Hunting and Ecology of Dugongs and Green Turtles, Torres Strait, Australia

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Grant 1626: In support of a study on exploitation and ecology of dugongs and green turtles in the Torres Strait.

A Place for Hunting

Many traditional seaside societies in the tropics were once highly adapted to and greatly dependent upon marine animals for subsistence. Along continental and insular margins, where the water was warm, shallow, and clear, and seagrasses and reefs were abundant, dugongs and green turtles commonly were the most important, sought-after, and culturally-esteemed large meat animals. Today, however, both traditional marine hunters and dugongs and green turtles have almost disappeared from tropical waters, having followed the pattern of so many other vanished societies and species that were overwhelmed by the spread of foreign colonization and commercialization of local faunal resources. Often they passed or were radically altered before much could be learned about the people's specialized cultural adaptation and their native knowledge of animal behavior, accumulated from generations of practical experience, or much about the natural history and ecology of the animals themselves. Largely extirpated from tropical coastal waters, seafaring and marine-resource–dependent peoples and the animals that provided both livelihood and a central cultural core are remembered almost solely from historical accounts. Yet in isolated corners of the tropics, small groups of marine hunters persist, as do the animals.

One such place is Torres Strait, where extensive shallow reefs support seagrass beds that are grazed almost exclusively by dugongs and green turtles; these animals are exploited solely by highly adapted marine hunters whose society, culture, and subsistence long have been intimately tied to these marine animals and environments.

The Torres Strait area is Australia's marine "outback" (Fig. 1). Starting in the 1860s, pearl shell, trochus, and bêche-de-mer attracted Europeans and others to the islands; in 1871, the London Missionary Society

1985 NGS Reports

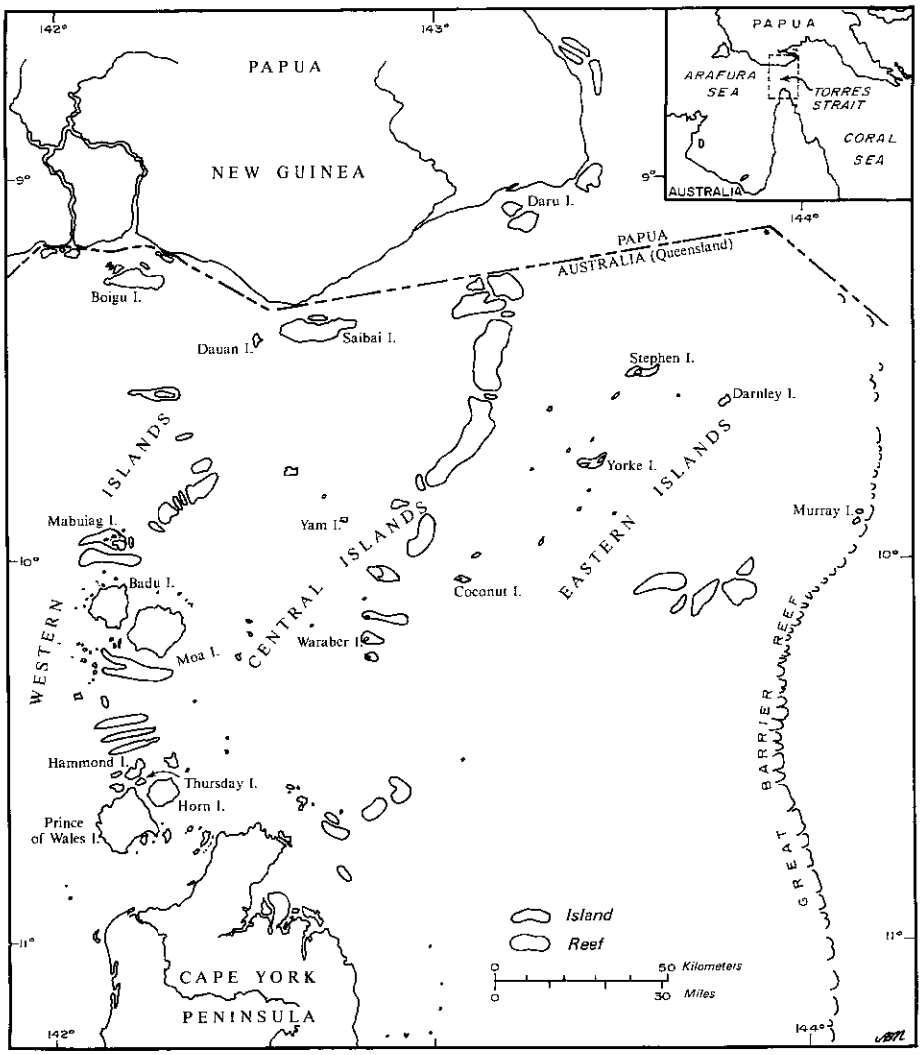

FIGURE 1. Torres Strait.

(LMS) began to Christianize the Islanders. The pearl shell beds became depleted, the LMS turned their missions over to the Anglican Church, most of the outsiders left what was turning into an economic backwater, and those who did not were excluded from residence when most of the islands were made reserves.

Australia's only indigenous Melanesian people live in Torres Strait. Overall, the Islanders share a distinct way of life with some linguistic and cultural variation among Eastern, Central, and Western Island groups.

Most of the island communities are politically and economically distinct from mainland Australia. Of the 17 inhabited islands, 14 are restricted reserves with a total resident population of about 2500 Torres Strait Islanders; the remaining three are "open," nonreserve islands, including tiny Thursday Island, the region's only commercial and administrative center, where live some 2000 Islanders and 1000 other people of multiethnic backgrounds. Queensland's Department of Aboriginal and Islander Advancement (DAIA) helps administer the reserve islands in cooperation with elected representatives from each community. Many of the Islanders receive social benefit payments from Queensland and commonwealth agencies with which they purchase some goods and foods from the small, state-supplied and -operated stores located on each island.

Reserve Islanders interact with the outside world through a one-way fence. They can travel between islands and to the mainland, but outsiders cannot visit the reserves without special permission from the elected island councils that administer community affairs, strictly limiting and controlling the intrusion of non-Islanders. To a large extent this has helped preserve a society and culture run by Islanders in their own way and with their own traditions.

Living on politically autonomous islands in the midst of extensive reefs, seagrass beds, and large numbers of dugongs and green turtles, and with most basic necessities taken care of through receipt of state and commonwealth benefits and occasional remittances from relatives who have emigrated to the mainland, the remaining Torres Strait Islanders have been able to maintain much of their traditional hunting way of life.

Research Objectives

The primary purpose of the research was to describe and analyze the pattern of relationships between a portion of the biotic and physical environment and culture and social organization; that is, between dugong and green turtle behavior and ecology and the marine environment, and Torres Strait Islander culture and society. The underlying approach and theory suggest that a fuller understanding of interactions of a human population, their culture, and their environment could be achieved by simultaneously considering each as part of a pattern that connects and reciprocally influences biological and cultural elements. Thus, to understand the behavior and ecology of a population of hunted animals, it is necessary to study the behavior and strategies of the hunters; so too,

investigation of cultural adaptation and social relationships within a community of hunters should logically extend to consideration of the natural history and spatial and temporal behavior of the animals hunted.

