OCEAN ECOLOGY

Marine Surveys, Analysis & Consultancy

Mounts Bay Seagrass Before-After-Control Impact Study 2023

OEL_IFCSEA1023_TCR_V01

+44 (0) 1452 740697 info@ocean-ecology.com www.ocean-ecology.com @Ocean_Ecology

Details

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V01	26/02/2024	Draft	Emily Sparkes	Dr Elena Cappelli	Ross Griffin
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Updates

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List of Abbreviations

ANOSIM	Analysis of similarity
CIFCA	Cornwall Inshore Fisheries and Conservation Authority
CPCe	Coral Point Count with Excel extensions
HRA	Habitats Regulations Assessments
IFCA	Inshore Fisheries and Conservation Authority
MCZ	Marine Conservation Zone
MESH	Mapping European Seabed Habitats
OEL	Ocean Ecology Ltd
RV	Research Vessel
SAC	Special Area of Conservation

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Non-Technical Summary

Ocean Ecology Limited (OEL) was commissioned by Cornwall Inshore Fisheries and Conservation Authority (CIFCA) to conduct detailed analysis of seabed imagery acquired by CIFCA with the aim of determining potential impacts of fishing activity on seagrass beds within Mounts Bay.

A two-day survey was undertaken by CIFCA in August 2023 during which seabed imagery was collected at paired stations before and after planned fishing activities. OEL subsequently used Coral Point Count with Excel extensions (CPCe) software to analyse the resulting imagery involving assessing the percentage cover of seagrass observed in the before and after fishing activity images.

Similarity scores derived from CPCe data showed that 34 % of paired stations exhibited a decrease in percentage seagrass cover between before and after surveys, while 32 % of paired stations showed an increase in percentage seagrass cover between surveys. However, statistical analysis conducted on percentage cover data reported no significant difference in seagrass cover between surveys.

1. Introduction

1.1. Project Overview

Ocean Ecology Limited (OEL) was commissioned by Cornwall Inshore Fisheries and Conservation Authority (CIFCA) to conduct detailed analysis of seabed imagery acquired by CIFCA with the aim of determining potential impacts of fishing activity on seagrass beds within Mounts Bay. The analysis of the imagery was conducted 'blind' in that CIFCA did not disclose the type of fishing activity that took place to ensure a completely objective assessment and avoid any potential bias. The results of this study will aid in the finalisation of Habitats Regulations Assessments (HRA) and Marine Conservation Zone (MCZ) assessments which are investigating the impact of the fishing activity on seagrass, a designated feature of the Fal and Helford Special Area of Conservation (SAC), Plymouth Sound and Estuaries SAC, Mounts Bay MCZ and the Whitsand and Looe Bay MCZ within the CIFCA District. The outcome of the assessments will determine whether restrictive management measures are required to ensure that the investigated fishery activity will not have a significant impact to the feature of sea grass in European Marine Sites, and that Cornwall IFCA is compliant with its obligations under section 154 of the Marine & Coastal Access Act 2009 in respect of sea grass as a feature of MCZs.

The study involved a two-day survey undertaken by CIFCA in August 2023 during which seabed imagery was collected at paired stations before and after planned fishing activities. OEL subsequently used Coral Point Count with Excel extensions (CPCe) software to analyse the resulting imagery involving assessing the percentage cover of seagrass observed in the before and after fishing activity images. This report presents the results of the analysis and interpretation of the resulting data as well as survey information taken from the field report compiled by CIFCA (cited as Jenkin *et al* 2023).

1.2. Aims and Hypotheses

The aim of the study was to compare still images from before and after planned fishing activities to determine and assess signs of impact on the seagrass beds around Mounts Bay.

The following hypotheses were formulated to test whether significant changes in seagrass cover occurred between before and after surveys:

Null hypothesis - H_0: No significant changes in seagrass cover occurred between before and after surveys.
Alternative hypothesis - H_a: Significant changes in seagrass cover occurred between before and after surveys.

1.3. Background Information

The survey was carried out in Mounts Bay located on the south coast of Cornwall as shown in Figure 1. The bay contains a large area of seagrass which is estimated at 290 ha (Ecospan, 2021) and also encompasses the Mounts Bay MCZ. However, the survey was carried out on a seagrass bed which was not located within the MCZ or any other designated area.

1.4. Mounts Bay Marine Conservation Zone (MCZ)

Mounts Bay Marine Conservation Zone (MCZ) is an inshore site which covers an area of almost 12 km^2 surrounding St. Michael's Mount. The Mounts Bay MCZ is part of a network of sites designed to meet conservation objectives under the Marine and Coastal Access Act (2009). The Mounts Bay MCZ lies in between MPAs, with the Lands End and Cape Bank SCI and the Runnel Stone MCZ to the West and the Lizard Point SCI to the East (Figure 1). This site protects a variety of habitats and species including areas of sand and soft sediment habitats, rocky habitats and seagrass beds. This in turn leads to a wide diversity of plant and animal species including stalked jellyfish *(Lucernariopsis ampanulate)*.

