

PREPRINT

THE JACK MACKEREL (TRACHURUS SYMMETRICUS)  
RESOURCE OF THE EASTERN NORTH PACIFIC

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INTRODUCTION

The jack mackerel before 1947, was of minor commercial importance having to take a back seat to the better known, more profitable, and more abundant Pacific sardine (Sardinops caeruleus) and the more desirable Pacific mackerel (Scomber japonicus). During these years it was referred to as "horse mackerel" and had relatively little market appeal. Much of the catch between 1926 and 1946 was absorbed by the fresh fish markets and consisted primarily of jack mackerel taken from mixed sardine and Pacific mackerel schools. Landings were low, varying between 183 and 15,573 short tons. During the 1947-48 season, the industry, after being hit hard by poor sardine landings, turned to the jack mackerel as a substitute sardine and landed approximately 71,000 short tons. Jack mackerel have been a major contributor to California's commercial landings ever since (Figure 1).

In 1948, the U.S. Pure Food and Drug Administration authorized the use of the common name jack mackerel on all labeling. This name was expected to have more consumer appeal than the original official name "horse mackerel".

The California Department of Fish and Game commenced routine length and age sampling of the commercial landings in 1947, the year the fishery first blossomed into being. Due to the apparent healthy condition of the resource and the need for emphasis on other fisheries these sample data have not been subjected to a complete analysis. We have recently completed the assignment of ages to the otoliths sampled and anticipate dedicating most of our effort in 1968 to writing a manuscript describing the fishery, its year-class composition and other factors affecting the yield.

The literature on the jack mackerel is somewhat scanty with the greatest part of it pertaining to: (i) taxonomy; (ii) egg and larva distribution, and survival; (iii) yield per area from California waters; and (iv) reviews of the jack mackerel fishery in California and preliminary discussions of biological knowledge.

Accordingly, for this paper, I have called upon past work and much unpublished data from our files, including station data from pre-season albacore cruises and the previously mentioned length and age data.

RANGE

The jack mackerel "population" represents a renewable resource of considerable range and magnitude. All available information indicates the distribution, as obtained primarily from surface observations, extends from the Gulf of Alaska in the north to Cape San Lucas, Baja California, Mexico

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Preprint of a paper prepared for the Annual Conference of the California Cooperative Oceanic Fisheries Investigations, Lake Arrowhead, California, 11-12 December 1967. To be published in Calif. Mar. Res. Comm., Calif. Coop. Ocean. Fish. Invest. Rept., Vol. 13.

in the south. Juveniles have been reported off Acapulco, the Revilla Gigedo Islands and the Gulf of Tehuantepec, although these may have been transported south in bait tanks of tuna boats (Fitch, 1956). Within this range lies an area of maximum density which extends from Point Conception to central Baja California.

The northern extension of the range has been well documented by the high seas sampling program of the International North Pacific Fisheries Commission (INPFC) (Figure 2). Significant numbers of large, adult jack mackerel were taken in a series of gill net sets during 1955 in the Gulf of Alaska as far north as lat.  $57^{\circ} 30'$  N. (Powell and Peterson, 1957). The offshore extent in this northern area was extended in 1963 to long.  $162^{\circ}$  W. (Ahlstrom, ms; H.A. Larkins, U.S. Bureau of Commercial Fisheries, Seattle, pers. comm.). The sampling program covered offshore areas to long.  $160^{\circ}$  E. but no jack mackerel were taken.

One of the best sources for data on the range and center of abundance of pelagic populations in our area is the egg and larva survey conducted each year by the U.S. Bureau of Commercial Fisheries. Jack mackerel eggs and larvae are among the most abundant taken in plankton collections by the survey. The center of abundance of the spawning population is off southern California and Baja California between Point Conception and Cape San Quintin (Figure 3). Larvae have been taken up to 400 miles off the coast of southern California. The surveys have not always delimited the seaward extension of spawning, however, they appear to have encompassed the area of maximum abundance. In recent years this has been remedied somewhat by the addition of two station lines with a seaward extent of 600-700 miles.

