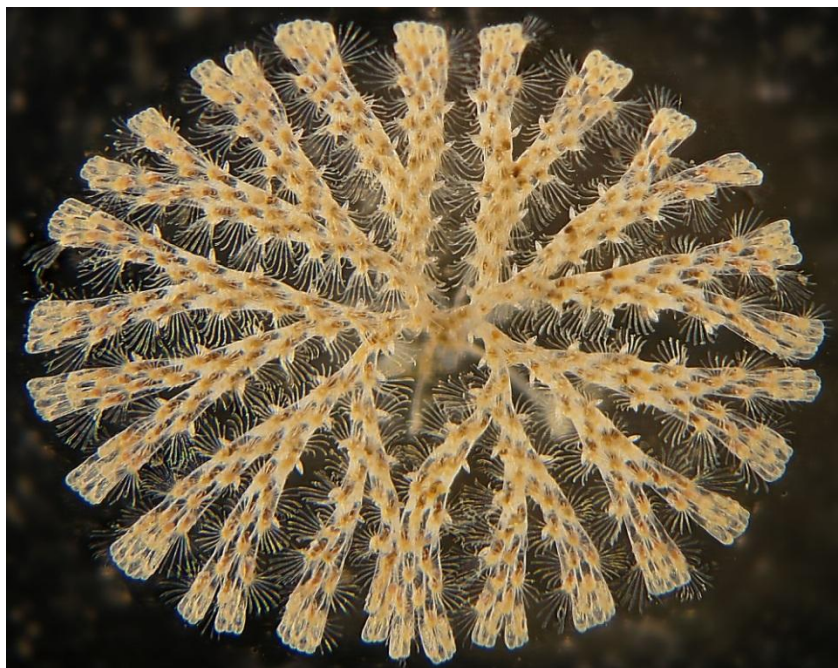


Report to The Bromley Trust

RAS 2015

Non-Native Species Rapid Assessment Surveys in English Marinas (E Anglia & W coast)



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Project details

This report describes the current distribution of NNS in marinas on the East Anglian and western coasts of England, comparing it to data from previous surveys from 2009/10 and to data from other areas of the UK. It supplements the report from the RAS 2014 project which surveyed the south coast. The data is of relevance to monitoring and pathway management obligations under the Marine Strategy Framework Directive (MSDF); will contribute to the annual compilation of Indicator B6 (Pressure from Invasive Species) of the UK Biodiversity Indicators published by Defra; 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 the management of NNS.

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Confidentiality

All data within this report is © 2016 MBA. We have used codes for the localities because some marina operators did not wish their establishments to be explicitly named.

Acknowledgements

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This project was part funded by The Marine Biological Association of the UK. We are grateful to Natural England for funding Ruth Crundwell's time and subsistence for the surveys of the W coast and to Cornwall Wildlife Trust for allowing Lisa Rennocks to assist us on the East Anglia surveys. Thanks to Stuart Jenkins, Bangor University for providing us with his 2009/10 survey data of the NW. The North West Wildlife Trusts helped fund and organise the NNS Workshop and Blackpool & The Fylde College provided an excellent venue. We would also like to thank all the marinas for permitting access and in particular Fleetwood Marina for letting us use their marina during the NNS workshop.



Executive Summary

This project was developed to build on the success of the RAS 2014 project (Wood et al. 2015a) which was partly funded by the Bromley Trust.

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 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 English coast. In 2013/14, marinas in the south-west, along the S coast and in Wales were studied, partly funded by the Bromley Trust's RAS 2014 project. These surveys documented rapid recent changes, suggesting that a resurvey elsewhere would also reveal extensive shifts. The RAS 2015 project funded rapid assessment surveys (RAS) in an additional 7 marinas in E Anglia and 6 marinas along the western coast of England. These areas were last surveyed for NNS in 2009/10 so were considered priority areas for action.

Twenty-three different marine NNS and two freshwater NNS were recorded during the surveys. The number of NNS recorded at each site rose between the 2009/10 and 2015 surveys at all but one site, where it stayed the same. The total number of NNS records rose by 46% in five years (40% E Anglia, 78% western coast), see Appendix V, which compares with the 27% increase in four years seen along the S coast reported in RAS 2014.

There were clear differences between the two areas studied for this report. In E Anglia species such as Wakame (*Undaria pinnatifida*) and the San Diego sea squirt (*Botrylloides diegensis*), are spreading rapidly, whereas other species such as the Leathery sea squirt (*Styela clava*) are already at maximum occupancy. Along the western coast the increase is mainly due to the arrival of species previously not recorded in that region e.g. the Orange-tipped sea squirt (*Corella eumyota*), and the San Diego sea squirt (*Botrylloides diegensis*) although there are still many NNS which are absent in this area e.g. the Ruby bryozoan (*Bugula neritina*), although they are common elsewhere in the UK. The large differences in the average number of NNS present along the western coast compared to E Anglia supports the findings of previous surveys in Wales and along the S coast. This difference is probably partly due to proximity to sources of NNS and partly due to environmental factors associated with the individual marinas, e.g. salinity and degree of enclosure.

Data from the RAS 2014 and RAS 2015 projects has contributed substantially to decision making regarding marine NNS by governmental organisations. The UK list of NNS to be monitored for Descriptor 2 of the MSFD was recently finalized, and approximately 60% of the chosen species occur regularly in marinas. Accordingly, the MBA's detailed RAS data, which include systematically recorded absences, now form a major part of the information defining

baseline species distributions for future MSFD monitoring. Data from the RAS 2014 and RAS 2015 projects has also been utilised in the compilation of the marine element of the UK Biodiversity Indicator B6. The documentation of species arrivals and their subsequent spread during repeated RAS has contributed very substantially to the increasing number of widely established marine invaders, which has been rising more steeply than those of the other habitats, highlighting very clearly the rapid rate of anthropogenic change in our coastal habitats (Appendix X). J. Bishop and C. Wood have also participated in an EU-wide horizon-scanning project.

A NNS identification workshop was held in Blackpool in collaboration with the North West Wildlife Trusts. This was very successful, with all places being taken and very good feedback from the attendees which included Wildlife Trust staff and volunteers, Environment Agency and Natural England staff and other stakeholders.

Engagement with marina operators, boat owners and workshop attendees has led to a number of opportunities to raise awareness of marine NNS and biosecurity. Information was obtained from the staff of each marina to gather data that could be relevant to a site's susceptibility to colonisation by NNS.

Recommendations regarding future monitoring include surveying of artificial habitats in NE and SW England last surveyed in 2012/13 and 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.

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1. Introduction

This project was developed to build on the success of the RAS 2014 project (Wood et al. 2015a) which was partly funded by the Bromley Trust.

Non-native species (NNS), introduced beyond their natural geographical range by human activities, pose serious threats to native species and ecosystems and can damage both human health and economic interests. Marine non-native species can damage native biodiversity and compromise economic activity just like better-publicized land and freshwater invasive species. Marine bioinvasions are less well studied than their terrestrial or freshwater counterparts, but have serious impacts on natural marine ecosystems, aquaculture and human health. Marine non-native species are transported around the world on ship's hulls, in ballast water and as hitch-hikers on aquaculture imports. Ports and marinas are frequently the first sites of colonization for NNS and can act as stepping-stones during secondary spread.

Such artificial structures have become the primary focus for rapid assessment surveys (RAS) for non-natives as the resulting assemblages are always submerged but readily accessible at any state of the tide, making them ideal for cost-effective surveillance of non-native taxa. Such surveys provide an important baseline for studies of neighbouring natural benthic communities and their ability to withstand invasion, and highlight the role of artificial habitats in the spread of marine NNS.

This project was intended to update the distribution of NNS in marinas on the English coast in areas that have not been recently surveyed. In 2013/14, marinas in the south-west, along the S coast and in Wales were studied. These surveys documented rapid recent changes (Bishop et al. 2014; Wood et al. 2015a; Wood et al 2015b), suggesting that a resurvey elsewhere would also reveal extensive shifts. The East Anglian and western English coasts were last surveyed for NNS in 2009/10 so were considered priority areas for action.

The data will be of relevance to monitoring and pathway management obligations under the Marine Strategy Framework Directive (MSFD) (European Commission 2008) which was introduced by the European Union to promote sustainable use of Europe's seas and conserve marine ecosystems, see Appendix IX for more details. It will also contribute to the annual compilation of Indicator B6 (Pressure from Invasive Species) of the UK Biodiversity Indicators published by Defra, see Appendix X, 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.

