

Aquarium Fisheries
Potential for Export from the Outer Islands
of the Cook Islands
Information Paper No.?

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Introduction

In the early 90's the annual sales of aquarium fish and invertebrates was estimated to be between NZ\$35 to NZ\$60 million. The Philippines, Hawaii, Indonesia, Mexico, Sri Lanka, Mauritius, Kenya, Maldives, Seychelles, and islands in the Caribbean Sea, Red Sea and the Pacific Region are the major suppliers and the main markets are the United States, Japan and Europe. Within the Pacific nine countries are known to export aquarium fishes they include, Cook Islands, Federate States of Micronesia, Tonga, Fiji, Palau, Kiribati, Marshall Islands, Vanuatu and Australia. There are no recent information regarding the value of aquarium fish exports form the Pacific however the export value of aquarium fish species form the Pacific Islands in 1993 was estimated to be around NZ\$2-3 million (Pyle, 1993). Given the high skill, dedication and initial capital investment involved, and the complex nature of the industry most companies within the Pacific Islands are foreign-owned but employ local fish collectors and warehouse staff. Collectors are paid according to the fish caught and may range from 25-50% of the wholesale price.

Candidate aquarium species are picked for their relatively small size, simple diets and bright or flamboyant coloration. In general, the collection of small fish for the aquarium trade makes use of a readily renewable resource, as long as fishing methods follow some simple rules. This is because most fish of interest in the aquarium trade are small species with rapid life cycles and because these species are largely ignored in traditional food fishing practices. At present there is little information on the impact of the aquarium trade for specific fish species, but the general opinion is that most species can sustain reasonable levels of harvest if collected using environmentally safe fishing practices.

Background to Cook Islands Aquarium Fishery

A Rarotonga-based company commenced commercial exploitation of aquarium fish in 1998, however this activity has not expanded to any of the outer islands. From the establishment of the fishery, approximately 35 fish collectors and 15 warehouse staff have been trained. The fishery employs on average five collectors and two warehouse staff annually, who earn between NZD80 to NZD500 per week depending on their catch and experience.

On Rarotonga a total of 35 marine ornamental fish species are collected by divers using self contain underwater breathing apparatus (SCUBA). These small colorful fish (between 40 to 150 mm in length) are caught with either small-meshed barrier or hand-held scoop nets, however, only eight species are in regular demand. Of these eight, five species contribute between 90 – 95% of the total catch over the past nine years. They comprise of 35% flame angels, 30% red hawks¹, 15% *Anthias ventralis*, 7% *Cirrhilabrus scottorum* and 7%, lemon peel, the first three can therefor be labeled as key species. However the composition of catch on an annual bases is more fragmented, during recent times the export of red hawks and flame angels has decreased with a corresponding increase in *Anthias ventralis*² these trends are primarily due to competition from other exporting countries. The remainder of the species is caught due to customer's request to add variety to the weekly shipment.

The majority of aquarium fish species are caught on the reef slope between depths ranging from 8 to 35 meters, with occasional specimens taken at depths in excess of 50 meters³. The bulk of the aquarium species are captured singularly with nets 1.5 meters in length and 1 meter high. However schooling species such as velvet and vents are driven into retaining nets where the quantity order and desired sizes are scoped.

Captured fish are kept in tanks with circulated fresh salt water on board medium size vessels (5-7 meter) prior to transfer into the warehouse holding facility. To avoid toxic waste build-up during air shipment most fish are not fed, three to five days prior to shipping.

Exports over the ten years of operation have averaged 18,250 fish per annum, worth an average value of NZD190, 000. In comparison with other export commodities⁴ from the Cook Islands over the same period the export of aquarium fish comprises an average value of 3% of total exports or 4.5% of exports from the fisheries sector (*check stats*).

Potential for Outer Islands Involvement

¹ Although the capture of Red Hawks sometimes require the notching of coral heads (the removal of some branches, between 10 – 15%), a study by University of Hawaii biologists indicates that re-growth is relatively rapid and the short-term damage is compensated by the replanting of branches.

² The declines in exports are due supply of cheaper fish from other pacific countries.

³ Local collectors do not catch fish in excess of 40 meters.

