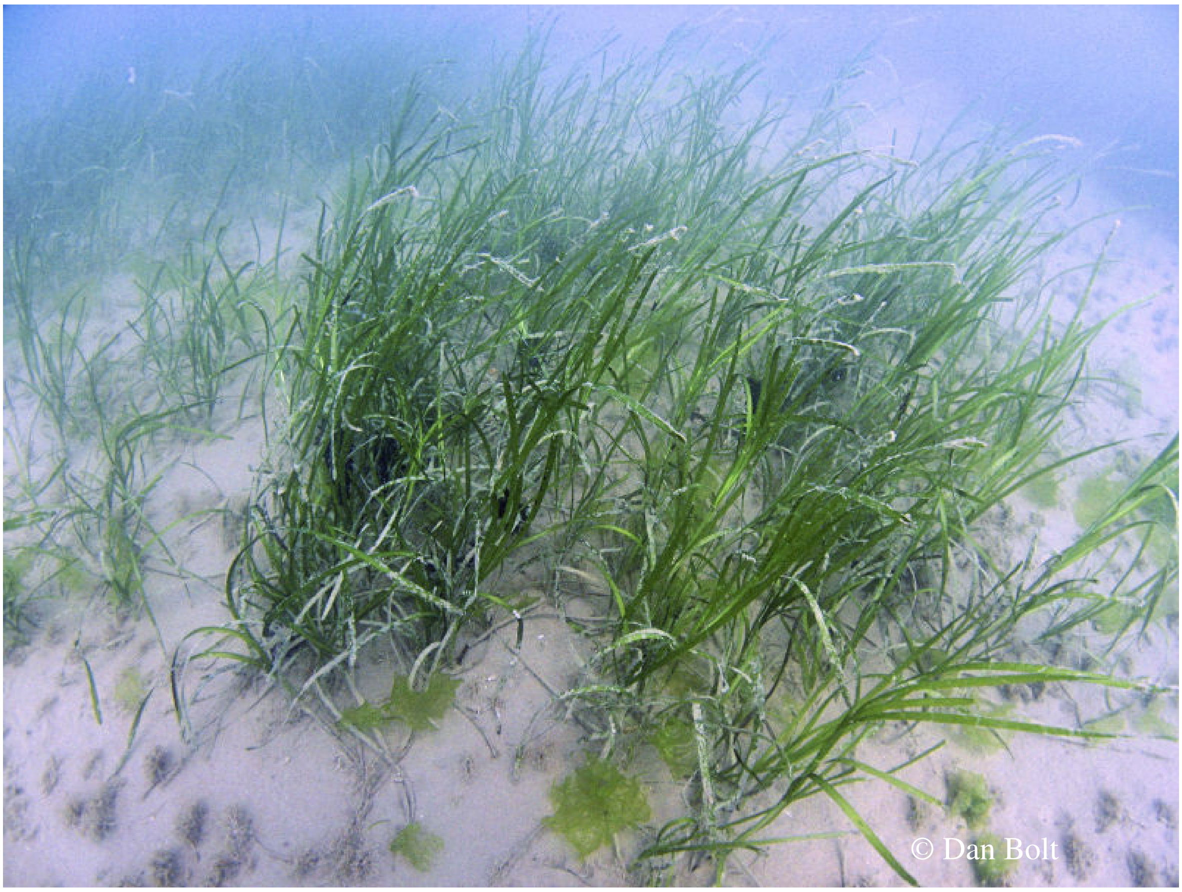
TORBAY SEAGRASS BED MONITORING SURVEYS 2008

Report for
Torbay Coast and Countryside Trust
November 2008



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Disclaimer:

The opinions in this report are those of the author, and do not necessarily reflect the positions of the Torbay Coast and Countryside Trust, or any other body.

Acknowledgments:

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Abbreviations used in this report:

BAP	Biodiversity Action Plan
BCD	Below Chart Datum
DDV	Drop Down Video
DV	Digital Video
DWT	Devon Wildlife Trust
EN	English Nature
GPS	Global Positioning System
JNCC	Joint Nature Conservation Committee
LBAP	Local Biodiversity Action Plan
MarLIN	Marine Life Information Network
MCZ	Marine Conservation Zones
NE	Natural England
REI	Relative Exposure Index
SAC	Special Areas of Conservation
UKBAP	United Kingdom Biodiversity Action Plan

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1 Executive summary

This study was funded by Natural England and is an action of "*The Nature of Torbay"* A Local Biodiversity and Geodiversity Action Plan 2006 - 2016 (Torbay Biodiversity Partnership 2006) under the marine habitats section 6.5 Seagrass research and monitoring actions M29 and M30. The data produced through the surveys are to be used to assess the current condition of the seagrass (*Zostera marina*) beds, how well conservation measures put in place in 2006/7 have performed and to suggest further management and conservation actions to protect the beds and direct future research.

The survey used drop down video and towed video to record the condition and presence/absence of seagrass along GPS positioned tracks through the study sites. Depth data was recorded and referenced to the GPS positions. For comparison studies the tracks recorded were superimposed (within the limits of the method) repeats of the 2006 and 2007 survey tracks. The video data was analysed by a subjective but robust scoring system to infer relative density along the tracks. All 2006 and 2007 data was reanalyzed using the same procedure.

The main objectives of this survey were to sample the condition of the five known seagrass beds within Torbay to get representative information on seagrass density, maximum depth and seagrass bed extent and to monitor changes since the SITA Trust funded baseline surveys of 2006 and the Fishcombe Cove post scallop dredge impact surveys of 2007.

The surveys indicate that between august 2006 and august 2008 all the seagrass beds showed a decrease in density. The least reduction was 13% at Millstones Bay and the greatest 59% at Fishcombe Cove. The decrease at Breakwater Beach, although apparent, has not been calculated due to methodological differences preventing comparison. At most sites the probable explanation for this is the poor summer growth conditions in 2007 and 2008 compared to 2006. At Fishcombe Cove the decrease in density is also associated with a decrease in coverage (extent) in the areas scallop dredged in November/December 2006. Interestingly when the 2008 Fishcombe data is compared to that from 2007 there is an increase in density which may suggest that parts of the bed are recovering.

The maximum depth of seagrass growth within Torbay remains similar to that in observed in 2006 at 5.2m BCD with all beds except Fishcombe Cove having similar a growth range as was observed in 2006. Fishcombe Coves maximum growth depth has decreased significantly from 3.5m BCD to 2.5m BCD. Again this may be a result of scallop dredge activity in 2006

Resource constraints meant that it was not possible to repeat all the mapping tracks from the 2006 surveys to assess changes in the extent of each of the seagrass beds. At the Millstones Bay, Torre Abbey Sands and Elberry Cove seagrass beds only a representative sample of the 2006 mapping tracks were repeated. No indication of change in extent was seen from this admittedly limited data at Millstones Bay and Torre Abbey Sands. Some westward movement of the southeast edge of the bed at Elberry was observed which again may be a result of scalloping in 2006. Fishcombe Cove was mapped in more detail than the other beds and the 2007 data shows a major reduction in extent of the bed when compared to the 2006 data. The 2008 data shows that although there has been some recovery in the overall density of the bed there has been no clear increase (recovery) in the extent of the bed when compared to the 2007 position.

Encouragingly there have been no reports of scallopers in Fishcombe Bay since winter 2006 which suggests that the voluntary no scalloping agreement has been effective and may in time lead to this bed resuming its former extent but this may take a number of years.

Considering the changes at Fishcombe Cove after the 2006 scallop dredging incident; and in light of the proposed Marine and Coastal Access Bill which specifically mentions the protection for seagrass beds through MCZs; and with the possible requirement to protect seagrass habitats as seahorse "places of shelter" implied through the recent inclusion of seahorses on to schedule 5 of the Wildlife and Countryside Act 1981, the conversion of the voluntary no scalloping agreement areas into a legally enforceable restriction should be investigated. It should be noted however that seahorses are not found exclusively in seagrass and to protect them further it may be necessary to protect all the complex shallow habitats in Torbay from mobile fishing gear. The unofficial agreement by trawlers with Devon Sea Fisheries Committee not to shoot multi rig gear within six miles of Berry Head is a positive move in this direction.

Continuing research and monitoring of the seagrass beds in Torbay is an action of the LBAP and for the larger beds the drop down video method employed in this study is effective in monitoring density and, to some degree extent changes using the 2006 data as baselines. However for a more complete picture additional funding will be required to fully remapping the larger beds by drop video or by aerial photography as was done for the Plymouth Sound surveys (E. Jackson 2006). In the smaller beds, and especially when assessing damage and recovery, positional errors need to be reduced and a more quantitative scoring system is required. Good year on year comparative data could be obtained by setting out permanent transects along the track positions used in this and the 2006 survey and using divers to video the transects and carry out quadrat counts. If adopted no anchoring zones may be necessary at Fishcombe Cove to protect the recovering seagrass and permanent transects.

The 2006 and 2008 Breakwater Beach mapping data is poor as the method employed is less suited to this narrow patchy seagrass bed type. If additional funds are not available, mapping by volunteer divers using SMB mounted GPS method should be investigated.

Mathematical modelling (REI) of the exposure of the seagrass beds around Torbay could be used to identify the sites most at risk from storm damage.

This could inform the LBAP and management strategy on the suitability of protection measures at each site.

A secondary objective of this study was to carry out speculative search at sites previously reported to have seagrass beds (St Marys Bay and Anstey's Cove) to determine the size and condition of any seagrass beds at these locations. Multiple tracks were surveyed from the shallows to beyond 5m BCD at each site but no seagrass plants or debris were found at either. This report concludes that no large seagrass beds currently exist at these sites.

2 Survey objectives

1. Sample survey the five seagrass beds within Torbay to obtain representative information on the seagrass density, maximum depth of growth and seagrass bed extent.

2. Compare this data with the August 2006 baseline surveys and identify changes to the seagrass beds.

3. To sample survey the Elberry Cove seagrass bed to look for any effects of the November/December 2006 scallop dredging incident.

4. To resurvey the Fishcombe Cove seagrass bed and compare the seagrass density, maximum depth of growth and seagrass bed extent to that found in the August 2006 baseline and the September 2007 DWT funded post November /December 2006 scallop dredging incident.

5. To investigate reports of seagrass beds at St Marys Bay and Anstey's Cove and map these beds if found.

3 Background

The largely subtidal seagrass beds in Torbay are comprised of the species *Zostera marina. Z. marina*, like all seagrasses, is a green grass like angiosperm plant which grows in intertidal and shallow subtidal areas on sands and muds forming dense beds which look like meadows under the sea. These marine flowering plants need to be sheltered from significant wave action to survive, this means that they are usually found in sheltered estuaries and shallow bays. They stabilise sediments and providing shelter and a surface for attachment for other species. Seagrass beds are recognised as important nursery grounds for many commercial fish species and are habitats with a high biological diversity. These ecological functions together with the fact that seagrass habitats suffered a significant decline in area during the twentieth century lead to them becoming a priority habitat in the UKBAP (Biodiversity: The UK Steering Group Report - Volume II: Action Plans (December 1995, Tranche 1, Vol 2, p262)) and the regional South West BAP (http://www.wildlifetrust.org.uk/avon/www/Habitats/Seagrass/seagrass.htm)

Seagrass beds have long been known to exist in Torbay (Devon Wildlife Trust 1995 - *The Great West Bay Marine Wildlife Survey*) and were partially mapped by C. Proctor in the 1997/1998 WWF, Torbay Council and English Nature funded *Torbay Zostera Mapping Project*. In 2006 and 2007 the SITA Trust funded Torbay Seagrass Project (TCCT 2007), building on the work of the earlier authors, mapped over 81 hectares of *Zostera marina* in the shallows of Torbay between the shoreline and the 5m BCD depth contour. The seagrass is present in three discrete beds at Millstones Bay, Fishcombe Cove and Breakwater Beach, and two extensive bed systems at Torre Abbey Sands/Livermead and Elberry Cove/Broadsands.

When compared to the published record of seagrass beds in Devon (Black, G. and Kochanowska 2004) this 81 hectares represents 30.8% of the total reported area for all seagrass species in Devon. Furthermore the beds also represent over 80% of the known subtidal *Zostera marina* beds in Devon It should be note however that recent mapping studies in Plymouth Sound, Salcombe and the Yealm may reduce these percentages. On the basis of size alone these seagrass beds of major importance to Devon's marine biodiversity.

What makes Torbay's beds particularly important is that they are fully marine with almost no freshwater influence. This type of seagrass bed has been found to have the most diverse range of animals associated with them including seahorses, juvenile fish and cuttlefish (J Borum, CM Duarte, D Krause-Jensen and TM Greve 2004).

Unfortunately Torbay's seagrass beds shallow location makes them highly sensitive to damage by human activities (D.M. Davison, D.J. Hughes, 1998) Boat keels, propellers and powerboat wake can scar the beds destabilising them and dislodging the plants. Some fishing practices, boats anchoring into the beds and anchor and buoy chain drag can also cause significant damage. Torbay is a popular tourist destination and water sports centre with many people using the shallows through out the year and therefore the possibility of significant habitat loss exists. These risks and features lead to the seagrass beds being identified as a priority habitat in the local BAP *The Nature of Torbay*.

4 Methods

4.1 DDV survey method

A RHIB (Rigid Hulled Inflatable Boat) is used as it allows access to shallow areas at all states of the tide.

A miniDV camcorder in a Gates underwater housing with an umbilical cable to a surface monitor was used. The video was powered by internal batteries and the surface monitor runs off a 12v car battery. In the 2006 surveys a 2kg diving weight provided the negative buoyancy to keep the camera close to the seabed whilst in use, in 2007 and 2008 a strong cradle which weighed more than 2kg was fitted to protect the camera and housing. The video system with its umbilical and support line was small and lights enough to be deployed by hand over the side of the RHIB, the operator controlled the length of the umbilical line by feel and observing the monitor picture.

In the speculative search for additional seagrass beds beyond the five known the video was deployed in a series of transects perpendicular to the shore (or at another angle if allowance for wind and current had to be made) the RHIB steering a set course at a speed of between 1-1.7km/hr as travelling faster than this causes the video to trail too high in the water column producing a poor image. Repeated parallel transects were run such that a picture of the seabed could be built up.

For the monitoring of the five known beds sites were chosen by review of the 2006 survey tracks to be representative of each seagrass bed in its density, depth range and extent together with the practical consideration of straightness. The number of transects chosen was dictated by their total length and therefore the time they would take to survey.

Where transects exceeded the one hour tape length, end of tape points were marked with a waypoint for return and completion at a later time. The video picture is monitored in real time and all video footage is recorded on miniDV tape for future analysis. Along the transect the down and up points, the inner and outer edges of the Seagrass beds and any noteworthy features were logged, two independent GPS units were used to record waypoints and depths were taken from the RHIB echo sounder.

4.2 DDV waypoint data analysis and mapping

The data recorded for each transect – depths (corrected to CD), times, observations and waypoints (downloaded in WGS84 format on to the GPS Trackmaker program) were transferred via an Excel spreadsheet to MapInfo for GIS mapping.

4.3 Video scoring and analysis

The video tracks miniDV tape recordings were transferred to Hard Drive for editing for display purposes and scoring for density. An observer without prior knowledge of the sites scored the video. The presence/absence and density of the seagrass over successive 15 second periods was estimated making use of the timestamp on the video. The scoring system is as follows:-

0 = no *Zostera*,
1 = few isolated plants,
2 = frequent *Zostera* plants with bare sand patches,
3 = a continuous *Zostera* bed with a little bare sand,
4 = dense *Zostera* bed.

To reduce subjectivity a training video with examples of the 5 classifications was used.

The scores are analysed in Excel and using the DDV start and end waypoint positions density along the transect can be related through times to distances along the transect. The GPS positions for the start and end of the tracks also enabled the 2008 data to be referenced against the 2006 and 2007 survey tracks.

