Report to The Bromley Trust

RAS 2016

Non-Native Species Rapid Assessment Surveys in English Marinas (NE & SW coasts)

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May 2017

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Cover image: *Schizoporella japonica* © J. Bishop

Project details

This report describes the current distribution of NNS in marinas on the North East and South West coasts of England, comparing it to data from previous surveys from 2009-2013 and to data from other areas of the UK. It supplements the reports from the RAS 2014 and RAS 2015 projects which surveyed the South coast, East Anglia and the West coast. The data is of relevance to monitoring and pathway management obligations under the Marine Strategy Framework Directive (MSFD); will contribute to the annual compilation of Indicator B6 (Pressure from Invasive Species) of the UK Biodiversity Indicators published by Defra; and will inform assessment of 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

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

Acknowledgements

We are grateful to the Bromley Trust for supporting this research. This project was part funded by The Marine Biological Association of the UK.

We would like to thank all the marinas for permitting access.

Executive Summary

This project was developed to complete the spatial coverage of the RAS 2014 project (Wood et al. 2015a) which was partly funded by the Bromley Trust and the RAS 2015 project (Wood et al. 2016) which was wholly 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 complete a set of surveys of marinas and harbours in all coastal regions of England and Wales between 2014 and 2016. This work began with the RAS 2014 project and was augmented by the RAS 2015 project and a similar scheme in Wales. These surveys documented rapid recent changes, suggesting that a resurvey around the remaining North East (NE) and South West (SW) sections of the English coast would also reveal extensive shifts. The NE was last surveyed in 2012, and the SW in 2013.

Thirty two different marine NNS were recorded during the surveys. The total NNS records generated was 248. The number of NNS records in the NE rose by 50% in four years. In the SW records increased by 7.3% in three years (see Appendices VI – VIII) and by 40% in the 7 years since 2009/10. It should be noted that in the SW many species such as Darwin's barnacle (*Austrominius modestus*) are now at maximum occupancy.

There were clear differences between the two areas studied for this report. In the NE there were generally low numbers of NNS with a mean of 3.1 species per site, whereas in the SW the mean was 12.9. These large differences support the findings of previous surveys of low numbers along the west coast of England and in Wales compared with much higher numbers in East Anglia and all 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.

In the NE there was evidence of new arrivals to the area e.g. the Orange ripple bryozoan (*Schizoporella japonica*) and Devil's tongue weed (*Grateloupia turuturu*) and ongoing rapid colonisation of additional sites by species already present, in particular the Orange-tipped sea squirt (*Corella eumyota*), the Tufty-buff bryozoan (*Tricellaria inopinata*) and the bryozoan *Bugulina simplex.* However there are still many NNS species common elsewhere in the UK which are absent in this area. In the SW the spread of species westward to and around the Falmouth area was apparent e.g. the San Diego sea squirt (*Botrylloides diegensis*), the Pacific oyster (*Magallana gigas*) and Wakame (*Undaria pinnatifida*).

Data from the RAS 2014 and RAS 2015 and RAS 2016 projects has contributed substantially to decision making regarding marine NNS by governmental organisations. 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. This data 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 marine invaders categorised as widely established, which has been rising more steeply than those of the other habitats, highlighting very clearly the rapid rate of anthropogenic change in our coastal habitat. Data has been used in a decadal review of the Marine Climate Change Impacts Partnership (MCCIP) Annual Report Cards.

One of the most significant outcomes from the RAS 2014, RAS 2015 and RAS 2016 projects was being asked to participate in a project funded by Natural England to assist port authorities and commercial marine operators to develop biosecurity plans, with the aim reducing the spread of NNS. Our species distribution data is now being used throughout England and Wales in the production of biosecurity plans for single sites, or for marina chains such as MDL and the Yacht Havens Group, or for whole geographical areas such as the Tamar Estuaries Area, the South Devon Area of Outstanding Natural Beauty and the Humber estuary. C. Wood was particularly involved in the writing of the draft biosecurity plan for the Tamar Estuaries area and in organising a workshop to support the plan development with local stakeholders.

Engagement with marina operators and boat owners 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 investigating how the survey methodology we use can be applied to natural shores, particularly those in Marine Protected Areas. Although many of these shores are regularly surveyed for native species, there is a paucity of data on the occurrence of NNS. We would like to test an 'NNS timed search' methodology on shores in the SW this year.

Further work should also be undertaken to better understand the relationship between the prevalence of NNS and site environmental properties such as salinity levels, depth, degree of enclosure, size and age of the development. This would capitalise on the data already gathered and could be used to inform future site risk assessments and planning.

As a result of Brexit there is uncertainty over the UK government's commitment to the implementation of statutory monitoring and surveillance of NNS under MSFD. The benefits and cost-effectiveness of the repeated surveys that we have undertaken is however increasingly widely appreciated and we will endeavour to keep this work going pending longer-term support.

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1. Introduction

This project was developed to build on the success of the RAS 2014 project (Wood et al. 2015) which was jointly funded by the Bromley Trust and Natural England, and the RAS 2015 project (Wood et al. 2016) which was wholly 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 complete a set of surveys begun with the RAS 2014 project and augmented by the RAS 2015 project and a similar scheme in Wales. These surveys documented rapid recent changes (Bishop et al. 2014; Wood et al. 2015a; Wood et al 2015b; Wood et al. 2016), suggesting that a resurvey around the remaining English coast would also reveal extensive shifts. Marinas in all coastal regions of England and Wales have now been surveyed for NNS between 2014 and 2016. The NE was last surveyed in 2012 (Bishop et al. 2015), and the SW in 2013 (included in the RAS 2014 report).

The data is 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. It has also contributed 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 conservation charities, government departments, non-departmental public bodies and other organizations concerned with environmental policy and management of NNS. The data is also increasingly being used to inform biosecurity planning in the marine sector.

This project had the following aims:

- To complete rapid assessment surveys (RASs) of marinas, harbours and aquaculture sites around the NE and SW coasts of England to assess the current distribution and rate of spread of non-native species (NNS).
- To raise awareness of NNS amongst marina operators through outreach interactions in marinas.

2. Surveys

2.1. Methodology - surveys

A target list of 38 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 all target species are given at Appendix I. The red seaweed *Pikea californica* (Pike's weed) was added to the target list used in RAS 2015. The Pacific oyster's scientific name has been changed from *Crassostrea gigas* to *Magallana gigas.*

23 marina sites along the coast were initially selected: 9 in the NE, 6 of which had been previously surveyed by us in 2012 plus 3 not previously surveyed; and 14 along the SW coast, all previously surveyed by us in 2013. As unfunded additions to the project we also decided to survey an extra site in east Cornwall and two sites in the Chichester area of the S coast, which we had not previously visited. Sites were examined between July and September 2016 for the presence of non-native species. A map of all sites is shown in 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 and RAS 2015 projects. In addition many native species were recorded. For the surveys in the NE J. Bishop and C. Wood were assisted by Chris Nall from the University of the Highlands and Islands (UHI), and for the surveys along the SW coast they were assisted by Lisa Rennocks from the Cornwall Wildlife Trust; both had been trained in the RAS methodology and had carried out previous surveys. At Hartlepool marina we were accompanied by Katy Barrett from Natural England who wished to observe the methodology and improve her NNS identification skills. At Portland we were accompanied by the National Seasearch Coordinator, Charlotte Bolton, and a staff member of the Dorset Wildlife Trust, Lin Baldock, to share expertise on species identification. Esther Hughes, a seaweed specialist at the MBA, accompanied us at two sites in Plymouth.

While visiting the marinas outreach conversations were initiated with marina operators and interested yacht owners with the aim of raising awareness of NNS. As in the RAS 2015 project, marina staff were asked a number of questions, see Appendix IX, to provide information that could be relevant to a site's susceptibility to colonisation by NNS. Waterproof copies of the *Identification Guide for Selected Marine Non-Native Species*, see http://www.mba.ac.uk/fellows/bishop-group-associate-fellow#b18 were handed out.

