BENTHIC SURVEY FOR EAST MOCLETT September 2021

Report prepared by ████████████████████████████████

Site sampled 08 September 2021

Report completed 20 November 2021

Introduction

This report has been prepared as an accompaniment to the most recent template for new Baseline Monitoring protocols (SEPA). It should be read in conjunction with "East Moclett MPFF SiteSuitabilitySurveyResults 08-09-21" which also contains all the raw data pertaining to the survey and to which all "worksheet" references apply.

All survey data are handled according to appropriate methods and reported as per the requirements of the template. Whole site results are presented using MDS and a single summary table to aid direct comparison between transects/stations. The whole site combined faunal matrix has also been inserted into the main report (Worksheet 3).

N.B. This version of the template appears to have some shortcomings:

1. Stations identifiers cannot be modified

In order to keep data together and for ease of examination in this survey, actual station identifiers (1, 3, 5, 6 ,7, 9) were entered in the "time" row.

2. There appears to be an error with Table 2 (Worksheet 2) – "surface smell/fungus" neither Y/N options available, nor can anything be typed in.

For this survey, there were no surface smells and no fungus at any of the stations but this is not indicated in the template as nothing could be entered.

3. There doesn't appear to be anywhere to enter <63µm/TOC figures, except where residues are indicated.

For this survey, figures were entered into tables 6-7 even though emamectin was not indicated.

1 Position Fixing and Sampling Details

Quality Assurance Statement

All fieldwork is carried out by competent and experienced personnel, trained in all aspects of soft-substratum benthic sampling**.**

1.1 Sampling

Samples were taken by the operator in accordance with the Environmental Monitoring plan (EMP) created by the same. Stations were located according to distance and positions maintained by ensuring the ropes were tensioned and with regular checks between grabs. Samples were taken using a $0.045m^2$ Van Veen grab. Water depths and grab fullness were recorded. All sediments were examined qualitatively for colour, consistency, texture, waste feed pellets, faeces, *Beggiatoa* spp. and H_2S smell. Positions of stations were recorded and inputted onto a chart upon return (Figure 1). They are also given as eastings and northings in Worksheet 1.

Samples were taken at:

Stations, 1, 3, 5, 6, 7 and 9.

During the survey period, the wind was light and variable, force 2

2 Methodology

2.1 Sample handling

2.1.1 Fauna

Two replicate grabs were collected at each station using a 0.045m2 Van Veen grab. Individual samples were carefully washed through a sieve (1mm) and the material retained transferred to labelled polyethylene bottles along with buffered formal saline (*ca* 15-20%) containing the vital stain, Rose Bengal. After a minimum period of fixation of 48 hours, samples were washed to remove the formaldehyde and all fauna extracted by hand. Specimens were identified to the lowest taxon and enumerated. Faunal identifications and counts are shown in Worksheet 3.

2.1.2 Particle Size Analysis

One grab sample was collected at each station and sub-sampled for PSA, using a corer through the full depth of the sample. Sediment was collected in a labelled container and deep frozen immediately upon return the same day, prior to conveyance to the laboratory for analysis by wet or dry sieving (as appropriate to the prevailing grain size). Samples were dried and sieved using a 10 sieve stack ranging from 2mm to 38µm. Classification, according to Wentworth (1922), was based on the Phi value calculated using the Folk and Ward (1957) method within Gradistat (v8; Blott, 2010).

