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The more practical and intelligent use of fishing grounds

Small-scale dredge-net fishery

In Japan dredge-net was operated only in limited shallow waters and its catch was confined to shellfish alone in the era before fishing boats became motorized, accompanied by the introduction of large-scale fishing gear and mechanized fishing methods. With these improvements dredge-net has become one of the most popular coastal shallow-water or inside-bay fisheries in Japan.

A variety of catches

Dredge-net fishery flourishes remarkably in other advanced fishing nations as well but its main catch is still limited to shellfish. In Japan this fishery operation is performed to catch not only shellfish, but also crustaceous (prawn, shrimp, blue carb, etc.) and demersal fish species (flatfish, sea eel, etc.).

Dredge-net is very effective in catching demersal fish and animal species in large quantities, thus ensuring a more stable haul than all other fisheries.

The aim of dredge-net fishery has changed with the introduction of more advanced fishing gear and methods, giving greater emphasis to the commercial nature of this fishery.

In brief, today's dredge-net fishery comes with two different aspects.

For better household economy individual fishermen wish to catch and sell more fish through their own methods. At the same time, however, they have to find better and more systematic ways their increased catches can be placed on a distribution channel for the many specified and unspecified consumers.

Three primary factors

Under these circumstances the problem of prime importance awaiting a solution is how to put the fishing grounds to more practical and intelligent use for the harmonized exploitation and conservation of marine resources.

This is not a problem that can be solved in a short time because the situation is charged with complex technical and social conditions.

Now let's take a look at the three primary factors that urge the earliest possible solution of this problem:

(1) Individual fishermen have to increase their fishery income by making the best of their fixed assets such as motorized fishing boats and advanced fishing gear.

(2) The fishing community must make up a modern commodity marketing system so that fishery products are always sold at reasonable prices.

(3) For each fishing ground effective resources control or reproduction measures must be taken so that overfishing is prevented and the suitable rate of reproduction is maintained.

High-efficiency fisheries can be a double-edged sword

It is important to note that trawlnet fisheries with their high operation efficiency can have a very crucial effect on the reproductivity of marine resources.

In some cases, these fisheries prove very effective in thinning out the surplus marine resources, thus improving the eventual reproductivity of these resources but there are also occasions when overfishing by such highly efficient fisheries can contribute to the exhaustion of marine resources.

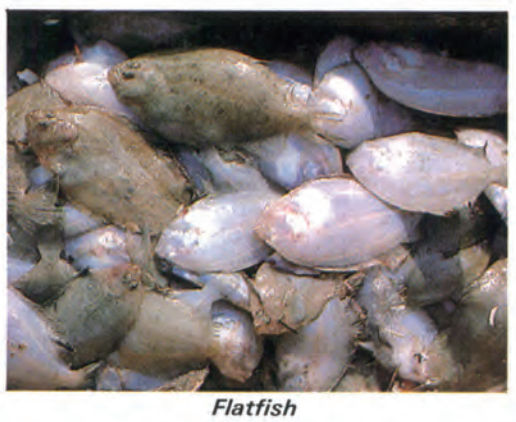
As mentioned before, dredge-net is a very popular coastal-water fishery by which a great number of fishing families earn a living.

In order to maintain and improve this important means of living, all people concerned, individually or collectively, are enthusiastic about improving the use of coastal-water fishing grounds as a whole. In brief, their efforts are aimed at achieving the following three goals:

(1) To organize a high-efficiency multiform operation system by changing the catch seasonally from one particular species of fish to another, so that the number of per-annum operations would be increased.

(2) To establish a marketing cooperative system with the fishery cooperative association acting as its nucleus, thus allowing each member fisherman to form a small family-based work system.

(3) To place the fishing grounds under fishermen's self-imposed control while striving to improve the reproductivity of marine resources aided by national or prefectural grants.



Flatfish

Lizard fish

Shrimp

Gazami crab

Prawn

Squilla

The present situation of Japanese coastal dredge-net fishery

Family-operated small-scale fishery

First, let's take a look at the present situation of Japanese coastal trawlnet fisheries.

Fig. 1 shows the catch by sea area.

Coastal trawlnet fisheries are operated over almost all the coastal waters of Japan all year round except the closed season. Fishing boats of up to 15 tons can be used in these fisheries according to Japanese fishery regulations but most of the boats in use are 3 to 10 tons.

The coastal waters of Hokkaido and Tohoku provide a greater number of good fishing grounds. In addition, the whole area of the Inland Sea of Japan and shallow sea areas of Ise Bay and Mikawa Bay are also known as good fishing grounds for these fisheries. In particular, the Inland Sea of Japan is collectively cited as the most typical fishing ground for today's coastal trawlnet fisheries for the following reasons:

* There is a far greater number of fishermen engaged in these fisheries.
* A wider variety of catches in larger quantities.
* A greater variety of fishing methods in use.

Japanese coastal trawlnet fisheries are mainly operated by small-scale family labor, all year round except the closed season.

These fisheries take the above form of operation based on the following three conditions:

1. A wider variety of fish species can be caught as salable commodities.
2. Mechanized method of operation has resulted in reduction of labor.
3. Fishermen are engaged in more than two kinds of fishery operations.

Self-employed fishing families

In recent years, coastal trawlnet fisheries operated in the coastal waters of Japan have brought approx. 300,000 tons of catches per annum. The number of fishing families engaged in these fisheries is in excess of 25,000.

Backed by the reformation of the Japanese fishery system and the high growth of Japanese economy in post-war days and also due to a number of technical innovations introduced to fishing boats, marine engines and fishing gear, these fishing families have become self-employed small-scale fishery operation units working full time in coastal trawlnet fisheries.

Coastal trawlnet fisheries presently in operation in Japan can be divided into three types; they are **"small otter trawl"**, **"ebi-kogi (beam trawl)"** and **"dredge net"**.

The combined total of fishermen engaged in beam trawl and dredge net is far greater than the number of fishermen engaged in small otter trawl. This stems from the fact that different prefectures have taken administrative measures to prohibit small otter trawl from being operated in all coastal waters except specifically designated areas where the extremely high operation efficiency of this type of fishery can cause the least effect upon other types of fisheries.

Dredge-net fishery is classified into the same category as beam trawl fishery in Japanese fishery statistics, thus making it impossible to extract only dredge-net concerned figures from these statistics. As mentioned later, however, most of the fishing families engaged in dredge-net fishery operate beam trawl fishery as well. This fact helps give a fairly good picture of Japanese dredge-net fishing families.

A wide variety of catches for sale

In general, trawlnet fisheries are operated to catch a wide variety of fish and aquatic animal species. Dredge-net fishery is not an exception and is operated to comb the sea bottom for catching whatever species of fish, shellfish, crab shrimp and other aquatic animals available.

Shown here are three different kinds of fishery statistics; the first two **(Fig.2 and Table 1)** provide nationwide figures and the last locally obtained data (the Inland Sea of Japan **Table 2**). These statistics will serve to clarify the present situation of catches by type of trawlnet fishery.

Intended main catch in dredge-net fishery differs from one fishing ground to another, depending on regional concentration or distribution of fish or aquatic animal resources.

Therefore, dredge-net fishery is subdivided into the following three types using different fishing gear and methods:

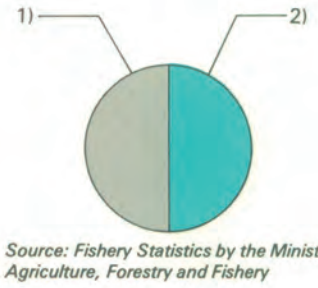
1. Demersal fish dredge-net operation
2. Shrimp/crab dredge-net operation
3. Shellfish dredge-net operation

Dredge-net fishery, regardless of the type of operation, brings several or more than 10 different kinds of catches.

Almost all catches are handled as perishables for shipment to surrounding villages or distant urban areas.

