SHARK BAY DEEP WATER SEAGRASS SURVEY

An assessment of deep water populations

of *Halophila spinulosa* (R.Br.) Aschers, August 1995.

Report to the Western Australian

Department of Conservation and Land Management.

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INTRODUCTION

The Shark Bay marine environment (Figure 1) hosts extensive seagrass communities (Walker *et al.*, 1988; Walker, 1989), with twelve species of seagrass and some of the highest coverage and spatial diversity ever recorded. The area was dominated by large monospecific meadows of *Amphibolis antarctica* (Labill.) Sonder ex Aschers, covering 3700 km^2 and *Posidonia australis* Hook. f. (200 km^2). Smaller seagrass species occupied an additional 500 km^2. The high observed diversity of seagrass species relates both to the environmental conditions (shallow, sheltered sediments) and to the location of the Bay, with both tropical and temperate species present.

Like all seagrass communities, the Shark Bay meadows are of considerable ecological significance (Walker, 1989). Read (1974) recorded that seagrasses were able to "baffle" a two-knot current, so minimising sediment transport. In addition to providing refuge for many invertebrate and small vertebrate fauna, the meadows appear to be a major food source for larger vertebrates such as turtles and dugongs (*Dugong dugon*). Given the concern over the populations of these animals, and the economic importance of many fish species in Shark Bay, these seagrass communities are attracting increasing scientific and management focus.

Professor Paul Anderson, University of Calgary, carried out research in the 1980's and 1990's focusing on the distribution and grazing behaviour of Shark Bay dugongs. Whilst collecting data in July, 1989 and 1992, Anderson discovered a previously unreported meadow of the seagrass *Halophila spinulosa* (R.Br.) Aschers off the north east coast of the Peron Peninsula (Anderson 1994). He estimated this stand to extend for a minimum of 300 km^2, in approximately 9-14 metres of water. This area corresponded to relatively large numbers of dugong sightings (Figure 2), with the animals displaying active diving behaviour, contrasting with that of dugongs feeding in shallower water.

Dugongs were previously thought to depend on a low quality diet of the temperate seagrass *A. antarctica* (Anderson 1982; Anderson 1986). Behaviour observed in 1992 raised the hypothesis that *H. spinulosa* may represent a more efficient alternative food source, of sufficient quality to compensate for higher costs of deep water foraging.

The purpose of this project was to investigate the ecology of *H. spinulosa*, to determine its spatial and temporal persistence, its potential as a major food source for dugongs and to check for any evidence of removal through trawling. This report describes the findings of surveys conducted in Shark Bay at the site of the meadow detailed by Anderson (1994).

MATERIALS AND METHODS

Study Area

Shark Bay is a large (13 000 km ^{2}), shallow (for the most part < 15 m deep) basin located on the western most point of Western Australia, approximately 700 km north of Perth (Figure 1) (Logan *et al.*, 1970). It is characterised by variable submarine geomorphology, divided into embayment plain, sublittoral platform and intertidal platform (Logan and Cebulski 1970). The bay was formed by marine transgression into a terrain of Pleistocene dunes creating a series of inlets and, in the southern portion of the bay, two major sounds, which are partially cut-off from the Indian Ocean.

A well developed hypersalinity gradient persists southwards into the bay. This is a consequence of its geomorphology combined with a high rate of evaporation (evaporation exceeds precipitation by a factor of 10) (Walker 1989).

The survey area was concentrated in the deeper waters east of the Peron Peninsula and west of the mainland, south of latitude 25°22.5'S and north of latitude 25°40'S (Figure 3). This corresponded with the area surveyed and described by Anderson (1994). A number of spot dives and video transects were conducted, the coordinates of which are listed in Table 1.

Transects

Towed video transects were conducted to determine the nature of any benthic communities. The video was towed behind the "James Scheerer", a 12.5m research catamaran. The position of the camera above the seabed was adjusted by adjusting the speed of the boat, to gain the best picture clarity, which was viewed on a colour monitor and recorded on a video cassette recorder aboard the vessel. Details of benthic biota were recorded from the video monitor and logged with other parameters such as GPS position, water depth, water temperature, salinity and light.

Spot dives were conducted at some sites when conditions made video recording difficult. Two divers, using hookah, made visual observations of any seagrass species present.

Benthic biota, physical features of the substrata and dive details are all recorded in Table 1. At various sites along each transect seagrass samples were collected to quantify the biomass.

