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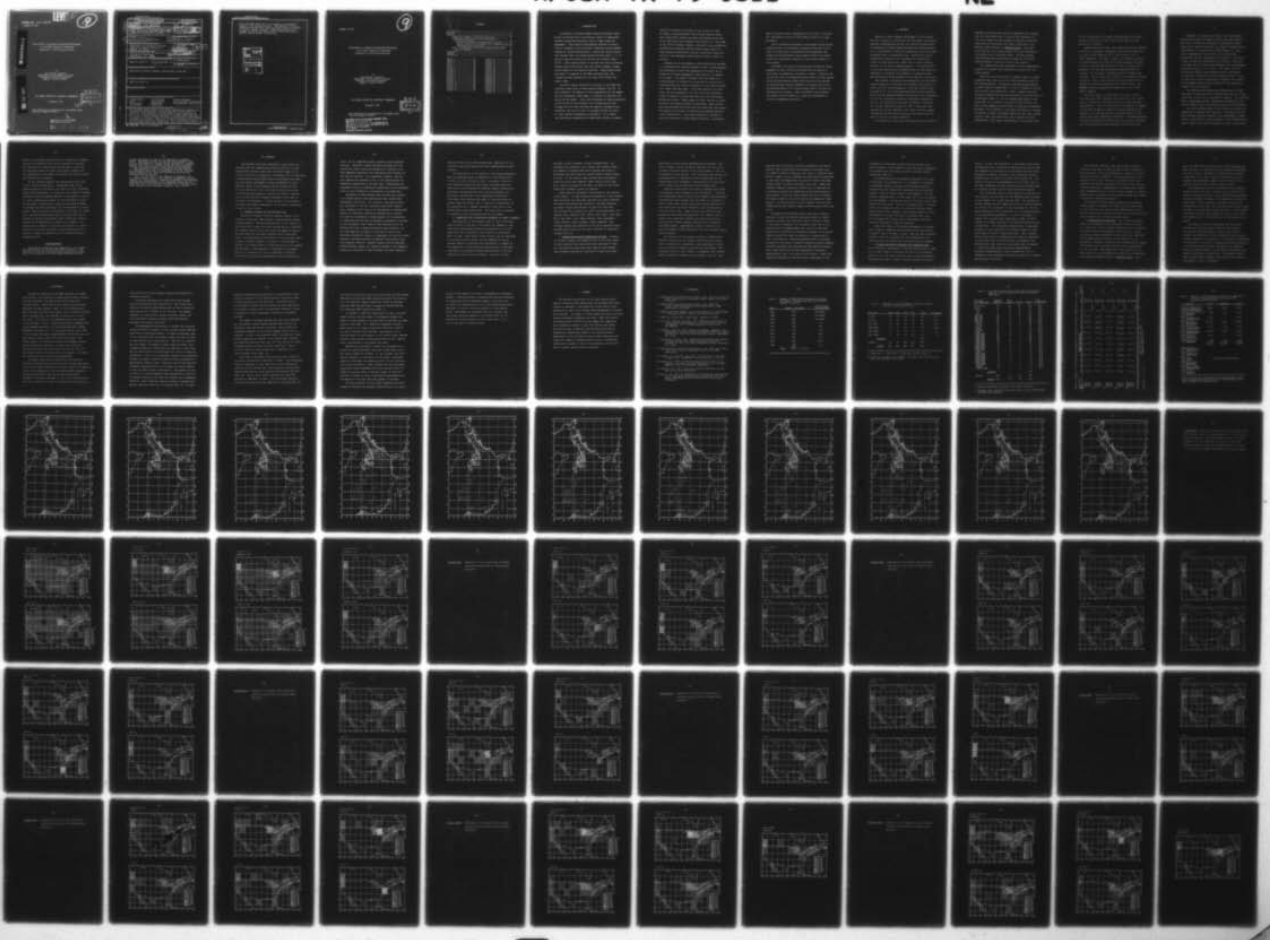

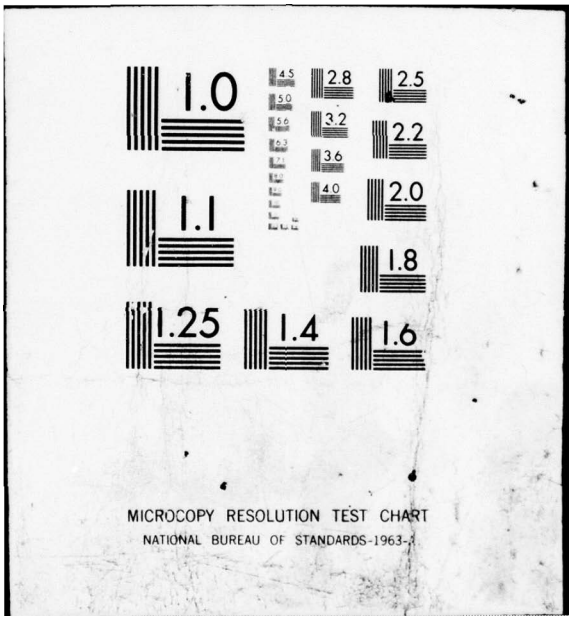
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Development of Computer-Generated Phenograms to Forecast Regional Conditions Hazardous to Low-Flying Aircraft

by

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The seasonal distribution of all North American gull species as derived from banding data and Christmas Bird Count reports is presented. The proportion of each month's gull population is shown for 6° square Zones designated by latitude and longitude. The number of birds present per Zone is plotted therein according to Quadrats (=¼ Zone). USAF bird strikes occurring during 1974-1977 also are mapped for comparison. This preliminary summary of gull distribution and strike data can be used to identify....

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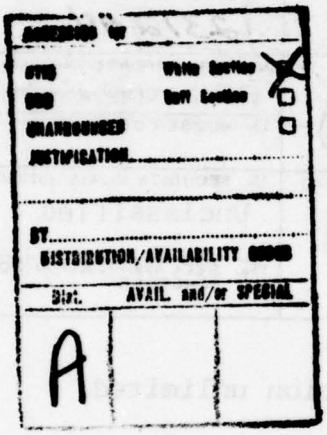
when and where gulls may be presenting a significant hazard to low-flying aircraft. Application of the information during flight planning could reduce the number of strikes caused by gulls. Continuing studies will attempt to refine the application of such bird data to predict hazard levels to aircraft.



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Development of Computer-Generated Phenograms to Forecast Regional Conditions Hazardous to Low-Flying Aircraft

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I. INTRODUCTION

Collisions or strikes between birds and aircraft occur across the United States and annually result in significant monetary losses and noteworthy risk to flight crews and passengers. High speed turbine-powered aircraft are particularly vulnerable to bird strikes, especially during takeoff, landing or low-altitude missions. During the 10-year period 1967 through 1976, the United States Air Force (Ref. 1, 2, 3) annually reported between 322 and 466 bird strikes (mean = 372.4). These figures (Table 1) include only those collisions between birds and aircraft that were severe enough to necessitate repairs to the aircraft involved. Unpublished strike data (Ref. 4) supplied by the USAF indicated that 1142 strikes had been reported for the years 1974 through 1977 (mean = 286).

The bird strikes occurred at a variety of altitudes and involved a wide array of avian species (Tables 2 and 3). In many instances, the species of bird responsible for the damage was not determined, which makes it difficult to describe the nature of the hazard. Gulls were documented as being responsible for 29 (4.7%) of the incidents that occurred during 1974 through 1977 for which altitude and species information are available, and for 53 of the 170 strikes (31.2%) for which at least species information is available. It is likely that gulls were responsible for additional strikes as several

species are seasonally abundant in the vicinity of many Air Bases or along potential low-altitude mission routes. The bird/aircraft problem is widely distributed across the nation and across the calendar as well (Table 4). About 80% of the 1974-77 strikes, however, occurred in the southeastern (36.5%) and southwestern (43.1%) United States (Table 4). These regions coincide with regions of high gull concentrations but also represent areas wherein aircraft traffic is heaviest.

Because of the seriousness of the bird/aircraft problem, it is desirable for mission planners to have a system whereby the occurrence of birds most hazardous to aircraft can be predicted for large geographical areas and for all seasons of the year. This report discusses the first phase of a study designed to forecast the occurrence of regional gull concentrations that could be hazardous to low-flying aircraft (i.e. under 2500 feet AGL). Gulls were selected for study since they are considered to be one of the most hazardous groups of species occurring near many U.S. Air Force Bases across the country. Other groups of birds, such as vultures, represent the primary problem at some Bases. Band recovery data and Christmas Bird Count data for gulls were used during this phase of the project to describe the seasonal patterns of gull distribution. Continuing studies will attempt to verify the accuracy of these seasonal patterns, incorporate

data for species poorly represented at this time in the data set, and predict levels of risk caused by gulls at or near Air Bases.

Use of information provided in this report during flight scheduling will not eliminate the hazard birds pose to aircraft, but when used in conjunction with procedures that reduce the attractiveness of Air Bases to gulls, the result should be a significant reduction in the annual number of bird strikes.

Eventually the type of distributional information being prepared for gulls should be provided for all species of birds that are frequently involved in strikes. Incentive for use of this type of information should result from the savings in dollars and possibly human lives that could be realized by avoiding heavy mission schedules in regions such as the SE and SW portions of the United States (Table 1) when bird populations are highest. Such a procedure could maintain the number of bird strikes at a level more acceptable to Air Force commanders and pilots.

II. METHODS

Because of their frequent involvement in bird strikes and their frequency of occurrence near Air Bases, gulls were selected as appropriate subjects for testing the feasibility of attempting to predict where and when bird concentrations will be high enough to raise the probability of a bird strike beyond the level of acceptable risk. Initially all gulls, regardless of species, were considered as a group since flocks of mixed species are common and the threat posed to aircraft is not usually species-specific. The distribution of each gull species may be examined later if that degree of resolution is revealed to be important in predicting gull distribution and strike probabilities at specific localities.

Two sources of data were used extensively at this initial stage of analysis to determine the seasonal distribution of gulls over most of North America. Bird band recovery data provided by the U.S. Fish and Wildlife Service Bird Banding Office and the Canadian Wildlife Service were most representative of all seasons and served as the primary information source. The banding data analyzed included all recoveries ($n = 74,255$) reported through July 1977. These data were examined as one set composed of all years for which banding information was available, and also on an annual basis for each of the last six years (1972-77).

Christmas Bird Count data accumulated during portions of

December and January were used for comparison with banding data for these months and to provide some indication of the actual number of gulls present at specific localities. These data were extracted from reports published by the National Audubon Society in American Birds. Christmas Count data for 1972 through January 1977 were analyzed as a group and also on an annual basis. The data gleened from Christmas Bird Counts from all parts of the United States amounted to about 9.5 million gull reports.

The combined data sets represent the most comprehensive inventory of seasonal gull populations available for the United States.

Both data sets were stored on computer tape in a format resembling that used by the U.S. Fish and Wildlife Service Bird Banding Office. Preliminary analysis was performed by a unique computer program (Ref. 5) that is capable of sorting and plotting large quantities of data. Computer data processing of banding data has been described by Cowardin (Ref. 6) and Davenport (Ref. 7), but the program developed for this study (Ref. 5) is unique in the kind of data listing, the kind of data mapping, and the kinds of statistical procedures provided. It is possible to sort data according to a variety of interest subjects, including species of bird, age, banding locality, date, age within date, and a variety of other combinations. This report concentrates on the results from

the entire data sets for banding and Christmas Count being sorted on the basis of month, and in some cases, by year and month of recovery.

Besides sorting the data, the computer plots each recovery according to geographic coordinates (latitude and longitude) on a map of North America (19^{o} to 59^{o}N latitude; 52^{o} to 125^{o}W longitude). The map is a Miller cylindrical projection (a modified Mercator projection) and was prepared from maps 6 and 7 in the Area Outline Series of the U.S. Army Corps of Engineers. On this map the spacing between meridians is constant, but the spacing between parallels increases with latitude. This is taken into account in the computer plotting of points. Great circle distances also were taken into consideration during the plotting of all locality data. The FORTRAN computer program was developed and run on an IBM 360/67 computer.

Each gull report is positioned on the map to within 41.4 miles (66.7 km) longitude, and from 47.0 to 34.1 miles (75.6 to 54.9 km) of latitude (from low to high latitudes, respectively). This is as accurate as the computer is capable of plotting the data on a map of this scale because of the spacing of the computer printer (10 characters/in of horizontal line, and 6 lines/inch vertically). Increased plotting accuracy is possible on regional maps of any area of interest but this necessitates new programming for each map scale.

Subsequent to computer processing, the investigators manually calculated the number of gulls that were reported each month in what were designated as geographical Zones. These are 6^{o} square blocks that are serially arranged across North America in checker board fashion (Figure 1). Each Zone is designated by two letters, one for each axis. Latitudinal rows are indicated by A' through G', and longitudinal columns are represented by A through M. Each Zone is divided into four equal-sized Quadrats that are designated within each Zone as 1, 2, 3 and 4. The number of gulls reported per Quadrat was determined as well, and depicts the relative distribution of gulls within each Zone. Both of these sorts could be performed by computer, but intially the programming effort would outweigh the time required to conduct the sorts manually.

The numerical and proportional banding data for Zones were used to graph and map the seasonal distribution of band recoveries for all gulls, regardless of species. The resulting maps or phenograms provide a generalized impression of the monthly change in gull distribution across the United States.

For use in determination of risk levels to aircraft and comparison of seasonal gull densities, the banding recovery data for each Zone was converted to the percentage it represented of each month's total recoveries. This information is used to depict the relative abundance of gulls in each Zone.

The actual number of recoveries reported for each Quadrat was retained and plotted on maps for each month. This procedure provides some indication of the intrazonal variations in distribution that occur because of differences in gull habitat quality. Graphs were prepared for each Zone having 0.2% or higher of the total gull recoveries. Each graph depicts the proportion of all recoveries reported in a particular Zone per month as well as the proportion of each Zone's monthly total that was reported per Quadrat.

For the purpose of this report, no attempt was made to interpret gull distribution in detail beyond that provided in the various maps and graphs. The level of analysis is designed to be applicable in the decision-making processes associated with reducing the number of gull/aircraft collisions rather than contributing to answering basic scientific questions about gull distribution. The graphics included are envisioned as providing a band of information from which flight planners and others may select blocks of data pertaining to specific areas (i.e. Zones) of interest that may influence individual planning decisions about routes in relation to time.

In addition, analysis was begun on several other forms of gull data, singly and in combination with the aforementioned types. These included the results of breeding bird surveys, solicited regional gull reports, wildlife refuge seasonal data,

published data on gull distribution, and data obtained during site visits. After comparing the accuracy of population estimates based on these data types, singly and/or in combination, it will be possible to select the most appropriate data set for use in forecasting gull densities potentially hazardous to aircraft. Each data set is tabulated according to the computer card format used for banding data. It is then stored on magnetic computer tape for later analysis. Presently our data bank includes about 15 million gull records. This aspect of the investigation will be elaborated upon during the second phase of the project (i.e. 1978-79).

U.S. Air Force data on bird strikes were solicited for the years 1974-77. These data can be used to compare the seasonal density of gulls in each Zone with the frequency of bird strikes in that Zone. Two levels of analysis were conducted: the first simply summarizes the frequency of strikes by gulls and non-gulls according to elevation (Table 3) at the time the strike occurred; the second depicts the distribution of strikes within the various Zones (Figure 32). The available strike information is inadequate for accurate prediction of hazard levels but a direct comparison of gull and strike distributions indicate the value of being able to determine where and when gulls will occur and consequently where risks to low-flying aircraft may be highest. More extensive use of the existing data for predicting actual risk levels is not feasible at this time because (1) about

85.1% of the strikes involved birds of unreported or unknown species; (2) important data such as location or altitude were missing from reports which reduced their suitability for identifying where and when gulls posed a hazard; and (3) information on the number of aircraft and missions within each Zone are not available.

Of the instances wherein the colliding bird was identified, 31.2% involved gulls. Undoubtedly some of the "unknown species" were gulls, but there is no way of knowing exactly what proportion. By using the total number of strikes involving gulls and unknown species, it is possible to arrive at a very conservative estimate of the risk posed by gulls in each Zone. Procedures for using the gull data provided for predicting strike potential will be discussed in a future report. Once key areas are identified on the basis of strike data, the gull distributional data for those Zones can be plotted on regional maps having larger scales and critical periods can be examined more closely (e.g. weekly). Increasing the resolution of analysis would permit the determination of just how far mission routes would have to be shifted to reduce the probability of a strike to within an acceptable level.

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The numerous graphs and maps appearing in this report were prepared by Jane Glaser and Russell Stearns. I am grateful to them for their dedication during this project and to my colleagues for their understanding while this

project dominated the time of the Department's graphics staff. Assistance during this project was provided by Sue Elston, Jack McMurtry, Stephen Patton and Linda K. Southern. Without their help this project would not have progressed through the tedious stages of data handling and analysis.

My appreciation also is extended to the many banders who permitted their data to be provided to us for this purpose through the U.S. Fish and Wildlife Service and the Canadian Wildlife Service.

Last, but not least, I am indebted to Jerrold H. Zar for his untiring effort on the computer programming that was essential to this project. Numerous revisions in the existing program were necessitated by the unexpected quantities of data that had to be sorted and the addition of new data types. These obstacles were overcome through Dr. Zar's efforts.

III. RESULTS

The available data were subjected to three levels of analysis: (A) the combined band recovery data for all gull species were sorted by month and the actual number of recoveries plotted by geographical coordinates; (B) the percentage of each month's band recovery data and Christmas Count data were calculated and mapped by Zones and Quadrats to show seasonal trends in gull movement across the Nation; and, (C) the proportions of all gull band recoveries occurring in each Zone were graphed to indicate the monthly distribution of gulls and their relative abundance within each of the Zone's four Quadrats. A brief narrative is provided to introduce the graphic presentation of the results pertaining to each of these topics.

A. NUMERICAL SUMMARY OF BAND RECOVERY DATA

Figures 1A through L show the computer display of the location of each gull band recovery reported during January through December. The data presented are for all species of gulls and for all years for which banding data are available. The complete data set also was sorted and mapped by species for each month for all years combined and for individual years. For determining the feasibility of using these types of data to predict hazards to aircraft, it was decided to restrict our initial effort to using the data for all species and all years. This approach is justified by the premise that it is the density of gulls, regardless of species, occurring in a particular geographical area that results in

gulls, per se, sometimes posing a hazard to high frequency aviation. Therefore, predicting where and when gull concentrations reach proportions dangerous to aircraft is of more immediate importance than determining which species of gull may be involved. It is important, however, that all gull species that regularly occur in the United States be adequately represented in the data base. Establishing the geographic origin of problem gull populations can be addressed later if this information is determined to be important.

The amount of band recovery data for each gull species is not equal because some species have been studied more intensively than others. As a results, some species which may contribute to the gull problem in particular regions (e.g. Franklin's Gull) are poorly represented by banding data (Table 5); therefore, analysis of banding data alone will not show the involvement of these species in the production of concentrations that may be seasonally hazardous to aircraft. In such instances, other types of data eventually will be obtained and used to describe distributional patterns. We are investigating the merit of using one or more of the following information sources to supplement our data for future analysis: published accounts of seasonal distribution, data from regional reporters, seasonal reports from the National Wildlife Refuge system, gull reports included in the regional inventories conducted by various Federal and State agencies

and site visits by our own research team. Quantities of information from these sources have been computerized and await analysis.

The distribution of the symbols on the computer-generated maps or phenograms gives an impression of the changing distribution of gulls during the year. In general, there is a more restricted pattern during winter and summer when the birds are on the wintering and breeding ranges, respectively. Conversely, spring and fall (pre- and post-breeding, respectively) are periods of more widespread distribution. These maps, while showing the number of band recoveries reported across the Nation, fail to indicate the proportion of the population (i.e. sample) occurring in each Zone of the United States during each month. This next level of analysis is achieved in the following section of this report.

B. SUMMARIZED GULL DISTRIBUTION ACCORDING TO ZONES & QUADRATS

Determination of the relative level of risk to aircraft posed by gulls in one part of the Nation as compared to some other part, necessitates knowing the proportion of the gull population that is present in each region at a particular point in time. Since direct counts of gulls are not available for all parts of the country, we are compelled to use an indirect method of obtaining this information. A sample of the population, in this case band recovery data or Christmas Count data, is accepted as being representative of the distribution of gulls across the Nation. The point in time

involved, in this instance, is each calendar month. In following this procedure, we recognize that several biases are inherent to banding data and procedures are being investigated that may eventually resolve some of these sources of error. In the interim, band recovery data continues to stand out as the most complete single source of gull data as it covers all months of the year, all parts of the United States and includes a variety of species.

Three types of information are provided in this section of the report: (1) maps showing the proportion of each month's band recoveries that have been reported (all years combined) from each Zone (Figures 2A through L), (2) maps comparing the annual monthly distribution of gulls for each year, 1972 through 1977 (January-July 1977): see Figures 3A-F, for January; 4A-F, February; 5A-F, March; 6A-F, April, 7A-F, May; 8A-F, June; 9A-F, July; 10A-E, August; 11A-E, September; 12A-E, October; 13A-E, November; 14A-E, December, and (3) maps showing the proportion of all gulls reported during Christmas Bird Counts for the years 1972-1977 in each Zone (Figures 15A & B).

1. Monthly Distribution Summarized by Zones -- Figures 2A through L display the proportion (%) of the total number of gulls reported that particular month from each 6^{o} Zone. All available band recoveries were used for this purpose. This procedure provides an indication of where gulls have

been known to occur during approximately two decades. The results reflect trends that may be expected but they do not provide an accurate picture of the actual number of gulls to be expected in some regions. This is because some species and some populations of species are poorly represented in the banded sample and consequently concentrations of these birds fail to show up in an analysis of band recovery data.

Long-term banding data also tend to moderate the effects of relatively recent changes in gull distribution. The data for the Oklahoma region provide a good example since published distributional data document the occurrence of thousands of gulls in that State during winter and the published accounts also verify that the great increase in gull populations is a fairly recent event. Band recovery data from this area during the winter period (Figures 2A & B), however, fail to support this observation because very few gulls from the northern Great Plains breeding population are included in the banded sample. Supplemental sources of data will be used in attempts to make adjustments for such omissions during future analyses.

The results from the present analysis of banding data identify areas having the largest concentrations of gulls, either consistently or seasonally, and concomitantly denote areas in which the hazard to aircraft may be highest. The recognized level of risk, however, is dependent upon several factors besides the number of gulls present, such as: the

type and size of aircraft involved in missions; the type of mission flown, particularly with respect to altitude; and, the number of missions flown per unit time in a specific area. Monthly changes in gull abundance are particularly significant in some areas and demonstrate the extent to which risk might change, either increase or decrease, over time. These preliminary findings, therefore, could be put to immediate use by persons interested in scheduling low-altitude missions in areas likely to have the lowest density of gulls, and hence the lowest potential risk of collision with members of these species. It should be kept in mind, however, that the bird strike problem near some Air Bases involves species other than gulls.

Although this information may be used now by mission planners, it does not provide sufficient detail for determining the actual risk that gulls pose to aircraft in each of the Zones or Quadrats. All we know at this time is the proportion of the banded sample that occurs in each Zone. This must be converted to a reasonable estimate of the actual number of gulls that might be present at a given point in time. Arriving at a conversion procedure that is uniformly accurate for all Zones is probably impossible because numerous variables influence gull distribution and population density. Also, equal effort has not been expended by biologists gathering gull data in all parts of the country. Under the constraints imposed by these and other limitations, we are

proceeding to investigate methods that may provide an acceptable measure of the number of gulls that may be competing for airspace with low-flying aircraft or aircraft during landing and take-off.

By concentrating on the population estimates for a particular Zone, for instance D'J, it is possible to visualize the seasonal changes in regional gull abundance and also envision how such changes will ameliorate the gull/aircraft problem. Zone D'J also provides a good example of the usefulness of Quadrat data. In this case, all of the recoveries are from Quadrat 1, the NW one-fourth of the Zone, rather than farther from the coast. This is to be expected as it is more likely that banded gulls will be recovered by people along beaches than at sea. However, this recovery pattern is also influenced by the fact that most of the gulls that occur in this region are littoral rather than pelagic and hence occur more frequently along the coastline.

Since this report is considered preliminary, an attempt was not made to summarize the distribution for each Zone or to predict risk to aircraft in each. Once the other available sources of data are combined with the banding data, risk predictions and an indication of accuracy will be attempted.

2. Annual Variation in Monthly Gull Concentrations -- An alternative to combining the band recoveries from all years into a single sample for analysis as done in the preceding section, is to use short-term data such as those accumulated during any one year or season to predict patterns of distri-

bution. To test the feasibility of using small, more easily obtained data sets, we sorted the band recovery data by year and compared the distribution of recoveries from each month. Presented in Figures 3 through 14 are the January through December data for each of the years 1972 through 1977. The figures for August through December do not include 1977 as the band recoveries for these months were not available when we received our data from the Fish and Wildlife Service.

The variability shown in these samples is indicative of that found in the data sets for the remaining years included in the complete set of band recovery data. The extreme difference between the 1977 sample and those for 1972-76 probably is a result of a large part of the recoveries for 1977 not being submitted as yet by reporters, or by processing delays at the Bird Banding Laboratory. If 1977 is excluded, it appears that a monthly map, regardless of year, is fairly indicative of where gulls are to be expected during any particular month. The variability between years is expressed primarily in the proportion of the annual sample for each month that is found in a particular Zone. Thus, although monthly data from any contemporary year might be indicative of where gulls will occur that month, the proportion of existing gulls that could be in any given area, as opposed to some other area, might be grossly underestimated. Obviously overestimation is also a possibility, but it stands as a more acceptable error when the goal is to reduce gull/aircraft collisions.

We conclude, therefore, that use of band recoveries covering a long span of years provides a better indication of what proportion of the gull population to expect at a given location and when to expect it. As mentioned earlier, this procedure is not error free but it provides the best geographical and seasonal coverage of the sets of data that are currently available. Supplemental or alternate data sources under consideration will be used in later attempts to improve accuracy and to provide for more precise coverage with respect to particular species and regions.

The results from this mode of analysis are presented in this report to document the extent to which annual data for any month may vary from the mean expected pattern (all years) so that flight planners may take this into account prior to the availability of a more detailed report.

3. Christmas Bird Count Data -- As a central clearing house for information on bird distribution does not exist, it is difficult to bring together sufficient data to describe the current nation-wide seasonal range of gulls. Unusual records are usually published, but the day-to-day occurrence of the common species receives little attention in the literature. Similarly, observers both professional and amateur are reticent about providing records of their observations for use by others. One exception to this pattern is the annual report on the Christmas Bird Counts that is published by the National Audubon Society in American Birds. Each

year over 1000 one-day counts are conducted throughout the Nation during a two-week period that embraces late December and early January. Although the census period represents a small part of the year, results provide some data that indicate the approximate number of gulls that may occur in specific areas for which banding data also exist.

The combined data for all Christmas Counts conducted during the last five years (through January 1977) are presented in Figures 15A and B. These published data represent the best available information for comparison with band recovery data. Such a comparison represents one means of determining just how many live gulls each band recovery might represent in various Zones across the Nation. The Christmas Count data also have been compared on a year by year basis with banding data, but those data are not presented in this report.

Procedures are being investigated that may permit a synthesis of these two forms of data for this purpose. The similarity between Figures 15A and B and 2A and L document the likelihood of such an approach being feasible. In most instances, the proportion of the population predicted for each Zone on the basis of banding data and the proportion of the month's total actually censused in the respective Zones are similar enough to be giologically acceptable and possibly statistically significant. No attempt is being made to apply these findings at this time as this phase of the project is still in progress.

C. RATE OF OCCURRENCE OF GULLS BY MONTH WITHIN EACH ZONE AND ITS QUADRATS

In the preceding analysis, we examined gull distribution on the basis of the proportion of each month's population, as represented by the recovered banded sample, that occurred in various parts (i.e. Zones) of the Nation. The information provided by this system is enhanced by knowing the proportion of the entire recovered banded sample that appears in each Zone across time. The result is a phenology of gull distribution within each 6^{o} square Zone that has produced at least 0.2% of the total band recoveries for all years. This provides an estimate of the proportion of the gull population that might be expected to occur in a particular Zone during any month of the year.

Figure 16 displays the frequency of occurrence of band recoveries from each of the Zones. Zones without any recoveries were omitted from this graph. An arbitrary decision was made to select Zones having at least 0.2% of the recoveries for graphing purposes. A separate graph was prepared for each Zone (Figures 17B'A through F'H) for the data for all years combined and for data from each of the years 1972 through 1977 (Figures 18 through 29). The graphs for Zones within each year are preceded by a histogram showing the proportion of the total recoveries for that year that were obtained from each Zone. The 0.2% cutoff point also was used for selection of Zones to graph within the annual data.

A histogram concomitant with the line graph for each Zone shows the proportion of each month's total recoveries for that particular Zone that occurred in each of the four Quadrats. The graphs combined indicate the proportion of all band recoveries from that particular Zone during each month of the year and the distribution of these birds within the Zone.

The Christmas Bird Count data were treated similarly but are not included in this report. Graphs are presented for these data that indicate the proportion of all gulls reported during December (Figure 30) and January (Figure 31) that were reported in each Zone.

IV. DISCUSSION

Information supplied by the USAF discloses that 1002 bird strikes, that resulted in damage and for which locality data were recorded, occurred during 1974 through 1977 (Figures 32A-L). About 35% of the strikes occurred during September through November (range 115-146 strikes/month). March and April had the next highest rate, 83 and 93 strikes/month, respectively, and combined accounted for 17.6% of the total. The rate for the remaining months was between 53 and 74 (mean - 63.3). These figures differ somewhat from those reported previously for the period May 1965 through September 1971 (Ref. 9). In this earlier study, about 35% of the strikes occurred during September and October with the next highest number (about 11%) occurring in May. The lowest number of strikes was reported for December through February which was generally the case during 1974-1977. During these years the strike rate for June was also low and ranked slightly below the level for January. The range for these four months was 53-62 strikes/month.

The peak strike months coincide with the period of heaviest bird migration and also the time of year when populations are highest because of the recent addition of numerous young to the population. The low strike months represent the period when most birds are on their winter range (December - February) and many are out of the United States. June also represents a period of restricted distribution as

most birds are on their breeding ranges and occupied with nesting activities.

Gulls were involved in at least 31% of the strikes that occurred during 1974 through 1977. One or more verified gull strikes occurred during each of the 12 months but never during all 12 months of any one year. The highest frequency of reported gull strikes occurred in March and July (14% each) followed by August (12%) and February, September and October (10% each).

The geographical distribution of strikes that occurred during 1974-1977 is similar to that reported during 1968-1971 (see Table 4 and Figures 32A-L). As might be expected, many of the localities with the highest strike rates are in Zones of high seasonal gull concentration. Some are not, however, and any attempt to document a direct cause and effect relationship between gull distribution as depicted by this study and the distribution of bird strikes will result in negative correlation. This is to be expected, because such an approach attempts to answer a specific question without possession of appropriately specific data. Presently most of the important parameters associated with a bird strike are either unknown or have not been listed in the reports. The species of bird involved in a strike frequently goes undetected as little or no evidence remains by the time the aircraft can be examined. Similarly, exact locations, specific routes, or general geographic locations often are not recorded (Ref. 3). If more

complete strike data were available, it would enable a more accurate evaluation of the hazard posed by particular kinds of birds according to time and place. The proportion of bird strikes for which the bird species has been identified is too small to assure that the calculated frequency of gull involvement at various geographic locations is reasonably accurate.

The number of strikes reported each year from 1970-1976 has consistently ranged between 300 and 400, with the exception of 1974 when 469 were reported. Bird strikes not considered hazardous or not causing damage usually are not reported. In 1971, an attempt was made to document all known strikes regardless of whether or not repairs were required. Over 1000 were reported that year, but only 384 met the usual accident/incident criteria for prior reporting. Thus, it is likely that for every strike that is reported, 2 or 3 others actually occur (Ref. 11).

About 83% of the known collisions with gulls (Table 3) occurred at elevations of 1000 feet or lower. This percentage figure is identical to that reported for the combined proportions of bird strikes that occurred during landing (30%), takeoff (26%) and low level missions (27%) during 1967-1972 (Ref. 10). Of all other strikes reported for 1974-1977, 56% were at 1000 feet or lower. For the period 1965-1971, 65% occurred during the first 1000 feet of altitude (Ref. 9).

The overall bird strike rate for all Air Force aircraft during 1974 was one strike per 8036 flying hours while the rate for the F-111 tactical fighter bomber that flies low altitude missions (200-1500 feet AGL) at speeds of 500-650 mph was one strike per 2098 flying hours (Ref. 3).

To generate a model for predicting the risk to aircraft posed by gulls, various types of information besides the number of birds present in an area must be available for each region or Zone (Ref. 12). Essential components of such a model would be the number of missions flown (air traffic), the type of mission (low altitude, touch-and-go, etc.), type and amount of gull habitat in the various areas, weather patterns, and seasonal distributional data for gull species poorly represented in the present data base.

Efforts are continuing to obtain the information required for predicting where, when and to what extent gulls may cause a hazard to aircraft. In the interim, the information contained in this report can be used by interested persons to determine the seasonal pattern of gull distribution across the Nation. When combined with the knowledged possessed by Base Commanders and flight planners about the number of missions flown in specific areas, it should be possible to obtain at least a qualitative determination of the degree of risk that gulls may present to aircraft.

The data presented in this report represent the first attempt to describe the seasonal distribution for an entire

group of avian species by blocks of geographical coordinates (Zones). Continuing effort to develop the data base necessary for predicting within reasonable degrees of accuracy the occurrence of concentrations of all avian species potentially hazardous to aircraft can be justified on a cost-benefit basis. Development of procedures that will prevent even one strike requiring repairs at the average 1974 cost of $32,000 per strike provides a return about equal to the cost of one year of research effort.

V. SUMMARY

The seasonal distribution of all North American gull species as derived from banding data and Christmas Bird Count reports is presented. The proportion of each month's gull population is shown for 6^{o} square Zones designated by latitude and longitude. The number of birds present per Zone is plotted therein according to Quadrats (=¼ Zone). USAF bird strikes occurring during 1974-1977 also are mapped for comparison. This preliminary summary of gull distribution and strike data can be used to identify when and where gulls may be presenting a significant hazard to low-flying aircraft. Application of the information during flight planning could reduce the number of strikes caused by gulls. Continuning studies will attempt to refine the application of such bird data to predict hazard levels to aircraft.

VI. REFERENCES

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3. USAF Bird Strike Summary, 1 Jan. 1971-31 Dec. 71. Directorate of Aerospace Safety, USAF, Norton AFB, California.

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Table 1. Summary of USAF Bird Strike Data Indicating the Number of Strikes per year that caused damage to aircraft.

Year	Number of Strikes	Total $ Loss (in millions)
1967	379	not known
1968	363	not known
1969	338	not known
1970	360	1.2
1971	383	13.5
1972	350	0.8
1973	323	24.6
1974	466	4.2
1975	399	26.1
1976	363	5.1
TOTAL	3724	$\bar{x}$ = 372.4

Table 2. Frequency of bird strikes at various altitudes (in feet above ground level).

Altitude	1968*	1969	1970	1971	Total	% Total**
0-100	77	55	41	42	215	21.3
101-500	60	40	58	39	197	19.5
501-1000	54	48	61	51	214	21.2
1001-2000	43	51	60	77	231	22.8
2001-3000	27	17	18	16	78	7.7
Over 3000	8	32	14	22	76	7.5
Subtotal					1011	
Unknown	94	95	108	136	433	
Totals	363	338	360	383	1444	

* 1968, Ref. 1; 1969, Ref. 2; 1970, Ref. 8; 1971, Ref. 3.

** refers to subtotal or the number of strikes for which altitude data were available (n = 1011)

Table 3. Altitudes at which gulls and other birds struck aircraft, 1974 through 1977 (from unpublished USAF data).

Altitude (in feet AGL)	Unknown Species	Non-Gulls*	Gulls	Total	% of Subtotal**
On ground	79	13	10	102	18.6
2-10	3	2	2	7	1.2
15-25	6	2	2	10	1.7
30	1	-	1	2	0.4
50	7	4	2	13	2.2
100-150	19	5	2	26	4.4
200-250	22	2	1	25	4.2
300-350	15	4	1	20	3.4
400-410	14	1	-	15	2.5
500-550	60	2	2	64	10.8
600	11	1	1	13	2.2
700-750	5	3	-	8	1.3
800	15	1	1	17	2.9
900-960	3	-	-	3	0.5
1000	52	8	-	60	10.1
1100-1200	11	1	1	13	2.2
1300-1400	10	2	-	12	2.0
1500-1687	34	7	1	42	7.1
1700-1800	16	1	1	18	3.0
1900-2000	28	10	1	39	6.6
2100-2250	4	-	-	4	0.7
2300-2500	14	1	-	15	2.5
2600-2700	5	1	-	6	1.0
2800-2950	2	2	-	4	0.7
3000-3100	17	1	-	18	3.0
3200	1	-	-	1	0.2
3400-3500	2	1	-	3	0.5
3900-4000	9	-	-	9	1.5
4500-4600	4	1	-	5	0.8
5000-5500	3	2	-	5	0.8
6000-6500	5	-	-	5	0.8
6700-7500	3	-	-	3	0.5
7900-8000	2	-	-	2	0.3
10000	2	-	-	2	0.3
14500-15000	3	-	-	3	0.5
Subtotal				594	
Unknown	485	39	24	548	
Totals	972	117	53	1142	

* species identified and known to be other than gulls

** includes only reports for which the kind of bird involved and altitude were recorded

Table 4. Summary of Birdstrikes by geographical location and month, USAF data for 3 years.

Continental USA*	Number of Strikes Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals	% of U.S. Total
NE														
1968	1	0	5	4	2	1	3	0	4	2	3	1	26	
1969	0	1	1	1	3	3	3	2	4	10	0	1	29	
1970	1	5	1	7	2	2	3	5	9	5	3	1	44	
1971	0	2	1	3	8	2	4	7	6	8	3	1	45	
												Total	144	13.2
SE														
1968	8	5	10	7	5	6	5	6	17	14	15	5	103	
1969	8	8	4	6	7	2	6	6	20	15	16	6	104	
1970	7	6	3	10	1	2	4	5	13	14	9	7	81	
1971	1	6	8	7	13	6	6	10	17	16	11	5	107	
												Total	395	36.5
NW														
1968	0	0	0	0	1	1	1	0	2	5	0	1	11	
1969	0	4	1	1	1	1	1	0	0	1	4	0	14	
1970	1	4	2	2	1	1	3	1	2	5	2	1	25	
1971	0	2	2	3	3	0	0	6	6	3	0	1	26	
												Total	76	7.0
SW														
1968	5	1	7	14	14	5	4	10	11	20	13	4	108	
1969	8	14	11	9	13	6	8	7	15	5	13	4	113	
1970	10	9	8	12	11	12	9	11	15	18	10	2	127	
1971	7	5	9	11	8	11	6	10	14	17	16	4	118	
												Total	466	43.1
Unknown														
1968	5	0	5	2	3	0	3	2	5	4	4	5	38	
1969	2	3	4	2	2	1	1	0	3	4	2	0	24	
1970	1	0	2	1	5	0	3	0	3	7	2	2	26	
1971	0	0	0	1	3	2	0	3	6	10	6	1	32	
												Total	120	

* foreign strikes are excluded from table but are included in totals for years presented elsewhere

Total for NE thru SW = 1081
Unknown location = 120

From Ref. 1, 2, 3 & 8

Table 5. Number of band recoveries by species, supplied by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service.

Species	U.S.	Canadian	Total
Glaucous-winged Gull (Larus glaucescens)	9,881	7,345	17,226
Great Black-backed Gull (L. marinus)	783	354	1,137
Western Gull (L. occidentalis)	1,515	--	1,515
Herring Gull (L. argentatus)	25,155	7,032	32,187
California Gull (L. californicus)	2,179	555	2,734
Ring-billed Gull (L. delawarensis)	12,307	8,952	21,259
Laughing Gull (L. atricilla)	1,521	--	1,521
Franklin's Gull (L. pipixcan)	134	110	244
	53,475	24,348	77,823*
Glaucous Gull (L. hyperboreus)			
Iceland Gull (L. glaucoides)			
Mew Gull (L. canus)	Less Than 100 Recoveries		
Heermann's Gull (L. heermanni)			
Bonaparte's Gull (L. philadelphia)			
Little Gull (L. minutus)			

*this total may not agree with that used elsewhere in this report because those recoveries that lacked complete data were excluded from computer sorts.

Figures 1A-L. Monthly distribution (January-December) of band recoveries for all gull species as plotted by the computer. Various symbols have been used to display the occurrence of more than 9 recoveries at a particular set of geographical coordinates. This procedures is essential as plotting accuracy is determined on this map scale by the size of each typed symbol and the spacing possible between symbols. A legend for the symbols used in all 12 maps of this series follows:

Map Legend

1	1 encounter	K	46-50 encounters
2	2 encounters	L	51-60 "
3	3 "	M	61-70 "
4	4 "	N	71-80 "
5	5 "	O	81-90 "
6	6 "	P	91-100 "
7	7 "	Q	101-125 "
8	8 "	R	126-150 "
9	9 "	S	151-175 "
A	10-12 "	T	176-200 "
B	13-14 "	U	201-225 "
C	15-16 "	V	226-250 "
D	17-18 "	W	251-275 "
E	19-20 "	X	276-300 "
F	21-25 "	Y	301-350 "
G	26-30 "	Z	351-400 "
H	31-35 "	$	401-450 "
I	36-40 "	=	451-500 "
J	41-45 "	#	501-1000 "
			More than 1000 encounters

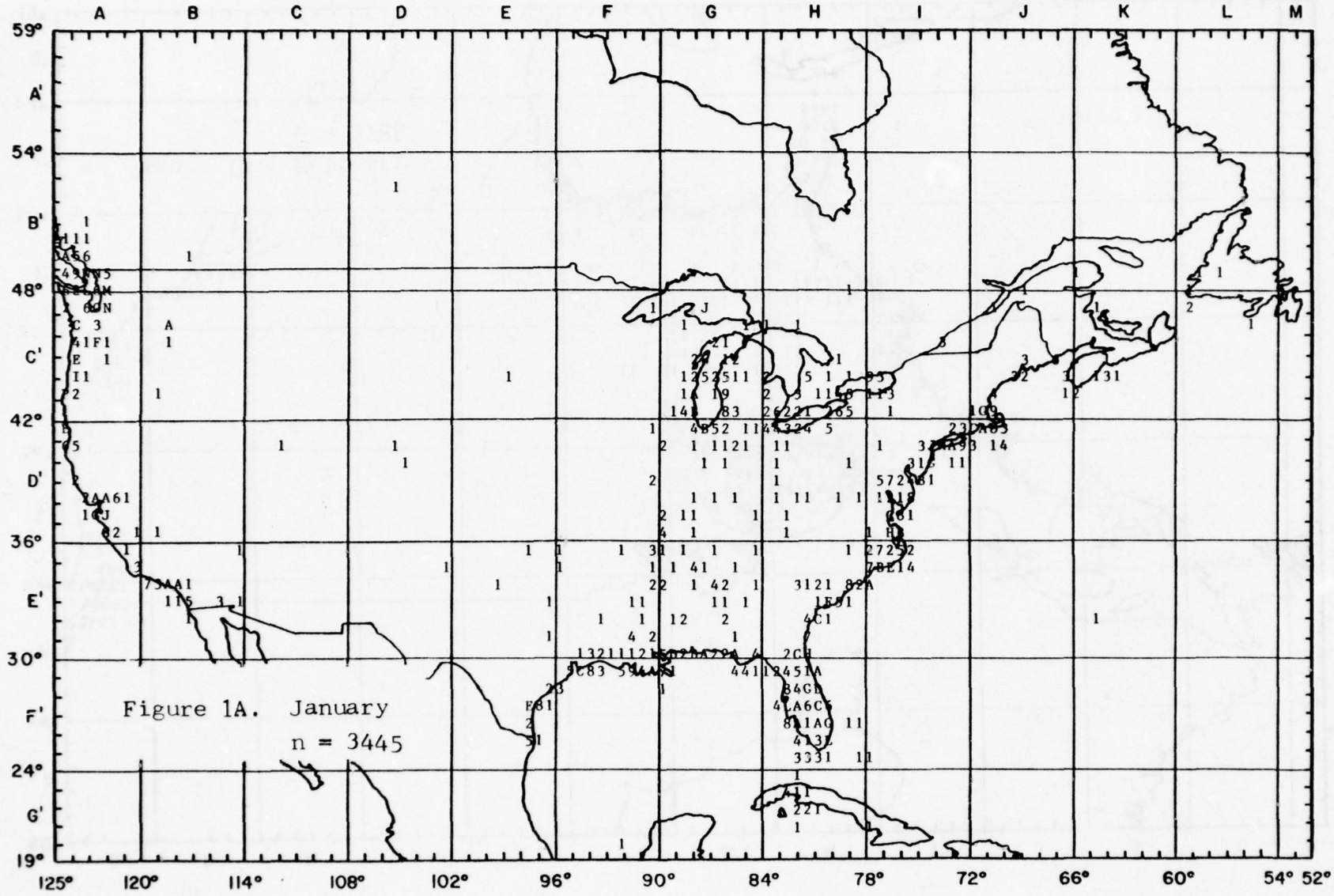


Figure 1A. January

n = 3445

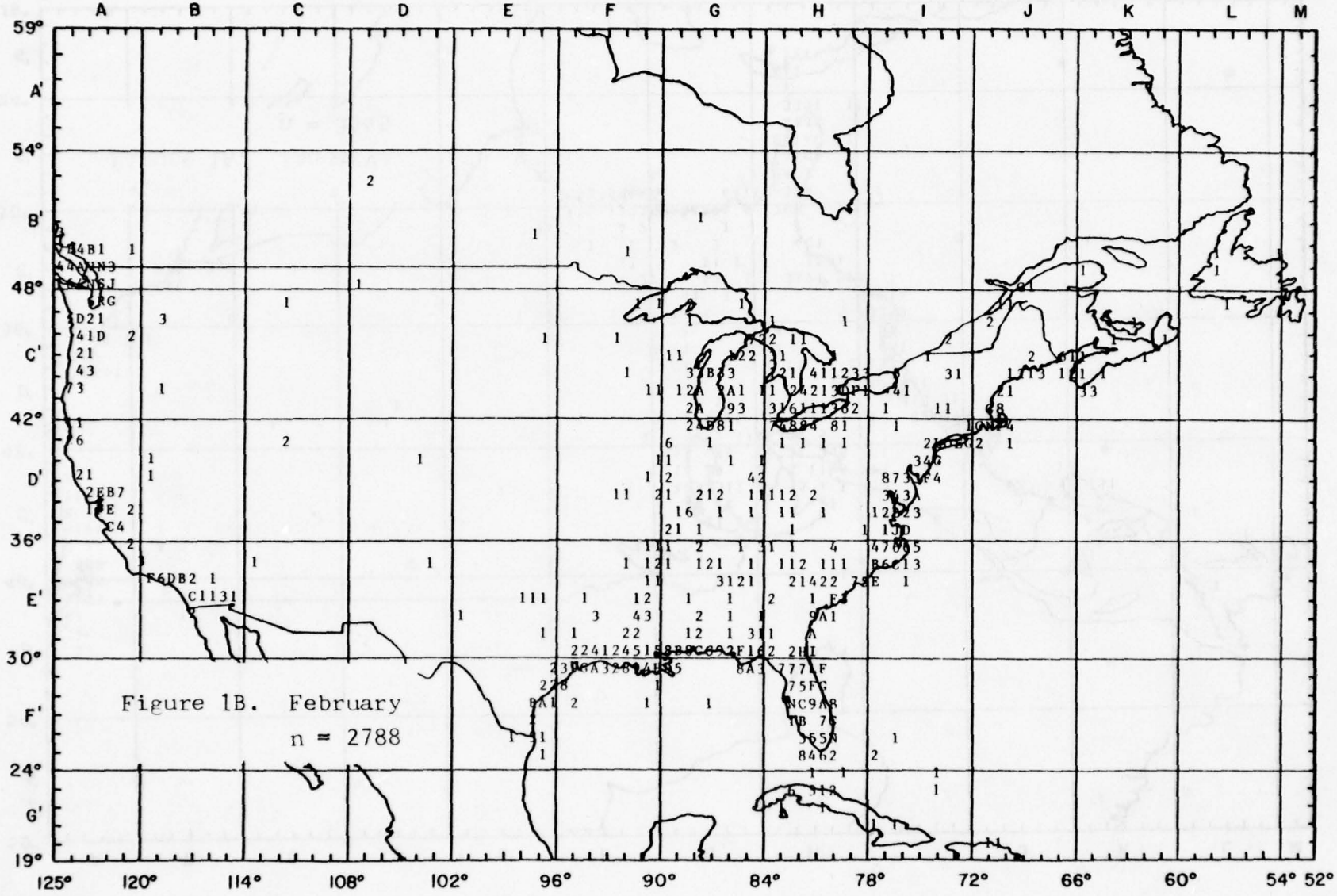


Figure 1B. February
n = 2788

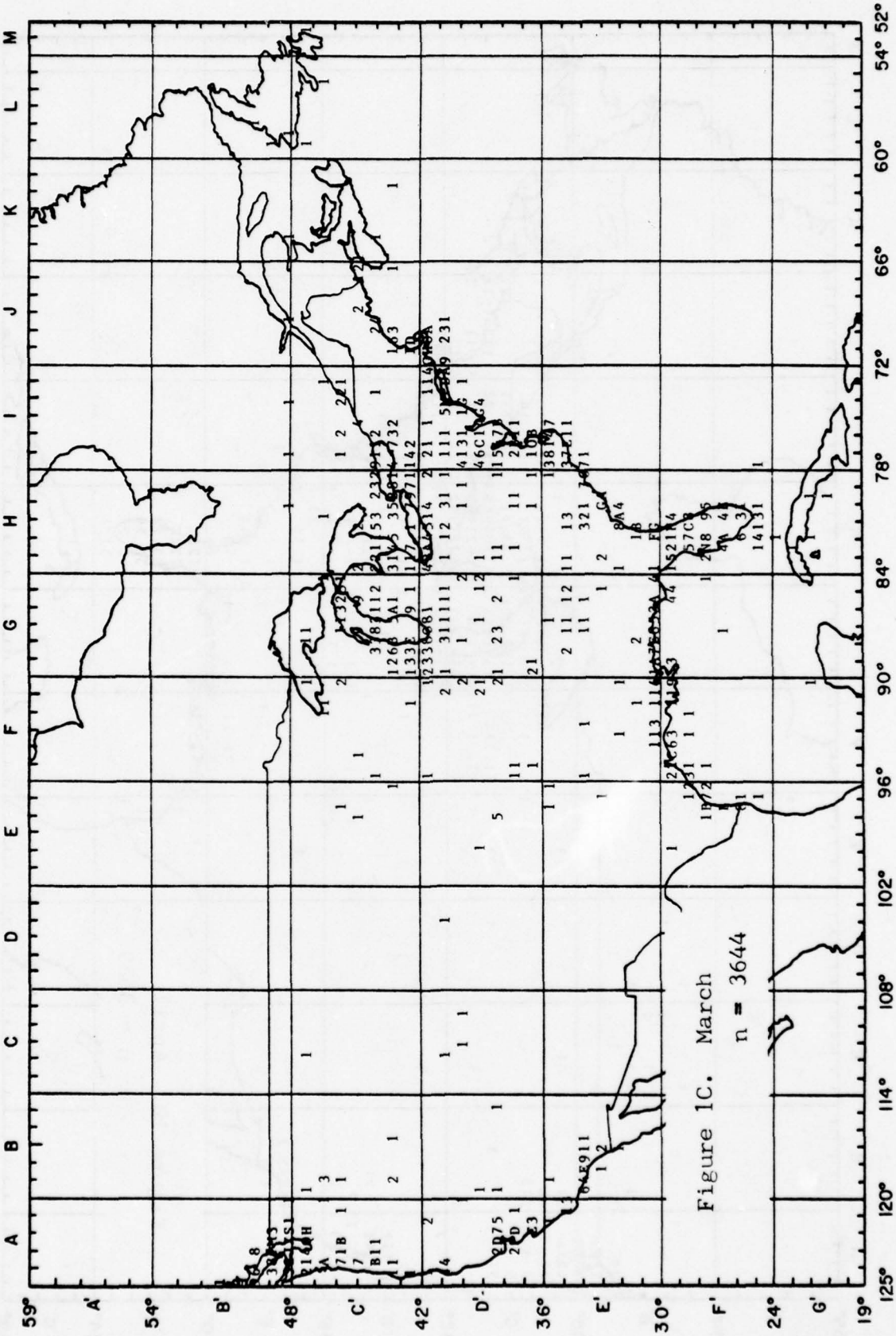


Figure 1C. March
n = 3644

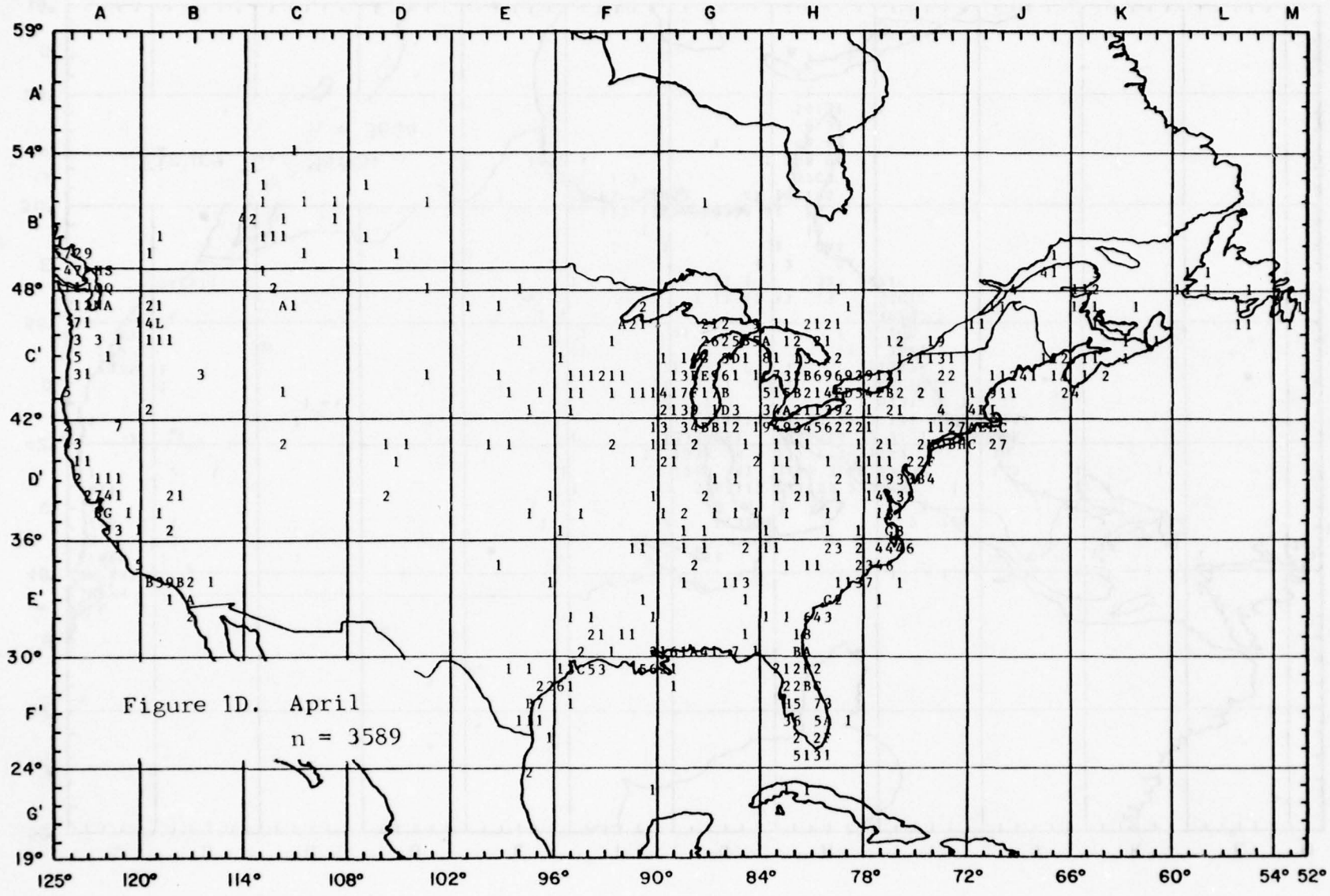


Figure 1D. April

n = 3589

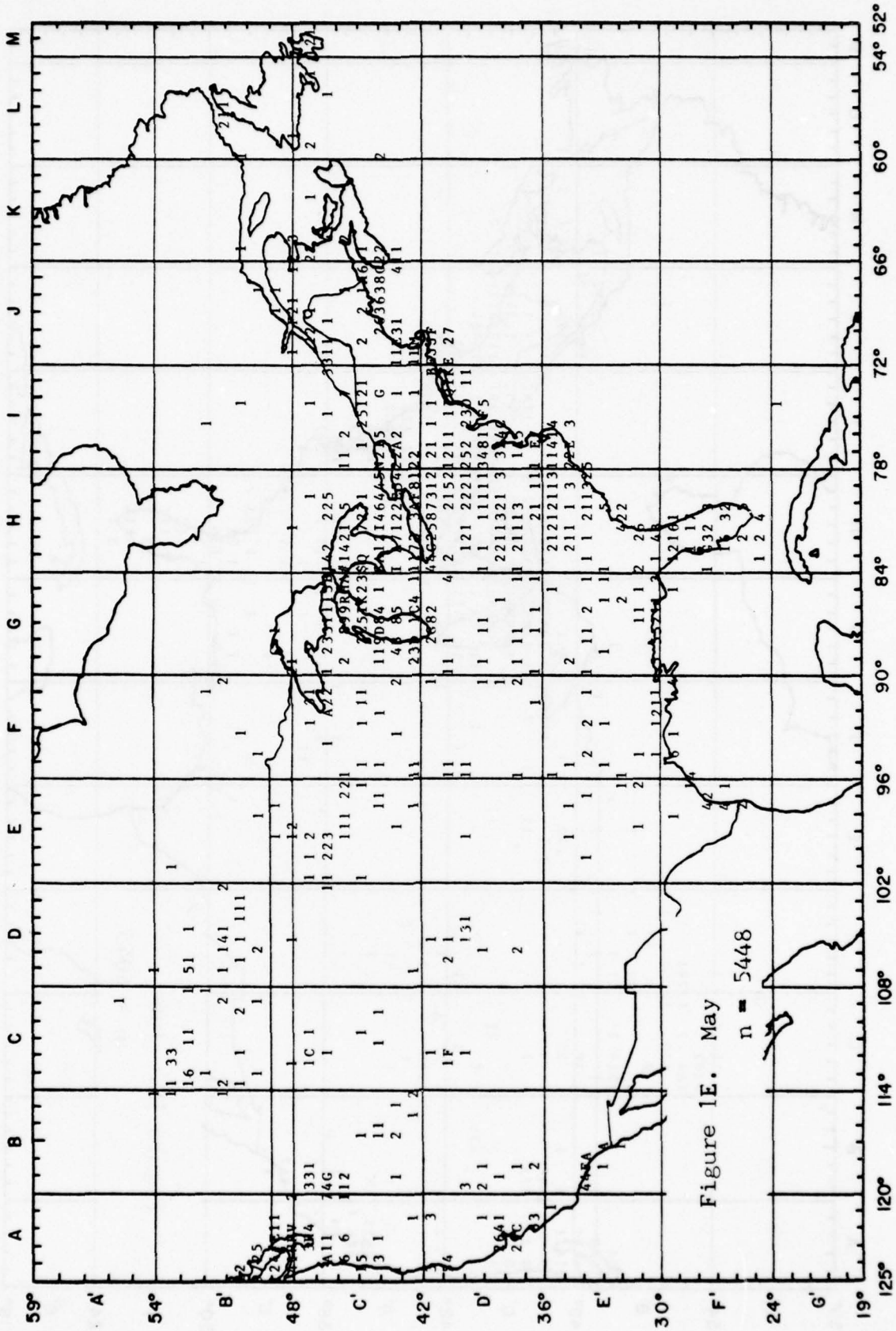


Figure 1E. May

n = 5448

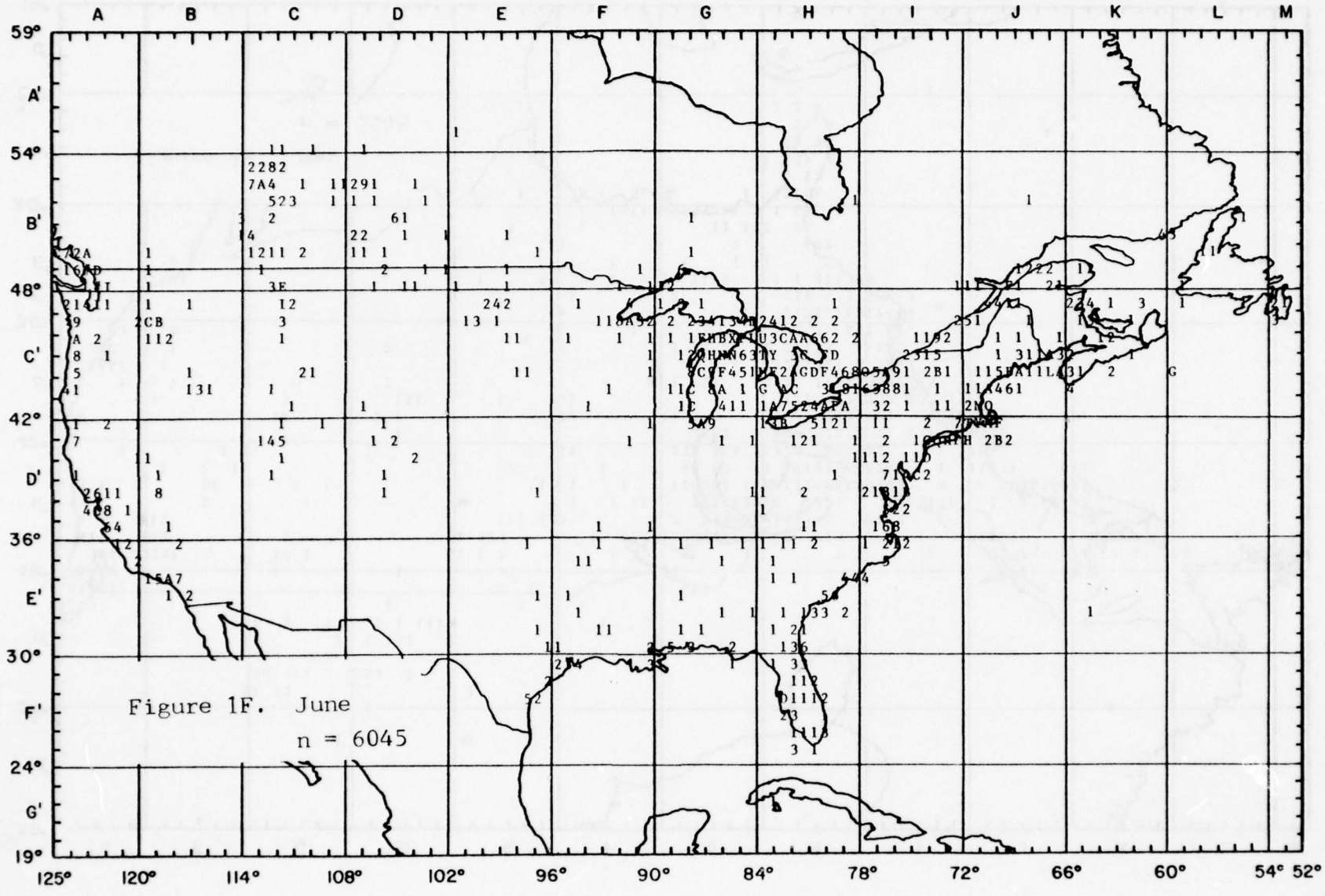


Figure 1F. June

n = 6045

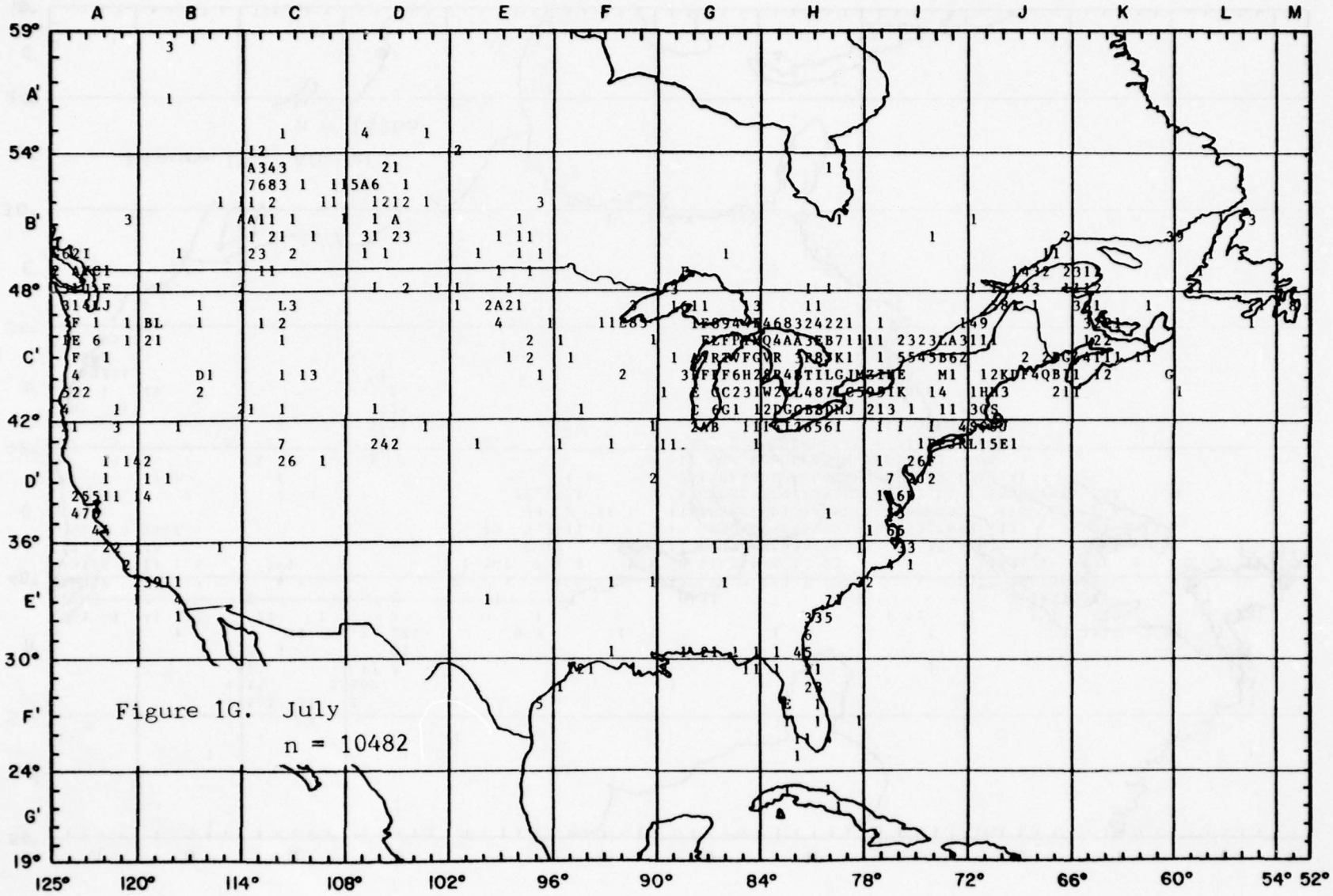


Figure 1G. July

n = 10482

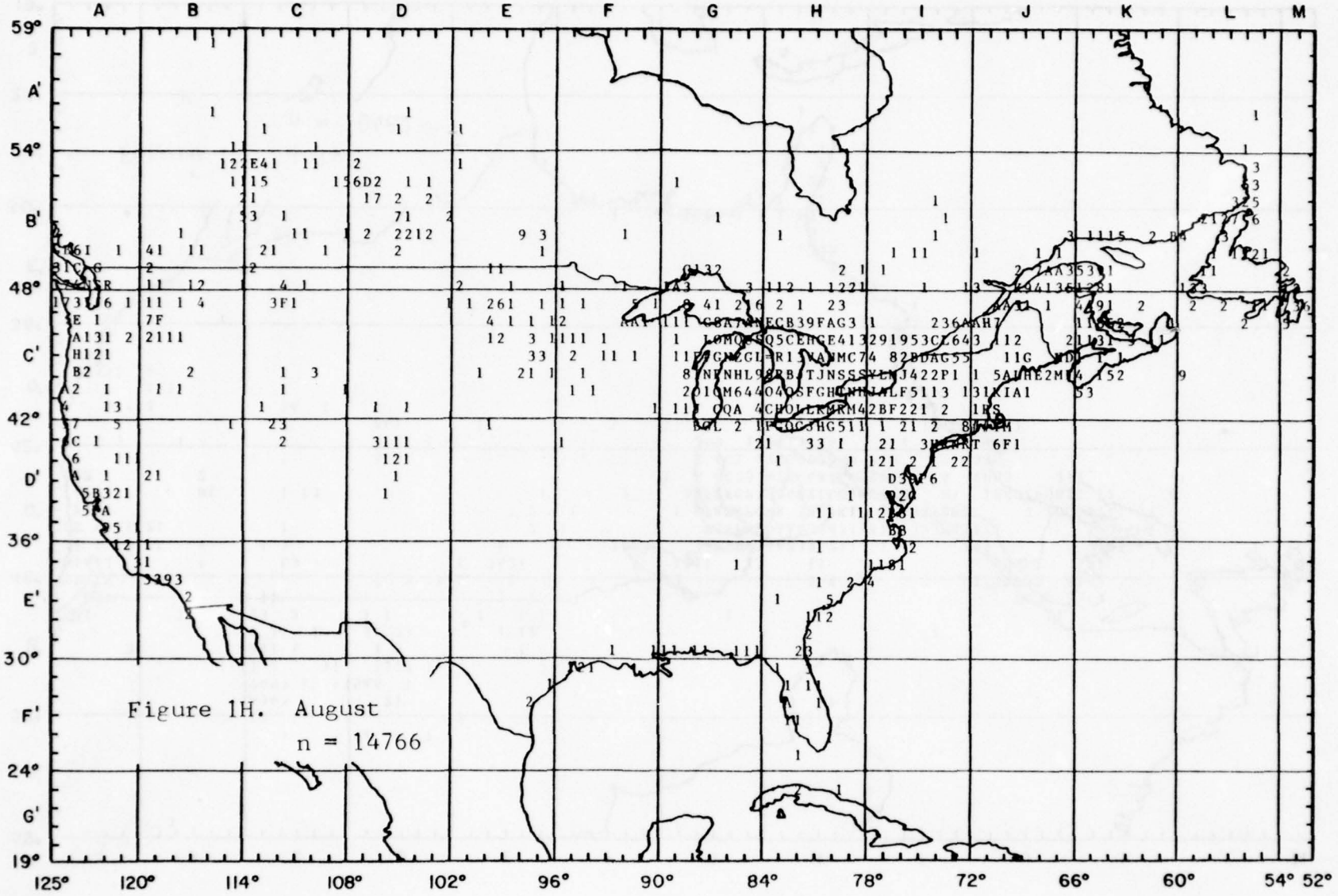


Figure 1H. August

n = 14766

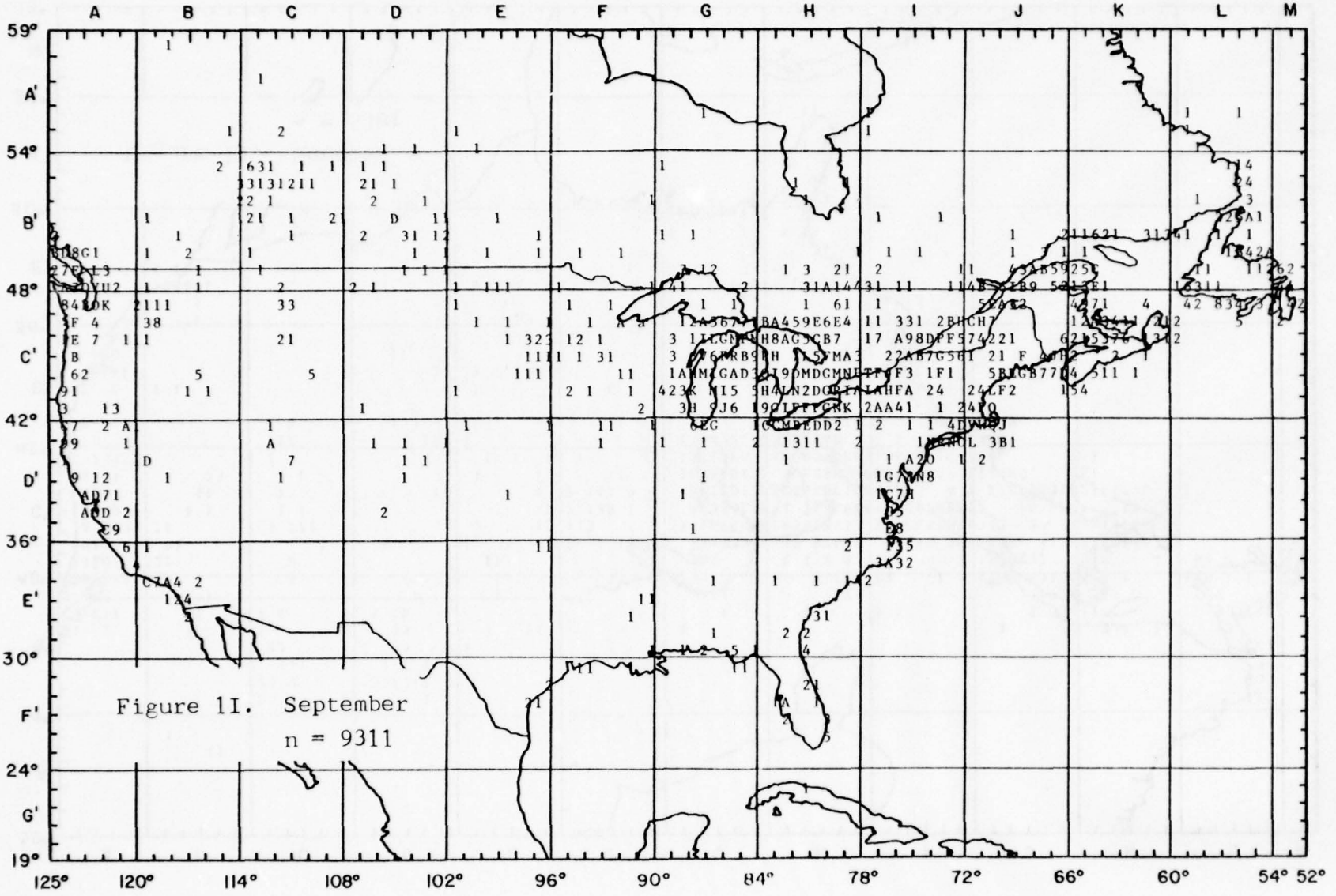


Figure 1I. September
n = 9311

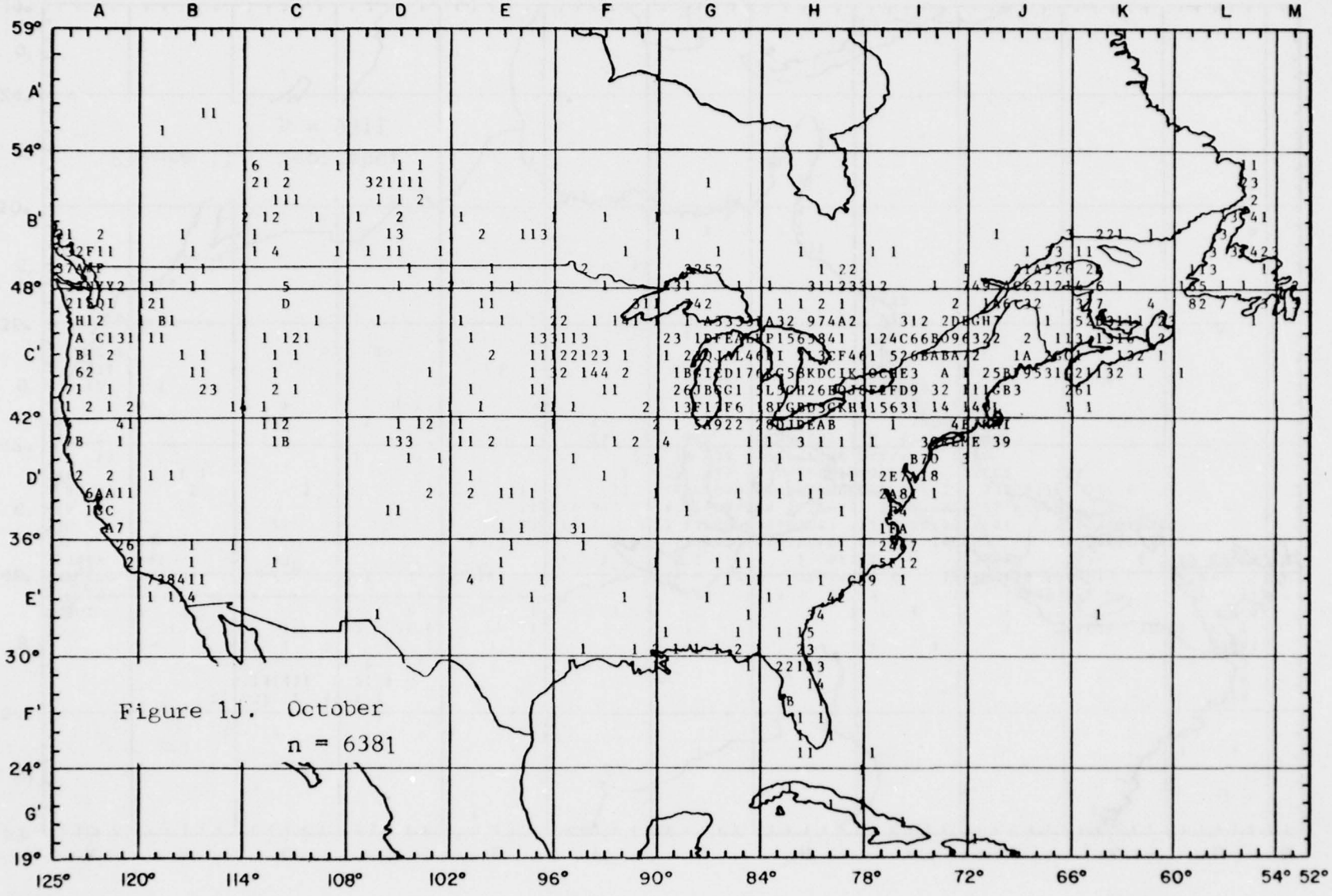


Figure 1J. October

n = 6381

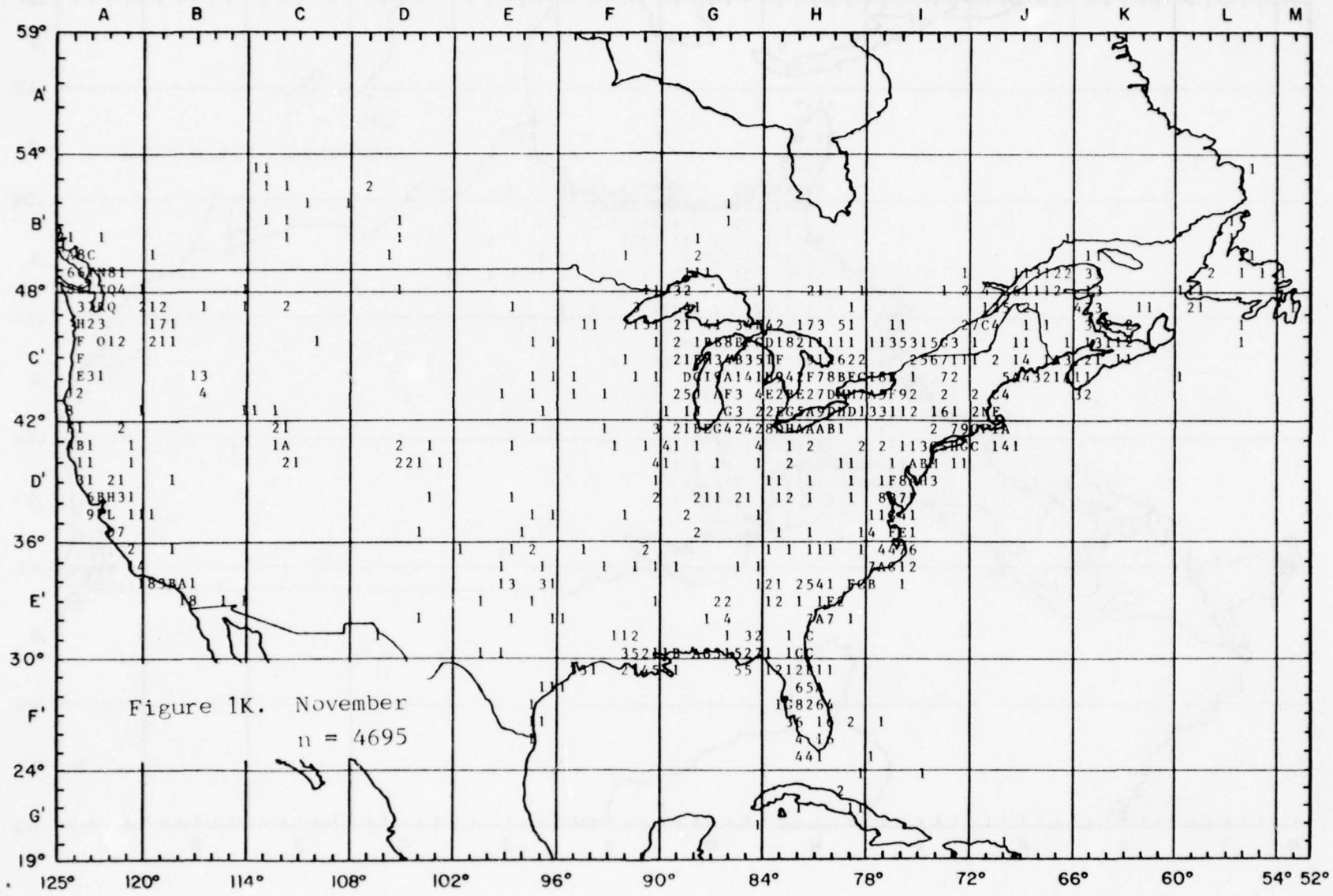


Figure 1K. November

n = 4695

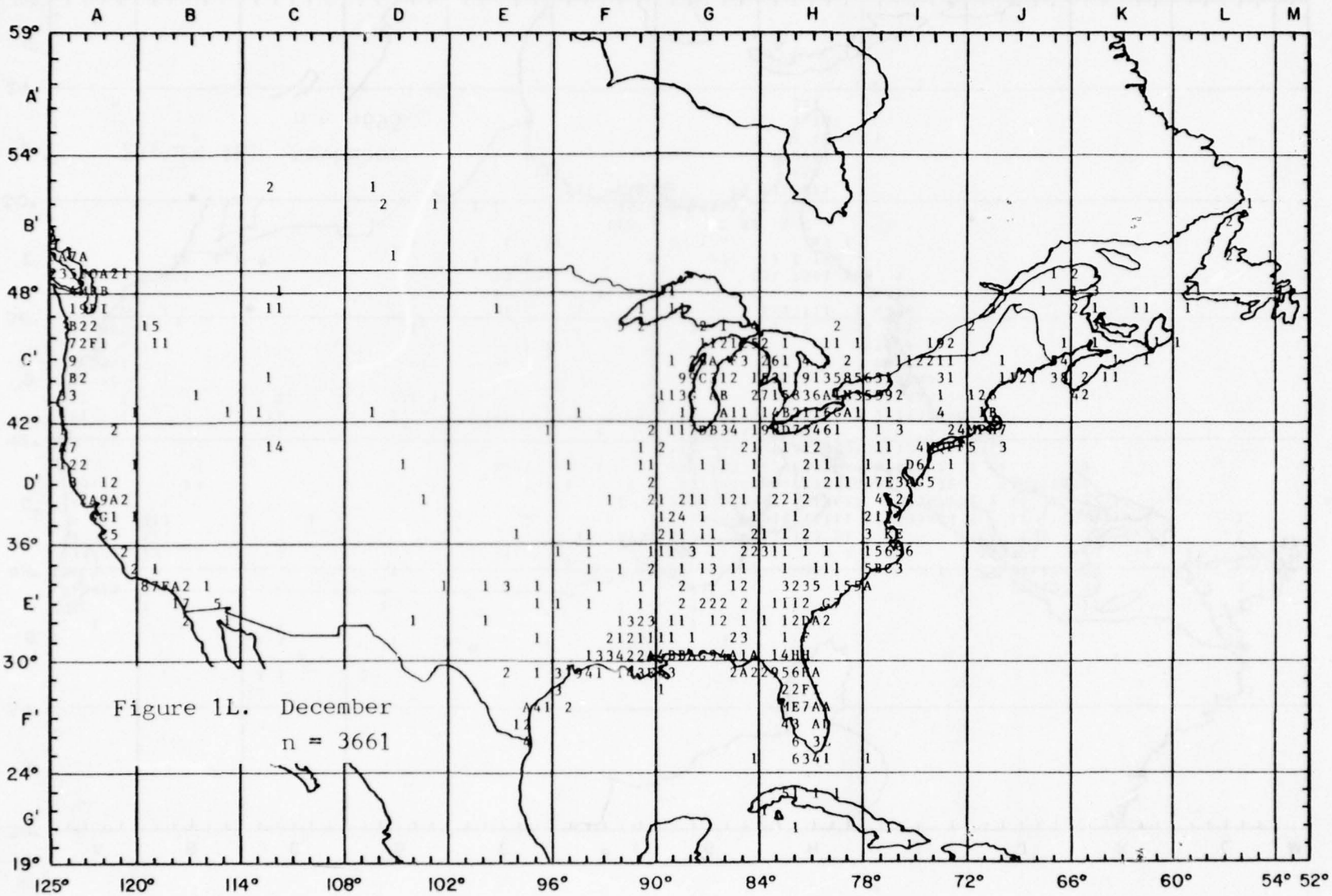


Figure 1L. December

n = 3661

Figures 2A-L. Percent of each month's total band recoveries per 6^{o} square Zone. The numbers appearing in some corners of Zones represent the actual number of reports for that Quadrat, i.e. that one-fourth of the Zone. Note that Blocks A and M are less than 6 degrees square as a result of the map being trimmed to emphasize the lower 48 states.

Figure 2A & B.

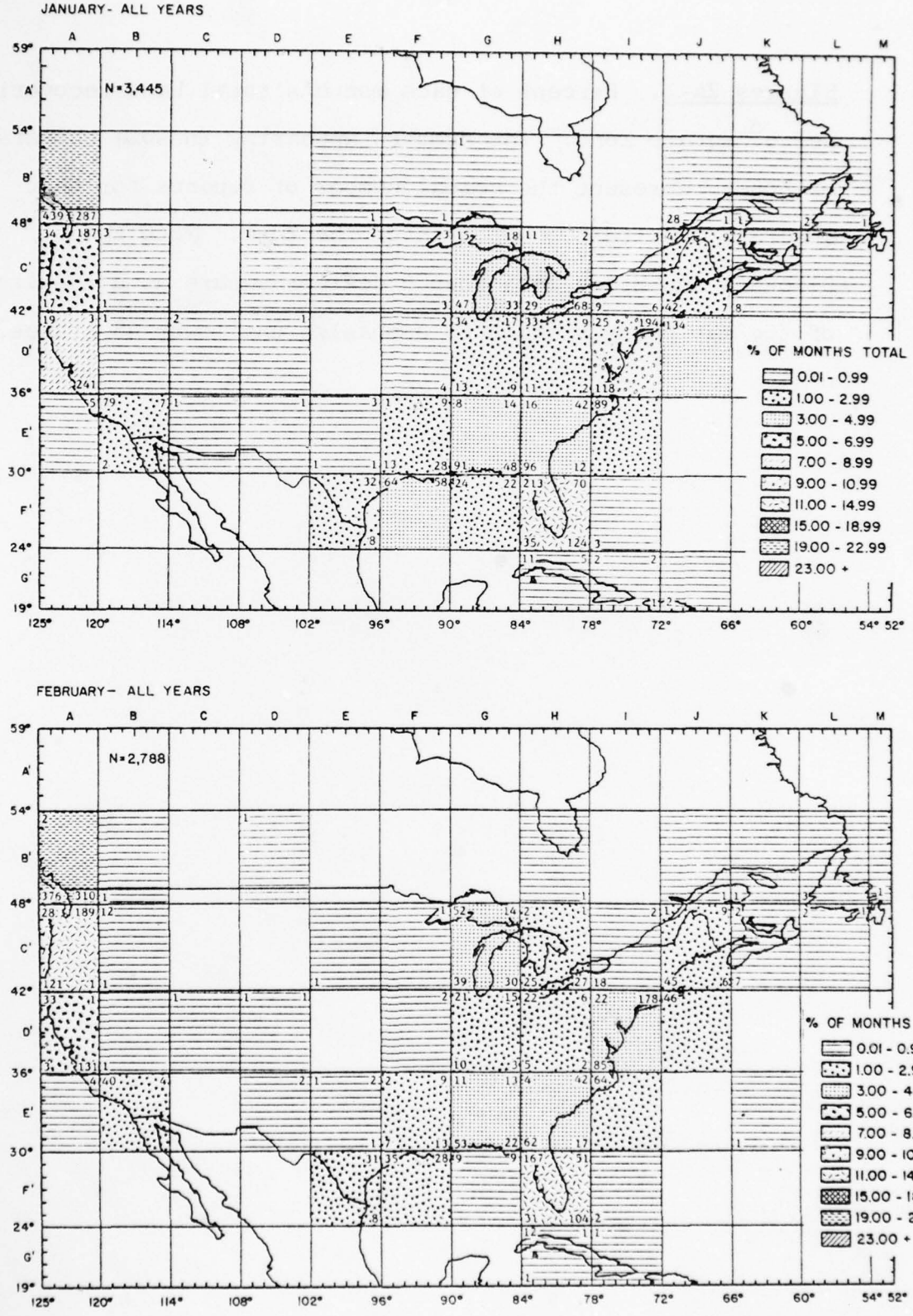
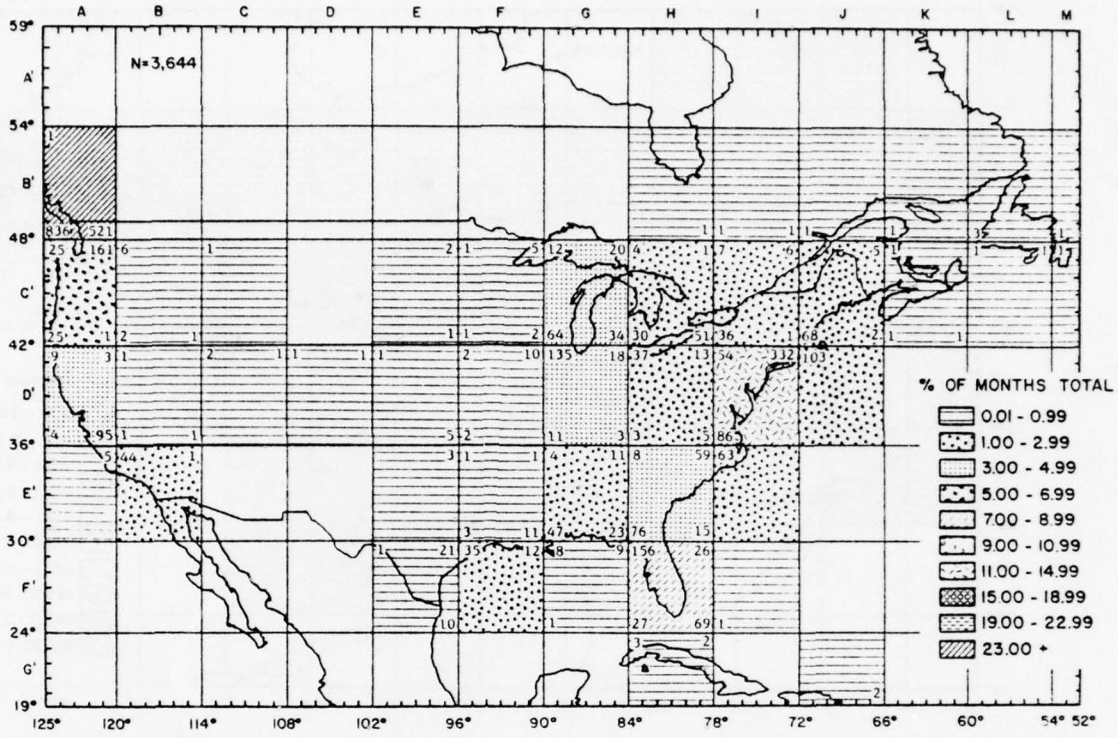

JANUARY- ALL YEARS
N=3,445
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
FEBRUARY- ALL YEARS
N=2,788
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 2C & D.

MARCH- ALL YEARS



APRIL- ALL YEARS

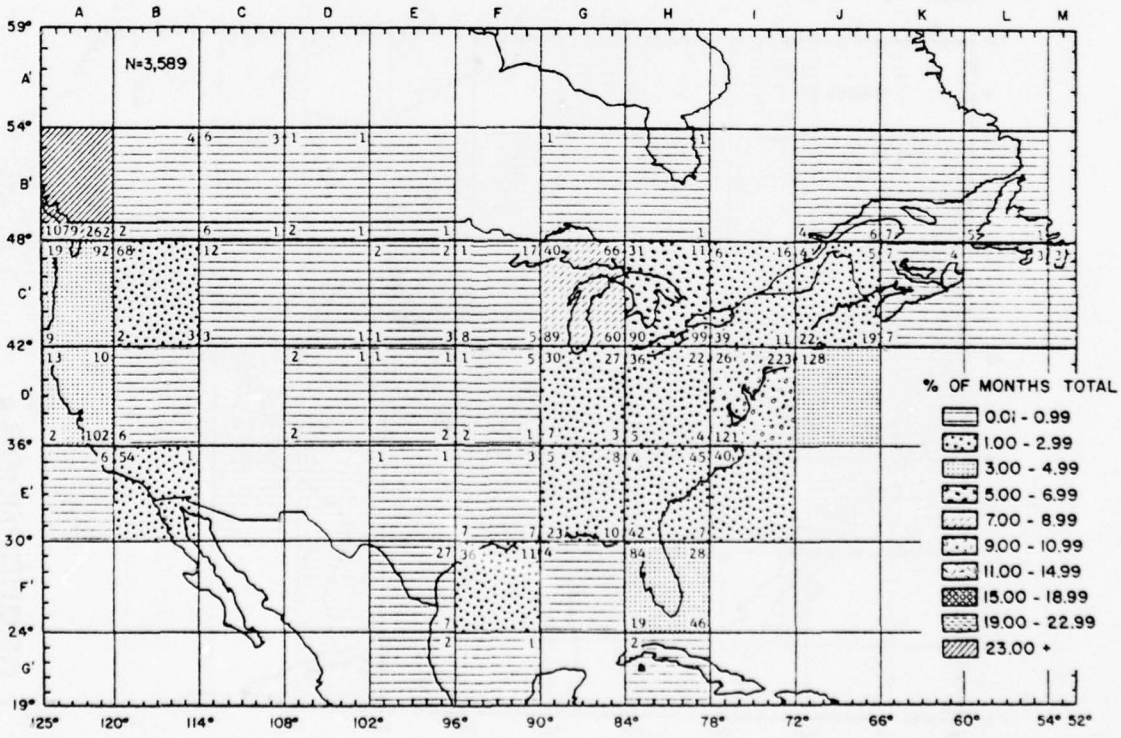


Figure 2E & F.

