METHODS

Study Reefs

There were 24 reefs/shoals for which the Great Barrier Reef Marine Park Authority required information (table 1, figure 1). All of these reefs were visited during this survey but quantitative surveys were only made at 18 locations. Three of the supposed reefs were mobile sand banks, one was shallow and algal dominated, another was a rock reef with only a few encrusting corals, and the last was unworkable at the time of our visit because of extremely poor visibility.

Table 1. List of the study reefs. The abbreviations used in subsequent tables are shown (Ab.), along with the ID number, date of visit, depth of survey area where appropriate, underwater visibility in metres at time of visit, and comments. Shoalwater locations are grouped into four sectors.

Reef	Ab.	ID no.	Date	Depth	Vis.	Comments
Pearl Bay Group	PB	22-081	11/12	1.5–2	4	Rubble reef with some corals
Clara Group		22-075	12/12	na	5	Steep rock reef with some corals: not surveyed
Donovan Shoal		22-040	16/12	na	7	Clean sand bank: not surveyed
White Shoal		22-055	16/12	na	6	Clean sand bank: not surveyed
Turn Shoal		22-050	16/12	na	6	Clean sand bank: not surveyed
NE Sector:						
North Ripple Is.	NR	22-047	17/12	1–3.5	7	
Holt Is.	Ho	22-045	17/12	1–3	9	
Unnamed Is.	Un	22-046	17/12	1–2.5	9	
Mumford Is.	Mu	22-042	16/12	1–3.5	8	
Ten Pin Rock	TP	22-044	16/12	1–4	7.5	
NW Sector:						
Five Trees Cay	FT	22-051	18/12	0–2	4	
Collins Is.	Co	22-052	15/12	1–4	4.5	
Eliza/Annie Is.		22-052	14/12	0–2	4	Shallow reef, algal dominated: not surveyed
Lingham Is.	Li	22-049	15/12	1–3	6	
White Rocks	WR	22-043	15/12	1–2.5	8	
SW Sector:						
Osborne Is.	Os	22-056	13/12	1–3	3.5	
Clara Is.	Cl	22-038	13/12	1	4	Algal dominated reef
Swan Is.	Sw	22-062	13/12	1–2	4	
Sun Is.	Sn	22-061	14/12	1–2.5	2	
Akens Is.		22-067	14/12		0.5	Limited reef area, gorgonian dominated: too dirty to survey
Edward Is.	Ed	22-060	14/12	1.5–3.5	4	
SE Sector:						
Bay Is.	Ba	22-064	12/12	1.5	4	
Connor Rock	Cn	22-066	18/12	0–2	2	Too small for two sites
Blind Rock	Bl	22-057	18/12	1–3	5	Too small for two sites

