

# Recommendations for Reducing the Rate of Spread and Potential Re-Invasion of *Didemnum vexillum*

## Executive summary and priority actions

In 2009 the GB *Didemnum vexillum* Working Group was set up to help coordinate and advise on the response to the invasive non-native seasquirt *D. vexillum* or Carpet Sea-squirt in Great Britain. As it is not considered feasible to fully eradicate this species from GB, the group agreed to produce recommendations to help reduce its rate of spread and re-invasion. This report should be considered advice from the working group to the GB Programme Board for Non-native Species.

Five potential pathways (recreational boating, fisheries / aquaculture, ship recycling, marine industries and commercial shipping (ballast and hull fouling)) were assessed. For each pathway the group considered whether adequate management was in place to control the spread/introduction of this species and if not, provided recommendations for improvement.

The recommendations of this report are specific to *D. vexillum*; however they are applicable across a broader range of marine Invasive Non-native Species (INNS). The working group suggests that this report could be the basis of a broader review of marine pathway management options.

Key recommendations, both specific and cross-cutting, are summarised below.

## Recreational boating

Increasing awareness along this pathway, combined with providing further guidance on how to respond and facilities for better biosecurity within marinas, are considered priorities. Educating the sector and providing them with the tools to address the issue through behaviour change is advocated as the way forward; a carrot rather than stick approach is likely to be more successful.

Priority recommendations:

- Develop basic biosecurity advice for boat owners and marinas, including simple boat and kit cleaning measures.
- Higher levels of biosecurity, such as disinfection berths should be implemented in areas with known *D. vexillum* populations.
- Provide a clear strategy for disseminating biosecurity guidance to all relevant stakeholders, including relevant awareness raising materials.
- Develop an email (and website) network for the delivery of new information.

- Make clear who the government point of contact is for local stakeholders to discuss concerns and report sightings (e.g. local statutory nature conservation organisation).
- Facilitate provision of closed loop wash down systems in priority marinas / yacht clubs.
- Work with colleagues in Europe to encourage similar biosecurity and awareness raising in priority areas.

## **Fisheries/Aquaculture**

Although there has been some recognition from parts of the fishing industry that marine non-native species are a relevant issue for them this does not appear to be the case across the sector.

Priority recommendations:

- Best practice biosecurity guidelines relating to *D. vexillum* are needed along with awareness raising of the risks to the industry should *D. vexillum* spread.
- More use of licence conditions and management plans need to be made.
- At an international level, we need to build on the protocols and links we already have with the ROI in relation to INNS biosecurity.

## **Ship recycling**

The UK Government is keen to develop ship recycling capacity in UK and has incorporated the IMO guidelines on ship recycling into a DEFRA Ship Recycling Strategy. This includes INNS and harmful aquatic organisms in the list of materials for which recycling facilities must have adequate management and mitigation procedures.

Although the issue of the risk of transporting / spreading INNS during ship recycling is recognised by both UK and International regulations, recent cases in the UK have highlighted a number of issues in terms of the short time regulators are given to assess the risks posed by such vessels, a lack of knowledge of *D. vexillum* shown by contractors carrying out INNS risk assessments / surveys and an attitude that if a non-native is already in UK waters then there is no need to remove it from vessels coming to the UK for recycling.

Priority recommendations:

- All ships coming to UK shipyards for recycling should be surveyed for INNS and cleaned prior to movement to their final destination.
- Awareness of the issues should be improved, for example through the Marine Industries Liaison Council.
- Further guidance should be provided for regulators to improve their understanding of INNS issues associated with ship recycling and how to manage them.

## **Marine industries (oil, gas, renewable and dredging)**

Priority recommendations:

- Assess uptake of existing general INNS guidance and encourage uptake if found to be lacking.
- Encourage similar guidance to be developed for all marine industries (not just oil and gas), e.g. offshore renewables
- Consider existing regulatory mechanisms to help enforce good practice if voluntary mechanisms are unsuccessful.

## **Shipping - Ballast water and biofouling**

Measures to control both of these pathways are already being considered by the International Maritime Organisation (IMO). These measures, including the development of biosecurity guidance, should be supported by GB.

## **Cross cutting issues**

There are a number of key themes which cut across the recommendations:

- Awareness levels are low and non-native species specific biosecurity is not well embedded. A significant awareness raising campaign with support from NGOs and industry is recommended (similar to Be Plant Wise) to address this.
- Partnership working is essential, particularly in relation to developing voluntary guidance.
- A better network of communication, utilising existing networks such as those of the Green Blue, should be developed through which information on existing and emerging issues can be exchanged with stakeholders.
- Existing guidance on biosecurity and pathway management for this species (e.g. from Australia and New Zealand) should be reviewed and used to help form the basis of GB guidance.
- Further research to understand factors effecting *D.vexillum* spread via each of the pathways covered in this paper is needed to enable more effective prioritisation and management of this INNS.
- As part of pathway management some targeted eradication is recommended in areas where this will significantly reduce the spread of *D.vexillum*.

## 1. Background

*Didemnum vexillum*, an invasive non-native marine tunicate, is present in one location in both Scotland and Wales and five locations on the south-coast of England. In Wales an eradication programme is ongoing to remove the infestation from Holyhead Marina. Eradication in Scotland and England is unlikely to be feasible.

Regardless of what action is taken (or not) to eradicate this species in England, Wales and Scotland it is considered necessary to consider pathway management to limit further spread and re-invasion.

In 2009 the GB *D. vexillum* Working Group was set up to help coordinate and advise on the GB response to this species. Given the potential difficulties of eradication in GB the Working Group consider pathway management a high priority to prevent further introduction and spread of this species. In developing these suggestions for improving pathway management the group was aware that for some pathways (e.g. ballast water) measures are already in place to manage the spread/introduction of *D.vexillum*. This report, or gap analysis, sets out the management for those pathways where measures are thought to be lacking.

## 2. Aims of Pathway Management

The pathways mostly likely to facilitate further introduction and spread of *D. vexillum* have been identified by the Working Group (Table 2.1).

*Table 2.1 Risks posed by pathways of D. vexillum introduction and spread in GB.*

Pathway	Risk of spread within GB	Risk of invasion from outside GB
Recreational boat users	high	high
Aquaculture/Fisheries	high	medium
Ship recycling	medium	low
Marine Industries	medium	low
Shipping	low	medium

The aim of pathway management is to:

- protect un-invaded habitats, particularly in areas closest to existing *D. vexillum* populations or with a direct pathway link;
- ensure eradication efforts are more sustainable by reducing the risk of re-invasion from existing GB populations;
- reduce the risk of new invasions from areas outside of GB;
- reduce the risk of *D. vexillum* being spread from GB to other countries.

### **3. Role of the GB Working Group for *D. vexillum* and Purpose of this Document**

The GB Working Group for *D. vexillum* was set up shortly after the initial finding of this species in Holyhead marina. It comprises relevant individuals from government, academia and industry and was set up to help provide a more coordinated approach to this species across England, Scotland and Wales. The Terms of Reference and membership of this group are presented in Appendix 1.

Drawing on the expertise of Working Group members, this document identifies relevant pathways along which *D. vexillum* could be spread or introduced, identifies some of the gaps in existing management and provides recommendations for improvement. A summary of the main recommendations is presented in Section 6 with detailed consideration provided in Section 7.

This status of this paper should be considered as advice from the GB Working Group for *D. vexillum* to the GB Programme Board. There is no commitment of funding to deliver the recommendations of this report, however it is hoped that these recommendations will be taken into consideration should funding become available.

### **4. Developing a broader Marine Pathway Management Plan**

Given the terms of reference of this group the recommendations of this report are specific to *D. vexillum*. However it is clear that recommendations made would be of broad benefit across many non-native taxa and not just this species. The group suggest that this report could be the basis of a broader review of marine pathway management options.

### **5. The Biology and Ecology of *D. vexillum***

*D. vexillum* is an invasive non native sea squirt with rapid growth and mat-forming capabilities that colonises artificial and natural hard substrata. The species is robust and can tolerate a wide range of environmental conditions, although it appears to be intolerant of low salinity conditions. *D. vexillum* has been reported in temperate waters worldwide including North America, New Zealand and Australia.

