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**FISHERIES RESOURCE MANAGEMENT DEVELOPMENT BY  
STOCK ENHANCEMENT IN OKINAWA**

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# **Fisheries Resource Management Development by Stock Enhancement in Okinawa**

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## **I. Introduction**

Okinawa Prefecture is composed of many small islands which are tropical in nature due to the influence of the warm Kuroshio current. The current brings many oceanic migratory species such as tuna, skipjack, mahimahi, wahoo and others to coastal and off-shore waters. These oceanic species are extensively exploited not only by local fisherman but also by larger commercial skipjack and tuna boats from mainland Japan.

Coastal aquatic resources are also tropical in nature and almost similar to those of the Pacific islands. With the increase of population and increasing demand for marine products, fishing pressure on reef resources and coastal sea-bottom fishes has been intensified. On the other hand, the conservation measures do not seem to have been fully understood and exercised properly.

In order to strengthen the re-stocking projects, technological studies on artificial propagation have been promoted in addition to biological and ecological studies on coastal high valued species for more than 10 years. The project seems to be time and money consuming.

The Okinawa Prefectural Government is putting more efforts into the promotion of resource management fishery and farming fishery as well as on the development of aquaculture fisheries to keep up the coastal productions. This paper outlines the general status of Coastal Fisheries, Fisheries Resource Management and Progress of Artificial Propagation Techniques.

## **II. Coastal Fisheries**

The "Coastal Fisheries" in terms of production is defined to operate in coastal waters with vessels of under 10 gross ton replacements in Japan. The locally constructed traditional wooden boats called Sabani which originally was less than 1 ton have been replaced with larger boats of 1-3 tons or 5-10 tons made of FRP equipped with modern navigation devices, colour fish finder and others. The installation of high-technology navigation equipment made their fishing operation range expand to far off-shore and to locate with great accuracy the targeted productive fishing grounds. This trend to increase the size of boats has been encouraged by an increasing demand of high valued fish such as tuna and deep-sea bottom fishes such as emperors, snappers, groupers and others. The economy of the Okinawa Prefecture is becoming tourism dependent and about 3 million tourists are visiting Okinawa yearly. Because of the limited supply of the local high valued species many varieties of similar high valued fishes are imported to meet the demands. The coastal fisheries production based on multi-gear and multi-species is stagnant at the level of 14,000 metric tons in the past several years, which comprises about 30 % of total fisheries production of 43,000 metric tons, although in Okinawa the coastal fishermen comprise 90% of the total fishermen (4,900) and the fishing vessels 96% of the total (4,000).

The catch of the coastal fisheries production by type of fishing is composed mainly of 19% of troll fishing, 15% of bottom fishing, 11% of gill-net fishing followed by squid fishing, tuna long-line fishing and SCUBA fishing. The installation of fish aggregation devices (FADs) deployed off-shore

along the 1,000 meter contour line contributed to the extensive development of troll fishing. It has proved to increase the CPUE compared to non FADs dependent trolling. The shift of fishing efforts to oceanic resources has been contributing to the decrease of fishing pressure on bottom fishes in coastal waters. Decreasing trends of the coastal resources and fears of depletion of some stocks are commonly acknowledged among the coastal fishermen. To meet the trend in the decrease of coastal fisheries production, we had ever introduced new fishing gears and methods which had proved its effectiveness to increase production. However, we learnt that the catch increase did not last long and the fishery became stagnant again within several years. The newly introduced fishing were bottom long-line fishing especially for blue snapper at the depth of 150 meters, a larger trap-net fishing set in the lagoons at the depth deeper than 10 meters up to 30 meters, and a giant squid fishing.

The bottom long-line fishing was so productive compared to the traditional hook-and-line fishing method and it extended to all the fishing communities, but the stock in their fishing grounds were depleted within several years and most of the fishermen were discouraged to continue this fishing method. No regulations and restrictions for the conservation of the resources were implemented because the off-shore fishing grounds were far off-shore and beyond the jurisdiction of fisheries rights system.