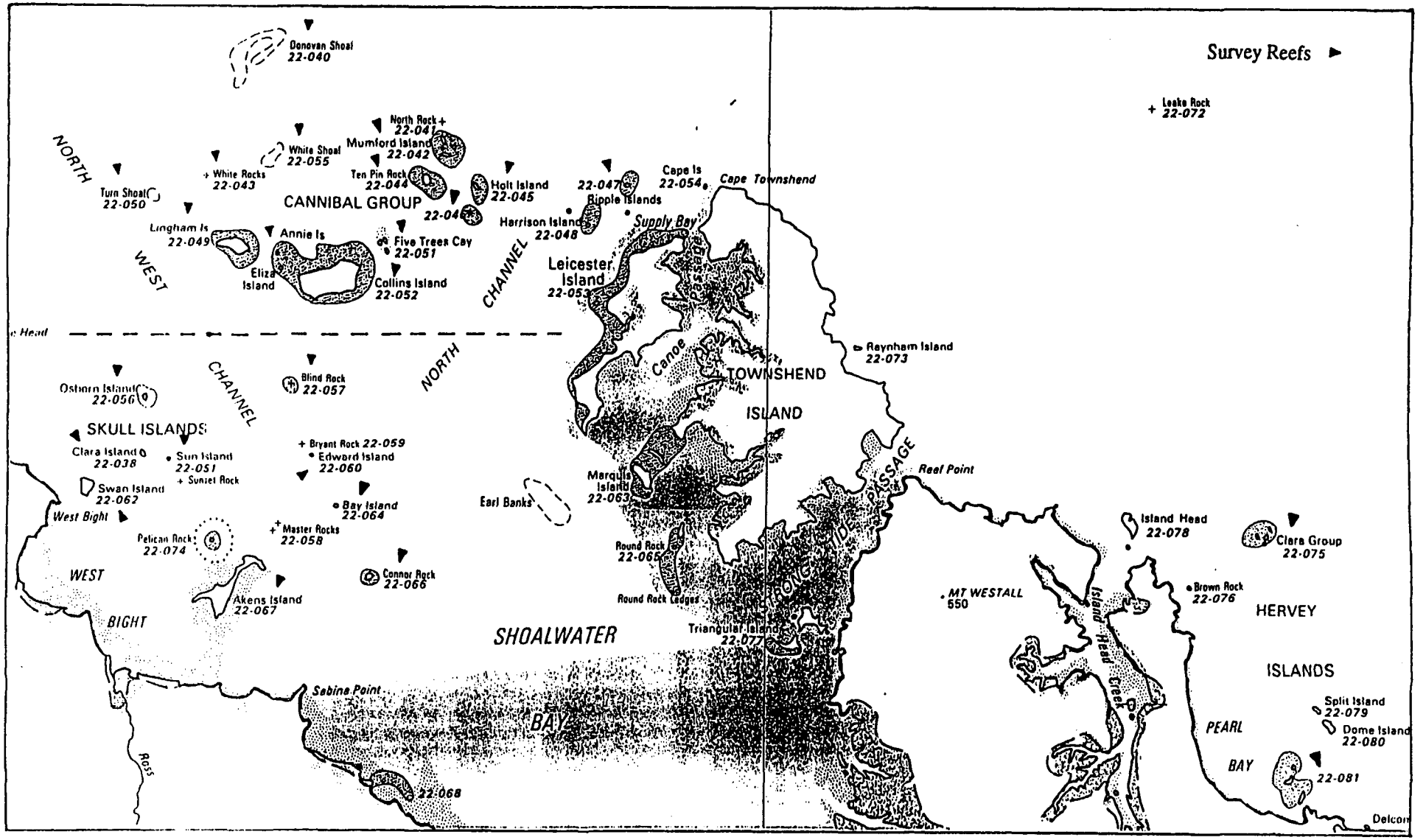

Figure 1. Map of the Shoalwater Bay area showing survey reef positions. Dashed line divides northern reefs from southern reefs.

Site Selection

At each location, sites were selected either using aerial photographs, where available, or by running around the area in the dive boat and selecting appropriate reef areas; usually those areas where the reef was widest. In some cases the 'reefs' around these islands dropped quickly to a sand or rubble floor and were merely algal covered rubble banks with a few corals amongst the algae. These areas were avoided in favour of reefs where coral development was greater. Where coral reefs were not present formal quantitative surveys were not carried out.

Benthic Cover Surveys

Surveys were made on the reef slope at depths determined appropriate from a quick initial reconnaissance. Many of the reefs were shallow and surveys were made along the lower edge of the reef where coral cover was usually highest, but in other cases the surveys were made in whichever stratum supported the highest coral cover. If the entire reef was algal dominated with very low coral cover (< 5%), no quantitative benthic surveys were made at that location. Where possible, two sites were surveyed at each location with at least 100 m between sites, in order to avoid confounding location with site. At two locations, Blind Rock and Connor Rock, the reef area was so small that two sites could not be surveyed. At each site five 20 m line intersect transects, run parallel to the depth contours, were recorded for the intersects of all benthic organisms. The following groups were recorded: macroalgae, algal turf, sponges, all hard corals, all soft corals. Hard corals were identified at species level except for the following familiar and structural groups: explanate *Montipora*, corymbose plate acroporids, staghorn acroporids, tabulate acroporids, massive poritids, finger poritids, all *Goniopora* and *Alveopora* species, all *Fungia* species. Most faviids were only separated to generic level in the quantitative surveys.

