Fish rescue in Dock 4 at Holborn Enabling Works, South Shields.

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1 EXECUTIVE SUMMARY

As part of the Holborn Enabling and Refurbishment Works (hereafter 'the Works'), the planning for a new housing development along the shore of the tidal River Tyne requires that Dock 4 (Fig. 1) will be infilled. As a condition of Planning Permission, a fish rescue operation is required within the dock and was undertaken by Ecospan Environmental Ltd. (Ecospan) over two survey from the 29th November to 2nd December, 2022, and the 17th – 20th July, 2023.

Fish rescue methods included seine nets, fyke nets, fish traps and hand nets. Fish processing included enumeration, species identification and fork length measurement utilising established procedures and guidance from the Environment Agency and IFCA. Salinity, temperature, and dissolved oxygen saturation was measured to inform analysis of the fish data..

The fish rescue operation consisted of two surveys, seven months apart. Survey included the deployment of 29 fish traps and three seine nets over the course of seven days fishing. Overall, 108 individuals of eight fish species were caught, including the successful capture and release of nine European eels (*Anguilla anguilla*); a protected, endangered species. All fish were processed with fish welfare as a paramount concern and released into the River Tyne in good condition. Based on fish trapping, the abundance of fish caught in Dock 4 reduced by 96% across the survey due to Ecospan's fishing efforts.

During survey 2, eight fish traps and six seine nets were deployed over two days. No fish were caught during this survey. A total of 186 green shore crabs (*Carcinus maenas*) were rescued from the dock during survey 2. The dock water was emptied slowly from ~40cm during which time there were no signs of fish presence. The majority of the dock was dry whilst the survey team were on standby, however a few discrete, very shallow, small pools of water remained. At this lowest level, no fish were observed and therefore, in combination with the zero catch it can be concluded that, any remaining fish in Dock 4 have been released to the River Tyne.

2 INTRODUCTION

The River Tyne extends for 73 miles in the north east of England and is utilised as an industrial and recreational port. The Middle Docks survey site at South Shields, located on the south bank of the river, have a long history as ship building and repair docks going back as early as the 18th century [1].

The river at the survey site is an estuarine system with a mixture of freshwater, brackish and marine species inhabiting it. Manmade structures such as docks influence physical processes of water bodies and provide structure that are suitable habitats for aquatic organisms [2].

Migratory species such as the Atlantic salmon (*Salmo salar*) and River lamprey (*Lampetra fluviatilis),* with various legislation protecting them, migrate to spawning locations upstream in the River Tyne catchment area [3]. The European eel (*Anguilla anguilla*) also inhabits the River Tyne and is classified as Critically Endangered by the IUCN Red List of Threatened Species. There are a number of local and national conservation initiatives and regulations in place to preserve them, such as the European Eel Regulation (2007) and the Eels Regulations (2009) for England and Wales [4] [5].

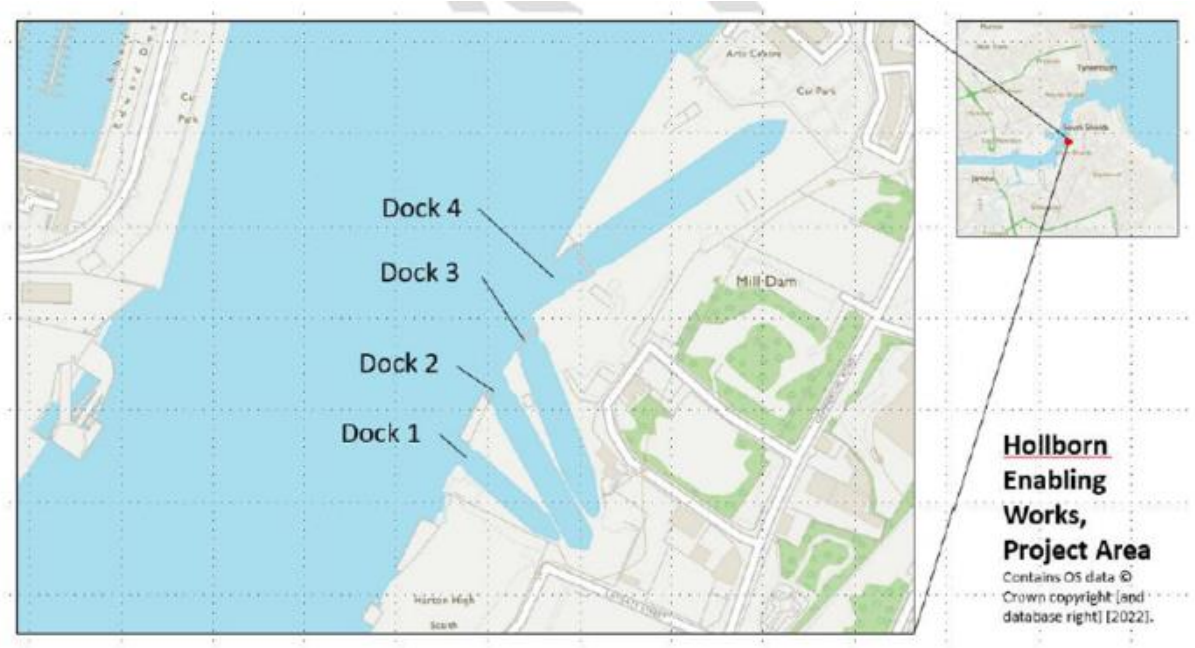
As part of the Holborn Enabling and Refurbishment Works (hereafter 'the Works'), the planning for a new housing development along the shore of the tidal River Tyne requires that Dock 4 (Fig. 1) will be infilled. Dock 4 is approximately 200m long and 30m wide with the 'open' end connected to the River Tyne facing south west, upstream of the river. Water flowing into the dock from the river has deposited floating debris and fine sediments in the dock over the years. Further debris has accumulated from the disuse of the docks since the late 1990s. A bund wall barrier based around the pre-existing lock gates foundations at the open end has been under development to seal Dock 4 since 2022.

As a condition of Planning Permission ST/318/20/LAA, (Condition 6), a fish rescue operation is required within the dock and was undertaken by Ecospan Environmental Ltd. (Ecospan).

3 METHODS

The water depth was due to be reduced (by pumping water over the side of the coffer dam at the end of the dock) to 1.5m above the seabed to facilitate the rescue operation. A floating pontoon and the boat Inshore Surveyor (MCA 5.35m Cat 4 inflatable, powered by a 25 hp outboard) was deployed into the water by crane and mobilised at the bottom of the sole access slipway.

