SOUTH PACIFIC COMMISSION

REPORT ON MARINE SURVEYS OF RAROTONGA AND AITUTAKI

(November 1976)

by

A. L. Dahl

Regional Ecological Adviser

Noumea, New Caledonia
February 1980

180/80

Report on a Marine Survey at Rarotonga undertaken 23-29 November 1976

by A. L. Dahl

South Pacific Commission

This report is based on a detailed examination of a variety of sites around Rarotonga, with particular emphasis on the area between Ngatangiia and Titikaveka. It has not been possible to examine all of the lagoon, so certain conclusions are based on extrapolation from the areas visited. Efforts were concentrated on the inner reef and lagoon environments which receive the most intensive human impact and utilization; time and weather did not permit a survey of outer reef areas seaward of the reef crest. Teariki Daniel, Ron Powell and Amata Tetevano contributed information to this study, and the survey department prepared comparative profiles of the Ngatangiia harbor area over the last 70 years; their assistance and that of the Conservation Service are greatly appreciated.

General aspects of the reefs and lagoons

Rarotonga is encircled by a fringing reef, although in some areas this is separated from the main island by a wide lagoon. Both the reef and lagoon seem to be under lain by a very flat coralline rock platform probably dating from earlier geological periods of reef-building; and this accounts for the very shallow nature of the lagoon.

Most Polynesian reefs in inhabited areas have long been exploited at their maximum sustainable yield, and with the advent of modern fishing techniques and development projects, yields in areas of high population concentration such as Rarotonga have declined considerably. The general impression of the inshore reefs and lagoons of Rarotonga is one of impoverishment and degradation, with little regeneration capacity capable of supporting the fishing demands of the local population. It will take time and careful management to restore the productivity of the coastal marine resources.

While there is no assurance that the Rarotonga reefs ever resembled those of Aitutaki, the following major differences have been noted:

Rarotonga	Aitutaki
Reef crests of coralline algal pavement (algal ridge) with scattered corals and thin algal turf.	Reef crests dominated by larger seaweeds such as Turbinaria and thick algal turf.
Few corals in immediate back-reef area flanking the lagoon.	Rich coral development on the inside margin of the reefs.
Larger benthic animals scarce on reef.	Abundant snails, shellfish, clams and other animals.
Lagoon patch reefs largely without living corals.	Many living corals on lagoon reefs except in localised areas.

While atoll reefs tend to be better developed than fringing reefs, the extreme differences between the two nearby areas must be accounted for in part at least by the factors discussed below.

The water circulation patterns tend to isolate the inner reef and lagoon areas of Rarotonga to some extent, so it is possible to sub-divide the reef into several areas on the basis of the principal structural characteristics (See Map 1)

(A) Avarua to Ngatangiia - narrow reef with solid pavement bottom and boulders in the inner area, covered with algal turf and a few corals near the reef crest.

(B) Ngatangiia Harbour to Tikioki - large lagoon with motus and distinctive bottom communities in inner channel area, marshes, and major fresh water inputs; lagoon reefs with almost no living coral, just crustose coralline algae and turfs, although the state of coral skeletons suggests that the lack of corals is a recent phenomenon; few reef fish observed, including parrot fish, perhaps as a result of the lack of corals; an area of considerable fisheries potential but presently degraded (see diagram).

(C) Tikioki to Auaavaroa Passage - similar to the open lagoon areas further east, only with lagoon current westward toward the passage; patch reefs healthier, with some very old corals, and reef fish. A considerable number of taramea (Acanthaster) were observed or reported in the area, and they are killing off the living corals at a relatively rapid rate.

(D) Avaavaroa Passage to Rutaki Passage - lagoon slightly narrower, with more extensive patch reef development.

(E) Rutaki Passage to White sands - less sandy bottom than above, with more boulders and patch reefs.

(F) White sands to Arorangi - reef with some living corals, backed by wide band of boulders and coral rubble, with narrow lagoon close to beach containing small coral heads with some small living corals.

(G) Black rock area - narrow but with deeper lagoon containing many large flat-topped patch reefs topped by living corals, but largely dead on the sides; water quite turbid, perhaps because of erosion caused by sand removal for construction purposes.

(H) Nikau to near Avatiu - wide lagoon with motu; sandy near shore but with extensive rocky substrate near reef.

(I) Avatiu and Avarua areas - largely disturbed by urbanisation and harbour development.

Critical habitats

There are certain habitats that are critical to the management of a resource and that should therefore be singled out for special attention:

- The shallow grassy marshes of the Ngatangiia harbor area, which are probably important breeding or nursery areas for certain species; one has already been destroyed for an earlier aquaculture project.
- Ngatangiia harbor and the major reef passages, which are major fish migration routes into and out of the lagoon.
- Any areas with substantial living corals, such as in the lagoon near the Titikaveka packing shed; many juvenile fish were observed in this area during the survey.
- The channel between the motus and the shoreline at Muri, which drains a major part of the lagoon, and has unusual bottom communities of corals and algae adapted to the strong current.

Environmental Problems

The infestation of the crown of thorns starfish (Acanthaster plancii or taramea) has come later than most other parts of the Pacific. After the major invasion of 1972-73, the numbers have apparently subsided somewhat. However, there are reports of many taramea and large areas of recently killed corals outside the reef in the vicinity of the Arorangi school about 4-5 months ago, and in the Rutaki passage three months ago. The present occurence of taramea in the lagoon in the Titikaveka area suggests that there may be an infestation moving eastward along the outer face of the southern reefs. While there is some evidence that taramea problems may be a natural event, the destruction of corals by taramea may seriously damage important local fisheries. Control measures are therefore in order.

The killing of fish with vegetable poisons (Barringtonia, Derris root), pesticides (Dieldrin, Lindane), or less frequently, explosives is a continuing problem in the Rarotonga lagoon, and is probably at least partly responsible for the dead patch reefs in many areas. Every attempt should be made to eliminate these destructive and short-sighted practices. Care should also be taken in using poisons on land to insure that they do not get into the streams and thus into the lagoon.