Quantitative samples

At the only site where seagrass was present, 6 replicates of 20 x 20cm quadrats were haphazardly placed within the bed and all above and below ground biomass was harvested. These samples were frozen on site. On return to the laboratory, quadrat samples were thawed and sorted. Shoot number and length, number of leaves per shoot and mean leaf length were determined for each quadrat. Above and below ground biomass was recorded with samples being dried at 70°C for

48 hours. Shoot and leaf measurements are included in Tables 1 and 2, with biomass results. The presence of animals and algae and substratum type were also noted.

Six sediment cores were collected within the seagrass meadows at the seagrass biomass site using poly carbonate cores 30cm long and 5cm in diameter. This sediment was sieved on site using a 500µm mesh sieve. This was done to estimate the seed stocks within the sediments. No seeds were found within the sieved sediments, however, making it impossible to infer the history of the meadow.

RESULTS AND DISCUSSION

The majority of the Shark Bay deep water study area was devoid of vegetation. The ground surveyed was typically bare sand, comprised of a coarse shell grit material. Some locations hosted sparse seagrass or macroalgal populations, however, plants numbered only a few per square metre. The only exception was the site of the third spot dive of the survey (see Table 1), where some clumps of *Halophila* spp. were observed. Three large clumps of *H. ovalis* totalling approximately 3m^2 (a liberal estimate) and 9 smaller clumps of *H. spinulosa* covering about 1m^2, were the most abundant seagrasses. Some smaller patches of *H. decipiens* were also present but covered a cumulative total of only 400cm^2. Quadrat collections were taken from these small patches and processed for quantitative data back at the laboratory. No conclusions or comparisons can be drawn about the ecology of these species in Shark Bay from these quantitative data, as they were the only collections made from the entire study area. These data are included for future comparisons.

Large amounts of detached *A. antarctica* were observed in drift at various deepwater locations. These very long plants probably originated from the well documented *A. antarctica* meadows in shallow water adjacent to the mainland coast (Walker 1989). Strong tidal currents are characteristic of Shark Bay, and may be the cause of their presence.

Various species of macroalgae, both attached and in drift, were observed at the various deep water sites. Species of *Halimeda, Penicillus, Dictyopteris* (Chlorophyta) and *Padina* (Phaeophyta) were common, whilst large accumulations of *Cladophora* species were often present in drift, often in conjunction with *A. antarctica.*

There was no evidence from these surveys, carried out at the same time of year where water temperature was similar, to reinforce the suggestion by Anderson (1994), that large monospecific prairies of *H. spinulosa* persist, serving as a preferred nutritional alternative for dugongs than the shallow water *A. antarctica* meadows. He purported that the extra nutrition gained from *H. spinulosa* may compensate for the extra effort expended by diving. It is interesting to note that no dugongs were observed during the 1995 survey.

Anderson (1994) recommended close monitoring of seagrasses in Shark Bay, given their ecological importance. He suggested that intensive trawling practices may deplete much of the benthic plant communities. Observations made during this study suggest that the absence of *H. spinulosa* is more likely to be a consequence of its habit than removal by trawling. Populations of smaller seagrass species, like *H. spinulosa*, are more ephemeral and are likely to vary spatially and temporally (Walker *et al.*, 1988; Walker 1989). Small changes in temperature, salinity and light have the potential to affect such plants on a wide scale. There is little evidence from studies to date of an effect of trawling on the feeding patterns of dugongs, turtles and economically important fish species.

Conclusions and Recommendations

The findings of this survey contrast with those carried out by Paul Anderson. The distribution of *H. spinulosa* is spatially and temporally variable in the Shark Bay marine environment, particularly in comparison with species of *Amphibolis* and*Posidonia*. A more thorough record of the occurrence of *H. spinulosa* in Shark Bay is desirable, in order to develop an understanding of its ecological significance.

To monitor dietary preferences of the larger vertebrates such as turtles and dugongs, future studies examining fecal material of these animals may be more effective. Fecal studies may also expose the possibility that Shark Bay dugongs are omnivorous, incorporating sessile invertebrates into their diet in addition to plants. Studies of Moreton Bay dugong populations revealed that some ascidians, sponges and other invertebrates are an important component of their diet, in some cases occurring in 73% of fecal samples (Preen 1985). An extension of such fecal studies could incorporate techniques of $\delta\ ^{12}C$ and ^{14}N analysis which could also assist in identifying where the main feeding grounds are, and in tracing migratory patterns.

