

Rapid assessment of marinas for invasive alien species in Northern Ireland



**The front cover shows only a selection of marinas
and invasive species highlighted in this report**

Cover photographs from left to right

1. Didemnum
2. Bangor Marina
3. Ringhaddy Marina
4. Watersipora
5. Perophora
6. Glenarm Marina

Research and Development Series 13/06

A report commissioned by the Northern Ireland Environment Agency

Rapid assessment of marinas for invasive alien species in Northern Ireland

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This report should be cited as follows -

Minchin, D.M and Nunn, J.D. (2013) *Rapid assessment of marinas for invasive alien species in Northern Ireland*. Northern Ireland Environment Agency Research and Development Series No. 13/06

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SUMMARY

Eleven marina sites were sampled using the Abundance and Distribution Range methodology during late August to early September 2012 on the coastline of Northern Ireland. This study involved sampling thirty different positions at each large marina for non-indigenous species that were targeted, following an initial study of the current distribution of non-indigenous species within northern Europe. The fifty-seven species selected for the target list were mainly of species that have demonstrated some impact elsewhere or were otherwise of general interest. Nine smaller floating units (pontoons) were sampled at small marina sites or where there was a single floating boardwalk. Some shore surveys took place, both during this survey, and a post-contract survey. Oysters were selected for examination at some sites.

Wakame *Undaria pinnatifida* was found in low numbers in Carrickfergus Marina attached to pontoons. This is the first record for the island of Ireland, representing a range extension northwards from the Isle of Man in the Irish Sea.

The Carpet Sea Squirt *Didemnum vexillum* was found at Ballydorn in Strangford Lough, the first record for Northern Ireland. Long pendulous and encrusting growths of this tunicate were found on the under-surfaces of a floating vessel and some pontoons. Other species recorded for the first time for Northern Ireland were: the bryozoan *Watersipora subtorquata* (at Ardglass), Purple Bushy Bryozoan *Bugula neritina* (at Carrickfergus), and during the post-contract survey, the colonial sea squirt *Perophora japonica* (Strangford Lough). It is unclear whether the brackish-water hydroid *Cordylophora caspia* has been recorded before, but this species was common in the Foyle and Bann estuaries.

The club tunicate *Styela clava* is now also known from Carrickfergus and Glenarm Marinas, and *Tricellaria inopinata* and *Bugula simplex* from several marinas around the coastline. The most widely distributed of the recently arrived species (post-2000) was the circum sub-Antarctic tunicate *Corella eumyota*, found at most marine sites.

Perophora japonica was recorded at Carlingford Marina during the preliminary fieldwork, new to the island of Ireland, and *Bugula fulva* new to the Republic of Ireland.

The greatest number of species attributed to a site during this survey was for Carrickfergus Marina, where twelve species were found (*Aplidium glabrum*, *Austrominius modestus*, *Bugula neritina*, *B. simplex*, *Caprella mutica*, *Colpomenia peregrina*, *Corella eumyota*, *Styela clava*, *Monocorophium acherusicum*, *M. sextonae*, *Tricellaria inopinata* and *Undaria pinnatifida*). This site is likely to receive more non-indigenous species in the future.

The current status of these and other non-indigenous species found is summarised in this report.

INTRODUCTION

This survey examines the abundance and distribution of a set of target species, which have been pre-selected on the basis of their expected or potential appearance, following their occurrence elsewhere in northern Europe.

The requirements of the project fall under seven parts. This report deals with the scientific aspects of the study (items 1 to 4 of Box 1). Items 5 to 7 were dealt with separately to the Northern Ireland Environment Agency. The area covered ranges from Lough Foyle to Carlingford Lough, using marinas and pontoons as the principal means of evaluating the presence and relative abundance of NIS. The study is an update of a survey, which took place in 2006, and examined seven of the marinas previously visited in Northern Ireland (Minchin, 2007a).

Box 1. The objectives of the project were to:

1. Develop a target list of species (identifying sector related species) through a desktop literature search.
2. Undertake a rapid assessment of target species using a recognised methodology for selected marina sites around the coast of Northern Ireland.
3. Undertake an examination of the nearby shoreline, near high risk marinas, for invasive species.
4. Where necessary collect voucher specimens of taxa for the NMNI ensuring confirmation of identification is acquired from acknowledged taxonomic experts.
5. Gauge the current level of knowledge of IAS with marina managers.
6. Promote the Invasive Species Ireland Codes of Practice for marina managers and recreational water users to marina staff whilst undertaking fieldwork.
7. Undertake fieldwork training of a CEDaR staff member in rapid marina survey techniques and identification.

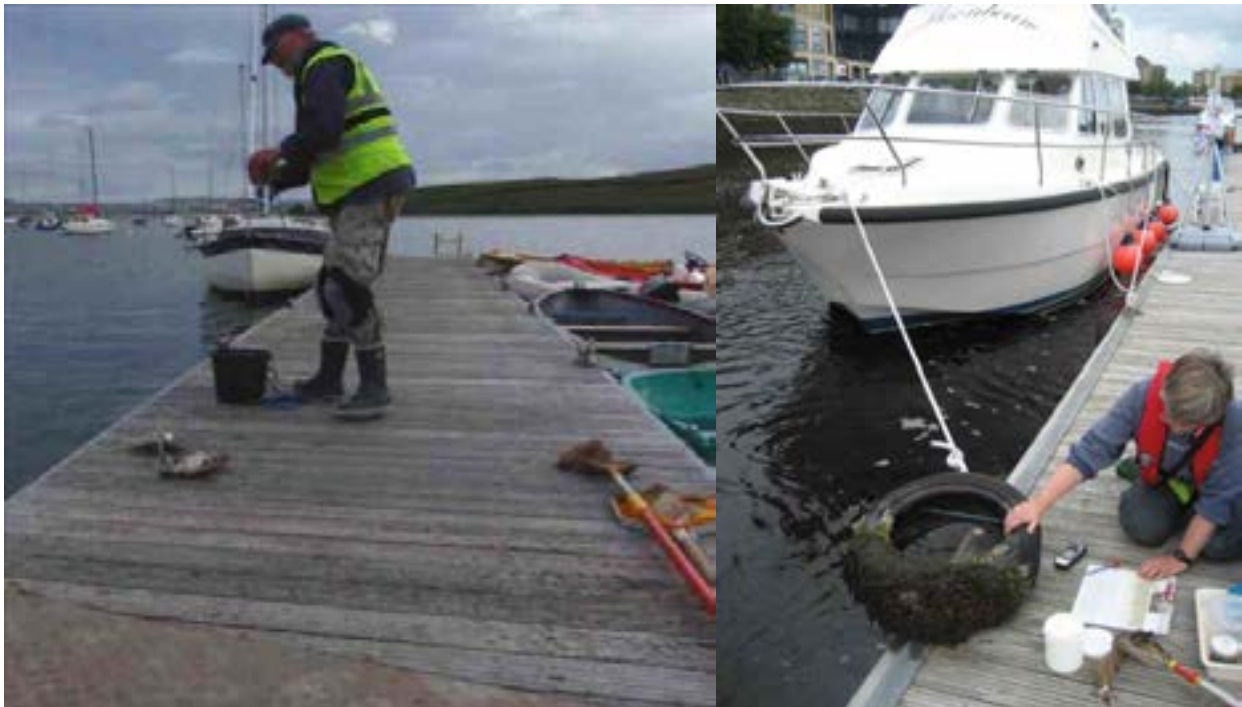
Marinas are convenient places to sample for immersed biota, as these can be sampled at any state of the tide and the boardwalks of the marinas provide for easy access. Over the last decade, marinas have been studied within different world regions involving a number of specialists of selected taxonomic groups (Pedersen *et al.* 2005; Cohen *et al.* 2005; Arenas *et al.* 2006; Buschbaum *et al.*, 2011) including marine algae (Mathieson *et al.*, 2008). Many impacting NIS have been revealed following these studies. However, the great majority of the species identified are of little interest to managers. The development of a target list of species (Ashton *et al.* 2006; Minchin, 2007b) reduces the sampling effort, marinas can be more rapidly surveyed and NIS of concern can be reported in direct time, should they be recognised when found. This enables a quick response where this is appropriate.

The target list approach was developed by Hayes *et al.* (2002). They produced a list of NIS that could arrive in Australia that would have a perceived impact. The basis for considering them as a potential risk was based on their known invasiveness elsewhere, and the likelihood of their spread with known pathways and vectors responsible for their arrival in Australia. Pathway analysis should also be considered as part of a rapid assessment.

The definition of a rapid assessment, according to Ramsar (2005) is:

'a synoptic assessment, which is often undertaken as a matter of urgency, in the shortest timeframe possible to produce reliable and applicable results for its defined purpose'.

Here we have undertaken a study of eleven marinas in Northern Ireland to produce a baseline of distribution and abundance of targeted species using the Abundance and Distribution Range (ADR) of each targeted NIS. In addition, some floating pontoons were studied for the presence or absence of NIS. Some shore surveys were also undertaken where it was possible to take advantage of the timing of low water, and subsequently during some weeks after the contract survey.



METHODS

The immersed portions of floating structures that support the boardwalks at marinas are used to monitor for non-indigenous species (NIS) in coastal, transitional and freshwater ecosystems. The effort for monitoring is independent of the relative abundance of NIS present, only involving more time when more than a single species is being targeted and sampled. The benefits of this method are that it can be employed at any time and at any tidal stage, making it both cost-efficient and practicable. By using a target list of potential impacting invaders i.e. those that are known to be of some management concern on account of their abundance and distribution elsewhere, an *a priori* set of species can be sought during such surveys. Some species on the target list can be recognised by familiarisation through examination of images on the web, from the literature, field guidance notes and from museum specimens.

The target list of species was developed from the likely transmission of alien biota from Britain. In the initial study by Minchin in 2006 throughout the island of Ireland (Minchin, 2007a), a total of twenty target species were selected. Of these, for Northern Ireland, only the NIS *Austrominius modestus*, *Corella eumyota* and *Sargassum muticum* were recorded during the survey, with *Corella eumyota* being the first record for the area.

Archived specimens obtained during the 2006 survey of some non-targeted species were revealed some years later. These included the bryozoans *Bugula neritina* and *Tricellaria inopinata* from sites in the Republic of Ireland. New and potential arrivals of NIS in Britain and Europe in the intervening years have added considerably to the target list. In all, a total of fifty-seven NIS were targeted for the present survey (Tables 1a-b).

Table 1a. Target species selected for study in this survey

Species	taxon	<15 psu	<30 psu	>30 psu	proximity	possible pathway	Reference
<i>Amphibalanus amphitrite</i>	barnacle			x	ROI	hulls	Minchin, 2007b
<i>Amphibalanus improvisus</i>	barnacle	x	x		NI	hulls	Minchin, 2007b
<i>Asparagopsis armata</i>	red alga		x	x	ROI	natural drift	Kraan <i>et al.</i> 2005
<i>Asterocarpa humilis</i>	tunicate			x	Wales & S England	hulls	Bishop <i>et al.</i> 2012
<i>Austrominius modestus</i>	barnacle	x	x	x	NI	hulls/stocking	Minchin, 2007a
<i>Botrylloides diegensis</i>	tunicate			x	S England?	hulls	J Bishop, <i>pers. comm.</i>
<i>Botrylloides violaceus</i>	tunicate			x	NI	hulls / aquaculture	Minchin, 2007a
<i>Bugula neritina</i>	bryozoan			x	ROI	hulls	Ryland <i>et al.</i> , 2011
<i>Calyptrea chinensis</i>	mollusc		x	x	NI	aquaculture	Minchin & Nunn, 2006
<i>Caprella mutica</i>	amphipod		x	x	NI	hulls, drift	Minchin, 2007b
<i>Ceratostomum inornatum</i>	mollusc		x	x	W France	oysters	Martel <i>et al.</i> , 2004
<i>Clymenella torquata</i>	polychaete		x	x	NI	aquaculture	Minchin, 2007b
<i>Codium fragile</i> ssp. <i>fragile</i>	green alga		x	x	NI	aquaculture / drift	Provan <i>et al.</i> , 2004
<i>Colpomenia peregrina</i>	brown alga		x	x	NI	drift/oysters	Mineur <i>et al.</i> , 2008
<i>Corella eumyota</i>	tunicate		x	x	NI	hulls	Minchin, 2007a
<i>Cordylophora caspia</i>	hydroid	x			ROI	birds, hulls	Healy & Oliver, 1998
<i>Crassostrea gigas</i>	mollusc		x	x	NI	aquaculture	Miossec <i>et al.</i> , 2009
<i>Crepidula fornicata</i>	mollusc		x	x	NI	aquaculture/stocking	McNeill <i>et al.</i> , 2010
<i>Diadumene lineata</i>	anemone	x	x	x	ROI	oysters	Minchin, 2007a
<i>Didemnum vexillum</i>	tunicate		x	x	ROI	hulls / aquaculture	Minchin & Sides, 2006

Table 1b. Target species selected for study in this survey

Species	taxon	<15 psu	<30 psu	>30 psu	proximity	possible pathway	Reference
<i>Ensis directus</i>	mollusc			x	Liverpool Bay	natural spread	Dansey, 2011
<i>Eriocheir sinensis</i>	decapod	x	x	x	Waterford Est.	vessels	Minchin, 2006
<i>Ficopomatus enigmaticus</i>	polychaete	x	x	x	ROI	hulls	Minchin, 2007 b
<i>Gracilaria vermiculophylla</i>	alga		x		NI	drift/oysters	C. Maggs, pers. comm.
<i>Grateloupia turuturu</i>	alga			x	Celtic Britain	hulls	Hardy & Guiry, 2003
<i>Hemigrapsus sanguineus</i>	decapod		x	x	N France	oysters/vessels	Dauvin, 2009
<i>Hemigrapsus takanoi</i>	decapod		x	x	N France	oysters/vessels	Dauvin & Delhay, 2011
<i>Heterosiphonia japonica</i>	alga		x	x	NI	hulls	J Nunn, pers. comm.
<i>Hydroides dianthus</i>	spirorbid		x	x	English Channel	hulls/aquaculture	Zibrowius & Thorp, 1989
<i>Hydroides ezoensis</i>	spirorbid		x	x	English Channel	hulls/aquaculture	Zibrowius & Thorp, 1989
<i>Limnoperna securis</i>	mollusc		x		W France	oysters/vessels	Adarraga & Martínez, 2012
<i>Limnoria quadripunctata</i>	isopod		x		ROI	hulls, drift	Minchin, 2007b
<i>Marenzelleria spp.</i>	polychaete	x	x		ROI	vessels	Aquafact, pers. comm.
<i>Mercenaria mercenaria</i>	mollusc		x	x	ROI?	aquaculture	J Mercer, pers comm.
<i>Mnemiopsis leydi</i>	ctenophore		x	x	The Netherlands	natural spread/ships	Faasse & Bayha, 2006
<i>Monocorophium sextonae</i>	amphipod		x	x	ROI	hulls, drift	Minchin, 2007b
<i>Mytilicola orientalis</i>	copepod		x		ROI	oysters	Steel & Mulcahy, 2001
<i>Mytilopsis leucophaeta</i>	mollusc	x	x		S Wales	hulls	Oliver <i>et al.</i> , 1998
<i>Neodioxyspira braziliensis</i>	spirorbid		x	x	English Channel	hulls/aquaculture	Knight-Jones <i>et al.</i> , 1975
<i>Palaemon macrodactylus</i>	decapod	x	x		English Channel	ships/natural spread	Worsfold & Ashelby, 2007
<i>Perophora japonica</i>	tunicate		x	x	English Channel	hulls	Baldock & Bishop, 2001
<i>Petricola pholadiformis</i>	mollusc		x	x	English Channel	oysters	Duval, 1963
<i>Pseudostylochus ostreophagus</i>	flatworm		x	x	W France	oysters	Miossec <i>et al.</i> , 2009
<i>Rapana venosa</i>	mollusc		x	x	south N Sea	vessels	Kerckhof <i>et al.</i> , 2006
<i>Rhithropanopeus harrisi</i>	decapod	x			S Wales	vessels	Ingle, 1980
<i>Sabellaria spallenzani</i>	polychaete		x	x	W France	hulls	Patti & Gambi, 2001
<i>Sargassum muticum</i>	alga		x	x	NI	natural spread/oysters	Boaden, 1995
<i>Schizoporella japonica</i>	bryozoan		x	x	Scotland	fenders	ERI, 2012
<i>Solidobalanus fallax</i>	barnacle			x	Irish Sea	hulls /fishing equip.	Southward <i>et al.</i> , 2004
<i>Solieria chordalis</i>	alga			x	English Channel	hulls	Arenas <i>et al.</i> , 2006
<i>Styela clava</i>	tunicate		x	x	NI	hulls	Nunn & Minchin 2009
<i>Synidotea laevicaudata</i>	isopod		x	x	W France	vessels	Mees & Fockedey, 1993
<i>Teredo navalis</i>	mollusc		x	x	NI	vessels, drift	Minchin, 2007b
<i>Tricellaria inopinata</i>	bryozoan		x	x	NI	vessels	Kelso & Wyse Jackson, 2012
<i>Undaria pinnatifida</i>	alga		x	x	English Channel	hulls	Fletcher & Farrell, 1999
<i>Urosalpinx cinerea</i>	mollusc		x	x	English Channel	oysters	Gibbs <i>et al.</i> , 1991
<i>Watersipora subtorquata</i>	bryozoan		x	x	ROI	hulls	Kelso & Wyse Jackson, 2012

Marinas were selected for ADR monitoring and pontoons for general studies based on the existing known small craft clubs and berthing areas about the coast, and further identified according to images obtained by using *Google Earth* and the *Ordnance Survey of Ireland* websites (Table 2). These marinas also covered those seven sites in Northern Ireland examined generally in 2006 (Minchin, 2007a).

Table 2: Sites visited – Rapid Marina Assessment Survey

ADR (abundance and distribution range sites); Time spent at each site in 24hrs local time; Predicted time of low water & height above Chart datum. Sites visited previously in 2006 (Minchin, 2007a) are marked (blue).

LOCALITY	Latitude/Longitude	Date	ADR	Time	Low Water	Height above CD (m)
Carlingford Marina, Carlingford Lough (Rol)	54° 03.10'N 06° 11.47'W	28/8/12	ADR	10.00-13.30	15.45	1.3
Foyle Marina, Foyle estuary	55° 00.32'N 07° 19.13'W	29/8/12	ADR	11.00-13.30	13.50	0.7
Culmore Point, Foyle Estuary	55° 03.01'N 07° 15.06'W	29/8/12	shore	14.00-15.00	13.50	0.7
Seaton's Landing, Bann Estuary	55° 09.23'N 06° 41.70'W	30/8/12	-----	10.00-11.45	14.30	river
Coleraine Marina, Bann Estuary	55° 07.60'N 06° 40.39'W	30/8/12	ADR	12.00-14.00	14.30	river
Portrush Pontoon	55° 12.45'N 06° 39.37'W	30/8/12	-----	15.00-15.15	13.00	0.4
Rathlin Island Pontoon	55° 17.51'N 06° 11.59'W	31/8/12	-----	10.00-11.30	13.30	0.3
Ballycastle Marina	55° 12.40'N 06° 14.29'W	31/8/12	ADR	12.30-14.30	13.50	0.3
Glenarm Marina	54° 58.16'N 05° 57.01'W	1/9/12	ADR	10.30-14.30	18.10	0.5
Kircubbin, Strangford Lough	54° 29.71'N 05° 32.40'W	2/9/12	shore	08.00-08.30	08.50	0.3
N of Herring Bay, Strangford Lough	54° 31.05'N 05° 33.19'W	2/9/12	shore	09.00-10.00	08.50	0.3
Carrickfergus Marina	54° 42.59'N 05° 48.66'W	2/9/12	ADR	13.00-17.30	06.50	0.3
Mahee Island, Strangford Lough	54° 29.70'N 05° 38.40'W	3/9/12	shore	09.00-11.30	09.20	0.4
Belfast Marina, Belfast Lough	54° 36.33'N 05° 54.85'W	3/9/12	ADR	13.00-16.30	07.20	0.4
Donaghadee Quarry Marina	54° 38.43'N 05° 31.67'W	4/9/12	-----	10.00-11.45	08.00	0.5
Bangor Marina, Belfast Lough	54° 39.90'N 05° 40.34'W	4/9/12	ADR	12.30-17.30	08.00	0.5
Ringhaddy Yacht Club Pontoon, Strangford Lough	54° 26.99'N 05° 37.85'W	5/9/12	-----	09.30-10.30	10.40	0.6
Whiterock Pontoon, Strangford Lough	54° 28.99'N 05° 38.73'W	5/9/12	-----	11.15-13.00	10.40	0.6
Ballydorn Marina, Strangford Lough	54° 29.44'N 05° 38.88'W	5/9/12	ADR	13.15-17.00	10.40	0.6
Portaferry Marina, Strangford Lough	54° 22.81'N 05° 32.81'W	6/9/12	ADR	10.00-13.30	11.20	0.8
Quoile Yacht Club Pontoon, Strangford Lough	54° 22.07'N 05° 40.68'W	6/9/12	-----	14.30-15.15	11.20	0.8
Killyleagh Yacht Club Pontoon, Strangford Lough	54° 23.55'N 05° 38.74'W	6/9/12	-----	15.30-16.15	11.20	0.8
East Down Yacht Club Pontoon, Strangford Lough	54° 24.87'N 05° 38.52'W	6/9/12	-----	16.30-17.15	11.20	0.8
Dundrum Bay	54° 15.95'N 05° 49.11'W	7/9/12	shore	10.30-11.30	10.00	1.6
Ardglass Marina	54° 15.70'N 05° 36.29'W	7/9/12	ADR	12.30-16.00	10.00	1.6
Warrenpoint Marina, Carlingford Lough	54° 06.02'N 06° 15.30'W	8/9/12	ADR	10.00-12.45	10.30	1.6
Mill Bay, Carlingford Lough	54° 03.64'N 06° 05.56'W	8/9/12	shore	13.00-14.00	10.30	1.6

In this study, a scraper with a pocket net mounted on an extendable pole of 4m was used to acquire samples from the immersed sides of floating pontoon units, poles and hulls. In addition, net-sweeps were used where soft fouling organisms were dominant on floating pontoons. In the Bann River, a Van-Veen grab was used to determine whether the zebra mussel *Dreissena polymorpha* or the Asian clam *Corbicula fluminea* was present.



Conditions at visited sites were noted for all marinas and pontoons (Table 3). Temperature was measured using an oceanographic reversing thermometer accurate to 0.1 °C. Temperatures were of surface temperature at -0.3 to -0.5m from the surface. Salinities were evaluated using a refractometer with an accuracy of ± 1 psu. Water transparency was measured using a standard Secchi disc to the nearest 25cm unit.

Weather conditions were estimated in terms of Beaufort units, and wind according to the perceived direction to eight compass points. The cloud coverage was in okta, eight sky coverage units at the time of the field study at a site. Precipitation during the survey refers to light rain.

Tidal levels and times were obtained from the software Tidecomp 2000
<http://www.pangolin.co.nz/tidecomp>.

Table 3: Conditions at each sampling site

Visibility using Secchi disc; PSU (salinity units); Temp (°C); Wind (Beaufort Units); Okta (cloud level); (pptn) precipitation.

LOCALITY	Secchi disc (m)	Temp °C	PSU	Wind	Okta	pptn
Carlingford Marina	2.75	16.0	33	SW 5	5/8	no
Foyle Marina. Foyle estuary	0.50	14.5	10	S 3	8/8	yes
Culmore Point, Foyle Estuary	shore	shore	shore	S 3	8/8	no
Seaton's Landing, Bann Estuary	0.75	14.0	1	SW 4	3/8	no
Coleraine Marina, Bann Estuary	(0.75)	(14)	1	SW 4	3/8	no
Portrush Pontoon	>3.00	----	34	SW 4	3/8	no
Rathlin Island Pontoon	3.50	11.0	35	S 2	8/8	yes
Ballycastle Marina	>2.00	12.0	34	S 2	8/8	yes
Glenarm Marina	4.00	12.0	35	W 6-7	6/8	no
Kircubbin, Strangford Lough	shore	shore	shore	W 3	3/8	no
N of Herring Bay, Strangford Lough	shore	shore	shore	W 3	3/8	no
Carrickfergus Marina	>2.00	14.5	35	SW 2	3/8	no
Mahee Island, Strangford Lough	shore	shore	shore	W 2	5/8	no
Belfast Marina, Belfast Lough	2.50	15.0	24	W 2	6/8	no
Donaghadee Quarry Marina	>2.00	13.0	35	NW 2-3	4/8	no
Bangor Marina, Belfast Lough	4.00	14.5	23	W 2-3	5/8	no
Ringhaddy Yacht Club Pontoon, Strangford Lough	3.25	13.5	35	W 2	5/8	no
Whiterock Pontoon, Strangford Lough	>1.50	14.5	35	W 2	4/8	no
Ballydorn Marina, Strangford Lough	3.25	12.5	34	W 2	4/8	no
Portaferry Marina, Strangford Lough	3.25	12.5	35	SE 6-7	3/8	no
Quoile Yacht Club Pontoon, Strangford Lough	2.75	13.0	34	SE 6-7	3/8	no
Killyleagh Yacht Club Pontoon, Strangford Lough	3.75	13.5	34	SE 6-7	3/8	no
East Down Yacht Club Pontoon, Strangford Lough	4.00	13.5	35	SE 6-7	3/8	no
Dundrum Bay	shore	shore	shore	W 2-3	6/8	no
Ardglass Marina	3.25	14.5	35	W 2-3	6/8	no
Warrenpoint Marina, Carlingford Lough	1.75	15.0	24	W 1	7/8	no
Mill Bay, Carlingford Lough	shore	shore	shore	W 1	7/8	no

Decontamination procedure

Where possible all equipment was initially bathed in freshwater. All sampling equipment in advance of arriving at site was then sprayed with an iodine preparation (Isosan ©) at high concentration. This was also used on boots, writing slates, collection bags and tubes.



The Abundance and Distribution Range (ADR) monitoring method involved sampling at selected areas within an assessment unit. The size of the assessment unit varied according to the expanse of the marina layout and design. Marinas with a carrying capacity of fifty or more craft were selected for this analysis. Thirty separate sampling positions were chosen from the sides and undersides of floating structures. The samples included the supporting poles, idle immersed ropes, chains, immersed fenders and heavily fouled boat hulls.

The ADR was calculated for each marina based on frequency of NIS within the thirty positions. Pontoons that were sampled had a simple list of targeted NIS should they be found. The ADR calculation for each NIS was based on the method of Olenin *et al.* (2007), and facilitated by the on-line service BINPAS at: <http://www.corpi.ku.lt/databases/index.php/binpas/>.

Abundance was evaluated as:

- *present* where a NIS made up only a small part of a community
- *common* where its abundance was frequent but less than half of the abundance of the native community
- *abundant* should it exceed half the native abundance, and dominated.

The distribution scales for each assessment unit were:

- *local*, where it appeared only in one place
- *several localities* where it was present in less than half of the stations where it may be expected
- *many localities* where it was found in more than half of the available localities
- *all localities* where almost all substrata, where it may be expected, are occupied.

Combinations of abundance and distribution provide a scale for NIS which occurs:

- **A:** in low numbers in one or several localities
- **B:** in low numbers in many localities or is common in one or several localities, or high numbers in one locality
- **C:** in low numbers in all localities, common in many localities or in high numbers in several localities
- **D:** and is common in all localities or is abundant in many localities
- **E:** and is abundant in all localities.

The first sampling site was undertaken at Carlingford Marina (Republic of Ireland), to test the approach and the equipment before embarking on the survey within Northern Ireland.

All photographs in this report were taken by the authors unless otherwise indicated. Authors are referred to by their initials – D. Minchin (DM) and J. Nunn (JN).

All species recorded are listed in Appendix 1.

FURTHER FIELDWORK: post-contract survey

On 5th September 2012, a sea squirt thought to be the highly invasive species *Didemnum vexillum* was observed at Ballydorn Lightship, Strangford Lough, in the presence of members of Marine Division, DoE(NI) staff (H. Edwards and A. Downie). Subsequent fieldwork (hereafter referred to as the post-contract survey) undertaken in late September and early October to establish the identity and distribution of this species was not part of the contract for the Rapid Marina Assessment. However, the majority of this work was undertaken by one of the authors (JN) in conjunction with colleagues from National Museums Northern Ireland and Marine Division, DoE(NI). It is considered essential that the stages undertaken in response to this threat be documented; and this Report is considered to be an appropriate repository for such information. Results from this Survey are presented separately, as part of a wider discussion concerning *Didemnum vexillum*.