There are frequent complaints about coastal erosion and the loss of beaches. Most of the beach sand around Rarotonga is produced by seaweeds that grow in the lagoon and on the reef. Newly-produced sand accumulates on the lagoon bottom and is probably carried up onto the beaches in certain types of wave or storm conditions. Sand is also transported along the beaches by wave and current action. Coastal processes are very complicated, and it is normal for beaches and other coastal areas to grow or erode periodically. However, the production of sand in the lagoon is limited, and any major removal of sand from an area will "starve" that area and those "downstream" from it in terms of sand movement.

The coastal marine ecosystems of Rarotonga are susceptible in many ways to terrestrial influences, particularly with respect to the streams that flow into the lagoon. The leaves and other plant material that are washed into the lagoon may provide an important input into detritus food chains in much the same way as mangrove forests in other island areas. Fresh water kills corals, and sediment smothers most reef plants and animals. Poor land use practices that result in more rapid runoff and increased erosion can therefore also be very damaging to reef fisheries. On the other hand, coastal marshes and other brackish water habitats can be beneficial as nursery areas for some species. Careful management of watersheds can therefore help to provide better fisheries.

With the rapid development of the coastal margins at Rarotonga, there will be increasing effects on marine ecosystems unless adequate controls are instituted. The seepage from septic tanks, pit toilets or other sewage installations, the alteration of runoff patterns, the dredging or filling of shallow water habitats, the increasing incidence of pollution, trash dumping, and even recreational and subsistence uses of the environment, all can contribute to degrading marine resources. It is therefore important that government be able to control or even block development projects when they threaten to damage marine areas, and in particular, critical habitats.

Establishment of a marine reserve

The establishment of a fisheries management area or reserve in the coastal marine environments of Rarotonga, with the possible exception of the Avarua and Avatiu harbor areas presents a number of advantages. While it cannot be justified solely on conservation grounds, it would provide a mechanism for organising the more effective management of the coastal resources of Rarotonga and for protecting the reefs and lagoon against certain types of harmful development. The principal purpose of the reserve would be to safeguard the natural fisheries productivity of the area, while at the same time maintaining a tourist resource and conserving sites of natural historic or scientific interest.

The reserve could be divided into zones dedicated to management for different principal uses:

Village fishing zones maintained to provide a continuing fish supply to adjacent villages;

Tourist zones designed to preserve scenic features, beautiful undersea life, and recreation areas for the benefit of the tourist industry;

Conservation zones in which protection of the natural system is most important, perhaps because of its role as a critical habitat for nearby village fisheries;

Sports fishing zones managed for visitors or residents who purchase a sports fishing license, the proceeds from which can help with the operation of the whole marine reserve.

The principal management responsibility, at least for the village fishing zones and perhaps for all zones, should be vested in the District Councils in consultation with the Conservation Service. The latter would retain some final power of veto if the very purposes of the reserve were threatened. It is at the village and district levels that people are most aware of what is happening to their environment, and with education they will be willing to make sound regulations and enforce them in their own collective interest.

It is important that the declaration of the marine reserve be immediately followed by educational and extension programmes in the villages to win the peoples support for the concept and to enlist their help in developing detailed management plans for the parts of the reserve in their district or under their responsibility. A variety of types of management techniques can be suggested for their consideration closed areas (raui) either temporary (to allow on area to recover) or permanent (to provide a "seeding" area from which adjacent exploited areas can be repopulated); controls on fishing methods (net sizes and lengths, spearguns, etc.); closed seasons or size limits for particular species, etc. Management plans and regulations would need to be subject to frequent review, particularly at first, to insure that the objectives of the reserve are being met. It might be necessary to set up some simple monitoring programme to provide some feed back of data to the District Councils and the Conservation Service on the effectiveness of the regulations.

The reserve could thus become the principal means of halting the present degradation of the marine resources of Rarotonga and of instituting sound management practices so that they can continue to serve the people long into the future.

Recommendations

1. A marine fisheries management reserve should be declared for all of the reefs and lagoons of Rarotonga and the adjacent coastal waters. The Conservation Service would then work with the District Councils and interested local groups to develop management plans for the various components of the reserve.

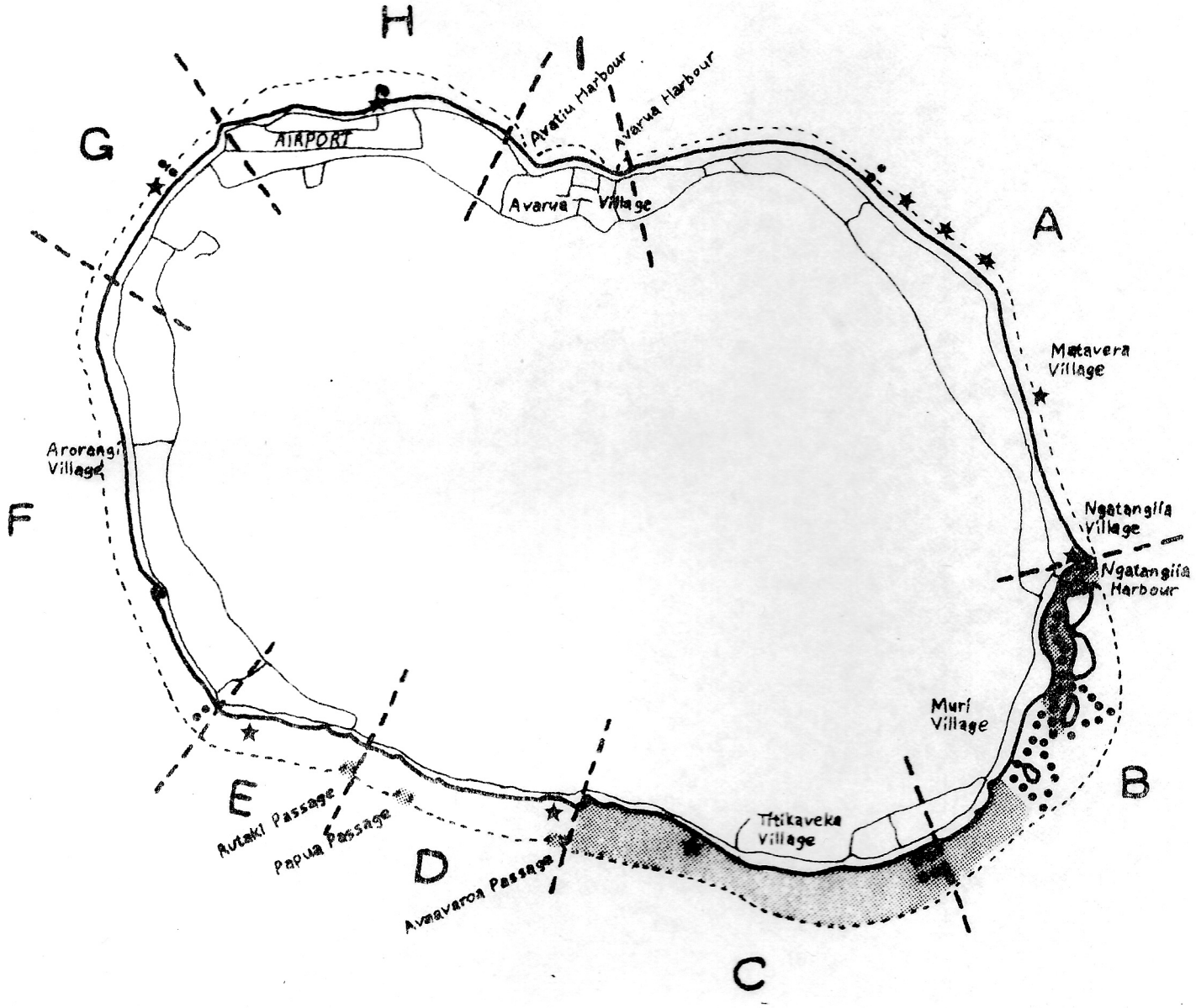
2. Further steps are needed both in enforcement and education, to eliminate the use of poisons and explosives in fishing.

