

— Set net fishery —

# What is making this “defensive fishery” more solid?

**S**ET NET FISHERY is a type of fishery in which the net gear is kept fixed in some specific areas for a long time so as to get fish or Crustaceas regularly every day when they come into the bag net unconsciously. In general, this type of fishery is called “defensive” fishery or “wait-and-see” fishery, in contrast to such aggressive types of fisheries as trawlnet and boat seine which are operated to aim at the moving schools of fish by net. This explanation, however, is not quite enough to form a clear definition of set net fishery because it can keep us from turning our eyes to a number of true advantages exclusive to this fishery. Of all types of fisheries which depend on the reproduction rate of fish species, set net fishery is most subject to the influence of various natural factors including sea-bottom nature, stream conditions and seasonal changes in migratory fish species. In order to meet this situation, fishermen are making practical and intelligent use of their techniques to catch the fish species sought, thus improving their diet and economic conditions. Now, let’s take a look at the advantages of set net fishery that aggressive types of fisheries like trawlnet and boat seine can not offer.

1. Set net fishery is a “wait-and-see” type fishery operated to catch only oncoming fish species, with much less possibility of overfishing than trawlnet or boat seine operated to go after moving fish schools.
2. The net is set in such a manner that it can continuously catch the fish for a long time until it is pulled up, that is, fish schools swimming with the stream are lured into the bag net by means of the tactfully set leader net. In this way the fishing operation is continued day and night. In addition, set net fishery is a very economical type of fishery in terms of the amount of labor needed. The net is dragged up once a day, usually in the morning (twice a day at some fishing grounds, in the morning and in the evening). This operation can be completed within two hours. The number of fishermen needed is not the same depending on the size of a net but in the case of small-scale set net operation it does not exceed five or six.
3. The fishing ground is not so far from the shore. This makes it possible to keep the catch fresh.
4. Many different species of fish are lured into the bag net and they are caught alive. Prime fish can be sold as “live fish”, bringing fishermen more profits. When the catch amount of mass-catch fish species is extremely large, part of the catch is kept in a fish preserve to control the amount of shipments, thus preventing a drastic fall in fish prices.

Set net fishery is considered very advantageous from the point of the utilization of resources, labor and capital but it is also true that it has the following weak points:

1. Set net fishery shares the same fishing ground with other types of fisheries. But for timely and sufficient measures taken for the practical and efficient use of this common fishing ground based on a comprehensive fishery program, social or economic problems could arise out of a possible friction between different types of fisheries.
2. Set net fishery is subject to the seasonal behaviors of migratory fish species,



A bumper catch of sardine! The catch amount is in excess of 100 tons per operation. (Large-scale set net operation at Manazuru)

resulting in drastic fluctuations in the amount of catch. The period of operation is also limited. In case the fishing ground is far from the marketplace and adequate shipment and transportation measures are not available, fishermen can not sell their catch at reasonable prices.

3. When the net is set, when it is withdrawn for re-setting, or when a bumper catch is foreseen during the height of season, much manpower is needed,

while at other times a small number of fishermen can quickly operate this fishery. Therefore, fishermen find difficulty in adjusting the manpower between the peak time and other times.

4. The large-scale set net fishery can not be operated without the large amount of fixed capital. In addition, fishermen must annually pay the considerable amount of repair and maintenance expenses for the net gear.

Despite all these weak points, however, Japanese fishermen are making this fishery more solid by making full use of its exclusive advantages to achieve the maximum potential of resources, labor and capital, while at the same time introducing various necessary improvements to their techniques and fishing gear with better economic and social conditions in mind.





Salmon set net by an 11-ton class Yamaha fishing boat

# Japanese set net fishery

Japanese set net fishery is classified into large and small scale types. While this classification conforms to the provisions of the Japanese Fisheries Act, it is also adapted to the current situation of this fishery in terms of management and operation patterns.

## Japanese fishery system

Set net fishery is divided into the following two types in accordance with the provisions of the Fisheries Act, and large-scale set net fishery is subdivided into two different types:

Large-scale set net	
1) Salmon/trout set net	This is operated in the coastal waters of Hokkaido to mainly catch salmon and trout.
2) General large-scale set net	The body net is set at the depth of more than 27 meters to catch various fish species other than salmon and trout. (There are exceptions to the above depth of water)
Small-scale set net	
All set net operations other than the abovementioned operations.	

Large-scale set net fishery is regulated by a prefectural government. Each person or corporation who wishes to conduct this

fishery, must make an application to the governor for a special licence granting him the set net fishery right. The licence holds good for five years.

All small-scale set net fishermen must obtain a fishing licence specified in the common fishery right which is granted to a local fishery cooperative by the governor. This right protects local fishermen by insuring them monopolistic catching of aquatic resources in their areas. In accordance with the enforcement regulations of this right, the cooperative sets the essential points of operation for this fishery, including actual fishing zones, number of fishing units, period of operation, etc.

Therefore, any fisherman who wishes to be licensed to operate this fishery in accordance with the above regulations, must be a registered member of the cooperative. The licence holds good for ten years.

## Fishing units

In Japan there are about 18,000 set net fishing units in operation as follows:

- Salmon/trout set net . . . . . 743 units
- General large-scale set net . . . 838 units
- Small-scale set net . . . . . 16,123 units

(1982 Fishery Statistics by the Ministry of Agriculture, Forestry and Fishery)

During the period from the early sixties to the early seventies both types of set net fisheries remained inactive, with a big drop

in the number of fishing units until a gradual upturn was seen in 1972. Salmon/trout set net fishery is operated only in the sea areas along the eastern coast of Hokkaido and the inshore Pacific areas along Northeastern Japan, through which a large school of salmon, most of which are chum salmon (*Oncorhynchus keta*), return to their mother rivers. General large-scale set net and small-scale set net are operated in almost all the coastal waters of Japan where fishermen stand a good chance of catching the fish species sought.

Large-scale set net, which requires a great number of fishermen, takes a form of management fishery using hired manpower in most cases. While self-employed fishermen still make up about 50% of those fishing units, organization management by company or cooperative is steadily increasing its relative share due to the fact that much capital and manpower is essential to this type of fishery.

Small-scale set net can be operated by the workforce of five or six fishermen even during the peak period and it takes a form of small-scale self-employed fishery using family labor alone.

## Table 3. Modernization of large-scale set net fishery

1. Improvement of fishing gear	<ol style="list-style-type: none"> <li>1. Improvement of net material (from jute yarn to synthetic fiber)</li> <li>2. Development of double bag net</li> <li>3. Adoption of large-size buoy (made of steel instead of bamboo or wood)</li> <li>4. Improvement of small-size buoy (from glass balls to plastic material)</li> <li>5. Improvement of net setting system (synthetic fiber as sandbag material, instead of natural fiber; and modified metal anchor or concrete block holding, instead of sand-bag system)</li> <li>6. Improvement of lead line (synthetic fiber rope using lead as its core)</li> </ol>
2. Improvement of fishing machinery and tools	<ol style="list-style-type: none"> <li>1. Improvement of net hauler (manual winch — ring type mechanical net hauler — catch hauler)</li> <li>2. Adoption of high performance fishfinder</li> <li>3. Laborsaving method of net setting</li> </ol>
3. Others	<ol style="list-style-type: none"> <li>1. Application of dyestuff on fishing net to keep off seaweed</li> <li>2. Adoption of large-size fish preserve</li> </ol>



Net catch hauler (large-scale set net)

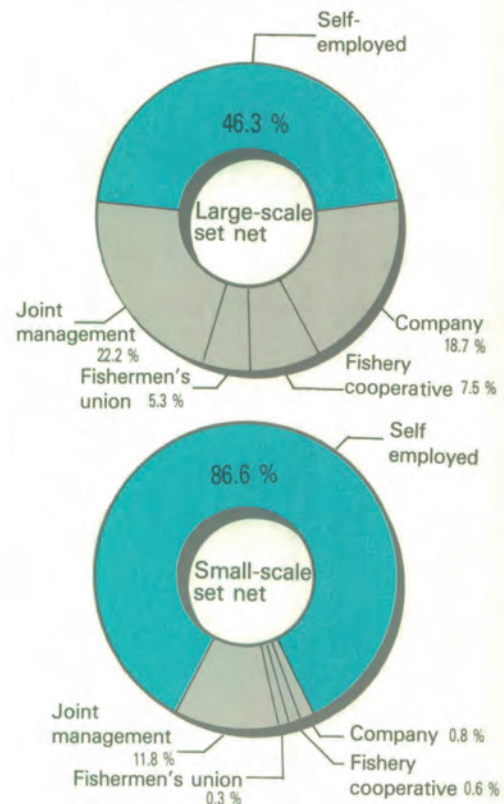


Buoy (large-scale set net)



Large (right) and small (left) anchors

Table 1 Percentage by type of fishery management

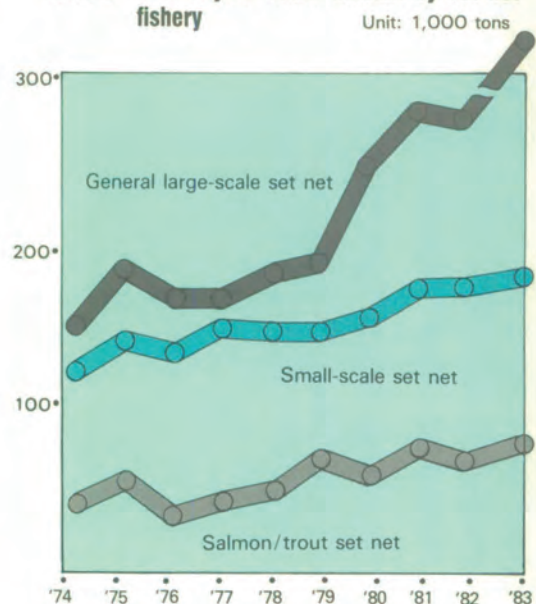


The 6th Fishery Census (1978)

## Scale of fishery

Table 2 shows the year-to-year catch for the period from 1972 to 1981. The amount of catch by each set net continued to increase. In the case of salmon/trout set net, the number of adult salmon which returned to their mother rivers, was greatly increased due to advanced artificial incubation and liberation techniques. A remarkable increase in sardine resources gave a boost to the amount of catch by general large-scale set net and small scale set net.

Table 2 Year-to-year catch amount by set net fishery



Note: Catch by type of fishery (1981)

1. Salmon/trout set net — 75,502 tons including 71,485 tons of salmon and trout species (95%)
2. General large-scale set net — 277,630 tons including 163,648 tons of sardine species (59%)
3. Small-scale set net — 170,610 tons including 65,039 tons of sardine species (38%)

(Statistics by the Ministry of Agriculture, Forestry and Fishery)

In recent years specific efforts have been continued to improve the fishing techniques of large-scale set net with the aim of increasing the overall operation efficiency.



# Three choices involved in set net fishery

There are three basic elements involved in starting a set net fishery operation. These include (1) **fishing grounds**, (2) **fishing gear** and (3) **a management system**. Let us take a look here at the decisions that must be made with regards to these three basic elements and the key problems involved in operating a successful small-scale set net fishing business.

## 1 Choosing a fishing ground

In establishing a set net fishery operation it goes without saying that the biggest factor is to secure a net location where large fish schools are migrating. When looking for a new fishing ground to develop one must first of all be certain that the sufficient amount of fish species suitable for catching by set net are present. In order to locate a suitable fishing ground, it is necessary to study the types of fish species present and their seasonal migrating habits in the coastal waters you wish to develop, and to investigate the feasibility of marketing the caught fish in your area.

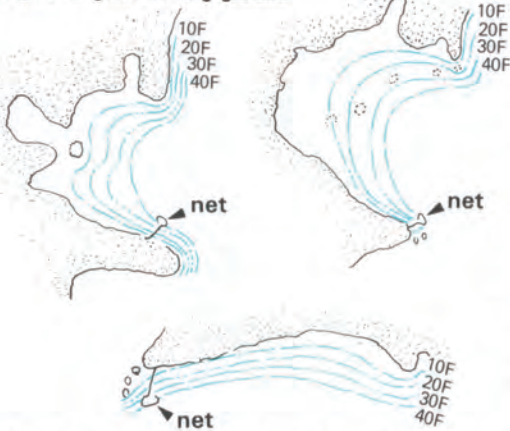
The areas or routes that schools of fish pass with high frequency are referred to as "fish routes". It is safe to say that the success or failure of a set net operation is determined almost completely by the position and angle of net setting in the "fish route".

The important factors that determine the configuration of the "fish routes" are; (1) the characteristics of the coastal isobath, (2) the configurations of natural reefs in the area, (3) the sea bottom topography and its interrelation to the currents and (4) the consistency of the sea bottom (rocky, sandy etc.). From a good knowledge of these inter-relating factors it is possible to estimate the types of fish, size of schools and seasonal changes that will occur in a given fish route.

### 1. The coastal isobath

In the case of large-scale set net fisheries catching mainly migrating species such as yellowtail, horse mackerel, mackerel, sardine and anchovy, the areas chosen as fishing grounds are the steep coast areas near the mouth of deep bay where a branch of the ocean current that has entered the bay and circled it is about to leave the bay again. The reason for this is that fish species that are migrating with the circulating currents along a coast form fish routes, and because each species migrates at a given depth, when they come to a place on the coast where the isobath lines are close together it is believed that the schools of fish are forced together and thus become concentrated in a small area. Based on his studies of the effectiveness of different large-scale set net locations throughout Japan for catching yellowtail, former Professor Hideaki Miyamoto of Nihon University has sighted several types of highly successful fishing ground configurations. In each of the examples the current is moving counterclockwise along the coast of the Pacific in an arched pattern.

Fig. 1 A good fishing ground



### 2. The existence and configurations of natural reefs

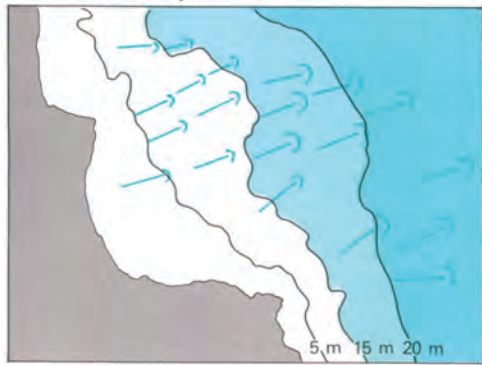
The natural reefs that dot the coastal

waters are beneficial in that they lure migrating fishes, but at the same time they also function as substantial obstacles.

