I. Characteristics, Structure And Resources Of The Sector
   a. Summary
   b. History And General Overview
   c. Human Resources
   d. Farming Systems Distribution And Characteristics
   e. Cultured Species
   f. Practices/Systems Of Culture

II. Sector Performance
   a. Production
   b. Market And Trade
   c. Contribution To The Economy

III. Promotion And Management Of The Sector
   a. The Institutional Framework
   b. The Governing Regulations
   c. Applied Research, Education And Training

IV. Trends, Issues And Development

V. References
   a. Bibliography
   b. Related Links

Characteristics, structure and resources of the sector

Summary

Commercial aquaculture production in Japan has developed dramatically since the end of the 2nd World War and today occupies an important place in the fisheries sector. Total aquaculture production in 2003 was estimated at 1,301,437 tonnes, worth US$ 4,199 million (FAO 2005), which corresponds to 22 percent of total national fisheries production and 31 percent of the total value produced in Japan. Marine aquaculture accounts for 96 percent of total aquaculture production and 90 percent of the total value produced.

More than 60 species are included in the aquaculture section of the annual fisheries statistics. Of these, the main species are Nori (27 percent of total aquaculture production, and 18 percent of the value produced), yesso scallop (20 and 7 percent), oyster (17 and 8 percent), Japanese amberjack (12 and 25 percent), red seabream (6 and 11 percent), and sea mustard (5 and 2 percent).

Aquaculture has contributed to bringing previously high-priced species within reach of the average consumer and has helped to create a more varied dietary culture. It has also contributed to the economy of remote areas by providing local employment. However, in recent years, overcrowded fish farms and excessive feeding have led to environmental deterioration of coastal areas, thought to be a major cause of eutrophication, red tides and fish diseases. To better manage these issues, additional technological development and institutional efforts are underway.

History and general overview

It is thought that around 100 B.C., irrigation ponds and ditches were used for raising freshwater fish in Japan. An ancient document recounts that fish were stocked and raised for palatine cuisine in palace ponds at the end of the 8th century. The first shellfish aquaculture recorded was seabed-sown cultivation of oysters in the Seto Inland Sea in the middle of the 16th century. Commercial ongrowing of red sea bream began at the start of the 17th century. Nori (laver) cultivation with a supporting system was started by fishermen living in Edo (Tokyo)
at the end of the 17th century. In the middle of the 19th century, semi-intensive carp culture in rice paddy fields started, as well as eel farming in ponds.

The first intensive aquaculture of marine fish, Japanese amberjack, mackerel and seabream, was carried out in enclosures in 1930. Cage culture was then developed in the 1950s, leading to major gains in productivity. Until the mid-1960s, Japanese amberjack was the most commonly cultured marine fish, but red sea bream increased its share, and today several dozen species are currently cultured all over Japan. Commercial aquaculture of oysters was first developed using a support system, which was superseded by hanging culture under rafts. From the 1950s, hanging culture with longlines, characterized by its resistance to high waves, predominated, mainly in the northern region of Japan. This technique was also utilized for the cultivation of larger seaweeds such as Japanese kelp (kombu). Pearl culture first succeeded in 1893. After 1910, the production of full-orbed pearls was made possible due to technical developments which have since been adopted by pearl farms worldwide (Ohshima 1994).

According to the Ministry of Agriculture, Forestry and Fisheries (MAFF), total aquaculture production in 2003 was estimated at 1 301 437 tonnes, worth US$ 4 199 million, corresponding to 22 percent of total national fish production and 31 percent of the total value of fish produced. More than 60 species are included in the aquaculture section of annual fisheries statistics. 96 percent of total aquaculture production, as well as 90 percent of the total value produced by aquaculture, is marine aquaculture (Statistics Department, MAFF 2005a).

### Human resources

In 2003, there were 23 068 enterprises engaged in marine aquaculture, employing 69 645 workers in the high season, of whom 35 560 were women. Some 4 495 enterprises were engaged in freshwater aquaculture, employing 11 558 individuals, 3 569 of whom were women. Therefore, in aggregate, the aquaculture sector in Japan supported 81 203 jobs in 2003. However, the number of enterprises and workers has been continuously declining in recent years (Statistics Department, MAFF 2005c).