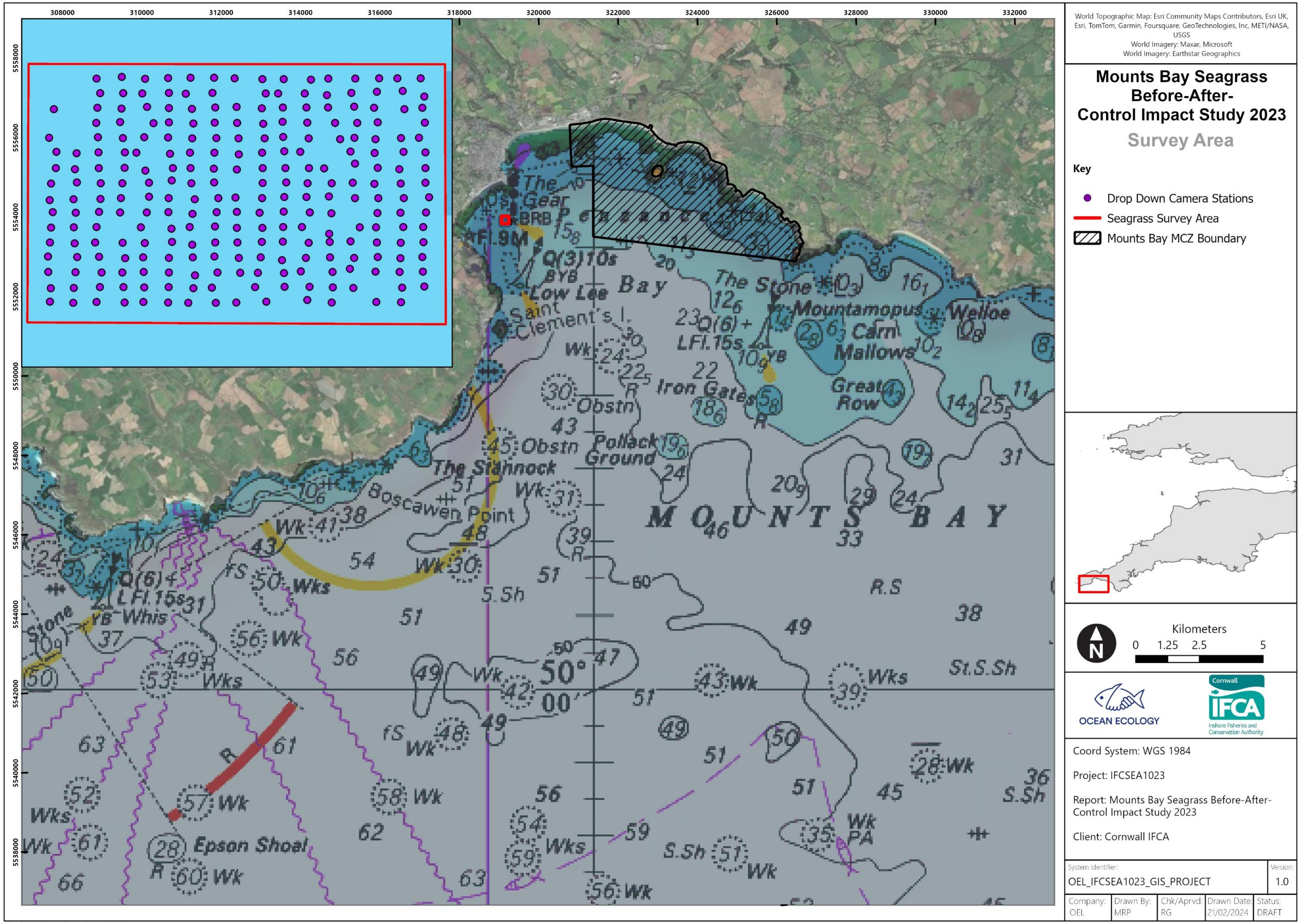


Figure 1 Overview of the survey area in relation to the Mounts Bay MCZ.

2. Survey Methods

2.1. Survey Approach

The survey was undertaken by CIFCA on the research Vessel '*Tiger Lily*'. Video and still imagery was collected using a STR SeaSpyder drop camera system. The survey was carried out in line with Mapping European Seabed Habitats (MESH) recommended operating guidelines for underwater video and photographic imaging techniques (MESH, 2008). CIFCA set up a sampling grid consisting of 20 stations east to west (labelled 1 to 20) and 20 stations running north to south (labelled A to T). Twenty tows were planned to sample across the grid, with tows numbered from T1 to T20. A total of 400 survey grid positions were planned and tows were pre-planned with a still image taken every 10 m on a planned grid position at a speed of a maximum 0.5 knots.

The survey was undertaken on the 15th and 16th of August 2023 as summarised in Table 1 below.

Table 1 Summary of survey activities undertaken by CIFCA

Date	Activity
15th August 2023	RV *Tiger Lily* departed Mylor at 05:00
	Camera deployed at 08:24 for a test tow
	Camera recovered at 15:00 after completing 19 tows
	Fishing operations commenced at 15:25
	Vessel returned to Newlyn at 16:05
16th August 2023	RV *Tiger Lily* departed Newlyn at 07:00
	Camera was deployed at 07:45 and 17 tows were successfully completed
	Camea was recovered to deck at 14:25
	Vessel alongside in Mylor at 17:00

2.2. Seabed Imagery Analysis

In order to determine the percentage cover of seagrass within each still image, CPCe software (Kohler & Gill, 2006), a widely used tool for monitoring biogenic habitats around the world (Odonnell, 2013; Tabugo et al., 2016), was utilised. The software offers an accurate, standardised, and repeatable methodology for determining percentage coverage from imagery.