A larger trap-net fishery operating in water deeper than 15 meters depth in the lagoons is granted exclusive access rights and operates successfully but the smaller trap-net set at water depth shallower than 15 meters is under the jurisdiction of Fisheries Cooperatives for proper and fair use of their fishing grounds. The trap-nets set beyond the low-tide line are so productive in catching the coastal schooling species such as sardines, carangid fish, rabbitfish and some scombrid family fishes which had never been caught in volumes with their traditional gears such as gill-nets, set-nets, drive-in-nets and hook-and-line fishing. However, with the increasing pollution of coastal waters, the polluted nets decreased its gear effectiveness and the catch had also decreased enough to discourage some of the fishermen to abandon the fishery. Many other fishermen who have been engaged in this fishing have also shifted their fishing efforts to ocean resources fishery in accordance with the FADs deployment and new exploitation of giant squid.

The FADs are installed mostly at the depth of 1,000 meter contour line about 20 miles off from the shores of respective islands. The total numbers set in the off-shore waters are restricted to 177 and its locations are also designated to offer equitable access to the FADs. These regulations are implemented by joint efforts of Federation of Fisheries Cooperatives of Miyazaki and Okinawa Prefectures to avoid conflicts between local Okinawan fishermen and commercial larger skipjack boats from Miyazaki Prefecture who are exploiting the same migrating stocks coming into the off-shore waters of the Japan archipelago.

During the past several years, the giant squid *Thysanoteuthis rhombus* has been extensively exploited. The average size of the squid is about 10 kgs and it is caught at the depth of 300- 650

meters of deep ocean but the best catch is made at the depth of 400-600 meters deep. Total landings for the past four seasons range from 1, 127 metric tons in the 1991-1992 season to 1, 492 metric tons in the 1993-1994 season. The increasing participation of smaller tuna boats has contributed to the increase in catch. Their fishing grounds are far off from the coast and therefore are not easily accessible for competition by the coastal fishermen. The squid is known to be distributed widely in the Pacific Ocean, so our local fishermen are more likely to exploit the locally available fraction of the Pacific wide stocks. However, based upon the decreasing CPUE in the local water, the closed season has been set since the 1994 season. At present as no other unexploited resources have been found in the coastal waters, there is no way to increase the fisheries production in Okinawa. In order to improve the stagnant production in the multi-species fishing, some fisheries cooperatives are looking for a chance to start with aquaculture of fishes and others. Several fisheries cooperatives have already been

successfully engaged in shrimp or seaweed culture. The aquaculture development is now the only possible means of increasing marine products in the coastal shallow waters.

### **III. Resource management**

In accordance with the growth of population and increase of recreational fishing population, fishing pressures on coastal resources have been intensified. The coastal commercial fishermen are facing competition with the recreational fishing activities. The charter-boat fishery is also growing and their operation range has been expanded as far as the FAD deployed areas.

However, there have been no movements for implementing regulations and restrictions to protect the targeted bottom and surface species because the fishing ground is beyond the prefectural jurisdiction.

A recent topic for resource management is the oceanic giant squid exploited locally although it is known that the squid is more widely distributed in the Pacific Ocean.

The squid has been intensively exploited since its discovery at near shore deep water. With the increasing fishing efforts on the locally available stock, the warnings of over-exploitation in terms of decrease of CPUE and higher catch rates of small size have been reported by many squid fishermen and the evidence was confirmed by the Okinawa Fisheries Research Laboratory (OFRL). The total production reached almost 1,500 metric tons due to quantitative landings by tuna boats that temporarily shifted from tuna long-line fishery. Based upon the fishermen's claim and supported by biological and ecological information provided from the research laboratory, the Okinawa Prefectural Government working together with the Fisheries Adjustment Committee was able to implement a regulation prohibiting fishing from every July 1 to October 31 since 1994. The squid is considered and reserved as an ever lasting local stock. This restriction is strictly adhered to by all fishermen and the control measures are considered to be satisfactory.

The coastal resource management measure regarding near shore waters is covered under the management of fishing rights system. The coastal waters including lagoons, reefs and extending offshore waters to the distance of about two to four kilometers are granted as exclusive fishing zones from the view point of better management of fisheries resources therein. The zones are

divided into districts of fisheries cooperatives and the management rights are vested into cooperatives. The gross area of the jurisdiction of each cooperative varies depending on the natural features of the district. The fishermen who belong to respective fisheries cooperatives are privileged to fish in the area of water which fall under their cooperative's jurisdiction.