This project had the following aims:

- To complete rapid assessment surveys (RASs) of marinas, harbours and aquaculture sites around the E Anglian and western coasts of England 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 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 37 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; 7 species were added to the list originally compiled for the RAS 2014 project: the barnacle *Hesperibalanus fallax*, the tube worm *Hydroides ezoensis*, the Asian shore and Brush-clawed crabs (*Hemigrapsus spp.*), Golden membrane weed (*Chrysmenia wrightii*), Hook weed (*Bonnemaisonia hamifera*), and Pom-pom weed (*Caulacanthus okamurae*); descriptions of all target species are given at Appendix I.

13 marina sites along the coast were selected: 7 in East Anglia, 6 of which had been previously surveyed by us in 2009 and 1 not previously surveyed; 6 along the western coast of England, 1 which had been surveyed by Bangor University in 2009 and by us in 2012, 3 which had been surveyed by Bangor University in 2010 using a similar protocol and 1 not previously surveyed. These sites were examined between July and September 2015 for the presence of non-native species. A map of all sites 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 including for the RAS 2014 project. In addition many native species were recorded. For the surveys in East Anglia J. Bishop and C. Wood were assisted by Lisa Rennocks from Cornwall Wildlife Trust, and for the surveys along the western coast they were assisted by Ruth Crundwell from Natural England; both had been trained in the RAS methodology and had attended previous surveys as surveyors or observers.

While visiting the marinas outreach conversations were initiated with marina operators and interested yacht owners with the aim of raising awareness of NNS. Marina staff were asked a number of questions, see Appendix VI, to provide information that could be relevant to a site's susceptibility to colonisation by NNS. Posters of NNS and waterproof copies of the *Identification Guide for Selected Marine Non-Native Species*, see <http://www.mba.ac.uk/bishop/non-native-species-guides/>, were handed out.

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

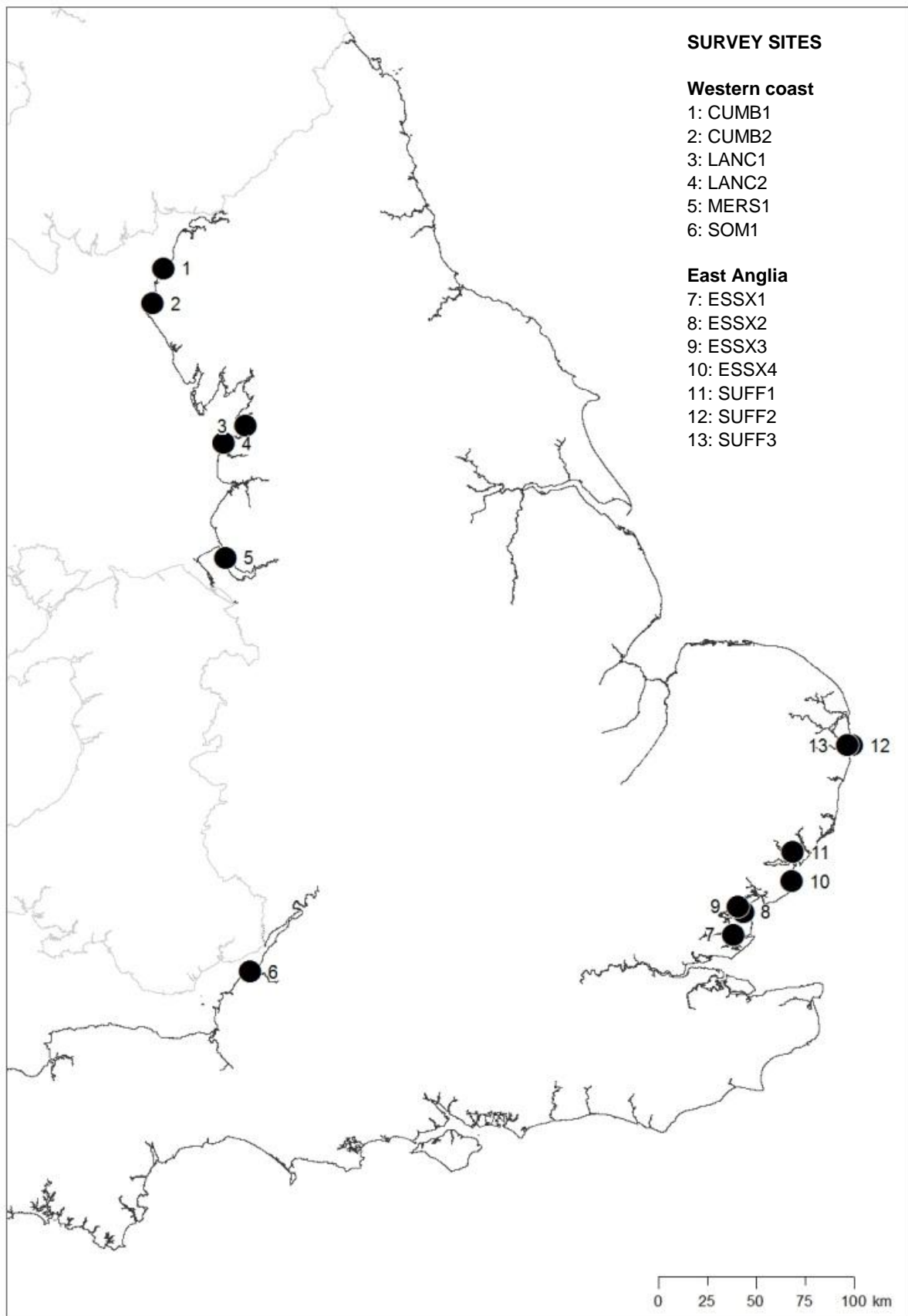


Figure 1: Locations of marinas surveyed for NNS in 2015

2.2. Results - surveys

The detailed NNS occurrence and abundance data is given in Appendix IV. The environmental measurements of salinity, temperature and turbidity are reported in Appendix II. A comparison between these survey results and those from 2009/10 is shown at Appendix V. All NNS species records will be made publicly available via NBN Gateway.

Species accounts

A total of twenty-three different marine NNS and two freshwater NNS were recorded during the surveys, the most frequently occurring being Darwin's barnacle (*Austrominius modestus*), the Leathery sea squirt (*Styela clava*), and the Tufty-buff bryozoan (*Tricellaria inopinata*), all being present at 9 or more of the 13 sites, see Figure 2. This level of site occupancy is equivalent to that seen for many of our most common native fouling organisms, such as the Vase sea squirt (*Ciona intestinalis*), the bryozoan *Cryptosula pallasiana* and the Purse sponge (*Sycon ciliatum*).

Occurrence details and images of 14 of the species recorded are given below, and a further 5 species are described in the RAS 2014 report.

Species on the target list not recorded during these surveys were: *Asterocarpa humilis*, *Ciona robusta*, *Perophora japonica*, *Watersipora subatra*, *Schizoporella japonica*, *Diadumene lineata*, *Hesperibalanus fallax*, *Urosalpinx cinerea*, *Hemigrapsus spp.*, *Grateloupia turuturu*, *Chrysomenia wrightii*, *Bonnemaisonia hamifera*, and *Caulacanthus okamurae*. No NNS not already on the target list were recorded.