A total of 543 images were analysed. A frame border was defined for each image and all photographic frames were overlaid by a matrix of randomly distributed points. A power analysis was undertaken prior to analyse the imagery in CPCe to determine the optimum number of points to overlay on each image. The following input parameters were defined to set up the power analysis:

Tails = Two (a two tailed test is required when the alternative hypothesis states that the null hypothesis is wrong - see Section 1.2)
Effect Size (Cohen's d) = 0.5 (medium size effect)
Significance level (α) = 0.05 (5 % Type I error)
Power ≥ 0.80 (≤ 20 % Type II error)

The software G*Power 3.1.9.7 (Kang 2021) was used to run the power analysis described above and ensure an adequate number of samples was selected to confidently test for changes in seagrass cover between surveys. The results of the power analysis indicated a statistical power of 87 % when 40 points were to be analysed per image. In other words, if 40 points were to be analysed in each image, there would be a 5 % chance of detecting an ecologically important change in seagrass cover where in fact there was no such change (Type I error – false positive). There would also be a 13 % chance of not detecting an ecologically important change in seagrass cover where such a change did in fact occur (Type II error – false negative).

The points overlaid on each image were then used to characterize and estimate the percentage cover of seagrass within the image. Each point was classified as either seagrass, other (red algae, seaweed etc) or not seagrass (bare sand, rock etc). The software measured the percentage cover of seagrass by scoring the presence of seagrass under each random point. An example screenshot of the analysis process is provided in Plate 1. The results were presented as a percentage of seagrass cover per image and per tow.

The data for each frame was stored in a .cpc file which contains the image filename, point coordinates and the identified data codes. The data from all images of each tow were then combined to produce automatically generated Excel spreadsheets.

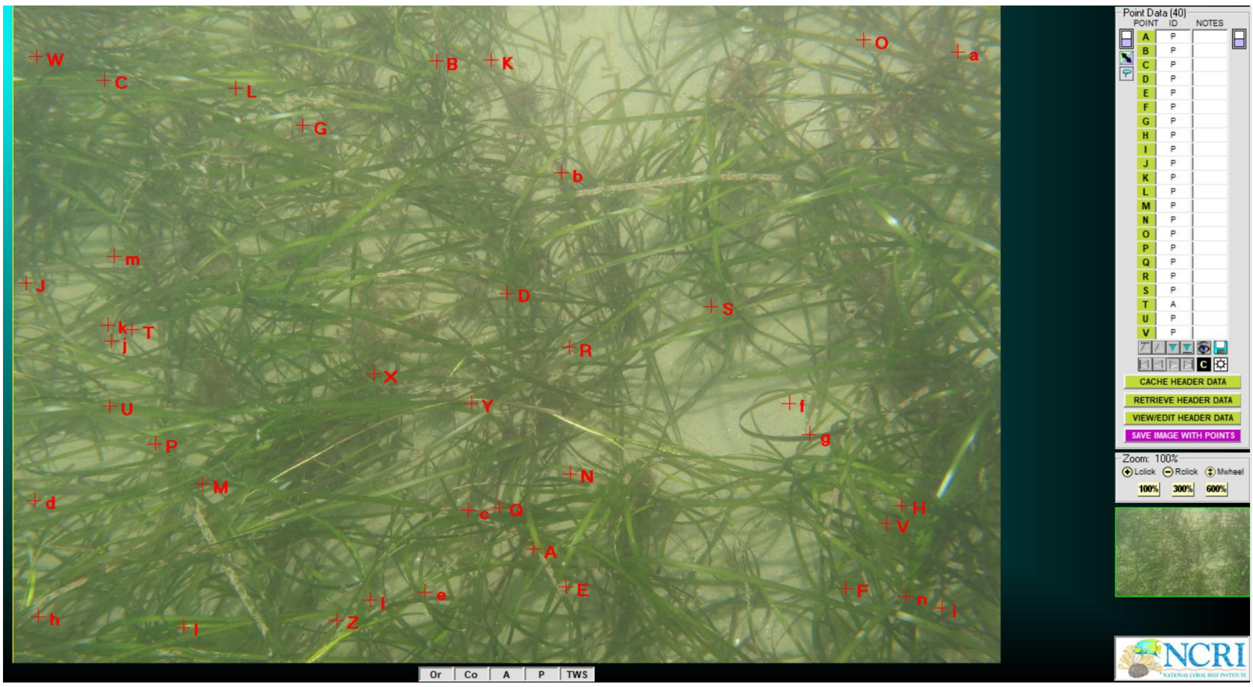


Plate 1 Example of CPCe analysis undertaken on each image with 40 random points assigned.

2.3. Data Analysis

Although a total of 543 images were processed within the CPCe software, 253 pairs of images (whereby the image from both the before and after survey aligned) were used for comparisons and data analysis. It should be noted however that in the CIFCA Field report (Jenkin *et al* 2023) it was stated that the before and after image for each station was not taken in exactly the same location due to issues with the ultrashort baseline acoustic positioning system.

Stations within tow 19 were not included in the analysis as images along tow 19 were not collected during the 'after' survey carried out on the 16/08/2023.

