Survey of *Zostera marina* bed at Jennycliffe Bay, Plymouth

07/06/04 & 08/06/04

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Report by Amy Bugg

Seasearch Coordinator for the MCS Plymouth Local Group

The Survey Team

Amy Bugg	-	Coordinator, Diver	-	PADI Advanced Open Water
Paul Cox	-	Diver	-	PADI Advanced Open Water
Kate Crawfurd	-	Diver	-	PADI Open Water
Liz Evans	-	Diver	-	PADI Open Water
Emma Jackson	-	Diver	-	PADI Divemaster
Louisa Jones	-	Diver	-	PADI Rescue Diver
Sean Lindsley-Leake	-	Diver	-	PADI Rescue Diver
Nigel Mortimer	-	Diver	-	BSAC 2nd Class
Emma Sartain	-	Diver	-	PADI Master SCUBA Diver
Jason Hall-Spencer	-	Photographer/Videographer	-	BSAC Advanced
Sean McTierney	-	Skipper	-	Commercially Endorsed Boat Skipper, Yacht Master

First Aiders

Amy Bugg	-	Emergency First Response, Oxygen Administration
Louisa Jones	-	Emergence First Response, PADI Rescue Diver
Sean McTierney	-	PADI MSDT (including Emergency First Response, Oxygen Administration, Rescue Diver), BSAC Rescue Management

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Introduction & Background Information

Zostera marina is a species of eelgrass. This seagrass is not seaweed, but a flowering plant. The name *Zostera* comes from the Greek word 'zoster', meaning 'belt', which describes the plants ribbon-like leaves. It is described on MarLIN's website as:

> "*Grass like flowering plant with dark green, long, narrow, ribbon shaped leaves 20-50 cm in length (exceptionally up to 2 m long) with rounded tips. Leaves shoot from a creeping rhizome that binds the sediment. Leaves and rhizomes contain air spaces, lacunae, that aid buoyancy. Numerous flowers occur on a reproductive shoot similar to those of terrestrial grasses.*"

Eelgrass is perennial and grows by both seed germination and vegetative growth (by spreading rhizomes). Vegetative reproduction probably exceeds seedling recruitment except in areas of sediment disturbance (Reusch *et al*, 1998; Phillips & Menez, 1988). It is a subtidal species whose depth of growth is limited by water clarity and incident light.

Eelgrass beds are important marine habitats. They can support diverse macroinvertebrate communities and may act as nursery grounds to many fish and shellfish species, providing shelter and protection from predators. They are thought to be the main habitat for seahorses in the British Isles (*The British Seahorse Survey*, Neil Garrick-Maidment and Louisa Jones, 2004) and beds in shallow water are also accessible to feeding waterfowl. They are recognised globally as both diverse and productive ecosystems.

There are three recognised species of eelgrass found in and around Britain. These are *Z. marina*, *Z. angustifolia* and *Z. nolitii* (dwarf eelgrass). However, there is some debate over whether *Z. angustifolia* is a true species, or actually a variety of *Z. marina* (Holt, Hartnoll and Hawkins, 1997). In UK literature they are distinguished from each other on the basis of morphology; outside the UK *Z. angustifolia* is considered to be a phenotypic variant of *Z. marina*.

There are several *Z. marina* sites within Plymouth Sound, located close to Drakes Island and within Jennycliffe Bay, Cawsand Bay and Firestone Bay.

It was decided to concentrate initially on the *Z. marina* bed at Jennycliffe as there is little previous information. The only knowledge we have on the site is from a Masters thesis by R.J. Allen, "*Evaluation of remote observation methods for surveying Zostera marina beds*" (1999). It concentrates on the comparison between the *Z. marina* beds at Drakes Island and Jennycliffe Bay, looking at the extent of the beds, mean shoot density and community structure. An ROV was used to survey the beds. The results showed that the Jennycliffe bed had an area of 5800m^2, with a mean shoot density of 20 (± 8.5) shoots per m^2 (approximately 20% cover). Allen also included a map in the thesis showing the extent of the bed at Jennycliffe.

As eelgrass beds are considered to be ephemeral in nature, it was not known if the information in the thesis was still accurate. It was decided to use this as a starting point for the survey.

Aims

Recently, habitat managers and organisations have become increasingly protective of eelgrass, due to its ecological importance and its vulnerability to coastal development. It helps stabilise shorelines, by softening the impact of waves and currents and provides an extremely important habitat for fish and wildlife. This became very apparent during the 1930's when beds on the Atlantic coasts of Europe and North America were severely reduced by an outbreak of "wasting disease". It is thought that a slight rise in water temperature weakened the eelgrass, leaving it vulnerable to infection and death from a normally harmless protistan, *Labyrinthula*. The effects on the marine ecosystem were immediate and severe – whole populations of fish, shellfish, waterfowl and other animals were affected, as well as the stability of shorelines.

According to the MarLIN website, *Z. marina* is strictly protected under the Berne Convention and whilst it does not have its own species Biodiversity Action Plan (BAP), it is covered by a Habitat Action Plan (HAP). The Devon Biodiversity Action Plan lists eelgrass as being a species of conservation concern. It is included in the Habitat Action Plan for seagrass, which includes the following objective:

"*Increase our knowledge of the distribution, extent and quality of Zostera beds in the South West*"

English Nature has now commissioned an audit of *Zostera* beds in Devon and Dorset and hope to look at (in order of priority):

Extent of bed
Density of shoots (m^2)
% epiphyte cover
Density of *Sargassum muticum* (and other non-native species)
% cover of algal matt (on seabed)

It is important to look for the presence of non-native species such as *S. muticum* as eelgrass is highly sensitive to their introduction, with an intermediate intolerance and low recoverability (*"Sensitivity assessment for Z. marina",* Marine Biological Association).

Dr. Ken Collins of Southampton University advised me that there is little quantitative data currently available on eelgrass. Following a meeting with all members of the survey team on May 10th 2004, it was decided to also record the length of the eelgrass shoots, to obtain additional quantitative data. We also decided to record any marine life that was present in the bed, as this can be used as an indicator of its health – obviously, a healthier bed can support a higher abundance and more diverse range of organisms. The presence of *Z. marina* flowers and seeds, lesions on the shoots (which would indicate wasting disease) and the presence of hydroids would also be noted.

The survey results will be submitted to English Nature for inclusion in the eelgrass audit report and also to the *Zostera* working group.

Methodology

Initially, an email was sent out to the MCS Plymouth Local Group asking for volunteers to take part in the survey. Divers needed to hold a suitable diving qualification (such as PADI Advanced Open Water or higher), have undertaken at least 20 open water dives (including at least 10 temperate sea dives), be of good overall health and have dived within the last 6 months.

There was a very good response and many people volunteered to help. As we only needed a small team, divers were then selected on the basis of relevant diving qualifications and experience. The final team consisted of me, Liz Evans, Emma Sartain and Sean Lindsley-Leake (all of University of Plymouth), Louisa Jones (the Seahorse Trust), Paul Cox (the National Marine Aquarium), Nigel Mortimer (South Hams District Council) and Emma Jackson (post-doctoral research fellow at UoP, who has studied eelgrass beds in Jersey). Jason Hall-Spencer (Royal Society research fellow at UoP) was brought in to photograph and video the bed and divers as they worked underwater. Kate Crawfurd was on stand-by as a reserve diver, in case anyone couldn't make it on the day.

I then secured the help of Sean McTierney of Plymouth Diving Centre, who allowed us to use their classroom for meetings and their boat for the surveys. They also provided a weekly shuttle (at cost) on Monday evenings, to the Jennycliffe eelgrass bed so we could monitor the marine life present.

A meeting with the survey team was held on 10th May 2004 at the dive centre, to discuss the methodology that would be used. We had a limited budget and it was important to get good, reliable data from the survey, in order to meet our main parameters and the additional data we wished to obtain. All input was welcomed.

The dates set for the survey were the 7th and 8th June 2004. As we did not know the exact position of the bed, I organised a weekly dive out to the site. Local MCS members were invited to come along and asked to fill in a Seasearch form at the end of each dive, to record marine life observed in and around the bed. Three pre-survey dives were planned, for Monday 17th, 24th and 31st May. The last of these dives was rescheduled to Wednesday 2nd June due to bad weather and poor visibility. We were able to determine the position of the bed, and gain a rough idea of its extent.

The methodology that had been proposed following the May 10th meeting (see *'Appendix'*) was altered slightly following the first two dives. It had originally been suggested that we would place a shot line in the middle of the bed, then work out along transects from there. The information from these dives suggested that there was no eelgrass to the West and South West of the middle of the bed. Sean and I therefore dived round the outer edges of the entire bed on June 2nd and sent up an SMB when we found the Westerly edge. This position was then marked using the GPS on the boat.

It had been decided that divers would follow transect lines to the North, North East, East, South East and South through the bed, placing a quadrat along each line every 2m and recording measurements on an underwater slate.

On the 6th June, Sean and I prepared the equipment that was to be used for the survey. Four steel-framed quadrats measuring 50x50cm had been donated by a friend. We drilled the quadrats and used nylon rope to divide them into 10cm sections along each edge. This enabled the divers to easily measure the density of the eelgrass and % cover of algal mat on the sea bed. Four reels, to be used as the transect lines, were marked every 2m with permanent pen. The divers could then follow these reels through the bed and place the quadrat on each mark. Four underwater slates were made up using tables I had designed to allow the divers to easily record the necessary measurements.

On the evening of the 6th of June, we went back to bed to set up for the survey the following day. We placed a buoy where we believed the Westerly edge of the bed to be (using the GPS reading we had obtained on 2nd June), and two divers went down to check this. A small adjustment was made after the divers had swum a circular pattern around the buoy to check its position, and then the transect lines were laid. The lines were laid to the North, North East, East, South East and South of the buoy. The divers used compasses to ensure the lines were laid on true, accurate bearings, made sure they were taught and secured them firmly using metal pegs so they would not move. The position of the buoy was recorded using the boat's GPS as 50º20.467 N, 004º07.799 W.


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On the 7th June, the team met at Plymouth Diving Centre at 7.30am. High water was expected at 9.55am and it was important to get out to the site before the tide turned, causing currents which would make survey work difficult. I did a short presentation with photos, showing the kind of marine life that was expected from the weekly dives on the site, *Z. marina* in flower, its seeds, epiphytes, algal mat and hydroids, so everyone knew exactly what they were looking for.

Teams were assigned to follow each transect line. As we already knew that the South and East lines were fairly short, it was decided that one team would survey both these lines. Nigel and Sean Lindsley-Leake would survey the North line, Emma Jackson and Paul would survey the North East line, Liz and Emma Sartain the South East line, and Louisa and I the East and South lines.

I went through the equipment that was to be used, explaining the tables on the underwater slates so everyone knew what measurements were needed, how to record them and how they should place their quadrat along the reels on the marks, which were 2m apart. We already knew that the bed is quite patchy with areas of bare sand in between. It was decided that if a quadrat was placed in a patch of bare sand, but there was a clump of eelgrass next to the line, they should move the quadrat across from the mark to that patch, noting how far away the patch was from the line.

