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PIER BENEATH: OBSERVATIONS OF THE MARINE FLORA AND FAUNA ASSOCIATED WITH YARMOUTH PIER, ISLE OF WIGHT.

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Abstract *With numbers of offshore structures increasing around our coast, it is important to understand how marine organisms might be affected by these developments. Benthic species may benefit from a greater surface area for colonisation, and it is possible that aggregations of fish, normally associated with rocky reefs, may become established. The extent to which fish utilise structures for grazing on surface benthos, for refuge or to hide in ambush for prey, is poorly understood. Here we present results of survey work conducted at Yarmouth Pier from 2017-2019 during a phase of reconstruction of the pier head. Data from the pier was mostly collected by volunteer Seasearch SCUBA divers and the deployment of Baited Remote Underwater Video (BRUV) from the pier head. Reference sites to the east and west of the pier were also sampled using BRUV to determine whether observed changes in species abundance were confined to the pier or could be generally attributed to the wider locality. A total of 140 species were recorded on the pier structure and seabed immediately below the pier and an additional 5 species were recorded from the Reference sites. BRUV surveys yielded more species from the pier than the Reference sites. During spring and summer 2018, recolonisation of the new pier piles was rapid and included pioneer benthic species not seen in the previous summer. Yet although the mobile fish assemblage differed from that prior to reconstruction of the pier head, this could be attributed to background variation. The pier is clearly attractive to invertebrates and a range of reef fish, including species of wrasse, pout, pollack and bass that individually benefit from the structure in different ways.*

Introduction

Piers are emblematic of seaside towns and resorts and offer unique perspectives and access over the water for visitors. On the Isle of Wight there are currently three accessible piers; Yarmouth, Sandown and Ryde, however in the 19th Century, large piers were also constructed at Cowes, Totland, Seaview, Ventnor and Shanklin, with the latter meeting its demise during the 1987 storm. Although popular with sea anglers, very little information exists on the marine ecology of piers, and what has been published is concerned mostly with benthic invertebrates and algae that foul pilings (Glasby, 1999, 2000; Connell and Glasby, 1999). The extent to which piers attract fish and other mobile species is much less known, partly because of the hazards associated with SCUBA diving around these structures, which may be subject to strong tidal conditions. It is known that pier pilings provide a surface for attachment of benthic organisms which may be a source of food for fish and other species (Clynick et al. 2007). The pilings can also be a refuge in strong tidal conditions and bass *(Dicentrarchus labrax)* are known to hide downstream in the slower flowing water behind pilings to ambush prey (Pickett and Pawson, 1994). Depending on aspect, pier decking and pilings might cast significant shade that might both attract and deter species. Lights on piers may also be attractive to some organisms at night. An important question is the extent to which the pier structure affords protection and/or food. Fish are known to aggregate around natural rocky reefs, wrecks and other artificial structures (Bohnsack, 1989, Pickering and Whitmarsh, 1997, Reubens et al. 2013), yet it is often unclear how they are benefiting from the habitat (Coleman and Connell, 2001; Clynick et al. 2007).

The marine environment is particularly harsh and all structures at sea require periodic maintenance. This can create opportunity to investigate species habitat preferences as when new structures are immersed, the habitat is disturbed and it can take some time before a mature benthic community becomes re-established. Species that rely on the benthic organisms for food may therefore not reappear immediately following the disturbance. Yet species that are seeking refuge from the structure itself may recolonise more quickly.

The aim of this investigation was to characterise the marine flora and fauna associated with Yarmouth Pier before and after reconstruction of the pier head in 2018. Surveys of marine life on the old wooden pier piles, together with associated fish and mobile invertebrate species commenced in summer 2017, prior to the main works the following spring. These surveys were repeated in summer 2018 and 2019 to determine whether any changes in the marine fauna and flora could be attributed to the reconstruction.

Yarmouth Pier

Yarmouth Pier is situated on the north-west coast of the Isle of Wight in the south of England and extends 186m into the Solent (Fig. 1). Immediately west of the pier is the Yar estuary and Yarmouth Harbour, which serves recreational craft and a small ferry port. The pier was opened in 1876 and has always been constructed from timber. Owing to attack from the wood boring isopod *Limnoria lignorum*, it has frequently been necessary to replace and refurbish the structure; yet because of the pier's Grade II listed heritage status, new works have always used wood. Prior to the current phase of restoration, work was carried out in 2007-8 when 54 support piles were replaced with greenheart timber along the length of the pier, but not on the pier head. Species recorded on a stack of five piles that had been removed is presented in Herbert (2009). In February 2018, work commenced to dismantle and fully reconstruct the pier head with refurbished greenheart timbers from Portsmouth dockyard and was completed in June 2018. The new pier head is very similar to the previous structure although a steel tube 'shoe' has been driven in to the sea bed to replace the wood 0.7m below low water springs. Vertical pilings are square in cross section and of side approximately 40cm. Most

new diagonal cross members have been positioned similarly to the previous design and there are some horizontal timbers above and below Low Water Spring tide mark. The pier is used mainly for pedestrians and currently receives only occasional summer berthing by passenger vessels, such as the PS Waverley, on the outside of the pier head.

The north-west coast of the Isle of Wight is relatively sheltered from prevailing south-westerly winds and the surrounding seabed consists mostly of soft sediments and gravels, beds of seagrass *(Zostera marina)* and patches of limestone and clay reef. Mean maximum sea temperature is 18°C and minimum 7.5°C. The tidal range is small – at 3m on spring tides and 2m on neap tides, however the west-east bidirectional flow is particularly strong on the spring ebb (west-going) tides and can exceed 3m/s. The area is part of Solent Maritime SAC and protected under the EU Habitats Directive. The Yarmouth-Cowes Marine Conservation Zone boundary is immediately east of the pier.

Methods

Seasearch SCUBA diving surveys

Dive surveys beneath the pier using SCUBA took place on August 1st and August 31st 2017 from *Wight Spirit* and on August 7th 2018 and August 27th 2019 from *Rocket*. The objective of the dives was to characterise and photograph the fauna and flora of the sea bed and the pier piles. Each survey lasted approximately 1 hour around slack water during neap tides when the water depth recorded about 3.7-3.9m, and was conducted by 3 pairs of divers in 2017 and 2019 and 2 pairs of divers in 2018. Species abundance followed Seasearch surveyor guidance http://www.seasearch.org.uk/downloads/Survformguide%202-14.pdf.

BRUV surveys

During the summers of 2017, 2018 and 2019, a Baited Remote Underwater Video (BRUV) unit was deployed from the pier head to survey and record mobile fauna. This technique is becoming more widely used for surveying subtidal mobile fauna where SCUBA surveys are difficult or where non-destructive methods are necessary (Unsworth et al. 2014; Whitmarsh et al. 2017; Jones et al. 2021). The unit consisted of a weighted aluminium frame and *GoPro* Hero 3 camera with underwater housing. A 1m pole extends in front of the camera at the end of which is a bait cage filled with 100g of chopped fresh mackerel. To compare changes in mobile underwater life around the pier with the surrounding habitats, a Reference Site to the east (mooring of RSYC Committee Boat *Countdown*) and west (Yarmouth Harbour Master mooring buoy S1) of the pier were also surveyed (Fig. 1). These sites are at a similar depth (2-3m below Chart Datum) to the sampling site at the pier head. Due to ongoing construction works and access difficulties, pier deployments in June 2018 were from the Mackley's barge stationed at the pier head. In each month, ten deployments were made over two sampling periods of 2-3 days with varying tidal conditions. Details of deployments are shown in Table 1.

