THE WICKSTEAD REPORT'S *THALASSIA* STUDY REVISITED 25 YEARS ON

FINAL REPORT

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Introduction

In recognising the urgent need for fill for land development and the economic importance of the natural environment the Cayman Islands Government, in 1973, contracted a comprehensive natural resource study to *"take into account the paramount need to maintain those features of the marine environment that are enjoyed by Caymanians and which attract tourists whilst at the same time not suggesting paralysing restrictions which would grossly interfere with the continuing process of development'* (Wickstead, 1976).

It was the aim of the Natural Resource Study (NRS), which became known as the Wickstead Report, to make recommendations that *'consider primarily those aspects of the marine biology of Grand Cayman most likely to be of direct or indirect economic and aesthetic value to the Island'* (Wickstead, 1976). *"and to provide a background of data for resource evaluation, development and conservation; it is thus a programme in applied, not pure, science, and the choice of topics for study and the assignment of projects (must be) in terms of this purpose and not of the intrinsic scientific interest of the area"* (Stoddart, 1974).

Although the Wickstead Report's purpose was to provide recommendations for what we now refer to as sustainable development of natural resources, it was also intended as a baseline survey that '*should provide the means for Government to assess the influence of development project on the environment'* (Wickstead Report, 1976).

In an effort to fulfil the terms of reference (Appendix I) a comprehensive survey of the natural marine environment was conducted that included an inventory of marine flora and fauna and an investigation into the physical oceanography of Grand Cayman, and for this purpose, Grand Cayman was divided into seven survey areas: North Sound and Little Sound, East End, South Sound, reef communities, littoral region, Great Beach, and Twelve Mile Bank

THE NORTH AND LITTLE SOUND

Because of its potential for real estate development, marl and sand extraction and the extension of leisure amenities, the NRS paid particular attention to the North and Little Sound. Located in the north-western part of Grand Cayman. The North Sound is, by far, the largest lagoon in the Cayman Islands. It encloses about 90km^2, when measured from Barkers to Rum Point.

The NRS team established 79 sampling stations in the North Sound. The autumn fieldwork took place from July 1974 to December 1974 and 37 of these sites were re-surveyed for the spring data, between January 1975 and July 1975. They collected biological and physical data from each field station that included, surface water temperature, water depth, water clarity, sediment depth, the density of *Thalassia* was measured in a 1/4 m^2 quadrat, algae collections and quantitative assessments.

The marine angiosperm *Thalassia testudinum* was the most abundant seagrass found in Grand Cayman. With the most extensive stands occurring within the North Sound, *Thalassia testudinum* became the focus of the NRS seagrass study.

Seagrass communities, constitute one of the three major coastal interface communities in the Caribbean along with coral reefs and mangrove ecosystems. Although there has been much research on seagrasses over the past 25 years, their valuable functions were well documented by 1976 and were discussed in the Wickstead Report Part IVA-Marine Biology, and may be described as the following:

1. **Substrate stabilisation and sediment entrapment** – the root and rhizome system of marine angiosperms consolidate sediments and attenuate wave energy, thus helping to prevent coastal erosion and keep coral reefs free of sediment by trapping and reducing re suspension (Ginsberg and Lowenstam 1958, Taylor and Lewis 1970, den Hartog 1971, Fonseca et al. 1983, Fonseca 1996a).

2. **Provision of settlement area –** seagrass leaves create and increase substrate area for the attachment of epibionts and the settlement of larvae such as the spiny lobster *Panulirus* argus (Zeiman, 1982).
3. **Provision of food –** seagrasses provide a direct and indirect food source. Direct grazing of organisms on the living plant material (turtles, fish, urchins etc) or utilisation of detritus from decaying seagrass material, such as leaves. The transport of seagrass material (detached leaves and detritus) to a location some distance away from the source allows for further distribution of energy (Zeiman, 1982).
4. **Nutrient cycling** - seagrasses remove nutrients such as nitrates and phosphates from the water column (Harlin and Thorne-Miller 1981). Their production of detritus and sediment trapping by the leaves provide organic matter for sediments (see 3 also). Some epiphytic algae on seagrass leaves have also been shown to fix nitrogen.
5. **Provision of shelter** - they serve as shelter for a variety of juvenile and adult marine fauna (Zeiman, 1982).

