REPORT
OF
DEMERSAL FISHERIES RESOURCE SURVEY
IN
THE REPUBLIC OF TURKEY

NOVEMBER 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

In response to a request from the Government of the Republic of Turkey, the Government of Japan decided to conduct a development study on Demersal Fisheries Resource Survey and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Turkey a study team headed by Dr. Kazunori Takagi six times during the period from May 22, 1991 to August 7, 1993.

The team held discussions with the officials concerned of the Government of the Republic of Turkey, and conducted field surveys at the study area. After the team of returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Turkey for their close cooperation extended to the team.

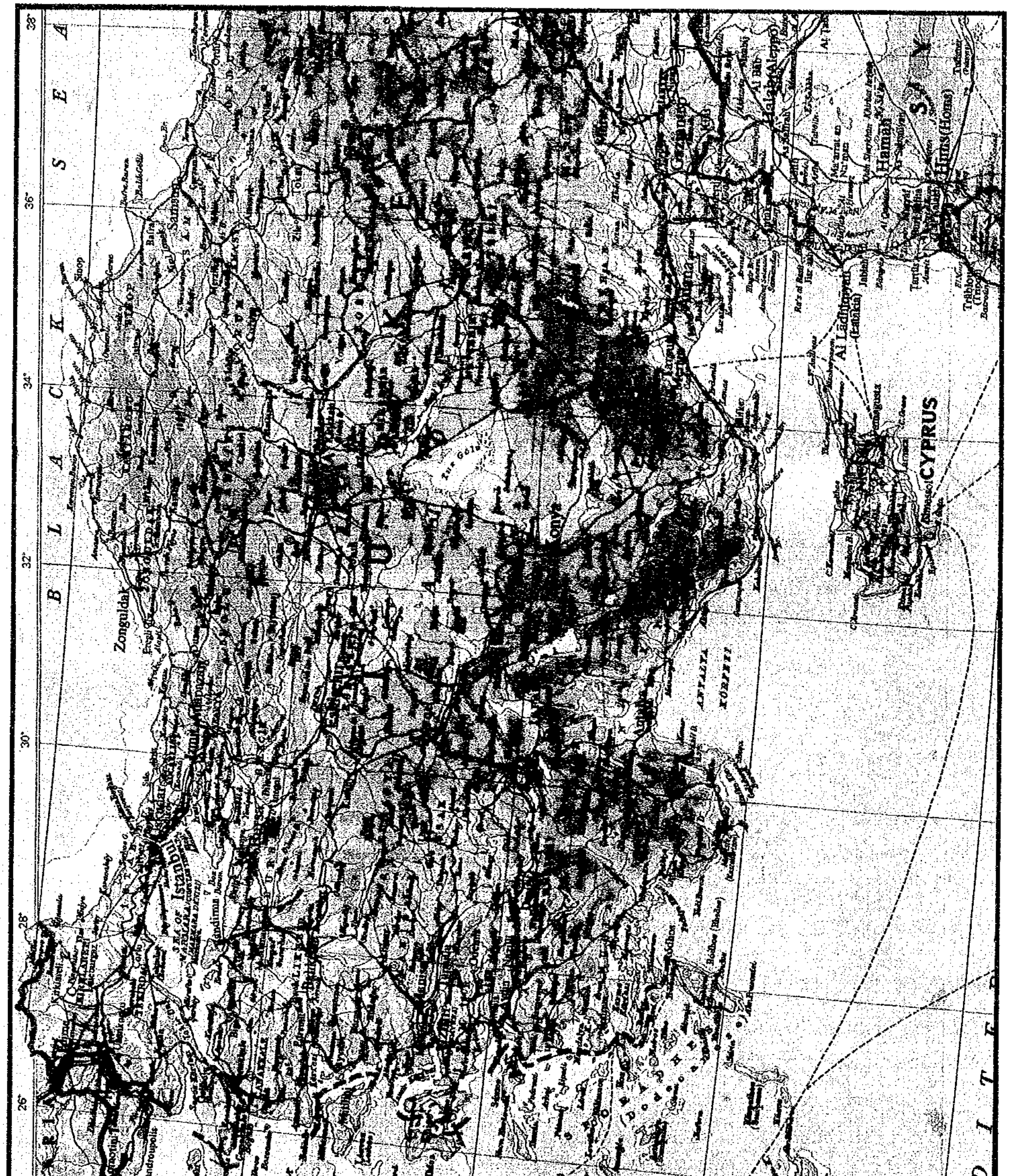
November, 1993

Kensuke Yanagiya

Kensuke Yanagiya
President

Japan International Cooperation Agency

THE MAP OF THE REPUBLIC OF TURKEY



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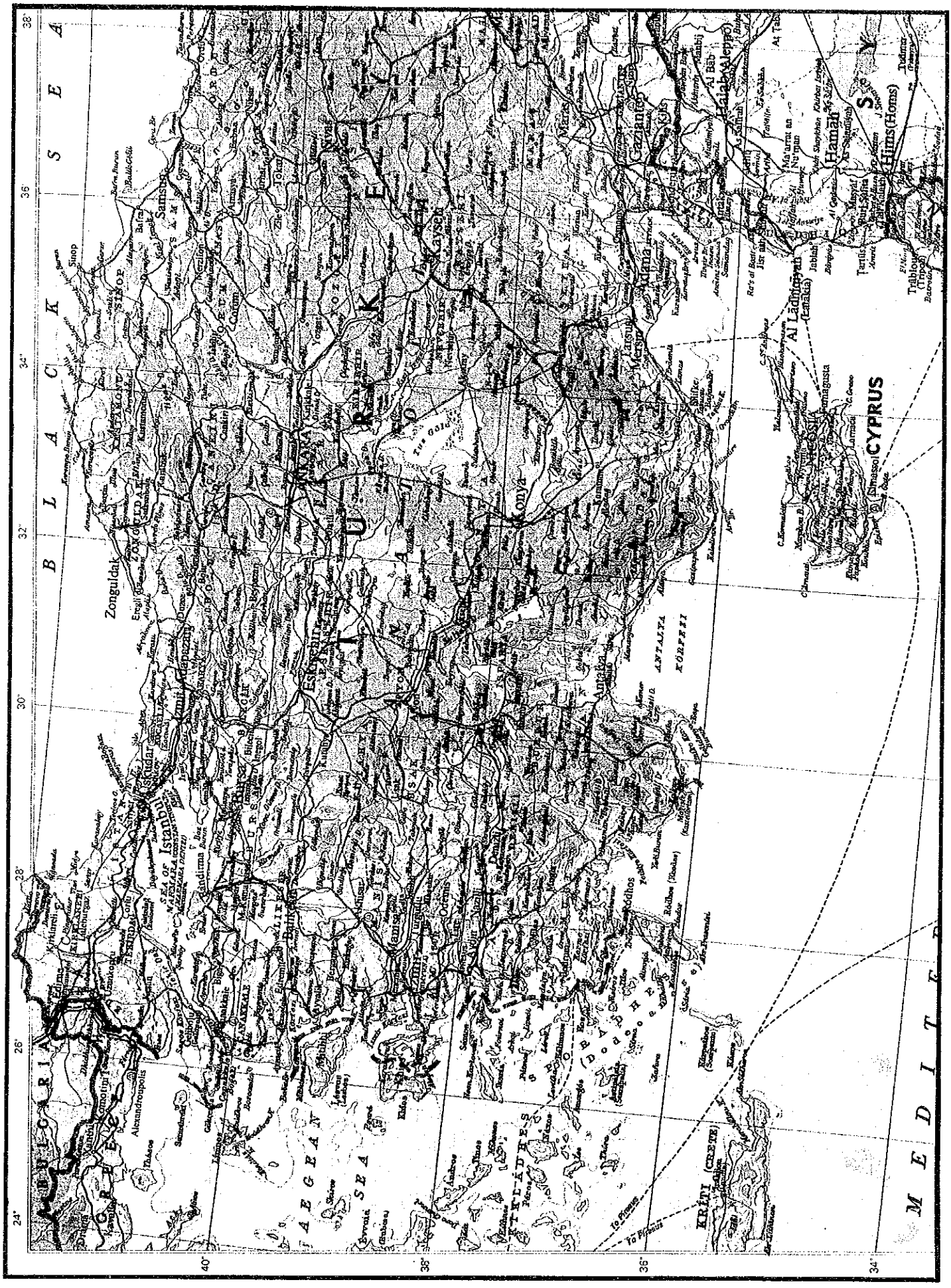

Summary

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1. Background of the Survey

Since the financial power of the private banks in the Republic of Turkey was not so strong, the investments of the agrofisheries sector, where the investment return rate was low, have not been too active. The Turkish government requested a loan from the World Bank to be used to promote the private investment of the agrofisheries sector and this loan was grated.

To guarantee this loan, the World Bank made it the Turkish government's duty to perform a fisheries resource survey to fulfill this agreement the Turkish government has requested our country, Japan, to carry out this survey. The Japanese government responded to this request and carried out a feasibility study in April, 1990, signed the Scope of Work agreement to be surveyed in November, 1990 and performed the demersal fisheries resource survey from May, 1991.

This survey was carried out based on an agreement between the Ministry of Agriculture and Rural Affairs of the Republic of Turkey and the Japan International Cooperation Agency.

2. Survey Objectives

The objectives of this fisheries resource survey conducted in Turkey consisted of 1) determining the distribution and stock sizes of commercially important species, 2) evaluating catchable amount of fishes with respect to unutilized and unexploited marine resources within sea areas around the Republic of Turkey excluding the Black Sea, and 3) making recommendations regarding rational fisheries management and development of demersal fisheries resource by the government of Turkey.

3. Surveyed Areas

The surveyed areas covered a total area of roughly 52,000 km^2 at water depths of 20-500 m, and included the continental shelf as well as the continental slope in territorial waters of the Republic of Turkey as well as in international waters.

4. Method of Demersal Fisheries Resource Survey

The surveyed areas were divided into five sub areas in order to more accurately estimate the stock sizes of demersal fishes and invertebrates by trawling. Each sub area was divided into three depth zones by contour at 100 m and 200 m resulting in stratification into a total of 15 strata. 170 survey stations were appropriately arranged, while taking into consideration the number of survey days, by stratified random sampling method. Trawling was carried out at each survey stations by hauling on the bottom for 30 minutes at a speed of 2-3 knots during the day

using trawling gear. Stock sizes were estimated assuming a efficiency of fishing 1.0.

5. Dates and Durations of Sea-Borne Survey and Number of Trawling Stations

The sea-borne survey was conducted in summer at 172 stations for 60 days from July 3, 1991 to August 31, 1991, in winter at 36 stations for 41 days from December 3, 1991 to January 12, 1992, in spring at 140 stations for 60 days from April 6, 1992 to June 4, 1992, and in autumn at 155 stations for 65 days from September 14, 1992 to November 17, 1992. Since the number of stations at which the winter survey was carried out was low due to bad weather and sea conditions as well as an equipment malfunction on the research vessel, a supplementary survey was conducted at 50 stations for 40 days from January 17, 1993 to February 25, 1993 resulting in a total of 86 stations for both winter surveys.

6. Research Vessel

The demersal fisheries resource survey, biological survey, mesh selectivity experiment, water temperature and salinity measurements, sea bottom topographical survey, comparative test of fishing efficiency and shrimp resource survey pertaining to the sea-borne survey were conducted using the R/V K. Piri Reis oceanographic research vessel (300 tons), which allows stern trawling, belonging to the Institute of Marine Sciences and Technology of Dokuz Eylul University in the Republic of Turkey. In addition, the Turgut Reis (25 tons) stern trawler commercial fishing boat was used for the comparative test of fishing efficiency with the research vessel.

7. Fishing Gear

The trawling gear used in the demersal fisheries resource survey was designed and fabricated at the Institute of Marine Sciences and Technology of Dokuz Eylul University. The gear was smaller than that typically used by commercial fishing boats. The fishing gear used in the mesh selectivity experiment consisted of test nets (having cod end mesh sizes of 50, 70, 90 and 110 mm) attached to the inside of the front of the cod end of the net used for the demersal fisheries resource survey. A single shrimp trawl net was newly fabricated and used for the trawling gear in the shrimp resource survey.

8. Biological Survey

The sea-borne survey consisted of identifying species caught at each survey station and measuring the weight and number of fish. Measurement of body length was carried out concentrating

primarily on commercially important species by the hole punching method. These measurements were carried out on a total of 51,440 fishes consisting of 8,355 fishes in the spring survey, 12,649 fishes in the summer survey, 20,341 fishes in the autumn survey and 10,095 fishes in the two winter surveys. In addition, biological surveys, including measurement of body length, body weight and observation of sex and ovary maturity, and measurements of male and female gonad weights, stomach contents surveys and collecting of age character, were conducted on a total of 22,301 fishes and invertebrate, consisting of 4,786 in the spring survey, 6,982 in the summer survey, 6,686 in the autumn survey and 3,847 in the two winter surveys.

9. Environmental Surveys

Measurements of water temperature and salinity were made in each season and at each survey station by CTD. The sea bottom topographical survey was conducted using an echo sounder.

10. Area Swept

The area swept required for estimation of stock size was calculated from the trawling distance and the width between wing-nets (the value determined from the width between otter boards actually measured by SCANMAR) at each survey station. The area swept at survey stations where the its width was unable to be measured by SCANMAR was estimated using a relational expression between the measured water depth and the width between wing-nets.

11. Species Composition of Catch

The appearance of species of fish in all areas surveyed was on the order of 60 families, while the number of species was the largest in summer at 171, and somewhat lower in the other seasons at 130-150. The number of sea breams *Sparidae* was the highest throughout all seasons, and there were also high appearances of rays *Rajidae* and cod fishes *Gadidae*. In addition, large numbers of sea basses *Serranidae*, horse mackerels *Carangidae*, wrasses *Labridae*, gurnards *Triglidae*, lefteye flounders *Bothidae* and soles *Soleidae* were also observed depending on the season. There were roughly 30 species of important invertebrates in each season. Those species demonstrating high appearance frequencies throughout all seasons consisted of deep-water pink shrimp *Parapenaeus longirostris*, elegant cuttlefish *Sepia elegans*, pink cuttlefish *Sepia orbignyana* and broadtail squid *Illex coindetii*. The appearance frequencies of musky octopus *Eledone moschata* and horned octopus *Eledone cirrhosa* were also high depending on the season.

12. Top Ranking Species for Catch Per Unit Area (kg/km^2) and Estimated Stock Size

Those species that demonstrated high values for catch per unit area at all depths in each season consisted of smallspotted catshark *Scyliorhinus canicula*, longnose spurdog *Squalus blainvillei*, thornback ray *Raja clavata*, hake *Merluccius merluccius*, Atlantic horse-mackerel *Trachurus trachurus*, red mullet *Mullus barbatus* and anglerfish *Lophius piscatorius*. Boarfish *Capros aper* demonstrated a high catch per unit area in all seasons except winter at depths of 201 m or more.

With respect to major invertebrates, the catch per unit area of deep-water pink shrimp *Parapenaeus longirostris* was high in each season and at all depths. Horned octopus *Eledone cirrhosa* demonstrated a high catch per unit area in summer. At depths of 201 m or more, the catch per unit area of Norway lobster *Nephrops norvegicus* was high throughout all seasons.

There were 15 species of fish (including 3 commercially important species) and 3 species of invertebrates (consisting of 2 species of shrimps and 1 species of octopus) that demonstrated estimated stock sizes of 1,000 tons or more. The majority of these demonstrated maximum stock sizes in summer. There were five species of fish having estimated stock sizes of 1,000 tons or more throughout all seasons, namely smallspotted catshark *Scyliorhinus canicula* (stock size range: 1,290-4,633 tons), longnose spurdog *Squalus blainvillei* (stock size range: 1,207-1,597 tons), thornback ray *Raja clavata* (stock size range: 1,706-2,825 tons), hake *Merluccius merluccius* (stock size range: 2,174-6,963 tons) and red mullet *Mullus barbatus* (stock size range: 1,126-2,585 tons).

13. Distribution and Stock Sizes of Important Species

Findings were obtained pertaining to distribution and stock size by season, area and depth for a total of 21 species consisting of 17 species of commercially important fishes as well as 1 species of fish, 2 species of shrimps and 1 species of mollusk that were newly added due to being considered to be important in view of their large stock sizes based on the results of this survey. The following provides a summary of the distribution and stock sizes of species having a mean estimated stock size of roughly 1,000 tons or more throughout all seasons.

Hake *Merluccius merluccius*

This species was distributed throughout all surveyed areas. The seasonal mean of catch per unit area was highest in The Sea of Marmara at 250 kg/km^2, followed by 64 kg/km^2 in the North Aegean Sea, and roughly 30 kg/km^2 in the South Aegean Sea, West Mediterranean Sea and East Mediterranean Sea. This species was widely distributed over depths of 20-500 m, and the density was particularly high at depths of 200 m or less in summer. The stock size of this species throughout all seasons was the highest among all 21 important species. Estimations of stock size by season consisted of 6,963 tons, the maximum value, in summer,

2,818 tons in spring, 2,608 tons in winter and 2,174 tons in autumn.

Atlantic Horse-Mackerel *Trachurus trachurus*

This species was distributed throughout all surveyed areas. The catch per unit area was high in The Sea of Marmara in the spring and winter at roughly 50 kg/km^2, high in the Aegean Sea in winter and autumn, falling within a range of roughly 20-50 kg/km^2. Estimations of stock size by season consisted of 1,741 tons, the highest value, in summer, 933 tons in winter, 845 tons in autumn and 791 tons in spring.

Red Mullet *Mullus barbatus*

This species was distributed throughout all surveyed areas. The catch per unit area was high from the South Aegean Sea to the Mediterranean Sea throughout all seasons at roughly 20-100 kg/km^2, and low in the North Aegean Sea and The Sea of Marmara at roughly 30-50 kg/km^2. The estimated stock size of this species was the second highest after hake *Merluccius merluccius* throughout all seasons. Estimations of stock size by season consisted of 2,585 tons in summer, the highest value, 1,866 tons in spring, 1,631 tons in winter and 1,126 tons in autumn.

Deep-Water Pink Shrimp *Parapenaeus longirostris*

This species was distributed throughout all surveyed areas. The catch per unit area was particularly high at stratum of 101-200 m in The Sea of Marmara, being roughly 200-300 kg/km^2 throughout all seasons. Estimations of stock size by season consisted of 1,291 tons in summer, the highest value, 1,099 tons in winter, 1,050 tons in spring and 784 tons in autumn. The estimated stock size in The Sea of Marmara accounted for roughly 70% of the estimated stock size in all areas throughout all seasons.

