Recent Developments in Aquaculture in Japan

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Abstract

Aquaculture production in Japan in 1993 was 1,351,000 tons, 15.6% of the total fisheries production. About 93.6% came from mariculture and 6.4% from freshwater aquaculture. The per cent contribution of aquaculture to total production has increased in recent years but partly because marine fisheries, especially of sardine and pollack, have decreased. Aquaculture has reached a plateau, and decreased slightly between 1992 and 1993. Diverse marine and freshwater species are cultured in Japan — various fishes, crustaceans, mollusks, seaweeds, sea squirt, sea urchin, and others. Research and development in mariculture focus on finding substitutes for animal protein in feeds, improvement of fish quality, protection of the culture environment, use of offshore floating culture systems, and protection from diseases. Research in freshwater aquaculture has expanded to include recreational fishing, the propagation and preservation of endangered species, and the construction of fish ladders for salmonids and other migratory species.

Introduction

The total production from fisheries and aquaculture in Japan has decreased in recent years. The total marine production was 8.49 million tons in 1993 (Table 1), only 66% of that in 1988 (12.85 million tons). This lower production was due to the significant decrease of the catches of the sardine *Sardinops melanostictus,* haddock *Theragra chalcogramma,* anchovy *Engraulis japonicus,* and squid *Todarodes pacificus* (Fig. 1).

Production from aquaculture has remained about the same or decreased slightly in recent years. The 1993 production from mariculture was 3% less than that in 1992; the freshwater production was 5% less (Table 1). The value of the production from aquaculture has increased to 700.4 billion yen (US$1 = 100 yen), almost 27% of the total value of the production from the fisheries sector (Table 2).

Table 1. Production from marine and freshwater fisheries and aquaculture in Japan. Data from MAFF (1994).

Sector	Production (tons) 1989	1990	1991	1992	1993
Marine					
Capture fisheries	9,899,700	9,570,010	8,515,100	7,771,500	7,224,000
Aquaculture	1,272,029	1,272,891	1,261,913	1,306,330	1,266,000
Total	11,171,729	10,842,901	9,777,013	9,077,830	8,490,000
Freshwater					
Capture fisheries	103,234	112,068	107,365	97,040	91,000
Aquaculture	98,535	96,851	97,367	90,762	86,000
Total	201,769	208,919	204,732	187,802	177,000
Total	11,373,498	11,051,820	9,981,755	9,265,632	8,667,000

Table 2. Value of the production from fisheries and aquaculture in Japan. Data from MAFF (1994).

Sector	Value of the production (billion yen) 1989	1990	1991	1992
Marine				
Capture fisheries	1,953.6	1,950.6	1,908.7	1,827.4
Aquaculture	567.2	609.3	639.6	612.4
Total	2,520.8	2,559.9	2,548.3	2,439.8
Freshwater				
Capture fisheries	64.7	65.0	68.0	68.5
Aquaculture	106.3	97.1	95.7	98.0
Total	171.0	162.1	163.7	166.5
Total	2,691.8	2,722.0	2,712.0	2,606.3

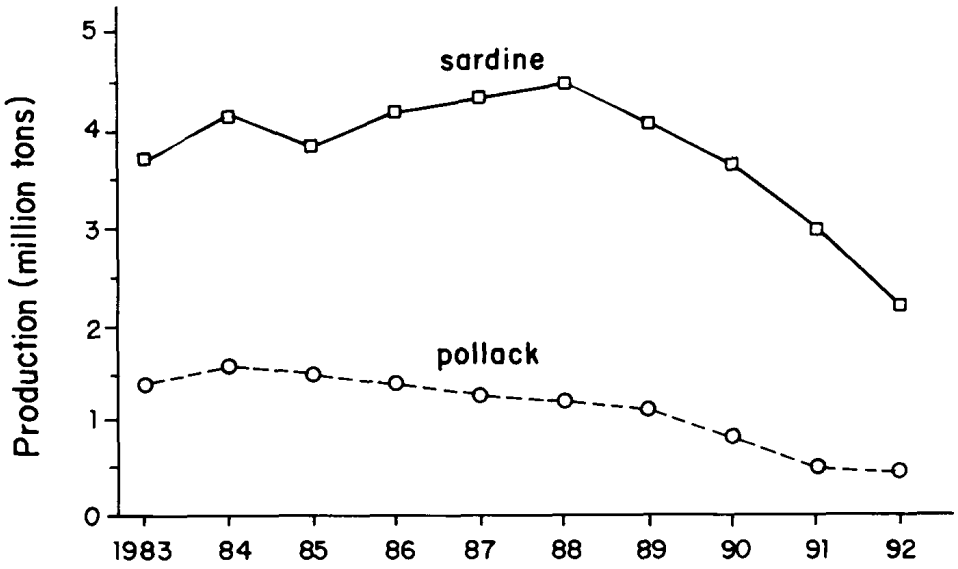

Fig. 1. Production from sardine and pollack fisheries in Japan. Data from MAFF (1994).