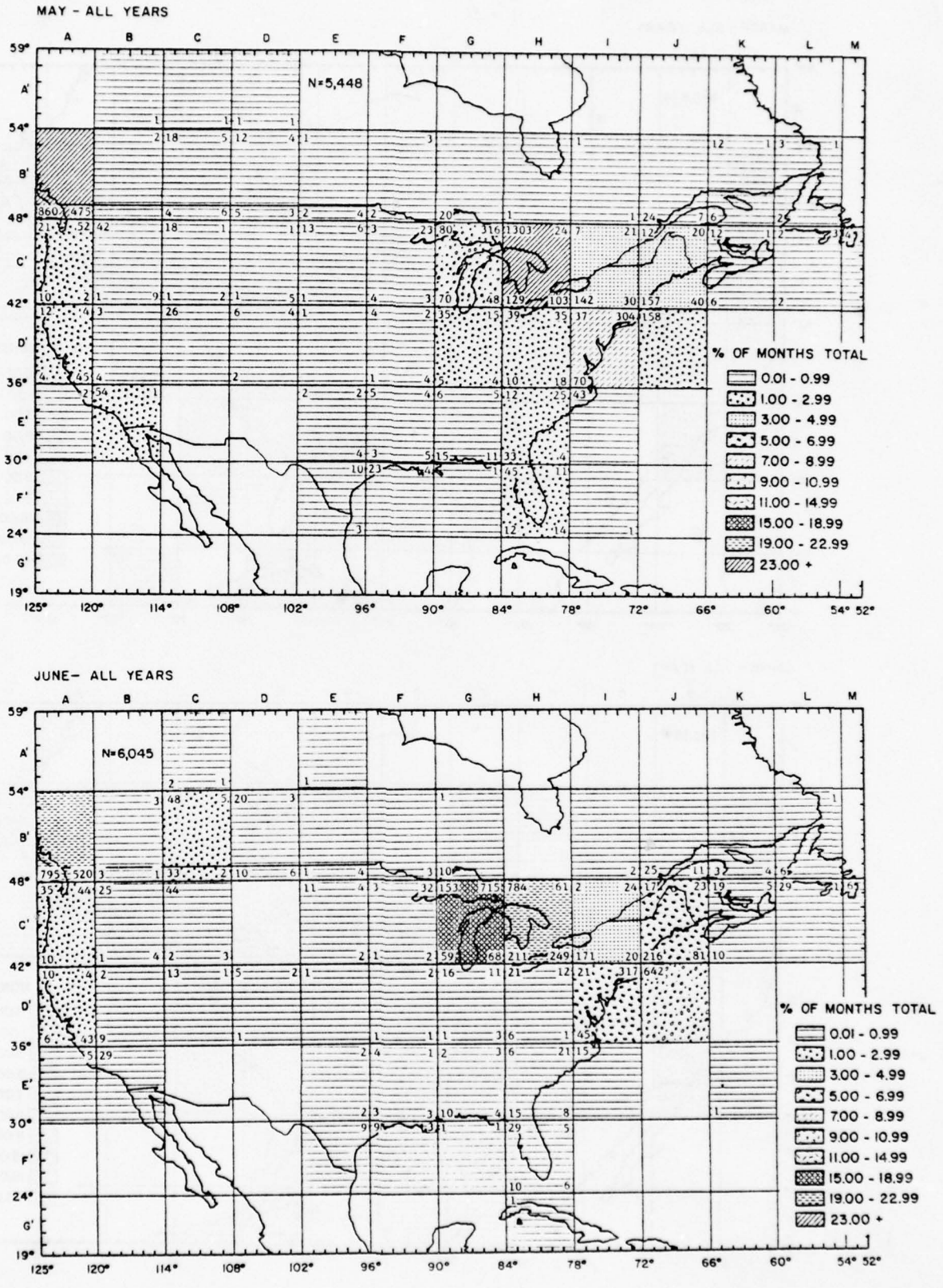
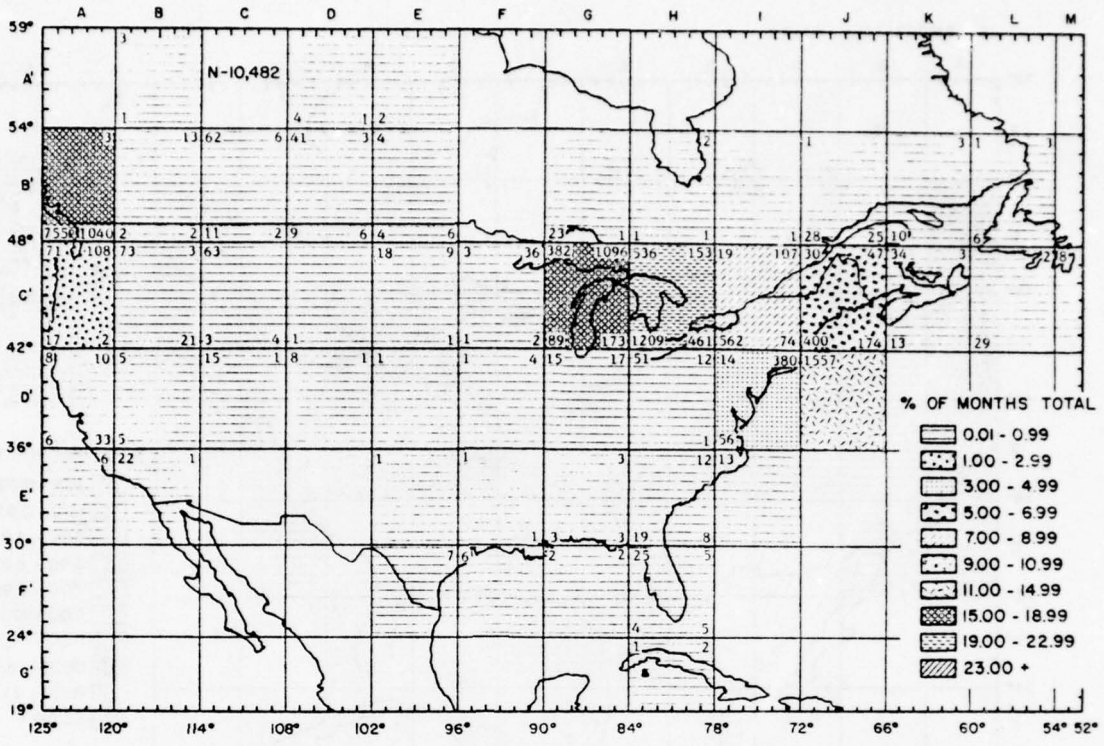

MAY - ALL YEARS
N=5,448
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
JUNE- ALL YEARS
N=6,045
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 2G & H.

JULY-ALL YEARS



AUGUST-ALL YEARS

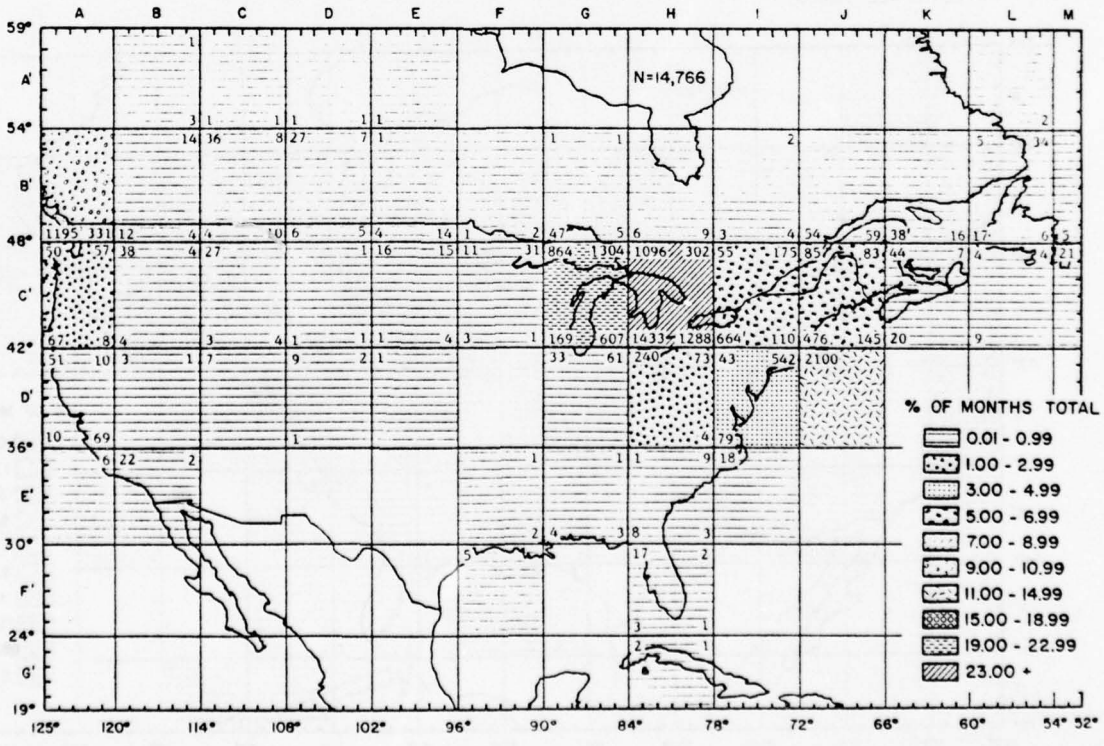


Figure 2I & J.

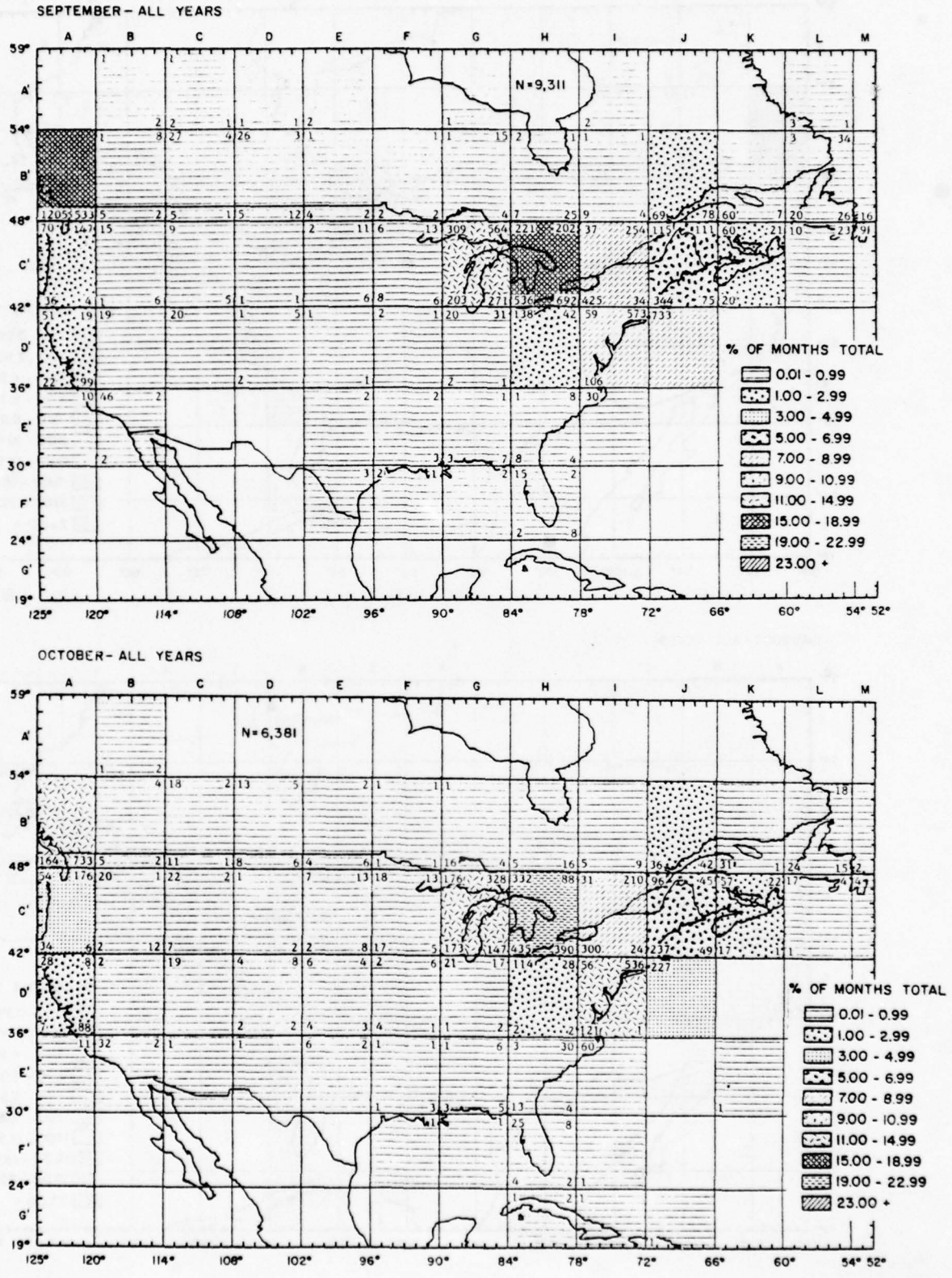
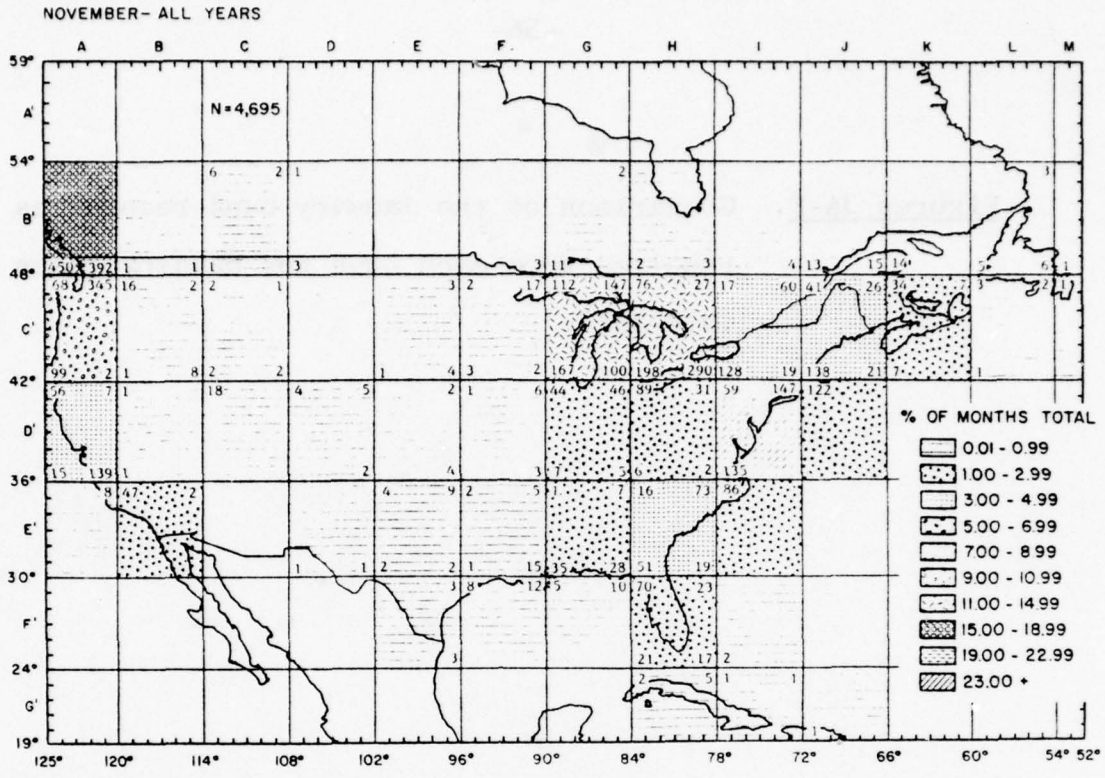
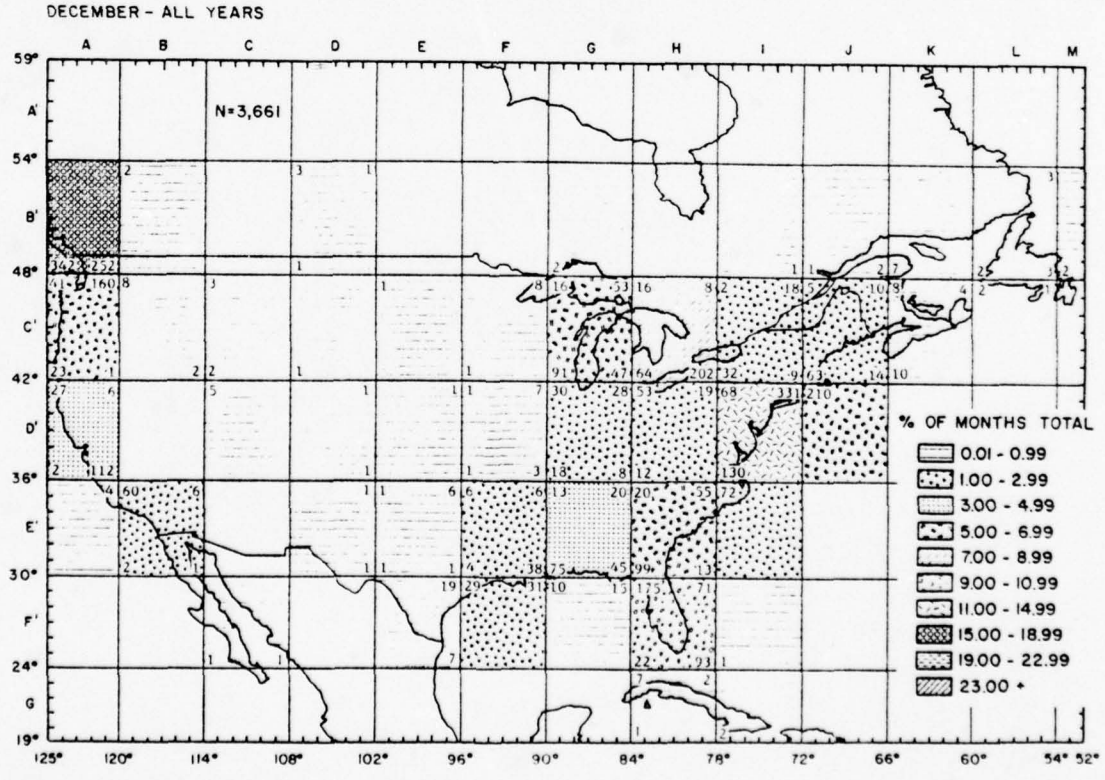

SEPTEMBER- ALL YEARS
N=9,311
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
OCTOBER- ALL YEARS
N=6,381
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 2K & L.


NOVEMBER- ALL YEARS
N=4,695
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +


DECEMBER - ALL YEARS
N=3,661
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 3A-F. Comparison of the January band recoveries reported from each Zone for banding years 1972-1977.

Figure 3A & B.

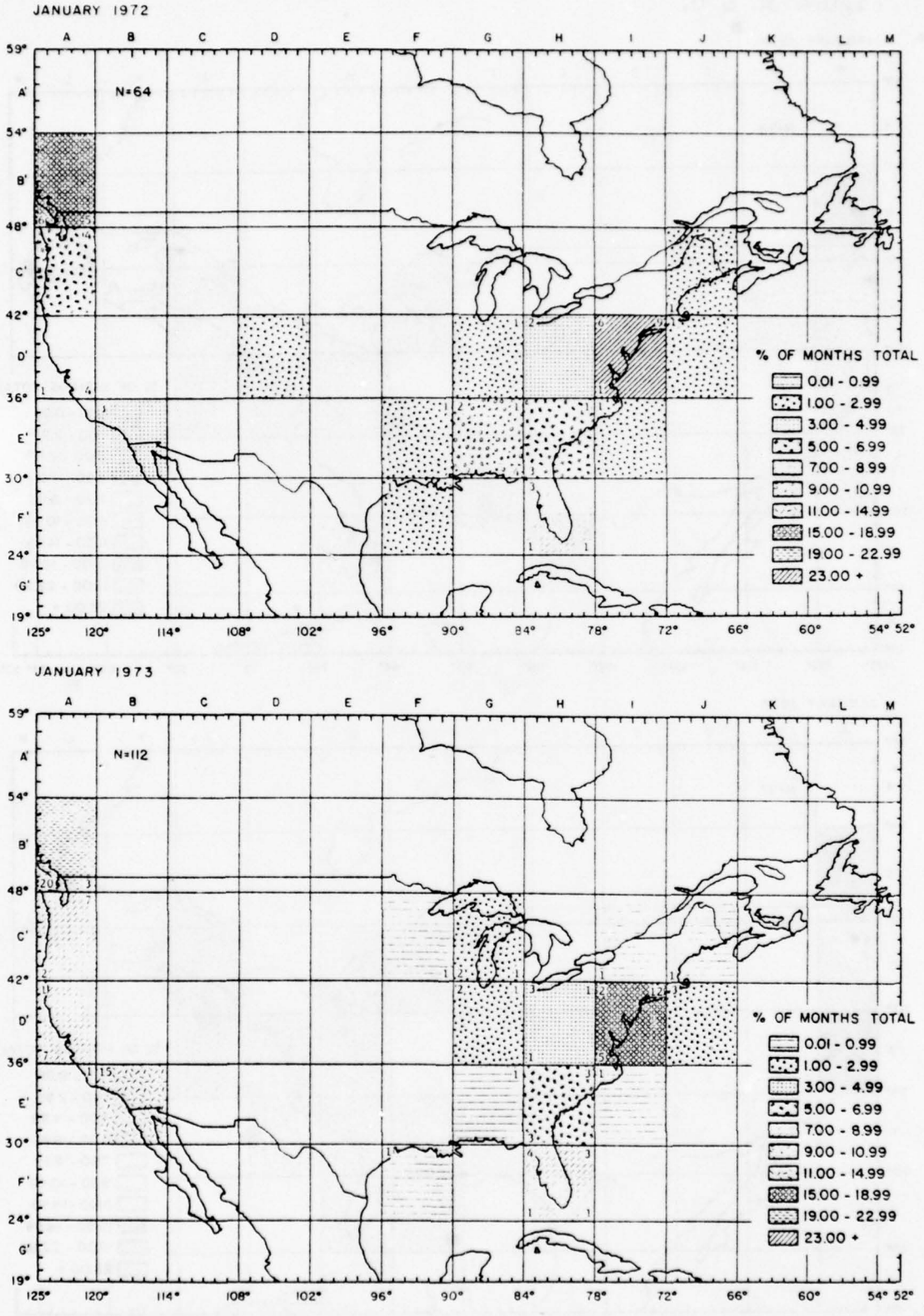

JANUARY 1972
N=64
JANUARY 1973
N=112
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
A B C D E F G H I J K L M
59° A' 54° B' 48° C' 42° D' 36° E' 30° F' 24° G' 19°
125° 120° 114° 108° 102° 96° 90° 84° 78° 72° 66° 60° 54° 52°

Figure 3C & D.

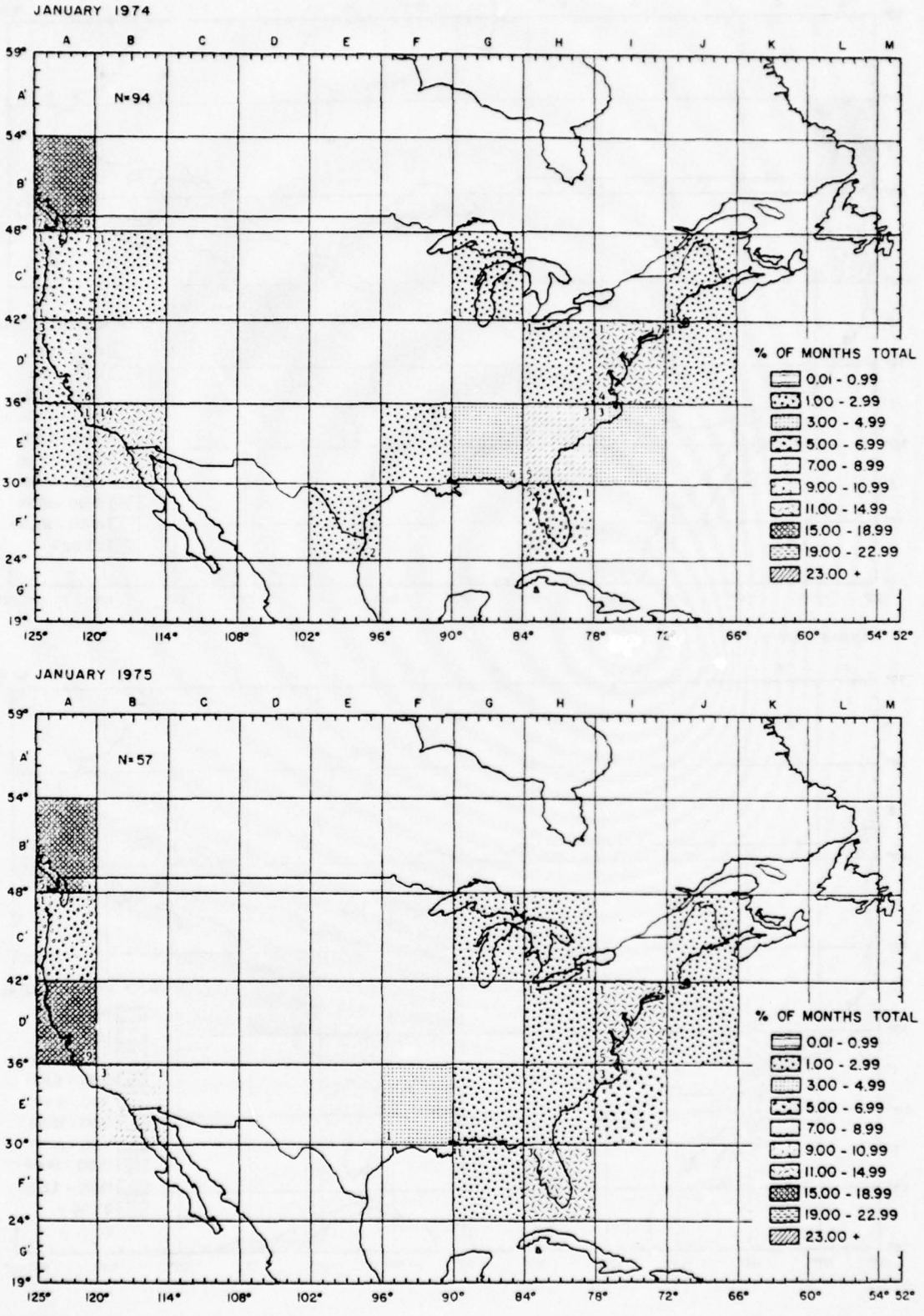
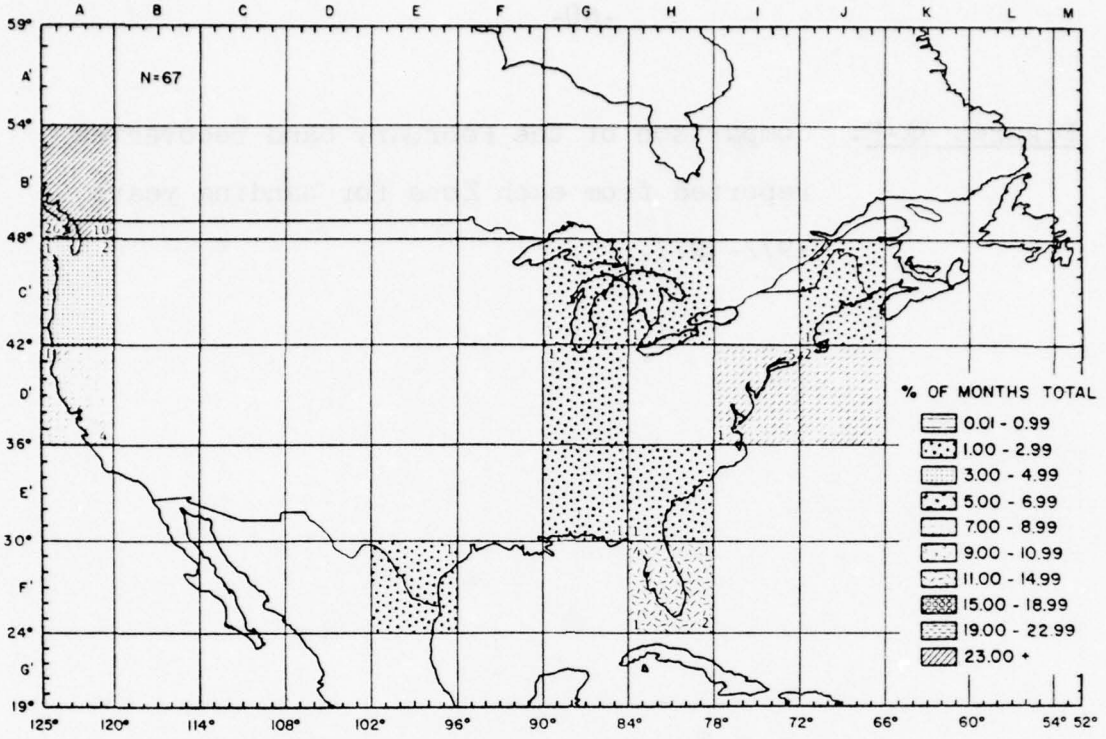
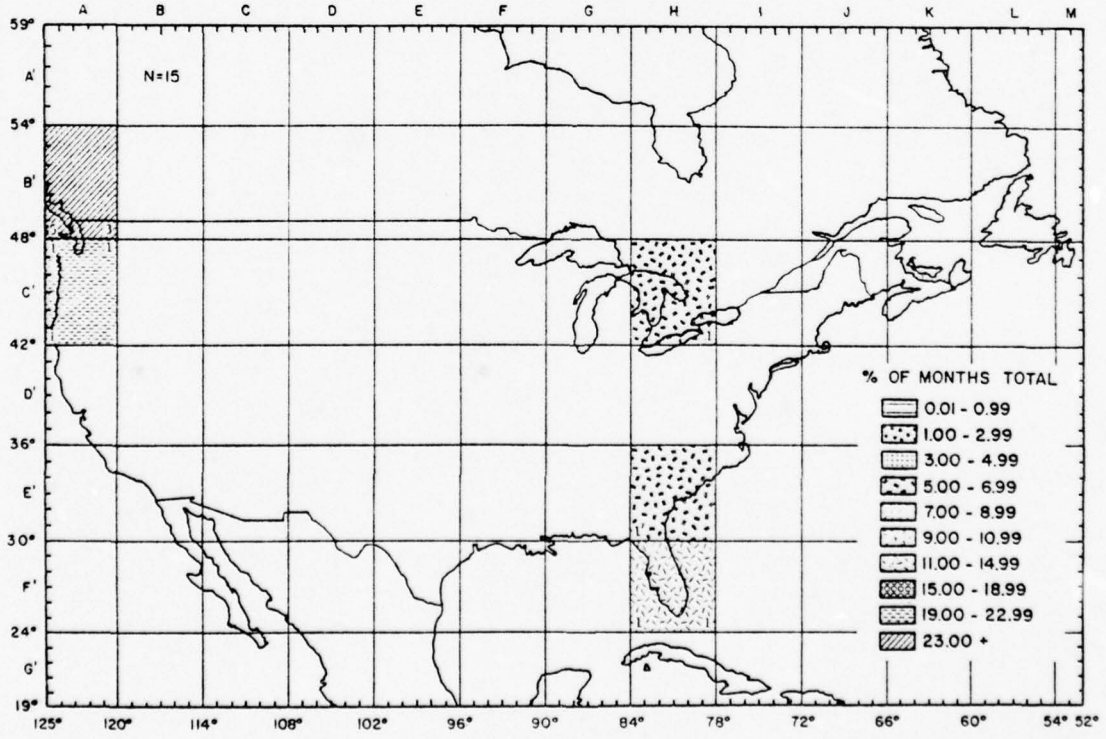

JANUARY 1974
N=94
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
JANUARY 1975
N=57
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 3E & F.

JANUARY 1976



JANUARY 1977



Figures 4A-F. Comparison of the February band recoveries reported from each Zone for banding years 1972-1977.

Figure 4A & B.

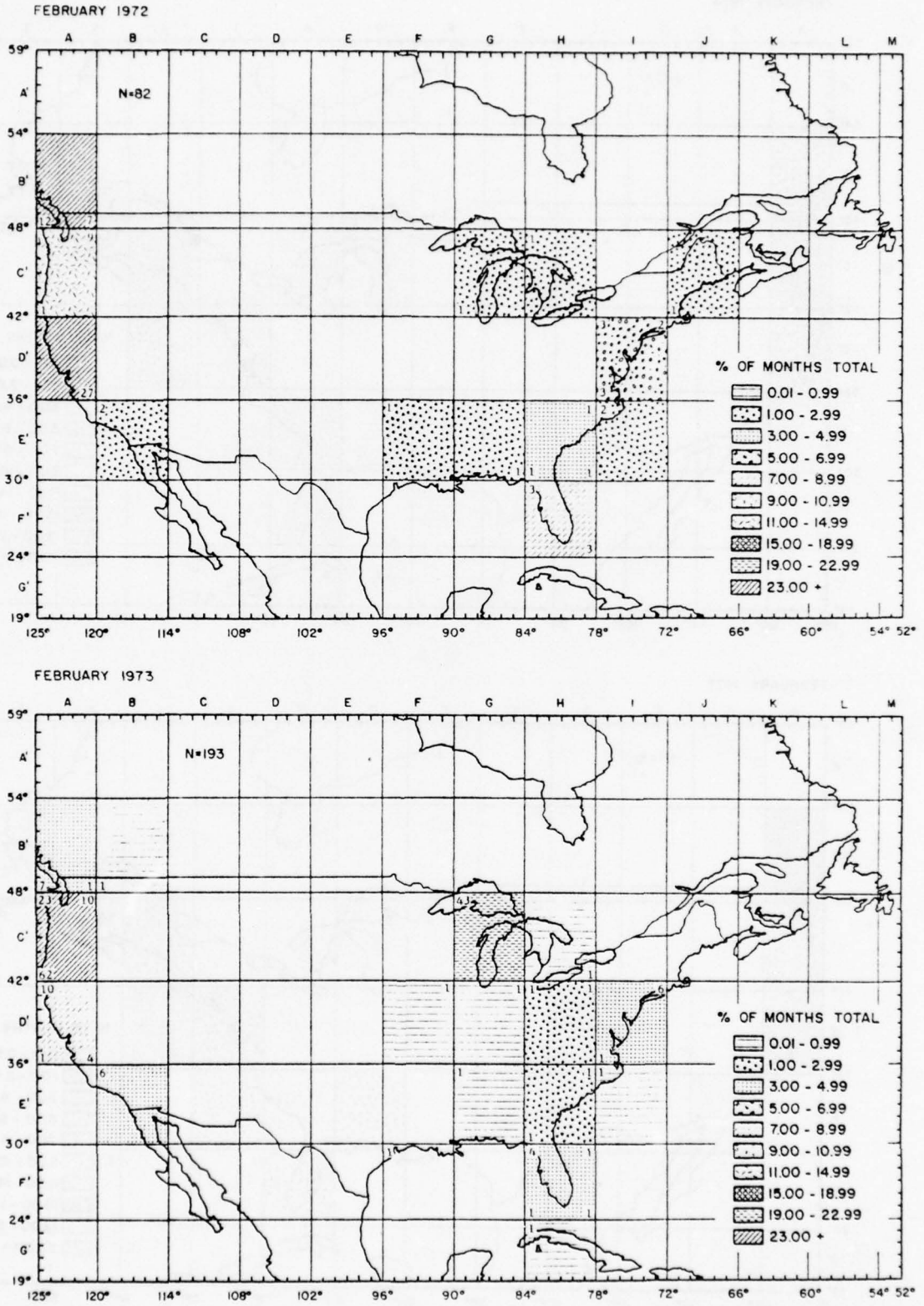
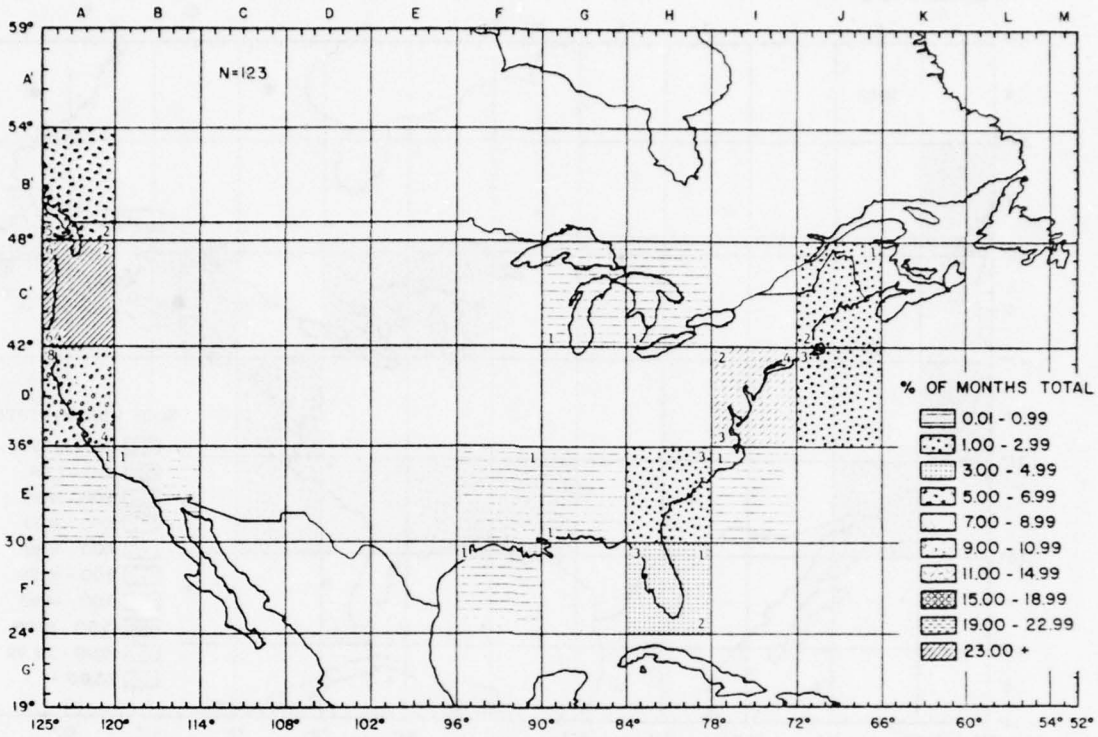

FEBRUARY 1972
N=82
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
FEBRUARY 1973
N=193
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 4C & D.

FEBRUARY 1974



FEBRUARY 1975

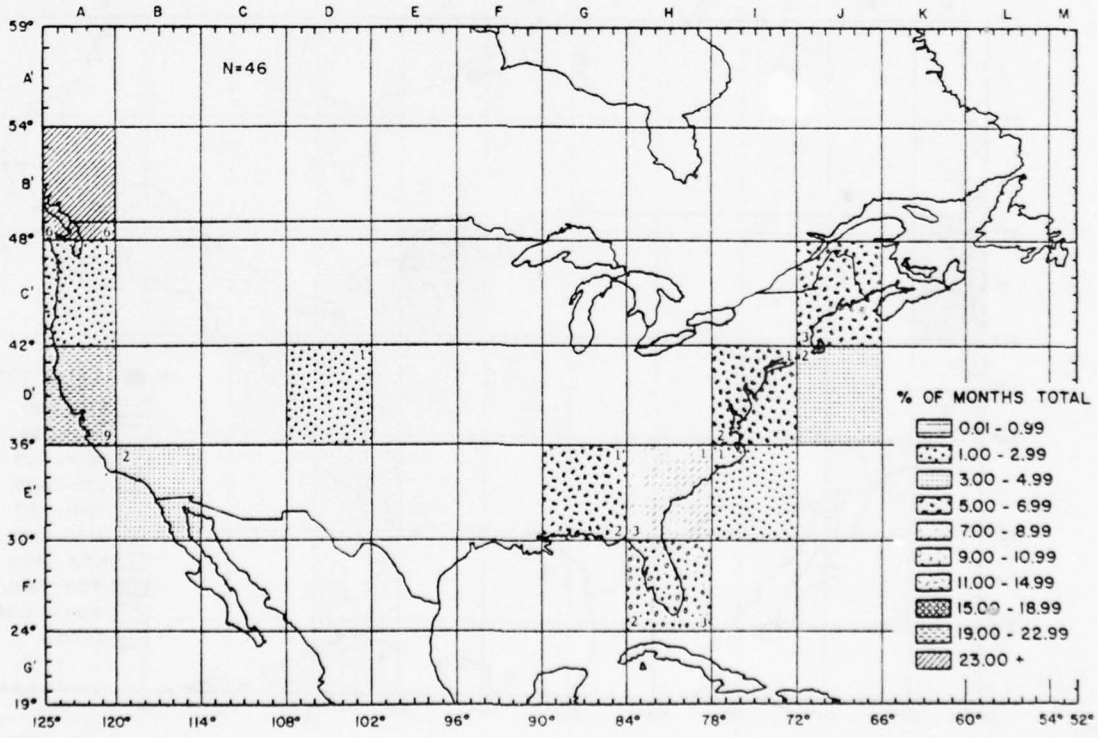
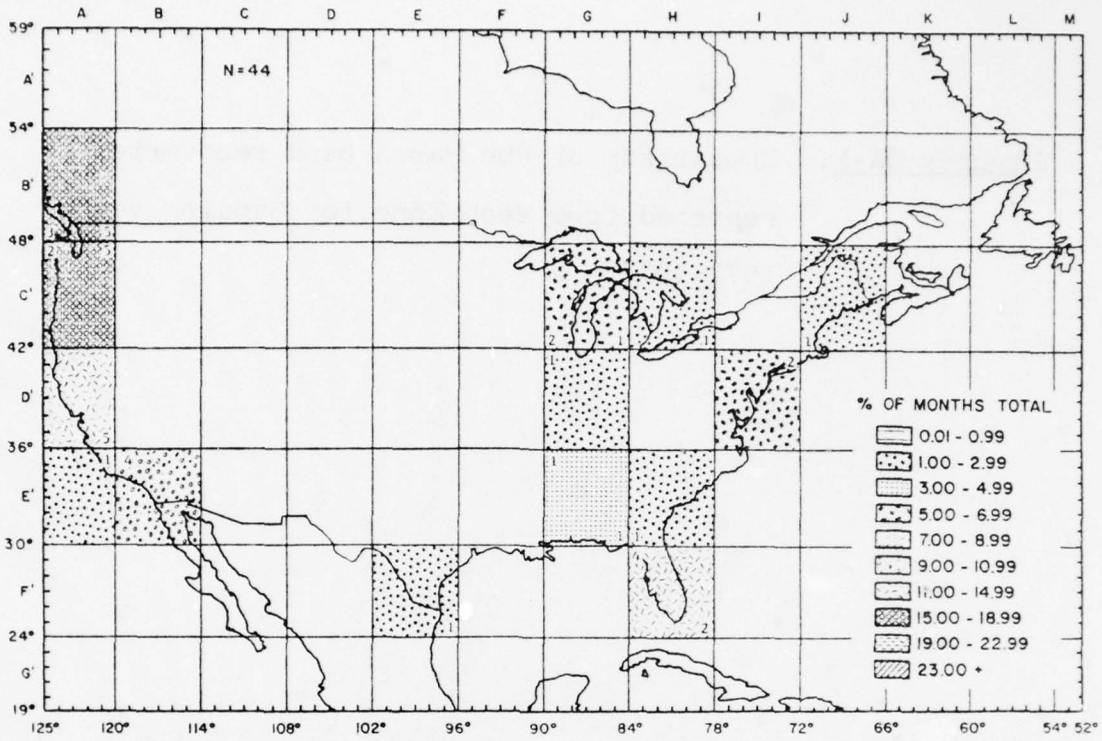
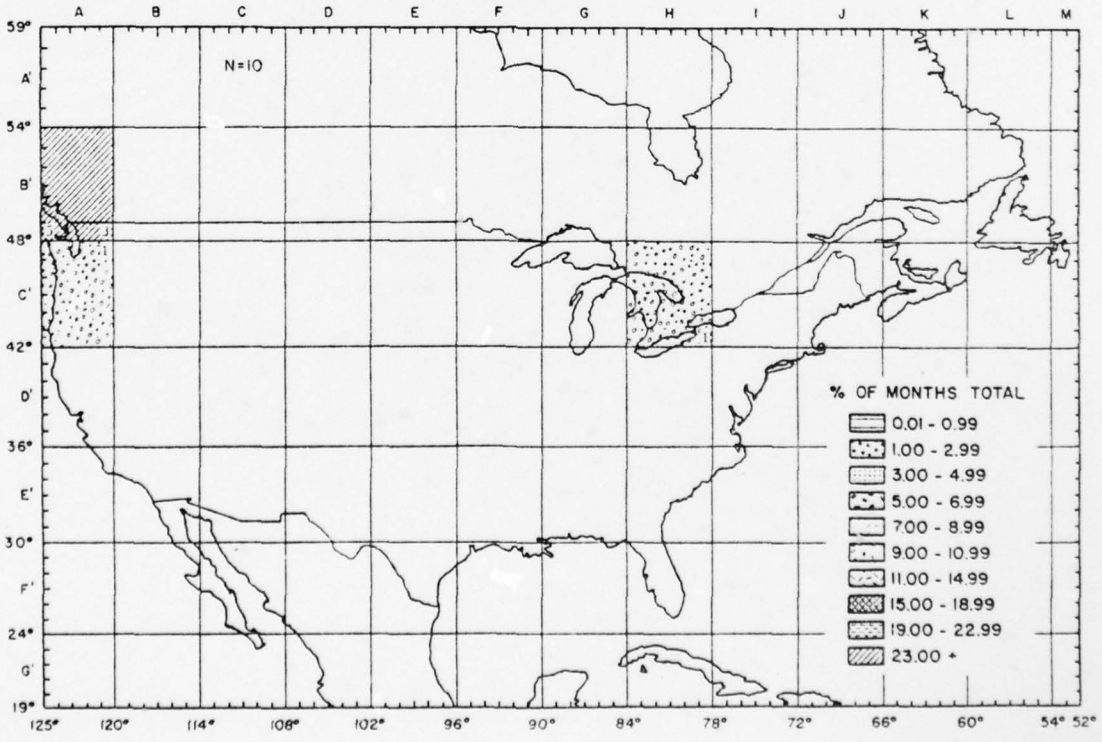


Figure 4E & F.

FEBRUARY 1976



FEBRUARY 1977



Figures 5A-F. Comparison of the March band recoveries reported from each Zone for banding years 1972-1977.

Figure 5A & B.

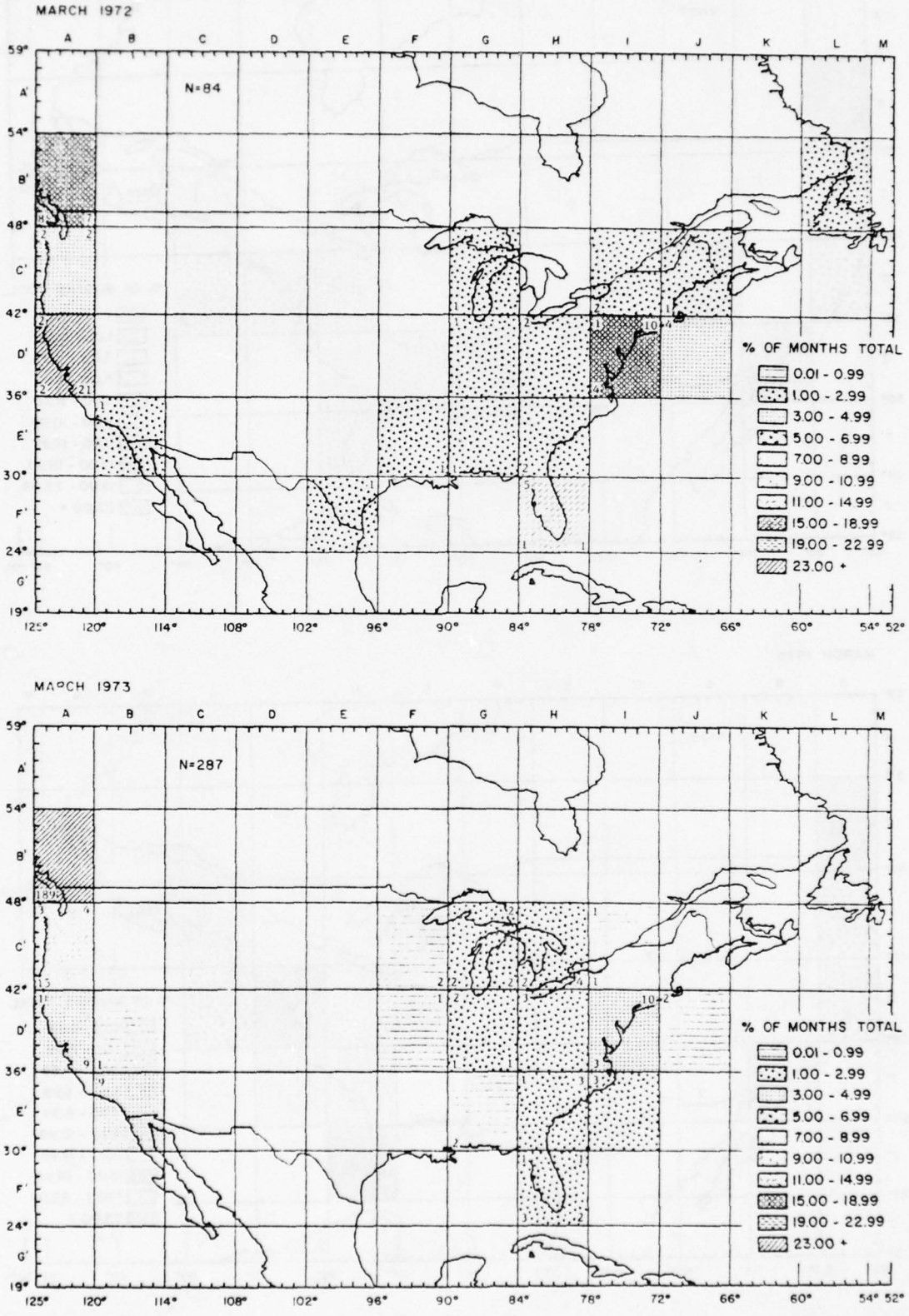
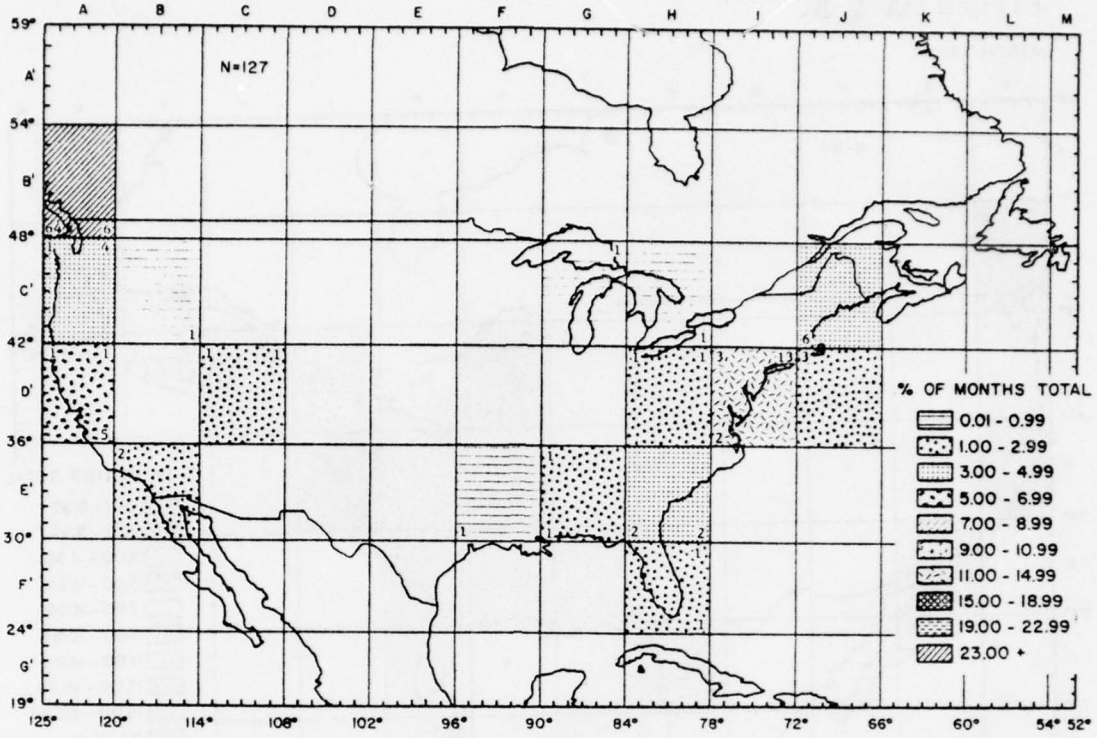

MARCH 1972
N=84
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
MARCH 1973
N=287
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 5C & D.

MARCH 1974



MARCH 1975

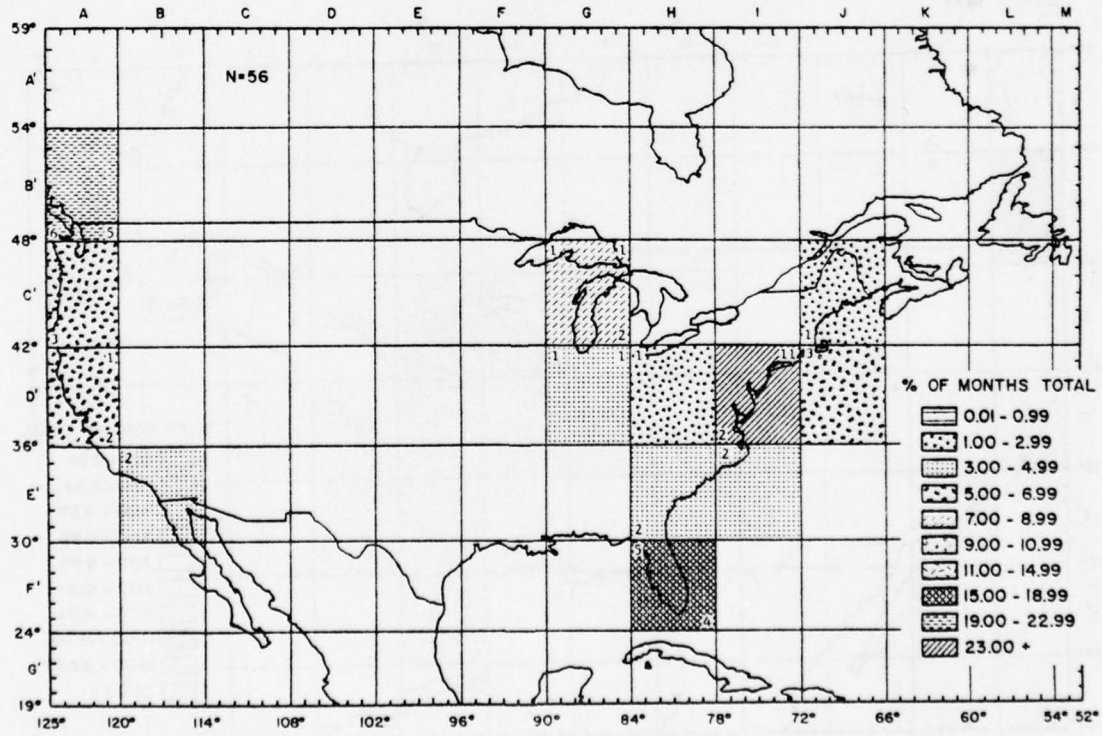
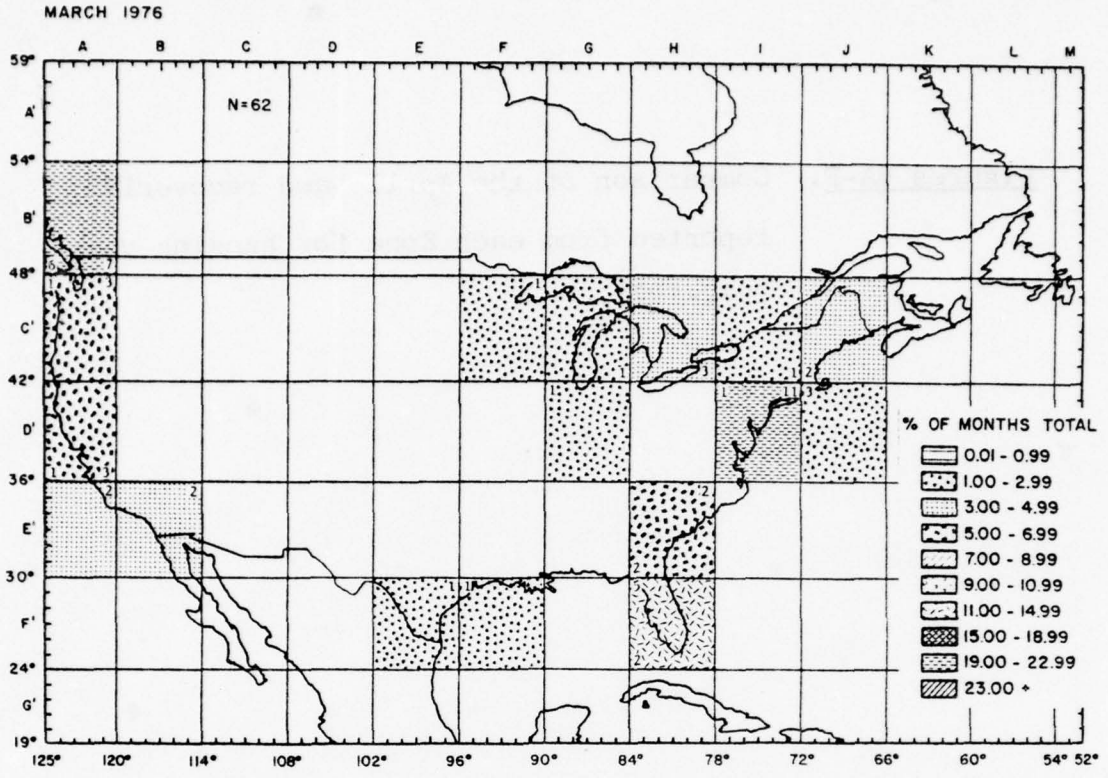
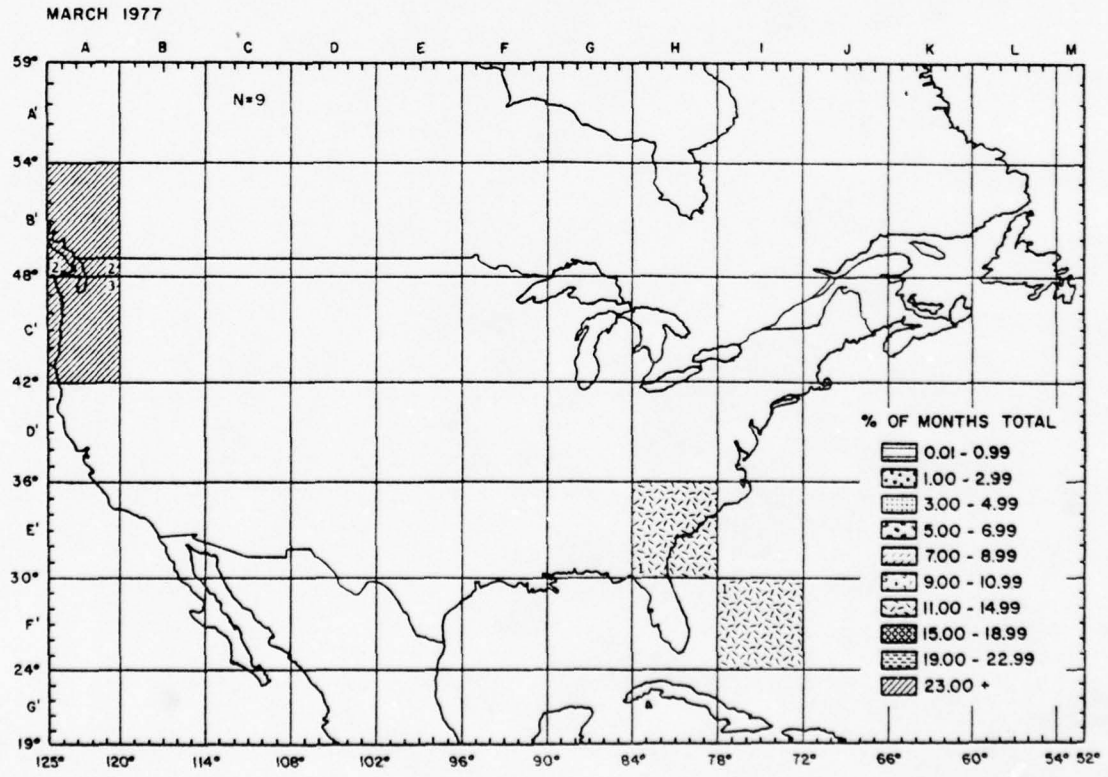


Figure 5E & F.


MARCH 1976
N=62
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +


MARCH 1977
N=9
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 6A-F. Comparison of the April band recoveries reported from each Zone for banding years 1972-1977.

Figure 6A & B.

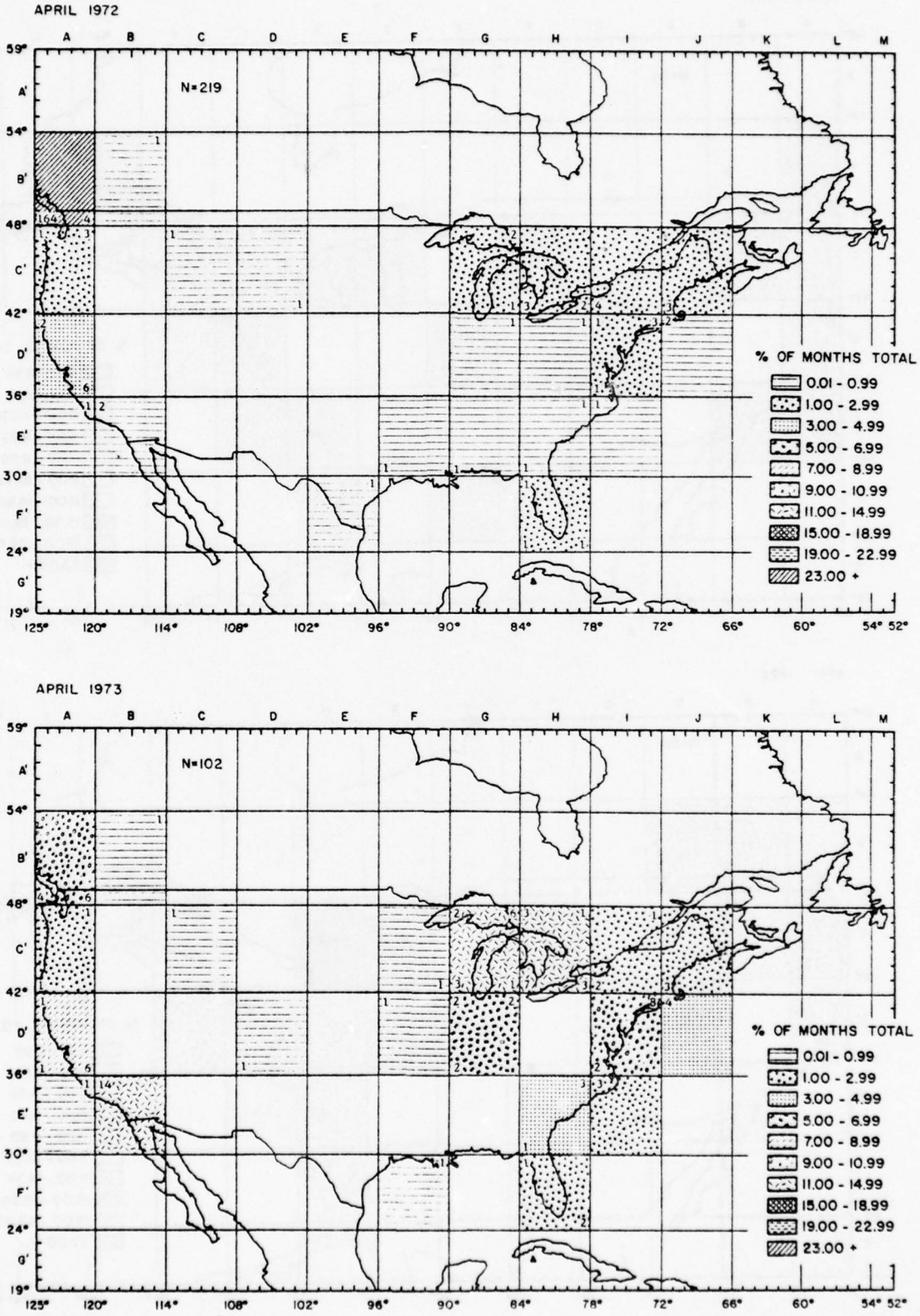
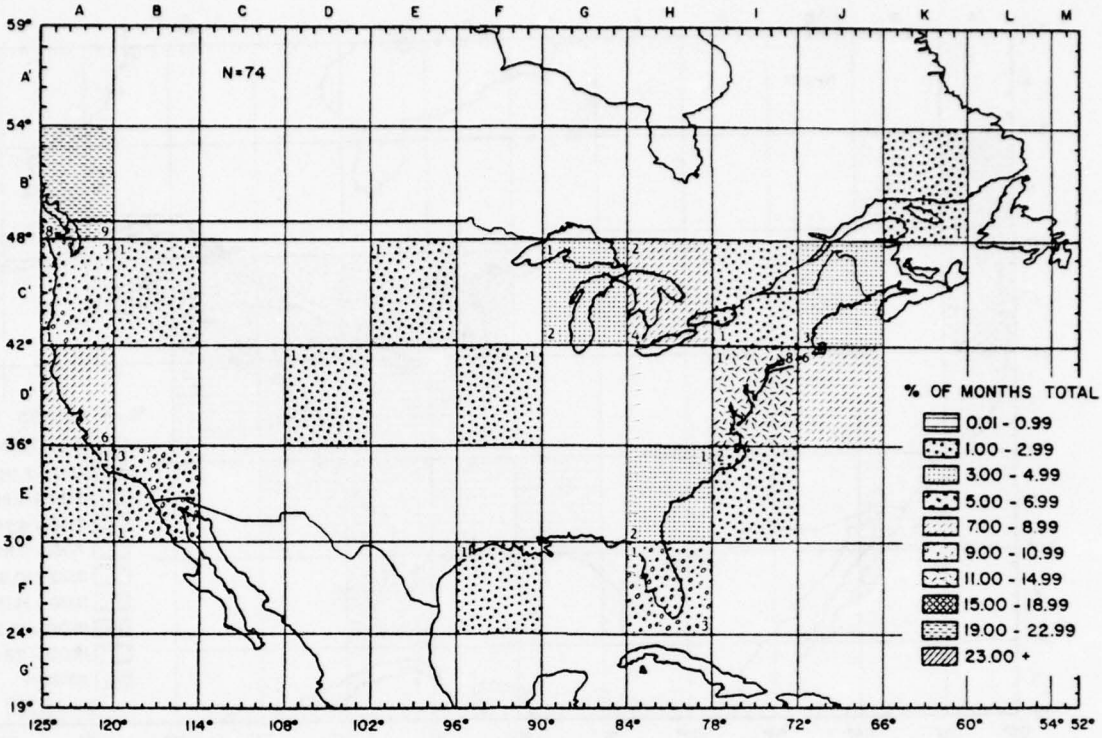

APRIL 1972
N=219
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
APRIL 1973
N=102
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 6C & D.

APRIL 1974



APRIL 1975

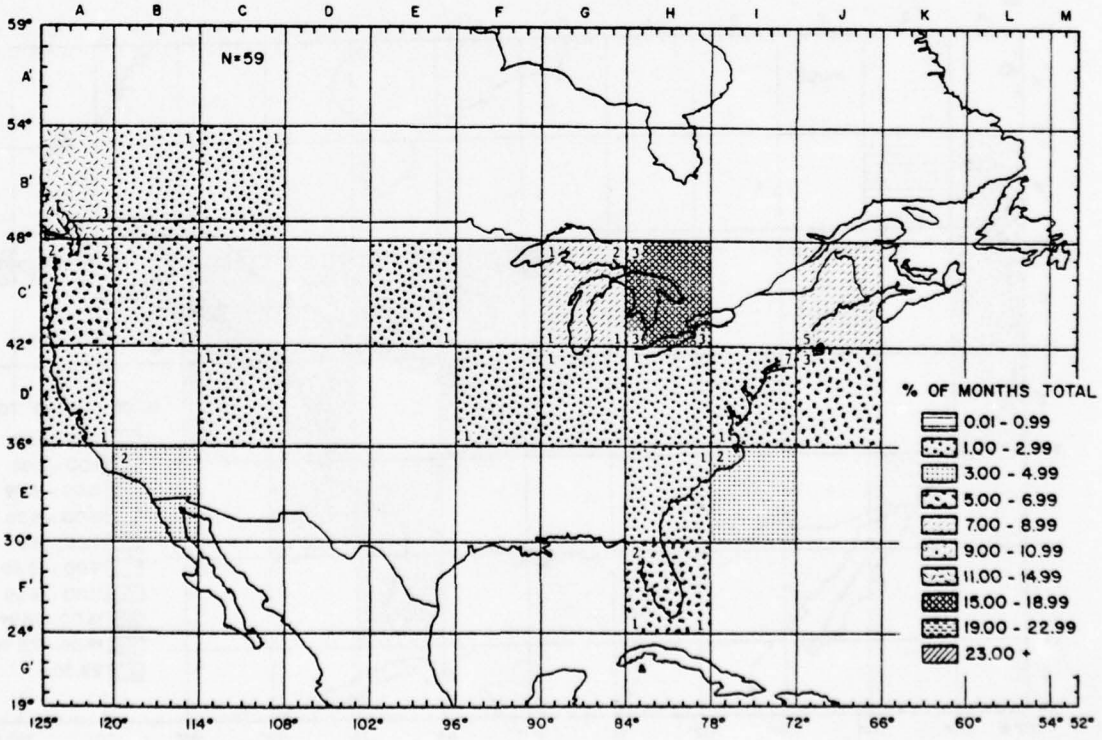
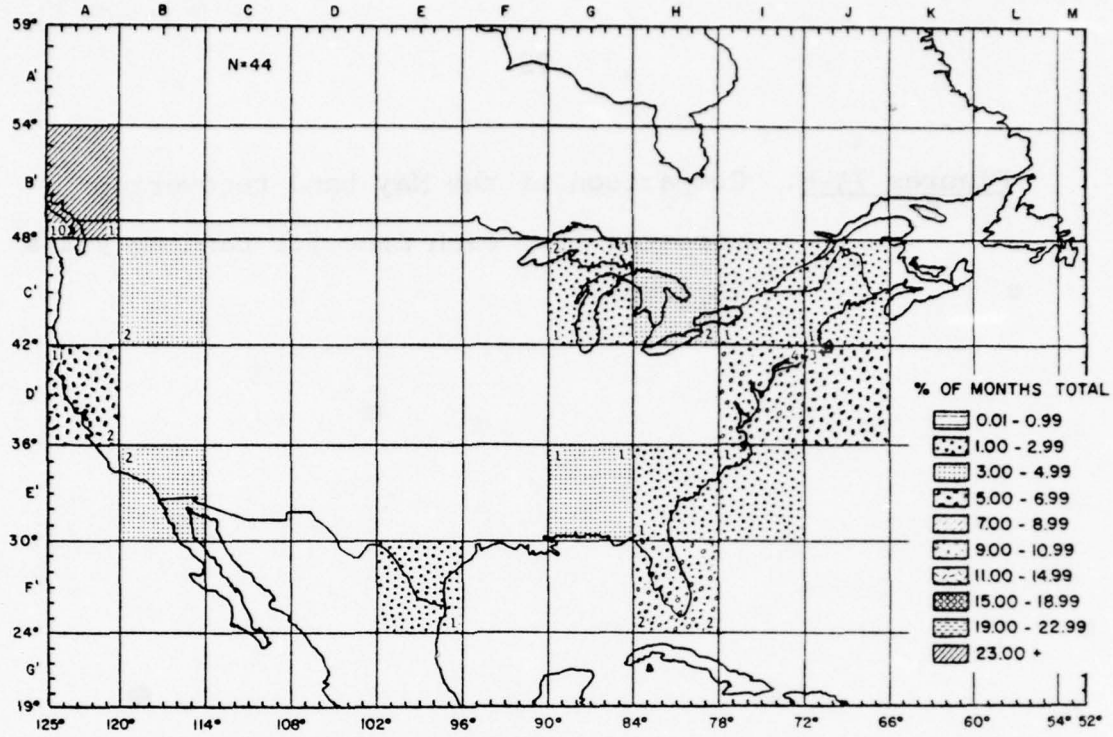
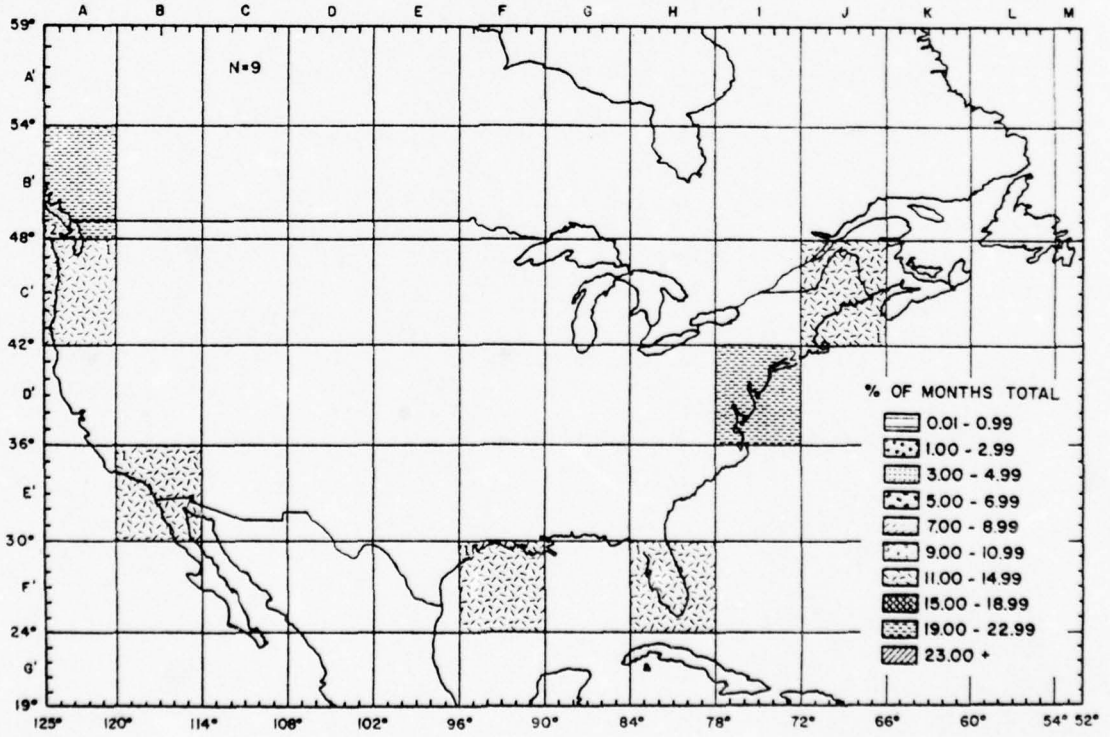


Figure 6E & F.

APRIL 1976



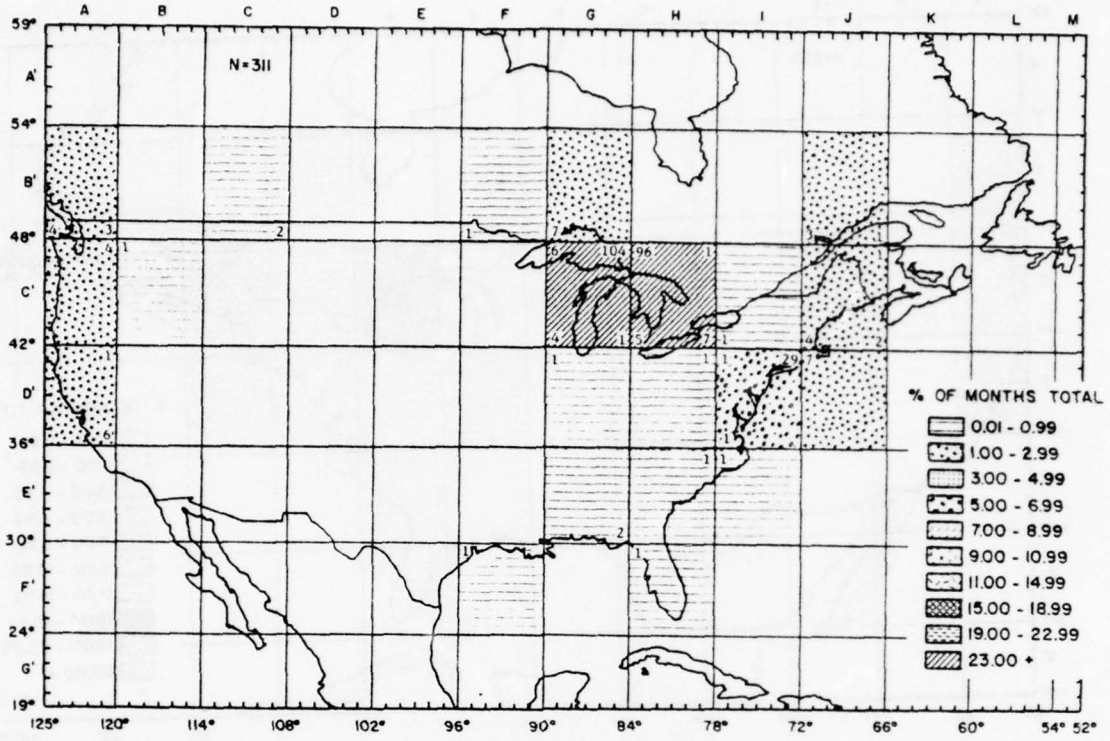
APRIL 1977



Figures 7A-F. Comparison of the May band recoveries reported from each Zone for banding years 1972-1977.

Figure 7A & B.

MAY 1972



MAY 1973

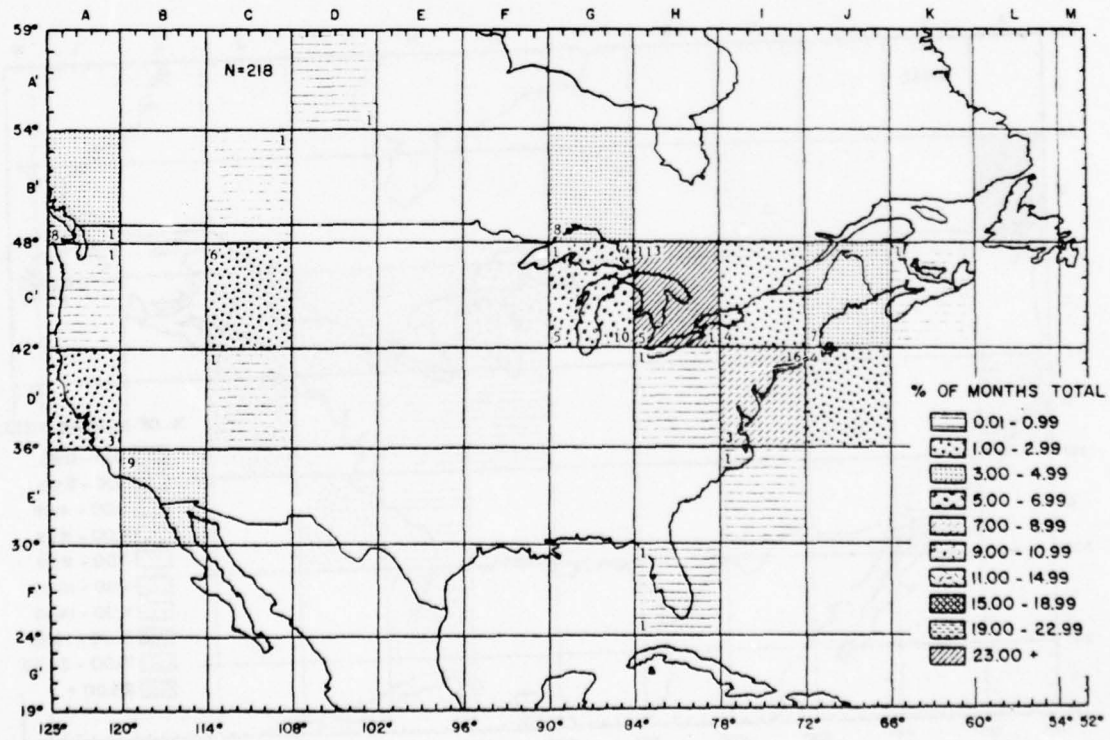
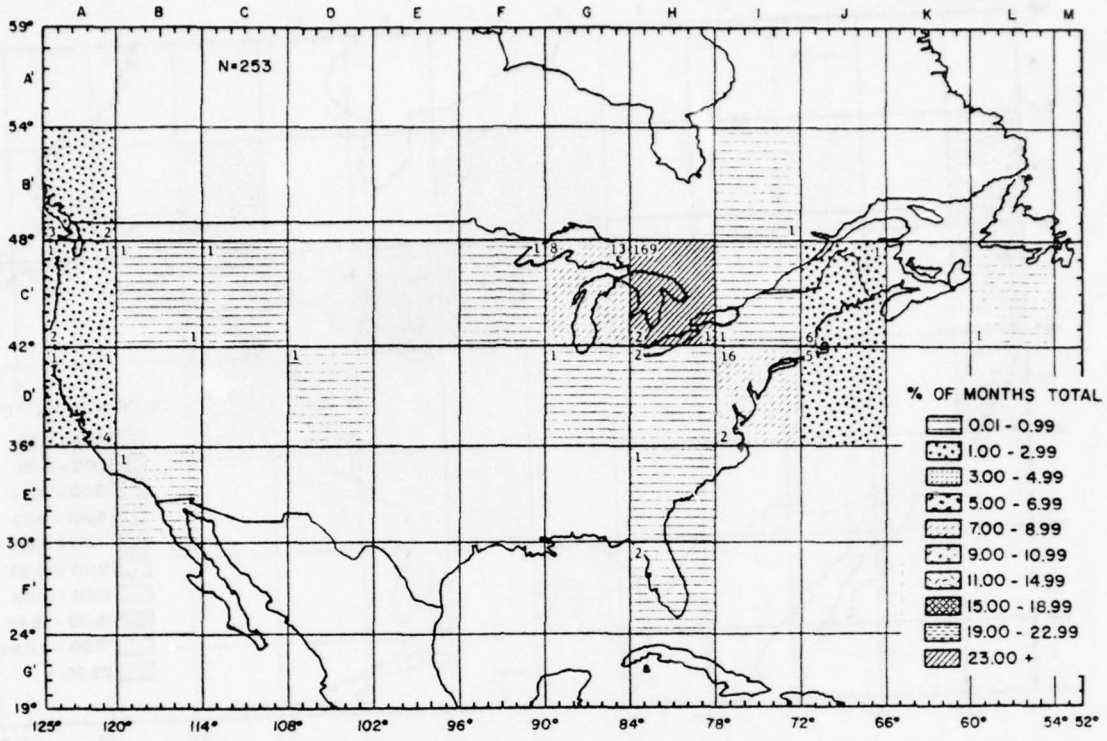


Figure 7C & D.

MAY 1974



MAY 1975

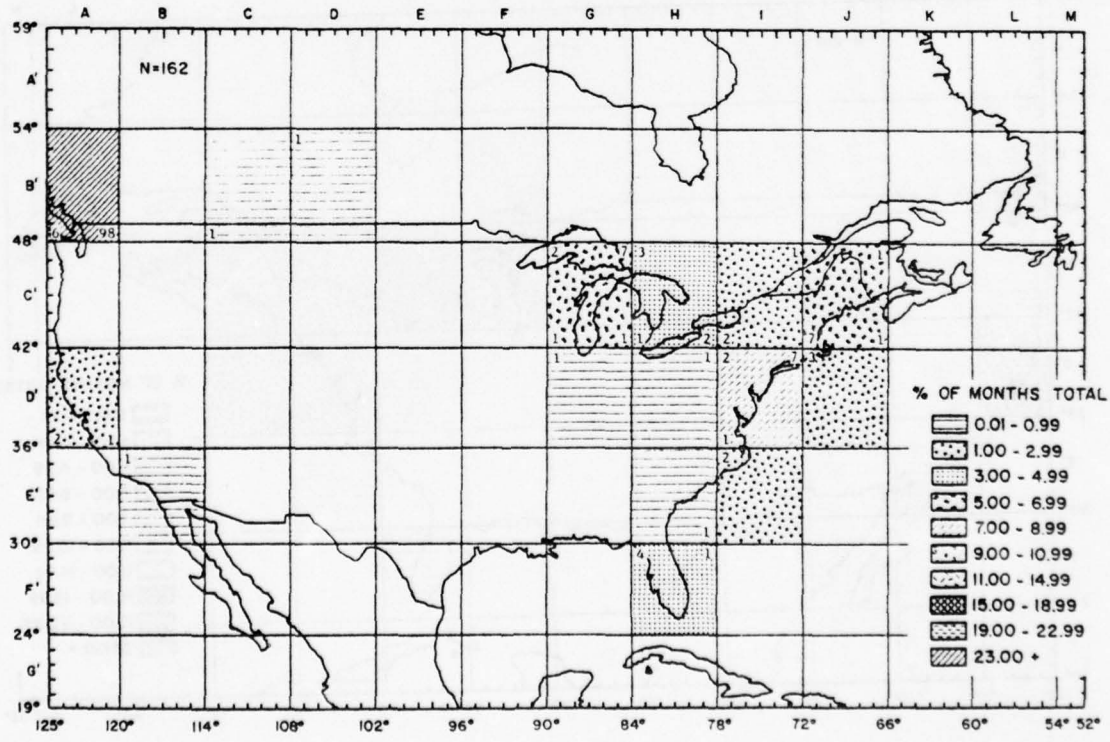
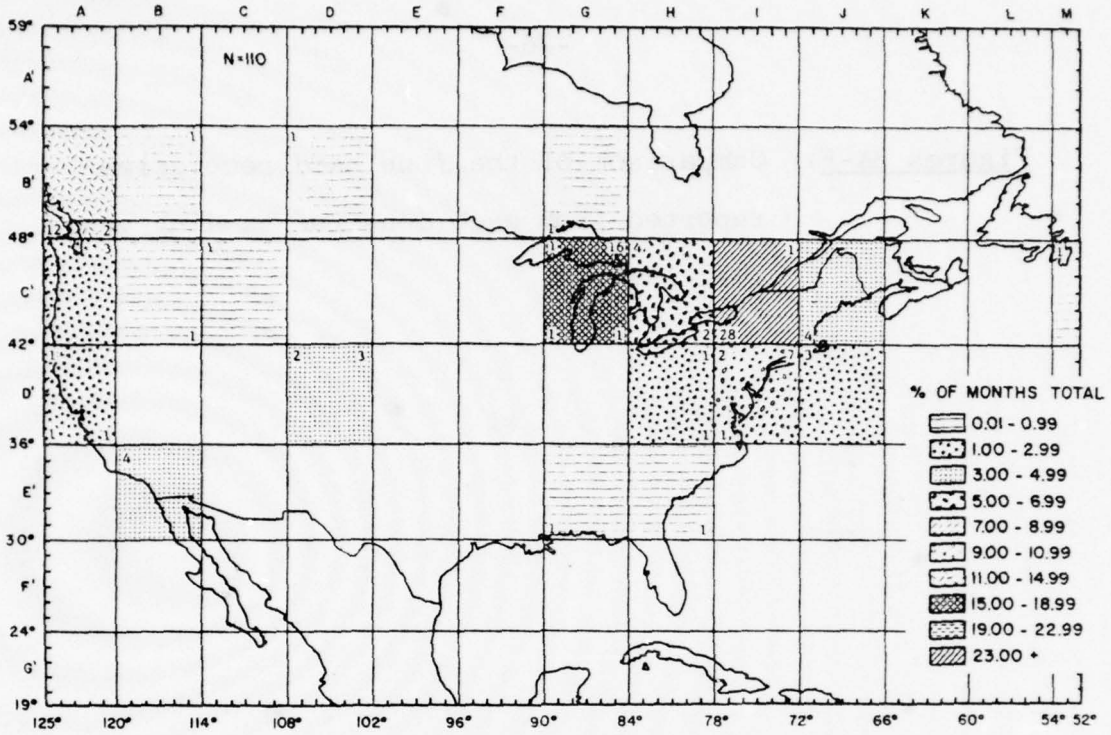
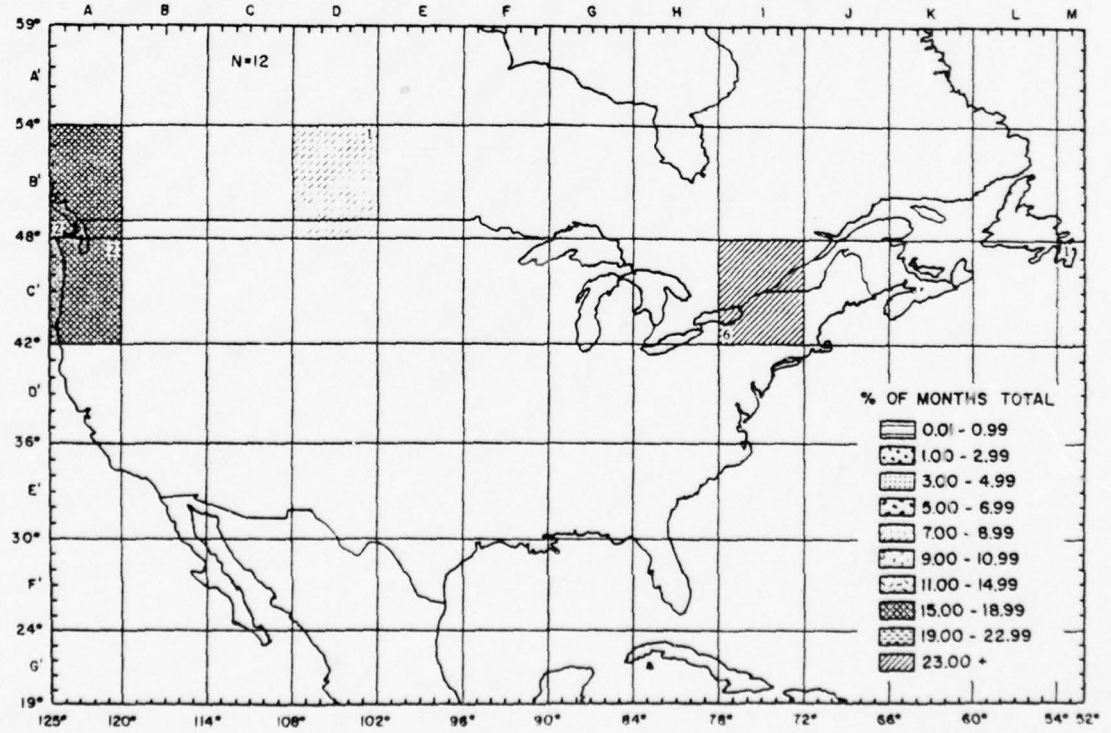


Figure 7 E & F.

MAY 1976



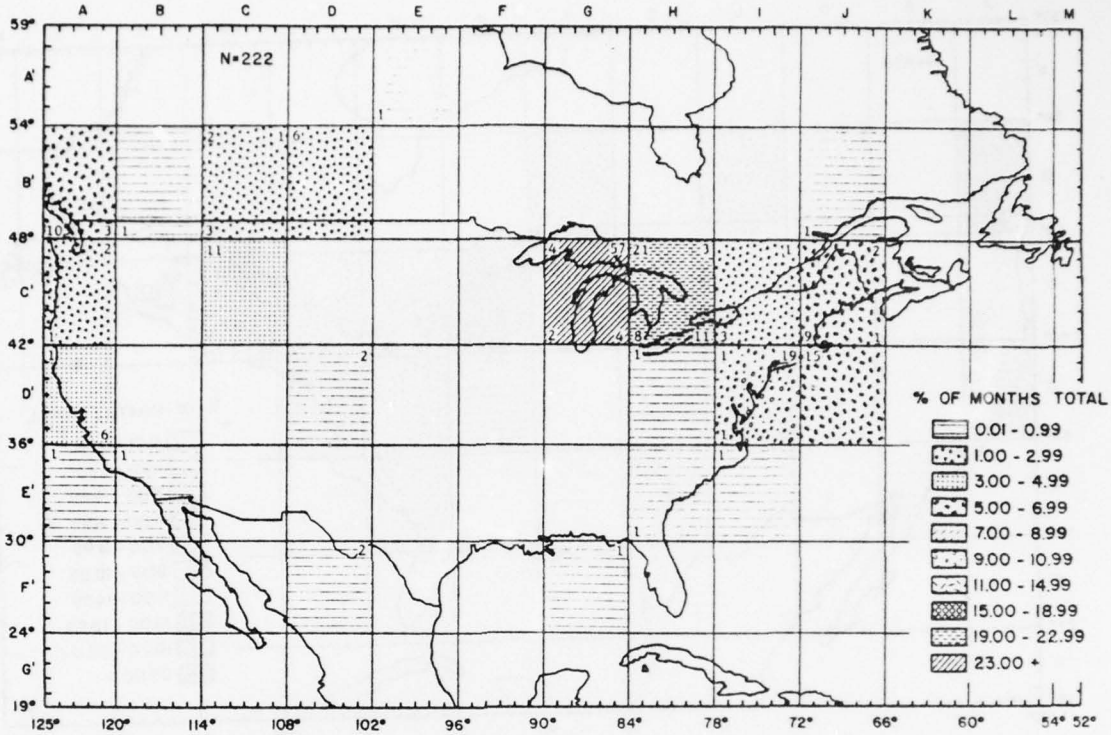
MAY 1977



Figures 8A-F. Comparison of the June band recoveries reported from each Zone for banding years 1972-1977.

Figure 8A & B. -77-

JUNE 1972



JUNE 1973

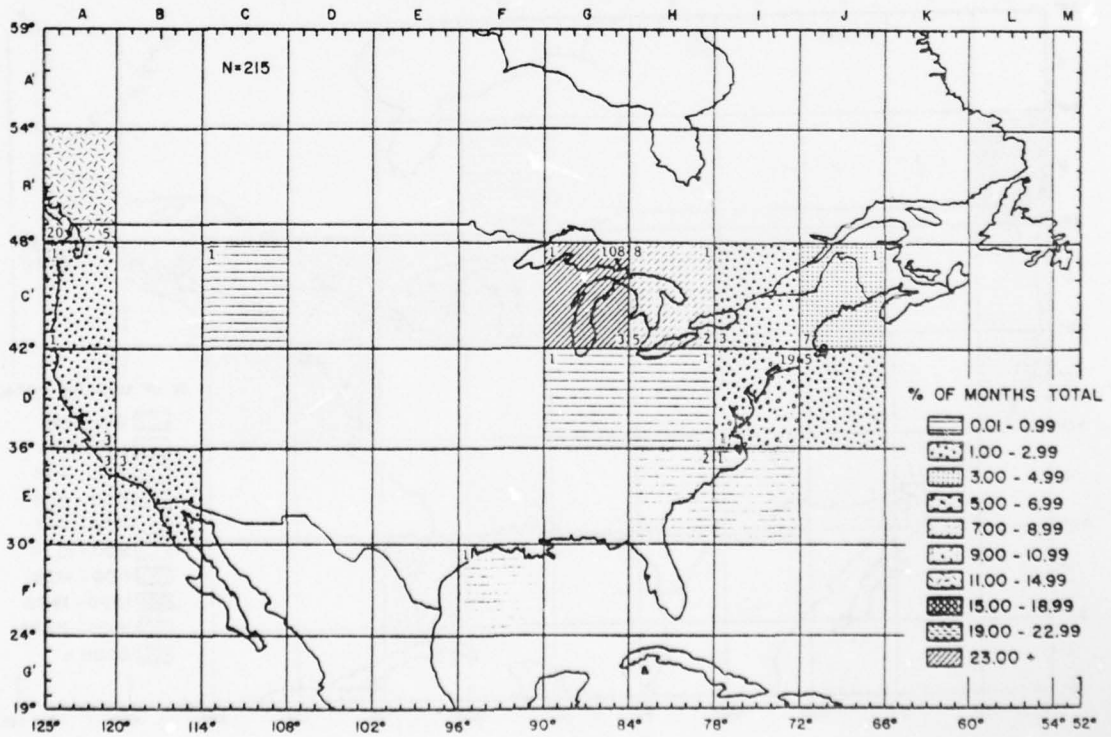
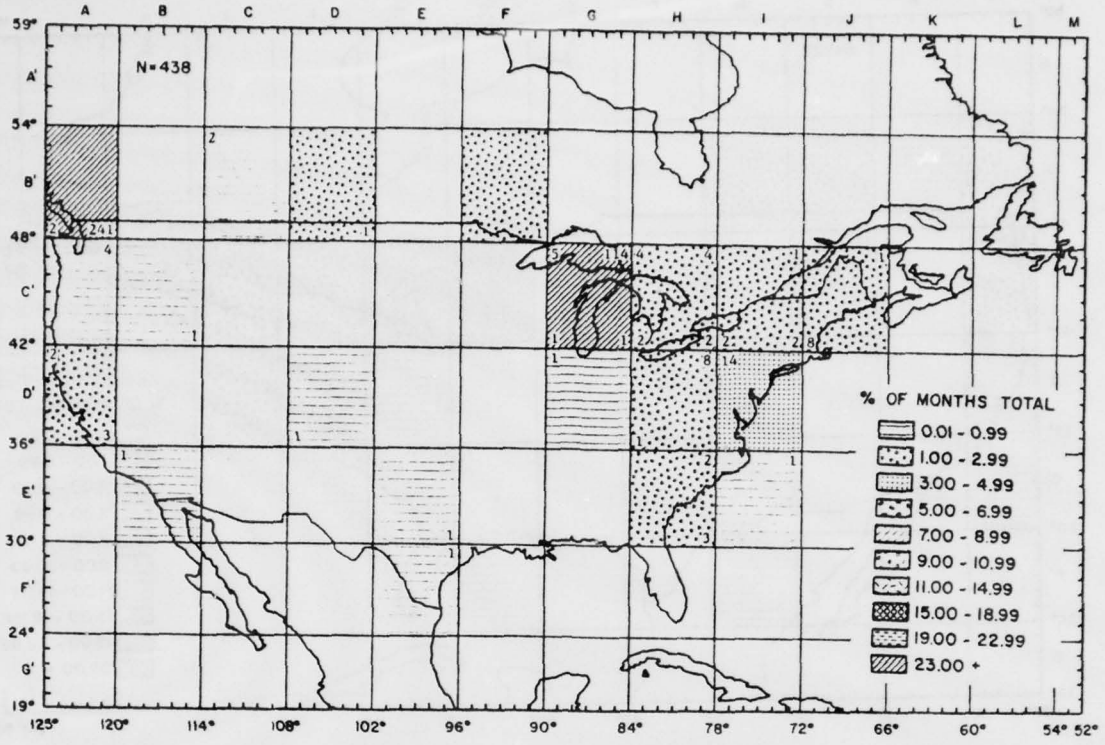


Figure 8C & D.