Norway Lobster *Nephrops norvegicus*

This species was distributed in the Aegean Sea at locations north of 28° north latitude, and particularly at depths of 201 m or more. The catch per unit area at stratum of 201-500 m in the North Aegean Sea was within a range of 14-28 kg/km^2 throughout all seasons. Estimations of stock size by season consisted of 1,221 tons in winter, the highest value, 1,094 tons in summer, 783 tons in spring and 719 tons in autumn. The percentage of estimated stock size in the North Aegean Sea with respect to estimated stock size in all areas was roughly 80% in spring and 90% or more in the other seasons.

14. Biological Findings of Important Species

Findings relating to size composition, relationship between body length and body weight, sex ratio, female maturity stages,

age composition and feeding habits were obtained for 21 important species based on the results of the biological survey. The following provides a summary of findings for those species having a mean estimated stock size of roughly 1,000 tons or more throughout all seasons.

Hake *Merluccius merluccius*

The range of the total length of this species was 2-78 cm. The mean total lengths in all areas and at all strata from spring to winter were, in order, 25 cm, 23 cm, 18 cm and 22 cm. The mean total length tended to increase as depth became deeper. Although there were no large differences observed in growth between males and females among juvenile of this species, females were larger than males among older fish. The sex ratio in all areas was within a range of 0.96-1.19. Although the spawning period extends throughout the year based on changes in the female maturity rate, the peak spawning period was judged to be in spring. The mature age of females was as early as 1 year, while the majority matured at 2 years. The major components of age composition in all areas consisted of 2 and 3 years old fish in spring and summer, and 1 and 2 years old fish in autumn and winter. Older fish age 6 years and over were largely distributed on the continental slope. This species primarily feeds on fishes, while also feeding on a relatively large number of benthic crustaceans.

Atlantic Horse-Mackerel *Trachurus trachurus*

The range of the fork length of this species was 6-39 cm. The range of the mean fork length in all areas and at all strata was 11-13 cm, with mean fork length increasing as depth became deeper. Although there were no large differences in growth between males and females at all ages, males tended to be larger than females among fish 5 years and older in spring and among fish 4 years and older in winter. The sex ratios in all areas were 0.64-1.18. Based on a study of female maturity rates, the spawning period was observed to extend throughout the year, and there were geographical differences observed in those peak periods. The mature age is as early as the first year, and probably as late as one full year. One year old fish accounted for the largest component of age composition in all areas in each season. This species mainly feeds on planktonic crustaceans.

Red Mullet *Mullus barbatus*

The range of the fork length of this species was 4-23 cm. The mean fork length in all areas and at all strata was 12-13 cm, and there were no differences between seasons. The mean fork length was dependent on depth, with mean fork length increasing as depth increased. Differences were observed between the growth of males and females at each age, with those differences appearing starting at 2 years of age. In other words, although there were no large differences in growth between males and

females among fish less than 1 year old, among fish age 2 years and older, females grew faster than males. The sex ratios in all areas were 1.66-2.61, and there was a larger number of females in each season. The peak spawning period of this species is believed to be in the spring, and the mature age is as early as the first year, and as late as one year old. The major components of age composition in each season consisted of 1 and 2 years old fish, while the ratio of fish 3 years and older tended to increase as depth became deeper. This species feeds on small benthic invertebrates.

Deep-Water Pink Shrimp *Parapenaeus longirostris*

The total length of this species was within a range of 4-20 cm throughout all seasons. The mean total length was 10-11 cm without any seasonal variation. The mean total length in The Sea of Marmara was dependent on depth, with the mean total length at depths of 201 m or more being greater than that at depths of 200 m or less. The total length of females of this species was greater than that of males. Although females grow to roughly a total length of 18 cm and body weight of 40 g, males stop growing at roughly a total length of 16 cm and body weight of 20 g. The number of females was roughly twice the number of males in all areas and in each season. Based on the appearance frequency of juvenile shrimp having a total length of 10 cm or less, the spawning period of this species was assumed to extend throughout the year.

Norway Lobster *Nephrops norvegicus*

The total length of this species was within a range of 4-22 cm throughout all seasons. The mean total length was 11-12 cm without any seasonal variation. Since more than 90% of females in autumn were incubating eyed eggs in their abdomen, and some females were observed to be incubating eyed eggs in winter, the spawning period of this species was assumed to be in winter.

15. Mesh Selectivity Experiment

Mesh selectivity experiments were carried out according to the cover net method for cod ends of 50 mm, 70 mm, 90 mm and 110 mm on 32, 93, 149 and 50 times, respectively, during the winter, spring, autumn and supplementary winter surveys. During the mesh selectivity experiments were conducted, the body lengths of 31,988 fishes caught using cod ends of mainly 50 cm and 70 cm were measured for the 21 important species.

Mesh selectivity curves for important species were prepared by determining the length at 50% retention (l_{50}) of each cod end primarily for 6 species consisting of hake *Merluccius merluccius*, Atlantic horse-mackerel *Trachurus trachurus*, red mullet *Mullus barbatus*, large-eye dentex *Dentex macrophthalmus*, annular sea bream *Diplodus annularis* and common pandora *Pagellus erythrinus* based on the results of the spring survey, autumn survey and two

winter surveys. The L_{50} values of each species by cod end mesh size are as shown below.

Hake *Merluccius merluccius*:
Cod 50 mm L_{50} 20.0 cm, Cod 70 mm L_{50} 26.0 cm, Cod 90 mm L_{50} 35.0 cm, Cod 110 mm L_{50} 36.5 cm
Atlantic horse-mackerel *Trachurus trachurus*:
Cod 50 mm L_{50} 16.5 cm, Cod 70 mm L_{50} 17.5 cm, Cod 110 mm L_{50} 27.5 cm
Red mullet *Mullus barbatus*:
Cod 50 mm L_{50} 16.5 cm, Cod 70 mm L_{50} 20.0 cm, Cod 90 mm L_{50} 23.0 cm
Large-eye dentex *Dentex macrophthalmus*:
Cod 50 mm L_{50} 13.0 cm, Cod 70 mm L_{50} 15.5 cm, Cod 90 mm L_{50} 19.0 cm
Annular sea bream *Diplodus annularis*:
Cod 50 mm L_{50} 12.0 cm, Cod 70 mm L_{50} 15.0 cm, Cod 90 mm L_{50} 18.0 cm
Common pandora *Pagellus erythrinus*:
Cod 50 mm L_{50} 14.0 cm, Cod 70 mm L_{50} 16.5 cm, Cod 90 mm L_{50} 17.5 cm

16. Comparative Test of Fishing Efficiency

Comparative tests of fishing efficiency between the K. Piri Reis research vessel and Turgut Reis commercial fishing boat were conducted in the North Aegean Sea and East Mediterranean Sea at depths of 200 m or less on 12 and 31 times, respectively, during a period of 30 days from April 6, 1992 to May 5, 1992 during the time of the spring survey. As a result of those tests, there were no differences observed in the species composition and body length composition by species of fish caught by both vessels. It was therefore judged that the surveys were conducted targeted at nearly the similar fish populations. With respect to the fishing efficiency between the research vessel and the commercial fishing boat, there were no significant differences between the two vessels in terms of total catches. However, in terms of catch size by species, the fishing efficiency of the research vessel was lower than that of the commercial fishing boat with respect to three benthic species (consisting of 1 species of *Scyliorhinus* and 2 species of *Triglidae*).

17. Shrimp Resource Survey

Surveys were conducted using a shrimp trawl net on 9 times each during the day and night for 5 days from November 8, 1992 to November 12, 1992 in Iskenderun Bay for the purpose of obtaining basic data for comparing the fishing efficiency of demersal fish trawling gear and shrimp trawling gear with respect to the catch of shrimps. As a result of those surveys, there were 2 species of shrimp caught during the day and 10 species caught at night.

Moreover, the catch (individuals) per unit area was extremely low, being only 1,815 individuals during the day and only 555 individuals at night. As a result of studying the composition of shrimp species, the catch (individuals) per unit area and the catch (individuals) per unit area by fishing gear type for shrimp, it was determined that, although there are shrimp having a high market value thriving in Iskenderun Bay, the stock size is extremely poor.

18. Fish Landing Site Surveys

Fisheries statistics from 1970 to 1990 published by the Turkish government were collected to obtain an understanding of the actual status of the fisheries in The Sea of Marmara, the Aegean Sea and Mediterranean Sea, and particularly to obtain an understanding of fluctuations in catch by area and species. During the sea-borne surveys were conducted, interview surveys were conducted at 5 fishing ports representative of each sub area regarding the actual status of the fisheries (fishing gear, fishing grounds, catch and so forth). The results of these surveys were used to obtain an understanding of the status of the fisheries in Turkey. In parallel with the fisheries interview survey, the body lengths of primarily commercially important species within catches landing to each port were measured to obtain an understanding of the composition of those body lengths.

19. Evaluation of Exploited Marine Resources

The actual status of marine resources thriving in the coastal waters of the Republic of Turkey as well as in international waters was estimated by integrating the total mortality coefficient, survival rate and biological findings as determined from government fisheries statistics published in 1990, estimations of stock size and age composition.

(1) Present Status of Exploited Marine Resources

With respect to the catch by area and species corresponding to the results of demersal fisheries resource survey carried out from 1991 to 1993, the catch of each species, as well as those levels, were assumed to have also continued in 1991 and 1992 by using the fisheries statistics of the Turkish government for 1990.

The upper limit, lower limit and mean of estimated stock size by season were determined for each species and area according to the species classifications of fisheries statistics for stock size estimations by area and species of the demersal fisheries resource survey.

The relationship between catch and stock size estimations is divided into 5 categories consisting of A) those species for which species distribution was confirmed from the sea-borne

surveys but there is no record of catch, B) those species for which distribution was not confirmed from the sea-borne surveys, and thus there is no record of catch, C) those species for which there is a record of catch despite distribution having not been confirmed, D) those species for which the mean of estimated stock size is smaller than the recorded catch, and E) those species for which the mean of estimated stock size is larger than the recorded catch.

The total mortality coefficient was determined by logarithmic regressions method using age composition. The total mortality coefficients determined for 8 species were within a range of 0.27-1.83. Although the total mortality coefficient of brushtooth lizardfish *Saurida undosquamis* was low at 0.27, the values for red mullet *Mullus barbatus* and hake *Merluccius merluccius* were considerably high at 1.52 and 1.83, respectively.

(2) Evaluation of Exploited Marine Resources

Since time differences in tabulated values and catch by fishing grounds, fishery type and species cannot be determined for fisheries statistics, their compatibility with stock size estimations is not adequate. In addition, since marine resources thriving outside the surveyed areas, marine resources in strata above the net opening of the trawling gear or those that migrate at different depths, as well as marine resources in areas where surveys using trawling gear are unable to be conducted are not included, and fishing efficiency of 1.0 is assumed, stock estimations are underestimated.

The tentatively calculated exploitation rate for the 6 examples of species and areas of category E) range from 0.26 to 0.82 (mean: 0.64), indicating that 60% or more of the total stock of each species was caught. These are believed to be high exploitation rate for demersal fishes considered to have a relatively long life span and small fluctuations in stock.

The age at full recruitment of the eight species of fishes, for which the total mortality coefficients (Z) and the survival rates (S) calculated, ranged from 0 to 3 years and about half were 2 years and younger fish. In addition, based on the biological knowledge the range of ages of the majority of species caught was from 0 to 6 or 7 years, and the life span of sea breams was short at 4-7 years, despite being considered to have a particularly long life span. The total mortality coefficients calculated from this data were within a range of 0.27-1.83 (mean: 1.07). This corresponds to a range of 0.16-0.76 (mean: 0.37) when converted into survival rates. This means that roughly only 37% of these fish resources survives.

When considered together with the finding that the proportion of juvenile fish among total fish caught is high while the proportion of older fish is low, it was judged that catches of demersal fish resources are excessively high.

20. Utilization of Unutilized Marine Resources and Potential for Development of Unexploited Marine Resources

Those species not contained in the fisheries statistics published by the government were considered to be unutilized species. Trawling in the Republic of Turkey is carried out on the continental shelf. Those species of fishes, crustaceans and mollusks caught at depths of 200 m or less and having an estimated stock size of 300 tons or more, excluding those species not contained in fisheries statistics, were studied by area and season.

With the exception of winter, stock size estimations of unutilized marine resources by season were largest in the North Aegean Sea. That in the winter was largest in The Sea of Marmara. Furthermore, there were no unutilized species having an estimated stock size of 300 tons or more observed in the West Mediterranean Sea.

The unutilized marine resources of nursehound *Scyliorhinus stellaris*, smallspotted catshark *Scyliorhinus canicula*, longnose spurdog *Squalus blainvillei*, common stingray *Dasyatis pastinaca* and violet stingray *Dasyatis violacea* can each be used in the form of fresh fish. In particular, since longnose spurdog *Squalus blainvillei* contains abundant amounts of vitamin A and squalene in its liver, it is highly valued in Spain and France as fresh fish. In addition, if a stable supply is able to be ensured, these species can probably also be exported to Japan for use as raw materials of fish paste products.

Unexploited marine resources were focused primarily on species thriving on the continental slope at depths of 201 m or more where Turkish domestic trawling operations are hardly carried out at all. Studies were conducted by area and season for species of unexploited marine resources having estimated stock sizes of 200 tons or more.

When the numbers of species and estimated stock sizes of unexploited resources were examined by area, these were found to be the largest in the North Aegean Sea throughout all seasons. There were 5-15 species of unexploited resources in the North Aegean Sea, and the estimated stock size of unexploited marine resources there was within a range of roughly 2,000-8,000 tons (seasonal mean: roughly 4,000 tons).

Deep-water pink shrimp *Parapenaeus longirostris* and Norway lobster *Nephrops norvegicus*, for which relatively large stock sizes were observed on the continental slope in the North Aegean Sea, are species having high economic value. Both of these species can be expected to be developed using deep-sea fishing gear.

Horned octopus *Eledone cirrhosa* was confirmed to be thriving at depths of 201 m or more in the Aegean Sea, and it is expected that this species will also be developed due to its large stock size in summer.

The use of trawling gear equipped with heavy ground rope is

effective in development and catch of these deep-sea resources. A desirable method for development of new resources is believed to involve continuation of catching of these species while maintaining a fixed amount of effort to catch these species, and carefully monitoring the degree of development while confirming annual fluctuations in CPUE values and body length composition.

21. Recommendation for Fisheries and Resource Managements and Future Managements of Fisheries Resources

Recommendation relating to managements of fisheries and its resources as well as future managements of fisheries resources were summarized based on a comprehensive estimation of the results obtained from these fisheries resource surveys conducted in Turkey.

(1) Fisheries and Resource Managements

1) Basic Concept of Managements

Different from mineral resources such as coal and petroleum, marine resources are renewable natural resources. We are obligated to pass on these abundant natural resources to our descendants by taking adequate precautions regarding the ecosystem that surrounds those resources. Fisheries managements refer to maintaining the fisheries in a desirable status, or bringing it as close as possible to that desirable status. Since marine resources conditions must also be healthy in order for the fisheries to be healthy, the manner of thinking with respect to fisheries managements must include the concept of resource managements.

Resource managements are performed based on resource evaluation. Resource evaluation refers to examining the status of marine resources in various ways and estimating whether resources are in a healthy status or not. When attempting to implement resource managements, the biological information of the marine resources to be managed should be adequately taken into consideration.

2) Trends of Fisheries Managements

The world wide trends of fisheries managements seem to moving from "Open access" to "Limited entry" and from "Top down management" to "Bottom up management".

(2) Strategies for the Fisheries Resources Management for the Future

1) Collecting of Fisheries Data and Establishment of a Management Organization

An accurate understanding of current fisheries data (including catch, effort statistics and biological information) is essential to serve as the basis for managements of fisheries and its resources. Thus, it is necessary to promptly establish an organization and system for that purpose.

2) Expansion and Strengthening of Fisheries Administration and Research Institutions

A system working in cooperation with research institutions is required for proper promotion of fisheries administration. Those results are largely dependent on the accumulation of testing and research results. In addition to strengthening of fisheries education, which serves as the foundation of this administration and research, it is also desirable to expand and strengthen the number of scientists and technicians, as well as research facilities, measuring instruments and so forth.

(3) Continuation of Fisheries Resource Surveys

1) Analysis of Acquired Data

In-depth analysis of data is required to effectively utilize information that has been obtained with the cooperation of numerous concerned parties and following huge investments both in terms of funding and manpower.

2) Continuation of Surveys

Fisheries and its resource managements also requires an accurate understanding of the manner in which target fisheries resources are changing under current fisheries operations. Thus, it will be necessary to carry out fisheries resource surveys to determine resource conditions every 2-3 years while using this current survey as a starting point.

3) Matters for Consideration

(a) Organization of Surveyed Species

It is necessary to narrow down the scope of species surveyed to those species that are commercially important, having large stock sizes and have a high potential for development.

(b) Organization of Survey Items

The current survey items should be reorganized into those items that are necessary to ensure adequate accomplishment of objectives.

(c) Acquisition of Research Vessel

In order to maintain consistency of data, it is necessary that future surveys be carried out using a research vessel and fishing gear having specifications identical to those used in the current survey. In cases when use of a research vessel becomes difficult, it most likely would be satisfactory to charter a fishing boat.

(4) Fisheries Regulations

Fisheries regulations consist of qualitative regulations, including the closed time-area and closed season for fishing, restrictions on the fishing gear and fishing methods used, restrictions on cod end mesh size and restrictions on the body lengths of fish caught, as well as quantitative regulations, including regulations on the amount of fishing effort (such as restrictions on the number of fishing boats and the number of fishing gear used) and regulation of catch limit itself by setting catch quotas.

1) Enlargement of Cod End Mesh Size

The age of the majority of species to be caught (age at full recruitment) was 2 years or older. The mesh size of the cod end used by commercial fishing boats is 44 mm. Since spawning of important species begins at around 1 year of age, the use of this mesh size results in fish being caught that have just reached a mature age. Thus, in order to maintain the reproductivity of marine resources, it is necessary enlarge the mesh size of the cod end being used to suppress the number of smaller fish caught and secure an adequate sized population of spawning fish. Although it is believed that this regulation will not reduce the number of fishing boats and only place a small economic burden on fishermen, it will be necessary to take into consideration the temporary reduction in income accompanying this decrease in the number of fish caught.

