Report to The Bromley Trust

RAS 2014 Non-Native Species Rapid Assessment Surveys in English Marinas

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February 2015

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Project details

This report describes the current distribution of NNS in marinas on the coast of S England, comparing it to data from previous surveys from 2009/10. The data is of relevance to monitoring and pathway management obligations under the Marine Strategy Framework Directive (MSDF) and to assessing the feasibility of granting exemptions under the Ballast Water Management Convention. The information will be of value to government departments, non-departmental public bodies, environmental charities and other organizations concerned with environmental policy and management of NNS.

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Acknowledgements

We are grateful to the Bromley Trust for supporting this research.

This project was part funded by Natural England and The Marine Biological Association of the UK. The surveys of thirteen marinas in SW England were carried out in 2013 and were funded by: a Defra 'INNS Pathways' project collaboration with Cornwall Wildlife Trust; an EU Interreg IVA grant (Marinexus); and The Marine Biological Association of the UK. We are grateful to Helen Jenkins for assisting on some surveys, Paul Clark at the Natural History Museum for confirming the identification of *Hemigrapsus takanoi*, and Charly Griffiths for producing the site map. We would also like to thank all the marinas for permitting access, and in particular Port Hamble Marina for letting us use the marina during the NNS workshop.

Confidentiality

 We have used codes for the localities because some marina operators did not wish their establishments to be explicitly named.

Executive Summary

Non-native species (NNS) introduced beyond their natural geographical range by human activities pose major threats to native biodiversity, human health and ecosystem services. It is therefore an urgent priority to minimize new introductions and reduce secondary spread of non-natives. Accordingly, NNS are a focus of good environmental status in the Marine Strategy Framework Directive and the subject of a European Regulation on the prevention and management of the introduction and spread of invasive alien species.

Ports and harbours provide sheltered artificial habitats associated with potential vectors including shipping and aquaculture activities, and are thus prime sites for the arrival and establishment of marine NNS. Marinas, frequent along the coast and often present close to or within ports, are important stepping-stones for secondary spread but have also been documented as points of primary entry.

This project was intended to update the distribution of NNS in marinas on the southern English coast and to raise awareness of NNS amongst marina and aquaculture operators through outreach interactions in marinas and an NNS workshop.

Previous surveys dating from 2009/10 (Bishop et al., in press), and subsequent work in SW England has documented rapid recent changes (Bishop et al. 2014), suggesting that a resurvey elsewhere on the south coast would reveal extensive shifts. Thirty marinas were subjected to rapid assessment surveys (RAS) in 2014 for the Bromley Trust/Natural England project, and data combined with that from 13 RAS already undertaken in 2013.

Thirty-three NNS were recorded during the surveys, 53% of sites having 12 or more NNS (Appendix V). The commonest seven NNS occurred at more than 30 of the sites, a sites—occupancy equivalent to our most common native fouling organisms. Three NNS considered to be new arrivals since the 2009/10 surveys were recorded, including the first UK occurrences of the Asian brush-clawed crab, *Hemigrapsus takanoi* and the golden membrane weed, *Chrysymenia wrightii*. In addition, the carpet sea squirt, *Didemnum vexillum* was recorded in Sussex, distant from its previously known populations. Amongst previously known NNS, particularly rapid colonization of new sites was documented by the red ripple bryozoan, *Watersipora subatra* and the compass sea squirt, *Asterocarpa humilis*. The number of NNS recorded at each site rose between the 2009/10 and 2013/14 surveys at 27 out of 32 sites that were revisited, falling in only one; this trend reflected an increase in four years of 27% in the number of NNS site records in comparable surveys. A picture is gained of ongoing arrival of NNS and their rapid spread through the marina network.

Recommendations regarding future monitoring include surveys along the remaining coast of England to complete the picture of distribution and prevalence of NNS, and further work to determine the relationship between the prevalence of NNS in marinas and site properties such as salinity levels, depth, degree of enclosure and size and age of the development. This information could inform the planning of marina developments.

A well-attended workshop was held at The Royal Southern Yacht Club in Hamble on 7 October 2014, with the aim of raising awareness amongst key stakeholder groups of marine NNS and the problems they present. The attendees included Environmental Officers from two large marina companies (MDL and Premier) and representatives from The Green Blue. The workshop received very good feedback. This feedback and direct discussion with

participants and those at two similar events in Wales during summer 2014 gave us considerable insight into appropriate NNS and biosecurity training tailored separately for marina management staff and for site workers, and incorporation of relevant information into existing accredited training schemes.

This project led to a number of other opportunities to raise awareness of marine NNS and biosecurity, including participation in the formulation of initiatives by the All Party Parliamentary Group on Biodiversity regarding non-native species, input into the list of marine NNS of EU concern, and presentation of survey data at the Marine Pathways conference (see Section 5).

Contents

List of tables

List of figures

1. Introduction

Non-native species (NNS) are a threat to native biodiversity, human health and ecosystem services. Accordingly, managing their means of spreading to minimize new introductions and reduce secondary dispersal is a global priority. NNS are a focus of good environmental status in the Marine Strategy Framework Directive (European Commission, 2008) which requires that NNS "are at levels that do not adversely alter the ecosystems". Sheltered artificial habitats provided by ports and harbours are prime sites for the arrival and establishment of NNS; marinas are important stepping-stones for secondary spread within a new bioregion (Clarke Murray et al. 2011) and may also act as points of primary entry (Bax et al. 2002; Griffith et al. 2009). Coastal ports, harbours and marinas are frequently located in transitional waters of river mouths and estuaries where introduced species can spread seaward or into river systems, according to their environmental requirements.

Marinas are priority sites for monitoring, being 'hotspots' for the occurrence of NNS (Arenas et al. 2006; Campbell et al. 2007; Mineur et al. 2012) and thus focal points for assessing the effectiveness of pathway management measures. Their floating pontoons allow access to shallow subtidal biota at any state of tide.

This project was intended to update the distribution of NNS in marinas on the English coast. Our previous surveys date predominantly from 2009 (Bishop et al., in press), and our subsequent work in SW England has documented rapid recent changes there (Bishop et al. 2014), suggesting that a resurvey elsewhere on the south coast after 5 years would reveal extensive shifts. The data will be of relevance to monitoring and pathway management obligations under the MSFD and to assessing the feasibility of granting exemptions under the Ballast Water Management Convention. The information will be of value to conservation charities, government departments, non-departmental public bodies and other organizations concerned with environmental policy and management of NNS.

There is very limited awareness amongst key stakeholder groups of marine NNS and the problems they present to local biodiversity and ecosystem services such as shellfisheries. Awareness raising and training are vital steps in developing a feeling of responsibility for the environmental effects of maritime activities among relevant stakeholders (the leisure boating industry and its customers, aquaculture, ports and harbours), thereby influencing behaviour.

This project had the following aims:

- To complete rapid assessment surveys (RASs) of marinas, harbours and aquaculture sites around the English coast to assess the current distribution and rate of spread of non-native species (NNS).
- To train Wildlife Trust staff and other interested parties in the identification of NNS and recording procedures.
- To raise awareness of NNS amongst marina and aquaculture operators through outreach interactions in marinas and an NNS workshop for interested stakeholders covering identification of NNS and guidance on biosecurity. (Biosecurity in this context is defined as taking action in order to minimise the introduction or spread of NNS.)

2. Surveys

2.1. Methodology - surveys

A target list of 32 non-native marine species was drawn up comprising a mixture of species previously identified in marina environments in the UK and species identified as likely arrivals from horizon scanning; descriptions of these species are given at Appendix I. 30 marina sites along the coast were selected, generally avoiding brackish sites. These sites were surveyed for the presence of non-native species between June and November 2014; a further 13 marinas had already been surveyed in 2013/14 under other funding. A map showing all sites surveyed is shown at Figure 1 and a list of the sites is included as Appendix II.

The surveys were carried out following the Rapid Assessment Survey protocol detailed in Appendix III; this methodology has been used in marinas throughout the UK over a number of years. In addition many native species were recorded. Interested stakeholders accompanied us at some sites to observe the methodology and/or improve their NNS identification skills; a list of these observers is given in Table 1.

While visiting the marinas outreach conversations were initiated with marina operators and interested yacht owners with the aim of raising awareness of NNS. Waterproof copies of the recently revised *Identification Guide for Selected Marine Non-Native Species*, see http://www.mba.ac.uk/bishop/non-native-species-guides/, and posters of NNS were handed out.

The specimens collected during the surveys were inspected later in the laboratory to make or confirm identifications.

Table 1: Natural England and Environmental Agency staff who attended surveys

Name	Role	Site visited
Ian Humpheryes	EA Senior Environmental Monitoring Officer	KENT2
Marija Nilova	NE Marine Adviser	HAMP3
Marija Nilova	NE Marine Adviser	HAMP4
Miriam Knollys	NE Senior Marine Adviser	HAMP2
Hilary Crane	NE Coastal Land Management Adviser	HAMP1
Sue Burton	NE Conservation Adviser	DORS3
Maxine Chavner	NE Marine Adviser	DORS3
Liz Bailey	NE Marine Adviser	DEV10
Liz Bailey	NE Marine Adviser	DEV9