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

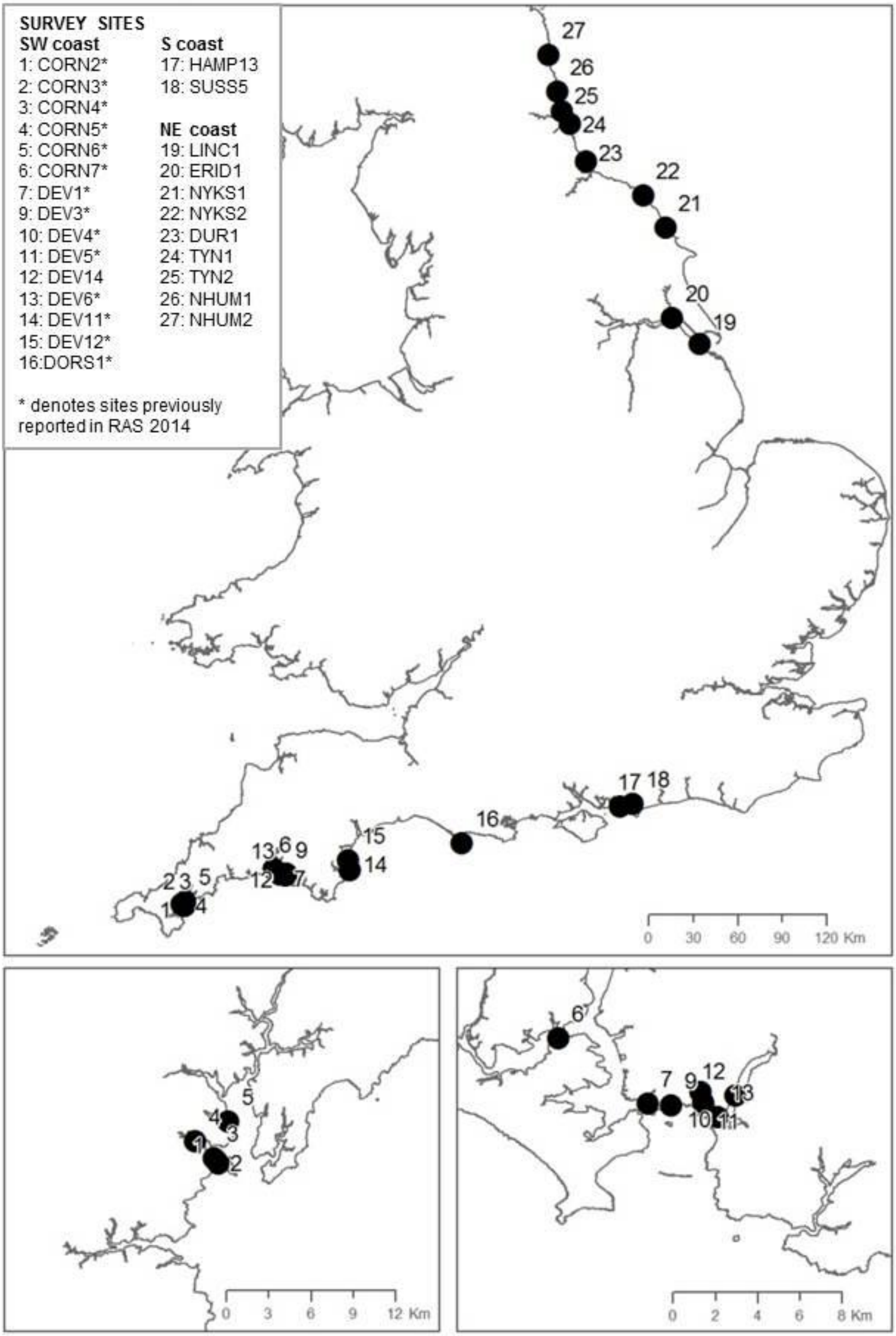

Figure 1: Locations of marinas surveyed for NNS in 2016

2.2. Results - surveys

The detailed NNS occurrence and abundance data is given in Appendices IV and V. The environmental measurements of salinity, temperature and turbidity are reported in Appendix II. A comparison between these survey results and those from previous surveys is shown in Appendices VI, VII and VIII. All NNS species records will be made publicly available via NBN Atlas.

Species accounts

Thirty two different marine NNS were recorded during the surveys, the most frequently occurring being Darwin's barnacle (*Austrominius modestus*) recorded at 23 of the 26 sites, the Tufty-buff bryozoan (*Tricellaria inopinata*) 19/26, the Leathery sea squirt (*Styela clava*) 16/26, and the Orange-tipped sea squirt (*Corella eumyota)*16/26, see Figure 2.

Occurrence details and images of nine of the species recorded are given below; a further fifteen are described in the RAS 2015 and RAS 2014 reports.

Species on the target list not recorded during these surveys were: the colonial ascidian *Botrylloides* species 'X', the Striped barnacle (*Amphibalanus amphitrite*), the barnacle *Hesperibalanus fallax*, the American oyster drill (*Urosalpinx cinerea*) and Pike's weed (*Pikea californica*). One additional NNS not on the target list was recorded, a brown seaweed *Dictyota cyanoloma*.

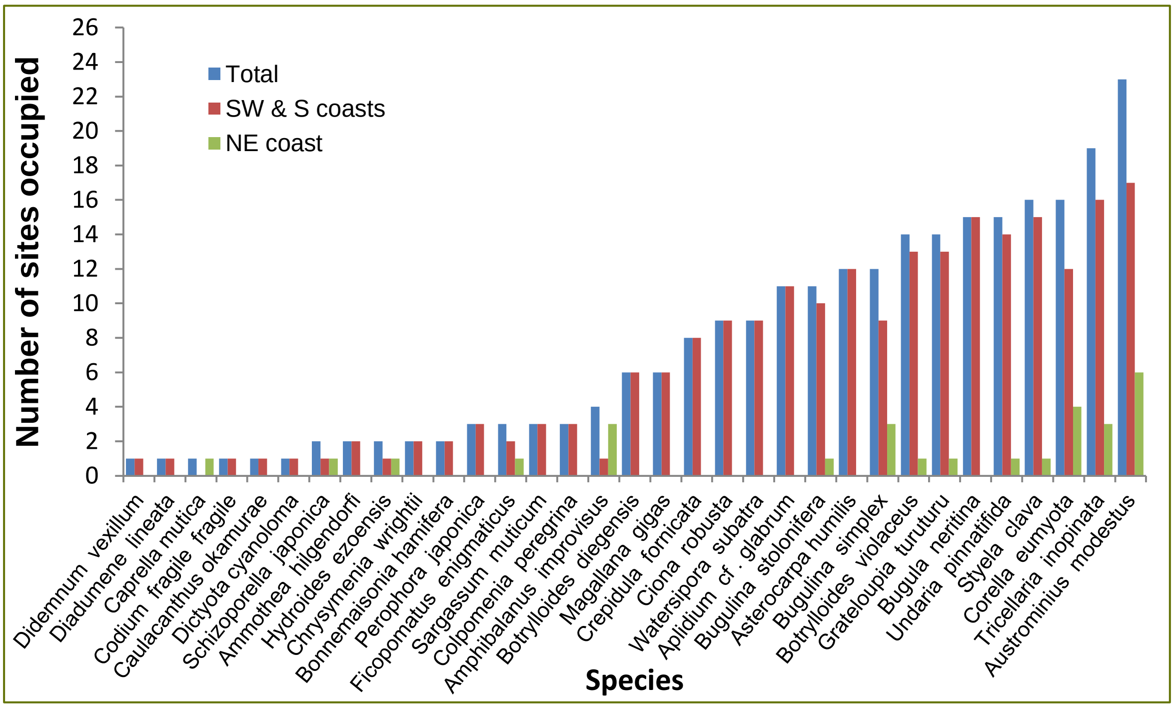

Figure 2: Frequency of occurrence of 32 NNS at 26 sites along the SW & S and NE coasts

Schizoporella japonica (Orange ripple bryozoan)

The Orange ripple bryozoan, originally from Japan, was first detected in the UK in Holyhead, north Wales, in 2010, then in northern Scotland in 2011 and Plymouth in 2012 (although recently an earlier single occurrence of *S. japonica* in Plymouth from 2009 has been discovered). It is now widespread throughout some areas of Scotland, including in natural habitats.

During the 2016 surveys it was discovered to be abundant in a harbour in Northumberland NHUM1 (Plymouth being the only other English site), possibly having spread southward from the East coast of Scotland. The current UK and European distribution of this invasive encrusting bryozoan, including the presence/absence records from the 2016 surveys and the RAS 2014 and RAS 2015 surveys, has now been published (Loxton et al. 2017).

Figure 3: *Schizoporella japonica*, Northumberland. Image: C. Wood

Botrylloides diegensis (San Diego sea squirt)

Figure 4: *Botrylloides diegensis,* Dorset. Image: C.Wood

This colonial ascidian native to the W coast of N America was first recorded in the UK in 2004 on the S English coast, where it is now very common in marinas. The RAS 2014 surveys discovered that it had spread westward from Brixham to a single site in Plymouth (not included in these surveys). It is now present in an additional Plymouth marina DEV4 and has spread even further west to Falmouth (CORN5), where a single colony was noted. However it was not found in the NE.

Perophora japonica (Creeping sea squirt)

This inconspicuous colonial ascidian, native to NE Asia, was first recorded in the UK in 1999 and seemed to be restricted to a limited number of sites in SW and S England. However in recent years it has been increasingly spotted by divers in natural habitats such as the Helford estuary in Cornwall, Strangford Lough in N Ireland, and on the shore e.g. at St Ives, Godrevy and Gunwalloe in Cornwall (D Fenwick, pers. comm.). In these 2016 surveys it was newly recorded from a marina in Dorset.

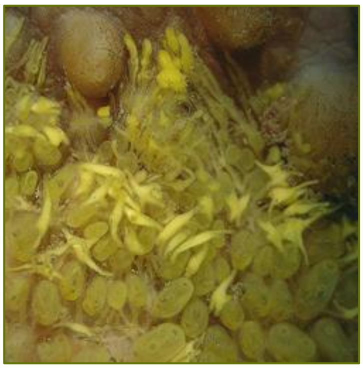

Figure 5: *Perophora japonica*. Image: J. Bishop

Corella eumyota (Orange-tipped sea squirt)

Figure 6: *Corella eumyota,* Devon. Image: J. Bishop

The Orange-tipped sea squirt is native to the S hemisphere and was probably introduced here via aquaculture. It spread rapidly around the UK after its discovery on the S coast in 2004. During these recent surveys it was found at 16 of the 26 sites, making it one of the most frequently recorded NNS. Whereas its abundance in SW marinas and on SW shores appears to be declining (it was not found at the CORN4, DEV1 and DEV4 sites where it was present in 2013), it appears to be spreading in the NE and records from natural shores elsewhere in the UK are being more regularly reported e.g. Kimmeridge (J Hatcher, pers. comm.), Lindisfarne (C Scott, pers. comm.).

Magallana gigas (Pacific oyster) previously called *Crassostrea gigas*

Pacific oysters were deliberately introduced to the UK in the 1960s for commercial purposes with the first record from the wild being in 1965. It was initially believed that temperatures in British waters would not be suitable for them to successfully reproduce, but escapees have established feral populations in S England and Wales. The Pacific oyster can alter habitats and ecosystems through reef formation; this can displace native oysters and have a negative impact on native biodiversity. Economically, although wild populations may be exploited by local fishermen, they can foul artificial structures and make shores unattractive to leisure users because of the sharpness of the shells underfoot. Natural England has developed guidance for voluntary groups on the manual removal of Pacific oysters.

Figure 7: *Magallana gigas*, Devon. Image: J. Bishop

We recorded Pacific oysters at 6 sites in the SW compared to 2 in 2013. Regular observations at a marina in Plymouth also indicate that there has been increased settlement in recent years, possibly due to the warmer winters.

Ficopomatus enigmaticus (Trumpet tube worm)

Figure 8: *Ficopomatus enigmaticus,* on a fender in Sussex. Image: C. Wood

The Trumpet tube worm sometimes forms dense aggregations which can be a severe fouling nuisance on boat hulls, pontoons and ropes, they readily attach to propellers which can result in engine failure. As reported in RAS 2015 the increasing abundance of this species around the English coast may be due to the recent mild winters and hot summers. During the RAS 2016 surveys it was found to be at super-abundant levels in one marina on the S coast and present at two further sites, one in the SW and one in the NE.