In an attempt to learn more about the relationship between natural reefs and the movement of fish schools as they approach the coastal waters, Mr. Isamu Mitani of the Kanagawa Prefectural Fisheries Experimental Station studied a large number of small-scale set net operations in Kaneda Bay on the Miura Peninsula.

Figure 2 shows that with a few exceptions, the leader nets all point toward a reef, or are positioned with their body nets next to a reef or between two reefs, showing that the location of reefs is directly related to the way the nets are positioned.

Fig. 2 Position of natural reefs and set nets in the southern end of Kaneda Bay (by Mr. Isamu Mitani)



### 3. Effects of the tides on fish behavior

There are a variety of traditional fishing methods that take advantage of the movement of fish and shellfish with the tides in shallow sea areas which are changed into an expansive tideland at high tide, among these the fishing method called "tateami" is one of the most common.

Areas in which inland marshes, lakes or rivers are connected to the shallow sea by estuaries provide excellent nursery grounds for the fry and fingerlings of various ocean fish species, due to the abundance of nutrients that these inland water bodies are sending into the sea water, and also due to the constant tidal exchange with the open sea. Therefore, these areas make ideal fishing grounds for small scale set net fishery.

### 4. Physical characteristics of the sea

In addition to the above mentioned factors, there are a number of physical properties of the sea which must be considered:

**Sea depth:** With today's technology, the deepest level at which a set net can be set is about 100 fathoms (183 meters). The deeper one goes, the stronger the forces of water stream become, thus tending to alter the shape of the net. Therefore, the net must be larger and heavier, which means that net hauling capability becomes another factor limiting the depth at which a net can be set.

**Strength of current power:** With the exception of the "tateami" which makes use of the flow of the current in shallow sea areas, most set nets need to be set in areas with relatively mild current power. If the current power is too strong it tends to distort the shape of the net, thus lowering its catching efficiency and also tends to cause various difficulties in the hauling operation. The maximum current power under which net hauling can be successfully performed is considered to be 0.4

knot/hour for an "otoshi-ami", and 0.6 knot/hour for an underwater set net.

**Wind speed:** A set net fishing ground must be an area with mild wind and wave conditions. Areas with strong winds invariably have rough wave conditions which hinder the net-hauling operation and in-

crease the rate of breakdown of the net and other fishing gear.

**Sea bottom consistency (sand, mud, rock etc.):** Rocky sea bottom areas are not suitable for set net operations because of the possibility of net destruction. The best sea bottoms for set net are mud, sand, pebble and shell, or a combination of these.

## 2 Choice of fishing gear

The history of the development of set net technology centers around two conflicting objectives, (a) to create a net which is easy for the fish to enter, and (b) to create a net from which it is difficult for the fish to escape once they have entered. To the basic net designs, then, the fishermen of each region make improvements and changes based on the habits of the species of fish which they have decided will be most profitable to catch considering the make-up of the fishing grounds and fish resources in their particular area.

A set net is made up basically of four parts:

1. Leader net ... This net's function is to obstruct the course of migration of schools of fish and to stimulate the fish and lead them in the direction of the body net.
2. Body net ... This net serves to stop the schools of fish and hold them. It includes a space called the "playground".
3. Bag net ... This net gathers fish and prevents them from escaping.

4. Slope and funnel net ... This net supplements the function of the bag net. It is a trap which lures the fish in and then cuts off their route of escape.

Based on their basic construction, set nets can be divided into 5 groups, as shown in figures 3 to 7.

### A group • Dai-ami

This is a prototype, large-scale set net which is seldom used today. Having the bag net included as part of the body net, when a school of fish was found to have entered, the mouth of the body net would be closed and the catching operation would proceed.

### B group • Otoshi-ami

This is the main net configuration used today in both large-scale and small-scale set net operations. Historically, it is an improvement on the "Dai-ami".

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Fig. 3

### A Dai-ami

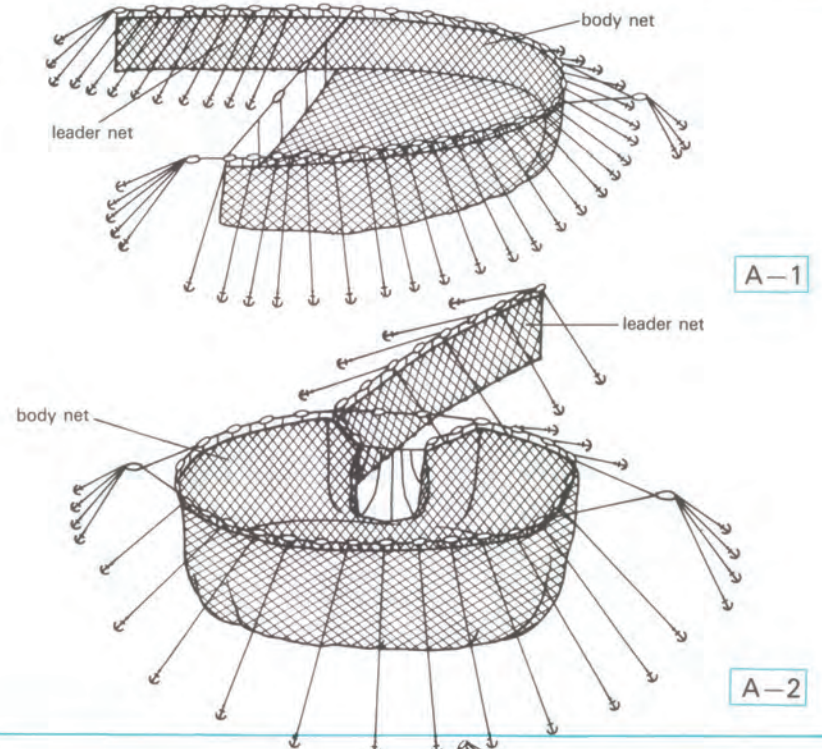
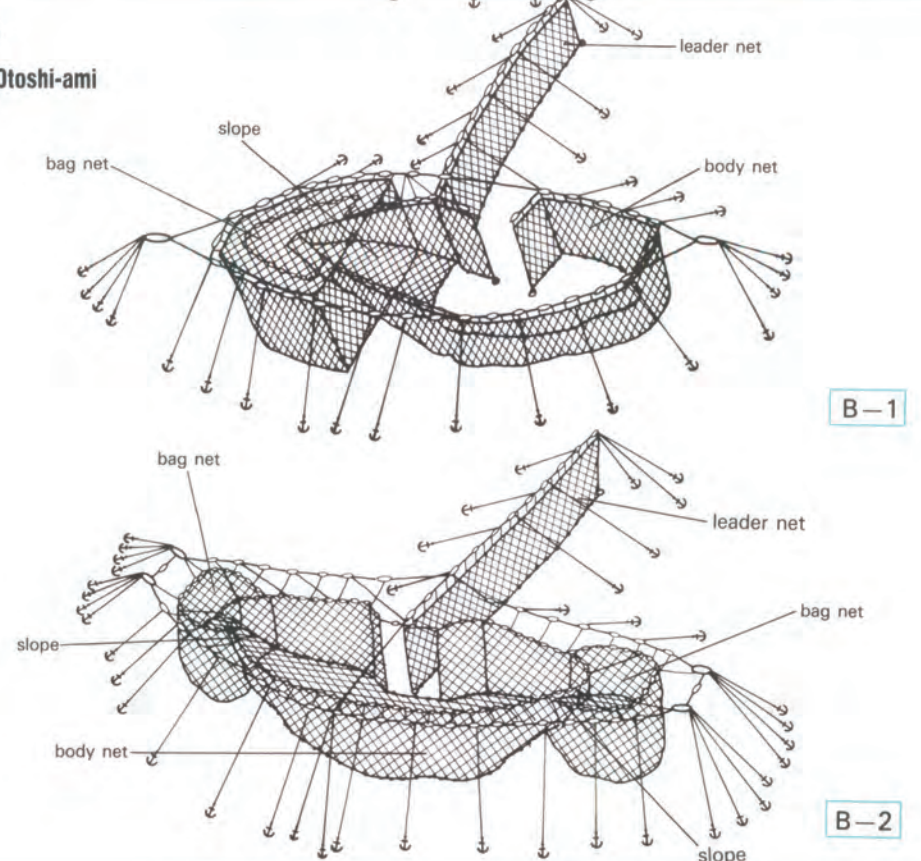


Fig. 4

### B Otoshi-ami





Continued from the previous page.

### C group • Choko-ami

This is a variation of the "otoshi-ami". Compared to the B group nets, this net is better suited for shallow water areas or areas where the fish migrations are spread out thinly over a large area.

### D group • Masu-ami

This is a small-scale set net that was developed in the 17th-18th centuries in the shallow water fishing grounds of the Inland Sea of Japan (Seto Naikai). They usually feature one or two funnel nets fitted in each bag net.

### E group • other small-scale set nets

These include the most primitive types of set net configurations. In some cases the

basic layout of the net is not clear, because they function by making use of some unique natural characteristic of a given fishing ground. For example, in E3 a tide pool functions as the bag net, and in E4 a current in a shallow sea area serves the function of the leader net.

Once a basic type of set net has been decided on the net is designed with consideration given to the place in which the leader net will be set, the proper size and shape for the mouth of the net, the size of the "playground", the proper angle for the slope, the dimensions of the funnel net and the volume of the bag net. Also, depending on the type of fish one is trying to catch, study must be made of the way the fish reacts to the net in order to determine the proper thread thickness, color (brightness), and mesh size to be used in the net construction.



Sardine emmeshed in the upper section of the bag net. This makes the hauling and re-setting operations very difficult. Shown clearly here by the presence of an unusually large catch, one can see the importance of choosing the proper mesh-size.

Fig. 5

### C group • Choko-ami

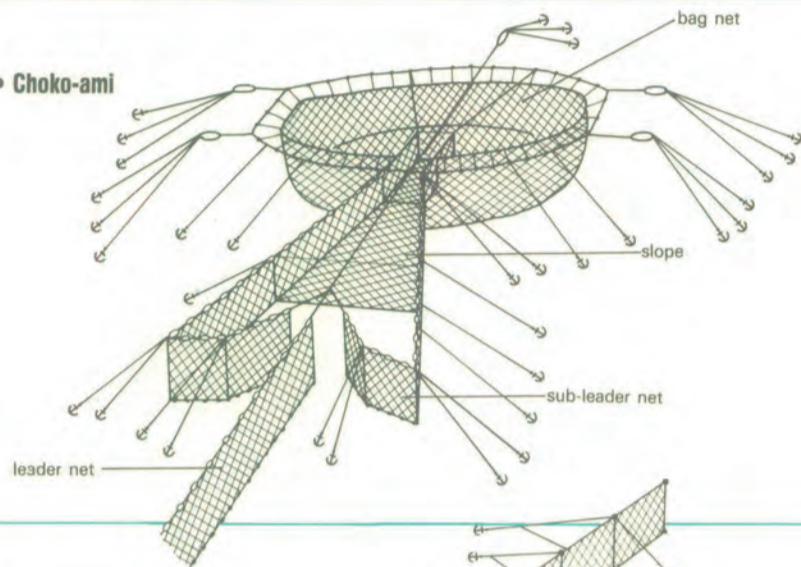


Fig. 6

### D group • Masu-ami

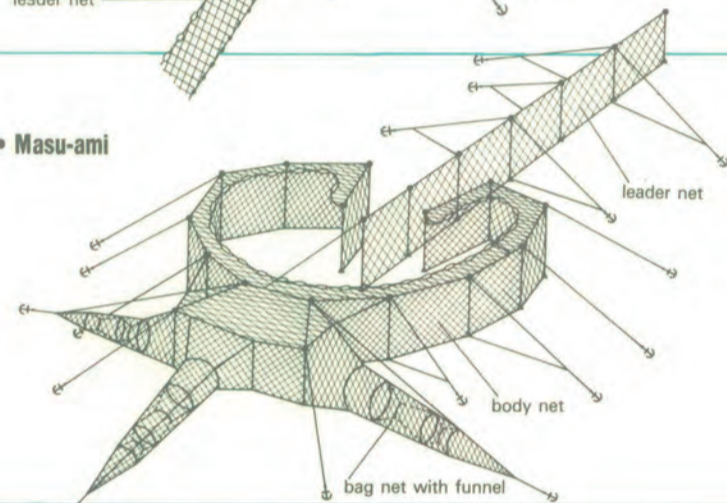
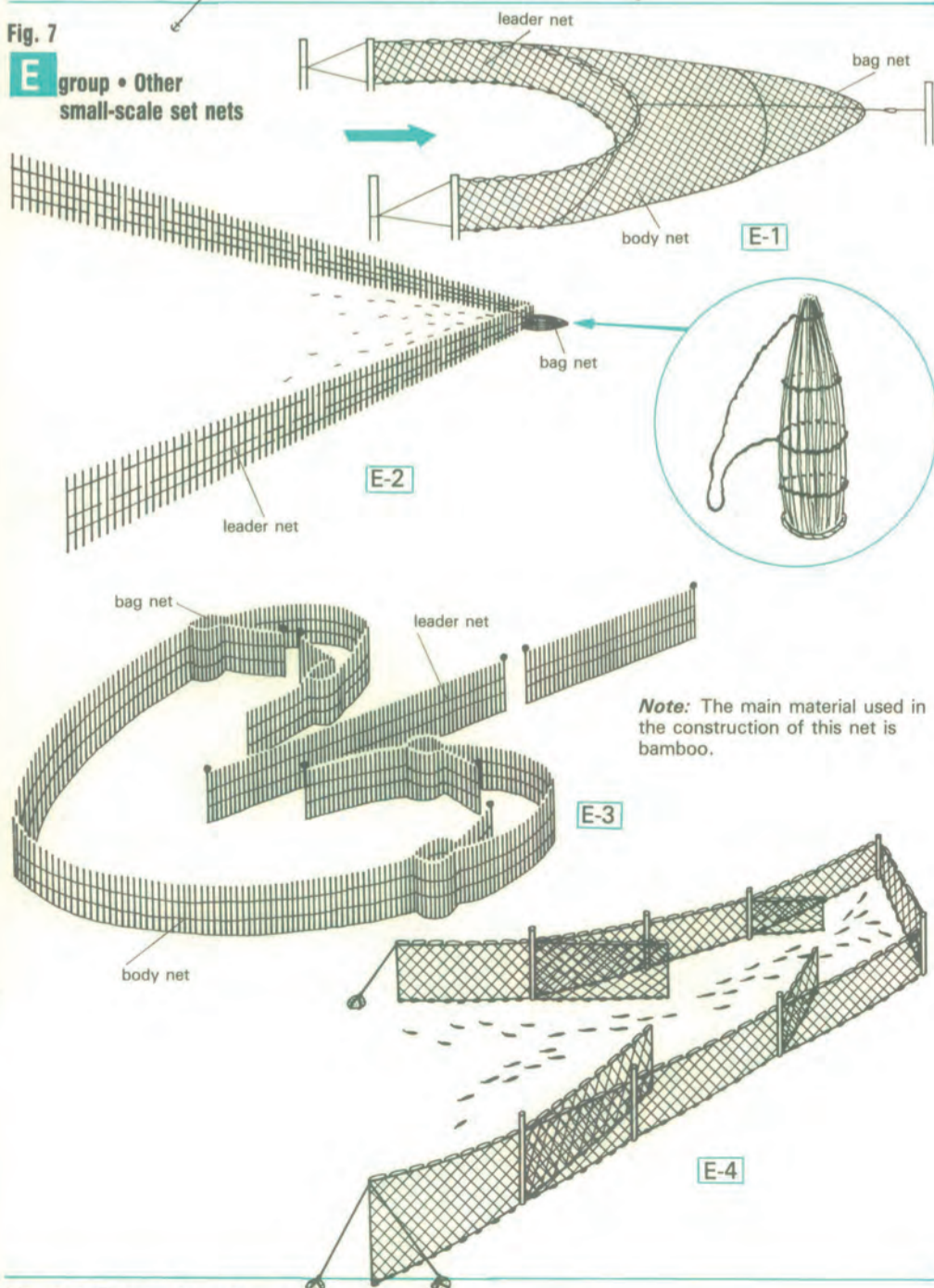


Fig. 7

### E group • Other small-scale set nets



## 3 Choosing the proper scale of operation

### 1. Choosing the scale of set net

If a large-scale set net is used, the size of the boat and nets, and the number of laborers who will be needed for the work at sea also increase, making a large capital investment necessary. There is also increased danger of having the nets washed away by strong current or rough seas. Therefore it is necessary to create a sound management organization with a strong economic and technological base capable of choosing suitable fishing grounds, predicting annual catch, and planning reliable programs of income and expenditure.

