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TOPIC REVIEW No. 37

**THE STATUS OF THE DUGONG
(DUGON DUGON) IN VANUATU**

**South Pacific Commission
Noumea, New Caledonia
May 1989**

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**THE STATUS OF THE DUGONG (DUGON DUGON)
IN VANUATU**

M.R. Chambers, E.Bani and B.E.T. Barker-Hudson

Loan no. 8491

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EXECUTIVE SUMMARY

This project was carried out to assess the distribution, abundance, cultural importance and threats to the dugong in Vanuatu. The study was carried out by a postal questionnaire survey and an aerial survey, commencing in October 1987. About 600 copies of the questionnaire were circulated in Vanuatu, and about 1000 kilometres of coastline surveyed from the air.

Dugongs were reported or seen to occur in nearly 100 localities, including all the major islands and island groups of Vanuatu. The animals were generally reported to occur in small groups; only in three instances were groups of more than 10 animals reported. Most people reported that dugong numbers were either unchanged or were increasing. There was no evidence that dugongs migrate large distances or between islands in the archipelago, although movements may occur along the coasts of islands and between closely associated islands.

Dugong hunting was reported from only a few localities, although it is caught in more areas if the chance occurs. Most hunting methods use traditional means, mainly the spear. Overall, hunting mortality is low, even in areas reported to regularly hunt dugongs. Accordingly, the dugong does not seem to be an important component of the subsistence diet in any part of Vanuatu, even though it is killed mainly for food. It is rarely caught for ceremonial purposes.

Generally, dugongs may be killed at any time of the year. In only a few localities were custom rules reported to determine when dugongs are killed, and such controls were mainly related to the yam harvesting and planting seasons. Overall, very few stories were reported about customs or traditions concerning the dugong. Apparently then, the dugong is not a very important animal to most Ni-Vanuatu.

On the available evidence, the dugong does not appear to be in any danger of decline or extinction in Vanuatu. The agencies which constitute such threats elsewhere - overhunting, high accidental death rates, pollution and loss of seagrass beds - do not exist in Vanuatu. Nor are they likely to on any appreciable scale in the foreseeable future. Thus Vanuatu may be one of the few countries in the dugong's very wide distribution where it is safe.

CHAPTER 1: INTRODUCTION

1.1 EXISTING KNOWLEDGE ON VANUATU'S DUGONGS

Several reports cite the presence of the dugong (Dugong dugon) in Vanuatu (e.g. Bertram and Bertram, 1973; Nishiwaki and Marsh, 1985). To date however there has never been any attempt to assess the numerical status or detailed distribution of the dugong in Vanuatu. Similarly, no information is available on the importance of the dugong to Ni-Vanuatu, either as a food source or in the various local cultures of the country.

1.2 DISTRIBUTION AND STATUS OF THE DUGONG

The islands of Vanuatu form the easternmost limit of the dugong's distribution. Overall, the dugong is widely distributed in shallow, coastal tropical and sub-tropical waters from east Africa to the southwest Pacific. Within much of this range, dugong numbers have greatly decreased in the recent past and in many areas it is now extinct or greatly reduced in numbers (Nishiwaki and Marsh, 1985). Declines have been caused by overhunting, accidental mortality from boats and fishing nets, pollution and loss of the seagrass beds which provide its staple food.

Elsewhere in the Pacific dugongs are present in Papua New Guinea (Hudson, 1977), New Caledonia and the Solomons (Nishiwaki and Marsh, 1985), Yap and Guam (Nishiwaki et al, 1979) and Palau (Brownell et al, 1981). In at least the latter three localities it is rare, whilst large numbers are in some parts of Papua New Guinea. Large populations of dugong, perhaps the most numerous remaining in the world are still to be found in Australia (Anderson, 1986; Heinsohn et al, 1978; Marsh, 1986; Prince et al, 1981).

Throughout its wide range, the dugong is considered to be an endangered species (IUCN, 1982). In many countries the dugong is legally protected and is intensively studied so that policies may be implemented for its conservation. In Vanuatu, the dugong is protected by the Fisheries Act of 1982, which forbids the capture of mammals in its territorial waters.

1.3 BACKGROUND TO THIS STUDY

This study was initiated by the Environment Unit of the Ministry of Lands, Minerals and Fisheries. It forms part of the Unit's programme to obtain sufficient information on major components of Vanuatu's fauna and flora as a pre-requisite to devising and implementing management programmes for them.

A project proposal was submitted in June 1987 to the South Pacific Regional Environment Programme (SPREP) with a request for funding assistance. SPREP agreed to provide US\$6000 from funds allocated to it by the Regional Seas Programme of the United Nations Environment Programme (UNEP).

1.4 THE VANUATU ARCHIPELAGO

The Vanuatu archipelago consists of a Y-shaped chain of 80 islands (70 inhabited in 1979) situated between about latitudes 13 - 20°S and longitudes 166 - 170°E (Figure 1). The total land area is 12,190 km² of which the largest island, Santo, has an area of 4,248 km². Most islands are mountainous and rugged, but a number of low-lying islands are present, e.g. the Maskelyne Islands off southeast Malekula and some of the offshore islands of east Santo and Malekula. In addition, there are a number of major platform reefs, the most notable of which are Cook Reef (west of Emae Island) and the Reef Islands (east of Ureparapara). The latter has a number of small sand cay islands, inhabited until a severe cyclone led to their evacuation in the 1930s.

The population of Vanuatu is about 140,000 with around 80% leading a traditional way of life. In this, shifting agriculture provides most food and is supplemented by hunting and gathering from reef, river and rain-forest. About 15,000 people live in the capital, Port Vila, on Efate Island. The only other major urban centre is Luganville on Santo.

The overall population density of Vanuatu is about 11.5 persons per km². In the rural areas it is less, about 9.9 per km². In many of the smaller islands it is considerably greater than this, e.g. more than 200 per km² in the Maskelyne Islands. Similarly, the coastal areas in general tend to have greater population densities than inland areas. In some of the major islands, particularly Efate, Erromango, Epi, Ambrym, Ambae and Santo, the interiors of the islands are virtually unpopulated. Thus the greatest pressure on Vanuatu's natural resources, including fauna and flora, is in the coastal regions of the islands.

Generally, Vanuatu is poorly developed. The major developments in the past were agricultural, chiefly coconuts and cattle, in the low-lying coastal areas. Such developments are being actively encouraged at the present time. In addition, crops such as cocoa and coffee, though present in Vanuatu for a long time, are being considerably expanded. Newer developments such as tourism (usually in coastal areas) and forestry are currently also geared to expansion. Overall though, the level of development is low and problems such as severe loss or degradation of natural fauna and flora, soil erosion and pollution are virtually unknown. A few localised instances of all these problems are present however, and can be expected to increase, albeit slowly, in the coming years.

At the present time the impact of both traditional agricultural and modern development programmes on coastal waters can be considered as minimal and not detrimental.

Geologically the islands of Vanuatu are complex and comparatively young. Most of the land surface has developed within the last 500,000 years as a result of the tectonic uplift and accumulation of volcanic rocks and reefs (Mallick, 1975). Extensive areas of some islands e.g. Efate, Santo and Pentecost are covered in raised and dissected limestone plateaux and terraces.

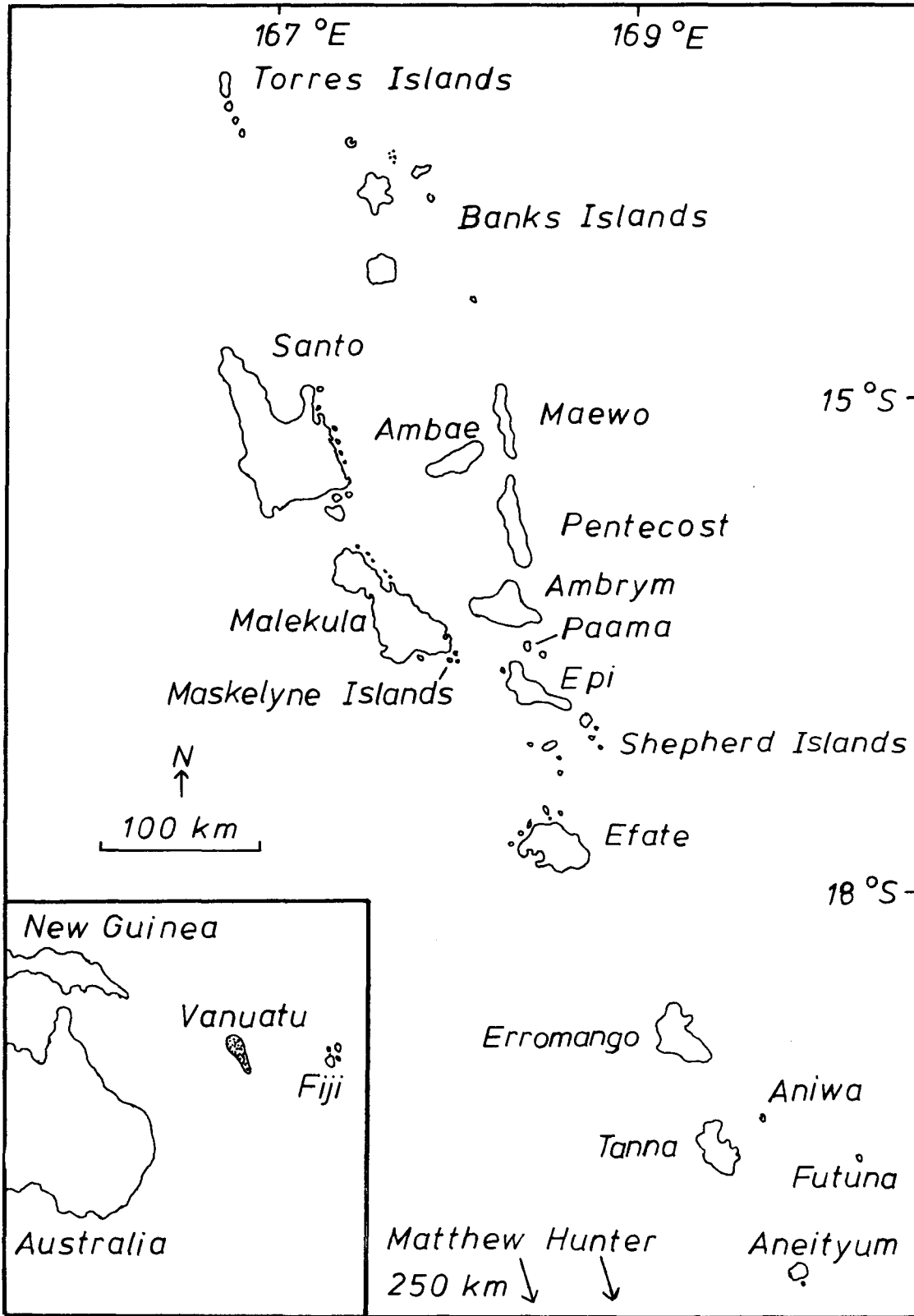


Figure 1. Major islands and island groups of Vanuatu

The islands of Vanuatu are oceanic i.e. they have never been attached to any continental or other island land mass. The islands are situated on the edge of the west Pacific tectonic plate, which is currently moving westwards over the top of the Indo-Australian plate. Extensive volcanic and seismic activities occur in Vanuatu as a result of these tectonic movements. The islands are located in very deep water (Figure 2), to the east of the New Hebrides trench which marks the location of the subduction zone of the Indo-Australian tectonic plate beneath the Pacific plate. Most islands are bordered for much of their perimeters by a narrow fringing reef generally not more than 2-300m wide. Beyond the reef edge the sea bed drops rapidly to the great depths shown in Figure 2. The fringing reef may either be completely exposed at low tide whilst in other localities there are shallow lagoons between the reef edge and shore. There are only limited areas of comparatively shallow, sheltered waters in Vanuatu.

1.5 CLIMATE

The climate of Vanuatu varies considerably along the length of the archipelago. In the north, conditions are hot and very humid with little seasonal variation. In the south, temperatures and rainfall are lower (Table 1) and seasonality is much more pronounced.

TABLE 1. RAINFALL AND TEMPERATURE DATA FOR SELECTED LOCALITIES IN VANUATU (30-YEAR AVERAGES TO 1987)

Locality	Mean annual rainfall (mm)	Mean monthly max. temp. (°C)	Mean monthly min. temp. (°C)
Vanua Lava	4,210	29.2	23.3
Port Vila	2,270	28.7	21.6
Aneityum	2,155	27.1	20.5

Vanuatu lies in the cyclone belt and is subjected, on average, to 2.6 cyclones per year. Generally, each place is struck by the full force of a cyclone about once every 30 years, but stormy winds associated with the edges of cyclones are common occurrences at all localities.

Prevailing winds in Vanuatu are generally from between the east and southeast (Figure 3) - about 80% of all recorded wind directions. Strong winds, particularly those associated with cyclones, may come from any direction however.

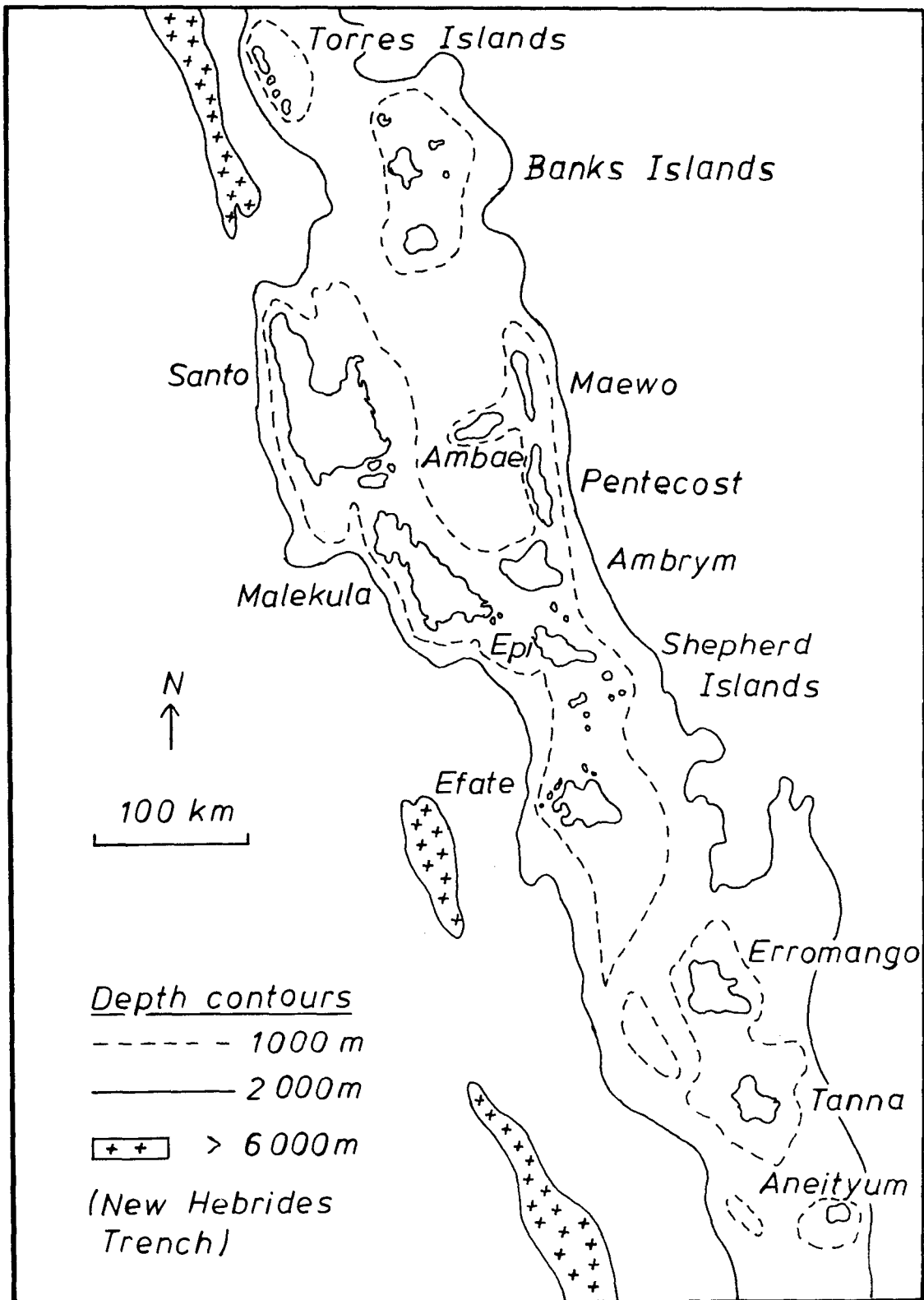


Figure 2. Major islands of Vanuatu with depth contours in the adjacent seas (from Mallick, 1975)