Offshore pre-season albacore cruises by the California Department of Fish and Game are another source of information giving insight into the seaward extension of jack mackerel (Figure 4). These trips occur during May and June of each year. Each night, when weather permits, a light station is occupied for 2-4 hours. A variety of specimens are dip netted and observations made of organisms under the light. At many stations, large, old jack mackerel, up to 5 pounds in weight and 61 cm (24 in.) FL are soon attracted to the light. Usually most of the fish stay on the periphery of the lighted area except for occasional feeding forays upon other organisms attracted by the light. During 1968 one of the largest, sustained concentrations of adult jack mackerel attracted to the vessel occurred 150 miles off Ensenada, Mexico (William L. Craig, Calif. Dept. Fish and Game, pers. comm.). Craig estimated at least 2-3 tons to be present on the surface.

Since 1957 these pre-season albacore surveys have covered an area of approximately 350,000 square miles. Many of the night light stations have extended 900 miles offshore (Figure 4). Stations occupied beyond 500 miles did not result in jack mackerel observations or catches.

Department of Fish and Game pelagic fish sea survey cruises, 1950-53, utilizing dynamite as a killing and stunning device, are still another source of material for estimating distribution and relative abundance (Heimann, 1966). During these years a series of night light stations were occupied off California and Baja California. When fish were observed a charge of dynamite was thrown into the school and specimens floating on the surface

were subsequently collected. Jack mackerel taken by this method ranged from 6-37 cm (2.4-14.6 inches) FL and consisted of juveniles, less than a year in age, and fish from 1-5 years of age. An index of abundance (Figure 5) was computed for each year and general area. This index consists of the percent frequency of occurrences of successful jack mackerel stations based on all stations occupied in a general area. The north-south distribution corresponds quite well with the 1952 larvae distribution.

A composite of all of the above distributional data takes on the general pattern as presented in Figure 2. It is interesting to note that the offshore extension of larvae, obtained by the CalCOFI surveys off southern California and northern Baja California, agrees quite well with the offshore extension of large adults as taken by the N.B. Scofield between 1957-1968. The 1963 catches of adult jack mackerel by the INPFC along long. 162° W. and between lat. 51-53° N. establishes the offshore distribution in this area quite well.

The occurrence of jack mackerel in the Gulf of Alaska appears to be related to the warming of surface waters with the progression of summer. Records of the INPFC suggest a seasonal range expansion of from a half to three-quarters of a million square miles in this region (Neave and Hanavan, 1960). Their data also suggest that the distance traveled by some fish may approximate 800 miles at a rate of 13-14 miles per day.

#### SIZES IN COMMERCIAL AND SPORT FISHERIES

The commercial fishery off southern California harvests fish between 15 and 38 cm (6 and 15 inches) FL. The fishery apparently harvests younger individuals from an inshore margin of a large, far ranging population occurring in the general range depicted in Figure 2.

Since 1953, the jack mackerel has contributed rather significantly to the sport catch. In that year 200,000 were taken; however, the catch has subsequently varied between 7,000 and 40,000 fish annually. The bulk of the jack mackerel caught by sportsmen in 1953 were in the size range of the offshore fish taken during the 1957-1968 N.B. Scofield albacore cruises (Figure 4).

#### MAGNITUDE OF RESOURCE

At the present time the magnitude of the jack mackerel resource is open to speculation. The offshore spawning range and distribution of adults has not been clearly delimited. Tagging has not been conducted and the Department's sea survey project has not been successful in locating jack mackerel schools. The present survey is confined to inshore areas and there are no pending plans to expand the survey so as to adequately cover the entire range of jack mackerel.

John S. MacGregor (1964) estimated there was an average biomass of 350,000 tons in the CalCOFI area during the years 1955-1957. His estimate was based on egg and larva surveys which did not cover the total spawning range of jack mackerel, and includes only spawning fish. Consequently, this estimate is probably low with respect to the total population.

Over the period covered by MacGregor and using his estimates it would appear that the southern California fishery harvested considerably less than 10% of the spawning fish in the CalCOFI area. Much of the 35,000 ton average annual landings by the commercial fishery, during these years, consisted of juvenile fish.

More recently, Elbert H. Ahlstrom presented an evaluation of the jack mackerel resource to the 1968 conference on The Future of the United States Fishing Industry held at the University of Washington on March 24-27. He estimated that the total resource in the eastern Pacific was between 2.1 to 4.8 million tons (based on an educated guess of the total population as  $1\frac{1}{2}$  to 2 times that in the CalCOFI area). This represents a resource of considerable magnitude.

