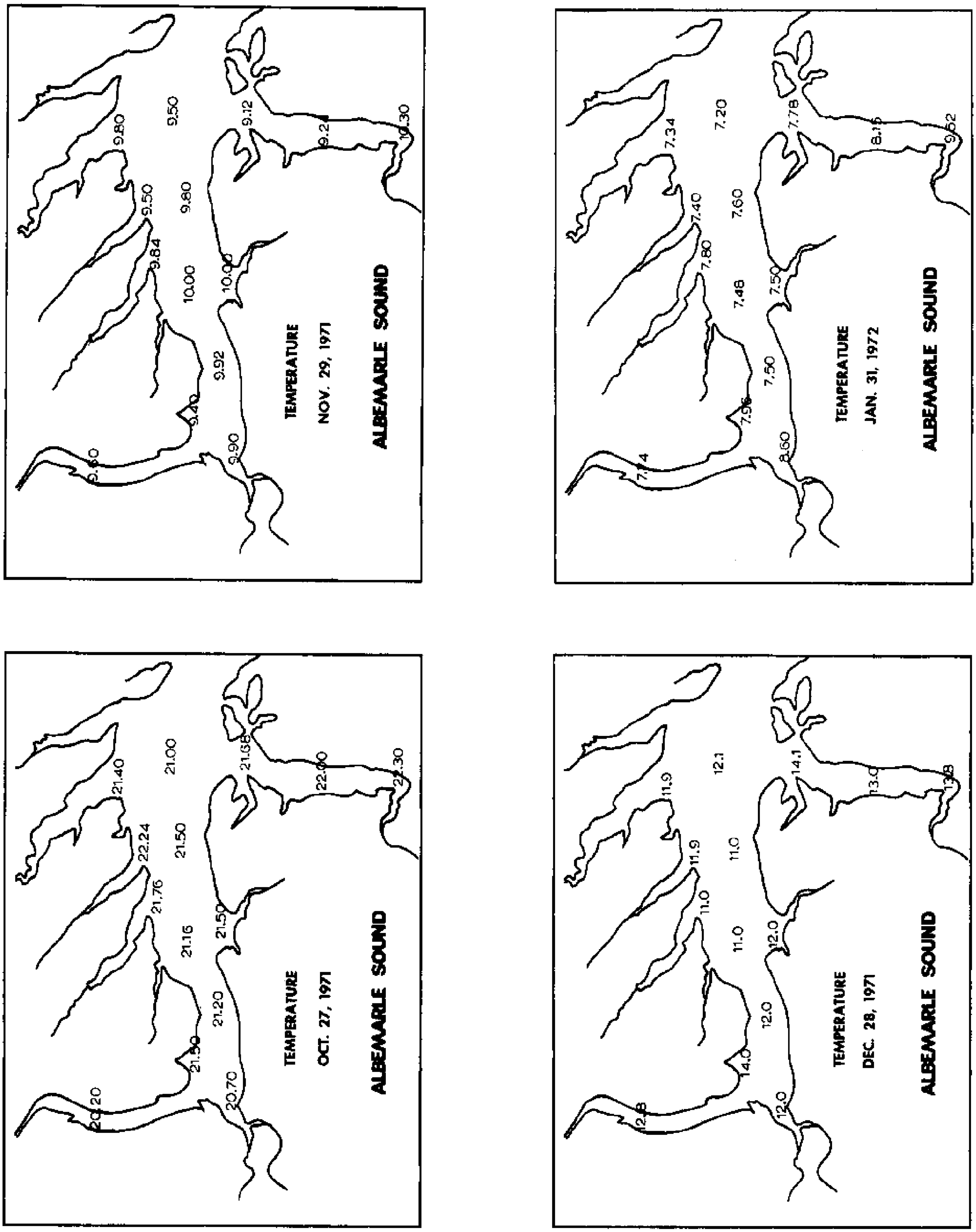


Fig. 20. Surface temperatures (°C) for 27 October, 29 November, 28 December 1971, and 31 January 1972 in the Albemarle Sound.

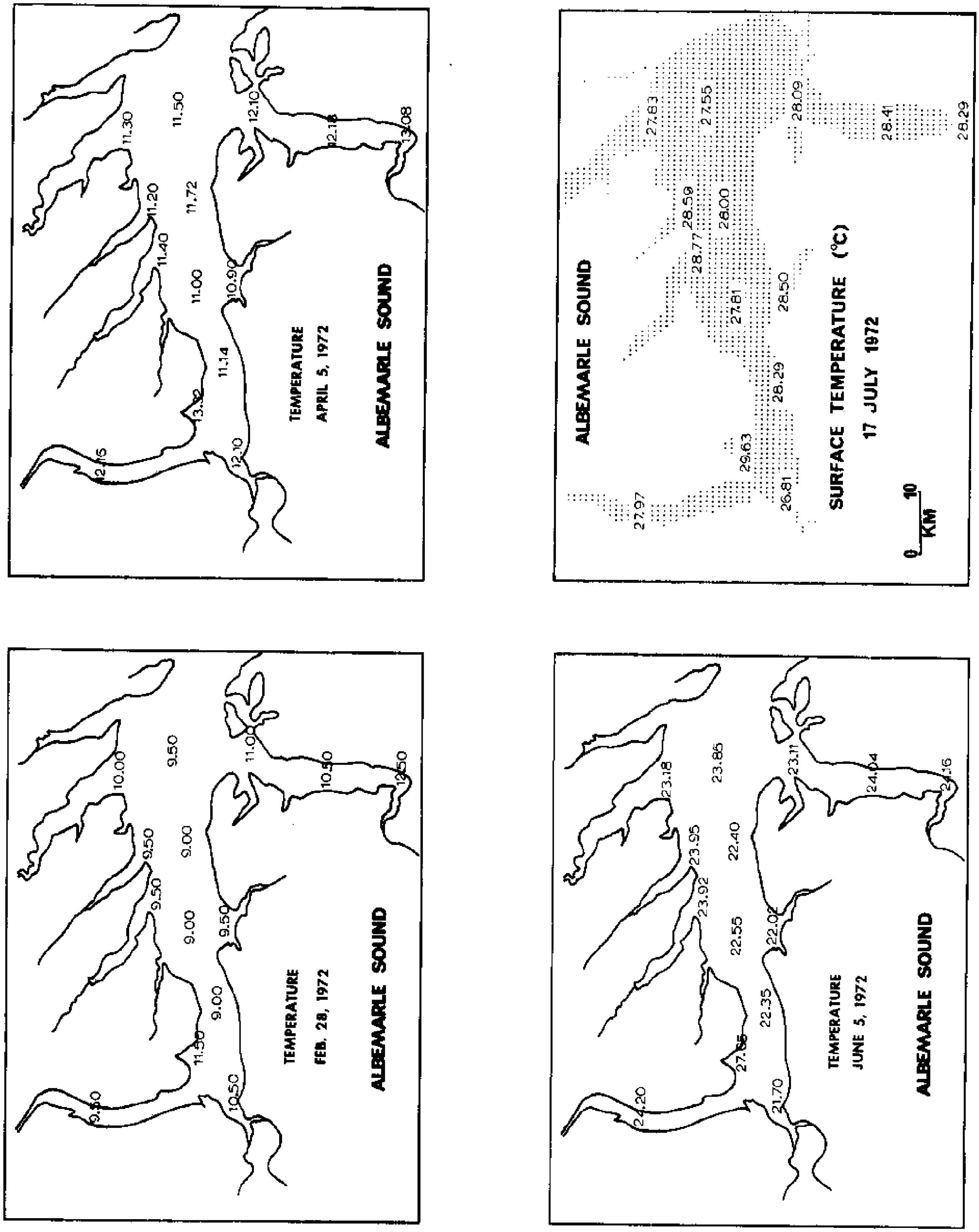


Fig. 21. Surface temperatures (°C) for 28 February, 5 April, 5 June and 17 July 1972 in the Albemarle Sound.

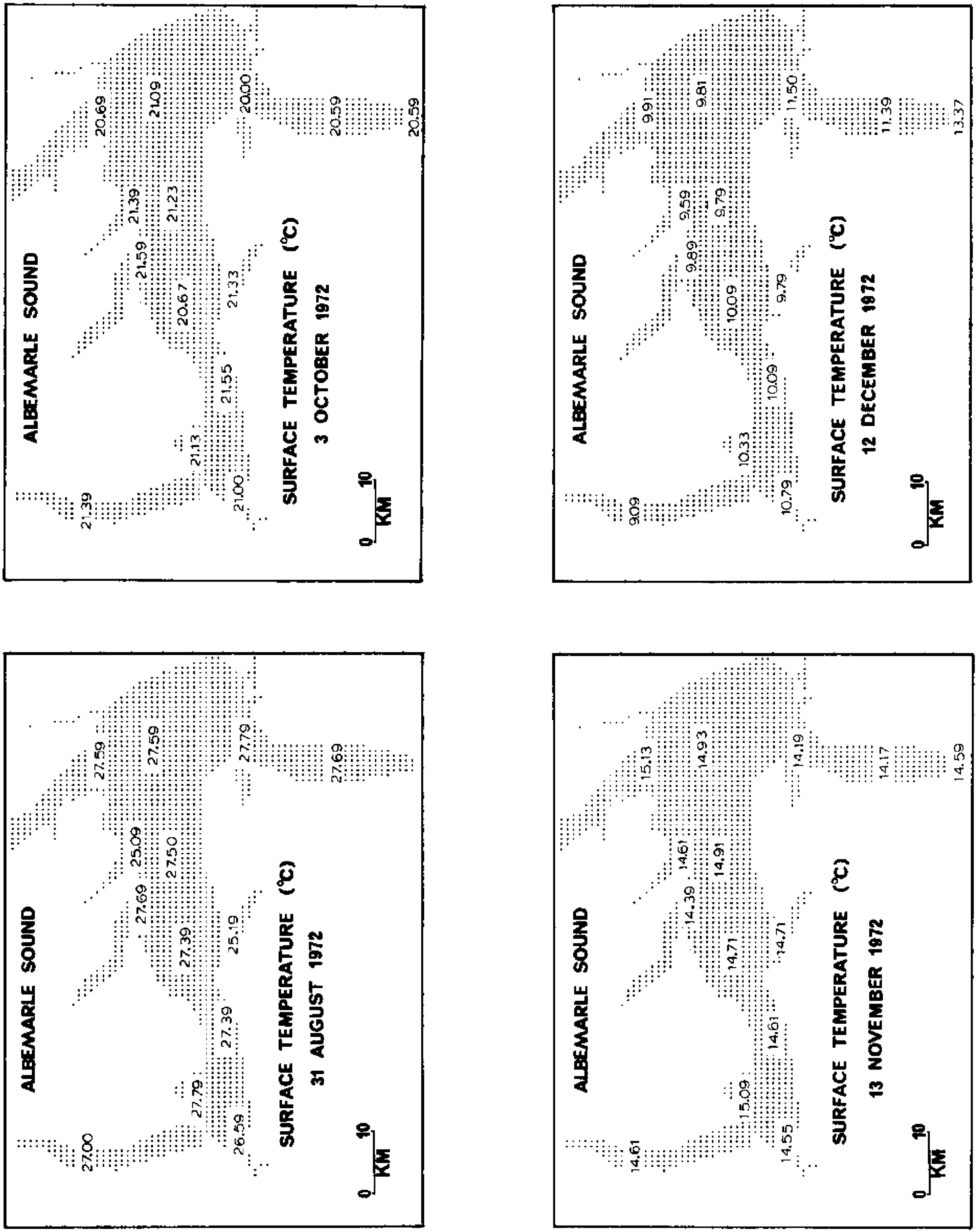


Fig. 22. Surface temperatures (°C) for 31 August, 3 October, 13 November and 12 December 1972 in the Albemarle Sound.

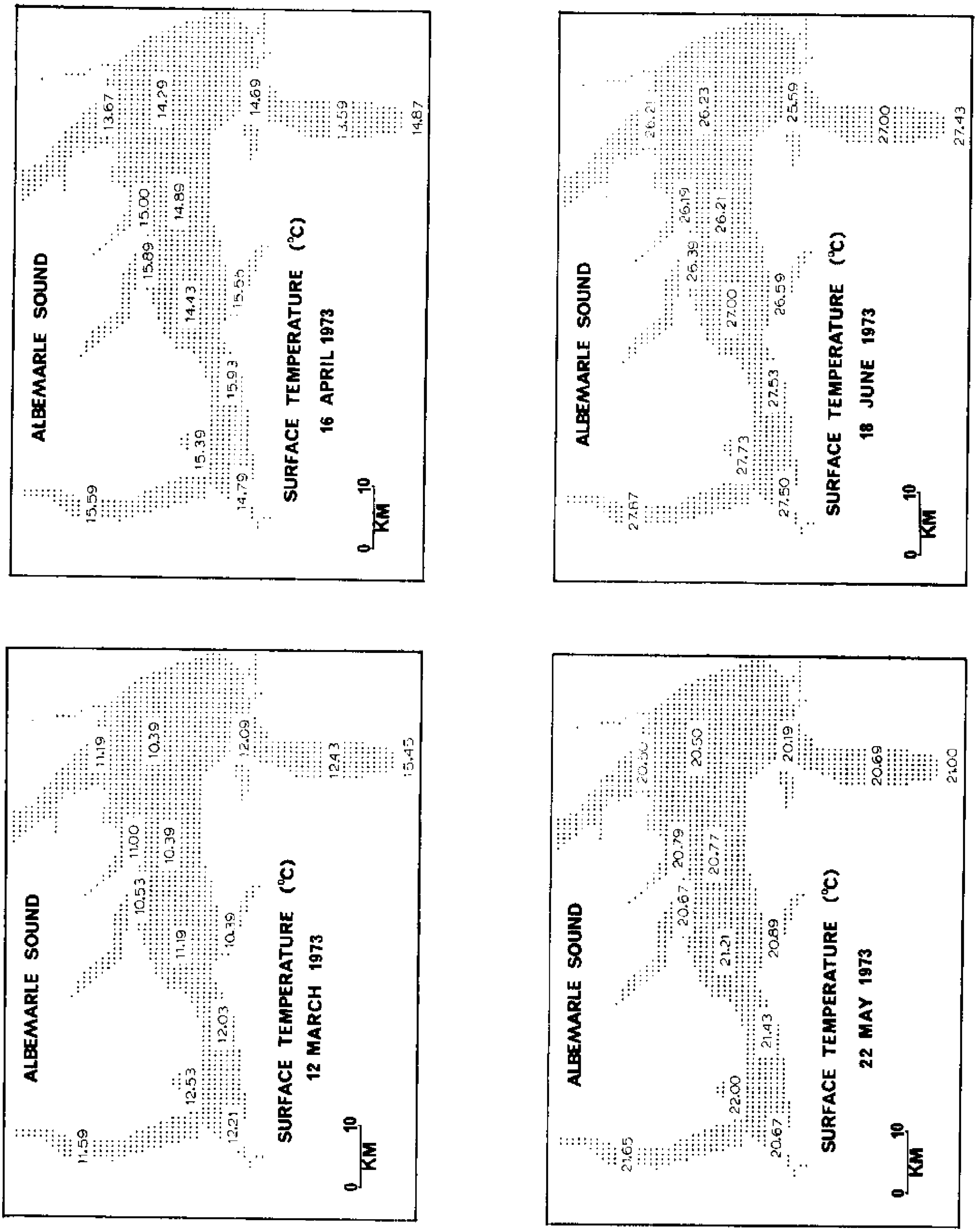


Fig. 23. Surface temperatures (°C) for 12 March, 16 April, 22 May and 18 June 1973 in the Albemarle Sound.

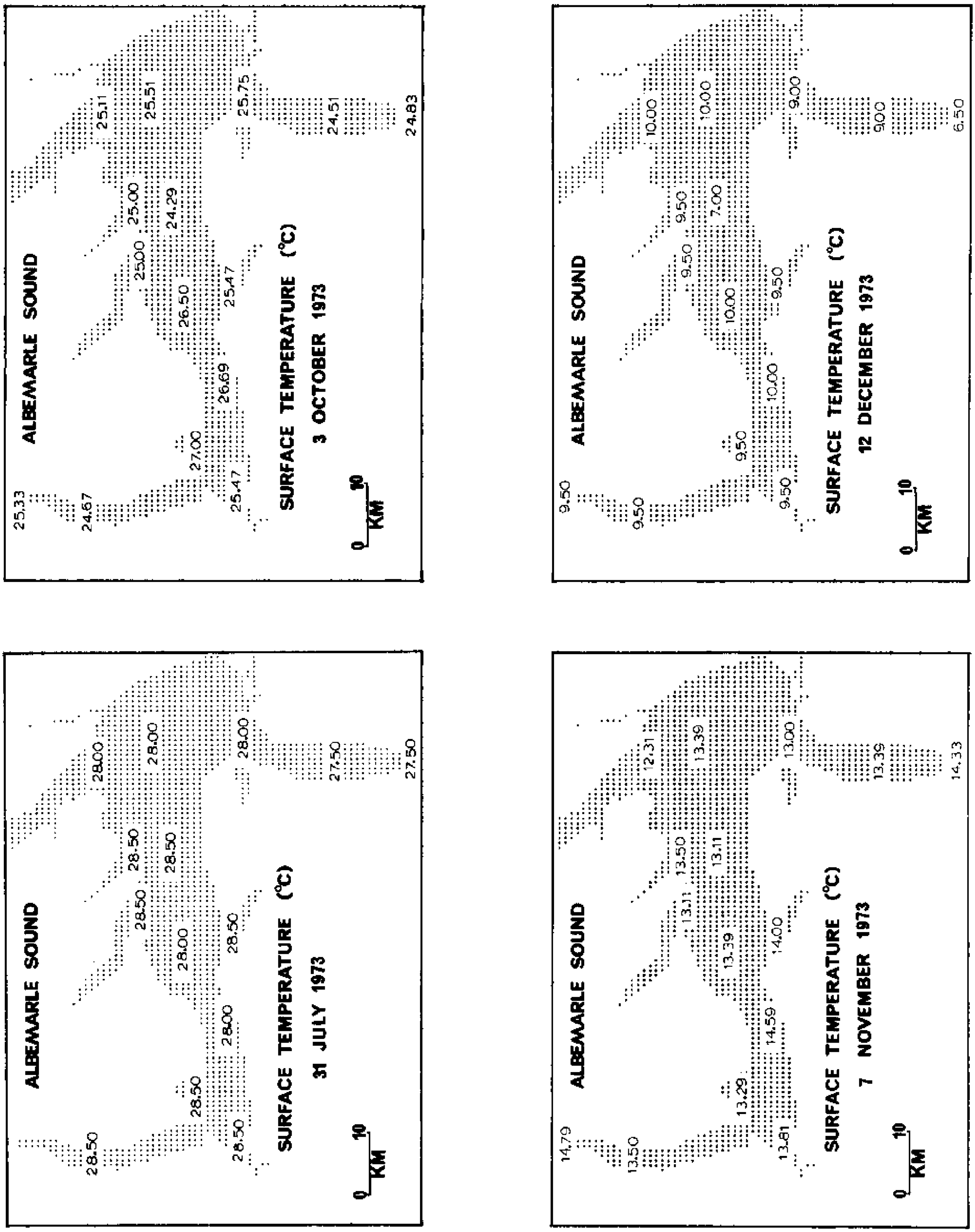


Fig. 24. Surface temperatures (°C) for 31 July, 3 October, 7 November and 12 December 1973 in the Albemarle Sound.

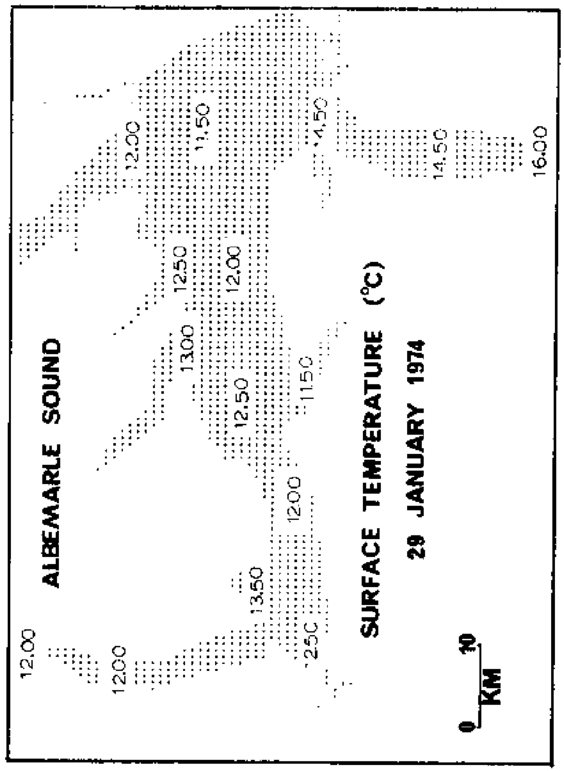


Fig. 25. Surface temperatures (°C) for 29 January 1974 in the Albemarle Sound.

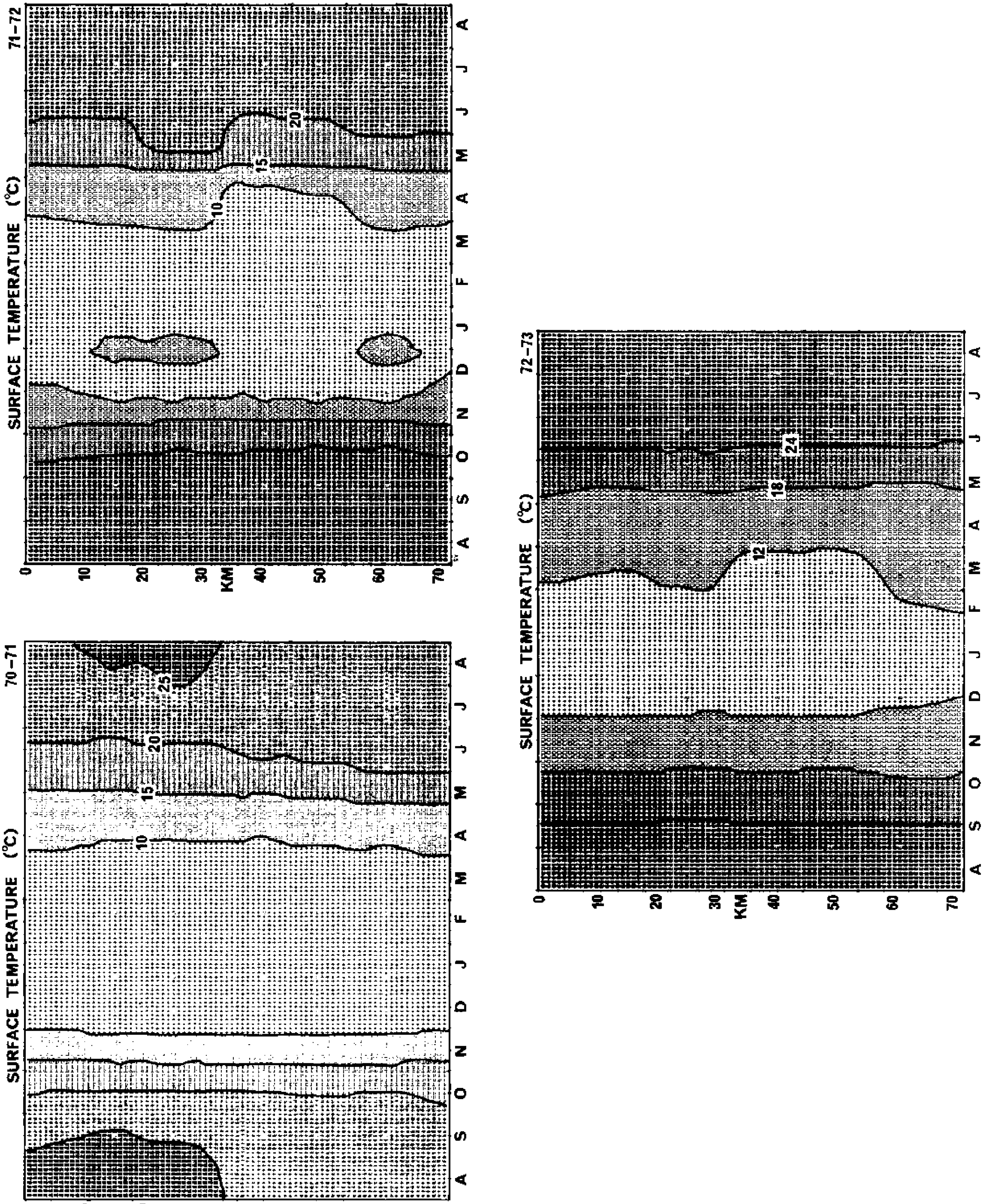


Fig. 26. Yearly maps of seasonal distribution of temperature (°C) in the Albemarle Sound 1970-1973.

IV. B. Nutrients

IV. B. 1. Phosphorus

Data are presented for two categories of phosphorus: total unfiltered phosphorus (TUP) and reactive phosphate (RP). Reactive phosphate is the form of phosphorus that is generally regarded as easily available for algal growth. Total unfiltered phosphorus is the sum of RP, particulate phosphorus, and dissolved organic phosphorus. Concentrations are expressed as ug-at PO_4/liter which can be converted to ug PO_4/liter is multiplied by 95 or to ug P/liter if multiplied by 32.

The concentrations of total unfiltered phosphorus (TUP) and reactive phosphorus (RP) were variable in both time and space. In general TUP and RP were higher in freshwater or upstream areas than in the sound itself. In September 1970 the TUP concentration was moderately high (Fig. 27) and ranged from 12 ug-at/liter in one upstream area to 2 ug-at/liter in the sound. The concentration of TUP declined in late 1970 while RP declined, then increased (Fig. 27). In early 1971, TUP was variable at from 1 to 3 ug-at/liter while RP increased to a maximum of 2 ug-at/liter in February (Fig. 29 and 30). Throughout mid 1971 both TUP and RP remained at relatively low concentrations (Fig. 31 and 32) followed by increases through late 1971 (Fig. 33 and 34) probably as a consequence of Hurricane Ginger in October 1971. The level of TUP in early 1972 were somewhat higher than in 1971 possibly because of some long-term effects of Hurricane Ginger. The concentration of RP remained at moderate levels. Both phosphorus fractions had maxima in the winter of 1971-1972 similar to those from other years (Fig. 34 and 35). Once again in 1973 the pattern of high winter TUP and RP concentrations, followed by summer lows, then by fall increases was exhibited (Fig. 39 to 43) although

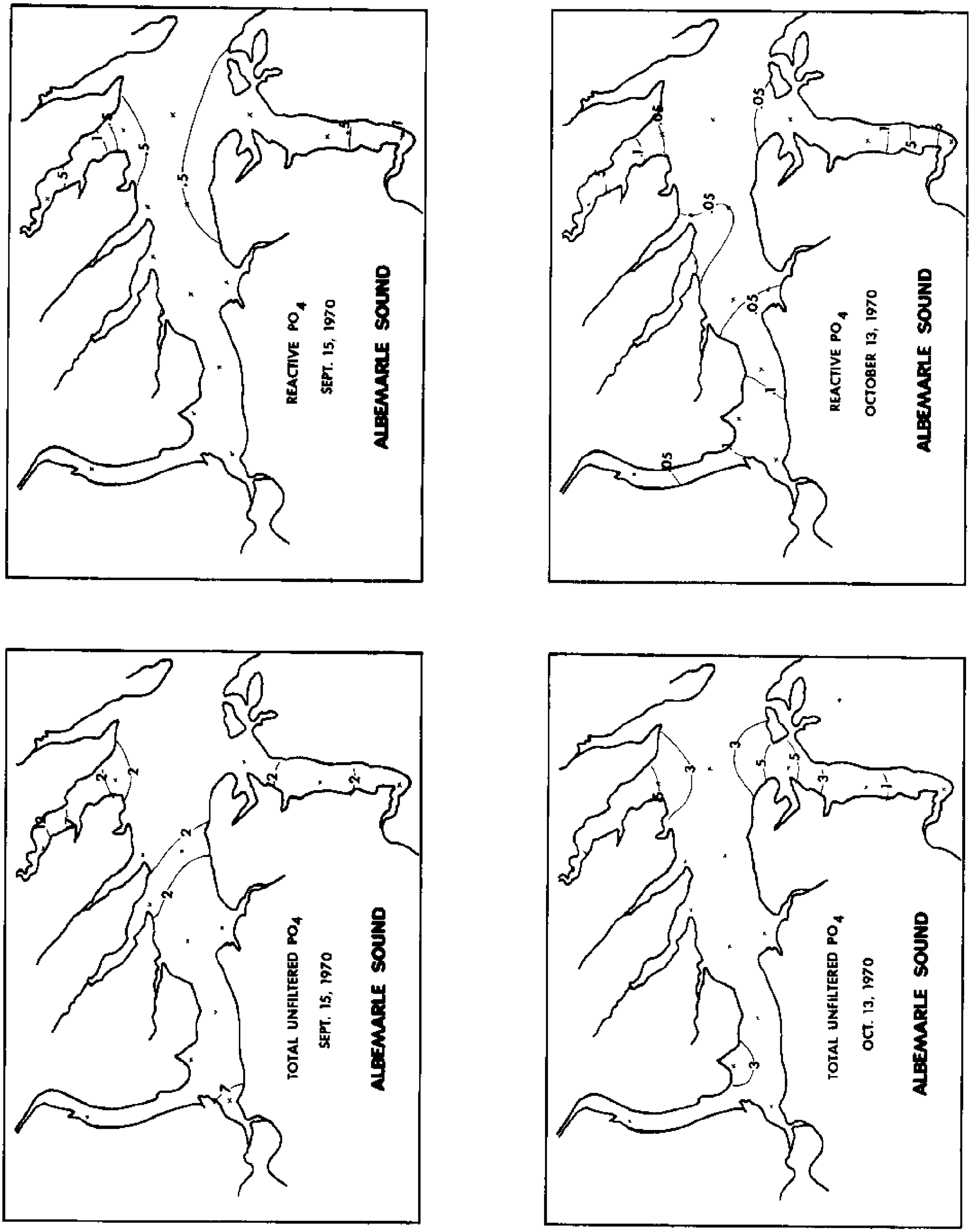


Fig. 27. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 15 September and 13 October 1970 in the Albemarle Sound.

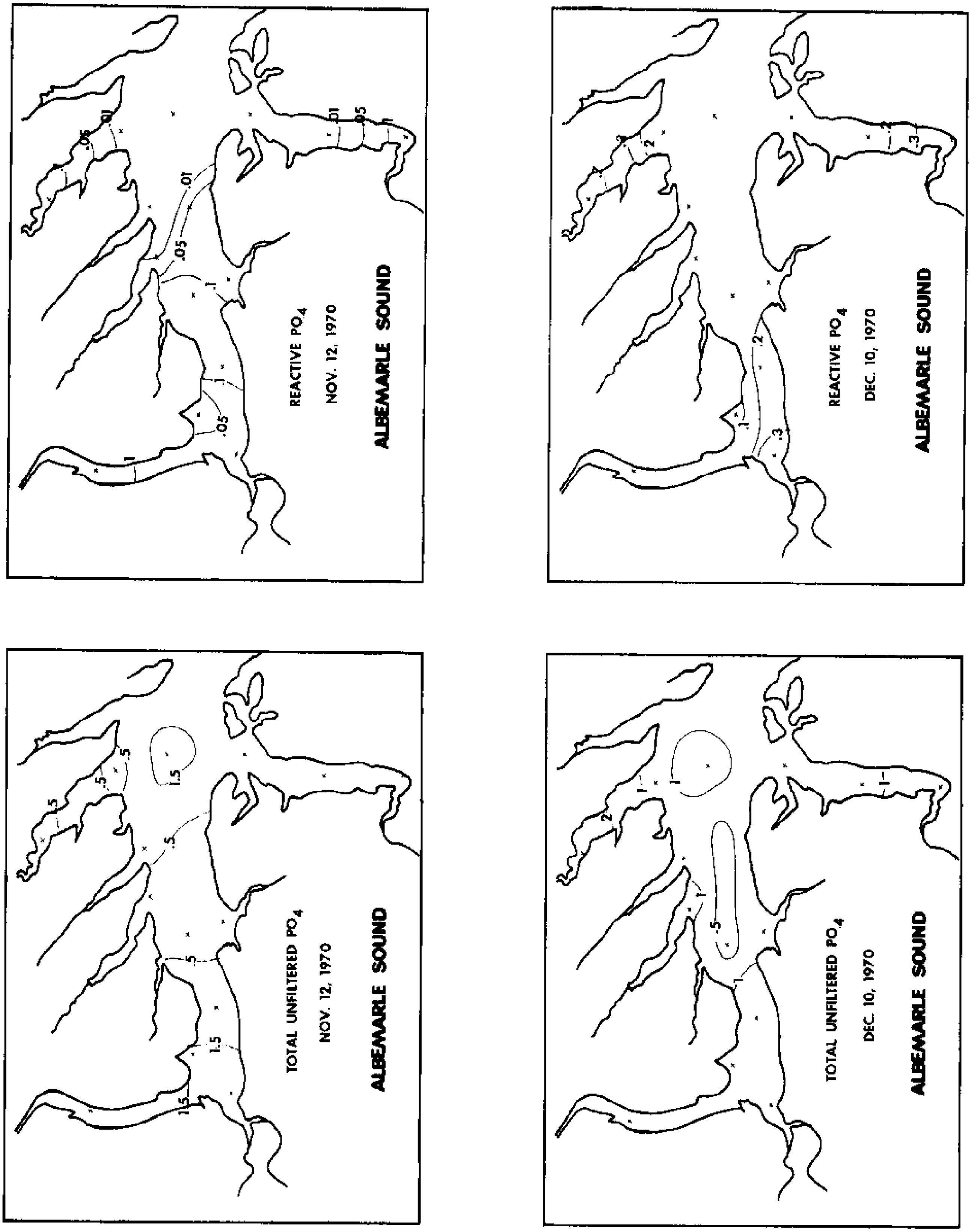


Fig. 28. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 12 November and 10 December 1970 in the Albemarle Sound.

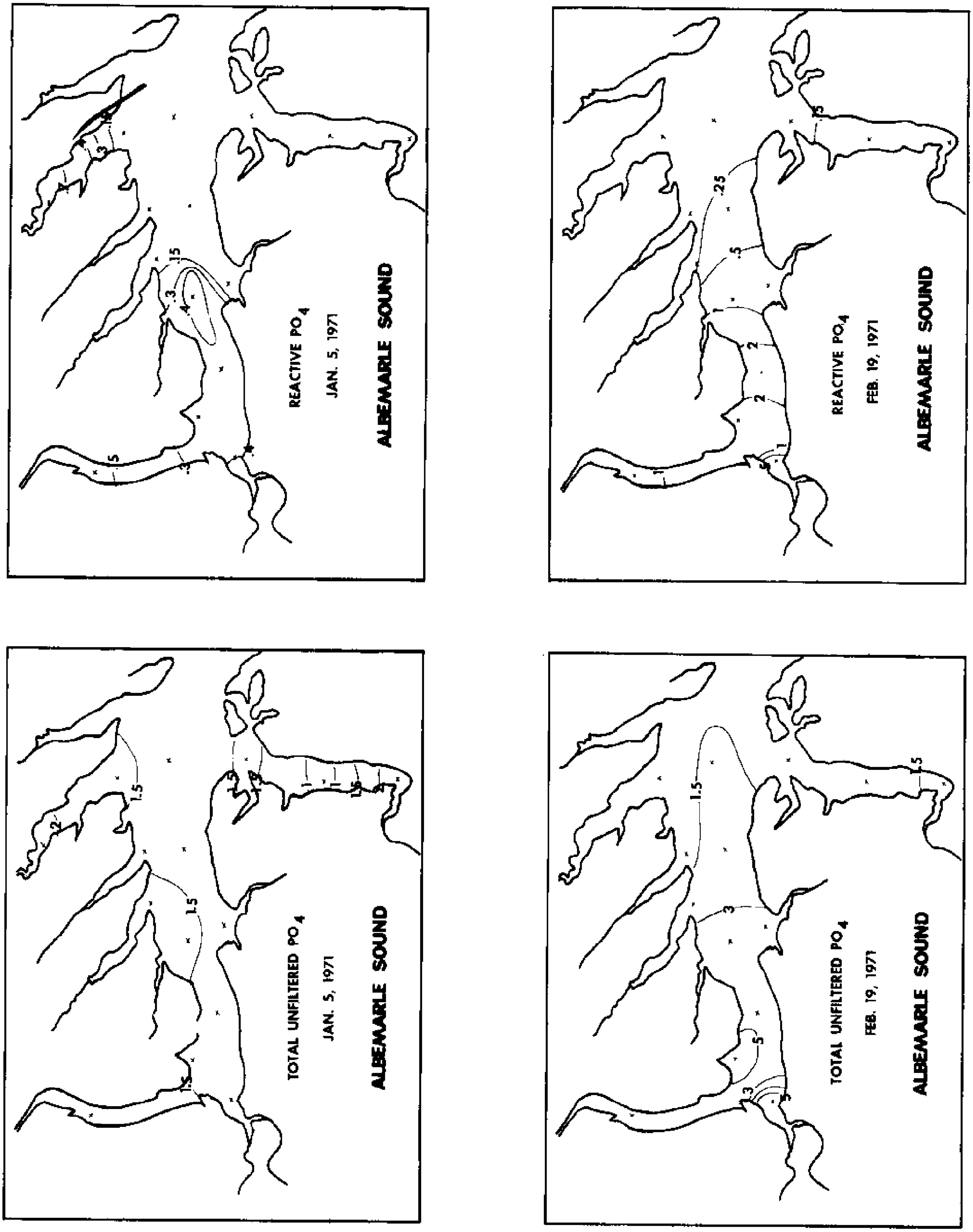


Fig. 29. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 5 January and 19 February 1971 in the Albemarle Sound.

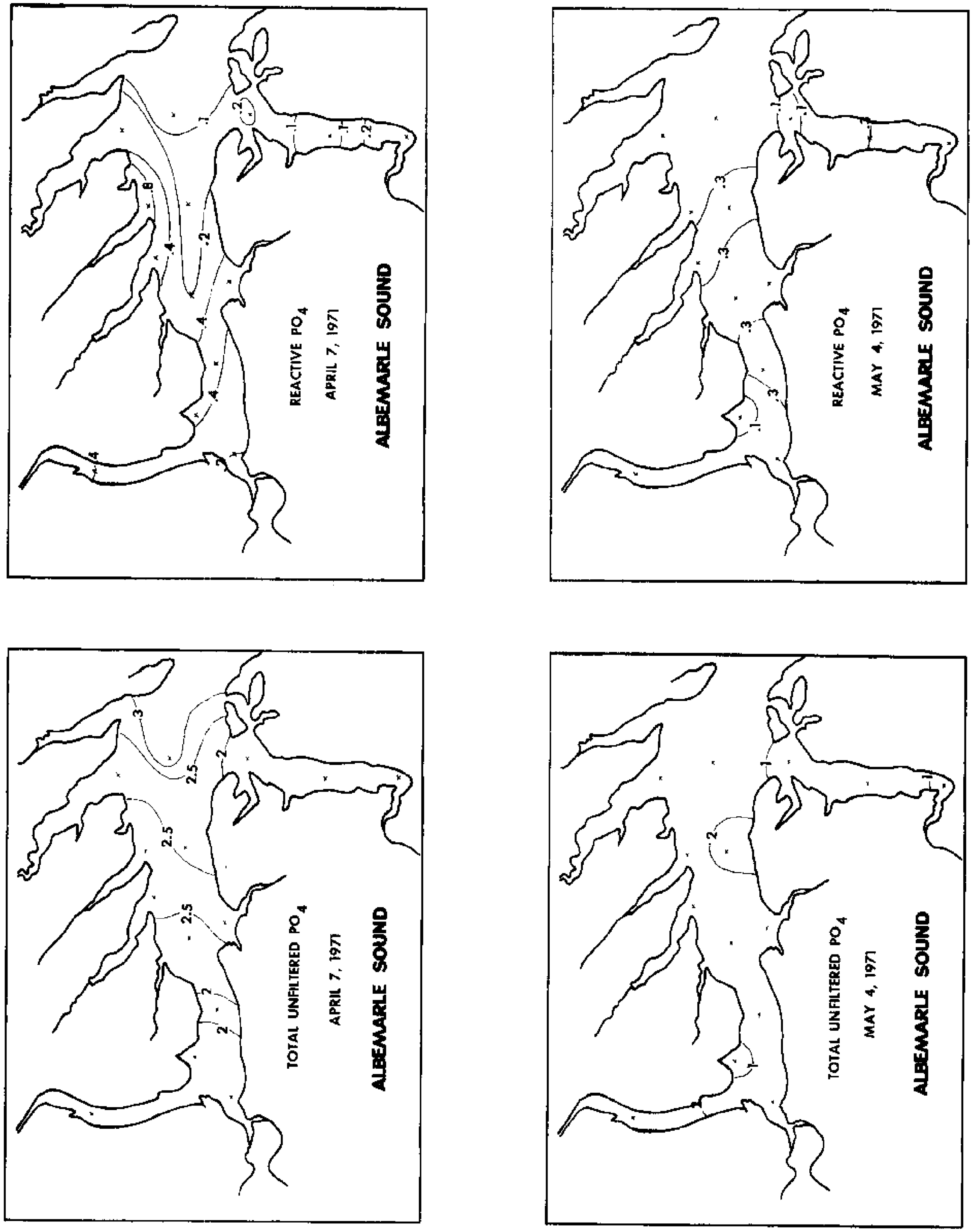


Fig. 30. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 7 April and 4 May 1971 in the Albemarle Sound.

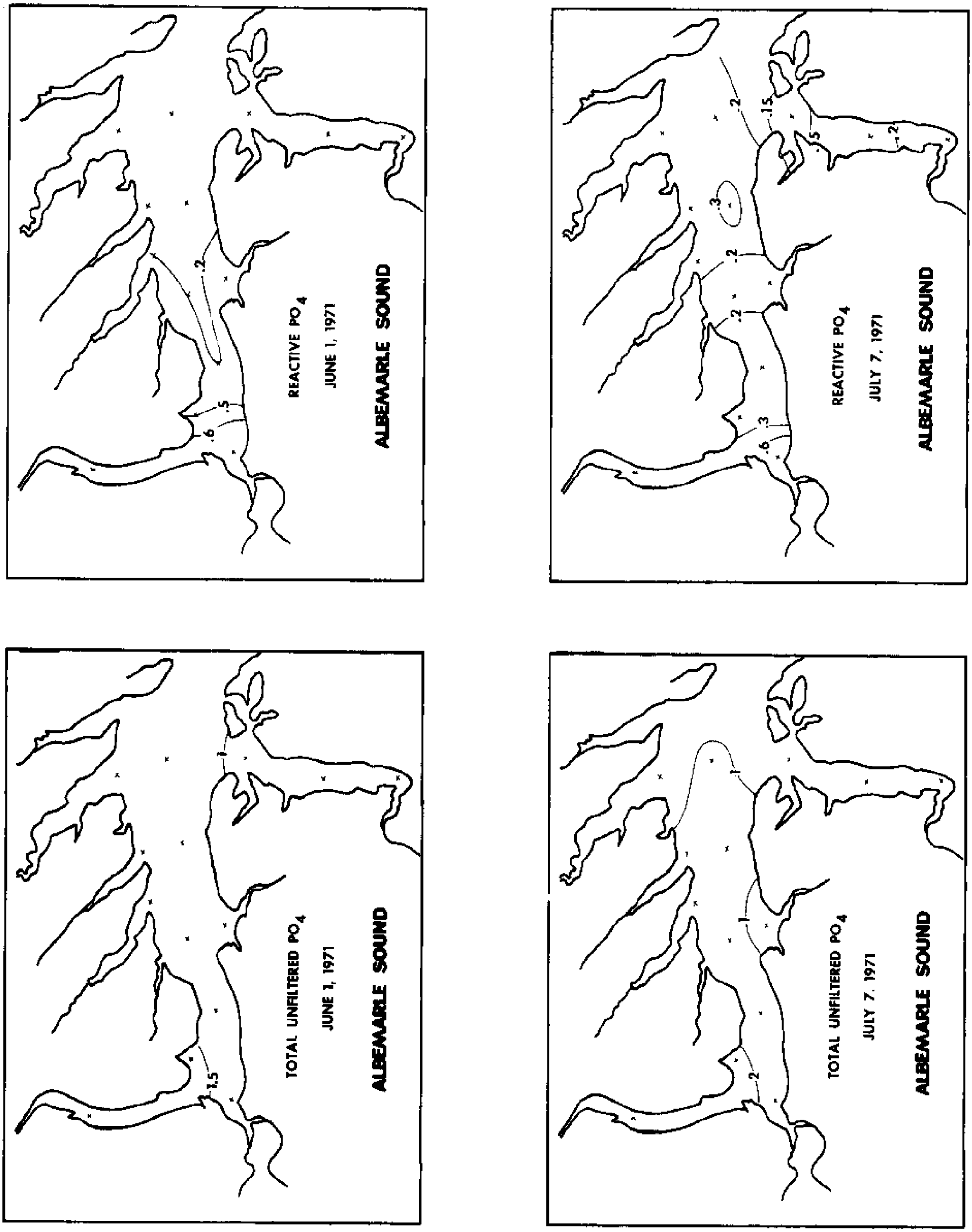


Fig. 31. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 1 June and 7 July 1971 in the Albemarle Sound.