Sexual reproduction: Larvae are brooded within the tunic and when released swim for a short period before finding and attaching to a suitable substrate. It is assumed that like other didemnids larvae are competent to settle upon release and that maximum duration of the larval stage is in the region of a few hours (Kott 2002; Valentine et al 2009). The release of larvae, and hence the period of settlement and recruitment occurs during warmer periods. Valentine

et al (2009) observed recruitment at 3 different sites in New England at differing temperatures but generally between 14 and 20C (although with some recruitment as low as 9C). Observations made at Holyhead marina in 2009 show recruitment occurred from August to early December at water temperatures between 16 and 9C (Jenkins et al 2010). Recruitment was predominantly near the surface, but occurred down to 2m depth.

Asexual reproduction : *D. vexillum* reproduces asexually by budding to expand colony size. Optimal asexual growth occurs at temperatures between 14-18°C, although growth can occur between 11°C and 25°C. Rapid growth through budding of zooids can produce large mats (e.g. Lengyel et al 2009) or pendulous growths. Fragments of colonies can reattach and grow, and serve to spread the species to new locations.

*D. vexillum* has the potential to disperse naturally by larval release or fragmentation from adult colonies . The short duration of the larval phase means that dispersion through this means is likely only to occur at a very local scale. Thus the very localised colonisation of the marina and one other location within Holyhead harbour despite a healthy and abundant adult population is no doubt a function of limited dispersal. In many species of tunicates the tadpole larvae typically disperse only a few metres (e.g. Davis and Butler 1989) although dispersal distances are presumably lengthened considerably in areas of strong tidal flow.

More considerable natural dispersal may occur through the spread of detached fragments of colonies either in water currents or attached to the bodies of mobile animals. This risk becomes even more apparent when the colony develops to the large pendulous stage (Kleeman 2009). The following extract from Kleeman (2009) describes this process:

*'There are anecdotal reports of divers observing lobes breaking off substrates and becoming lodged on surrounding substrata, reattaching and over the course of several months thriving in their new locations. It has been observed that during suspension, fragments adapt to the water habitat by changing their gross morphology into spheres (Carman, 2008) and that 60% of fragments are capable of surviving suspension for 18 days while 15% can survive in suspension for 30 days. Furthermore, Bullard et al. (2007) found that fragments can re-attach within six hours after being in contact with the substrate. Thus, fragments are viable for a considerable amount of time and may tolerate being transported great distances before settling and reattaching. Dispersal via fragmentation may have two significant advantages. First, reattached lobe fragments may be less susceptible to competition or predation than small newly settled larvae. Second, brooded larvae contained in fragments could be released before or after reattachment and further increase dispersal capability. It has been suggested that the widespread distribution of *D. vexillum* in Georges Bank may be a result of the constant disturbance and fragmentation by scallop dredging operations, resulting in colony fragments floating away and reattaching (Lengyel et al., 2009).'*

In terms of the role of pathway management in considering natural dispersal, the following issues are worthy of consideration:

Environmental conditions (temperature, salinity, depth, substrata) which promote the development of a healthy population of *D. vexillum* clearly provide the springboard from which natural dispersal can occur. Dispersal via fragmentation will be facilitated by environmental conditions which promote the pendulous growth form. It is not currently clear what such conditions are (or indeed whether development of this growth form is environmentally mediated).

Dispersal via larvae or fragments will be enhanced in areas of high tidal flow.

*D. vexillum* typically grows subtidally on artificial and natural hard substrata (including rock outcrops and mixed substrata - pebbles, cobbles and boulders) and shallow intertidal rock pools. Thus natural dispersal will be largely influenced by the availability of hard substrata.

Active growth, reproduction and recruitment occur in the warmer summer and autumnal months. This is the period during which natural dispersal is expected. Colonies may die back considerably in cold conditions.

There are no reports of rafting by *D. vexillum* or hitchhiking on other organisms, although it has been found on seagrass (Carman and Grunden 2010) so there is the potential for it to be dispersed via this pathway.

The detachment of fragments of *D. vexillum* (for example through fishing disturbance) will promote dispersal of the species in areas where current flow is sufficiently high.

## **6. Summary of Specific Recommendations**

The working group has summarised specific recommendations and where possible provided rough estimates of their cost in Table 6.1.

It is envisaged that a wide range of organisations, both government and non-government, would be involved in implementing and funding these recommendations. Some recommendations relate to ways of working or small, quick win, pieces of work that could be undertaken by organisations within their existing roles and responsibilities. Other recommendations would require specific funding.

A large scale multi factorial project aimed at improving awareness, commissioning research, undertaking targeted eradication, developing biosecurity and pathway management in the marine environment is recommended by the working group. This would help deliver many of these specific recommendations in this report and could include measures to encompass a wider range of marine non-native species.



Table 6.1 Summary of recommendations for reducing the rate of spread and re-invasion of *D. vexillum* in GB.

Recreational Boating and Diving				
	Objectives	Recommendations	Priority	Indicative Cost Estimate
Awareness raising and behaviour change	<p>Improve understanding of and need for better biosecurity.</p> <p>Encourage early identification of new populations.</p> <p>Improve up take of appropriate cleaning.</p>	Consolidate and maximise the use of existing guidance and information (e.g. Green Blue and RYA material), develop additional materials in partnership if necessary.	High	<p>Total: £50-100k pa (+ £10-15k per marina for closed loop wash down system)</p>
		Disseminate information to relevant stakeholders .	High	
		Develop and roll out simple, clear guidance for appropriate cleaning for boat owners and marina operators.	Med	
		Encourage the inclusion of INNS in RYA and BMF training courses.	Med	
		Provide key points of contact at NE / CCW /SNH / SAMS to provide guidance to stakeholders.	High	
		Establish ID service to confirm species records e.g. through MBA.	High	
Facilitate provision of closed loop wash down systems in priority marinas / yacht clubs (details in Appendix 4).	Hlgh			
Planning	Reduce the rate of marina infection and provide easier control within	Develop guidance for planners and others on better marina design with regards biosecurity.	Med	<p>Total: £25-30k</p>
		Build biosecurity aspects into environmental accreditation schemes (e.g. Blue Flag see 7.1 for further examples).	High	

	infected marinas.			
International Cooperation	Share responsibility where relevant with European partners.  Improve biosecurity in high risk areas.	Identify key marinas at risk of acting as an invasion source for GB.  Make key contacts relevant to each high risk marina.  Share awareness raising materials and attempt to agree appropriate controls.	Med  Med  Med	Total: £25k
<b>Fisheries</b>				
	<b>Objective</b>	<b>Recommendations</b>	<b>Priority</b>	<b>Indicative Cost Estimate</b>
Awareness raising and behaviour change	Increase the up-take of good practice and discourage high risk activities.	Develop sector specific guidance on good practice / biosecurity for fisheries activities in partnership with relevant organisations.  Disseminate key messages through appropriate media (e.g. posters, leaflets, newsletters, websites etc).  Provide guidance and materials for regulators to encourage good practice.	High  High	Total: £50-100k
Policy and enforcement	Required if voluntary arrangements are insufficient	If necessary, review whether existing licensing and permit conditions can be used to encourage good practice and provide guidance for this to regulators.	Low	Total: £5-10k
International cooperation	Encourage uptake of good practice beyond GB and reduce the risk of INNS entering or	Identify and share information with relevant counterparts outside of GB.	Med	Total: £20k

	leaving GB.			
<b>Ship Recycling</b>				
	<b>Objective</b>	<b>Recommendations</b>	<b>Priority</b>	<b>Indicative Cost Estimate</b>
Awareness raising, behaviour change and enforcement	Support responsible approaches to ship recycling through better understanding of INNS issues.	<p>Input into existing initiatives (e.g. MILC).</p> <p>Develop clear guidance, with relevant partners, on risks associated with INNS and ship recycling, including key messages about good practice.</p> <p>Review policy / regulation for ship recycling and develop clear guidance on how it should be used.</p> <p>Disseminate guidance for regulators (e.g. through training) on how to respond to INNS issues associated with ship recycling.</p> <p>Conduct research on sustainable methods for decontaminating large vessels and best methods for preventing spread of INNS</p>	<p>Med</p> <p>Med</p> <p>Med</p> <p>High</p> <p>Med</p>	Total: £150k
International cooperation	Improve adoption of good practice beyond GB.	Work with the IMO to raise awareness of the issue of INNS and ship recycling and incorporate into any future guidance.	Low	Total: £20k
<b>Marine Industries</b>				
	<b>Objective</b>	<b>Recommendations</b>	<b>Priority</b>	<b>Indicative Cost Estimate</b>
Awareness raising and Behaviour Change	Raise awareness across all relevant industries.	Work with partners to develop general guidance for all industries use existing information (e.g. oil and gas guidance document). Encourage uptake among industries.	Med-Low	Total: £100k