Fig. 1 Catch by sea area (1981)

- **Coastal trawlnet fisheries** **384,000 tons**
  - (1) Non-beam trawl/otter trawl 115,000 tons
  - (2) Beam trawl/dredge net 269,000 tons



Source: Fishery Statistics by the Ministry of Agriculture, Forestry and Fishery

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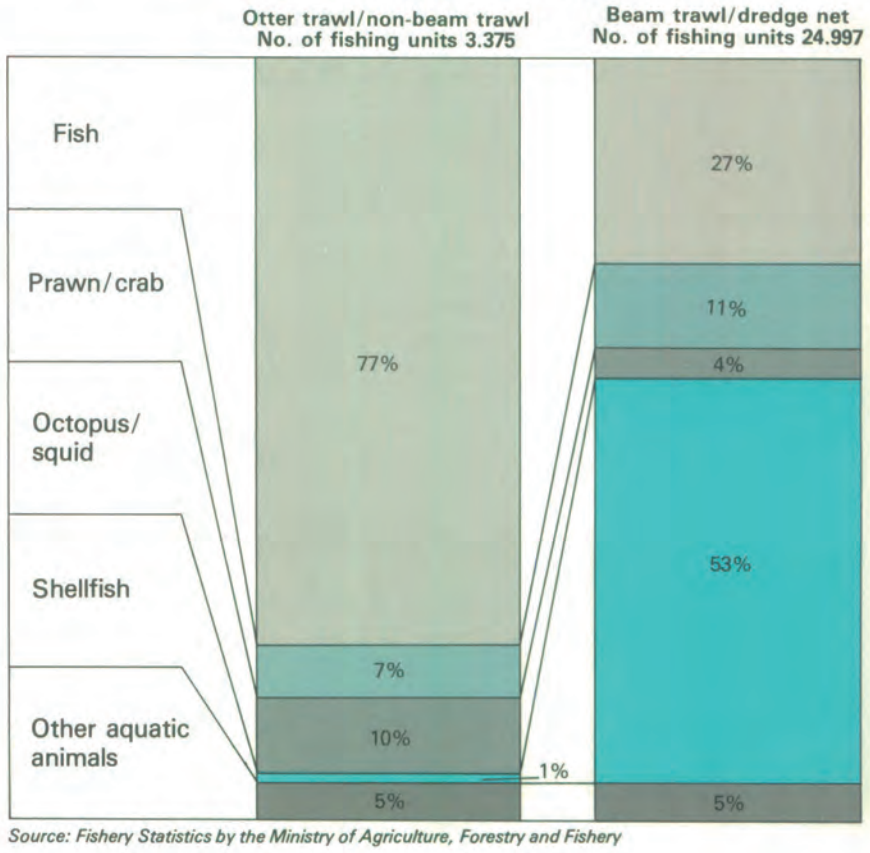
Fig. 2 Number of fishing units and breakdown of catches by type of fishery operation (1981)



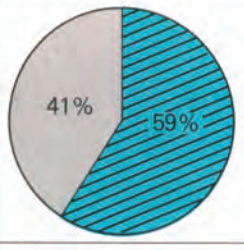
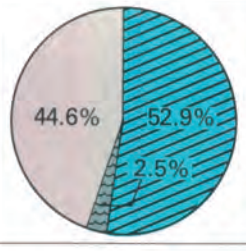
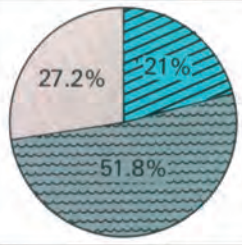
Source: Fishery Statistics by the Ministry of Agriculture, Forestry and Fishery

Table 1 Beam trawl/dredge net: Catch by fish species (1981)

Grand total 268,578 tons

Fish total	**71,136 tons**	Ray	438 〃
Horse mackerel	533 tons	Sea bream and the like	1,172 〃
Mackerel	50 〃	Sea bass	646 〃
Flatfish and the like	15,383 〃	Launce	5,855 〃
Codfish	619 〃	Other fish	36,816 〃
Atka mackerel	227 〃		
Bighand thornyhead	465 〃	**Prawn and the like**	**26,347 tons**
Sailfin sandfish	331 〃	**Crab and the like**	**4,120** 〃
Drum/croaker	1,434 〃	**Squid and the like**	**6,337** 〃
Lizardfish	4,155 〃	**Octopus and the like**	**4,062** 〃
Purple pike conger	133 〃	**Shellfish**	**143,145** 〃
Atlantic cutlassfish	2,287 〃	**Other aquatic animals**	**13,429** 〃

Table 2 The Inland Sea of Japan: Catch by fishing method (1981)

	Otter trawl	Beam trawl	Dredge net
Total fish catch	26,000 tons	57,400 tons	27,400 tons
Catch breakdown			
Fish total	15,000 tons * Flatfish and the like * Lizardfish * Atlantic cutlass-fish * Drum/croaker * Red sea bream	30,400 tons * Flatfish and the like * Drum/croaker * Lizardfish * Atlantic cutlassfish * Sea bream and the like	5,800 tons * Flatfish and the like
Shellfish total	35 tons * Various kinds	1,600 tons * Various kinds	7,500 tons * Edible cockle * Ark shell * Others
Other aquatic animals total	10,600 tons * Prawn and the like * Cuttlefish * Squid and the like * Octopus	25,400 tons * Prawn and the like * Cuttlefish * Squid and the like * Octopus * Sea slug * Crab	7,500 tons * Prawn and the like * Cuttlefish * Octopus * Sea slug * Crab

* = Main species caught in large quantities.

Source: Fishery Statistics by the Agricultural Administration Department for Chugoku and Shikoku Districts

Each fishery cooperative serves as the center of joint shipment and marketing of these catches so that they can be placed on a distribution channel smoothly.

Mechanization of fishing methods and reduction of labor

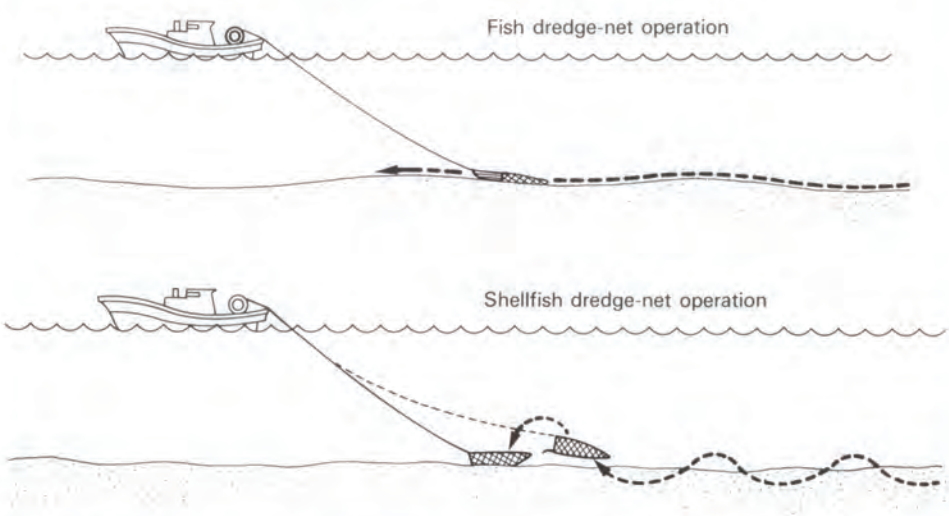
The decade from about 1960 to 1970 saw the remarkable mechanization of coastal fishery operations in Japan, with the following social conditions as its setting:
The Japanese Government was pushing ahead with its income-doubling program, encouraging more and more people to shift from primary industries to secondary or tertiary industries.
This inevitably resulted in the extreme shortage of young labor force in fishing villages, which in turn quickened the progress of fishing method mechanization as a measure to counter it. As a result, there appeared a great number of self-employed fishing families all over Japan (each using a small fishing boat of 3 to 5 tons crewed by one or two persons).

Yearly multiple fishery operations

These self-employed fishermen are making efforts to increase their income and return the original investment in fishing boats and gear by increasing the number of per-annum operation days.
In general, the period of fishery operation is influenced by the seasonal migration of fish species. Therefore, fishermen must shift from one kind of fishery operation to another periodically each year.
Coastal dredge-net fishery can be operated only in the season of winter, because (1) rake-shaped teeth are used to dig out demersal fish like flatfish, shellfish and crustaceaus like prawn and crab which have a habit of keeping themselves buried in the muddy sand of the sea bottom during the winter months, and (2) operation is prohibited during the summer months so that sea-bottom spawning grounds can be protected from these rake-shaped teeth before and after the spawning season.
This makes it necessary for all dredge-net fishing families to engage in some other kind of fishery operation during the summer months, thus resulting in a nationwide standardized pattern of operation, namely prawn beam-trawl fishery in summer and dredge-net fishery in winter.
These two kinds of fisheries can be operated by the same fishing boat. This means each fisherman can use his fixed assets on a better paying basis. In addition, these two kinds of fisheries can make up for each other's loss caused by an unforeseen decrease in the amount of catches, stabilizing or increasing fishermen's income.
Fig. 3 shows how dredge-net fishery (or beam-trawl fishery) is positioned in terms of relative economic importance in Japanese coastal fisheries.
Given here are nationwide average figures from each kind of fishery operation by 3 to 5 ton class fishing boats for general comparison relative to the following two points:
(1) Yearly catches per fishing unit
(2) The number of per-annum operation days per fishing unit
As you see, dredge-net fishery (or beam-trawl fishery), as well as small otter trawl, is operated on a more stable and better paying basis than the others. In short, dredge-net fishery proves more productive than such traditional fisheries as gillnet, pole-and-line and long line, while it can be operated on a more stable basis benefiting from a larger number of operations per annum than mass-catch type fisheries like purse seine, boat seine and stick-held dip net.