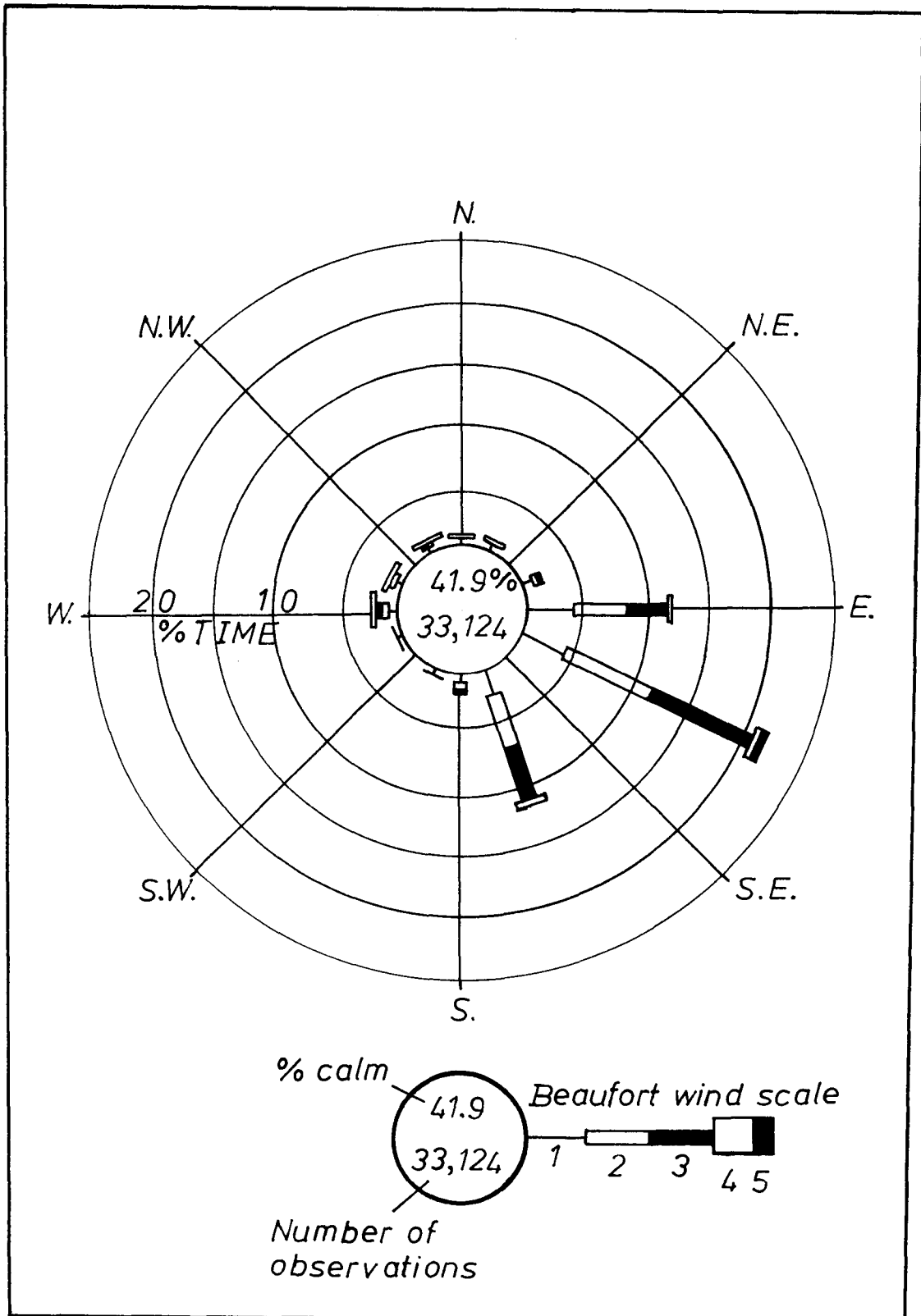


Figure 3. Wind pattern for Port Vila, Vanuatu, for the period 1968-1981 showing direction, force and duration of winds (from the Vanuatu Meteorological Service)

CHAPTER 2: AIMS AND OBJECTIVES OF THE DUGONG SURVEY

2.1 AIMS

The aims of the dugong survey were to acquire information on the present status and cultural importance of the dugong in Vanuatu. This information would then provide the basis for preparing and implementing management policies, if such were thought to be necessary or advisable.

2.2 OBJECTIVES

To realise the above aims, the following major objectives were set for the dugong survey:

- a) to locate those parts of Vanuatu in which the dugong is present.
- b) to assess the abundance of the dugong in Vanuatu, together with any changes that may have occurred.
- c) to assess the importance of the dugong to Ni-Vanuatu, in terms of its importance as a food source, source of other useful items, and its place in local cultures and customs.
- d) to identify and assess any threats there may be to dugong populations in Vanuatu.
- e) to devise programmes and policies for dugong conservation, if such a need is identified.
- f) to recommend further studies as required.

In addition, a number of further objectives were set, such as gathering information on dugong movements and feeding areas. Although no less important than (a) to (f) above, they are more difficult to obtain information on with the methods used in this study.

Finally, a number of subsidiary objectives were set which did not involve the dugong directly. These included the collecting of information on human activities in coastal sea areas and on the presence of other large marine species. Information on these factors would assist in the understanding of the overall environment in which the dugong occurs.

CHAPTER 3: METHODS

Two main methods were used in the dugong survey - a postal questionnaire survey and an aerial survey. Both methods have been extensively used before in dugong investigations (e.g. Anderson, 1986; Anderson and Heinsohn, 1978; Hudson, 1977 and 1981; Marsh and Saalfield, in press; Marsh and Sinclair, in press).

3.1 THE QUESTIONNAIRE SURVEY

The Environment Unit devised a simple questionnaire designed to provide information to realise objectives (a) to (f) in Chapter 2. This was initially written in English and then translated into Bislama, the pidgin lingua-franca of Vanuatu (Annex 1).

Thus the questionnaire was specifically designed to collect information on:

- localities where dugong occur
- dugong abundance at these localities
- changes in dugong numbers
- importance of these localities as feeding areas
- dugong movements within the archipelago
- whether dugong are caught in this locality
- reasons for killing dugong
- seasonality in killing dugong
- methods of capturing dugong
- numbers of dugong caught
- disappearance of dugong from localities
- people's concern about dugongs
- custom laws and traditions about killing dugongs.

The questionnaire was widely distributed by three methods. Firstly, 331 copies were sent to people who either could be expected to have knowledge of the dugong or would be able to contact people who could supply it. Major categories in this group were: Agricultural Field Officers (59), Village Area Councils (62), Fisheries Field Officers (50), Island Councils of Chiefs (44), Ministerial Secretaries (30), Cultural Centre Field Assistants (27), Local Government Councils (11), Local airline pilots (30) and local diving clubs (10). Each questionnaire was accompanied by a letter explaining the purpose of the survey and a stamped, addressed envelope for ease of return. These forms were distributed in October 1987.

Secondly, 280 copies were distributed in late November 1987 to the students of Malapoa College, Vanuatu's senior secondary school. Students were requested to take the questionnaire back to their villages in the summer vacation and complete the form with assistance from parents, elders or chiefs of the village. Each questionnaire was again accompanied by an explanatory letter and a stamped, addressed envelope.

Finally, the complete questionnaire, in Bislama, was inserted in the Vanuatu Weekly, the country's only newspaper, on 7 November 1987. An article on the dugong was printed simultaneously. The paper sells about 1,400 copies each week.

Thus in total, the questionnaire probably reached about 2,000 households, some 10% of total households in Vanuatu.

3.2 AERIAL SURVEY

Aerial surveys have been used extensively in locating and assessing dugong populations (e.g. Hudson, 1981; Marsh and Saalfield, in press). The main objective of the present survey was to locate areas in which the dugong occur. Such a basic objective corresponds to the First-level survey category of Anderson (1985), and accordingly required only such relatively simple techniques as described by Anderson (1982) and Heinsohn et al (1976).

The aircraft used was a Britten Norman Islander, a high-wing plane suitable for such survey work. Surveys were carried out by flying at a speed of 100 knots at an altitude of 140m (450 feet). A strip width of 200m on either side of the aircraft was surveyed. Generally, the survey was carried out by flying parallel to the coastline at a distance of about 200m from the edge of the fringing reef. Much of Vanuatu's coastline is bordered with narrow fringing reefs beyond which the sea bed drops rapidly to extreme depths (Figure 2). Large areas of enclosed, comparatively shallow water are rare in Vanuatu e.g. Havannah Harbour on Efate, Port Stanley on Malekula. Such areas were criss-crossed in a series of transects, though these were not at regular intervals and did not cover the whole of such enclosed localities.

The survey route (Figure 4) was designed to cover most major islands within the Vanuatu archipelago, although not all coasts of each island could be surveyed. In total, the survey involved 12 flying hours covering just over 1000km of coastline. The survey was flown between 8-11 December 1987. In addition to the pilot, the plane carried seven observers, only one of whom had previous experience of dugong aerial surveys.

Each observer filled in a survey form (Annex 2) for each leg of the flight. The observers recorded dugongs or other large animals seen (e.g. dolphins, rays, sharks and turtles). In addition, observers were asked to note the behaviour of animals seen (swimming, idling, feeding, diving, on the surface) and their location (fringing reef, seagrass beds, lagoon, open water, sandy areas, mangroves, rivers) and to note the presence and types of boats at sea.

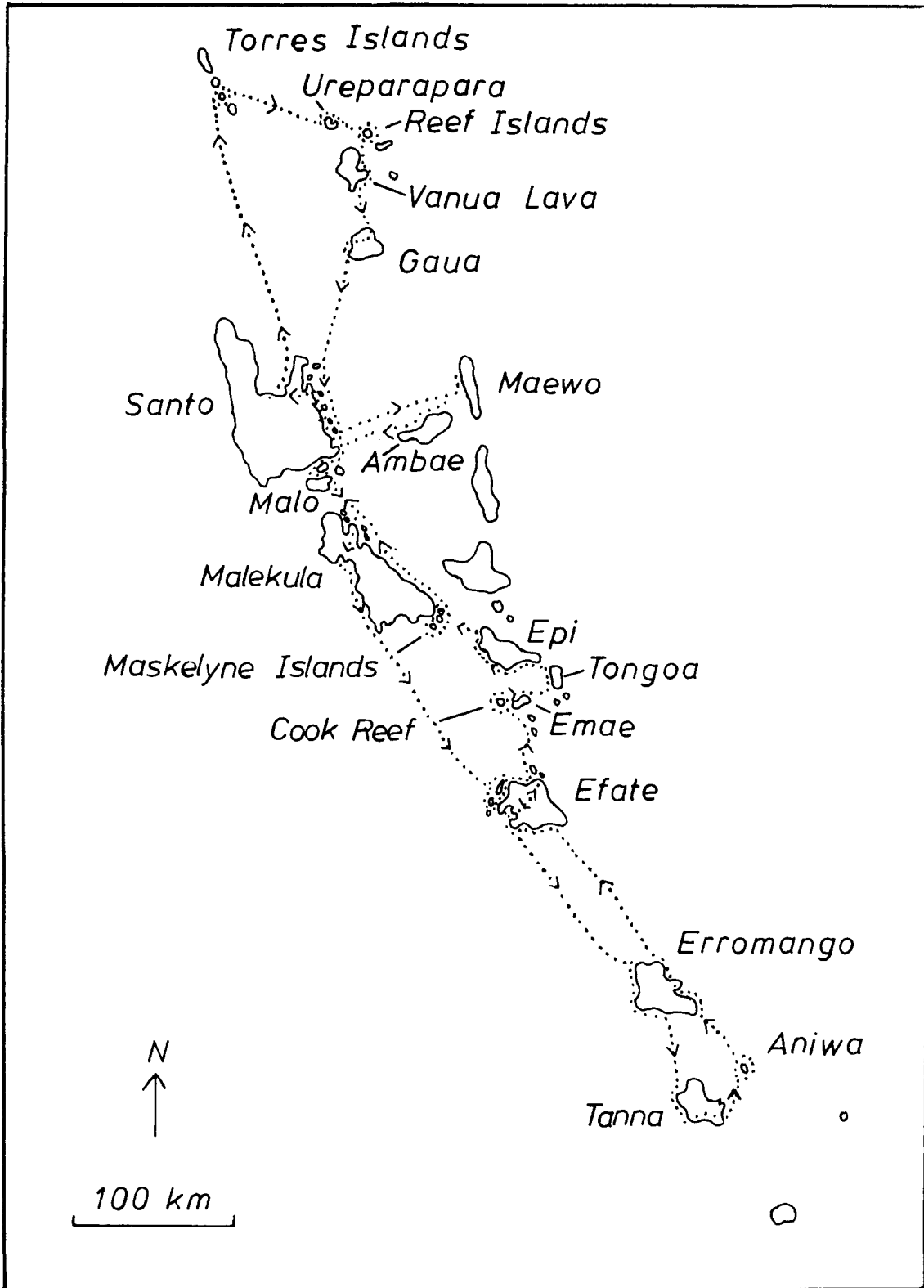


Figure 4. Map of Vanuatu with route taken during the dugong aerial survey, 3-11 December 1987

CHAPTER 4: RESULTS

4.1 RESULTS OF QUESTIONNAIRE SURVEY

A total of 102 useable replies were obtained to the end of April 1988. Of these, 86 were received from the 331 questionnaires sent to Government Officers and other interested personnel. This was a satisfactory response rate of 26.0%. From the other two groups, 12 responses (4.3%) were received from Malapoa school students and 4 replies to the newspaper insert. These latter two response rates were disappointing and not worth the effort put into planning for them.

4.1.1 Distribution and abundance of dugong

A list of place names at which dugongs were stated to occur is given in Table 2, together with their reported abundance. The general distribution of dugongs in Vanuatu is shown in Figure 5 and the more detailed locations, from Table 2, are shown in Figures 6 - 17. The numbers of locations reported in Table 2 and Figures 5 - 17 are fewer than in the questionnaire replies received. This is because some responses reported dugongs from closely adjacent localities and these are not distinguished separately in this analysis. Also, on several occasions, different respondents reported dugongs from exactly the same locality.

Figure 5 shows that the dugong is widely distributed throughout Vanuatu. It occurs on every major island from Aneityum in the south to Hiu, the most northerly island of Vanuatu. Some major islands e.g. Efate, Santo and Malekula have dugongs reported from many localities whereas others e.g. Tanna and Erromango, had few reported localities.

Dugongs were reported to occur in small groups of rarely more than 10 animals (Table 3).

More than half the group sizes reported were of single or pairs of animals. Several respondents stated that the pairs consisted of mother and calf, although most made no comment on the sex/age distribution of the groups. Of the 3 - 10 group size, some respondents stated that they saw 3 animals only, although most gave no indication of group size. In the three records of 10+, there were no indications of actual group sizes seen.

Three islands were reported to have no dugongs - Futuna, Buninga and Mere Lava. In addition, dugongs were reportedly absent from the Dillon's Bay area of west coast Erromango and Wusi on west coast Santo. A number of respondents stated the absence of dugongs from particular localities, but others stated them to be present at or close to these places. In such instances, the positive sightings were taken as correct.

TABLE 2. REPORTED LOCATIONS AND ABUNDANCES OF DUGONG IN VANUATU

Locality	No. of Dugongs Reported
TORRES ISLANDS	
Hiu Island	1
Tegua Island	1
Toga Island	1
BANKS ISLANDS	
Kaska (Gaua)	3 - 10
Kerepua (Vanua Lava)	3 - 10
Kwanglav (Vanua Lava)	3 - 10
Lalngetak (Vanua Lava)	3 - 10
Lesereplag (Ureparapara)	3 - 10
Nagpen River (Vanua Lava)	3 - 10
Port Patteson (Vanua Lava)	3 - 10
Ravenga Island (Vanua Lava)	1
Sola (Vanua Lava)	3 - 10
Telvet (Mota Lava)	3 - 10
Vureas (Vanua Lava)	3 - 10
SANTO AND OFFSHORE ISLANDS	
Hog Harbour	10 +
Jeriviu (Big Bay)	2
Luganville	2
Nokuku	2
Palikulo	2
Port Latour (Aore Island)	3 - 10
Tangoa Island	3 - 10
Tavonamala (Big Bay)	2
AMBAE	
Loloaru	2
Lolovenue	2
Lolowai	2
Lovutialao	2
Redcliff	2
Vuinago	2
MAEWO	
Kerai	3 - 10
Narovorovo	3 - 10

TABLE 2. (Continued)

Locality	No. of Dugongs Reported
PENTECOST	
Abwatuntora	1
Arasa	2
Bwatnapne	3 - 10
Homo Bay	3 - 10
Lamalanga	2
Laone	2
Loltong	2
Lonorore	1
Panas	3 - 10
Ranputor	3 - 10
MALEKULA AND OFFSHORE ISLANDS	
Akhamb Island	2
Bushman Bay	2
Crab Bay	1
Khuneveo Island	2
Kindu	2
Lakatoro	3 - 10
Lawa	2
Lehuru	2
Lembinwen	3 - 10
Lerongrong	3 - 10
Pellonk	2
Port Stanley	3 - 10
Rano Island	3 - 10
Sakao Island	3 - 10
Sarmette	1
South West Bay	3 - 10
Uri Island	3 - 10
Uripiv Island	3 - 10
Vao Island	2
Wala Island	3 - 10
Wiawi	2
AMBRYM	
Craig Cove	2
Fonteng	3 - 10
Megham	3 - 10
Ranon	2
Ranvergere	3 - 10
Ulei	2

TABLE 2. (Continued)

Locality	No. of Dugongs Reported
PAAMA	
Kellai	2
Liro	2
Now	2
Tavulai	2
Vaoleli	2
EPI	
Laman Bay	10 +
Lomaru Bay	3 - 10
Mapvilao	3 - 10
Mate	3 - 10
Port Kweimi	2
Walavea	1
SHEPHERD ISLANDS	
Siwa (Emae Island)	3 - 10
EFATE AND OFFSHORE ISLANDS	
Erakor	1
Eratap	2
Kakula Island	2
Moso Island	10 +
Natapao (Lelepa Island)	2
Nekapa (Nguna Island)	2
Ngurua (Emao Island)	3 - 10
Pango	2
Paonangisu	2
Piliura (Pele Island)	2
Sunae (Moso Island)	2
Tikilaso (Nguna Island)	3 - 10
ERROMANGO	
Tuwit	3 - 10
TANNA	
Port Resolution	1
ANEITYUM	
Itchepthav	1
Port Patrick	2