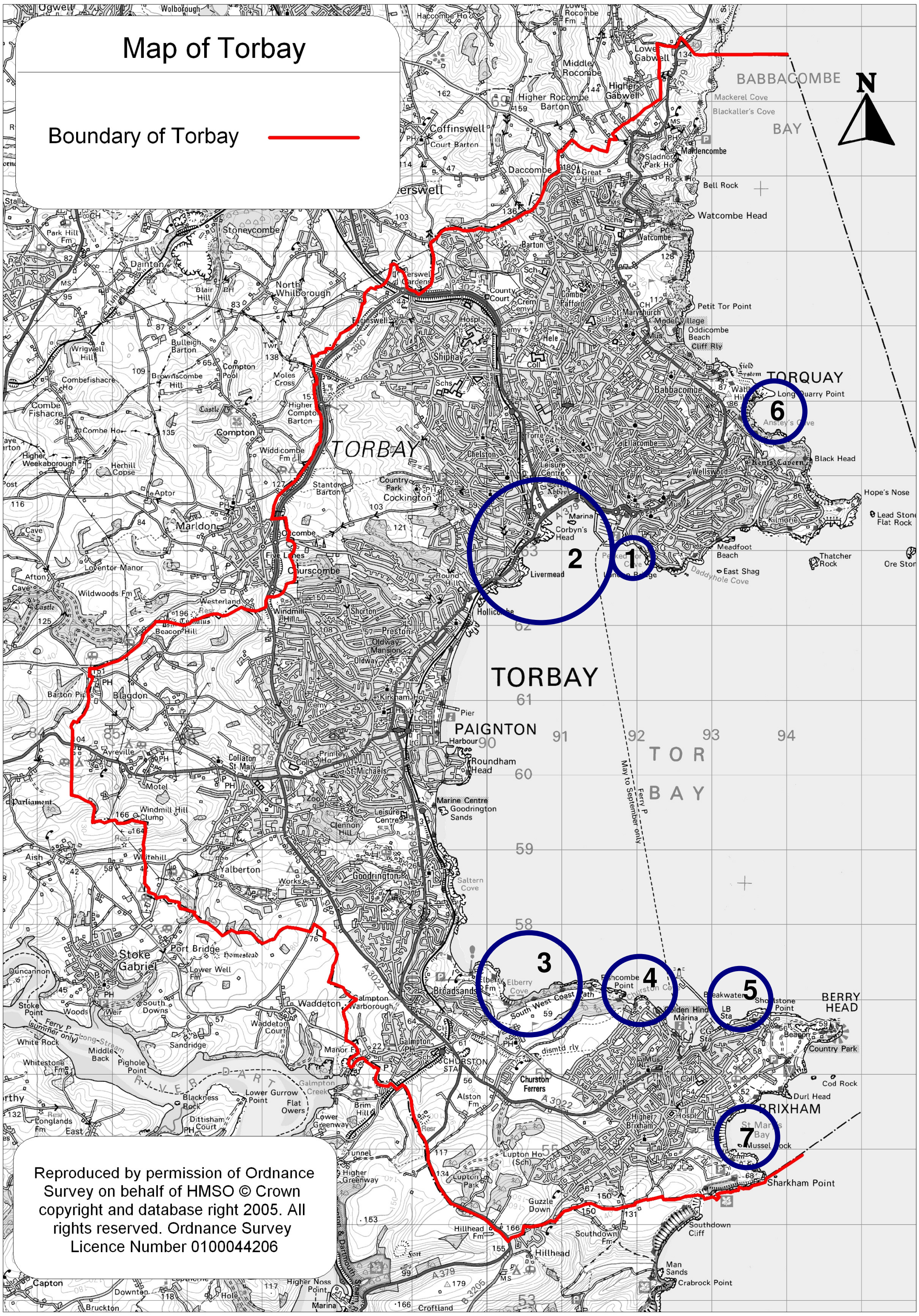
6. Results

Notes to assist the interpretation of the following diagrams

- Survey tracks are presented as a series of location maps (Figures 2, 6, 9, 14 and 20) showing the chosen (new) monitoring tracks superimposed on the map and position of the 2006/7 mapping survey tracks.

- The density along the new 2008 monitoring tracks is represented as a histogram under the original 2006/7 track density histogram (Figures 3, 4, 7, 10, 11, 12, 15, 16, 17 and18). As the repeat tracks are only sections (the straightest and thus easiest to retrace) of the earlier tracks, the track start and end points in 2008 are not the same as in 2006/7. To allow for this, vertical lines are drawn that represent the waypoints for the start and end of the 2008 tracks and these positions reference the 2008 to the region of the original 2006/7 track. This enables comparison of densities for the same locations within the errors of the methods used. The difference in start position for the new 2008 track relative to the 2006/7 start is recorded as the offset in the top left hand corner of the figure.

- The distance in metres given under the histograms is inferred from the time along the track and due to the changes in rate of travel between the years does not corresponded year on year. The density along the tracks should not be compared using the distance in metres along each track.



1	Millstones Bay	**5**	Breakwater Beach
2	Torre Abbey Sands	**6**	Anstey's Cove
3	Elberry Cove	**7**	St Marys Bay
4	Fishcombe Cove		

Figure 1
Locations of the seven survey sites investigated with drop video equipment in this study.

5.1 Millstones Bay Survey

The seagrass bed at Millstones Bay is shown as survey site 1 on the map in Figure 1. The tracks from the study in 2006 which were repeated for this survey are shown as the dotted red lines in Figure 2.

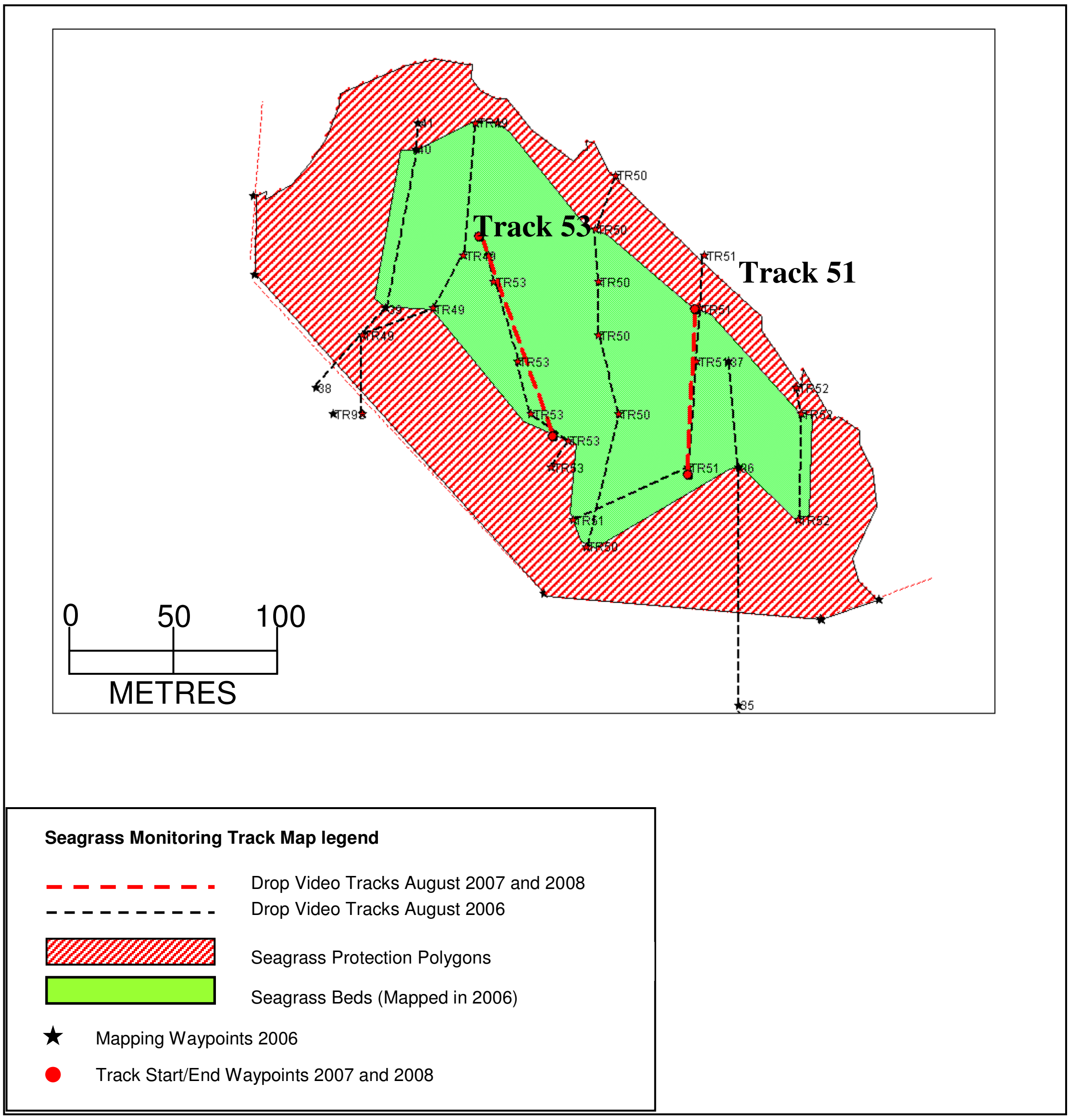


Figure 2
GIS Map of the Millstones Bay seagrass bed showing the 2006 and 2008 drop video tracks compared in the survey.

5.1.1 Seagrass extent, depth and density assessment

The subjective leaf density scores for the successive 15 second time periods along the tracks are shown in Figure 3 for track 51 and Figure 4 for track 53. The comparative data from the 2006 survey are shown together with the seabed depth below chart datum (BCD). The 2008 track data has been aligned with the 2006 using the gps positions of the start and end points of each track and mapping these using the GIS to calculate the offset.

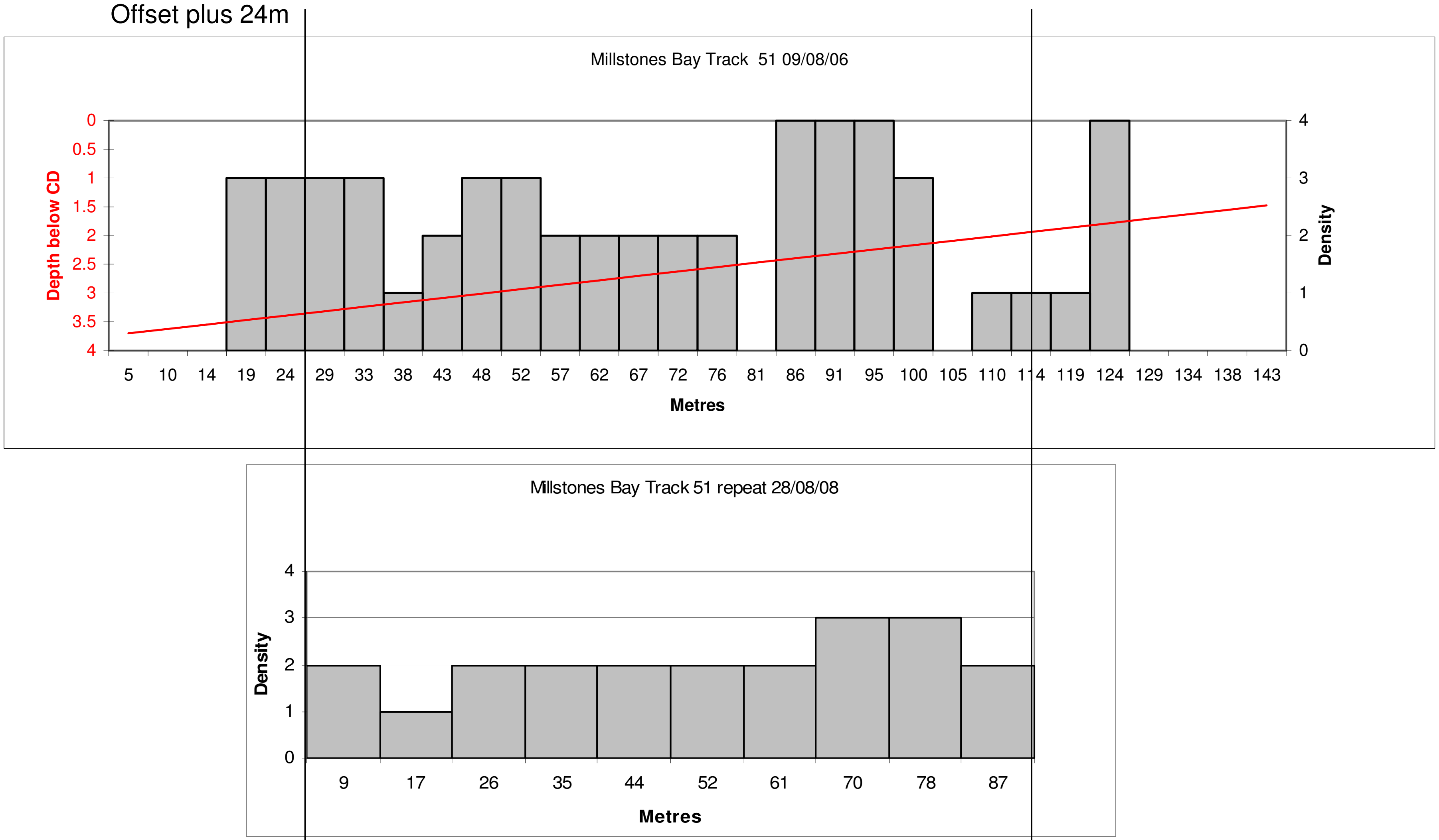


Figure 3
Seagrass density for track 51at Millstones Bay with the 2008 drop video track (below) compared to the 2006 track (above).

Offset plus 12m

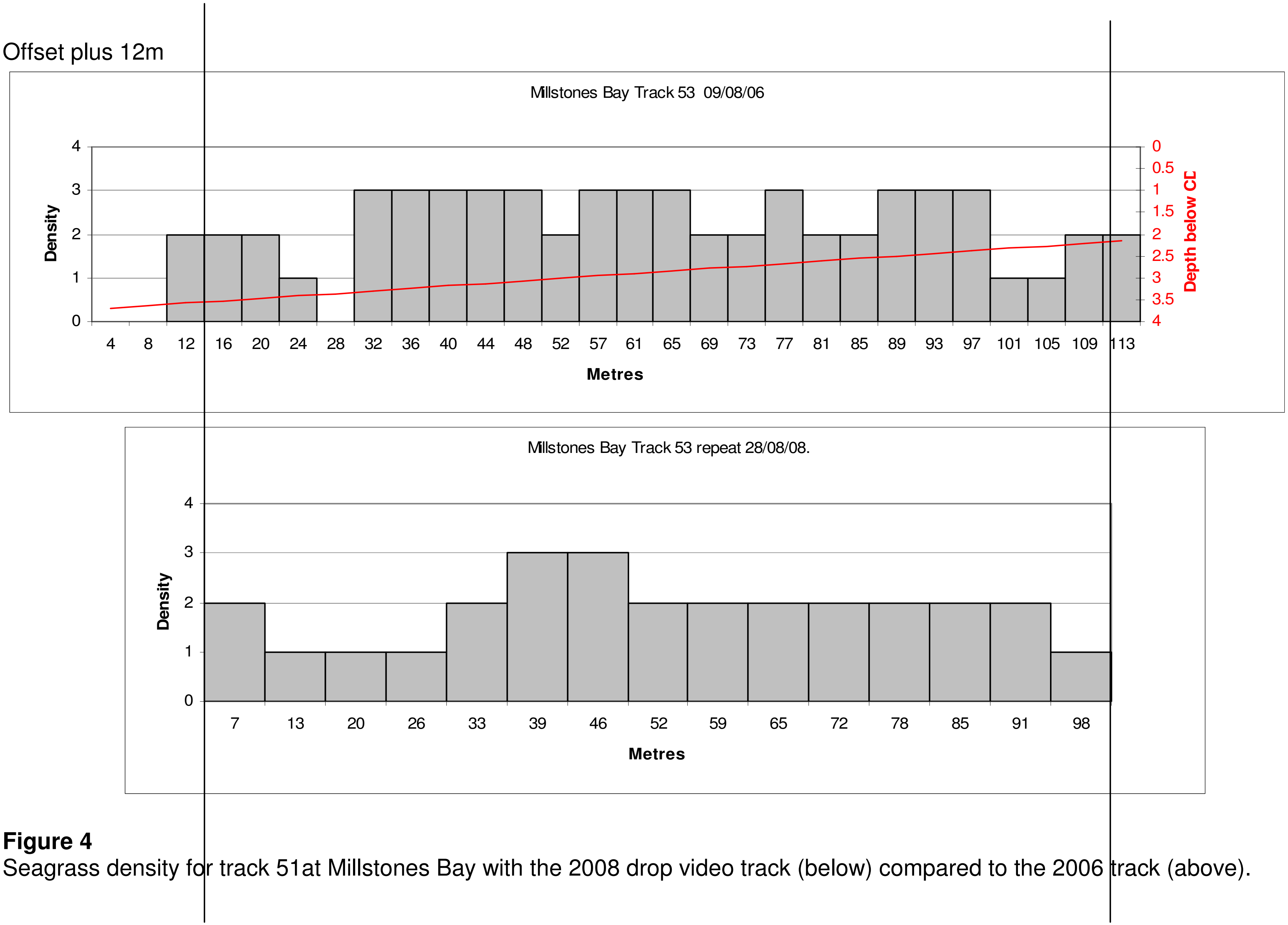


Figure 4
Seagrass density for track 51at Millstones Bay with the 2008 drop video track (below) compared to the 2006 track (above).