When planning the introduction of set net fishery in your own country's waters for the first time, the first step would be to initiate small-scale set net operations. Then, based on the operational experience gained from these small-scale operations, you should proceed to investigate the feasibility of introducing large-scale set net fishery operations.

Following this line of thought, we would like to introduce here some actual examples of small-scale set net fisheries being conducted along the Pacific coast of central Japan, as representative of the wide range of small-scale set net operations throughout the Japanese Islands, and to show the problems faced by small-scale set net fishing families and how they are being managed. We hope that our readers will find useful information in these examples.

### 2. Division of fishery managements in Japanese coastal fishery

Table 4 (page 5) is an analysis of coastal fishing families in Japan according to the scale and characteristics of their fishery operations.

When viewed from the standpoint of labor and capital investment, the types of fishery management groups involved in coastal fisheries in Japan can be divided into 4 basic types (see Table 6 on page 5.)

Table 7 attempts to show graphically the two dimensions of labor and investment as they apply to the above mentioned fishery classifications shown in table 6.

### 3. Present condition of small-scale set net fishery

As shown earlier, the large majority, in fact 87%, of all small-scale set net fishery operations are privately managed, and depend mainly on family labor. According to the Sixth Fishery Census (1978), the division of labor between family and hired labor is as follows: (a) operated strictly

with family labor; 71%, (b) operated with family & hired labor; 4%, (c) operated strictly with hired labor; 25%.

In recent years the dependence on hired labor has continued to decrease, with more and more fisheries being operated with family labor alone.

The national average fishery catch per fishing unit in 1982 was 11 tons, with a large part of the catch consisting of surface fish species like sardine, anchovy, horse mackerel, mackerel and squid, and bottom fish species including flatfish, flounder and sea bream. The national average earnings and expenses per fishing unit are shown in the following chart:

### Earnings and expenses of a household operating small-scale set net fisheries (1982) (Unit: ¥1000)

Fishery income (A)	7,570
Fishery expenses (B)	4,040
Fishery profit (A-B=C)	3,530
Profits other than fishery (D)	2,430
Total annual income per household (C+D=E)	5,960

### 4. Problems involved in small-scale set net fishery management

Let us take a look at the family-managed small-scale set net fishery from the standpoint of the problems of fishing ground utilization, securing a labor force, distribution and sale, and raising capital for investment.

#### (1) Making practical, intensive use of fishing grounds:

In Japan, the local fishery cooperative association is the body which decides, both legally and practically, how the fishing grounds will be divided for use among its members, within the limits of its fishing rights. This makes up a very practical system. However, the individual set net fisherman must work to improve his productivity within the limits set by the cooperative, and at the same time cooperate with other fishermen to insure the optional use of the available local fishing grounds. A fisherman who neglects these responsibilities will not only see a deterioration in his own productivity, but is also likely to be criticised by neighboring fishermen for the abuse of his fishing rights.

Recently the set net fishing grounds in coastal waters are being destroyed by a number of phenomena involved in the nation's overall industrialization, such as the reclamation and urbanization of shallow sea areas and the resulting decrease in water quality, and the direct dumping of waters from factories into coastal waters.



**Table 4. Analysis of coastal fishing families in Japan**

Type	Characteristics
Fishery operations using powered boats of up to 10 tons	(1) 0 ~ 3 ton-class Operated by family members. Includes a combination of angling, long-line, gill-net shell gathering, and seaweed gathering to fill out a year-round fishing schedule. Initial capital investment is small, requiring non-fishing part-time jobs to fill out family income.
	(2) 3 ~ 5 ton-class Uses a combination of family and hired labor to conduct two or three basic types of fisheries along with other miscellaneous fisheries in a year-round fishing schedule. Capital investment is higher than the 0 ~ 3 ton class. Fishery income is also higher but dependence on outside jobs for income is still high.
	(3) 5 ~ 10 ton-class Trolling, purse seining, pole-and-line fishing for skipjack, squid jigging and off-shore gill netting are the primary fisheries, conducted mainly by employed labor managed by a business-like management system. In this class constant enterprising efforts are necessary to keep fishing boats, gear and machinery modernized for a high investment, high income fishery business.
Aquaculture management	Involved in aquaculture of yellowtail, prawn and pearl oyster is a considerably large number of large-scale fishing units but aquaculture of laver, scallop and kelp is operated by fishermen involved primarily in boat fisheries. Aquaculture operations by fishermen involved primarily in coastal fishery tend to be small-scale with low investment in facilities and are operated by family labor to provide a steady income.
Groups managing small-scale set net or beach seine net fisheries	Small-scale set net fisheries are a different group from the previously mentioned fishing boat fisheries. They are conducted widely throughout Japan's coastal waters, and will be discussed in detail in the following pages. Beach seine fisheries are on the decline, being limited mostly to operations conducted as tourist attractions.
Fishing operations using non-powered boats and not using those boats	In Japan, the motorization of fishing boats occurred at a very rapid rate following World War II. Today there are very few non-powered boats involved in fishery, and fisheries supported by non-powered boats will soon be non-existent.

**(2) Securing labor for set net fishery:**

Securing a sufficient labor for set net force is a problem of primary importance, not only for large-scale set net fishery, but also for small-scale operations as well. Japan's rapid economic growth in the sixties and seventies caused a shift in the young labor force of the fishing village to secondary and tertiary industries. The resulting increase in the average age of fishery laborers and the increased cost of labor, have made it more and more difficult to secure sufficient labor for small-scale set net fishery. Therefore, these fishermen have aggressively sought to maintain their marine production by the introduction of new manufacturing technology to mechanize their operations as much as possible, thus reducing the number of man-hours required and economizing on labor.

Set net fishery is a highly seasonal, passive or waiting type of fishing method. This means that careful planning of production and labor requirements is necessary to insure a constant year-round income. Since long ago, set net fishermen have combined the following types of fishing activities, or side jobs in other industries, to supplement their incomes.

**I Traditional types of supplementary work:**

These formats can be divided into the following three patterns:

- Conducting farming or lumbering as a side business.
- Working part-time for a large-scale set net enterprise while at the same time, conducting a self-employed small-scale set net fishery.
- Using a small-scale fishing boat to conduct angling, long line or gill net fishery as a side business.

Recently, however, with the exception of areas with extremely rich fishing grounds this type of business pattern is disappearing. The reason for this is that, since Japan's period of rapid economic growth, fishermen have stopped trying to maximize their "fishery income" and started to think in terms of maximizing their "overall income".

**II Set net fishery and aquaculture as a combined business:**

For a long time fishermen have practiced a type of business in which yellowtail fingerlings which are caught in set nets in the summer are kept in fish preserves and raised on feed made from the mass-catch mackerel and horse-mackerel from the same set nets, until after the winter hibernation season, when they can be sold as mature yellowtail. Also, because the set net fishing grounds are good as culturing waters, there are many cases of fishermen using the culture of a variety of fish species and edible seaweeds as a side business.

**III Side business in industries other than fishery**

There are cases where the fisherman will seek employment on land as a waged laborer, and also many cases where the fisherman will lease his boat for game fishing or use part of his home as a private boarding house.

**(3) Improvement of distribution and sale of catch:**

In the case of set net fishery, the fish caught in the net are still alive. It is necessary to have a means to take advantage of this important characteristic so that the catch can be sold at a higher price.

- High quality fishes should be shipped as live fish.
- A fish preserve should be constructed at the landing port, so that the fish can be kept stocked until the optimum time for shipping.
- At times of unusually large catches, the number of net haulings should be reduced to maintain a steady fish price at the market.

Another characteristic of set net fishery is that a wide variety of fish are caught in the same net. A sales system should be set up to maximize the freshness of the fish when they reach the market.

- Small-catch fishes can be sold to local tourist inns and hotels.
- Home processing of catch for sale as processed foods.
- Extra fish from large catches can be used as material for aquaculture feed or fish meal.
- The landing port should be equipped with ice-making equipment and frozen storage facilities.

**(4) Securing public financing for investment:**

In order to conduct set net fishery it is necessary to invest in basics such as a net, related fishing gear, and several boats, as well as fees for setting and removing the nets, maintenance of the nets, machinery used in the everyday working of the nets and also labor expenses.

In order to encourage the growth of small-scale set net fishery by artisanal fishermen a system of low-interest loans for fishery investment, financed by government funds, is essential.

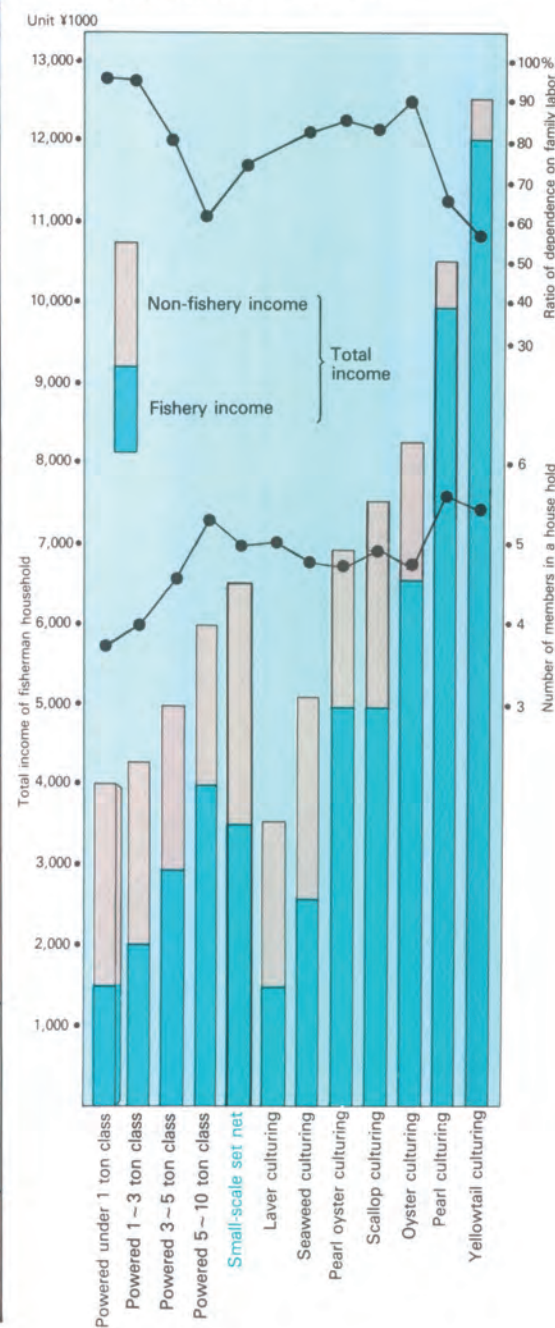
In Japan, there is a combined depository called the "Agriculture and Forestry Central Depository" which handles the combined investment funds for the agriculture, forestry and fishery industries. Financed by the national government and the local prefectural grants, this organization offers low-interest, long-term loans to coastal fisheries, for the "Modernization of Fisheries" on a large scale all over Japan.

In addition, there is a totally government-financed loan depository for agriculture, forestry and fishery, that makes special low-interest, long-term loans to fishermen in accordance with the government's "Program for the Improvement of the Structure of Coastal Fishery".

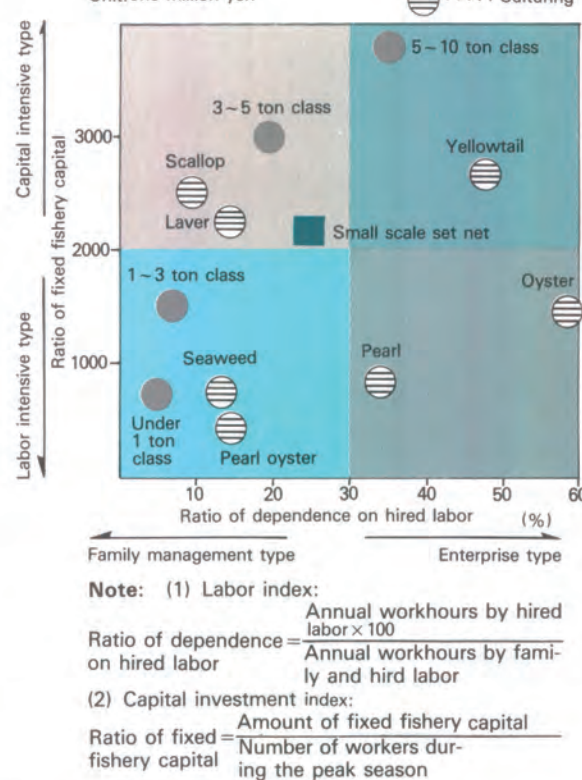
**Table 6. Types of management of coastal fisheries**

Family-type fisheries	(1) Fishery operations depending mainly on family labor and do not involve a large capital investment. (2) Fishery operations depending mainly on family labor, but using production methods calling for a large capital investment.
Enterprise-type fisheries	(3) Fisheries depending mainly on hired labor but not involving large capital investment. (4) Fisheries depending mainly on hired labor and using production methods involving large capital investment.

