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Mechanization and the Family Revolution

YAMAHA
YAMAHA MOTOR CO., LTD., Public Relations Division, 2500 Shingai, Iwata, Shizuoka 438, Japan Telephone 0538(32)1145, Facsimile 0538(37)4250

The single most important development in fishery since the beginning of recorded history has been the motorization of fishing boats. Just as the invention of the steam engine sparked the industrial revolution on land, the use of steam engines on boats led to the "industrialization" of fishery.

By definition, a fishing boat must perform four basic functions. These are, (1) mobility (the capability to travel over a given distance of water), (2) the ability to locate fishing grounds, (3) the capacity to perform the fishing operation, and (4) the capacity to transport the catch. It is only when a boat can perform all four of these functions that it can truly be called a fishing boat. Of course, over the long history of fishery, mankind developed techniques to harness wind power to propel his boats over long distances and use the power of currents to operate his fishing nets, but none of these techniques could compare with the advantages of mounting a steam engine on the fishing boat.

We can cite three major operational advantages that come with motorization of a fishing boat.

(1) It ensures a given level of high horsepower capability.

(2) Long hours of continuous operation are possible.

(3) Devices for mechanizing the fishing operation can be run off the main engine.

Of these, (1) encouraged the building of bigger fishing boats and (2) made it possible for fishermen to seek out fishing grounds farther from shore. As for (3), it not only encouraged the mechanization of the fishing operation but also led to the development of new systems of mechanization that economized traditional fishing methods and also led to attempts to develop entirely new fishing methods.

The major functional advances that came with the motorization of fishing boats led to development of fishing boat technology in two basic directions. One direction saw a concentration of the fishing boat functions (the four functions of mobility, searching capability, fishing operation and transport) all in one boat for much higher productivity. The most representative of this type of fishing boat is the large-scale trawl boat that includes even an on-board fish processing factory. The other direction was the division of these basic functions among a number of specialized boats that work together as a type of fishing task force. A good example of this direction is seen in today's purse seine fleets consisting of net boats, lamp boats and transport boats working as a team. In either case, motorization opened the way for mechanization of the fishing process and development of fishery as a mass-production industry. As a result, in Japan we see the development of fishery in the latter half of the 19th century into a variety of middle- and small-scale investment enterprises for offshore fishery and large-scale investment enterprises for distant-sea fishery.

However, there is one more fishery sector that we must examine, coastal fishery. Compared to offshore and distant-sea fishery, the mechanization of coastal fishing boats has proceeded at a much slower pace; in fact it can be said to only have begun in earnest after World War II. But the effect of this mechanization on fishing villages made up of the roughly 300,000 artisanal fishermen in this sector has been profound, widespread and deep. The mechanization of fishery was accompanied by major transformations in the areas of finance and labor, and in the case of coastal fishery these changes particularly affected the state of the fishing family and the importance of family labor. Even today, when the unmotorized fishing boat has virtually disappeared from Japan's coasts, the effects of this change are still being felt.

Tohshijima island in Mie Prefecture is a place known for its large number of "husband-and-wife boats," fishing boats operated by married couples. Working as a team, the husband generally operates the boat and the fishing machinery while the wife does the net casting and hauling, sorting of the catch and helps with the landing of the catch in port. The top photo shows the net-casting operation in two-boat type seine fishery. The net boat is manned by one man and two women, while the other boat is operated by one man alone. The bottom photo shows the sorting of the catch, in this case sand lance.

In this issue we will focus on coastal fishery as we take a look at the basic technological developments that spurred the mechanization of fishing boats and trace the social and economic changes it has brought to the fishing communities. On the next page we will outline the basic problems involved in this issue's theme, the mechanization of fishing boats, while the following pages will be devoted to a report on the changes that the mechanization process has brought about with regard to the two mainstay fishing methods of coastal fishery; namely, small-scale trawl and boat seine fishery.

This issue is the first of a three-part series in which Fishery Journal will explore the subject of fishing boat modernization from a broad perspective. In the next issue the focus will shift to the technical aspects of fishing boat modernization, while the third issue will explore measures for dealing with the various stages of modernization.

Mechanization of fishing boats in Japan

The history of the mechanization of fishing boats in Japan has been integrally related to the development of the structure of modern fishery in the country. With it has come the definition of three types of fishing businesses, large-enterprise fishing business, middle- and small-scale fishing business and the coastal fishing family, each with its own financial make-up and each designating a distinct fishery sector; namely, distant-sea fishery, offshore fishery and coastal fishery. From the standpoint of investment capital and labor, these three sectors are interrelated, forming what might be considered a multi-leveled structure to the country's overall fishing industry. Within this structure, the distant-sea fishery sector has been gradually withdrawing from the distant-sea fishing grounds since the adoption of 200-mile territorial rights in the 1970s and has undergone restructuring as an industry, branching out into general marine-product trading enterprises and foodstuff companies. In the future, Japan's fishery production will come mainly from the remaining two sectors of offshore and coastal fisheries.

[1] The foundation of large enterprise fishery

All sectors of Japanese industry flourished with the opening of the country to international trade after the Meiji Restoration in 1868, and this economic growth brought with it an increase in demand for fishery products and a resulting growth in the market. However, fishery production failed to keep pace with this new demand, as the industry failed to emerge from the stagnation of the old era. In response to this situation, the new government made the promotion of fisheries a top priority on its general policy.

In 1897, the government passed a Distant-sea Fishery Subsidy Act that went into effect the following year. The purposes of this Act were (1) to promote the fishing industry through the exploitation of previously undeveloped fishing grounds in the seas around Japan, (2) to support distant-sea fishery by building Western-style fishing boats and improving the then low level of Japanese fishermen's proficiency in the arts of navigation and fishing techniques, and (3) to build a native fishing fleet that could compete with the large fleets of American, British, Russian and other foreign boats catching sea otters and seals, etc., in the Japanese offshore waters, thus defending the country's maritime interests. Of these, (3) was especially important to Japanese statesmen as a measure to defend national interests and take an exertive stance with regard to the country's territorial integrity.

Under this program the government offered subsidies to cover part of the financial outlay for fishing interests building steam-powered fishing boats over 100 tons and sail-powered fishing boats over 60 tons with the intention of engaging in fishery in the seas surrounding Japan. Operators who took advantage of this subsidy program subsequently engaged not only in the capture of sea mammals like whales, sea otters and seals, but also expanding their operations to a wide range of fish, including shark, tuna, skipjack and cod. The government also responded by amending the Fisheries Subsidy Act several times to expand the framework of its subsidies.

With the introduction of large-class steam and sailing vessels and importation of the latest fishing techniques from the West, the government sought to establish a modern fishing industry all at once. However, with the exception of whaling and the capture of sea otters and seals, the results of the industry's fishing efforts were poor. Not only were the fishermen unsuccessful at adapting their traditional fish-finding techniques to the new Western-style fishing boats, the products of these long-voyage offshore fishing ventures did not fit the needs of the Japanese market, traditionally based on the consumption of fresh fish, but also, in another ironic twist, the increased length of time at sea spurred inflation in labor costs to the extent that many operations became financially inviable.

Amidst these failures, however, two new types of fisheries imported from the West took root in Japan: Norwegian style whaling and steamship trawl fishery. These fisheries began to flourish with the establishment of incorporated companies for Norwegian style whaling in 1899 and steamship trawl fishery in 1908, respectively. As both of these ventures produced successful results, there followed a rush of operators adopting the same methods. However, as production from these new fishing methods continued to grow, it caused increasing friction with coastal fishermen engaged in traditional fisheries, even resulting in sporadic confrontations between the two. Eventually this conflict caused the modern whalers and steamship trawl operators to abandon the coastal waters and develop their operations around distant-sea fishing grounds. The entrepreneurs who established these prosperous new fisheries were all people of financial means, like merchants, landowners and politicians, who originally entered fishery because of its potential for profitable investment.

It is important to note here that it was investment from outside the fishing industry that formed the foundation for the modernization of the industry. And, it was from these same fishery enterprises that we later saw the emergence of some of Japan's largest fishing corporations, like Taiyo Fishing Co., Ltd. (present Maruha Corp.), Nippon Suisan Kaisha, Ltd. and Nichiro Gyogyô Kaisha Ltd (present Nichiro Corp.).

