

The Development of Fish Aggregate Device in the Cook Islands.

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Summary

Since 1980 a program of fish aggregation device (FAD) deployment has been carried out in the Cook Islands. Government has deployed all FADs between 1 to 3 nautical miles from shore at depths ranging from 800 to 1,600 meters. The FADs have undergone various designs with varying degrees of success. The average FAD life-span during the early 1980s was nine months; however, it increased to 18 months, with some FADs in operation in excess of 30 months. Each FAD cost between NZD7,000 and NZD9,000 to build and deploy.

Since their introduction, FADs have been widely accepted as a very effective apparatus in coastal small-scale fishing activities, specifically for pelagic species. Judging by the progressive behavior of local fishing communities, there is sufficient reason to believe that FADs have created productive fishing zones for Cook Islands fishers to enable them to supply the ever-increasing local market for fresh fish. FADs are an integral part of local fishing communities, and provide a reasonable form of income to the increasing fishing community.

Key-words: Fish aggregate device technology and development, data collection, FAD social and economic impact, South Pacific, Cook Island.

Background

The country

The Cook Islands comprises 15 islands that extend over 1,500 kilometers of ocean in a north-south orientation. The country, located between 156° and 167° W longitude and between 8° and 23° S latitude (central Polynesia), has a 200-mile economic zone (EEZ) of 1,830,000 square kilometers. The 15 islands have a total land area of 237 square kilometers and fall naturally into the Northern and Southern groups (*figure 1*). The islands of the Northern Group, as well as Aitutaki and Manuae in the Southern Group, are typical coral atolls, generally enclosing a lagoon. The southern islands of Mauke, Mitiaro, Mangaia and Atiu are volcanic with elevated encircling reef platforms adjacent to the coast. These islands have soils which range from heavily weathered and infertile soil in the older islands to the highly productive younger soils of Rarotonga, which is a high volcanic island.

The Cook Islands climate is generally mild. In the Southern Group, temperatures range from 16°C in August to 32°C during January with an annual average of 25°C. In the northern atolls, temperature range from 20°C to 37°C, averaging 29°C. Rainfall can vary considerably from year to year; however, it is normally around 200 centimeters per year. Winds are predominantly from the south-east quarter, with average speeds varying from 13 km/hr in the Southern Group to 16 km/hr in the Northern Group. The Cook Islands lies within the cyclone belt and during the cyclone season (November to March) is subject to occasional tropical cyclones.

The Cook Islands is a self-governing state in association with New Zealand. The country has a population of approximately 18,000; the majority reside on Rarotonga (55%) and Aitutaki (13%) (Anon 1997). The Cook Islands cash economy is best developed on Rarotonga, the capital and seat of government, and on Aitutaki, which

is a popular tourist destination. The economy is primarily based on growing tourism, offshore banking and black pearl industries.

Marine resources and fisheries

The fisheries sector is one of the nation's major exploitable natural resources. Marine resources are divided into aquaculture (primarily for black pearls), offshore fisheries (tuna and tuna-like species), coastal reef associated fisheries, and offshore minerals (magnesium). With the exception of the pearl industry on Manihiki, development activities to date have experienced problems due to various constraints. They include (1) the lack of investment capital, (2) limited entrepreneurial and management skills, (3) the dispersed and isolated nature of the islands, and (4) lack of infrastructure. Currently the capacity to commercially utilise these resources is lacking. As a consequence the resources in the Cook Islands have yet to be fully developed.

The production of black pearls from Manihiki and Penrhyn is one of the country's major industries and is ranked as the second largest export earner after tourism. Black pearls (raw and processed) accounted for an average of 85 per cent of exports from the marine sector over the last 10 years. Other export fisheries include ornamental fishes, trochus and black-lip pearl shells. Within ecological safe limits, efforts are being made towards the full commercial development of these fisheries.