Divers then kitted up and loaded the equipment onto the boat, before setting off for Jennycliffe Bay, with Sean as skipper.

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Once at the site, it was explained to the team that as we did not know how long the survey would take, we could not give them a maximum bottom time for the dive. It was decided instead that should anyone reach 50 bar of air remaining in their cylinder, they should return to the buoy and surface, but fortunately all the recordings were made before this happened.

Divers then kitted up and entered the water in their teams, one person with the quadrat and one person with the slate. They descended down the buoy, found their transect line and swam along it, recording the necessary information every 2 meters and noting any marine life they saw on the way. Divers had been provided with small plastic sealable bags to take samples of any *Z. marina* seeds or flowers, shoots with legions present, and any epiphytes or hydroids they could not identify (some 'fluffy' seaweeds can easily be mistaken for hydroids. Jason had volunteered to identify any samples that were taken). Shoots were measured using the quadrats, which had cm measurements marked on one side.

Once divers reached the edge of the bed (or the end of their transect line), they turned around and followed the transect line back to the shot line, where they then made their ascent. In mine and Louisa's case, once we had finished the South line, we returned to the shot line, followed the East line, then returned once again to the buoy and made our ascent. Jason, who was filming the survey, swam along all of the transect lines recording the divers at work, before returning to the buoy to make his ascent.

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Once everyone was safely back on board the RIB, we returned to the dive centre and transferred the information recorded from the underwater slates to paper copies of the tables. Divers were then asked if there was anything further they would like to do the following day. It was suggested that the North line be extended as the divers had reached the end of this transect line before reaching the edge of the bed. It was also noted that there was a patch of eelgrass to the North West of the shot line. Another line would be reeled out in this direction so that this patch could also be recorded.

On the 8th June, the team met at the dive centre at 8.30am. High water was expected at 10.48am. Kate Crawfurd joined the team as I was not well enough to dive. She was briefed on what had happened the day before. It was decided that Liz and Emma Sartain would go in first, to reel in the South line and use it to extend the North line. Louisa and Paul would go in just after to reel in the South East line and use it to create the new North West line. This line was expected to be quite short, as the patch the divers had noted the day before was fairly small so they would then reel in the East line as well. Kate and Emma Jackson would go down to reel in the North East line and then survey the North West line (reeling it in once they had finished). Nigel and Sean Lindsley-Leake would be last in, to survey the extended part of the North line and reel both the North lines in once they had finished. I would stay on the boat as crew with the skipper.

Once all this was completed, we again returned to the dive centre to transfer the information form the underwater slates onto paper copies of the table. Everyone stated that they were happy with what we had done over the two days and nobody felt we had missed any significant parts of the bed.

<u>Results</u>

Diagrams on the following pages show a summary of the information collected for each individual transect line (Figures 1–6, NW, N, NE, E, SE and S) and a summary of the density of the bed (Figure 7). The tables containing the raw data can be found in the *'Appendix'* section.

Below are photographs showing some of the marine life present in and around the bed at Jennycliffe. All photographs © Jason Hall-Spencer 2004.

Spiny spider crab, *Maja squinado*

Spiny starfish, *Marthasterias glacialis*

Mating nudibranchs, *Limacia clavigera*

Greater pipefish, *Sygnathus acus*

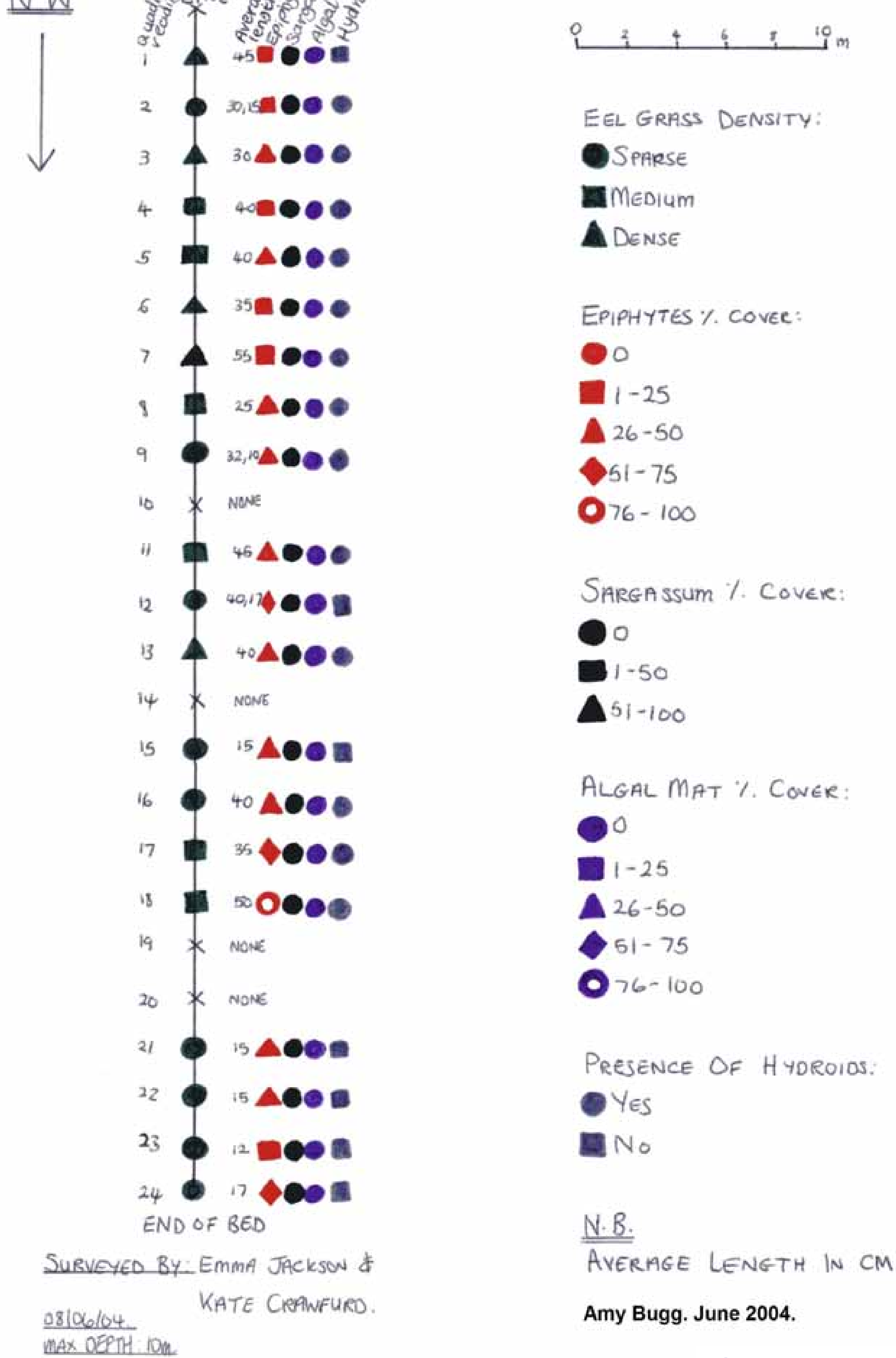
Netted dog-whelk, *Hinia reticulata*, eggs

Razor shell, *Ensis ensis*

Large necklace shell (Moon snail), *Euspira catena*

Alder's necklace shell, *Polinices*

pulchellus, egg case



Amy Bugg. June 2004.

Figure 1

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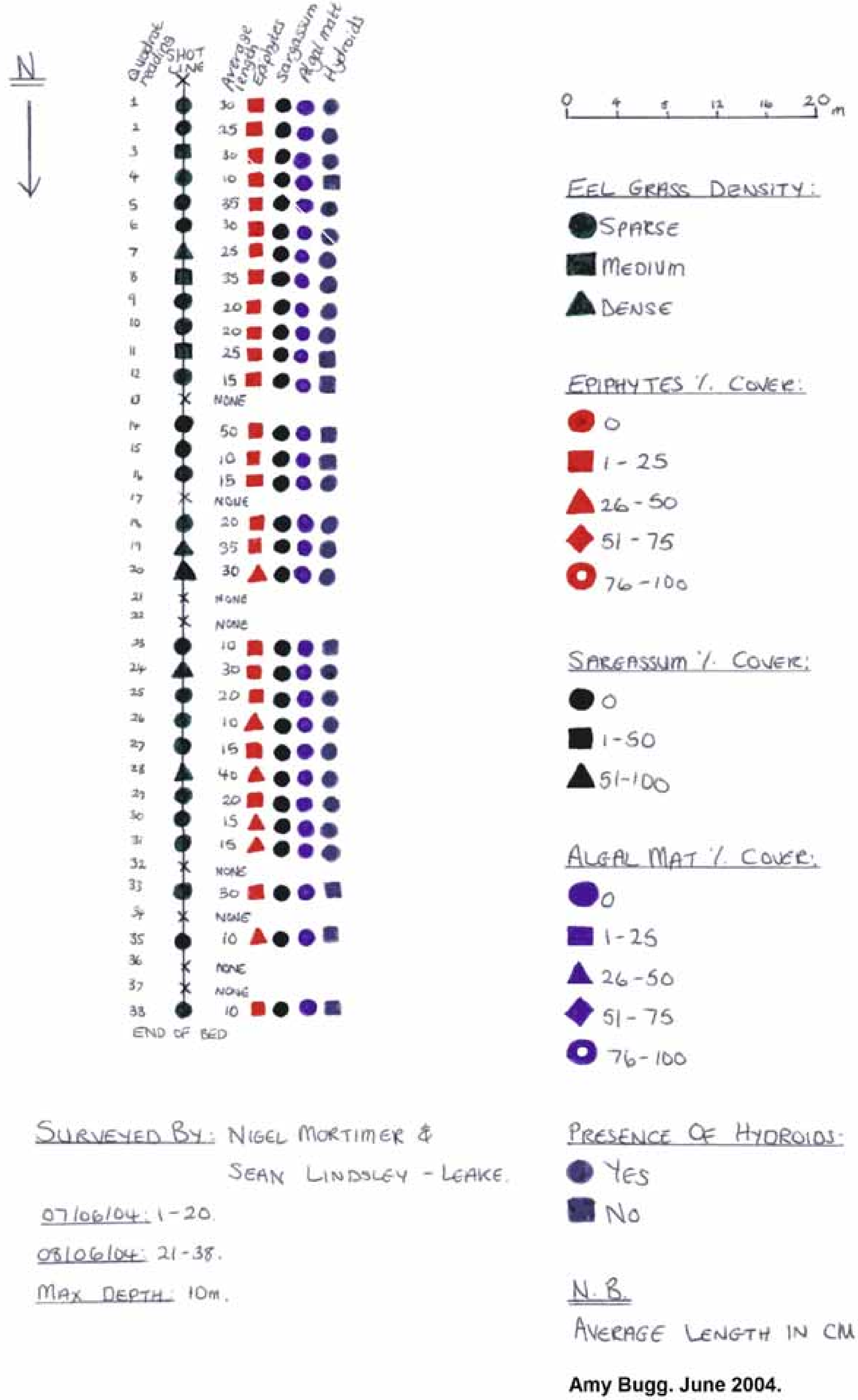

N
Quadrat reading
SHOT LINE
Average length
Epiphytes
Sargassum
Algal mat
Hydroids
NONE
END OF BED
0 4 8 12 16 20 m
EEL GRASS DENSITY:
SPARSE
MEDIUM
DENSE
EPIPHYTES % COVER:
0
1 - 25
26 - 50
51 - 75
76 - 100
SARGASSUM % COVER:
0
1 - 50
51 - 100
ALGAL MAT % COVER:
0
1 - 25
26 - 50
51 - 75
76 - 100
SURVEYED BY: NIGEL MORTIMER &
SEAN LINDSLEY - LEAKE.
07/06/04: 1 - 20.
08/06/04: 21 - 38.
MAX DEPTH: 10m.
PRESENCE OF HYDROIDS:
YES
NO
N.B.
AVERAGE LENGTH IN CM
Amy Bugg. June 2004.