[2] The development of offshore fishery

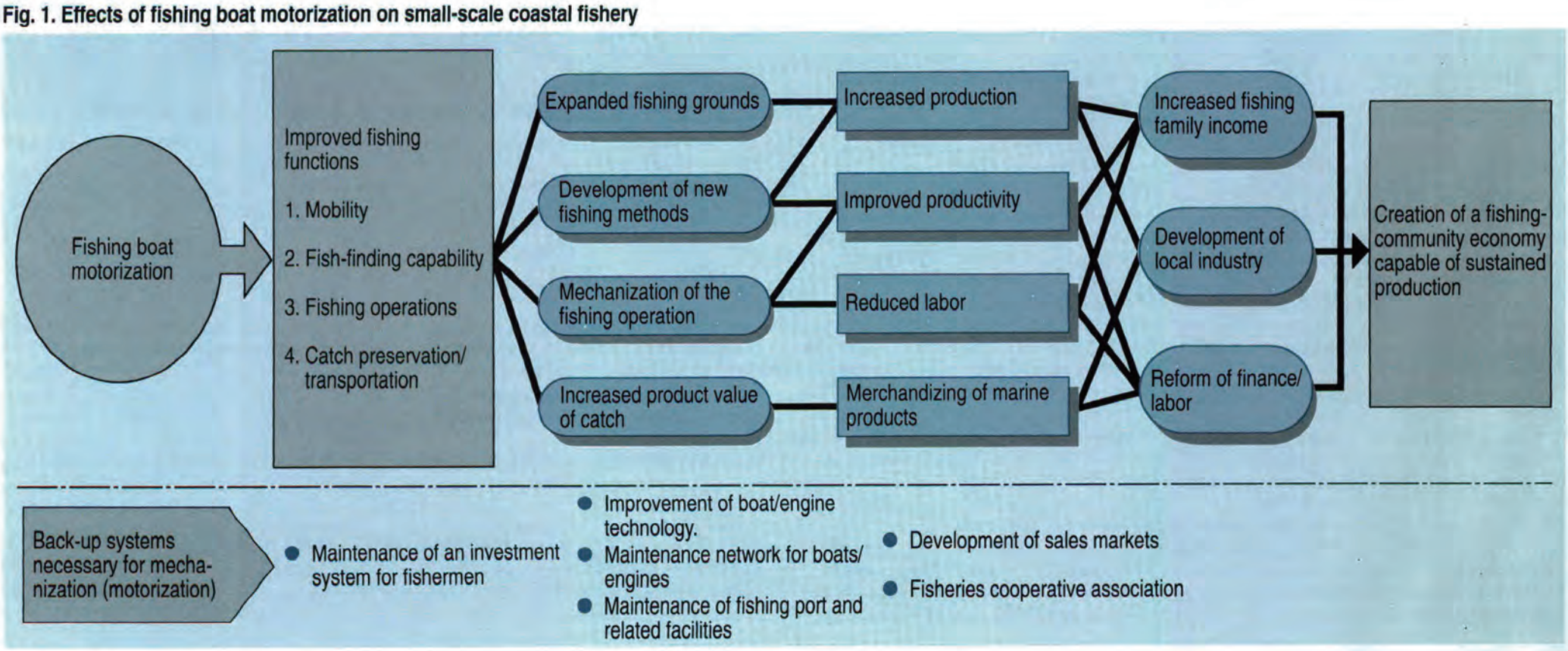
The Fisheries Experimental Stations established by the government in each prefecture after 1894, have played an important role in Japan's fishery development. With the launch of the "Fuji-maru" in 1906, for example, the Shizuoka Prefectural Fisheries Experimental Station successfully undertook the first experiment in skipjack pole-and-line fishery from a boat with an oil-burning engine. Compared to the steam engine, the oil-burning engine was easier to start and stop and required less labor to operate. Furthermore, it was smaller in size and weight and its fuel lighter and easier to handle than a coal-burning steam engine, all of which made it more suitable for smaller fishing boats. The first oil-burning engines were imported to Japan in or about 1896 for use in factories, and their number grew rapidly over the next ten years. It was these engines that were then adapted for use on boats.

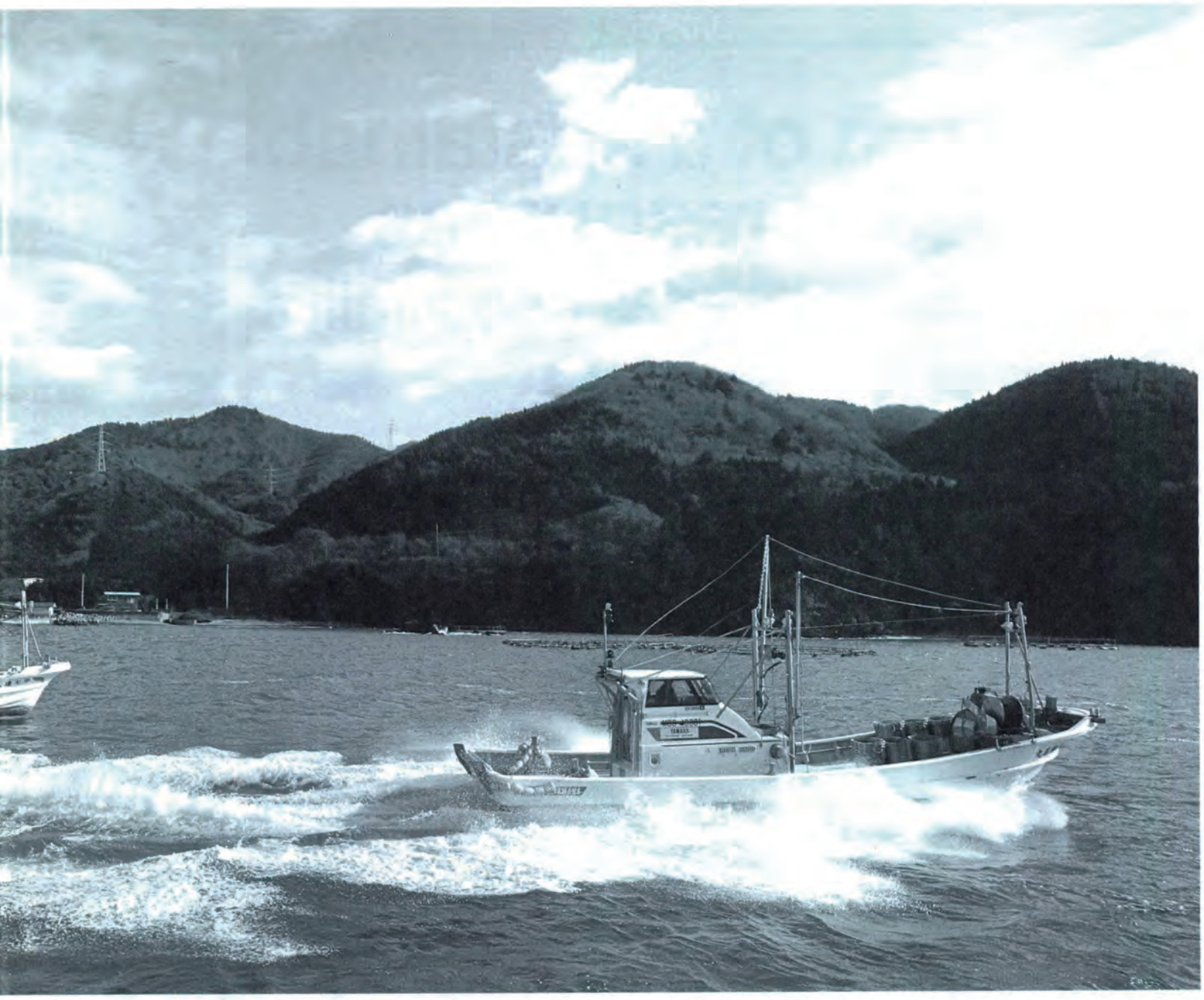
After the success of the "Fuji-maru," 6 horsepower to 25 horsepower oil-burning engines became standards for use on fishing boats. The rapid increase in Japanese fishery production beginning around 1907 **(Fig.2)** can be seen as a direct result of the introduction of oil-burning engines on fishing boats. The fisheries that these new boats were used for included skipjack pole-and-line fishery, tuna longline fishery, purse seine and trawl fisheries. Among these it was skipjack fishery that showed the most dramatic increase in production due to motorization.

Since long before the advent of motorized boats, a type of skipjack pole-and-line fishery using 20-ton class sailing vessels and manned by 30 or more fishermen had developed in the

Pacific coast prefectures like Shizuoka and Kochi washed by the Kuroshio current. These boats would conduct fishing voyages of more than a week under sail. In this sense, they already constituted a manufacturing type of enterprise fishery in which the catch was manually processed on board the fishing vessel. Since this manufacture technology and labor base built up over long years of experience in skipjack fishery during the 17th to 19th centuries could be applied directly to operations using the new motorized vessels, skipjack fishery was in a position to benefit greatly from the advent of motorization. Thus, the foundations were laid for skipjack, tuna and other offshore fisheries in the second and third decades of this century, paving the way for the establishment of small- and middle-scale fishery enterprise.

Fig. 1. Effects of fishing boat motorization on small-scale coastal fishery





Roughly 300,000 small-class fishing boats are at work today in Japanese coastal fishery. Most common among these are diesel-powered 1- 3 ton and 3 - 5 ton boats, making up some 40% of the total. Fishermen choose the most suitable type of boat based on the fishery they engage in and the size of their operation. At the same time, there has been a growth in 1-ton class utility boats motorized by means of outboard motors. These boats are employed largely in shellfish and seaweed gathering operations and aquaculture in shallow water areas.

[3] Evolution of the "nuclear fishing family" in coastal fishery

The motorization of boats in coastal fishery was very slow in taking place. Although this was in part due to slow progress in the development of small internal-combustion engines, by far the biggest reason for this delay was the lack of available investment capital in this sector.

Motorization of small coastal fishing boats finally began in the 1920s. Records tell us that compared to no more than 2,000 motorized boats under 20 tons in this sector in 1915, the number grew rapidly to 5,000 in 1920 and 12,000 by 1925. **(Fig. 3)**. As Japan entered its Showa Period after 1926, this growth in motorized fishing boats continued. Ironically, however, the new impetus behind this growth was the advent of economic depression. Following the collapse of the monetary system in 1927, the Japanese economy was drawn into the worldwide depression. The country's farmers and fishermen were especially hard hit by severe drops in market prices and an increasing burden of debt. In an attempt to aid the impoverished farming communities and fishing villages, the government launched a positive relief program which, sought to strengthen the joint marketing system of the fishery cooperatives to increase fish prices by eliminating capital loss to middlemen. Under this program, subsidies and loans were also appropriated for renovation of fishing port and storage facilities, support of joint enterprises initiated by the fishery cooperatives as well as granting subsidies for the construction of small-class motorized fishing boats. At the same time, recognition was given to the importance of fishery cooperative activities, and measures were taken to strengthen their economic activities.

Supported in this way by the government program, motorization of small fishing boats proceeded until 1940, when the war put the country in a state of national emergency. With this motorization by hot-bulb engines or electric ignition type engines, operators of small-size fishing boats for pole-and-line, longline, gill net and set net fisheries came to depend on engine power for getting to and from their fishing grounds and for transporting their catch.

