ORKNEY ISLANDS COUNCIL

HARBOUR AUTHORITY

BALLAST WATER MANAGEMENT POLICY

FOR

SCAPA FLOW

OIC Harbour Authority Ballast Water Management Policy for Scapa Flow *10 December 2013*

Orkney Marine Environmental Protection Committee / Forum *29 April 2014, 29 Nov 2017 and 20 Apr 2023*

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ORKNEY ISLANDS COUNCIL, HARBOUR AUTHORITY BALLAST WATER MANAGEMENT POLICY

1 BACKGROUND

1.1 In line with its responsibility to enable safe, economic and environmentally sustainable operation of the 29 piers and harbours located in the Orkney Islands, including Scapa Flow, Orkney Islands Council (OIC), Harbour Authority has developed a revised Policy for Ballast Water Management (BWM) in Scapa Flow.

1.2 Previous Policies preclude ballast water discharge within Scapa Flow, except in the case of certain vessels subject to a pre-agreement. This was considered to afford the necessary high level of protection from oil pollution by the discharge of ballast water from non-segregated ballast tanks. This threat has now been removed as legislation requires that ballast water is not carried in tanks that have previously carried oil cargoes. Subsequently, there has been a greater awareness of the threat of non-native species and pathogen introductions and poor water quality that indiscriminate ballast water discharge could pose.

1.3 It is intended that this Policy and revisions will continue to afford a high level of environmental protection while also facilitating commercially important shipping activities. This revised Policy has been subjected to strategic environmental assessment (SEA)[1], and Habitats Regulations Appraisal to determine whether it is likely to have significant effects on any European designated sites according to the Habitats Directive (92/43/EEC). Measures to mitigate potential environmental impacts have been identified and are documented in the Environmental Report[2].

1.4 A monitoring programme will be implemented to identify any adverse environmental impacts of ballast water management and shipping activities. A monitoring framework has been proposed in the Environmental Report[2.] This includes monitoring of several aspects of the environment and monitoring

[1] As required by the Environmental Assessment (Scotland) Act 2005.
[2] OIC Marine Services 2013. OIC Ballast Water Management Policy SEA Environmental Report

for the presence of invasive non-native species. The monitoring and recording programme for invasive non-native species is described in Annex 5 of this policy. Monitoring results will be made available as requested and the programme reviewed on a regular basis as agreed with statutory authorities (see Annex 4, note 5).

1.5 This Policy and revisions seeks to implement the level of protection that will be afforded by the International Convention for the Control of Ships Ballast Water and Sediments (2004) (hereafter referred to as 'the Convention') when it enters into force, and where practicable to follow guidelines issued under IMO Resolution A.868.

2 SCOPE

2.1 This Policy applies to all ships intending to conduct ballast water management and / or discharge within Scapa Flow, in particular:-

(a) The policy applies to all vessels over 400 gt within or using the Scapa Flow Oil Port or Anchorage Facility as defined by the harbour authority limits, and

(b) With reference to vessels carrying out ship to ship oil or liquid gas operations

(i) within 500m (radius) of designated STS locations 1 to 4 as shown on United Kingdom Hydrographic Office (UKHO) Chart 35.

3 POLICY

3.1 This Policy and revisions introduce measures compliant with the Convention, adopted by consensus at an International Maritime Organisation (IMO) diplomatic conference in 2004, despite the fact that the Convention has yet to enter into force. (see Annex 4, note 1)

3.2 Associated port procedures enhance on the International Convention for the 'Control and Management of ships' Ballast water and Sediment' adopted in 2004, and the guidelines issued under IMO Resolution A.868 (20).

3.3 The discharge of a ships' ballast water whilst within Scapa Flow is prohibited unless in accordance with the following:-

All Vessels

(a) i) The total quantity of ballast water for discharge is limited to that which is essential, and

ii) Ballast water for discharge must have been exchanged in accordance with Regulation D1 (empty refill / through flow) within the designated area as bounded by the following coordinates:

Eastern Exchange Area (EEZ);

57^0 40'N, 001^0 00'W to

58^0 40'N, 002^0 15'W to

60^0 00'N, 000^0 20'W to

60^0 00'N, 002^0 00'E to

57^0 40'N, 002^0 00'E and back to

57^0 40'N, 001^0 00'W

Or

iii) The ballast water for discharge must have been taken on-board or exchanged in accordance with the Convention's Regulation B4 criteria, i.e. at a location where the depth is 200m or more, and at a minimum of 50 nautical miles from the nearest land

and in either case (a) (ii) or (iii) above

iv) The Master must submit to the Harbour Authority prior to arrival 'Ballast Water Reporting Form' (SF 07-008) or similar indicating the position and time of taking onboard and/or exchange of the ballast water and a ‘Ballast Water Discharge Request Form’ (SF 07-009) or similar indicating those tanks and quantities being requested for discharge.

v) Ship to ship oil cargo or liquid gas transfer operations may only be undertaken at or within 500m of designated STS locations 1 to 4 as shown on United Kingdom Hydrographic Office (UKHO) Chart 35.

(e) Vessels that for any reason cannot comply with the conditions described in will not be permitted to de-ballast within the Harbour limits, without the permission of Harbour Master.

(f) Vessels fitted with IMO Convention compliant and certificated ballast water treatment systems (regulation D2) must always exchange ballast water (as per this Policy), and regardless of whether the IMO Convention has come into force - prior to undertaking ballast water treatment, before discharge of any ballast water will be authorised within Scapa Flow.

(g) OIC Harbour Authority reserves the right to refuse permission to discharge ballast water within Scapa Flow, and to place limits on the quantity to be discharged or require additional safeguards or restrictions.

4 REPORTING AND CERTIFICATION

4.1 As indicated in clause 3.2 b) (iv), to obtain permission to discharge ballast water the Master must provide OIC Harbour Authority with a Ballast Water Reporting Form (SF07-008), or similar, indicating the position and time of taking on-board and/or exchange of the ballast water, and a Ballast Water Discharge Request Form (SF07-009) or similar, indicating those tanks and quantities being requested for discharge. Permission will be granted to the Master either directly or through the Ship’s agent as appropriate.

4.2 All ships are required to be prepared to submit for inspection a Ballast Water Management Plan as described by Regulation B-1 of the Convention, and a Ballast Water Record Book as described by Regulation B-2. In addition, with the Harbour Authority recognising that it has no absolute authority, the

Harbour Authority may request to inspect such records (ie: ships logbooks and vessel positional records) as it deems necessary to show that a vessel has completed the requirements of this Policy before permission to discharge ballast water is granted to the Master.

5 MONITORING

5.1 In accordance with Article 9 of the Convention, OIC Harbour Authority may at their discretion require a ship to submit certification for verification, inspect ballast water records, and/or sample ballast water for immediate determination of salinity levels.

6 RESPONSIBILITIES

6.1 Fulfilment of the requirements of this Policy is the responsibility of the Ship's Master.

6.2 It is the responsibility of the Ship's Master to obtain written permission from the Harbour Authority prior to any ballast water discharge into the sea within Scapa Flow.

6.3 It is the responsibility of the Ship's Master to ensure that ships only conduct ballast water discharge for which they have permission.

6.4 It is the responsibility of the Ship's Master to ensure that accumulations of sediments within ballast water tanks are monitored and removed in a timely fashion, in accordance with Resolution MEPC.127(53) (IMO Convention Guideline 4) and / or amendments.

6.5 It is the responsibility of the Harbour Master (or deputy) to ensure that the process of applications to discharge ballast water, and any ensuing inspections or sampling, are conducted in a timely manner to minimise delays to vessels.

7 NOTES ON THE POLICY

7.1 Enforcement of this Policy will ensure that ballast water discharged into Scapa Flow or other Orkney coastal waters presents a minimal risk in terms of water quality, non-native species and pathogen introduction. This is particularly important because of the unique ecological resources in and around the area, and their protection under The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

7.2 Those operations that will require the discharge of the greatest volume of ballast water (ship to ship oil and liquid gas cargo transfers) will be restricted as described in clause 3.3, such that they will be remote from the Loch of Stenness SAC (approximately 13.5km) and the Hoy SPA (approximately 5km).

8 POLICING OF THE POLICY

8.1 Vessels undertaking exchange within the EEZ will be monitored using Automated Identification System (AIS) data and / or any other systems available to the Harbour Authority (see clause 4.2), to ensure they have slowed down sufficiently in order to undertake exchange as specified in clause 3.3.

8.2 Ballast water records will be inspected for details on exchange and treatment operations. Sampling of vessels ballast water will be carried out in accordance with Article 9 of the Convention. If there are grounds for believing that the condition of the ship or its equipment does not correspond to the particulars on the Ballast Water Management Treatment System / Certificate, or the Master and crew are not familiar with the essential on-board procedures relating to ballast water management, then a detailed inspection will be carried out.

ANNEX 1 IMO BALLAST WATER STANDARDS

Regulation D1 *Ballast Water Exchange Standard*

1. Ships performing Ballast Water exchange in accordance with this regulation shall do so with an efficiency of at least 95 percent volumetric exchange of Ballast Water.

