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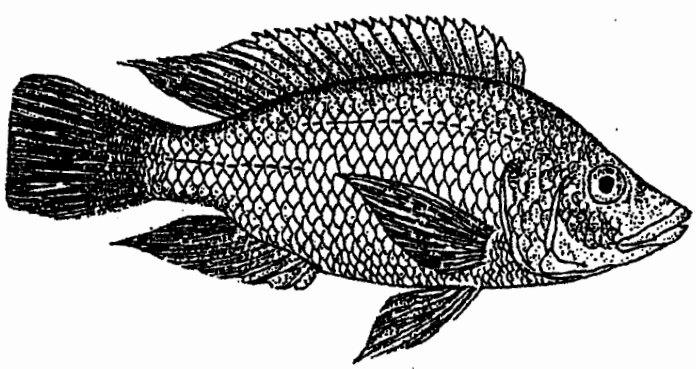
FIELD REPORT 10.

A REVIEW OF INTRODUCTIONS OF AQUATIC SPECIES INTO WESTERN SAMOA AND AN ASSESSMENT OF THEIR ENVIRONMENTAL IMPACTS

1991



Report prepared for the Government of Western Samoa by the Food and Agriculture Organization of the United Nations based on the work of Leon P. Zann.

1. INTRODUCTIONS OF FOREIGN SPECIES

The following is a working paper documenting the introductions of exotic aquatic species into Western Samoa and assessing their known, and potential, environmental impacts. It was produced to assess the environmental effects of proposed introductions in the Fisheries Division's aquaculture program, and in response to growing concerns by the Department of Lands and Environment and the O le Siosiomaga Society and others on the degradation of the Western Samoan environment.

1.1 Potential benefits ... and problems

Introduced, cultivated varieties and species are the basis of all modern agriculture. As well as those introduced for agriculture, many other exotic or foreign species of plants and animals have become established outside their natural range by accident, and as ornamentals, pets, exhibits etc.

The introduction of exotic species may sometimes have catastrophic environmental effects, particularly on fragile island ecosystems. Unregulated by their natural predators and diseases, the introduced species may undergo population explosions, depleting their food supply, or eating, overgrowing or outcompeting important native or cultivated species. There are numerous, well documented examples around the world of adverse introductions but undoubtedly this is the tip of the iceberg: most adverse ecological effects of introductions are probably undocumented. However, the effects are often dramatic: the ecology of much of New Zealand and Australia in particular has been devastated by the introduction of scores of animals such as rabbits, foxes, cats etc and by hundreds of weeds and other plants, and many native species have been forced into extinction.

Various aquatic plants, fish and shellfish have also been widely introduced around the world for stocking of natural and artificial water bodies, for aquaculture, and as ornamentals. Many adverse effects on native ecology are documented. For example, water hyacinth has taken over rivers in many parts of the world; introduced mangroves are colonising Hawaii shores; carp are changing the habitat of local species in Australia; Nile perch has depleted native fisheries in Africa etc.

Hundreds of species of land plants and animals have been purposely or accidentally introduced into Western Samoa since the first Samoans brought the coconut, taro and other species for cultivation. About half the plants in this country are exotics (Whistler, 1990). While many of these have been beneficial for agriculture, some have become obvious pests. However, the effects of most remain unknown.

Although the number of aquatic species which have been introduced into Western Samoa for aquaculture or stocking is small (around 10 species known), this is expected to increase as aquaculture develops in this country. The purpose of this discussion paper is therefore to review the past introductions of marine and freshwater species into Western Samoa, to evaluate their effects where these are known, to detail plans for future introductions, and to establish some guidelines to avoid adverse environmental impacts.

2. ACCIDENTAL MARINE INTRODUCTIONS

Many species of plants and animals are carried from country to country as 'fouling' on the undersides of ships, and as larvae in their bilges and ballast tanks. Environmental damage is difficult to assess, although effects on fisheries are sometimes evident. For example, an Australia barnacle almost completely wiped out Britain's oyster industry last century while the Japanese cup oyster *Crassostrea gigas* has seriously damaged Australia's and New Zealand's native oyster industries this century.

So great has been the mixing of harbour species that it is not possible to say where many of them came from, and what harm (if any) they have caused. No doubt various species of algae, sponges, bryozoans, barnacles etc have been carried into Apia and other Western Samoa ports in this manner, but none have become a conspicuous pest.

In general the accidental introduction by vessels is uncontrollable, although ships can be encouraged to discharge bilge and ballast water at sea before entry to harbour.