Over the past 20 years, monitoring seagrasses has rapidly become one of the primary methods to determine overall health and condition of aquatic environments (Dennison *et al*, 1993; Stevenson *et al*, 1993) as seagrass communities serve as sensitive indicators of human pollution and perturbations (Kemp, 1983). *Seagrass beds are very sensitive to changes in their environment, and are particularly vulnerable to any decrease in the transmission of light through the water column and dredging of the sandy and muddy bottoms on which they grow* (Fourqurean, *et al,* 2002). Dredging and filling of coastal areas for navigation and development can directly remove potential seagrass habitat (Zieman *et al*.1989b); alter hydrological conditions that lead to erosion (Giesen *et al*. 1990; Larkum and West 1990); as well as cause a reduction in light available to seagrasses by increasing turbidity (Onuf 1994). Increasing human population density in coastal regions has often led to eutrophication, which can reduce light available for seagrasses; eutrophication has been implicated in the loss of seagrasses from many areas of the world (e.g. Cambridge *et al*. 1986; Orth and Moore 1983). Recreational and commercial use of seagrass beds can also damage them. For example, contact of the bottom by outboard motors can cause scars that can take years to recover (Zieman 1976); the cumulative impacts of such frequent events can lead to complete loss of seagrass beds from heavily trafficked areas (Sargent *et al.* 1995). Commercial harvesting of shellfish can also have severe effects on seagrass beds (Thayer *et al.* 1984).

Since the completion of the Wickstead Report the North Sound has been the focus of intense multi-use development. Dredging, filling and canalisation of the perimeter of the North Sound for development has given rise to the removal of mangroves, the in-filling of the tidal area, the concreting of the ‘soft’ coastal zone and the change in bottom topography by way of borrow pits *etc.* This development coupled with increasing tourism, recreation, and natural resource use (fishing for example) has meant that the North Sound has become a major multi-use area of Grand Cayman. In summary, all the potential seagrass perturbations outlined above, with the exception of commercial harvesting of shellfish, have occurred in the North Sound.

Much of the findings of the Wickstead report are still referred to today, 25 years on, and such was the comprehensiveness of the report, that it forms the basis of marine research and coastal management in the Cayman Islands. However, *baseline surveys are in practice of use only if re-monitoring of the environment is undertaken from time to time and knowledge is continuously accumulated* (Wickstead, 1976). This report revisits the *Thalassia* study of the Wickstead Report in light of 25 years of development. It will discuss the quantitative changes in the North Sound *Thalassia* communities at the original Wickstead study sites, provide *Thalassia* density maps from the original Wickstead data and data collected in 2001 and suggest seagrass and water quality monitoring strategies for the future.

Methods

The location of the original Wickstead survey sites in the North and Little Sound were documented as co-ordinates and were subsequently relocated via GPS (figures 1a and b). The spring survey was conducted between February and May 2001, and the autumn survey between August and October 2001. At each site the following parameters were measured:

PHYSICAL DATA COLLECTION

1. Surface water temperature – ^{0}C
2. Water depth using a weighted fibreglass tape measure – cm
3. Sediment depth. A steel measuring rod, marked off in cm increments, was pushed into the lagoon floor by a diver/snorkeller until bedrock was reached. This was repeated six times per site. The average depth achieved is reported is cm. (see Appendix 2 for complete results)
4. The bottom type at each site was noted.
5. Water clarity/ turbidity. Two divers descended to 1m below the surface with a white-sided Secchi disc and attached measuring tape. While one diver held the Secchi disc, the other swam horizontally away with the measuring tape until the limit of Secchi visibility was reached. The distance at this point was measured in m.

THALASSIA TESTUDINUM DATA COLLECTION

Four ¼ m^2 quadrats were thrown from each side of the bow and stern of the survey boat. If *T. testudinum* was present in a quadrat then each blade/ bundle of blades (figure 2) was cut away at the middle of the branch/short shoot by a diver, using ordinary scissors, until all the blades were removed from the quadrat. To be considered, 'inside the quadrat', branch/short shoot must be within the quadrat. The cut blades were place in a mesh bag for transport to the surface.

At the surface, all the blades were carefully moved from the mesh bags into seawater filled ziplock bags, one ziplock bag per quadrat, then transported on ice to a fridge in the DOE laboratory.