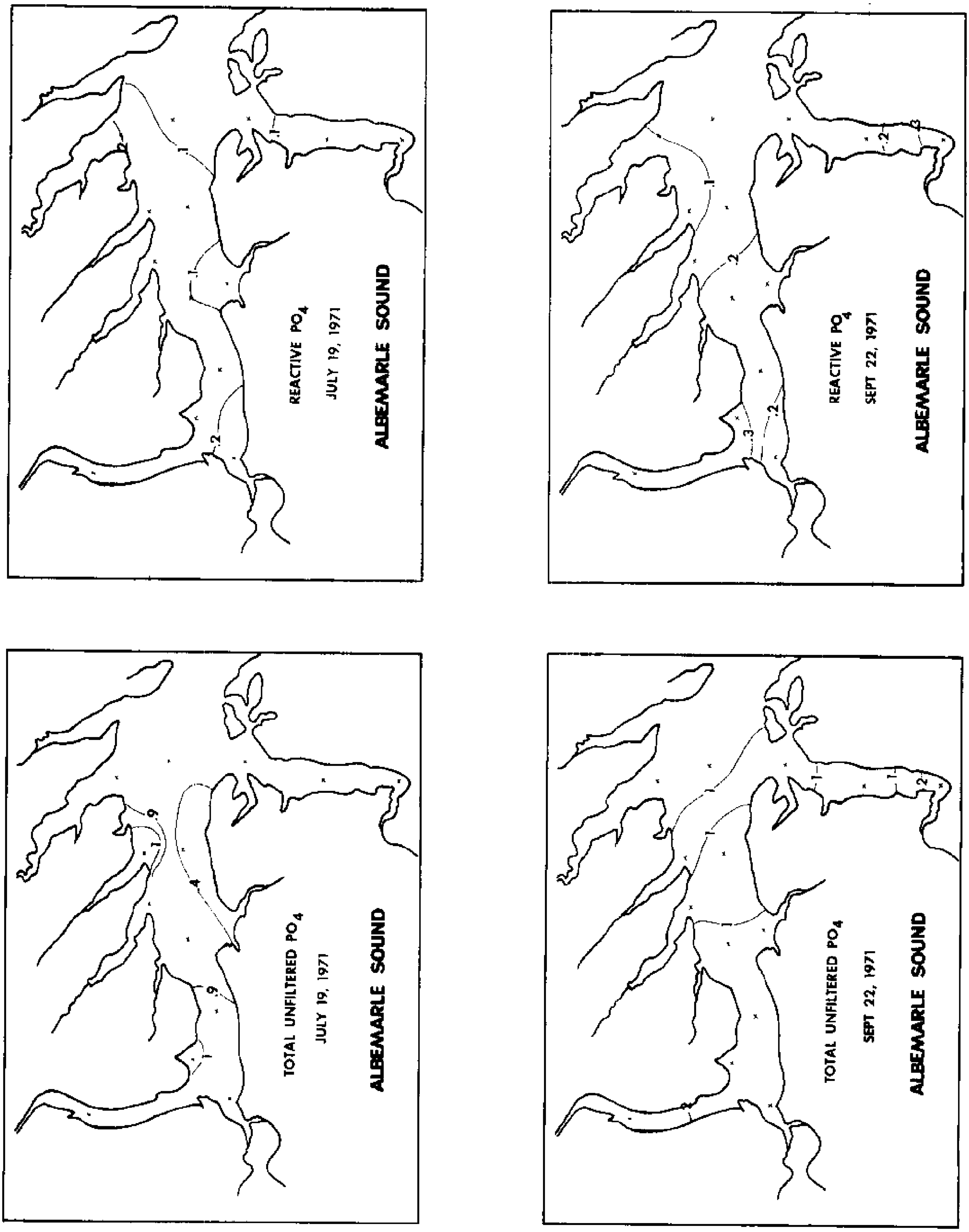


Fig. 32. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 19 July and 22 September 1971 in the Albemarle Sound.

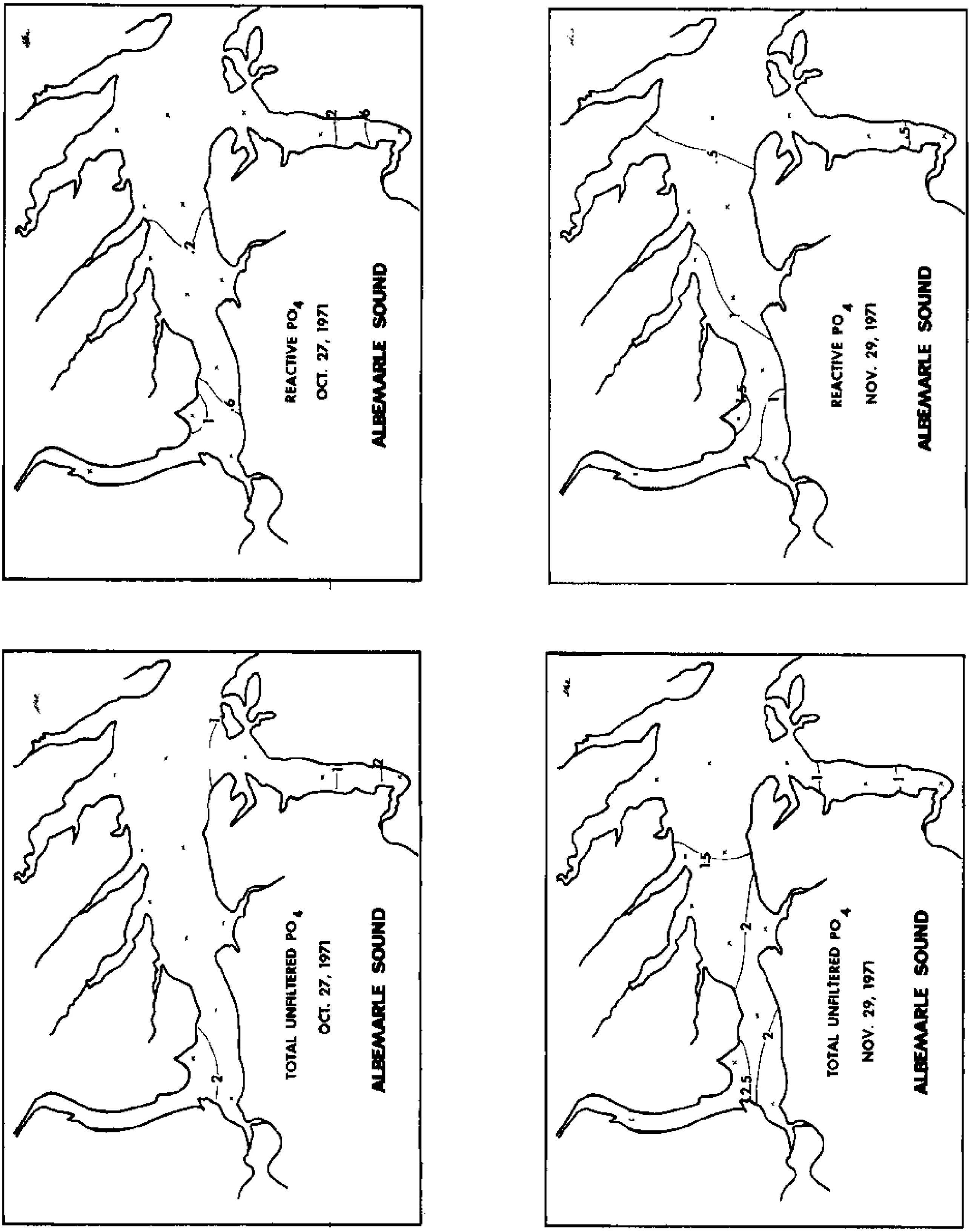


Fig. 33. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 27 October and 29 November 1971 in the Albemarle Sound.

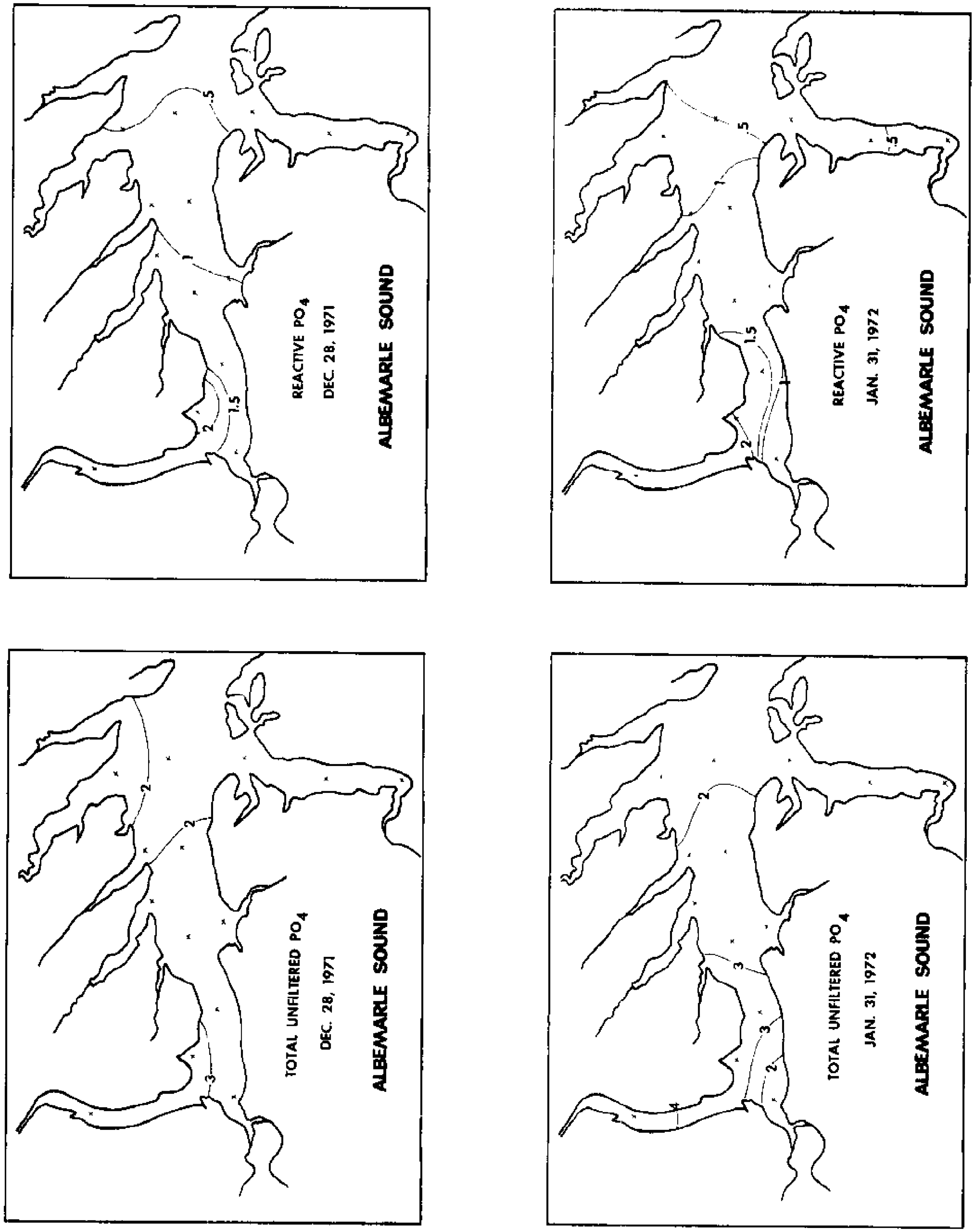


Fig. 34. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 28 December 1971 and 31 January 1972 in the Albemarle Sound.

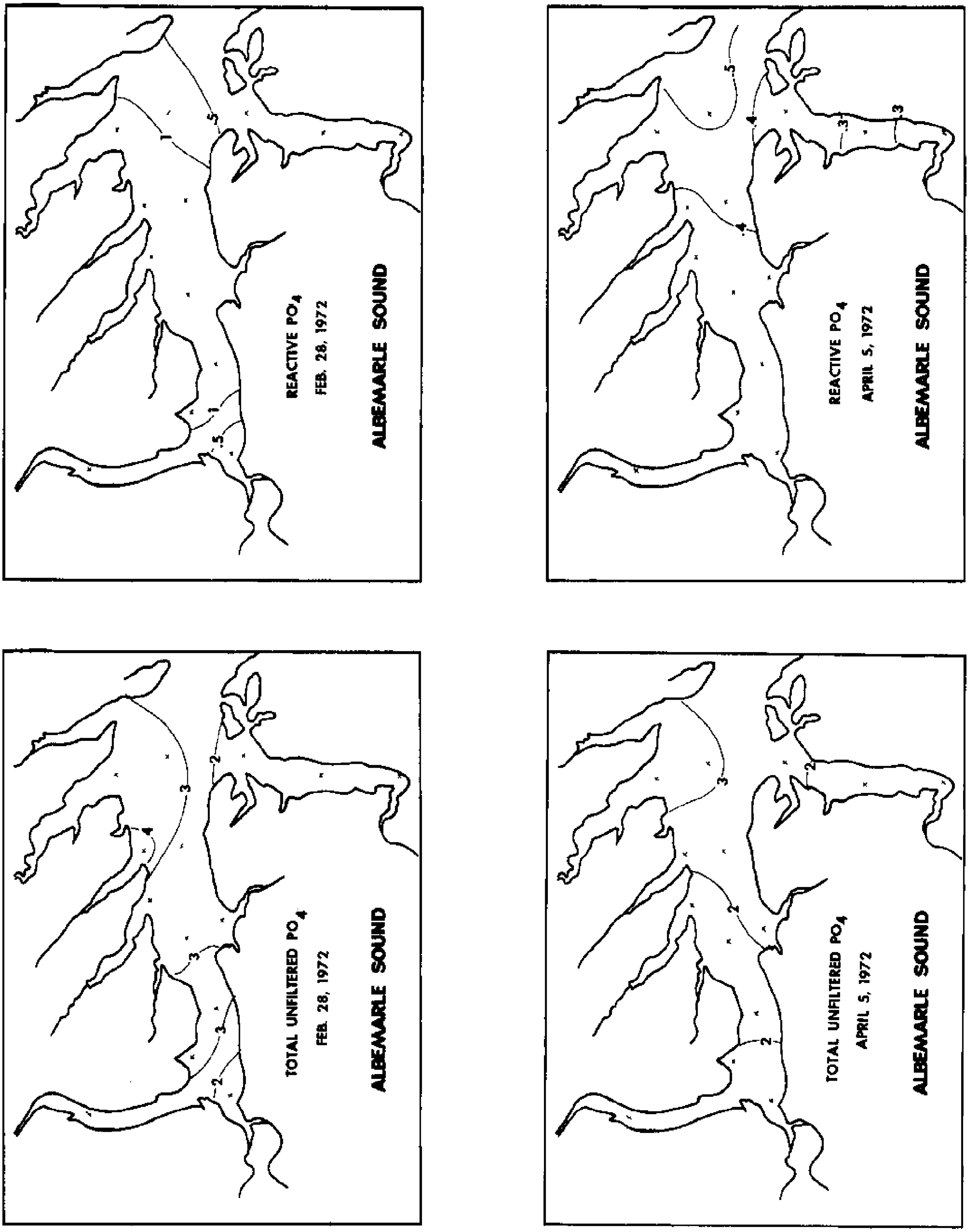


Fig. 35. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 28 February and 5 April 1972 in the Albemarle Sound.

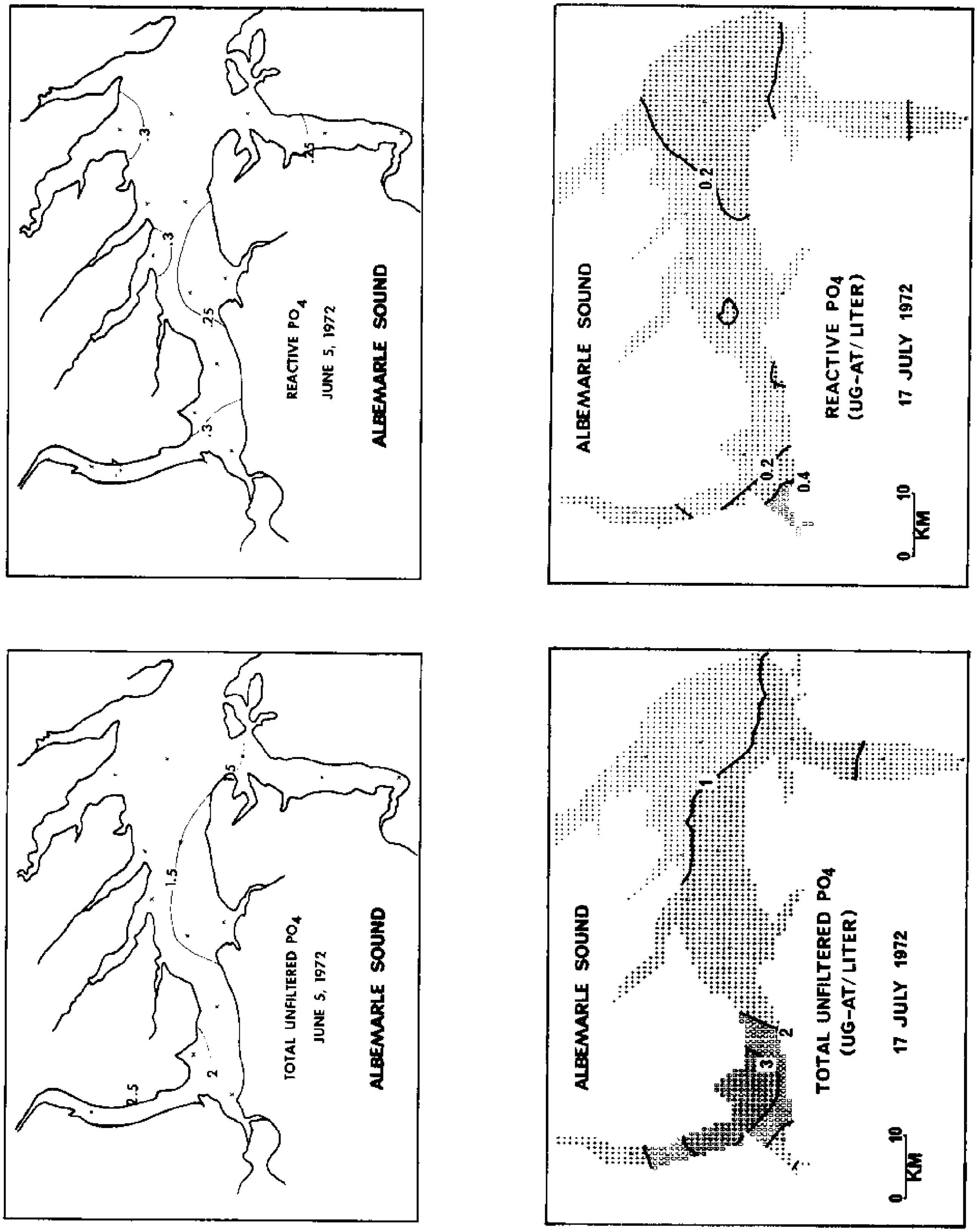


Fig. 36. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 5 June and 17 July 1972 in the Albemarle Sound.

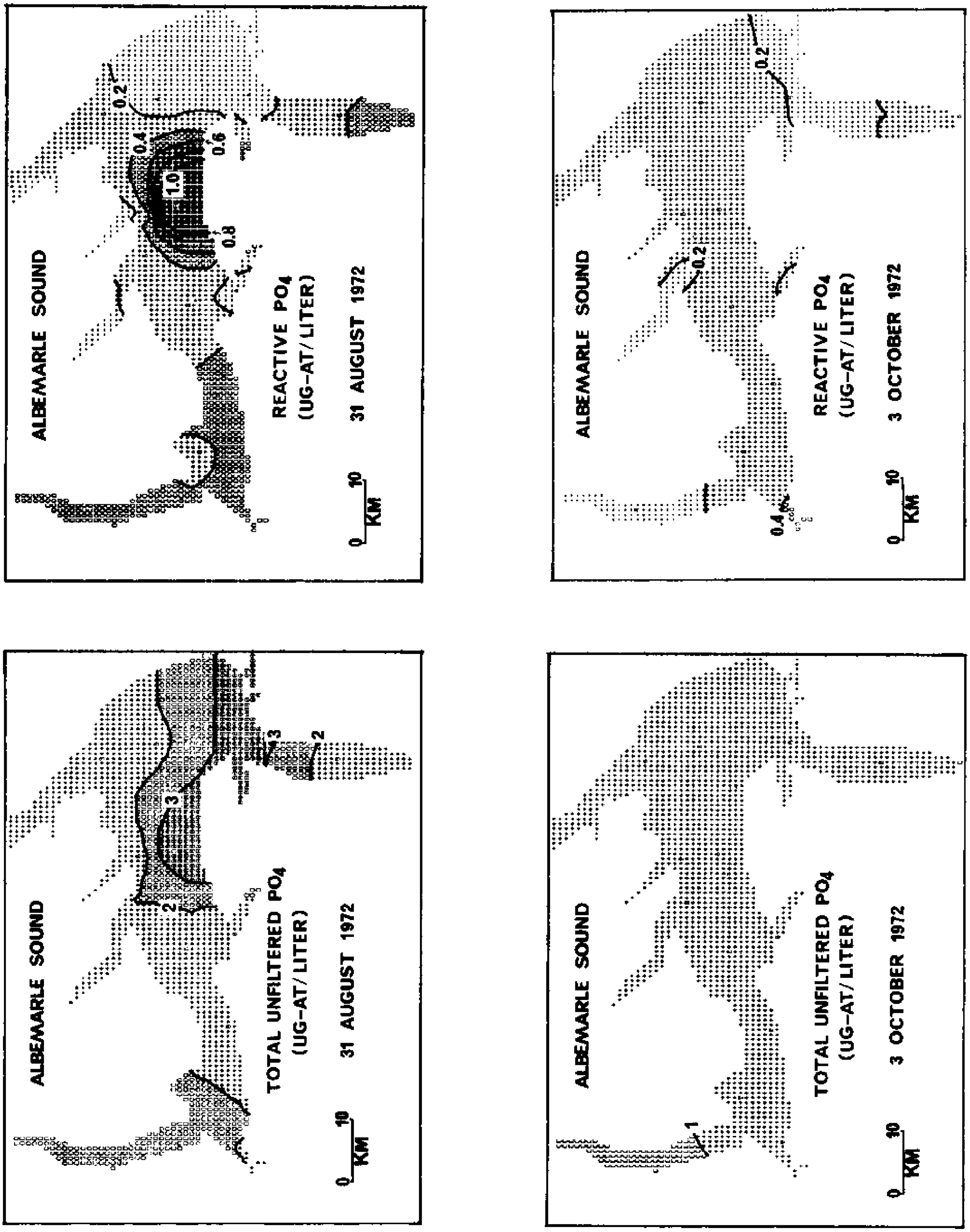


Fig. 37. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 31 August and 3 October 1972 in the Albemarle Sound.

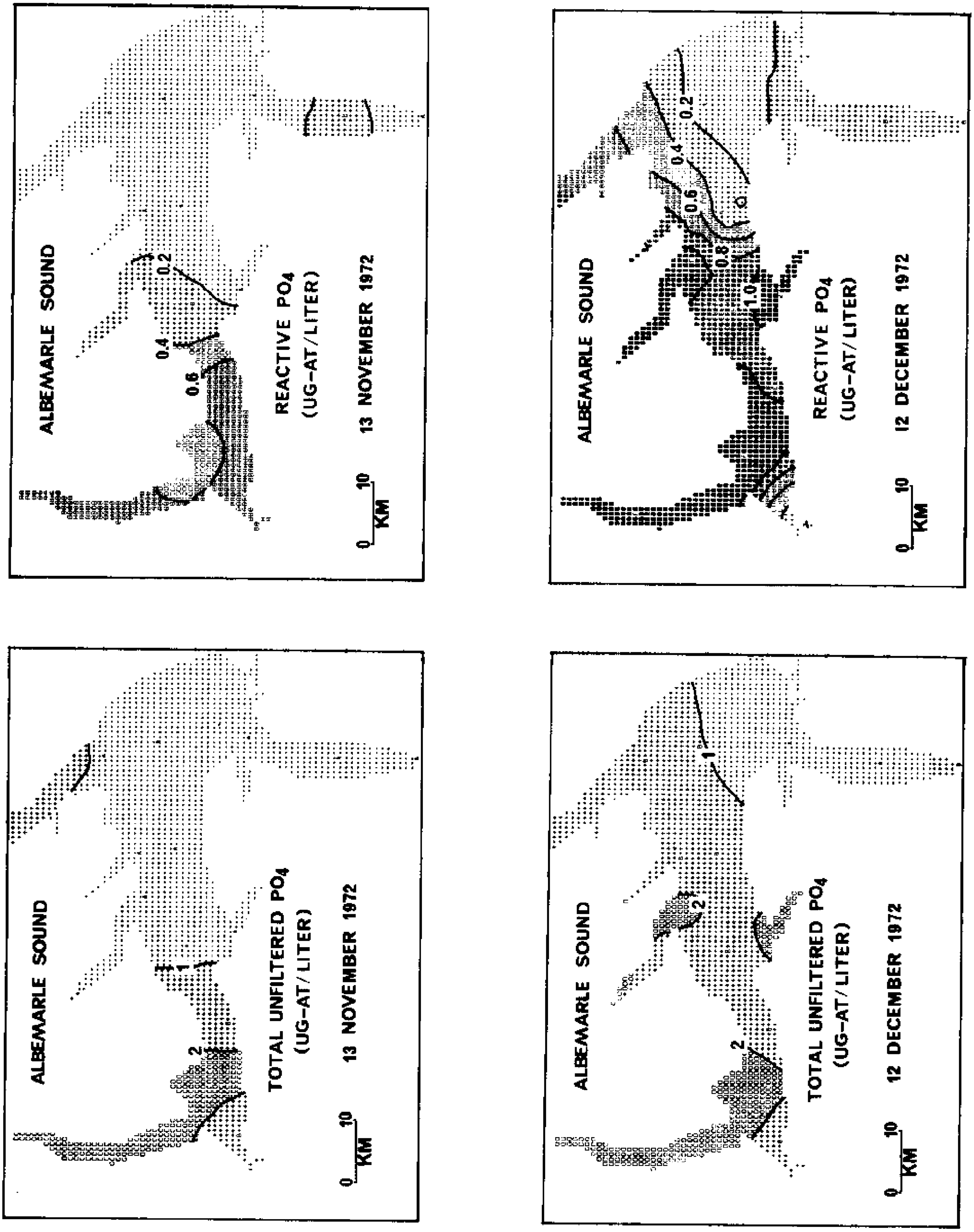


Fig. 38. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 13 November and 12 December 1972 in the Albemarle Sound.

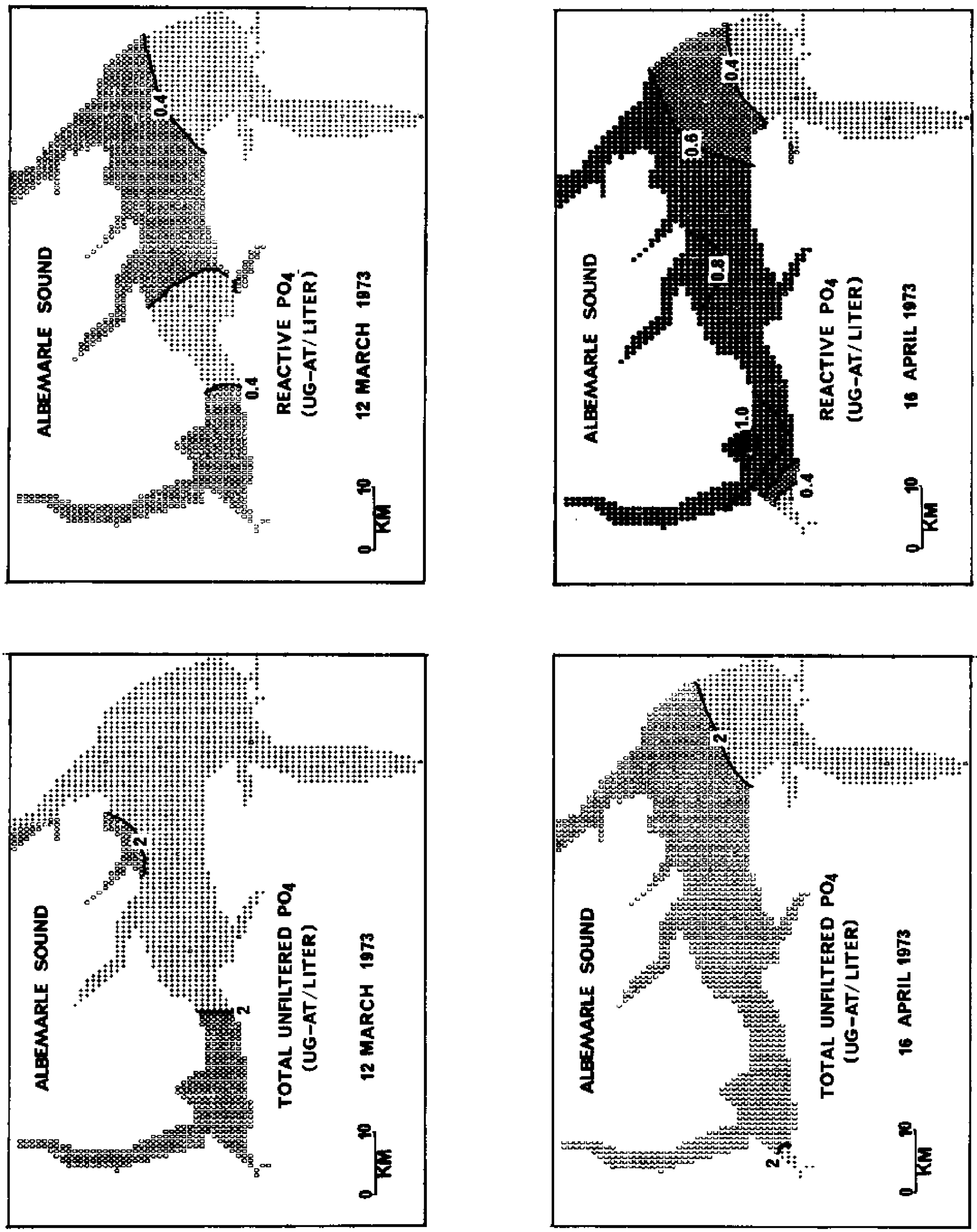


Fig. 39. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 12 March and 16 April 1973 in the Albemarle Sound.

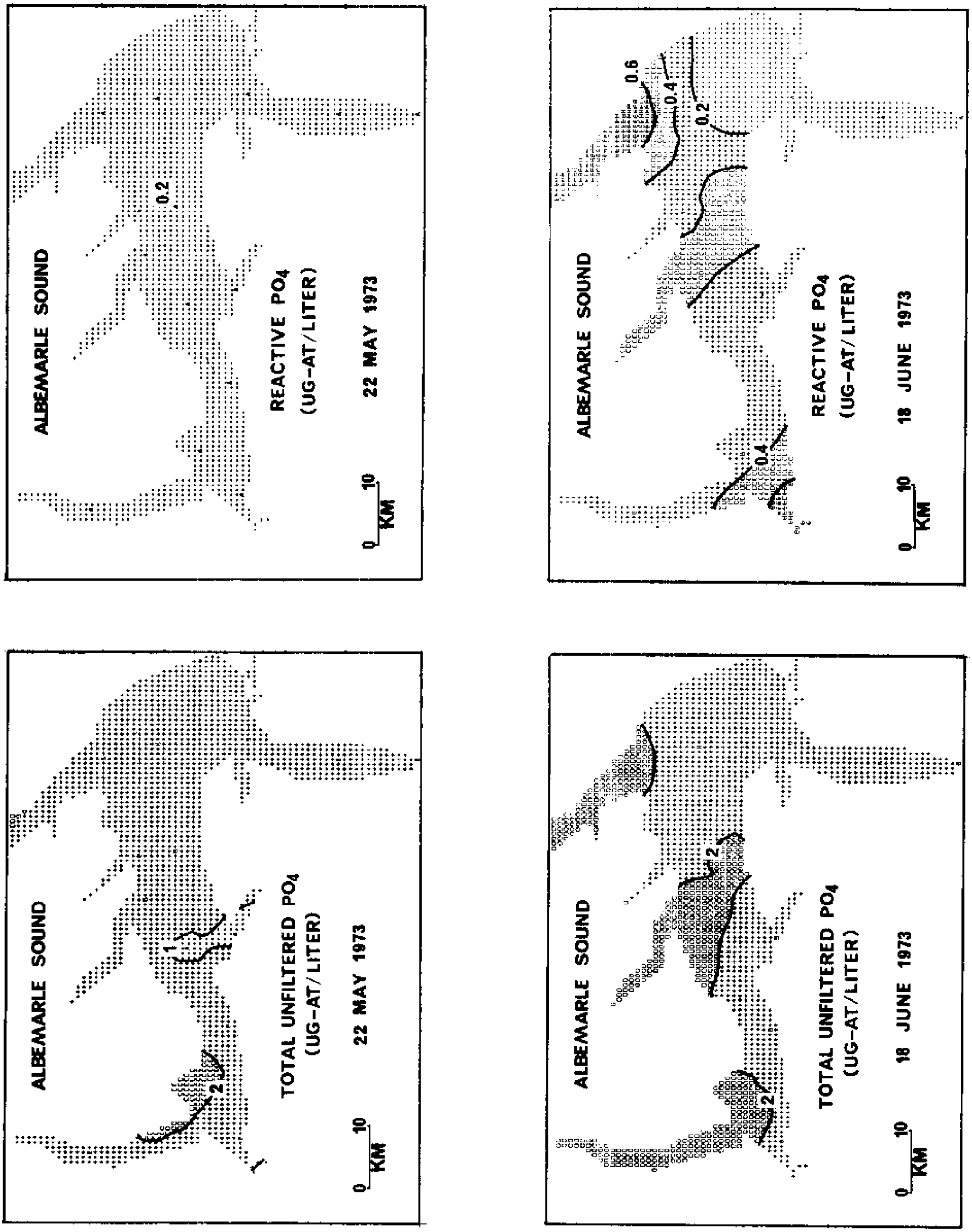


Fig. 40. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 22 May and 18 June 1973 in the Albemarle Sound.

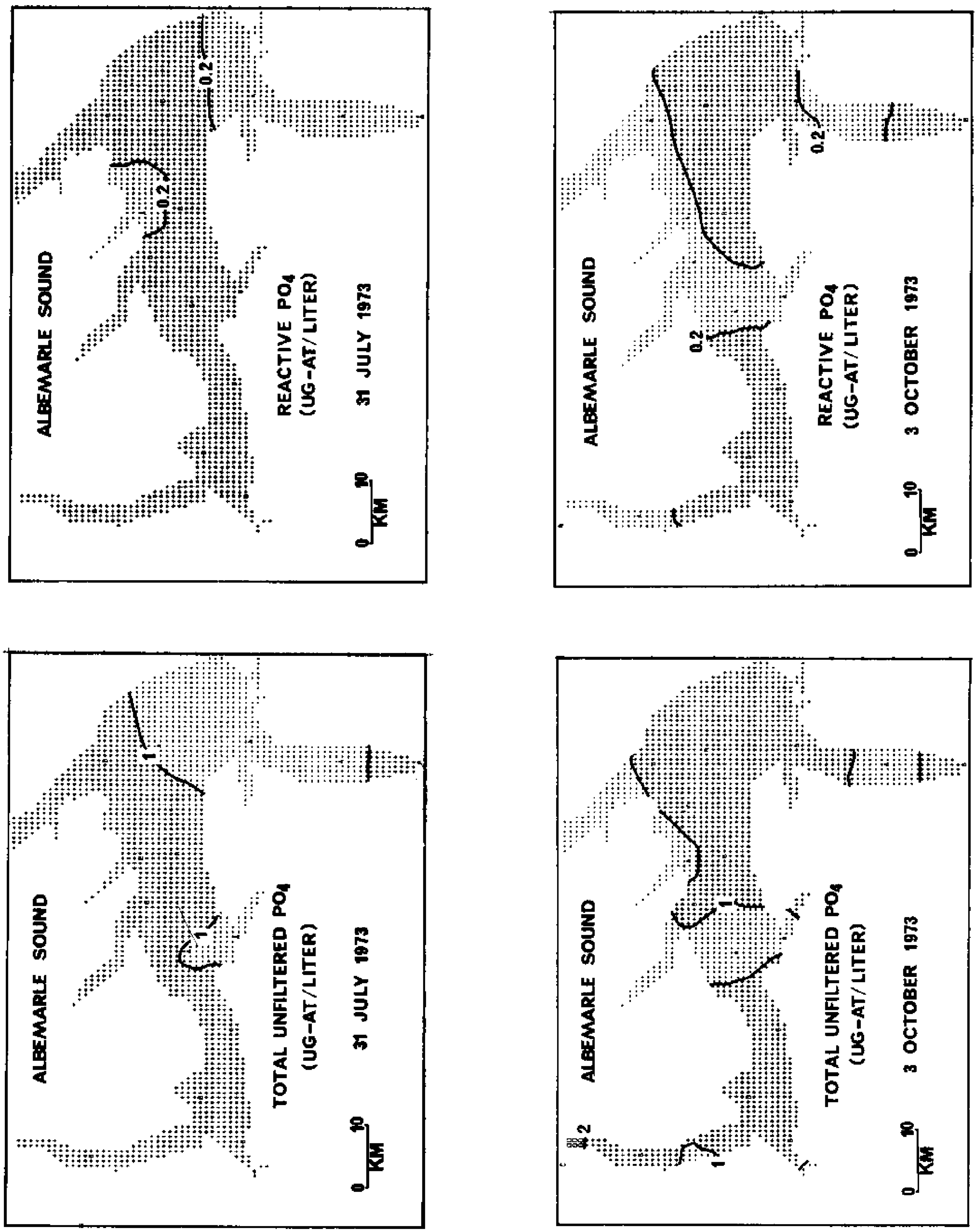


Fig. 41. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 31 July and 3 October 1973 in the Albemarle Sound.

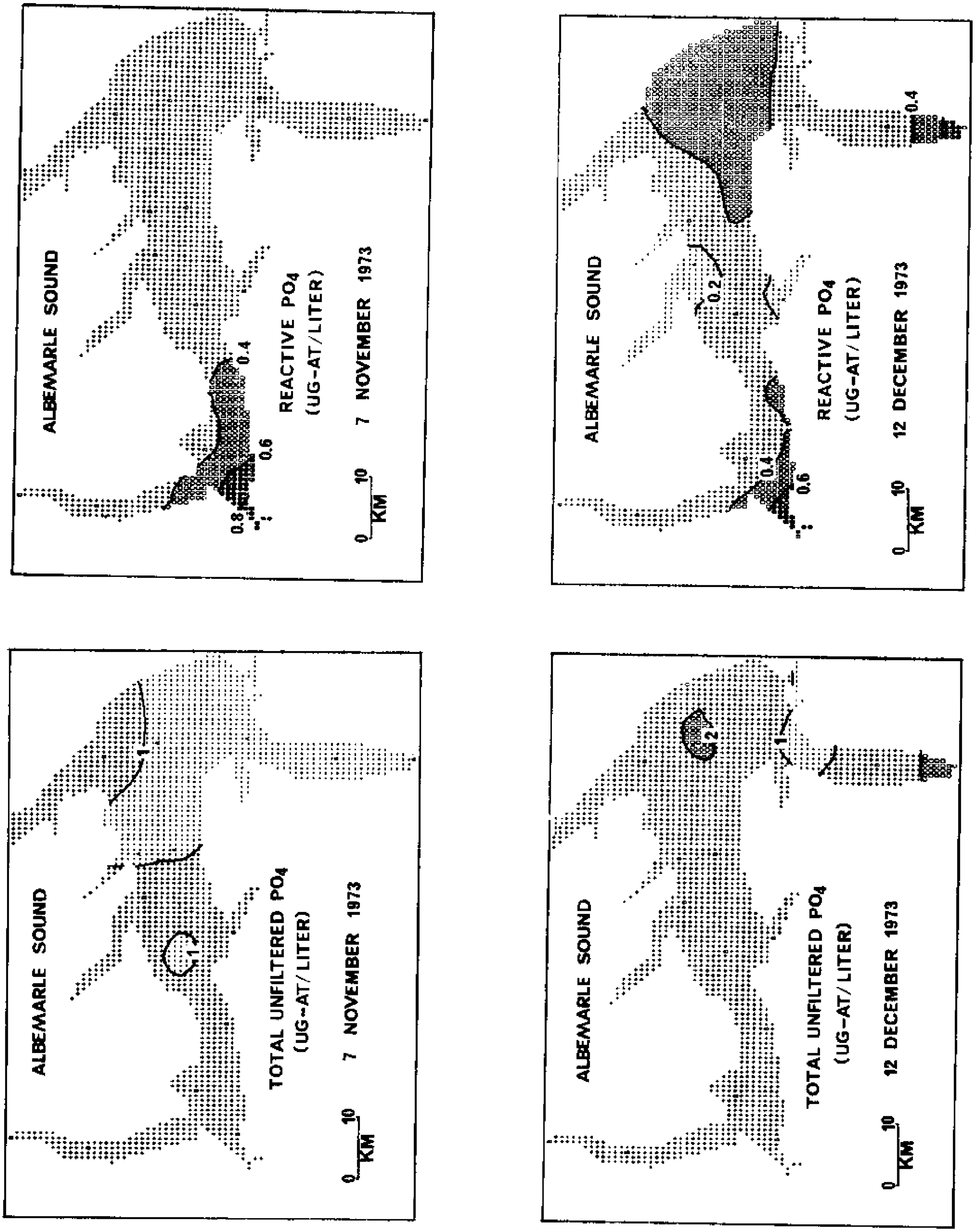
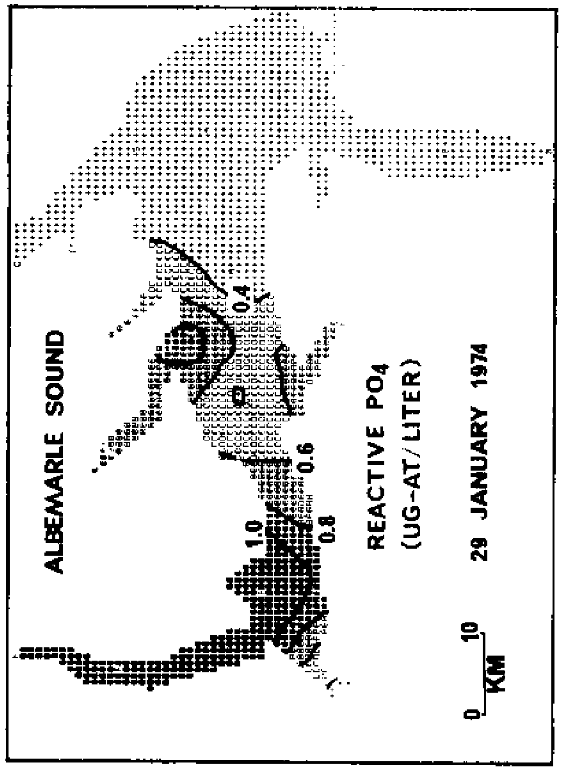


Fig. 42. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 13 November and 12 December 1973 in the Albemarle Sound.