JUNE 1974



JUNE 1975

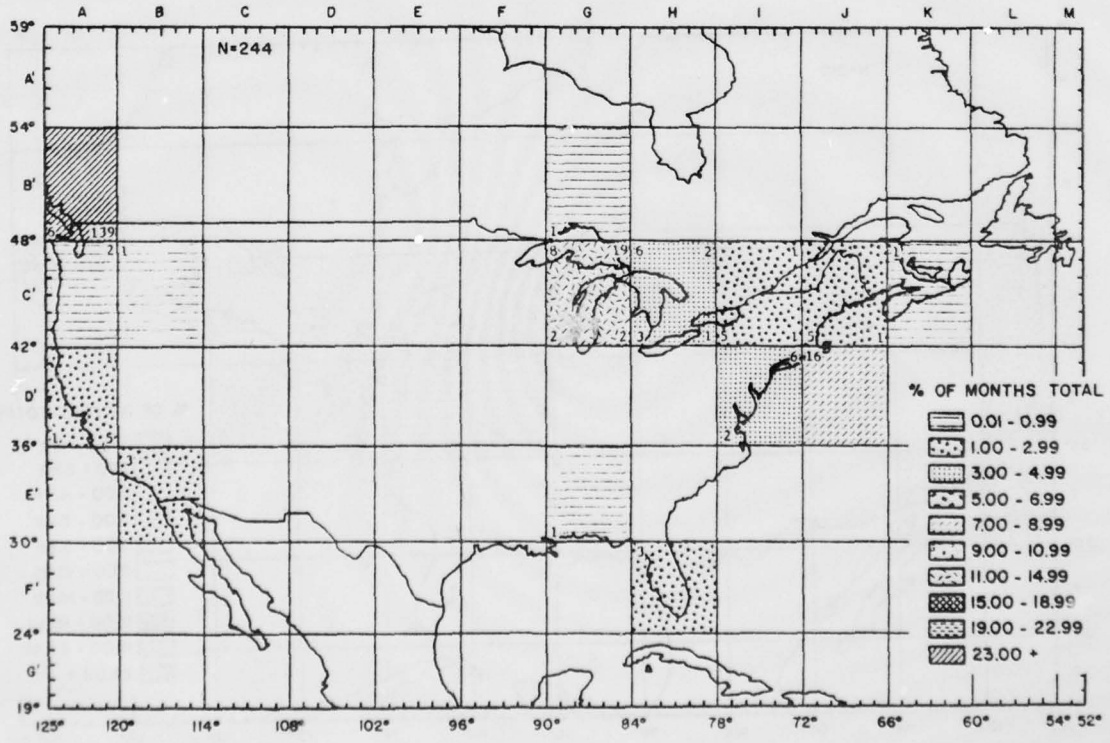
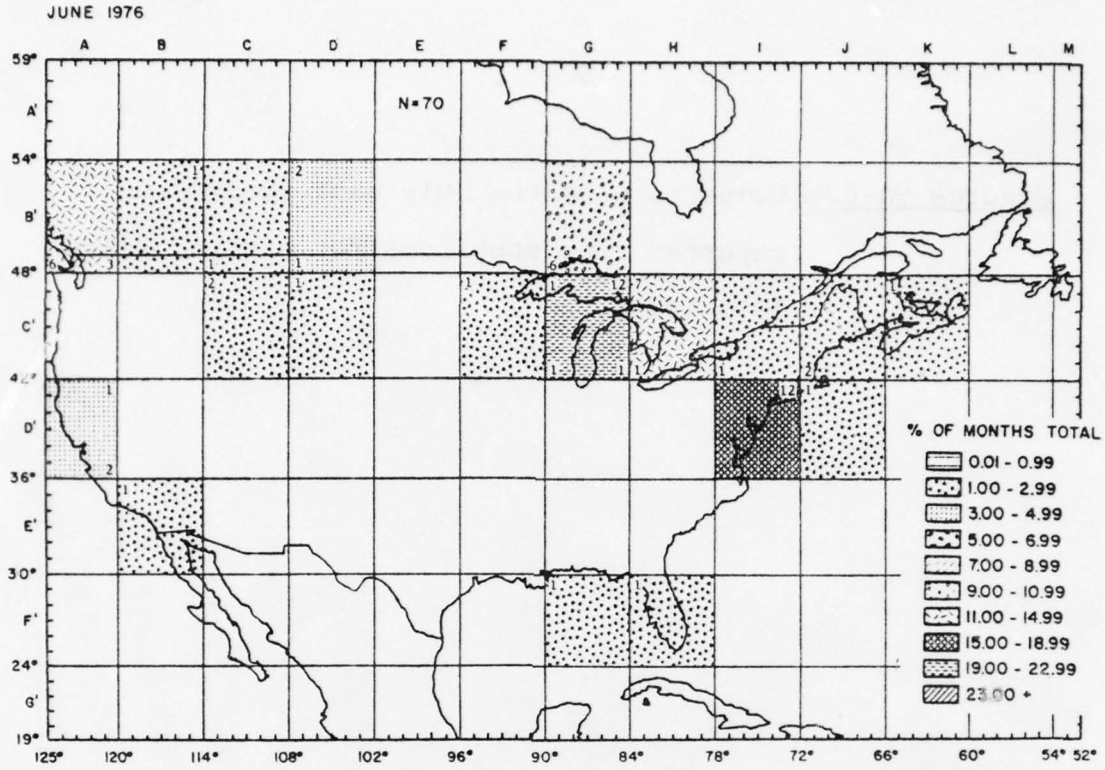
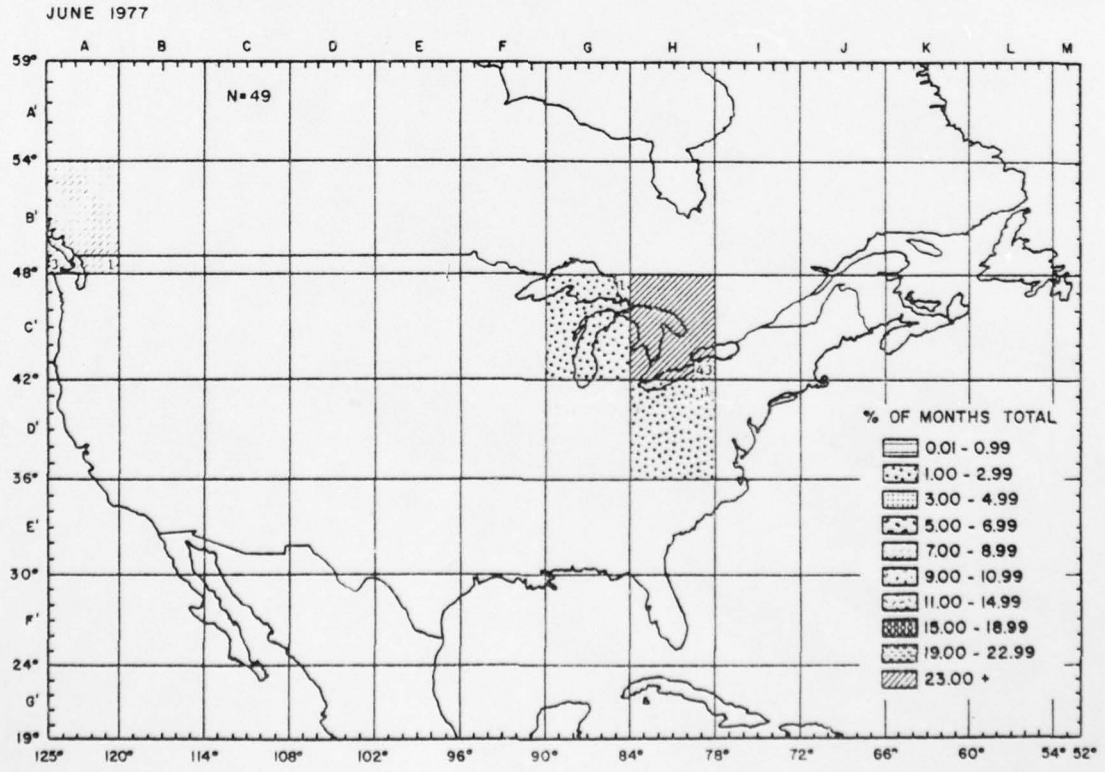


Figure 8E & F.


JUNE 1976
N=70
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +


JUNE 1977
N=49
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 9A-F. Comparison of the July band recoveries reported from each Zone for banding years 1972-1977.

Figure 9A & B.

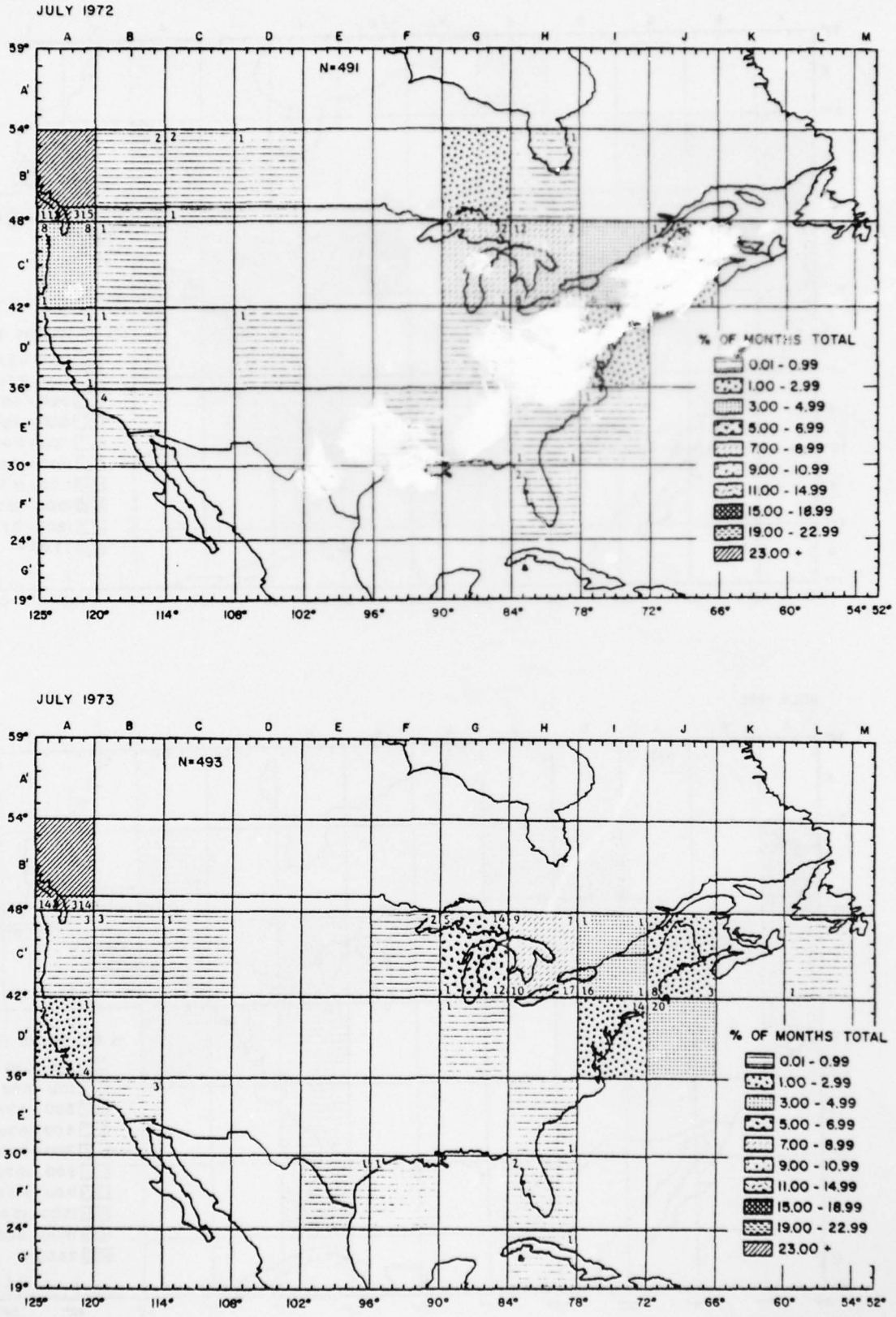
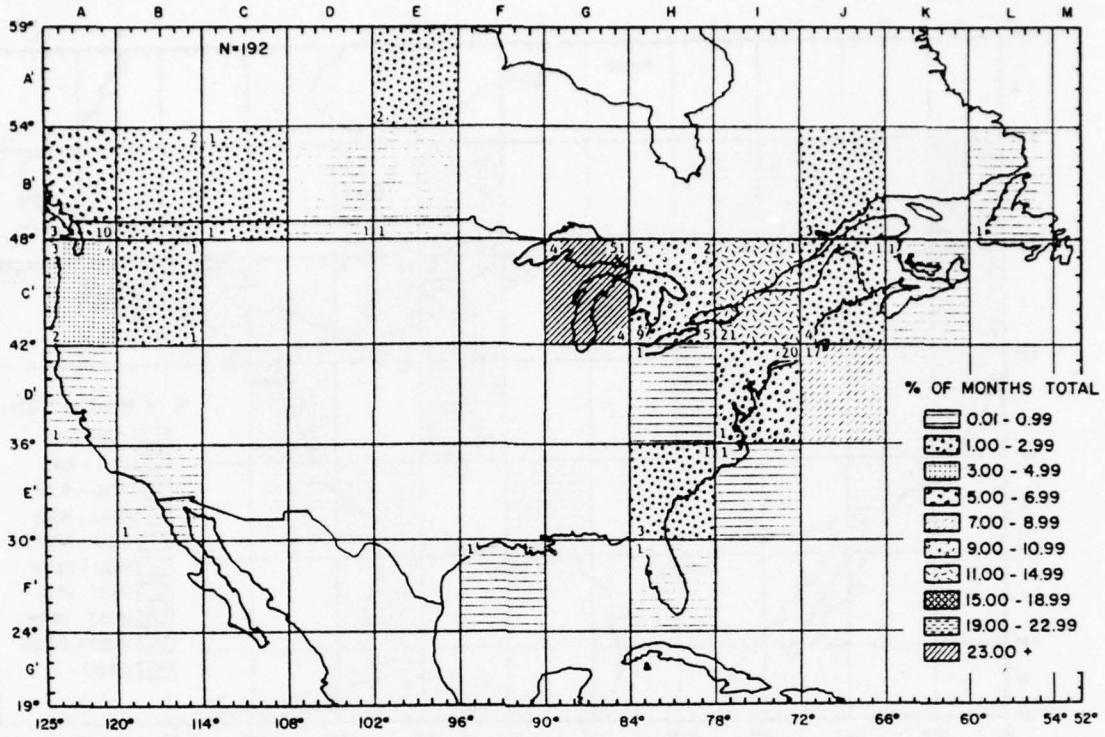

JULY 1972
N=491
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
JULY 1973
N=493
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 9C & D.

JULY 1974



JULY 1975

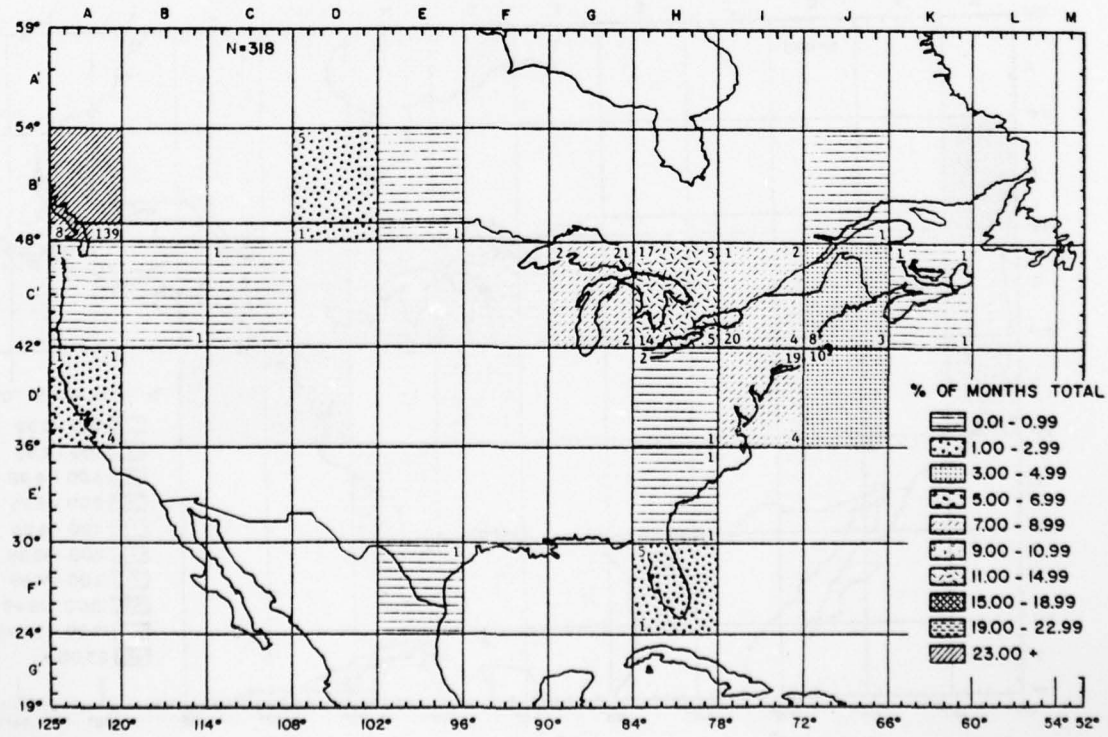
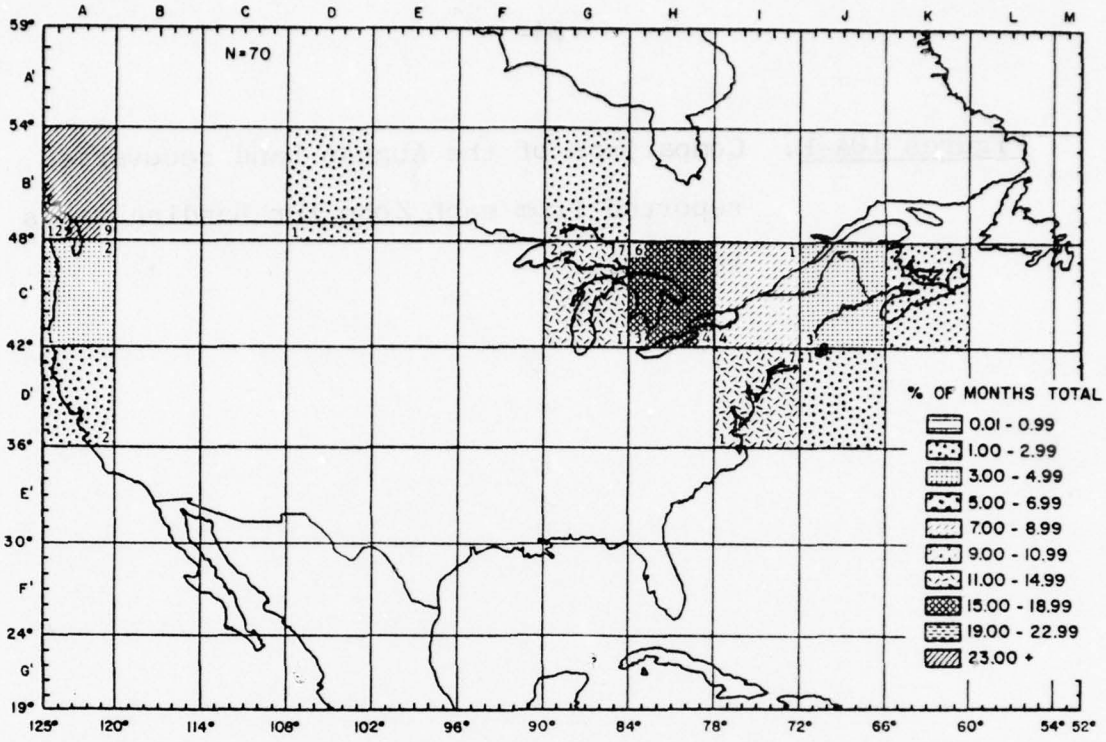
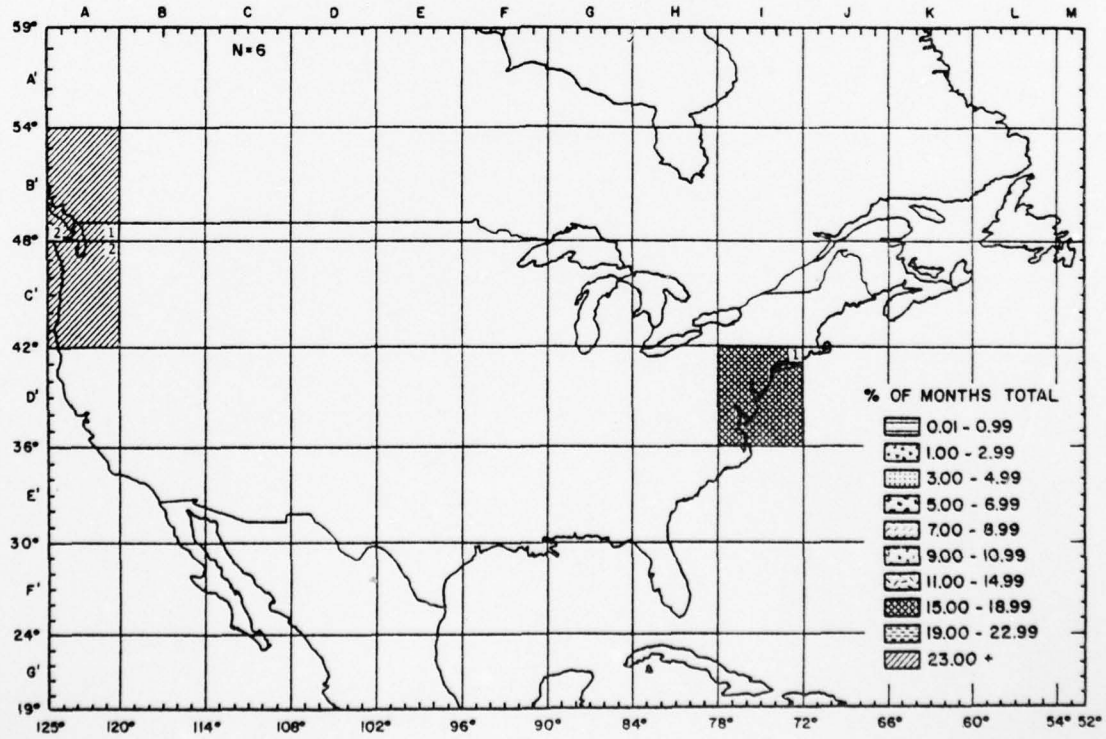


Figure 9E & F.

JULY 1976



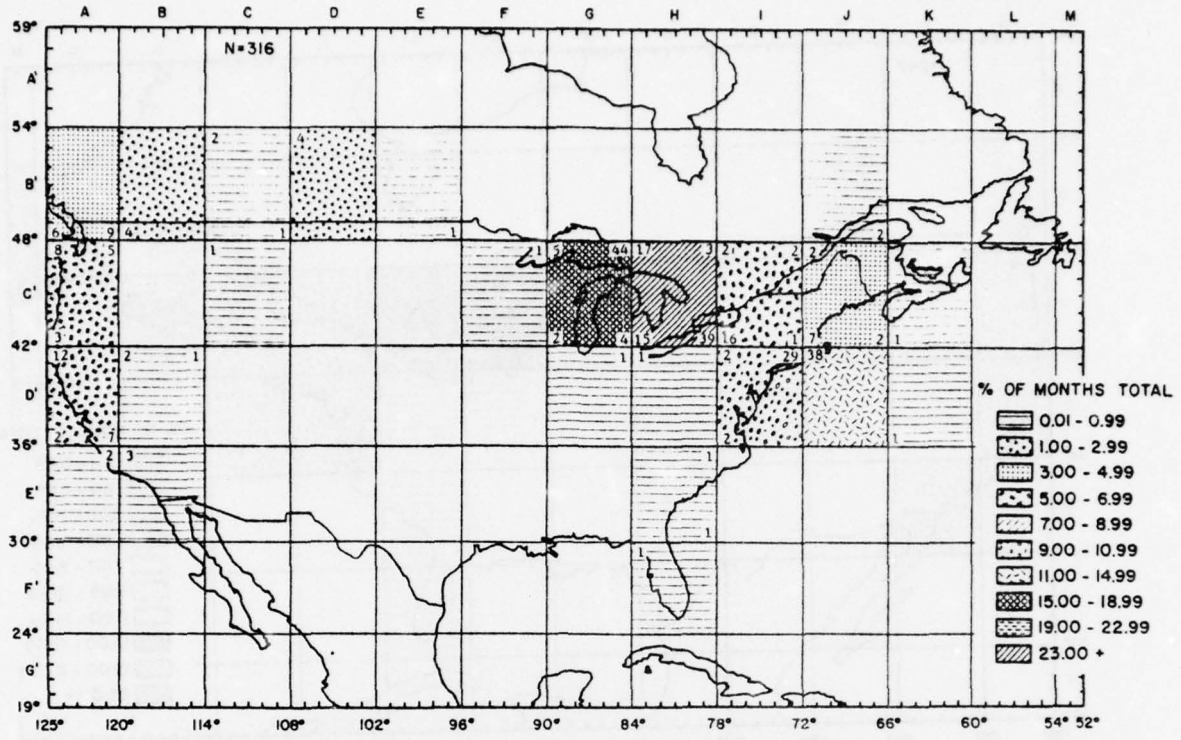
JULY 1977



Figures 10A-E. Comparison of the August band recoveries reported from each Zone for banding years 1972-1976.

Figure 10A & B.

AUGUST 1972



AUGUST 1973

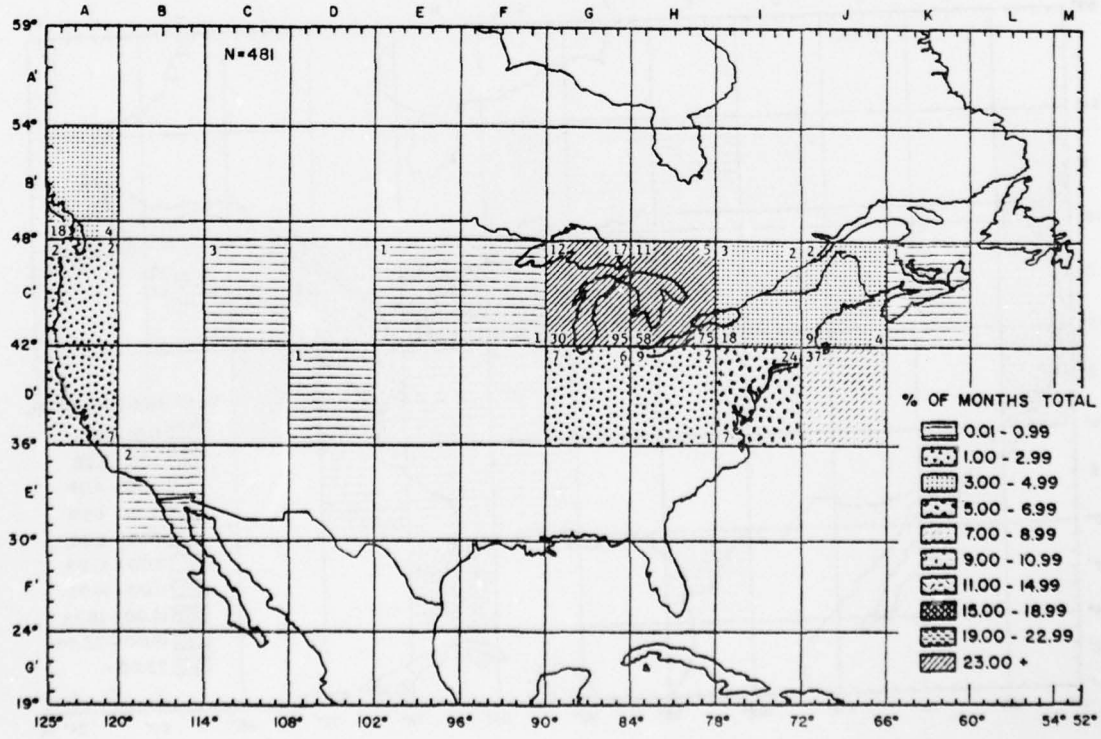


Figure 10C & D.

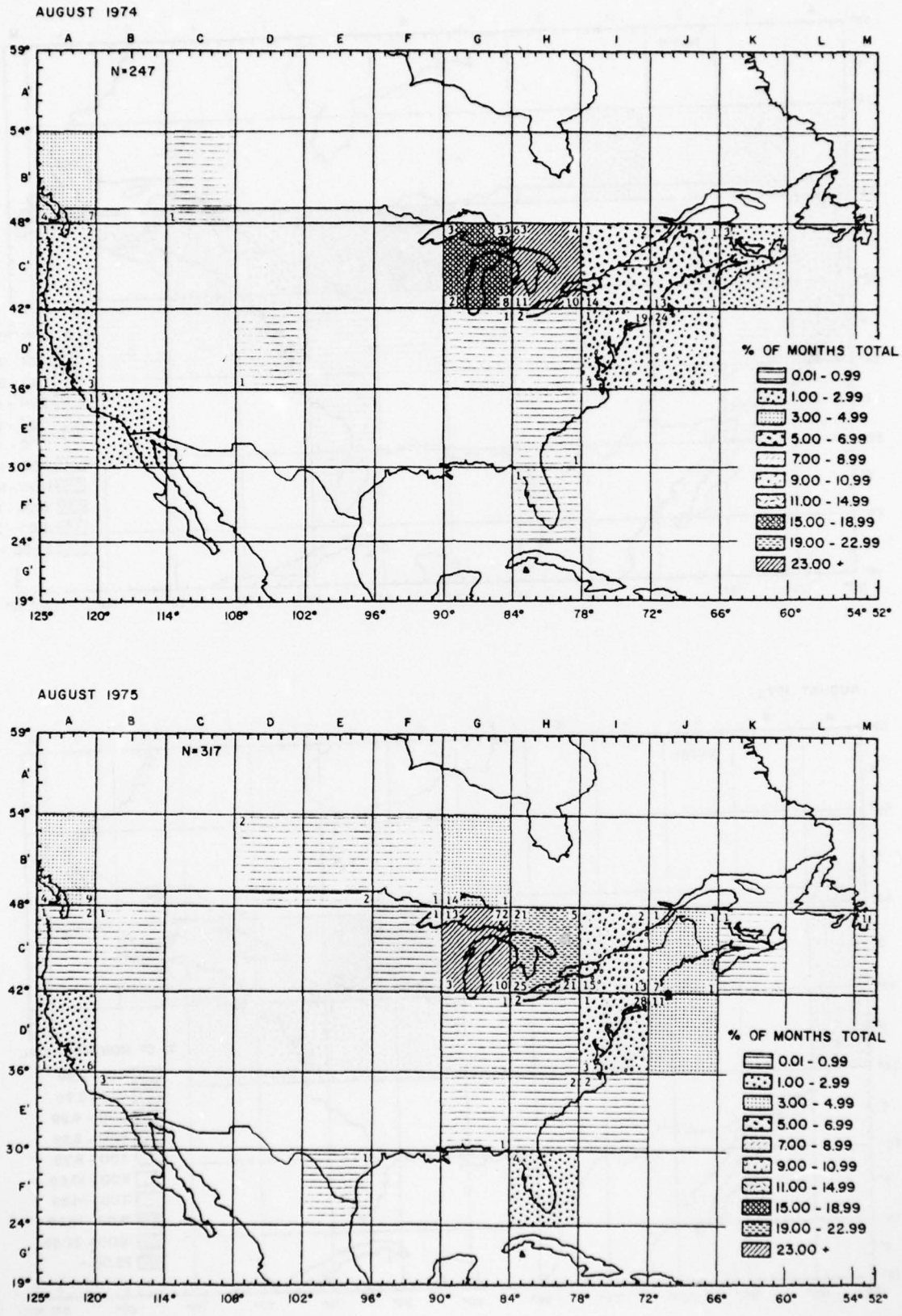
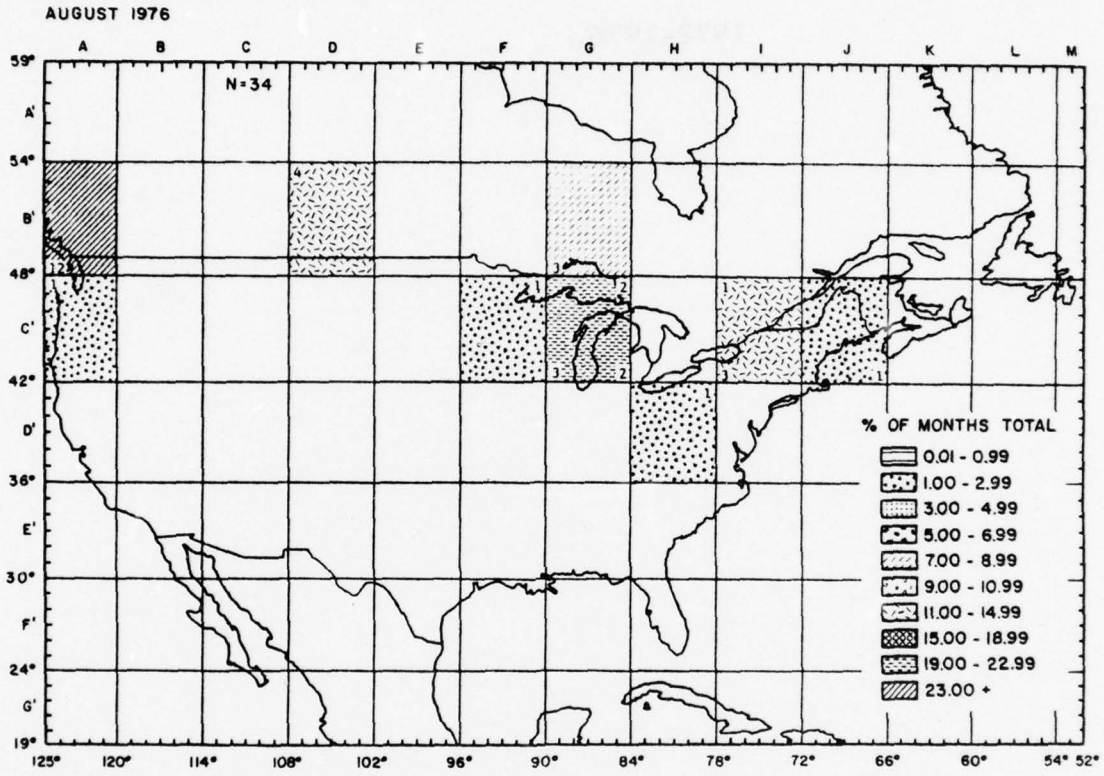

AUGUST 1974
N=247
AUGUST 1975
N=317
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
A B C D E F G H I J K L M
59° A' 54° B' 48° C' 42° D' 36° E' 30° F' 24° G' 19°
125° 120° 114° 108° 102° 96° 90° 84° 78° 72° 66° 60° 54° 52°

Figure 10E.


AUGUST 1976
A B C D E F G H I J K L M
N=34
59°
A'
54°
B'
48°
C'
42°
D'
36°
E'
30°
F'
24°
G'
19°
125° 120° 114° 108° 102° 96° 90° 84° 78° 72° 66° 60° 54° 52°
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 11A-E. Comparison of the September band recoveries reported from each Zone for banding years 1972-1976.

Figure 11A & B.

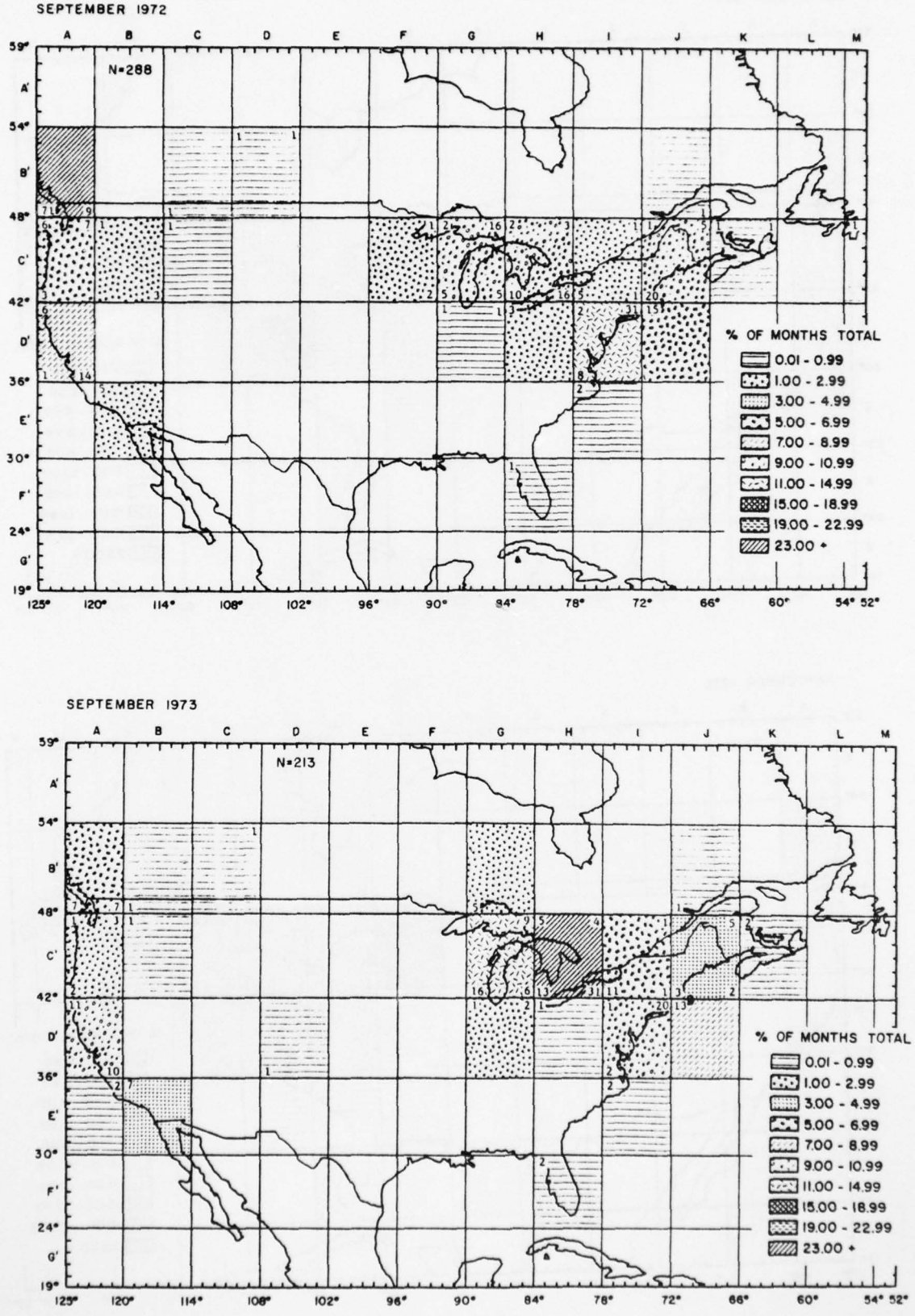
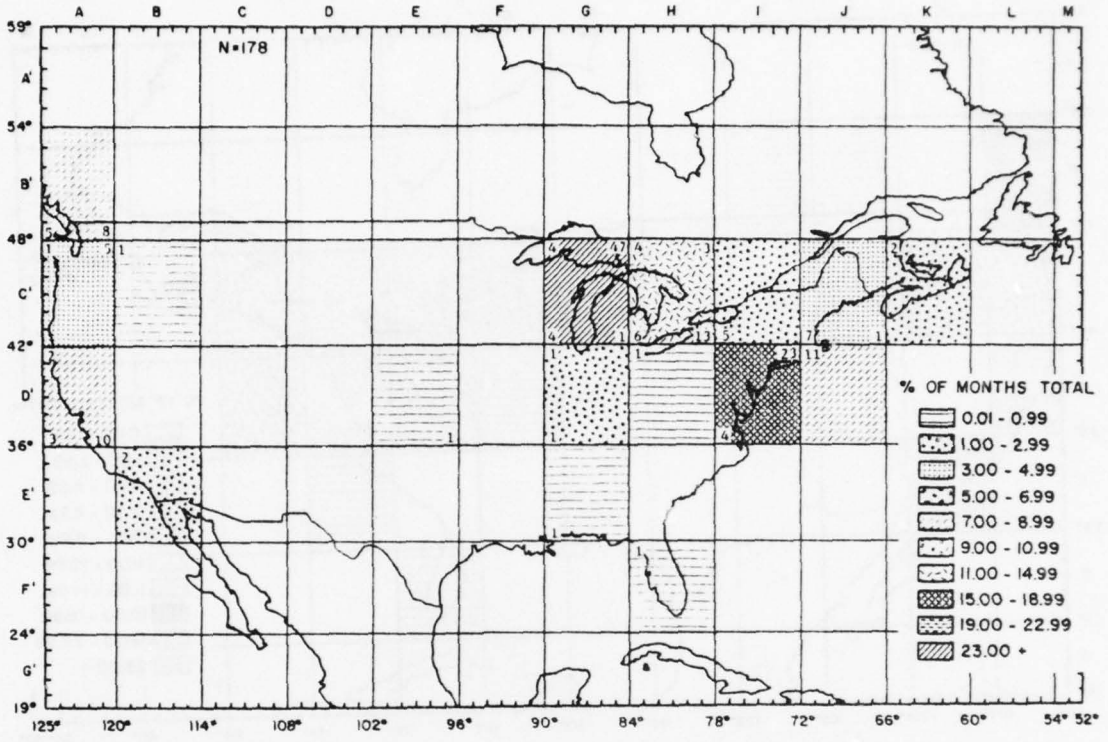

SEPTEMBER 1972
N=288
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
SEPTEMBER 1973
N=213
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 11C & D.

SEPTEMBER 1974



SEPTEMBER 1975

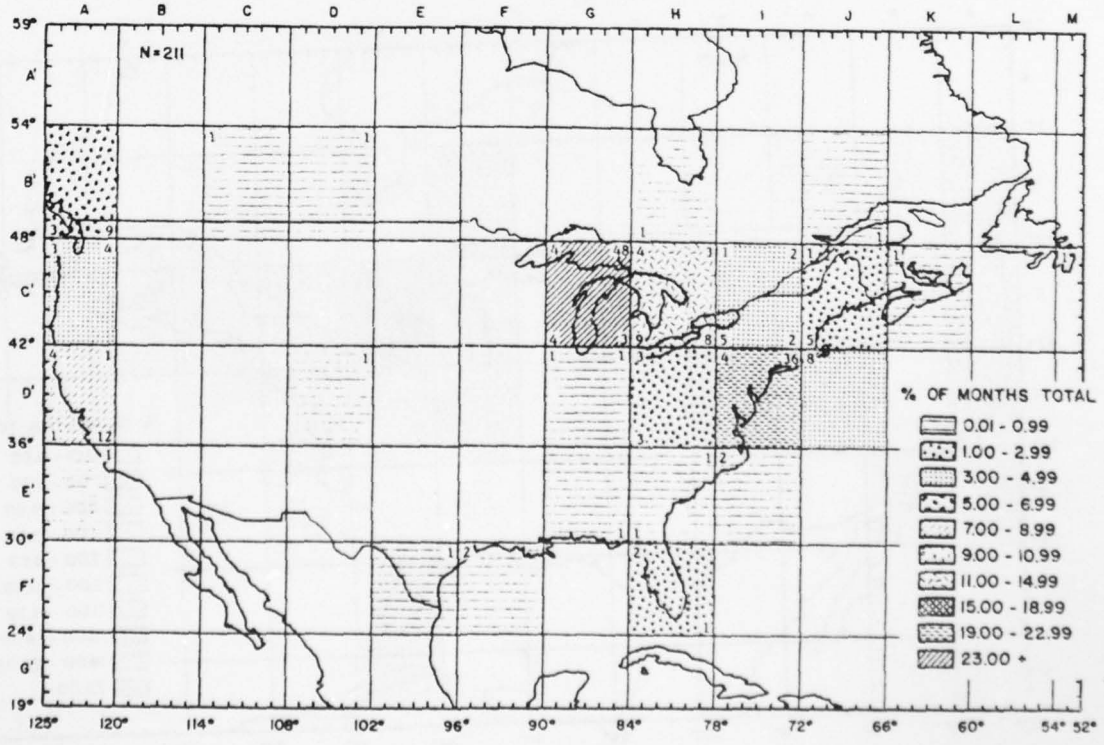
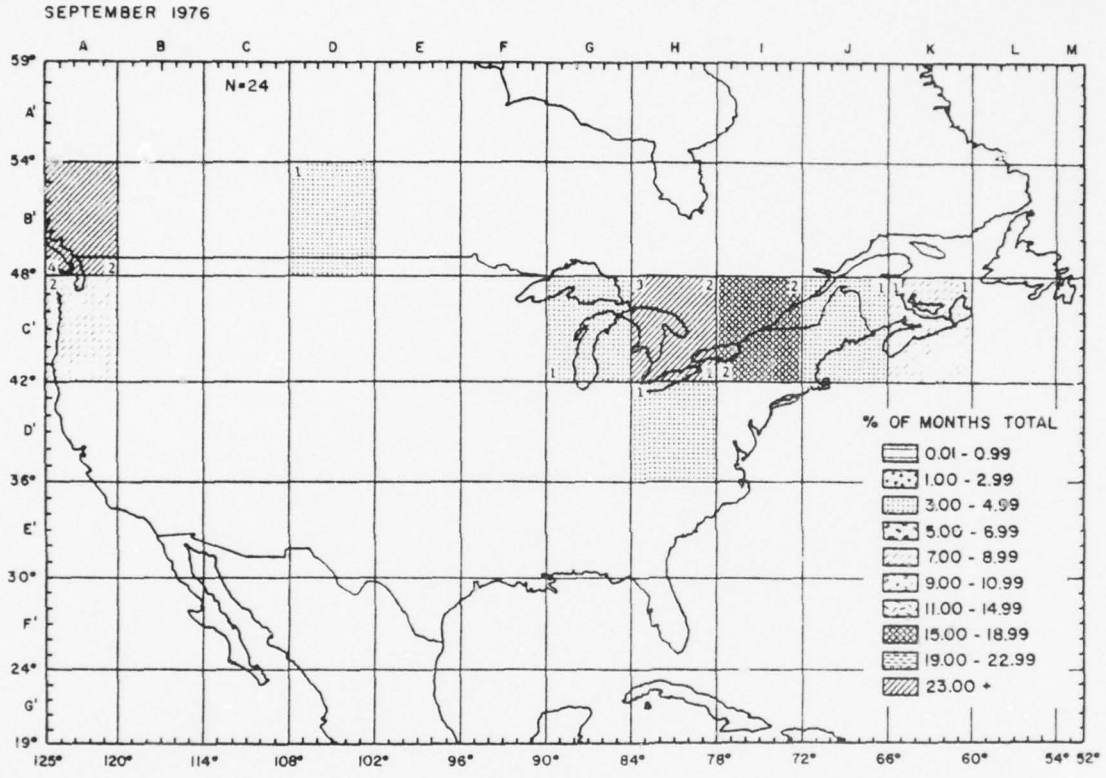


Figure 11E.


SEPTEMBER 1976
N=24
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

AD-A068 812 NORTHERN ILLINOIS UNIV DE KALB DEPT OF BIOLOGICAL SC--ETC F/G 1/2
DEVELOPMENT OF COMPUTER-GENERATED PHENOGRAMS TO FORECAST REGION--ETC(U)
NOV 78 W E SOUTHERN AFOSR-77-3431

UNCLASSIFIED AFOSR-TR-79-0611 NL

2 OF 3
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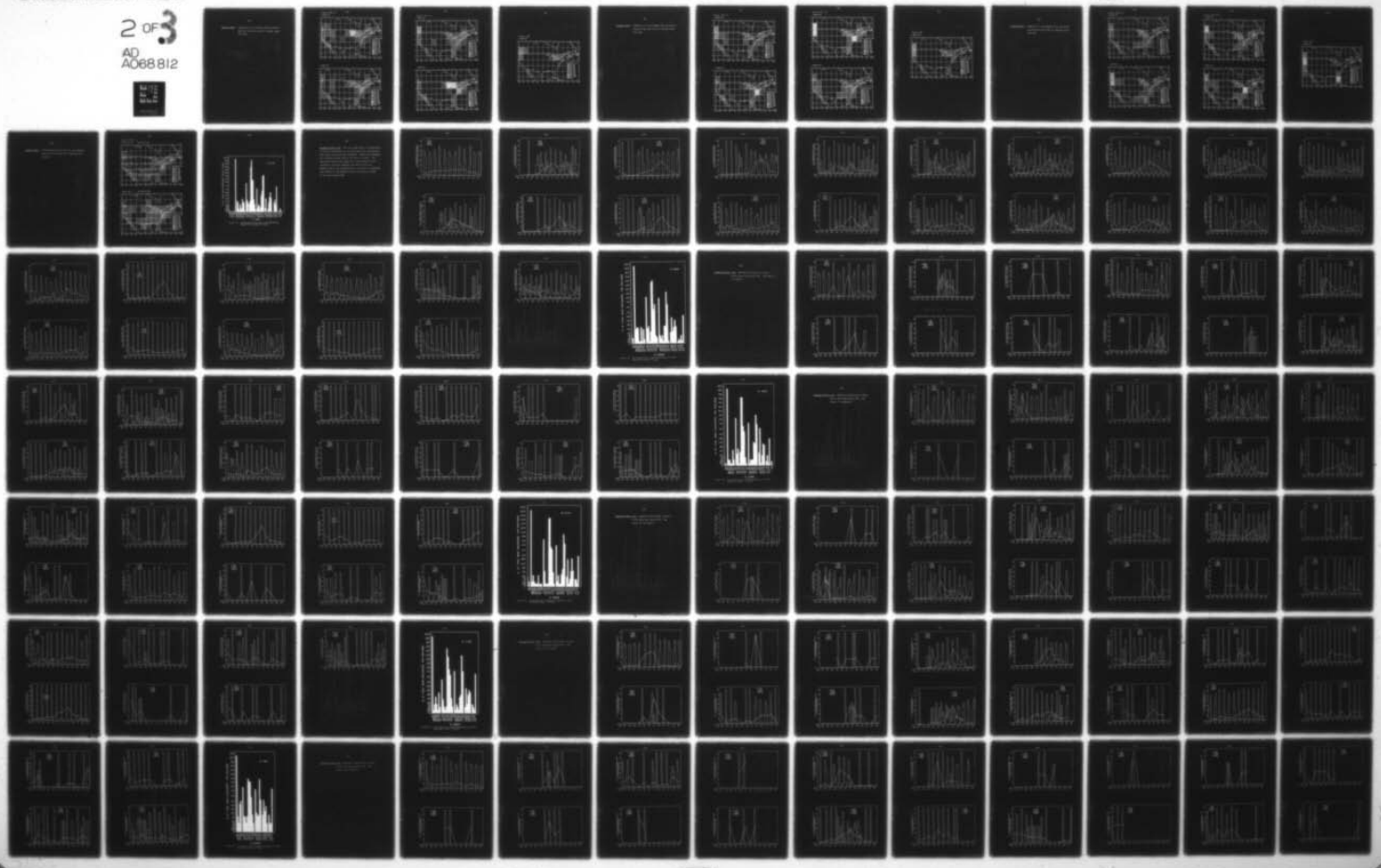
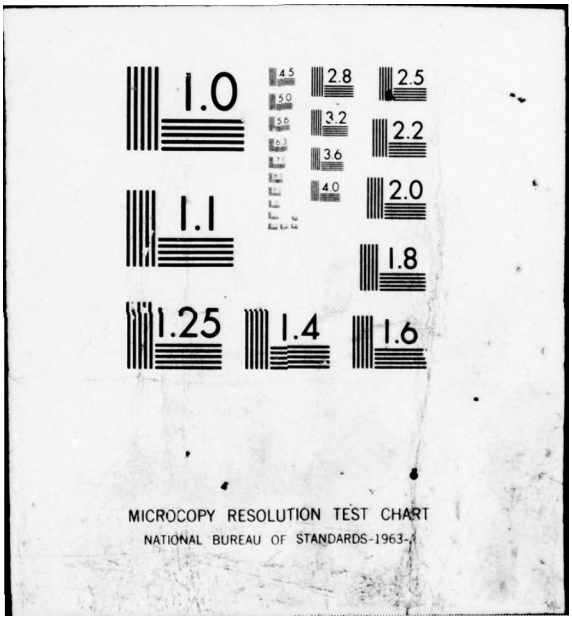
A068812

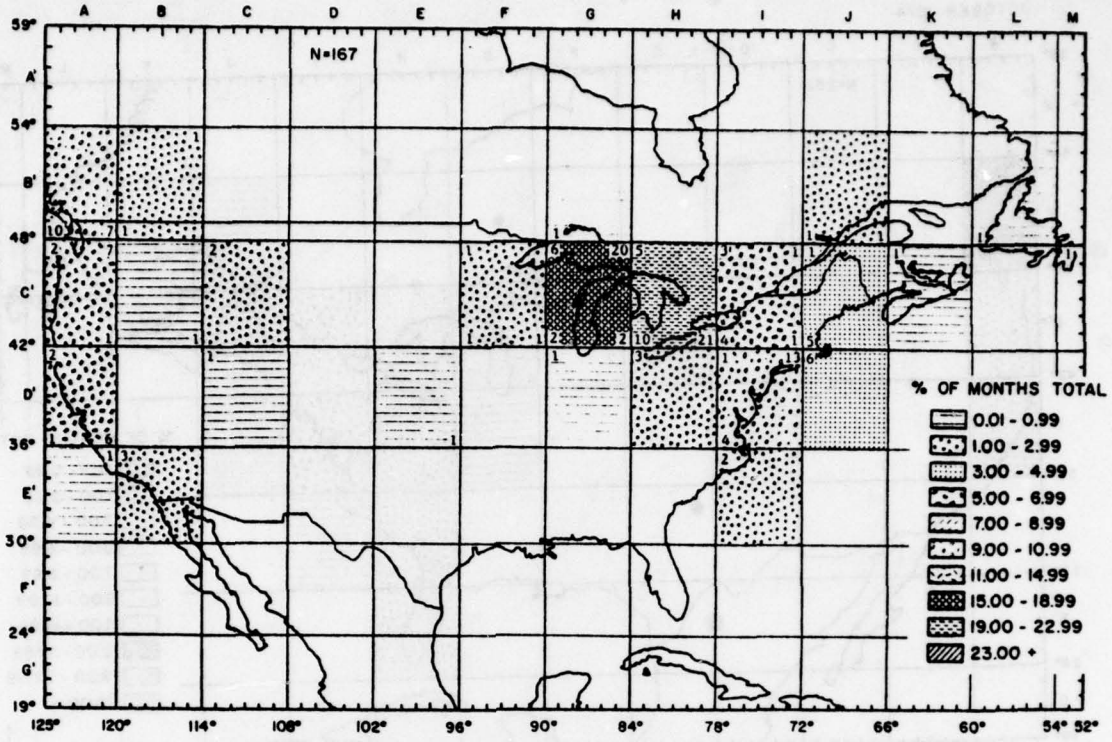



1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Figures 12A-E. Comparison of the October band recoveries reported from each Zone for banding years 1972-1976.

Figure 12A & B.

OCTOBER 1972



OCTOBER 1973

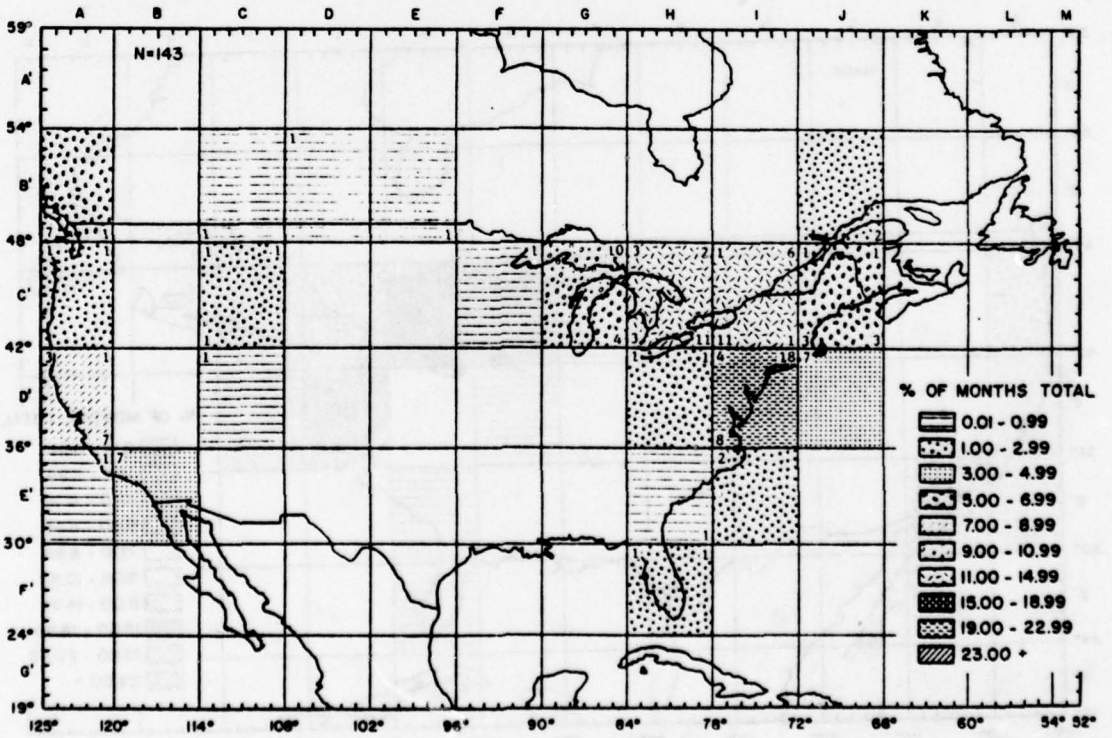


Figure 12C & D.

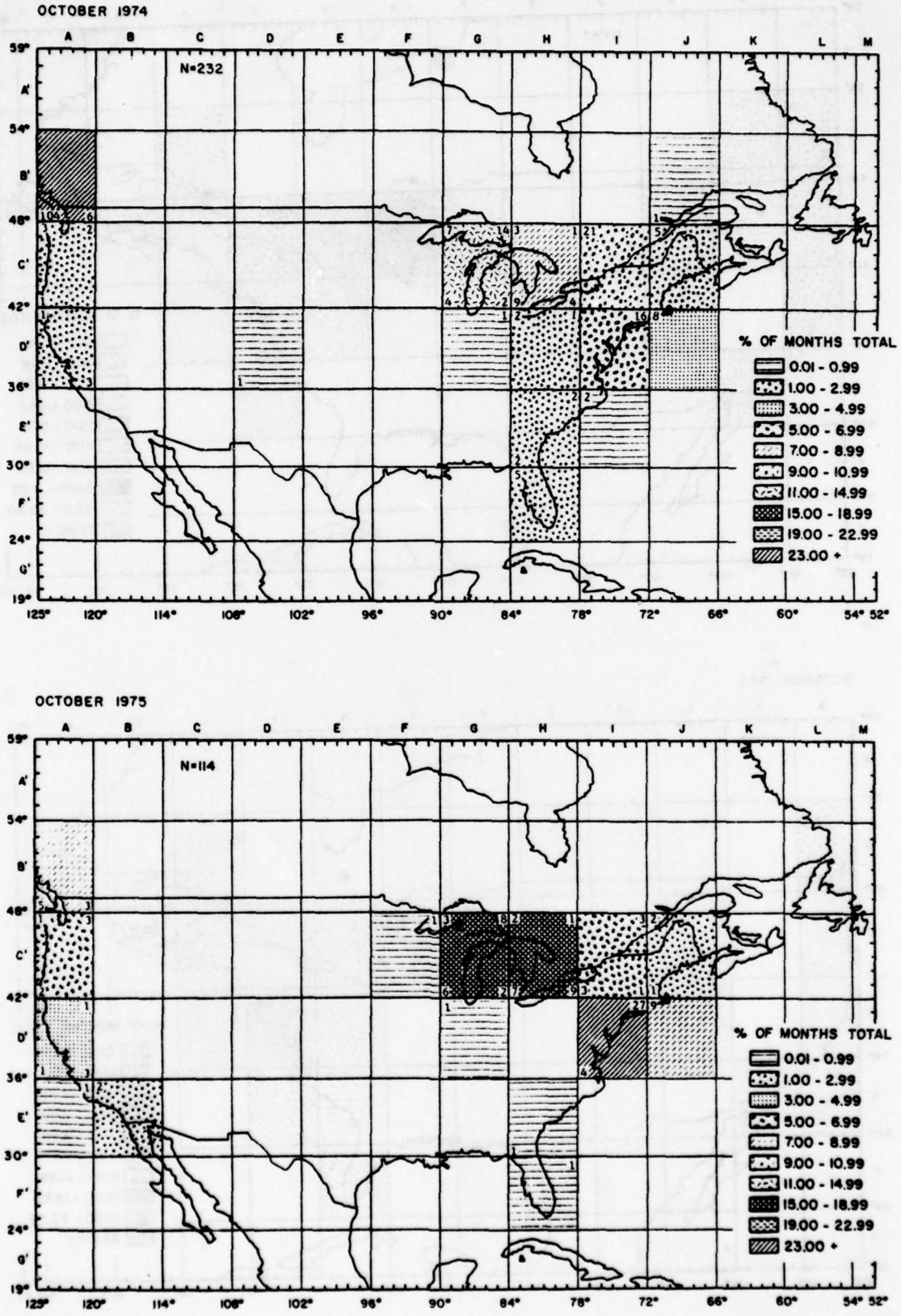
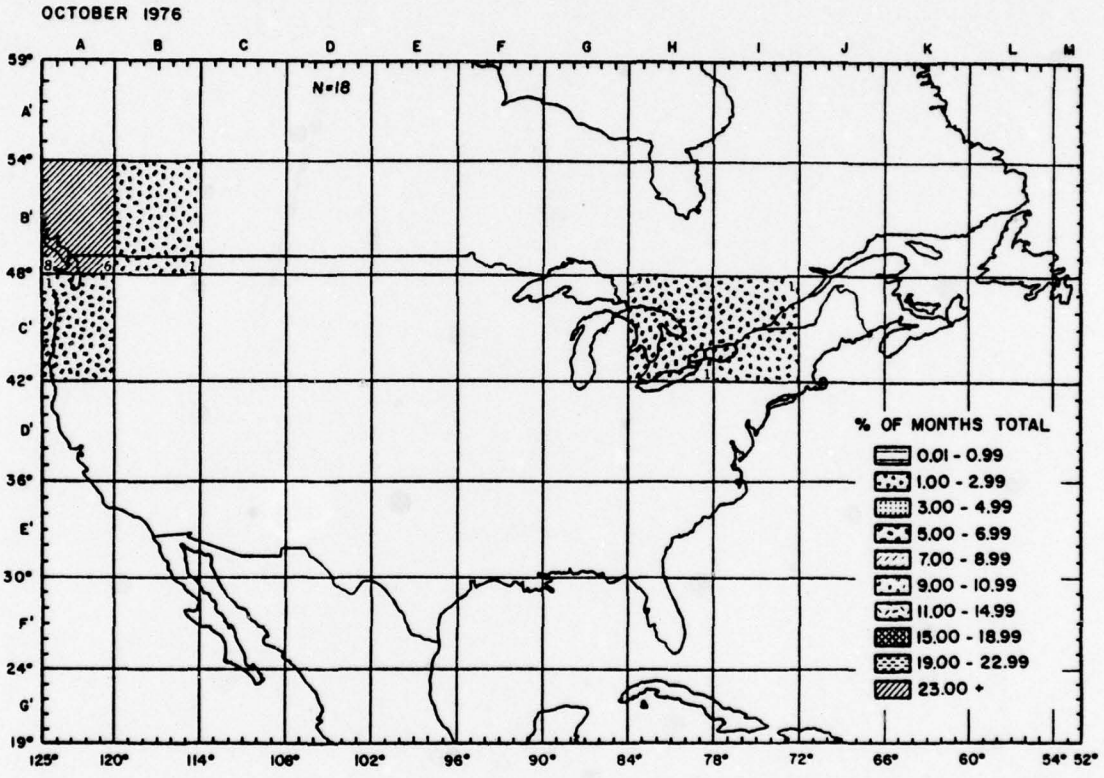
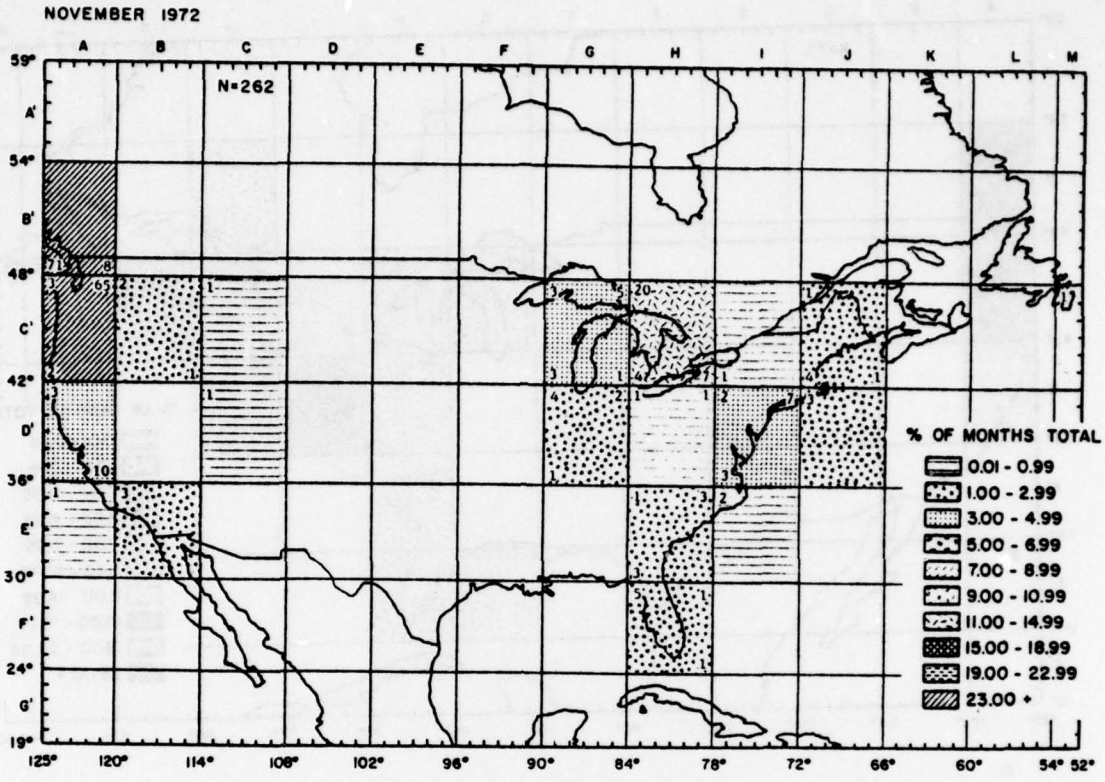

OCTOBER 1974
N=232
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +
OCTOBER 1975
N=114
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 12E.


OCTOBER 1976
N=18
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 13A-E. Comparison of the November band recoveries reported from each Zone for banding years 1972-1976.

Figure 13A & B.


NOVEMBER 1972
N=262
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

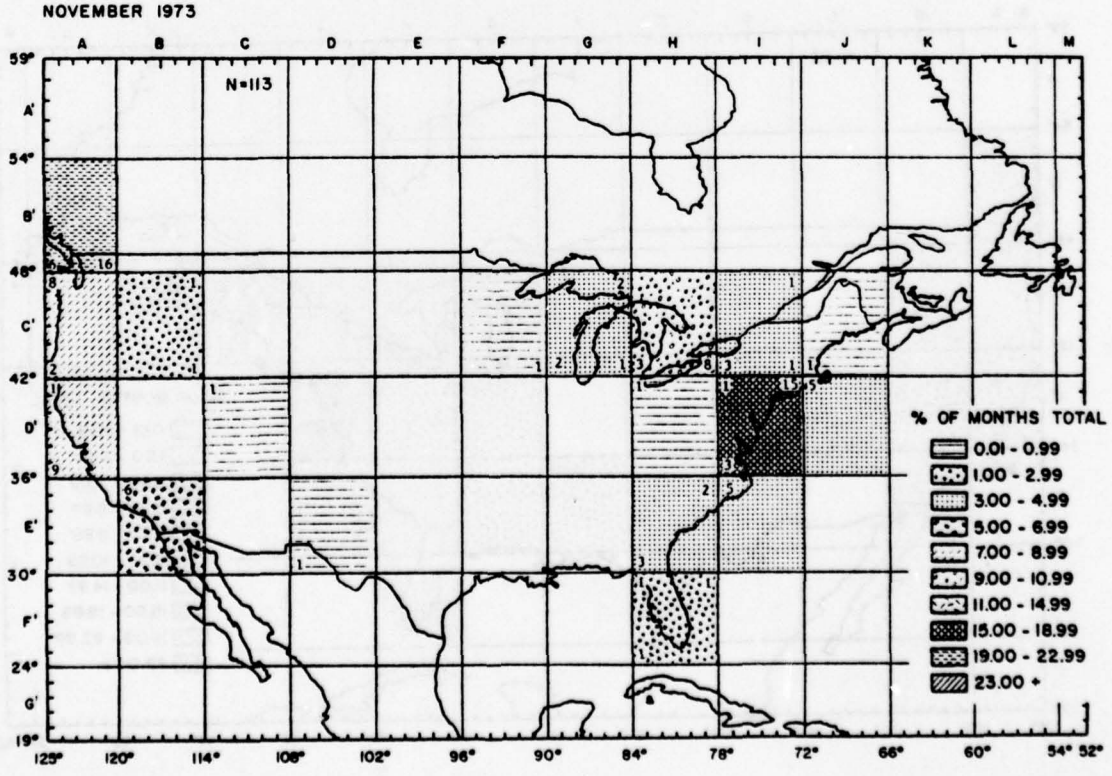
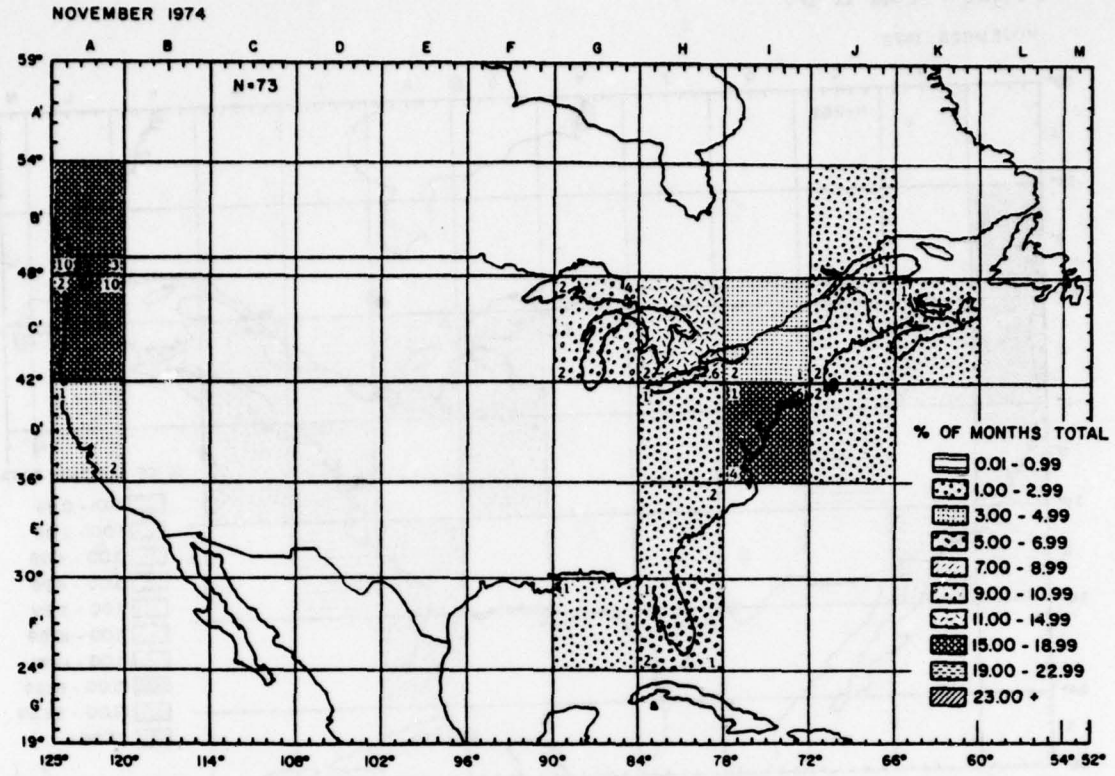

NOVEMBER 1973
N=113
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 13C & D.


NOVEMBER 1974
N=73
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

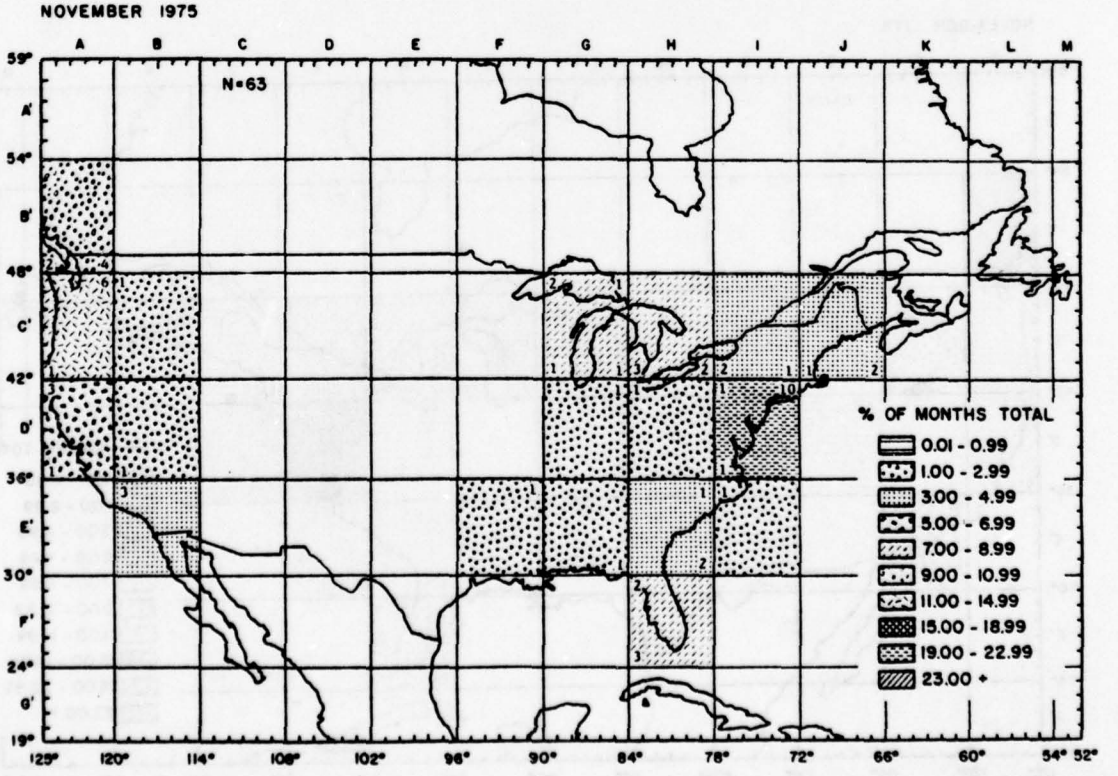
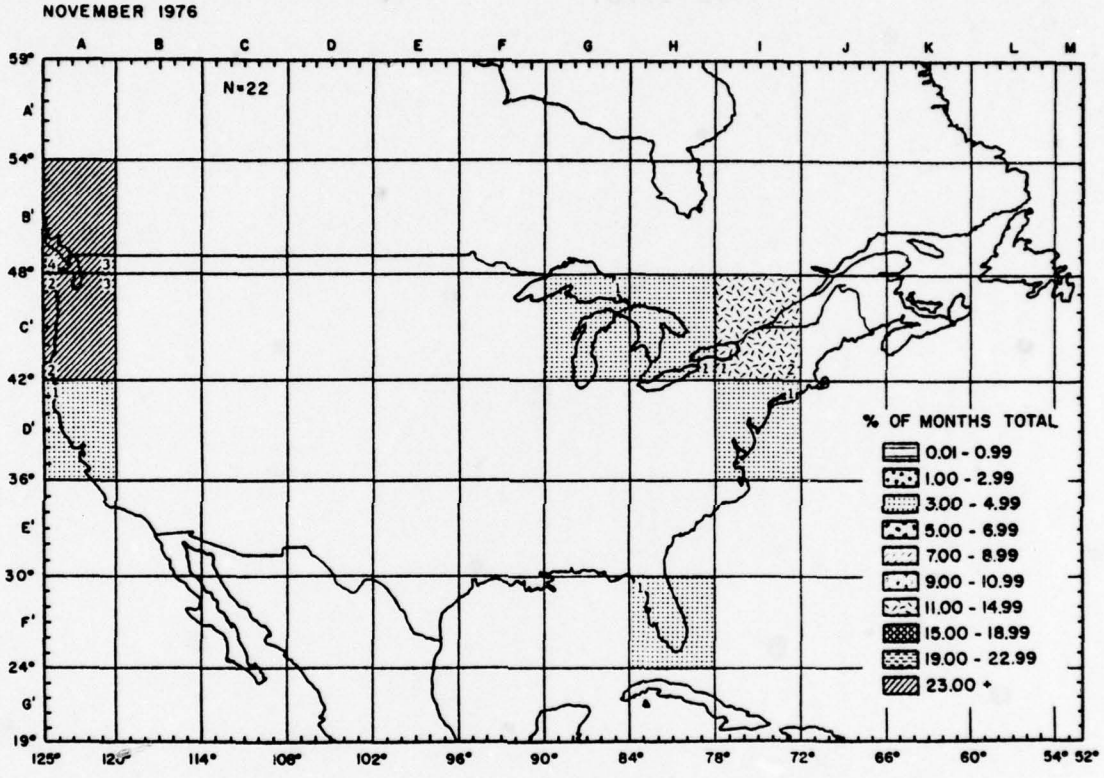

NOVEMBER 1975
N=63
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figure 13E.


NOVEMBER 1976
N=22
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 14A-E. Comparison of the December band recoveries reported from each Zone for banding years 1972-1976.

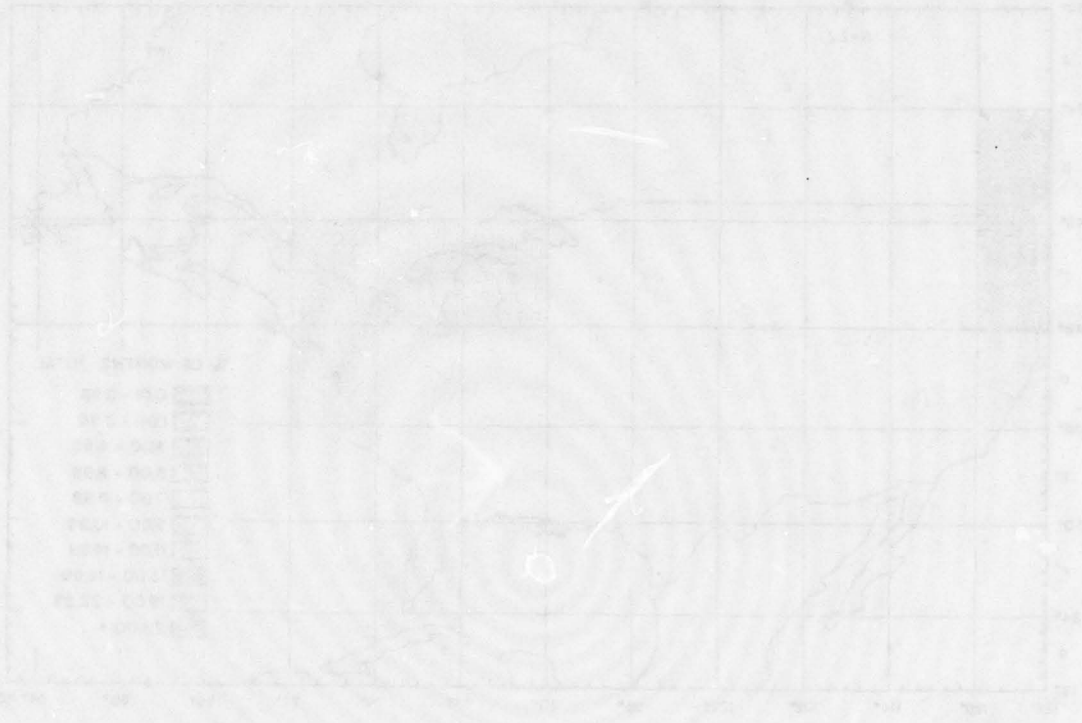
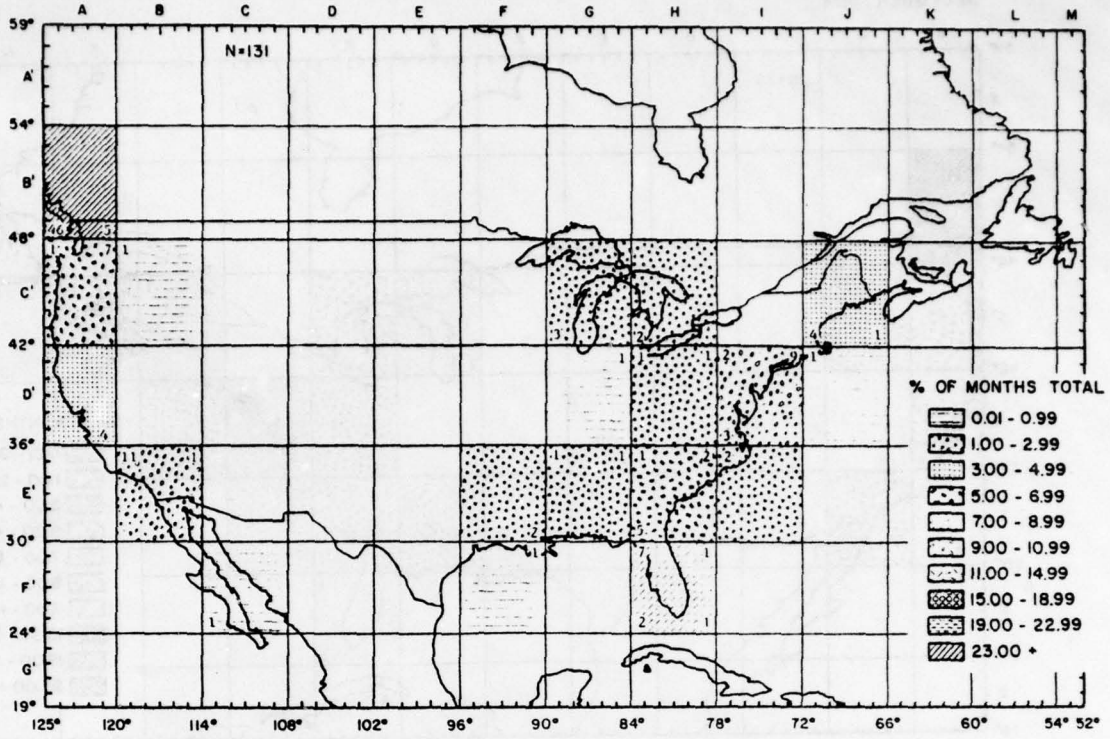


Figure 14A & B.

DECEMBER 1972



DECEMBER 1973

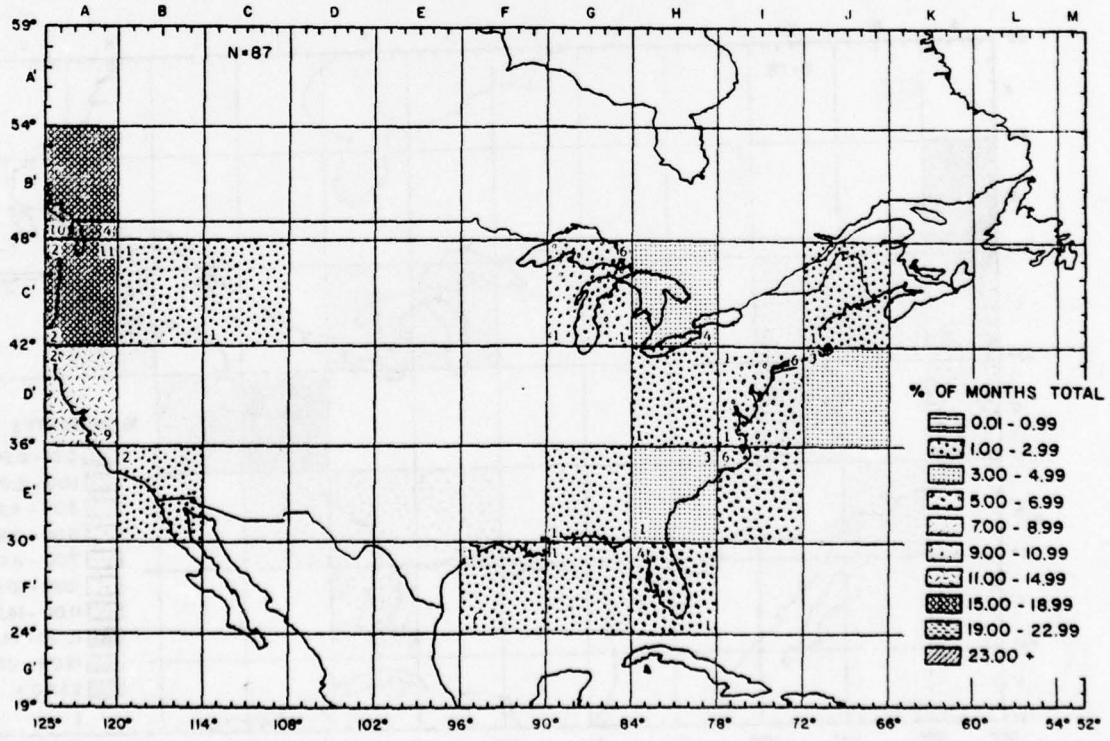


Figure 14C and D.

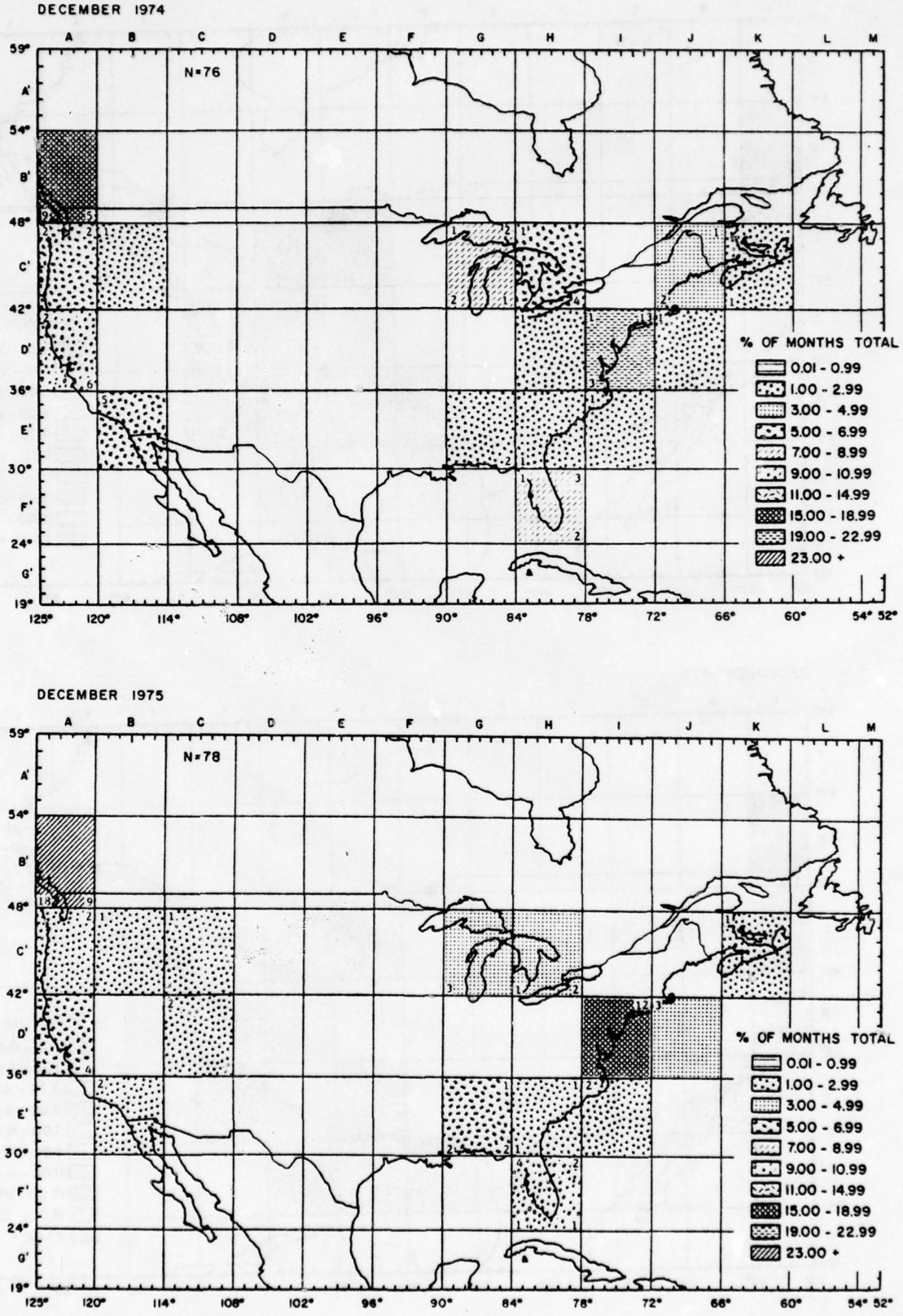
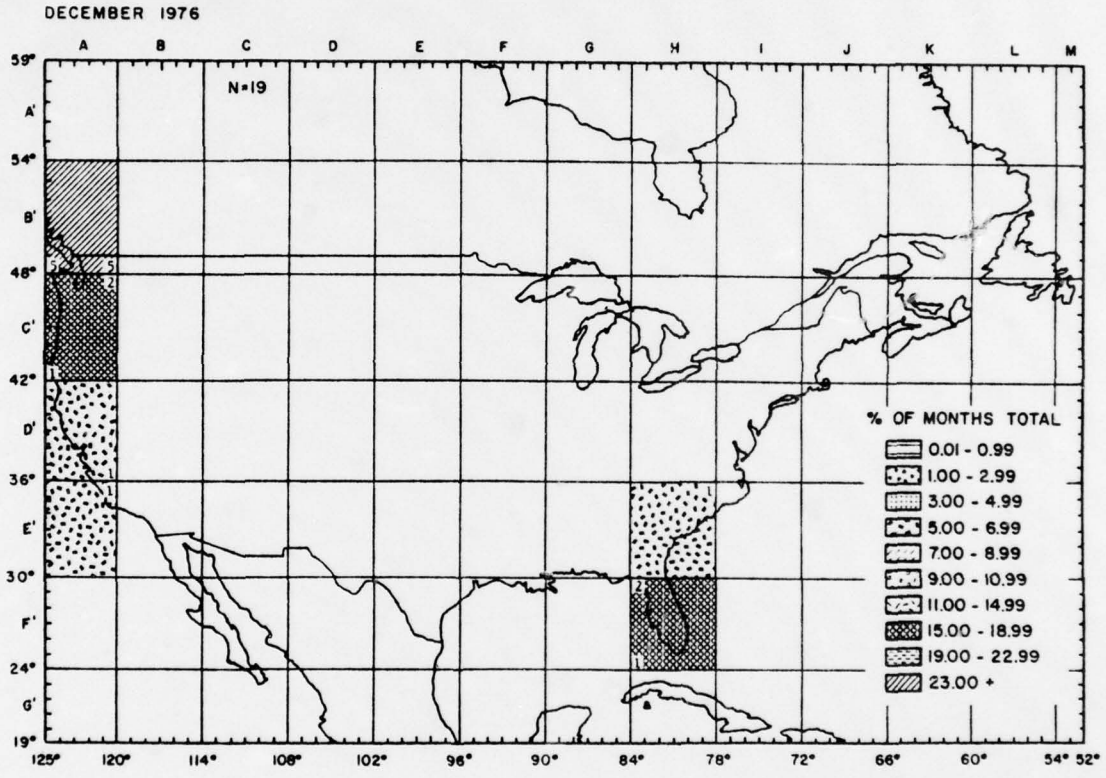
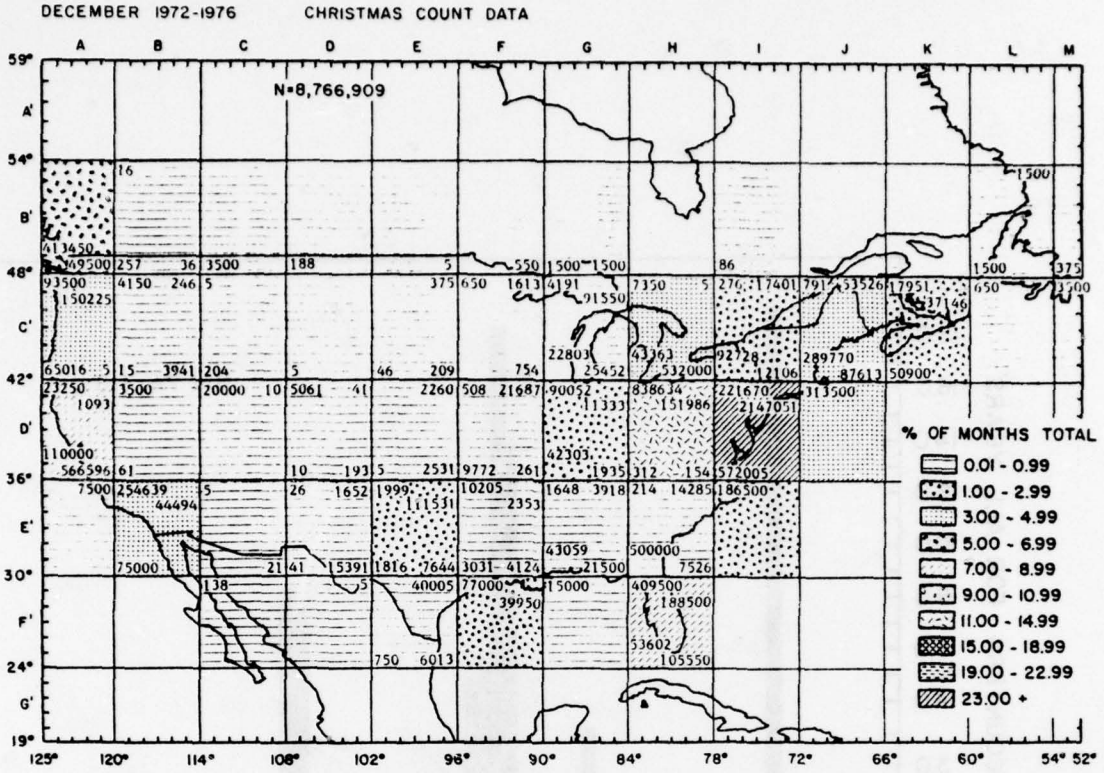


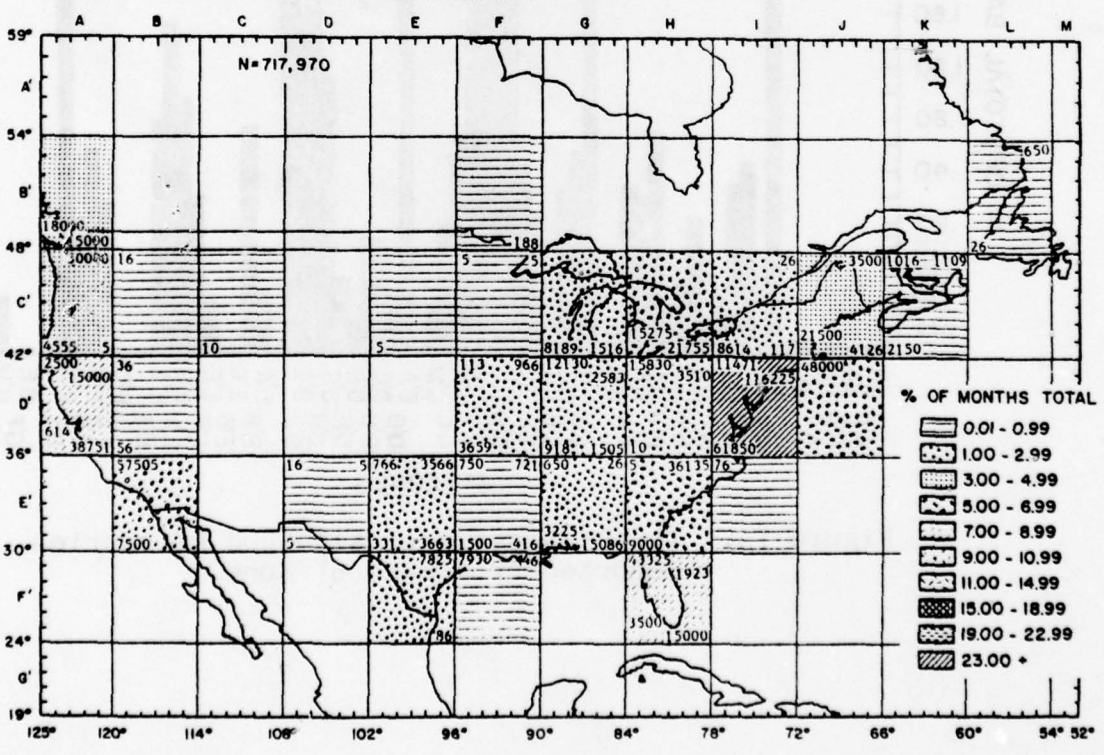
Figure 14E.


DECEMBER 1976
N=19
A
B
C
D
E
F
G
H
I
J
K
L
M
59°
A'
54°
B'
48°
C'
42°
D'
36°
E'
30°
F'
24°
G'
19°
125°
120°
114°
108°
102°
96°
90°
84°
78°
72°
66°
60°
54° 52°
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

Figures 15A-B. Christmas Bird Count data for the combined years of 1972 through 1977 (December and January).

Figure 15A & B.