Figure 1. Location of Dock 4 at Holborn South Shields.



3.1 Site assessment and environmental parameters

Environmental parameters were measured to support any findings in the fish data. Salinity, temperature, and dissolved oxygen were measured where possible using a hand-held refractometer, thermometer and an EXO2 Multiparameter Sone YSI probe. Depth soundings were collected using a lead line and measuring tape.

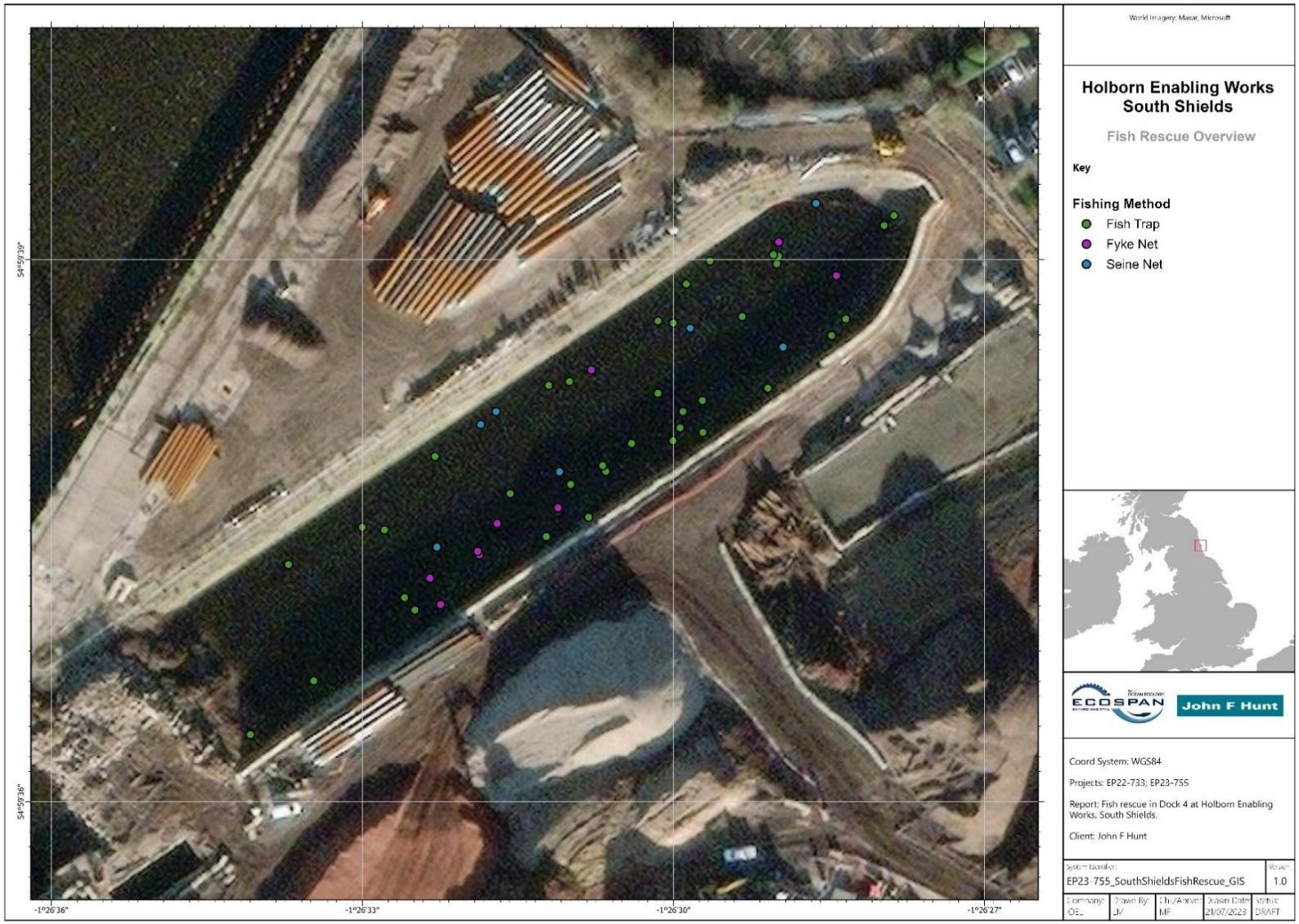
Before any fish were caught, a release area was identified which provided protection to the released fish from the Works, from any un-isolated dock areas (to encourage return into the main river system) and from nearby predators such as gulls and cormorants to prevent predation on released fish.

Optimal fishing positions for conducting seine netting effectively and safely were determined once on site and throughout the course of the survey. This was based on anthropogenic obstructions (debris) and the seabed morphology; these features were uncovered as the water depth was reduced.

3.2 Fishing methods

The sampling events and methods have been plotted in Fig. 2 and their coordinates have been provided in Appendix 1.

Figure 2. Sampling locations within Dock 4 for various fishing methods.



3.2.1 Fish traps

Each fish trap was 100cm high, 62cm wide and 96cm long. Each pot was constructed from 10mm knotless mesh with two soft eyes and baited with mackerel. The pots were weighted using lead diving weights and lifted by small yellow floats, then secured to surface buoys for retrieval (Fig. 3). These traps were baited and set around the dock overnight then retrieved the following day with an average deployment time of 18 hours.

Fish traps were thus utilised to provide an alternative method of fish capture that favours different species, in order to target all possible individuals.

Figure 3. Fish traps during deployment with the lifting buoys attached to the top frame visible on the shallow water's surface.



3.2.2 Fyke nets

Double fyke nets were deployed, that were 0.5 m high, 2.5 m long with a 10 mm mesh cod end, joined by a 3 m long leader with 15 mm mesh. Due to their length, the fyke nets were deployed diagonally across the width of the dock, anchored on one side and buoyed on the other to act as a barrier to fleeing fish.

3.2.3 Seine netting

To determine the identity and relative abundance of species, seine netting was undertaken throughout the accessible length of the dock. The net used was 45 m long, 1.5 m deep and had a 10 mm mesh size throughout with a weighted ground rope to ensure that the bottom of the net was in contact with the seabed.

The net was deployed from Inshore Surveyor beginning on the 'shore' (pontoon or bank) where one surveyor remained to hold the end of the net float line. The boat was then reversed back out across the dock until half of the net was deployed. At this point the boat was steered back to the shore whilst the remainder of the net was deployed, resulting in the net forming a horseshoe shape (Fig. 4). Upon reaching the shore a second surveyor disembarked from the

boat taking the end of the float line. The two surveyors on shore then hauled the net towards each other to close the net.