Rate of travel
It can be seen from the density track figures that the 15 second time samples equate to greater distances in the 2008 survey tracks than in the 2006 survey tracks. This indicates that the video travelled over the ground at a faster rate in 2008 than in 2006. For track 51 the video covered 9m in 15 seconds in 2008 compared to 5m in 2006. For track 53 the video covered 7m in 15 seconds in 2008 compared to 4m in 2006. These speed figures are approximate as they are interpolated from the GIS mapping distances and the time stamps for track start and end waypoints.

Extent
For this bed the survey was designed to look at changes in seagrass density within the bed between 2006 and 2008 and not change in extent.

Growth depth
During the 2008 survey the maximum depth at which seagrass plants were observed at Millstones Bay was 4.0m BCD.

Density changes
The Tracks show a general reduction in the seagrass density scores between 2006 and 2008. To better presents this the frequency of density scores has been displayed in Figure 5 and shows a reduction in the higher density scores 4 and 3 and a rise in the lower density scores 2 and 1 when compared to the 2006 data. No zero scores are recorded for the 2008 survey tracks as they are completely within the area of the seagrass bed (as can be seen from Figure 2). The arithmetical mean of the seagrass density for the repeated Millstones Bay tracks in 2006 was 2.25 (no units) and for the same tracks in 2008 was 1.96 (no units).

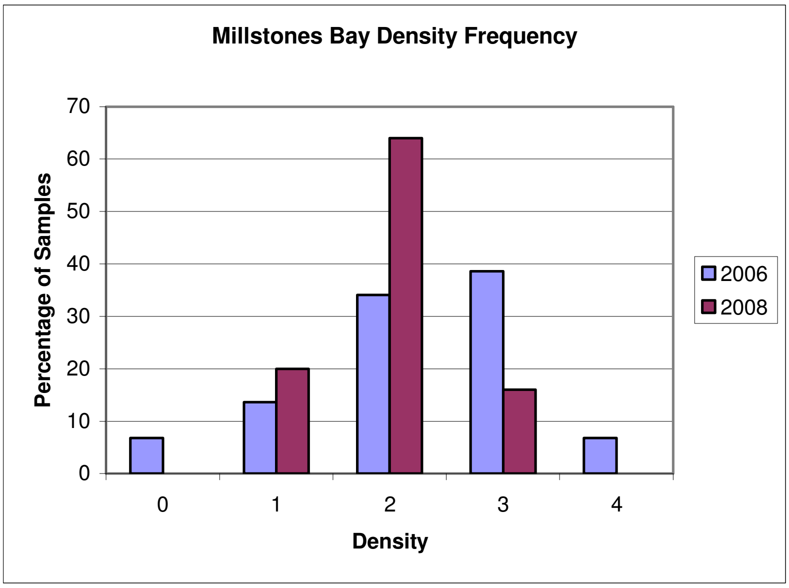


Figure 5
Seagrass density frequency histogram for all Millstones Bay tracks.

5.2 Torre Abbey Sands Survey

The seagrass bed at Torre Abbey Sands is shown as survey site 2 on the map in Figure 1. The track from the study in 2006 which was repeated for this survey is shown as the dotted red lines in Figure 6.

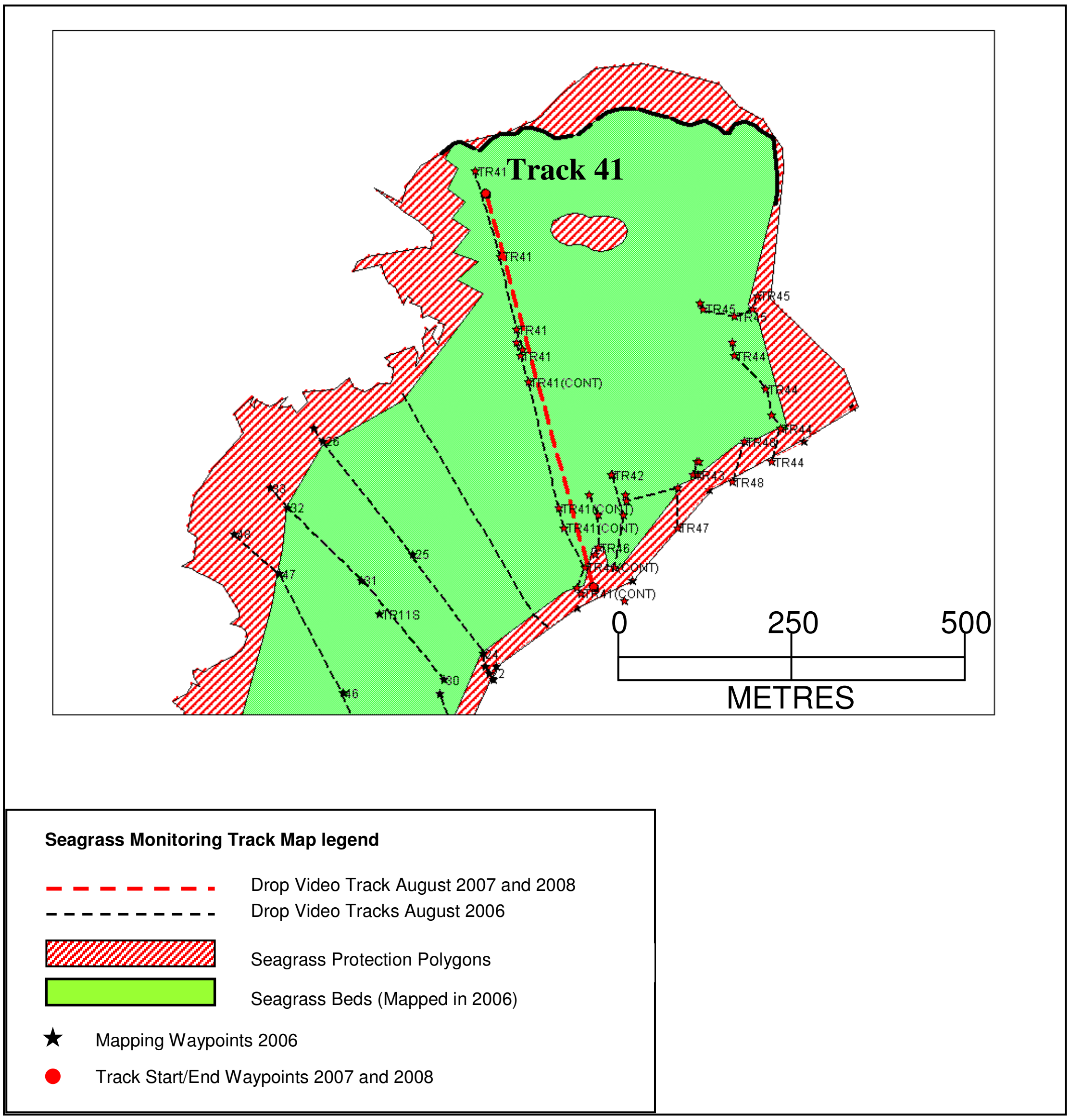


Figure 6
GIS Map of the Torre Abbey Sands seagrass bed showing the 2006 and 2008 drop video tracks compared in the survey.

5.2.1 Seagrass extent, depth and density assessment

The subjective leaf density scores for the successive 15 second time periods along the track are shown in Figure 7 for track 41. The comparative data from the 2006 survey (track 41 and 41A) are shown together with the seabed depth below chart datum (BCD). The 2008 track data has been aligned with the 2006 using the gps positions of the start and end points of each track and mapping these using the GIS to calculate the offset.

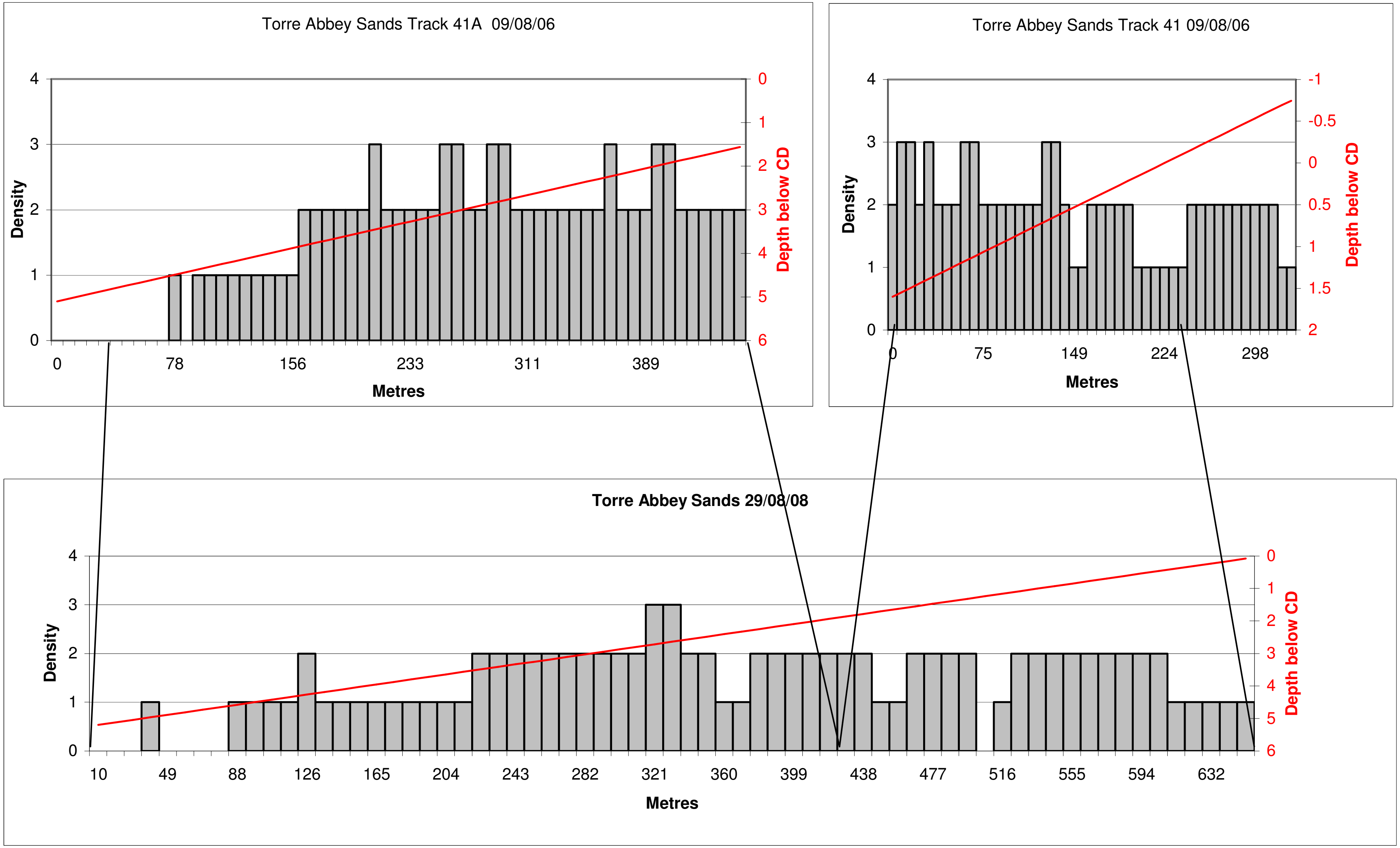


Figure 7
Seagrass density for track 41 at Torre Abbey Sands with the 2008 drop video track (below) compared to the 2006 track (above).

Rate of travel
It can be seen from the density track figures that the 15 second time samples equate to greater distances in the 2008 survey tracks than in the 2006 survey tracks. This indicates that the video travelled over the ground at a faster rate in 2008 than in 2006. For track 41 the video covered 9m in 15 seconds in 2008 compared to 7-8m in 2006. These speed figures are approximate as they are interpolated from the GIS mapping distances and the time stamps for track start and end waypoints.

Extent
For this bed the survey was designed to look at changes in seagrass density within the bed between 2006 and 2008 and not change in extent.

Growth depth
During the 2008 survey the maximum depth at which seagrass plants were observed at Torre Abbey Sands was 5.1m BCD.

Density changes
As for Millstones Bay the Torre Abbey Sands track show a general reduction in the seagrass density scores between 2006 and 2008. To better presents this the frequency of density scores has been displayed in Figure 8 and shows a reduction in the higher density scores 3 and 2 (there are no 4 scores in the 2006 or 2008 time samples) and a rise in the lower density scores 1 and 0 when compared to the 2006 data. The arithmetical mean of the seagrass density for the repeated Torre Abbey Sands track in 2006 was 1.83 (no units) and for the same track in 2008 was 1.42 (no units).

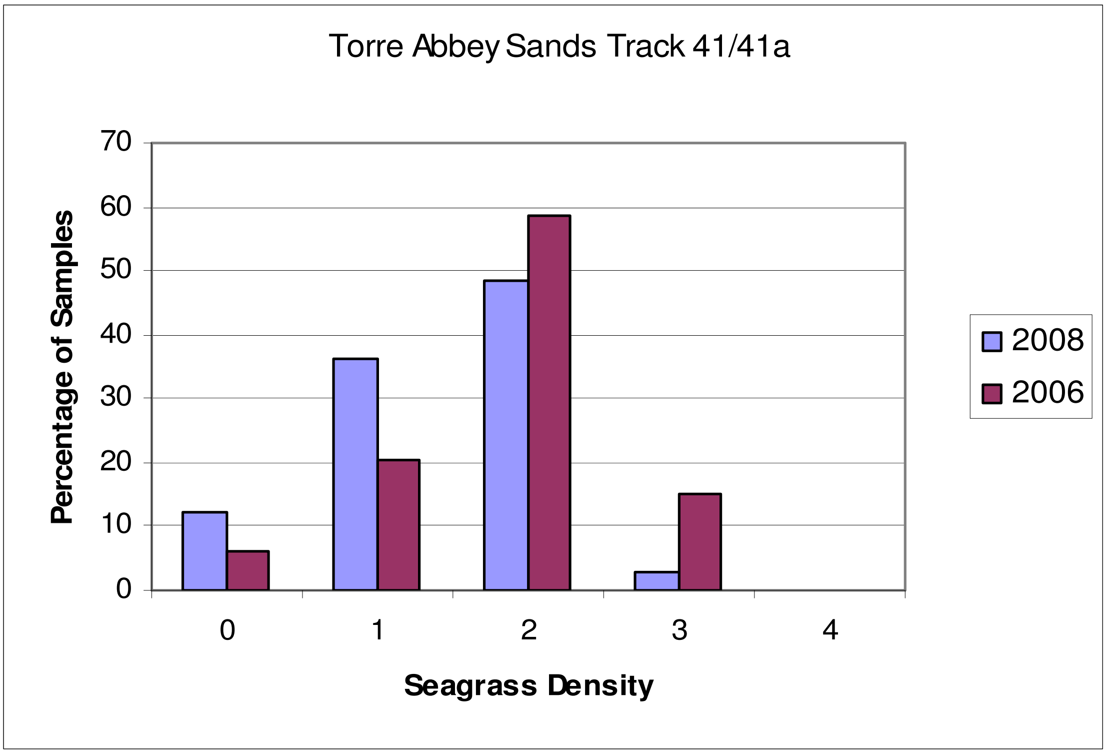


Figure 8
Seagrass density frequency histogram for the Torre Abbey Sands tracks.

