Results and conclusions of the biosocioeconomic assessment of the impact of the artificial reefs (ARs) on the small-scale fisheries in Ranong Province, Thailand

28. *RESULTS*

28.1 *Environmental conditions and animal communities*

28.1.1 Environmentally, ARs 1 and 2 are located very close to mangrove and estuarine areas and are, hence, prone to high turbidity. This could, perhaps, play a negative role on the sealife dwelling near these ARs. AR3 showed less suspended solids, particularly during the dry winter months of the northern hemisphere. The Southwest Monsoon in the summer months brings heavy rain and heavy run-off from the mangroves and estuaries, causing considerable mixing of water. These conditions also contribute to inorganic nutrients being discharged into the sea. While AR2 has pronounced mangrove run-off, AR3 is dominated by seawater intrusion and, hence, has better marine conditions, relatively clear water and less suspended solids. Higher nutrient levels at ARs 1 and 2 also contribute to high chlorophyll content.

The sediments around ARs I and 2 are fine and are, therefore, generally unsettled by the dynamics of the water in their areas. But the sand and mud around AR3 comprise of larger-sized grains and are, thus, less easily disturbed. The weak turbulence observed in the water may be due to bottom obstruction contributed by the scattered modules of the ARs, but is of little consequence.

These observations indicate that the locations of AR1 and AR2 did not favour colonization and aggregation of various organisms of commercial value, though nutritional enrichment of the water was evident. AR3 appeared to have environmental conditions more favourable for the objectives of the Government's artificial reef project. The presence of ARs did not seem to affect the natural environmental conditions in any significant way.

28.1.2 Underwater visual census was almost impossible at ARI and AR2 due to poor visibility caused by turbidity. Observations showed that the modules were haphazardly scattered at the bottom and not in the formation expected. The underwater visual census was, therefore, almost entirely at AR3.

Organisms belonging to major groups of animals, such as seafans, sponges, worms, oysters and barnacles, covered almost the entire concrete surfaces. Crawling among these were starfish, tiny shrimp, worms, crab, brittle stars, sea urchins, limpets, sea slugs, sea snails etc.

The oysters (*Saccostrea* spp.) were an edible variety and proliferation of this species in this area was a new development. When the oysters increased in number, the clumps became too heavy, broke off and dropped to the sea bottom, where they formed a hard substratum on which new oyster spat settled. Thus, the surface area of the AR also increased.

From the results of the study, it became evident that positioning of the deployment vessel at the location and the system of lowering the module have to be improved to achieve better positioning of the modules in relation to one another.

28.1.3 During the three field observations, statistically significant differences were recorded in the seasonal variations of the biomass of organisms on the AR. The average of these three values also appeared to differ with the position on the AR — from approximately 2,500 to 3,760 g/m^2 on the upper surface of the horizontal beam of the module to 6,899-8,685/m^2 on the vertical column of the module and 11,447-14,843 g/m^2 on the under side of the horizontal beam of the modules.

28.1.4 Since monitoring commenced about three years after installation of ARs in Ranong, the colonization was expected to have stabilized. During the three underwater visual censuses, 101 species of fish, representing 42 families, were encountered. About 80 per cent of the species were found to be residents, while the rest (Fusilier, Jacks/Trevally, Anchovy etc.) were transitory.

28.1.5 Five types of fish were identified based on the pattern of association with the AR:

- Type A in physical contact with the AR or occupying crevices (Groupers, Dottyback, Lionfish etc);
- Type B swimming close to modules (Damselfish, Cardinalfish, Boxfish, Filefish, Leatherjackets, Puffers etc);
- Type C swimming through and around the modules, but closer to the bottom (Snappers, Sweetlips, Parrotfish, Rabbitfish, Ponyfish, Butterflyfish, Angelfish, Triggerfish, Surgeonfish etc);
- Type D preferring to orientate close to the bottom, near the basal parts of the modules, but extending their range over the open sand area (Goatfish, Monocle bream, Emperors, Lizardfish, Perches, Cobia, Pipefish, Whiting, Stingray etc); and
- Type E, pelagics hovering above the modules (Jacks/Trevallies, Batfish, Barracuda, Halfbeak, Anchovy, Eagle rays etc.).