Grateloupia turuturu Devil's tongue weed

Figure 9: *Grateloupia turuturu*, Lincolnshire. Image: C. Wood

Devil's tongue weed is a large red alga from the NW Pacific, with broad slippery blades and a very small holdfast. Although it has been present in the UK since 1969, in recent years it seems to be spreading more aggressively. *G. turuturu's* large size and high reproductive output means it can out-compete many native macroalgae in the low intertidal and shallow subtidal zones; it can also alter trophic patterns and cause habitat loss through shading. Here we report the first record from the NE coast, the nearest known population being in Dover.

Undaria pinnatifida (Wakame or Japanese kelp)

Wakame is a brown kelp native to the NW Pacific. It is very fast growing with fronds reaching 1-3m, the blade has a distinct midrib and, when reproductive the stipe has a characteristic frill. It is particularly prevalent along the S coast of England and has been identified as a risk to the ecological status of MPAs. It competes for space with native kelp species and may be a nuisance fouling jetties, vessels, moorings and buoys; it has the potential to impact on aquaculture through fouling.

Figure 10: *Undaria pinnatifida*. Image: J. Bishop

Since the RAS 2014 surveys Wakame has spread to a further 2 sites in Falmouth, despite eradication attempts by Cornwall Wildlife Trust. It has also recently been reported from a marina near Edinburgh, the first record from Scotland (GBNNSS 2016).

Dictyota cyanoloma

This brown seaweed with distinctive blue iridescent margins is native to Australia. It was first observed in the UK in 2013 in a marina in Falmouth during the 2013 Defra/CWT surveys which contributed to the RAS 2014 report. However it was not included in that report as its identification was awaiting confirmation (Steen et al. 2017). In Spain, Portugal and Morocco it has spread to natural habitats so could impact native species. *D. cyanoloma* was again found in the recent 2016 surveys at the same marina in Falmouth (CORN5), it was not found anywhere else.

Figure 11: *Dictyota cyanoloma*, Falmouth. Image: J. Bishop

Site accounts

As part of the RAS 2015 project we developed a series of questions for marina operators (Appendix IX), with the intention of gathering information about factors such as salinity and degree of enclosure which could influence the susceptibility of a marina to invasion by new NNS. We repeated this exercise in the RAS 2016 surveys. The marina operators were happy to provide the requested information and we are hoping to gather the same information from 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 site's susceptibility to invasion by NNS.

The total number of NNS records generated from these surveys was 248: 220 from the SW and S coasts and 28 from the NE coast. The mean number of NNS recorded at the survey sites was 12.9 along the SW and S coast combined, and 3.1 along the NE coast. The sites with the highest number of NNS were spread throughout the SW and S coasts: DEV5 (18), CORN5 (17), HAMP13 (16), DORS1 (16) and DEV1 (16), see Figure 13 and Appendices IV and V. The sites with the lowest occupancy were nearly all along the NE coast with 7 of the 9 marinas surveyed having 3 or fewer NNS. The exception was DEV14, a Plymouth site which we did not report on in RAS 2014; it is on the R. Plym and is very brackish with a high freshwater river flow.

The results for the NE coast of England with low average numbers of NNS, were very similar to those we found in Wales (Wood et al. 2015b), and the western coast of England (RAS 2015). One likely explanation for this is that many had lock gates and low or fluctuating salinities, see Appendix II. However NYKS1 (Scarborough harbour) is open, fully saline and hosts a rich variety of native fouling species, yet we still only found three NNS there. Another possibly major contributing factor is that the SW and S coast sites are close to the European coast, from where many NNS have been introduced (Bishop et al. 2014).

At one marina in the Chichester area the Trumpet tube worm (*Ficopomatus enigmaticus*) was sufficiently abundant to be a severe fouling nuisance on yachts and pontoons, and thus to be having an economic impact on the marina and boat owners.

Figure 12: Northumberland marina NHUM2. Image: C. Wood

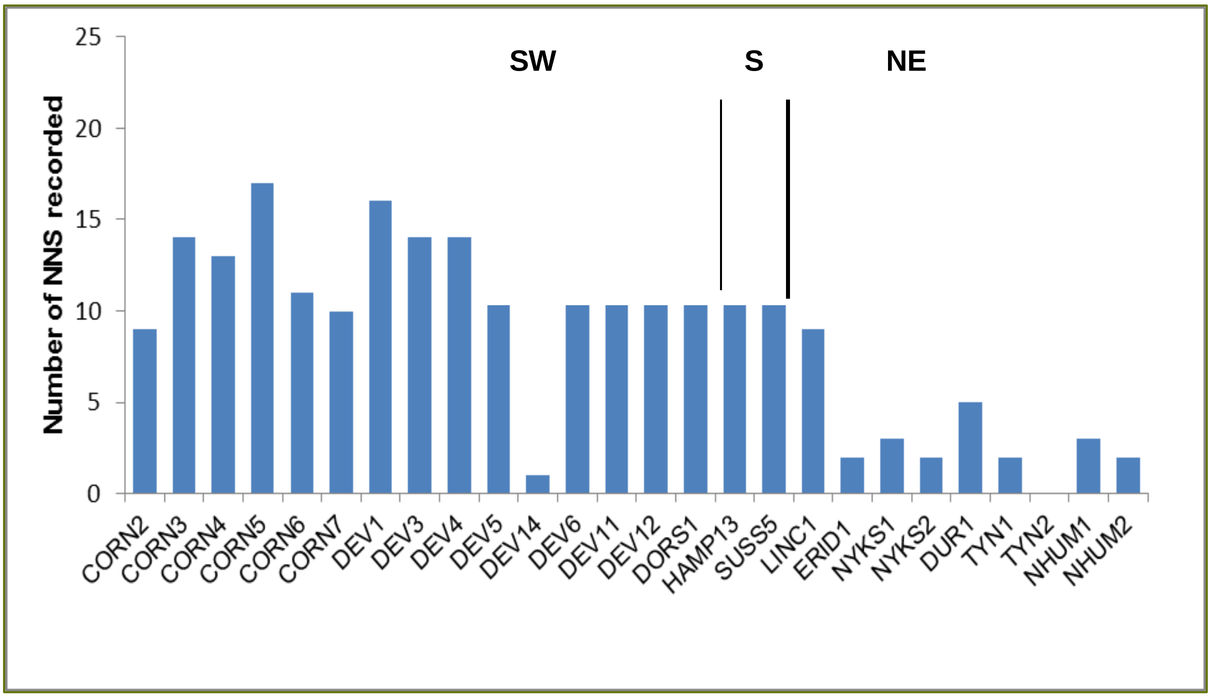

Figure 13: Counts of NNS recorded at sites along the SW, S and NE coast of England

Trends

In the NE there were 6 sites and 21 species common to the 2012 and 2016 surveys, and the total number of NNS records generated rose from 12 to 18, an increase of 50% in four years, see Appendix VII. Along the SW coast there were 14 sites and 32 species in common between the 2013 and 2016 surveys, and the total number of NNS records rose from 165 to 177, an increase of 7.3% in three years, see Appendix VI.

A summary of the changes in the number of sites occupied by species is shown in Figure 14 for the NE and Figure 15 for the SW coast. Along the NE coast the increase is mainly due to the spread of *Corella eumyota* and the erect bryozoans *Tricellaria inopinata* and *Bugulina simplex* and our first survey record for *Bugulina stolonifera* (although it had been recorded in the area once before in 1993). There are still many NNS species common elsewhere in the UK which are absent in this area.

In the SW more comparisons can be made, as by 2013 our surveys were targeting an increased number of species. Here species such as *Ciona robusta*, *Botrylloides violaceus, B.diegensis*, *Magallana gigas*, *Undaria pinnatifida* and *Bugulina stolonifera* are spreading particularly in the Falmouth area, whereas several species are probably already at maximum occupancy e.g. *Austrominius modestus*, *Tricellaria inopinata* and *Bugula neritina*. This could explain the lower percentage increase between 2013 and 2016. It should be noted that *Corella eumyota* appears to be less common now in the SW, being recorded at 10 sites in 2016 compared to 13 in 2013. However, it is still one of the most frequently occurring NNS.

