SOUTH PACIFIC REGIONAL ENVIRONMENT PROGRAMME

REEF AND LAGOON RESOURCE MANAGEMENT IN WESTERN SAMOA

A report prepared by:

Dr Robert E. Johannes
Division of Fisheries Research
C S I R O
P.O. Box 20
North Beach, W.A. 6020
Australia.

August 1982.

73/83

INTRODUCTION

This report is the outgrowth of a ten-day trip to Western Samoa in response to a request to investigate problems of "reef and lagoon management." It is, of course, far beyond the capabilities of any short-term consultant to cover adequately the host of problems associated with the sound management of the reef and lagoon environments of Western Samoa (or any other Pacific island country). Man-years of work carried out by a variety of people trained in a wide range of disciplines are required. The extended services of experts in reef, lagoon and mangrove ecology, marine pollution, marine parks, fisheries biology and fisheries socioeconomics are all needed. Assistance in drafting environmental legislation (of which there is currently almost none) is also desirable.

At present, development in the coastal zone is not planned or managed in any integrated way. In addition destructive fisheries practices, a wide range of types of pollution, and the degradation of Western Samoa's very limited mangrove resources by cutting and filling all proceed largely uncontrolled. The current Five Year Development Plan acknowledges the need for an Environmental Management Unit which would establish environmental impact assessment procedures, promote interdepartmental consultation on environmental management, assist in further development of environmental education, formulate environmental legislation and collect and maintain data on the state of the environment. It is hard to imagine a sounder set of environmental objectives. But words are not deeds; funds are very limited and as the Five Year Development Plan acknowledges, "lack of qualified staff and supervisors has been the single most important reason for delay in the implementation of (government) projects."

As a consequence I will suggest, in this report, some ways of tackling environmental problems that could be pursued without a major new commitment of government funds or expertise. This is not intended to suggest that the sound management of reef and lagoon resources can be accomplished in the absence of additional trained personnel and increased government expenditure. It cannot. But, given current political and economic realities, it seems useful to consider how to make some progress in the absence of adequate funds and manpower.

REEF AND LAGOON FISHERIES

Although Western Samoa's reefs and lagoons have been repeatedly described for more than 40 years as overfished, the 1978 Fishery Catch Assessment Survey (Anonymous, 1978) indicated a total annual yield of 666,000 kg for all of Western Samoa except the Apia urban area. With a total reef and lagoon area of 23,100 hectares (area of water less than 50 m deep - figures calculated for me from government survey maps by the Department of Forestry), this catch amounts to an annual yield of roughly 3 tons per square kilometer. Mr. Alfonso Phillip, Chief Fisheries Officer, believes that this catch estimate is too low by about 40% due to incomplete data gathering. This leads to a likely harvest rate of about 4.0 tons per square kilometer.

Such a catch rate is not low by the standards of coral reef fisheries (e.g. Marshall, 1979). One reason for such yields in a fishery with a long history of very heavy fishing pressure is that Samoans eat an unusually large range of species of fish and invertebrates and thus do

not "waste" as much of the reefs' potential productivity as many other peoples do. Another factor which may help to explain the fairly high yield of Western Samoa's shallow waters is that reef fish production may not decrease rapidly when reefs are heavily harvested. Catch-per-unit effort certainly decreases under heavy fishing pressure. But where plenty of subsistence labor is available (in the form of women and children as well as men in Western Samoa) efficiency is of much less concern than it is in a strictly commercial fishery. So as catch-per-unit-effort goes down (that is, when one has to fish much longer to catch the same amount) fishing effort simply goes up. On heavily fished reefs such as Western Samoa's the fish are much smaller on the average, than in less intensively fished areas. But the total weight of fish produced per unit area may not be strikingly reduced.

Therefore, although catch restrictions would improve the cath-per-unit-effort, there is no guarantee that it would substantially increase the total yield of seafood. Thus there is doubt as to whether such a programme would contribute greatly to three of the four objectives of the Fisheries Department as stated in their 1980 Annual Report; that is, to increase fish production, reduce imports and improve nutrition. In addition, such a programme would probably work against the fourth objective - to increase employment. Moreover, limiting fishing effort in a labour-intensive, largely subsistence fishery in a country with high unemployment would be politically unacceptable.

Based on temperate zone examples there is often a tendency in the Pacific islands to feel that comprehensive and continuing catch statistics are the path to good nearshore fisheries management. This is a mistake. Good catch statistics are almost impossible to obtain in a typical Pacific island nearshore fishery where so many species, so many different fishing methods, and so many distribution channels are involved. The cost of routinely obtaining reliable, comprehensive statistics would dwarf the economic benefits that might be derived.

Furthermore, sound, comprehensive principles of reef and lagoon fisheries management do not exist, and it will be a long time before they do. The problems of multi-species management reach their greatest complexity in such fisheries. Scientific understanding of the basic biology of most of the species involved is very poor and the research needed to remedy this situation is extremely time-consuming and expensive.

At present the Fisheries Division does not devote much effort to managing nor gathering catch statistics concerning reef and lagoon fisheries. Given the problems discussed above this does not seem unreasonable. But there are probably a few individual species of reef fishes for which some form of management would prove useful. Mullet, for example, have formed an important portion of reef fish catches in Western Samoa, particularly during on their seasonal reproductive migrations. Mullet are exceptionally vulnerable to overfishing during these runs. In consequence mullet fisheries have failed, or are failing, in other parts of Oceania.

No information is presently available in Western Samoa concerning its mullet fisheries. In the absence of catch statistics, efforts to obtain and record relevant information possessed by reef fishermen could

throw considerable light on this and other fisheries matters at a small fraction of the cost of conventional fisheries data-gathering programmes. If such information indicated that mullet spawning runs were greatly depleted, banning the sale of mullet during the spawning season would be a simple, inexpensive move in the direction of rebuilding stocks. I have discussed in more detail how to obtain valuable management information from fishermen in a paper included with this report as Appendix A.

In short, the comprehensive management of the reef and lagoon fishery in Western Samoa is impractical for the foreseeable future, but stocks of certain species might eventually be managed profitably. Scope for the immediate improvement of Samoa's reef and lagoon resources lies elsewhere, - in reducing widespread marine pollution and destructive fishing practices.

FISHING WITH DYNAMITE

Dynamiting of fish has been a widespread problem in Western Samoa for at least 80 years (see Appendix C). Explosives kill not only target fish, but also the very small ones, thereby reducing fishable stocks in future years. Dynamite is often set off on coral heads, reducing them entirely or in part to rubble. Since many reef fishes depend upon corals for shelter, destroying corals reduces reef fish production. Large coral heads are many tens of years old. Recent studies in the Philippines revealed that recovery of a reef community from dynamiting took, on the average, 38 years (Alcala and Gomez, 1979). Dynamite is also a hazard to the fishermen who use it; at least five Western Samoan men have been killed by premature explosions according to fishermen I interviewed, and a larger number have been seriously injured.

An unusual opportunity arose to interview an experienced dynamite fisherman during the course of this study. The man had retired from dynamite fishing six years earlier, having earned enough money from his illegal activities to enable him to buy a store. Naturally he preferred not to have his real name used, so he will be referred to here as Fanaki'a. Fanaki'a was an intelligent, articulate individual who seemed to have no reservations about answering frankly all questions put to him.

Dynamite fishing is of two types in American Samoa. One method involves throwing dynamite from a boat at free-ranging fish schools (notably mullet) in midwater. The length of the fuse is adjusted so as to detonate the charge at the depth at which the fish are swimming. Three to four sticks are usually used. Matches are taped to the fuse and lit with a cigarette. Sometimes chopped up fish is used to lure schools near the boat.

A different technique is used for bottom fish. A larger charge is employed - typically eight sticks, plus wires and detonator cap. The charge is placed by a diver on a coral head. The wires leading from the charge to the boat are usually covered with sand for a distance of 10-20 meters from the charge; bare wires are believed to tend to scare the fish. Four torch cells in the boat provide the power to detonate the blast. Two boats are used. In one boat close to the blast site an observer watches until sufficient fish have gathered, then hand signals to the other boat to detonate the charge. The blast is usually set off from a distance of about 40 yards. Of the two types of dynamite fishing this one inflicts the greatest damage to the marine environment.

A number of fishermen have been prosecuted for selling dynamited fish at the Apia market. Dynamited fish of species with swim bladders can often be distinguished from those caught by other methods. The air bladder and intestines are generally ruptured and bones protrude into the body cavity (see Table 1). However fish of species without swim bladders are not so readily identified. Fanaki's said that even he could not identify fish without air bladders which had been dynamited.

Table 1. Characteristics of Dynamited Fish of Species which Possess Air Bladders - Evidence for Court Cases.

VISUAL APPEARANCE:

1. The air bladder is almost always ruptured and blood clots are found in its lumen.

2. The vertebral column may be fractured in any part along its length.

3. Localized hemorrhages are present around the area of fractured parts due to the destruction of the blood vessels and tearing of adjacent tissues.

4. Parts or all of the contents of the body cavity may be damaged or crushed with hemorrhages depending upon the size, shape, position and distance of the fish from the explosion.

5. Fracture and/or dislocation of the abdominal ribs from the vertebral column may be found especially in spiny fishes, with accompanying hemorrhages present in the area of the fracture.

6. The blood vessels below the vertebral column may break and cause hemorrhages of varying degrees along that region.

7. Rupture of the parietal peritoneum, especially that attached to the abdominal ribs.

APPEARANCE WHEN X-RAYED:

1. Dislocation and/or fracture of the vertebral column and ribs, if present, are clearly shown in the negative.

2. The air bladder, if ruptured, will be filled with blood and will be obliterated in the negative. If not ruptured and, therefore, filled with air as in normal fish, it occupies a definite shape and position in the abdominal cavity.