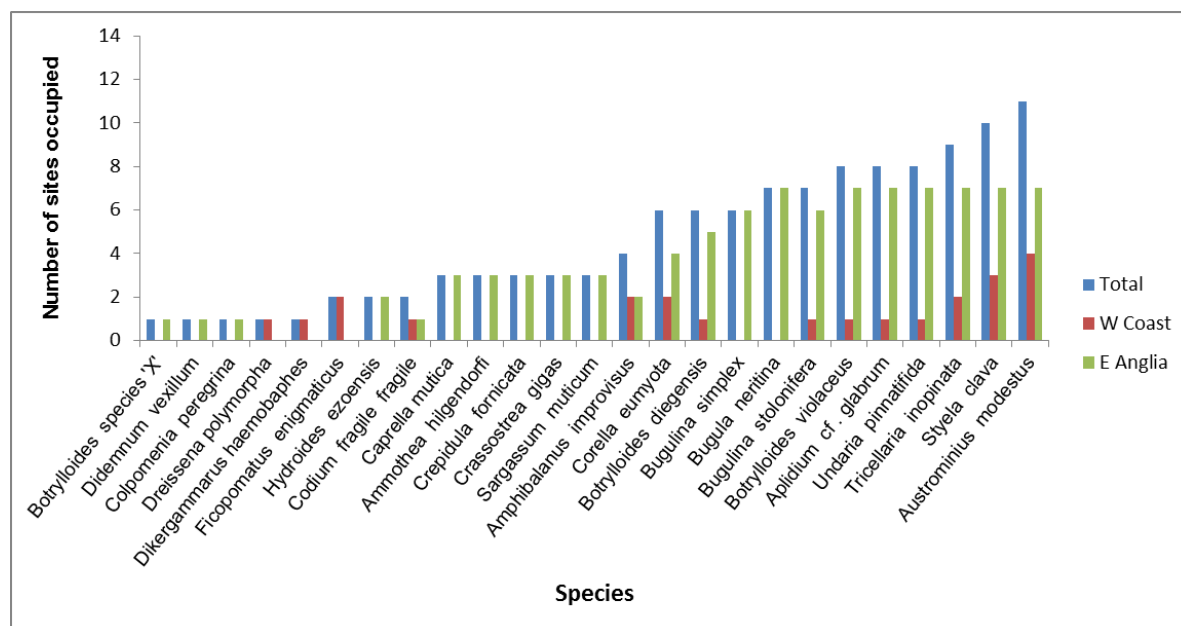


Figure 2: Frequency of occurrence of 23 NNS at 13 sites along the E Anglian and W coasts

Austrominius modestus (Darwin's barnacle)

Darwin's barnacle (*Austrominius modestus*) was the most prevalent NNS found during the surveys, as was the case during the 2009/10 surveys (see Appendix V). It was recorded at 11 of the 13 sites. It is the most frequently recorded species from marinas around the UK especially in habitats subjected to fluctuating salinity. This probably represents maximum occupancy of suitable sites.

Figure 3: *Austrominius modestus*. Image: J. Bishop



Ficopomatus enigmaticus (Trumpet tube worm)

The Trumpet tube worm (*Ficopomatus enigmaticus*) was recorded at only two of the sites visited. However, at CUMB2 it was super-abundant and a severe fouling nuisance on yacht hulls, pontoons and ropes. This marina has previously requested advice from us as to how to remove it, has advised boat owners on what they can do about it, and has carried out cleaning and procedural changes such as opening the lock gates more frequently, in an attempt to eradicate it. The increase in abundance and number of sites occupied by this species, as recorded along the S coast in the RAS 2014 report (Wood et al. 2015a) and in



Wales (Wood et al. 2015b) may be due to the recent mild wet winters and hot summers as *F. enigmaticus*, a temperate/warm temperate species, was thought to be at the limit of its range for maintaining populations and sexual reproduction on the S English coast (Zibrowius and Thorp 1989).

Figure 4: *Ficopomatus enigmaticus* fouling a plank of wood in Cumbria. 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, the R. Dart in Devon, and 1 marina in Plymouth. In 2011 it was discovered in SE England along the N Kent coast (Hitchen 2012) and during the RAS 2014 surveys a single colony was found and removed from a marina in Sussex. In these surveys in 2015 it was recorded at a single marina in Essex, so again it has extended its range along the south/east coast. However it does not seem to be spreading along the western coast, as it is



Figure 5: *Didemnum vexillum*, Essex. Image: J. Bishop

absent even from those marinas close to the original invasion in 2008 at Holyhead, Wales. However, it was discovered in the Firth of Clyde in Scotland in 2010.

Botrylloides species (Orange cloak and San Diego sea squirts)

Currently there are known to be at least two non-native *Botrylloides* species in the UK, the Orange cloak sea squirt (*Botrylloides violaceus*) and the San Diego sea squirt (*Botrylloides diegensis*); there is possibly a third, at present referred to by us as *Botrylloides* sp. X, whose identity and status is currently unknown. There is also a putatively native species, *Botrylloides leachii*. It is not always possible to distinguish colonies of these different species morphologically, even if dissected. For that reason here we have reported the presence of *B. violaceus* only where its identity has been confirmed by the presence of the distinctive, very large embryos and/or pink-purple brooded larvae. Similarly, we only recorded *B. diegensis* when it occurred as one of the known distinctive colour morphs.

B. violaceus is now one of the most common NNS found in marinas, and it was found at all of the E Anglia sites.

B. diegensis has spread rapidly in E Anglia; whereas in 2009 it was recorded in only one marina it is now present in four. Perhaps more significantly it was also found in a marina on the western coast in Lancashire, far away from any previously known occurrences (nearest record in Burry Port, S Wales).



Figure 6: *Botrylloides diegensis*, Suffolk. Image: J. Bishop

Aplidium cf. glabrum (colonial sea squirt)



Figure 7: *Aplidium* cf. *glabrum*, Lancashire. Image: B. Lynam

The colonial ascidian *Aplidium glabrum* is a northern species with a UK range limited to the colder waters of N Scotland (Millar 1966). Unpublished data from the surveys of the S English coast in 2004 reported by Arenas et al. (2006) show specimens which keyed out as *Aplidium glabrum* being present at a number of sites. We now consider it probable that this is a different, as yet unidentified, *Aplidium* species not native to the UK, which has been spreading rapidly around the UK and Europe (Wood et al. 2015a; Wood et al. 2015b). It was recorded at seven sites during these surveys.

Bugula neritina (Ruby bryozoan)

This easily identifiable erect bryozoan was first recorded in Great Britain in 1911, but then in the 1990's was considered to be extinct in GB (Eno et al. 1997); an apparent recolonization and rapid expansion has occurred as it was recorded at numerous sites along the S coast in 2004 (Arenas et al. 2006). In these recent surveys it was found at all 7 sites in E Anglia. However it was not found along the western coast.



Figure 8: *Bugula neritina*, with close-up. Images: J. Bishop

Bugulina simplex and *Bugulina stolonifera*

These species have recently been re-classified taxonomically; they were previously referred to as *Bugula simplex* and *Bugula stolonifera*. There were very few UK records of these two non-native *Bugulina* species up until 2010, although they were known to be present in the UK in the 1950s; this is believed to be due to under reporting (Ryland et al. 2011). Here we report *B. simplex* from 6 sites in E Anglia, but it was not recorded along the western

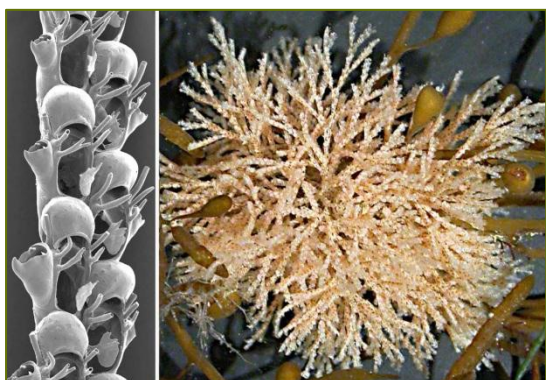
coast. *B. stolonifera* shows a similar picture, being present at 6 sites in E Anglia, but also one site in Merseyside. As these species have been present in the UK for a long time it is probable that this increase in recorded occurrences is due to improved identification and reporting rather than spread. Both species have now been shown to be relatively common in the fouling fauna in artificial habitats.



Figure 9: *Bugulina simplex*. 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 in marinas all around the UK coast and also on some natural shores. It was present in 9 of the 13 sites surveyed in 2015.



The increase in the recording of *Bugula stolonifera*, which has a similar gross morphology though readily distinguishable under the microscope, leads us to recommend that, when surveying, a number of samples are taken for microscopical examination, as both species may be present.

Figure 10: *Tricellaria inopinata*, with close-up. Images: A. Yunnie/J. Bishop

Undaria pinnatifida (Wakame or Japanese kelp)

Wakame (*Undaria pinnatifida*) is a large brown kelp which is becoming very common around the UK in artificial habitats such as marinas; it is now also being recorded in natural habitats such as Plymouth Sound (Heiser et al. 2014). In 2014 we recorded its first occurrences in Wales (Wood et al. 2015b). In E Anglia it was found at all 7 sites being abundant at 6 of them, whereas in 2009 it was present at only 3 of the sites. Along the western coast *U. pinnatifida* was already known from LANC2, but it was not found at any other locations.