The PRIMER v7 software package (Clarke & Gorley, 2015) was utilised to undertake the statistical analysis on the before and after datasets. Euclidean distances (ED) calculated between paired stations were used to test for dissimilarity in seagrass cover before and after fishing activities took place. The larger the distance the larger the difference in seagrass cover among the two paired stations. To assess whether ED indicated a statistically significant difference in seagrass cover before and after fishing activities took place, they were converted into similarity scores ranging from 0 to 100 % using the function:

$$1 - \left(\frac{ED}{100}\right)$$

Where 100 is the difference that could have been assigned to images from paired stations. This meant that a similarity score of 100 indicated no change in seagrass cover between surveys while a similarity score of 0 indicated no similarities between paired stations. Assuming a 5 % significance level, paired stations with a similarity score of 95 or higher were considered to have not experienced a significant change in seagrass cover between before and after surveys. In all other instances the change was deemed significant with similarity scores close to 95 indicating high similarity in seagrass cover between surveys while scores close to 0 indicated a large change in seagrass cover between surveys.

A one-way analysis of similarity (ANOSIM) was also used to test for significant changes in seagrass cover across the whole site between before and after surveys. ANOSIM can be used as permutation-based hypothesis testing to test for differences between groups of samples (e.g. before and after). The output is expressed as an R Statistic indicating the magnitude of change and a p value representing the significance of change. Assuming changes are significant ($p < 0.05$), R Statistic values close to 0 indicate a high degree of similarity and therefore small changes in seagrass cover between surveys whereas values closer to 1 are indicative of a low level of similarity and large changes in seagrass cover between surveys.

3. Results

3.1. Sampling Effort

The proposed sampling plan included the collection of seabed imagery at 400 stations during the before and after surveys, however, only 275 images were collected during the before survey and 266 during the after survey (Jenkin *et al* 2023). Of these, 253 images were collected from the same station (paired) during each survey and could be analysed to assess changes in seagrass cover between surveys.

Due to the reduction is scope from the proposed 400 paired stations to 253, a *post hoc* power analysis was run to compute the achieved power based on:

Tails = Two
Significance α = 0.05
Sample size = 253
Effect size (Cohen's d) = 0.3 (small effect); 0.5 (medium effect); 0.8 (large effect)

The results of the power analysis indicated an achieved power of 99 % for small effect size and of 100 % for both medium and large effect sizes. This meant that the analysis of 253 paired stations allowed to assess small effect with a Type II error of 1% and medium to large effect size with virtually no Type II error indicating that even though there was a reduction in the number of stations sampled, they still covered enough of the survey area to provide the basis for robust statistical analyses.

3.2. Imagery Analysis

The results of the CPCe analysis revealed that 48 % of the paired stations sampled saw a decrease in seagrass cover between the before and after surveys. The largest decrease was observed at station T17_P17 where seagrass cover decreased by 67.5 % from 82.5 to 15 % coverage. However, the average decrease in seagrass cover across all stations where a decrease was observed was 13 %.

Forty four percent of stations saw an increase in seagrass cover between the before and after surveys where the largest increase was observed at station T8_E8 where seagrass cover increased by 52.5 % from 22.5 % to 75 % cover. The average increase across all stations where an increase was observed was 12 %.

The remaining 7.5 % of stations saw no significant difference in seagrass cover between the before and after survey.

In general, across the whole site, the average (± standard error) of difference in seagrass cover between paired stations and surveys was 0.82 ± 0.96 % No obvious spatial pattern was observed with regards to changes in seagrass cover across the survey area (Figure 2 and Figure 3).

