

North East Crab Mortalities- Environment Agency Vessel Survey Report- 14th-18th Nov

1. Incident Summary

Dead crabs and lobsters began washing up on Teesmouth coastal beaches in early October 2021. By the 9th Nov of crab deaths reports indicated the area affected extended as far south as Runswick Bay. An EA formal incident response structure was established, with a multi-agency partnership group including the EA, MMO, Cefas, NEIFCA, and Local Authorities. The Incident has now been formally handed to Defra, whilst EA remains a partner within the ongoing investigation.

2. Aims and Objectives of Survey

Various evidence was collected at pace to identify any obvious cause with sampling focused more in the intertidal in the initial stages of the investigation. As the EA had relatively limited data subtidal data, subtidal surveys were commissioned to provide evidence to support the ongoing investigation.

Objectives

- To inform if impact has affected the wider subtidal marine biological communities – to date only crabs and lobsters have been recorded as impacted.
- To provide further information on the spatial scale of impact to wider environmental receptors.
- To gather further supporting data on the water column.

3. Survey design – notes on principles and priority for survey team

- In this incident, given the impacts currently seem to be focused on larger decapoda (Green shore, Velvet swimming, Edible, Porcelain crabs and Lobsters, a high number of 'coarse' samples may be more valuable in providing the required information of impact to these species than a small number of fully processed samples.
- Sampling to occur inside and outside the zone of impact, taking advantage of existing stations where we have relevant historical baseline data.
- Sampling to take place outside (to the south) of zone of impact to provide a control. NB. Control may need to move further south if the sampling takes time to implement.
- Work north taking samples on the way moving towards the area of impact to **ensure biosecurity**.
- Additional trawls to be taken on route from Humber where time allows to secure a control site should impact have advanced into other planned control site.
- Use Otter Trawl and Day Grab (See EA WFR standards sampling method). Add small underwater camera where possible to grab to acquire video images of seabed.
- Gather information from grab and trawls when brought onboard as a **priority** to indicate state and health of fauna present. Collect evidence of any impact (or not) on wider ecosystem, that may not have been apparent in intertidal visual surveys.
- Both in-situ visual records of multiple samples (presence/absence, live/dead/moribund) and retaining samples preserved for full laboratory analysis will contribute to the evidence base.
- Prioritise trawling over benthic rapid assessment methodology if short of time.
- If conditions at sea deteriorate and samples cannot be assessed on board, the preserved samples will be important for those locations.
- Water samples required (contaminants GCMS and LCMS, metals and phytoplankton) to support other investigation needs and as supporting data for benthic biological data.
- Specific sample numbers are not critical and it is recognised that the survey design may need to be flexible on the day.

4. Sampling methods

These follow Environment Agency standards methods with the exception of the novel 'rapid' onboard assessment which are detailed in the Appendix.

Where appropriate Water Framework Regulation (WFR) survey design was followed - differences occurred with number of tows, replication etc, which was not required to be followed for this incident. Focus on obtaining critical incident information rather than WFR classification compliant replication or sample effort.

Priority*	Sampling Device	Sampling Type (as indicated on maps)	Samples	Notes
1	Otter Trawl	Trawl	1 x 10–15 min tow	Proposed Epifauna rapid assessment methodology (see Appendix below)
1	Day Grab	Benthic community	5 x Biota (stacked sieves)	Proposed Benthic invertebrates rapid assessment methodology (see Appendix)
2 (1 if rapid assessment is not possible)	Day Grab	Benthic community	1 x Biota + PSA 1 mm sieve mesh in coastal waters, 0.5 mm in estuary.	WFR compliant sampling methodology as detailed in Environment Agency Operational Instruction (OI) 009_07 and 104_10.
3	Go-pro camera mounted on Day Grab	Benthic community	Video captured during each grab deployment	Oblique view of the seabed set up where possible
1	Day Grab	Sediment Chemistry	Sediment chemistry and particle size	EA sediment contaminants sampling methodology as detailed in OI 452_09.
1	Water sampler – surface	WQ	<ul style="list-style-type: none"> Organics (GCMS and LCMS scans) METALS (det code METD, HGD, ASSED). PHYTOPLANKTON (live + preserved) 	Phytoplankton sampling – please see Appendix.
1	Sub-surface water sampler ~ 1 m above seabed	WQ	<ul style="list-style-type: none"> Organics (GCMS and LCMS scans) METALS (det code METD, HGD, ASSED). PHYTOPLANKTON (live + preserved) 	Phytoplankton sampling – please see Appendix.
1	Idronaut CTD vertical profile – surface and near-seabed	WQ	In situ physico-chemical determinands	Standard suite – Dissolved oxygen, temperature, salinity, turbidity, pH