## FISHERY

### Seasons

Jack mackerel are caught on the southern California fishing grounds throughout the year. In the early days of the fishery, shortly after 1947, the monthly catches were simply related to the activity of the fleet searching for sardines and mackerel (Roedel, 1953). As a result, fleet activity was low during late winter and spring months, reflecting the close of the sardine season and the scarcity of Pacific mackerel in spring. Current monthly landings do not reflect the clear seasonal pattern evidenced in the early days of the fishery.

### Landings

Jack mackerel landings in the southern California area have fluctuated widely (Figure 1). Many of these fluctuations are related to changing market demand and the resurgence of competing species such as Pacific mackerel and Pacific sardine. It is hypothesized that availability and vulnerability also played a part in these erratic catches; especially since the fishery was being prosecuted in a small part of a much larger biological range. A better insight into the true nature of these factors must await future study and analysis.

### Areas

The southern California fleet catches jack mackerel from Point Conception to San Diego and offshore as far as San Nicolas Island and Tanner and Cortes Banks. The offshore distribution of these catches over the years has been related also to Pacific mackerel and sardine fishing. In 1961-64 Cortes Bank and other offshore regions produced 62% of the total jack mackerel catch of 145,167 tons (Figure 6). The sardine fishery was at a low level and scouting was pointed more in the direction of jack mackerel (Duffy, 1968).

I do not wish to imply that the yield per area of jack mackerel has at all times been related to sardine and mackerel scouting. The commercial fishery operates in a small part of the overall species range and movements of fish into and out of the limit of our fleet would certainly affect the yield per area.

### Size, Age, Year-Class and Structure

Fish taken off southern California by the United States fishery and off Ensenada by the Mexican fishery are young fish between 15 and 38 cm (6 and 15 inches) FL. These fish are all less than 7 years-of-age. In recent years the catch has consisted primarily of 1, 2 and 3 year-old-fish.

Preliminary examination of unpublished length frequency and year-class data has shown that dominant year classes are evident in the fishery. Some of these carry through the fishery for periods up to 4 years, others less; some appear dominant for variable periods, disappear for extended periods and then reappear.

For example, the 1958 year-class first showed up as approximate one-year-olds in March 1959. It carried the fishery through 3 years, almost single-handedly most of the time, for total seasonal landings of 34,000 tons, 25,000 tons and 55,000 tons in 1959-60, 1960-61, and 1961-62 respectively.

Jack mackerel appear to remain inshore, where they are vulnerable to round haul gear, for 3-6 years. Apparently, as they grow older and larger, they become unavailable and inhabit the deeper offshore waters outside the range of the existing fisheries. Fish taken from these offshore areas have been aged to 25 and 30 years.

While processing our jack mackerel data it became evident that the size and age structure of the fish entering the catch has changed rather significantly since 1953. This change occurred after a series of years in which large catches were made averaging about 52,000 tons. The stock had not been fished significantly before 1947 (Figure 1) and during this series of years with large catches (1947-53) fish were generally large, most between 9 and 15 inches long and up to 6 and 7 years of age. Since that time the percentages of fish 4 years and older have decreased significantly to where they are now relatively rare in southern California catches.

#### SUMMARY

1. The jack mackerel "population" is extensive and ranges from the Gulf of Alaska in the north to Cape San Lucas in the south and up to 1,200 to 1,300 miles seaward. The offshore extent has not been positively delimited.
2. Known areas of greatest population density, consisting primarily of juveniles and young adults, occur between Pt. Conception, California and central Baja California, Mexico and up to 90 miles offshore.
3. Large, old fish up to 61 cm (24 inches) fork length and 30 years of age are abundant 180-500 miles off southern California and Baja California. Large, adult jack mackerel move into the surface waters of the Gulf of Alaska during the summer.
4. The present fisheries operate in a small portion of the overall range, harvesting juveniles and young adults off southern California and northern Baja California.

5. Initial examination of fishery year-class composition from 1947-67 shows the occurrence of dominant year-classes which enter the southern California fishery as 1-year-olds and continue dominant up to 4 years. Some year-classes appear dominant for variable periods, disappear for extended periods and then reappear.
6. One estimate of population size from egg and larva survey data indicates a spawning population of about 350,000 tons in the CalCOFI area. Another estimate places the total eastern Pacific population at 2.1 to 4.8 million tons.