To investigate changes in mobile assemblages into the hours of darkness a mono-BRUV unit fitted with a single SEAC R3 LED Dive Torch (500 Lumens) was deployed from the pier head. Surveys were carried out from 10:00 hrs - 00:00 midnight (14 hours total) during two neap tides (23rd, 24th August) and two spring tides (29th, 30th August). Deployments were for 20 mins on each hour.

The video footage from each BRUV deployment was analysed in 1-minute sections using MS Media Player and the number of species seen (S) over each 20-minute

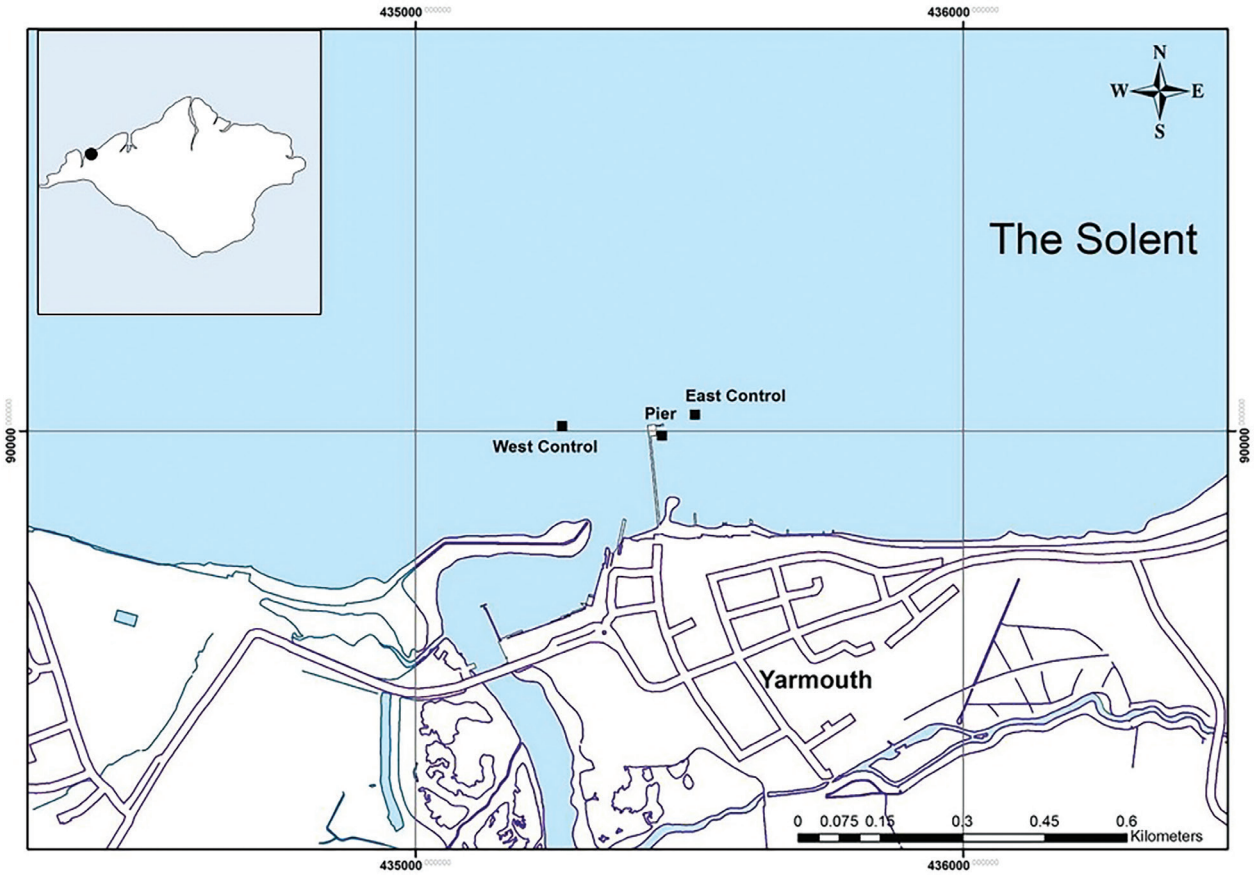

Fig. 1: Location of Yarmouth Pier on the north-west coast of the Isle of Wight and BRUV Reference sites east and west of the pier head. Crown copyright and database rights 2021 Ordnance survey (100025252).

deployment was recorded. Additionally, the maximum number of individuals of each species seen in any frame over the 20-minute deployment was also noted (Max N). The total Max N is the overall maximum number of individuals of all species observed in any one frame during the deployment.

Video surveys of pier piles

During a neap tide on October 14th 2017, video surveys of the benthic fauna and flora colonising the outer pier piles on the pier head were conducted using a *GoPro* Hero 3 camera fixed to the end of a 6m fishing pole lowered beside the piles. The pole was guided down the pile by a researcher in a kayak. The objective was to obtain data on the percentage coverage of main species groups on the pilings, which could be compared with coverage of new pilings in 2018.

Current speed and water temperature

Surface water temperature was measured beneath the pier using an alcohol thermometer at the steps prior to video surveys. At the same time, the current flow and direction was also measured using a hand-held meter. On the spring tide of August 14th 2018, a *StreamPro* Acoustic Doppler Current Profiler (ADCP) was deployed to measure current velocity throughout the water column and specifically to record the effect of the pier piles on current velocity. The ADCP was towed from a harbour dory along a 5m north-south transect up-tide and down-tide of pier head 2-3 hrs after High Water. With the tide ebbing fast, the Harbour Dory was tied to the pier legs and the ADCP towed along the length of the boat approximately 3m downstream of the pier.

Results

Sea temperature and visibility

In 2017, sea temperatures rose during the summer survey period from 17°C in June to 20°C in August. BRUV survey days had mostly good water visibility (2-3m) and fine weather with moderate SW winds.

In 2018, sea temperatures were slightly higher and increased from 17°C in June to 20°C in August. BRUV survey days were generally sunny and warm throughout the summer with light-moderate southerly winds. Water visibility was poor in June (<1m) due to algal bloom, but improved to 2-5m in August. During surveys in August 2019, maximum sea temperatures recorded were 22.4°C, reducing to 18.5°C by late evening. Survey days had poor – moderate water visibility (1-3m) and fine settled weather.