Within this general research theme the project had four principal interrelated objectives:

(1) To describe dugong and green turtle natural history, behavior, and ecology, and seagrass availability;

(2) To assess the effects of hunting on these animal populations and to measure hunting intensity and productivity;

(3) To study Islander perception and knowledge of dugong and green turtle natural history and ecology and associated environmental factors that influence animal movements and availability; and

(4) To analyze the significance of these animals, hunting, and knowledge of natural history to the culture and society of the Islanders.

Previous Research in Torres Strait

Very little research had been done on Torres Strait Islanders or on dugongs, green turtles, and seagrasses in the area. Biological research by others most relevant to our work include studies by Anderson and Heinsohn (1978), Barnett and Johns (1976), Bertram and Bertram (1973), Bustard (1971, 1972), Carr and Main (1973), Heinsohn (1972), Heinsohn and Birch (1972), Heinsohn and Marsh (1977), Heinsohn and Spain (1974), Heinsohn, Spain, and Anderson (1976), Hudson (1976), Husar (1975), Spain and Heinsohn (1975), and Wake (1975). Most of the research on dugongs in Australian waters focused on physiology, feeding habits, general life history, estimates of population numbers, and general conservation status. Green turtles received even less attention. Prior to our project, no long-term, on-site research had been done on seasonal and spatial changes in dugong and green turtle populations or on the consequences of subsistence hunting on these populations.

In 1898, A. C. Haddon led a research team to Torres Strait to do the first interdisciplinary study of a primitive people. Much of the research was conducted on Murray and Mabuiag Islands. The results were published in six volumes between 1901 and 1935. These books contain a wealth of early post-European contact descriptions of Islander culture, society, hunting techniques, and rituals. Surprisingly, other than a study of political organization, no in-depth cultural and social research had been done after Haddon's ground-breaking investigations and before our project. It must be pointed out, however, that there are helpful studies of Torres Strait Islanders by Beckett (1963, 1965, 1967, 1972, 1977), Duncan (1974), Harris (1977, 1979), Laade (1971), Lawrie (1970), and Walker (1972).

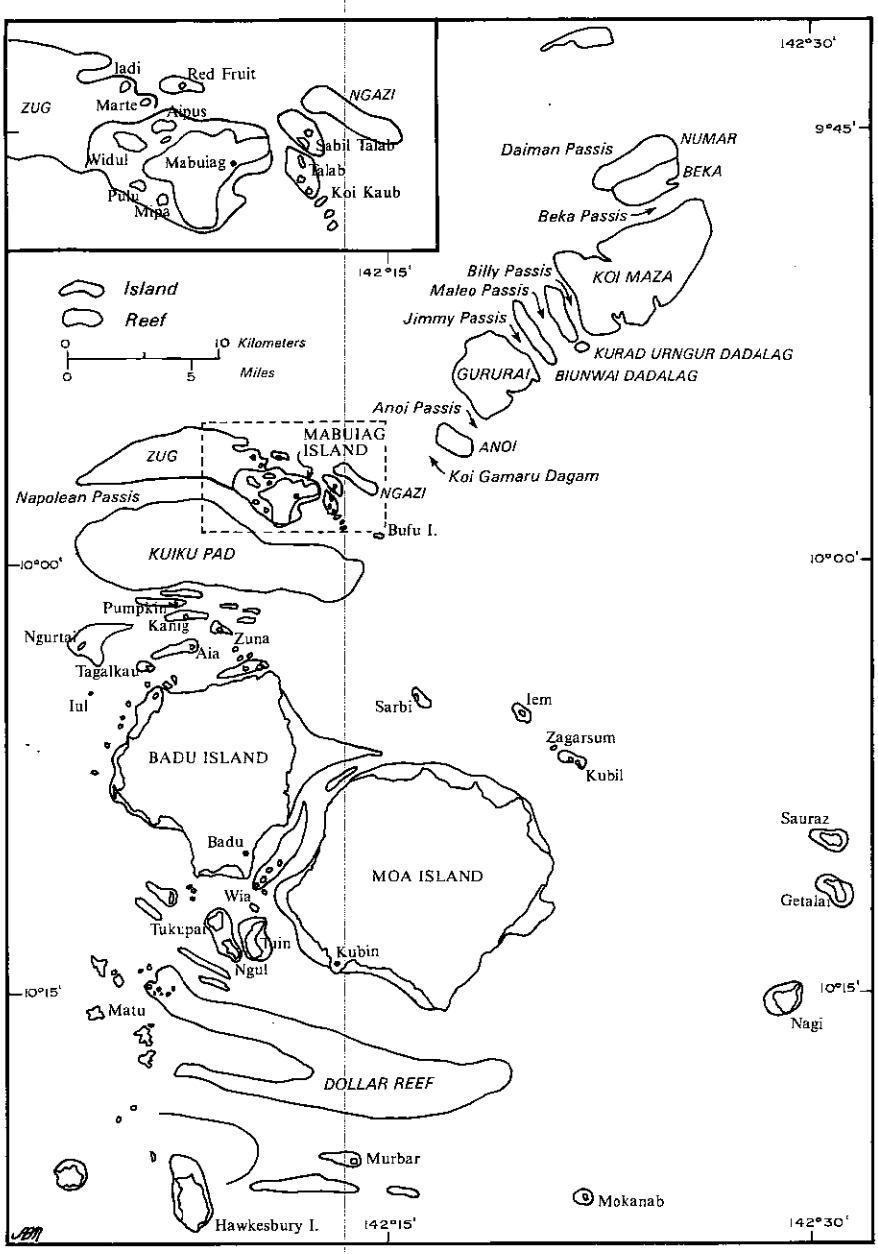

FIGURE 2. Study area.

FIGURE 3. A "Dinghy Blessing" for our inflatable and motor. Canon Amber of Mabuiag Island (Anglican Church) gives the blessing—standard operating procedure for a new dinghy and motor in Torres Strait, without which no Islander would accompany us. After the blessing, a feast is given for the entire community; this serves to socially distribute the good fortune of the individual who can afford such expensive purchases. In our case, the $200 feast was an unexpected deduction from the NGS-supported research budget. (Photograph by Judith Nietschmann.)

Research Methods

In July 1976, my wife Judith (co-investigator), our son, and I went to Torres Strait to spend a year living on a small reserve island. We selected Mabuiag Island and were granted permission by the Islanders to do our proposed research. In this we were fortunate because Haddon's 1898 Cambridge Expedition research centered on this same island and we were able to work with the descendants of his informants, and because Mabuiag was well known in the region for its hunters and large adjacent reefs. Mabuiag is a small, rugged island, 3 × 5 km in size, and has a population of some 125 people who live in 22 households. We made frequent trips to distant reefs, uninhabited small islands, and Islander communities on Badu and Moa Islands (Fig. 2).