**Table 5. Household's income/number of members in a household/ratio of dependence on family labor**

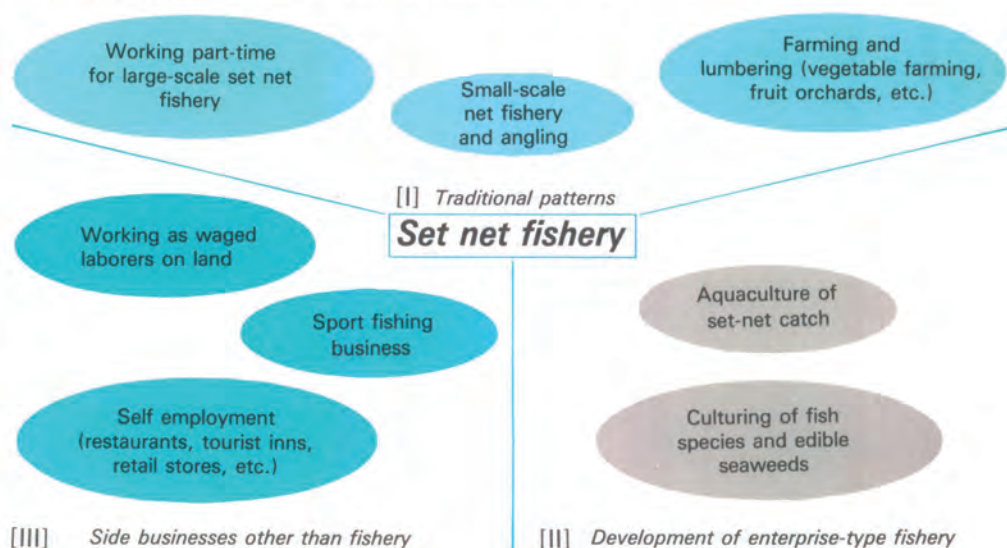


**Table 7. Capital and labor**

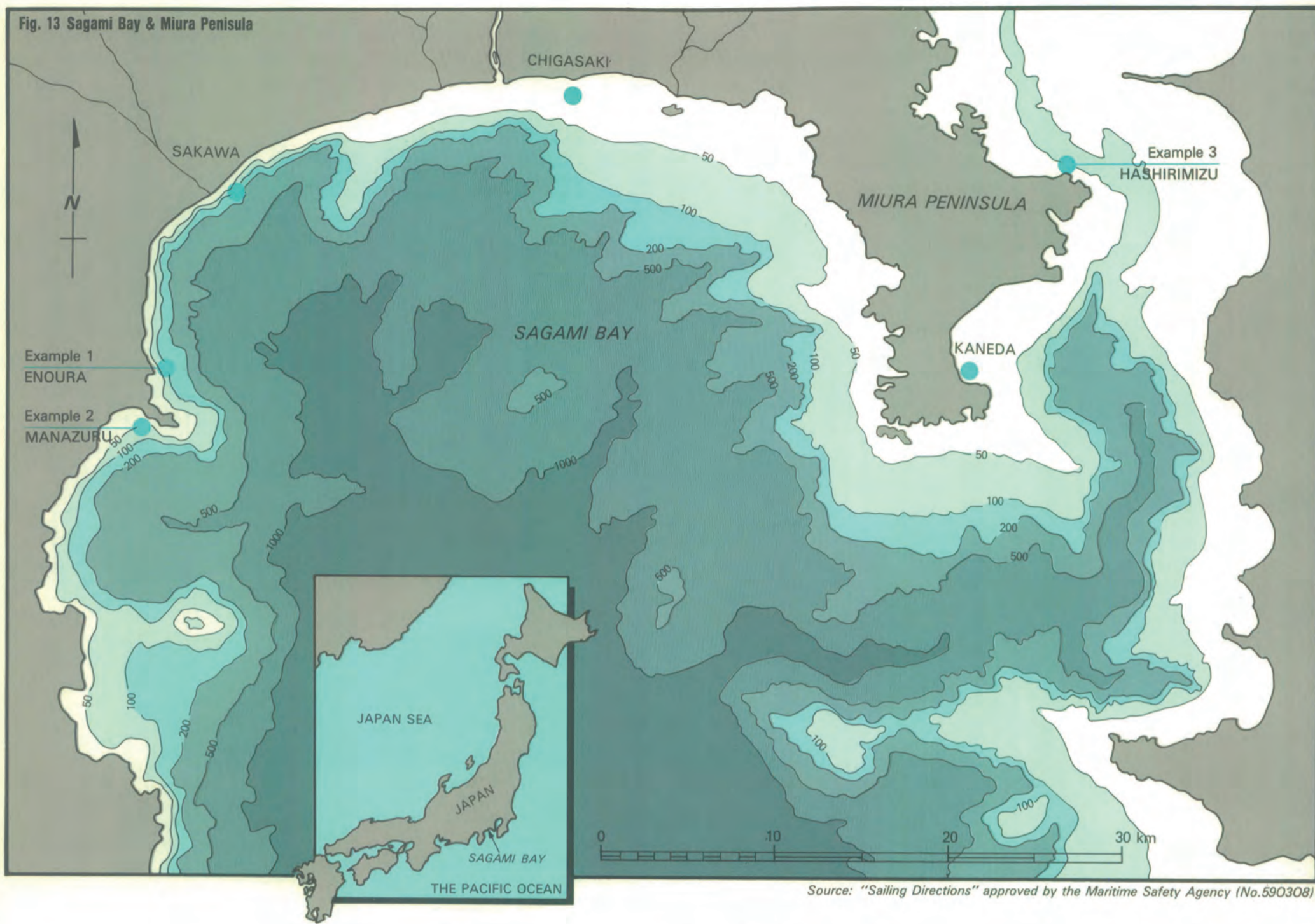


Annual Survey on Fishery Economics by the Ministry of Agriculture, Forestry and Fishery-1981

**Table 8. Side businesses of small-scale set net fishermen**







# Set net fishery in

## Geographical features

**Sagami Bay:** Kanagawa Prefecture is contiguous to the western extremity of the Tokyo Metropolitan area. Sagami Bay which is washing the Pacific coast of this prefecture, has a gently-sloping expanse of continental shelf in its eastern half. There is little continental shelf in its western half and the 200-meter isobath reaches the sea areas only 900 meters from the coast. The Kuroshio Current (warm current) which is circulating along the coast makes various migrating fish species concentrated in this bay area.

**Miura Peninsula:** This peninsula is characterized by an expanse of low hills. Its coastal waters are mostly shallow, with a lot of natural reefs and rocks. These waters also feature a number of small bay areas, with the largest of all situated along the southeastern part of the peninsula.

## Types of nets

About 48 large-scale and 110 small-scale set net fishing units are presently in operation in the coastal waters of Kanagawa Prefecture, as shown in table 9.

In order for the fisherman to choose a suitable net for his fishing ground, he must study various factors such as fish species sought, the sea bottom topography and its interrelation to the currents, while at the same time taking into consideration the overall feasibility of operation including the estimate of maximum catch amount.

The factor of prime importance that determines his choice is the sea bottom topography.

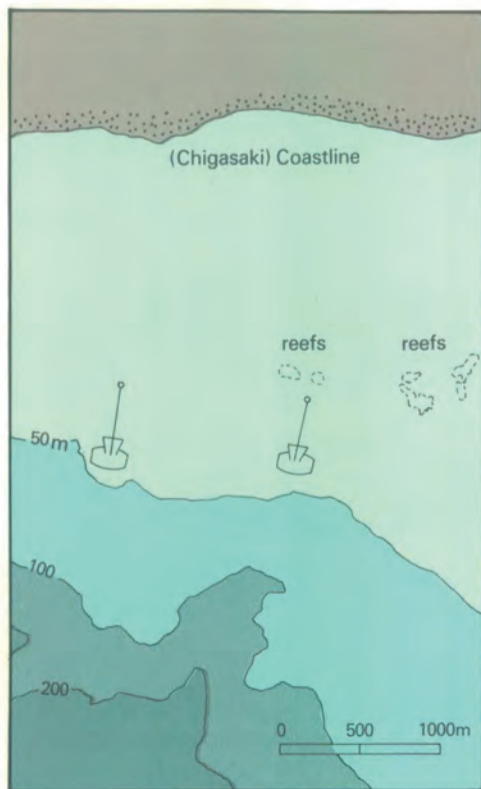
The two-mouth Choko-ami is considered most suitable for the shoal extending to a

**Table 9. No. of fishing units by type of net (1983)**

	Large	Small
• Otoshi-ami		
1. One-end bag net	11	Approx. 60
2. Both-end bag net	1	0
3. Choko-ami (sake cup shape)	27	Approx. 40
4. One-end underwater	3	0
5. Both-end underwater	5	0
6. One-end underwater and the other-end bottom set	1	0
• Masu-ami	0	4 to 6
• Other types	0	4 to 6
<b>Total</b>	<b>48</b>	<b>Approx.110</b>

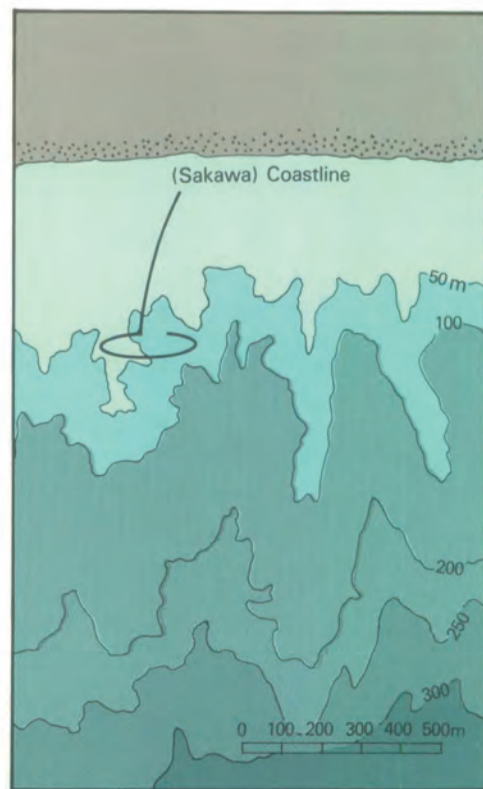
**Fig. 14 Shoal fishing ground**

(large scale set net - choko ami)



**Fig. 15 Deep coastal-water fishing ground**

(large-scale set net - one-end bag net)



great distance where fish species are spread thinly over a large area, while the one-mouth bag net is mostly used for deep coastal waters with the aim of making the schools of fish concentrated in a small area along their routes.

The underwater set net and bottom set net have come to be used in many fishing grounds due to the adoption of power-driven machinery and equipment since the late sixties.

The aims of using these nets are :

1. to increase the amount of catch by preventing the fish from escaping out of the bag net as effectively as possible.
2. to increase the species of fish caught by catching demersal fish as well.
3. to develop offshore fishing grounds by adopting these seaworthy set net methods.

## Catches

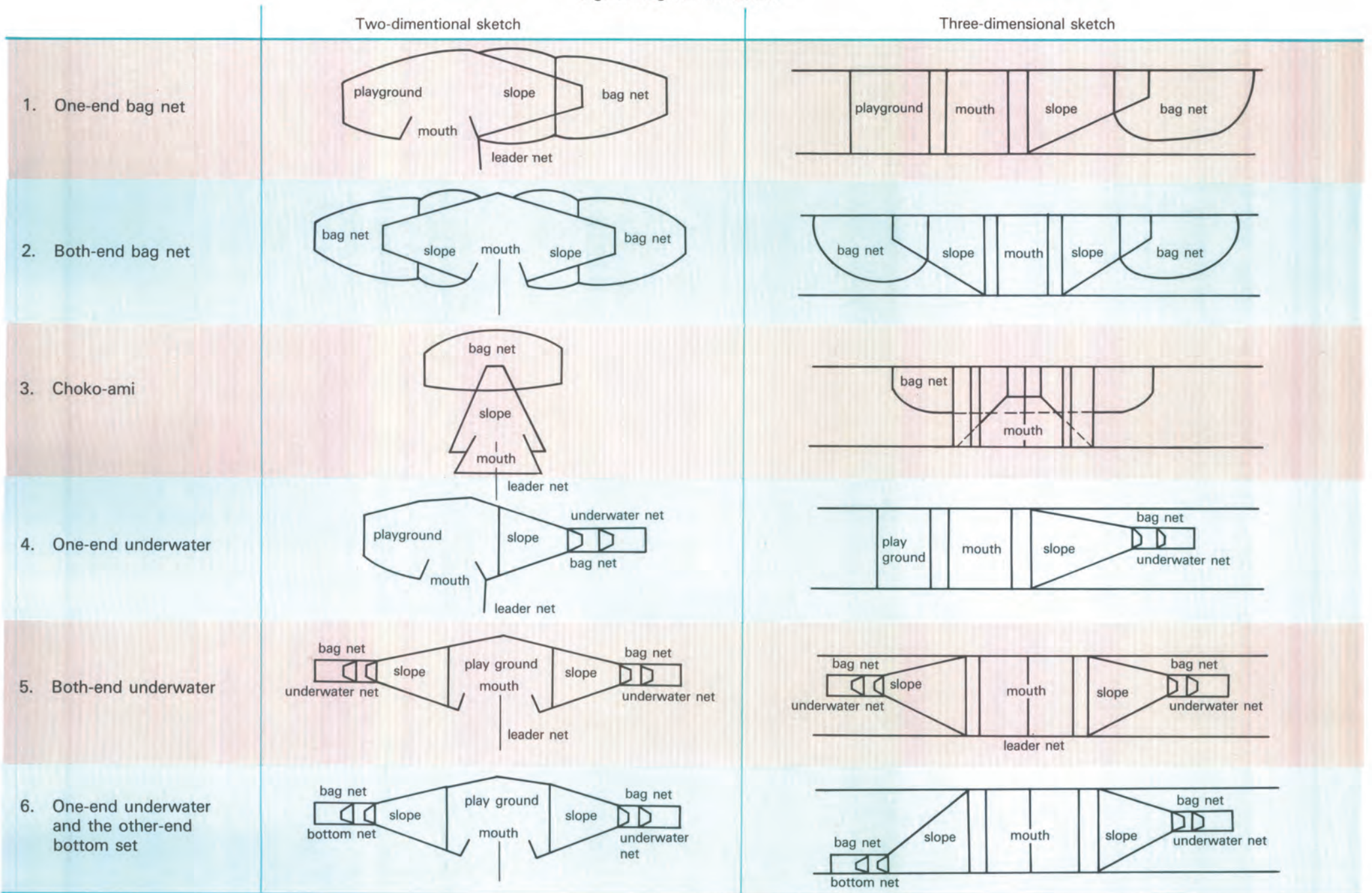
Please see a separate table for the present situation of set net catches by fish species in Kanagawa Prefecture. The combined catch amount of large-scale and small-scale set nets makes up 10 to 20% of the total catch amount by all types of fisheries in this prefecture. Main fish species caught in these sea areas are sardine, anchovy, mackerel, horse mackerel, frigate mackerel, yellowtail, hairtail, file fish, etc.