### Farming systems distribution and characteristics

Marine and freshwater aquaculture is conducted in all 47 Japanese prefectures.
Cultured species

Marine fish (Kumai, 2005)

Japanese amberjack (*Seriola quinqueradiata*), and greater amberjack (*Seriola dumerili*)

Japanese amberjack and greater amberjack are the most economically important species in Japan; they account for 25 percent of the total production value of aquaculture. The Noami family in Kagawa Prefecture started enclosure aquaculture in 1930. Since the 1950s, cage culture has been widely adopted in the western region of Japan. Production rapidly increased from 1 431 tonnes in 1960, reaching 43 354 tonnes in 1970 and 149 311 tonnes in 1980. Today, production is around 150 000 tonnes, aquaculture production doubled that of marine capture production. Although artificial seed production was technically accomplished in the 1960s, wild seeds are still mainly used for production.

Red seabream (*Pagrus major*)

Since ancient times, red sea bream has been prized as the 'king of fish' in Japan, because of its elegant appearance and colour as well as its superior taste. It has become essential for celebrity meals for New Year parties or wedding ceremonies as an "auspicious fish." The production value accounts for 10 percent of the total value of aquaculture. The seed production technique was developed in the 1960s and the main production method is cage culture. It is commonly cultivated around Kyushu Island and in the Seto Inland Sea.

Other marine fish

An artificial hatching technique was developed in 1965 for the Bastard halibut (*Paralichthys olivaceus*), followed by commercialization in 1977. Production has dramatically risen since 1985, increasing from 648 tonnes in 1983 to 3 097 tonnes in 1988 and then 6 039 tonnes in 1990. In recent years, inland aquaculture has also been developing. In addition to the above species, Japanese horse mackerel (*Trachurus japonicus*), striped jack (*Pseudocaranx dentex*) and tiger puffers (*Fugu rubripes*) can be listed as the other main marine fish species cultivated. In 2002, the complete aquaculture of northern bluefin tuna (*Thunnus thynnus*) was accomplished by Kinki University.

Freshwater fish (Takashima and Murai, 2005)

Eels (*Anguilla* spp.)

Eel is the main species in freshwater aquaculture, and accounts for 40 percent of total production both in amount and value. Almost 100 percent of domestic eels are produced by aquaculture. Production of *Anguilla japonica* was first commercialized in 1879 and then developed mainly in the central regions of the Pacific Coast. It is now also actively conducted in the western region of Japan. In recent years, it is thought that *Anguilla anguilla* and *A. rostrata* fry from Europe and the United States, respectively, have escaped into the wild in Japan. As for fish seed, wild eel fry is commonly captured for use, but since 2003, the National Research Institute of Aquaculture (NRIA) succeeded with seed production.

Ayu (*Plecoglossus altivelis*)

Commercialization has progressed since the 1960s. Currently Ayu is released into rivers for use by the commercial and recreational fisheries. Ayu production accounts for approximately 20 percent of the total amount earned in freshwater aquaculture.

Other freshwater fish

For rainbow trout (*Oncorhynchus mykiss*), 10 000 eggs were brought in from California in 1977. Currently, the culture of rainbow trout is commercialized across the country and they have been released into many rivers. The culture of common carp (*Cyprinus carpio*) commenced in the Edo era. In addition, ornamental carp (or koi carp), which are species with various colour mutations, are produced for display. Carp production in Japan has been severely damaged by the Koi Herpes Virus (KHV) since 2003.

Shellfish (Mori, 2005)
Yesso scallop (*Patinopecten yessoensis*)
The Yesso scallop (*Patinopecten yessoensis*) is one of the main species in coastal aquaculture in the Northern region of Japan. It has been exported to China for more than 200 years. Although in the past it was mainly bred using seabed-sown cultivation, success in hanging aquaculture in 1958 and subsequent technological progress have greatly increased its production.