Judith did most of the research on social and economic relationships

FIGURE 4. We traveled some 5000 mi (8045 km) in these two dinghies. The inflatable permitted quiet drifting for observations of feeding grounds and was convenient for scuba diving; the aluminum dinghy was faster and more seaworthy in rough weather. Styrofoam cases protected camera gear from spray, rain, sun, and wave shock. From left to right: Repu Sakawai, Barney Nietschmann, Jr., and Judith Nietschmann.

among the Islanders, while I worked with the hunters. Together with our son we made above-water and underwater observations of dugongs and green turtles. What to others might appear to have been esoteric research was to the Islanders a central part of their lives and thus they took it upon themselves to instruct us in kinship reckoning, social responsibilities, and hunting and environmental knowledge. To an Islander, one does not learn from observation alone, but through participating in "Island Custom" (Fig. 3).

Research methods included formal and informal discussions with hunters (interviews and questionnaires); observations made during some 50 hunts and butcherings; recording and measurement of the species, sex, size, quality, catch site, time spent, and distance traveled for each animal taken by hunters on three islands (Mabuiag, Moa, Badu); mapping of island and reef environments and distribution of seagrasses; collection of Islander natural history knowledge; several hundred hours of observation of dugong and green turtle behavior (from bamboo obser-

vation platforms, boats, and underwater with scuba equipment); collection of in situ and stomach content samples of seagrasses; two aerial surveys to count populations; small-scale tagging experiments with dugongs and green turtles; photographic recording (8000 frames) of hunting, of dugong and green turtle behavior, and of seagrasses and seasonal changes in environmental conditions; participant observation in kinship networks and distribution and receipt of meat from hunts (amounts measured and estimated); and collection of relevant historical materials from major libraries in Australia (University of Queensland, Australian National University, University of Sydney, the Mitchell Library, and the National Library).

Special equipment included two small boats (Fig. 4), two 25-hp outboards, air compressor and scuba equipment, 300 lb of camera gear, hydrophone and tape recorder, and observation platforms (which we constructed) over reef feeding grounds (Fig. 5).

After our departure, records of hunting returns were kept by an Islander in each of three communities (Mabuiag, Kubin, Badu), which greatly expanded the data range beyond our year-long collection period.

Research Results

The research project yielded a large quantity of biological and cultural information and many promising leads for further investigation. I present only a sketch here, since research results have been and will be published in detail elsewhere (B. Nietschmann, 1976, 1977a, 1977b, 1982, 1983, in press; J. Nietschmann, 1979, 1980, 1981; Nietschmann and Nietschmann, 1977, 1981).

Dugongs, Green Turtles, and Seagrasses

The dugong *(Dugong dugon)* and the green turtle *(Chelonia mydas)* are the world's only exclusively marine mammal and reptile which are herbivorous. These animals are unique in the sea because they convert the primary production of seagrasses and some algae into high-quality and good-tasting protein. Green turtles use more marine habitats, have greater dietary diversity, and tolerate rougher sea conditions than do dugongs, which prefer sheltered inshore and reef waters, largely consume only seagrasses, and move to leeside locations during rough weather. The green turtle's greater habitat and dietary range reduce its resource competition with the dugong.

Torres Strait is one of the world's most important remaining areas where can be found large, co-resident populations of dugongs and green turtles. These animals are abundant in the waters surrounding Mabuiag, Moa, and Badu Islands—the area we studied. Both these animals exert

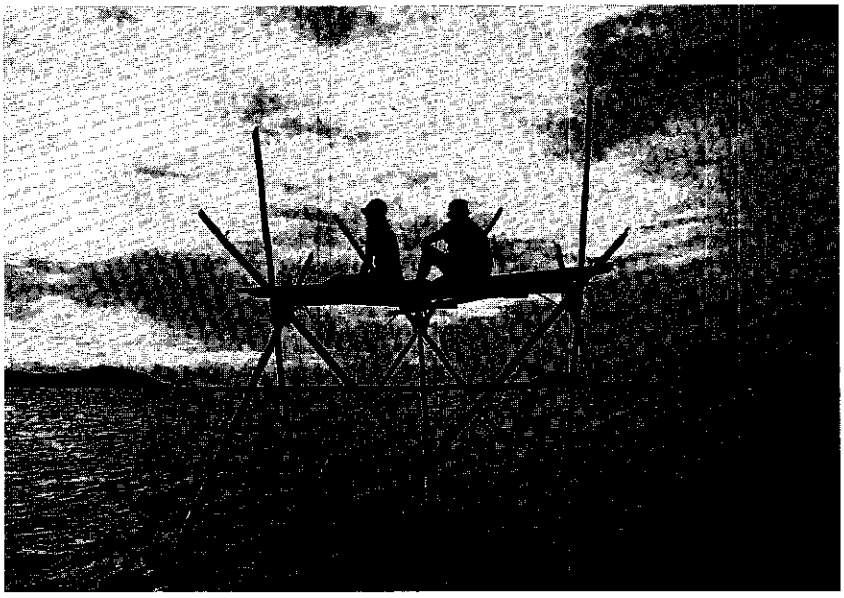

FIGURE 5. A bamboo platform that we built on a seagrass reef-flat to observe dugongs. The structure is modeled after the hunting platforms *(nat)* that were once used for night harpooning. (Photograph by Barney Nietschmann, Jr.)

considerable grazing pressure on seagrass beds, and some green turtles eat large amounts of algae. Estimates of daily grazing consumption are 40 to 50 kg for an adult dugong and 5 to 8 kg for a large green turtle. Dugongs taken by hunters averaged 212.7 cm in length and 254.8 kg in weight; green turtles averaged 94.9 cm in carapace length and 131.1 kg in weight (Table 1). Dugongs yield approximately 35% of body weight in usable meat and fat, and green turtles provide about 50%.

These animals are difficult to study in Torres Strait because they are often hard to see in the frequently turbid and rough water, they are on the surface for very brief breathing periods (Fig. 6), and they have been hunted for so long that they readily flee from any unusual disturbance. We were able to reduce search time in looking for these animals by following environmental cues taught to us by the hunters (tidal movements, currents, winds, and so on), and by seeking the densest stands of seagrasses and then waiting for the animals.

Seagrasses, and thus dugongs and green turtles, are more abundant in the Western Island region than elsewhere in Torres Strait, because of shallower waters and extensive reefs and protected island-fringing reefs

TABLE 1. Sizes (cm) and Weights (kg) of a Sample of Dugongs and Green Turtles Taken by Mabuiag Island Hunters, 1976-1977

	Green Turtles (♂ 10, ♀ 44, N=54)			
	Mean	*Min.*	*Max.*	*Range*
Carapace length (cm)	94.9	72.0	114.0	42.0
Carapace width (cm)	73.1	57.5	87.0	29.5
Plastron length (cm)	76.2	61.0	87.0	26.0
Head width (cm)	11.8	9.5	13.0	3.5
Weight (kg)	131.1	52.2	205.0	152.8

	Dugongs (♂ 29, ♀ 11, N=40)			
	Mean	*Min.*	*Max.*	*Range*
Fluke width (cm)	68.6	51.0	88.0	37.0
Basal fluke girth (cm)	43.8	30.0	55.0	25.0
Maximum girth (cm)	148.5	112.0	178.0	66.0
Flipper length (cm)	35.7	27.0	46.0	19.0
Flipper width (cm)	15.4	12.0	18.0	6.0
Body length (cm)	212.7	174.0	256.5	82.5
Weight (kg)	254.8	159.0	351.0	192.0

and flats. Except for two species of *Halophila* (found in sheltered intertidal areas alongside fringing mangrove mud and silt flats), seagrasses do not occur in dense, single-species stands. Seagrass densities, distribution, and species composition vary depending on depth, exposure, type of bottom, and grazing selectivity. Seasonal variations in water turbidity, tidal range, and dominant wind direction also influence seagrass abundance and accessibility. Seagrass densities are generally low throughout the western Torres Strait due to environmental factors and grazing pressure. Thus, any one particular reef cannot support long-term grazing by sizable herds of dugongs and green turtles (Fig. 7). Due in part to environmental flux and ecological changes in seagrass, and, to a lesser extent, to algae availability, dugongs and green turtles exhibit frequent and wide-ranging patterns of local movement among dispersed feeding areas.