Figure 4. Personnel conducting seine netting.



3.2.4 Hand netting

Once water depth had significantly reduced, the survey team observed the dock for signs of fish activity. Two personnel remained on standby with mudders (mud walking footwear), seawater-filled buckets and hand nets to retrieve any stranded fish.

3.3 Fish identification and processing

Each catch was processed upon being caught; captured fish were transferred immediately to a large bucket.

Fish caught were identified to species level where possible by experienced marine biologists. Identification aids were used in the field and included the Environment Agency's Fish Identification Field Guide (2009) amongst other resources. A photographic reference collection of each species captured was collated for quality purposes.

Caught fish were measured to enable the age classes to be determined. The standard fork length (i.e., the length from the tip of the snout to the fork of the tail fin) of the first 50 individuals of each species captured was measured to the nearest mm using measurement boards.

Techniques and equipment planned for use if large fish, unidentifiable fish or large numbers of fish were caught, were not required during the survey operations. At all times fish welfare

was paramount and all fish caught in the survey operations could be identified, enumerated, measured and maintained healthy until release.

3.4 Survey 1

There were two fish rescue operations made by Ecospan. The first survey occurred on the 29/11/2022 – 02/12/2023 and the 06/12/2023 – 08/12/2023. Upon arrival to the site in December the dock was not fully sealed by the bund and the water level followed tidal variations. Additionally, the water pump became clogged restricting the ability to reduce the water levels. A second larger pump was sourced to assist in the reduction of water to a level suitable for seine netting, however, this was not possible at any point during the survey. The minimum water depth encountered was 4m (Fig. 5). As the bund was actively being strengthened and the pumps were on during survey 1, fishing activities at the southwest end of the dock were restricted for safety reasons. As such, fishing was undertaken using daily overnight baited fish traps. Fyke nets were deployed at each end the dock throughout the period of disturbance by fish trap collection activities and were also baited and used as additional traps. Three seine nets were deployed and did recover some fish but as the net sank out of sight, this could not be used reliably to target all fish during survey 1. The locations of the seine netting and fyke netting operations during survey 1 are plotted in Fig. 6.

Figure 5. The water level during survey 1, with seine netting being conducted from the vessel.

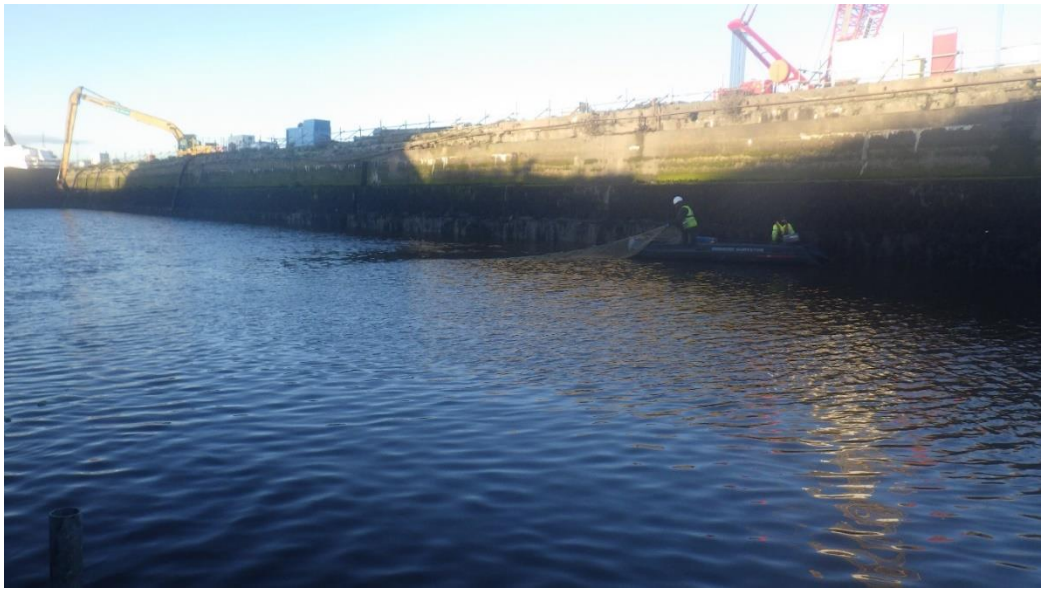
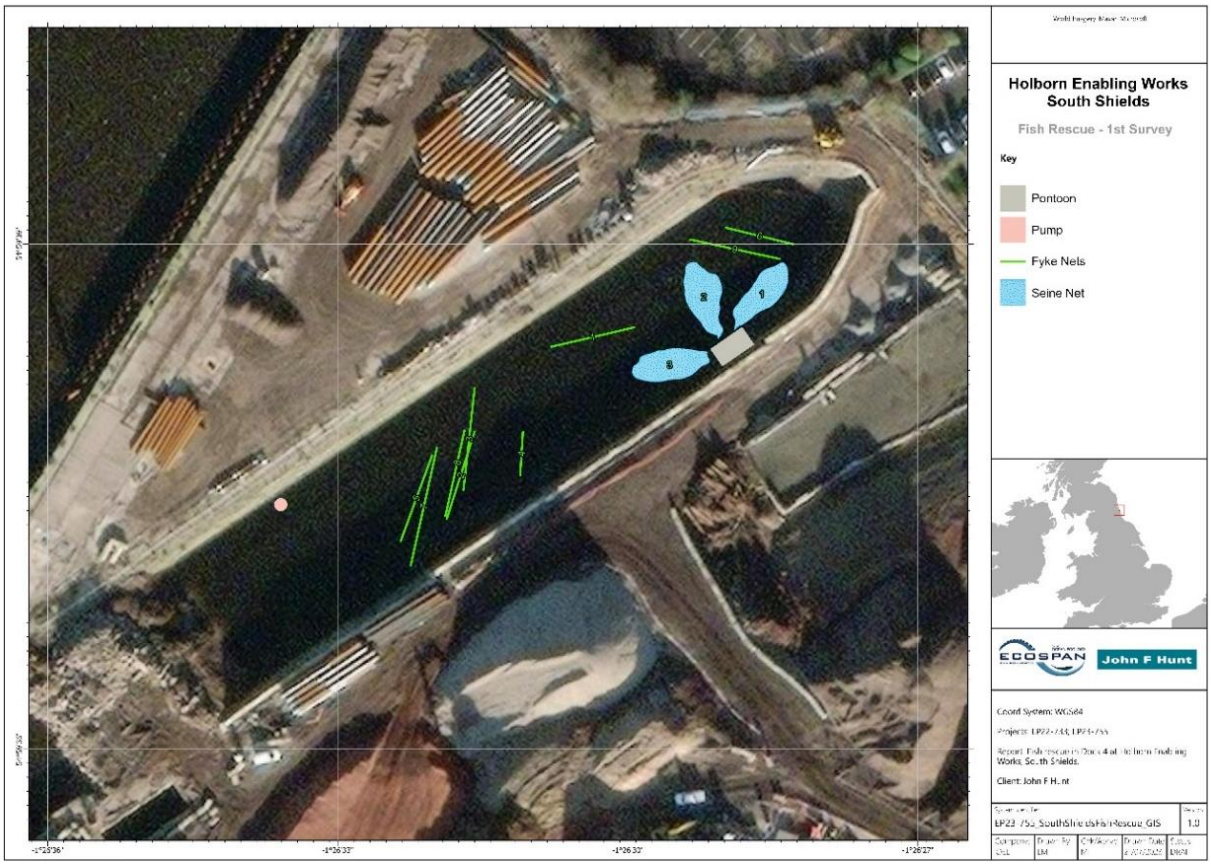