The consumption of food derived from the sea ranges from 15 kg/person/year on Rarotonga to 45 kg/person/year on Aitutaki and 100 kg/person/year on Penrhyn, with an overall annual average per capita consumption of 47 kg. There are three main areas fished in the Cook Islands the reefs, the near coast and offshore. Reef-associated fisheries are predominantly utilised by Cook Islanders and remain largely

subsistence in nature. Bottom-, troll-, spear- and gillnet-fishing, and gleaning and scoop-netting of flying fish are common activities used to exploit both the near coast and reef fisheries. In addition to subsistence harvesting, small-scale commercial fishing occurs in the more populated southern islands, particularly on Rarotonga and Aitutaki where urban population and tourism have created a strong demand for fresh seafood. The establishment of fish aggregation devices (FADs) since 1980 has resulted in the increased production of pelagic fish species including *Katsuwonus pelamis* (skipjack tuna), *Thunnus albacares* (yellowfin tuna), *Thunnus alalunga* (albacore), *Thunnus obesus* (bigeye tunas), *Coryphaena hippurus* (mahimahi), *Aanthocybium solandri* (wahoo) and *Makira* spp (billfish).

The Cook Islands currently has a limited capacity to fish in oceanic waters. As a consequence the Ministry of Marine Resources (government agency) has established licensing agreements with distant water fishing nations in order to exploit the country's tuna resources. The country is, however, keen to establish a locally based, small-scale (20-30 meter vessels) longline fishery, possibly through joint ventures with foreign investors.

FAD Program

History

In 1980 a program of FAD deployment was introduced to the Cook Islands. The major objectives of the introduction were to improve productivity by reducing scouting time and associated travelling costs, to improve the safety of small-scale fishing operations, and to divert fishing effort from coastal species to pelagic fishes.

All FADs deployed by the government in the Cook Islands are anchored to the seabed in positions intended to be accessible by small boat owners. At the introduction of the FAD program in 1980 a total of seven and three boats regularly fished for pelagic species on Rarotonga and Aitutaki respectively (Dashwood, J. and Herman, T. pers. comm.). The fleet has steadily grown and in 1999 a total of 60 and 20 boats fish regularly on the respective islands. Fleet size on each of the remaining islands, which have occasionally had FADs, range between 5 to 10 boats. The boats are mostly wooden skiffs from 4.5 to 7 meters in length, powered by outboard engines from 25 to 90 h.p.

These regular FAD-fishing vessels, most of which operate on a part-time basis, utilise a variety of fishing methods, including trolling, vertical longline and drop-stone fishing with the occasional episode of live bait-, night-, and pole-and-line fishing. These methods are best described by Preston et al. (1987, 1999). Over the last 15 years government and intergovernmental organisations have developed and implemented training programs to improve fishing craft, gear and fish handling techniques to ensure a reasonable supply of tuna and other pelagic species to the local markets. However, the current demand still exceeds supply.

FAD technology and deployment

Since the implementation of the FAD program, various designs have been used in the Cook Islands with varying degrees of success. Initial float systems were constructed from a number (1 to 3) of foam-filled plastic or steel (200 liter) drums lashed together or welded in steel frames. This was followed by the use of aluminum catamarans developed in Samoa. These designs were found to have bow and stern responses to wind and current directions, therefore were subject to turning in either anti-clockwise or clockwise directions. The outcome of these sudden movements caused twisting in the main mooring line despite the presence of a substantial number of swivels. These designs were later replaced with steel spar buoys and more recently with the Indian Ocean designs (refer to Gates et al. 1996).

Hardware components were made of galvanized steel with the occasional attachment of anodes. Initially, three-strand polypropylene rope (22-mm) was used as the main mooring with chain attached at the center of the mooring line to create a catenary curve. The catenary curve was later improved with the use of nylon rope (19-mm) as the upper portion of the mooring line. By 1998, eight-strand nylon and polypropylene rope substituted the three-strand mooring line.

In total, approximately 70 FADs have been deployed on various islands in the Cook Islands in depths ranging from 800 to 1,600 meters. During deployment the buoy is released and the mooring line laid-out as the deployment vessel steams away from the buoy. The anchor is released when the vessel reaches the intended FAD site. Depending on sea conditions, the deployment vessel releases the mooring line either in a circular, zigzag or hairpin configuration over the intended FAD site. FADs that were unintentionally dropped in shallow water have had the mooring line shortened; however, little can be done to those dropped in areas deeper than intended.

The Cook Islands FAD program has provisions for monthly inspections and maintenance. This involves diving using SCUBA equipment to allow visual checking of the upper components and if necessary repair or replacement of worn components; this has to be managed as best as possible, often under very dangerous conditions. Common problems observed during inspections included worn hardware components (normally after the FAD has been in place in excess of nine months) and the mooring line fouled with fishing gear.