3. INTRODUCTIONS FOR STOCKING AND AQUACULTURE

In Western Samoa the Fisheries Division, other agencies, and private individuals have introduced a number of exotic aquatic species. The history of each known aquatic introduction to this country is briefly reviewed below:

3.1 Mosquitofish, topminnows (*Gambusia* , *Poecilia*)

3.1.1 Reasons for introduction, origins

The small freshwater 'mollies' have been introduced into many islands to assist in the control of mosquitos. The topminnow, or Mexican molly (*Poecilia mexicana*) was introduced into streams and ditches in Western Samoa around the beginning of the century for mosquito control and were aquacultured as tuna baitfish at Vaitoloa between 1978-82 (Popper, 1982). The mosquitofish *Gambusia* is also recorded from freshwater but details surrounding its introduction are unknown.

3.1.2 Distribution

Today mosquitofish are to be found today in almost every permanent body of freshwater in the country.

3.1.3 Environmental impacts

The various mosquitofish are reputed to be useful biological controls of mosquito larvae, and are certainly preferable to widescale application of environmentally damaging insecticides. Their effects on the aquatic ecosystem and on native fish of Western Samoa are not known but they undoubtedly consume much in addition to mosquito larvae.

3.1.4 *Recommendations*

nil

3.2 Goldfish (*Carassius auratus*)

3.2.1 Reasons for introduction, origins

Goldfish or carp, originally cultivated as ornamental fish and for aquaculture in China, are established in the volcanic crater lake, Lake Lanoto'o, on Upolu. Details

surrounding the introduction are unknown, but it is likely that they were introduced from domestic ornamental goldfish which may revert to a wild type.

3.2.2 Distribution
Lake Lanoto'o, central Upolu

3.2.3 Environmental impacts
Adverse environmental effects on the lake are unknown, but judging from oversea's experience, the carp's habit of stirring up bottom sediments while feeding has probably disturbed the ecology of the lake's benthic (bottom) and planktonic communities.

3.2.4 *Recommendations*
If Lake Lanoto'o becomes a National Park, consideration should be given to the removal of the carp to restore the natural benthic ecology of the lake.

3.3 African Tilapia (*Oreochromis (Tilapia) mossambica*)
3.3.1 Reasons for introduction, origins
The African tilapia, a medium sized nesting cichlid, capable of rapid growth and reproduction in a wide range of fresh and brackish water types, has been widely aquacultured in Africa, and E and SE Asia. It was introduced by SPC into almost every Pacific Island (including Western Samoa) during the 1960's as a potential food fish and for mosquito and weed control. In this country African tilapia were used in aquaculture trials as tuna baitfish in the 1970s (Popper, 1982) and were reared in a pilot aquaculture project at Alofiosalani plantation in 1990-91.

3.3.2 Distribution
Tilapia are today found in most bodies of freshwater in Western Samoa, including Lake Lanoto'o. They may live in brackish or salt water. They are often found in bathing pools in Western Samoa but there are no observations of them in the sea. The Fisheries Division maintained a breeding population but these have been destroyed on advice of the FAO Regional Aquaculturist.

3.3.3 Environmental impacts
African tilapia are reputed to be pests in some areas of the South Pacific (eg Fagauta lagoon in Tonga, several Kiribati atolls, Niu in Tuvalu, Nauru (eg Ranoemihardjo, 1981), Fanning Atoll, (Lobel, 1980)) because they eat or compete with juvenile milkfish and mullet (eg Randall, 1987). In California they have been held responsible for the decline of native fishes (Knaggs, 1977).

Because of their tendency to 'stunt' (ie remain a small size when crowded) and their poor taste when grown in confined waters, African tilapia are not accepted by most Pacific Islanders. However, they may be effective in mosquito control.

3.3.4 *Recommendations*

African tilapia should be eradicated wherever possible.

If eradication is not possible in any situation, Israel tilapia should be released into the water body to improve the strain for fisheries.

3.4 Israel Tilapia (*Oreochromis (Tilapia) niloticus*)

3.4.1 Reasons for introduction, origins

The Israel tilapia is a native of north Africa which has been selectively bred for aquaculture in recent decades. It is a superior species for aquaculture than the African tilapia. It is fast growing, reaching maturity and marketable size (about 0.3 kg) in about six months under optimal conditions, and does not 'stunt' in high population densities. The Israel tilapia and the African tilapia can interbreed and the hybrid has intermediate characters of the two species. It is therefore desirable that the Israel tilapia strain is kept pure. Yields from ponds are about 6-10 tonnes/ha/year, and up to 60 tonnes/ha/year for modern hybrid strains.