Oyster (*Crassostrea gigas, C. nippona*)
Seabed sowing cultivation of oysters has been performed in the tidelands of the Seto Inland Sea since the middle of the 16th century. However, the practical use of hanging culture with rafts was promoted in the 1920s, resulting in the expansion of production areas to other areas than tidelands. The production of oysters dramatically increased after aquaculture became possible in offshore fisheries by the adoption of hanging culture with longlines in the first half of the 1950s. Currently, *Crassostrea gigas* and *C. nippona* are the main species in shellfish aquaculture.

Other shellfish
Among other shellfish cultured in Japan there are Abalone (*Haliotis discus*), Japanese carpet shell (*Ruditapes philippinarum*), Japanese scallop (*Pecten albicans*) and tunicate (*Tunicata*).

Other species (Seaweed, prawn, pearls)
Nori or laver (*Porphyra* spp. - *Porphyra pseudolinearis* and *P. yezoensis*)
Cultivation of Nori (*Porphyra* spp.) was started by fishermen in Tokyo Bay at the end of the 17th century using a support system. The success of artificial seed production in 1952 led to the expansion of production areas across the country. It is one of the main species in Japan's aquaculture industry, accounting for 28 percent of the volume of production and 20 percent of the value produced by aquaculture in Japan.

Sea mustard or wakame (*Undaria pinnatifida*)
For sea mustard, or wakame (*Undaria pinnatifida*), technological development was stimulated by research institutes and fishery industries in the 1950s, leading to the commercial cultivation of sea mustard from around 1965. It currently accounts for 5 percent of total aquaculture production, 2 percent of the total value produced in Japan.

Other seaweeds
Japanese kelp, or kombu (*Laminaria japonica*, *L. angustata*, *L. longissima*, *L. ochotensis*) and *Cladosiphon okamuranus*, are also cultured.

Kuruma prawn (*Marsupenaeus japonicus*)
For kuruma prawn, hatching and raising in ponds started in 1889. Artificial seeds were introduced in 1963, which led to increased production. These aquaculture techniques have been transferred to China, Southeast Asia, India and Latin America.

Pears
Kōkichi Mikimoto was the first to succeed in pearl culture in 1893, followed by the technical developments needed for producing full-orbed pearls. After 1910, the production of full-orbed pearls was enabled by technical progress which have since been adopted by pearl farmers worldwide. These days, pearls are raised by hanging aquaculture. The production value accounts for approximately 5 percent of the total value of aquaculture and they are exported overseas.

| Practices/systems of culture |

Marine aquaculture can be divided into intensive aquaculture, mainly for fish, and extensive aquaculture for shellfish and seaweed. Until around 1960, natural seawater ponds and inlets surrounded by embankments or nets were widely utilized for extensive aquaculture. However, in recent years, this practice has only been applied to kuruma prawns and a few other fish and shellfish species.
Cage culture is commonly used for finfish aquaculture. Cage culture can be divided into two different methods: (1) the floating method; and (2) the rope method. With the floating method, net cages are suspended under floats made of wood, bamboo, steel pipes or plastic tubes. The standard sizes of cages in the floating method are 5 x 5 m or 10 x 10 m. This method offers easy maintenance, but is vulnerable to waves. With the rope method, net cages are attached by ropes to buoyant devices and moored to anchors or concrete blocks. These can be used for large-scale cage culture of larger fishes, such as tuna and Japanese amberjack.

Floats and ropes are also commonly used as buoyant structures to suspend cultured shellfish and Japanese kelp. Floats are used for oysters, scallops, pearl oysters, abalone, etc.

The horizontal method is used for nori culture. It is necessary to use the sea surface waters to culture this species. Nets are thus spread horizontally between support stakes driven into the substrate or attached to longlines, then moored to anchors. Seaweeds adhere to and propagate on these horizontal nets.

As for the freshwater aquaculture, the running water method is used for cold-water species, such as ayu and rainbow trout. Eel and carp are cultured using either the still water or running water methods. Non-feeding, extensive freshwater aquaculture for carps was very common until 1950s, but it is rarely seen today. More details of aquaculture practices in Japan can be found in Mottet (1981), Honma (1993), FAO (1999) and Sugiyama (2006).