		Where relevant, provide additional awareness raising materials (including information for websites and for workshop / presentations).  Conduct research to establish that the introduction of fixed and hard substrates do provide suitable substrates for INNS and if so, how to best control for the spread of INNS via these structures.	Med	
Policy, enforcement and international cooperation	Use of existing regulation to raise awareness of INNS and the risk and input into new developments.	Identify and input into existing policy initiatives (e.g. UK Marine Policy Statements).  Develop and disseminate (including through training) guidance for regulators on INNS issues associated with marine industry.	NA  High	Total: £15-20k
<b>Shipping</b>				
	<b>Objective</b>	<b>Recommendations</b>	<b>Priority</b>	<b>Indicative Cost Estimate</b>
Ballast	Utilise existing measures, i.e. Ballast Water Management Convention (IMO, 2004).	No action necessary – monitor and engage with existing provision.  Ratification expected shortly.	NA	NA
Biofouling	Utilise existing measures, i.e. draft guidelines being developed by IMO.	No action necessary – monitor and engage with existing provision.  Guidance expected to be agreed 2011.	NA	NA

## 7. Detailed Guidance on Managing Potential Pathways of Spread and Introduction

### 7.1 Recreational Boating

#### Background

To date much of the work on invasive species within this sector has been bound up within guidance related to anti-fouling and not specifically targeted at any one species. Although awareness INNS has been raised for inland waterways and freshwater plant species in particular, the subject of marine INNS is less publicised. As with shipping, much work in this area has already been done in New Zealand and Australia and much can be learnt from them. Within the forthcoming International Maritime Organization (IMO) draft guidelines for reducing the risk of introducing non-native species via biofouling, recreational boating is covered in a separate annex. Although this pathway management plan sets out suggestions for managing this vector from a UK perspective it is important to realise that the adoption of IMO guidelines will carry with it certain obligations that will be placed upon the recreational boating sector in relation to biofouling. It is worth therefore bearing in mind the pertinent aspects of the draft IMO guidelines when drawing up this pathway management plan.

#### Potential pathways of spread and introduction

INNS are spread by recreational boating through biofouling on the hull. This is commonly controlled by the application of antifoulant. Historically the main ingredients in biocidal antifouling coatings have been copper or tributyltin (TBT). However, the environmental impacts of TBT were considered significant and led to a ban for recreational boat use (vessels under 25m) in 1987. Since then the majority of antifoulants have been copper based, in which the main biocide is cuprous oxide, which is toxic to marine life, thereby stopping the build up of organic fouling.

However, evidence suggests that many INNS still arrive in the UK via the hulls of recreational craft and *D. vexillum* is one such species (Griffith et al., 2009, Herborg et al., 2009). Those vessels that are used infrequently and therefore spend long periods of time stationary in marinas or on moorings are most likely to act as a vector for *D. vexillum*. This problem is obviously exacerbated in cases where *D. vexillum* becomes widespread within a particular area because the colonisation of underwater infrastructure provides a stepping stone for the non-native species to settle on relatively well maintained vessels with increased ease.

The role of pontoon and other marina infrastructure in the spread of non-native invasive species is also of importance. The submerged portions of pontoon floats provide extensive attachment surfaces, often heavily colonised by algal and sessile animal populations which can act as major sources of and

receive immigrants from recreational boat hulls. Management of pontoons appears to differ widely; in some marinas they seem to be left in place for years until they require replacement, while other sites have a cycle of lifting pontoons for cleaning and maintenance.

In addition, pontoons can be towed from place to place and in some cases are moved quite frequently; this could also be a significant agent of local and regional spread of non-native species.

### Awareness raising

In recent years increasing efforts have been made by the Royal Yachting Association (RYA) and the British Marine Federation (BMF) to improve awareness of environmental issues in general in the recreational boating sector, including the problems associated with biofouling and INNS. Over the past 5 years, this has been achieved through The Green Blue Project, the joint environmental programme funded by the RYA and the BMF. To date awareness raising has taken the form of factsheets, guidance on best practice, features in magazines and on the internet and face-to-face interaction through events or structured meetings. Whilst some work has been done on biofouling so far it has not been tackled as a priority work area. Quite a lot of material is available related to antifouling and it will be necessary to link in with this existing guidance to provide continuity for end users. Recent observations by the Marine Biological Association has highlighted the importance of drawing attention to the potential for 'niche sites' to house INNS e.g. the lower-edge of the keel, the propeller/prop shaft region (and trim tabs of motor cruisers).

As The Green Blue has been in existence for 5 years now its reputation is well established within the sector and as such could act as an excellent platform and conduit through which to raise awareness of INNS in general and *D. vexillum* in particular.

It may be necessary to produce new, up-to-date material for dissemination and both the RYA and the BMF should raise awareness separately through their individual organisations to raise the profile of INNS and *D. vexillum* with their members. Both organisations have a wealth of publicity tools at their disposal which could be used to increase awareness and understanding of the issues. For example, the RYA publishes a quarterly magazine for its members and the autumn edition will feature an article on *D. vexillum*.

Both the RYA and the BMF provide training courses for its members and the wider recreational boating community. There may be opportunity for inclusion of biofouling issues within the syllabi of some courses. It is unlikely that this would focus on any one species but more generally on the impacts of biofouling for boat performance and the marine environment. The Green Blue already has some input into certain qualification courses run by the RYA although it is minimal. However, there is no reason why this could not be explored further as an awareness raising option.

A number of environmental accreditation schemes are already in existence for marina operators e.g. Blue Flag, Green Dragon, The Yacht Harbour Association (TYHA) Gold Anchor, and there may be scope to build in criteria relevant to INNS to such certification procedures. The Blue Flag scheme has widespread success in Europe but less so in the UK however could still potentially be a route through which to achieve international consistency. TYHA is in the process of rewriting its Gold Anchor scheme and as The Green Blue is providing advice to TYHA in drafting the new criteria there is definitely scope for building INNS into the revamped scheme.

Any materials that are produced to raise awareness must be industry focussed and translate to actions on the ground i.e. what do they need to do? Where can they find more information? It is also imperative that any awareness raising effort extends across all of the UK with buy in from at least the key organisations working in the sector e.g. RYA, BMF, SBA, ISA, TYHA. In other words the message must be the same wherever or however end users receive it.

Discussion has taken place regarding the potential prioritisation of marinas/facilities to be contacted in relation to *D. vexillum*. This raises some difficulties in establishing a blanket approach i.e. in England, Scotland, Wales and N Ireland different priorities will apply. Furthermore, although improving, the current understanding of the distribution of *D. vexillum* around the UK is patchy and therefore any priority list that is drawn up may quickly become out of date. A suggested starting point therefore would be to compile a list of all facilities/marinas around the UK and contact them all initially with the same general messages, with more focussed efforts being auctioned as necessary. This will also help to manage any 'why me and not them' feelings that could otherwise be introduced.

When seeking to influence the recreational boating sector it is important to recognise that any recommended action/biosecurity rule must be applicable to all marina operators/boatyards, particularly if there is a cost involved to either the operator or the end user. If this is not the case then it could potentially represent a business disadvantage and buy in will be extremely difficult to secure.

Any guidance that is produced must be backed up with an information portal (either online or by telephone) where people can go and find more detailed answers to questions they may have, for example:

- What radius from an infection site is considered to be at risk?
- What physical factors will prevent the spread of *D. vexillum* in particular?

Where clean up is decided to be the route forward then the funding route must be identified in advance to avoid confusion. People may be reluctant to report the presence of *D. vexillum* if they know that clean up of their facilities will be

at their own cost, particularly if they are a small business with limited resources. This is an important factor that must be communicated with any awareness raising that takes place.

The use of public media e.g. newspapers, magazines etc to raise awareness and spread key messages must be carefully worded such that it does not have an adverse impact on any individual operators; such 'bad press' will not encourage reporting/communication of the presence of *D. vexillum* which is so important for understanding the risk that this management plan seeks to manage.