Intertidal sites within the near area of Ballydorn Lightship, and at an oyster farm at Paddys Point, were examined for the presence of *Didemnum vexillum* (Table 4; Figure 1). Methodology consisted primarily of walking the area and searching appropriate habitats at low water. Habitats included lower shore algae (e.g. *Fucus serratus*), under boulders and under kelp in the sublittoral fringe. Samples were taken of any suspect specimens and sent, under contract, for identification by J. Bishop (Appendix 2). In addition a number of dives were undertaken by Marine Division staff, DoE(NI) in Strangford Lough; and the pontoon on the north side of Sketrick Island (Strangford Moorings) was examined using the techniques given above (not a full ADR).

Table 4: Sites visited – *Didemnum vexillum* Survey in Strangford Lough, Co. Down

LOCALITY	Lat/Long	Date	type	Time
Ballydorn Lightship	54° 29.46'N 05° 38.92'W	17/9/12	shore	07.15-07.45
Ballydorn Quay	54° 29.42'N 05° 38.86'W	17/9/12	shore	08.00-08.15
Sketrick Island N (near pontoon)	54° 29.34'N 05° 38.75'W	17/9/12	shore	08.15-08.30
Sketrick Island narrows	54° 29.41'N 05° 38.57'W	17/9/12	shore	08.45-09.30
Sketrick Island pontoon	54° 29.35'N 05° 38.75'W	17/9/12	-----	10.00-10.45
Mahee Island narrows	54° 29.77'N 05° 38.66'W	18/9/12	shore	08.30-10.00
Whiterock Bay	54° 28.90'N 05° 38.75'W	19/9/12	shore	08.45-09.45
Braddock Island	54° 28.87'N 05° 38.39'W	19/9/12	shore	09.45-10.45
Paddys Point	54° 31.07'N 05° 38.80'W	20/9/12	shore	10.15-11.15
Rainey Island narrows & boatyard	54° 29.62'N 05° 38.93'W	21/9/12	shore	10.30-12.30
Ballydorn Lightship	54° 29.46'N 05° 38.92'W	25/9/12	dive	10.12-10.35
Sketrick Island pontoon	54° 29.35'N 05° 38.75'W	25/9/12	snorkel	-----
Rainey Island narrows	54° 29.62'N 05° 38.93'W	3/10/12	shore	09.15-10.00
Ballydorn Lightship (BBC filming)	54° 29.46'N 05° 38.92'W	3/10/12	dive	15.19-15.42
Sailing Marker	54° 30.39'N 05° 36.34'W	3/10/12	dive	-----
Sailing Marker	54° 29.72'N 05° 35.59'W	3/10/12	dive	-----
Yacht 'Melanie', Whiterock Bay	54° 29.13'N 05° 38.39'W	3/10/12	dive	-----
Survey by MD staff – various vessels, structures, moorings, jetties Ringhaddy, Whiterock, Ballydorn	-----	18/10/12	camera	-----
Sketrick Island south	54° 29.18'N 05° 38.42'W	19/10/12	shore	10.15-11.30



Figure 1. Sites visited in Ballydorn Area during post-contract survey for *Didemnum vexillum*

● new sites – representative points are given ● sites visited during Rapid Marina Assessment Survey

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RESULTS

The Rapid Marina Assessment Survey took place over the period 29 August to 8 September 2012. A preliminary survey evaluating and testing the equipment took place on 28 August at Carlingford Marina and on the nearby Greenore shore. In all, eleven marinas were examined in Northern Ireland using the ADR methodology (Figure 2; Table 2). Each site visited is described below, and a summary of findings given, including the ADR scores.

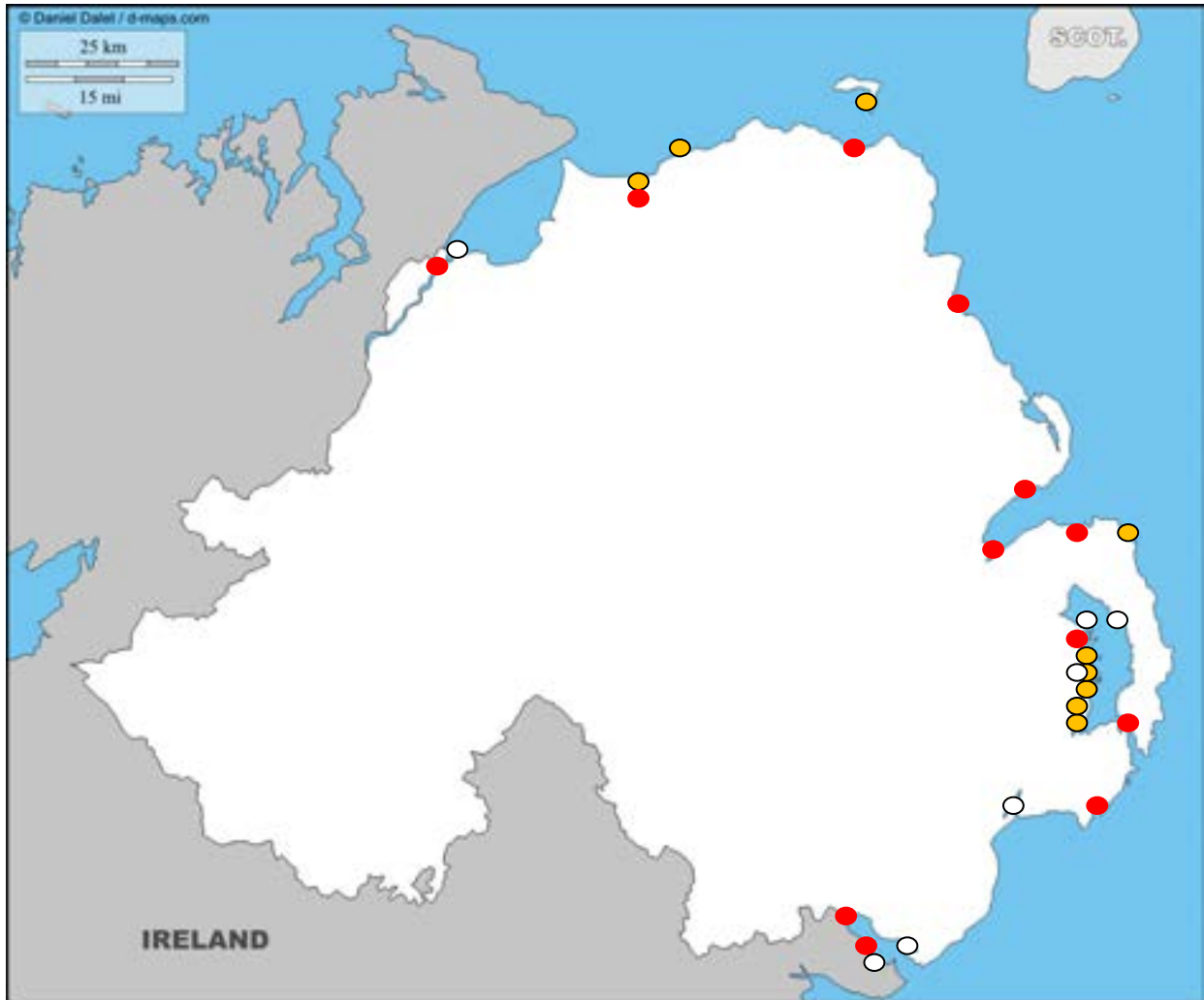


Figure 2. Sites sampled during the period 28 August to 8 September 2012.

Marinas where ADR surveys took place (red), pontoons sampled (orange), and shore sites visited (white). Clockwise marinas: Foyle, Coleraine, Ballycastle, Glenarm, Carrickfergus, Belfast, Bangor, Copelands, Ballydorn, Portaferry, Ardglass, Warrenpoint and Carlingford (preliminary test site).

CARLINGFORD MARINA, Carlingford Lough (RoI)

28 August 2012



This is a sheltered site, except during high water at spring tides with an easterly wind when waves pass over the breakwater. The site has marine conditions, and near to the entrance of the Carlingford Lough there is a greater exchange of water. Pontoons are distributed on either side of a floating hulk from which access is obtained. The kelp *Saccharina latissima* is extensively distributed attached to floating pontoons, and this is fouled with many species. Fouling mainly consists of soft organisms.

	Present	Common	Abundant	Frequency	ADR
<i>Austrominius modestus</i>	1	0	0	1/30	A
<i>Botrylloides violaceus</i>	4	4	0	8/30	B
<i>Bugula neritina</i>	8	19	3	30/30	D
<i>Corella eumyota</i>	1	0	0	1/30	A
<i>Didemnum vexillum</i>	8	2	0	10/30	B
<i>Perophora japonica</i>	7	1	0	8/30	B
<i>Sargassum muticum</i>	1	0	0	1/30	A

During the 2006 survey (Minchin, 2007a), six species were recorded: *Austrominius modestus*, *Botrylloides violaceus*, *Corella eumyota*, *Didemnum vexillum*, *Monocorophium sextonae* and *Sargassum muticum*. *Bugula neritina* was collected in 2008 by C. Maggs and DM (Ryland *et al.*, 2011). *B. fulva*, a cryptogen, was found for the first time in the Republic of Ireland at this marina site. *Didemnum vexillum* was confirmed as being present in 2008 and 2009 (JN, Loughs Agency). *Sargassum muticum* was still present in 2008 (JN).

In 2012, the most frequent NIS was *Bugula neritina*, being common close to the water surface forming extensive bushy growths. This had an ADR of 'D' as it was present at all of the thirty sampling sites, and was generally common attached to pontoons, to some boat hulls and to fenders. Colonies were also attached to a wide range of other organisms including *Ascidella aspersa*, and *Saccharina latissima*. *Didemnum vexillum* did not form extensive pendulous growths at this site, but overgrew many large fouling invertebrates at a third of the sites sampled. Its relative abundance at this site would appear not to have been as frequent as in the previous 2006 survey (Minchin, 2007a). *Sargassum muticum*, although frequently washed ashore near Greenore, was rare at this marina site, only snagged on a single pontoon chain near the entrance. *Corella eumyota* may be more extensive than has been recorded. *Perophora japonica* (the first record for the island of Ireland) and *Botrylloides violaceus* were confirmed as present by G. Lambert, the cryptogenic bryozoan *Bugula fulva* (id J. Porter, conf. J. Ryland) and *Tricellaria inopinata* by J. Porter.

Austrominius modestus, *Gracilaria vermiculophylla* and *Sargassum muticum* were recorded in the intertidal nearby at Greenore.

FOYLE MARINA, Foyle Estuary

29 August 2012



This long pontoon boardwalk lacks finger units due to the strong tidal stream in the estuary of the Foyle situated below the Council offices and running parallel to the river bank. At the time of sampling, few boats were berthed alongside. This is in a low salinity turbid water region with a strong vertical zonation of the pontoon floats. The marina was installed in 2001 and not all available berths are utilised.

	Present	Common	Abundant	Frequency	ADR
<i>Amphibalanus improvisus</i>	16	11	3	30/30	C
<i>Cordylophora caspia</i>	1	2	0	3/30	B

The brackish water barnacle *Amphibalanus improvisus*, a cryptogenic species, was generally common, giving an ADR value of 'C'. The Ponto-Caspian hydroid *Cordylophora caspia*, also a cryptogen, was present in clusters at some of the sampling sites on partly immersed tyres used as fenders along the pontoon. Red algae of 4 to 8 cm in length were abundant about the edge of the pontoon close to water level and often were attached to *A. improvisus*. The algae were abundant and *C. caspia* may be more frequent than realised as small colonies may have been present entangled within the dense algal tufts, increasing the ADR of 'B'.

O'Riordan (1967), in a review on cirripedes, records *Amphibalanus (Balanus) improvisus* from the Foyle, and there are no known records since then. *C. caspia* may be a new record for the area. The species may have been present for some time.

CULMORE POINT, Foyle Estuary

29 August 2012



This low gradient shore consisted of soft and firm muddy sands and banks of sands and gravels. A neat culture operation of *Crassostrea gigas* was being managed on these mobile substrata. There were no drifts of algal detritus, despite a noticeable tidal current in the region. Wind from an easterly direction would have resulted in the use of a different trestle design in order to reduce loss or damage to oysters and oyster bags from wave-slap. Oysters from this operation were deep, and were of an attractive market shape.

Previous records from Culmore Point include *Austrominius modestus* and *Crassostrea gigas* (JN, 2011). Both these species and *Amphibalanus improvisus* (on cast up log) were recorded during this Survey.

Crassostrea gigas were generally in good condition, but the edge of the gills in some specimens had a wavy margin. The cause for this is unknown. This condition is not serious, but similar gill damage has been noted in Cork Harbour where a stronger wavy gill margin was found in 2002. A similar effect had been found in the native oyster *Ostrea edulis* on the west and south coasts of Ireland in the 1980s, but has not been observed since. The condition at that time was sufficiently damaging to result in high native oyster mortalities in Connemara. One possible cause for this was the finding of a copepod new to science *Herrmannella duggani* (Holmes & Minchin, 1991) which eroded the gill margins. Neither the commensal copepod *Mycicola ostreae* (found on oyster gills) nor the parasitic copepod *Mytilicola orientalis* (found in the oyster gut) were found in the sampled oysters.

SEATON'S LANDING, Bann Estuary

30 August 2012



Two separate pontoon units were linked to the river bank, divided by a launching area. One long pontoon, with yacht and cruiser berths, ran parallel to the river bank and has been in service since 2003-5. The marina is in a tidal area subject to strong currents in a region of low, and probably variable, salinity. The pontoons were held in place by moorings and chain. Pontoons had a styrofoam surface which was difficult to sample.

The hydroid *Cordylophora caspia* was abundant on immersed tyres close to the water surface. It is not known whether *C. caspia* has been recorded from this estuary before.

While sampling in the Bann Estuary here, a single drift plant of the North American, Nuttall's pondweed, *Elodea nuttallii* was found. It was entangled in a mooring chain of the pontoon. Van-Veen grab sampling did not recover the zebra mussel *Dreissena polymorpha* nor *Corbicula fluminea*, although there were accounts of clams being landed by foraging otters on the stern platforms of some craft. These may have been unionids. *Gammarus tigrinus* (det. R. Snijder) and the North American pondweed *Elodea nuttallii* were also recorded here.

COLERAINE MARINA, Bann Estuary

30 August 2012



This set of pontoons has been present since 2005-6, and is held in place by vertical piles. There are two main pontoon stretches arranged parallel to the river bank, the innermost set being the most sheltered from current action. Piles were also sampled to a depth of 3.5m depth. One vessel from Lough Neagh was present having recently arrived, but the hull had been cleaned before leaving the Lough. There were no zebra mussels from this region in any samples.

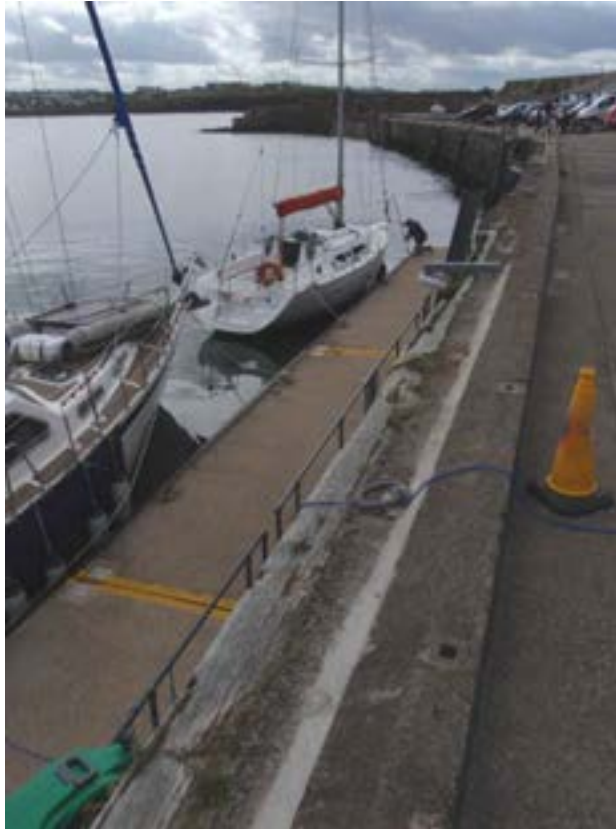
	Present	Common	Abundant	Frequency	ADR
<i>Amphibalanus improvisus</i> (dead)	13	0	1	14/30	A
<i>Cordylophora caspia</i>	13	10	0	23/30	B
<i>Potamopyrgus antipodarum</i>	1	2	0	3/30	B

The presence of shell remains of *Amphibalanus improvisus* would indicate that, at times, populations of this barnacle colonise the floating pontoons and vertical piles from a residual population occurring most probably in deeper water and perhaps further downstream. Such colonisation events most probably take place during prolonged periods of low rainfall. When colonisation takes place, the ADR value would probably exceed 'A'. The remains of this species were found during the previous survey in 2006 at the same locality.

At this site, *Cordylophora caspia* was also found, suggesting a very widespread occurrence of the species in this estuary. The New Zealand mudsnail *Potamopyrgus antipodarum* was present at an ADR value of 'B', but this species can form rapid and dense populations over short periods of time and so this value is only representative for the time of the survey. *Gammarus tigrinus* (det. G. Rowe) was also recorded here.

PORTRUSH PONTOON

30 August 2012



A single pontoon of ~40m in length was situated alongside the quayside. The floating units were extensively colonised by kelps and green algae. Small cruisers, yachts and one fast craft were berthed alongside at the time of the study.

Corella eumyota and *Tricellaria inopinata* have both been previously found in Portrush Harbour (Oct 2011, JN; Nunn *et al.*, 2012). During this survey, both these species were recorded. The cryptogenic amphipod *Monocorophium insidiosum* was also found (det. G. Rowe).

RATHLIN PONTOON

31 August 2012



This floating pontoon was close to, but separate from the Harbour where the ferry from Ballycastle berths. The pontoon exceeds 100m in length, and was angled to extend out into the harbour. There was an extensive cover of *Saccorhiza polyschides*. The site has totally marine conditions, and a full tidal exchange exposed to a southerly fetch. Few craft were alongside.

Previous records at Rathlin Pontoon include *Caprella mutica* (R. Snijder, June 2011), *Corella eumyota* and *Colpomenia peregrina* (JN, Aug 2011).

During this survey, *Corella eumyota* was found to be abundant; *Caprella mutica* and *Tricellaria inopinata* (det. J. Porter) were present. The bryozoan *Bugula simplex* was observed here and the cryptogen *B. fulva* (det. J. Porter conf. J. Ryland). There is a diverse assemblage of species at this site, and the surface of the floating pontoons was not easily sampled due to the extensive cover of holdfasts.

BALLYCASTLE MARINA

31 August 2012



This is a very sheltered marina protected by a high wall. A storm drain discharges to the most inner part of the enclosure, causing periodic salinity reductions. At the time of sampling, there was a dark scum and withered kelps at the innermost part of the marina. The floating units were made of styrofoam covered in a plastic canvas. Sections of pontoons were devoid of fouling where the limpet *Patella vulgata* was present.

	Present	Common	Abundant	Frequency	ADR
<i>Corella eumyota</i>	6	0	0	6/30	A

The survey in 2006 did not record any alien species (Minchin, 2007a). Only *Aplidium glabrum*, *Corella eumyota*, *Bugula simplex* (ADR unknown; det. J. Porter conf. J. Ryland) and the cryptogenic amphipod *Monocorophium insidiosum* (det. G. Rowe) were recorded during this survey. The presence of *Corella eumyota* represents a new locality for this species at an ADR 'A'.

GLENARM MARINA

1 September 2012



This is a walled harbour with two main pontoons, each with finger units for berthing a vessel on either side. Pontoon floating units had concrete surfaces. The sheltered conditions varied, and there was a greater tidal exchange near the entrance. Conditions were fully marine. Nearby, to the south, was a stone quay used for servicing the offshore salmon farm. Nets of the farm were cleaned offshore. At the time of the survey, a yacht based in Poland was berthed here.

	Present	Common	Abundant	Frequency	ADR
<i>Corella eumyota</i>	15	0	0	15/30	A
<i>Styela clava</i>	1	0	0	1/30	A

The circum-Antarctic tunicate *Corella eumyota* and *Styela clava* at this marina represent a new site for both of these species. The *S. clava* found was of a single juvenile. On marina pontoons, *S. clava* tends to occur in greater abundance on the underside of marina floating units, and a snorkel survey could reveal the overall extent of this species at this site. *Tricellaria inopinata* and *Bugula simplex* were recorded here (det. J. Porter; conf. J. Ryland), together with *Caprella mutica* (det. R. Snijder) and the cryptogenic amphipod *Monocorophium insidiosum* (det. G. Rowe).

KIRCUBBIN, Strangford Lough

2 September 2012



This site is mainly gravel, some sandy mud, and boulders, lying close to the slip of Kircubbin Yacht Club. The Kircubbin area has a number of species recorded: *Austrominius modestus* (Northern Ireland Littoral Survey (NILS), 1985 and subsequently), *Corella eumyota* (JN, 2011), *Crassostrea gigas* (JN, 2011), *Codium fragile* ssp. *fragile* (NILS, 1985 and subsequently), *Colpomenia peregrina* (MD (DoENI), 2011), *Sargassum muticum* (MD, DoE(NI), 2002, 2011).

Colpomenia peregrina and *Corella eumyota* were recorded during this survey.

North of HERRING BAY, Strangford Lough

2 September 2012



This shore was primarily firm sandy mud with many scattered boulders, particularly at low water. The boulders were encrusted with barnacles, and had a rich associated fauna. Recent visits to this site by JN have recorded *Corella eumyota* (2011, 2012), *Crassostrea gigas* (2011, 2012), *Austrominius modestus* (2011, 2012), *Colpomenia peregrina* (2012) and *Sargassum muticum* (2012).

Austrominius modestus, *Corella eumyota* and *Crassostrea gigas* were recorded during this survey.

Both *Crassostrea gigas* and *Ostrea edulis* were examined at this site. While there were indications of a number of year classes of *O. edulis* present, including the 2012 settlement, only massive *C. gigas* were found. These Pacific oysters were cemented to large boulders on the shore, and some had become displaced. Specimens had *Polydora* damage to the shell, whereas the native oyster did not have this condition. No *Mycicola ostreae* or *Mytilicola orientalis* were found associated with these oysters.

CARRICKFERGUS MARINA

2 September 2012



This is a large marina with many services and several pontoon stretches introduced on different dates. Pontoons were covered in plastic canvas, hard plastic or concrete depending on the year of immersion. There is a greater diversity at the marina entrance. Marine conditions would appear to exist throughout the marina. Some of the pontoons were replaced in 2008. Several craft with heavily fouled hull surfaces were berthed alongside.

	Present	Common	Abundant	Frequency	ADR
<i>Austrominius modestus</i>	9	0	0	9/30	A
<i>Bugula neritina</i>	24	5	1	30/30	C
<i>Caprella mutica</i>	5	1	0	22/30	A
<i>Colpomenia peregrina</i>	3	0	0	3/30	A
<i>Corella eumyota</i>	12	0	0	12/30	A
<i>Styela clava</i>	5	0	0	5/30	A
<i>Undaria pinnatifida</i>	2	0	0	2/30	A

The kelp Wakame *Undaria pinnatifida* was recorded here, the first for the island of Ireland. Three specimens were obtained giving an ADR of 'A'; but overall this species within the marina may be more extensive. A visit to this Marina on 29th August 2013 (JN, Marine Division staff) confirmed that this species was distributed throughout the marina on all pontoons examined.

The first record for Northern Ireland for the purple and brown forms of the bryozoan *Bugula neritina* was also noted. This species was common, forming bushy tussocks on pontoons and heavily fouled boat hulls close to the water surface to give an ADR of 'C'.

This marina is a new site in Northern Ireland for the Asian tunicate *Styela clava*, present in low numbers in the areas sampled, and the bryozoan *Tricellaria inopinata*. *Austrominius modestus*, *Bugula simplex* (det. J. Ryland), *Caprella mutica*, *Colpomenia peregrina*, *Corella eumyota*, the cryptogenic tunicate *Aplidium glabrum*, and the cryptogenic amphipods *Monocorophium acherusicum* (det. R. Snijder & G. Rowe) and *M. sextonae* (det. G. Rowe) were also recorded here, giving a total of twelve NIS and cryptogens for this marina.

Crepidula fornicata has been found on the shore nearby at Carrickfergus Castle and Fisherman's Quay since 2009 (McNeill *et al.* 2012), but was not seen during this survey. This marina was the first record for *Corella eumyota* in Northern Ireland, found during the previous survey in June 2006 (Minchin, 2007a).

MAHEE ISLAND gravel spit, Strangford Lough

3 September 2012



This site is a small gravel spit with scattered boulders at low water. There is a nearby artificial clay pond, known to have been dug to about 1m depth in the 1940s/50s to hold oysters. It is locally thought that the spit was also artificially created at around that time. A strong tidal current, with sediment scouring, passes over this spit and so fine sediments have been winnowed away from this site to leave gravels, stones and some small boulders.

Previous records from this site include *Austrominius modestus* (JN, 2004 and subsequently) and *Calyptrea chinensis* (JN, 2004 and subsequently, absent 1999). *Sargassum muticum* is common on the lower shore, very often attached to stones and shell carried onto the gravel spit. The brown alga, the oyster thief *Colpomenia peregrina* (JN 2007) is known from Strangford Lough since 1934 (Morton, 1994) and *Corella eumyota* (JN 2011) recently expanding. All these species were observed during this Survey. The cryptogenic amphipod *Monocorophium insidiosum* was also found (det. G. Rowe).

Over a substantial area of the gravel on the lower shore, the southern distributed red alga *Chondracanthus acicularis* was recorded (identified by C. Beer and C. Maggs). This is the first site in Northern Ireland for this species. It was not seen during a visit in July 2012, only two months previously. This is probably the most northern site recorded for this species in Europe. However, under the name *Gigartina acicularis*, a specimen almost two-hundred years earlier was attributed to J Templeton, but according to Morton (1994), the identity of this single specimen may have been incorrectly determined.

BELFAST MARINA, Belfast Lough (Inner)

3 September 2012



This marina lies within the port region of Belfast in brackish conditions. There are two parallel pontoon stretches and small finger berths with small floatation units. The pontoons were installed during 2009 in time for the Tall Ships event. There are plans to expand the extent of the marina.

	Present	Common	Abundant	Frequency	ADR
<i>Austrominius modestus</i>	24	0	0	24/30	B

There is a vertical zonation on the floating units, with the cryptogen *Monocorophium insidiosum* (det. R. Snijder & G. Rowe) amongst other amphipods close to the surface with red algae, and with extensive mussel fouling below.

The Australasian barnacle *Austrominius modestus* is a prominent NIS present at this site, and then appearing only at the highest level on pontoon floats or on the piles close to the quay wall.

The only species previously recorded from this area is *Teredo navalis*, status unknown (Thompson, 1856).

DONAGHADEE QUARRY MARINA

4 September 2012



This is a marina in what was once a quarry. At low water, the floor of the marina is shallow with a build-up of algal debris in the central region as a result of deposition due to the current circulating within. Some poor water exchange areas within the most sheltered part of the marina have bacterial mats of *Beggiatoa* on the mud surface. The marina has a high containing wall and quay, and when exposed to strong easterly winds can use a sluice to prevent wave action from entering. This is one of the earliest marinas to be developed, with the first pontoon sections placed in 1976.

No NIS were recorded here in 2006 (Minchin, 2007a). During this survey, *Corella eumyota* and the cryptogenic amphipod *Monocorophium insidiosum* (det. G. Rowe) were the only alien species recorded.

BANGOR MARINA, Outer Belfast Lough

4 September 2012



This large marina has been operating since 1985. In the innermost part, there is a storm drain which discharges water and during flooding events there can be an overflow from municipal waste management service areas. These waste discharges result in a surface layer of reduced salinity and a distinct halocline was found for much of the inner part of the marina during the survey. Marine conditions can prevail, but mainly close to the entrance. The extent of pontoons and berthed craft tend to hold back the lowest salinity region to close to the storm drain discharges. Mussels were common on the lower part of the pontoons, and above the mussels were green algae. Where there were hanging laminae of kelp, there was more extensive fouling with tunicates and amphipods.