DECEMBER 1972-1976 CHRISTMAS COUNT DATA
N=8,766,909
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +


JANUARY 1972-1977 CHRISTMAS COUNT DATA
N=717,970
% OF MONTHS TOTAL
0.01 - 0.99
1.00 - 2.99
3.00 - 4.99
5.00 - 6.99
7.00 - 8.99
9.00 - 10.99
11.00 - 14.99
15.00 - 18.99
19.00 - 22.99
23.00 +

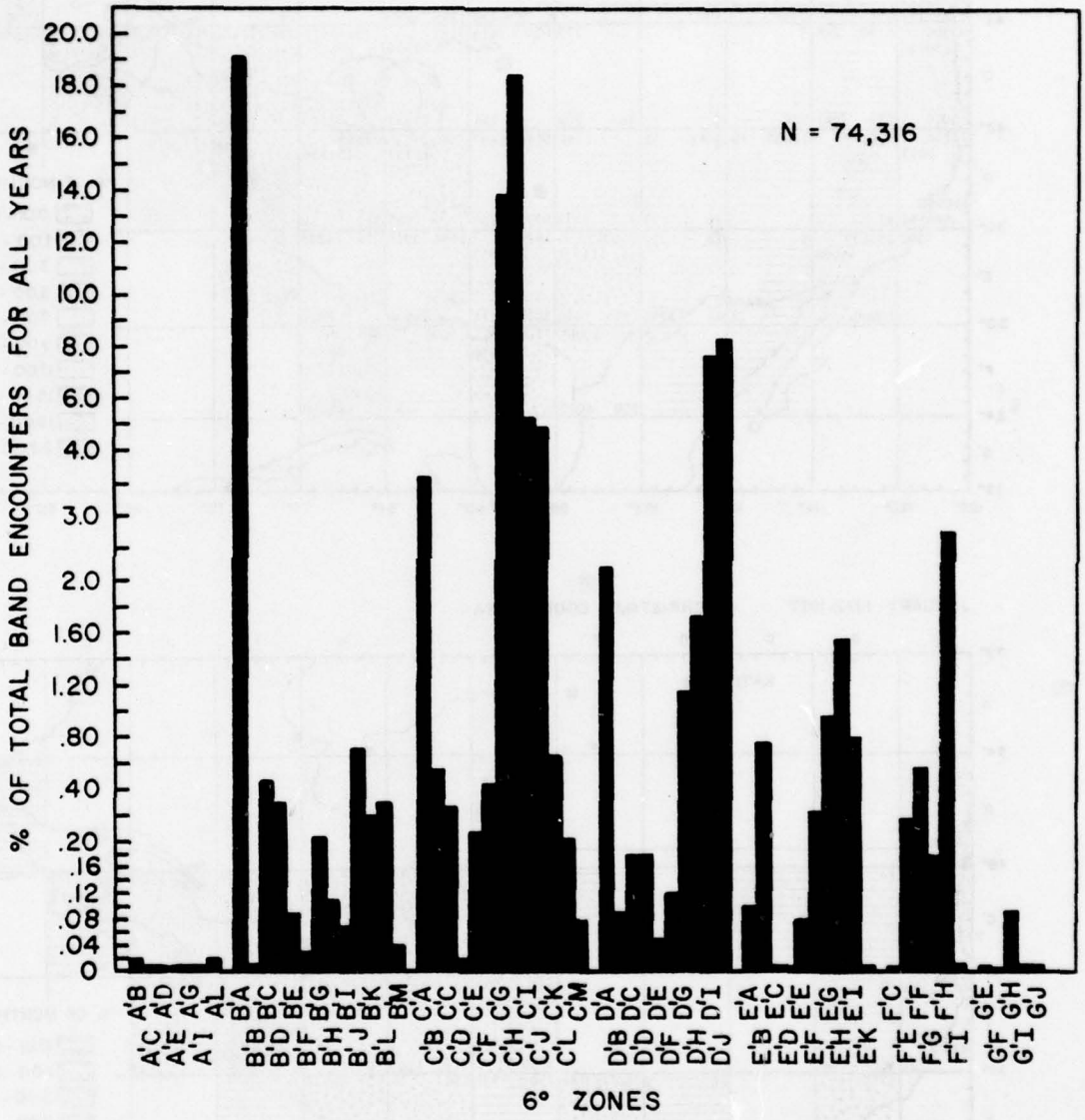
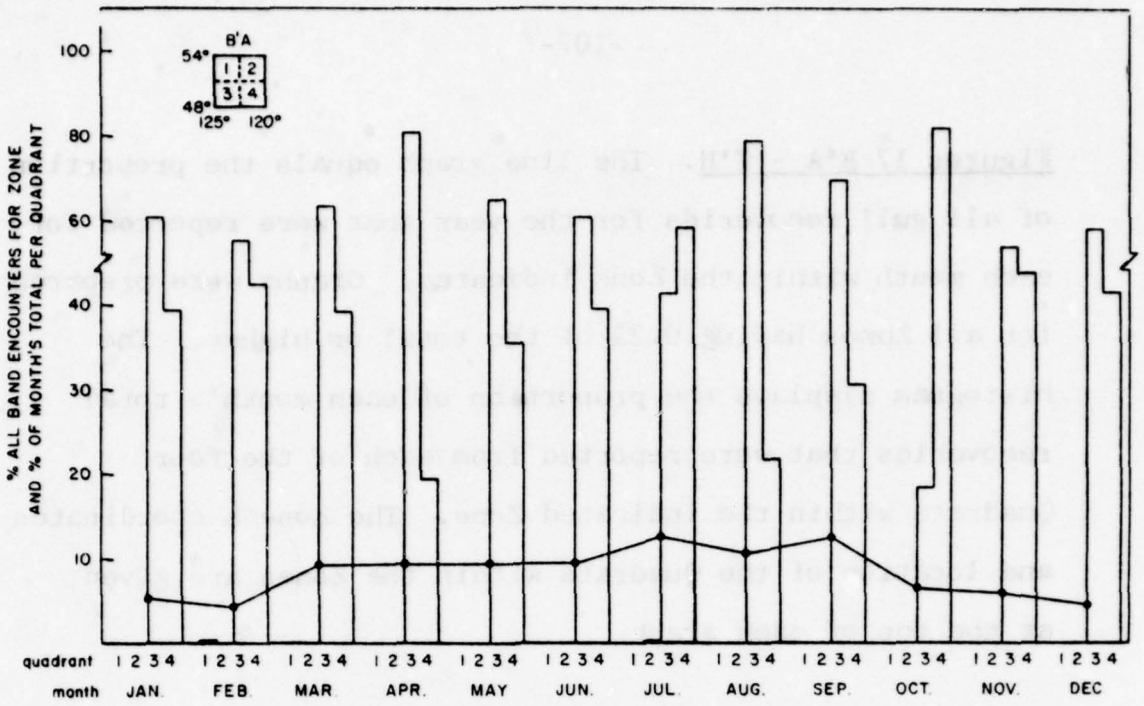
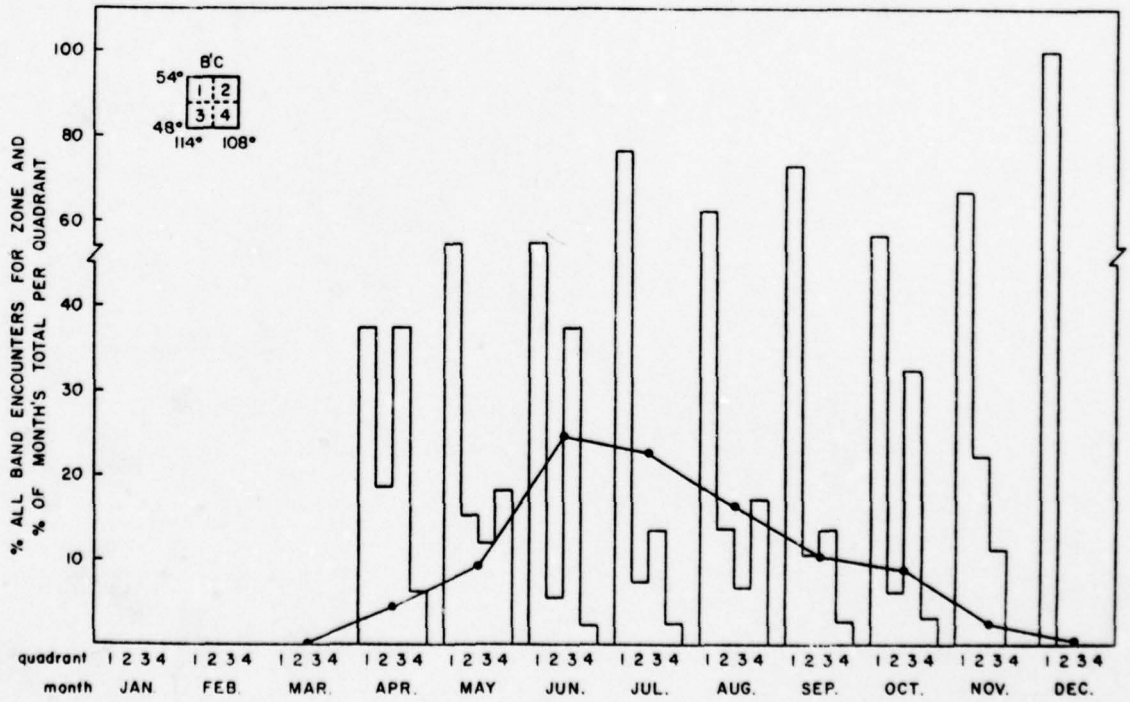
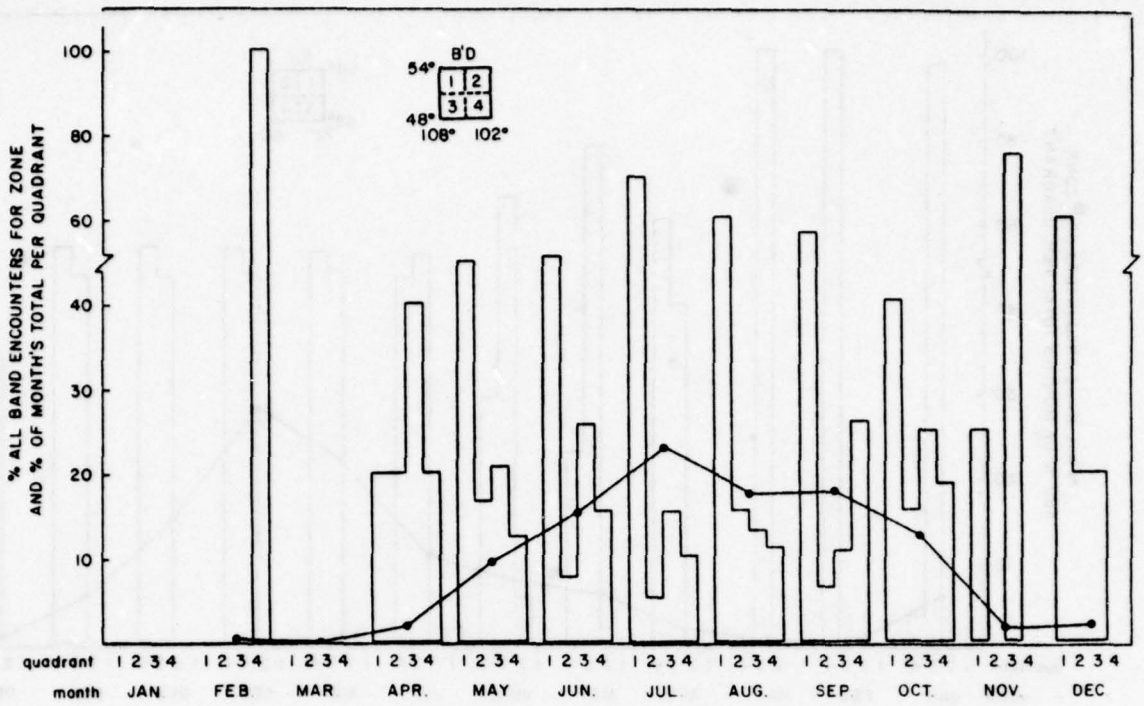


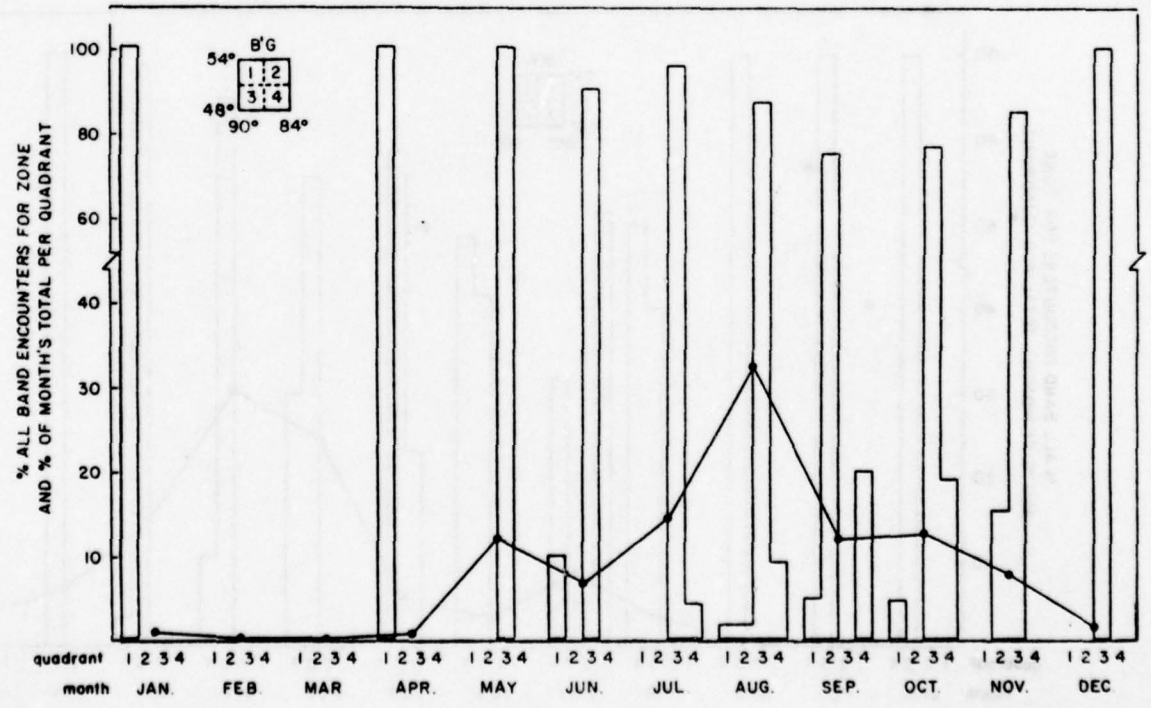
Figure 16. The Proportion of All Band Recoveries Reported from Each 6° Zone.

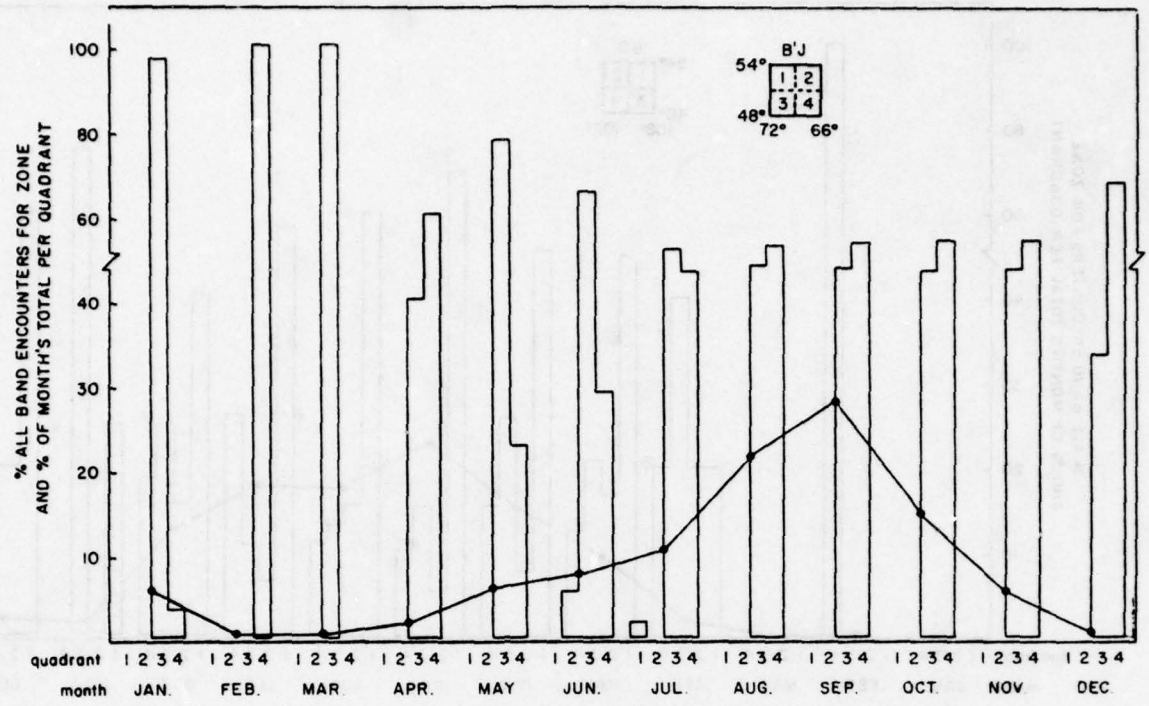
Figures 17 B'A - F'H. The line graph equals the proportion of all gull recoveries for the year that were reported for each month within the Zone indicated. Graphs were prepared for all Zones having 0.2% of the total or higher. The histogram displays the proportion of each month's total recoveries that were reported from each of the four Quadrats within the indicated Zone. The Zone's coordinates and location of the Quadrats within the Zones are given at the top of each graph.


B'A
54°
48°
125°
120°
1
2
3
4
% ALL BAND ENCOUNTERS FOR ZONE
AND % OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'C
54°
48°
114°
108°
1
2
3
4
% ALL BAND ENCOUNTERS FOR ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'D
54°
48°
108°
102°
1
2
3
4
% ALL BAND ENCOUNTERS FOR ZONE
AND % OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC


B'G
54°
48°
90°
84°
1
2
3
4
% ALL BAND ENCOUNTERS FOR ZONE
AND % OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC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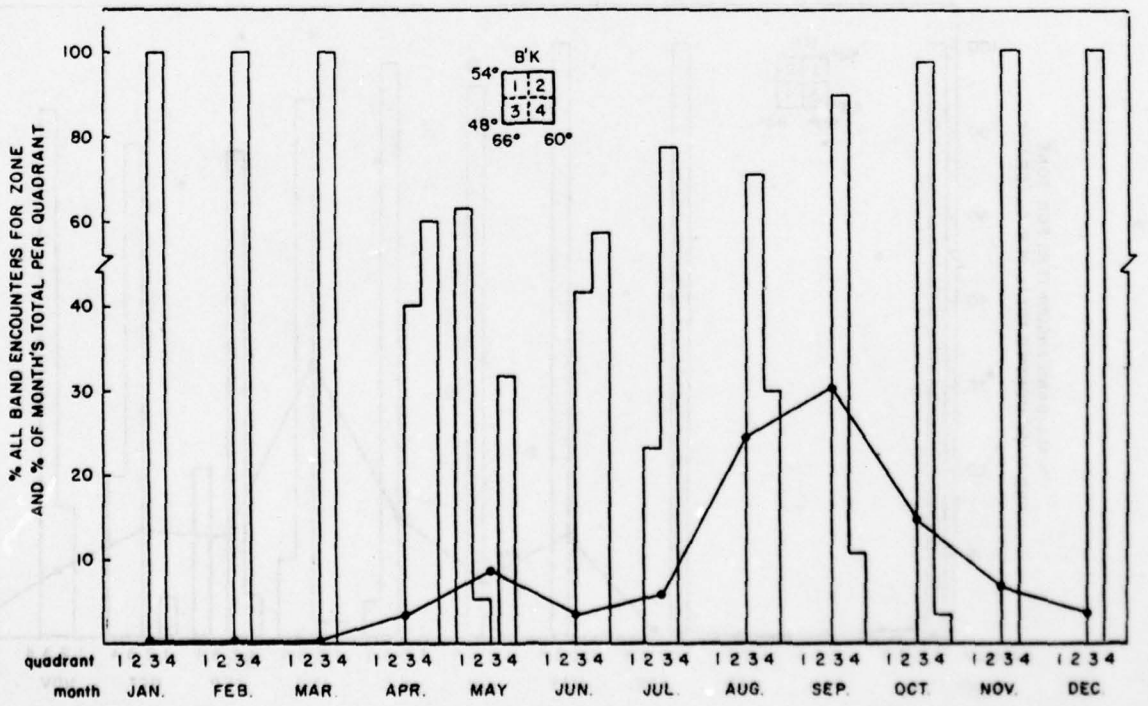
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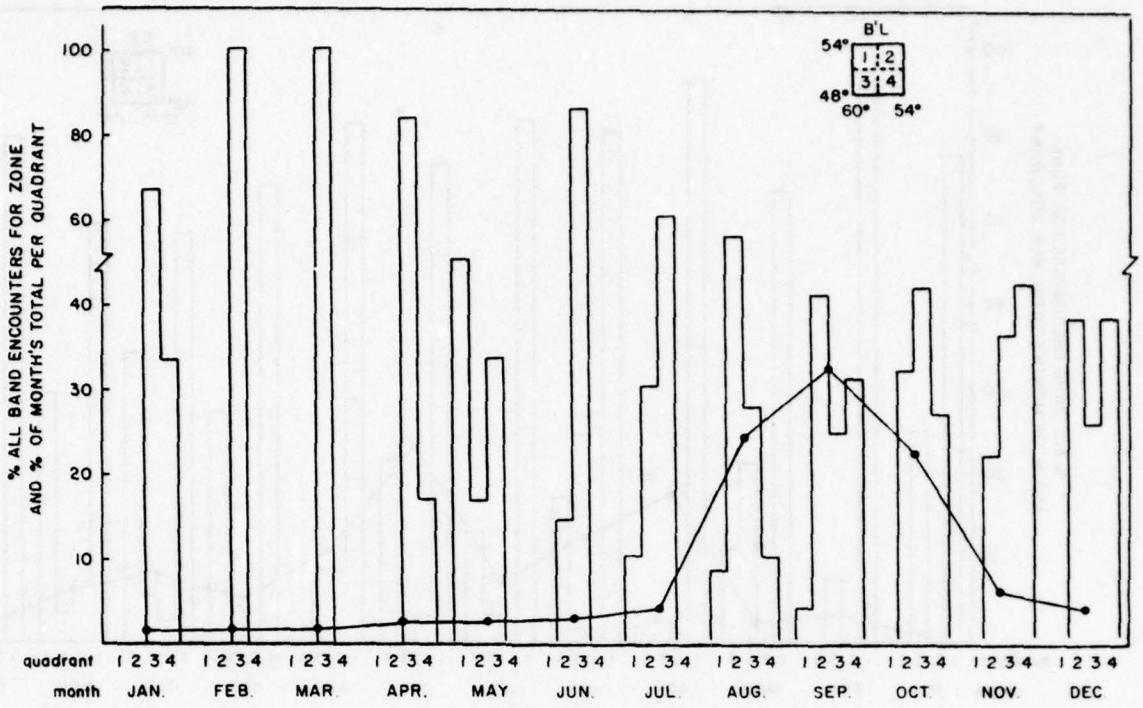
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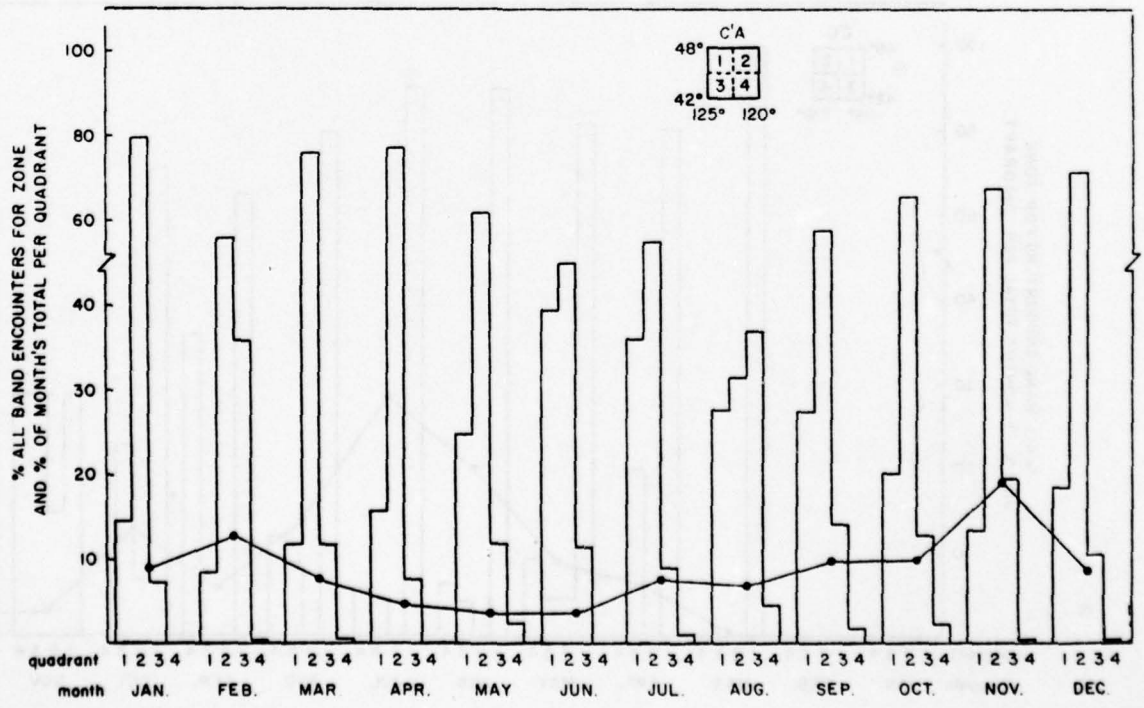
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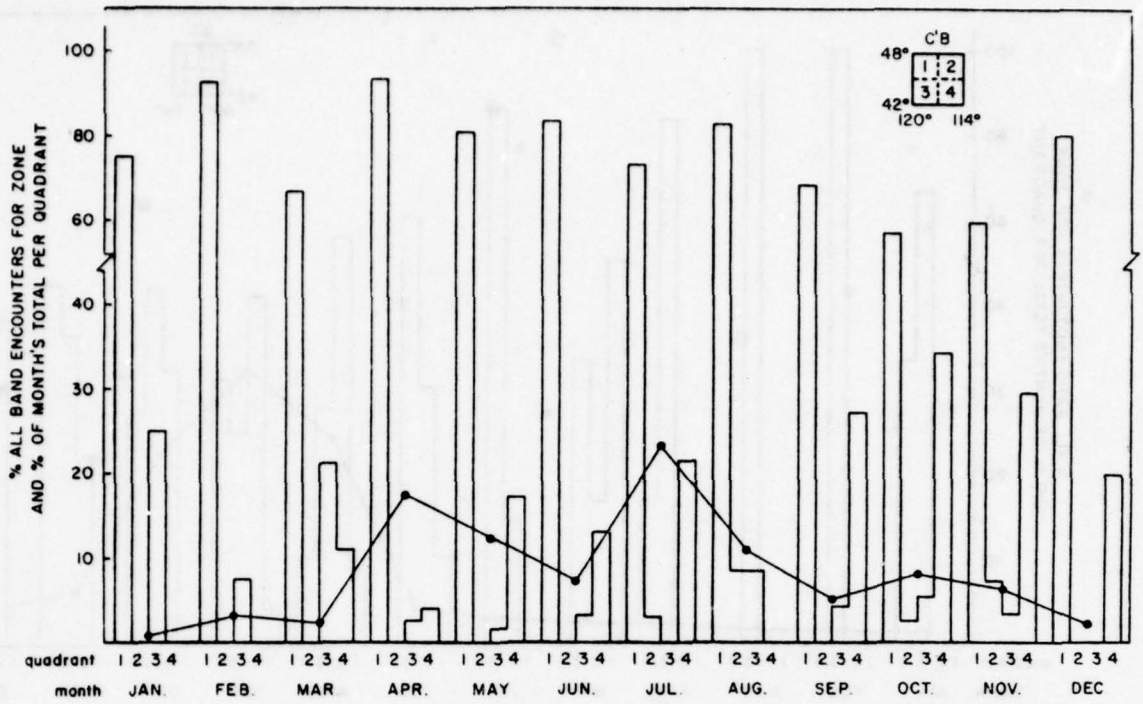
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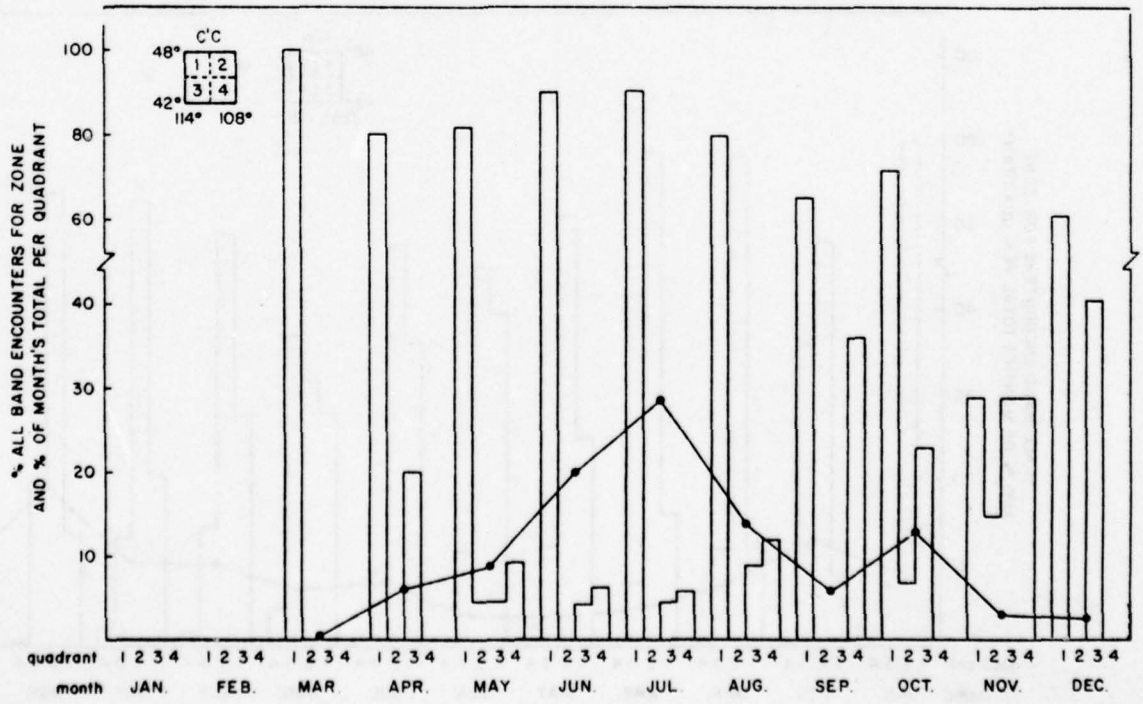
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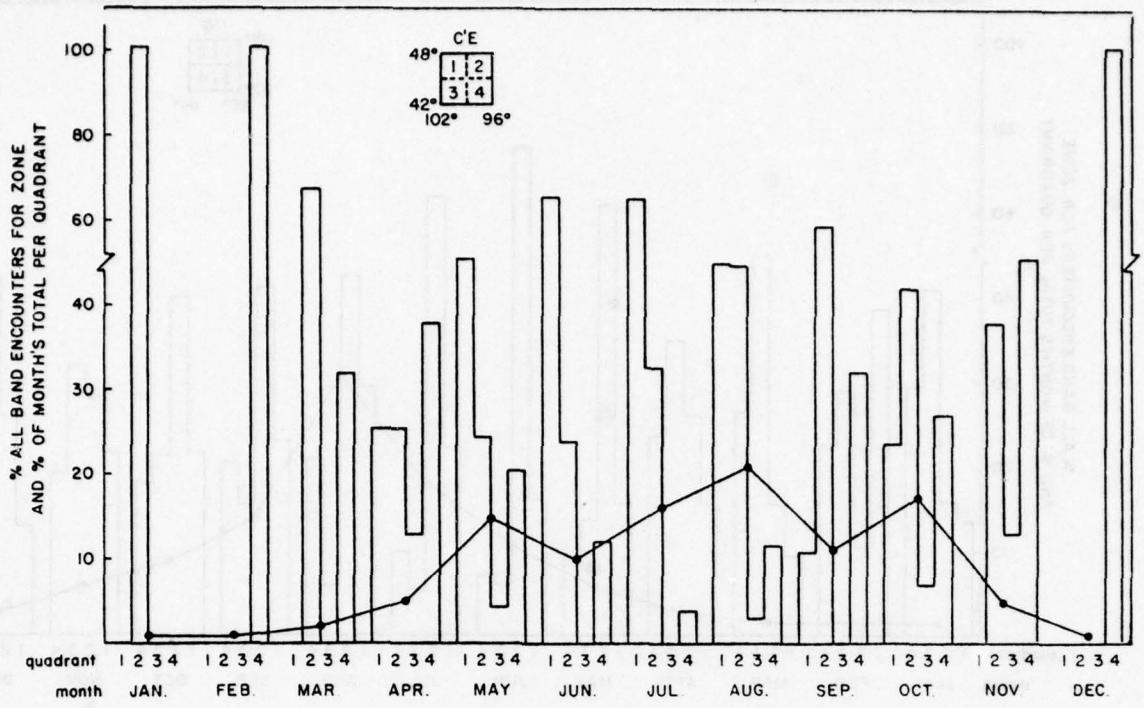
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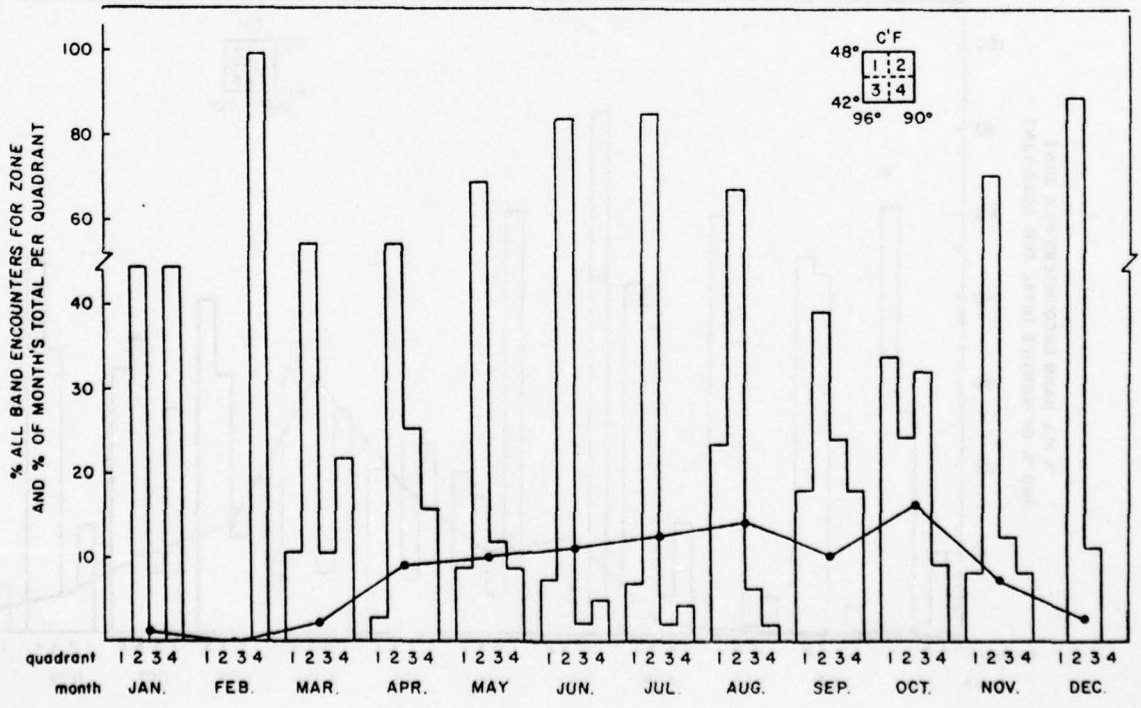
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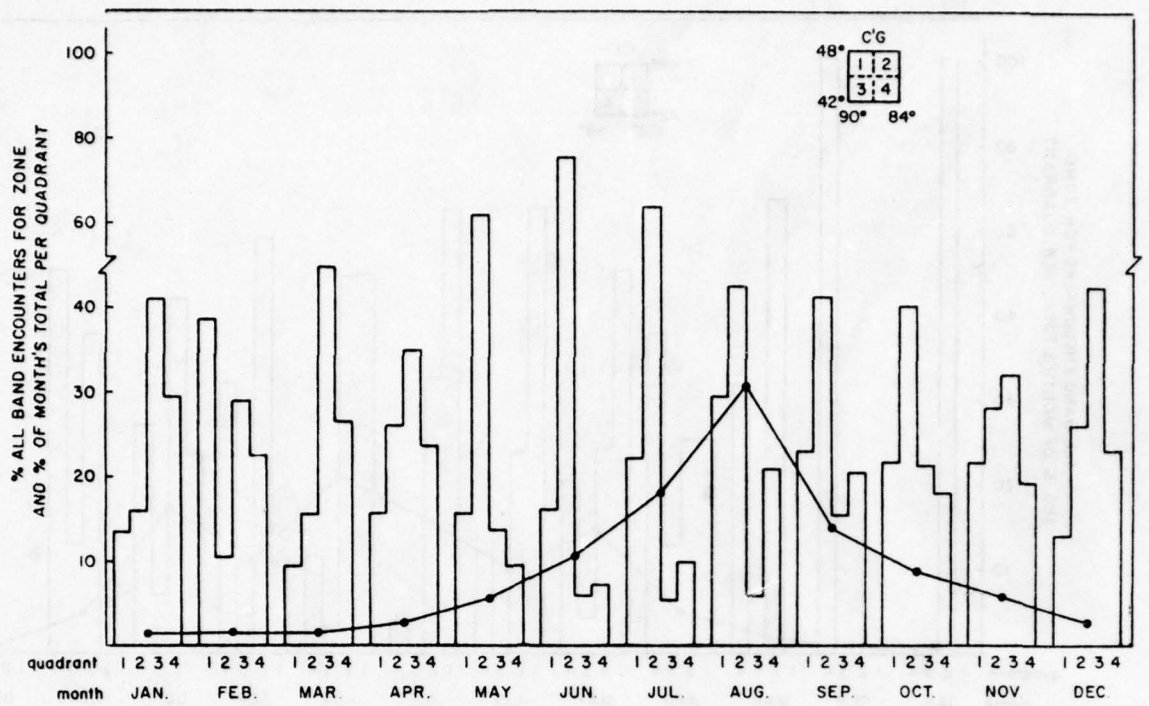
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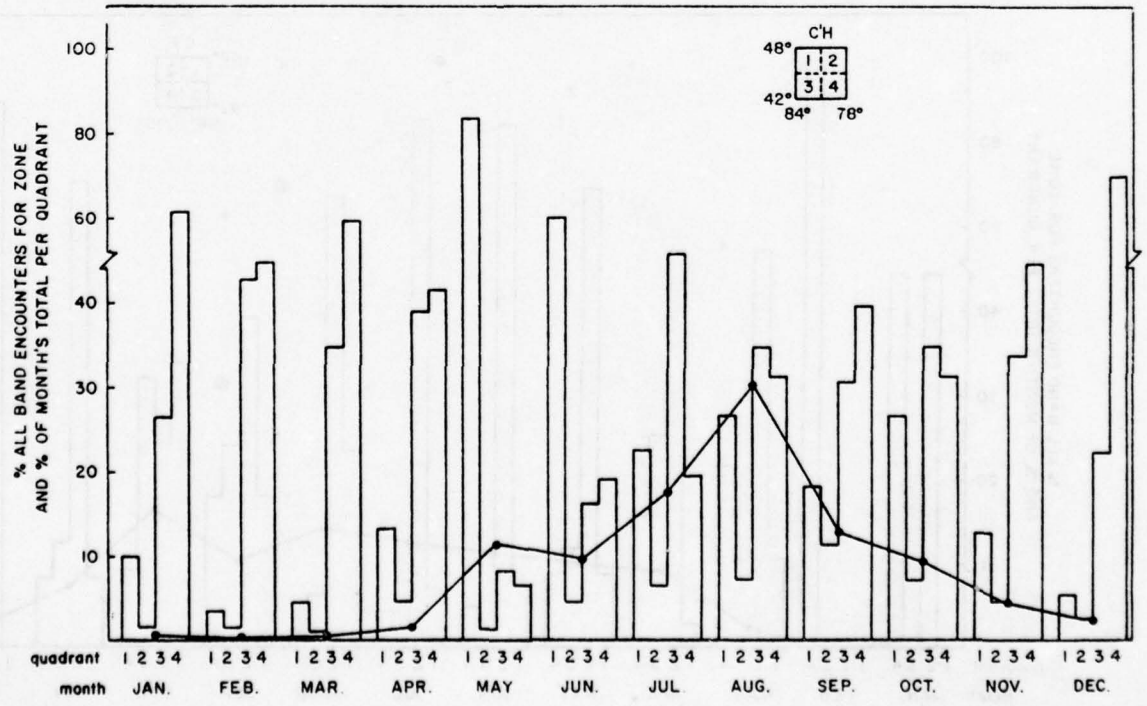
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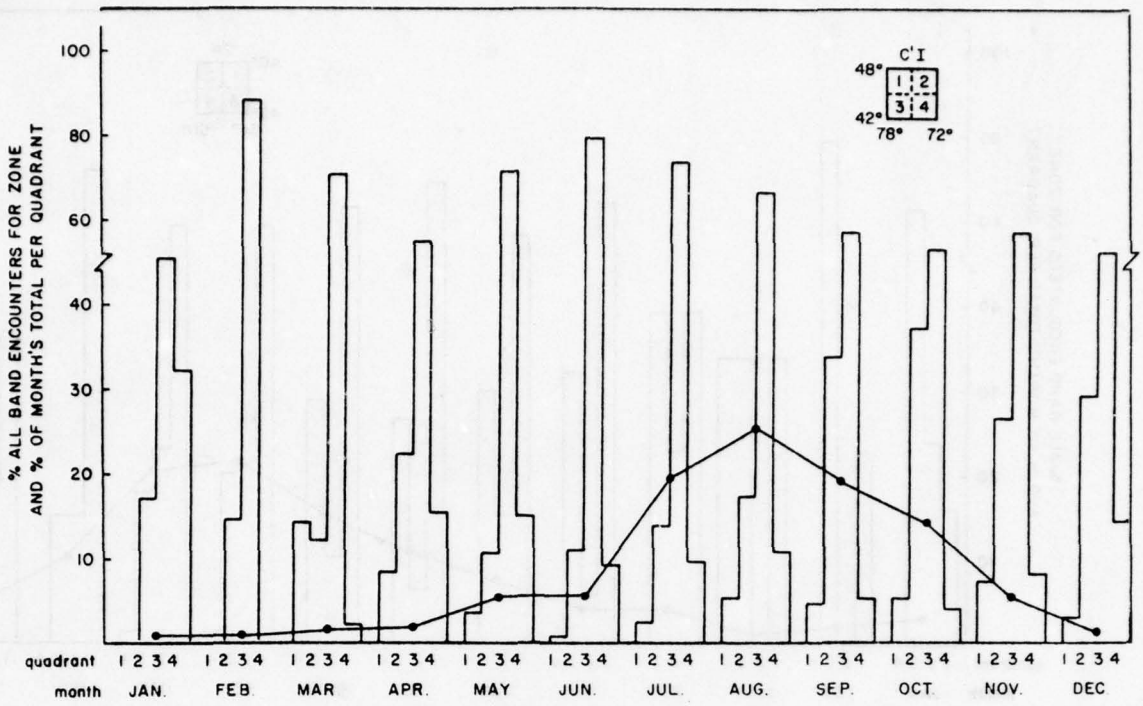
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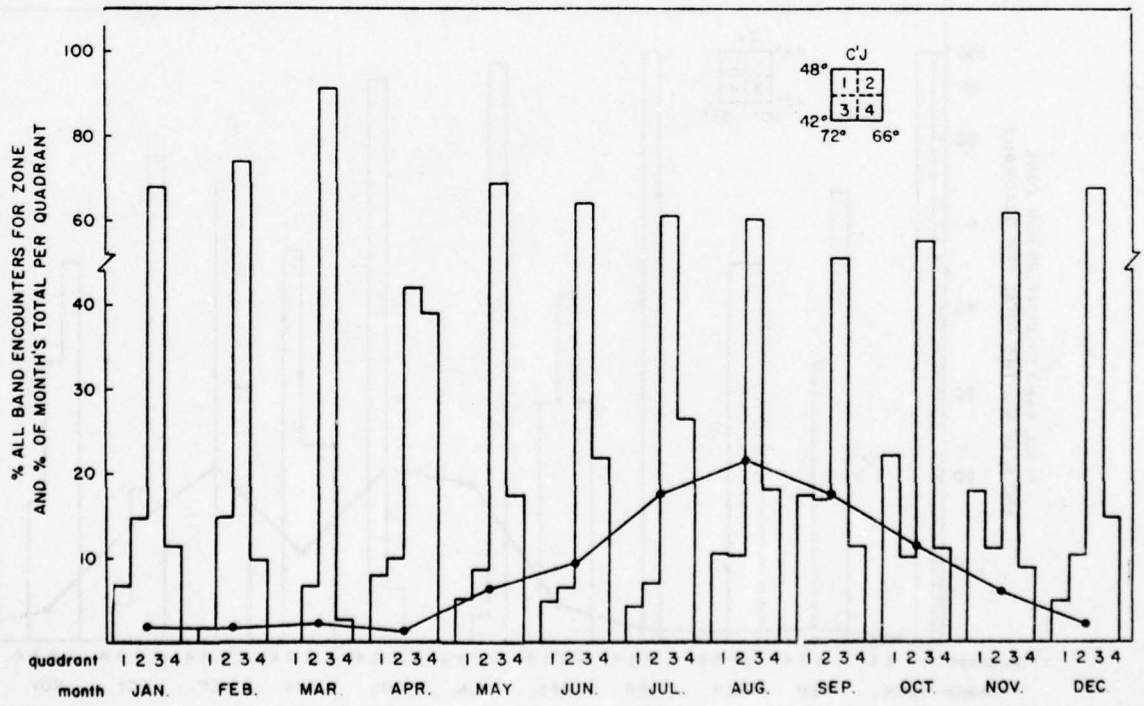
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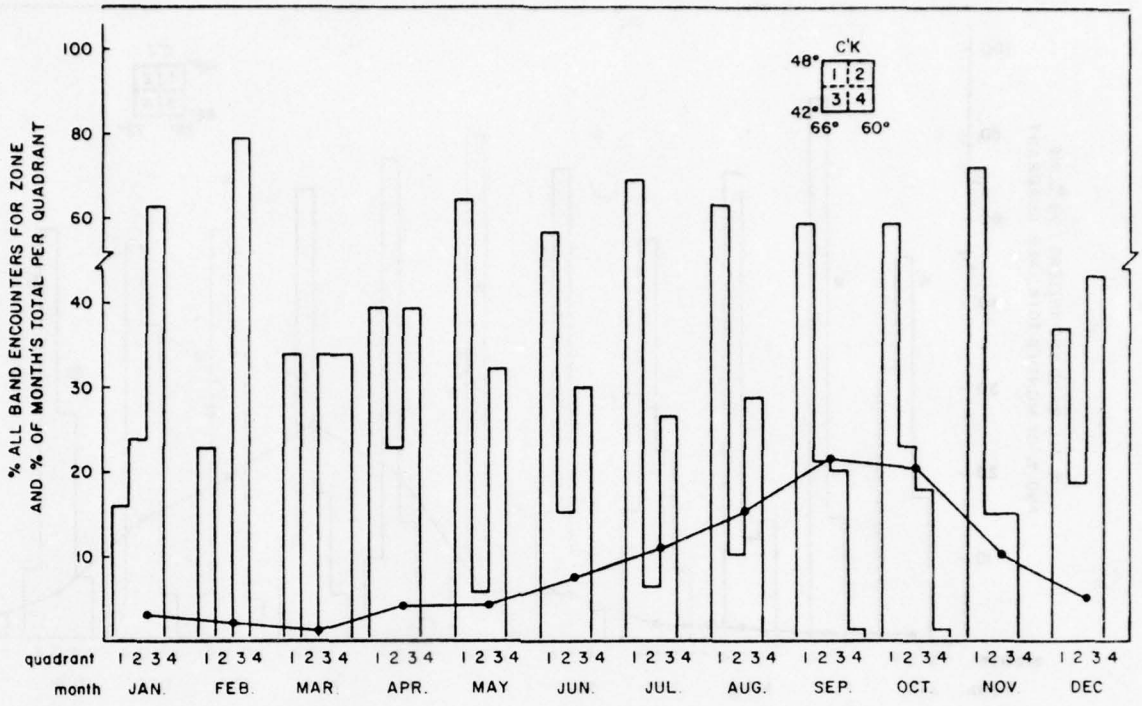
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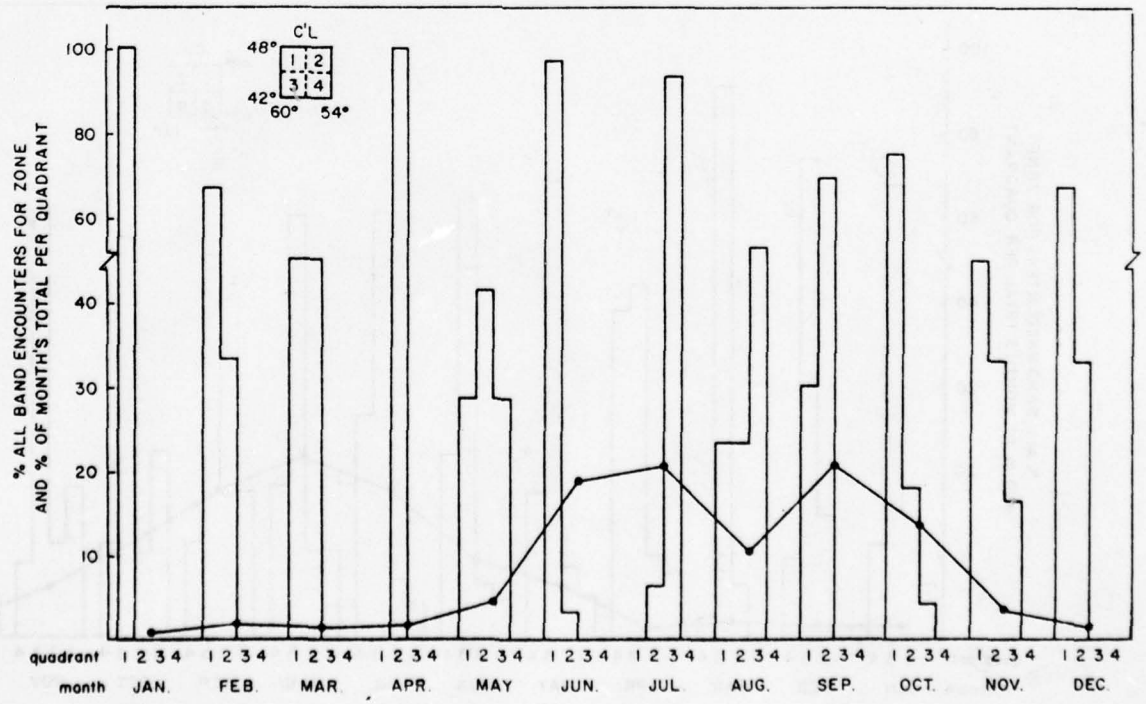
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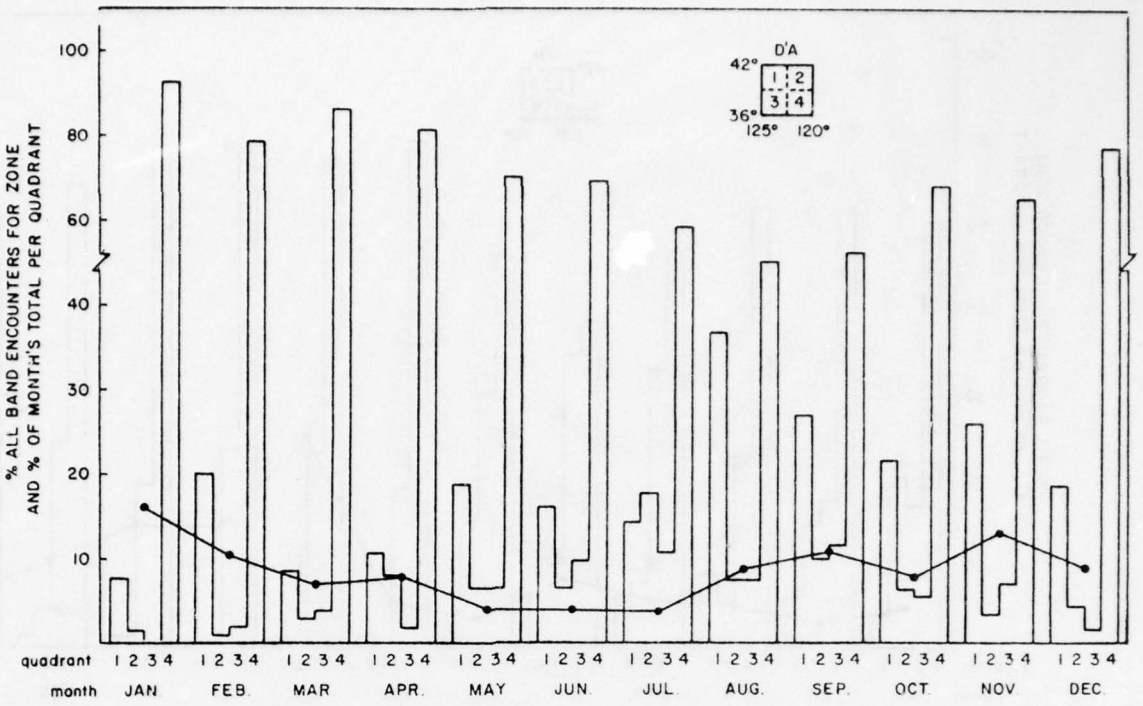
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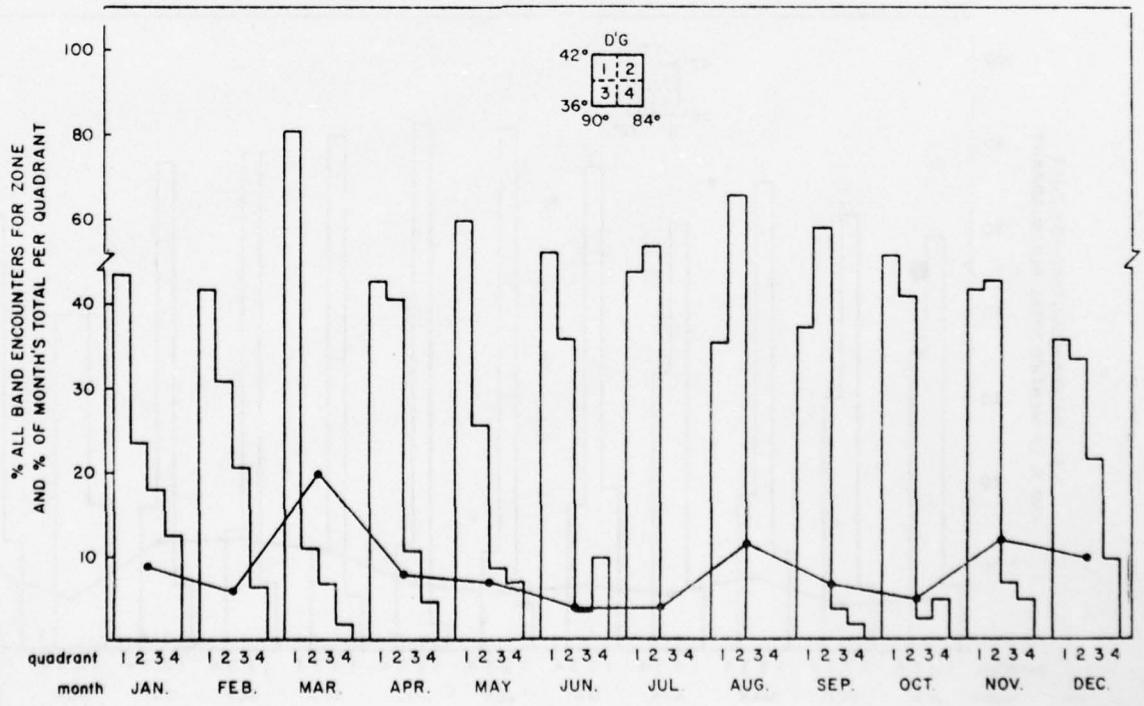
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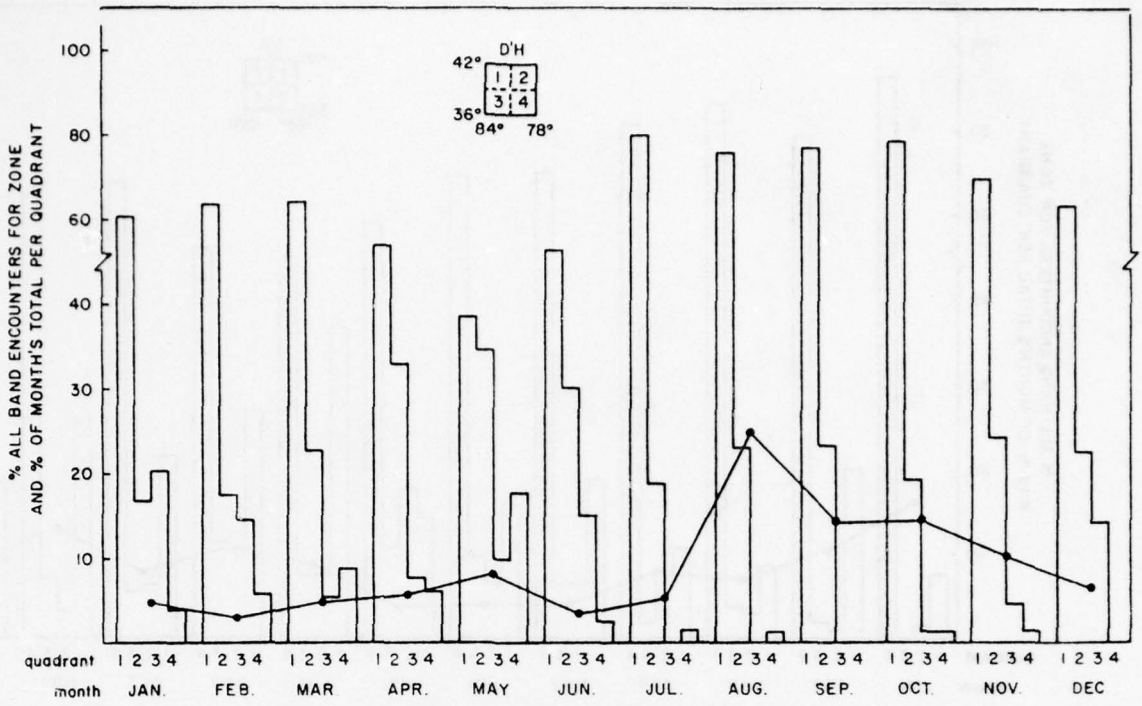
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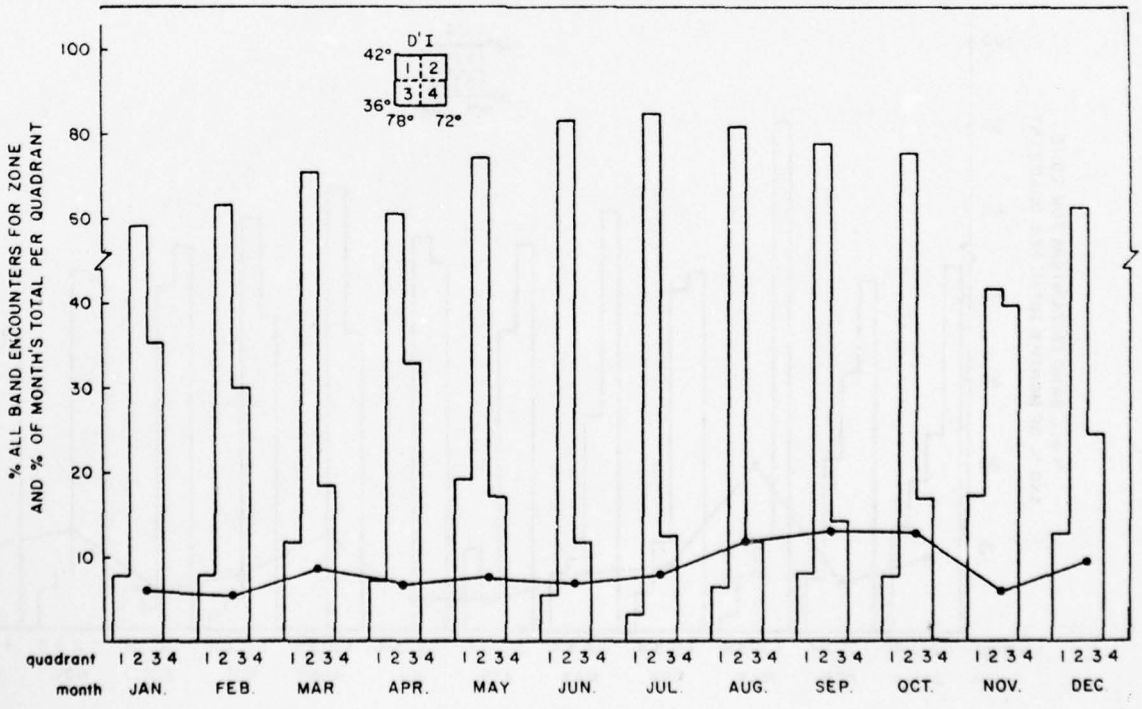
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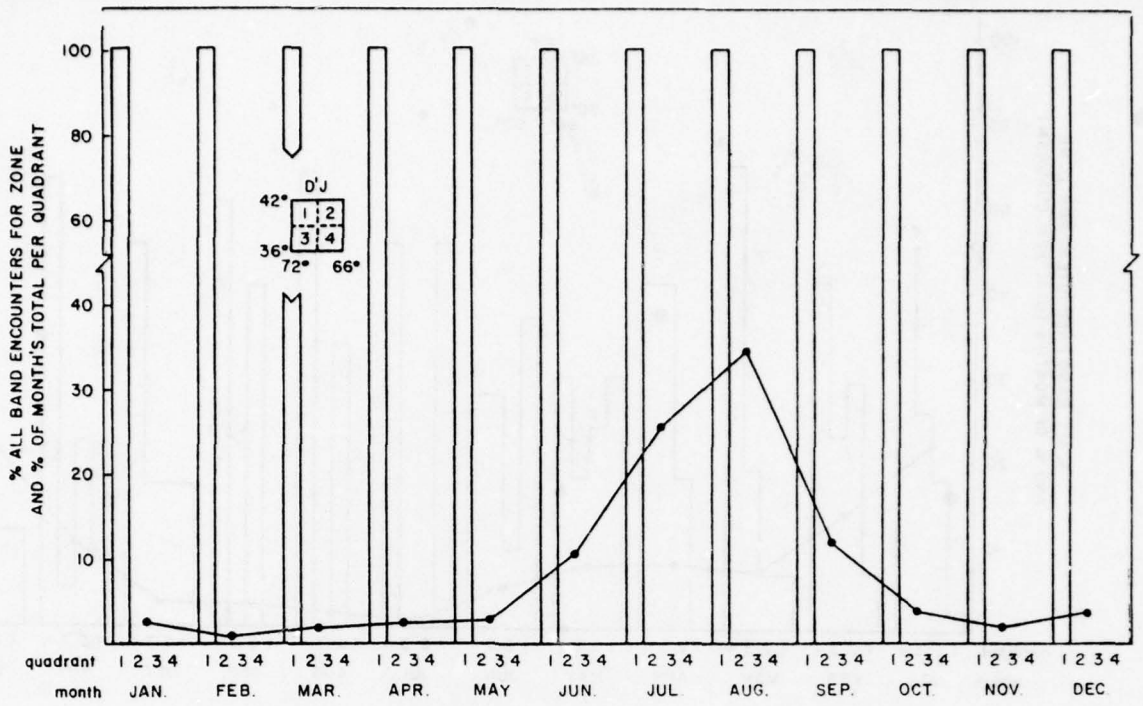
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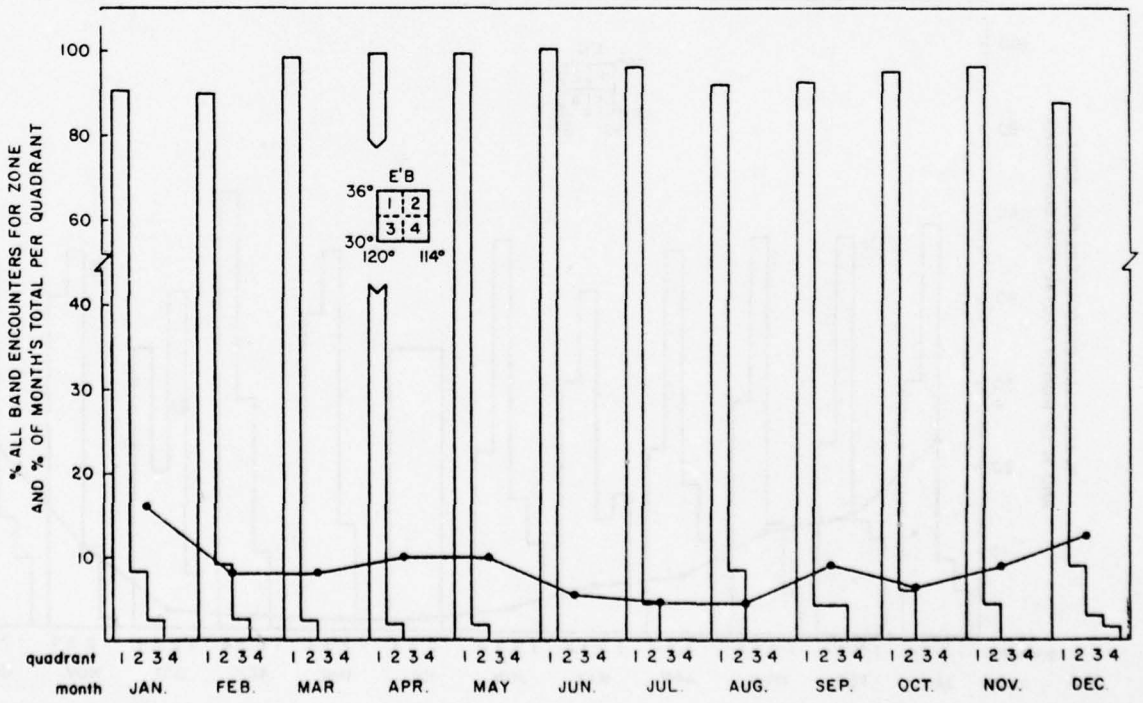
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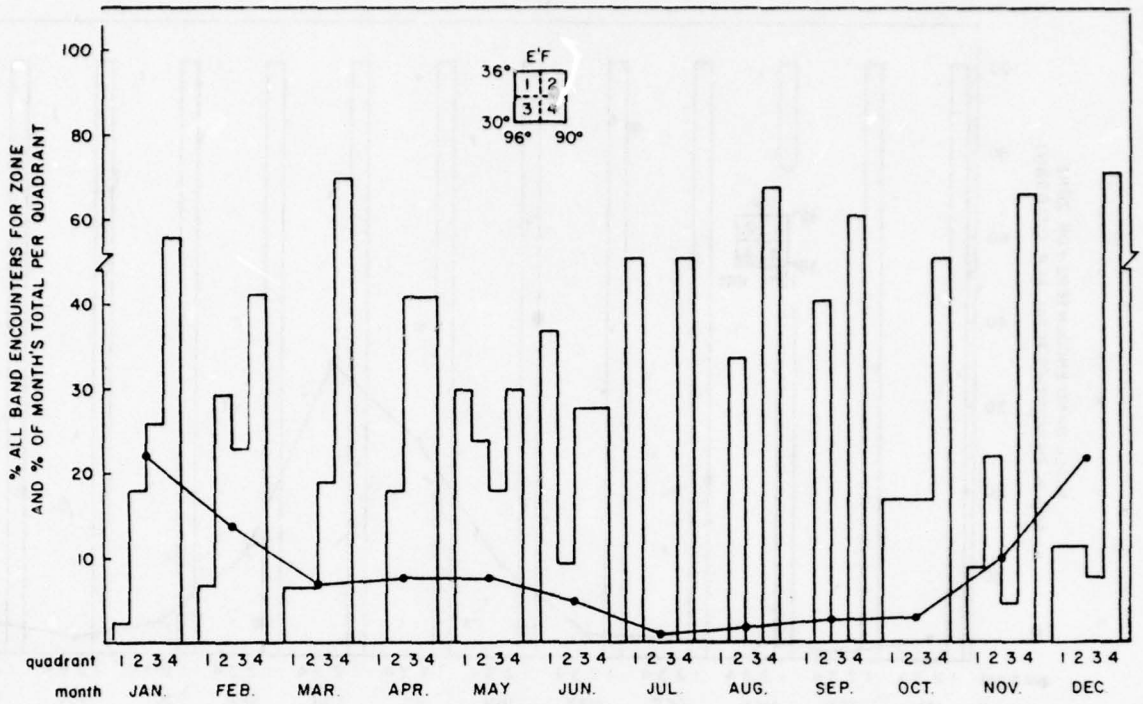
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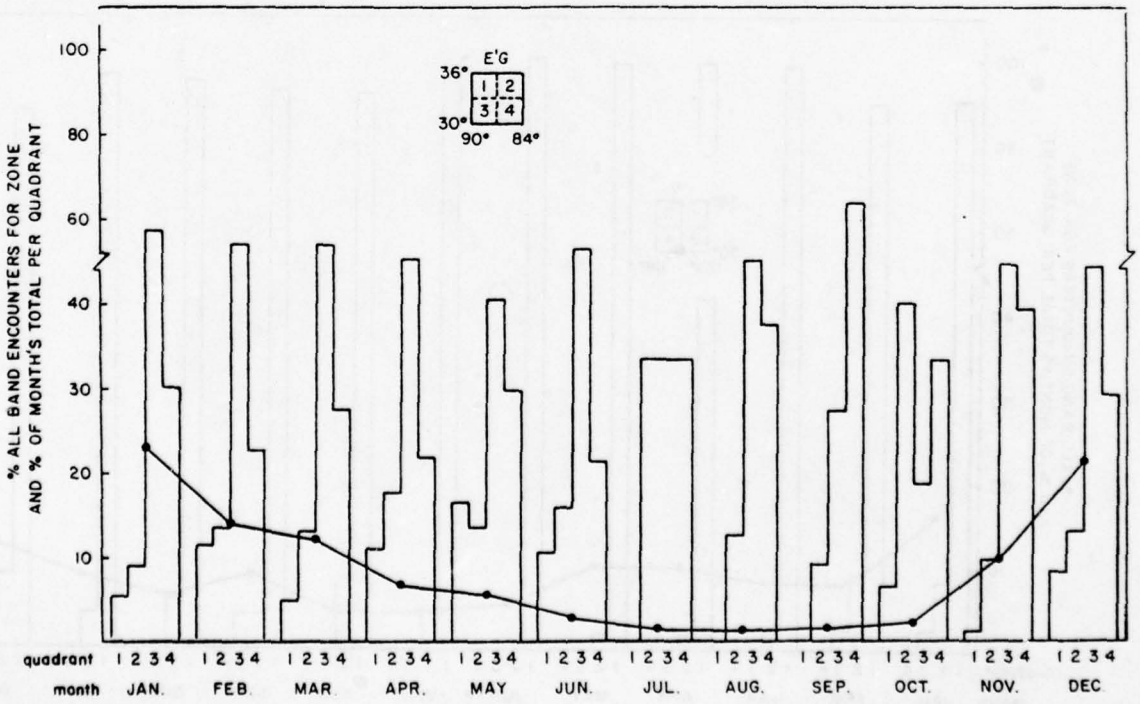
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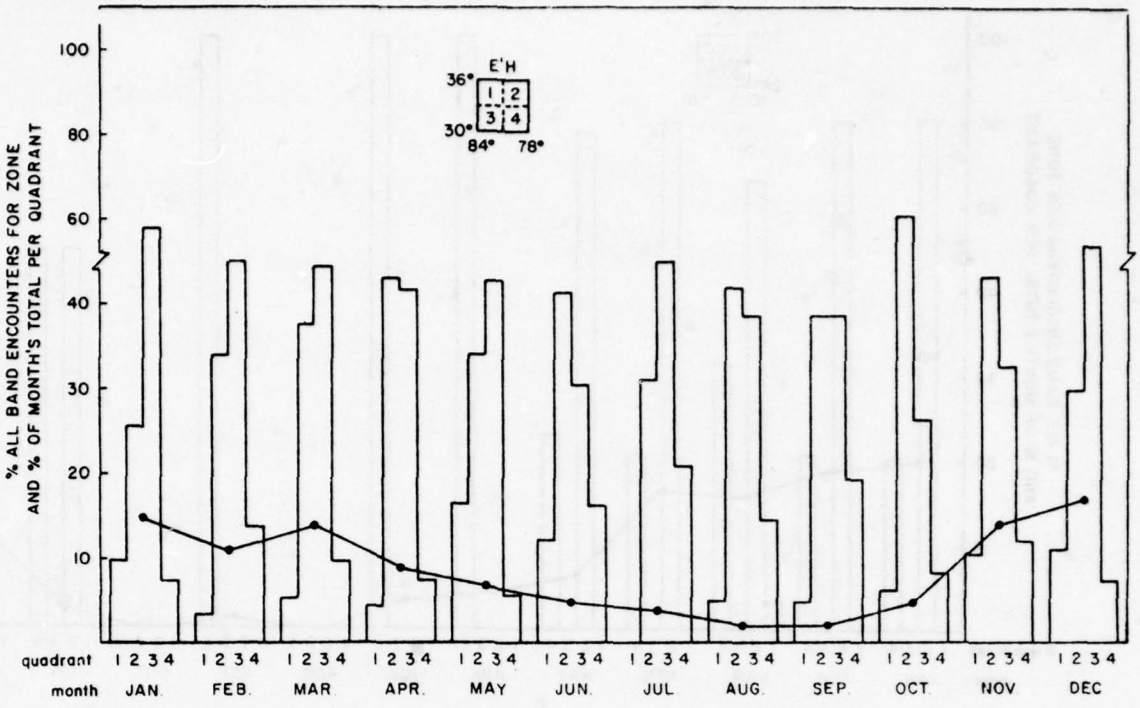
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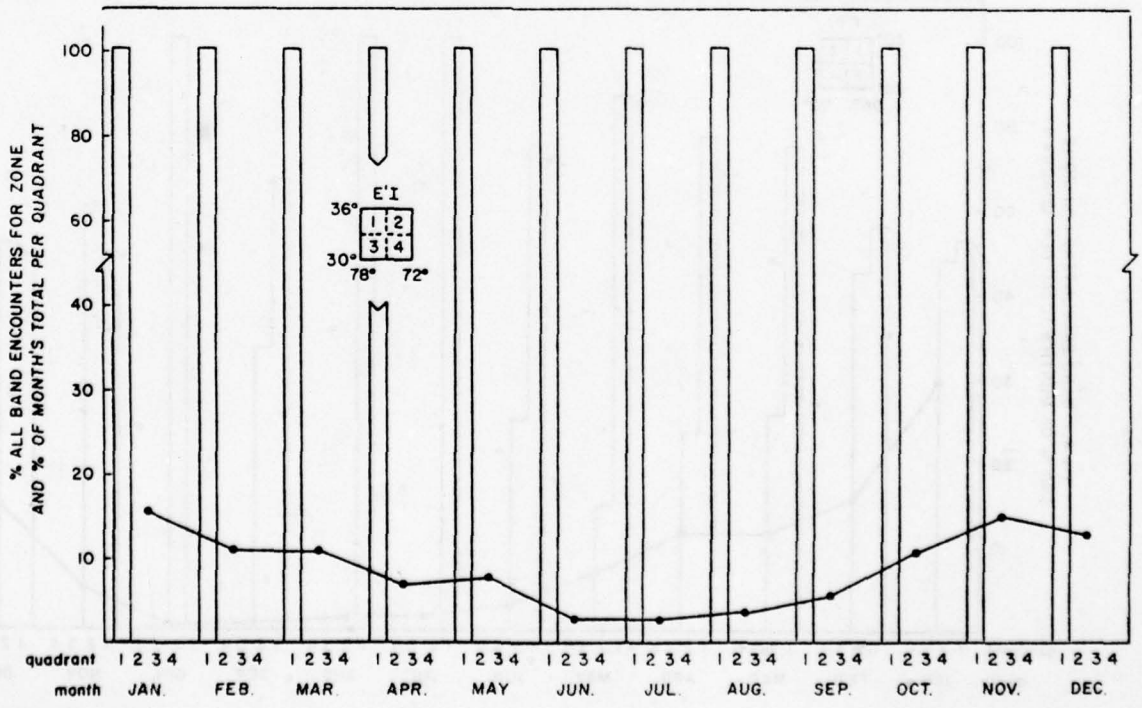
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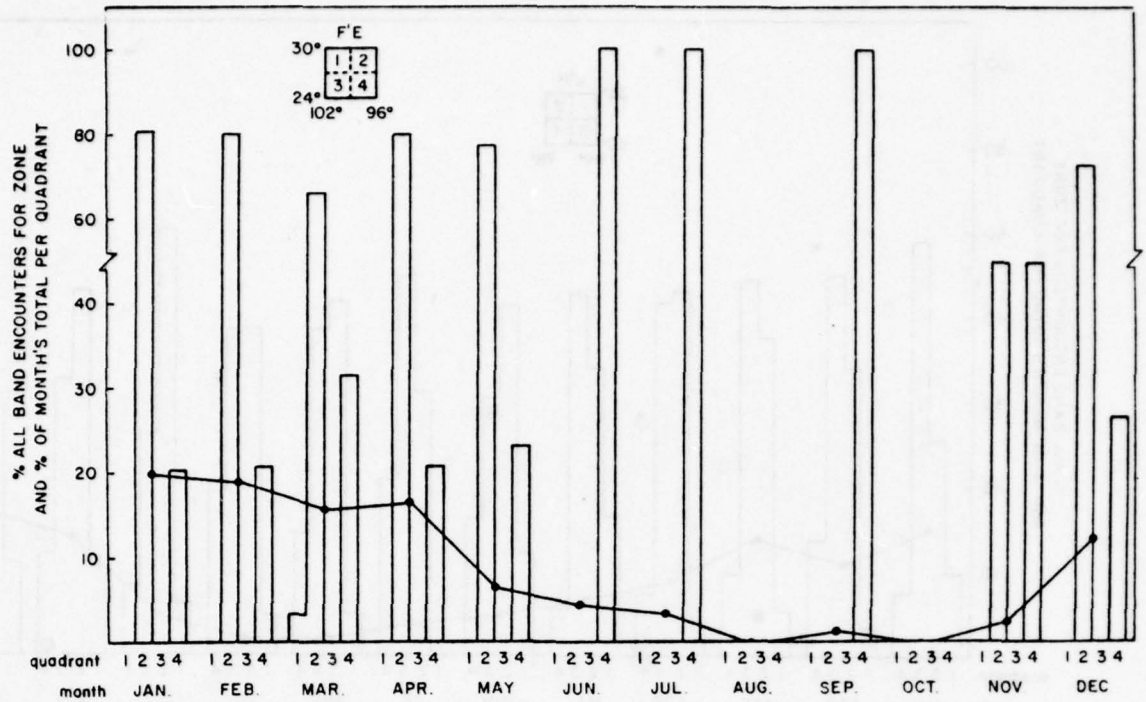
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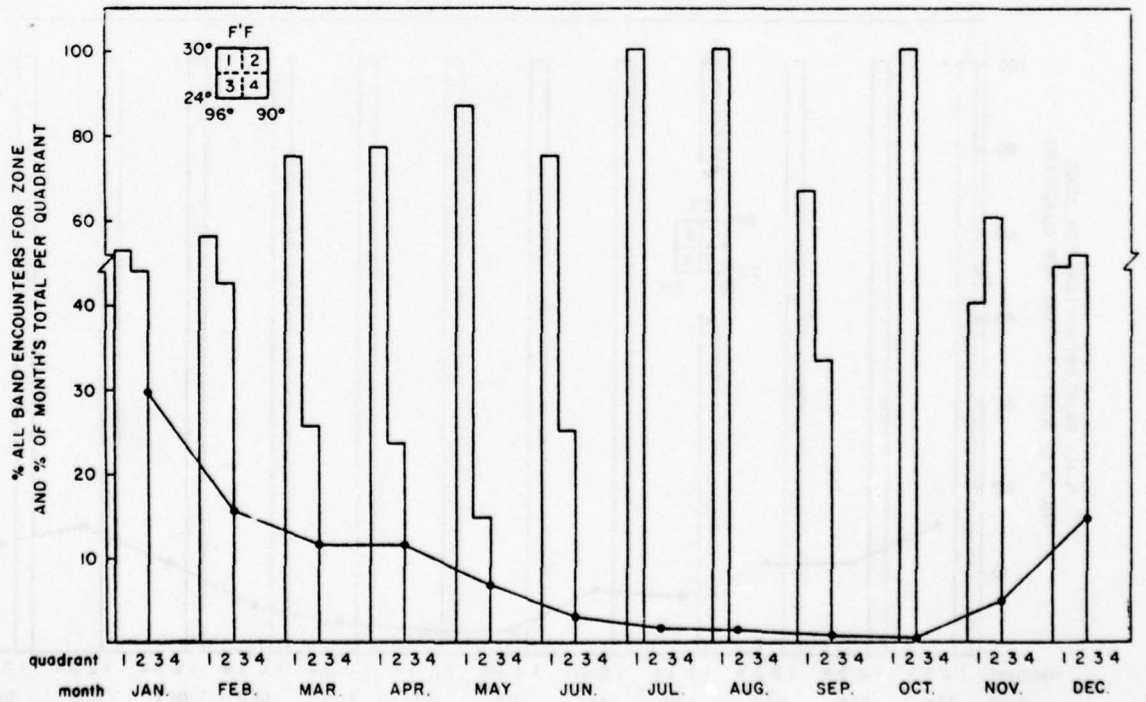
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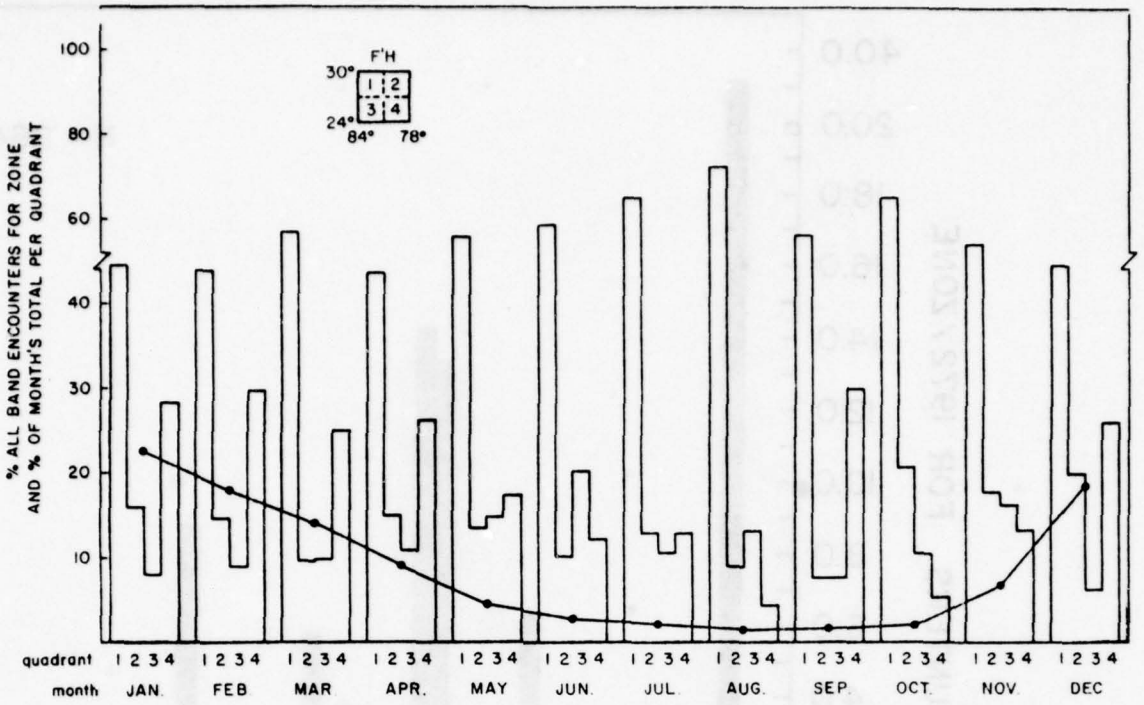
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month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

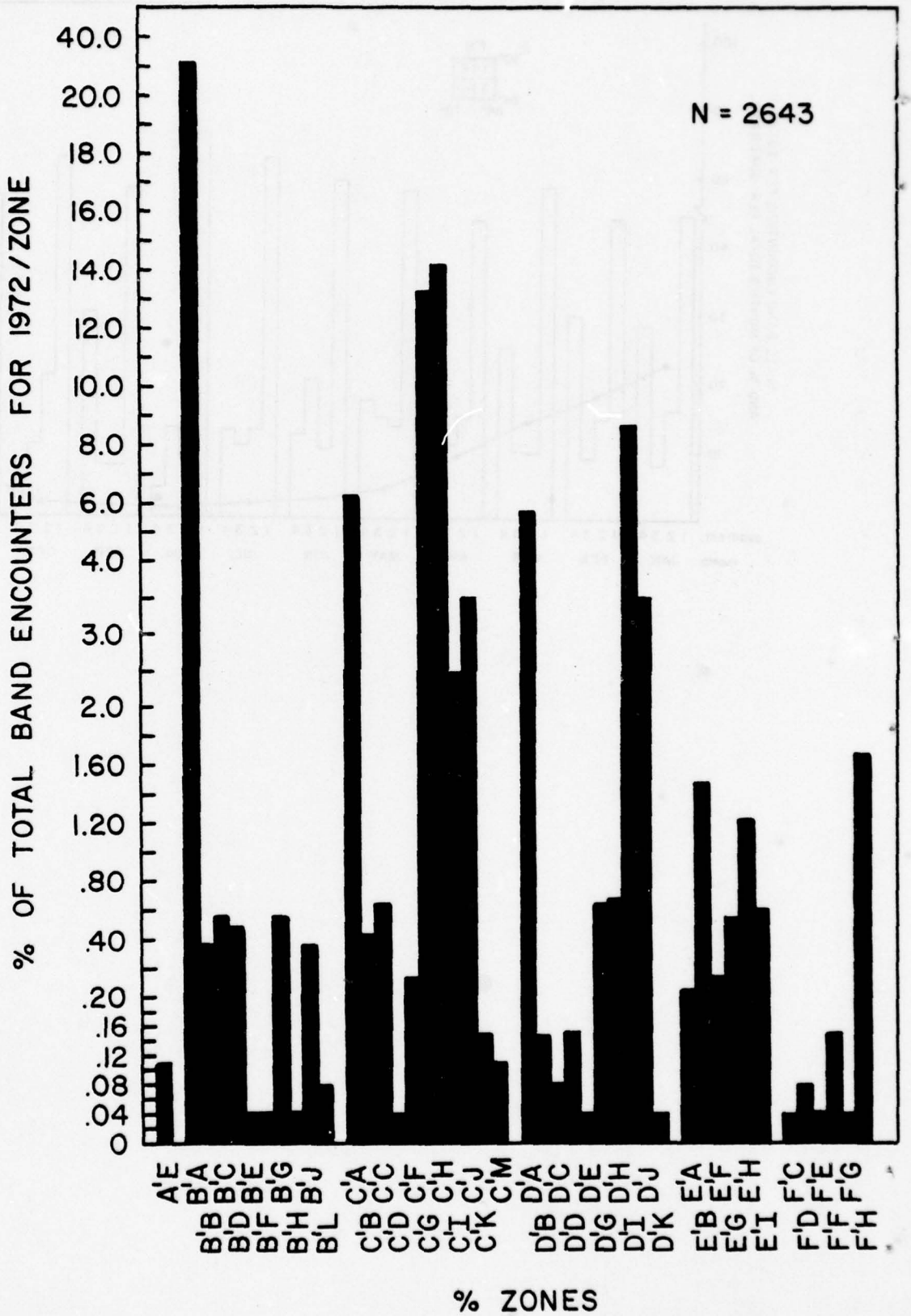
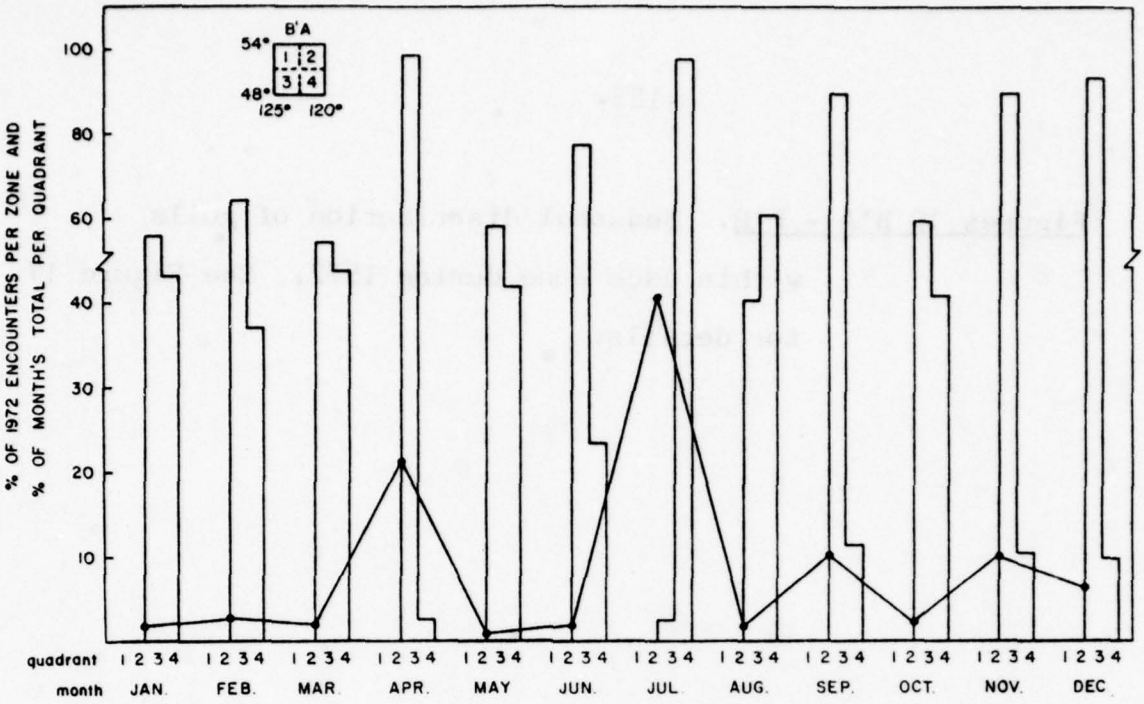
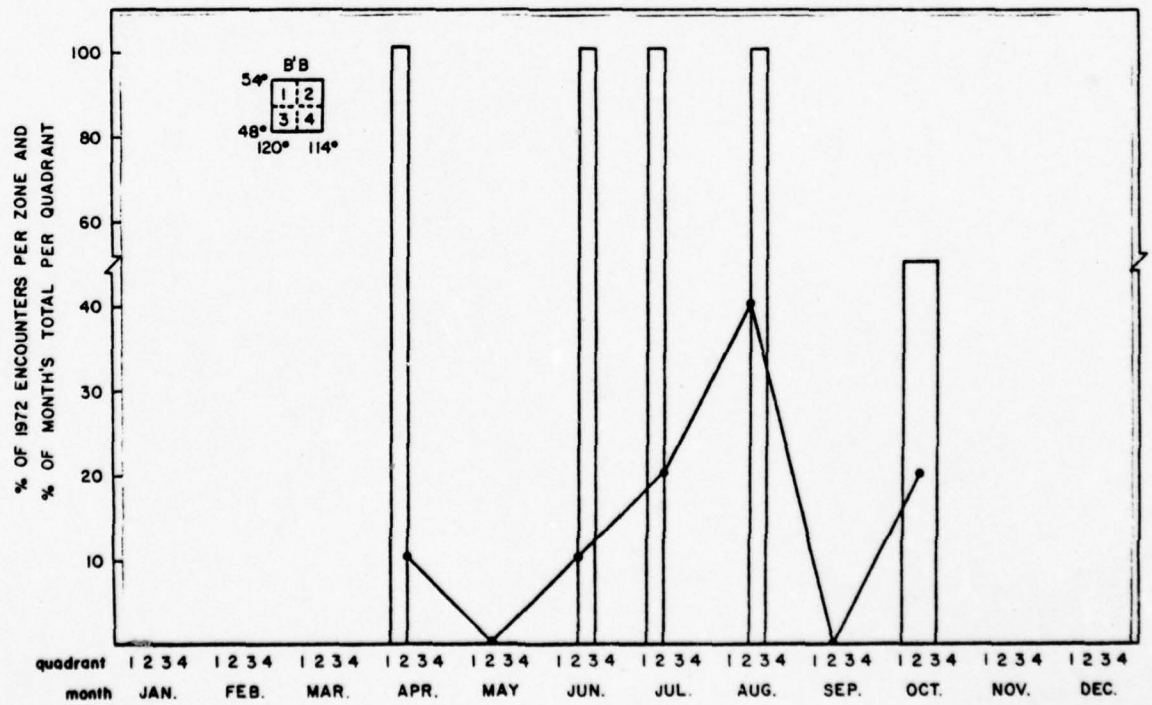
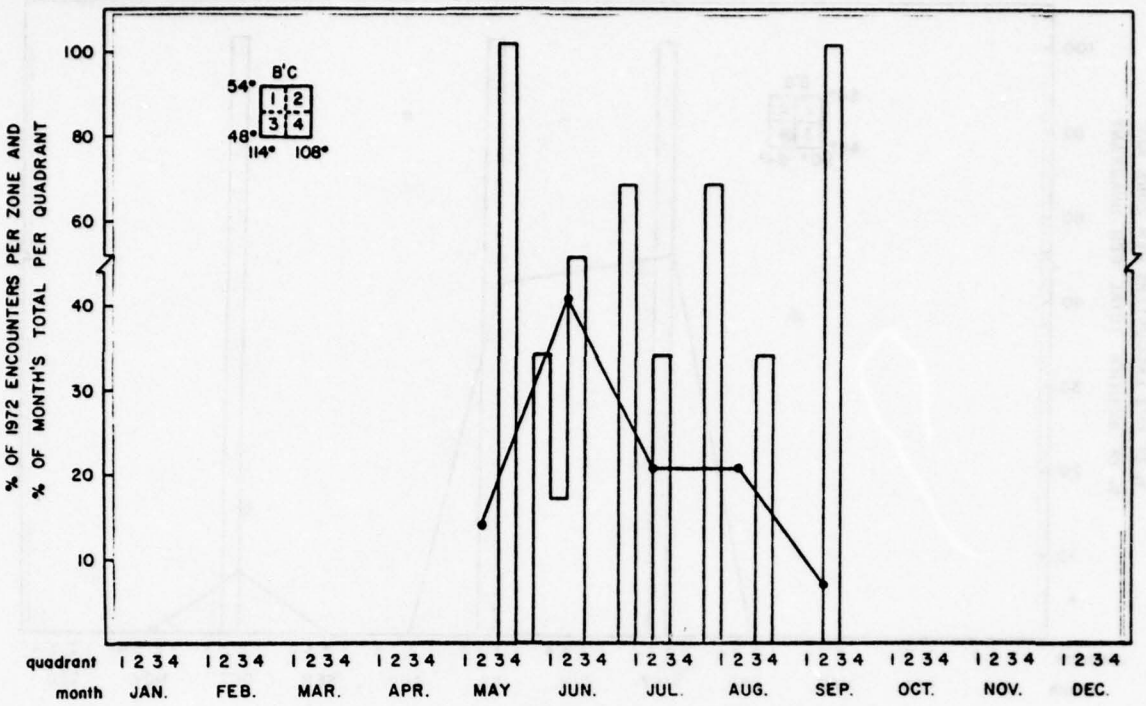


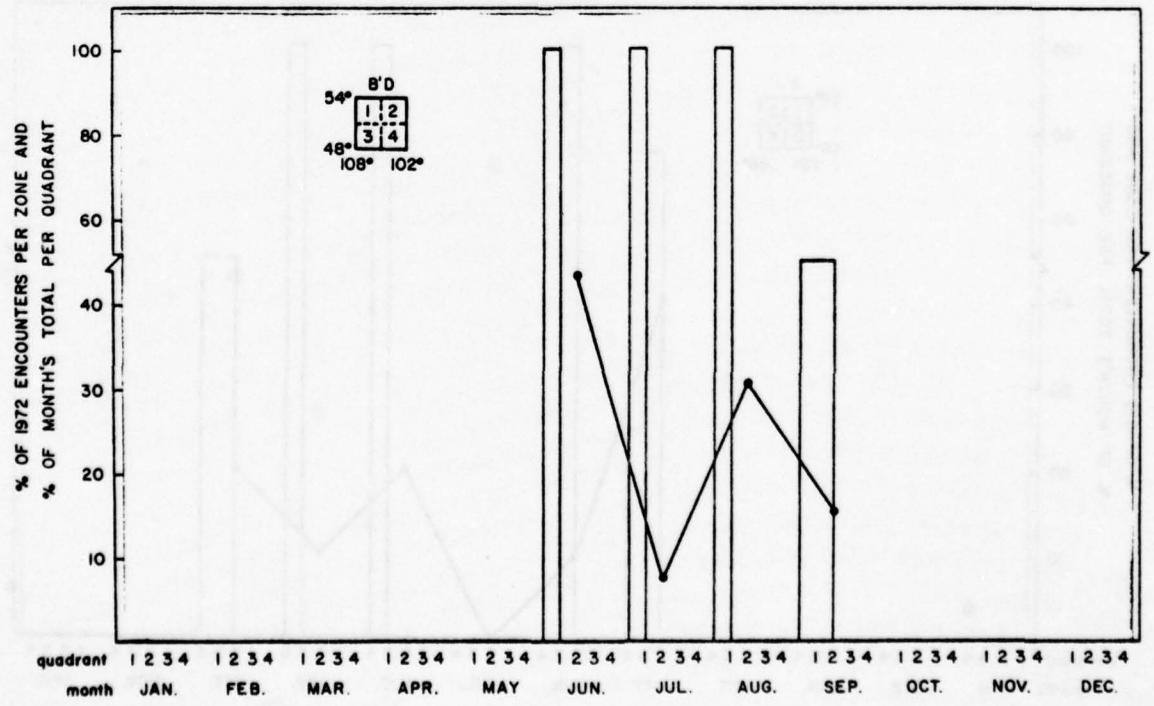
Figure 18. The Proportion of Band Recoveries for 1972 Reported in Each 6^{o} Zone.