Comparing the fish aggregation at the ARs with that at a nearby natural reef, 41 species (40%) were found to be common, though at least 78 species (77%) had been expected to be common on the basis of records from the Andaman natural reefs. The remaining 23 per cent are assumed to be confined to the AR only and included economically important species like Spotted sickle *(D. pun ctata),* Longface emperor *(L. olivaceus),* Johnius snapper *(L. johni),* Groupers *(E. bleekari* and *E. undulosus),* Cobia *(R. canadum),* Whiting (S. *sihama)* Trevally *(C. ignobilis* and *C. sem).* Kingfish *(Seriolina nigrofasciata)* and Anchovy *(Stolephorus* sp.). With higher proportions of target species at the ARs, opportunities for better income to fishermen were greater for those fishing there.

28.2 *Impact of ARs on the fishing methods*

28.2.1 Twentytwo types of fishing gear are used by fishermen in the villages adjacent to the three ARs, but the major ones are only the trammelnet, squid trap, whiting gillnet, crab glilnet, grouper trap and scoopnet. A comparison of the results of the gear census in 1987 with those of the gear survey in 1992 showed that there has been a significant increase in the use of the trammelnet, crab gillnet, whiting gillnet, squid trap, scoopnet and grouper trap. At the same time, there was reduced use of the mullet gillnet, kingmackerel gillnet, pomfret gitlnet, otter trawis, crab liftnet, setnet etc. New gear introduced after installation of the ARs are gilinets for Threadfin, Mackerel and Sardine, stick-held castnet for Squid, Crab traps, trollingline, bottom longlines, set bagnet, shrimp castnet etc. Gear in the six villages surveyed has increased from 568 units in the predeployment period to 1264 in 1992.

28.2.2 Fishing trials conducted near the three ARs indicated better performances near AR3 than at the other two. The potential for the development of bottom vertical longline, bottom longline and fish trap were evident, but more trials are necessary to confirm the economic feasibility of those at the three ARs.

Though fish trap construction was demonstrated to the fishermen in one village, demonstration of some of the other experimental gear was not achieved due to the short duration of the project.

It was, however, evident that trawler operation in the AR areas had been reduced significantly, while the number of small-scale fishing operations had increased at the ARs, particularly at AR3.

28.3 *Impact of ARs on the performance of small-scale fisheries*

28.3.1 Lack of information on the performance of the fisheries during the predeployment phase makes quantification of the impact of ARs on the performance after deployment difficult. However, based on available information, it was learned that the catch rate of squid traps had increased by 265 per cent. The whiting gillnet had also shown progressive improvement in the catch rate. But trammelnet showed only slight improvement. It should be recommended that the whiting gillnet and trammelnet values recorded refer to fishing areas in proximity to the AR and not inside it.

28.3.2 Data gathered at the ARs between 1988 and 1993, during the shrimp and fish trawl surveys by the Government research vessel, indicated increase in the catch of shrimp, squid, demersals and pelagic fish. Production also increased considerably, almost doubling, but it was not clear whether this was due to aggregation of the sparsely scattered resources at the AR, enhancement of the biomass of these resources (leading to increase in the density distribution of the stocks) or reduction in the exploitation by trawling (contributing to increased availability of these resources for the small-scale fisheries).

28.3.3 The total investment on the ARs in Ranong province was Baht 15,700,000. AR3 alone cost Bht 3,337,878, but the gross income generated in 1992 by the fisheries in the two villages near it was Baht, 11,991,249. The other two ARs have not been rewarding, so far, for reasons already mentioned.