⁴ In the context of this paper export commodities include, pearls, pearl shell, fish, pawpaws, taro, maire etc.

Intro sentence about there being room in the world market and the lack of development in the marine sector.

Other islands in the Cooks particularly those with frequent air links and reasonable or competitive freight rates to and out of Rarotonga have the potential for the commercial exploitation of aquarium fish. However the lack of interest, experience, knowledge and investment capital has prevented any collecting on these islands. Careful handling and adequate time for recuperation are critical to avoid high mortality and consistency or reliability in supply, are vital factors affecting the viability of and ornamental fish export operation. In addition consistent and quality supply of fishes in demand are major factors, which contribute to exporters favorable reputation as a reliable source of supply. The easiest means of spreading aquarium fish development throughout the Cook Islands would be for smaller outer-island based operators to feed into an established operation on Rarotonga or set up additional warehouse facilities this is however an option for the private sector. *(The easiest means for the outer island segment but not necessarily the sole means or the best means) problem with Cooks - competing with Guam, Hawaii, Christmas island, Majuro, Fiji, Phillipines, supplying cheaper fish, standing of living export price low, low air links, competitive freight rates.*

The main constraints for outer-island involvement in this industry include the lack of:

1. information regarding the aquarium fish industry,
2. people keen to dedicate themselves to this venture,
3. suitable infrastructure,
4. capital cost of setting up capture and warehouse facilities, the,
5. high cost of freight from outer islands,
6. relatively small human populations⁵ and, the
7. relatively high cost associated with development on outer islands.

Government policy emphasis is placed on balanced development between Rarotonga and the outer islands and to facilitate private sector lead growth. This paper attempts to provide information with regards to factors generally not available to those on the outer islands. *(Workshops to deal with this)* They included what species groups are involved,

⁵ The availability of manpower is limited on islands with small populations.

how can they be caught, how to care for and keep fish healthy and what are appropriate methods of packing and transportation. With regards to the remaining constraints such as freight cost, the personal willing and dedication, capital cost and high island specific associated cost (e.g. fuel, social cost) this is left for local island councils, and the private sector.

This paper attempts to provide a summary of the aquarium trade, with particular emphasis on the requirements for small-scale operations. Bearing in mind the constraints on many of the outer islands, it is hoped that this paper may promote involvement that could lead to increased knowledge and experience. The paper will be of practical use for those planning to enter into fish aquarium fish collecting, maintenance and export. Aspects of the general life history are also covered; these include general habitat, feeding and reproduction. The paper also contains sections on resources management, safety and cost of establishing a small export operation. We hope the information will be of help to those who are intending to capture handle and export marine aquarium fish species. With time and experience some operators could possibly move up the scale of investment and production in future years.

Note: We however emphasis that by reading this paper alone you be able to fully understand and successfully operate an aquarium fish export venture. For those who are serious you will require more reading, we recommend visit to an established operator, and training.

Target Species & General Biology

The target species⁶ for the aquarium trade are found in close association with coral and have distinct feeding and reproductive characteristics (Table 1). Most species generally have relatively short life spans (up to ten years). In most short-lived species reproductive maturity is reached at an early age (between ? to ?% of expected life spans). The majority of target aquarium species have a female initial phase, followed by a male phase. Spawning is concentrated into a short period, often at sundown or shortly afterwards and they produce large numbers of eggs, that after hatching have an oceanic

⁶ Due to the variety of fish species collected for the aquarium trade, the biology of each family group will not be discussed in detail. For information on the biology and other aspects of the aquarium fishery, the interested reader is directed to a recent publication by the Forum Fisheries Agency, entitled, 'Nearshore Marine Resources of the South Pacific' edited by Wright and Hill, 1993: chapter 6; *Marine Aquarium Fish*, by Richard L. Pyle and associated reference material.

larval phase, lasting from two to eight weeks. After the larval phase they recruit to isolated reefs, successful recruitment is however largely dependent on Ocean currents. Maximum size for each species varies, however the majority of species harvested for the aquarium trade range from approximately 50 to 150mm in length. These fish are generally territorial or have limited forage area, which makes them suitable for the restrictive area of a display tank. The general biological characteristics for the species' most commonly harvested in the Cook Islands (Rarotonga) are summarized in the table below.