Figure 11: *Undaria pinnatifida*. Image: J. Bishop

Ammothea hilgendorfi (Japanese sea spider)



This species has been present in the UK for some time, without noticeable spreading from the Solent area, where it was first recognised in 1978. However it was recently reported from Essex (Bamber 2012) and here we report it from two further sites in Essex. In addition we were requested to confirm the identification of a specimen from Reculver in Kent which a Shoresearch volunteer, R. Shrubsole, had found, so the species is consolidating its presence on the east coast.

Figure 12: *Ammothea hilgendorfi* (preserved), Essex.
Image: J. Bishop

Dreissena polymorpha (Zebra mussel)

This highly invasive freshwater mussel was recorded at LANC1, a freshwater marina on the Lancaster canal. This species was already known to be present in the Lancaster canal system. Identification was confirmed by David Milburn from the Environment Agency.



Figure 13: *Dreissena polymorpha*. Image: J. Bishop

Dikerogammarus haemobaphes (Demon shrimp)

The highly invasive freshwater Demon shrimp (*Dikerogammarus haemobaphes*) is native to the Ponto-Caspian Region of Eastern Europe. It was first discovered in the UK in the R. Severn in 2012, and is now widespread throughout the UK canal system. It is a voracious predator that kills a range of native species, including young fish, and can significantly alter ecosystems. We recorded it at LANC1 situated on the Lancaster canal, a northern extension of its known range. Identification was confirmed by David Milburn from the Environment Agency. As this is an



Figure 14: *Dikerogammarus haemobaphes* (preserved), Lancashire. Image: C. Wood

'Alert' species the record has already been added to the online briefing information at <http://www.nonnativespecies.org/alerts/index.cfm>

Site accounts

As explained in more detail in the RAS 2014 report our experience of carrying out more than 200 surveys in over 95 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.
- Depth.
- Degree of enclosure.
- Size and age of marina development.
- Number of berths/usage.

In order to investigate this relationship further we developed a series of questions for the marina operators (Appendix VI) with the intention of gathering information about these factors. The marina operators were happy to provide the requested information so we are hoping to gather the same information from 60+ other marinas we have surveyed over recent years with the intention of analysing our survey data against these and other environmental data in an effort to pin-point the most significant factors in determining a sites susceptibility to invasion by NNS.



Figure 15: E Anglia marina ESSX1. Image: J. Bishop

The total number of NNS records generated from these surveys was 116: 93 from E Anglia and 23 from the western coast. The mean number of NNS recorded at the survey sites was 13.3 in E Anglia and 3.5 along the western coast.

The sites with the highest number of NNS were all in Essex: ESSX1 and ESSX3 (16), ESSX2 (15), and ESSX4 (13), see Figure 16 and Appendix IV. The sites with the lowest occupancy were all along the western coast with 5 of the 6 marinas only having 3 or less NNS. One of these was a freshwater marina, which is not our area of expertise so it may well contain additional NNS which we did not detect. The results for the western coast of England with low average numbers of NNS, were very similar to those we found in Wales (Wood et al. 2015b), whereas the higher numbers of NNS found in E Anglia are comparable to those of the south coast detailed in the RAS 2014 report. A likely explanation for this large difference between the marinas on the east and west coasts is that all the west coast marinas had lock gates and low or fluctuating salinities, see Appendix II. Another possibly major contributing factor is that the E Anglia sites are close to the European coast, from where many NNS have been introduced (Bishop et al. 2014).

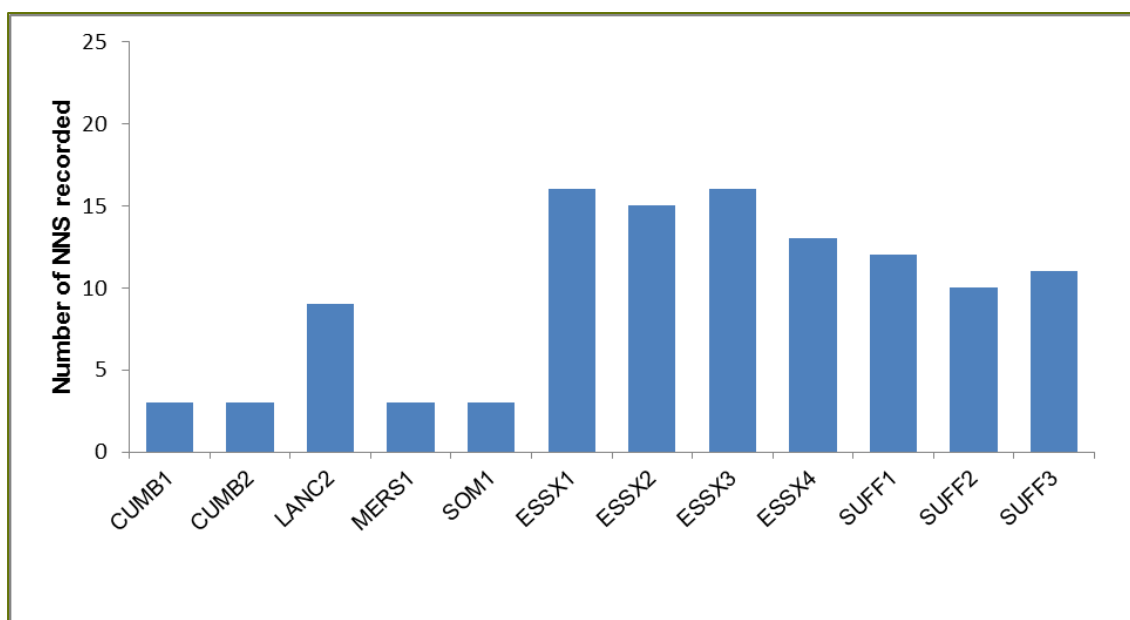


Figure 16: Counts of NNS recorded at sites along W coast and E Anglia (excludes freshwater site)

Trends

For the 10 sites and 20 species common to the 2009/10 and 2015 surveys, the total number of NNS records rose from 59 to 86, an increase of 46% in five years (40% E Anglia, 78% western coast), see Appendix V. This compares with the 27% increase in four years seen along the S coast. A summary of the changes in the number of sites occupied by species is shown in Figure 17 for E Anglia and Figure 18 for the western coast. These show that in E Anglia species such as *Undaria pinnatifida*, *Aplidium* cf. *glabrum* and *Botrylloides diegensis* are spreading rapidly, whereas some species are already at maximum occupancy e.g. *Styela clava*, *Tricellaria inopinata* and *Bugula neritina*. Along the western coast the increase is mainly due to the arrival of species previously not recorded in that region e.g. *Corella eumyota*, *Botrylloides diegensis* and *Aplidium* cf. *glabrum* although there are still many NNS species which are absent in this area e.g. *Didemnum vexillum* and *Bugula neritina* although they are common elsewhere in the UK.

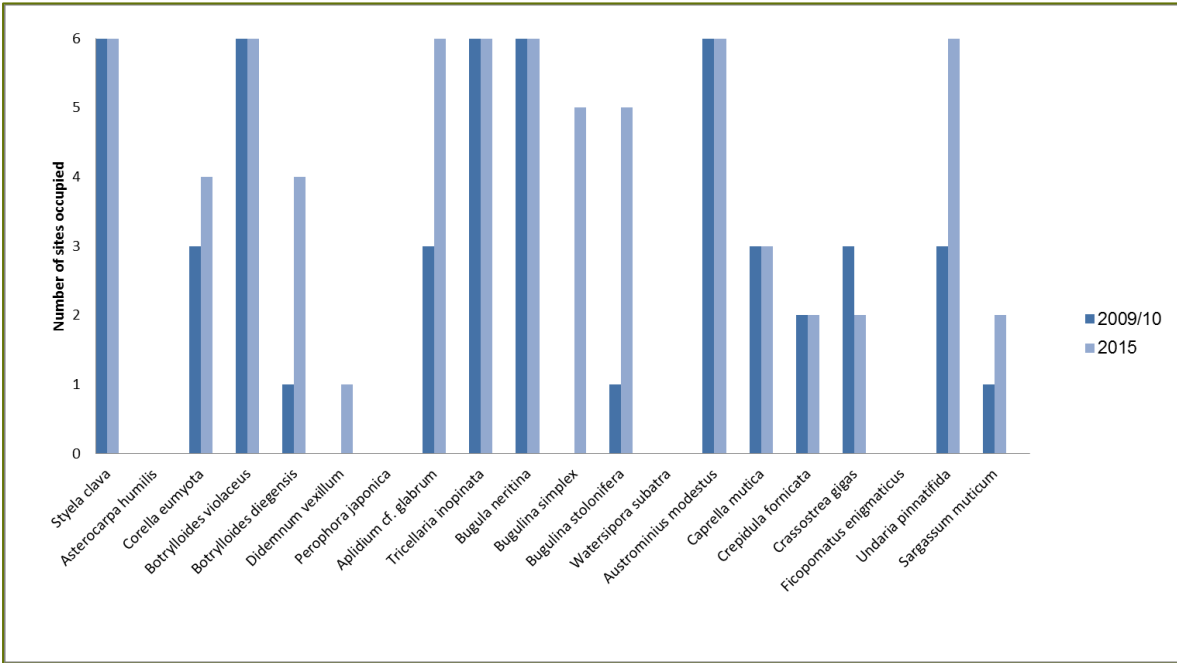


Figure 17: Change in occurrences of 20 species at E Anglia sites from 2009/10 to 2015