3. A survey is needed of the outer slope of the southern reef to determine if there are still concentrations of Taramea. Collections should be organised to destroy the taramea in the Titikaveka area of the lagoon and in any concentrations found outside the reef.

4. Removal of beach sand should only be allowed, if at all, at those stream mouths where the sand is impeding proper drainage.

5. Controls should be instituted on all coastal development. In particular, no habitations should be permitted on the motus at Muri, since the surrounding waters contain critical habitats for lagoon fisheries.

6. Comprehensive planning should be instituted for the Ngatangiia Harbor Muri area to insure that the natural values of the area will be protected in any developments that take place. The area has great potential for tourist visits as well as recreation use by the people of Rarotonga, but accommodations and high density facilities should be avoided.



Marine Study November 1976
By A.L. Dahl, S.P.C.

Map 1 : Rarotonga Island

H Principal Reef And Lagoon Areas

★ Visual Examination

• • Detailed Site Survey

Critical Habitats

CODE FOR MAP 2, NGATANGIIA HARBOUR AREA

(1) Harbour - An old photograph shows four schooners anchored here around the turn of the century.

(2) New fish traps were built in the late 1960's.

(3) A dry stream with the mouth blocked by a sand bar.

(4) A sea wall built in front of the church to stop erosion. The rampart has been removed.

(5) Eroding old foundation of mission school.

(6) Swamp - breeding area for fish which used to be deeper and is now filling with sand.

(7) Heaviest sediment in heavy rain.

(8) Erosion of 7-10 metres. Much sand removed by man.

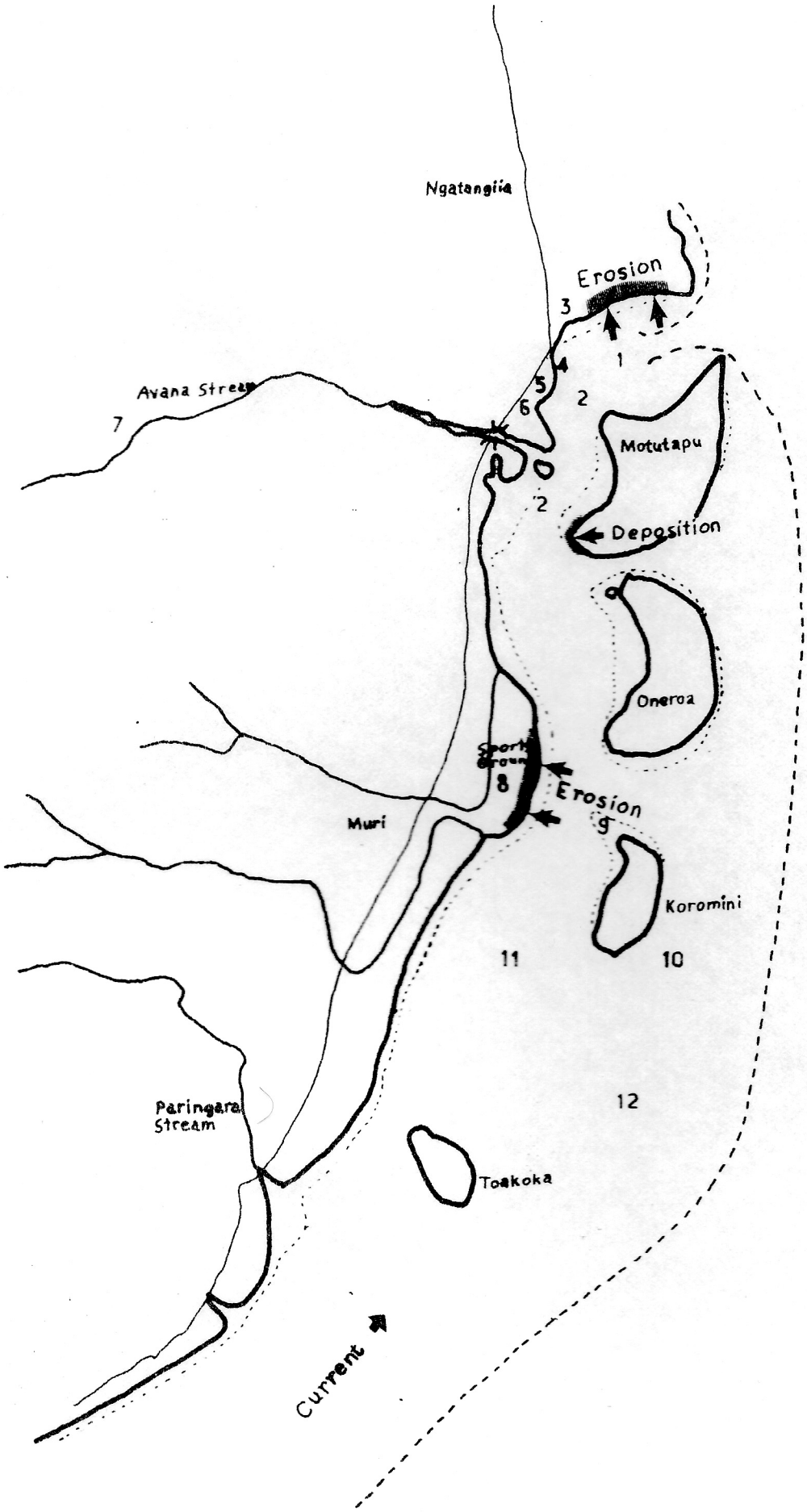
(9) Builds up when calm and washes away in heavy seas.