Current flow

In 2017, at the pier and west control site, an equal number of hand-held deployments were made during west and east flowing tides and spring and neap cycles, however at the eastern site 92% were made during east flowing currents due to operational constraints. The mean current velocity during BRUV deployments at the two control sites did not differ significantly (west 0.35 m/s; east 0.38 m/s – approx. 0.7 knots) (Fig. 2). The mean current velocity at the pier survey site was significantly less than the control sites (0.05 m/s = 0.1 knot), due to shelter from the pilings. In 2018, an equal number of deployments were made on spring and neap cycles. At the western control site, an equal number of deployments were made on both east flowing and west flowing tides, however at the pier and eastern site the majority were made on east flowing tides. As in 2017, the mean current velocity at the two control sites was greater than at the pier (west 0.31 m/s; east 0.26 m/s; pier 0.09 m/s) (Fig. 3).

The ADCP survey in August 2018 showed the impact of the pier piles in reducing mean current velocity in the water column from 0.63 m/s upstream to 0.36 m/s (Fig.3).

The number of species observed monthly from BRUV surveys at each site generally increased during the summer, reaching a maximum at the pier in August (Fig.4). The mean *MaxN* was also highest at the pier during most survey months except in August 2018 when large numbers of juvenile black bream (*Spondyliosoma cantharus*) were seen at the western control site (Fig. 5).

2017 survey

In 2017, the distribution of species on the old piles was zoned strongly with depth, with the yellow maritime sunburst lichen (*Xanthoria parietina*) present above the extreme high water mark.

Green seaweeds (*Ulva* spp.) occupied the highest of the algal zones, below which were found the brown wracks e.g. bladder wrack (*Fucus vesiculosus*) and occasional patches of knotted wrack (*Ascophyllum nodosum*). Descending further, a narrow and occasionally dense band of barnacles (*Semibalanus balanoides* mixed with (*Austrominius modestus*)) was present with occasional

Year	Dates	West Control	Pier Head	East Control	Total video minutes
2017	June 22nd, 29th, 30th	10	10	6	480
	July 19th, 20th, 26th, 27th	10	10	10	600
	August 16th, 17th, 28th, 29th	10	10	10	600
2018	June 15th, 16th	10	10	10	553
	July 20th, 23rd, 30th	10	10	10	635
	August 5th, 6th, 19th, 20th	10	10	10	605

Table 1: Dates, number of BRUV deployments and total minutes of video obtained at each sampling site during June, July and August 2017 and 2018. All deployments were made during daylight from 09:00-17:00 DST. (Daylight Saving Time).

limpets (*Patella vulgata*). At extreme low tide mark, red seaweeds *Halurus flosculosus* and *Calliblepharis ciliata* became more prominent, with sponge *Halichondria panicea*, and bryozoans *Flustra foliacea* and *Chartella papyacea* more common towards the base of the piles.

Surveys of the pier in summer 2017 yielded a total of 102 species, including 43 seaweeds, 58 species of invertebrates and fish and the seagrass *Zostera marina* (Appendix 1). All species were found either on the old piles and cross members, swimming or on

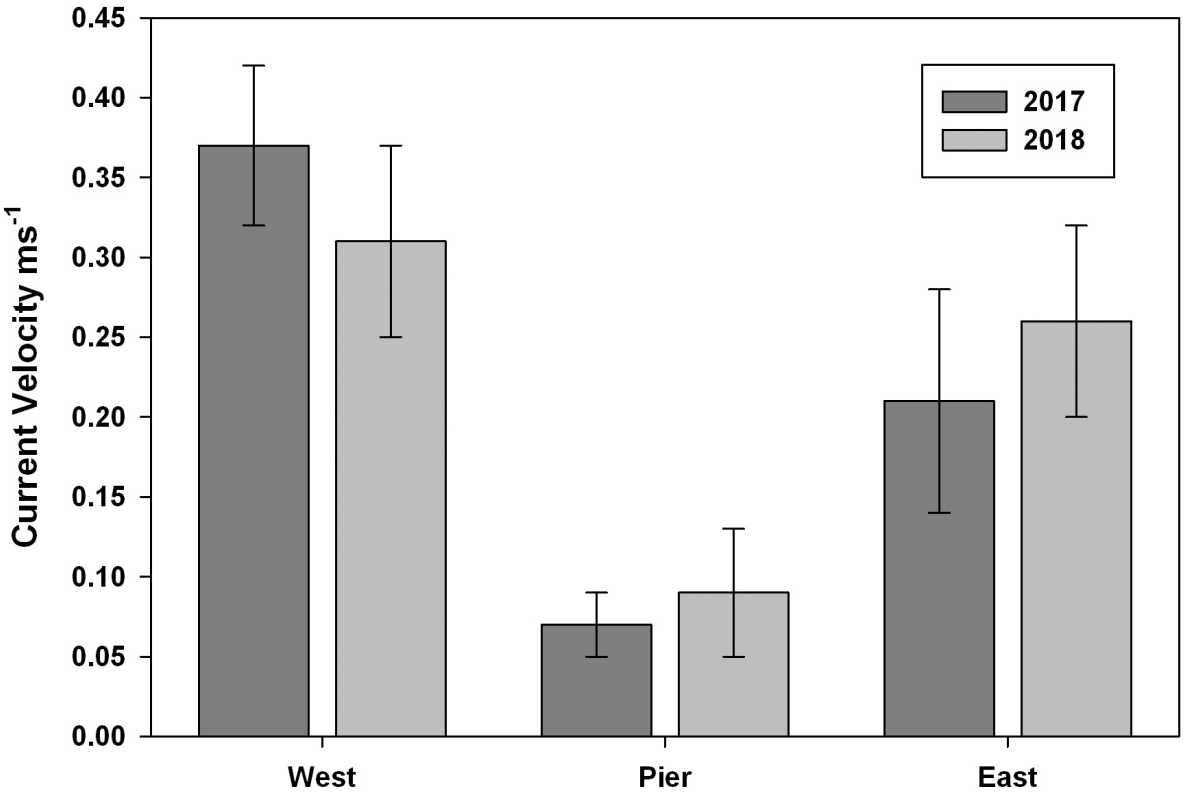

Fig 2: Mean current velocity during BRUV surveys measured using hand-held meter at each sampling location in 2017 and 2018. Samples ranged n = 4-10 in June, July and August. Error bars show +/- SE.