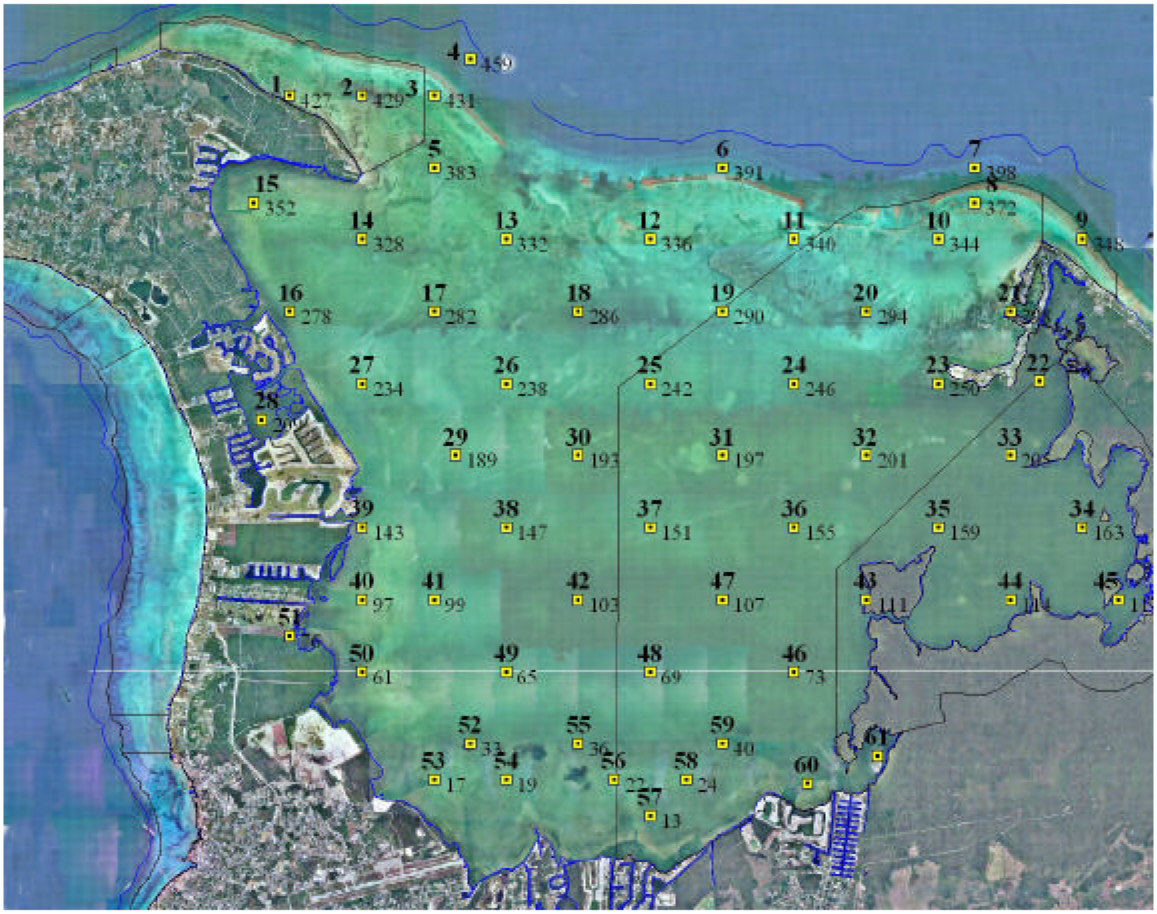


Figure 1a: Aerial photograph of the North Sound with site numbers. Numbers in bold (1-61) are 2001 site identification. Other numbers are the Original Wickstead site numbers.