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Captions for Figures

- FIGURE 1. California landings of jack mackerel taken off California. The season extends from May of one year through April of the next.
- FIGURE 2. Generalized pattern depicting the range of jack mackerel in the eastern Pacific. This range represents the surface distribution resulting from records of adults, juveniles, and eggs and larvae as obtained by various Pacific coast research agencies (similar to Figure 2, Ahlstrom ms).
- FIGURE 3. Distribution of jack mackerel larvae in 1952.
- FIGURE 4. Distribution of adult jack mackerel off southern California and Baja California as depicted by successful night light stations made during the pre-season albacore surveys of the California Department of Fish and Game (from 1957 through 1968). The frequency diagram represents the numbers of fish by length taken on these cruises.
- FIGURE 5. North-south distribution of jack mackerel as inferred from records of the R/V YELLOWFIN, 1950-53. Stations were run primarily to assess sardine young-of-year abundance and usually did not extend beyond 10 miles from shore. The bars represent the percent frequency of occurrence of successful jack mackerel stations as computed for all stations occupied in a general area.
- FIGURE 6. Three-season total jack mackerel catch per numbered block; seasons 1961-62, 1962-63, and 1963-64 (Duffy, 1968). The total catch for these seasons was 145,167 tons.

FIGURE 1

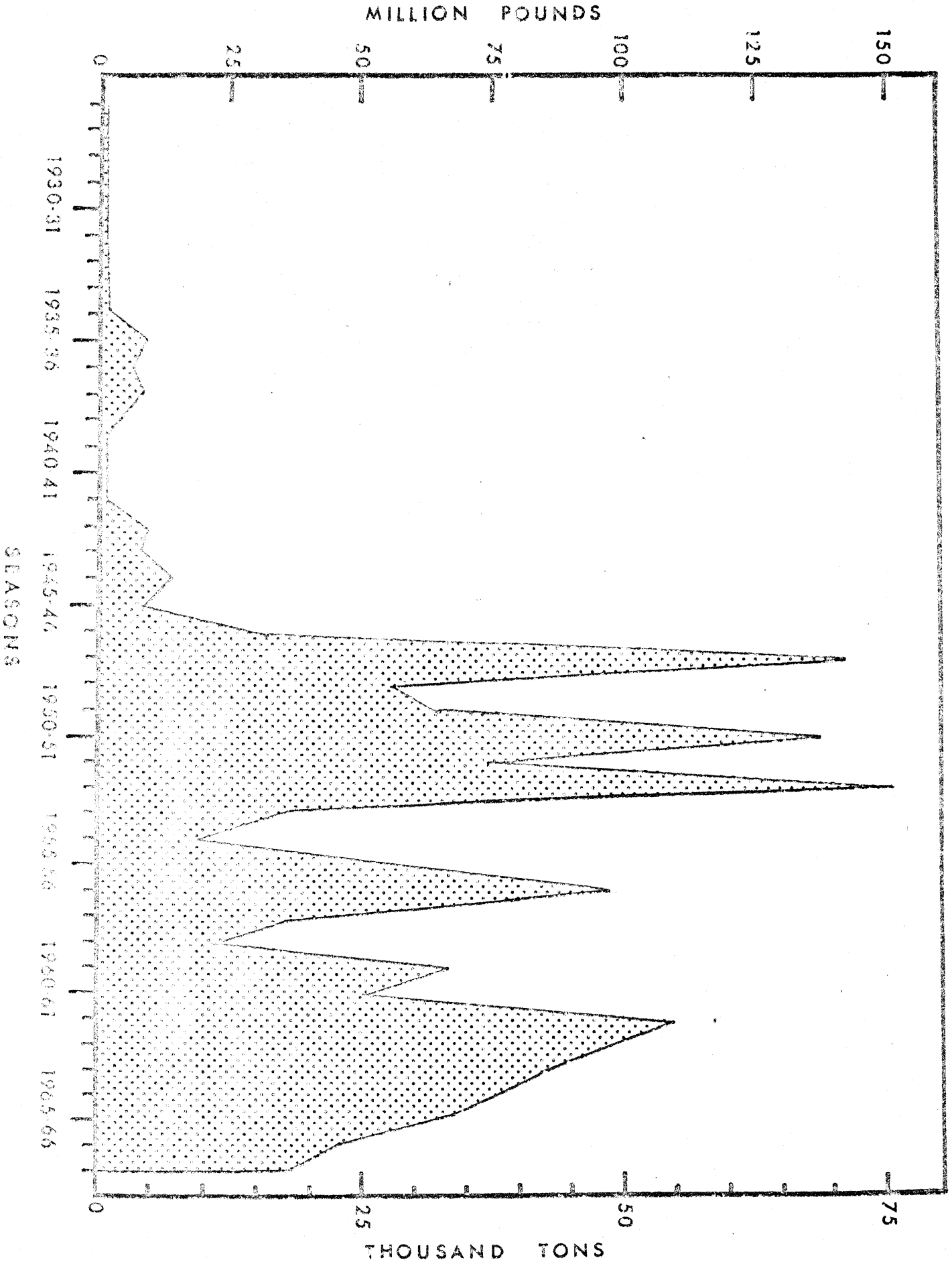
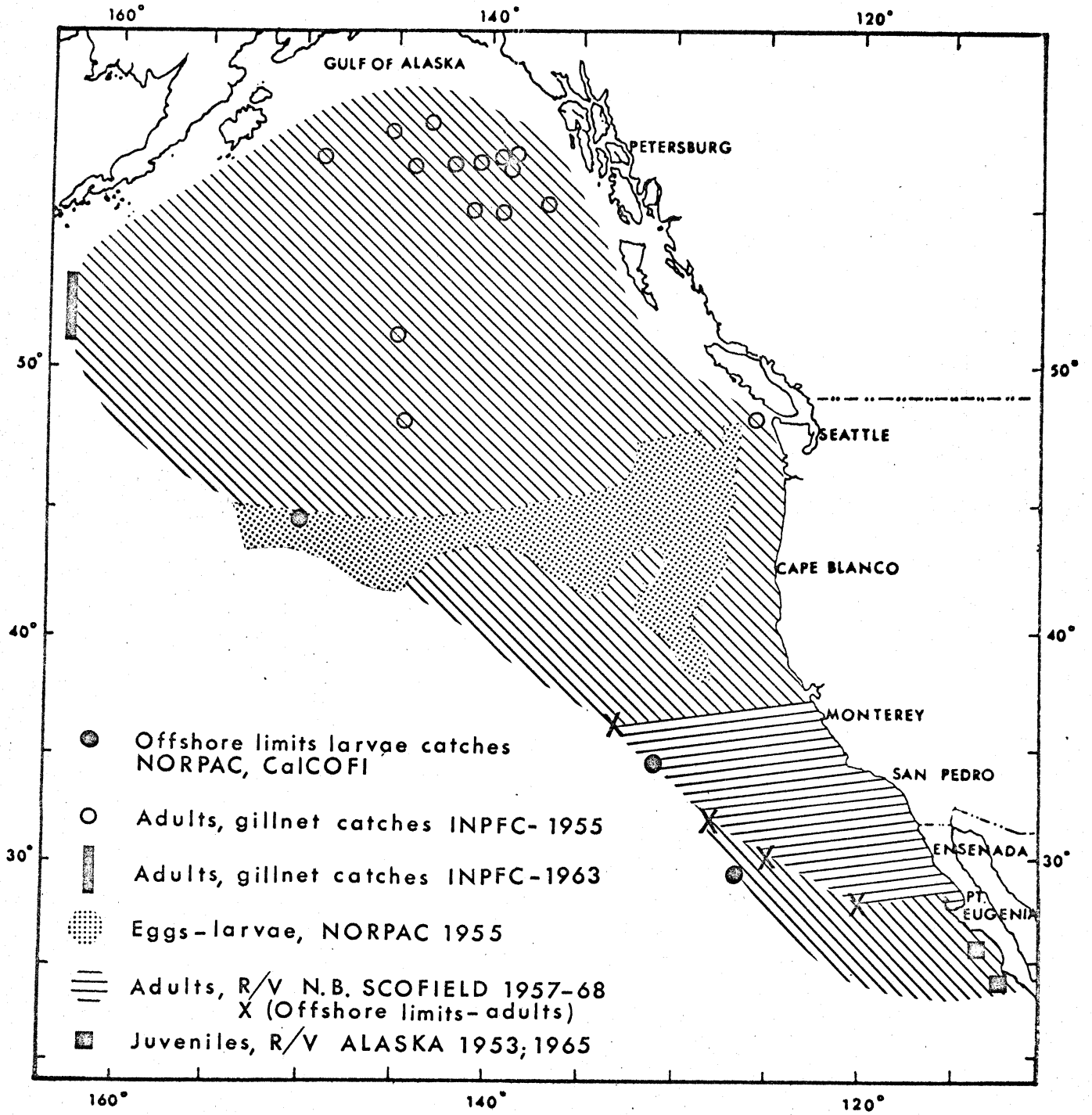