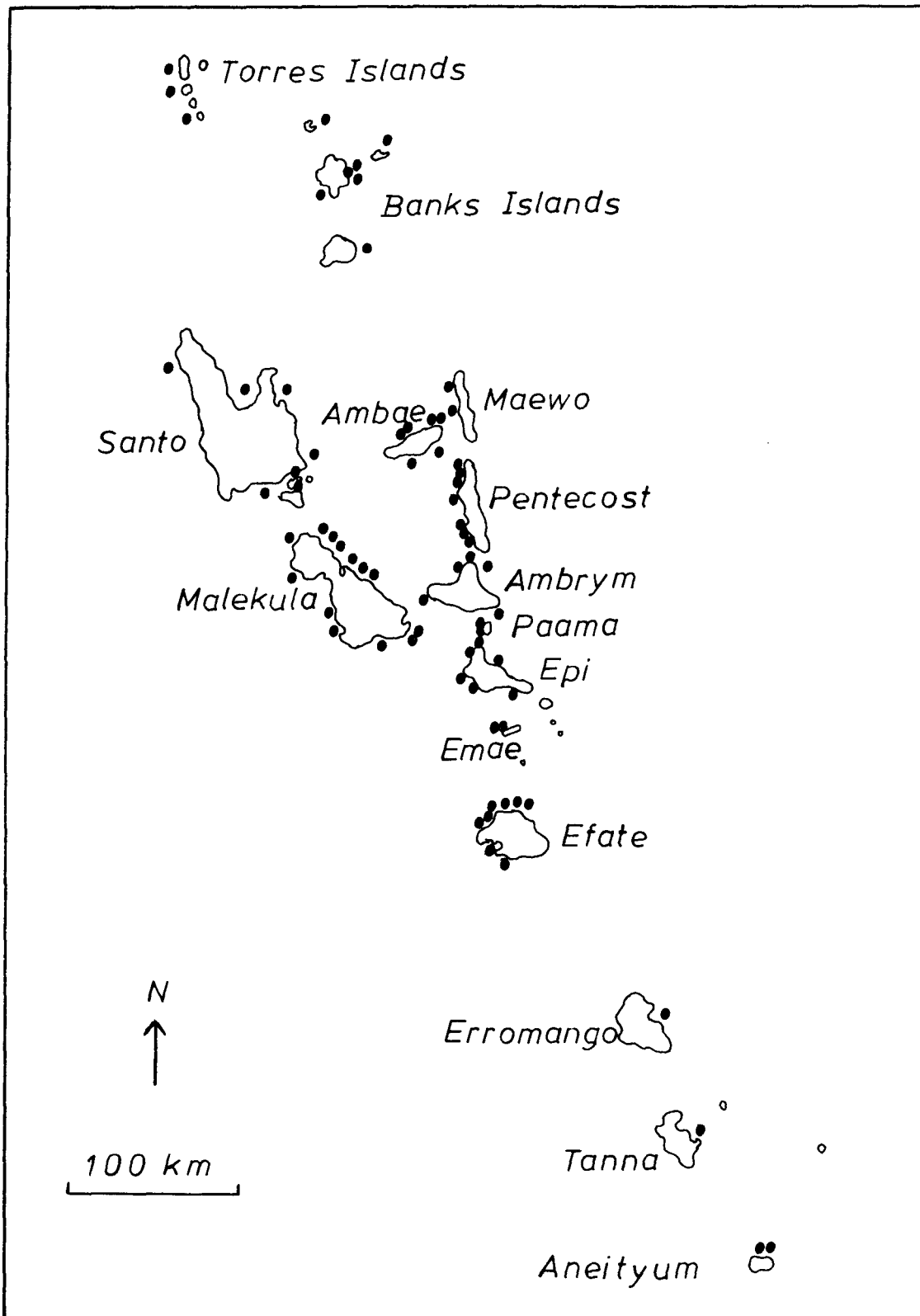


Figure 5. Map of Vanuatu, with generalised distribution of reported dugong localities (●)

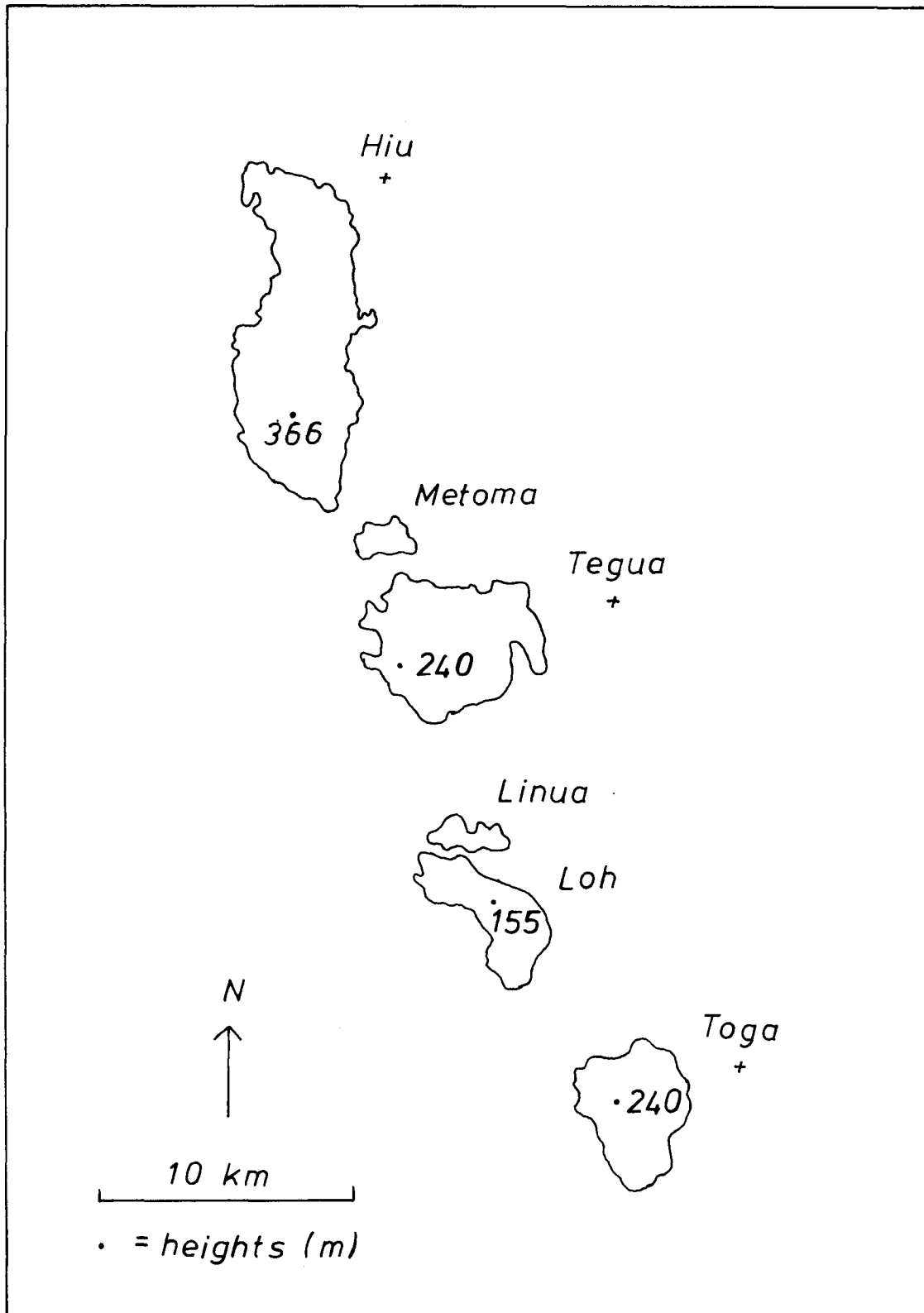


Figure 6. The Torres Islands, with islands reported to have dugongs (+). Precise locations not reported

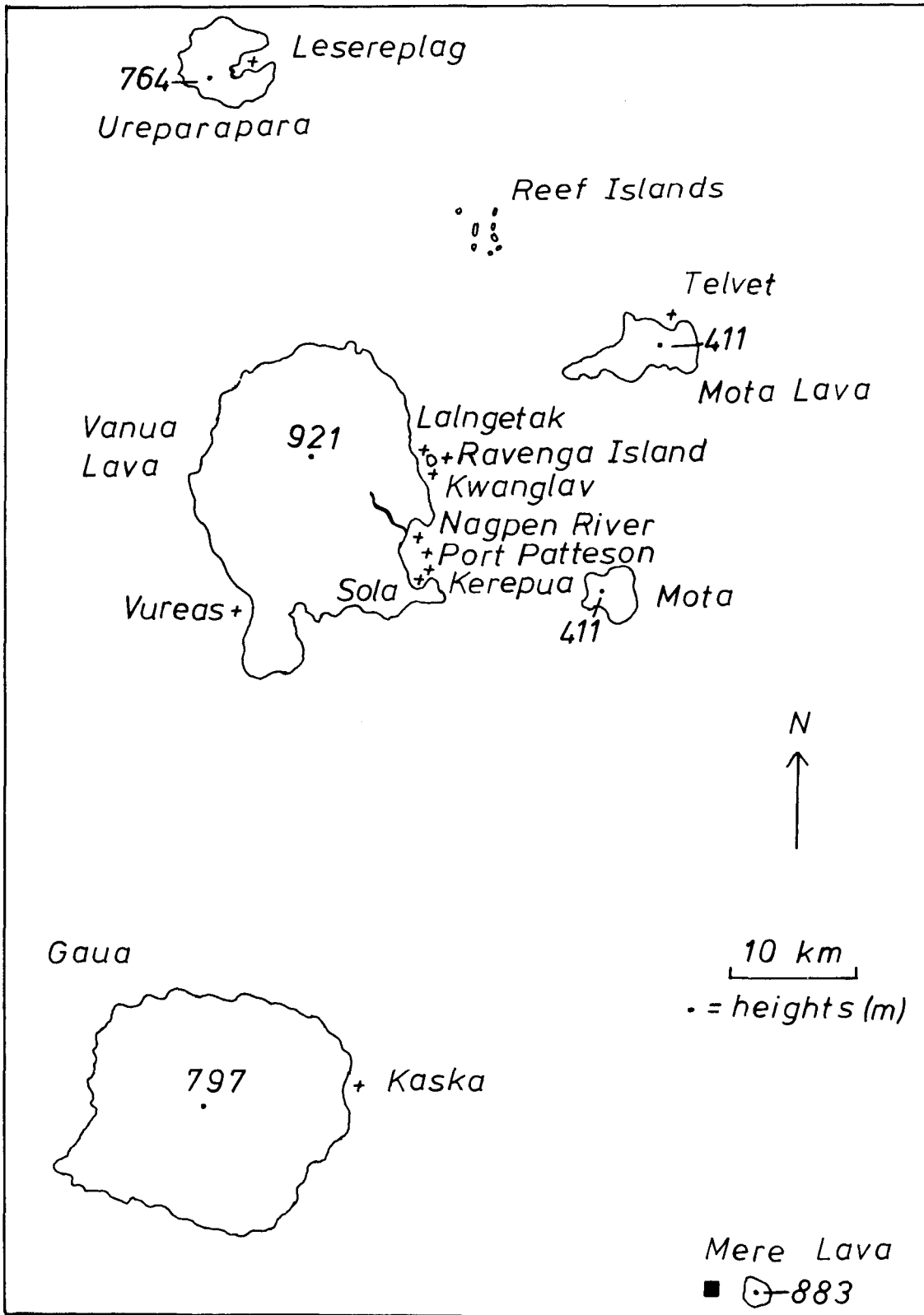


Figure 7. The Banks Islands, with localities reported to have dugongs (+) or no dugongs (■)

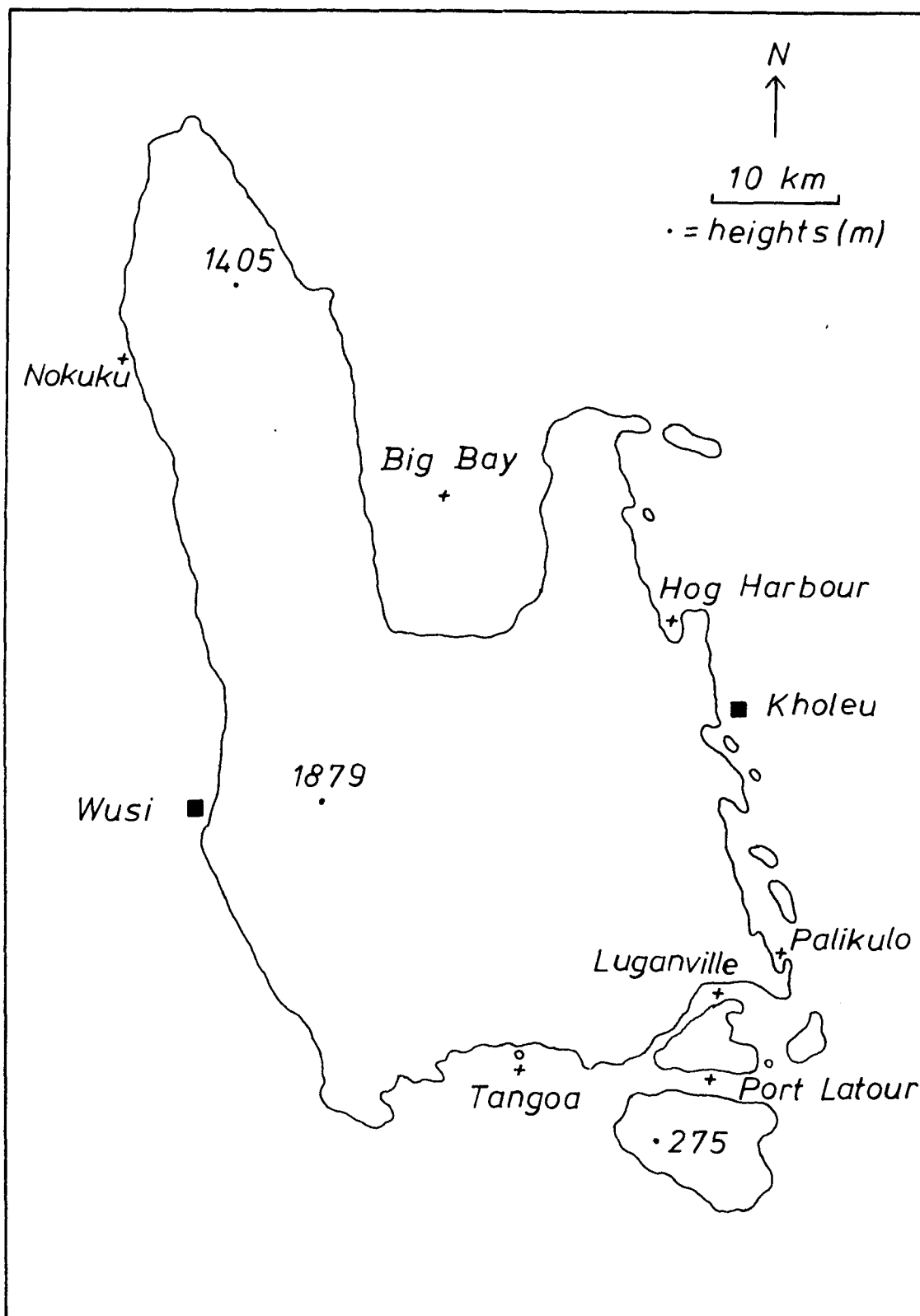


Figure 8. Santo and offshore islands, with localities reported to have dugongs (+) or no dugongs (■)

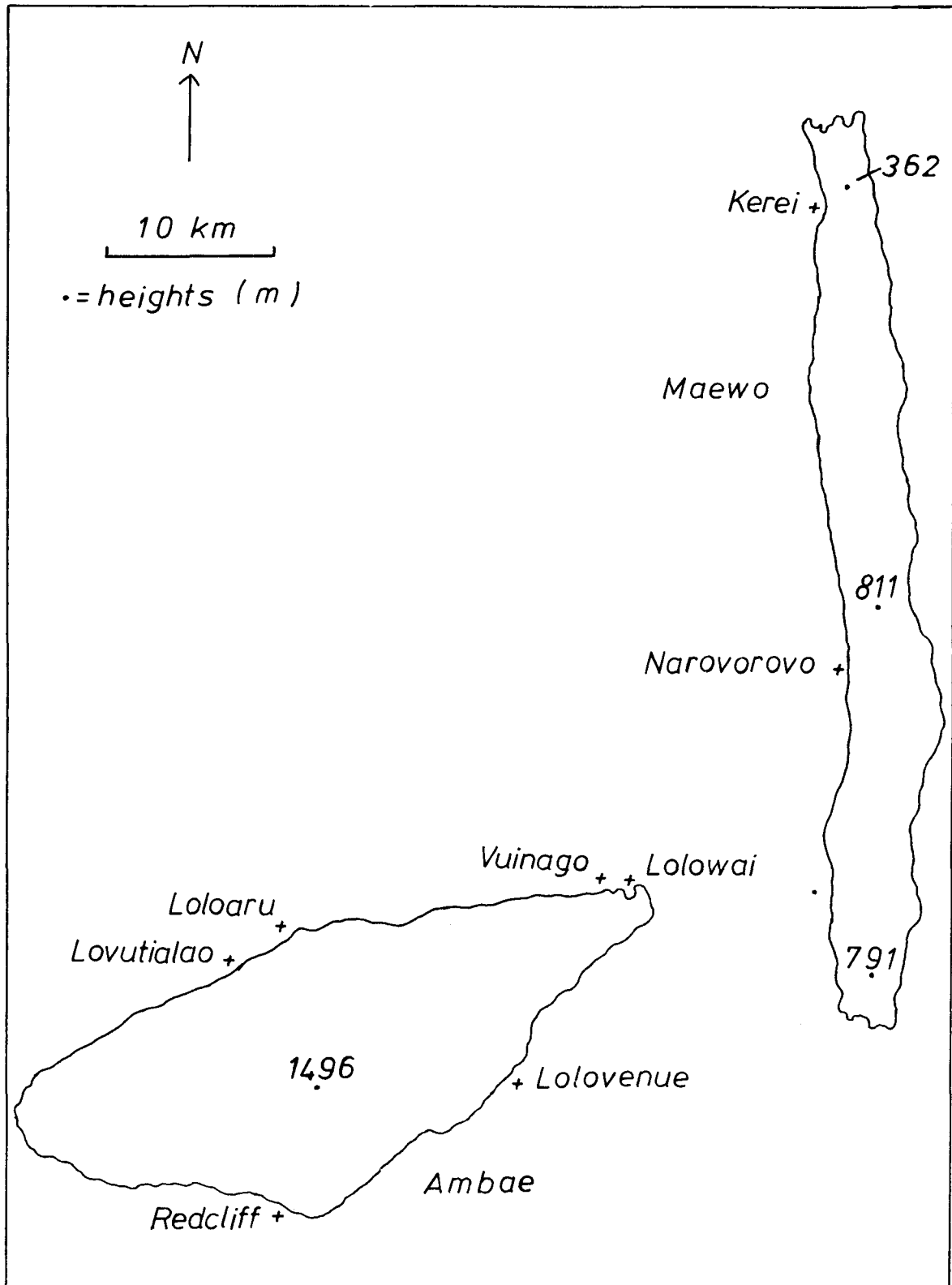


Figure 9. Ambae and Maewo Islands, with localities reported to have dugongs (+)