Some fishermen I interviewed believed that dynamite fishing was decreasing somewhat due to reduced availability of dynamite and to the actions of the Pule nu'u - villages leaders who have been given more responsibility by the government in recent years to enforce government laws. Whether or not this is true, dynamiting appears to remain a very serious problem according both to the director of fisheries, Mr. Phillip, and Fanaki'a, particularly in the area between Apia and the airport.

Several fishermen pointed out that a Pule nu'u has jurisdiction only over people from his own village. Fishermen therefore needed only move to waters adjacent to other villages to use dynamite without local interference. The loss of traditional control by villagers over fishing in waters adjacent to their villages (see below) prevents the Pule nu'u from controlling the illegal activities of outsiders in these waters.

It is unlawful for members of the public to purchase dynamite. But dynamite used by the government and (more rarely) by industry is entrusted to the care of casual laborers. Mr. Phillip stated that only by putting dynamite under the supervision of "highly responsible people" could its illegal transfer to fishermen be stopped. Fanaki'a went one step further. He stated that until expatriates are placed in charge of all dynamite it will continue to find its way into the hands of fishermen. This, he says, is because the Fa'a Samoa, or "Samoan Way," makes it next to impossible for a Samoan to refuse requests coming from his relatives - including requests for dynamite. (The "Samoan Way" might just as aptly be called the "Pacific Way" in this context, for the same problems exist throughout Oceania. Fanaki'a was echoing precisely a recommendation made to me several years ago by fishermen of the Northern Mariana Islands where dynamiting of fish was also a problem).

POISONING OF FISH

As in many other Pacific Islands the pounded root of the Derris elliptica (called ava niukini in Western Samoa because of its being brought originally from New Guinea) is used to poison fish. Derris is not as effective as dynamite but it is cheaper and easier to obtain; the plant now thrives in the bush in Western Samoa and attempts to eradicate it would be impractical.

Derris elliptica, like dynamite, kills juvenile fish, shellfish and even (at high concentrations) corals. It, like dynamite, appears to be used most heavily along the coast of Upolu between Apia and the airport. Some people in Apia felt that the Pule nu'u were effectively reducing the use of Derris in the villages. Fishermen, were generally not in agreement with this. "The chiefs don't go fishing very often", said one. "The fishermen just hide the ava niukini in their baskets until they are out in their boats." There is apparently no quick and inexpensive way for identifying fish which have been killed with Derris.

I heard rumours that household bleach was also used to kill fish. This method, though illegal is widespread in Oceania. A Micronesian fishermen once told me that shortly after being killed by bleach, fish develop markedly reddened eyes. This might be an aid to the identification of bleach-killed fish, but I have not verified this claim.

I also heard rumours that the herbicide, Paraquat, has been used to kill fish on occasion. If true, this mirrors the disturbing increase in the use of pesticides to kill fish in other parts of Oceania. In addition to the damage such chemicals do to the marine environment they also pose a threat to consumers of the fish. Serious multiple poisonings have occurred in Micronesia as a result of eating lagoon fish poisoned with a pesticide.

Paraquat breaks down when heated. So adequate cooking may reduce the threat of poisoning. But since Samoans often eat their fish raw, this fact is not very reassuring.

Bleach, pesticides, Derris and other local plant poisons such as Barringtonia, or futu, are all readily available. Controlling their availability effectively is not practical. The only way to reduce their use in fishing substantially is through education. I will return to this general subject below.

MANUAL DESTRUCTION OF CORALS

There is a long-standing custom in Western Samoa of breaking corals apart in order to extract fish and invertebrates for food. This practice remains widespread according to people with whom I talked. Its destructiveness is so obvious that it hardly requires comment. Once again education, as discussed in a later section, seems to be the only effective means of combatting the problem.

SOIL EROSION

Because of increasing population and pressures of economic development, lands of less than normal agricultural potential are being cleared. "These lands not only have a much lower agricultural potential, they are also much more susceptible to erosion because of their steep inclines and their soils" (Western Samoa's Fourth Five Year Development Plan 1980-81, Vol. I).

It is not only the land that suffers from such erosion, but also the reefs. For the soil that is a precious resource on the land becomes a pollutant when deposited on corals. Exposure of reefs to brackish, silt-laden water associated with flooding brought about by bad land management has probably caused more damage to coral reef communities throughout the tropics than all other forms of human activity combined.

Time did not permit a detailed survey of this problem in Western Samoa. But Samoans from a number of districts told me of the destruction of reef communities and deterioration of fishing that they felt was associated with accelerated erosion due to land clearing.

A particularly serious problem appears to exist in connection with the Vaisigano River, which empties into Apia Harbour. Ten years ago, according to the residents living along the river, the water was clear. Today the river is very turbid and carries large volumes of silt into the harbor after heavy rains. Comparison of seabed depth contours from bathymetric surveys done in 1975 and 1981 suggest that the seabed has shallowed by up to five feet in the central and eastern parts of the Harbor in the alarmingly short space of six years (Gauss, 1981).

Cutting of firewood along the banks of the river is believed to be a major contributor to this accelerated erosion. Although it is illegal to cut trees within 60 feet of a river bank in Western Samoa, enforcement is extremely difficult. First, the land is privately owned; forcing owners not to cut trees on their own land is bound to create resentment. Secondly, very high fossil fuel costs have driven many people back to using wood for their cooking fires. Wood has become very scarce in the Apia area in consequence. The price of wood has risen, I was told, by 1000% since 1976. A single armload of wood now costs two tala in the Apia market - more than four times the minimum hourly wage.

I am no expert on erosion control. But let me make one tentative suggestion for consideration in connection with this problem. If cutting of firewood along rivers cannot be stopped without unacceptable consequences, then perhaps it is possible to plant trees along the river which can tolerate heavy cutting, thereby preserving a healthy root system and some ground cover to minimize soil erosion. One possible candidate is Leucana, a genus already present on Upolu. I draw the attention of the readers of this report to a recently published paper by M.D. Benge entitled, "Leucana: the tree that defies the woodcutter", a copy of which is appended to this report as Appendix B.

PESTICIDES

Pesticides are used widely and rather indiscriminately in Western Samoa. Interviews with knowledgeable individuals indicate that conditions exist that favour the contamination coastal waters with these chemicals. Typically pesticides find their way into the marine environment in runoff. In Western Samoa this process is reportedly accelerated by people commonly pouring excess pesticides onto the ground near streams and erosion ditches and using herbicides not designed for aquatic weed control in drainage ditches.

Pesticides can kill fish and other marine organisms. (Dr. Karl Marschall of Western Samoa has performed some pioneering experiments demonstrating that exposure to low levels of DDT can, over a period of weeks, lead to the gradual deterioration and ultimate death of reef corals). Moreover, even at sublethal levels, pesticides can concentrate in edible reef animals to the point where they become unsafe for human consumption.

A wide variety of pesticides are commonly used in Western Samoa. In the absence of any monitoring of pesticides in marine organisms it is impossible to state confidently which pesticides constitute the most worrisome threats. But an educated guess suggests that Paraquat and Lindane are among the most likely compounds. Paraquat is very heavily used and does not reaily biodegrade. The toxicity of Paraquat is such that it is available only to qualified weed control specialists in the United States. In Western Samoa it is available to everyone. Like Lindane it may be transported into water courses and then to coastal waters.

When paraquat is absorbed to clay particles it becomes tightly bound and is reportedly unavailable to plants, or to animals which might ingest the particles if they are carried into streams and coastal waters. But, according to Juo and Orginni (1978), "highly weathered soils in the humid tropics contain predominantly kaolinite, so that these soils probably have a much smaller capacity to deactivate paraquat than soils in the temperature regions where montmorillonite is the dominant clay mineral."

The tendency of bivalves (clams, cockles, mussels, oysters etc.) to accumulate high body levels of pesticides from waters containing very low amounts is well documented. There are a number of popular species of edible bivalves in nearshore waters in Western Samoa. A list of important edible bivalves that should be monitored for pesticide residues is given in Table 3. Ideally a variety of other species should be monitored too - particularly representative species of carnivorous fishes which are known to concentrate pesticides to a greater degree

than herbivorous (plant-eating) species. (A few pesticide analyses for fish are available in Western Samoa - but as the species were not recorded the data are virtually worthless. Species, size, location and time should all be recorded for specimens taken for pesticide analysis).

Pesticide analysis is a fairly expensive and complicated procedure involving specialized techniques. I have, to date, been unable to locate a laboratory willing to do some preliminary analyses of pesticide residues without charge to Western Samoa. IRETA at the Alafua campus has hopes of obtaining equipment for pesticide residue analyses. The purchase of such equipment and the obtaining of personnel trained to run it and to intepret the results in terms of health and environmental risks deserves high priority.

It is clear that much greater control over the labelling, use and disposal of pesticides is also needed in Western Samoa to reduce unnecessary threats to man in both marine and terrestrial environments.

Table 2. Commonly Eaten Estuarine or Reef Flat Bivalve Molluscs That Should be Examined for Pesticide Levels.

Samoan name	Scientific name
fatuaua	Spondylus avicularis
pipi	Asaphis deflorata
tugane	Lima fragilis

SEWAGE POLLUTION

Little time was available to investigate problems that exist with respect to the discharge of domestic wastes into coastal waters. The 1980 report on Apia Water Supply and Sewerage by Murray-North Partners Ltd., recommends that Apia's sewerage be discharged off Mulinu'u Point, the pipe running on a bearing slightly East of North to a discharge point 800 m clear of the reef in about 40 m of water. The high degree of dilution that would occur before the effluent reached the surface and the long-term offshore current running from east to west in the area indicate that, as the report suggests, there would be very little impact of the discharge on nearby shallow waters, including the marine reserve at Palolo Deep.

CROWN OF THORNS STARFISH

Much concern was voiced by fishermen concerning the impact of Acanthaster, the crown-of-thorns starfish, on reefs along the south and east coasts of Upolu during the past decade. Eradication efforts failed in one case because funds for destroying the starfish ran out.