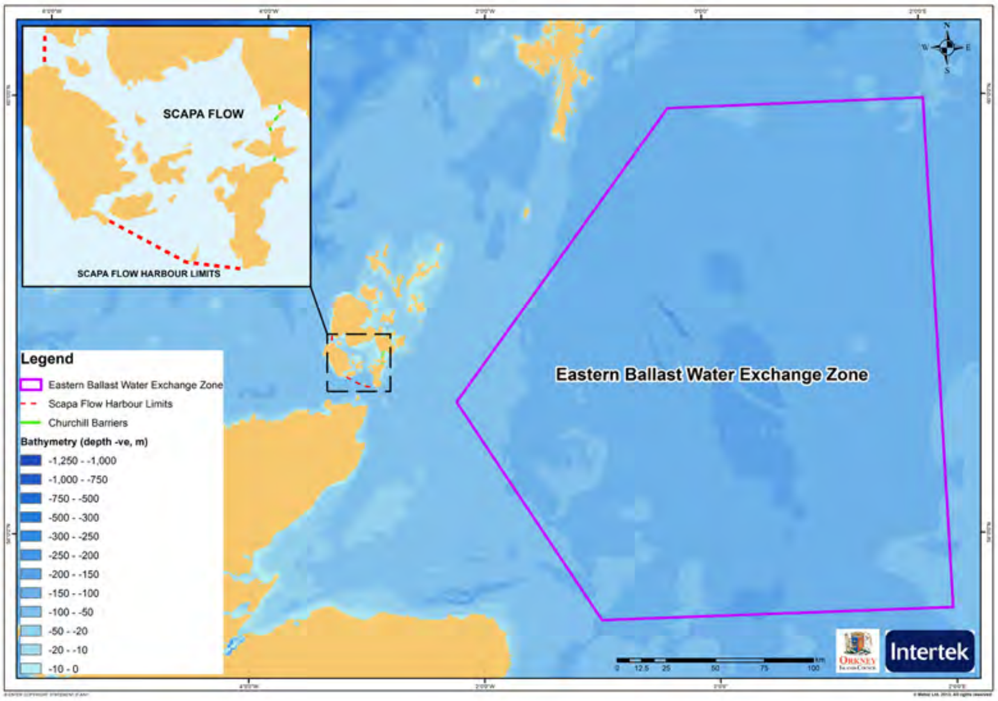
2. For ships exchanging Ballast Water by the pumping-through method, pumping through three times the volume of each Ballast Water tank shall be considered to meet the standard described in paragraph 1. The empty refill method of exchanging ballast water may be accepted provided the ship can demonstrate that at least 95 percent volumetric exchange is met.

Regulation D2 *Ballast Water Performance Standard*

Ships conducting ballast water management shall discharge less than 10 viable organisms per cubic metre greater than or equal to 50 micrometres in minimum dimension and less than 10 viable organisms per millilitre less than 50 micrometres in minimum dimension and greater than or equal to 10 micrometres in minimum dimension; and discharge of the indicator microbes shall not exceed the specified concentrations.

ANNEX 2 EASTERN EXCHANGE ZONE (EEZ)

Ballast Water Exchange Area shown enclosed by the purple lines, as bound by the coordinates listed in clause 3.3.

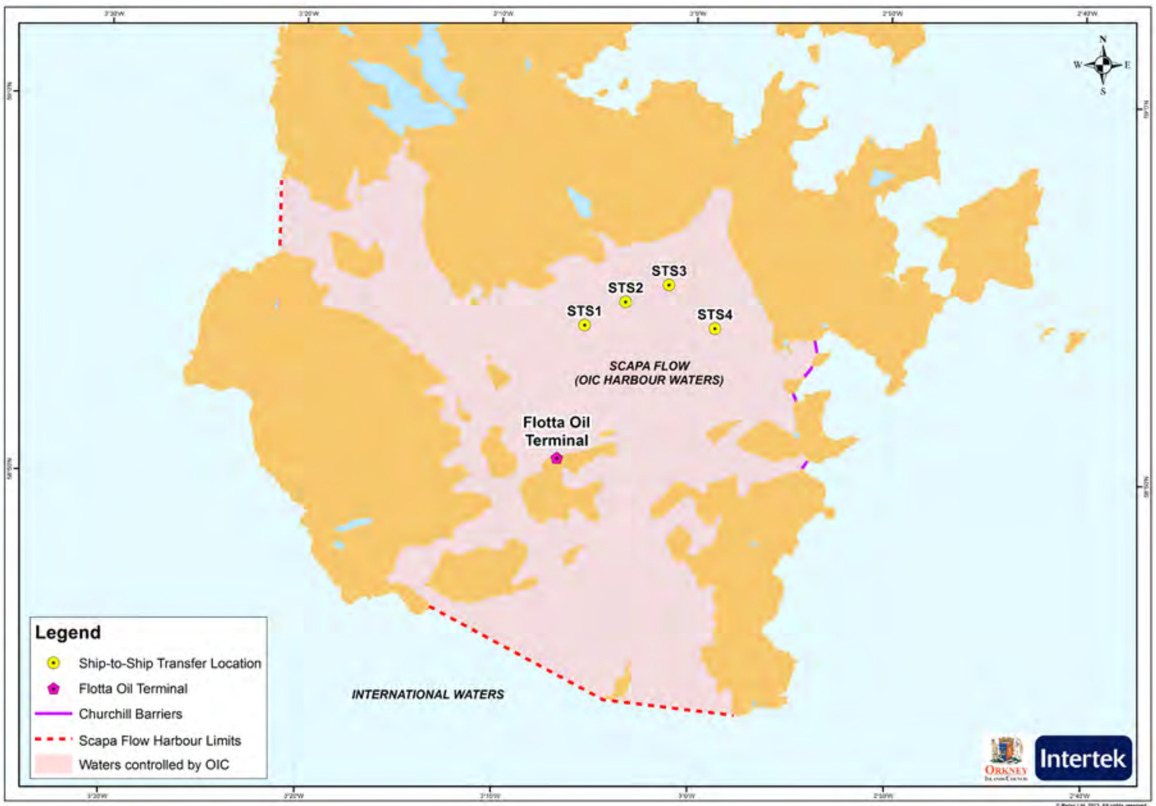


The exchange area has been specified because it has similar summer and winter temperature and salinity regimes at the sea surface and depth to Scapa Flow. The zone hosts a Northern North Sea planktonic assemblage. Whereas to the south of the zone this assemblage becomes more mixed, in addition to the water quality and salinity becoming more influenced by estuarine inputs. The zone is 25 miles from land at its nearest point and is considered to host a discrete biological community to be representative of North Sea rather than coastal water.

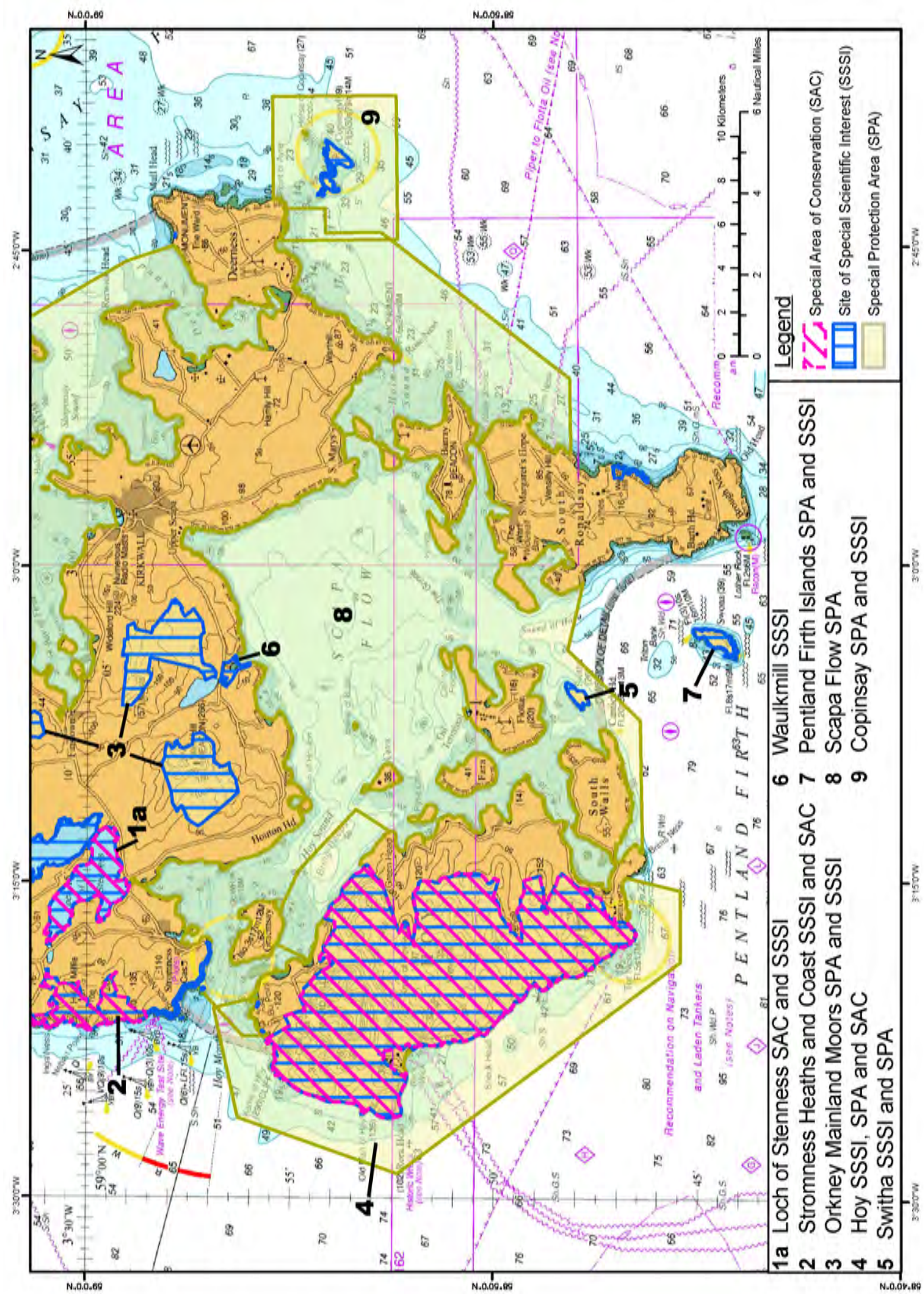
Use of this zone for ballast water exchange complies with Regulation B-4 of the IMO Convention as it allows ships en route to Scapa Flow to exchange ballast water in open sea conditions without significant diversion and consequent delay. It is noted that Regulation B-4 may become defunct on the IMO Convention entering into force, but this standard will continue to be used by the Harbour Authority in relation to an acceptable ballast water exchange standard.