5.3 Elberry Cove Survey

The seagrass bed at Elberry Cove is shown as survey site 3 on the map in Figure 1. The tracks from the study in 2006 which were repeated for this survey are shown as the dotted red lines in Figure 9.

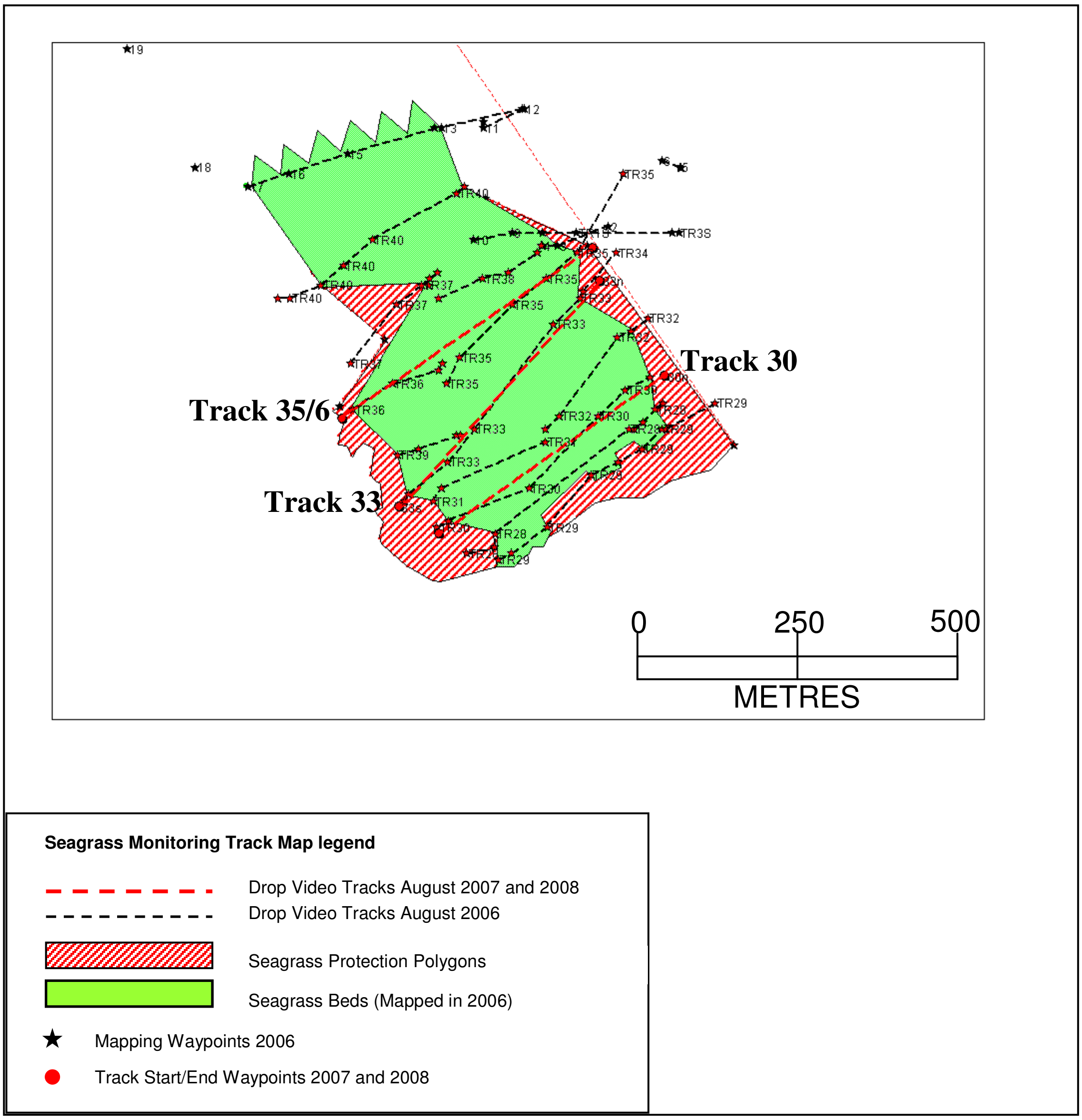


Figure 9
GIS Map of the Elberry Cove seagrass bed showing the 2006 and 2008 drop video tracks compared in the survey.

5.3.1 Seagrass extent, depth and density assessment

The subjective leaf density scores for the successive 15 second time periods along the tracks are shown in Figure 10 for track 30, Figure 11 for track 33 and Figure 12 for track 35/6. The comparative data from the 2006 survey are shown together with the seabed depth below chart datum (BCD). The 2008 track data has been aligned with the 2006 using the gps positions of the start and end points of each track and mapping these using the GIS to calculate the offset.

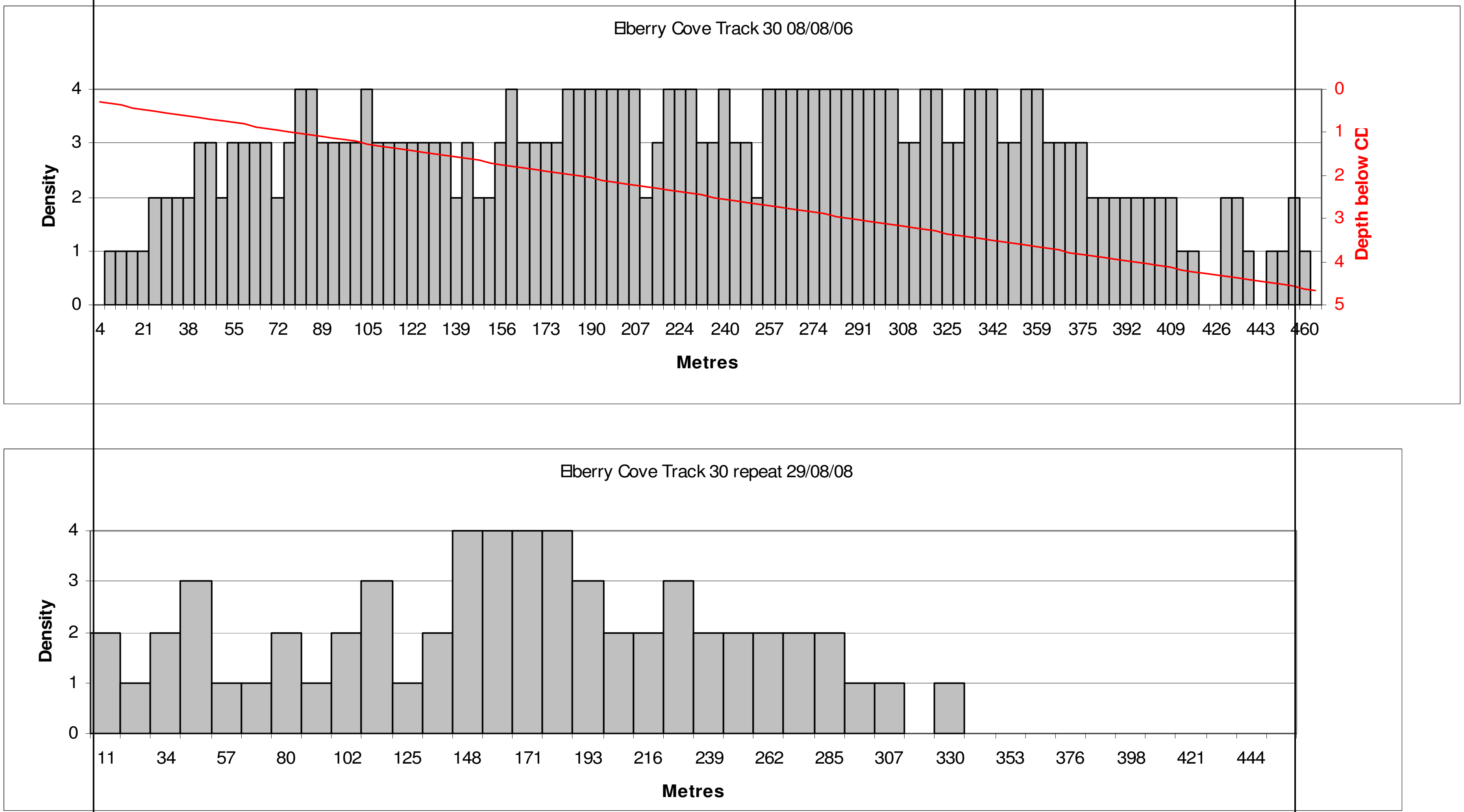


Figure 10
Seagrass density for track 30 at Elberry Cove with the 2008 drop video track (below) compared to the 2006 track (above).

Offset minus 14m

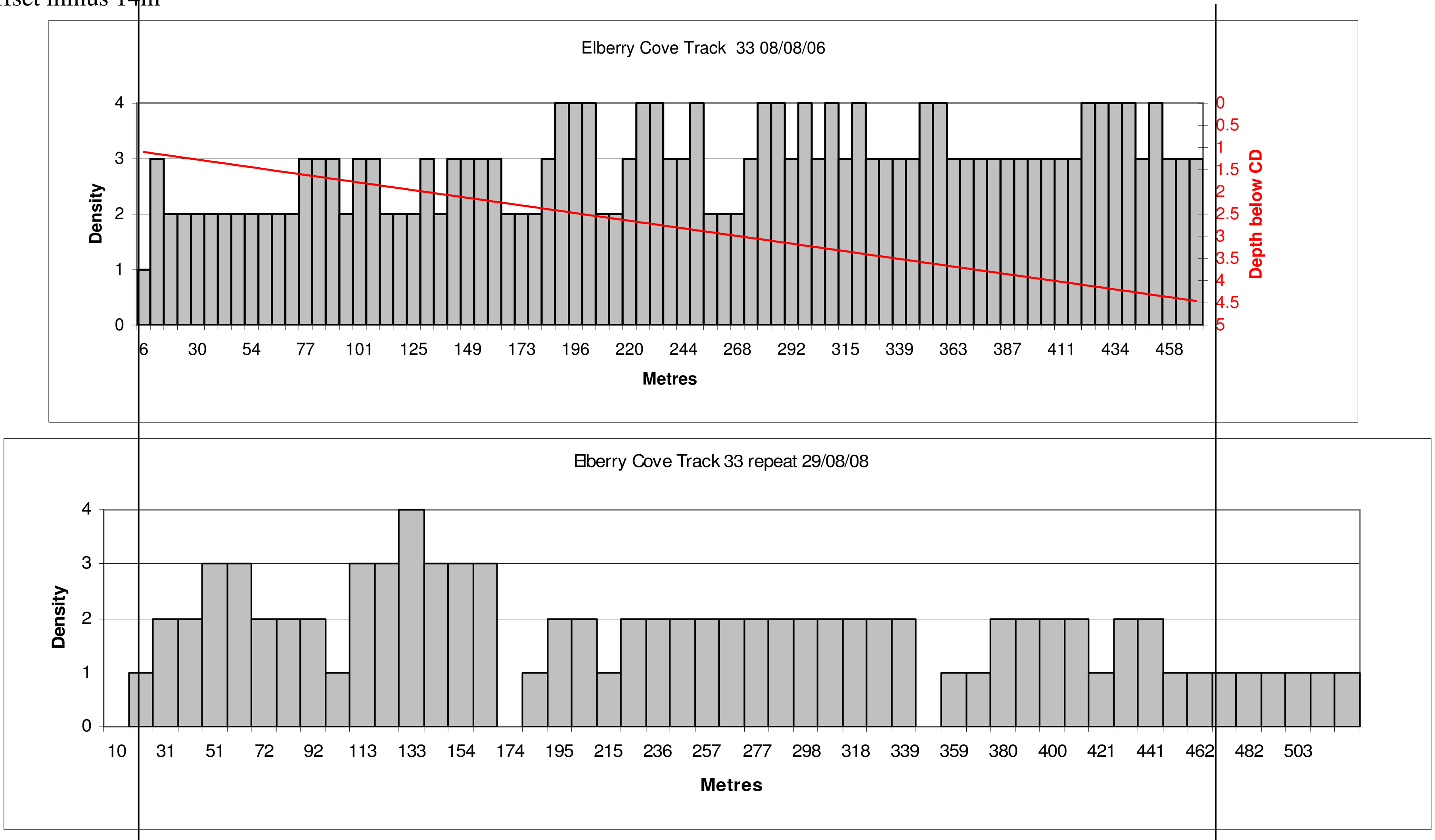


Figure 11
Seagrass density for track 33 at Elberry Cove with the 2008 drop video track (below) compared to the 2006 track (above).

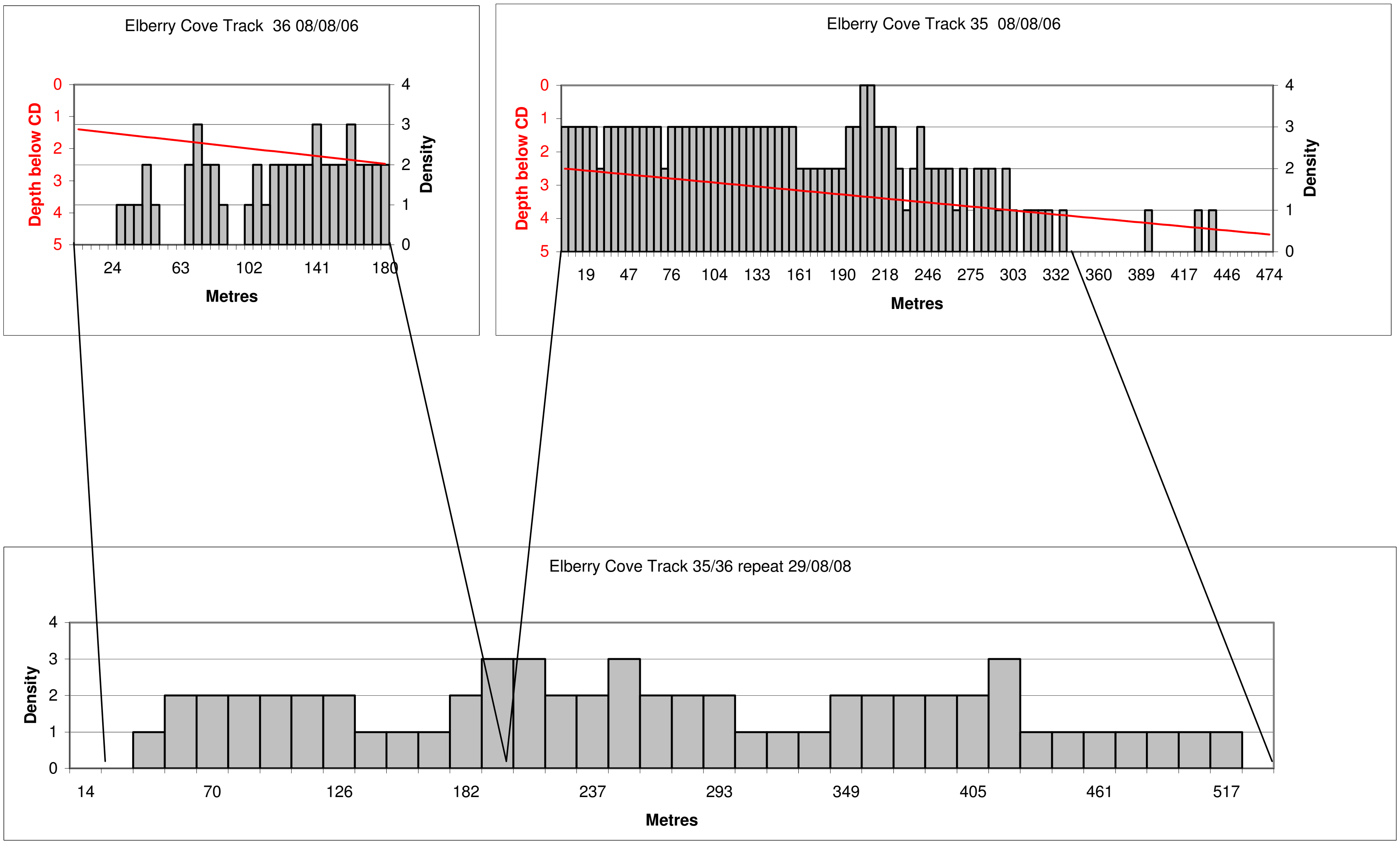


Figure12
Seagrass density for track 35/6 at Elberry Cove with the 2008 drop video track (below) compared to the 2006 track (above).