Figure 2

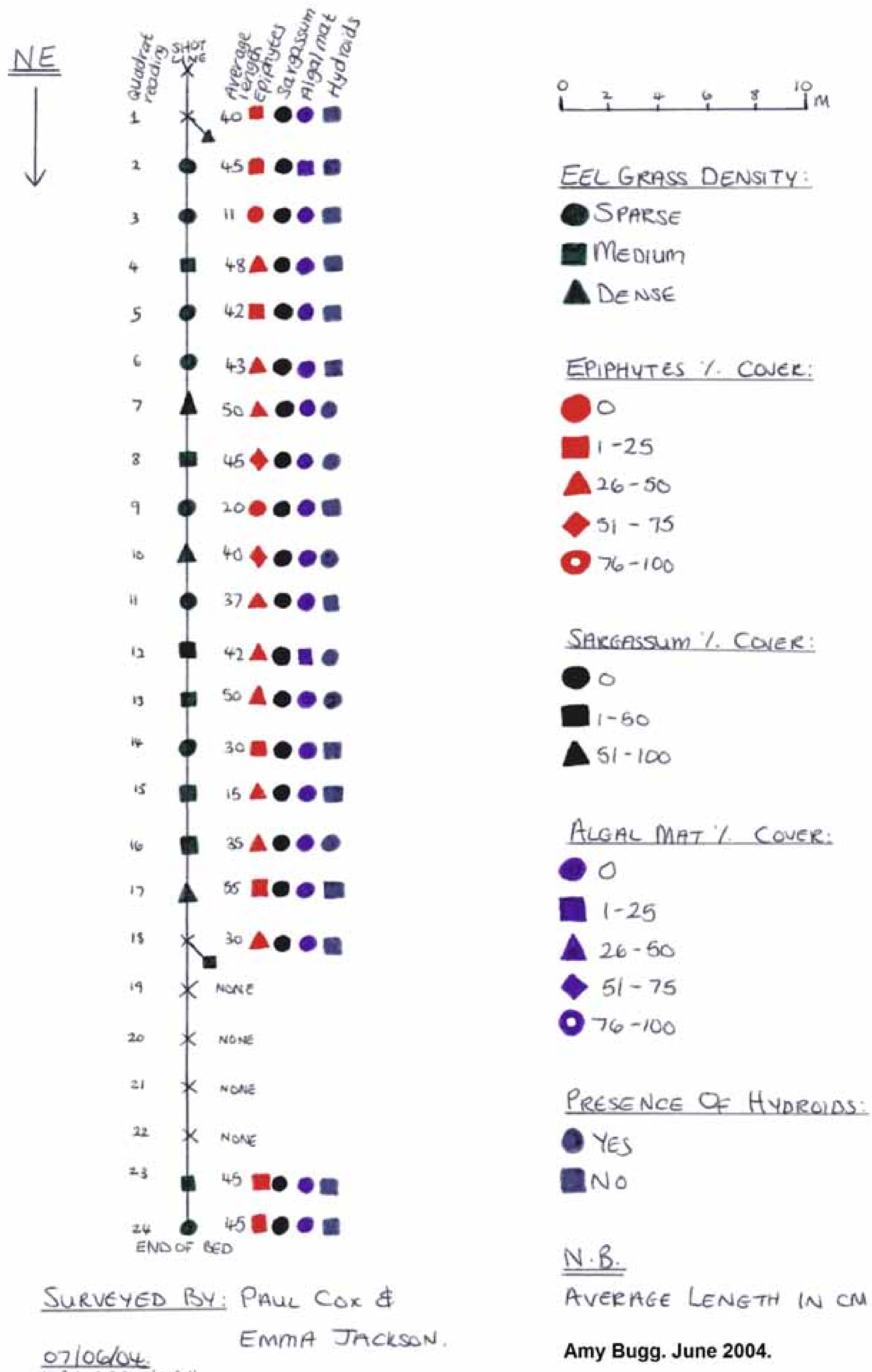
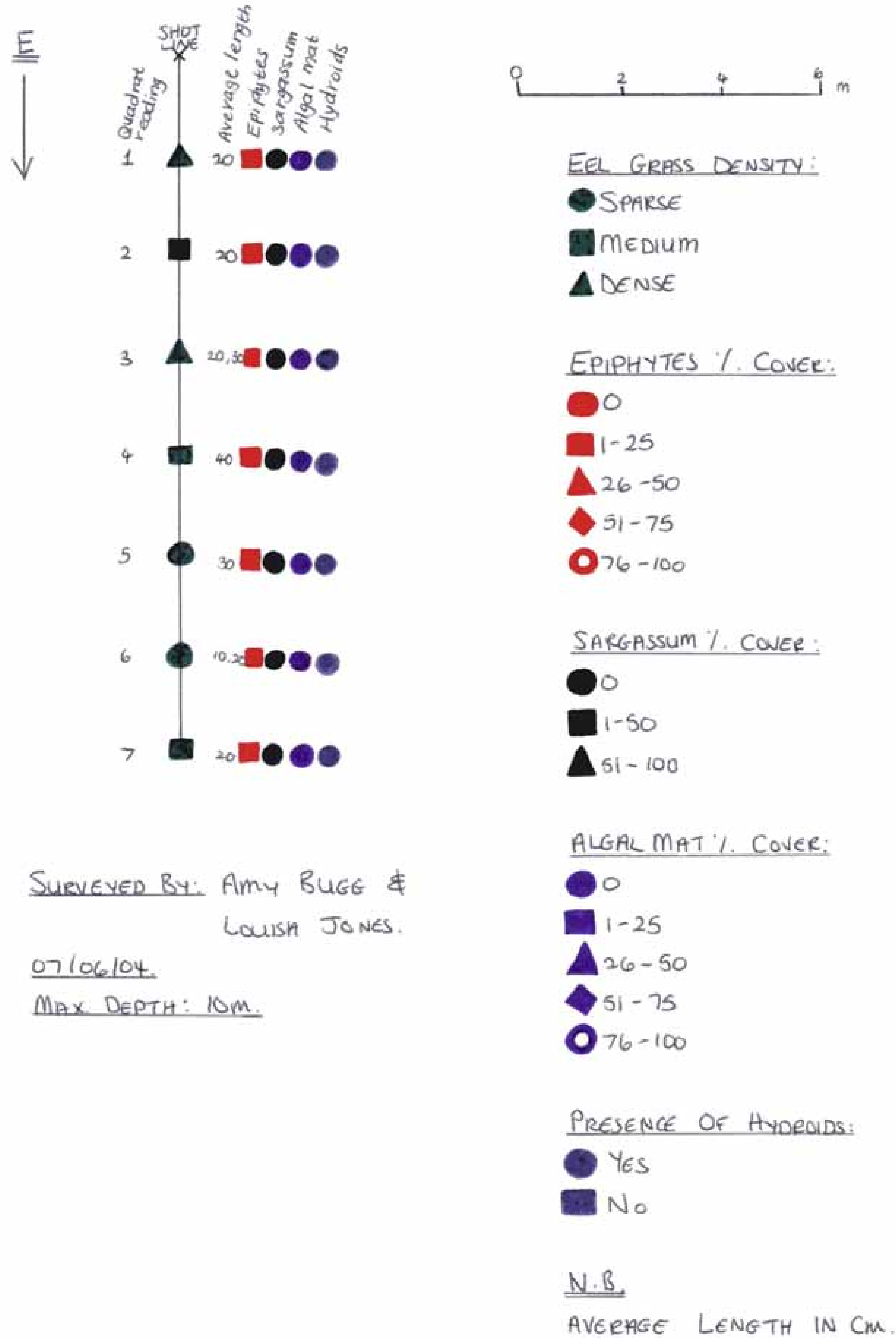
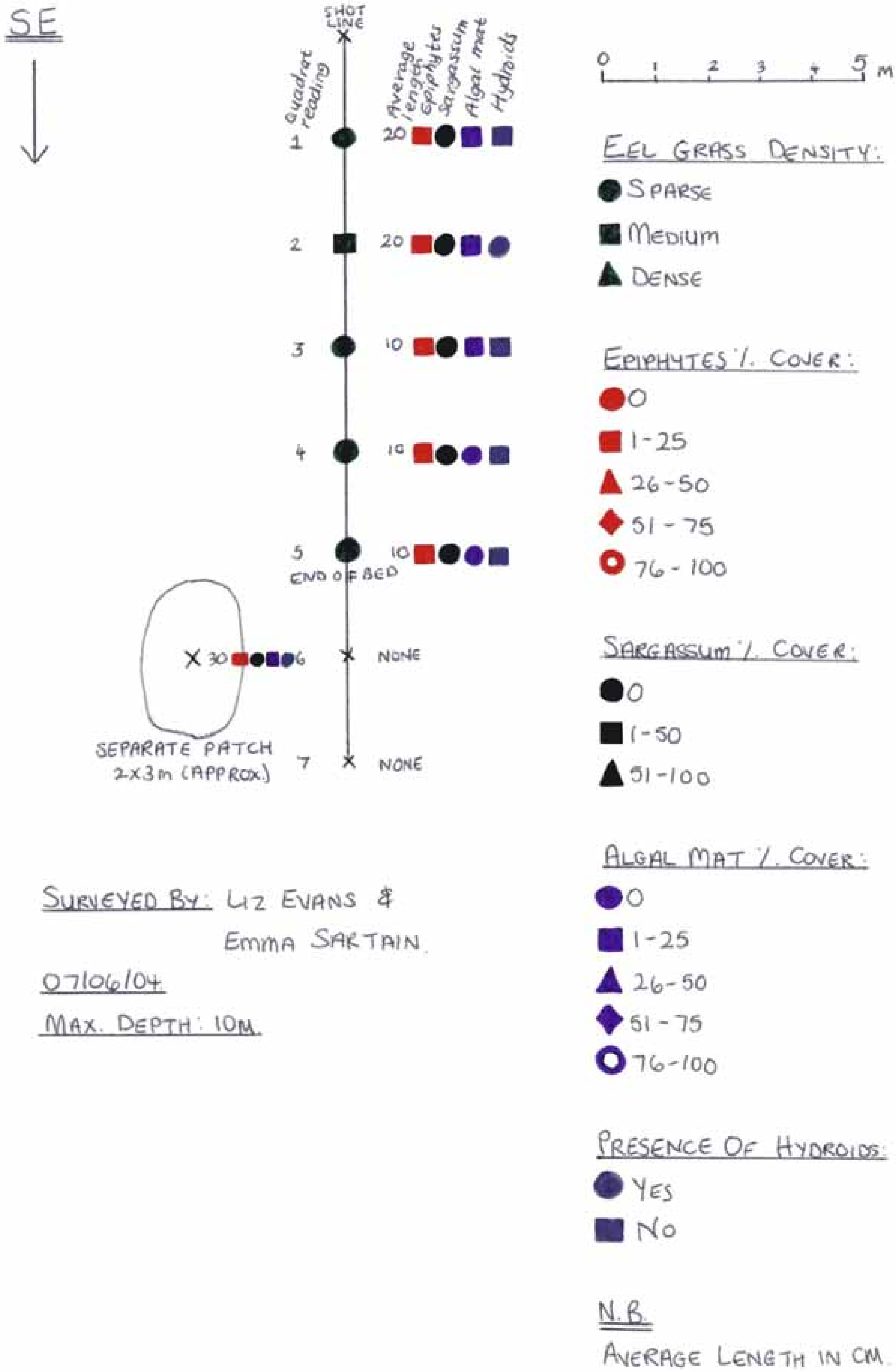