Outline of dredge-net operation

Fig. 4



The outline of dredge-net operation is shown in Fig. 4.
The fishing gear is divided into several types which differ from one another in operation method, weight, shape and size of the opening, and mesh size of a bag net.

(a) Operation method

If the desired catch is demersal fish or crustaceaus, the iron frame with dredge teeth slides over the sea floor by means of a pair of runners fitted to the fore part. In the case of shellfish collecting, special weights are used in place of the runners, so that the iron frame assembly is lifted from the sea floor at intervals. This method prevents muddy sand from accumulating in front of the combing teeth. (see Fig. 4)
Several different means including changing the length of a towing warp are in use to lift the iron frame assembly from the sea floor at intervals.

(b) Weight

The weight of this fishing gear must be decided depending on the horsepower of an engine and towing capacity of a fishing boat.
Dredge-net fishery in the Inland Sea of Japan is operated by 3 to 5 ton class fishing boats (driven by engines of up to 15 hp according to Japanese fishery regulations) Therefore, the dredge-net fishing gear is available in several different weights; 100 kg, 130 to 150 kg, 200 kg, 400 kg and 500 kg.

(c) Shape and size of the opening

In Japan, there is no standardized shape or size of the opening but in most cases the overall width of the iron frame assembly is 250 to 300 cm. The overall height of this assembly is 20 to 30 cm when fitted to a fish or prawn dredge net, and 30 to 40 cm when fitted to a shellfish dredge net, because in the case of the latter the bottom of the assembly sinks deeper into the muddy sand than in the case of the former.

(d) Bag net

The bag net presently in use is made of polyethylene material.
The mesh size varies depending on the catch sought, as follows:
* Shellfish species - 60 mm
* Demersal fish species - 35 to 43 mm
* Prawn species - 28 mm

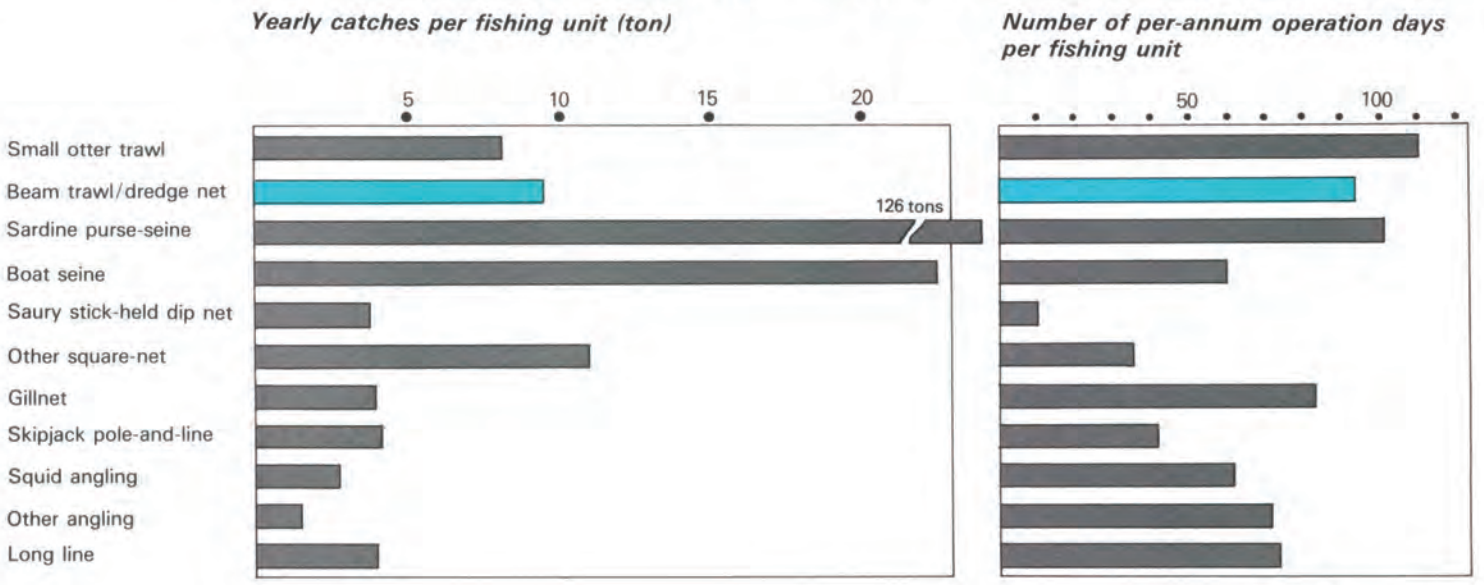
(Sangawa Area, Ehime Prefecture)

The net is cast and pulled up from the stern of a fishing boat. The towing warp is rolled in by (1) a line hauler (driven electrically or hydraulically) mounted on the stern deck or (2) a side drum connected directly to the main engine.

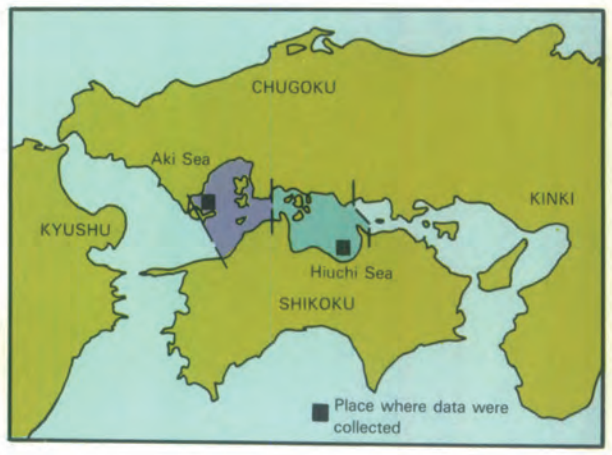
Note: Japanese fishery control regulations (effective from 1952) prohibit the use of a special device-equipped dredge net and operation of otter trawl in all the coastal waters of Japan except specifically designated areas. As for the Inland Sea of Japan, such a dredge net can be used in the following four designated areas:
* Aki Sea Area
* Hiuchi Sea Area
* Harima Sea Area
* Kii Channel Area

Mentioned below are three main reasons for it:
(1) This fishery provides a means of livelihood indispensable to small self-employed fishing families.
(2) This fishery, if operated properly, causes no serious effect upon resource conservation.
(3) Effective measures can be taken to regulate the use of fishing grounds between this fishery and other kinds of fisheries such as angling and gillnet.

Fig. 3 3 to 5 ton class fishing boats: Operation efficiency by kind of fishery (1981)



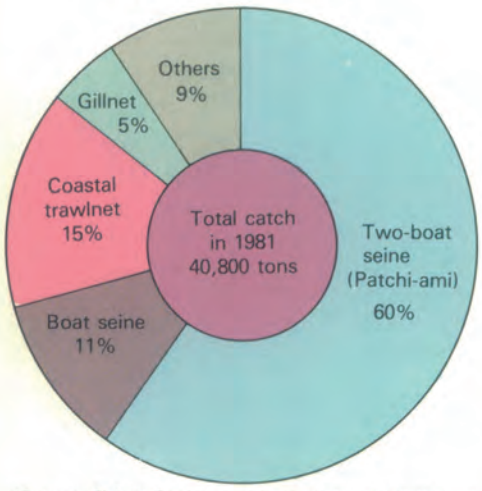
Case examples of dredge-net fishery



(Hiuchi Sea and Aki sea)

Hiuchi Sea

Hiuchi Sea Fisheries



(Source: Fishery Statistics by the Agricultural Administration Dept. for Chugoku and Shikoku Districts)

The Hiuchi Sea which occupies the middle part of the Inland Sea of Japan is divided into two types of water areas. One is an area with a basin-shaped sea floor extending from the middle to the east, and the other a strait area with numerous small islands in the west.
In the former area two-boat seine and coastal trawlnet fisheries are widely operated, while in the latter island area angling fishery is especially popular.
Introduced here are the data of dredge-net operation type A (sensha-kogi) collected from the Sangawa Fishery Cooperative, Iyo-Mishima City on the east coast (see Table 1).