The Fisheries Division has imported 300 Israel tilapia as future broodstock for aquaculture on June 2, 1991. The strain was initially developed in Israel and Thailand, and imported for a successful aquaculture project in Fiji. The fish are currently under quarantine at the Fisheries Division but should be released into breeding ponds in the near future.

3.4.2 Distribution

About 200 fish under quarantine, Fisheries Division (100 died in transit). Planned release at Alofiosalani ponds and possible release in Afulilo reservoir.

3.4.3 Environmental impacts

Environmental impacts of the introduction of Israel tilapia into Western Samoa are considered minimal as they will be replacing, or hybridizing with, the already present African tilapia to produce an acceptable food fish. The two species are very similar in habitat and behaviour.

The advantages of this introduction are potentially great. This species has demonstrated aquaculture potential overseas, and is a far better species for stocking than African tilapia. Village level aquaculture would greatly increase Western Samoa's fisheries yields, improve nutrition, provide an income for rural Western Samoans, and would hopefully reduce pressure on the capture fisheries.

Israel tilapia has already been introduced into Fiji, Tonga and other Pacific Islands to replace African tilapia. There are no known adverse environmental impacts.

There is no possibility of an accidental escape at Alofiosalani as the nearest stream is almost one mile away.

Potential impacts of the Afulilo watershed have been considered in recent environmental impact assessment of the Afulilo project for the Department of Lands and Environment (Waugh et al., 1991). Because the water shed is free of exotics (one of the few in Western Samoa), they recommended that tilapia or other exotics not be introduced into the reservoir. If feasible, non-reproductive hybrids might be introduced. The report gives doubts as to the feasibility of any introductions in the initial years because of poor water quality.

3.4.4. *Recommendations*

Israel tilapia should be released at Alofiosalani for aquaculture.

Depending on the results of this project, they should be released more widely for aquaculture.

Stocking the Afulilo Reservoir should be deterred until the water quality is established. However a decision must be made as soon as possible to avoid 'contamination' of stocks by African tilapia.

Israel tilapia should be released where African tilapia are impossible to eradicate, to create a hybrid suitable for fishing.

3.4 Giant clams (family Tridacnidae: *Tridacna gigas; T. derasa; Hippopus hippopus*)

3.4.1 Reasons for introduction, origins

Western Samoa has two species of clams, *Tridacna squamosa* and *T. maxima*. A third species, *Hippopus hippopus*, is recently extinct. The existing clam stocks have been very heavily fished and numbers have been so severely depleted in most areas that they are also approaching local extinction.

The giant clams have great aquaculture potential as they are fast growing, reach a large size, and do not require feeding (they grow their own plant food in their fleshy mantles). Research and development of clam farming has been undertaken in Palau, Solomon Islands and Australia in the past decade. Hatcheries have been established in Fiji, Tonga, American Samoa, Cook Islands, Marshalls, Ponape and other islands.

3.4.2 Distribution

The Fisheries Division in Western Samoa has established a small-scale hatchery and has produced several thousand *Tridacna squamosa* yearlings (W Samoan and Tokelau genotypes) for stocking a private clam farm at Aleipata. It has also imported a number of consignments of exotic, faster growing species for growth trials.

Details of imports of clams, and their present status are:

. 1,000 yearling *T. derasa* from Palau 1988 (about 100 remain at Aleipata farm)
. several adult *T. squamosa* from Tokelau 1989 as brood stock (these subsequently died)
. 700 yearling *T. gigas* from Cairns, Australia, 1990 (400 doa; 200 remaining) .
about 150,000 settled lavae of *H. hippopus* from Solomons, 1990 (all dead)
. about 15,000 three month old seed of *T. gigas* from Orpheus Island, Australia 1991 (consign lost for two days; only 100 alive and currently under quarantine)
. about 15,000 three month old seed of *H. hippopus* from Orpheus Island 1991 (alive and under quarantine)

plus:

. about 1,000 yearling and adult *T. derasa* from Pelau into American Samoa as hatchery broodstock, 1988-91.

3.4.3 Environmental impacts

As there are a number of clam predators (mainly gastropods - *Pyramidella* spp; *Cymatium* spp etc) which cause mortalities in overseas nurseries, the major clam producers and SPC have established some guidelines for introductions of seed from hatcheries. These include a quarantine prior to export for at least three months in one micro filtered water, and the quarantine on arrival of three to six months. The latter is generally not a problem as the juvenile clams are kept in ponds ashore to avoid predation.