	Present	Common	Abundant	Frequency	ADR
<i>Austrominius modestus</i>	17	0	0	17/30	A
<i>Caprella mutica</i>	10	1	1	12/30	A
<i>Corella eumyota</i>	12	0	0	12/30	A

Six NIS were found - these were the tunicate *Corella eumyota* present at several sites with an ADR of 'A' and a similar value for *Caprella mutica* and *Austrominius modestus* the latter being present in the uppermost zone. *Tricellaria inopinata* and large colonies of *Bugula simplex* were present (det. J. Porter; conf. J. Ryland). The cryptogenic amphipod *Monocorophium insidiosum* was also found (det. G. Rowe).

Only one species, *Austrominius modestus* was recorded here during the previous Marina Survey (Minchin, 2007a) and subsequently nearby in 2011 (JN). Since that date, *Caprella mutica*, *Styela clava* (both R. Snijder, 2009), *Corella eumyota* (JN, 2011), *Botrylloides violaceus* (probable) (JN, 2011), *Bugula simplex* (JDN, 2011 det. J. Porter) and *Tricellaria inopinata* (Nunn *et al.*, 2012) have been recorded. *Sargassum muticum* has also been seen near the marina (JN, 2011).

RINGHADDY YACHT CLUB, Strangford Lough

5 September 2012



This is a set of two pontoon lengths used for the berthing of tenders for the moored recreational craft in the bay. Conditions were fully marine. Fouling on pontoons was mainly of algae, tunicates and Anthozoa.

A number of species have been previously recorded here or in the vicinity of the pontoon: *Caprella mutica* (MD, DoE(NI), 2009), *Austrominius modestus* (JN, 2009), *Sargassum muticum* (JN, 2004), *Crassostrea gigas* (JN, 2004), *Calyptrea chinensis* (JN, 2011), *Corella eumyota* (JN, 2011), *Colpomenia peregrina* (JN, 2012) and *Heterosiphonia japonica* (JN 2012 conf. C. Beer).

During this survey, *Austrominius modestus*, *Caprella mutica*, *Corella eumyota*, *Colpomenia peregrina*, *Heterosiphonia japonica* (nearby on shore) and *Sargassum muticum* were recorded.

WHITEROCK MARINA, Strangford Lough

5 September 2012



This is a single pontoon unit used for loading and unloading to service the moored craft within the bay. Conditions are fully marine, with soft fouling from algae and tunicates on the floating units.

Codium sp., possibly *fragile* ssp. *fragile*, *Corella eumyota* and *Austrominius modestus* were recorded here during the present survey.

BALLYDORN MARINA, Strangford Lough

5 September 2012



Access is via a ramp to the lightship. The pontoons are clustered alongside. The marina is in an area with a fast tidal flow within a sheltered part of Strangford Lough close to a former oyster farm service area. Several vessels are moored to the outer pontoon, and tenders to the moored craft in the bay lie between the lightship and the shore.

	Present	Common	Abundant	Frequency	ADR
<i>Austrominius modestus</i>	2	0	0	2/30	A
<i>Colpomenia peregrina</i>	2	0	0	2/30	A
<i>Corella eumyota</i>	6	0	0	6/30	A
<i>Didemnum vexillum</i>	7	1	0	8/30	B
<i>Sargassum muticum</i>	6	0	0	6/30	A

Here the carpet sea squirt *Didemnum vexillum* was found to be present, occurring mainly on the stern hull of the lightship. The pendulous growths were similar to those found in Malahide Estuary, north of Dublin, in 2006. Also present were encrusting carpets of this tunicate. It occurred at almost one third of the sampling sites, and was common at one site to provide an ADR of 'B'.

All other species present were present in low numbers at less than half of the sites samples to provide an ADR of 'A'. *Aplidium glabrum* was also present.

PORTAFERRY MARINA, Strangford Lough

6 September 2012



This marina is in a region of strong tidal flow. The marina is protected by an outer line of pontoons that reduce the wave action for the inner sheltered region. The pontoons, where berthing takes place, form an ‘F’ outline with small finger units supported by small floating units. Craft berthed include yachts, cruisers and small work boats. Conditions are fully marine, and the floating units have an extensive cover of kelps.

	Present	Common	Abundant	Frequency	ADR
<i>Caprella mutica</i>	25	0	0	25/30	B
<i>Colpomenia peregrina</i>	20	0	0	20/30	B
<i>Corella eumyota</i>	8	0	0	8/30	A
<i>Sargassum muticum</i>	6	0	0	6/30	A

Two species appear at an ADR of ‘B’ where they were present in low numbers in more than half of the sites sampled; *Colpomenia peregrina* occurring close to the waterline and *Caprella mutica* attached to filamentous algae and kelps to give an ADR value of ‘B’. The tunicate *Corella eumyota* and *Sargassum muticum* were present in low numbers in less than a quarter of the sites giving an ADR of ‘A’. The cryptogenic amphipod *Monocorophium sextonae* was also found (det. G. Rowe).

Sargassum muticum and *Austrominius modestus* were found here during the 2006 survey (Minchin, 2007a), and subsequently on the shore nearby (JN, 2011). Additional species previously found here are: *Caprella mutica* (MD, DoE(NI), 2011), *Corella eumyota* and *Colpomenia peregrina* (both JN, on the shore nearby 2011).

QUOILE YACHT CLUB, Strangford Lough

6 September 2012

This is in an area with highly variable salinity, due to being close to a barrage that holds back freshwater which can spill into this part of the bay. The pontoons are used for holding tenders for craft moored within the bay. The floats are extensively covered with mussels, with a small zone close to the water surface with green and red algae.

Corella eumyota and *Austrominius modestus* were found here during this survey.



KILLYLEAGH YACHT CLUB, Strangford Lough

6 September 2012



This is a single floating pontoon providing a service area for loading and unloading for the vessels moored within the bay in a region with marine conditions. The floating units had soft fouling biota.

Previous records here are *Corella eumyota* and *Austrominius modestus* (both JN, 2011). These species were recorded during this survey. The cryptogenic amphipod *Monocorophium sextonae* was also found (det. G. Rowe).

EAST DOWN YACHT CLUB, Strangford Lough

6 September 2012



This is a single pontoon used for the holding of tenders for the vessels moored within the bay. The conditions are fully marine, and there was soft fouling on the floating units.

Corella eumyota, *Botrylloides violaceus* (probably, G. Lambert *pers. comm.*) with a transparent matrix and orange zooids, the cryptogenic bryozoan *Bugula fulva* (det. J. Porter; conf. J. Ryland), and the barnacle *Austrominius modestus* were recorded here on this survey. The cryptogenic amphipod *Monocorophium sextonae* was also found (det. G. Rowe).

DUNDRUM BAY

7 September 2012



This is a very sheltered and expansive bay which almost entirely drains at low water spring tides. There is an oyster farm present, but not at the site visited within the bay. The shore is very slightly sloped with small rises of gravel over a sandy mud with occasional stones. Brackish conditions prevail.

This site is the first recorded area for *Gracilaria vermiculophylla* in Northern Ireland, by C. Beer (conf. C. Maggs) on 27th July 2012. When visited on this survey, the species was present in large tangled drifts and mounds over a substantial area. *Amphibalanus improvisus* was recorded in 1987 from Inner Dundrum Bay (NILS), but was not seen on this survey. *Austrominius modestus* was recorded.

ARDGLASS MARINA

7 September 2012



This marina is in a sheltered and shallow part of an embayment protected at low water by scattered rocky reefs and near to the fishing port quay. Marine conditions prevail, and the floating units are dominated by soft fouling. Kelps predominate and there is a high diversity of organisms.

	Present	Common	Abundant	Frequency	ADR
<i>Colpomenia peregrina</i>	10	0	0	10/30	A
<i>Corella eumyota</i>	24	0	0	24/30	B
<i>Watersipora subtorquata</i>	2	0	0	2/30	A

At this site, the tunicate *Corella eumyota* was found in low numbers at many sites to provide an ADR of 'B'. All others were recorded in low numbers at less than half of the sites to provide an ADR of 'A'. *Tricellaria inopinata* (det. J. Porter) was recorded. The presence of *Watersipora subtorquata* is the first record for Northern Ireland. The cryptogenic amphipod *Monocorophium sextonae* was also found (det. G. Rowe).

The previous survey in 2006 only recorded *Austrominius modestus* and *Sargassum muticum* (Minchin, 2007a), neither of which were seen during the present survey.

WARRENPOINT MARINA, Carlingford Lough

8 September 2012



This is a small marina in the innermost part of Carlingford Lough subject to brackish water, being adjacent to the Newry Canal and river. Berthed in the area were fishing craft and port service vessels as well as leisure craft. The site is protected by quay walls in the port region. Here fishing vessels tend to their catch of mussels dredged within the inner part of the bay.

	Present	Common	Abundant	Frequency	ADR
<i>Austrominius modestus</i>	10	11	5	26/30	B
<i>Corella eumyota</i>	3	0	0	3/30	A

There was heavy fouling, and extensive growths of sponges attached to ropes and bags hanging from the pontoon into midwater.

Austrominius modestus was abundant at a few localities, especially on piles to give an ADR of 'C'. The tunicate *Corella eumyota* was present only at three sites giving an ADR of 'A'. *Aplidium glabrum* was present. The cryptogenic amphipod *Monocorophium sextonae* was also found (det. G. Rowe).

MILL BAY, Carlingford Lough

8 September 2012



This almost flat bay lies just inside the entrance to Carlingford Lough. It is an extensive shallow sloping shore of sandy mud and with some stones and surface shallow pools and stones.

Austrominius modestus and *Gracilaria vermiculophylla* were recorded here during the present survey.

Post-Contract Survey – Strangford Lough



BALLYDORN LIGHTSHIP shore & BALLYDORN QUAY **[J. Nunn, B. Picton, A. Downie]**

17 September 2012

The shore opposite Ballydorn Lightship and around the adjacent Quay was examined for the presence of *Didemnum vexillum*. The shore near the Lightship was a steep boulder slope with some siltation and *Fucus serratus* on the lower shore. Towards the Quay, the shore became flat and dominated by gravel with *Sargassum muticum*. Possible colonies were found on blades of *Fucus serratus* and sent for identification to J. Bishop (Appendix 2). Identification was equivocal, but is considered to be likely.

Previous records in this area are *Calyptraea chinensis* and *Sargassum muticum* (JN, 2011). Both of these together with *Aplidium glabrum*, *Austrominius modestus*, *Corella eumyota* and *Heterosiphonia japonica* were also recorded during this survey.

SKETRICK PONTOON – shore nearby **[J. Nunn, B. Picton, A. Downie]**

17 September 2012

The shore close to a pontoon on the north side of Sketrick Island was examined. This was a steep slope with boulders and some siltation. *Austrominius modestus*, *Heterosiphonia japonica* and *Sargassum muticum* were recorded. No *Didemnum vexillum* was seen.

SKETRICK ISLAND NARROWS
[J. Nunn, B. Picton, A. Downie]

17 September 2012



Principal recording took place at this site on low water. The area was subject to high tidal flow, and consisted mainly of boulders encrusted with barnacles. Boulders at low water were covered thinly with *Fucus serratus* and kelp, with a very rich under-boulder fauna.

Austrominius modestus, *Calyptrea chinensis*, *Crassostrea gigas*, *Colpomenia peregrina* and *Sargassum muticum* had previously been recorded here in 2011 (JN). All these species were recorded during the present survey, together with *Aplidium glabrum*, *Botrylloides violaceus* (det. G. Lambert), *Corella eumyota* and *Perophora japonica*. *Perophora japonica* was abundant here in August 2013 (JN, B. Picton), and many *Diadumene lineata* were recorded.

Possible colonies of *Didemnum vexillum* were found on blades of *Fucus serratus* and sent for identification to J. Bishop (Appendix 2). Identification was equivocal, but is considered to be likely. Similar colonies were seen on 8th August 2013 (JN, B. Picton).

SKETRICK PONTOON
[J. Nunn, B. Picton, A. Downie]

17 September 2012



This private pontoon, run by Strangford Moorings, was a simple T-shape. The pontoons were approximately seven years old, replacing an older structure, and are never removed during the winter. The pontoon itself is not often used as a mooring.

The site was examined, using the general techniques described in the Methods section (not a full ADR), for the presence of *Didemnum vexillum*. The species was present, overgrowing mussels, confirmed by R. Holt (NRW). Samples were sent for identification to J. Bishop (Appendix 2). Identification was equivocal, but considered to be likely (Appendix 2). This species was also observed here on 21st August 2013 (JN, Marine Division staff).

Aplidium glabrum, *Austrominius modestus*, *Corella eumyota*, and *Sargassum muticum* were also recorded.

MAHEE ISLAND NARROWS
[J. Nunn, B. Picton, A. Downie]

18 September 2012



Mahee Island narrows @ A. Downie

This site is very similar to the narrows at Sketrick Island, being subject to a strong tidal flow. Boulders encrusted with barnacles dominate the main part of this shore, with some kelp and red algae on the lower shore. The under-boulder fauna is very rich.

Previous records at this site include *Sargassum muticum*, *Austrominius modestus* (both JN, 2004), *Calyptrea chinensis* (B. Picton, 2010) and *Diadumene lineata* (A. Reft, 29th September 2010).

All these species were seen on the present survey, together with *Corella eumyota*, *Aplidium glabrum*, *Botrylloides violaceus* (probably, G. Lambert *pers. comm.*) and *Heterosiphonia japonica*. No *Didemnum vexillum* was seen.

WHITEROCK BAY

19 September 2012

[J. Nunn, B. Picton, A. Downie]



Whiterock Bay @ B. Picton

Whiterock Bay is very sheltered, being mainly gravel with some mud, covered with *Ascophyllum nodosum*, and *Fucus serratus* at low water.

Austrominius modestus, *Calyptrea chinensis*, *Colpomenia peregrina*, *Corella eumyota* and *Heterosiphonia japonica* were recorded while walking the shore from Whiterock Yacht Club to the Causeway to Braddock Island. No *Didemnum vexillum* was seen.

BRADDOCK ISLAND

19 September 2012

[J. Nunn, B. Picton, A. Downie]



The entire shore of Braddock Island was walked, with particular attention paid to the eastern spit. The island was primarily sheltered gravel and mud with scattered boulders. *Ascophyllum nodosum* dominated the middle shore, with *Fucus serratus* and some kelp at low water.

Previous records include *Austrominius modestus*, *Calyptrea chinensis* and *Crassostrea gigas* (all JN, 2009).

Austrominius modestus, *Corella eumyota*, *Botrylloides violaceus* (possibly, G. Lambert pers. comm.) and *Heterosiphonia japonica* were recorded during the present survey. Only shells of *Calyptrea chinensis* were seen. No *Didemnum vexillum* was seen.

PADDY'S POINT
[J. Nunn, A. Downie]

20 September 2012



Paddy's Point is a long term oyster farm for *Crassostrea gigas*, originally installed by Cuan Fisheries, but has since passed into different ownership. The trestles lie over firm muddy sand.

This site is the first recorded area for *Sargassum muticum* in Northern Ireland (Boaden, 1995). Other species recorded are *Crassostrea gigas* (casual close to trestles, JN, 1990 & 2007) and *Austrominius modestus* (JN, 2007).

During the present survey, *Austrominius modestus* and *Crassostrea gigas* (not feral) were recorded again, together with *Aplidium glabrum*, *Botrylloides violaceus* (possibly, G. Lambert *pers. comm.*), *Corella eumyota* and *Heterosiphonia japonica*. *Sargassum muticum* was not seen.

A very small sample of a *Didemnum* sp. was seen attached to a loose aquaculture bag containing a few *Crassostrea gigas*, which is probably *vexillum* (Appendix 2). Another specimen attached to *Fucus serratus* was identified from a photograph as probably *D. vexillum* by Gretchen Lambert. A visit on 9th September 2013 (JN, Marine Division staff) failed to observe any colonies of the suspect *Didemnum* sp.

RAINEY NARROWS & BOATYARD

21 September 2012

[J. Nunn, B. Picton, A. Downie, C. Morrow], with a further visit 3 October 2012 [J. Nunn, H. Edwards]



This area is a complex of gravel, muddy sand, boulders and mussel beds, subject to strong tidal flow. The under-boulder fauna is very rich. Live maerl beds exist in the channel offshore, with a substantial dead maerl bed on the other side of this channel on Rainey Island itself. The area examined was from the boatyard to the north of the channel, and along the shore to the narrows with Rainey Island.



Previous records at this site/area were only for dives which took place as part of Ph.D. studies by S. Vize (QUB) on the maerl beds present in the channel. These dives took place from Rainey Island to Ballydorn and Rainey Island to Sketrick Island during 2001-2003. Species recorded were *Calyptrea chinensis*, *Monocorophium sextonae* and *Sargassum muticum*.

Aplidium glabrum, *Austrominius modestus*, *Calyptrea chinensis*, *Corella eumyota*, *Heterosiphonia japonica*, *Perophora japonica* and *Sargassum muticum* and were recorded during the present survey.

In addition, there were many samples of *Didemnum* c.f. *vexillum* on *Fucus serratus*, together a large patch at low water over stones, rocks, boulders and on kelp stipes (Appendix 2). No similar colonies or the patch were observed during a visit on 21st August 2013 (JN).

BALLYDORN LIGHTSHIP

25 September 2012

[R. Holt, R. Snijder, H. Edwards]

A single dive took place in very poor visibility under Ballydorn Lightship. R. Holt (NRW) confirmed that samples taken on this dive were of *Didemnum vexillum*.

SKETRICK ISLAND PONTOON

25 September 2012

[R. Holt, T. Mackie, R. Snijder]

A single snorkel took place near this pontoon. R. Holt (NRW) confirmed that samples taken on this snorkel were of *Didemnum vexillum*.

SAILING MARKERS & ROPES

3 October 2012

[T. Mackie, H. Edwards, R. Snijder, G. Burrows, J. Nunn]

A number of spot dives took place on sailing markers and ropes in the main Lough and within the channel close to Ballydorn Lightship. No *Didemnum vexillum* was present.

YACHT 'MELANIE', Whiterock Bay

3 October 2012

[T. Mackie, H. Edwards, R. Snyder, G. Burrows, J. Nunn]



Samples were scraped from the hull of the abandoned yacht 'Melanie'; and divers also took a sample.

Caprella mutica (det. R. Snijder) and *Corella eumyota* were recorded. No *Didemnum vexillum* was present (Appendix 2).

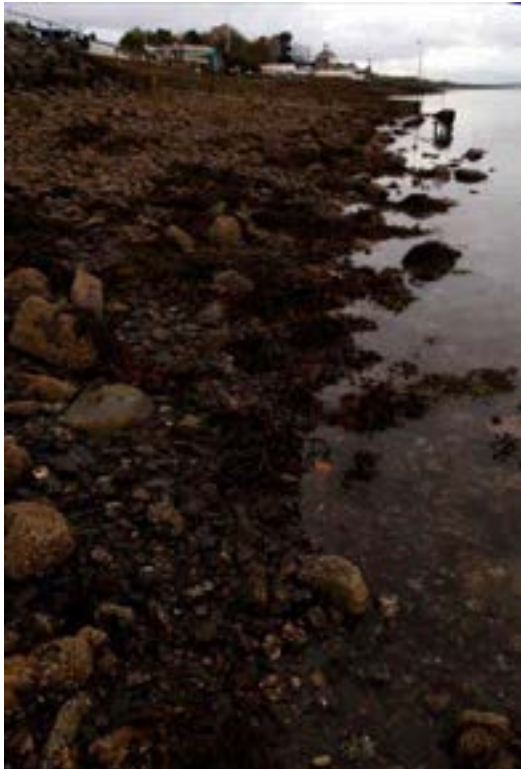
RINGHADDY, WHITEROCK, BALLYDORN
[H. Edwards]

18 October 2012

A boat survey on *S.V. Modiolus* used a pole camera, ideal for identifying vessels and structures for further examination. Various vessels, floating structures, moorings and jetties in Ringhaddy, Whiterock and Ballydorn were examined and while heavy fouling was observed on many, no *D. vexillum* seen.

SKETRICK ISLAND south
[J. Nunn, A. Downie]

19 October 2012



This sheltered shore was walked for several hundred metres on the south side of Sketrick Island. It was primarily a boulder slope with sparse algal cover.

Aplidium glabrum, *Austrominius modestus*, *Colpomenia peregrina*, *Corella eumyota* and *Heterosiphonia japonica* were recorded. No *Didemnum vexillum* was seen.

DISCUSSION

Six species were found for the first time in Northern Ireland, and of these two are of special importance due to the impact they have generated in other world regions. These are the tunicate *Didemnum vexillum* found at the Ballydorn Marina in Strangford Lough and *Undaria pinnatifida* (new to the island of Ireland) found in the Carrickfergus Marina in Belfast Lough. Both of these species have worldwide distributions in temperate environments.

The bryozoan *Bugula neritina* was frequent and at all sites sampled at the Carrickfergus Marina, Belfast Lough. At Ardglass Marina, two colonies of the encrusting bryozoan *Watersipora subtorquata* were found. The brackish-water hydroid *Cordylophora caspia* may be a new record for Northern Ireland, but may have been present for some decades.

The stoloniferous tunicate *Perophora japonica* was recorded from Strangford Lough during the post-contract Survey. This is the most northerly record for its presence in Europe. This species was also recorded from Carlingford Marina, which is the first record for the island of Ireland.

Two species were recorded, whose status is currently unclear – the tunicate *Aplidium glabrum*, the red alga *Chondracanthus acicularis*.

Range extensions were noted for the tunicate *Styela clava* in particular, but also for a number of other species e.g. *Bugula simplex* and *Tricellaria inopinata*. Full accounts for each species are given below.

There has been a marked change in the six year period for the presence of NIS and cryptogens at the seven Northern Irish marinas. Thirty two new records for these seven marina sites were found in 2012 when compared with 2006 (Table 5). This indicates that surveys should be undertaken more frequently. The classification of each species found in 2012 using an ADR will enable relative changes over time to be recorded.

Non-indigenous species continue to arrive in Irish waters. This is part of a continuing trend throughout Europe. Some of the species found in this study may have arrived some years before their discovery. The majority of NIS found at marinas in this investigation will most probably have arrived on the hulls of leisure craft or with shipping. Ballast water discharges might have resulted in the free-living stages of some species being transmitted. However, it is possible that a small number might even have been spread naturally. The resting menont stage of the hydroid *Cordylophora caspia* could be transmitted by birds. Its distribution in Ireland includes brackish lagoons about the Irish coast where migrating birds visit (Oliver & Healy, 1998). Birds also assemble in estuarine regions and so occur in the same regions as the known occurrence of this hydroid and as a result should be considered to be a cryptogen. Its occurrence in the Foyle and Bann tidal regions in high, but localised concentrations might indicate that this species is more frequent than it has been previously known.

	Coleraine Marina		Ballycastle Marina		Carrickfergus Marina		Bangor Marina		Copelands Marina		Portaferry Marina		Ardglass Marina		Carlingford Marina	
	2006	2012	2006	2012	2006	2012	2006	2012	2006	2012	2006	2012	2006	2012	2006	2012
<i>Amphibalanus improvisus</i>	+	A														
<i>Aplidium glabrum</i>				+		+										
<i>Austrominius modestus</i>						A	+	B			+		+		+	A
<i>Botrylloides violaceus</i>															+	B
<i>Bugula fulva</i>																+
<i>Bugula neritina</i>						C									+	D
<i>Bugula simplex</i>				+		+		+								
<i>Caprella mutica</i>						+		+			B				+	
<i>Colpomenia peregrina</i>						A					B					
<i>Cordylophora caspia</i>		B														
<i>Corella eumyota</i>				A	+	A		A			A		B		+	A
<i>Didemnum vexillum</i>															+	B
<i>Monocorophium acherusicum</i>						+										
<i>Monocorophium insidiosum</i>				+				+		+						
<i>Monocorophium sextonae</i>						+					+		+		+	
<i>Perophora japonica</i>																+
<i>Potamopyrgus antipodarum</i>		B														
<i>Sargassum muticum</i>											A		+		+	A
<i>Styela clava</i>						A										
<i>Tricellaria inopinata</i>						+		+					+			+
<i>Undaria pinnatifida</i>						+										
<i>Watersipora subtorquata</i>													A			

Table 5. A comparison of the occurrence of cryptogens and NIS for 2006 and 2012, at seven Northern Irish marinas and for Carlingford Lough. + = no ADR assessment made, A-D are ADR levels of assessment; NIS in **bold**. Note: Bryozoa were not targeted in 2006.

Some of the marinas despite their relative proximity to marine conditions were subject to freshwater runoff *via* storm drains. This undoubtedly had a bearing on the fouling communities at such localities as was noted at the Bangor and Ballycastle marinas. Bangor Marina in particular had been subject to considerable freshwater run-off during the summer period, changing the fouling community from previous visits. Some marinas were persistently exposed to low salinities: these were in the Foyle and Bann estuaries. Some sites will be exposed to moderate but fluctuating salinities such as for the studies at Belfast Port and Warrenpoint.

Most marinas were close to regions of shipping traffic. As a result it is unclear whether it is leisure craft or ship hulls that provide the most likely opportunities for the arrival of previously unrecorded NIS in Northern Ireland. Nevertheless some species e.g. *Styela clava* and *Corella eumyota* were found on the hulls of at least one leisure craft during this investigation berthed alongside a marina. They will have been extensively fouled, and were unused in 2012 up to the time of examination. Such vessels, if moved

elsewhere without the hull being cleaned, pose a risk of spreading attached, or otherwise associated, NIS. This spread could also take place following the sale of such a fouled craft.

Imports of seed mussels containing NIS could become introduced to Carlingford Lough, a situation that may have been responsible for the introduction of *Crepidula fornicata* to Belfast Lough (McNeill *et al.*, 2010). Following an arrival, this, and other species, is likely to become rapidly spread with discards of bycatch. Such activities can result in incremental range expansions of NIS over a wide area. Movements of molluscs from Belfast Lough might also enable transmissions of the resting stage of the toxic and non-toxic stages of the dinoflagellate *Alexandrium tamarense* (Brosnahan *et al.*, 2010). In the case of Strangford Lough, recreational craft and oyster stock movements are a likely means of transmission of NIS. Here, for example, *Corella eumyota* was found attached to leisure craft hulls as well as to living native oysters.

SPECIES Aug-Oct 2012	Foyle Marina		Seaton's Marina	Coleraine Marina	Portrush pontoon	Rathlin Pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	Belfast Marina	Bangor Marina	Copelands Marina	Ballydorn Marina	Skefrick Island pontoon	Whiterock Pontoon	Ringhaddy Pontoon	Portaferry Marina	Quoile Pontoon	Killyleagh Pontoon	East Down Pontoon	Ardglass Marina	Warrenpoint Marina	Carlingford Marina	
	<i>Amphibalanus improvisus</i>	D	+	A																				
<i>Aplidium glabrum</i>						+			+				+	+							+			+
<i>Austrominius modestus</i>									A	B	B		A	+	+	+			+	+			C	A
<i>Botrylloides violaceus</i>																								B
<i>Botrylloides c.f. violaceus</i>											?										?			
<i>Bugula fulva</i>						+															+			+
<i>Bugula neritina</i>									C															D
<i>Bugula simplex</i>						+	+	+	+		+													
<i>Caprella mutica</i>						+	+	+		+						+	B							
<i>Colpomenia peregrina</i>									A				A			+	B					A		
<i>Cordylophora caspia</i>	B	+	B																					
<i>Corella eumyota</i>					+	+	+	A	A		A		A	+	+	+	A		+	+	B	A	A	A
<i>Didemnum vexillum</i>													B	+										B
<i>Gammarus tigrinus</i>		+	+																					
<i>Monocorophium</i>									+															
<i>Monocorophium insidiosum</i>						+	+	+		+	+	+												
<i>Monocorophium sextonae</i>									+								+		+	+	+	+		
<i>Perophora japonica</i>																								A
<i>Potamopyrgus</i>				B																				
<i>Sargassum muticum</i>													A	+		+	A							A
<i>Styela clava</i>								A	A															
<i>Tricellaria inopinata</i>						+	+	+	+		+											+		+
<i>Undaria pinnatifida</i>									A															
<i>Watersipora subtorquata</i>																						A		
Total confirmed spp.	2	3	4	2	6	4	6	12	2	6	1	6	5	2	5	5	5	0	3	5	5	4	9	

Table 6. Relative occurrences at examined marinas and pontoons of twenty four cryptogens and NIS. NIS in **bold**. Marina sites in yellow are where high numbers of cryptogens/NIS were found.

The rapid assessment approach to evaluate the distribution of a selected number of NIS using floating pontoons revealed new aliens to Northern Ireland and range extensions for some previously known NIS in this region (Figure 3; Table 6). The ADR approach enabled an assessment of the relative abundance at eleven marinas. Pontoons also provided information on NIS distributions. The current information increases the number of NIS known in Northern Ireland but this study will not have covered subtidal communities which also need to be surveyed. The current information and the evaluation of the ADR at widely dispersed sites, provides a baseline in relation to Descriptor 2 of the Marine Strategy Framework Directive (Olenin *et al.*, 2011) for marinas.