There can no longer be any doubt that Acanthaster invasions do serious damage to reef communities. But a cost-effective solution to the problem has not been found anywhere in the world. I doubt that channeling additional funds into eradication programmes would be justified in Western Samoa, except perhaps if a marine reserve were threatened.

It provides some consolation to know that the starfish populations should eventually shrink to normal levels and most of the affected reef communities should gradually recover provided they are not hit in the meantime by some of the other destructive influences discussed above.

The question of whether or not crown-of-thorns invasions are triggered by man's activities remains highly controversial. Mr. Phillip and fishermen remember invasions occurring in Western Samoa as far back as the early 1930's.

THE TUNA FISHERY

The recent rapid expansion of the tuna fishery off Western Samoa is showing great promise for taking some of the pressure off reef and lagoon resources and significantly reducing costly imports of fish and meat. The alia boat-building and training programme, plus the use of tuna aggregation devices has culminated in what may turn out to be the most successful fisheries development programme ever seen in the South Pacific. It is too early to be complacent however.

Experimental seining trials on aggregated tuna carried out by by American Samoan boats, plus documented poaching by the latter, has generated very great resentment among alia fishermen in Western Samoa. Some have threatened to cut loose the expensive aggregation devices if some improvement in this situation is not seen. This problem must be addressed quickly and forcefully.

A longer term and potentially more serious problem is that the tuna fishery depends upon stocks that are also fished by other Pacific island nations; tuna tagged in New Zealand, Australia, Tonga, Fiji, Wallis and Futuna and Tuvalu have all been caught subsequently in Western Samoan waters. Tuna fisheries experts agree that these stocks may eventually be overfished unless some form of national quotas are agreed upon. Such agreements do not seem imminent. Western Samoa's solution to its fish-shortage may not be maintained indefinitely unless greater efforts are made by all involved Pacific nations to reach agreement on this matter.

Parenthetically I would like to emphasize one of the reasons for the high catches of tuna made around Western Samoa's aggregation devices. The first devices were placed more or less at random around Western Samoa and attracted disappointingly few tuna. Later the devices were placed at locations suggested by local fishermen. Catches at these locations were markedly better.

Yellowfin and skipjack tuna make daily onshore offshore migrations around Pacific Islands, that are predictable by local fishermen both as to timing and location (Johannes, 1981). The offshore terminus of this migration "where the tuna sleep" in Samoan fishermen's parlance, has proven to be where tuna aggregation devices work well. This is an example of the extremely important information that Pacific Island fishermen possess, but fisheries biologists do not. It is also an excellent demonstration of why, as recommended later in this report, a systematic effort should be made in Western Samoa to collect and record fishermen's knowledge.

FISHING SUPPLIES

When asked to list their biggest problems, fishermen consistently included fuel costs and the difficulty of obtaining motors and parts. They asked that the tax on fuel be waived. The potential problem of tax-free fuel being used for illegitimate purposes might make such a scheme undesirable. I therefore simply draw attention to this request without passing any judgement as to whether or not it would be practical.

The problem of inadequate supplies of motors and parts does not seem so difficult to remedy. I found that there was only one outboard motor left for sale in the government Agriculture Store. No new ones were expected for several months. Only one commercial outlet in Apia carries outboard motors - a single brand, sold at a much higher markup (along with spare parts) than motors sold in the Agriculture Store. This situation favours the fishermen who can afford the higher prices - a case of the (relatively) rich being able to get richer while the poor fishermen get poorer.

I was told that the problem was due to the Agriculture Store having inadequate cash reserves to allocate sufficient money to the purchase of motors. The remedy for this problem seems clear. The the difficulty apparently lies in getting appropriate government personnel to take the problem seriously.

A related problem is the availability of sufficient and appropriate fishing tackle (tuna lures in particular) in the Agriculture Store. In part the problem relates to the (understandable) lack of knowledge among people in the Agriculture Store as to precisely what should be ordered and how much. The appropriate knowledge is available in the Fisheries Division. It does not seem unreasonable, therefore, that the Fisheries Division take over the ordering and marketing of fishing supplies, or at least be responsible for working up the orders for the Agriculture Store.

MARINE PARKS AND RESERVES

The development of marine parks and reserves in Western Samoa is not proceeding with much speed. Western Samoa is well behind a number of other Pacific Island countries in this regard. Tonga is a conspicuous nearby example. I can only reiterate what is already obvious to those concerned with this in Western Samoa; without more money and additional trained personnel the marine parks programme will continue to languish.

The only marine reserve presently in existence is at Palolo Deep near Apia. Park personnel are obviously working hard to make this reserve a success both in terms of education for local students and as a tourist attraction. Two problems are apparent, however. First, the reserve is clearly being fished surreptitiously (probably at night). A swim around the periphery of the park indicated that the fish were more wary than they would be in a completely protected preserve and that there was a noticeable absence of larger fish. A truly protected preserve can provide students and tourists with underwater spectacle far superior to what presently exists. Every effort should therefore be made to ensure that no fishing whatsoever is allowed in the reserve.

The second problem is that Palolo Deep is not being made well enough known to tourists. Although brochures have been printed describing the facility, none was available in the hotels I investigated, nor even in the government tourist office. Many tourists in the hotel in which I stayed were unaware of nearby Palolo Deep. I was told that costs prohibited the printing of sufficient numbers of these brochures. The existing brochures include photographs of the reserve which add considerably to their cost. Colorful photographs are useful outside Western Samoa to attract tourists. But, once the tourist has arrived, what he or she most wants in the way of tourist publications is written material. To attract tourists to Palolo Deep inexpensively, a stencilled leaflet without pictures would suffice, provided that hotels and other tourist gathering places were kept well-stocked.

TRADITIONAL SAMOAN FISHING RIGHTS

Traditionally Samoans had elaborate customs of ownership of fishing rights. These were briefly described in a German language periodical in 1902 by von Bulow. I append a translation of his paper to this report because it is hard to obtain, and understanding these rights is important in relation to the management of coastal marine resources (Appendix C).

The right to fish in reef, lagoon and mangrove areas was owned, according to Samoan custom, by adjacent villages, families or chiefs. (This tradition is widespread in Oceania (Johannes, 1978)). Under such conditions people generally used their marine resources more carefully, for they could be confident that the benefits of doing so - better future yields - would go entirely to them. Thus, in Pacific island countries where traditional fishing rights are still strong, dynamiters, for example, are severely dealt with in the villages. This and other abuses of the fishery are thus discouraged and this is done at no cost to the government.

When fishing grounds are open to everyone, however, it is in the best interests of fishermen to catch all they can and use destructive methods in doing so if it makes the job easier. If they do not, someone else probably will, for no one has control over behavior on the fishing grounds (except, in theory, the government, for whom it is quite impractical to police the fishing grounds effectively). Fishing grounds open to everyone are thus open to constant abuse.

What is the situation today in Samoa with regard to traditional controls on fishing? They have obviously weakened since von Bulow's time but the details are not clear. Here I can only provide a few fragments of relevant information before going on to recommend that a thorough study of these customs be carried out.

Customs relating to the traditional ownership of fishing rights in reef and lagoon areas (as distinct from mangrove areas which I will discuss separately) have largely disappeared according to several people I interviewed. Nevertheless there are indications that some of these rights persist in some areas. van Pel (1960) states that around Monono Island only the inhabitants may catch mullet and atule. On Savai fishing for "whitebait" during the annual run is reportedly the exclusive right of the people of the village of Gatavi. Two recent unpublished government reports refer to existing "fishing rights" without further details, and one government official I interviewed stated emphatically that traditional fishing rights still exist in some areas but could give me no details.

The Western Samoan Government "would like to have a record compiled of traditional knowledge on Samoan land tenure, culture and resource use practices" (Anonymous, 1980). Similar studies in other Pacific islands have almost always overlooked the marine environment. I urge Western Samoa not to make the same mistake. Efforts should be made to investigate and record remaining traditional marine tenure (fishing rights) and resource use for several reasons. First, where villagers control fishing activities in their waters, fish yields and the general environmental health of these waters will be enhanced. The reasons for this were described above.

Secondly the use of traditionally owned waters by outsiders (including the government) for bait-fishing, other types of fishing, or any other purposes (such as filling and dredging) will generate much less local resistance if local customs are understood and respected. Tuna bait fisheries, for example, have been totally discouraged in a number of other Pacific island areas because of lack of understanding of customary fishing rights and associated negotiation procedures, with the consequent alienation of traditional owners (e.g. Johannes, 1982).

Thirdly, attempts to acquire areas for coastal or marine parks and reserves will proceed with fewer problems when the government possesses a good understanding of local tenure systems. Plans for the acquisition and control of some of Western Samoa's few, precious, and rapidly dwindling mangrove areas for national reserves are not proceeding satisfactorily at present. One reason for this is that little is known about traditional ownership patterns as they pertain to these areas. One cannot negotiate meaningfully with villagers whose relevant ownership customs are not fully understood.

Such knowledge should be obtained before a resource is at issue. Otherwise villagers can invent or alter what they claim to be their traditions to their own advantage. This is an old story in the Pacific islands in the context of land tenure. It is also rapidly becoming a major problem in marine areas as populations increase and coastal marine resources are more intensely contested.

I therefore recommend that a comprehensive study be made as soon as possible of fishing rights as they pertain to all coastal waters. As described above, some of these traditions may prove to be of great value in terms of sound reef and lagoon resource management. If so they should be legally recognized. (The ownership by the government of coastal waters below the high tide mark need not prevent the government from recognizing traditional fishing rights in these waters, as other Pacific Island countries such as Fiji and Papua New Guinea have demonstrated). In addition traditional fishing rights must be better understood by government and business interests if new coastal development schemes (parks, bait fisheries, coastal construction) are to proceed with maximum cooperation from villagers. Means of obtaining some of this information will be discussed in a later section of this report. See also Appendix A.

