Environment Agency Incident Investigation – Crab and Lobster Mortalities

October- December 2021

This summary documents steps taken by the Environment Agency (EA) in October to December 2021 in response to the crab and lobster mortalities. As the Incident response was so wide ranging, this document only provides an overview – more detailed information can be supplied as required.

INCIDENT REPORTS to the EA

Initial reports of crabs dying around the Tees shore came into the EA on the 4.10.21.
Note: The bait digger who reported the dying crabs on 4.10.21 also commented that he had seen dead crabs two weeks previously, although not in high numbers.

11 reports were received between 4.10.21 and 8.10.21. Reports around 8.10.21 were categorised as a category 1 Incident (major, serious, persistent and/or extensive impact or effect on the environment, people and/or property or on our operations).
The EA's National Incident Recording System (NIRS) has recorded (i) 1 incident (NIRS 01999737) with 45 reports associated with it between 4.10.21 and 6.12.21 for North-East Area and (ii) 1 incident (NIRS 02007995) with 13 reports associated with it reported between 2.11.21 and 21.11.21 for Yorkshire Area.

INCIDENT SAMPLING TIMELINE (key dates only)

Officers attended the site of the initial report on the 8.10.21 to collect incident samples. Further sampling and investigations were then undertaken as the incident spread.

08.10.21 EA Marine monitoring officers attended five sites on the shore around the Tees mouth. Dead and dying crabs were observed on four shores (Bran Sands, Redcar, Greatham Creek, Seaton Carew Beach), with no visible impacted animals on the fifth shore (Seaham Harbour).
Only crabs and lobsters were seen to be impacted. All other observed marine organisms were unaffected. Large edible crabs and lobster (dead and dying) were seen – these are not usually observed in the intertidal so considered to indicate weakened/exposed offshore and washed in.
Details can be found at -
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1117459/summary-crab-investigation-08102021.pdf
Environmental samples were taken at Bran Sands - 3 surface sediment scrapes, surface water samples (knee height water), blue mussels (Mytilus edulis), moribund crab samples.

25.10.21 A significant wash up occurred after stormy weather. EA site visit information (Saltburn, Redcar, Bran Sands, Seaton Carew, Seaham Harbour) is summarised in -
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1117460/summary-crab-investigation-25102021.pdf
The storm had washed up large amount of kelp and old razor shells etc (normal storm washup) but the large numbers of moribund crabs and lobsters were unusual, indicating that the cause of the mortalities was ongoing. Only crabs (green shore, velvet swimming, edible, porcelain), and lobsters were observed as impacted (range of ages classes).
Environmental samples were taken at the sites - In situ meter readings (DO, salinity, temperature), water samples and moribund crabs.

On both shore visits crabs were either dead, or on their backs twitching/ very lethargic with no fight left in them. Photographs and video from shore visits are available.

08.11.21 – Northeastern Inshore Fisheries and Conservation Authority's (NE IFCA) vessel collected water samples (surface and bottom) at Seaton channel, Tees Mouth, Tees Estuary main channel, Seaton Carew, Redcar, and Saltburn. EA collected phytoplankton samples at Runswick Bay, Saltburn and Seaham. Moribund crabs collected at Runswick Bay.

14.**11.21** – The EA's vessel surveyed, from Flamborough Head up to Tees mouth, to (i) inform if impact has affected the wider subtidal marine biological communities (ii) provide further information on the spatial scale of impact to wider environmental receptors and (iii) to gather further supporting data on the water column. The survey is documented in - **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1117532/NE-crab-incident-vessel-survey-monitoring-report.pdf**