Rate of travel
It can be seen from the density track figures that the 15 second time samples equate to greater distances in the 2008 survey tracks than in the 2006 survey tracks. This indicates that the video travelled over the ground at a faster rate in 2008 than in 2006. For track 30 the video covered 11m in 15 seconds in 2008 compared to 4-5m in 2006. For track 33 the video covered 10m in 15 seconds in 2008 compared to 6m in 2006. For track 35/6 the video covered 11m in 15 seconds in 2008 compared to 5m in 2006.These speed figures are approximate as they are interpolated from the GIS mapping distances and the time stamps for track start and end waypoints.

Extent
For this bed the survey was designed to look at changes in seagrass density within the bed between 2006 and 2008 and not change in extent.

Growth depth
During the 2008 survey the maximum depth at which seagrass plants were observed at Elberry Cove was 4.7m BCD.

Density changes
As for Millstones Bay and Torre Abbey Sands tracks the Elberry Cove tracks show a general reduction in the seagrass density scores between 2006 and 2008. To better presents this the frequency of density scores has been displayed in Figure 13 and shows a reduction in the higher density scores 4 and 3 and a rise in the lower density scores 2, 1 and 0 when compared to the 2006 data. The arithmetical mean of the seagrass density for the repeated Elberry Cove tracks in 2006 was 2.56 (no units) and for the same track in 2008 was 1.67 (no units).

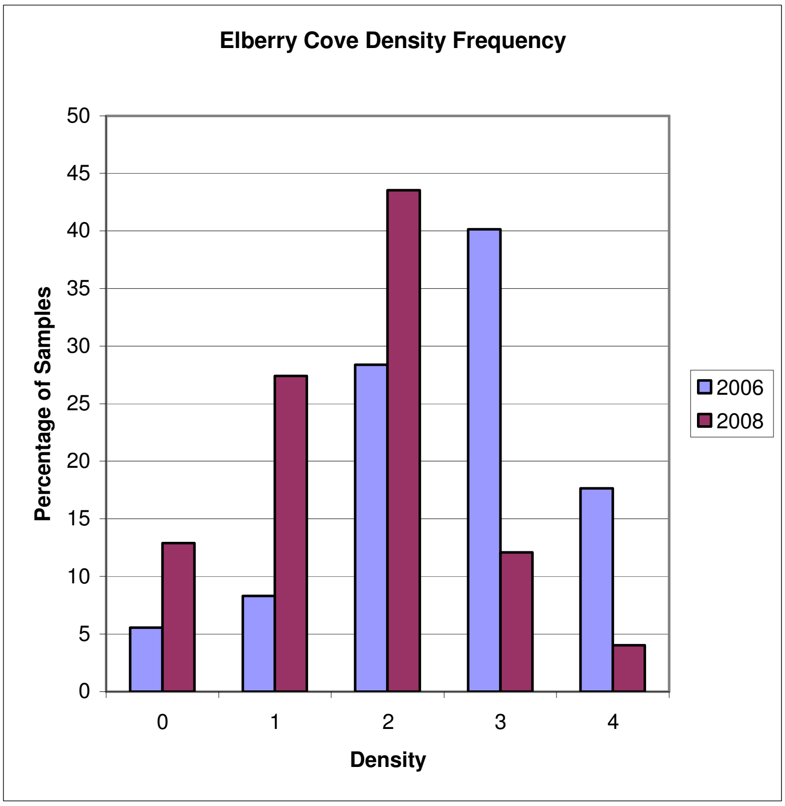


Figure 13
Seagrass density frequency histogram for the Torre Abbey Sands tracks.

5.4 Fishcombe Cove Survey

The seagrass bed at Fishcombe Cove is shown as survey site 4 on the map in Figure 1. The tracks from the study in 2006 which were repeated for the 2007 survey and this survey are shown as the dotted red lines in Figure 14.

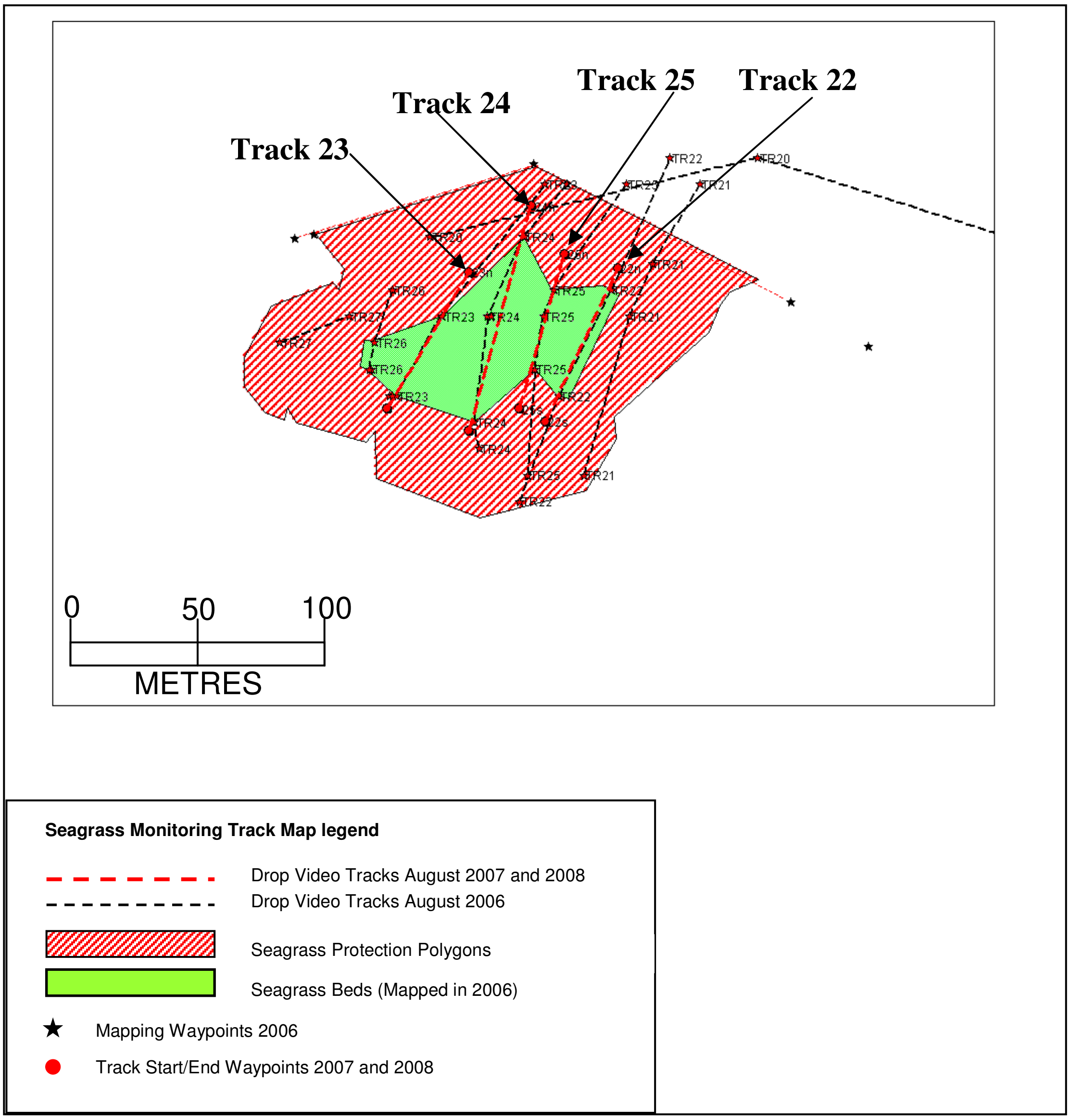


Figure 14
GIS Map of the Fishcombe Cove seagrass bed showing the 2006, 2007 and 2008 drop video tracks compared in the survey.

5.4.1 Seagrass extent, depth and density assessment

The subjective leaf density scores for the successive 15 second time periods along the tracks are shown in Figure 15 for track 22, Figure 16 for track 23, Figure 17 for track 24 and Figure 18 for track 25. The comparative data from the 2006 and 2007 surveys are shown together with the seabed depth below chart datum (bcd). The 2008 track data has been aligned with the 2006 and 2007 data using the gps positions of the start and end points of each track and mapping these using the GIS to calculate the offset.

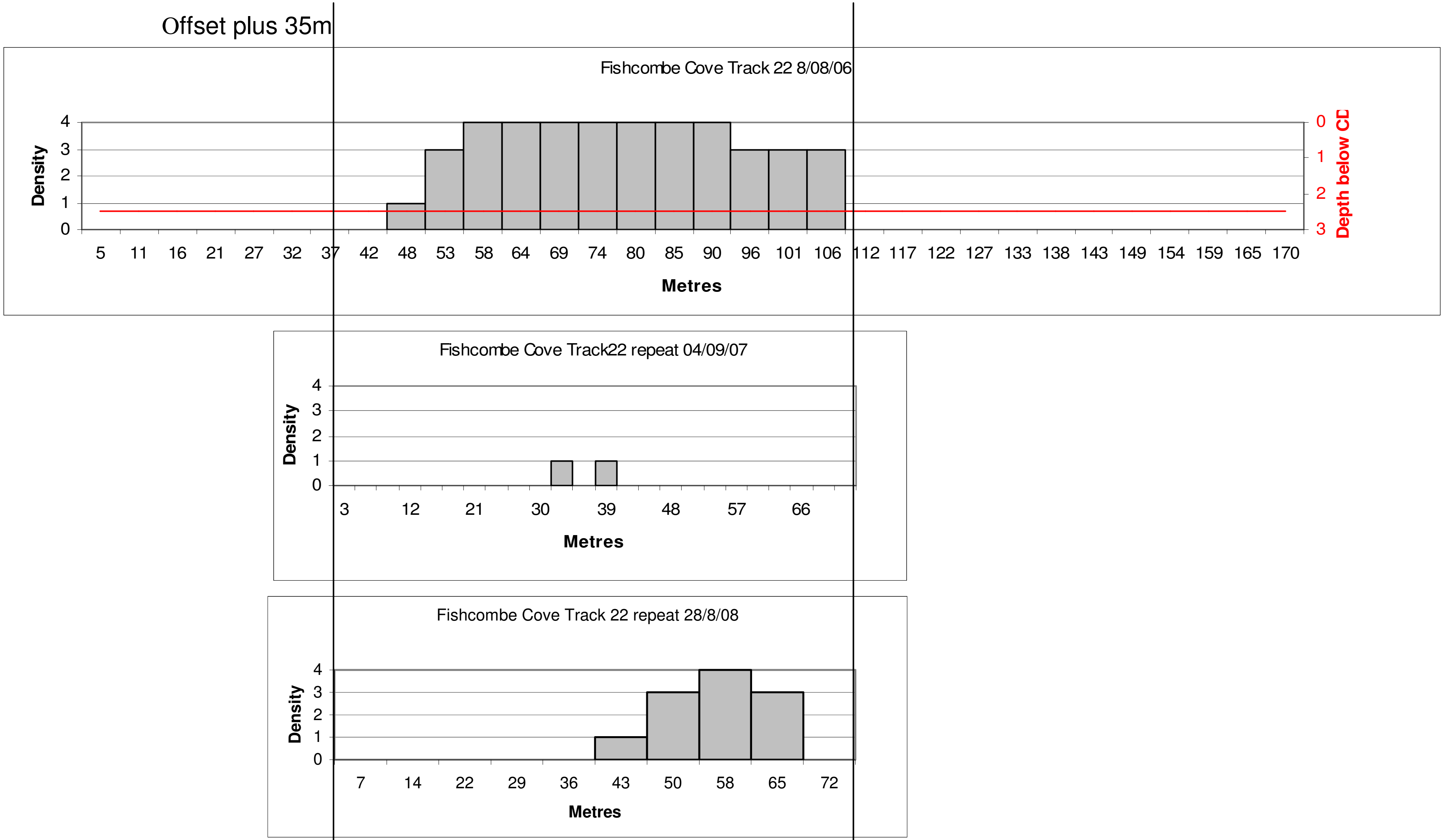


Figure 15
Seagrass density for track 22 at Fishcombe Cove with the 2008 drop video track (below) compared to the 2007 and 2006 tracks (above)

Offset minus 6m

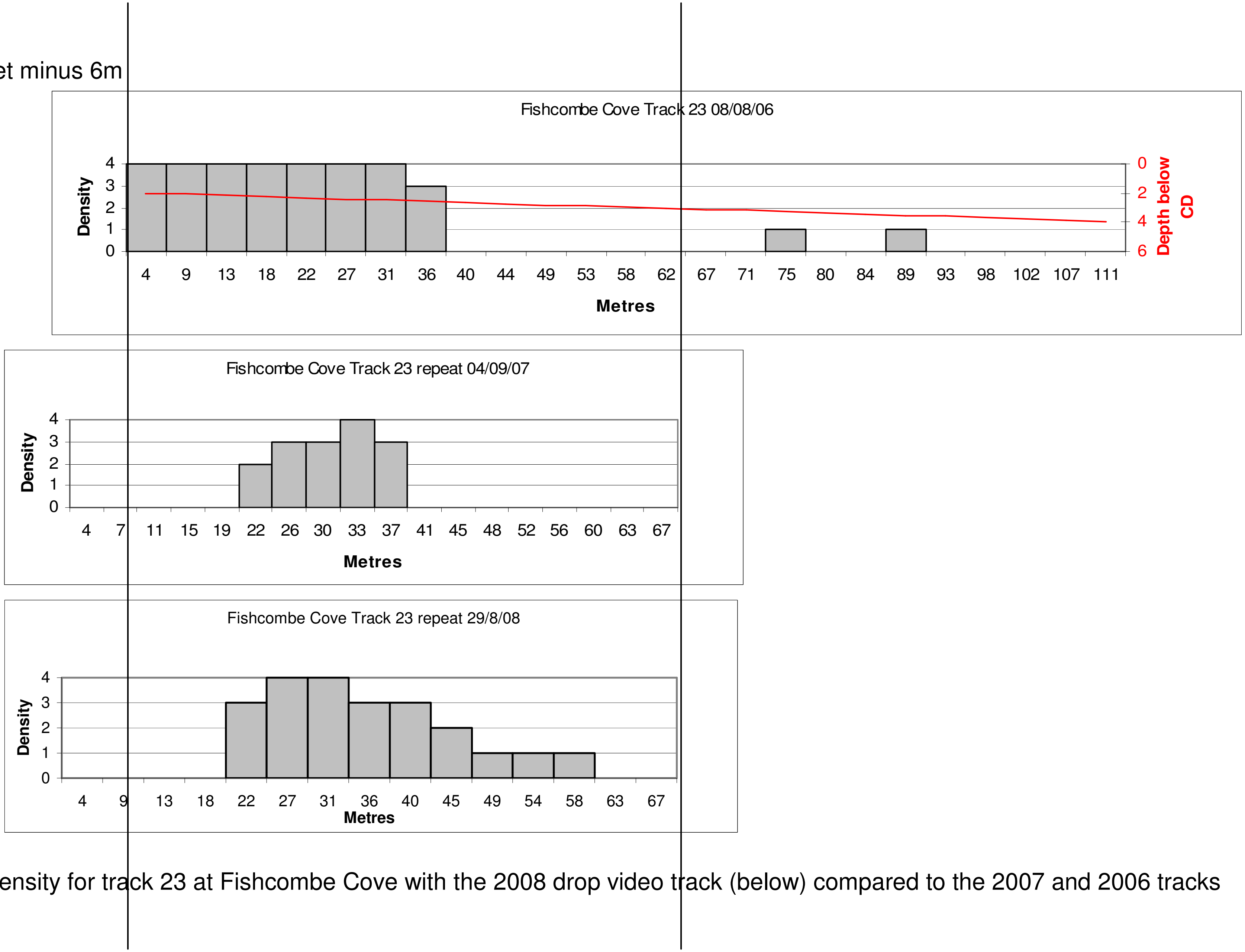


Figure 16
Seagrass density for track 23 at Fishcombe Cove with the 2008 drop video track (below) compared to the 2007 and 2006 tracks (above)