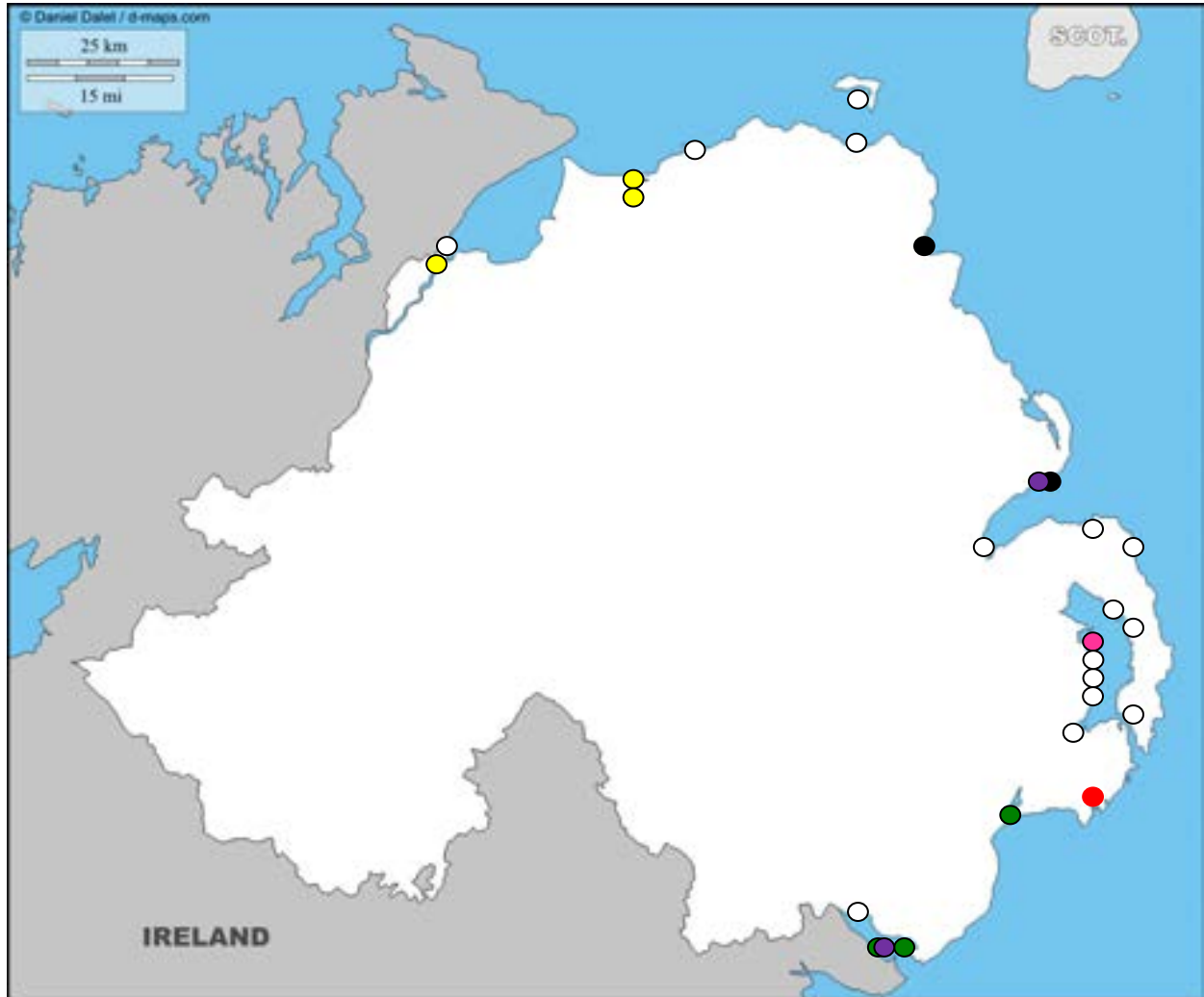


Figure 3. Distribution of selected species found August-September 2012.

Cordylophora caspia (yellow); *Styela clava* (black); *Watersipora c.f. subtorquata* (red); *Bugula neritina* (purple); *Didemnum vexillum* and *Perophora japonica* (pink); *Gracilaria vermiculophylla* (green); none of selected species seen (white)

Although the ADR method is ideal for the evaluation of the distribution of NIS on marinas and pontoons, there is a considerable benefit associated with simple intertidal surveying. Walking the shore and examining all available habitats (under boulders, on algae etc.) provides additional information, a broader understanding of these species, and may reveal additional species, such as *Diadumene lineata* and *Chondracanthus acicularis* (Table 7 below).

SPECIES Aug-Oct 2012	Littoral sites															
	Culmore Point, Foyle Estuary	Kircubbin, Strangford Lough	N of Herring Bay, Strangford Lough	Mahee Island spit, Strangford Lough	Dundrum Bay	Mill Bay, Carlingford Lough	Ballydorn (shore), Strangford Lough	Sketrick island N, Strangford Lough	Sketrick Island narrows, Strangford Lough	Mahee Island narrows, Strangford Lough	Whiterock Bay, Strangford Lough	Braddock Island, Strangford Lough	Paddy's Point, Strangford Lough	Rainey Island narrows, Strangford Lough	Sketrick Island south, Strangford Lough	Greenore, Carlingford Lough
<i>Amphibalanus improvisus</i>	+															
<i>Aplidium glabrum</i>						+		+	+			+	+	+		
<i>Austrominius modestus</i>	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Botrylloides violaceus</i>								+	?							
<i>Calyptrea chinensis</i>				+				+	+	+				+		
<i>Chondracanthus acicularis</i>				+												
<i>Colpomenia peregrina</i>		+		+				+		+					+	
<i>Corella eumyota</i>		+	+	+		+		+	+	+	+	+	+	+	+	
<i>Crassostrea gigas</i> (feral)		+	+					+								
<i>Diadumene lineata</i>									+							
<i>Didemnum vexillum</i>						?		?				?	?			
<i>Heterosiphonia japonica</i>						+	+		+	+	+	+	+	+	+	
<i>Gracilaria vermiculophylla</i>					+	+										+
<i>Monocorophium insidiosum</i>				+												
<i>Perophora japonica</i>								+						+		
<i>Sargassum muticum</i>				+		+	+	+	+					+		+
Total confirmed spp.	2	3	3	7	2	2	5	3	9	7	5	3	4	7	5	3

Table 7. Relative occurrences at examined littoral sites of sixteen cryptogens and NIS. NIS in **bold**. Intertidal sites in yellow are where high numbers of cryptogens/NIS were found.

SPECIES ACCOUNTS

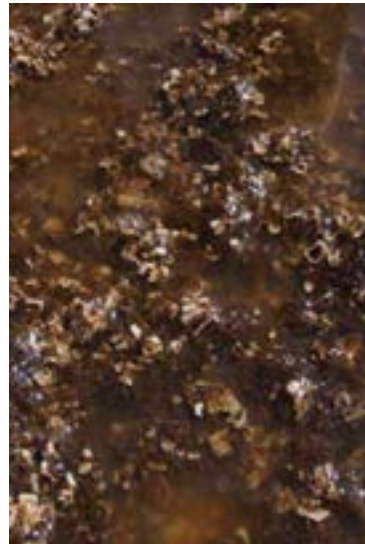
Aplidium glabrum, *Bugula fulva*, *Chondracanthus acicularis*, *Monocorophium acherusicum* and *M. insidiosum* are included here although their status as non-indigenous species is currently uncertain. Non-indigenous and cryptogenic species recorded (with certainty) during this survey are highlighted in blue. Those not observed during this survey but recorded previously are in white. Species accounts are in alphabetical order by genus. *Didemnum vexillum* is treated separately, and in more detail, at the end of the species accounts.

Species found in Northern Ireland	taxon
<i>Amphibalanus improvisus</i>	barnacle
<i>Aplidium glabrum</i>	tunicate
<i>Asparagopsis armata (drift only)</i>	red alga
<i>Austrominius modestus</i>	barnacle
<i>Botrylloides violaceus</i>	tunicate
<i>Bugula fulva</i>	bryozoan
<i>Bugula neritina</i>	bryozoan
<i>Bugula simplex</i>	bryozoan
<i>Calyptrea chinensis</i>	mollusc
<i>Caprella mutica</i>	amphipod
<i>Chondracanthus acicularis</i>	red alga
<i>Clymenella torquata</i>	polychaete
<i>Codium fragile ssp. fragile</i>	green alga
<i>Colpomenia peregrina</i>	brown alga
<i>Corella eumyota</i>	tunicate
<i>Cordylophora caspia</i>	hydroid
<i>Crassostrea gigas</i>	mollusc
<i>Crepidula fornicata</i>	mollusc
<i>Diadumene lineata</i>	anemone
<i>Didemnum vexillum</i>	tunicate
<i>Gammarus tigrinus</i>	amphipod
<i>Gracilaria vermiculophylla</i>	alga
<i>Heterosiphonia japonica</i>	alga
<i>Molgula manhattensis? *may be confused with M. socialis</i>	tunicate
<i>Monocorophium acherusicum</i>	amphipod
<i>Monocorophium insidiosum</i>	amphipod
<i>Monocorophium sextonae</i>	amphipod
<i>Perophora japonica</i>	tunicate
<i>Potamopyrgus antipodarum</i>	mollusc
<i>Sargassum muticum</i>	alga
<i>Styela clava</i>	tunicate
<i>Teredo navalis</i>	mollusc
<i>Tricellaria inopinata</i>	bryozoan
<i>Undaria pinnatifida</i>	alga
<i>Watersipora subtorquata</i>	bryozoan

***Amphibalanus improvisus* (Darwin, 1854)**



Foyle marina



Coleraine Marina

The cryptogenic barnacle, *Amphibalanus improvisus* was alive in the Foyle Estuary and at the marina was frequently found to be overgrown by *Cordylophora caspia* (see above). It was also found intertidally at Culmore Point. Only shell remains of this barnacle were found in the Bann Estuary. Living specimens were not retrieved using a Van-Veen grab in the Bann Estuary, but it is likely that there is a zone where living specimens exist and colonise those areas where the dead material was found, during periods of low rainfall. This species has previously only been known from the Foyle estuary (O’Riordan, 1967), Inner Dundrum Bay (Northern Ireland Littoral Survey, 1987), and New Bridge, Lough Foyle (JN, April 2012). Elsewhere the species is widely distributed in the Republic of Ireland in estuaries and lagoons (Minchin, 2007a, 2007b).

***Aplidium glabrum* (Verrill, 1871)**

During the survey, it became apparent that an unusual, but previously unknown, colonial tunicate was being seen at several sites, frequently overgrowing other species. During the post-contract survey, it was found to be widespread in Strangford Lough. It would seem that this tunicate recently arrived in the Lough, as it had not been observed with certainty prior to 2010/2011. It was identified as a polyclinid tunicate by B. Picton, and internet research by JN identified this species as *Aplidium glabrum*. This species was confirmed from specimens collected from Ballycastle Marina (G. Lambert, *pers. comm.*).



Ballydorn Lightship



Rainey Island narrows @ B. Picton



Mahee Island narrows @ B. Picton

The status of this species as an 'alien' is unclear at present. It is normally only present in cold to Arctic regions. J. Bishop (Marine Biological Association) states: 'We have been recording a polyclinid that keys out as *Aplidium glabrum* in marinas and harbours on the [English] Channel coasts for some years in the knowledge that *A. glabrum* should not be anything like this far south, and presume it is some form of import'.

It is listed as an alien and present since 2000 by the checklist for the Belgian part of the North Sea (www.vliz.be/imisdocs/publications/148946.pdf), and in the Dutch Wadden Sea (http://www.nobanis.org/species%20alert_11%20new%20marine%20species%20in%20NL.asp). We are unsure as to its status, and it might be considered to be cryptogenic until further distributional records in northern Europe are known.

***Asparagopsis armata* Harvey**

This southern species was not recorded during the present surveys, but is known from the west and south coasts of Ireland (Morrissey *et al.*, 2001). There is a report of fresh drift (a large plant) of *Asparagopsis armata* being seen by N. McQuaid of Marine Division (DoE(NI)) during a routine survey at Doon Bay, Rathlin Island in May 2012.

***Austrominius modestus* (Darwin, 1854)**

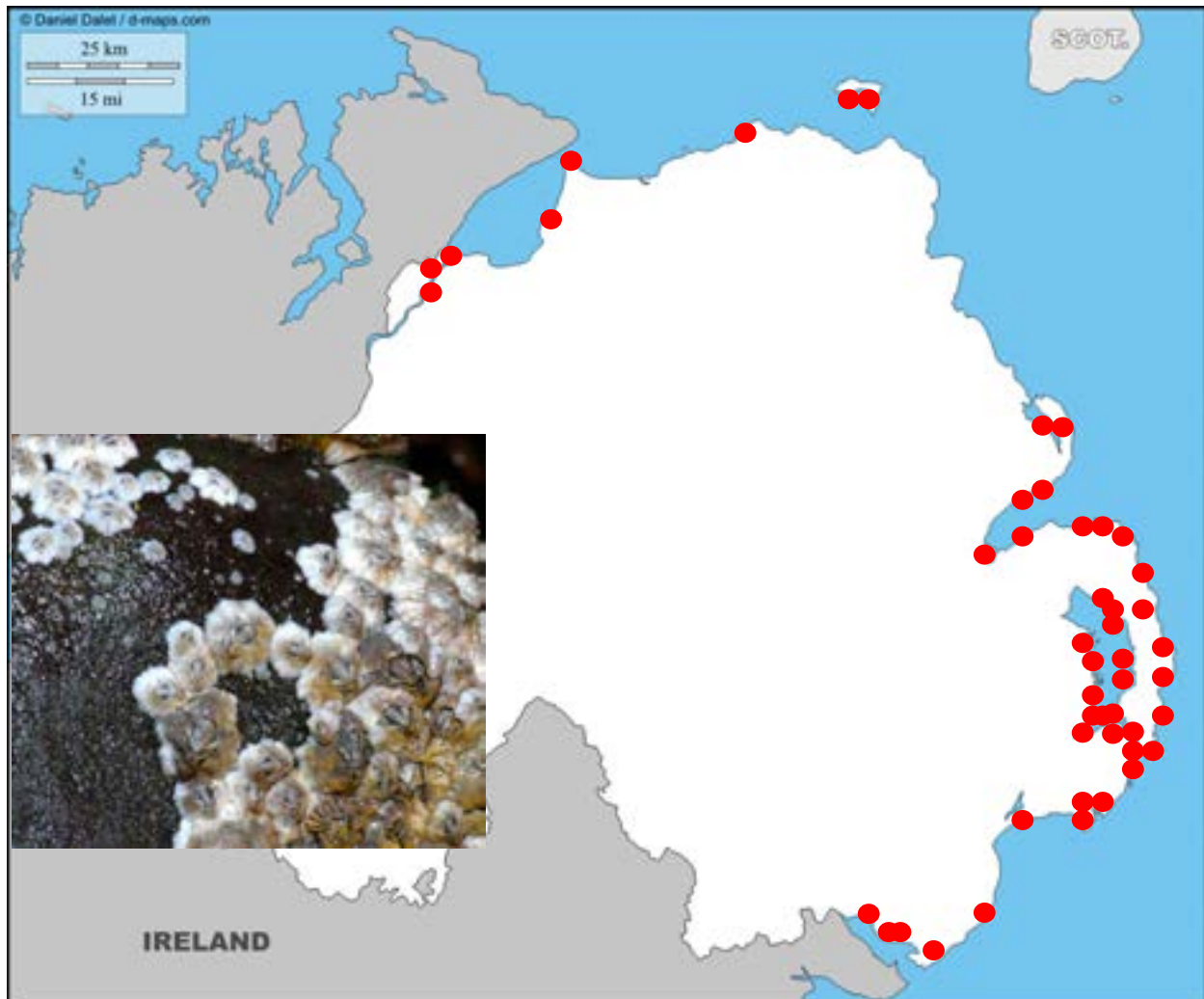


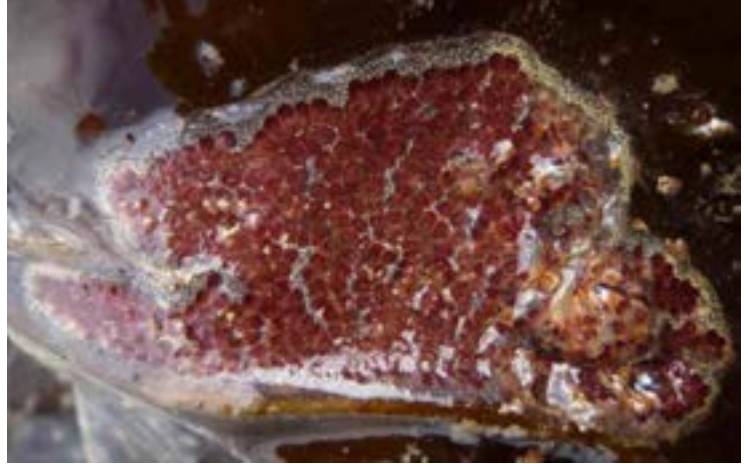
Figure 4. Distribution of *Austrominius modestus* in Northern Ireland. Image: Mahee narrows @ B. Picton

Austrominius modestus, Darwin's Barnacle, was recorded at most sites visited, and may have been found on shores near to marinas had these been surveyed. It has been widely recorded for many years in Northern Ireland, particularly in Strangford Lough (Figure 4). The species is now widely distributed about the Island of Ireland, in particular within estuarine areas and sheltered bays (O'Riordan, 1996).

***Botrylloides violaceus* Oka, 1927**



Botrylloides sp. East Down Yacht Club



Botrylloides sp. East Down Yacht Club

Identification of this species is difficult due to its similarity to *B. leachii*; both species have a broad colour range, for example, from yellow, orange, red to purple.

B. violaceus was previously only known from Bangor Marina (2011, J. Nunn (probable)) in Northern Ireland. This species was only recorded with certainty from Sketrick in Strangford Lough, and Carlingford Marina during the present survey (conf. G. Lambert). A number of other specimens are thought to probably be this species (East Down Yacht Club; Mahee Island; Braddock Island; Paddy's Point).

***Bugula fulva* Ryland, 1960**

This cryptogenic bryozoan was found at Rathlin pontoon and East Down Yacht Club (det. J. Porter, conf. J. Ryland).

Bugula fulva was previously recorded in August 2012 by attendees at a Hydroid & Bryozoan Workshop from Strangford Lough (S of Walter's Rocks; Portaferry Marina and Limestone Reef).

The current status of *Bugula fulva* is unknown, treated here as a cryptogen; but is quite likely to be a NIS. The origin of the species is unknown and it could 'always' have been present in these islands (J. Ryland, *pers. comm.*).

***Bugula neritina* (Linnaeus, 1758)**



Carrickfergus Marina (both images)



Archived material collected by DM in January 2006 (Minchin, 2007a) from Malahide Marina was subsequently identified as *Bugula neritina* by J. Ryland. *Bugula neritina* was also collected (in abundance) from Carlingford Marina on 2nd August 2008 by C. Maggs. It was present at both sites later in August and September 2008 (Ryland *et al.*, 2011). Both the brown and purple forms were recorded from Carlingford Marina in 2012.

Bugula neritina (purple and brown forms) was found, abundant, attached to buoys and kelp stipes throughout Carrickfergus Marina, the first record for Northern Ireland. It was subsequently recorded from south of Abbey Rock, Strangford Lough (coll. H. Edwards, det. J. Nunn) on 21st August 2013.

***Bugula simplex* Hincks, 1886**

This bushy bryozoan was found at five sites in during the present survey (Rathlin pontoon, and Ballycastle, Glenarm, Carrickfergus and Bangor Marinas. It had previously been collected only from Bangor Marina (2nd August 2011 coll. JN, det. J. Porter), the first record for the island of Ireland.

It was first recorded in Britain more than fifty years ago from south Wales in the Milford Docks (Ryland, 1958) and subsequently from North Wales in Holyhead Harbour. More recently has been recorded from south-western England and from the west coast of Scotland. It is known from the Dutch coast where it is seasonally abundant, during August and September, at marinas. It is also known from Belgium and Brittany (Ryland *et al.*, 2011).

***Calyptrea chinensis* (Linnaeus, 1758)**



Mahee Island gravel spit (both images)

The 'benign' Chinese hat limpet *Calyptrea chinensis* was first recorded in Northern Ireland at Mahee Island gravel spit on 5th June 2004 (Minchin & Nunn, 2006), and subsequently there in 2007, 2010, 2011 and 2012. It was found again at this site during the present survey. There was more than one year class distributed from near low water to just below the mid-tidal area. Most were attached to small pebbles and some had brood. It was also found at several other sites during the post-contract survey, increasing its known range in the Lough. *Calyptrea chinensis* had previously been recorded at several sites in Strangford Lough, and at Barneys Point, Larne Lough (JN, 2012).

Half-grown oyster, and adult stock movements have been implicated in the transmission of this species. Previous records in Ireland and Scotland are all associated with areas where oysters were imported. The population at Mahee Island in Strangford Lough was only recognised in comparatively recent times (Minchin & Nunn, 2006) and if present at an earlier time would almost certainly have been recorded, as this has been a special study area since 1999. While this area is known to have imported native oysters soon after the Second World War, possibly from Brittany, the more likely scenario is that they arrived with a more recent importation. This species does not have a pelagic stage, but releases small crawlers. These as well as adults could be carried by tidal movements. However it is unclear whether these currents could have resulted in the drag of stones by large algal growths by the currents from a nearby oyster farm. Such dragging does take place over the spit where a significant population is known.

***Caprella mutica* Schurin, 1935**

The skeleton shrimp *Caprella mutica* was first recorded in Northern Ireland at Bangor Marina (23rd June 2009, R. Snijder), and subsequently at Ringhaddy (2009, R. Snijder), Rathlin Harbour (2011, R. Snijder) and Portaferry Marina (2011 JN). This species was found widely during the present survey.

Elsewhere it has been reported associated with salmon cages on the west coast of Ireland (Tierney *et al.*, 2004), from Cork Harbour and from the east coast (Minchin & Holmes, 2006) and it is widely distributed elsewhere on the Scottish west coast (Cook *et al.*, 2007). It was found over a wide area around the Northern Irish coast, being found at Rathlin Pontoon to the Portaferry Marina.

***Chondracanthus acicularis* (Roth) Fredericq**



Mahee Island spit

A dense but highly localised population of the red alga *Chondracanthus acicularis* was found on Mahee Island on a gravel and stone spit over which a strong tidal current passed. Plants had almost cylindrical entangled fronds were dark brown-red in colour and almost 10cm in length with irregular bipinnate branching with short pointed apices.

Plants in September 2012 were anchored to small stones forming distinct bushy clumps not noticed during a visit to this same site in July 2012. Several hundreds of specimens were present below mid tidal level and low water. The species was also observed on subsequent visits to the site on 12th April 2013 and 24th August 2013, confirming that it is present from spring to autumn



According to algaebase (http://www.algaebase.org/search/species/detail/?species_id=127) this plant is widely distributed worldwide occurring in the Mediterranean Sea, Macaronesia, the Americas including the West Indies, Africa and the Indian and Pacific Oceans and Australasia. In Europe the most northerly records are from Ireland. *C. acicularis* has a southern and western distribution within these islands, with records ranging mainly from Cork to Galway in Ireland, SW England and SW Wales [NBN Gateway, [www//data.nbn.org.uk](http://data.nbn.org.uk), 7.12.12].

Mahee Island spit

The present record represents the most northern population known in Europe and probably a new species to Northern Ireland. There has only been one previous record of the species in the Belfast herbarium (as *Gigartina acicularis*), found from the Antrim coast by a Mr Templeton and recorded by a Mr Turner (Morton, 1994). Morton indicates that the species is very rare in Northern Irish coastal waters, and that the specimen found by Templeton over two hundred years earlier may not have been correctly determined. The Mahee specimens were identified by C. Beer & C. Maggs.

It is unclear whether this species should be considered to be an NIS in Northern Ireland. Here we have considered it to be a cryptogen.

***Clymenella torquata* (Leidy, 1855)**

This species was not seen during the Rapid Assessment Survey. However it has been recorded consistently (every year 1999 – 2011 except 2007) from infauna by Marine Division, Department of the Environment Northern Ireland (MD, DoE(NI)) in Carlingford Lough. This site CL2 06/01/E300 (54° 04.30'N 06° 11.59'W, depth 4-5m) is next to shellfish beds, and is regularly monitored. It was initially incorrectly identified as *C. cincta*, but re-identification and revaluation of voucher specimens indicated this species (T. Mackie, *pers. comm.*).

The species is likely to have been established for a long time, having been introduced with large consignments of the American oyster *Crassostrea virginica* from Long Island Sound from c. 1880-1930. It is also known from Britain where American oyster layings took place (Eno *et al.*, 1997). Surveys taking sediment samples are more likely to reveal this species.

***Codium fragile* ssp. *fragile* (Suringar) Hariot**

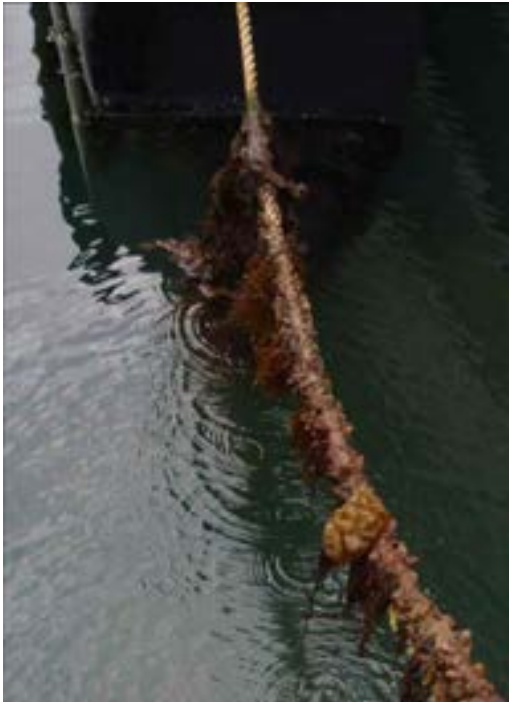


Whiterock Yacht Club

Specimens similar to *Codium fragile* ssp. *fragile*, the Green Seafingers alga were found at two sites attached close to the water surface to pontoons (Whiterock Yacht Club & Ardglass Marina). Identification of the subspecies requires a specialist to confirm their identity. Mineur *et al.* (2008) found the subspecies at Ardglass where a *Codium fragile* subspecies was also found in this study. The specimens collected in this survey are thought to be *Codium tomentosum* (C. Beer, *pers. comm.*).

Codium fragile ssp. *fragile* was widely recorded in Strangford Lough by the Northern Ireland Littoral Survey (1985-86), and there more recently and throughout Northern Ireland by MD, DoE(NI) (2002-2011).

***Colpomenia peregrina* Sauvageau**



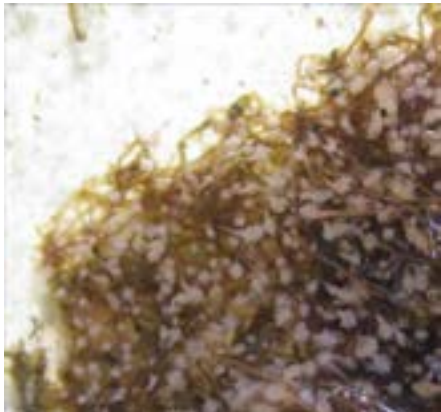
Carrickfergus Marina, attached to rope

This species is very widely distributed throughout Northern Ireland and the Republic (Minchin, 1991). It was found at several sites in Strangford Lough and at Carrickfergus Marina during the present surveys. It is frequently found attached to pontoons close to the water surface.

***Cordylophora caspia* (Pallas, 1771)**



Foyle Marina



Foyle Marina

This cryptogenic hydroid (native to the Ponto-Caspian region) *Cordylophora caspia* was found in the estuaries of the Foyle (Foyle Marina) and Bann (Seaton's Landing & Coleraine Marina), and is probably more extensively distributed than is generally known. It occupied a zone close to the water surface, and locally formed dense mats somewhat resembling an alga in places except the zoids were small but clearly white/cream in colour.