Figure 6. **Locations of the seine netting and fyke netting operations conducted during survey 1.**



Additionally, winds and tides distributed aggregations of floating rubbish and debris presenting another obstacle to seine netting. To address this, it was collected at one end of the dock and/ or retained (Fig. 7).

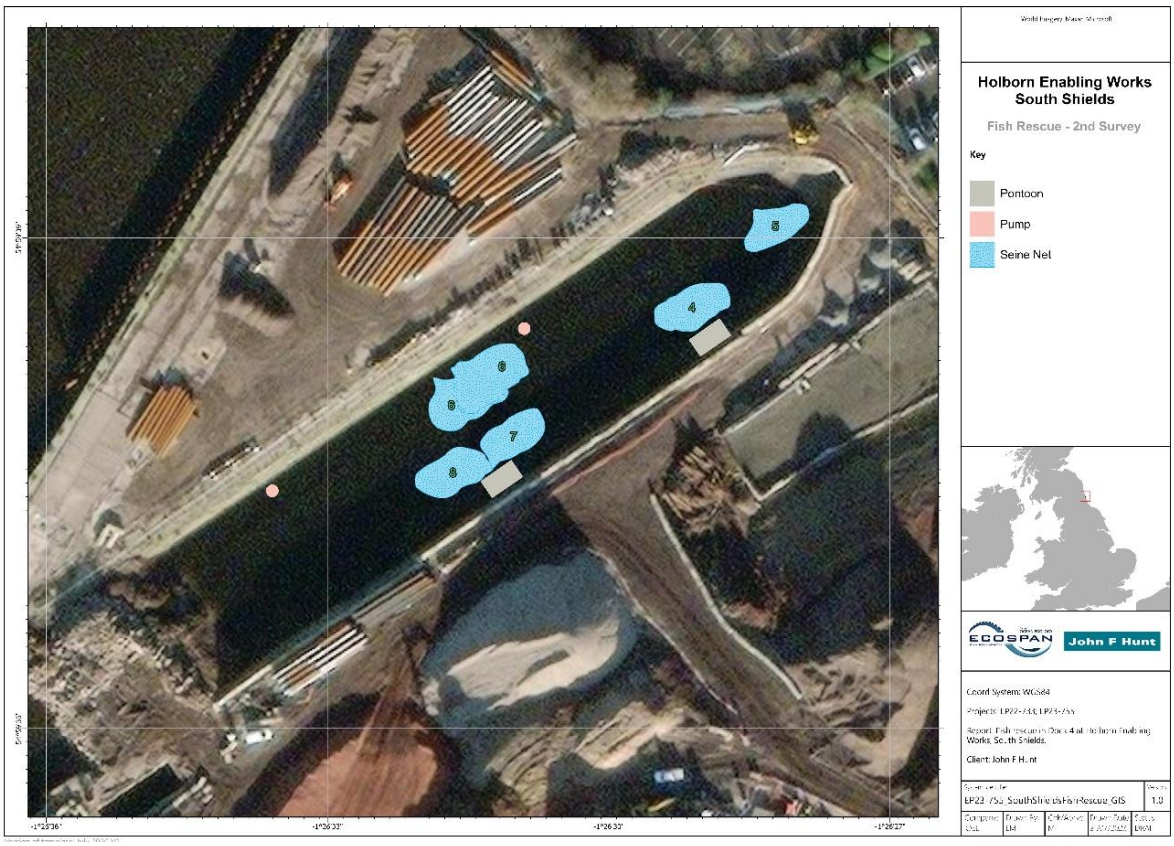
Figure 7. **Barrier created to hold the rubbish and debris collected.**



3.5 Survey 2

The survey team returned once the reinforced bund and pumps were effectively able to reduce the water depth. Survey 2 thus took place from 17/07/2023 - 20/07/2023 when the water depth was between 1m and 1.5 m. This enabled the continuation of the survey. The locations of the seine netting sampling efforts have been provided in Fig. 8.

Figure 8. Locations of the seine netting operations conducted during survey 2.



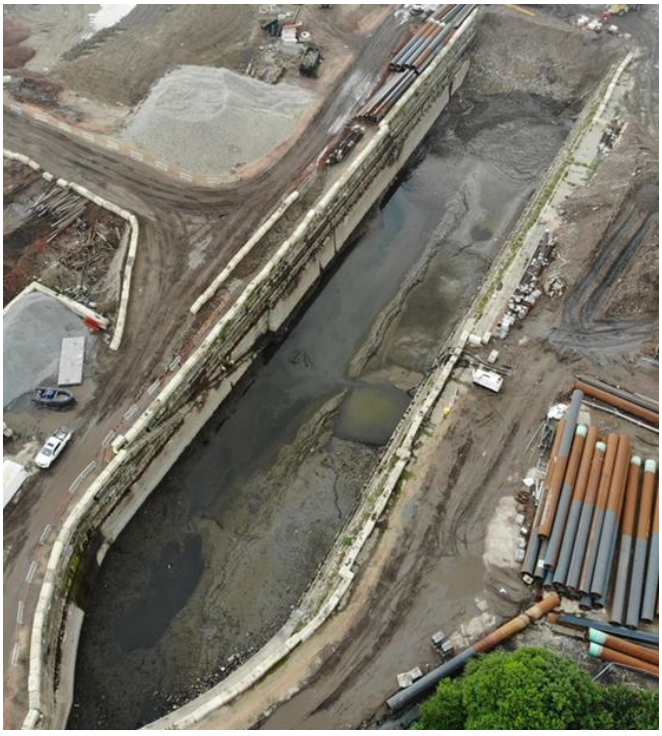
On the 17/07/2023 the survey team arrived and deployed fish traps that were retrieved and processed the following morning. A sediment ridge down the length of the middle of the dock, that created a system of isolated pools suitable for seine netting was revealed once the water level was reduced to ~1.5m. Consequently, fyke nets were not utilised. The pools were accessed by rowing the vessel and moving the pontoon or using the revealed mudbanks. Various obstructions to seine netting (Fig. 9) were present and influenced the locations that could be safely and effectively fish. The seine net snagged on a metal pipe (top right image in Fig. 9) on one of the deployments leading the subsequent redeployment in a similar location that avoided the obstacle. Further overnight fish traps were then set and retrieved the following morning.