ENVIRONMENTAL EDUCATION

Compared with other Pacific island countries the level of environmental awareness is not high among the Western Samoan public. There is a "shocking lack" of environmental education in the schools, to quote one very knowledgeable Western Samoan educator. The New Zealand based curriculum contains little of relevance to the ecology and conservation of tropical island environments.

There is little teaching of environmental subjects in the Secondary Teachers College. The teachers are aware of this and concerned about it. But they are understaffed and none is trained specifically in this area.

The Institute for Research, Extension and Training in Agriculture at the Alafua Campus badly needs funding for a teacher of conservation and ecology. At present there are no funds to fill such a position in 1982 or 1983.

Nothing can substitute for education when the better management of natural resources is the goal. In the absence of an environmentally aware public, environmental legislation is ineffective. Where the public understands environmental issues, public criticism of polluters, fish dynamiters etc. can make the government's job of natural resource management easier, cheaper and more effective. Each year's delay in establishing a comprehensive programme of environmental education - in the schools, colleges and villages, through newspapers and on the radio, by means of the Pule nu'u, the women's committee, the youth clubs and the churches - makes the effective management of Western Samoa's hard-pressed resources more difficult and increases economic and social disruption. The churches possess unusual power and influence in Western Samoa. If they wished to they could make a major contribution to this effort.

The Forestry Department has been showing two environmental films in the villages. Experience has shown that the films are not well understood. One of the films, Story of an Island, is designed especially for Pacific island peoples and it is a pity if the people of Western Samoa do not get the full benefit of its important messages. Experience gained by the Samoan German Crop Protection Programme indicates that considerable discussion, with active audience participation encouraged, will increase the impact of such films.

LOW COST, HIGH QUALITY RESEARCH RELATING TO NATURAL RESOURCE USE.

Although Western Samoa receives considerable foreign aid it is apparent that it lags behind a number of other Pacific island countries in the area of resource management. A number resource-related problems are raised in this report that cannot be meanfully addressed without considerable research. Marine-oriented research projects of high priority include recording valuable local marine lore, studying traditional systems of fishing rights and monitoring the impact of human activities on the health of the marine environment. When foreign aid dollars are already stretched thin, how does one go about finding the support for such activities? I would like to suggest one method which, as far as I know, has never been attempted.

There is a strong and continuing desire among social and natural scientists to carry out research in the Pacific islands, including Western Samoa. At the same time there is also a growing skepticism among islanders concerning the value to them of much of this research, and a growing feeling that more emphasis should be placed in future on research of practical benefit to local people. A major problem here is that researchers must often, of necessity, plan their research activities far away in distant universities and government laboratories prior to their ever setting foot in the islands. How much better off researchers and islanders would both be if researchers knew, in advance, of some of the problems with which island peoples need and want assistance!

This could be accomplished if island governments advertised their desire to see researchers investigate particular problems. The government need not necessarily commit any funds to such projects (although offers of assistance in locating accommodation, translators, some transportation etc. would provide additional encouragement to researchers at minimal government expense).

Let us suppose the government of Western Samoa put a small advertisement in (for example) Pacific Island Monthly, advising social scientists interested in Pacific islands that there was a need for someone to carry out research on traditional fishing rights in Western Samoa. A graduate student seeking a thesis research project in Western Samoa, and seeing this advertisement, might well decide to tackle the project - at little or no expense to Western Samoa.

There is a second and possibly much more important source of free expertise on local environmental matters that is not being exploited effectively by island governments - the islanders themselves. Much of what we know about the natural resources of developed countries can be found in libraries. But in many developing countries, such as Western Samoa, a large portion of this knowledge exists only in the heads of some of the older men and women. Scientists are belatedly discovering that such information, concerning the bush, the garden and the sea, assumes encyclopedic importance in Pacific island countries, and is superior in some important respects to that of western science. In many cases, however, it is no longer being transmitted from generation to generation effectively, often being lost as its owners die.

Among those island citizens who know least about such things are the young members of the highly educated elite whose learning years are often spent remote from their villages. Ironically it is these very people who will be most responsible for determining patterns of natural resource use and conservation in their countries in years to come. Their technological and economic sophistication cannot possibly be put to best use in the absence of the vital knowledge of their natural resources possessed by some of their elders in the villages.

Educational institutions in developing countries have a responsibility to help retain such knowledge. Its absence from their curricula amounts unintentionally to a tacit assertion that it is no longer worth learning. Yet its effective transmission cannot be achieved entirely in a typical classroom setting. So what can be done?

I would like to suggest that a course on traditional and contemporary use of natural resources be made mandatory for all students in Western Samoa's teachers' and agricultural colleges. As one of the course requirements each student would be asked to submit a report describing some aspect of traditional resource use or knowledge in his or her village. The necessary research might be carried out during Christmas break when many students return home. Copies of these reports would be kept on permanent file where, collectively, they would grow to become a large and unique source of traditional knowledge.

The gathering of such knowledge by Samoan students (along with information on such subjects as traditional fishing rights) would be very consistent with the Western Samoa Government's desire, as expressed in the Five Year Development Plan, to enable "local people to be researchers, guardians and providers of those aspects of Samoan culture which are considered necessary for the present and future." (A very preliminary list of valuable things Western Samoan fishermen know about the animals they harvest - things largely unknown to marine biologists - is presented in Table 3).

All teachers need such training - not just teachers of biology, agriculture or fisheries. All teachers need to understand the nature and limits of their natural resources, for within a few years their students will be the ones who make the important decisions concerning the uses to which these resources are put.

Financial assistance for the study of traditional Western Samoan marine lore and fishing rights might be sought through the Fund for the Preservation of South Pacific Cultures, Australian Development Assistance Bureau (see Appendix D).

Table 3. A Few Examples of Valuable Biological Information Possessed by some Western Samoan Fishermen but Largely Unknown to Marine Science

Seasonal migrations - timing and paths taken

Anae - mullet - Crenimugil?

Anae - red-lipped mullet -

ingana - "whitebait" (eleotrid?) (migrates seasonally from rivers to sea to spawn).

'anamangi - "whitebait" (eleotrid?) (migrates seasonally from rivers to sea to spawn).

Seasonal and/or monthly aggregations of adults, often for spawning - timing and locations.

Gatala - a variety of species of groupers - Serranidae

Pone - black surgeon fishes - Acanthurus spp.

Pelu pelu - small mackerel-like fishes - Decapterus sp.?

Anae - red-lipped mullet

Malai - paddletail snapper - Lutjanus gibbus

Malauli - Trevallies

Alogo - blue-lined surgeonfish - Acanthurus lineatus

Lo - rabbitfish - Siganus spp.

(Also a number of species of edible land crabs which migrate to the water's edge on a lunar cycle to release their larvae into the water).

Seasonal aggregations of juveniles (generally just after migration inshore after their initial offshore pelagic stage) - timing and locations.

Lo - rabbitfish - Siganus spp.

Lupo - trevally (juvenile phase name)
- mullet

Daily movements to and from nearshore waters - timing and locations

Skipjack and yellowfin tuna.

SUMMARY OF RECOMMENDATIONS

1. The present lack of emphasis of the Fisheries Division on the comprehensive monitoring and managing of reef and lagoon fisheries seems justified, although certain individual reef species might profitably be managed.

2. Dynamite fishing can only be fully controlled by entrusting dynamite to highly responsible personnel.

3. Soil erosion along river banks (with consequent pollution of coral reefs) might be reduced by planting trees such as Leucana that can withstand heavy cutting.

4. Monitoring of pesticide residues in selected edible reef animals is needed.

5. The tuna fishery shows great promise but two problems must be addressed if it is to expand and sustain itself as hoped for:

   a. the problem of the seining of aggregated tuna by outsiders,

   and

   b. the problem of setting national quotas on shared tuna stocks.

6. More funds should be made available for the purchase of outboard motors and fishing equipment for sale to fishermen. The Fisheries Division should have more influence on ordering these items.

7. Studies of traditional Samoan fishing rights and fishing knowledge are needed in order to improve fisheries management and facilitate development and the establishment of marine parks and reserves in coastal waters.

8. An environmental education programme is recommended in which students of all types and levels study traditional Samoan knowledge concerning the nature and usage of natural resources.

9. A means of advertising to attract free or inexpensive research projects relevant to Samoa's environmental problems is suggested.

REFERENCES CITED

Alcala, A.C., and E.D. Gomez. 1979. Recolonization and growth of hermatypic coral reefs in the Central Visayas, Philippines. p. 645-657 In: Proc. Internat. Symp. Marine Biogeography and Evolution in the Southern Hemisphere. Auckland, New Zealand Dept. Sci. Industr. Res.

Anonymous. 1978. Fishery Catch Assessment Survey 1978. Department of Statistics, Apia, Western Samoa. 19pp.

Gauss, G.A. 1981. Apia Harbour Survey, Samoa. Cruise Report No. 55. U.N.D.P. Economic and Social Commission for Asia and the Pacific. 10 pp.

Johannes, R.E. 1978. Traditional Marine Conservation Methods in Oceania and their Demise. Ann. Rev. Ecol. Syste. 9, 349-364.

Johannes, R.E. 1981. Words of the Lagoon. Fishing and Marine Lore in the Palau District of Micronesia. 245 pp. Univ. California Press, Berkely.

Johannes, R.E. 1982. Implications of traditional marine resource use for coastal fisheries development in Papua New Guinea, with emphasis on Manus. p. 239-249 In: L. Morauta, J. Pernetta and W. Heaney. (Eds.) Traditional Conservation in Papua New Guinea: Implications for Today. Institute of Applied Social and Economic Research, Port Moresby.

Juo, A.S.R., and O.O. Oginni. 1978. Adsorption and desorption of paraquat in acid tropical soils. J. Environm. Qual. 7(1):9- .