WHAT WAS SAMPLED AND WHY

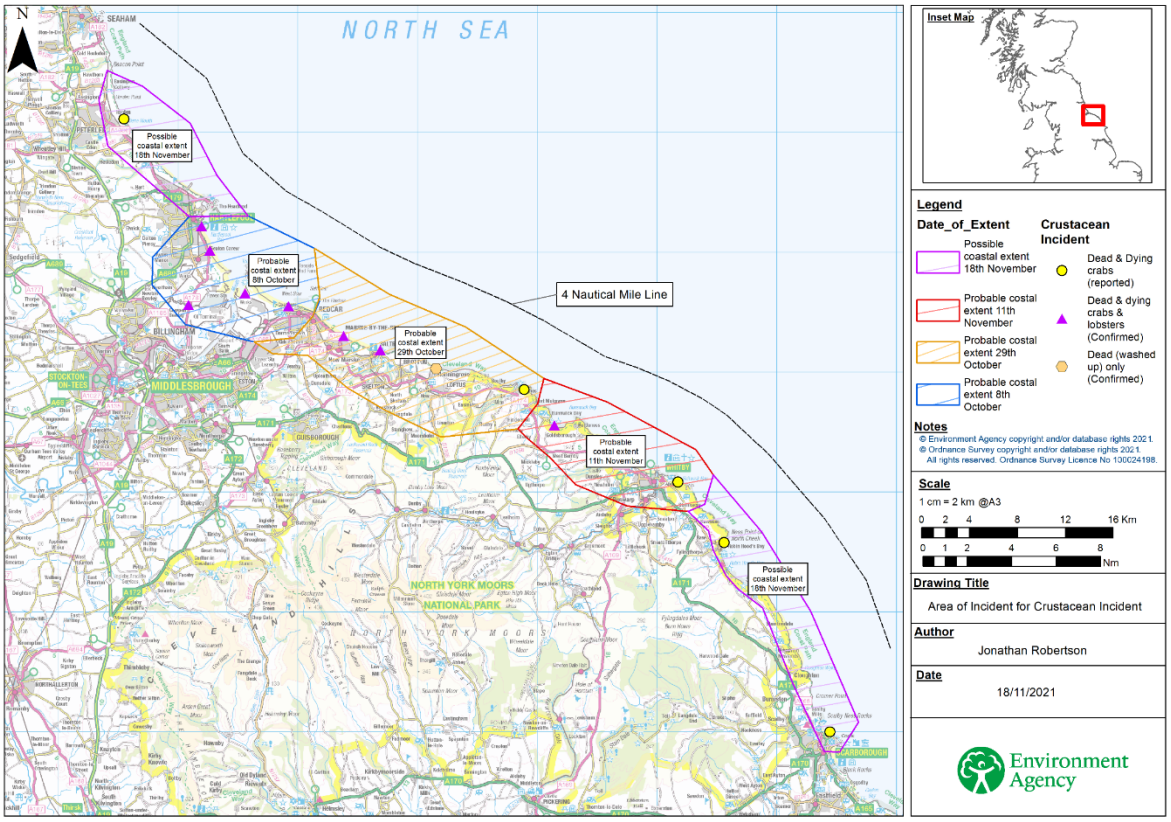
Water - To see whether there are any unusual chemical signals in the water which could be driving the crab deaths.
Crabs - To look for any excessive amounts of chemicals in the crab flesh which could point to the cause of the mortality (allowing us to then back track and focus sampling for any identified chemical in water, sediment, or crab food sources).
Sediment - To look for unusual chemical signals in the sediment (some chemicals bind quickly to the sediment, so may not be detected easily in water).
Mussels **-** Bran Sands mussels are used as a biomonitor for the long-term assessment of contaminants within the Tees Estuary. If the mussels were exposed to a chemical spill, they may show a spike compared to historic records**.**
Phytoplankton - Could a toxic phytoplankton bloom be the cause of the mortality? Waters had been warm and stable prior to the mortalities and autumn phytoplankton blooms are a part of the natural seasonal cycle.
Biological communities - To identify whether other species were impacted– both on the shoreline, seabed and in trawls (identifying the species' affected could help identify the cause of the Incident)

Multiple crab samples were stored (frozen) in anticipation of any new information and potential future analysis. These additional samples were later passed to the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) as part of the scientific research.