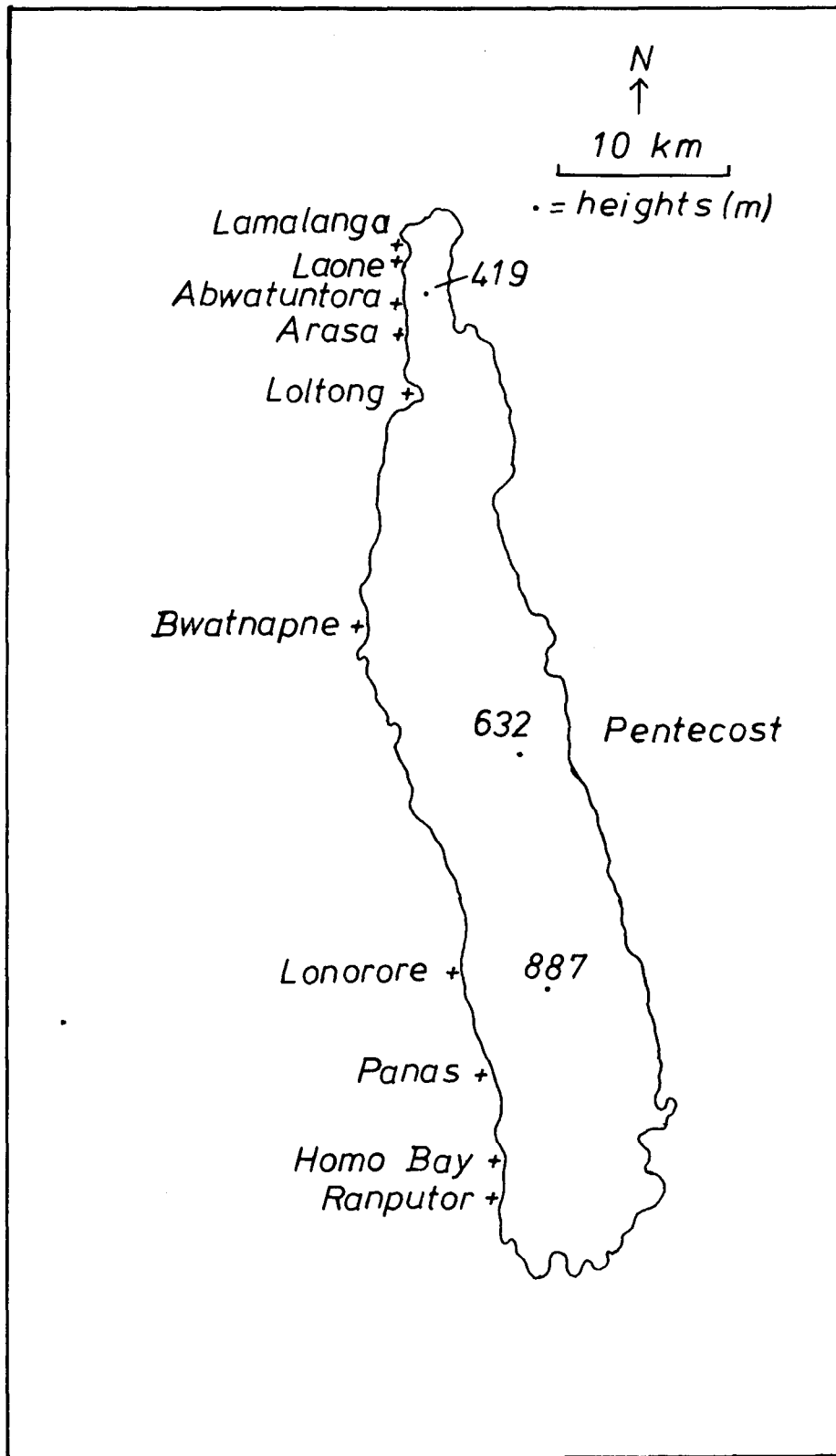


Figure 10. Pentecost island, with localities reported to have dugongs (+)

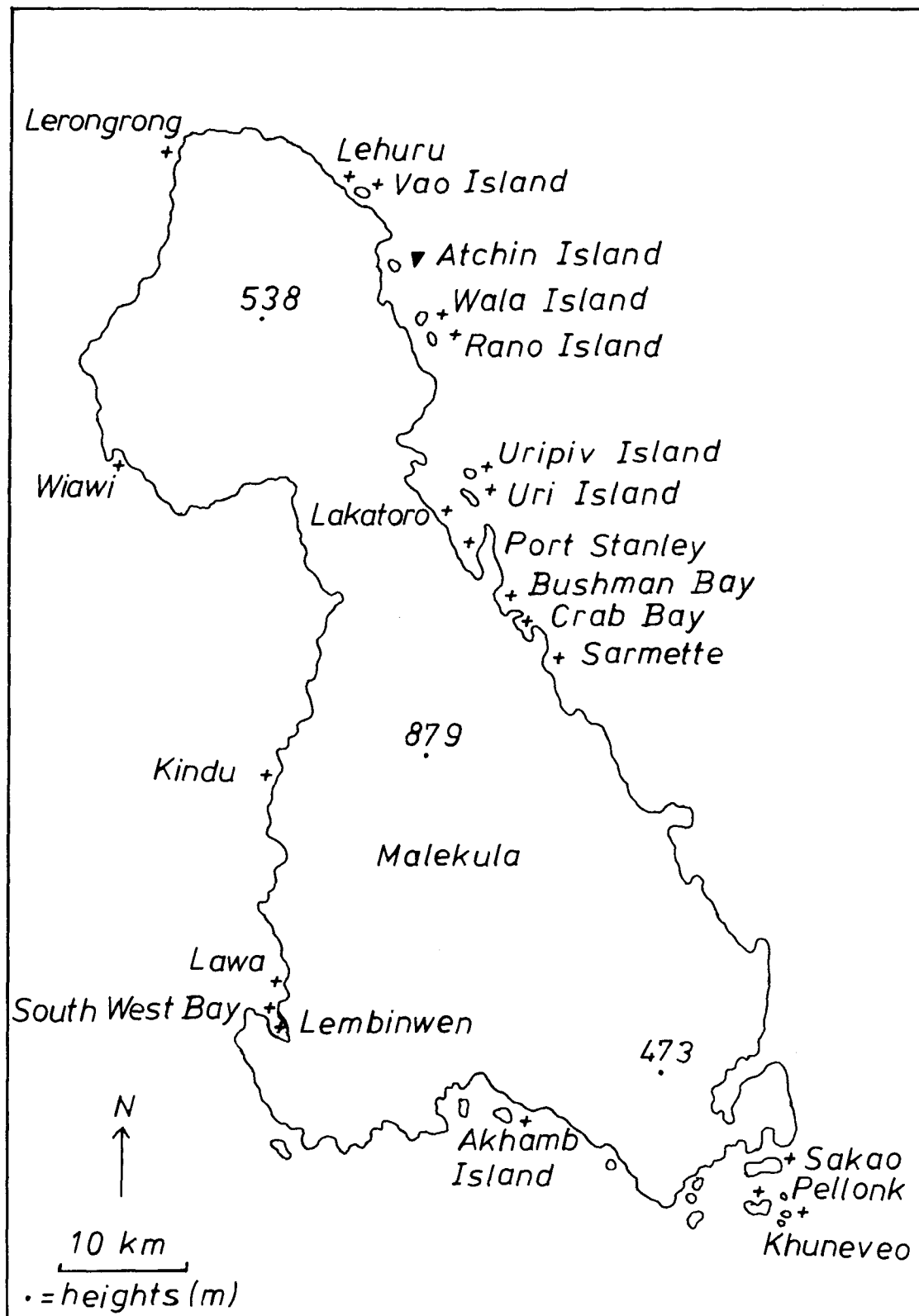


Figure 11. Malekula and offshore islands, with localities reported to have dugongs (+) and where seen on the aerial survey (▼)

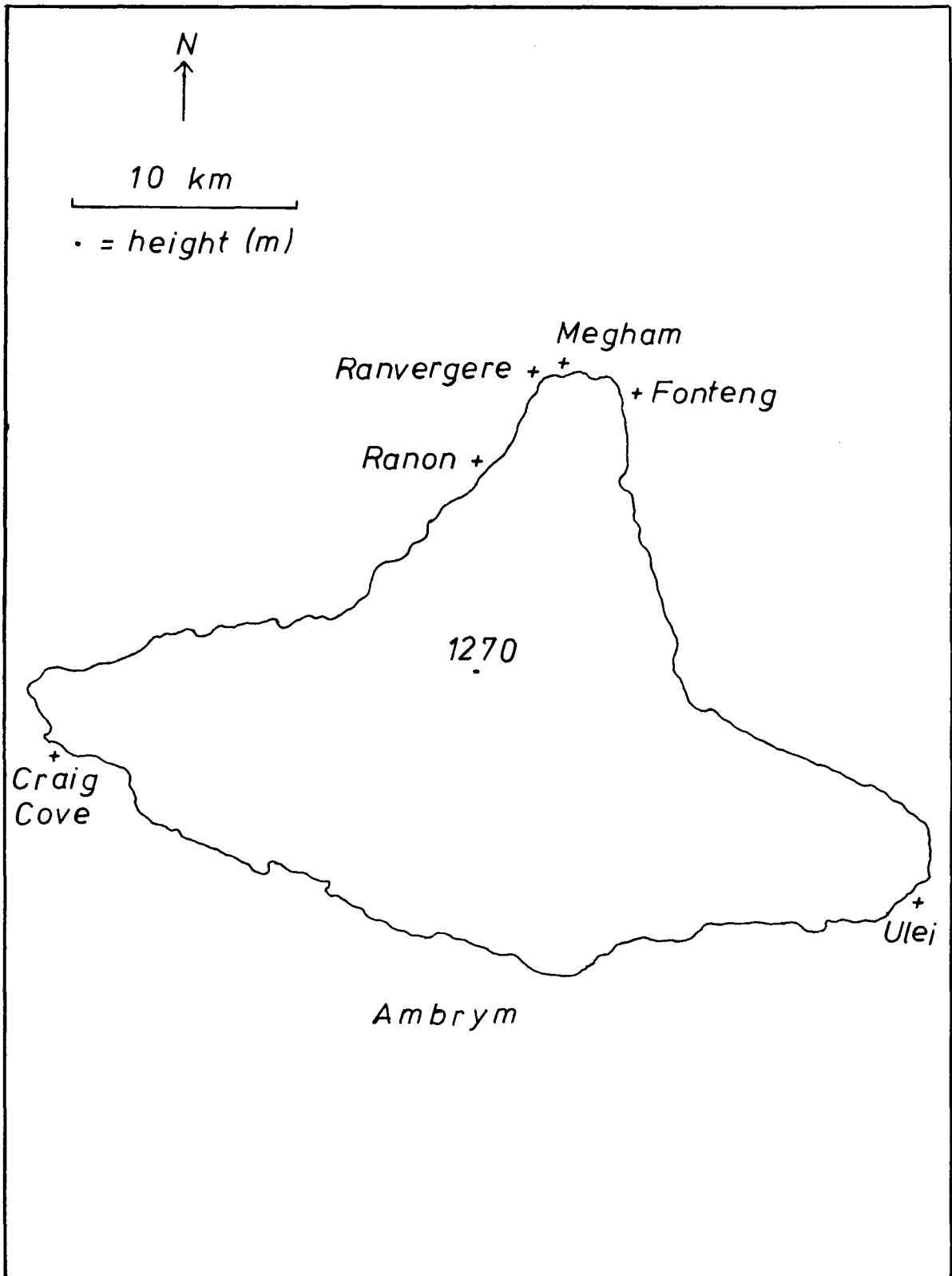


Figure 12. Ambrym island, with localities reported to have dugong (+)

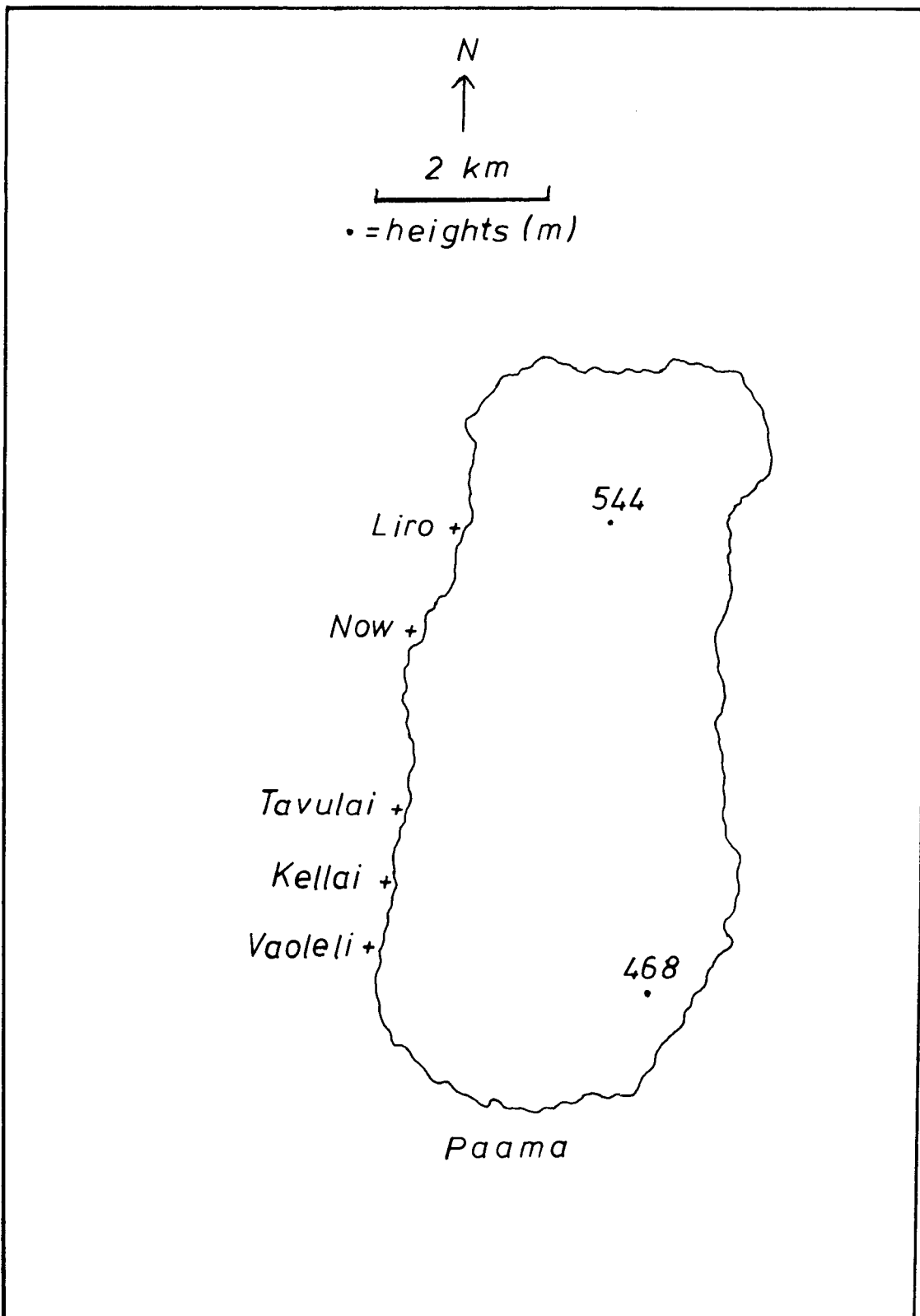


Figure 13. Paama island, with localities reported to have dugong (+)