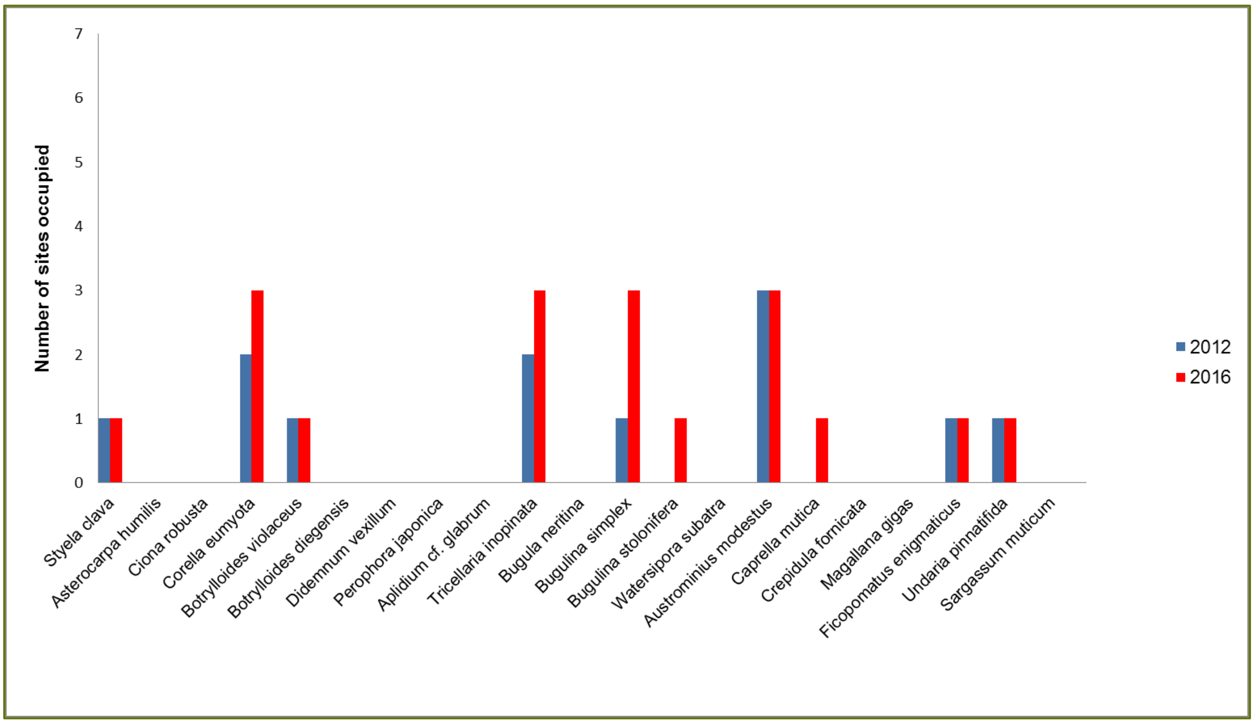

Figure 14: Changes in occurrence of 21 species at 6 NE sites from 2012 to 2016

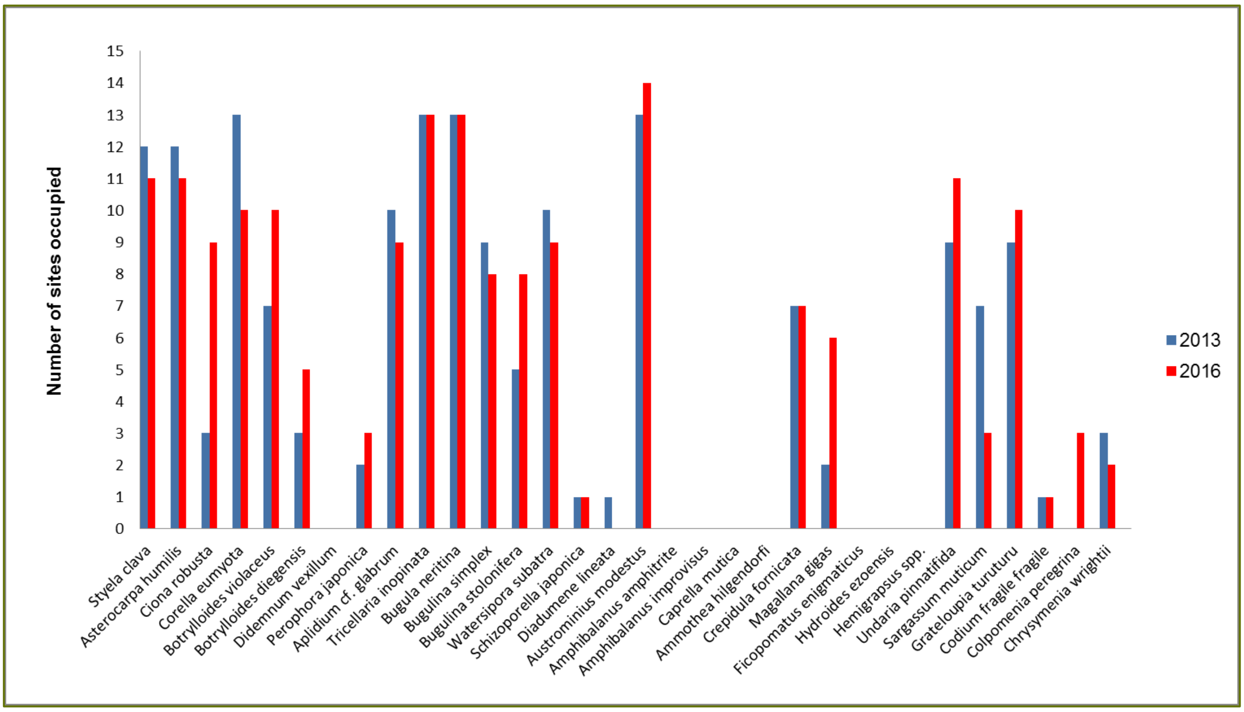

Figure 15: Change in occurrences of 32 species at 14 SW sites from 2013 to 2016

For the SW it is also possible to compare NNS counts between 2009/10, 2013 and 2016 for 20 species over 10 sites; this shows an increase of 30.6% between 2009/10 and 2013 and a further increase of 7.2% from 2013 to 2016, see Figure 16 and Appendix VIII.

Note these figures ignore species which have arrived or spread in that period but were not specifically looked for in 2009/10 e.g. *Schizoporella japonica, Grateloupia turuturu* and *Chrysymenia wrightii*.

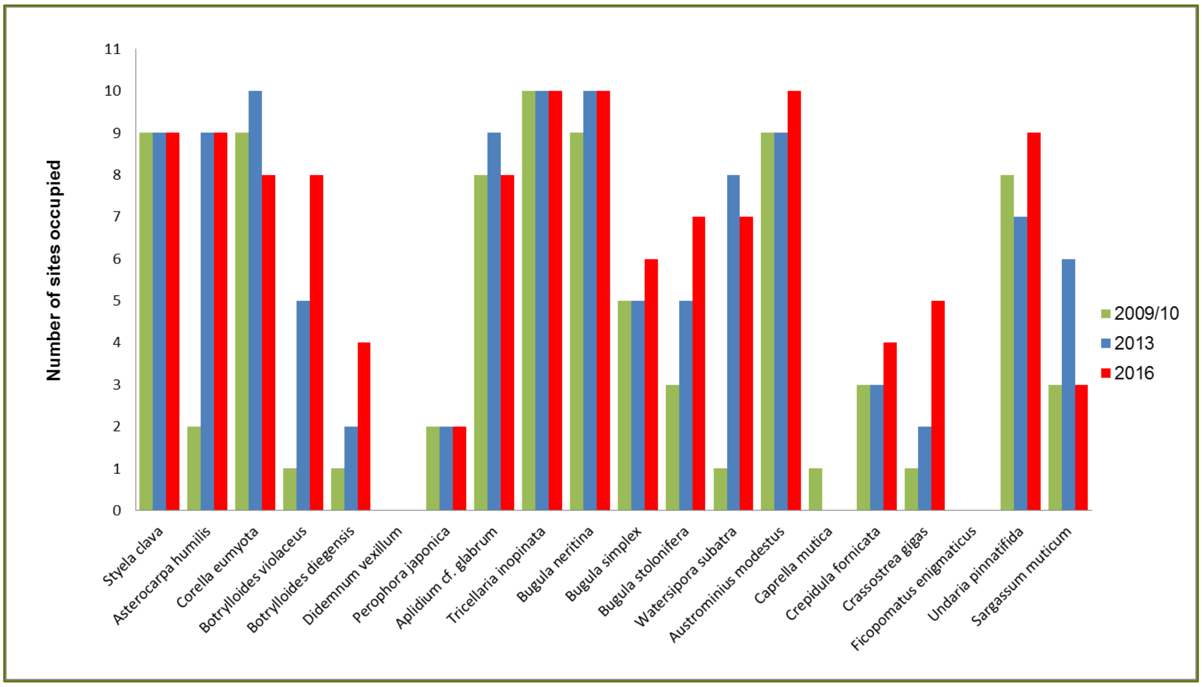

Figure 16: Changes in occurrences of 20 species at 10 SW sites from 2009/10, to 2013 and 2016

Figure 17, Figure 18 and Figure 19 present the same information analysed by site. It can be seen from Figure 17 that in the SW the Falmouth area (sites CORN2 to CORN5) has experienced a greater increase in occupancy than Plymouth (DEV1 to DEV6).