### Sector performance

#### Production

Total aquaculture production in 2003 was estimated at 1,327,361 tonnes, worth US$ 4,428,962,000, corresponding to 22 percent of total national fish production and 31 percent of the total value of fish produced in Japan.

Marine aquaculture accounts for 96 percent of total aquaculture production, and 90 percent of the total value produced by aquaculture. The main cultured species are nori (27 percent of total aquaculture production, and 18 percent of the value produced), yesso scallop (20 and 7 percent), oyster (17 and 8 percent), Japanese amberjack (12 and 25 percent), red seabream (6 and 11 percent), and sea mustard (5 and 2 percent), eels (2 and 4 percent), ayu (1 and 2 percent), rainbow trout (1 and 1 percent), and pearls (0.002 and 5 percent). (Statistics Department, MAFF 2005a).

The graph below shows total aquaculture production in Japan according to FAO statistics:

#### Market and trade

To facilitate the distribution of products and exchange of information, more than 50 central wholesale markets have been established all over Japan. Tokyo Metropolitan (Tsukiji) Central Wholesale Market, established in 1923, is the most famous among them.

Aquaculture products are shipped through local fisheries cooperative associations, or individually procured by purchase brokers, then brought to wholesale markets and sold by auction. Wholesale dealers must hold permits from the Ministry of Agriculture, Forestry and Fisheries and pay a commission fee. In the case of the Tokyo Metropolitan Central Wholesale Market, the commission fee for seafood is 5.5 percent of the price. Intermediate wholesalers or authorized dealers then purchase products from the wholesale dealers in relatively small amounts and deliver them to retail stores, restaurants, etc. (JIFRS, 2004)

As for exported aquaculture species in Japan, the main product is pearls. The export value of pearls in 2005 was US$ 243 million (Japan Tariff Association, 2006). Major export markets are the United States, Germany,
Switzerland, Hong Kong, Italy, and Korea. Ornamental fish were also exported for US$ 9.3 million to the UK, Hong Kong, Germany, the United States and the Netherlands. Small quantities of fillets of yellowtail, live red seabream, and yesso scallops were also exported.

<table>
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<th>Contribution to the economy</th>
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<td>After the 2nd World War, aquaculture was very important as a source of animal protein, especially in remote places in the mountains. Today, however, aquaculture contributes to bringing previously high-priced species (such as amberjacks, red seabream, or eels) within the range of the average consumer, helping to create a varied dietary culture. Aquaculture has also contributed to the local economy and job creation in remote districts.</td>
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<th>Promotion and management of the sector</th>
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<td><strong>The institutional framework</strong></td>
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<td>Fisheries activities in Japan are administered by the Fisheries Agency of the Ministry of Agriculture, Forestry and Fisheries. The Fisheries Agency (FA) is responsible for preserving and managing marine biological resources and fishery production activities, but in practice many tasks have been delegated to prefectural governments and local Fisheries Cooperative Associations (FCAs). Aquaculture activities are supervised mainly by the Fisheries Agency’s Fish Ranching and Aquaculture division of the Resource Enhancement Promotion Department.</td>
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<th>The governing regulations</th>
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<td>The principal law that regulates fishery activities is the <strong>Fisheries Law (1949, as revised in 1962)</strong>, which deals in detail with several kinds of fishing rights and licenses for Japanese individuals and groups of persons. The Law is administered by the Ministry of Agriculture, Forestry and Fisheries. Within the MAFF, the Fisheries Agency (FA) is responsible for preserving and managing marine biological resources and fishery production activities. The FA maintains several research institutes, such as the National Research Institute of Aquaculture (NRIA).</td>
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In Japan, the marine waters are divided into a number of sea areas as administrative units for fisheries adjustment. With a few exceptions, essentially each sea area corresponds to the maritime zone of a coastal prefecture. The Fisheries Law establishes Sea Area Fisheries Adjustment Commissions and a Central Fisheries Adjustment Council to address matters of policy, implementation and enforcement under the Law in each sea area and to ensure the coordination of prefectural fisheries development within the overall national framework. The Sea Area Fishery Adjustment Commissions come under the joint jurisdiction of the MAFF and the prefecture governments.