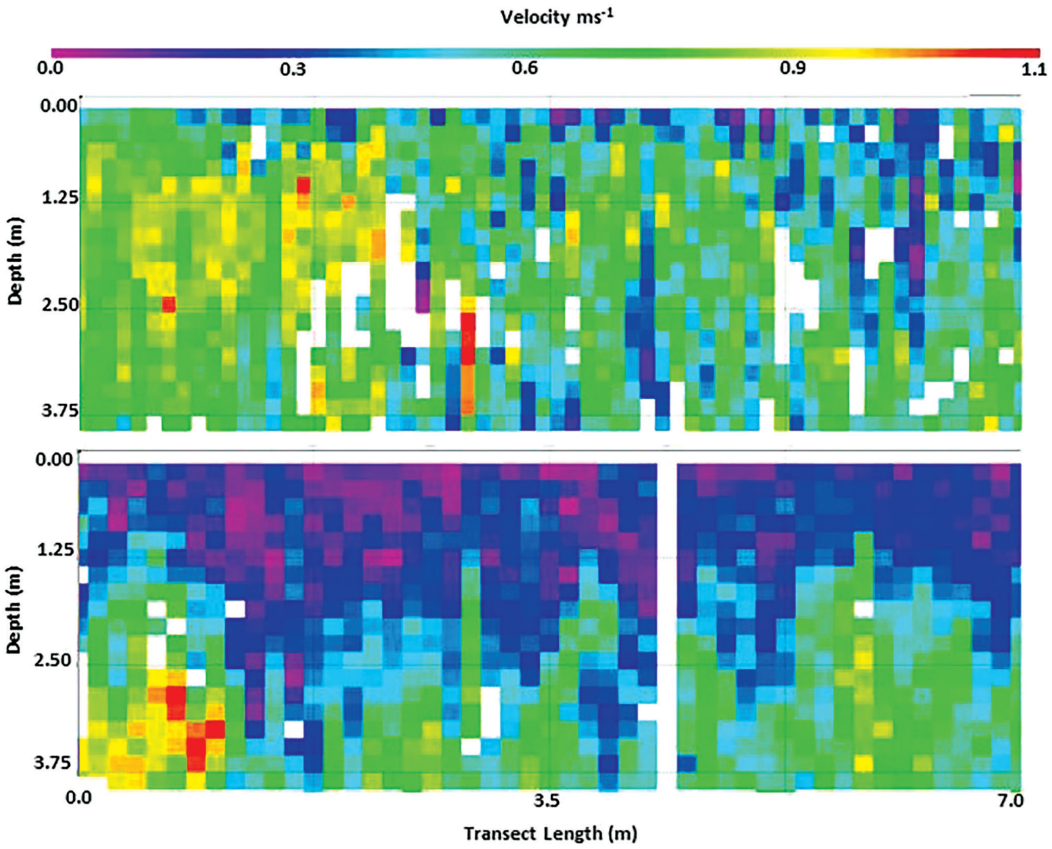

Fig 3: Mean current flow patterns along 7.0m (North-South) transect upstream (above) and downstream (below) of the pier obtained using ADCP 2-3 hrs after HW on 14th August 2018. Vertical axis on each image is water depth from surface to sea bed. The blue represents slow flowing water behind the horizontal wooden cross members and pier piles.

the sea bed within 2m of the structure. Colonising the pier structure were nine species of algae, including common red seaweeds *Aglaothamnion tenuissimum, Halurus flosculosus* and *Calliblepharis ciliata* and brown algae *Halydris siliquosa*. Occasional plants of the kelp *Sacchorhiza polyschides* was recorded towards the base of the structure. Of the macroinvertebrates associated with the pilings, the most common and obvious fouling species were the bryozoans *F. foliacea C. papyacea* and sponge *H. panicea*. The barnacle *Perforatus perforatus* was frequent in patches at lower intertidal levels and mid subtidal depths. Of the 15 species of fish observed, pollack (*Pollachius pollachius*), pout (*Trisopterus luscus*), corkwing wrasse (*Crenilabrus melops*) and sand smelt (*Atherina sp.*) were most numerous. Edible crab (*Cancer pagurus*) (Fig.6), velvet swimming crab (*Necora puber*) and spider crabs (*Maja brachydactyla*) and *Inachus* sp. were seen on the sea bed around the piles. In addition, the native oyster (*Ostrea edulis*) was recorded at several locations on the seabed in proximity to the pier pilings. One of the most spectacular species observed was the cuttlefish (*Sepia officinalis*) (Fig 7.) at the pier head. The seagrass *Zostera marina* was seen in small clumps 1.5-2.0m east of the mid- section of the pier, but not beneath the structure itself.

A total of 23 mobile species were identified from BRUV videos obtained at the three sampling sites (Appendix 2). These comprised six species of crab and lobster, three molluscs and fourteen fish species, including bib, pollack (Figs. 8 and 9), and different species of wrasse. Of the three sampling sites, the pier had the greatest variety of species (19 species) (Fig. 4).

2018 survey

A total of 55 species/taxa were recorded by *Seasearch* either on the new piles or swimming in proximity and/or on the seabed within 2m of the pier (Appendix 1). This represents just over half the total number of species seen in 2017, yet, 20 of these species had not been recorded the previous year. Some of these species, particularly the sea squirts *Ciona intestinalis* and *Ascidiella aspersa* can be early pioneering colonists.

Early stage community development was observed on the exposed steel sections including low densities of barnacles (*Balanus crenatus*), slipper limpet (*Crepidula fornicata*), keel worm (*Spirobranchus* sp.) and a uniform belt of mixed filamentous and foliose red algae with *Ulva* sp.

Of particular interest regionally was the first Isle of Wight and Solent record of the cushion starfish (*Asterina phylactica*). Sea squirts (*Ciona intestinalis* and *Ascidiella aspersa*) and bryozoans were present in low abundance; however, overall zonation on the piles was weak. The sand and gravel seabed around the base of the pilings was scoured by the strong currents, with exposed blue clay, debris and some aggregates that had fallen in to the scour pit. The dish around the piles may also have been caused by liquefaction of the substrate during pile driving, allowing for some erosion followed by silt infill from surrounding sediments.

Although access to the pier deck was not possible during construction, by May and June 2018, green algae (*Ulva* sp.) were visible in upper intertidal sections of the new wooden piles. A light-moderate, yet patchy settlement of the barnacle *Semibalanus balanoides* was also observed in June.

In July and August, spectacular numbers of bass were observed gaining shelter from piles during strong ebb flows on spring tides, (Fig. 9). The bass, along with large numbers of black-headed gulls, herring gulls and some

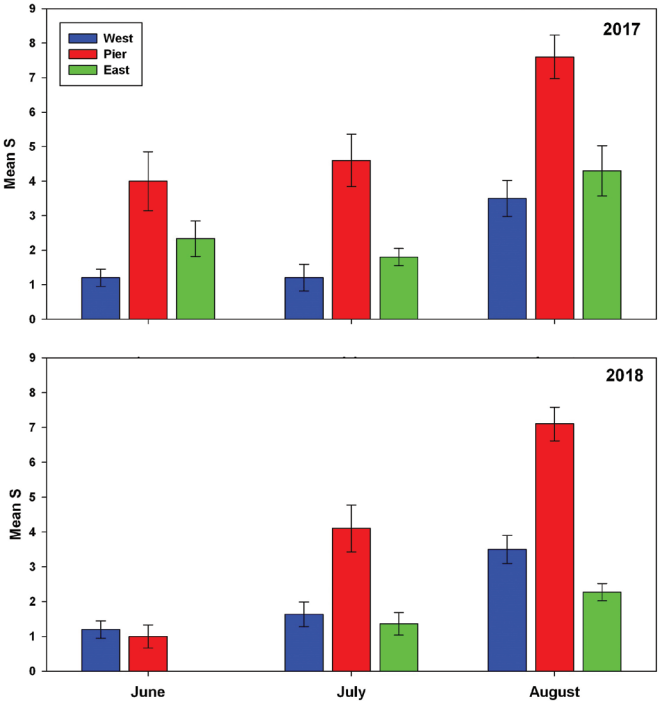

Fig 4: Mean species richness (S) of mobile fauna per 20 min deployment calculated from BRUV footage obtained at each sampling site in June, July and August 2017 and 2018 (there were no species recorded at the eastern control site in June 2018). Error bars show +/- SE.