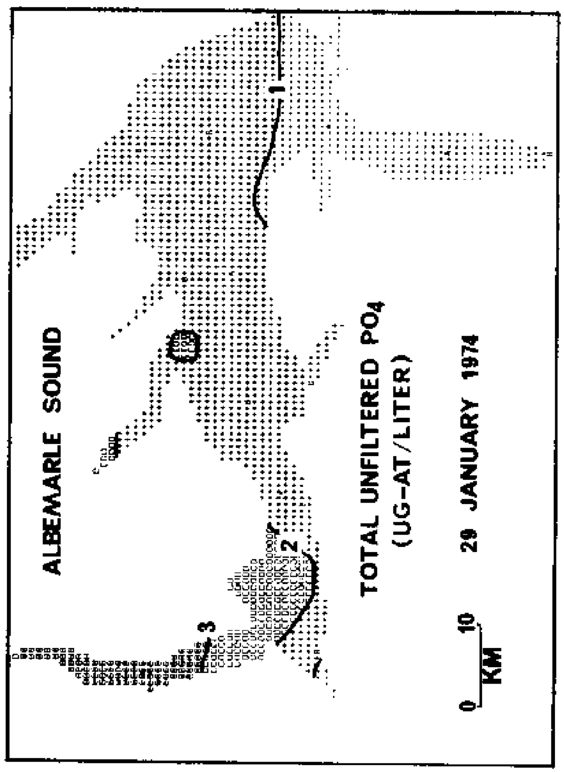


Fig. 43. Total unfiltered phosphorus and reactive phosphorus (ug-at/liter) for 29 January 1974 in the Albemarle Sound.

the winter concentrations were somewhat low because of the extremely wet year in 1973.

Total unfiltered phosphorus ranged from 0.27 ug-at/liter on 12 November 1970 (Fig. 28) to 12 ug-at/liter on 15 September 1970(Fig. 27). Except for the dry year of 1970, TUP was generally less than 3.5 ug-at/liter. The highest concentrations occurred from late fall to early spring in the mid to upper estuary (Fig. 44). When the summary isopleths of annual salinity and TUP are compared there is some evidence that low TUP seawater dilutes high TUP sound water -- i.e., the salinity increases as the TUP concentrations decrease. In addition, the concentration of TUP was affected by tributary input and overland runoff. On several days (e.g., Fig. 35, 28 February 1972) high phosphorus water occurred at the mouths of some tributaries. This took place several days after high flow periods recorded by gauges on the nearby Chowan River tributaries. There is little evidence that runoff from any one town (such as Edenton) causes an increase in TUP.

Reactive phosphate ranged from undetectable concentrations on 12 November 1970 (Fig. 28) to 6.1 ug-at/liter on 13 October 1970 (Fig. 27) and was generally less than 1 ug-at/liter. On 13 October 1970, the RP ranged from the study maximum in an upper tributary to near the study minimum in the sound. Reactive phosphate generally increased upriver and around Edenton, possibly as a result of fertilizer and residential runoff. Concentrations were highest in the mid to upper estuary during the winter and were lowest in the fall and spring (Fig. 45). Like TUP, there is a close inverse correlation between salinity and RP concentration in the lower estuary, indicating that low phosphorus seawater dilutes high phosphorus water from the river or from land runoff. Apparently RP and TUP vary together since changes in RP alone can not explain wholly the changes in TUP.

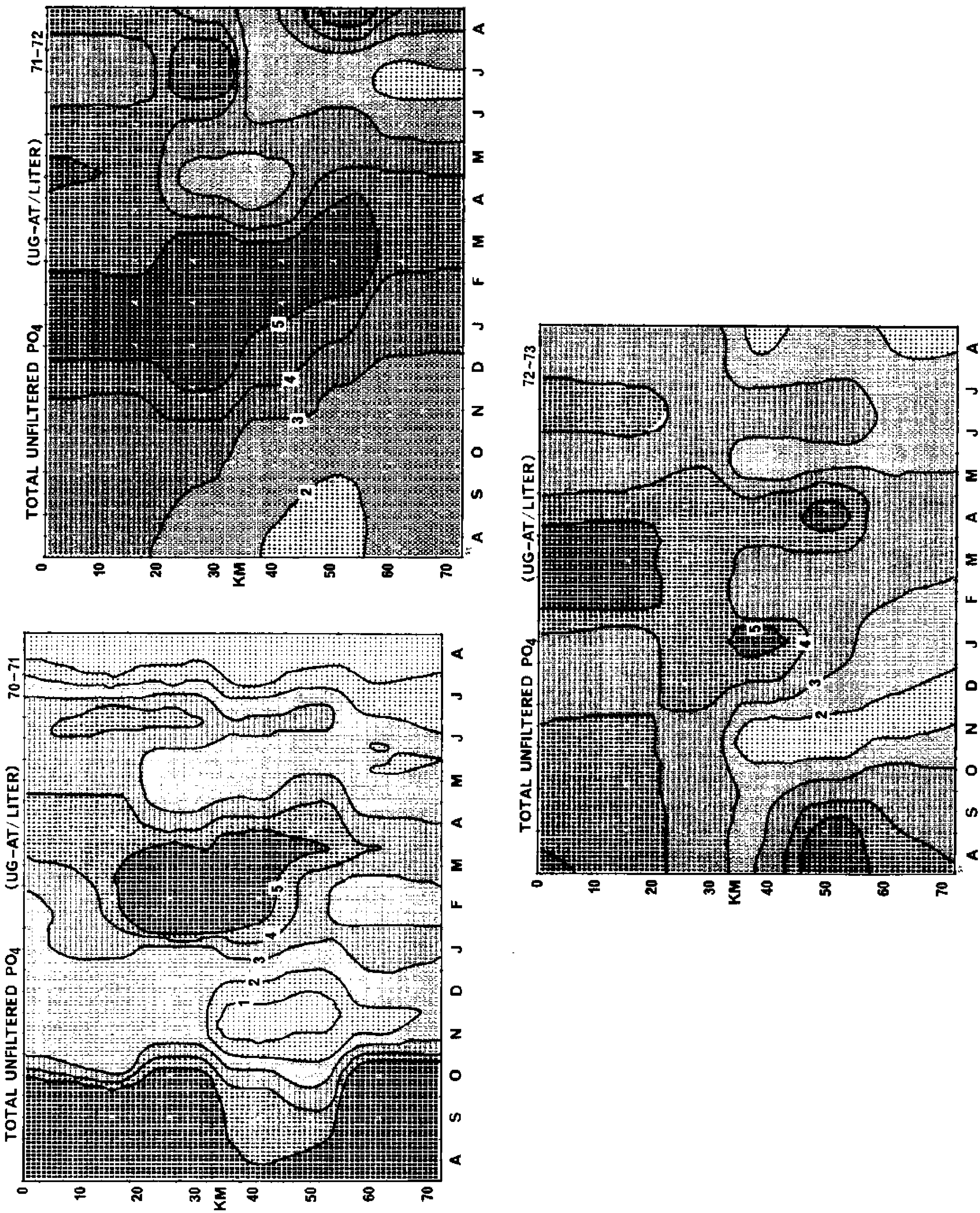


Fig. 44. Yearly concentration of total unfiltered phosphorus (ug-at/liter) for 1970-1973 in the Albemarle Sound.

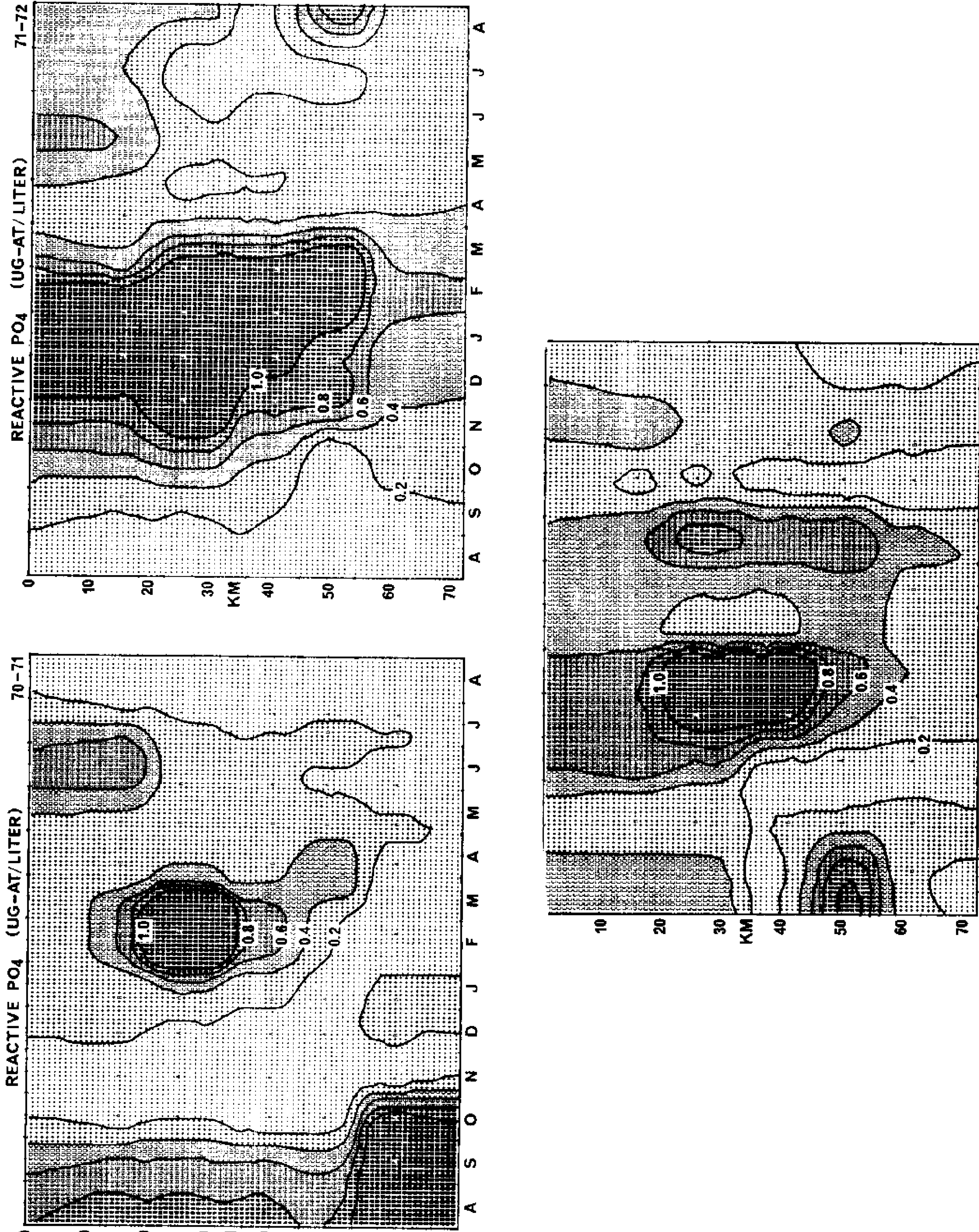


Fig. 45. Yearly concentration of reactive phosphorus (ug-at/liter) from 1970-1973 in the Albemarle Sound.

Phosphorus concentrations in Albemarle Sound are much lower than those in the Neuse River system (Hobbie and Smith 1975) or in the Pamlico River system (Hobbie 1974). In the Neuse system TUP ranged from less than 1 to about 20 ug-at/liter and was usually less than 5.5 ug-at/liter. In the Pamlico, TUP ranged from 2 to as much as 85 ug-at/liter but was generally less than 10 ug-at/liter. Reactive phosphorus ranged from 1 to as much as 75 ug-at/liter, generally less than 5.5 ug-at/liter. In these systems the peaks of phosphorus concentration appear in the mid to upper estuary during the summer. A distinct mid-winter peak of phosphorus, as occurs in the Albemarle, does not occur in the Neuse or Pamlico systems.

There is no proven criterion for the level of phosphorus that is unhealthy for an estuary; however, Ketchum (1969) suggested that most highly eutrophic estuaries on the east coast had total phosphorus concentrations in excess of 2.8 ug-at/liter. Although TUP was less abundant in Albemarle Sound than in the Tar-Pamlico or Neuse systems, this threshold still was exceeded on numerous occasions.

The generally high phosphorus concentrations in the Neuse and Pamlico systems are understandable. Common sources of phosphorus in this area are sewage treatment and septic tank effluent, industrial activity, and overland residential runoff. Such inputs to the Neuse River include the town of New Bern (1970 population: 14,041) and the Cherry Point Marine Base. Inputs to the Tar River, which empties into Pamlico sound, include the towns of Washington, Rocky Mount and Greenville (1970 populations: 8,633; 33,297; and 28,522 respectively) and the Texasgulf phosphate mining operation. In contrast, there are no large population centers on Albemarle Sound (1970 population of Edenton, N. C.: 4,359) and no large industries that add significant amounts of phosphorus. There are large paper mills much further upsteam in Virginia whose effects are probably small by the time the water reaches Albemarle Sound. In comparison to the Albemarle system, there is more TUP and RP in Pamlico Sound and the ratio between TUP and RP is lower. This is probably the result of a number of factors including the activities of the Texasgulf phosphate mining operation which adds some RP to the river. There are an estimated two billion tons of phosphate ore under the present site on the Tar River (Clay et al. 1975).

However, in addition to the phosphorus from urban and industrial sources, rivers entering these large estuaries also receive phosphorus from agricultural runoff. This may well be the most important source of phosphorus as the density of population and industry is comparatively still quite low. The drainage basins of the Tar-Pamlico River and of the Neuse River include extensive areas of heavily-fertilized farmlands while the drainage basin of Albemarle Sound is less intensively fertilized. In addition, the Roanoke River has several large reservoirs which may remove large amounts of phosphorus.

IV. B. 2. Nitrogen

Data are presented for several forms of nitrogen. Monthly concentration contours and yearly summary isopleths are presented for the three major inorganic forms of nitrogen: ammonia, nitrate, and nitrite. Yearly summary isopleths are presented for dissolved organic nitrogen and particulate nitrogen. Total nitrogen is the sum of the organic and inorganic forms. Concentrations are expressed as ug-at/liter. To convert ug-at/liter of NH_4, NO_3, or NO_2 to ug-at N/liter multiply by 14. To convert ug-at/liter of NH_4, NO_3, or NO_2 to ug/liter of NH_4, NO_3, or NO_2 multiply by their respective molecular weights (18, 62, or 46).

IV. B. 2. a. Nitrate

In overview, the concentration of nitrate was generally high in the winter and low in the summer. However, during each year of the study the details of this pattern were different. In late 1970, nitrate concentrations were quite variable ranging from 1 to 26 ug-at/liter (Fig. 46). Nitrate increased rapidly to 80 ug-at/liter in February 1971 then began to disappear (Fig. 47). In mid 1971, the nitrate values were quite low. There was a fall peak of nitrate in October 1971 (Fig. 49) following Hurricane Ginger, with generally high nitrate concentrations throughout late 1971. In early 1972 the nitrate concentrations remained high, falling off after February as before. However, the peak concentrations were not as high as in 1971 (Fig. 50). Summer concentrations were again low but there was no strong, late increase as before (Fig. 51). Nitrate concentrations remained quite low throughout most of 1973 as a consequence of the high flows that year (Fig. 52 and 53). Near normal concentrations began to appear as this study terminated in early 1974. The trend of high winter concentrations, the fall 1971 peak after Hurricane Ginger, and the low 1973 year are evident in the summary isopleths (Fig. 55).

Nitrate is the most abundant inorganic nitrogen species in Albemarle Sound. Concentrations ranged from 0.01 ug-at/liter on 17 July 1972 (Fig. 50) to 82.7 ug-at/liter on 19 February 1971 (Fig. 47). Nitrate is more abundant in freshwater sections of the sound and its tributaries. Of the two major tributaries, the Chowan River appears to have larger amounts of nitrate (Fig. 47: 19 February 1971, 4 May 1971; Fig. 49: 27 October 1971) than the Roanoke River. This may be due to the activities of a large nitrogen fertilizer plant at Tunis on the Chowan River that has added substantial quantities of nitrogen to the river in the past. However, this is not to say that the Chowan River is a better source of nitrate than the Roanoke River since nitrate can be abundant in the Roanoke River (Fig. 48: 7 July 1971) and the flowrate is much higher than the flowrate of the Chowan River.

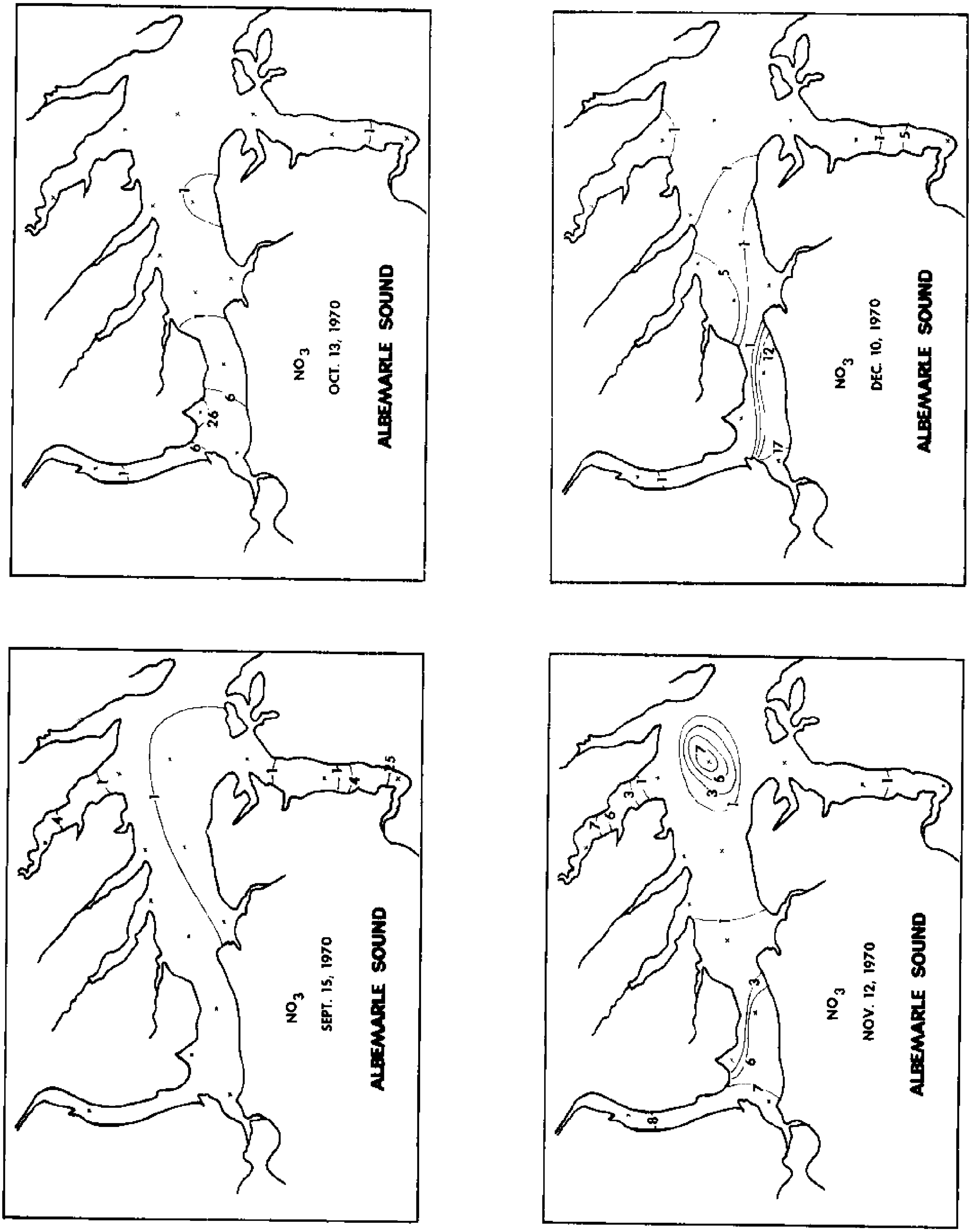


Fig. 46. Nitrate (ug-at/liter) for 15 September, 13 October, 12 November and 10 December 1970 in the Albemarle Sound.

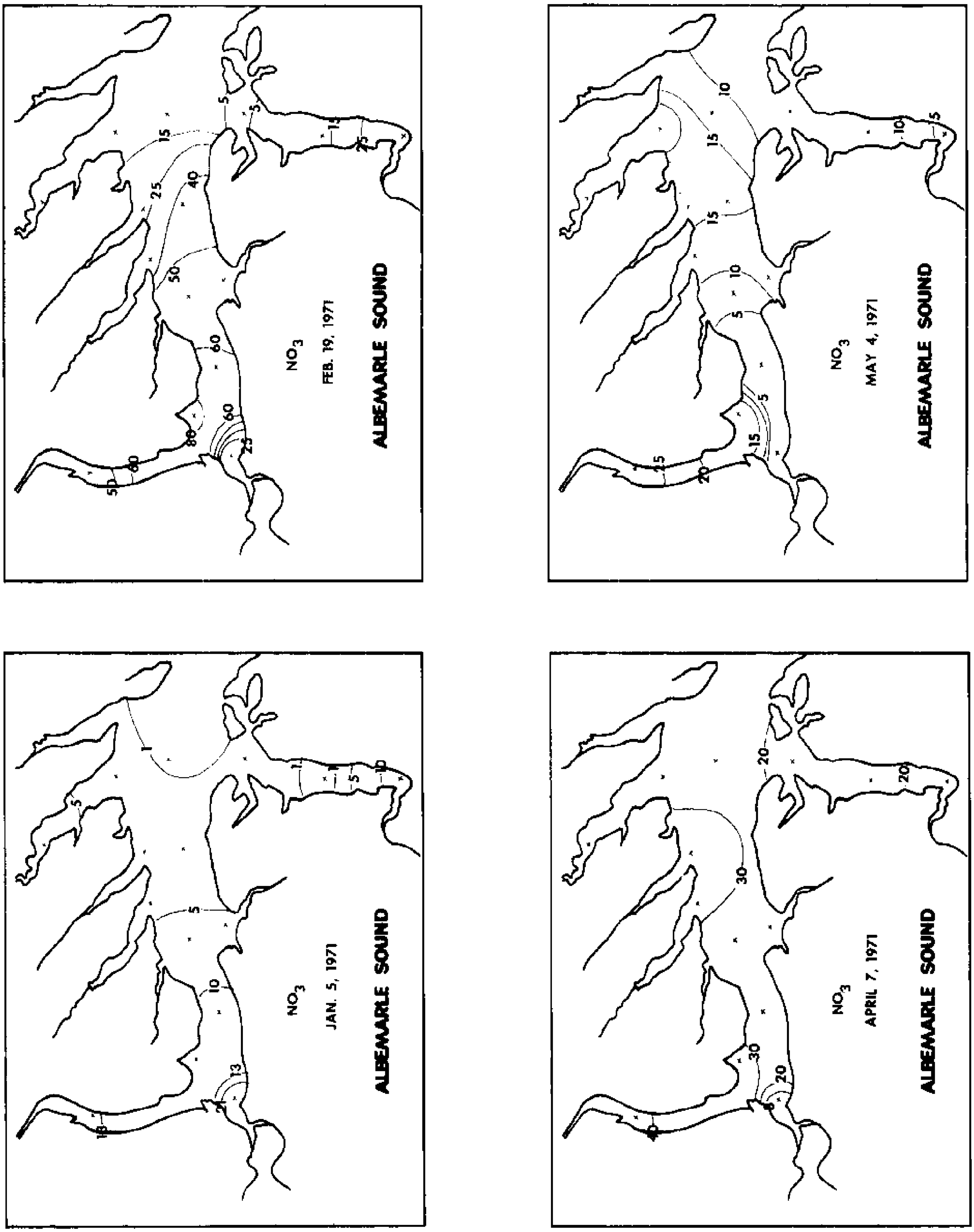


Fig. 47. Nitrate (ug-at/liter) for 5 January, 19 February, 7 April and 4 May 1971 in the Albemarle Sound.

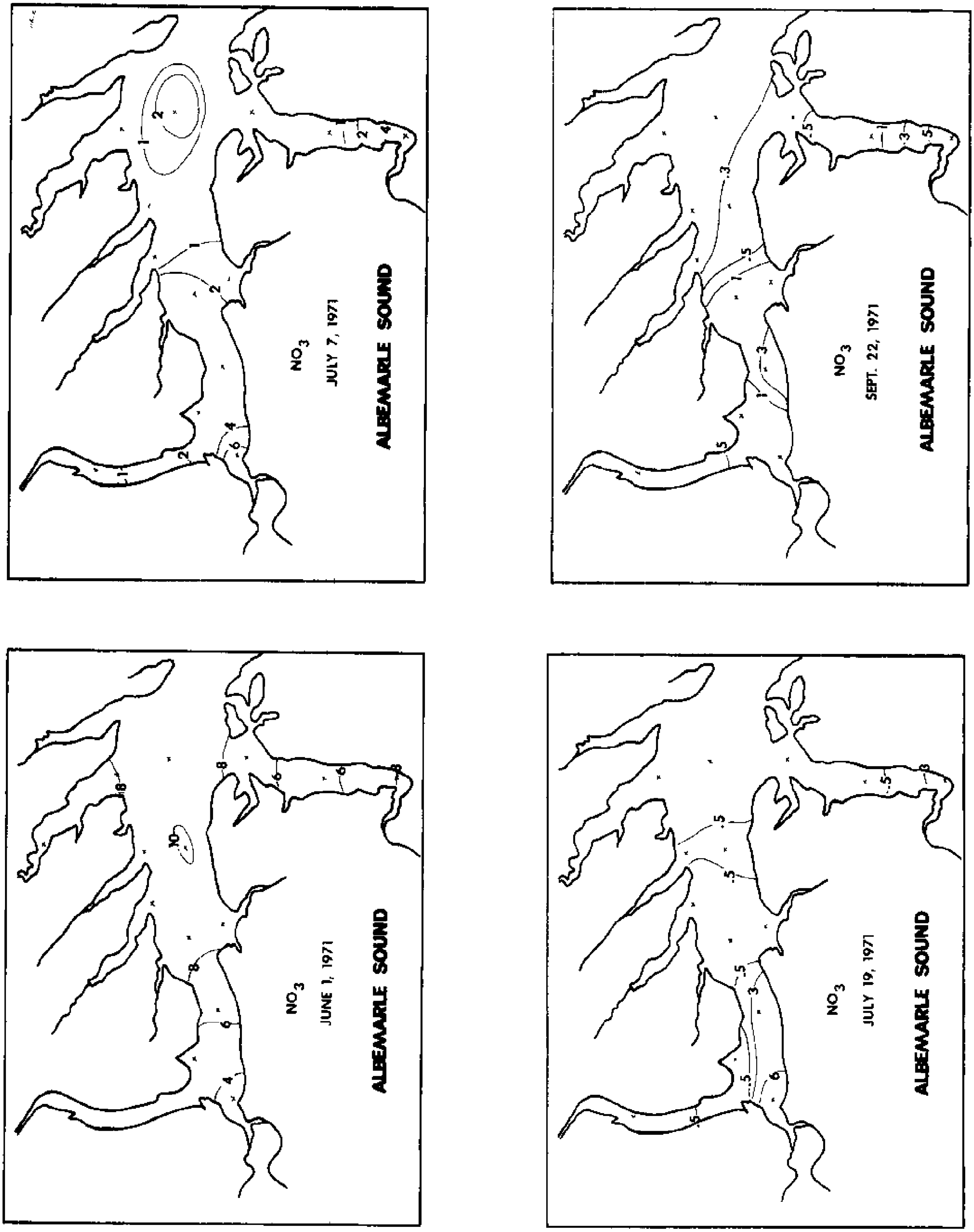


Fig. 48. Nitrate (ug-at/liter) for 1 June, 7 July, 19 July and 22 September 1971 in the Albemarle Sound.

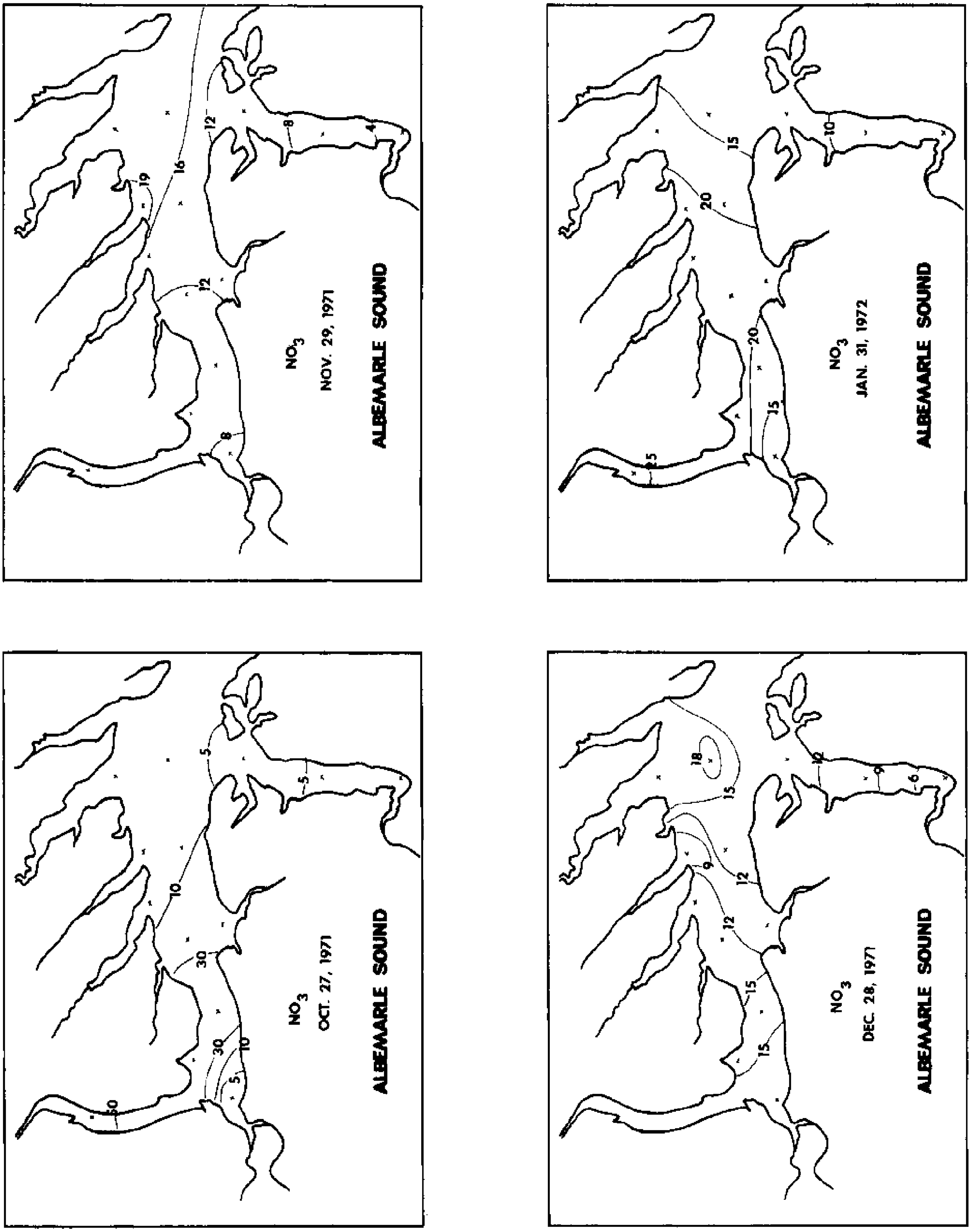


Fig. 49. Nitrate (ug-at/liter) for 27 October, 29 November, 28 December 1971, 31 January 1972 in the Albemarle Sound.

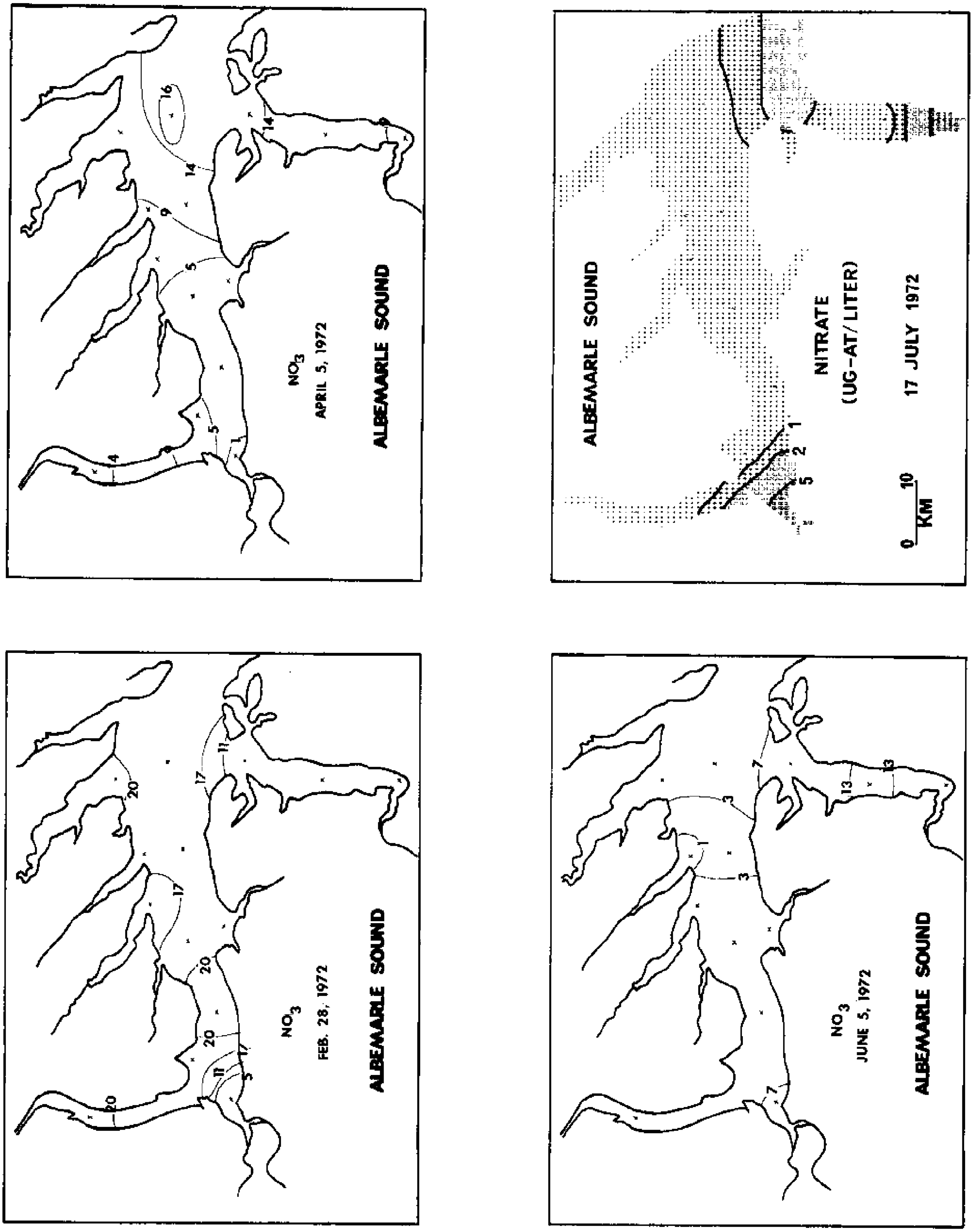


Fig. 50. Nitrate (ug-at/liter) for 28 February, 5 April, 5 June and 17 July 1972 in the Albemarle Sound.

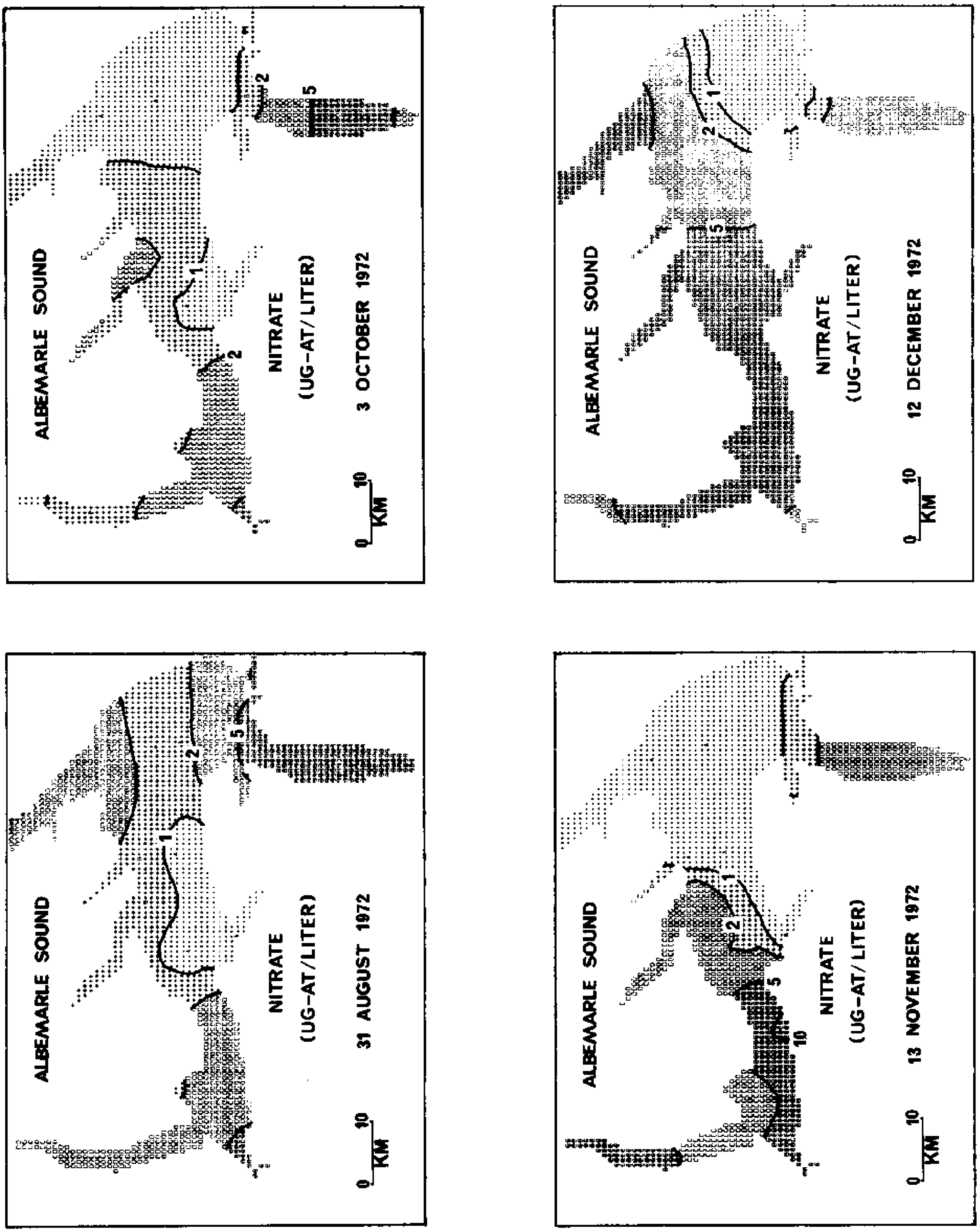


Fig. 51. Nitrate (ug-at/liter) for 31 August, 3 October, 13 November and 12 December 1972 in the Albemarle Sound.

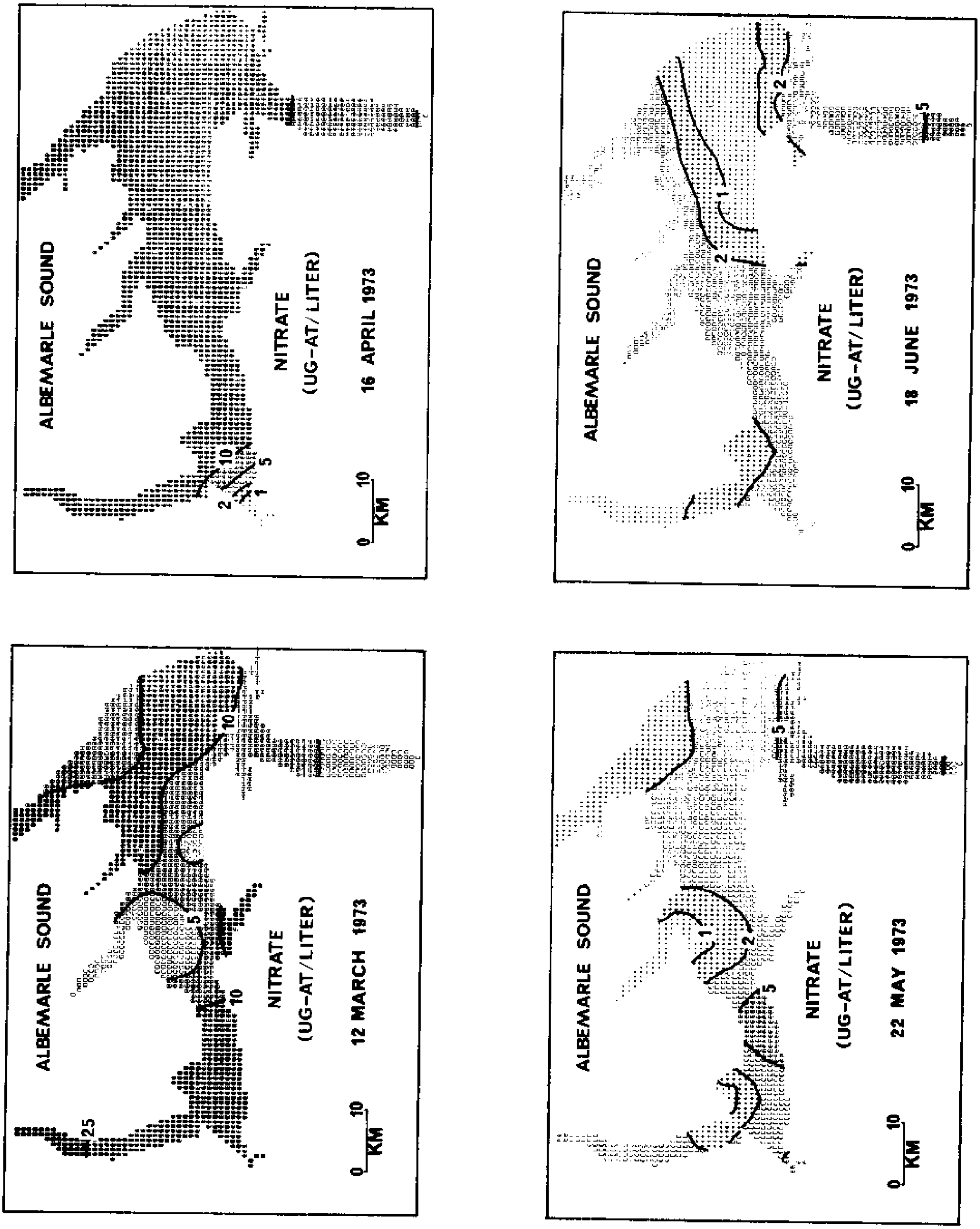


Fig. 52. Nitrate (ug-at/liter) for 12 March, 16 April, 22 May and 18 June 1973 in the Albemarle Sound.