Figure 9. Obstructions encountered that dictated safe locations for seine netting.



Once the water level had dropped further to ~40cm (Fig. 10) the pools and banks could not be accessed using the boat due the number of obstructions and sediment barriers, some of which are shown in Fig. 9. Due to the inaccessibility of some areas around the dock by vessel, it was not feasible to conduct seine netting past this point.

Figure 10. Aerial image of the dock with a water level of around 40cm.



The dock was not be drained entirely due to various water inputs around the dock shown in Fig. 11 and 12. The lowest water level achieved can be seen in Fig. 13. Stringent observations were made to determine whether any fish remained in the dock through monitoring for signs of fish such as tail wake, visual contact or sediment disturbance. None were observed; thus, no hand netting was undertaken. One pool close to the pump had reduced visibility due to an active inflow pipe that was uncovered (right hand image of Fig. 12). This pool could not be fished safely or effectively due to the inflow and the nearby obstructions including the pump. The water depth was estimated to be a maximum of ~15cm based on earlier measurements. This, combined with the lack of signs of fish across the rest of the dock, means it is unlikely that any remaining fish were residing here.

Figure 11. The water inputs into the dock from either pipes or cracks/gaps in the dock wall



Figure 12. Two of the four water inputs to the dock, including an inflow pipe.



Figure 13. Lowest water level of the dock (15cm).



4 RESULTS AND DISCUSSION

Data from both surveys were analysed together as a continued survey effort.

4.1 Environmental parameters

The temperature, dissolved oxygen percentage saturation (DO%), salinity and sediment type were determined where possible during the fish surveys. DO% could only be collected during survey 2 and salinity and temperature were measured for most of the operational days. The DO% was obtained at the top of the water column just under the surface and at the bottom of the water column close to the sediment. The results are presented in Table 1.

Table 1. Measured environmental parameters.

Date	Water Temperature (Celsius)	Salinity (PPT)	DO%
29/11/2022	45	18	N/A
30/11/2022	4.9	19	NIA
01/12/2022	4.9	24	NIA
02/12/2022	6.3	20	N/A
06/12/2022	6.5	21	N/A
07/12/2022	N/A	20	NIA
08/12/2022	N/A	20	N/A
18/07/2023	14.3	23	32-53
19/07/2023	14.3	23	32-53

The sediment type across the dock was very fine mud (particle size of <63 µm) with a redox layer close to the surface indicating a very anoxic benthic (bottom sediments) environment.

4.2 Fish rescue

The fishing type and number of deployments across both fish surveys have been summarised in Table 2.

Table 2. The fishing method and number of deployments over both fish surveys.

Type	Count
Fish Trap	37
Fyke Net	9
Seine Net	9
Hand Net	0

Fish species were only caught during survey 1 (photos of some of the species caught are provided in Fig. 14).

Figure 14. Photos of individual fish caught at various stages of the rescue process, labelled with their scientific and common species name.



The fish species and the abundances caught over the course of the survey 1 are graphically presented in Figs. 15 and 16.

Figure 15. Fish species and their abundances caught over survey 1.

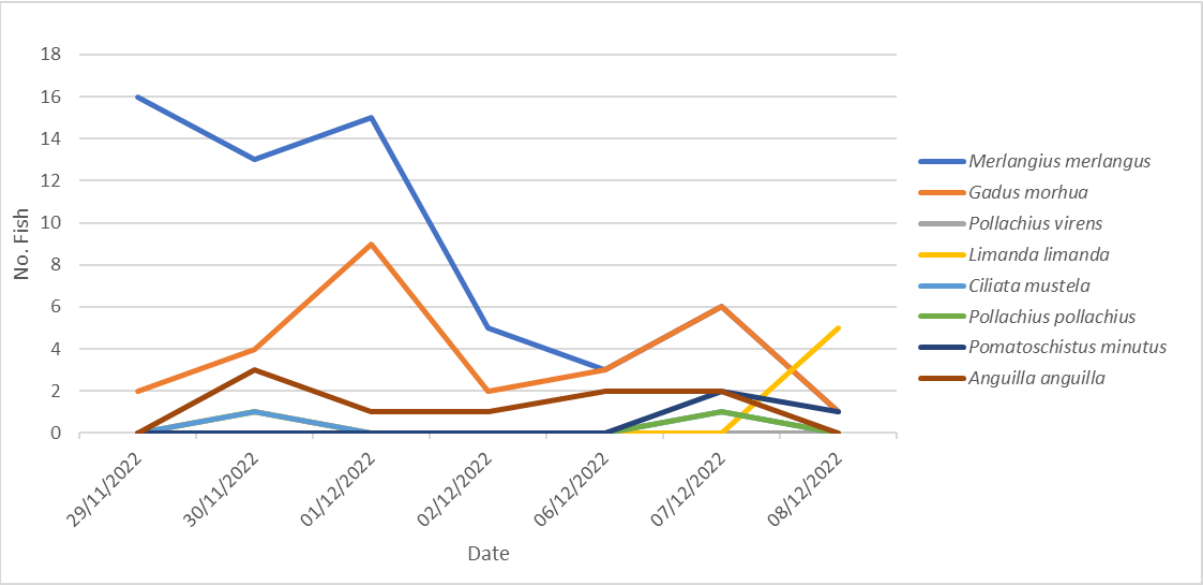
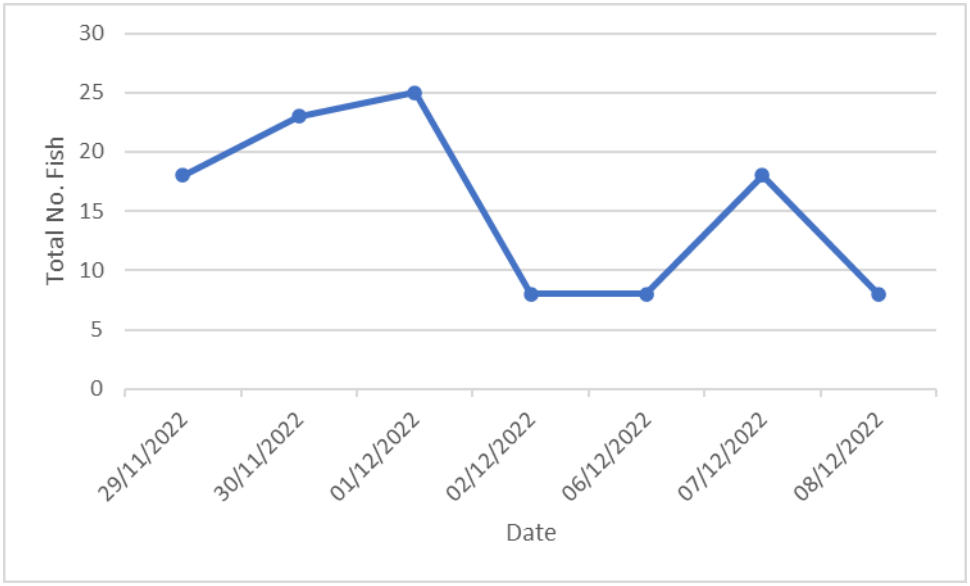