Priority*	Sampling Device	Sampling Type (as indicated on maps)	Samples	Notes
	measurements			
3	Seaspyder camera system – NEIFCA to explore possibility	Drop Camera	1 x 150 m tow at each site	

*highest priority = 1, lowest = 3

5. Sampling locations

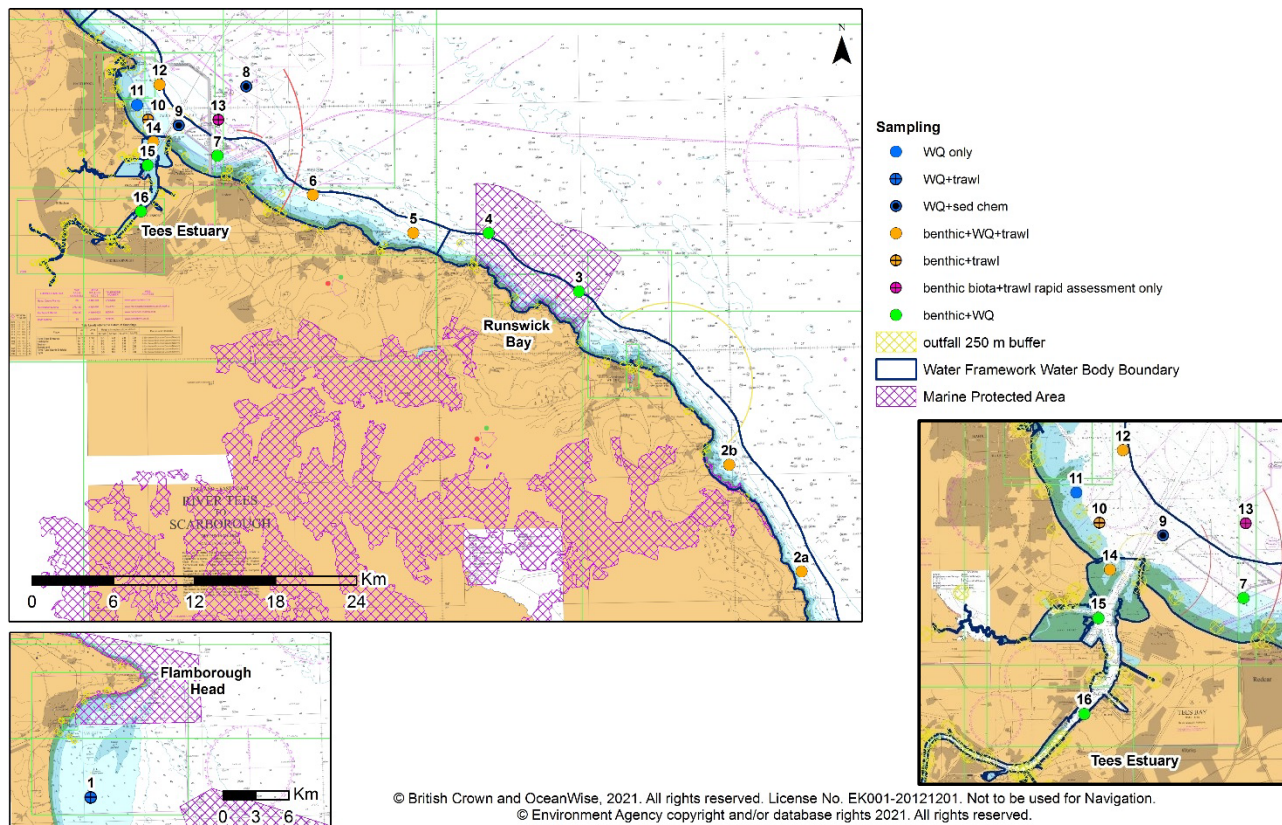


Figure 1. Map showing original planned locations along Teeside down to North Yorkshire coast, with two detailed inset for Flamborough to the south and the sites within Tees estuary and Hartlepool Bay.