As determined from the analysis of a limited number of stomach samples and from underwater observations, dugongs are more discriminate seagrass grazers than green turtles, and also consume smaller quantities of algae (Table 2). Islanders claim that the more esteemed, fat dugongs and turtles feed on seagrasses *(damu)*, and that animals with less and poorer fat eat more algae *(pagar)*. This contention was generally confirmed by stomach content analysis and observations made during

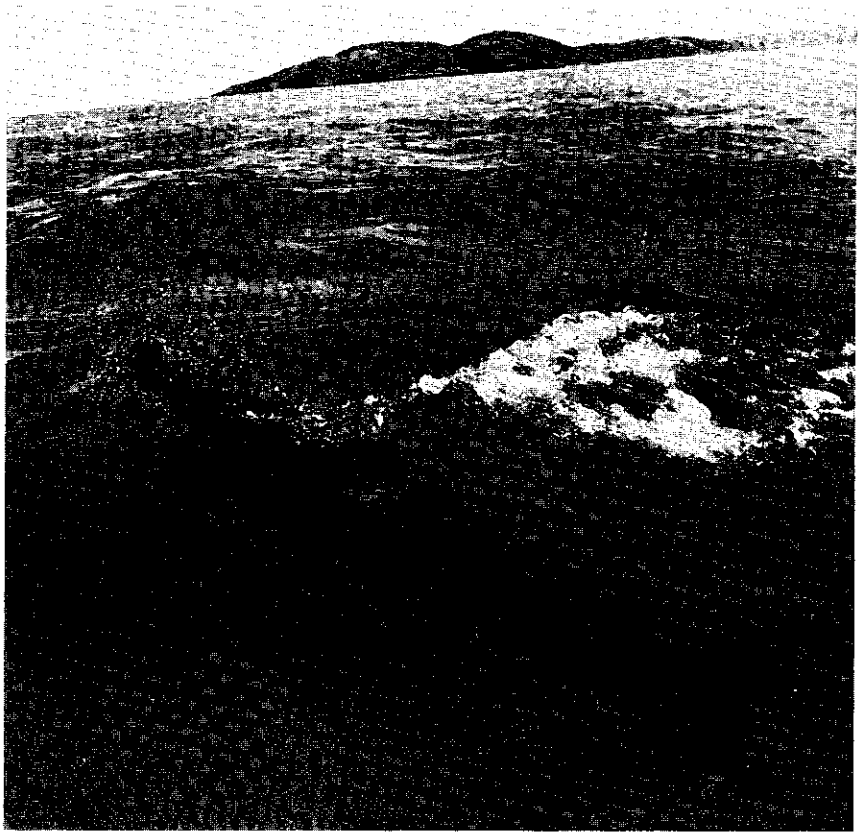

FIGURE 6. A dugong surfacing for air. Diving times average 1½ to 2 min and range to an infrequent 9 min depending on activity and sea conditions. Dugongs only remain on the surface for a few seconds before diving again. To harpoon a dugong, hunters must accurately estimate breathing-diving intervals and current and dinghy drift speed in order to position the bow of the craft directly behind an ascending dugong.

butcherings. It appears that high grazing pressure from large herbivore populations on low-density seagrass beds may have resulted in differences in feeding behavior, animal condition, and fat abundance, and in the overgrazing of some areas. Several large pastures have been stripped of grass, primarily by dugongs. Overgrazed seagrass beds are especially noticeable around Hammond, Moa, Badu, and Mabuiag Islands. On all these islands people complain that the decrease in seagrasses has led to a parallel reduction in some species of fish.

TABLE 2. Seagrass Species and Percentages in Dugong Stomach Contents, Mabuiag Island, March-June, 1977

	Estimated percentages of seagrasses as portion of total leaf material (certain percentage not identifiable)															
Dugong number	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
Seagrass																
Thalassia hemprichii	50	20	30	40		60	45	50	50	30	35	45	60	25	50	40
Cymodocea sp.		5		5								5				
Halodule pirifolia		20														
Thallasodendron ciliatum					5	5			5	5	5	5		25		5
Enhalus acroides	30		60	35	60	10	25	40	30	40	35	20	10	20	15	40
Halophila sp.		40			10	5	5			10	5		10	20	15	5
Zostera sp.																

Identification and analysis done by Miss Judy Hart, Botany Department, James Cook University, Townsville, Queensland.

FIGURE 7. Dugong feeding trails *(nura)* on an exposed bed of *Halophila* seagrass. Each serpentine trail represents one continuous feeding dive. Daily tidal range can be as much as 3.5 m so that large shallow reefs are alternatingly opened and closed to grazing activity. During low tides hunters search for areas with fresh feeding trails to which the dugongs will return on the rising tide.

Stomach content analysis of 6 green turtles gave estimated percentages of 90 to 100% algae, 5 to 10% seagrass; but 16 dugong samples had estimated percentages of 90 to 100% seagrass, 10%, or less, algae. Based on this very small sample of dugong stomach contents, seagrass consumption by percentage rank is *Thalassia hemprichii* (47.7%), *Enhalus acroides* (35.6%), *Halophila* sp. (9.5%), *Thallasodendron ciliatum* (4.6%), *Halodule pirifolia* (1.5%), *Cymodocea* sp. (1.1%), and *Zostera* sp. (0.0%).

The Islanders distinguish between two general types of dugongs and green turtles, based on their behavior and appearance, and on the nature and condition of their fat. These differences were also apparent from our observations.

What the Islanders call *gatau waru* (bad, dry reef turtle) appear to be old green turtles, primarily algae-grazers, and semiresident on particular reefs (marker-tagged *gatau waru* confirmed site fidelity). They are slow and sluggish swimmers, easy to approach, do not move around much, and are frequently stranded on home reefs during low tides (Fig. 8). Although green turtles in the Pacific have been observed to haul out on a beach to "bask," *gatau waru* strandings are very different. Only old males

FIGURE 8. Stranded green turtles *(gatau waru)* on a Mabuiag fringe reef. This 17,500-m^2 reef was the home feeding ground for 30 to 40 *gatau waru*. Marine algae provided the bulk of these turtles' diet. *Gatau waru* are not exploited by Islanders except for an occasional kill to feed pigs.

and females are stranded. Their carapaces are heavily silted and barnacled and their plastrons are depressed. They are rarely seen in deep water; they have never been seen mating, nor have any eggs been found in butchered females (killed only for pig feed). Their fat is thin and tar-black in color. They weigh about 20% less than *kapu waru* (Table 3).