ACKNOWLEDGMENTS

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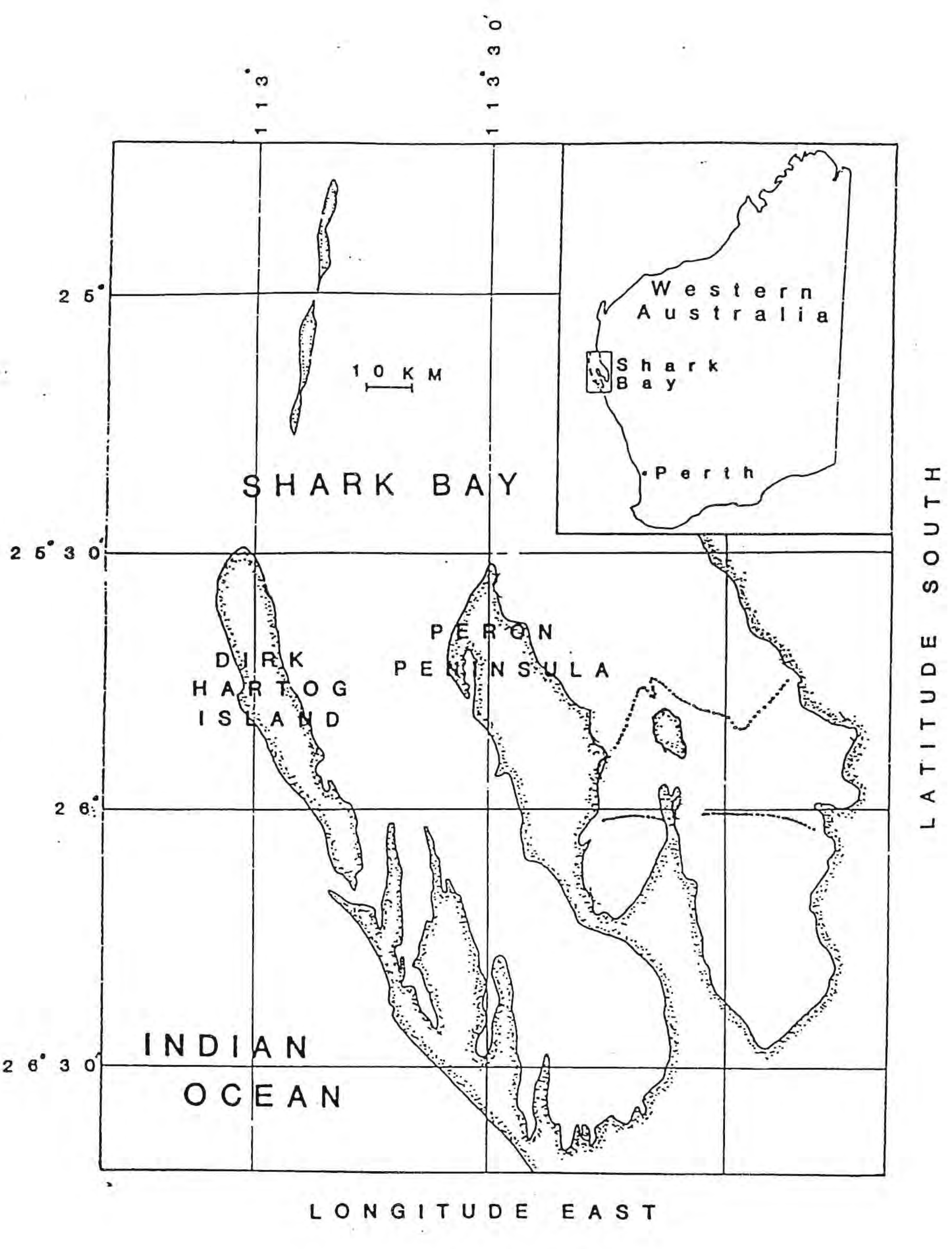

Figure 1. Location map of Shark Bay.