The sites and sample design was not all delivered as planned during the survey. Flexibility to changing evidence and logistics were needed.

Table 1. Original planned sites and sample types

Easting	Northing	Station_name	Station	Sampling
520832	459773	S of Flamborough Head	1	Water quality (WQ) +trawl
502543	496248	Control site - Hundale Point - possibly rocky	2a	benthic+WQ+trawl
497194	504144	Control site - Robin Hood's Bay	2b	benthic+WQ+trawl
486064	516948	Runswick Bay MCZ south east	3	benthic+WQ
479382	521278	Runswick Bay MCZ north west	4	benthic+WQ
473792	521283	Skinningrove Wick	5	benthic+WQ+trawl ¹
466370	524090	Sea off Saltburn(5)	6	benthic+WQ+trawl ¹
459300	527000	Sea off Redcar(4)	7	benthic+WQ ¹
461441	532117	Dredger spoil ground	8	sed chem+WQ ¹
456441	529233	Dredged channel	9	sed chem+WQ ¹
454179	529684	Seaton Carew WFR otter trawl site	10	benthic+trawl ¹
453353	530754	Sea off Seaton Carew(3)	11	WQ only ¹
455022	532257	Hartlepool Bay	12	benthic+WQ+trawl ¹
459385	529665	Tees Bay	13	biota+trawl rapid assessment only
454562	528013	Bran Sands	14	benthic+WQ+trawl ¹
454143	526288	Phillips Buoy	15	benthic+WQ ¹
453639	522886	Teesport	16	benthic+WQ ¹

- 1 Phytoplankton live samples needed at these locations alongside preserved samples. Not required to south of Runswick Bay.

6. Results

Actual Survey Completion – key exceptions

- No live phytoplankton samples were taken as they could not be taken to port for couriering in time without comprising collection of more important survey information.
- No samples were collected for Cefas disease analysis as Cefas did not require them at that time. (These samples could not be stored as they need to be fresh for receipt at the lab).
- Replication of benthic grabs had to be curtailed due to time constraints - onboard rapid assessment risked compromising the completion all the priority sample sites.
- Three lower priority sites were removed from the programme as the full survey could not be done in the 3 days – sites 8, 13 and 16.
- No video clips were taken during the grab sampling, none were taken of the samples onboard the vessel. The video underwater proved too turbid to be of use.
- Go pro was used with the grab but visibility was poor so data has limited value.
- Some mixed crab samples were stored for future chemical analysis, if required, as were the sediment chemistry samples.
- The NEIFCA did trial a video camera drop down on Weds 24th November in the area of expected impact (site to be confirmed by NEIFCA), but reported this had limited success, however they did see live shrimps.

	Sample status	Analysis status
Trawl data	Collected	Complete, some crabs stored frozen until decided if needed for further assessment
Benthic invertebrate grabs	Collected (1 rep per site)	Rapid assessment onboard completed, preserved samples for fully quantitative analysis looking for available contractor, but feedback so far indicates long lead in.
Water chemistry	Collected	Lab analysed
In situ physico chemical data	Collected	Complete
Phytoplankton – preserved samples	Collected	Complete
Phytoplankton - live samples	Not collected	n/a
Sediment physical and chemical samples	Collected	Particle size sent for analysis, Chemical samples frozen until decided if needed.

6.1 Trawl Data

- From the 5 sites where trawling provided a catch, the samples did not note any unusual dead or dying invertebrates or fish, except those crab species noted as already impacted in this incident.
- Shrimp were healthy.
- Most fish species caught were relatively mobile and representative of more pelagic nature.
- Both male and female crab were showing signs of impacts in the area where high level of dead and dying crabs had been reported on the beaches.
- No evidence of impacts was noticed south of Skinningrove, at the next site at Robin Hoods Bay.