NE
Quadrat reading
SHOT LINE
Average length
Epiphytes
Sargassum
Algal mat
Hydroids
1 40
2 45
3 11
4 48
5 42
6 43
7 50
8 46
9 20
10 40
11 37
12 42
13 50
14 30
15 15
16 35
17 55
18 30
19 NONE
20 NONE
21 NONE
22 NONE
23 45
24 45
END OF BED
0 2 4 6 8 10 M
EEL GRASS DENSITY:
SPARSE
MEDIUM
DENSE
EPIPHYTES % COVER:
0
1 - 25
26 - 50
51 - 75
76 - 100
SARGASSUM % COVER:
0
1 - 50
51 - 100
ALGAL MAT % COVER:
0
1 - 25
26 - 50
51 - 75
76 - 100
PRESENCE OF HYDROIDS:
YES
NO
N.B.
AVERAGE LENGTH IN CM.
SURVEYED BY: PAUL COX & EMMA JACKSON.
07/06/04.
MAX. DEPTH: 10M.
Amy Bugg. June 2004.

Figure 3



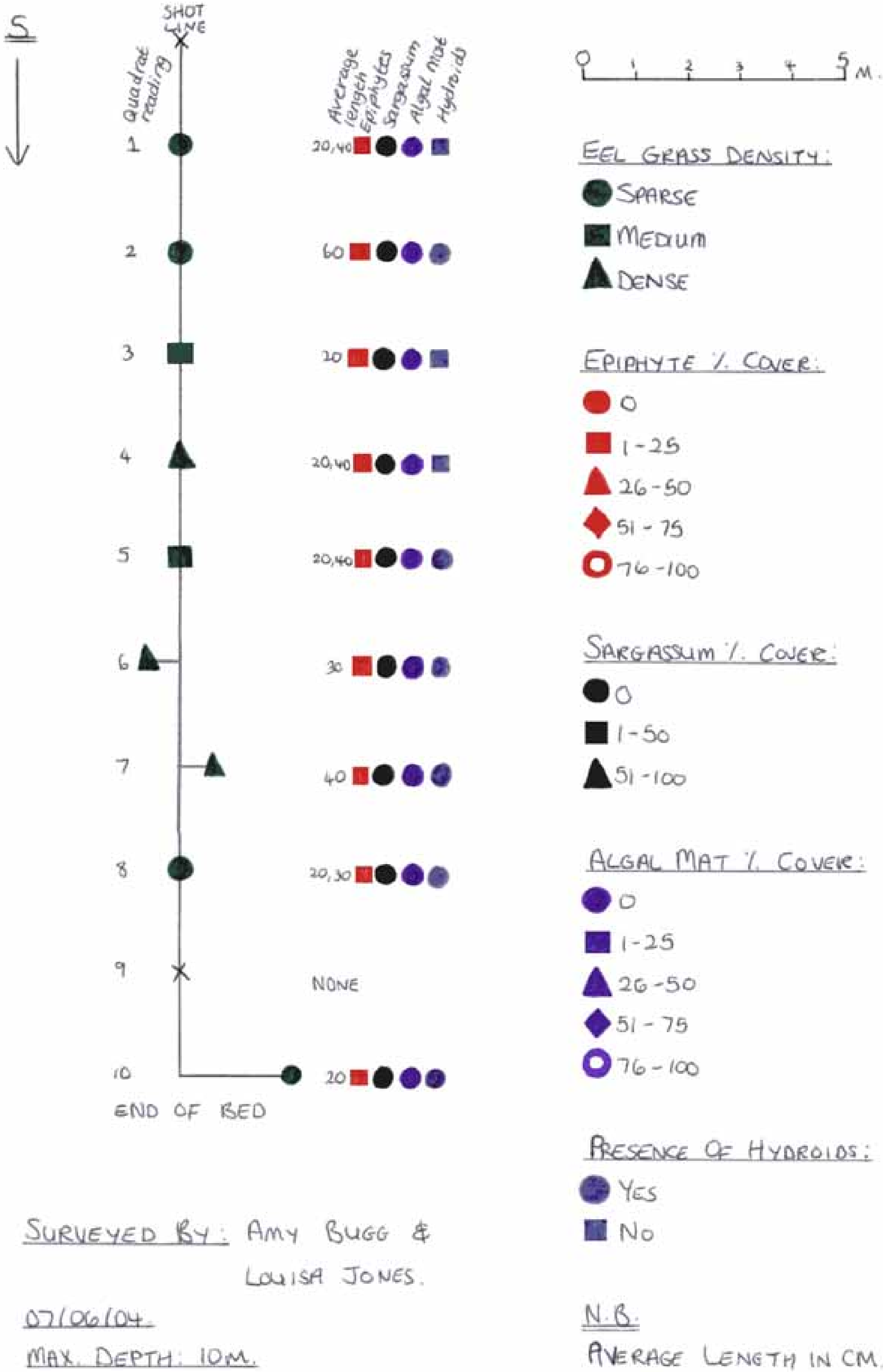
Amy Bugg. June 2004.

Figure 4



Amy Bugg. June 2004.

Figure 5



Amy Bugg. June 2004.

Figure 6

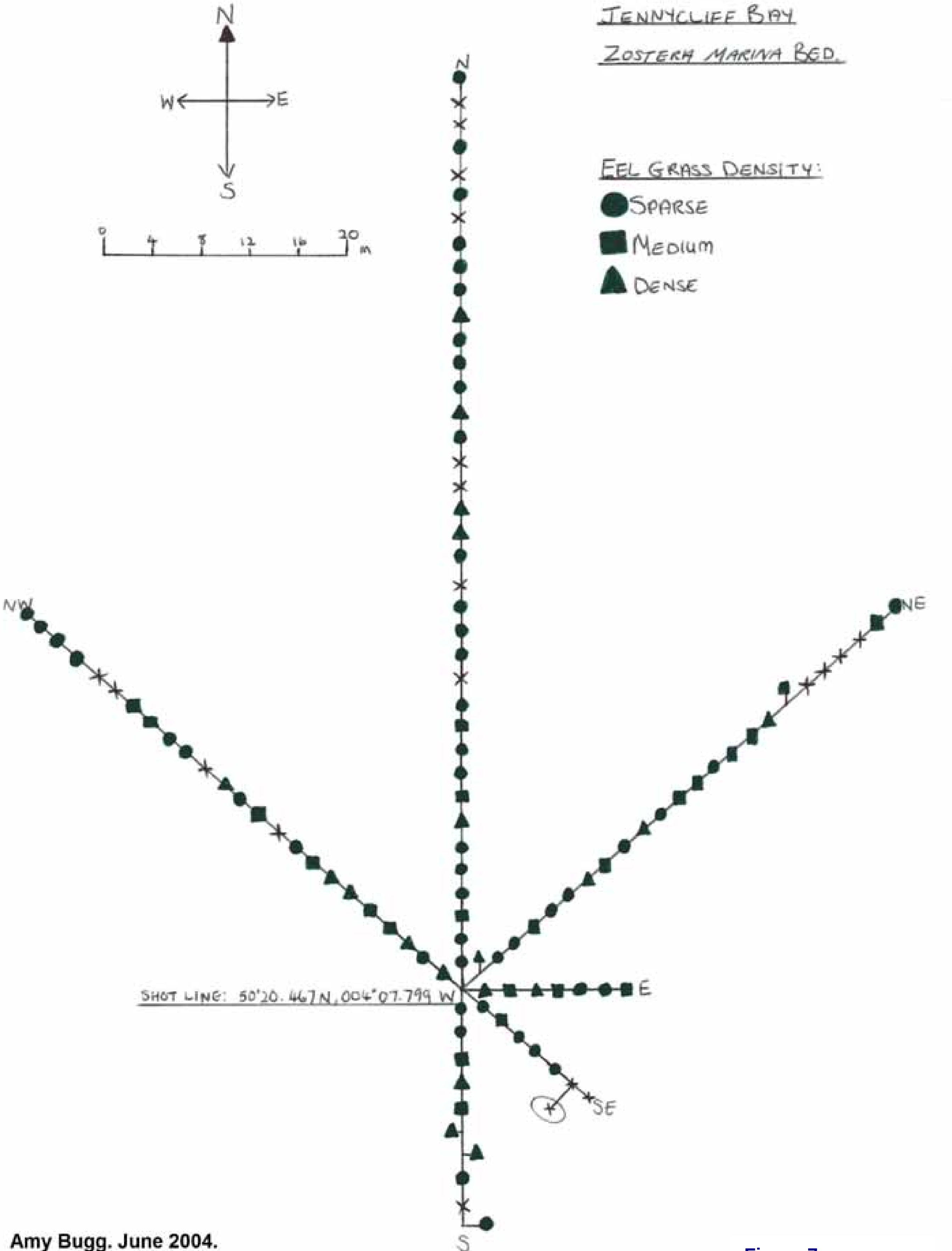
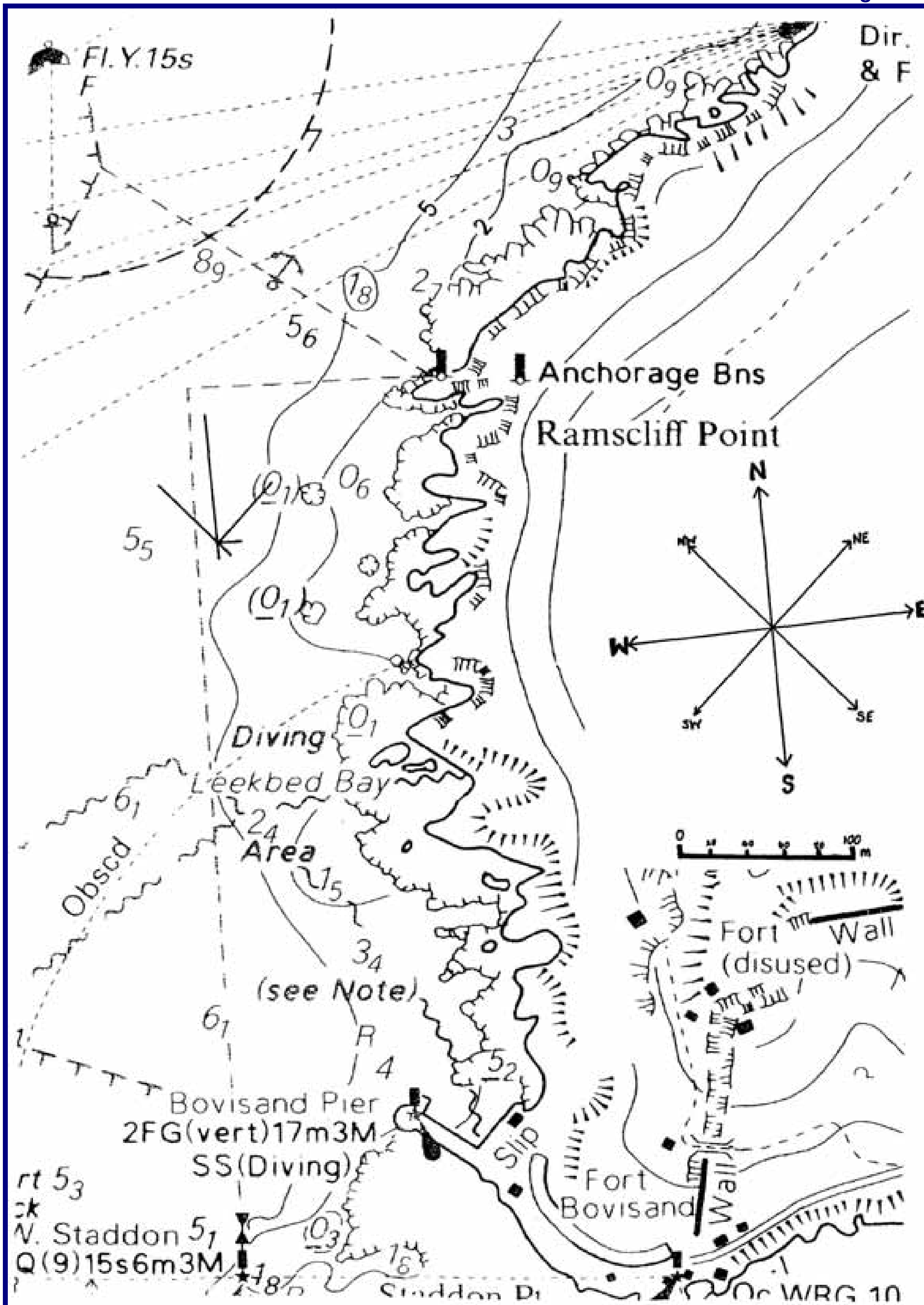