2) Allocation of the Amount of Fishing Effort

It is necessary not only to regulate the mesh size of cod end and to freeze the number and size of the fishing boats and power of engines but also to regulate fishing in specific areas and at times when juvenile and small fishes are mainly distributed.

When attempting to introduce fishery regulations relating to mesh size and the amount of fishing effort, the purpose and effects of those regulations should be adequately explained to those fishermen affected in advance to obtain their understanding. It is also necessary to simultaneously deploy check functions that can be performed by operators themselves as well as establish a system for administrative management. Fisheries regulations that are ignored by fishermen cannot be expected to be effective.

(5) Rational Utilization of Marine Resources

Based on the results of this fisheries resource survey, the latent stock size of demersal fishes within the territorial waters of Turkey and international waters cannot be said to be abundant, being equal to roughly only 1/10th that found in other areas. Under the present circumstances in which young (small) fish account for the majority of fish caught and older fish are few in number, based on judgments made from the results of this survey, the potential for development of any resources that could be the targets of trawling is considered to be poor.

Therefore, it is proposed that currently existing resources and the environment surrounding those resources be used precisely and effectively.

1) Utilization and Development of Unutilized and Unexploited Marine Resources

Among those resources thriving on the continental shelf, the stock sizes of nursehound *Scyliorhinus stellaris*, smallspotted catshark *Scyliorhinus canicula*, longnose spurdog *Squalus blainvillei*, common stingray *Dasyatis pastinaca* and violet stingray *Dasyatis violacea* are considerably large as stock sizes of single species. It is therefore necessary to attempt to make even more effective use of these species. Together with further increasing the added value of resources already being used at present through the development of fisheries processing technology and the establishment of distribution mechanisms for processed products in the future, it is also believed to be possible to stimulate domestic consumption and exports by promoting the use of unutilized marine resources.

With respect to development of unexploited marine resources thriving in the regions of the continental slope, development can be initially expected for those species that are currently already being utilized in consideration of investment effects as well as having high economic value.
These species are presently limited to deep-water pink shrimp *Parapenaeus longirostris* and Norway lobster *Nephrops norvegicus*. The estimated stock sizes on the continental slope of hake *Merluccius merluccius* and Atlantic horse-mackerel *Trachurus trachurus* are relatively abundant, and are considered to be applicable to trawl fishing. Since both these species are widely distributed in pelagic and intermediate strata, development and utilization of these resources can be expected in the future. Moreover, since the distribution and presence of horned octopus *Eledone cirrhosa* have been confirmed at depths of 201 m or more in the Aegean Sea, development of these resources is expected in summer during which the stock size of this species is abundant.

2) Development of Resources by Fishing Gear and Fishing Methods other than Trawling Gear

Development of marine resources can also be considered using bottom long line, bottom set nets or bottom gill net and prawn cages for marine resources thriving on rocks, off the bottom or those that migrate between various depths that are unable to be utilized with trawling gear.

(6) Promotion of Propagation and Aquaculture

The further promotion of propagation and aquaculture operations targeted at freshwater fish using the numerous natural and artificial lakes distributed throughout Turkey is proposed as a means of promoting propagation and aquaculture.
In addition, although propagation and aquaculture of sea fish is presently being carried out in bays and inlets spreading along the coasts of The Sea of Marmara, the Aegean Sea and the Mediterranean Sea, since development is considered to be possible for many more species and locations through the introduction of advanced technology, it will also be important to aggressively proceed with the introduction of such technology.

The recommendations described above are the result of studies of the potential for effective utilization of marine resources already existing in the international and territorial waters surrounding the Republic of Turkey from the standpoint of their effective utilization. In the case these recommendations are implemented, it is desirable that methods be employed that allow these recommendations to be implemented in a form that matches the actual status of the fisheries conditions in Turkey.

CONTENTS

Chapter 1 Introduction

Chapter 1 Introduction

Geographical Characteristics

The Republic of Turkey (to be referred to as "Turkey") is comprised of two sections, consisting of the Anatolian peninsula and the Eastern Thracia, region in the southeastern portion of the Balkan peninsula. The country is located on both sides of the Bosporus Straits that connect the Black Sea and The Sea of Marmara, and spans across sections of both Europe and Asia. Geographically, it is located between 35 degrees 51 minutes and 42 degrees 06 minutes latitude, and 25 degrees 40 minutes to 44 degrees 48 minutes longitude. Turkey covers a total land area of roughly 814,578 km^2, of which 790,200 km^2 are located in Asia and 24,378 km^2 are located in Europe.

Turkey has a population of 55,540,000 people, and a population density of 68 people per square kilometer.

On land, the country is bordered by the Republic of Gruziya to the northeast, Iran to the east, Iraq to the southeast, Syria to the south and the People's Republic of Bulgaria and the Republic of Greece to the northwest. Nearly all the Anatolian peninsula of Turkey is either hilly or mountainous, while the plain is surrounded by the sea and mountains.

With respect to its coastlines, the Black Sea lies to the north, The Sea of Marmara and the Aegean Sea to the west, and the Mediterranean Sea to the south. The lengths of those coastlines are 1,695 km, 1,000 km, 2,800 km and 1,577 km, respectively, thus giving Turkey a total coastline of 7,072 km.

Turkey's climates can broadly be divided into three diverse types. These consist of a Mediterranean climate along The Sea of Marmara, the Aegean Sea and Mediterranean Sea, a steppe climate characteristic of the central plateau having fair, dry weather in the summer months, and a temperate, humid climate having large amounts of rainfall in the region along the coast of the Black Sea.

Status of Economy

Although Turkey is a self-sufficient agricultural nation producing abundant amounts of agricultural products including grain, beans and fruits, it has aggressively promoted industrialization policies from the 1950's to the first half of the 1970's, primarily in the 1960's. As a result, the gross domestic product (GDP) per one person has increased to $US 1,173. However, these industrialization policies are primarily focused on imports that have prevented the country's export industry from developing. As a result, Turkey suffered considerable economic hardships resulting from increases in the monetary amount of crude oil imports due to two oil crises, and these hardships are continuing at present.

Although the proportions of the agricultural, forestry and

fisheries industries within the GDP have demonstrated a decreasing trend due to aggressive promotion of industrialization, they continue to play an important role in Turkey's economy. With the approval of the National Parliament, the Turkish government drafted its 6th five-year plan (1990-1994) in May 1989 in an effort to improve the balance of its current account.

Status of Fisheries

According to the statistics of the fisheries for 1990 published by the Turkish government, Turkey's total catch was 385,114 tons, while exports of fishery products totaled 23,065 tons and imports totaled 16,500 tons. The per capita consumption of fishery products is 6.2 kg. A breakdown of the total catch (385,114 tons) consists of, in order of decreasing catch, sea fish (297,123 tons: 77.1%), crustaceans and mollusks (44,894 tons: 11.7%), freshwater fish (37,315 tons: 9.7%) and aquaculture (5,782 tons: 1.5%). This breakdown indicates that the proportion of sea fish is quite high. With respect to the size of catches of sea fish according to location, 199,830 tons were caught in the Black Sea (67.3%), while 97,293 tons were caught in The Sea of Marmara, the Aegean Sea and Mediterranean Sea (32.7%). A breakdown of sea fish caught in the Black Sea consists of anchovy (66,409 tons: 33.2%), horse mackerels (65,163 tons: 32.6%) and whiting (16,259 tons: 8.1%), indicating large catches pelagic fish. A breakdown of sea fish caught in The Sea of Marmara, the Aegean Sea and Mediterranean Sea consists of pilchard (16,118 tons: 16.6%), chub mackerel (12,371 tons: 12.7%), mullets (8,914 tons: 9.2%), anchovy (7,626 tons: 7.8%) and horse mackerels (6,761 tons: 6.9%). Here too, the majority of catch consists of pelagic fish. Although the relative weight of fishery products is not large, as a result of having a vast coastline containing coves and inlets as well as approximately 900 natural lakes and 114 artificial lakes, Turkey possesses the foundation for growth of its fisheries.

Background of Survey

The government of the Republic of Turkey has requested a loan from the World Bank in order to promote its agro-industry sector, the most important of its manufacturing industries, accounting for roughly 30% of the nation's manufacturing industrial output and roughly 19% of its manufacturing industry exports. Upon receiving this request, the World Bank decided to provide a loan totaling $US 150 million premised on the terms of providing technical guidance to banks participating in the two-step loan program, conducting surveys of fisheries resources in bodies of water surrounding Turkey and implementing training programs dealing with export marketing. The World Bank included an amount of $US 6.2 million in the total amount of the loan to cover costs

required for conducting the surveys, training program and so on specified in the terms of the loan. In the case the cooperation of an international organization or organization of a third country is obtained, with respect to those costs required for conducting surveys, training and so on, those costs can be allotted to the main body of the loan. Consequently, the Turkish government decided to request the assistance of Japan in conducting its survey of fisheries resource.

The surveys of fisheries resource specified as terms of the loan by the World Bank are composed of 5 types consisting of: (1) Acoustic survey, (2) Demersal fish survey, (3) coastal reconnaissance, (4) inland fisheries survey, and (5) marketing survey.

After examination of this request, the Japanese government agreed to the providing of technical assistance. The Japan International Cooperation Agency (JICA), serving as the executive organization, conducted a contact survey in April 1990. JICA held discussions concerning the contents of the request from the Turkish government, confirmation of order of priority, survey items, survey methods and the system by which surveys are to be implemented, for each of the five types of surveys listed above. In addition, the possibility of cooperation by Japan in each of these areas was also examined.

As a result, with the exception of the acoustic survey and demersal fish survey being conducted at the time by the Institute of Marine Sciences of the Middle East Technical University in the Black Sea with funding provided by the North Atlantic Treaty Organization (NATO), basic agreement was reached with Turkey to conduct a resources survey targeted at demersal fish in The Sea of Marmara, the Aegean Sea and Mediterranean Sea.

Moreover, JICA dispatched a survey team to Turkey in October 1990 to discuss the Scope of Work (S/W). Discussions were held concerning specific methods for implementing the demersal fish survey agreed on by both parties at the time of the contact survey, as well as the roles to be played by both sides. A final decision was reached concerning the Scope of Work on November 13th of that same year.

Objects and Procedures

The objectives of this survey consisted of: 1) clarifying the distribution of commercially important fish species and determining the status of those resources, 2) estimating the amount of the maximum sustainable catch of demersal fish with respect to unutilized and unexploited resources within sea areas surrounding Turkey excluding the Black Sea, and 3) making recommendations relating to rational fisheries management and development of demersal fish resources by the Turkish government.

This demersal fisheries resource survey was discussed between JICA and the Ministry of Agriculture, Forestry and Rural Affairs (MAFRA, later reorganized into the Ministry of Agriculture and

Rural Affairs, MARA, in August 1992) in line with the Scope of Work described above, and was then carried out with the guidance and cooperation of the Work Advisory Committee of JICA.

This cooperative demersal fisheries resource survey was carried by chartering the R/V K. Piri Reis, owned by Institute of Marine Sciences and Technology of Dokuz Eylul University. After determining the locations to be surveyed by stratified random sampling, the survey was carried out targeted at demersal fish using trawling gear. After completion of the preliminary survey during the months of May to June 1991, the actual survey was carried out five times from July 1991 to March 1993. Surveys were conducted five times, consisting of those in the winter, summer, spring and autumn, and one supplemental survey in the winter.

The survey consisted of surveying the amount of demersal fish resources using trawling gear as well as an oceanographic survey, a mesh selectivity experiment, a comparative test of fishing efficiency with commercial fishing boats, and a shrimp resource survey. The survey was carried out based on the Scope of Work and an execution schedule.

The survey report consisted of comparisons, analyses and studies of data, including that contained in seasonal progress reports (in Japanese) already issued and Interim Report, an estimation of the present status of resources of demersal fish inhabiting sea areas surrounding Turkey, and the ideal form of fishery and resource management targeted at those resources.

Chapter 2 Outline of Survey

Chapter 2 Outline of Survey

2-1 Objective

The objectives of each survey item conducted are as indicated below.

2-1-1 Demersal Fisheries Resource Survey

To study seasonal distribution and movement with respect to commercially important fish species (Table 2-1) along with evaluation of those resources, and the potential for development of unutilized and unexploited resources.

2-1-2 Biological Survey

To determine body length composition and biological information with respect to commercially important species.

2-1-3 Mesh Selectivity Experiment

To determine the relationship between the age (or body length) at which fish are first captured and the size of cod end mesh size with respect to commercially important species.

2-1-4 Water Temperature and Salinity Measurements

To determine the marine environments (distribution of water temperature and salinity) of sea areas targeted by this survey with respect to demersal fish resources.

2-1-5 Sea Bottom Topographical Survey

To search the sea bottom for locations that allow trawling prior to hauling the trawl net, and to obtain an understanding of the distribution of schools of fish.

2-1-6 Comparative Test of Fishing Efficiency

To determine the fishing efficiency of the trawling gear used by the research vessel and a commercial fishing boat.

2-1-7 Shrimp Resource Survey

To mainly compare the fishing efficiency of trawling gear for demersal fish and trawling gear used for shrimp with respect to catching of shrimp.

2-1-8 Fish Landing Site Survey

To survey the actual status of the fisheries in the Republic of Turkey, and contribute to resource management of demersal fish together with the results of the sea-borne survey.

Table 2-1 Commercially Important Species (Species Targeted for Measurement)

No.	Family name	Scientific name	Common name
1	Synodontidae	*Saurida undosquamis*	Brushtooth lizardfish
2	Merlucciidae	*Merluccius merluccius*	Hake
3	Serranidae	*Serranus cabrilla*	Comber
4	〃	*S. scriba*	Painted comber
5	Mullidae	*Mullus barbatus*	Red mullet
6	〃	*M. surmuletus*	Striped red mullet
7	〃	*Upeneus moluccensis*	Golden-banded goatfish
8	Sparidae	*Sparus aurata*	Gilt-head sea bream
9	〃	*Dentex macrophthalmus*	Large-eye dentex
10	〃	*Diplodus annularis*	Annular sea bream
11	〃	*D. vulgaris*	Common two-banded sea bream
12	〃	*Pagellus erythrinus*	Common pandora
13	〃	*P. acarne*	Axillary sea bream
14	〃	*P. bogaraveo*	Red sea bream
15	Sphyraenidae	*Sphyraena sphyraena*	Barracuda
16	〃	*S. chrysotaenia*	Obtuse barracuda
17	Soleidae	*Solea vulgaris*	Common sole, Dover sole

Note: Important invertebrates are also to be measured.

2-2 Surveyed Areas

The surveyed areas consisted of areas within the territory of Turkey and in international waters in The Sea of Marmara, the Aegean Sea and Mediterranean Sea at water depths of 20-500 m (Fig. 2-1). Furthermore, in order to accurately estimate the amount of demersal fish stocks, the surveyed areas were divided into five sub areas (Fig. 2-2), and each sub area was stratified into three water depth zones by contour lines at depths of 100 m and 200 m (Fig. 2-3). The total area of the survey target sea areas is roughly 52,000 km^2. The area of the survey was calculated using marine charts published by the Turkish Navy (chart Nos.: 21, 22, 22A, 31, INT 3600 32, INT 3600 33 and INT 3708 29).

2-3 Survey Dates and Durations

The seasonal survey dates and durations (from boarding to disembarking) are as indicated below.

Summer Survey: 60 days from July 3 to August 31, 1991

Winter Survey: 41 days from December 3, 1991 to January 12,1992

Spring Survey: 60 days from April 6 to June 4, 1992, during this time, a comparative test of fishing efficiency was conducted for 30 days from April 6 to May 5.

Autumn Survey: 65 days from September 14 to November 17, 1992, during this time, the shrimp resources survey was conducted for 5 days from November 8 to November 12.