(10) Dynamiting for fish

(11) Used to have schools of mullets until dynamited.

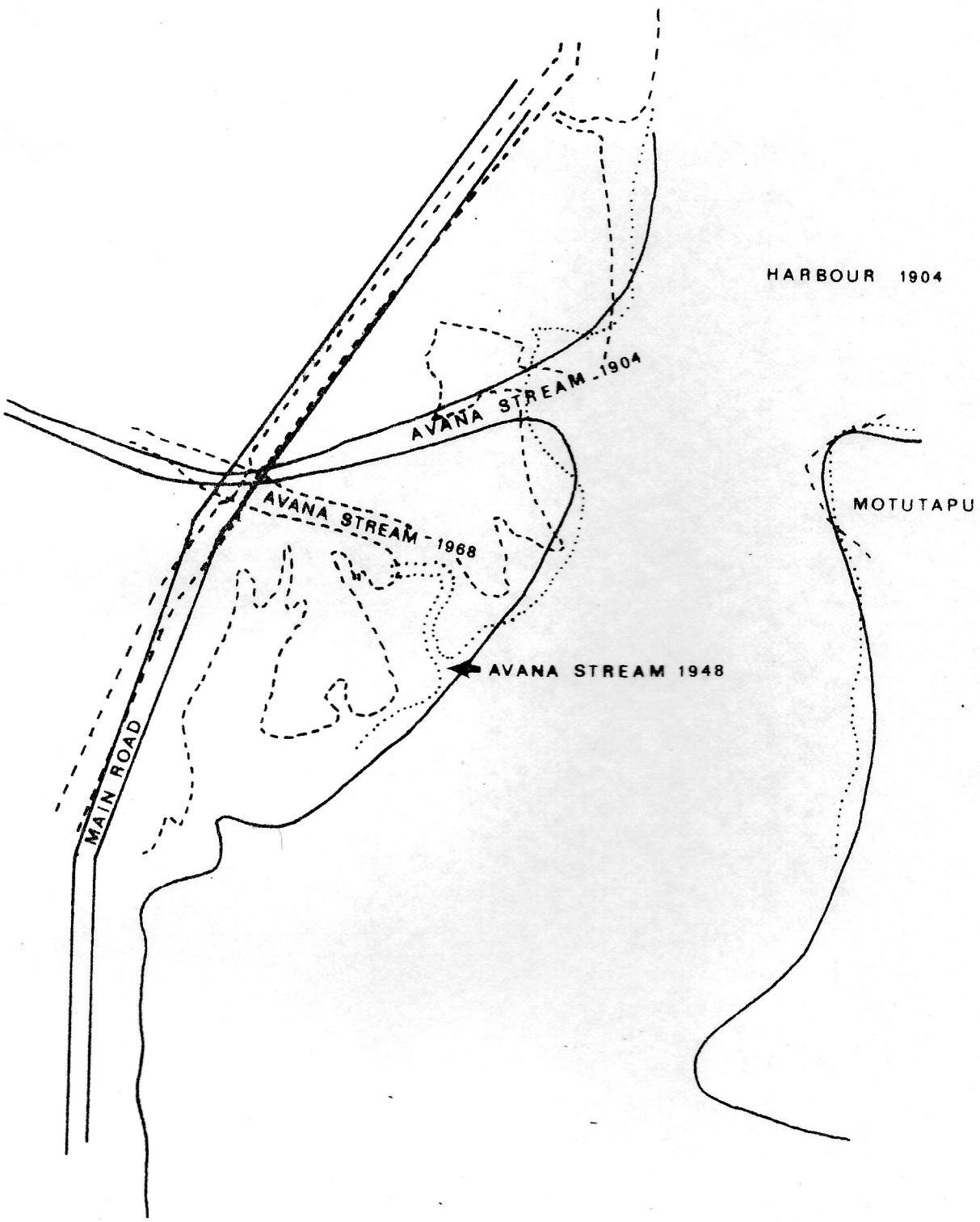
(12) Much fishing of this area is done with New Guinea Creeper, Lindane, and dynamite.

The last cyclone was during 1963-64.



Map 2 : Ngatangiia Harbour Area

Marine Study 23 November 1976
By A.L. Dahl, S.P.C.



Map 3 : Shoreline changes in Ngatangiia Harbour

1904 ——————

1948 .....

1968 - - - - - - - - - - - -

Report on a Marine Survey of Aitutaki undertaken 17-20 November 1976

by A.L. Dahl

South Pacific Commission

The following notes and observations are based on a brief but extensive survey of the lagoon and reefs of Aitutaki undertaken with the assistance of Ngati Tuiravakai and the cooperation of the staff of the Conservation Service. Reports by Stoddart and Pillai have also provided useful information.

An atoll, or almost atoll, such as Aitutaki must be treated as a single integrated ecosystem for environmental management purposes, particularly in the marine environment. Conservation measures for such large systems must generally combine protective measures for certain critical habitats with more general management policies designed to prevent the degradation of the whole system.

Some of the principal elements of the system are as follows:

1. The main island provides, through stream runoff, a major nutrient input into adjacent lagoon waters.

2. The shallow waters surrounding the main island are an area of high phytoplankton productivity, as evidenced by their green coloration, and support large numbers of young fish.

