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Integrated Management for Sustainable Contribution of Coastal Fisheries to Protein Supply

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Demand for animal protein is predicted to increase further due to a combination of global population increase and economic growth. Because aquatic animals are more efficient in protein production than land animals, and fishery products have high nutritional and health values, fisheries are important for the food security of human being. However, fish stocks are being depleted at an alarming rate by the indiscriminate fishing as well as destruction of the natural habitats on a global scale. The growing aquaculture is not able to sustain its contribution to world fish supplies without reduction of wild fish input in feed and adoption of ecologically sound management. On the other hand, increase in the production of coastal fisheries can be possible by implementing integrated management worldwide. The successful examples in Japan indicate that stock enhancement by fishers can be incentive for the integrated management and may result in increased production.

1 Introduction

In 20 century the world population increased from 2 billion to 6 billion and it reached an alarming milestone of 6 billion on Oct. 12, 1999. The growth rate is slowing because of increased education and use of family planning which have pushed down the fertility rates all over the globe, and the AIDS epidemic which kills 3 million people around the world every year. Current projection for 2150 is 9.8 billion downgraded from 11.5 billion estimated in 1992[1]. However, the rapid aging of society and predicted population decrease in a few years due to sharp decline in the fertility rate may be responsible for economic stagnation in Japan as has been suggested by Wallace[2], which can be called as "Japanese Disease". In order to overcome this situation and to prevent collapse of the national pension system, the government of Japan is trying to introduce various measures to recover the birth rate. Also the social security in China faces an unintended consequence of its population engineering, "one child policy"[3]. Thus the population control is very difficult and the world population keeps expanding until human being might extinct like dinosaurs. Population growth will put an increasing burden on food and water supplies, and the environments, if poor countries develop their economies in the same wasteful way industrial nations have[1].

Recently, UN Secretary-General Annan says that global food supply is sufficient as a whole but it is not evenly distributed. As a matter of fact, already 840 million people suffer from chronic malnutrition worldwide, which include 530 millions in Asia, 220 millions in Africa South of Sahara, 40 millions in Near East and North Africa, and 60 millions in Latin America and Caribbean according to the 1996 World Food Summit. FAO recently estimates that one billion people in the world suffer from hunger and malnutrition and about 1 % of them actually die from starvation each year[4]. Consequently, the demand for food, especially for animal protein is predicted to increase further due to the combination of increases in population and income.

Living aquatic resources is an important natural renewable source of food and fisheries is one of the most efficient means of providing large quantities of high quality protein. In this paper, we examine whether fisheries production will be able to meet ever increasing demand for animal protein and propose a possible solution to enhance fisheries

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productions using available information and data.

2 Fish as food

Fish protein is generally recognized as a valuable ingredient in a balanced diet. It has high biological value and contains all essential amino acids. Fish oil also contributes essential fatty acids which are necessary for the proper development of the brain and the body. Due to these nutritional and health values, annual per capita consumption of fish is predicted to increase from about 16kg to 19~21kg in 2030. More than 50% increase is predicted in Latin America, Caribbean and South Asia, and up by 84% in China [5].

For the developing countries as a whole, fish currently makes up about 19% of the total animal protein consumption or just over 5 % of protein from both animal and plant origin[5]. Because aquatic animals are more efficient in protein production than land animals [6], fisheries are important for the food security of those population living in coastal areas and along the major rivers and lakes, not only in Africa and Asia but also in part of Latin America where protein supply is most needed[7].

As for demand, regarding increase due only to population growth and per capita supply of fish for direct human consumption remains at the level it was in 1990, the total need for fish for direct human consumption in 2010 will be some 87 million metric tonnes (MT). However, when other factors such as, economic growth with improving living standard are taken into consideration, demand may be in the range of 110-120 million MT. Supply of fish for direct human consumption may be in the range of 70-110 million MT depending on the assumptions. Under the most pessimistic assumptions on future supply, there will be a significant shortfall [7]. The ocean should continue to provide for a substantial portion of the world's protein demand. The present trends of over-fishing, wide-scale disruption of coastal habitats and the rapid expansion of non-sustainable aquaculture operations, may threaten the world's food security[8].