### Behaviour change

When seeking to change behaviour it is important to realise that most recreational boaters make decisions related to boat maintenance based on cost, location and availability. The fiscal implications of any proposed changes will also be the deciding factor for marinas and boatyards. In order for behavioural change to take place therefore it must be easy and cost efficient. Closed loop wash down systems (with disposal of any waste to landfill) are the best way to ensure that hulls are cleaned in such a way that no material is released back into the environment. Presently there are very few of these around the UK as they are relatively expensive to install. In addition as businesses recoup the cost of installation by charging more for the service, they are not heavily used. If a boat owner is faced with the option of paying more for a closed loop wash down or something cheaper but less environmentally friendly a short distance away they are more than likely to opt for the latter. The reality is therefore that the majority of boat hulls are cleaned in such a way that at least some material ends up back in the sea.

One suggestion to encourage behavioural change from the business side of the sector is therefore to facilitate the provision of closed loop wash down systems through, for example, funding for the capital works/subsidising the service once it is installed. If the service can be offered more widely and at a comparative cost to less contained cleaning methods then not only will more marinas/boatyards be able to install them but many more boat owners will make use of them. Furthermore, if funding is targeted at marinas/yacht clubs where *D. vexillum* is known to be present then it represents a benefit for businesses in reporting the presence of *D. vexillum*. This will encourage more people to come forward and thus improve the distribution data for the UK.

Behavioural change for the end user can be further facilitated through awareness raising, particularly through the provision of guidance that educates the recreational boat user on the best methods of hull cleaning and antifoul use for controlling the spread of *D. vexillum*. This guidance should be user friendly and clear, containing information on how to clean your hull, where to dispose of the waste, the best time of year to do it and why it is important. This guidance should be distributed as widely as possible throughout the sector. The Green Blue Project has produced some useful material to date that could be easily updated and then used to assist with this.



The guidance should include detail to cover what sort of antifoul is best to prevent re-attaching (toxic/non-toxic/booster biocide/booster biocide free) and some sort of guide as to which type of recreational boater is more likely to be at risk and why e.g. keel boats (regular use, slow speeds), power boats (used less frequently and move long distances at speed) or dinghies (bilge water, trailer movement issues etc); the importance of inspecting mooring stock should also be included.

Once people understand why they need to change their behaviour and the best way how, they need to have access to the facilities that allow them to carry through this behavioural change. It is therefore important that both ends of the 'behavioural change' issue are addressed. In short, if it is easy, people will do it.

### Planning

The draft IMO guidelines that are being drawn up are likely to be the main basis for any new planning legislation that may/may not be developed in relation to biofouling. However the guidelines will be voluntary at first and with suitable awareness raising and guidance formal planning legislation should be unnecessary.

It might be useful to explore the idea of producing guidance on marina design that encourages better biosecurity in general. Some work has been done on this in New Zealand/Australia and an overnight 'quarantine' system is being considered in Holyhead Harbour. Research into the best materials to use that may discourage settlement of INNS and *D. vexillum* in particular could be drawn upon or signposted to marina designers, along with any practical ways of minimising the risk of spread around the marina through design.

Another way of encouraging biosecurity to be a consideration in marina planning is through recognition of certain facilities in environmental accreditation schemes e.g. TYHA Golden Anchor. Improving awareness of environmental accreditation schemes in general and more specifically biosecurity aspects of it should encourage marina operators to consider INNS control in their design. Increased publicity of such environmental accreditation schemes and associated buy-in by the end user will also encourage marina operators to want to be involved as it should represent a business benefit.

### International cooperation

International liaison is a hugely important aspect of this PMP. Until such time that the draft IMO guidelines are being followed by every country it is important that international cooperation can be achieved in other ways. If, for example, all UK marinas and recreational boat owners work hard to manage *D. vexillum* around their coastline but the same measures are not being taken in France or the Netherlands, the chances are that a visiting yacht will bring *D. vexillum* back into a recently cleaned marina.

Suitable contacts should be identified in each country, particularly those from which recreational vessels frequently cruise across to the UK e.g. France, Netherlands, Scandinavia. Sharing of information and resources should be undertaken and an attempt to ensure uniformity of measures should be made. At the very least, routes by which the management techniques in place in the UK can be communicated to potential visitors should be found. This issue should be approached from both sides, ensuring those boats returning to the UK from overseas are contacted i.e. key marinas/ports can be targeted based on information held in the UK on areas that are 'most visited' (the RYA cruising atlas may be able to help inform this).

A number of European organisations already exist that could help to raise the profile of *D. vexillum* and INNS in general. The RYA performs the secretariat role for the European Boating Association (the association for recreational boaters across Europe) and the BMF has direct contact with the European Boating Industries (the association for boating industries across Europe). Both these organisations meet regularly and have corresponding activities in-between whiles thereby providing a good opportunity for raising awareness across Europe.

PIANC (The World Association for Waterborne Transport Infrastructure) is in the process of setting up an EU working group looking at 'Environmental Impact Aspects of Recreational Navigation Infrastructure' which is essentially tasked with looking into sustainable and environmentally friendly marina design. Although the 'findings' of this group will not be published for some time (likely 12 month timescale) it would be useful to ensure biosecurity is considered in their work. Both the RYA and the BMF have been approached to be a part of this working group and at the very least could be a corresponding member with the ability to contribute to the study and its outcomes.

## 7.2 Fisheries/Aquaculture

### Background

The following fishery activities are considered to be potential pathways for the spread and / or introduction of *D. vexillum*:

- Shellfish cultivation (both intertidal and subtidal). *D. vexillum* could be transported with aquaculture stock. This may result in spread around GB or introduction from outside of GB. Recent evidence from Ireland (pers. com. John Kelly) suggests that the movement of farmed oysters may be the source of the latest *D. vexillum* infestation on the west coast of Ireland.
- Bottom trawling. Debris from the sea floor is moved and dumped by bottom trawling and may take with it INNS, including *D. vexillum*. This has been a significant pathway for the spread of *Crepidula fornicata* and could be for *D. vexillum*.
- Other fisheries such as recreational, line, pot, net, etc. These may facilitate the spread of *D. vexillum*, particularly through contaminated equipment. However, as this equipment is not often stationary in the water for long and is often removed from the water and dried it is not considered a high risk pathway.
- Shellfish processing. Poor biosecurity within shellfish processing plants where live material is often discharged back into the environment could lead to significant problems with the transfer of *D. vexillum* both within and between countries. This has been a significant pathway for the spread of other INNS.

There may be a small risk from contaminated nets, pots and ropes but simple biosecurity measures such as thoroughly drying gear after use should mean that the risk is very small. Pots that are lifted and dropped again within a short period of time (up to two hours) in another area may be a small risk. Also beach set nets that may be moved to another bay or estuary and reset on the same tide may cause a small risk.

### Potential pathways

The pathways associated with different types of fishery are shown in Table 1.

Many marine fisheries rely on vessels, which may spread *D. vexillum*, for example through hull fouling and ballast water. These issues are addressed in other chapters and are not considered here.

*Table 1: Potential pathways relevant to fisheries and their likely risk level*

Potential Pathway	Shellfisheries	Bottom trawling Fisheries	Other
Vessel biofouling	✓	✓	✓
Net biofouling		✓	✓
Bottom trawling bycatch and discard to other areas		✓	
Movement of stock to other areas	✓		✓
Spread via processing plants	✓		✓
Use of fixed structures such as ropes and trestles	✓		✓

### Behaviour Change

Desirable behaviour change includes reducing the practice of activities considered most likely to cause spread and encouraging better biosecurity.

Examples of high risk activities are suggested below. It is recommended that a complete list is developed in partnership with stakeholders:

- Shellfish fisheries reducing the risk of *D. vexillum* in aquaculture stock
- Recreational fishermen preventing the spread of live-bait.

There are already biosecurity measures used by some parts of the fishing industry, to reduce the risk of spreading disease in particular. It is recommended that biosecurity guidance should be developed in partnership with the industry and take into consideration existing biosecurity measures.

There are examples of non-native species biosecurity practice in Great Britain, for example in response to *Crepidula fornicata* in the Menai Strait. Where possible the lessons learnt from these experiences should be included in the development of guidance.