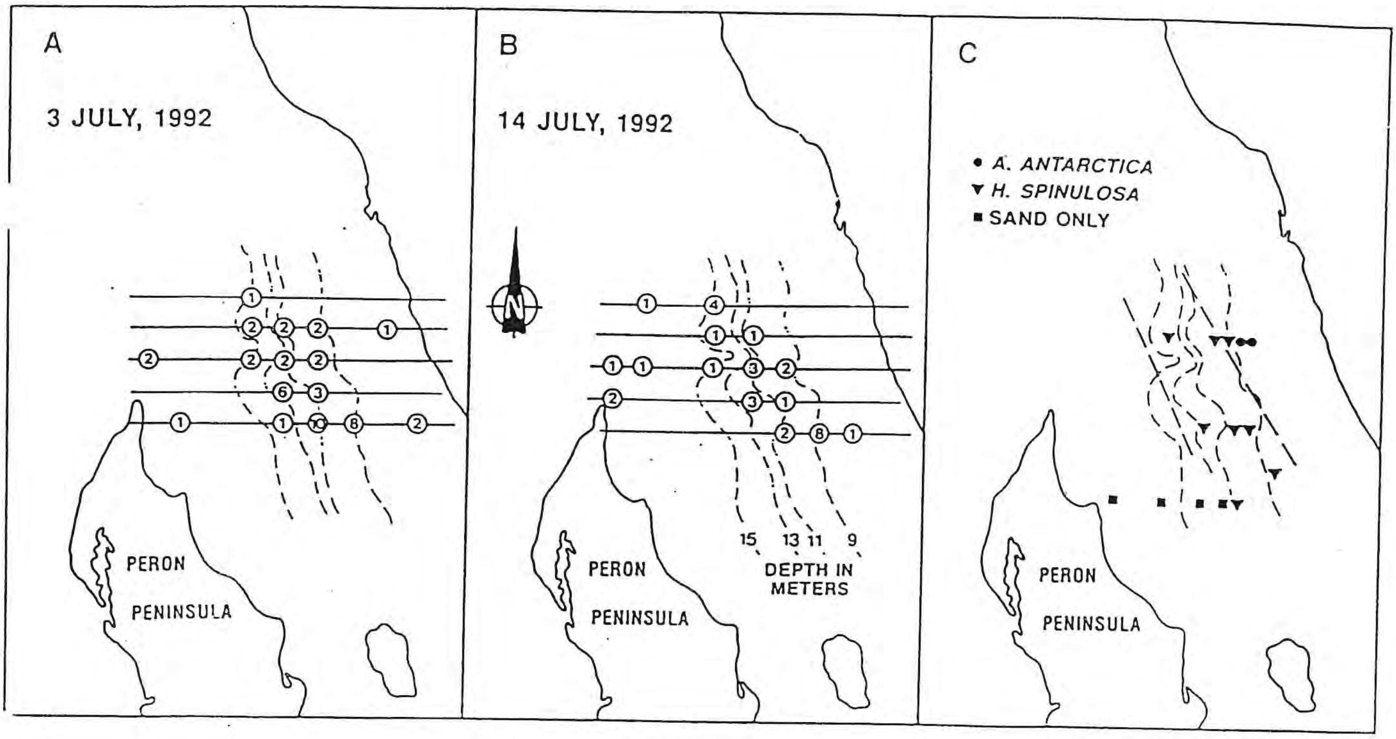

Figure 2. Flight lines and aerial counts of dugongs by Anderson in July 1992 (A and B). Circled numbers refer to the number of dugong units (solitary adults or cow-calf pairs) sighted in each 5km segment of transect. Observed seagrass meadows adjacent to dugong sightings are also given (C). (from Anderson 1994).