The **Fisheries Cooperative Association Law (1948, as amended)** provides the legal framework for local Fisheries Cooperative Associations (FCAs) who bear the responsibility for a particular geographical area and whose membership are fishers from communities within this area. Within the framework laid out by the prefectures, and as local conditions dictate, each FCA establishes its own regulations for the control and operation of fishery operations and the conservation and rational exploitation of fishery resources. In terms of day-to-day operations, the Japanese fisheries sector, although subject to higher level regulation, is essentially self-managed by the FCAs or federations of FCAs.

The **Law to Ensure Sustainable Aquaculture Production (1999)** seeks to prevent the self-induced environmental deterioration around fish farms. Pursuant to this law, the MAFF issued Basic Guidelines to Ensure Sustainable Aquaculture Production (1999) and the FCAs developed and implemented "Aquaculture Ground Improvement Programmes", which can be developed individually by a single FCA or jointly by more than one FCA, and which must be approved by the prefectural authorities.
Applied research, education and training

Fisheries research in Japan has developed in three ways. Firstly, several fisheries research institutes were established by the national government since 1929. The National Research Institute of Aquaculture (NRIA) was established in 1979 to conduct basic research on aquaculture and provide information for industries. In 2001, the research institutes were reorganized into a Fisheries Research Agency, composed of 9 research institutes and 2 departments. Secondly, prefectural fisheries experiment stations were established by prefectural governments. These experimental stations are conducting locally-specific and applied research. Thirdly, research programmes were established in Universities. The first national fisheries University was established in 1889, known today as the Tokyo University of Marine Science and Technology. The National Fisheries University, found in 1941, is also conducting education and research on fisheries theory and technology. Today, more than 18 faculties or departments in Universities are conducting fisheries research and education in Japan. As of 2004, there were also 47 fisheries-related high schools with 12 620 students.

Trends, issues and development

In recent years, overcrowded farming and excessive feeding have led to the environmental deterioration of aquaculture sites and appear to have become a major cause of eutrophication, red tides and fish disease. To reduce the pollution caused by aquaculture operations, improvement in feed practices from use of live feed to dried pellets, and the development of automatic feeding machines which can limit feed residues in water by using optical sensors have been under way. In response to growing environmental awareness, the Law to Ensure Sustainable Aquaculture Production was enacted in 1999. In addition to these efforts to reduce organic loads, it is essential to establish an integrated utilization/conservation system of coastal zones in a balanced manner from the viewpoint of the material circulation function of natural ecosystems.

Also, in recent years, a new viral disease, possibly carried by imported seeds, have struck, with significant damages. For example, in 2003, the Koi Herpes Virus (KHV) disease occurred, and at the end of 2004, the occurrence of KHV disease was confirmed in 39 of the 47 prefectures in Japan. But there are no specific cure for it at the moment. In order to deal with these new diseases, genetic researches have been progressing in the development of specific strains which can tolerate aquaculture conditions, but there are wide concerns about the safety of products as food and genetic impact on native fishes.

Another issue is a decline in fish prices, mainly due to overproduction, increased fish imports and decreased per capita fish consumption in Japan. As measures against this trend, various efforts have been made. For example, in order to cope with the overproduction and over competition, many firms are trying to create branded products identified by producing area and methods. Production traceability systems via internet are under development to differentiate products and add the credibility for food safety. Fishermen's organizations and government are also promoting the traditional Japanese food culture and seafood consumption, as well as the creation of new seafood products or cooking recipe suitable for the modern cuisine.

References

Bibliography

FAO publications related to aquaculture for Japan.


FAO Fisheries and Aquaculture Department


Related links

FAO FishStatJ – Universal software for fishery statistical time series
Fisheries Agency
Fisheries Research Agency
Japan Fisheries Association
Japan Sea Farming Association (Japanese only)
Ministry of Agriculture, Forestry and Fisheries of Japan
National Federation of Fisheries Cooperative Associations (Zengyoren)
National Fisheries University
National Research Institute of Aquaculture
Tokyo Metropolitan Central Wholesale Market