Table 1. Some biological characteristics of common aquarium fishes harvested from Rarotonga. (Source; Pyle, R.L. 1993). (*other lagoon species may be available, need to determine species availability*)

Common family name	Feeding Habits	Reproductive patterns	Habitat
Hawkfishes	Carnivores	Spawn at dusk, Harem forming, pelagic larval phase	Shallow reef, associated with coral colonies (pocillopora spp)
Damselfish	Herbivores Planktivores Omnivores	Harem forming, and aggregate forming. Spawn during the morning, demersal eggs.	In amongst coral rubble.
Wrasse	Omnivores	Harem and school forming. Protogynous. Spawn throughout the day.	Throughout all areas of reef and lagoon.
Angelfish	Herbivores Omnivores	Harem forming and pair forming. Spawn at dusk. Pelagic larval phase.	Throughout entire reef system.

Given the above constraints it may appear sensible if Cook Island collectors maintain smaller scale or part time operations. Higher than average value and quality fishes could be targeted so that the operation would be competitive and economically attractive. Low value species are within the price range of \$ 0.50 to \$1.00. These species are generally in high supply and if targeted as the main species, would be difficult to financially support a Cook Islands aquarium fishery on outer islands.

Table 2. (Source; Pyle, R.L. 1993, CIAF)

Species (Family name)	Value (NZ\$)	Demand	Depth (m)	Method of collection
Pomacanthidae (Angelfish)				Hand net and small barrier net with poker
Acanthuridae (Surgenfishes & Tangs)				Hand net and large barrier net
Labridae (Wrasses)				Hand net and small barrier net with poker
Serranidae (Basslets)				Hand net and small barrier net with poker
Chaetodontidae (Butterflyfishes)				Hand net, occasionally small barrier net with poker

Types of Aquarium Fish Harvesting Operations (need to re-look at this)

Three scales of harvesting and export operations are identified, they include; 1) large-, 2) medium-, and, 3) small-scale.

- 1) Large scale: this size of operation employs between 15 to 20 keen enthusiastic individuals, with relatively high capital (in excess of NZ\$500,000) and operating cost (grater than \$250,000 per annum). Capital equipment includes boats, a dive compressor, dive equipment, warehouse and packing equipment, transportation, generators, UV filters, saltwater pumps, air filling facilities and other complicated yet durable equipment capable to withstand the hash elements of the marine environment. Employees have an understanding of fish disease, water quality/chemistry, equipment maintenance, first aid, and business management. Operations of this magnitude also import fish from smaller operators for onward export. These operations have the capacity to import and export fish and invertebrates in excess of 70,000 pieces per annum (1,500 – 2,000 fish per week). Given the relatively high air freight costs and the relatively small and dispersed nature of reef systems within the Cook Islands, this magnitude of aquarium fish collection is considered too large for a single island in the Cook Islands.

- 2) Medium scale: This size of operation requires a boat, dive gear, transportation, holding and packing facilities, UV filters, saltwater pumps etc. Capital cost is within the order of NZD100,000 to NZD200,000 dollars and operating expenses between 30 to 50% of gross revenue. Staff employed may range from 5 to 10. This scale of operation has the capacity to export between 15,000 to 30,000 fish and invertebrates.
- 3) Small scale or part time operation: This scale assumes a boat and means of transportation (truck) are available, capital cost to successful export 200 to 300 quality species per week is within the order of \$2.50/species. This requires diver gear, etc. A group of 3-4 individuals could invest ?? \$, Assuming they target high value species potentially earn between 1 to 3 million dollars per annum. (bit messy)
100 fish per week/. High value 2.50, schooling fish minimum two divers, three divers in case one gets sick, cant target only high value fish, market. Power fule double on outer islander.

Capture Method/s

The higher than average value aquarium fish species tend to be found along the reef slope, so boats, SCUBA or Hookah systems are required. The majority of aquarium fishes can be collected by hand nets and barrier nets. Hand nets are made from monofilament mesh (mesh size 13 – 20 mm) strung around a stainless steel wire hoop. The hoops vary in shape and size however are generally large enough to encompass a human head. Barrier nets are rectangular in shape with monofilament mesh (mesh size 13 – 20 mm), weighted along the bottom with lead and floats attached on the headline. The weights (lead) are closely spaced to allow the net to follow the substratum closely. They are generally one to five meters long.