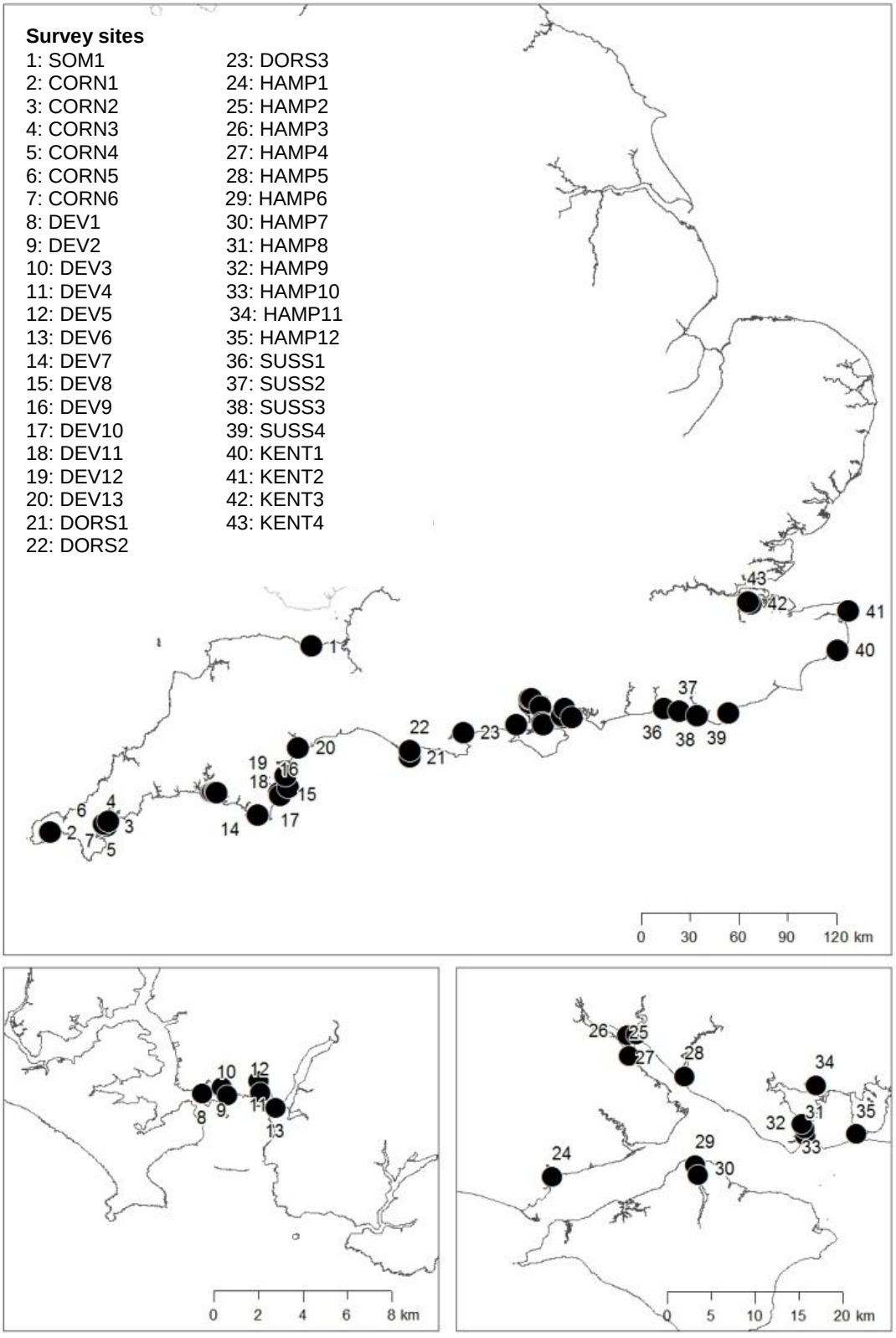

Figure 1: Locations of marinas surveyed for NNS in 2013/2014

2.2. Results - surveys

The detailed NNS occurrence data is given in Appendix V. The environmental measurements of salinity, temperature and turbidity are reported in Appendix IV. A comparison between these survey results and those from 2009/10 is shown at Appendix VI. All NNS species records and some native species records have been entered into Marine Recorder and transferred to Natural England. The survey metadata has been entered into MEDIN. The process of making this data publicly available via NBN Gateway has begun.

Species accounts

A total of thirty-three different marine NNS were recorded during the surveys, the most frequently occurring being the orange-tipped sea squirt *Corella eumyota,* Darwin's barnacle *Austrominius modestus*, the tufty-buff bryozoan *Tricellaria inopinata*, the ruby bryozoan *Bugula neritina*, and the leathery sea squirt *Styela clava*, all being present at 33 or more of the 43 sites, see Figure 2. This level of site occupancy is equivalent to that seen for our most common native fouling organisms such as the fluted sea squirt *Ascidiella aspersa*, the vase sea squirt *Ciona intestinalis* Type B, the bryozoan *Cryptosula pallasiana* and the purse sponge *Sycon ciliatum*.

The only species not recorded from the target list was the American oyster drill *Urosalpinx cinerea.* Two NNS not on the target list were also recorded, the Asian brush-clawed crab *Hemigrapsus takanoi* and the tube worm *Hydroides ezoensis.*

Three species are considered to be new arrivals since the 2009/10 surveys, the Asian brush-clawed crab *Hemigrapsus takanoi*, the golden membrane weed *Chrysymenia wrightii* and the orange ripple bryozoan *Schizoporella japonica*. The first two of these were new records for the UK.

The species shown to be spreading most rapidly are the red ripple bryozoan *Watersipora subatra* and the compass sea squirt *Asterocarpa humilis*.

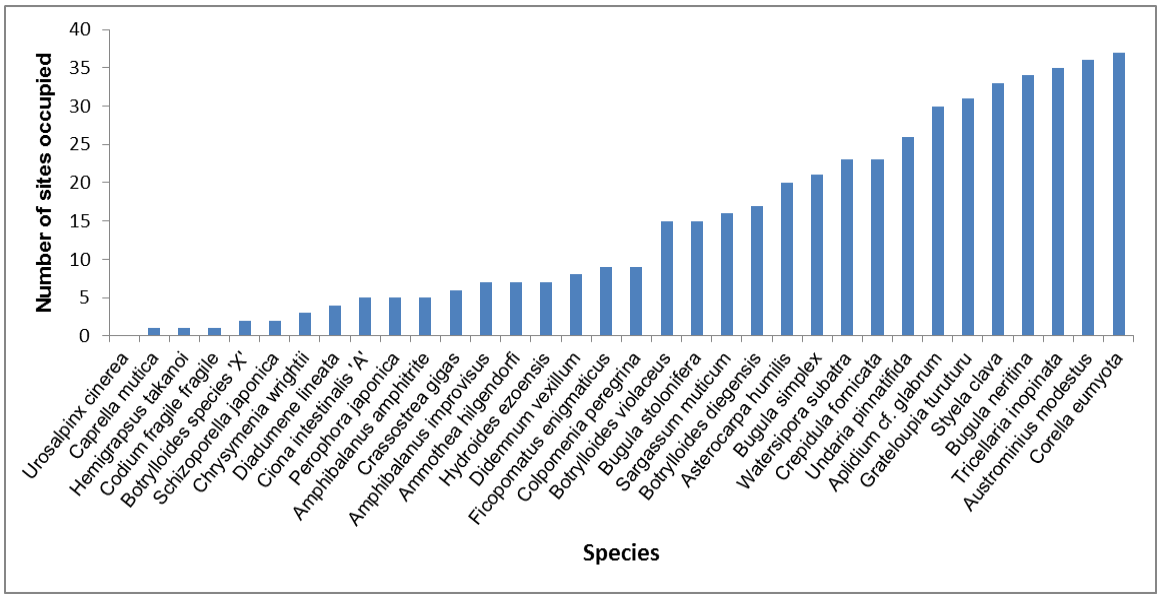

Figure 2: Frequency of occurrence of 34 NNS at 43 sites along the S coast of England

Hemigrapsus takanoi (Asian brush-clawed crab)

Here we report the first UK record for *Hemigrapsus takanoi* the Asian brush-clawed crab, from Gillingham marina (Wood et al., in press). A single crab was found on a rope hanging from a floating pontoon. It was removed and sent to Paul Clark at the Natural History Museum for confirmation of the identification. It has a European distribution from N Spain to Denmark with particularly dense populations around Boulogne-sur-mer and Dunkirk (Dauvin et al. 2009; Landschoff et al. 2013, Figure 1). Roy et al. (2014) considered *H. takanoi* to be one of the top ten species most likely to impact on biodiversity but not yet established in GB. It is considered a threat to the native shore crab *Carcinus maenas* (Dauvin et al. 2009). Subsequently an earlier record has come to light from Brightlingsea, Essex (Wood et al., in press).

Figure 3: *Hemigrapsus takanoi*, Gillingham Marina. Image: C. Wood

Didemnum vexillum (Carpet sea squirt)

In 2009 Defra funded surveys mapped the occurrence of the carpet sea squirt *D. vexillum* in England. At that time it was recorded from the Solent region (3 marinas in Gosport, 1 in Lymington and 1 in Cowes), 1 marina and a number of other pontoons on the R. Dart, Devon, and 1 marina in Plymouth. These records were detailed in unpublished reports to Defra. It was discovered in SE England along the N Kent coast in 2011 (Hitchen 2012).

During the 2014 surveys a single colony was found and removed from a Sussex marina, SUSS2; this is some distance from the previously known occurrences in Kent and Gosport. It was also recorded at an additional marina in the Southampton area, HAMP3. It was not found in Plymouth or the R. Dart, although a small colony was found in the R. Dart in 2012. *D. vexillum* was also present at the Kent aquaculture site visited; that population is being monitored by the Environment Agency.

Figure 4: *Didemnum vexillum*, Sussex. Image: J. Bishop

Asterocarpa humilis (Compass sea squirt)

The compass sea squirt *Asterocarpa humilis* was first discovered in Salcombe and Weymouth in 2009 (Bishop et al. 2013); it has spread rapidly, now having a range in England from Cornwall to Sussex and the species has recently been found in Wales and Scotland. We found it at 14 sites during these surveys; the comparison with 2009/10 shows an increase from 4 to 14 sites.

Figure 5: Asterocarpa humilis, Plymouth. Image: J.Bishop

Watersipora subatra (Red ripple bryozoan)

The red ripple bryozoan *Watersipora subatra* was previously referred to as *Watersipora subtorquata*. In these surveys it was documented in 23 marinas. This species has shown the largest increase in site occupancy since 2009/10, from 4 to 19 of the 32 revisited sites. Its range has been extended westward from Plymouth to West Cornwall and eastwards from Gosport to Sussex, with progressive infilling between them. This rapid spread supports the supposition that this species is a recent arrival.

Figure 6: *Watersipora subatra*, Plymouth. Image: J. Bishop

Schizoporella japonica (Orange ripple bryozoan)

This encrusting bryozoan was first recorded in the UK at Holyhead marina in 2010 (Ryland et al. 2014). This species is spreading rapidly in Scotland, particularly around Orkney, but in England is currently only present in Plymouth, where it was first recorded in 2012 (Bishop et al., in press). In these 2013/14 surveys it was only found in two Plymouth marinas, DEV1and DEV2, where it was abundant.

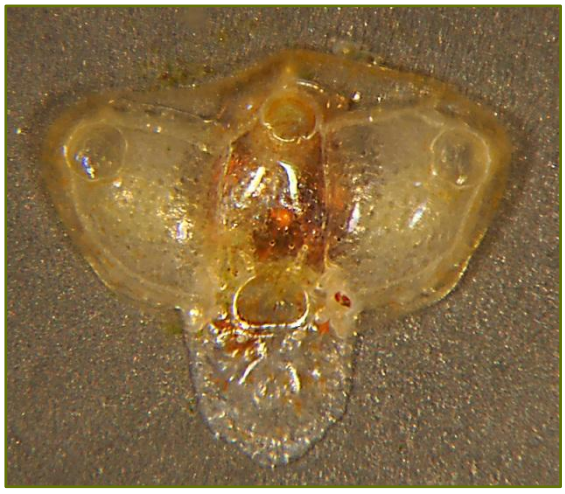

Figure 7: Early stage of *Schizoporella japonica*, Plymouth. Image: J. Bishop

Tricellaria inopinata (Tufty-buff bryozoan)

This erect bryozoan has spread extremely rapidly since the first UK record in 1998, now being found all around the UK coast and also on some natural shores. It was present in 35 of the 43 sites surveyed in 2013/14, and rated as abundant at 21 of them (Appendix V). This probably represents maximum occupancy of suitable sites.