Supplementary Winter Survey: 40 days from January 17 to February 25, 1993

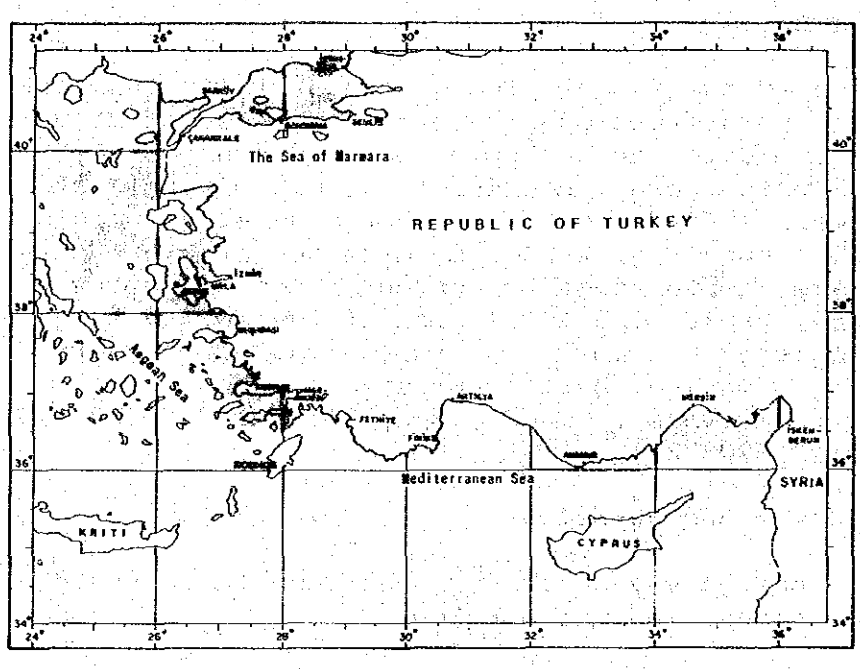


Fig.2-1 Map of the survey area

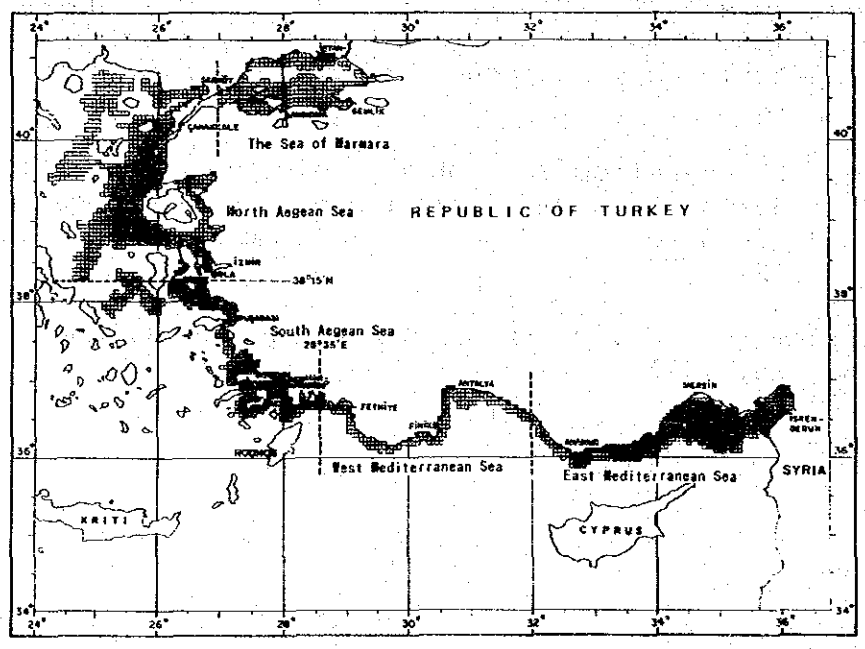
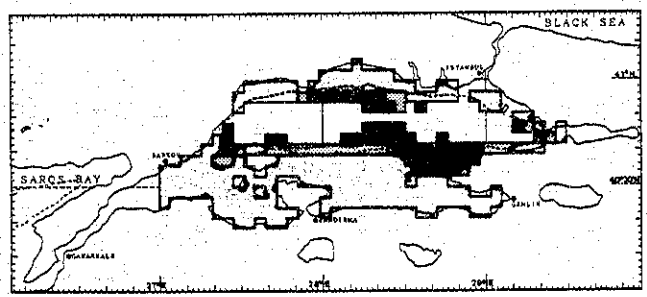
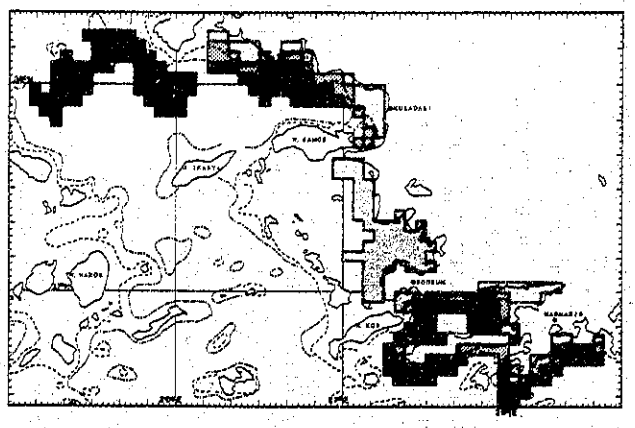


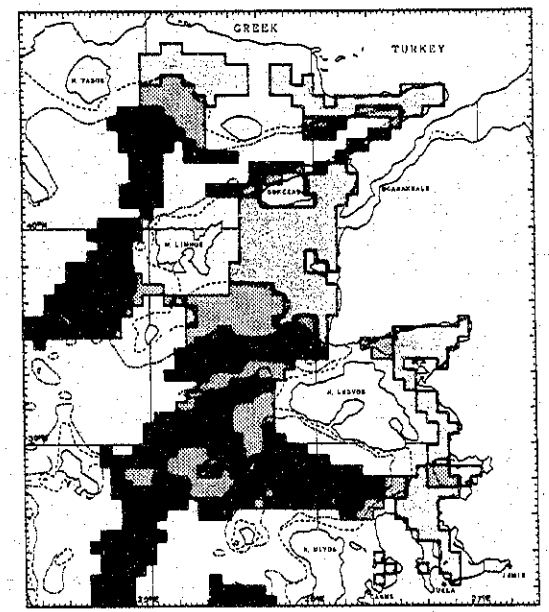
Fig.2-2 Map of the five sub-area for bottom trawl survey



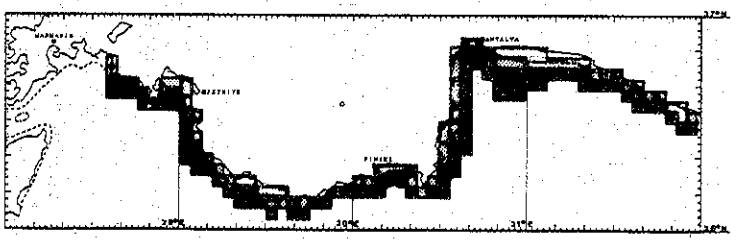
The Sea of Marmara



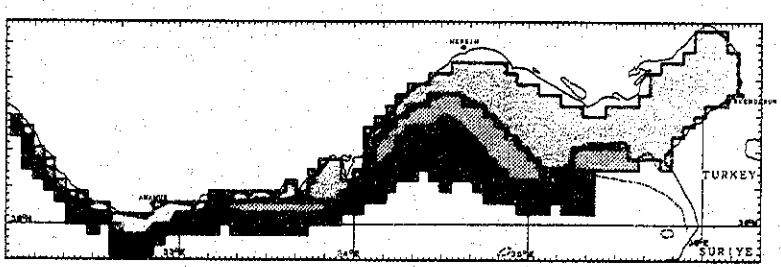
South Aegean Sea



North Aegean Sea



West Mediterranean Sea



East Mediterranean Sea

20～100m
101～200m
201～500m

Fig. 2-3 Three depth strata of each sub-area stratified by isobaths 100m and 200m

2-4 Research Vessel

The R/V K. Piri Reis, a vessel owned by Institute of Marine Sciences and Technology of Dokuz Eylul University, located in the city of Izmir in the Republic of Turkey, was used for the research vessel. In addition, the Turgut Reis, a commercial fishing boat operated by Foca Harbor in the Izmir Prefecture of the Republic of Turkey, was used in the comparative test of fishing efficiency with the research vessel carried out in the spring. Major data and specifications of these two vessels are as indicated below.

a) R/V K. Piri Reis
Type: Oceanographic observation ship allowing stern trawling
Gross tonnage: 300 tons
Major dimensions: 36 m length x 8.1 m width x 3.8 m draft
Engine: 610 horsepower, Diesel engine
Max. speed: 12 knots
Year built: 1978 (in Oldersum, Germany)
Registration: Germany, Lloyd No.: 15487/1
Nautical instruments: Decca radar, satellite navigation instruments (NASS), GPS
Observation instruments: Scanning sonar, echo sounder, CTD
Fishing gear: Trawling winch (2, 4 tons each), SCANMAR bottom trawling gear, shrimp trawling gear

b) Turgut Reis
Type: Stern trawling boat
Gross tonnage: 25 tons
Major dimensions: 19 m length x 4.5 m width x 2.8 m draft
Engine: 350 horsepower, Diesel engine
Max. speed: 7 knots
Year built: 1950 (in Greece)
Nautical instruments: Decca radar
Fishing gear: Two trawling winches, bottom trawling gear

2-5 Fishing Gear Used

The fishing gear used in the demersal fisheries resource survey (loaded on the K. Piri Reis) was designed and fabricated by the Institute of Marine Sciences and Technology of Dokuz Eylul University, and consisted of trawling gear for bottom trawling equipped with ground rope 27.9 m in length and head rope 20.6 m in length (Appendix Fig. 1).

The mesh selectivity experiment was performed by attaching the knotted net to be tested on the inside of the front end of the cod end of this fishing gear (indicated with an * in Appendix Fig. 1).

An overview of the specifications of the trawling gear used by the commercial fishing boat, Turgut Reis, for the comparative

test of fishing efficiency are as indicated in Appendix 2.

The shrimp trawling gear equipped on the K. Piri Reis and used in the shrimp resource survey consisted of a single shrimp trawl net equipped with ground rope 29.8 m in length and head rope 25.4 m in length (Appendix Fig. 3).

2-6 Researchers and Crew Members

The following researchers and crew members participated in the survey.

a) Planning (the Work Advisory Committee)
   Japan: Tadashi Inada (Tohoku National Fisheries Research Institute)
   Shigeyuki Kawahara (National Research Institute of Far Seas Fisheries)
   Tatsuki Nagai (Nansei National Fisheries Research Institute)
   Turkey: E. F. AKYUZ (Ministry of Agriculture and Rural Affairs)

b) Sea-Borne Survey Personnel
   Japan: Takeji Ohtsuka (Sanyo Techno Marine, Inc.)
   Osamu Arakawa (Sanyo Techno Marine, Inc.)
   Turkey: H. A. BENLI (Dokuz Eylul University)
   In addition, there were also many other survey personnel from Dokuz Eylul University and Ege University.

c) Fish Landing Site Survey Personnel
   Turkey: Specialists of the regional offices of the Ministry of Agriculture and Rural Affairs

d) Captain and Crew Members
   Captain: M. KIRCADAG (Institute of Marine Sciences and Technology, Dokuz Eylul University)
   Crew members: 13-19 members
   (Institute of Marine Sciences and Technology, Dokuz Eylul University)

Chapter 3 Survey Methodology

Chapter 3 Survey Methodology

3-1 Sea-Borne Survey

3-1-1 Demersal Fisheries Resource Survey

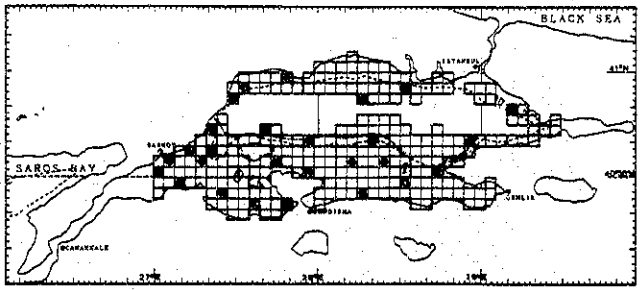
The surveyed areas were divided into 1,903 blocks each covering an area of 3 square miles (Fig. 2-2), and these blocks were then further stratified into three water depth zones for each sub area (Fig. 2-3). Each of these blocks was then used as a survey station (trawling station).

The planned trawling stations consisted of 170 stations for each season, and these 170 stations were distributed in proportion to the area of each stratum. However, in the case of distribution of stations in strata from 201-500 m, the areas of those strata were weighted by a factor of 0.5. Furthermore, in order to process the estimated values numerically, a minimum of three stations were assigned to each stratum (Table 3-1).

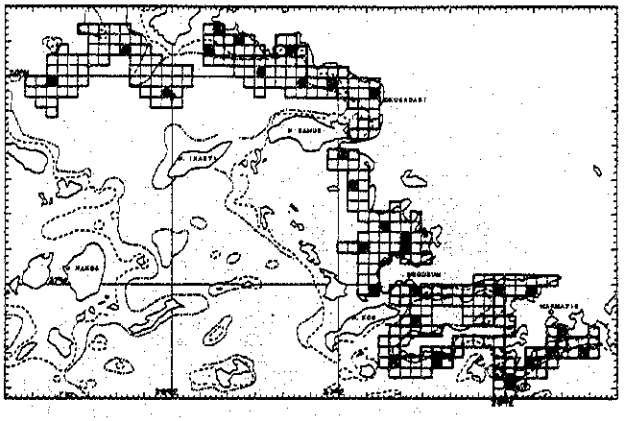
The locations of the planned trawling stations for each season were determined by random sampling method (Figs. 3-1-1 to 3-1-4). As a general rule, the method in which nets were hauled during trawling consisted of hauling the net on bottom for 30 minutes at a constant speed between 2-3 knots during the day. Each species of the catches caught at each trawling station was weighed and counted.

Table 3-1 Strata Area, Number of Blocks and Planned Number of Stations by Sub Area

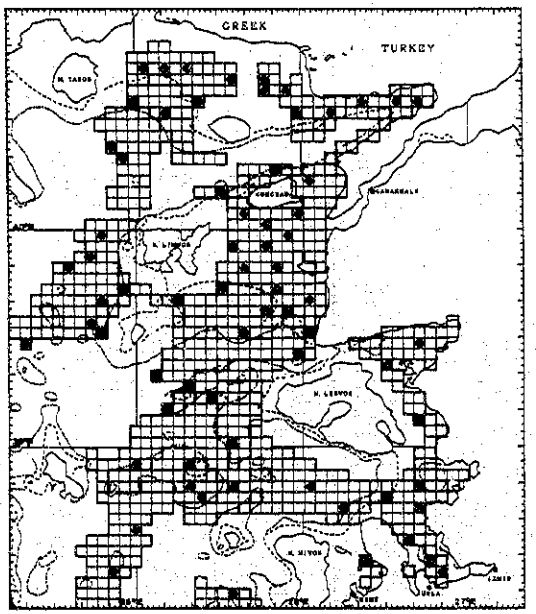
Stratum / Sub area	Area in km²			No. of 3 mile-square blocks			No. of stations		
	20~100m	101~200m	201~500m	20~100m	101~200m	201~500m	20~100m	101~200m	201~500m
The Sea of Marmara	5,429	601	1,334	182	27	47	21	3	3
North Aegean Sea	8,540	4,051	9,986	244	174	355	34	16	20
South Aegean Sea	3,210	1,220	4,448	100	50	141	13	5	10
West Mediterranean Sea	1,116	593	1,440	44	27	93	4	3	3
East Mediterranean Sea	5,927	1,762	2,178	208	76	135	24	7	4
Sub total	24,222	8,227	19,386	778	354	771	96	34	40
Total	51,835			1,903			170		



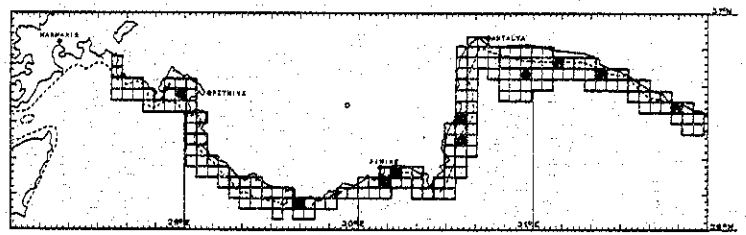
The Sea of Marmara



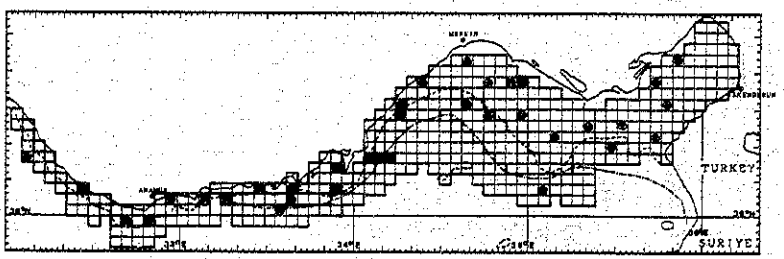
South Aegean Sea



North Aegean Sea

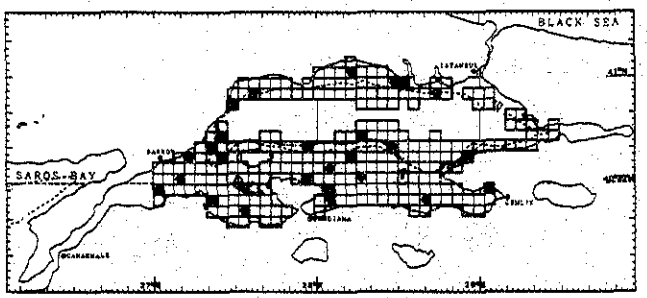


West Mediterranean Sea

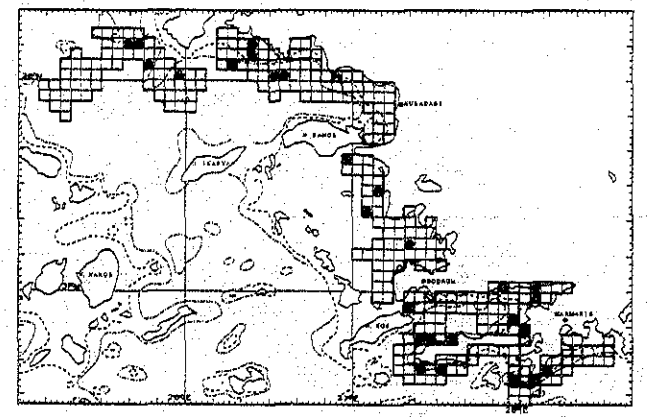


East Mediterranean Sea

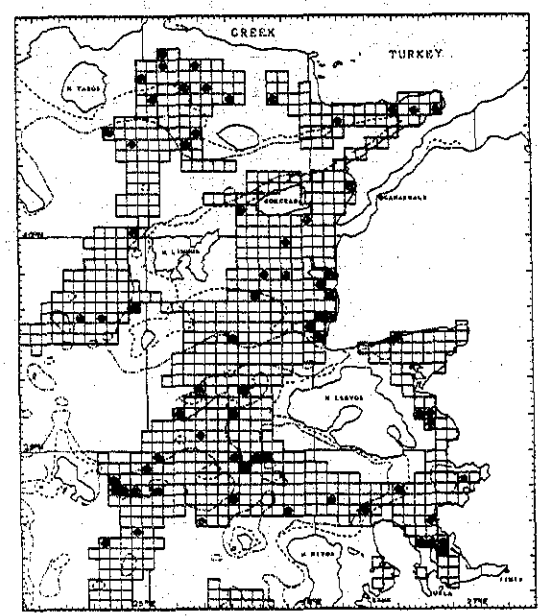
Fig.3-1-1 The positions of the trawl stations selected by random sampling in the summer season survey