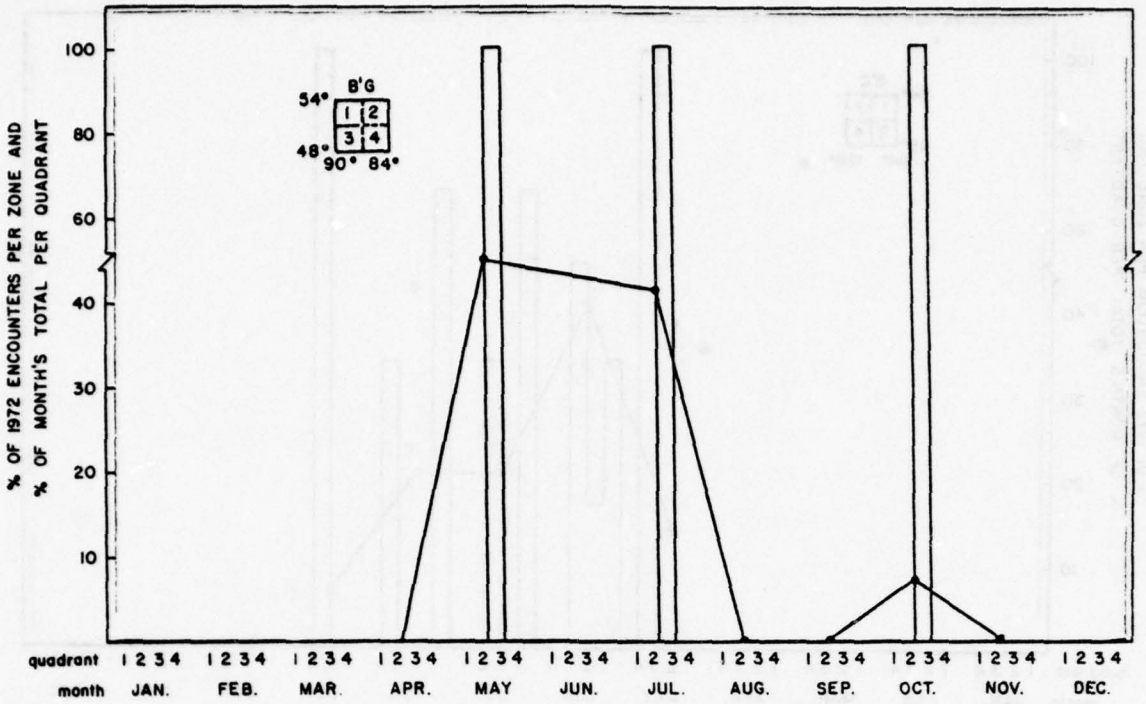
Figures 19 B'A - F'H. Seasonal distribution of gulls within each Zone during 1972. See Figure 17 for details.

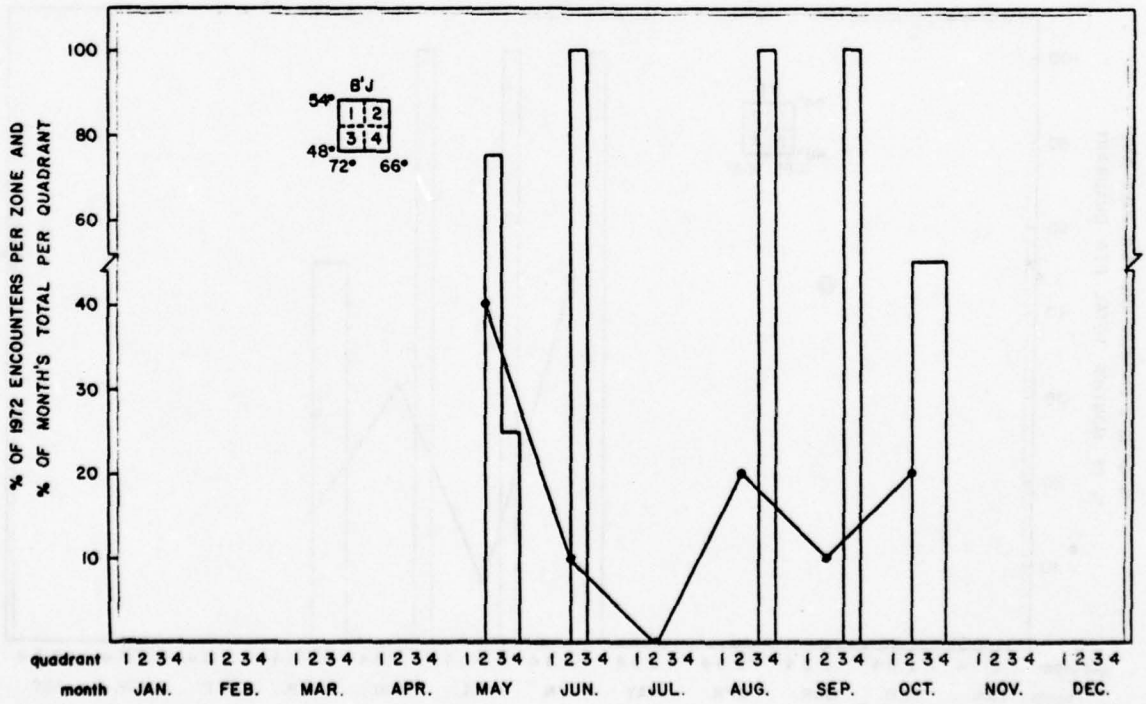

B'A
54°
48°
125°
120°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'B
54°
48°
120°
114°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'C
54°
48°
114°
108°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'D
54°
48°
108°
102°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'G
54°
48°
90° 84°
1 2
3 4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'J
54°
48°
72° 66°
1 2
3 4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
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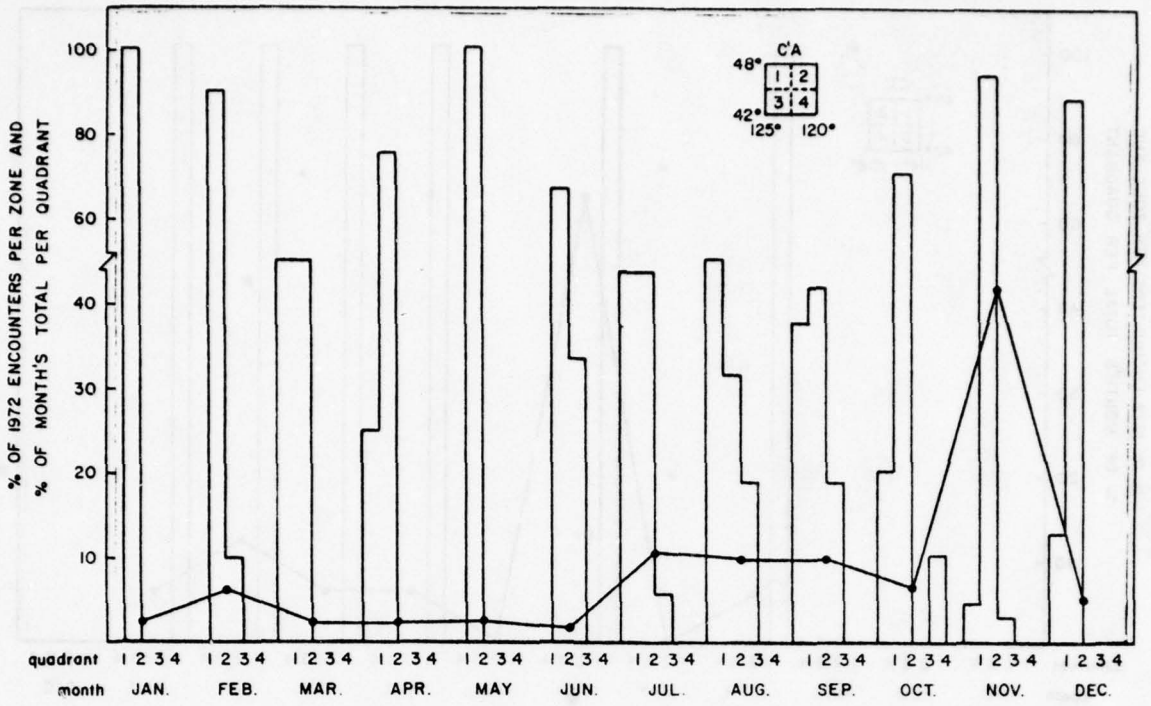
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'A
48°
42°
125°
120°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
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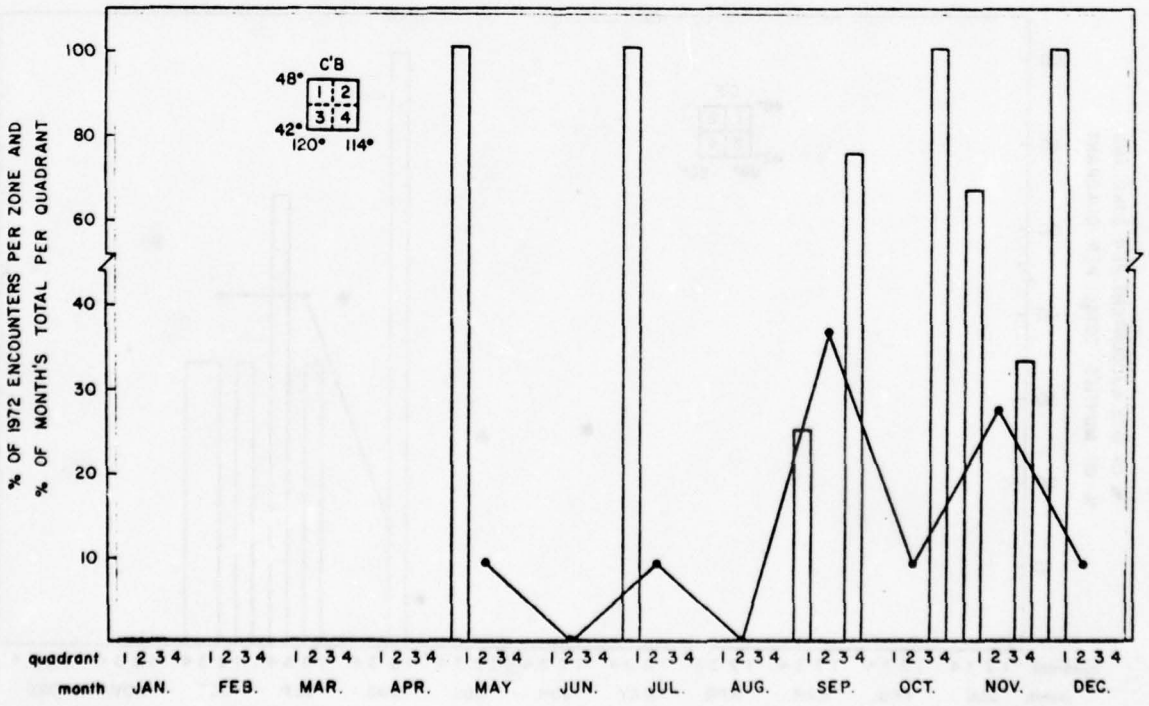
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'B
48°
42°
120°
114°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
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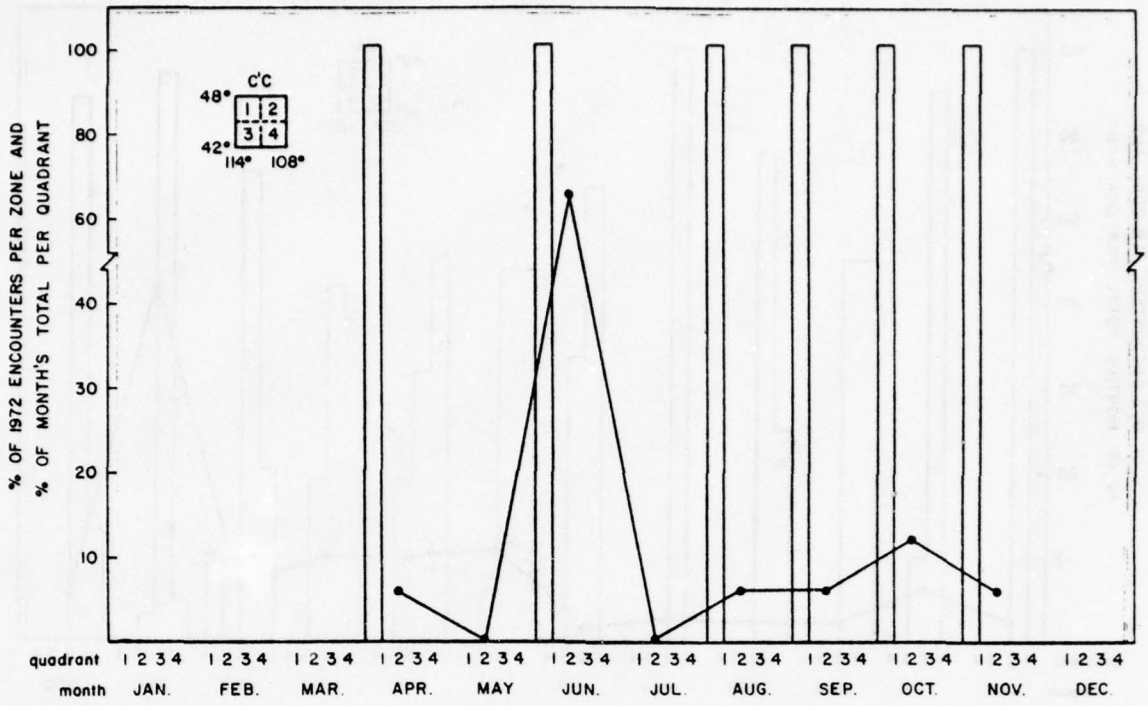
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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C'C
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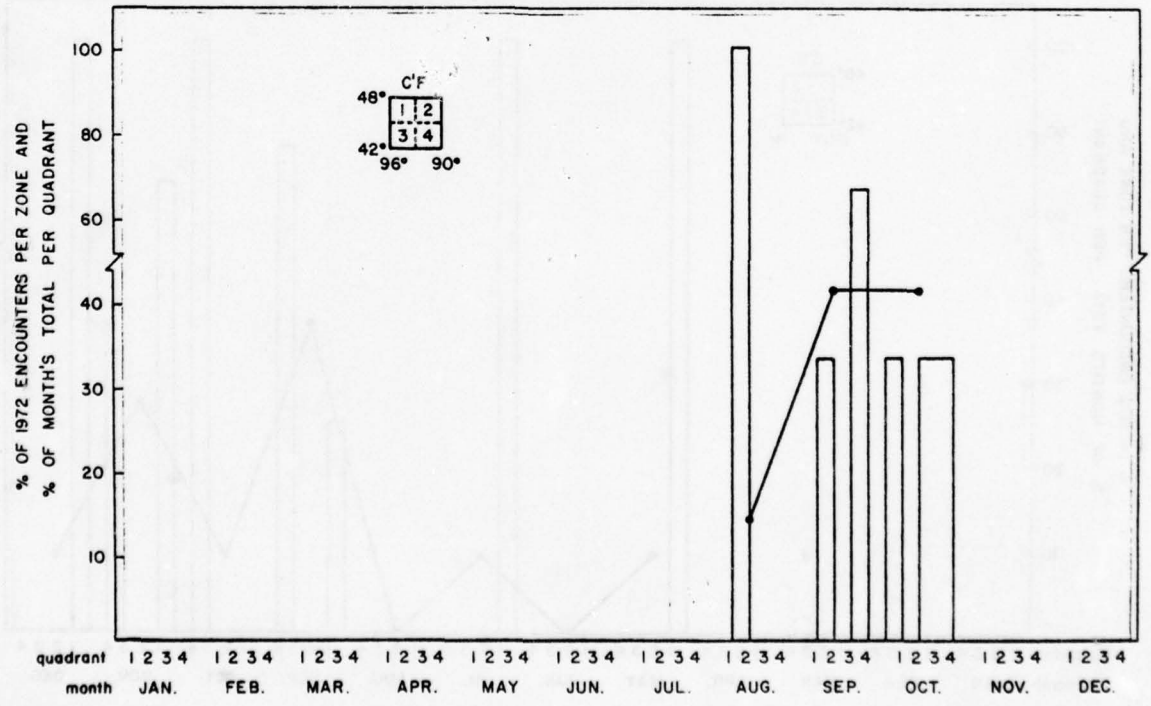
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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C'F
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96°
90°
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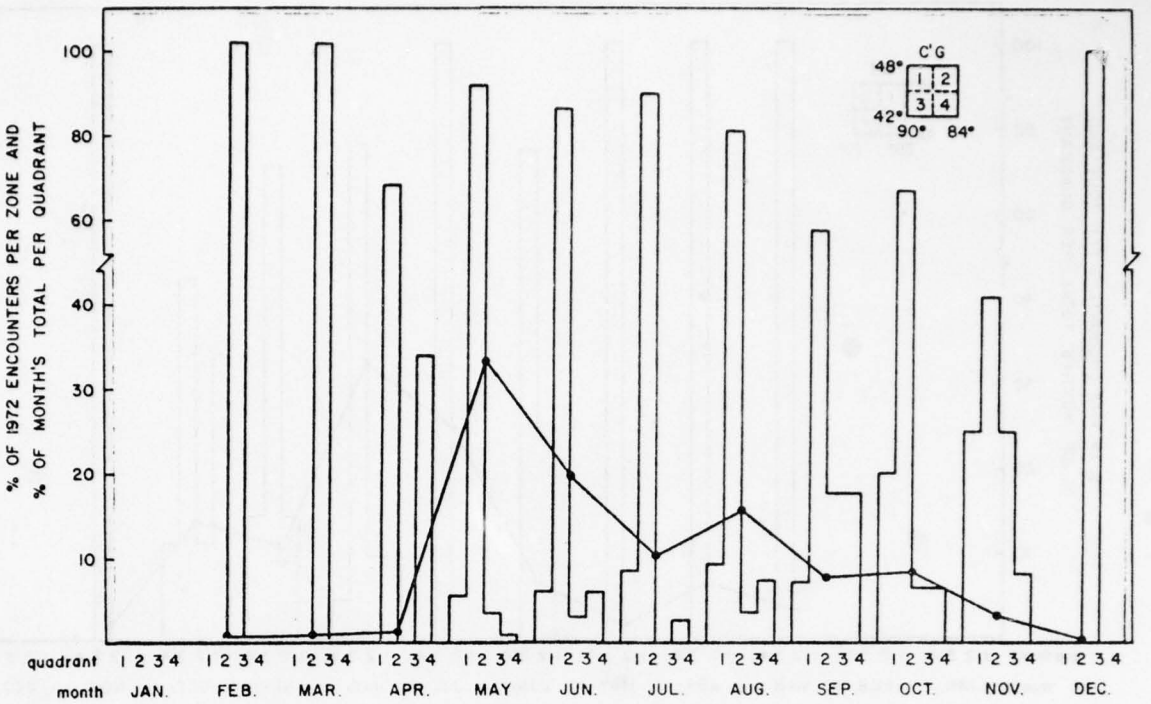
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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C'G
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84°
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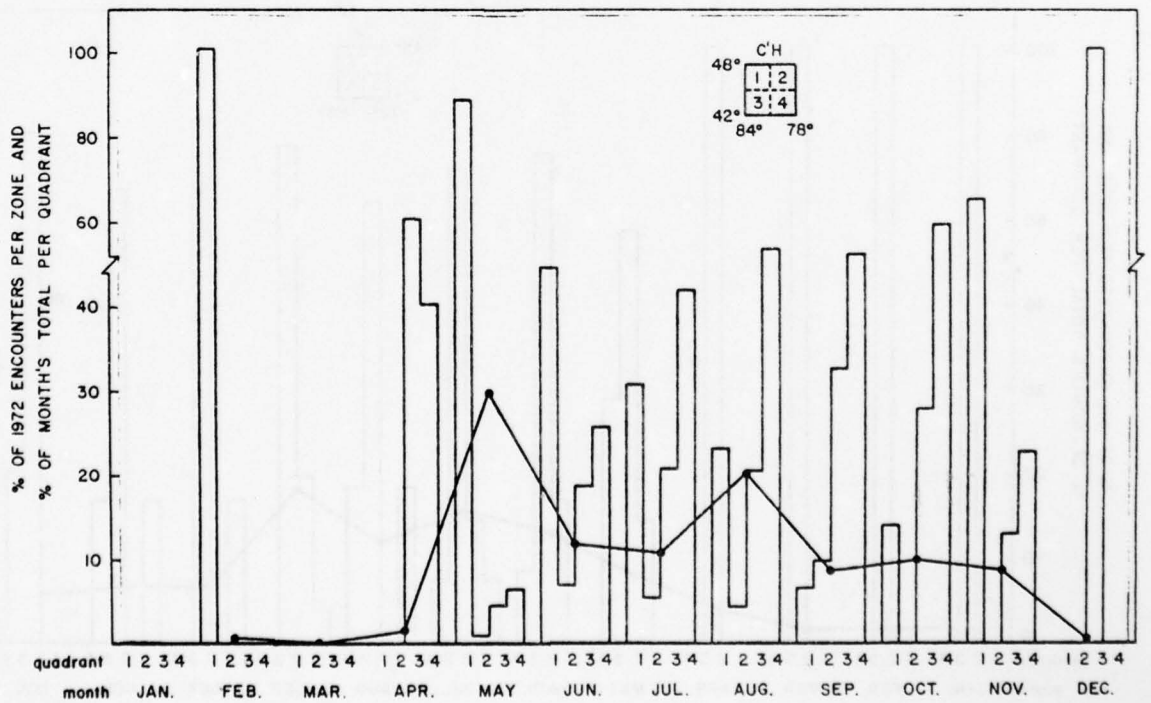
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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C'H
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78°
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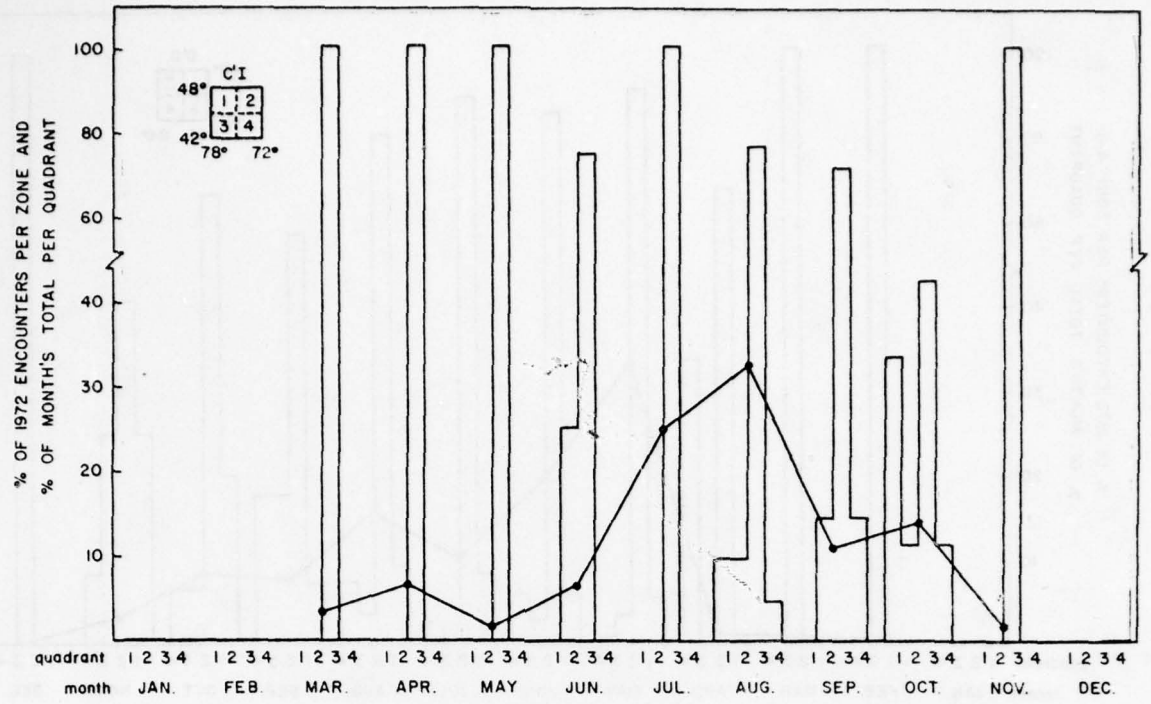
3
4
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'I
48°
42°
78°
72°
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3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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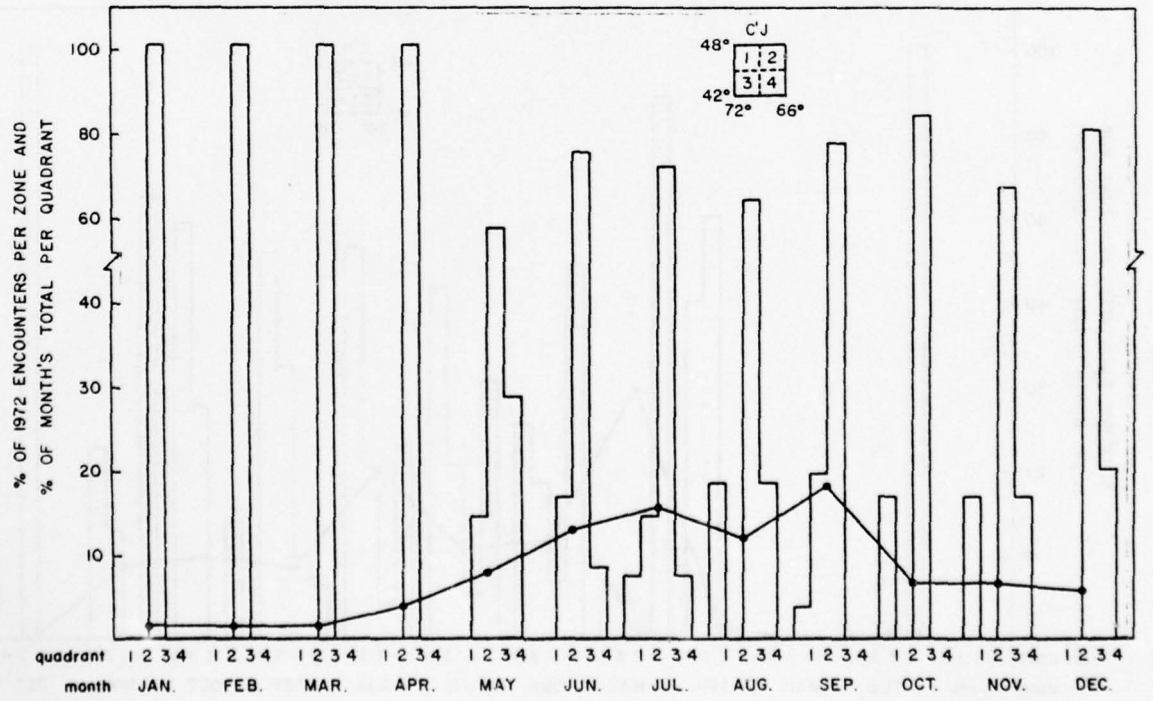
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'J
48°
42°
72°
66°
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% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
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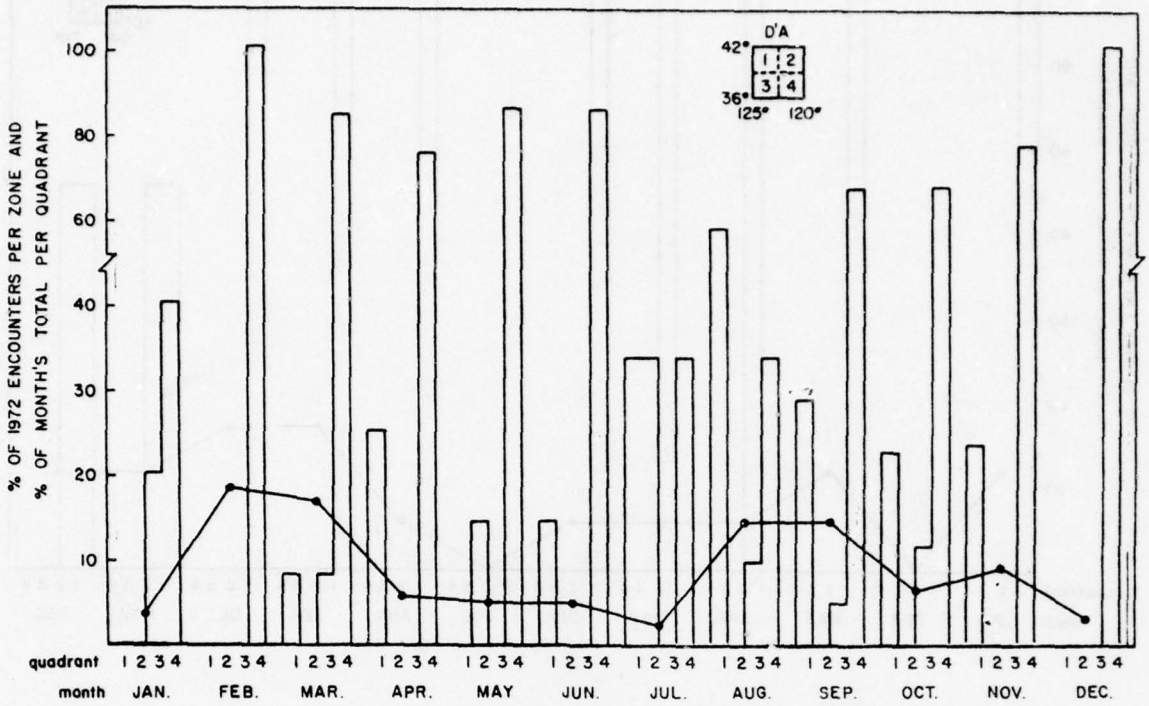
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'A
42°
36°
125°
120°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
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30
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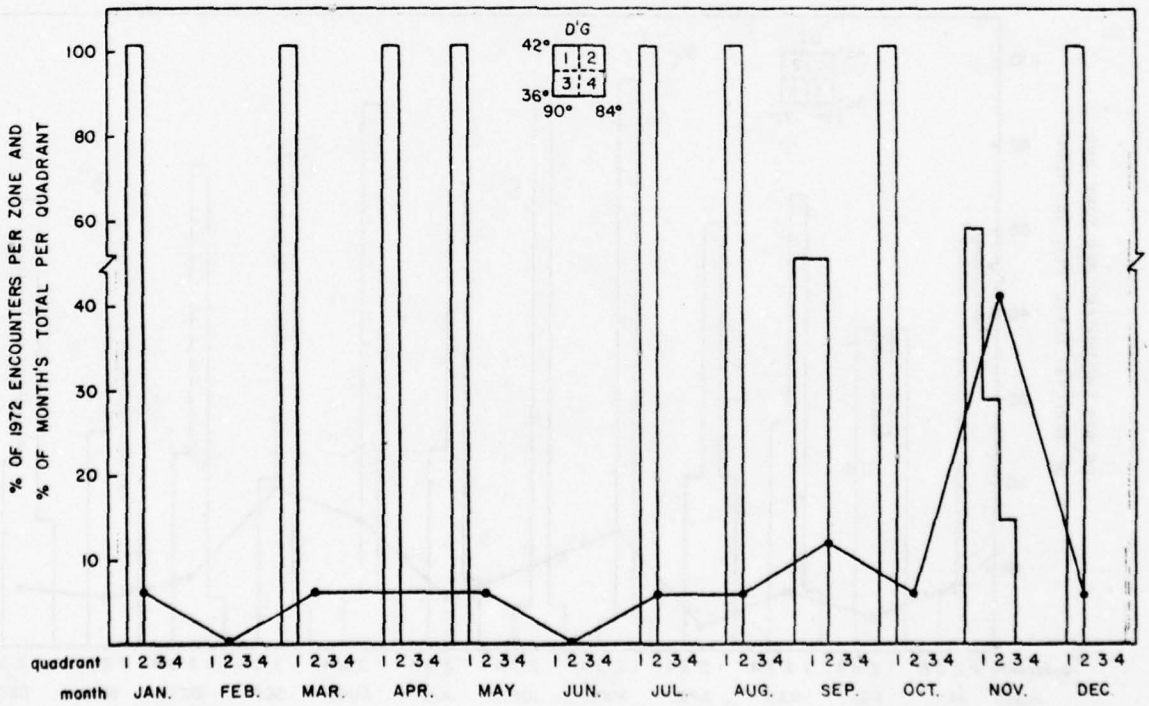
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'G
42°
36°
90°
84°
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2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
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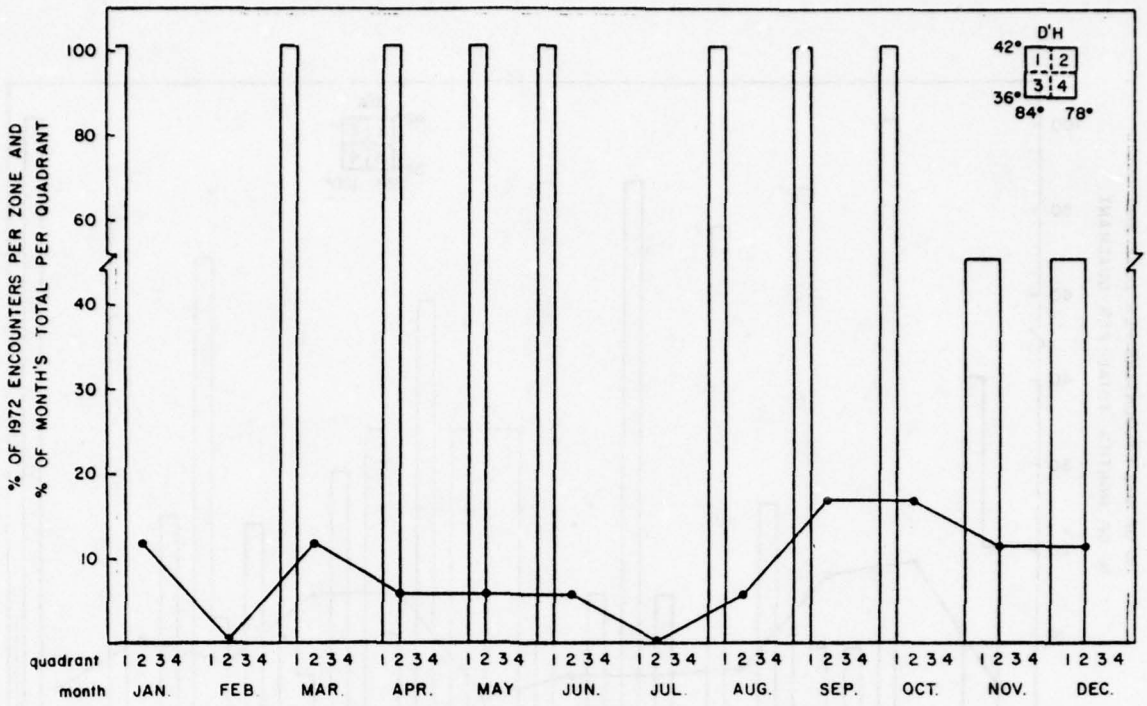
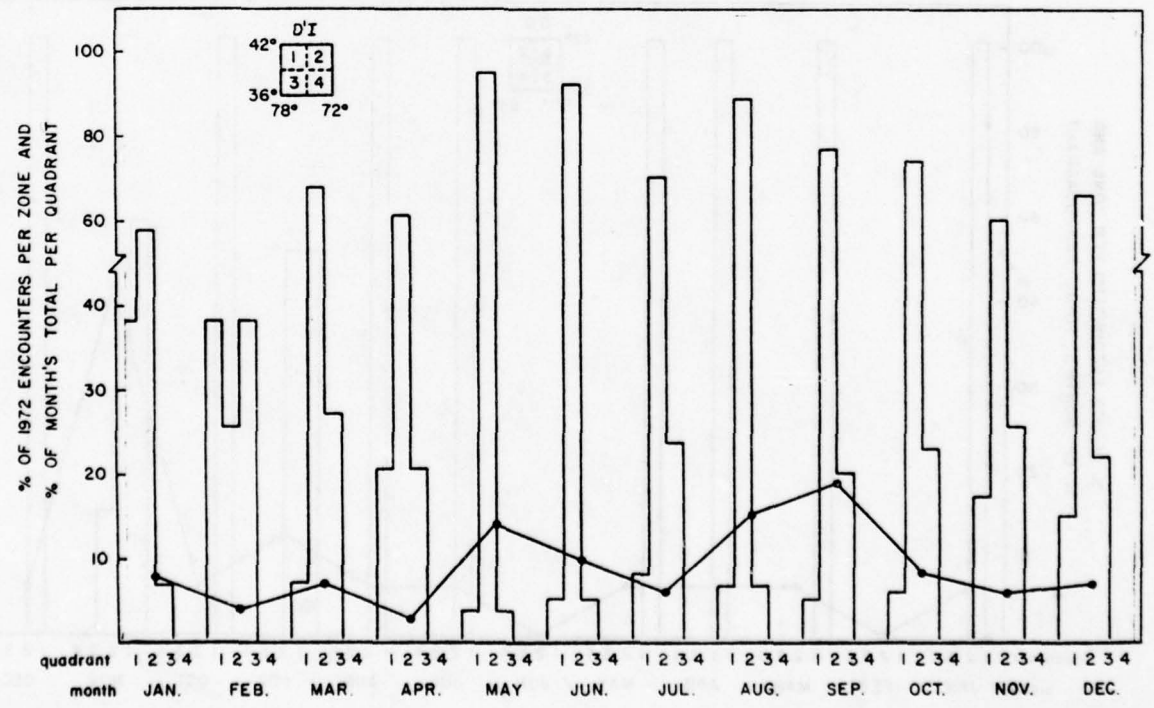
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'H
42°
36°
84°
78°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'I
42°
36°
78°
72°
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4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
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60
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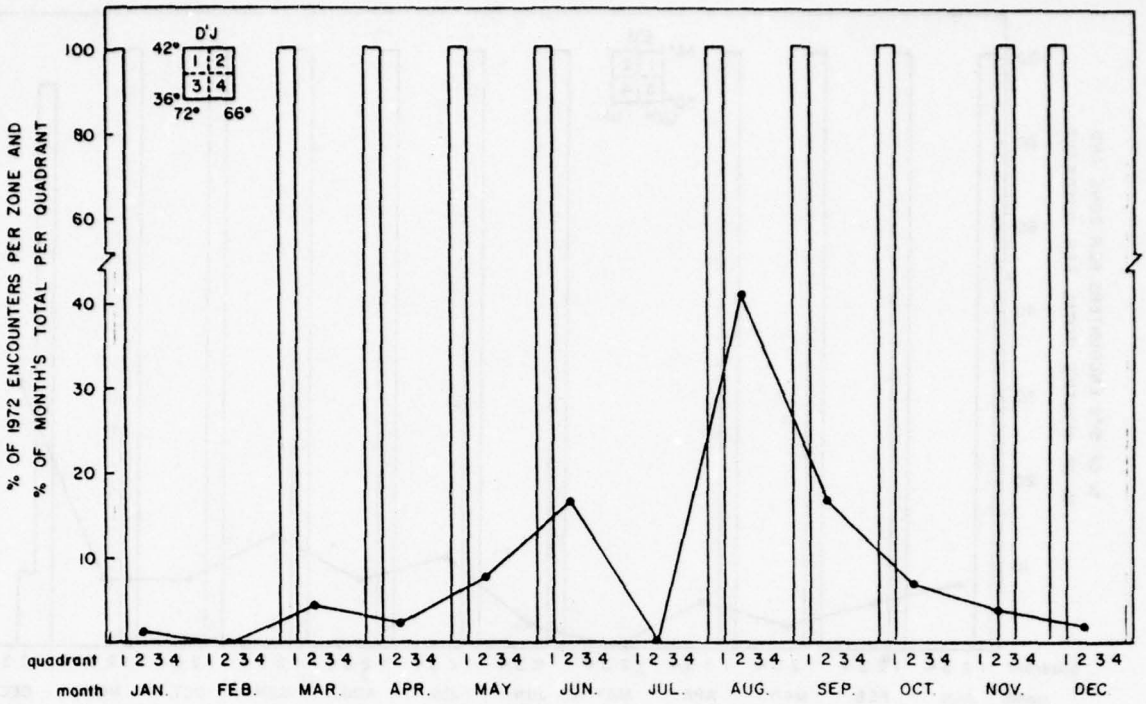
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'J
42°
36°
72°
66°
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4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
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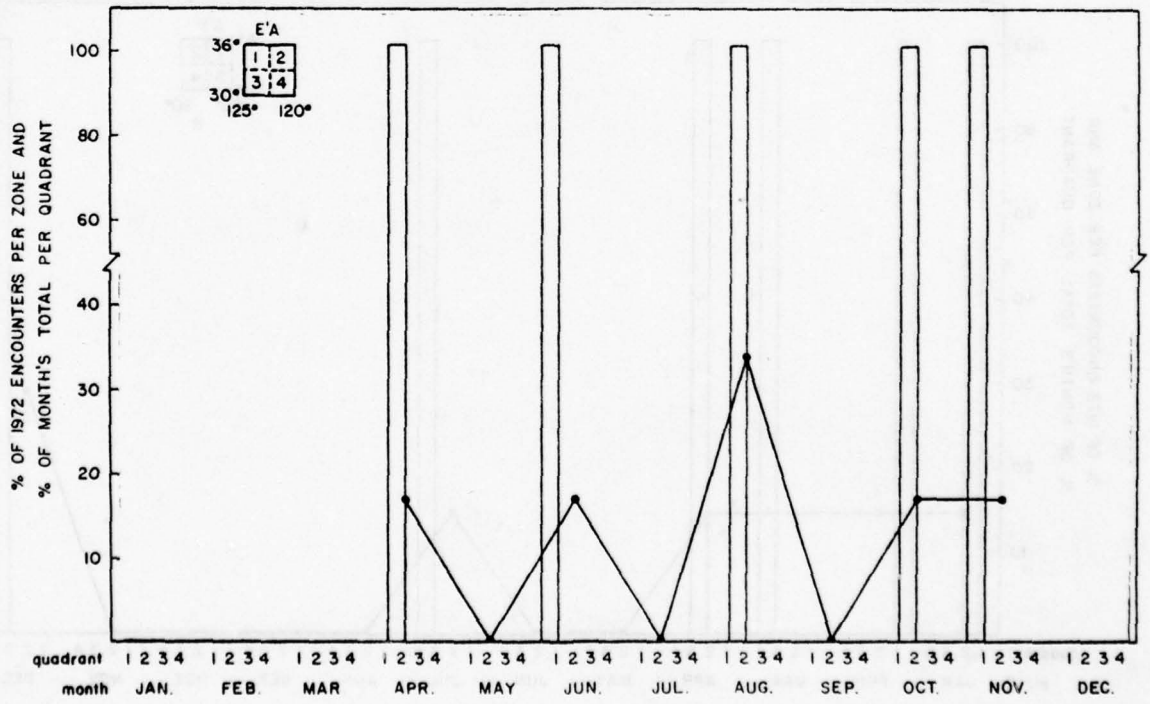
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC


E'A
36°
30°
125°
120°
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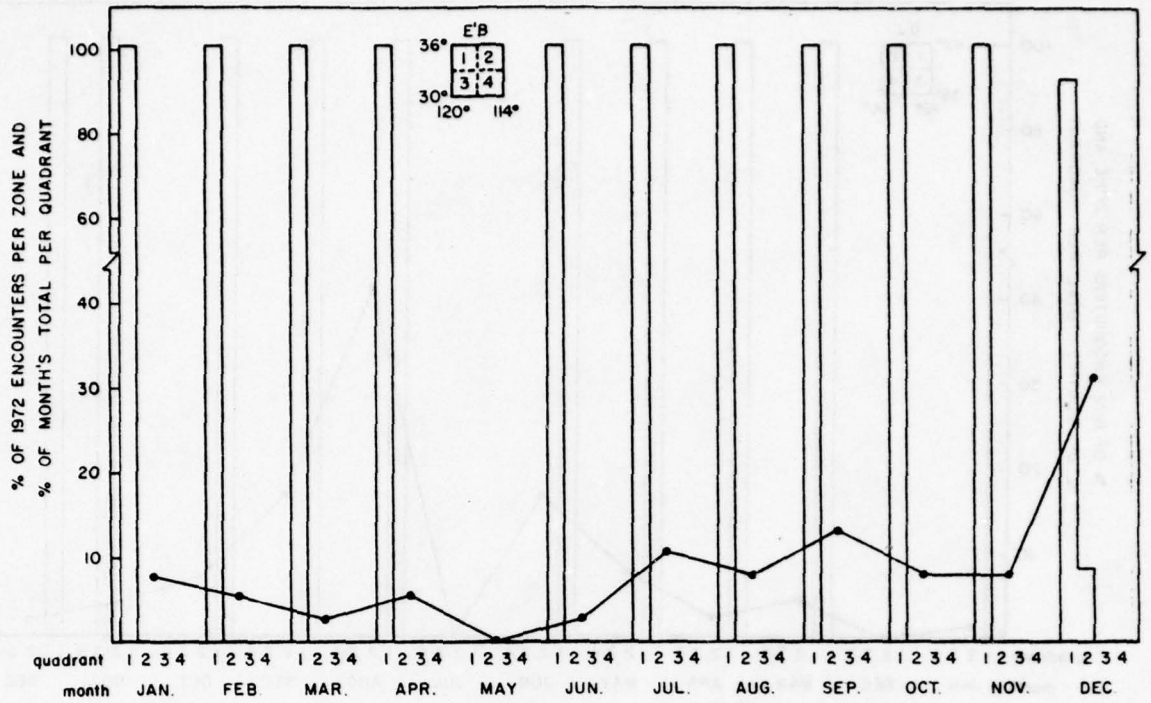
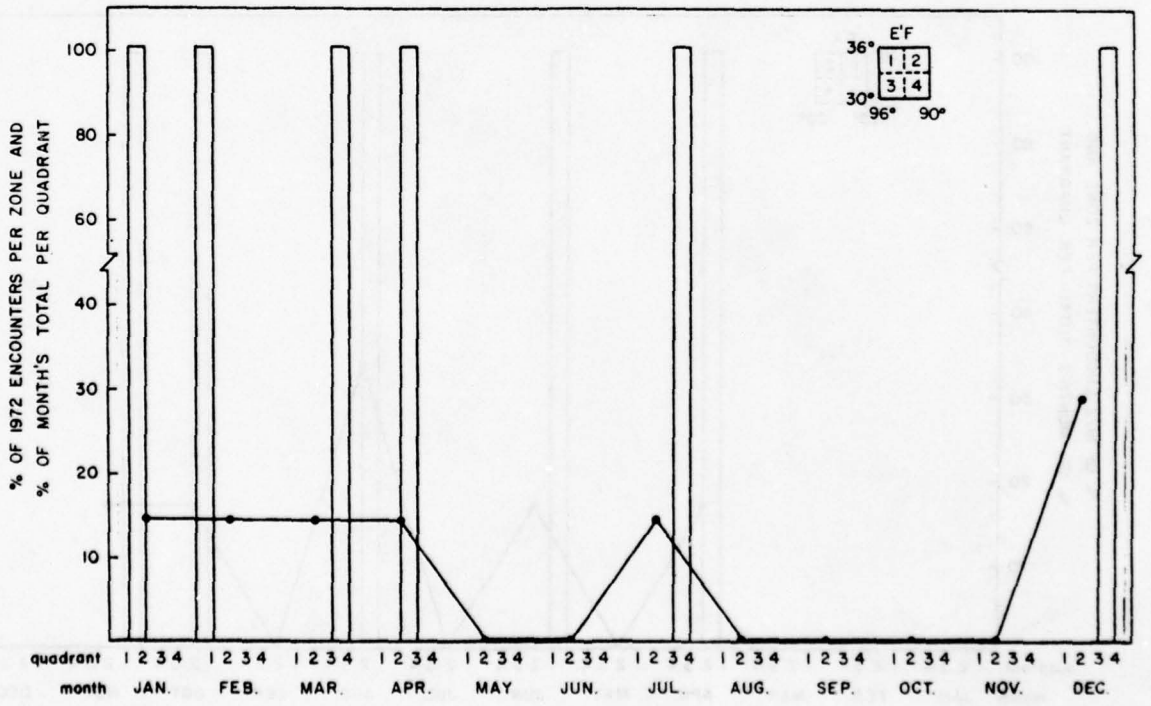
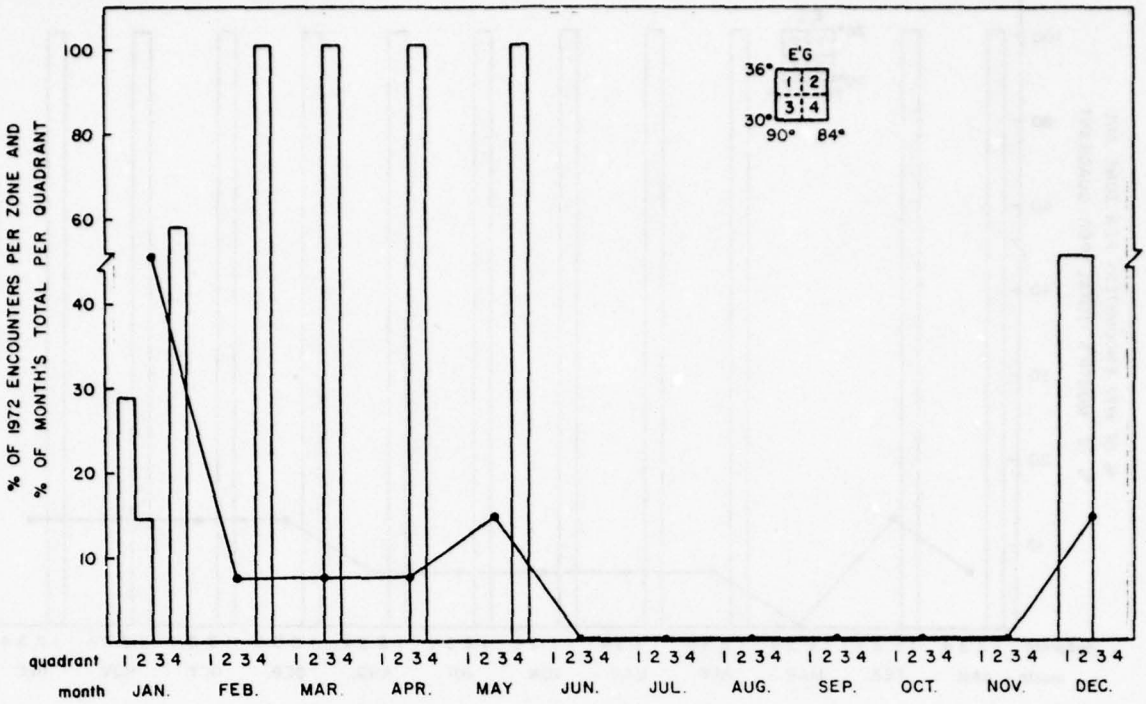
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


E'B
36°
30°
120°
114°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


E'F
36°
30°
96°
90°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


E'G
36°
30°
90° 84°
1 2
3 4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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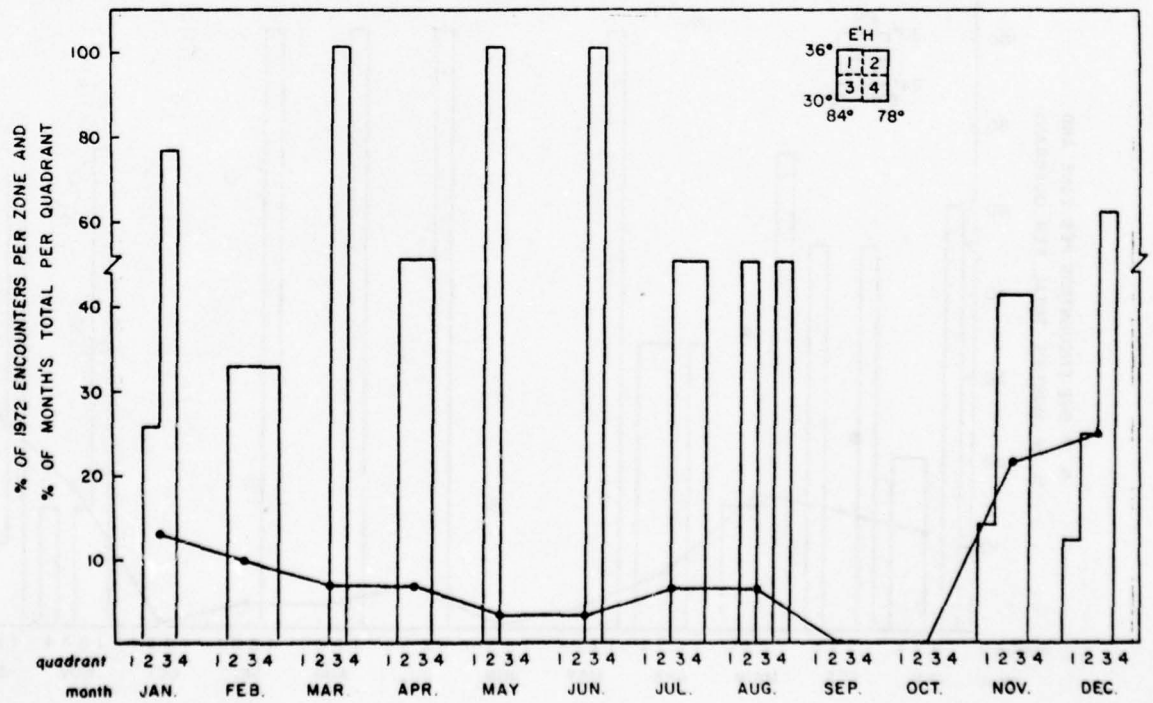
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


E'H
36°
30°
84° 78°
1 2
3 4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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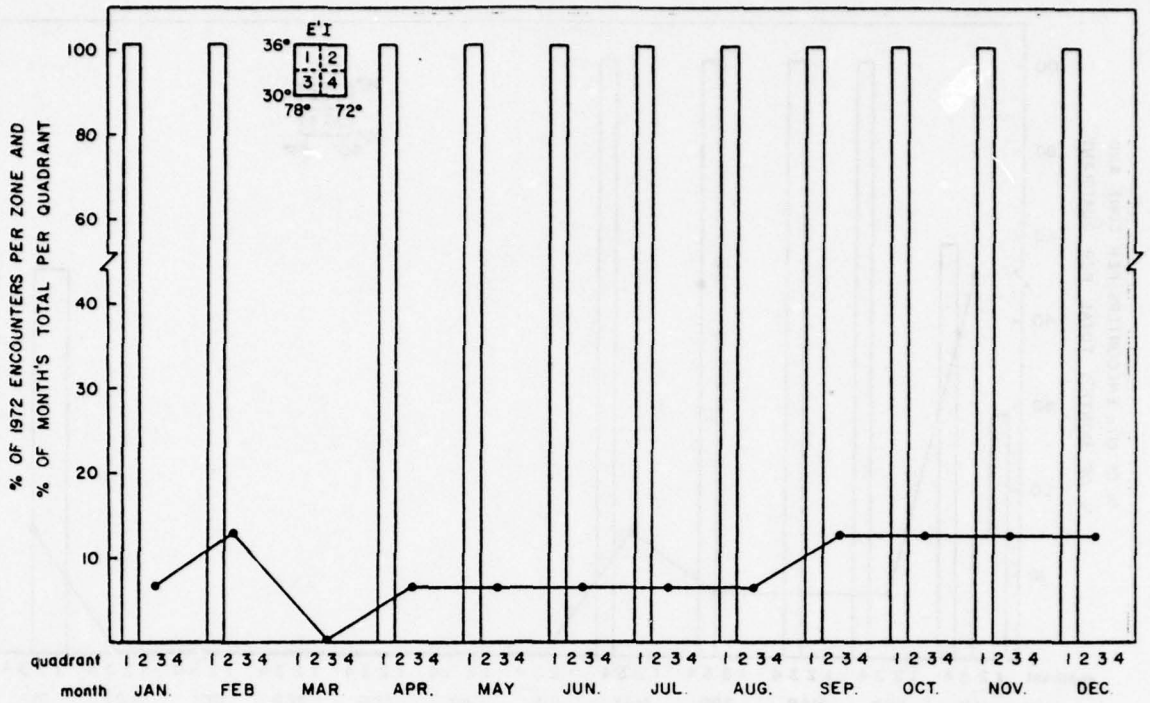
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


E'I
36°
30°
78°
72°
1
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4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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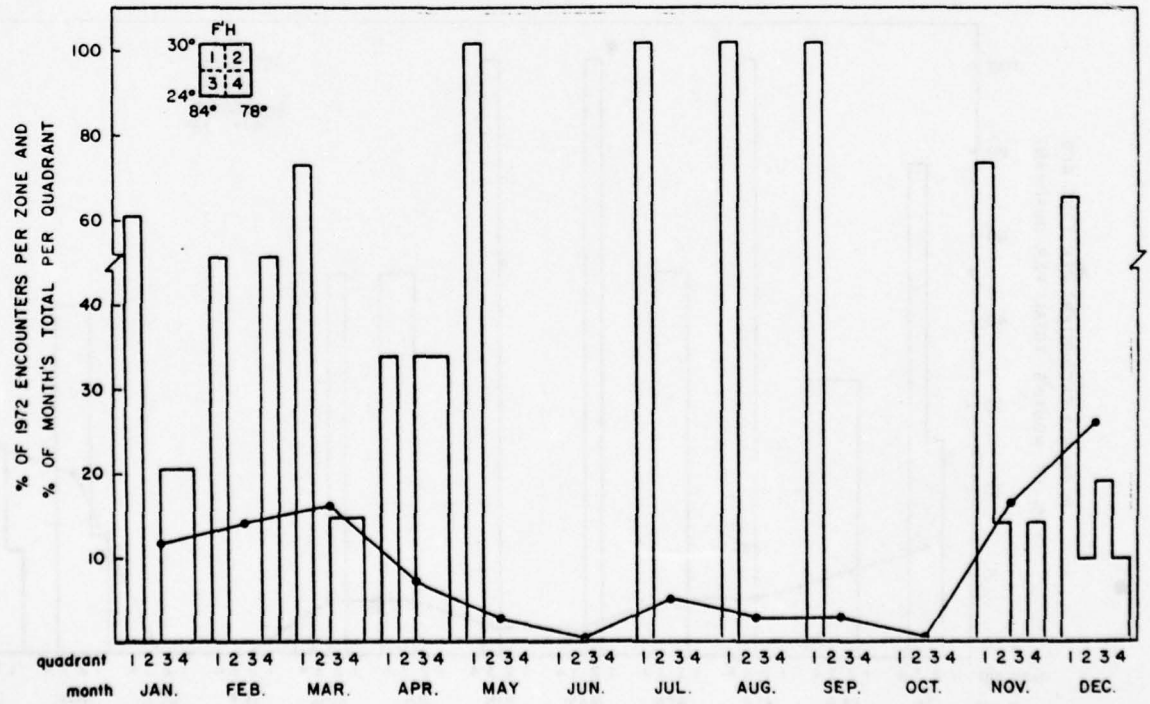
quadrant 1 2 3 4
month JAN. FEB MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC


F'H
30°
24°
84°
78°
1
2
3
4
% OF 1972 ENCOUNTERS PER ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
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30
20
10
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

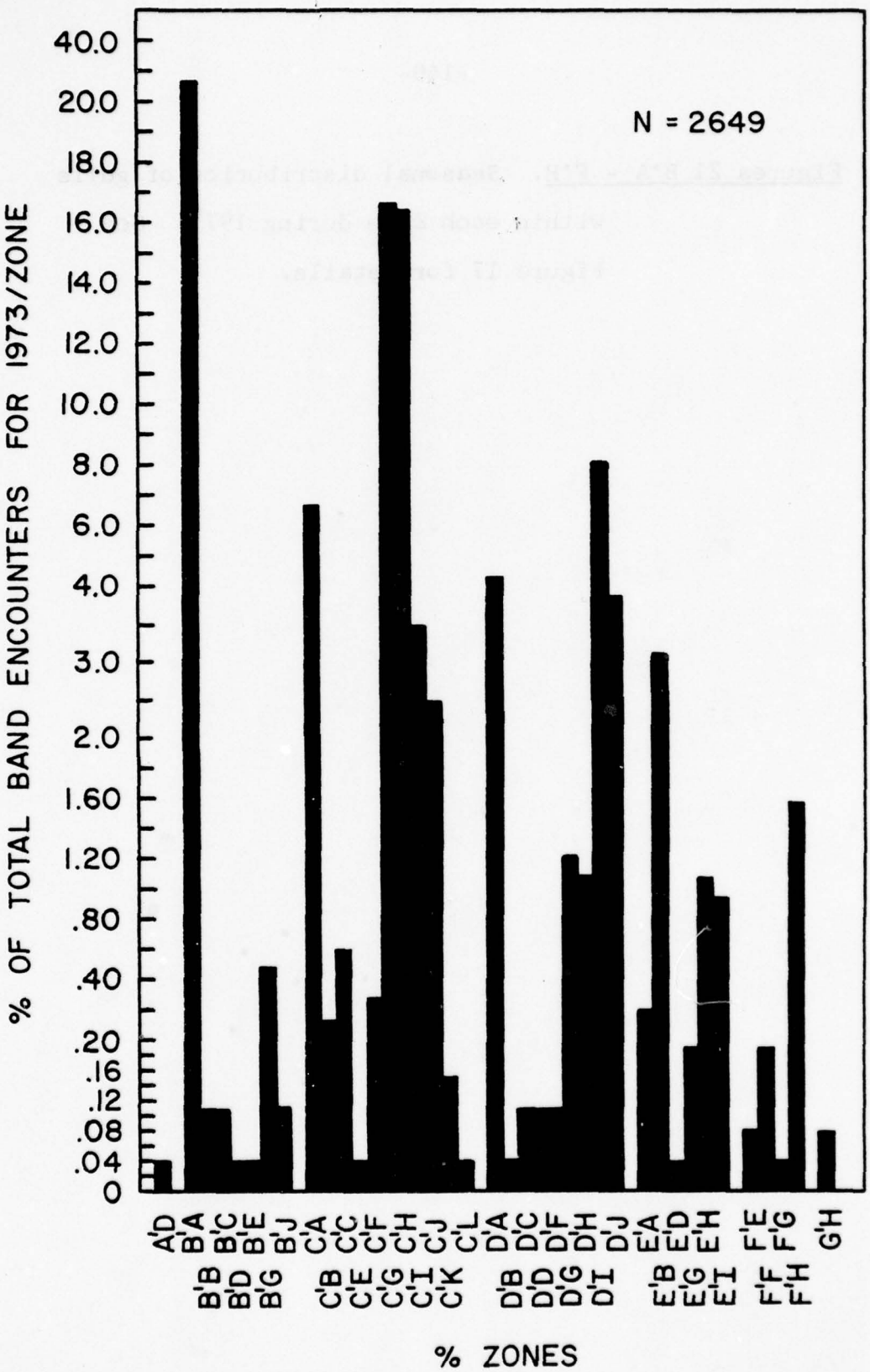
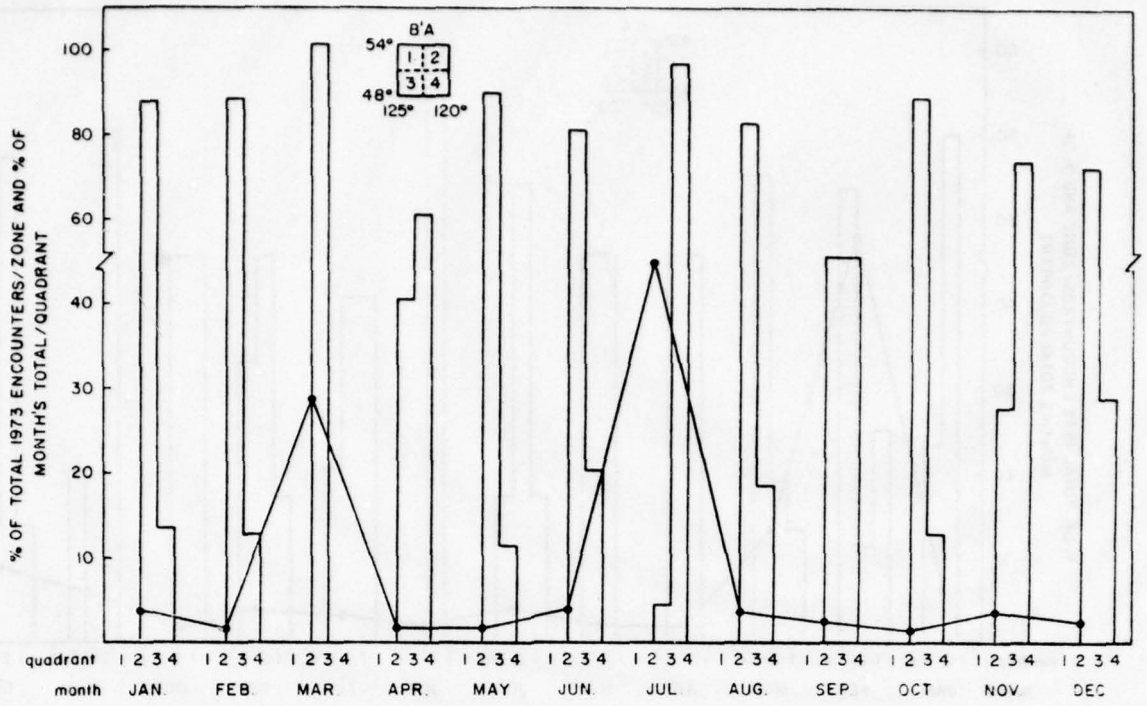
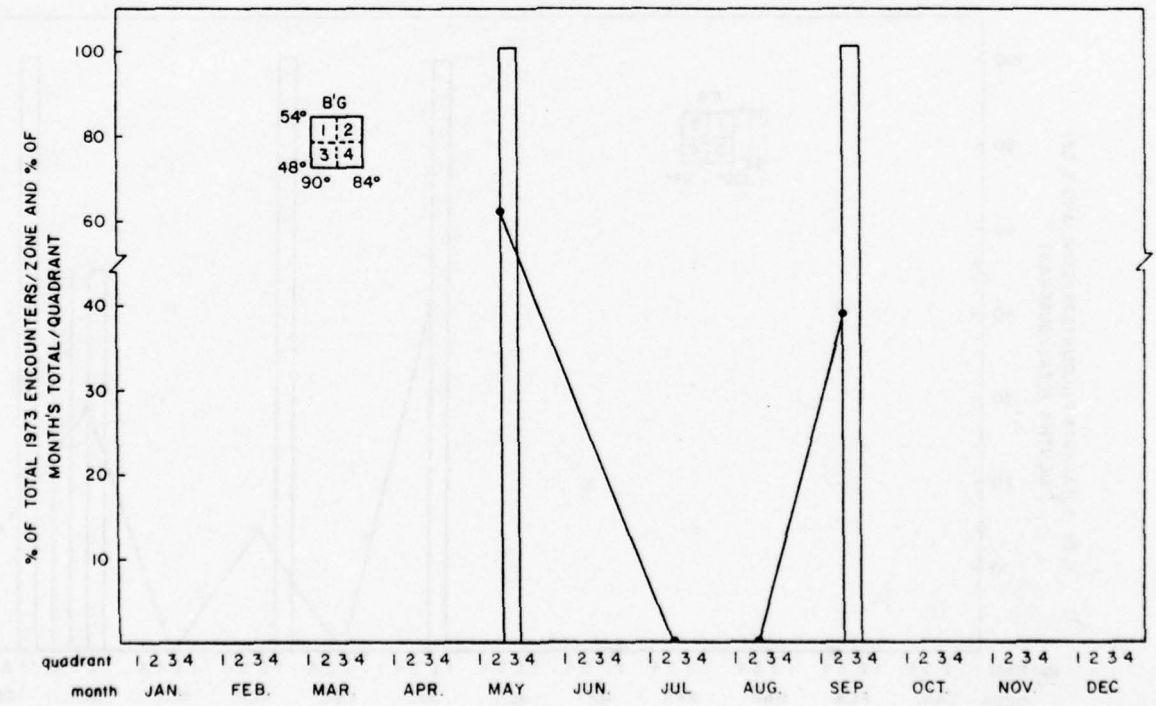
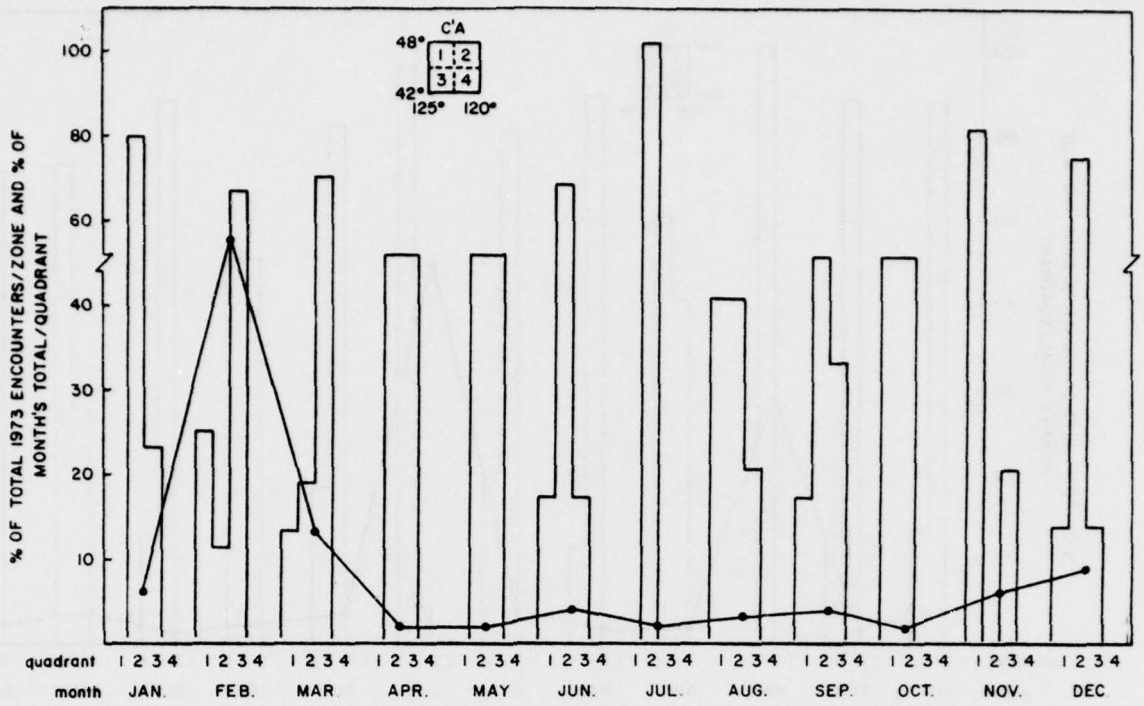


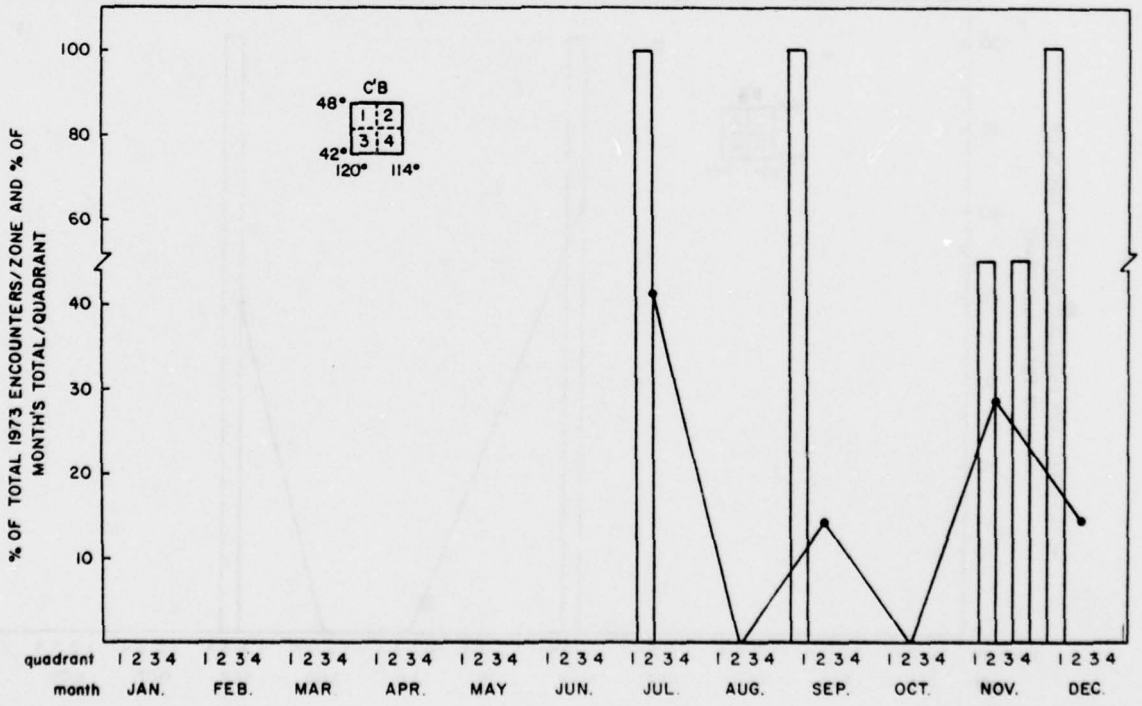
Figure 20. The Proportion of Band Recoveries for 1973 Reported in Each 6° Zone.

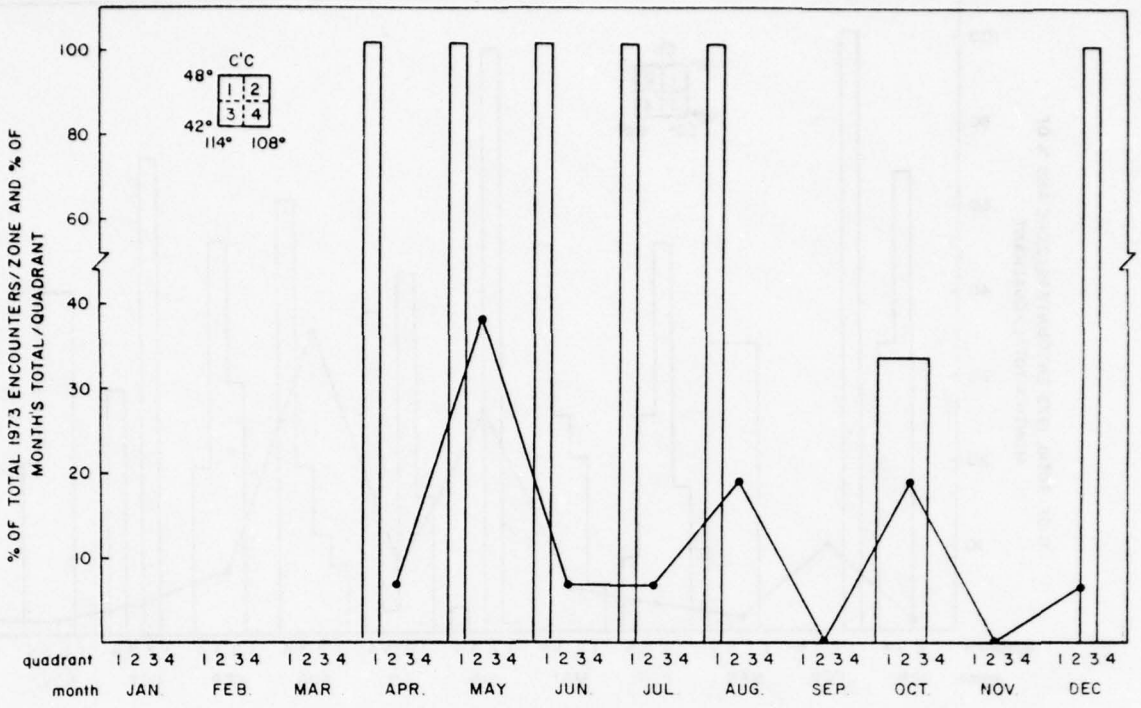
Figures 21 B'A - F'H. Seasonal distribution of gulls within each Zone during 1973. See Figure 17 for details.

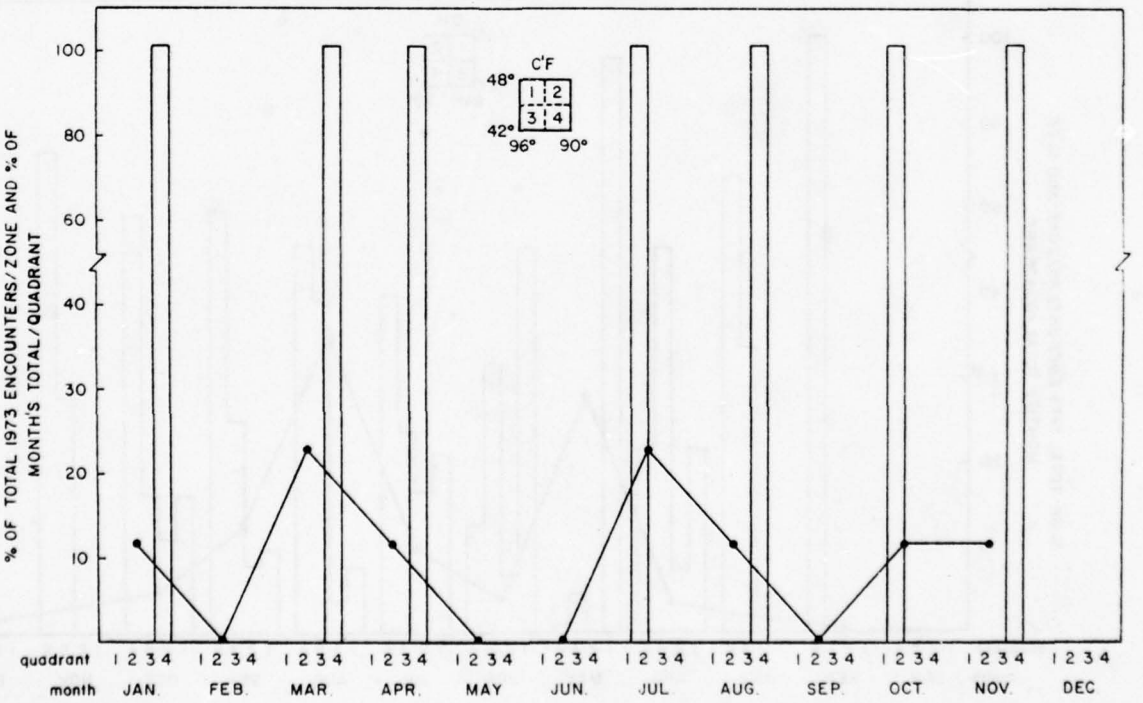

B'A
54°
48°
125°
120°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

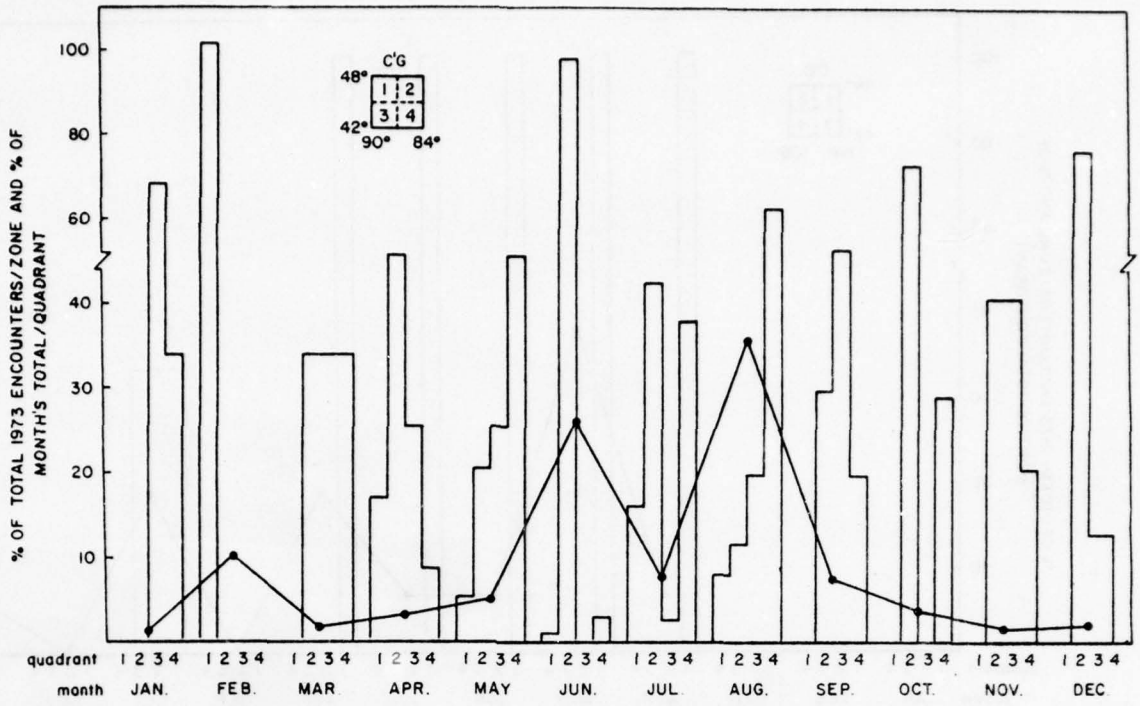

B'G
54°
48°
90°
84°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'A
48°
42°
125°
120°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'B
48°
42°
120°
114°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'C
48°
42°
114°
108°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'F
48°
42°
96°
90°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'G
48°
42°
90°
84°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
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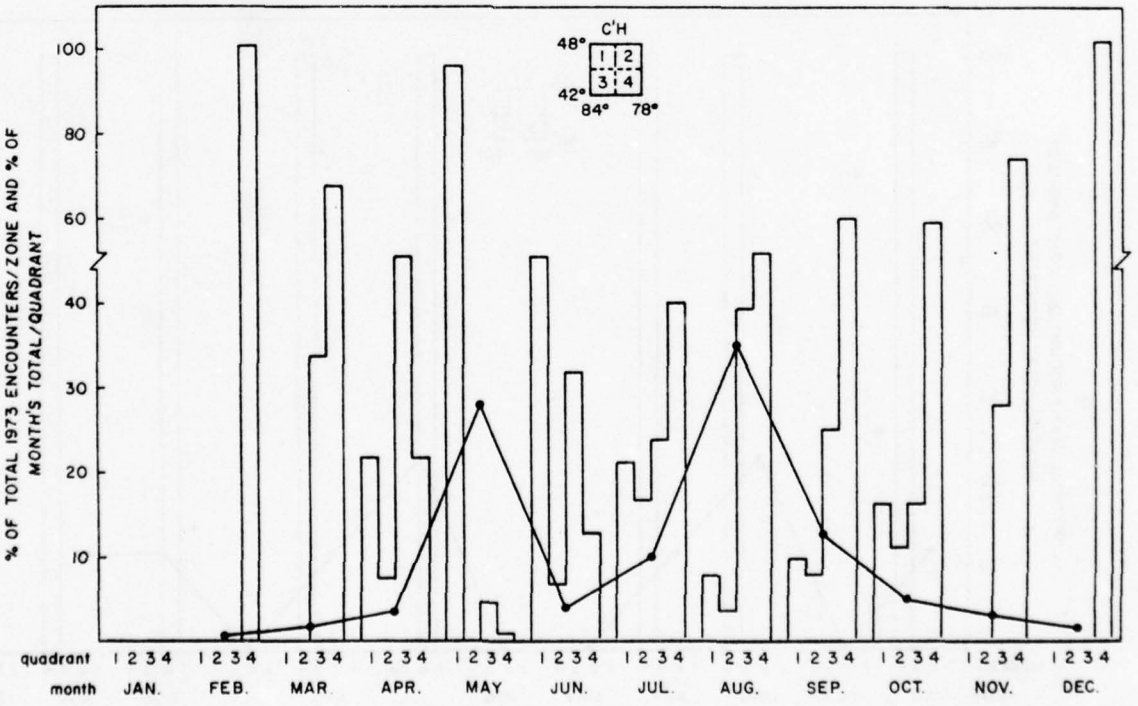
30
20
10
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'H
48°
42°
84°
78°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
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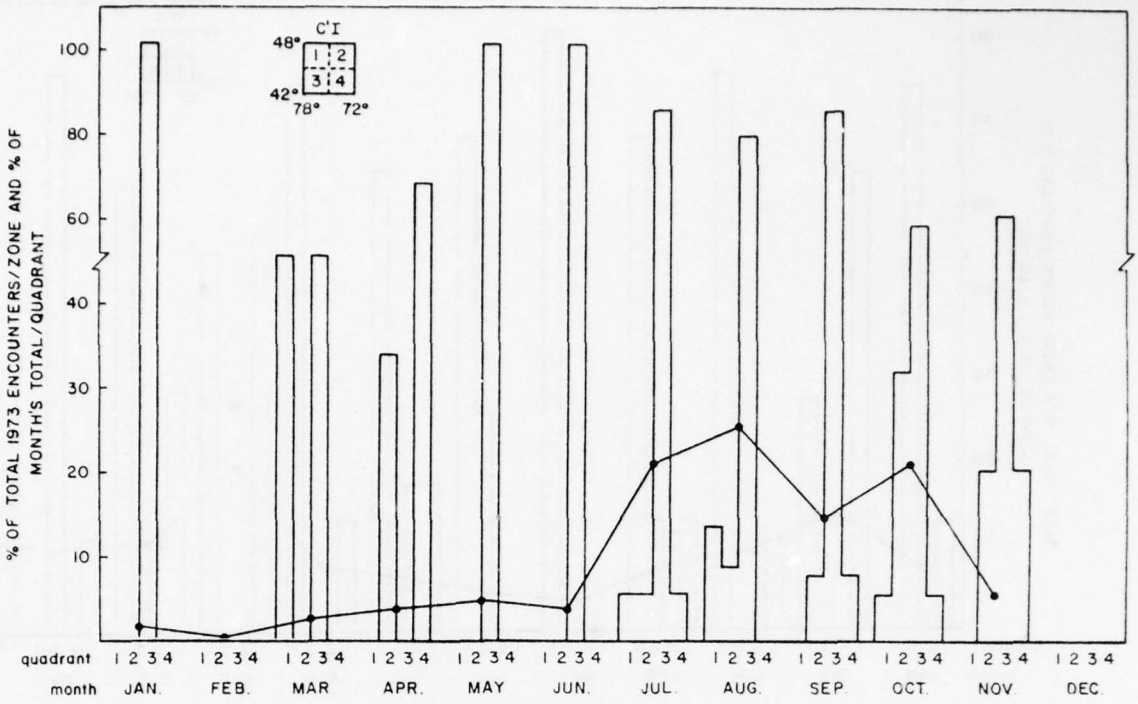
quadrant 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'I
48°
42°
78°
72°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
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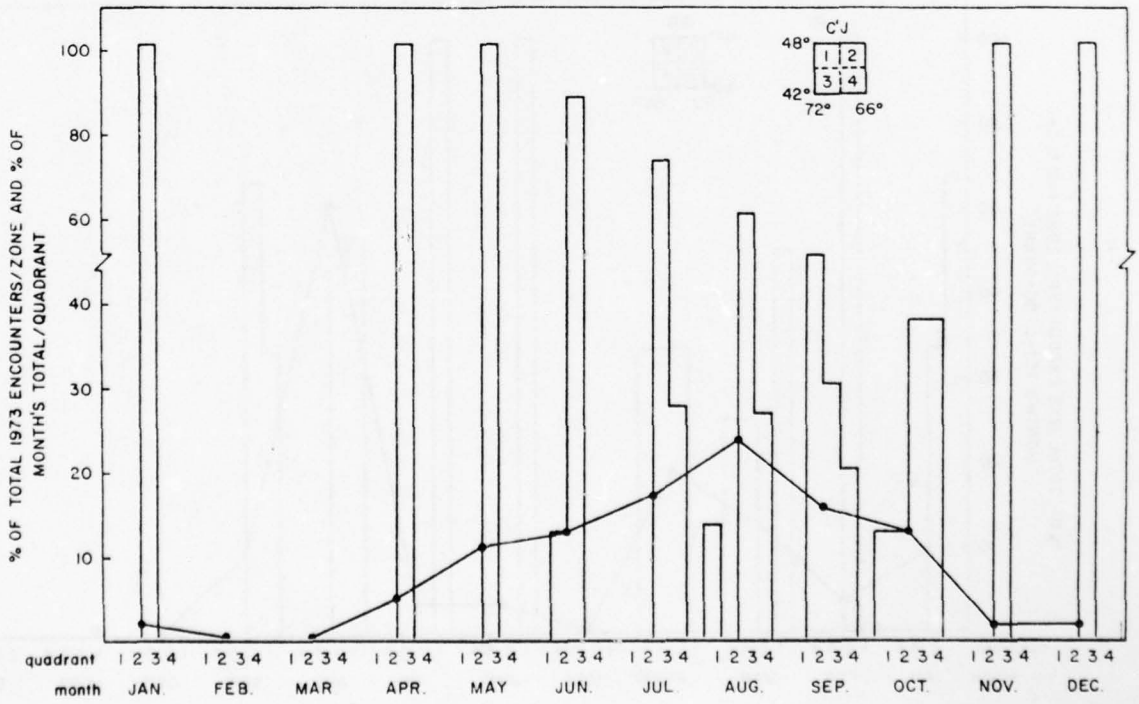
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'J
48°
42°
72°
66°
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% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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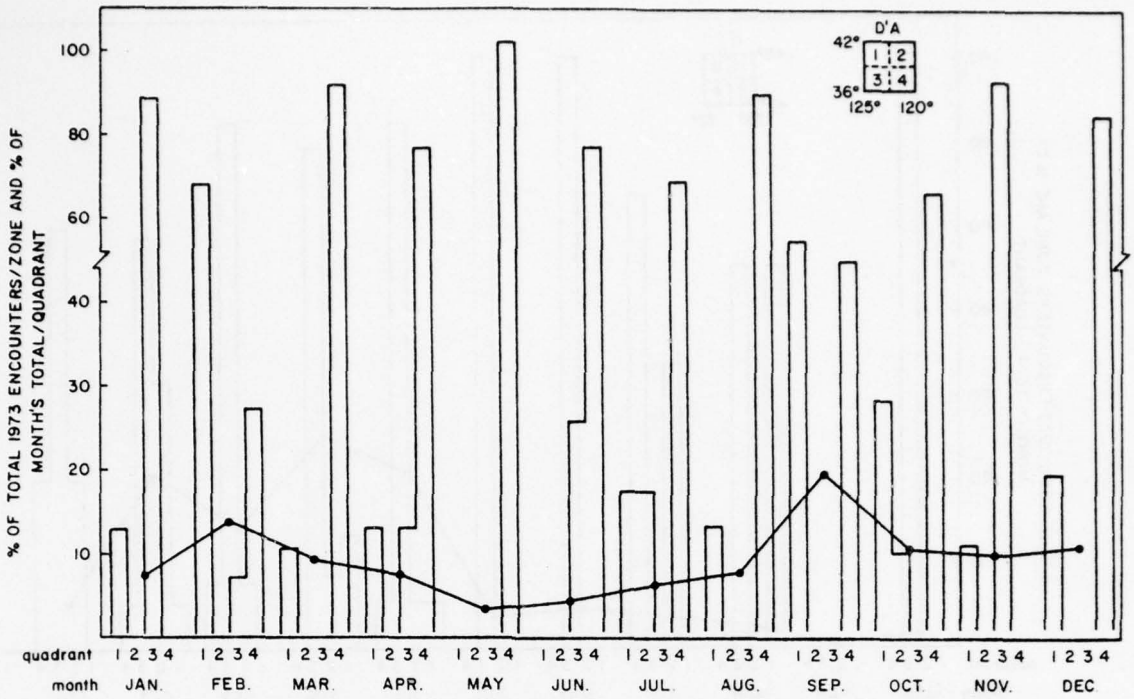
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'A
42°
36°
125°
120°
1 2
3 4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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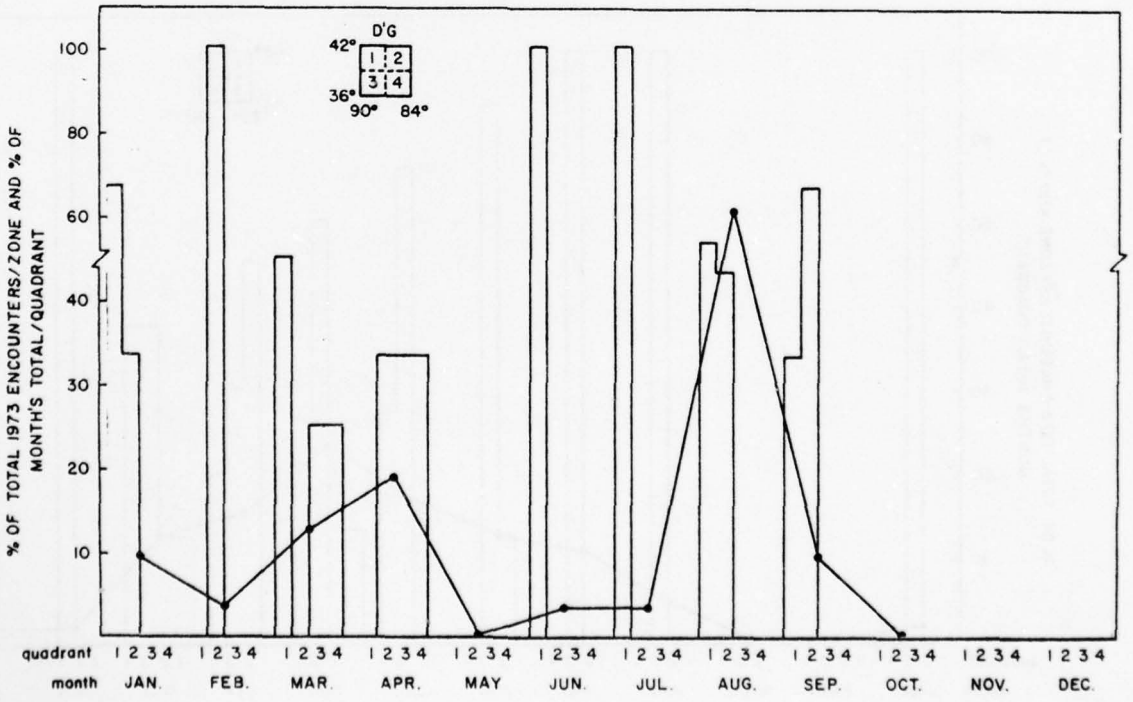
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'G
42°
36°
90°
84°
1 2
3 4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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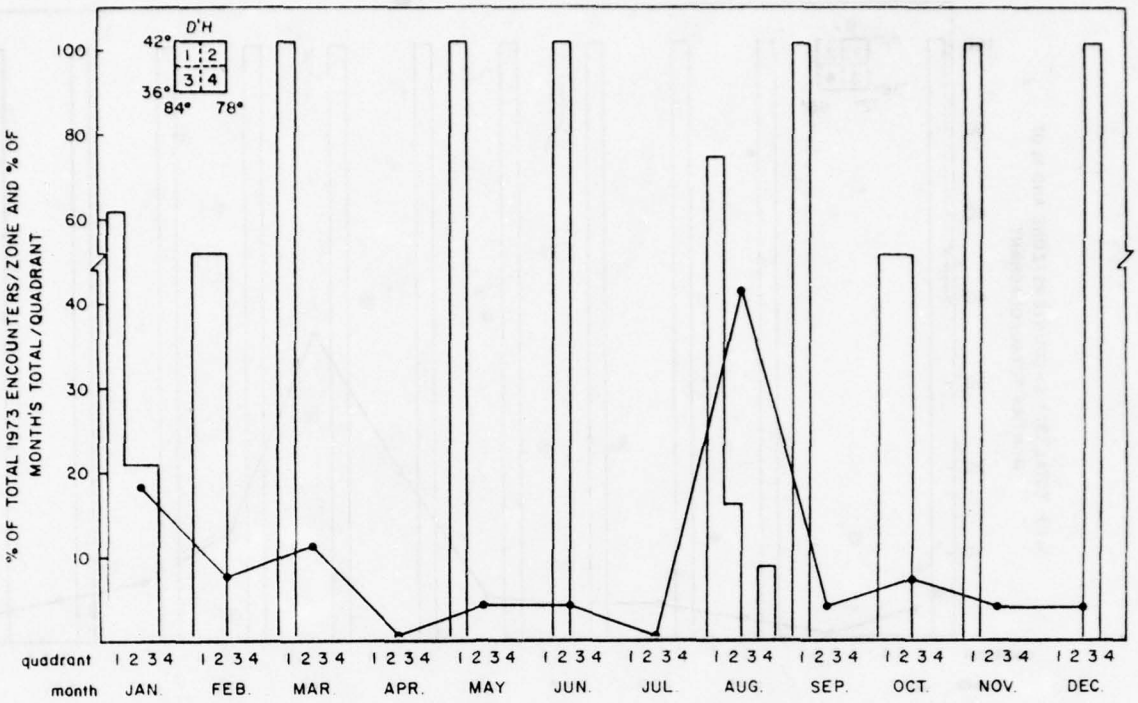
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'H
42°
36°
84°
78°
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4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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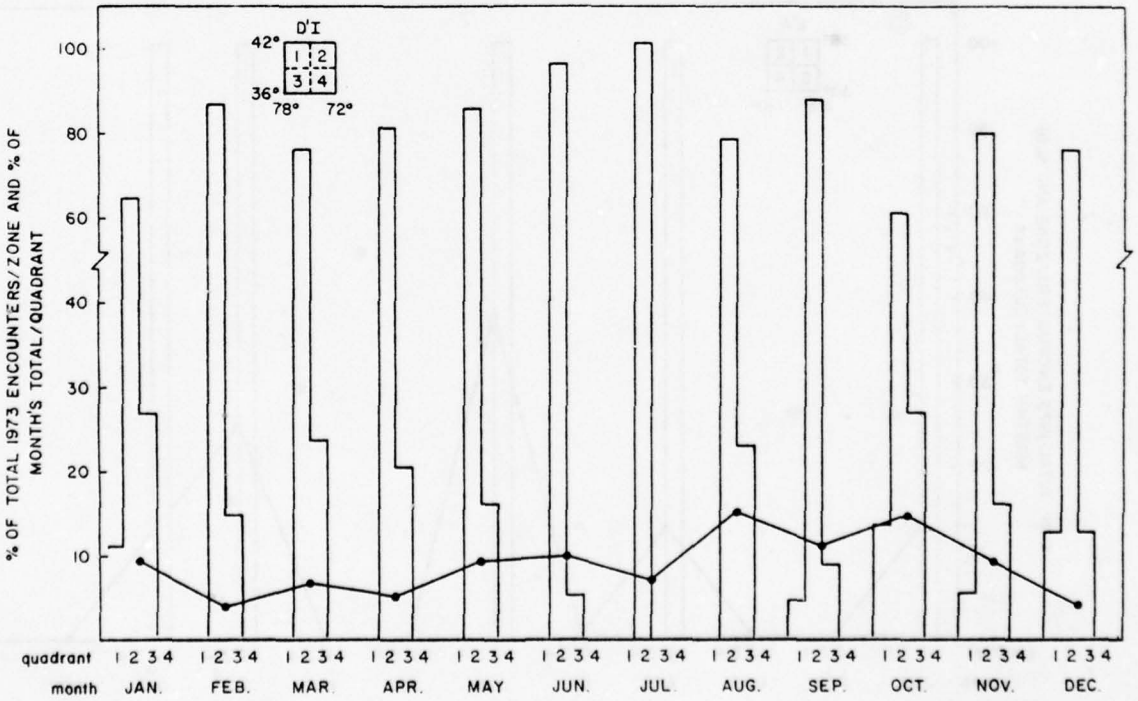
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'I
42°
36°
78°
72°
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4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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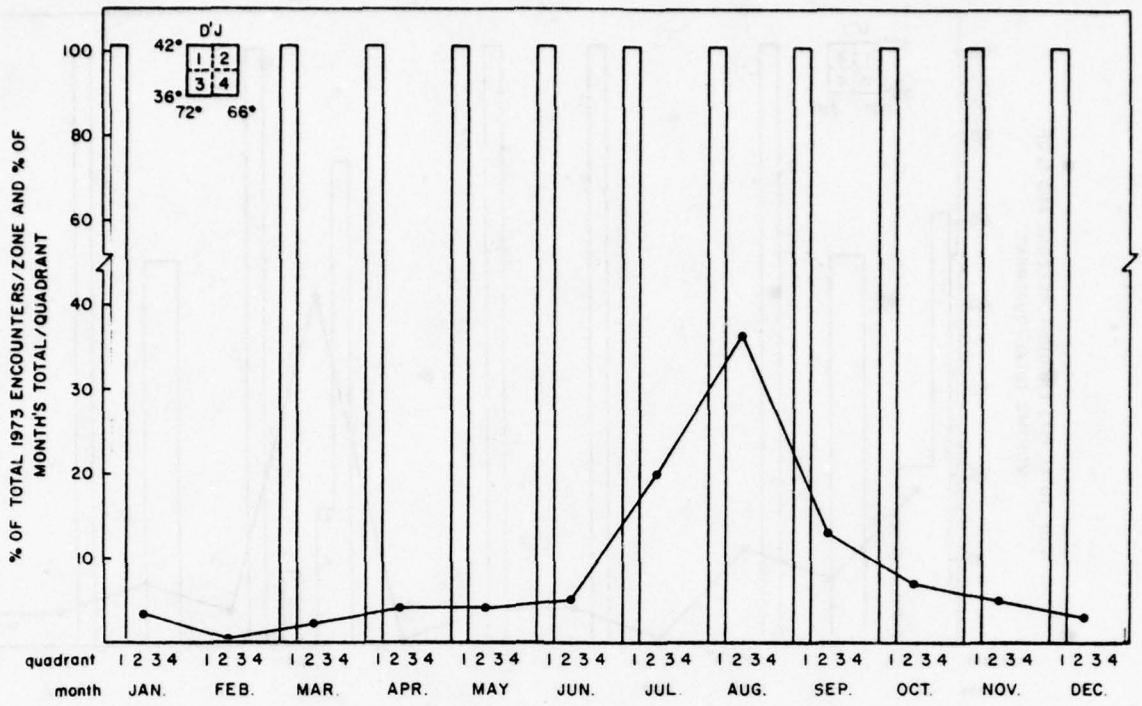
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