3 Fisheries production in the world

3.1 Productions of capture fisheries and aquaculture

Up to the end of the 1980s total fish production increased faster than the population growth. Global production from capture fisheries and aquaculture is currently the highest on record and remains very significant for global food security, providing more than 15% of total animal protein supplies[5].

As shown in Tables 1 and 2 , China remains by far the largest producer in both capture fisheries and aquaculture. The rapid rise in China's reported production, particularly the 2 to 3 -fold increase of its catch since 1990, is in marked contrast to the almost halving of other countries' catch from this region, which dropped to less than 9 million MT over the same period[5]. There are increasing indications that statistics of China for capture fisheries and aquaculture productions may be exaggerated as suggested by Watson and Pauly[8]. From this reason, FAO has decided to discuss the production statistics of China separately from the rest of the world. Preliminary catch reports for 2001 from fishing countries including China indicate that there may be a marked decrease in global capture production to about 92 million MT[5].

Unlike capture fisheries, aquaculture production has continued to increase markedly (Table 2). Excluding China, world aquaculture production without aquatic plants, exhibited a somewhat lower average annual growth rate (5.3%) in the 1990s than it did in the 1980s (7.1%). It is believed that aquaculture potential still exists in many areas and for many species. Asia represents 90% of world aquaculture production. According to FAO statistics, aquaculture contribution to global supplies of fish, crustaceans and mollusks continue to grow from 3.9% of total production by weight in 1970 to 27.3% in 2000[5].

The Bangkok Declaration and Strategy[9] emphasize the need for the aquaculture sector to continue development towards its full potential, making a net contribution to global food availability, domestic food security, economic

Table 1. Capture production in major countries (10^3 ton)

	Country	2001	2000	1999	1997	1992	1991	1984
1	China	16,529	16,987	17,240	15,722	8,323	7,372	5,926
2	Peru	7,986	10,659	8,429	7,870	7,502	6,898	3,320
3	U. S. A.	4,944	4,745	4,750	4,983	5,191	5,127	4,991
4	Japan	4,719	4,987	5,202	5,926	7,730	8,498	12,022
5	Indonesia	4,204	4,140	3,987	3,791	2,889	2,835	2,252
6	Chile	3,797	4,300	5,051	5,811	6,432	5,959	4,500
7	India	3,763	3,742	3,472	3,525	2,844	2,825	2,865
8	Russia	3,628	3,974	4,141	4,662	5,510	6,895	-------
9	Thailand	2,881	2,924	2,929	2,900	2,875	2,619	2,135
10	Norway	2,687	2,703	2,620	2,857	2,431	2,012	2,466
World Total		92,356	95,440	93,205	93,909	85,418	84,545	83,932

Source: FAO Fishstat "Capture production 1980-2002"[9]

Table 2. Aquaculture production in major countries (10^3 ton)

	Country	2001	2000	1999	1997	1992	1991
1	China	26,050	24,581	22,790	19,316	8,256	6,881
2	India	2,203	1,942	2,035	1,862	1,389	1,221
3	Indonesia	864	789	647	663	518	500
4	Japan	802	763	759	807	818	803
5	Thailand	724	732	603	540	371	353
6	Bangladesh	687	657	620	432	227	211
7	Chile	566	392	274	272	68	
8	Vietnam	519	511	467	405	132	165
9	Norway	512	491	466	368	131	161
10	U. S. A	461	428	479	438	414	364
World Total		37,851	35,487	33,447	28,632	15,405	13,724

Source: FAO Fishstat "Aquaculture production 1980-2002"[9]

growth, trade and improved living standard. However, the growing aquaculture industry must reduce wild fish inputs in feed and adopt environmentally more friendly management practices to maintain its contribution for world fish supplies[10]. Many aquaculture products are medium to high valued commodities for export and not for protein supply of people. Also market forces and government policies in many countries favor rapid expansion of high-valued carnivorous species[10] in lieu of herbivorous species. On the other hand, marine capture fisheries provide high quality but still cheap protein almost 9 -fold more than aquaculture excluding China[5]. Artisanal and small-scale fisheries contribute more than a quarter of world catch and account for half of the fish used for direct human consumption[11]. After the Convention of the Law of the Sea has legitimized 200-mile exclusive fisheries zones to coastal states, coastal fisheries are becoming more important than before especially for the developing countries.