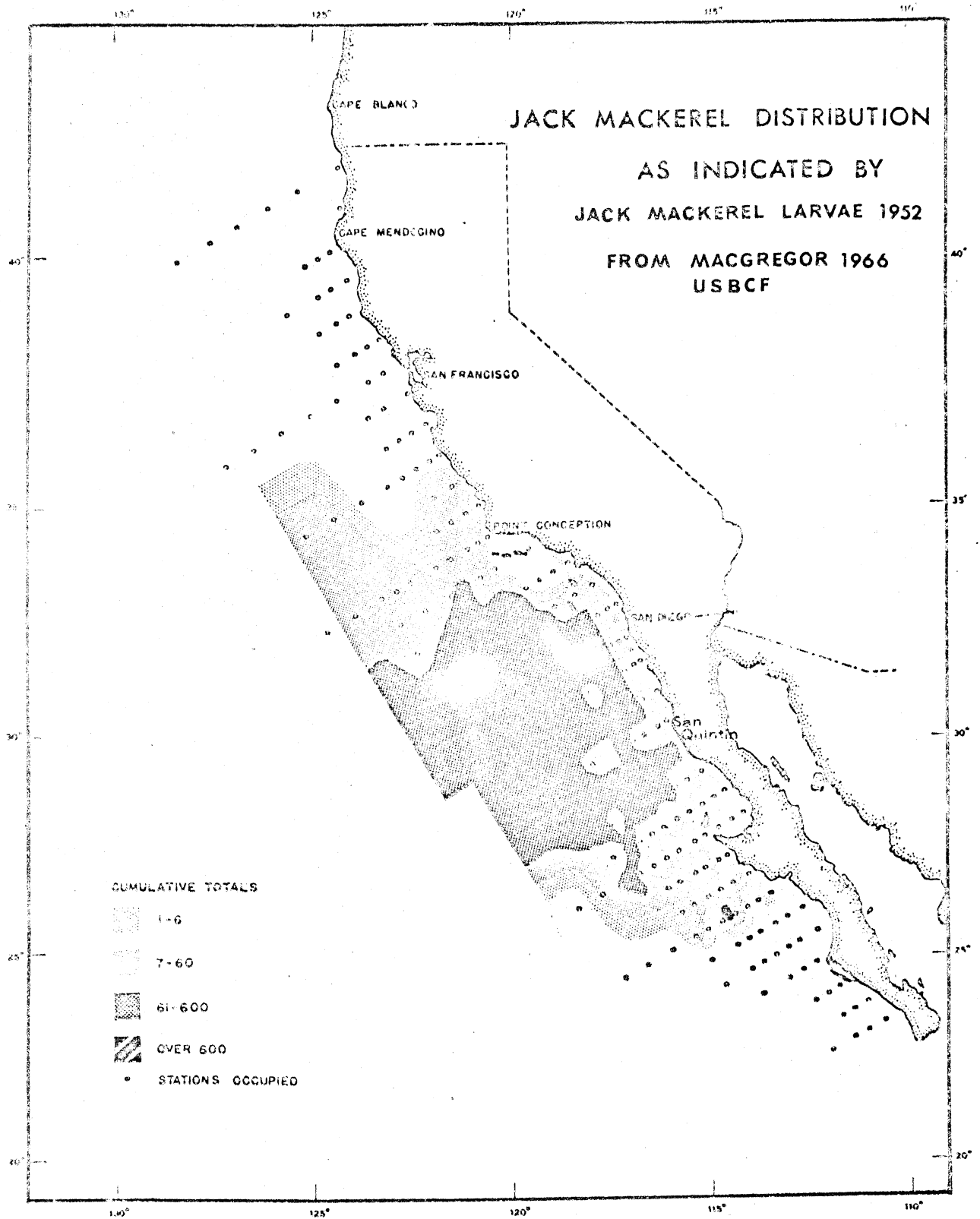


FIGURE 2