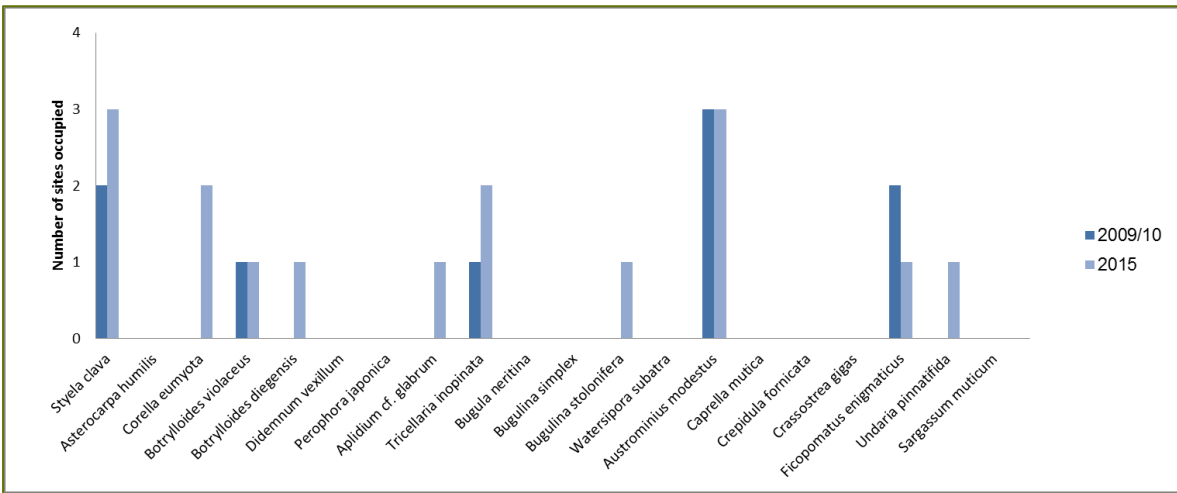


Figure 18: Change in occurrences of 20 species at W coast sites from 2009/10 to 2015

Figure 19 shows the same information analysed by site, this clearly shows that at all but one of the sites there has been an increase in the number of different NNS recorded, staying the same at only one. Again, as detailed in the RAS 2014 report this is a similar picture as that seen in other parts of the UK.

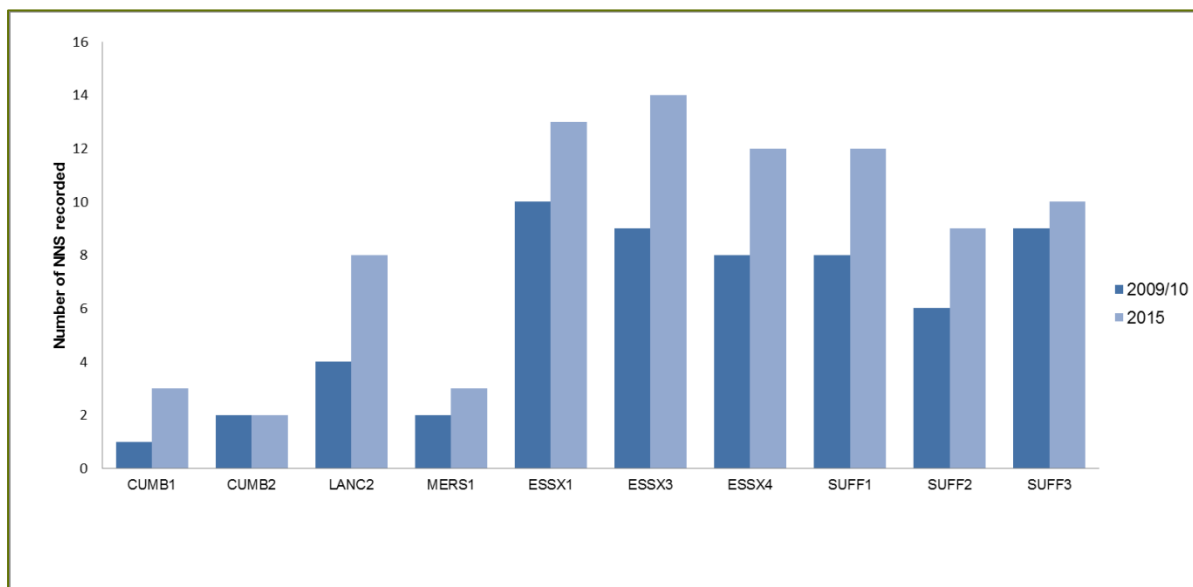


Figure 19: Change in numbers of 20 NNS at 10 sites from 2009/10 to 2015

2.3. Discussion - surveys

The most significant observations resulting from the RAS were:

- The ongoing rapid colonisation of additional sites by species already recorded in the 2009/10 surveys, in particular Wakame (*Undaria pinnatifida*), Orange-tipped sea squirt (*Corella eumyota*) and San Diego sea squirt (*Botrylloides diegensis*).
- No species new to the UK were detected.
- The large differences in the average number of NNS present along the western coast compared to E Anglia, supporting the findings of previous surveys in Wales and along the S coast. This difference is probably partly due to proximity to sources of NNS and partly due to environmental factors associated with the individual marinas e.g. salinity and degree of enclosure.
- The discovery that the bryozoans *Bugulina simplex* and *Bugulina stolonifera* are widespread, probably due to previous under-reporting, although rapid spreading cannot be ruled out.
- The appearance of the San Diego sea squirt (*Botrylloides diegensis*) in the NW, the nearest previous record being in S. Wales.

Subsequent to the surveys we have supplied all the marinas with their individual data; which will assist them in drawing up biosecurity plans. The offer to provide this information was welcomed by the marina operators. The data has also been used in developing the MSFD baseline maps of NNS monitoring species.

It is recommended that:

- Funding is made available to permit the surveying of artificial habitats in NE England, last surveyed in 2012. In addition re-surveying of the SW coast, last carried out in 2013 should be considered.
- 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.

3. Workshop

A workshop was held at The Blackpool & The Fylde College. It was organised in collaboration with the North West Wildlife Trusts for Wildlife Trust staff and volunteers, Environment Agency and Natural England staff and other stakeholders including some students from the college. The main aim of the workshop was to improve their NNS identification skills. The training included: talks on identification of NNS specific to marinas and aquaculture, including some predicted invaders; a trip to Fleetwood marina to view organisms in situ and collect specimens for later examination; a practical session with an extensive selection of live and preserved specimens; and information on how to report sightings using established recording schemes such as the Sealife Survey which is part of the Marine Sightings Network, available at <http://www.mba.ac.uk/recording/>.



Figure 20: J. Bishop with workshop attendees at Fleetwood marina. Image: NWWT

Each attendee was provided with a copy of the latest *Identification Guide for Selected Marine Non-Native Species*, see www.mba.ac.uk/bishop/non-native-species-guides/, NNS posters and other guidance regarding biosecurity and recording.

The workshop was well attended (22 attendees) and received very good feedback; a summary of the feedback is given in Appendix VIII.



