Monitoring marine non-native species in marinas and on leisure boats to document patterns of geographical range extension.

John Bishop, Marine Biological Association, Plymouth, U.K.

Video showing:

Sessile animals on a yacht hull and on the chains that hold the pontoons in a Brittany marina

The dominant species are sea-squirts (ascidians)
Artificial structures provide living space for species that need hard surfaces to grow on, allowing them to spread beyond their normal range.

If the structures move around, species can be carried far beyond their natural geographical home.

Marine boating is big business!

The UK leisure boating, super-yacht and small commercial vessel industry (marine) in the UK in 2012-13:

£ 2.9 billion / 3.5 billion € total revenue
4200 companies
31,000 full-time equivalent jobs
256 coastal/tidal marinas, with 52,000 berths
540,000 marine leisure boats (dinghies, yachts or power boats of 2.5-24 m)

Marinas in Plymouth

Sources: British Marine Federation, Royal Yachting Association
To what extent do leisure boating and the associated marina sites spread of non-native species around coasts?

1. What lives on marina structures?

2. What grows on boats?
1. What lives on marina structures?

Rapid assessment surveys (RAS)

• Quick and efficient (single visit)

• Small team of experts visit the pontoons; examine pontoon floats, and fenders, ropes, keep-nets etc. accessible from the surface for fixed period (generally 1 h)

• Target species recorded, limited collection of specimens for later lab identification

• Before leaving site: discussion of specimens, compilation of individuals’ observations into joint overall record
Marina RASs
(English & Welsh coasts 2014-16)

81 sites
Maximum 19, mean 9.3 sessile animal & algal NNS per site

Survey sites

Geographical variation in prevalence of NNS
Individual sites with low values: fresh water influence

Marinas and non-natives: which species?

Total occurrences of each of 18 sessile animal NNS in RASs of English marinas

‘Top six’ in marinas

www.mba.ac.uk
Trends revealed by repeated RASs

Changes in 20 NNS at 32 English marinas subjected to RASs in both 2009-10 and 2013-14

Most species have spread, some rapidly, giving a 27% increase in records for these 20 NNS.
Settlement panels

15 x 17 cm plastic panel

Quantitative data (100 points scored)

Native and non-native taxa

Moulin Blanc, Brest
New and 6-month panels

Photo Wilfried Thomas, SBR
Brittany and Devon+Cornwall marinas are distinct

2011+2012+2013

Multi-dimensional scaling plot based on community composition on panels
Native and non-native animal taxa
There are persistent differences between sites: the panels from a particular marina tend to plot together across years.

e.g. Perros Guirec in three successive years.
2. What grows on boats?

**Hull surveys**
Hull surveys

• 72 boats, Devon marina; 50 boats, Brittany marinas.
• Mostly well-maintained: boats being taken out for annual anti-foul
• Mostly yachts of 9-12 m

Plymouth

n = 72 boats
Mean = 3.8 NNS per boat

Brittany

n = 50 boats
Mean = 4.4 NNS per boat

Sessile animals only.
Rare to find vessel without NNS
Hull surveys

Data from Devon

Same ‘top six’ on hulls as in marina pontoon surveys
Tricellaria inopinata  
(Pacific bryozoan)  
>90% of yachts

This bryozoan (moss animal) is commonly found in ‘niche areas’ such as the propeller / prop shaft and on the underside of the keel. Low natural dispersal: adult phase not motile (grows attached), larval phase brief
Species ranked by their frequency on yacht hulls

<table>
<thead>
<tr>
<th>Plymouth</th>
<th>Brittany</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tricellaria inopinata (B)</strong></td>
<td><strong>Tricellaria inopinata (B)</strong></td>
</tr>
<tr>
<td>Austrominius modestus (C)</td>
<td>Bugula neritina (B)</td>
</tr>
<tr>
<td>Bugula neritina (B)</td>
<td>Asterocarpa humilis (A)</td>
</tr>
<tr>
<td>Botrylloides violaceus (A)</td>
<td>Corella eumyota (A)</td>
</tr>
<tr>
<td>Styela clava (A)</td>
<td>Austrominius modestus (C)</td>
</tr>
<tr>
<td>Corella eumyota (A)</td>
<td>Styela clava (A)</td>
</tr>
<tr>
<td>Watersipora subtorquata (B)</td>
<td>Botrylloides violaceus (A)</td>
</tr>
<tr>
<td>Bugula simplex (B)</td>
<td>Watersipora subtorquata (B)</td>
</tr>
<tr>
<td>Hydroides ezoensis (P)</td>
<td>Bugula simplex (B)</td>
</tr>
<tr>
<td>Asterocarpa humilis (A)</td>
<td>Perophora japonica (A)</td>
</tr>
<tr>
<td>Amphibalanus amphitrite (C)</td>
<td>Didemnum vexillum (A)</td>
</tr>
<tr>
<td>Ficopomatus enigmaticus (P)</td>
<td></td>
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<tr>
<td>Crepidula fornicata (G)</td>
<td></td>
</tr>
</tbody>
</table>