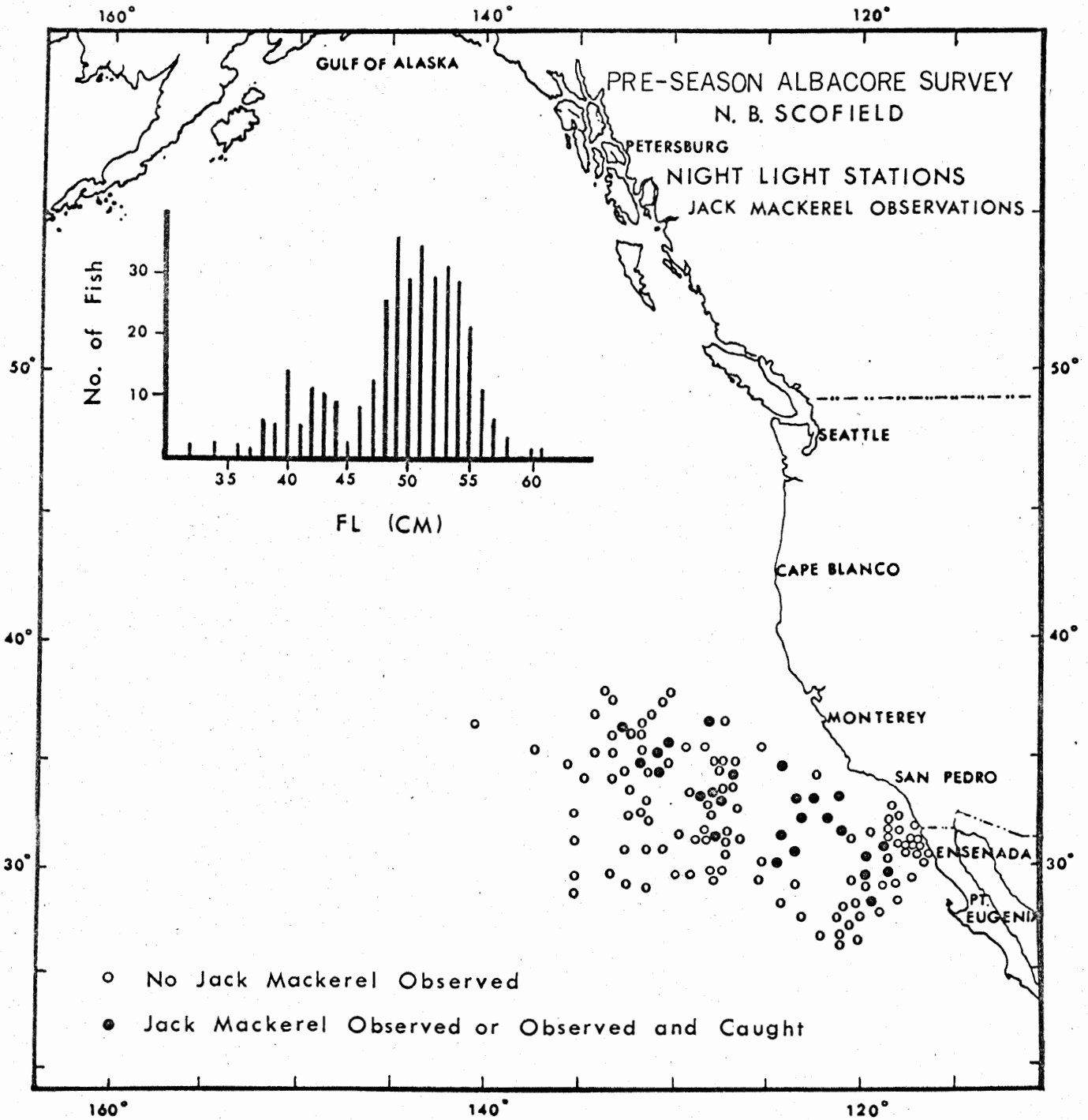
3 3/8"