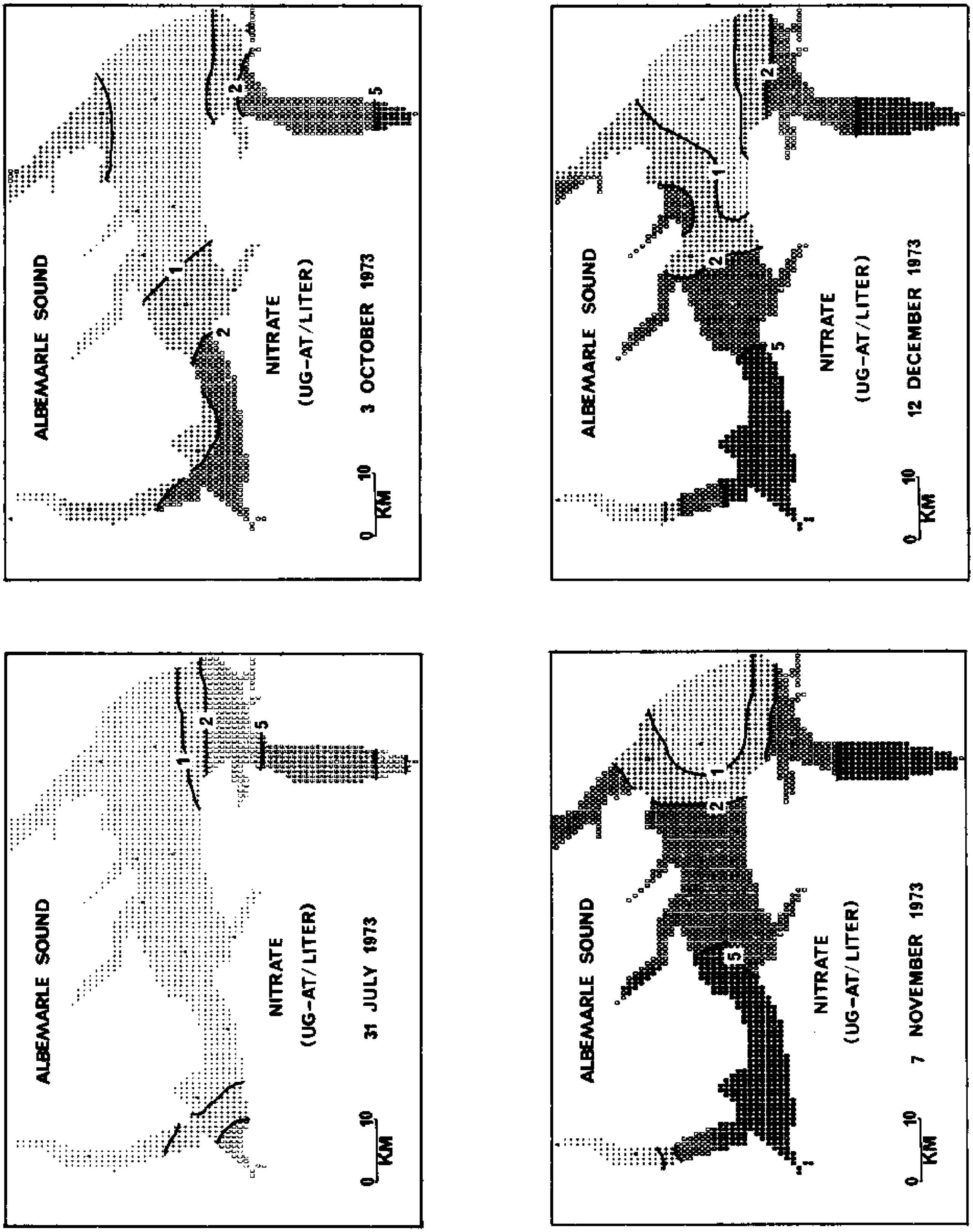


Fig. 53. Nitrate (ug-at/liter) for 31 July, 3 October, 7 November and 12 December 1973 in the Albemarle Sound.

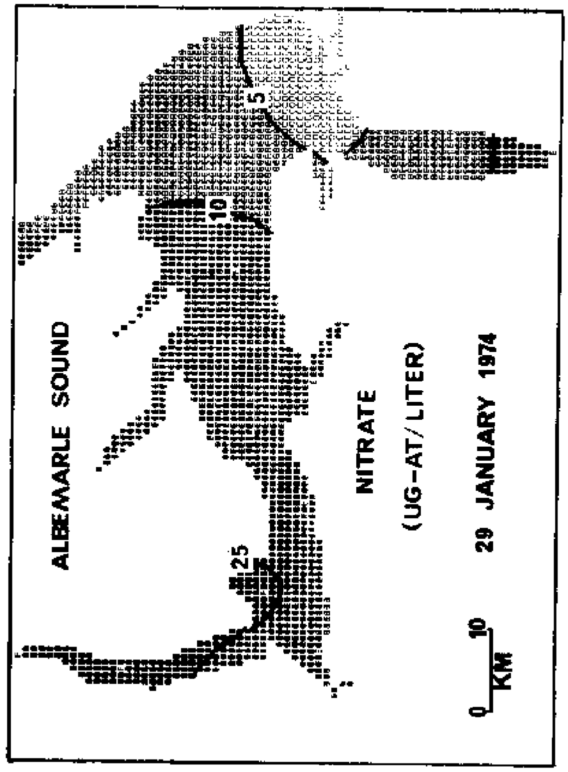


Fig. 54. Nitrate (ug-at/liter) for 29 January 1974 in the Albemare Sound.

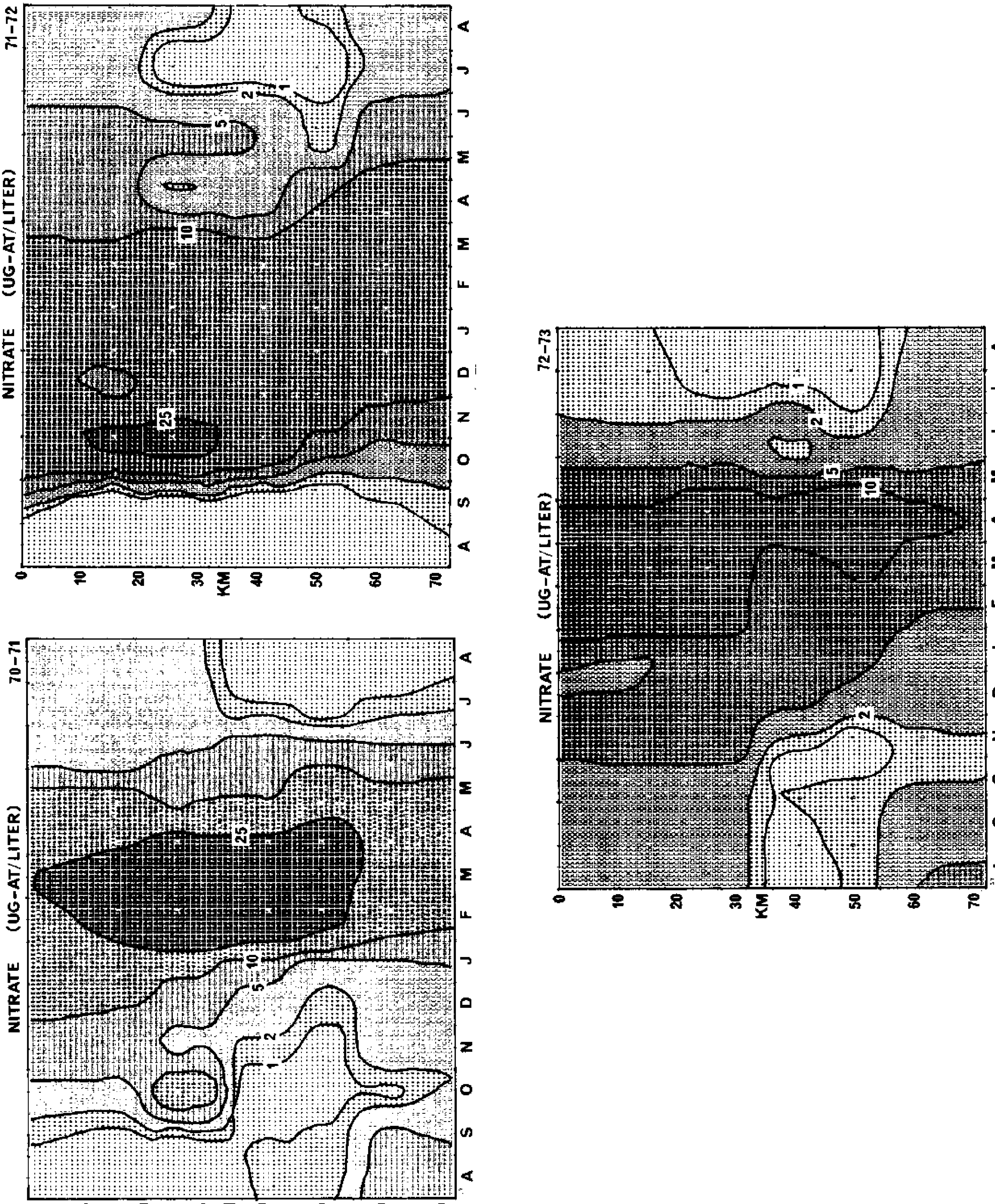


Fig. 55. Yearly concentrations of Nitrate (ug-at/liter) from 1970-1973 in the Albemarle Sound.

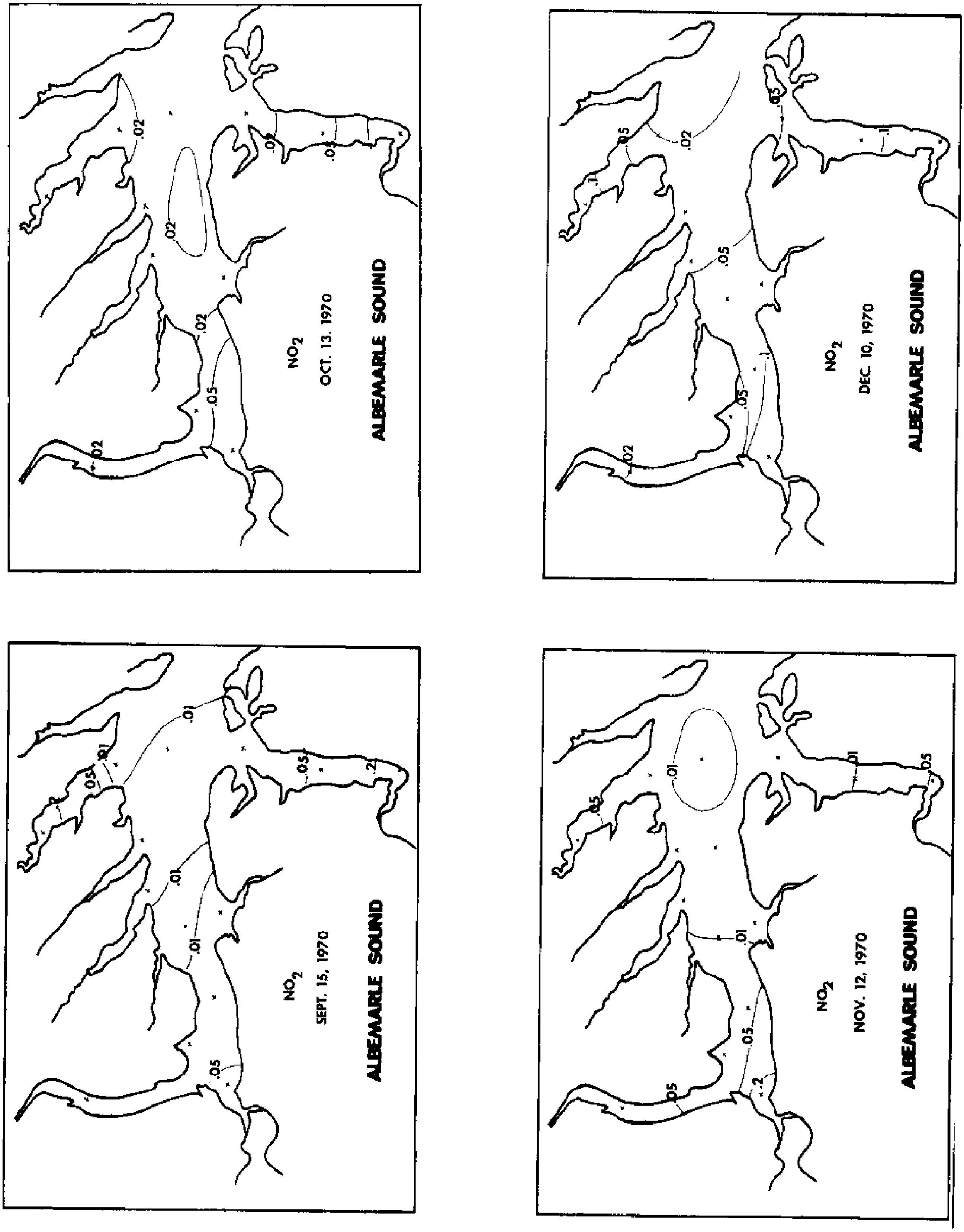


Fig. 56. Nitrite (ug-at/liter) for 15 September, 13 October, 12 November and 10 December 1970 in the Albemarle Sound.

These results are in substantial agreement with those reported by Stanley and Hobbie (1976) who intensively studied four stations in the lower Chowan River just before it enters Albemarle Sound. They found a distinct nitrate maximum in the winter and minimum in the summer. They attribute this pattern to high winter runoff and high summer algal uptake. Winter high concentrations ranged from 21 to 50 ug-at NO_3/liter; summer low concentrations ranged from less than 7 to 21 ug-at NO_3/liter but were often less than 2 ug-at/liter at the lower two stations. As in the sound, nitrate was usually more abundant than ammonia.

In the Neuse River, nitrate concentrations ranged from 0.3 to 70 ug-at NO_3/liter (Hobbie and Smith 1975). In the Pamlico nitrate varied from 1 to 25 ug-at NO_3/liter (Hobbie 1974). Similar patterns were observed in each estuary. Summer is generally a period of low nitrate concentrations while concentrations are higher during the winter. Freshwater is a source of nitrate which is quickly utilized by the time nitrate-rich water reaches mid-estuary.

On 19 February 1971 the concentration of nitrate at the Edenton station was 80 ug-at NO_3/liter (4.96 mg NO_3/liter). The U. S. Public Health Service considers 10 mg NO_3/liter to be unsafe for drinking water and levels as high as found on this date might have been harmful for aquatic life.

IV. B. 2. b. Nitrite

Nitrite is never very abundant in aquatic systems. Nitrite appears as an intermediate in the full oxidation of NH_4^+ to NO_3^-. Ammonium is used as an energy source for some bacteria that subsequently produce nitrite. The nitrite is used as an energy source by other bacteria that subsequently produce NO_3^-.

The nitrite and nitrate concentration patterns were similar (Fig. 65). Concentrations peaked in mid-winter with minima in the summer. The same progression of events occurred: high concentrations in early 1971 and 1972 (Fig. 57 and 59), a fall peak in 1971 after Hurricane Ginger (Fig. 59), and uniformly low concentrations in the wet year of 1973 (Fig. 62 to 63) until the end of the study (Fig. 64).

Nitrite concentrations in Albemarle Sound ranged from undetectable in late 1970 to 3.17 ug-at NO_2/liter on 31 January 1972 (Fig. 59). Generally concentrations were higher up-river and in tributaries. As with nitrate, there is no strong correlation with salinity indicating that oceanic dilution is not important. Understandably, high nitrite concentrations seem to coincide loosely in time and space with high nitrate and ammonium concentrations.

As was found in Albemarle Sound, Stanley and Hobbie (1976) found that nitrite was not abundant in the lower Chowan River. Nitrite nitrogen concentrations ranged from undetectable concentrations to about 1 ug-at/liter. They did not observe any significant spatial or temporal patterns of nitrite concentrations.

In the Neuse River nitrite concentrations ranged from undetectable to 1.32 ug-at NO_2/liter (Hobbie and Smith 1975), while concentrations in the Pamlico River ranged from 0.02 ug-at/liter to 1.15 ug-at/liter (Hobbie 1974). Patterns are similar except that the distribution of nitrite is more uniform in the Albemarle Sound than in the other two estuaries.

IV. B. 2. c. Ammonia

Ammonia concentrations were erratic both spatially and temporally. Concentrations began at moderate levels in September 1970 (Fig. 66) with

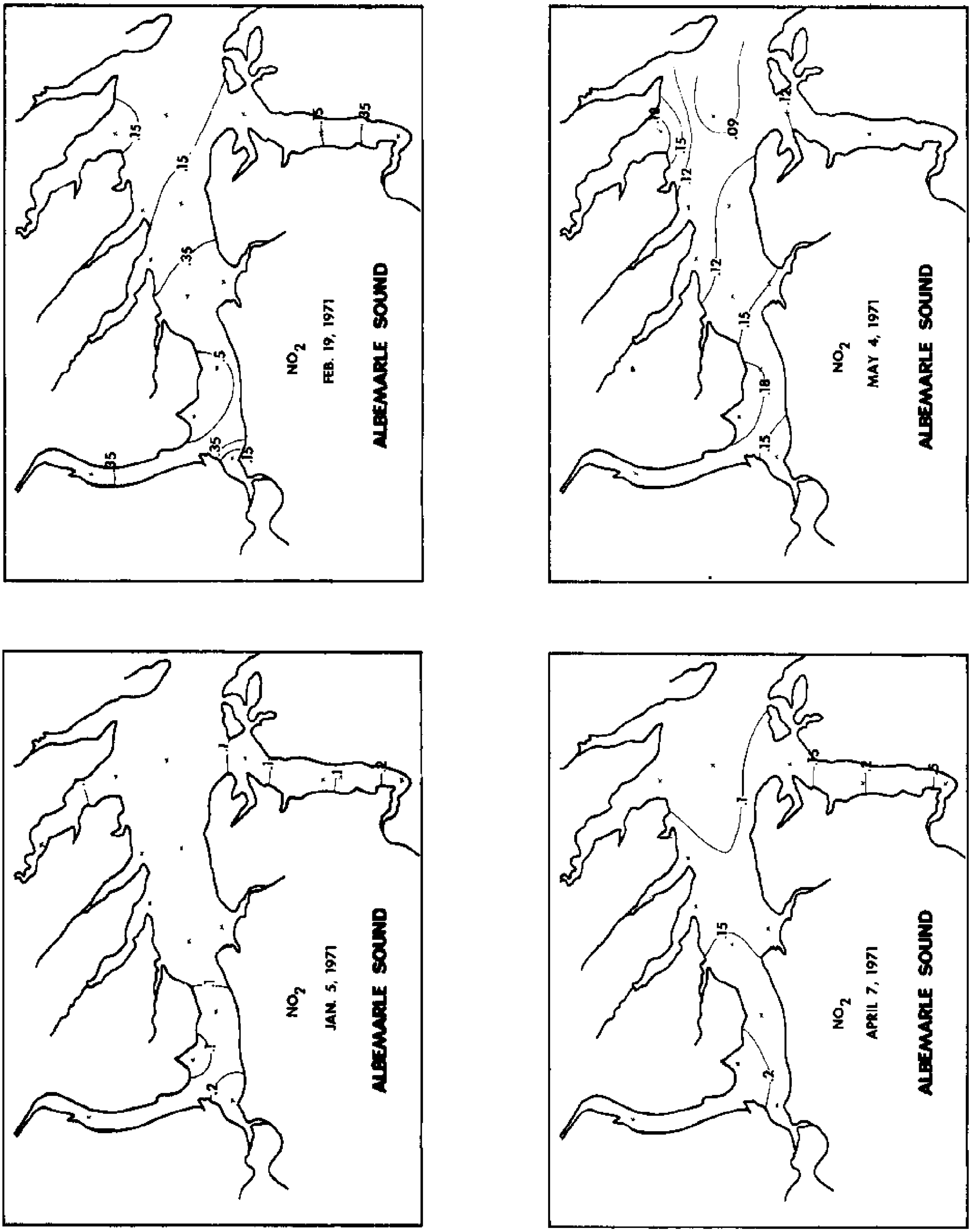


Fig. 57. Nitrite (ug-at/liter) for 5 January, 19 February, 7 April and 4 May 1971 in the Albemarle Sound.

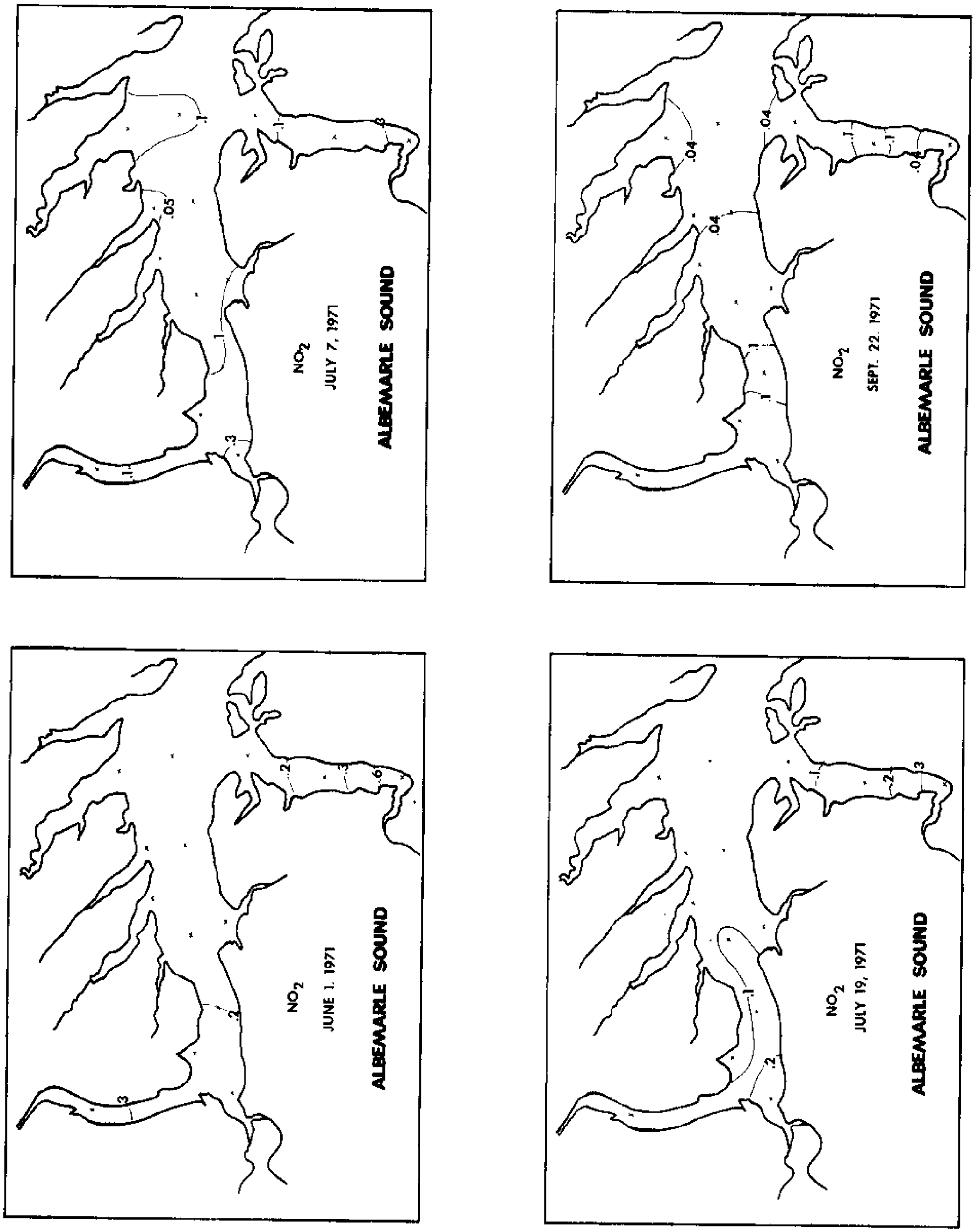


Fig. 58. Nitrite (ug-at/liter) for 1 June, 7 July, 19 July and 22 September 1971 in the Albemarle Sound.

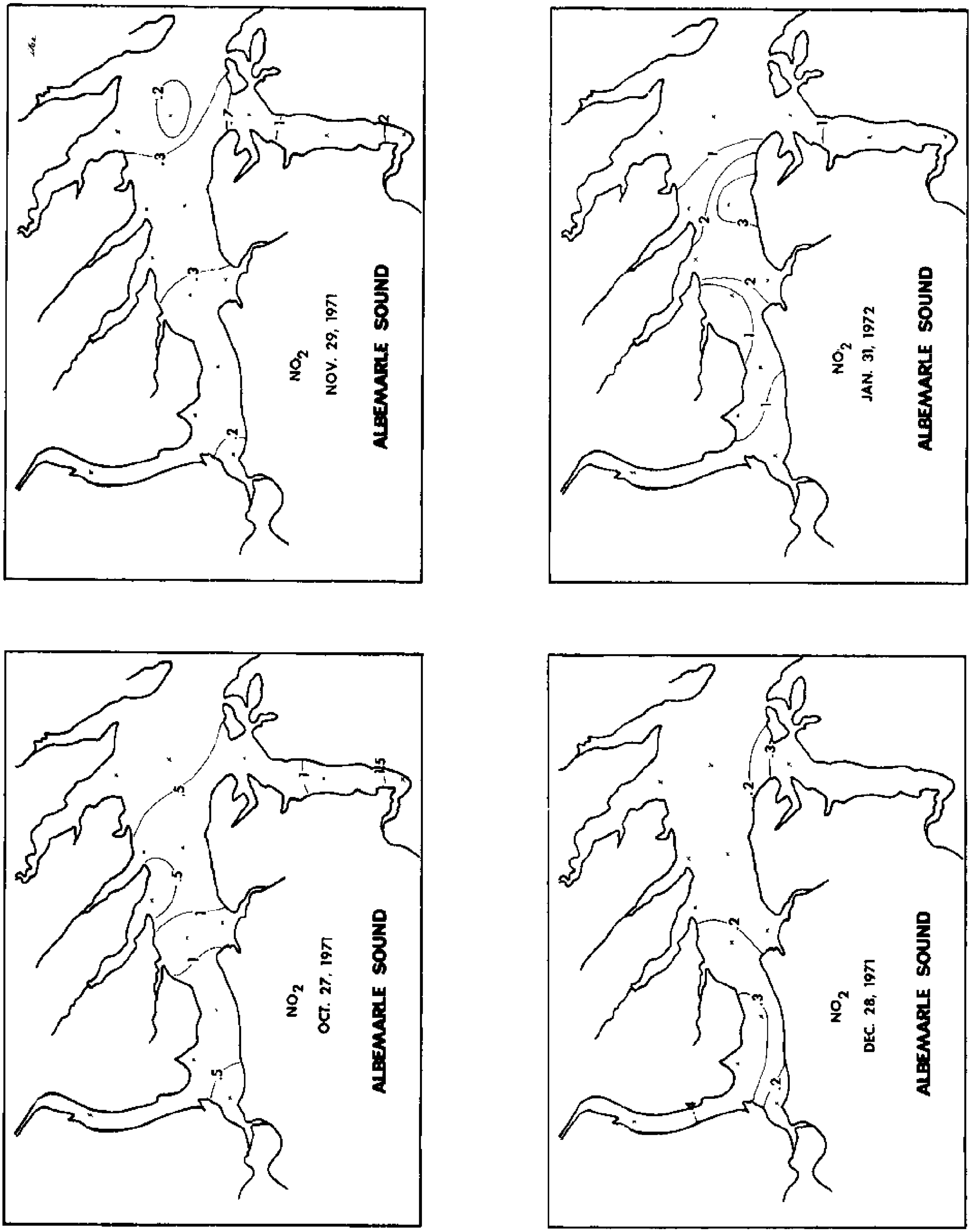


Fig. 59. Nitrite (ug-at/liter) for 27 October, 29 November, 28 December 1971 and 31 January 1972 in the Albemarle Sound.

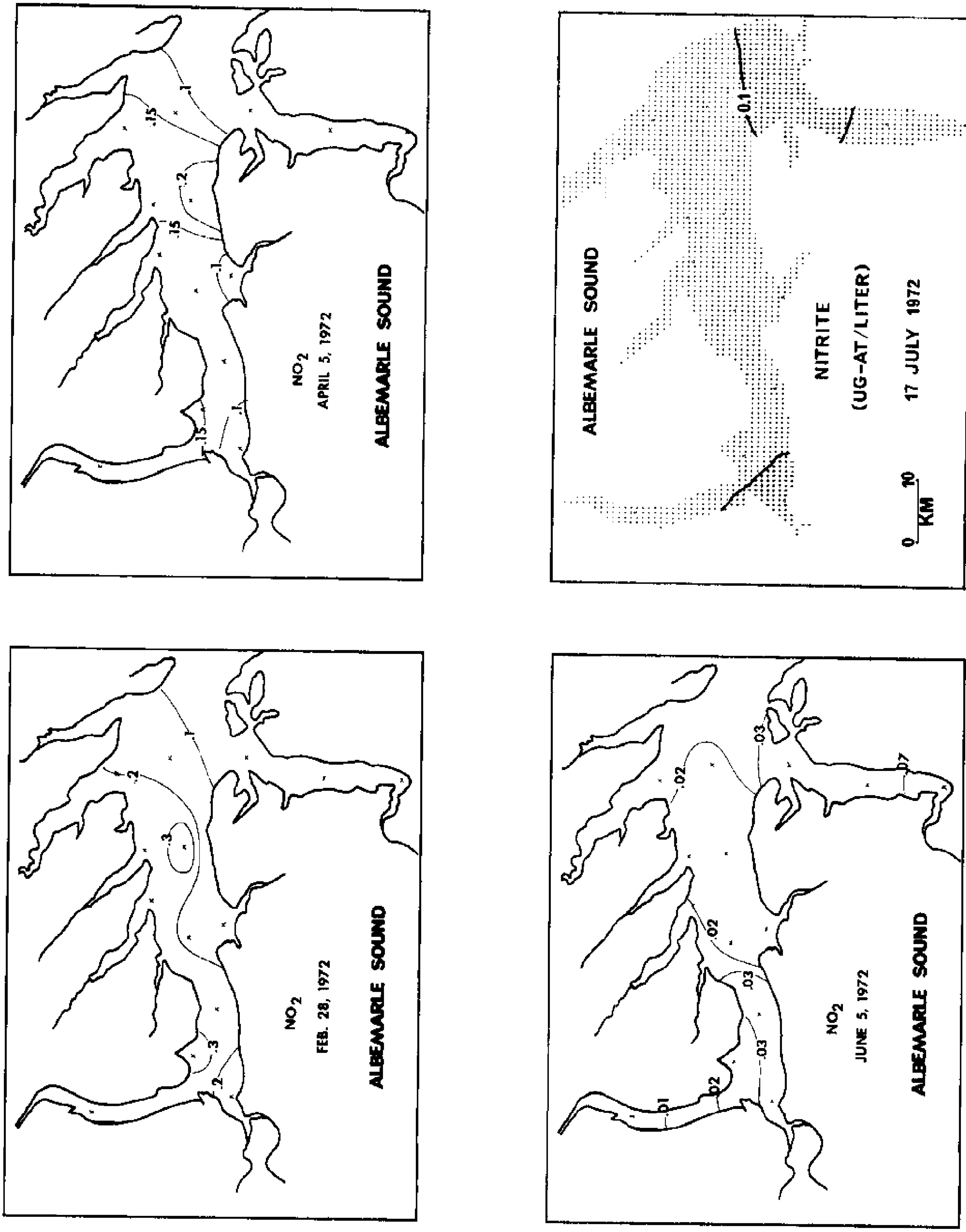


Fig. 60. Nitrite (ug-at/liter) for 28 February, 5 April, 5 June and 17 July 1972 in the Albemarle Sound.

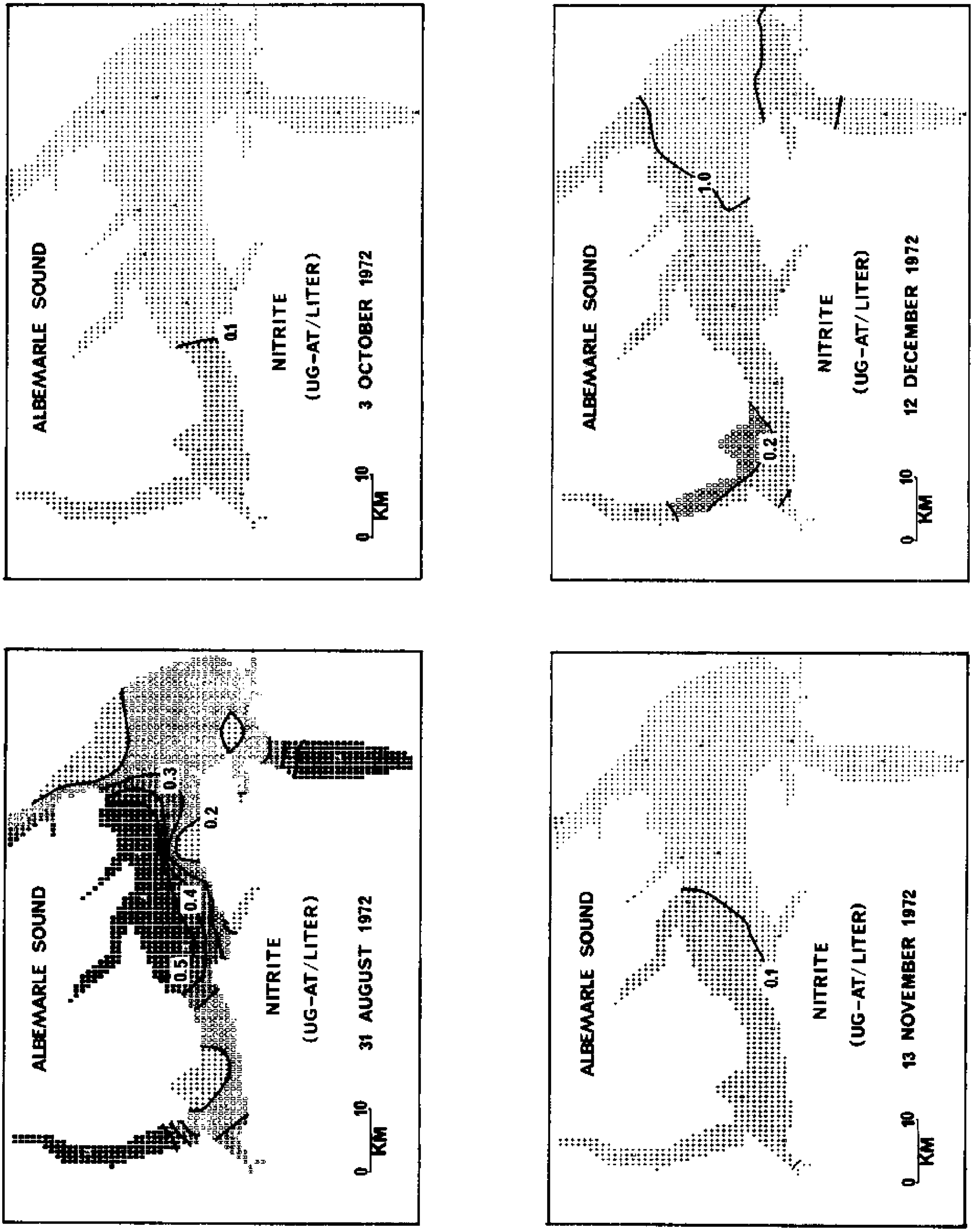


Fig. 61. Nitrite (ug-at/liter) for 31 August, 3 October, 13 November and 12 December 1972 in the Albemarle Sound.

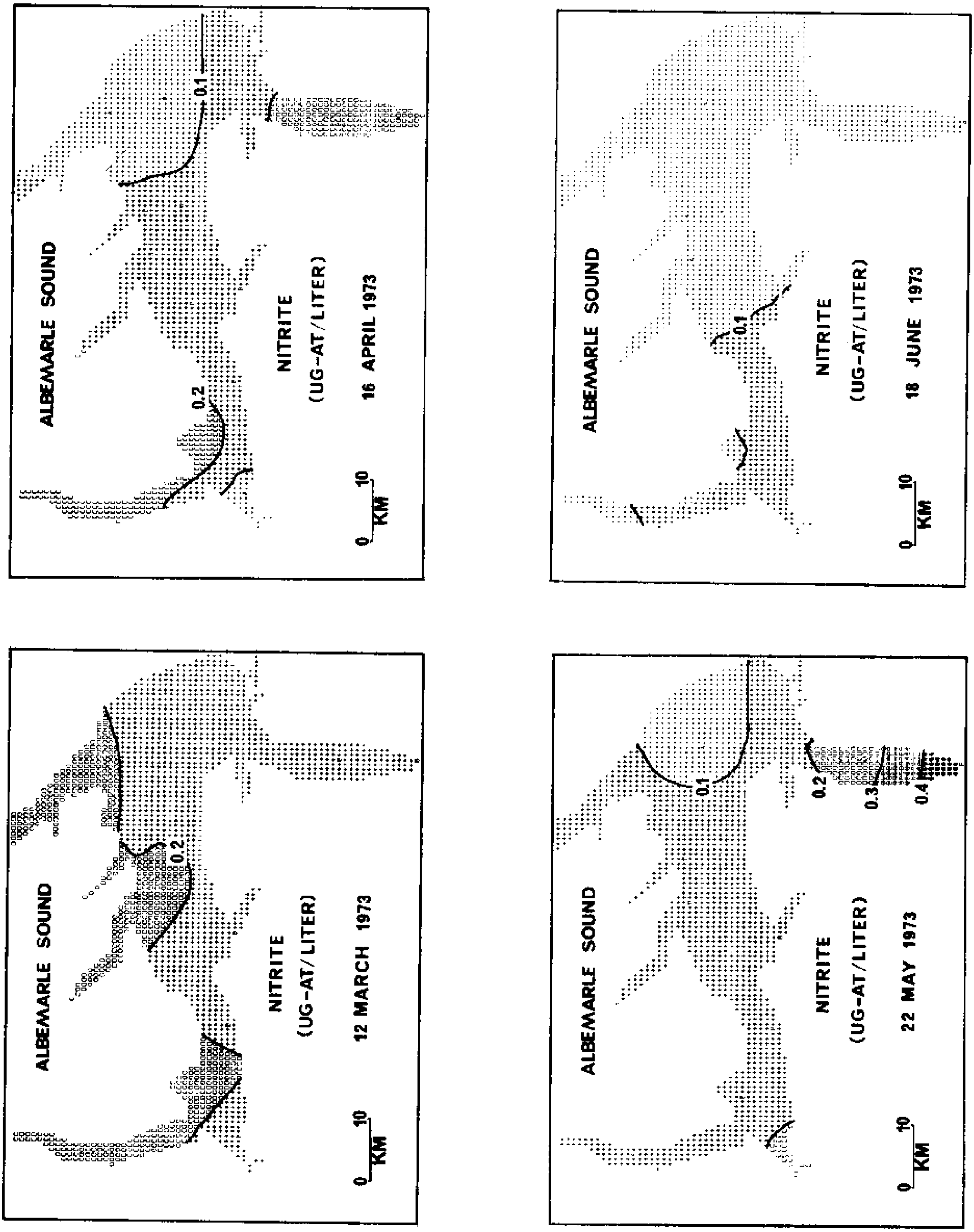


Fig. 62. Nitrite (ug-at/liter) for 12 March, 16 April, 22 May and 18 June 1973 in the Albemarle Sound.

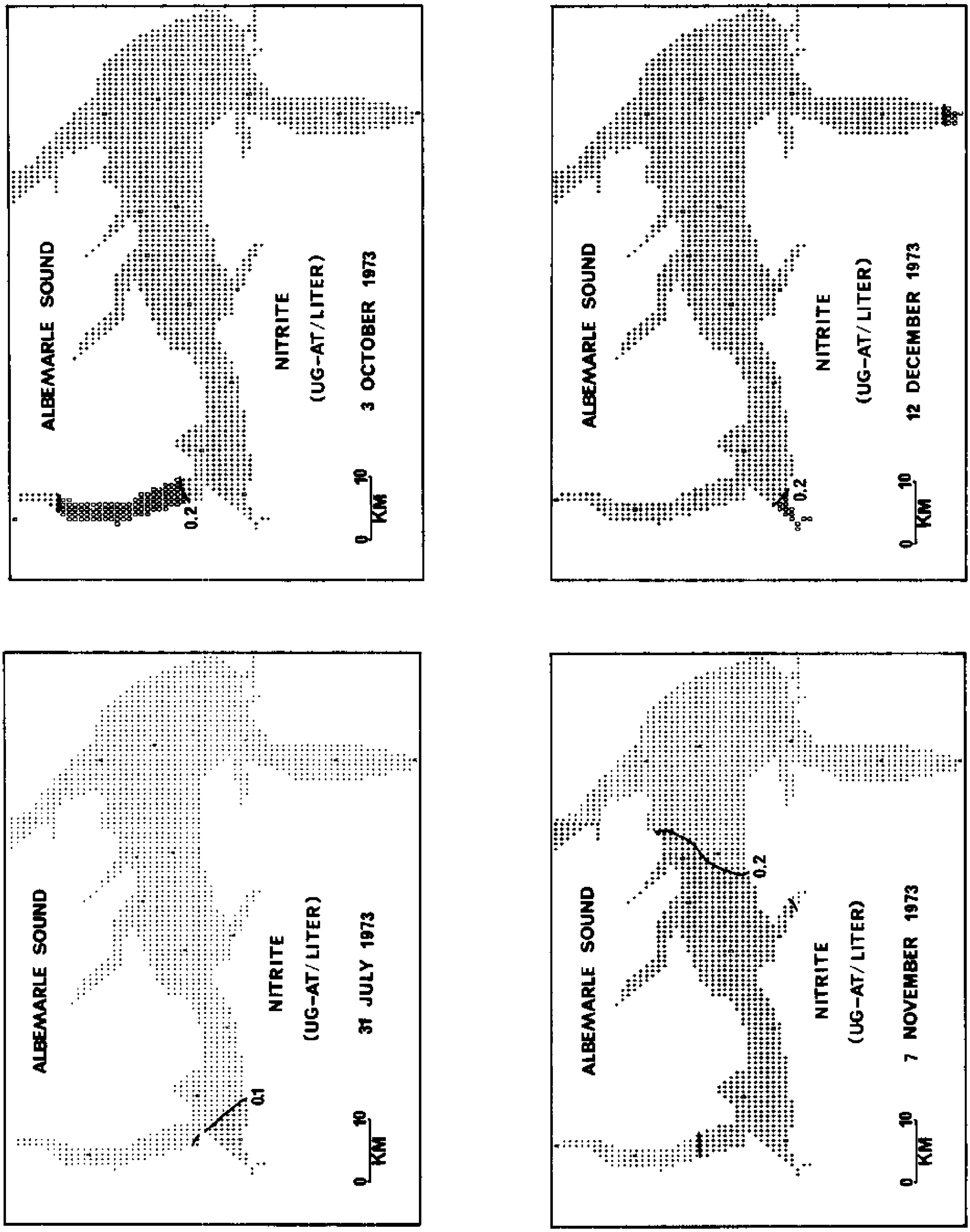


Fig. 63. Nitrite (ug-at/liter) for 31 July, 3 October, 7 November and 12 December 1973 in the Albemarle Sound.