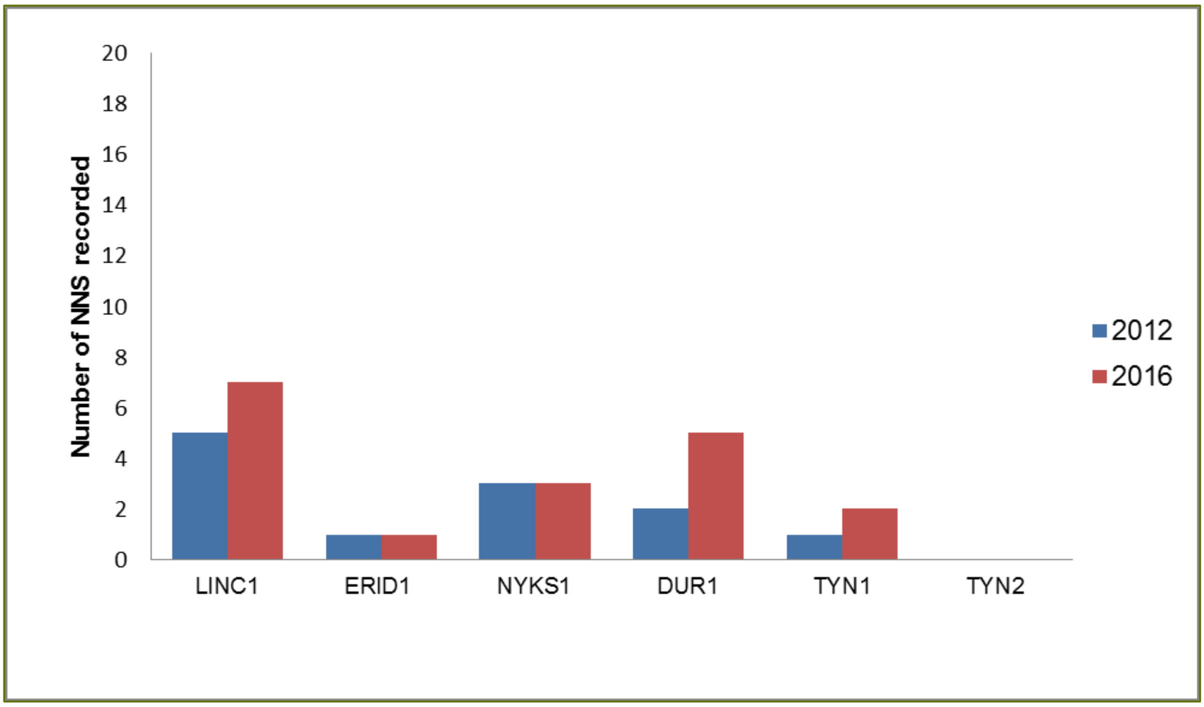

Figure 17: Change in numbers of 21 NNS at 6 NE sites from 2012 to 2016

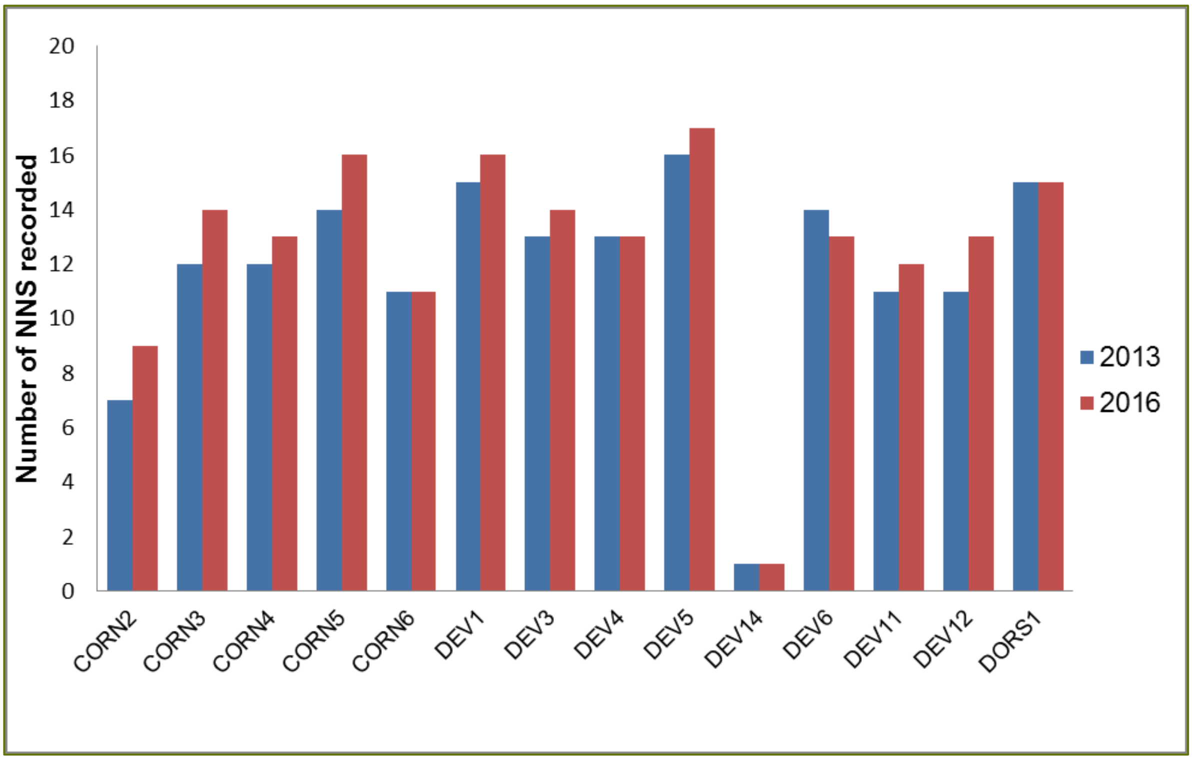

Figure 18: Change in numbers of 32 NNS at 14 SW sites from 2013 to 2016

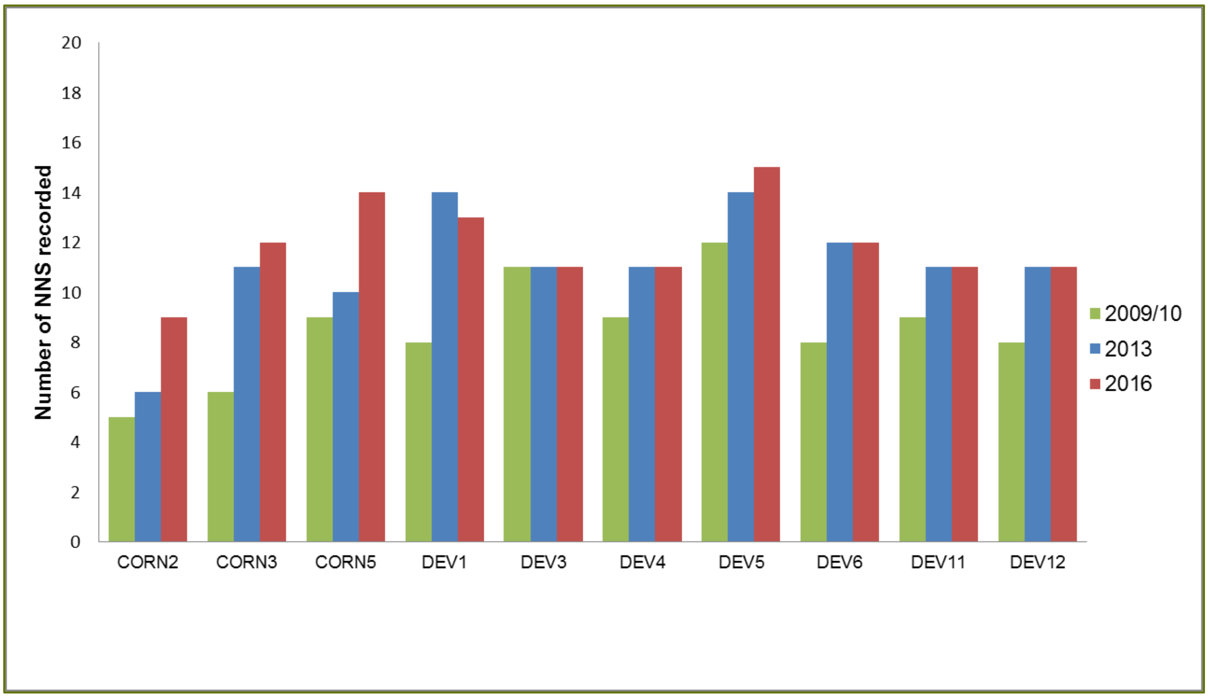

Figure 19: Change in numbers of 20 NNS at 10 SW sites from 2009/10 to 2013 and 2016

2.3. Discussion - surveys

The most significant observations resulting from the RAS were:

- In the NE the first record of the Orange ripple bryozoan (*Schizoporella japonica*), the only other English records being from Plymouth. The first NE record for Devil's tongue weed (*Grateloupia turuturu*) and our first survey record for *Bugulina stolonifera*.
- In the NE the ongoing rapid colonisation of additional sites by species already recorded in the 2012 surveys, in particular the Orange-tipped sea squirt (*Corella eumyota*), the Tufty-buff bryozoan (*Tricellaria inopinata*) and *Bugulina simplex*.
- In the SW the spread westward of the San Diego sea squirt (*Botrylloides diegensis).*
- In the SW the increasing presence of the Pacific oyster (*Magallana gigas*), Wakame (*Undaria pinnatifida*) and the solitary sea squirt *Ciona robusta.*
- In the SW several species appear to have reached a maximum occupancy, being present at virtually all suitable sites e.g. Darwin's barnacle (*Austrominius modestus*), the Tufty-buff bryozoan (*Tricellaria inopinata*) and the Ruby bryozoan (*Bugula neritina*).
- Along the S coast the invasive Carpet sea squirt was recorded at a site not previously visited by us in the Chichester area.
- The large differences in the average number of NNS present along the NE coast compared to the SW and S coasts, supporting the findings of previous surveys of low numbers along the west coast of England and in Wales compared to much higher numbers in East Anglia and all 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.

Subsequent to the surveys we have supplied all the marinas with their individual data, see Appendix X; which will assist them in drawing up biosecurity plans. The offer to provide this information was welcomed by the marina operators.

2.4. Recommendations

It is recommended that an investigation be carried out into how the survey methodology we use can be applied to natural shores, particularly those in Marine Protected Areas. Although many of these shores are regularly surveyed for native species, there is a paucity of data on the occurrence of NNS. We would like to test an 'NNS timed search' methodology on shores in the SW this year.

Further work should 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. This would capitalise on the data already gathered and could be used to inform future site risk assessments and planning.

As a result of Brexit there is uncertainty over the UK government's commitment to the implementation of statutory monitoring and surveillance of NNS under MSFD. The benefits and cost-effectiveness of the repeated surveys that we have undertaken is however increasingly widely appreciated and we will endeavour to keep this work going pending longer-term support.

3. Additional actions

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

- One of the most significant outcomes from the RAS 2014, RAS 2015 and RAS 2016 projects was being asked to participate in a project funded by Natural England to assist port authorities and commercial marine operators to develop biosecurity plans, with the aim reducing the spread of NNS. Our species distribution data is now being used throughout England and Wales in the production of biosecurity plans for single sites, or for marina chains such as MDL and the Yacht Havens Group, or for whole geographical areas such as The Tamar Estuaries Area, the South Devon Area of Outstanding Natural Beauty and the Humber estuary. C. Wood was particularly involved in the writing of the draft biosecurity plan for the Tamar Estuaries area and in organising a workshop to support the plan development with local stakeholders including staff from IFCAs, MMO, Environment Agency, Duchy of Cornwall, National Trust, Local Authorities, Harbour Authorities, the Royal Navy, and commercial operators including Babcock, Princess Yachts, MDL, Yacht Havens group, local boatyards and many others. A poster explaining the project was presented at the South West Marine Ecosystems conference in April 2017 and will be displayed at the GB NNS 14th Stakeholder Forum on Non-Native Species in Cardiff in June, see Appendix XI. A report on the project was also included in the April 2017 Marine Pathways Newsletter (GBNNS 2017).

- We have received a number of requests to provide NNS Identification courses, from beginner to expert level, and two courses are being provided at the MBA in June 2017.

- Collaboration with Chris Nall, University of the Highlands and Islands, on the NE surveys resulted in a joint grant application to Vattenfall, a global energy company, for a project 'Evaluating the potential for offshore wind farms to act as dispersal corridors for non-native species'. Unfortunately the bid was unsuccessful.

- Discussions with the national Seasearch Coordinator, Charlotte Bolton, has led to plans for a combined diving and marina survey of the Dart estuary to determine the current distribution of the invasive Carpet sea squirt (*Didemnum vexillum*).

- A Cumbria Wildlife Trust trainee, Hayden Hurst, has followed up on the RAS 2015 surveys in the NW, by repeating the surveys and deploying settlement panels in the same marinas as part of a Heritage Lottery Funded project in partnership with Natural England and the MBA (Hurst 2016). His report, which relied heavily on the RAS 2015 report, showed an increase in frequency of NNS of 17% in just one year since 2015, mainly due to the colonisation of additional sites by *Bugulina stolonifera* and the Trumpet tube worm (*Ficopomatus enigmaticus*).

- The networking mentioned above has extended our contacts and avenues through which to disseminate information and guidance regarding the threats presented by NNS.

- Data from the RAS 2014, RAS 2015 and RAS 2016 projects have contributed substantially to the annual compilation of Indicator B6 (Pressure from Invasive Species) of the UK Biodiversity Indicators published by Defra.