Kapu waru (good, reef, and open-water turtle) are fast and agile swimmers, wary and skittish, and difficult to catch; they have clean carapaces, filled-out plastrons, and are heavy; they feed more on seagrasses than on algae; move around a great deal from reef to reef, do not stay long on particular reefs, and are never stranded; they copulate during the mating season; butchered females are often gravid; and they have abundant green fat and savory meat.

The differences between these two types of turtles may be due to age, competition over scarce resources (seagrasses), or, perhaps, disease or parasites.

TABLE 3. Comparison of Sizes (cm) and Weights (kg) of *Gatau Waru* (Bad, Dry Reef Turtle) and *Kapu Waru* (Good, Open-Water, and Reef Turtle). Mabuiag Island Area, 1976-1977

	Gatau waru (♂ 32, ♀ 41, N=73)			
	Mean	*Min.*	*Max.*	*Range*
Carapace length (cm)	99.1	86.0	112.0	26.0
Carapace width (cm)	73.0	61.0	84.0	23.0
Plastron length (cm)	76.6	65.0	85.0	20.0
Head width (cm)	12.4	11.25	14.25	3.0
Weight (kg)	105.7	79.4	147.4	68.0

	Kapu waru (♂ 10, ♀ 44, N=54)			
	Mean	*Min.*	*Max.*	*Range*
Carapace length (cm)	94.9	72.0	114.0	42.0
Carapace width (cm)	73.1	57.5	87.0	29.5
Plastron length (cm)	76.2	61.0	87.0	26.0
Head width (cm)	11.8	9.5	13.0	3.5
Weight (kg)	131.1	52.2	205.0	152.8

In other areas of the world, the green turtle *Chelonia mydas* has been hunted so intensively and for so long that older turtles are rarely found, and have not been described in the literature. I believe that the *gatau waru* are old turtles, past breeding age.

Islanders distinguish *wati dangal* (bad, island dugong) from *malu dangal* (good, sea dugong). A *wati dangal* has thin, bad-tasting fat, and thin body shape; it frequents shallow, leeside island margins, and is a less selective grazer, consuming a higher proportion of algae. Islanders consider a *wati dangal*, like a *gatau waru*, to be inedible. *Malu dangal* have very different characteristics: thick and good-tasting fat, fuller, more rounded bodies; they are usually found on distant reefs and primarily consume seagrasses; and they are more difficult to catch. Differences between *wati* and *malu* dugong do not coincide with age or size but may result from competition over and adaptation to different food sources: seagrasses and algae. Dugongs have switched from their normal seagrass diet to algae because of environmental pressures. For example, Heinsohn and Spain (1974) found that with the destruction of near-shore seagrass beds off Townsville by the 1971 cyclone Althea, dugongs switched to feeding on brown algae, which have a faster recovery rate in disturbed areas than do seagrasses.

Along with the density and distribution of seagrasses, tides and general sea conditions are important environmental influences on the temporal and spatial occurrence of dugongs and green turtles. Many of the

reef and island-margin feeding grounds are so shallow that they are dry during low tide. The animals move to near-shore and shallow reef areas to feed during high tides and then move during low tides to resting and feeding grounds in deeper water. Complicating this general pattern of high-low tide movement is a wide range of complex tidal conditions (Nietschmann, 1977b). Tidal changes in Torres Strait are among the most varied in the world. The area experiences two dominant weather patterns that affect tidal conditions and dugong and green turtle movements. During the southeast trade-wind season (May through September), gusting and strong winds and low tides during the day force the animals from the large and shallow windward reefs; they move to lee-side reefs and island margins during the nighttime high tides. The northwest monsoon season (December through April) reverses the pattern: High tides occur during daylight hours, and there is a 180° shift between windward and leeward. Variations in tides and currents, wind direction, seagrass abundance, and sea conditions make up a kaleidoscope of environmental patterns that influence and determine dugong and green turtle movement, distribution, and herd size.

Dugongs are social animals, and group composition does not fluctuate as much as with green turtles. Yet, depending on environmental and ecological conditions, dugong herd size and composition do change. During the southeast trade-wind season, dugongs were commonly seen feeding and moving alone or in pairs during the day, but at night they formed small groups of 5 to 10 animals. In the northwest trade-wind season, larger groups of dugongs (10 to 30) gathered in the lee of reefs and islands during the day and spread out during nighttime low tides.

We made the first underwater recordings of dugong vocalizations in the wild (1 to 8 kHz). Most of the sounds were emitted when the animals first discovered our presence. These may be distress sounds and a signal for quick departure. Other distinct chirping sounds were heard and taped. Dugong vocalizations seemed to be important in social behavior between individual animals and in herd dynamics, especially during turbid water periods.

Estimates of dugong and green turtle populations proved far too problematical to be worthwhile at this stage of research. Aerial surveys produced counts that conflicted with surveys done the day before from hilltops and from boats. Based on year-after-year high hunting returns, the presence of overgrazed seagrass beds, and unanimous responses by Islanders, dugong and green turtle population numbers are high in the Torres Strait. Recruitment and migration from dugong and green turtle populations off southern Papua New Guinea and northern Queensland may maintain high local densities and balance losses from hunting and natural mortality.

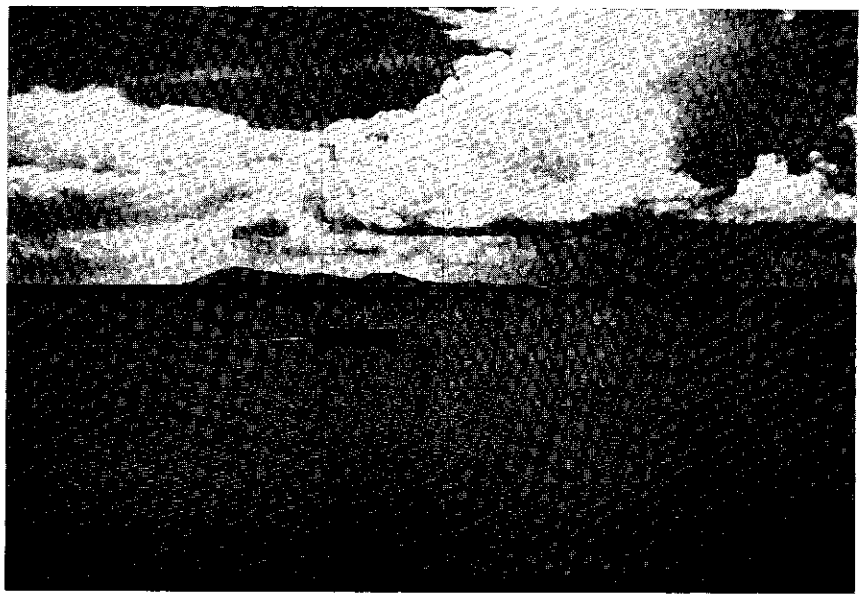

FIGURE 9. Harpooning a dugong off Mabuiag Island. In order to pierce the animal's inch-thick skin and to hit the backbone area accurately, hunters jump with their 4.5-m-long harpoons. One of the crew will quickly help the hunter get back in before the harpoon line uncoils to the end and the dinghy is rapidly pulled away. The harpooned dugong will soon tire from swimming against the water drag of the dinghy and 70 fathoms of ½-in. nylon line.