PSA results are shown in Worksheet 2

2.1.3 Total Organic Carbon (TOC)

The same grab sample was sub-sampled for TOC, using a marked corer. Sediment was collected from the top 5cm, placed in a labelled container and deep frozen immediately upon return the same day, prior to conveyance to the laboratory for analysis. Samples were air dried at 30°C and milled, subsampled and treated with hydrochloric acid to remove inorganic carbon. The subsample was re-dried to remove excess acid and analysed using a Dumas combustion TOC analyser. The method involves combustion in in excess oxygen and measures the amount of carbon dioxide released. The analysis is calibrated with standards of known carbon content.
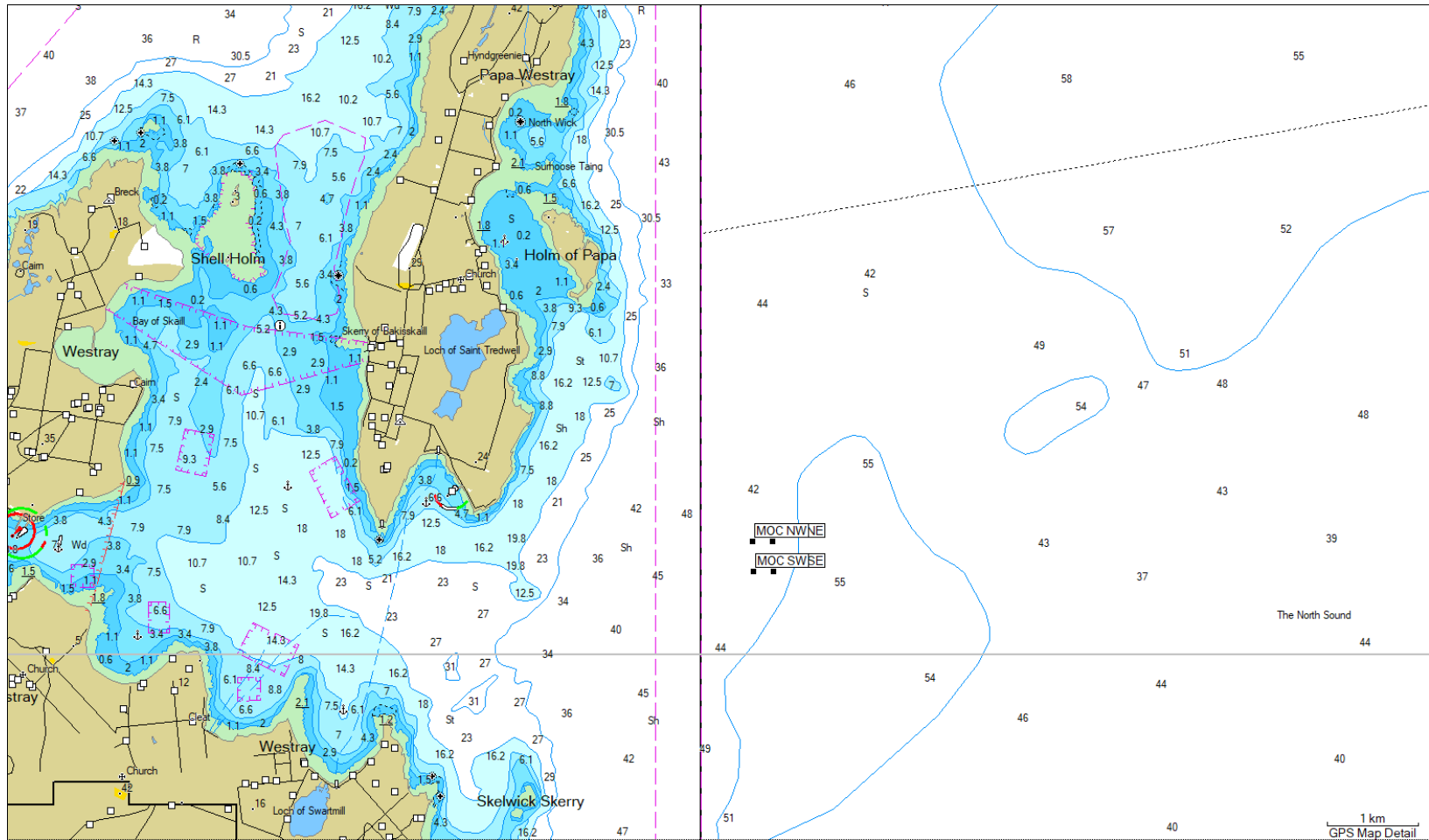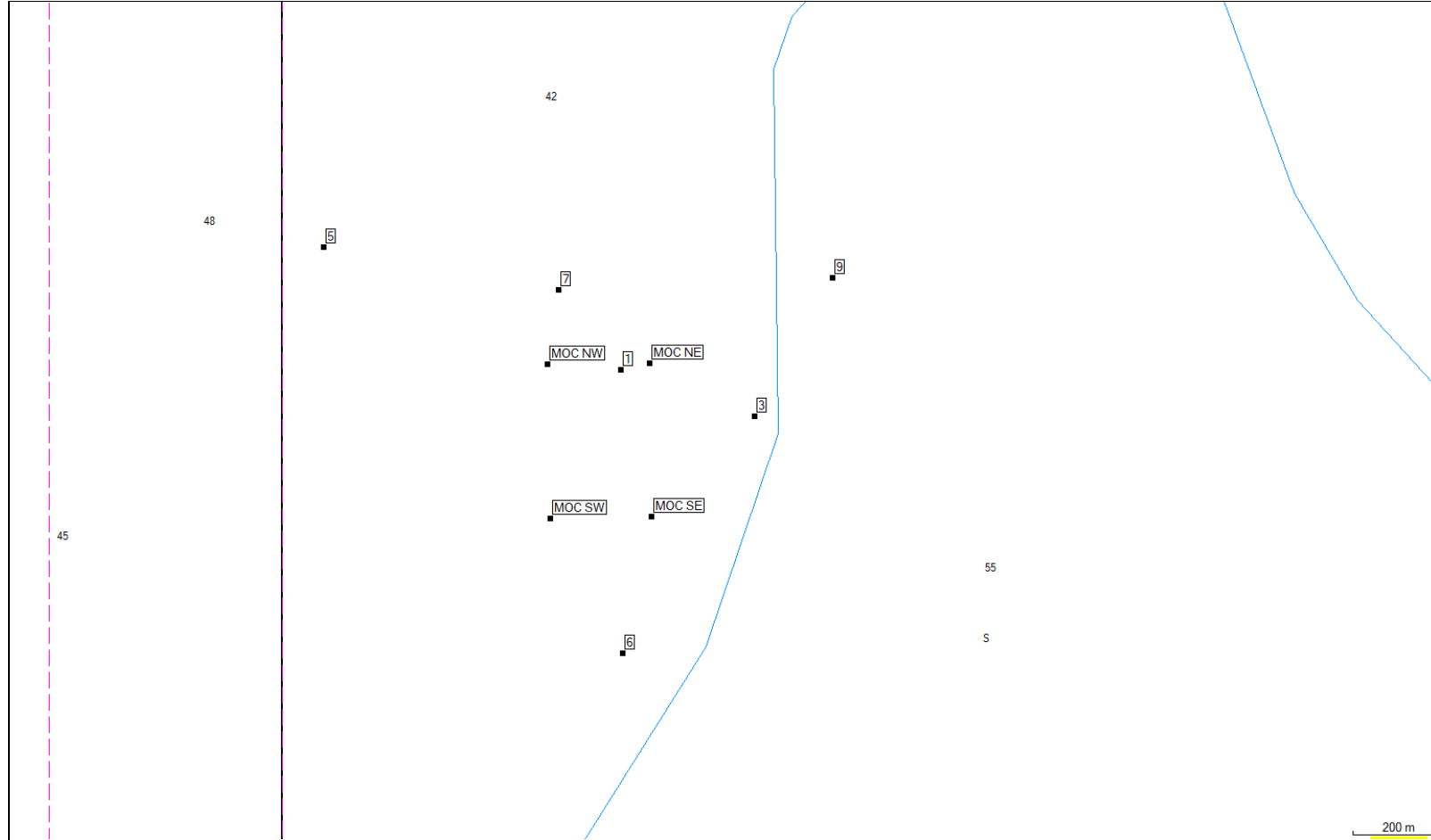
TOC results are shown in Worksheet 2