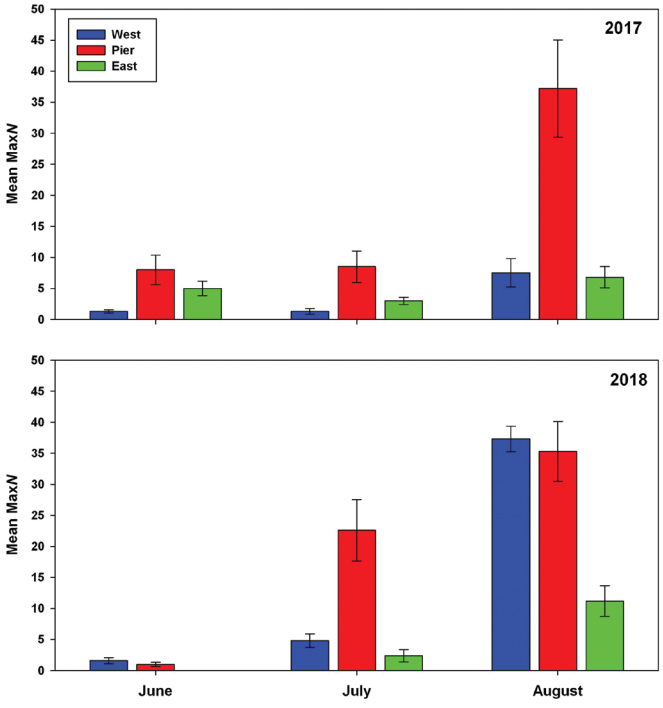

Fig 5: Mean *MaxN* (Mean maximum total No. of individuals of mobile fauna seen in 20 min deployment) calculated from video footage obtained at each sampling site in June, July and August 2017 and 2018. Error bars show +/- SE.

Fig 6: Edible crab (*Cancer pagurus*) at base of piles.
Photo A. Hall

Fig 7: Cuttlefish (*Sepia officinalis*) at the pier head.
Photo A. Hall

Fig 8: Pollack (*Pollachius pollachius*) and Bass (*Dicentrarchus labrax*) beneath the pier in September 2016. In the foreground is the bryozoan *Flustra folicaea* and colonial sea squirt *Botryllus schlosseri*.
Photo: A. Hall

Fig 9: Bass beneath the pier in September 2019.
Photo R.J.H. Herbert

common and sandwich terns, engaged in a feeding frenzy when shoals of bait fish were swept through the pier. In June and July, common terns that had captured prey in proximity to the pier were observed flying north across the Solent towards the Beaulieu River, where there is a small breeding colony

In 2017 and 2018, numbers of bass, pollack, corkwing wrasse and ballan wrasse were typically greater around the pier (Figs. 10 and 11).

Following replacement of piles at the pier head, a total of 29 mobile species were recorded from BRUV videos across the three sites (Appendix 2). These comprised four species not seen in 2017, including spurdog (*Squalus acanthias*), common smoothound (*Mustelus mustelus*), painted goby (*Pomatoschistus pictus*) and European anchovy (*Engraulis encrasicolus*). Again, the pier had the greatest variety of species recorded (19 species).

2019 survey

In total, *Seasearch* divers recorded fifteen species of seaweeds and twenty species of benthic and mobile fauna, including shanny (*Lipophrys pholis*), which was not found in 2017-2018 (Appendix 1). Three non-native species recorded; the Korean sea squirt (*Steyela clava*), wireweed (*Sargassum muticum*) and the cold-temperate circumpolar sea squirt (*Corella euymota*), which is previously unrecorded from Yarmouth.

The BRUV surveys yielded a total of 17 species of mobile fauna including five invertebrates. Four species of wrasse were observed, with corkwing being almost ubiquitous although never numerous. Bass were less frequent than in August 2018, yet pollack were more visible during hours of darkness and appeared to be attracted towards the torchlight, as were cuttlefish and red mullet. Species richness and abundance fluctuated significantly over both neap and spring tidal cycles. On the two neap tide days, species richness and abundance appeared to coincide with periods of higher current flow between low and high water; however this was less clear on spring tides. Sand smelt (*Atherina* sp.) were mainly observed during the flood tides and were most numerous during the neap tide flood on 23rd August. Conversely, bass were most prominent immediately after High Water on spring tides and present on the first part of the ebb (Fig.12).

At midnight, during a neap tide on 23rd August a mantis shrimp (*Rissoides desmaresti*) swam across the bait pole and disappeared down a burrow.

Discussion

There is no doubt the pier offers habitat to a relatively large number invertebrates and fish, which would otherwise either not be present at all, or be in much smaller numbers. The environment created by the pier is complex, and attributing benefits of the structure to specific mobile species is difficult. Yet the replacement of the pier head with new pilings offered a rare opportunity to examine this more closely. During the summer of 2018, the fauna and flora on the new pilings was not as diverse as that recorded on the older piles in 2017, although the coverage of green *Ulva* sp. and the red alga *Ceramium* sp. was already surprisingly high. Yet there was very little evidence for reduced abundance and diversity of associated mobile species in 2018 as a consequence.

Differences observed could equally be attributed to natural variation in populations, which is commonly seen in these habitats. Individual species will have 'good' and 'poor' years depending on variation in recruitment and survival. In both years, much of the species mobile assemblage was not unlike a shallow subtidal rocky reef, where a variety of species dominated by wrasse,