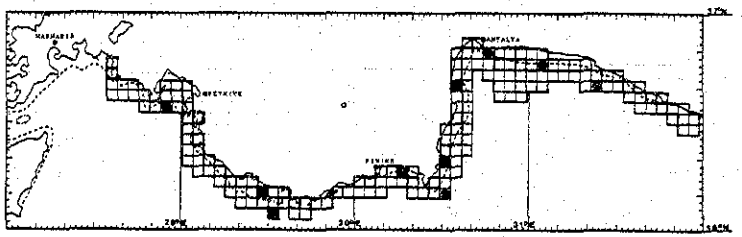
The Sea of Marmara



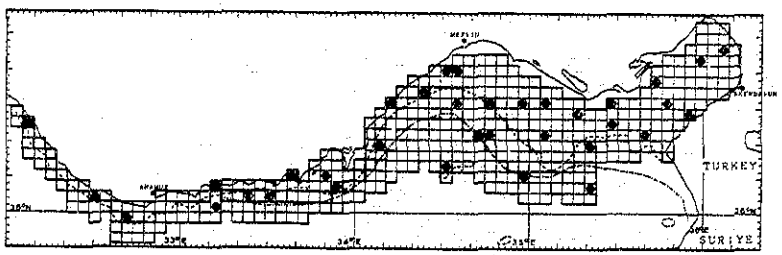
South Aegean Sea



North Aegean Sea

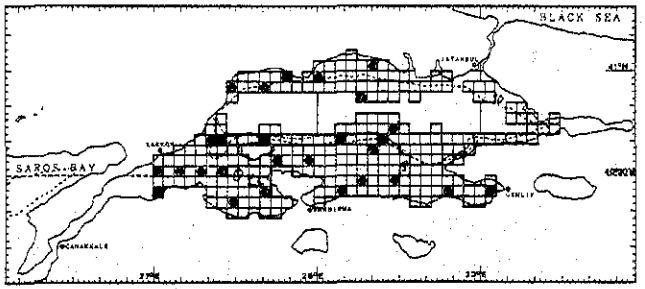


West Mediterranean Sea

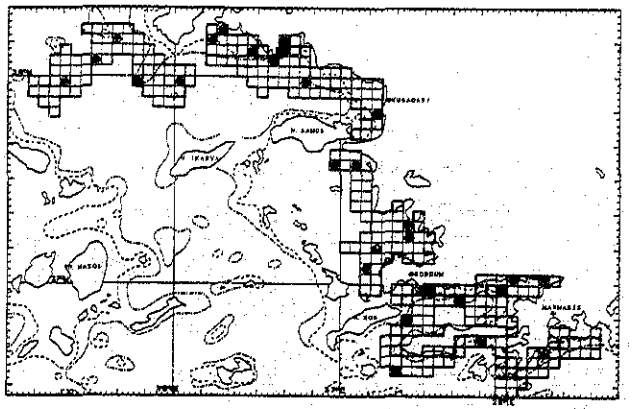


East Mediterranean Sea

Fig.3-1-2 The positions of the trawl stations selected by random sampling in the winter season survey



The Sea of Marmara



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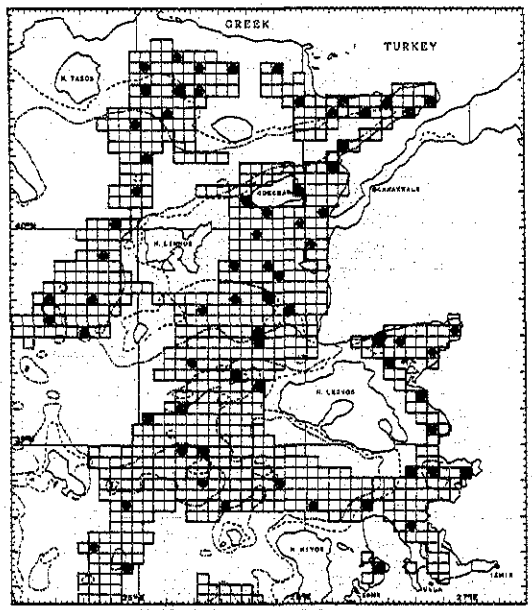

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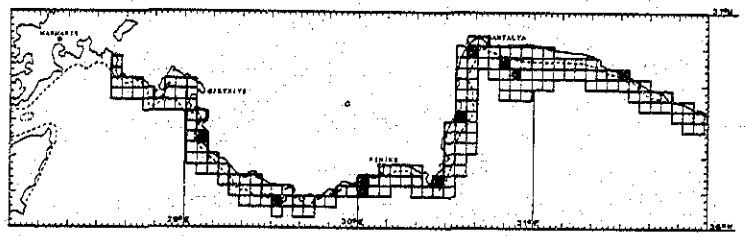

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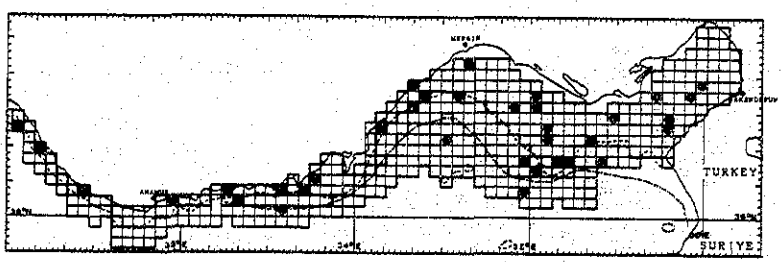
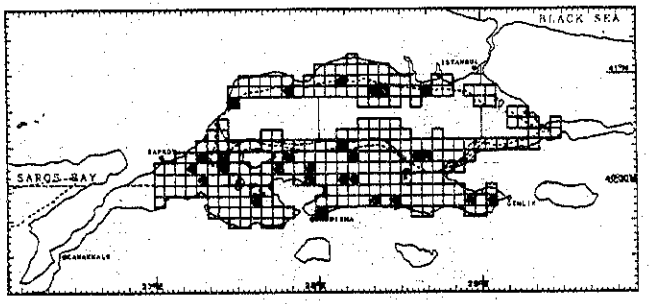
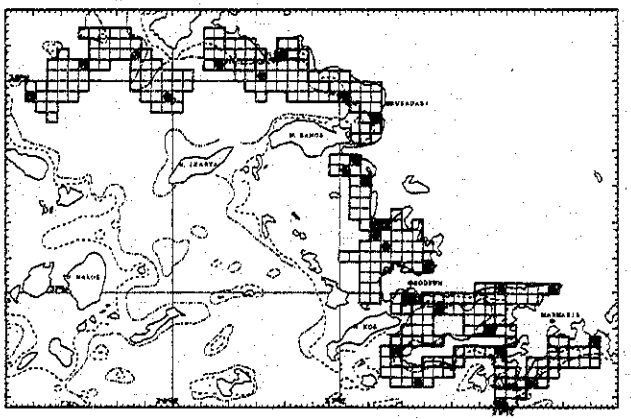


East Mediterranean Sea

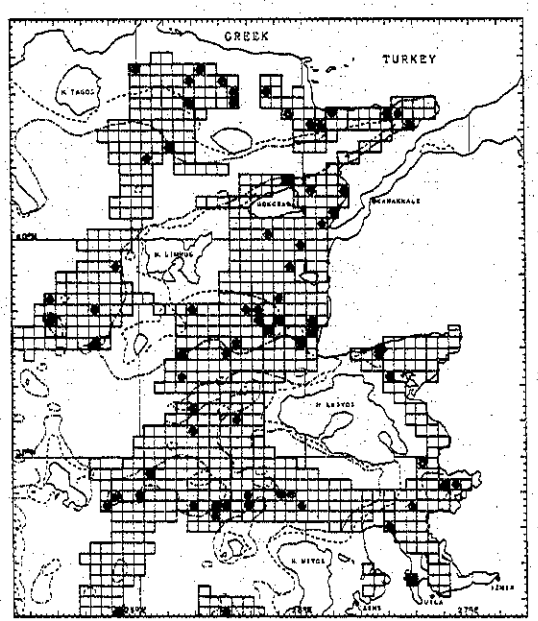
Fig.3-1-3 The positions of the trawl stations selected by random sampling in the spring season survey



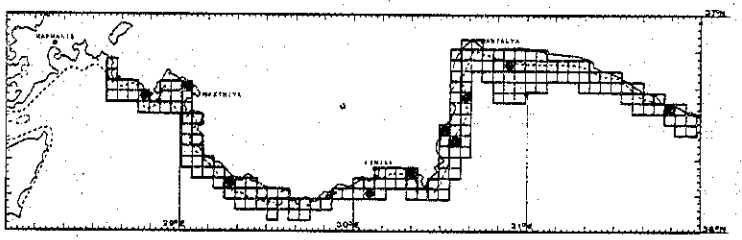
The Sea of Marmara



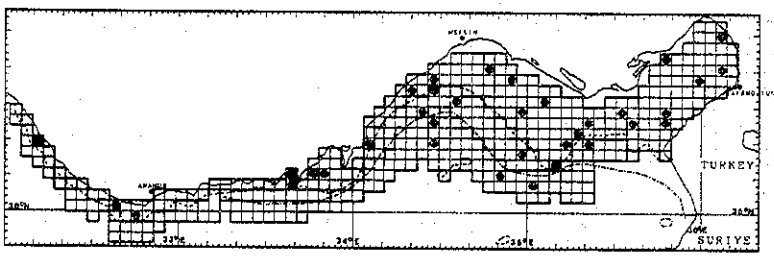
South Aegean Sea



North Aegean Sea



West Mediterranean Sea



East Mediterranean Sea

Fig.3-1-4 The positions of the trawl stations selected by random sampling in the autumn season survey

The estimations of stock sizes were calculated based on the area-swept method. The estimations of stock sizes, standard error and coefficient of variation were calculated using the following equations.

$$d_{ij} = X_{ij} \; / \; a_{ij}$$

$$B_i = A_i \; . \; \bar{d}_i$$

$$SB_i = A_i \frac{S_{di}}{\sqrt{n_i}}$$

$$B = \Sigma \; B_i$$

$$SB = \sqrt{\Sigma \; SB_i^2}$$

$$CV = SB \; / \; B \; x \; 100$$

where:

d_{ij} = Density at j-th station in i-th stratum (kg/km^2)
X_{ij} = Catch at j-th station in i-th stratum (kg)
a_{ij} = Area swept at j-th station in i-th stratum (km^2)
B_i = Stock size in i-th stratum (tons)
A_i = Area in i-th stratum (km^2)
$\bar{d}_i$ = Mean density of i-th stratum (kg/km^2)
SB_i = Standard error of stock size in i-th stratum
Sd_i = Standard deviation of density in i-th stratum
n_i = No. of trawled in i-th stratum
B = Total stock size (tons)
SB = Standard error of total stock size
CV = Coefficient of variation (%)

The area swept per haul was calculated from the trawling distance (m) of the trawling net and the width between wing-nets (m). The width between wing-nets was calculated from the width between otter boards (m) as measured by the SCANMAR.

For the estimations of stock sizes, the catch rate of a school of fish present within the area of the haul being caught by 1 time of hauling, or in other words, the efficiency of fishing of the trawling gear, was assumed to be 1.0.

3-1-2 Biological Survey

Body length was measured using the hole punching method for each trawling station for the purpose of obtaining the composition of body lengths for commercially important fish species (Table 2-1). At the same time, a biological survey was also conducted on commercially important species to investigate body length, body weight, determination of sex, female maturity, gonad weight and stomach contents. In addition, other fishes,

invertebrates, and particularly shrimps, squids and octopuses, considered to be commercially important, were also suitably taken to be targets of this survey in addition to the 17 fish species shown in Table 2-1.

3-1-3 Mesh Selectivity Experiment

Mesh selectivity experiments were carried out during the winter, spring and autumn surveys, but not during the summer survey. This experiment was carried out by the cover net method in which test nets having mesh sizes of 50 mm, 70 mm, 90 mm and 110 mm were attached to the inside of the front end of the cod end of bottom trawl net (indicated with a * in Appendix Fig. 1).

3-1-4 Water Temperature and Salinity Measurements

Water temperature and salinity values were recorded using a CTD from the surface stratum (several meters beneath the surface) to the bottom stratum (several meters or several tens of meters from the bottom) at each of the trawling stations (within each block).

3-1-5 Sea Bottom Topographical Survey

Those locations of the sea bottom that allow trawling were determined in advance by using an echo sounder.

3-1-6 Comparative Test of Fishing Efficiency

Comparative tests of fishing efficiency were conducted in the spring in the North Aegean Sea and East Mediterranean Sea at a depth of 200 m or less. These tests were conducted in the form of parallel operation of the K. Piri Reis, which was used for the research vessel, and a commercial fishing boat, the Turgut Reis. Although the trawling method, counting and weighing of fish caught were the same as that employed in the demersal fisheries resource survey, the biological survey conducted by the commercial fishing boat only consisted of measuring body length by the hole punching method.

3-1-7 Shrimp Resource Survey

Shrimp resource surveys were conducted in the autumn. Iskenderun Bay in the East Mediterranean Sea was selected for the surveyed area (Fig. 3-2). The survey stations consisted of 10 stations in the vicinity of water depths of 20 m, 50 m, 75 m, 150 m and 350 m along two lines running from the innermost portion of the bay to the mouth and outside of the bay. The surveys were scheduled to be conducted once during the day and once at night at each station for a total of 20 times. The method of net hauling was the same as that in the demersal fisheries resource

survey. The catches were counted and weighed for each species from each trawling station. With respect to shrimp in particular, in addition to measuring total length, carapace length and body weight, sex was also determined based on a maximum limit of 20 shrimp.

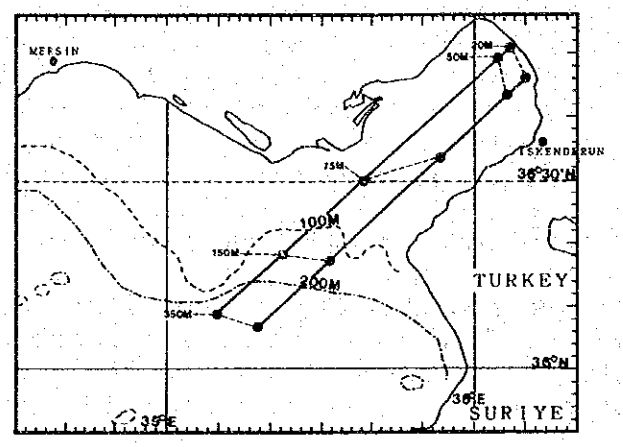


Fig. 3-2 Planned Shrimp Trawling Stations as Selected by Line Transection Methods in Autumn Survey

3-2 Fish Landing Site Survey

3-2-1 Collection of Fisheries Statistics

Fisheries statistics published by the government of the Republic of Turkey were collected for the past 21 years from 1970 to 1990. These were used to obtain an understanding of the present status of the fisheries in Turkey, and particularly, to obtain an understanding of the size of catches according to area and species, along with any fluctuations in those catches.

3-2-2 Fisheries Interview Survey

Interview surveys were conducted regarding the actual status of the fisheries (including fishing gear, fishing grounds, catch and so forth) at the fishing ports located in the representative prefectures for each sub area (Table 3-2) for a period of roughly 30 days during the time sea-borne surveys were being conducted. Furthermore, these surveys were supervised by survey personnel at each of the regional offices of the Ministry of Agriculture and Rural Affairs.

Table 3-2 Names of Prefectures Surveyed in Fisheries Interview Survey

Sub area	Prefecture
The Sea of Marmara	I S T A N B U L
North Aegean Sea	C A N A K K A L E
South Aegean Sea	M U G L A
West Mediterranean Sea	A N T A L Y A
East Mediterranean Sea	M E R S I N

3-2-3 Survey of Length Composition

The body lengths of primarily the commercially important species shown in Table 2-1 that were caught and landed at the fishing ports located in the representative prefectures for each sub area port were measured in parallel with the fishery interview survey. This survey was also supervised by survey personnel at each of the regional offices of the Ministry of Agriculture and Rural Affairs.

3-3 Analysis Methods

The stock sizes of target fish (stock size, number of fish) varies throughout recruitment into the fish population, growth and death (natural mortality and fishing mortality). The parameters that define these processes are determined according to the biological characteristics of the target species and the characteristics of the fishery engaged in fishing. These parameters determine stock size and rate of stock size fluctuations, and are referred to as the resource parameters.

3-3-1 Resource Parameters

(1) Natural Mortality Coefficient (M)

The natural mortality coefficient refers to the instantaneous rate of decrease due to natural causes other than fishing, and is one of the most difficult coefficients to estimate. Various methods have been proposed for its estimation. In this case, if the shape of the fish survival curve was assumed to be constant regardless of species, we considered that the mortality coefficient in the natural status ought to be proportional to the inverse of life span. Based on this relationship, we obtained the relational expression from the relationship between life span and natural mortality coefficient for 5 species of fish for which the natural mortality coefficient has been relatively accurately determined by Tanaka (1960).

$$M = 2.5/Xd$$

In this equation, Xd represents the maximum age of the fish.

In this survey, M was determined by considering the maximum age obtained from four sea-borne surveys to be equal to life span.

(2) Growth Parameters

Based on the results of age determination by otolith, we applied Von Berterlanffy's growth equation from the mean body length by age so that the limiting body length would not exceed the maximum body length of fish caught.

3-3-2 Estimation of Optimum Catch Coefficient

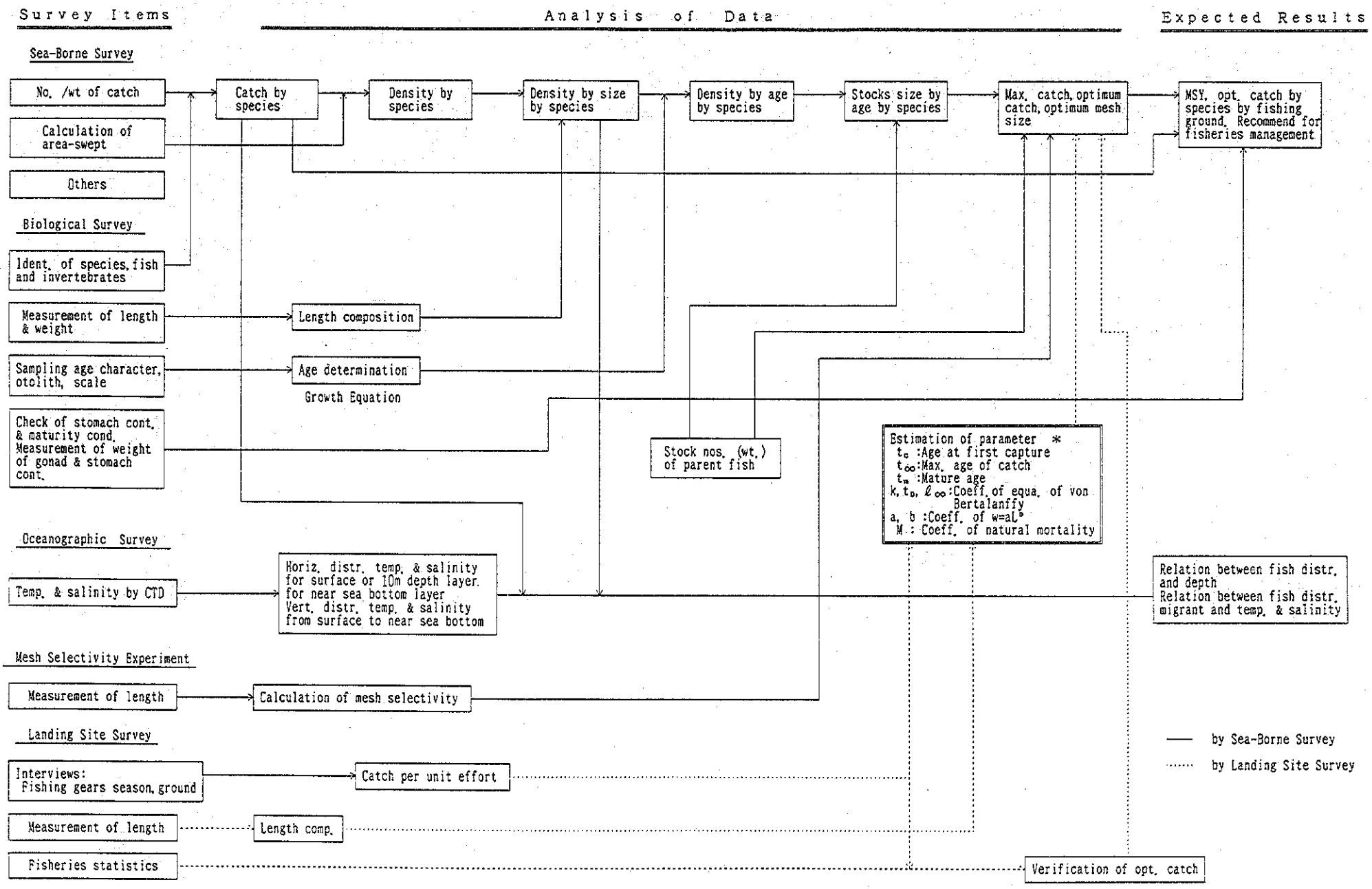
$F_{0.1}$ and F_{max} were determined from the catch size per recruit into the population as calculated according to the Thompson and Bell method for those species for which biological information were able to be obtained. In this case, $F_{0.1}$ was taken to be F_{opt}.