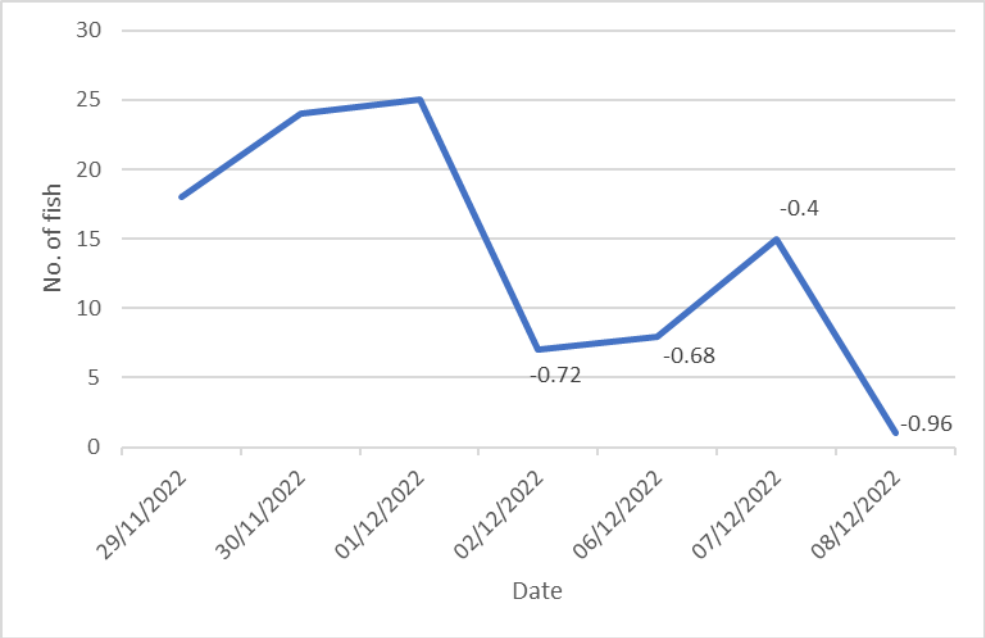
Figure 16. The abundance of fish caught over survey 1.



There was a general trend for the abundance of each species caught to reduce as the fish rescue progressed (Figs. 15 and 16). The exception to this was the occurrence of Common dab (*Limanda limanda)* and Sand goby (*Pomatoschistus minutus)* being caught at the end of survey 1 which could have been caused by the change in fishing methods. Fig. 17 shows there was a large percentage decline in the abundance of fish caught in fish traps as survey 1 progressed. The percentage decreases have not been standardised to catch per unit of effort as the number of traps deployed each day during survey 1 was the same except for on the final day of survey 1 (08/12/2022), where one extra shorter deployment was conducted. Abundance of each fish species was relatively low towards the end of the survey 1. This indicates the success of the fish rescue operation in reducing (through capture and release) the number of the fish present

in the dock. Additionally, survey 1 involved the successful capture and release of nine European eel, an endangered and protected species [4] [5].