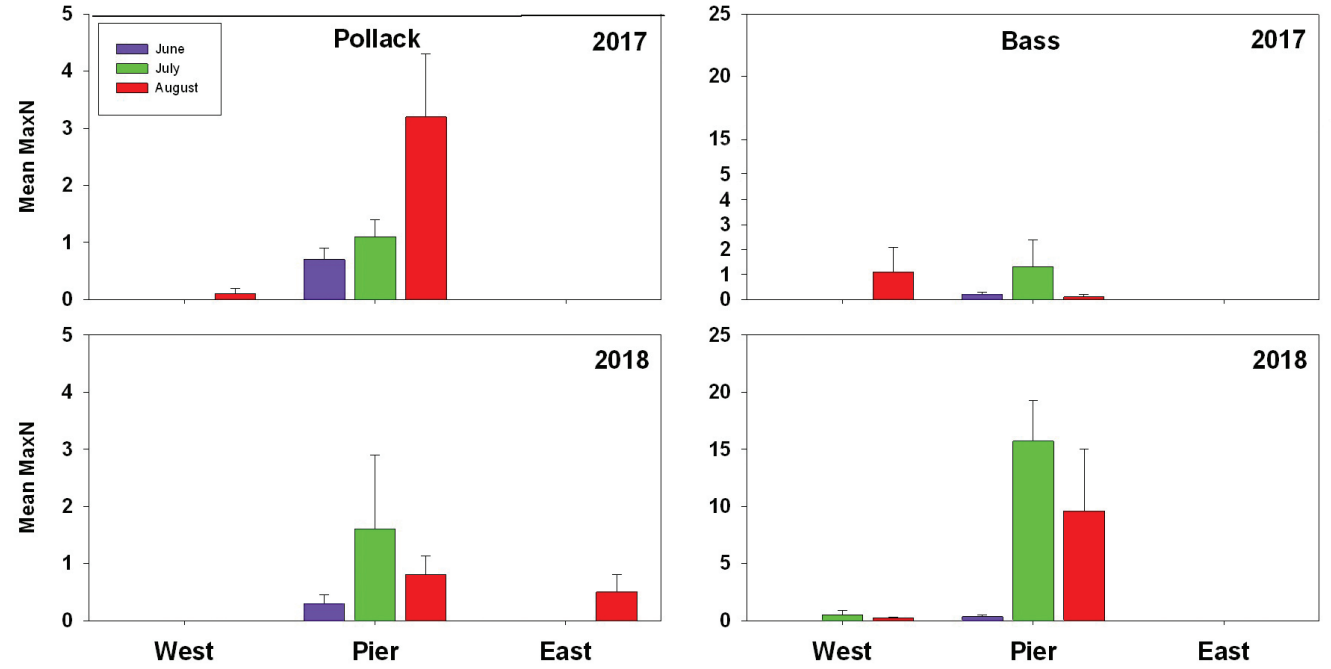

Fig 10: Mean *MaxN* pollack and bass recorded in 2017 and 2018. Values calculated from BRUV footage obtained at each sampling site in June, July and August 2017 and 2018. Note difference in axis scale for bass. Error bars show +/- SE.

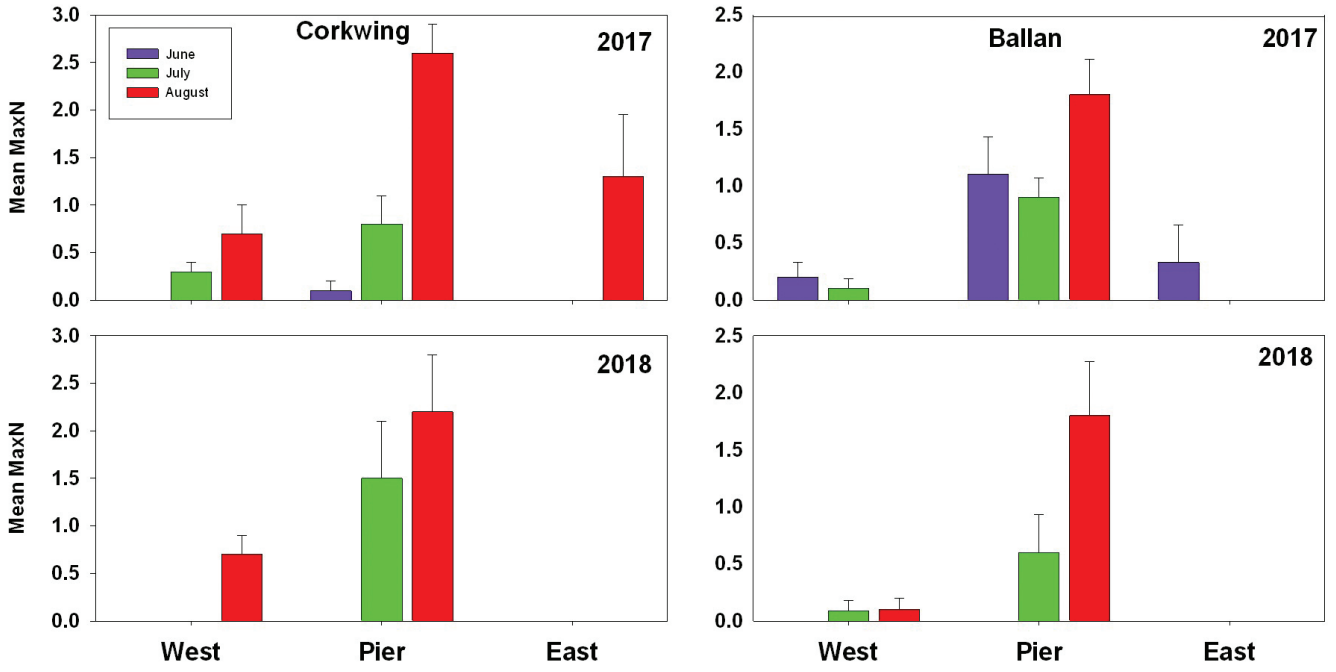

Fig 11: Mean *MaxN* corkwing wrasse and ballan wrasse recorded in 2017 and 2018. Values calculated from BRUV footage obtained at each sampling site in June, July and August 2017 and 2018. Error bars show +/- SE.

pouting and gobies, are also likely to be prevalent. The protection and shelter afforded by the piles might mimic boulders and overhangs in natural habitats, enabling species to gain shelter from strong currents, ambush prey and hide from predators. Planktivorous sand smelt appeared to benefit from moderate current flow beneath the pier, yet they were much less common on the ebb flowing tides than on the flood. It is possible this may relate to an inability to stem the faster current, or because of greater predation risk from bass and pollack which arrive at high water and can be dominant beneath the pier during the ebb.

As with natural habitats, some species may forage directly on the seabed. When viewing from the pier steps at low slack water, there were occasional observations of corkwing wrasse foraging on pile fouling. The seabed beneath the pier is different to the control sites, and consists of larger cobbles which may have rolled down with the tide and become trapped amongst the structure. There are broken sections of former piles and a whole array of items dropped by pier visitors, including mobile phones! This adds structural complexity to the seabed and provides habitat for crabs and smaller benthic algae and animals which are prey for larger species. Although there was localised disturbance of this habitat during re-construction, this appears not to have negatively affected the mobile fauna.