3.2 Prospect for marine capture fisheries

Fisheries resources are common property and the preoccupation of *res nullius* results in over-fishing, although they are self-renewable resources and their sustainable utilization is possible with a proper management. The rapid expansion of artisanal fishing capacity under the open access regimes has begun to exert over-fishing pressures on the coastal fisheries resources, especially in Asia and Africa[11]. The over-exploitation of stocks is a major threat to sustainability and there is a considerable danger that over-fishing will continue and worsen. According to the re-

cent FAO estimation[5], only 25% of the major fish stocks are underexploited or moderately exploited. About 47% of the main stocks are fully exploited and very close to their maximum sustainable limits. Another 18% of stocks are over-exploited and stocks will decline further and catch will decrease unless remedial management action is taken to reduce the over-fishing conditions. The remaining 10% of stocks have become significantly depleted or recovering from depletion.

An average of 27 million MT of fish is discarded as by-catch each year in commercial fisheries[12]. The feasibility of avoiding by-catch through selective fishing must be investigated from both technological and biological aspects to establish the character of the by-catch and the bio-economic benefits that can be derived from such efforts.

Predation has a significant impact on marine and freshwater ecosystems through the food chain. The diversity and complexity of predator-prey interaction and their effects on fish stocks are considerable[7]. Certain species of cetaceans, such as sperm whales, mink whales and humpbacks are rapidly increasing in number. Depending on the methods used for estimation, whales consume marine organisms 2 to 4-fold more than the total capture productions in the world[13]. Thus rational utilization of whales as protein source should be considered, which also increase availability of the limited fisheries resources for human consumption[14,15].

3.3 Effects of the marine environment

Fish habitats are being rapidly degraded in many parts of the world by industrial, urban and agricultural pollution, landfill, damming and diversion of rivers, clearance of mangroves, resources mining, marine based pollution, deforestation in the hinterland etc. The damage to fish habitat caused by the fisheries sector also can be significant. Among the principal causes are: trawling, which may adversely affect certain habitat and bottom fauna; the use of dynamite and some destructive fishing techniques; the destruction of coastal wetland and mangrove areas by aquaculture pond construction; aquatic pollution caused by intensive coastal aquaculture and so on[7].

The regime shift which is defined as cyclic shift on the global, decadal scale of the climate-marine ecosystem has been widely recognized for marine production at the lower trophic levels[16]. Large-scale natural changes in oceanic and climatic conditions such as El Nino and Aleutian low pressure system, which are responsible for large-scale variation in fisheries resources, can have an adverse effect on sustainable production of fish[17-19]. Also, global warming may have tremendous effect on the regime shift and in turn on the fisheries production throughout the world oceans[20]. Thus prospect for sustainable fisheries production is not so optimistic even to maintain the present level. We need comprehensive strategy on resources management from long-term point of views.

4 Policies for sustainable development

4.1 Ecosystem-based fisheries management

The highly productive marine ecosystem is being affected by a combination of fishing impacts, environmental change and alteration on the marine ecosystem as mentioned in the previous section. One important weakness of current management is its common emphasis on restricting fishing capacity and effort, instead of following a more positive approach by altering the incentive structure through a rights-based approach, so as to encourage fishers to view their role as one of stewardship for fisheries resources and ecosystems rather than simply as exploiters of particular species[21]. In the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem held in 2001, urgent implementation of ecosystem-based fisheries management was addressed to help overcome some of the impediments experiences with conventional management[21]. This ecosystem-based focus provides scope for an increased involvement of regional bodies in establishing integrated marine and coastal management measures. This type of fisheries management has been practiced in Japan for many decades.

4.2 Integrated fisheries management for sustainable development in future

For integrated management, not only resources man-

agement described above, following measures also should be included to overcome the present situation.

a. Economic strategy

Over-fishing due to competition among fishers result not only depletion of the precious marine resources but also decrease prices of the harvests. Also, rational utilization of the harvest must be exercised to make as much money as possible out of the harvested products with careful handling, and improvements in processing and distribution systems.

b. Fishing gear selectivity

Discards which is estimated to be 20 to 30 MT annually in the world also should be reduced by using various selective fishing gears especially in shrimping and crabing industries[12]. More studies on selective fishing gears are needed to avoid unnecessary by-catch of sea birds or sea turtles and especially endangered species. From ecological point of view, however, it might be better practice to harvest non-target trash fish as well without discarding. Those can be used at least for fish meal production[10].

c. Environment management

Destructions of the spawning and nursery grounds should be minimized and those existing now must be conserved as much as possible or should be protected by designating them as sanctuaries.