ANNEX 3 STS LOCATIONS IN SCAPA FLOW

Ship to ship oil and liquid gas cargo transfer operations may only take place in accordance with the Policy and at positions as illustrated below:-



Location of SAC, SSSI, and SPA areas around Scapa Flow:-



ANNEX 4 NOTES

Notes;

1: The Convention entered into force on 8 September 2017.

Since the Convention come into force, all ships must have ballast water management plan, ballast water record book and International Ballast Water Management Certificate. All vessels must be fitted with compliant treatment systems – at the vessel’s first survey / docking after ratification, or by 8 September 2024 at the latest, after which all ships must meet D2 standard.

2: With reference to the numbers of ship-to-ship operations it is expected that there will be an average of one operation per week. These figures are those used for all of the HRA (AA) assessments and have been used for the relevant recommendations.

3: In addition, and using a worst-case scenario, the amount of exchanged ballast water proposed to be discharged into Scapa Flow has been set at 30,000 to 40,000 tonnes per operation. There will be occasions when due to the size of vessel this will be less. In addition, there will be times, dependant on sea and weather conditions, which after completion of the ballast water exchange process the Master of a vessel decides to arrive with minimum ballast water on board. This will lead to much reduced volumes of exchanged ballast water being discharged into Scapa Flow. Regardless of this and to ensure that a worst-case scenario is used the amounts have not been reduced when studies, modelling and recommendations have been considered during the generation of this revised Policy.

4: The Harbour Authority will maintain an effective and monitoring system, as it has done for over twenty years, with respect of the following:-

Rocky shore Marine and Climate Change and Biodiversity surveys conducted at three yearly intervals

Year 1	Year 2	Year 3
Full set of MarClim Surveys	**Core MarClim Surveys**	**Core MarClim Surveys**
Dyke End	Dyke End	Dyke End
Glimps Holm (3rd barrier)	Glimps Holm (3rd barrier)	Glimps Holm (3rd barrier)
Holm of Houton	Holm of Houton	Holm of Houton
Banks		
Broughness		
Dingieshowe		
Hoxa Head		
Long Geo		
Marwick		
Point of Ness		
Skipi Geo (Brough of Birsay)		
Eday pier, Eday		
Sandybank, Eday		
Crockness, Hoy		
Pegal Bay, Hoy		
Rousay Pier, Rousay		
Scockness, Rousay		
Kettletoft, Sanday		
Noust of Ayre, Sanday		
Ness of Ork, Shapinsay		
Kirk Taing, Westray		
Rapness, Westray		

Sandy shore species surveys conducted annually

Year 1	Year 2	Year 3
Core sandy shore sites	**Core sandy shore sites**	**All sandy shore sites**
Congesquoy	Congesquoy	Congesquoy
Quoys	Quoys	Quoys
Scapa	Scapa	Scapa
Waulkmill	Waulkmill	Waulkmill
		Cumminess
		Swanbister
		Kirkhope
		Longhope
		Lyrawa
		Mill Bay
		Creeklands

Rocky shore Marine Climate Change and Biodiversity (MarClim) surveys

Each rocky shore site is visited once in every three years with three sites visited annually. The surveys are conducted at pre-determined locations around Scapa Flow and Orkney. The surveys are conducted at a transect line from top of the shore to the low tidal area. Species are recorded with the aid of a survey form and allocated to a SACFOR abundance scale. During the survey photographs of the site and species seen are taken.

Sandy shore surveys

Sandy core samples are taken yearly from four sites and every three years from eleven sites during low water springs. The samples are collected from 1 - 3 sampling stations (site dependent), using a core of 155mm diameter to a depth of 100mm. The samples are sieved through a sieve with mesh of 500µm. In each site five replicate samples are collected. In laboratory the benthic macro-invertebrate samples are hand sorted, identified to the family level and counts for abundance are made.

In addition, Flotta Oil Terminal has confirmed that OIC can have access to the tri-annual sea bed survey that they carry out.

All results would be available to Statutory Bodies and the Harbour Authority would work with the same to ensure that high standards are met.

The above collection of data would provide a continual assessment and trend analysis – it should be noted that there are other import mechanisms for introduced species other than ballast water.

The Harbour Authority takes, on behalf of other Statutory Bodies, water samples from locations within Scapa Flow for chemical analysis – this will be maintained.

The Harbour Authority will provide assistance to (whenever possible) and work with any Statutory Body, University, College or others who set up mechanisms whereby further sampling regimes or studies are established for Scapa Flow.

The full and detailed monitoring and recording procedure is shown in Annex 5 of this policy.

ANNEX 5 MONITORING AND RECORDING SYSTEM FOR MARINE NON-NATIVE SPECIES: SCAPA FLOW AND LOCH OF STENNESS

Monitoring and Recording System for Marine Invasive Non-Native Species: Scapa Flow and Loch of Stenness

Original:	**Adopted by OIC 10 December 2013**
Revision 1:	**OMEPC 29 April 2014**
Revision 2:	**OMEPC 29 November 2017**
Revision 3:	**OMEPF 20 April 2023**

OIC Harbour Authority Ballast Water Management Policy for Scapa Flow *10 December 2013*

Orkney Marine Environmental Protection Committee / Forum *29 Apr 2014, 29 Nov 2017 and 20 Apr 2023*

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Revision Log

Revision 1: OMEPC Mtg; 29 April 2014 – Notes

Section	Type of update	Details
1. Introduction, p. 5	Added	Point added to list: To trigger an appropriate and timely response to an introduction of INNS as per guidance from GB NNS Secretariat.
2. High risk species list, p. 6, paragraph 2.	Changed	Sentence changed to: As of April 2014, eight NNS have been recorded in Scapa Flow, Table 2.
2. High risk species list, p. 6, Table 2.	Amended	Table amended to include following species: Red seaweed *Bonnemaisonia hamifera* Red seaweed *Heterosiphonia japonica* Harpoon weed *Asparagopsis armata* Pacific oyster *Crassostrea gigas*
2. High risk species list, p. 7	Added	Following paragraph added: Many marine NNS are currently either unclassified or not yet listed (for example orange encrusting invertebrate *Schizoporella japonica* and red seaweed *Heterosiphonia japonica*) under the UK TAG classification of aquatic alien species according to their level of impact. Therefore, the potential for damaging impact on native habitats and biota is not confined to those NNS currently recognised as of high risk.
3. Site selection, p15, Table 3.	Amended	Numbering of Submerged obstruction, East of Graemsay and Moaness Pier changed.
4. Description of methods, p. 19	Removed	Remotely Operated Vehicle Survey removed from sampling methods.
4. Description of methods, p. 20	Added	Paragraph describing methods for phyto- and zooplankton tows added.
4. Description of methods, p. 20	Added	Paragraph describing methods for sample collection, sorting and identification.
5. Baseline survey, p. 21	Added	A section added with timings of monitoring survey in 2014 and following monitoring surveys from there on.
5. Baseline survey, p. 22.	Amended	Table 4. amended to include when each survey method was used during baseline survey (Phase1 and/or Phase 2) and if the mentioned survey method will be used during monitoring phase.
6. Recording and reporting of results, p.23	Amended and added	Paragraph on Local reporting system amended to include ‘annual’ and ‘verbally’ in the first two sentences. Talisman Energy changed to Talisman Sinopec Energy UK Ltd. Following sentence added: On discovery of any new marine NNS SNH will be alerted as soon as reasonably possible.
Appendix 1.	Amended	Table amended as per revised UK TAG paper, Feb 2014
Appendix 3.Figure 2-1.	Amended	Figure 2-1 updated.

Revision 2: OMEPC Mtg; 29 November 2017 – Notes

Section	Type of update	Details
Page 8	Added	Table of Contents inserted.
Section 2, 2nd para	Amended	Number of NNS recorded in Scapa Flow updated to reflect that 22 NNS have been recorded in Orkney Islands of which 17 have been recorded in Scapa Flow up to the end of 2016.
Section 2 High risk species list, Table 2	Removed	'Invasive' removed from Table 2 heading.
Section 2 High risk species list, Table 2	Amended	Table updated to reflect number of NNS recorded up to the end of 2016.
Section 2 High risk species list, Summary	Amended	Chinese mitten crab moved from the list of species not recorded in Scotland to the list of species recorded in Scotland.
Section 2 High risk species list, species summaries	Amended	Chinese mitten crab species summary distribution description and map updated.
Section 6, Recording and reporting of results, 2nd heading	Added	International added to National reporting system heading.
Section 6, Recording and reporting of results, National and International reporting system	Amended	Text updated as per Figure 1 the Contingency Plan flow diagram.
Section 7 Contingency Plan, 2. Reporting	Amended	Text amended to reflect updated contingency plan flow diagram.
Section 7 Contingency Plan, 4. Action Plan	Amended	Text amended to reflect updated contingency plan flow diagram.
Section 7 Contingency Plan, Figure 1	Amended	Contingency Plan flow diagram replaced with updated version.
Section 9, Bibliography	Added	Clyde River Foundation (2017) reference added to the Bibliography.
Section 9, Bibliography	Added	Marine Scotland Science (2017) reference added to the Bibliography.
Appendix 1	Amended	Table amended as per revised UK TAG paper, July 2015, version 7.6.
Appendix 2	Removed	Species data removed as incomplete and out of date. This information is included in the annual NNS Monitoring Reports.
Appendix 3 and 4	Amended	Numbering changed to reflect the removal of Appendix 2.