The major feature of this closed access fishery is that control is exercised at the cooperative level and the cooperatives are vested on implementation of regulations and restrictions which are similar to those imposed by the Prefectural Government.

Depending on their reliance on the adjacent reef and lagoon resources and on their acknowledgment of the status of exploited resources, cooperatives can implement strict regulations and restrictions over the Prefectural criteria and enlist more species within their jurisdiction.

As a common step to implement the management measures, fishermen are encouraged to use their initiative in each fishing method. Management committees consisting of several fishermen representatives are organised and vested to implement regulations and restrictions on types of fishing methods because they are clearly aware of the status of the exploiting stocks. In addition, the initiative of the participating fishermen will promote self confidence among other fishermen. The committees are

organized by each group of different fishing methods such as net-fishery, hook-and-line fishery, reef gleaning fishery, troll fishery and seaweed farming.

The regulations and restrictions cover all aspects of fishing activities such as gears, fishing methods, season, size of targeted species, qualification of fishermen to engage in certain fishery and etc. However, the unsatisfactory enforcement is considered to be a decreasing trend in fisheries production.

Another kind of fishing right is granted for aquaculture. This right is reserved not only for the fisheries cooperatives but also for individual and groups of fishermen, and a private company. The exclusive right is mostly for cultures of fish, pearl shell, of pearl, giant clams and seaweed. The period of the exclusive use of fishing grounds is limited to 5-10 years depending on the kind of fishery rights which are common fishing right, larger trap-net fishing right, mother of pearl culture, fish culture and seaweed culture. These rights are renewed every 5 years except for pearl culture and shrimp culture which are renewable every 10 years because of heavy investment of funds to operate the business.

The resource management fishery is still far from reaching its goals. Biological and ecological studies to monitor and access the status of many important species are strongly requested in order to provide better and effective management methods on coastal resources and to shift from the effective fishing aimed gears.

#### IV. Aquacultural Resource Enhancement

The extensive pressure on the coastal resources has been increased by the outgrowth of local population and rapid progress of development projects such as construction of golf courses and roads and re-arrangement of farm land.

The requirements of development of aquacultural resource enhancement (ARE) techniques have been increased in connection with the ever declining trends of reef resources and high valued fishes. During heavy rains, the lagoon waters change into yellow-brown colours by the rain water carrying silts originating from the various development projects. The pollution is serious and it affects not only the survival and reproduction rates of the aquatic resources but also fisheries productions. All departments of the Okinawa Prefectural Government are now working together trying to reduce the silt suspension of the outflowing waters and the concerned agriculture land improvement sections are working on trying to reserve the soils.

To protect the reef resources and increase the stock population by ARE, the technological studies began with black-lip pearl shell, *Pinctada margaritifera* by OFRL and later by joint efforts with the National Fisheries Research Institute.

The developed techniques were then transferred to a local black pearl company who further developed their own techniques for their expansion of commercial operations. Today all of the mother shells used for pearl production are artificially produced and they are challenging for gold pearl production by importing the broodstock, *P. maxima* from the Philippines.

Another aspect of pearl culture development is that a group of fishermen started mother shell culture with seeds supplied from the company. Depending upon the availability of sites for culture the company is ready to cooperate and access the fishermen for further development of the pearl cultures.

Re-stocking programme of one of the cuttlefish species, *Sepia latimanus*, once tried by the Laboratory has been further undertaken by development of spawning-nest devices, juvenile rearings and releasing techniques into lagoons by the National Sea-farming Centre located in Okinawa.

Reef-boring clam *Tridacna crocea*, once abundantly seen on reefs has been extensively exploited by commercial and increasing recreational fisheries because it is highly favoured and the supplies cannot meet up with the demands. Because of the strong market demands for this species, a total of 27 fishermen ventured into its culture obtaining exclusive fishing rights for proper sites and supported by seed supplies from the OFRL since 1993.

The OFRL and the Prefectural Sea-farming Centre are expected to support the venture by supplying enough seeds. Because of its boring nature, reef bedding devices for planting the seeds have been contrived and provided among the concerned fishermen. As the survival rates are considered to be highly related to the size of the seed, optimum sizes for transplanting is one of the concerns.