Through regular improvements, FAD longevity in the Cook Islands has improved considerably; however, it is by no means perfect. Prior to 1985, average life expectancy was within the order of nine months; this was later extended to an average of 18 months primarily due to a regular maintenance program. Between 1990 and 1995 average longevity increased slightly; however, a number of FADs were in place in excess of 30 months, with one FAD achieving 61 months.¹ These long-lasting FADs were steel spar buoys deployed in sites which had previously been surveyed using echo-sounding and global positioning (GPS) equipment. In an effort to improve the longevity of FADs, 200 meters of soft PVC tubing was added to protect the upper portion of the mooring line, and the spar buoy was substituted with the Indian Ocean raft. Despite site surveys and regular maintenance the loss rates have been unacceptably high. The short lifespan is believed to be due to the lack of pressure resistance in the buoy system.² This could be improved by substituting a number of purse seine floats with pressure floats capable of withstanding depths to 300meters.

¹ This FAD initially had a steel spar buoy, which was replaced after 24 months due to heavy rust. The second buoy was replaced after 28 months with the Indian Ocean design which lasted for a further 9 months.

² The buoy system comprises 40-50 purse seine floats (each has a buoyancy of 7 kg) strung onto 30 meters of PVC-coated 16 mm galvanized wire rope. We suggest, if this system is going to be used, to add 4-5 pressure floats (each having a buoyancy of 20 kg) capable of resisting 300 meter depths and alternatively strung between purse seine floats.

Apart from deployment errors and mechanical failures, FADs have been lost through ship collisions, sabotage and cyclones. Ship collisions have occurred in the past due to inadequate markings and little consideration given by the deployment agency to local shipping activity. Collision problems have now been minimised by the clear marking of FADs and closer cooperation with shipping authorities. With regards to sabotage, FAD moorings have been cut for unknown reasons and lights removed by early morning fishers to hinder FAD identification by other fishers.

On several occasions, particularly during early morning troll fishing, disputes have arisen among fishers or individual boat owners from other locations. However, the most contentious issue with regards to FADs and people in the Cook Islands is the use of mid-water fishing techniques and the capture of bait fish. During mid-water fishing activities fishers tend to moor boats to FADs. Other fishers believe that this causes undue stress to the FAD mooring system and that the use of ground bait drives tuna and associated species to depths where troll fishing is ineffective. On some occasions the disputes have become serious, with fishers being threatened with machetes. There is one known case of firearm use but fortunately no fishers were harmed. Fishers have disagreed to bait fishing at FADs due to the justifiable reason that bait fish attract large schools of pelagic fishes. However, individuals carrying out FAD inspections have reported that large school's of bait fish (*Decapterus macarellus* and *Selar crumenophthalmus*) are generally not found at FADs during periods of good pelagic fish catches.

Data collection

Attempts have been made to determine the benefits of FADs to fishing communities in the Cook Islands. These have generally involved the recording of information

such as species, size composition, fishing methods and fishing period. However information from outer islands is incomplete and hence difficult to interpret. As a consequence, this report only relates to the FAD program on Rarotonga.

Sims (1988) reported that trolling around FADs produced higher returns in terms of catch volume than trolling along reef areas. He also reported that FADs enhanced the development of highly productive mid-water fishing activities. Mitchell (1997) reported a five-fold increase in catches around FADs compared to the reef coast. A third study showed that fishers made slightly more (20%) fishing trips to FADs as opposed to the reef coast (Bertram et al. 1999). It also reported a 35 per cent increase in annual yield and the fishing community received a ten-fold catch return on the money paid for deploying one FAD. The latest report concluded that in the absence of FADs, fishing effort would largely be distributed along the coast or perhaps a decline in catch volume may be expected.