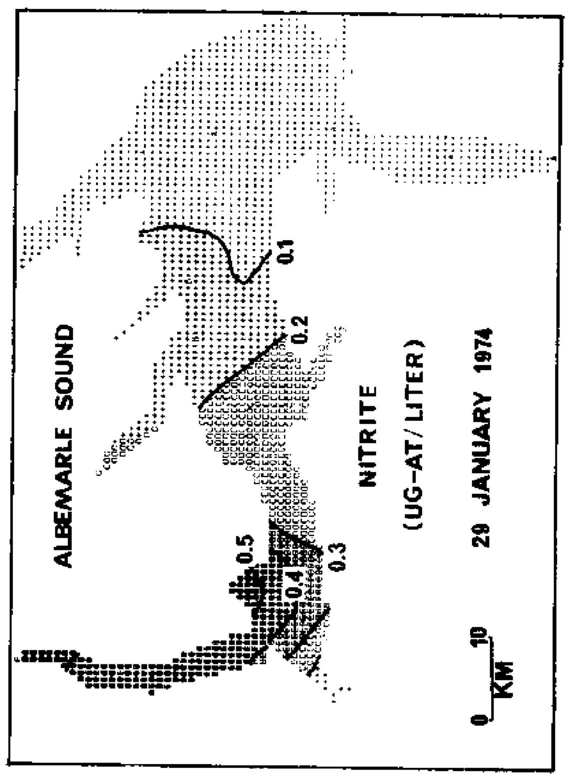


Fig. 64. Nitrite (ug-at/liter) for 29 January 1974 in the Albemarle Sound.

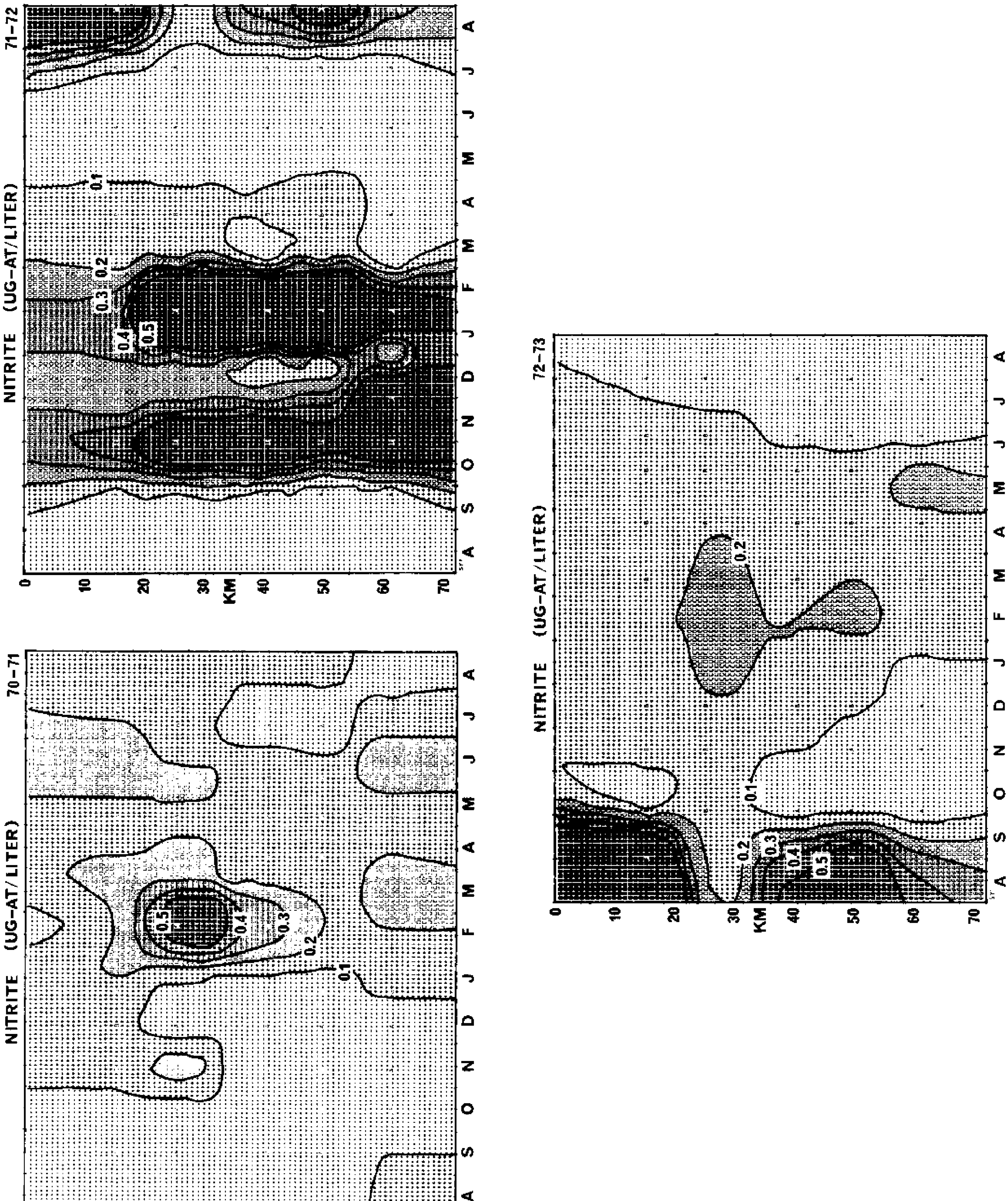


Fig. 65. Yearly concentrations of Nitrite (ug-at/liter) from 1970-1973 in the Albemarle Sound.

high concentrations but patchy distributions throughout late 1970. In November and December 1970 the Roanoke River was a source of high ammonium water (24 ug-at/liter) and in November 1970 a large pocket of high ammonium water (18 ug-at/liter) existed in the middle of the sound (Fig. 66). Ammonium concentrations rapidly peaked in February 1971 at 20 ug-at/liter then fell through spring. There was a transient peak in early July that disappeared by late July (Fig. 68). Hurricane Ginger in October 1971 caused elevated concentrations throughout late 1971 and early 1972 (Fig. 69). Rather than peaking as in early 1971, ammonium concentrations continued to fall in early 1972 (Fig. 70) and remained relatively low, except in the tributaries, for the remainder of the year (Fig. 71). This trend continued through early 1973, with no strong February peak, because of the wet conditions that year (Fig. 72). The short dry period beginning in July 1973 brought patchy, high ammonium conditions near tributaries (Fig. 73) but as rains returned at the end of the year these concentrations declined (Fig. 74).

Ammonia concentrations in Albemarle Sound varied from 1.37 ug-at NH_4/liter on 7 November 1973 (Fig. 73) to 35.42 ug-at NH_3/liter on 27 October 1971 (Fig. 69) after Hurricane Ginger. In general ammonia is more abundant in the freshwater regions of the sound. There is some evidence that ammonium concentrations can be unusually high at salt-fresh water interfaces such as the mouths of tributaries (Fig. 63: 1 June 1971, Fig 70: 28 February 1972); however, the concentration of ammonium varies erratically in time and space (Fig. 75). For example, in the winter of 1971 there was a distinct mid-sound peak. This peak is not evident in 1972 and 1973. Also, a peak following Hurricane Ginger is evident in the fall of 1971 but no peak occurs in June 1972 after tropical storm Agnes.

Like nitrate and nitrite, the concentrations and distributions of ammonia were similar in Albemarle sound and in the lower Chowan River

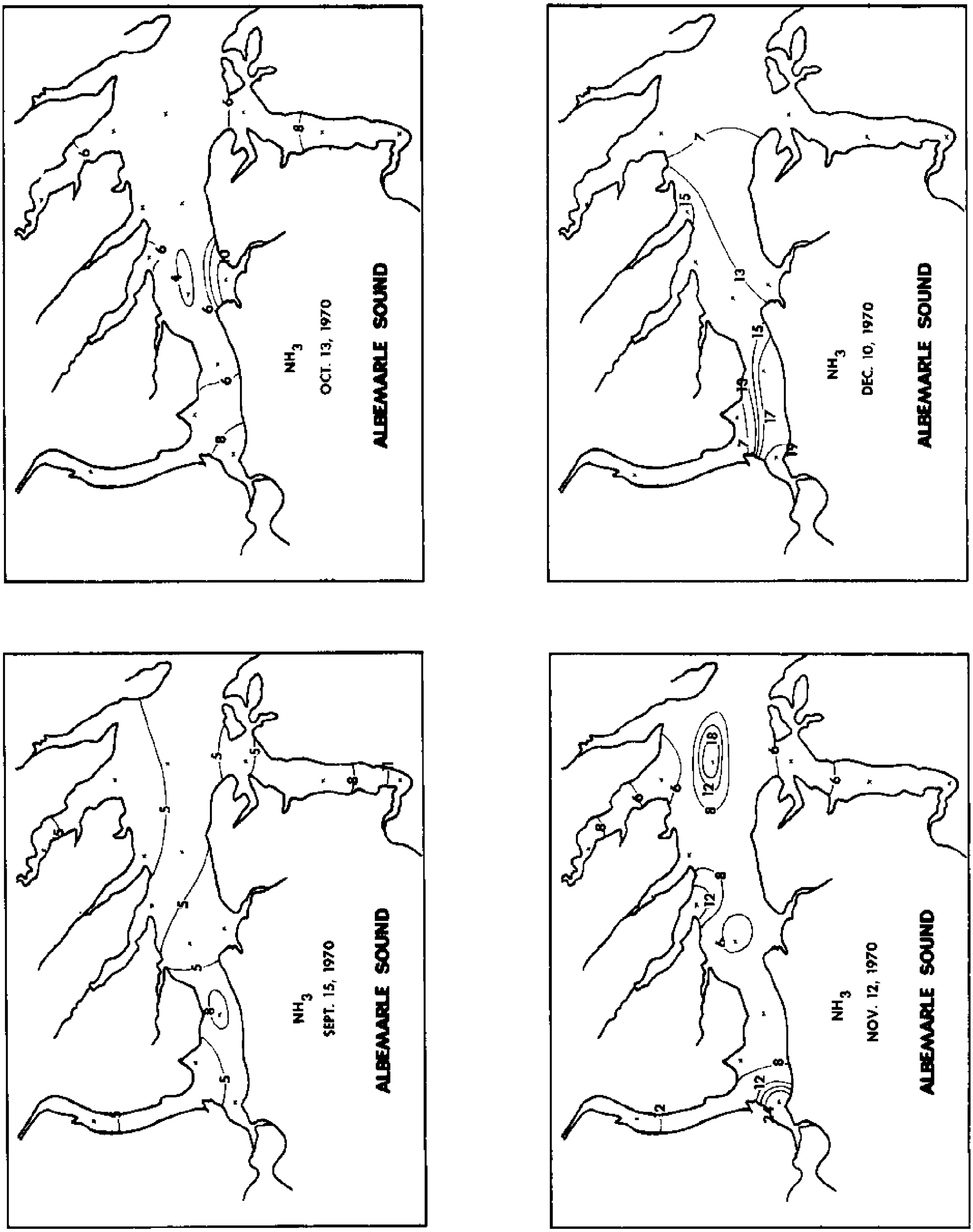


Fig. 66. Ammonia (ug-at/liter) for 15 September, 13 October, 12 November and 10 December 1970 in the Albemarle Sound.

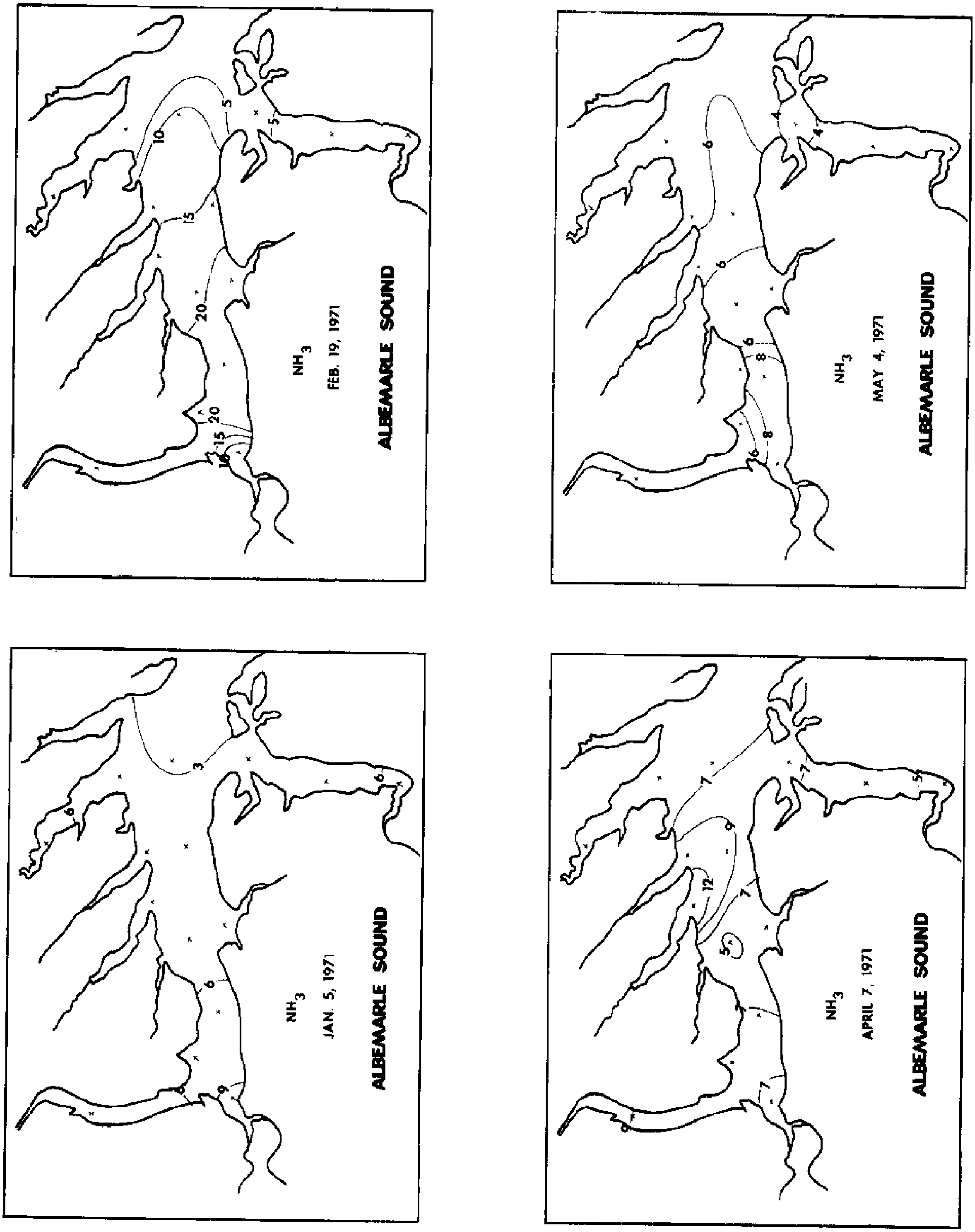


Fig. 67. Ammonia (ug-at/liter) for 5 January, 19 February, 7 April and 4 May 1971 in the Albemarle Sound.

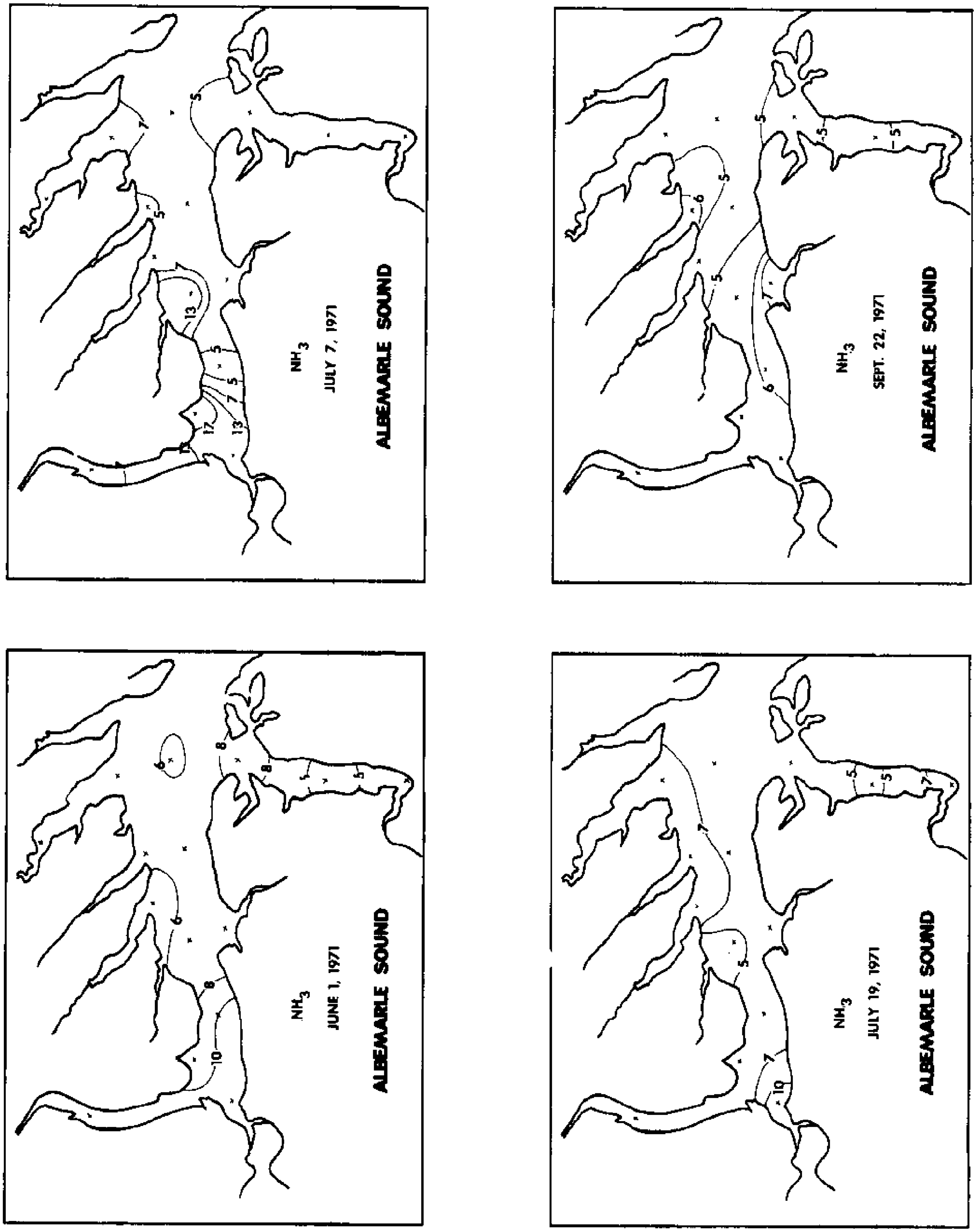


Fig. 68. Ammonia (ug-at/liter) for 1 June, 7 July, 19 July and 22 September 1971 in the Albemarle Sound.

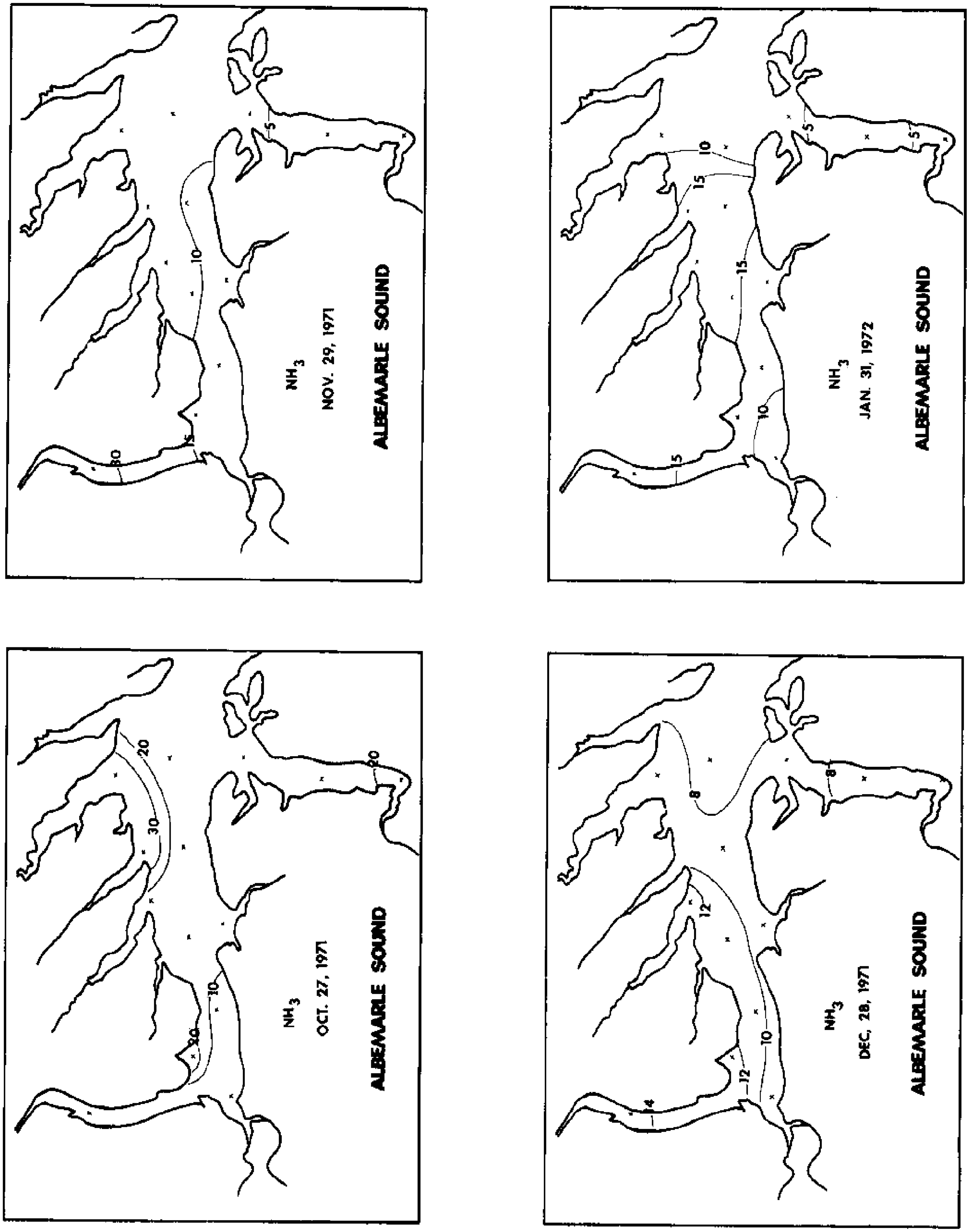


Fig. 69. Ammonia (ug-at/liter) for 27 October, 29 November, 28 December 1971 and 31 January 1972 in the Albemarle Sound.

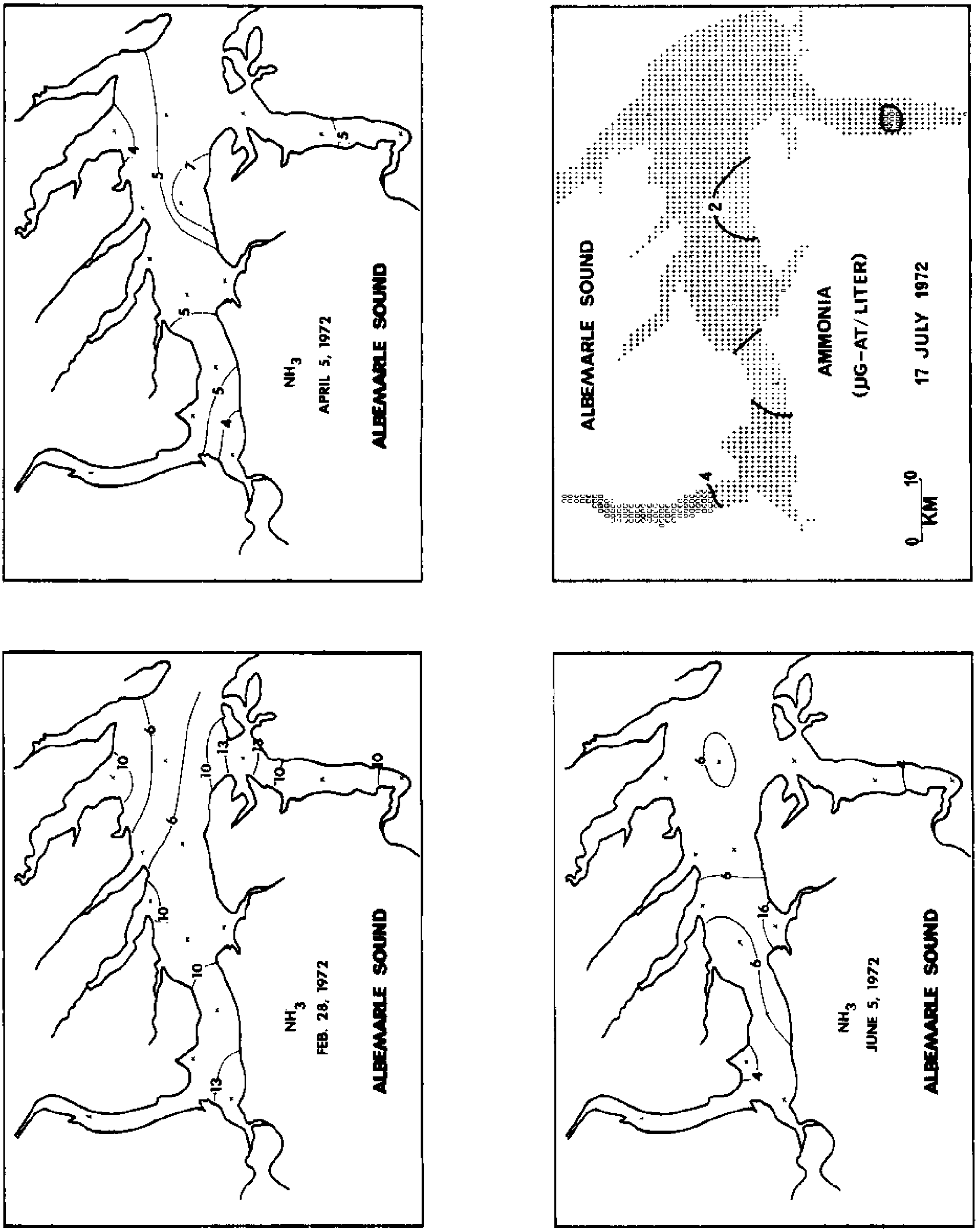


Fig. 70. Ammonia (ug-at/liter) for 28 February, 5 April, 5 June and 17 July 1972 in the Albemarle Sound.

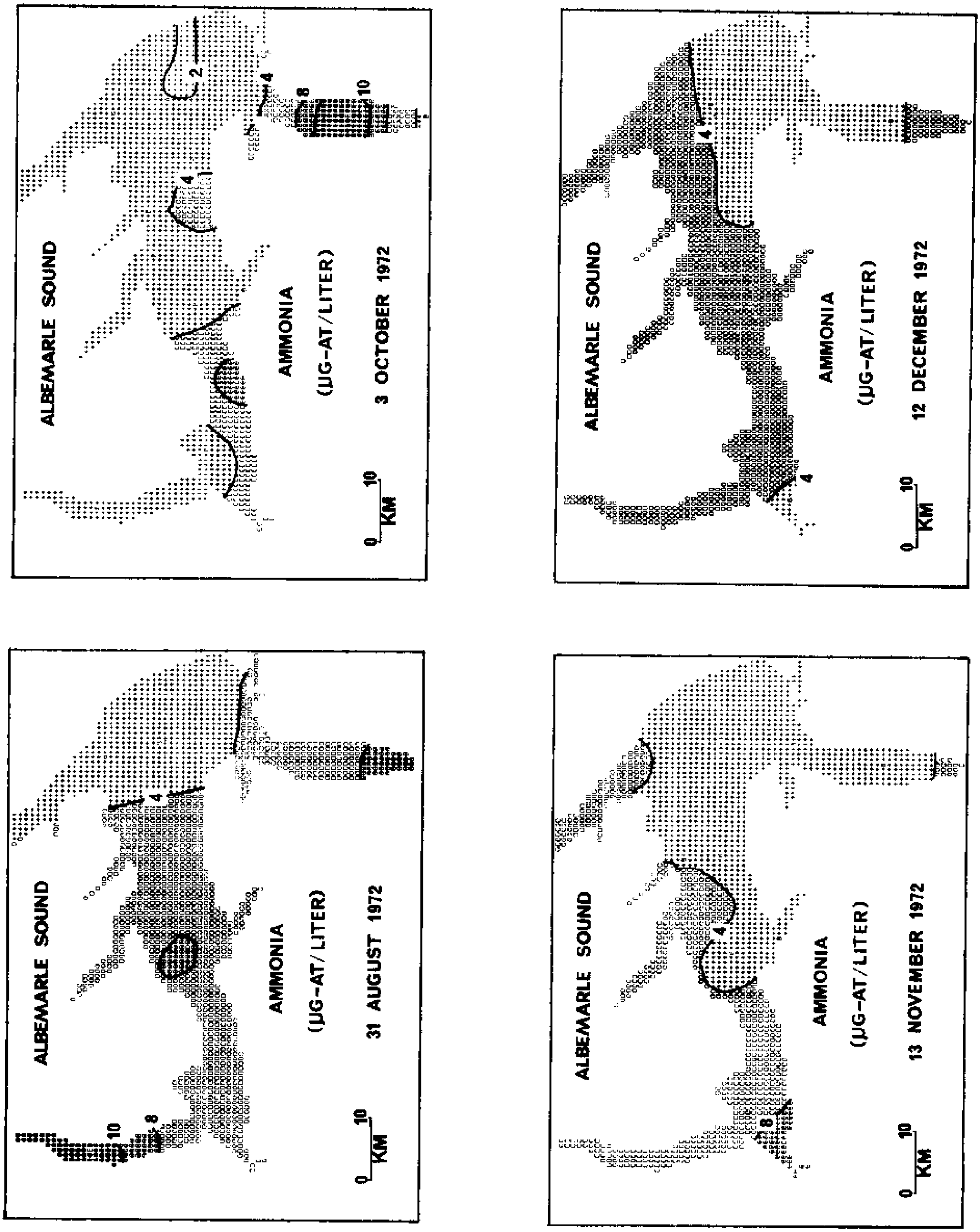


Fig. 71. Ammonia (ug-at/liter) for 31 August, 3 October, 13 November and 12 December 1972 in the Albemarle Sound.

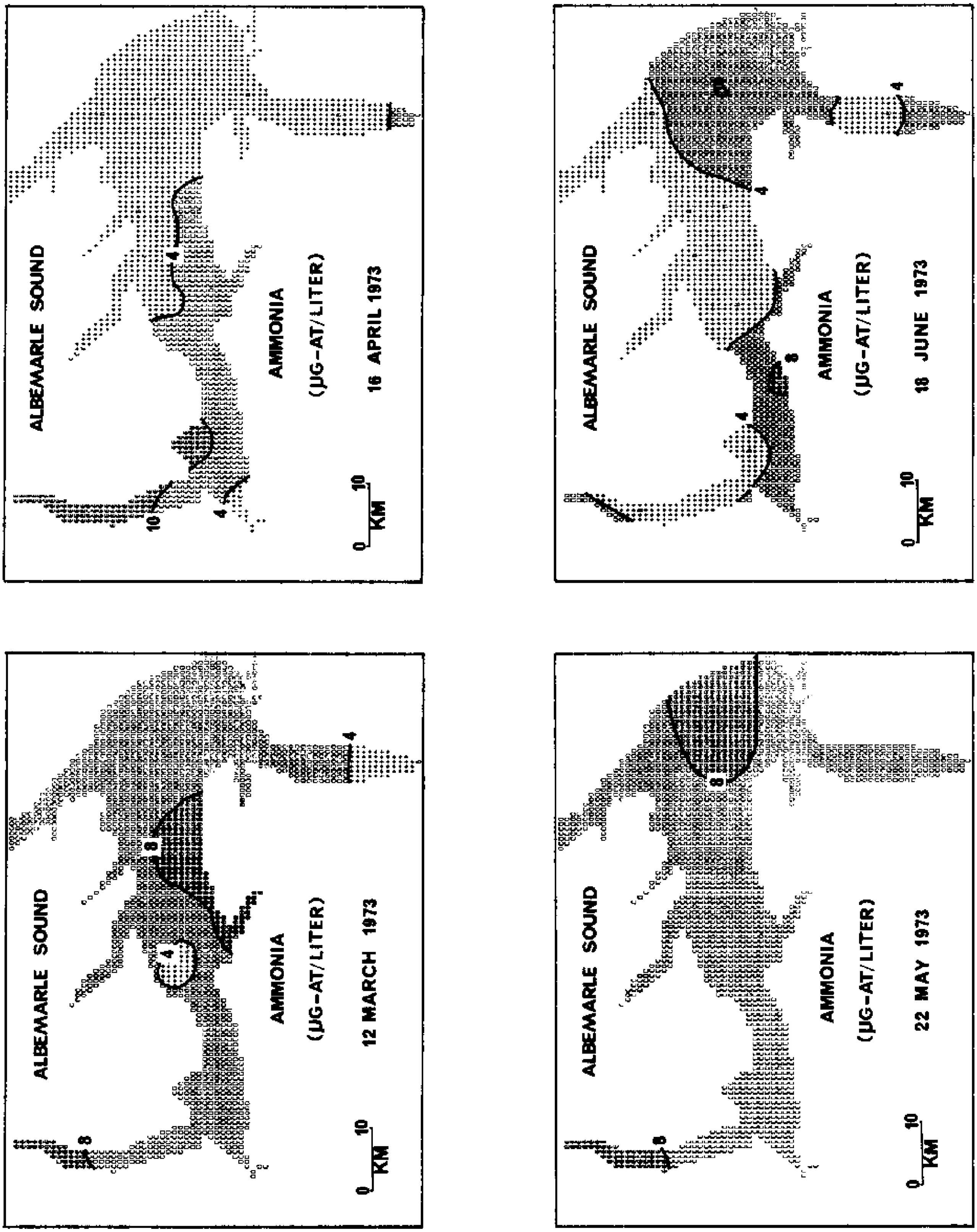


Fig. 72. Ammonia (ug-at/liter) for 12 March, 16 April, 22 May and 18 June 1973 in the Albemarle Sound.

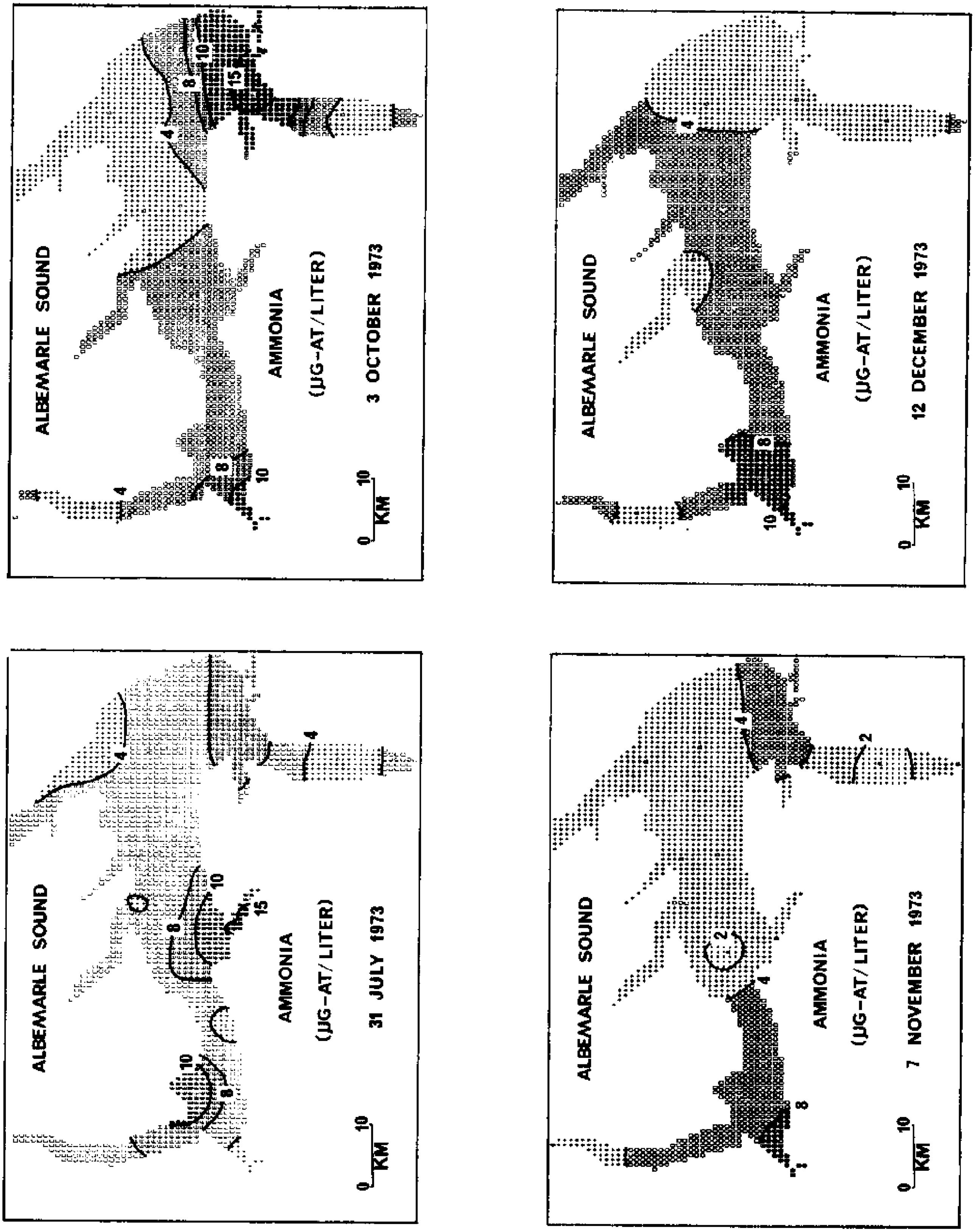


Fig. 73. Ammonia (ug-at/liter) for 31 July, 3 October, 7 November and 12 December 1973 in the Albemarle Sound.

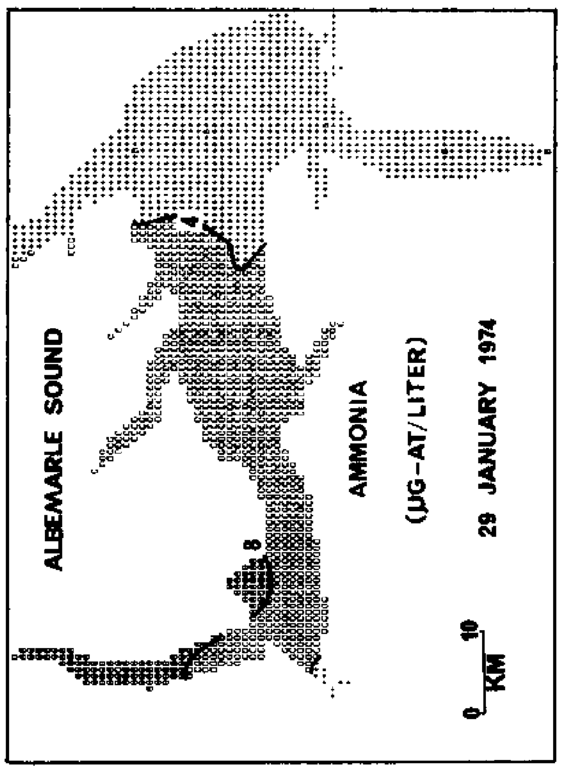


Fig. 74. Ammonia (ug-at/liter) for 29 January 1974 in the Albemarle Sound.

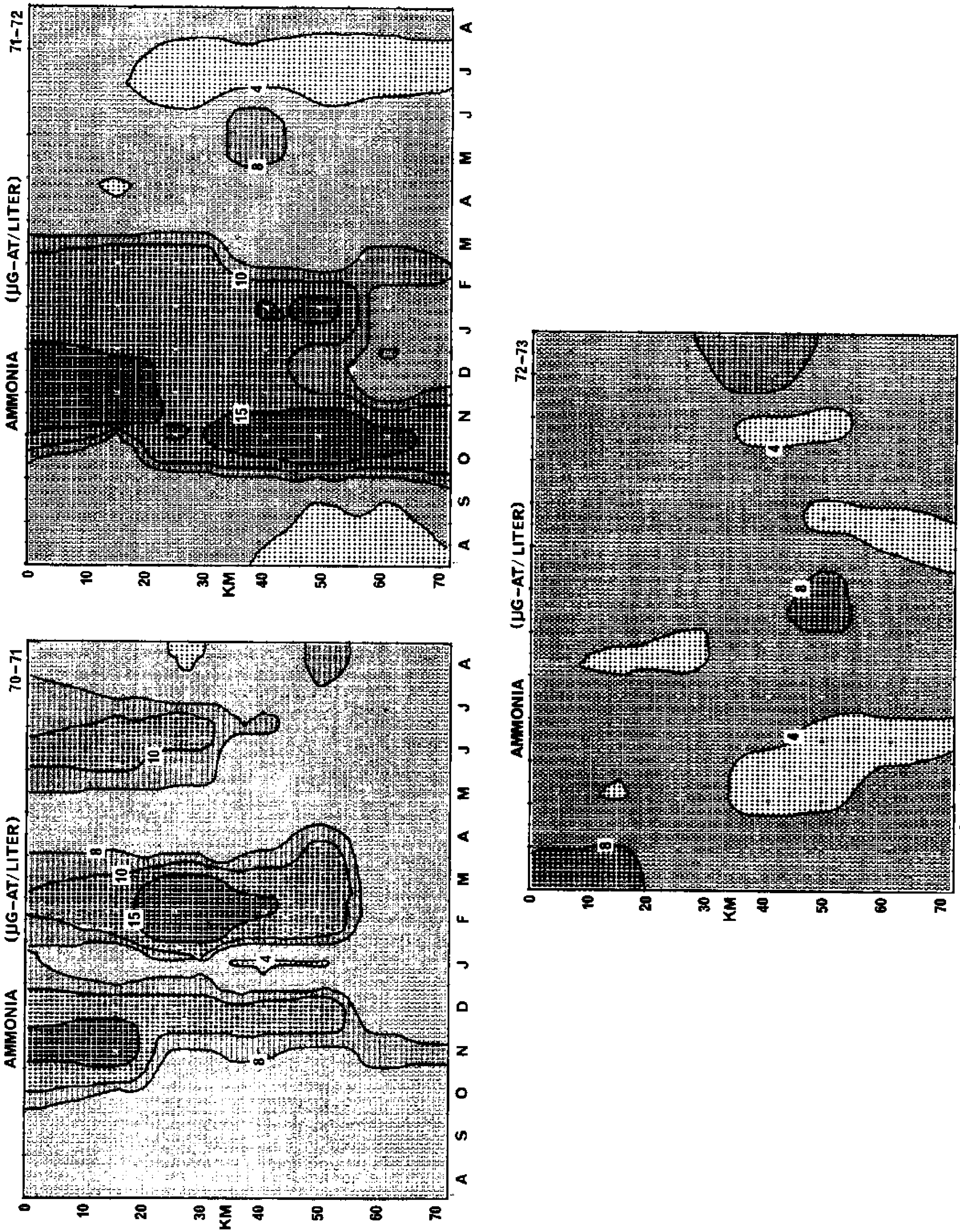


Fig. 75. Yearly concentration of Ammonia (ug-at/liter) from 1970-1973 in the Albemarle Sound.