Ficopomatus enigmaticus (Trumpet tube worm)

The trumpet tube worm *Ficopomatus enigmaticus,* was recorded at nine of the sites visited. There has been an increase in occupancy from 4 to 8 of the comparable sites surveyed in 2009/10. The increase in abundance and number of sites occupied by this species may be due to the mild wet winter and hot summer as *F. enigmaticus*, a temperate/warm temperate species, is thought to be at the limit of its range for maintaining populations and sexual reproduction on the S English coast (Zibrowius and Thorp 1989). This species can be a severe fouling nuisance; we have observed this ourselves this summer in Swansea and have received requests for information and guidance from marinas in Portishead, Whitehaven and the R. Itchen.

Figure 8: *Ficopomatus enigmaticus* fouling a rope in Swansea. Image: C. Wood

Chrysymenia wrightii (Golden membrane weed)

The golden membrane weed *Chrysymenia wrightii*, a red alga, was first encountered in the UK at 3 marinas in Falmouth, during the 2013 Defra/CWT surveys which contributed to this report (Bunker 2014). It is possible this species is present elsewhere; we collected putative specimens from Hampshire, but the identity could not be confirmed.

Figure 9: Chrysymenia wrightii, Falmouth. Image: F. Bunker

Site accounts

Our experience of carrying out nearly 200 surveys in over 70 marinas in the UK and Brittany, over the last 10 years, leads us to suggest that the susceptibility of a marina to invasion by new NNS is dependent on a number of factors, including but not limited to:

- Closeness to a major port or ferry terminal as a source of propagules.
- Salinity levels, average and variability: In general it appears that marinas which are fully saline and are subject to only infrequent and minor salinity excursions harbour more NNS than brackish water sites or those subject to regular fluctuations e.g. in an estuary. However some NNS are highly tolerant of such conditions and may out-compete native species resulting in dominance of a site by a single NNS. However the long-term monitoring of salinity in this habitat using probes presents difficulties due to the high level of fouling.
- Depth: Shallow water sites may dry out during low tides; they are also susceptible to greater temperature fluctuations during summer and winter, which may kill off some species. Deeper waters can provide refuges from low salinity events as the waters are often highly stratified with the fresh water forming a surface layer over a higher-salinity base layer. NNS may survive at depth on ropes, chains and pilings and then recolonize surface structures rapidly at a later date.
- Degree of enclosure: Lock-gated marinas can be subject to salinity fluctuations if rainwater is retained or there are storm drains which feed into the basin. There is also a factor of larval retention within more enclosed marinas which may lead to larger populations of NNS developing.
- Size and age of marina development.

The total number of NNS records generated from these surveys was 494. The mean number of NNS recorded at the survey sites was 11.5 (range 3-19), with 53% of sites having 12 or more NNS, see Figure 10.

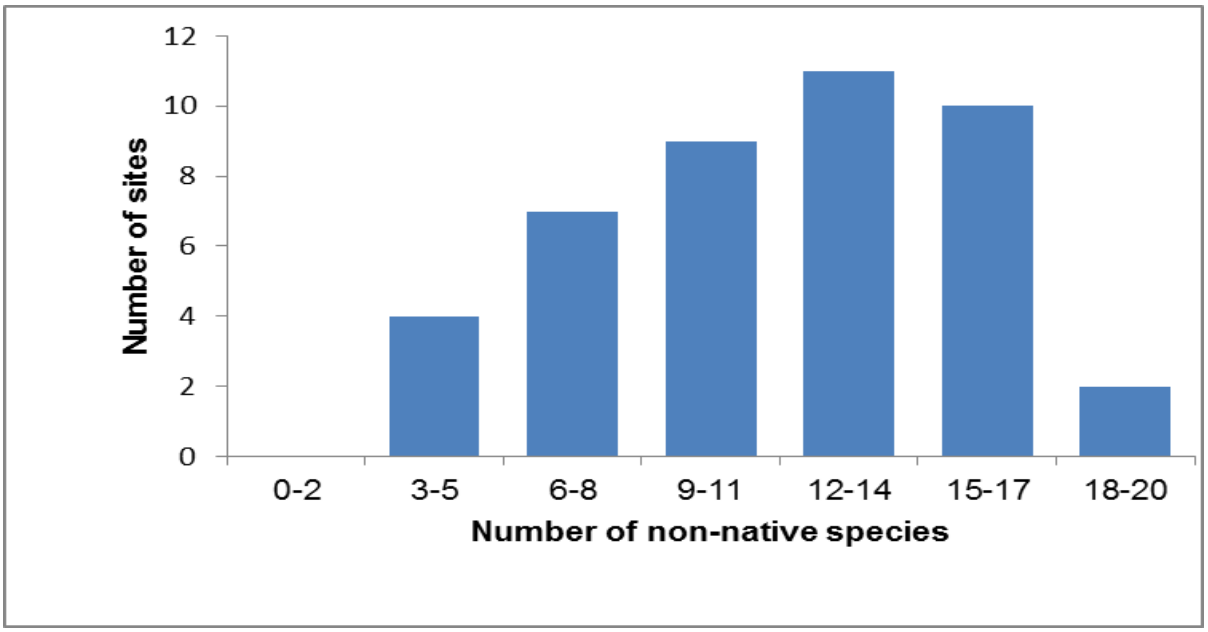

Figure 10: Frequency distribution of sites on S England coast in terms of number of NNS recorded per site.

The sites with the highest number of NNS were HAMP8 (19); DORS2 (18); HAMP5, HAMP4 and HAMP3 (all three in Southampton) (16); and DORS3 (16); see Figure 11 and Appendix V. All of these sites are near to major ports. The sites with the lowest occupancy are SUSS3 (3), KENT4 (4), DEV13 (5) and KENT3 (5). One possible explanation for this is that they all have low or fluctuating salinities, see Appendix IV. Other possible contributing factors are that KENT4, DEV13 and KENT3 have lock gates, and SUSS3 is shallow. However HAMP5, a marina which is on an estuary, has one of the highest numbers of NNS, possibly because it has deep water which provides refuges for NNS.

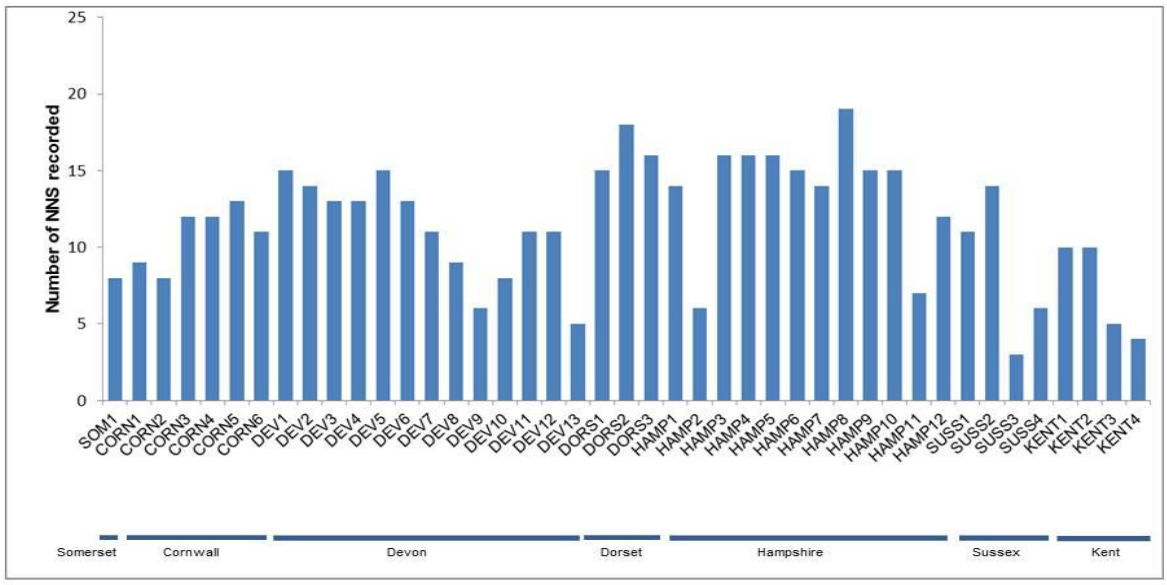

Figure 11: Counts of NNS recorded at sites around coast of S England

Figure 12: South coast marina. Image: J. Bishop

Trends

For the 32 sites and 20 species common to the 2009/10 and 2013/14 surveys, the total number of NNS records rose from 260 to 330, an increase of 27% in four years, see Appendix VI. A summary of the changes, detailed in the species accounts, in the number of sites occupied by species is shown in Figure 13. Figure 14 shows the same information analysed by site, this clearly shows that at the majority of sites there has been an increase in the numbers of different NNS recorded (27 of 32),falling in only one.