In other countries such as Australia and New Zealand there are also guidelines, protocols and restrictions on the movement of shellfish for example ([www.nt.gov.au/d/Fisheries/index.cfm?header=Vessel%20Inspections](http://www.nt.gov.au/d/Fisheries/index.cfm?header=Vessel%20Inspections)) and there are national bio-fouling guidelines for fishing vessels ([www.marinepests.gov.au/fishing](http://www.marinepests.gov.au/fishing), Appendix 2). These should be used to help develop guidance within GB.

Where possible a non-regulatory approach is preferred to avoid placing additional burdens on business, however some regulation may need to be considered.

### Awareness Raising

Awareness of the potential to spread *D. vexillum* through fishery activities is considered likely to be low, although a number of fisheries will have biosecurity measures relating to disease.

Raising awareness could be used to:

- Alert those involved in fisheries to the issues and risks posed by *D. vexillum*.
- Encourage those involved in fisheries activity to consider the risk of spreading INNS when undertaking work.
- Encourage identification and reporting of *D. vexillum*.
- Encourage active engagement and partnerships to facilitate behaviour change.

It is likely that many approaches to raising awareness of *D. vexillum* will be equally applicable to other marine non-natives. Therefore, where appropriate, it would be prudent to develop more general INNS awareness raising tools. Any materials should be developed in partnership with key industry bodies. This will facilitate acceptance of the messages by individuals working in the sector. The consequence of reporting INNS will be a concern of operators and should be discussed and resolved in cooperation with them.

### International Cooperation

Significant populations of *D. vexillum* occur elsewhere in Europe, particularly Ireland and France. The transfer of species for aquaculture poses a risk. Cooperation with Ireland over the movements of shellfish in relation to slipper limpets is already happening. However bio-security measures would have to be developed for *D. vexillum* to work alongside current practices.

The movement of shellfish, regarding animal health conditions and certification requirements for placing on the market (intra-community trade) within the EU, is regulated through Commission Regulation 1251/2008. The Fish Health Inspectorate at Cefas control these movements in and out of GB.

The movements of shellfish for processing and relaying within Europe are not, in terms of INNS currently regulated. However some member states (eg Holland) now require certificates listing all known species in the area of the shell fishery before allowing shipments into the country.

### Research

Currently there is a lack of scientific evidence about the risks of spread via fisheries activities. Rope, cage and trestle culture, the dispersal of colonies via catch discards from bottom trawlers and shellfish movements would appear to pose the greatest risk in terms of *D. vexillum* and other INNS spread and research should be directed to these fields.

## 7.3 Ship Recycling

### Background

The risks of introduction of INNS to GB waters posed by ballast water and biofouling have already been outlined in this document and this also applies to vessels coming to UK shipyards for recycling. At the international level, it is estimated that due to the International Maritime Organization's (IMO) decision to phase out single-hulled tankers, by 2010 approximately 400 EU-flagged tankers will require recycling.

At the end of November 2005, the IMO's General Assembly adopted a Resolution to develop a new mandatory instrument on ship recycling and 'The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009', was adopted in May 2009.

The resolution is aimed at ensuring that ships, when being recycled after reaching the end of their operational lives, do not pose any unnecessary risk to human health and safety or to the environment. Regulations in the new Convention cover: the design, construction, operation and preparation of ships so as to facilitate safe and environmentally sound recycling, the operation of ship recycling facilities in a safe and environmentally sound manner; and the establishment of an appropriate enforcement mechanism for ship recycling, incorporating certification and reporting requirements.

Defra are committed to the development of a UK Ship Recycling Strategy (Defra, 2007). The Strategy builds on the 'IMO Ship Recycling guidelines, 2003' and establishes domestic policy for the recycling of UK Government-owned vessels, sets out relevant waste controls and recommendations for owners and operators of UK-flagged vessels and provides guidance to those wishing to recycle ships in the UK and cites one of its aims as being: "to encourage, through the provision of guidance, the development of UK capacity for recycling of end-of-life vessels in an environmentally sound manner".

In March 2005, Defra commissioned BMT Defence Services Limited (BMT) to undertake a study of ship recycling capacity in the UK. Since the study, there have been several facilities that have taken steps to obtain the necessary consents and permits to undertake ship recycling activities. These include Able UK in Teesside and Harland & Wolff in Belfast, both of which have since accepted vessels for decommissioning which were found to harbour INNS prior to movement to the facilities (Mackie, *pers comm.*; Aldridge, 2008).

### Potential pathways of spread and introduction

It has already been stated in this document that vessels will be more heavily fouled e.g. when they are obsolete or have been stationary for a long time, when they are slow moving or when they are badly maintained (Davidson et

al. 2008, GISP 2008, Coutts et al. 2010), all of which could apply to vessels which have been mothballed prior to decommissioning (e.g. Hull Q790), or been crippled in an area where INNS are resident (e.g. *MSC Napoli*)

The UK Ship Recycling Strategy recognises the risk of introduction of INNS posed by vessel recycling and the regulators who issue licences for such work in the UK (EA, SEPA, NIEA) require recycling facilities to demonstrate they have procedures in place for managing potentially hazardous materials, including harmful aquatic organisms, non-indigenous species and marine growth in ballast water and on the hull, and sediments in ballast tanks.

In the case of Hull Q790 for example, Condition 2.5.4 of the EA Waste Management License states:

“At least one 1 month prior to receipt of a Unit (*defined as vessel in this case*) a method statement for that Unit covering the identification and control of potentially harmful aquatic organisms and non-indigenous species in marine growth, ballast water and ballast sediments shall be submitted in writing to the Agency and that Unit shall only be accepted following written approval of the method statement”. However, as the independent report on the method statement supplied by Able UK for the Q790 (Aldridge, 2008) highlighted, this pathway will not be managed unless:

- Contractors surveying the vessel locate and correctly identify all INNS present; and
- Clearer guidance is given on procedures that should be followed when an INNS is found that is already present in UK waters.

### Awareness raising

The issues raised during the issuing of the WML to Able UK for Hull Q790 highlight the need for awareness raising amongst industry, contractors and regulators about the risks of *D. vexillum* e.g. the contractors who carried out the INNS survey of the vessel in France were unaware of this taxa until it was raised by the independent reviewer of the method statement submitted by Able UK to the EA (Aldridge, 2008). Consequently the identification of a *Didemnum* sp. on the hull was not included as a potential INNS in the list of non-natives present as it was assumed to be a native. A more precautionary approach would be to assume any *Didemnum* sp found during such surveys are assumed to be *D. vexillum* until proved otherwise, which was the view the EA took when appraising the WML for this vessel.

Information therefore needs to be provided to the relevant regulators, industry bodies and survey contractors about the risks posed by of *D. Vexillum* ,including how to identify *D. Vexillum*, waters where it has already been found, and recommended ways of decontaminating vessels before they are moved.

Most of the guidance / information could be that developed for dissemination between other pathway stakeholders rather than specialist material created



especially for those involved in vessel decommissioning. However it must be as comprehensive as possible because experience shows that regulators are required to make decisions regarding the issuing of WML on short notice (e.g. the NIEA had only two days prior warning of the *MSC Napoli* coming to Harland and Wolff and the EA had to commission an independent review of the Able UK – Q790 method statement and respond to the contractor within a week).

The Marine Industries Liaison Council, which is an umbrella group representing a number of marine trade bodies in the UK, launched a 'UK Marine Industries Strategic Framework' in March 2010 in conjunction with the Department for Business Innovation and Skills, one task of which is to develop a 'Sustainability, Environmental and Regulation Action Plan' that will cover topics like vessel recycling. Engagement with this group may be the best way to raise awareness of INNS and disseminate recommendations to the industry. <http://www.maritimeindustries.org/milc/files/18594-BIS-MarineIndustryStrategyWEB.pdf>

### Behaviour change

The assertion in the Able UK – Q790 method statement that 'the non-native species identified on the hull are in abundance in Brittany and present in UK waters, therefore mitigating control measures are not necessary' suggests that steps need to be taken to dispel the notion held by industry that introduction of non-natives to areas already affected or when other parts of UK are already impacted is acceptable.

Regulators must also be made aware of this so such assertions from recycling facilities are not accepted without further investigation or advice from experts.

It may also be necessary to work with industry to look at most appropriate methods for decontaminating vessels that are harbouring INNS such as *D. vexillum*. The assumption currently seems to be that this can be done by the recycling facility upon receipt of the vessel provided measures are taken to prevent the non-natives being released from the facility post removal i.e. by cleaning the hull in a dry dock and collecting all residues for disposal on land.