3-3-3 Estimation of Optimum Yield, Etc.

Optimum yield (OY) and maximum sustainable yield (MSY) were calculated from the equations shown below.

$$OY = 0.5 * F_{0.1} * B_o$$
$$MSY = 0.5 * F_{max} * B_o$$

F_{max} was taken to be F_{msy}, the catch coefficient that gives MSY. A basic flow chart of survey items and data analysis is shown in Fig. 3-3.



* Estimation will be carried out only enough data obtain.

Fig. 3-3 Analytical Flow Chart of Demersal Fisheries Resource Survey

Chapter 4 Data Acquisition

Chapter 4 Data Acquisition

4-1 Sea-Borne Survey

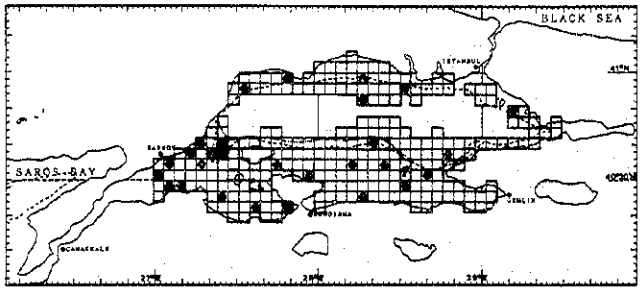
4-1-1 Demersal Fisheries Resource Survey

The number of locations at which trawling surveys were carried out consisted of 172 trawling stations in the summer, 140 stations in the spring and 155 stations in the autumn.

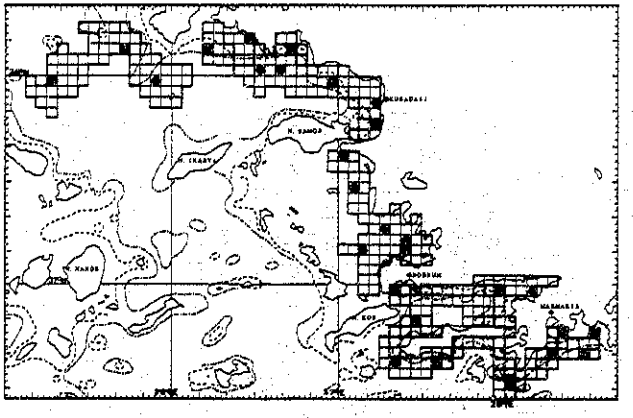
During the winter survey, the number of trawling stations was reduced to 36 due to bad weather and sea conditions as well as a malfunction in the instruments of the research vessel. In order to proceed with the survey as planned, a supplementary trawling survey was conducted at 50 trawling stations one year later. Although there was a time delay between the winter and supplementary winter surveys, these results were analyzed as a whole because the season much regarded than year in this survey (Table 4-1 and Figs. 4-1-1 to 4-1-4).

Table 4-1 Number of Trawling Stations Actually Carried Out by Season and Sub Area

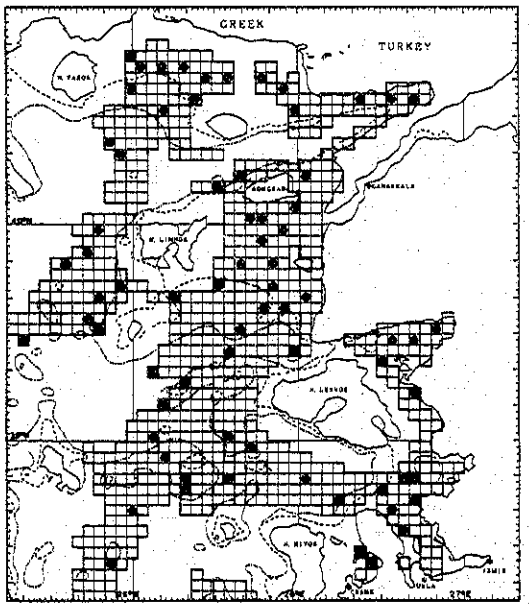
Season	Summer			Winter			Spring			Autumn		
Sub area \ Stratum (m)	20~100	101~200	201~500	20~100	101~200	201~500	20~100	101~200	201~500	20~100	101~200	201~500
The Sea of Marmara	22	4	2	15	3	3	21	3	3	21	3	3
North Aegean Sea	35	16	20	18	8	7	27	8	10	32	11	13
South Aegean Sea	13	5	10	5	4	4	12	5	6	13	5	10
W. Mediterranean Sea	4	3	3	3	3	3	4	3	3	4	3	3
E. Mediterranean Sea	24	7	4	4	3	3	24	7	4	23	7	4
Sub total	98	35	39	45	21	20	88	26	26	93	29	33
T o t a l	172			86			140			155		



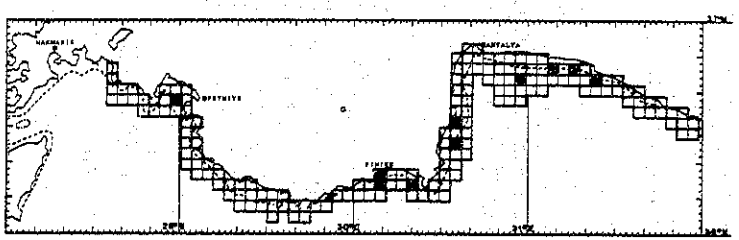
The Sea of Marmara



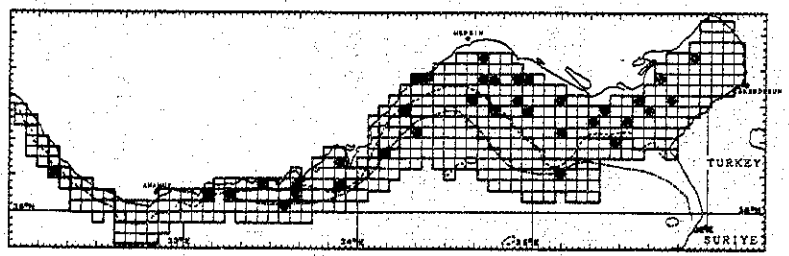
South Aegean Sea



North Aegean Sea

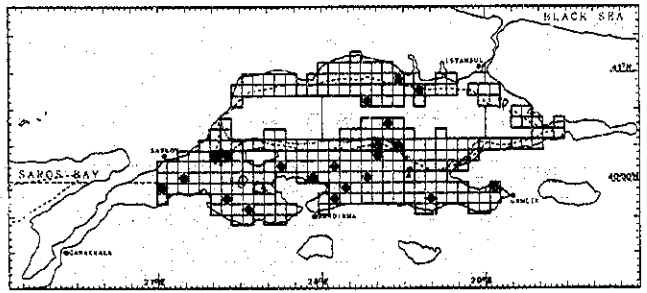


West Mediterranean Sea

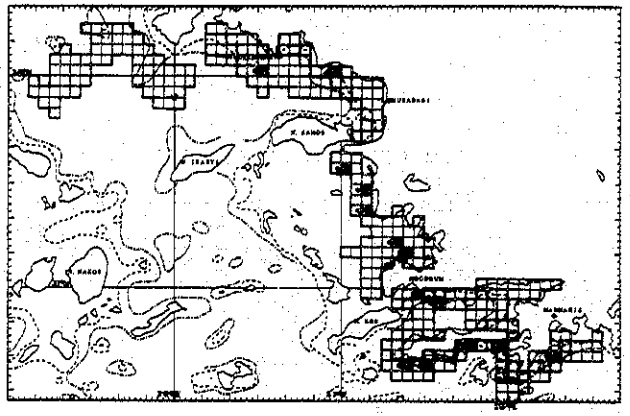


East Mediterranean Sea

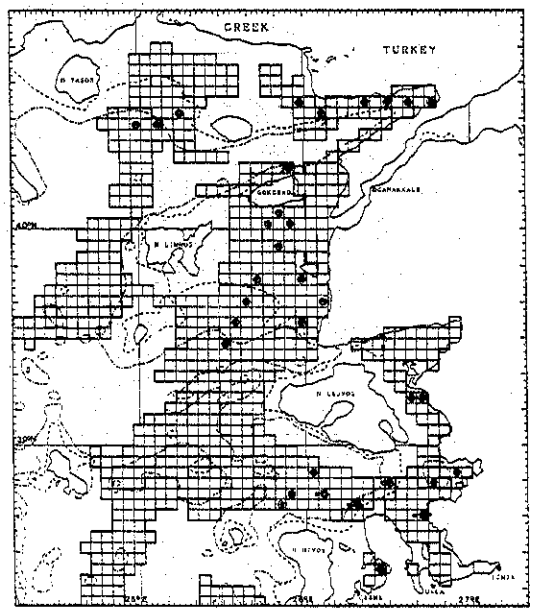
Fig.4-1-1 The positions of the trawl stations actually trawled in the summer season survey



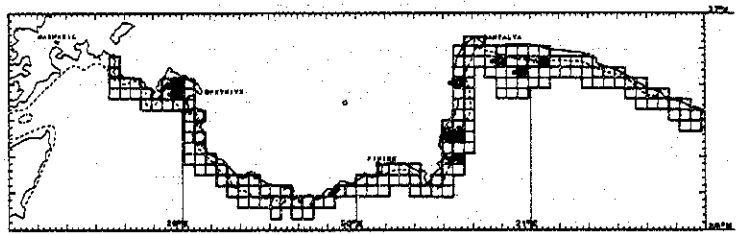
The Sea of Marmara



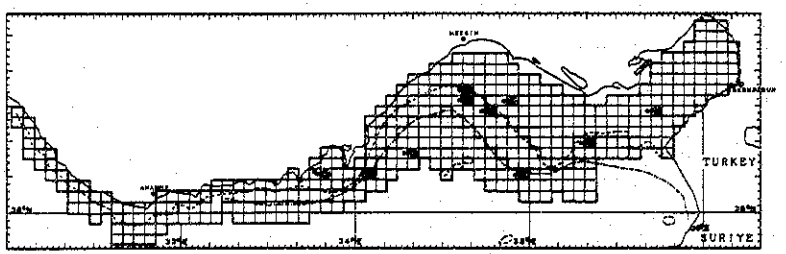
South Aegean Sea



North Aegean Sea



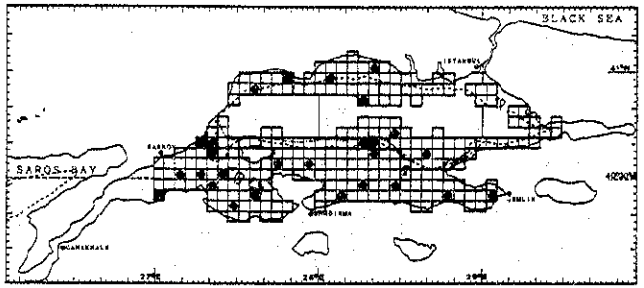
West Mediterranean Sea



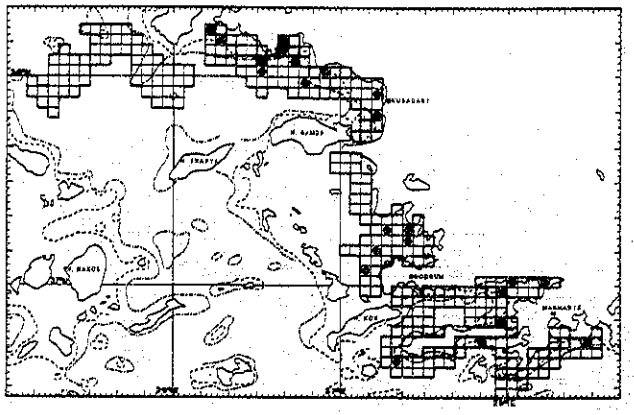
East Mediterranean Sea

Fig.4-1-2 The positions of the trawl stations actually trawled in the winter season survey

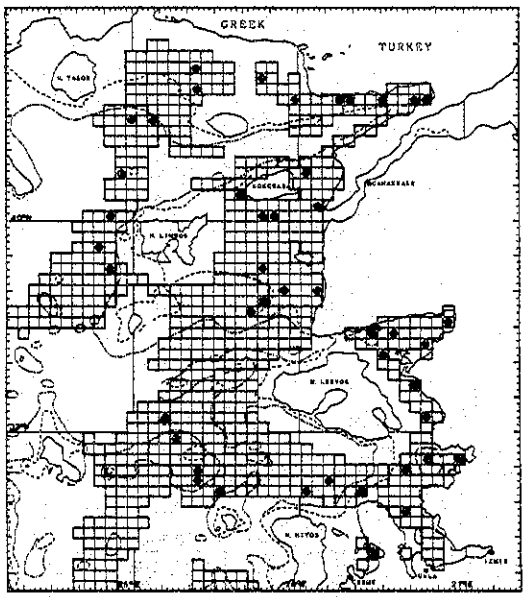
* First winter season survey



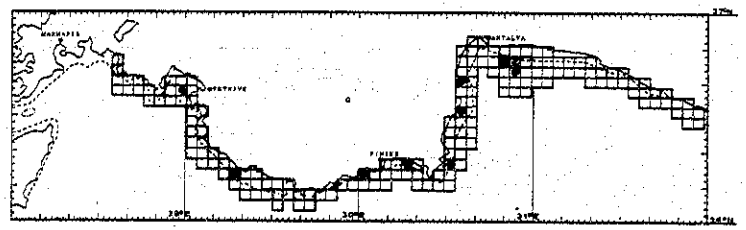
The Sea of Marmara



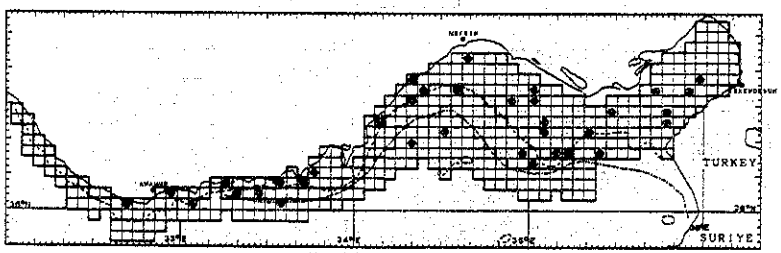
South Aegean Sea



North Aegean Sea

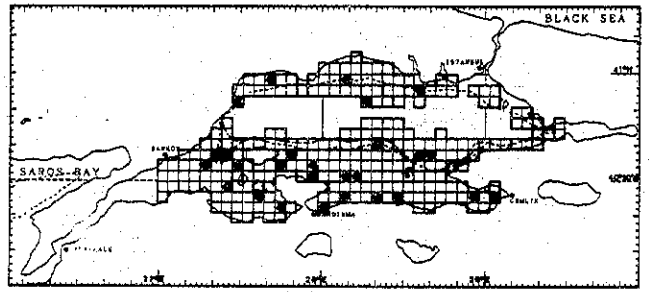


West Mediterranean Sea

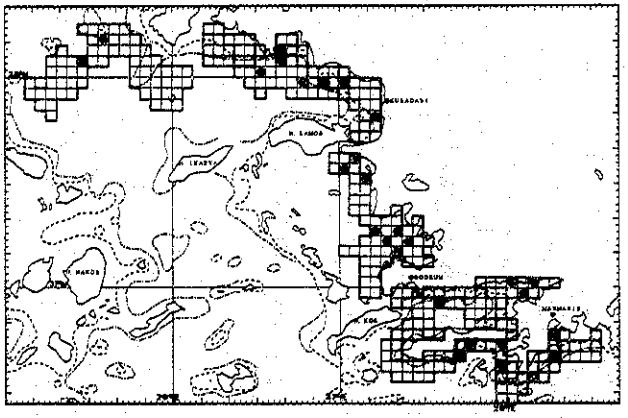


East Mediterranean Sea

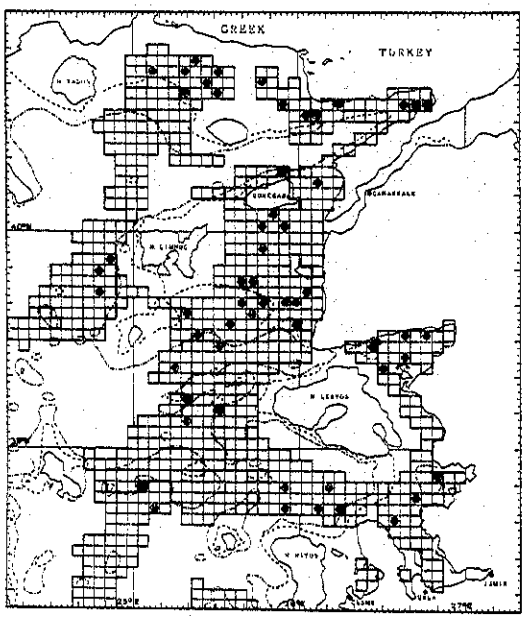
Fig.4-1-3 The positions of the trawl stations actually trawled in the spring season survey



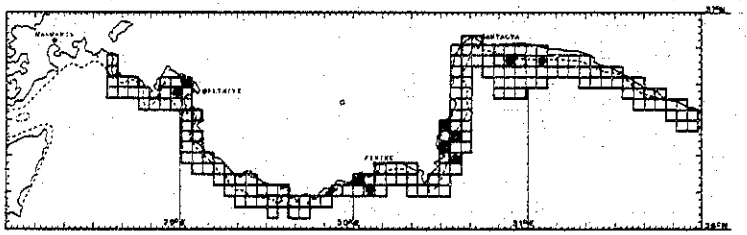
The Sea of Marmara



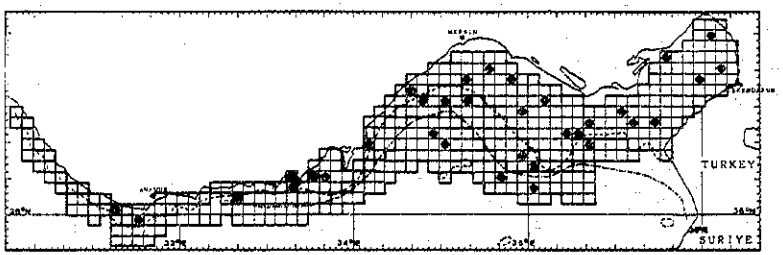
South Aegean Sea



North Aegean Sea



West Mediterranean Sea



East Mediterranean Sea

Fig.4-1-4 The positions of the trawl stations actually trawled in the autumn season survey

Distance trawled (hawling speed x hawling time) was recorded for all trawling stations. The width between wing nets was measured by the SCANMAR for all seasons excluding summer. Values for the width between wing nets at trawling stations where the width between wing nets was unable to be measured were estimated for each season using the relational expression between water depth (D) (using the mean value of the water depth when the trawl net touches on bottom and the water depth when the trawl net is off the bottom) and width between wing nets (W) indicated below.