- Our data has also been used in a decadal review, by the Marine Climate Change Impacts Partnership (MCCIP), of how our understanding of marine climate change impacts has evolved over time, which will also look ahead to the future. J. Bishop and C. Wood are contributing to this review. Our data on the spread of species previously restricted by temperature limits such as *Ficopomatus enigmaticus* is particularly relevant. The MCCIP Report Card and associated backing papers are currently in the final stage of review.

- Details from the surveys were tweeted from @NNSatMBA.

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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 robusta	Formerly referred to as *Ciona intestinalis* Type A. Solitary ascidian, very similar in appearance to native species *Ciona intestinalis*. 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 *Ciona intestinalis*; fouler of aquaculture equipment; 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 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.
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 in 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). 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 websites, was based on a mis-identification.	Starting to appear in natural habitats e.g. off Norfolk coast; Salcombe estuary, Devon; Helford estuary, St Ives, Godrevy and Gunwalloe in 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, but a rapid recolonization has since occurred (Ryland et al. 2011).	Widespread in UK, can affect biodiversity. An abundant fouling organism that colonizes a variety of sub-tidal substrata including artificial structures and vessel hulls.
Bugulina simplex	Previously called *Bugula simplex.* 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.
Bugulina stolonifera	Previously called *Bugula stolonifera.* 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.

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. Now being found in natural habitats on boulders. 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 were from Scotland and Plymouth (Ryland et al. 2014). In 2016 recorded in Blyth, Northumberland (Loxton et al. 2017)	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, initially associated with artificially warmed sites.	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.

Hesperibalanus fallax	Previously called *Solidobalanus fallax.* *S*mall 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.
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). 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.
Magallana gigas (Pacific oyster)	Previously called *Crassostrea gigas.* A bivalve mollusc with thick, rough shells. Occurs naturally in Japan and SE Asia. First introduced from Portugal (as *C. angulata*) 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	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 spp. (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, *Hemigrapsus takanoi* (brush-clawed crab) from R. Medway and Brightlingsea (Wood et al. 2015c); *H. sanguineus* (Asian shore crab) from Wales and Kent (Seeley et al. 2015).	Threat to biodiversity as they compete 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, up-lift 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.
Chrysymenia wrightii (Golden membrane weed)	Large, glistening red seaweed. Indigenous to Japan. First UK record from Falmouth in 2013 (Bunker 2013).	Effects unknown.
Caulacanthus okamurae (Pom-pom weed)	Small red seaweed forming dense springy clumps. Native to Asia. First UK record 2004 on S coast (Brodie et al. 2016).	Turf formation can alter habitat displacing macro invertebrates, such as barnacles.
Bonnemaisonia hamifera (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.
Pikea californica (Pike's weed)	A dense bushy red seaweed. Native to Pacific coast of N. America. Earliest UK record 1967 from Isles of Scilly (Maggs & Ward 1996), has been restricted to there until 2015 when it was recorded in a marina in Cornwall.	Effects unknown.
Dictyota cyanoloma (not on target list)	A brown seaweed with distinctive blue iridescent margins. Native to Australia (Steen et al. 2017). First recorded in the UK in 2013 in a marina in Falmouth.	Has spread to natural habitats in Spain, Portugal and Morocco so could impact native species.

Appendix II: Marinas surveyed with environmental measurements

Marina Code	County	Date of survey	Lock gate/ Sill?	Salinity (surface)	Salinity (2m)	Temp ^{0}C (surface)	Temp ^{0}C (2m)	Turbidity Secchi depth (m)
SW coast								
CORN2*	Cornwall	04/08/2016	Y	35.4	35.5	16.5	16.0	>3.0
CORN3*	Cornwall	04/08/2016		35.2	35.5	16.3	16.1	
CORN4*	Cornwall	04/08/2016		35.5	35.4	16.3	16.4	3.0
CORN5*	Cornwall	05/08/2016		35.7	35.4	16.4	15.9	3.2
CORN6*	Cornwall	05/08/2016		35.4	35.3	17.1	16.5	>2.4
CORN7*	Cornwall	21/09/2016		33.0	34.0	17.4	17.3	1.7
DEV1*	Devon	09/08/2016		33.7	34.6	16.7	16.0	4.0
DEV3*	Devon	09/08/2016		34.3	35.0	17.2	16.0	3.6
DEV4*	Devon	11/08/2016	Y	34.8	34.4	17.3	16.6	5.6
DEV5*	Devon	11/08/2016		33.6	34.6	16.9	16.1	4.6
DEV14	Devon	12/08/2016		32.9	33.8	17.9	17.4	3.2
DEV6*	Devon	12/08/2016		31.9	34.2	17.3	16.4	4.0
DEV11*	Devon	10/08/2016		35.6	35.6	16.2	16.2	3.8
DEV12*	Devon	10/08/2016		35.3	35.5	17.1	17.1	>2.6
DORS1*	Dorset	15/09/2016						2.8
S coast								
HAMP13	Hampshire	14/09/2016		35.1	35.0	19.9	19.4	3.5
SUSS5	W Sussex	13/09/2016	Y	33.3	33.3	21.5	20.1	2.6
NE coast								
LINC1	Lincolnshire	18/07/2016	Y	27.0	27.2	20.7	17.9	1.4
ERID1	East Riding of Yorkshire	19/07/2016	Y	13.0	13.2	20.7	19.1	1.8
NYKS1	N Yorkshire	19/07/2016		34.7	34.7	17.4	15.6	3.9
NYKS2	N Yorkshire	19/07/2016		30.2	34.0	18.8	15.4	3.2
DUR1	Durham	20/07/2016	Y	34.0	34.0	19.3	18.5	4.9
TYN1	Tyne & Wear	20/07/2016		26.6	32.8	17.0	15.0	2.4
TYN2	Tyne & Wear	21/07/2016	Y	30.4	31.8	18.7	15.8	2.4
NHUM1	Northumberland	21/07/2016		34.0	34.2	15.5	15.0	2.6
NHUM2	Northumberland	22/07/2016	Y	27.6	34.0	15.1	13.7	>1.4

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.

No salinity/temperature data for DORS1 due to theft of meter.

* Denotes sites previously reported in RAS 2014.

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 SW and S coast surveys were carried out by JDB, CAW and LR, the NE coast surveys by JDB, CAW and CRN. 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 17 sites on the SW & S coast in 2016

	ASCIDIANS										BRYOZOANS						OTHER ANIMALS													ALGAE											
SITE CODE	Styela clava	Asterocarpa humilis	Ciona robusta	Corella eumyota	Botrylloides violaceus	Botrylloides diegensis	Botrylloides species 'X'	Didemnum vexillum	Perophora japonica	Aplidium cf. glabrum	Tricellaria inopinata	Bugula neritina	Bugulina simplex	Bugulina stolonifera	Watersipora subatra	Schizoporella japonica	Diadumene lineata	Austrominius modestus	Amphibalanus amphitrite	Amphibalanus improvisus	Hesperibalanus fallax	Caprella mutica	Ammothea hilgendorfi	Crepidula fornicata	Urosalpinx cinerea	Magallana gigas	Ficopomatus enigmaticus	Hydroides ezoensis	Hemigrapsus spp.	Undaria pinnatifida	Sargassum muticum	Grateloupia turuturu	Codium fragile fragile	Colpomenia peregrina	Chrysymenia wrightii	Bonnemaisonia hamifera	Caulacanthus okamurae	Pikea californica	Dictyota cyanoloma		Total species
SW coast																																									
CORN2	1	1	0	1	1	0		0	0	0	1	2	1	0	0	0	0	1	0	0	0	0	0	0		1	0	0	0	0	0	0	0	0	0		0	0			9
CORN3	1	1	2	1	2	0		0	0	0	3	3	1	1	3	0	0	1	0	0	0	0	0	1		0	0	0	0	1	0	1	0	0	0		0	0			14
CORN4	1	1	1	0	1	0	0	0	0	0	2	2	0	0	2	0	0	2	0	0	0	0	0	1		1	0	0	0	1	0	2	0	0	1		0	0			13
CORN5	1	1	3	1	2	1	0	0	0	1	2	2	1	2	0	0	0	2	0	0	0	0	0	1		1	0	0	0	1	0	0	0	0	1		0	0	1		17
CORN6	1	0	1	1	2	0	0	0	0	0	2	2	2	1	0	0	0	2	0	0	0	0	0	1		0	0	0	0	0	0	1	0	0	0		0	0			11
CORN7	2	0	0	0	3	0		0	0	0	3	0	0	1	0	0	1	3	0	1	0	0	0	0		0	1	0	0	1	0	1	0	0	0		0	0			10
DEV1	1	1	1	0	1	0	0	0	1	2	2	2	0	2	0	0	0	2	0	0	0	0	0	1		1	0	0	0	3	1	3	0	1	0		0	0			16
DEV3	2	1	0	1	1	0	0	0	0	1	3	3	0	1	2	1	0	1	0	0	0	0	0	0		0	0	0	0	3	0	1	0	1	0		0	0			14
DEV4	0	0	3	0	2	1	0	0	0	1	1	3	2	1	1	0	0	1	0	0	0	0	0	0		1	0	0	0	2	0	1	0	0	0	1	0	0			14
DEV5	3	1	1	1	3	0	0	0	1	3	3	3	1	2	3	0	0	1	0	0	0	0	0	0		1	0	0	0	3	1	3	0	0	0		1	0			18
DEV14	0	0	0	0	0	0	0	0	0	0	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			1
DEV6	1	1	0	1	3	0	0	0	0	2	3	1	0	1	1	0	0	1	0	0	0	0	0	1		0	0	0	0	3	0	2	0	0	0		0	0			13
DEV11	2	2	1	1	0	3	0	0	0	2	3	3	0	0	3	0	0	1	0	0	0	0	0	0		0	0	0	0	3	1	0	0	0	0		0	0			12
DEV12	2	2	1	1	0	3	0	0	0	1	3	3	2	0	2	0	0	1	0	0	0	0	0	0		0	0	0	0	3	0	1	0	0	0		0	0			13
DORS1	3	2	0	1		3	0	0	2	3	3	3	1	0	3	0	0	1	0	0	0	0	0	1		0	0	0	0	1	0	3	2	2	0		0	0			16
S coast																																									
HAMP13	2	1	0	2	1	2	0	2	0	1	3	3	0	0	0	0	0	1	0	0	0	0	1	1		0	0	1	0	1	0	3	0	0	0	1	0	0			16
SUSS5	1	0	0	1	1	0	0	0	0	1	3	2	3	3	0	0	0	1	0		0	0	1	0		0	3	0	0	1	0	3	0	0	0		0	0			13
Sites occupied	15	12	9	12	13	6	0	1	3	11	16	15	9	10	9	1	1	17	0	1	0	0	2	8	0	6	2	1	0	14	3	13	1	3	2	2	1	0	1	220	220