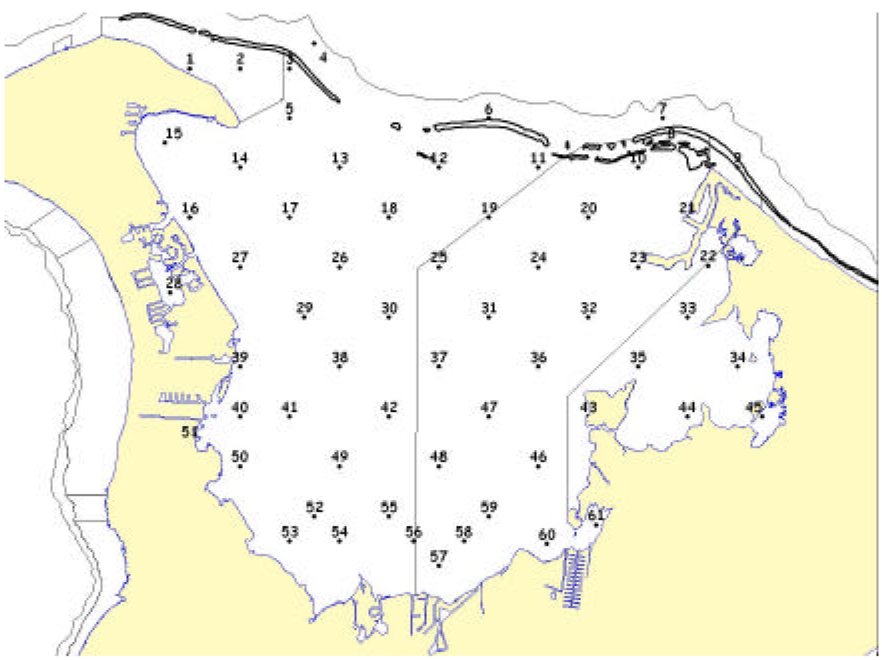


Figure 1b: Map of sites

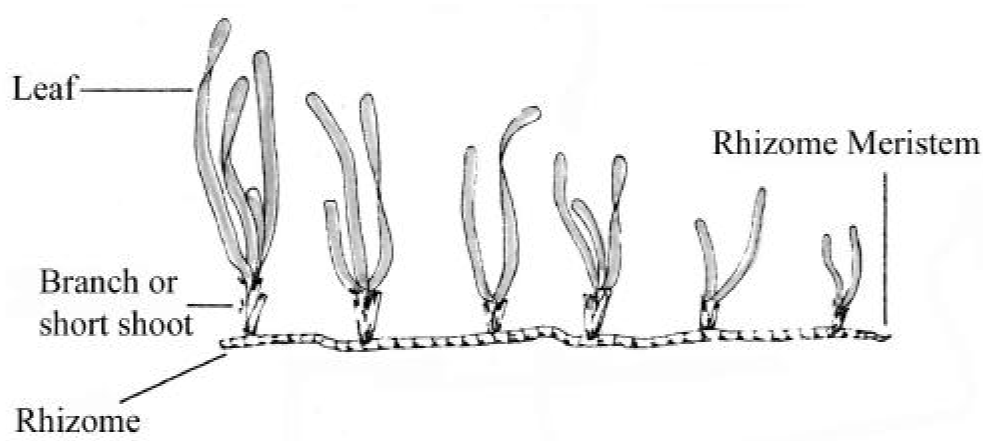


Figure 2: From Zeiman (1982) *Thalassia testudinum* morphology.

Back at the lab each bag was sorted – individual blades were separated from its short shoot bundle and trimmed at the sheath/blade interface (figure 2) and rinsed with filtered seawater to remove any loose sediments or algae. Prepared blades were then carefully placed, so that they did not overlap, on a white tray with a ruler and ID sign, then photographed from above using a digital camera (figure 3). The digital camera was mounted on an arm above the troy to ensure that the image was taken from the same distance each time.

figure 3: Image of sorted blades on a white tray, with ID tag and calibration ruler

Each photograph was analysed, using the windows based program Image Pro Plus, to generating a spreadsheet with the length, in cm, of each *Thalassia* blade in the photograph (figure 4). The program was calibrated using the ruler from the image.

With these figures average blade length for each site and number of blades per m^2 was calculated.