3 Site Maps

Figure 1(a) Chart showing proposed site position for East Moclett benthic survey

Figure 1(b) Chart showing stations - East Moclett benthic survey. No site infrastructure in place but proposed cage corners indicated.

4 Sample Processing and Data Analysis

Quality Assurance Statement

All sample processing is carried out by a competent analyst, with internal and external quality control measures implemented to ensure the data are fit for purpose. As part of the drive for quality, Biotikos carries out periodic specimen checks with independent experts and is also a participant in the National Marine Biological Analytical Quality Control scheme (NMBAQC).

4.1 Fauna

Specimens are identified to the lowest taxon and enumerated. Data are subjected to a suite of univariate and multivariate analyses. Combined data can be found in Worksheet 3.

4.1.1 Univariate Analyses

Shannon-Weiner Diversity Index, H′ where

$H' = -\Sigma_i \, p_i \, (\log_2 p_i)$ (p_i is the proportion of the total count arising from the $_i$th species).

Pielou's Diversity, J′ which is a measure of equitability

$J' = H'_{(observed)} / H'_{(max)}$ H′ $_{(max)}$ is the maximum possible diversity *i.e.* if all species were equally abundant. Pielou's Index always varies between >0 and 1.

Margalef's index, d is a measure of species richness

$d = (S - 1)/\ln N$, where S is the number of taxa and N is the number of individuals.

Margalef's index minimizes the effect of sample size and is considered more useful than considering the number of taxa alone.

(Total density (TD)/Polychaete density (PD), calculated as abundance per square metre:

Density = abundance/0.09 based on 2 x 0.045m^2 grabs per station.

Infaunal Trophic Index, ITI where species are assigned to one of 4 feeding groups to indicate the degree of disturbance at a station (1 filter/suspension feeders, 2 detritus feeders, 3 deposit feeders, 4 sub-surface deposit feeders).

Scores between 0-30 classify as "degraded," 30-60 classify as "changed" and 60-100 classify as "normal." ITI is evaluated from 100% of those taxa for which scores have been allocated.

4.1.2 Multivariate Analyses

Cluster Analysis and Multidimensional Scaling

PRIMER software is used to run Cluster Analysis and Multidimensional Scaling based on the Bray-Curtis coefficient of similarity, under square root transformation of data to decrease dominance effects. MDS generates an ordination plot which is a useful visual aid in inferring causal aspects such as gradients of organic enrichment. The strength of the analysis is represented by the stress value shown on the plot, where values of 0-0.05 show the best representation. The dendrogram, generated by cluster analysis is regarded as less powerful than MDS but does provide some quantitative means of viewing the data and is useful to separate stations when they plot very closely together. MDS presents an overall picture of relative similarity within the faunal matrix rather than examining specific details which are more fully elucidated by examining the various univariate analyses.

Infaunal Quality Index, IQI

The Infaunal Quality Index (IQI) was developed with the aim of assessing the ecological status of macrobenthic invertebrate infaunal assemblages within soft substrata in UK coastal and transitional water bodies. It was developed for, and is used by, the Environment Agency for Water Framework Directive compliance monitoring, primarily in river basin ecology. IQI was recently sanctioned for use in the assessment of substrata associated with marine finfish aquaculture, to be utilised in the regulation of the same, with a trigger value of 0.64. IQI is calculated using an excel workbook, created by the EA which considers faunal data from a single $0.1m^2$ grab sample. The calculations in this report are derived from $0.09m^2$ (2 x $0.045m^2$ grab samples) as authorised by SEPA. The accuracy/reliability of IQI may be compromised by certain types of substrata, notably those which are poorly sorted with large amounts of fines or coarse material. Additionally, because of its provenance in fresh-brackish water systems, the IQI worksheet regards fully marine salinities (35) to be out with the remit of the calculation and all figures are based on a coastal salinity value of 32.5 in accordance with SEPA.

5 Results and Summary

5.1 Substratum – sensory

The proposed fish farm at East Moclett is situated in waters of approximately 53m deep. The benthos around the site and outer stations is composed of a variety of substrata but all are well sorted with a mix of medium to coarse sands and gravel/stone. None of the stations contained any mud. At the time of sampling, there were no indications of organic loading at the cage edges with sediments described as "light or medium" in all cases. There were no signs of *Beggiatoa* spp., faeces or surface sulphide smell at any of the stations.

5. 2 Benthic Macrofauna

Table 5.2 Overview of fauna from 6 stations (2 reps each) – East Moclett 2021

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Total number of infaunal species	191
Total number of individuals	995
No. polychaete species	94
No. crustacean species	43
No. mollusc species	31
Site station with the highest no. species.	5 (84 taxa)
Site station with the highest no. individuals	5 (322 specimens)

5. 3 Multivariate Analyses

The MDS analysis shows excellent good representation with a stress level of 0. The plot reveals very little, with stations plotting individually. This is unsurprising, given that this is a baseline survey with an array of individually structured communities. The detail of each assemblage is more fully elucidated by the univariate analyses below.