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

Appendix V: Occurrence of fouling NNS at 9 sites on the NE coast in 2016

	ASCIDIANS										BRYOZOANS						OTHER ANIMALS													ALGAE											
SITE CODE	Styela clava	Asterocarpa humilis	Ciona robusta	Corella eumyota	Botrylloides violaceus	Botrylloides diegensis	Botrylloides species 'X'	Didemnum vexillum	Perophora japonica	Aplidium cf. glabrum	Tricellaria inopinata	Bugula neritina	Bugulina simplex	Bugulina stolonifera	Watersipora subatra	Schizoporella japonica	Diadumene lineata	Austrominius modestus	Amphibalanus amphitrite	Amphibalanus improvisus	Hesperibalanus fallax	Caprella mutica	Ammothea hilgendorfi	Crepidula fornicata	Urosalpinx cinerea	Magallana gigas	Ficopomatus enigmaticus	Hydroides ezoensis	Hemigrapsus spp.	Undaria pinnatifida	Sargassum muticum	Grateloupia turuturu	Codium fragile fragile	Colpomenia peregrina	Chrysymenia wrightii	Bonnemaisonia hamifera	Caulacanthus okamurae	Pikea californica	Dictyota cyanoloma		Total species
NE coast																																									
LINC1	3	0	0	0	1	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	2	0	0		0	0	2	0	1	0	2	0	0	0		0	0			9
ERID1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0		0	1	0	0	0	0	0	0	0	0		0	0			2
NYKS1	0	0	0	2	0	0	0	0	0	0	3	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			3
NYKS2	0	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	0	0	0	0	0	0	0	0		0	0			2
DUR1	0	0	0	1	0	0	0	0	0	0	1	0	2	2	0	0	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0			5
TYN1	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			2
TYN2	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
NHUM1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0			3
NHUM2	0	0	0	0	0	0	0	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			2
Sites occupied	1	0	0	4	1	0	0	0	0	0	3	0	3	1	0	1	0	6	0	3	0	1	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	28	28
Combined totals: SW, S & NE	16	12	9	16	14	6	0	1	3	11	19	15	12	11	9	2	1	23	0	4	0	1	2	8	0	6	3	2	0	15	3	14	1	3	2	2	1	0	1	248	

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

Appendix VI: Comparison between 2013 and 2016 surveys in SW

ASCIDIANS

	Styela clava		Asterocarpa humilis		Ciona robusta		Corella eumyota		Botrylloides violaceus		Botrylloides diegensis		Didemnum vexillum		Perophora japonica		Aplidium cf. glabrum	
	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016
SW coast																		
CORN2	0	1	1	1	0	0	1	1		1	0	0	0	0	0	0	0	0
CORN3	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	1	0
CORN4	1	1	1	1	0	1	1	0		1	0	0	0	0	0	0	0	0
CORN5	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	1	1
CORN6	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
DEV1	1	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	1	1
DEV3	1	1	1	1	0	0	1	1		1	0	0	0	0	0	0	1	1
DEV4	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	1	1
DEV5	1	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1
DEV14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEV6	1	1	1	1	0	0	1	1	1	1	0	0	0	0	1	0	1	1
DEV11	1	1	1	1	0	1	1	1		0	1	1	0	0	0	0	1	1
DEV12	1	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0	1	1
DORS1	1	0	1	1	0	0	1	1	0		1	1	0	0	0	1	1	1
2013	12		12		3		13		7		3		0		2		10	
2016	11		11		9		10		10		5		0		3		9	

BRYOZOANS

	Tricellaria inopinata		Bugula neritina		Bugulina simplex		Bugulina stolonifera		Watersipora subatra		Schizoporella japonica	
	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016
SW coast												
CORN2	1	1	1	1	1	1	0	0	0	0	0	0
CORN3	1	1	1	1	0	1	1	1	1	1	0	0
CORN4	1	1	1	1	1	0	0	0	1	1	0	0
CORN5	1	1	1	1	1	1	1	1	0	0	0	0
CORN6	1	1	1	1	1	1	0	1	0	0	0	0
DEV1	1	1	1	1	0	0	1	1	1	0	0	0
DEV3	1	1	1	1	1	0	0	1	1	1	1	1
DEV4	1	1	1	1	1	1	0	1	1	1	0	0
DEV5	1	1	1	1	1	1	1	1	1	1	0	0
DEV14	0	0	0	0	0	0	0	0	0	0	0	0
DEV6	1	1	1	1	0	0	1	1	1	1	0	0
DEV11	1	1	1	1	1	0	0	0	1	1	0	0
DEV12	1	1	1	1	0	1	0	0	1	1	0	0
DORS1	1	1	1	1	1	1	0	0	1	1	0	0
2013	13		13		9		5		10		1	
2016	13		13		8		8		9		1	

OTHER ANIMALS

	Diadumene lineata		Austrominius modestus		Amphibalanus amphitrite		Amphibalanus improvisus		Caprella mutica		Ammothea hilgendorfi		Crepidula fornicata		Magallana gigas		Ficopomatus enigmaticus		Hydroides ezoensis		Hemigrapsus spp.	
	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016
SW coast																						
CORN2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0
CORN3	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
CORN4	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
CORN5	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
CORN6	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
DEV1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
DEV3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEV4	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
DEV5	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
DEV14	0	0	1	1	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEV6	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
DEV11	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEV12	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DORS1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
2013	1		13		0		0		0		0		7		2		0		0		0	
2016	0		14		0		0		0		0		7		6		0		0		0	

ALGAE and totals

	Undaria pinnatifida		Sargassum muticum		Grateloupia turuturu		Codium fragile fragile		Colpomenia peregrina		Chrysymenia wrightii			Total 2013	Total 2016	Change
	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016		2013	2016	Change
SW coast																
CORN2	0	0	0	0	0	0	0	0	0	0	0	0		7	9	2
CORN3	0	1	0	0	0	1	0	0	0	0	1	0		12	14	2
CORN4	1	1	0	0	1	1	0	0	0	0	1	1		12	13	1
CORN5	0	1	0	0	1	0	0	0	0	0	1	1		14	16	2
CORN6	0	0	0	0	1	1	0	0	0	0	0	0		11	11	0
DEV1	1	1	1	1	1	1	0	0	0	1	0	0		15	16	1
DEV3	1	1	1	0	1	1	0	0	0	1	0	0		13	14	1
DEV4	1	1	1	0	1	1	0	0	0	0	0	0		13	13	0
DEV5	1	1	1	1	1	1	0	0	0	0	0	0		16	17	1
DEV14	0	0	0	0	0	0	0	0	0	0	0	0		1	1	0
DEV6	1	1	0	0	1	1	0	0	0	0	0	0		14	13	-1
DEV11	1	1	1	1	0	0	0	0	0	0	0	0		11	12	1
DEV12	1	1	1	0	0	1	0	0	0	0	0	0		11	13	2
DORS1	1	1	1	0	1	1	1	1	0	1	0	0		15	15	0
														165	177	12
2013	9		7		9		1		0		3		165			
2016	11		3		10		1		3		2		177			

Notes: Presence/Absence at 14 sites, 32 species common to both sets of surveys.
1=Present, 0 = Not present, blank = Not looked for or not noticed

Appendix VII: Comparison between 2012 and 2016 surveys in NE

	ASCIDIANS																	
	Styela clava		Asterocarpa humilis		Ciona robusta		Corella eumyota		Botrylloides violaceus		Botrylloides diegensis		Didemnum vexillum		Perophora japonica		Aplidium cf. glabrum	
	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016
NE coast																		
LINC1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
ERID1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYKS1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
DUR1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
TYN1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
TYN2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	1		0		0		2		1		0		0		0		0	
2016	1		0		0		3		1		0		0		0		0	

	BRYOZOANS										OTHER ANIMALS										ALGAE						
	Tricellaria inopinata		Bugula neritina		Bugulina simplex		Bugulina stolonifera		Watersipora subatra		Austrominius modestus		Caprella mutica		Crepidula fornicata		Magallana gigas		Ficopomatus enigmaticus		Undaria pinnatifida		Sargassum muticum				
	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	Change
NE coast																											
LINC1	1	1	0	0		1		0	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0	5	7	2
ERID1	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0
NYKS1	1	1	0	0		1		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
DUR1	0	1	0	0	1	1		1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	5	3
TYN1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
TYN2	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
																									12	18	6
2012	2		0		1		0		0		3		0		0		0		1		1		0		12		
2016	3		0		3		1		0		3		1		0		0		1		1		0		18		

Notes: Presence/Absence at 6 sites, 21 species common to both sets of surveys.
1=Present, 0 = Not present, blank = Not looked for or not noticed

Appendix VIII: Comparison between 2009/10, 2013 and 2016 surveys in SW

ASCIDIANS

	Styela clava			Asterocarpa humilis			Corella eumyota			Botrylloides violaceus			Botrylloides diegensis			Didemnum vexillum			Perophora japonica			Aplidium cf. glabrum		
	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016
CORN2	0	0	1	1	1	1	0	1	1			1	0	0	0	0	0	0	0	0	0	0	0	0
CORN3	1	1	1	1	1	1	1	1	1		1	1	0	0	0	0	0	0	0	0	0	0	1	0
CORN5	1	1	1	0	1	1	1	1	1			1	0	0	1	0	0	0	0	0	0	1	1	1
DEV1	1	1	1	0	1	1	1	1	0		1	1	0	0	0	0	0	0	0	0	1	1	1	1
DEV3	1	1	1	0	1	1	1	1	1	0		1	0	0	0	0	0	0	0	0	0	1	1	1
DEV4	1	1	0	0	0	0	1	1	0		1	1	0	0	1	0	0	0	0	0	0	1	1	1
DEV5	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
DEV6	1	1	1	0	1	1	1	1	1		1	1	0	0	0	0	0	0	1	1	0	1	1	1
DEV11	1	1	1	0	1	1	1	1	1	0		0	0	1	1	0	0	0	0	0	0	1	1	1
DEV12	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1