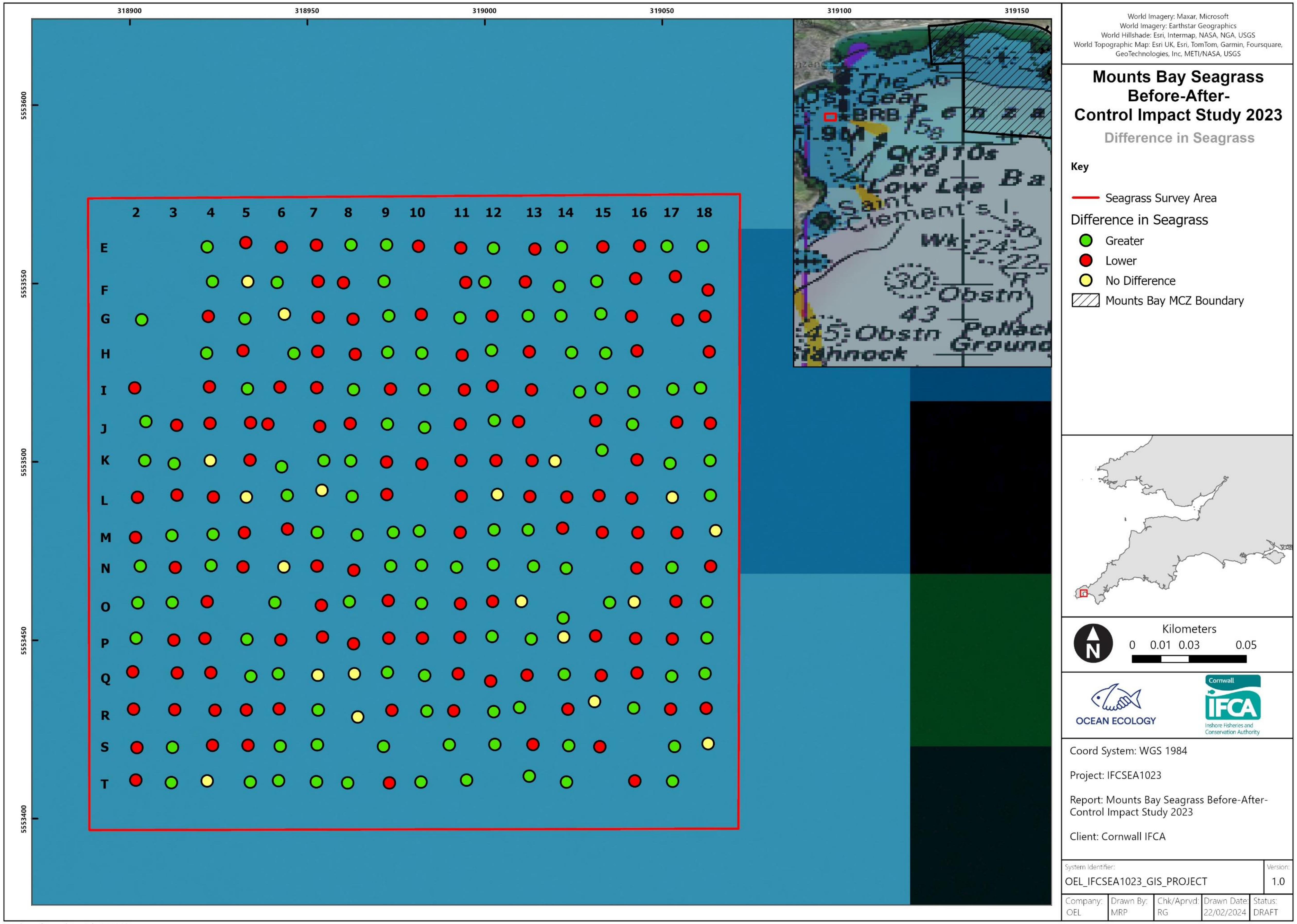


Figure 2 Change in seagrass cover between the surveys undertaken before and after planned fishing activities.

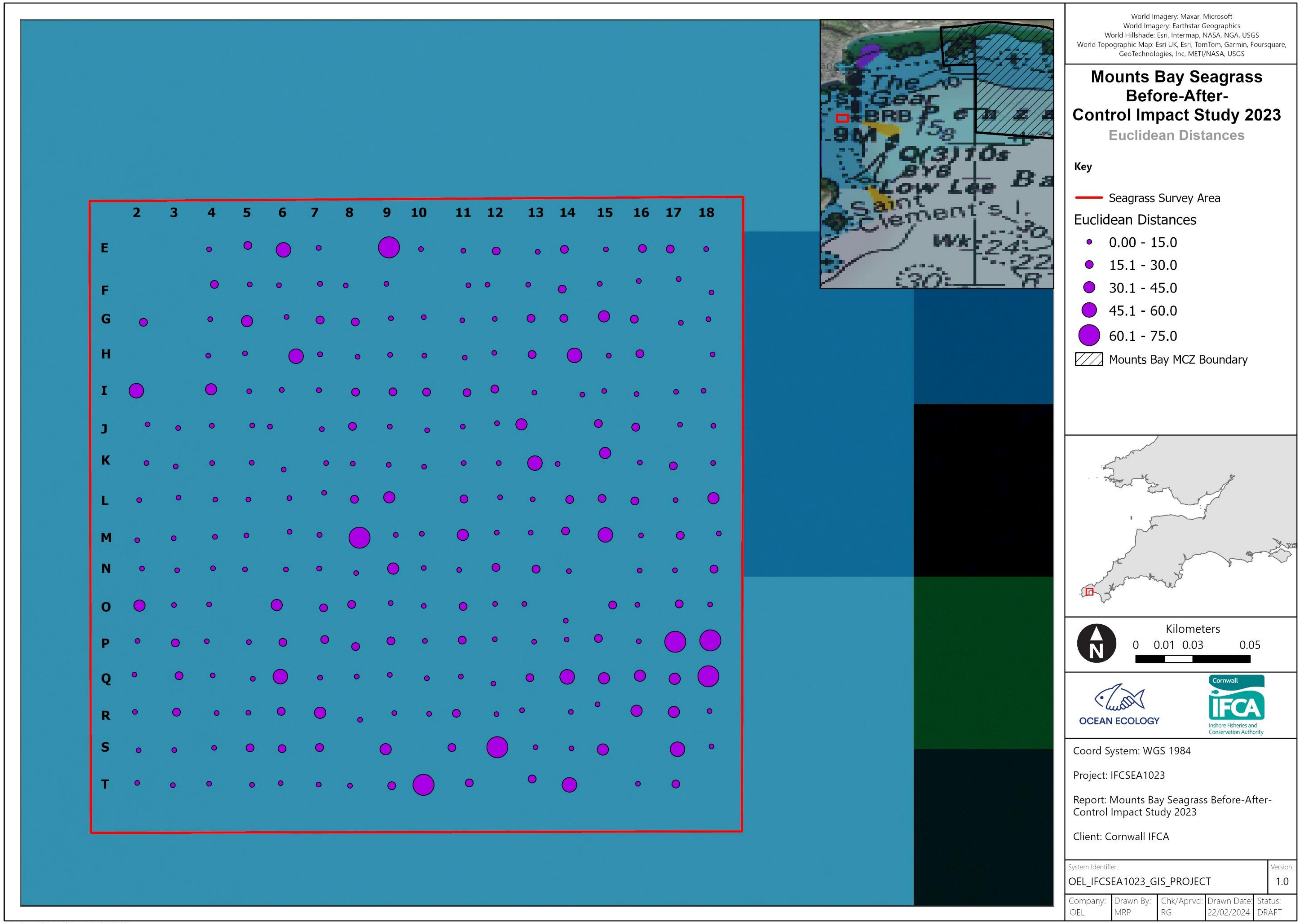


Figure 3 Euclidean Distance values relating to the percentage change in seagrass cover before and after planned fishing activities. Higher values indicate a larger difference between before and after percentage cover of seagrass.