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Dendrogram of Faunal Data – East Moclett 2021

Group average
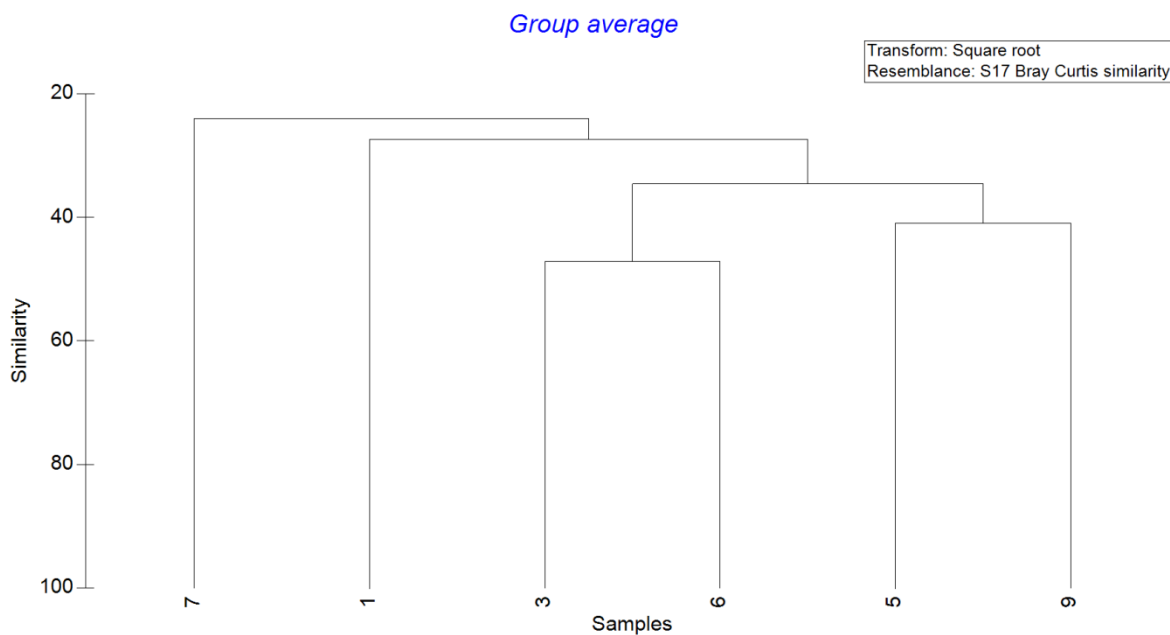
Ordination Plot of Faunal Data – East Moclett 2021
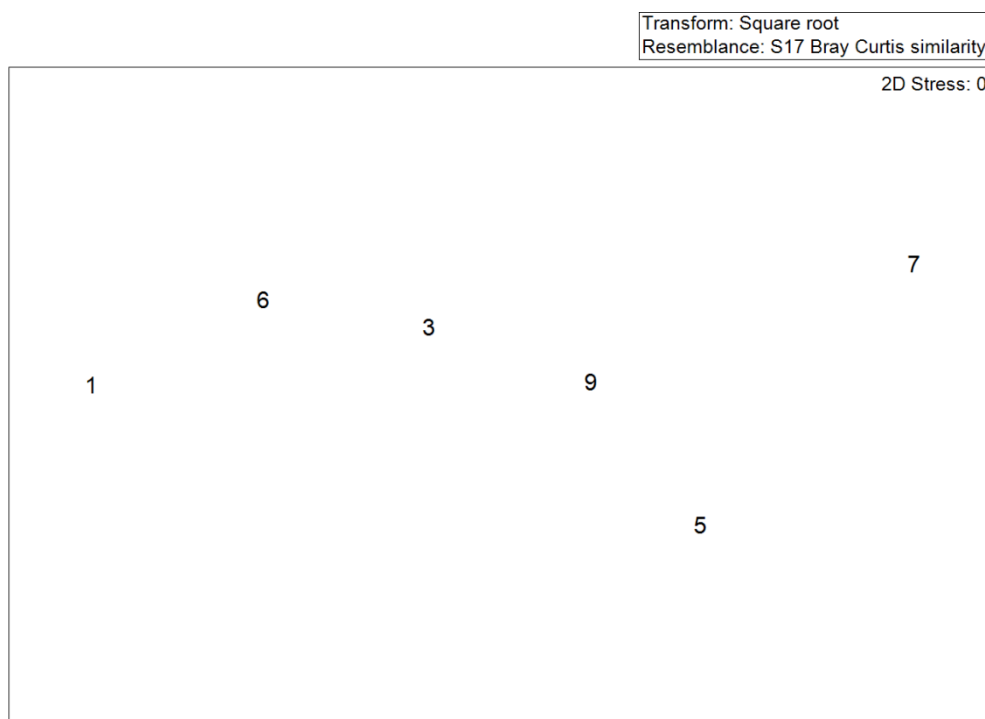
5.4 Univariate Analyses and Additional Information