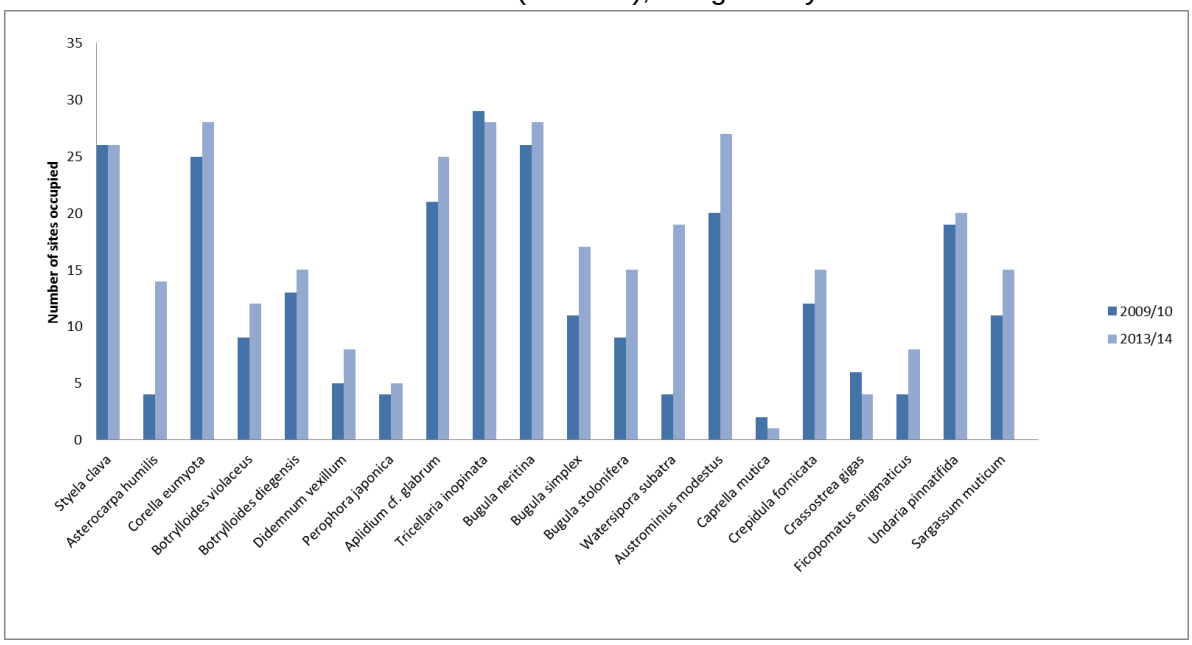

Figure 13: Change in occurrences of 20 species at 32 sites from 2009/10 to 2013/14

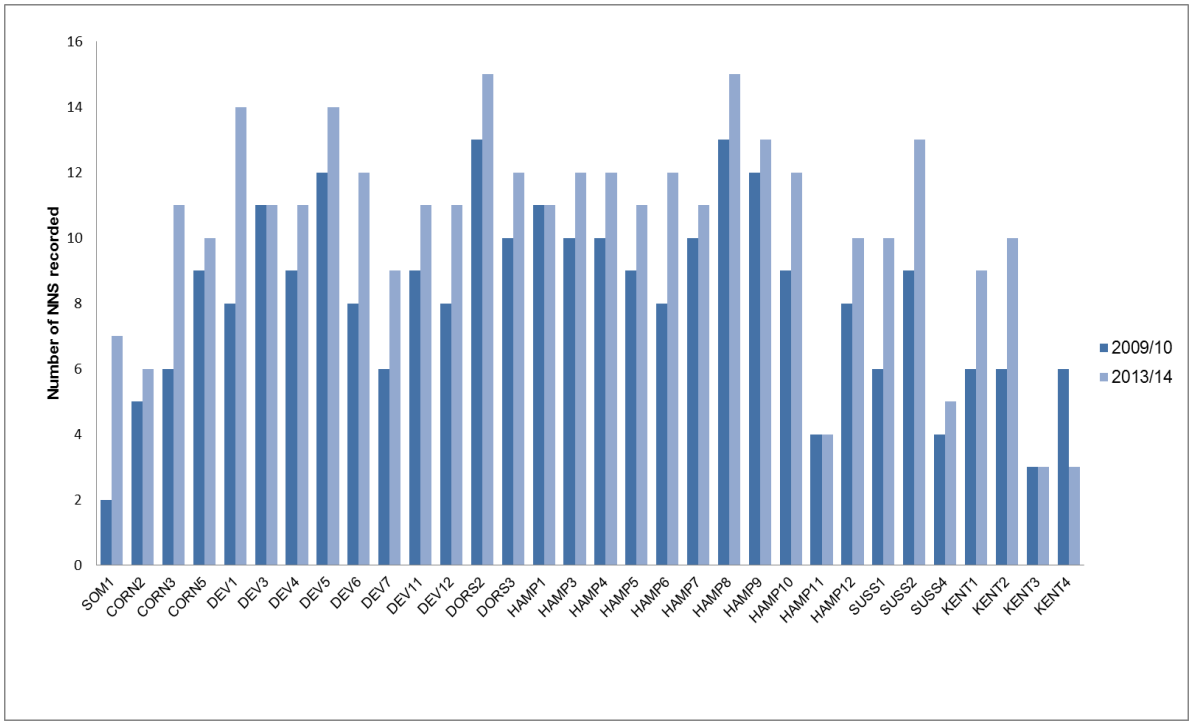

Figure 14: Change in numbers of 20 NNS at 32 sites from 2009/10 to 2013/14

2.3. Discussion - surveys

The most significant observations resulting from the RAS were:

- The arrival of the Asian brush-clawed crab *Hemigrapsus takanoi*, the orange ripple bryozoan *Schizoporella japonica* and golden membrane weed *Chrysymenia wrightii*; these species are currently very restricted in their range in England and attempts at eradication or the introduction of control measures might be considered.
- The ongoing colonisation of additional sites by species already recorded in the 2009/10 surveys, in particular the red ripple bryozoan *Watersipora subatra* and the compass sea squirt *Asterocarpa humilis.* The spread of such species could be monitored to check the effectiveness of pathway management.
- It is also apparent that some NNS are so widespread and common that any attempts at control are unlikely to be successful. In the area surveyed these species are occupying virtually all suitable sites. Examples are: the orange-tipped sea squirt *Corella eumyota*, Darwin's barnacle *Austrominius modestus*, the tufty-buff bryozoan *Tricellaria inopinata*, the ruby bryozoan *Bugula neritina* and the leathery sea squirt *Styela clava*.

Figure 15: Explaining NNS guide. Image: C. Wood

Comparable surveys were carried out in 14 marinas in Wales in 2014. A much higher proportion of the Welsh sites were brackish, shallow or lock-gated, which may at least in part explain the much lower mean of 4.5 NNS per site (range 1-10). It is unfortunate that it was not possible to secure sufficient funding to include sites in NW, E and NE England, to enable a more complete picture of the UK distribution and prevalence of NNS to be drawn.

Subsequent to the surveys we have supplied the data for MDL and Premier marinas to their respective Environmental Officers, who attended the workshop. The MDL Environmental Officer had requested this information, which is an indication that the workshop was successful in engaging their interest. We will be following up with them as to how useful they found the information to be.

It is recommended that:

- Funding is made available to permit the surveying of artificial habitats in East Anglia, NW and NE England in 2015, to provide a more coherent account of the UK distribution of NNS.
- Further work be undertaken to better understand the relationship between the prevalence of NNS and site properties such as salinity levels, depth, degree of enclosure, size and age of the development.
- Consideration be given to eradication or the introduction of control measures for *Hemigrapsus takanoi*, *Schizoporella japonica* and *Chrysymenia wrightii*.
- Relevant staff and voluntary groups who work on the shore are made aware of the presence of *Hemigrapsus spp.* in the UK. They should be encouraged to collect,

photograph and freeze any putative specimens. Potential finds should be reported to Paul Clark at the Natural History Museum who may wish to take samples for DNA analysis to use in determining the source population.

- Marina operators are informed about the levels of NNS in their marinas.

3. Aquaculture sites

3.1. Site visit - Kent

An information-gathering visit was made to an oyster hatchery in Kent, close to the area where the carpet sea squirt *Didemnum vexillum* is present on the natural shore. All stages of the production process were observed, including phytoplankton production, hatchery, nursery and maturation of oysters for market. This site was known to have *D. vexillum* present in some areas. During discussions with the owner regarding problems with NNS or fouling in general it appeared that green algae were a significant problem in the ponds, whereas *D. vexillum* was currently only a minor inconvenience. Potential control mechanisms worth exploring were also discussed. The Environment Agency is aware of the presence of *D. vexillum* and monitors the site regularly.

Figure 16: Aquaculture site in Kent. Image: C. Wood

3.2. Other sites

It was planned to visit a second site, a mussel farm in Falmouth. However, following an initial discussion with the owner, this visit was cancelled due to the closure of the area for shellfish harvesting due to an outbreak of *E.coli.* An alternative aquaculture site in Exmouth was identified, a meeting held, and an offshore site visit arranged. Unfortunately, subsequent bad weather prevented this visit from taking place. It is planned to visit both sites in spring 2015 to record the presence of NNS and discuss further with the owners any problems they have with NNS.

4. Workshop

4.1. Description

A workshop was organised for marina operators, port operators and other stakeholders with the aim of raising awareness of NNS. The training included: identification of NNS specific to marinas and aquaculture, including some predicted invaders; a practical session with an extensive selection of live and preserved specimens; a trip to a marina to view organisms in situ; biosecurity guidance; and information on how to report sightings using established recording schemes.

The workshop was held at The Royal Southern Yacht Club in Hamble on 7 October 2014 and the visit was to Port Hamble Marina. The course was advertised via a range of media and organisations including: email flyers (see Appendix VII) to marina operators, aquaculture firms, offshore energy organisations, Wildlife Trusts, local councils, etc.; The Green Blue (the joint environment programme created by the British Marine Federation and Royal Yachting Association); twitter messages via the MBA, ShoreThing and Porcupine; the MBA and Bromley websites.

Figure 17: Hamble workshop. Image: C. Wood

Two more workshops with a very similar format were held in Wales in June and July 2014; these were attended by marina operators, off-shore energy workers and a range of other stakeholders. These workshops were funded by a grant from the Resilient Ecosystems Fund administered by Natural Resources Wales (NRW). Free places were offered to stakeholders from SW and NW England as well.

We have subsequently attended advanced training in marine biosecurity, to ensure we are providing the very best advice to the marine sector.

4.2. Discussion - workshop

The workshop was well attended and received very good feedback; a summary is given in Appendix VIII. The attendees included Environmental Officers from two large marina companies (MDL and Premier) and representatives from The Green Blue. Discussions with them and with attendees at two workshops held in Wales in 2014 led to the following recommendations:

- Training for marina management should focus on biosecurity and practical advice; they are less interested in NNS ID (C. Wood is attending further training in biosecurity in February).
- NNS ID and awareness training is best delivered to marina workers on-site in small groups and should focus on easily recognisable species for which actions would be required e.g. horizon species.
- Some biosecurity training should be incorporated into existing accredited training schemes for marina staff.

As a result of discussions with The Green Blue staff at the workshop we have subsequently assisted them in a number of ways, including:

- Provision of 80 waterproof copies of the recently revised *Identification Guide for Selected Marine Non-Native Species*, see www.mba.ac.uk/bishop/non-native-species-guides/.
- Provision of materials for use in accredited training of marina staff.
- Provision of images of NNS and advice for posters and leaflets, including one for use during sailing holidays around the Greek Islands.
- Guidance on acquisition of acrylic embedded specimens and preparation of preserved specimens for use in displays at boat shows.