Elsewhere in Ireland it is known from coastal lagoons, Durnesh Lough, Donegal (Oliver & Healy, 1998), and also Ladys Island Lake in Co Wexford. It is likely to have been present in Ireland for a long time and is most probably under-recorded. The earliest account suggests a presence in 1842 'Recorded by Hincks in 1868 as *Cordylophora lacustris*, from Dublin and London' (Hincks, 1868). There are no records for Ireland on NBN Gateway, and only scattered records in England & Scotland as far north as the Hebrides.

Corella eumyota Traustedt, 1882

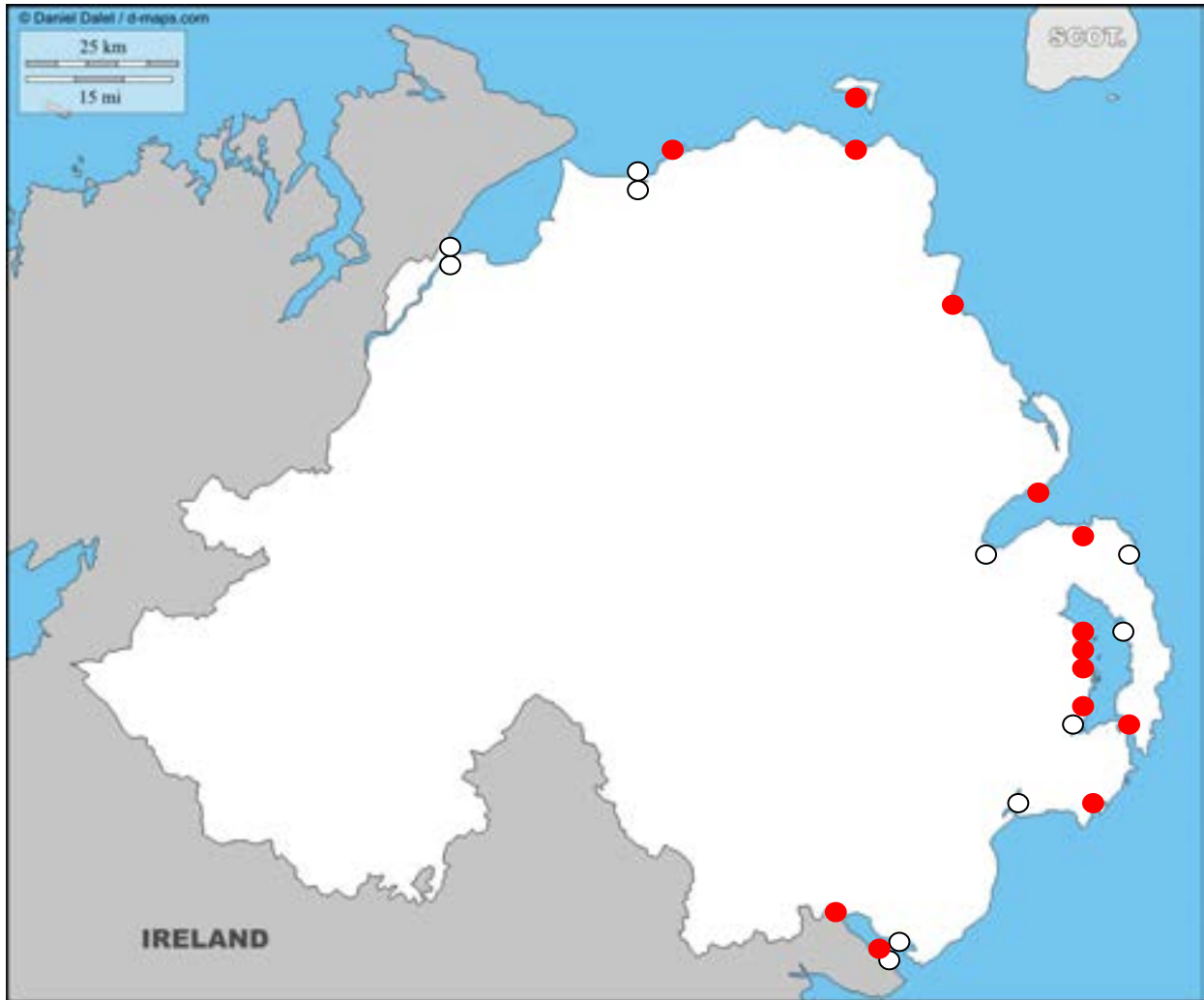


Figure 5. Distribution of *Corella eumyota* (red) found at pontoons/marinas during August-September 2012

This is probably the most widely distributed of the alien tunicates, and was frequently found in marinas and on pontoons and shores during the present surveys (Figure 5). It was found attached to the native oyster in Strangford Lough.



The circum sub-Antarctic tunicate *Corella eumyota* was first recorded from Northern Ireland at Carrickfergus Marina in 2006 (Minchin, 2007a). Since that date, it has spread very rapidly throughout Northern Ireland, being recorded from many shores at Portrush, Rathlin Island, Larne Lough, Belfast Lough and Strangford Lough, and Bangor Marina during 2011-2012 (JN, Figure 6)

Rathlin pontoon

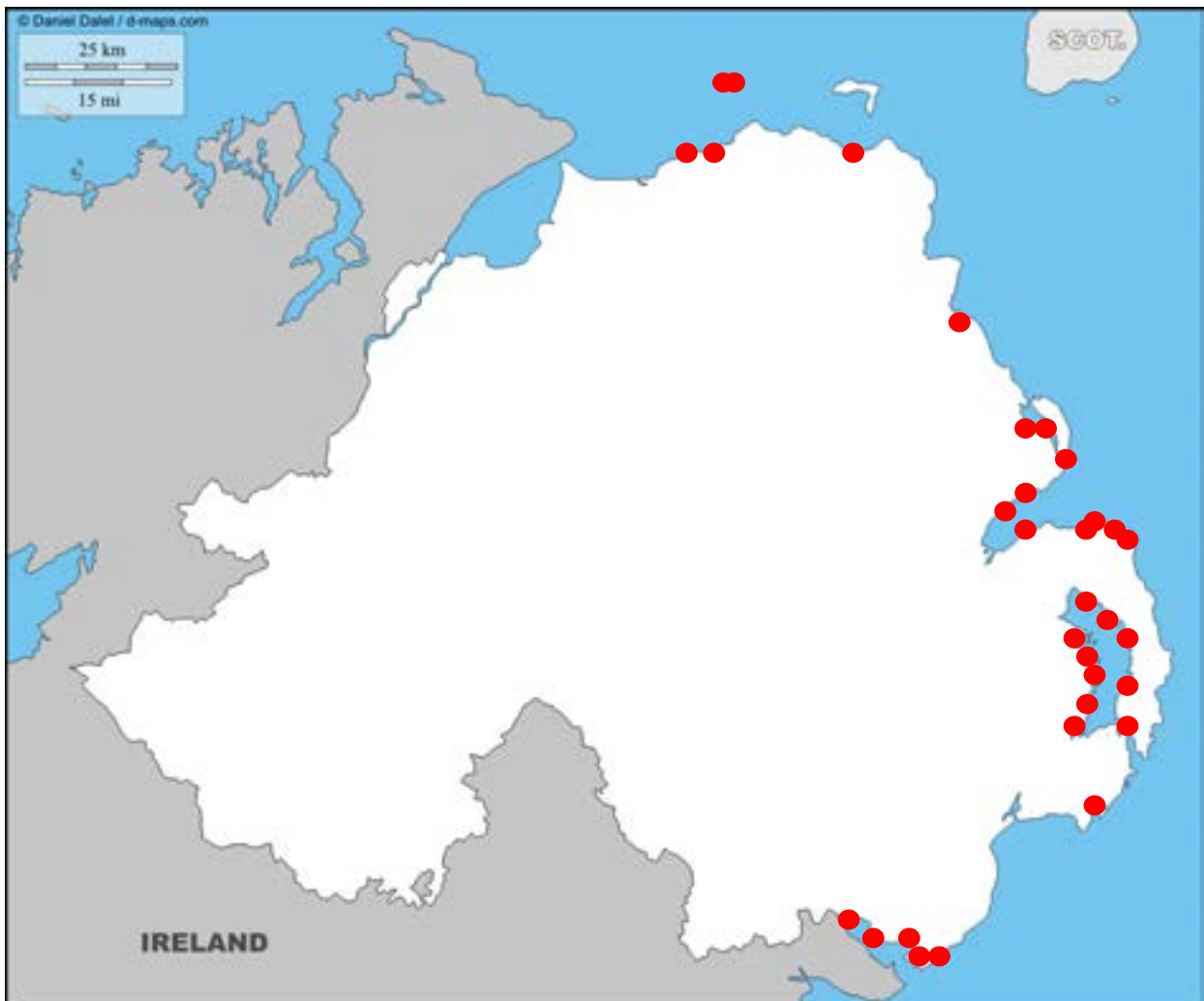


Figure 6. Distribution of *Corella eumyota* in Northern Ireland (all records)

***Crassostrea gigas* (Thunberg, 1793) and *Ostrea edulis* Linnaeus, 1758**

There are several shores in Strangford Lough that seem well suited for the cultivation of oysters. There has been recruitment in some consecutive years of the native oyster, but the Pacific oyster would seem to have had no recent settlements, as only massive individuals could be found on the eastern shore in Strangford Lough (north of Herring Bay). These were sampled and no associates *Mytilicola orientalis* or *Myicola ostreae* were found in the gut or on gills respectively for either species. Both oyster species had good gill condition.

However at Culmore Point in the Foyle Estuary, a well maintained Pacific oyster farm had adult oysters with a wavy gill margin. This condition is similar but not as extensively damaged as was found in the Pacific oyster in Cork Harbour in 2002. Some years before, a more serious gill condition was found in the native oyster on the west, south-west coasts of Ireland. Here, some of the oysters had died from very reduced gills. The causative organism was thought to be a gill grazer *Herrmannella duggani* (Holmes & Minchin, 1991). It is unclear whether this gill condition in the Foyle Estuary results from such an activity; but if so it may be new to the region.

Some of the shells were bored by the shell boring worm *Polydora*.



Culmore Point (both images)

Smaller individuals of *Crassostrea gigas* (feral) were seen at Sketrick Island narrows and escapees from aquaculture at Paddys Point during the post-contract survey. This species has previously been widely recorded from Strangford Lough, primarily on the eastern shore from Pig Island to Kircubbin, and on the western shore from Paddys Point to Castleward Bay. Feral specimens have also been recorded from Barney's Point, Larne Lough in 2012 (JN).



Crassostrea gigas, North of Herring Bay



Ostrea edulis, North of Herring Bay

***Crepidula fornicata* (Linnaeus, 1758)**

This species was not found during this survey. It was first recorded from Northern Ireland on 4th March 2009, dredged in Belfast Lough (2 specimens attached to the scallop *Pecten maximus*). Subsequently it has been widely recorded both intertidally and in the sublittoral throughout Belfast Lough, particularly at Fisherman's Quay near Carrickfergus (McNeill *et al.*, 2010), where there is a breeding population.

***Diadumene lineata* (Verrill, 1869)**



Mahee Island narrows © B. Picton

This species was first recorded in Northern Ireland by A. Reft on 29th September 2010 at Mahee Island narrows. A single specimen was recorded at the same site by JN during the post-contract survey. A subsequent visit to Sketrick Rapids on 8th August 2013 recorded many specimens (JN, B. Picton)

It was first recorded in Ireland by Ryland & Nelson-Smith (1975) and subsequently by Minchin (2007a) from Tralee Bay. The species is most probably spread by movements of oysters.

***Gracilaria vermiculophylla* (Ohmi) Papenfuss**



Dundrum Bay

Extensive drifts of *Gracilaria vermiculophylla* were found in Dundrum Bay. Locally dominant drifts accumulated above the mid-tide level with deposits of >10cm deep in places. Some living plants were found close to the neap high tide area. In Mill Bay, Carlingford Lough, it was not as prevalent, but was present inside the sea entrance of the lough over extensive areas of muddy sand. It was also found on the southern side of the same Lough near to Greenore. This alga in Carlingford Lough occurred in patches in shallow puddles overlying a waterlogged sandy-mud from above the mid-tide level.



Dundrum Bay

This plant is very tolerant to aerial exposure, and may be expected to occur elsewhere. It has been recognised elsewhere to be an ecosystem engineer by transforming the surface cover and causing some impacts to infauna as a result of it producing ~90% of the biomass in some habitats (Thomsen *et al.*, 2006).

G. vermiculophylla was known to exist in Northern Ireland in Dundrum (first recorded 27th July 2012, 54° 15.95'N 05° 49.07'W; C. Beer, *pers. comm.*) and Carlingford bays (C. Maggs, *pers. comm.*, Cook *et al.*, 2012). It was subsequently recorded from Granagh Bay, Strangford Lough (coll. & det. J. Nunn) on 25th August 2013.

***Heterosiphonia japonica* Yendo, 1920**



Ringhaddy Harbour, Strangford Lough

Heterosiphonia japonica was found on the shore near Ringhaddy pontoon, and subsequently at a number of sites, during the post-contract survey in Strangford Lough (Appendix 1). There were only a small number of specimens found close to low water. This was very different to their earlier [JN, March 2012] seasonally abundant distribution on this same shore.

Heterosiphonia japonica was first recorded from Ballyhenry, Strangford Lough in 2011 [C. Maggs, *pers. comm.*]. Since that date, it has been found at a number of sites throughout Northern Ireland, including Portrush Harbour and Ballycastle Bay by Seasearch divers (C. Beer, *pers. comm.*).

***Molgula manhattensis* (De Kay, 1843)**



Molgula sp. Glenarm

Records of *Molgula manhattensis* from the island of Ireland have not yet been confirmed, despite accounts that refer to it being found there (Minchin, 2007b). Both *M. socialis* and *M. tubifera* have similarities with *M. manhattensis*. Berrill (1931) considered *M. manhattensis* to occur in Britain, but stated it to be a synonym of *M. tubifera*, whereas Hayward and Ryland (1995) believe that these species are distinct.

One of the more recent surveys on the south coast of Britain (Arenas *et al.*, 2006) failed to find this species, recording only *M. socialis*, presumed to be a native species. As there is much confusion over these closely related species, some genetic studies may aid in resolving these difficulties.

At a number of marinas and pontoons during the present survey, a '*Molgula*' species was observed, often frequent in abundance. It is not possible to differentiate between *M. socialis* and *M. manhattensis* without dissection of specimens (G. Lambert, *pers. comm.*). All those specimens collected from Northern Ireland during this survey, and then examined by G. Lambert, were *Molgula socialis*. *Molgula citrina* was recorded from Carlingford Marina (G. Lambert *pers. comm.*).

***Monocorophium* spp. [*M. acherusicum* (Costa, 1853), *M. insidiosum* (Crawford, 1937), *M. sextonae* (Crawford, 1937)] and *Gammarus tigrinus* Sexton, 1939**



'*Corophium*' sp. Ballycastle Marina



'*Corophium*' sp. tubes Whiterock Yacht Club

There were three cryptogenic amphipods found during the survey: *Monocorophium acherusicum* from Carrickfergus Marina (det. R. Snijder & G. Rowe), *M. insidiosum* from six sites around Northern Ireland, and *M. sextonae* from six sites in the southern part of Northern Ireland (det. G. Rowe).

Monocorophium insidiosum was first found in Ireland from the south coast in 2002 in coastal lagoons (Oliver *et al.*, 2006; Minchin, 2007a). These authors considered it to be exotic.

Monocorophium acherusicum was first recorded in Ireland in 2007 from the Malahide Marina on the Irish east coast (Daniels *et al.*, 2009).

The cryptogen *M. sextonae* has previously been widely seen from the outer Ards Peninsula (NILS, 1984) and Strangford Lough (NILS, 1985-87; S. Vize, 2001-03). All three species have been widely recorded in Northern Ireland by Marine Division, Department of the Environment.

The freshwater/brackish NIS *Gammarus tigrinus* was recorded from both Seaton's Landing and Coleraine Marina.

***Perophora japonica* Oka, 1927**



Sketrick Island narrows @ B. Picton

The first record of *Perophora japonica* for the island of Ireland was made in Carlingford Marina (conf. G. Lambert) during the present survey. It was then recorded by B. Picton at Sketrick Island narrows, Strangford Lough during the post-contract survey, and in some abundance from Rainey Island narrows on *Fucus serratus* (JN). The species was present in subsequent visits to both these sites in August 2013 (JN), with an increase in abundance at Sketrick.

The nearest record for this species is Plymouth, and so these represent the most northerly populations for this species.

***Potamopyrgus antipodarum* (J E Gray, 1843)**



The New Zealand mudsnail, *Potamopyrgus antipodarum*, was found at Coleraine Marina in the Bann Estuary. It is very widely distributed throughout Northern Ireland, primarily in freshwater.

It has been known in Ireland for over a hundred years (Massey, 1903).

***Sargassum muticum* (Yendo) Fensholt**



Mahee Island gravel spit

In the present surveys, *Sargassum muticum* was found to be widely distributed on the west shore of Strangford Lough. At the Mahee Island gravel spit, many plants attached to small stones had been carried by current movements across the spit.



Mahee Island gravel spit

Sargassum muticum was first recorded from the island of Ireland at Paddys Point, Strangford Lough in 1995 (Boaden, 1995). Since that date, it has spread extensively throughout Strangford Lough. Additional populations are known from elsewhere about the Irish coast (Figure 7; Simkanin, 2004).

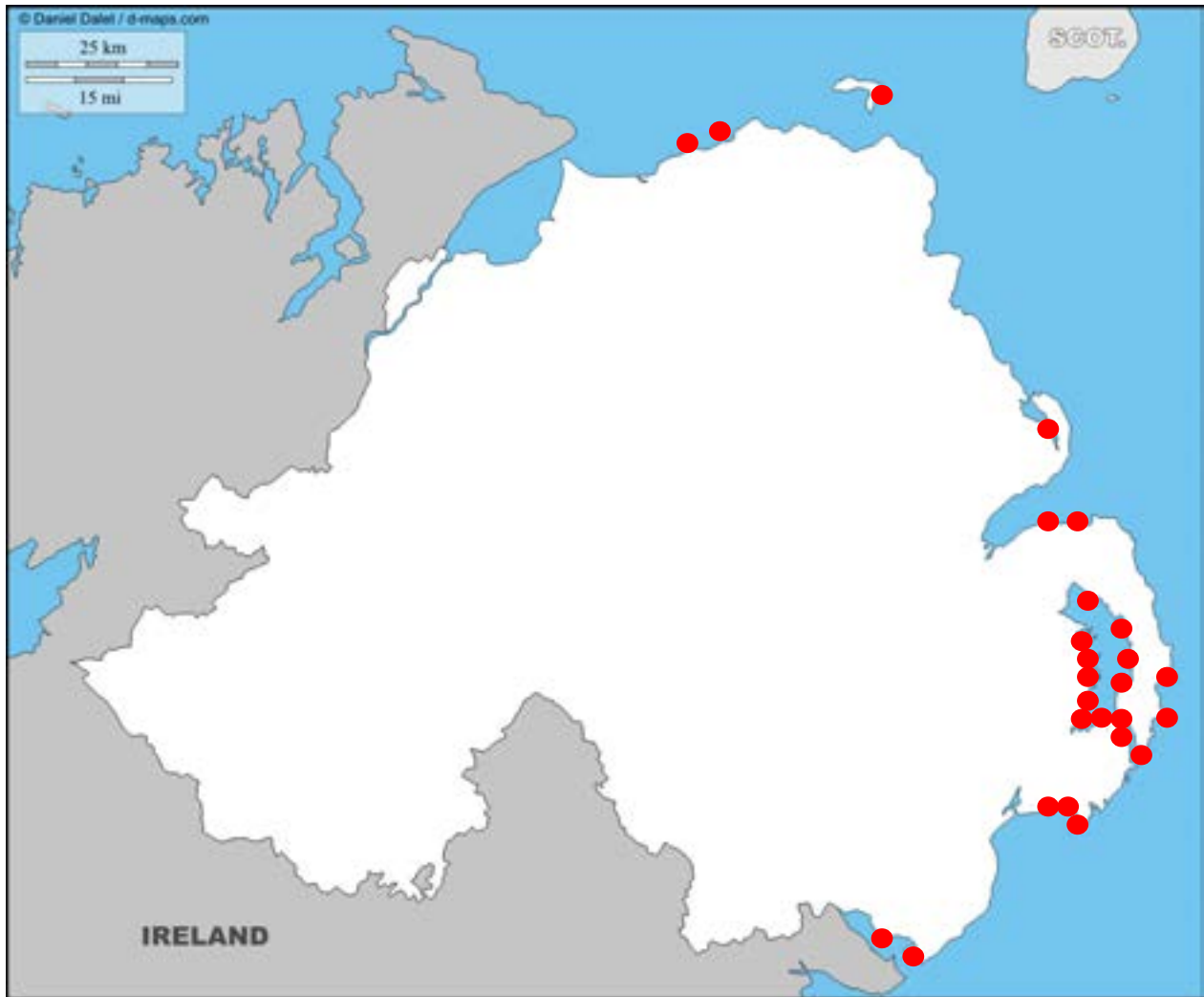


Figure 7. Distribution of *Sargassum muticum* in Northern Ireland

***Styela clava* Herdmann, 1881**

The Asian club tunicate *Styela clava* has only previously been found in Northern Ireland in Larne Lough (Nunn & Minchin, 2009), with the first record being from the disused cement factory at Magheramourne (J. Moore & C. Goodwin, 18th June 2008) at a depth of 3m to 5m. It has subsequently been recorded at additional sites in Larne Lough, at Bangor Marina (R. Snijder, 2011) and the Royal North of Ireland Yacht Club at Cultra (C. Maggs, *pers. comm.*).



Carrickfergus Marina

During this survey, it was found at Carrickfergus and Glenarm marinas. A single small specimen was attached to general material on the side of a pontoon at Glenarm. At Carrickfergus, however, there were many large specimens attached to the hulls of berthed vessels that had been idle for the summer of 2012, and to fouling on pontoons. A subsequent visit to Carrickfergus Marina on 29th August 2013 indicated that there was not change in the abundance and distribution of *S. clava*.

***Teredo navalis* Linnaeus, 1758**

This species has only been recorded from ‘the timbers of a ship returned from a foreign voyage’ in Belfast Harbour (Thompson, 1856). Its status as live or shell only is uncertain. Nichols (1900) considered that this record probably to be of *Teredo* [*Psiloteredo*] *norvegica*. It was not recorded during the present surveys.

***Tricellaria inopinata* d’Hondt & Occhipinti Ambrogi, 1985**

Tricellaria inopinata was first recorded from Northern Ireland from Bangor Marina on 22nd August 2011 (Nunn *et al.*, 2012), and subsequently at Portrush Harbour. The species was confirmed from both those sites during the present survey, and in addition from Glenarm, Rathlin, Ardglass, Carrickfergus and Carlingford Marinas (det. J. Porter).

This species is known from Ireland from Malahide and Carlingford in 2006 (Ryland *et al.*, 2011) and has more recently been reported from Dublin Bay (Kelso & Wyse-Jackson, 2012).

***Undaria pinnatifida* (Harvey) Suringar**



Carrickfergus Marina (both images)



The finding of only three plants of *Undaria pinnatifida* in Carrickfergus Marina may indicate a recent arrival to this site. It is unclear whether this species occurs elsewhere in the same region on the lower shore or if it might be more widely established. The finding represents the first account of this kelp in Irish waters.

According to the NBN Gateway (<http://www.searchnbn.net/>), it has been reported from the Isle of Man to the south of Douglas and at the Fleetwood marina in Lancashire, where there are docks. It occurs in the Queen Anne's battery marina in

Plymouth, where it is abundant both on tyre fenders and on the floating pontoon units at a high level of abundance.

The Carrickfergus site should be regularly re-examined in relation to this finding to evaluate the full range and extent of the species. A visit on 29th August 2013 (JN, Marine Division staff) found that this species was now distributed throughout the Marina, with many young plants.

U. pinnatifida is one of the species that has been linked to recreational boating (Acosta & Forrest, 2009), and movement by fouled craft from this marina could result in its spread to other regions.

***Watersipora subtorquata* (d'Orbigny, 1852)**

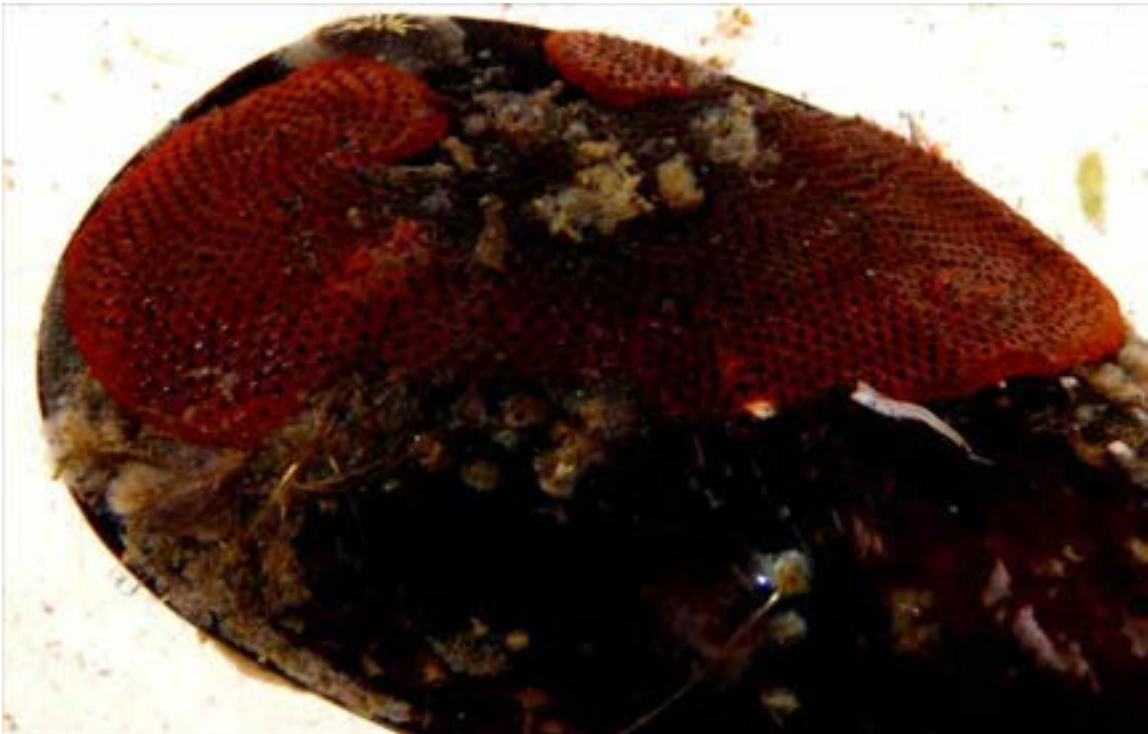


The first record for Northern Ireland of the red/orange form of *Watersipora subtorquata* was found in Ardglass (confirmed by J. Ryland). Two colonies were found, one overgrowing the shell of a mussel and the other a sponge.

This species was recently recorded from Dun Laoghaire Marina (Kelso & Wyse Jackson, 2012) which is the first known record for the island of Ireland, a not unexpected occurrence.

Ardglass (both images)

The species can, under suitable conditions, become locally abundant. It has previously been found associated with the hulls of leisure craft, but also with oysters. The grey form has been most generally found with oysters (Ryland *et al.*, 2011).



***Didemnum vexillum* Kott, 2002**

Some species that were found in this survey are of particular concern. The long pendulous growths and encrusting 'carpet' typical of *Didemnum vexillum* were found on the underside of pontoons and on the stern section of a decommissioned light vessel that form a marina platform at Ballydorn on 5th September. Identification was initially confirmed by R. Holt (Natural Resources Wales (NRW)), and then by J. Bishop contracted to evaluate microscopic characters (Appendix 2). This species was subsequently found (probably) in only one region of Strangford Lough (Ballydorn, Sketrick Island north, Sketrick Island pontoon, Rainey Island narrows), with a 'probable' identification from a photograph from Paddy's Point by G. Lambert (Figure 8). It is only elsewhere recorded on the island of Ireland in Carlingford and Malahide Marinas (Minchin & Sides, 2006; Minchin, 2007b), Galway Bay (2007 JN *pers. obs.*) and Clew Bay (2007, J. Kelly *pers. comm.*).



Ballydorn Lightship



Carlingford Marina



Ballydorn Lightship



Ballydorn Lightship



Small colonies of this species may be easily overlooked as the larger colonies would appear to have a more distinctive form. As a result, this tunicate may be more widely distributed about the coast.

Sketrick Island pontoon @ B. Picton

Identification of this species requires confirmation, as it is the larvae, contained until a late developmental stage, that are needed for this process. Larvae are normally present in the late summer and autumn. Where there are the more typical pendulous growths of the species, these indicate a more recognisable form, but confirmation is still required.