3. The stream mouths, swamps and marshes probably play an important role in fish reproduction, as evidenced by the report of mullet, grouper and snapper migrations into such areas after heavy rains. The recent sediment accumulation, filling and alterations in such areas may have a significant long-term impact on fisheries productivity.

4. The windward reefs to the east of the lagoon are areas of high primary productivity, support large mussel and other mollusk concentrations, and provide major sediment inputs into the lagoon.

5. The more protected southern reef has rich and extensive coral development, providing excellent habitats for fish, particularly parrot fish.

6. The western (leeward) reef appears to differ somewhat in structure in the north adjacent to the main island (as described by Stoddard and Pillai), and in the south fronting on the lagoon. In the north, the foundation platform is deeper and the reef structure more open than elsewhere, while an algal ridge occurs further to the south. Extensive patch reefs occur just inside the reef, but many of those in the central section have few living corals. It was reported that large fish are now less common but clams (Tridacna) much more abundant in this area.

7. There is continuing sand accumulation in the south western corner of the atoll around Maina, and perhaps also in other parts of the lagoon.

8. Seawater in the marginal reef areas is constantly received by tidal and wave flows in and out across the reef. The residence time of water in the lagoon appears increasingly long with increasing depth and distance from the reefs.

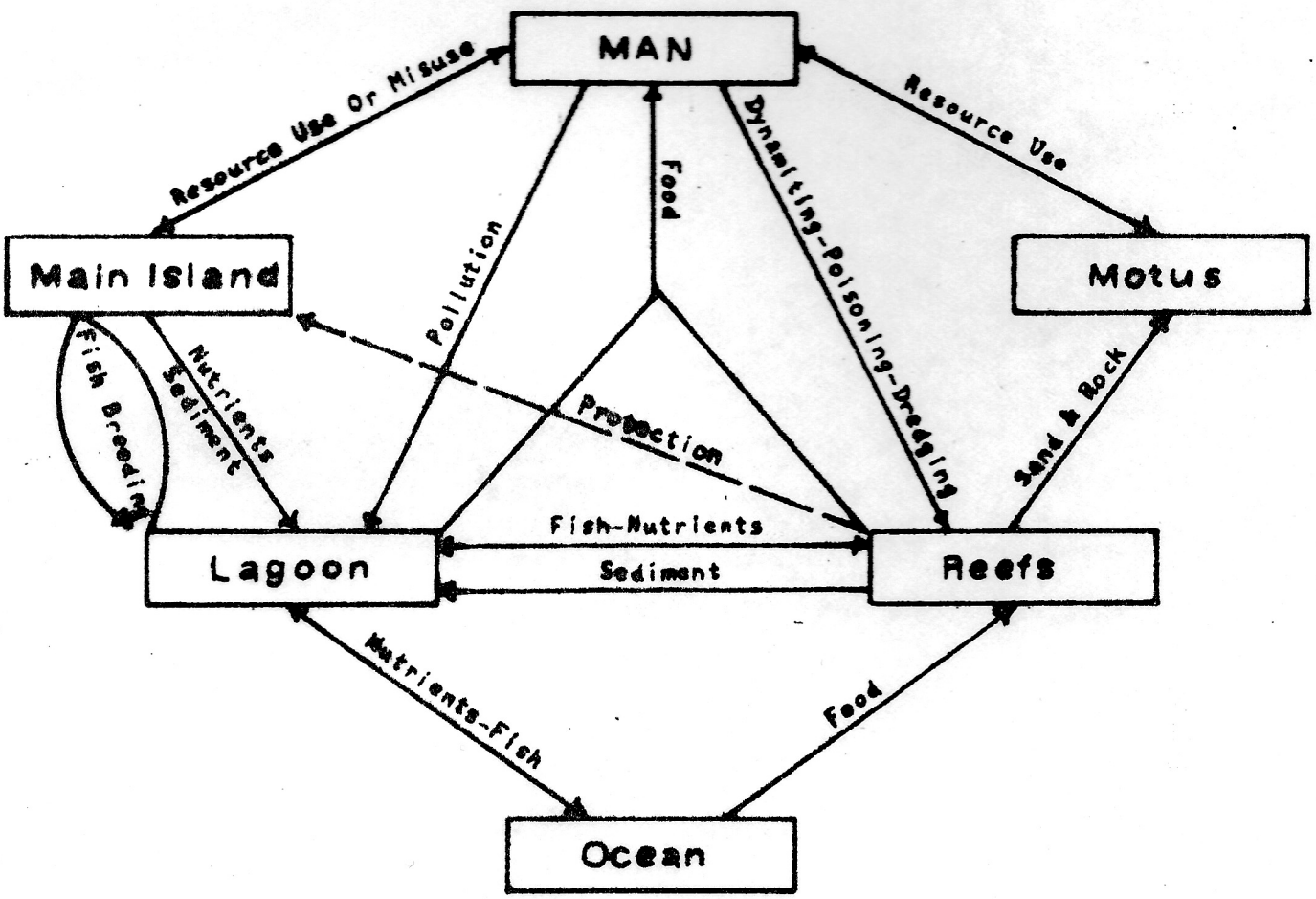
9. Much of the present reef development is on platforms dating from earlier geologic periods.

10. Most lagoon patch reefs have large areas of dead coral, and appear to have been subjected to considerable stresses (natural or man-made). Community diversity decreases northward from the rich southern patch reefs, and inward towards the main island. There appears to be some correlation between living coral coverage and good fishing.

11. There are reports of significant migrations of fish between areas of the lagoon, and through channels connecting the lagoon with the outside reef, often at particular seasons of the year.

12. The motus have probably been built largely by hurricane action. Severe hurricane effects can therefore be expected on the outer reefs, and development projects such as aquaculture there would probably by unwise.

Components of the Aitutaki ecosystem



Management Principles

Island fisheries will be carefully monitored and managed to maintain or improve the catches of island fishermen on a sustainable basis.

The swamps, stream mouths, near-shore shallows and reefs, and other areas important for fish breeding and as habitats for young fish will be protected from direct disturbance or from alteration by siltation or run off from poor land use.