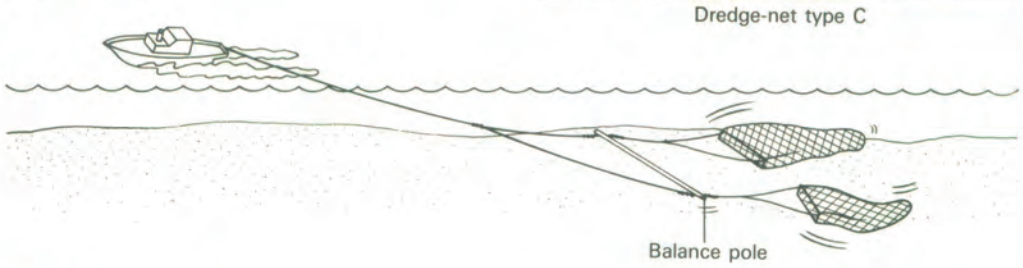
Table 1. Yearly operation schedule by an average fisherman using a 5-ton class fishing boat (Sangawa, Hiuchi Sea)

Method	Main catch sought	Jan. Mar. May Jul. Sep. Nov.
1. Dredge-net operation type A (sensha-kogi)	Prawn, squilla, flatfish and Gazami crab	
2. Dredge-net operation type B (tekkan-kogi)		
3. Dredge-net operation type C (kaiketa-kogi)	Edible cockle and ark shell	
4. Beam trawl	Shrimp, harvest fish and Atlantic cutlassfish	
5. Two-boat seine	Halfbeak	

3. Dredge-net type C

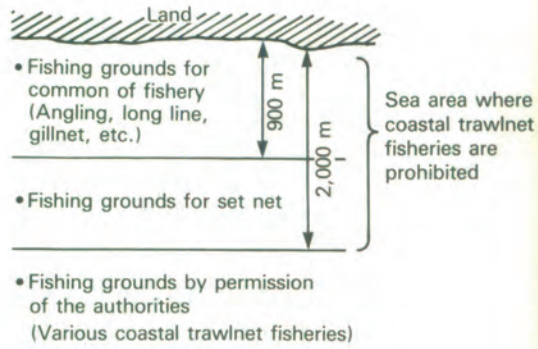
This type, like type A, has a number of iron teeth on the lower edge of the frame. But it features special weights in place of the runners.
As shown in the photo and illustration, two bag nets are fitted to the frame by means of a pole.
These bags jump alternately through the balancing action of this pole while they are towed along the sea floor.
Net design is the same as type A. Mesh size is 60mm.

Dredge-net type C



Operation type A

Fishermen can reach a fishing ground within 30 to 45 minutes after leaving port early in the morning.
A sea floor of muddy sand at a depth of 17 to 20 meters is suitable for this operation. Towing operation is continued for 30 minutes or so while the boat is moving at a speed of 2 or 3 knots.
Within 10 to 15 minutes net casting and hauling operations are completed by means of a power-driven device.
Duration of daily operation is usually 6 hours, during which towing operation is repeated 12 or 13 times. In this way they work 100 to 150 days per annum or even 200 days benefiting from the calm weather conditions of this inland sea area.
Fishing grounds in this sea area are controlled by type of fishery as follows:



Coastal trawlnet fishing household's income and outgo

Each daily operation brings a fishing household a catch worth about ¥40,000 and the yearly income of this household is estimated at ¥3.5 to 4 mil.
The boat is powered by an engine of up to 15 hp. Fuel consumption is estimated at 100 to 120 liters per day.
About ¥10 mil. must be invested in the purchase of a boat and engine. In addition, a dredge net and net hauler cost a household about ¥500,000 each.
Furthermore, a set of iron teeth (about ¥100,000) must be replaced every other year, whereas a towing wire warp is renewed each year.

Various dredge-net operations

Dredge-net fishery presently operated in this area is divided into three types, namely type A (sensha-kogi), type B (tekkan-kogi) and type C (kaiketa-kogi).
Fishing gear used in each type is outlined as follows:

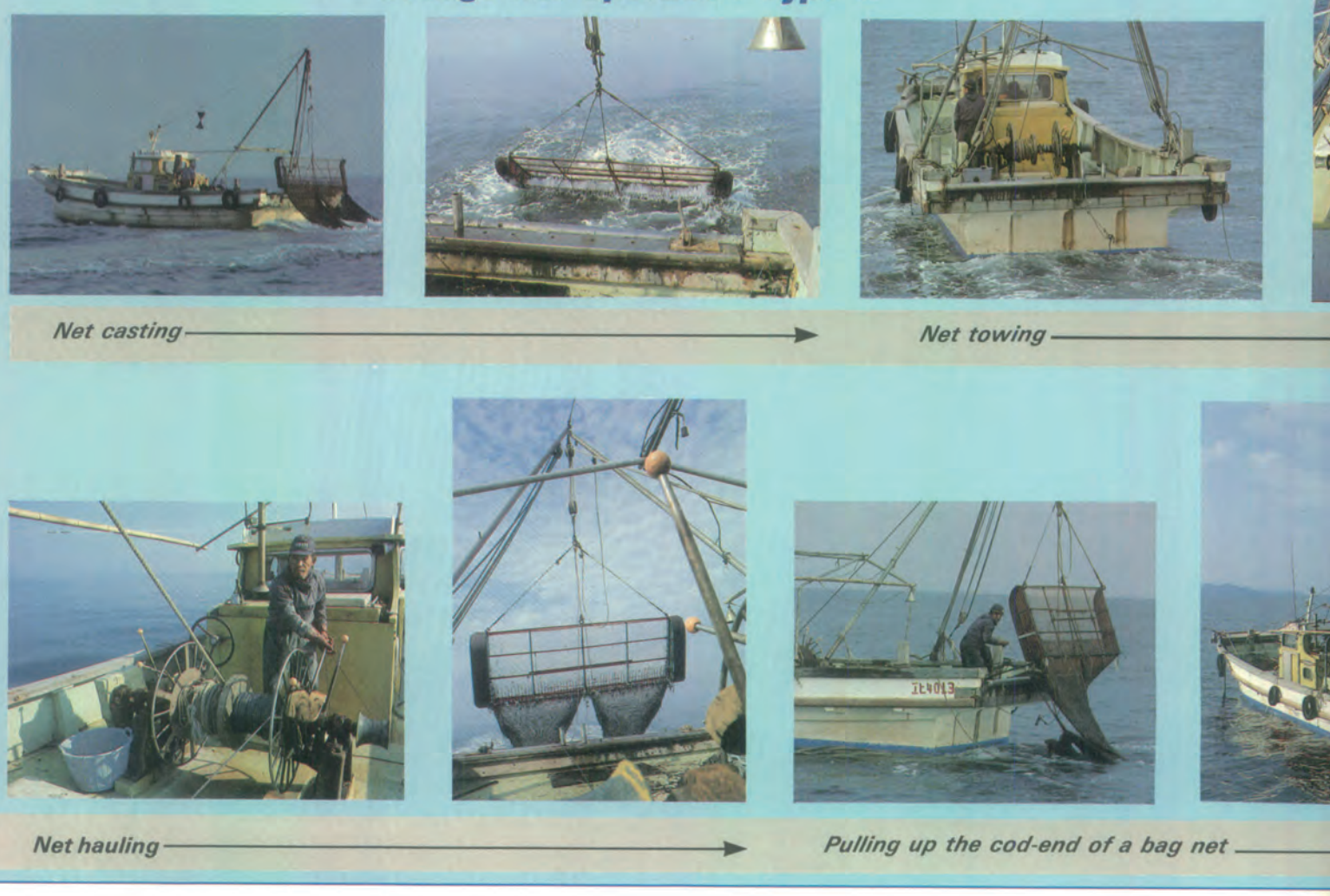
1. Dredge-net type A

This fishing gear has long been in use in this sea area.
An iron frame which has a number of iron teeth on its lower edge is fitted to the opening of a bag net.
This assembly slides over the sea floor by means of a pair of runners fitted to the fore part.
Wire netting over these runners prevents the assembly from sinking in muddy sand while sliding over the sea floor.
This fishing gear is used to collect a variety of fish, crustaceaus and shellfish species. The mesh size depends on the catch sought.