Figure 21: Attendees examining specimens they had collected from the marina. Image: NWWT



Figure 22: Attendees examining preserved specimens. Image: C. Wood

4. 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 has contributed significantly to the production of baseline survey maps of 24 key NNS species for use in the UK's response to the Marine Strategy Framework Directive (MSFD) monitoring for Descriptor 2 of Good Environmental Status, as required by the European Commission. For some species our survey data has contributed over 85% of the baseline presence/absence records, see Appendix IX.
- Data from the RAS 2014 and RAS 2015 projects have contributed substantially to the annual compilation of Indicator B6 (Pressure from Invasive Species) of the UK Biodiversity Indicators published by Defra, see Appendix X.
- Data will be used in a decadal review of the Marine Climate Change Impacts Partnership (MCCIP) Annual Report Cards to which J. Bishop and C. Wood are contributing. Our data on the spread of species previously restricted by temperature limits such as *Ficopomatus enigmaticus* is particularly relevant.
- J. Bishop and C. Wood have also participated in an EU-wide project on the prevention of spread of invasive alien species through horizon-scanning (Roy et al. 2015).
- The RAS 2014 report available on the Bromley Trust website has been used as a reference source by taxonomists and surveyors.
- A scientific paper on the distribution of NNS around England prior to these surveys has been published (Bishop et al. 2015). A follow-up paper is being drafted to record the recent marked changes documented in the surveys.
- Following our E Anglia surveys we received photos of yacht hulls from marina workers who we had engaged with, requesting assistance to identify the species present. The images were annotated and sent back to them. This demonstrates the benefit of active engagement with marina staff and users.
- Details from the surveys and workshop were tweeted from @NNSatMBA.

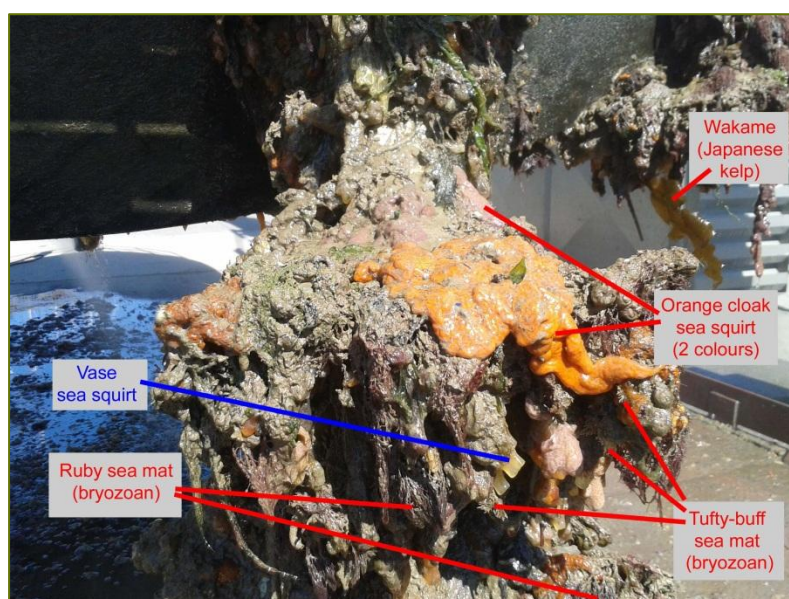


Figure 23: Annotated image of boat propeller. Annotation: J. Bishop

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Appendix I: Target list of non-native species

Non-native species	Description	Level of Threat
<i>Styela clava</i> (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.
<i>Asterocarpa humilis</i> (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.
<i>Ciona robusta</i>	Formerly referred to as <i>Ciona intestinalis</i> Type A. Solitary ascidian, very similar in appearance to native species <i>Ciona intestinalis</i> . Considered native to the NW Pacific. Currently known only from the SW coast, Newlyn to Torquay (Nydham and Harrison 2011). For distinguishing features see Sato et al. (2012).	Recently distinguished; threat to biodiversity – ‘cryptic’ species, potentially hybridises with native <i>Ciona intestinalis</i> ; fouler of aquaculture equipment; competes for food with farmed species such as mussels and oysters.
<i>Corella eumyota</i> (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.
<i>Botrylloides violaceus</i> (Orange cloak sea squirt)	Colonial ascidian native to NW Pacific. Grows on hard artificial 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.
<i>Botrylloides diegensis</i> (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.
<i>Botrylloides</i> sp. X	Colonial ascidian, origin and identity unknown.	Recently distinguished. Effects unknown.
<i>Didemnum vexillum</i> (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.

<i>Perophora japonica</i> (Creeping sea squirt)	A colonial ascidian of NE Asian origin, first recorded in Plymouth in 1999 (Nishikawa et al. 2000). Until recently only recorded from a limited number of sites in SW and S England, although widespread in France, however it has recently appeared in a number of natural habitats in estuaries and on the shore around the UK. 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.
<i>Aplidium cf. glabrum</i>	A colonial ascidian, similar in zooidal morphology to native <i>Aplidium glabrum</i> , 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.
<i>Tricellaria inopinata</i> (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.
<i>Bugula neritina</i> (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, but a rapid recolonization has since occurred (Ryland et al. 2011).	Widespread in UK, can affect biodiversity. An abundant fouling organism that colonises a variety of sub-tidal substrata including artificial structures and vessel hulls.
<i>Bugulina simplex</i>	Previously called <i>Bugula simplex</i> . Erect straw-coloured bryozoan that forms funnel-shaped colonies. Thought to be native to eastern seaboard of N America or the Mediterranean. Until recently there were few UK records (Ryland et al. 2011).	Effect unknown.
<i>Bugulina stolonifera</i>	Previously called <i>Bugula stolonifera</i> . Greyish-buff erect bryozoan which forms short compact tufts. Native to the Atlantic and Mediterranean. Until recently only known from S Wales and a few isolated English sites (Ryland et al. 2011).	Effect unknown.

<i>Watersipora subatra</i> (Red ripple bryozoan)	Previously referred to as <i>Watersipora subtorquata</i> . 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.
<i>Schizoporella japonica</i> (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 <i>S. japonica</i> is known to inhibit the growth of adjacent species.
<i>Diadumene lineata</i> (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.
<i>Austrominius modestus</i> (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.
<i>Amphibalanus amphitrite</i> (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, initially associated with artificially warmed sites.	Now occurring on S coast of England. Can be a fouling nuisance on yacht hulls and equipment.
<i>Amphibalanus improvisus</i> (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.

<i>Hesperibalanus fallax</i>	Previously called <i>Solidobalanus fallax</i> . Small 6-plated barnacle with calcareous base, typically epibiotic. Plates white with reddish-purple patches. Native to tropical Atlantic coast of Africa. Rare along southwest coasts of England and Wales but becoming more frequent. First UK record 1994 (Southward et al. 2004).	Effect unknown.
<i>Caprella mutica</i> (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.
<i>Ammothea hilgendorfi</i> (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.
<i>Crepidula fornicata</i> (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.
<i>Urosalpinx cinerea</i> (American oyster drill)	A gastropod native to E coast USA. First recorded in Essex oyster grounds in 1927 (Orton and Winckworth 1928). It became widely distributed across Essex and Kent coasts, but there are few recent records.	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.
<i>Crassostrea gigas</i> (Pacific oyster)	A bivalve mollusc with thick, rough shells. Occurs naturally in Japan and SE Asia. First introduced from Portugal (as <i>C. angulata</i>) 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.

<i>Ficopomatus enigmaticus</i> (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.
<i>Hydroides ezoensis</i>	A tube worm thought to originate from Japan, indigenous to NW Pacific. First recorded in UK from Southampton Water in 1976 (Thorpe et al. 1987).	Aggregations can be a nuisance, fouling harbour structures and ships' hulls. May provide habitat for free-living and sessile invertebrates.
<i>Hemigrapsus spp.</i> (Asian shore and brush-clawed crabs)	Small crabs native to the NW Pacific. Occur on muddy and rocky shores and in sheltered estuaries and port area. First UK records 2014, <i>Hemigrapsus takanoi</i> (brush-clawed crab) from R. Medway and Brightlingsea (Wood et al. 2015c); <i>H. sanguineus</i> (Asian shore crab) from Wales and Kent (Seeley et al. 2015).	Threat to biodiversity as they compete with native shore crab <i>Carcinus maenas</i> .
<i>Undaria pinnatifida</i> (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.
<i>Sargassum muticum</i> (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.
<i>Grateloupia turuturu</i> (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.