(Stanley and Hobbie 1976). In the lower Chowan River ammonia was characterized by the lack of a clear seasonal pattern. Ammonia concentrations ranged from less than 1 ug-at NH_4/liter to about 21 ug-at NH_4/liter. However on occasion ammonia existed in excess of 50 ug-at NH_4/liter. In general, ammonia was less abundant than nitrate.

Ammonium concentration in the Neuse river ranged from 2 to 60 ug-at NH_4/liter (Hobbie and Smith 1975). The value of 60 ug-at NH_4/liter occurred in December 1971 after Hurricane Ginger in October 1971. The next highest concentration of ammonium was 35 ug-at NH_4/liter. In the Pamlico system there were higher summer freshwater concentrations of ammonia than in the Albemarle. Concentrations in the Pamlico appear to be more variable than the other two systems but there is no clear cut pattern that holds for every year in any of the three systems.

IV. B. 2. d. Particulate and Dissolved Organic Nitrogen

Only summary isopleths are presented for particulate (PN) and dissolved organic nitrogen (DON)(Fig. 76 and 77). Experience in this system as well as in the Neuse and Pamlico (Hobbie and Smith 1975, Hobbie 1974) has shown that the distribution of these variables is extremely patchy in time and space. In the Chowan River, Stanley and Hobbie (1976) found a general trend of increasing particulate nitrogen during the summer as a result of increasing algal biomass. However, the internal variability is high. Furthermore, PN is usually the smallest nitrogen pool except for nitrite and ranged from 1 to 10 ug-at N/liter.

The UV digestion technique used to analyse for DON and PN during the Albemarle, Neuse, and Pamlico system studies was not entirely satisfactory. Subsequent investigations determined that the UV digestion is incomplete and

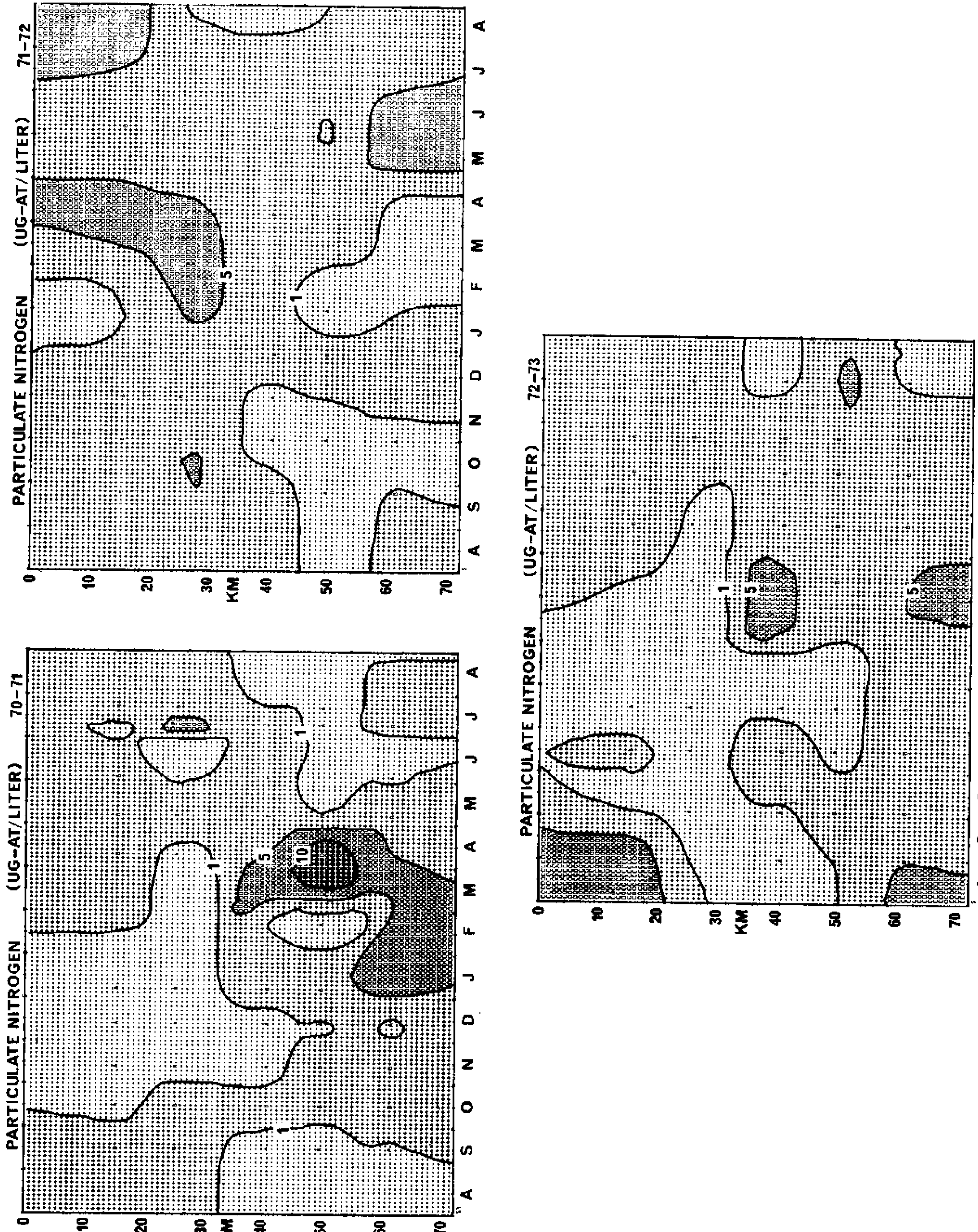


Fig. 76. Yearly concentration of particulate nitrogen (ug-at/liter for 1970-1973 in the Albemarle Sound.

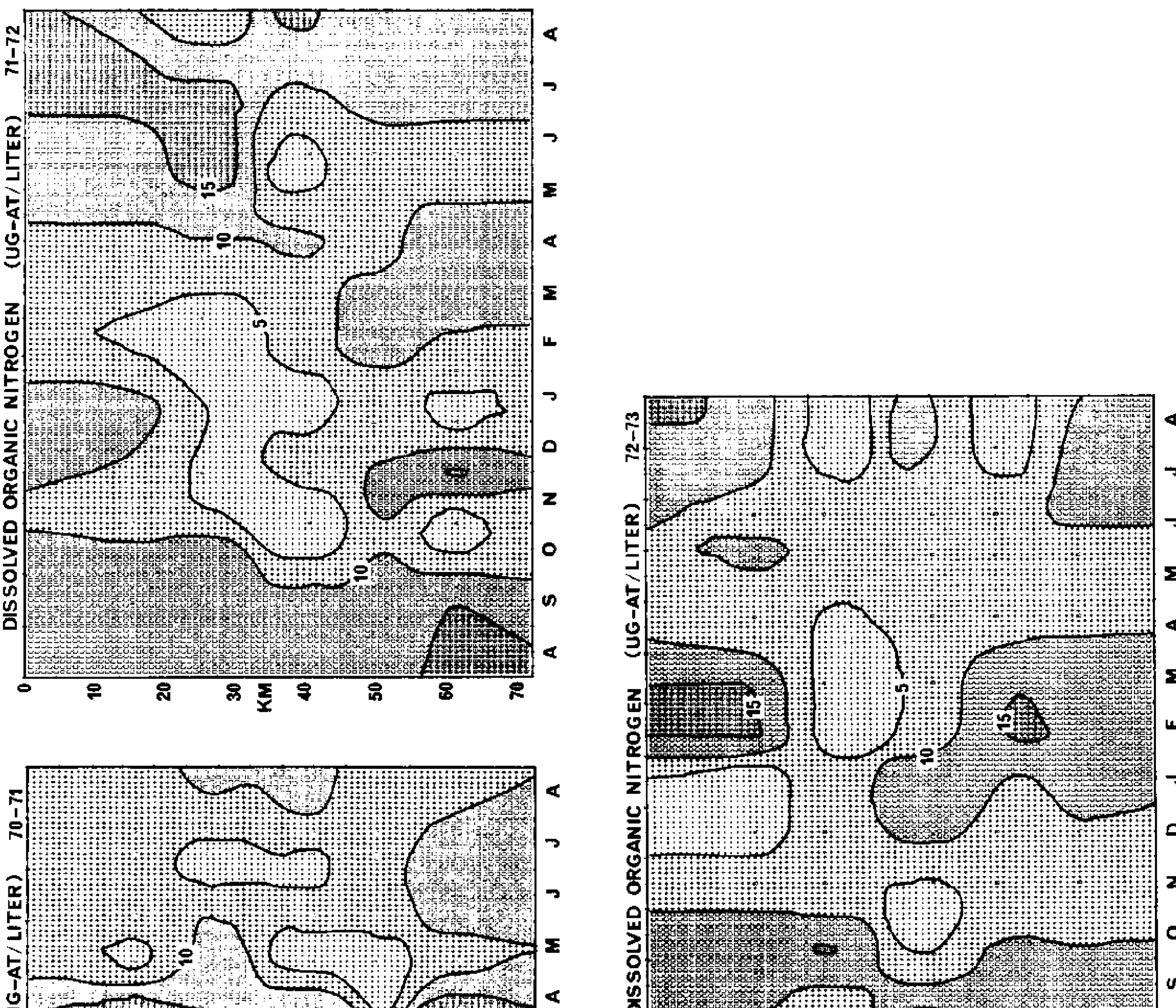


Fig. 77. Yearly concentrations of dissolved organic nitrogen (ug-at/liter) for 1970-1973 in the Albemarle Sound.

gives variable results. As a consequence DON and PN values reported are minimum estimates of these variables. For example, DON varied from about 5 to 20 or 25 ug-at N/liter in all three studies using the UV digestion technique. Stanley found from 35 to 110 ug-at N/liter as DON in the Chowan River in his study using a Kjeldahl digestion procedure. There is increasing evidence that DON may represent from 50 to 90% of the total nitrogen pool in natural systems (Tusneem and Patrick 1971, Harrison and Hobbie 1971). As important as this fraction is, it is likely that the methods used were insufficient to reveal a pattern if it was present.

IV. C. Biological Effects

IV. C. 1. Oxygen

Apparently there is adequate oxygen in Albemarle Sound throughout most of the year. Oxygen isopleths are not presented but data for surface and bottom oxygen concentrations are presented in Appendix I. At the salinities normally encountered in Albemarle Sound maximum oxygen saturation ranges from about 5 ml O_2/liter at 30°C to about 9 ml O_2/liter at 5°C. Complete tables for oxygen saturation as a function of temperature and salinity may be found in Green and Carrit (1967). With this in mind, the percent oxygen saturation in Albemarle Sound is almost always above 60% and very often above 80 to 90%, even at the bottom.

Since stratification is not an important factor in Albemarle Sound, there is usually relatively little difference between surface and bottom dissolved oxygen (DO) concentrations. However, some patterns are evident. Often, surface DO is near normal concentrations but bottom DO is below normal because of high benthic metabolism or decomposition rates. Alternately, bottom DO may be higher than surface DO. This can occur if bottom temperatures are cooler than surface temperatures since maximum DO is inversely related to temperature. In such cases surface and bottom percent oxygen saturation actually may be similar. Finally, surface waters may become supersaturated with DO (saturation greater than 100%). This can occur when actively photosynthesizing algae produce more oxygen than can diffuse from the water they inhabit to the atmosphere above.

The same general patterns observed in Albemarle sound are found in the Tar-Pamlico and Neuse systems (Hobbie 1974, Hobbie and Smith 1975). Oxygen is usually abundant and surface waters are often supersaturated. However, there is a distinct seasonal oxygen minimum in the latter two systems, especially the Tar-Pamlico system. In late spring and early summer bottom DO levels can fall below 10% of saturating values in the Neuse River and can go to zero in the Pamlico system. In comparison, percent oxygen saturation in Albemarle Sound during May and June is no lower than at any other time of the year. The lowest DO level observed in Albemarle Sound occurred on 27 October 1971 (oxygen saturation less than 20%). It is probable that this was a consequence of Hurricane Ginger which passed through this area in early October 1971. Excluding this event, the lowest DO levels were generally observed in the upper Alligator River (station 15). In relative terms this station was farther upstream (i.e., closest to the headwaters) than any other station sampled.

If "biological health" can be related to DO availability, then these three systems should probably be ranked in order of increasing health as follows: Tar-Pamlico, Neuse, and Albemarle.

IV. C. 2. Chlorophyll *a*

The chlorophyll *a* values reported ug Chl *a*/liter are corrected for phaeophytin and thus represent a simple estimate of the viable phytoplanktonic biomass. The number should be considered as relative only because it is well known that the amount of chlorophyll per algal cell will change with changing nutrient or light conditions.

The distribution of chlorophyll _a_, like PN and DON, is patchy and variable. Throughout late 1970 Chl _a_ values were relatively low (Fig. 78). This condition continued in early 1971 but bloom conditions (25 ug Chl _a_/liter) did occur in the Roanoke River in April and in the Chowan River in May of that year. Concentrations remained relatively low throughout the summer with one bloom off Edenton, North Carolina in July (Fig. 80). Chl _a_ values remained quite low throughout late 1971 (Fig. 81) and early 1972 (Fig. 82) probably because high flow conditions after Hurricane Ginger washed algae out of the sound. As conditions stabilized and temperatures warmed in April, extensive blooms occurred throughout the sound. Another bloom in July was confined to the middle of the sound. Chl _a_ concentrations then returned to a moderate level for the remainder of 1972 (Fig. 83) and early 1973. In May 1973 a bloom occurred off Edenton again, but was gone by June (Fig. 84). Late 1973 was characterized by low Chl _a_ concentrations with the exception of a bloom in the upper Chowan River in October 1973 (Fig. 85).

Chl _a_ concentrations in Albemarle Sound ranged from less than 1 ug Chl _a_/liter on several dates to 43.3 ug Chl _a_/liter on 17 July 1972 (Fig. 82). Chl _a_ concentrations were lowest in the winter and highest in the spring and late summer. High concentrations tended to appear in the freshwater sections of the estuary although this is not a strong relationship since high concentrations can also occur in the lower estuary (Fig. 80: 22 September 1971, Fig. 83: 31 August and 3 October 1972). There are no data available to determine if different species of algae are involved in

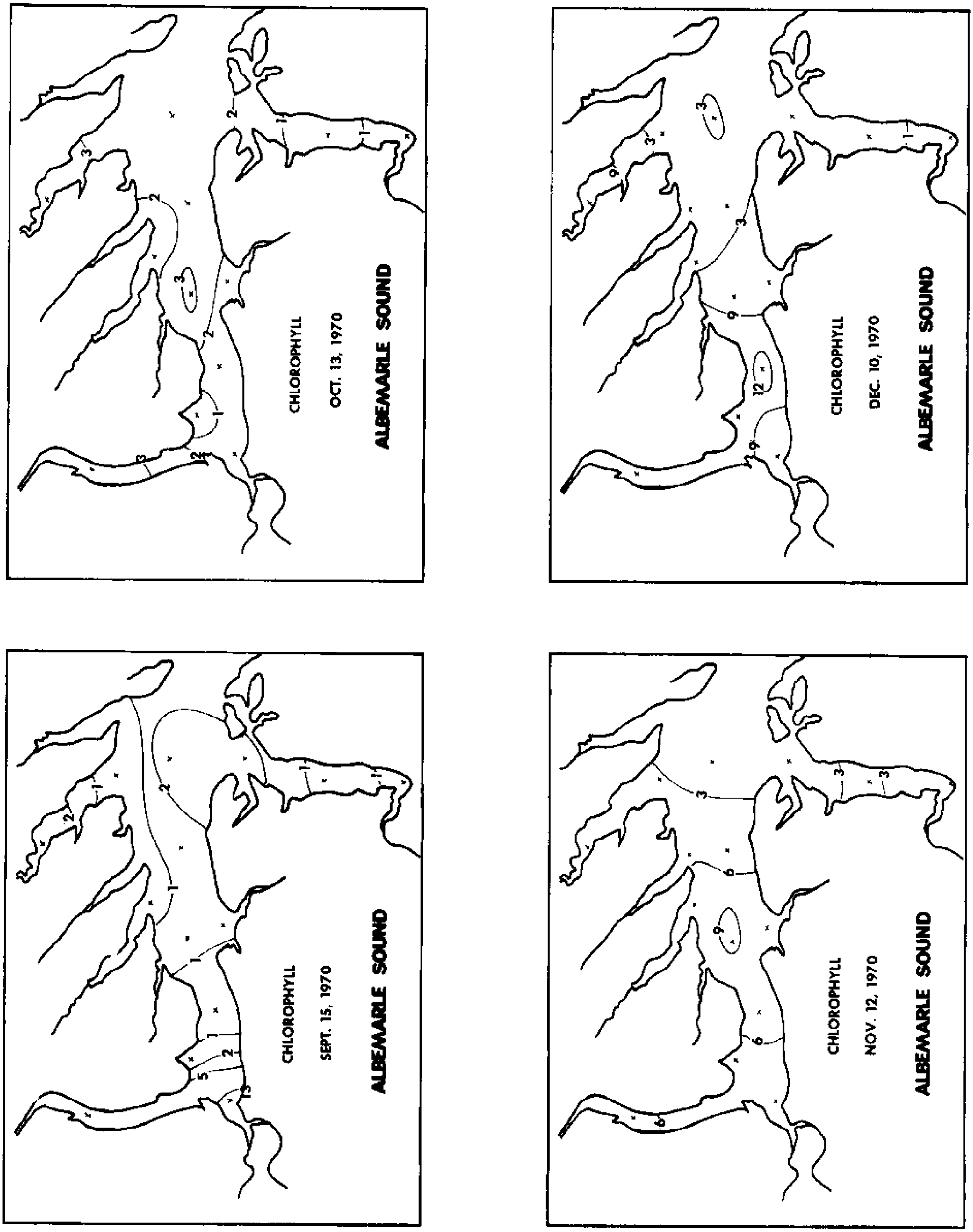


Fig. 78. Chlorophyll a (ug/liter) for 15 September, 13 October, 12 November and 10 December 1970 in the Albemarle Sound.

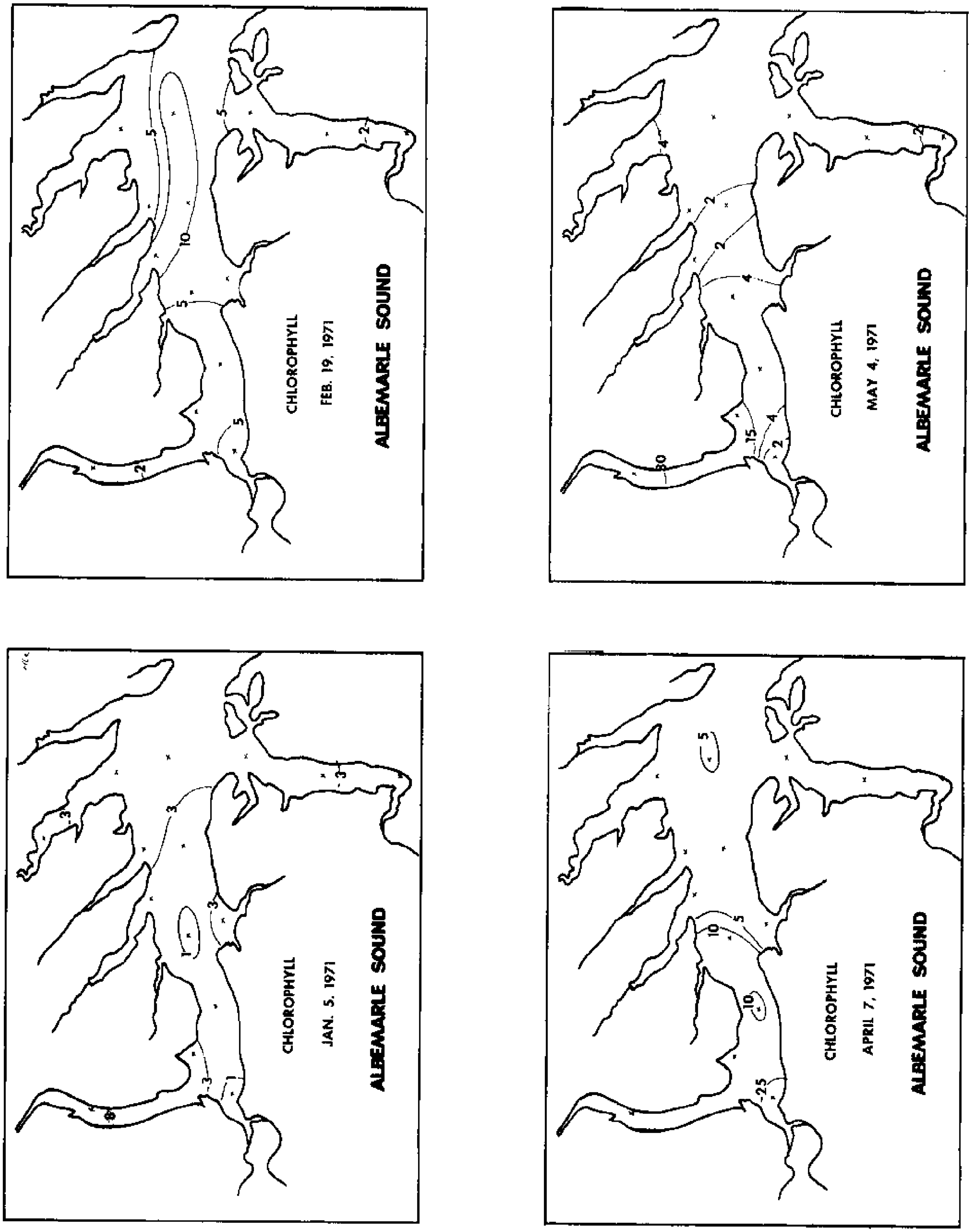


Fig. 79. Chlorophyll a (ug/liter) for 5 January, 19 February, 7 April and 4 May 1971 in the Albemarle Sound.

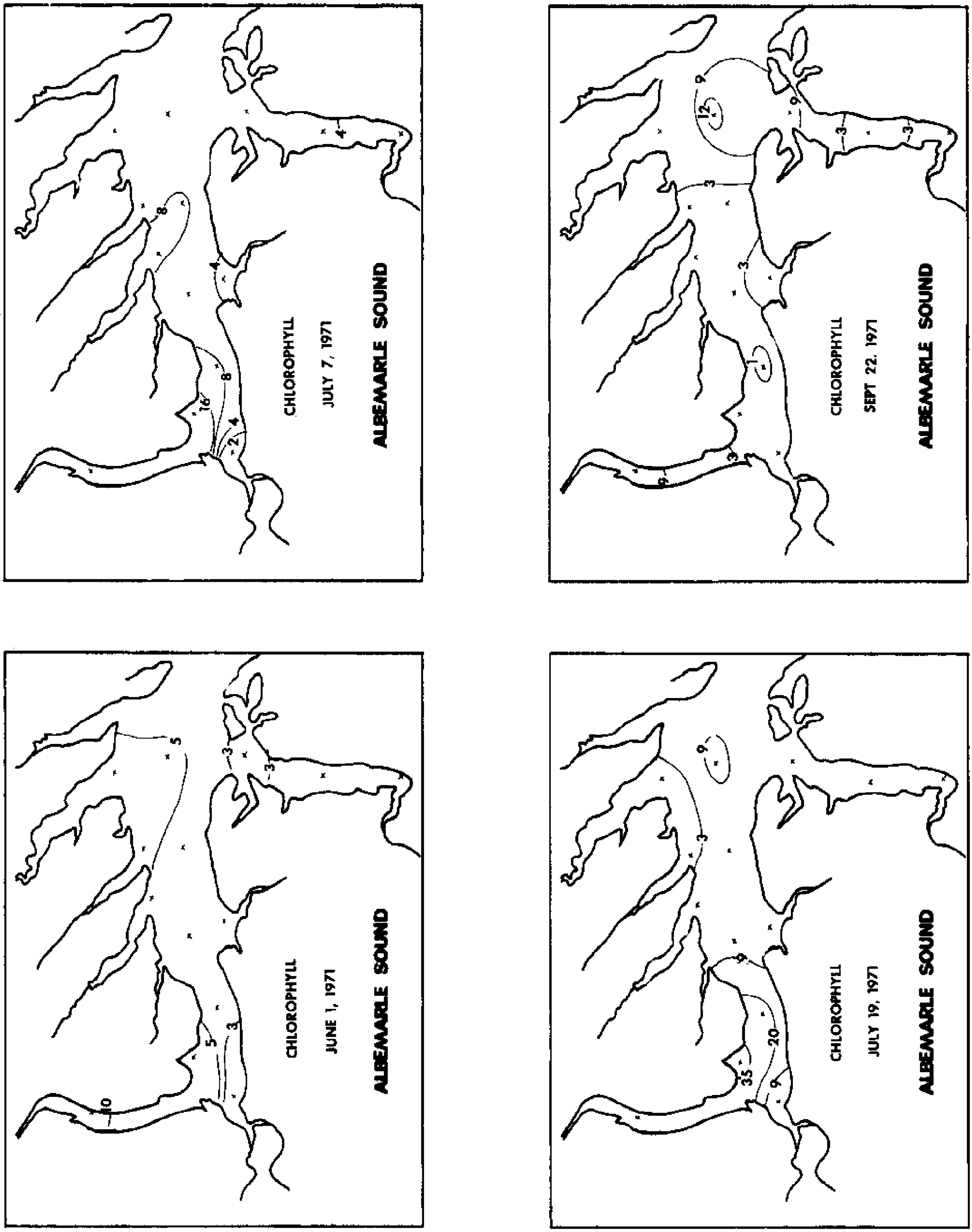


Fig. 80. Chlorophyll a (ug/liter) for 1 June, 7 July, 19 July and 22 September 1971 in the Albemarle Sound.

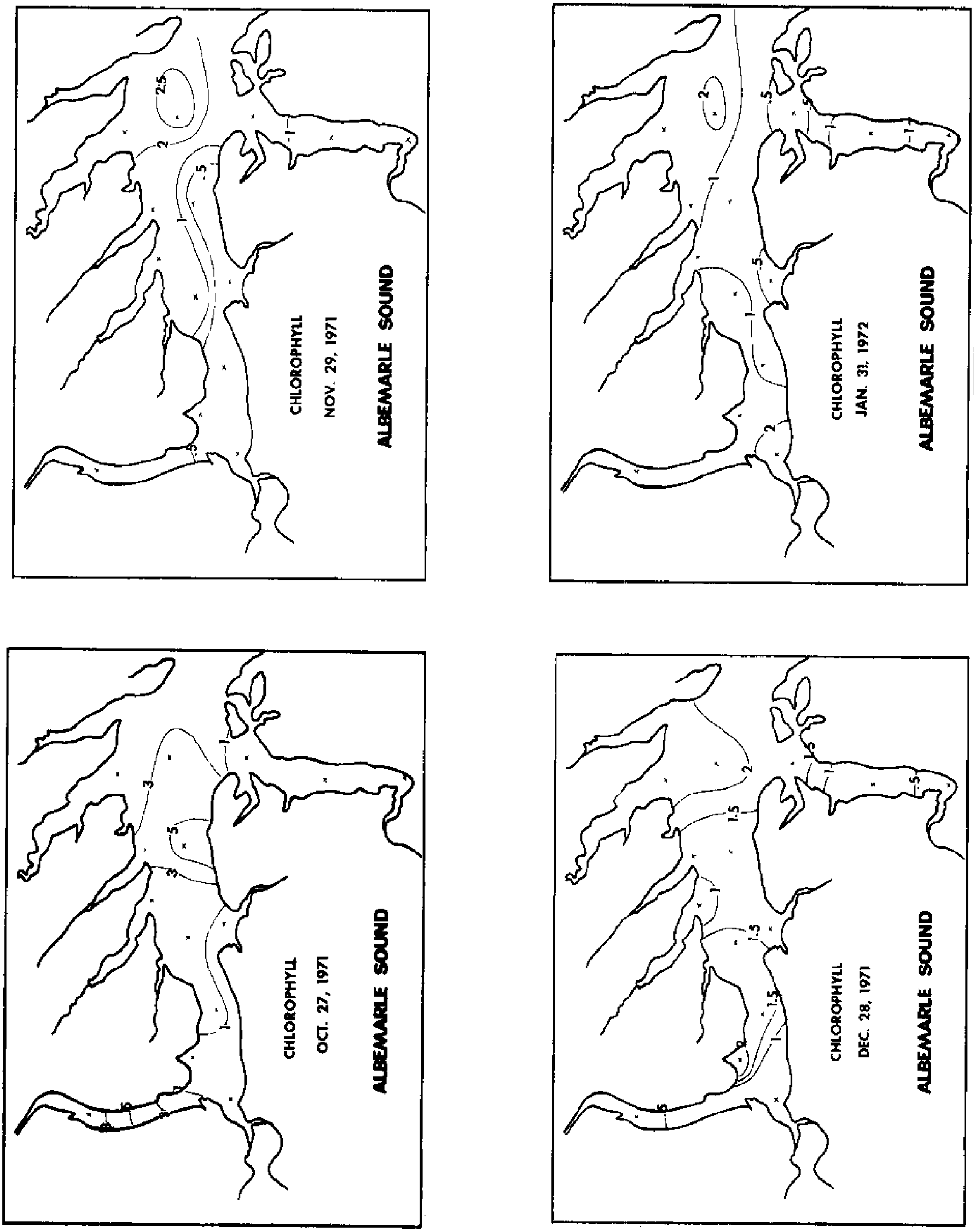


Fig. 81. Chlorophyll a (ug/liter) for 27 October, 29 November, 28 December 1971 and 31 January 1972 in the Albemarle Sound.

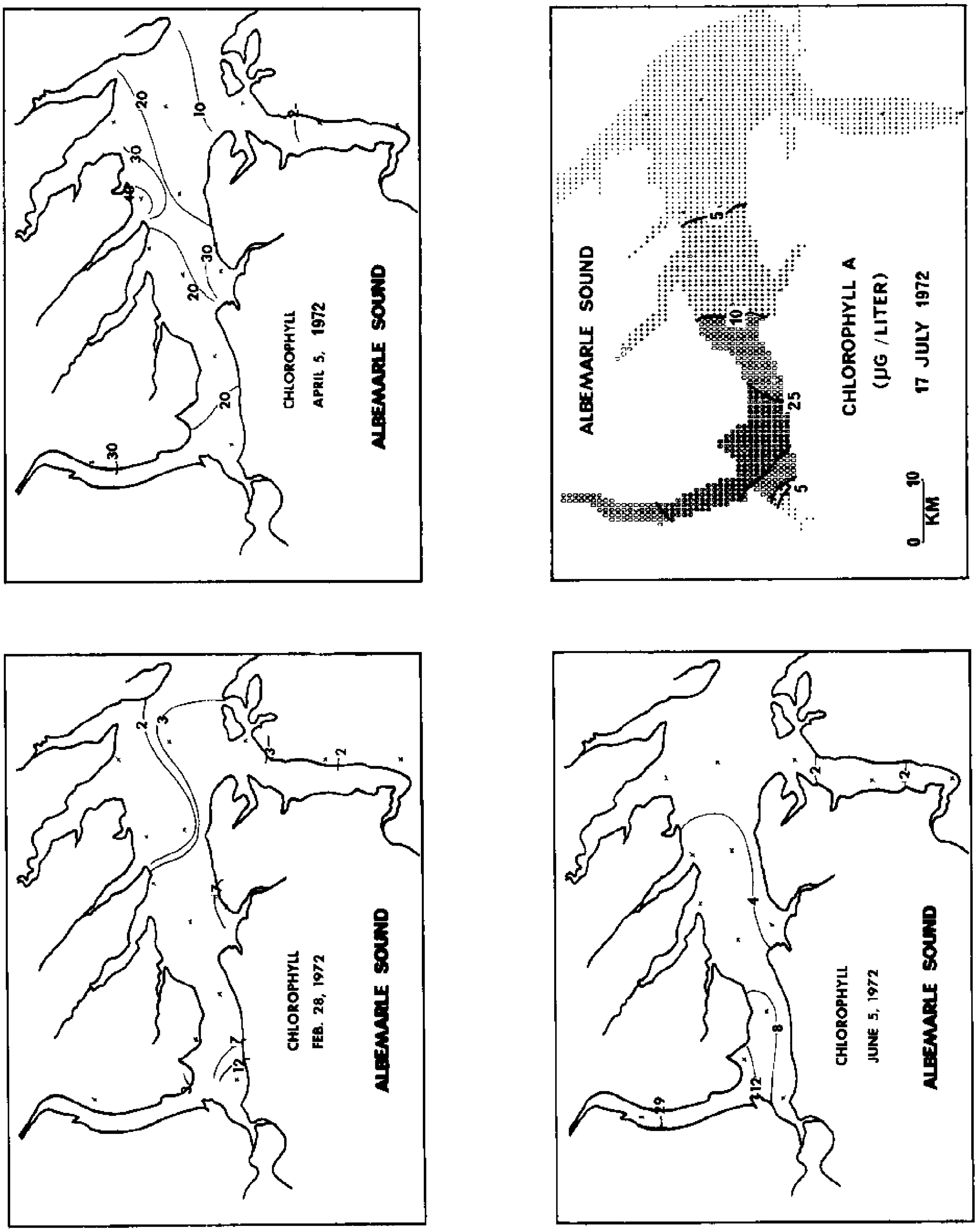


Fig. 82. Chlorophyll a (ug/liter) for 28 February, 5 April, 5 June and 17 July 1972 in the Albemarle Sound.

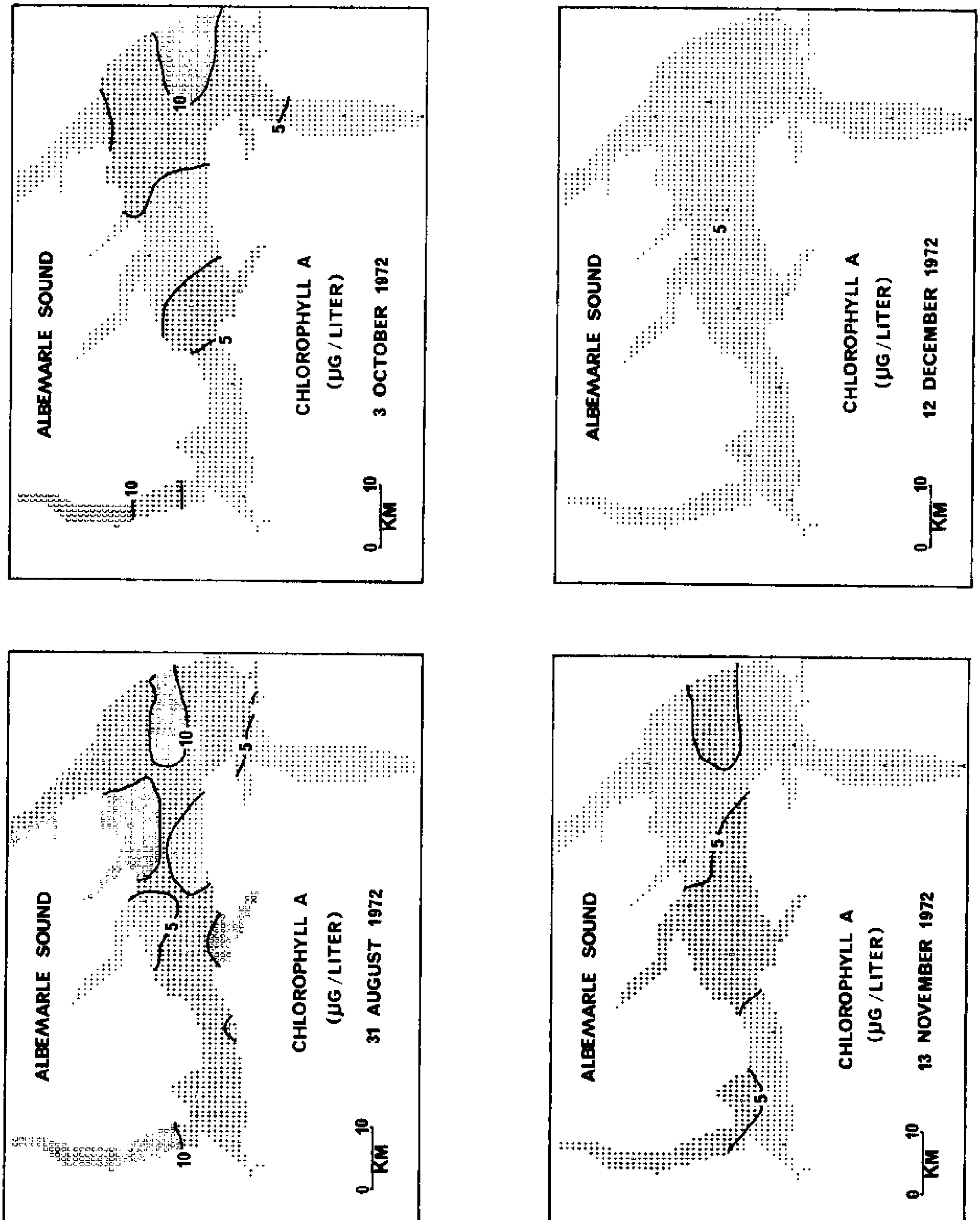


Fig. 83. Chlorophyll a (ug/liter) for 31 August, 3 October, 13 November and 12 December 1972 in the Albemarle Sound.

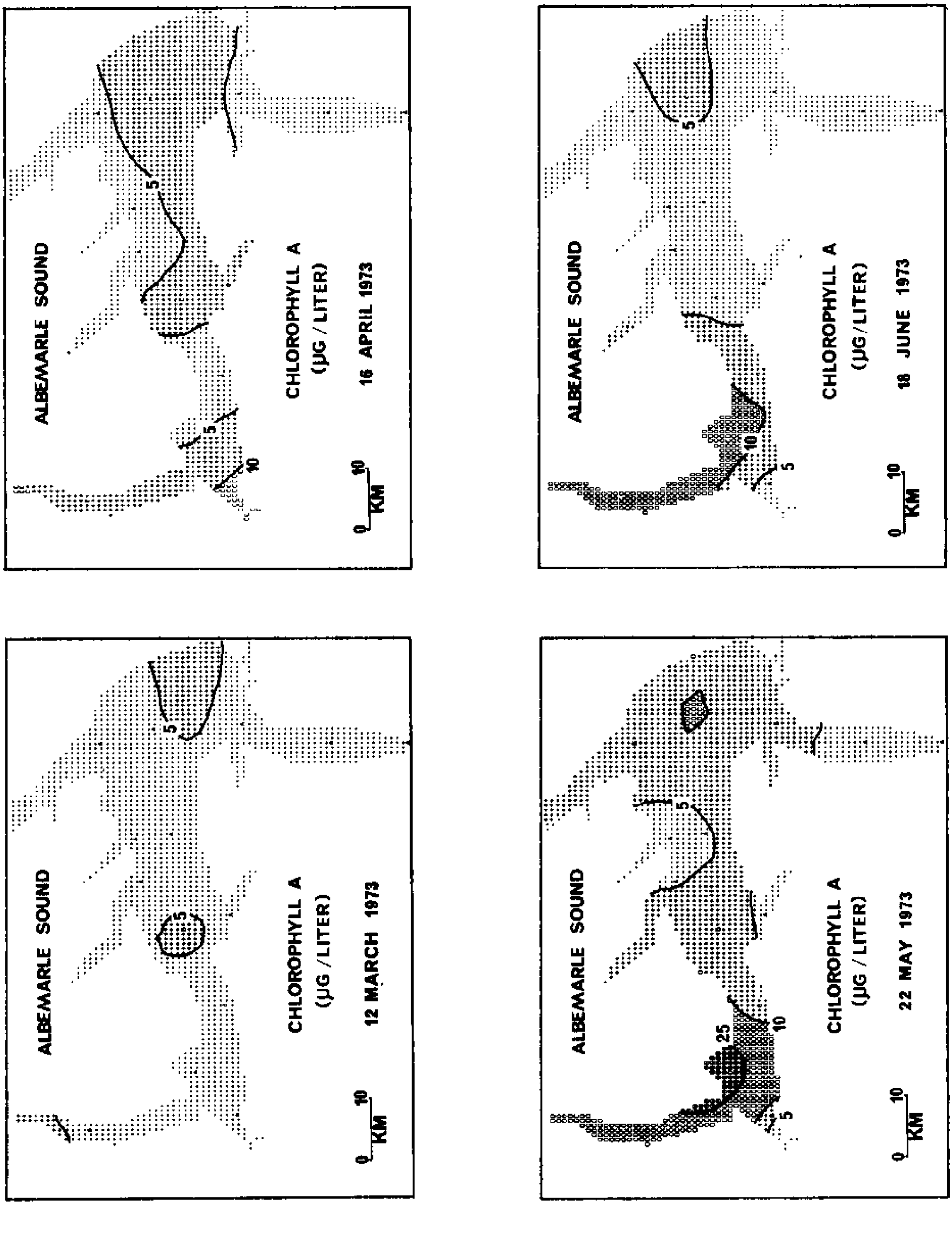


Fig. 84. Chlorophyll a (ug/liter) for 12 March, 16 April, 22 May and 18 June 1973 in the Albemarle Sound.

these different areas. There is not a strong correlation between Chl a patterns and patterns of PN or DON possibly because of inadequacies discussed above of the analysis for the latter components.

Hobbie and Smith (1975) and Hobbie (1974) state that about 25 ug Chl a/liter indicate an algal bloom in the Neuse and Pamlico systems. By this criterion, bloom conditions occur in the Albemarle system in late spring and summer (Fig. 79: 4 May 1971; Fig. 80: 19 July 1971; Fig. 81: 5 April 1972, 5 June 1972, and 17 July 1972; Fig. 84: 22 May 1973) and occasionally in the fall (Fig. 85: 3 October 1973). Most of these blooms occurred in the Chowan River during the summer when this river flows very sluggishly (Stanley and Hobbie 1976) or around Edenton possibly as a result of effluent and runoff.

The algae causing these blooms, blue-green algae, having tiny gas vacuoles that allow them to float at the surface of the water and thus avoid the problems of being mixed below the zone of adequate light. However, this group of algae is found almost exclusively in freshwater and so does not grow in the estuary.