Marshall, N. 1979. Fishery yields of coral reefs and adjacent shallow water environments. In: Stock Assessment for Tropical Small Scale Fisheries. Proc. Internat. Workshop, Univ. of Rhode Island, Sept. 19-21, 1979.

Van Pel, H. 1960. Report on the Sea Fisheries, of Western Samoa. MS. Rept. 23 pp. South Pacific Commission, Noumea.

ACKNOWLEDGEMENTS

I had interviews with the following, whose unfailing cooperation I gratefully acknowledge.

Forestry Section, Agriculture Department

Iosefatu Reti
Etene Tuilepa
Kalati Poai
Richard Burgess
Rod Matthews

Fisheries Office, Department of Economic Planning

Alfonso Phillip
Fili Suafoa
Jane Albert
James Hollyer
Viliamu

Lands Department

J.T. Soon

Department of Works

Lua'iufi Tone

Apia Obervatory

Ed Burke
Luatua Vaitupu Joane

Agriculture Store

F. Sa'aga Fau
Gail Nystrom

Department of Statistics

Mussolini Crawley

USP School of Agriculture, Alafua Campus

Tau'ili'li Uili

Samoan German Crop Protection Project

Dirk-Heinrich Stechmann

Secondary Teachers College

Tili Afamasaga
Nu'fau Petaia

Others

Karl Marschall
David Fryauff
Fishermen at Aleipata, Apia and Faleasiu

APPENDIX A

BULLETIN OF MARINE SCIENCE, 31(3): 673–680, 1981

WORKING WITH FISHERMEN TO IMPROVE COASTAL TROPICAL FISHERIES AND RESOURCE MANAGEMENT

R. E. Johannes

ABSTRACT

Marine resource development and management schemes in developing countries have often been designed without significant consultation with, or understanding of the users of these resources. They often fail in consequence. Tackling resource management problems at the village level is thus increasingly being encouraged. Collaborating with villagers provides opportunities and difficulties quite unlike those encountered in more conventional environmental studies. For what does one look—and how? Specific examples are given of how working with artisanal fishermen can yield otherwise inaccessible insights into such matters as: unappreciated resource areas and their vulnerability to damage through coastal development, important aspects of the biology of target species, relevant local oceanographic phenomena, the local cultural palatability of proposed management schemes and local traditional conservation practices of continuing value. Appropriate research methods are also briefly discussed.

Discussion

Fishing traditionally supplied the bulk of the animal protein for human consumption in many coastal areas in the tropics, but in the past few decades this has changed. The introduction of new fishing technology has led, at least temporarily, to increased landings in many areas. But an increasing percentage of the catch is usually exported, while increasing quantities of lower quality processed foods are imported. This has contributed to a marked deterioration in local diets. It has also led to the increasing impoverishment of many traditional fishermen. So much has been written about these problems (Forman, 1970; Nietzchmann, 1973; Cordell, 1973; Alexander, 1975; Kent, 1976; Lawson, 1978; Anonymous, 1978; Smith, 1979; Johannes, 1978a; 1981) that further documentation is unnecessary.

One might guess that, under the circumstances, marine research and resource management in these regions would focus on protecting traditional fisheries and putting more locally caught fish in villagers' mouths. But, owing to the impact of western economics on government perceptions of development priorities, this has not generally been the case. Traditional fisheries are usually part of a very localized system of exchange that often does not involve money. Even where it does, this rural cash flow rarely shows up fully in government economic statistics gathered in cities and district centers. And where there are not enough visible dollars to articulate a need, the economic system fails to identify that need (Kent, 1976).

Such past shortsightedness is an example of why western "experts" in resource management are looked upon with growing disillusionment in developing countries. They are increasingly seen as writers of instant prescriptions based on lightning visits to administrative centers—prescriptions that all too often prove ineffective or worse because their authors have little understanding of local economic, political, cultural or environmental conditions.

In Sri Lanka, for example, "very few countries had the benefit of advice from so many specialists in planning and development of fisheries." But, although "two decades of development effort have gradually increased production in the

coastal fishery," it has also "transformed a limited yet coherent traditional industry into a warped and dislocated one full of internal contradictions and tensions" (Anonymous, 1978, 59). "Employment opportunities have diminished, social inequalities have been exacerbated, and many fishing households have been further impoverished" (Alexander, 1975).

Marine resources and environmental and cultural constraints upon their use often vary greatly from village to village in the tropics. This circumstance casts doubt on the appropriateness of even the most detailed marine resource management research project carried out in district centers. Smith (1979) reflects the growing awareness of this fact when he calls for "locale-specific" fisheries projects. What has yet to be emphasized by those calling for more work in individual fishing communities, however, is that to be effective this approach requires western biologists—and biologists from developing countries who were trained in the west—to modify their customary research habits substantially. Tackling environmental and resource use problems at the village level in the tropics presents both opportunities and difficulties that are often quite unlike those encountered in more conventional environmental studies.

Once one arrives in a fishing community, for what does one look—and how? Here I will discuss, (1) some examples of the useful insights that can arise when biologists seek the knowledge and advice of fishermen or examine their traditional patterns of resource use, and (2) some methods and pitfalls peculiar to marine biological research involving human intermediaries, i.e., fishermen.

Examples Of What Can Be Learned From Traditional Fishermen

Traditional Marine Conservation Methods.—Most governments and fisheries agencies in the tropics have not fully recognized that traditional coastal fishing systems have a demonstrated potential for sustained yield and employment that should be the envy of many temperate zone fisheries managers. Centuries ago Pacific islanders, for example, developed almost all of the marine conservation measures that westerners devised only within the past 80 years (Johannes, 1978a; 1981). The most important of these, reef and lagoon tenure, is a form of limited entry. Considered by many fisheries experts to be the cornerstone of sound fisheries management, limited entry systems have nonetheless been eroded or destroyed in many island groups by western colonialists who did not understand their value. Research is urgently needed to describe in detail those reef and lagoon tenure systems and other traditional conservation measures that have survived, to evaluate their efficacy, and to support their legal recognition where their value remains high.

Explicit legal recognition of traditional fishing rights can help prevent the expropriation and overharvesting of traditional nearshore fishing grounds by outsiders with modern boats and gear—a serious problem in many developing countries. But very little is known about these customs. This is fertile ground for research by both social and natural resource scientists. Studies should address not only traditional boundaries but also allocation of resources within these boundaries. Some clans, may, for example, have the exclusive rights to use fish traps, while others possess the rights to use nets. Some clans or individuals may have exclusive rights to certain species, or to certain areas within the overall village boundaries. Some fishing grounds may be shared by two or more villages, while each of these villages has exclusive rights to other fishing grounds (Allan, 1957; Johannes, 1981; Baines, in press).

The existence of traditional tenure of mangrove swamps and other inshore waters also has important implications for the development of aquaculture (John-

ston, 1977). For example, the higher costs of policing ponds sited on commonly held property may render such sites less attractive than those on tenured property.

Stock Assessments.—Roedel (1979) has noted the need in small scale tropical fisheries for "a simple to apply quick-and-dirty way of getting first approximations" of stocks and their populations dynamics. Fishermen often possess information that could be useful in this context. They often know, for example, the seasonal migration paths taken by some important species, such as mullet and mackerel—information that is essential if stock boundaries are to be established.

They sometimes also know the spots and times at which a wide range of species aggregate to spawn. (The number of fishes known by biologists to form lunar spawning aggregations has more than doubled in the past few years as a consequence of information volunteered by Pacific island fishermen (Johannes, 1978b; 1981).) Spawning aggregations appear to provide biologists with an excellent opportunity to monitor stocks, because they occur at such predictable times and places. These aggregations might also provide a useful focus for management since particularly large catches are often made from them (Johannes, in press).

Pacific island fishermen have sometimes placed restrictions upon their own catches on spawning grounds when they observed stocks dwindling in an apparent response to overfishing (Johannes, 1978a; 1981). Traditionally they did not take any more fish from these aggregations than could be absorbed by their communities. But, as distant markets materialize, the incentive to harvest in moderation diminishes, and aggregations of reef fish in their spawning stupor are exceptionally vulnerable to overharvesting (Olsen and La Place, 1979; Johannes, 1981). Quantitative studies of this problem in collaboration with fishermen are badly needed.

The Impact of Coastal Construction on Movements of Fish and Fishermen.—The disruption by dams of the migrations of spawning and juvenile salmon and other fishes is common knowledge in the temperate zone. But it is not generally recognized that because many reef and lagoon fishes also migrate (albeit usually over comparatively short distances) their movements are likewise vulnerable to disruption by dredging and filling in coastal waters. Two examples serve to illustrate the problem.

Recently the government on a large Pacific atoll decided to construct a causeway between two islands. This was the last unobstructed channel in the very heavily populated southern part of the atoll. The others had been blocked by causeways some years earlier. Like the other causeways, the new one was to be solid—without a bridge to provide for passage of water (and boats) between the ocean and the lagoon.

Interviews with local fishermen indicated that the planned causeway posed serious potential problems for them. The migration routes taken by many spawning reef and lagoon fish are constant from year to year. The pathways of some of these species are well known to the fishermen of the atoll. For centuries this knowledge enabled them to harvest large numbers of fish during spawning runs.

One of the species which carry out these migrations is the bonefish, *Albula vulpes*. This species is both the most important shallow water food fish on the atoll in terms of volume landed and the most popular food fish on the atoll. According to fishermen, bonefish migrate from the lagoon to the outer reef edge to spawn for 3 to 5 days around the full moon. [This coincides with information provided for this species by fishermen on other tropical Pacific islands (Johannes

1981).] Originally migrations occurred through three channels in the southern part of the atoll. The planned causeway would block the last of these channels.