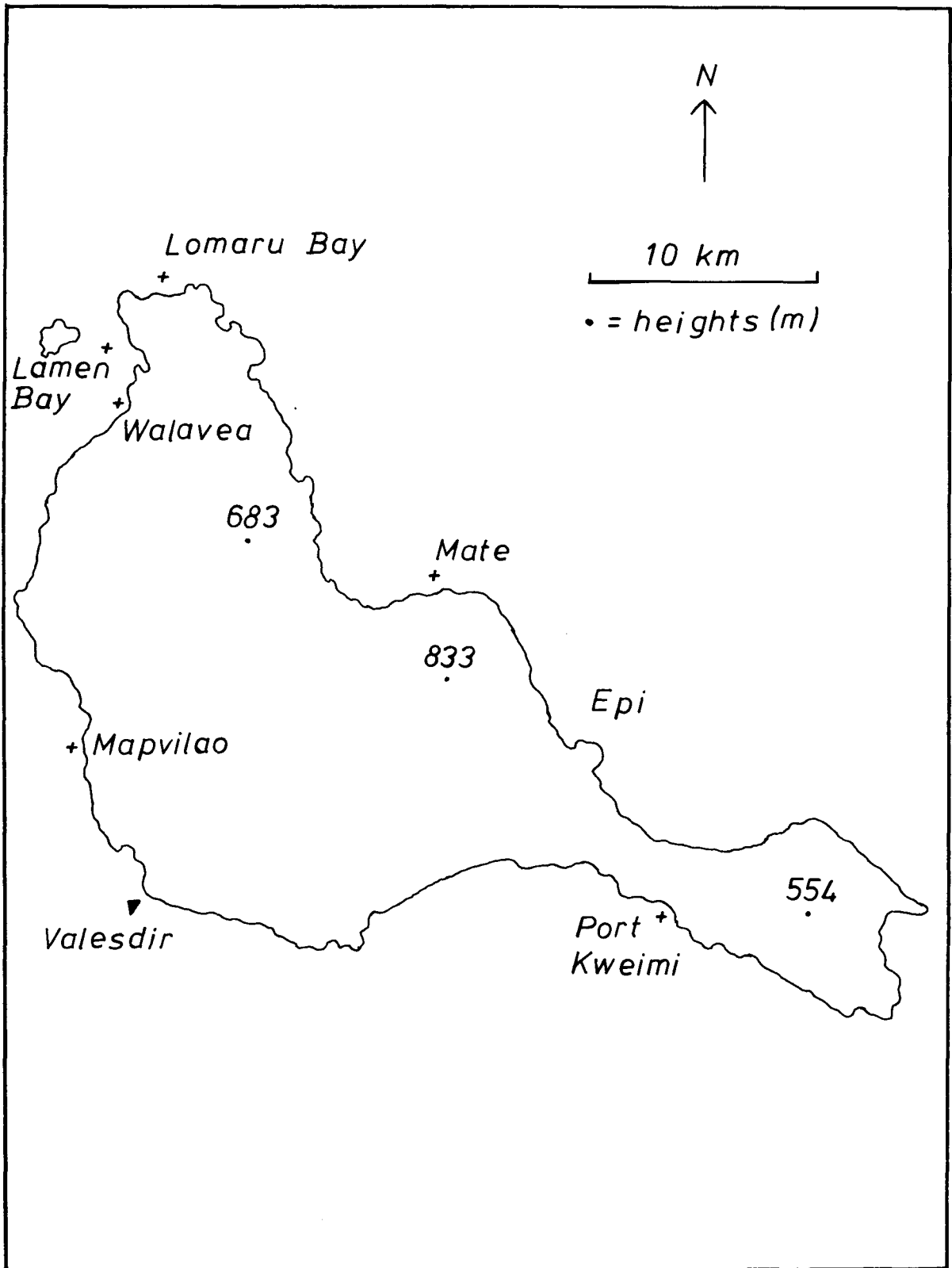


Figure 14. Epi island, with localities reported to have dugongs (+) and where seen on the aerial survey (▼)

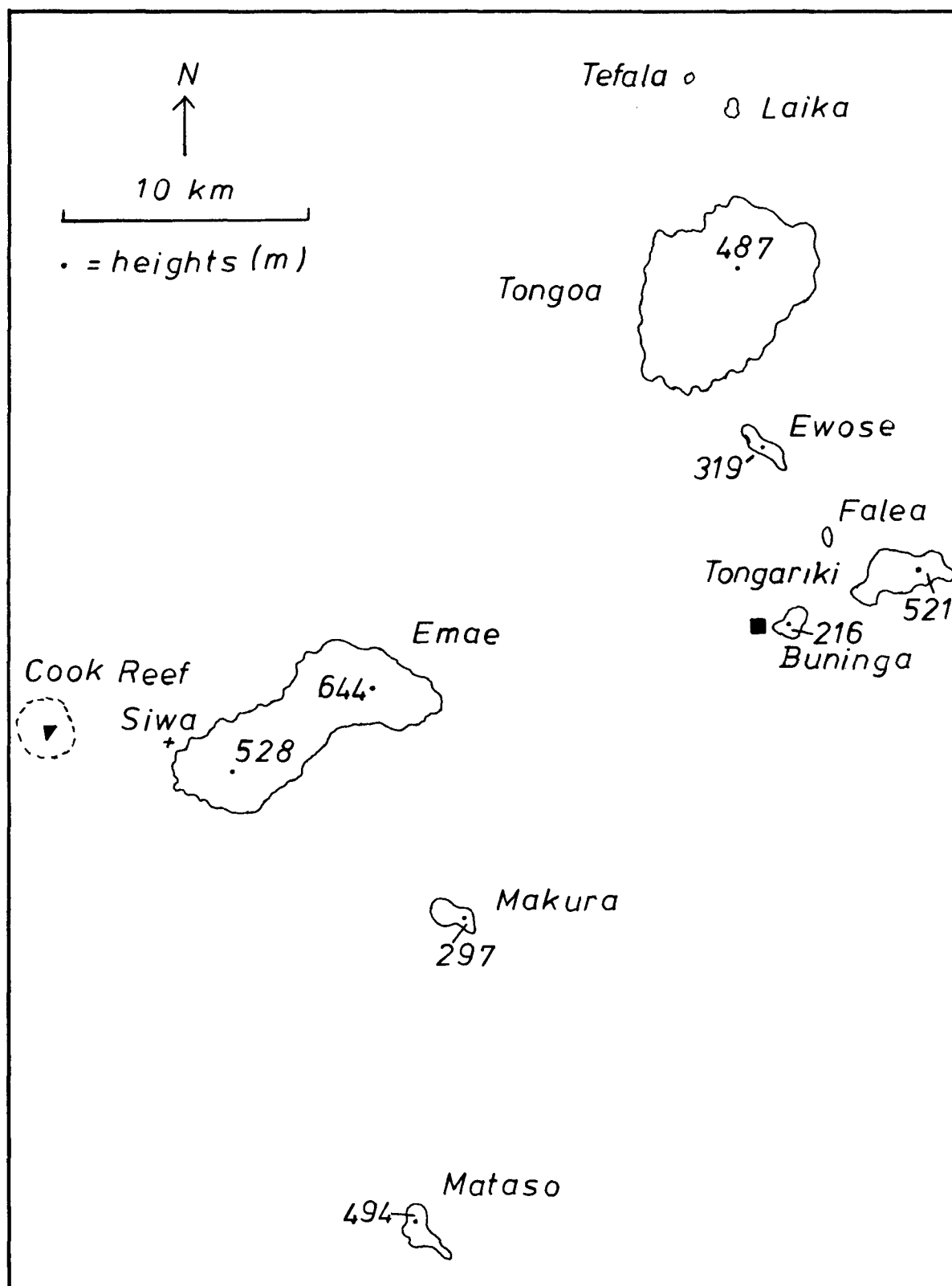


Figure 15. Shepherd islands, with localities reported to have dugongs (+) or no dugongs (■) and where seen on the aerial survey (▼)

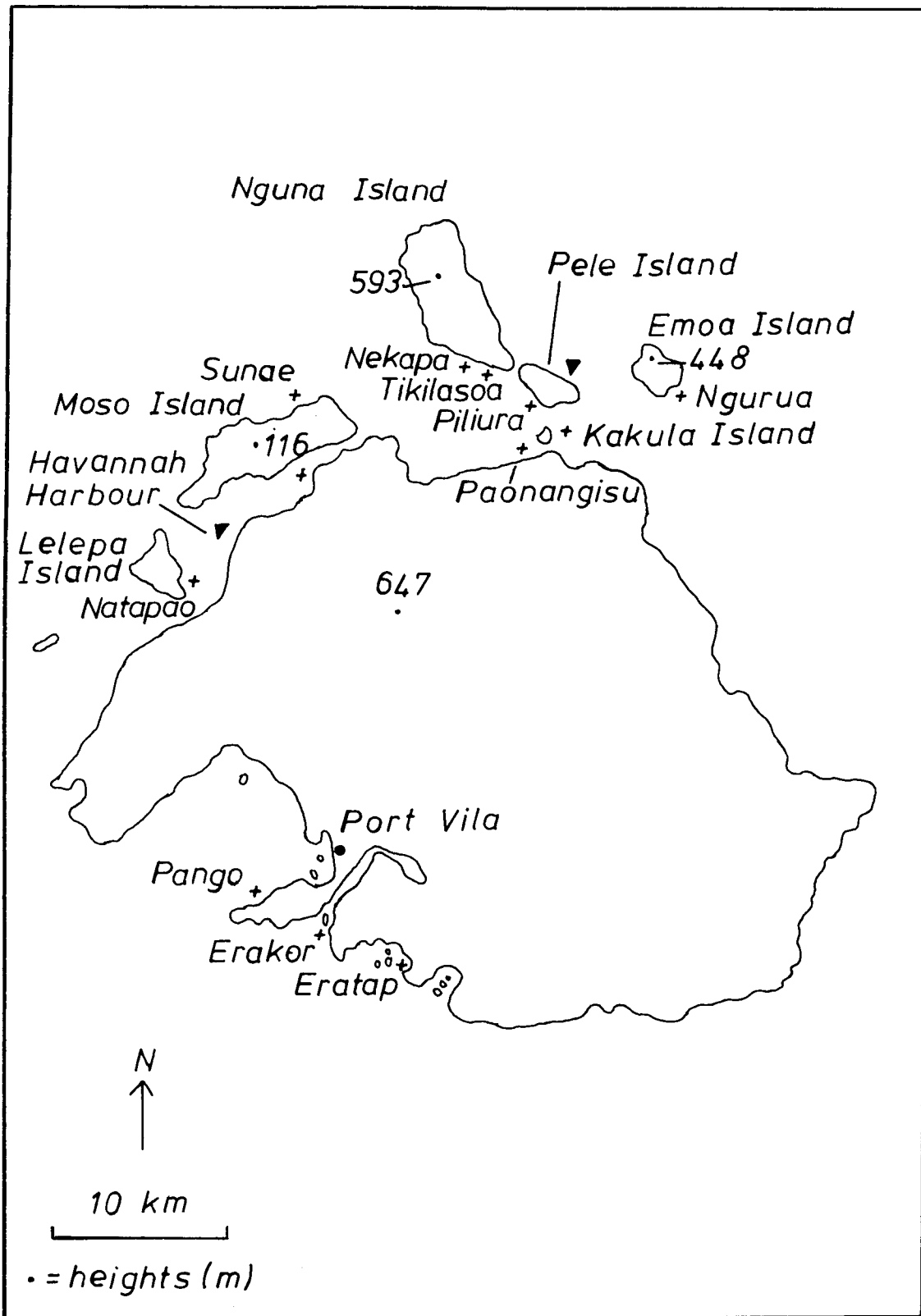


Figure 16. Efate and offshore islands, with localities reported to have dugongs (+) and where seen on the aerial survey (▼).

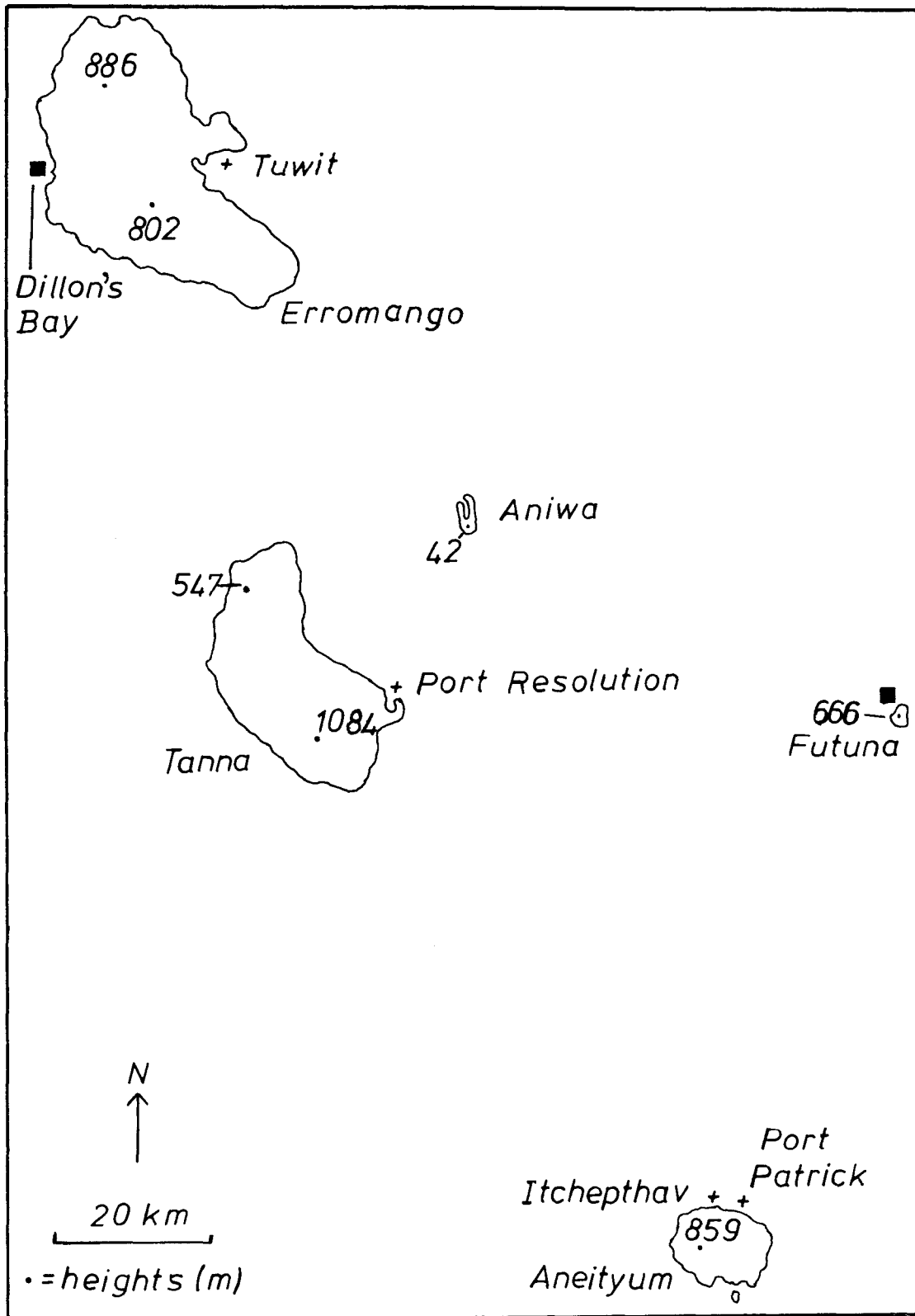


Figure 17. The southern islands of Vanuatu, with localities reported to have dugongs (+) or no dugongs (■)

TABLE 3. THE FREQUENCY OF DUGONG GROUP SIZES REPORTED IN THE DUGONG QUESTIONNAIRE SURVEY

Group size of dugong	Numbers of reports of this size	% of total reports
1	12	12.6
2	42	44.2
3 - 10	38	40.0
10 +	3	3.2
	95	100.0

4.1.2 Changes in dugong numbers

A total of 80 respondents replied to the question concerning changes in dugong numbers. Their answers are summarised in Table 4.

TABLE 4. CHANGES IN DUGONG NUMBERS AS REPORTED IN THE QUESTIONNAIRE SURVEY

Respondents reporting that dugong numbers have:		
Increased (%)	Decreased (%)	Stayed the same (%)
22 (27.5)	14 (17.5)	44 (55.0)

Thus more than 80% of respondents thought that dugong numbers in their area had either increased or remained the same and less than 20% that their numbers had decreased.

4.1.3 Feeding areas of dugongs

Of the 85 respondents who answered this question, 50 (59%) stated that dugongs feed in the locality referred to by them, whilst 35 (41%) thought they didn't. In addition, several respondents said that dugongs feed over a wide area.

This question was intended to supply information to find the locations of major dugong feeding grounds, if indeed such exist. The question was not well framed however and the information received probably shows, at best, that dugong feeding areas (seagrass beds) are widely distributed. Thus no detailed analysis of the responses to this question will be made.

4.1.4 Dugong movements within the archipelago

Question 10 was answered by 86 people, of whom 40 reported that dugongs are found in their area the whole year round, whilst 46 stated they are seen in some months only.

Out of the 46 people who said dugongs occurred in their area for only some months of the year, 27 answered question 11 as to which months these were (Table 5). From these results there is no clear indication of seasonal movements along the archipelago, although because of the low and sometimes confused responses to questions 10 and 11 it is difficult to interpret the answers conclusively. Of the 27 respondents who answered question 11, most of them (17) reported dugongs as occurring in their area for one or two months only.

Sometimes the responses to questions 10 and 11 produced some contradictory responses. Thus some respondents reported dugongs as occurring in all months (question 10), but then in question 11 stated they were found in some months only. Similarly some respondents said dugongs were not seen in all months, but then ticked off all the months in question 11. In such cases, the responses to both questions were not assessed.

Several responses said that dugongs were more easily observable at periods of high tide, whilst others said they were more visible during times of particularly hot weather.