Offset plus 9m

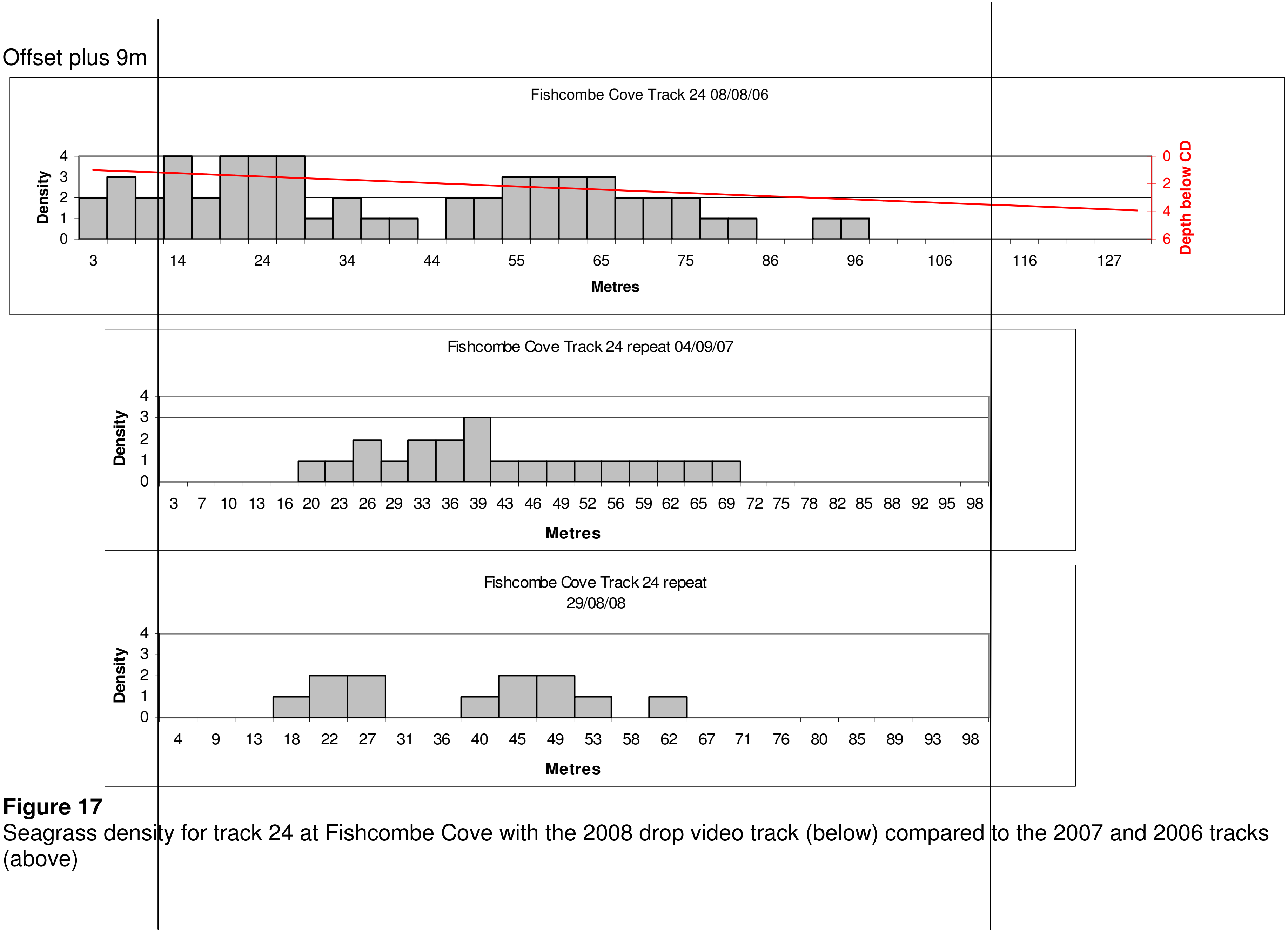


Figure 17
Seagrass density for track 24 at Fishcombe Cove with the 2008 drop video track (below) compared to the 2007 and 2006 tracks (above)

Offset plus 28m

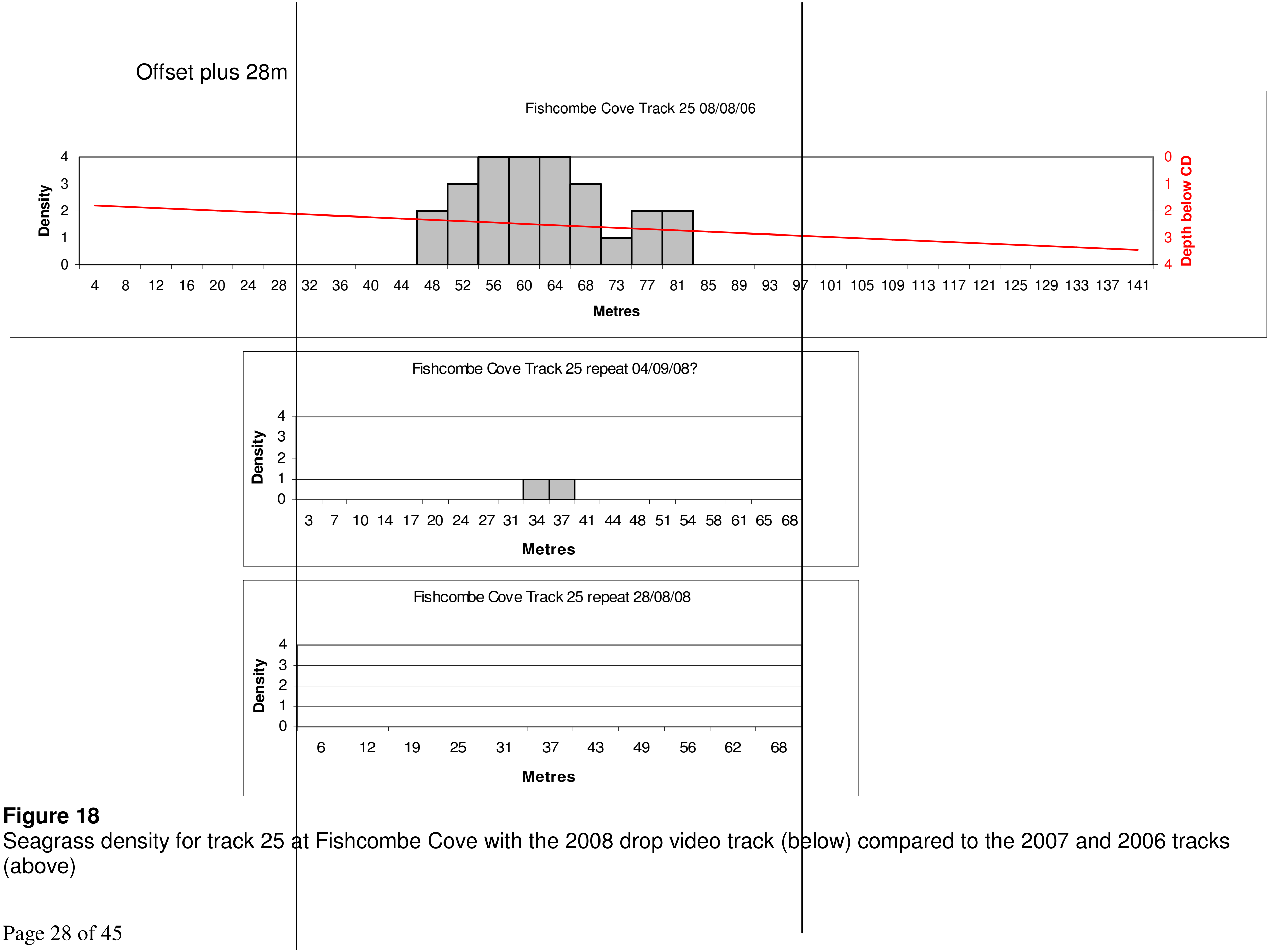


Figure 18
Seagrass density for track 25 at Fishcombe Cove with the 2008 drop video track (below) compared to the 2007 and 2006 tracks (above)

Rate of travel
It can be seen from the density track figures that the 15 second time samples equate to greater distances in the 2008 survey tracks than in the 2006 and 2007 survey tracks. This indicates that the video travelled over the ground at a faster rate in 2008 than in 2007 and 2006. For 2006 the equipment covered the 3-5m in 15 seconds and in 2007 travelled 3-4m in that time, in 2008 the distance covered was 4-7m.These speed figures are approximate as they are interpolated from the GIS mapping distances and the time stamps for track start and end waypoints.

Growth Depth
During the 2008 survey the maximum depth at which seagrass plants were observed at Fishcombe Cove was 2.5m BCD.

Extent and density changes
The surveys present a more complex situation than in the previous seagrass beds with the inclusion of the 2007 survey data. In overview there is a similar general reduction in the seagrass density scores between the 2006 tracks and the 2008 repeats, however there is also a decrease in the coverage (extent) of the seagrass in all of the tracks between 2006 and 2007, followed between 2007 and 2008 by an increase in coverage along tracks 22 and 23 and a decrease in coverage along tracks 24 and 25. To better presents this the frequency of density scores has been displayed in Figure 19 and shows for 2007 a reduction in the density scores 4, 3 and 2 and a rise in the lower density scores 1 and 0 when compared to the 2006 data showing that the bed became considerably less dense between those years. Looking at the 2008 frequencies shows that the density scores 4, 3 and 2 increased over those for 2007, and frequencies 1 and 0 decreased compared to 2007.

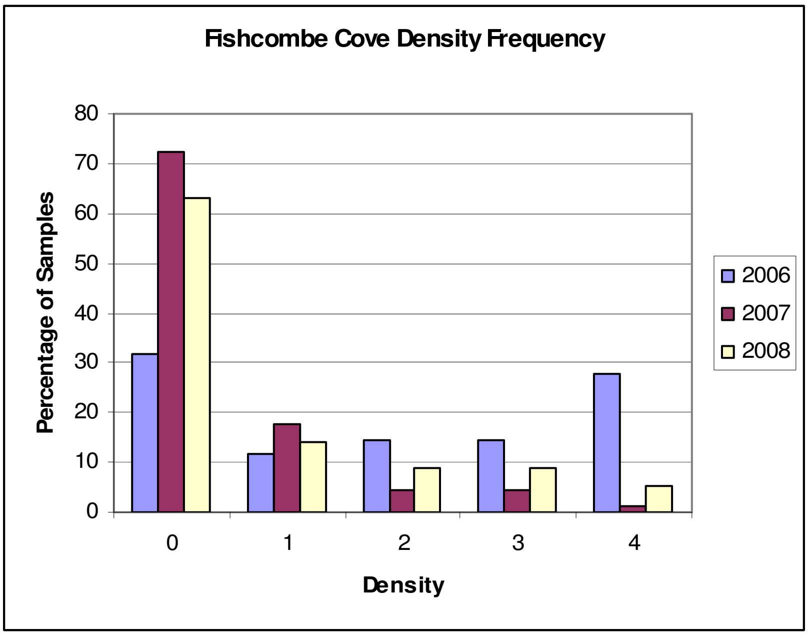


Figure 19
Seagrass density frequency histogram for the Fishcombe Cove tracks.

The arithmetical mean of the seagrass density for the repeated Fishcombe Cove tracks in 2006 was 1.95 (no units) and for the same tracks in 2007 was 0.44 (no units) and in 2008 was 0.79 (no units).

5.5 Breakwater Beach Survey

The seagrass bed at Breakwater Beach is shown as survey site 5 on the map in Figure 1. The new tracks for this survey which were not repeats of those from the study in 2006 are shown as the dotted red lines in Figure 20.

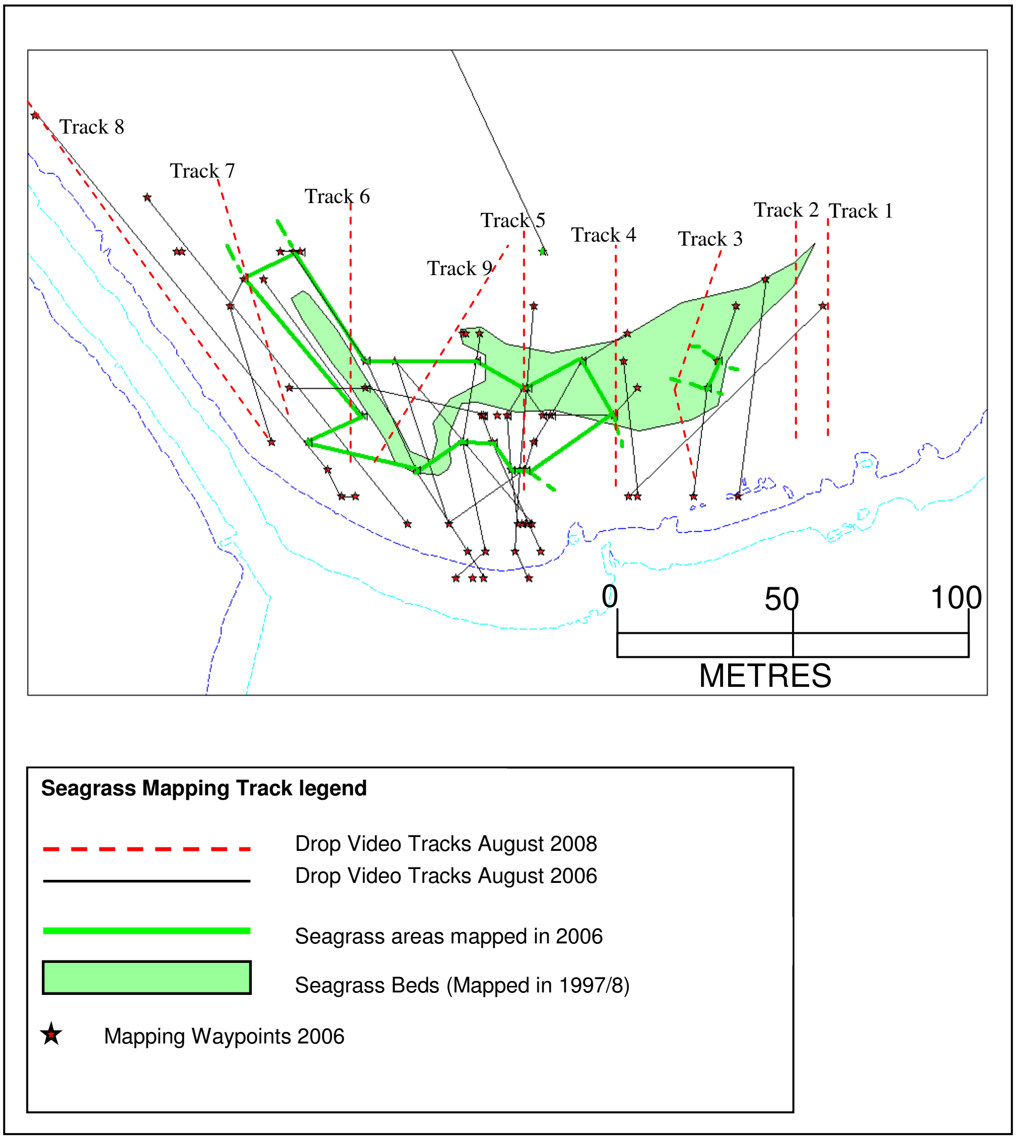


Figure 20
GIS Map of the Breakwater Beach seagrass bed showing the 1997/8 survey polygon overlaid with the 2006 polygon outlines and 2008 drop video tracks from this survey.