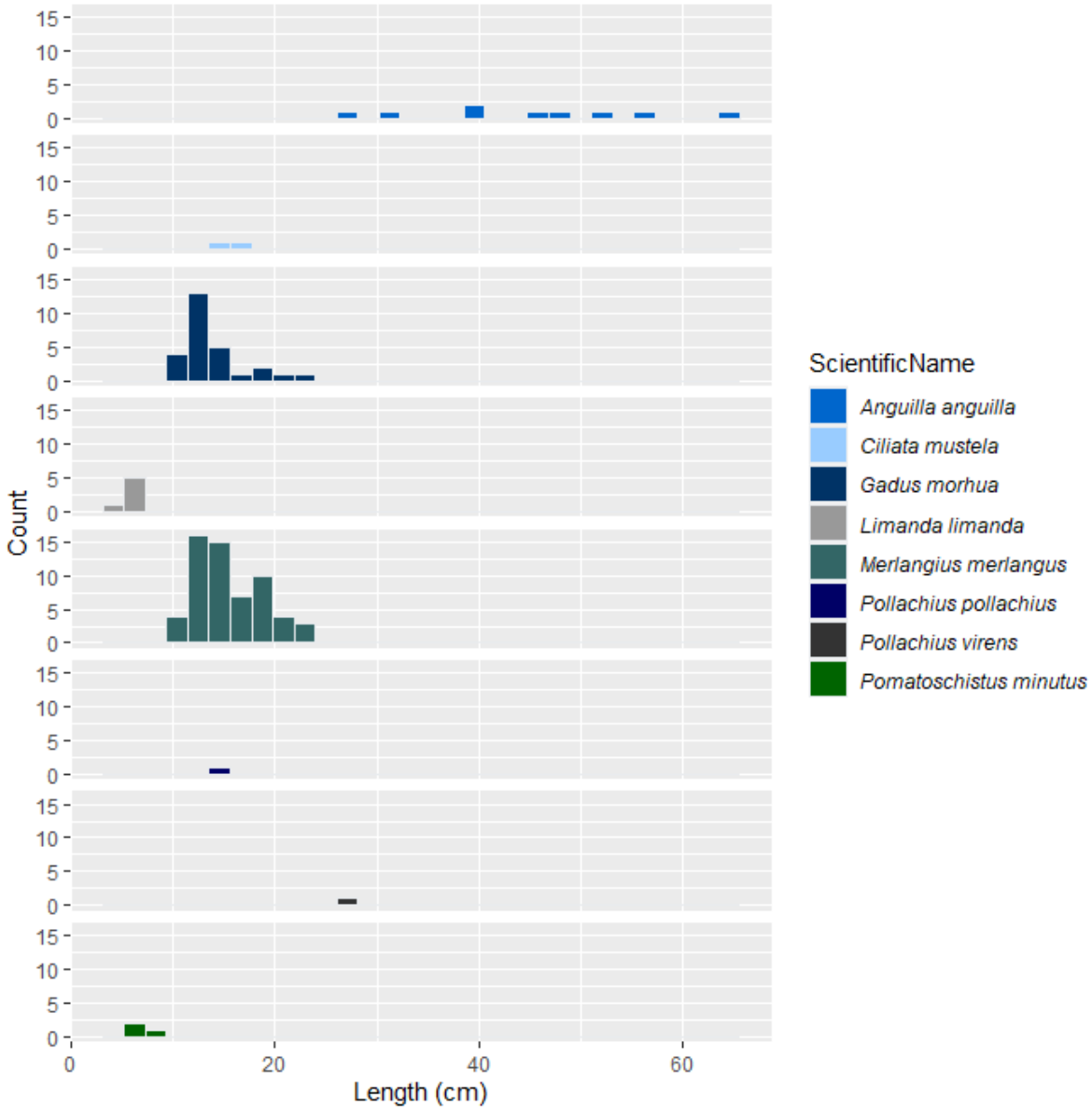
Figure 17. The collective abundance of fish (all species) caught in fish traps during survey 1, with labels showing the percentage decline in the abundance from the peak abundance caught on 01/12/2022.



The 96% decrease in the abundance of fish caught in fish traps that occurred over the course of survey 1 implies that the removal of fish during survey 1 is a substantial reason for the lack of fish caught in survey 2. The temperatures measured during survey 2 support favourable conditions for the species previously encountered [6] [7]. The levels of dissolved oxygen measured might have caused a degree of physiological stress to fish inhabiting the dock [8] [9] [10] and biotic interactions and factors within the dock, particularly prey availability, could have influenced fish survival. However it is likely given the intensive fishing efforts made that all fish were removed in 2022.

Length frequency graphs can be used in fisheries analysis to determine the abundance of different age classes in order to determine population demographics within an area. Frequency length histograms have been plotted for each species caught during survey 1 (Fig. 18). Due to the limited dataset, it is difficult for some species to determine much from these histograms. European eels (*Anguilla anguilla*) occurred within the dock ranging from 27.5 to 65cm. Eels within this size range would be considered late-stage juveniles to early-stage adults. It is likely some of these individuals would have reach reproductive maturity and are therefore important to populations of European eels through reproductive potential [11]. From the histograms, the size of the Atlantic cod caught suggests all of these were juveniles [12] [13] [14]and the majority of whiting (*Merlangius merlangus*) caught were likely juveniles [15] [16].

Figure 18. Length Frequency histograms for fish species caught during survey 1.



During survey 2 only green shore crab (*Carcinus maenus*) were caught. The abundances across both surveys are provided in Figs. 19 and 20 which show their abundance generally increased over time particularly between the first and second surveys. Survey 2 occurred during the summer which is post spring recruitment with warmer water likely increasing the activity levels of crabs within the dock. Additionally, due to the removal of fish during survey 1, crabs might have experienced reduced predation pressure.

Figure 19. **Abundance of shore crab (*Carcinus maenus*) caught by each fishing technique and day.**

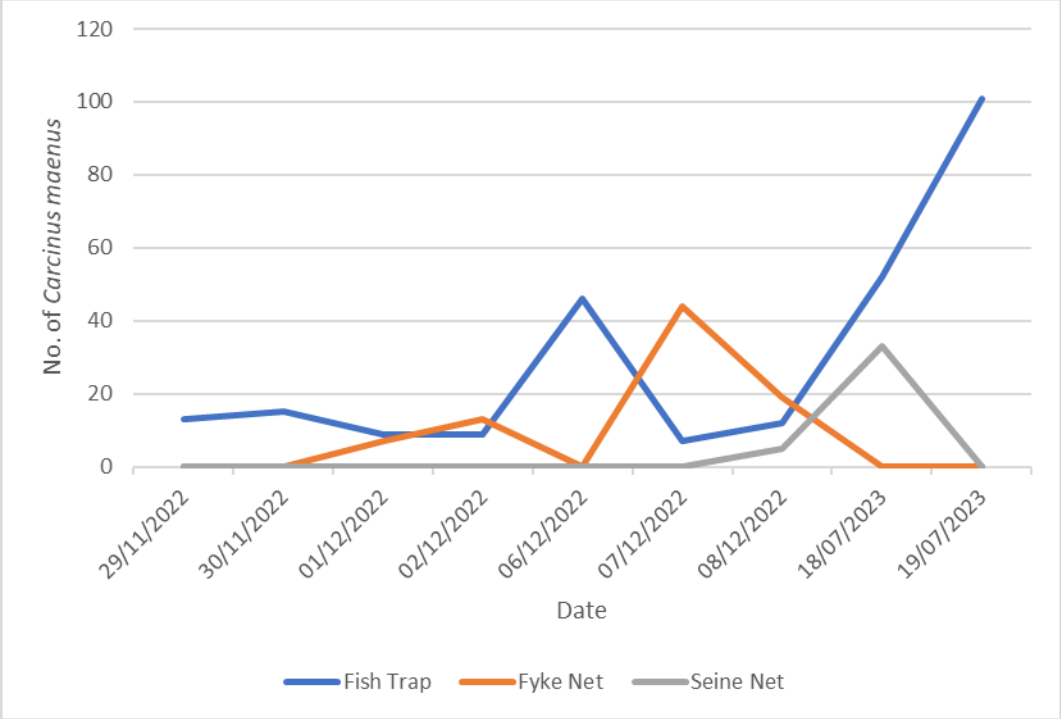
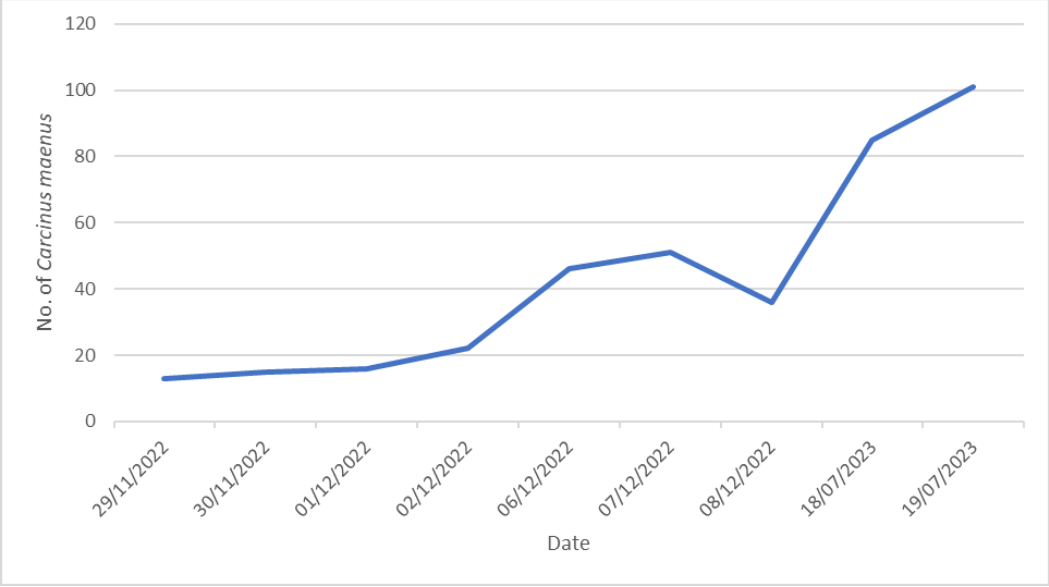