Most recently, sea conditions have helped to increase the catch amount of file fish.

The catch amounts of individual fish species fluctuate from year to year but these fluctuations are mutually offset, thus keeping the combined total amount of all fish species at a relatively constant level on a long-term basis.



Fig. 16 Bag net variations



# Kanagawa Prefecture

Table 10. Facts about set net fishery in Kanagawa Prefecture (1981)

	Unit: Ton		
	Large-scale set net	Small-scale set net	Grand total
Total fish catch	13,523	2,904	16,427
<b>FISH SPECIES</b>			
Frigate mackerel	285	48	333
Sardine	8,881	1,854	10,735
Anchovy	404	241	645
Horse mackerel	244	66	310
Mackerel	1,329	115	1,444
Yellowtail	380	31	411
Hairtail	127	91	218
Sawara niponia	35	1	36
Perch	47	55	102
Barracuda	162	57	219
Grunt	85	23	108
File fish	547	27	574
<b>AQUATIC ANIMAL SPECIES</b>			
(cuttlefish, squid, etc.)	92	43	135
Grand total	13,615	2,947	16,562

Total catch amount by all types of fisheries in Kanagawa Pref. 95,262

More than 160 species of fish are caught by set net fishery in Kanagawa Prefecture. The catch amount by the first 3 or 5 nets in terms of productivity makes up about 50% of the total, while the first 10 account for more than 90%.

This indicates that the set net fisherman must make a good choice of net type and set location depending on fish species sought.



## Management

Set net fishing units are divided into the following categories:

- Large-scale set net ..... 48 units
- Fishery cooperative management 8 "
- Joint management by cooperative and individual fishermen 15 "
- Fishermen's union 1 "
- Company 13 "
- Self-employed 11 "
- Small-scale set net Approx. 110 units mostly self-employed and several units adopt joint management by cooperative and individual fishermen.

As mentioned above, large-scale set net fishery adopts five different types of management, each of which is capitalized by fishermen alone, although non-fishery interests also made an investment in this fishery for some time after World War II.

In this fishery operation each fishing unit formerly required about 150 fishermen.



But the number of fishermen required has been decreased to about 30 due to the introduction of labor-saving machinery and equipment, and improved nets. Each fishing unit, however, is still suffering from a lack of hands, especially young fishermen.

Small-scale set net fishery is mostly conducted by self-employed fishermen. In most cases it is operated by a fisherman and his son or wife. Even in case no family labor is available, hired labor is kept to a minimum.

Materials are offered by Mr. Taisuke Hiramoto, Kanagawa Prefectural Fisheries Experiment Station.



# Actual examples of small-scale set net fishery

The main types of small-scale set net fishery include (a) small-scale "otoshi-ami", (b) "masu-ami", and (c) others such as "hari-ami", "tateboshi-ami", "eri", "sudate", etc. Among these, (a) requires the largest crew to operate, followed by (b) and then (c). We will introduce here 3 examples of (a) and (b) type operations from Kanagawa Prefecture and one example of a (c) type operation from Shizuoka Prefecture.

## EXAMPLE 1

This is an area with a steep coastal drop-off, in which the net is set in a sandy seabottom area at a depth of 15 fathoms. In this area there are four small-scale set net fishing units, all of which are using a both-end "otoshi-ami". At one time all of these fishing units used what is known as an "one-end otoshi-ami", but a little over 10 years ago fishermen began to change to the present type of net in an effort to improve their operation efficiency. Regarding the placement of nets, the locations at which nets can be placed are controlled by the common of fishery system, which means that the random changing of net location is not permitted.

### Fishing gear

Figure 17 shows the shape of nets in use up until 1976. Because net hauling was performed entirely by hand, it required 5 or 6 laborers to operate. The net was hauled up hand over hand starting at point P and moving toward point Q, where the trapped fish were then caught.

Figure 18 shows the improved net configuration introduced in 1977. Improvements to the net included the following features:

- (1) Two bag nets were fitted on opposite sides in an attempt to increase catch effectiveness. Because of this, two body net entrances were created on either side of the leader net, where before there had been only one.
- (2) The leader net length was increased from 105 meters to 130 meters to increase the number of fish schools intercepted by the leader net.
- (3) The slope was improved. The angle of the slope was reduced to a gentler angle in order to decrease the fish's resistance to entering, and thus increase catch efficiency. In addition, a ceiling net was strung over the top part of the slope to prevent fish from escaping.

Then in 1979, the net configuration depicted in Fig. 19 was adopted. The new configuration included the following major improvements:

- (1) Four pulleys were fitted on the ropes supporting the bag net. Two ropes are strung through these pulleys and under the lower part of the bag net. When these tow ropes were pulled by a powered winch, they performed the same net-raising function that had previously been performed by the crew raising the net, hand over hand in the direction of the upper part of the slope.
- (2) The width of the body net mouth was made even larger.

In summarizing the results of these improvements, first of all, the addition of the pulleys and powered winches simplified the hauling operation, making it possible for 4 men to perform the job which previously required 5 or 6 men. Secondly, the presence of the above mentioned powered winches also meant that adjustment and maintenance of the shape of the net could be performed more accurately.

Thirdly, with the new net configuration, a larger number of demersal fish began to be caught along with main catch of surface fish, meaning larger over-all catches by each net

## Small-scale "otoshi-ami"

(Enoura, Kanagawa Pref.)

Fig. 17 Net configuration before improvement

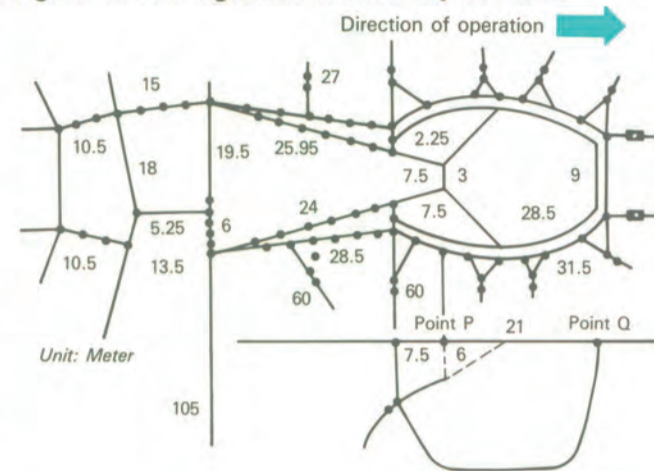


Fig. 18 Improved net configuration (1)

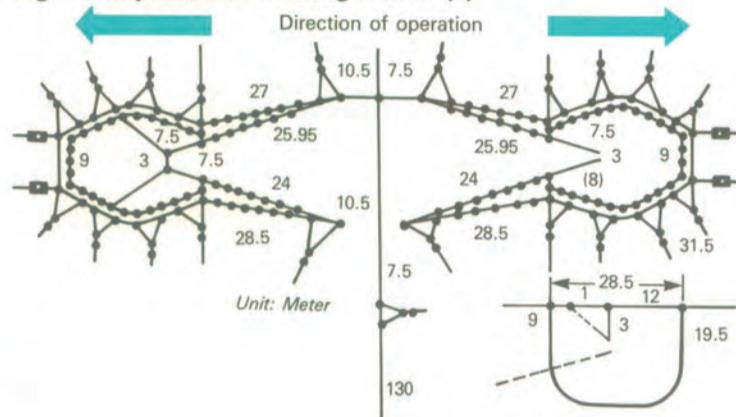


Table 11 Present net specifications

Parts of net	Material	Thickness	Mesh size	Hang-in ratio
Leader net	Nylon	4 to 6 mm $\phi$	120 to 300 mm	68 to 70 %
Body net	Nylon	2 to 4 mm $\phi$	100 to 120 mm	68 to 70 %
Slope	Nylon	2 to 4 mm $\phi$	100 to 120 mm	60 %
Bag net	Nylon	210 d. 12 to 21 yarns	20 mm	68 %

### Fishing boat

This set net fishery is operated with a 7 ton fishing boat powered by a 110hp diesel engine (continuous rated output). In addition, another boat, powered by an outboard, is used. It is not, however, necessary for the set net operation, rather it is used for seaweed culture activities.

### Types of fish caught

So as not to interfere with large-scale set net fisheries, which are most active in the winter season, small-scale set net operations are suspended in the winter, leaving the months of April to November open for these operations. Although a large number migrating fish species are caught by the set nets, in this area red barracuda is by far the largest single species, making up over 70 % of the total annual catch in terms of gross sales. Table 12 shows the season in which each species migrates into these coastal waters.

### Income and expenses

The small-scale set net fishermen of this area are also engaged in various side-businesses such as seaweed culture, gill

View of Enoura Port and nearby fishing grounds



Fig. 19 Improved net configuration (2)

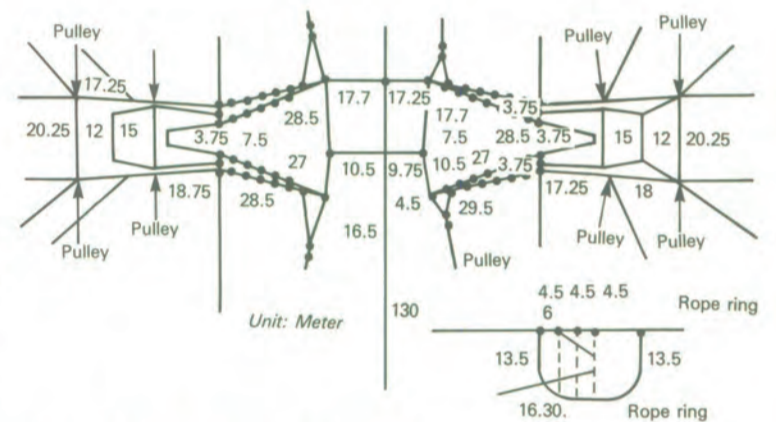


Table 12 Migratory season by species

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Horse mackerel												
Mackerel												
Sercola aureovittata												
Bashoika (squid)												
Juvenile yellowtail												
Juvenile horse mackerel												
Frigate mackerel												
Sardine												
Red barracuda												

net, angling and dive fishing. The fisherman which we interviewed here, is engaged in kelp culture and, in the summer, used part of his house as an inn for tourists. The annual catch by small-scale set net for fishermen in the area ranges between 10 million and 15 million yen. With the added income from their various side businesses the average household brings its annual gross sales to the 15 million yen level.

One fisherman we visited operates his set net fishery with the help of his wife and two additional crew, which he hires at a rate of 3,000 yen a day. These two crew members are farmers who use the fishing income to supplement their farming income. Fuel expenses total about 3,000 yen per fishing day. In addition to these, another important expense is involved in measures to keep the net free of seaweeds. When seaweeds begin to grow on the net they block the light entering the netted area, thus making the inside of the net darker which discourages fish from entering. Like Tokyo Bay, this sea area is one of increasing eutrophication, so, in the summer, the longest period the nets can be left without cleaning is 10 days. To clean their nets of seaweeds, the fishermen here use chemical weed-proofing, and about once every two months the nets are pulled out of the water and landed for a complete cleaning by means of a water pump.

All these measures cost the fisherman about 1 million yen a year.

### Investment:

- 1) fishing boat (7-ton) 25 million yen (lasts 15 years)
- 2) net gear 35 million yen (lasts 10 years)

\* One set of reserve nets is usually kept on stock

- 3) Others  
Wrecker vehicle, net-cleaning pump, small-size truck

### Fisheries cooperative association

The Enoura Fisheries Cooperative has a total of 113 regular and associate members. Among these only 9 are engaged solely in fishery, with another 15 being engaged primarily in fishery with some side-business, and the remaining 89 members being primarily farmers who use fishery only to supplement their farm incomes. In addition to small-scale set net fishery, members are engaged in gill net fishery, octopus potting, angling, dive fishing and seaweed culture. The main farm crop of this area is mandarin oranges, grown throughout the coastal mountains.

Resource materials provided by Mr. Tatsumi Takahashi (Enoura Fisheries Cooperative Association)



# EXAMPLE

# 2

# “Masu-ami”

(Manazuru, Kanagawa Pref.)

As seen in Fig. 20 there is one large-scale and 10 small-scale set net fishing units in the waters surrounding the Manazuru peninsula. The peninsula is the meeting point of two coastal currents, a northern upper flow and a southern lower flow, running along either side of the peninsula. The waters off the end of the peninsula where the two currents flow into each other is an area of rough wave conditions.

The two underwater set nets positioned at the end of the peninsula are an attempt to use this kind of net to extend the fishing grounds into this rough water area. The third underwater net, set near the coast in a sandy-bottom shallow water area (5-25 meters deep) is an attempt to catch barracuda (*Sphyraene japonica*). The other seven small-scale set nets shown on the map are all “masu-ami”. The body net is set at a depth of 20-25 meters over a sandy bottom or above a rocky reef. The net is located in such a way that the leader net mouth surround a deep spot in the sea. The set net operation which we researched for this article is the one at the left on the map, indicated by the arrow.