Rainey Island narrows @ B. Picton



Figure 8. The probable distribution of *Didemnum vexillum* in Strangford Lough (excluding Paddy's Point)

● *D. vexillum* (probable) ○ No *D. vexillum* recorded during present surveys

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The pendulous growths of ~40cm+ in length at Ballydorn were easily seen, since these occurred within 0.5m of the water surface in relatively clear water. The tidal current in this region will almost certainly have caused some of these growths to detach. Such fragments, based on studies elsewhere, are known to be viable and can reattach (Martin *et al.*, 2010). For example, the colonial tunicate *Botryllus schlosseri* is viable, even after a high pressure treatment of their colonies overgrowing rope-grown mussels, for at least 18 days afterwards and may be reproductively viable (Paetzoid & Davidson, 2010). As a result this *D. vexillum* population may extend over a larger area that is currently known.

D. vexillum is most probably beyond practical control in Strangford Lough. The confirmation of specimens from other sites within Strangford Lough will provide an indication as to the overall spread of the species. There is an implication that oyster movements might have been involved in the arrival of *D. vexillum* to the Lough. This is based on the finding of a colony which resembles this tunicate being removed from the oyster bags of oysters in culture at Paddy's Point. While no blame can be apportioned to the management of the oyster farm, all further imports of oysters for cultivation should undergo some preventive procedures. Such control measures have been developed to reduce the risk in the spread of the Asian tunicate *Styela clava* by using brine dips (Minchin & Duggan, 1986). Such methods should be examined for this colonial species. It is known that there was a disappearance by *D. vexillum* from the pontoons in Malahide, which is believed to have been due to a freshwater flush from the adjacent lagoon following heavy rains. In this case, a freshwater bath may be suitable to control the further spread of this tunicate. Leisure craft are almost certainly involved in transmissions, as colonies of *D. vexillum* have been found to extensively foul the hulls of craft that have been idle for some time. Vessels remaining afloat overwinter pose a greater risk than other craft. Idle vessels that are for sale pose a great risk, as a new owner may 'sail' the vessels to a new locality without having the vessel cleaned.

Response to the discovery of *Didemnum vexillum* in Strangford Lough

1. 5th September. Probable substantial *Didemnum vexillum* colony found at Ballydorn Lightship in the presence of two members of Marine Division staff (H. Edwards, A. Downie). Contact made with appropriate Marine Division staff on the day.
2. 10/11th September. The two yacht clubs nearest to the discovery (Down & Strangford) contacted by phone and advised of the potential find and that a press release would be issued. Following the calls, copies of the Code of Practice were issued to them, and advice on cleaning boats away from the water was provided by J. Early (NIEA).
3. 12th September. Strangford Lough Management Committee informed by NIEA.
4. 13th September. NIEA/Marine Division meeting to discuss response to *D. vexillum* discovery.
5. 14th September. The first press release advising of the potential find was issued. <http://www.northernireland.gov.uk/index/media-centre/news-departments/news-doe/news-releases-doe-september-2012/news-doe-140912-marine-experts-warn.htm>
6. 17th September – 21st September intertidal survey (spring tides) for *D. vexillum* - J. Nunn (NMNI), B. Picton (NMNI), A. Downie: Ballydorn area, Sketrick Pontoon area, Sketrick Island narrows, Mahee Island narrows, Whiterock Bay, Braddock Island, Paddys Point, Rainey Island narrows. *Didemnum* c.f. *vexillum* seen on shore near Ballydorn Lightship, Sketrick pontoon, Sketrick Island narrows, Rainey Island narrows.

7. 22nd September. J. Bishop, Marine Biological Association, Plymouth contracted to examine putative *D. vexillum* samples from Ballydorn.
8. 25th September. Dive and snorkel on Ballydorn Lightship by R. Holt (NRW), H. Edwards & R. Snijder (Marine Division, DoE(NI)). R. Holt confirmed *D. vexillum* identification. Snorkel around pontoon on north side of Sketrick Island (Strangford Moorings) by R. Holt, T. Mackie (Marine Division, DoE(NI)) & R. Snijder. Small pieces collected and confirmed by R. Holt as *D. vexillum*.
9. 27th September. Letters were issued to all the yacht clubs and marinas in Strangford Lough advising of the find and outlining actions they should take once the identification was confirmed, in addition to sending an alert poster and copies of the marina managers and recreational water users Codes of Practice.
10. 27th September intertidal Rainey narrows H. Edwards & J. Breen – no *D. vexillum* seen [tide poor].
11. 28th September. Following the confirmation a second press release was issued. <http://www.northernireland.gov.uk/index/media-centre/news-departments/news-doe/news-releases-doe-september-2012/news-doe-280912-an-invasive-sea.htm>
12. 2nd October. Report by J. Bishop formally confirming the identification of *D. vexillum* from Ballydorn Lightship.
13. 2nd October. J. Breen (Head of Marine Conservation Team, Marine Division, DoE(NI)) gave a presentation to the members of Down Cruising Club (Ballydorn).
14. 3rd October. J. Breen was interviewed by BBC Newsline as part of the overall story. Dives by Marine Division staff [T. Mackie, G. Burrows, H. Edwards, R. Snijder] on Ballydorn Lightship. Following the filming, further dive surveys for *D. vexillum* were undertaken in the main channel of Strangford Lough in addition to examining a selection of racing markers, moored yachts and mooring lines. No *D. vexillum* seen in the channel.
15. 3rd October intertidal Rainey Narrows J. Nunn & H. Edwards – samples taken.
16. 4th October. BBC Newsline aired the story at 6.30pm with Claire Savage and Donna Traynor covering the finding. J Early was also interviewed.
17. 5th October. Examination of fouling on lifted out pontoons at Whiterock (Strangford Lough Yacht Club) by H. Edwards. No *D. vexillum* seen.
18. 15th October. J. Bishop contracted to examine a further set of samples from the Ballydorn area.
19. 18th October. Boat survey on *S.V. Modiolus*. Use of pole camera from AFBI, ideal for identifying vessels and structures for further examination. Various vessels, floating structures, moorings and jetties in Ringhaddy, Whiterock and Ballydorn were examined by H. Edwards and while heavy fouling was observed on many, no *D. vexillum* seen.
20. 19th October. Intertidal survey of south Sketrick Island by J. Nunn and A. Downie. No *D. vexillum* seen.
21. 23rd October. Report by J. Bishop concerning samples from additional sites equivocal – *D. vexillum* cannot be ruled out for sites in the Ballydorn, Sketrick and Rainey areas; samples from the Whiterock area are not *D. vexillum*.
22. 19th November. Letters were sent to all the yacht clubs and marinas in Strangford Lough area inviting them to a *Didemnum* information session at Ards Arts Centre.
23. 28th November 2012. *Didemnum* information session held at Ards Arts Centre for yacht clubs and marinas in Strangford Lough.

CONCLUSION

An assessment of eleven marinas was made using the ADR method. No localities were found to have a high abundance and distribution level for non-indigenous species above 'C', except for *Amphibalanus improvisus* in the Foyle Estuary and *Bugula neritina* at the Carlingford Marina. Some species at the lower values 'A' and 'B' may become abundant at a future time. Species that will have recently arrived can subsequently expand their populations - this may be expected in the case of *Undaria pinnatifida* and *Didemnum vexillum*.

The species, Wakame *Undaria pinnatifida*, found in these surveys is a new record for the island of Ireland. A further four species, new to the coast of Northern Ireland, were the Carpet Sea Squirt *Didemnum vexillum*, the tunicate *Perophora japonica*, and the bryozoans *Bugula neritina* and *Watersipora subtorquata*. The cryptogenic hydroid *Cordylophora caspia* may also be new to Northern Ireland, but is certainly a range extension with new sites in the estuaries of the Foyle and Bann.

Range extensions of several species were noted, in particular the tunicates *Styela clava* and *Corella eumyota* and the bryozoans *Bugula simplex* and *Tricellaria inopinata*. *Bugula fulva*, recorded from Carlingford Marina during the preliminary fieldwork, is a new record for the Republic of Ireland. *Perophora japonica* was also recorded there, and is the first record for the island of Ireland.

At the time of writing, the status of the species provisionally assigned to *Diplosoma listerianum* is still under question. It will require further research to determine whether this species is non-native and/or invasive.

Surveys such as this one could be conducted every two years (Figure 9), but some species, such as *Didemnum vexillum*, may need to be targeted more frequently and using different sampling methods.

RECOMMENDATIONS

- Surveys using the ADR method can be practically undertaken, and could be repeated at two year intervals to provide an indication of the arrival, spread and impact of NIS using marina pontoons. The biopollution method, which measures the impact of an NIS, initially involves an assessment using the ADR method. We have shown that the ADR can be undertaken rapidly at marina sites which are easily re-visited. The method is part of a suggested approach for monitoring sites in relation to the Marine Strategy Framework Directive. For some species, such as *Undaria pinnatifida* and *Didemnum vexillum*, and species with a seasonal distribution such as some marine algae, more regular and additional survey methods are required. The RAS marina surveys do not take account of organisms that are highly mobile, planktonic species or in-fauna. Separate surveys using different methods might be expected to reveal further NIS.

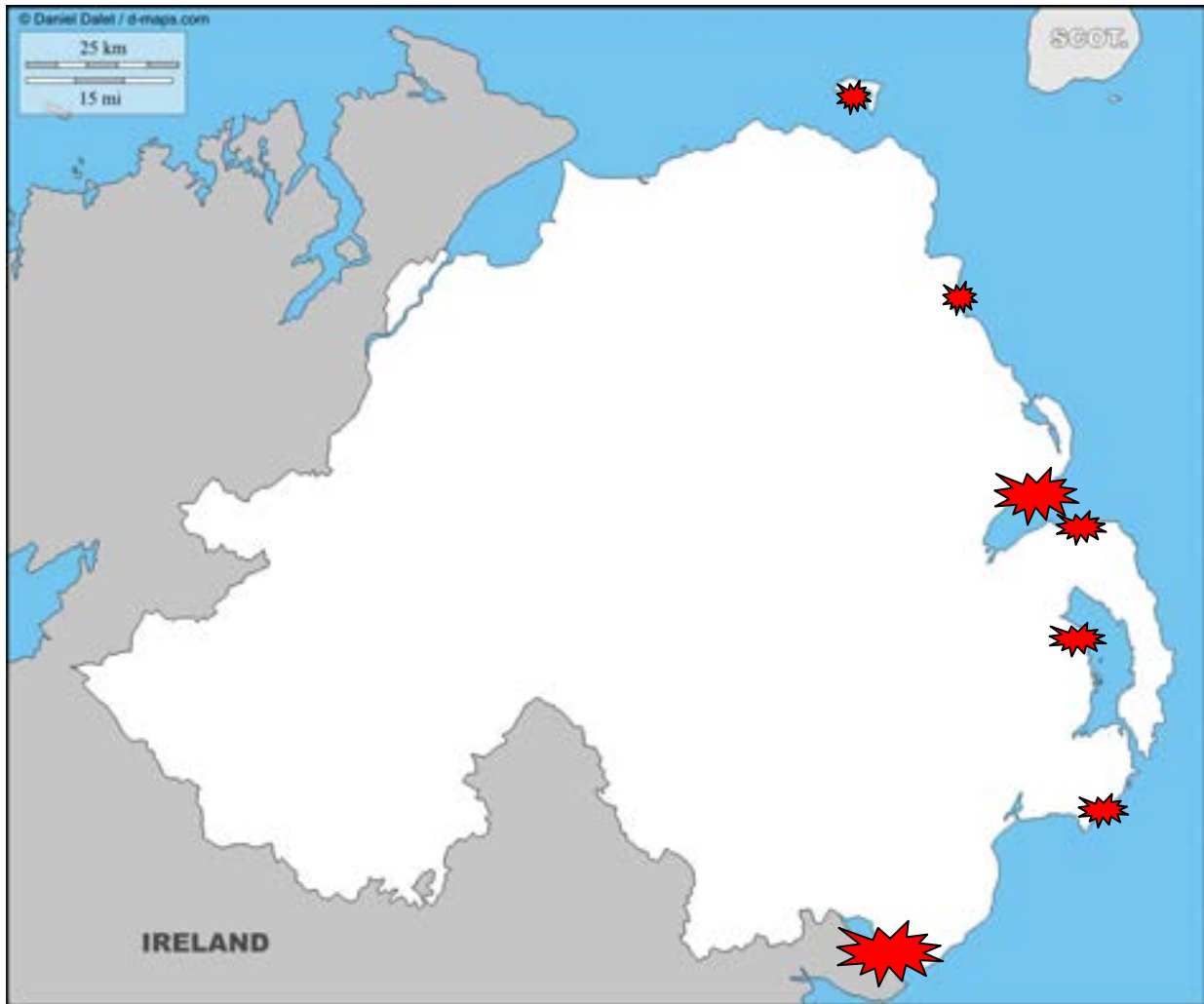


Figure 9. Sites that should be regularly monitored, sizes indicating relative likelihood of invasions.

- Fouled craft in the Carrickfergus Marina should be examined by diving, as it is strongly suspected that, should these vessels be moved elsewhere, they may spread NIS occurring at that site. This site may be also be worthy of a follow-up survey of the pontoons in 2013.
- Further intertidal and sublittoral surveys should be undertaken in Strangford Lough to document the distribution of invasive tunicates, especially *Didemnum vexillum*. In particular, Rainey Island and the NW of Strangford Lough should be surveyed in some detail including seasonal coverage.
- Further surveys, conducted in the course of other specific projects, i.e. young fish surveys, environmental surveys, shore surveys and environmental impact studies should include invasive NIS of particular concern.
- The marina surveys should be linked, if possible, to similar surveys in the Republic of Ireland, Scotland, England and Wales, as species arriving within either managed region can spread in either direction, and a common management approach is needed.

- Potential NIS arrivals should be listed and searched for during future surveys, taking into account their European biogeography.
- Pathways of spread, if correctly identified, may aid in the management of non-indigenous species. Those most impacting, based on their population abundance and the impacts they cause, should be of special interest to managers.
- Advance contact with specialists who have knowledge of target taxa should be part of contingency arrangements for future surveys and local expertise should be maintained/developed, in particular for tunicates and marine algae.
- An investigation into the state of the gill condition of Pacific oysters in the Foyle region is advised. It is possible the condition may become more serious.

ACKNOWLEDGEMENTS

We would like to express our thanks to the marina managers and staff that enabled us to visit and sample at the selected marina sites; staff of the Department of the Environment NI for their support and Fiona McCrory (National Museums Northern Ireland) for design support.

We gratefully thank the following for identification of selected species:

C. Beer (marine algae); J. Bishop (*Didemnum vexillum*); G. Lambert (tunicates); Bernard Picton (sponges/hydroids/anemones/echinoderms); J. Porter (bryozoans especially *Tricellaria inopinata*); G. Rowe & R. Snijder (small crustaceans); J. Ryland (*Watersipora*; *Bugula* conf.).

REFERENCES

- Acosta, H. & Forrest, B.M. 2009. The spread of marine non-indigenous species via recreational boating: a conceptual model for risk assessment on fault tree analysis. *Ecological Modelling* **220**: 1586-1598
- Adarraga I, Martinez J (2012) First record of the invasive brackish water mytilid *Limnoperna securis* (Lamarck, 1819) in the bay of Biscay. *Aquatic Invasions* **7**: 171-180
- Arenas, F.F., Bishop, J.D.D., Carlton, J.T., Dyrinda, P.J., Farnham, W.F., Gonzalez, D.J., Jacobs, M.W., Lambert, C., Lambert, G., Nielsen, S.E., Pederson, J.A., Porter, J.S., Ward, S. & Wood, C.A. 2006. Alien species and other notable records from a rapid assessment survey of marinas on the south coast of England. *Journal of the Marina Biological Association U.K.* **86**: 1329–1337
- Ashton, G., Boos, K., Shucksmith, R. & Cook, E. 2006. Rapid assessment of the distribution of marine non-native species in marinas in Scotland. *Aquatic Invasions* **1**: 209-213
- Baldock, B. & Bishop, J.D.D. 2001. Occurrence of the non-native ascidian *Perophora japonica* in the Fleet, southern England. *J. Mar. Biol. Assoc. U.K.* **81**: 1067
- Berrill, N.J. 1931. Studies in tunicate development. Part II. Abbreviation of development in the Molgulidae. *Philosophical Transactions of the Royal Society of London* **219B**: 281-346
- Bishop, J.D.D., Roby, C., Yunnice, A.L.E., Wood, C.A., L  v  que, L., Turan, X. & Viard, F. 2012. The southern hemisphere ascidian *Asterocarpa humilis* is unrecognised but widely established in NW France and Great Britain. *Biological Invasions* DOI 10.1007/s10530-012-0286-x
- Boaden, P.J.S. 1995. The adventive seaweed *Sargassum muticum* (Yendo) Fensholt in Strangford Lough, Northern Ireland. *Irish Naturalists' Journal* **25**: 111-113
- Brosnahan, M.L., Kulis, D.M., Solow, A.R., Erdner, D.L., Percy, L., Lewis, J. & Anderson, D.W. 2010. Outbreeding lethality between toxic Group 1 and non-toxic Group III *Alexandrium tamarense* spp. isolates: predominance of heterotypic encystment and implications for mating interactions and biogeography. *Deep Sea Research*. **57**: 175-189
- Buschbaum, C., Lackschewitz, D. & Reise, K. 2011. Nonnative macrobenthos in the Wadden Sea ecosystem. *Ocean & Coastal Management* **68**: 89-101
- http://meeting.helcom.fi/c/document_library/get_file?p_l_id=16324&folderId=1150049&name=DLFE-42448.pdf
- Cohen, A.N., Harris, L.H., Bingham, B.L., Carlton, J.T, Chapman, J.W., Lambert, C., Lambert, G., Ljubenov, J.C., Murray, S.N., Rao, L.C., Reardon, K. & Schwindt, E. 2005. Rapid assessment survey for exotic organisms in southern California bays and harbors, and abundance in port and non-port areas. *Biol. Invasions* **7**: 995-1002
- Cook, E.J., Jenkins, S., Maggs, C., Minchin, D., Mineur, F., Nall, C. & Sewell, J. 2012. MCCIP Report Card (2012-13) – Non-native species (unpublished)
- Cook, E.J., Jahnke, M., Kerckhof, F., Minchin, D., Faasse, M., Boos, K. & Ashton, G. 2007. European expansion of the introduced amphipod *Caprella mutica* Schurin 1935. *Aquatic Invasions* **2**: 411-421
- Daniels, L.C.E., Holmes, J.M.C. & Wilson, J.G. 2009. *Paradoxostoma anglicorum* (Crustacea: Ostracoda) and *Monocorophium acherusicum* (Crustacea: Amphipoda), new to Ireland from Malahide Marina, Co. Dublin *Irish Naturalists' Journal* **30**: 32-34
- Dansey, P. 2011. *Ensis directus* (Conrad 1843) (Bivalvia: Solenoidea) found in Liverpool Bay (Sea area S24). *Journal of Conchology* **40**: 679
- Dauvin, J-C. 2009. Establishment of the invasive Asian shore crab *Hemigrapsus sanguineus* (De Haan, 1835) (Crustacea: Brachyura: Grapsoidea) from the Cotentin Peninsular, Normandy, France. *Aquatic Invasions* **4**: 467-472
- Dauvin, J-C. & Delhay, J-B. 2011. First record of *Hemigrapsus takanoi* (Crustacea: Decapoda: Grapsidae) on the western coast of north Cotentin, Normandy, western English Channel. *Marine Biodiversity Records* 3. DOI: <http://dx.doi.org/10.1017/S1755267210000928>

- Duval, D.M. 1963. The biology of *Petricola pholadiformis* Lamarck (Lamellibranchiata: Petricolidae). *Proc. Malac. Soc.* **35**: 89-100
- Environmental Research Institute (ERI) 2012. [erielements, summer 2012. www.eri.ac.uk/files/downloads/downloads2251.pdf](http://www.eri.ac.uk/files/downloads/downloads2251.pdf)
- Faasse, M.A. & Bayha, K.M. 2006. The ctenophore *Mnemiopsis leidyi* A. Agassiz 1865 in coastal waters of the Netherlands: an unrecognized invasion. *Aquatic Invasions* **1**: 270-277
- Fletcher, R.L. & Farrell, P. 1999 Introduced brown algae in the North East Atlantic, with particular respect to *Undaria pinnatifida* (Harvey) Suringar. *Helgoländer Meeresuntersuchungen* **52**: 259-275
- Gibbs, P.E., Spencer, B.E. & Pascoe, P.L. 1991. The American oyster drill, *Urosalpinx cinerea* (Gastropoda): evidence of decline in an imposex-affected population (R. Blackwater, Essex). *J. Mar. Biol. Assoc. U.K.* **71**: 827-838
- Hardy, F.G. & Guiry, M.D. 2003. *A check-list and atlas of the seaweeds of Britain and Ireland*. The British Phycological Society
- Hayes, K.R., McEnnulty, F.R. & Silva, C. 2002. *Identifying potential marine pests: an inductive approach*. Centre for Research on Marine Pests. Report to Environment Australia, 42pp.
- Hayward, P.J. & Ryland, J.S. (eds.) 1995. *Handbook of the Marine Fauna of North-West Europe*. Oxford University Press, 800 pp.
- Healy, B. & Oliver, G.A. 1998. *Coastal lagoons in the Republic of Ireland*. Vol. 1 Outline and summary of a survey of Irish coastal lagoons. Report to the National Parks and Wildlife Service
- Hincks, T. 1868. *A history of the British hydroid zoophytes*, vol. I & II. London: van Voorst
- Holmes, J.M.C & Minchin, D. 1991 A new species of *Herrmannella* (Copepoda, Poecilostomatoida, Sabelliphilidae) associated with the oyster *Ostrea edulis* L. *Crustaceana* **60**: 258-269
- Holmes, J.M.C. & Minchin, D. 1995. Two exotic copepods imported into Ireland with the Pacific oyster *Crassostrea gigas* (Thunberg). *Irish Naturalists' Journal* **25**: 17-20
- Ingle, R.W. 1980. *British Crabs*. British Museum of Natural History London, 222pp.
- Kelso, A. & Wyse Jackson, P.N. 2012. Invasive bryozoans in Ireland: first record of *Watersipora subtorquata* (d'Orbigny, 1852) and an extension of the range of *Tricellaria inopinata* d'Hondt and Occhipinti Ambrogi, 1985. *BioInvasions Records* **1**: 209-214
- Kerckhof, F., Vink, R., Nieweg, D.C. & Post, J.N.J. 2006. The veined whelk *Rapana venosa* has reached the North Sea. *Aquatic Invasions* **1**: 35-37
- Knight-Jones, P., Knight-Jones, E.W., Thorp, C.H., & Gray, P.W.G. 1975. Immigrant spirorbids (Polychaeta: Seditaria) on the Japanese *Sargassum* at Portsmouth, England. *Zoologica Scripta* **4**: 145-149
- Kraan, S. & Barrington, K. 2005. Commercial farming of *Asparagopsis armata* (Bonnemaisoniaceae, Rhodophyta) in Ireland, maintenance of an introduced species. *J. Appl. Phycol.* **17**: 103-110
- Martel, C., Viard, F., Bourguet, D. & Garcia-Meunier, P. 2004. Invasion by the marine gastropod *Ocenebrellus inornatus* in France: 1, scenario for the source of introduction. *Journal of Experimental Marine Biology and Ecology* **305**: 155-170
- Martin, J.L., LeGresley, M.M., Cooper, J.A., Thorpe, B., Locke, A., Simard, N., Sephton, D., Bernier, R., Bérubé, I., Hill, B., Keays, J., Knox, D., Landry, T., Lander, T., Nadeau, A. & Eatson, E.J. 2010. Rapid assessment for *Didemnum vexillum* in Southwest New Brunswick. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2882, 16pp.
- Massey, A.L. 1903. New locality for *Paludestrina jenkinsi*. *Irish Naturalist* **11**: 19
- Mathieson, A.C., Pedersen, J. & Dawes, C.J. 2008. Rapid assessment surveys of fouling and introduced seaweeds in the northwest Atlantic. *Rhodora* **110**: 406-478
- McNeill, G., Nunn, J. & Minchin, D. 2010. The slipper limpet *Crepidula fornicata* Linnaeus, 1758 becomes established in Ireland. *Aquatic Invasions* **5 Supplement 1**: S21-25
- Mees, J. & Fockedey, N. 1993. First record of *Synidotea laevidorsalis* (Miers, 1881) (Crustacea: Isopoda) in Europe (Gironde estuary) France. *Hydrobiologia* **264**: 61-63

- Minchin, A. 1991. Further distributional records of the adventive marine brown alga *Colpomenia peregrina* (Phaeophyta) in Ireland. *Irish Naturalists' Journal* **23**: 380-381
- Minchin, D. 2006. First Irish record of the Chinese mitten crab *Eriocheir sinensis* (Milne-Edwards, 1854) (Decapoda: Crustacea). *Irish Naturalists' Journal* **28**: 303-304
- Minchin, D. 2007a. Rapid coastal survey for targeted alien species associated with floating pontoons in Ireland. *Aquatic Invasions* **2**: 63-70
- Minchin D. 2007b. A checklist of alien and cryptogenic aquatic species in Ireland. *Aquatic Invasions* **2**: 341-366
- Minchin, D. & Duggan, C.B. 1986. The distribution of the exotic ascidian, *Styela clava* Herdman, in Cork Harbour. *Irish Naturalists' Journal* **22**: 388-392
- Minchin, D. & Holmes, J.M.C. 2006. The first record of *Caprella mutica* Schurin, 1935 (Crustacea: Amphipoda) from the east coast of Ireland. *Irish Naturalists' Journal* **28**: 321-323
- Minchin, D. & Nunn, J. 2006. Further range extensions of the marine gastropod *Calyptraea chinensis* (L.) in Ireland. *Irish Naturalists' Journal* **28**: 200-203
- Minchin, D. & Sides, E. 2006. Appearance of a cryptogenic tunicate, a *Didemnum* sp. fouling marina pontoons and leisure craft in Ireland. *Aquatic Invasions* **1**: 143-147
- Mineur, F., Johnson, M.P. & Maggs, C.A. 2008. Non-indigenous marine macroalgae in native communities: a case study in the British Isles. *Journal of the Marine Biological Association U.K.* **88**: 693-698
- Miossec, L., Le Deuff, R.-M. & Gouletquer, P. 2009. Alien species alert: *Crassostrea gigas* (Pacific oyster). *ICES Cooperative Research Report No. 299*. 42 pp.
- Morrissey, J., Kraan, S. & Guiry, M.D. 2001. *A guide to commercially important seaweeds on the Irish coast*, 66pp. An Bord Iascaigh Mhara, Dublin
- Nichols, A.R. 1900. A list of the marine Mollusca of Ireland. *Proceedings of the Royal Irish Academy (Series 3)* **5**: 477-662
- Nunn, J.D. & Minchin, D. 2009. Further expansions of the Asian tunicate *Styela clava* Herdman 1882 in Ireland. *Aquatic Invasions* **4**: 591-596
- Nunn, J.D., Goodwin, C. & Picton, B.E. 2012. First record of the marine alien bryozoan *Tricellaria inopinata* in Northern Ireland. *Porcupine MNHS Newsletter* **32**: 54
- Olenin, S., Minchin, D. & Daunys, D. 2007. Assessment of biopollution in aquatic ecosystems. *Marine Pollution Bulletin* **55**: 379-394.
- Olenin, S., Elliott, M., Bysveen, I., Culverhouse, P., Daunys, D., Dubelaar, G.B.J., Gollasch, S., Gouletquer, P., Jelmert, A., Kantor, Y., Mézeth, K.B., Minchin, D., Occhipinti-Ambrogi, A., Olenina, I. & Vandekerckhove, J. 2011. Recommendations on methods for the detection and control of biological pollution in marine coastal waters. *Marine Pollution Bulletin* **62**: 2598-2604
- Oliver, P.G., Holmes, A.M. & Mettam, C. 1998. *Mytilopsis leucophaeta*, (Conrad, 1831) [Bivalvia: Dreissenoidea]. A species new to the British fauna. *Journal of Conchology* **36**: 13-18
- Oliver, G.A., McGrath, D. & Healy, B. 2006. The amphipod *Corophium insidiosum* Crawford in Ireland. *Irish Naturalists' Journal* **28**: 324-326
- O'Riordan, C.E. 1967. Cirripedes in Ireland (Irish cirripedes in the collections of the National Museum of Ireland and in the literature). *Proceedings of the Royal Irish Academy* **65B**: 285-296
- O'Riordan, R.M. 1996. The current status and distribution of the Australian barnacle *Austrominius modestus* Darwin in Ireland. In: B.F. Keegan & R. O'Connor (eds) *Proceedings of the Irish Marine Science Symposium 1995*, pp. 207-218. Galway University Press, Galway
- Paetzold, S.C. & Davidson, J. 2010. Viability of golden-star tunicate fragments after high-pressure water treatment. *Aquaculture* **303**: 105-107
- Patti, F.P., Gambi, M.C. 2001. Phylogeography of the invasive polychaete *Sabella spallanzani* (Sabellidae) based on the nucleotide sequence of internal transcribed spacer 2 (ITS2) of nuclear DNA. *Marine Ecology Progress Series* **215**: 169-177