The reconstruction of Japan's fishing industry after the war began first of all with financial support to large enterprise fishery and middle to small enterprise fishery. This was because the fishery policy at the time was based on the expansion of fishing grounds under the motto of moving "from coastal waters out to offshore waters and from offshore to distant-sea waters." Moving out of the reconstruction period and into the period of high-rate economic growth in the late 1950s, the government launched a new fishery policy that sought to accommodate changes in the national economy and population structure by promoting the growth of coastal fishery.

Amidst the background of high economic growth during the dozen or so years between 1960 and 1973, a number of factors such as the flight of fishermen to other professions, decrease in size of the fishery work force and aging of the fishing community population, effected the social structure of the fishing communities. On the other hand, the introduction of advanced technology and adoption of the Coastal Fishery Structure Improvement Project brought the industry to a turning point in terms of production potential. This in turn led to active promotion of motorization and up-sizing of coastal fishing boats.

On the financial side, it is important to note the effects of the fishery cooperative savings campaigns begun about 1960, that brought new cumulative investment capital to the fishery cooperative system. Based on this system's financial reserves, a program of long-term, low-interest fishery modernization loans for coastal fishermen was established in 1970, with the national and local governments providing interest subsidies. This program gave another big boost to the motorization and modernization of coastal fishing boats.

Since 1960, the number of people employed in fishery in Japan has continued to decline, but this trend has also been accompanied by a trend toward increased fishing efficiency in coastal fishery. As for the forces that have led to the increased production and improved fishing efficiency of coastal fishery, we can cite (1) an increase in the number of motorized 1 - 3 ton and 3 - 5 ton fishing boats, and (2) the development of aquaculture in shallow sea areas. Despite yearly fluctuations in production, the coastal fishing industry has been successful at steadily increasing the income of fishing families. Since olden times, coastal fishermen have tended to supplement their fishing income by seeking seasonal work in other industries. However, today those families engaged in coastal fishery and aquaculture are able to make their living mostly from these fisheries. In other words, by making efficient use primarily of family labor on a year-round fishing schedule, fishing families are able to earn an income equal to or even exceeding that of the average city worker. This group is referred to as the "nuclear fishing family." It is on these families that the future development of coastal fishery in Japan rests.

Acknowledgments: This article is based largely on research treatises by Prof. Yutaka Hirasawa and Tokuo Ninohei.

Fig. 2. Japanese Fishery Production

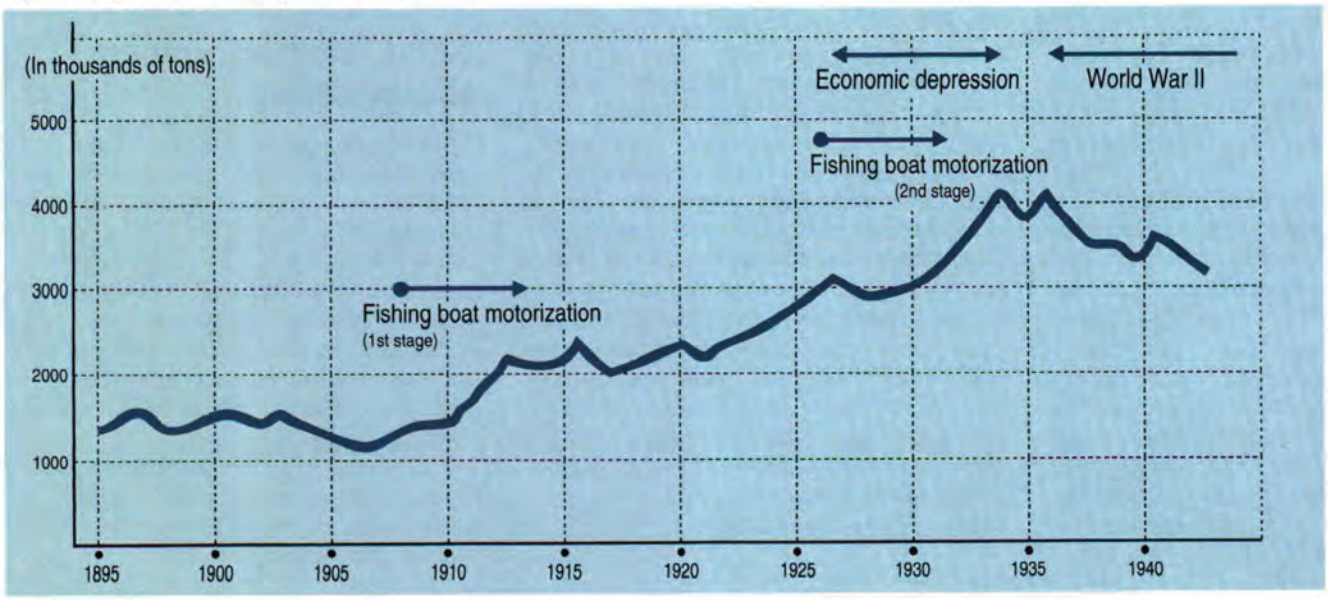
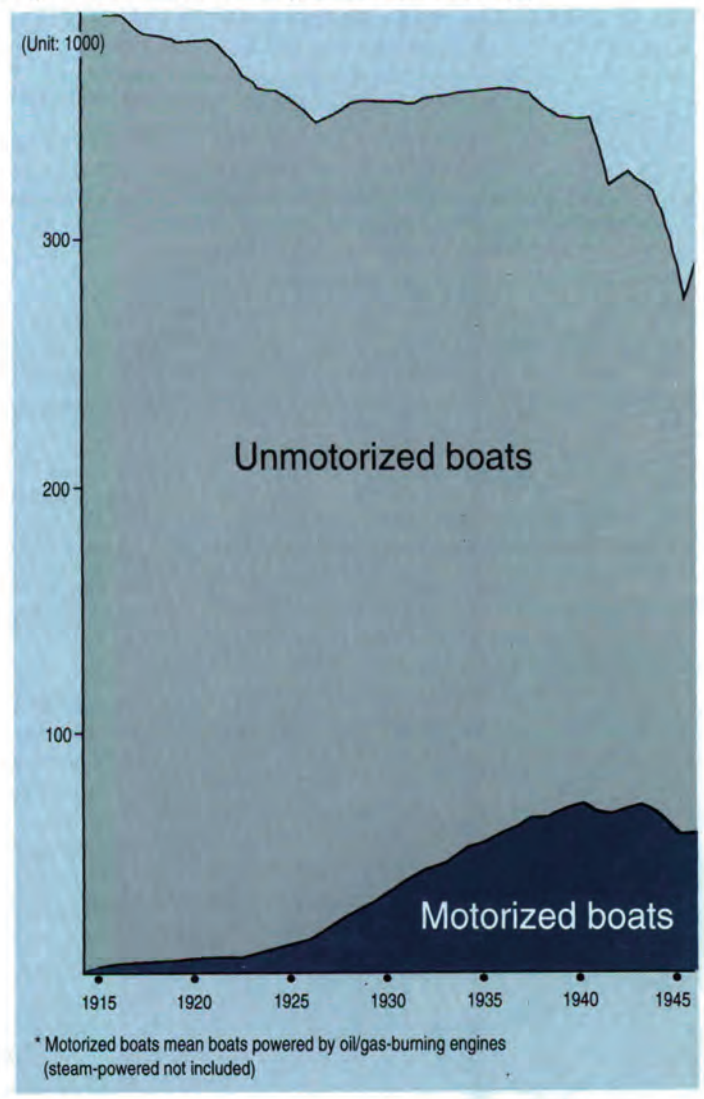
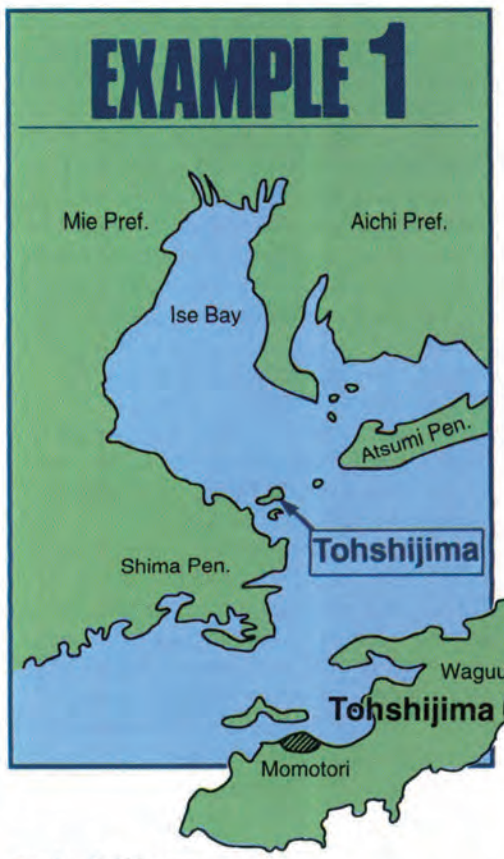


Fig. 3. Number of fishing boats under 20 tons



In search of a sustainable balance in resources
- The Tohshi Fisheries Cooperative



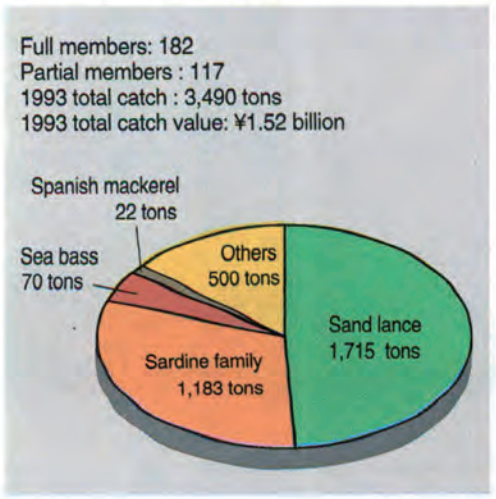
Scoop net fishery. Sand lance swim in "patches" near the surface and have the habit of congregating into tightly packed schools when threatened by predators. When frightened by means of pebbles thrown in the water or poking the surface with a pole, the fish try to bury themselves among the other fish in the school, forming a tight mass. While continuing to frighten the fish to keep the school intact, the fishing boat cruises slowly, gathering more fish and increasing the size of the school until it becomes large enough to begin scooping up with a landing net. The operation is performed by a three-man team; a pilot, a frightener (pole or pebbles) and a net man.