Other species for re-stocking projects include trochus, green snail, sea-urchin, swimming crab, mangrove crab and emperor, although these technological aspects are still considered or experimental stages.

Re-stocking projects of the swimming crab including its ecological and biological studies have been conducted for several years. The recruited stock from re-stocking has been acknowledged to be supporting their landings among the crab-dependent fishermen although their landings are still small.

The term of exclusive fishing right for cultures is restricted to 5 or 10 years depending on the types of culture and species, and renewed every 5 or 10 years. In 1993 all fishing rights were renewed. Because of the ever-increasing demand for marine products and the ever-decreasing trend of reef resources, the aquaculture venture attracted many fishermen to engage in aquaculture. Notably increased number of applications were granted respectively in each aquaculture practice, seaweed culture permits were increased from 105 to 152, fish culture from 6 to 58 and tridacna culture from 0 to 20.

Alga, *Cladosiphon okamuranus* farming in lagoons are outstanding and encouraged by strong market in mainland Japan. Its production far exceeds the natural harvests. The cultured production of 1, 816 metric tons in 1983 has been increased to 10,000 metric tons and is still on an increasing trend. However, quality control has been emphasized to make better marketable products rather than increasing the production. Other seaweed, *Monostroma nitidum* and *Caulerpa lentillifera* are also cultured but the production is small because of limited availability of proper culture sites.

Shrimp culture is increasing their production taking advantage of no disease contaminations and warm climate. The production in 1993 was 425 metric tonnes.

Successful fish culture starting with red porgy, obtained from mainland Japan by several groups of fishermen, is encouraging the concerned fishermen to obtain ample supplies from government including those of other local high valued species.

Okinawa Prefectural Government is concentrating on eight species to further the development of ARE techniques aiming to attain the production target at size and number in the following table:

Targeted Species for ARE

<u>Common English Name</u>	<u>Scientific Name</u>	<u>Targeted No. of Seed</u>	<u>Targeted Size of Seed Released (mm)</u>
1. Spangled emperor	<i>Lethrinus nebulosus</i>	800, 000	100
2. Black porgy	<i>Acanthopagrus siiculus</i>	100, 000	100
3. Black porgy	<i>Acanthopagrus australis</i>	350, 000	100

<u>Common English Name</u>	<u>Scientific Name</u>	<u>Targeted No. of Seed</u>	<u>Targeted Size of Seed Released (mm)</u>
4. Swimming crab	<i>Portunus pelagicus</i>	750, 000	8
5. Boring clam	<i>Tridacna crocea</i>	100, 000	8
6. Trochus	<i>Trochus niloticus</i>	200, 000	30
7. Green snail	<i>Turbo marmoratus</i>	50, 000	30
8. Sea-urchin	<i>Tripneustes gratilla</i>	150, 000	10

Facilities on shore and adjacent water of both the OFRL and the Prefectural Sea-farming Centre have been expanded to scale up their production.

In 1994, the National Fisheries Research Institute opened a branch station in Okinawa to work on topical species. The joint efforts of the organizations are expected to expedite the accumulation of biological and ecological information, including the development of ARE techniques.

#### V. Final remarks

Okinawa has JICA Okinawa International Centre, as a training centre. Many trainees from various countries have been receiving training in many programmes. In addition to JICA facility, the Overseas Fisheries Cooperation Foundation (OFCF) also has fisheries training programmes in Okinawa. The Okinawa Prefectural Government is supporting these programmes by offering use of the Prefectural facilities and accepting trainees for practices.

Many fisheries trainees from several Pacific islands have been receiving training in all aspects of coastal fisheries and farming programmes. Because of the similarity of the climatical nature and the similarity of marine life, the trainees feel at home in Okinawa.

The main policies on fisheries of the Okinawa Prefectural Government are to develop aquaculture to cover the declining coastal production, to strengthen management fisheries for better utilization of the coastal resources, and to promote the farming fishery for full use of the reefs and lagoons.

I hope the information and knowledge as well as the developed techniques accumulated in Okinawa could be contributive to the development of coastal fisheries in the respective Pacific islands.