Species Diversity and Size Frequencies

Species lists were made during the transect surveys and were added to during a 30 minute random swim around each location covering the depth range of the reef. Intersect lengths from the line transects were used to construct size frequencies for each location. Such size frequencies are necessarily biased as the intersect length is almost always less than the true diameter of the coral colony, but we suggest that they provide a useful relative estimate for these reefs as the same technique was used in all locations. For larger species, records of the diameter of all large colonies (greater than 100 centimetres for acroporids, greater than 50 centimetres for all other groups) encountered during an approximately 90 minute haphazard swim around the location by a second observer (R. Berkelmans) were made while the first observer (A.M. Ayling) was completing the intersect transects and the species list. These were added to the frequencies from the line transects, adding a further source of bias, but again the same techniques were used in all locations and these data were considered useful for comparative purposes.

Other Criteria

In addition to the above measurements, a measure of underwater visibility was made at each site (table 1), and an assessment of the aesthetic value of each location made on a five point scale from poor (1) to excellent (5). The Great Barrier Reef Marine Park Authority requested that aesthetics be ranked from the point of view of a casual scuba diver to give an indication of their value in a social context. Representative underwater photographs were taken of each location when underwater visibility permitted.

Done Biodiversity Value

Done's suggested biodiversity value (V_b) indicating the uniqueness of the area of interest in the regional context is :

$$V_b = \Sigma (c_j \bullet \alpha^j)$$

where c_j = the proportion of colonies, plants or bottom cover (as appropriate) in category j with j = commonness index for regional species pool, and with $j = 1$ for common; $j = 2$ for rare, and $j = 3$ for previously unreported and α = a constant, here arbitrarily set at 10 so as to produce a maximum V_b of 1000 (i.e. when 100% of colonies, plants or bottom cover in the area are previously unreported).

Thus a site with a species list typical of the region would score 10, a site with equal abundance of common, rare and unreported would score 366, and a site with a unique composition (all species previously unreported in the region) would score 1000.

This index depends entirely on the definition of the region within which the area of interest (in this case Shoalwater Bay) is compared. Presumably in this case the region would have to be considered as the entire Great Barrier Reef, the region the Great Barrier Reef Marine Park Authority is responsible for managing. We used the abundance references from Veron (1986) to assign each species to one of the three commonness categories suggested by Done. Because of the species groupings we made in surveying the line intersect transects it was not possible to separate the area covered by rare species from that covered by common species as some of the groupings included both rare and common species. Instead we calculated a biodiversity value based on the *number*, rather than area covered, of species in each abundance category.

Done Bioconstruction Value

Done suggests that 'time for replacement' is a 'natural' currency for bioconstruction value, since longevity and large size equate with mass and structural importance. He further suggests that each site may be assigned two values:

Unweighted value V_u = age of the oldest sessile benthos (be it coral, algae, sponge or soft coral).

Alternatively, taking into account the abundance of benthos of different ages,

$$\text{Area-weighted value } V_w = \Sigma (a_i \bullet m_i) \text{ years}$$

where a_i = age class i (in years) m_i = proportion of individuals, or of defined area covered by individuals, of age class a_i.

Both indices assign a zero value to bare sand, and low value to young benthos (< 5 years old, e.g. the algal turfs or pioneer corals on rubble or other newly disturbed areas). Both assign a value of 1000 to a site completely covered by 1000 year old coral heads.

We found that the area weighted index gave a different value when calculated based on the proportion of individuals compared to that calculated based on the percentage cover of individuals, and as a result we calculated two different bioconstruction values. As mentioned above we used biased size frequency data to define age class, and converted size to age for the different coral groups using the data of Done (1990) and personal observations on fringing reef communities. Average annual *diameter* increases for the different groups were assumed to be:

Acroporids	8 centimetres
Pocilloporids	5 centimetres

Turbinaria spp.	5 centimetres
Poritids	2 centimetres
Faviids	1 centimetres
Other corals	5 centimetres

No data on growth rates of corals on these southern fringing reefs are available, and it may be that growth rates are lower in this area than on other fringing reefs due to lower average temperatures and turbid water conditions. However, as the indices obtained from these data were used for comparative purposes within the Shoalwater Bay locations only, the accuracy of these growth estimates is not particularly important.