KNOWN EXTENT OF IMPACT (Oct – Dec 2021)

Intelligence regarding the spatial extent of impact was gathered from all partners and their contacts.

Map: Extent of known Impact and timeline



There were no reports from the Tees Barrage of dead/dying crustaceans. The furthest confirmed crab deaths upstream of Tees mouth were at Greatham Creek managed realignment site.

Tidal currents movement in both direction during the tidal cycle were considered https://www.pdports.co.uk/wp-content/uploads/2020/12/Tide-Stream-Atlas_compressed_Part2.pdf .The residual current in this region is from north to south but tidal currents will be both directions along the coast which may be enough to drive exchange to the north.

Crabs reported found moribund and dead at Hayburn Wyke (South of Robin Hoods Bay) on 22.11.21. It was estimated at this time that the impact was moving south at around 0.85km per day.

MULTI AGENCY INVOLVEMENT FROM THE START

The EA initially led the Incident response on the **presumption** that a pollution event had occurred. (The EA is the lead authority for incidents originating from a land-based or river source, and at that time there was a localised impact around the mouth of the Tees, a historically industrial estuary.) Incident samples were collected (including sending crabs to CEFAS Fish Health Inspectorate for pathogen and toxin analysis), regulated activity and discharge intelligence gathered, and partner organisations contacted with respect to their remits.

Due to the large number of edible crabs and lobsters washed up on the 25.10.21, the Food Standards Agency (FSA) were notified. As local officers had not experienced anything like this previously, marine and chemical colleagues were consulted across the EA and UK technical groups. Technical experts in the OSPAR and NORMAN networks were also consulted.

Weekly partners meetings were initiated on 29.10.21 (EA, Defra Comms, NE IFCA, Marine Management Organisation (MMO), UK Health Security Agency (UK HAS), FSA, CEFAS, Natural England, Redcar & Cleveland Council) to share results, intelligence, and plans. (*Slide pack updates and Minutes documenting evolving thinking available*)

EVIDENCE LINES CONSIDERED

With no known cause, the Incident response considered as wide a range of information as possible including -

- Environment officers reviewed environmental permits and scrutinised industrial sites in the Teesside area and found no evidence of abnormal discharges that could lead to altered water quality.
- Sewage discharge -there had been no unusual discharges in the Tees. There were no reports from Northumberland Water Limited of any issues at their assets and no unusual activity
- Hartlepool power station (monitored weekly) had nothing unusual to report
- The EA's environmental radiological monitoring programme (25.10.21 and 22.10.21) showed nothing unusual (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1117454/EA-briefing-Defra-radiation-NE-Coast-261121.pdf)
- Oil spill - no incident report had been filed with the spill response team (no visual sheens or spills)
- Only maintenance dredging was occurring at the end of September (MMO and Tees Port)
- CEFAS Fish Health Inspectorate reported no evidence of infection (no white spot virus 29.10.21)
- Seismic activity and cables associated with windfarms – there was no permitted activity or research activity occurring
- Algal toxins – at the time of the Incident monitoring there were no obvious phytoplankton blooms. Initial toxin analysis from CEFAS was negative
- Natural event? Unlikely due to the behaviour and longevity
- **Combination of exposures?**

If this was a large toxic pollution incident, including something that could have arisen from Teesside, we would have expected to see -

- Other species affected
- Some indication of a contaminant of concern in the water samples or crab tissue
- Dilution mitigation (exposed, well mixed coastal waters) - would expect this to have a big part to play in reducing any impact form a point source to reduce the impact in time and space

No levels of chemical concentrations were detected that would be needed to impact over the time and space of this Incident.

WHICH CHEMICALS WERE ANALYSED FOR?