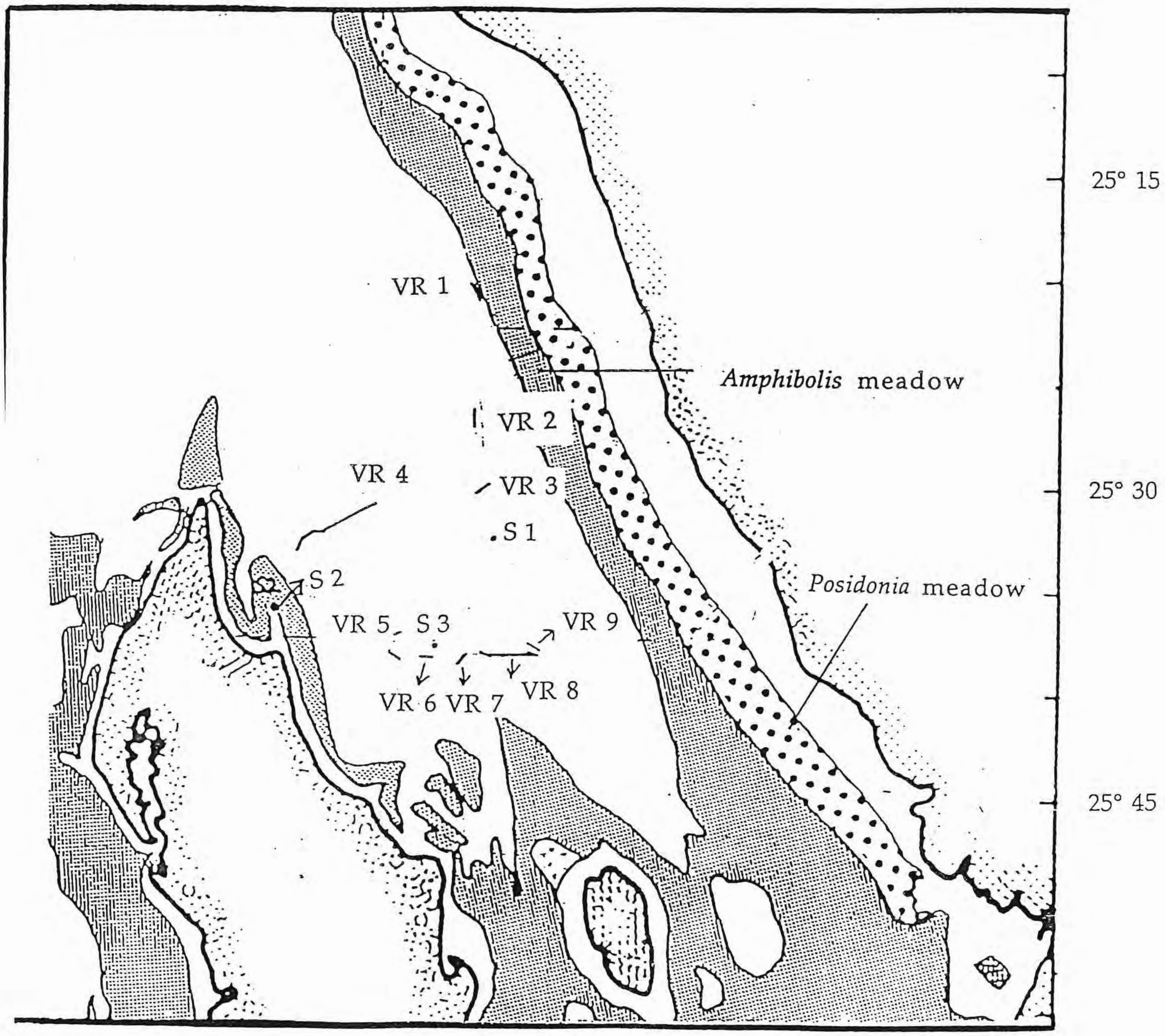

Figure 3. Location of deep water video surveys and hookah spot dives conducted during 1995

Table 1. Details of biota observed from towed video surveys and spot dive inspections using hookah equipment

POSITION	DESCRIPTION	DATE
25°32.46'S 113°46.35'E	**First spot dive.** Gravelly Shell Bottom-no ripples. Sparse occasional *Amphibolis antarctica* stems with some also in drift. Some macroalgae, including *Halimeda* sp. and *Dictyopteris* sp. Depth-10.9-11.6 m Temperature-18.7°C Salinity- 37‰	28-8-1995
25°35.61'S 113°34.44'E	**Second spot dive**. Herald Bite Shelter. Strong southerly winds. Some *Posidonia australis, Halodule uninervis* (seagrass) and *Padina, Penicillus* sp. (macroalgae). Depth- 3.5m Temperature- 18.7°C Salinity- 40‰	29-8-1995
25°25.27'S 113°45.09'E to 25°25.25'S 113°45.64'E	**First video run.** Bare sand/coarse sediment. No vegetation observed. Depth- 14m Temperature-17.8 °C	
25°25.27'S 113°45.09'E to 25°25.25'S 113°45.09'E	**Second video run.** Shell grit. Some *A. antarctica* (ca.5%) and *Penicillus* sp. Depth- 10.9m Temperature- 18.2°C	
25°30.02'S 113°45.76'E to 25°30.14'S 113°45.43'E	**Third video run.** Coarse shell/grit sediment. No benthic seagrass, some drift *A. antarctica*. Bioturbated. Depth- 11.2-11.5m Temperature- 18.2°C	
25°31.76'S 113°39.32'E to	**Fourth video run-Start of depth transect across to Herald bite.** *Dictyopteris* sp. growing on coarse shell grit substratum. *A. antarctica* and *Cladophora* sp. in drift. Depth- 15.2m Temperature- 18.2°C	
25°32.18'S 113°37.30'E to	**Depth transect cont'd-**coarse grit substratum continued with much drift filamentous algae and some *A. antarctica.* Tidal stream present. Depth- 14m Temperature-18.2 °C	
25°32.41'S 113°36.31'E to	**Depth transect cont'd-**very similar to previous Depth-13.3-5m Temperature-18.2°C	
25°32.46'S 113°36.7'E to	**Depth transect cont'd-**tiny amounts of drift, very turbid water. Bare grit substratum. Depth- 12.9m	
25°32.46'S 113°36.6'E to	**Depth transect cont'd-**some benthic *Penicillus* sp. with still lots of *Cladophora* sp in drift. Depth 12.2m	