D'J
42°
36°
72°
66°
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% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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30
20
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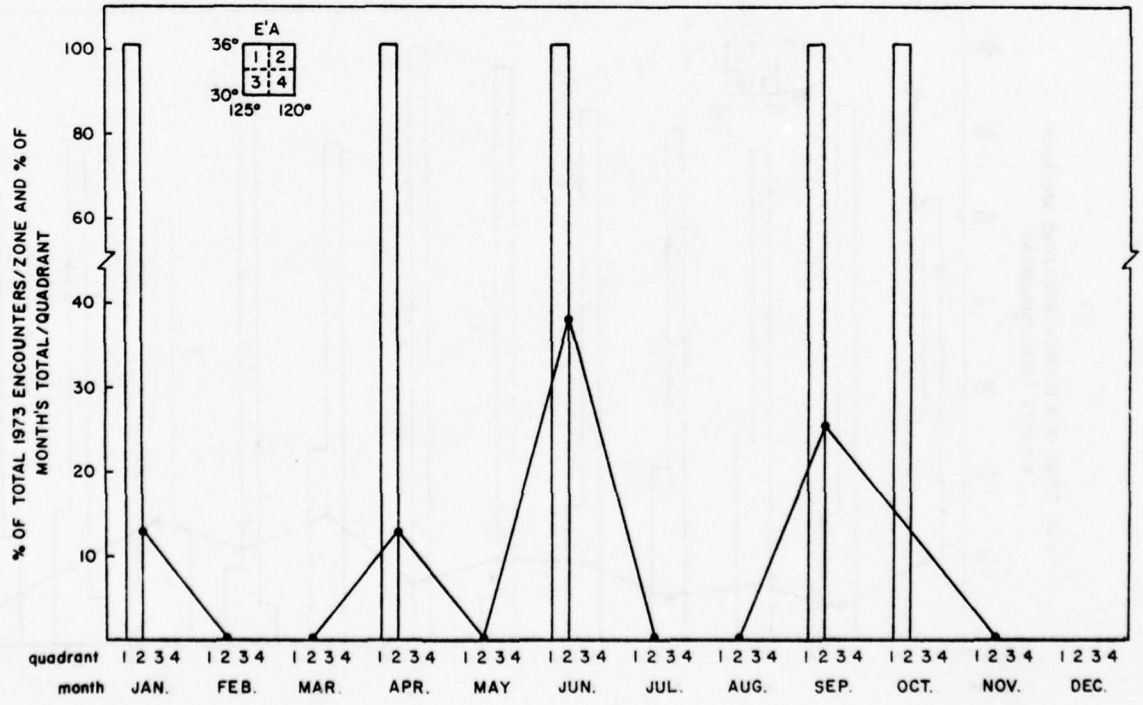
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


E'A
36°
30°
125°
120°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
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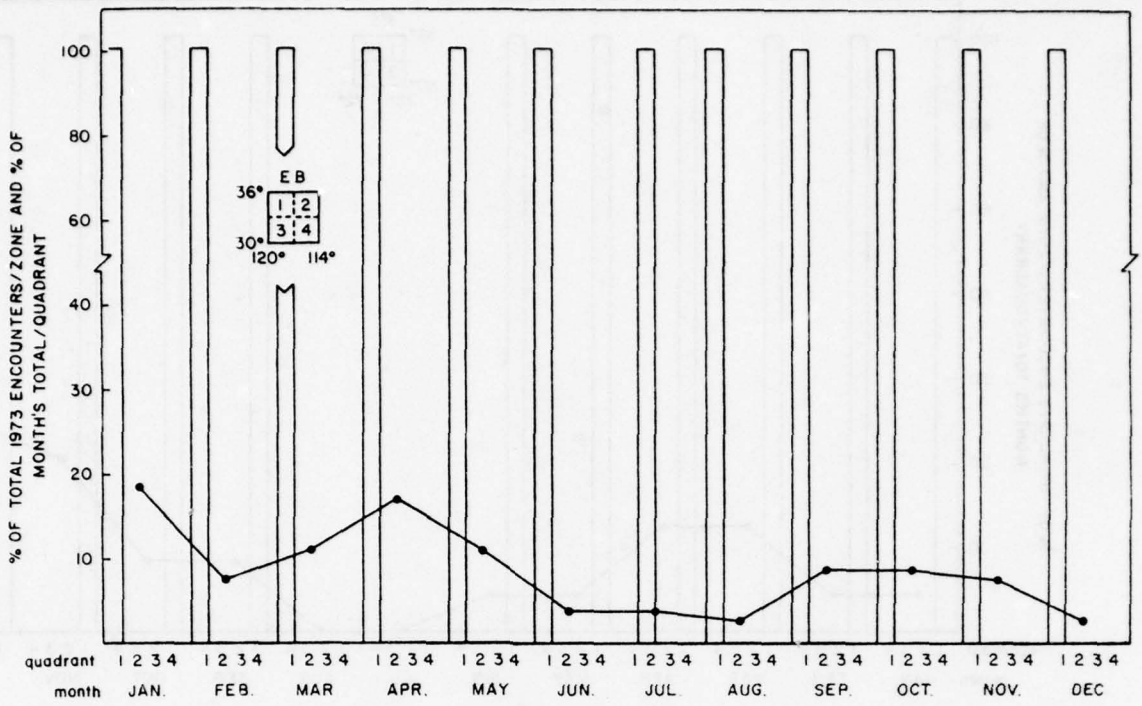
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
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30
20
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EB
36°
30°
120°
114°
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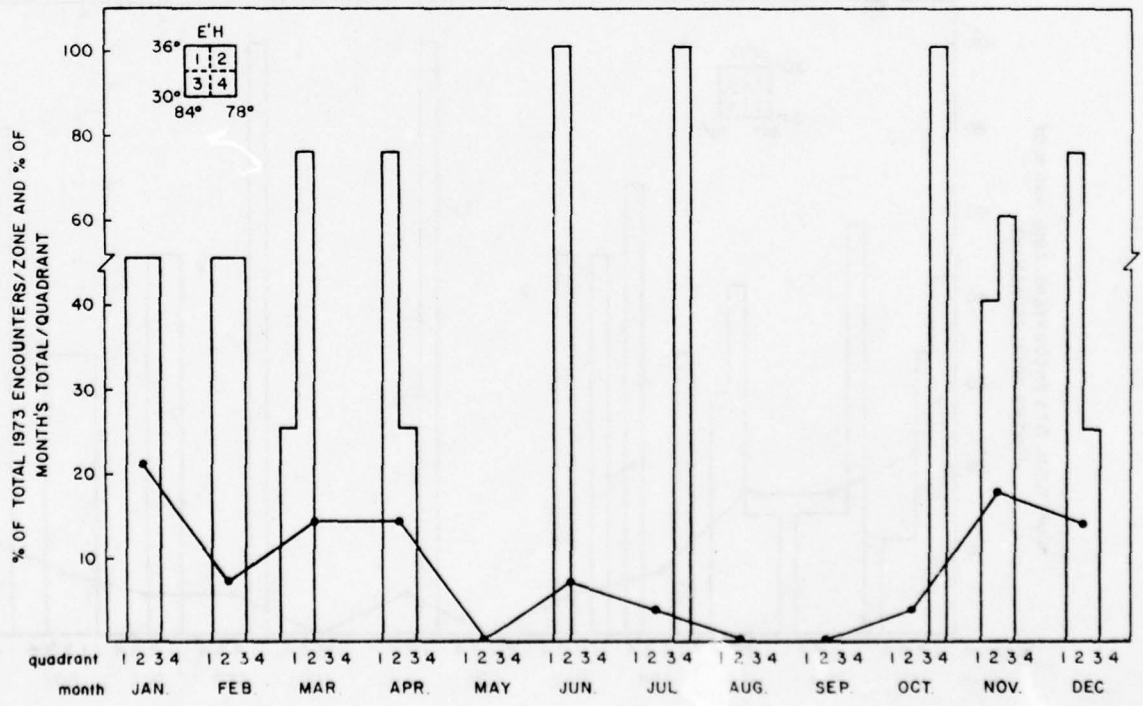
3
4
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC


% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
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40
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20
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E'H
36°
30°
84°
78°
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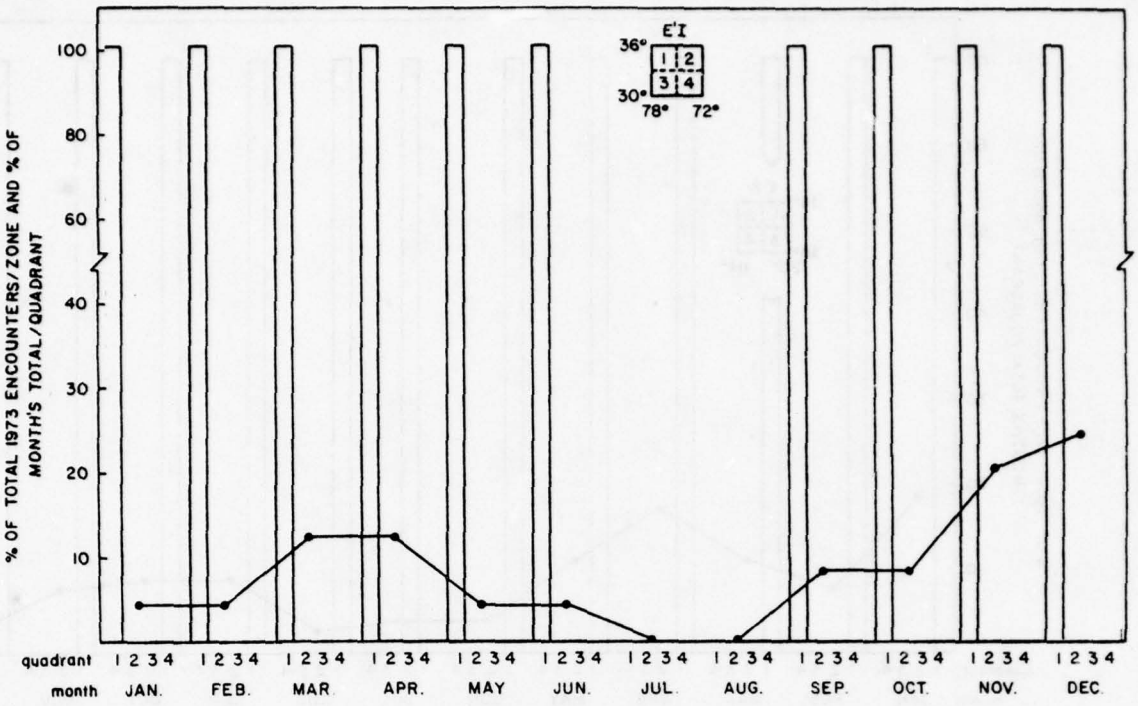
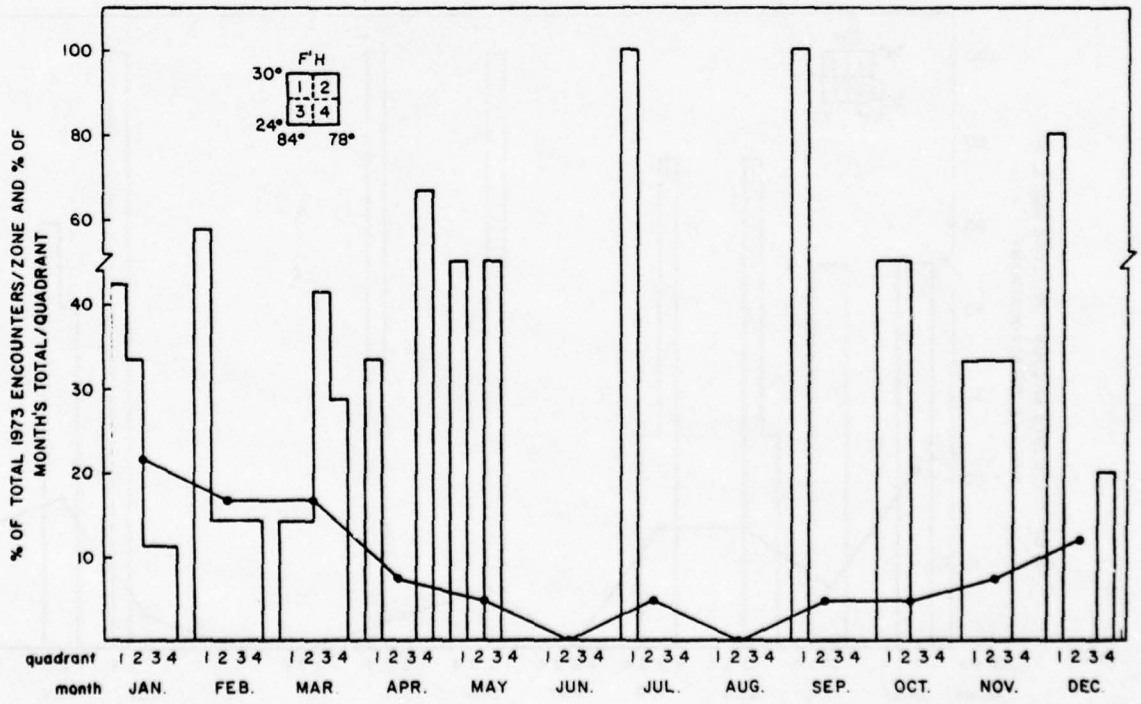
3
4
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC


E'I
36°
30°
78°
72°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


F'H
30°
24°
84°
78°
1
2
3
4
% OF TOTAL 1973 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

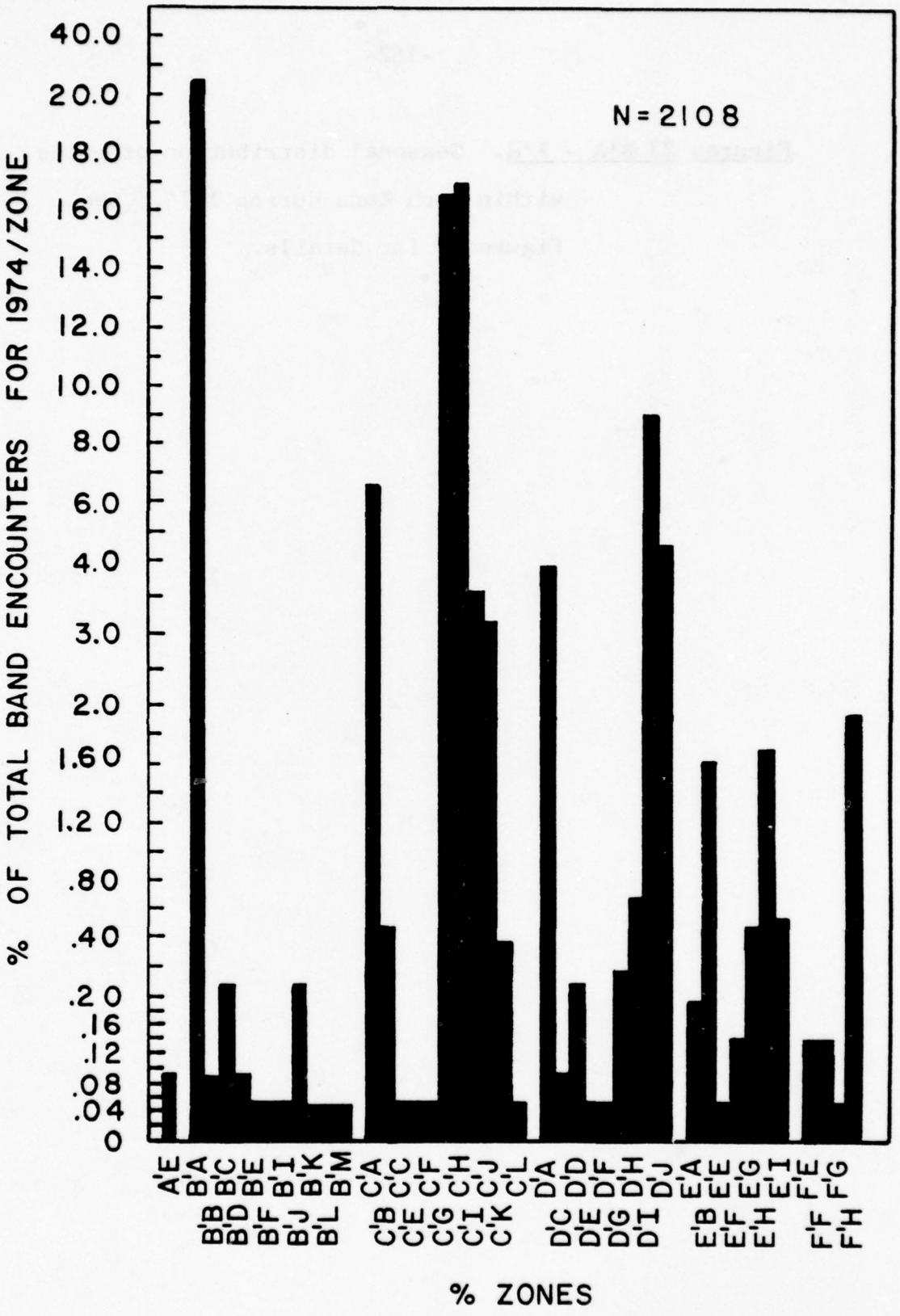
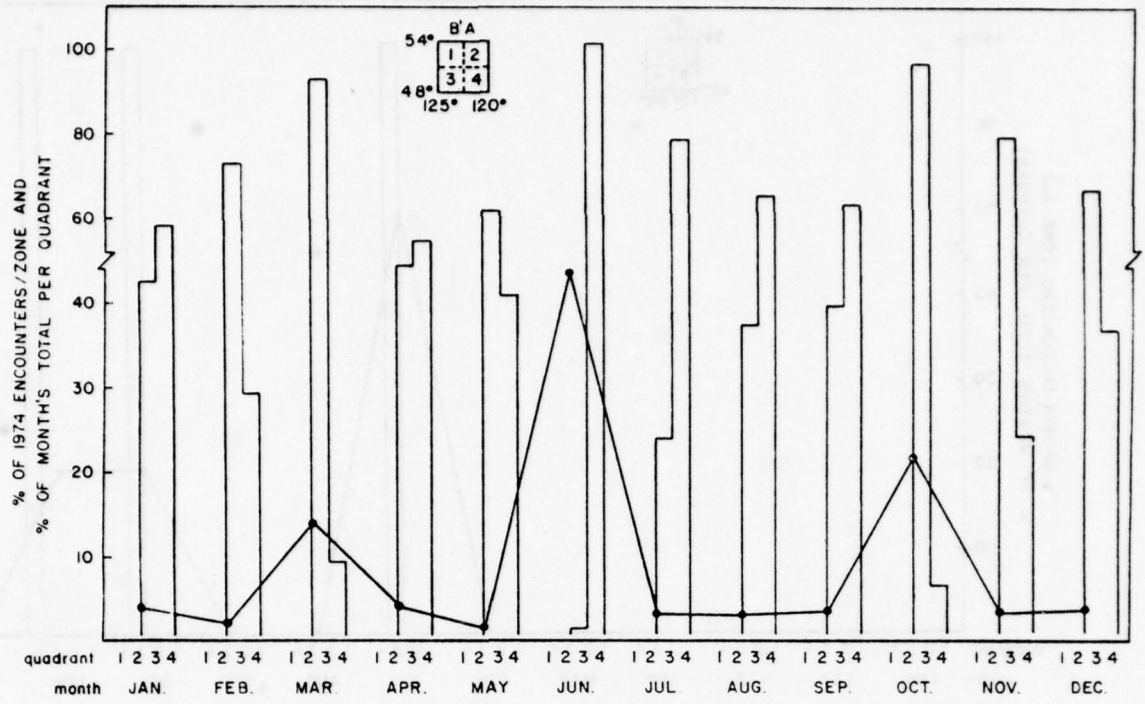
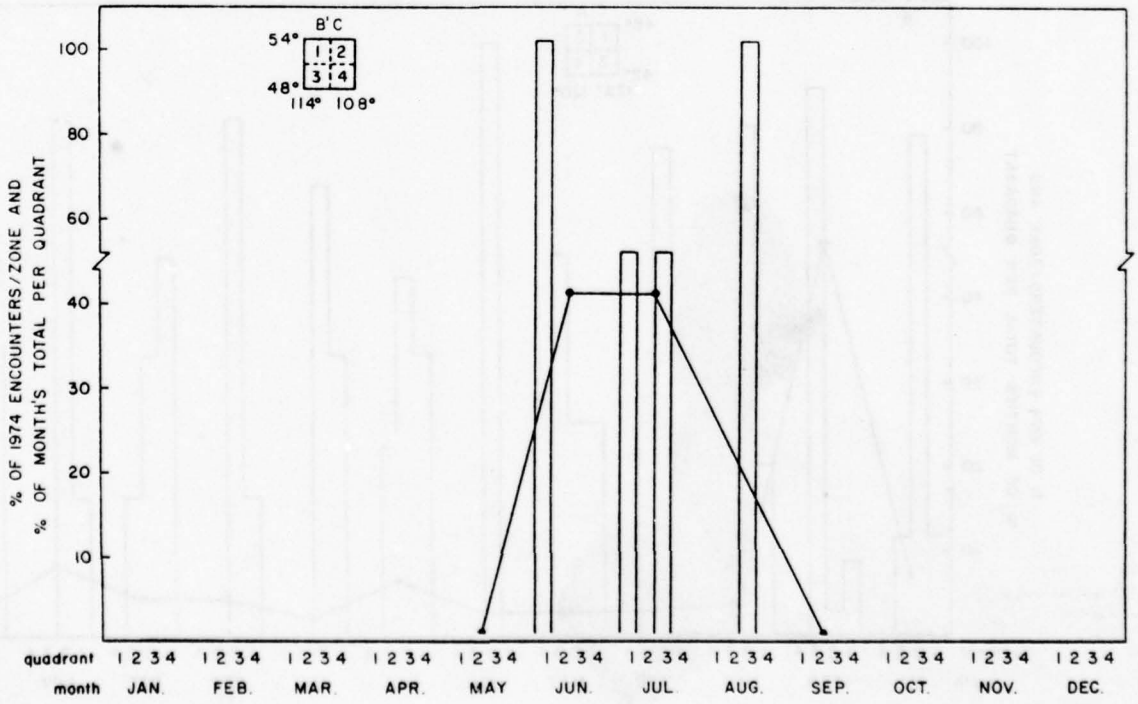
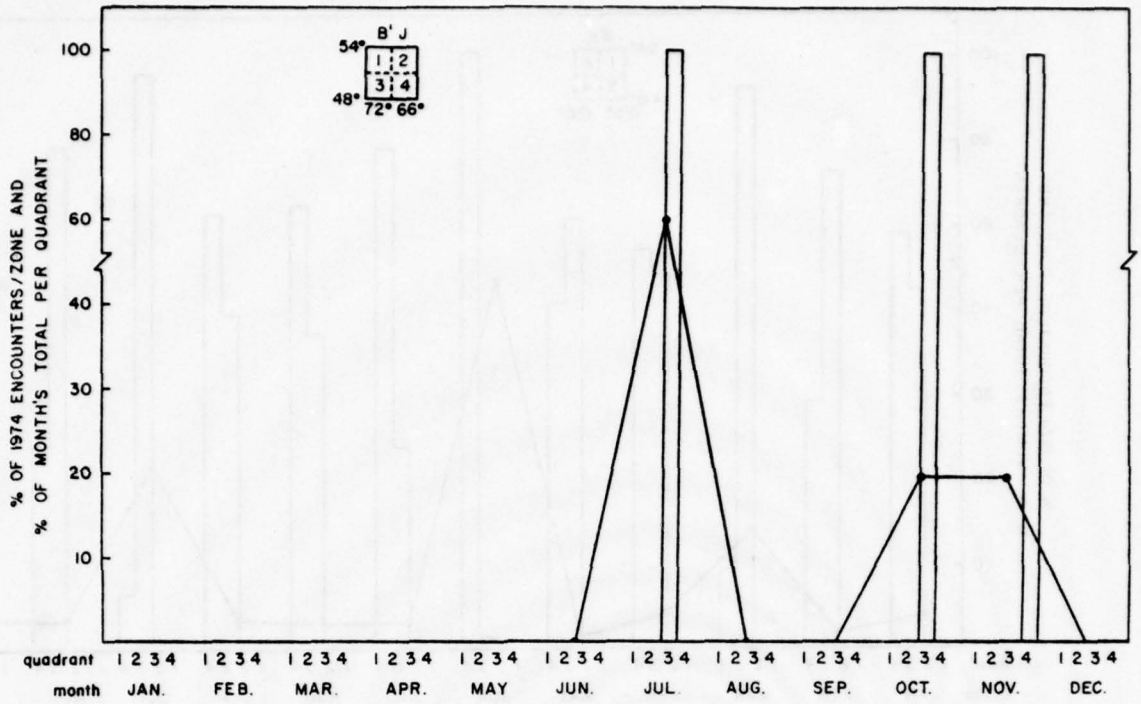


Figure 22. The Proportion of Band Recoveries for 1974 Reported in Each 6° Zone.

Figures 23 B'A - F'H. Seasonal distribution of gulls within each Zone during 1974. See Figure 17 for details.


B'A
54°
48°
125°
120°
1
2
3
4
% OF 1974 ENCOUNTERS/ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B'C
54°
48°
114°
108°
1
2
3
4
% OF 1974 ENCOUNTERS/ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


B' J
54°
48°
72° 66°
1 2
3 4
% OF 1974 ENCOUNTERS/ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
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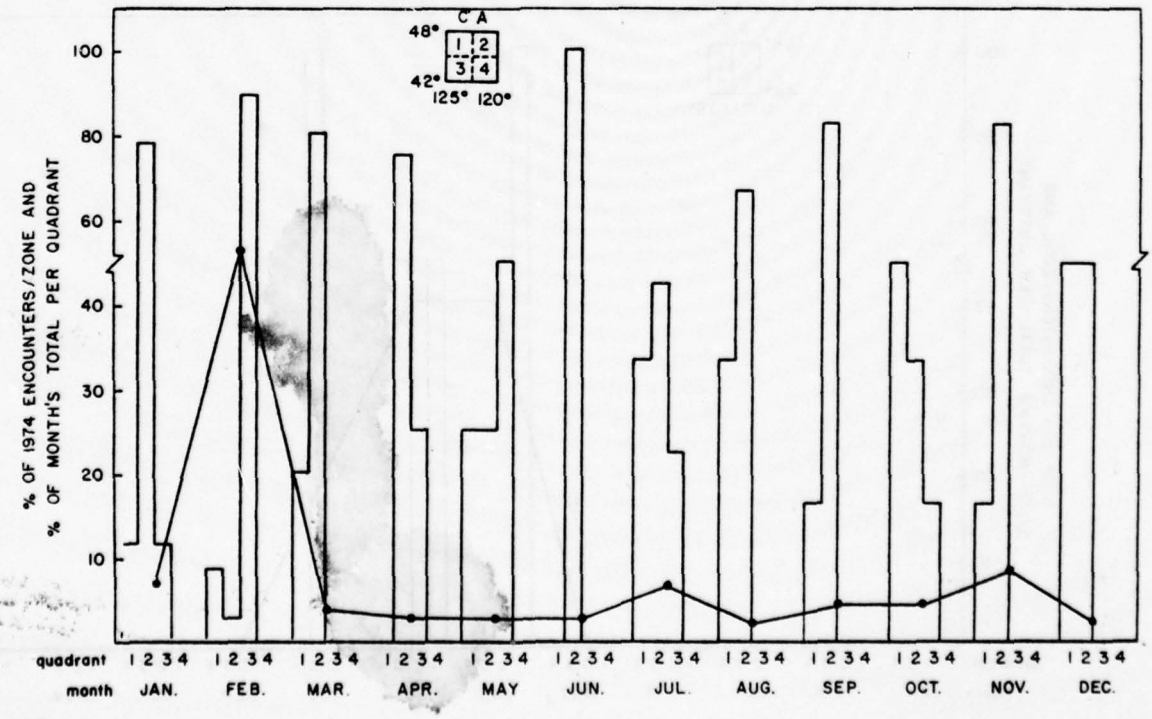
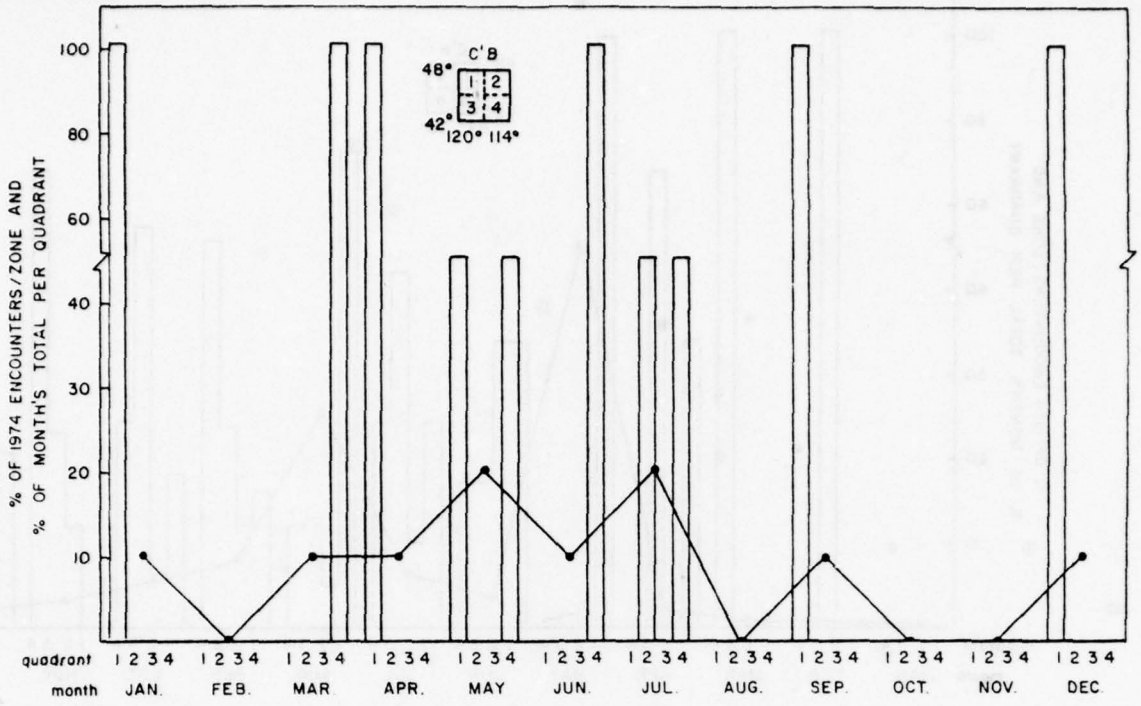
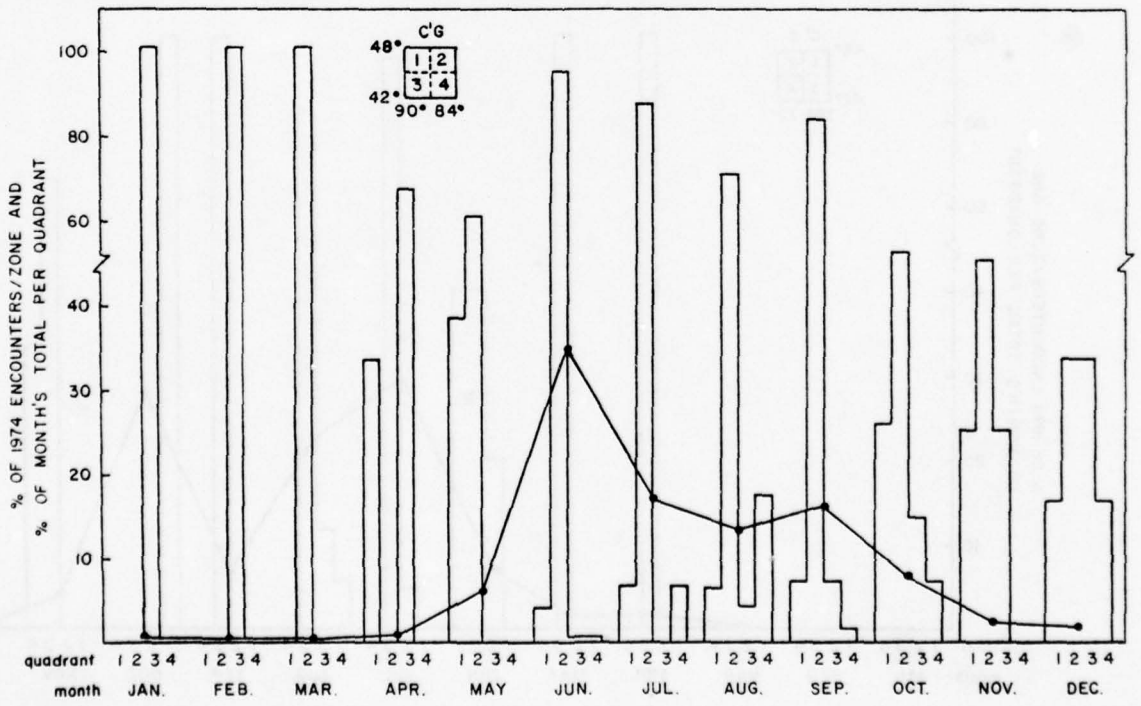
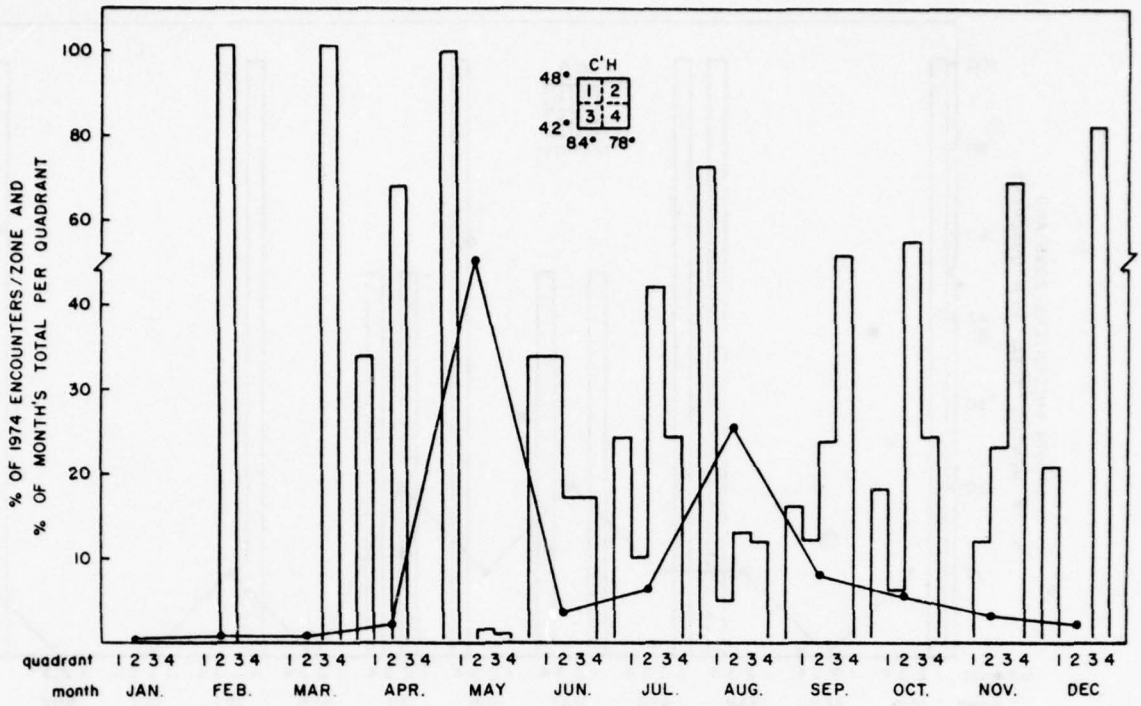
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C A
48°
42°
125° 120°
1 2
3 4
% OF 1974 ENCOUNTERS/ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'B
48°
42°
120° 114°
1 2
3 4
% OF 1974 ENCOUNTERS/ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'G
48°
42°
90° 84°
1 2
3 4
% OF 1974 ENCOUNTERS/ZONE AND
% OF MONTH'S TOTAL PER QUADRANT
100
80
60
40
30
20
10
quadrant 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.


C'H
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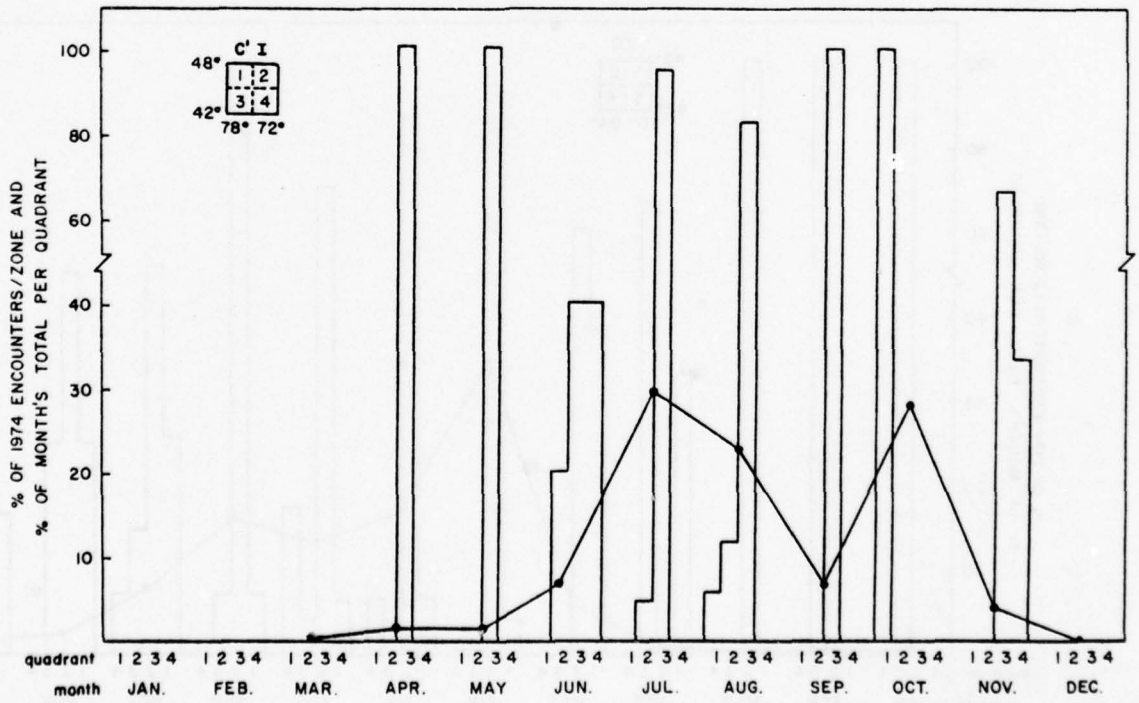
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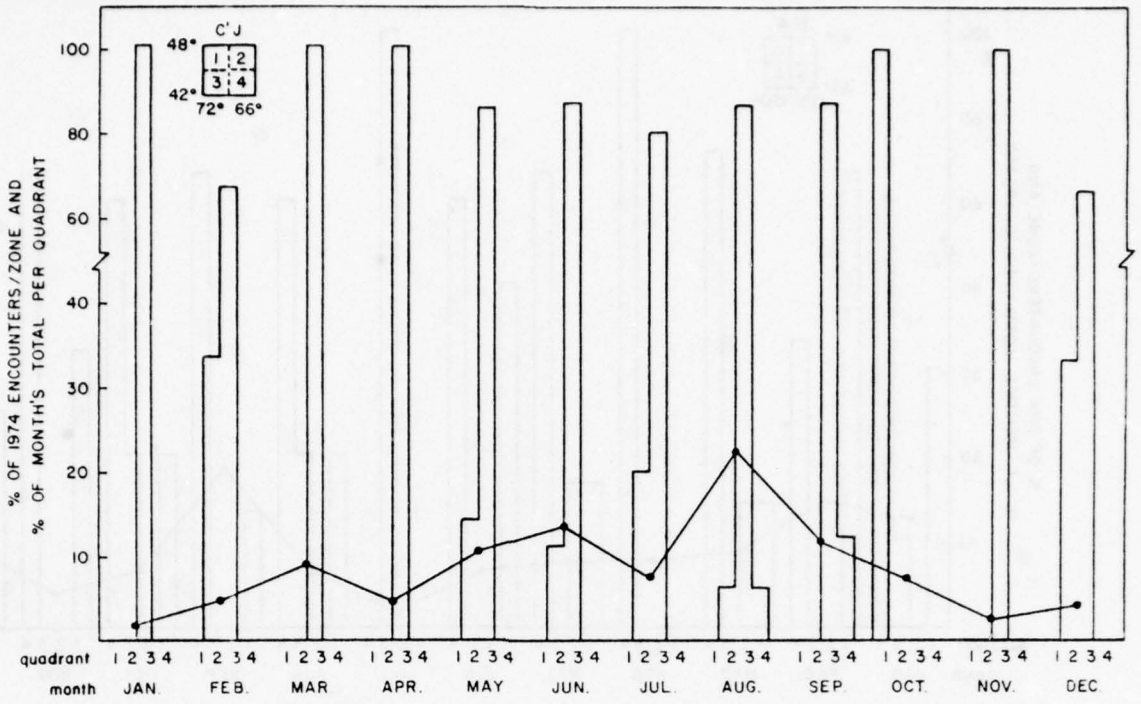
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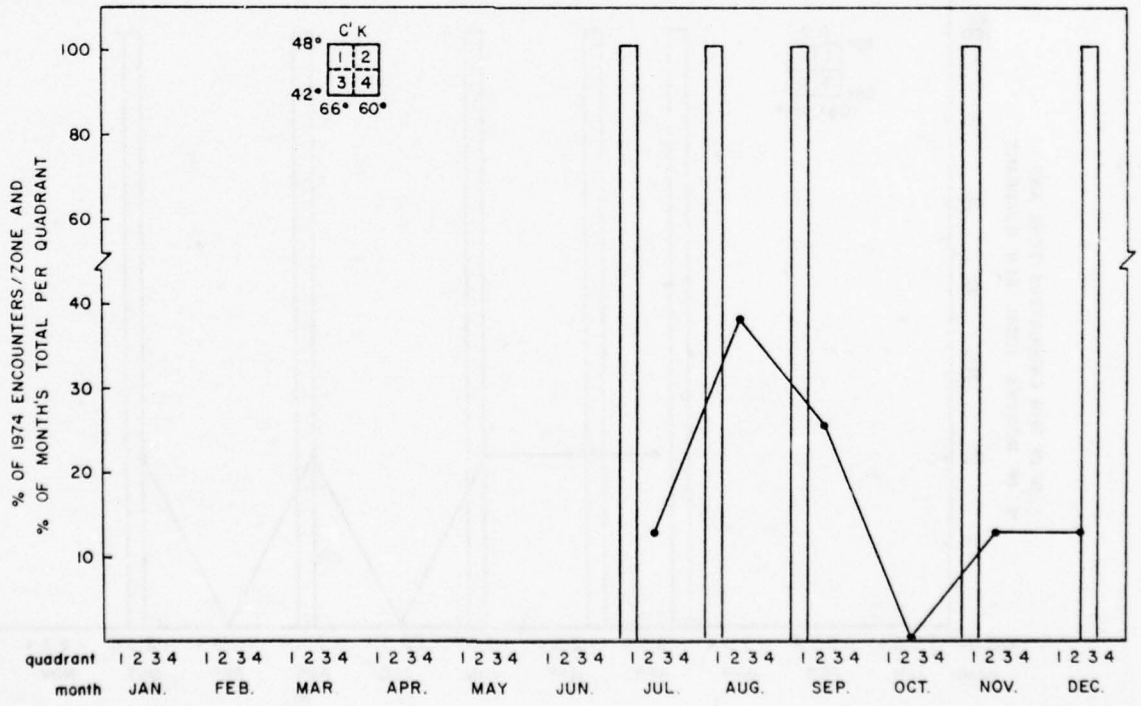
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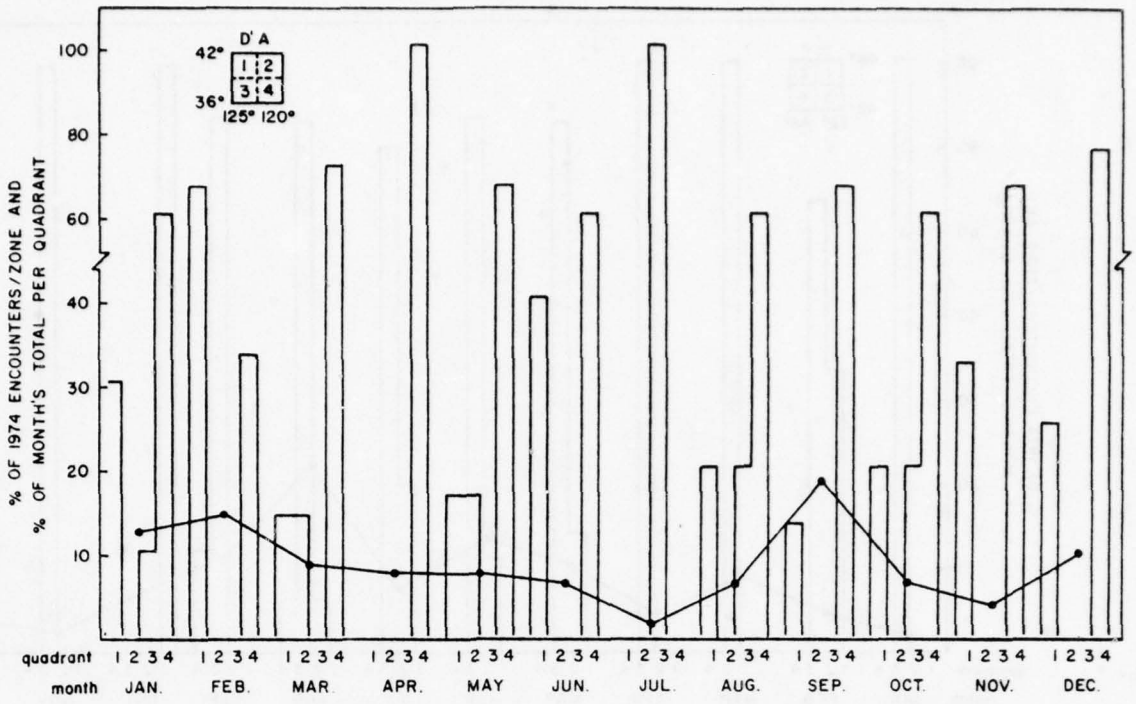
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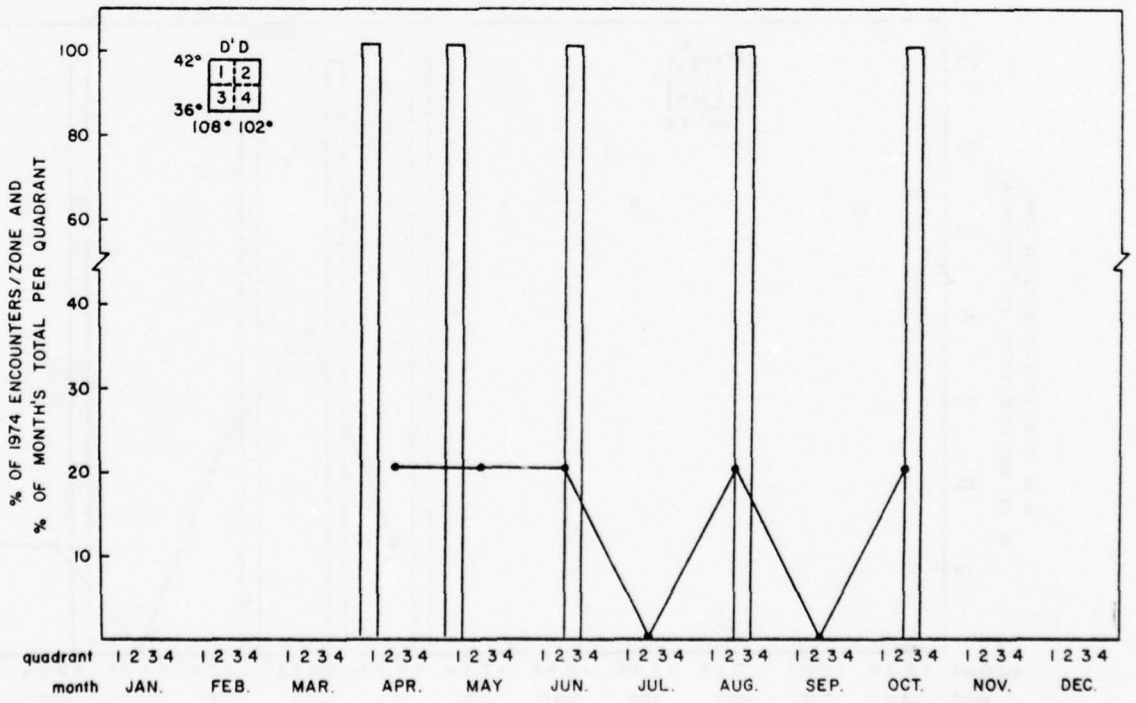
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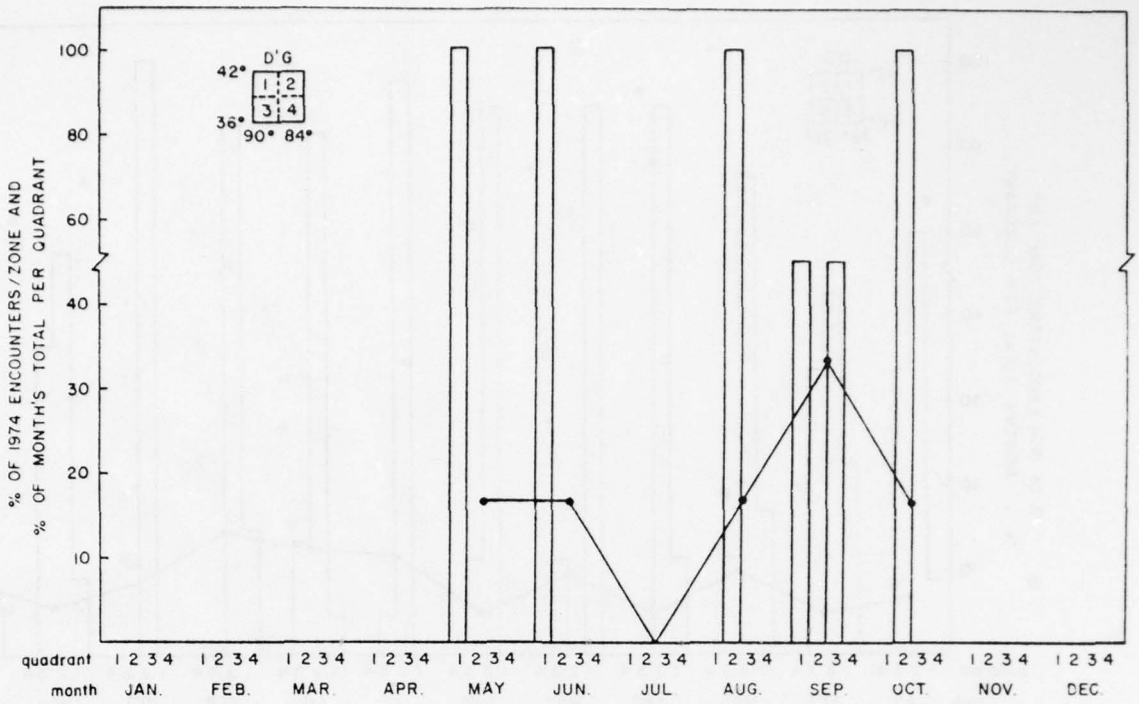
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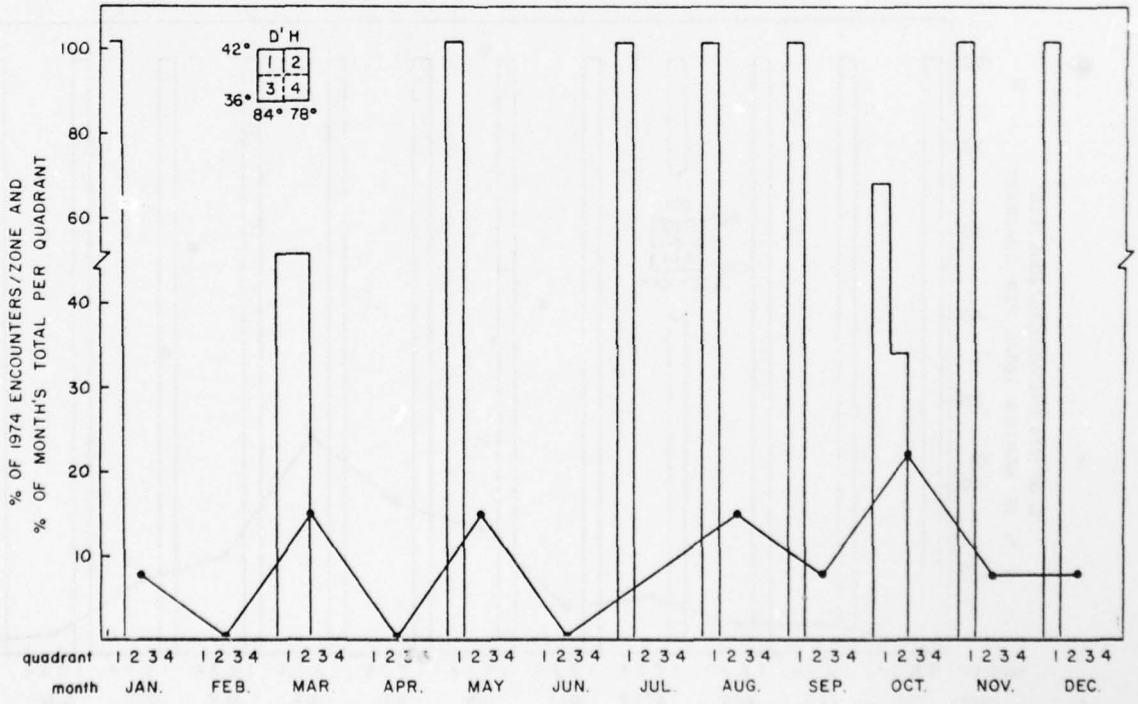
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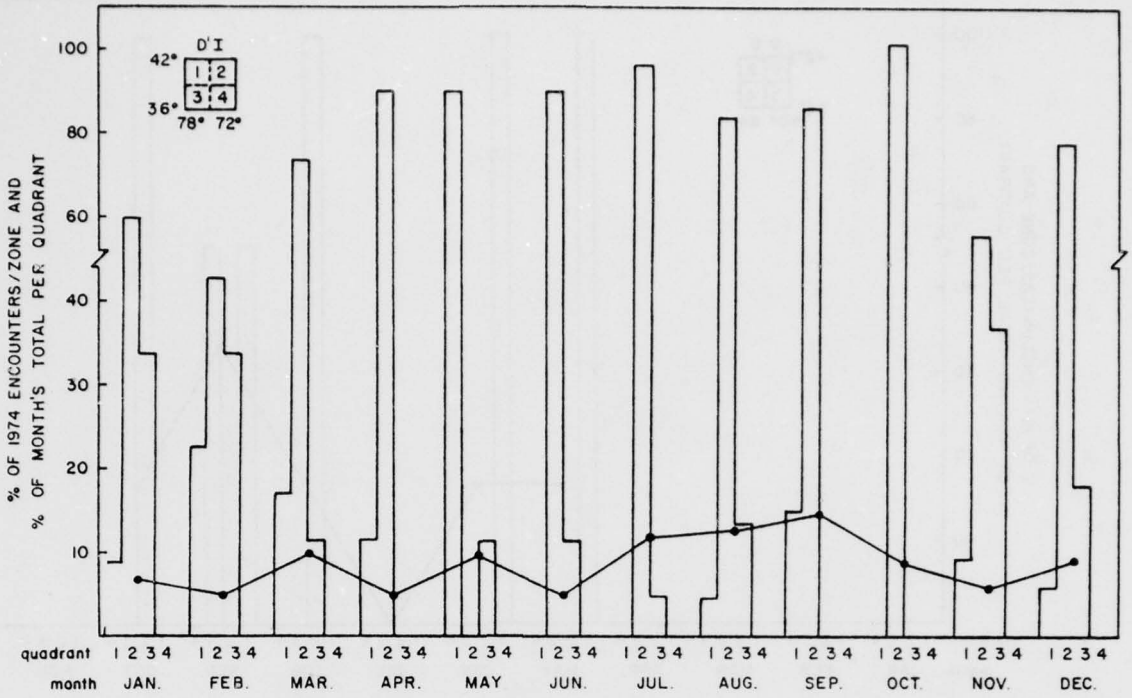
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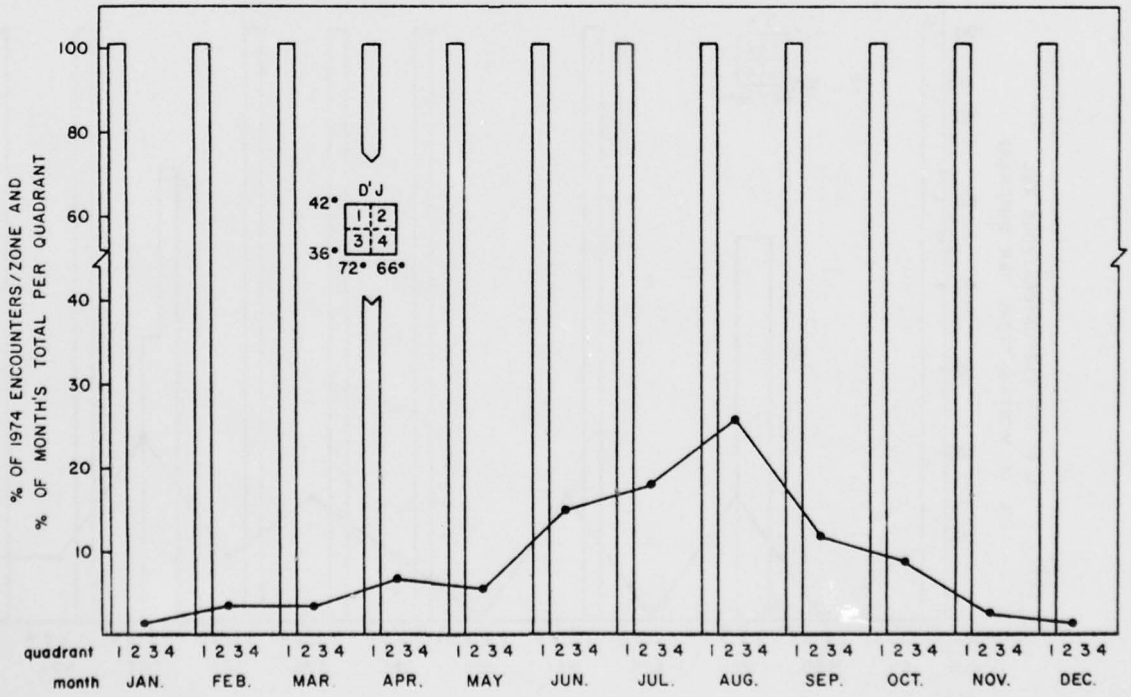
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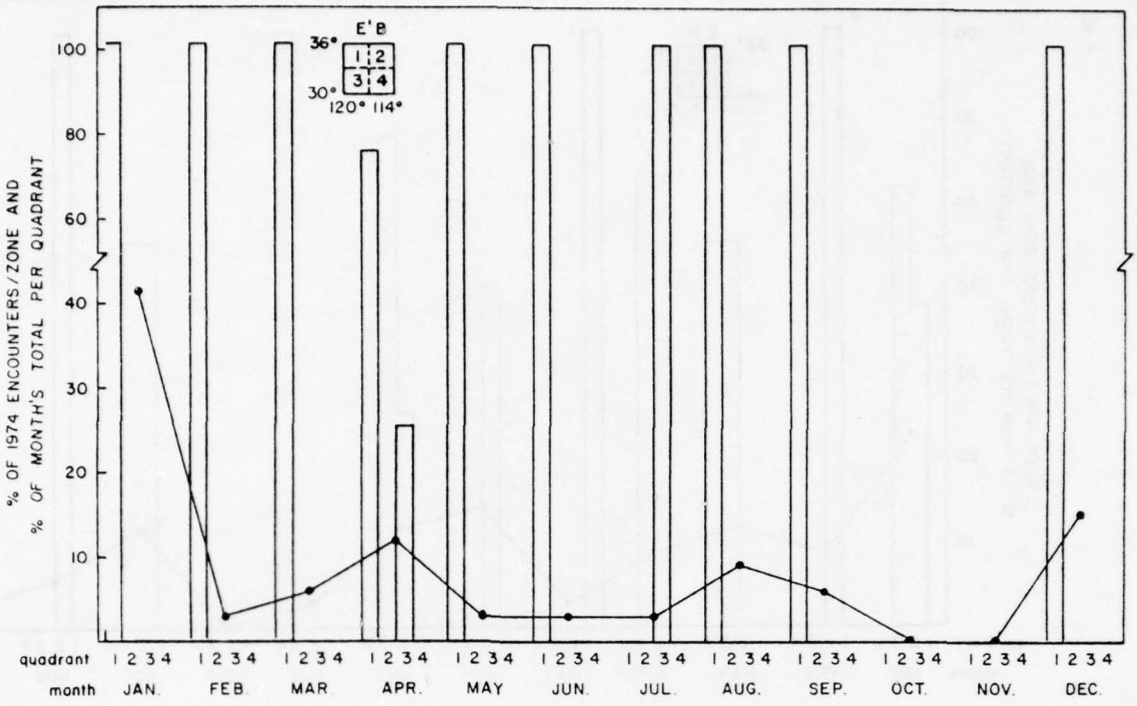
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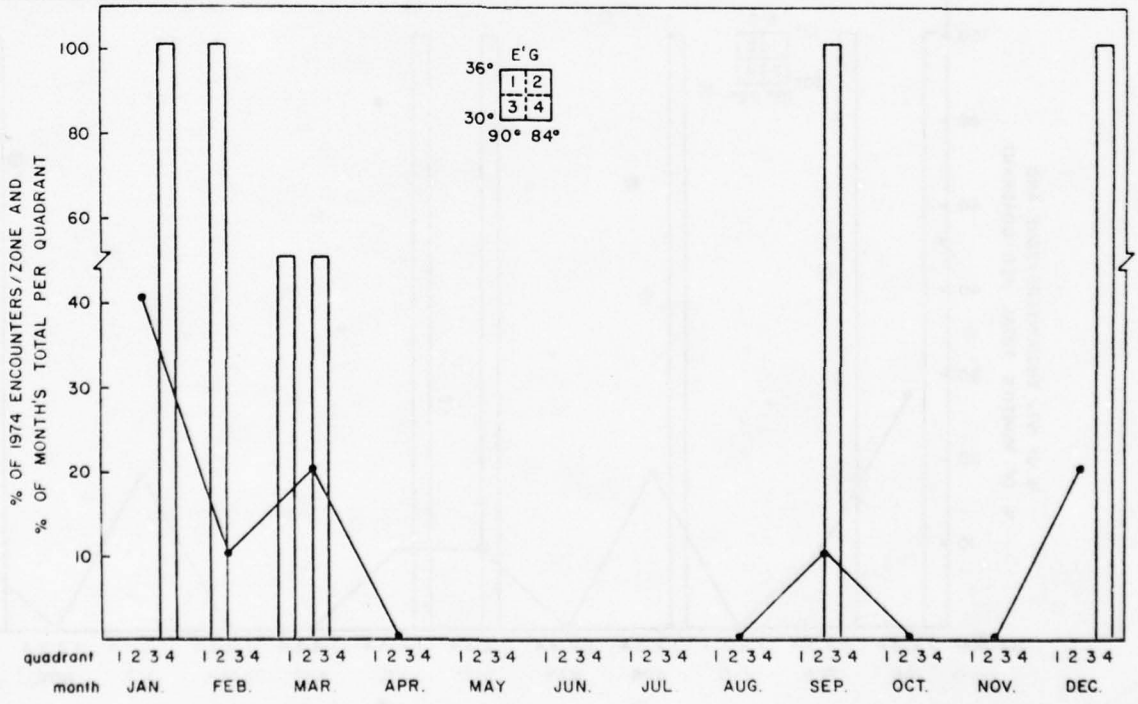
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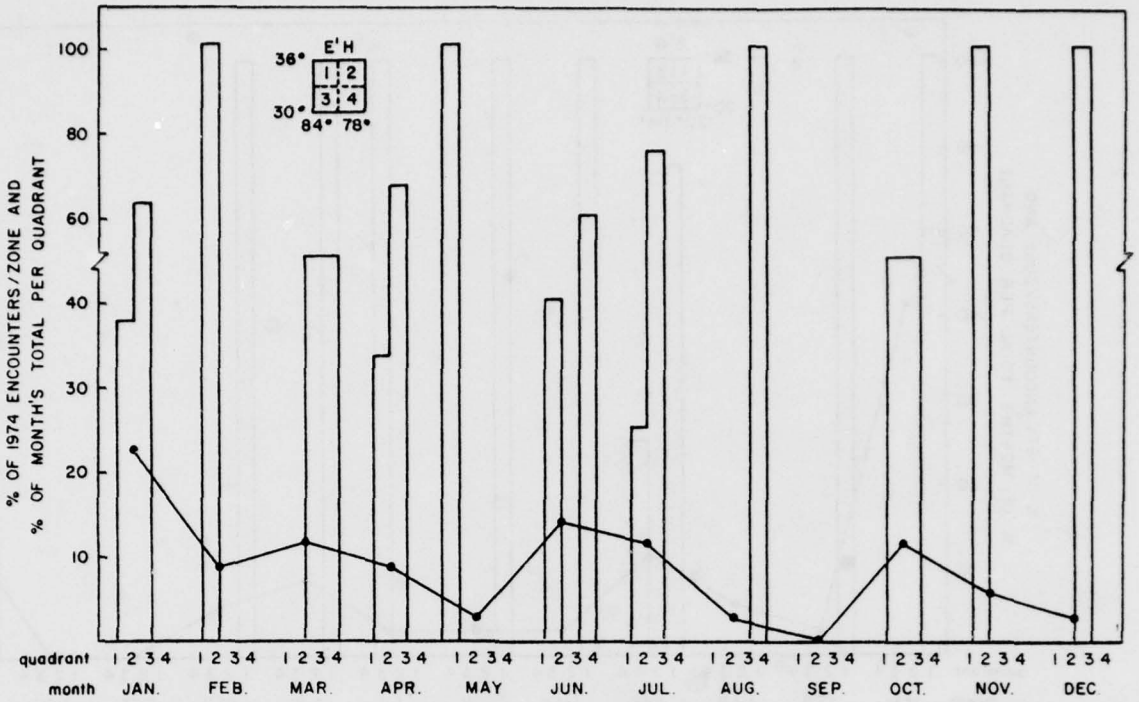
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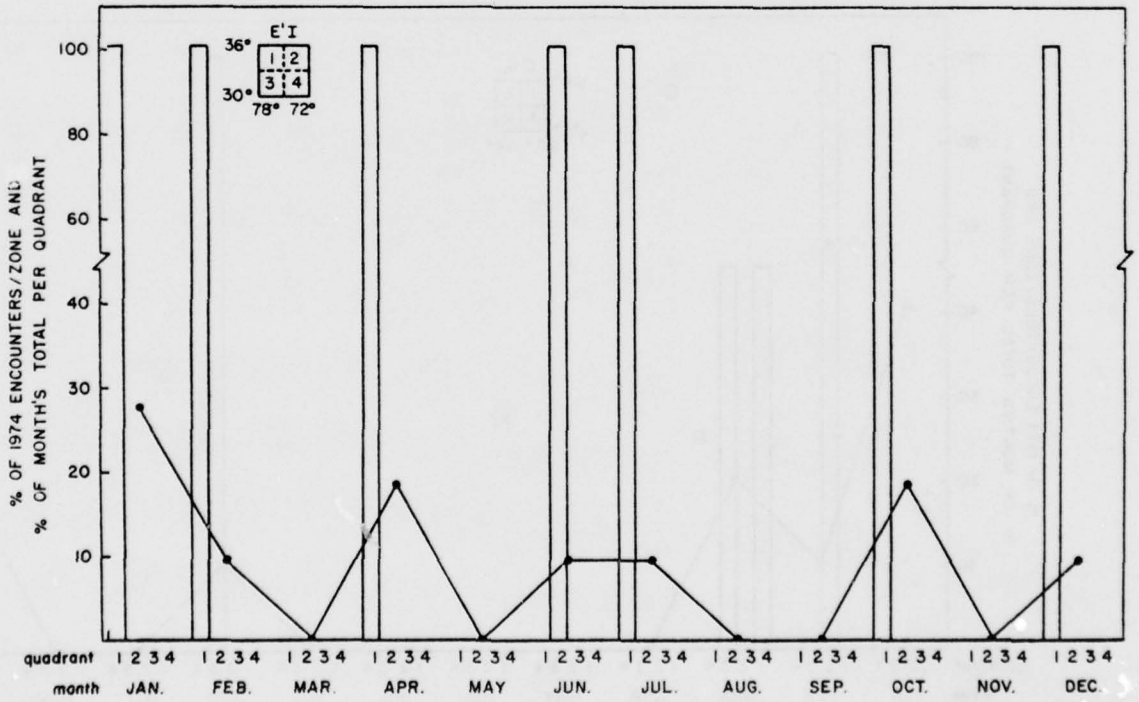
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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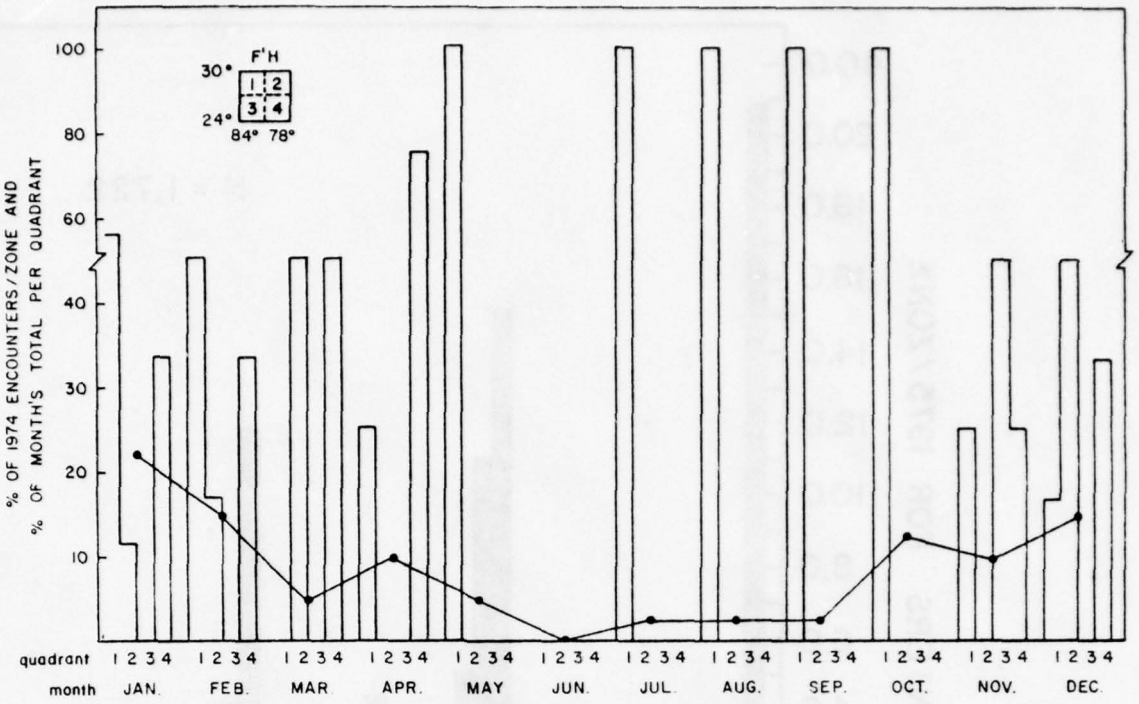
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month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

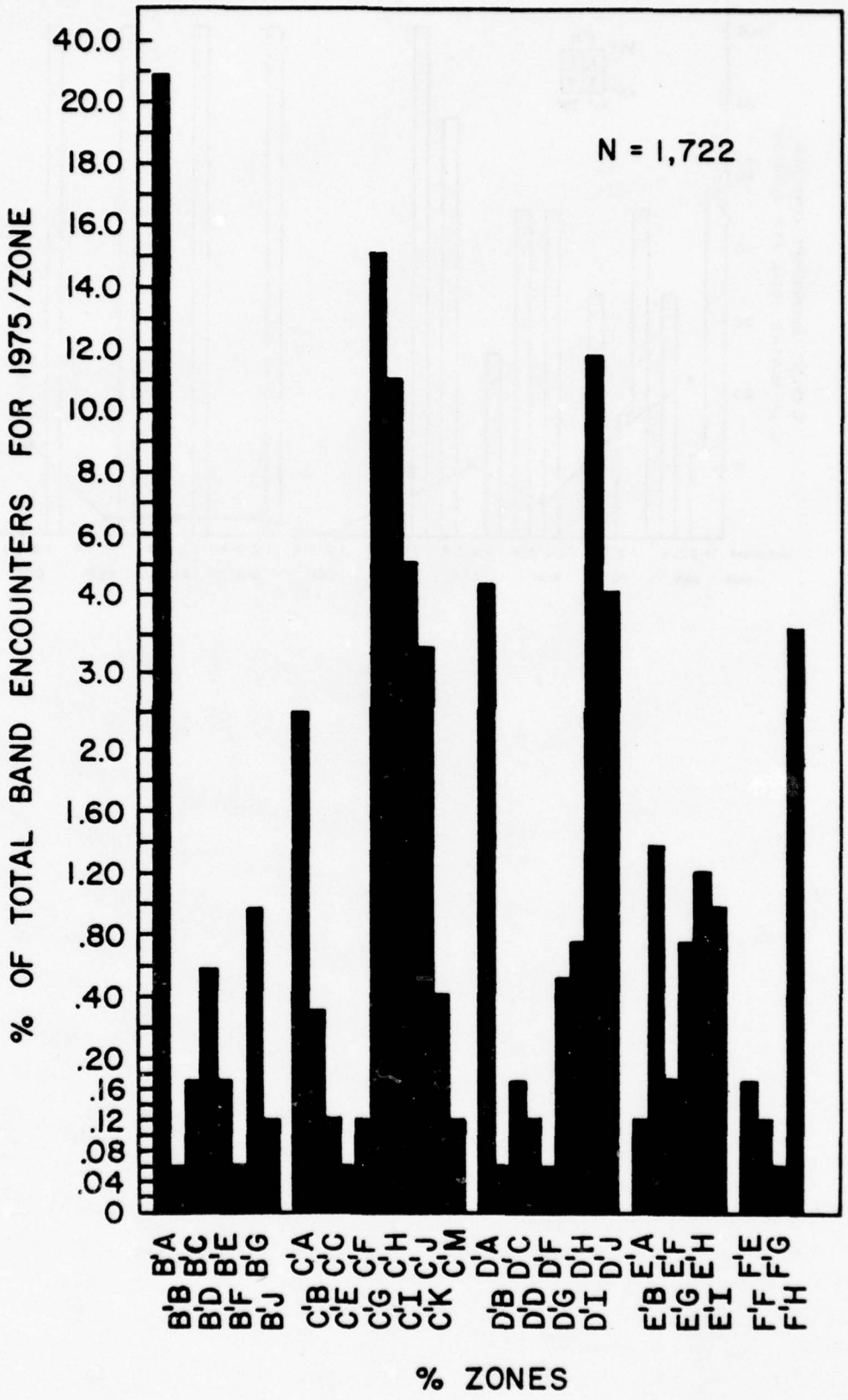
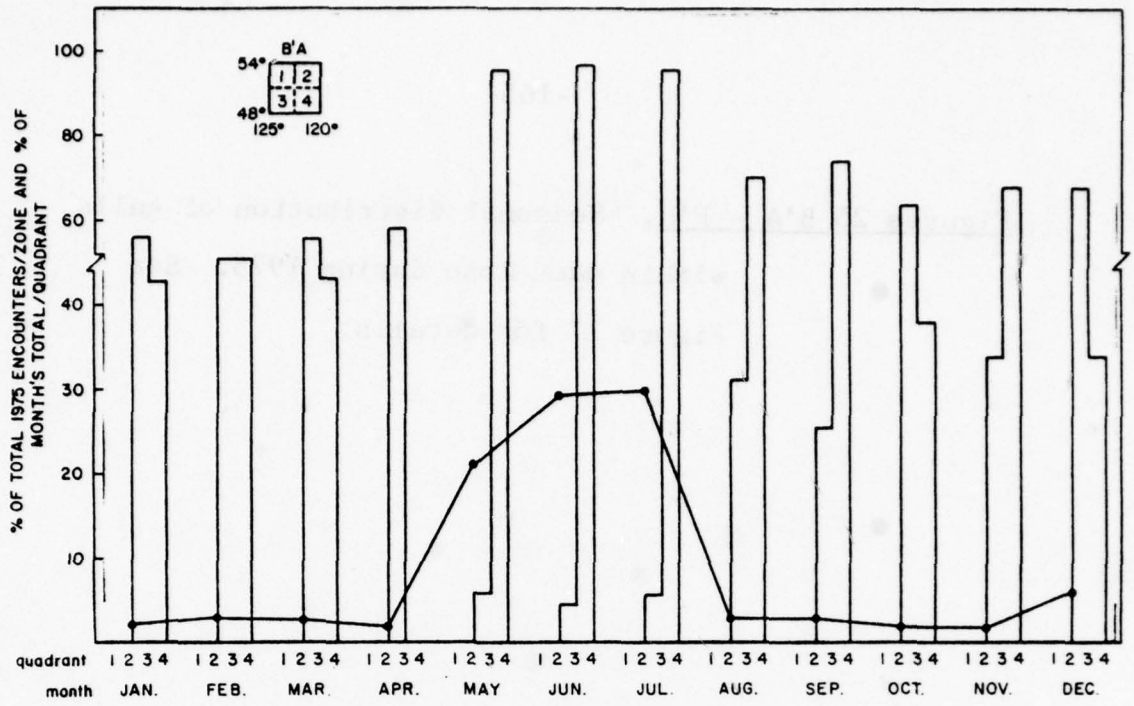


Figure 24. The Proportion of Band Recoveries for 1975 Reported in Each 6^{o} Zone.