<i>Codium fragile fragile</i> (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, up-lift and move commercially produced shellfish and seaweed.
<i>Colpomenia peregrina</i> (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.
<i>Chrysomenia wrightii</i> (Golden membrane weed)	Large, glistening red seaweed. Indigenous to Japan. First UK record from Falmouth in 2013 (Bunker 2013).	Effects unknown.
<i>Caulacanthus okamurae</i> (Pom-pom weed)	Small red seaweed forming dense springy clumps. Native to Asia. First UK record 2004 on S coast (Brodie et al. 2015).	Turf formation can alter habitat displacing macro invertebrates, such as barnacles.
<i>Bonnemaisonia hamifera</i> (Hook weed)	Purplish-pink seaweed with delicate feathery fronds with curved hooks. Native to NW Pacific. Earliest UK record 1893 from Falmouth (Buffham et al. 1896), now widespread.	It may become the dominant alga competing with other algae and seagrasses.

Appendix II: Marinas surveyed with environmental measurements

Marina Code	County	Date of survey	Salinity (surface)	Salinity (2m)	Temperature °C (surface)	Temperature °C (2m)	Turbidity Secchi depth (m)
CUMB1	Cumbria	04/09/2015	30.6	30.8	15.4	15.4	1.4
CUMB2	Cumbria	03/09/2015	29.9	30.4	16.4	16.7	
LANC1	Lancashire	03/09/2015	0.4	0.4	17.7	17.7	>2.0
LANC2	Lancashire	03/09/2015	31.9	32.1	16.5	16.6	3.0
MERS1	Merseyside	04/09/2015	26.3	26.4	17.0	17.3	3.4
SOM1	Somerset	23/09/2015	25.8	25.7	16.1	15.8	2.2
ESSX1	Essex	10/07/2015	34.8	34.8	19.8	19.7	1.2
ESSX2	Essex	09/07/2015	35.5	35.4	20.4	19.5	
ESSX3	Essex	09/07/2015	35.7	Max depth 0.4m	18.0	Max depth 0.4m	>0.4
ESSX4	Essex	08/07/2015	34.5	35.3	19.0	19.0	1.6
SUFF1	Suffolk	08/07/2015	33.9	34.0	19.4	19.1	2.0
SUFF2	Suffolk	07/07/2015	34.3	34.1	18.4	17.7	1.8
SUFF3	Suffolk	07/07/2015	33.6	33.6	19.0	18.6	2.4

Note: We have used codes for the localities because some marina operators did not wish their establishments to be explicitly named. More detail on the localities is available subject to a confidentiality agreement.

All environmental measurements refer to the dates of surveys given.

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. The East Anglia surveys were carried out by JDB, CAW and LR, the western coast surveys by JDB, CAW and RC. 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, turbidity was estimated using a Secchi disk.

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: Occurrence of fouling NNS at 13 sites on the English coast in 2015

SITE CODE	ASCIDIANS									BRYOZOANS						OTHER ANIMALS										ALGAE						FW		Total species																		
	<i>Styela clava</i>	<i>Asterocarpa humilis</i>	<i>Ciona robusta</i>	<i>Corella eumyota</i>	<i>Botrylloides violaceus</i>	<i>Botrylloides diegensis</i>	<i>Botrylloides species 'X'</i>	<i>Didemnum vexillum</i>	<i>Perophora japonica</i>	<i>Aplidium cf. glabrum</i>	<i>Tricellaria inopinata</i>	<i>Bugula neritina</i>	<i>Bugulina simplex</i>	<i>Bugulina stolonifera</i>	<i>Watersipora subatra</i>	<i>Schizoporella japonica</i>	<i>Diadumene lineata</i>	<i>Austrorhinus modestus</i>	<i>Amphibalanus amphitrite</i>	<i>Amphibalanus improvisus</i>	<i>Hesperibalanus fallax</i>	<i>Caprella mutica</i>	<i>Ammothea hilgendorffi</i>	<i>Crepidula fornicata</i>	<i>Urosalpinx cinerea</i>	<i>Crassostrea gigas</i>	<i>Ficopomatus enigmaticus</i>	<i>Hydroides ezoensis</i>	<i>Hemigrapsus spp.</i>	<i>Undaria pinnatifida</i>	<i>Sargassum muticum</i>	<i>Grateloupia turuturu</i>	<i>Codium fragile fragile</i>		<i>Colpomenia peregrina</i>	<i>Chrysomenia wrightii</i>	<i>Bonnemaisonia hamifera</i>	<i>Caulacanthus okamurae</i>	<i>Dreissena polymorpha</i>	<i>Dikergammarus haemobaphes</i>												
WEST																																																				
CUMB1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3						
CUMB2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3				
LANC1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	2					
LANC2	3	0	0	1	2	1	0	0	0	1	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9		
MERS1	3	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3			
SOM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3		
Sites occupied	3	0	0	2	1	1	0	0	0	1	2	0	0	1	0	0	4	0	2	0	0	0	0	0	0	2	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	23			
E ANGLIA																																																				
ESSX1	3	0	0	0	3	2	1	2	0	1	3	1	2	1	0	0	2	0	1	0	0	0	1	0	1	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	
ESSX2	2	0	0	0	3	3	0	0	0	1	2	3	3	2	0	0	1	0	0	0	0	1	1	0	1	0	0	0	3	3	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
ESSX3	3	0	0	0	2	1	0	0	0	1	1	3	2	2	0	0	2	0	1	0	2	1	1	0	1	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
ESSX4	3	0	0	1	3	2	0	0	0	1	2	3	2	2	0	0	0	1	0	0	0	3	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
SUFF1	2	0	0	1	3	3	0	0	0	2	1	3	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
SUFF2	1	0	0	3	1	0	0	0	0	1	2	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
SUFF3	2	0	0	2	2	0	0	0	0	2	2	3	0	2	0	0	2	0	0	0	3	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Sites occupied	7	0	0	4	7	5	1	1	0	7	7	7	6	6	0	0	7	0	2	0	3	3	3	0	3	0	2	0	7	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	
Combined totals	10	0	0	6	8	6	1	1	0	8	9	7	6	7	0	0	11	0	4	0	3	3	3	0	3	2	2	0	8	3	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	

Notes:

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 V: Comparison between 2009/10 and 2015 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	Bugulina simplex	Bugulina simplex	Bugulina stolonifera	Bugulina 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	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	2009/10	2015	Change				
WEST																																															
CUMB1	0	1		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2			
CUMB2	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0
LANC2	1	1		0	0	1	1	1	0	1	0	0	0	0	1	1	1	0	0		0		0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	8	4
MERS1	1	1		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0		0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1
																																				9	16	7									
E ANGLIA																																															
ESSX1	1	1	0	0	0	0	1	1	1	1	0	1	0	0	0	1	1	1	1		1		1	0	0	1	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	10	13	3			
ESSX3	1	1	0	0	0	0	1	1	0	1	0	0	0	0	1	1	1	1	1		1		1	0	0	1	1	1	1	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1	9	14	5
ESSX4	1	1	0	0	1	1	1	1	0	1	0	0	0	0	0	1	1	1	1		1		1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	8	12	4		
SUFF1	1	1	0	0	0	1	1	1	0	1	0	0	0	0	1	1	1	1	1		1		1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	8	12	4
SUFF2	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1		1		0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	6	9	3
SUFF3	1	1	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1		0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	9	10	1	
																																				50	70	20									
2009/10	8	0	3	7	1	0	0	3	7	6	0	1	0	9	3	2	3	2	3	2	3	2	3	1	59																						
2015	9	0	6	7	5	1	0	7	8	6	5	6	0	9	3	2	2	1	7	2	86																										

Notes:

Presence/ Absence at 10 sites, 20 species common to both sets of surveys. 1=Present, 0= Not present, Blank = Not looked for or not noticed or ID uncertain.

2009/10 surveys on western coast conducted by Bangor University.

Undaria pinnatifida was recorded in LANC2 in 2007 (a single specimen) but was not seen in 2009/10.