5.5.1 Seagrass extent, depth and density assessment

The subjective leaf density scores for the successive 15 second time periods along the new mapping tracks are shown in Figures 21 to 29 for mapping tracks 1 to 9.

The data from the 2006 survey has not been shown as reference to Figure 20 shows that the tracks are not repeats of those in 2006 and therefore not comparable.

The histograms of the 2008 tracks are displayed below for completeness.

From the tracks in Figure 20 and the density histograms 21-29 the bed can be extrapolated as a band of sparse patchy seagrass between >5m and 65m (with bare patches) in width in a similar position to that found in the 2006 and 1999 surveys.

The density of the seagrass predominantly scores 1 with only one of the 15 second samples showing a level 2 score.

The maximum depth at which seagrass plants were observed at Breakwater Beach was 4.0m BCD

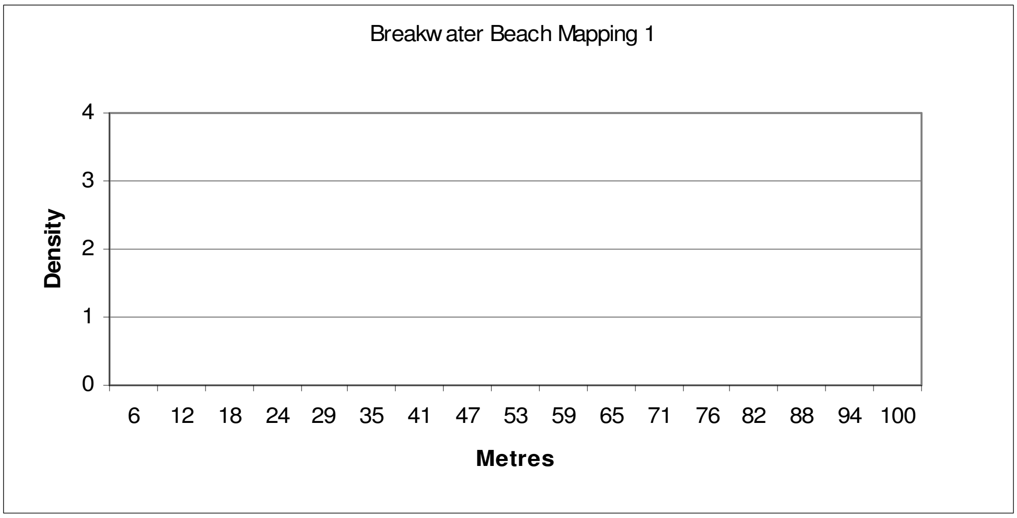


Figure 21
Seagrass density with distance for mapping track 1.

Figure 22
Seagrass density with distance for mapping track 2.

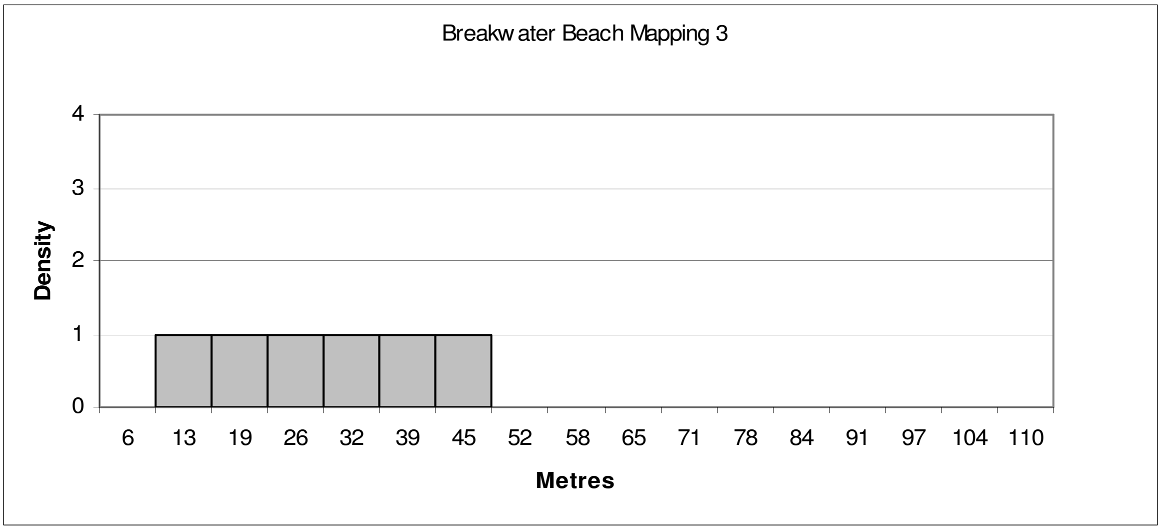


Figure 23
Seagrass density with distance for mapping track 3.

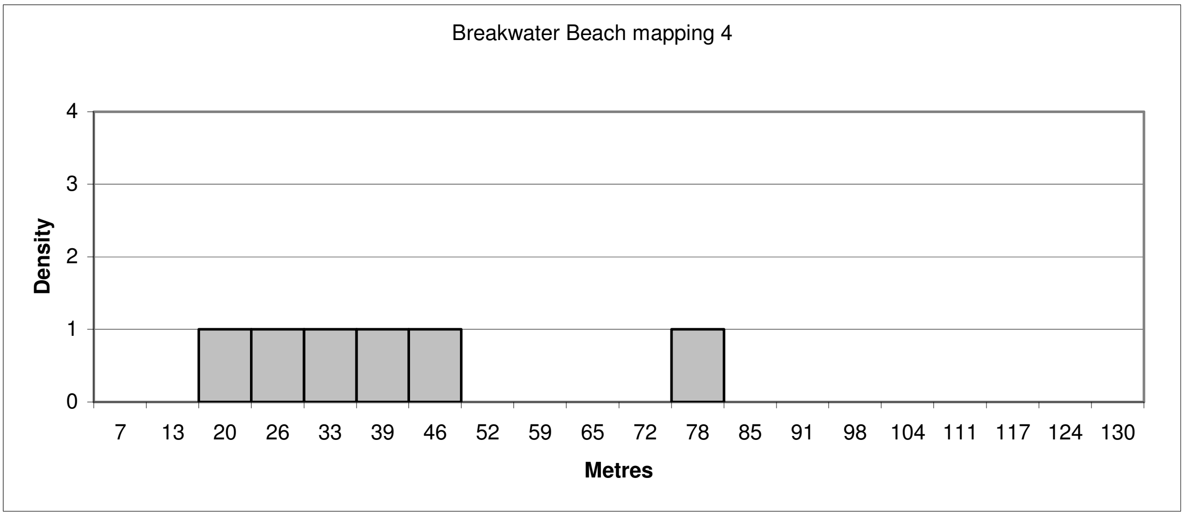


Figure 24
Seagrass density with distance for mapping track 4.

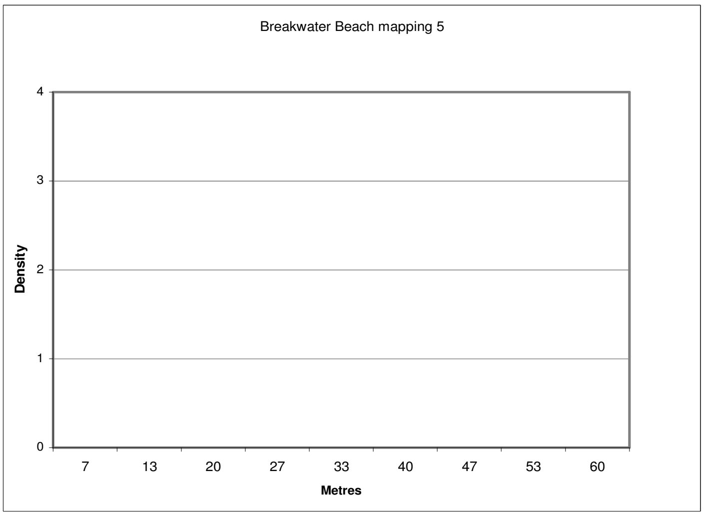


Figure 25
Seagrass density with distance for mapping track 5.

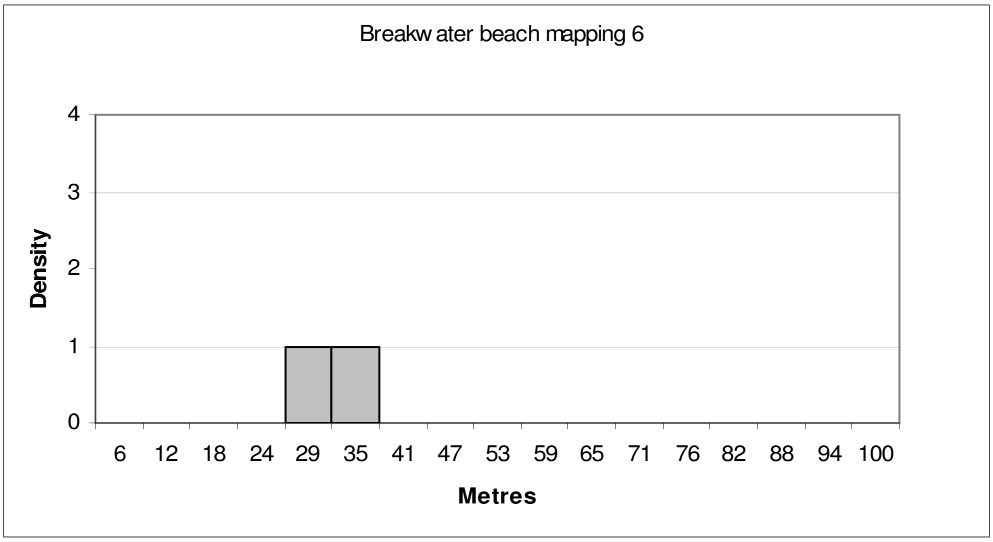


Figure 26
Seagrass density with distance for mapping track 6.

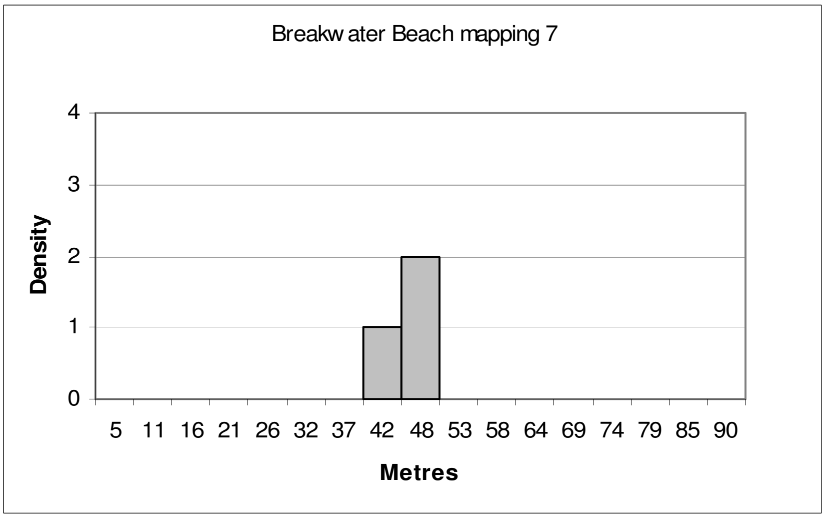


Figure 27
Seagrass density with distance for mapping track 7.

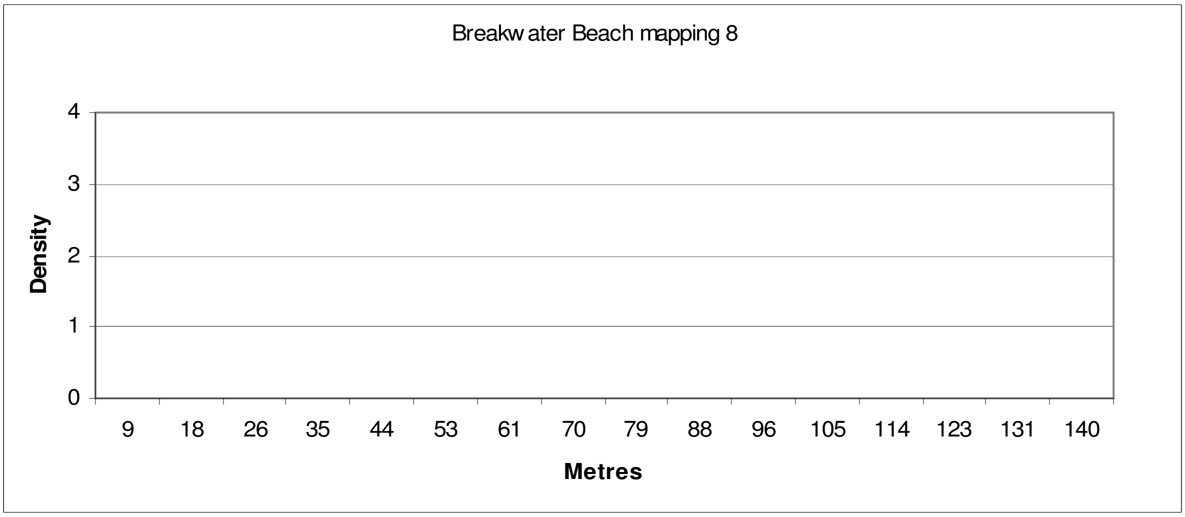


Figure 28
Seagrass density with distance for mapping track 8.

Figure 29
Seagrass density with distance for mapping track 9.

As the 2008 tracks are not positionally similar to the tracks in 2006/7 they are not comparable so no further analysis was carried out on the data.

6. Discussion

6.1 Method

6.1.1 Choice of method –using mapping methods to obtain density estimates

The original objective of the survey in 2006 was to map all the Seagrass beds in Torbay. In deciding on the method to be used there was a trade off between covering as large an area as possible and the precision of positions and the subjectivity of the density scores produced. A diver survey using DGPS positioning could have produced quadrat based transect surveys giving precisely positioned plantlet density and leaf length data capable of statistical analysis to investigate year on year effects and impact effect. However the use of HSE qualified survey divers was as outside the budget available and would not have allowed the survey of all the sites in Torbay and the location of the outer edges of all the main Seagrass beds. For these reasons the method was rejected for the 2006 surveys

So it is appreciated that the baseline data from 2006 is not the best possible data for measuring density changes and/or anthropogenic impacts (such as in Fishcombe Cove) due to the subjectivity of observer scoring and the positional errors intrinsic in the method. However the 2006 data is the only data available. If the limitations of the data are taken into consideration useful comparisons can be made.

6.1.2 Changes to equipment between 2006 and 2008

The year on year comparison is limited by changes and improvements made to the drop video equipment between 2006 and 2008. In the 2007/8 surveys the video camera had more robust protection than in 2006, this added weight to the camera and enabled faster travel over the sea bed with less trailing of the umbilical cable. Furthermore the addition of a vane to stabilise the camera enabled the recording of the transects in the direction of travel where as in the 2006 surveys the camera was free to rotate and often recorded the path behind the camera. These factors enabled the equipment to travel faster over the seabed and covering more ground in a set time period. As the scoring process works on giving a single score for the distance travelled in 15 seconds the faster the video travels the more it will tend to filter out variability along the track giving values closer to the mean and compressing the range of densities recorded (this can be seen best in the Millstone Bay tracks. This has to be considered when the 2006, 2007 and 2008 data sets are compared.
This could be improved if all tracks could be carried out at a set speed; unfortunately this was not possible due to the effects of wind and currents on the speed of the boat. Alternatively the scoring times could be varied between tracks such that a time sample represents a standard distance over the ground, for example 30m. This was attempted but produced a very complex scoring procedure that was not easy to implement with the resources available.

6.1.3 Subjectivity of video scoring

The scoring of the track video is, even with training and review, a subjective process. In order to limit this subjectivity and prevent observer bias one observer, who had no prior knowledge of the sites or their history, was used. They first scored all the video from 2007 and 2008 and then rescored all the comparable tracks from 2006.