Immediate Goals

1. The Island Council should make local fisheries management rules concerning fishing techniques permitted or prohibited, times and places for catching particular species, closed seasons or areas (raui) necessary to protect reproducing species or to allow over-exploited resources to recover. The length of nets and the size of net mesh should be limited according to the area being fished and the type of fish being caught.

2. It might be helpful if the Island Council appoints an advisory group of local fishermen to inform it of fishing conditions and catches, or in some other way collects information on the current status of the fishery.

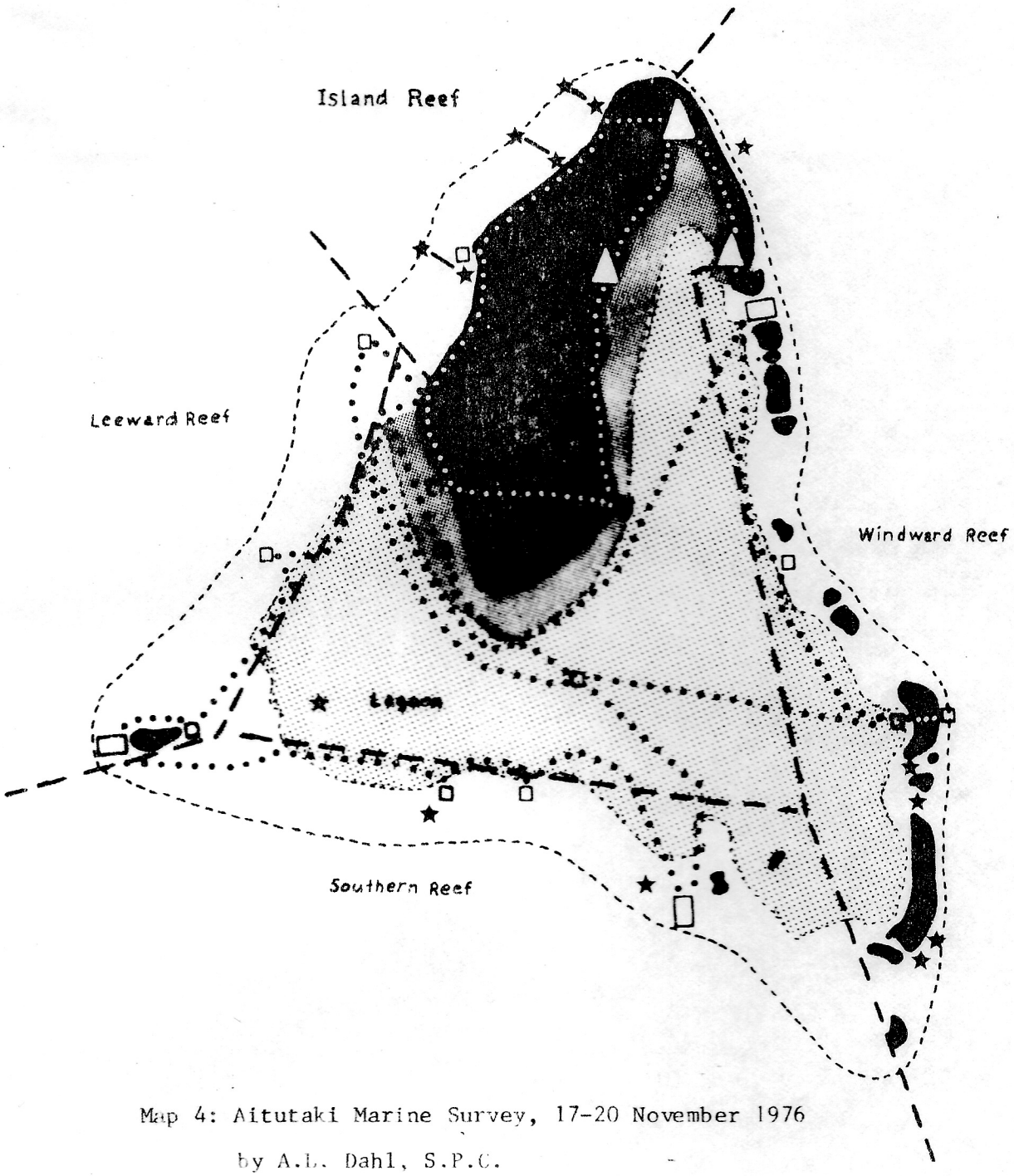
3. The Taakarere swamp should be made a nature reserve and protected against any development that might damage its role in maintaining the island fishery.

4. The small swamps at Vai Tiare and Oatu have been cut off from the lagoon by roads. These roads should be relocated behind the swamps, or enough culverts should be provided to allow the free flow of water through the swamps and to prevent sedimentation. These swamps and any similar areas should also be given reserve status.

5. Improved water-shed management practices, including reafforestation along stream banks and on steep slopes, are needed to improve stream flow and to reduce sediment run off that has caused filling at stream mouths.

6. Fishermen who use poisons or explosives are destroying fishing for everyone for a long time into the future, and should receive both local and, if necessary, legal punishment. Their acts are like chopping down other peoples trees or poisoning their taro patches.