JENNYCLIFF BAY
ZOSTERA MARINA BED.
N
W
E
S
0
4
8
12
16
20
m
EEL GRASS DENSITY:
SPARSE
MEDIUM
DENSE
N
NW
NE
E
SE
S
SHOT LINE: 50°20.467N, 004°07.799 W
Amy Bugg. June 2004.

Figure 7

This map shows the position of the transect lines followed for the survey in Jennycliffe Bay, radiating from the shot line. This was positioned on the Westerly edge of the bed, at 50º20.467 N, 004º07.799 W.

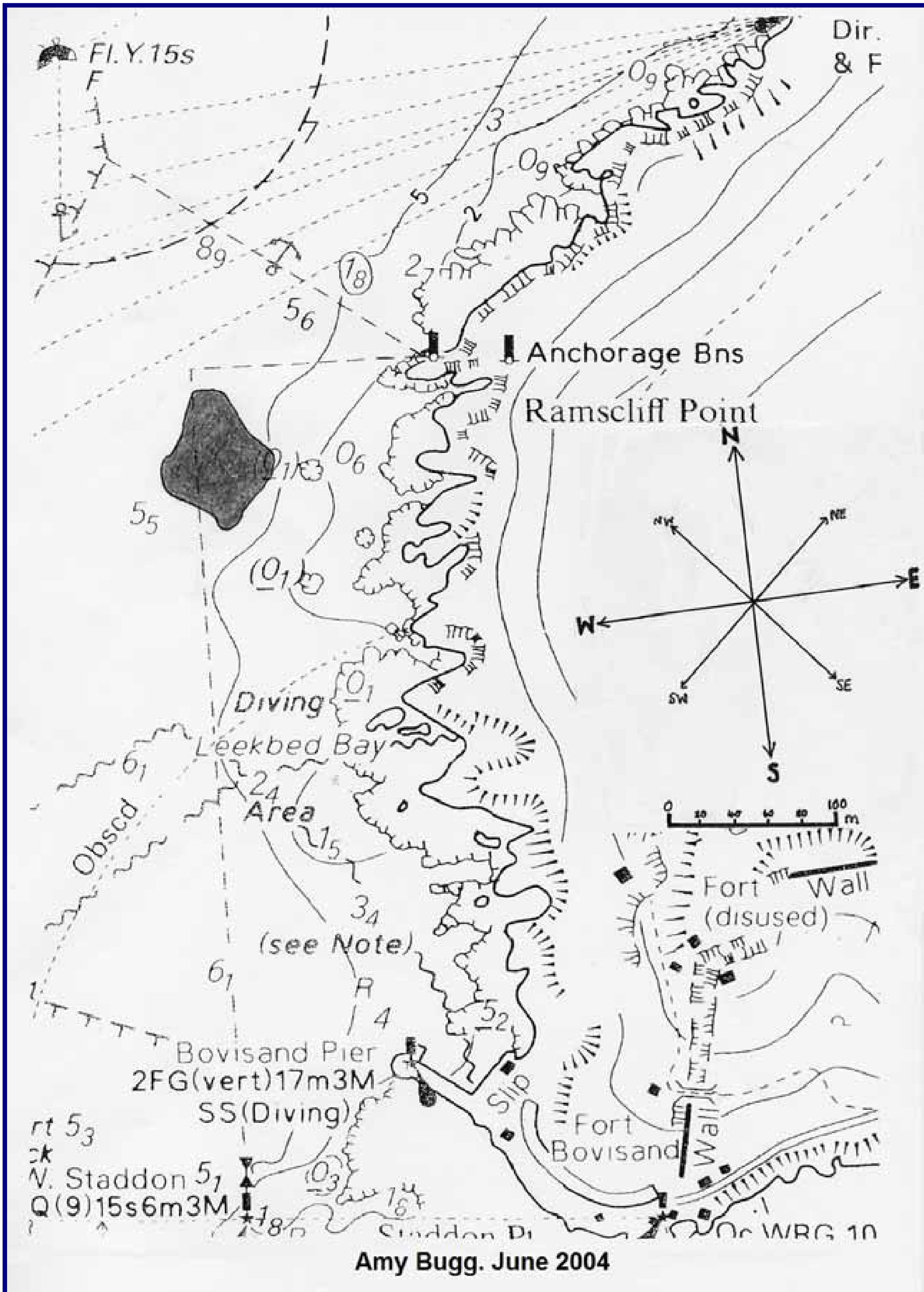
Figure 8



Amy Bugg. June 2004.

This map shows the extent of the eelgrass bed at Jennycliffe Bay.

Figure 9



Amy Bugg. June 2004

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Data Analysis

The results of the survey (shown in Figures 1–6) reveal some very interesting information about the Jennycliffe eelgrass bed.

The eelgrass is sparse over 44.55% of the bed, medium over 20.91% and dense over 17.27%. This means that the majority of the bed has sparse eelgrass shoots, whilst 17.27% has no shoots at all. This is generally bare sand with many burrows present, although there are some patches of kelp as well. As density is one of the main features of the bed that we had to look at, Figure 7 shows just the density of the bed along each transect line followed, enabling a quick comparison.

The extent of the bed can be seen clearly in the '*Maps*' section. Figure 8 shows the transect lines followed for the survey and their position relative to the coast. Having dived the site several times, we know that there are some patches of eelgrass between the lines we followed, and Figure 9 shows the estimated extent of the bed.

The eelgrass shoots to the North West of the bed are, on average, 30.35cm in length, to the North 22.83cm, North East 38.4cm, East 23.3cm, South East 19cm and South 30.77cm. Over the whole bed, the average length of shoots is 24.28cm.

On average, there is 1-25% epiphyte cover over 73.8% of the whole bed. There are no epiphytes present in the remainder of the bed.

No non-native species such as *S. muticum* were recorded in any part of the eelgrass bed.

Algal mat was recorded only along the North East and East transects. Algal mat is therefore estimated at 1-25% across 6.9% of the sea bed (within the North/North East area of the eelgrass bed).

Hydroids were recorded across the entire bed, with 59.8% of the area estimated to contain them.

Many *Z. marina* flowers and seeds were recorded throughout the entire bed. Dr. Emma Jackson remarked that there seemed to be quite a high number of these seeds and flowers present, which could indicate that the bed is experiencing environmental stress – greater sexual reproduction by the eelgrass leads to increased genetic diversity (*MEPS: 265*, Billingham *et al*, 2003) which could improve the eelgrass' chance of survival. However, as we don't know the normal flowering density for this particular bed, we can't be sure if this is the case.

Diver also reported many shoots with dark lesions on them, particularly within the South end of the bed. Some samples were taken and afterwards examined by Dr. Emma Jackson, who was sure it was wasting disease.