Although the limited sample sizes were not conclusive, and a number of trawls did not provide any catches, the surveys continue to support the fact that it is crab species (and lobsters) that are impacted in this incident.

Time and subsequent heavy weather have prevented further samples being taken to add to the evidence base. Any future trawl surveys are currently on hold whilst awaiting future instruction re the Investigation .

The trawl logs are provided in the survey files:

EA 2021-11-14 Humber Guardian_log.xlsm

EA 2021-11-16 Humber Guardian_log.xlsm











EA 2021-11-17 Humber Guardian_log.xlsm

EA 2021-11-18 Humber Guardian_log.xlsm

In situ water data for salinity, dissolved oxygen, pH and temperature, were within expected ranges for these sites and this time of year.

The samples were rapidly assessed onboard according to the epifaunal approach provided in Appendix 1 and the results summarised in Table 2 below.

Table 2. Description of trawl biota catches and photos from data obtained using onboard epifauna assessment

Date	Site No.	Site name	Description of biota caught	Main catch photo	Crab focused images	Summary info
14-Nov-21	1	South of Flamborough Head	1 x C. maenas (carapace width 55 cm) and 4 x L. holtsatus (carapace widths 35-45 cm) all alive and displaying apparently normal behavior. Also a few dab, sprat and comb jellies. No dead biota present.			Control site well south of any reported impacted crabs or lobsters. No crab or other biota recorded impacted
14-Nov-21	2B	Robin Hoods Bay	1 x N. puber (carapace width 65 cm) and 21 x L. holtsatus (carapace width ~40cm) all alive and displaying apparently normal behavior. Also a few whiting, dab, a small cod, a small grey gurnard and comb jellies. No dead biota observed.			Nearby site recently reported dead crabs, but no crab or other biota appear impacted in catch.
16-Nov-21	5	Skinningrove Wick	10 x L. holtsatus (7 F, 3 M) carapace width 2.5 cm to 4.5 cm which are listless with unusually high levels of claw shedding and ineffective limb movement/swimming effort. 2 x N. puber (F) carapace width 50 cm and 60 cm, tending to invert and apparently moribund. Various whiting, dab and plaice all showing apparently normal behaviour. 1 Crangon sp. showing apparently normal behaviour.			Expected Impact area. Crab showing signs of impact aligned with those of incident. Other species not impacted.
16-Nov-21	6	Saltburn	Net empty	No photos		Expected Impact area, lack of catch significance unknown as not previously sampled
16-Nov-21	7	Redcar	Net empty	No photos		Expected Impact area, lack of catch significance unknown as not previously sampled
16-Nov-21	9	Dredged channel	Net empty	No photos		lack of catch significance unknown as not previously sampled, but recently dredging would have an impact on less mobile species.
17-Nov-21	10 / rep A	Seaton Carew	1 x L. holtsatus (F) carapace width 3.5 D8 cm, moribund. 1 x C. cassivelanus, carapace width 2 cm, dead. Several dab, whiting a pogge and a few Crangon sp. and small squid, all alive and displaying apparently normal behaviour.			Expected Impact area. Crab showing signs of impact aligned with those of incident. Other species not impacted.
17-Nov-21	10 / rep B	Seaton Carew	3 x L. holtsatus (F) carapace width 4 cm, 1 x L. depurator (F) carapace width 4.5, all of which were listless with uncoordinated paddling efforts and inhibited aggressive response. Also several dab, plaice, herring and a few sole, whiting and grey gurnard, all of which were apparently unaffected. A few Crangon sp. also present and apparently unaffected.			Expected Impact area. Crab showing signs of impact aligned with those of incident. Other species not impacted.
17-Nov-21	12	Hartlepool Bay	Just 2 small cod present in gear, both alive and apparently not showing any unusual symptoms.	No photos		lack of invertebrate catch significance unknown as not previously sampled
17-Nov-21	14	North Gare Sands	Net empty	No photos		Expected Impact area, lack of catch significance unknown as not previously sampled

6.2 Benthic Invertebrate Data

From the 5 sites sampled and a rapid assessment onboard completed, the samples did not note any unusual dead or dying invertebrates. Brittle stars were encountered at Runswick bay and were healthy.