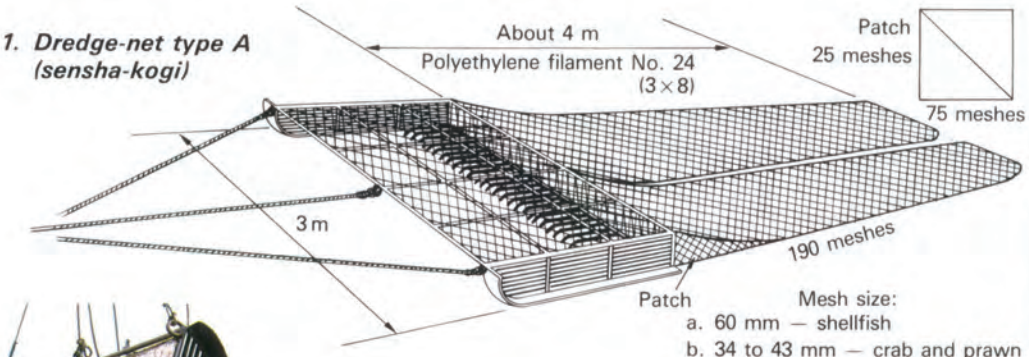
2. Dredge-net type B

This fishing gear was introduced only a few years ago in this sea area. The iron frame has a special chain device in place of the iron teeth. This device scrapes the sea floor to dig out fish and crustaceaus, especially Gazami crab.
But the operation period of dredge-net type B is very limited by fishery control regulations because the chain device can easily damage the sea floor.

Dredge-net Operation Type A



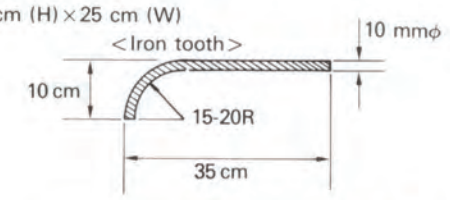
1. Dredge-net type A (sensha-kogi)



Mesh size:
a. 60 mm — shellfish
b. 34 to 43 mm — crab and prawn
c. 28 mm — shrimp

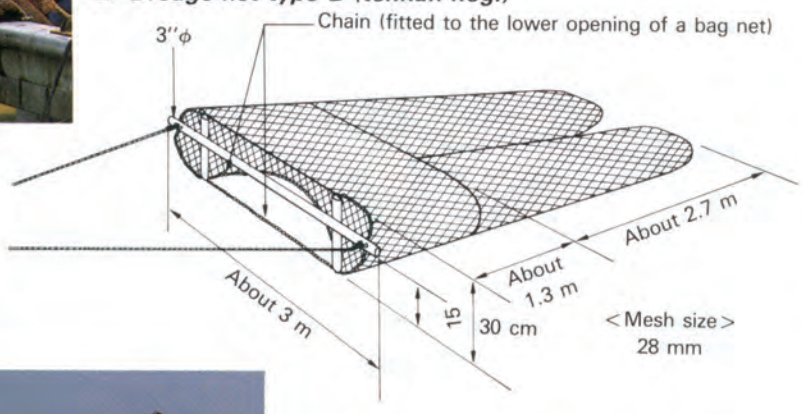
Dredge-net type A

Warp: 9 mm×200 mm
Runner: 1 m (L)×25 cm (H)×25 cm (W)



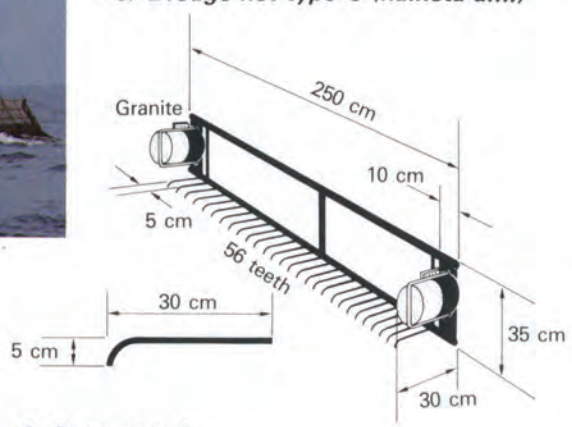
60 teeth (at intervals of 5 cm)

2. Dredge-net type B (tekkan-kogi)



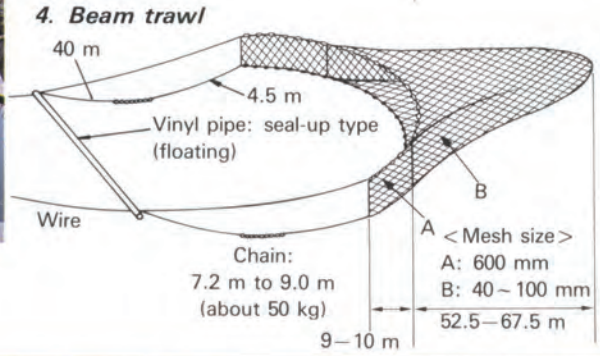
Yamaha fishing boat DT-45-0A

3. Dredge-net type C (kaiketa-ami)



Sangawa fishing port

4. Beam trawl



Yamaha fishing boat DT-45-0A



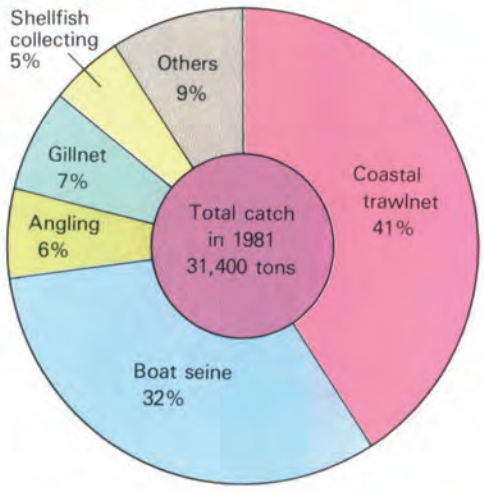
Net hauling



The catch

Aki Sea

Aki Sea Fisheries



(Source: Fishery statistics by the Agricultural Administration Dept. for Chugoku & Shikoku Districts)

There are numerous islands, shore reefs and straits in this sea area, thus providing good habitats for various fish species. Therefore, in former days gillnet fishery and pole-and-line fishery by small fishing boats flourished in this sea area. 3 to 5 ton class fishing boats became popular due to the rapid mechanization of fishing boat and gear later than the sixties. This has given a boost to the growth of coastal trawlnet and sardine boat-seine fisheries all over this sea area.

As shown in table 2, there are three different types of coastal trawlnet fisheries presently in operation. They are shellfish dredge net, fish dredge net and beam trawl (ebi-kogi).

In reference to beam trawl (ebi-kogi), see issue No. 16 of "Fishery Journal.

Various dredge-net operations

The fishing gear in use for shellfish dredge-net operation and fish dredge-net operation look identical. But minor specifications differ from one type to the other.

Introduced here are pictures showing actual scenes of shellfish dredge-net operation for comparison with dredge-net operation type A or C in the Sangawa Area of the Aki Sea.

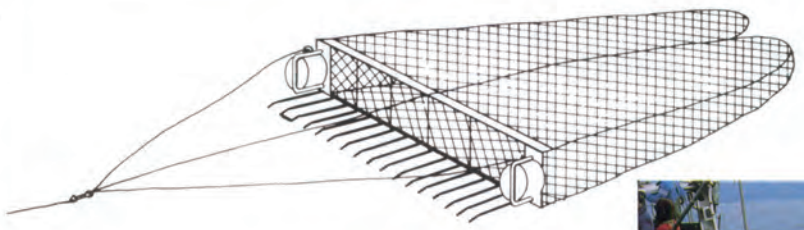
As you may notice, the hauling roller is not mounted on the stern deck. The towing warp is tied to the side roller connected directly to the engine installed on the starboard. In this way net towing and hauling operations are performed.

The side roller installed on the port side is used to roll in the rope tied to the end of a bag net so that the net is hauled up and secured on the deck.

The towing warp tied to the side roller on the starboard tows the dredge net along the sea floor via a cylindrical spring device which is hung down on the side of the bridge. This device gives an intermittent impetus to the towing warp, which in turn lifts the iron frame assembly from the sea floor.