For schooling fish, barrier nets are generally set in a 'V' configuration and divers herd fishes into the net by hand or using a poker (metal or fiberglass rod). When fish have entered the net, divers close the ends and capture fish singularly by hand nets. Species living in close association with coral are generally caught singularly with hand held nets and pokers. Although toxic chemicals are sometimes used overseas they are detrimental

to the ecosystem and are not recommended⁷. (mention breaking or coral as one draw back of this fishery, branches are planted).

After the capture of fish they are immediately placed in some sort of container for example a rigid perforated plastic container⁸. On ascent most species of fish taken from deep water require decompression to adjust to the changing pressure. The fish must be brought to the surface slowly (*what is a reasonable rate*) or the swim bladder can be punctured with a hypodermic needle. The latter method of decompression requires skill. Once the fish is brought to the surface they are placed in holding facilities on board the fishing vessel. Twenty to fifty liter plastic containers with portable (battery-operated) air pumps filled with seawater are suitable for small fishing vessels.

Holding and caring for Fish if there is no holding tank facilities

Upon returning to shore, live fish can be stored in home made capsules (figure?). To construct a capsule a 200mm length of 50mm diameter poly-vinyl-chloride (PVC) pipe with one female cap fitting is required. One end of the PVC pipe is flame heated and sealed by compression (clamped in a bench-vice). The female cap is placed on the opposite end of the sealed PVC pipe to create a capsule. About ten 15mm holes are randomly drilled in the PVC pipe to allow the flow of water.

In order to prevent fish battles, which will result in damaged fish fins, each capsule should contain only one fish. These capsules are placed on a buoyed line in the lagoon to await transportation. The buoyed line should be situated in a well-protected area at a depth of three to four meters.

Packing and Air Transportation

For air transportation fish should be carefully removed from capsules and packed in double-layered polyethylene bags with sufficient water to ensure the fish are completely submerged. The polyethylene bags are then filled with pure oxygen. The bags should be sealed with rubber bands and stocked in Styrofoam fish boxes. The packing of fish should begin about three hours before the scheduled flight. Upon the export of fish an

⁷ Chemicals are

⁸ For example a 10 liter plastic bucket (including lid) with numerous holes

“agent/consignee” on the receiving end (Rarotonga) should be notified. (*expected percent mortality ? cost?*)

Capital Cost

The materials listed below are for a small-scale operation exporting within the order of 100 high value healthy fish per week. It assumes the operator owns a reasonable size boat (3 – 5 meters) with an out board motor and some means of transportation e.g. utility pickup truck.

Material	Cost (NZ\$)
SCUBA gear	
Tank, BCD and computerized regulator	
Wet suit, fins, mask and snorkel	
PVC capsules (100)	
Buoys (2)	
Long line (30 meters of 12mm line)	
200 meters of 6mm rope	
Fishing nets and rods	
Aerator	
Fish bins	
Swim-bladder piecing needle (10 Regularly replaced)	
Warehouse	
Operating Cost include: Fuel, oil, freight, repairs to fishing equipment, tank fills, communication cost, packing supplies (if SCUBA gear is used)	
Warning of potential problems	
Contact names and phone numbers	

Note: prior to entering into this type of operation it is advisable that the interested individual consult an established operator on Rarotonga. Training in fish collection,

handling, and packing techniques is essential for a successful operation. It is also recommend that (*additional reading*)

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Safety (relate this to aquafish, boats and diving)

Common injuries experienced by individuals working in the marine environment are cuts on the fingers from healthy sharp edges of shells and coral. In the tropics small skin breaks can become seriously infected if not treated properly. Therefore if blood leaks occur disinfectants, antiseptic solutions or creams (e.g.) should be applied to avoid serious infections. It is advised that a basic first aid kit be kept at home and on your workboat to treat any wounds. You can put together a kit that is cheap and simple and should be sufficient to cope with most common injuries incurred at sea. Your kit should have at least something for pain, (e.g. Aspirins, Panadol), Band-Aids, some bandages, sterile gauze, adhesive tape, antiseptic liquid and ointment. These supplies could be kept together in something simple such as a child's plastic lunch box or even an ice cream container. If further medical assistance is required, make sure the doctor or nurse treating the victim knows what type of animal bit or stung the victim.