Restorations of the destroyed habitats in coastal areas are needed by mechanical means and by construction or restoration of seaweed bed etc. Creation of new fishing ground by introducing additional structure such as reefs and seaweed bed into the environment may increase carrying capacity of the surrounding area. Japan is the world leader in artificial reef technology for commercial fisheries enhancement[22].

d. Stock enhancement

Once certain stocks are depleted, stock enhancement of the particular species may be needed. Stocking has many desirable features including limited managerial requirements and low inputs, use of existing water bodies, and absence of pollution, while the beneficiaries often comprise large numbers of economically and socially disadvantaged people. Introductions, however, require good planning and regulation in order to avoid damage to local fisheries diversity. Regulations should be based on the precautionary principle of avoiding risk and the rules must be effectively enforced. Emphasis should be given to the stocking of native species[7].

Stock enhancement plays integral parts for resources management of the coastal fisheries in Japan. Mass releases of the hatchery-reared seeds or seedlings of more than 80 species have been carried out along the coasts of the entire Japanese archipelago[23]. Marine fish enhancement has been attracting global attention[24]. The subjects on artificial reefs and stock enhancement were also taken up in the ICES Workshop to Evaluate the Potential for Stock Enhancement held in Copenhagen, Denmark on 19-24 May 1994. The Second International Symposium on Stock Enhancement and Sea Ranching was held in Kobe, Japan on 28 January- 1 February, 2002 in which about 400 people from 21 countries participated.

5 Fisheries management in Japan

5.1 Outline of fisheries productions and socio-economic structure

As seen from Table 1, capture production shows significant decline since 1988 mainly due to drastic reduction in harvest of Japanese sardine. Up until the middle of 1980's, aquaculture production showed impressive increase. However, the overall production is stagnant since 1992 as shown in Table 2 and the declining trends are apparent in freshwater species.

Reflecting the declining production, numbers of marine fishery enterprises, fishers and fishing vessels keep decreasing but still there are so many small enterprises especially in the coastal fisheries. Total numbers of fishers dropped from 700 thousand in 1960 to 253 thousand in 2001. As seen as characteristic of the fishing workforce in developed countries, ratio of fishers older than 40 years is rapidly increasing and nearly 32% of male marine fishers were more than 60 years of age. Average annual income of households engaged in the coastal fishing is about 6.7million yen in 2000, of which only 46% was from fishing-related activities and they depend on income from side-business to compensate shortage in the fisheries income. That of household engaged in the aquaculture was nearly twice as much as the fishing-households[25].

5.2 Specific feature of fisheries management in coastal fisheries

a. Limited entry

According to the Fishery Law, limited entry is employed instead of open access. Fishery right and licenses are to be granted only to fishers or fishing enterprises actually engaged in fishing and leasing arrangement of those are prohibited.

Fisheries Adjustment Committees, established for each area, are charged with preparing comprehensive plans for the full and rational use of coastal fishing grounds, and based on these plans, fishery rights and licenses are to be granted to Fisheries Cooperative Associations (FCA) and the individuals belong to FCA[26].

b. Community based co-management system

In this system, FCA plays indispensable role as nonprofit organizations, which became an integral part of community development policy in rural fishing villages after World War II. In both administrative and economic functions, FCA has contributed to the society in various ways by: reduction of administrative management cost; creation of employment and economic opportunities for rural development; promotion of environmental security; education and guidance to local people; research and resources enhancement; and national security[27].

Input control implementing by FCA reduce unnecessary fishing efforts to minimize wasting operational costs and over supply of fish. In pool system for products and fuel expense, fishers act together and profit is equally distributed. In catch limit system, minimum size, fishing days, closed season, total catch and so forth are agreed among fishers according to advice by the respective prefectural fishery experimental station[28].

There is another merit for this system such as, no compliance problem. Community based fisheries management in Japan has been developed with an idea and initiative of fishers themselves. Therefore, there is no compliance problem. There has been no case that the governments (national or prefectural) are involved in a community based fisheries management[28].