Figure 18: Workshop attendees at Port Hamble Marina. Image: The Green Blue

5. Additional actions

The grant from The Bromley Trust which enabled us to carry out the surveys and run the workshop has also contributed directly or indirectly to the following actions:

- The survey data was presented at the Marine Pathways conference in Cardiff on 25th February 2015, emphasising the general prevalence of non-native species in marinas and the rapid increase in recent years documented in the 2014 surveys - see poster reproduced as Appendix IX. (This conference addressed the identification and management of pathways of human-assisted dispersal of non-native species, and was convened by the relevant government departments / agencies and attended by the relevant NGOs including WWF and the Wildlife Trusts.)
- We were invited to attend a meeting of the All Party Parliamentary Group on Biodiversity, focusing on the issue of non-native species, at the House of Commons in July 2014. We contributed to the discussion, particularly concerning the UK Government's failure to ratify the international Ballast Water Management Convention. Following the meeting, the APPG sent a letter, to which we contributed sections presenting two arguments for ratification, to the Environmental Audit Committee urging ratification of the treaty. Further contributions to APPG Biodiversity discussions on non-native species have been made in subsequent telephone conferences.
- We provided advice to Cefas (Centre for Environment, Fisheries & Aquaculture Science, an executive agency of Defra) on the draft target list of marine non-native species for monitoring under the EC Marine Strategy Framework Directive, suggesting the substitution of irrelevant or problematic species on the draft list with more suitable species, for which we provided supporting information. This spring JDB will participate as a lead expert for marine species in the process determining the list of Species of Union Concern in the EU Regulation on Invasive Alien Species.
- We provided comments and feedback to Natural England on their draft Invasive Species Theme Plan for the Improvement Programme for England's Natura 2000 Sites (IPENS: http://www.naturalengland.org.uk/ipens2000).
- We produced a Welsh version of our *Identification Guide for Selected Marine Non-Native Species* and revised and enlarged versions in English and French, see http://www.mba.ac.uk/bishop/non-native-species-guides/ , and distributed waterproof hard copies to a wide range of stakeholders.
- We produced an identification guide to early growth stages of fouling marine invertebrates, including some images from specimens collected during surveys, freely available online for use by environmental managers, researchers and students monitoring for the occurrence of NNS, see http://www.mba.ac.uk/bishop/early-stages/.
- We contributed NNS factsheets for new non-native species found in the surveys to the Great Britain Non-native Species Secretariat website, http://www.nonnativespecies.org/home/index.cfm , and updated distribution data for earlier species on the same website.
- A scientific paper on the distribution of NNS around England prior to these surveys is in press. A follow-up paper is being drafted to record the recent marked changes documented in the surveys and will be submitted within six months.
- We undertook advanced training to enable us to provide the best, up-to-date biosecurity advice to marina operators, yacht owners and aquaculture sites in future workshops.

- We contributed to a section on NNS in the Salcombe Harbour guide which provides information to all visitors to the Salcombe/Kingsbridge estuary.

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Appendix I: Target list of non-native species

Non-native species	Description	Level of Threat
Styela clava (Leathery sea squirt)	Solitary, stalked ascidian native to NW Pacific. First recorded in UK 1953 in Plymouth Sound, Devon (Carlisle 1954). Widespread in the UK for some decades.	Detrimental to aquaculture in some world regions, but may increase biodiversity per unit area of substrate.
Asterocarpa humilis (Compass sea squirt)	Solitary ascidian native to S Hemisphere. First recorded in UK in 2009 in SW England (Bishop et al. 2013).	Recently recognised, and spreading rapidly in England, potential fouler of aquaculture equipment, clumps could clog pipes, potential competitor for food and space with cultured bivalves. Now entering natural habitats.
Ciona intestinalis Type A	Solitary ascidian, very similar in appearance to native species Type B. Considered native to the NW Pacific. Currently known only from the SW coast, Newlyn to Torquay (Nydam and Harrison 2011). For distinguishing features see Sato et al. (2012).	Recently distinguished; threat to biodiversity – 'cryptic' species, potentially hybridises with native Type B; fouler of aquaculture equipment (as is Type B); competes for food with farmed species such as mussels and oysters.
Corella eumyota (Orange-tipped sea squirt)	Solitary ascidian, widespread throughout cooler waters of southern hemisphere. First recorded in the UK on the S coast in 2004 (Arenas et al. 2006). Now present throughout the UK.	Widespread in UK, forms large clumps, potential fouler of aquaculture equipment; entering natural habitats.
Botrylloides violaceus (Orange cloak sea squirt)	Colonial ascidian native to NW Pacific. Grows on hard substrates as well as mussels, solitary ascidians and algae. First recorded in UK 2004 on the SW English coast (Arenas et al. 2006).	Widespread in UK, threat to biodiversity and aquaculture through smothering, could block inlet pipes; entering natural habitats.
Botrylloides diegensis (San Diego sea squirt)	Colonial ascidian native to the W coast of N America. First recorded in UK in 2004 on the S English coast.	Spreading in England, threat to aquaculture through smothering.
Botrylloides sp. X	Colonial ascidian, origin and identity unknown.	Recently distinguished. Effects unknown.
Didemnum vexillum (Carpet sea squirt)	A colonial ascidian thought to be native to NW Pacific region (Lambert, 2009). First recorded in UK 2008 in Holyhead Marina (Griffith et al. 2009).	Local threat to biodiversity and local aquaculture through smothering. Thought to be a high impact invasive due to its rapid fouling abilities.

Perophora japonica (Creeping sea squirt)	A colonial ascidian of NE Asian origin, first recorded in Plymouth in 1999 (Nishikawa et al. 2000). Presently occurs in only a limited number of sites in SW and S England, although widespread in France. A record from Milford Haven in 2002, included on various Web sites, was based on a mis-identification.	Starting to appear in natural habitats e.g. off Norfolk coast; Salcombe estuary, Devon; Helford estuary, Cornwall; Strangford Lough, N Ireland.
Aplidium cf. *glabrum*	A colonial ascidian, similar in zooidal morphology to native Aplidium glabrum, but found in warmer waters than are typical of the native species (Millar 1966). Origin and identity unknown.	Widespread in UK, threat to biodiversity and aquaculture through smothering, could block inlet pipes; entering natural habitats.
Tricellaria inopinata (Tufty-buff bryozoan)	An erect bryozoan native to temperate Pacific. Capable of enduring a wide spectrum of temperatures and salinities, as well as high organic content. Settles on a wide range of anthropogenic and natural substrata. First recorded in UK 1998 on S English coast (Dyrynda et al. 2000).	Widespread in UK. Fouling nuisance and can affect biodiversity; entering natural habitats.
Bugula neritina (Ruby bryozoan)	A purplish-brown bryozoan that forms erect, bushy growths. Present from SW Scotland around Welsh and English coasts to Lowestoft. First recorded in c.1911 but by late 1990s was thought to be no longer present, a rapid recolonization has since occurred (Ryland et al. 2011).	Widespread in UK, can affect biodiversity. An abundant fouling organism that colonies a variety of sub-tidal substrata including artificial structures and vessel hulls.
Bugula simplex	Erect straw coloured bryozoan that forms funnel-shaped colonies. Thought to be native to eastern seaboard of N America or the Mediterranean. Few UK records (Ryland et al. 2011).	Effect unknown.
Bugula stolonifera	Greyish-buff erect bryozoan which forms short compact tufts. Native to the Atlantic and Mediterranean. Known from S Wales and a few isolated English sites (Ryland et al. 2011).	Effect unknown.

Watersipora subatra (Red ripple bryozoan)	Previously referred to as *Watersipora subtorquata.* An orange/red encrusting bryozoan from the S Hemisphere. Occurring from the lower intertidal to shallow sub-tidal. First recorded in Plymouth in 2008 (Ryland et al. 2009), it is now known from Plymouth to Poole Harbour, and in France from Brittany and Bordeaux.	Tolerant to copper based antifoulants. Spreading rapidly in England. It is highly invasive and has become common on coastlines throughout global cool-temperate waters since the 1980s.
Schizoporella japonica (Orange ripple bryozoan)	A bright orange encrusting bryozoan native to the N Pacific. Recorded in Holyhead marina in 2010, only other UK records are from Scotland and Plymouth (Ryland et al. 2014).	Recently recognised as an invasive species. Can form encrustations on ships, piers, buoys and other man-made structures in harbours and marinas. May compete for space with native species and S. japonica is known to inhibit the growth of adjacent species.
Diadumene lineata (Orange-striped anemone)	Small orange-striped anemone, native to Pacific. Probably introduced from Japan into the Atlantic towards the end of the 19th century. Distributed around Britain and throughout continental Europe (Stephenson, 1935; Williams 1975).	Effect unknown.
Austrominius modestus (Darwin's barnacle)	Four-plated barnacle native to Australasia, first recorded in UK in 1946 (Crisp 1958).	Widespread throughout UK, competes for space with native barnacles. This species has largely displaced other barnacles in estuaries in SW Britain although impacts are less significant on exposed rocky shores.
Amphibalanus amphitrite (Striped barnacle)	Species of acorn barnacle native to SW Pacific and Indian Oceans. First recorded in UK in 1937 in Shoreham Harbour, Sussex (Bishop 1950). Populations have been found in S England and S Wales.	Now occurring on S coast of England. Can be a fouling nuisance on yacht hulls and equipment.
Amphibalanus improvisus (Bay barnacle)	Smooth, white or pale grey, 6-plated barnacle with a cosmopolitan distribution. First recorded in the UK by Darwin in 1854. Tolerant of brackish waters.	May dominate and outcompete native species, especially for available habitat. It can be a nuisance through fouling of ships' hulls, water inlet pipes, aquaculture products and equipment and other submerged structures.
Caprella mutica (Japanese skeleton shrimp)	Amphipod native to NE Asia. First recorded in the UK in 2000 from a salmon farm in Oban, Scotland (Willis et al. 2004).	Widespread, serious threat to native skeleton shrimp populations even at low densities. On the west coast of Scotland, their abundance can reach 300,000 individuals m^{-2}. It has the potential for significant impacts on benthic communities.