All three studies reported mid-water fishing activities to be more productive than troll fishing. Bertram et al. (1999) estimated average gross income of NZD210 and NZD95 for mid-water and troll fishing trips respectively; however, they found only 10 per cent of all trips made to FADs carried out mid-water fishing activities during 1998. Returns to fishers are highly variable depending on fisher experience and vessel economics. The average monthly catch values for FAD troll fishing range from NZD30 to NZD155, with an overall average of NZD95 per trip (calculated from Bertram et al. 1999). Catch composition by weight for fishing at FADs during 1998 comprised 75 per cent *T. albacares*, 12 per cent *K. pelamis*, 9 per cent *A. solandri* and the remaining 4 per cent made up of *Makira* spp, *Elagatis bipinnulata*, *C. hippurus*, *Sphyrna barracuda* and *T. alalunga*. These estimates were similar to those reported by Mitchell (1997).

Social and economic impact

No studies in the Cook Islands have quantified the social-economic importance of FADs to fishing communities and society as a whole, or how the FAD interact with the national economy. This is recognized as an important yet difficult task. Since the introduction of the FAD program, there has been an increase in the number of fishers who regularly fish, most of whom operate on a part-time basis. Currently there are 19 full-time³ fishers on Rarotonga, three of whom are charter operators (*figure 3*). On Aitutaki there are a total of four full-time fishers and one full-time charter operator. Part-time⁴ fishers appear to have increased rapidly; this could be due to improved economics of fishing and the increasing demand for seafood, which has created alternative opportunities to supplement household income. FAD fishing in the Cook Islands remains largely a male-dominated activity, with fishers ranging in age from 17 to 65 years. Fishers regard FADs as useful tools, and nearly always visit FADs when fishing in the area.

Finance

Despite the generally accepted benefits that FADs bring to fishing communities, the central government financing agency does not seem to recognise the importance of FAD programs. Prior to 1993 the majority of FADs deployed in the Cook Islands were funded through aid programs with little financial contribution by government. Subsequent FADs were purchased through the operating budget of the government agency responsible for the program. However, due to economic reform (in 1995) and prioritization of government activities, the agency responsible for the program

³ Full-time fishers are those who fish to provide more than 90 per cent of their income.

was unable to continue with the purchase of FAD materials for future deployment at various locations. As a consequence of this difficulty and in an effort to instigate a 'user-pays' system, fishers were asked to develop means to generate funds for the program. An association was formed in November 1998 with representation from all fishing clubs in the Cook Islands. This association's primary task is to identify areas where government can more effectively provide assistance, and to assist government in developing coastal fisheries policy guidelines and regulatory measures on the use of FADs. Through cooperative efforts between the Association and Government agencies, fishers have made contributions, which range between 15 to 30 percent to the FAD program. Fishing communities⁵ have used and suggested different methods to raise funds for their FAD program they include the following:

- Ø The Aitutaki fishing clubs currently have two FADs, at the time of writing one FAD was 11 months old the second 27 months, both were funded by government and aid sources. Club members have agreed to designate a day in which fishermen fish and sell the catch at reduced prices. The fishing days would occur during periods of high catch rates and when there is a general glut on the tourist market (restaurants, hotels).
- Ø Mangaiia Island has a relatively smaller club membership and lacks significant tourist facilities. Club members have designated the first Saturday of each month (weather dependent) as FAD fund raising fishing days.
- Ø Boat owners of the four fishing communities on Rarotonga contribute NZD50 per year to their respective clubs.

⁴ Part-time fishers are those who fish on a regular basis to supplement household income; this does not include recreational fishers.

Ø On Manihiki a fishermen/pearl farmer voluntarily funded 60 per cent of a complete FAD. This surprisingly generous offer is the first of its kind. To avoid the possibility of ownership that may result in disputes, or sabotage, the Ministry of Marine Resources has requested that other fishermen also contribute towards their FAD fund.

Funds raised by each club are placed in their respective accounts. Using the various systems three FADs have been deployed and materials for two more FADs have been ordered. It is anticipated that the contribution by fishing communities will gradually increase with time particularly the more developed fishing communities of Rarotonga and Aitutaki.

⁵ There are several fishing communities and clubs in the Cook Islands, these bodies consist of president, committee and club members, and some have clubhouses (similar to a sports clubs). The Cook Islands Fishermen's Association is a body made up of all fishing club presidents.