Will bonefish and the several other species of food fish that normally migrate through this channel (e.g., mullet, goatfish) seek an alternate route out of the lagoon if the causeway is blocked? Unfortunately, nothing is known about how bonefish and other reef fish react to such conditions. But we do know that fish behavior tends to be rather stereotyped and inflexible. Some migrating temperate zone species, such as salmon, do not spawn if denied access to their customary spawning grounds, but simply resorb their gametes.

One side of the roughly triangular atoll still provides free access to the sea. But the currents, mean depth and benthic communities on this side of the atoll are all quite different from those of the channel. Even if bonefish did adopt this alternative exit, the impact on fishing would still be serious, for both their capture and transport would be much more arduous than at present. They would entail longer trips to the fishing grounds and searching over an area of potential egress roughly 20 times as wide as the original migration channel.

Blocking the channel might also reduce the number of juvenile bonefish and *other species entering the lagoon. The larvae of these and many other species of* reef and lagoon fish hatch out over deep ocean water. The larvae spend some days or weeks in the open ocean before migrating back to their shallow inshore adult habitats. The wide unrestricted eastern side of the atoll might provide suitable access for bonefish post-larvae. But it cannot be taken for granted that post-larvae that would otherwise enter the lagoon via the channel would henceforth use the alternate route.

Tuna, caught outside the lagoon, account for more than 50% of the fish caught locally and over 60% of the commercial catch. The proposed causeway would also create problems for this fishery, necessitating much longer trips to reach the fishing grounds, and, consequently, much higher fuel costs. The seriousness of this can be judged by the following facts: the atoll is poor and overpopulated; there is a shortage of local fish and an "alarming" amount of cash is spent, according to a local fisheries officer, on imported fish; the tuna fishery is already under stress because of the rapidly increasing cost of fuel for outboard motors.

I asked four fishermen independently why they had not raised their concerns about the causeway with the government. Their replies were almost identical. Each said that the government did things to suit the government, not the people of the atoll, and that they felt they would not be listened to.

For the sake of completeness it should be said that the government in question has since gone out of existence and the causeway may never be completed owing to the lack of sufficient dredge fill. But the potential problems it posed are representative of those in many tropical coastal areas. Typically, there is insufficient communication between coastal planners and fishermen.

The scientific question that arises here is also of general significance in tropical coastal waters. Many Pacific islands have been linked by causeways. Majuro is a striking example. What are the impacts of such causeways on the egress of spawning fish and the ingress of juveniles? How flexible are the migratory patterns of reef and lagoon fishes?

A second type of migration typical of reef food fish is both important to coastal fishermen and vulnerable to poorly planned dredging or filling. As the tide rises many species of fish move from the outer reef slope or from mangrove estuaries onto the reef flat and across it to their feeding grounds. Because their migration routes are narrowly defined, consistent, and often heavily travelled, they are

important to reef fishermen (Johannes, 1981). On one Pacific island I visited recently, fishermen were angry because dredging and filling associated with nearby road construction had obliterated two of these migration routes. The fishermen pointed out that there were many adjacent areas that could have been dredged with minimal damage to their fisheries. Had they only been asked for advice on the matter, they could have pointed this out. Further inquiry would doubtless uncover many similar events in other coastal areas in the tropics.

Local Hydrography.—Knowing local currents, their seasonal changes and their influences on navigation and fish movements, is second nature to the artisanal fishermen. Native fishermen on several small islands in the south western Pacific are intimately familiar with a particular island wake pattern that has never been described by physical oceanographers (Johannes, 1981). Such currents strongly influence the distribution of tuna and certain other species near these islands. Fisheries resource managers who do not avail themselves of this kind of information impose unnecessary difficulties on their work (Anonymous, 1978).

Fish Systematics and Biology.—"Time and time again, biologists have been excited with the capture of what was assumed to be a rare species, only to learn that local fishermen know the species well by common names," (Bullis, 1978). The taxonomic expertise of tropical fishermen is sometimes formidable, but tapping it often requires learning their classification system. Asking fishermen to give the derivations of the local names of fish sometimes yields information concerning their biology; these names sometimes allude to their behavior, diet, habitat or the means by which they are best caught (Johannes, 1981). Such information is often not found in any journal; our scientific knowledge of most tropical food fishes is meager. Moreover, the costs of obtaining it using more conventional research methods would often be greater than the value of the fishery to which it were applied.

Traditional Fishing Methods.—Industrial fishing is, of course, highly energy intensive. Leach (1976) calculates, for example, that it takes 20 units of energy from fossil fuels in UK fisheries to produce one unit of food energy (see also Bardach, in press). In such fisheries human labor provides less than 1% of the total energy expended. Traditional fisheries in developing countries once involved no fossil fuel at all; human labor supplied the motive force, and still does in many areas. As fuel prices rise, the value of human labor rises and the low catch per unit of human effort characteristic of traditional fisheries becomes progressively less unattractive economically. Labor-intensive fishing will, of necessity, assume greater importance as the fuel crisis deepens. Understanding traditional fishing (and sailing) skills and encouraging their retention will help foster greater independence, both for developing countries and for their fishing communities, as greater energy self-sufficiency becomes increasingly important.

Some Suggestions for Working with Artisanal Fishermen

Working in villages according to a neat timetable is often impossible. Fishermen are only available when they are not fishing or engaged in other essential village activities. The researcher must adjust his or her schedule to theirs. More time must therefore be allotted to such work than might at first seem necessary. Thus "lightning" visits work even less well in the villages than in the district centers.

Holt (1962) stated that, "biologists, it has been our experience, are able to find out the facts about fishing as a human activity only when they do not identify themselves with administration and policy-making." Undoubtedly reactions of fishermen to outsiders asking a lot of pointed questions will vary from one group

to another, and will sometimes be negative. But it has been my experience that if you make it clear from the start that you wish to *collaborate* in order to improve the fishery, fishermen are often eager to discuss problems which they believe resource policy changes could alleviate. It *is* sometimes important, however, to disassociate one's self from fisheries *enforcement* personnel.

Not all fishermen are valuable sources of information. Younger men, in particular, are less likely to be broadly familiar with fishing conditions in their area. Although work with older fishermen more often requires the use of an interpreter, it is worth the extra effort. The best fishermen are also often the most knowledgeable and it pays to seek out those who enjoy a high reputation among their people.

Traditionally, fishing has been a prestigious activity in Oceania, particularly in Polynesia and Micronesia, and good fishermen are often proud of their knowledge and careful to transmit it accurately (Johannes, 1981). Nonetheless, it is useful to test the reliability of prospective informants. For this purpose I often ask two series of questions on fishing or fish biology: (1) questions to which I already know the answer and (2) plausible questions to which I am confident the fisherman could not possibly know the answer. The responses provide a good indication of how productive the ensuing interview is liable to be. On the basis of these responses I have interviewed individuals for as little as 20 minutes or as long as 200 hours. Naturally the more time spent on the fishing grounds (with the fishermen, when this is possible) the deeper will be one's understanding of the information obtained verbally. In areas where fishing is a low status occupation, such as in parts of the Caribbean, Southeast Asia and India, good information may perhaps not be so readily forthcoming from fishermen, although I have no firsthand experience to substantiate this surmise.

Where interviews are focussed on a specific local situation the interviewer is obviously limited to the expertise of fishermen in the vicinity. But for those whose interests are less tied to specific localities, it pays to devote considerable effort initially to locating the most potentially productive research sites. Less productive areas include those where westernization has become deeply entrenched. Here much traditional knowledge has been lost, and competition tends to make fishermen secretive. Hawaii is a case in point.

It would be very misleading to give the impression that even under the most favorable conditions one can obtain valuable information from fishermen simply by sitting down with them and saying "tell me everything you know." In some areas where considerable knowledge about the sea exists, local customs may prevent its being readily discussed. In Ponape, in the Caroline Islands, for example, bad luck is believed to befall anyone who divulges all he knows about a subject. Even in the absence of such cultural impediments, fishermen cannot be expected to volunteer much valuable information if the interviewer is not clear in his own mind about what he is searching for. He should possess a good grounding in biology, ecology and oceanography in order to steer interviews in productive directions, taking full advantage of answers that open up new and potentially interesting areas of inquiry. Proof of this is implicit in the extensive literature on Pacific island anthropology, in which fascinating hints concerning native marine lore abound, but are almost never developed (Johannes, 1981). Traditional anthropologists have generally not had sufficient grounding in biological science to enable them to exploit effectively the valuable indigenous ecological knowledge that more specifically focussed inquiry could have yielded (Vayda and Rappaport, 1968).

The ideally equipped researcher would be well versed not only in marine en-

vironmental subjects but also in social science. Such individuals are rare, and the collaboration of marine scientists and social scientists in such studies is thus especially desirable. The perspective of the social scientist enables an interviewer to interpret fishermen's information more effectively in the context of their own culture. Resource management schemes are of little value if they are not culturally palatable to those they are meant to benefit.

Making the most of the knowledge and perceptions of villagers concerning their fish and fisheries requires learning their language, living in their village for extended periods of time and gaining their acceptance by participating in village activities. Unfortunately, constraints of time and money will preclude such commitments in most villages. Governments might therefore consider supporting intensive studies in representative villages with cautious extrapolation of the findings to similar less well-studied villages. This approach is by no means fully satisfactory; seldom are any two villages alike in all the cultural, political, economic and environmental features that shape their fisheries. But some compromise must be made between a policy of complete neglect and one of all-encompassing investigation.

Interviewing techniques and ways of gaining rapport with villagers will not be discussed further here because the anthropological literature contains an abundance of relevant material. Useful reviews can be found, in Freilich (1977) and Benjamin (1953).

In most fishing cultures it is the men who do most of the fishing, and in some cases cultural constraints make it difficult for women researchers to gain their cooperation. There is one area of fishing in which female researchers would be at an advantage however. Women often carry out the bulk of reef gleaning that goes on in many tropical coastal areas. Reef gleaning, an important subsistence activity in Oceania (Hill, 1978), consists of the gathering by hand of various small fishes and invertebrates on the reef flat during low tides. Some women possess valuable information concerning seasonal trends in the reproduction and distribution of their quarry and other useful information not well known to the men. This knowledge is often more likely to be divulged to the female investigator.