Figure 20. **Total abundance of shore crab (*Carcinus maenus*) caught over time.**



5 CONCLUSION

Overall, two surveys (seven months apart) were conducted by Ecospan to catch and release fish inhabiting Dock 4, Holborn Enabling Works, that is projected to be infilled. A combination of seine netting (nine deployments), fyke nets (nine deployments) and fish traps (37) were used to capture fish. A total of eight fish species and 108 individuals were caught and successfully relocated during the initial survey. This included the endangered and protected European eel

[4] [5] of which nine individuals were rescued. No fish were caught during the second survey. Other factors such as the dissolved oxygen and food availability could have influenced fish survival between survey 1 and 2. However, it is most likely that this indicates the success of survey 1 at successfully rescuing fish from the dock.

After no fish were caught during survey 2, the water level was reduced in the dock to the lowest feasible level (water inputs prevented the complete drying out of the dock). No fish or signs of fish presence were seen in the dock as it dried out, indicating a lack of any remaining fish. The data and observations outlined in this report show that, by all available means, any fish in Dock 4 were removed and relocated to the safe location on the Tyne Estuary.

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7 APPENDIX

Appendix 1. Coordinates (WGS84) of all sampled locations with fishing method utilised.

Sample Name	Latitude	Longitude	Type
SSFT1	54.9935	-1.4426	Fish Trap
SSFT2	54.9937	-1.4427	Fish Trap
SSFT3	54.9941	-1.4417	Fish Trap
SSFT4	54.9940	-1.4414	Fish Trap
SSFN1	54.9940	-1.4419	Fyke Net
SSFN2	54.9937	-1.4422	Fyke Net
SSFT5	54.9938	-1.4424	Fish Trap
SSFT6	54.9937	-1.4420	Fish Trap
SSFT7	54.9940	-1.4417	Fish Trap
SSFT8	54.9942	-1.4417	Fish Trap
SSFT9	54.9936	-1.4424	Fish Trap
SSFT10	54.9938	-1.4418	Fish Trap
SSFT11	54.9938	-1.4421	Fish Trap
SSFT12	54.9941	-1.4412	Fish Trap
SSFN3	54.9938	-1.4421	Fyke Net
SSFT13	54.9942	-1.4411	Fish Trap
SSFT14	54.9942	-1.4414	Fish Trap
SSFN4	54.9938	-1.4420	Fyke Net
SSFT15	54.9936	-1.4424	Fish Trap
SSFT16	54.9938	-1.4425	Fish Trap
SSFN5	54.9937	-1.4423	Fyke Net
SSFT17	54.9942	-1.4414	Fish Trap
SSFT18	54.9940	-1.4419	Fish Trap
SSFT19	54.9939	-1.4423	Fish Trap
SSFT20	54.9938	-1.4419	Fish Trap
SSFT21	54.9942	-1.4411	Fish Trap
SSFT22	54.9941	-1.4412	Fish Trap
SSFN6	54.9942	-1.4414	Fyke Net
SSFT23	54.9938	-1.4419	Fish Trap
SSFT24	54.9934	-1.4428	Fish Trap
SSFN7	54.9936	-1.4423	Fyke Net
SSFT25	54.9940	-1.4420	Fish Trap
SSFN8	54.9937	-1.4422	Fyke Net
SSFT26	54.9939	-1.4419	Fish Trap
SSFT27	54.9941	-1.4417	Fish Trap
SSFT28	54.9941	-1.4415	Fish Trap
SSFT29	54.9940	-1.4414	Fish Trap
SSSN1	54.9940	-1.4414	Seine Net
SSSN2	54.9940	-1.4414	Seine Net
SSSN3	54.9940	-1.4414	Seine Net
SSFN9	54.9941	-1.4412	Fyke Net
SSFT30	54.9939	-1.4416	Fish Trap
SSFT31	54.9939	-1.4418	Fish Trap
SSFT32	54.9942	-1.4416	Fish Trap
SSFT33	54.9942	-1.4414	Fish Trap
SSSN4	54.9941	-1.4416	Seine Net
SSSN5	54.9943	-1.4413	Seine Net
SSSN6a	54.9939	-1.4421	Seine Net
SSSN6b	54.9939	-1.4422	Seine Net
SSSN7	54.9938	-1.4420	Seine Net
SSSN8	54.9938	-1.4420	Seine Net
SSFT34	54.9940	-1.4416	Fish Trap
SSFT35	54.9939	-1.4416	Fish Trap
SSFT36	54.9939	-1.4416	Fish Trap
SSFT37	54.9939	-1.4417	Fish Trap