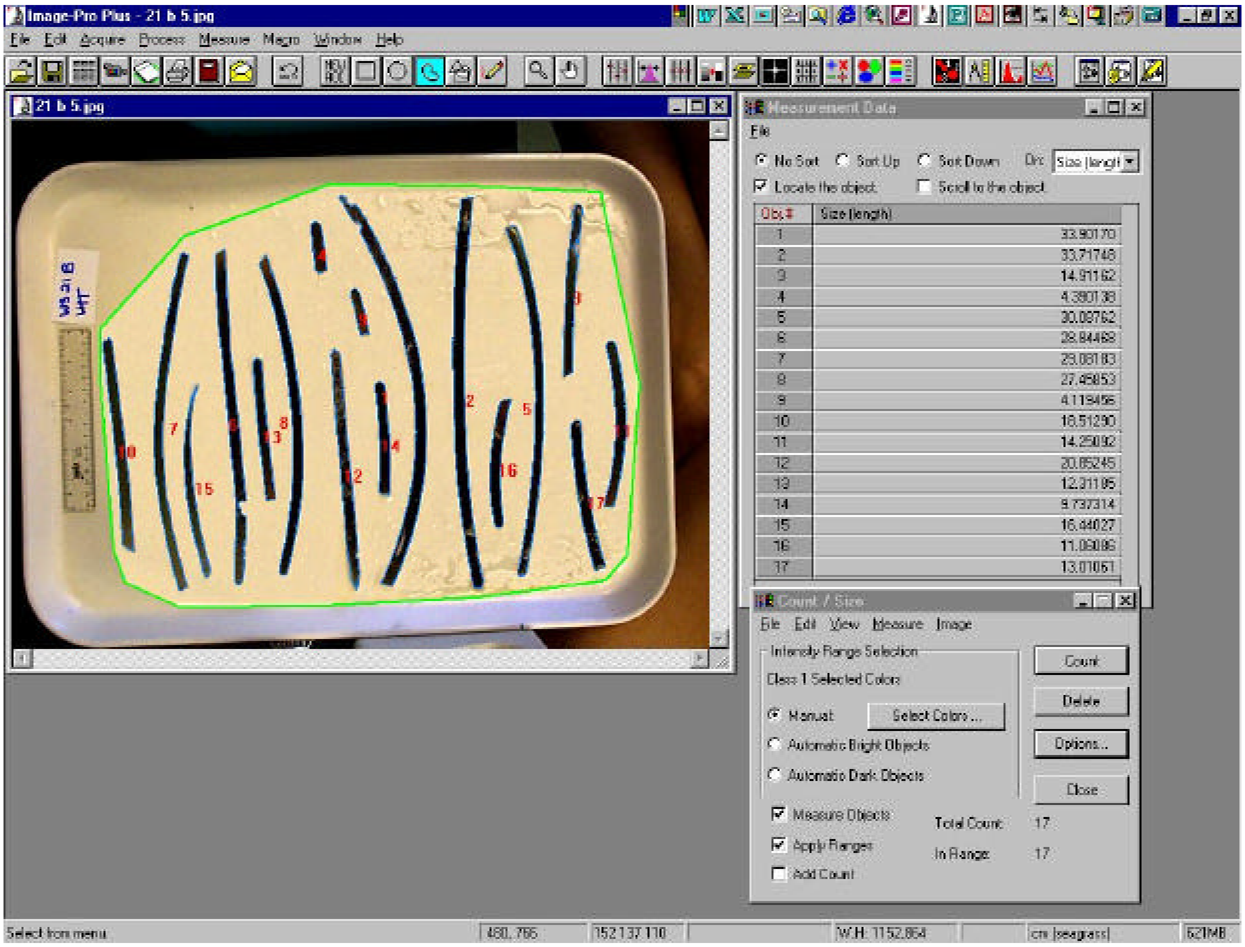


Figure 4: Image Pro Plus analysis of seagrass blades.

Results

1. Surface water temperature:

	Average Temperature Spring, °C	Average Temperature Autumn, °C	Max temperature Spring °C	Max temperature Autumn °C	Min temperature Spring °C	Min temperature Autumn °C
1974-75	25.87	28.23	27	31.5	25	24
2001	27.00	30.22	28.7	31.5	23.7	29.1

Table 1: Surface water temperature – average, max and min, for all the sample periods.

2. Water Depth: Average water depth at the North Sound sites was 3m.

   NB: Depth measurements have not been corrected with tide.

3. Sediment Depth ranged from none to over a meter. See *figure 5* for sediment depth distribution across the survey sites.
4. Five classifications were established to describe the bottom type at each site. These were:
   a) Sand
   b) Marl
   c) Soft Marl
   d) Peat
   e) Hard Pan

Figure 6 graphically illustrates the bottom types found at the sites.