It would be more precautionary to amend guidance / regulations to require recycling facilities to have non-native species removed from vessels prior to their transfer to prevent the spread of these taxa during transit.

We also need to ensure that hulls are taken into dry dock as quickly as possible rather than being moored outside of facilities and allowed to re-foul.

### Influencing planning/policy

To ensure that UK Ship Recycling policies adequately reflect the need to reduce risk of spread of *D. vexillum* and other INNS via this pathway is

reduced there is a need to feed in to MILC Strategic Framework action plan outlined above, ensure any policies are fully aligned with those developed for non-vessel decommissioning activities e.g. oil rigs, renewable infrastructure, develop clear policy / guidance for regulators and industry and feed all developments in this area back to the IMO.

### International liaison

To ensure that risks posed by vessels coming to the UK from other waters are minimised contact with the IMO and relevant international trade bodies needs to take place to ensure they are aware of the issues of *D. vexillum* and have incorporated these into guidance being developed on transport of INNS by biofouled vessels as well as their ship recycling guidance. There is also a need to liaise with international agencies to produce a list of areas where *D. vexillum* is known to be present and pass on to contractors / regulators to further reduce risk of spread via vessels coming from affected areas outside the UK.

### Research

Research on sustainable methods for decontaminating large vessels would further understanding of the issues surrounding INNS / *D. vexillum* being transported by decommissioned vessels or during ship recycling and the best methods for preventing the spread of INNS via this pathway:

## 7.4 Marine Industries

### Background

The marine industries considered are:

- oil and gas
- renewable
- aggregates
- dredging (including disposal of dredged material in the marine environment)

A list of the key organisations involved in these industries is provided in Appendix 3.

### Potential Pathways of Spread & Introduction

Marine industries rely heavily on vessels to undertake their operations so there will be considerable overlap with the pathway management plan for shipping. However, there are marine industry-specific issues that will not be covered by other plans. The following table identifies the potential pathways relevant to the marine industries listed above.

*Table 1: Potential pathways relevant to marine industries*

Potential Pathway	Marine Industry			
	Oil & Gas	Renewables	Aggregates	Dredging
Transportation on fouled marine equipment, reclaimed materials or vessel hulls	✓	✓	✓	✓
Transportation and discharging of contaminated ballast water	✓	✓	✓	✓
Introduction of fixed structures & hard substrata (directly providing suitable habitat &/or stepping stones for <i>D. vexillum</i> )	✓	✓		
Fragmentation and consequent dispersal following disturbance.			✓	✓
Disposal of transported contaminated sediments within marine environment via dredging	✓	✓	✓	✓

The spread and introduction of *D. vexillum* to GB seems most likely to have occurred as a result of vessel movements, probably via recreational boats. Consequently, the biofouling and ballast water pathways for *D. vexillum*, covered in the shipping pathway management plan, are highly relevant to the marine industries sector. However, the sector should also consider other potential pathways, particularly transportation on other marine equipment and the dispersal of *D. vexillum* as a result of disturbance or the transportation of contaminated sediments.

### Behaviour Change

Two international industry bodies, IPIECA (the global oil and gas industry association for environmental and social issues) and OGP (International Association of Oil and Gas Producers), have produced a very thorough joint guidance document (88 pages) entitled 'Invasive Alien Species and the Oil and Gas Industry: guidance for prevention and management' (IPIECA and OGP 2010 <http://www.ogp.org.uk/pubs/436.pdf> ). This provides guidance on the invasive species pathways created by the oil and gas industries and prevention / control guidance for each of their activities. It includes detailed advice on prevention and control methods and, would bring considerable biosecurity benefits.

It is unknown whether similar guidance exists for other marine industries. If not, it is recommended that other marine industries be encouraged to develop similar guidance using the oil and gas industry guidance as a template.

It is unclear what uptake of this guidance there is within the UK. It would be desirable to assess what awareness and up-take of this guidance exists.

Recommendations for improving awareness and adoption of the guidance is provided below (awareness raising and enforcement).

### Awareness Raising

To encourage penetration of the guidance that has been developed the following recommendations are suggested:

- Awareness raising activities should be undertaken in partnership with or by industry representatives. Working in partnership will ensure that the actions are specific and relevant. Also engagement through industry representatives for awareness raising would increase the likelihood of industry providing support, both financial and human resources.
- Where possible guidance should be simplified and targeted for specific groups (e.g. posters, leaflets, articles for each relevant group / activity) including consideration of developing simple key messages.
- Key messages and summary (or full) guidance could be included on industry websites. Links can obviously be made to other websites with relevant information as well as providing industry-specific content.

- Biosecurity messages and guidance should be included in face-to-face engagement with wider representation from the industries to ensure that the issues of *D. vexillum* and other INNS were understood. The industry organisations generally hold environmental forums that cover a range of topics, which would provide the ideal opportunity to present information as there are good engagement levels
- Specific biosecurity workshops could be held for industry. In order to achieve good engagement levels, the workshops may need to be specific to each industry and perhaps relate to topics such as biofouling and/or ballast water where there are likely to be new standards to be achieved by industry.

### Enforcement

Voluntary behaviour change is usually preferred over regulation; however regulatory approaches may be required if adoption of voluntary guidance is poor.

The activities of the oil and gas, renewables, aggregates and dredging industries require various licences or permits in order to take place. The licensing and permitting processes may provide an opportunity to ensure marine non-native species issues, including *D. vexillum*, are taken into consideration by industry and their behaviour adjusted accordingly. However this would require the support of the licensing authorities and would need to be discussed with the various licensing authorities, which are outlined in Appendix 3.

As reviews and consultations of relevant legislation arise this will provide opportunities for the statutory organisations to recommend that licensing and permitting processes include management and control measures for *D. vexillum* and other INNS. For example, National Policy Statements (NPSs) are currently being developed for offshore energy (by DECC) and ports (by DoT) in the UK.

### International Cooperation

With two international oil and gas industry bodies, IPIECA and OGP, currently acknowledging that non-native species are an issue for the offshore oil and gas industry this provides a good opportunity for further engagement.

A potential European forum has been identified for the aggregates and dredging industries; the European Marine and Sand Gravel Group (EMSAGG). EMSAGG ([www.ciria.org.uk/emsagg](http://www.ciria.org.uk/emsagg)) is an independent body through which the sharing and dissemination of information between industry, regulators and other stakeholders is achieved. The forum includes European government departments and agencies, regulators, economists, resource planners and research bodies. However, it is not known whether marine non-native species and *D. vexillum* are considered as an issue by the group.

The European Wind Energy Association (<http://www.ewea.org/>) may provide an opportunity for engagement with the renewables industry on marine non-native species and *D. vexillum* beyond the UK and Ireland.

However it is not known whether these organisations are the most appropriate for international cooperation on *D. vexillum* or whether they would be willing to engage on the issue.

### Research

The introduction of fixed structures and hard substrates, which then directly provide suitable habitat and/or stepping stones to suitable habitat for *D. vexillum*, has been identified as a potential marine industries pathway. This is a hypothesised rather than a confirmed pathway, therefore it would be helpful to undertake specific research on this issue (note: the Scottish Association for Marine Science is currently working on a related issue entitled “Provision of refuges for invasive non-native species by marine renewable energy structures”).

Knowledge and understanding regarding relevant pathways may change in the future and therefore a review of marine industries research requirements should be undertaken periodically, perhaps every 2-3 years.

## 7.5 Shipping

### Background

This is a pathway where previous research and consultation with industry has already been carried out, particularly in New Zealand and Australia. Much of this work has informed the development of International Maritime Organization (IMO) draft guidelines for reducing the risk of introducing non native species via biofouling.

This chapter therefore aims to outline the main findings of the research that has been carried out previously, give an overview of how the IMO guidelines will be tackling the issue of spread of non native species and specify areas where there may need to be more UK focussed advice to the relevant stakeholders.

Relevant dates relating to the progress of IMO work are provided below:

#### Ballast Water Management Convention

- Ratification expected shortly (set criteria must be reached to ratify the convention, these are expected to be met hopefully within the next year, following which there will be a period of 12 months before the convention comes into force).