Chemicals were analysed for in water, sediments, blue mussels and crab tissues over the course of the Incident Investigation. Both fully quantitative and semi quantitative (screening) tests were employed to investigate as many chemicals as possible in the different matrices. The actual list of chemicals for each matrix /sampling occasion varied. Results are published as part of the EA Open Data Open WIMS data but have also been published as part of the Incident reporting Evidence gathered under the Defra-group investigation into Crustacean Mortality of Autumn 2021 - data.gov.uk

Semi quantitative screens (Gas Chromatography Mass Spectrometry (GCMS) and Liquid Chromatography Mass Spectrometry (LCMS) look specifically for the list of substances as outlined in the EA's target database. In addition, this methodology searches against the National Institute of Standards and Technology (NIST) library; a spectral library of tens of thousands of substances. These screens are typically only used for water samples.
In the course of this Incident, the GCMS screen was also used to consider chemical signals from sediments and biological tissue (crabs and blue mussels). This could only be considered as an indicative presence/absence signal as the method, even semi-quantitatively, has not been validated for these solid matrices.

An Inductively Coupled Plasma Mass Spectrometry (ICP-MS) scan was also used to investigate water samples. This method can measure most metals and several nonmetals from the Periodic Table and include but is not limited to the following: Lead, Copper, Zinc, Cadmium, Chromium, Nickel, Aluminium, Boron, Silver, Arsenic, Selenium, Tin, Molybdenum, Cobalt, Titanium, Antimony, Beryllium, Vanadium, Tellurium, Uranium, Thallium, Strontium, Lithium, Sodium, Potassium, Magnesium, Calcium, Manganese, Iron, Barium. In addition to the above samples, the EA commissioned CEFAS to analyse for metals in the crab tissue (arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc).

Cyanide was not initially tested for (later specifically requested by the Whitby fishermen), as both fish and crustaceans are known to be sensitive to cyanide. No mass mortalities of fish were washed up on beaches around the Tees and Hartlepool power station indicated no major changes in intake catches of fish. Later, externally analysed water samples showed that cyanide concentrations were below the level of analytical detection.

HOW WERE CHEMICAL DATA INTERPRETED?

Chemical analysis results were considered, where possible, against known concentrations of contaminants in the water bodies. Water quality in the Tees has been monitored historically, including as a Surveillance water body under the Water Framework Regulations. Contaminants in the Tees have also historically been monitored for OSPAR in fish tissue, blue mussels and sediment.

Water samples indicated nothing unusual compared to historic records. Due to the tidal nature and mixing of the coastal waters (huge dilution), it was considered that a single spill event may go undetected. For this reason, the crab tissue was investigated, despite having no validated analytical methodology, and accepting that any data generated would only provide a direction for further investigation. As GCMS analysis of crab tissue had not previously been undertaken, there was also no knowledge of what to expect to see in a healthy crab.

CRAB TISSUE DATA

METALS (fully quantitative data) - Concentrations of all of the metals (chromium, nickel, copper, zinc, arsenic, cadmium, lead, selenium, manganese, iron, and mercury) analysed in the body tissues were consistent with that of CEFAS' existing dataset from edible meat from Brown crab (except for iron in all 3 shore crab collected at Runswick Bay). https://s3.eu-west-1.amazonaws.com/data.defra.gov.uk/Shellfish/10_XCHEM21N_Certificate_of_Analysis.pdf

ORGANICS (indicative only – GCMS and not validated for biota tissue) From the initial analysis, the range of substances indicated was broad, including industrial chemicals such as styrene, a range of phthalates and some chlorinated compounds. There were a number of substances that may be expected to be present naturally in the crab tissues e.g. cholesterol, desmosterol, palmitoleic acid etc. https://s3.eu-west-1.amazonaws.com/data.defra.gov.uk/Shellfish/06_Tees_incident_Crab_semi-quantitative_GCMS_screen.ods

Without a 'baseline' to work to, detected substances were considered for follow-up. What was indicated to be pyridine, appeared to be detected at higher concentrations than many other substances in the crab tissue and was flagged for further consideration (chemical behaviour, environmental ecotoxicology, natural and anthropogenic sources and cross referencing with data from other matrices i.e., water, sediment and blue mussel tissue).