Appendix VI: Form used for collecting information from marina staff

Survey title **BROMLEY 2015**

MARINA:

DATE:

No. of berths:	Area m ² :	Age:
Enclosure %:		
Lock gates/sill:		
Depth/ drying out:		
Freshwater inputs: Drains? Run-off?		
Problem species: Timescale? What action?		
Maintenance regime: Pontoon cleaning, method & frequency Chemicals? Dredging?		
Hull cleaning facilities:		
Visits from overseas:		
Distance from major port or ferry terminal:		
Berth-holder profile: Leisure boats Dive/angling charters Commercial fishing		

Appendix VII: NNS workshop flyer



MARINE NON-NATIVE SPECIES: A ONE-DAY WORKSHOP

Wednesday Sept 2nd 2015 9.30am-4.00pm

Blackpool & The Fylde College
University Centre Campus, FY1 4EE

This workshop offers an introduction to:

- ❖ Identification of non-native fouling species found in marinas and ports, such as sea squirts, bryozoans, seaweeds and barnacles
- ❖ Field trip to Fleetwood Haven marina to examine species in situ

Intended for: Wildlife Trust staff and others employed in the marine sector.

To book or for more information

Email: livingseasnw@cumbriawildlifetrust.org.uk Tel: 01539 816318



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North West
Wildlife Trusts

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- Blackpool & The Fylde College

Date of Course: 02/09/15

Attendees: Total 22 (Wildlife Trust staff 9, WT volunteers 3, Natural England 3, Environment Agency 3, College staff 1, College students 3)

<i>Content</i>	Poor/ no	Average/ partly	Good/ mostly	Excellent/ completely
Were the expected items covered in sufficient detail?			44%	56%
Was the content suited to your requirements?			35%	65%
Was the course content easy to understand?			29%	71%
Was the supporting information sufficient?			6%	94%

<i>Trainer(s)</i>	Poor	Average	Good	Excellent
How well conducted was the training?			6%	94%
How well paced was the delivery of information?		6%	12%	82%
How effectively did the trainer(s) deliver the information?			12%	88%

<i>Facilities</i>	Poor	Average	Good	Excellent
Rate the training facilities			23%	77%
Rate the standard of equipment			23%	77%
Rate the refreshment facilities			37%	63%

Would you recommend others to do this course? Yes **100%**

Would you attend similar courses run by the MBA in the future? Yes **100%**

If so, what topics would you like to see covered in future courses?

Seaweed ID. Saltmarsh plants. Crustaceans (2). Bivalves (2). Marine mammals Fish. Native seasquirts. Climate change species. Monitoring methodology (2). Ecological impacts of NNS. Management of NNS.

What would you have improved about the course?

Nothing, really good foundation. Too much information to absorb in short time. Increase to two days. Brought a hand lens. Less Powerpoint. More time at marina (2).

What did you like most about the course?

Practical hands-on (7). Seeing a lot actual specimens (5). Marina trip to collect specimens (4). Good mix of talks and practical (3).

How did you hear about the course?

Colleague (4). Cumbria WT (8). College/University (4).

Appendix IX: Marine Strategy Framework Directive

The Marine Strategy Framework Directive (MSFD) was introduced in 2008 by the European Union to promote sustainable use of Europe's seas and conserve marine ecosystems. Its objective is to 'protect, preserve and improve the environment for present and future generations'. The main goal of the directive is to achieve Good Environmental Status in Europe's seas by 2020. The directive defines Good Environmental Status as **"marine waters that provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive"**. There are 11 descriptors to guide evaluation of Good Environmental Status. Descriptor 2 is for Non-indigenous species – levels to be minimised.

MSFD is a cyclical process with each cycle taking 6 years. It requires EU countries to develop marine strategies following a specific timeline. The process follows a logical sequence of looking at the current state of the marine environment and setting targets, developing monitoring to measure progress against the targets, identifying measures that are needed to achieve the targets and then ongoing monitoring, evaluation and adaptation. For the first step, EU countries must carry out an initial assessment of the marine environment and define what 'Good Environmental Status' looks like for them. This includes setting targets and indicators, making Good Environmental Status something that can be measured.

MSFD divides Europe's seas into regions and sub-regions. Within a sub-region the countries included are required to coordinate the development of their marine strategies.

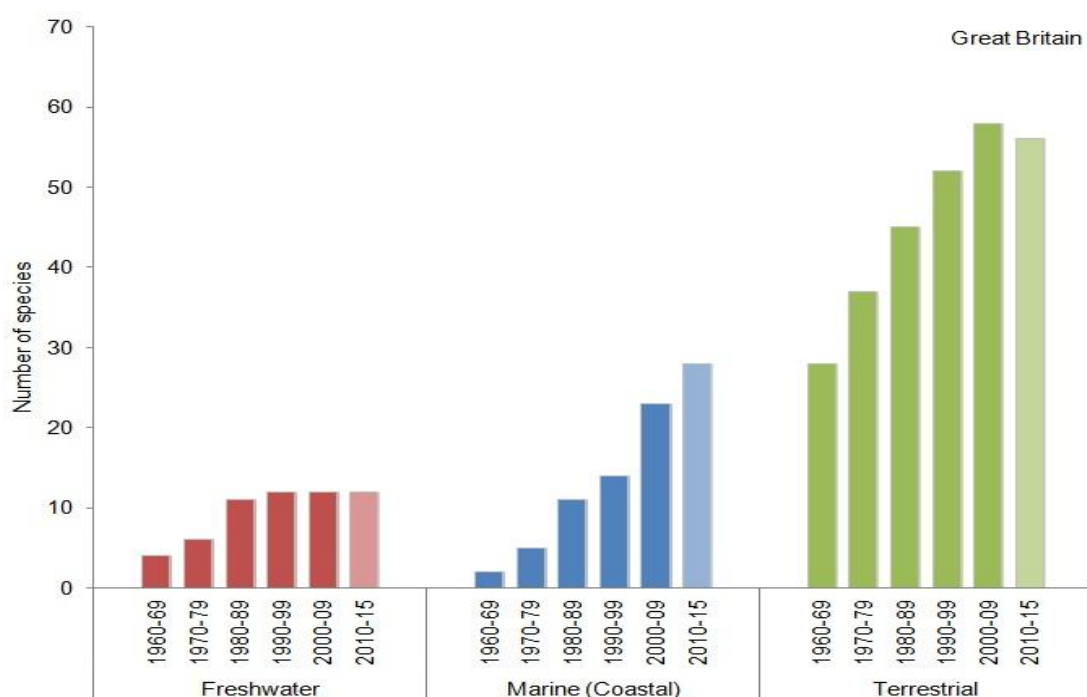
(Information taken from the Celtic Seas Partnership website: <http://celticseaspartnership.eu/background/>.)

J. Bishop and C. Wood have advised on the development of the list of non-native species to be monitored to meet pathway management obligations under the MSFD. The data from RAS 2014, RAS 2015 and data from previous survey work by the group has contributed significantly to the baseline data for these species, for example they have provided 85-95% of the baseline presence/absence records for *Amphibalanus amphitrite*, *Asterocarpa humilis*, *Watersipora subatra* and *Ficopomatus enigmaticus*.

Appendix X: UK Biodiversity Indicators

The United Kingdom is a signatory to the Convention on Biological Diversity (CBD) and is committed to the biodiversity goals and targets ('the Aichi targets') agreed in 2010 and set out in the Strategic Plan for Biodiversity 2011-2020. The UK is also committed to developing and using a set of indicators to report on progress towards meeting these international goals and targets. There are related commitments on biodiversity made by the European Union, and the UK indicators may also be used to assess progress with these. The indicators are useful tools for summarising and communicating broad trends.

Indicator B6 description - Pressure from invasive species



The figure shows the change in number of invasive non-native species established across more than 10 per cent of the land area of GB, or more than 10 per cent of the extent of the coastline. There are 180 established invasive non-native species included within the indicator, comprising 39 freshwater species, 34 marine species and 107 terrestrial species. For the latest period 2010–2015, compared with 2000–2009, the number of these established in or along more than 10 per cent of Great Britain's land area or coastline has increased for freshwater species, to 14 from 13 and for marine species, to 27 from 23. Terrestrial species have decreased to 56 from 67. The short-term trend is not assessed.

Information taken from <http://jncc.defra.gov.uk/page-4229> (Crown copyright)

Data from the RAS 2014 and RAS 2015 projects has been utilised in the compilation of the marine element of Indicator B6. The documentation of species arrivals and their subsequent spread during repeated RAS has contributed very substantially to the increasing number of widely established marine invaders, which has been rising more steeply than those of the other habitats, highlighting very clearly the rapid rate of anthropogenic change in our coastal habitats.



Figure 24: Selection of NNS from an Essex marina. Image: J. Bishop