When we talk about managing a resource we really mean managing the people who use that resource. In order to do so more effectively, studying and putting to use their knowledge and customs, with their collaboration and endorsement, does not seem unreasonable. Moreover the benefits to us, as gatherers of knowledge, can be substantial.

Literature Cited

Alexander, P. 1975. Do fisheries experts aid fisheries development? Marit. Stud. Mgmt. 3: 5–11.

Allan, C. H. 1957. Customary Land Tenure in the British Solomon Island Protectorate. Rept. British Solomon Island Protectorate Special Land Comm. Honiara, Western Pacific High Commission. 329 pp.

Anonymous. 1978. The long struggle to build up Sri Lanka's fishing industry. Ship and Boat Internat. 31(9): 59–61.

Baines, G. B. K. (In Press). Pacific islands: Development of coastal marine resources of selected islands. *In*: Chia Lin Sen, C. H. Soysa, B. Lockwood, W. L. Collier (Eds.). Man, Land and Fish: Coastal Resource Use and Development in Asia. Univ. Singapore Press.

Bardach, J. E. In Press. Economic energy use in fishing. Proc. 14th Pacific Science Congress, Academy of Sciences, U.S.S.R.

Benjamin, P. 1953. Interview techniques and field relationships. Pages 430–451 *in* A. K. Kroeber et al., eds. Anthropology Today. Univ. Chicago Press.

Bullis, H. R. Jr. 1978. The biological and technological basis for further development of artisanal fisheries in the Caribbean area. *Gulf Carib. Fish. Instit.* 30: 166–172.

Cordell, J. C. 1973. Modernization and marginality. Oceanus. 17: 28–33.

Forman, S. 1970. The raft fishermen: Tradition and change in a Brazilian peasant economy. Indiana Univ. Press, Bloomington. 158 pp.

Freilich, M. (Ed.). 1977. Marginal natives at work: Anthropologists in the field. Cambridge: Schenkman. (Dist. by Halstead [Wiley]), New York. 325 pp.

Hill, H. B. 1978. The use of nearshore marine life as a food resource by American Samoans. Pacific Islands Program, Univ. of Hawaii. Misc. Working Pap. 1978. 170 pp.

Holt, S. J. 1962. Discussion. Page 483 *in* R. Hamlisch, ed. Economic effects of fishery regulation. *FAO Fish. Repts. #5. FAO, Rome.*

Johannes, R. E. 1978a. Traditional marine conservation methods in Oceania and their demise. Ann. Rev. Ecol. Syst. 9: 349–364.

———. 1978b. Reproductive strategies of coastal marine fishes in the tropics. Envir. Biol. Fish 3: 65–84.

———. In Press. Using knowledge of the reproductive behavior of reef and lagoon fishes to improve fishing yields. *In*: J. Bardach, J. J. Magnuson, R. May and J. Reinhart (eds.). Fish Behavior and Fisheries Management. I.C.L.A.R.M. Manila.

———. 1981. Words of the lagoon. Fishing and Marine Lore in the Palau District of Micronesia. University of California Press. 245 pp.

Johnston, R. S. 1977. The relationship between property rights arrangements and the nature of aquaculture developments. Pages 147–153 *in* B. Lockwood and K. Ruddle, eds. Small scale fisheries development: social science contribution. East-West Center, Honolulu.

Kent, G. 1976. Dominance in fishing. J. Peace Res. 18: 35–47.

Lawson, R. M. 1978. Incompatibilities and conflicts in fisheries planning in Southeast Asia. Southeast Asian J. Soc. Sci. 6: 115–136.

Leach, G. 1976. *Energy and food production.* IPC *Science and Technology Press. Guildford, Surrey.* 137 pp.

Nietzchmann, B. 1973. Between land and water. Seminar Press, New York. 279 pp.

Olsen, D. A., and J. A. La Place. 1979. A study of a Virgin Islands grouper fishery based on a breeding aggregation. Gulf Carib. Fish. Instit. 31: 130–144.

Roedel, P. M. 1979. Scientific assistance to Caribbean fisheries. Gulf Carib. Fish. Instit. 31: 66–69.

Smith, I. R. 1979. A research framework for traditional fisheries. ICLARM Studies and Reviews No. 2. International Center for Living Aquatic Resources Management, Manila. 40 pp.

Vayda, A. P., and R. A. Rappaport. 1968. Ecology, cultural and non-cultural. Pages 477–497 *in* J. A. Clifton, ed. Introduction to Cultural Anthropology. Houghton-Mifflin, Boston.

DATE ACCEPTED: February 12, 1981.

ADDRESS: *CSIRO Division of Fisheries and Oceanography, Box 20, North Beach, Western Australia.*

George Borgstrom, in the July 1976 issue of *Smithsonian,* wrote that: 'In the course of man's quest for food, more than half of the world's forest cover has vanished, large areas of grasslands have been plowed, and major groundwater reserves irreversibly drawn down. Forest and pasture lands have been squeezed down to wholly inadequate levels. Erosion, desertification, waterlogging and salination have destroyed much tilled land and are jeopardising still more. Irrigation reservoirs are filling with silt at 10 times the anticipated rate. Such problems are equally grave in numerous other countries that should be labelled biologically overdeveloped rather than designated underdeveloped. Despite impressive postwar advances in yields per acre, 40–60% of the world food production increase has come from expanded acreage. To accommodate future billions, half of the now remaining forests will have to be cut down and much surviving grassland with ambitious plans for expanded forest production, not least of all in the poor world where 80% is used for firewood. Most of the remaining accessible forests lie in the humid tropical zone, on land poorly suited for intensive agriculture.'
Aurelio Peccei of the Club of Rome warns that the tropical rain forests are being destroyed at a rate of 20ha/min.

LEUCAENA
2: the tree that defies the woodcutter

Michael D. Benge
United States Agency for International Development
Washington, DC

LEUCAENA has been well known throughout the tropics since the late 1800s as a shade tree for coffee, vanilla, quinine, cacao, and tea; as a companion-fertilizer crop; for protection against wind erosion on certain soils; and as a nurse-fertilizer plant with fruit and forest trees. In Indonesia teak plantings intercropped with *Leucaena* outgrew pure stands by almost 100%.

In the tropics forest removal decreases the land's ability to hold and recycle nutrients in the face of high year-round temperatures and periods of leaching rainfall. Most minerals available in the tropical ecosystems are tied up in dead and living organic systems. The levels of available minerals that are free in the soil are always low. Mycorrhiza, which is abundant in the surface litter and thin humus of the forest floor, is believed to be capable of digesting dead organic litter and passing minerals and food substances through the hyphae to living root cells. In this manner, little soluble mineral leaks into the soil where it can be leached away. Many trees will not grow without mycorrhizal fungal symbionts.

Leucaena has a vigorous taproot and limited lateral branches that angle downward. Roots are commonly as deep as the tree is tall. With its deep-growing root system, *Leucaena* can obtain nutrients from soil strata that are not accessible to most other plants. Surrounding the roots of *Leucaena* are masses of mychorrhizae that can metabolise unavailable phosphorus and other minerals. These minerals are taken up by the mychorrizal mass and then slowly released to the plant.

Symbiotic nitrogen-fixing bacteria also draw or fix nitrogen from the air and store it in bacterial clusters on the *Leucaena* roots. The plant then transfers minerals and nitrogen to its leaves. The constant leaf drop provides a rich organic litter, making the plant an efficient recycler of those nutrients and a constant, readily available source of free fertilizer. *Leucaena* can thus be compared with a pump—it pumps nutrients from the deep soil strata to

Leucaena is an excellent source of firewood. When cut, it readily coppices, providing an abundant and renewable source of wood

the surface soil.

Organic materials—humus and soil organisms that live in the soil—play an essential role in preserving the soil structure and fertility needed for productive farming. Organic matter holds the soil in place when rain falls and wind blows, and reduces the wasteful, polluting run-off of applied chemical nutrients, thus increasing the efficiency of their use.

Population devastates forests

The population explosion is accelerating forest devastation. Until industry can absorb the unemployed and population is checked, migration to upland areas will continue in man's quest for arable land.

Excessive and irresponsible logging coupled with the quest for more agricultural land are two main causes of denudation in many areas of the world. In many lesser-developed countries, industrialisation and massive use of motorised vehicles demand huge oil imports which cause an imbalance of trade. Many feel that this is easily remedied by exporting what seems to be a never-ending supply of natural resources such as lumber and logs. The damage that has been done, more often than not, is realised too late

Shifting cultivator is a scapegoat

Swidden agriculturists, often referred to as slash-and-burn cultivators or fire-farmers, are another problem. In many countries they have been declared illegal occupiers of forest lands. They often bear the brunt of the blame for denudation. A convenient scapegoat, slash-and-burn cultivators can be separated into two groups—sedentary and traditional. The sedentary cultivator is usually a migrant who has left the lowlands for the mountainside, either in search of land for cultivation or to flee social pressures. He usually tries to farm hillsides with cultivation practices used in the lowlands, farming the same land year after year without crop rotation and making little or no organic or chemical inputs. This damages the soil structure and causes erosion. He soon finds that he needs more land, which he gains by cutting more forested areas. The traditional slash-and-burn cultivator is generally a cultural minority, who has, over the years, realised the relationship between forest regrowth and soil fertility. Those people's shifting cycle is usually from two to four years and they refarm fallow fields that had grown to second- or third-growth timber after a period of years. If you study closely their practices in some areas, you find that many practise natural erosion control and reafforestation methods. For example, certain groups in New Guinea reafforest with *Casuarina*, a nitrogen-fixing, non-leguminous tree. In the Philippines, the Ikalahans plant broom straw and windrow crop residues on the contour as an erosion-prevention measure. Those practices, inherent in their traditional systems, disappear as lowlanders compete for their land and laws are passed preventing their natural rotational patterns. Subsequently, the soils are soon lain waste, depleted, and taken over by noxious grasses and weeds—the slash-and-burn cultivators forced from their lands and thus deprived of their means of livelihood. Are they to blame or are we, as technocrats who have offered them no alternatives? 'Hunger is not the tragedy of an empty stomach, it is the tragedy of a human mind and abilities not used.'