Tohshijima

The small island of Tohshijima is one of a group of islands located at the mouth of Ise Bay. While the mouth of the bay is formed between the Shima Peninsula and the Atsumi Peninsula, Tohshijima is located closer to the Shima Peninsula with its Rias type coastline. The island is blessed with abundant fishery resources, including the crustaceans, shellfish, seaweeds and demersal shore fishes that inhabit the shallow waters immediately around the island and the migrating fish species that pass through the waterway of the bay mouth in their migrations between the outer sea and the bay waters. Of the three villages on the island, Tohshi on the eastern end of the island with a population of 1,700 people in 352 households is a typical fishing village in which 166 households engage in fishery. The fact that fishermen have inhabited this site since ancient times is proven by the reference to Tohshi in Japan's oldest collection of poetry, the Manyoshu, and the fishermen of Tohshi today take great pride in this long heritage.

All the fisheries engaged in by the island's fishermen is small-scale coastal fisheries. The targets of the island's fisheries are highly varied, including traditional diving fisheries for abalone, top shell and seaweeds along with active boat fisheries using seine, trawl net, hand-and-line and gill net. In 1993, the total catch landed by the Tohshi Fisheries Cooperative amounted to 3,490 tons, with a sale value of ¥1.52 billion. In recent years, the value of the annual catch has stayed between ¥1.4 and ¥1.5 billion, with fishes constituting the largest portion of the catch at a value of roughly ¥1 billion. The types of fishes caught can be divided basically into two groups, fish like red sea bream, flatfish, sea bass, Spanish mackerel and sillaginid which are traded on the Japanese market as high-value fish, and mass catch fish like sand lance and anchovy. **(Fig. 4)** The former group is caught from 1 ~ 3 ton or 3 ~ 5 ton motorized boats with the hand-and-line or gill net methods, while the latter is caught from 5 ~ 10 ton or 10 ~ 15 ton fishing boats using the seine method. The basic type of net operated here from 10 ~ 15 ton fishing boats is a large-scale seine net that the fishermen refer to as a "bacchi ami (net)."

Fig. 4. Fishery breakdown (Tohshi Fisheries Cooperative statistics)



Sand lance

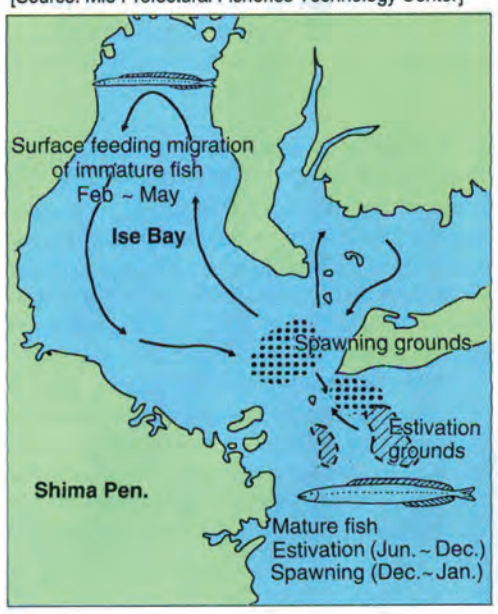
Sand lance [*Ammodytes personatus*] is a fish that has long played an important part in the lives of the people of Tohshijima. Adult sand lance that migrate around the island or along the coasts of the peninsulas in winter are caught and prepared by boiling with seasonings. The people of the island say that the New Year can't be welcomed in without eating this dish made from the winter's first catch of sand lance.

Sand lance is a migrating fish resource that originates in the northern seas and is distributed in large numbers along the cold-water coasts of Japan's northern island of Hokkaido and the Sanriku coast, Ise Bay and Seto Inland Sea coasts of the Pacific side and the Tottori and Shimane Prefecture coasts of the Japan Sea side of Japan's main island. There are two sand lance spawning grounds located near the mouth of Ise Bay where the fish come to spawn in late December and early January. The spawning grounds have sand bottoms and the eggs that are released stick to the pebbles. The eggs hatch out about two weeks after spawning and the fry ride the sea currents, which carry them gradually into the bay waters. Immediately after hatching, the fry begin feeding on animal planktons like the nauplius larvae of copepods and spread out over the inner waters of the bay as they grow. It is believed that, depending on current conditions, large quantities of sand lance fry are also carried out of the bay into the outer sea waters where they mostly die due to poor feeding conditions, thus never becoming the target of fishery. **(Fig. 5)**

Sand lance have a fast growth rate. Within about 60 days after hatching, in other words by late February or early March, the fry have grown to "whitebait" with a body length of 3.5 cm, and by April they become young fish with a body length of about 5 cm. Continuing to grow at this pace, they reach maturity by June with a body length of 7 ~ 8 cm. After this the sand lance begin to build up stores of body fat as they migrate from the inner waters of the bay out toward the mouth. At this point they begin to show a habit of burying themselves in the sand bottom as the summer water temperature climbs above 18° C. By the time the water temperature reaches 20° C, almost the entire population have buried themselves in the sand. This is a habit called "estivation," as the antonym of hibernation. It is believed to be a unique habit this originally north sea species acquired in the process of adapting itself to warmer southern habitats.

The estivation grounds are in an area of the mouth of the bay somewhat farther out than the spawning grounds, and are limited to areas with a bottom consistency of coarse sand. During the estivation period the sand lance rely on energy from their stored body fat. In autumn, when the water temperature begins to drop again, their gonads begin to mature. And when the temperature in the bottom waters drops below 15° C the sand lance emerge from the sand and move to the spawning grounds. After spawning, the adult fish continue to live and join the fishing stock once again as one-year-old fish. In the case of Ise Bay, however, as we will see in the following pages, the intensity of fishing pressure from the various fisheries is such that sand lance seldom survive to become two-year-old fish.

Fig. 5. The life cycle of sand lance
[Source: Mie Prefectural Fisheries Technology Center]

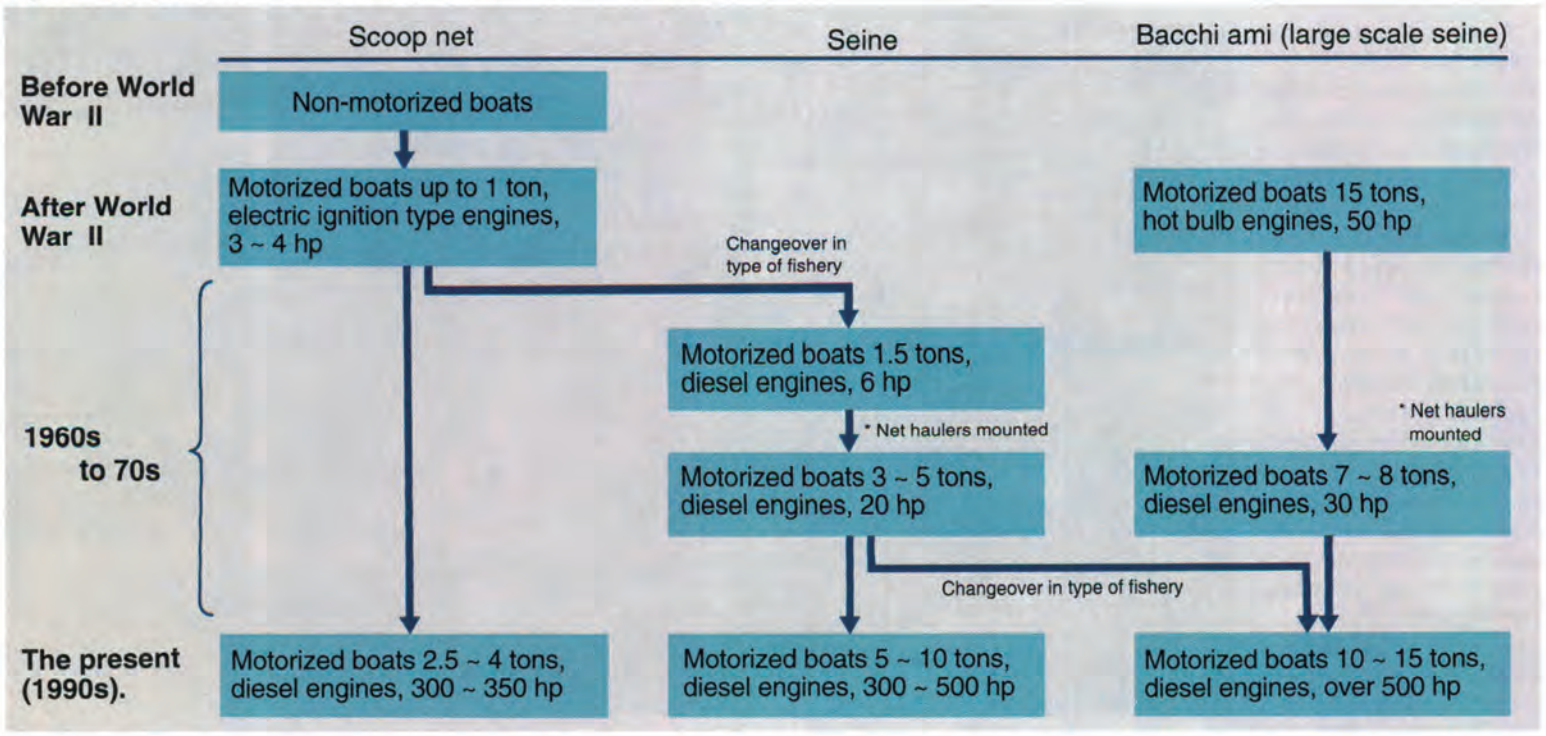


Sand lance fishery and motorization

With the exception of the estivation period from June to December, sand lance are caught by fisheries through the various stages of the roughly half a year of their life cycle from January through May. Sand lance is a fish that has commercial value in all stages of its growth from the "whitebait" fry stage to maturity. As a result, different fisheries and fishing methods have evolved to exploit the differing life conditions of sand lance in each stage of its life cycle.