That bass arrived in considerable numbers in 2018 would indicate that it is shelter provided by the structure,

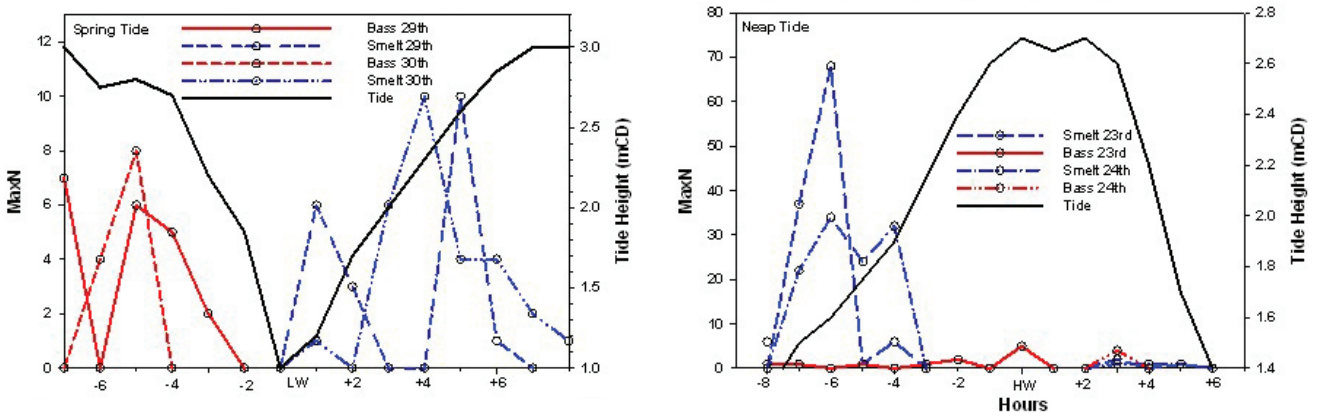

Fig 12: Changes in abundance (*MaxN*) of sand smelt and bass over spring and neap tide cycles. X-axis is hours before and after Low or High Water. Note different y-axis scales.

August 23rd Low Water 09:31 and 22:01; High Water at 17:06. Sunrise 06:04, Sunset at 20:10.
August 24th Low Water at 10:26 and 23:06; High water at 18:13. Sunrise at 06:06, Sunset at 20:07.
August 29th High Water at 10:35 and 22:45, Low Water at 16:20. Sunrise at 06:13, Sunset at 19:57.
August 30th High Water at 11:11 and 23:20; Low Water at 17:08. Sunrise 06:15, Sunset 19:55. All times DST.

and not the colonising benthos, which is of principal importance for this species. The pier's unique location and provision of shelter, in a region of particularly strong tidal currents, is important. The combined biological and hydrodynamic conditions created by the pier structure have established a beneficial feeding area for species of conservation importance.

Over the three years 2017-2019, a total of 135 different species taxa were recorded either on the pier structure or in immediate proximity in the water column or sea bed. Additionally, the lobster (*Hommarus gammarus*), hermit crab (*Paguridae* sp.) and spurdog (*Squalus acanthias*) was recorded at the BRUV control site to the east of the pier (RSYC mooring) and the scallop (*Pecten maximus*) to the west (YHC mooring). For such a small narrow transect, this is particularly notable and is one of the most detailed surveys of its kind (Intertidal, SCUBA and BRUV) undertaken in the Solent. The observation of the cushion star (*Asterina phylactica*) by *Seasearch* divers beneath the pier in August 2018 was of particular interest. This appears to be a new record for the Solent region and a significant range expansion east in the Channel. The native oyster (*Ostrea edulis*), a Species of Principal Importance (NERC Act 2006 Section 41), was recorded in both years on the seabed beneath the structure.

The discovery of the mantis shrimp (*Rissoides desmaresti*) in 2019 is, to the best of knowledge, the first record of active swimming behaviour 'in situ' around the English coast. The species has been recorded and photographed by divers in North Wales (Ramsay & Holt, 2001) and one specimen was seen beneath a rock in an intertidal pool at Bembridge in September 2011 (Herbert: personal records). Many have been dredged up as by-catch from oyster fishermen over the years (Herbert *et al.* 2011; Griffin *et al.* 2012). One specimen was caught by an angler at Yarmouth Pier in July 2012 using sand-eel as bait (Herbert: personal records). The species remains uncommonly recorded in the British Isles; however, its cryptic behaviour may disguise a much more widespread distribution.

Future work

The overall impression is that the life beneath the pier is rich and interesting and a habitat worthy of continued investigation. More research should be carried out on the diverse range of habitats in proximity to the pier and harbour entrance, including the seagrass beds and cobble beach beside Gossips café. Yarmouth is an ideal site to create a marine observatory due to the unique access provided for the general public; there are very few places in the Solent where one can 'walk over the water' and observe the strength of the ebbing spring tide below. The survey work was of great interest to the many visitors strolling along the pier and the new interpretation in the Round House is a great asset. A short video *Pier Beneath*, to be shown in the newly refurbished Round House, has been created from the BRUV footage obtained during the project.

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Appendix 1: Species recorded within different habitats of Yarmouth Pier 2017-2019.

Abundance: S - Superabundant; A - Abundant; C - Common; F - Frequent; O - Occasional; R - Rare; P - Present
See text for further details and Seasearch surveyor guidance available at:
http://www.seasearch.org.uk/downloads/Survformguide%202-14.pdf

		2017							2018	2019		
		Pile Sublittoral			Seabed			Pile Littoral		New piles	Sea bed	Old piles
Group	Species	Inner	Mid	Outer	Inner	Mid	Outer					
Lichen	*Xanthoria parietina*							P				
Algae	*Acrosorium ciliolatum*					O	P					
	Aglaothamnion tenuissimum	F			O							F
	Apoglossum ruscifolium											O
	Ascophyllum nodosum							P				
	Asparagopsis armata					R						
	Bryopsis plumosa				P							
	Calliblepharis ciliata			C	O	F	C		F	O	O	F
	Callophyllis sp.											F
	Carradoriella elongata								A			
	Ceramium nodulosum								A			
	Ceramium secundatum				O							
	Chaetomorpha sp.								O			
	Chondria capillaris				O							
	Chondria dasyphylla					O						
	Chondrus crispus					R						
	Cladophora sericea	R	R		R	R						
	Cladophora sp.								F			R
	Cladostephus spongiosus					O						
	Corallina officinalis								O			O
	Corallinacea sp.		O		F				O			
	Cryptopleura ramosa				O	O	O					O