Revision 3: OMEPF Mtg; 20 April 2023 – Notes

ORKNEY ISLANDS COUNCIL, HARBOUR AUTHORITY BALLAST WATER MANAGEMENT POLICY

Section	Type of update	Details
1.2	Amended	'The existing Policy' changed to 'Previous Policies'
1.3	Amended	'revised Policy' changed to Policy and revisions' This change has been made throughout the Policy document.
3.3 a) onwards	Removed	Text from 3.3 a) onwards all text removed up until heading 'All Other Vessels'. Heading 'All Other Vessels' changed to 'Other Vessels'. (d) changed to (a)
3.3 (a) ii)	Amended	'(ie. at least three times by volume for each ballast tanks)' changed to '(empty refill / through flow)'. (EEZ) added after Eastern Exchange Zone.
3.3 (f)	Added	Following text added after '(as per this Policy)' : 'and regardless of whether the IMO Convention has come into force'
6.4	Added	Following text added to the end of the paragraph: and / or amendments.
8.2		'Ballast Water Management Treatment System /' added before 'Certificate'.
Annex 2	Removed	Last sentence of the first paragraph removed.
Annex 2	Added	Following text added to the end of second paragraph: 'It is noted that Regulation B-4 may become defunct on the IMO Convention entering into force, but this standard will continue to be used by the Harbour Authority in relation to an acceptable ballast water exchange standard.'
Location of SAC, SSSI, and SPA areas around Scapa Flow.	Added	Scapa Flow SPA added to the map.
Annex 4, Notes: 1	Changed	Text changed to: The Convention entered into force on 8 September 2017. Since the Convention come into force, all ships must have ballast water management plan, ballast water record book and International Ballast Water Management Certificate. All vessels must be fitted with compliant treatment systems – at the vessel's first survey / docking after ratification, or by 8 September 2024 at the latest, after which all ships must meet D2 standard.
Annex 4, Notes: 2	Removed	Text removed.
Annex 4, Notes: 5	Amended	Rocky shore and sandy shore survey information changed to reflect the current rocky shore and sandy shore monitoring programmes.

ANNEX 5:

MONITORING AND RECORDING SYSTEM FOR MARINE INVASIVE NON-NATIVE SPECIES: SCAPA FLOW AND LOCH OF STENNESS

Section	Type of update	Details
Section 2 High Impact species list, Table 1	Added	Table 1 updated according to the revised UK TAG paper, January 2021, version 8. Four species added to the list: • *Hemigrapsus sanguineus* • *Hemigrapsus takanoi* • *Homarus americanus,* and • *Undaria pinnatifida.*
Section 2 High Impact species list, Species summaries	Added	Four species summaries added: • *Hemigrapsus sanguineus* • *Hemigrapsus takanoi* • *Homarus americanus,* and • *Undaria pinnatifida.*
Section 2 High Impact species list, Species summaries	Amended	All species summaries updated with latest information on their distribution and new maps created.
Section 2 High Impact species list, Table 2	Amended	Table 2 updated to reflect number of NNS recorded up to the end of 2022.
Section 7, Contingency Plan	Amended	Text updated to reflect updated contingency plan flow diagram.
Section 7, Contingency Plan, Figure 1	Amended	Contingency Plan Flow Diagram replaced with updated version.
Section 9, Bibliography	Added	Bibliography updated with references from new and updated species summaries.
Appendix 1	Amended	Table amended as per revised UK TAG paper, January 2021, version 8.

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1 Introduction

During the consultation period for the Orkney Islands Council Revised Ballast Water Management Policy, in 2012 it was highlighted that a rigorous monitoring programme for the presence and the trends of targeted marine invasive non-native species (INNS) in Scapa Flow would be a necessary component of the policy.

This report explains the reasoning behind a high-risk species list, the site selection process, the methods used and the monitoring schedule and contingency plan. The main aims of this study are:

- To conduct a baseline survey so that current distribution of INNS in Scapa Flow can be determined.
- To plan a monitoring programme which will be able to detect trends in the INNS distributions in Scapa Flow.
- To set a monitoring and reporting schedule.
- To trigger an appropriate and timely response to an introduction of INNS as per guidance from GB NNS Secretariat.

This document is a part of the Orkney Islands Council Revised Ballast Water Management Policy. This is not a comprehensive biosecurity plan for Scapa Flow. Only possible introductions of invasive non-native species via ships ballast water will be discussed other pathways are not considered.

Definitions:

Non-native species vs. Invasive non-native species
Non-native species are species that have been transported outside their natural range.

Some of these species can become invasive if they spread rapidly, damage our environment, the economy, our health and the way we live.

Vector or pathway. These are the means by which a species is moved from place to place due to human activity.

2 High Risk species list

A list of marine non-native species according to their impact has been compiled using advise from UK Technical Advisory Group (UK TAG) on the Water Framework Directive (2021), Appendix 1.

The High-Impact species for the baseline survey and for the monitoring programme are from the UK TAG list and includes eleven species, Table 1.

Table 1. High-Impact Species, Scapa Flow monitoring programme.

Scientific name	Common name	Environmental risk	Socio-economic Risk
Crepidula fornicata	Slipper limpet	HIGH	HIGH
Didemnum vexillum	Colonial tunicate	HIGH	HIGH
Eriocheir sinensis	Chinese mitten crab	HIGH	HIGH
Ficopomatus enigmaticus	Marine tubeworm	HIGH	HIGH
Hemigrapsus sanguineus	Asian shore crab	HIGH	HIGH
Hemigrapsus takanoi	Asian shore crab	HIGH	HIGH
Homarus americanus	American lobster	HIGH	HIGH
Styela clava	Leathery sea squirt	HIGH	HIGH
Urosalpinx cinerea	American oyster drill	HIGH	HIGH
Spartina anglica	Common cord-grass	HIGH	HIGH
Undaria pinnatifida	Japanese kelp	HIGH	HIGH

A short description of each High-Risk species including the current distributions is presented here.

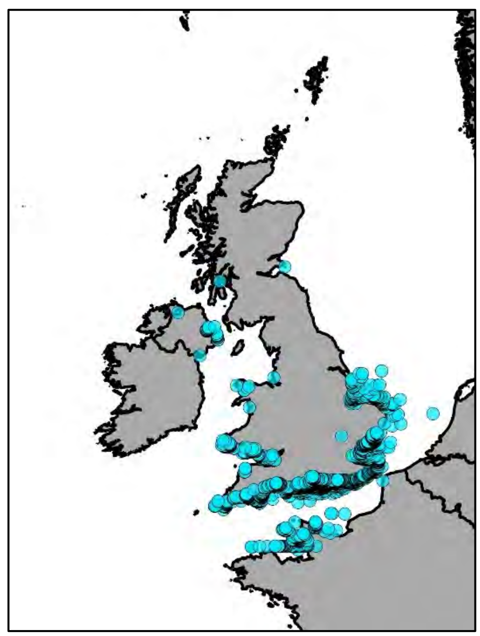
Crepidula fornicata (Linnaeus, 1758) - Slipper limpet

Shell is oval and up to 5 cm in length. The large shell opening has a shelf, extending half its length. Shell is smooth and white, cream, yellow or pinkish in colour with streaks or blotches of red or brown. Commonly found in curved chains or stacks made up of several individuals (GB NNSS, 2023a).

***Credipula fornicata*, slipper limpet**
Image: David Fenwick (NBN Atlas, accessed 29 03 2023)

Slipper limpet can smother seabed species, alter seabed habitat structure dramatically and compete for food and space with other filter-feeding species including mussels and oysters Thieltges et al., 2006). It's also likely to consume the planktonic larvae of some species. *C. fornicata* has been known to foul a variety of hard-shelled commercially important and farmed species and man-made structures and equipment.

Description of *Crepidula fornicata*, Slipper limpet status in GB
Crepidula fornicata was introduced to GB in the 1880s/1890s as a hitchhiker on American oyster imports (Blanchard, 1997). It is well established in the southern coasts of England and Wales (Bohn et al., 2015) and spreading northward. Now present on the east coast (up to Spurn Head) and west coast (up to Cardigan Bay) of England (GB NNSS, 2023a). Two records from Scotland have been confirmed (NBN Atlas, accessed 29 03 2023).



Slipper limpet distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 15:59:11 UTC 2023.

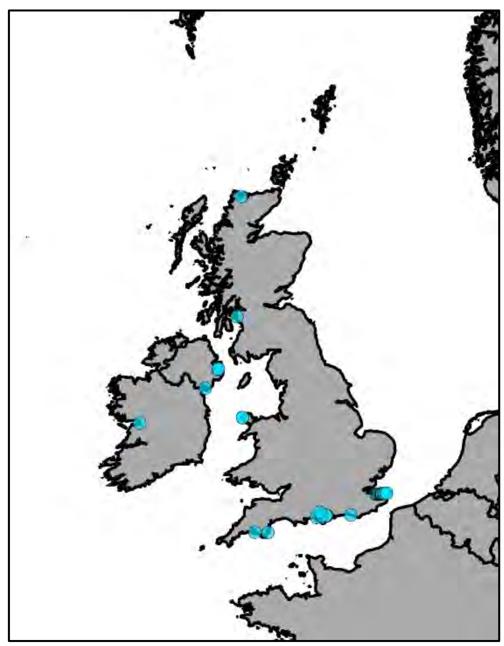
Didemnum vexillum Kott, 2002 - Carpet sea squirt

***Didemnum vexillum*, carpet sea squirt**
Image: Rohan Holt, CCW.

Pale orange, cream or off-white colonies forming extensive, thin (2-5 mm) sheets; can form long pendulous outgrowths. Firm, leathery texture and veined or marbled appearance. Numerous small pores in surface close when colony disturbed to produce tiny whitish spots; larger water exits occur at intervals (GB NNSS, 2023b).