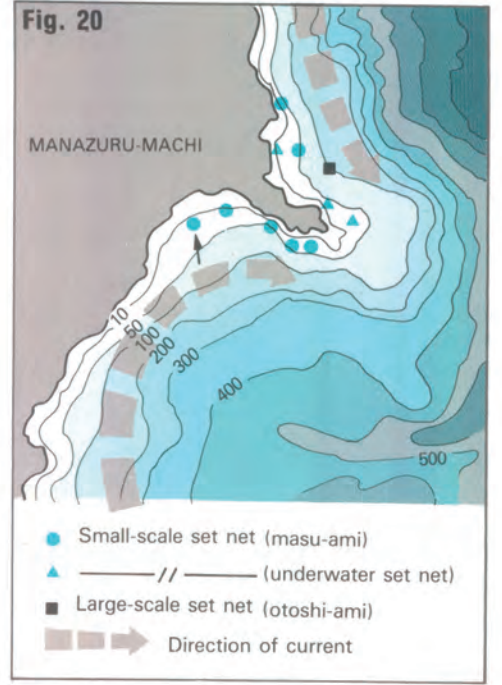
A view of the fishing ground



Closing the mouth of the body net



Raising the body net to drive fish toward bag nets



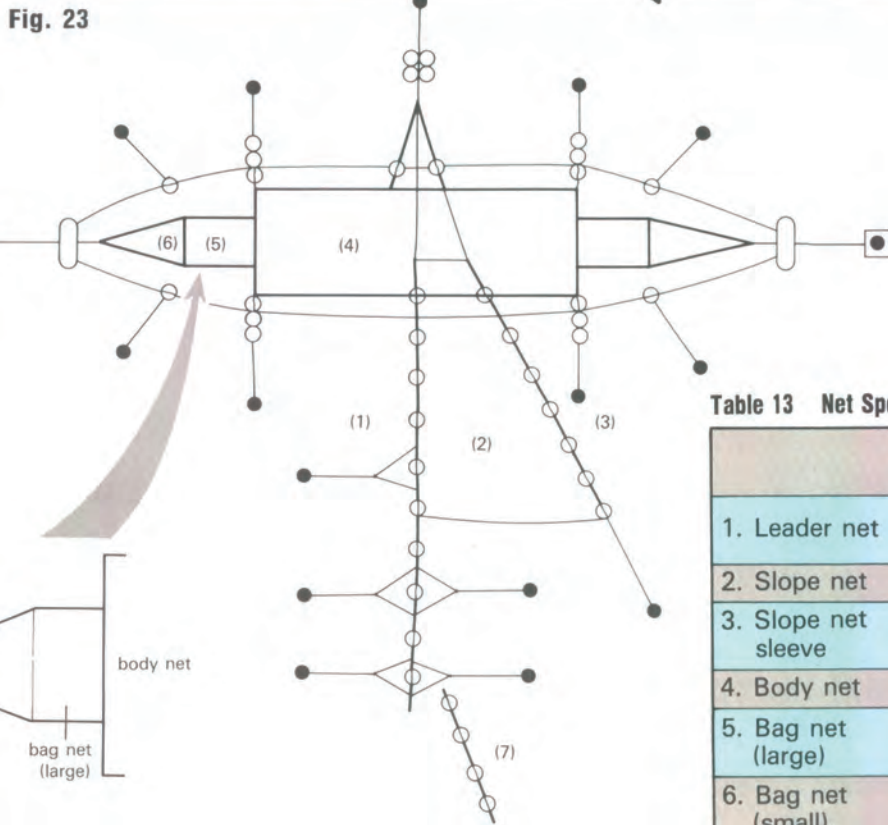
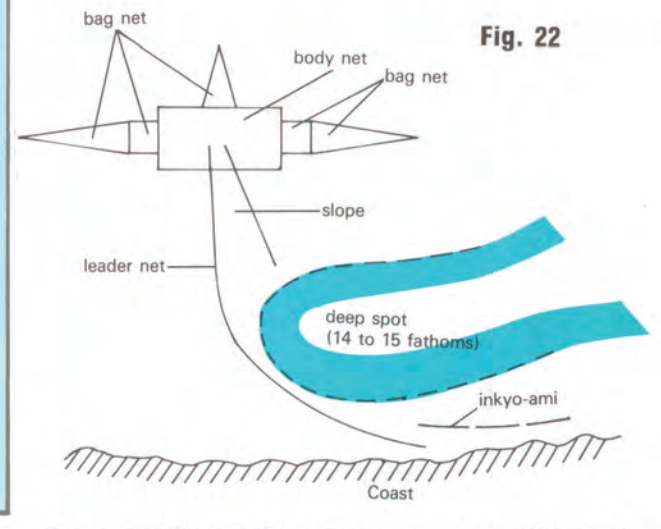
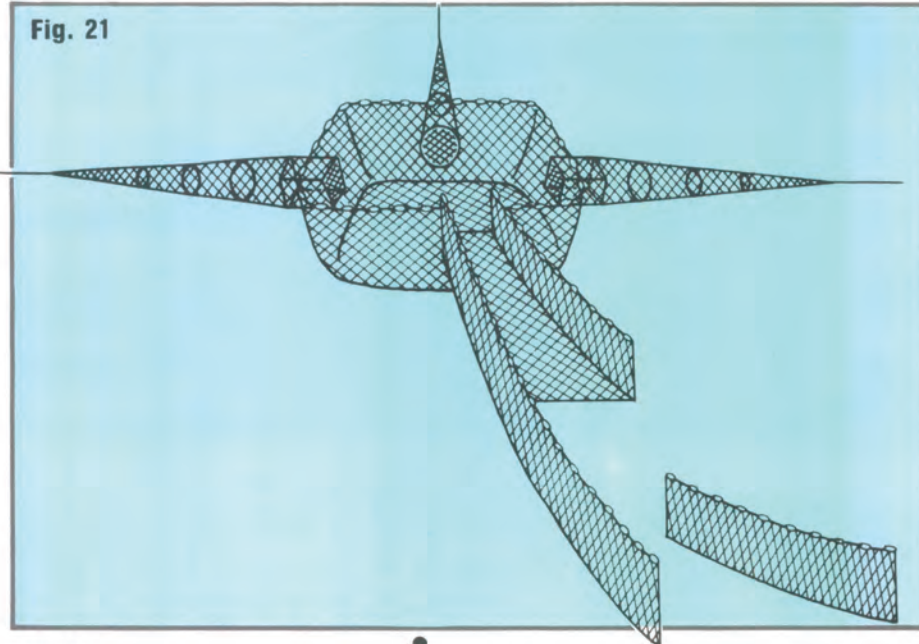
Raising of the bag nets using a Yamaha DX-29A-1A

## Fishing gear

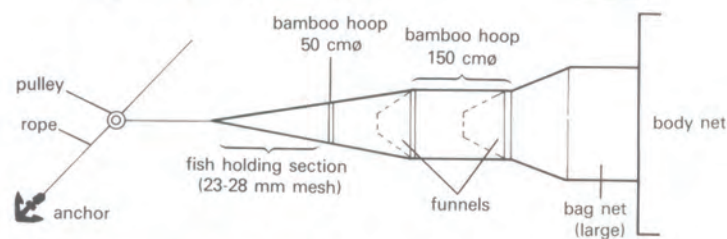
This “masu-ami” is larger in scale than the “masu-ami” that is introduced in Example (3) on the next page. The body net is a 27 meter × 9 meter elongated square to which bag nets are fitted at three locations, to the right, left and far side from the net mouth. There is also a slope net attached to the mouth of the bag net.

The unique characteristics of the small-scale set nets in this area can be explained historically. Originally, the set nets used in the Manazuru area were “otoshi-ami”. Around 1960, however, in an effort to reduce the scale of their net operations, fishermen here adopted the “choko-ami” (see reference to “choko-ami” on page 5) After that, the fishermen began to make various improvements to their nets, resulting in the present “masu-ami” that we see in use today. Although the present net is a “masu-ami” its body net closely resembles that of the “choko-ami”, and the slope net of the previous “otoshi-ami” has been adopted as a part of the new net configuration.

These improvements in the nets and changes in net type can be seen as efforts on the part of the fishermen to find the optimum fishing gear to coincide with changes in the sea conditions resulting in a change in their environment, such as changes in the composition of fish migrations and the decrease in the available work force for fishery operations. An “inkyo-ami” is used here to supplement the function of the leader net in leading fish toward the body net. This “inkyo-ami” is made from a used net, and its length is adjusted depending on the season.



### Bag net (small) structure



### Rope (shown by fine lines)

(a) rigging and support ropes for net ... nylon 20-22 mm ø; (length of rigging ropes are 2.5 to 3 times the water depth)

(b) the anchor rope ... nylon 24-26 mm ø

### Buoys

(a) main buoy (marked by ◻) ... a propane gas tank is used

(b) “shaku-dama” (marked by ○) ... made of hard plastic 360 mm ø  
(c) “aba” ... plastic foam, set at 50 cm intervals

### Anchor

(a) large anchor (marked by ◼) ... weighing 100kg  
(b) small anchor (marked by ◉) ... weighing 40 to 60kg

Table 13 Net Specifications

	Material	Thickness	Mesh size	hang-in ratio	length	width
1. Leader net	Sea King*	3 mmø	300 mm	0.7	100-130 m	—
2. Slope net	nylon	210D25y.	120-150mm	0.75	20-25m	—
3. Slope net sleeve	“	“	“	“	20-25 m	—
4. Body net	“	0.4 mmø	43 mm	0.6	27 m	9 m
5. Bag net (large)	“	“	“	0.75	6 m	4.5 m sq.
6. Bag net (small)	“	“	“	“	7.5 m	—
7. Inkyo-ami	Sea King*	3 mmø	300 mm	0.7	45 m	—

**Note:** \*This net is composed of polyester twine and polyethylene flat yarn, which gives a slick surface that makes it difficult for seaweeds to grow on and it has been developed especially for the leader net of set net fisheries.



Bag net as seen in the water



# Actual examples of small-scale set net fishery

## Fishing boat

The fishing boat used here is a Yamaha DX-29A-1A. This boat is designed as a multi-purpose boat suitable for set net fisheries, as well as aquaculture operation, gill net, and angling fishery. It is equipped with a Yamaha MD20 type diesel engine. Other equipment include one derrick, 2 capstans, three-direction rollers in two locations, and one watering pump. The boat's cost is 5.6 million yen.

### DX-29A-1A SPECIFICATIONS

LOA ..... 8.96 meters  
 Beam ..... 2.20 meters  
 Depth ..... 1.07 meters  
 Total weight ..... 2.06 tons  
**ENGINE SPECIFICATIONS**  
 Yamaha MD20 .... Continuous-rated power output  
 30PS/1,700rpm

## Types of fish caught

The main catches of these nets are species of the squid family. These include *Sepioteuthis lessoniana*, *Todarodes pacificus*, *Doryteuthis bleekeri* etc. with *Sepioteuthis* (catching season May-Aug.)

being the most important catch, accounting for 70 - 80 % of the total annual catch in terms of sales value. Besides the squid family, small numbers of grey mullet, sea base, *Grella punctata* and *Seriola Aureovittata* are also caught

## Operation

In the main fishing season, from spring to summer, the body net is emptied and the fish caught once every morning. However, in autumn and winter when the number of fish drops off the nets will be emptied of fish only once every 2 or 3 days. The operational process involves (1) closing the mouth of the slope net, (2) forcing the fish out of the body net, and (3) pulling up of the bag nets, in order. All three of the bag nets are hauled up and emptied. The job is performed by 2 men, and everything is done by hand. No machinery is used (the derrick is used only when re-setting or cleaning the nets).

## Income and expenses

The income from these set net operations varies greatly from one fishing unit to the next, but each fishing household earns at

**Table 14 Economic outline of small-scale set net fishing households(1982)**

(Pacific coast areas of central Japan including Kanagawa)

(A) Fishery income (gross)	6.8 million yen
(B) Fishery expenses	2.47"
(A - B = C) Fishery income (net)	4.33"
(D) Non-fishery income (net)	2.14"
(C + D = E) Total net income per fisherman household	6.47"

least 5 to 6 million yen a year from their fishery businesses. Labor costs, fishing gear maintenance and fuel costs, fishing gear maintenance and fuel costs total between 3 and 4 million yen in every case.

**Note:** Compared to the national average, the size of the small-scale set nets operated in Kanagawa Prefecture are small, meaning the income and expenses involved are also smaller. However, due to income from non-fishery side businesses, the net income of these fishermen comes up to the national average.

## Fisheries cooperative association

There are about 100 regular members in the Manazuru Fisheries Cooperative, while another 10 run their own small-scale set net operations. In addition to set net, "wakame" seaweed culture, gill net, and trolling are also conducted, but they are

not strong businesses. The main side-business for the set net fishermen is renting out their boats for sport fishing.



"Wakame" seaweed culture as a side business

Resource materials provided by Mr. Shimpei Kobayashi (Manazuru Fisheries Cooperative Association)

# EXAMPLE 3

## Small-scale "Masu-ami"

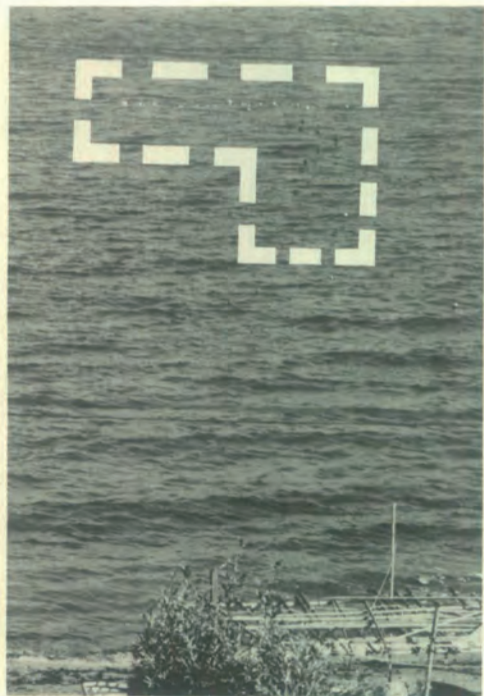
(Hashirimizu, Kanagawa Pref.)

There is a steep gorge over 1,000 meters deep in the ocean floor off Kannonzaki Point (Paleozoic era Tokyo river gorge). This topography acts to concentrate the tidal currents entering and leaving Tokyo Bay up against Kannonzaki, causing a very fast tidal flow. At their fastest point, the tides off Kannonzaki flow at a speed of approximately 2 knots.

For small-scale set nets, locations are chosen in inlets which slow down the tidal current, and level, sandy sea bottom areas with a depth of 7 - 8 meters are the most



Hauling in a bag net (Yamaha W-20 type workboat)



Position of a set net

suitable setting grounds. Because the nets are meant to catch fish that come into the shallow coastal waters to spawn, it is important to find a site near a rocky reef with thick seaweed growth.