Table 2. Iwakuni Area, Aki Sea

Method	Main catch sought	Jan.	Mar.	May	Jul.	Sep.	Nov.
1. Shellfish dredge-net operation	Edible cockle and ark shell	■	■				■
2. Fish dredge-net operation	Flatfish and other misc. fish species	■	■				■
3. Beam trawl	Shrimp and misc. fish species			■	■	■	■



Shellfish dredge net/fish dredge net

	Iron frame				Bag net			Towing warp		Bridle	Total weight
	Width	Height	No. of teeth	Intervals	Thickness	Mesh size	Overall length	Thickness	Length		
Shellfish dredge net	3 m	40 cm	55	5 cm	Poly 60 ~ 90	60 mm	4 ~ 5 fathoms	Wire rope 7 ~ 9 mm ×6	80 ~ 100 m	4 ~ 5 m	Approx. 70 kg
Fish dredge net	3 ~ 4 m	30 cm	60 ~ 80	4.5 cm	Poly 60 ~ 90	60 mm	7 fathoms	Wire rope 7 ~ 9 mm ×6	80 ~ 100 m	4 ~ 5 m	Approx. 50 kg

Shellfish dredge-net operation, Iwakuni Area, Aki Sea

Net hauling

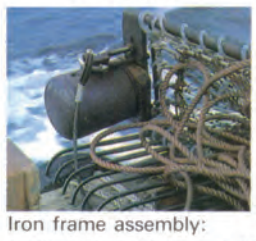
The catch: edible cockles

Stern deck of DT-41D-0A

Bow deck of DT-41D-0A

Yamaha fishing boat DT-41D-0A

Towing operation: side roller and spring device on the starboard



Iron frame assembly: teeth and cast-iron weight

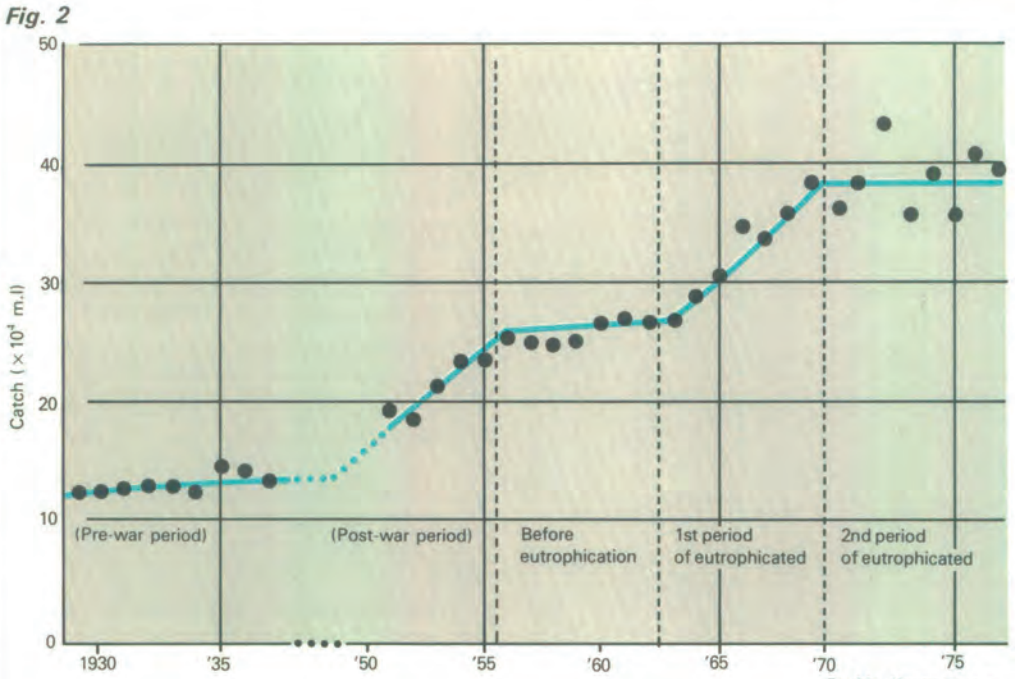
The factors behind intensively developed inshore fishing grounds

THE INLAND SEA of Japan (Seto Naikai) is an inland sea area between the western part of the Main Island and the Shikoku Island. It joins the Pacific via the Kii and Bungo Channels.

In this sea area in 1981 boat fisheries brought approx. 470,000 tons of catches (30% of the total catch by Japan's coastal boat fisheries), while the catch by culture fisheries amounted to some 340,000 tons which made up 36% of the total catch amount by Japan's culture fisheries. It is even more important to note that coastal trawlnet fisheries brought some 110,000 tons of catches, thus accounting for approx. 25% of the total catch amount by boat fisheries in this sea area.

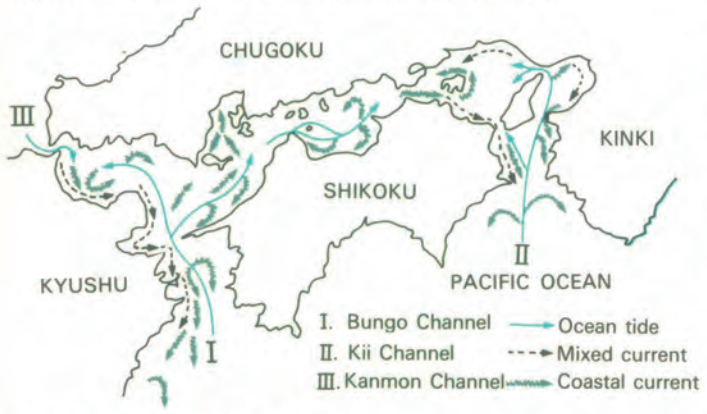
It was early in the 17th century that various types of coastal fisheries became very flourishing in the Inland Sea of Japan. Since then, this sea area has maintained its position as the center of Japanese coastal fisheries. In recent years, especially since the end of World War II, these fisheries have become highly developed, resulting in a more intensive use of fishing grounds than ever before.

Fig. 2



By Mr. Kaoru Tatara

Fig.1 Undercurrents of the Inland Sea of Japan



Marine geographical features

THERE ARE numerous islands and straits located throughout this sea area, thus providing a certain kind of marine geographical complexity. The climate is mild nearly all year round. Various organic substances are constantly being supplied into this sea area through a great number of rivers, while the exchange of seawater takes place at frequent intervals in conjunction with the characteristics of tidal currents. These factors prove a great boon to the reproduction of plant plankton. In addition, the natural conditions and geographical features of this sea area provide a very inhabitable environment for various fish and shellfish species. It is estimated that more than 600 species of fish and shellfish inhabit this sea area, approx. 100 of which are caught in commercial fishery operations. Fish resources are roughly divided into the following three categories of species:

Category 1: Mother fish migrate from high seas into this inland sea area for spawning (red sea-bream, Spanish mackerel, etc.).

Category 2: The fry which were hatched in high seas areas come to settle in this inland sea area until they become adult fish (yellowtail, sea eel, etc.).

Category 3: Some of the common fish species remain their whole lifetime in this inland sea area (sea bass, black porgy, flatfish, prawn, crab, shellfish, etc.).

Rapid fishery development

FISH RESOURCES are found in abundance in the eastern water area, while the western water area is blessed with shellfish and demersal animal resources such as prawn and crab. The above type of resource distribution has long been formed in close relation to marine geographical conditions peculiar to this sea area. For example, it is obvious that an extensive tideland in the western part of the Suo Sea area has been an ideal habitat for shellfish species. On the other hand, schools of fish coming from high seas pass through or settle in the Kii Channel or Osaka Bay. This clarifies the reason why the eastern water area of the Inland Sea is abundant in fish resources.

The above factors alone, however, are not enough to clarify why such sea areas have become abundant in particular fish species, thus giving a boon to the development of specific types of fisheries. It must also be taken into consideration how fishermen have dealt with these resources. In a word, they have concentrated efforts on harmonizing the exploitation of resources with progressive fishery development.

Fig. 2 shows year-to-year catch amount in this sea area.

The period from 1945 to 1955 in the postwar days saw a great increase in catch amount due to the increased number of fishermen and mechanization of fishing methods and gear.

Another remarkable increase was recorded in the period from 1960 to 1970, due to the relatively complex factors as follows:

(1) Eutrophication of seawater
The increased amount of waste water from coastal industrial and housing zones resulted in the eutrophication of seawater. This benefited the reproduction of various fish and shellfish species.

(2) Effective thinning-out
Fishing intensity was greatly increased by improved fishing methods and gear. This had a certain thinning-out effect upon the eventual reproductivity of fish or shellfish species which might have overpropagated in this sea area.