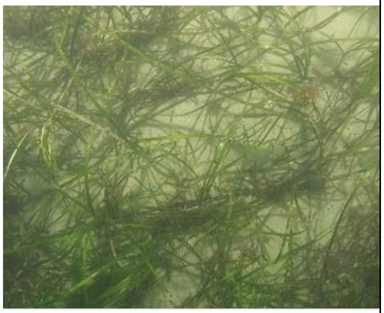
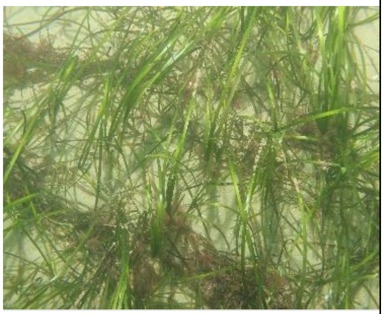
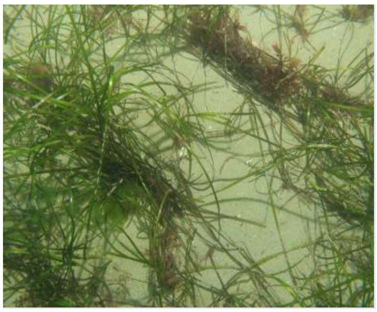
3.3. Euclidean Distances and Similarity Scores

Euclidean distances calculated between paired stations used to test for dissimilarity in seagrass cover between the two surveys are provided in Appendix I. Based on similarity scores derived from the calculated Euclidean distances (see Section 2.3), 166 paired stations (66 %) presented a statistically significant difference (less than 95 % similarity) in the percentage cover of seagrass between surveys with 80 paired stations reporting a significant increase in seagrass cover between surveys while the remaining 86 stations reported a significant decrease in seagrass cover between surveys.

Sixty-eight of the paired stations (27 %) showed no statistically significant difference in the percentage cover of seagrass between surveys (more than 95 % similarity), while the remaining 19 stations presented no change in seagrass cover with the percentage cover remaining the same between surveys (100 % similarity).

T7_P17 showed the lowest similarity score (32.5 % similarity) meaning this station showed the highest difference in percentage seagrass cover between surveys. Table 2 presents an example of the comparison between paired images with Euclidean distances derived from the CPCe analysis results where percentage cover of seagrass was calculated in paired images collected during both surveys. The full table with all paired stations can be found in Appendix I.

Table 2 Example of paired images with Euclidean Distance similarity score

Station	Image before fishing activity	Image after fishing activity	Change in seagrass cover (%)	Euclidean Distance
T2_G2			^	15
T9_K9			v	7.5
T11_T11			^	15
T18_N18			v	15

3.4. Spatial changes in seagrass cover

Figure 4 shows the percentage cover of seagrass based on all paired stations along each vertical tow (north – south). Tow 17 saw the largest change in range of percentage seagrass cover between surveys with seagrass cover ranging from 40 % - 82.5 % in the before survey to 15 % – 87.5 % in the after survey. An ANOSIM test run on the full dataset based on tow and survey revealed a significant and high level of similarity in seagrass cover along each tow between before and after surveys (p = 0.6 % and R statistic = 0.022), meaning that the H_0 of no significant changes in seagrass cover between before and after surveys could be accepted.

Similarly, Figure 5 shows the percentage cover of seagrass based on all paired stations along each horizontal tow (east – west). An ANOSIM test run on the full dataset based on tow and survey revealed a significant and high level of similarity in seagrass cover along each horizontal tow between before and after surveys (p = 0.1 % and R statistic = 0.039), meaning that the H_0 of no significant changes in seagrass cover between before and after surveys could be accepted.