Ammothea hilgendorfi (Japanese sea spider)	Pycnogonid native to N Pacific. Thought to be introduced as hull fouling from Japan. First recorded in the UK in Southampton Water in 1978 (Bamber 1985; Bamber 2012).	Preys on hydroids and anemones.
Crepidula fornicata (Slipper limpet)	Medium sized gastropod native to E coast of the Americas from Canada and Mexico. British population was introduced in 1890 in association with imported oysters (Eno et al. 1998).	Habitat alteration, threat to biodiversity and aquaculture. Now a pest in commercial oyster beds.
Urosalpinx cinerea (American oyster drill)	A gastropod native to E coast USA. First recorded in Essex oyster grounds in 1927 (Orton and Winckworth 1928). Now widely distributed across Essex and Kent coasts.	Threat to aquaculture through feeding on bivalves. It is a major pest to the commercial oyster industry preying heavily on both native and introduced oyster species. It feeds preferentially on oyster spat and has been reported to decimate stocks of oyster spat in some estuaries.
Crassostrea gigas (Pacific oyster)	A bivalve mollusc with thick, rough shells. Occurs naturally in Japan and SE Asia. First introduced from Portugal into the River Blackwater, Essex, in 1926 (Utting and Spencer 1992). Re-introduced in 1965 to Conwy, North Wales (MAFF quarantine) from the USA and British Columbia (Walne and Helm 1979).	Displacement of native oysters; reef formation leading to habitat alteration.
Ficopomatus enigmaticus (Trumpet tube worm)	A tube worm of unknown origin. Occurs in warm and temperate regions of both S and N hemispheres. Originally observed in London Docks in 1922 (Monro 1924), it favours coastal brackish waters.	Aggregations can change the geomorphology of the local ecosystem by altering hydrodynamic and sediment characteristics, and provide complex habitat for benthic species. May enhance water quality by removing particulate matter, but also reported to increase eutrophication in some instances. The tubes can be a fouling nuisance and block pipes.
Hydroides ezoensis **NOT ON ORIGINAL TARGET LIST**	A tube worm thought to originate from Japan, indigenous to NW Pacific. First recorded in UK from Southampton Water in 1976 (Thorp et al. 1987).	Aggregations can be a nuisance, fouling harbour structures and ships' hulls. May provide habitat for free-living and sessile invertebrates.

Hemigrapsus takanoi (Asian brush-clawed crab) **NOT ON ORIGINAL TARGET LIST**	A small crab native to the NW Pacific. Occurs on muddy and rocky shores and in sheltered estuaries and port area. First UK record 2014 from R. Medway and Brightlingsea (Wood et al., in press).	Threat to biodiversity as it competes with native shore crab *Carcinus maenas*.
Undaria pinnatifida (Wakame)	Large brown alga indigenous to temperate regions of Japan, China and Korea. Grows on hard substrates from low intertidal to approx. 18 m. Tolerant of salinities as low as 20 (Wallentinus 2007). First recorded in UK June 1994 in the Solent (Fletcher and Manfredi 1995).	Competes for space with native kelp species. May be a nuisance fouling jetties, vessels, moorings and buoys.
Sargassum muticum (Wireweed)	Large brown alga indigenous to Japan and NW Pacific. Grows on hard substrates in shallow water down to approx. 5 m. First recorded in UK 1971 in Isle of Wight (Farnham et al. 1973).	Overtops and shades native seaweeds. Fouling hazard to yachts.
Grateloupia turuturu (Devil's tongue weed)	Large red alga found growing on hard substrates down to 2 m below low water mark. Native to Pacific, probably Japan. Probably introduced to UK by spores travelling in ballast water. First recorded at Southsea beach in the Solent, in 1969 (Farnham and Irvine 1973).	Threat to native red algae, the large, broad blades may shade neighbouring species.
Codium fragile fragile (Green sea fingers)	Green seaweed with spongy finger-like branches. Native to the Pacific Ocean: Japan and Korea. In GB it was first recorded from the Yealm Estuary, Devon in 1939, growing on oyster shells (Silva 1955).	Has the potential to compete with native species for space, forming dense assemblages and potentially altering community structure. A nuisance to fisheries and aquaculture, particularly on NW Atlantic shores, it fouls nets and may attach to uplift and move commercially produced shellfish and seaweed.
Colpomenia peregrina (Oyster thief)	Brown alga forming inflated thin-walled hollow spheres. Native to the Pacific Ocean. Introduced to Cornwall and Dorset from France in 1907 (Cotton 1908).	May smother native species; can attach to oysters, become air-filled and buoyant then float away with the animal.

Appendix II: Details of marinas surveyed

Marina code	County	Survey*	Date of survey
SOM1	Somerset	Bromley/NE 2014	30/06/2014
CORN1	Cornwall	Bromley/NE 2014	09/11/2014
CORN2	Cornwall	Defra/CWT 2013	02/09/2013
CORN3	Cornwall	Defra/CWT 2013	02/09/2013
CORN4	Cornwall	Defra/CWT 2013	02/09/2013
CORN5	Cornwall	Defra/CWT 2013	03/09/2013
CORN6	Cornwall	Defra/CWT 2013	03/09/2013
DEV1	Devon	Defra/CWT 2013	04/09/2013
DEV2	Devon	Bromley/NE 2014	17/10/2014
DEV3	Devon	Defra/CWT 2013	01/09/2013
DEV4	Devon	Defra/CWT 2013	01/09/2013
DEV5	Devon	Defra/CWT 2013	01/09/2013
DEV6	Devon	Defra/CWT 2013	02/09/2013
DEV7	Devon	Bromley/NE 2014	28/08/2014
DEV8	Devon	Bromley/NE 2014	03/09/2014
DEV9	Devon	Bromley/NE 2014	03/09/2014
DEV10	Devon	Bromley/NE 2014	03/09/2014
DEV11	Devon	M'exus RAS 2013	18/07/2013
DEV12	Devon	M'exus RAS 2013	18/07/2013
DEV13	Devon	Bromley/NE 2014	12/09/2014
DORS1	Dorset	MBA 2013	29/11/2013
DORS2	Dorset	Bromley/NE 2014	26/09/2014
DORS3	Dorset	Bromley/NE 2014	26/09/2014
HAMP1	Hampshire	Bromley/NE 2014	25/09/2014
HAMP2	Hampshire	Bromley/NE 2014	25/09/2014
HAMP3	Hampshire	Bromley/NE 2014	23/09/2014
HAMP4	Hampshire	Bromley/NE 2014	25/09/2014
HAMP5	Hampshire	Bromley/NE 2014	24/09/2014
HAMP6	Hampshire	Bromley/NE 2014	24/09/2014
HAMP7	Hampshire	Bromley/NE 2014	24/09/2014
HAMP8	Hampshire	Bromley/NE 2014	06/10/2014
HAMP9	Hampshire	Bromley/NE 2014	08/08/2014
HAMP10	Hampshire	Bromley/NE 2014	08/08/2014
HAMP11	Hampshire	Bromley/NE 2014	19/09/2014
HAMP12	Hampshire	Bromley/NE 2014	07/08/2014
SUSS1	Sussex	Bromley/NE 2014	07/08/2014
SUSS2	Sussex	Bromley/NE 2014	07/08/2014
SUSS3	Sussex	Bromley/NE 2014	06/08/2014
SUSS4	Sussex	Bromley/NE 2014	06/08/2014
KENT1	Kent	Bromley/NE 2014	06/08/2014
KENT2	Kent	Bromley/NE 2014	05/08/2014
KENT3	Kent	Bromley/NE 2014	05/08/2014
KENT4	Kent	Bromley/NE 2014	04/08/2014

* Defra/CWT 2013 = Defra funded 'INNS Pathways' project collaboration with Cornwall Wildlife Trust; M'exus RAS 2013 = Interreg IVA funded cross-channel Marinexus project; MBA 2013 = Marine Biological Association funded.

Appendix III: Rapid assessment survey (RAS) protocol

Surveys were undertaken at any state of tide from the surface (i.e. from floating pontoons, without diving or snorkelling). Each marina was contacted in advance for permission to undertake the survey and to enable preparation of any required documentation or safety requirements. For the majority of surveys JDB, CAW and ALEY visited each marina as a team to conduct the RAS. At each site, the available pontoons were apportioned equally between the three staff, who worked independently for one hour. In addition to inspection of the pontoons themselves, submerged artificial substrates such as hanging ropes, keep cages, fenders, etc., and natural substrates such as kelps were pulled up and examined. Hooks and scrapers were used if necessary to access material for inspection. The 15-minute interval (1-15, 16-30, 31-45, 45-60 min) in which each target species was first encountered was recorded, and an estimate of abundance made on a three-point scale ([Not recorded], Rare-occasional, Frequent-common, Abundant-superabundant). Specimens were collected to substantiate significant findings, or for discussion. At the end of the hour the staff gathered to compare notes and record joint summary observations on a standard form. Specimens were discussed and relaxed prior to preservation if required for laboratory identification or as tokens of significant records. Salinity and temperature were recorded using a YSI 30 meter.

An assessment of the adequacy of the one-hour search interval was made by checking that the rate of discovery of new taxa had fallen to a very low level by the fourth 15-minute interval. Additional time was added when necessary at larger or more complex sites.

On completion of the survey all equipment was washed with a disinfectant and then rinsed in fresh water to prevent transfer of NNS between sites.

Appendix IV: Environmental measurements

Marina code	Salinity (surface)	Salinity (2m)	Temperature ^{0}C (surface)	Temperature ^{0}C (2m)	Turbidity Secchi depth (m)
SOM1	29.1	29.1	19.0	18.1	
CORN1	35.4	35.7	13.4	13.5	1.8
CORN2	35.1	35.1	17.6	17.2	
CORN3	35.0	35.1	18.1	17.6	
CORN4	35.3	35.2	17.2	17.1	
CORN5	34.0	34.5	17.3	17.2	
CORN6	35.6	35.2	18.2	17.2	
DEV1	34.4	34.8	17.0	16.9	
DEV2	30.9	31.2	15.5	15.4	2.2
DEV3	35.0	34.9	17.1	16.9	
DEV4	35.2	34.9	17.7	17.4	
DEV5	33.7	34.1	16.5	16.5	
DEV6	34.2	34.2	18.6	17.1	
DEV7	34.8	34.7	17.4	17.1	1.9
DEV8	32.4	32.3	17.7	17.6	1.2
DEV9	32.4	33.8	17.5	17.0	1.8
DEV10	33.2	34.4	17.2	16.9	2.2
DEV11	35.7	35.3	21.1	19.6	
DEV12	35.7	35.4	19.2	18.7	
DEV13	33.3		18.5		
DORS1	35.4	35.3	9.7	9.7	
DORS2	34.0	35.3	18.0	17.6	2.6
DORS3	32.9	33.8	17.1	17.2	1.8
HAMP1	34.6	34.4	17.5	16.9	2.0
HAMP2	31.6	31.5	17.7	17.5	3.4
HAMP3	31.6	31.7	18.4	18.4	2.6
HAMP4	28.0	32.3	16.5	18.1	2.4
HAMP5	26.6	27.1	17.7	17.6	1.0
HAMP6	34.5	34.5	18.0	18.0	1.8
HAMP7	34.5	34.5	18.1	18.1	0.5
HAMP8	35.1	35.1	16.1	16.2	1.0
HAMP9	34.9	34.9	20.7	20.8	1.8
HAMP10	34.9	34.9	21.2	21.2	2.0
HAMP11	33.4	34.5	18.9	18.8	
HAMP12	34.9	34.6	22.4	22.3	1.2
SUSS1	33.9	33.8	22.4	21.7	2.4
SUSS2	34.7	34.9	20.5	20.5	2.0
SUSS3	30.4	34.3	21.7	19.9	0.9
SUSS4	35.0	35.0	21.7	21.7	1.8
KENT1	17.0	33.3	17.2	19.0	1.2
KENT2	34.5	34.4	21.1	20.6	2.2
KENT3	28.0	27.9	21.6	21.5	3.6
KENT4	27.4	27.3	21.8	21.7	2.6