BROZOANS

	Tricellaria inopinata			Bugula neritina			Bugula simplex			Bugula stolonifera			Watersipora subatra		
	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016
CORN2	1	1	1	1	1	1	1	1	1		0	0	0	0	0
CORN3	1	1	1	1	1	1		0	1		1	1	0	1	1
CORN5	1	1	1	1	1	1	1	1	1		1	1	0	0	0
DEV1	1	1	1	0	1	1		0	0		1	1	0	1	0
DEV3	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1
DEV4	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1
DEV5	1	1	1	1	1	1		0	1	1	1	1	0	1	1
DEV6	1	1	1	1	1	1		0	0		1	1	0	1	1
DEV11	1	1	1	1	1	1	1	1	0		0	0	1	1	1
DEV12	1	1	1	1	1	1		0	1		0	0	0	1	1

OTHER ANIMALS

	Austrominius modestus			Caprella mutica			Crepidula fornicata			Crassostrea gigas			Ficopomatus enigmaticus		
	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016	2009/10	2013	2016
CORN2	1	1	1	0	0	0	0	0	0	0	0	1	0		0
CORN3	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0
CORN5	1	1	1	0	0	0	1	1	1	0	0	1	0	0	0
DEV1	1	1	1	0	0	0	1	1	1	0	1	1	0	0	0
DEV3	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0
DEV4	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0
DEV5	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0
DEV6	1	1	1	0	0	0	0	0	1	0	0	0		0	0
DEV11	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
DEV12	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

ALGAE

	Undaria pinnatifida			Sargassum muticum		
	2009/10	2013	2016	2009/10	2013	2016
CORN2	0	0	0	0	0	0
CORN3	0	0	1	0	0	0
CORN5	1	0	1	0	0	0
DEV1	1	1	1	1	1	1
DEV3	1	1	1	0	1	0
DEV4	1	1	1	0	1	0
DEV5	1	1	1	1	1	1
DEV6	1	1	1	0	0	0
DEV11	1	1	1	0	1	1
DEV12	1	1	1	1	1	0

	2009/10	2013	2016
CORN2	5	6	9
CORN3	6	11	12
CORN5	9	10	14
DEV1	8	14	13
DEV3	11	11	11
DEV4	9	11	11
DEV5	12	14	15
DEV6	8	12	12
DEV11	9	11	11
DEV12	8	11	11
	85	111	119

	Styela clava	Asterocarpa humilis	Corella eumyota	Botrylloides violaceus	Botrylloides diegensis	Didemnum vexillum	Perophora japonica	Aplidium cf. glabrum	Tricellaria inopinata	Bugula neritina	Bugula simplex	Bugula stolonifera	Watersipora subatra	Austrominius modestus	Caprella mutica	Crepidula fornicata	Crassostrea gigas	Ficopomatus enigmaticus	Undaria pinnatifida	Sargassum muticum	
2009/10	9	2	9	1	1	0	2	8	10	9	5	3	1	9	1	3	1	0	8	3	85
2013	9	9	10	5	2	0	2	9	10	10	5	5	8	9	0	3	2	0	7	6	111
2016	9	9	8	8	4	0	2	8	10	10	6	7	7	10	0	4	5	0	9	3	119

Presence/Absence at 10 sites, 20 species common to all three sets of surveys.

1=Present, 0 = Not present, blank = Not looked for or not noticed

Appendix IX: Form for collecting information from marina staff

Survey title **BROMLEY 2016**

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 X: Sample report to marina operator

NNS recorded in Scarborough harbour in 2012 and 2016

The Bishop Group of the Marine Biological Association of the UK have carried out Rapid Assessment Surveys (RAS) for non-native species at over 80 sites in England and Wales, predominantly marinas, since 2009.

A target list of non-native species is used. This target list has changed over the years as new species have arrived.

Three records of NNS were generated from Scarborough harbour. This is average for marinas along the NE coast.

Report prepared by:

Christine A. Wood
Bishop Group,
Marine Biological Association of the UK
10/05/2017

Additional sources of information:

GB Non-native Species Information Portal: http://www.nonnativespecies.org/factsheet/

Bishop Group website: http://www.mba.ac.uk/fellows/bishop-group-associate-fellow

Non-native species (NNS) Rapid Assessment Survey Results Scarborough harbour			
Scientific name	Common name	2012	2016
Sea squirts			
Styela clava	Leathery sea squirt	×	×
Asterocarpa humilis	Compass sea squirt	×	×
Ciona robusta		×	×
Corella eumyota	Orange-tipped sea squirt	✓	✓
Botrylloides violaceus	Orange cloak sea squirt	×	×
Botrylloides diegensis	San Diego sea squirt	×	×
Botrylloides species 'X'			×
Didemnum vexillum	Carpet sea squirt	×	×
Perophora japonica	Creeping sea squirt	×	×
Aplidium cf. glabrum		×	×
Sea mats (Bryozoans)			
Tricellaria inopinata	Tufty-buff bryozoan	✓	✓
Bugula neritina	Ruby bryozoan	×	×
Bugulina simplex			✓
Bugulina stolonifera			×
Watersipora subatra	Red ripple bryozoan	×	×
Schizoporella japonica	Orange ripple bryozoan		×
Barnacles			
Austrominius modestus	Darwin's barnacle	✓	×
Amphibalanus amphitrite	Striped barnacle		×
Amphibalanus improvisus	Bay barnacle		×
Hesperibalanus fallax			×
Other animals			
Caprella mutica	Japanese skeleton shrimp	×	×
Ammothea hilgendorfi	Japanese sea spider		×
Crepidula fornicata	Slipper limpet	×	×
Magallana gigas	Pacific oyster	×	×
Ficopomatus enigmaticus	Trumpet tube worm	×	×
Hydroides ezoensis			×
Hemigrapsus spp.	Asian shore/brush-clawed crab		×
Diadumene lineata	Orange-striped anemone		×
Seaweeds			
Undaria pinnatifida	Wakame	×	×
Sargassum muticum	Wireweed	×	×
Grateloupia turuturu	Devil's tongue weed		×
Codium fragile fragile	Green sea fingers		×
Colpomenia peregrina	Oyster thief		×
Chrysymenia wrightii	Golden membrane weed		×
Caulacanthus okamurae	Pom-pom weed		×
Bonnemaisonia hamifera	Hook weed		×

Report prepared by Christine A. Wood, Bishop Group, Marine Biological Association of the UK
Data collected by J.D.D. Bishop, C.A. Wood, C.R. Nall
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Appendix XI: Biosecurity planning poster

A Biosecurity Plan for Non-natives in the Tamar Estuaries Complex

Christine Wood[1], Anna Yunnie[2], Tom Vance[2] and Sarah Brown[3]

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The GB Invasive Non-native Species Strategy emphasises the prevention of new arrivals or, failing that, rapid detection and response to eradicate or control fresh incursions. These aims, embodied in the EU Invasive Alien Species Regulation, the WFD and the MSFD, require the identification and management of the actual pathways of introduction, with appropriate monitoring and surveillance. The Marine Pathways Project (2013-15) addressed this requirement and, following pilot studies in 2015/2016, Natural England instigated a project to provide training in biosecurity planning and assistance for key stakeholders nationwide, and to pilot the development of overarching estuary-wide biosecurity plans. The project was coordinated by the C2W consultancy.

In the South West, two such estuary-wide plans are being developed in consultation with local stakeholders: one for the estuaries of the South Devon Area of Outstanding Natural Beauty (SD AONB) and the other for the Tamar Estuaries complex. The lead stakeholders directing the resulting biosecurity plans will be, respectively, the SD AONB itself and the Tamar Estuaries Consultative Forum (TECF—a body bringing together all the authorities with responsibility for managing the waters of Plymouth Sound and the Tamar estuaries).

South Devon AONB. Within the overall SD AONB biosecurity plan, five estuaries each have their own mini-plan.

The Tamar Estuaries complex. The extent of TECF's management area is shown (pale blue).

The Tamar Estuaries workshop

The Marine Biological Association and PML Applications Ltd were jointly involved in developing the draft Tamar Estuaries Area Biosecurity Plan and delivering a stakeholder workshop on 1st March 2017, which attracted a wide range of participants.

Plymouth is a busy port including western Europe's largest naval base, a commercial port handling over 2M tonnes of goods a year, an international ferry terminal, and one of the busiest marine leisure concentrations in the UK. Thus the Tamar Estuaries area is subject to high levels of marine traffic, making it highly vulnerable to the introduction of NNS, yet it has one of the highest concentrations of Marine Protected Areas in England.

Organisations represented at the Tamar Estuaries workshop

TECF members	Commercial stakeholders
Associated British Ports	Babcock International
Cattewater Harbour Commissioners	Blagdon's Boatyard
Cornwall and Devon & Severn IFCAs	Brittany Ferries
Duchy of Cornwall	Mashford's Boatyard
Environment Agency	Mayflower Marina
National Trust	Plymouth Yacht Haven
Natural England	Princess Yachts
Plymouth City Council	Queen Anne's Battery Marina
Queen's Harbour Master	

NNS already impacting the Tamar Estuaries complex.

Populations of Slipper Limpet and Pacific Oyster are responsible for the unfavourable status of some habitats in the Plymouth Sound and Estuaries SAC (Natural England Condition Assessment, 2016). Wireweed and Wakame are noted in the Plymouth Sound and Tamar Estuary IPENS Site Improvement Plan as having the potential to dominate areas and thus exclude native species.

Control of the Pacific Oyster is the subject of a new NE-led initiative in the Yealm Estuary, linking to the SD AONB Biosecurity Plan. This involves the monitoring and physical removal of the oysters by trained volunteers.

Next steps

The draft biosecurity plan has been updated following input from the workshop participants, and submitted to TECF.

Actions likely to be adopted include:

- Encouraging stakeholders to develop and share biosecurity plans for their own sites
- Provision of training in NNS awareness and identification for local stakeholders
- Promoting public awareness of NNS and the Check-Clean-Dry campaign, for instance by placing new signs in places frequented by the relevant stakeholders
- The development of an information network for stakeholders, including e-mail alerts of significant local sightings of NNS
- The development of rapid-response control and eradication procedures for newly-detected NNS, if feasible .

C2W · Tamar Estuaries Consultative Forum · Natural England · PML Applications Ltd

www.mba.ac.uk