5.3 Specific problems in coastal fisheries

a. Depletion of stocks in the coastal waters

The resources of certain species, especially high priced fishes such as flounders, red sea bream, tiger puffer etc. are decreasing[23]. In order to restore the depleted stocks, the resources recovery projects on several target species have been started with close collaboration among fishers, and prefectural and national governments[23].

b. Conflict with aquaculture

Pollution of coastal waters by fish farming is one of the reasons for frequent occurrences of red tide which may kill wild fish as well. Reduction in the price due to over production is often seen. Also, use of wild juveniles as seeds may play a certain role in reduction of the wild stocks such as tiger puffer and eel.

c. Conflict with recreational fishing

Number of person engaged in recreational fishing is steadily increasing and total numbers for marine waters and inland waters reached to about 40 and 10 millions, respectively in 1998. Annual catch by recreational boat fishing was about 30,000 tons in 1997. In certain species such as red sea bream whose juveniles have been released in large number by fishers, more fish have been caught in recreational fishing than by commercial fishing[24].

6 Necessity of integrated approach and its successful examples

In order to overcome these obstacles together with socio-economic and environmental problems mentioned in the previous sections, and to pursue the sustainable development of fisheries, the government officials as well as fishers feel necessity of integrated approach for the fisheries management much more than before. Various measures for the integrated management have been enhanced under the initiatives by national or prefectural governments and FCA, and one of the examples is the resources recovery project described in previous section. Japan has been playing a leading role in this respect in the world and is expected to play more active role. There are many successful examples such as follows.

6.1 Stock enhancement of Japanese flounder in Aomori Prefecture

After starting annual release of 2 - 4 millions of large

sized juveniles, the harvest increased from about 200 MT to over 1200 MT in less than 10 years as shown in Fig. 1 partly supported by occurrence of the dominant year class in 1995 but the estimated ratio of released fish in total catch is now about 7.3%. Another measures being taken by FCA members are setting of sanctuary for the juveniles and increasing minimum size to be caught from 30 to 35cm[29].

Each fisher voluntarily provides 4 % of total income from the flounder fishing for the juvenile production. This practice makes fishers to feel that the released fish are not common property but their own property which can be incentive toward proper fisheries management and enhance their effort to maximize profit out of the harvest by such as catching more fish alive[30].

6.2 Boze Fisheries Cooperative Association in small trawl fishery

Boze FCA which conducts small trawl fishery is located on tiny islands in the Seto Inland Sea, Japan and members of the FCA are voluntarily taking following measures as integrated management. Fishing permit is also controlled by FCA[31].

a. Resource management

As the resources management, introduction of no fishing day (2 days per week), stock enhancement of many species, limiting mesh size of the net and releasing of small seized fish captured are exercised by fishers themselves.

b. Another measures being taken

Conservation of the fishing grounds is carried out by not allowing themselves littering, bringing back collected trash with net and selection of fish market to sell the harvests for better price as a marketing strategy.

c. Results of these measures

As the results, the average income from fisheries is much higher (more than 10 million yen) than that of national average. Although fisheries is not attractive for young people any more because it is considered as a 3 -D job, dirty, dangerous and demanding with less income than that of national average, recruits of young keep increasing and age structure of this FCA is much younger than national average (Table 3).