Results and findings from benthic analyses at East Moclett are summarised in Table 5.4. Communities are classified as per the categories below, based on the combined outcomes of the faunal data handling. They are offered in an attempt to deliver a meaningful description of the benthos at each station whilst avoiding constrictive terminology such as "good/bad/pass/fail."

Impacted/Strongly impacted - very high annelid and/or nematode densities or very low densities/afaunal (following population crash). Very low species richness/ diversity/ ITI/ IQI.

Enriched – combined enrichment species account for almost all individuals present in the community with high annelid and sometimes also high nematode densities. Low species richness/diversity/ITI/ IQI. Can be stable or may be transitionary.

Moderately Enriched/Disturbed – increases in enrichment taxa and faunal densities compared to undisturbed stations but other species are present in reasonable numbers. Intermediate or reduced levels of species richness/diversity/ITI/IQI. Community may be in a pre-proliferative or early proliferative state with small/variable sized enrichment polychaetes and this may be patchy both in physical and temporal terms.

Changing – *possible* early signs of enrichment including increases in species richness/diversity with respect to outer, undisturbed/reference stations. Possible increases in faunal densities. Enrichment species sometimes present in small numbers, ITI may be slightly reduced or not, IQI usually still high.

Undisturbed - compares favourably to wider locale. No proliferative taxa/enrichment species. Varying species richness/diversity/ITI/IQI – and not necessarily as high as 60 (ITI) or 0.64 (IQI)
(*i.e.* **indices lower than the trigger values above may be "normal" for certain marine substrata).**

* Some communities may categorise as a combination of the last two where the details are not known or not obvious.

* The term "annelid" is used to include oligochaete species (notably *Tubificoides benedii*) which can occur in abundance in some circumstances.

Table 5.4 Summary of benthic survey - East Moclett 2021, detailing salient features of stations

Station ID (depth, m)	Species best represented (% total individuals)	No. spp.	Shannon-Weiner Diversity (H′)	Total PD (no per m2)	Enrichment PD (no per m2)	ITI	IQI	% mud/ TOC	Impact
1 (53.1)	*Owenia* sp. (20) *S. limicola* (9) *A. brevicornis* (8)	34	4.45	456	0	76.9	0.76	0/ 0.2	Undisturbed
3 (55.5)	*A. brevicornis* (15) *Owenia* sp. (5) *E. pusillus* (5)	67	5.42	856	11	76.1	0.73	1/ 0.3	Undisturbed
5 (49.9)	*Chone* sp. (12) *Polycirrus* spp. (10) *Owenia* sp., *E. southerni* (both 7)	84	5.36	2622	56	77.1	0.86	0/ 0.1	Undisturbed
6 (55.5)	*Owenia* sp. (11) *A. brevicornis* (9) Edwardsiidae (7)	57	5.25	800	0	72.4	0.77	0/ 0.3	Undisturbed
7 (48.7)	*P. medusa* (9) *G. lapidum* (7) *S. mauretanica*, *G. costulata*, *A. squamata* (all 6)	43	5.05	567	11	65.1	0.63	0/ 0.1	Undisturbed
9 (55.0)	*A. brevicornis*, *A. prismatica*, *T. ovata* (all 6) *Chone* sp., *E. southerni* (both 5) *M. fragilis*, *J. caudata* (both 4)	80	5.79	1089	22	74.4	0.76	0/ 0.2	Undisturbed

Where PD = Polychaete Density, ENPD = Enrichment polychaete density, mud=fraction <63µm TOC = total organic carbon (% w/w dry matter)

5.4 Non-Technical Summary

Benthic samples from the proposed site at East Moclett fish farm were taken from six stations across the area. The types of species found and their relative abundances indicate no disturbance, with diverse, surface feeding communities throughout. All findings including physico-chemical and sensory parameters indicate that locale is not naturally subject to deposition.