There are two types of ear problems: 1) Ear infections are common but seldom an emergency situation. 2) Ear injuries such as burst ear drums are serious and are usually caused by failure to clear ears during descent. The best way to prevent ear injuries is by using careful, non-forcing clearing technique before entering the water and repeatedly during decent. (wet ears, treatment).

Hypothermia or feeling cold causes discomforts while working underwater. In 28 - 30°C it is possible for divers to work for 1-2 hours without becoming seriously chilled. Chilling can be overcome by wearing a 3-5mm wet suit. Continuous chilling may cause long term illnesses. (J. Mitchell *pers comm*). (*Also while on the boat wear wind-breaker over the wetsuit to maintain body heat*)

Very high surrounding temperature that results in an extreme rise in body temperature causes heat stroke. Wearing a hat and light colored, protective clothing will help prevent this condition. Signs and symptoms include, patient feeling hot and dizzy, headaches, the patients skin feels hot and looks red, pulse is full and pounding, breathing may be noisy. Deep unconsciousness may develop very quickly. Rest patient in cool place and remove outer clothing. If unconscious, put patient in safety position monitor breathing and circulation and seek medical help immediately.

Reflection off sand and water, Sunglasses and long term eye fuckups

If underwater breathing apparatus (e.g. SCUBA or Hooka) is used it is mandatory for divers to be certified and follow safety procedures. Divers can suffer from decompression sickness (the bends) the importance of proper training in the use of compressed air while diving cannot be over-emphasized.

Lagoon nursery workers have encountered various reef organisms, though some are dangerous they posed no real danger, workers are at little risk if a measure of common sense is used. The organisms encountered are listed with precautions, advised action and treatment if workers are harmed. (Mention farms in deep water)

Morays eels and sharks; these should be left alone and not be provoked. If big sharks are observed one should remove him/her self from the water. It is also recommended to warn fellow workers of the situation. If bitten hospital treatment is recommended, in extreme case burial may be required.

Stonefish, on many occasions are well camouflaged usually in association with coral. Stonefish tend to be territorial (living in a certain area) they should be either shot or one should take great precaution when diving or working around them. If stung place a hot damp towel on the infected area particularly if stung on the body, limbs such as feet and hands can be placed in hot water (as hot as bearable). However make sure the water or towel is not too hot that it cooks your body or limbs.

Lionfish, are occasionally found under coral ledges they produce a sting if touched. Although not fatal they provide a pain and itch which may last from one to six hours. Unless one does not mind the minor pain or irritant it is recommended that these creatures be left alone.

Fire coral and blue bottle (jellyfish), if stung apply ice water or rub stung area with an ice cube. Remove spines or tentacles (i.e. using tweezers not rusty pliers) soak the infected area in vinegar or alcohol (mentholated sprits or similar, not Jamaican Rum) or get buddy to urinate on infected area, hot water treatment is also useful. Seek medical help if a victim shows signs of dizziness, vomiting or other weird behaviors.

Cone shells are considered rather pretty by most idiots; however may produce a deadly toxin when stung, if left alone there is virtually no chance of being attacked. If venomous cone shells are picked up we hope you have previously taken out life insurance policies.

Management Guidelines

Establishing management guidelines for the aquarium fish industry is high on the agenda if exploitation is expanded to outer islands within the group. It is anticipated that these regulations be designed to achieve the following goals, (1) minimize the conflicting issues between different user groups, (2) prevent overfishing, (3) encourage local participation, and (4) maintain and increase economic benefits to the country.

In summary, the Rarotonga experience with a recently developed fishery for aquarium fish has been a success, in terms of creating employment; fisheries development and self imposed management. However local participation at the management level/investor has remained static. Although there has been some objection to the operations of the industry, there appears to be no local depletions of the species concerned. Only one study has determined the impacts of aquarium fish collection on coral reefs. With the current concerns further monitoring is required.

Species	4 cm	5 cm	6 cm
<i>T. maxima</i> (blue)	4.80	6.50	9.20
<i>T. maxima</i> (green)	3.80	4.80	6.70