Colonies can overgrow other fauna and in Holyhead Marina, Wales were in particular found growing on solitary ascidians (Griffith et al., 2009). In west coast of Scotland, it has been observed on artificial substrates at several marinas and harbour areas (Beveridge et al., 2011). Associated with a shellfish farm in Loch Creran *D. vexillum* has also been found growing on or as loose sections on natural substrate (Turrell et al., 2016; Begg et al., 2019).

Description of Didemnum vexillum, Carpet sea squirt status in GB
Carpet Sea-squirt was first recorded in GB at Holyhead Marina in Wales in 2008 (Griffith et al., 2009). Since then it has been recorded in several marinas in GB: North Wales, Devon, the Solent and the Clyde (GB NNSS, 2023b). In 2010 *D. vexillum* was recorded in Largs Yacht Haven, Fairlie Quay Jetty, Fairlie Moorings and Clydeport Jetty on the west coast of Scotland (Beveridge et al., 2011). In 2016 it was recorded in Loch Creran, Scotland (Turrell et al., 2016). The record on the NBN Atlas Distribution map from north coast of Scotland is of unconfirmed record (J. Kakkonen, pers. comm. 29 03 2023).



Carpet sea squirt distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 16:11:56 UTC 2023.

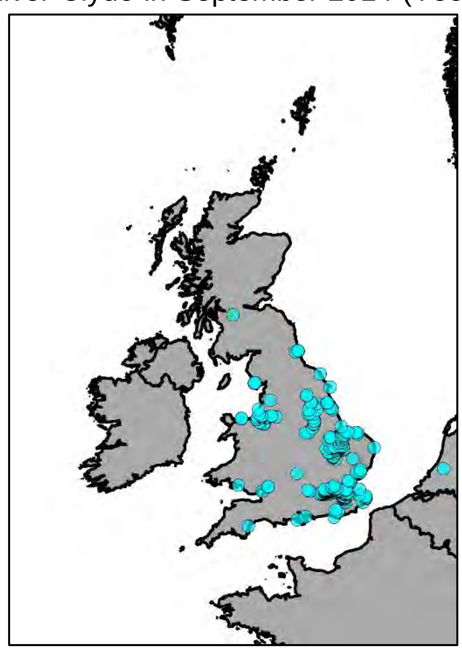
Eriocheir sinensis H. Milne Edwards, 1853 - Chinese mitten crab

Chinese mitten crabs are large olive-green to brown crabs with body length up to 56 mm (GB NNSS, 2023c). The body is square in outline with four teeth on each front side. The claws are covered with a dense mat of hair giving the impression of mittens (GB NNSS, 2023c). The leading edges of the legs are also very hairy.

***Eriocheir sinensis*, Chinese mitten crab**
Image: The Food and Environment Research Agency (Fera).

Chinese mittens crabs migrate between brackish / seawater habitat and riverine freshwater habitats as part of their lifecycle (Gilbey et al., 2008). Young crabs migrate from estuaries to rivers where they stay until they are ready to reproduce. Chinese mitten crabs burrow into riverbanks de-stabilizing and destroying the intertidal area (Gilbey et al., 2008; GB NNSS, 2023c).

Description of *Eriocheir sinensis*, Chinese Mitten Crab status in GB
Eriocheir sinensis is established in the Rivers Thames, Medway and Ouse and recorded from several sites throughout England and Wales, including the rivers Tyne, Tamar, and Dee and Southfields Reservoir near Castleford, Yorkshire (GB NNSS, 2023c). The species was first recorded in Scotland on the River Clyde in September 2014 (Yeomans and Clark 2016; Clyde River Foundation, 2017).



Chinese Mitten Crab distribution in UK.
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 15:54:36 UTC 2023.

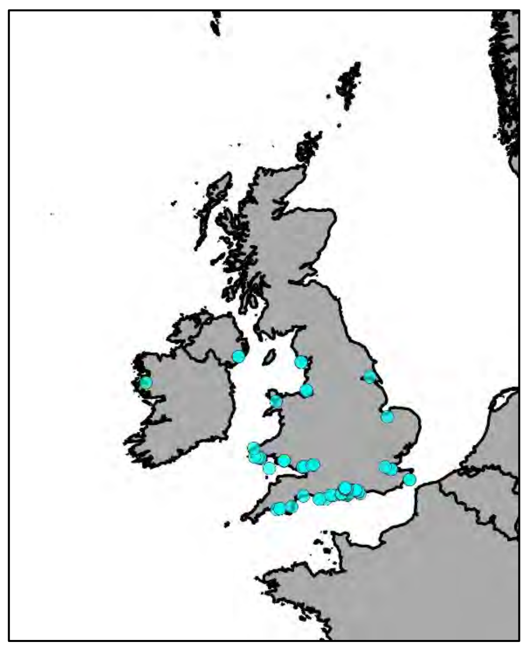
Ficopomatus enigmaticus (Fauvel, 1923) – Australian tubeworm

Ficopotamus enigmaticus is a fan worm which forms clumps or reefs of upright, white, intertwined chalky tubes (1-3 mm diameter) with flared collars (Richards, 2008). Each tube houses worm with thousands of individuals able to form large reefs (Richards, 2008).

***Ficopomatus enigmaticus*, Australian tubeworm**
Image: David Fenwick (NBN Atlas, accessed 29 03 2023)

The reefs of *F. enigmaticus* can change the local ecosystem by modifying hydrodynamic and sediment characteristics and by providing habitat for species (GB NNSS, 2023d). *Ficopotamus enigmaticus* is a brackish water species and requires hard substrate for its initial settlement (Heiman et al., 2008).

Description of *Ficopomatus enigmaticus*, marine tubeworm status in GB
Ficopotamus enigmaticus is recorded from several locations on south coast of England and Wales (Eno et al., 1997) and in Ireland (Minchin and Eno, 2002). No records from Scotland have been made.



Marine tubeworm distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 16:17:33 UTC 2023.

Hemigrapsus sanguineus (De Haan, 1835) - Asian shore crab

Asian shore crab *H. sanguineus* are small crabs with a square-shaped shell (GB NNSS, 2023e). The shell has three distinct teeth on either side of the front (anterior) margin. Colouration varies from dark orange to dark green. The pincers of *H. sanguineus* are marked with red, purple or brown spots with distinctive banding on the walking legs. (GB NNSS, 2023e). *Hemigrapsus sanguineus* is primarily associated with exposed natural and artificial intertidal rocky habitats but have been found in soft sediments and from subtidal habitats (GB NNSS, 2023e).

***Hemigrapsus sanguineus*, Asian shore crab**
Image: Ondřej Radosta

H. sanguineus has had major ecological impacts on the native fauna of rocky shore on the east coast of North America, economic impacts are unclear (GB NNSS, 2023e).

Description of *Hemigrapsus sanguineus*, Asian shore crab status in GB
First record of Asian shore crab *H. sanguineus* in GB was from north-west coast of Guernsey in 2000. Since then, it has been recorded from several locations on Guernsey and Jersey. In May 2014 individual male specimens were recorded in Wales and south-coast of England (Seeley, Sewell and Clark, 2015). No records have been made in Scotland.

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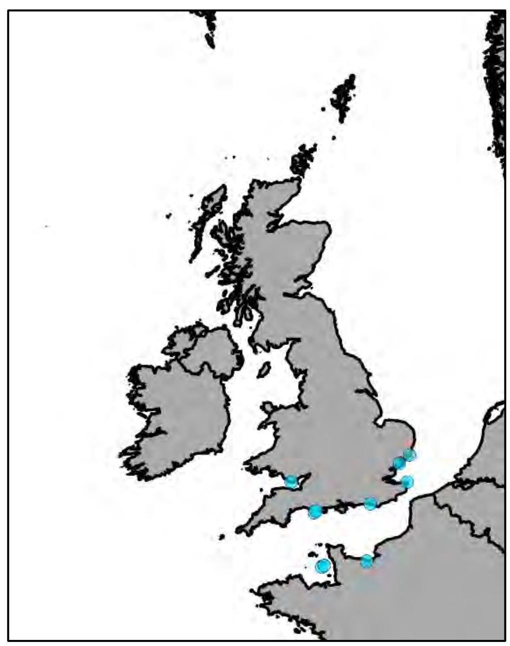

Asian shore crab *H. sanguineus* distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 16:17:33 UTC 2023

Hemigrapsus takanoi Asakura & Watanabe, 2005 - Asian shore crab

Asian shore crab *H. takanoi* are small crabs with a square-shaped shell (GB NNSS, 2023f). The shell has three distinct teeth on either side of the front (anterior) margin. Colouration varies from dark orange to dark green. The shell, legs and claws of *H. takanoi* are covered in tiny dark spots, large males have a small patch of yellow-brown fuzzy growth on the claws (GB NNSS, 2023f). *Hemigrapsus takanoi* prefer sheltered sites and are found under boulders and other hard structures (GB NNSS, 2023f).

***Hemigrapsus takanoi*, Asian shore crab.**
Image: Ondřej Radosta

Description of *Hemigrapsus takanoi*, Asian shore crab status in GB

First record of *H. takanoi* from GB was made from the River Medway, Kent and the River Colne, Essex, England in 2005 (Wood et al., 2015). Since then, it has become established in Kent with further records made from Suffolk (Ashelby et al., 2017). Several individuals were recorded from Norfolk in October 2022, indicating a significant north-wards range extension of this species (P. Davison, pers. comm. March 2023). No records of *H. takanoi* have been made in Scotland.