(1) Whitebait ... As a food. Processed by boiling and sold that way as a food. Or, processed by boiling and then drying. (Caught by boat seine or "bacchi ami")

Fig. 6 The advancement of motorization in sand lance fishery



(2) Young fish ... As a food. Processed the same as whitebait. Or, boiled down in a soy-flavored seasoning (tsukudani). (Caught by boat seine)
(3) Adult fish ... Mainly for uses other than food. Fish caught in summer with a high fat content are frozen and used as feed for aquaculture. (Caught by boat seine or bacchi ami)
(4) Adult fish (after spawning) ...As a food. Fish caught in winter after spawning are fried as "kama-age" or boiled as "tsukudani." (Caught by scoop net)

(1) Scoop net fishery (2.5 ~ 4 ton class boats)
The catching of sand lance by the scoop net method has been conducted in Ise Bay since the 18th century or earlier. This fishing method takes advantage of the strong schooling behavior of sand lance after the spawning period. Since olden days this fishing method was conducted by a crew of three working from a one ton class boat. When the fishermen found a "toriyama," a flock of seabirds feeding off a school of fish near the surface, they would row toward the school and, as they drew near, keep the school from dispersing by throwing pebbles in the water around the school or poking the water around it by means of a pole with bird feathers attached to the end in order to frighten and keep the fish together until they could be scooped up by a landing net. The fishing gear and fishing method used in this fishery today remain unchanged, but over the years the boats have changed, first from unpowered boats to ones powered by hot-bulb engines, and later to ones with high-speed diesel engines. This brought a dramatic increase in the speed with which the fishermen could reach a school of fish, which is the reason the method has survived to this day.

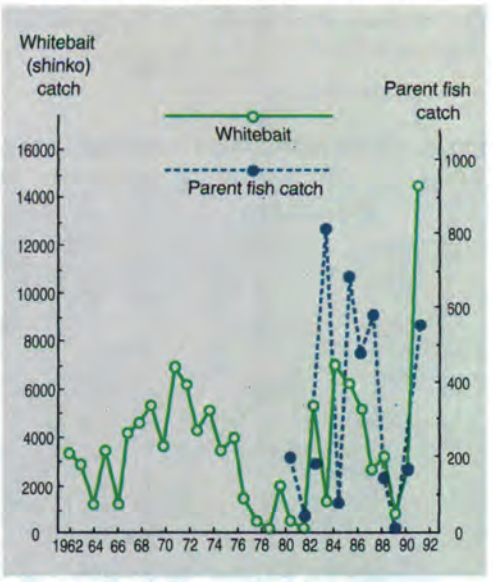
(2) Boat seine fishery (3 ~ 5 ton or 5 ~ 10 ton boats)
The catching of sand lance whitebait began with the advent of marine diesel engines in the 1960s. The increased horsepower of these engines made it possible for the first time for these fishermen to tow a seine net with their boats. For this new fishery slightly larger boats came into use, and an increasing number of fishermen switched over from scoop net fishery to seine fishery for whitebait. As the number of seine operators increased, they began to catch adult fish as well as whitebait.
At first the net casting and net hauling operations were done by hand, but in 1970 the first mechanized net hauler was mounted on a fishing boat here in Tohshijima. These devices drew power from the boat's main engine to haul the net mechanically, and within a few years their use had spread throughout the island.
The mechanization of the fishing operation in this way caused a big change in the labor situation, with the emphasis shifting from group labor to family labor. Thanks to the tradition of women participating actively in the diving fisheries for abalone and top shell, the wives of Tohshijima fishermen were used to working on the sea. If a wife could crew on a boat operated by her husband and help perform the fishing work, a fishing operation could be conducted solely as a one-family business. Thus the motorization of fishing boats and the mechanization of the fishing operation brought about the predominance of family-based fishing operations. Initially, 3 ~ 5 ton boats were the standard for these fishing families, but in recent years the average tonnage has increased to the 5 ~ 10 ton classes.

(3) Bacchi ami fishery (10 ~ 15 ton boats)
Another type of fishery that has developed in Ise Bay uses a large-scale seine called a "bacchi ami." First introduced in 1936 for catching adult sand lance, it has since been adapted to catching whitebait. At first the fishery was conducted by a pair of 15-ton boats powered by 50 hp hot-bulb engines, with the net being operated manually by crew of 10 to 15 men per boat. With the introduction of diesel engines in the 1960s, the size of the boats was reduced for a while to the 7 ~ 8 ton class, but with the advent of higher horsepower models the fishing boats once again increased in tonnage proportionally. Today the standard bacchi ami operation uses two 10 ~ 15 ton boats powered by engines over 500 hp.
For a long time there were no bacchi ami operators on Tohshijima, but beginning around 1990 some fishermen began switching from regular seine to the bacchi net method. At present there are seven boat seine operation units (14 boats) and nine bacchi ami operation units (18 boats) working out of Tohshijima.
In the latter half of the 1950s fishermen from the Aichi Prefecture side of Ise Bay also began catching sand lance whitebait. This meant that the fishing grounds expanded to cover the entire bay. The Aichi Prefecture boats adopt a strategic fishing schedule by which they concentrate their sand lance whitebait fishing at the time when the commercial value is the highest and then shift their operations to catch anchovy whitebait in the Pacific coastal waters outside the Bay. As a result, a processing industry specializing in whitebait has been established on the Aichi Prefecture side of the Bay. **(Fig.6)**

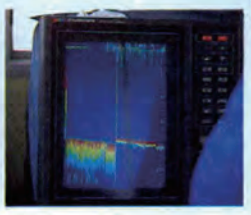
Resource conservation type fishery

The motorization of fishing boats and the advances in engine performance have resulted in a steady increase in catching capability with regard to the fishery resources. This in turn has increased fishery production and increased the income of the households engaged in fishery. However, at the same time this increase in catching capability has resulted in harmful overfishing that threatens the very existence of the fishing industry.
The peak fishing period for sand lance falls in March and April, and in Ise Bay there is no other significant fishery conducted during these months. That is why the boat seine and bacchi net sand lance fishery that brings in between 20 and 50% of the fishermen's yearly income is especially important. At present a combined total of approximately 300 sand lance fishing operation units (600 boats) from Mie and Aichi Prefectures are active in Ise Bay. The most important catch for these operators is the "shinko" or "new fry" period of the whitebait stage. And, because about 90% of the resources are caught during this stage, there is a constant danger of passing the threshold of overfishing.
From 1978 to 1982 there was a period of extremely poor catches. **(Fig.7)** Although this

Fig. 7. Sand lance catch for Mie Pref.

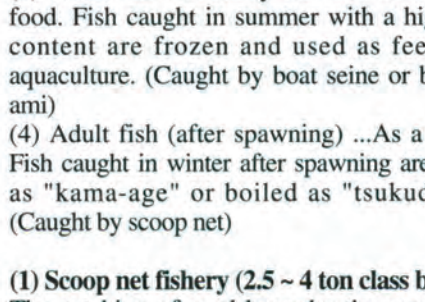


The introduction of echo sounder fish finding equipment in the 1960s, has enabled fishermen to locate whitebait schools



Adult sand lance caught by boat seine. The body length is 7 ~ 8 cm.

The scoop net fishing gear. Pebbles (top), a pole tipped with bird feathers (middle) and the landing net (bottom)



Hauling a "bacchi ami (net)" on a 12 ton Yamaha fishing boat.

(Above) A net hauler. The drum is divided into two sections, one for winding in the lead rope (left) and the other for the net. (Right) When hauling, the net is wound in as far as the wing net.

was believed to be primarily the result of changes in the sea environment due to a deviation in the course of the Kuroshio Current, it caused a sense of crisis among the fishermen who suddenly found their catches greatly diminished. Their response was to take measures to prohibit the catching of adult sand lance before the spawning period. After that the resources recovered to the point that in 1992 the largest catch ever recorded, some 14,000 tons were landed. However, a failure to regulate production caused all their efforts to be wasted in a "large catch, low price" market syndrome. From this experience the fishermen became aware of the importance of a resource conservation type approach to fishery in which (1) the reproductive capacity of the sand lance resources is preserved in order to achieve a stable level of fishery resources and (2) unproductive fishing operations are avoided in favor of a more economical and efficient catching schedule.

According to surveys conducted by the Mie Prefectural Fisheries Technology Center, the reproductive patterns for sand lance, in other words the relationship between the number of parent fish one year and the early-stage resources that appear the following year, is believed to conform to the Ricker model. **(Fig. 8)** If too many parent fish are caught before spawning, the size of the next generation resources will diminish. Conversely, if too many parent fish are left in the population, large numbers of the fry that appear in the next generation will be eaten by the adult fish or die due to a lack of available food, with the end result that there is no significant increase in the resource population. Thus, taking into consideration such factors as changes in the sea environment, the Center has reached the conclusion that a parent population of between 1 and 1.5 billion must be maintained in order to ensure stable sand lance fishery resources every year.

Sand lance have the unique habit of estivation, and it is believed that the mortality rate is very low during this estivation period. Also, since this is a species that reaches maturity and spawns a new generation all in the space of one year, and since this resource is confined to the waters of Ise Bay and its entire life cycle is completed within the Bay waters, it is possible to conduct sustainable resource management type fishery with regard to sand lance as long as (1) over 1 billion fish are left uncaught and preserved as parent fish for the next year's spawning and (2) fishing is prohibited in the period just prior to spawning and only adult fish that have completed spawning are caught by fisheries.