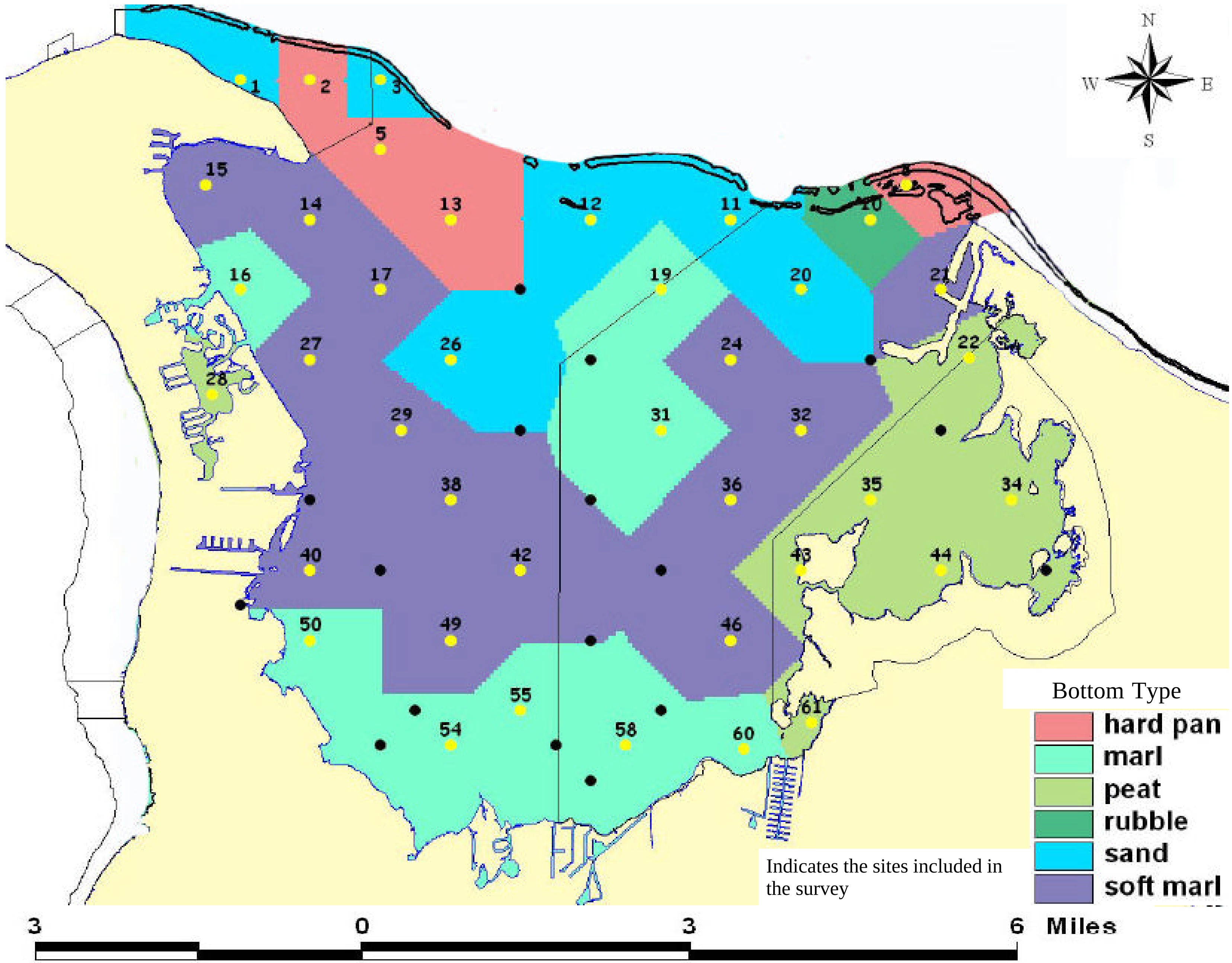
5. Water clarity/turbidity:

	Secchi measurements, cm Spring	Secchi measurements, cm Autumn
1974-75	659	656
2001	810	474