References

- [1] Anon., Cook Islands 1996 census of population and dwellings. Main Report. *Min. Fin. Eco. Man.* Cook Islands, 1997, 105 p.
- [2] Bertram I., Tatuava S., Kaitara I., Rongo N., Apolo T., Roi N., Mitchell J., Makikiriti N., Rarotonga Fish Aggregate Device (FAD) and coastal catch report for 1998, *Mis. Rep No. 99/19. Min. Mar. Res.*, Cook Islands, 1999, 14 p.
- [3] Gates P., Cusack P., Preston G., Watt P., Rigging deep-water FAD moorings, Vol. II. *Sec. Pac. Comm.* Nouméa, 1996, 43 p.
- [4] Mitchell J., FAD survey report *Mis. Rep No. 97/1. Min. Mar. Res.*, Cook Islands, 1997, 4 p.
- [5] Preston G., Mead P., Chapman L., and Taumai P., Deep-bottom fishing techniques for the Pacific Islands. A manual for Fisherman, *Sec. Pac. Comm.* Nouméa, 1999, 82 p.
- [6] Preston G., Chapman L., Mead P., and Taumai P., Trolling techniques for the Pacific Islands. A manual for Fisherman, *Sec. Pac. Comm.* Nouméa, 1987, 126 p.
- [7] Sims N., A cost-benefit analysis of FADs in the artisanal tuna fishery in Rarotonga. *SPC/Inshore Fish. Res./BP. 36.*, Nouméa, 1988, 11 p.

List of figures

Figure 1. The islands of the Cook Islands.

Figure 2. The growth of full-time and part-time fishers and fishing crafts on Rarotonga.