Indigenous techniques are needed

Dr Dioscoro L. Umali, Assistant Director-General, FAO Regional Office in the Far East, Bangkok, summarised the problem faced by developing countries when he castigated the roles that affluent intellectuals and technicians have played in attacking world hunger and poverty by emphasising plantation export crops and sales of modern technology: 'Help us to build production systems that are not carbon copies of those in industrialised countries. Our need is for models that are simple, based on indigenous sources and techniques native to the soil.'

J. Sholto Douglas and Robert A. de J. Hart, in the book 'Forest Farming', wrote that: 'Vast areas of the world which are at present unproductive or under production—savannahs and virgin grasslands, jungles and marshes, barren uplands and rough grazings, deserts and farmlands abandoned owing to erosion—could be brought to life and made more hospitable to human settlement. The know-how exists to make abundant contributions to man's food needs by methods combining scientific and technological research with traditional husbandry. The tool with the greatest potential for feeding men and animals, for regenerating the soil, for restoring water-systems, for controlling floods and droughts, for creating more benevolent microclimates and more comfortable and stimulating living conditions for humanity, is the tree.'

The challenge of finding solutions has stimulated the development of new programmes across the world. Cropping systems based on perennial tree crops, cover crops, and proper management procedures offer maximum environmental protection as well as a profitable alternative for the marginal farmer (redundantly termed the poorest of the poor), who now cultivates once-forested uplands. In one such system *Leucaena leucocephala* is planted in contour bands 5m in width and intercropped in alternating 10m bands. The *Leucaena* is cut and applied to the intercropped annual crops as an organic mulch, providing fertilizer that the marginal farmer could not otherwise afford. Such a constant source of fertilizer would eliminate the need for continued shifting agriculture, because the trees that the marginal farmer previously slashed and burned for fertilizer would be replaced by *Leucaena* and would no longer be needed.

Growing yams under *Leucaena*

In the Philippines, a modified version of this is being tested with the Mangyans, a cultural minority group that inhabits the mountains of Mindoro, an island off the southern Luzon. Their basic staple is 'nami', *Discorea hispidia*, a shade-loving yam, that grows wild under a forest canopy. At the University of the Philippines at Los Baños (UPLB), *Discorea* was domestically cultivated under a normal forest canopy. Test plots of the yam yielded a projected 30 tonnes of tubers/ha. Because of *Leucaena's* value as a fertilizer plant, *Discorea* could yield even higher if cropped under a canopy of *Leucaena*. Cassava, *Manihot esculenta*, is a root crop that is extensively cultivated throughout the developing countries. Cassava has high nutrient requirements and its continuous cropping rapidly depletes the soil's plant food reserves. On hilly terrain, cassava cultivated without ground cover seriously accelerates soil erosion. In many areas, cassava is planted to produce starch for sizing, clothes starch, and pastes, and for tapioca production. *Discorea* starch could possibly replace part of the cassava starch used for industrial purposes. In such a manner a forested area could be double cropped with trees and a root crop grown as well; reducing the area planted to the nutrient-demanding, erosion-indicing cassava.

E. F. Schumacher coined the term 'intermediate technology' to describe the types of approaches and industries needed in the developing world. 'I have named it intermediate technology', he said, 'to signify that it is vastly superior to the primitive technology of bygone ages but at the same time much simpler, cheaper, and freer than the supertechnology of the rich'. *Leucaena* would surely qualify as intermediate technology.

APPENDIX C

FISHING RIGHTS OF THE NATIVES OF GERMAN SAMOA

by W. von Bulow
in Globus LXX XII, p. 40-41 (1902)
(translated from German by Christa Johannes)

Fishing rights are a peculiarity of Samoan customary rights. The regulations relating to fishing rights are as many and various as the regulations relating to customary rights concerning the possession, acquisition and disposal of land. The natives' subsistence comes mainly from agriculture and fishing.

It is not surprising, therefore, that these two sources of livelihood are specially protected by customary rights. According to customary law the boundary between land and sea is the line which marks the waves crashing against the coast at the time of mean high water, namely the "high water mark." The space between this high water mark and the respective water's edge at any particular time is considered a traffic route.

The space between this traffic route and the outer edge of the reef, that is, the "lagoon", is considered the fishing ground.

Just as all land in Samoa has its owner - even if in time it has become more and more difficult in some cases to determine the rightful owner - so all Samoan fishing grounds have their owners.

These owners are either communities, chiefs' families, or else ownership rights or certain parts of ownership rights go with the possession of particular areas of a fishing ground. (Translator's note - the meaning of the second half of this sentence seems unclear).

These customary rights are old and have remained valid into most recent times.

Offences against these laws were punished by the local assembly up to the most recent times.

Fishing outside the reefs, "to the ends of the world", to Tutuila and Manua in the East, to Toelau in the North, the Uea and Viti in the West, and the Foga mamao in the South, is free. But there are valid rules even for fishing outside the reef (particularly in relationship to shark fishing - lepa malie - and bonito fishing - alo atu), rules that are determined by the guild of fishermen, the tantai, and which are enforced by the latter. These are outside the framework of this work.

Fishing rights are generally considered as non-saleable in Samoa. Nevertheless in the 1870's it happened that native fishing grounds were surrendered to strangers; this, however, in part without obtaining the assent of the state. Thus it happened, for example, with the so-called "little harbour" of the harbour of Apia.

On the island of Upolu, where the natives are no longer so singularly dependent on the yields from their fishing grounds as formerly when the number of foreigners was smaller and the opportunity of making a living (working for wages?) was less, interest in the former fishing grounds seems to have already greatly declined.

On the island of Savaii, on the other hand, the old customs still continue in their purest form, the boundaries of fishing rights are still least obliterated, and the effort and joy in fishing are still most pronounced.

Therefore it is on this island that infringements into fishing rights are felt most acutely. The worst infringement of this kind is dynamiting within the reef. It is without doubt that in a circumference of many meters all sea animals die where a single ½ cartridge of this material explodes. As fish mostly spawn within the reefs, it is quite conceivable that a well-stocked fishing ground can be ruined - depopulated - within a very short time.

These fishing grounds, which carry with them ownership rights or parts of ownership rights which favour village communities, extended families, or individual title-holders, are known. Known both according to their general position as well as according to their boundaries in relationship to each other.

These fishing grounds make up part of the wealth of the owner and therefore should be protected by law today just as much as any other possession - something which until this day has actually been the case in the villages.

Fishing rights entitle the owner to every kind of fishing on his fishing ground, to the piling up of coral and stone heaps as hiding places for fish, and to setting up any number of fish and crab traps.

The duties of an owner of a fishing ground are in general the following:

1. If he catches certain large species of fish (the turtle, laumei, is also considered as "fish" - ia) he has to turn them over to the village assembly or in some villages to particular chiefs or to particular speakers (translator's note - talking chiefs?).

2. In addition he has to follow the orders of the village assembly if for a certain period it forbids the catching of atule (South Sea Herring) in order for the assembly to gain time to prepare to catch this fish in the lauloa (a large drag-net), or

3. if the assembly declares the ocean "forbidden" - sa - because a high chief has died, or because during the transfer of the remains of a long-deceased person from the present grave to a new grave his bones were "bathed" by the sea.

4. The owner has to allow his own village or neighbouring localities to cast their large drag-net, but to do so without searching through the stone heaps he has set up himself,

5. as well as to allow everyone to cross his fishing ground while dragging a fishing lure, pa, any time of day or night.

In civilized countries fishing with explosives is heavily punished.

It is hoped that studying the customary rights of the Samoans concerning fishing will contribute to their fair treatment by foreigners and to the maintenance of our fish supply.

AUSTRALIAN DEVELOPMENT ASSISTANCE BUREAU

DEPARTMENT OF FOREIGN AFFAIRS

P.O. BOX 887
CANBERRA CITY, 2601
Telephone 486644, 619111
Telegrams AUST DE VAID
Telex 62631

APPENDIX D

ACTION OFFICER

REFERENCE 81/4469

2 MAR 1982

Mr R.E. Johannes,
Principal Research Scientist,
Marine Laboratories,
CSIRO Division of Fisheries Research,
P.O. Box 20,
NORTH BEACH. W.A. 6020

Dear Mr Johannes,

Thank you for your letter of 28 January seeking information about access to funds for cultural activities. The source of funds to which you refer is known as the Fund for the Preservation of South Pacific Cultures. Although funding is provided by ADAB, the Fund itself is administered by an Advisory Committee based in the Department of Foreign Affairs.

To obtain information on when the Committee will be meeting to consider requests and the parameters within which it will approve projects, you may care to write to the following person:

Mr G. Hannaford
Secretary to the Advisory Committee,
Fund for the Preservation of South
Pacific Cultures,
Department of Foreign Affairs,
PARKES. A.C.T. 2600

As is the case with all other forms of Official Development Assistance, requests for assistance from the Cultures Fund can only be considered if they have the endorsement of, and originate from, the government of the country concerned.

In the case you outline, the Western Samoa Government will need to submit a fully documented and costed request to the Australian High Commission in Apia, who will then forward it to the relevant officers in the Department of Foreign Affairs.

I trust that the foregoing information will be of assistance to you.

Yours sincerely,

(D.S. Campbell)
Acting Assistant Secretary
Pacific, Asia, Africa, Programs Branch