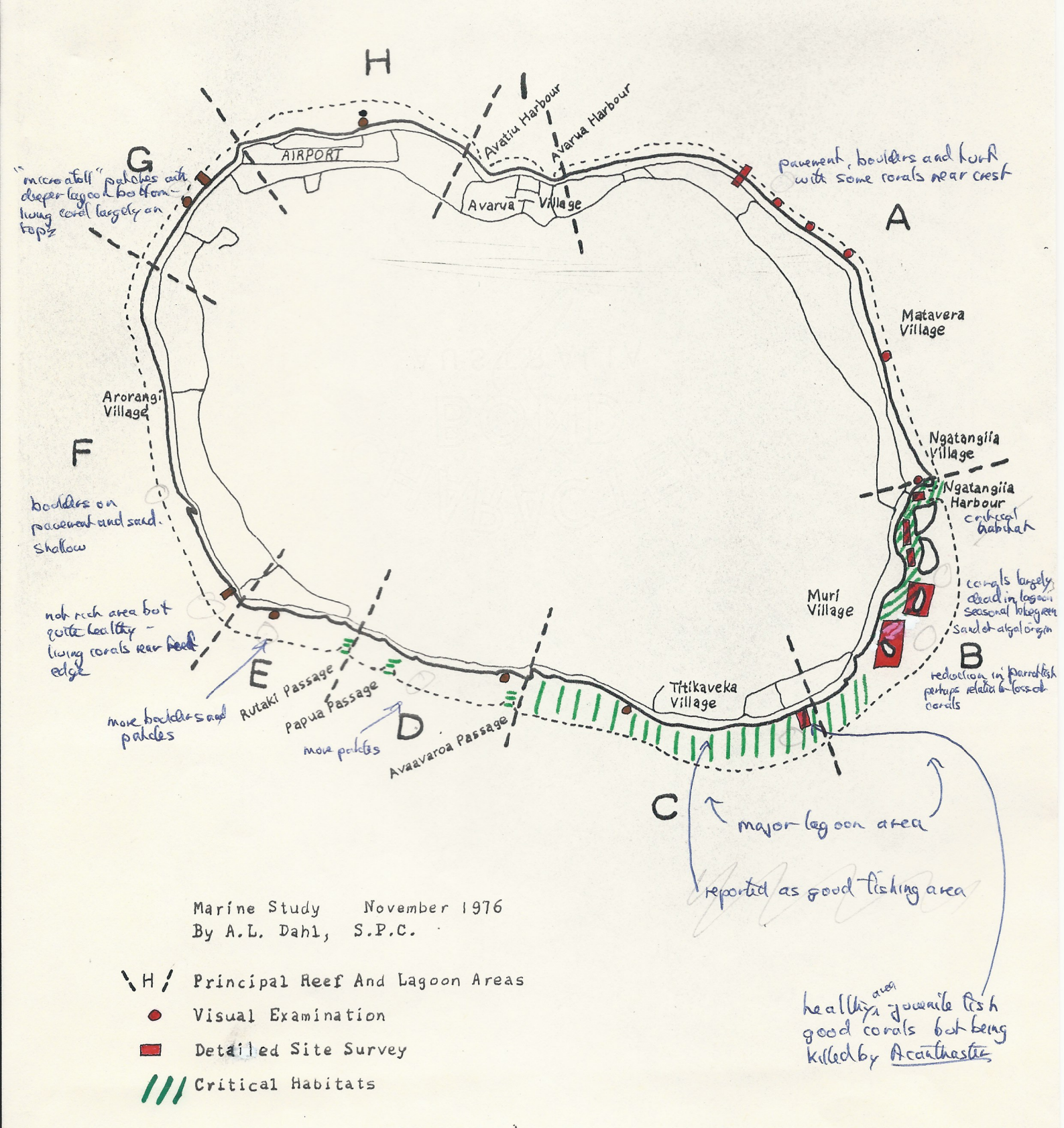
7. Every attempt should be made to prevent pollution of the shallow waters around the main island, particularly by agricultural chemicals, as these waters stay the longest in the lagoon and are important fish nursery grounds.



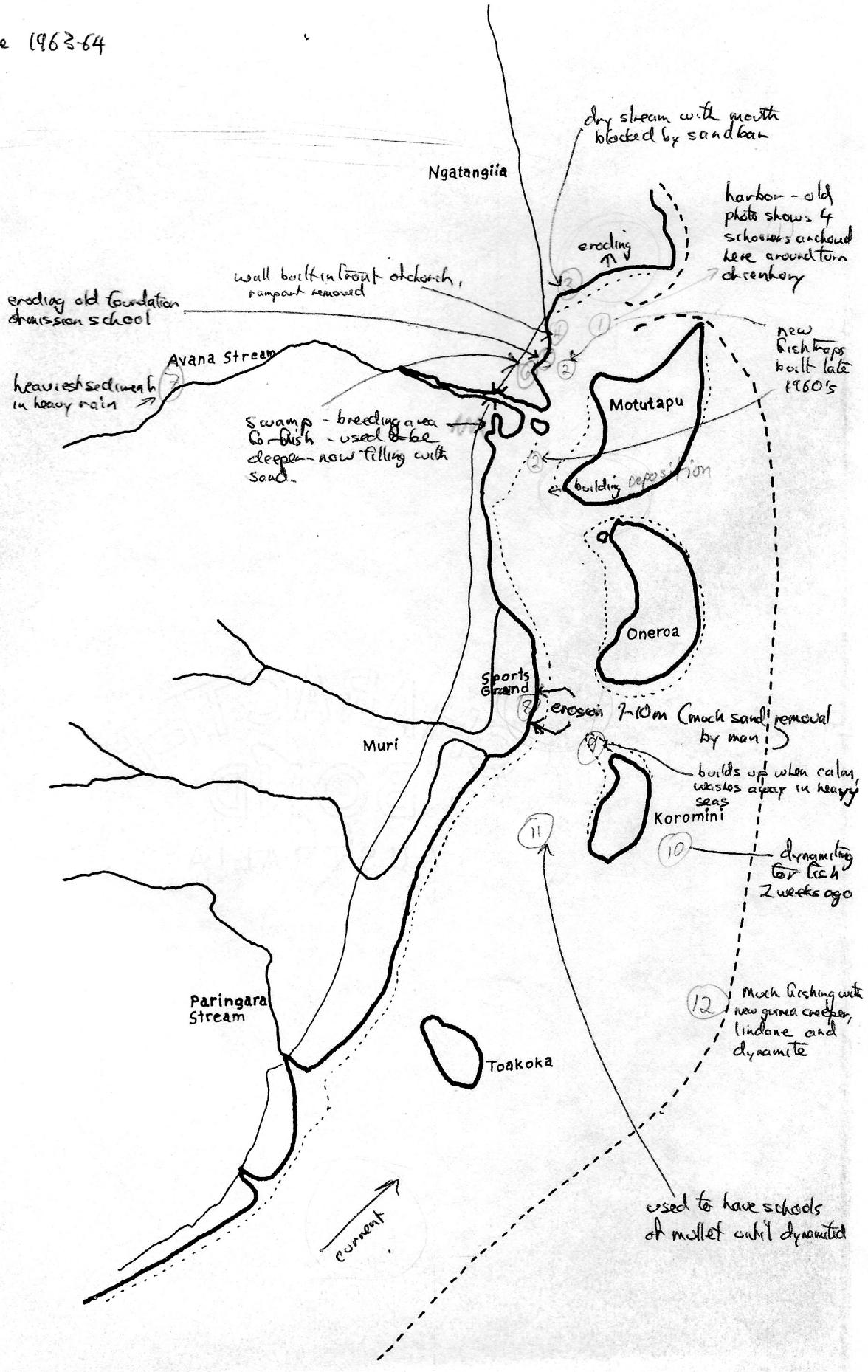
Map 4: Aitutaki Marine Survey, 17-20 November 1976

by A.L. Dahl, S.P.C.