28.4 *Impact of ARs on fisherfolk and their income*

28.4.1 The results of a socioeconomic survey of the six fishing villages adjacent to the three ARs were compared with the secondary data from the Fisheries Censuses of 1985 and 1990 and the BOBP extension project survey of 1986. The rate of increase in the number of fishing households near the ARs was higher than the increase of fishing households in Ranong Province as a whole. This was probably due to the establishment of the ARs.

28.4.2 The number of trawlers in these fishing villages decreased by 41 per cent with the installation of ARs, while the number of small boats operating whiting gillnet, trammelnet and squid traps increased by about 6, 3 and 18 times, respectively.

28.4.3 All fishing households in the villages are primarily fishing households with their own craft and gear — 61 per cent involved only in fishing, 15 per cent in fishing and fish-processing, 19 per cent in fishing and nonfishery activities and 5 per cent in fishing, fishery-related and nonfishery activities. Those close to AR1 and AR3 depended on fishing more than those adjacent to AR2.

Income from fishing was 84 per cent of the total income and the average net income to a household fishing near an AR in 1992 was about Baht 37,322. The average was higher for those fishing around AR3 (Baht 55,159)) than at AR2 (Baht 34,341) and ARI (Baht 25,724). Engel's Coefficient (EC) (percentage of the food expense in relation to total expenditure) was 55 per cent for the villages near the ARs, whereas it was about 76 per cent in the Ranong Province. The EC average was about the same near all three ARs. Fishermen using larger boats or operating squid traps also had a higher standard of living than those operating other gear.

Comparing the data of the BOBP survey of 1986 (Boonchuwong, p. 1987) in the area of AR3 with that of the survey in 1992, it was observed that there was a 26 per cent increase in fishing income (from Baht 36,580 to Baht 46,083 per year), while the average debt of a fishing household decreased 21 per cent (from Baht 8523 in 1986 to Baht 6775 in 1992). These findings show that the living standard of fishing near AR3 had increased, with Engel's Coefficient decreasing from 75 per cent to 54 per cent.

28.5 *Awareness and perception of small-scale fisherfolk*

Ninetythree per cent of the fishermen in the villages near the ARs were aware of their installation and their positions, 68 per cent knew that ARs aggregated fish and 57 per cent believed that ARs could prevent trawlers from operating in the area. Fiftytwo per cent knew that they could catch more fish at ARs, but only 36 per cent felt that there was a saving of time by fishing at ARs. Forty per cent of the fishermen accepted that ARs enabled a longer fishing-season than before. Most of them accepted that ARs are suitable for small-scale fisheries and that ARs should be common property.

29. *CONCLUSIONS*

- ARs altered the structure of small-scale fisheries in the area by increasing the number of households as well as the number of small-scale fishing craft and gear, while reducing the participation by the trawlers.
- There were more opportunities created to fish with new types of gear.
- Although the income of fishing households was not very high, the standard of living in the areas near the ARs is higher than the average level of small-scale fisherfolk in Ranong Province.
- The selection of locations for ARs should be investigated in greater detail to ensure maximum benefit on the investment made.
- The deployment or installation process needs to be improved to ensure the expected formation of ARs, so as to ensure which will be most effective in meeting all project objectives.
- The present study had many limitations, such as:
  - insufficient pre-installation surveys;
  - incomplete seasonal coverage of environmental investigation;
  - inadequate underwater visual census and sampling of the catches by various gear, particularly of biological parameters such as length-frequencies, maturity stages of animals, spawning, and association of eggs, larvae and juveniles of commercially valuable species at the ARs.
- Data need to be gathered to determine the stocks in the area of the ARs and the changes in their biomass, in order to assess any enhancement of the resources.
- Experimental fishing needs to be continued systematically to establish viability and to determine developmental steps, including demonstration.
- The use of ARs as a management tool for nearshore areas, and regulation and control mechanisms for the fisheries, are yet to be established. A legal framework with jurisdiction over fishing rights needs to be introduced and implemented by Government.