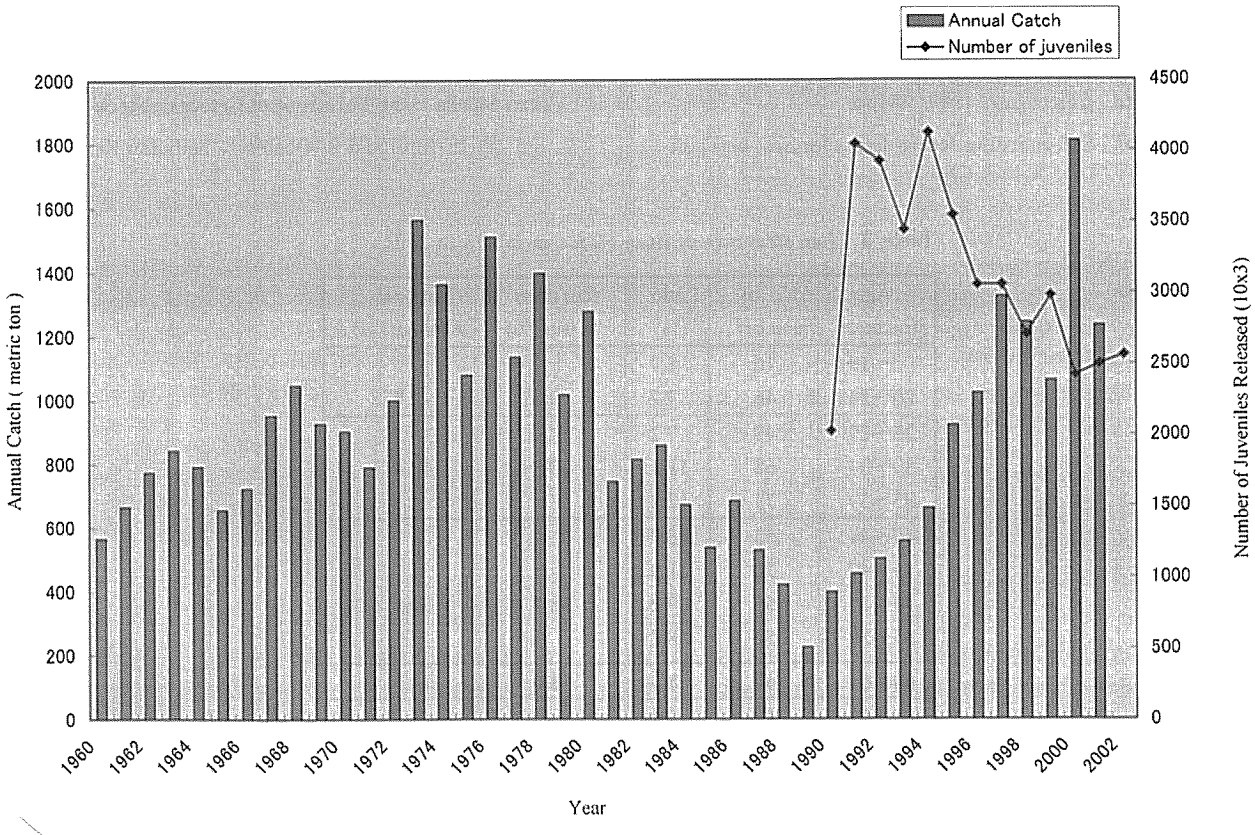

Fig. 1. Annual catch of Japanese flounder and number of the juveniles released
Source: Committee on Flounder Stock Enhancement in Aomori Prefecture (2002)[29]

These examples indicate that stock enhancement is integral part of the coastal fisheries in Japan and stock enhancement by fishers themselves may be incentive for fishers to view their role as one of stewardship of fisheries management. If integrated management described above is practiced, it is possible to enhance fisheries production in coastal waters and activate the fishing community where younger generations are willing to join.

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Table 3. Age structure of Boze FCA's members in 2001

Age structure	No. of member	Ratio (%)	Year class Ratio (%)	National Average (%)
~19	10	1.7		
20~24	46	7.7	9.4	2.8
25~29	43	7.2		
30~34	68	11.4	30.8	12.4
35~39	73	12.2		
40~44	53	8.9		
45~49	71	11.9		
50~54	55	9.2	38.7	39.6
55~59	52	8.7		
60~64	48	8.0	8.0	13.3
65~69	44	7.4		
70~74	26	4.4	13.1	32.0
75~	8	1.3		
Total	597	100.0	100.0	100.0

Sources: Fisheries Agency[25] and Maegata (2002)[31]

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タンパク質供給増に貢献する沿岸漁業の統合的な漁業管理

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世界的な人口増加と生活水準の向上に伴うタンパク質需要の増加が予想され，高品質のタンパク質を効率よく生産できる水産物の供給増が期待されている。しかし，世界的な水産資源の減少と海洋環境の悪化などにより今後の増産に悲観的な見通しがなされている。世界の各地で食用水産物の供給源として重要な位置を占めている沿岸漁業において，日本ですでに広く実施されている統合的な管理手法を多くの国が採用することにより，世界的規模の増産を今後も期待できると推察される。また，漁業者が人工種苗を自前で放流することは資源回復の一助となるばかりでなく，統合的な漁業管理に不可欠である自主的管理に対する漁業者へのインセンティブになると思われる。