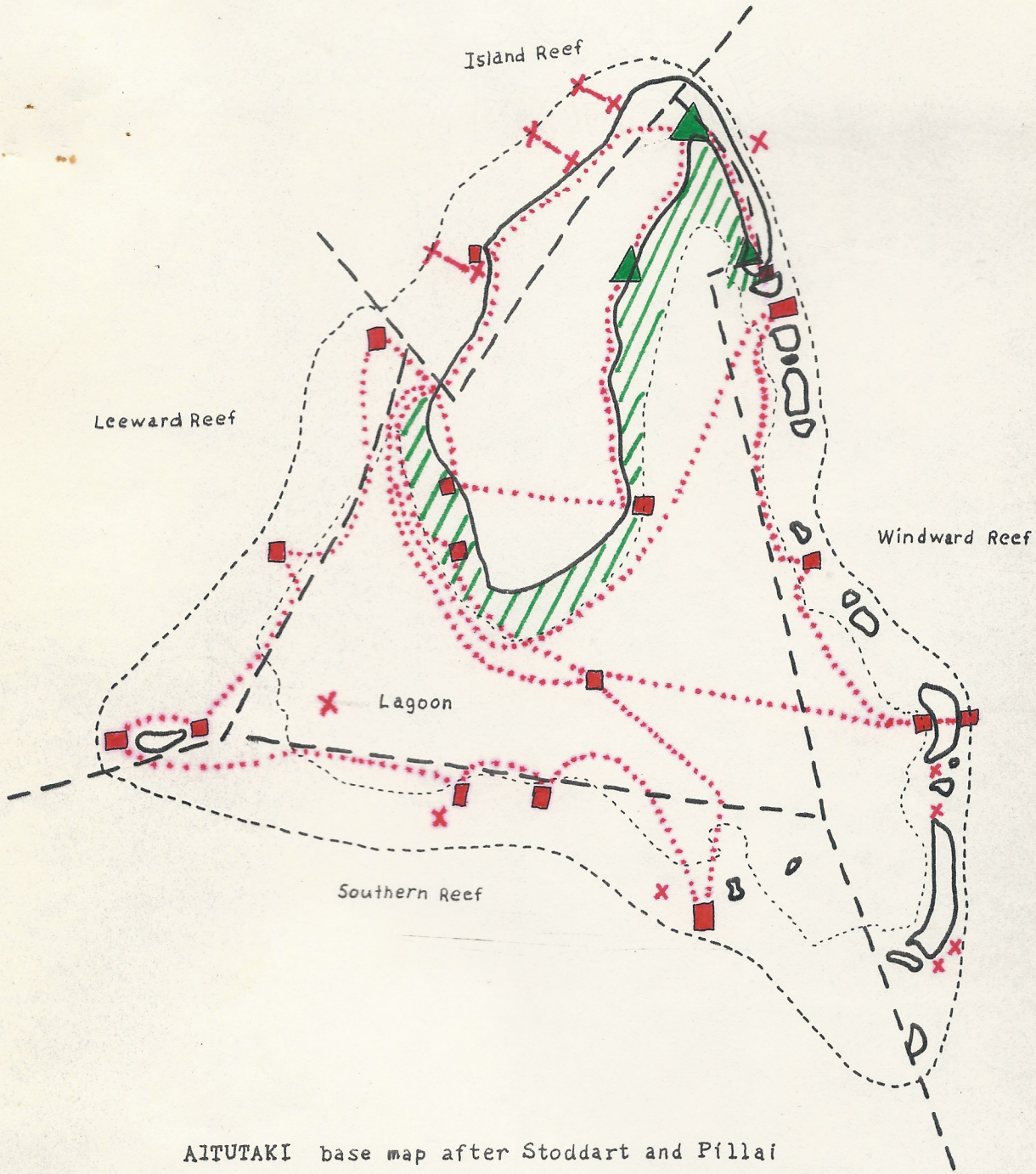
- Survey Routes
- Sites Examined
- Principal Fishing Zones for which Regulations should be made
- Proposed Reserves Areas
- Sites reported in Stoddard and Pillai
- Environmentally sensitive shallow Water Areas
- Deep Lagoon
- Coral Reef Areas


H
G
A
F
E
D
C
B
AIRPORT
Avatiu Harbour
Avarua Harbour
Avarua Village
"micro atoll" patches with deeper lagoon bottom - living coral largely on top?
pavement, boulders and hurh with some corals near crest
Matavera Village
Arorangi Village
Ngatangiia Village
Ngatangiia Harbour
critical habitat
boulders on pavement and sand. Shallow
Muri Village
corals largely dead in lagoon seasonal blue green sand of algal origin
reduction in parrotfish perhaps related to loss of corals
not rich area but quite healthy - living corals near reef edge
more boulders and patches
Rutaki Passage
Papua Passage
more patches
Avaavaroa Passage
Titikaveka Village
major lagoon area
reported as good fishing area
healthy area juvenile fish good corals but being killed by Acanthaster
Marine Study November 1976
By A.L. Dahl, S.P.C.
H Principal Reef And Lagoon Areas
Visual Examination
Detailed Site Survey
Critical Habitats

Cash cyclone 1963-64



Marine Study 23 November 1976
By A.L. Dahl, S.P.C.



AITUTAKI base map after Stoddart and Pillai

Marine Survey 17-20 November 1976
by A.L.Dahl, S.P.C.

Survey Routes

Sites Examined

Principal Fishing Zones For Which Regulations Should Be Made

Proposed Reserves Areas

Environmentally Sensitive Areas

Sites Reported in Stoddard and Pillai