The Australian Orpheus Island hatchery did not initially export species beyond their natural range because of the conservational issues but has recently exported seed of two exotics to this country. The question of introduction of the establishment of exotic clam species in Western Samoa has not yet been addressed as none of the Western Samoa imports have yet reached sexual maturity. (The first to do so would be the Palau *T. derasa* imported in 1988 and due to commence reproduction in 1992). As about 700 of the American Samoa imports have now reached sexual maturity and have probably spontaneously spawned in the sea (L. Bell, pers. comm.), the species must be regarded as having being introduced into the Samoa Group.

The establishment of exotic giant clam species would probably have little or no adverse environmental impact. The clams are not 'keystone' species in the reef ecosystem. They take minimal feed from the water and are occupiers only of space only. Because of their particular niche, life history strategy and the great mortality of early stages, it is inconceivable that clams could become so abundant as to pose an environmental threat. The opposite would be the case in this country; fishing pressure would always greatly reduce their abundances, necessitating some management of stocks.

3.4.4 *Recommendations*

The Samoan genotype of the locally endangered T. squamosa *should be preserved by aquaculture. Importation of exotic* T. squamosa *should be avoided.*

H. hippopus *should be reintroduced (from the Great Barrier Reef and/or Solomon Is.) as it is completely extinct in this country.*

The three month quarantine of all clam seed before and after importation should be mandatory to avoid introduction of exotic predators and diseases.

The establishment of breeding populations of T. gigas *and* T. dersasa *should be considered as the giant clams are benign introductions, as they are of importance to artisanal fisheries and aquaculture, and as reproductive* T. derasa *are already present in American Samoa.*

3.5 Pacific oysters (*Crassostrea gigas*)

Western samoa has two species of oyster, *Crassostrea echinata* 'and *C. amasa.* Both have a minor subsistence value. Although the former has been aquacultured in some countries, it is difficult to collect sufficient spat and growout techniques have not been perfected.

3.5.1 Reasons for introduction, origins

The Pacific, Japanese or giant cup oyster is a native of the temperate northern Pacific but has been spread widely via ship's fouling or through introductions for aquaculture throughout the cool-temperate Pacific. It is a large, fast growing species, of good taste, and very suited for culture.

In June 1990 a consignment of Pacific oyster seed (ca 2-4 months age, 8mm size) was imported by FAO Pacific Islands Aquaculture Development program for growth trials at Fusi Safata. These comprised 5,000 diploid seed (ie normal genetics, capable of reproduction) and 50,000 triploid seed (ie an additional chromosome, do not produce gonads, faster growing). The oyster seed was produced by Kuiper Mariculture, California, from local aquacultured oysters (originally probably North West Pacific

origins). As the triploidy technique is not completely successful, about 10% of the 'triploids" were probably reproductive diploids (Cutler, 1991).

3.5.2 Distribution
About 57,000 were placed in pouches in Fusi lagoon, Safata, and about 3,000 triploids were placed at Namu'a, Aleipata. The Fusi oysters were all harvested by April 1991, but it is likely that some of the diploid stock spawned in December 1990 and January 1991. The Aleipata seed all died by September 1990 well before sexual maturity.

It is unlikely that the spawning at Safata was successful, as the water temperature is probably too high for reproduction in Western Samoa. No evidence of spat from the supposed diploid spawning was seen on rocks around Fusi. Despite several attempts, his species could not be established in Fiji.

3.5.3 Environmental impacts
Although it has enhanced oyster production throughout the Pacific, the Pacific oyster has frequently had an adverse environmental impact by displacing native species of oysters because of its rapid growth. In New Zealand and Australia it has displaced aquacultured native species. However, oyster farmers in these areas have switched to culturing the invading species.

The temperature is probably too high in this country for regular successful reproduction. The stress of spawning is reputed to kill this species in the warm tropics. However, the environmental impacts if they became established at Safata would not be as serious. The local species of oysters are uncommon in the area. They would be heavily harvested. There is little suitable habitat for their establishment in Western Samoa as they require silt free rocky shores and nutrient rich waters).

3.5.4 Recommendations
The culture of fast growing, non-reproductive triploid Pacific oysters is an appropriate industry for Safata.

The possibility of viable, reproducing populations of Pacific oysters becoming established on Samoan shores is low.