4.1.5 Localities in which dugongs are hunted

From the questionnaire replies, it was possible to document in which of 76 localities dugongs were regularly hunted (Table 6). In total, dugong hunting was reported from 16 localities, whilst in the other 60 it was stated no hunting took place. In four of the latter group dugongs were reportedly hunted in earlier times. In two places, Piliura on Pele Island and Eratap on Efate, it was reported to be taboo to kill dugongs.

The localities from which dugong hunting is reported are confined to mainly three regions of Vanuatu - the Maskelynes area of southeast Malekula, northern Epi and parts of Efate. In addition villages on Santo (Nokuku) and Pentecost (Loltong and Ranputor) were stated to hunt dugongs in contrast to other reported localities on these islands.

Several people replied that they were forbidden by their religious beliefs (Seventh Day Adventist) from hunting and eating dugong.

Although most people said that dugongs were not hunted in their areas a number did say that dugongs were killed on an opportunistic basis if the chance presented itself or that they were killed accidentally.

TABLE 5. MONTHS DURING WHICH DUGONGS ARE REPORTED TO BE PRESENT AT VARIOUS LOCALITIES IN VANUATU

Locality	Months during which dugongs reported to be present
SANTO AND OFFSHORE ISLANDS	
Nokuku	August
Nokuku	September
Port Latour (Aore Island)	May - June
Tangoa Island	September - October
Tavonamala (Big Bay)	July
AMBAE	
Loloaru and Lovutialao	October
MAEWO	
Kerei	May
Narovorovo	April - August
PENTECOST	
Arasa	September
Loltong	November - April
Lonorore	September
Panas	January - February
MALEKULA AND OFFSHORE ISLANDS	
Rano Island	November - January
Sakau Island	November
Sakau Island	December - February
Uri Island	June - July
Vao Island	September
Wiawi	November - February
AMBRYM	
Craig Cove	January - July
Ranon	June - October

TABLE 5. (Continued)

Locality	Months during which dugongs reported to be present
PAAMA	
Kellai, Tavulai, Vaoleli	August - September
EPI	
Mate	November - January
EFATE AND OFFSHORE ISLANDS	
Nekapa (Ngunu Island)	August - September
Pango	May - August
Tikilaso (Ngunu Island)	October
ANEITYUM	
Itchepthav	May - July
Port Patrick	December - February

TABLE 6. LOCALITIES IN WHICH DUGONGS ARE REPORTED TO BE REGULARLY HUNTED OR NOT HUNTED AT ALL (* DUGONGS REPORTED TO HAVE BEEN HUNTED IN EARLIER TIMES)

Locality	Dugongs reported to be regularly hunted
BANKS ISLANDS	
Kaska (Gaua)	NO
Kerepua (Vanua Lava)	NO
Lalngetak (Vanua Lava)	NO
Lesereplag (Ureparapara)	NO
Nagpen River (Vanua Lava)*	NO
Port Patteson (Vanua Lava)	NO
Ravenga Island (Vanua Lava)	YES
Sola (Vanua Lava)	NO
Telvet (Mota Lava)	NO
Vureas (Vanua Lava)	NO
SANTO AND OFFSHORE ISLANDS	
Hog Harbour	NO
Jeriviu (Big Bay)	NO
Nokuku	YES
Port Latour (Aore Island)	NO
Tangoa Island	NO
Tavonamala (Big Bay)	NO
AMBAE	
Lolovenue	NO
Lolowai	NO
Redcliff	NO
Vuinago	NO
MAEWO	
Kerei	NO
Narovorovo	NO
PENTECOST	
Abwatuntora	NO
Arasa	NO
Bwatnapne	NO
Homo Bay*	NO

TABLE 6. (Continued)

Locality	Dugongs reported to be regularly hunted
PENTECOST (Continued)	
Laone	NO
Loltong	YES
Lonorore	NO
Panas	NO
Ranputor	YES
MALEKULA AND OFFSHORE ISLANDS	
Akhamb	NO
Khuneveo Island	YES
Lakatoro	NO
Lerongrong	NO
Pellonk (Uliveo Island)	YES
Port Stanley	NO
Rano Island	YES
Sakau Island	YES
South West Bay	YES
Uri Island	NO
Uripiv Island	NO
Vao Island	NO
Wala Island	NO
Wiawi	NO
AMBRYM	
Craig Cove	NO
Fonteng	NO
Megham	NO
Ranon	NO
Ranvengere	NO
Ulei	NO
PAAMA	
Kellai	NO
Liro	NO
Now	NO
Tavulai	NO
Vaoleli	NO

TABLE 6. (Continued)

Locality	Dugongs reported to be regularly hunted
EPI	
Laman Bay	YES
Lomaru Bay	YES
Mapvilao	YES
Mate	NO
Port Kweimi	NO
SHEPHERD ISLANDS	
Siwa (Emae Island)*	NO
EFATE AND OFFSHORE ISLANDS	
Erakor	YES
Eratap*	NO
Natapao (Lelepa Island)	YES
Nekapa (Nguna Island)	YES
Ngurua (Emao Island)	NO
Pango	NO
Paonangisu	YES
Piliura (Pele Island)	NO
Sunae (Moso Island)	NO
Tikilaso (Nguna Island)	NO
ERROMANGO	
Tuwit	NO
TANNA	
Port Resolution	NO
ANEITYUM	
Itchepthav	NO
Port Patrick	NO

4.1.6 Reasons for killing dugong

Out of a total of 48 replies to this question (No. 13), 44 said that dugong were killed for food only, 3 for oil and food and 1 for food and teeth. The latter reply (from Pango, Efate) did not say what the teeth were used for. Dugongs were reportedly used for oil from Mapvilao and Mate (Epi) and Nekapa (Nguna).

Some people replied to this question even though they had reported in the questionnaire that dugongs were not hunted or killed in their locality. Their answers were included because they are presumably reliable reporters of the reasons why people in other localities kill dugong.

Several people answered that they did not know the dugong was edible.

4.1.7 Seasonality of dugong hunting

There were 43 replies to the question asking if dugongs were killed at any special time. Of these, 38 stated that they could be killed at any time of the year.

In five localities, dugongs were reportedly killed at special times. Three of these were related to the yam seasons. Thus at Lamén Bay (Epi), dugongs are hunted at the time of the March full-moon, coinciding with yam harvest. At Sakau (Maskelyne Islands) dugongs are also sometimes hunted at the time of the yam harvest, though the month was not stated. In north Efate, dugongs are hunted at the time of planting of the new yam crop, from August to October. Elsewhere, dugongs were reportedly hunted during the "hot season" (approximately December - April) at Lolong (Pentecost) and at the times of special custom ceremonies at Paonangisu (Efate).

Two people stated that there used to be special times in earlier days but not any more.

4.1.8 Methods of killing dugong

Dugongs were reported to be killed in a variety of ways and these are summarised in Table 7.

Dugongs are apparently mostly killed by spearing, with more than half the answers reporting this method. Several people mentioned that ropes were attached to the spears. The next most common method was to block the nostrils, thereby suffocating the dugong. Items reportedly used for this were coconut husk fibres, coral, stone, wood and fingers.

In five instances, nets were used. In at least two of these cases the nets were specifically set for dugongs, whilst in the other three it was not clear if the nets were for dugongs or fish. In the former cases, (Ravenga Island, Vanua Lava and Lamén Bay, Epi) the nets were specially made from bush materials. At Lamén Bay the net was reported to be

400 - 600 yards long (360 - 540 m) and to use thorny vines. The net was then used to fence off an area of reef (see also section 4.1.12). At Rano Island (Malekula) dugongs were reportedly trapped by building a stone wall around part of the reef. Extensive stone walls were seen amongst mangroves and in the shallow sub-littoral at Ureparapara (Chambers, personal observation, April 1988) but it is not known for what purpose these are used.

Dugong were reportedly killed by a number of weapons in addition to spears. These included guns (5), axes (2), spear gun (1) and knife (1). In addition, dynamite was reported from two places. Accidental deaths are apparently rare and were attributed to fishing nets (twice) and out-board engines (once).

Many people mentioned that dugongs were often caught in shallow water, particularly when stranded in pools by the receding tide.

TABLE 7. METHODS BY WHICH DUGONGS ARE REPORTEDLY KILLED IN VANUATU

Method	Number of people reporting this method
Spear	30
Blocking the nostrils	6
Setting nets	5
Gun	5
Dynamite	2
Axe	2
Accident - nets	2
Accident - boats	1
Stone wall	1
Spear gun	1
Knife	1

4.1.9 Frequency of dugong deaths

The reported frequencies of dugong deaths, from all causes, are listed in Table 8.

The highest reported frequency was two dugongs per year, from Nekapa on Nguna Island. A number of other localities reported one or two per year (though not always every year) - Loltong (Pentecost), Khuneveo, Pellonk and Sakau (Maskelyne Islands), South West Bay (Malekula), Lamén Bay (Epi) and Paonangisu (Efate). Elsewhere, the mortality rate was reportedly lower, generally only one in the last 10 or 20 years.

Generally, those localities in which dugongs are reportedly hunted gave a mortality rate of one or two dugongs per year. Mortalities were much lower in areas in which dugongs were killed by accident or on an opportunistic basis.

4.1.10 Changes in dugong localities

Few respondents answered this question (No. 17) concerning areas in which dugongs were now absent from areas in which they used to occur. A number of the answers mentioned localities in which dugongs are in fact known to occur or are closely adjacent to areas where they occur.

In view of the low and sometimes inaccurate response to this question, no further analysis was attempted.

4.1.11 Concern about the dugong

Most people answered this question, 52 stating they were worried about the dugong, whilst 34 said they weren't.

Few people amplified their answers by giving reasons for their concern or lack of it. Only one person reported he was worried by overfishing. Conversely, another person said there would always be plenty of dugongs.

4.1.12 Custom law and dugongs

Of the people who answered this question, 51 said there were no custom laws concerning the killing of dugongs. However, 7 people related such custom stories:-

Lamen Bay, Epi: When planning to catch dugongs, women are not allowed to swim in the sea for two months before. Men are forbidden to throw stones, arrows or spears into the sea. The men who are to catch the dugongs are not allowed in the houses and must live in the forest. During this time the men will make a special net (360 - 540 m long) from creepers, vines and thorny branches. The net is used to fence off a portion of the reef and any dugong will be trapped. The thorns will "sting" the dugong's eye.

TABLE 8. REPORTED FREQUENCY OF DUGONG DEATHS FROM ALL CAUSES. (* LOCALITIES REPORTING REGULAR HUNTING OF DUGONGS)

Locality	Frequency of dugong deaths	
BANKS ISLANDS		
Kaska (Gaua)	In total, 1 every 1 or 2 years	
Kerepua (Ureparapara)		
Lalngetak (Vanua Lava)		
Port Patteson (Vanua Lava)		
Sola (Vanua Lava)		
Telvet (Mota Lava)		
Nagpen River (Vanua Lava)		One in 1972
Vureas (Vanua Lava)		One in 1966
SANTO AND OFFSHORE ISLANDS		
Nokoku	One in 1976	
Port Latour (Aore Island)	One in 1984	
Tavonamala (Big Bay)	One in the last 10 years	
PENTECOST		
Bwatnapne	One in 1960	
Loltong*	Sometimes 1/year	
Ranputor*	One in the last 3 years	
MALEKULA AND OFFSHORE ISLANDS		
Akhamb Island	Not in the last 3 years	
Khuneveo Island*	Sometimes 1 or 2/year	
Pellonk (Uliveo Island)*	1 or 2/year	
Rano Island*	2 in 1979, none since	
Sakau Island*	Sometimes 1/year	
South West Bay*	Sometimes 1 or 2/year	
Uri Island	One every 10 - 20 years	
Wala Island	One in 1981	
AMBRYM		
Moru	1 in 1950	
Ranon	1 in 1961	
Ulei	1 every 10 - 20 years	

TABLE 8. (Continued)

Locality	Frequency of dugong deaths
EPI	
Lamen Bay*	Sometimes 1 or 2/year
Mapvilao*	One in 1986
Port Kweimi	Less than 1/year
EFATE AND OFFSHORE ISLANDS	
Erakor*	Not every year
Nekapa (Nguna Island)*	2/year
Pango	Occasionally
Paonangisu*	Sometimes 1 or 2/year
TANNA	
Port Resolution	1 in 1951

Malekula (place not specified): The dugong is a special animal, in the same way as a bullock. According to custom law, if you kill a dugong, you must give it to the chief. In return, the chief must give you a pig.

Ranputor (Pentecost): In the old days, only those people who offered sacrifices of pigs or followed other customs were allowed to hunt for dugongs. They could only hunt dugongs at special times and places. But nowadays, anyone can catch dugongs when he wants. This shows that respect for custom laws has vanished.

Paonangisu (Efate): Some families here are descended from fish. If a member of a fish family dies, or is to become a chief, then meat must be provided. If the family has no meat, then a custom fish from the sea will provide a large fish, turtle or dugong for the family to catch. Thus dugongs are only caught for such a custom ceremony.

Naure (Malekula): A long time ago, the old men from Naure killed a dugong. Their chief ordered them to give it to the village of Potovro. This they did and the Potovro people ate it. To this day, the Potovro people have not repaid this debt as they have been unable to catch a dugong as big as the one they received. Thus the Naure people are now considering taking some of the land belonging to the Potovro people.

Khuneveo Island (Maskelyne Islands): If your wife is pregnant, you won't be able to catch a dugong. This is because the dugong will swim away from you when you are in your canoe. But if your wife is not pregnant, the dugong will come close to the canoe and you'll be able to catch it.

Rano Island (Malekula): Anyone can catch a dugong. However, when it is dead, you must find out if it is a male or female. Then you must cut out the reproductive organs and show them to the people and children.

In addition, four people related other stories concerning the dugong:-

Tanna (locality not specified): When dugongs want to die, they come close inshore.

Lamen Bay (Epi): Dugongs with wounds on them will stay close inshore. This is to prevent them from attracting and being attacked by sharks.

Hog Harbour (Santo): If you are in your canoe and meet a dugong that is blocking your route, you must stop and wait and not try to go around him. Otherwise, he will move too and continue to obstruct you. When the dugong wants you to proceed, he will jump up, dive back into the water, and wave his tail. This means you can continue. If you and a dugong want to travel on the same route, you must let him go first and then follow on after.

Emao Island (Efate): Dugongs are helpful to people. They will save people from drowning. When we see them in the water, we like to play with them.

In one locality (Aneityum), the respondent stated that the dugong was a new animal there, and thus there could not be any custom traditions. Several respondents replied that the people in their areas had no interest in the dugong, and it was just another animal in the sea. Thus again, no traditions are likely in such a situation.

4.2 RESULTS OF AERIAL SURVEY

4.2.1 Dugong sightings

During the aerial survey, 11 dugongs were sighted (Table 9, Figures 11, 14, 15, 16). Of these, 5 sightings were of single animals, two of mother/calf pairs and one of a pair of adults. Most of the animals (6) were seen in the sheltered waters around north Efate. All sightings were at or close to localities from which dugongs were reported in the questionnaire survey. With approximately 1000 km of coastline surveyed, dugong sighting frequency was about 0.01 dugongs per kilometre.

In all cases except one, dugongs were idling on the surface when sighted. In the other instance, the dugong was being chased by a shark in shallow water over a fringing reef.

4.2.2 Sightings of other fauna

Other large animals seen during the aerial survey are listed in Table 10 and shown in Figures 18 and 19. In total, during the 12 hours of flying there were 13 turtle sightings, 8 ray sightings, 6 shark sightings and 4 dolphin sightings.

4.2.3 Seagrass beds

During the survey, sightings of seagrass beds were made and their approximate locations marked on maps. However, during subsequent visits by boat to some of these localities, seagrass was either absent or very sparse. In the light of at least some obviously erroneous sightings during the aerial survey, no analysis of the sightings will be attempted.

4.2.4 Boat sightings

During the survey records were kept of boats sighted at sea. A total of 157 canoe sightings and 54 motorised (outboard engine) boats were seen, a ratio of 3 canoes to every motorised boat. The latter are mainly used for offshore line-fishing and as inter-island taxis. In addition, a number of small coastal trading vessels were seen.

4.2.5 Conditions during the aerial survey

During the aerial survey, conditions for sighting dugongs were only moderately good. Cloud cover usually varied between 50 and 85%, whilst sea conditions generally ranged from 2 to 3 on the Beaufort scale. The level of both these factors was thus sufficient to reduce light penetration into water and thereby impair sub-surface visibility. In addition, air turbulence occasionally made it difficult to fly in steady straight lines.

However, because of the necessity to complete the survey between 8 - 11 December, there was no option but to make the survey despite the less than optimum conditions. It is not possible to estimate how sightings would have varied given better atmospheric and sea conditions.