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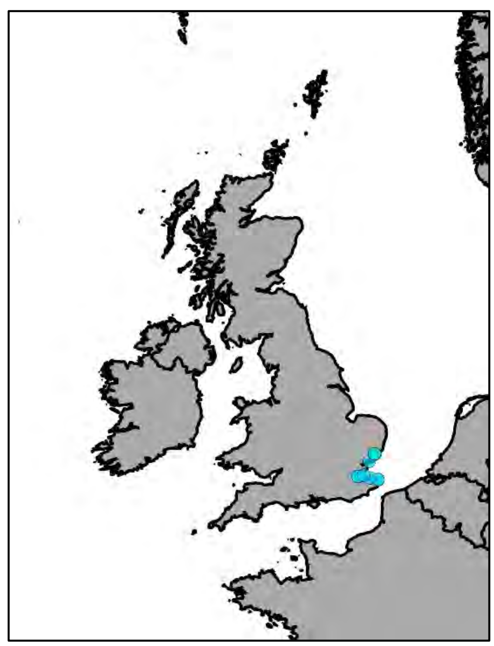


Asian shore crab *H. takanoi* distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 16:20:24 UTC 2023.

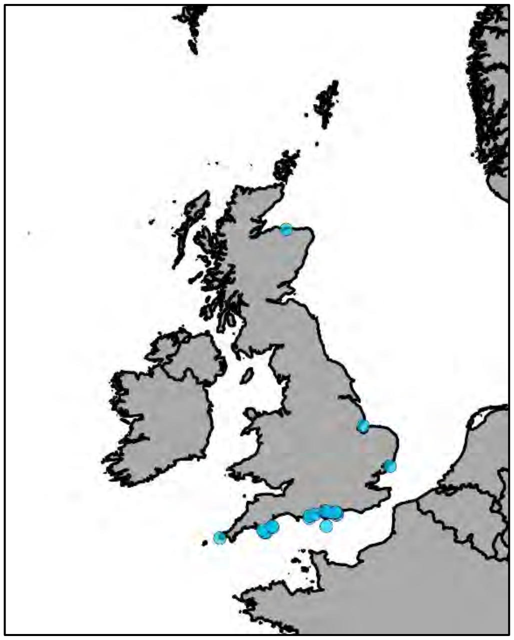
Homarus americanus H. Milne Edwards, 1837 - American lobster

American lobster *Homarus americanus* is similar to the native European Lobster; however, it tends to be larger with body length up to 50cm, with dark bluish green to greenish brown colouring with a reddish tint on body and claws and it has morphological features on the rostrum which distinguish it from the latter. Distinguishing between the two species can be difficult and may require expert assistance (Stebbing et al., 2023).

***Homarus americanus*, American lobster**
Image: GBNNSS

Description of *Homarus americanus*, American lobster status in GB

H. americanus was first recorded in British waters in 1988 where it was recorded in the Solent (GB NNSS, 2023g). It is now considered to be very common in British waters: however, a reproducing population is not considered to be established (Stebbing et al., 2023). Interbreeding and hybridisation with native lobsters is considered a risk and in 2019 a juvenile American lobster was recorded for the first time in European waters along the North-East coast of England (Tinlin-Mackenzie et al., 2022). One individual has been caught and recorded in Scotland (GB NNSS, 2023g).



American lobster distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 16:22:06 UTC 2023.

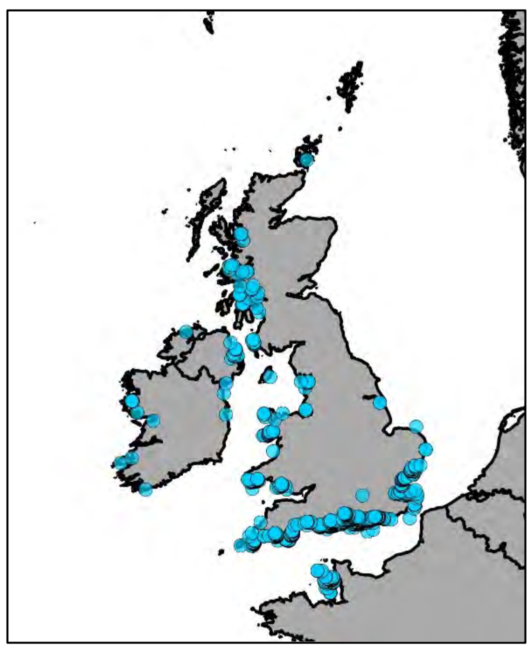
Styela clava Herdman, 1881 - Leathery sea squirt

A brown, non-colonial (unitary or 'solitary') sea squirt up to 20 cm tall, attached by a small flat holdfast at the base of a narrow stalk, and with two siphons close together at the free end (GB NNSS, 2023h). The surface is tough and leathery, with folds and swellings. The siphons show dark brown stripes when open (GB NNSS, 2023h).

***Styela clava*, leathery sea squirt.**
Image: Andrew Want

Styela clava always attaches to hard substrate in shallow water, especially in harbours and marinas but also on natural rocks, stones and shells (Lützen, 1998. It is a large organism that can achieve high densities and has proved to be a nuisance to long-line mussel farming in eastern Canada (Locke et al., 2007).

Description of *Styela clava*, Leathery sea squirt status in GB
Styela clava was first recorded in UK in Plymouth, Devon in 1953 (Carlisle, 1954). It is now established in the Clyde, Scotland, around the south coast of England to the Humber (Davis et al., 2007; GB NNSS, 2023h). A single specimen was recorded in Scapa Flow, Orkney in 2020 (Want and Kakkonen, 2021). The individual tunicate was removed, and no further records have been made since.



Leathery sea squirt distribution in UK
NBN Atlas occurrence download at NBN Atlas
accessed on Wed Jan 25 16:05:05 UTC 2023.

Urosalpinx cinerea (Say, 1822) - American oyster drill

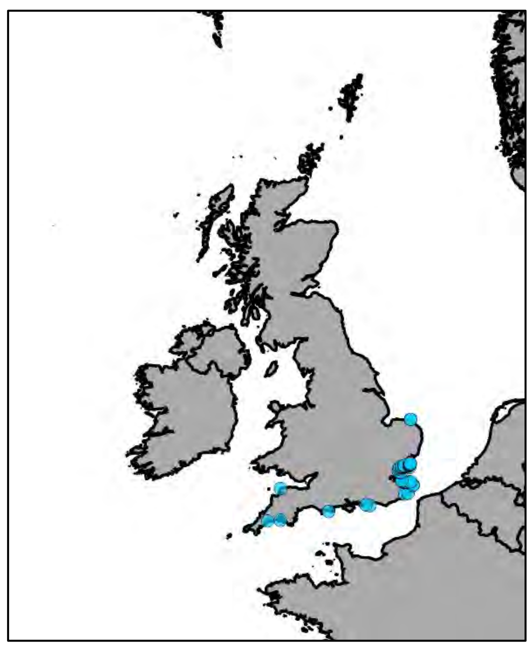
A tall, conical shell, up to 4 cm high and 2 cm broad, with a sharply pointed spire and up to eight rounded whorls bearing pronounced ridges and ribs (GB NNSS, 2023i). Yellowish, orange or grey in colour, sometimes with irregular brown marks. The aperture is oval with an open canal at the base (GB NNSS, 2023i).

Urosalpinx cinerea, American oyster drill
Image: Joop Trausel and Frans Slieker ·

Urosalpinx cinerea does not have a free-swimming larval phase, long distance introductions are due to transport of eggs, juveniles or adults amongst Pacific oyster *Magallana gigas* shells or other contaminated substrate (Didderen and Gittenbergen 2013). *Urosalpinx cinerea* are a nuisance species to the shellfish industry and it preys heavily on both native and introduced oyster species (Cole, 1942; Faasse and Ligthart, 2009).

Description of *Urosalpinx cinerea*, American oyster drill status in GB

The American oyster *Urosalpinx cinerea* drill was first recorded from Essex, UK in 1927 (Orton & Winckworth, 1928). Since then, it has been recorded along the Essex and Kent coasts, especially in estuaries and associated with oyster shellfish farms (GB NNSS, 2023i). No records have been made from Scotland.



American oyster drill distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 16:08:06 UTC 2023.

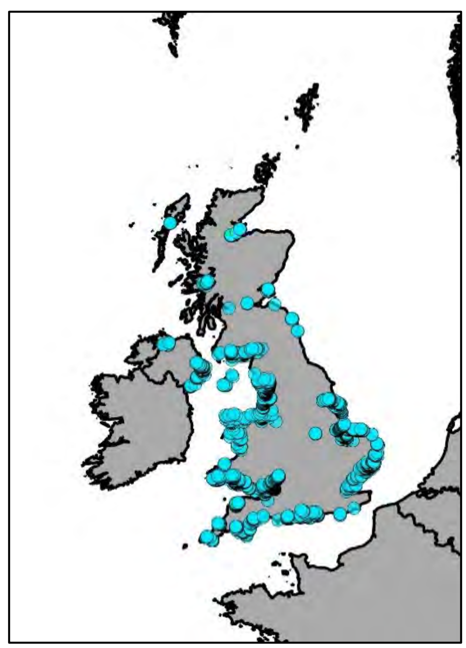
Spartina anglica C.E. Hubbard, 1968 - Common cord-grass

***Spartina anglica*, Common cord-grass**
Image from: http://de.wikipedia.org/wiki/Salz-Schlickgras

A robust, loosely tufted, perennial saltmarsh grass with short, thick rhizomes; culms 30 - 130 cm long and erect; leaves stiff, flat or inrolled, and ribbed above; inflorescence a long narrow panicle of two to nine erect spikes 8 - 15 cm long (Global Invasive Species Database, 2023).