- Pedersen, J., Bullock, R., Carlton, J.T., Dijkstra, J., Dobroski, N., Dyrinda, P., Fisher, R., Harris, L., Hobbs, N., Lambert, G., Lazo-Wasem, E., Mathieson, A., Miglietta, M-P., Smith, J., Smith III, J. & Tyrrell, M. 2005. *Marine Invaders in the Northeast: Rapid assessment survey of non-native and native marine species of floating dock communities, August 2003*. MIT Sea Grant College Program No. 05-3, 46pp.
- Provan, J., Murphy, S. & Maggs, C.A. 2004. Tracking the invasive history of the green alga *Codium fragile* ssp. *tomentosoides*. *Molecular Ecology* **14**: 189-194
- Ramsar, 2005. Guidelines for the rapid assessment of inland, coastal and marine wetland biodiversity. 9th Meeting of the Conference of the Parties to the Convention on Wetlands. Kampala, Uganda, 8-15 November 2005, 44pp. http://www.ramsar.org/pdf/key_guide_rapidassessment_e.pdf
- Ryland, J.S. 1958. *Bugula simplex* Hincks, a newly recognized polyzoan from British waters. *Nature* **181**: 1148-1149
- Ryland, J.S. & Nelson-Smith, A. 1975. Littoral and benthic investigations on the west coast of Ireland – IV (Section A: faunistic and ecological studies). Some shores in counties Clare and Galway. *Proceedings of the Royal Irish Academy* **75B**: 245-266
- Ryland, J.S., Bishop, J.D.D., De Blauwe, H, El Nagar, A., Minchin, D., Wood, C. & Yunnice, A.L.E. 2011. Alien species of *Bugula* (Bryozoa) along the Atlantic coasts of Europe. *Aquatic Invasions* **6**: 17-31
- Simkanin, C.M. 2004. The invasive seaweed *Sargassum muticum* (Yendo) Fensholt in Lough Hyne Marine Nature Reserve, Co Cork. *Irish Naturalists' Journal* **27**: 481-482
- Southward, A.J., Hiscock, K., Moyse, J., Elfimov, A.S. 2004. Habitat and distribution of the warm water barnacle *Solidobalanus fallax* (Crustacea: Cirripedia). *Journal of the Marine Biological Association U. K.* **84**: 1169-1177
- Steel, S. & Mulcahy, M.F. 2001. Impact of the copepod *Mytilicola orientalis* on the Pacific oyster *Crassostrea gigas* in Ireland. *Diseases of Aquatic Organisms* **47**: 145-149
- Thompson, W. 1856. *The Natural History of Ireland*, volume 4. Reeve, Benham & Reeve, London
- Thomsen, M.S., McGlathery, K.J. & Tyler, A.C. 2006. Macroalgal distribution patterns in a shallow, soft-bottom lagoon, with emphasis on the non-native *Gracilaria vermiculophylla* and *Codium fragile*. *Estuaries Coasts* **29**: 465-473
- Tierney, T.D., Kane, F., Naughton, O., Kennedy, S., O'Donoghue, P., Copley, L. & Jackson, D. 2004. On the occurrence of the caprellid amphipod, *Caprella mutica* Schurin 1935, in Ireland. *Irish Naturalists' Journal* **27**: 437-439
- Worsfold, T.M. & Ashelby, C.W. 2007. Additional UK records of the non-native prawn *Palaemon macrodactylus*. *Journal of the Marine Biological Association U.K.* 2 - Biodiversity Records
- Zibrowius, H. & Thorp, C.H. 1989. A review of the alien serpulid and spirorbid polychaetes in the British Isles. *Cahier Biologie Marine* **30**: 271-285

APPENDIX 1

Species lists for Rapid Assessment Survey & subsequent shore survey in Strangford Lough in 2012.

Please refer to Table 2 & Table 4 for details for each site. Sites are listed in chronological order.

Twenty-nine living non-indigenous and cryptogenic species are highlighted pale blue. The remaining records are casual observations only for each site.

Species appear alphabetically according to taxonomic group. Taxonomy is according to WoRMS (World Register of Marine Species <http://www.marinespecies.org/>)

Records during the Rapid Assessment Survey are by D. Minchin & J. Nunn. Records from the subsequent post-contract survey are primarily by J. Nunn, with some observations by B. Picton. Identifications for some difficult groups are by those listed in the Acknowledgements.

PORIFERA					
<i>Amphilectus fucorum</i>	Rainey narrows				
<i>Aplysilla rosea</i>	Whiterock Bay	Braddock Island			
<i>Aplysilla sulfurea</i>	Whiterock Bay	Braddock Island			
<i>Baera nivea</i>	Mahee narrows	Whiterock Bay			
<i>Clathrina</i> sp.	Mahee narrows	Braddock Island			
<i>Cliona celata</i>	Braddock Island	Rainey narrows			
<i>Dysidea fragilis</i>	Rainey narrows				
<i>Grantia compressa</i>	East Down Y.C.	Ardglass Marina	Ballydorn shore	Mahee narrows	Braddock Island
	Rainey narrows				
<i>Halichondria panicea</i>	N of Herring Bay	Kircubbin Y.C.	Warrenpoint Marina	Ballydorn shore	Sketrick N
	Sketrick pontoon	Mahee narrows	Whiterock Bay	Braddock Island	Paddys Point
	Rainey narrows				
<i>Haliclona</i> sp.	Paddys Point				
<i>Hymeniacidon perleve</i>	Kircubbin Y.C.	Mahee Island	Warrenpoint Marina	Ballydorn shore	Sketrick N
	Mahee narrows	Whiterock Bay	Paddys Point	Rainey narrows	
<i>Halisarca dujardini</i>	N of Herring Bay	Ballydorn shore	Paddys Point	Rainey narrows	
<i>Mycale minima</i>	Rainey narrows				
<i>Ophlitaspongia papilla</i>	Whiterock Bay	Rainey narrows			
<i>Scypha ciliata</i>	Rathlin pontoon	Carrickfergus Marina	Donaghadee Marina	Whiterock Y.C.	East Down Y.C.
	Portaferry Marina	Ardglass Marina	Warrenpoint Marina	Sketrick pontoon	Mahee narrows
	Paddys Point	Rainey narrows			
<i>Terpios fugax</i>	Braddock Island				

CNIDARIA					
<i>Actinia equina</i>	Mahee narrows				
<i>Alcyonium digitatum</i>	Carrickfergus Marina				
<i>Cereus pedunculatus</i>	Ballydorn shore	Mahee narrows			
<i>Cordylophora caspia</i>	Foyle Marina	Seaton's Landing	Coleraine Marina		
<i>Cyanea capillata</i>	Culmore Point	Kircubbin Y.C.	Portaferry Marina		
<i>Diadumene lineata</i>	Mahee narrows				
<i>Dynamena pumila</i>	Mahee Island	Ballydorn shore	Mahee narrows	Paddys Point	Rainey narrows
<i>Hydractinia echinata</i>	Paddys Point				
<i>Laomedea flexuosa</i>	Portrush pontoon				
<i>Obelia geniculata</i>	Portrush pontoon	Rathlin pontoon			
<i>Obelia longissima</i>	Portrush pontoon	Warrenpoint Marina			

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<i>Obelia dichotoma</i>	Rathlin pontoon				
<i>Metridium senile</i>	Glenarm Marina	Carrickfergus Marina	Donaghadee Marina	Bangor Marina	Ringhaddy Y.C.
	Whiterock Y.C.	Ballydorn Y.C.	East Down Y.C.	Portaferry Marina	Ardglass Marina
	Warrenpoint Marina	Sketrick pontoon	Mahee narrows	Melanie yacht	
<i>Sagartia</i> sp.	Ardglass Marina				
<i>Sagartia elegans</i>	Mahee narrows				
<i>Sertularia argentea</i>	Rainey narrows				
<i>Tubularia indivisa</i>	Sketrick pontoon				
<i>Tubularia larynx</i>	Ballydorn Y.C.				
<i>Urticina felina</i>	Kircubbin Y.C.	Mahee Island	Mahee narrows		

NEMERTEA					
<i>Lineus longissimus</i>	Bangor Marina	Ardglass Marina			

ENTOPROCTA					
<i>Pedicellina cernua</i>	Mahee narrows				

ANNELIDA					
<i>Alentia gelatinosa</i>	Ardglass Marina				
<i>Arenicola marina</i>	Culmore Point	Kircubbin Y.C.	Dundrum Bay	Mill Bay	Paddys Point
<i>Eupolymnia nebulosa</i>	N of Herring Bay	Ballydorn shore	Sketrick pontoon	Mahee narrows	Whiterock Bay
	Braddock Island	Paddys Point	Rainey narrows		
<i>Filograna implexa</i>	Mahee narrows				
<i>Janice conchilega</i>	Paddys Point	Rainey narrows			
<i>Pomatoceros triqueter</i>	N of Herring Bay	Kircubbin Y.C.	Belfast Marina	Bangor Marina	Portaferry Marina
	Ardglass Marina	Mahee narrows	Whiterock Bay	Rainey narrows	
<i>Sabella pavonina</i>	Carrickfergus Marina	Bangor Marina	Ringhaddy Y.C.	Ballydorn Y.C.	Portaferry Marina
	Warrenpoint Marina	Whiterock Bay	Paddys Point	Melanie yacht	
<i>Serpula vermicularis</i>	N of Herring Bay	Ardglass Marina			
<i>Spirorbis</i> sp.	Braddock Island	Paddys Point			

CHELICERATA					
Pycnogonida	Rathlin pontoon				
<i>Achelia echinata</i>	Mahee Island				

CRUSTACEA					
<i>Amphibalanus improvisus</i>	Foyle Marina	Culmore Point			
Amphipoda	Foyle Marina	Coleraine Marina	Belfast Marina	Portaferry Marina	
<i>Ampithoe gammaroides</i>	Rathlin Pontoon				
<i>Ampithoe rubricata</i>	Rathlin Pontoon				
<i>Aora gracilis</i>	Rathlin Pontoon				
Aoridae	Ballycastle Marina				
<i>Apocorophium lacustre</i>	Foyle marina				
<i>Austrominius modestus</i>	Culmore Point	Carrickfergus Marina	N of Herring Bay	Mahee Island	Belfast Marina
	Bangor Marina	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	Quoile Y.C.
	Killyleagh Y.C.	East Down Y.C.	Dundrum Bay	Warrenpoint Marina	Mill Bay
	Ballydorn shore	Sketrick N	Sketrick narrows	Sketrick pontoon	Mahee narrows
	Whiterock Bay	Braddock Island	Paddys Point	Rainey narrows	Melanie yacht
<i>Balanus balanus</i>	Carrickfergus Marina	Bangor Marina	East Down Y.C.	Ardglass Marina	Sketrick N
<i>Balanus crenatus</i>	Portrush pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	Kircubbin Y.C.
	Mahee Island	Belfast Marina	Donaghadee Marina?	Bangor Marina	Ringhaddy Y.C.
	Whiterock Y.C.	Ballydorn Y.C.	Quoile Y.C.	Killyleagh Y.C.	Portaferry Marina
	Warrenpoint Marina	Sketrick N	Mahee narrows	Melanie yacht	
<i>Cancer pagurus</i>	N of Herring Bay	Ballydorn Y.C.	Ardglass Marina		Mahee narrows
	Braddock Island	Paddys Point	Rainey narrows		
<i>Caprella acanthifera</i>	Mahee Island				

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<i>Caprella mutica</i>	Rathlin pontoon	Glenarm Marina	Carrickfergus Marina	Bangor Marina	Ringhaddy Y.C.
	Portaferry Marina	Melanie yacht			
<i>Carcinus maenas</i>	Culmore Point	Carrickfergus Marina	N of Herring Bay	Belfast Marina	Donaghadee Marina
	Bangor Marina	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	Killyleagh Y.C.
	Portaferry Marina	Dundrum Bay	Ardglass Marina	Warrenpoint Marina	Ballydorn shore
	Mahee narrows	Whiterock Bay	Paddys Point	Rainey narrows	
<i>Corophiidae</i>	Seaton's Landing	Ballycastle Marina			
<i>'Corophium' spp.</i>	Foyle Marina		Carrickfergus Marina	Portaferry Marina	
<i>Crassikorophium bonnellii</i>	Ardglass Marina				
<i>Dynamene bidentata</i>	Rathlin Pontoon				
<i>Galathea sp.</i>	Whiterock Bay				
<i>Galathea squamifera</i>	Portaferry Marina	Ardglass Marina			
<i>Gammarellus homari</i>	Portaferry Marina				
<i>Gammaropsis maculata</i>	Rathlin Pontoon				
<i>Gammarus sp.</i>	Foyle Marina	Coleraine Marina	Seaton's Landing	Belfast Marina	Portaferry Marina
<i>Gammarus tigrinus</i>	Coleraine Marina	Seaton's Landing			
<i>Gammarus zaddachi</i>	Foyle Marina	Portrush Pontoon			
<i>Hippolyte sp.</i>	Carrickfergus Marina	Ardglass Marina			
<i>Hyale nilssoni</i>	Belfast Marina				
<i>Hyas araneus</i>	Ballydorn Y.C.				
<i>Idotea sp.</i>	Portrush Pontoon	Rathlin Pontoon			
<i>Idotea balthica</i>	Rathlin Pontoon				
<i>Idotea neglecta</i>	Rathlin Pontoon				
<i>Jaera sp.</i>	Foyle Marina	Belfast Marina			
<i>Jassa sp.</i>	Rathlin pontoon	Glenarm Marina	Carrickfergus Marina	Bangor Marina	Ringhaddy Y.C.
	Ballydorn Y.C.	Melanie yacht			
<i>Jassa falcata</i>	Ringhaddy Y.C.	Ballydorn Y.C.	Portaferry Marina	Melanie yacht	
<i>Leptocheirus pilosus</i>	Foyle Marina				
<i>Microdeutopus gryllotalpa</i>	Ballycastle Marina				
<i>Monocorophium acherusicum</i>	Carrickfergus Marina				
<i>Monocorophium insidiosum</i>	Portrush Pontoon	Ballycastle Marina	Glenarm Marina	Mahee Island	Belfast Marina
	Donaghadee Marina	Bangor Marina			
<i>Monocorophium sextonae</i>	Carrickfergus Marina	Killyleagh Y.C.	East Down Y.C.	Portaferry Marina	Ardglass Marina
	Warrenpoint Marina				
<i>Palaemon serratus</i>	Rathlin pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	Donaghadee Marina
	Ardglass Marina				
<i>Pilumnus hirtellus</i>	Ringhaddy Y.C.	Ballydorn Y.C.	Ardglass Marina	Mahee narrows	
<i>Pisidia longicornis</i>	N of Herring Bay	Donaghadee Marina	Whiterock Y.C.	Portaferry Marina	Ardglass Marina
	Mahee narrows	Whiterock Bay	Paddys Point		
<i>Porcellana platycheles</i>	Kircubbin Y.C.	Mahee narrows	Whiterock Bay	Braddock Island	Paddys Point
<i>Phtisica marina</i>	Carrickfergus Marina	Mahee Island	Ballydorn Y.C.		
<i>Semibalanus balanoides</i>	Ballycastle Marina	N of Herring Bay	Glenarm Marina	Killyleagh Y.C.	Dundrum Bay
	Mill Bay	Paddys Point	Rainey narrows		
<i>Spirorbis sp.</i>	Glenarm Marina				
<i>Stenothoe monoculoides</i>	Portrush Pontoon				
<i>Stenothoe valida</i>	Portaferry Marina				
<i>Verrucaria stroemia</i>	Portrush pontoon	Mahee narrows	Braddock Island		

MOLLUSCA					
<i>Acanthochitona crinita</i>	Portrush pontoon	N of Herring Bay	Kircubbin Y.C.	Mahee narrows	Whiterock Bay
	Braddock Island	Paddys Point	Rainey narrows		
<i>Aeolidia papillosa</i>	East Down Y.C.	Portaferry Marina			
<i>Aequipecten opercularis</i>	East Down Y.C.	Portaferry Marina	Ardglass Marina		
<i>Ammonicera rota</i>	Mahee narrows	Braddock Island			
<i>Anomia ephippium</i>	N of Herring Bay	Mahee Island	Portaferry Marina	Whiterock Bay	Braddock Island
	Rainey narrows				
Anomiidae	Ballycastle Marina				
<i>Archidoris pseudoargus</i>	Carrickfergus Marina	Warrenpoint Marina			
<i>Barnea candida</i>	Mahee Island				

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<i>Buccinum undatum</i>	N of Herring Bay	Mahee Island	Whiterock Y.C.	Ballydorn shore	Sketrick narrows
	Mahee narrows	Whiterock Bay	Braddock Island	Rainey narrows	
<i>Calliostoma zizyphinum</i>	Mahee Island	Sketrick narrows	Mahee narrows	Whiterock Bay	Braddock Island
<i>Calliostoma zizyphinum</i> var. <i>lyonsii</i>	N of Herring Bay	Ballydorn shore	Mahee narrows	Rainey narrows	
<i>Calyptraea chinensis</i>	Mahee Island	Ballydorn shore	Sketrick narrows	Mahee narrows	Whiterock Bay
	Rainey narrows				
<i>Cerastoderma edule</i>	Culmore Point	Kircubbin Y.C.	Mahee Island	Dundrum Bay	Mill Bay
	Whiterock Bay	Paddys Point	Rainey narrows		
<i>Chlamys varia</i>	N of Herring Bay	Ballydorn shore	Sketrick pontoon	Mahee narrows	Whiterock Bay
	Braddock Island	Paddys Point	Rainey narrows		
<i>Coryphella lineata</i>	Portaferry Marina				
<i>Coryphella verrucosa</i>	Portaferry Marina				
<i>Crassostrea gigas</i>	Culmore Point	N of Herring Bay	Sketrick narrows	Paddys Point	
<i>Dendronotus frondosus</i>	Portaferry Marina				
<i>Diodora graeca</i>	N of Herring Bay	Mahee narrows			
<i>Doto coronata</i>	Portrush pontoon	Rathlin pontoon			
<i>Eatonina fulgida</i>	Braddock Island				
<i>Elysia viridis</i>	Rainey narrows				
<i>Eubranchus pallidus</i>	Rathlin pontoon				
<i>Facelina auriculata</i>	Glenarm Marina	Carrickfergus Marina	Mahee Island	Portaferry Marina	Ardglass Marina
<i>Facelina bostoniensis</i>	Portaferry Marina	Sketrick narrows	Whiterock Bay	Rainey narrows	
<i>Gibbula cineraria</i>	N of Herring Bay	Kircubbin Y.C.	Mahee Island	Ballydorn Y.C.	Ballydorn shore
	Sketrick narrows	Mahee narrows	Whiterock Bay	Braddock Island	Rainey narrows
<i>Gibbula umbilicalis</i>	Kircubbin Y.C.	Mahee Island	Sketrick narrows	Mahee narrows	Whiterock Bay
	Rainey narrows				
<i>Goniodoris nodosa</i>	East Down Y.C.				
<i>Helcion pellucidum</i>	Portrush pontoon	Rathlin pontoon	Glenarm Marina	Carrickfergus Marina	East Down Y.C.
	Portaferry Marina	Ardglass Marina			
<i>Hermaea bifida</i>	Whiterock Y.C.	Ardglass Marina	Ballydorn shore	Mahee narrows	Whiterock Bay
	Rainey narrows				
<i>Heteranomia squamula</i>	Glenarm Marina	Ardglass Marina			
<i>Hiatella arctica</i>	Killyleagh Y.C.	Portaferry Marina	Ardglass Marina		
<i>Lacuna pallidula</i>	Braddock Island				
<i>Lacuna vincta</i>	Rathlin pontoon	Glenarm Marina	Portaferry Marina	Ardglass Marina	Braddock Island
<i>Lamellaria latens</i>	Carrickfergus Marina	Sketrick narrows	Paddys Point	Rainey narrows	
<i>Lamellaria perspicua</i>	Carrickfergus Marina				
<i>Lepidochitona cinerea</i>	Whiterock Bay	Rainey narrows			
<i>Littorina fabalis</i>	Kircubbin Y.C.	Mahee Island	Ballydorn shore	Sketrick narrows	Mahee narrows
	Whiterock Bay	Braddock Island	Rainey narrows		
<i>Littorina littorea</i>	Culmore Point	N of Herring Bay	Kircubbin Y.C.	Belfast Marina	Dundrum Bay
	Mill Bay	Sketrick narrows	Mahee narrows	Whiterock Bay	
	Braddock Island	Paddys Point	Rainey narrows		
<i>Littorina obtusata</i>	Paddys Point				
<i>Littorina saxatilis</i>	Mahee Island	Dundrum Bay	Mahee narrows	Whiterock Bay	Paddys Point
<i>Macoma balthica</i>	Culmore Point				
<i>Modiolarca tumida</i>	Ardglass Marina	Sketrick pontoon	Mahee narrows	Braddock Island	Paddys Point
	Rainey narrows				
<i>Mytilus edulis</i>	Culmore Point	Portrush pontoon	Rathlin pontoon	Ballycastle Marina	Carrickfergus Marina
	Kircubbin Y.C.	Belfast Marina	Donaghadee Marina	Bangor Marina	Ringhaddy Y.C.
	Whiterock Y.C.	Ballydorn Y.C.	Killyleagh Y.C.	East Down Y.C.	Portaferry Marina
	Dundrum Bay	Ardglass Marina	Warrenpoint Marina	Ballydorn shore	Sketrick N
	Sketrick pontoon	Mahee narrows	Whiterock Bay	Braddock Island	Paddys Point
<i>Nucella lapillus</i>	Kircubbin Y.C.	Mahee Island	Ballydorn shore	Sketrick narrows	Mahee narrows
	Braddock Island	Paddys Point	Rainey narrows		
<i>Ocenebra erinacea</i>	Ballydorn shore	Sketrick narrows	Whiterock Bay	Braddock Island	Rainey narrows
<i>Odostomia eulimoides</i>	Mahee narrows				
<i>Omalogyra atomus</i>	Braddock Island	Paddys Point			
<i>Onchidoris muricata</i>	Rainey narrows				
<i>Onoba semicostata</i>	Braddock Island	Rainey narrows			

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<i>Osilinus lineatus</i>	N of Herring Bay	Kircubbin Y.C.	Dundrum Bay	Whiterock Bay	
<i>Ostrea edulis</i>	N of Herring Bay	Kircubbin Y.C.	Mahee Island	Ballydorn shore	Sketrick narrows
	Mahee narrows	Whiterock Bay	Paddys Point	Rainey narrows	
<i>Patella vulgata</i>	Ballycastle Marina	Glenarm Marina	N of Herring Bay	Kircubbin Y.C.	Donaghadee Marina
	Bangor Marina	Killyleagh Y.C.	Portaferry Marina	Dundrum Bay	Ardglass Marina
	Ballydorn shore	Sketrick N	Mahee narrows	Whiterock Bay	Braddock Island
	Paddys Point	Rainey narrows			
<i>Pecten maximus</i>	Ardglass Marina	Paddys Point			
<i>Peringia ulvae</i>	Dundrum Bay	Paddys Point			
<i>Pododesmus patelliformis</i>	Rathlin pontoon		Mahee narrows		
<i>Potamopyrgus antipodarum</i>	Coleraine Marina				
<i>Pusillina inconspicua</i>	Braddock Island	Paddys Point	Rainey narrows		
<i>Pusillina sarsi</i>	Paddys Point				
<i>Rissoa interrupta</i>	Mahee narrows	Braddock Island	Paddys Point	Rainey narrows	
<i>Rissoa parva</i>	Mahee narrows	Braddock Island	Paddys Point		
<i>Rissoella diaphana</i>	Braddock Island	Paddys Point	Rainey narrows		
<i>Rissoella opalina</i>	Braddock Island	Rainey narrows			
<i>Skeneopsis planorbis</i>	Braddock Island				
<i>Spisula subtruncata</i>	N of Herring Bay	Paddys Point			
<i>Tapes decussatus</i>	Mahee narrows				
<i>Timoclea ovata</i>	Mahee Island				
<i>Tricolia pullus</i>	Braddock Island	Paddys Point			
<i>Trivia arctica</i>	Portaferry Marina				
<i>Trivia monacha</i>	Ballydorn Y.C.	Mahee narrows	Braddock Island	Rainey narrows	
<i>Turtonia minuta</i>	Paddys Point				
<i>Venerupis senegalensis</i>	N of Herring Bay	Bangor Marina	Ringhaddy Y.C.	Ballydorn Y.C.	Portaferry Marina
	Mahee narrows	Paddys Point	Rainey narrows		

BRYOZOA					
<i>Alcyonidium gelatinosum</i>	Culmore Point	Mahee narrows	Paddys Point		
<i>Bowerbankia</i> sp.	Portrush pontoon				
<i>Bowerbankia imbricata</i>	Warrenpoint Marina				
<i>Bugula flabellata</i>	Ballycastle Marina				
<i>Bugula fulva</i>	Rathlin pontoon	East Down Y.C.			
<i>Bugula neritina</i>	Carrickfergus Marina				
<i>Bugula plumosa</i>	Portrush pontoon	Ringhaddy Y.C.			
<i>Bugula simplex</i>	Rathlin pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	Bangor Marina
<i>Cellepora pumicosa</i>	Braddock Island				
<i>Celleporella hyalina</i>	Rathlin pontoon	East Down Y.C.	Ardglass Marina		
<i>Celleporina hassalli</i>	Braddock Island				
<i>Conopeum reticulum</i>	Belfast Marina				
<i>Crisia denticulata</i>	Mahee Island				
<i>Crisia eburnea</i>	East Down Y.C.	Mahee narrows			
<i>Cryptosula pallasiana</i>	Rathlin pontoon	Ballycastle Marina	Donaghadee Marina	Bangor Marina	Warrenpoint Marina
<i>Electra pilosa</i>	Portrush pontoon	Rathlin pontoon	Carrickfergus Marina	Mahee Island	Ringhaddy Y.C.
	Whiterock Y.C.	Killyleagh Y.C.	East Down Y.C.	Portaferry Marina	Ardglass Marina
	Ballydorn shore	Sketrick pontoon	Mahee narrows	Braddock Island	Paddys Point
	Rainey narrows	Melanie yacht			
<i>Flustrellidra hispida</i>	Portrush pontoon	Ardglass Marina	Rainey narrows		
<i>Membranipora membranacea</i>	Portrush pontoon	Rathlin pontoon	Carrickfergus Marina	Bangor Marina	Ballydorn Y.C.
	Killyleagh Y.C.	Portaferry Marina	Ardglass Marina		
<i>Oshurkovia littoralis</i>	Rathlin pontoon	Portaferry Marina	Ardglass Marina		
<i>Schizomavella linearis</i>	Braddock Island				
<i>Scrupocellaria reptans</i>	Mahee Island	Ballydorn Y.C.	Ballydorn shore		
<i>Scrupocellaria scruposa</i>	Portaferry Marina	East Down Y.C.	Braddock Island	Rainey narrows	
<i>Tricellaria inopinata</i>	Portrush pontoon	Rathlin pontoon	Glenarm Marina	Carrickfergus Marina	Bangor Marina
	Ardglass Marina				
<i>Watersipora</i> c.f. <i>subtorquata</i>	Ardglass Marina				