Note: All environmental measurements refer to the dates of surveys given at Appendix II

Appendix V: Occurrence of fouling NNS at 43 sites on the English coast in 2013/14

	ASCIDIANS										BRYOZOANS						OTHER ANIMALS												ALGAE						
SITE CODE	Styela clava	Asterocarpa humilis	Ciona intestinalis 'A'	Corella eumyota	Botrylloides violaceus	Botrylloides diegensis	Botryloides species 'X'	Didemnum vexillum	Perophora japonica	Aplidium cf. glabrum	Tricellaria inopinata	Bugula neritina	Bugula simplex	Bugula stolonifera	Watersipora subatra	Schizoporella japonica	Diadumene lineata	Austrominius modestus	Amphibalanus amphitrite	Amphibalanus improvisus	Caprella mutica	Crepidula fornicata	Urosalpinx cinerea	Crassostrea gigas	Ficopomatus enigmaticus	Ammothea hilgendorfi	Hydroides ezoensis	Hemigrapsus takanoi	Undaria pinnatifida	Sargassum muticum	Grateloupia turuturu	Codium fragile fragile	Colpomenia peregrina	Chrysymenia wrightii		Total species
SOM1	0	0	0	1	0	0	0	0	0	0	3	0	1	1	0	0	0	3	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0		8
CORN1	2	2	1	2	0	0	0	0	0	0	2	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0		9
CORN2	0	1	0	1		0	1	0	0	0	2	2	1	0	0	0	1	1	0	0	0	0	0	0	1?	0	0	0	0	0	0	0	0	0		8
CORN3	2	1	0	3	1	0	1?	0	0	1	3	3	0	1	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1		12
CORN4	1	1	0	2	1?	0	0	0	0	0	3	2	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1		12
CORN5	1	2	1	1	2?	0	0	0	0	1	3	3	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1		13
CORN6	1	2	1	2	1	0	0	0	0	0	2	3	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0		11
DEV1	1	1	0	2	1	0	0	0	0	1	3	1	0	1	1	0	0	3	0	0	0	1	0	1	0	0	0	0	2	1	2	0	0	0		15
DEV2	3	1	0	1	2	1	0	0	0	1	3	1	1	0	2	3	0	1	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0		14
DEV3	2	1	0	2		0	0	0	0	1	3	3	1	0	2	2	0	2	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	0		13
DEV4	1	0	2	1	2	0	0	0	0	2	2	3	3	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	0		13
DEV5	1	2	0	2	2	0	0	0	1	2	3	2	0	1	2	0	0	2	0	0	0	0	0	1	0	0	0	0	3	1	2	0	0	0		15
DEV6	1	2	0	1	3	0	0	0	1	2	2	2	0	1	1	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0		13
DEV7	1	1	0	2	0	0	0	0	1	2	3	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0		11
DEV8	1	1	0	3	1	0	?	0	0	2	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0		9
DEV9	1	0	0	3		0	?	0	0	2	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0		6
DEV10	0	0	1	2		0	?	0	0	2	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0		8
DEV11	2	1	0	1	1?	2	0	0	0	1	2	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0		11
DEV12	2	2	0	1	0	3	0	0	0	1	1	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0		11
DEV13	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	2	0	0	0	0	0	0	2	0	0	0		5
DORS1	2	2	0	2	0	1	0	0	0	1	2	1	1	0	2	0	0	2	0	0	0	2	0	0	0	0	0	0	3	1	3	2				15
DORS2	1	1	0	2	2	1	0	0	2	1	2	3	0	1	3	0	0	1	1	1	0	1	0	0	2	0	0	0	1	0	3	0	0	0		18
DORS3	2	0	0	1	3	3	0	0	0	2	3	3	0	0	3	0	0	1	0	1	0	1	0	0	0	1	0	0	1	1	3	0	1	0		16
HAMP1	1	0	0	1	0	3	?	1	0	1	3	2	1	1	0	0	0	1	0	1	0	0	0	0	3	0	1	0	0	0	1	0	0	0		14
HAMP2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	?	0	3	0	0	0	0	1	1	0	2	0	0	0	1	0	0	0		6
HAMP3	1	0	0	1	3?	1?	0	1	0	1	3	2	0	0	1	0	0	3	0	2	0	3	0	0	1	1	1	0	2	1	2	0	0			16
HAMP4	2	0	0	1	3	0	0	0	0	1	3	3	1	1	0	0	0	3	0	2	0	2	0	0	3	1	3	0	1	0	2	0	0	0		16
HAMP5	2	0	0	2	2?	0	0	0	0	1	3	2	1	0	1	0	0	2	0	2	0	2	0	0	0	1	1	0	2	1	2	0	1	0		16
HAMP6	2	0	0	2	0	1	0	1	0	1	3	2	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	2	2	3	0	1	0		15
HAMP7	1	0	0	2		1	0	1	0	1	3	2	0	0	1	0	1	2	0	0	0	1	0	0	0	0	0	0	0	1	3	0	1	0		14
HAMP8	1	1	0	1	1?	2	1?	2	1	1	3	1	1	0	2	0	0	1	0	0	0	1	0	0	0	1	1	0	1	1	3	0	2	0		19
HAMP9	2	0	0	1		2	1?	3	?	1	3	3	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	3	2	2	0	1	0		15
HAMP10	2	1	0	1	0	3	1?	3	0	1	3	3	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	3	0	1			15
HAMP11	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0	0	1	0	3	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0		7
HAMP12	1	0	0	2	1	2	1	0	0	1	1	3	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0		12
SUSS1	2	0	0	1	1	3	0	0	0	1	3	3	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0		11
SUSS2	2	3	0	2	0	3	0	1	0	2	2	2	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1		0	1	0		14
SUSS3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0		3
SUSS4	0	0	0	0	0	3	0	0	0	0		3	1	1	1	0	0	0	2		0	0	0	0	0	0	0	0	0	0	0		0	0		6
KENT1	1	0	0	2	1	0	1?	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	1	0	1	0	0	0		10
KENT2	3	0	0	1	1	2	0	0	0	0	3	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0		10
KENT3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	3	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0		5
KENT4	0	0	0	0	0	0	0	0	0	0		0	0	2	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0		4
Sites occupied	33	20	5	37	15	17	2	8	5	30	35	34	21	15	23	2	4	36	5	7	1	23	0	6	9	7	7	1	26	16	31	1	9	3	494	494

Abundance scores: Adapted and abbreviated SACFORN scale: 3 = Abundant/Superabundant, 2 = Frequent/Common, 1 = Rare/Occasional, 0 = Not present, blank = Not looked for or not noticed, ? = ID uncertain

Appendix VI: Comparison between 2009/10 and 2013/14 surveys

	ASCIDIANS																BRYOZOANS										OTHER ANIMALS										ALGAE						
	Styela clava	Styela clava	Asterocarpa humilis	Asterocarpa humilis	Corella eumyota	Corella eumyota	Botrylloides violaceus	Botrylloides violaceus	Botrylloides diegensis	Botrylloides diegensis	Didemnum vexillum	Didemnum vexillum	Perophora japonica	Perophora japonica	Aplidium cf. glabrum	Aplidium cf. glabrum	Tricellaria inopinata	Tricellaria inopinata	Bugula neritina	Bugula neritina	Bugula simplex	Bugula simplex	Bugula stolonifera	Bugula stolonifera	Watersipora subatra	Watersipora subatra	Austrominius modestus	Austrominius modestus	Caprella mutica	Caprella mutica	Crepidula fornicata	Crepidula fornicata	Crassostrea gigas	Crassostrea gigas	Ficopomatus enigmaticus	Ficopomatus enigmaticus	Undaria pinnatifida	Undaria pinnatifida	Sargassum muticum	Sargassum muticum				
	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14	2009/10	2013/14		2009/10	2013/14	Change
SOM1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1		1	0	0		1		0	0	0		1	0	0	0	1	0	0		2	7	5
CORN2	0	0	1	1	0	1			0	0	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	1	1	0	0	0	0	0	0	0		0	0	0	0		5	6	1
CORN3	1	1	1	1	1	1		1	0	0	0	0	0	0	0	1	1	1	1	1		0		1	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0		6	11	5
CORN5	1	1	0	1	1	1			0	0	0	0	0	0	1	1	1	1	1	1	1	1		1	0	0	1	1	0	0	1	1	0	0	0	0	1	0	0	0		9	10	1
DEV1	1	1	0	1	1	1		1	0	0	0	0	0	0	1	1	1	1	0	1		0		1	0	1	1	1	0	0	1	1	0	1	0	0	1	1	1	1		8	14	6
DEV3	1	1	0	1	1	1	0		0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	1	0	1	0	0	0	1	1	0	1		11	11	0
DEV4	1	1	0	0	1	1		1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	1		9	11	2
DEV5	1	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1		0	1	1	0	1	1	1	1	0	0	0	0	1	0	0	1	1	1	1		12	14	2
DEV6	1	1	0	1	1	1		1	0	0	0	0	1	1	1	1	1	1	1	1		0		1	0	1	1	1	0	0	0	0	0	0		0	1	1	0	0		8	12	4
DEV7	1	1	1	1	1	1		0		0	0	0	0	1	1	1	1	1	1	1		0		0		0		1		0		0		0		0		1		0		6	9	3
DEV11	1	1	0	1	1	1	0		0	1	0	0	0	0	1	1	1	1	1	1	1	1		0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1		9	11	2
DEV12	1	1	0	1	1	1	0	0	1	1	0	0	0	0	1	1	1	1	1	1		0		0	0	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1		8	11	3
DORS2	0	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	1	0	0	1	1	0	1	0	0		13	15	2
DORS3	1	1		0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1		0		0	1	1		1	0	0	1	1	0	0	0	0	1	1	0	1		10	12	2
HAMP1	1	1		0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1		1	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0		11	11	0
HAMP3	1	1	0	0	1	1					0	1	0	0	1	1	1	1	1	1		0		0	0	1	1	1	0	0	1	1	1	0	0	1	1	1	1	1		10	12	2
HAMP4	1	1	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1		1		1	0	0	1	1	0	0	1	1	1	0	0	1	1	1	0	0		10	12	2
HAMP5	1	1	0	0	1	1	1		1	0	0	0	0	0	1	1	1	1	1	1		1		0	0	1	0	1	0	0		1	0	0	0	0	1	1	1	1		9	11	2
HAMP6	1	1	0	0	1	1		0	0	1	0	1	0	0	0	1	1	1	1	1		0		1	0	1	1	0	0	0	1	1	0	0	0	0	1	1	1	1		8	12	4
HAMP7	1	1	0	0	1	1			1	1	1	1	0	0	0	1	1	1	1	1		0		0	0	1	0	1	0	0	1	1	1	0	0	0	1	0	1	1		10	11	1
HAMP8	1	1		1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		0	1	1		1	1	1		0	0	0	0	1	1	1	1	1		13	15	2
HAMP9	1	1	0	0	1	1			1	1	1	1	0		1	1	1	1	1	1		0		0	0	1	1	1	0	1	1	1	1	0	0	0	1	1	1	1		12	13	1
HAMP10	1	1	0	1	1	1		0	0	1	1	1	0	0	0	1	1	1	1	1		0		0	0	1	1	1	0	0	0	1	1	0	0	0	1	1	1	0		9	12	3
HAMP11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0		4	4	0
HAMP12	1	1		0	1	1	1	1	1	1	0	0	0	0		1		1	1	1		1	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0		8	10	2
SUSS1	1	1		0		1		1	1	1	0	0	0	0	1	1	1	1	1	1		1		1	0	0	1	1	0	0	0	0	0	0	0	0		0		0		6	10	4
SUSS2	1	1		1	1	1		0	1	1	0	1	0	0	1	1	1	1	1	1		1		0	0	1		1	0	0	1	1		0	0	0	1	0	1	1		9	13	4
SUSS4	0	0		0	0	0	1	0	1	1	0	0	0	0		0	0		1	1	0	1	1	1	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0		4	5	1
KENT1	1	1		0	1	1	0	1	0	0	0	0	0	0	1	1	1	1	0	0		0		0	0	0	0	1	0	0	0	0		1	1	1	1	1	0	0		6	9	3
KENT2	1	1		0	1	1	0	1	0	1	0	0	0	0	1	0	1	1	0	1		1		0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1		6	10	4
KENT3	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0		1	0	0	0	0		3	3	0
KENT4	1	0		0	0	0	1	0	1	0	0	0	0	0	0	0	1			0		0	1	1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0		6	3	-3
																																												260	330	
2009/10	26		4		25		9		13		5		4		21		29		26		11		9		4		20		2		12		6		4		19		11		260			
2013/14	26		14		28		12		15		8		5		25		28		28		17		15		19		27		1		15		4		8		20		15		330			