It colonizes the lower zones of estuarine salt marshes and intertidal mudflats, excluding native flora and fauna and can lead to a loss of habitat for feeding and roosting, seriously affecting populations of migratory wildfowl and waders (Global Invasive Species Database, 2023). It may compete with areas used for commercial oyster and mussel farming. *Spartina anglica* is an aggressive invasive ranked among the "100 world's worst alien invaders" by the International Union for Conservation of Nature (IUCN).

Description of *Spartina anglica*, Common Cord-grass status in GB
Common cord-grass is established and invasive grass of estuarine saltmarshes in England, Wales and southern Scotland (GBIF Secretariat, 2022).



Common cord-grass distribution in UK
NBN Atlas occurrence download at NBN Atlas accessed on Wed Jan 25 15:41:30 UTC 2023.

Undaria pinnatifida (Harvey) Suringar, 1873 - Japanese kelp

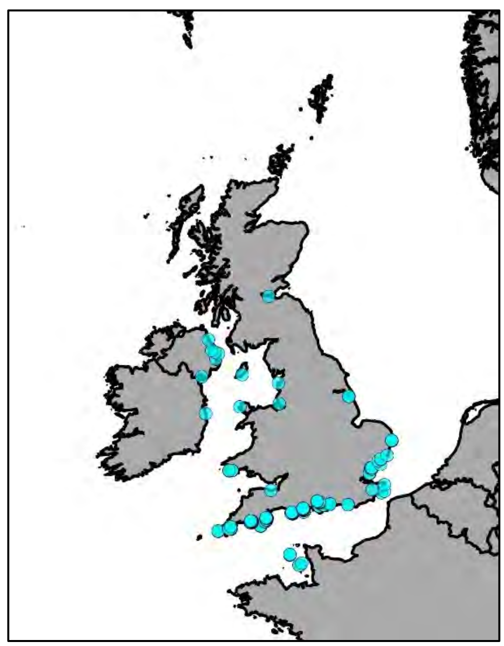
Japanese kelp *Undaria pinnatifida* is a large brown kelp with a branched holdfast giving rise to a stipe (GB NNSS, 2023j). The stipe has wavy edges, the blade is broad and flattened with a distinct midrib, individuals can reach up to 3m in length (GB NNSS, 2023j).

***Undaria pinnatifida*, Japanese kelp**
Image: Kathryn Birch - CCW

In GB *Undaria* can be found subtidally and in the very low intertidal and can rapidly colonize new or recently disturbed man-made structures such as floating marina pontoons, rope, pylons, vessel hulls and navigation buoys. It can grow at depths of up to 18 m and can grow in a wide range of wave exposures, from sheltered marinas to the open coast. It may also grow on loose cobbles and shells (GB NNSS, 2023j). Within natural environments Undaria is found in highest abundance in moderately sheltered to moderately exposed open coasts or bays near the open sea (Floc'h, Pajot, & Mouret, 1996; Russell et al., 2008; Saito, 1975 in Epstein & Smale, 2017).

Description of *Undaria pinnatifida*, Japanese kelp status in GB

In Britain the first record was in 1994 in the Hamble Estuary, in the Solent (Fletcher and Manfredi, 1995). Since then, the range has extended between Ramsgate and Torquay in 2004. It is also found on the shores and marinas around Plymouth and elsewhere on the south coast of England (GB NNSS, 2023b). First record of *U. pinnatifida* in Scotland was from Port Edgar Marina near Edinburgh in 2016 (L. King, pers. comm. 22 September 2016).



Japanese kelp distribution in UK
NBN Atlas occurrence download at NBN Atlasaccessed on Wed Jan 25 16:31:34 UTC 2023.

Marine non-native species recorded in Orkney

Twenty-six marine NNS have been recorded in Orkney Islands, of which twenty-one have been recorded in Scapa Flow (Kakkonen et al., 2019; Want and Kakkonen, 2021; OICHA unpublished data, 2023), Table 2.

By the UK TAG classification of aquatic alien species according to their level of impact many marine NNS are either unclassified or not yet listed. Any NNS has potential to become invasive, the OICHA NNS monitoring will therefore identify and report all NNS.

Table 2. Marine and brackish non-native species in Orkney Islands.

Scientific name	Orkney distribution	Environmental Risk	Socio-economic Risk
Antithamnion nipponicum	*Scapa Flow*	LOW	LOW
Asparagopsis armata	*Scapa Flow, Shapinsay, Westray*	LOW	LOW
Asterocarpa humilis	*Scapa Flow, Kirkwall Marina, Shapinsay, Eday and Westray*	LOW	LOW
Boccardia proboscidea	Scapa Flow	LOW	LOW
Bonnemaisonia hamifera	*Scapa Flow and Northern Outer Isles*	None Known	None Known
Botrylloides violaceus	*Kirkwall Marina*	LOW	LOW
Bugulina simplex	*Kirkwall and Stromness Marinas*	None Known	None Known
Caprella mutica	*Many locations incl. Scapa Flow*	MEDIUM	LOW
Codium fragile	*Many locations incl. Scapa Flow*	LOW	LOW
Colpomenia peregrina	*Many locations incl. Scapa Flow*	LOW	LOW
Corella eumyota	*Scapa Flow, Kirkwall Marina, Shapinsay, Eday and Westray*	LOW	MEDIUM
Dasysiphonia japonica	*Many locations incl. Scapa Flow*	None Known	None Known
Fenestrulina delicia	*Scapa Flow*	None Known	None Known
Goniadella gracilis	Scapa Flow	None Known	None Known
Melanothamnus harveyi	*Many locations incl. Scapa Flow*	LOW	LOW
Mya arenaria	*Loch of Stenness*	None Known	None Known
Potamopyrgus antipodarum	*Loch of Stenness, Scapa Flow*	MEDIUM	MEDIUM
Schizoporella japonica	*Scapa Flow, Kirkwall Marina, Shapinsay, Westray and Papay Westray*	None Known	LOW
Styela canopus	*Kirkwall and Stromness Marinas*	None Known	None Known
Telmatogeton japonicus	*Scapa Flow and Sanday*	None Known	None Known
Tricellaria inopinata	*Scapa Flow, Kirkwall Marina, Eday and Westray*	MEDIUM	LOW
Historical records and species recoded by other organisations.			
Austrominius modestus	*Stromness Marina*	None Known	None Known
Diadumene lineata	*Wide Firth and Shapinsay Sound*	LOW	LOW
Magallana gigas	*Scapa Flow*	MEDIUM	MEDIUM
Sargassum muticum	*Marwick and Birsay*	MEDIUM	LOW
Styela clava	*Scapa Flow*	HIGH	HIGH

3 Site selection

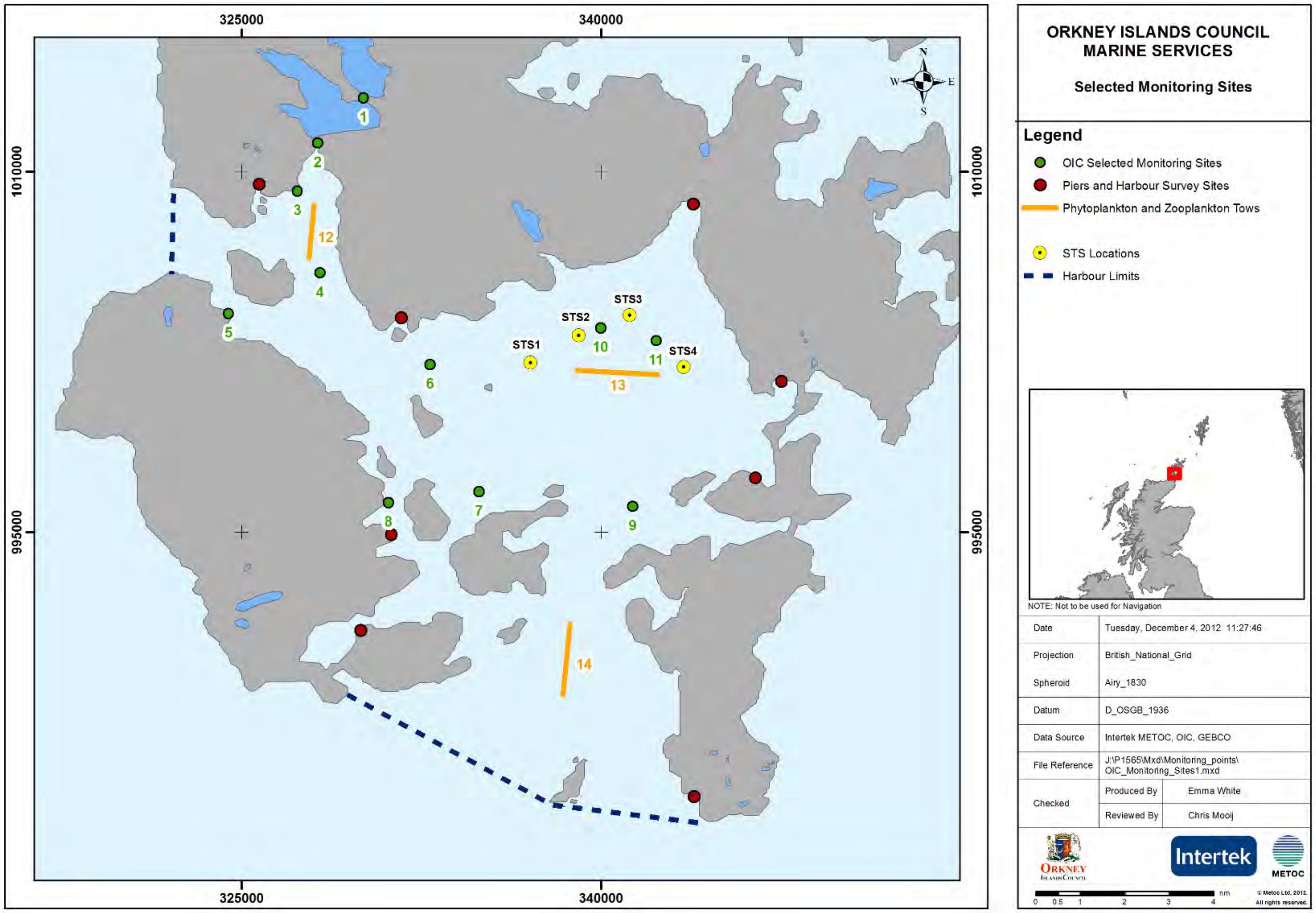
Most marine INNS surveys have been conducted in port environments (Hewitt and Martin, 2001; Arenas et al., 2006; Ashton et al., 2006; Pederson et al., 2003). Information on INNS monitoring in natural environments is limited but work has been conducted on non-native species in rocky shores by Mieszkowska and her team in Plymouth Marine Laboratory.