CULTURAL AND SOCIAL CONTEXT OF HUNTING

Hunting is more than simply a means of getting meat to eat (Fig. 9). In the Torres Strait, marine hunting is the major activity of many males. It provides the majority of protein to households, it sets the context in which much cultural history and environmental knowledge are taught and reviewed, it is the source of the most favored item distributed among kin to satisfy social obligations, and it is based on a complex body of theory, logic, and technique that ensure high returns that reinforce traditional knowledge. Hunting is not a haphazard, catch-as-catch-can affair. Decisions of exactly when and where to go, which specific animal to try for, how to butcher it, and to whom to distribute the meat all follow a coherent, systematic pattern.

Torres Strait hunters share a body of knowledge that is detailed, complex, exacting, and productive. Islanders classify dugongs and green turtles by age, sex, location, type, size, and quality of fat and meat as named in the following list.

DUGONG *(Dangal)*

Age, Sex, Social Grouping	
garka dangal	male dugong
ipika dangal	female dugong
kazi dangal	young dugong
ngawaka dangal	adolescent female
kaukuik dangal	adolescent male
barakutau garka	adolescent male that stays with mother
sabi gudad	single male
puru dangalal	mating dugongs
kazilaig	pregnant dugong
nanaig	nursing mother
gilab	big, old dugong
tuarlaig	herd "leader"
ulakal	5 to 10 herd size
dangalal buai	"family" herd size, 10 or more

Location	
malu dangal	far reef, sea dugong
wati dangal	shallow water, island dugong

Type	
ubar dangal	black dugong
kaiad-gamul dangal	red-brown dugong
miakal dangal	white (albino) dugong, rare
kapu dangal	common, good dugong
wati dangal	bad dugong

Size	
gilab	a really big dugong
koi dangal	big dugong
nurai dangal	medium-sized dugong
mugi dangal	small dugong

Quality	
mina tupaial dangal	very fat
tupaial dangal	fat
tupigai dangal	"half-and-half," just edible
wati dangal	lean, bad fat, inedible

GREEN TURTLE *(Waru)*

Age and Sex	
garka waru	male green turtle
ipika waru	female green turtle
kazi waru	hatchling
sulal waru	mating turtles
gatau waru	old, dry reef turtle

Location	
kapu waru	open water and reef turtle
gatau waru	dry reef turtle
Type	
taupai kaubalnga	short-tailed male
naipie	long-tailed male
kapu waru	usually female
gatau waru	"bad" turtle, male or female
Size	
waiatan baba-sigmai waru	a really big turtle
koi waru	big
nurai	medium
mugi waru	small
Quality	
mina kapu waru	very fat
kapu waru	fat
gatau waru	lean, bad fat, inedible

Combinations of perceived characteristics exponentially expand the range of categories listed. The ability to recognize and predict tide and sea conditions involves determination of tidal cycle, moon phase, wind direction, island or reef exposure, and time of season. I was taught to distinguish some 50 different tide and sea conditions, and although this is but the basic repertoire of a novice hunter it goes well beyond textbook descriptions. A few examples should give an appreciation of the complexity of the Islanders' perception: *kukiau gi iabagar* is a northwest monsoon season daytime high tide; *mugi batainga ura,* an early morning strong clear-water west-to-east tide; *kadigat,* a long clear-water slack tide between two neap tides; and *kutau usalai,* a dirty-water afternoon west-to-east tide that occurs two to three days after new or full moons during the southeast trade-wind season. Large and small underwater features are all named. Reefs, passages, channels, sandbanks, feeding grounds, shallow- and deep-water places, coral heads, and various zones on reefs have both generic and specific names, many of which are important places in legends and myths.

Legends are the mnemonic means to recall mental maps and calendars which, in turn, determine the location and timing of hunting activity. Thus cultural history is intimately tied to natural history. For the Islanders, history has a spatial context and the present has an elaborate temporal dimension.

Dugongs and green turtles are extremely wary and elusive, yet the Islanders' skill is such that hunting is reliable and productive. Long-term

TABLE 4. Recorded Hunting Returns of Green Turtles and Dugongs for Mabuiag, Moa (Kubin Village), and Badu Islands, 1976-1979

		Mabuiag						*Kubin*						*Badu*						*Total*	
		Turtles			*Dugongs*			*Turtles*			*Dugongs*			*Turtles*			*Dugongs*			*Turtles*	*Dugongs*
		♂	♀	*Total*	♂	♀	*Total*	♂	♀	*Total*	♂	♀	*Total*	♂	♀	*Total*	♂	♀	*Total*		
1976	September	0	12	12	5	4	9													12	9
	October	1	13	14	2	9	11													14	11
	November	0	13	13	4	0	4							1	26	27	3	5	8	40	12
	December	1	9	10	9	5	14							0	21	21	4	14	18	31	32
1977	January	0	16	16	10	2	12	0	10	10	4	2	6	0	12	12	6	3	9	38	27
	February	1	4	5	4	2	6	0	17	17	3	0	3	0	18	18	9	7	16	40	25
	March	0	9	9	4	3	7	0	5	5	3	1	4	1	10	11	8	9	17	25	28
	April	6	10	16	2	0	2	0	17	17	1	1	2	2	21	23	4	1	5	56	9
	May	1	8	9	7	5	12	1	9	10	2	2	4	0	28	28	3	1	4	47	20
	June	0	10	10	11	2	13	1	11	12	2	1	3	0	19	19	6	3	9	41	25
	July	0	8	8	5	6	11	0	9	9	2	1	3	0	12	12	5	7	12	29	26
	August	0	9	9	5	3	8	0	6	6	3	1	4	0	15	15	5	4	9	30	21
	September	0	11	11	6	7	13	0	27	27	2	7	9	0	15	15	8	6	14	53	36
	October	0	14	14	2	3	5	0	20	20	0	5	5	0	16	16	6	5	11	50	21
	November	0	19	19	2	5	7	0	12	12	0	3	3	0	19	19	3	3	6	50	16
	December	0	16	16	4	3	7	0	20	20	0	4	4	0	20	20	5	4	9	56	20
1978	January	0	20	20	3	2	5							0	18	18	4	2	6	38	11
	February	0	13	13	9	9	18							0	15	15	7	6	13	28	31
	March	0	9	9	4	6	10							0	10	10	6	8	14	19	24
	April	0	15	15	6	7	13							0	13	13	3	2	5	28	18
	May	0	13	13	5	8	13							0	27	27	5	2	7	40	20
	June	0	14	14	9	9	18							0	26	26	6	1	7	40	25
	July	0	16	16	5	2	7							3	16	19	1	4	5	35	12
	August	0	19	19	2	0	2							1	19	20	1	1	2	39	4
	September													0	13	13	4	2	6	13	6
	October													0	21	21	0	0	0	21	0
	November													0	26	26	2	0	2	26	2
	December													0	16	16	3	1	4	16	4
1979	January													1	13	14	2	1	3	14	3
	February													0	14	14	1	2	3	14	3
	March													0	12	12	0	3	3	12	3
		10	300	310	125	102	227	2	163	165	22	28	50	9	511	520	120	107	227	995	504

hunting records for Mabuiag, Moa, and Badu Islands show that monthly catches vary considerably, but collectively they are high (Table 4). For every hunting trip there was a 75% chance of getting an animal. Dugongs are more sought-after but are more difficult to harpoon; consequently, turtles made up a greater percentage (66%) of the total recorded catch, and of these, 98% were females, since the Islanders prefer their fat.