% of yachts colonised by each species

www.mba.ac.uk
Example of rapid spread: *Tricellaria inopinata*, bryozoan of Pacific origin

About 12 years to spread right round the coast of Great Britain, as shown by marina surveys

Presumably yacht-assisted

Now occurring increasingly on natural shores

Scottish data:
E. Cottier-Cook et al., SAMS
Repeated summer RASs of marinas in Brittany and SW England

Compass sea squirt *Asterocarpa humilis*

First French records 2005
First UK records 2009

<table>
<thead>
<tr>
<th>Marina</th>
<th>2010</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falmouth</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Pendennis inner</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pendennis outer</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mayflower</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Millbay</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Sutton Harbour</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q. Anne’s Battery</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ply. Yacht Haven</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Brixham</td>
<td>✓</td>
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<tr>
<td>Torquay</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

SW England: Example of very rapid regional spread between marinas

Species is still rarely seen on natural shores in Devon and Cornwall

www.mba.ac.uk
Undaria pinnatifida
Wakame, Japanese Kelp

On a hull
Spread of *Undaria pinnatifida* from marinas onto natural rocky coastlines

Study in SW England. *U. pinnatifida* present at 13/13 marinas surveyed, but only 17/35 natural rocky reef sites in the same areas. Presence/absence of *U. pinnatifida* at a natural site is most strongly related to the site’s proximity to a marina, and to the abundance and spore production of that marina’s *U. pinnatifida* population.

Suggests that marinas facilitate spread and establishment in natural sites. (Similar conclusion from molecular study: Guzinski etal. 2018. DOI: 10.1111/eva.12647)

Epstein & Smale (2017) *Biological Invasions* DOI 10.1007/s10530-017-1610-2
Didemnum vexillum Carpet sea squirt

Species regarded in UK as potentially very serious pest, especially to bivalve aquaculture

Immediate reporting of discoveries requested
Attempted eradication of carpet sea squirt (*Didemnum vexillum*) in Holyhead marina (N Wales)

*D. vexillum* discovered 2008, restricted to marina within large harbour complex. Arrival from Ireland? .... on leisure boat?

Nearby mussel farming threatened, so eradication attempted.
Holyhead Marina 2009-2013

Underwater surfaces progressively wrapped/bagged (anoxia), bleach added inside wrapping. Wraps/bags re-used.

£500,000 / 600,000 € spent

Unsuccessful; would need to do whole site simultaneously, not sequentially

Images:
Natural Resources Wales
Assessment by expert group of representative NNS from different habitats for feasibility of eradication

Results suggest marine NNS are even harder to eradicate than those in other habitats

Marine NNS:
‘Open’ populations, often high potential for larval dispersal
Extensive, inter-connected habitat
Early detection relatively unlikely (inaccessible habitat, unfamiliar organism types)

→ Prevention of introduction, rather than subsequent eradication, the best intervention
Rapid INNS Management Toolkit: Marine Biosecurity Resources

What is biosecurity?

Biosecurity is about reducing the risk of introducing or spreading invasive non-native species (and other harmful organisms such as diseases) in the wild.

This section provides guidance on biosecurity including documents and presentations on biosecurity measures in the marine environment.

All the RAPID LIFE resources are freely available to be used for training and development of biosecurity actions.

Marine Biosecurity Guidance Documents

- Marine Best Practice by Sector
  - Examples of Marine INNS
- How to Write a Marine Biosecurity Plan - Large Scale
- How to Write a Marine Biosecurity Plan - Small Scale
- Impacts of INNS on Marine Sector
- Marine Biosecurity Case Studies
- Marine Engineering Biosecurity Solutions
- Marine Biosecurity for Construction and Events
- Biosecurity Examples from Other Sectors
- Marine INNS Control Measures
- Hull Fouling Guidance
- Marine Related Legislation
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