Although it is acknowledged that the onboard rapid approach has its limitation, the results obtained continue to support the fact that crab species were the only noted species impacted in this incident.

The grab samples were processed and preserved in formaldehyde if a full quantitative identification is required by the Investigation going forward.

Preserved samples will add weight to the conclusions from the onboard rapid assessment and may allow for some comparison with expected benthic community where past data exists, such as the site at Runswick Bay MCZ.

The grabbing logs are provided in the survey files:

EA 2021-11-15 Humber Guardian_log.xlsm






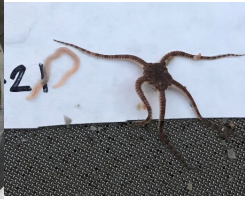



EA 2021-11-17 Humber Guardian_log.xlsm

EA 2021-11-18 Humber Guardian_log.xlsm

In situ water data for salinity, dissolved oxygen, pH and temperature, were within expected ranges for these sites and this time of year.

The samples were rapidly assessed onboard according to the epifaunal approach provided in Appendix 1 and the results summarised in Table 3 below.

Table 3. Description of onboard rapid assessment of live grab biota samples and photos of sample after sieving

Date	Site No.	Biota grab no.	Site name	Description of biota observed	Sieved sample photo	Summary info
15-Nov-21	2B	1	Robin Hoods Bay	Sandy sample, 3-4 annelid worms and a copepod/possible lobster larvae all alive and showing apparently normal behaviour. No dead biota recorded		Nearby site recently reported dead crab
15-Nov-21	2B	2	Robin Hoods Bay	Sandy sample, 3 annelid worms all alive and showing apparently normal behaviour. No dead biota recorded		Nearby site recently reported dead crab
15-Nov-21	2B	3	Robin Hoods Bay	Sandy sample, 3 annelid worms all alive and showing apparently normal behaviour. No dead biota recorded		Nearby site recently reported dead crab
15-Nov-21	2B	4	Robin Hoods Bay	Sand		Nearby site recently reported dead crab
16-Nov-21	3	1	Runswick Bay (south east MCZ)	Sandy mud with a few annelid worms and brittle stars, all alive and showing apparently normal behaviour. No dead biota recorded. Associated separate sample for chemistry picked up 2 live brittlestars in sandy mud.		Nearby site recently reported dead crab
17-Nov-21	10	2	Seaton Carew	Muddy sand with shell fragments, no apparent biota present in sample		Expected Impact area
17-Nov-21	9	4	Dredged channel	Sand with a brittlestar and a dew annelid worms, all alive and showing apparently normal behaviour	 	Recently dredged
17-Nov-21	12	1	Hartlepool Bay	Sand, little sign of biota		
18-Nov-21	15	4	Phillips buoy	Soft muddy sample with numerous annelid worms, alive and apparently behaving normally		
18-Nov-21	16	3	N. Gare sands	Sand, a few annelid worms seen in potted sample, alive and apparently behaving normally		Expected Impact area

18-Nov-21	7	2	Sea off Redcar	Sand with small brittlestar and a few annelid worms, alive and apparently behaving normally		Expected Impact area
18-Nov-21	6	3	Sea of Saltburn	Sand - insufficient sample volume for biota sample collected at this site		Expected Impact area
18-Nov-21	10	3	Seaton Carew	Muddy sand, a few small annelid worms visible in potted sample, alive and apparently behaving normally		Expected Impact area
18-Nov-21	12	4	Hartlepool Bay	Sand, a few small annelid worms visible in potted sample, alive and apparently behaving normally		

6.3 Water chemistry

Data have been analysed – to be added to contaminant overview

6.4 Phytoplankton

From the 24 preserved samples (12 surface and 12 bottom samples), Cefas reports that there was nothing unusual of note in these samples (Table 4). With no bloom levels recorded

In addition to the noted species requested (Appendix 2), were found small quantities of common species, normal for the season, including *Skeletonema spp*, *Gyrosigma/Pleurosigma*, *Protoperdinium sp*, *Cylindrotheca sp*, indet armoured dinoflagellates and indet raphiated diatoms in all the samples.