TABLE 9. DUGONG SIGHTINGS DURING THE AERIAL SURVEY OF VANUATU, 8 - 11 DECEMBER 1987

Locality	Numbers of adults/young	Behaviour	Observations
Havannah Harbour, Efate	1 adult and 1 young	Idling on surface	Open water between Lelepa and mainland
Havannah Harbour, Efate	1 adult	Idling on surface	Open water between Moso and mainland
Pele Island, north side	1 adult	Swimming below surface	Over fringing reef, harassed by shark
Havannah Harbour, Efate	2 adults	Idling on surface	Open water off Ulei
Cook Reef	1 adult	Idling on surface	Inside reef rim over sand bottom
Valesdir, Epi	1 adult	Idling on surface	Open water
Lamen Bay, Epi	1 adult	Idling on surface	Over sand bottom
Atchin Island, north Malekula	1 adult and 1 young	Idling on surface	Open water

TABLE 10. LOCALITIES AND NUMBERS OF DOLPHINS, RAYS, SHARKS AND TURTLES RECORDED DURING THE DUGONG AERIAL SURVEY OF VANUATU, 8 - 11 DECEMBER 1987

Locality	Numbers of dolphins, rays sharks and turtles recorded
BANKS ISLANDS	
Reef Islands	8 ray, 1 shark
SANTO AND OFFSHORE ISLANDS	
Big Bay	16 dolphin, 1 turtle
Cape Queiros	5 dolphin
Malo Island	1 turtle
Palikulo	2 turtle
Segond Channel	1 ray, 1 turtle
Turtle Bay	1 turtle
AMBAE	
Walaha	1 shark
MAEWO	
Laone	1 turtle
MALEKULA AND OFFSHORE ISLANDS	
Atchin Island	1 turtle
Lambubu Bay	1 turtle
Maskelyne Islands	1 turtle
Midway to Efate	1 ray
South West Bay	6 shark, 2 turtle
EPI	
Cape Foreland	1 shark, 1 turtle
SHEPHERD ISLANDS	
Mataso Island	1 ray

TABLE 10. (Continued)

Locality	Numbers of dolphins, rays sharks and turtles recorded
EFATE AND OFFSHORE ISLANDS	
Havannah Harbour	2 ray
Mele Bay	1 turtle
Midway to Erromango	1 ray
Pele Island	2 shark
Port Vila Harbour	3 ray
Undine Bay	1 ray, 8 shark, 1 turtle
ERROMANGO	
North coast	16 dolphin
ANIWA	
North coast	20 dolphin

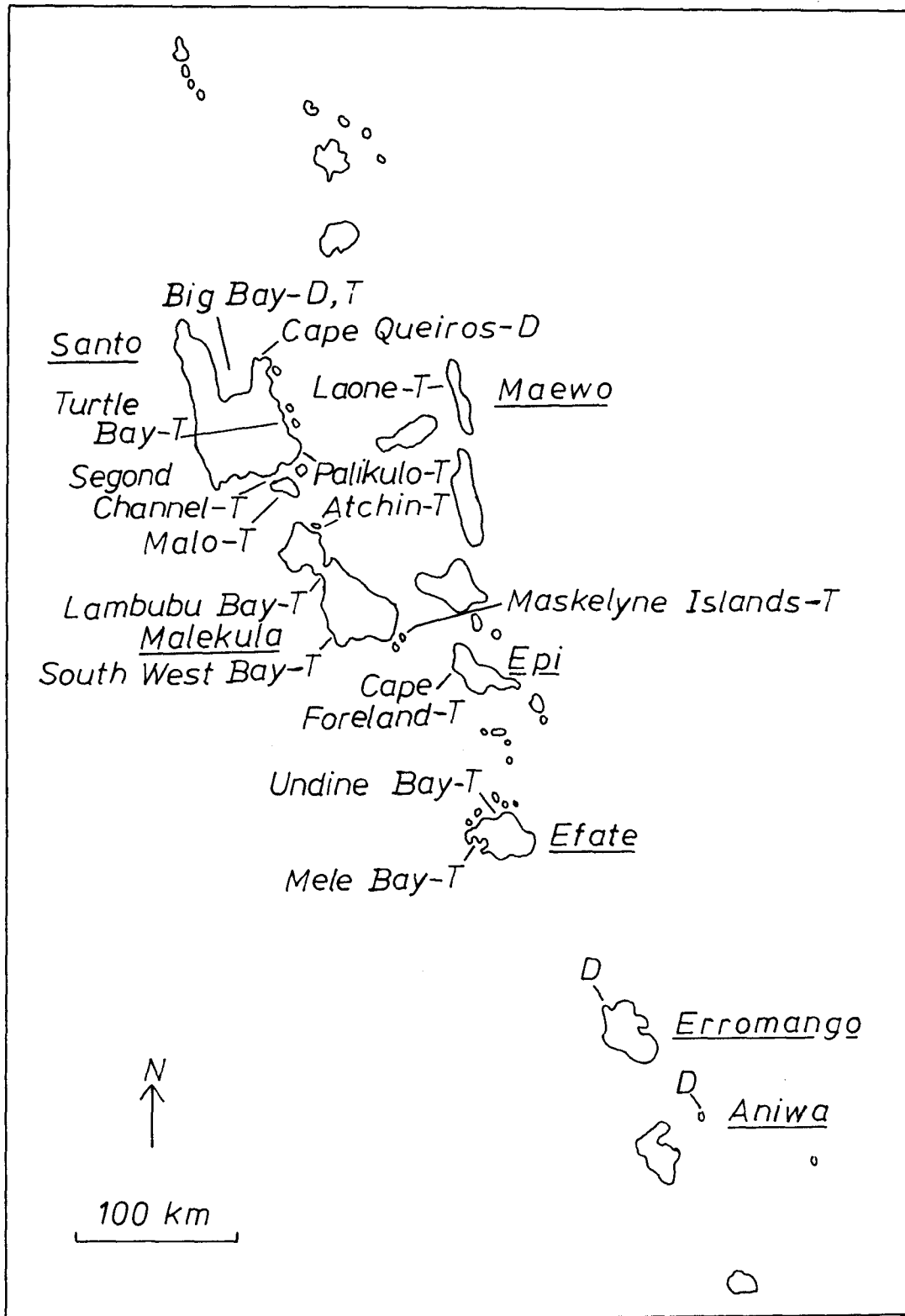


Figure 18. Map of Vanuatu showing the location of dolphin (D), and turtle (T) sightings during the dugong aerial survey, 8 - 11 December 1987

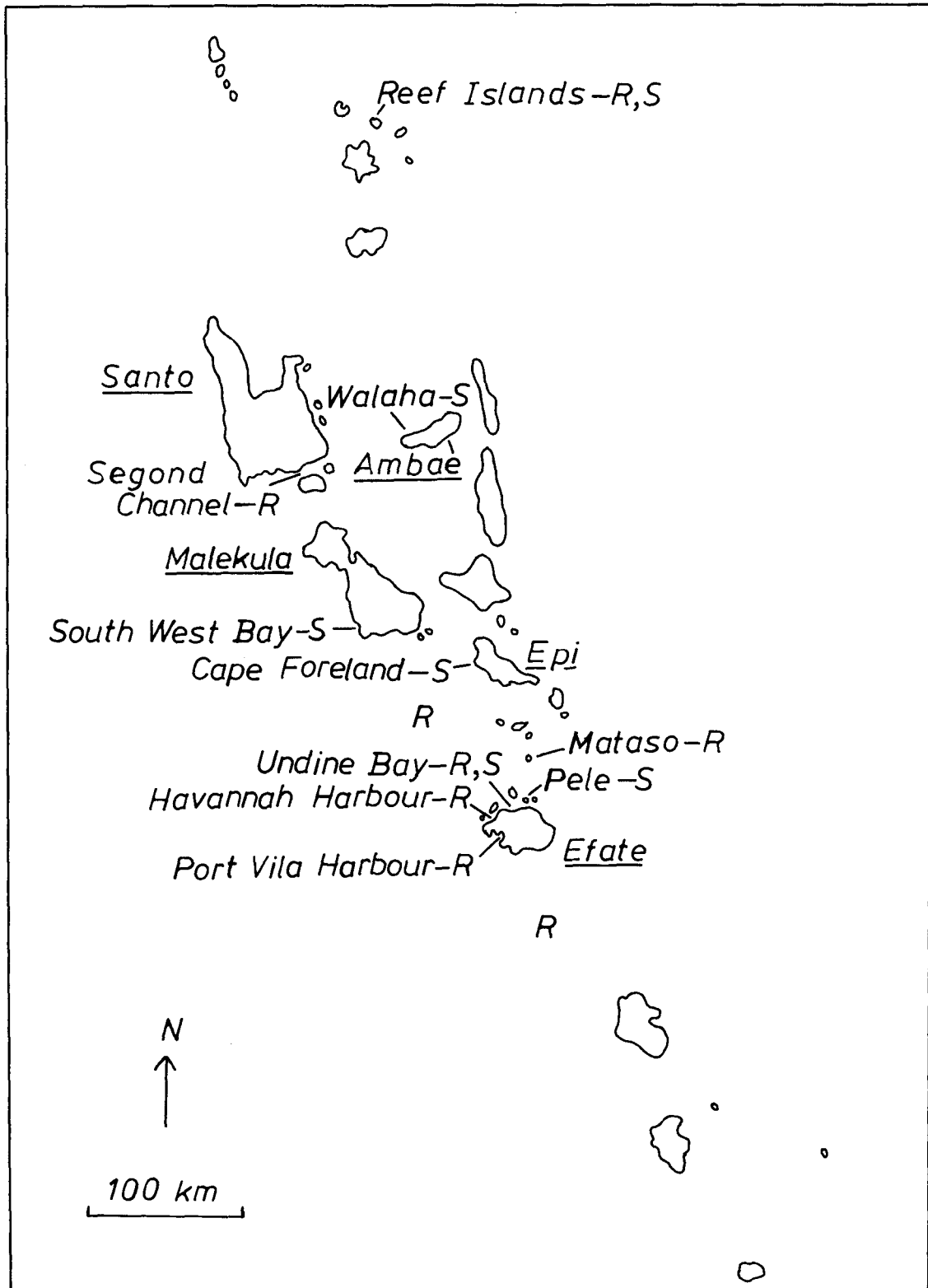


Figure 19. Map of Vanuatu showing the localities of ray (R) and shark (S) sightings during the dugong aerial survey, 8 - 11 December 1987

CHAPTER 5: DISCUSSION OF RESULTS

The dugong is clearly distributed throughout Vanuatu from Aneityum in the south to the Torres Islands in the north (Figure 5). It occurs at every major island in the archipelago and most of the smaller ones as well. It appears to be absent from a number of small rugged islands e.g. Futuna, Buninga and Mere Lava, the east coasts of major islands such as Efate, Pentecost and Maewo and much or all of the west coasts of Santo, Erromango and Tanna. Absences however must be interpreted with some caution as they may only reflect the lack of replies from these areas. In only a few instances were there actually questionnaire replies stating that the dugong did not occur in these localities.

Although this survey was not specifically intended to study the detailed ecology of the dugong in Vanuatu, one such aspect may be discussed here. The dugong records are nearly all from localities protected from the prevailing east/southeast winds (Figures 6 - 17). Thus the majority of reported dugong localities are either from the west coasts of islands or, if from the south and southeast coasts (e.g. Malekula and Santo), shelter is readily available from the offshore islands and in the bays of these coasts. In the instances of dugongs recorded from more exposed coasts, then sheltered bays, or lagoons behind the reef are generally present at or close to the locality. Thus dugongs in Vanuatu are apparently distributed in the more sheltered waters of the country.

The lack of dugong records from the exposed east coasts of, for example, Efate, Pentecost and Maewo may reflect the lack of sufficient adequate shelter and/or the absence of seagrass beds. The apparent scarcity of dugong at west Santo, Tanna and Erromango may also be real, as these coasts are extremely rugged with fringing reefs absent or poorly developed. Thus again, shelter and/or seagrass beds are likely to be scarce.

Dugongs in Vanuatu seem to occur only in small groups, with most being reported as single or pairs of animals (Table 3). In only three localities (Havannah Harbour, Hog Harbour and Lamén Bay) were more than 10 dugongs reported to occur. These three localities are, for Vanuatu, comparatively large areas of relatively sheltered, shallow water. Though in Vanuatu "shallow" is a relative term - Havannah Harbour has a maximum depth of 124 m.

In Vanuatu, water depths in excess of 1000 m generally occur only a few kilometers off the coast (Figure 2). Thus dugongs are always likely to occur very close to the coast in association with shallow bays and fringing or platform reefs and the shelter and seagrass beds that may be associated with these areas. As these areas are of limited size in Vanuatu, it is therefore likely that the small group sizes reported in the survey present a realistic picture of the actual situation. As dugongs were reported from many localities in the country, it appears probable that at least a high proportion of coastal areas of shallow, sheltered water each support a small number of dugong.

The dugong localities reported in Table 2 should not necessarily be considered as fixed points of occurrence or permanent populations. Given the small area of some of these places, it is quite possible that dugongs, at least in some regions of Vanuatu, move along and around the island coasts. The evidence in Table 5, that dugongs only occur in some areas for one or a few months, may be an indication of such movements.

Given the very deep water and comparatively large distances between many of the islands, the extent of inter-island movements may be fairly restricted. Clearly though, it has occurred in the past given the present distribution pattern. As one respondent from the southernmost island of Aneityum stated that the dugong is a new animal there, it is possible that the dugong has only recently completed its occupation of the entire archipelago (no information is available from the isolated and uninhabited, small rugged islands of Matthew and Hunter, 250 km to the south).

Although dugongs seem to occur in only small numbers in each locality, the population numbers appear to be stable. Thus more than 80% of respondents stated that dugong numbers in their area were either increasing or the same as before (Table 4). It therefore appears that these small and scattered dugong populations can adequately maintain themselves in the face of whatever current pressures they are subjected to.

As the dugong is a herbivore feeding almost entirely on seagrasses, the distribution and abundance of seagrasses will be the ultimate factors determining their numbers and distribution. At the present time, little is known of seagrass distribution in Vanuatu. The questionnaire and aerial surveys provided little reliable information about this. On a recent survey of coral reefs in Vanuatu, Chambers (in preparation) found nine species of seagrass. These were Cymodocea rotundata, C. serrulata, Enhalus acoroides, Halodule pinifolia, H. uninervis, Halophila ovalis, Syringodium isoetifolium, Thalassia hemprichii and Thalassodendron ciliatum. All these species are reported by Nishiwaki and Marsh (1985) to be eaten by the dugong.

Availability of these seagrasses will depend to some extent on the habitat in which they occur. Chambers (in preparation), found at least two major seagrass habitats. In some shallow sheltered localities, the seagrasses formed extensive sub-littoral beds in bays or areas between islands e.g. Ureparapara, Moso, Undine Bay, the Maskelynes and Loltong Bay. In such areas, dugongs will have 24-hour access to feeding grounds. In more exposed areas seagrasses were more sparsely distributed behind fringing reefs, generally in narrow bands along the lower intertidal areas of sandy shores and in the shallow sublittoral in front of the reef flats. In these areas, dugongs will be more restricted in their feeding times, access being possible only at higher tide levels.

Seagrasses in Vanuatu seem to occur always in shallow water. Thus Chambers (in preparation), rarely found any of the nine species in depths greater than 2 m. Much of the biomass was in intertidal areas or the very shallow sublittoral. In several areas, the intertidal seagrasses were found to have been recently killed off, perhaps as a result of heavy rains

coinciding with low tides. Rough seas associated with cyclones may also destroy seagrass beds, as may rapid volcanic uplift of coastal areas. Cyclones occur every year, whilst in 1965 an earthquake resulted in a 1 metre rise of the intertidal area over a large part of east Malekula. Thus the seagrass beds in Vanuatu are liable to become locally extinct or damaged from a variety of natural causes. In turn, such effects will be a factor in the distribution and abundance of dugongs, at least on a local scale.

The questionnaire survey provided no reliable information on dugong movements. In particular there was no evidence that dugongs undertake seasonal movements along the length of the archipelago. In Australia dugongs migrate large distances, apparently in response to seasonal changes in food availability and water temperature (Anderson, 1986). In Vanuatu the comparatively great inter-island distances may inhibit any such regular movements, though clearly they have occurred, and presumably still do from time to time.

A number of respondents reported that dugongs were only present in their area for a limited time of the year (Table 5). This may indicate that dugongs move around the coasts of the islands and that some localities at least may not support the year-round presence of dugongs. Presumably those areas with extensive sub-littoral seagrass beds would be the localities more likely to support permanent dugong populations. Whatever the situation, and more work would be needed to demonstrate the actuality of round-island dugong movements, the dugongs of one island, or a group of close islands, should be considered as a single population, rather than as being subdivided into discrete units permanently attached to a particular bay or lagoon.

Dugongs appear to be hunted in three main regions of Vanuatu (Section 4.1.5). It thus appears that in Vanuatu dugong hunting is not a widespread tradition or way of life. Although most people replied that dugongs were not regularly hunted in their areas, some did say that dugongs were taken on an opportunistic basis when the chance arose or they were captured accidentally. Such opportunities were reported to occur when dugongs were stranded in pools on the reef flat by the receding tide. In such cases the dugongs have presumably come close inshore at high tide to feed on the seagrass belt in the intertidal and shallow sub-littoral.

Dugong mortality from all causes (Table 8) appears to be low. Generally, it was not reported to exceed one or two animals per year, even in areas that regularly hunt them. It was frequently much lower, even in dugong-hunting localities. Thus the dugong is nowhere likely to be a major component of the subsistence diet. Given the apparently low hunting mortality and the fact that most people reported no decline in dugong numbers, it seems that at the present levels of exploitation the dugong is in no danger of being over-hunted. If this is indeed so, then Vanuatu is in a fortunate position with respect to its dugong population.

In Vanuatu the dugong appears to be killed almost entirely for food, with oil being a subsidiary reason (Section 4.1.6). The meat is taken presumably mainly for subsistence purposes, and occasionally for ceremonial reasons. There are no records of dugong flesh being sold in the markets. The absence of any commercialization of its meat also augurs well for the dugong in Vanuatu. In other Pacific areas e.g. Papua New Guinea, dugongs are used to supply teeth for ornaments and jewellery, bones for utensils, spears and clubs, skin for earrings and amulets, and the skull and whiskers for display in the men's meeting house in some regions. The meat is also freely marketed in some areas of Papua New Guinea (Hudson, 1977). In New Caledonia, dugong tusks are sold at US\$60 each (Chambers, personal observation, 1988).

In most localities where dugongs are killed, hunting can take place at any time of the year, and is not apparently governed by any custom or tradition (Section 4.1.7). Thus custom control appears to be the exception rather than the norm in Vanuatu. Where such controls do operate, they are mostly related to the yam seasons, in themselves events of great significance in Vanuatu.