25°32.54'S 113°35.99'E to	**Depth transect cont'd**-ripples in substratum, starting to form a bank structure Depth 11.5m	
25°33.35'S 113°35.73'E to	**End of depth transect**-Bare sand substratum, mega ripples and dimpling, tidelines. Total distance of depth run approximately 64nm	
25°38.06'S 113°40.9'E to 25°38.16'S 113°41.03'E	**Fifth video run**-cruised South-East from Herald Bight towards Paul Anderson's study area. Lots of burrows observed in substratum with some coverage of *Penicillus* sp. No seagrass evident.	30-8-1995
25°38.11'S 113°42.47'E to 25°38.10'S 113°42.74'E	**Sixth video run**-bare sand Depth- 11.2m	
25°38.04'S 113°42.76'E	**Third Spot Dive**-88% bare sand but some seagrass present: 3 clumps of *Halophila ovalis* approx. total 2-3 m^2 10 clumps of *Halophila decipiens* approx. total 400cm^2 9 clumps of *Halophila spinulosa* approx. total 1m^2 Samples taken-results given in next appendix. Some macroalgae also observed *Champia* (Rhodophyta), *Dictyopteris* (Phaeophyta) and *Penicillus* (Chlorophyta) sp. Depth- 11.8m Temperature- 18.7 °C Salinity- 40.5‰ **Light Readings** (taken at 12:10 hours)	

Air	1905 $\mu E\ m^{-2}\ s^{-1}$
Surface	1147
0.5m	1453
1.0m	1193
2.0m	795
3.0m	617
4.0m	479
5.0m	445
7.0m	329
9.0m	252
11.0m	177
12.0m	126

25°38.13'S 113°44.27'E to 25°38.116'S 113°44.38'E	**Seventh video run**-Bare sand, bioturbated. Length of run approximately Depth-12.1m Temperature-18.2°C
25°38.03'S 113°45.77'E to	**Eighth video run-Start-** not as bioturbated. Depth-10.6m Temperature-18.2°C

25°38.06'S 113°45.83'E to	"Dill-Pickle" shaped Ascidians present Depth-11.2m
25°38.06'S 113°47.33'E to	Depth-11.2m Temperature-18.2°C
25°38.07'S 113°47.67'E	**End of eighth run-**Bare sand for most of survey. No seagrass present.
25°37.85'S 113°47.29'E to 25°38.08'S 113°47.86'E	**Ninth video run / Fourth spot dive-**Very rapid current on surface but not present on bottom. No benthic seagrass communities but large amounts of *A. antarctica* in drift. Depth-11.2m Temperature-18.7°C Salinity-39‰

Table 2. Results of seagrass shoot number and biomass for samples collected from Shark Bay in 1995 (25°38.04'S,113°42.76'E).