FIGURE 3



*Map of Jack Mackerel Distribution*

FIGURE 4



No Reduction

FIGURE 5

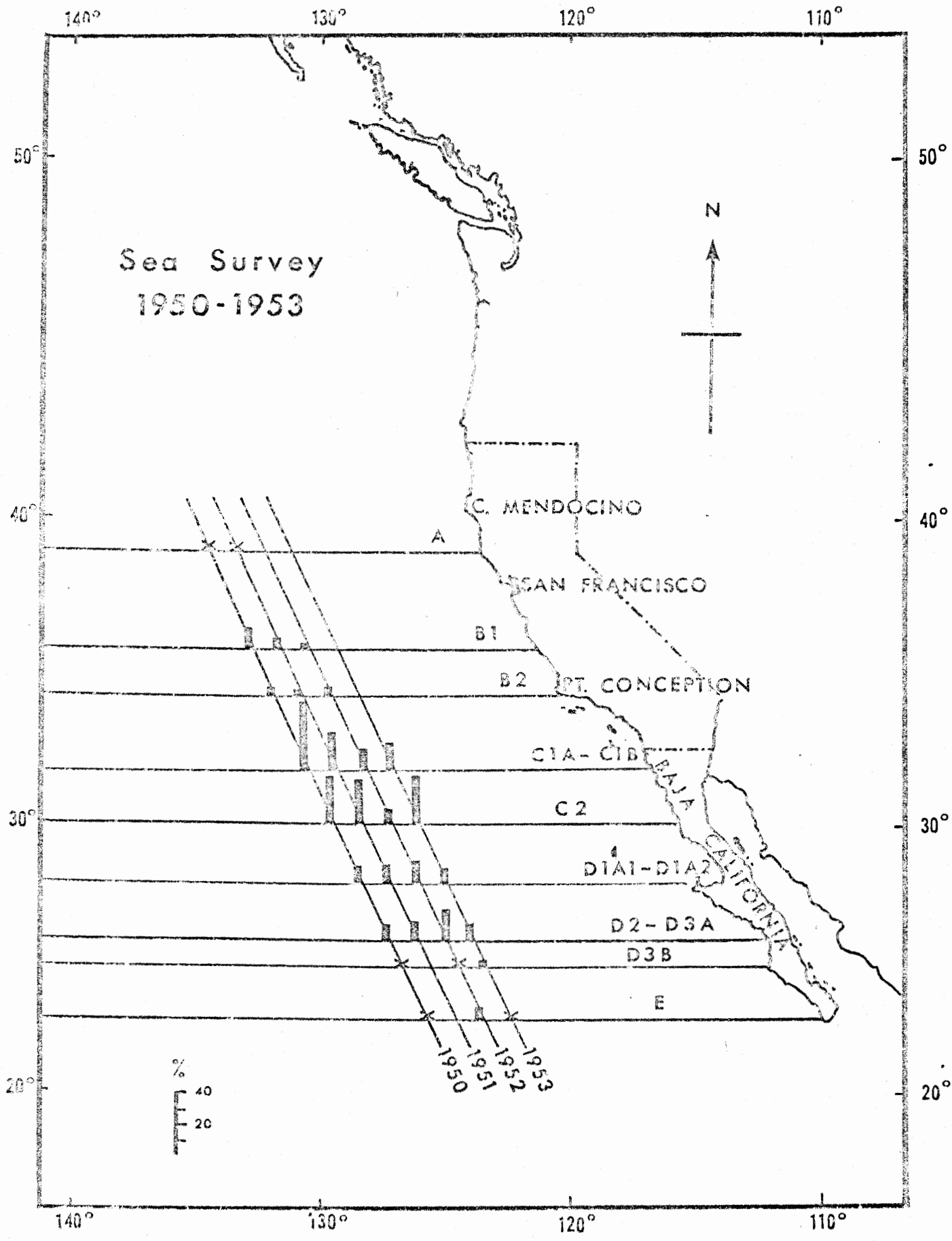


FIGURE 6

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