Marine life in and around the bed has been abundant and diverse, recorded both on the weekly dives and during the survey. The list below follows the format specified on the Seasearch forms and shows which species have been observed so far:

Sea weed

Brown

Oarweed – *Laminaria digitata*
Sugar kelp – *Laminaria saccharina*
Tangle (cuvie) – *Laminaria hyperborea*
Kelp – *Laminaria ochroleuca*

Red

Purple laver – *Porphyra umbilicalis*

Green

Sea lettuce – *Ulva lactuca*

Sponges

None

Hydroids

Various species

Anemones and corals

Snakelocks anemone – *Anemonia viridis*
Sea anemone – *Peachia cylindrica*

Soft corals

None

Sea fans and sea pens

None

Jellyfish

Moon (common) jellyfish – *Aurelia aurita*

Worms

Peacock worm – *Sabella pavonina*
Segmented worm – *Myxicola Infundibulum*
Lugworm – *Arenicola Marina*
Fan worm – *Bispira volutacornis*
Candy stripe flatworm – *Prostheceraeus vittatus*
Parchment worm – *Chaetopterus variopedatus*
Bristle worm – *Cirratulus cirratus*

Barnacles

None

Shrimps and prawns

Brown shrimp – *Crangon crangon*

Crabs and lobsters

Common hermit crab – *Pagurus bernhadus*
Common hermit crab with associated parasitic anemone – *Pagurus bernhardus* with *Calliactis parasitica*
Hermit crab with associated cloak anemone – *Pagurus prideaux* with *Adamsia carciniopados*
Spider crab – *Maja squinado*
Velvet swimming crab – *Necora puber*
Edible crab – *Cancer pagurus*
Common lobster – *Homarus gammarus*

Molluscs

Limpet – *Patella spp.*
Otter shell – *Lutraria lutraria*
Oyster drill – *Ocenebra erinacea*
Rough periwinkle – *Littorina saxatilis*
Large necklace shell (Moon snail) – *Euspira catena*
Alder's necklace shell egg case – *Polinices pulchellus*
Painted top-shell – *Calliostoma zizyphinum*
Auger (or tower) shell – *Turritella communis*
Whelk – *Buccinum undatum*
Dog-whelk – *Nucella lapillus* + eggs
Small dog-whelk – *Hinea (Nassarius) pygmaea* + eggs
Netted dog-whelk – *Hinea reticulata* + eggs
European cowrie – *Trivia monacha*
Sea slug – *Philine aperta*

Gastropods and bivalves

Razor shell – *Ensis ensis*
Sand gaper – *Mya arenaria*
Blunt gaper – *Mya truncata*

Scallops

Queen scallop – *Aequipecten opercularis*

Nudibranchs

Sea slug – *Limacia clavigera* + eggs

Cephalopods (squid, cuttlefish, octopus)

Common cuttlefish – *Sepia officinalis*

Bryozoans

Sea-mat – *Membranipora membranacea*

Starfish and brittlestars

Common starfish – *Asterias rubens*
Spiny starfish – *Marthasterias glacialis*
Sand star – *Astropecten irregularis*
Cushion star – *Asterina gibbosa*
Sand burrowing brittle star – *Amphiura brachiata*

Urchins

Common heart urchin (sea potato) – *Echinocardium cordatum*

Sea cucumbers

Cotton spinner – *Holothuria forskali*

Sea squirts

Orange sea grapes – *Stolonica socialis*

Fishes

Thornback ray – *Raja clavata*
Homelyn ray – *Raia maculata*
Ballan wrasse – *Labrus bergylta*
Corkwing wrasse – *Crenilabrus melops*
Cuckoo wrasse – *Labrus bimaculatus*
Rock cook – *Centrolabrus exoletus*
Black goby – *Gobius niger*
Painted goby – *Pomatoschistus pictus*
Sand goby – *Pomatoschistus minutus*
Greater pipefish – *Sygnathus acus*
Snake pipefish – *Entelurus aequoreus*
Deep snouted pipefish – *Sygnathus typhle*
Greater sand eel – *Hyperoplus lanceolatus*
Lesser sand eel – *Ammodytes tobianus*
Lesser spotted dogfish – *Scyliorhinus canicula*
Lesser weever – *Echiichthys vipera*
Long-spined sea scorpion – *Taurulus bubalis*
Bib (pouting) – *Trisopterus luscus*
Dragonet – *Callionymus lyra*
Garfish – *Lepisosteus osseus*
Garpike – *Belone belone*
Plaice – *Pleuronectes platessa*
Pollack – *Pollachius pollachius*
Sprat – *Sprattus sprattus*
Unidentified shoals of juvenile fish

Birds and mammals

None

Others

Epiphytes (various)
Fucoids (various)
Filamentous algae (various)
Red algae – *Polysiphonia lanosa*
Eelgrass – *Zostera marina* + seeds and flowers

As a healthy eelgrass bed can support a higher abundance and wider range of organisms, the prolific and diverse marine life observed in and around the Jennycliffe bed would suggest it is very healthy. However, it should be remembered that some divers observed that some of the eelgrass, particularly towards the South end of the bed, had dark lesions on the leaves, which could indeed be wasting disease. On a later dive on August 2nd, I observed that some of the eelgrass patches had turned brown in colour and appeared to be dying.

On the dive in August, it was realised that there was a distinct decrease in both the number and abundance of species, although there was still a fair amount of marine life present. This could indicate that the bed is no longer as healthy as it previously was.

Conclusion

The Jennycliffe eelgrass bed is fairly sparse, though some patches are denser and generally have longer shoots. The patchy formation of the bed would suggest high water motion in the area and currents have indeed been felt by some divers. This tends to create a mosaic of individual mounds rather than an eelgrass meadow (*Marine Biology – An Ecological Approach*, J.W. Nybakken, 2001).

The bed grows on a sandy substrate, which has numerous burrows present (for example, of the bivalve *Ensis ensis*). This burrowing is thought to cause disturbance in seagrass beds (Dawes, 1998) and the disruption of sediments is likely to interfere with the eelgrass' vegetative mode of reproduction. This could therefore account for the sparseness of the bed and may prevent it from growing across the sand (and thus creating a meadow). It could also explain the apparent higher than average density of eelgrass flowers and seeds.

Eelgrass beds are renowned for their ability to support diverse and abundant communities (R.J. Allen, 1999), so the profusion of marine life observed at the Jennycliffe bed is to be expected. However, it is quite surprising that the bed can support such high numbers of life given that it is relatively sparse over most of its area – higher quantities of seagrass have been found to support larger communities (Heck and Westone, 1977). It could be that the nearby kelp beds provide additional habitats and protection from predators, allowing a larger number and higher diversity of organisms to be present round the eelgrass bed.

The bed is not currently under threat by any non-native species, such as *S. muticum*, but does support hydroids and epiphytic growth. There is very little algal mat within the bed on the sea bed.

It does appear that the Jennycliffe bed could be affected by the wasting disease, as divers reported black spots on some of the shoots. As a healthy bed can support a higher abundance of marine life, the recent decrease in the associated community could suggest that there is indeed something wrong with the bed, as would the patches I observed that were dying back. I have been advised by Dr. Keith Hiscock of the Marine Biological Association that is not the time of year for this to occur. It should happen in the Autumn and even then not conspicuously. It could be that the warm weather has caused an increase in epiphytic growth – the epiphytes growing on the eelgrass shoots could block out the sunlight, causing the shoots to die.

Continued monitoring of the bed at Jennycliffe would useful to see if there are any other significant changes to the eelgrass or its associated community. It would also be worth taking more samples of shoots and getting an expert to examine the lesions, to ascertain whether or not the bed was diseased.

Other *Z. marina* sites and future action

Drakes Island

The 1993 Devon Wildlife Trust (DWT) report states (on page 37, number 19: Asia shoal) the following of the Drakes Island *Z. marina* bed:

> *"Zostera marina bed north of Drakes Island jetty, thinning to muddy sand and pebble on the edge of the channel slope. Thick Z. marina with lots of drift algae and many Gobiusculus flavescens. Muddy sand typical, with occasional tubeworms and anemones and many Pomatoschistus spp."*

There is further description of the bed on page 86 of the report, and under section 2.3.4.7.2. There is also some detail of the bed listed in the Inventory of eelgrass beds in Cornwall and the Isles of Scilly (site number C45), and a map of the site from the Environmental Records Centre for Cornwall and the Isles of Scilly (project series number 5, map 18 - Plymouth Sound).

It would be useful to dive the site at some point as there has been recent dredging in the area. English Nature requested that the dredging was not directly over the site but it would be useful to compare the bed as it is now, to its previous state. English Nature have aerial photographs of the site which clearly show the Drakes Island bed so a comparison would be relatively easy. Dr. Emma Jackson has offered her services to analyse the photographs properly for a fee. It is interesting to note that a local diver, Dave Peake, reported finding some eel grass shoots floating freely around the wreck of the *James Eagan Layne* in Whitsand Bay. It was his opinion that they could have been washed up from some of the dumped sediment from the Drakes Island dredging.

Cawsand Bay

The DWT report has information on the *Z. marina* bed in Cawsand Bay (section 2.3.4.7.1). It would seem that the bed at this site was affected by the wasting disease in the early 1930's and by subsequent outfalls discharging into the bay. There are some details of the site in the Inventory of eelgrass beds in Cornwall and the Isles of Scilly (site number C46) and the site is shown on map number 17 - Cawsand Bay in the Environmental Records Centre for Cornwall and the Isles of Scilly, project series number 5. There is further information on the site in the DWT report, page 93. Sporadic eelgrass was reported in the area in 2000 and the site has been identified as a priority for further investigation. It is hoped that the MCS Plymouth Local Group will be able to survey the site in the future once more funding has been secured.

Firestone Bay

There is some information available on Firestone Bay through the MarLIN 'Underwater Interactive Tour' (see *References*). The seabed landscape is shown, and there is some information on the 'Seagrass and sandy sediment', 'Shallow boulders and sediment', 'Rock slopes', 'Eastern King pinnacles and slopes', 'Cliffs and overhangs' and 'Deep seabed' habitats. There is however, no detailed information on the eelgrass bed itself.

The bed was surveyed last year by a team of snorkelers, under direction from Andrea Crump. Andrea used to run the MCS Plymouth Local Group but has since moved onto a job as Litter Projects Coordinator at the main MCS headquarters. We have unfortunately been unable to find the results of this survey, although it was believed that the information was entered into GIS so it might be possible to track it down. A recent email from one of the survey participants, David Dixon, stated that:

"We did not complete the work due to limited bottom time as we were all snorkelling + inflatable with GPS... It was at the time recommended that divers were needed as snorkelling only allowed the shallower portion of the site to be surveyed (but did prove very useful). The extent of this site was larger than expected".

I have been advised that diving at that location can be difficult due to strong currents, so further thought would be needed on the best method of survey.

I am continuing to organise dives each week to regulaurly survey the Cawsands and Jennycliffe eelgrass beds with volunteers from the MCS Plymouth Local Group and a boat provided at discount by Deep Blue dive centre. We hope to locate the position of the Cawsands bed and will continue to dive at Jennycliffe, noting any apparent changes to the bed and it's associated community.

Interest in this has been shown by another local dive centre. I am now assisting them with organising similar Seasearch dives for their dive club. I have asked them to record any marine life observed on Seasearch forms, to be sent to the MCS.