The actual items involved in resource management for sand lance consist of the following four:

(1) Preservation of parent fish for spawning: The winter fishing season for parent fish is opened only after the Center has verified that the spawning period is completed.

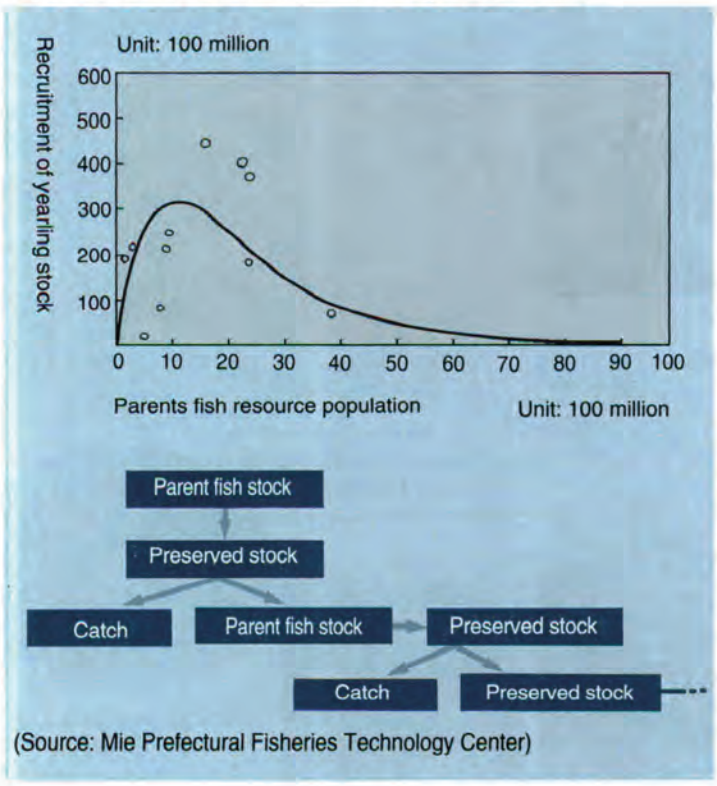
(2) Deciding the date for the opening of the whitebait fishing season: In order to achieve a balance between resource preservation and economic stability in the fishing industry, a fishery management simulation model has been created that takes into account both biological and economic factors. Based on the calculations derived from this model for the optimum season opening date, repesentatives from the Mie and Aichi fishing industries meet to decide the actual opening date.

(3) Deciding the date for closing the fishing season: Based on monitoring data from the Fisheries Technology Center concerning the size of the remaining fry population as the fishing season progresses, representatives from the two prefectures decide together on the closing date.

(4) Conservation of the estivation grounds: In the past, it is believed that estivation grounds existed at various points around Ise Bay, but due to factors like silt accumulation and other types of environmental deterioration, there are now only two remaining estivation grounds at the mouth of the Bay. The destruction of these last remaining grounds would mean the extinction of the Ise Bay sand lance population. Practical means must be found for conserving this estivation environment.

In 1990, the sand lance fishery operators of Mie and Aichi Prefectures got together under the leadership of their respective producers unions to form a fishery management system that now is responsible for the execution of the above four measures. Meanwhile, the Mie Prefectural Fisheries Technology Center continues to provide sea environment forecasts and conduct fishery management-related surveys and research so that it can offer advice to the fishing industry based on scientific data.

Fig. 8. Stock-recruitment relationship in sand lance



(Source: Mie Prefectural Fisheries Technology Center)

On Tohshijima one sees many young men at work in the fishery industry, both on the sea and in port. The catch kept in a hold is landed by means of a fish pump.

Toward a new social structure

Do the "husband and wife boats" presently operating in Tohshi represent a permanent labor situation? Beginning with the motorization of fishing boats and advancing through stages of improving engine performance, mechanization of the fishing process and the addition of sophisticated navigation equipment, today's modernized coastal fishing boats have made it possible for independent fishing operations to be conducted by individual households purely on the basis of family labor. At the same time, however, this change has presented several new problems. One of these is the problem of succession of the fishing business by the next generation.

In the past, in Japanese fishing communities, the eldest son was expected to join his parents on the fishing boat and begin learning the fisherman's profession as soon as he finished junior high school, the end of mandatory education in Japan. However, with the advent of Japan's high economic growth since the 1960s, the trend throughout Japan, including the fishing communities, is for most children to continue their education at least through high school. The growth of industry in all sectors at the same time created many new job opportunities, and after finishing their education, the number of young people leaving the fishing villages where they were born to seek jobs in the urban centers began to increase dramatically. Very few young people remained in most fishing villages and the average age of fishermen in the industry began to climb. This is a phenomenon seen throughout Japan's coastal fisheries, and Tohshijima is no exception. Thus, it can be said that the "husband and wife boats" have also been a measure to compensate for a lack of younger generation successors to the fishing industry.

However compared to other districts, the town of Tohshi still has a large number of young people and the average age of fishermen remains low. There are two subgroups in the local fisheries cooperative, the "Young Men's Group" for men between the ages of 27 and 40 and the "Youth Corps" for youths between the ages of 15 and 26. It is surprising to see that the former has 80 members and the latter 50, accounting for about 50% of the total members.

The fact that so many young men are working energetically in fishery here in Tohshi can be attributed to the following three factors;

- Abundant fishery resources support a prosperous fishing industry in which young people can earn an income equal to city workers.
- Although Tohshi is an island, it is close to large cities and life is not much different from that of the urban centers.
- There is a unique unity among the people of Tohshi, due in part to the survival of the "youth dormitory" system.

Let us take a look here at the "youth dormitory" mentioned in item three. The youth dormitories are places where boys who have reached adolescence are sent to room in common dormitories. The dormitories, called "neya" (sleeping quarters), are actually sections of suitable houses in the town, and the master of the house who lends out part of it as a youth dormitory is called the "neya oya" (house parent), while the youth boarders are called "neya ko" (house children).

After taking their evening meal at their own homes, the youths gather at the neya at night where they dorm with a group of boys of the same age. In the morning they go to work on the fishing boats from the neya. This dormitory life style continues from the age of 15 to the age of 26. By living communally in this way, the youths learn about the fishing profession and also how to live as a member of the local society. The dormitory also becomes the place where youths are oriented into the rites of intersexual relations, as the other young men in the dormitory help and encourage the young man in finding a marital partner. Parents look for a man they respect in the town to become the neya oya of their sons, and this house father serves the role of a tutor in various aspects of the youths' education.

For the youths of Tohshi, the neya experience is a sort of "rite of passage" into maturity. The bonds that are formed during these ten years of communal life are strong, and the youths who have lived together in the same neya become "brothers" who help each other throughout their lives.

This youth dormitory system is one that traditionally was quite common among the farming and fishing communities of Western Japan. For generations it served an important role in building social bonds beyond those of family and blood relations alone. But since the Meiji Period it has gradually disappeared. In this sense, the youth dormitories of Tohshi are an exceptional case.

However, the times are bringing changes to the neya of Tohshi, too, it seems. Today 15 neya are still in operation in Tohshi, but among the youths boarding in them are now some who are not eldest sons or who have no intention of continuing the fishing business of their parents. Those who have chosen to go on to senior high school stay in the neya only on the weekends. Meanwhile, we also see an increasing number of young women who are reluctant to become the wife of a fisherman and thus choose to seek employment outside the island. As a result, there are a number of fishermen who are unable to find wives and remain bachelors in their thirties.

Two of the prominent programs that the local cooperative's "Young Men's Group" have worked on in the last few years are its "Wife-finding Program" and the "Conservation Management Fishery Program." With regard to the former, they have worked in cooperation with the youth clubs of local agricultural cooperatives to hold parties at a resort on nearby Shima Peninsula where young men and women can meet. With regard to the latter, they have established a program for the intermediate raising and release of flatfish fry to build that resource.

These two programs are very representative of the problems fishing communities in Japan today are dealing with. A leader of the Tohshi Young Men's Group, Mr. Yoshiyuki Hamaguchi comments: "In Tohshijima we live by fishery. One of our most important goals is to build a fishing society that is attractive to young people." The fishermen of Tohshi are in the midst of seeking a new balance with the fishery resources of their waters, but at the same time they are having to build a new social structure that will provide the labor to carry the fishing industry into the next generation.

Big successes, big problems
- Present conditions and issues in Seto Inland Sea trawl fishery

The Seto Inland Sea

The Seto Inland Sea is formed between the three Japanese islands of Honshu, Shikoku and Kyushu and covers an area of some 19,000 square kilometers. It connects to the outer ocean by way of three straits at the eastern and western ends of the Sea, through which it receives inflows of ocean water. In addition to the roughly 600 islands of various sizes scattered throughout it, the Seto Inland Sea has a complex shape with alternating narrow waterways and wide open sea areas and a coastline indented by bays of varying sizes. Numerous rivers flowing into the Sea give its waters an abundant supply of nutrients, while influxes of ocean waters serve to slowly exchange the inland sea water. The combination of these factors provide the conditions for the formation of excellent fishing grounds. The many shallow water areas, tidelands and zostera zones all over the Sea serve as the spawning and nurturing grounds for a multitude of fish and shellfish species.

Among the abundant variety of species that become the target of fisheries here in the Seto Inland Sea are fishes, shellfishes, other marine animals and seaweeds that are indigenous to its waters, as well as migrating fishes that enter the Sea from the outer ocean waters in certain seasons. The main fishery targets include some 30 species of fish, 10 species of prawns and crabs, six species of squids and octopuses and 10 species of shellfish.