Table 4. Preserved phytoplankton sample -analysis report

Sample Number	Site Number	Date Collected	Pseudonitzschia spp	Dinophysis acuta	Karenia mikimotoi	Gymnodinium sp	Oscillatoria	Nothing of interest found
13	1 Surface	14/11/2021						Y
14	1 Bottom	14/11/2021						Y
15	2B Surface	14/11/2021						Y
16	2B Bottom	14/11/2021		40	200	400		
17	3 Surface	15/11/2021	1600					
18	3 Bottom	15/11/2021						Y
19	4 Surface	15/11/2021						Y
20	4 Bottom	15/11/2021						Y
21	5 Surface	15/11/2021						Y
22	5 Bottom	15/11/2021	1400					
23	6 Surface	16/11/2021						Y
24	6 Bottom	16/11/2021	600		200			
25	7 Surface	16/11/2021						Y
26	7 Bottom	16/11/2021						Y
27	9 Surface	18/11/2021						Y
28	9 Bottom	18/11/2021						Y
29	11 Surface	18/11/2021	1000					
30	11 Bottom	18/11/2021	800					
31	12 Surface	18/11/2021	160					
32	12 Bottom	18/11/2021	240					
33	14 Surface	18/11/2021	440			40		
34	14 Bottom	18/11/2021	280					
35	15 Surface	18/11/2021	800				15000	
36	15 Bottom	18/11/2021						Y

7. Observations/Thoughts

The main objectives of the survey were to provide additional evidence wrt the ongoing crab mortalities.

Specifically,

Has this incident affected more than just the crabs species and lobsters already known to have died?

No other evidence was gathered that suggested other species had been impacted. The full quantitative analysis of the grab samples which were preserved has yet to be completed, but the live samples from both the grabs and trawls indicated other species observed were all alive and appeared healthy. These included, starfish, annelids, brown shrimp, sea gooseberries and other fish both pelagic and demersal.

This is not conclusive since the catches were of a relatively small size, and the more pelagic species could have moved in or out of any sampled area relatively recently, so not be impacted as severely as less mobile crabs and

lobsters. However, that conclusion is given greater weight when it is noted in the trawl samples from the 16th and 17th crab continuing to be impacted on at Seaton Carew, when other taxa observed in the trawls and grabs appeared healthy from these locations.

This may mean crabs and lobsters were more sensitive or vulnerable to any possible contaminant or disease agent, or it could mean they are the target group of any disease or other biological agent.

To inform the scale of impact to wider environmental receptors

No other taxa were seen to be impacted. This was also noted on the beach surveys early in the incident when live fish and invertebrates (other than crab and lobster) were found to be healthy in rockpools and the fact that other species were not reported dead on the beaches in any unexpected numbers. Note: Other species would be expected to occur in small numbers after the stormy weather early in October.

To gather further data on the water column

Phytoplankton blooms and the presence of microalgal toxins were all negative. This matches the findings of the phytoplankton bloom and toxin data collected for preserved samples earlier in the incident around Teesmouth and the coast to the south. The lack of live samples for bloom analysis in these later samples may have reduced the ability to identify or record all cyanobacteria or smaller dinoflagellate species present but this is unlikely to result in any changed outcome, and that microalgae is considered unlikely to have been the cause of these crab and lobster deaths.

Water chemistry data has yet to be fully evaluated but the initial heavy metals and in situ water column data has not shown anything of note. This data remains an important part of the investigation that still need to be assessed, particularly as it provides

- Additional data from depth , where most data to date , but not all, water column data have been surface samples.
- Data from wider area of coverage than earlier samples collected in the lower Tees estuary, Tees bay and Hartlepool Bay area

To gather information on the scale and nature of the environmental impact

No other sites at Robin Hoods Bay and further south of Flamborough Head showed any signs that crab or other biota had been impacted. While beach records of crab deaths have been reported as far south at Scarborough, these are not at the same intensity or level as on the beaches further up the coast.

This could suggest the event occurred to the north and impacts travelled south, but evidence from crab and lobster pot fishers indicated that crabs were dying in pots of the coast some distance south of the original reported incident. This data is key as it points to the fact that those crabs were becoming ill in those pot locations and not being moved south by the currents as moribund individuals.