Animals are hunted for subsistence and thus hunting pressure is predicated on kin obligations and community population size and is spread fairly evenly throughout the year. Influencing hunting frequency are social and economic factors such as money available to buy gasoline and oil, desire for fresh meat, and the number and scheduling of feasts. Environmental flux also limits and encourages hunting activities.

Intervals between catches generally were no more than 2 to 3 days, although extreme weather periods often precluded hunting for a week or more. Butcherings are frequent and represent an important social activity. The manner and method used to cut up an animal follow traditional butchering patterns and social exchanges (Fig. 10).

During 1977, hunters from the three islands caught a total of 515 green turtles (almost all females) and 274 dugongs (152 males, 122 females). Amounts of meat obtained for this period averaged 0.31 kg (0.68 lb) per person per day for the combined three-community population. Additional meat from fishing and reef foraging increased the daily average to 0.35 kg (0.77 lb). Individual community meat returns varied from this composite average due to differences in location and availability of gasoline and working outboard motors (Table 5).

More dugongs and turtles are being taken for subsistence than have been previously reported. For example, in 1973, Bertram and Bertram noted that 24 dugongs were taken annually at Mabuiag. Estimates and recorded totals for 1976-1978 suggest that the annual Mabuiag catch is 100. Other underestimates are common. Increased catches could be the result of three possible factors: more hunters, more dugongs and turtles, or previous estimates that were too conservative. A very rough estimate of the average annual catch in Torres Strait is 2100 green turtles and 750 dugongs.

It costs money to hunt, yet meat is given to people free. Outboard motors and aluminum dinghies cost $1500 to $2500 and gasoline is $2.75 per gallon. The hunter and his household incur all these expenses. In what is a heavily monetized economy meat is given away freely and equally as it always has been. Continuation of traditional, socially based meat distribution reduces modern economic disequilibrium among households, maintains social solidarity, and ensures a more than adequate receipt of protein (Fig. 11). The receipt of meat is a social transaction, dependent upon kinship ties and independent of cash wealth.

FIGURE 10. In butchering a dugong a traditional pattern of cutting lines is followed to aid in systematic dismemberment into particular cuts, each of which has a species-specific name and is preference-classed for distribution to hunters, butchers, and kin. Dugongs are butchered into 45 meat and organ categories; green turtles into 30.

TABLE 5. Number of Dugongs and Green Turtles Taken in 1977 by Island Community, per Capita, and for Time and Distance

	Mabuiag (pop. 125)	*Kubin (Moa Is.) (pop. 65)*	*Badu (pop. 325)*
Hunting catch			
green turtles	142	165	208
dugongs	103	50	121
Per capita catch			
green turtles	1.13	2.54	.64
dugongs	.82	.77	.37
green turtles and dugongs	1.95	3.31	1.01

	Mean round-trip distance (km) traveled to catch animal			*Mean time spent (hr) to catch animal*	
	Dugong	*Green Turtle*		*Dugong*	*Green Turtle*
Male	18.6	17.5	Male	3:08	:57
Female	16.2	23.0	Female	3:41	2:03
Mean	17.4	22.9	Mean	3:20	1:56

Economic dependency and continuation of traditional social customs are not a contradiction in terms in Torres Strait Islander society.

Why has hunting persisted in the face of high operating expenses, access to imported foods and materials, and the availability of social benefit payments from state and commonwealth governments? Hunting continues to be an important cultural activity that preserves a way of life and a body of knowledge that gives meaning to livelihood and existence. To be a hunter is a cultural and perceptual affirmation of being an Islander. The persistence of hunting in the Torres Strait represents an extraordinary situation that involves isolation and acculturation, natural and cultural history, legislation and economics, and a remarkable adaptation by a seafaring people to the world's only two species of large marine herbivores.

Acknowledgments

Research was supported by National Geographic Society Grant 1626, in 1976, and by a visiting appointment as Senior Research Fellow in the Department of Human Geography, Research School of Pacific Studies, Australian National University (ANU), Canberra. Among the many people in this department who aided us, R. Gerard Ward, Diana Howlett, Elizabeth Lawrence, Shirley Halton, and Ken Lockwood provided tremendous help. Skip Rhodes and Alan McDonell of the Department of

FIGURE 11. Meat distribution is a social consequence of a hunt. Members of the hunting crew receive special cuts, as do the men who help butcher. A novice hunter is trained by his maternal uncle *(audi)*, and when he becomes a harpooner he will continue to honor that training by inviting his *audi* to help butcher. After the obligatory pieces are given out, the balance is distributed equally by type of cut into containers brought from specified households. Here, meat from two dugongs is sufficient for distribution to all 22 Mabuiag Island households.

Biogeography and Geomorphology at ANU lent us field equipment and provided sage advice. In Torres Strait, John Buchanan and Tom Bartlett of the DAIA helped arrange transport to the outer islands and channeled mail and supplies to us during the research period. Flo Kennedy always had a place for us on Thursday Island and kept us well fed on good food and island stories. Island Chairmen kindly provided accommodation and assistance: Naseli Nona, Mabuiag Island; Joey Nona, Badu Island; Wees Nawia, Kubin Village, Moa Island; and Tanu Nona and Getano Lui. Many Islanders helped us with our research, especially Repu Sakawai, James Eseli, Freddie Savage, Gib Gaulai, Kami Paipai, Young Bani, and Elliot Whop. Seagrass samples were analyzed in the Botany Department, James Cook University, Townsville, Queensland. A faculty grant from the University of California, Berkeley, funded assistance for computer analysis of the field data. I thank all these individuals, departments, and institutions.

REFERENCES

ANDERSON, PAUL K., and HEINSOHN, GEORGE E.
1978. The status of the dugong, and dugong hunting in Australian waters: A survey of local perceptions. Biological Conservation, vol. 13, pp. 13-26.

BARNETT, C., and JOHNS, D.
1976. Underwater observations of dugong in northern Queensland, Australia, with notes on dugong hunting and recommendations for future research. Advisory Committee on Marine Resources Research, Scientific Consultation on Marine Mammals. Paper 106, Mammals in the Seas Conference, Bergen, Norway.