* * *

Fishery has been well developed in the Seto Inland Sea since olden times, and today boat fisheries using a full range of methods from trawl, boat seine, purse seine and gill net to angling and longline are conducted actively along with prosperous aquaculture industries raising oyster, yellowtail, Japanese flounder, red sea bream, laver and "wakame" seaweed. In accordance with 1992 statistics, fisheries in the Seto Inland Sea account for some 17% of the total national production for coastal boat fisheries and 28% of the total aquaculture production. Of the types of boat fisheries conducted here, seine fishery accounts for the largest share of the overall production with 105,000 tons (32% of the Seto Inland Sea total), followed by small-scale trawl fishery with 90,000 tons (28%) and small-scale purse seine with 39,000 tons (12%), with these three making up 72% of the total. Looking at the various fishing methods from the standpoint of number of operators, however, we find that angling has the largest number with 10,800 operators (24%), followed by small-scale trawl with 9,500 (22%) and gill net with 10,600 operators (24%), with these three making up 70% of the total. When we look at these two sets of figures concerning production and number of operators, it seems clear that small-scale trawl fishery forms the core of the fishing industry here in the Seto Inland Sea.

* * *

The fact that the Seto Inland Sea is one with a particularly large number of islands has been a boon to fisheries here. Not only have the shore waters around the islands served as nurturing grounds for marine resources that in turn create rich fishing grounds, the islands have also served as stepping stones for the spread of fishery culture, as fishermen have moved from one island to the next and increased their spheres of activity. Although there are some islands in the Seto Inland Sea with large areas of farmland and rice fields, there are many other small islands with very little tillable land that nonetheless proved suitable sites for fishermen to establish new villages and thus expand their fishing grounds. While specializing in fishery, these villages were able to obtain the other necessities of life through trade or barter with farming communities nearby.

The most mobile among the various types of fishermen were those engaged in angling and longline fishery. When they found a good new fishing ground they would settle on an island nearby. When the population of this new community grew too large to be supported by the fishing ground, a part of the population would leave the island in search of new fishing grounds. Wherever a prosperous fishing village of hand-and-line or longline fishermen became established, a small group of small-scale net fishermen would also take up residence, making a living off this community by catching shrimps, etc., to supply to the fishermen as bait. This is the basic model by which fishery developed here in the Seto Inland Sea from the ancient into the medieval ages. With the advent of the late feudalistic society, groups of fishermen with fishing rights granted by local feudalistic loads ruling the agrarian society became established. It was from these groups that large-scale net fisheries using set net, square net, etc., evolved.

* * *

The original form of small-scale trawl net is the small, hand-drawn net used for catching shrimps, etc. **(Fig. 9)** This method had already come into use sometime in the 14th to 15th century. The hand drawn net is operated by two fishermen in a small boat. The net is cast into the water while rowing in an offshore direction. After the net is completely cast, the boat is rowed back to the bouy attached to the starting end of the net. The boat is then anchored and the two fishermen, each with one lead rope, begin pulling in the net to land the catch. While the main catches is usually shrimp, this method also catches demersal fishes and other demersal marine animals.

The rowing trawl is a later development than the hand drawn net. Modifications such as bamboo poles to hold open the mouth of the net or sinkers to keep the net on the sea floor were added to the net gear. This enabled the net to be pulled along the bottom by rowing the fishing boat; in other words, to "trawl" by rowing the net.

Using the same net gear, another trawling method was conceived in which an underwater "sea anchor" was used to pull the boat

Table 1 Present status of Seto Inland Sea fishery (1992 statistics)

Fishing method	Fishery production (tons)	Number of fishing operators (boats)
Small-scale trawl	90,400	9,530
Gill net	20,000	10,556
Angling (hand-and-line)	16,100	10,777
Boat seine	105,300	1,641
Small-scale purse seine	38,900	71
Others	54,100	11,217
Total	324,800	43,792

Fig. 9. Trawl net fisheries before motorization

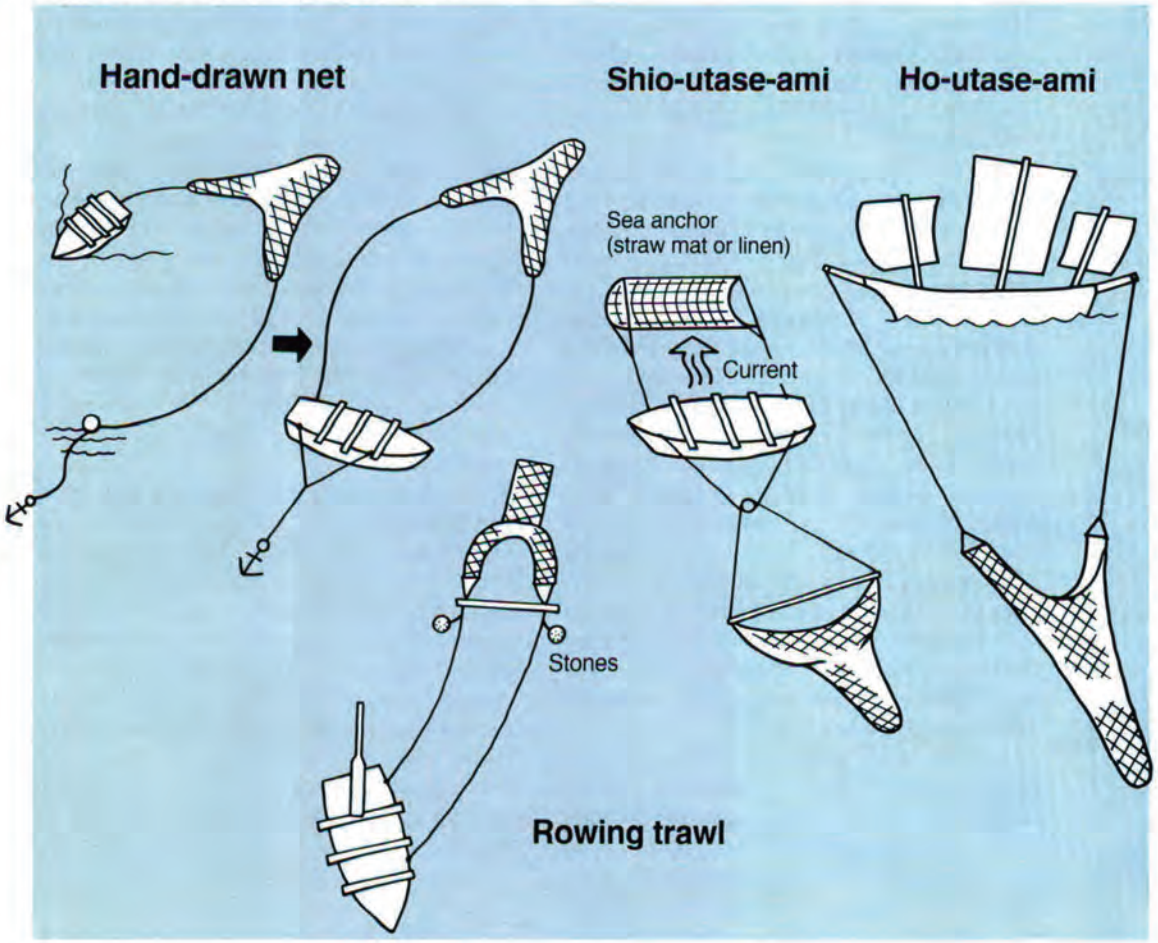
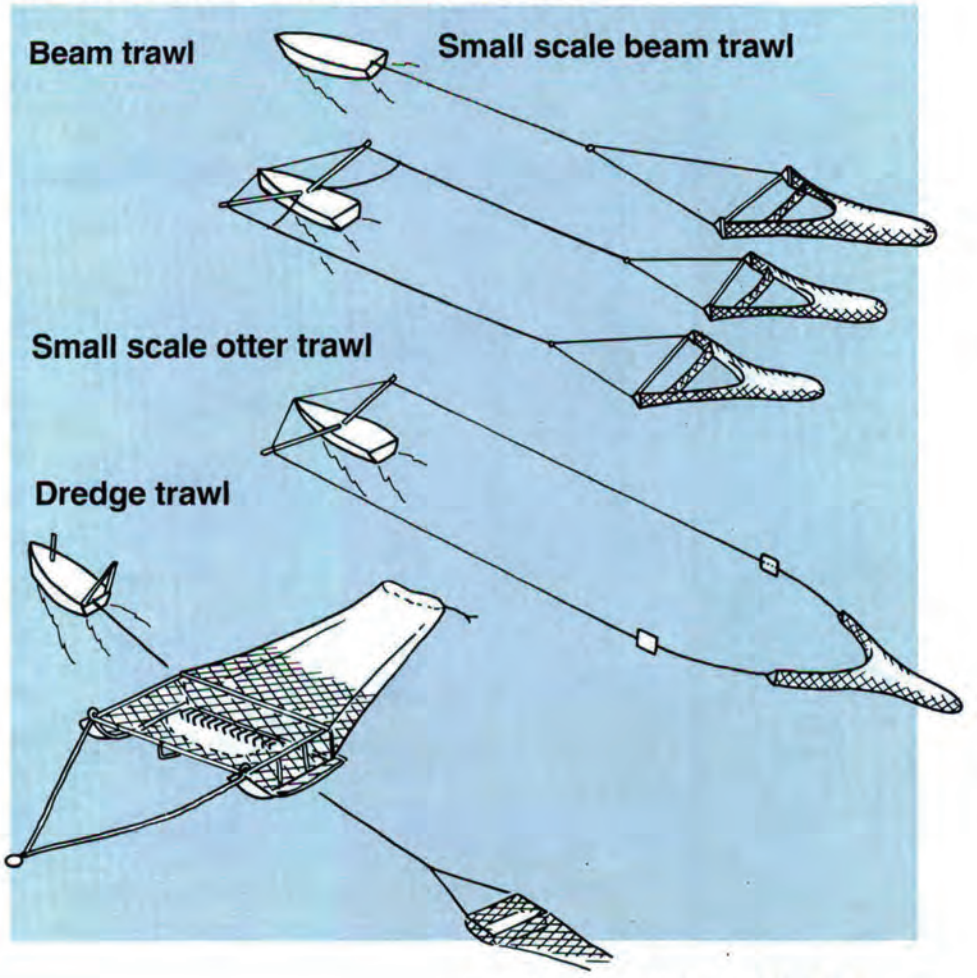


Fig. 10. Small-scale trawl types using motorized boats



SMALL-SCALE TRAWL FISHERY IN JAPAN

Shrimp beam trawl fishery. The catch is sorted by species and put in the boat's fish holds.