Relational expression used for summer and spring surveys:
W = 5.665 + 0.015D
No. of data: 121 (using the total number of data for winter and spring)
Correlation coefficient: 0.73
Relational expression used for autumn survey:
W = 9.068 + 0.018D
No. of data: 146 (autumn data)
Correlation coefficient: 0.69
Relational expression used for supplementary winter survey:
W = 9.818 + 0.018D
No. of data: 31 (supplementary winter data)
Correlation coefficient: 0.70

The area swept for the trawling stations for each season (distance trawled x width between wing nets) was calculated based on this data to determine the mean area swept per haul (Table 4-2).

Table 4-2 Mean Area Swept per Haul by Season

Season	Summer	Winter	Spring	Autumn
Mean (km²)	0.01847	0.02196	0.01643	0.02467
Standard deviation(km²)	0.00367	0.00652	0.00432	0.00641
Range (km²)	0.01392~0.03272	0.00648~0.03746	0.00667~0.02824	0.01068~0.04422

4-1-2 Biological Survey

The numbers of specimens for measurement of body length composition carried out primarily on commercially important species (refer to Table 2-1) are indicated in Table 4-3 by season and species.

Table 4-3 Number of Specimens for Measurement of Body Length Composition by Season and Species

No.	Scientific name	Summer	Winter	Spring	Autumn
1	* *Saurida undosquamis*	489	140		100
2	*Chlorophthalmus agassizii*	83	1,057	549	126
3	* *Merluccius merluccius*	2,178	1,428	1,091	3,609
4	*Merlangius merlangus euxinus*	1,005	113		959
5	*Micromesistius poulassou*	229	71	31	365
6	*Trisopterus minutus capelanus*	220	62	252	834
7	* *Serranus cabrilla*	63	32	397	278
8	*S. hepatus*	200			
9	* *S. scriba*	70			
10	*Trachurus trachurus*		1,730	514	5,638
11	*T. mediterraneus*		180		
12	*Argyrosomus regius*	40			
13	* *Mullus barbatus*	3,076	2,563	3,102	4,391
14	* *M. surmuletus*	179		82	23
15	* *Upeneus moluccensis*	1,286	781	282	416
16	* *Sparus aurata*				46
17	*Boops boops*	315	423		
18	*Pagrus pagrus*			65	110
19	* *Dentex macrophthalmus*	584	476	159	402
20	*D. maroccanus*	63			
21	* *Diplodus annularis*	1,161	355	648	723
22	* *D. vulgaris*		102	27	
23	* *Pagellus erythrinus*	1,031	91	666	889
24	* *P. acarne*	315	396	374	1,432
25	* *P. bogaraveo*		95	116	
26	* *Solea vulgaris*	62			

*: Indicates those commercially important species of Table 2-1. In addition, measurements were not carried out on *Sphyraena sphyraena* and *S. chrysotaenia* due to the small size of the catch.

The numbers of specimens for the biological survey carried out, in principle, on a maximum of 20 individual fish at a trawling station and primarily on commercially important species, are indicated in Table 4-4 by season and species.

Table 4-4 Number of Specimens Measured for Biological Survey by Season and Species

No.	Scientific name	Summer	Winter	Spring	Autumn
1	*Synodus saurus*			20	
2	* *Saurida undosquamis*	331	66	89	137
3	*Chlorophthalmus agassizii*	20	80	99	79
4	* *Merluccius merluccius*	1,164	614	609	1,114
5	*Merlangius merlangus euxinus*	40	20		80
6	*Micromesistius poutassou*	52	59	46	134
7	*Trisopterus minutus capelanus*	80	60		80
8	* *Serranus cabrilla*	193	75	100	176
9	*S. hepatus*	20			
10	* *S. scriba*	20			
11	*Epinephelus aeneus*	2			
12	*Trachurus trachurus*		311	259	496
13	*T. mediterraneus*		40	12	
14	*T. picturatus*			3	
15	*Pomadasys incisus*	20			
16	*Argyrosomus regius*	20			
17	* *Mullus barbatus*	1,084	636	933	1,090
18	* *M. surmuletus*	132	30	170	67
19	* *Upeneus moluccensis*	300	120	152	207
20	* *Sparus aurata*	9	14	24	31
21	*Pagrus pagrus*	42		21	68
22	*Boops boops*	100	40	50	
23	* *Dentex macrophthalmus*	286	87	151	217
24	*D. maroccanus*	54			
25	* *Diplodus annularis*	381	104	214	193
26	* *D. vulgaris*	11	20	20	18
27	* *Pagellus erythrinus*	466	117	436	387
28	* *P. acarne*	127	40	95	195
29	* *P. bogaraveo*	5	81	73	20
30	*Lepidopus caudatus*	54	20		
31	* *Sphyraena sphyraena*	9			13
32	* *S. chrysotaenia*	22	12		6
33	*Helicolenus dactylopterus d.*	9			
34	* *Solea vulgaris*	66	11	8	23
35	*Aristaeomorpha foliacea*		40		
36	*Metapenaeus monoceros*			14	
37	*Parapenaeus longirostris*	934	671	731	768
38	*Penaeus japonicus*				17
39	*Plesionika heterocarpus*	198	60	80	100
40	*Nephrops norvegicus*	215	197	210	224
41	*Oratosquilla massavensis*	117		20	20
42	*Loligo forbesi*				173
43	*L. vulgaris*	72			173
44	*Illex coindetii*				211
45	*Eledone cirrhosa*	327	102	147	12
46	*E. moschata*		104		151
47	*Octopus vulgaris*		16		6

*: Indicates those commercially important species of Table 2-1.

No. 1 - No. 34: Fishes, No. 35 - No. 40: Shrimps, No. 41: Mantis shrimp, No. 42 - No. 44: Squids, No. 45 - No. 47: Octopuses

4-1-3 Mesh Selectivity Experiment

The number of times mesh selectivity experiments were carried out in the winter, spring and autumn are indicated by season, sub area and mesh size of the cod end. In addition, the stations where mesh selectivity experiments were carried out are indicated in Fig. 4-2-1 to 4-2-3 by season and cod end.

Table 4-5 Number of Times of Mesh Selectivity Experiments

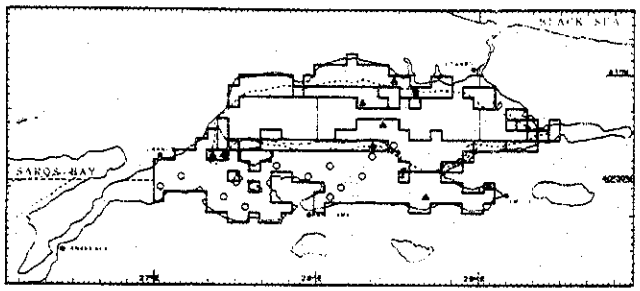
Season / Sub area \ Cod(mm)	Winter		Spring				Autumn	
	50	70	50	70	90	110	50	70
The Sea of Marmara	12	9		13	11	3	19	8
North Aegean Sea	13	16		14	11	8	33	17
South Aegean Sea		13	16		7		9	19
West Mediterranean Sea		9		10				10
East Mediterrancan Sea		10					20	14
Sub total	25	57	16	37	29	11	81	68
Total	82		93				149	

The number of specimens for measurement of body length by species with respect to the mesh selectivity experiment are indicated in Table 4-6 by season and cod end.

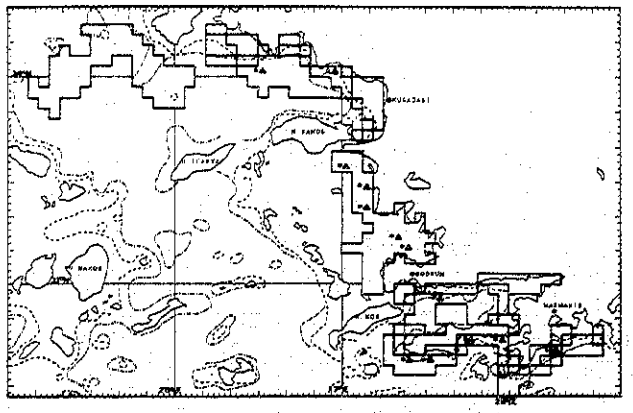
Table 4-6 Number of Specimens for Measurement of Body Length with Respect to Mesh Selectivity Experiment

No.	Season / Scientific name \ Cod(mm)	Winter		Spring				Autumn	
		50	70	50	70	90	110	50	70
1	* *Saurida undosquamis*		146						100
2	*Chlorophthalmus agassizii*		897					56	70
3	* *Merluccius merluccius*	767	416		453	227	288	1,575	1,631
4	*Merlangius merlangus euxinus*	113						616	107
5	*Micromesistius poutassou*		71			31		23	342
6	*Trisopterus minutus capelanus*	21	41					131	566
7	* *Serranus cabrilla*	32		261				197	
8	*Trachurus trachurus*	753	800		109		396	2,268	3,238
9	* *Mullus barbatus*	835	1,321	463	600	342		2,360	1,756
10	* *M. surmuletus*			46			36	23	
11	* *Upeneus moluccensis*		781					305	29
12	* *Sparus aurata*								46
13	*Boops boops*		437						
14	*Pagrus pagrus*							51	59
15	* *Dentex macrophthalmus*		468			115		59	304
16	* *Diplodus annularis*	76	256	131	64			66	618
17	* *D. vulgaris*		102						
18	* *Pagellus erythrinus*		91		281	139		150	700
19	* *P. acarne*		396	100				598	794
20	* *P. bogaraveo*	95			85				
21	*Lepidopus caudatus*		68						

*: Indicates those commercially important species of Table 2-1.

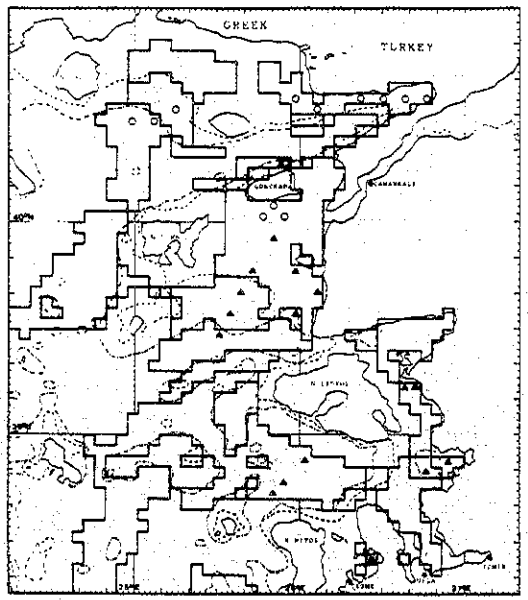


The Sea of Marmara

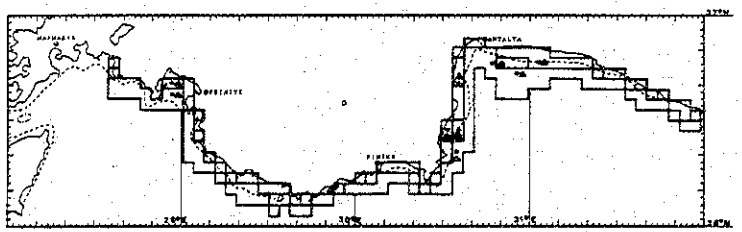


South Aegean Sea

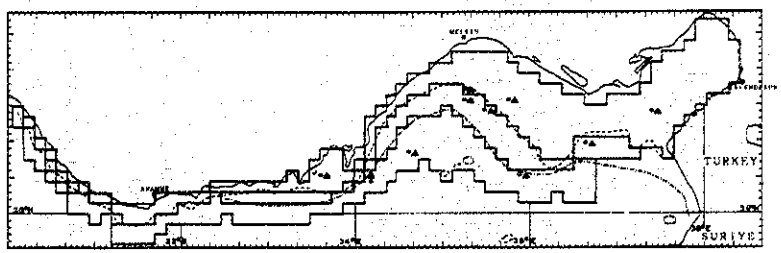
○ : 50mm Cod-end
▲ : 70mm Cod-end



North Aegean Sea



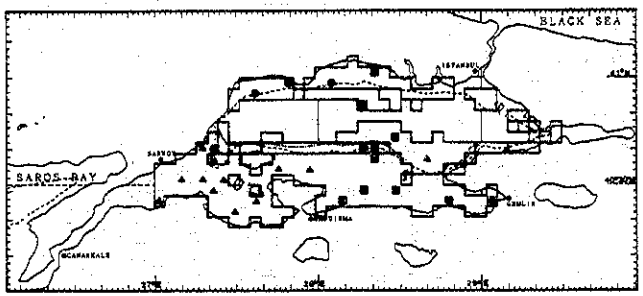
West Mediterranean Sea



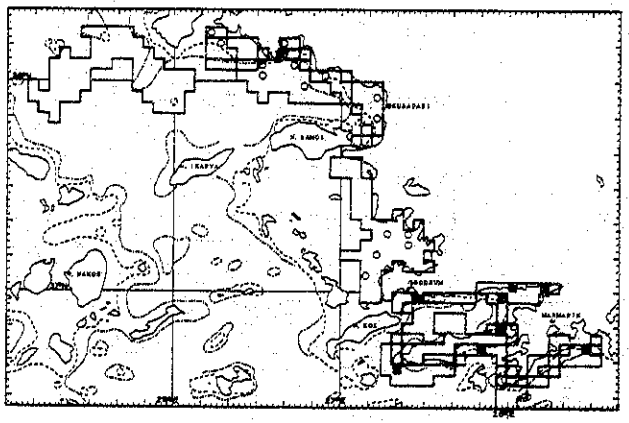
East Mediterranean Sea

Fig.4-2-1 The positions of the stations carried out for the mesh selectivity study in the winter season survey

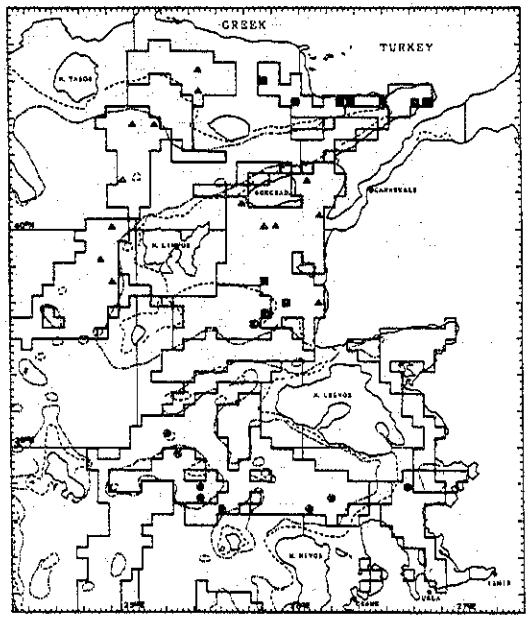
* First winter season survey



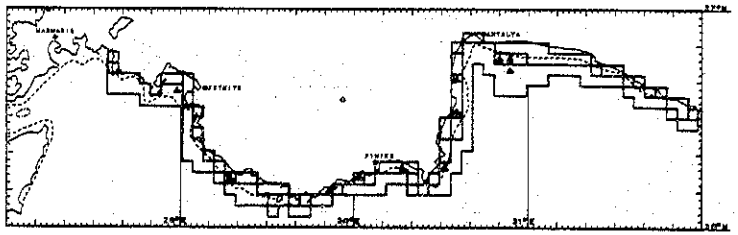
The Sea of Marmara



South Aegean Sea



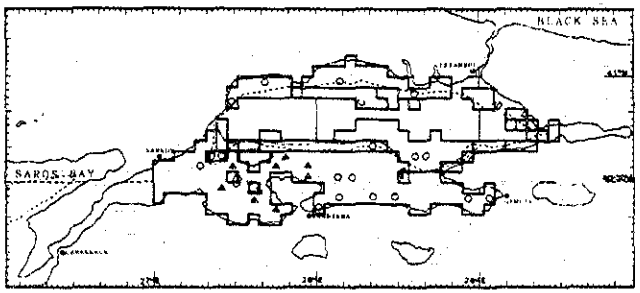
North Aegean Sea



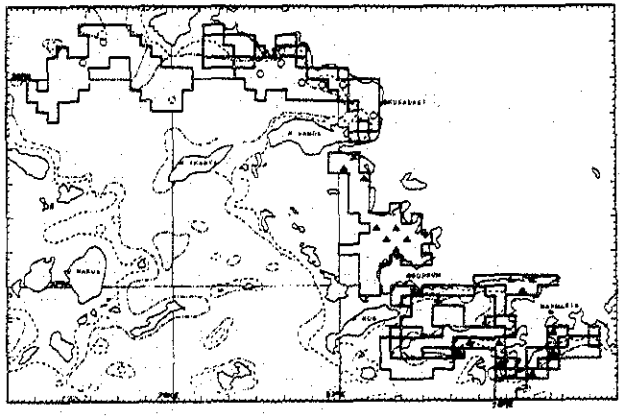
West Mediterranean Sea

○ : 50mm Cod-end
▲ : 70mm Cod-end
■ : 90mm Cod-end
● : 110mm Cod-end

Fig.4-2-2 The positions of the stations carried out for the mesh selectivity study in the spring season survey