BECKETT, JEREMY
1963. Politics in the Torres Strait Islands. Unpublished Ph.D. dissertation (Anthropology), Australian National University, Canberra.
1965. Australia's Melanesian minority: Political development in the Torres Strait Islands. Human Organization, vol. 5, pp. 152-158.
1967. Elections in a small Melanesian community. Ethnology, vol. 6, no. 3, pp. 332-344.
1972. The Torres Strait Islanders. Pp. 307-326 *in* "Bridge and Barrier: The Natural and Cultural History of Torres Strait," D. Walker, ed. ANU Press, Canberra.
1977. The Torres Strait Islanders and the pearling industry: A case of internal colonialism. Aboriginal History, vol. 1, no. 1, pp. 77-104.

BERTRAM, G.D.F., and BERTRAM, C.K.R.
1973. The modern Sirenia: Their distribution and status. Biol. Journ. Linnean Soc., vol. 5, pp. 297-338.

BUSTARD , ROBERT
1971. Marine turtles in Queensland, Australia. Marine Turtles, Proceedings of the 2nd Working Meeting of Marine Turtle Specialists, International Union for Conservation of Nature and Natural Resources, Supplementary Paper, no. 31, pp. 23-38.
1972. Sea turtles: Their natural history and conservation, 220 pp. Taplinger Publishing Company, New York.

CARR, A. F., and MAIN, A. R.
1973. Turtle farming project in Northern Australia: Report of an inquiry into ecological implications, 80 pp. Commonwealth of Australia, Canberra.

DUNCAN, HELEN
1974. Socio-economic conditions in the Torres Strait: A survey of four reserve islands. *In* "The Torres Strait Islanders, vol. I," 88 pp. E. K. Fisk, ed. Department of Economics, Australian National University, Canberra.

HADDON, A. C., ed.
1901-35. Reports of the Cambridge Anthropological Expedition to Torres Straits, vols. 1 (1935), 2 (1901-1903), 3 (1907), 4 (1912), 5 (1904), 6 (1908). Cambridge University Press, Cambridge.

HARRIS, DAVID R.
1977. Subsistence strategies across Torres Strait. Pp. 421-463 *in* "Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia and Australia," J. Allen, J. Golson, and R. Jones, eds. Academic Press, New York and London.
1979. Foragers and farmers in the Western Torres Strait Islands: An historical analysis of economic, demographic and spatial differentiation. Pp. 75-109 *in* "Social and Economic Systems," P. C. Burnham and R. F. Ellen, eds. Academic Press, London.

HEINSOHN, GEORGE E.
1972. A study of dugongs *(Dugong dugon)* in northern Queensland, Australia. Biological Conservation, vol. 4, no. 3, pp. 205-213.

HEINSOHN, GEORGE E., and BIRCH, W. R.
1972. Foods and feeding habits of the dugong *(Dugong dugon)* in northern Queensland, Australia. Mammalia, vol. 36, no. 2, pp. 414-422.

HEINSOHN, GEORGE E., and MARSH, HELENE
1977. Sirens of tropical Australia. Australian Nat. Hist., vol. 19, no. 4, pp. 106-111.

HEINSOHN, GEORGE E., and SPAIN, ALISTER V.
1974. Effects of a tropical cyclone on littoral and sub-littoral biotic communities and on a population of dugongs (*Dugong dugon* [Muller]). Biological Conservation, vol. 6, no. 2, pp. 143-152.

HEINSOHN, GEORGE E.; SPAIN, ALISTER V.; and ANDERSON, PAUL K.
1976. Populations of dugongs (Mammalia: Sirenia): Aerial survey over inshore waters of tropical Australia. Biological Conservation, vol. 9, pp. 21-23.

HUDSON, B.E.T.
1976. Dugongs: Distribution, hunting, protective legislation and cultural significance in Papua New Guinea. Advisory Committee on Marine Resources Research, Scientific Consultation on Marine Mammals, Paper 86, Mammals in the Seas Conference, Bergen, Norway.

HUSAR, SANDRA L.
1975. A review of the literature of the dugong *(Dugong dugon)*. U. S. Fish and Wildlife Res. Rep., no. 4, pp. 1-30.

LAADE, WOLFGANG
1971. Oral traditions and written documents on the history and ethnography of the northern Torres Strait Islands, Saibai-Dauan-Boigu, 125 pp. Franz Steiner Verlag, Wiesbaden.

LAWRIE, MARGARET
1970. Myths and legends of Torres Strait, 372 pp. University of Queensland Press, Brisbane.

NIETSCHMANN, BERNARD
1976. The ecology of marine herbivores, seagrasses, and Torres Strait Islanders, 16 pp. Preliminary Research Report, Department of Human Geography, Research School of Pacific Studies, Australian National University.
1977a. Torres Strait Islander hunters and environment, 17 pp. Work-in-progress Research Report, Department of Human Geography, Research School of Pacific Studies, Australian National University.

1977b. The wind caller. Nat. Hist., vol. 86, no. 3, pp. 10-16. (Reprinted in Reader's Digest, Canadian Edition, October, 1977.)

1982. Indigenous island peoples, living resources and protected areas. Paper presented at the 3rd World National Parks Congress, Bali, Indonesia, October 10-22.

1983. Traditional societies and biosphere reserves. Paper for the Man and Biosphere Program, First International Meeting, Minsk, Soviet Union.

——. Torres Strait Islander sea resource management and sea rights. Paper presented at the UNESCO Workshop on Traditional Management of Coastal Systems, Jakarta, Indonesia, December 5-9. UNESCO. (In press.)

NIETSCHMANN, BERNARD, and NIETSCHMANN, JUDITH

1977. Eight decades on an island: Social and ecological relationships in the Torres Strait, 33 pp. Final Research Report, Department of Human Geography, Research School of Pacific Studies, Australian National University.

1981. Good dugong, bad dugong; bad turtle, good turtle. Nat. Hist., vol. 90, no. 5, pp. 54-63, 86-87.

NIETSCHMANN, JUDITH

1979. Haddon the headhunter. Paper at the 23rd Annual Meeting of The Kroeber Anthropological Society, University of California, Berkeley.

1980. Another way of dying: The social and cultural context of death in a Melanesian community, Torres Strait. Ph.D. dissertation, Anthropology, Univ. of Michigan, 382 pp.

1981. Tombstone openings, cultural change and death ceremonies in Torres Strait, Australia. Kabar Seberang, no. 8/9, pp. 1-15.

SPAIN, A. V., and HEINSOHN, G. E.

1975. Size and weight allometry in a North Queensland population of *Dugong dugon* (Muller) (Mammalia: Sirenia). Australian Journ. Zool., vol. 23, pp. 159-168.

WALKER, D. (ed.)

1972. Bridge and barrier: The natural and cultural history of Torres Strait, 437 pp. Department of Biogeography and Geomorphology, Australian National Univesity Press, Canberra.

WAKE, JUDITH

1975. A study of the habitat requirements and feeding biology of the dugong, *Dugong dugon* (Muller), 121 pp. B.S. Honors Thesis (School of Biological Sciences), James Cook University, Townsville, Queensland.

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