		2017							2018	2019		
		Pile Sublittoral			Seabed			Pile Littoral		New piles	Sea bed	Old piles
Group	**Species**	Inner	Mid	Outer	Inner	Mid	Outer					
Algae *Continued*	*Delesseria sanguinea*					R						
	Desmarestia ligulata		O									
	Dictyota dichotoma				C	F	O		F	O		
	Dictyota spiralis				R							
	Fucus serratus					R		R				
	Fucus vesiculosus							P				
	Furcellaria/Polyides sp.								R			
	Gracilaria bursa-pastoris				O							
	Gracilaria gracilis				F	O	O					
	Gracilaridae sp.								F			
	Grateloupia subpectinata						P					
	Grateloupia turuturu						P					
	Griffithsia corralinoides								P			
	Halarachnion sp.								O			
	Halidrys siliquosa			C		O	O					
	Halopithys incurva				F							
	Halurus equisetifolius				F		R					C
	Halurus flosculosus	F	C		F							C
	Heterosiphonia plumosa			O	O	F	O			O		
	Hypoglossum hypoglossoides				P				P			
	Laminaria digitata				O	O						
	Metacallophyllis laciniata					O						
	Naccaria wiggii					O						
	Osmundea sp.	O			O							
	Palmaria palmata								O			F
	Plocamium cartilagineum				O							
	Plocamium sp.					O	O		F			
	Red crusts (on shell)						P					
	Rhodymenia holmesii				R							
	Saccharina latissima				R	O	F		R			
	Saccorhiza polyschides	R	R									
	Sargassum muticum			O	C	O	F		O	O		
	Symphocladiella parasitica				R							
	Ulva lactuca				O							
	Ulva sp.				F	O	O	P				C
	Vertebrata byssoides		P									
Plants	*Zostera marina*					O			R			
Porifera	*Amphilectus fucorum*		R									P
	Cliona celata		R									
	Dysidea fragilis	O	O						O			
	Halichondria panicea		O							F		C
	? *Hymeniacidon perlevis*								R			
	Porifera crusts	O		O	R							P
	Sycon ciliatum								R			
Cnidarians	*Aglaophenia* sp.								O			
	Anemonia viridis								P			
	Sertularella cf. *rugosa*						P					
	Hydrallmania falcata				R	R			R			
	Hydrozoa sp.								C/O			
Annelids	*Spirobranchus triqueter*				O					F		
Crustacea	*Austrominius modestus*	F						P				
	Balanus crenatus								O			
	Cancer pagurus						R					
	Carcinus maenas				R							
	Cirripedia				O							
	Inachus sp.						P					
	Ligia oceanica							P				
	Maja brachydactyla				R		O					
	Necora puber				O	O	O		O		C	
	Perforatus perforatus							P				
Molluscs	*Semibalanus balanoides*							P	O			
	Calliostoma zizyphinum								R	O		
	Crepidula fornicata				O	O	O					
	Littorina littorea							P				
	Littorina saxatilis							P				

		2017							2018	2019		
		Pile Sublittoral			Seabed			Pile Littoral		New piles	Sea bed	Old piles
Group	Species	Inner	Mid	Outer	Inner	Mid	Outer					
Molluscs *Continued*	*Nucella lapillus*				R			P				
	Ocenebra erinaceus				O							
	Ostrea edulis				O	O	O					
	Rissooidea sp.								F			
	Patella vulgata			O				P				
	Sepia officinalis						R					
	Sepiola atlantica						P					
	Steromphala sp.				R	R						
	Steromphala cineraria								O			
	Steromphala umbilicalis							P				
	Thecacera pennigera	R										
	Tritia reticulata					R	O					
Bryozoans	*Amathia lendigera*	C			P							
	Bugula sp.		R			R						
	Chartella papyracea	C	O									
	Crisiidae sp.			P								
	Electra pilosa	O		O								
	Flustra foliacea	F	F	A					R	O		
	Obelia geniculata						O					
	Parasmittina trispinosa	R		R								
	Scrupocellaria/Tricellaria sp.				C				F			
Echinodermata	*Asterina phylactica*								R			
Ascidians	*Ascidiella aspersa*								O			O
	Botryllus schlosseri								R			
	Botrylloides leachii									O		
	Botryllus schlosseri				R		R					
	Ciona intestinalis								R			
	Clavelina lepadiformis		R									
	Corella eumyota									F		
	Dendrodoa grossularia		R		R				R			
	Didemnum maculosum	R										
	Diplosoma cf.*listerianum*				P							
	Molgula sp.								O			
	Polycarpa errans								F			
	Styela clava		R									
Pisces	*Atherina* sp. (Sand smelt)					P						
	Callionymus sp. (Dragonet)					R						
	Ctenolabrus rupestris (Goldsinny wrasse)						O					
	Gobius sp. (Goby)					R						
	Gobiusculus flavescens (Two-spot goby)				R							
	Labrus bergylta (Ballan wrasse)	O							O			
	Lipophrys pholis (Shanny)									O		
	Parablennius gattorugine (Tompot blenny)								R			
	Pollachius pollachius (Pollack)	O					A					
	Pomatoschistus sp. (Goby)					O	R		O			
	Pomatoschistus minutus								O			
	Spondyliosoma cantharus (Black bream)								O			
	Syngnathus acus (Greater pipefish)								R			
	Symphodus melops (Corkwing wrasse)	O	O			O			O			
	Trisopterus luscus (Bib)		O			O	C					

Appendix 2: Mobile species recorded using BRUV at each of the three survey sites in 2017, 2018 and 2019. Values are *MaxN* recorded with single BRUV unit and 20 minute soak time in June, July, August (2017, 2018) and August only in 2019.

			2017			2018			2019
Group	**Common Name**	**Scientific Name**	**West Control**	**Pier**	**East Control**	**West Control**	**Pier**	**East Control**	**Pier**
Cnidaria	Moon jellyfish	*Aurelia aurata*				1	1		
Crustacea	Edible Crab	*Cancer pagurus*	1	1	1		1		1
	Green shore Crab	*Carcinus maenas*		1					
	Hermit Crab	Paguridae sp.			3	1		1	
	Lobster	*Hommarus gammarus*			1			1	
	Spider Crab	*Macropodia rostrata*				1		1	
	Spiny Spider Crab	*Maja brachydactyla*	2	2	3	3	1	3	1
	Velvet swimming crab	*Necora puber*	2	2	1		3		3
	Mantis shrimp	*Rissoides desmaresti*							1
Mollusca	Great Scallop	*Pecten maximus*	1						
	Common Cuttlefish	*Sepia officinalis*			1				1
	Netted Dog Welk	*Tritia reticulata*	1		7	1		6	
Fish	Sand smelt	*Atherina* sp.	21	52					68
	Golden grey mullet	*Chelon aurata*		1					1
	Thin lipped mullet	*Chelon ramada*				1			
	Corkwing Wrasse	*Symphodus melops*	3	5	7	2	7		4
	Goldsinny wrasse	*Ctenolabrus rupestris*	10				3		
	Bass	*Dicentrarchus labrax*		11		4	52		6
	Anchovy	*Engraulis encrasicolus*				195	421		
	Black Goby	*Gobius niger*		1	1	1			
	Goby Two spot	*Gobiusculus flavescens*		1			2		1
	Ballan Wrasse	*Labrus bergylta*	1	4	2	1	5		2
	Cuckoo wrasse	*Labrus mixtus*					1		
	Red Mullet	*Mullus surmuletus*				2	2	3	1
	Common smoothound	*Mustellus mustellus*					1		
	Tompot Blenny	*Parablennius gattorugine*		2			1		1
	Pollack	*Pollachius pollachius*	1	12			13		4
	Common goby	*Pomatoschistus microps*			2	2	1		
	Sand Goby	*Pomatoschistus minutus*	1	1		3	1		
	Painted Goby	*Pomatoschistus pictus*						1	
	Black bream (Adult)	*Spondyliosoma cantharus*	2	4	6	3	3	21	7
	Black bream (Juv)	*Spondyliosoma cantharus*				47	33	27	
	Spurdog	*Squalus acanthias*						1	
	Ballons Wrasse	*Symphodus bailloni*		1					
	Gurnard sp.	Triglidae		1				1	
	Bib (pout)	*Trisopterus luscus*		29	1		2		8
TOTAL			**12**	**18**	**13**	**16**	**20**	**11**	**16**