3.6 Phillipine green mussel ***(Perna viridis)***
3.6.1 Reasons for introduction, origins
The Phillipine green mussel is a native of the tropical northern Pacific. It is a prolific, fast growing species capable of some of the highest yields of any marine animal. It is aquacultured widely in SE Asia and some countries in the South Pacific (Fiji, Tonga, French Polynesia) have tried to establish its aquaculture. Several consignments of seed were imported by the Fisheries Division between 1986-88 from Tahiti (from stock of SE Asian origin).

Trials were undertaken on the aquaculture potential of Phillipine mussels at Fagaloa and Safata on Upolu, and Asau on Savaii. Encouraging results were obtained only from Asau, and wild populations became established from natural spawnings of the aquacultured stock. However, the breaching of the airstrip at Asau during cyclone Ofa has increased the ocean circulation within the bay, making it less eutrophic and less suitable for the establishment breeding populations, and for aquaculture.

3.6.2 Distribution:
Since Ofa the mussels at the Asau wharf have greatly declined, or even entirely disappeared, suggesting that the introduced populations in the bay will eventually become extinct. The aquaculture project has now been cancelled (H. Tanaka. pers. comm.).

3.6.3 Environmental impacts:
The impacts of the mussels on the ecology of Asau bay is not known but would have been restricted to the wharf community (itself a fouling community) and parts of the subtidal shoreline. It must be noted that the bay was formerly eutrophic, and has since returned to a more natural state.

3.6.4 *Recommendations:*
Environmental impacts should be considered if the project is revived. Impacts probably minimal.

3.7 Trochus or Top shell (*Trochus niloticus*)
3.7.1 Reasons for introduction, origins:
Several species of trochid snails are present in Western Samoa. The largest species (*Tectis pyramis:* Aliao) is of some importance in the subsistence fishery but has been depleted by heavy fishing pressure.

The trochus (*Trochus niloticus*) is a large West Pacific species which occurs naturally as far eastwards as Fiji/Solomons/Palau but not in Samoa. It was traditionally used in the manufacture of mother-of-pearl buttons but was replaced by plastics 30-40 years ago. However a renewed demand for 'genuine' pearly buttons and ornaments from Asia has greatly increased the demand for shell and prices have more than doubled in the past five years (eg about USD$7,000-10,000 per tonne in Fiji).

Because of its fisheries value, the trochus has been widely transplanted throughout the Pacific by the Japanese, SPC and FAO:. Gillett (1990) records introductions into over 80 different islands. It is an appropriate artisanal fishery for the Pacific Islands and some introductions have been spectacularly successful (eg 40 individuals were introduced into the Cook Islands around 1970; today it is a multimillion dollar resource). FAO (Zann,1990) has therefore recommended its introduction into Western Samoa as a future fishery.

3.7.2 Distribution:
In trial shipments in 1990 around 100 trochus were imported by FAO into Western Samoa from (Zann; Gillett). Eighty were released around the clam farm at Aleipata on Namu'a (40) and Nuutele (40) Islands.

3.7.3 Environmental impacts:
Trochus are regarded as a benign introduction. There is a single anecdotal report form a fisherman in one of the Cook Islands that one native trochid species appeared less common since the introduction (Sims, 1985). Trochus are algal -feeders and would probably not seriously compete with native species as the standing crop of algae is high on most reefs and densities of large native trochids are very low from overfishing.

3.7. 4 *Recommendations:*
Adult trochus should be introduced into selected areas of Western Samoa to establish breeding populations for future fisheries.

When possible, a quarantine period of one week should be given to identify any moribund and potentially diseased individuals.

3.8 Giant Malayan shrimps (*Macrobrachium rosenbergii*)

3.8.1 Reasons for introduction, origins:
Western Samoa has one species of freshwater shrimp, *Macrobrachium lar*, which is of some importance in the subsistence diet. The related giant Malayan shrimp (*M. rosenbergii*) is a larger, faster growing, SE Asian fresh water species well suited for aquaculture. Farms for this species have been established in SE Asia and the Pacific (Hawaii; Guam; Fiji; French Polynesia) though there is doubt on the commercial viability of most Pacific Island ventures (H. Tanaka, pers. comm.). Western Samoa undertook aquaculture triáls between 1982-86. A commercial venture was established but closed about two years later.

A shipment of *M. rosenbergii* post-lavae were imported in late 1990 as an aquaculture experiment in a small freshwater pond at Lotofaga by the Hans Siedel Foundation.

Because the larvae require specific salinities for their development they can only be reared in a hatchery. It is therefore not possible for this species to become permanently established in Western Samoa.