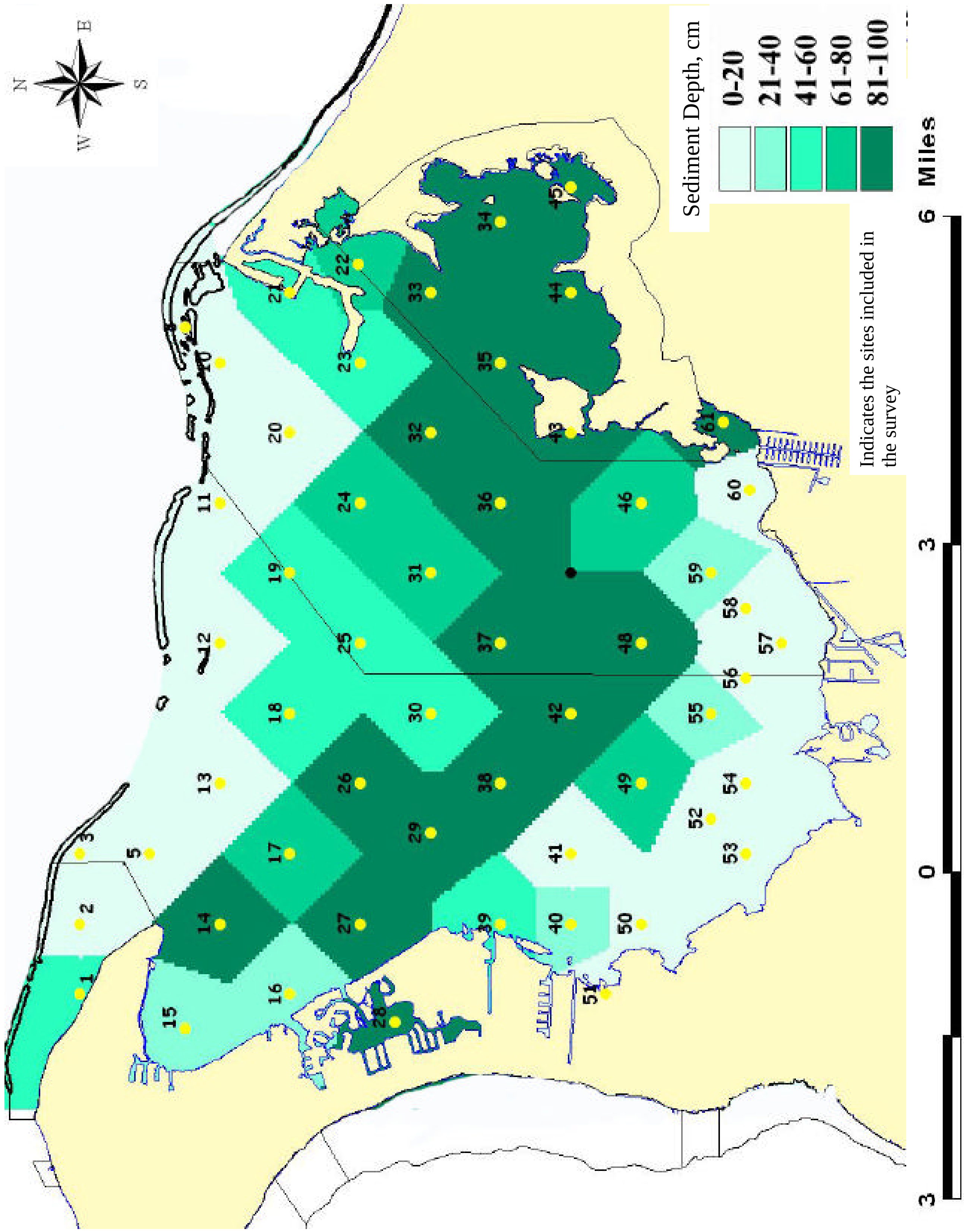
Table 2: Average Secchi measurements for the sample periods.

6. The seagrasses *Thalassia testidinum, Halophila decipiens, H. engelmanni* and *Syringodium filiforme* were all observed in the North Sound during the 2001 survey.