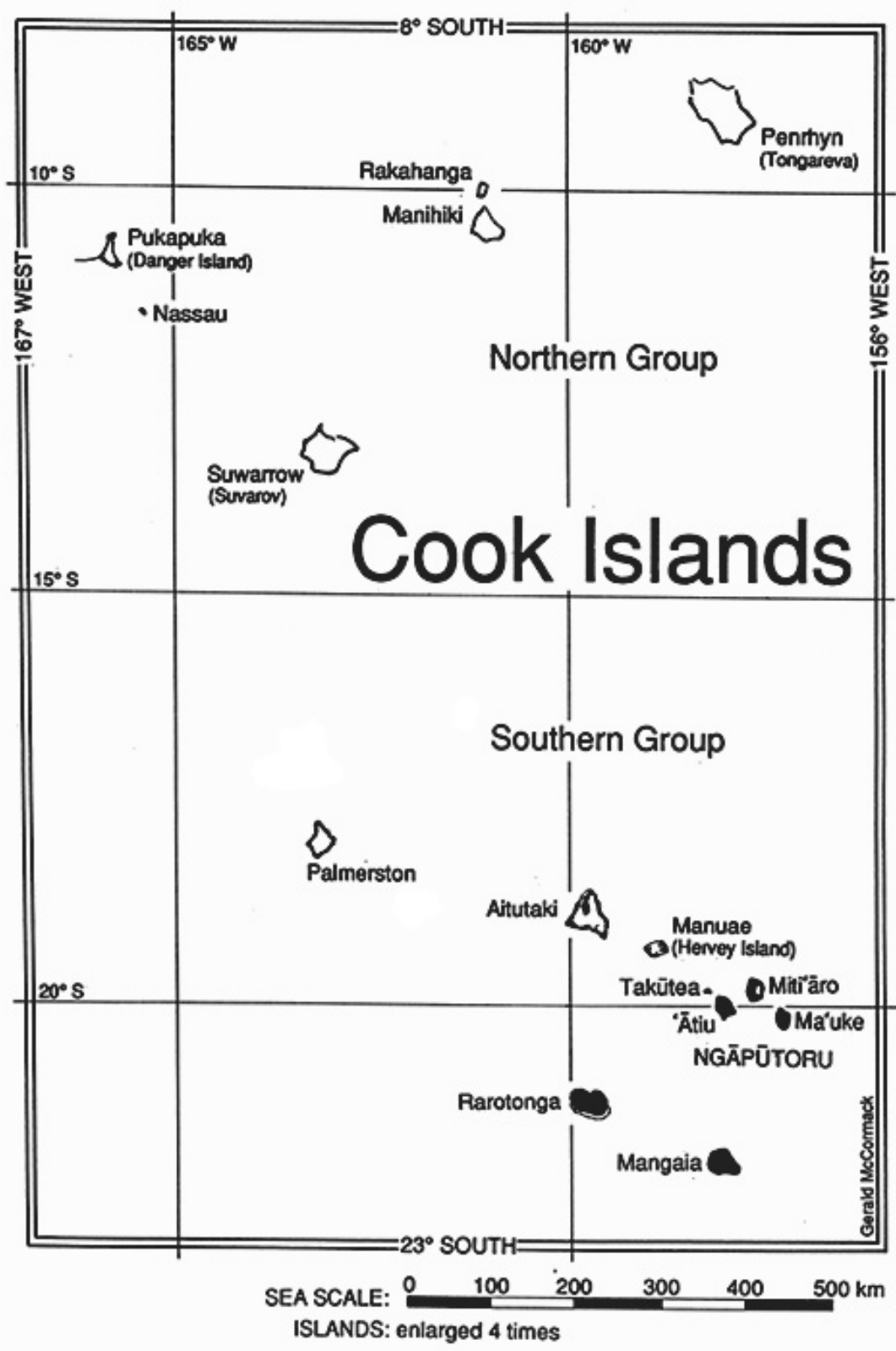


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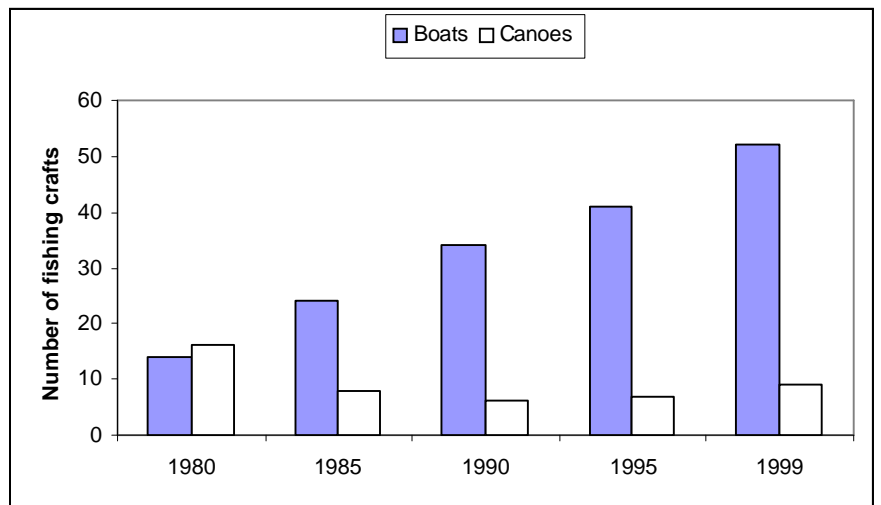
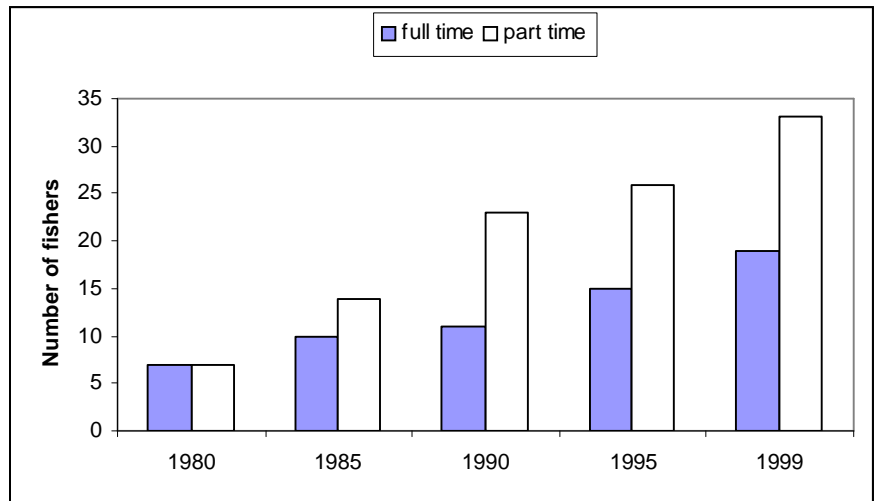


Figure 2. The growth of full-time and part-time fishers (top graph) and fishing crafts (bottom graph) on Rarotonga. The graphs do not include recreational fishers or their fishing crafts.