3.8.2 Distribution:
Lotofaga pool, E. Upolu.

3.8.3 Environmental impacts:
Impacts of pool construction may have effect on local ecology. Native species may be displaced temporarily.

3.8.4: *Recommendations:*

Environmental impacts of pond construction should be considered in each case.

3.9 Seaweed (*Eucheuma* sp)

3.9.1 Reasons for introduction, origins:
Many species of seaweed (ie macro algae) are present on Samoan lagoons and reefs. They are of minor importance in the subsistence fishery. The red alga *Eucheuma* is aquacultured in SE Asia and the Pacific as a raw product for alginates etc which are widely used as food additives. Two consignments of about 15 kg of *Eucheuma* have recently been imported into Western Samoa by the Fisheries Division for aquaculture trials.

3.9.2 Distribution:
Consignment a (March 1991): placed on rope 'lines' at Aleipata: all died by mid April.
Consignment b (June 1991): placed in cages at ten locations west of Apioa and off Aleipata.
(Note: may have been introduced off Afega area in 1970s for growth trials: L. Bell (pers. comm.).

3.9.3 Ecological impacts:
Experience with introductions of Eucheuma in other Pacific Islands indicates that there is no great danger of the species spreading to adjacent reefs. Although there was

initial concern that introduced cuttings would overgrow reefs in Hawaii, a detailed study of the ecological effects found that it could not become established without the help of man as it can only reproduce by vegetative fragmentation and does not form holdfasts. Nor did it appear to compete with native algal macrophytes (Russell, 1983). However, there is the danger of accidentally introducing associated algae. *Acanthophora spicifera* (Vahl) Boerg., *Dictyota acutiloba* J. Ag., *Hypnea musciiiformis* (Wulfen) Lamx. and *Ulva reticulata* Forsshal apparently became established in Fanning Atoll via epiphytes on introduced Eucheumna from Hawaii (Russell, 1982). *Acanthophora* from Guam has apparently been spread to Hawaii and then on to Samoa and Fiji, via Eucheuma cuttings (Doty, 1978).

There are no known reports of adverse impacts reported from Kiribati, in Vava'u in Tonga , and in Fiji during the past 10-15 years.

3.9.4 *Recommendations:*

Eucheuma appears to be a benign introduction of considerable aquaculture potential to village level aquaculture in Western Samoa.

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4. SOME PERSPECTIVES ON AQUATIC INTRODUCTIONS

The following perspectives may assist in developing guidelines for introductions into Western Samoa:

Because of the decline of capture fisheries around the world, the serious depletion of inshore marine resources in Western Samoa, and the decline in consumption of aquatic foods in this country, high priority must be given to the development of aquaculture in the coming decades.

The introduction of cultivated species and strains is essential in aquaculture, but may create potential problems with the introduction of harmful predators, diseases and adverse environmental impacts.

The introduction of aquatic organisms for aquaculture or stocking is analogous with the introduction of exotic organisms for agriculture. (An introduction for aquaculture should not necessarily attract greater attention from environmentalists than the introduction of any new organisms fo agriculture to any new area.)

Insufficient attention has been given in the past to potential adverse environmental impacts in Western Samoa.

The aquatic ecosystems of Western Samoa are largely unstudied. They have probably already significantly disturbed by siltation, pollution, introductions etc.

It is impossible to predict with any certainty the environmental impacts of most introductions, particularly any second-order ecological effects.

An empirical approach is probably most useful in any "environmental impact studies". Which countries have introduced the particular organism? What are their experiences?

There will always be some risks with any introduction.

The potential risks must always be balanced with the potential benefits (ie the increase in fisheries yields, the improvement of nutritition, development of export industries).

In Western Samoan coral reefs are primarily a fisheries resource. They must be conserved and safe guarded to ensure sustainable use, but 'conservation/ preservation' of pristine environments in the conventional Western sense is an inappropriate goal.

It can be argued that any introduction which will be significantly beneficial to the human population, and has not been demonstrably harmful in any other country (particularly another South Pacific Island) is appropriate.

An appropriate period of quarantine should be imposed in each case to avoid the accidental entry of associate organisms, including diseases and predators.

Aquatic organisms are difficult to transport. Many die in transit. All are stressed on arrival. An extended period of quarantine is often not feasible.

The Fisheries Division should continue to be responsible for evaluation of aquatic introductions, but in all cases should consult with the Division of Environment and Conservation on environmental factors, and with the Quarantine Section.