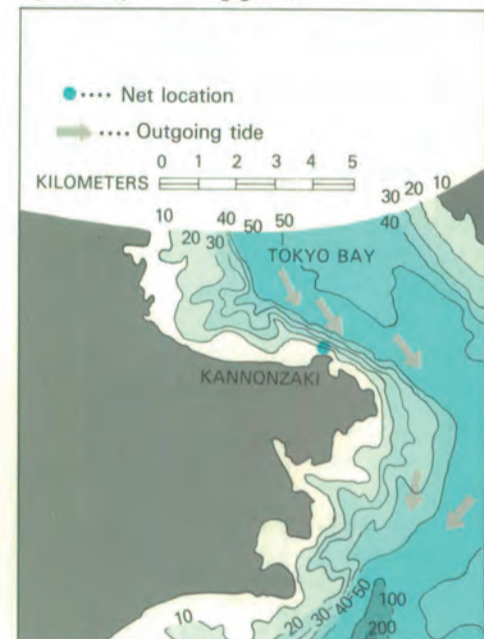
Also, because fish migrate into Tokyo Bay from the ocean in the spring and out again in the autumn, it is ideal to be able

to change the locations of the nets depending on the season.

## Fishing gear

The "masu-ami" is a fishing gear well suited to small fishing grounds. Also, since

Fig. 25 Map of fishing grounds



the netting is held firmly in place by anchors (4 large, 4 small) on the sea floor, the net has good resistance against current potency, and is easy to keep in proper position. The net pictured here is a masu-ami designed for use at a depth of 9-10 meters. If a net is to be used in deeper water than this, the water forces at work trying to distort the net also become larger, so a larger over-all net design becomes necessary.

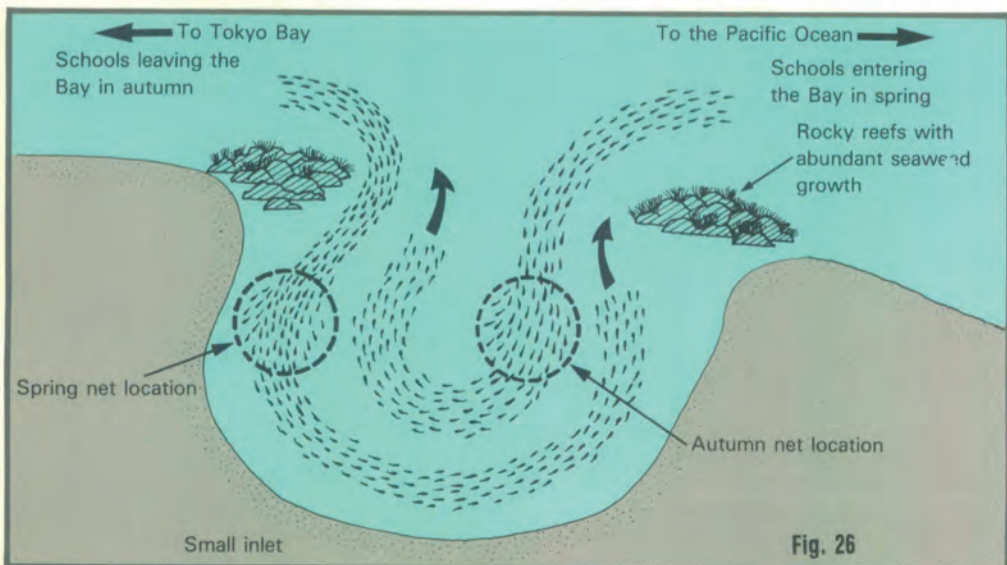
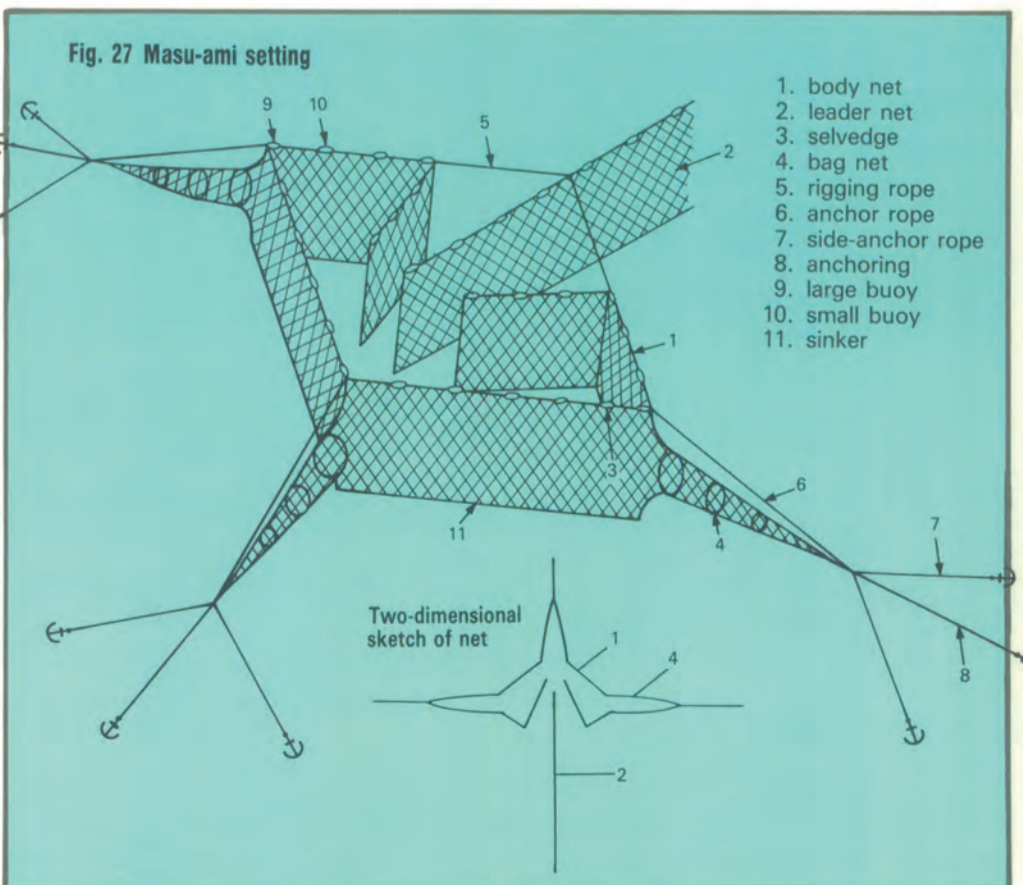


Fig. 26





### (1) Important measurements

The mesh size of the net used in bag net varies in size from 28 to 43 mm depending on the type of fish being caught. The larger the mesh size, the brighter the interior will be, making it easier for large fish such as sea bass, sea bream, flatfish and flounder to enter the net. However, if the mesh is too large, fish will tend to get emmeshed in the net, making the hauling operation extremely difficult. When fully assembled, the over-all length of the bag net is 8 meters.

The funnel net is attached to the bag net just three mesh eyes in front of the position of the hoop of vinyl pipe. If it is attached directly to the hoop, it will become too rigid, thereby increasing the incidence of injury or death to fish struggling to escape from the net (See photo).

### (2) How the bag net is attached to the body net

- Starting at center point four tenths of the way up the net from the bottom, a vertical and horizontal line are cut in the net in a "+" pattern.
- Four triangular peices of net are prepared (A,B,C,D). These are then fitted into the cut sections of the body net and sewn in place.
- The ends of the triangles are then sewn to the periphery of the bag net.
- This creates a smooth curved connection between the bag net and body net when the bag net is pulled out tight, reducing the fishes' reluctance to entering the net to a minimum.

Fig. 30 Triangular net pieces

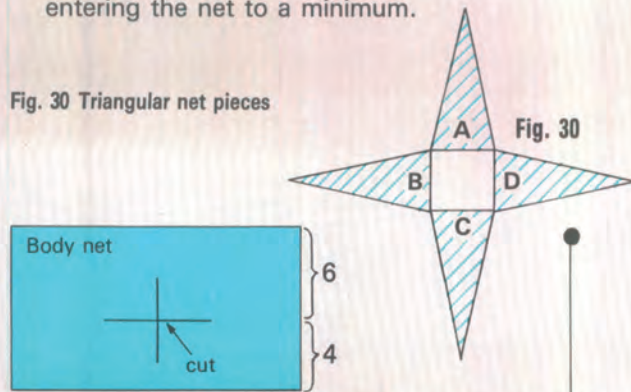
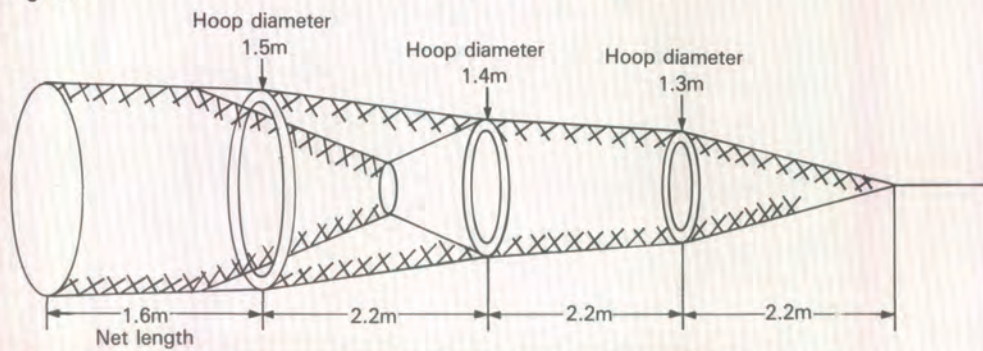
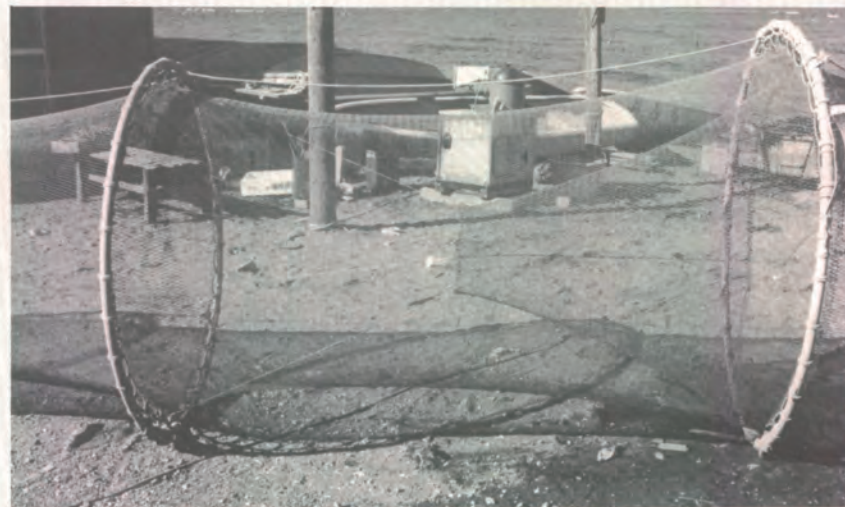


Fig. 29

## Bag nets



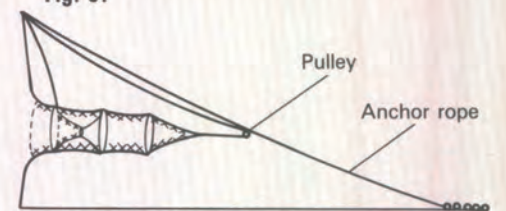
A complete bag net



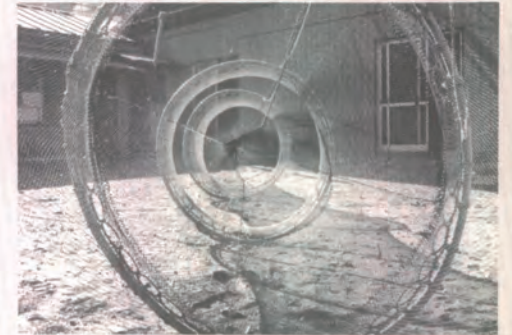
Bag net showing funnel

### Hanging the bag net

Fig. 31



A pulley is used to facilitate adjustment of the tension on the bag net, as well as to allow for easy adjustment of the angle at which the bag net is hung according to the habits of the fish being caught. However, in any case the bag net must always be kept off the sea bottom.



The way a funnel is attached to the bag net.

Fig. 28 Net setting

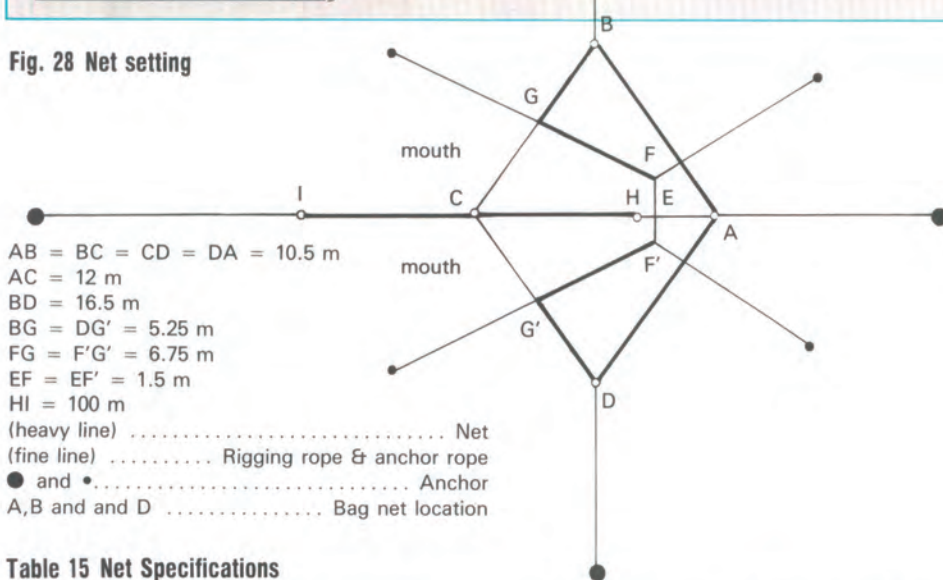


Table 15 Net Specifications

sign	Parts of net	Material	Thickness (diameter)	Mesh size	Depth(No. of meshes)	Hang-in ratio
1	Body net	Kuremona	0.4 mm	61 mm	150	70 %
2	Leader net	"	0.4 mm	76 mm	120	70 %
3	Selvage	Nylon or Kuremona	0.7~0.9 mm	61 mm	10	none
4	Bag net	Kuremona	0.4 mm	43 mm	See another diagram	
5	Rigging rope	Kuremona	14 mm	Body net length 35 m		
6	Anchor rope	"	15 mm	Length of 200 m needed		
7	Small anchor rope	"	14 mm	Each rope length: water depth + 3 m; 2 ropes for each main rope		
8	Anchoring	Sandbag	Weight 110-130kg × 58 bags			
9	Main buoy	Plastics	30 cm ø, 15 pieces			
10	Small buoy	Foam-plastics	20-25 pieces on body net			
11	Sinker	Lead	About 100g 210 pieces on body net and 440 pieces on leader net			

### Fishing boat

An outboard motor equipped boat of the 20ft. class is used. The outboard is a 25hp model.