#### Biofouling Guidance

- Anticipated final agreement date – early 2011
- Voluntary role-out 2011 for 3-5 years
- Following the voluntary role-out there will be a review and decision on whether regulation is required to make guidance mandatory

### Potential pathways of spread and introduction

As fouled vessels will use more fuel when underway there has always been a need to keep biofouling to a minimum and this has usually been achieved through the use of antifouling paints and in-water cleaning. The previous environmental concerns associated with antifouling paints were related to the effect of tributyltin (TBT) on organisms in the aquatic environment (see ANZECC, 1997). These TBT paints are no longer used and the focus has shifted to the risk posed by the transport of non native organisms *via* biofouling.

The role of biofouling as a vector has long been understood (Eno et al. 1997, Cranfield et al. 1998, James and Hayden 2000, Coutts and Taylor 2004) and the role of shipping and recreational craft in the transport of non native ascidians has been recognised for some time (Lambert and Lambert, 1998). Shipping and/or recreational craft have been implicated in the introduction of *D.vexillum* (Minchin and Sides, 2006; Coutts and Forrest, 2007; Griffith et al. 2009; Herborg et al. 2009) and it is considered possible that non native

ascidians could be transported by both ballast water and fouling (Lambert and Lambert, 1998) although records of *D.vexillum* have tended to be associated with biofouling.

Research that has been carried out on biofouling has indicated that in most cases the vessels will be most heavily fouled in protected “niche” areas such as sea chests, bow thrusters or areas where antifouling paints have not been applied or have been damaged (Taylor and Rigby 2002, Coutts et al. 2003, GISP 2008). However, there are also cases where the vessels will be more heavily fouled e.g. when they are obsolete or have been stationary for a long time, when they are slow moving or when they are badly maintained (Davidson et al. 2008, GISP 2008, Coutts et al. 2010). There have been attempts to assess whether certain types of vessels pose more of a risk (Davidson et al. 2009) or whether certain areas such as the Great Lakes are under greater threat from this vector (Sylvester and Maclsaac 2010).

The two vectors i.e. ballast and biofouling have both been the subject of discussions at an international level at the IMO and this has resulted in the adoption of the Ballast Water Management Convention (IMO, 2004). This convention, once ratified, will require vessels to treat their ballast water to a known discharge standard and this standard will be phased in over time depending on the size and age of the vessels with older, larger vessels being the last that will have to comply. The issue of biofouling has also been discussed and there are now a set of draft guidelines that aim to reduce the risk of introducing non native species *via* this vector. It is hoped that these guidelines will obtain final agreement in early 2011 and will then be operated on a voluntary basis for a period of time (3-5 years, to be decided) after which time a decision will be taken as to whether the voluntary approach is effective or whether it is necessary to make the guidelines mandatory.

The IMO convention and guidelines are not species specific i.e. they do not target *D.vexillum* alone but aim to reduce the risk of non native species overall.

### Awareness raising

The research and consultation with industry that has been carried out by countries such as New Zealand and Australia has been very successful at raising awareness of the issue of biofouling and its role in transporting non native species.

The results of much of this work have been collated and updated to produce Codes of Practice (e.g. GISP 2008) or biofouling management guidelines for specific types of vessel, for example the Australian government has produced a set of guidelines for recreational vessels, the petroleum production and exploration industry, commercial fishing vessels, non-trading vessels and commercial vessels ([http://www.marinepests.gov.au/marine\\_pests/publications](http://www.marinepests.gov.au/marine_pests/publications)).



There is therefore a lot of knowledge regarding the risk posed by shipping and much of this is based on scientific research and consultation with the relevant industries. This has been presented to the shipping industry at a high level within the International Maritime Organization (IMO) but there may be a need to encourage further dissemination of this information at a more regional level.

### Behaviour change

As shipping is an international pathway for the transport of non native species any change in behaviour is likely to have to be through international agreement.

The IMO guidelines (as currently drafted) would require practical consideration to be given to, amongst others, the choice of anti-fouling system, the usual speed and activity of the vessel, application of the anti-fouling system in areas known to be prone to corrosion, the positions of dry docking supports at each dry docking so that one area is not continually missed and paying attention to known “niche” areas and ensuring the anti-fouling system is applied correctly.

The draft guidelines also provide advice on how best to undertake in-water inspection, cleaning and maintenance procedures for ships. The guidelines provide examples of situations where it may be possible to undertake such cleaning with a reduced risk to the aquatic environment because e.g. the material washed off is able to be captured and disposed of on land.

There is also advice on design and construction and this provides practical considerations such as reducing the number of niche areas as much as possible or positioning them where they can be easily accessed. Another suggestion is to round or bevel edges so that the anti-fouling coatings will adhere better.

The draft guidelines also suggest keeping a Bio-fouling Record Book, disseminating information regarding biofouling requirements through the IMO, training and education, additional measures e.g. during an emergency situation and future work required to further the efficacy of the guidelines.

For the guidelines to work successfully on a voluntary basis there will have to be a change in behaviour to some extent in order that the pragmatic suggestions made in the guidelines are followed. If this change does not take place then it is likely that discussions to make the guidelines mandatory would go ahead.

### Influencing planning/policy

The previous research and consultation carried out, particularly in New Zealand and Australia, has influenced the development of the IMO biofouling guidelines. Ongoing research (including in the UK) will provide further details

regarding the risk associated with biofouling and will be used to update the guidelines as necessary

### Research

The draft IMO guidelines suggest future research should concentrate on practical measures such as managing biofouling in niche areas e.g. through design or new anti-fouling systems and in-water cleaning systems that manage the biofouling and other contaminants e.g. by collecting the material that is cleaned off the hull.

Other areas of research could include how to deal with vessels that have large amounts of fouling – how should they be dealt with? Where should they be cleaned?

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## **Appendix 1. – Terms of Reference and Membership of GB Working Group for *D. vexillum***

### Terms of Reference

The main purpose of the working group is to bring together relevant stakeholders and experts to advise on a GB response to threats posed by *Didemnum vexillum*. The working group will be established for an initial 12-month period which may be extended.

- To advise the GB Non-native Species Programme Board (through the Rapid Response Working Group) on issues relating to *Didemnum vexillum*.
- To assist with prioritisation of work related to *Didemnum vexillum*.
- To offer advice on the eradication trial in Holyhead marina.
- To advise on and assist in raising awareness of the species and promoting vigilance, detection and reporting of potential sightings;
- To advise and assist in the production and dissemination of publicity material to relevant stakeholders/sectors. This could include:
  - A code of practice
  - Leaflets
  - ID Sheets
  - Alerts
- To keep a watching brief and seek to fill in any gaps in survey and monitoring work throughout GB.
- To scope the future action needed following the survey work and eradication trial;
- To advise on and prioritise research and taxonomic/identification requirements.
- To instigate and take forward communications and the development of joint action with Northern Ireland, the Republic of Ireland and the Isle of Man.
- To explore the need for joint action with relevant countries in Continental Europe.

## Membership

### Full members:

- Gabe Wyn, Countryside Council for Wales (Chair)
- Olaf Booy, Non-native Species Secretariat (Secretary)
- Alison Smith, Welsh Assembly Government DE&T
- Bill Sommerfield, Welsh Assembly Government Policy
- Caroline Price, Royal Yachting Association (The Green Blue)
- Ellen Burt, Marine Scotland
- Fiona Manson, Scottish Natural Heritage
- Holly Niner, Joint Nature Conservation Commission
- James Bussell, Natural England
- John Bishop, Marine Biological Association
- John Kelly, Envirocentre (Ireland)
- Lucie Skates, Environment Agency
- Lyndsay Brown, Marine Scotland
- Niall Moore, Non-native Species Secretariat
- Rohan Holt, Countryside Council for Wales
- Simon Mackown, Defra
- Stuart Jenkins, Bangor University
- Tracy McCollin, Marine Scotland
- Trevor Renals, Environment Agency
- Viv Collins, Welsh Assembly Government Policy

### Corresponding members:

- Angela Robinson, Scottish Government
- Brian Clark, British Marine Federation
- David Jarrad, Shellfish Association GB
- Eliz Cook, Scottish Association for Marine Science
- John Radcliffe, Countryside Council for Wales
- Kate Smith, Countryside Council for Wales
- Mark Gray, Seafish
- Richard Ferris, Joint Nature Conservation Commission



## **Appendix 2. – Example list of biosecurity guidance produced by the Australian government**

*Available from: [http://www.marinepests.gov.au/marine\\_pests/publications](http://www.marinepests.gov.au/marine_pests/publications)*