6.1.4 Positional errors

There are a number of factors which produce positional errors hampering reproducibility and thus limit the conclusions that can be drawn and comparisons that can be made for the year on year data, these are:-

- Non differential GPS accuracy – even though waypoints were only taken when the satellite number and position allowed an EPE (estimated position error) of less than 4m this meant that when retracing 2006 tracks (also subject to an EPE of 4m) the position error could be up to 8m.
- Drop video equipment trail – the angle of the camera umbilical and the length of umbilical deployed meant that the camera was often up to 5m behind the boats GPS aerial, especially in deeper water. However this error would always be in the same direction as in the 2006 tracks so would have a small effect on the overall positional difference.
- XTE (cross track error) a result of the inability to travel exactly along the original track, which was caused by wind induced leeway and the difficulty of keeping the RHIB on a heading when travelling at very slow speeds. Excessive XTE would result in the track being abandoned and repeated
- These positional errors represent the greatest problem at Fishcombe where the surveys were attempting to map precise damage and changes so this date needs to be interpreted with these considerations in mind.

6.2 Location of previously unmapped seagrass beds

Searches using the same drop down video method were used to look for unmapped seagrass beds at sites immediately outside Tor Bay. In 2006 and 2007 divers and snorkelers had reported that seagrass beds existed at St Marys Bay south of Berry Head and at Anstey's Cove north of Hopes Nose (D. Bolt personal communication 2006). These sites were surveyed but no seagrass plants or debris was found at either site. This report concludes that no large seagrass beds currently exist at these sites. It is a possibility that small seagrass patches exist and that the number and placing of survey tracks resulted in these being missed by the survey, however as no "stray" seagrass plants or debris were observed this possibility remains remote. Other than through sampling error the difference between this surveys results and the earlier reports may be explained by the reported beds, which are probably small pioneer beds arising from seeds or broken off seagrass rhizome fragments carried to these sites by currents from the main Tor Bay beds, being destroyed before they could become fully established due to the higher level of storm exposure at these sites (compared to seagrass bed sites within Tor Bay).

6.3 Assessment of the seagrass bed condition

The same drop down video technique (with minor alterations) as was used to map the main Tor Bay seagrass beds in 2006 was used in these surveys to enable direct comparison of the video and comparison year on year of density estimates produced for each bed. It should be recognised that mapping methods are being used to remap as well as establish density estimates and that because of this the density scoring method is not quantitative and introduces an element of subjectivity into the results. This was unavoidable if the 2006 baseline data are to be used to asses the present condition of the seagrass.

Changes to the extent, depth range and/or density of the seagrass beds would be expected to be a result of poor growth, storm damage or anthropogenic factors.

6.3.1 Changes in seagrass density

Between the surveys of august 2006 and august 2008 all seagrass beds showed a decrease in the density (standardised visual subjective leaf density) of seagrass, Millstones Bay density decreased by 13% from 2.25 to1.96, Torre Abbey Sands decreased by 22% from 1.83 to 1.43 and Elberry Cove decreased by 45% from 2.56 to 1.67 (subjective density score, no units). This reduction probably results from the less suitable summer growth conditions in 2007 and 2008 when compared to 2006 (fewer hours of sunshine, colder temperatures and greater rainfall
(source Met Office -http://www.metoffice.gov.uk/climate/uk)

At Fishcombe Cove the scallop dredge damage that was observed in December 2006 (Torbay Seagrass Project (1184) report to SITA 2006 chapter 5) complicates interpretation of the decrease by 59% from 1.95 to 0.79 seen between 2006 and 2008. The density change at Fishcombe Cove is most probably the result of both scallop dredge damage and the poor summers.

At Breakwater Beach the data suggests that the seagrass bed has changed considerably in position and this makes any comparisons of density between the old and new extent difficult to interpret in meaningful way.

6.3.2 Seagrass growth depth range at each bed

In spite of the seagrass being more sparse in 2008 compared to 2006 the maximum depth for the growth of seagrass showed no significant reduction at the Millstones Bay (at 4m bcd cf. 4.3 in 2006), Torre Abbey Sands (at 5.1m bcd cf. 5.2 in 2006), Elberry Cove (at 4.7m bcd cf. 4.7 in 2006) and Breakwater Beach beds (at 4.0m bcd cf. 4.2 in 2006). At Fishcombe Cove the loss of part of the deeper eastern side of the bed, probably due to the scallop dredging in 2006, resulted in the maximum depth for the growth of seagrass in this bed reducing from 3.5m bcd in 2006 to 2.5m bcd in 2008.

6.3.3 Changes to the seagrass bed extent

Resource constraints meant that it was not possible to repeat all the mapping tracks from the 2006 surveys. So for the seagrass beds at Millstones Bay, Torre Abbey Sands and Elberry Cove only a representative sample of the 2006 mapping tracks were repeated. At Fishcombe Cove the seagrass bed was fully remapped using the same track positions as in the 2006 mapping survey (these had also been used in the 2007 post scallop dredging survey). At Breakwater Beach remapping was carried out using new regularly spaced parallel tracks as the 2006 survey tracks were of varying orientation due to changing weather conditions and therefore very difficult to retrace with any degree of accuracy (and has resulted in problems in comparing the data sets).

The tracks gave no suggestion of a reduction in extent at Millstones Bay or Torre Abbey Sands.

At Elberry Cove the southernmost track (track 30) suggested a reduction in the bed extent at its south-eastern edge. One possible cause for this is that during the winter months of 2006, before the introduction of the voluntary no scalloping areas, there was considerable scalloper activity close to the shore along the southern edge of Torbay between Brixham and Elberry Cove and vessels would scallop into the area of the Elberry Cove seagrass bed (Torbay Seagrass Project (1184) report to SITA 2006 chapter 5). The reduction to the Elberry Cove bed observed may have resulted from this damage caused by this activity. The effects observed at Fishcombe Cove would support this hypothesis.

Fishcombe cove

As the Fishcombe Cove seagrass bed is one of the least exposed to storm damage in Torbay and as the other seagrass beds (discounting Breakwater Beach for the reasons given below) show little change in extent, it is unlikely that growth or storm effects have caused the reduction in the extent of this bed. There is a possibility that the reductions are due to positional errors inherent in the method but is unlikely that these alone could result in the large changes observed. It seems most probably that the changes are a result of the scalloping events in November and December 2006. In light of this the change in both extent and density need to be considered together. The diver surveys in December 2006 and the video surveys in September 2007 suggest that these scalloping events caused a significant reduction in the bed size and Seagrass density to the eastern side of the bed, there was also an increase in bare seabed patches observed within the bed (see Figures 17 and 18 also personal observations 14th December 2006). The 2007 data shows this major reduction when compared to the 2006 data; however the 2008 data shows that there has been some recovery in the overall density of the bed but there has only been a small reduction in the amount of bare patch within the bed, this is clearly shown in the distribution of densities in Figure 19.

Although the 2006 survey fortuitously (for assessing impact effects if not for the seagrass!) captured information on the Fishcombe seagrass bed prior to the scallop dredge activity we have no information to describe the effects this event had on the rhizome bed within the sea bed. One speculative explanation for the observed changes may be that the scallop dredges broke off just the above the seabed seagrass plantlets in many areas but removed the whole Seagrass rhizome in others. So that what we could be seeing in the two years since the dredging is the Seagrass growing back where the plantlets (but not buried rhizomes) were removed and no growth where the whole rhizome was removed. The large quantities of seagrass plantlets and rhizomes washed up on the strandline post the 2006 scalloping incident may support this.

That some recovery has occurred between 2007 and 2008 may suggest that further damage through scalloping has not occurred and that the voluntary no scalloping agreement has been effective in preventing a reoccurrence. It is noted though that the recovery has not returned the site to pre impact extent or density (see Figures 15-19).

The other anthropogenic factor at Fishcombe that may impact the seagrass is the mooring of boats although there is no evidence to indicate a major fluctuation in anchoring frequency to account for the reduction in density between 2006 and 2007and slight increase between 2007 and 2008.

Breakwater Beach

When the 2006 Breakwater Beach survey data was compared to the 1999 surveys (C. Proctor 1999) considerable difference in bed position and shape was observed. It was suggested that this was possibly due to the bed being naturally more variable as the site is the bed most exposed to storm damage in Torbay, particularly from easterly and north-easterly winter storms. The 2008 data presented here again suggests that this bed has changed in both position and shape, however the shape and character of this bed, narrow with sparse, patchy growth, together with the inbuilt positional errors of the method used (and exacerbated by the use of different orientation tracks in 2008) cast doubt on the accuracy of the maps produced. The possibility exists that the variability may then not be an exposure effect but an artefact of the method. From this it can be seen that this site requires further investigation using a more positionally accurate method, suitable ones would be either by diver towed GPS or by aerial photography.
Looking at the density however shows that the seagrass in the bed in 2008 was scored predominantly as 1 with only a one incidence of a 2 score, bearing in mind the problems with this survey there was a reduction compared to the 2006 average of 1.67 (Torbay Seagrass Project (1184) report to SITA 2006) from this it appears that the seagrass in this area has, like the other beds, experienced a reduction in density probably attributable to poor growing conditions.

7 Conclusions

7.1 Seagrass bed condition

The surveys indicate that between august 2006 and august 2008 all the seagrass beds showed a decrease in density. The least reduction was 13% at Millstones Bay and the greatest 59% at Fishcombe Cove. The decrease at Breakwater Beach, although apparent, has not been calculated due to methodological differences preventing comparison. At most sites the probable explanation for this density decrease is the poor summer growth conditions in 2007 and 2008 compared to 2006. At Fishcombe Cove the decrease in density is also associated with a decrease in coverage (extent) in the areas scallop dredged in November/December 2006, promisingly comparing the 2007 data to the 2008 shows an increase in density in Fishcombe Cove suggesting that parts of the bed are now recovering.

The maximum depth of seagrass growth within Torbay remains similar to that in observed in 2006 at 5.2m BCD with all beds except Fishcombe Cove having similar a growth range as was observed in 2006. Fishcombe Coves maximum growth depth has decreased significantly from 3.5m BCD to 2.5m BCD. Again this may be a result of scallop dredge activity in 2006

Resource constraints meant that it was not possible to repeat all the mapping tracks from the 2006 surveys to assess changes in the extent of each of the seagrass beds. At the Millstones Bay, Torre Abbey Sands and Elberry Cove seagrass beds only a representative sample of the 2006 mapping tracks were repeated. No indication of change in extent was seen from this admittedly limited data at Millstones Bay and Torre Abbey Sands. Some westward movement of the southeast edge of the bed at Elberry was observed which again may be a result of scalloping in 2006. Fishcombe Cove was mapped in more detail than the other beds and the 2007 data shows a major reduction in extent of the bed when compared to the 2006 data. The 2008 data shows that although there has been some recovery in the overall density of the bed there has been no clear increase (recovery) in the extent of the bed when compared to the 2007 position.

A secondary objective of this study was to carry out speculative search at sites previously reported to have seagrass beds (St Marys Bay and Anstey's Cove) to determine the size and condition of any seagrass beds at these locations. Multiple tracks were surveyed from the shallows to beyond 5m BCD at each site but no seagrass plants or debris was found at either. This report concludes that no large seagrass beds currently exist at these sites. As no new seagrass beds have been found it is likely that the area of seagrass associated with Torbay is the 80.1hectares in 5 main beds identified in the 2006 survey.

7.2 Management

Considering the changes at Fishcombe Cove after the 2006 scallop dredging incident; and in light of the proposed Marine and Coastal Access Bill which specifically mentions the protection for seagrass beds through MCZs; and with the requirement to protect seagrass habitats implied through the recent inclusion of seahorses on to schedule 5 of the Wildlife and Countryside Act 1981, the conversion of the voluntary no scalloping agreement areas into a legally enforceable restriction (such as a DSFC bylaw) should be investigated.

Regarding the protection of seahorses, it should be noted that seahorses are not found exclusively in seagrass (http://www.britishseahorsesurvey.org) and to comply with the Wildlife and Countryside Act 1981 it may be necessary to protect all the complex shallow habitats in Torbay from mobile fishing gear. The unofficial agreement by trawlers with Devon Sea Fisheries Committee not to shoot multi rig gear within six miles of Berry Head is a positive move in this direction.

7.3 Further work

Year on year monitoring

The time series of surveys into seagrass bed condition that was started in 2006 and continued through this survey needs to be continued as it should produce not only a way of monitoring the effectiveness of conservation measure but also considerable information on the natural variability of seagrass beds with weather conditions and relative exposure (see below) . As continuing research and monitoring of the seagrass beds in Torbay is an action of the Torbay LBAP this would be expected to happen.

However in light of the discussion given above of the errors and limitations of the methodology applied in this survey modifications and new methods will be needed. For the larger beds the drop down video method employed in this study is effective in monitoring density and, to some degree extent changes using the 2006 data as baselines. However for a more complete picture additional funding will be required to fully remapping the larger beds by drop video or by aerial photography as was done for the Plymouth Sound surveys (E. Jackson 2006).

In the smaller beds, and especially when assessing damage and recovery, positional errors need to be reduced and a more quantitative scoring system is required. Good year on year comparative data could be obtained by placing permanent markers of flagstones and submerged buoys at the ends of transects (similar to the method employed in the Lyme Bay monitoring by the University of Plymouth) and using diver directed surveys to video the transects (tracks) and carry out quadrat counts along the transects. At Fishcombe Cove tracks 22, 23, 24 and 25 could be thus marked and surveyed annually to monitor recovery (data could then be usefully compared to the 2006/07/08 data). At Millstones Bay the data could test the hypothesis that this is a high stability bed (least impacted bed anthropogenically and from this survey the least changed 2006 to 2008) and can be used as a control site for other surveys. At Breakwater Beach surveys could monitor for changes and, in conjunction with exposure modelling, test a high exposure high variability hypothesis (see below). Some provision would need to be made at these sites to prevent the removal or movement of markers and transect lines in particular no anchoring zones may be necessary at Fishcombe Cove.

Gain more precise data on Breakwater Beach

The data on Breakwater Beach is poor as the method employed in the surveys is not suited to long, narrow and patchy seagrass beds as exists here. The data and would be greatly improved by diver mapping using the SMB mounted GPS method. This gives a smaller positional error and avoids the need to extrapolate the track data to produce polygon maps. This may be achievable at low cost as Breakwater Beach is a popular recreational dive site with many dive clubs using it for training and it may be possible to get them involved in the mapping as a club project.

Exposure modelling of the seagrass beds and assessing natural risk
Mathematical modelling (REI) of the exposure of the seagrass beds around Torbay could be used to identify the sites most at risk from storm damage. This could inform the LBAP and management strategy on the suitability of protection measures at each site. To accurately assess the exposure at each site, it is recommended that a Relative Exposure Index (REI) map for the area is calculated. Software is freely available from NOAA for calculating REI (WEMO (Fonseca et al. 2006)) following the methods adapted by Fonseca and Bell (1998), which calculates an index based on maximum wind speeds, frequency of wind direction, effective fetch and bathymetry.

Standardisation of video methods – best practice
One observation beyond this study is that there are a number of different Drop Video and towed video methods being used to survey Seagrass beds around the UK coasts at this time and it would be useful to standardise these methods with respect to the field of view (and lens type), angle of incidence, speed of tow, methodology of scoring density (human or automated) and ground truthing methods (diver or other). This would then develop a best practice method and also allow valid comparison between data obtained by different methods.

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Survey of Eelgrass bed communities within Plymouth Sound and Estuaries (Devon) Special Areas of Conservation (SACs) and Salcombe-Kingsbridge Estuary (Devon) Site of Special Scientific Interest (SSSI) WP5: Configuration of Seagrass landscapes Jackson E. (2006)

Web resources

Met Office -http://www.metoffice.gov.uk/climate/uk

The British Seahorse Survey - http://www.britishseahorsesurvey.org

The South West Regional BAP
http://www.wildlifetrust.org.uk/avon/www/Habitats/Seagrass/seagrass.htm

Further information

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