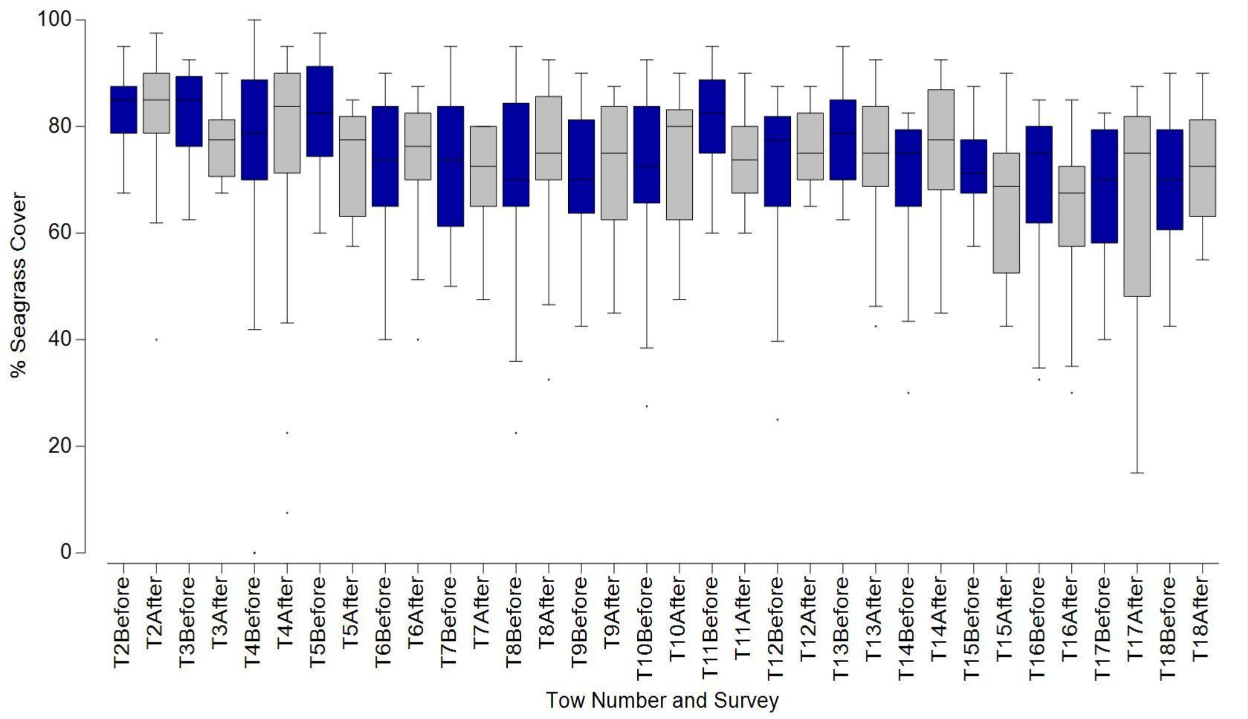


Figure 4 Box plot presenting the difference in percentage seagrass cover before and after across each vertical tow.

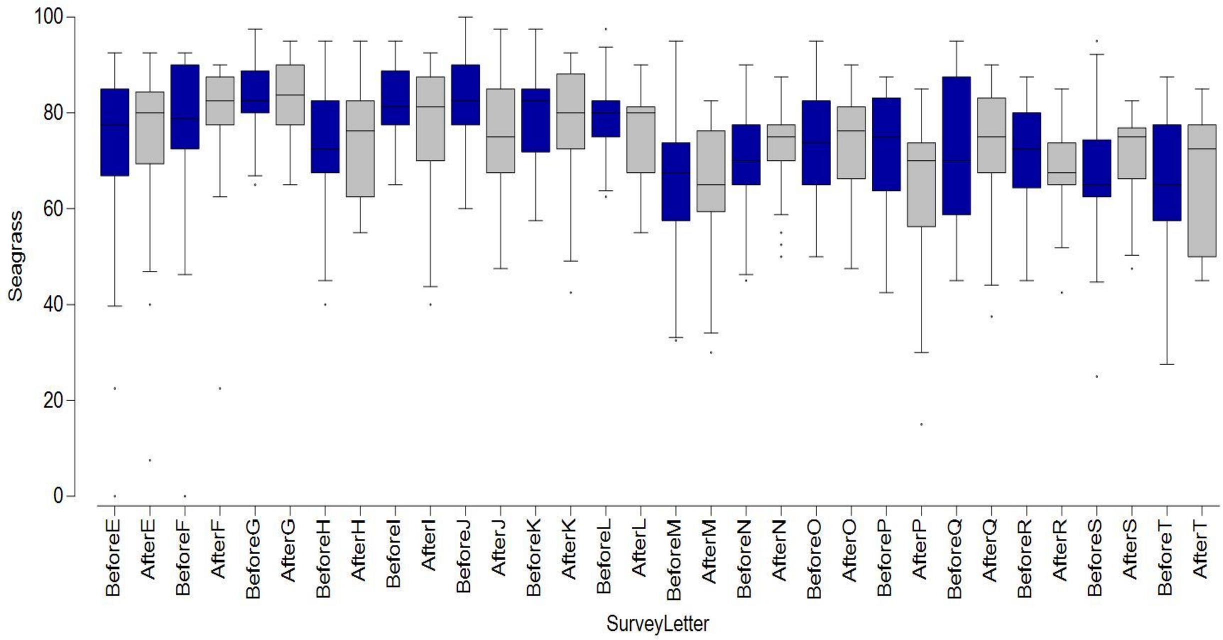


Figure 5 Box plot presenting the difference in percentage seagrass cover before and after across each horizonal tow.

3.5. Temporal changes in seagrass cover

The full dataset was also assessed based on before and after surveys and the results of the ANOSIM test indicated that there was no statistically significant difference in the percentage cover of seagrass across the whole site between surveys (p = 52.8 %, R=- 0.001). Figure 6 illustrates the findings of the ANOSIM test. Once again the H_0 of no changes in seagrass cover between surveys could be accepted.