Dugongs are killed by a large number of methods (Table 7), but the most common way is by spearing. Traditional means of killing greatly outnumber modern ways, and presumably this means in turn that most dugongs are killed by traditional methods. The only non-traditional methods recorded were dynamite, guns, spear guns and possibly knives and axes. If in the old days axes and knives made from stone, wood, shell or bone were used to kill dugongs, their modern steel equivalents can only be considered a refinement of a traditional technique. Counting knives and axes as a non-traditional hunting method, only 11 records (20%) of reported hunting methods use modern techniques.

In only three instances were dugong deaths reported from accidental causes - nets (twice) and boats (once). Thus, at the present at least, accidental mortality does not appear to be the common cause of death that it is in some countries. This in turn is probably a reflection on the comparative scarcity of motorised boats compared to canoes (Section 4.2.4) in Vanuatu as well as the dependence on fishing lines rather than nets to catch fish in coastal waters.

From the results of the questionnaire survey it appears that in most localities of Vanuatu the dugong is not considered an important animal either in terms of food or culture. It is hunted on a regular basis by few people and figures in few traditional stories (Section 4.1.12). Although it is eaten in many more localities than those in which it is regularly hunted, it is in these places taken irregularly on an opportunistic basis, much as any other animal would be. In such situations, the dugong has no special importance.

From the questionnaire survey, it is not clear whether the current apparent unimportance of the dugong to most Ni-Vanuatu is a modern state of affairs or has always been so. As cultures change, so maybe the dugong has lost an importance it previously had. Certainly, some people

did say that old traditions about the dugong had disappeared. It is also clear that great cultural changes in Vanuatu have indeed occurred within the last 200 years, since European contact. Some of these changes have involved massive decreases in the Ni-Vanuatu population. The extent of these changes will never be known, but the size of the population in Vanuatu before European contact is put variously at between 150,000 and 1.5 million. In the 1930s, the population was about 40,000. Thus clearly, whole cultures have disappeared from the country. Additionally, European developments in coastal regions, chiefly religious and agricultural, led to the whole-scale movements of people from the interiors of islands to the coastal regions. It is likely that many, at least, of these interior dwellers would have no customs, traditions or knowledge of the dugong. In turn, their descendants may not have acquired or developed much awareness of the dugong. Whatever the reasons for the dugong's lack of importance in Vanuatu, it is in contrast to that of many coastal dwellers in other areas of the Pacific. Thus in Papua New Guinea, the Solomons and with some coastal aborigines in Australia, the dugong is highly regarded as a food source and in local cultures.

The aerial survey provided disappointing results. Only 11 dugongs were sighted, nearly all in areas from which they had been reported by the postal survey. The other sightings were in areas in which dugongs could reasonably be inferred to occur. Thus with respect to overall distribution, localities of occurrence, and group size, the aerial survey provided no additional information to the postal survey.

This lack of additional information was not due to the inexperience of most of the observers, the route flown or viewing conditions during the survey. Rather, it was probably due to the dispersed nature of dugongs in Vanuatu and their apparent tendency to occur in small groups, making their observation difficult.

One important feature that the aerial survey did reveal is the apparent unsuitability of much of the country's coastline as dugong habitat. Generally, Vanuatu's coasts are rugged, with cliffs and rocky shores bordered by a narrow fringing reef, typically up to 300 metres wide. Beyond the reef rim, water depths increase rapidly to several thousand metres only a few kilometres offshore. The dugong, not a strong swimmer, has as its preferred habitat sheltered, shallow waters in which its food, seagrasses, can grow. Such localities are comparatively rare in Vanuatu, and the best examples are found at Havannah Harbour and Undine Bay (Efate), Lamén Bay (Epi), the Maskelyne Islands, the southeast and east coasts of Malekula and Santo and Ureparapara. Apart from these localities, the coasts are generally rugged and exposed with only small bays. The large platform reefs at Cook Reef and Reef Islands are virtually devoid of seagrasses (Chambers, in preparation). Many of the small bays though do support dugongs and in fact the animal is perhaps more abundant and common than could be generally supposed given the prevailing environment.

The aerial survey also revealed the general paucity of large marine animals of all kinds (Table 10). Although the Vanuatu archipelago is

quite extensive, the waters around it are oceanic in nature and thus generally less fertile than seas close to continental land masses. This lack of fertility probably reduces the numbers of large marine fauna compared to what occurs in waters adjacent to continental land masses, and may also reduce the suitability of the Vanuatu coasts as dugong habitat.

Vanuatu is the easternmost point of the dugong's distribution, which from west to east stretches from east Africa to Vanuatu. Thus Vanuatu must be considered as offering only a marginal and less than optimum habitat for the dugong. What are the factors that determine Vanuatu as the easternmost limit of the dugong is not certain. Perhaps it is an inability to cross the extensive area of open sea between Vanuatu and Fiji. However, the dugong can cross large areas of open sea, as is evidenced by its presence in Palau and Guam. The presence of hostile coasts and only comparatively small areas of suitable habitat would not in themselves make Vanuatu the end-point of the dugong's distribution. Such features however may cause additional stress to the factors that make Vanuatu a marginal locality.

Cyclones may also contribute to the general unsuitability of Vanuatu for dugongs. These occur regularly (Section 1.5) and depending on wind direction a particular locality may offer no shelter at all. In such cases, local dugong populations may be exterminated. However, dugongs were present at Ureparapara in April 1988 after the island was struck full-force by a cyclone three months earlier. The seagrass beds were still extensive. Thus dugongs can certainly survive cyclones, although it is doubtful if they would at all times. Presumably, unless the locality is very isolated, recolonisation of a dugong-depleted area would occur fairly quickly from nearby populations.

The hunting and other pressures to which the dugong is subjected do not appear to be reducing its numbers to any noticeable extent. Thus despite hunting and the possibility that Vanuatu may in any case be a marginal habitat, the dugong's future in the country seems assured for the foreseeable future. Human coastal populations are generally low, and there are no planned developments that would seriously pollute coastal waters or degrade or destroy seagrass beds. The only areas of (moderately) polluted waters in Vanuatu are those of Port Vila Harbour and the lagoons at Erakor, close to Port Vila. These are also by far the most densely populated regions of Vanuatu. Yet dugongs occur at Erakor and have been seen in 1988 by the sea wall at the centre of Port Vila.

The apparent indifference of many Ni-Vanuatu to the dugong may be the most important factor in its long-term survival in Vanuatu. Whatever happens, it won't be hunted to extinction. At the same time, it is clear that to some Ni-Vanuatu the dugong is an important animal. Such discrepancies in attitude are doubtless further expressions of the very great variety of cultures in Vanuatu.

CHAPTER 6: ACKNOWLEDGEMENTS, LITERATURE CITED AND OUTPUTS

6.1 ACKNOWLEDGEMENTS

We are grateful to Caroline Barlow, Jules Ellis, Andrew Feriam and Larry Hunt for acting as observers on the aerial survey. We also wish to acknowledge the skill and expertise of the pilot, Keith Barlow. We are also grateful to the many people who took the time and trouble to complete the dugong questionnaire survey, thereby providing most of the information in this report.

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6.3 OUTPUT

Chambers, M.R. and E. Bani. 1988. Custom, tradition and the dugong (Dugong dugon) in Vanuatu. Naika 29: 17-25.

Other papers under the joint authorship of Chambers, Bani and Barker-Hudson are planned for:

- Naika
- An international scientific journal e.g. Biological Conservation
- Sirenia

CHAPTER 7: PROBLEMS AND ENVIRONMENTAL SIGNIFICANCE AND IMPLICATIONS

7.1 PROBLEMS ENCOUNTERED

None

7.2 ENVIRONMENTAL SIGNIFICANCE AND IMPLICATIONS

7.2.1 Local

The project has carried out the first detailed survey of the dugong in Vanuatu. The results have established that the dugong is distributed throughout the archipelago. The national population is made up of small numbers of dugongs at many localities, including all the major islands and island groups. Generally, the dugong is not extensively hunted and appears to have little cultural significance. In a few localities though the dugong is regularly hunted and in these areas it does appear to have a cultural value, but from the reported catch-rates it does not seem to be a major item of the subsistence diet.

So far as can be inferred from the results, dugong numbers are not decreasing through hunting pressure. Additionally, there appear to be no pressures from pollution, accidental mortality or loss of seagrass beds, at present or in the foreseeable future.

7.2.2 Sub-regional and regional

In the southwest Pacific, dugongs are found in Micronesia (Yap, Guam and Palau) and Melanesia (Papua New Guinea, the Solomons, New Caledonia and Vanuatu). In Micronesia it is rare and must be considered in danger of extinction. In Melanesia, the dugong is fairly common in some areas of Papua New Guinea. In some of these localities it is extensively hunted and is widely sold in markets. Numbers have decreased in recent years and the long-term prospects of the dugong in Papua New Guinea must be considered as uncertain unless the hunting rate is reduced. In New Caledonia and the Solomons the status of the dugong is not known, but it is hunted in both countries.

So far as is known at present then, Vanuatu has the region's only reasonable dugong numbers that are not subjected to any great pressures that could lead to a marked decline in their numbers. It is not possible to make an accurate estimate of dugong numbers in Vanuatu. However, it was reported from nearly 100 localities in the present survey, and must presumably occur at other ones as well. The average number reported from each locality is about 2 or 3. Thus there are probably at least 200 or 300 dugongs in Vanuatu and possibly many more.

7.2.3. Global

Globally, the dugong is widely distributed from east Africa to the south-west Pacific. Across much of this range, the dugong has already disappeared and is becoming rare in many other places. These declines and extinctions are caused by factors not operating in Vanuatu - over-hunting, high accidental mortalities, pollution and loss of seagrass beds.

Vanuatu is the easternmost point of the dugong's range. Thus it appears that at this eastern limit, the dugong population is secure for the foreseeable future. Vanuatu's dugong population is probably not large compared to numbers elsewhere (at least several thousands occur in Australia). Vanuatu is perhaps, however, one of the few countries throughout the dugong's extensive range in which it is not in danger of decline or extinction.

7.2.4 Management and policy

The results of this project show that the dugong is widely distributed throughout Vanuatu and has apparently not declined in numbers, at least in recent memory. Additionally, there are no foreseeable pressures such as pollution or seagrass loss that would lead to a prediction that numbers will decline in future.

The islands of Vanuatu have been populated for at least 4,000 years. It thus appears that whatever pressures the Ni-Vanuatu have exerted on dugong numbers by hunting during this period, and the available evidence indicates this is slight, the species is well able to maintain its numbers at this pressure. As there is no reason to think hunting pressure will increase, there does not seem to be a strong need to create marine reserves or introduce other measures specifically concerned with dugong protection.

It is an objective of the Vanuatu Government to create a system of protected terrestrial and marine areas in the country. When the question of establishing marine reserves is considered in more detail, then areas known to contain relatively large numbers of dugongs, as well as other marine fauna and flora of value, should be given priority. Such areas would include:

- a) Havannah Harbour, Undine Bay and the extensive intertidal reef flats to the east of Kakula Island (which contain rich seagrass beds). This area probably serves as one continuous dugong habitat.
- b) The Maskelyne Islands.
- c) The Port Stanley area of Malekula, including Uri and Uripiv islands.
- d) The Hog Harbour area of Santo.

The survey showed that dugongs in Vanuatu are apparently found at many localities, usually in small numbers. Thus any marine reserve designed to have dugongs as a major component of its value should be fairly large. The small numbers of dugong present in any one small locality would be comparatively highly at risk of extinction through hunting, accident, disease or cyclone.

Although coastal developments, and therefore increased pressures on the dugong, are slight and expected to remain so for the foreseeable future, they will occur from time to time. Thus a small tourist resort is planned for Samoa Point in Havannah Harbour. As part of the planning requirements, the project developers had to produce an environmental impact statement. In this statement, the developers were advised to restrict speed boat activities to a very small part of the harbour in order to reduce to a minimum the chance of accidental collisions with dugongs. The developers have agreed to abide by this recommendation.

In the longer term, there is the possibility of gold mining in Vanuatu. Gold deposits have been found in Efate (close to Havannah Harbour), Malekula and Santo. If any of these prospects are mined, then a major consideration would be the impact of the mine on coastal water quality in general, including potential impacts on dugongs.

At the present time, the dugong is protected by law in Vanuatu. Large fines can be imposed for killing them, but so far as is known no-one has ever been prosecuted for killing a dugong. The law in fact refers to "marine mammals" and is probably more geared to preventing the killing of whales for commercial reasons than the subsistence killing of dugongs. In view of the small numbers of dugongs killed and the difficulty of enforcing such a law in remote localities anyhow, there appears to be little to be gained from attempting to stop the killing of dugongs in Vanuatu, so long as it is confined to subsistence food and ceremonial requirements. The situation should be kept under review however, and if any noticeable increase in the killing of dugongs occurred, resulting in for example the sale of meat in markets, then the law should be enforced.

CHAPTER 8: RECOMMENDATIONS FOR FOLLOW-UP AND FURTHER WORK

8.1 WORK IN VANUATU

There does not appear to be an urgent need for follow-up work in Vanuatu. Dugong stocks do not seem to be declining and are widely distributed at many localities throughout the country. There is thus no overriding need to acquire more information as a basis for instituting urgent management procedures. Given this widely dispersed population, occurring in small numbers at generally remote localities, the possibilities for extensive field work studies are limited in any case.

More detailed studies would be required if a major development programme affecting coastal regions were to be implemented. The only such foreseeable projects would be if mining were to commence. In such a case, an impact study on the coastal marine environment would be required and this would include the dugong.

The most suitable area for a dugong study in Vanuatu would be the Havannah Harbour - Undine Bay area. The area contains comparatively large numbers of dugong and is readily accessible from land and sea.

Although the dugong appears to be under no threat in Vanuatu, the situation should not be regarded with complacency. A follow-up postal survey should be carried out after about 5 years to determine if any changes have occurred, and the situation reviewed again after that.

In the meantime, a number of educational initiatives will be undertaken by the Environment Unit. These will include articles and items for the press and radio in Vanuatu, outlining the results of this project. In addition, a copy of the final report will be given to the Curriculum Unit of the Ministry of Education so that details and findings of the project will be incorporated into Primary and Secondary school science and social science units.

This current project reports a number of custom and traditional beliefs relating to the dugong. These are interesting, and may well have only touched the surface of a much more extensive knowledge. It would be interesting to make more detailed studies in localities such as north Efate, Lamén Bay and the Maskelynes to find out more of the importance of the dugong in local cultures in Vanuatu.

Given the comparatively few data from the aerial survey, there would not appear to be any requirement to hold another such survey.

6.2 OVERSEAS WORK

So far as is known, the status of dugongs in New Caledonia and the Solomons is poorly understood. Studies should be carried out in these countries, so as to complete the dugong picture for its southwest Pacific distribution. Initially, these surveys should be carried out by a postal questionnaire. An aerial survey should only be carried out after if deemed necessary after evaluation of a postal survey.

ANNEX 1. DUGONG QUESTIONNAIRE - ENGLISH VERSION PRIOR TO
TRANSLATION INTO PIDGIN

The dugong is one of Vanuatu's most important and interesting animals but very little is known about it here. We would like your help in finding out about Vanuatu's dugongs. Can you please answer as many of these questions as possible. If you don't know the answer, a village elder or chief may be able to help.

1. Your name: 2. Your occupation:

3. Your address:

4. Name of island for which you are giving dugong information:

5. Village or part of island for which you are giving information:

6. When walking or boating in this area, do you see dugongs:
Nearly everytime: Often: Sometimes: Never: (Please tick)
 If dugongs are never seen in this area, this is useful information.
 Please return the form to let us know.
 If you do see dugongs, please answer as many as possible of the following questions.

7. Are there now more dugongs, fewer dugongs or the same number as before:
More: Less: Same: (Please tick)

8. How many dugongs are there in the groups you see:
1: 2: 3 - 10: More than 10: (Please tick)

9. Do dugongs feed in this area: Yes: No: (Please tick)

10. Do dugongs live here all the year: Yes: No: (Please tick)

11. If only in some months, which ones: (Please tick)
 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct.
 Nov. Dec.

...../Continued

ANNEX 1. (Continued)

12. Are dugongs hunted in this area: Yes: No: (Please tick)
13. Are dugongs hunted for other reasons besides food:
(Please give details)
14. Are there special occasions when a dugong is needed for a celebration:
15. How are dugongs killed:
16. About how many dugongs are killed in one year:
17. Have dugongs disappeared from any places that you know of:
18. Are you worried about dugongs in your area:
19. Are there any custom laws concerning hunting of dugongs, e.g. dugongs can only be hunted at special times or in certain places or by special people. Please give details if possible.

ANNEX 2. DUGONG AERIAL SURVEY FORM

Observer: Date: Region: Sheet number:

Time of flight conclusion: Time of survey conclusion:

Time of flight commencement: Time of survey commencement:

Duration of flight: Duration of survey:

Survey height: Survey speed: Distance surveyed:

Beaufort wind: Beaufort sea: Glare: Cloud: Tide:

OBSERVATIONS

Time	Locality	Species + Nos. of adult/young	Behaviour - swimming, idling, feeding, diving, surface	Habitat and observations - fringing or submerged reef, seagrass, lagoon, open water, sand, mangrove, river, boats, villages etc.
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ANNEX 2. (Continued)

Seating arrangement in aircraft:

Pilot _____ (Survey leader)

Sketch map of flight routeDugong data

Total sighted:

Adults:

Young:

% young:

Distance surveyed:

Dugongs/km:

Group sizes:

1 5

2 6

3 7

4 8

Turtle data

Total sighted:

Distance surveyed:

Turtles/km:

Group sizes:

Other species seen