By Amy Bugg
Seasearch Coordinator for the MCS Plymouth Local Group

Proposed Methodology For Surveying Eel Grass Bed

Jennycliff Bay 7th/8th June 2004

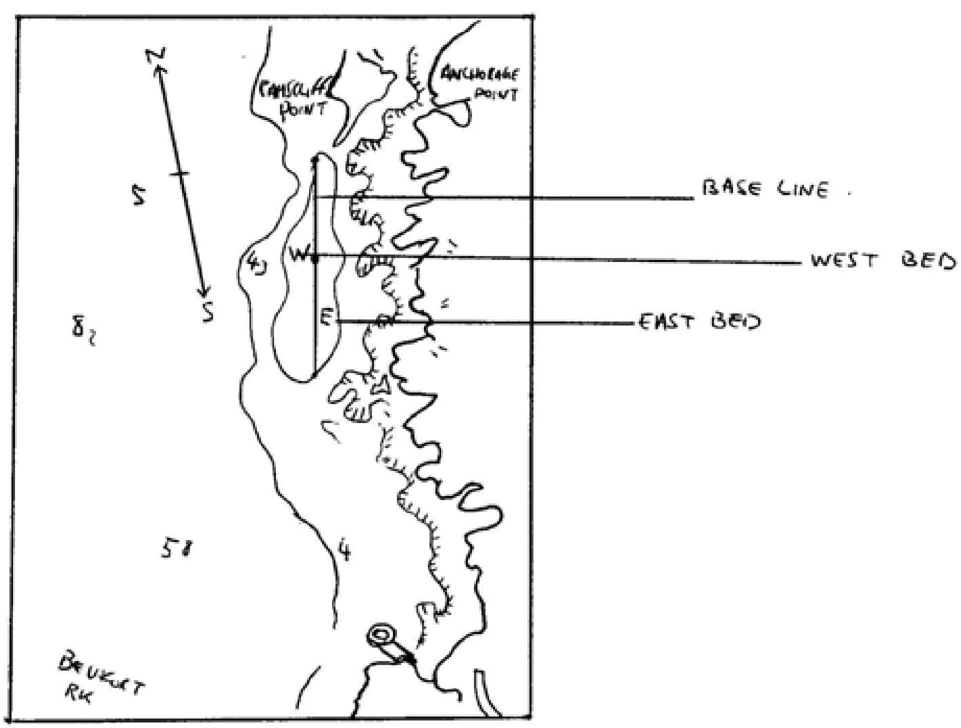
In order of priority

Extent
Density (m2)
% epiphyte cover
Density of Sargassum (and other non-native species)
% cover of algal mat (on seabed)

Extent
The extent of the bed is to be determined on Monday 17th May, 24th and 31st. Using a team of 6-8 divers we intend to drop a shot line into what is believed to be the centre of the bed. In buddy teams divers will then swim at 45' using reels heading to the outer parameters. When divers have reached the edge of what is to be considered east side of the shot (deep to shallow as moving toward the shoreline) they will deploy a surface marker bouy estimated depth 3m. These positions will then be marked using GPS

When completed divers will use the same proposed technique for covering the area of the west side of the shot (swimming to slightly deeper water, estimated 7m-9m)

FIG 1.



Density

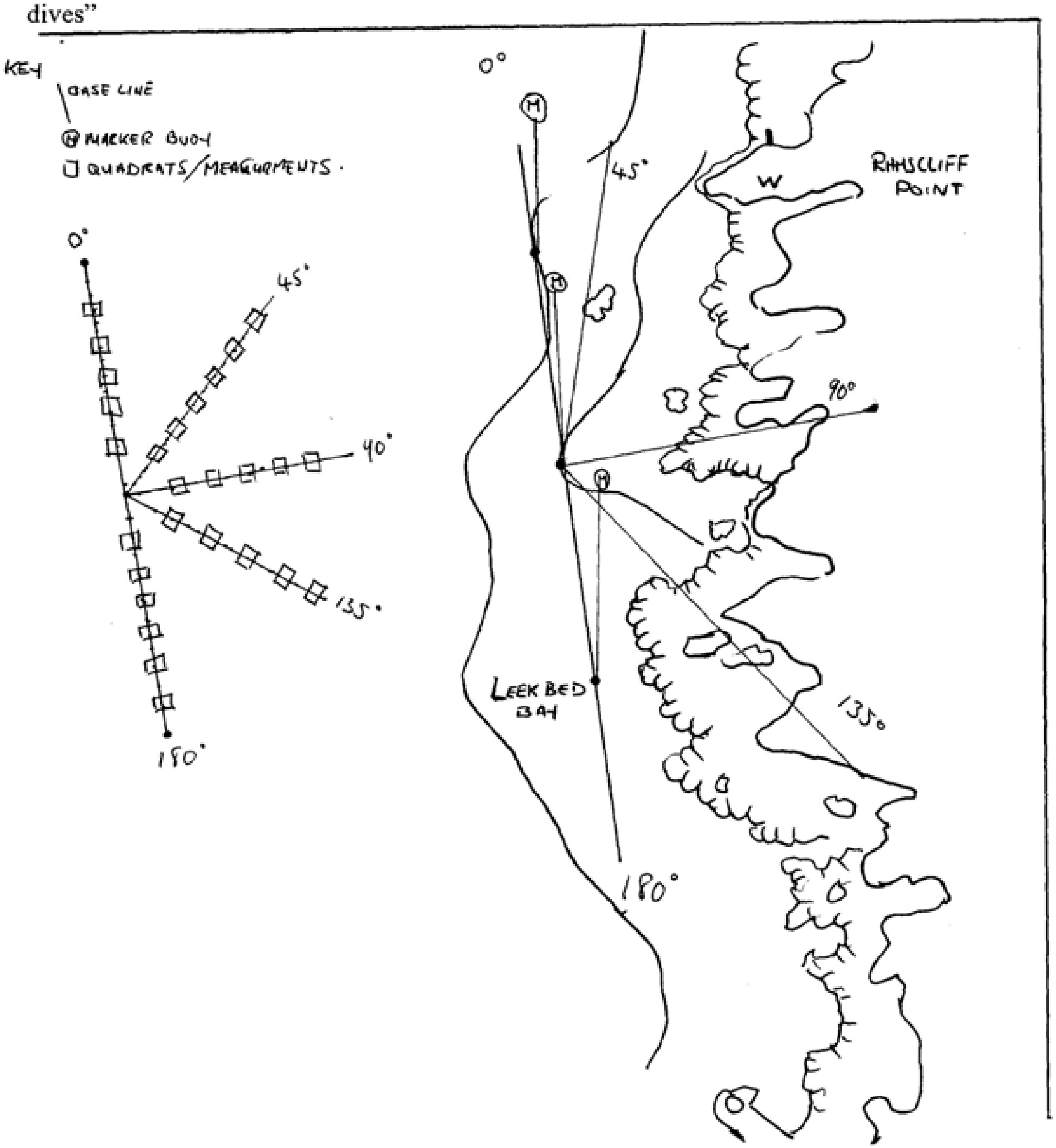
Once the extent has been verified, on Monday 7th June, a base-line will be put into position in the middle of the site and will run from North to South and marked with surface markers bouys.

Divers will then descend down a shot to the middle of the base line, then swimming along lines (put in position that morning) at 45' with quadrat and slate will measure distances every 2m. Diver 1 is to lay quadrat and Diver 2 to transfer info on to slate. This technique should continue to the outer parameters. Once completed it is suggested that divers return to the centre of base line to make their ascent.

It is proposed to use the suggested technique for the East side of the bed on day 1 (Monday7th) and the exact same method for the West side of the bed on day 2 (Tuesday8th)

It is also proposed that video and photography of the area be submitted as part of the survey.

"please note this method is proposed and subject to change pending the pre-survey dives"



On the following pages are tables containing the raw data collected from the survey, from the North West, North, North East, East, South East and South transect lines. The tables are of the same format as used on the underwater survey slates.

Quadrat reading	Density of eel grass: Sparse (S), Medium (M), Dense (D)	Average length of eel grass shoots (cm)	Presence of epiphytes? No (N) or % cover	Presence of Sargassum? No (N) or % cover	Algal matt on sea bed? No (N) or % cover	Presence of hydroids? Yes (Y) or No (N)
1	D	45	10	N	N	N
2	S	30, 15	20	N	N	Y
3	D	30	30	N	N	Y (lots)
4	M	40	20	N	N	Y
5	M	40	30	N	N	Y
6	D	35	20	N	N	Y
7	D	55	10	N	N	Y
8	M	25	40	N	N	Y
9	S	32, 10	30	N	N	Y
10	NONE					
11	M	45	50	N	N	Y
12	S	40, 17	70	N	N	N
13	D	40	30	N	N	Y (lots)
14	NONE					
15	S	15	50	N	N	N
16	S	40	30	N	N	Y

17	M	35	60	N	N	Y
18	M	50	80	N	N	Y
19	NONE					
20	NONE					
21	S	15	50	N	N	N
22	S	15	50	N	N	Y
23	S	12	10	N	N	N
24	S	17	60	N	N	N

North West

<table>
<tr><th colspan="2">Marine life observed – Quadrat reading:</th><th>Additional notes:</th></tr>
<tr><td>1 Nudibranch eggs, 6 flowers, filamentous algae, bryozoans</td><td>12 Polysiphonia, no flowers</td><td rowspan="10">NORTH WEST

Evidence of wasting disease (black legions) on majority of shoots.
Where very evident measured.

MAX DEPTH 10m
8 JUNE 04

EMMA JACKSON
KATE CRAWFURD</td></tr>
<tr><td>2 Evidence of wasting disease lesions</td><td>13 Polysiphonia, no flowers</td></tr>
<tr><td>3 4 flowers, filamentous algae, hydroids, evidence of wasting disease</td><td>14</td></tr>
<tr><td>4 Limacia clavigera, 8 flowers, nudibranch eggs</td><td>15</td></tr>
<tr><td>5 Callionymas sp., bryozoan, 6 flowers, filamentous algae</td><td>16 Small seedlings</td></tr>
<tr><td>6 4 flowers, M. squinado nearby</td><td>17 Nudibranch eggs, Polysiphonia</td></tr>
<tr><td>7 Bryozoans, filamentous algae and epiphytes, P. barnhardus, sea slug eggs</td><td>18 One Sepia officinalis (15cm), 3 flowers, Polysiphonia</td></tr>
<tr><td>8 Polysiphonia, Hinea reticulatus eggs, bryozoan</td><td>19 8 flowers, Bryozoa</td></tr>
<tr><td>9 4 flowers, filamentous algae and epiphytes, 2 of shoots seedlings</td><td>20 NONE</td></tr>
<tr><td>11 Evidence of wasting disease</td><td>21 NONE</td></tr>
</table>

Quadrat reading	Density of eel grass: Sparse (S), Medium (M), Dense (D)	Average length of eel grass shoots (cm)	Presence of epiphytes? No (N) or % cover	Presence of Sargassum? No (N) or % cover	Algal matt on sea bed? No (N) or % cover	Presence of hydroids? Yes (Y) or No (N)
1	S	30	15	N	N	Y
2	S	25	15	N	N	Y
3	M	30	20	N	N	Y
4	S	10	10	N	N	N
5	S	35	15	N	N	Y
6	S	30	5	N	N	Y
7	D	25	20	N	N	Y
8	M	35	5	N	N	Y
9	S	20	10	N	N	Y
10	S	20	15	N	N	N
11	M	25	20	N	N	Y
12	S	15	15	N	N	N
13	NONE					
14	S	50	20	N	N	N
15	S	10	20	N	N	N
16	S	15	10	N	N	Y
17	NONE					
18	S	20	25	N	N	Y

19	D	35	5	N	N	Y
20	D	30	50	N	N	Y
21	NONE					
22	NONE					
23	S	10	25	N	N	N
24	D	30	20	N	N	Y
25	S	20	25	N	N	Y
26	S	10	45	N	N	Y
27	S	15	20	N	N	Y
28	D	40	30	N	N	Y
29	S	20	20	N	N	Y
30	S	15	40	N	N	Y
31	S	15	30	N	N	Y
32	NONE					
33	S	30	20	N	N	N
34	NONE					
35	S	10	35	N	N	N
36	NONE					
37	NONE					
38	S	10	25	N	N	N