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ECHINODERMATA					
<i>Amphipholis squamata</i>	Rainey narrows				
<i>Antedon bifida</i>	Mahee Island	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn shore	Sketrick N
	Sketrick narrows	Sketrick pontoon	Mahee narrows	Braddock Island	Rainey narrows
	Melanie yacht				
<i>Asterias rubens</i>	Carrickfergus Marina	N of Herring Bay	Ballydorn shore	Sketrick N	Braddock Island
	Paddys Point	Rainey narrows			
<i>Henricia</i> sp.	Braddock Island				
<i>Leptasterias muelleri</i>	N of Herring Bay	Mahee Island	Ballydorn shore	Sketrick narrows	Mahee narrows
	Whiterock Bay	Braddock Island	Rainey narrows	Melanie yacht	
<i>Ocnus brunneus</i>	Rainey narrows				
<i>Ophiocomina nigra</i>	Braddock Island				
<i>Ophiothrix fragilis</i>	Carrickfergus Marina	N of Herring Bay	Mahee Island	Ballydorn Y.C.	East Down Y.C.
	Portaferry Marina	Ardglass Marina	Ballydorn shore	Mahee narrows	Paddys Point
	Rainey narrows				
<i>Pawsonia saxicola</i>	Mahee narrows	Braddock Island	Rainey narrows		
<i>Psammechinus miliaris</i>	Ballydorn shore	Braddock Island	Paddys Point	Rainey narrows	
<i>Thyone roscovita</i>	Whiterock Y.C.	Mahee narrows			

TUNICATA					
<i>Aplidium glabrum</i>	Ballycastle Marina	Carrickfergus Marina	Ballydorn Y.C.	East Down Y.C.	Warrenpoint Marina
	Ballydorn shore	Sketrick narrows	Sketrick pontoon	Mahee narrows	Paddys Point
	Rainey narrows				
<i>Ascidia conchilega</i>	Ballycastle Marina	N of Herring Bay	Ardglass Marina	Mahee narrows	Whiterock Bay
	Braddock Island	Rainey narrows			
<i>Ascidia mentula</i>	Bangor Marina	Whiterock Bay			
<i>Asciella aspersa</i>	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	Donaghadee Marina	Bangor Marina
	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	East Down Y.C.	Portaferry Marina
	Ardglass Marina	Warrenpoint Marina	Ballydorn shore	Sketrick pontoon	Mahee narrows
	Whiterock Bay	Braddock Island	Paddys Point	Rainey narrows	Melanie yacht
<i>Asciella scabra</i>	Sailing marker 2				
	Rathlin pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	N of Herring Bay
	Donaghadee Marina	Bangor Marina	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.
	Killyleagh Y.C.	East Down Y.C.	Portaferry Marina	Ardglass Marina	Ballydorn shore
<i>Botrylloides</i> sp.	Paddys Point	Rainey narrows			
	Glenarm Marina	Carrickfergus Marina	Donaghadee Marina	Bangor Marina	Ringhaddy Y.C.
<i>Botrylloides violaceus</i>	Ballydorn Y.C.	Ardglass Marina	Ballydorn shore	Sketrick pontoon	
	East Down Y.C.	Sketrick narrows	Mahee narrows	Braddock Island	Paddy's Point
<i>Botryllus schlosseri</i>	Rathlin pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	Donaghadee Marina
	Bangor Marina	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	East Down Y.C.
	Ardglass Marina	Warrenpoint Marina	Ballydorn shore	Mahee narrows	Braddock Island
	Rainey narrows				
<i>Ciona intestinalis</i>	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina	N of Herring Bay	Donaghadee Marina
	Bangor Marina	Ringhaddy Y.C.	Whiterock Y.C.	Portaferry Marina	Ardglass Marina
	Ballydorn shore	Sketrick N	Sketrick pontoon	Mahee narrows	Whiterock Bay
	Braddock Island	Paddys Point	Rainey narrows		
<i>Clavelina lepadiformis</i>	Carrickfergus Marina	Ardglass Marina	Rainey narrows		
'Colonial sea squirt'	Glenarm Marina				
<i>Corella eumyota</i>	Portrush pontoon	Rathlin pontoon	Ballycastle Marina	Glenarm Marina	Carrickfergus Marina
	N of Herring Bay	Kircubbin Y.C.	Mahee Island	Donaghadee Marina	Bangor Marina
	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	Ballydorn Y.C.	Quoile Y.C.
	Killyleagh Y.C.	East Down Y.C.	Portaferry Marina	Ardglass Marina	Warrenpoint Marina
	Ballydorn shore	Sketrick narrows	Sketrick pontoon	Mahee narrows	Whiterock Bay
<i>Corella parallelogramma</i>	Braddock Island	Paddys Point	Rainey narrows	Melanie yacht	
<i>Dendrodoa grossularia</i>	Glenarm Marina				
	Portrush pontoon	Ballydorn Y.C.	Ballydorn shore	Sketrick pontoon	Mahee narrows
<i>Didemnum</i> sp. not <i>vexillum</i>	Braddock Island	Rainey narrows			
	Portaferry Marina				

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<i>Didemnum maculosum</i>	Whiterock Y.C.	Sketrick pontoon	Mahee narrows	Whiterock Bay	Braddock Island
	Rainey narrows				
<i>Didemnum vexillum</i>	Ballydorn Y.C.				
<i>Didemnum c.f. vexillum</i>	Ballydorn shore	Sketrick narrows	Sketrick pontoon	Rainey narrows	Paddy's Point
<i>Diplosoma</i> sp.	Sketrick pontoon	Mahee narrows	Whiterock Bay	Melanie yacht	
<i>Diplosoma listerianum</i>	Bangor Marina	Whiterock Y.C.	Ardglass Marina	Mahee narrows	
<i>Diplosoma ?spongiforme</i>	Bangor Marina	Whiterock Y.C.			
' <i>Molgula</i> ' sp.	Glenarm Marina	Bangor Marina	Ballydorn Y.C.		
<i>Molgula socialis</i>	Ballycastle Marina	Carrickfergus Marina			
<i>Morchellium argus</i>	Mahee narrows	Braddock Island	Paddy's Point		
<i>Perophora japonica</i>	Sketrick narrows	Rainey narrows			
<i>Perophora listeri</i>	Foyle Marina				
<i>Polyclinum aurantium</i>	Mahee narrows				
<i>Pyura</i> sp.	Whiterock Bay	Braddock Island			
<i>Styela clava</i>	Glenarm Marina	Carrickfergus Marina			
<i>Trididemnum</i> sp.	Whiterock Y.C.	Ballydorn Y.C.	Melanie yacht		
<i>Trididemnum cereum</i>	Whiterock Y.C.				

OSTEICHTHYES					
<i>Anguilla anguilla</i>	Seaton's Landing	Whiterock Bay			
<i>Cyclopterus lumpus</i>	Portaferry Marina				
<i>Gobiusculus flavescens</i>	Ardglass Marina				
<i>Lepidogaster candollei</i>	Braddock Island				
<i>Lepidogaster lepidogaster</i>	Whiterock Y.C.				
<i>Nerophis lumbriciformis</i>	Rathlin pontoon	Ballycastle Marina	Donaghadee Marina	Warrenpoint Marina	
<i>Pholis gunnellus</i>	N of Herring Bay	Mahee Island	Ballydorn Y.C.	Ardglass Marina	Mahee narrows
	Whiterock Bay	Braddock Island	Paddys Point	Rainey narrows	
<i>Spinachia spinachia</i>	Rathlin pontoon	Carrickfergus Marina	Ringhaddy Y.C.	Whiterock Y.C.	Ardglass Marina
<i>Trisopterus minutus</i>	Portrush pontoon				

RHODOPHYTA					
<i>Ceramium</i>	Belfast Marina				
<i>Chondracanthus acicularis</i>	Mahee Island				
<i>Chondrus crispus</i>	N of Herring Bay	Kircubbin Y.C.	Donaghadee Marina	Ballydorn Y.C.	Portaferry Marina
	Mill Bay	Mahee narrows	Whiterock Bay	Braddock Island	Paddys Point
	Rainey narrows				
<i>Corallina officinalis</i>	Rathlin pontoon	N of Herring Bay	Portaferry Marina	Ardglass Marina	Mahee narrows
	Whiterock Bay	Braddock Island			
<i>Dilsea carnosa</i>	Glenarm Marina	Donaghadee Marina	Mahee narrows	Paddys Point	Rainey narrows
<i>Furcellaria lumbricalis</i>	Whiterock Bay	Braddock Island			
<i>Gracilaria vermiculophylla</i>	Dundrum Bay	Mill Bay			
<i>Griffithsia corallinoides</i>	Mahee narrows	Rainey narrows			
<i>Halurus flosculus</i>	Whiterock Y.C.				
<i>Heterosiphonia japonica</i>	Ringhaddy Y.C.	Ballydorn shore	Sketrick N	Mahee narrows	Whiterock Bay
	Braddock Island	Paddy's Point	Rainey narrows		
<i>Lomentaria articulata</i>	Portrush pontoon	Ardglass Marina	Mahee narrows		
<i>Osmundea</i>	Portaferry Marina	Mahee narrows	Paddys Point		
<i>Palmaria palmata</i>	Mahee Island	Braddock Island	Rainey narrows	Melanie yacht	
<i>Plocamium cartilagium</i>	Portaferry Marina				
<i>Polysiphonia lanosa</i>	Culmore Point				
<i>Porphyra</i> sp.	Glenarm Marina	Bangor Marina			

OCHROPHYTA					
<i>Alaria esculenta</i>	Portrush pontoon	Rathlin pontoon	Glenarm Marina	Donaghadee Marina	Bangor Marina
<i>Ascophyllum nodosum</i>	Culmore Point	Kircubbin Y.C.	Mahee Island	Donaghadee Marina	Dundrum Bay
	Ballydorn shore	Mahee narrows	Whiterock Bay	Braddock Island	Paddys Point
	Rainey narrows				
<i>Chorda filum</i>	Rathlin pontoon	Ringhaddy Y.C.	Portaferry Marina	Whiterock Bay	Braddock Island
	Melanie yacht				

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<i>Cladostephus spongiosus</i>	Kircubbin Y.C.	Mahee narrows	Paddys Point		
<i>Colpomenia peregrina</i>	Carrickfergus Marina	Kircubbin Y.C.	Mahee Island	Ringhaddy Y.C.	Ballydorn Y.C.
	Portaferry Marina	Sketrick narrows	Whiterock Bay		
<i>Desmarestia</i> sp.	Ballydorn Y.C.				
<i>Dictyota dichotoma</i>	Portrush pontoon	Rathlin pontoon	Kircubbin Y.C.	Mahee Island	Donaghadee Marina
	Ringhaddy Y.C.	Ballydorn Y.C.	Portaferry Marina	Mahee narrows	Paddys Point
	Rainey narrows				
<i>Fucus serratus</i>	Culmore Point	Kircubbin Y.C.	Donaghadee Marina	Ballydorn shore	Mahee narrows
	Whiterock Bay	Braddock Island	Rainey narrows		
<i>Fucus spiralis</i>	Kircubbin Y.C.	Donaghadee Marina	Dundrum Bay	Mill Bay	Mahee narrows
	Braddock Island	Paddys Point	Rainey narrows		
<i>Fucus vesiculosus</i>	Culmore Point	N of Herring Bay	Kircubbin Y.C.	Dundrum Bay	Mill Bay
	Whiterock Bay	Paddys Point	Rainey narrows		
<i>Halidrys siliquosa</i>	N of Herring Bay				
<i>Laminaria digitata</i>	Donaghadee Marina	Killyleagh Y.C.	Portaferry Marina	Ballydorn shore	Mahee narrows
	Braddock Island	Rainey narrows			
<i>Laminaria hyperborea</i>	Rathlin pontoon	Glenarm Marina	Ballydorn Y.C.		
<i>Leathesia diffiformis</i>	Rathlin pontoon	N of Herring Bay	Braddock Island	Paddys Point	
<i>Pelvetia canaliculata</i>	Kircubbin Y.C.	Donaghadee Marina	Dundrum Bay	Mahee narrows	Braddock Island
	Rainey narrows				
<i>Saccharina latissima</i>	Portrush pontoon	Carrickfergus Marina	Mahee Island	Donaghadee Marina	Bangor Marina
	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	Killyleagh Y.C.	Portaferry Marina
	Ardglass Marina	Warrenpoint Marina	Ballydorn shore	Sketrick pontoon	Braddock Island
	Rainey narrows				
<i>Saccorhiza polyschides</i>	Portrush pontoon	Rathlin pontoon	Glenarm Marina	Donaghadee Marina	Bangor Marina
	Killyleagh Y.C.	Portaferry Marina	Ardglass Marina	Rainey narrows	
<i>Sargassum muticum</i>	Mahee Island	Ringhaddy Y.C.	Ballydorn Y.C.	Portaferry Marina	Ballydorn shore
	Sketrick N	Sketrick narrows	Sketrick pontoon	Mahee narrows	Rainey narrows

CHLOROPHYTA					
<i>Bryopsis hypnoides</i>	Donaghadee Marina	Ringhaddy Y.C.	Ballydorn Y.C.	Portaferry Marina	Ardglass Marina
<i>Cladophora rupestris</i>	N of Herring Bay	Kircubbin Y.C.			
<i>Codium</i> sp.	Whiterock Y.C.	Ardglass Marina			
<i>Ulva 'lactuca'</i>	Portrush pontoon	Rathlin pontoon	Glenarm Marina	Carrickfergus Marina	Belfast Marina
	Bangor Marina	Ringhaddy Y.C.	Whiterock Y.C.	Ballydorn Y.C.	Killyleagh Y.C.
	East Down Y.C.	Portaferry Marina	Dundrum Bay	Ardglass Marina	Ballydorn shore
	Mahee narrows	Rainey narrows			
<i>Ulva</i> sp.	Culmore Point	Dundrum Bay			

ANGIOSPERMAE					
<i>Zostera noltii</i>	Paddys Point				

APPENDIX 2

Laboratory identification of didemnid samples from Northern Ireland collected in 2012

Dr John Bishop [Marine Biological Association of the United Kingdom, Plymouth] was contracted in October 2012 to identify a number of samples of suspected *Didemnum vexillum*. The first samples were from the Rapid Marina Survey 2nd-7th September; the second set was from the intertidal survey undertaken 17th-21st September. The two reports are given here, edited to remove duplicate methodology & references, and for clarity of presentation.

REPORT 1: 2ND OCTOBER: SUMMARY

Eighteen specimens were received, of which six were sectioned and stained. Some of the specimens from Ballydorn, only, displayed the combination of characters presented in the literature for *Didemnum vexillum* (Carpet Sea Squirt). It is concluded that *D. vexillum* occurs at Ballydorn, but that its occurrence elsewhere is not substantiated.

REPORT 2: 23RD OCTOBER: SUMMARY

Seventeen specimens were received, of which eight were sectioned and stained. One sample (Whiterock, abandoned yacht) could be referred to the genus *Trididemnum*. The remaining specimens that were processed could not be scored for sufficient characters to refer them unequivocally to a genus, although *Didemnum* appeared the most likely generic assignment. Assuming they did belong to *Didemnum*, in each case unscored characters or lack of complete agreement with the expected character-states for *Didemnum vexillum* precluded a firm identification as *D. vexillum*. The specimens were strongly contracted, and generally small.

MATERIAL: 1

Eighteen didemnid colony pieces in five vials were received, as follows:

Ballydorn, 5-9-12: 8 pieces

Whiterock, 5-9-12: 2 pieces

Portaferry Marina, 6-9-12: 2 pieces

Carrickfergus, 2-9-12: 1 piece

Ardglass, 7-9-12: 2 pieces

Initial perusal of the material indicated that the specimens in a vial were not all from the same colony, and clarification was obtained from J Nunn (e-mail 26-9-2012) that the priority was to check for the occurrence of *Didemnum vexillum* at Ballydorn, Whiterock and Portaferry.

MATERIAL: 2

Seventeen didemnid colony pieces in seven vials and one pot were received, labelled as follows:

Ballydorn, shore adjacent to lightship, 17-9-12: 2 pieces

Ballydorn Quay, 17-9-12: 2 pieces

Sketrick Island, shore, 17-9-12: 2 pieces

Sketrick pontoon, 17-9-12: 2 pieces

Paddy's Point, 20-9-12: 1 piece

Rainey Narrows (pot), 21-9-12: 1 piece

Rainey Narrows (vial), 3-10-12: 3 pieces

Whiterock, abandoned yacht, 3-10-12: 4 pieces

Field photographs were provided by J Nunn from Ballydorn (shore), Sketrick rapids, Sketrick pontoon, Paddy's Point and Rainey rapids, and in some cases these could be recognised as colonies included in the samples sent.

When more than one piece was present in a container, the piece for processing was selected according to 1) its external appearance (closest similarity to the expected appearance of *D. vexillum*) and 2) suitability for hand sectioning (size, shape, substrate and absence of hard inclusions such as barnacle shells).

METHODS

In the laboratory, about 10 short vertical slices of ≤ 1 mm thickness were cut from each specimen to be processed, using a razor blade. A small piece from the colony surface was also removed and mounted on a cavity slide for inspection of spicules under the compound microscope. The slices were placed in a small plastic pot of 35% ethanol to partially rehydrate, and were shaken, which sometimes resulted in the displacement of larvae that could subsequently be gathered from the bottom of the pot. While rehydration was taking place, one or more of the sections was examined under a stereomicroscope to determine the distribution of spicules throughout the depth of the colony. The slices were all then rinsed in water and placed in 1% HCl for 1 to 1.3 h to dissolve the spicules, and then stained in Mayer's Haematoxylin (Sigma 51275, diluted x 5 with distilled water) for 20 to 30 minutes. They were then examined under water against a dark background with a stereo dissecting microscope (Leica MZ FLIII) and lighting from above, to note tunic and zooidal characteristics. If necessary, additional larvae could also be dissected from the slices at this stage.

The following characters confirmed generic assignment to *Didemnum* according to tabular keys in Monniot *et al.* (1991; revised by F. Monniot & G. Lambert in 2008 (unpublished)) and Rocha *et al.* (2012):

- Branchial basket of zooid with four rows of stigmata (excludes *Trididemnum*).
- Presence of calcareous spicules in tunic (excludes *Diplosoma*).
- Sperm duct coiled (excludes *Lissoclinum*, *Diplosoma*, *Clitella*).
- Testis with single lobe (excludes *Polysyncraton*).
- Cloacal aperture of zooids widely open, not tubular (excludes *Leptoclinides*, *Atriolum*).

Diagnostic characters of *Didemnum vexillum* Kott, 2002 were taken from Kott (2002) and Lambert (2009):

- Colonies single-coloured (beige, cream, pale orange or pale yellow), lacking distinct colour pattern.
- Zooids clumped or aggregated into small groups.
- Stellate calcareous spicules with 8-11 rays in optical section, mostly near surface of colony, sparse or absent deeper in tunic.
- Main cloacal (exhalant) channels in tunic deep, extending at least to depth of zooidal abdomens.
- Cloacal channels appearing at surface as darker (spicule-free), slightly meandering lines.
- Hypoabdominal lacunae in tunic absent.
- Sperm duct with 8-11 coils.
- Larva with 3 adhesive papillae and 6 pairs of vascular ampullae; mature unhatched larva 484-660 μ m long.

An additional character observed in previous occurrences was scored, being thought potentially relevant to the identification of *D. vexillum*:

- Contracted oral siphons of zooids marked by white spot (a concentration of calcareous spicules; shown in Lambert (2009) figure 2A&B.).

Examination of a specimen was stopped once it became apparent that an identification as *Didemnum vexillum* could definitely be excluded.

TAXONOMIC COMMENTARY

The Didemnidae have miniaturized and simplified zooids, offering relatively few readily scorable characters with distinct and unambiguous alternative states. *Didemnum* is the largest genus within the family and the second largest within the ascidians as a whole, with almost 240 named species currently regarded as valid (Sanamyan & Monniot, 2012). For many of these species, the descriptions are old and/or very incomplete. The currently accepted morphological character-set used to recognise *Didemnum vexillum*, detailed by Lambert (2009), is based on direct comparison with only seven or eight other *Didemnum* species, and there are many examples of identical or overlapping characters states even within that subset. For example, the *D. vexillum* larval 'formula' of three adhesive papillae plus six pairs of vascular ampullae is shared by five of the other entities considered by Lambert, and can also be seen in additional European species (e.g. Lafargue & Wahl, 1887). It thus seems probable that the available character-set used here does not uniquely distinguish *D. vexillum* within the entire genus.

RESULTS

SPECIMEN SET 1

The observations made are summarized in Table 1 below. Unhatched larvae recovered from the final Ballydorn specimen (processing number 6) listed in Table 1 had a mean length of 514 μm (range 495-550, n = 6), within the size range indicated by Lambert (2009) for *D. vexillum*.

The other specimens from Whiterock and Portaferry, not reported above, have grey-black colouration (not known in *D. vexillum*) and are probably *Trididemnum* sp.

Table 1. Scoring of characters in preserved didemnid samples with character states for *D. vexillum*.

	Colony						Branchial basket		Testis		Larva		Comments
	Colony single-coloured, pale	Clumping of zooids into small groups	spot	Deep cloacal channels	Cloacal channels dark (spicule-free)	Spicules stellate, most near-surface	Rows of stigmata in branchial basket	Atrial aperture widely open (not tubular)	Coils in sperm duct	Testis lobes	Pairs of vascular ampullae	Adhesive papillae	
<i>D. vexillum</i>	✓	✓	✓	✓	✓	✓	4	✓	8-11	1	6	3	Kott (2002); Lambert (2009)
Location/date/processing number													
Ballydorn, 5/9/12 2	✓	✓	✓	✓	✓	✓ *	4	?	?*	?	6	3	Could be <i>D. vexillum</i> but some characters unscorable. * spicules quite dense towards base; sperm duct is
Ballydorn, 5/9/12 3	x	x				*	3	x	10				<i>Trididemnum</i> sp. *Spicules stellate but very sparse throughout.
Ballydorn, 5/9/12 4	✓	✓	✓	✓	✓	✓	4	✓	8-9	1	?	?	Could be <i>D. vexillum</i> but some characters unscorable (larvae not seen).
Ballydorn, 5/9/12 6	✓	✓	✓	✓	✓	✓	4	✓	9-10	1	6	3	Full character set for <i>D. vexillum</i> confirmed.
Whiterock, 5/9/12 1	x	x	✓	x	x	*	3	x	7-8	1	4	3	<i>Trididemnum</i> sp. *Spicules stellate but sparse throughout.
Portaferry Marina, 5/5/12 5	✓			✓		*			8	1	4-5	2	Probably <i>Didemnum</i> sp., but not <i>D. vexillum</i> ; small colony

SPECIMENS 2:

In some cases, testes or larvae could not be found. In addition, when larvae were recovered, counts of the number of pairs of vascular ampullae were variable between individual larvae in some cases, although the observed range generally included the number (6) described in *Didemnum vexillum*. (I have previously encountered limited individual variation in counts of larval vascular ampullae in specimens believed to be *D. vexillum*.)

The specimens were in general strongly contracted, making it difficult to discern some of the diagnostic characters, particularly those of the branchial basket necessary to rule out the genera *Trididemnum* and *Leptoclinides*.

The observations made are summarized in Table 2 below. In one case (specimen 8, Whiterock, identified as *Trididemnum*) it was possible to rule out an identity of *Didemnum vexillum*. The other specimens in the Whiterock vial appeared conspecific with the processed piece.

Comments are made below on the identity of the other seven specimens, all of which could belong to the genus *Didemnum*.

1. Ballydorn shore 17/9/12. On characters scored, not possible to rule out *Leptoclinides*; if specimen is a *Didemnum*, the general distribution of spicules throughout tunic and lack of count of larval vascular ampullae cast doubt on identification as *D. vexillum*. Field photograph does suggest *D. vexillum*.
2. Ballydorn quay, 17/9/12. On characters scored, not possible to rule out *Leptoclinides*; if specimen is a *Didemnum*, general distribution of spicules throughout tunic and lack of details of larva cast doubt on identification as *D. vexillum*.
3. Sketrick shore, 17-9-12. On characters scored, not possible to rule out *Trididemnum* or *Leptoclinides* (if *Trididemnum*, certainly not conspecific with specimen 8, Whiterock). If specimen is a *Didemnum*, count of 5 pairs of larval vascular ampullae (possibly 6 in one specimen) casts doubt on identification as *D. vexillum*. Field photograph does suggest *D. vexillum*.
4. Sketrick pontoon, 17/9/12. On characters scored, not possible to rule out *Lissoclinium* or *Polysyncraton*. If specimen is a *Didemnum*, count of 5-7 pairs of larval vascular ampullae casts doubt on identification as *D. vexillum*. Field photograph does suggest *D. vexillum*.
5. Paddys Point, 20/9/12. On characters scored, not possible to rule out *Leptoclinides*; if specimen is a *Didemnum*, arrangement of zooids and water channels in tunic and lack of details of larva cast doubt on identification as *D. vexillum*. Field photographs equivocal.
6. Rainey narrows (pot) 21/9/12. On characters scored, not possible to rule out *Leptoclinides*; if specimen is a *Didemnum*, general distribution of spicules throughout tunic and count of 5 pairs of vascular ampullae in minority of larvae (6 in majority) cast doubt on identification as *D. vexillum*. Field photographs equivocal.
7. Rainey narrows (vial) 3/10/12. On characters scored, not possible to rule out *Leptoclinides*; if specimen is a *Didemnum*, unclear arrangement of zooids and water channels in tunic, low number of coils in sperm duct and range of 4-6 pairs of vascular ampullae in larvae cast doubt on identification as *D. vexillum*. Field photographs equivocal.

Several of the colonies examined were heavily colonised by a nestling mytilid bivalve, believed to be *Musculus subpictus*, and/or amphipods (*Tritaeeta* sp.) embedded in the tunic.

Table 2. Scoring of characters in preserved didemnid samples, with character states for *D. vexillum*.

	Colony						Branchial basket		Testis		Larva		Comments
	Colony single-coloured, pale	Clumping of zooids into small groups	Spot	Deep cloacal channels	Cloacal channels dark (spicule-free)	Spicules stellate, most near-surface	Rows of stigmata in branchial basket	Atrial aperture widely open (not tubular)	Coils in sperm duct	Testis lobes	Pairs of vascular ampullae	Adhesive papillae	
Location, date													
<i>D. vexillum</i>	✓	✓	✓	✓	✓	✓	4	✓	8-11	1	6	3	Kott (2002); Lambert (2009)
1. Ballydorn shore, 17/9/12	✓	✓	✓	✓	✓	*	4	?	9	1	?	3	Very few larvae, none mature. *Stellate spicules in surface layer, but also generally
2. Ballydorn quay, 17/9/12	✓	✓	✓	x*	✓	x**	4	?	10	1	?	?	No larvae. *Very thin colony (on <i>Fucus</i>). **Stellate spicules in surface layer, but also generally distributed.
3. Sketrick shore, 17-9-12	✓	✓	✓	✓	✓	✓	?	?	9-11	1	5 (-6?)	3	Branchial baskets too contracted to score.
4. Sketrick pontoon, 17/9/12	✓	✓	✓	✓	✓	✓	4	✓	?	?	5-7	3	Testes not seen. Larval count (ampullae)
5. Paddys Point, 20/9/12	✓	x	✓	x	x	✓	4	?	9	1	?	?	No larvae.
6. Rainey narrows (pot), 21/9/12	✓	✓	✓	✓	✓	x*	4	?	9	1	5-6	3	Larval count variable (6 pairs commonest). *Stellate spicules in surface layer, but also generally
7. Rainey narrows (vial), 3/10/12	✓	not clear	✓	✓	not clear	✓	4	?	7-8	1	4-6	3	Larval count variable.
8. Whiterock yacht, 3/10/12	x	x	x	x	x	x*	3	x**	Not scored		4**	3	<i>Trididemnum</i> sp. *Spicules stellate but generally distributed; ** Narrow 'spout' present

REFERENCES

- Kott, P. 2002. A complex didemnid ascidian from Whangamata, New Zealand. *Journal of the Marine Biological Association of the United Kingdom* **82**, 625-628
- Lafargue, F. & Wahl, M. 1987. The didemnid ascidian fauna of France. *Annales de l'Institut Oceanographique* **63**, 1-46
- Lambert G. 2009. Adventures of a sea squirt sleuth: unravelling the identity of *Didemnum vexillum*, a global ascidian invader. *Aquatic Invasions* **4**: 5-28
- Monniot C., Monniot F. & Laboute P. 1991. Coral Reef Ascidiaceans of New Caledonia. ORSTOM, Paris, 248 pp.
- Rocha, R., Zanata, T. & Moreno, T. 2012. Keys for the identification of families and genera of Atlantic shallow water ascidians. *Biota Neotropica* **12**, 269-303
- Sanamyan, K. & Monniot, C. 2012. *Didemnum* Savigny, 1816. In: Shenkar N., Gittenberger A., Lambert G., Rius M., Moreira Da Rocha M., Swalla B.J., Turon X. (2012) Ascidiacea World Database. Accessed through: World Register of Marine Species on 2nd October 2012 at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=103456>



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