Figures 25 B'A - F'H. Seasonal distribution of gulls within each Zone during 1975. See Figure 17 for details.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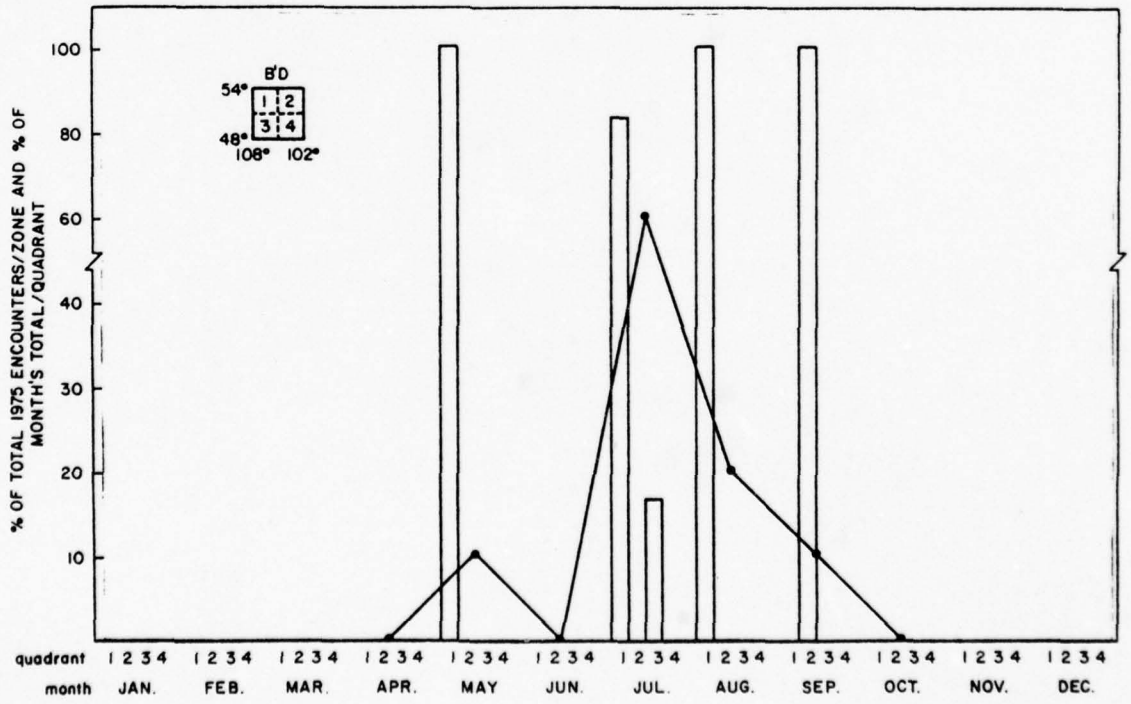
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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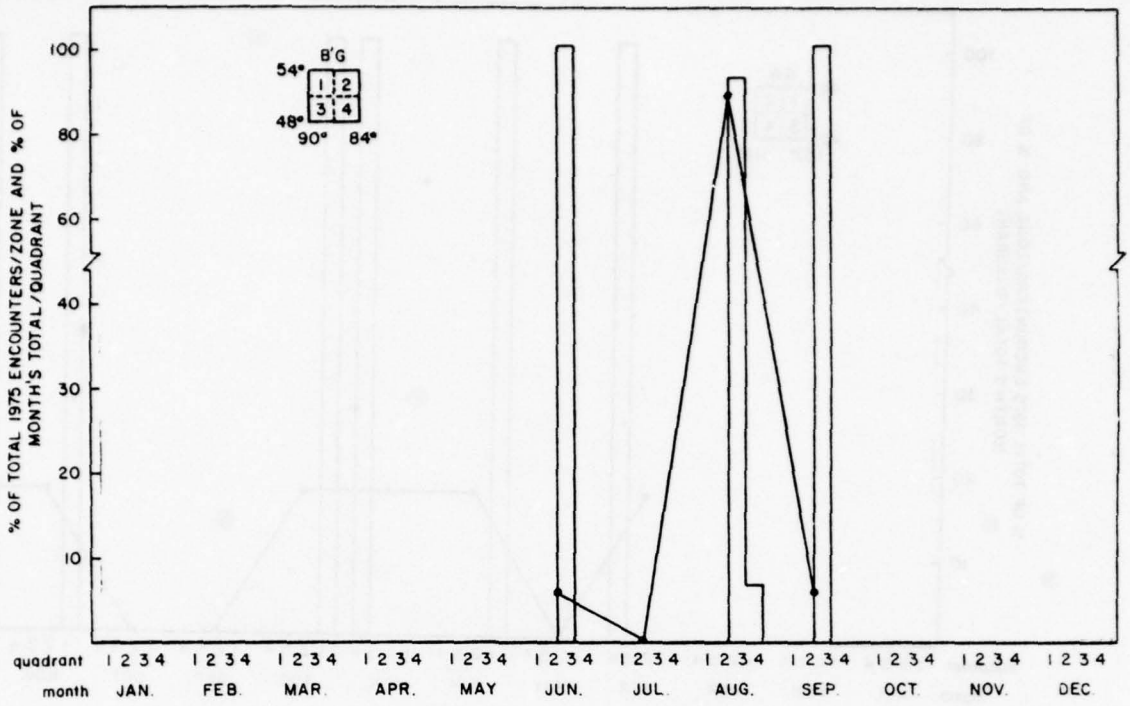
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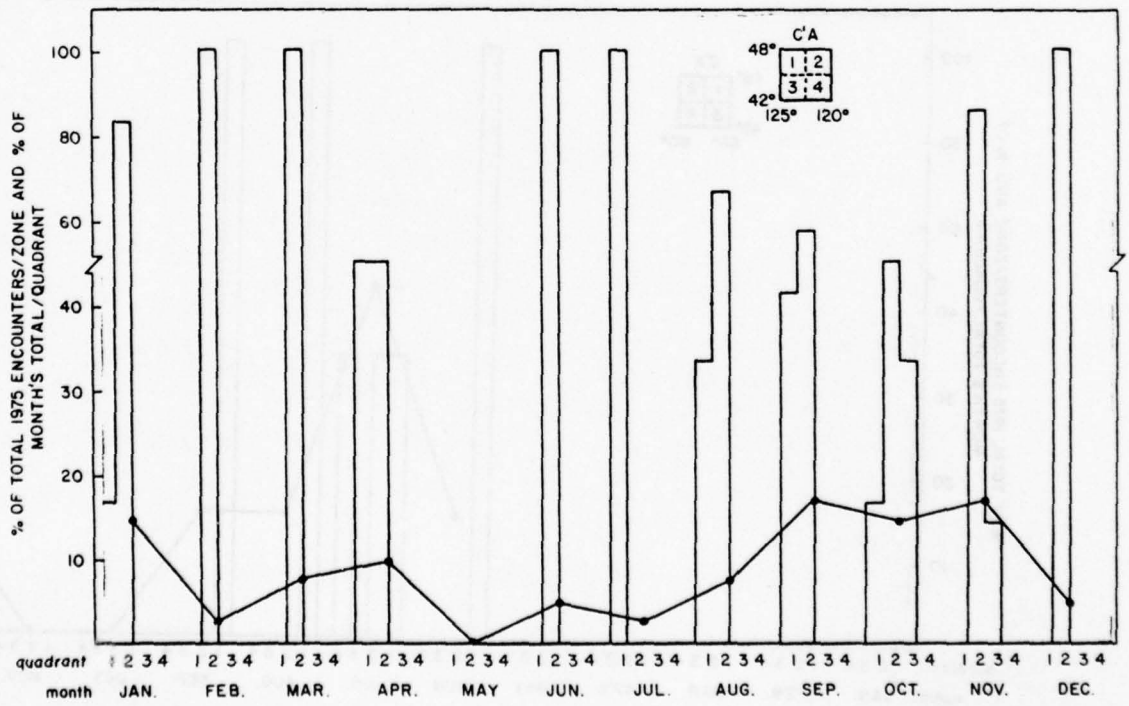
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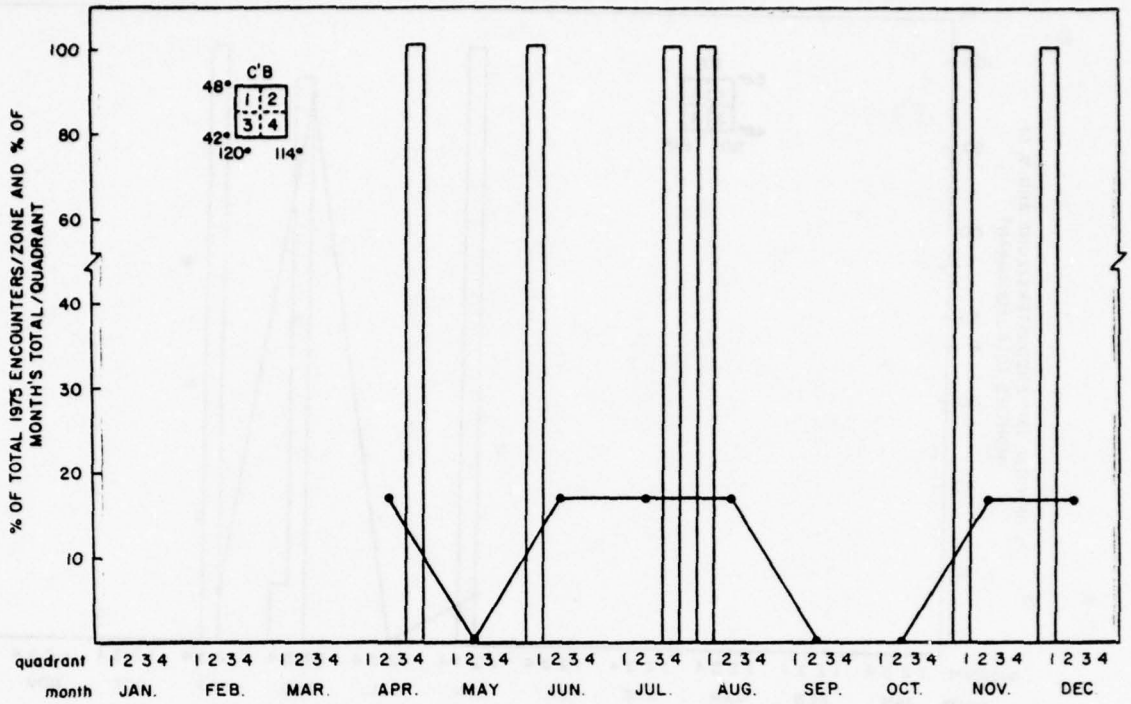
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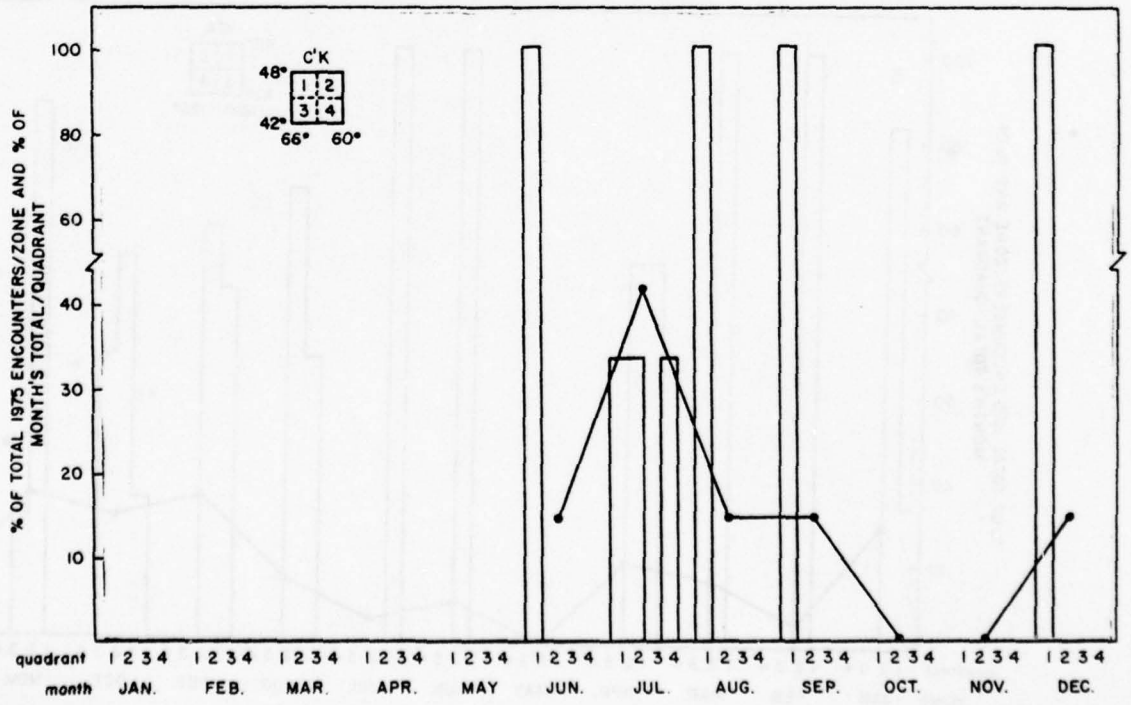
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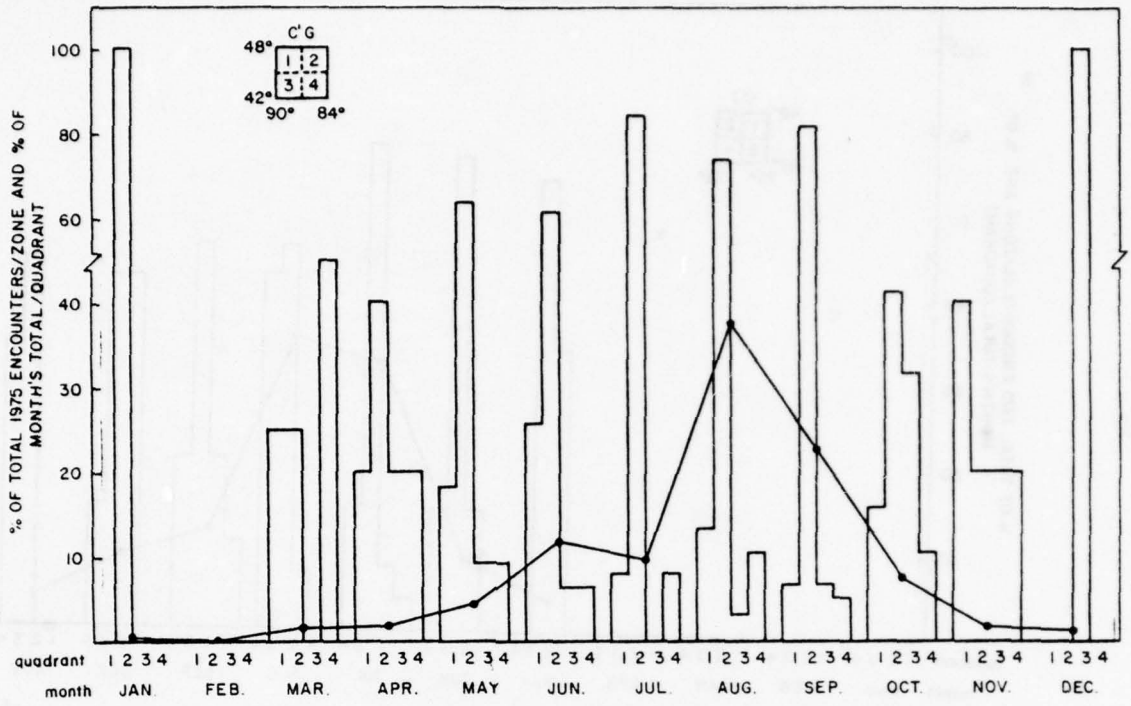
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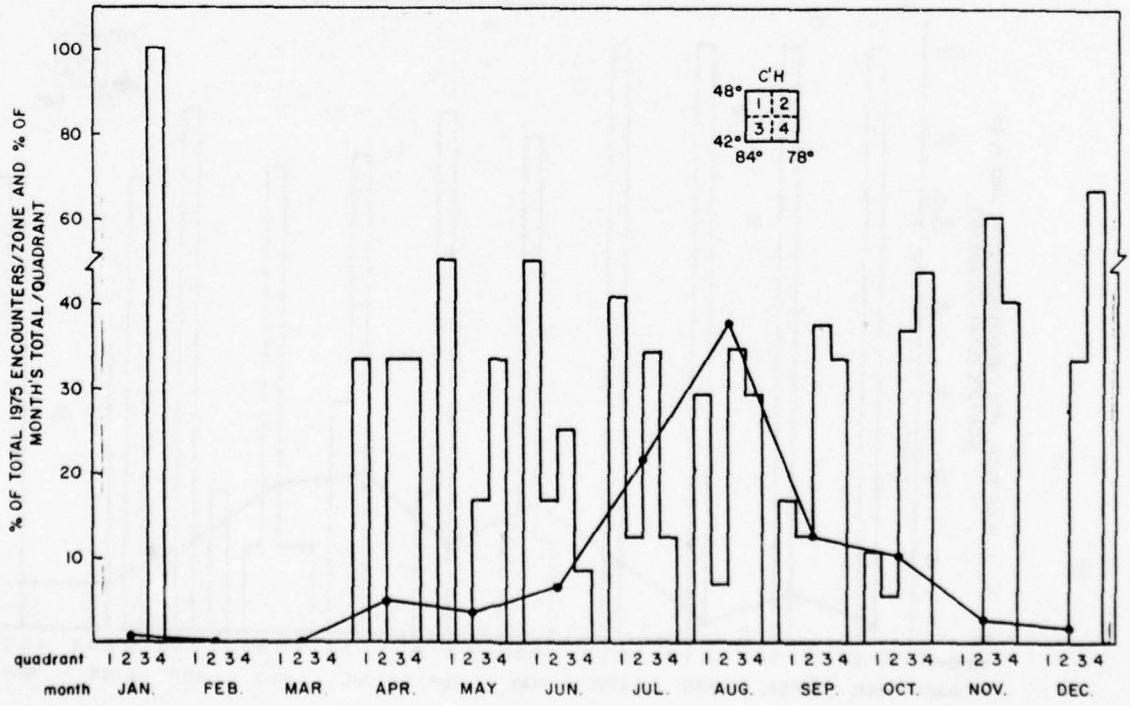
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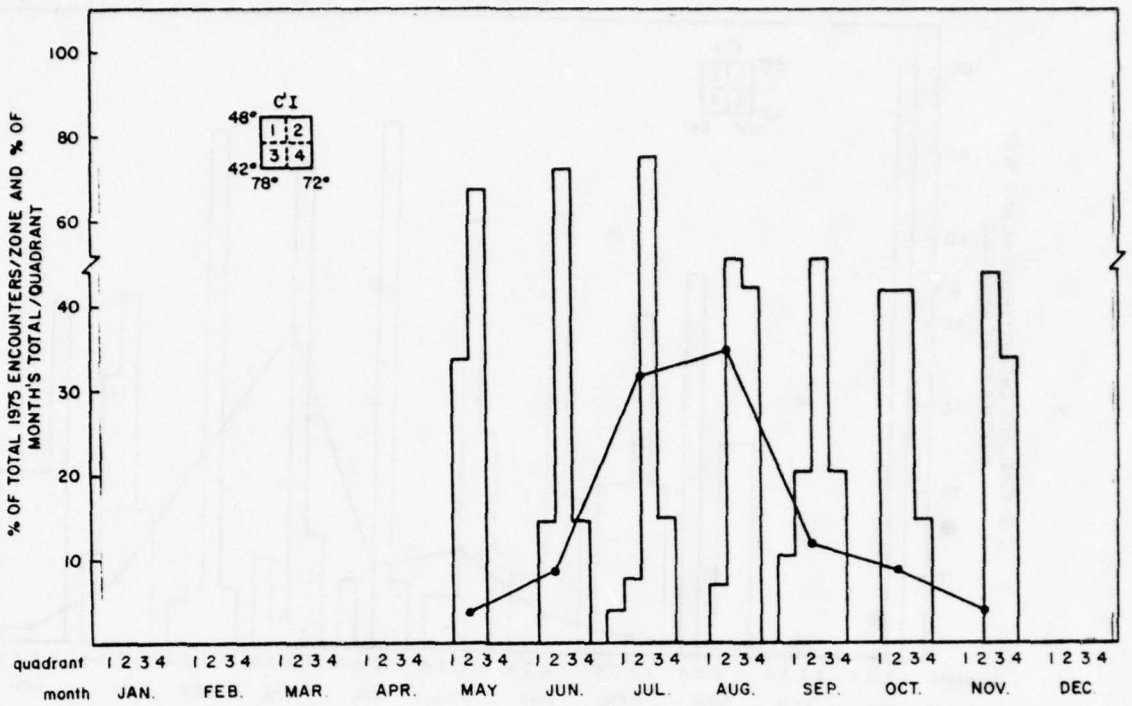
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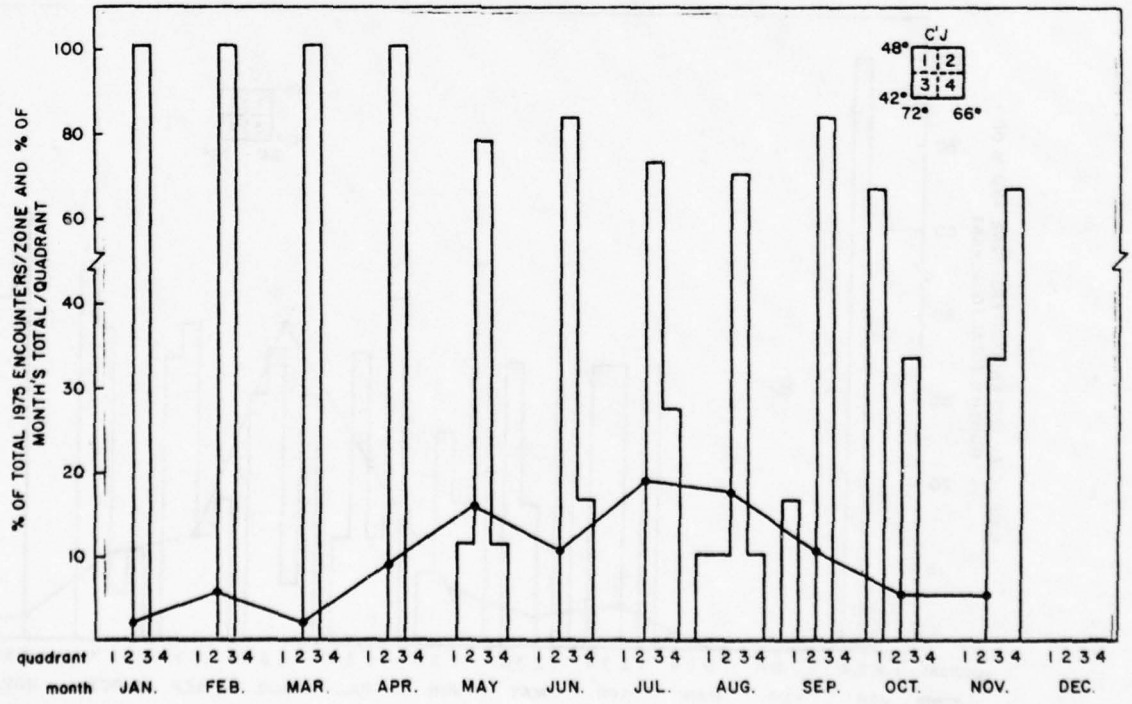
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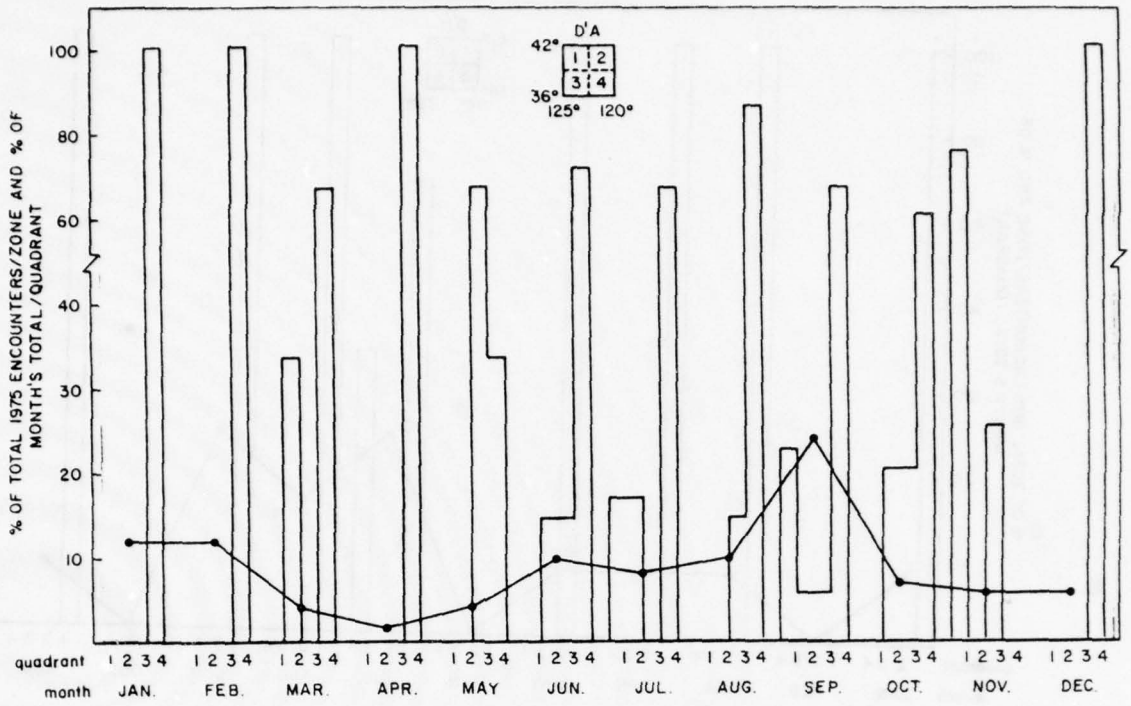
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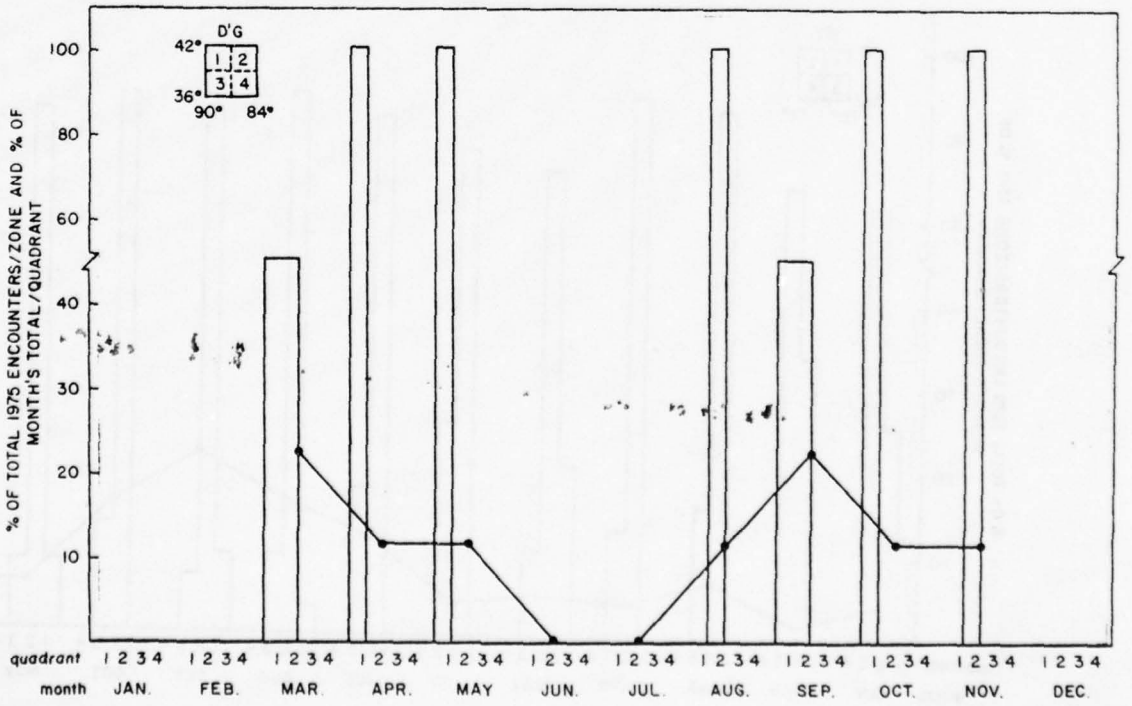
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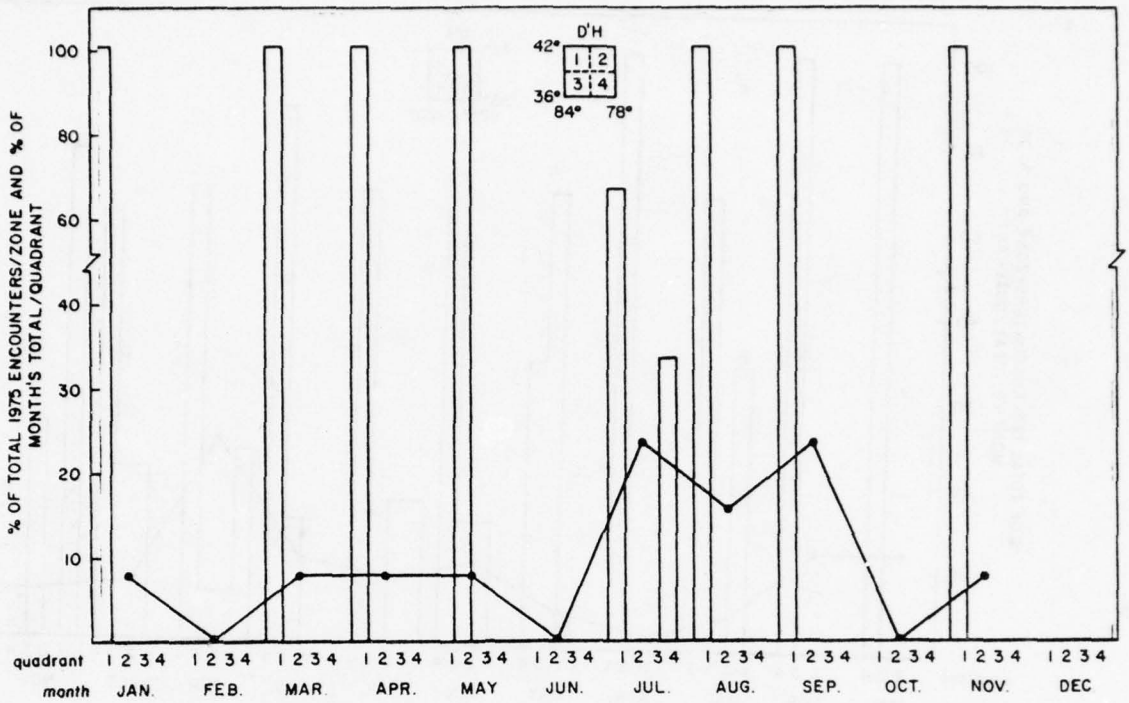
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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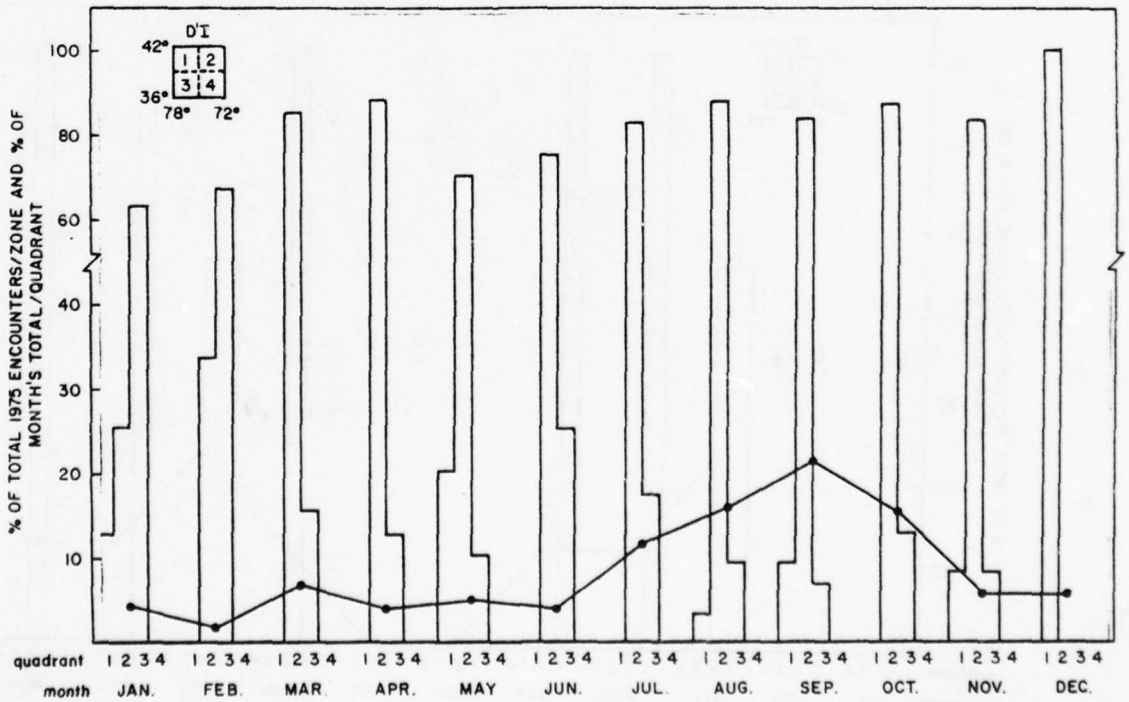
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC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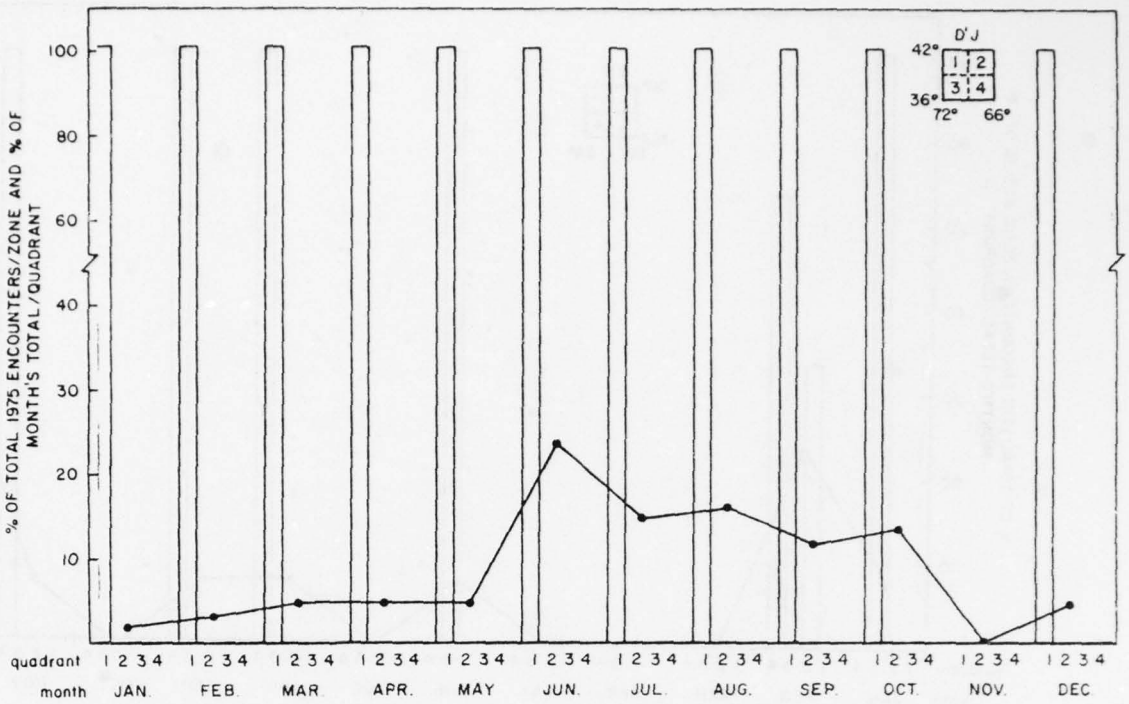
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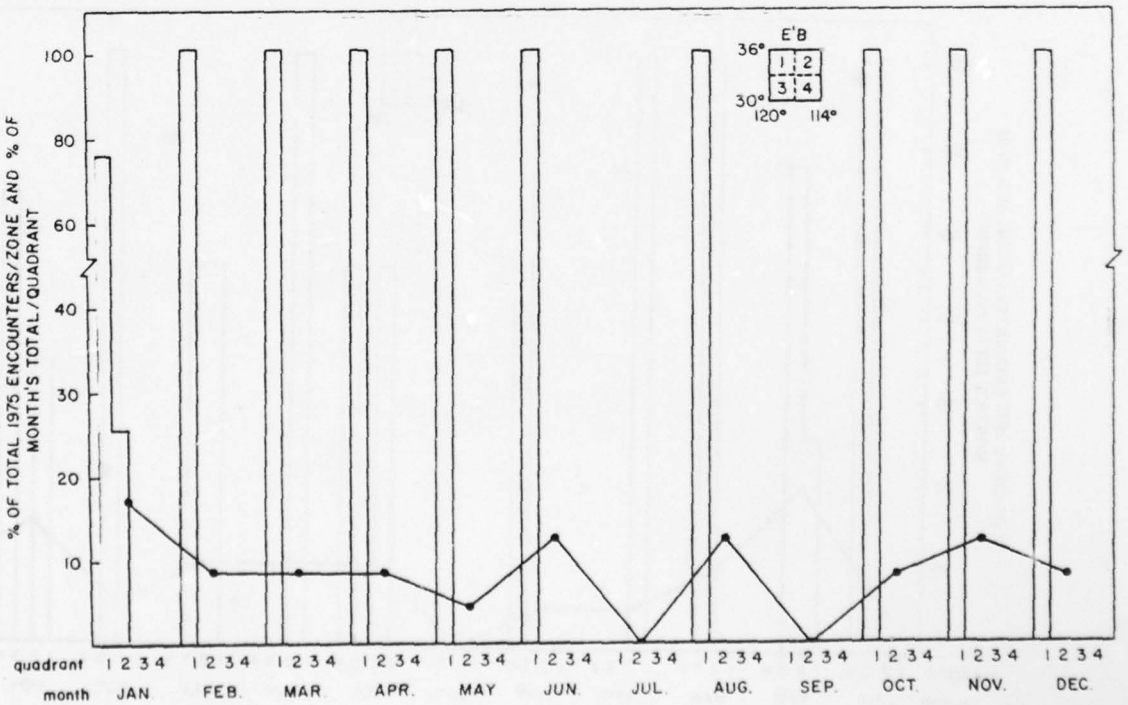
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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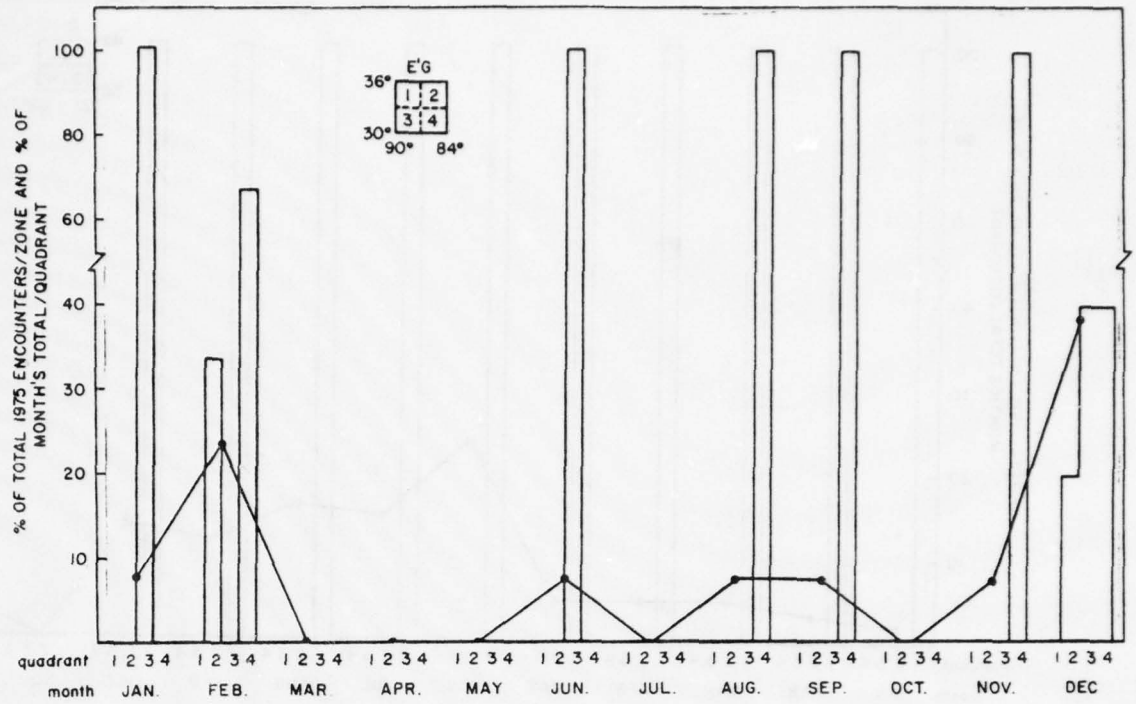
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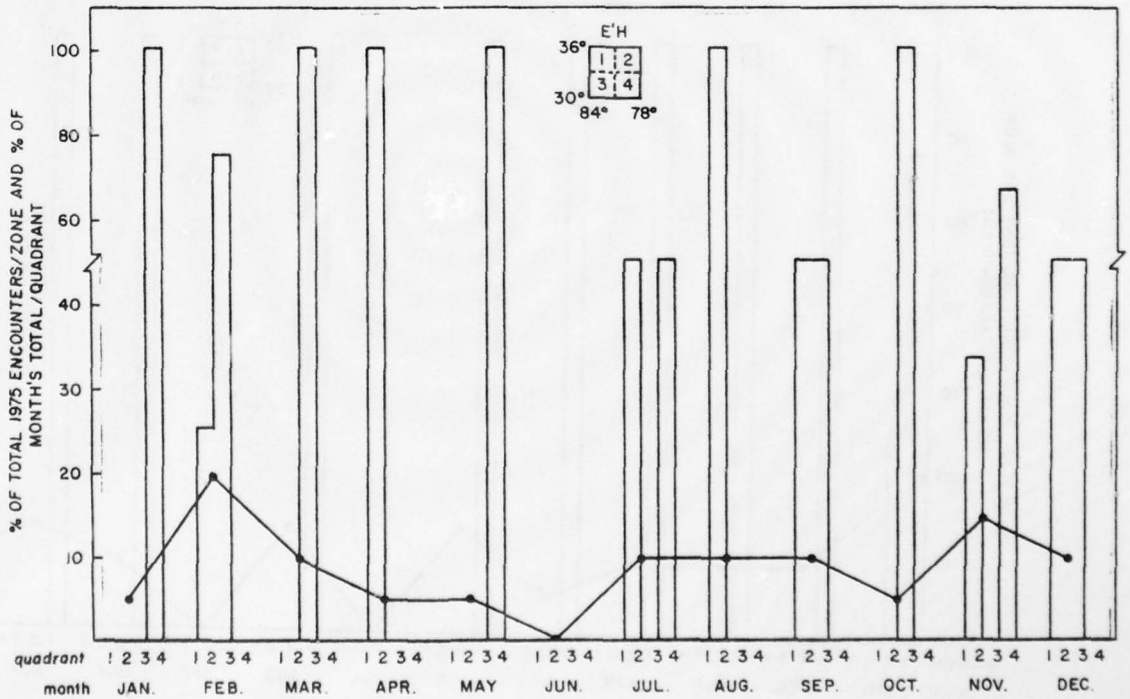
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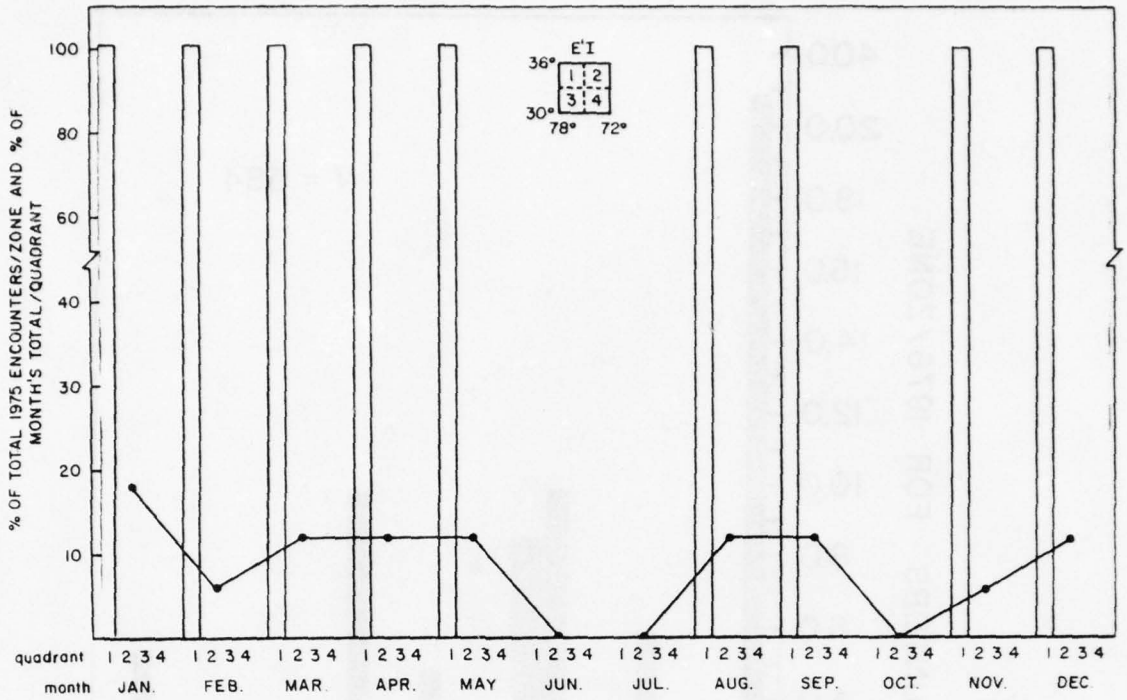
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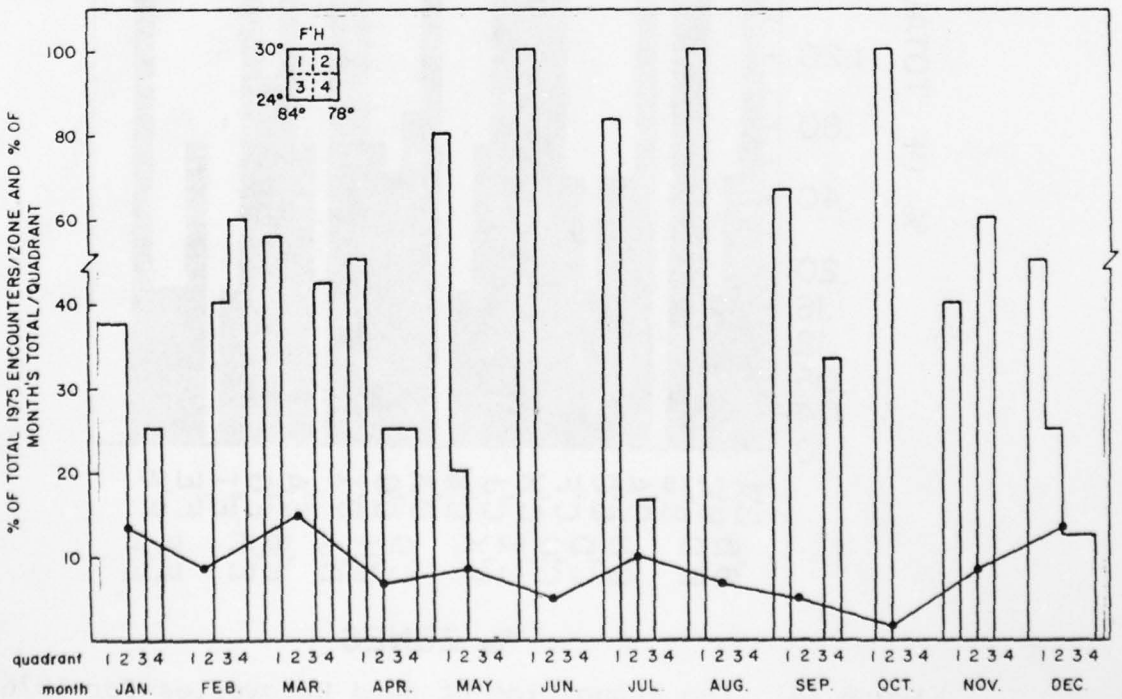
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC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month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC

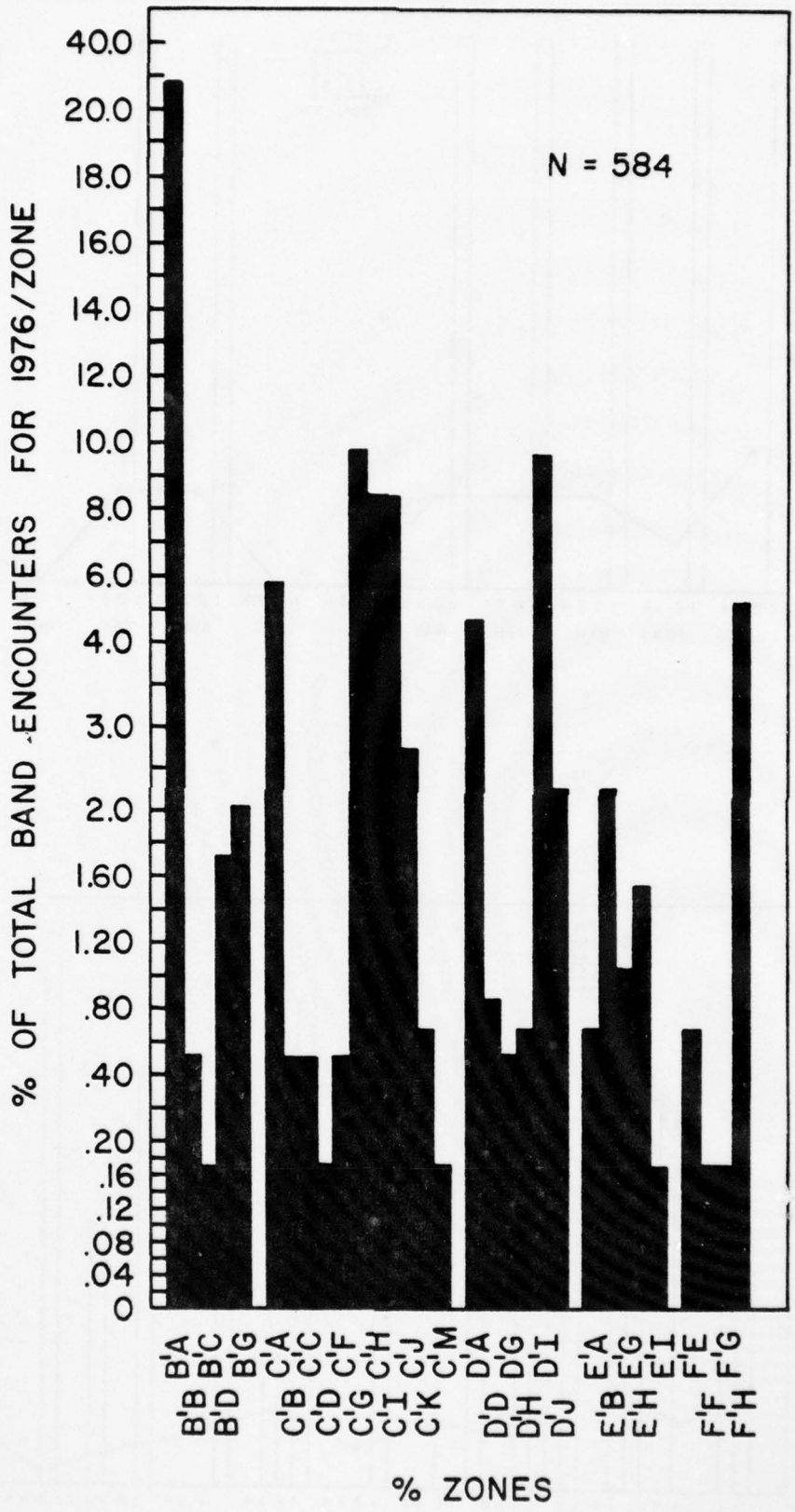
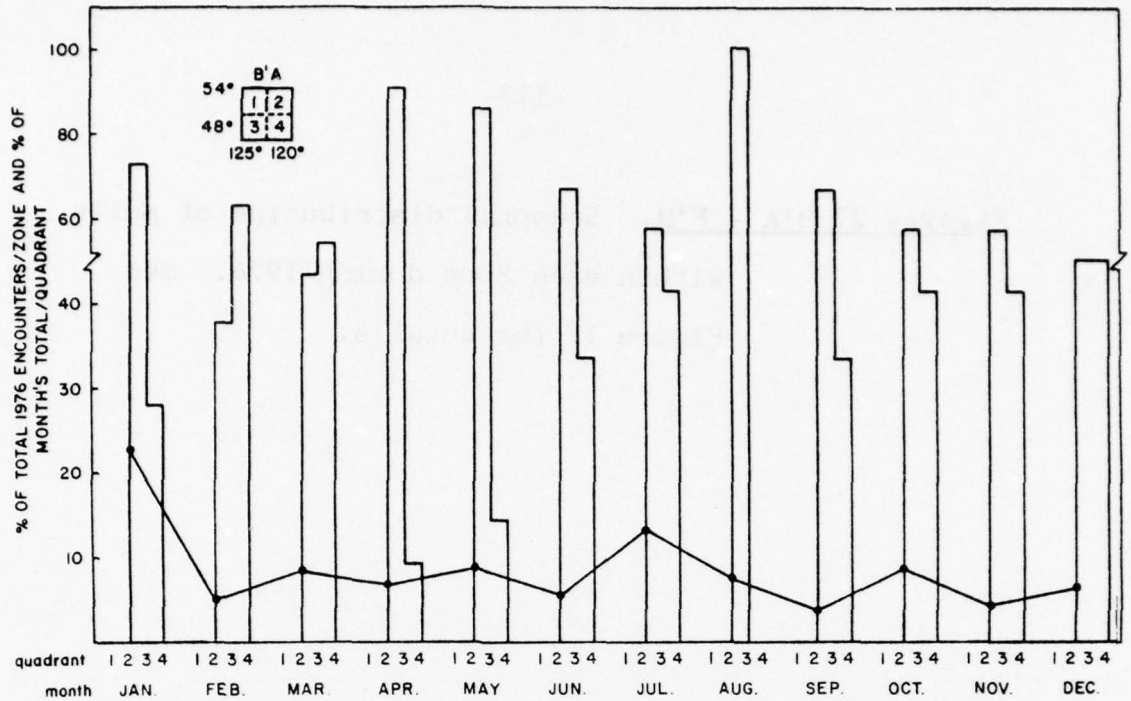


Figure 26. The Proportion of Band Recoveries for 1976 Reported in Each 6^{o} Zone.

Figures 27 B'A - F'H. Seasonal distribution of gulls within each Zone during 1976. See Figure 17 for details.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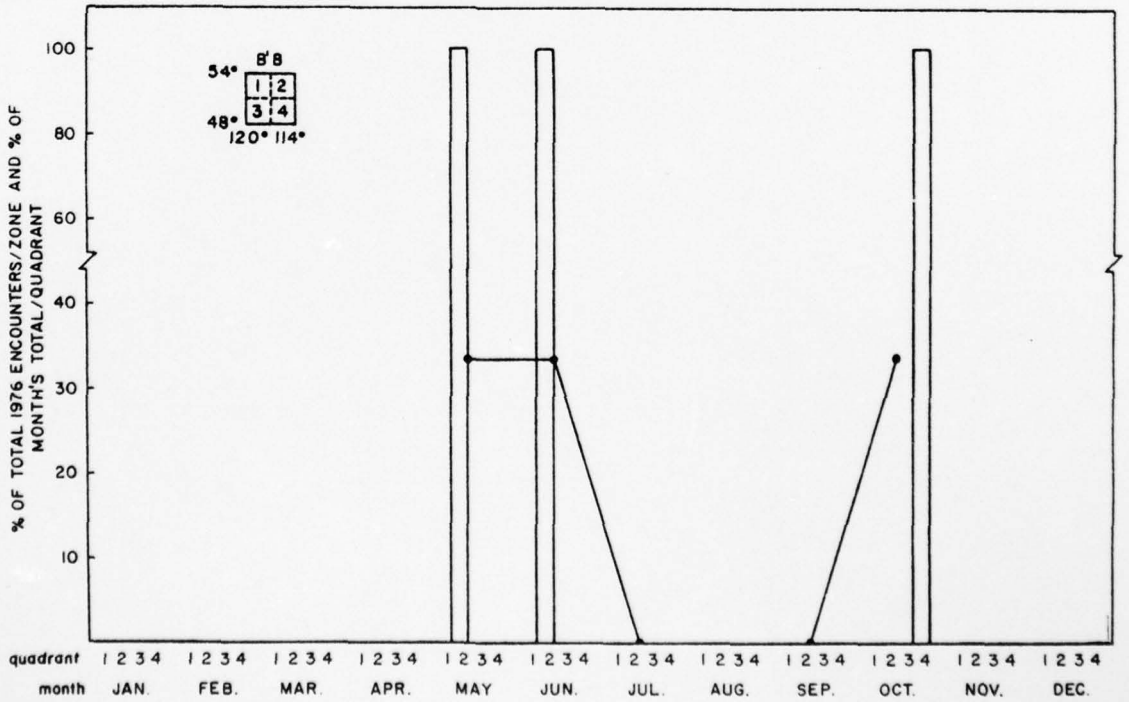
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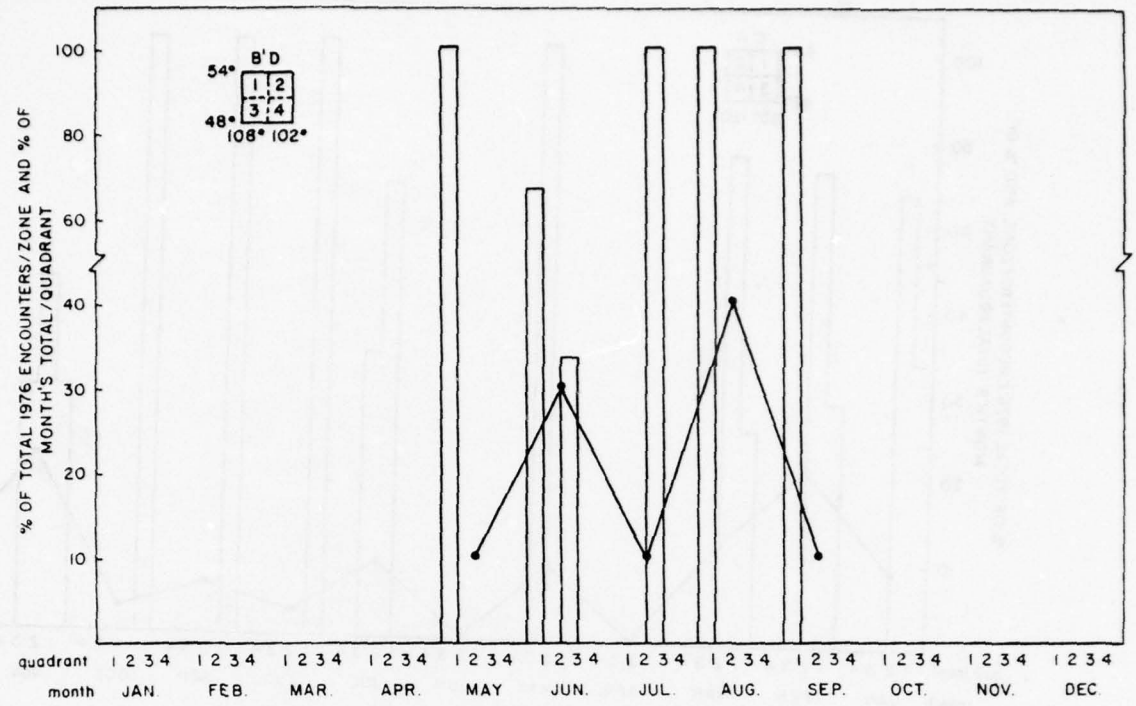
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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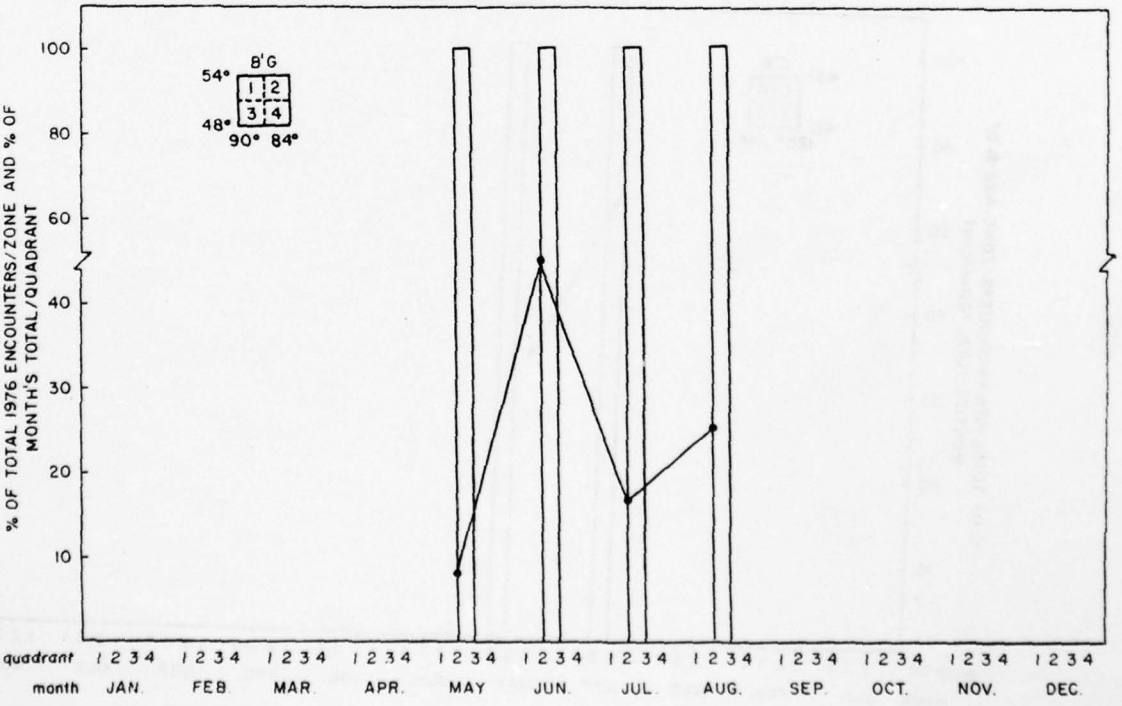
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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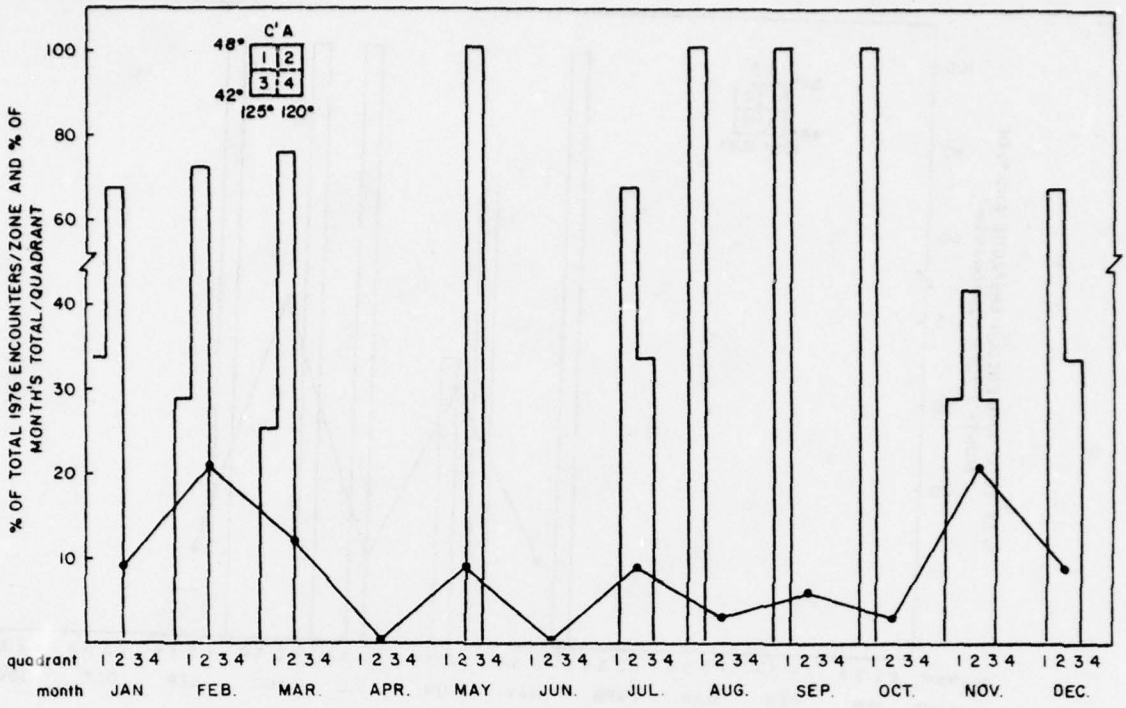
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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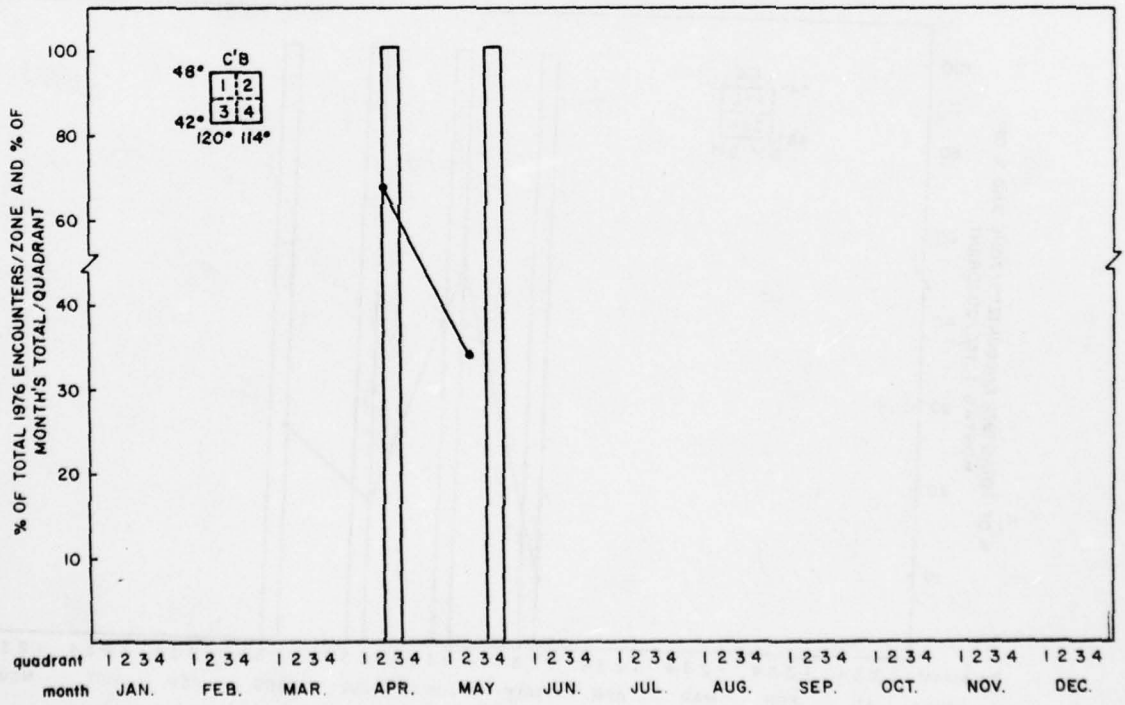
month JAN FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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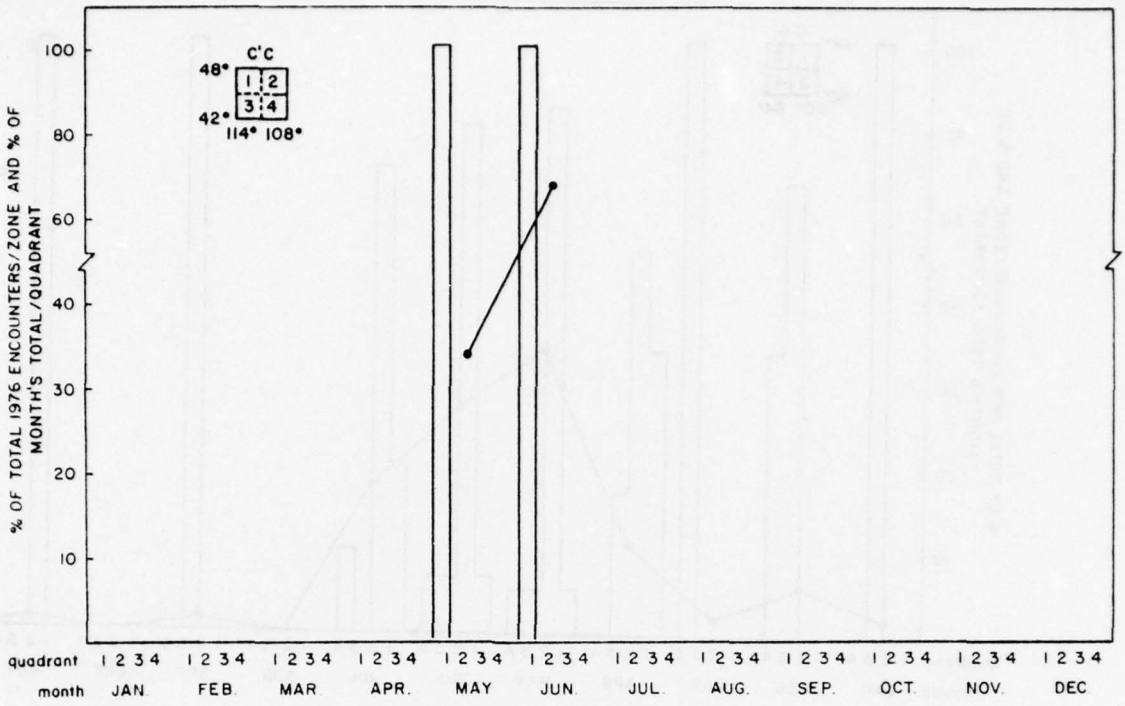
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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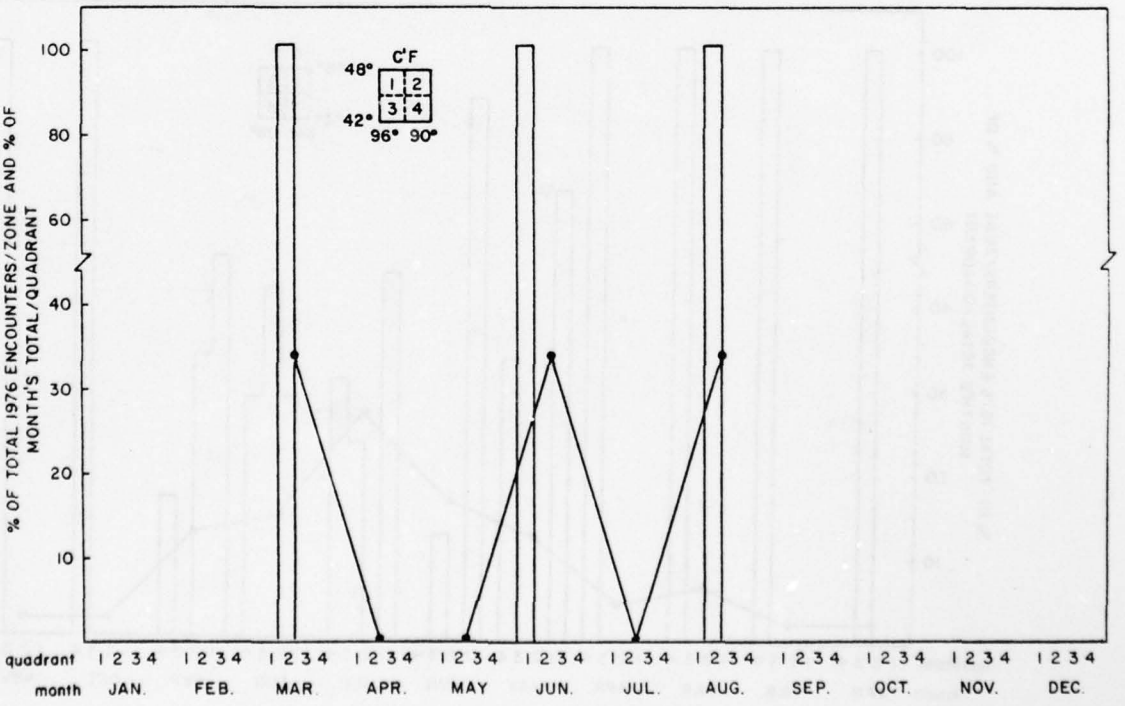
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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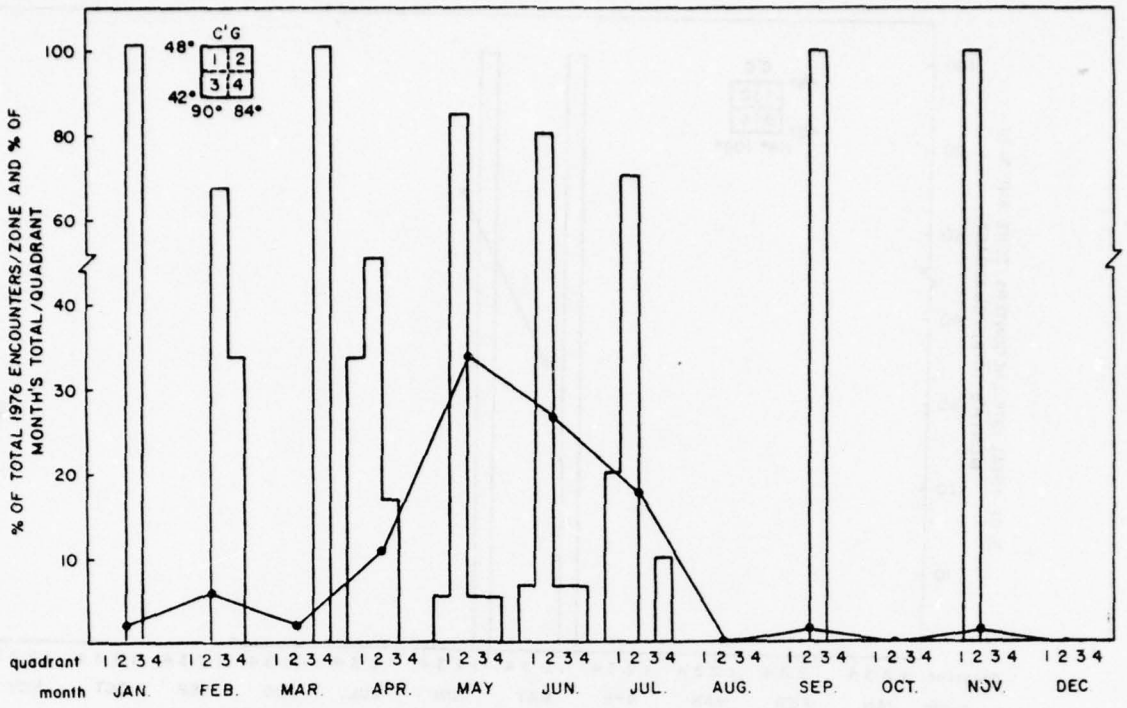
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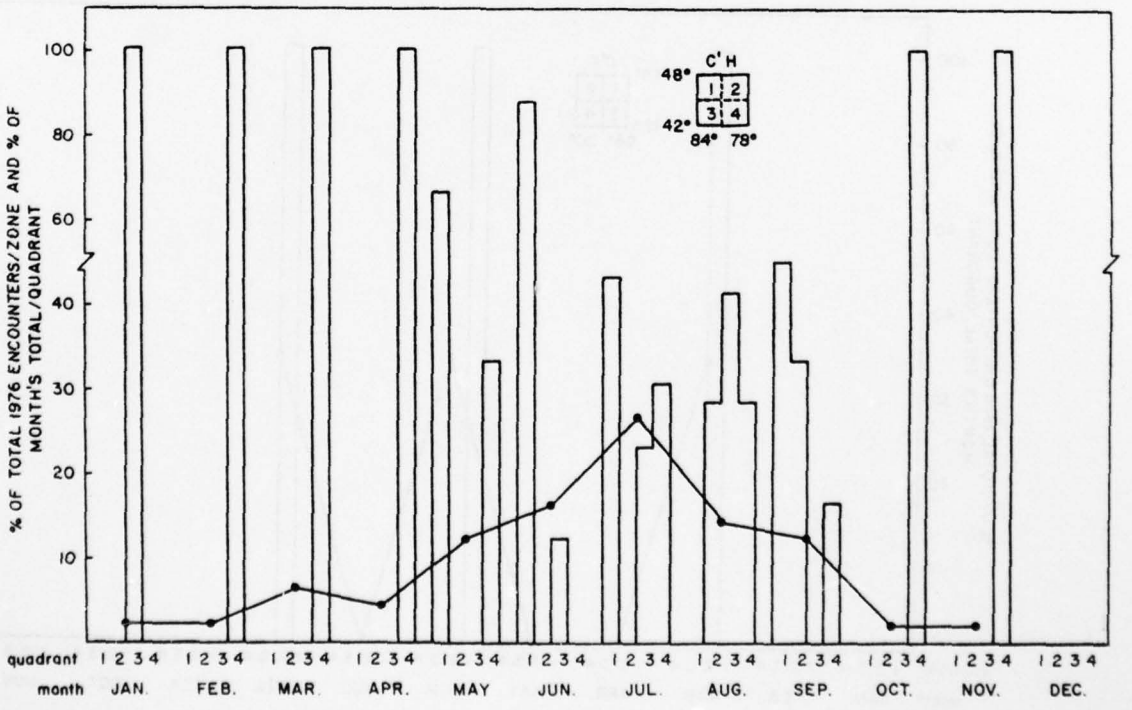
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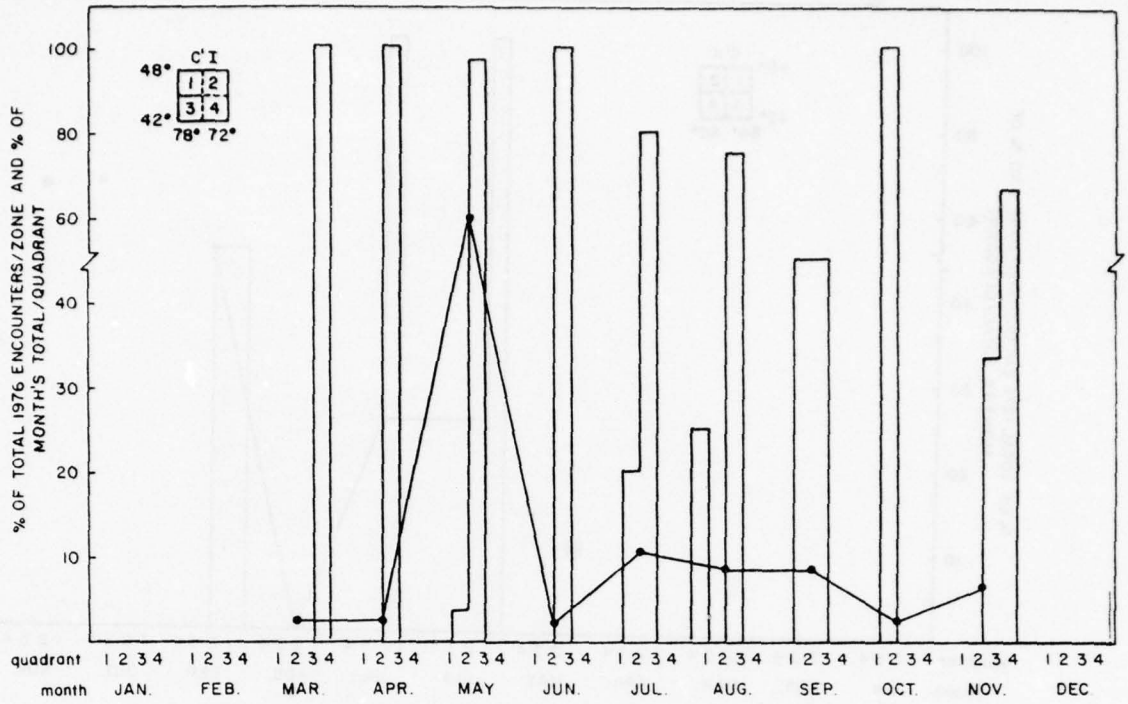
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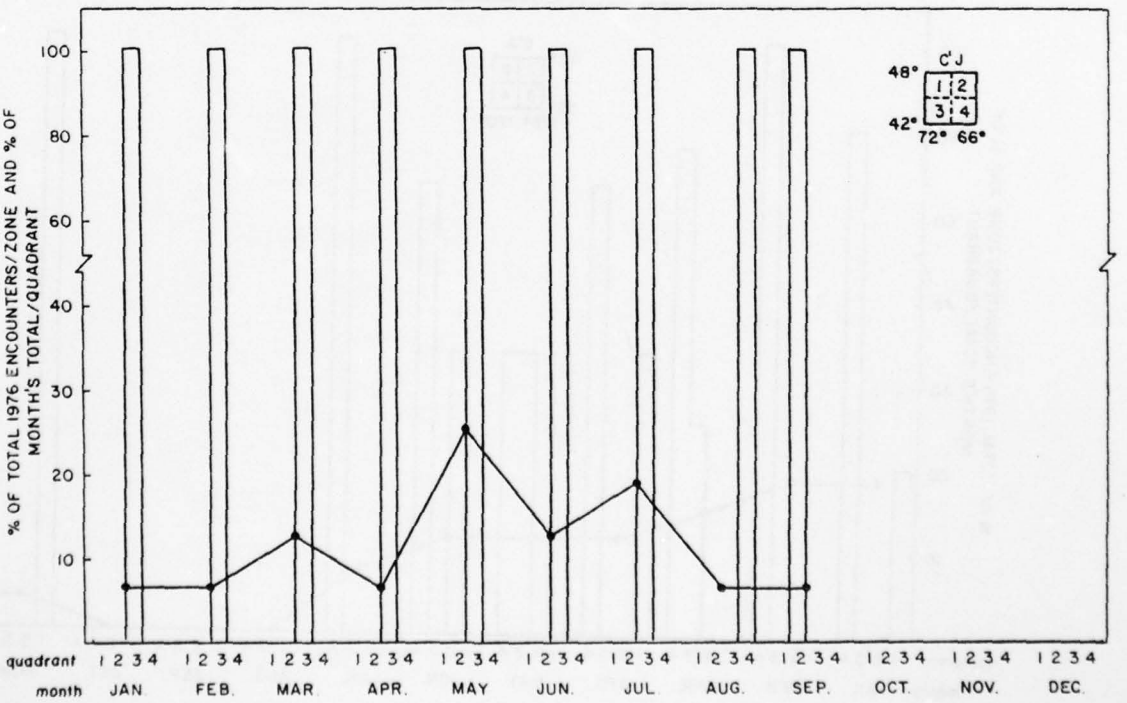
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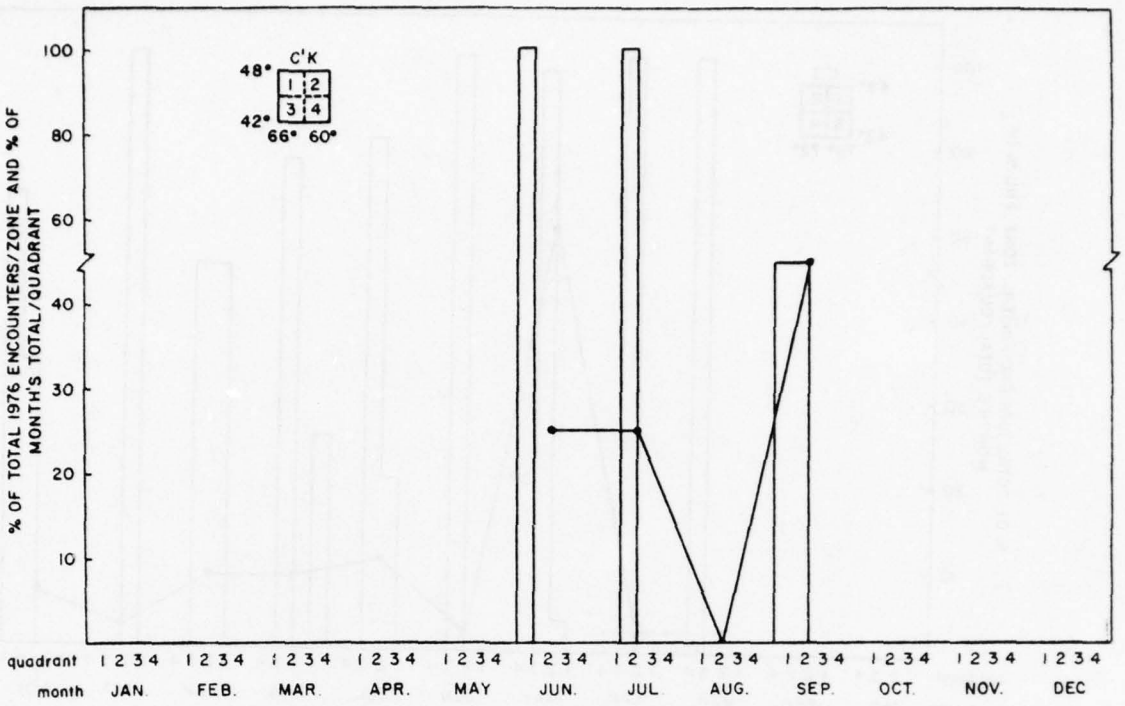
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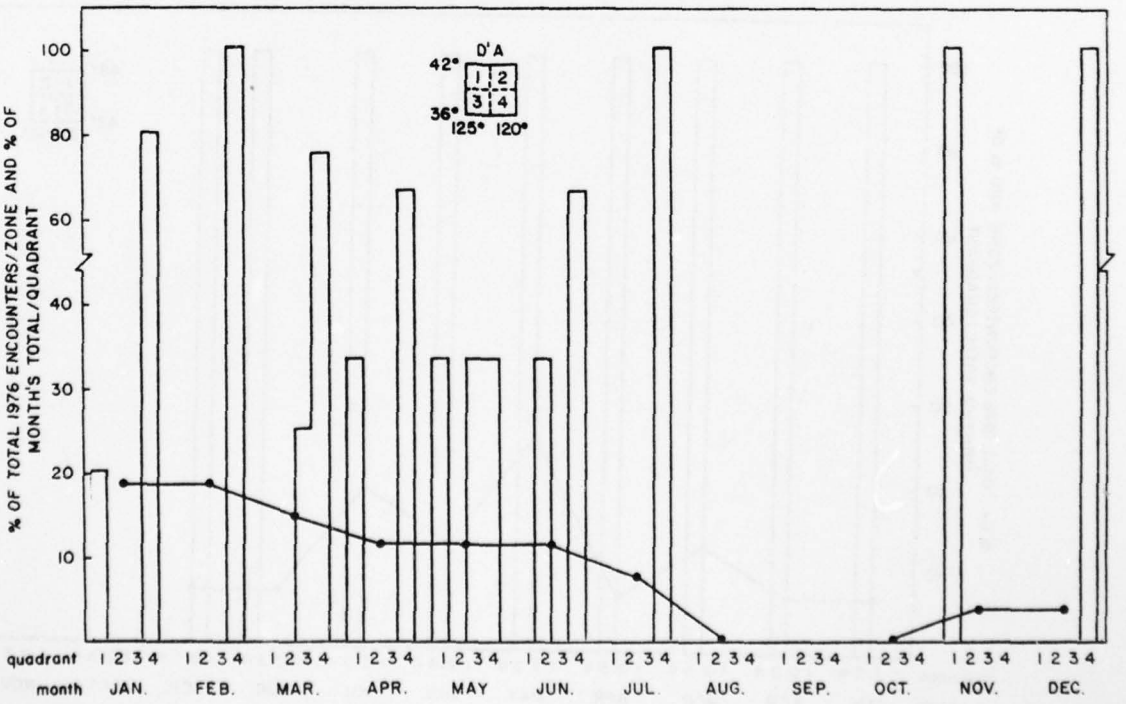
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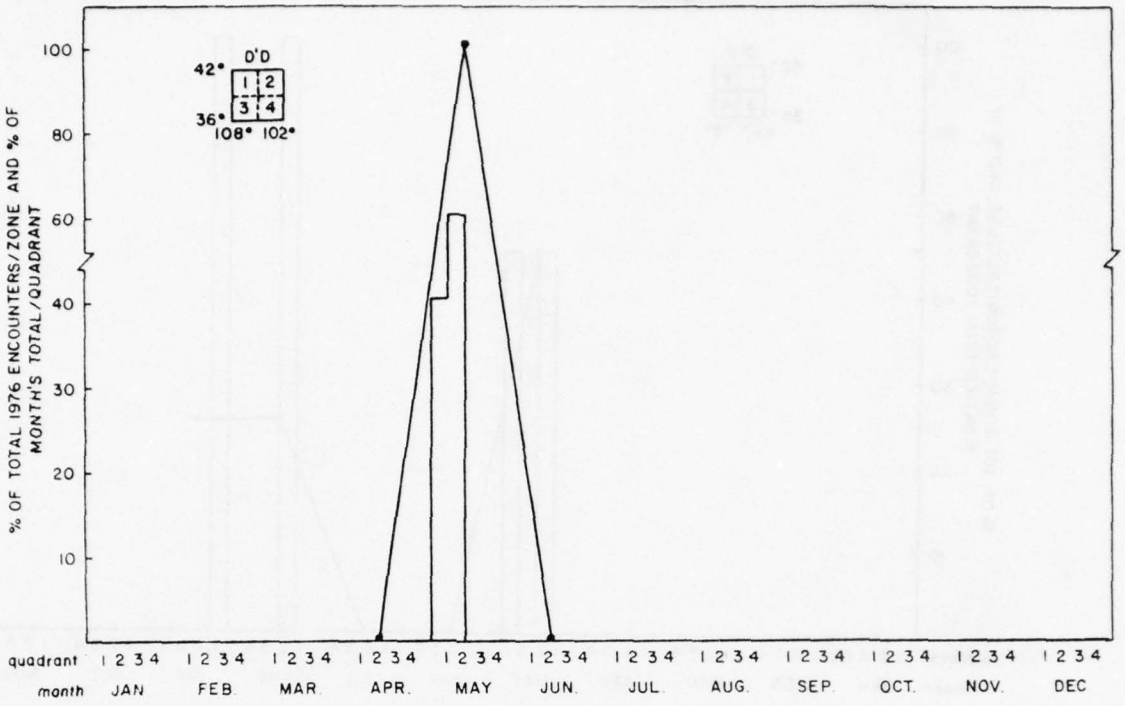
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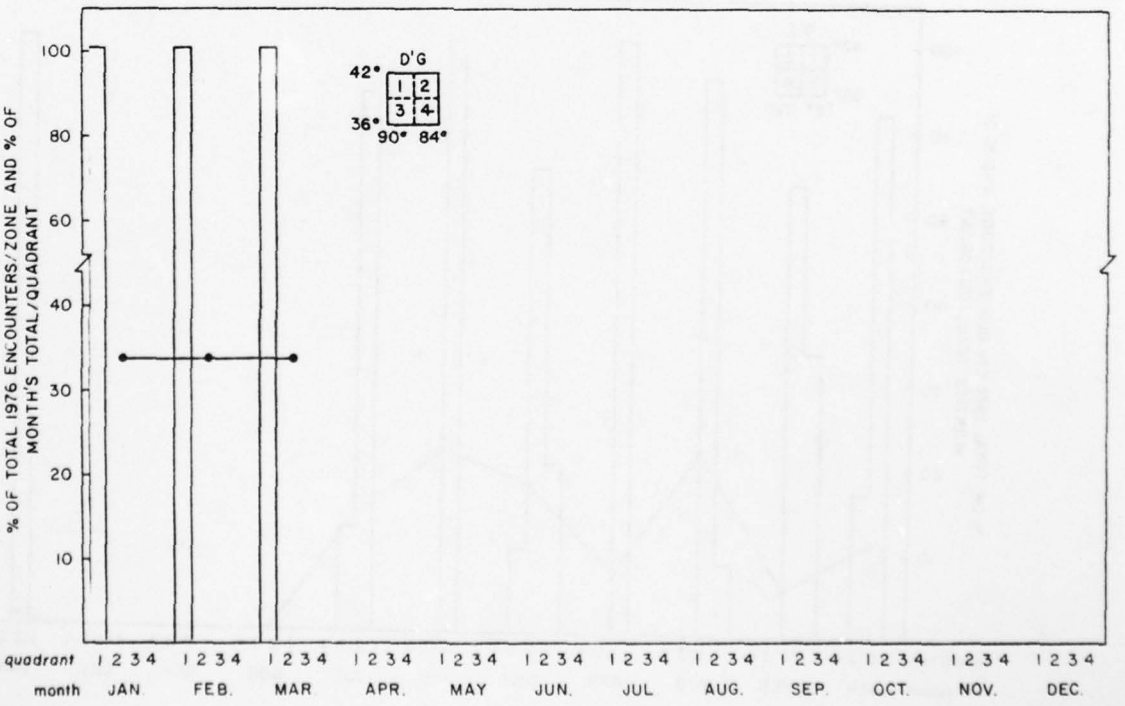
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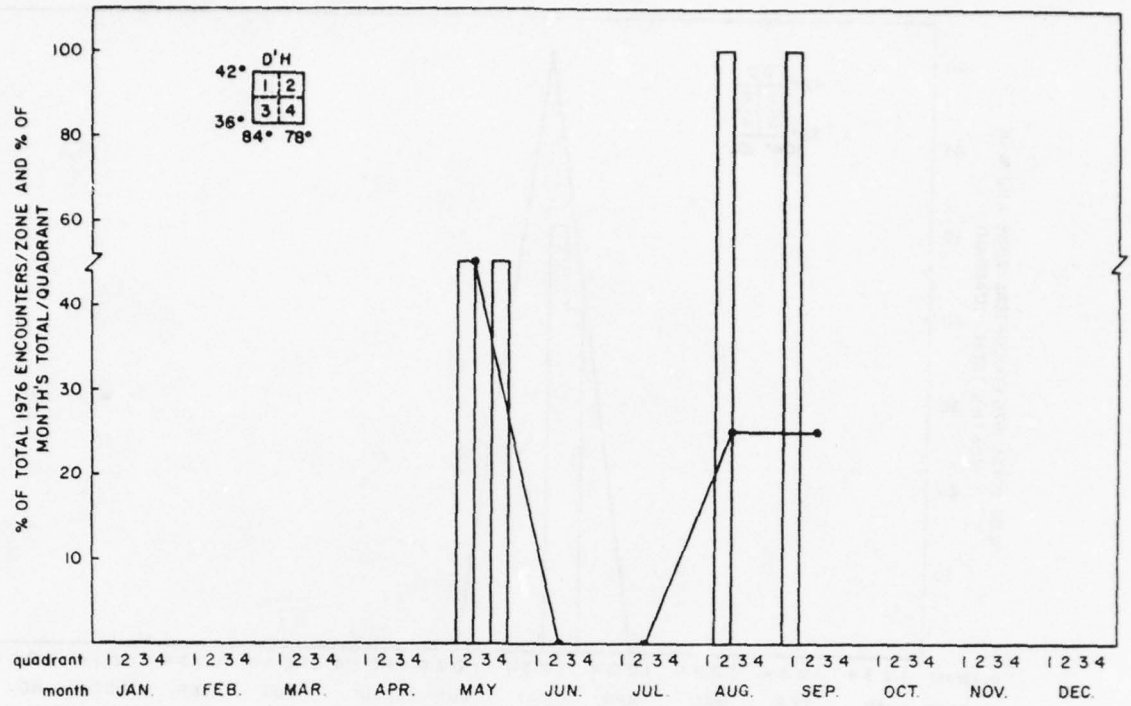
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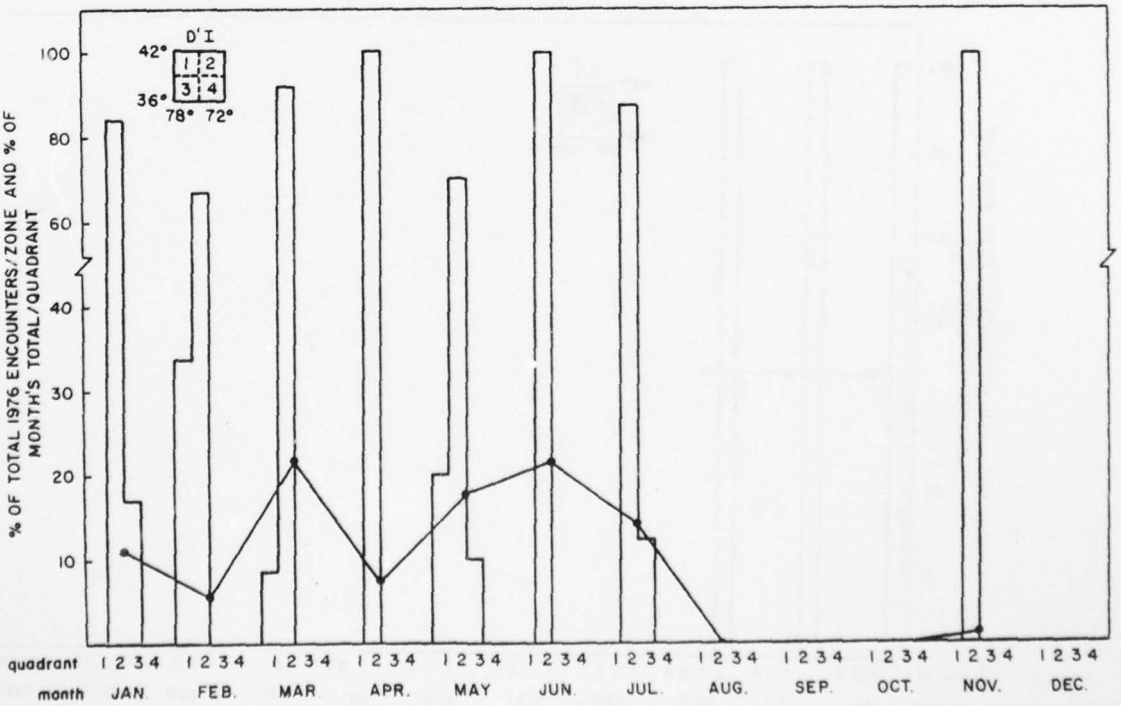
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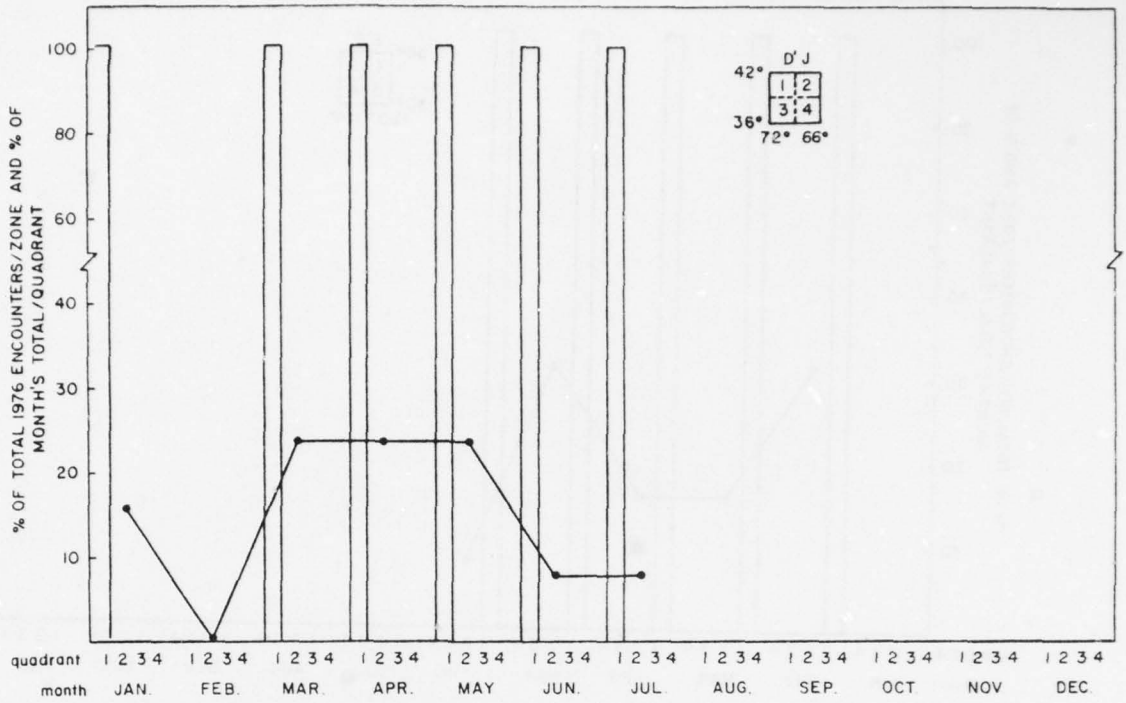
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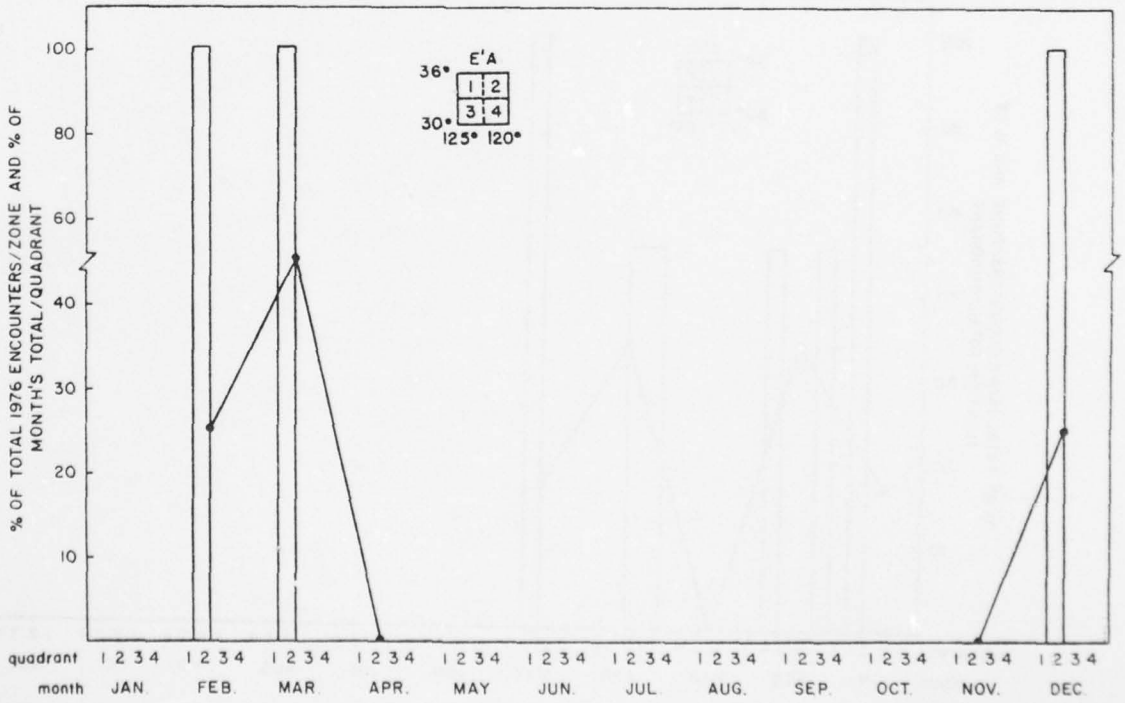
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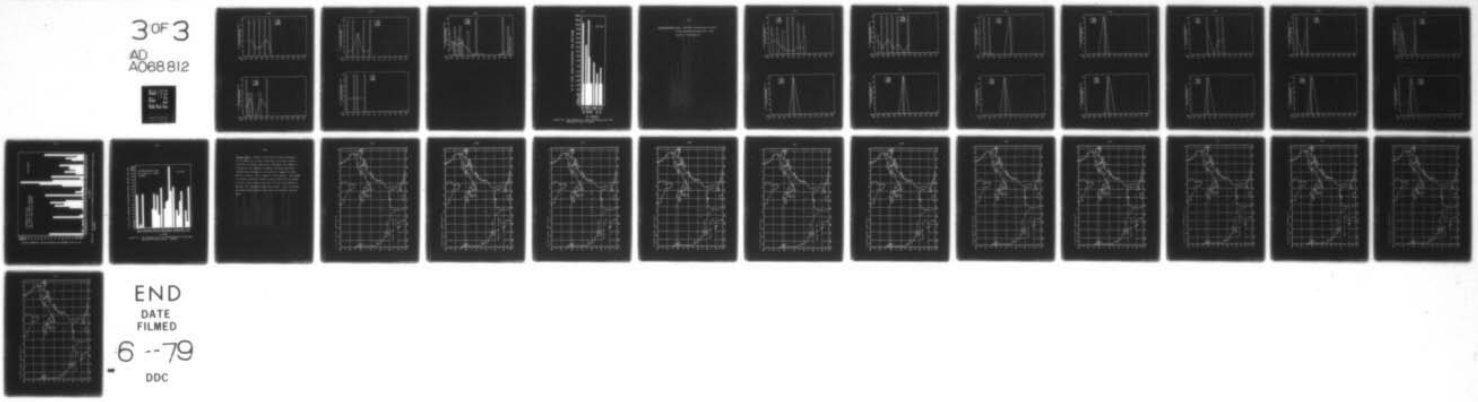

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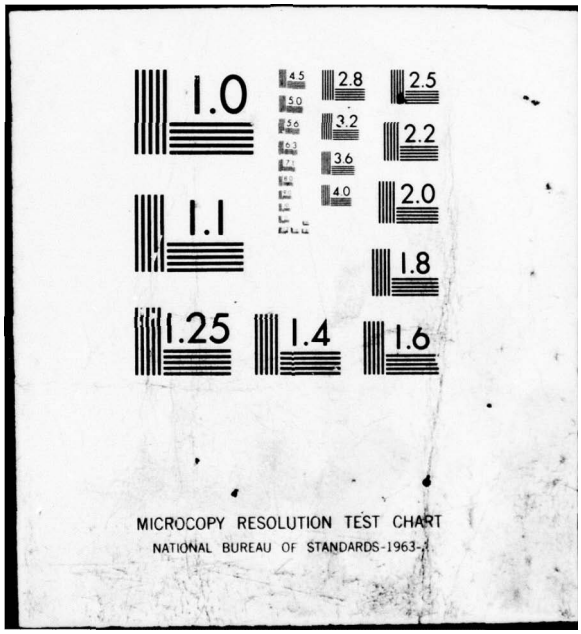
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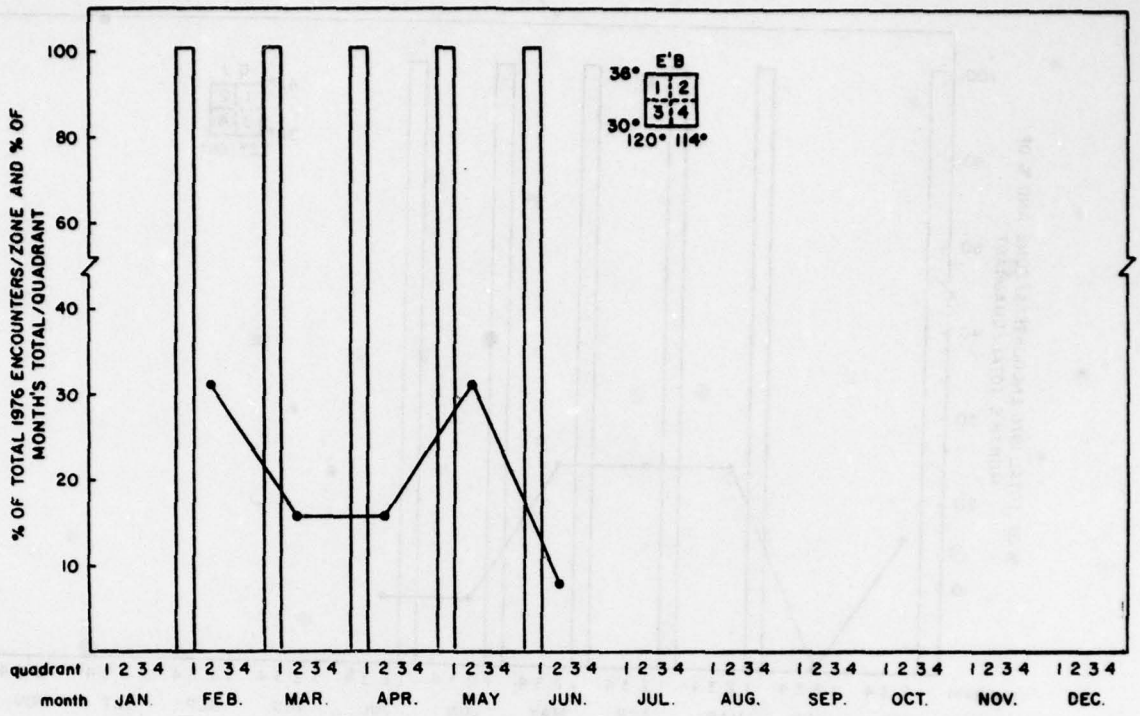
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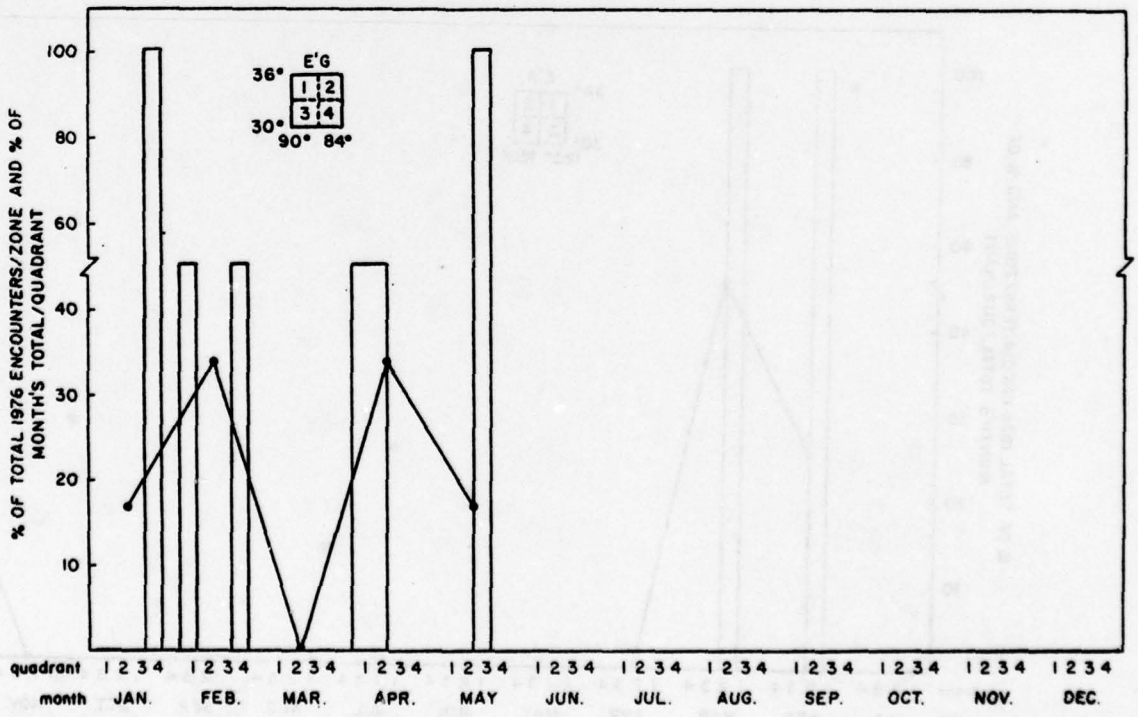
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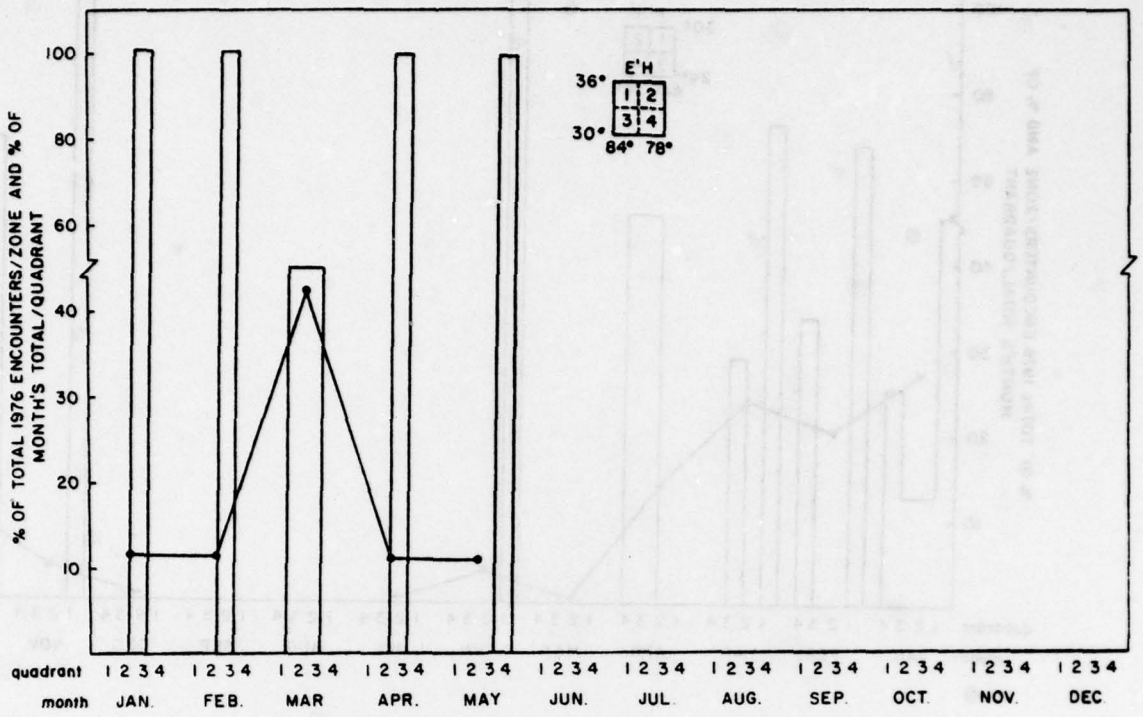
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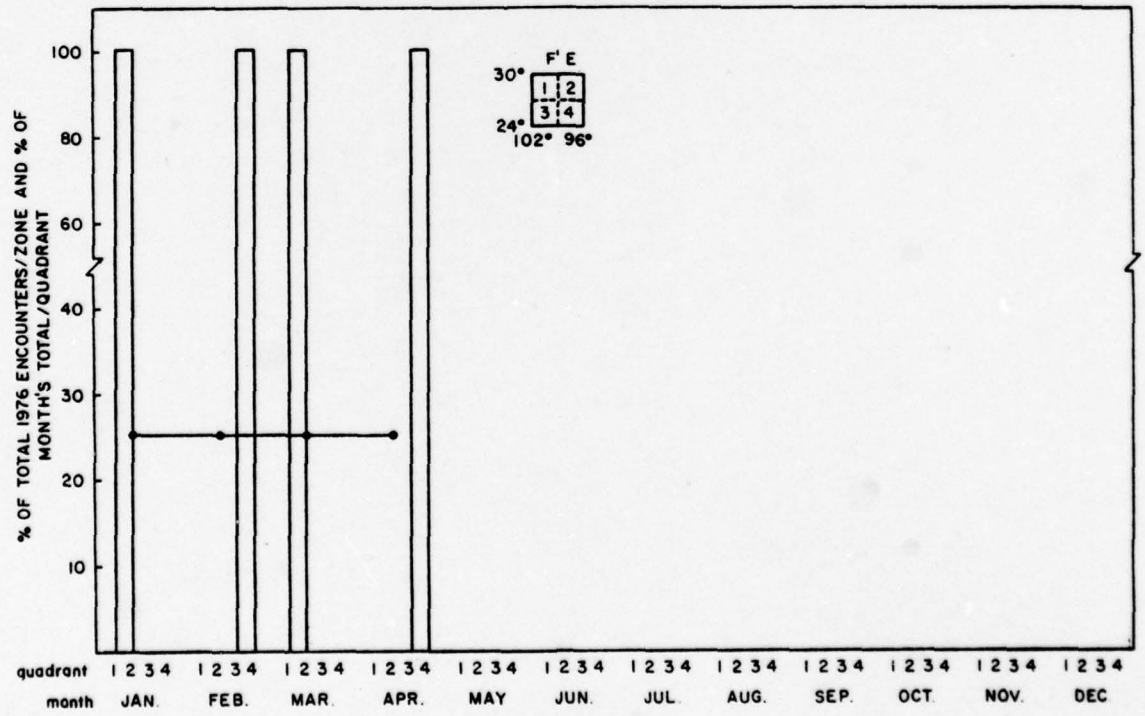
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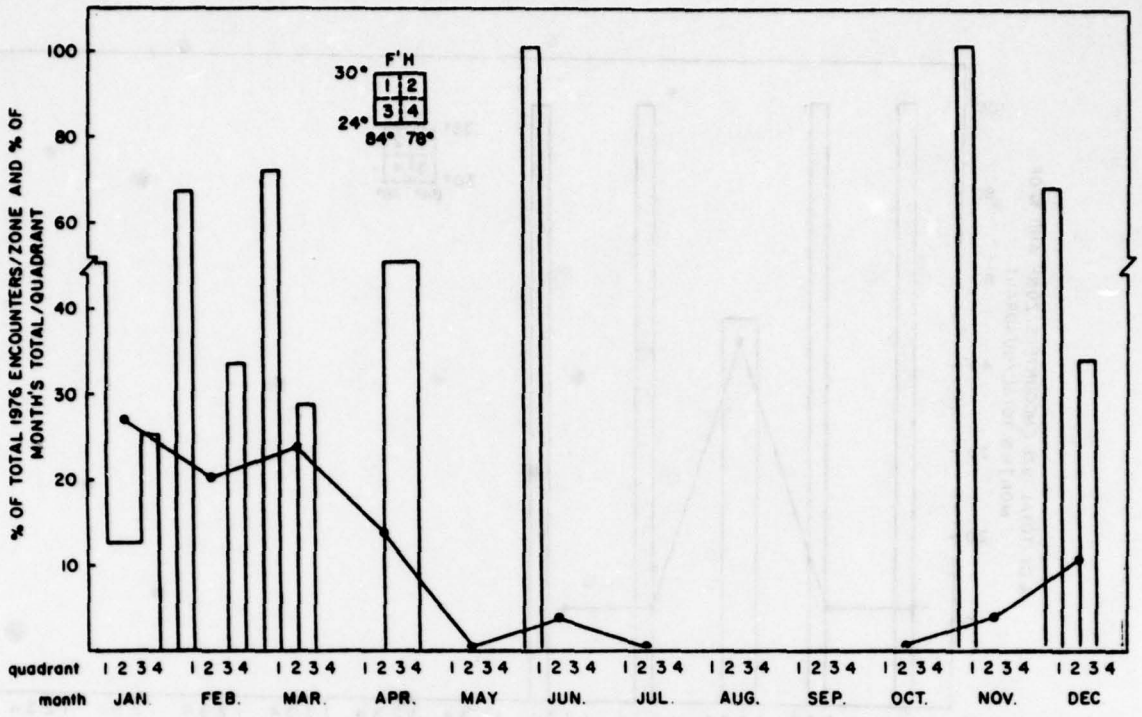
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC

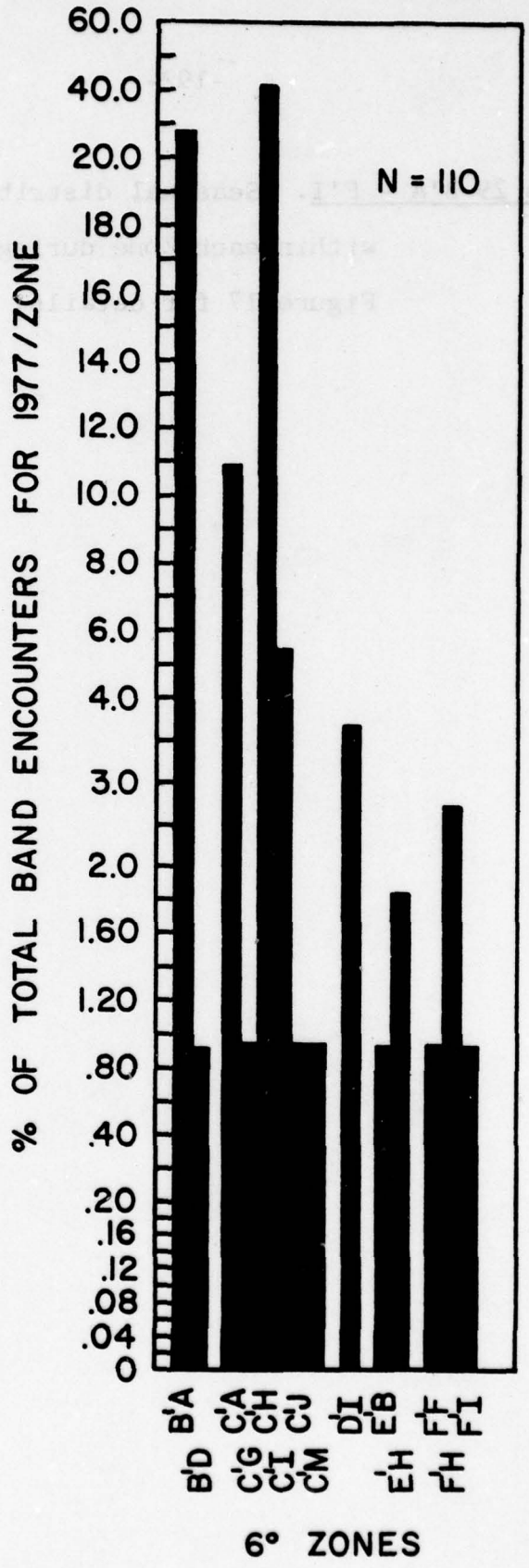
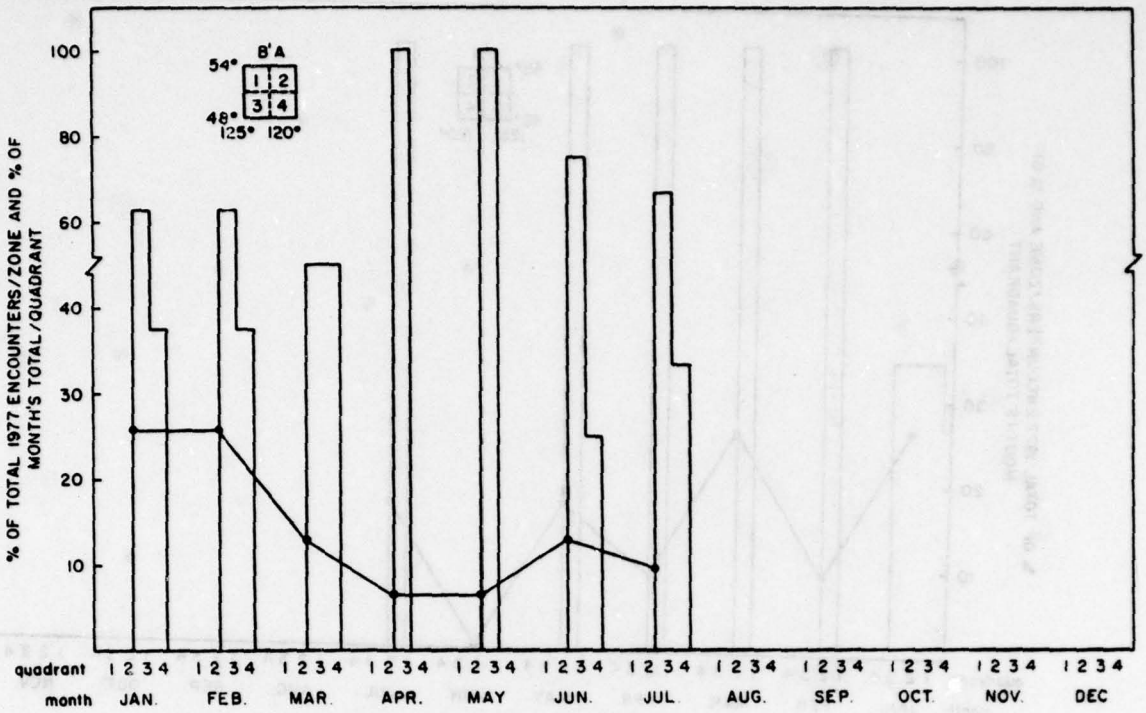


Figure 28. The Proportion of Band Recoveries for 1977 Reported in Each 6° Zone.