Bottom Type at the Survey Sites, 2001



Average Sediment Depth at the Survey Sites, 1974, '75 and 2001



THALASSIA TESTUDINUM RESULTS

site number	spring 1975 # blades per 1/4m2	autumn 1974 # blades per 1/4m2	average # blades 1974/ 1975	spring 1975 blade length cm	autumn 1974 blade length cm	average blade length 1974/ 1975	spring 2001 blade length cm	autumn 2001 blade length cm	average blade length 2001	spring 2001 # blades per 1/4m2	autumn 2001 # blades per 1/4m2	average # blades in 2001
1	0		0	0		0	8		8	546		546
2	0		0	0		0						
3	0		0	0		0	9		9	62		62
4	0		0	0		0						
5		66	66		11	11						
6	0		0	0		0						
7	0		0	0		0						
8	0		0	0		0						
9	0		0	0		0						
10	0		0	0		0						
11	0		0	0		0	7		7	190		190
12		76	76				7		7	221		221
13	0		0									
14		198	198		27	27						
15	226	65	146	17	12	15	6	9	7	115	146	130
16	171	107	139	19	12	16	13	11	12	444	252	348
17		219	219		19	19						
18	358	207	283	16	15	16						
19		67	67		12	12						
20	66	58	62	5	12	9	6	7	6	305	353	329
21		270	270		32	32	14	15	14	354	296	325
22												
23		293	293		17	17						
24	173	123	148	14	14	14	11		11	325		325
25		154	154		22	22						
26	221	224	223	15	20	18	10		10	348		348
27	224	165	195	14	15	15	11	11	11	303	214	259
28		0	0		0	0						
29	113	94	104	10	40	25	12	12	12	260	335	298
30		172	172		12	12						
31	227	153	190	10	23	17	8	10	9	217	195	206
32	162	109	136	19	48	34	23	32	27	67	20	43
33		127	127		37	37						
34	173	119	146	22	40	31	18	22	20	386	253	319
35	88	47	68	30	28	29	12	9	11	167	259	213
36	165	152	159	10	18	14	10		10	268		268
37		138	138		39	39						
38	217	107	162	17	50	34	20		20	100		100
39	0	166	83		18	18						
40		102	102		7	7						
41	0	157	79		38	38						
42	182	76	129	34	48	41	25	27	26	125	139	132
43	98	67	83	14	40	27	7		7	202		202
44	126	106	116	28	50	39						
45		184	184		55	55						
46	136	205	171	30	30	30	20	20	20	283	266	275
47		113	113		45	45						
48		104	104		55	55						

site number	spring 1975 # blades per 1/4m2	autumn 1974 # blades per 1/4m2	average # blades 1974/ 1975	spring 1975 blade length cm	autumn 1974 blade length cm	average blade length 1974/ 1975	spring 2001 blade length cm	autumn 2001 blade length cm	average blade length 2001	spring 2001 # blades per 1/4m2	autumn 2001 # blades per 1/4m2	average # blades in 2001
49	163	196	180		48	48	13		13	98		98
50	50	146	98	8	12	10						
51	0	0	0	0	0	0						
52		208	208		22	22						
53	62	118	90		6	6						
54		247	247		28	28	7	9	8	311	272	292
55		177	177		30	30	9		9	311		311
56		132	132		18	18						
57	87	107	97	5		5						
58		49	49		24	24	7	10	8	408	378	393
59	222	151	187	21	30	26						

Table 3: Thalassia data from all the sample periods.

	spring 1975 # blades per 1/4m2	autumn 1974 # blades per 1/4m2	average # blades 1974/ 1975	spring 1975 blade length cm	autumn 1974 blade length cm	average blade length 1974/ 1975	spring 2001 blade length cm	autumn 2001 blade length cm	average blade length 2001	spring 2001 # blades per 1/4m2	autumn 2001 # blades per 1/4m2	average # blades in 2001
Average for all sites	**100**	**134**	**113**	**11**	**26**	**19**	**12**	**14**	**12**	**257**	**241**	**249**

Table 4: Thalassia data - averages calculated for all sites.

DATA ANALYSIS

The results shown in *table 3* were tested for normality using the Kolmogorov-Smirnov test. All ‘number of blades’ data was tested for normal distribution and all ‘blade length’ data were tested for normal distribution. Graphs 1 and 2 illustrate the results of the Kolmogorov-Smirnov test.

The test on ‘number of blades’ shows that the data distribution was not significantly different from normal (P >0.05) with a P-value of 0.095. As the data was normally distributed a simple t-test was employed to examine the differences of number of blades per ¼ m^2 quadrat from 1974/75 and 2001.

The Kolmogorov-Smirnov test on the ‘blade length’ indicates that the data was significantly different from normal (P< 0.05) with a P-value of <0.01. As the data was