The amount of catch continued to increase by 6 to 7% each year over the period of about 10 years. At the same time, the contents of catch changed as follows:

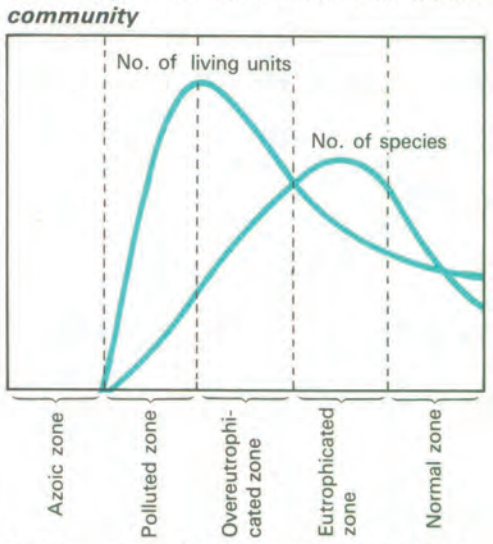
* The catch amount of prime fish species like red sea-bream, sea bass and yellowtail decreased considerably.
* The catch amount of plankton feeders such as anchovy, launce and shirasu (fry of anchovy) increased especially in the eastern water area.
* Shellfish species like short-necked clam and ark shell were produced in large quantities at frequent intervals over the western water area.

There were lying the following factors behind these phenomena:

(1) Fishing effort was first concentrated on increasing the catch amount of prime fish species due to the improvement of fishing methods and gear. The catch sought shifted to middle or low class fish species after prime fish species were overfished.

(2) The biota in this sea area underwent rapid changes during the process of seawater eutrophication.

Fig. 3 Degree of seawater eutrophication and change in the state of demersal animal community



In this sea area fishermen have consistently increased their fishing intensity for the past 10 or more years in an effort to boost the eventual reproductivity of fish and shellfish resources, thereby increasing the amount of catch by leaps and bounds. On the other hand, however, a drastic increase in total catch amount has degraded the mean trophic level of the catch. In general, the fish of lower trophic level is lower in commodity value. Therefore, the degraded trophic level of the catch has resulted in a significant impact in commercial fisheries. This is posing a crucial problem concerning an alternative decision regarding the targets of the government's fishery development policy. One is to simply increase the catch amount of middle or low class fish species with an increase in the supply of fish protein in mind, while the other is to put greater effort in increasing the production of prime fish species. The government must choose between the two.

Small-scale but versatile fishery operations

THE SITUATION of coastal trawlnet fisheries in the Inland Sea of Japan is shown below: (Source: '81 Fishery Statistics by the Agricultural Administration Department for Chugoku and Shikoku Districts)

Coastal trawlnet fisheries in the Inland Sea of Japan (1981)

Type	No. of fishing units (Using 3 to 5 ton fishing boats)	Aggregate no. of operation days	Catch amount (ton)
Non-beam trawl	2,291	22,298	1,540
Otter trawl		219,715	26,109
Beam trawl	8,003	696,216	57,402
Dredge-net trawl	5,830	277,083	27,416

Note: *A fishing unit which is engaged in two or more types of fisheries is counted as one in all items concerned.*

In regards to coastal trawlnet fisheries, the number of fishing units accounts for approx. 44% of the nationwide figure. The amount of catch makes up approx. 30% of the nationwide total, while the aggregate number of operation days amounts to 50% or more of the nationwide figure. As mentioned earlier, more than 100 species of fish and shellfish inhabit this sea area but the absolute quantity of each species is relatively small and only several species concentrate in particular water areas, as follows:

* **Anchovy** — caught in the ratio of more than 10% of the total catch (tons) in the whole area of the Inland Sea of Japan.
* **Sardine** — more than 10% of the total catch in the Osaka Bay area.
* **Drum/croaker** — more than 10% of the total catch in the Bisan Strait area.
* **Short-necked clam** — more than 10% of the total catch in the Suo Sea area.
* **Shirasu (anchovy fry)** — more than 10% of the total catch in the Kii Channel area.
* **Launce** — more than 10% of the total catch in the Harima Sea area.
* **5 to 10%** — purple pike conger (Kii Channel), Atlantic cutlassfish (Kii Channel), launce (Osaka Bay), cuttlefish (Kii Channel, Hiuchi Sea and Iyo Sea each), sea slug (Aki Sea), ark shell (Bisan Strait) and pen shell (Bisan Strait).
* **Other species** — 1% or less each.

In short, the number of fish species is large but they are caught in relatively small quantities each. This type of fishery is closely related to the marine geographical conditions of this sea area. In addition, complex fishery limitations common to all intensive fishing grounds have spurred the growth of a great number of small-scale fishing units everywhere along the coast of this sea area.

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by Kaoru Tatara
(Bull. Nansei Reg. Fish. Res. Lab. (13) 111 ~ 133 (1981))

Productivity of the Inshore Fishing Grounds
Changes of Productivity in the Seto Inland Sea (Review)
by Kaoru Tatara
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An experimental fishing ground control

— *Case study of dredge-net fishing grounds* —

IN JAPANESE coastal fisheries the effective control of aquatic resources has recently become a matter for increased public concern.

In general, the importance of aquatic resource control is strongly advocated whenever a particular type of fishery reaching the stage of expansion comes into conflict with various environmental conditions. Until such a situation is brought about things follow the process below:

1. Introduction of improved fishing methods and gear
2. Increased catch amount
3. Increased number of newcomer fishermen
4. Free competition
5. Equalized catch amount
6. Overfishing due to intensified competition
7. Signs of resource exhaustion
8. Importance of resource control recognized

"Reproduction" and "propagation" are the two essential factors for the preservation of aquatic resources. Therefore, in the effective control of these resources, restrictions must be placed on fishery operations in favor of their biological characteristics as follows:

1. Fishing effort is limited so as to avoid overfishing.
2. Adequate protection is provided to their spawning grounds and mesh size is controlled so that the amount of exploitation has the least effect on their reproductivity.

Aquatic resource control aims at the continuous development of fisheries and must experience the process of trial and error in its early stages because there is no sufficient store of resource research or survey data available for the purpose.

Let's take up the situation of several shellfish fishing grounds as good case examples.

It is well known to everybody that shellfish species reproduce themselves in abnormally enormous quantities in a certain cycle. No scientific law can give an account of this mysterious phenomenon. But it must be closely related to a particular change in marine environmental conditions beyond the interference of modern fisheries.

Enormous quantities of shellfish resources become the main catch sought by coastal small-scale fishermen. This gives a boost to the mechanization of fishing methods and gear.

CASE I

In 1972 the sandy seashore area facing the Kashima Sea (Ibaragi Pref.) saw the reproduction of kotamagai (Gomphina melanaegis) in extremely large quantities. In the period from 1974 to 1979 all 3 to 5 ton class fishing boats were engaged in shellfish dredge-net fishery over this sea area. At its height total catch amounted to 5,000 tons per annum. This meant that each boat brought 50 to 100 thousand yen daily for its one-hour operation!

Catch amount, however, began to show a drastic decrease after 1979.

CASE II

In 1974 a similar phenomenon was seen over the Nakoso seashore area about 100 km north of Kashima.

CASE III

The Isobe seashore area which is about 100 km north of Nakoso is abundant in surf clam resources and shellfish dredge-net is one of the most popular fisheries in this area. Line hauling method in this fishery operation became mechanized later than 1964. This greatly increased the fishing intensity but annual catch amount showed a sharp decline from 406 tons (1967) to only 30 tons (1972).

In these three cases, mechanized fishing methods increased the fishing capacity beyond the reproductivity of shellfish resources.

Fishermen in these areas formed individual research groups to implement effective measures to counter this situation as follows:

A. Research group of Kashima-Sea fishery cooperative

IN THIS AREA the fishing ground was controlled in the following manner even before fishing methods became mechanized:

(a) Rigid adherence to a closed season (spawning season from April 15 to July 14)
(b) Restrictions on the number of operation days (4 days a month)
(c) Reduced duration of operation (July to Dec. 1975 — 3 hours a day; Jan. to Jun. 1976 — 1.5 hours a day; later than Jul. 1976 — 1 hour a day)
(d) Transplanting shellfish fry from densly populated areas to the established preserve area.
(e) Coastal patrol by cooperative members (prevention of poaching)

Despite these control measures the amount of catch continued to decrease later than 1979. This urged the research group to take other effective measures to cope with the situation.