Figures 29 B'A - F'I. Seasonal distribution of gulls within each Zone during 1977. See Figure 17 for details.


B'A
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% OF TOTAL 1977 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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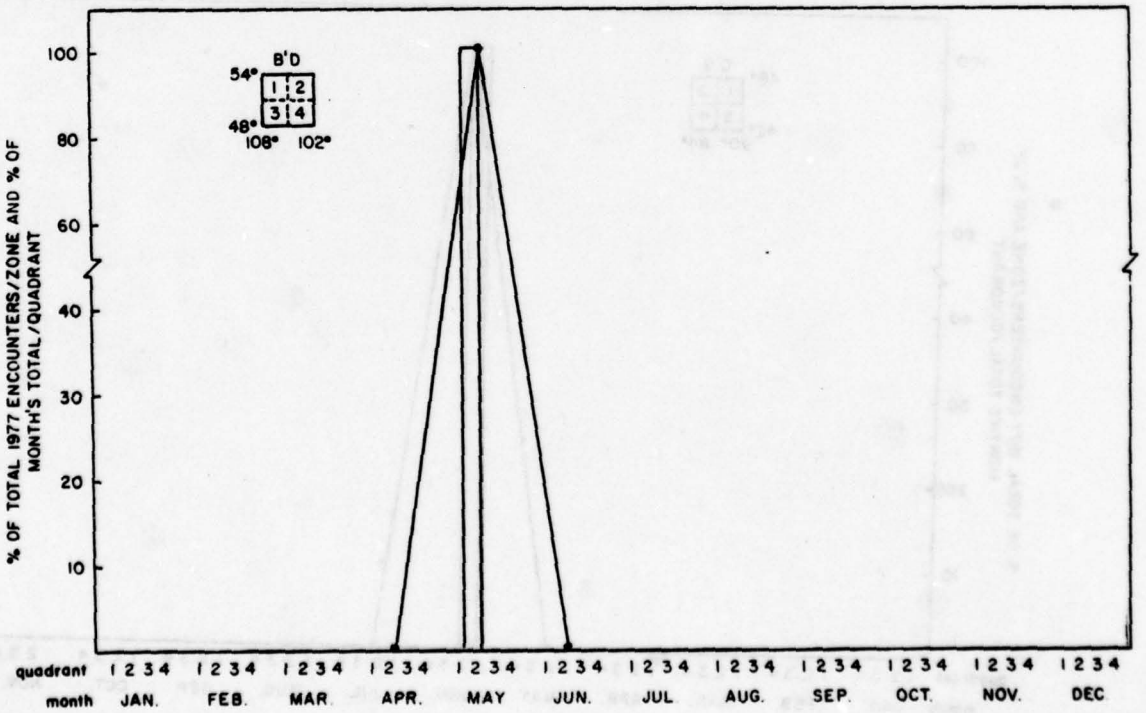
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC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% OF TOTAL 1977 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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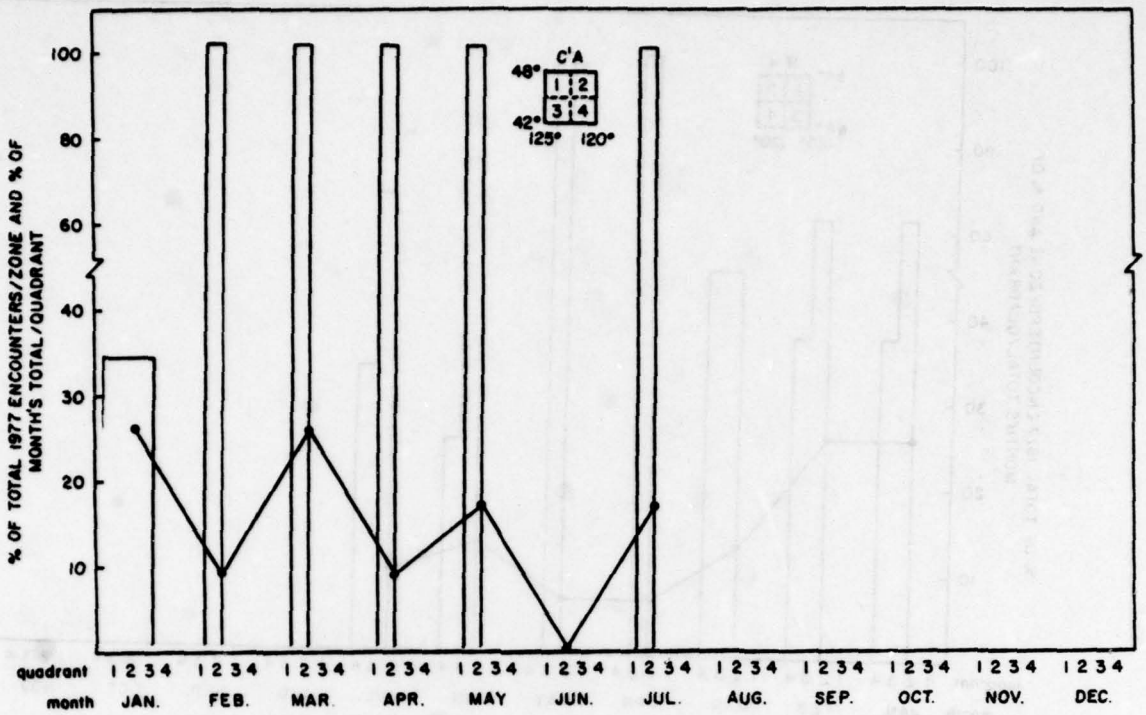
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC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% OF TOTAL 1977 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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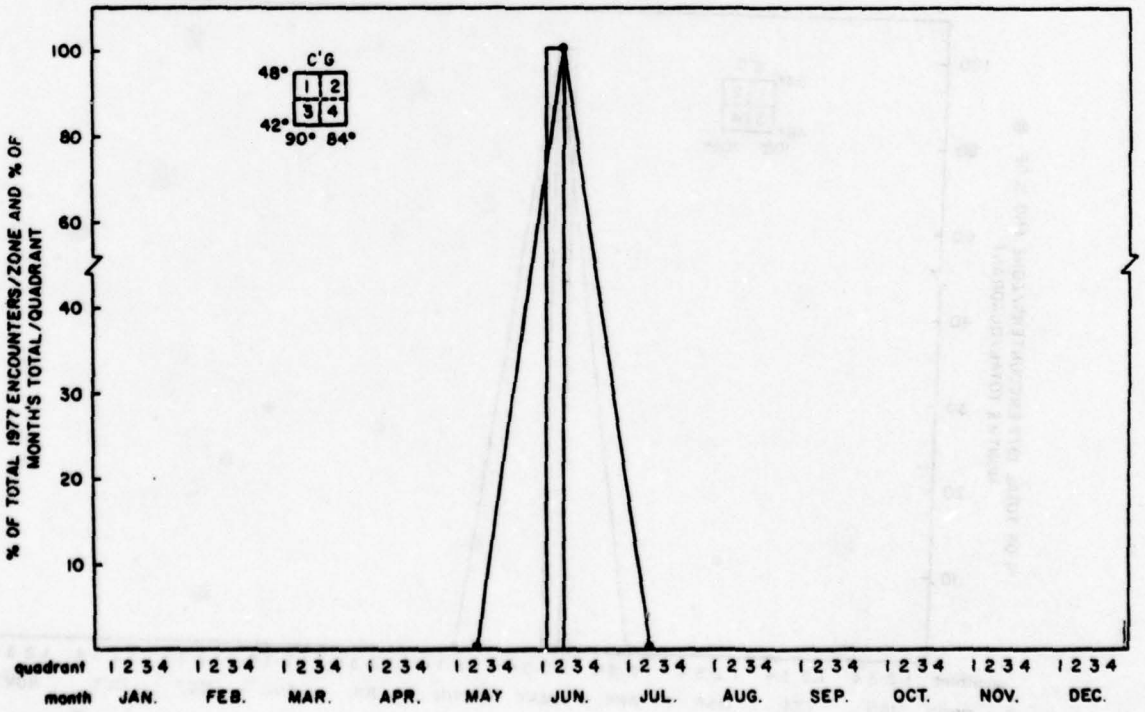
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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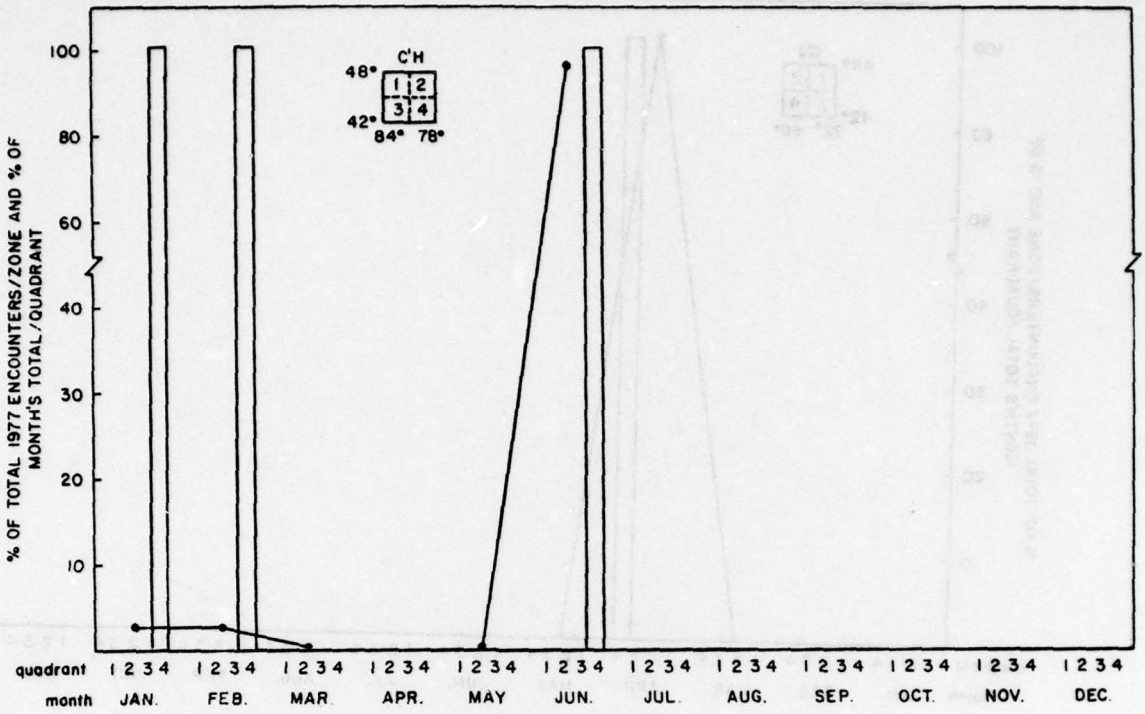
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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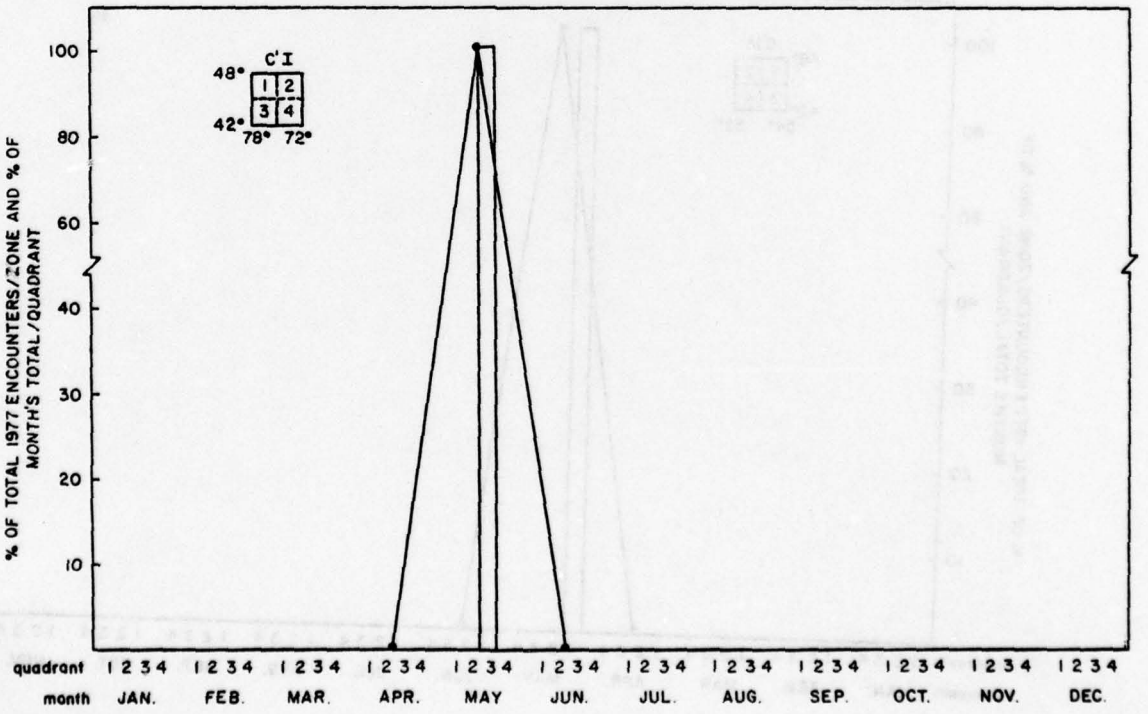
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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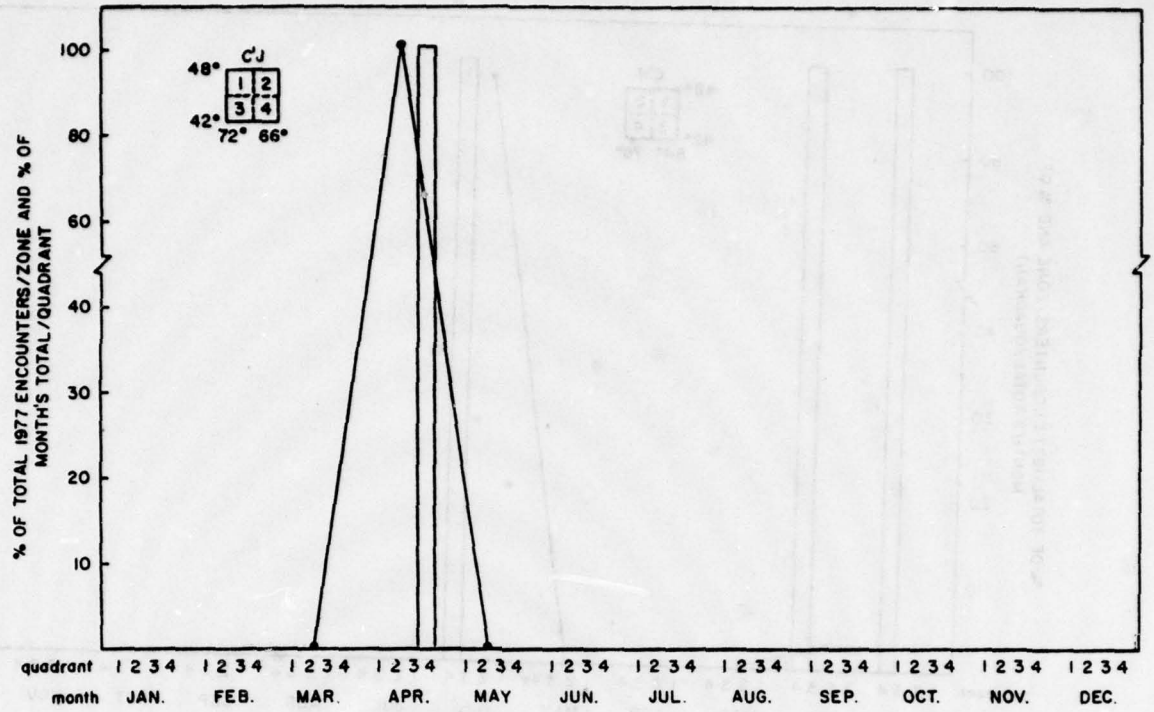
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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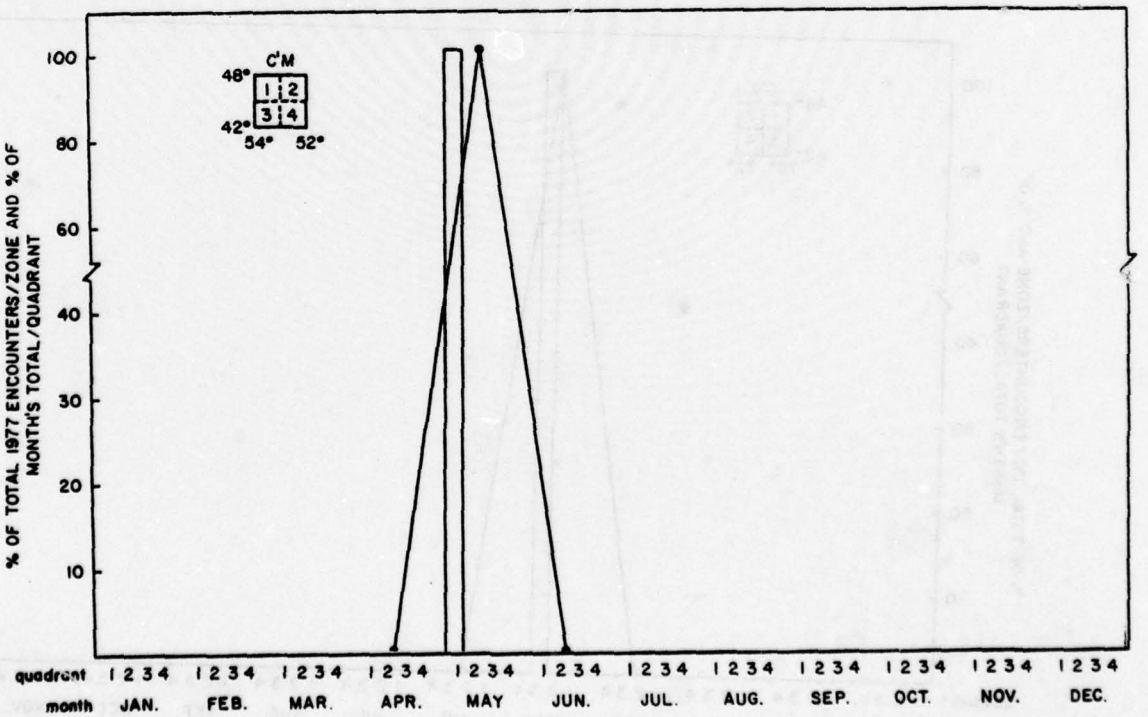
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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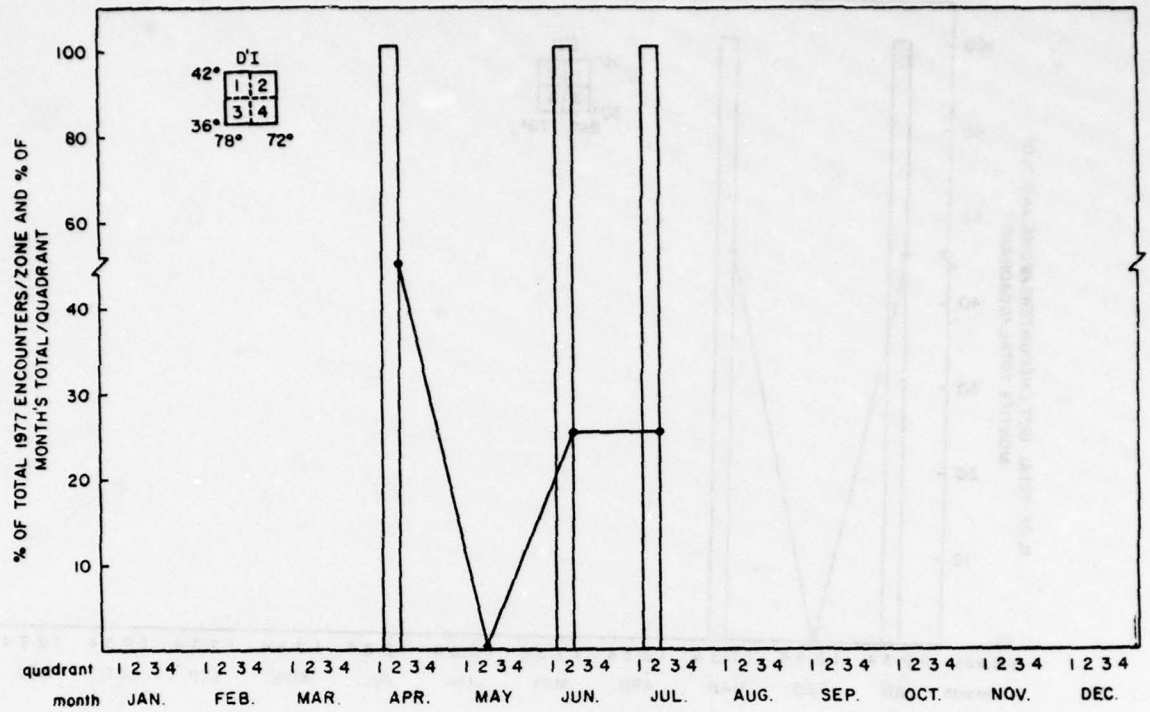
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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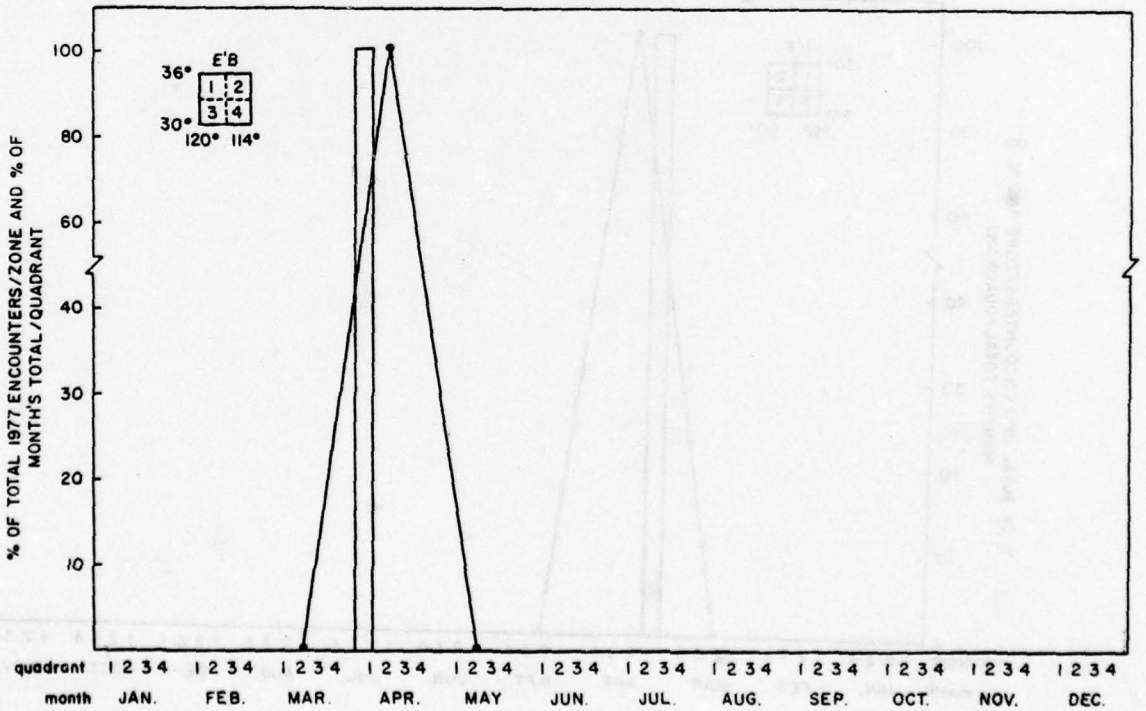
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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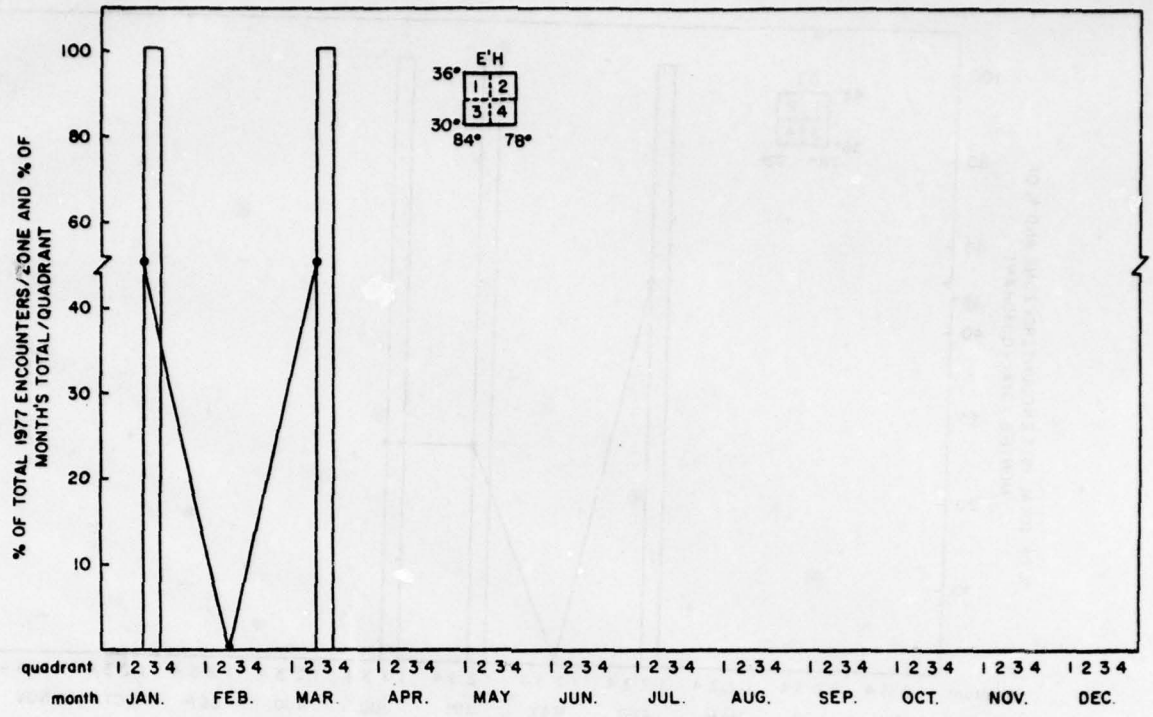
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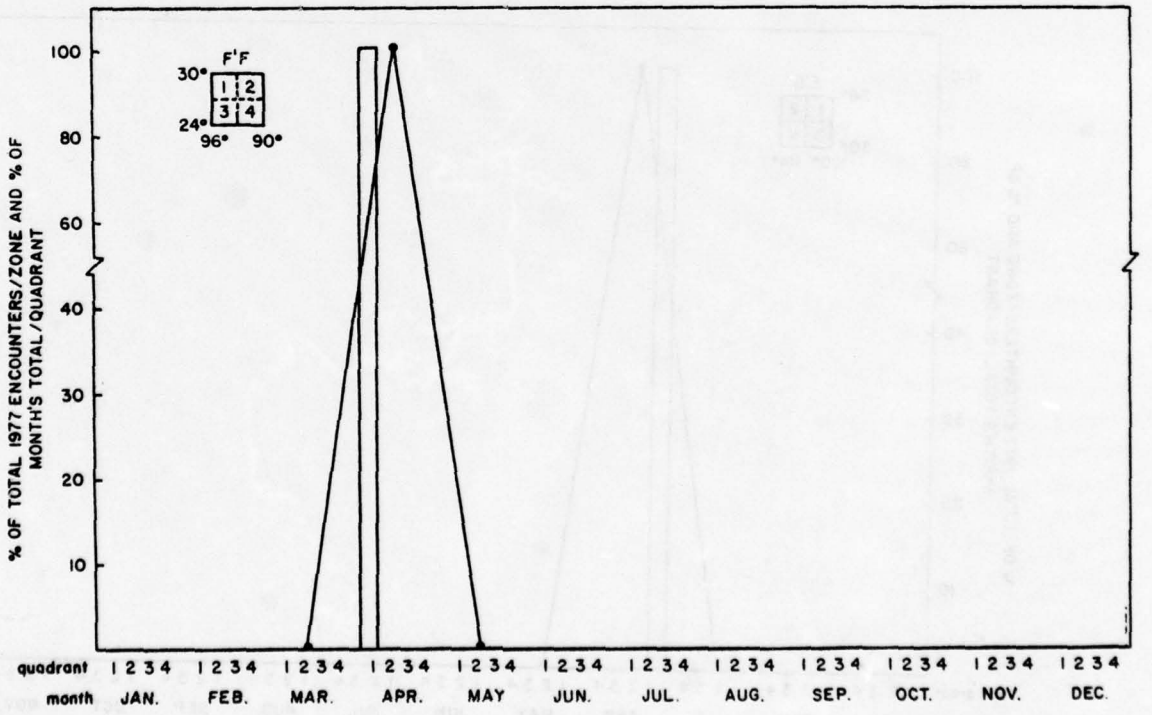
month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.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% OF TOTAL 1977 ENCOUNTERS/ZONE AND % OF MONTH'S TOTAL/QUADRANT
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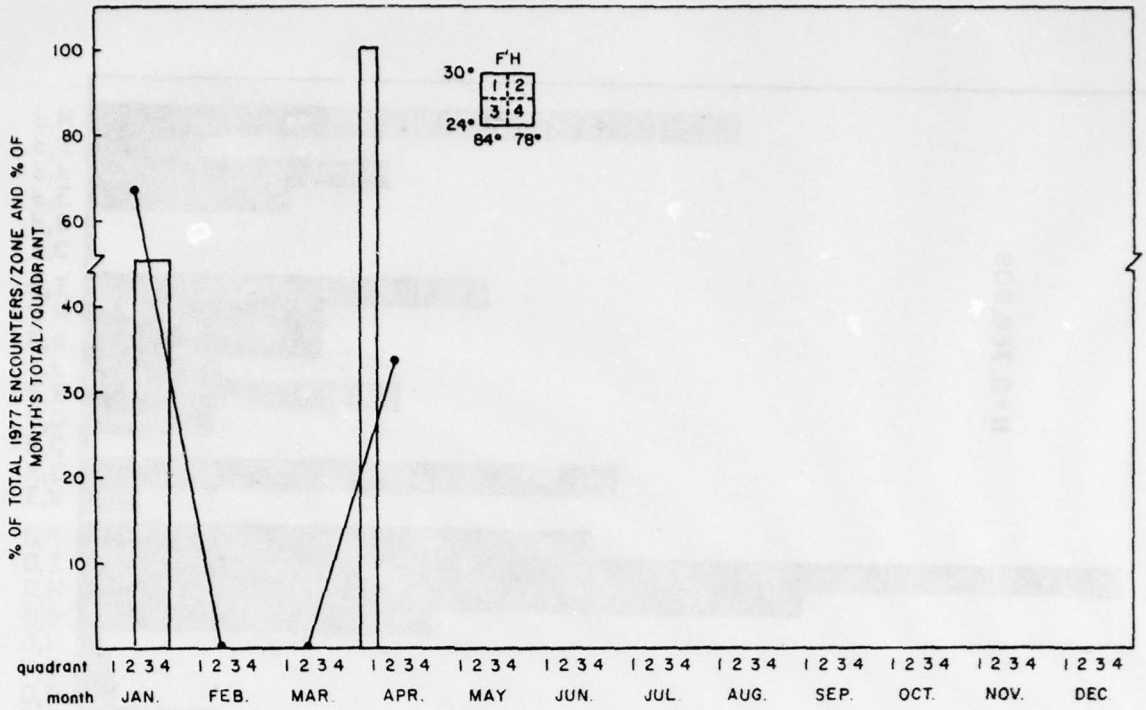
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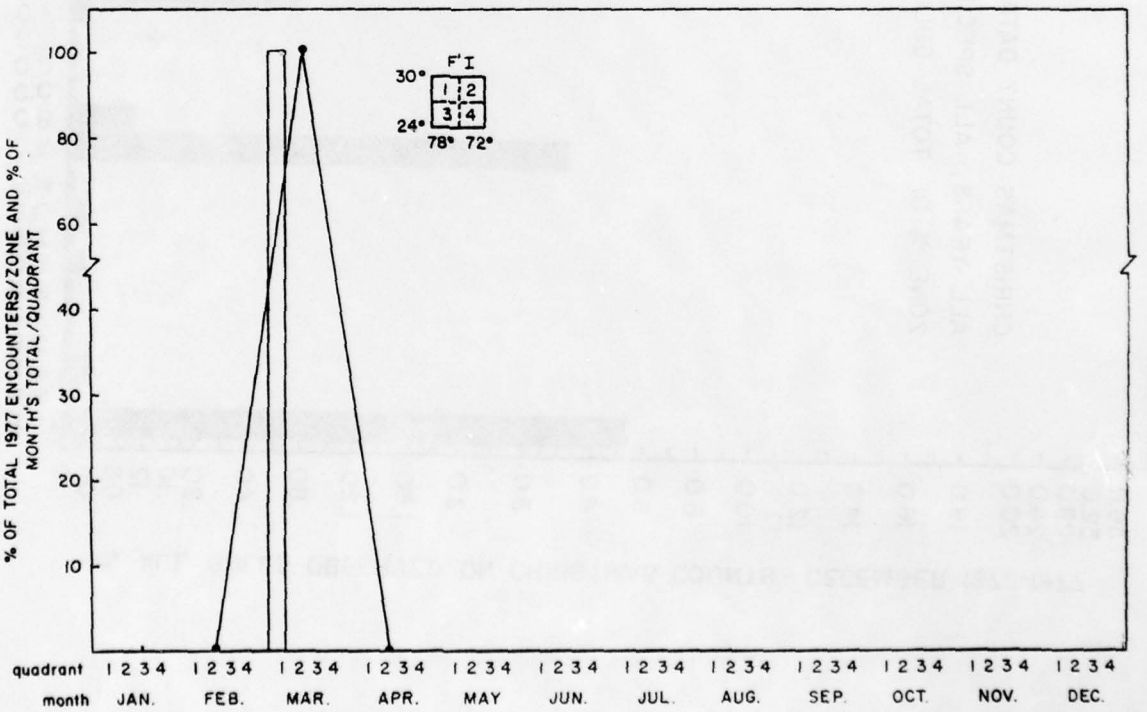
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month JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

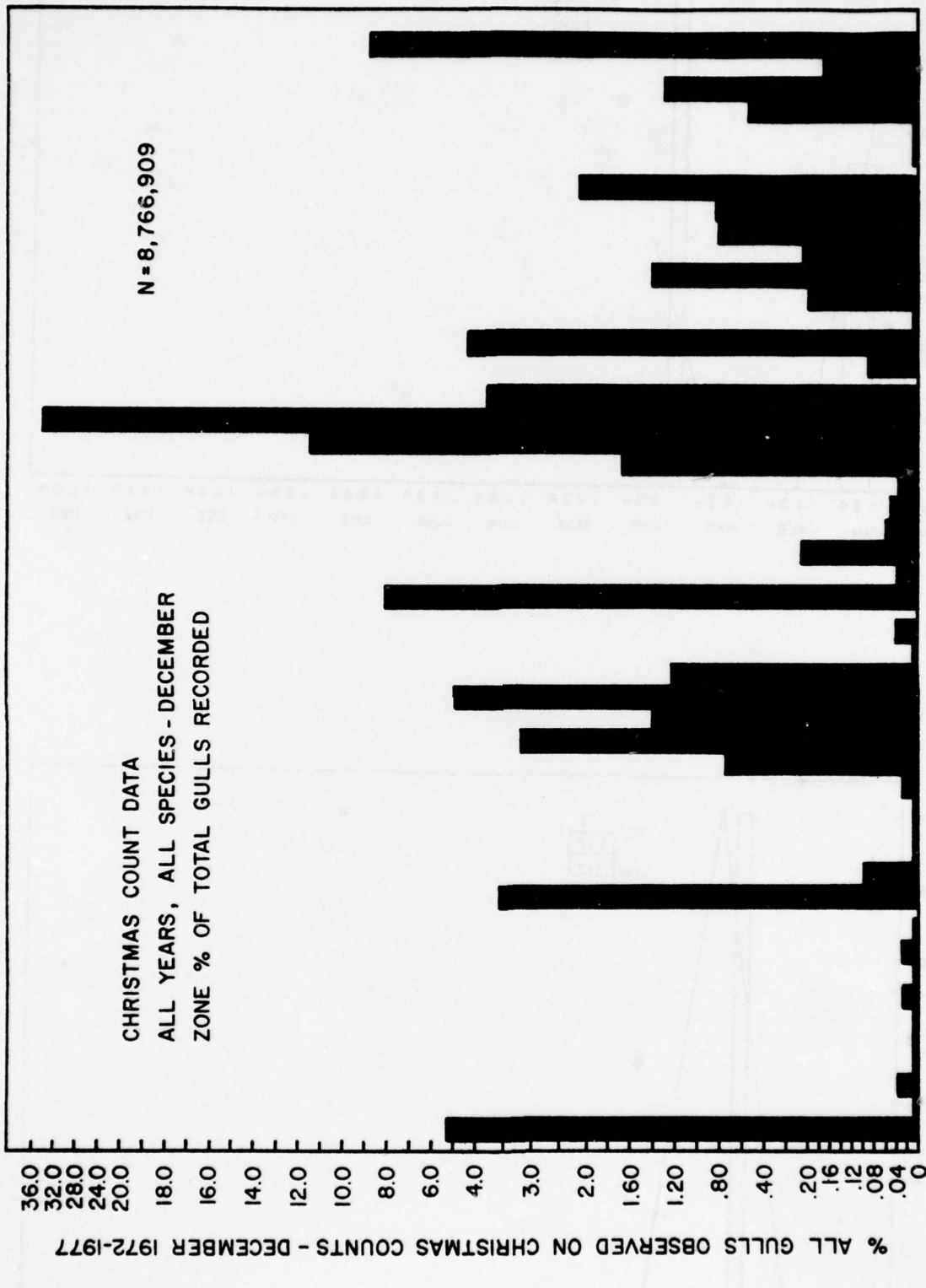

Figure 30. The Proportion of All Christmas Bird Count Data Reported From Each Zone. December.

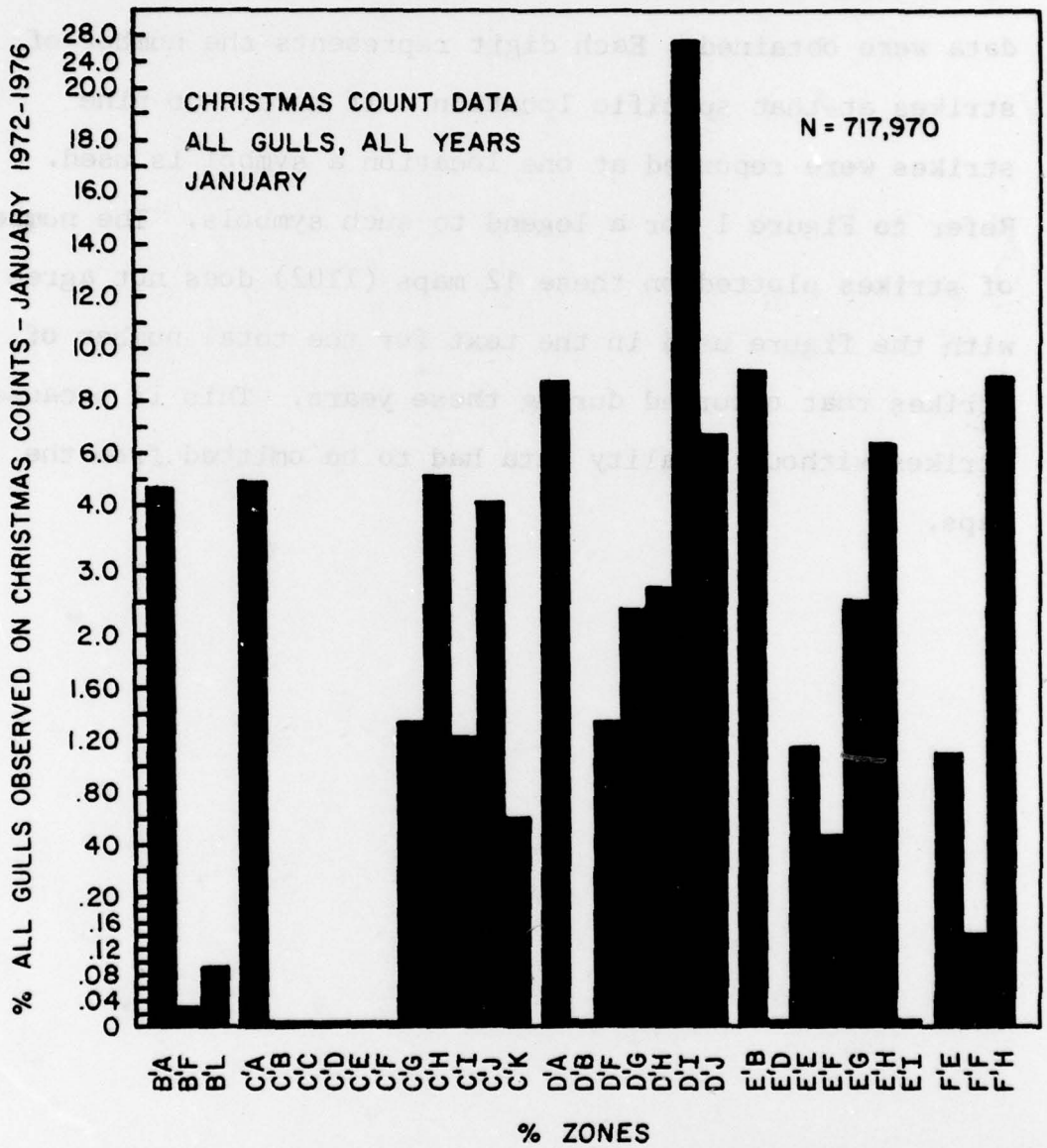

Figure 31. The Proportion of All Christmas Bird Count Data Reported From Each Zone. January.

Figures 32A-L. Monthly distribution (January-December) of all USAF bird strikes, 1974-1977, for which locality data were obtained. Each digit represents the number of strikes at that specific location. If more than nine strikes were reported at one location a symbol is used. Refer to Figure 1 for a legend to such symbols. The number of strikes plotted on these 12 maps (1102) does not agree with the figure used in the text for the total number of strikes that occurred during these years. This is because strikes without locality data had to be omitted from the maps.

All Strikes by Month - JANUARY 1974-1977

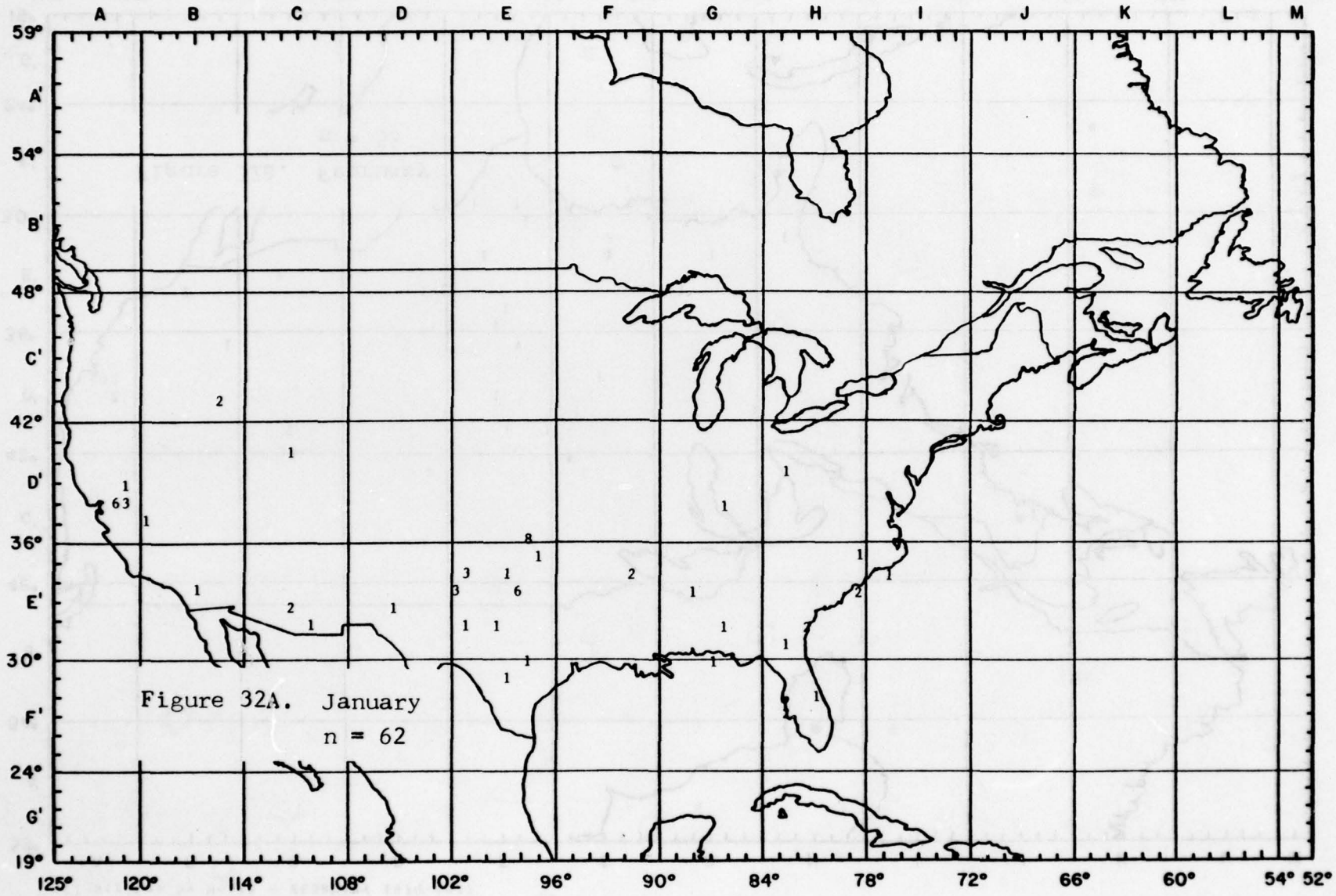

Figure 32A. January
n = 62

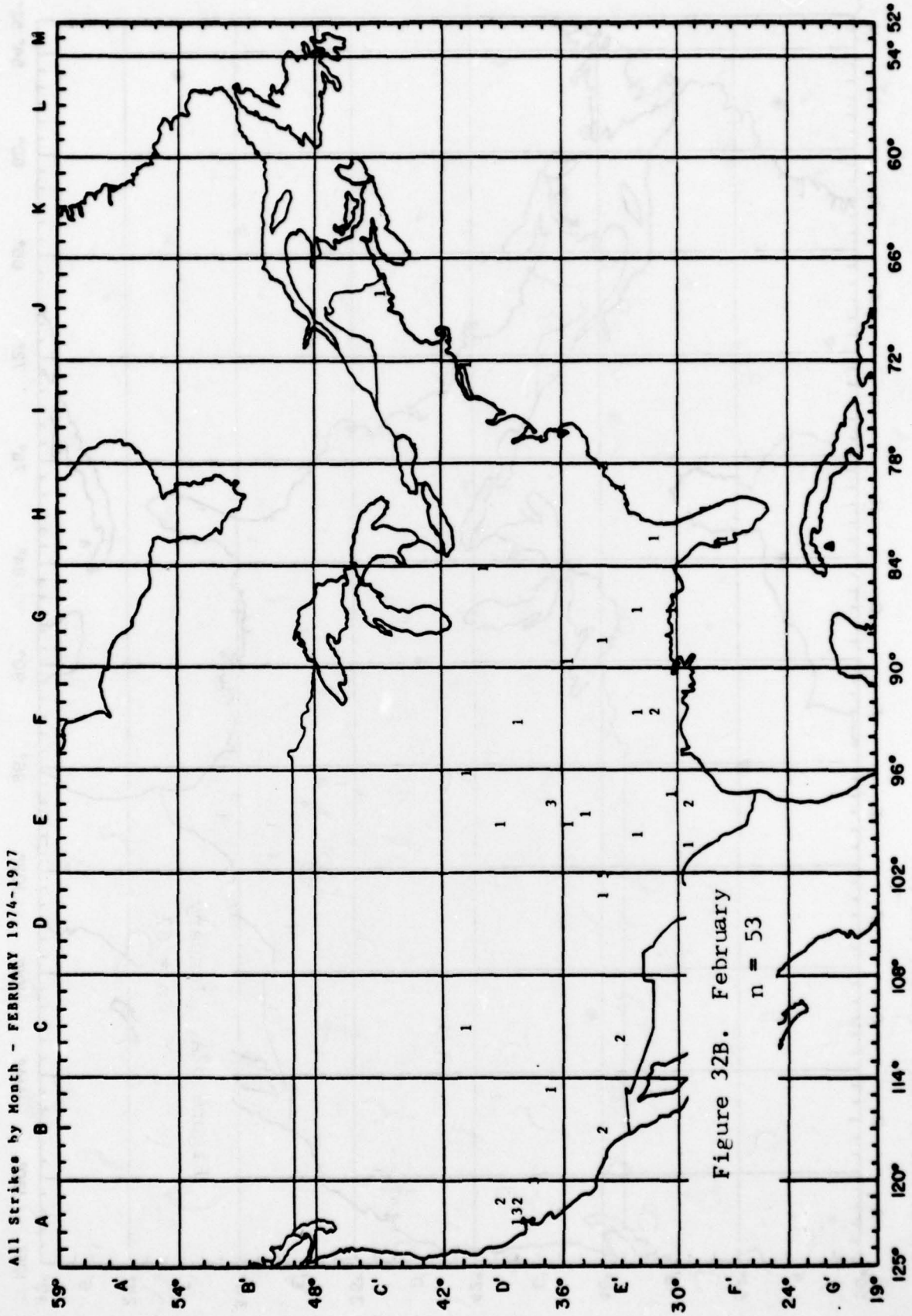

Figure 32B. February
n = 53

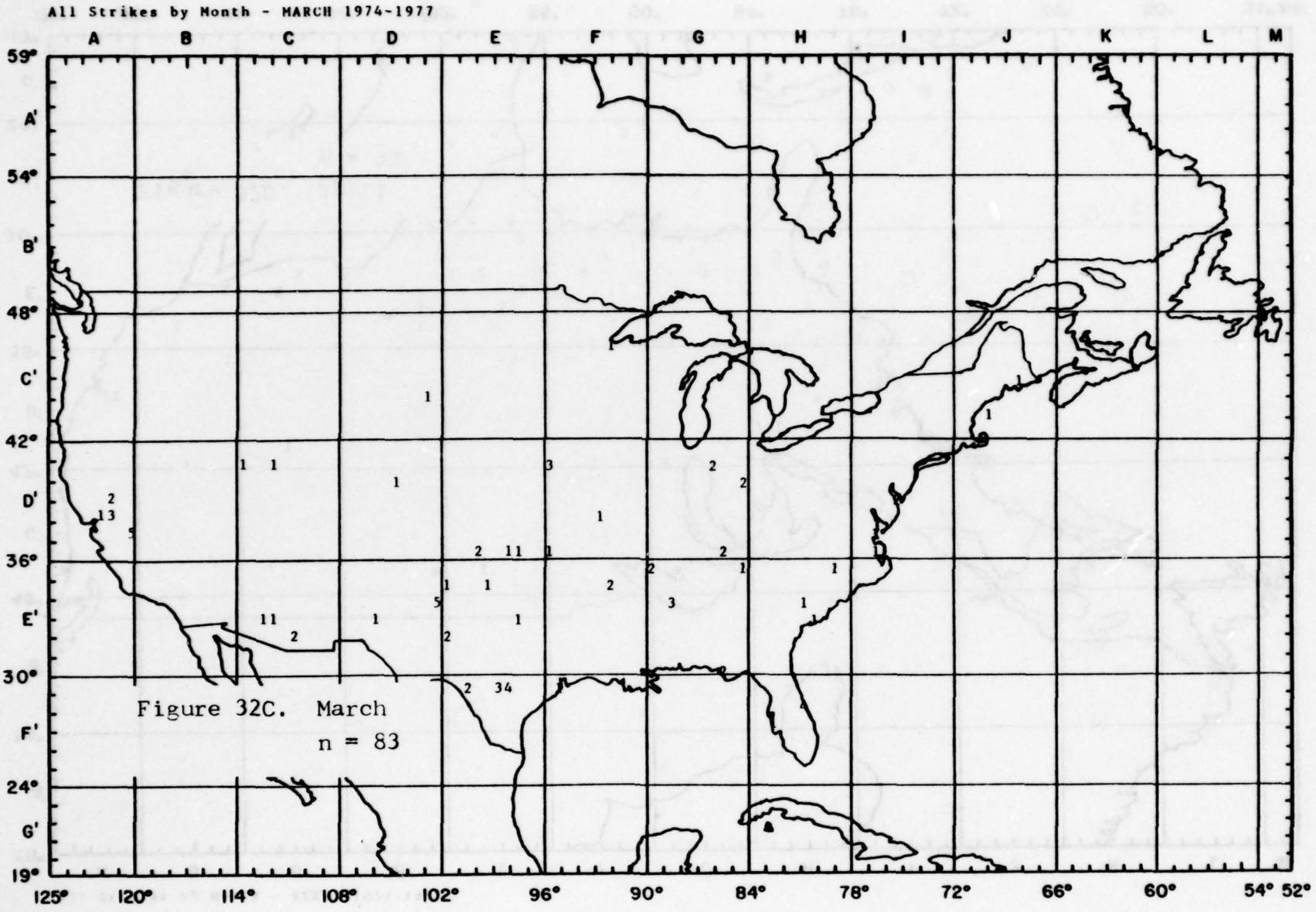

Figure 32C. March
n = 83

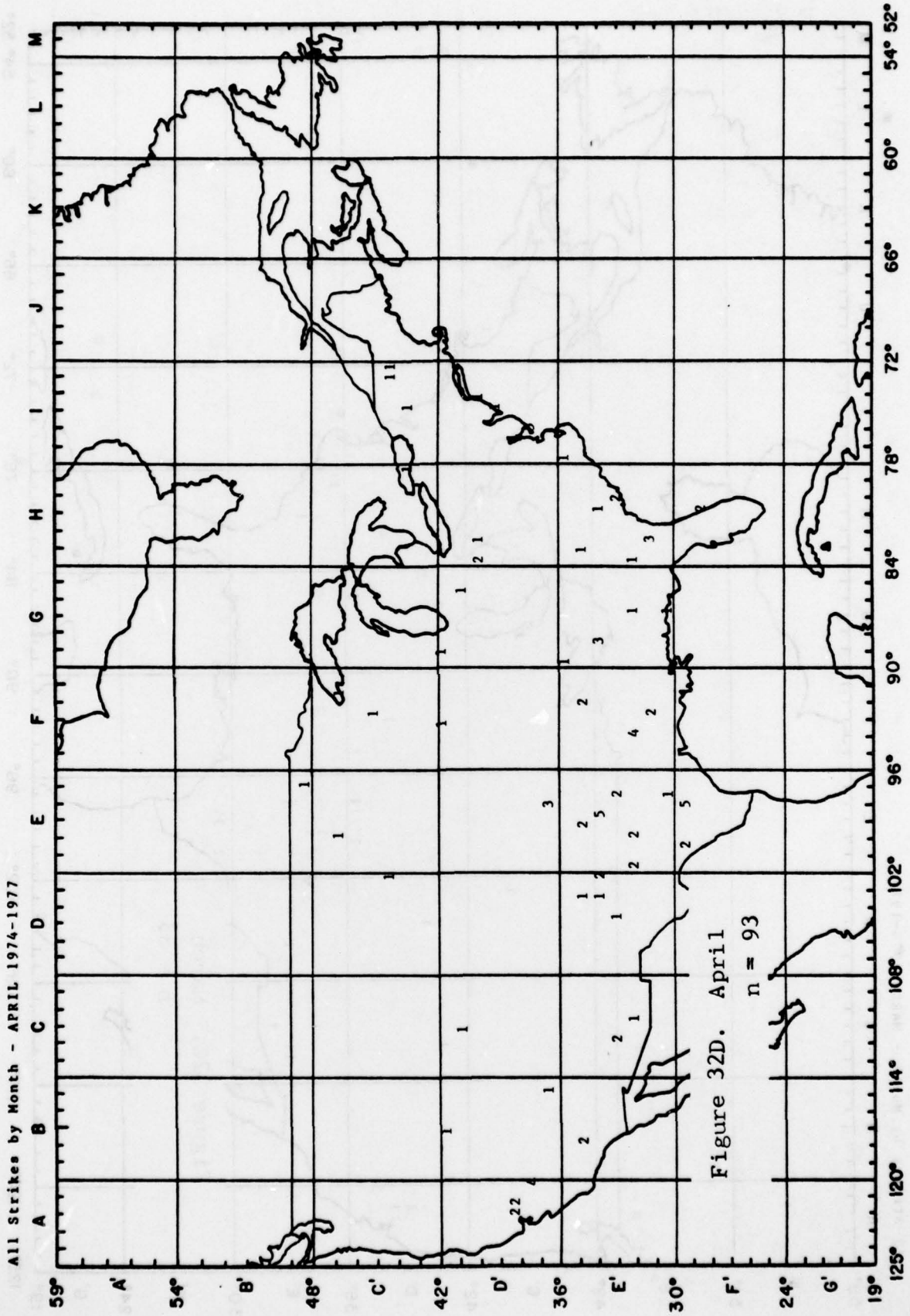

Figure 32D. April
n = 93

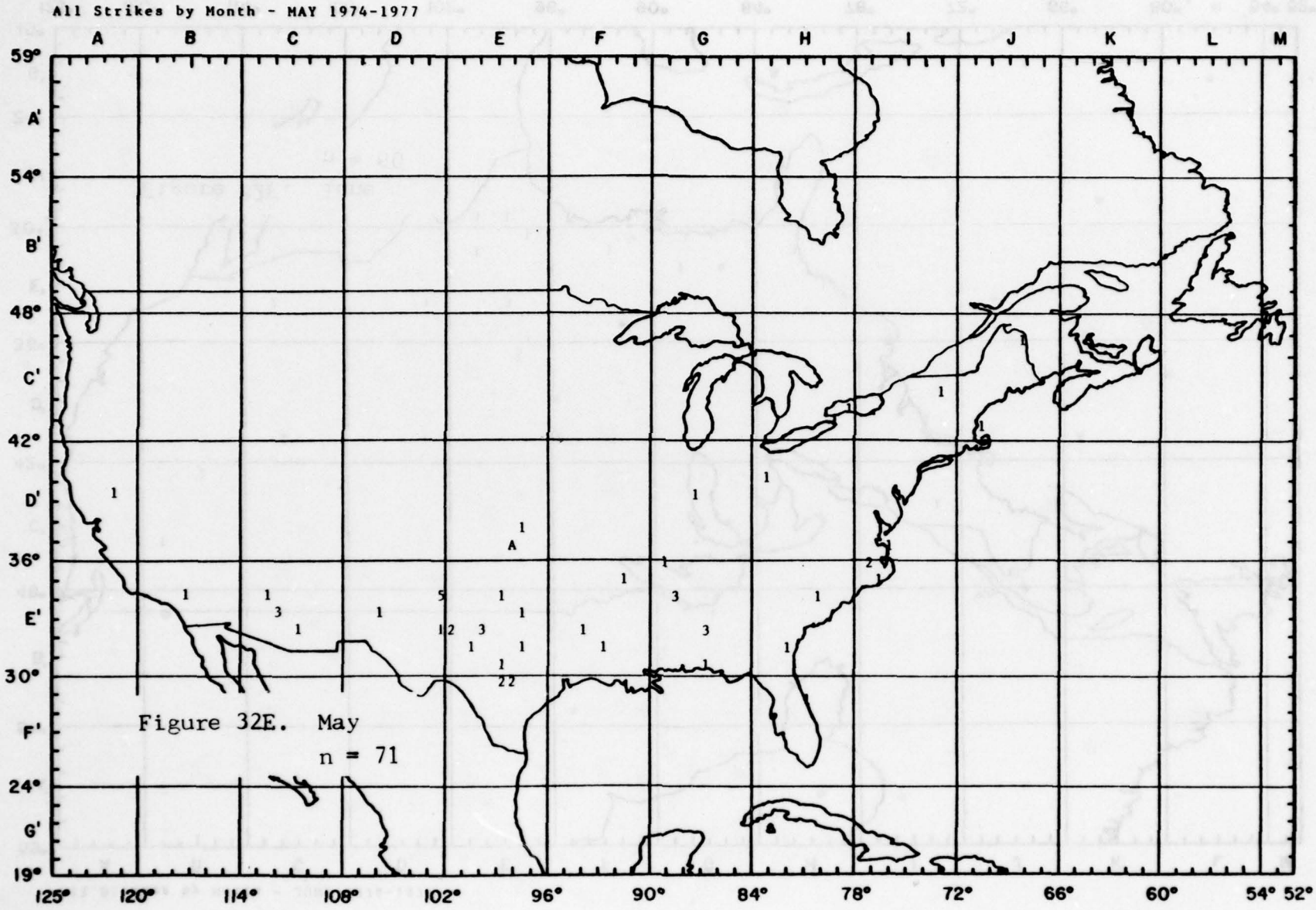

Figure 32E. May
n = 71

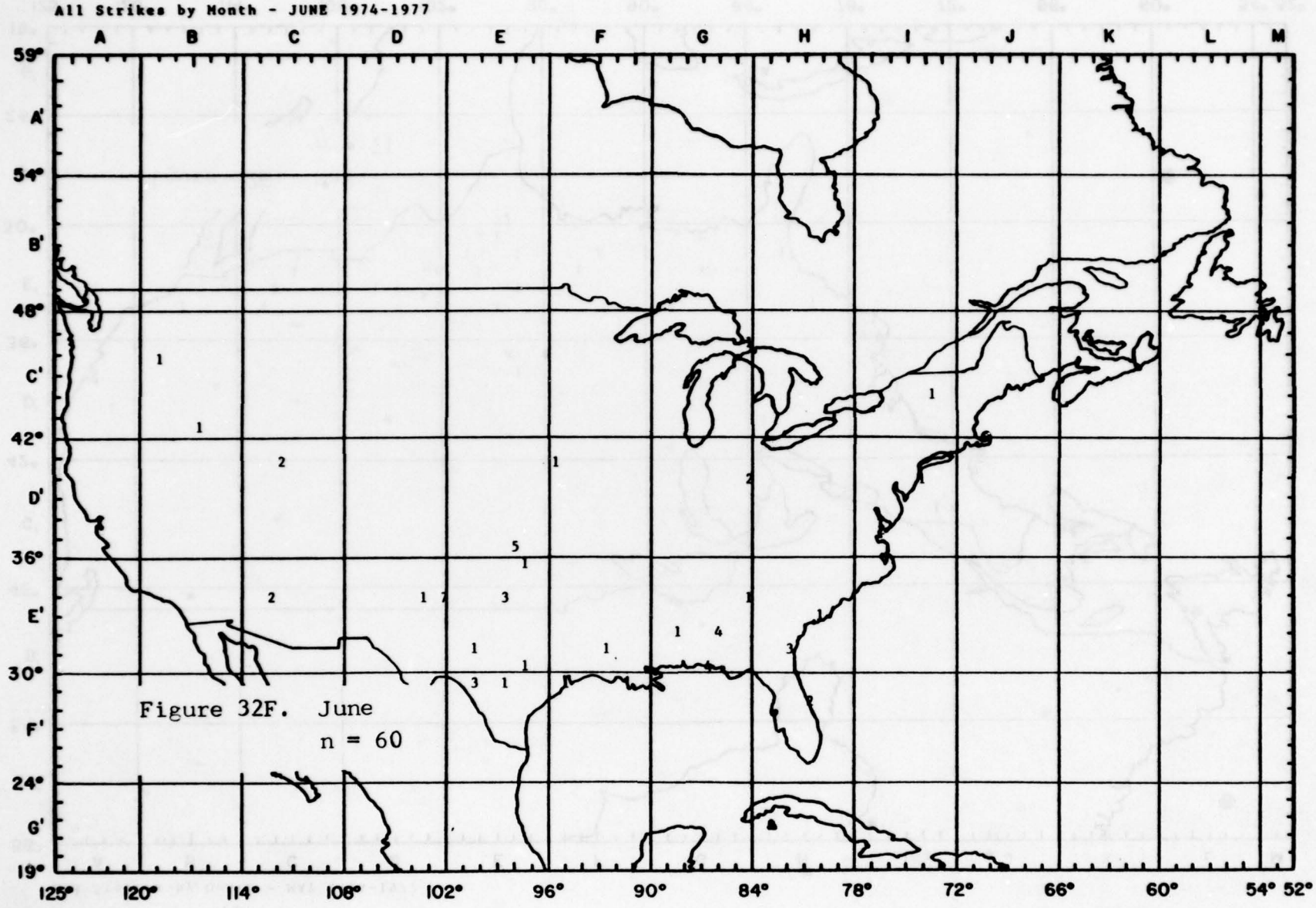

Figure 32F. June
n = 60

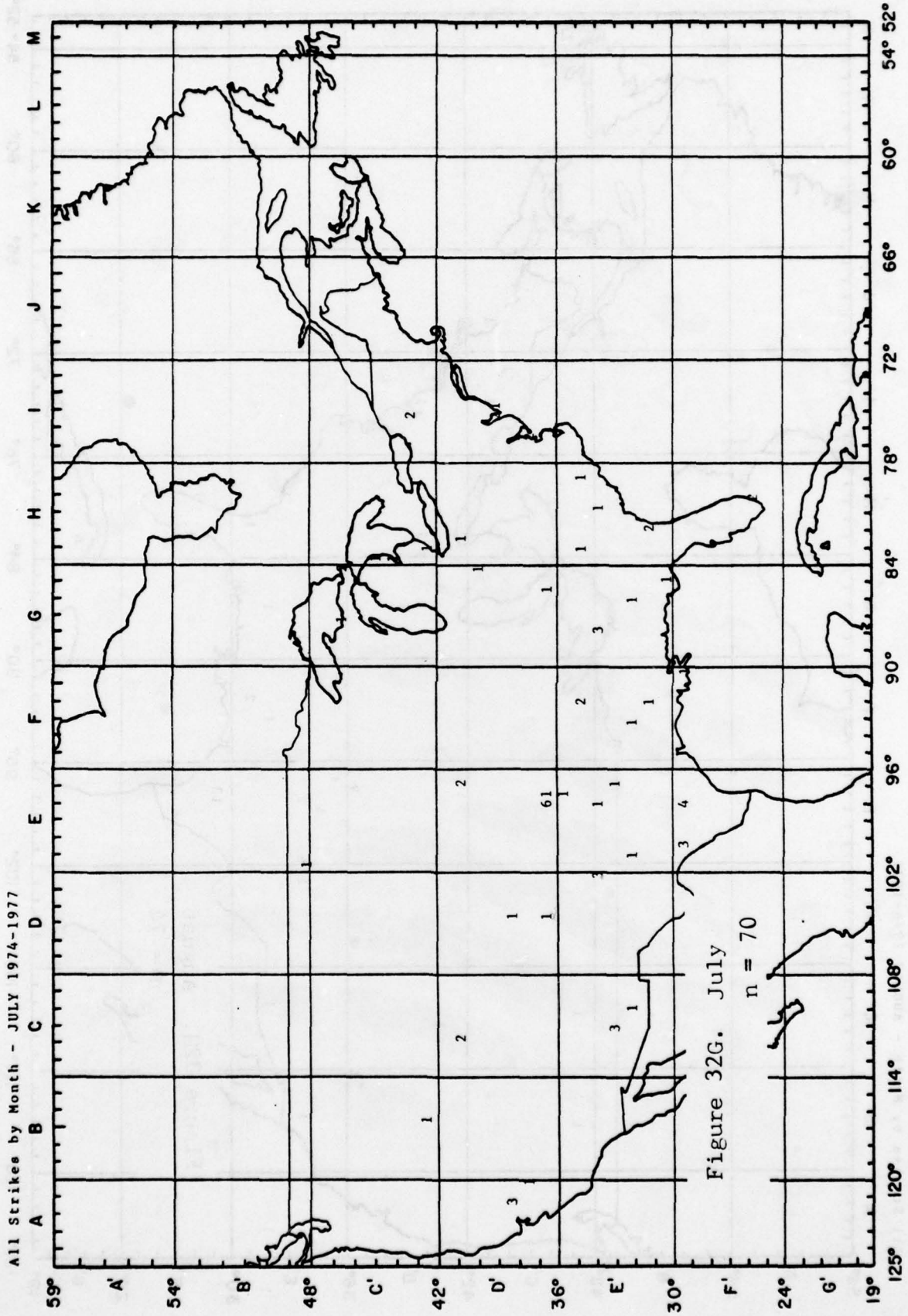

Figure 32G. July
n = 70

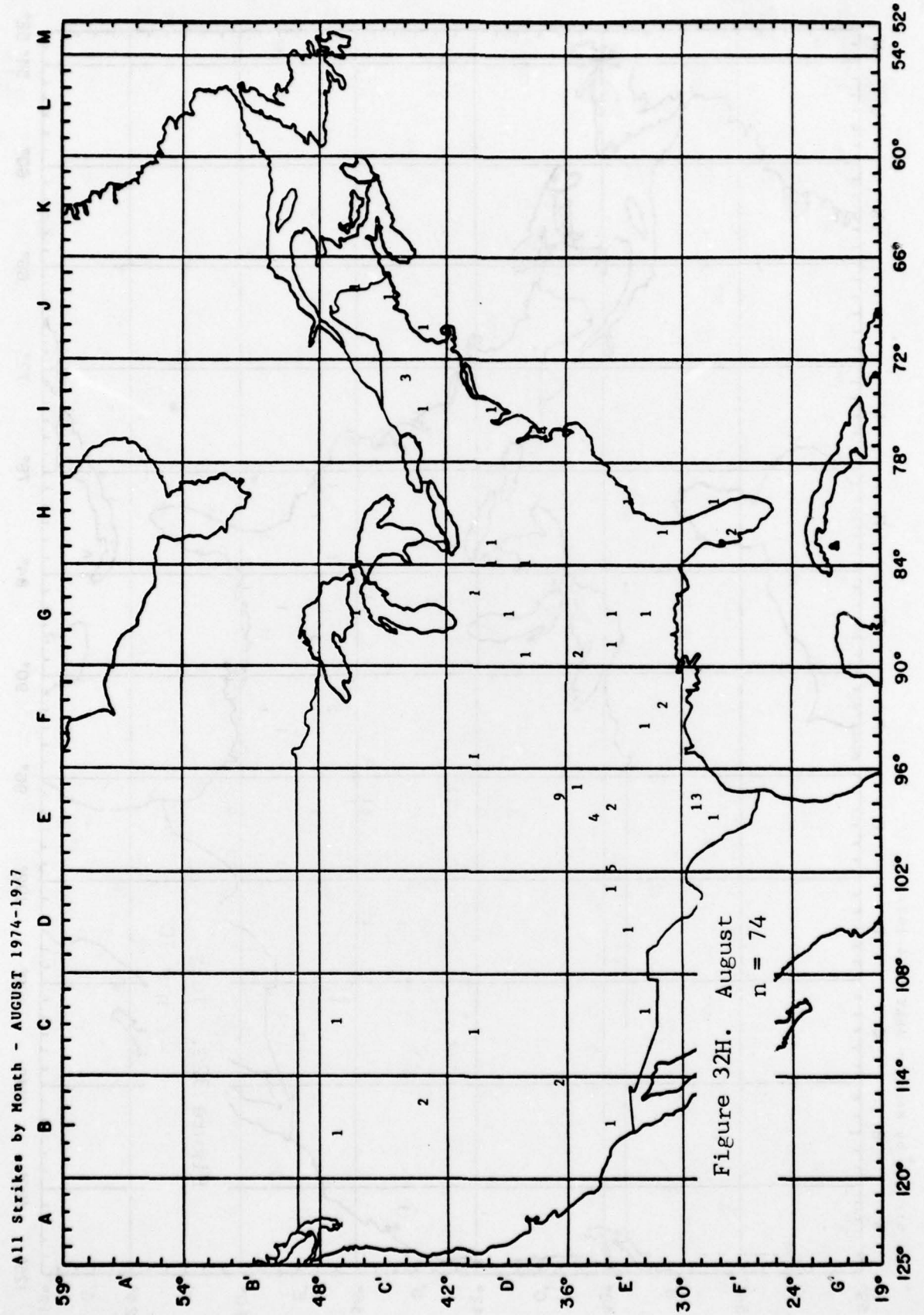

Figure 32H. August
n = 74

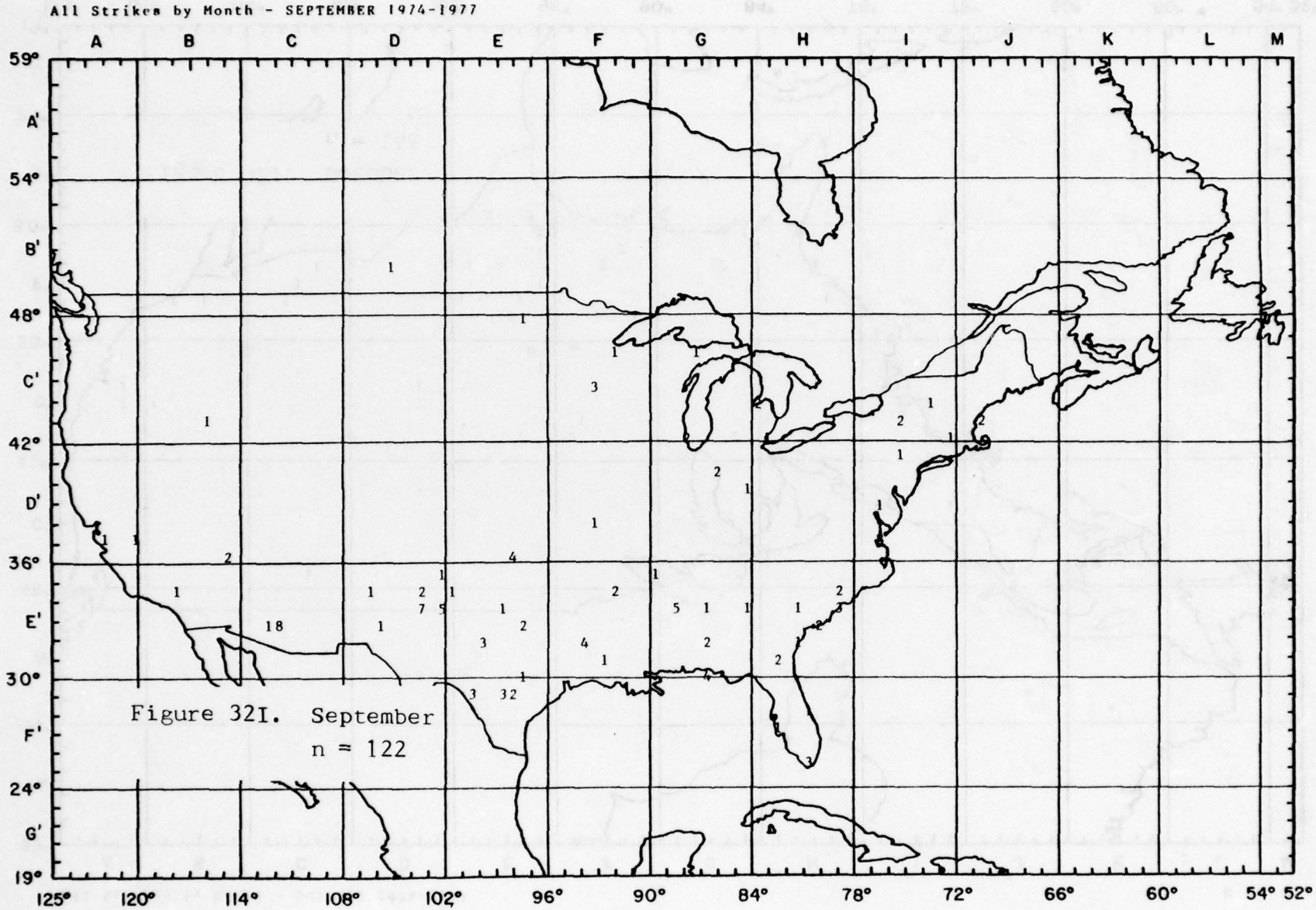

Figure 32I. September
n = 122

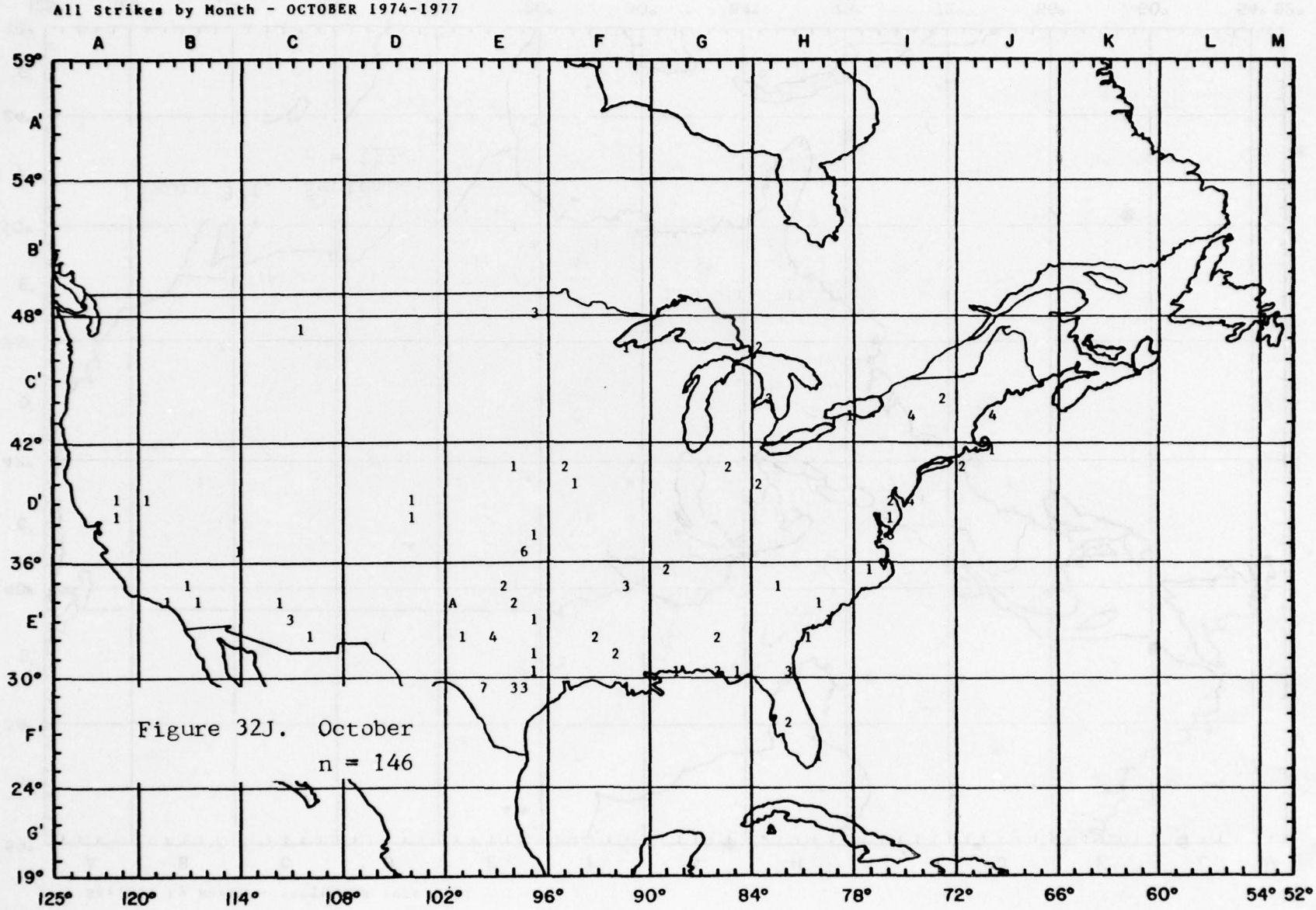

Figure 32J. October
n = 146

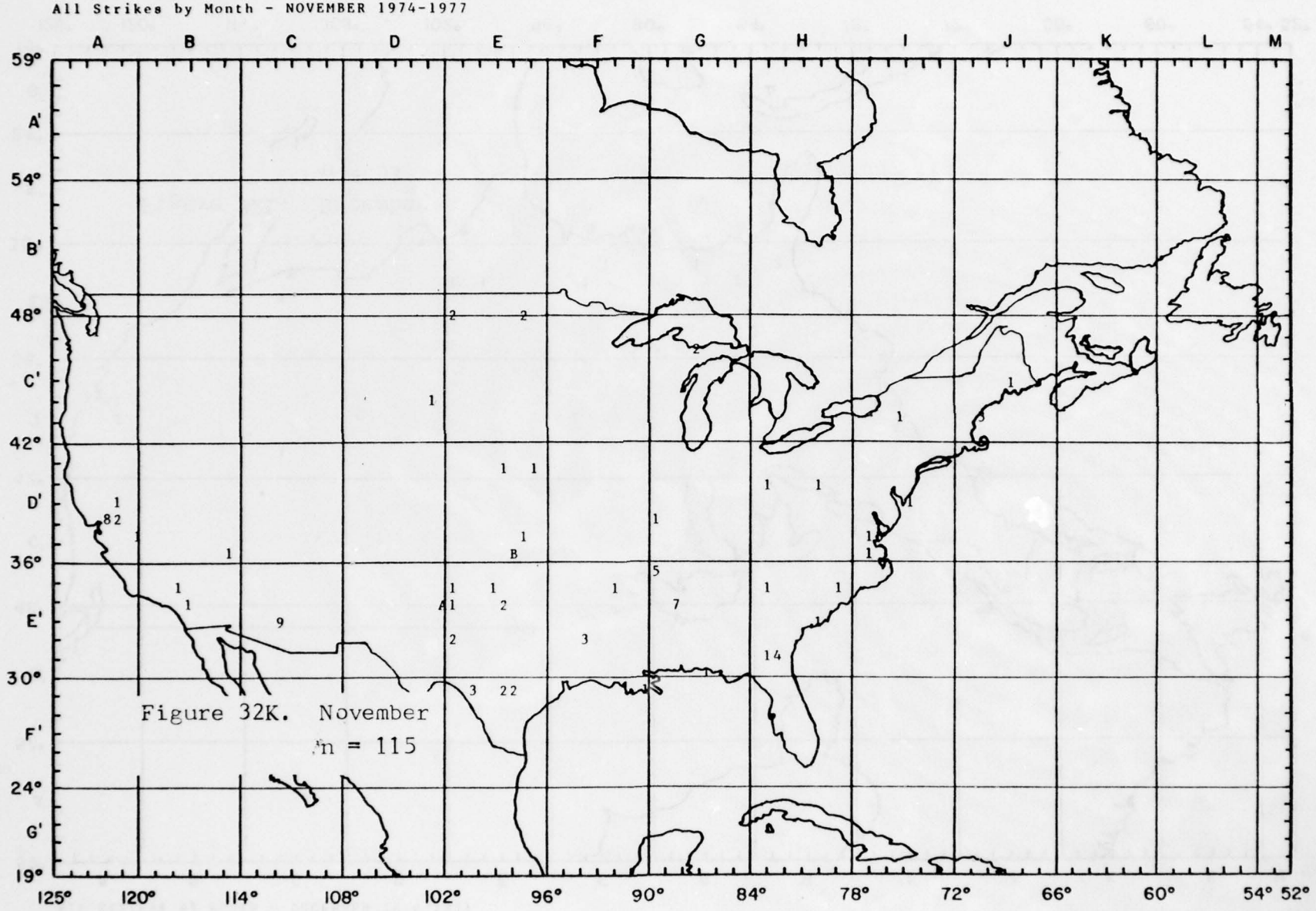

Figure 32K. November
n = 115

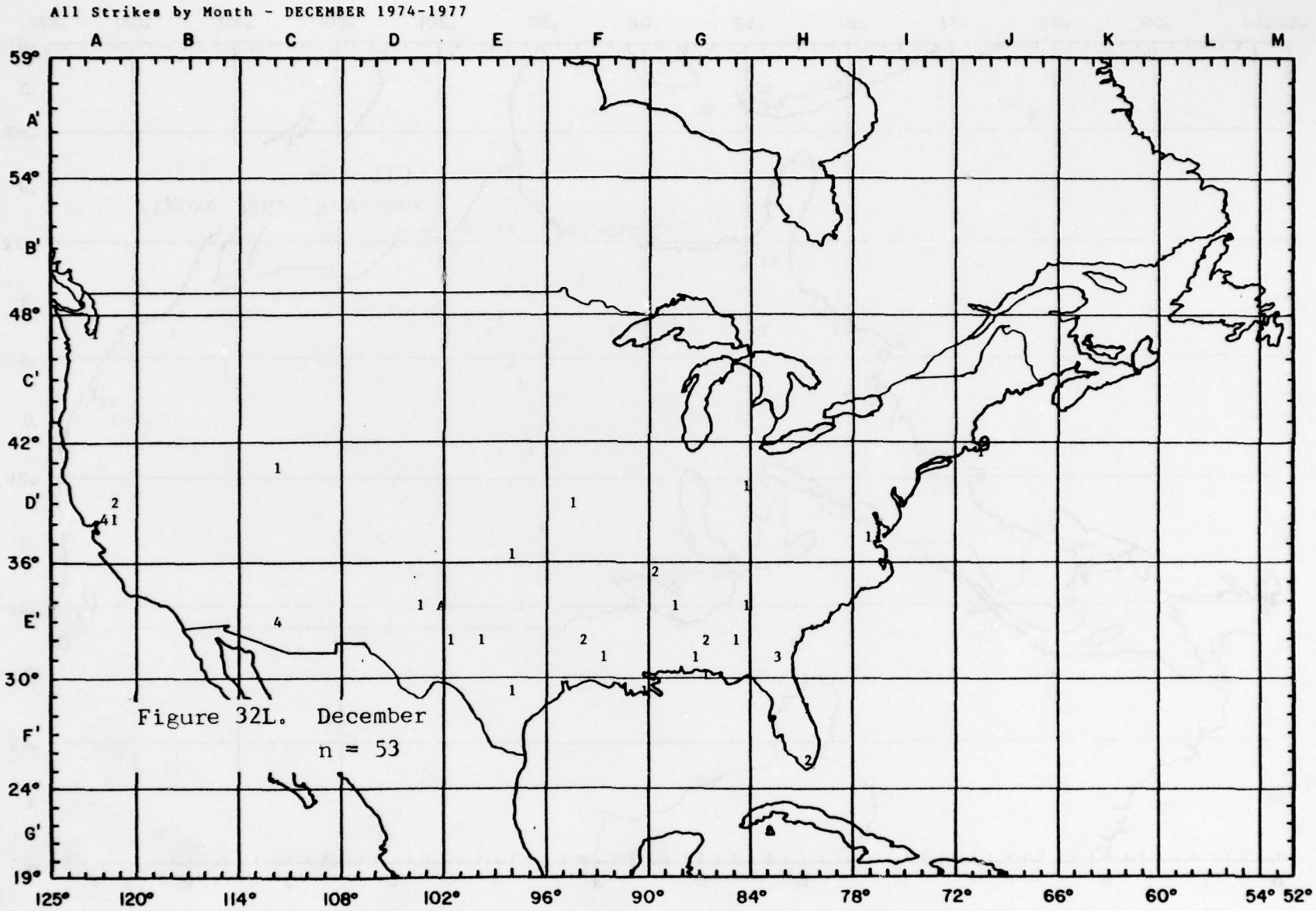

Figure 32L. December
n = 53