Technical developments in aquaculture in Japan have been earlier described by Mito and Fukuhara (1988), Umezawa (1994), and Kato (1994).

The lower production from aquaculture in recent years has been due to lower demand and consumption of fish as a result of bad economic conditions and greater import of fisheries products. Market prices of aquaculture products have also decreased as these have become ordinary daily dishes.

As in many other countries, self-pollution of aquaculture grounds has become a serious problem in Japan (Mito and Fukuhara 1988). Diseases have become very common (Sako 1995).

Mariculture

Mariculture produced various species, mostly fishes, mollusks, and seaweeds (Table 3). In 1992, the oyster *Crassostrea gigas,* scallop *Patinopecten yessoensis,* and other mollusks contributed 454,336 tons; pearls from the oyster *Pinctada fucata* amounted to 69 tons. Contributions also came from the sea squirt *Cynthis roretzi* and the kuruma shrimp *Penaeus japonicus.*

Some 33 species of marine fishes are cultured in Japan, and the main ones are yellowtail *Seriola quiqueradiata,* red sea bream *Pagrus major,* coho salmon *Oncorhynchus kisutch,* flounder *Paralichthys olivaceus,* horse mackerel *Trachurus japonicus,* puffer *Takifugu rubripes,* and striped jack *Pseudocaranx dentex* (Table 4). A total of 263,503 tons were produced in 1993, less than in 1992. The production of yellowtail decreased, but those of red sea bream, flounder, horse mackerel, and puffer increased.

Table 3. Mariculture production in Japan. Data from MAFF (1994).

Group	Production (tons) 1989	1990	1991	1992
Fishes	235,126	255,506	267,794	263,503
Shrimp	2,813	2,636	2,491	2,187
Sea squirt	10,406	7,272	6,676	7,834
Oyster	256,313	248,793	239,217	244,905
Scallop	180,255	192,042	188,834	208,050
Other mollusks	1,456	1,486	1,340	1,381
Pearl	69	70	68	69
Seaweed	585,546	565,060	555,454	578,357
Others	45	26	39	44
Total	1,272,029	1,272,891	1,261,913	1,306,330

Table 4. Production of fishes from mariculture in Japan. Data from MAFF (1994).

Species	Production (tons) 1989	1990	1991	1992
Yellowtail	153,164	161,106	161,077	148,701
Red sea bream	45,536	51,636	60,127	65,950
Coho salmon	19,849	23,608	25,730	25,519
Flounder	4,283	6,039	6,515	7,128
Horse mackerel	6,655	5,863	5,889	7,161
Puffer	1,657	2,895	2,893	4,668
Striped jack	859	1,368	1,758	1,853
Black Porgy	129	136	117	118
Crimson sea bream	505	94	52	117
Filefish	45	67	177	99
Others	2,344	2,694	3,459	2,789
Total	235,126	255,506	267,794	263,503

The main seaweeds for culture are several species of *Porphyra, Undaria,* and *Laminaria.* The total harvest in 1993 was 578,357 tons (Table 5.)

Table 5. Production of seaweeds in Japan. Data from MAFF (1994).

Species	Production (tons) 1989	1990	1991	1992
Porphyra	403,290	387,245	403,363	382,805
Undaria	108,451	112,974	99,092	112,302
Laminaria	64,383	54,297	42,619	72,924
Others	9,422	10,544	10,380	10,326
Total	585,546	565,060	555,454	578,357

Searanching

In addition to intensive mariculture, searanching has been conducted by national (Japan Seafarming Association), prefectural, city, and town fishermen's associations. Mass production of important species for stocking in coastal seas has been conducted since 1964 in Japan. About 80 species of aquatic animals are ranched with seed from hatcheries. Several ranched species such as the red sea bream, flounder, kuruma shrimp, blue crab *Portunus trituberculatus,* abalone, and scallop have contributed significant production.

Ocean ranching of salmon was started in 1888 and the national project has been carried out for more than 100 years now. The number of salmon *Oncorhynchus keta* juveniles that have been released in the ocean was 2.04 billion in 1992. The average rate of return to the mother river is nearly 3%, better than ten years ago.

Recent developments include the searanching of Japanese scallop in northern Japan, searanching of striped jack with seed that have gone through a conditioning procedure, and the acoustic habituation system for the red sea bream (Umezawa 1994).