Crab tissue from crabs outside the known impacted area were sourced for comparison.

Nine crab samples were analysed by GCMS – 4 from obviously impacted crabs (Bran Sands, Saltburn, Seaton, Runswick Bay) and 5 from comparison areas (St Mary's Lighthouse, South Shields, Norfolk Wash x2 and Cornwall). No further crabs were analysed at this time as, without a fully quantitative analytical method, it was concluded that it would provide no further useful information.

PYRIDINE

Pyridine was primarily not considered as the cause of the mortalities as (i) pyridine was indicated as present in crab tissue from healthy crabs from comparison sites (naturally occurring?) and (ii) there was no pyridine signal in water. (We would have expected to have detected a chemical signal considering the levels of a chemical that would of be required to be released from a single point to impact over the scale of time and space observed.)

As with all chemicals considered, once a substance was flagged, both behaviour of the chemical and potential sources was explored. Pyridine (CAS no. 110-86-1), according to the EU REACH registration, is readily biodegradable and has a low bioaccumulation potential based on its log K_{ow}. The 48-h EC50 for lethality in crustaceans (Daphnia) is 320 mg/L (based on data for a related substance). No chronic ecotoxicity data for invertebrates was available. Pyridine is not classified for environmental hazards under the CLP Regulation.

There have been no known land-based discharges of pyridine since 2017. Previously, 2 sites produced waste waters with small amounts of pyridine. Both sites used biological treatment plants to breakdown pyridine and other substances before to discharge to the Tees estuary.

- The former Vertellus Speciality UK Limited site at Seal Sands operated a chemical manufacturing facility producing organic chemicals. It produced a very small volume (figure to be obtained) of wastewaters which were likely to have included pyridine and its

derivatives. These wastes were treated by an on-site effluent treatment plant and subject to huge dilution by the receiving waters. This discharge ceased in 2017 and from then onwards all waste waters were tankered off site. The site closed completely in 2021.

- Sahaviriya Steel Industries UK Limited (SSI) operated the Teesside Integrated Iron and Steel works on the south bank of the Tees Estuary until it ceased operations in 2015. Any excess by-product was treated in either an onsite effluent treatment plant prior to its consented discharge into the River Tees or transferred for third party treatment at Northumbrian Water Limited's Industrial Effluent Treatment Plant.

HAND OVER TO DEFRA

At the beginning of December 2021, the EA handed the Investigation to Defra to lead and to commission scientific research.

- We had been unable to detect a pollution source
- With the analytical methods available to us, we were unable to detect a plausible chemical cause
- Further investigation/questions to be answered would require scientific research rather than Incident response processes

EA MONITORING POST DECEMBER 2021

- Routine monthly **water** quality sampling in the Tees estuary - chemicals, nutrients, dissolved oxygen, chlorophyll, phytoplankton
- Contaminants in **fish tissue** from the Tees Bay (for WFR, autumn 2022)
- We have extra phytoplankton monitoring sites in the coastal waters of Tees Bay (monthly)
- We have some additional **water** quality sites around the proposed dredge area
- We analysed blue mussels in the Tees in the early Spring 22 (annual monitoring for OSPAR and WFR)
- An external contractor was commissioned to carry out a shore survey in January and September 2022 – small shore crabs (born this year) were found in September 2022 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1117445/aquatic-environments-decapod-mortality-results.pdf

  https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1117456/Intertidal-decapod-survey-Northeast-coast-September-2022.pdf
- Intertidal and subtidal benthic invertebrate surveys in the Tees estuary were carried out in 2022 – awaiting results.