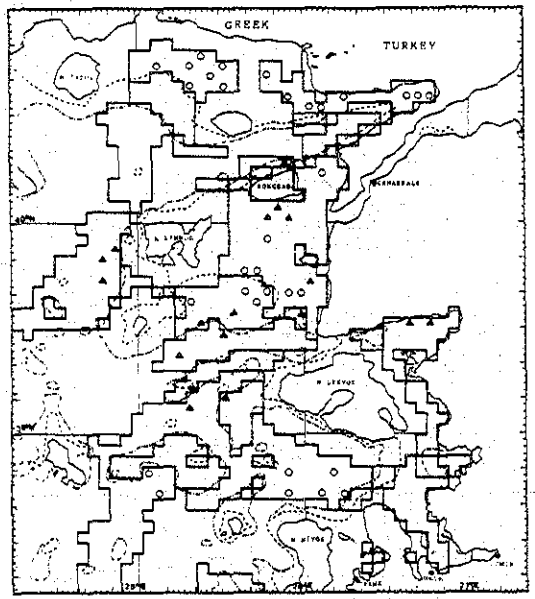


The Sea of Marmara

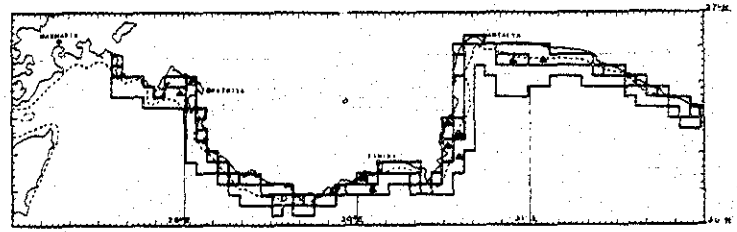


South Aegean Sea

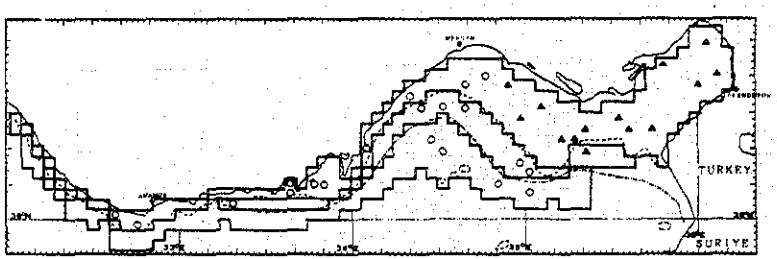
○ : 50mm Cod-end
▲ : 70mm Cod-end



North Aegean Sea



West Mediterranean Sea



East Mediterranean Sea

Fig.4-2-3 The positions of the stations carried out for the mesh selectivity study in the autumn season survey

4-1-4 Water Temperature and Salinity Measurements

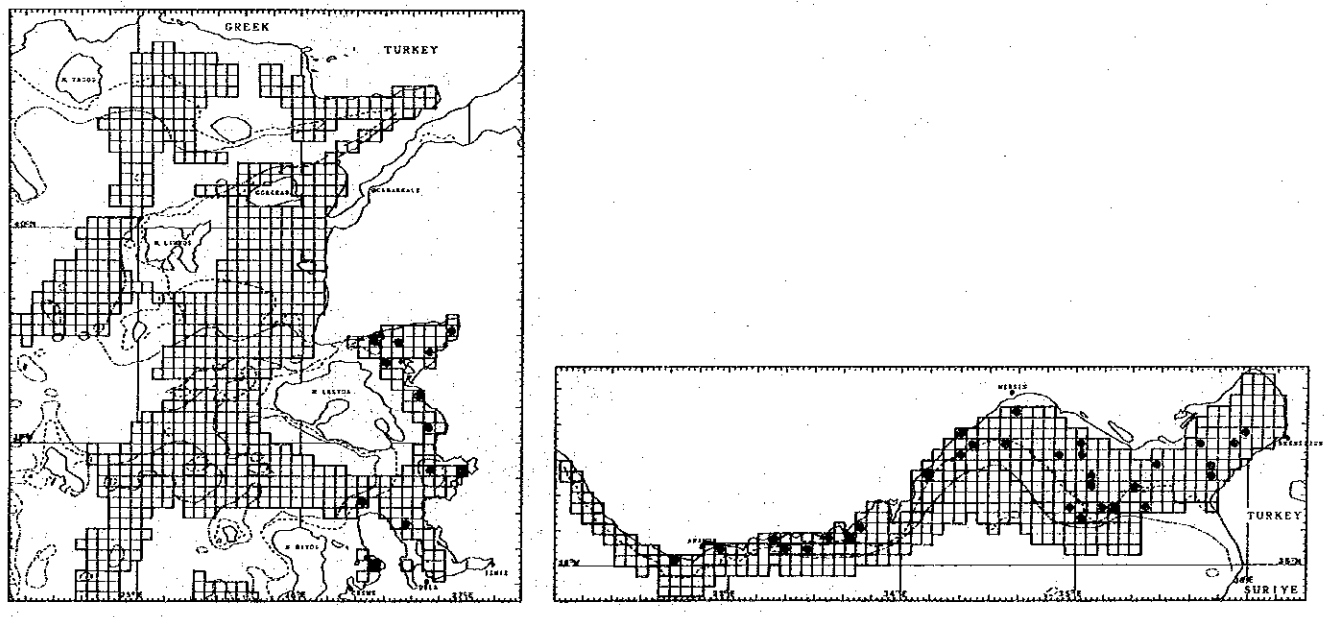
Detailed analysis of measurement data of water temperature and salinity from surface strata to bottom strata was commissioned to the Turkish side as a subject for future research. Summaries of the horizontal distribution of water temperature and salinity on the bottom strata for all surveyed areas are indicated in Fig. 4-3 and Fig. 4-4 by season.

4-1-5 Sea Bottom Topographical Survey

The condition of the sea bottom, distribution of fish schools and so on of the trawling sites were recorded in this survey.

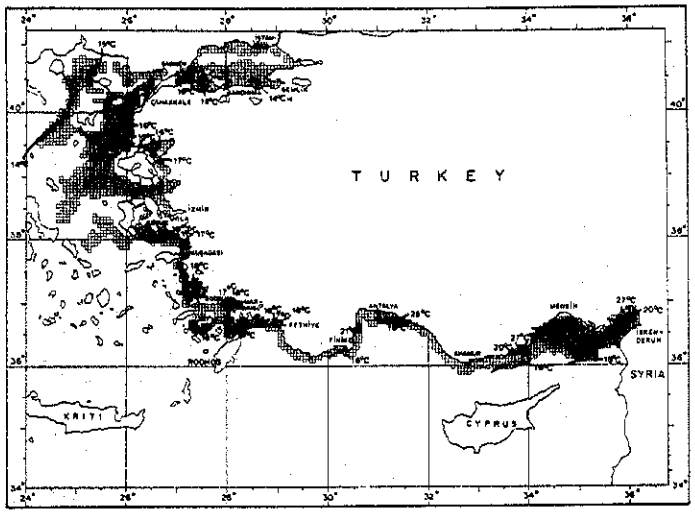
4-1-6 Comparative Test of Fishing Efficiency

The number of times of parallel operation of the K. Piri Reis, used for the research vessel, and the Turgut Reis, a commercial fishing boat, carried out in the spring consisted of 12 times in the North Aegean Sea and 31 times in the East Mediterranean Sea for a total of 43 times. The stations where comparative tests of fishing efficiency were carried out are indicated in Fig. 4-5.

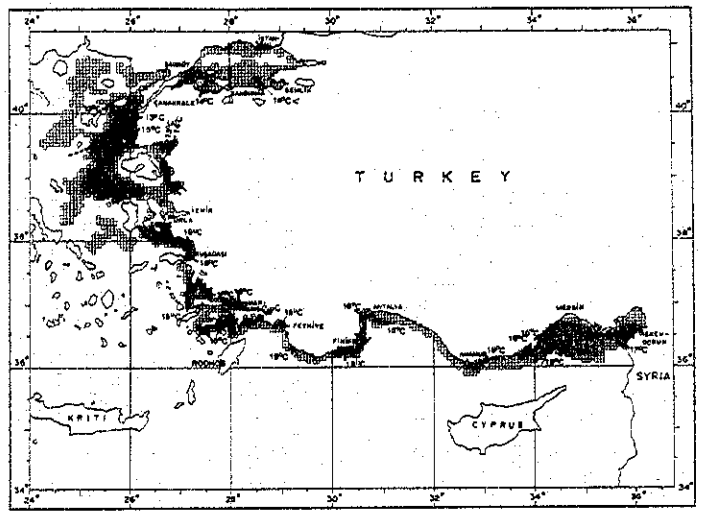


North Aegean Sea East Mediterranean Sea

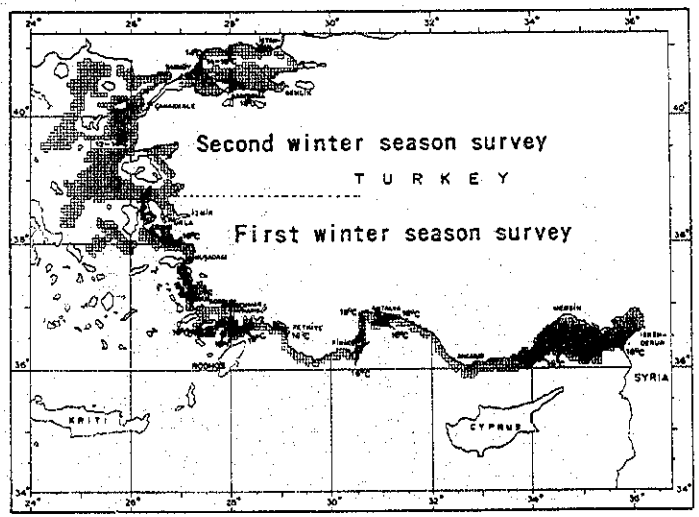
Fig. 4-5 The Stations for Comparative Tests of Fishing Efficiency Carried Out in Spring Survey



Summer



Spring



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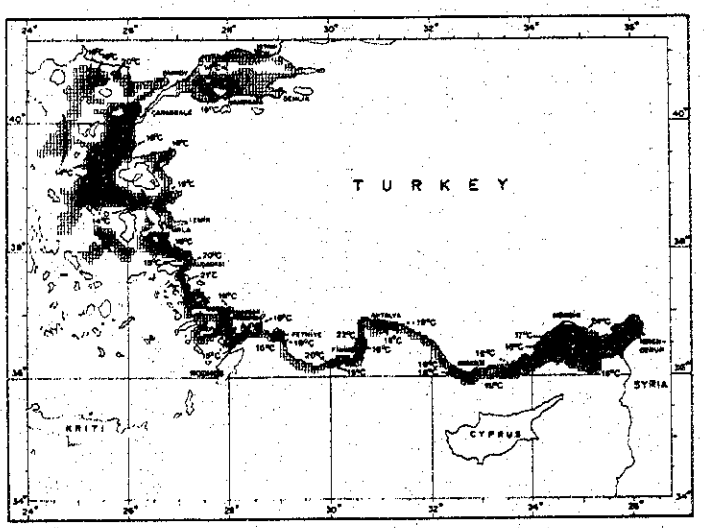
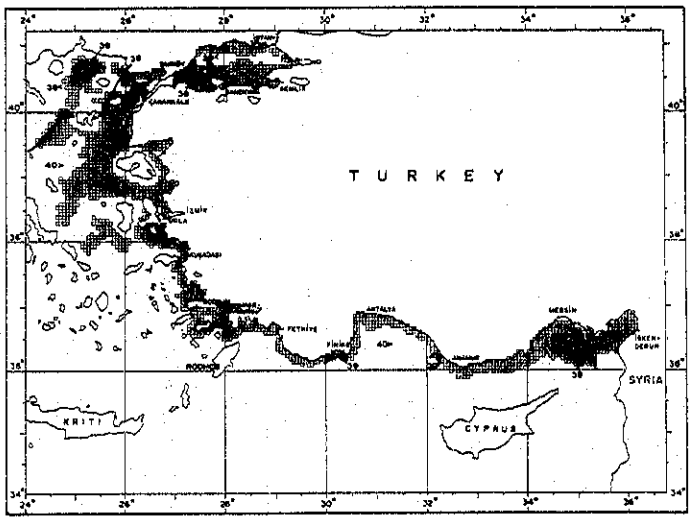


Autumn

Fig.4-3 The outline of the bottom temperatures observed during the four seasons survey



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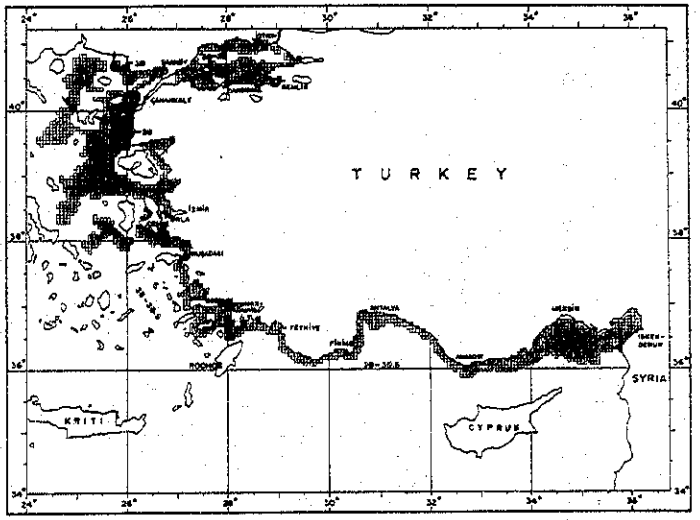
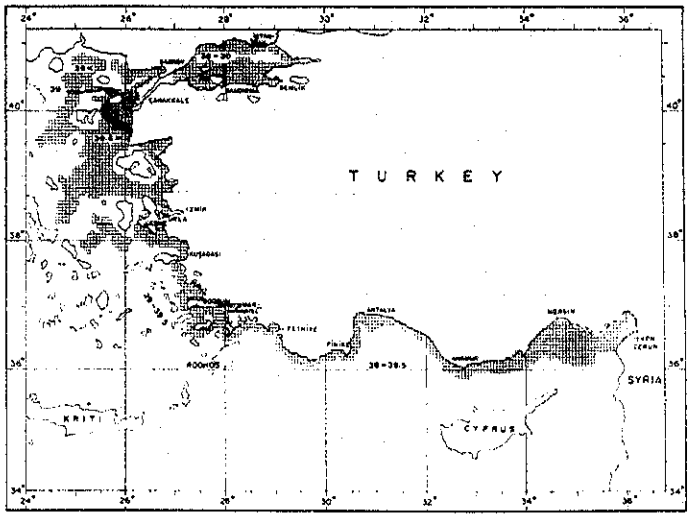
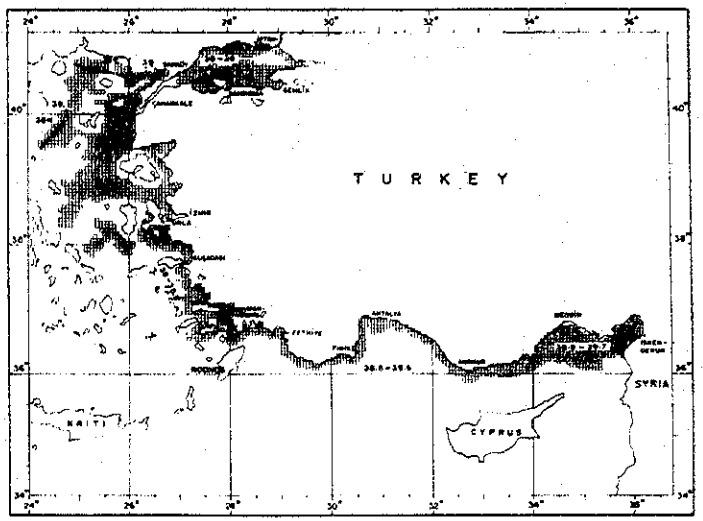


Spring



Winter



Autumn

Fig.4-4 The outline of the bottom salinities observed during the four seasons survey

4-1-7 Shrimp Resource Survey

The number of shrimp trawling operations carried out in Iskenderun Bay in the East Mediterranean Sea during autumn are indicated in Table 4-7 by time of day and water depth.

Table 4-7 Number of Shrimp Trawling Operations

Depth (m)	No. of hauling		
	Day	Night	Total
20	3	3	6
50	2	2	4
75	2	2	4
150	1	1	2
350	1	1	2
All area	9	9	18

In addition, the shrimp trawling stations are indicated in Fig. 4-6.

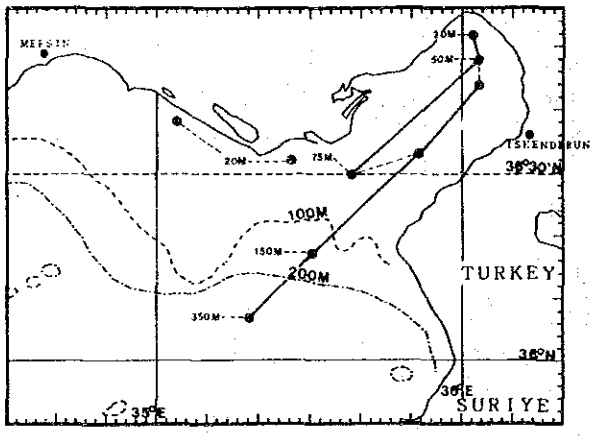


Fig. 4-6 Shrimp Trawling Stations in Autumn Survey