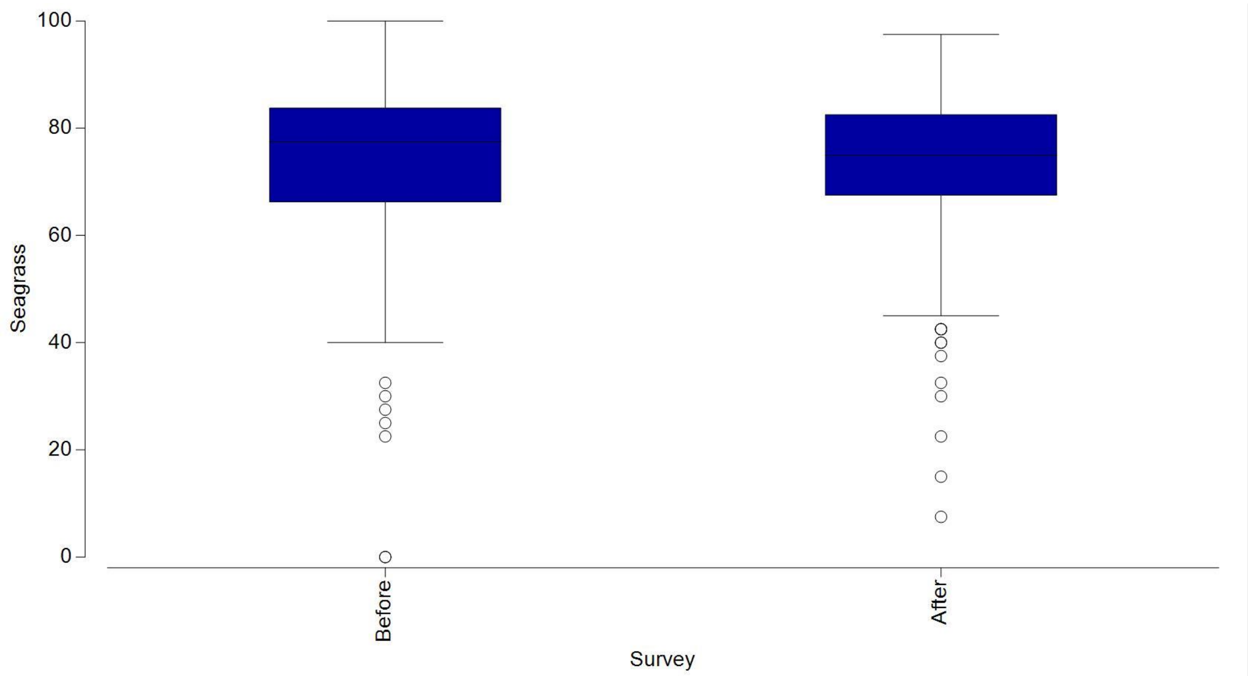


Figure 6 Box plot presenting the percentage cover of seagrass between surveys.

4. Discussion

Based on similarity scores, the majority of paired stations (66 %) saw a change in seagrass cover between before and after surveys with 32 % of stations showing an increase in seagrass between surveys and 34 % of stations showing a decrease. Considering that changes in seagrass cover between surveys were observed in either direction (increase or decrease), it is unlikely that the same driver, fishing activity, was responsible for the observed variations in seagrass cover.

ANOSIM tests were conducted on the full dataset to assess for spatial and temporal changes in seagrass cover between surveys and along tows. High similarity in seagrass cover was observed along both vertical and horizontal tows while no significant changes in seagrass cover were observed across the survey area between surveys. Therefore, the H_0 of no significant changes in seagrass cover between surveys could be accepted.

One limitation was noted within the CIFCA Field report (Jenkin *et al* 2023) which was that the before and after images for each site were not necessarily collected in exactly the same location. Therefore, paired images were not exact replicates of each other before and after fishing activities took place. It should also be noted that there may be some limitations to the assessment undertaken as part of this study due to the CPCe methodologies employed. For instance, in some images analysed using CPCe, seagrass cover might have been underrepresented as areas of relatively high seagrass densities were not covered by the random point sampling, while in other images seagrass cover might have been overestimated as the random sampling included areas with sparse seagrass within an otherwise barren image. However, as determined through power analysis, the effects of this should be limited due the 87 % chance of detecting an ecologically important change in seagrass cover where such a change does occur. The use of CPCe and image analysis in this instance also only provides a planar view over the top of the seagrass and therefore does not fully take into consideration what is below. It would therefore be difficult to determine whether seagrass rhizomes have been damaged. Additionally, there was no requirement of assessing changes in the epibiotic communities associated with seagrass beds which may have been more evident than changes in the percentage cover of seagrass over the short amount of time passed between the two surveys were undertaken.

This study has focused on the percentage cover of seagrass which is an effective measure of seagrass condition and can also indicate spatial and temporal changes in seagrass abundance (Fourqurean et al., 2001, Neckles et al., 2012). However, the short timescale of this study could pose potential limitations to assessing the full extent of impact of fishing activities on the seagrass beds within Mounts Bay. The next step for CIFCA in terms of monitoring potential impacts of fishing activities on seagrass bed would then be to monitor the intensity of fishing activities to ensure there is no cumulative significant impact on seagrass beds.

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OCEAN ECOLOGY

ÅKERBLÅ GROUP

Main Office
Tel: +44 (0)1452 740 697
Email: info@ocean-ecology.com

River Office,
Severnside Park, Epney,
Gloucester GL2 7LN

Scottish Office
Tel: +44 (0)1631 254 275
Email: info@ocean-ecology.com

European Marine Science Park,
Malin House, Dunbeg,
Oban PA37 1SZ

+44 (0) 1452 740697 info@ocean-ecology.com www.ocean-ecology.com @Ocean_Ecology

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