▲*The otter trawl operation*

◀*Dredge net fishery*

sideways with the current while trawling with a net. In Japan this method was called "shio-utase-ami," or a tide-driven trawl. By using the power of the ocean currents in this way, it became possible to trawl over long distances.

The method that uses wind power to pull a net was called "ho-utase-ami," or sail-driven trawl in Japan. This method is said to have been invented by the fishermen of Kishiwada on the shores of Osaka Bay in the early 18th century. The ho-utase-ami method eventually developed on various scales, including small-scale boats and nets that operated in the seaweed beds of shallow waters, middle-size utase that operated farther offshore from 50-foot class boats and large-scale utase operated from boats of 60 feet or more. There were also variations in the number of nets pulled by one boat, with three-net and five-net rigs being common as well as single-net rigs.

It was in the middle of the 18th century that the fishermen of Amagasaki in Osaka Bay invented a new net gear that had iron claws attached to the front of the net that raked the sea floor in order to catch shellfish living in the bottom sand and silt. This method was called "keta-ami," or dredge net. This gear began a new type of fishery called "ho-keta-ami" or sail-driven dredge in which the keta-ami rig was pulled by a sail-driven boat.

Fishery by the ho-utase-ami method reached its peak in the 18th and 19th centuries, while small-scale hand-drawn net, rowing trawl and shio-utase-ami methods continued to be used steadily as basic fishing operations.

* * *

The mechanization (motorization) of trawl fishery in Japan occurred in two stages: (1) motors used for getting to and from the fishing ground with sail power used for the actual transverse trawling, and (2) motors used for getting to and from the fishing grounds and also for lengthwise trawling. The first fishermen to motorize their boats were doing so around the year 1910, but it was not until the 1920s that motorization began in earnest in coastal fishery.

With the completion of motorization of coastal fishing boats, the traditional hand-drawn net, rowing trawl, shio-utase-ami and ho-utase-ami methods gave way to the beam trawl method in use today. At the same time, the hoketa-ami was replaced by the dredge net method operated from motorized boats. Another method we will call otter trawl was developed by coastal fishermen from Osaka Bay as a variation on methods used in distant-sea trawl fishery. In this method, boards attached to the respective towing ropes serve to keep the mouth of the net open as it is pulled through the water. It is used primarily for catching fishes and is adopted by fishermen changing over from the hand-drawn net method. Its use is permitted only in parts of Osaka Bay and the sea of Harima. **(Fig. 10., Fig. 11)**

* * *

Since the days of the sail-driven (ho-utase-ami) method, small-scale trawl fishery in the Seto Inland Sea has been a "trouble spot" for fishery authorities. Being a highly effective fishing method, there is a constant danger of overfishing the resources and, since the fishing gear is dragged along the sea bottom, there is also the fear of the fishing ground environment being damaged. Despite constant efforts by the authorities to limit ho-utase-ami operations, the number of unlicensed operators continued to increase.

Amidst the need to increase food production in the desperate years following World War II, there was a period when the authorities had to tacitly condone the increase in small-scale trawl fishing operations. But, with the passing of the new Fisheries Law in 1949, order was returned to the fishing industry under the authority of the national Fisheries Agency, and a system was established by which only boats under five tons and powered by a motor of less than 10 hp could be licensed to engage in small-scale trawl fishery. Furthermore, measures were taken to reduce the number of boats engaged in this type of fishery between 1950 and 1955.

However, by this time Japan had entered a period of rapid industrial growth, and the technological advances that filtered down to the fishing villages proved to be sufficient to compensate for the loss of manpower that was drawn away by other industries. So it became necessary to begin increasing the size of the fishing boats once again, and also to mechanize the fishing work. Under the government program for the modernization of coastal fisheries, the limits on horsepower for boats involved in small-scale trawl fishery were gradually lifted. In this way, the small-scale trawl fishing industry, made up of fishermen who once engaged in very small-scale fishery, have increased their operating capacity enough with the use of 3 to 5-ton motorized fishing boats to establish a sound position for themselves as the predominant type of fishery in the Seto Inland Sea.

* * *

In September of 1983, representatives from 16 fishery cooperatives from Kagawa Prefecture, one of the prefectures facing the Seto Indand Sea, got together for a conference which gave birth to the "Kagawa Fisheries Think Tank."

Dedicating themselves to the problems of conservation and propagation of fishery resources and the establishment of resource conservation type fishery, this organization made small-scale trawl fishery the focus of their first actual programs. In Kagawa Prefecture this is the largest single type of fishery, with 1,500 boats in operation and a production that accounts for 20% of the prefecture's catch in terms of tonnage and 40% in terms of sale value.

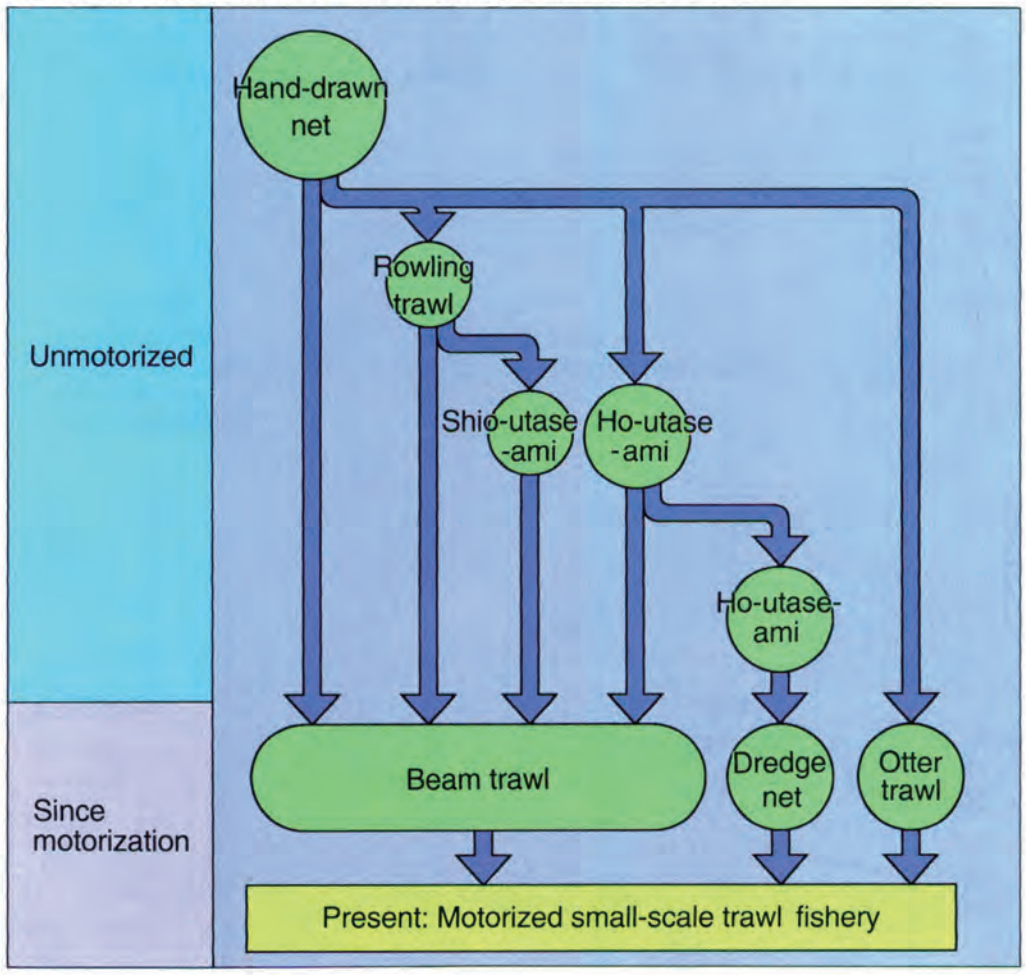
In addition to undertaking reviews of small-scale trawl fishery regulations concerning fishing season, number of operating days and hours, fishing grounds and fishing gear, this organization has also initiated such resource conservation movements as prohibiting the catching of undersized fishes and shellfish and releasing from the catch any egg-bearing gazami crab. With regard to 19 species of fish and shellfish, the organization has printed posters with life-size photos showing the minimum size fish/sellfish of each species that should be kept. They have used these posters in their efforts to encourage fishery cooperative members to return to the sea any catch below the designated sizes. Also, for the purpose of both improving working conditions for fishermen and reducing fishing pressure on the fishing grounds, they are promoting the adoption of a work week with regular holidays on which fishing is not conducted. In response to this, some of the more progressive cooperatives have already adopted a 5-day work week.

Behind the kinds of self-imposed measures we see originating from groups like this "Think Tank" is a clear sense of crisis with regard to conditions that the coastal fishing industry finds itself confronted with in recent years.

- Industrial development around the Seto Inland Sea has caused a deterioration of the sea environment that is undermining the reproductive capacity of the fishery resources.
- Attempts to make up for decreasing production due to reduced resources by increasing the performance of their fishing boats has resulted in an increase in the percentage of small fish/shellfish in the catch, thus decreasing the added value of the production.
- Increasing volumes of imports of marine products has caused a drop in market prices.

One of the leaders of the Think Tank says he believes that the only way for coastal fishery to survive is to abandon the old philosophy of competing for a larger catch and change over to fishing activities based around the conservation and replenishment of resources. He also stresses that putting this new type of fishery into effect will require a change in the consciousness of each and every fisherman and develop cooperative programs for the sake of the industry.

Fig. 11. Lineage of small-scale trawl fishery in the Seto Inland Sea



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