### Types of fish caught

Sea bass fingerlings are the primary catch, with other minor catches including flatfish, flounder, mature sea bass, young sea bass, cuttlefish, Japanese stingfish, seachub, fugu rebripes, grey mullet, etc.

### Operation

The set nets are operated from Oct. 1st to May 31st of the following year. In the summer when the water temperature rises, the fish stop migrating into the coastal waters. The height of the fishing season is from the middle of March to the end of April.

The fishing operation can be performed sufficiently by one person. After releasing the rope which stretches out the bag net, the bag net is hauled up into the boat by means of a rope attached to the bag net

especially for that purpose.

Once the net is on board the boat, the string holding the end of the net closed is untied and the fish are emptied into the boat. Then, the string is re-tied to close the end of the net again, and the net is thrown back in the water, after which the stretching rope is pulled through the pulley, bringing the bag net back out to its original position. In this way, all three of the bag nets are checked for fish. The entire operation takes about 30 minutes.

### Management

This fishery is carried out roughly 150 days of the year, with one day's catch equalling 20-50 kilograms or 10 to 15 thousand yen worth of fish. Since this set net fishery income is not sufficient to support a household, the fisherman has to manage a combination of various businesses such as seaweed culture, etc. The fisherman we interviewed was using his son and his son-in-law as helpers in running the following yearly schedule of operations:

Table 16 Yearly business schedule

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Set net												
"Nori" seaweed culture												
Rental-boat service												
Seaside tourist inn												

Resource materials: Provided by Mr. Sakae Miura (Eastern Yokosuka Fisheries Coop.) and Mr. Yoshiaki Ikeda (Kanagawa Prefectural Fisheries Experiment Station)



**EXAMPLE**  
**4**

# Other small-scale set net fishery

(Lake Hamana, Shizuoka Pref.)

Lake Hamana is a saltwater lake connected to the ocean by way of a 200 meter wide channel (Imagiri-kuchi). It has a total area of about 70 square kilometers. The average depth throughout the lake is 4 meters. Having a rate of exchange with the ocean water at the channel mouth of  $4,200 \times 10^4 \text{m}^3/\text{day}$  the lake has a very high salinity, with an average chlorine content of 15-16‰ throughout the lake. It should be noted, however, that the farther portions of the lake from the ocean tend to form basins which inhibit the exchange of sea water. Although there is a difference of about 80 cm between high and low tide at the mouth of the channel, near Muragushi (the point marked by X in Fig. 33), there is almost no change in the water level due to tides.

The fisheries of Lake Hamana are unique in that they are supported by two groups marine life; (1) species that live in low salinity water areas, and (2) species that circulate between the two environments of the open sea and inland waters in their life cycle.

For example, these waters provide an abundance of the nutrient salts necessary for the seaweed culture which is conducted here. The environment is also well suited for clam culture, so local fishermen developed an "asari", a short-necked clam, and oyster culture industry. Also, in the areas of the lake which have a substantial exchange of sea water with the ocean due to tidal effect, small-scale set net, gill net and angling fisheries have developed, catching a variety of species that migrate into the lake in the spring and feed in these waters throughout the summer and fall.

At present there are 254 fishermen engaged in small-scale set net fishery in Lake Hamana. The fishing grounds here are sandy bottom areas with a depth of less than 4 meters, and, as can be seen from Fig. 33, the fishing operations are concentrated in the southern half of the lake. In the northern half of the lake, on the other hand, there are areas of over 5 meters in depth where the sea water tends to stagnate, creating a muddy bottom condition, which in the summer becomes an azoic zone due to the lack of oxygen in the water.

## Fishing gear

The small-scale set net used in Lake Hamana consists of (1) a leader net, (2) a body net hung in a triangular configuration, and (3) three bag nets.

The leader net is laid out parallel to the direction of the tidal flow, with the mouth of the body net usually being set on the down-tide side. However, different types of settings are used depending on the season.

For example, in spring and summer when large numbers of fish come into the lake from the ocean, moving around the lake in a daily pattern that follows the ebb and flow of the tide, a pair of nets will be set facing each other, as in Fig. 34, to take advantage of the two tidal movements each day. On the other hand, in autumn, as shown in Fig. 34 a single net will be used to take advantage of only the outgoing tide. The purpose of this setting is to catch the prawn that have been raised in the lake waters but begin to migrate toward the ocean in autumn.

## Fishing boat

The boats used here are 1.5 ton FRP construction fishing boats, equipped with a 12 horsepower diesel engine.

## Operation

In the period from Jan. 16th to March 24th when fingerling and fry are migrating

Fig. 32

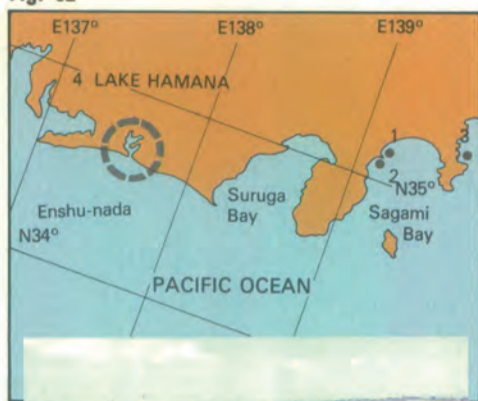
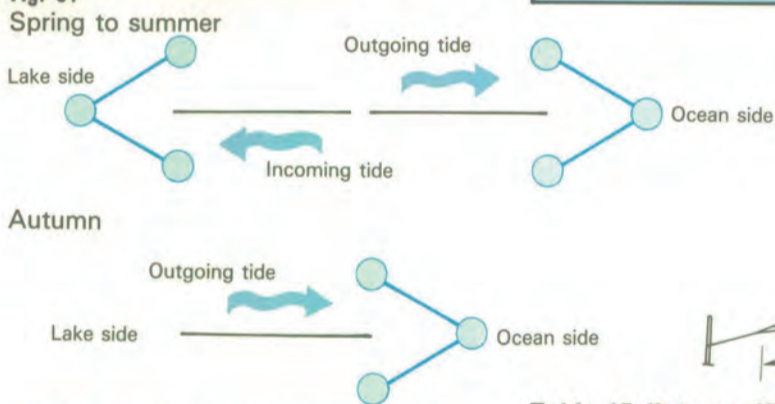


Fig. 34



into the lake, the local fisheries cooperative prohibits all fishing activities. With this exception, fishing is carried out throughout the year. The bag nets are emptied of fish once a day in the morning. This operation can involve either one or two men. In the summer, to prevent seaweed from growing on the nets, the nets are taken out of the water in the morning and hung out on poles during the day and then put back in the water in the evening.

## Types of fish caught

The marine products from the lake for 1982 were as follows;

- Fish and crustacean — 784 tons
- "Asari" clam — 7,832 tons (with shells)
- "Nori" seaweed (cultured) — 339 tons (unprocessed)
- Oyster (cultured) — 1,130 tons (with shells)

Among these products, set net fisheries accounted for 642 tons of fish and crustaceans. The important species include goby, gazami-crab, grey mullet, prawn eel fry, flounder, miscellaneous goby species, sea bass, gizzard shad, etc., with large catches of demersal fish species and crustaceans (prawns, gazami-crab) standing out in particular.

Fig. 33 Distribution of small-scale set net fishing units around Lake Hamana

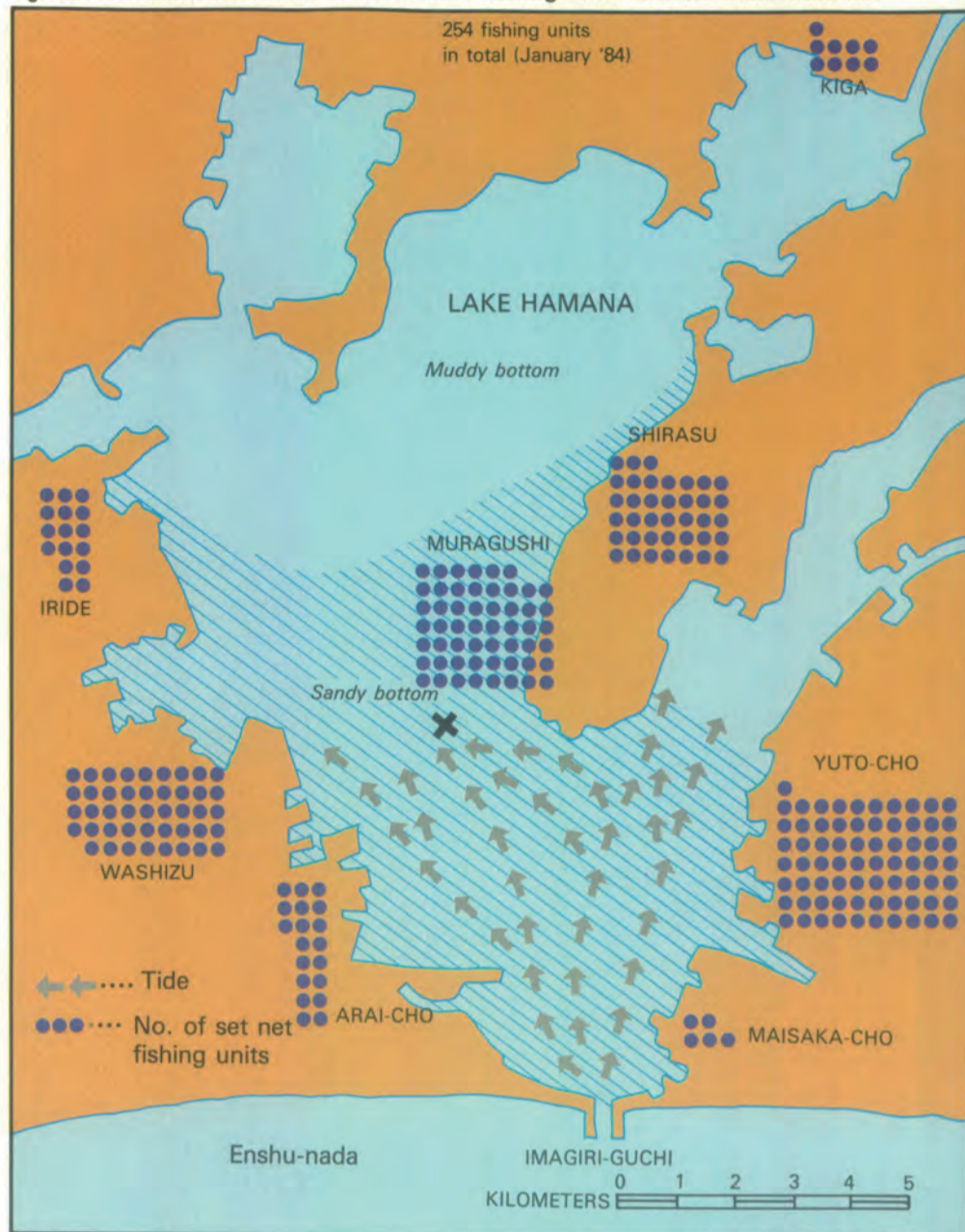


Fig. 35

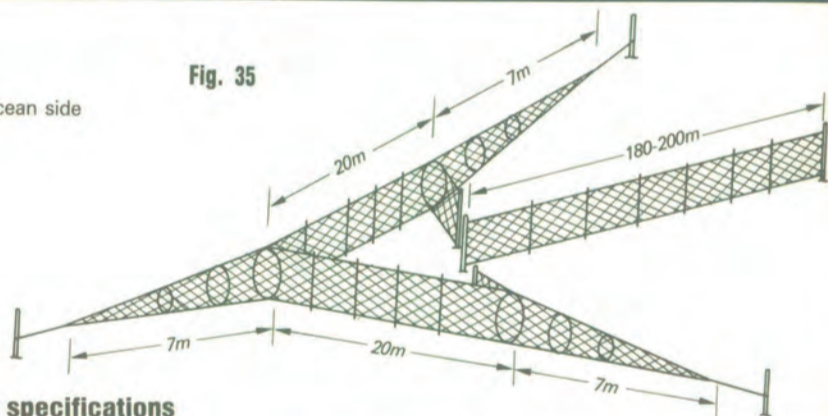


Table 17 Net specifications

Parts of net	Material	Thickness	Mesh size	Net height (no. of mesh eyes)	Hang-in ratio
Leader net	Nylon	210D.6-9y	34-38mm	300-400	5-8%
Body net	"	"	28-30mm	400	10%
Bag net	"	"	20mm	300-400 (circumference)	0

The diameter of the mouth of the bag net is 80cm.

Vinyl pipe is used to create a hoop structure.

## Income and expenses

The value of the catch by set net fishery varies greatly in different areas of the lake, with set nets in the Maisaka area, near the channel mouth yielding from 6 to 7 million yen a year per net, as contrasted to nets in the central parts of the lake which average only 2-3 million yen a year.

The basic work pattern for fishermen in this area is a half farming/half fishing pattern. For example, of the 71 fishermen involved in set net fishery in the Yuto area, 50 are also involved in farming (mostly vegetable farming). In addition to set net fishery, these fishermen will conduct side businesses in "asari" clam gathering, oyster culture, catching eel fry for aquaculture seeding, or operating sport fishing services for tourists.

The materials for one set of nets to conduct set net fishery on a small scale cost the fisherman about 800 thousand yen. (One reserve set of nets must always be kept on hand, as well).

## Fisheries cooperative association

Although at one time there were 17 separate cooperatives scattered around the lake shore, in 1965 they were united to form one Hamana Fisheries Cooperative Association. With the creation of one unified cooperative it became possible to undertake large-scale fishery propagation activities, the most noteworthy of which is a stocking project, which every year dispatches large quantities of fry of the various species of marine life important to the lake's fishermen. The figures for 1982 stocking include 4.6 million shrimp fry, 200,000 crab (gazami) fry, 3,000 adult sweetfish, and 300 tons of "asari" clam fry.

Resource materials are provided by the Hamana Fisheries Cooperative and the Hamana-ko Branch of the Shizuoka Prefectural Fisheries Experiment Station.