Notes: Presence/ Absence at 32 sites, 20 species common to both sets of surveys. 1=Present, 0= Not present, Blank = Not looked for or not notice or ID uncertain.

Appendix VII: NNS workshop flyer

MARINE NON-NATIVE SPECIES : A ONE-DAY WORKSHOP

Tuesday October 7th 2014 9.30am-4.30pm
Royal Southern Yacht Club
Rope Walk, Hamble SO31 4HB

This workshop offers a basic introduction to:

- Identification of non-native fouling species found in marinas and ports, such as seaweeds, barnacles and sea squirts
- Ways to reduce the introduction and spread of non-natives.

Intended for: marina & port operators and users, shellfish farmers, divers, fishers and others employed in the marine sector.

To book or for more information
Email: cwo@mba.ac.uk Tel: 01752 633335

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Appendix VIII: NNS workshop feedback summary

The MBA would welcome comments on our training courses. This will help us develop our future training program. If you have any additional comments or would like to elaborate or clarify any points, please include these on the reverse of this sheet.

Course Title: NNS WORKSHOP- RSrnYC, HAMBLE
Date of Course: 07/10/14

Content	N/A	Poor/ no	Average/ partly	Good/ mostly	Excellent/ completely
Were the expected items covered in sufficient detail?			**10%**	**10%**	**80%**
Was the content suited to your requirements?			**10%**	**20%**	**70%**
Was the course content easy to understand?			**10%**	**20%**	**70%**
Was the supporting information sufficient?				**30%**	**70%**

Trainer(s)	N/A	Poor	Average	Good	Excellent
How well conducted was the training?				**10%**	**90%**
How well paced was the delivery of information?				**20%**	**80%**
How effectively did the trainer(s) deliver the information?				**20%**	**80%**

Facilities	N/A	Poor	Average	Good	Excellent
Rate the training facilities				**50%**	**50%**
Rate the standard of equipment				**30%**	**70%**
Rate the refreshment facilities			**20%**	**60%**	**20%**
Rate the lunch provided			**40%**	**50%**	**10%**

Would you recommend others to do this course? **90%** Yes **10%** Depends
Would you attend similar courses run by the MBA in the future? **90%** Yes **10%** No

If so, what topics would you like to see covered in future courses?
Impact of chemicals and/or litter from boating on marine ecosystems
Upcoming legislation and effect on industry
Invasion biology – vectors & impacts
More detail on invasive species (2)
ID of groups of marine species e.g. bryozoans, sponges (2)
Rapid Assessment Survey technique and other survey methods (2)
Other locations, not just marinas

What would you have improved about the course?
Less technical detail
Potential implications for marine industry
Targetted more to marina operators
More information on content beforehand
Longer in marina (2)
Microscopes
More vegetarian choice
Closer to home

What did you like most about the course?
Visit to marina (2)
Learning to identify species
Talking to experts and forming contacts
Instructors very knowledgeable and enthusiastic (2)
Plenty of opportunities to talk with instructors due to small group size
Practical aspects - collecting in marina and ID (6)
Good mix of practical and lectures

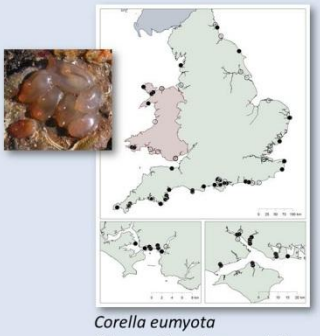
How did you hear about the course?
Invitation email (4)
The Green Blue (1)
Colleague (3)
MBA website (2)

Appendix IX: Marine Pathways conference poster (Cardiff, 25th February 2015)

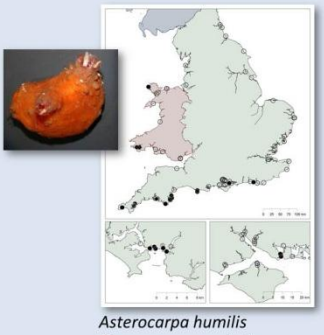
UPDATING THE DISTRIBUTIONS OF MARINE NON-NATIVE FOULING SPECIES IN WELSH AND ENGLISH MARINAS

Christine Wood, John Bishop and Anna Yunnie

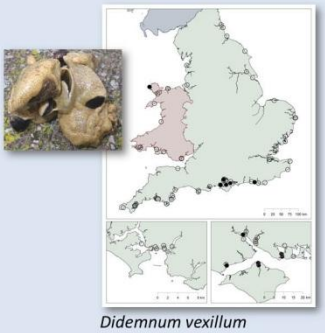
As artificial habitats, marinas are of low priority for conservation agencies and volunteer recorders. But marinas are often in or near to MPAs, and NNS are very prominent in their fouling communities. In 2013-14, we conducted rapid assessment surveys (RASs) at marinas and harbours to assess the current distribution of over 30 NNS around the English and Welsh coasts. Examples are shown below; filled circles denote presence. (NB: information for East Anglia is from 2009.)



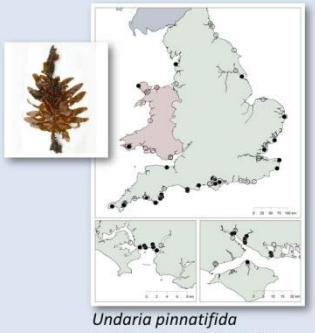
Corella eumyota
(Orange-tipped sea squirt)
UK since 2004



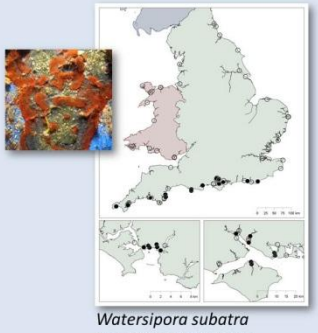
Asterocarpa humilis
(Compass sea squirt)
UK since 2009



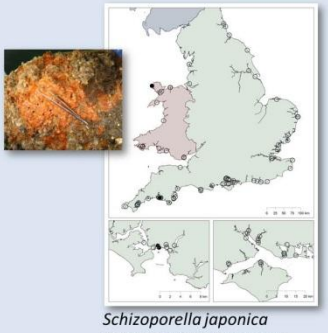
Didemnum vexillum
(Carpet sea squirt) (Also N Kent coast) UK since 2008



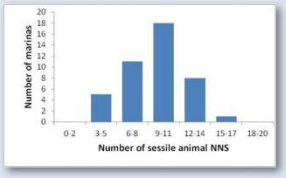
Undaria pinnatifida
(Wakame, Japanese kelp)
UK since 1994



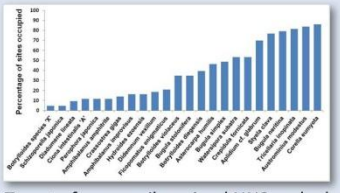
Watersipora subatra
(Red ripple bryozoan)
UK since 2008



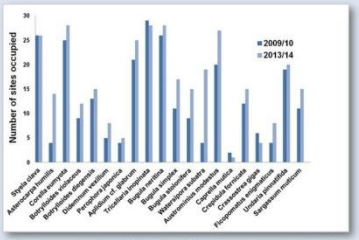
Schizoporella japonica
(Orange ripple bryozoan)
UK since 2010



Over 50% of the 43 south coast marinas surveyed had 10 or more sessile animal NNS. Non-native motile animals and algae could be added to these totals.



Twenty-four sessile animal NNS ranked by their frequency of occurrence in south coast marinas. The commonest, including species only discovered in 2004, occupy almost 90% of sites.



Changes in 20 NNS at 32 sites subjected to RASs in 2009-10 and 2013-14. Most species have spread, some rapidly, giving a 27% increase in records for these NNS.

Funding

Resilient Ecosystems Fund

Ariennir gan Lywodraeth Cymru
Funded by Welsh Government

Bioamrywiaeth Cymru Biodiversity Wales
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WALES BIODIVERSITY PARTNERSHIP

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