Appendix 1

Epifaunal rapid assessment methodology

- I. Deploy the Otter trawl for a 10–15 min tow at each of the specified stations.
- II. Rapidly separate all fish from the catch. Record species presence and note condition i.e. if individuals are alive/freshly dead/decaying/showing evidence of disease. Return all live individuals as soon as possible.
- III. Separate any crustaceans if present from the rest of the catch, recording species, sex individuals (if possible), note down the range of sizes present for each species – are there adults and juveniles?, counts (if time) and condition as above.
- IV. Process the remaining catch – check and record other groups/species present – note anything unusual.
- V. Take photographs of the catch – ensure labels are clearly visible.
- VI. Record short video clips ~15 seconds to capture animal activity.

Benthic invertebrates rapid assessment methodology

- I. Sample effort should be as many 0.1 m² Day Grab deployments as practically possible. A minimum of **five** grabs has been suggested at each of the specified stations.
- II. When processing the sample, stack the sieves with the largest mesh (5 mm) on top (assuming no 2 mm or 4 mm sieves are available) to reduce the time required for sieving multiple coarse samples whilst retaining the main taxa of interest.
- III. Note any observations such as: discoloured water, strange smell, signs of disease or foam.
- IV. Gently flush the sieve contents into a white sorting tray (if available) with a sample label. Ensure a small quantity of seawater is present to facilitate and/or encourage movement.
- V. Record a short video clip (~15 seconds) of the contents of the tray. Ensure the focus and lighting are adjusted appropriately and the label is clear. Note: There may be difficulties in determining whether smaller individuals are alive or dead in the video imagery.
- VI. If possible, record the underside of crabs to determine sex.
- VII. Try and capture signs of life from non-crustaceans (e.g. movement in echinoderms, polychaetes, gastropods [may need some time to emerge from shell] etc. and whether bivalves are firmly closed).
- VIII. Nearest identifiable group is sufficient in situ. If this is simply crabs (as listed above), lobsters, amphipods, shrimps, polychaetes, gastropods, echinoderms then that is still helpful. The practicalities of this on the day may determine the approach.

Epifauna specimen collection

Please be prepared to collect samples of affected crabs or lobsters. These may need to be refrigerated or frozen as required.

Phytoplankton samples

Alongside the normal collection and preservation procedure for marine phytoplankton samples, collect an additional unpreserved (live) sample. These will be analysed at the Cefas Plankton Laboratory within 24 hours of collection.

Appendix 2.

Key list of potentially harmful microalgal species and some identification issues to note

Potentially harmful microalgal bloom taxa List	Identification uncertainties
<i>Amphidinium carterae</i>	
<i>Anabaena</i> sp. [a Cyanobacteria]	Shrinkage of cells in Lugols iodine
<i>Dinophysis</i> spp.	
<i>Dinophysis acuta</i>	
<i>Dinophysis norvegica</i>	
<i>Dinophysis acuminata</i>	
<i>Dinophysis caudata</i>	
<i>Dinophysis fortii</i>	
<i>Dinophysis ilnfundibulum</i>	
<i>Dinophysis miles</i>	
<i>Dinophysis ovum</i>	
<i>Dinophysis sacculus</i>	
<i>Dinophysis tripos</i>	
<i>Gonyaulax spinifera</i>	
<i>Gymnodinium</i> spp.	
<i>Gymnodinium catenatum</i>	
<i>Karenia mikimotoi</i>	
<i>Lingulodinium polyedrum</i>	
<i>Nodularia spumigena</i> [a Cyanobacteria]	Shrinkage of cells in Lugols iodine
<i>Oscillatoria</i> spp [a Cyanobacteria]	Shrinkage of cells in Lugols iodine
<i>Phaeocystis</i> spp.	
<i>Phaeocystis globosa</i>	
<i>Phalacroma mitra</i>	
<i>Phalacroma rotundata</i>	
<i>Prorocentrum</i> spp.	
<i>Prorocentrum lima</i>	
<i>Protoceratium reticulatum</i>	
<i>Pseudo-nitzschia</i> spp.	
<i>Pyrodinium</i> spp.	