A question remains as to what triggers an algal bloom since inorganic nutrients are available in considerable quantities at times when Chlorophyll a concentrations are very low. The opposite is also true as Stanley and Hobbie (1976) have shown. During the summer extensive algal populations can exist on a small amount of standing inorganic nitrogen by rapidly recycling the nitrogen. In addition to nutrients, temperature and light may exert significant influences on the frequency of bloom conditions. Seasonal changes in temperature can be responsible for a 6 to 10 fold change in nitrogen uptake (Stanley and Hobbie 1976). However, light may be limiting all year. The 1% light level in the Chowan River was commonly at a depth

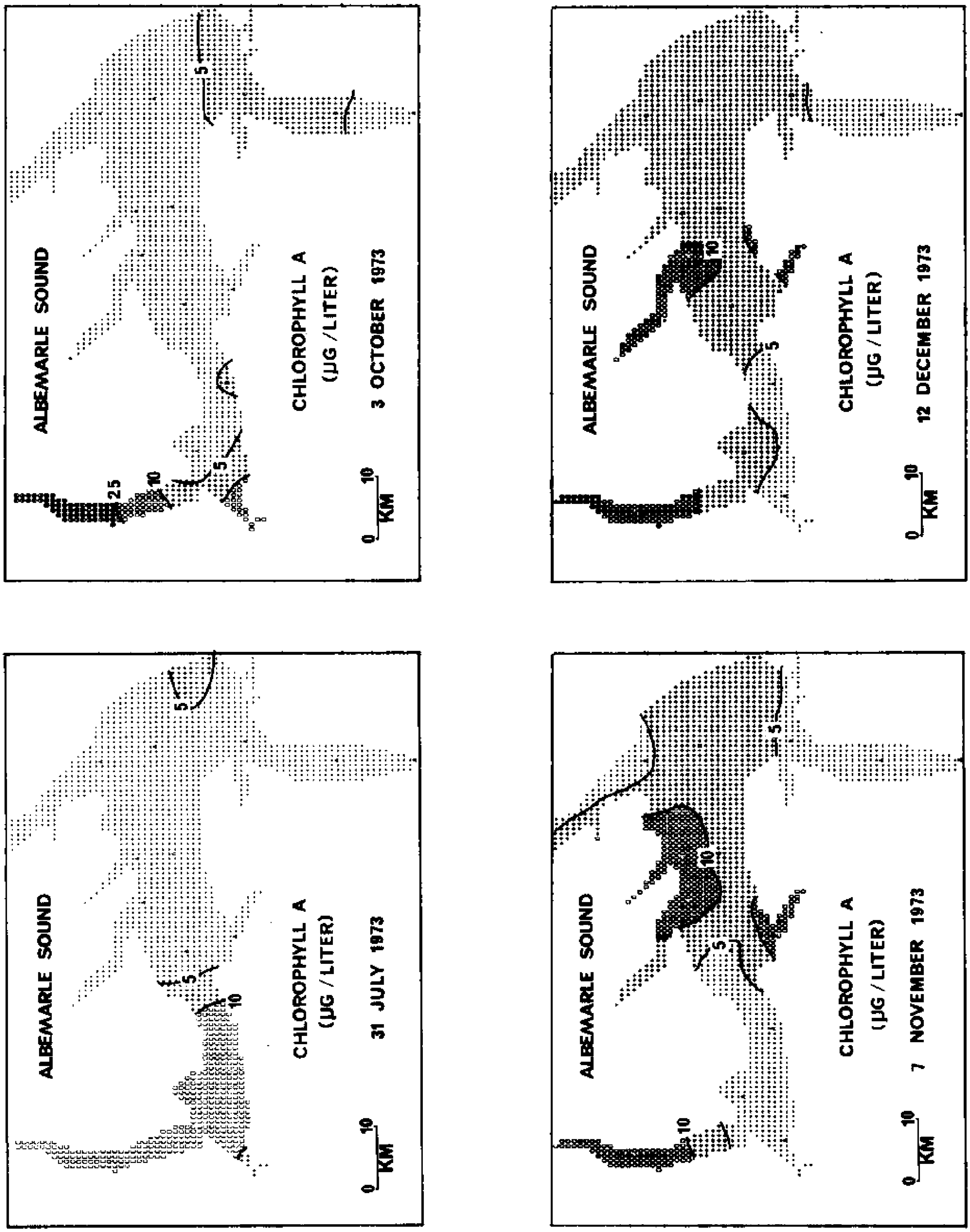


Fig. 85. Chlorophyll a (ug/liter) for 31 July, 3 October, 7 November and 12 December 1973 in the Albemarle Sound.

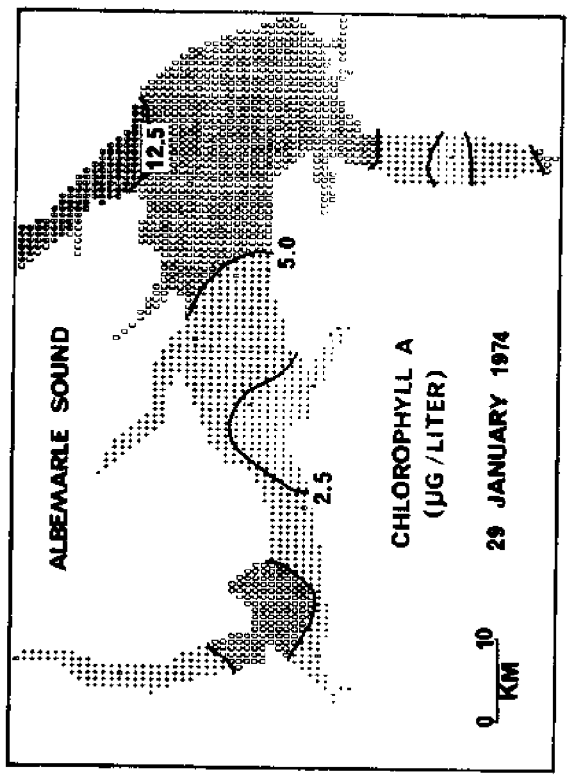


Fig. 86. Chlorophyll a (ug/liter) for 29 January 1974 in the Albemarle Sound.

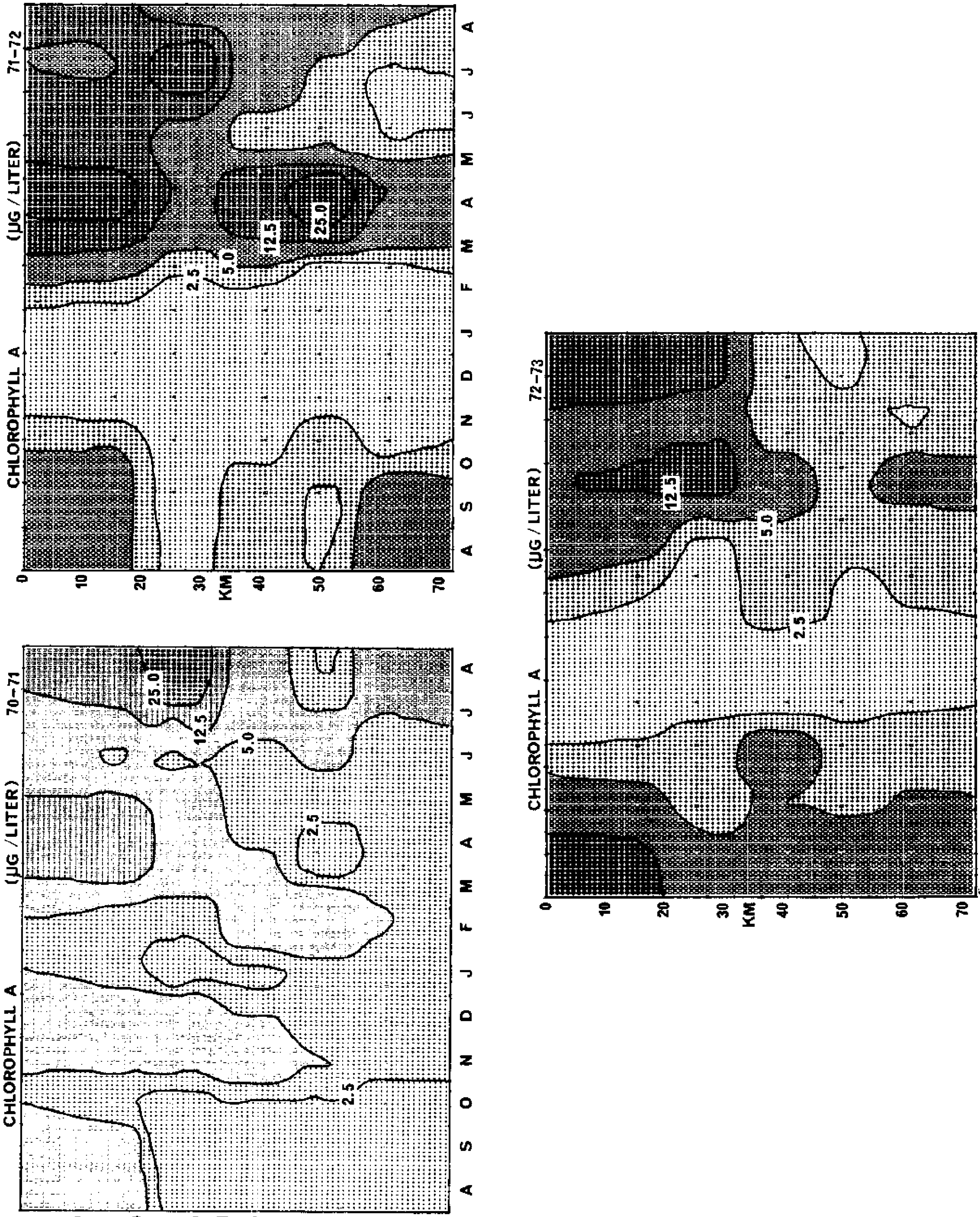


Fig. 87. Yearly concentration of chlorophyll a (ug/liter) for 1970-1973 in the Neuse River.

of less than 1 m and seldom at a depth greater than 2 m. The average extinction coefficient in the Chowan of 3.5 per meter places the 1% light level at 0.8 m. Assuming that the algal populations are well mixed in the shallow Chowan River (average depth 4.5 m), Stanley and Hobbie state that the observed light saturation curves dictate that 80% of the algal population is light limited. A consideration of light and temperature limitations could therefore easily explain why bloom conditions do not occur more frequently in this nutrient rich estuary.

The situation is identical in the Neuse and Pamlico estuaries. Hobbie and Smith (1975) found Chl *a* concentrations ranging from less than 1 to about 75 ug chl *a*/liter in the Neuse River while Hobbie (1974) found concentrations ranging from less than 1 to about 100 ug Chl *a*/liter in the Pamlico. In two unusually large blooms, Chl *a* concentrations reached 225 ug Chl *a*/liter in the Neuse River and exceeded 400 ug Chl *a*/liter in the Pamlico river. Algal biomass was typically slightly higher in these systems than in the Albemarle system and although blooms occurred more frequently, they did not occur in conjunction with every period of high nutrient concentrations. Temperature and light limitations may explain these observations also.

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APPENDICES

APPENDIX ABBREVIATIONS AND UNITS

CODE	PARAMETER AND UNITS
STA	Sampling station (see Figure 2) (note that Station 10 not sampled after 710105)
TEMPS	Surface water temperature (^{o}C)
TEMPB	Bottom water temperature (^{o}C)
SALS	Surface water salinity (ppt)
SALB	Bottom water salinity (ppt)
OXYS	Surface water dissolved oxygen (ml/liter)
OXYB	Bottom water dissolved oxygen (ml/liter)
CHL	Chlorophyll _a_ (ug/liter)
NO_2	Nitrite nitrogen (ug-at N/liter)
NO_3	Nitrate nitrogen (ug-at N/liter)
NH_4	Ammonia nitrogen (ug-at N/liter)
TUN	Total unfiltered nitrogen (ug-at N/liter)
TFN	Total filtered nitrogen (ug-at N/liter)
TUP	Total unfiltered phosphorus (ug-at P/liter)
TFP	Total filtered phosphorus (ug-at P/liter)
RP	Reactive phosphorus (ug-at P/liter)
****	Data not taken

Appendix I. Temperature, salinity, oxygen, chlorophyll a, and data for estuary stations.

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
700915	201	28.78	26.30	0.30	0.30	5.78	4.98	5.77
700915	202	30.50	29.10	0.30	0.30	7.00	4.60	13.31
700915	203	29.38	26.70	0.30	0.30	5.71	4.98	1.33
700915	204	28.40	28.10	0.72	1.05	5.69	4.80	0.16
700915	205	27.70	26.06	1.42	1.93	5.65	5.30	1.60
700915	206	28.22	26.45	1.63	2.96	5.41	4.08	1.12
700915	207	27.80	26.60	1.58	1.58	5.46	5.48	0.32
700915	208	28.18	26.15	2.30	2.60	5.94	5.11	1.76
700915	209	26.30	26.17	2.04	2.00	5.65	5.61	0.96
700915	210	28.00	25.70	1.00	1.14	6.13	5.01	2.72
700915	211	26.84	25.32	2.52	2.70	5.80	5.87	0.03
700915	212	27.28	25.36	3.44	3.50	9.01	6.25	3.52
700915	213	27.20	26.24	3.54	3.60	5.92	5.98	2.40
700915	214	20.02	25.78	2.80	2.74	5.72	5.43	0.96
700915	215	27.46	26.80	2.50	7.46	4.87	3.23	1.28

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
701013	201	24.18	23.08	0.30	0.30	6.76	6.33	3.36
701013	202	24.10	23.43	0.42	1.00	5.31	5.30	1.60
701013	203	24.30	23.40	0.40	0.40	5.95	5.25	0.48
701013	204	23.42	22.80	0.62	0.62	5.88	6.23	1.92
701013	205	23.84	23.06	2.63	2.63	6.16	5.93	3.04
701013	206	24.24	22.96	2.40	3.04	6.15	5.11	1.76
701013	207	23.94	23.60	2.14	2.14	5.93	5.36	1.44
701013	208	23.00	23.00	2.52	2.82	6.50	5.65	2.08
701013	209	23.66	23.70	2.93	2.93	6.23	6.15	
701013	210	24.52	23.23	1.32	1.55	6.50	6.67	4.00
701013	211	24.00	23.04	3.00	3.63	6.50	6.64	
701013	212	24.00	22.75	4.38	5.06	6.74	6.56	2.40
701013	213	23.60	23.27	4.23	4.88	6.35	6.21	
701013	214	24.18	22.77	2.87	2.90	6.31	6.00	0.03
701013	215	24.46	23.10	3.90	9.72	6.33	4.68	1.44

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
701112	201	15.26	14.92	0.60	0.62	6.98	6.13	6.86
701112	202	16.00	15.24	0.35	0.50	6.17	5.63	5.07
701112	203	15.77	15.22	0.55	0.55	6.64	6.06	5.34
701112	204	15.24	14.92	1.00	1.00	7.07	6.70	6.94
701112	205	15.24	15.24	2.38	2.38	6.99	6.67	9.89
701112	206	15.70	15.25	3.55	3.55	5.66	5.87	6.98
701112	207	15.15	15.52	3.40	3.84	5.94	6.93	6.68
701112	208	15.33	15.15	2.32	2.42	7.24	7.23	4.54
701112	209	15.20	15.20	2.40	2.40	6.88	7.16	5.88
701112	210	15.00	15.00	1.73	1.63	6.64	7.04	4.81
701112	211	15.28	15.22	7.00	7.00	4.70	6.89	3.47
701112	212	15.30	15.60	5.38	10.20	5.69	7.00	2.13
701112	213	15.38	15.00	5.32	7.37	4.42	4.52	1.60
701112	214	15.22	15.40	3.20	3.20	4.55	4.47	3.20
701112	215	15.78	15.25	5.08	7.44	4.50	3.50	1.60

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
701210	201	8.35	8.55	0.90	1.20	7.31	6.95	10.30
701210	202	8.10	8.35	0.40	0.85	6.41	6.25	5.76
701210	203	7.80	8.20	1.10	1.15	7.17	6.54	9.66
701210	204	8.14	9.20	1.58	1.76	9.05	5.59	12.18
701210	205	8.25	8.60	2.52	3.60	5.68	5.64	8.65
701210	206	7.78	7.96	2.50	3.78	11.97	6.30	6.57
701210	207	8.15	8.32	3.62	3.62	4.43	5.48	1.44
701210	208	8.32	9.10	3.45	4.75	5.32	3.94	2.80
701210	209	8.20	9.06	4.30	5.50	6.19	5.49	2.88
701210	210	7.96	7.60	2.60	3.50	6.02	6.82	10.42
701210	211	7.92	8.55	5.04	6.12	6.93	6.50	1.44
701210	212	8.55	8.04	5.65	6.00	5.58	5.95	3.10
701210	213	8.30	7.04	3.96	4.01	6.38	6.80	2.40
701210	214	8.40	7.96	3.90	3.90	6.15	6.41	2.78
701210	215	8.24	8.42	4.14	4.25	5.69	6.49	0.96

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710105	201	6.32	6.32	0.00	0.00	9.06	9.39	8.33
710105	202	7.65	7.65	0.00	0.00	7.89	8.06	0.96
710105	203	7.12	7.22	0.00	0.00	9.46	8.88	3.20
710105	204	6.40	6.40	0.20	0.10	8.99	8.40	1.60
710105	205	6.55	6.55	1.00	1.00	8.51	9.02	0.80
710105	206	6.55	6.67	2.32	2.32	9.33	9.24	3.20
710105	207	6.65	6.30	2.06	2.06	8.82	8.19	2.56
710105	208	6.26	6.26	4.25	4.25	9.67	8.50	2.56
710105	209	6.40	6.40	4.25	4.35	9.19	8.88	4.00
710105	210	7.62	6.80	3.55	3.80	7.51	7.30	2.56
710105	211	6.70	6.55	5.85	5.85	7.44	7.63	4.00
710105	212	6.20	6.20	6.10	6.10	7.15	8.16	4.00
710105	213	6.10	6.10	5.60	5.35	7.34	8.02	4.00
710105	214	6.84	6.72	3.80	3.80	7.81	7.64	3.40
710105	215	9.46	7.65	3.42	6.83	8.21	6.56	1.44

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710219	201	7.50	7.20	0.00	0.00	8.13	8.32	1.60
710219	202	8.50	8.00	0.00	0.00	8.73	7.57	6.57
710219	203	10.00	7.20	0.00	0.00	10.35	8.85	3.57
710219	204	9.50	7.80	0.00	0.00	8.66	9.02	2.67
710219	205	8.00	7.50	0.00	0.00	8.81	10.49	5.76
710219	206	7.50	5.90	1.10	1.10	8.73	8.41	5.60
710219	207	8.00	7.00	2.10	1.10	10.38	8.70	10.08
710219	208	8.00	5.90	1.10	1.60	9.66	9.61	13.36
710219	209	8.00	6.50	3.30	1.60	8.38	8.63	4.27
710219	211	7.00	6.30	3.30	2.10	9.53	8.84	3.68
710219	212	7.80	6.80	3.30	2.10	8.83	8.17	11.38
710219	213	7.80	7.00	3.30	2.10	8.68	8.93	4.81
710219	214	8.00	7.80	3.30	1.60	8.20	7.96	3.60
710219	215	9.00	8.00	2.10	1.10	7.47	7.53	1.78

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710407	201	11.18	11.00	0.00	0.00	7.38	7.41	10.15
710407	202	11.68	11.46	0.00	0.00	7.46	7.32	25.66
710407	203	11.52	11.34	0.00	0.00	7.31	7.37	14.37
710407	204	10.82	10.68	0.00	0.00	3.83	3.78	8.82
710407	205	11.28	11.08	0.00	0.00	7.76	7.58	10.76
710407	206	10.92	10.90	0.00	0.00	7.56	7.77	2.28
710407	207	11.06	11.06	0.00	0.50	7.97	7.64	2.52
710407	208	11.22	11.10	0.50	0.50	7.94	7.50	1.00
710407	209	12.06	11.44	1.10	1.10	7.34	7.54	2.05
710407	211	11.20	11.20	1.10	1.10	7.58	7.66	1.78
710407	212	10.70	10.80	1.80	1.80	7.83	7.57	5.52
710407	213	11.42	11.30	1.80	1.80	7.83	7.46	3.04
710407	214	12.40	12.40	1.80	1.10	7.16	7.03	2.40
710407	215	13.70	13.36	0.50	0.00	6.29	6.34	1.20

Appendix I. (Continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710504	201	15.70	15.30	0.00	0.00	6.98	6.86	33.84
710504	202	15.30	14.90	0.00	0.00	6.49	6.47	1.44
710504	203	16.00	15.70	0.00	0.00	6.85	6.85	18.12
710504	204	15.80	15.20	0.00	0.00	6.39	6.38	4.16
710504	205	16.00	15.20	0.00	0.00	6.48	6.54	4.16
710504	206	15.80	15.50	0.00	0.00	6.58	6.55	4.00
710504	207	16.10	15.80	0.00	0.60	6.50	6.43	0.96
710504	208	16.40	16.20	0.00	0.60	6.56	6.54	1.77
710504	209	16.40	16.30	0.60	1.10	6.91	6.60	3.84
710504	211	16.30	16.20	1.10	1.10	6.87	6.79	4.00
710504	212	15.40	15.20	1.10	1.10	6.72	6.74	2.88
710504	213	16.50	16.20	2.10	2.10	6.46	6.42	2.08
710504	214	17.20	17.00	2.10	2.10	6.38	6.34	3.68
710504	215	17.80	17.50	1.10	1.10	5.52	5.79	0.64

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710601	201	22.10	21.80	0.50	0.00	5.71	5.39	10.10
710601	202	20.20	20.30	0.00	0.00	4.26	4.03	1.60
710601	203	21.30	21.20	0.00	0.00	5.76	5.50	7.05
710601	204	21.70	21.50	0.00	0.00	5.79	5.64	3.20
710601	205	22.10	21.80	0.00	0.50	5.69	5.63	3.20
710601	206	22.80	21.80	0.50	0.00	6.00	5.39	3.52
710601	207	23.30	23.30	0.50	0.50	5.73	5.73	3.20
710601	208	23.10	22.20	0.50	1.10	5.81	5.59	3.52
710601	209	23.30	22.50	0.50	0.50	6.06	5.77	6.41
710601	211	23.00	22.00	1.10	2.10	5.98	5.17	5.77
710601	212	25.20	23.00	1.10	1.60	6.10	5.67	5.61
710601	213	24.10	22.80	2.10	2.10	5.86	5.84	2.40
710601	214	25.20	22.80	2.10	2.10	5.56	5.50	4.33
710601	215	26.10	23.00	1.10	1.10	4.76	4.71	3.20

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710707	201	25.40	25.40	0.00	0.00	5.01	4.88	16.83
710707	202	25.20	25.00	0.00	0.00	4.50	4.34	1.44
710707	203	25.60	25.60	0.00	0.00	5.42	4.97	18.92
710707	204	25.40	25.20	0.00	0.00	5.01	5.45	8.82
710707	205	25.20	25.10	0.00	0.00	5.43	5.51	5.77
710707	206	25.40	25.30	0.00	0.00	5.59	5.24	3.42
710707	207	25.70	25.40	0.00	0.00	5.35	5.18	8.49
710707	208	26.20	25.70	0.00	0.00	5.46	5.31	8.17
710707	209	26.10	25.80	0.00	0.00	5.43	5.05	4.16
710707	211	26.20	25.90	0.00	0.00	5.42	5.39	4.49
710707	212	26.10	26.10	0.00	0.00	5.46	5.46	4.97
710707	213	26.10	25.70	1.10	1.10	5.34	5.26	4.33
710707	214	26.80	26.10	1.10	1.10	5.55	5.74	4.49
710707	215	27.50	27.10	1.10	1.10	4.75	4.59	2.72

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710719	201	28.20	27.90	0.00	0.00	5.90	5.72	20.52
710719	202	27.70	27.50	0.00	0.00	4.75	4.53	7.21
710719	203	29.00	28.30	0.00	0.00	6.01	5.60	35.96
710719	204	27.90	27.20	0.00	0.00	5.67	4.34	20.68
710719	205	27.80	27.40	0.00	0.00	5.47	5.54	7.37
710719	206	27.10	26.90	0.00	0.00	5.53	5.12	6.89
710719	207	27.20	26.80	0.00	0.00	5.17	5.06	5.61
710719	208	27.00	26.70	0.00	0.00	5.25	5.13	5.29
710719	209	27.20	26.90	0.00	0.00	5.05	4.97	2.40
710719	211	26.90	26.70	0.00	0.00	5.30	5.26	2.40
710719	212	27.20	27.00	0.00	1.10	5.58	4.98	9.14
710719	213	27.20	27.00	1.10	2.10	5.28	5.11	7.53
710719	214	27.00	26.80	1.10	2.10	5.79	5.01	7.05
710719	215	27.50	27.10	2.10	2.10	4.55	4.39	6.89

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
710922	201	26.14	26.00	0.02	0.02	4.77	5.05	10.42
710922	202	26.30	26.24	0.00	0.01	5.03	4.97	2.40
710922	203	26.08	26.10	0.00	0.00	3.93	3.82	1.28
710922	204	26.10	26.18	0.02	0.02	4.94	4.93	0.80
710922	205	26.00	25.94	0.04	0.04	5.42	5.39	2.88
710922	206	26.00	26.03	0.08	0.08	4.96	5.12	8.01
710922	207	26.30	26.32	0.08	0.08	5.24	5.07	1.76
710922	208	26.34	26.34	1.10	1.08	5.43	5.33	1.60
710922	209	26.30	26.36	1.20	1.20	5.42	5.44	2.72
710922	211	26.02	26.20	2.24	2.80	4.99	5.24	6.09
710922	212	26.00	26.00	3.30	3.40	5.46	5.29	12.02
710922	213	26.48	26.36	2.78	2.74	5.43	5.42	9.14
710922	214	26.90	26.90	1.90	1.82	4.90	5.09	2.08
710922	215	27.32	27.08	1.10	1.12	4.29		4.81

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
711027	201	20.20	20.30	0.00	0.00	4.79	4.18	8.17
711027	202	20.70	20.60	0.00	0.00	2.72	2.44	0.80
711027	203	21.50	20.70	0.30	0.30	4.04	4.33	0.64
711027	204	21.20	20.72	0.50	0.90	5.17	3.90	1.60
711027	205	21.16	20.72	0.60	1.50	5.48	5.39	1.12
711027	206	21.50	20.86	0.40	2.80	4.27	3.70	0.80
711027	207	21.76	20.90	0.50	1.60	5.55	5.63	1.92
711027	208	21.50	21.24	0.20	0.20	5.30	6.19	5.29
711027	209	22.24	21.10	0.30	1.70	6.19	6.01	3.52
711027	211	21.40	21.24	3.00	3.00	4.82	5.56	2.24
711027	212	21.00	20.90	3.40	4.10	5.99	5.29	3.84
711027	213	21.68	21.24	0.68	0.78	5.31	5.23	0.80
711027	214	22.00	21.68	0.00	0.00	4.54	4.95	0.48
711027	215	22.30	21.68	0.00	0.00	1.51	0.94	0.64

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
711129	201	9.60	9.50	0.00	0.00	7.30	7.24	0.96
711129	202	9.90	9.78	0.00	0.00	6.20	6.06	0.32
711129	203	9.40	9.50	0.00	0.00	7.37	7.32	0.48
711129	204	9.92	9.80	0.00	0.00	7.58	7.60	0.48
711129	205	10.00	10.00	0.00	0.00	7.83	7.54	1.28
711129	206	10.00	9.78	0.00	0.00	7.74	7.62	0.48
711129	207	9.84	9.80	0.00	0.00	7.45	7.68	1.12
711129	208	9.80	9.78	0.00	0.00	7.35	7.79	0.48
711129	209	9.50	9.40	0.00	0.00	7.32	7.46	1.12
711129	211	9.80	9.50	1.00	1.14	7.48	7.54	2.40
711129	212	9.50	9.70	1.10	0.90	7.74	7.79	2.72
711129	213	9.12	9.12	0.00	0.00	7.35	7.40	1.44
711129	214	9.24	9.08	0.00	0.00	7.07	7.12	0.64
711129	215	10.30	10.28	0.00	0.00	4.99	4.63	0.80

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
711228	201	12.80	11.90	0.00	0.00	6.70	6.91	0.48
711228	202	12.00	11.50	0.00	0.00	6.92	6.88	0.64
711228	203	14.00	13.00	0.00	0.00	6.72	7.12	2.08
711228	204	12.00	11.00	0.00	0.00	7.62	7.16	1.76
711228	205	12.00	11.00	0.00	0.00	7.39	7.38	1.76
711228	206	11.00	11.00	1.10	1.10	7.53	7.52	1.28
711228	207	11.00	10.80	0.50	0.50	7.44	7.51	0.80
711228	208	11.00	11.00	1.10	4.30	7.36	7.45	1.28
711228	209	11.90	11.00	2.10	2.10	7.39	7.45	1.28
711228	211	11.90	11.00	4.30	4.30	6.54	7.29	2.40
711228	212	12.10	11.90	4.30	4.30	7.44	7.47	2.08
711228	213	14.10	13.00	2.10	3.25	7.09	7.17	1.92
71128	214	13.00	12.80	2.10	2.10	6.66	6.82	0.64
711228	215	13.80	12.60	1.10	1.10	5.68	5.67	0.48

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
720131	201	7.74	7.84	0.00	0.00	7.64	7.93	1.28
720131	202	8.60	7.90	0.00	0.00	7.24	7.22	2.88
720131	203	7.96	7.90	0.00	0.00	7.59	7.57	1.92
720131	204	7.50	7.42	0.00	0.00	7.74	7.75	0.80
720131	205	7.48	7.62	0.00	0.00	7.95	7.93	1.60
720131	206	7.50	7.50	0.00	0.00	8.17	7.71	0.42
720131	207	7.80	7.76	0.00	0.00	8.04	7.97	0.96
720131	208	7.60	7.60	0.00	0.00	7.95	8.01	0.64
720131	209	7.40	7.40	0.00	0.00	8.09	3.65	1.12
720131	211	7.34	7.20	0.00	0.00	8.05	8.04	1.28
720131	212	7.20	7.20	0.00	0.00	8.08	8.23	2.13
720131	213	7.78	7.58	0.10	0.00	7.90	7.85	0.48
720131	214	8.15	8.08	0.08	0.10	7.22	7.01	1.20
720131	215	9.52	9.34	0.10	0.12	7.57	7.40	0.91

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
720228	201	9.50	9.00	0.00	0.00	7.78	7.80	2.56
720228	202	10.50	10.00	0.00	0.00	7.77	7.53	12.02
720228	203	11.50	10.00	0.00	0.00	7.42	7.74	3.36
720228	204	9.00	8.50	0.00	0.00	8.02	7.98	3.20
720228	205	9.00	8.50	0.00	0.00	8.09	7.92	4.38
720228	206	9.50	8.00	0.00	0.00	8.27	8.17	7.21
720228	207	9.50	8.50	0.00	0.00	7.96	7.97	3.68
720228	208	9.00	9.00	0.00	2.00	8.27	8.06	1.60
720228	209	9.50	9.50	0.00	0.00	7.78	8.03	1.37
720228	211	10.00	10.00	0.55	0.00	7.98	8.05	1.49
720228	212	9.50	9.50	2.10	1.10	8.22	8.16	3.21
720228	213	11.00	11.00	0.55	0.55	7.82	7.72	3.66
720228	214	10.50	10.50	0.55	0.55	7.44	7.21	2.04
720228	215	12.50	12.00	0.55	0.55	5.94	6.33	1.12

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
720405	201	12.16	12.16	0.00	0.00	7.76	7.74	31.18
720405	202	12.10	12.30	0.00	0.00	7.73	7.68	23.24
720405	203	12.32	13.04	0.00	0.00	7.43	7.36	16.13
720405	204	11.14	11.10	0.00	0.00	7.25	7.20	5.61
720405	205	11.00	11.04	0.00	0.00	7.70	7.50	15.71
720405	206	10.90	11.06	0.00	0.00	7.83	7.51	33.35
720405	207	11.40	11.40	0.00	0.00	7.25	7.01	10.02
720405	208	11.72	11.24	0.00	0.00	7.52	7.55	19.24
720405	209	11.20	11.18	0.00	0.00	7.59	7.57	41.69
720405	211	11.30	11.40	0.10	0.10	7.76	7.76	29.64
720405	212	11.50	11.50	0.80	0.78	7.36	7.40	16.12
720405	213	12.10	12.10	0.62	0.62	7.03	6.99	3.95
720405	214	12.18	12.20	0.70	0.80	6.76	6.88	1.69
720405	215	13.08	12.88	0.54	0.60	5.95	5.97	1.44

Appendix I. (continued)

DATE	STA	TEMPS	TEMPS	SALS	SALB	OXYS	OXYB	CHL
720605	201	24.20	21.58	0.00	0.00	6.48	6.61	29.67
720605	202	21.70	21.59	0.00	0.00	4.64	6.62	4.81
720605	203	27.65	21.70	0.00	0.00	7.24	4.52	12.83
720605	204	22.35	21.83	0.00	0.00	6.96	4.26	8.98
720605	205	22.55	22.30	0.00	0.00	6.64	6.82	5.13
720605	206	22.02	21.75	0.00	0.00	6.53	6.29	3.68
720605	207	23.92	22.90	0.00	0.02	6.14	5.85	4.16
720605	208	22.40	22.40	0.15	0.15	6.56	6.18	4.81
720605	209	23.95	21.72	0.15	0.20	6.28	6.39	4.49
720605	211	23.18	22.30	0.38	0.38	6.24	6.61	2.88
720605	212	23.85	22.02	0.68	0.74	6.31	6.05	3.20
720605	213	23.11	22.88	0.57	0.57	5.55	5.62	2.08
720605	214	24.04	22.75	0.50	0.66	5.33	5.50	1.12
720605	215	24.16	25.46	0.80	0.68	3.89	3.83	2.72

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
720717	201	27.98	26.60	0.16	0.16	6.21	6.14	22.45
720717	202	26.82	25.52	0.20	0.14	5.94	5.71	2.88
720717	203	29.64	29.00	0.08	0.14	5.61	6.03	43.30
720717	204	28.30	26.42	0.10	0.10	6.24	5.90	21.33
720717	205	27.82	26.78	0.14	0.22	5.80	5.60	9.30
720717	206	28.50	26.60	0.22	0.30	5.81	5.33	7.69
720717	207	28.78	26.90	0.34	0.40	5.60	5.49	6.89
720717	208	28.60	27.00	0.44	0.56	5.72	5.66	4.49
720717	209	28.00	27.02	0.50	0.70	5.27	5.06	4.81
720717	211	27.84	26.78	0.82	1.20	5.53	5.46	3.20
720717	212	27.56	27.00	1.40	1.62	5.21	5.27	3.52
720717	213	28.10	26.22	1.30	1.34	5.32	5.06	2.40
720717	214	28.42	27.10	1.00	1.00	4.92	4.64	1.60
720717	215	28.30	27.74	0.90	0.92	4.91	4.52	1.60

Appendix I. (continued)

DATE	STA	TEMPS	TEMPS	SALS	SALB	OXYS	OXYB	CHL
720831	201	27.00	25.90	0.00	0.00	5.63	5.54	20.84
720831	202	26.60	26.40	0.00	0.00	5.27	5.22	7.69
720831	203	27.80	27.80	0.00	0.00	5.66	5.36	8.82
720831	204	27.40	27.40	0.00	0.00	5.56	5.45	4.81
720831	205	27.40	27.40	0.60	0.60	5.56	5.01	8.49
720831	206	25.20	25.10	0.60	0.70	5.38	4.63	13.36
720831	207	27.70	27.50	0.20	0.20	5.46	5.35	1.92
720831	208	25.10	25.00	0.60	0.70	5.36	5.02	19.30
720831	209	27.50	27.40	0.30	0.30	4.95	4.94	1.60
720831	211	27.60	26.90	0.30	0.20	5.25	5.14	5.61
720831	212	27.60	27.50	0.80	0.90	5.24	4.56	10.42
720831	213	27.80	27.10	0.70	0.80	4.94	4.90	4.81
720831	214	27.70	27.60	0.90	0.90	4.72	4.67	2.08
720831	215	NOT SAMPLED						

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
721003	201	21.40	21.40	0.02	0.00	6.18	6.13	13.63
721003	202	21.00	21.00	0.06	0.02	6.32	5.69	1.12
721003	203	21.14	21.00	0.02	0.10	6.11	5.91	4.49
721003	204	21.56	21.40	0.10	0.02	6.33	6.16	1.92
721003	205	20.68	20.70	1.14	1.14	5.92	5.78	6.73
721003	206	21.34	21.18	1.40	1.72	6.24	5.88	6.73
721003	207	21.60	21.10	0.74	1.00	5.95	5.81	1.60
721003	208	21.40	21.22	0.90	0.90	5.81	5.78	5.13
721003	209	21.24	20.44	1.08	1.20	6.12	6.06	2.72
721003	211	20.70	20.70	2.00	2.14	6.06	6.03	4.81
721003	212	21.10	21.10	3.02	2.90	5.99	5.71	9.62
721003	213	20.00	20.08	2.30	2.38	6.09		6.89
721003	214	20.60	20.56	1.00	1.00	4.93	5.27	2.08
721003	215	20.60	20.62	2.18	2.40	5.19	5.10	2.72

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
721113	201	14.62	14.22	0.00	0.00	6.68	6.47	5.13
721113	202	14.56	14.14	0.00	0.00	5.94	5.65	0.64
721113	203	15.10	14.00	0.00	0.00	6.88	6.19	6.73
721113	204	14.62	14.44	0.00	0.00	6.79	6.52	0.80
721113	205	14.72	14.58	0.00	0.00	7.11	7.23	9.30
721113	206	14.72	14.40	0.00	0.00	7.31	7.22	5.93
721113	207	14.40	14.68	0.00	0.00	7.12	5.74	6.89
721113	208	14.62	14.16	0.00	0.26	6.91	6.85	2.08
721113	209	14.92	15.00	0.22	0.18	6.90	6.76	5.61
721113	211	15.14	14.40	0.40	0.60	7.14	6.63	3.21
721113	212	14.94	14.44	1.68	1.68	6.99	6.86	5.13
721113	213	14.20	14.24	1.68	1.76	6.77	6.99	3.36
721113	214	14.18	41.20	0.90	0.90	6.49	6.53	3.36
721113	215	14.60	15.44	2.72	4.68	6.11	4.80	3.21

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
721212	201	9.10	9.24	0.00	0.00	7.76	7.36	0.64
721212	202	10.80	10.78	0.00	0.00	6.70	6.70	0.96
721212	203	10.34	10.32	0.00	0.00	5.85	7.24	2.40
721212	204	10.10	10.20	0.00	0.00	7.42	6.85	0.64
721212	205	10.10	10.20	0.00	0.00	7.21	7.54	0.64
721212	206	9.80	9.80	0.00	0.00	7.35	7.24	1.12
721212	207	9.90	9.90	0.00	0.00	7.92	7.46	0.80
721212	208	9.60	9.58	0.00	0.00	7.62		1.28
721212	209	9.80	9.60	0.00	0.00	7.52	7.70	1.60
721212	211	9.92	9.90	0.10	0.00	7.58	7.68	1.12
721212	212	9.82	9.80	0.16	0.22	8.02	8.06	4.81
721212	213	11.50	11.44	0.80	0.72	7.36	7.78	3.20
721212	214	11.40	11.40	1.00	1.00	7.30	7.32	0.80
721212	215	13.38	13.38	0.40	0.60	5.14	5.30	0.80

Appendix I. (continued)

DATE	STA	TEMPS	TEMPS	SALS	SALB	OXYS	OXYB	CHL
730312	201	11.60	12.10	0.00	0.00	7.38	6.67	4.49
730312	202	12.22	12.22	0.00	0.00	6.95	7.00	2.89
730312	203	12.54	12.70	0.00	0.00	7.45	7.15	1.28
730312	204	12.04	11.90	0.00	0.00	6.72	7.68	1.92
730312	205	11.20	11.12	0.00	0.00	7.61	7.59	5.61
730312	206	10.40	9.90	0.00	0.10	7.93	7.94	4.33
730312	207	10.54	10.54	0.08	0.18	7.55	7.61	2.08
730312	208	11.00	10.38	0.40	0.40	7.78	7.68	2.40
730312	209	10.40	10.38	0.50	0.54	6.98	7.45	2.56
730312	211	11.20	11.12	0.90	0.80	7.62	7.47	1.60
730312	212	10.40	10.28	0.82	1.20	8.06	7.33	4.49
730312	213	12.10	12.00	1.18	1.18	7.40	7.21	4.00
730312	214	12.44	12.44	0.90	0.92	7.18	6.88	1.48
730312	215	15.46	15.50	0.58	0.58	4.49	5.31	2.72

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
730416	201	15.60	13.50	0.16	0.18	6.80	6.62	9.14
730416	202	14.80	13.20	0.10	0.10	6.88	7.01	11.22
730416	203	15.40	14.16	0.10	0.10	6.85	6.71	5.13
730416	204	15.94	13.74	0.20	0.16	6.91	6.71	4.00
730416	205	14.44	12.44	0.00	0.10	7.38	7.07	5.61
730416	206	15.56	13.90	0.06	0.10	7.22	7.12	5.13
730416	207	15.90	13.70	0.32	0.30	7.24	7.26	4.16
730416	208	15.00	13.38	0.40	0.40	7.32	7.26	4.00
730416	209	14.90	13.80	0.30	0.62	7.34	5.30	5.13
730416	211	13.68	13.84	1.00	1.00	7.33	4.96	3.52
730416	212	14.30	16.04	0.90	1.90	7.63	7.49	8.33
730416	213	14.70	13.20	1.02	1.00	7.07	7.22	4.00
730416	214	13.60	13.90	0.96	0.90	6.61	6.66	2.08
730416	215	14.88	15.20	1.02	1.04	4.95	5.13	1.60

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
730522	201	21.66	20.80	0.00	0.00	6.65	5.55	19.24
730522	202	20.68	20.52	0.00	0.00	5.38	5.34	6.41
730522	203	22.00	20.94	0.00	0.00	6.94	5.77	29.67
730522	204	21.44	20.18	0.00	0.00	6.15	5.29	5.77
730522	205	21.22	20.20	0.00	0.00	6.43	5.94	8.66
730522	206	20.90	20.38	0.00	0.00	6.14	6.25	4.00
730522	207	20.68	20.68	0.10	0.00	6.22	6.11	4.81
730522	208	20.80	20.50	0.06	0.06	6.24	6.15	3.20
730522	209	20.78	21.20	0.08	0.10	6.12		4.81
730522	211	20.50	20.70	0.20	0.12	5.89	5.97	8.01
730522	212	20.50	20.40	1.10	1.08	6.41	5.99	9.94
730522	213	20.20	20.10	0.34	0.42	6.17	6.27	7.34
730522	214	20.70	20.60	0.84	0.90	5.67	5.59	2.72
730522	215	21.00	21.00	0.78	0.80	5.16	5.04	2.56

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
730618	201	27.88	26.64	0.20	0.18	0.06	5.07	17.64
730618	202	27.50	26.80	0.20	0.22	5.25	5.23	3.20
730618	203	27.74	27.24	0.18	0.10	5.88	5.36	12.83
730618	204	27.54	27.00	0.10	0.26	5.41	5.22	8.01
730618	205	27.00	26.78	0.18	0.22	5.28	5.18	4.33
730618	206	26.60	26.30	0.30	0.22	5.38	5.23	2.72
730618	207	26.40	26.30	0.20	0.22	5.41	5.27	4.00
730618	208	26.20	26.20	0.20	0.20	5.32	5.36	2.40
730618	209	26.22	26.22	0.12	0.20	5.45	5.55	4.33
730618	211	26.22	26.20	0.30	0.30	5.49	6.03	4.33
730618	212	26.24	26.24	0.76	0.68	5.41	4.91	5.61
730618	213	25.60	25.60	0.70	0.70	5.30	5.28	1.76
730618	214	27.00	27.10	0.80	0.84	5.08	5.05	1.60
730618	215	27.44	27.10	1.00	0.90	4.65	4.58	1.60

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
730731	201	28.50	28.00	0.00	0.00	6.57	6.08	20.84
730731	202	28.50	28.00	0.00	0.00	5.77	4.67	10.42
730731	203	28.50	28.50	0.00	0.00	5.96	5.81	14.36
730731	204	28.00	27.50	0.00	0.00	6.22	5.46	13.63
730731	205	28.00	28.00	0.00	0.00	5.38	5.20	2.56
730731	206	28.50	28.00	0.00	0.00	5.64	5.27	3.36
730731	207	28.50	28.00	0.00	1.11	5.24	9.36	2.40
730731	208	28.50	28.00	0.00	1.11	5.52	5.00	1.92
730731	209	28.50	28.00	0.00	2.22	5.47	5.52	2.88
730731	211	28.00	27.50	1.11	2.22	5.38	5.30	3.20
730731	212	28.00	27.50	2.22	3.33	5.66	5.69	4.49
730731	213	28.00	27.50	1.11	2.22	5.16	4.82	4.33
730731	214	27.50	27.00	0.00	0.00	3.88	3.74	2.72
730731	215	27.50	27.00	0.00	0.00	3.76	3.51	3.36

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
731003	200	25.34	24.00	0.32	0.30	5.82	6.22	32.14
731003	201	24.68	24.10	0.30	0.30	6.37	5.06	11.38
731003	202	25.48	24.00	0.50	0.60	5.40	4.78	1.76
731003	203	27.00	25.34	0.30	0.50	5.68	5.30	5.29
731003	204	26.70	24.78	0.34	0.48	5.51	5.47	2.88
731003	205	26.50	25.60	0.56	1.00	6.23	5.60	2.08
731003	206	25.48	24.20	0.76	0.90	5.97	5.70	3.04
731003	207	25.00	24.48	0.70	0.82	5.38	5.52	2.88
731003	208	25.00	24.42	0.68	0.84	5.96	5.54	2.24
731003	209	24.30	24.30	0.72	0.72	5.82	5.83	3.20
731003	211	25.12	24.50	0.60	6.34	5.74	5.70	1.76
731003	212	25.52	24.52	0.92	4.70	5.71	5.78	7.85
731003	213	25.76	24.88	1.80	1.80	5.56	5.36	5.29
731003	214	24.52	24.40	1.06	1.12	5.39	5.26	2.88
731003	215	24.84	24.82	0.00	0.00	4.86	4.61	3.20

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
731107	200	14.80	13.42	0.00	0.00	5.61	6.41	16.51
731107	201	13.50	13.30	0.00	0.00	6.62	5.36	15.39
731107	202	13.82	13.10	0.00	0.00	5.58	4.87	2.72
731107	203	13.30	12.10	0.00	0.00	5.69	5.34	3.68
731107	204	14.60	15.80	0.10	0.20	5.64	5.58	3.20
731107	205	13.40	13.60	0.10	0.34	6.36	5.73	4.33
731107	206	14.00	13.90	0.10	0.46	5.84	5.71	12.99
731107	207	13.12	14.90	0.32	0.46	5.41	5.71	12.34
731107	208	13.50	14.00	0.58	0.84	6.21	5.61	14.11
731107	209	13.12	13.80	0.46	0.72	6.21	6.04	8.49
731107	211	12.32	13.68	0.50	1.82	4.89	5.70	4.00
731107	212	13.40	13.52	1.02	1.96	5.70	5.81	8.82
731107	213	13.00	11.10	2.40	2.34	6.00	5.48	3.84
731107	214	13.40	13.18	1.22	1.48	5.70	5.23	1.44
731107	215	14.34	14.10	0.00	0.00	4.89	4.38	4.00

Appendix I. (continued)

DATE	STA	TEMPS	TEMPB	SALS	SALB	OXYS	OXYB	CHL
731212	200	9.50	9.00	0.00	0.00	7.97	7.65	33.03
731212	201	9.50	9.50	0.55	0.55	7.53	7.73	18.92
731212	202	9.50	8.50	1.10	0.55	7.36	7.28	2.08
731212	203	9.50	9.50	0.55	0.55	7.62	7.47	8.01
731212	204	10.00	9.50	1.10	1.10	7.63	7.35	2.24
731212	205	10.00	9.00	2.10	2.10	7.57	7.63	8.82
731212	206	9.50	9.00	3.25	3.25	7.61	7.27	9.78
731212	207	9.50	8.50	3.25	3.25	7.89	7.74	10.74
731212	208	9.50	9.00	3.25	3.25	7.65	8.32	7.69
731212	209	7.00	9.00	3.25	3.25	7.74	7.40	9.46
731212	211	10.00	9.50	4.30	3.25	7.47	7.37	8.01
731212	212	10.00	9.50	4.30	4.30	7.61	7.57	8.35
731212	213	9.00	10.00	3.25	3.25	7.44	7.49	5.29
731212	214	9.00	8.00	3.25	2.10	7.59	7.34	3.84
731212	215	6.50	7.00	3.25	3.25	7.21	6.84	3.04

Appendix II. Nitrogen and phosphorus data for estuary stations.