SAMPLE	SPECIES	SHOOT #	ABOVE GROUND BIO. (g.dwt/quad.)	BELOW GROUND BIO (g.dwt/quad.)	TOTAL BIOMASS (g.dwt/quad.)
1	*H. ovalis*	13	0.11	0.04	0.15
2	*H. spinulosa*	16	0.33	0.09	0.34
3	*H. spinulosa*	7	0.10	0.03	0.13
4	*H. spinulosa*	4	0.06	0.04	0.10
5	*H. decipiens*	15	0.01	0.02	0.03
6	*H. spinulosa*	6	0.02	0.10	0.12
7	*H. spinulosa*	11	0.16	0.06	0.24
MEAN		**10.29**	**0.11**	**0.06**	**0.16**
S.E		**1.77**	**0.04**	**0.01**	**0.12**

Table 3. Morphological information pertaining to seagrass samples collected from Shark Bay in 1995 (25°38.04'S,113°42.76'E).

SPECIES	SHOOT No.	SHOOT LENGTH (cm)	No. LEAVES PER SHOOT	MEAN LEAF LENGTH(cm)
H. ovalis	1	2.80	1.00	2.90
	2	2.00	1.00	3.00
	3	2.00	1.00	2.90
	4	2.80	1.00	2.80
	5	3.20	1.00	2.70
	6	3.70	1.00	2.90
	7	3.00	1.00	3.10
	8	0.80	1.00	1.00
	9	0.80	1.00	0.50
	10	2.80	1.00	2.90
	11	1.10	1.00	3.20
	12	3.50	1.00	2.90
	13	3.10	1.00	2.80
MEAN		**2.43**	**1.00**	**2.58**
S.E		**0.27**	**0.00**	**0.22**
H. spinulosa	1	5.50	23.00	2.70
	2	11.00	26.00	2.50
	3	7.50	24.00	2.70
	4	2.50	14.00	2.00
	5	10.50	40.00	2.00
	6	8.30	27.00	2.80
	7	0.60	6.00	1.30
	8	5.60	22.00	2.70
	9	3.10	9.00	2.00
	10	2.30	8.00	1.40
	11	4.80	16.00	2.60
	12	10.80	44.00	2.00
	13	7.80	30.00	2.40
	14	4.10	5.00	2.50
	15	3.50	9.00	0.70
	16	0.60	8.00	1.20
MEAN		**5.53**	**19.44**	**2.09**
S.E		**0.87**	**3.02**	**0.16**
H. spinulosa	1	3.00	15.00	2.60
	2	3.20	19.00	2.60
	3	6.20	27.00	2.60
	4	2.20	8.00	2.00
	5	2.20	9.00	1.70
	6	2.20	10.00	0.90
	7	2.00	10.00	2.00
MEAN		**1.13**	**5.29**	**0.78**
S.E		**0.56**	**2.62**	**0.24**
H. spinulosa	1	4.50	16.00	2.00
	2	3.70	21.00	2.30
	3	17.00	11.00	1.80
	4	3.60	21.00	2.30
MEAN		**7.20**	**17.25**	**2.10**
S.E		**3.27**	**2.39**	**0.12**

H. decipiens	1	0.60	1.00	0.12
(petiole length	2	0.00	2.00	0.80
not shoot length)	3	0.10	2.00	0.10
	4	0.30	2.00	0.12
	5	0.60	4.00	0.13
	6	0.20	1.00	0.13
	7	0.60	2.00	0.14
	8	0.30	2.00	0.15
	9	0.00	2.00	0.70
	10	0.30	1.00	0.14
	11	0.45	1.00	0.90
	12	0.20	2.00	0.11
	13	0.60	2.00	0.90
	14	0.80	1.00	0.10
	15	0.20	2.00	0.21
MEAN		**0.35**	**1.80**	**0.32**
S.E		**0.06**	**0.20**	**0.08**
H. spinulosa	1	5.00	21.00	2.70
	2	3.00	19.00	2.60
	3	1.50	9.00	1.70
	4	0.40	10.00	0.90
	5	4.00	19.00	2.20
	6	2.50	14.00	2.70
	7	3.40	12.00	2.50
MEAN		**2.83**	**14.86**	**2.19**
S.E		**0.58**	**1.82**	**0.25**
H. spinulosa	1	3.30	18.00	2.40
	2	4.30	15.00	2.70
	3	3.30	14.00	2.10
	4	2.20	11.00	2.00
	5	2.00	13.00	2.40
	6	3.50	18.00	2.50
	7	4.00	21.00	2.10
	8	1.50	7.00	1.50
	9	4.00	14.00	2.20
	10	0.50	6.00	1.00
	11	0.00	5.00	0.50
MEAN		**2.60**	**12.91**	**1.95**
S.E		**0.44**	**1.58**	**0.20**