North + 10m to N → rock reef

Marine life observed – Quadrat reading:		Additional notes:
1 Bryozoans	**20** Bryozoans	**NORTH**
3 Bryozoans	**21**	
6 Bryozoans	**22**	Netted dog whelks with eggs on eel grass Razor shells Otter shells Lobster
9 Bryozoans	**23**	Yellow tipped nudibranch with lots of white nudibranch eggs on eel grass Sea potatoes Cushion star
10 Bryozoans	**24** Bryozoans	*Philine aperta* *Limacia clavigera* with eggs Cloak anemone and hermit crab Male pipefish with eggs
11 Bryozoans	**25** Bryozoans	
14 Bryozoans	**26**	
16 Bryozoans	**27**	7 JUNE 04 (1-20) 8 JUNE 04 (21-38)
18 Bryozoans	**28** Bryozoans	NIGEL MORTIMER SEAN LINDSLEY-LEAKE
19 Bryozoans	**30** Bryozoans	

Quadrat reading	Density of eel grass: Sparse (S), Medium (M), Dense (D)	Average length of eel grass shoots (cm)	Presence of epiphytes? No (N) or % cover	Presence of Sargassum? No (N) or % cover	Algal matt on sea bed? No (N) or % cover	Presence of hydroids? Yes (Y) or No (N)
1	Quadrat moved 1m North D	40	20	N	N	N
2	S	45	20	N	10	N
3	S	11	N	N	N	N
4	M	48	30	N	N	N
5	S	42	10	N	N	N
6	S	43	30	N	N	N
7	D	50	40	N	N	Y
8	M	45	60	N	N	Y
9	S	20	N	N	N	N
10	D	40	70	N	N	Y
11	S	37	30	N	N	N
12	M	42	40	N	5	Y
13	M	50	30	N	N	Y
14	S	30	20	N	N	N
15	M	15	40	N	N	N
16	M	35	40	N	N	Y
17	D	55	20	N	N	N
18	Quadrat moved 1m North M	30	50	N	N	Y

19	NONE Bare sand					
20	NONE Bare sand					
21	NONE Bare sand					
22	NONE Bare sand					
23	M	45	10	N	N	N
24	S	45	20	N	N	N

North East

Marine life observed – Quadrat reading:		**Additional notes:**
1 Filamentous algae, *Hinea reticulatus*	**11** *Polysiphonia*, *P. bernhardus*	**NORTH EAST**
2 7 flowers	**12** 2 flowers, filamentous algae, nudibranch eggs	
3	**13**	
4 Nudibranch eggs, *Hinea reticulatus* eggs, filamentous algae	**14** Epiphytes – *Polysiphonia*, *Callionymas lyra*, *Pomatoschistus sp.*, *Ensis ensis*, *Hinea reticulatus* x 3. Black lesions – wasting disease?	
5 Bryozoan colony, nudibranch eggs	**15** Lesions on about 40% of leaf surface – wasting disease?	7 JUNE 04
6 *Ensis ensis* (siphons only), filamentous algae, nudibranch eggs	**16** 13 flowers, epiphytes – *Polysiphonia* and other filamentous, bryozoan colonies, hydroids	PAUL COX EMMA JACKSON
7 6 flowers, *Polysiphonia* epiphyte (filamentous)	**17** 12 flowers, epiphytes – filamentous including *Polysiphonia sp.*, 2 x *Hinea reticulatus* and eggs	
8 Bryozoan, 13 flowers, filamentous algae	**18** Edge of large patch. Filamentous epiphytes, bryozoan	
9 1 flower	**23** 3 flowers, mysids > 10	
10 *Callionymas lyra*, bryozoan, filamentous and crusteose epiphytic algae, 17 flowers, hydroids	**24**	

Quadrat reading	Density of eel grass: Sparse (S), Medium (M), Dense (D)	Average length of eel grass shoots (cm)	Presence of epiphytes? No (N) or % cover	Presence of Sargassum? No (N) or % cover	Algal matt on sea bed? No (N) or % cover	Presence of hydroids? Yes (Y) or No (N)
1	D	20	10	N	N	Y
2	Quadrat moved 0.5m left M	20	4 + sea matt	N	N	Y
3	D	20, 30	10	N	N	Y
4	Quadrat moved 0.5m left M	40	10	N	N	Y
5	Quadrat moved 1m left S	30	8	N	N	Y
6	S	10, 20	4 + sea matt	N	N	Y
7	M	20	12	N	N	Y

East

<table>
<tr><th colspan="2">Marine life observed – Quadrat reading:</th><th>Additional notes:</th></tr>
<tr><td>1 White and yellow nudibranch, fluffy seaweed</td><td>11</td><td rowspan="10">EAST

MAX DEPTH 10m
7 JUNE 04

AMY BUGG
LOUISA JONES</td></tr>
<tr><td>2 White and yellow nudibranch, painted topshell, lots of nudibranch eggs, razor shell Ensis ensis</td><td>12</td></tr>
<tr><td>3 Red filamentous seaweed</td><td>13</td></tr>
<tr><td>4 Dog whelk eggs, red seaweed, eel grass seeds</td><td>14</td></tr>
<tr><td>5 Netted dog whelk and eggs</td><td>15</td></tr>
<tr><td>6 Ensis ensis</td><td>16</td></tr>
<tr><td>7 Large spiny starfish. Nearby lobster pot containing large spider crab and several edible crabs</td><td>17</td></tr>
<tr><td>8</td><td>18</td></tr>
<tr><td>9</td><td>19</td></tr>
<tr><td>10</td><td>20</td></tr>
</table>

Quadrat reading	Density of eel grass: Sparse (S), Medium (M), Dense (D)	Average length of eel grass shoots (cm)	Presence of epiphytes? No (N) or % cover	Presence of Sargassum? No (N) or % cover	Algal matt on sea bed? No (N) or % cover	Presence of hydroids? Yes (Y) or No (N)
1	S	20	20	N	20	N
2	M	15	20	N	20	Y
3	S	20	10	N	10	N
4	S	15	10	N	N	N
5	S	25	10	N	N	N
6	Sand					
7	Sand					
8	Sand					
9	Sand					
10	Sand					
11	Sand					
12	Sand					
13	Rocks, kelp, red algae					
14	Rocks, kelp					
15	Rocks, kelp					
16	Rocks, kelp					
17	Sand					
18	Sand					

19	Kelp, rocks					
20	Kelp, rocks					

South East

<table>
<tr><th colspan="2">Marine life observed – Quadrat reading:</th><th>Additional notes:</th></tr>
<tr><td>1 Goby (small), whelks/gastropods</td><td>11</td><td rowspan="10">SOUTH EAST

Additional quadrat readings: 21-24, all sand, no eel grass

6 – patches of eel grass 1-2m left of line
7 – patches to left, getting further away
8 – eel grass further away still
9 – could no longer see patch to left

Went back to no. 6
- centre of patch (to left of line) about 3m from the line.
Patch was about 2x3m

Quadrat reading from centre of patch:
Average length: 30cm
Epiphytes: 20% cover
Algal matt: 5% cover
Hydroids: few

7 JUNE 04

LIZ EVANS
EMMA SARTAIN</td></tr>
<tr><td>2 Nudibranch eggs, gastropods</td><td>12 Sea potato</td></tr>
<tr><td>3 Nudibranch eggs, gastropods</td><td>13 Pollack/wrasse (young)</td></tr>
<tr><td>4</td><td>14 Pollack, cuckoo wrasse (young)</td></tr>
<tr><td>5 Sea potato, worm/bivalve holes</td><td>15</td></tr>
<tr><td>6</td><td>16 Large goby</td></tr>
<tr><td>7 Small wrasse</td><td>17</td></tr>
<tr><td>8</td><td>18</td></tr>
<tr><td>9</td><td>19</td></tr>
<tr><td>10</td><td>20</td></tr>
</table>

Quadrat reading	Density of eel grass: Sparse (S), Medium (M), Dense (D)	Average length of eel grass shoots (cm)	Presence of epiphytes? No (N) or % cover	Presence of Sargassum? No (N) or % cover	Algal matt on sea bed? No (N) or % cover	Presence of hydroids? Yes (Y) or No (N)
1	S	20, 40	8	N	N	N
2	S	60	12	N	N	Y
3	M	20	4	N	N	N
4	D	20, 40	4	N	N	N
5	M	20, 40	10	N	N	Y
6	Quadrat moved 0.5m left D	30	5 + sea matt	N	N	Y
7	Quadrat moved 0.5m right D	40	12	N	N	Y
8	S	20, 30	5	N	N	Y
9	NONE					
10	Quadrat moved 2m left S	20	2	N	N	Y

South

Marine life observed – Quadrat reading:		**Additional notes:**
1 Large pregnant male greater pipefish, netted dog whelk, sand goby, dragonet	**11**	**SOUTH**
2 Netted dog whelk, white and yellow nudibranch, dog whelk eggs on eel grass	**12**	
3 Small hermit crab, netted dog whelk and eggs, black spots on eel grass – wasting disease	**13**	Small spider crab Crab and cloaked anemone Fan worm Male dragonet **-** courting
4 White and yellow nudibranch, dog whelk (pink bits on shell) and eggs, burrows – *Ensis ensis* or *Lutraria lutraria*	**14**	
5 Dog whelk eggs, dragonets, sand goby, hermit crab	**15**	
6 Small hermit crab, slightly diseases eel grass (black spots), nudibranch eggs	**16**	
7 Netted dog whelk, mating nudibranchs – white and yellow	**17**	MAX DEPTH 10m 7 JUNE 04
8 Dog whelk eggs, lots of red seaweed	**18**	AMY BUGG LOUISA JONES
9 Sand goby, 2 netted dog whelks, *Lutraria lutraria*, fluffy seaweed	**19**	
10 Netted dog whelk eggs, hermit crab. Some black spots on eel grass	**20**	

References

- *Devon Biodiversity Action Plan*, http://www.devon.gov.uk/biodiversity/

- *Devon Wildlife Trust report* (1993)

- *Effect of shoot density on the infaunal macroinvertebrate community within a Zostera marina seagrass bed*, P.J. Webster, A.A. Rowden and M.J. Attrill (1996)

- *Evaluation of Remote Observation methods for surveying Zostera marina beds*, R.J. Allen (1999)

- *Great British Marine Animals*, Paul Naylor (2003)

- *Inventory of eelgrass beds in Cornwall and the Isles of Scilly* (site number C45)

- Marine Life Identification Network (MarLIN) website: http://www.marlin.ac.uk and Underwater Interactive Tour: http://www.marlin.ac.uk/learningzone/interactive/interactiveframe.htm

- Port Townsend marine Science Centre website: http://www.ptmsc.org/index.html

- *Project series number 5*, Environmental Records Centre for Cornwall and the Isles of Scilly

- *The British Seahorse Survey*, Neil Garrick-Maidment and Louisa Jones (2004)

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- Dr. Keith Hiscock of the Marine Biological Association