### National biofouling management guidelines

- National biofouling management guidelines for recreational vessels
- National biofouling management guidelines for commercial fishing vessels
- National biofouling management guidance for non-trading vessels
- National biofouling management guidance for the petroleum production and exploration industry
- National biofouling management guidelines for commercial vessels

### National Control Plans

- National control plan for the northern Pacific seastar
- National control plan for the Asian bag or date mussel
- National control plan for the European green shore crab
- National control plan for the Japanese seaweed or wakame
- National control plan for the European or basket shell clam
- National control plan for the European fan worm

### Emergency response

- Australian Emergency Marine Pest Plan (EMPPlan)

### Marine pest monitoring

- Australian marine pest monitoring manual
- Australian marine pest monitoring guidelines

### Biofouling resources for commercial fishers

- Onboard guide to biofouling management
- Brochure: Help stop marine pests invading our fishing grounds
- Poster: I'm keeping marine pests out to keep me in business
- Guidelines for domestic commercial fishing vessels to manage marine pests

### Research reports

- The relative contribution of vectors to the introduction and translocation of invasive marine species
- Review of biosecurity and contaminant risks associated with in-water cleaning

### Appendix 3. – Brief list of some networks and stakeholder groups

International Council for the Exploration of the Sea has two relevant Working Groups:

- WG Ballast and Other Ship Vectors (WGBOSV).
  - Chair – Tracy McCollin [t.mccollin@marlab.ac.uk](mailto:t.mccollin@marlab.ac.uk)
- WG on Introductions and Transfers of Marine Organisms. (WGITMO). This group keeps a record of non native species found in the ICES area and also has access to a number of taxonomic experts.
  - Chair – Henn Ojaveer [henn.ojaveer@ut.ee](mailto:henn.ojaveer@ut.ee).

European Maritime Safety Agency (EMSA)

- Brian Elliott [Brian.ELLIOTT@emsa.europa.eu](mailto:Brian.ELLIOTT@emsa.europa.eu)

Manager Strategic Science Team, Senior Science Advisor, Marine MAF Biosecurity New Zealand, Policy & Risk Directorate

- Naomi PARKER [Naomi.Parker@maf.govt.nz](mailto:Naomi.Parker@maf.govt.nz)

Stichting Anemoon. Netherlands organisation that uses volunteers for research in the marine environment (includes SETL, a project deploying settlement plates in harbours and on jetties, linked to Marine Invasions Laboratory of Smithsonian Environmental Research Centre (USA).) May be able to provide information on relevant trade or governmental organisations in the Netherlands. Contact with knowledge of sea squirts:

- Adriaan (Arjan) Gittenberger. CEO GiMaRIS Marine Research, Inventory & Strategy solutions, Leiden BioScience Park, Niels Bohrweg 11-13, 2333 CA Leiden, The Netherlands.  
[Gittenberger@GiMaRIS.com](mailto:Gittenberger@GiMaRIS.com)

*Possible contacts in offshore industry organisations*

Industry	UK Industry Organisation	Possible Contacts	Website
Oil & Gas	Oil & Gas UK	Mick Borwell, Environmental Issues Director	<a href="http://www.oilandgasuk.co.uk">www.oilandgasuk.co.uk</a>
Renewables	Renewable UK	To be identified	<a href="http://www.bwea.com">www.bwea.com</a>
Aggregates	British Marine Aggregate Producers Association (BMAPA)	Mark Russell Director Marine Aggregates	<a href="http://www.bmapa.org">www.bmapa.org</a>
Dredging	Federation of Dredging Contractors or British section of the Central Dredging Association	To be identified	<a href="http://www.federation-dredging.co.uk">www.federation-dredging.co.uk</a>  <a href="http://www.dredging.org/content.asp?page=30">www.dredging.org/content.asp?page=30</a>

*Marine industry licensing authorities and advisers*

Industry	Licensing Authority	Statutory Advisers
Oil & Gas	Department of Energy & Climate Change	JNCC/NE/SNH/CCW Marine Scotland/Cefas
Renewables	Scottish Government Infrastructure Planning Commission Marine Management Organisation	JNCC/NE/SNH/CCW Marine Scotland/Cefas
Aggregates	Marine Management Organisation	JNCC/NE/SNH/CCW Marine Scotland/Cefas
Dredging	Scottish Government Marine Management Organisation	JNCC/NE/SNH/CCW Marine Scotland/Cefas

# Appendix 4 – Factsheet on a closed loop wash down facility from the Green Blue

## WHAT WE KNOW ABOUT... CLOSED LOOP BOAT WASH DOWN SYSTEMS

This fact sheet examines ways of removing antifouling contamination from the waste water generated by pressure washing a boat hull.

**INTRODUCTION**

In the UK, boats are often pressure washed when they are hauled out to clean the hull of biofouling such as weed, barnacles and algae. Fouling builds up while the boat is in the water and reduces the boat's speed, affects manoeuvrability and can wash further afield species to new areas. Fouling builds up more quickly in saltwater but can also occur in freshwater environments.

The majority of boat-hulls are coated with wet-acting antifouling paint. Therefore the waste water following pressure washing (wash down) may contain antifouling residue. The best street schemes and systems exist to remove this antifouling residue from the wash down water.



**BOATING FACT SHEET 5**

### WHERE TO FIND A CLOSED LOOP SYSTEM

There are very few closed loop systems in operation in the UK. Here is a list of those in full operation that are known to The Green Blue:

**SEALIFT 2**

SEALIFT 2 is based in the River Medway in Cowes, on the Isle of Wight. Fresh water is used to pressure wash the vessels which is then filtered and returned to the foul sewer. As the system operates very close to the river water level, in our experience a small amount of wash down water does inevitably seep into the river. However, the system is a vast improvement on the majority of other facilities.

[www.sealift2.com](http://www.sealift2.com)

**MEMORANDY AND PORTLAND NATIONAL SALVAGE ACADEMY**

Weymouth is the UK's Olympic sailing venue and it boasts many international facilities. These include a dedicated berthing for boats at Weymouth, more boats in an area designed for pressure washing. Fresh water is used and waste water drains off into the foul sewer. All drain covers on-dock are clearly marked to indicate whether they are designed to remove or surface waters.

[www.mpsa.org.uk](http://www.mpsa.org.uk)

**CALETH STORAGE & MOORING AT BECCLES**

The boathouse has installed a fully fledged closed loop system. Gullison received a grant from the British Authority's Sustainable Development Fund (SDF) and other methods of sailing clubs wishing to install similar facilities could by the same route if they are located within an English National Park or AONB. Boats are washed down in a contained tank, the water runs off into a contained tank, it then passes through a Vialtech filtration system which can remove up to 95% of contaminants. The clean water is then returned to the tank.

<http://www.gullison-boatmooring-and-mooring.co.uk>

**EUROPE - BRITISH INFLA YACHT CLUBS**

One of the few genuine closed loop systems that The Green Blue has heard of date is actually based in Germany at the British Inflatables Yacht Club. The wash down water is collected in a sump then passed through a series of filtration and settlement tanks. The clean water is then used again through the powerwash. We understand that this system is relatively cheap and easy to run, but obviously some land works would be required to install a fully on-site in the UK.

<http://www.binyg.co.uk/>

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[www.thegreenblue.org.uk](http://www.thegreenblue.org.uk)

**THE LEGAL FRAMEWORK**

Sewage discharges of pollution affect not just wash down and maintenance facilities. Much of the comes under the Water Resources Act (1991), regulating any polluting matter entering controlled waters. The waste products of the wash down or boat maintenance may also be classified as hazardous depending on their concentration and will need to be disposed of as necessary under the appropriate waste regulations. The

boating provider has a duty of care to carry the out under the same regulations. Run-off from hull cleaning operations at marinas, boatyards and sailing clubs is all classed as a trade effluent. As it may contain particles of the bottom paint and fragments of hull material. These particles and fragments can contain metals such as copper and other chemicals that impede marine growth and should be classified as special hazardous waste. With the prior permission of the local water company or the competent unit of the Environment Agency, a licence may be granted to dispose of the run-off to the foul sewer. Where this is not possible, waste run-off should be contained on-site for off site disposal (in accordance with legislation) or on-site treatment and possible reutilisation using a closed-loop system.