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
700915	201	.03	0.70	5.73	4.60	2.20	26.69	26.64	0.55
700915	202	.06	0.65	7.32	7.60	2.57	27.19	20.54	0.70
700915	203	.02	0.54	3.44	3.25	1.70			0.66
700915	204	.03	0.96	9.01	4.30	2.32	25.55	23.61	0.60
700915	205	.00	0.61	4.89	2.57	1.30	21.35	21.35	0.73
700915	206	.02	1.39	3.72	2.33	2.34	18.94	18.94	0.55
700915	207	.02	0.94	6.54	1.95	1.20	22.33	21.35	0.56
700915	208	.02	1.58	7.35	1.98	1.00	23.17	22.33	0.50
700915	209	.02	0.57	3.67	2.34	1.52	22.41	22.41	0.55
700915	210	.27	4.05	5.62	12.10	8.66			5.52
700915	211	.00	0.66	4.38	1.95	1.06	20.80	20.44	0.30
700915	212	.02	1.34	5.13	2.95	0.95	23.68	23.54	0.70
700915	213	.02	1.39	4.93	2.35	0.94	21.82	18.98	0.27
700915	214	.06	0.61	6.11	1.80	0.90			0.27
700915	215	.22	25.53	11.66	2.20	2.00	30.84	30.73	1.00

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
701013	201	.02	0.63	7.49	1.60	0.27	27.00	27.00	0.03
701013	202	.07	6.22	8.11	1.35	0.78	31.28	31.28	0.17
701013	203	.04	26.29	7.85	4.20	3.70			0.27
701013	204	.05	2.07	5.91	1.55	1.03	36.76	34.32	0.09
701013	205		0.58	3.82	2.30	1.70	30.20	25.52	0.04
701013	206	.01	0.29	11.73	1.87	0.27	29.96	29.20	0.05
701013	207	.01	0.46	6.54	1.24	0.41	25.36	25.36	0.10
701013	208	.03	1.14	4.54	1.26	0.40	26.90	26.90	0.05
701013	209	.01	0.30	5.71	1.25	0.39	34.32	31.16	0.05
701013	210	.13	0.73	7.27	5.58	1.30			0.65
701013	211	.03	0.19	5.14	5.00	0.37	31.60	26.40	0.05
701013	212	.00	0.24	5.16	2.05	0.37	32.00	28.88	0.03
701013	213	.01	0.70	6.44	6.20	4.82	25.96	24.40	0.07
701013	214	.03	0.08	8.31	1.21	0.38			0.05
701013	215	.15	1.70	8.69	0.88	0.52	26.76	26.76	6.10

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
701112	201	.09	8.29	13.99	1.10	0.70	37.34	37.34	0.17
701112	202	.23	7.79	24.09	1.94	1.10	40.84	40.45	0.08
701112	203	.02	2.91	7.55	1.55	0.55			0.02
701112	204	.45	6.58	7.97	0.90	0.70	31.21	31.21	0.16
701112	205	.01	2.02	5.19	0.40	0.17	30.26	30.26	0.17
701112	206	.00	1.19	6.43	0.27	0.06	28.55	28.00	0.06
701112	207	.00	0.75	12.87	0.44	0.02	29.36	29.36	0.01
701112	208	.00	0.48	6.89	0.48	0.10	27.77	25.47	0.05
701112	209	.00	0.64	6.74	0.70	0.18	30.92	27.61	0.00
701112	210	.08	7.28	8.18	1.73	1.10			0.17
701112	211	.00	0.36	4.47	0.27	0.14	25.67	25.67	0.00
701112	212	.02	7.07	19.24	2.38	0.14	49.40	48.62	0.00
701112	213	.00		4.68	0.77	0.08			0.00
701112	214	.01	0.51	7.25	0.69	0.27	42.40	28.98	0.00
701112	215	.05	1.47	7.97	0.70	0.42	60.29	58.35	0.17

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
701210	201	.02	1.05	6.39	1.60	0.44	34.90	34.90	0.10
701210	202	.19	17.55	19.80	1.17	0.75	41.08	41.08	0.35
701210	203	.01	0.60	6.44	1.42	1.05			0.05
701210	204	.09	12.37	17.33	1.36	0.75	37.95	37.95	0.25
701210	205	.07	5.11	13.36	0.08	0.44	32.35	32.06	0.10
701210	206	.07	0.87	7.63	0.80	0.44	29.76	29.76	0.10
701210	207	.04	5.07	13.96	1.12	0.74	31.10	31.10	0.12
701210	208	.03	1.63	9.14	0.08	0.75	30.52	29.56	0.11
701210	209	.03	0.94	o6.63	0.80	0.75	24.84	24.19	0.14
701210	210	.11	3.13	6.98	2.40	1.80			0.75
701210	211	.02	1.30	5.60	0.90	0.43	33.50	33.50	0.12
701210	212	.02	0.79	6.96	1.27	0.65	29.56	27.26	0.14
701210	213	.05	0.50	6.76	0.65	0.50	33.98	33.10	0.10
701210	214	.07	0.53	6.75	0.75	0.43			0.14
701210	215	.17	7.91	6.42	1.27	1.08	24.44	24.44	0.38

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710105	201	.11	13.10	3.23	1.60	0.76	27.91	27.84	0.13
710105	202	.24	21.85	9.23	1.40	1.15	28.38	28.02	0.40
710105	203	.05	10.28	7.84	1.40	1.13			0.37
710105	204	.12	10.43	7.30	1.15	0.93	28.38	28.13	0.35
710105	205	.09	8.00	4.48	1.60	1.57	33.96	33.96	0.50
710105	206	.08	5.64	3.67	1.13	0.92	25.70	21.77	0.12
710105	207	.04	3.19	3.78	1.80	1.57	24.81	22.49	0.12
710105	208	.06	2.75	3.40	1.22	0.58	25.70	20.67	0.10
710105	209	.06	2.14	5.94	1.20	0.65	29.20	26.59	0.13
710105	210	.15	6.07	7.03	2.08	1.67			0.75
710105	211	.05	3.64	3.57	1.70	1.42	35.77	23.91	0.11
710105	212	.04	0.73	2.97	1.03	0.70	22.31	15.70	0.12
710105	213	.11	2.14	3.29	1.50	0.98			0.14
710105	214	.08	0.76	3.22	0.98	0.50	25.34	23.02	0.12
710105	215	.22	11.00	6.82	2.52	1.25	45.69	40.69	0.12

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710219	201	.29	45.10	15.38	4.25	2.42			0.95
710219	202	.13	15.68	9.59	0.35	1.00			0.35
710219	203	.60	82.70	22.95	5.65	3.73			1.97
710219	204	.52	63.07	24.41	4.85	3.65			2.20
710219	205	.40	54.84	16.76	3.20	2.00	75.80	83.38	0.95
710219	206	.41	54.46	22.12	3.17	1.95			0.85
710219	207	.23	34.92	7.15	2.00	1.00	55.71	54.57	0.25
710219	208	.27	44.36	14.36	2.20	1.00	63.67	61.39	0.30
710219	209	.13	17.58	11.37	1.25	0.85	48.51	50.40	0.20
710219	211	.17	10.41	4.39	1.25	0.60	30.32	31.83	0.17
710219	212	.14	13.02	10.10	1.65	0.65	17.35	15.16	0.22
710219	213	.16	4.74	4.21	1.10	0.55			0.20
710219	214	.15	11.12	6.61	1.10	0.55			0.10
710219	215	.39	26.80	8.10	1.50	0.09	54.57	56.85	0.10

Appendix II. (Continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710407	201	.24	40.79	9.00	2.35	1.42	64.79	62.72	0.40
710407	202	.18	7.54	6.53	2.20	0.85	44.06	38.11	0.20
710407	203	.27	31.79	8.01	2.40	1.25			0.40
710407	204	.17	28.71	7.01	1.85	1.20	52.80	52.80	0.40
710407	205	.16	24.94	4.50	2.20	1.00	51.61	44.62	0.20
710407	206	.12	24.98	5.92	2.80	1.20	56.77	48.43	0.40
710407	207	.13	35.50	12.56	2.65	1.25	59.55	59.47	0.45
710407	208	.10	35.13	10.26	2.10	1.00	65.90	37.79	0.20
710407	209	.14	37.79	10.24	2.75	1.20	55.58	55.58	0.85
710407	211	.08	26.65	5.49	2.37	0.85	50.81	48.43	0.25
710407	212	.09	23.94	6.22	3.20	0.70	50.02	38.03	0.00
710407	213	.12	15.18	8.90	1.27	0.60			0.20
710407	214	.19	15.07	4.34	1.00	0.45	47.64	42.00	0.05
710407	215	.56	22.62	5.05	1.30	0.70	54.70	54.70	0.25

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710504	201	.17	27.21	4.41	2.90	1.00	32.71	27.75	0.30
710504	202	.12	1.98	8.44	1.10	0.80	21.83	21.83	0.30
710504	203	.20	15.32	5.73	0.80	0.52			0.00
710504	204	.18	1.92	8.86	1.45	1.15	30.47	27.01	0.40
710504	205	.14	7.25	4.32	1.30	1.10	18.90	18.73	0.20
710504	206	.15	10.69	4.92	1.55	1.00	24.04	23.43	0.20
710504	207	.11	13.32	7.07	1.35	1.15	22.70	15.45	0.40
710504	208	.14	16.72	6.78	2.20	1.15	29.08	26.93	0.47
710504	209	.10	17.73	4.53	1.55	0.90	26.50	25.29	0.20
710504	211	.20	23.32	4.65	1.30	1.00	36.85	32.54	0.20
710504	212	.08	14.52	7.32	1.45	0.90	28.83	27.19	0.20
710504	213	.12	5.05	3.94	0.70	0.52			0.10
710504	214	.14	7.97	4.24	0.95	0.60	24.47	16.78	0.30
710504	215		15.39	4.06	1.10	0.70			0.30

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710601	201	.32		10.40	1.75	1.15	29.43	26.41	0.67
710601	202	.23	3.20	11.07	1.35	1.00	20.06	20.06	0.67
710601	203	.24	5.57	8.05	1.55	0.80			0.50
710601	204	.20	6.20	10.00	1.25	0.90	25.72	25.03	0.20
710601	205	.18	9.50	6.12	1.15	0.90	24.25	23.52	0.20
710601	206	.18	8.70	6.35	1.36	1.00	23.95	20.50	0.27
710601	207	.16	9.50	5.85	1.35	0.90	23.52	22.74	0.20
710601	208	.14	10.00	6.65	1.25	0.90	23.26	22.01	0.17
710601	209	.15	9.00	6.55	1.25	0.80	18.12	23.47	0.17
710601	211	.14	8.00	6.95	1.15	0.60	24.60	24.60	0.10
710601	212	.13	9.20	5.90	1.25	0.60	26.97	26.97	0.10
710601	213	.15	6.60	8.52	0.90	0.60			0.10
710601	214	.22	5.10	5.80	0.80	0.51	28.48	26.75	0.10
710601	215	.65	8.00	6.12	0.90	0.60	33.57	33.57	0.10

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710707	201	.09	0.89	6.15	2.16	1.06	20.93	25.89	0.34
710707	202	.33	6.81	13.35	1.78	2.64	24.60	18.68	0.66
710707	203	.11	2.93	17.60	2.44	1.00			0.22
710707	204	.10	2.06	4.25	1.32	0.86	21.79	16.40	0.22
710707	205	.06	3.77	13.55	1.12	0.58	20.06	15.96	0.16
710707	206	.10	1.27	5.30	0.96	1.34	15.88	13.76	0.16
710707	207	.06	0.50	5.80	1.68	0.86	16.57	13.33	0.26
710707	208	.08	0.48	5.30	1.84	0.96	13.59	14.67	0.32
710707	209	.04	0.80	4.95	1.28	0.90	17.69	16.40	0.24
710707	211	.10	0.73	9.75	0.64	1.04	18.34	15.71	0.24
710707	212	.12	3.01	5.10	1.26	0.82	18.55	16.40	0.24
710707	213	.08	0.33	3.60	0.84	0.58			0.14
710707	214	.14	0.41	4.05	0.74	0.56	19.93	16.40	0.18
710707	215	.37	4.73	3.80	0.96	0.68	25.68	27.14	0.22

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710719	201	.11	0.84	5.22	0.94	0.84	23.56	18.94	0.18
710719	202	.25	6.17	10.22	0.97	0.97	23.73	21.49	0.28
710719	203	.07	0.37	5.90	1.34	0.92			0.18
710719	204	.17	4.39	6.59	0.94	0.84	20.11	15.62	0.18
710719	205	.12	0.29	4.81	0.54	0.72	16.65	17.56	0.10
710719	206	.07	0.29	6.04	0.40	0.52	17.65	17.43	0.08
710719	207	.07	0.47	8.18	0.60	0.74	14.32	10.18	0.10
710719	208	.09	0.61	6.95	0.38	0.68	14.84	15.58	0.18
710719	209	.07	0.51	7.63	1.52	0.64	17.99	16.22	0.12
710719	211	.05	0.37	7.18	0.68	0.68	16.48	13.33	0.20
710719	212	.06	0.27	5.09	0.48	0.46	15.27	15.06	0.08
710719	213	.07	0.32	6.72	0.60	0.60			0.08
710719	214	.12	0.26	4.99	0.56	0.56	16.65	17.99	0.18
710719	215	.32	3.01	7.24	0.54	0.60	22.31	24.86	0.14

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
710922	201	.08	0.37	5.99	2.06	0.76	18.21	14.97	0.38
710922	202	.07	0.66	5.72	1.36	0.54	22.52	21.92	0.14
710922	203	.06	0.55	5.31	1.84	1.14			0.36
710922	204	.12	3.60	6.09	1.22	0.84	20.21	20.71	0.24
710922	205	.09	1.35	5.40	1.34	0.68	19.55	17.65	0.30
710922	206	.09	1.17	7.04	1.04	0.66	19.93	18.77	0.30
710922	207	0.05	0.15	4.18	0.94	0.36	16.14	13.68	0.12
710922	208	0.04	0.35	4.04	0.78	0.50	16.83	16.83	0.16
710922	209	0.03	0.29	6.54	1.16	0.58	16.14	15.92	0.04
710922	211	0.05	0.15	4.54	0.80	0.48	16.14	14.32	0.10
710922	212	0.03	0.15	4.95	0.98	0.54	20.41	14.15	0.12
710922	213	0.07	0.47	5.77	1.56	0.44			0.16
710922	214	0.17	0.97	4.77	0.64	0.54	20.28	22.44	0.14
710922	215	0.01	5.41	5.54	2.32	1.10	26.32	28.05	0.38

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
711027	201	0.67	53.89	8.73		1.56	69.91	70.78	0.72
711027	202	0.30	3.97	7.93	1.88	1.58	26.32	22.96	0.64
711027	203	0.90	30.13	20.66	2.24	2.00			1.26
711027	204	0.59	36.63	9.95	1.42	1.16	51.79	47.04	0.54
711027	205	1.15	29.68	19.00	1.36	1.08	48.77	46.61	0.38
711027	206	1.04	29.84	17.38	1.48		48.77	48.33	0.54
711027	207	0.24	6.57	19.76	1.22	0.86	29.69	31.29	0.58
711027	208	0.62	9.99	17.23	1.84	0.56	29.34	29.26	0.14
711027	209	0.52	7.83	35.42	1.08	0.54	29.78	29.78	0.14
711027	211	0.20	5.27	32.39	1.16	0.58	29.56	29.56	0.14
711027	212	0.30	5.74	10.43	1.06	0.28	20.50	22.31	0.14
711027	213	0.52	3.88	14.05	0.76	0.56			0.18
711027	214	1.06	5.40	11.51	0.98	0.64	32.84	32.75	0.16
711027	215	1.54	6.13	21.03	2.20	1.76	23.30	21.36	0.96

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
711129	201	0.27	10.66	33.62	2.74	2.16	41.64	40.48	1.40
711129	202	0.13	6.74		1.36	1.22	28.05	23.82	0.50
711129	203	0.30	11.80	13.79	2.86	2.64			1.68
711129	204	0.24	10.94	10.98	2.24	1.90	31.89	28.44	1.30
711129	205	0.22	10.07	9.85	1.56	1.36	26.67	27.62	0.74
711129	206	0.29	13.57	14.52	2.46	1.36	32.80	30.55	0.90
711129	207	0.35	15.24	9.66	1.88	1.62	36.47	35.60	1.08
711129	208	0.34	15.39	10.56	1.48	1.36	35.30	36.16	0.90
711129	209	0.39	19.17	9.16	1.52	1.34	38.84	40.13	0.90
711129	211	0.24	17.68	7.48	1.20	0.94	36.68	33.23	0.50
711129	212	0.17	16.71	9.17	1.28	0.76	34.95	34.74	0.30
711129	213	0.76	8.66	5.08	1.08	0.76			0.30
711129	214	1.57	7.88	4.35	0.54		37.11	36.90	0.26
711129	215	2.18	3.85	4.25	1.88	1.58	32.80	27.96	0.70

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
711228	201	0.43		14.95	3.10	2.84	33.66	38.84	1.80
711228	202	0.19	12.90	9.90	2.36	1.90	34.52	34.52	1.10
711228	203	0.36	15.96	12.90	3.60	2.80			2.40
711228	204	0.34	15.96	10.31	2.04	1.86	31.50	26.97	1.20
711228	205	0.23	12.04	11.27	2.30	1.56	30.21	28.91	1.10
711228	206	0.17	9.06	9.90	2.24	1.64	26.75	27.62	1.00
711228	207	0.19	13.37	12.72	2.50	1.82	31.07	25.46	1.10
711228	208	0.18	14.84	9.22	2.04	1.74	28.48	23.09	0.90
711228	209	0.17	6.73	8.54	1.94	1.46	27.62	29.65	0.70
711228	211	0.14	15.75	9.97	2.84	1.14	29.34	29.34	0.50
711228	212	0.17	18.08	6.72	1.40	0.90	27.83	24.60	0.60
711228	213	0.34	14.00	8.72	1.30	1.00			0.40
711228	214		9.36	7.81	1.10	0.94	16.83	21.14	0.30
711228	215		4.89	7.18	1.40	1.20	22.65	21.79	0.40

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
720131	201	0.58	25.24	16.63	4.40	4.00	19.85	19.29	2.50
720131	202	0.15	11.39	7.36	1.90	1.60	18.34	16.83	0.62
720131	203	1.99	22.44	13.72	3.60	3.30			2.00
720131	204	1.11	19.85	13.95	3.20	2.82	23.65	25.37	1.56
720131	205	0.63	20.71	16.08	2.70	2.20	31.42	28.14	1.20
720131	206	2.26	22.22	13.81	2.40	2.20	29.34	32.71	1.40
720131	207	2.24	20.67	16.58	2.74	2.60	37.11	37.11	1.46
720131	208	3.17	19.42	19.90	2.70	2.30	33.44	31.50	1.32
720131	209	1.29	20.24	15.08	2.06	1.90	26.67	28.26	1.00
720131	211	0.31	17.26	9.63	1.90	1.76	32.80	30.42	0.76
720131	212	0.31	14.50	8.04	1.96	1.44	28.26	33.88	0.50
720131	213	0.63	13.16	5.54	1.14	1.14			0.48
720131	214	1.24	9.38	3.22	1.36	1.16	23.22	28.91	0.48
720131	215	1.32	6.30	5.72	1.60	1.60	13.59	14.67	0.86

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
720228	201	0.25	21.25	10.31	2.50	1.92	37.98	42.72	0.80
720228	202	0.12	4.20	13.77	1.80	1.04	17.78	16.87	0.36
720228	203	0.32	17.65	12.49	3.30	2.26			1.06
720228	204	0.29	28.87	12.54	3.22	2.56	44.88	38.62	1.30
720228	205	0.16	17.65	6.04	2.88	1.86	30.21	29.56	1.00
720228	206	0.18	19.81	6.04	2.92	1.76	35.30	30.42	1.10
720228	207	0.22	15.49	10.31	2.72	2.28	38.83	38.41	1.30
720228	208	0.35	19.85	7.22	2.96	2.24	37.11	39.92	1.46
720228	209	0.21	18.34	5.59	4.04	2.20	38.93	38.32	1.34
720228	211	0.20	20.06	10.31	3.36	2.16	35.39	37.54	1.12
720228	212	0.15	18.99	5.54	3.04	1.74	37.89	36.25	0.90
720228	213	0.06	10.46	13.49	1.70	1.34			0.40
720228	214	0.03	10.72	6.45	1.46	0.88	27.19	28.91	0.30
720228	215	0.06	10.35	11.49	1.26	1.06	25.68		0.28

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
720405	201	0.18	14.19	5.59	2.26	1.18	33.23	27.62	0.34
720405	202	0.08	0.56	3.68	2.46	0.66	19.63	13.59	0.38
720405	203	0.15	6.94	5.54	2.18	1.04			0.36
720405	204	0.12	2.33	5.77	1.44	0.86	17.04	19.42	0.32
720405	205	0.12	3.66	4.81	1.34	0.96	20.06	18.99	0.36
720405	206	0.09	3.64	4.68	2.02	1.12	23.30	18.99	0.32
720405	207	0.13	5.86	4.40	1.68	0.86	20.37	19.42	0.36
720405	208	0.23	11.78	7.45	2.84	1.28	33.23	29.34	0.46
720405	209	0.16	8.89	4.18	2.28	1.06	24.29	21.58	0.38
720405	211	0.18	11.86	3.81	3.14	1.26	30.98	27.19	0.46
720405	212	0.12	16.16	5.27	3.06	1.34	34.09	31.50	0.54
720405	213	0.02	14.93	5.45	2.04	1.00			0.36
720405	214	0.02	11.91	5.09	1.32	0.76	35.60	34.09	0.28
720405	215	0.02	8.41	4.18	1.50	0.94	23.95		0.38

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
720605	201	0.03	3.94	5.38	2.64	1.20	29.50	25.25	0.80
720605	202	0.03	7.70	4.35	1.80	1.34	26.10	24.40	0.34
720605	203	0.01		3.40	2.12	1.30			0.24
720605	204	0.04	5.18	6.00	1.70	1.20	27.40	25.70	0.28
720605	205	0.02	3.19	5.45	1.44	1.10	17.25	17.10	0.20
720605	206	0.02	4.94	16.75	1.40	1.30	20.55	20.50	0.24
720605	207	0.02	5.99	6.20	1.76	1.46	23.75	18.10	0.36
720605	208	0.02	2.98	4.66	1.50	1.10	15.00	14.75	0.26
720605	209	0.01	0.10	5.31	1.78	1.32	16.40	14.75	0.28
720605	211	0.02	3.44	5.48	1.60	1.30	22.10	18.10	0.32
720605	212	0.12	3.44	6.27	1.64	1.14	23.90	23.10	0.28
720605	213	0.04	9.97	4.00	1.50	0.96			0.28
720605	214	0.06	13.45	5.41	1.20	0.80	36.25		0.24
720605	215	0.09	10.29	3.71	1.18	0.84	33.75	21.25	0.24

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
720717	201	0.08	0.14	4.86	1.76	0.96	22.00	18.50	0.30
720717	202	0.17	5.94	3.52	1.64	0.90	23.00	27.25	0.50
720717	203	0.07	0.13	3.56	3.96	1.10			0.02
720717	204	0.07	0.19	1.12	2.00	0.54	21.90	18.00	0.20
720717	205	0.08	0.83	2.53	1.10	0.80	17.50	12.00	0.20
720717	206	0.05	0.12	2.63	1.10	0.54	14.25	12.75	0.14
720717	207	0.07	0.01	2.60	1.10	0.70	14.50	15.00	0.14
720717	208	0.07	0.01	3.28	0.86	0.70	17.25	15.00	0.14
720717	209	0.05	0.15	1.53	1.60	0.80	16.50		0.20
720717	211	0.05	0.03	3.49	0.84	0.50	11.60	16.50	0.20
720717	212	0.05	0.37	3.53	0.80	0.54	14.95	14.40	0.30
720717	213	0.16	2.60	2.48	1.10	0.70			0.16
720717	214	0.05	0.44	4.01	0.96	1.10	32.00	12.65	0.16
720717	215	0.05	8.65	3.39	0.96	0.90	29.95	29.95	0.36

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
720831	201	1.57	2.47	11.20	2.64	1.46	17.65	16.70	0.56
720831	202	0.34	5.57	5.15	2.00	1.06	22.00	6.35	0.44
720831	203	0.16	2.35	6.73	2.04	1.28			0.38
720831	204	0.22	3.50	5.63	1.72	1.04	15.70	14.70	0.54
720831	205	0.57	0.70	8.31	1.20	0.54	22.00	21.50	0.20
720831	206	0.17	0.21	4.77	1.42	0.46	25.60	25.60	0.14
720831	207	0.56	1.50	5.11	2.04	1.20	21.30	21.30	0.28
720831	208	1.06	1.69	4.74	1.64	0.50	22.57	22.57	0.28
720831	209	0.21	0.70	4.98	3.94	2.38	14.75	12.70	1.54
720831	211	0.11	3.32	3.50	1.68	0.84	42.95	35.60	0.26
720831	212	0.27	1.26	3.22	1.82	0.54	14.45	12.10	0.12
720831	213	0.21	5.50	4.26	3.25	0.56			0.14
720831	214	0.72	7.60	7.42	1.32	0.94			0.38

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
721003	201	0.12	1.37	3.16	2.30	1.66	21.25	19.50	0.02
721003	202	0.14	5.07	4.81	1.96	1.66	21.85	21.85	0.40
721003	203	0.16	2.32	2.30	1.90	1.56			0.24
721003	204	0.17	2.82	9.48	1.96	1.60	23.37	23.37	0.30
721003	205	0.06	0.79	2.68	1.54	1.16	10.25	9.65	0.24
721003	206	0.04	0.18	3.67	1.32	0.96	10.70	8.75	0.20
721003	207	0.07	2.20	3.19	1.40	1.12	10.20	10.20	0.20
721003	208	0.08	1.65	2.98	1.50	1.18	13.40	11.75	0.30
721003	209	0.07	1.47	4.53	1.70	1.06	22.25	20.50	0.30
721003	211	0.06	0.57	2.98	1.70	1.28	14.25	10.40	0.30
721003	212	0.03	0.15	1.99	1.90	1.04	16.17	16.17	0.24
721003	213	0.03	1.29	3.53	1.86	1.30			0.20
721003	214	0.05	5.80	11.43	1.76	1.30	21.35	20.75	0.20
721003	215	0.04	4.47	3.19	2.00	1.30	24.75	23.25	0.36

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
721113	201	0.17	6.05	4.81	2.26	1.58	24.50	22.00	0.76
721113	202	0.12	6.45	8.86	1.84	1.52	20.00	19.50	0.70
721113	203	0.18	3.37	6.87	2.06	1.48			0.54
721113	204	0.14	10.62	7.11	1.86	1.54	19.56	19.56	0.74
721113	205	0.12	1.95	2.40	0.88	0.78	12.25	10.75	0.24
721113	206	0.07	0.15	3.53	0.72	0.64	9.10	8.00	0.10
721113	207	0.12	3.47	7.11	0.86	0.66	19.50	14.50	0.20
721113	208	0.06	0.37	3.53	0.86	0.64	9.12	9.12	0.12
721113	209	0.06	0.36	2.85	0.86	0.54	11.25	10.00	0.10
721113	211	0.08	0.52	4.05	0.98	0.68	12.40	11.75	0.10
721113	212	0.05	0.18	3.16	0.88	0.56	16.75	13.00	0.10
721113	213	0.09	1.38	3.91	0.90	0.36			0.10
721113	214	0.06	3.67	3.67	0.90	0.56	19.35	14.25	0.22
721113	215	0.06	3.42	4.22	0.98	0.82	18.25	16.80	0.10

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
721212	201	0.19	5.20	5.66	2.14	1.94	12.50	12.50	1.04
721212	202	0.10	5.20	3.60	1.60	0.96	13.85	13.75	0.46
721212	203	0.23	6.97	5.22	2.46	2.18			1.42
721212	204	0.16	8.97	4.29	1.70	1.64	19.87	19.87	0.96
721212	205	0.16	7.60	4.94	1.50	1.38	26.65	25.40	0.86
721212	206	0.18	5.87	6.52	2.30	1.86	26.05	26.05	1.28
721212	207	0.17	6.55	6.87	2.12	1.66	22.50	22.40	1.10
721212	208	0.12	4.20	5.70	1.52	1.24	17.85	17.30	0.76
721212	209	0.10	4.32	3.60	1.34	0.98	18.52	18.52	0.26
721212	211	0.10	5.25	4.98	1.46	1.06	19.10	18.65	0.48
721212	212	0.07	1.42	3.77	1.04	0.64	18.40	18.25	0.10
721212	213	0.12	0.56	2.74	0.76	0.50			0.28
721212	214	0.07	4.70	3.60	0.68	0.66	23.10	15.60	0.34
721212	215	0.05	4.07	5.94	1.26	0.76	17.75	16.65	0.34

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
730312	201	0.21	25.00	7.97	2.64	1.90	41.00	40.00	0.50
730312	202	0.16	11.87	5.87	2.54	1.50			0.42
730312	203	0.22	17.75	5.94	2.72	1.96			0.46
730312	204	0.19	11.05	4.39	2.08	1.26	23.25	23.25	0.40
730312	205	0.16	2.50	3.53	1.72	1.16	27.65	17.90	0.30
730312	206	0.17	13.55	9.68	1.92	1.46	30.50	26.75	0.40
730312	207	0.25	4.67	7.66		2.04	21.35	17.50	0.56
730312	208	0.20	16.05	6.49	2.02	1.38	35.50	33.00	0.56
730312	209	0.20	4.95	9.89	1.72	1.48	33.75	32.65	0.48
730312	211	0.21	8.50	5.97	1.84	1.40	30.75	30.75	0.46
730312	212	0.17	10.62	6.21	1.96	1.40	30.50	24.00	0.40
730312	213				1.44	0.96			0.30
730312	214	0.16	4.70	4.12	1.34	0.70	35.00	32.50	0.26
730312	215	0.16	2.95	2.95	1.30	0.60	23.75	13.05	0.26

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
730416	201	0.22	21.65	8.93	2.80	1.80	34.50	30.60	0.86
730416	202	0.05	0.42	3.09	1.98	1.16	18.55	14.60	0.28
730416	203	0.23	14.87	8.59	2.50	1.88			1.04
730416	204	0.16	16.00	6.45	2.26	1.90	20.50	19.85	0.70
730416	205	0.18	12.00	4.05	2.14	1.46	24.40	24.00	0.74
730416	206	0.13	12.50	6.70	2.26	1.64	26.50	26.25	0.66
730416	207	0.15	17.00	3.67	2.66	1.78	32.45	24.50	0.86
730416	208	0.11	17.00	2.50	2.66	1.66	31.90	29.40	0.76
730416	209	0.11	18.00	4.12	2.64	1.66	30.00	27.40	0.76
730416	211	0.09	15.55	2.74	2.16	1.58	24.75	24.10	0.66
730416	212	0.08	15.37	2.40	2.08	1.18	28.60	22.50	0.46
730416	213	0.17	11.20	3.50	1.36	0.86			0.34
730416	214	0.30	7.75	2.92	1.58	0.70	25.90	19.00	0.28
730416	215	0.20	4.57	4.63	1.50	0.86	30.90	26.90	0.36

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
730522	201	0.18	4.25	8.59	1.84	0.92	25.90	20.75	0.16
730522	202	0.21	4.37	6.70	1.32	0.66	26.00	25.25	0.16
730522	203	0.15	0.88	5.75	2.10	0.94			0.16
730522	204	0.17	7.75	7.83	1.74	0.86	24.95		0.18
730522	205	0.14	1.19	5.66	0.96	0.56	17.15	16.75	0.06
730522	206	0.11	2.87	4.39	0.96	0.70	21.45	16.95	0.08
730522	207	0.12	1.27	5.49	1.26	0.86	17.10	16.45	0.14
730522	208	0.14	3.37	5.32	1.26	0.84	19.60	15.50	0.06
730522	209	0.15	3.87	5.77	1.44	0.96	24.75	21.40	0.06
730522	211	0.10	1.51	6.08	1.74	0.84	21.60		0.04
730522	212	0.07	2.12	9.34	1.34	0.50	27.45	25.25	0.04
730522	213	0.18	5.52	6.25	1.24	0.58			0.04
730522	214	0.31	6.37	6.45	1.50	0.54	22.60	20.50	0.04
730522	215	0.50	4.62	5.80	1.30	0.74	17.80	13.80	0.04

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
730618	201	0.10	0.55	3.95	2.64	1.26	20.60	14.25	0.28
730618	202	0.16	3.50	6.32	1.96	1.64	20.75	18.00	0.66
730618	203	0.10	1.37	2.68	2.06	1.12			0.34
730618	204	0.16	3.22	8.51	1.76	1.08	18.50	16.25	0.36
730618	205	0.09	3.00	2.13	1.90	1.12	16.00	11.30	0.24
730618	206	0.10	2.45	4.22	1.26	0.94	20.90	17.50	0.22
730618	207	0.07	2.17	2.98	2.36	1.90	17.00	12.20	0.52
730618	208	0.07	2.37	2.88	1.56	1.14	16.35	10.10	0.26
730618	209	0.06	0.78	3.53	2.06	1.54	18.45	15.60	0.54
730618	211	0.07	2.75	2.98	2.14	1.64	17.75	14.00	0.66
730618	212	0.05	0.16	7.73	1.36	0.80	18.15	13.60	0.16
730618	213	0.04	3.00	4.91	1.30	0.94			0.14
730618	214	0.04	3.70	3.64	1.36	0.76	24.50	24.40	0.14
730618	215	0.05	7.37	6.80	1.20	0.80	27.40	25.40	0.18

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
730731	201	0.05	0.22	6.15	1.74	0.86	25.45		0.34
730731	202	0.14	2.57	3.77	1.68	0.94	19.75	19.40	0.38
730731	203	0.07	0.74	11.95	1.94	0.94			0.38
730731	204	0.06	0.25	2.68	1.64	0.78	15.25	10.95	0.32
730731	205	0.06	0.44	9.34	0.96	0.64	13.75	13.60	0.22
730731	206	0.04	0.67	15.42	0.88	0.52	27.00	27.00	0.22
730731	207	0.06	0.38	3.67	1.46	1.04	20.40	20.00	0.24
730731	208	0.05	0.35	7.00	1.46	0.90	17.85	10.40	0.16
730731	209	0.05	0.31	6.87	1.34	0.92	12.35	9.85	0.22
730731	211	0.05	0.07	3.71	1.26	0.96	28.00	26.95	0.26
730731	212	0.05	0.19	4.39	0.92	0.66	11.60	11.25	0.24
730731	213	0.05	4.12	9.62	0.86	0.50			0.16
730731	214	0.05	7.42	2.16	0.86	0.64	17.35	15.90	0.16
730731	215	0.05	1.37	5.90	1.46	0.64	19.62	19.62	0.16

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
731003	200	0.14	0.26	4.19	2.34	0.66			0.16
731003	201	0.23	1.28	3.67	1.30	0.64	19.40	15.60	0.16
731003	202	0.17	3.17	10.72	1.10	0.66	20.00	14.25	0.36
731003	203	0.18	1.82	6.76	1.34	0.64			0.36
731003	204	0.14	2.16	4.19	1.46	0.70	27.65	27.35	0.34
731003	205	0.14	1.90	7.14	0.86	0.60	16.42	16.42	0.18
731003	206	0.14	1.74	5.77	0.98	0.56	14.12	14.12	0.16
731003	207	0.14	0.17	3.53	1.04	0.50	11.50	11.50	0.16
731003	208	0.13	0.85	2.50	0.96	0.54	17.85	16.85	0.16
731003	209	0.11	0.43	2.85	1.14	0.54	14.60	13.20	0.30
731003	211	0.15	1.18	3.43	1.04	0.56	16.57	13.37	0.18
731003	212	0.10	0.20	3.36	1.20	0.44	23.25	17.10	0.24
731003	213	0.15	2.22	16.49	1.18	0.44			0.20
731003	214	0.15	4.07	3.02	0.96	0.46	24.40	22.40	0.20
731003	215	0.15	6.00	4.91	1.12	0.70	26.90	24.00	0.24

Appendix II. (Continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
731107	200	0.06	0.40	2.54	1.60	0.80			0.26
731107	201	0.06	0.32	4.05	1.34	0.64	19.00	14.60	0.28
731107	202	0.17	7.25	9.00	1.74	1.24	29.25	25.45	0.80
731107	203	0.13	6.80	5.78	1.36	1.00			0.36
731107	204	0.13	6.17	7.62	1.24	0.84	24.05	24.05	0.46
731107	205	0.14	5.04	1.37	0.94	0.60	24.55	24.55	0.26
731107	206	0.11	3.30	3.26	1.34	0.56	18.50	17.15	0.26
731107	207	0.14	3.87	4.05	1.36	0.70	23.25	22.75	0.24
731107	208	0.11	3.12	3.19	0.88	0.78	17.35	17.35	0.34
731107	209	0.09	3.17	3.02	0.96	0.58	15.65	15.65	0.26
731107	211	0.08	1.55	3.43	1.18	0.64	17.70	15.25	0.34
731107	212	0.07	0.32	3.09	0.96	0.44	17.65	14.35	0.28
731107	213	0.07	2.95	4.53	0.90	0.62			0.24
731107	214	0.07	6.17	1.61	0.70	0.48	29.2[illegible]	26.75	0.31
731107	215	0.07	5.55	3.26	0.80	0.52	22.40	22.10	0.34

Appendix II. (continued)

DATE	STA	NO2	NO3	NH4	TUP	TFP	TUN	TFN	RP
731212	200	0.16	0.72	7.35	1.56	0.36			0.26
731212	201	0.10	0.43	3.02	1.36	0.46	19.50	15.15	0.32
731212	202	0.20	8.50	10.03	1.40	1.00	28.00	24.75	0.66
731212	203	0.14	5.70	8.76	1.50	0.50			0.26
731212	204	0.19	6.80	4.98	1.42	0.70	23.15	23.15	0.42
731212	205	0.12	3.20	4.70	1.30	0.62	19.55	19.55	0.26
731212	206	0.14	3.07	5.08	1.56	0.60	24.00	21.10	0.16
731212	207	0.12	1.75	3.50	1.38	0.56	19.12	19.12	0.14
731212	208	0.14	2.32	6.18	1.46	0.52		21.50	0.26
731212	209	0.13	0.88	6.70	1.54	0.94	15.25	15.25	0.40
731212	211	0.12	1.00	4.05	1.52	0.62	14.85	13.35	0.40
731212	212	0.10	0.50	3.36	2.06	0.70	22.45	18.10	0.46
731212	213	0.16	2.95	3.26	0.94	0.46			0.36
731212	214	0.16	5.55	3.19	1.54	0.56	20.60	17.45	0.26
731212	215	0.21	6.07	4.22	2.44	0.86	26.50	26.40	0.74