Freshwater Culture

Production from both inland fisheries and freshwater aquaculture has decreased since about 1990 to 90,762 tons in 1992 (Tables 1). The value of the aquaculture production was 64% greater than that of capture fisheries in 1989, but was only 43% higher in 1992 (Table 2). The main species for freshwater culture are eels *Anguilla* spp., carps *Cyprinus carpio* and *Carassius auratus,* rainbow trout *Oncorynchus mykiss,* ayu *Plecoglossus altivelis,* and Nile tilapia *Oreochromis niloticus* (Table 6). A considerable amount of soft-shelled turtle and freshwater algae are also produced.

Table 6. Production from freshwater aquaculture in Japan. Data from MAFF (1994).

Species group	Production (tons) 1989	1990	1991	1992
Eels	39,704	38,855	39,013	36,299
Common carp	17,479	16,309	16,160	15,061
Crucian carp	1,236	1,191	1,210	1,079
Rainbow trout	15,596	15,395	15,127	14,480
Other trouts	4,292	4,677	4,870	4,905
Ayu	13,390	12,978	13,855	12,794
Nile tilapia	5,283	5,825	5,647	4,697
Other fishes	405	454	357	322
Soft-shelled turtle	743	799	764	763
Prawns	32	34	19	20
Mollusks	6	5	9	6
Pearl	0.9	0.7	0.7	0.2
Algae	368	327	335	333
Total	98,535	96,851	97,367	90,762

Future Directions of Aquaculture

Advancement of searanching technology and coastal resources management

With the institution of the 200-mile exclusive economic zone, it has become very important to preserve coastal fishing grounds and manage the fisheries resources. In order to advance searanching technology, the coastal ecosystems and their carrying capacities should be investigated. Fish behavior, populations dynamics, and genetic structure should be studied to provide the scientific basis for fisheries resources enhancement with cultured juveniles and for suitable laws in environmental protection.

Development of seed production technology for new species

In Japan during the past 30 years, seed production technologies have been developed for several species of fishes, crustaceans, mollusks, seaweeds. For yellowtail, the technology for broodstock maintenance and induced spawning has been well developed. The supply of yellowtail juveniles for cage culture is assured, capture of wild seed is reduced, and recruitment of cultured yellowtail into natural habitats is possible through searanching.

Active research is going on in the seed production of bluefin tuna and other tunas, eels, groupers, spiny lobster, and bivalves with very high commercial value. 'Complete' culture (the entire life cycle under human management) would be possible if and when seed production

technology could be developed for these species. Technologies for bivalves and crustaceans are particularly needed.

Improvement of biological quality of cultured species

There are three major ways to improve biological quality: (1) genetic breeding, (2) production of healthy seed for culture, and (3) addition of commercial value (color, meat quality, shape) to aquaculture products prior to marketing. Production of new races that grow faster and resist disease will be possible through genetic breeding and biotechnology (see Kato 1994, Chen 1995). Methods are being developed to produce juveniles with no deformities and with high stamina during handling, transport, and cage culture. Consumer preferences are being taken into consideration in the production and postharvest processing of cultured species. Scientific activity in these three fields is very high in Japan and important results have been obtained.

Use of defatted soybean meal for marine fish culture

The sardine fishery has greatly declined in recent years and production of fish meal from this species has been reduced. Substitutes for fish meal in aquaculture feeds are urgently needed. The development of feeds with vegetable proteins is important. Defatted soybean meal has been found most effective and successful among the various protein sources tested; it can substitute for 30-40% of the fish meal in feeds for yellowtail (Shimeno et al. 1993a, 1993b). In the near future, marine fishes may be cultured with feeds made with vegetable proteins.

Development of offshore culture systems

Self-pollution of cage culture sites in coastal waters is one of the barriers to further expansion of mariculture in Japan. Large-scale offshore floating cages have been tested. Successful development of this new culture technology will allow aquaculture to expand offshore and reduce pollution near shore.

Development of land-based and closed rearing systems

For some species, land-based and closed rearing systems are feasible both technically and economically and are currently being tested.

Protection of the culture environment and prevention of diseases

Active research continues on the carrying capacities of culture sites, pollution, red tides, amelioration of the culture environment, and prevention and control of diseases.

Recreational fishing

About 20-30 million Japanese enjoy game fishing. But, current science and technology in fisheries and aquaculture are not for sport fishing, but for food supply. Studies in fish behavior, ecology and physiology would be useful in developing scientific sport fishing from searanching.

Protection of endangered and migratory species

The propagation and preservation of endangered species is now high priority on the research agenda. For example, fish ladders are being developed to allow migrating salmon and other fishes to return to their home streams despite dams and other conversions.

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