Research and survey data from a local fisheries experiment station revealed the growth rate and life cycle of Korean clam and kotamagai (Gomphina melanaegis), thus allowing the fishermen to form a fairly accurate estimate of the fluctuation in the volume of these shellfish resources. This provided a biological ground in dealing with the problem of aquatic resource control and resulted in the following new measures:

1. **Establishment of a voluntary no-fishing zone**
   In 1980 kotamagai resources were found in large quantities over this inshore area and the fishery cooperative established a voluntary no-fishing zone over a shoreline distance of 14 km for the protection of shellfish fry.
   Kotamagai grows to 3cm in shell length two years after its birth. From then on, it grows 14 to 27g each year. This means that if 100 mil. units should inhabit the non-fishing zone, shellfish resources could be increased by 1,400 to 2,700 tons per annum. The average span of kotamagai's life is 10 years. Througout this period the no-fishing zone is continuously controlled to ensure the stable catch amount of dredge-net fishery.
2. **Improvement of fishing gear**
   The mesh size of a bag net is 5.5cm according to fishery control regulations but the fishery cooperative increased it to 6cm so that it could prevent shellfish fry from being mixed up in the catch. In addition, iron dredge teeth were altered in shape and length in order to lessen the damage to the catch. The fitting angle to an iron frame was also changed and allowed the catch to go over the teeth and into the bag net smoothly. These improvements reduced the damage rate from 20% to 10%, thus resulting in a more effective use of shellfish resources.

B. Research group of Nakoso fishery cooperative

VARIOUS RESTRICTIONS were imposed on fishery operations to prevent overfishing. Fishermen, however, were anxious about their future because kotamagai resources would inevitably taper off.

The research group then took up the artificial reproduction of surf clam of higher commodity value as a theme for study as follows:

1. A local fisheries experiment station confirmed that a water area along the coast would provide a good habitat for this shellfish species.
2. In April, 1977 a working group was formed to study the biological characteristics of this shellfish species and the method of resource control under the guidance of fishery experts.
3. The said water area was designated as a no-fishing zone. In December, 1977 about 1.5 tons of mother shellfish were transplanted from the Isobe area to this water area.
4. The members of this working group learned much about the method of fishing ground control through cooperation with the staff of Isobe fishery cooperative.
5. Large quantities of shellfish fry were found over this water area when the first investigation was conducted on the actual effect of transplantation in November, 1978. In December of the same year, 1.5 tons of mother shellfish were again transplanted to this water area.

C. Research group of Isobe fishery cooperative

HIT BY A DRASTIC FALL IN CATCH AMOUNT in 1972, the research group tackled the problem of aquatic resource control from 1973 on, as follows:

1. A surf clam fishing ground control group was formed to map out an annual fishing plan prior to the opening of a fishing season based on the actual situation of shellfish resources, so that timely and reasonable restrictions could be imposed on fishing operations.
2. Later than 1973 voluntary restrictions were imposed on the number of net operations, duration of operation, mesh size, shell size and fishing zone. In addition, later than 1978 a joint operation system was adopted and takings were equally distributed among all fishermen concerned.
3. Seized young shellfish were restocked into a designated preserve zone, if their shell size was found smaller than a prescribed standard. In addition, underwater netting and sandbags were adopted to keep shellfish fry within the preserve zone.

These measures made all fishermen recognize the importance of resource control, thus the situation of resources was considerably improved after 1974. 1975 saw the production of shellfish fry in the largest quantities ever. In the 1977-1978 period the total catch showed a massive increase (600 to 800 tons). Fishermen are still maintaining this proven system for effective resource conservation and stable catch amount.

Introduced below is the list of aquatic resource control measures:

Target	General method	Concrete measures	Effectiveness	Problems concerning control
Prevention of excessive resource thinning-out.	• Restrictions on fishing effort (Adjustment of restrictions on fishery operations. Restrictions on catch amount)	• Restrictions on the number of fishing boats in use. • Restrictions on tonnage. • Restrictions on horsepower.	○	1. Too long a closed season results in the lay-off of employees, which can cause the shortage of labor force after the season opens. Some secondary fishery is necessary. 2. Too strict a control concerning a non-fishing zone is contradictory to the effective use of aquatic resources. (On the other hand, relaxed control can cause a confliction between different types of fisheries.) 3. It is difficult to anticipate to what extent protection measures are effective for spawning season, spawning grounds and fry growth grounds. 4. More consideration must be given to the effective use of total demersal fish resources by taking into account a possible competition with other types of fisheries, especially coastal trawlnet fisheries.
		• Restrictions on the efficiency of fishing gear and method.	×	
		• Restrictions on any other factors which might lead to an increase in fishing effort.	×	
		• Establishment of a closed season.	○	
		• Establishment of a no-fishing zone.	○	
		• Restrictions on catch amount	×	
	• Restrictions on catching the young fish.	• Restrictions on mesh size.	△	
		• Restrictions on the size of fish caught.	×	
Ensuring the least effect on the reproductivity of resources.	• Adequate protection to schools of spawning fish. • Adequate protection to young fish.	• Same in principle as the above. • Establishment of a closed season (spawning season and fry growth season)	○	
		• Establishment of a no-fishing zone (spawning grounds and fry growing grounds)	○	
	• Constant supply of young fish in sufficient quantities.	• Restrictions on mesh size.	△	
		• Restrictions on the size of fish caught.	×	
Artificial seeding for resource propagation.	• Stock of seeds	• Transplantation and stock of natural seeds. • Production and stock of artificial seeds. • After-stock protection.	△	

Note ○ = *Satisfactory* △ = *Sometimes satisfactory* × = *Unsatisfactory*

Source: Fishery Documents by the Fisheries Agency

Housewives work together

The strong sense of collective responsibility in a community

In a number of fishing villages on the coastal districts of Japan, housewives belonging to the women's division of fishery cooperatives, work together in an effort to put miscellaneous catches to more effective use. Their efforts are well rewarded.

A good example is given by the housewives, members of the women's division of the Niihama Fishery Cooperative in the eastern part of Ehime Prefecture facing the Inland Sea of Japan.

These housewives are engaged in joint processing of shrimps caught by small-scale dredge-net fishery or beam trawl fishery (ebi-kogi).

A recent drastic rise in fuel and material prices became a heavy burden on their household economy and they had to safeguard their family finances by increasing earnings with their own labor.

In this fishing village shrimps were dry-processed in small quantities for just household consumption or for complimentary gifts to others in the days before these housewives became aware of the potential commodity value of them.

At first, each housewife started shrimp-processing as her homework.

Dry-processed shrimps, shipped to the market of the fishery cooperative, were more favorably received by consumers than had been anticipated.

Encouraged by this success, all housewives concerned agreed to develop shrimp-processing into a joint work so that operation efficiency could be increased. Improvements included the purchase of an oil dryer which allowed them to continue dry-processing work even in rainy weather, while sun drying was the only means of home processing.

In addition, both the fishery cooperative and its women's division were in favor of this project, thus granting these housewives the subsidies of ¥150,000 and ¥100,000 respectively.

Joint investment by all participating members amounted to ¥50,000, which increased the total of their workable funds to ¥300,000 just enough for completing all necessary arrangements including the preparation of an oil dryer-equipped workshop.

In this workshop the oil dryer has the capability of drying about 200 kg of raw shrimps within 4 hours or so and this work process is performed twice a day. The oil dryer is daily operated by 3 housewives.

The use of the dryer has greatly improved the quality of processed products and sales have continued to increase.

Roughly calculating, dry-processing has increased the commodity value of shrimps by ¥325 per kg of raw material.

The excellent results of this joint work are summarized as follows:

* Improved individual household economy
* Contributing to the more effective use of miscellaneous catches
* Promotion of fish consumption throughout surrounding areas
* Fostering better human relations within a community

It must not be overlooked that the success these housewives have made with their new project is due to the following pre-environmental and technical conditions:

(1) Their joint work started based on desirable human relations which had previously been fostered through various circle activities such as a movement for the improvement of living conditions within the village community.

(2) Their community had been in good relations with neighbouring farming villages.

(3) Quite a simple processing method served the purpose.
Processed products were sold as local specialities or exhibited for spot sale on various feast days.

(4) All necessary arrangements were smoothly completed (including draw-up of an annual production plan).

After-catch work process

1 Demersal fish, shrimp, crab and shellfish are caught together with various sea-floor plants and animals.

2 Sorting the catches in the intervals of net operation.

3 Each operation brings a catch of 10 to 15 kg.

4 Shrimps are kept in a live well until the boat returns to port.

5 Sorted catches are put into respective polyethylene baskets.

6 Washing before shipment.

7 Shipment to the market of a fishery cooperative.