The main object of the Scapa Flow monitoring programme is to detect any INNS potentially been introduced in ballast water. For that reason, Intertek METOC prepared a briefing note to provide scientific justification to aid the site selection process. Appendix 2. has the full briefing note. See Table 3 and Map 1. for the survey sites.

Table 3. List of Monitoring sites

ID no.	Monitoring site	Approximate position
1	Road with sluice gates between Loch of Stenness and Loch of Harray, West Mainland Orkney	Along B9055
2	Brig O Waithe Bridge	Along A965
3	Outflow pipe, Stromness sewage works	North of Bu Point
4	Submerged obstruction, East of Graemsay	As per chart 35
5	Moaness Pier, Hoy	As per chart 35
6	Wrecks, North and East of Cava	As per chart 35
7	Navigational buoy, Vanguard	58˚51.418”N 003˚06.236”W
8	Navigational buoy, Gutter Sound	58˚50.705”N 003˚11.493”W
9	Navigational buoy, Grinds	58˚50.90’N 003˚00.80’W
10	Location in close proximity to STS2 and STS3	STS2: 58˚54’47.9”N 003˚03’33.8”W STS3: 58˚55’17.0”N 003˚01’18.1”W
11	Location in close proximity to STS3 and STS4	STS4: 58˚54’08.7”N 002˚58’55.2”W
12	Phytoplankton and zooplankton tow	Clestrain Sound
13	Phytoplankton and zooplankton tow	Middle of Scapa Flow
14	Phytoplankton and zooplankton tow	Entrance to Pentland Firth

Map.1. Locations of monitoring sites in Scapa Flow.



Description of the sites

1. Bridge with sluice gates between Loch of Stenness and Loch of Harray, West Mainland Orkney

This site is within Loch of Stenness. Might have access issues as it is not affected by tides.

2. Brig o Waithe Bridge

This site is on the pathway from STS operations to Loch of Stenness. The Brig O Waithe Bridge forms a part of an on-going rocky shore monitoring site (Bridge of Waithe) which has been visited 16 times in 1996-2012. Areas of the bridge can be accessed at low tide, boat use advisable.

3. Outflow pipe, Stromness

This site is on the pathway from STS operations to Loch of Stenness. The outflow pipe forms part of an on-going monitoring site (Skatelan Skerry and Bu) which has been visited 16 times in 2002-2012. The pipe is concrete and can be accessed at low tide.

4. Moaness Pier, Hoy

This site is on the pathway to the western access of Scapa Flow.

5. Submerged obstruction, East of Graemsay

This site is on the pathway from STS operations to Loch of Stenness. Least depth at this site is 5.8m. Surveys will be conducted by divers. Access by boat.

6. Wrecks, Cava

This site is on the pathway from STS operations to Loch of Stenness and will be surveyed by divers. It must be noted that in this site there are six German light cruiser wrecks in depths of up to 35m. We might not be able to survey each wreck but might have to survey them in rotational basis. Access by boat.

7. Navigation buoy, Vanguard

Control site. After maximum impact modelling this site was identified to be outside of the 'impact plume'. Open water site, access by boat.

8. Navigation buoy, Gutter Sound

This site was identified as being on the outer edge of the impact plume. Open water site, access by boat.

9. Navigation buoy, Grinds

Control site. After maximum impact modelling this site was identified to be outside of the 'impact plume'. Open water site, access by boat.

10. Location in close proximity to STS2 and STS3

This site is in middle of Scapa Flow between STS2 and STS3. Open water site, access by boat.

11. Location in close proximity to STS3 and STS4

This site is in middle of Scapa Flow between STS3 and STS4. Open water site, access by boat.

12. Phytoplankton and zooplankton tow

This phytoplankton and zooplankton tow will be taken from near Bu Point towards Clestrain Sound.

13. Phytoplankton and zooplankton tow

This phytoplankton and zooplankton tow will be taken from middle of Scapa Flow.

14. Phytoplankton and zooplankton tow

This phytoplankton and zooplankton tow will be taken from Hoxa Sound towards Pentland Firth.

4 Description of Methods

For the sampling methods we have followed the guidance from following sources:

Hewitt C.L and Martin R.B., (2001) Revised protocols for baseline port surveys for introduced marine species: survey design, sampling protocols and specimen handling. Centre for Research on Introduced Marine Pests.

Inglis G, Gust N, Fitridge I, Floerl O, Woods C, Hayden B and Fenwick G. (2006) Dunedin Harbour (Port Otago and Port Chalmers) Baseline survey for non-indigenous marine species (Research Project ZBS2000/4) Biosecurity New Zealand Technical Paper no: 2005/10.

Pederson, J., Bullock, R., Carlton, J., Dijkstra, J., Dobroski, N., Dyrynda, P., Fisher, R., Harris, L., Hobbs, N,, Lambert, G., Lazo-Wasem, E., Mathieson, A., Miglietta, M-P., Smith, J,, Smith, I.J., Tyrrell, M. (2003) Marine invaders in the northeast: Rapid assessment survey of non-native and native marine species of floating dock communities, August 2003. Massachusetts Institute of Technology, Sea Grant College Program.

A summary of each sampling technique is presented here, for full descriptions see Hewitt and Martin (2001), Inglis et al. (2003) and Pederson et al. (2003).

Rapid Assessment Survey

Sites are visually inspected for a minimum of 30mins from the surface level to approximate depth of 0.5m. In intertidal sites, all of the surface which is exposed at low tide will be surveyed. All non-native species found, will be collected and taken to laboratory.

All samples collected will be disposed of according to Wildlife and Natural Environment (Scotland) Act 2011.

Scrape sampling

This technique involves scraping a set area (quadrat) of fouling organisms and placing all material into a sampling tub. All specimens in the scrape samples will be identified in laboratory.

Bottom sediment grab samples

This method involves collecting benthic samples from the site. Three replicates of the samples will be collected at each site. The samples will be processed on site by using 0.5mm mesh sieves, contents will be transferred into sampling tubs. Identification of samples will be carried out in laboratory.

Settlement panels

Settlement panels will be placed in sites 1, 2, 3, 7, 8 and 9. The settlement panels will give a clean platform on which INNS can be detected in their earlier growth stages.

Environmental data

At each site salinity and temperature measurements will be taken. Monthly salinity and temperature measurements will be taken from anchorage 9 as shown on Chart 35.

Phytoplankton and zooplankton tows

For each phytoplankton sample 30m drop net trawls will be taken using a net of 500mm in diameter with 20 micron mesh as recommended by Hewitt and Martin (2001). The net will be dropped down the full length and then steadily pulled up through the water column. Three replicate samples will be taken at each site.

For the zooplankton sample the method will be the same as for phytoplankton but a net of 500mm in diameter with 100micron mesh (Hewitt and Martin 2001) will be used.

Rocky shore and sandy shore surveys

As part of their on-going monitoring programme the Marine Environmental Unit surveys 17 rocky shore sites and 14 sandy shore sites within Scapa Flow. There is in-house expertise on identification of INNS therefore it will be possible to integrate these surveys into our INNS monitoring programme.

Sample collection, identification and sorting

All samples will be collected by Marine Environmental Unit, Marine Services personnel and will be preserved on arrival to laboratory.

Sample sorting and identification will be performed by a certified taxonomic laboratory. All specimens will be identified to the lowest taxonomic level possible.

5 Baseline survey

Before an on-going monitoring programme can commence it is essential that a comprehensive baseline survey of the area in question is conducted. Bishop and Hutchison (2011) state that without full documentation of all native and non-native species present at a site, a survey may be of little value as a baseline against which to assess future arrivals. It is therefore essential to conduct a baseline survey during which all specimens collected are identified by using expert taxonomists.

The baseline survey will consist of survey visits to each one of our monitoring sites during February 2013 and August 2013. Methods used at each site are detailed in Table 4. Settlement panels will be placed on selected sites in July, for a period of 8 weeks, retrieval being in September.

On- going Monitoring programme

Once our baseline survey is completed and the current distribution of INNS and native species in the monitoring sites are known, the on-going monitoring programme for INNS in the area can commence.

For our monitoring programme all sites will be visited, once a year during the summer months, June, July and August. See Table 4. for the methods used at each site. Addition to this, settlement panels will be placed on selected sites in July, for a period of 8 weeks, retrieval being in September. Benthic samples will be taken in rotation with Scottish Environment Protection Agency's benthic invertebrate community assessments sampling, this is indicated as * in Table 4.

After each monitoring year the survey methods and frequency will be reviewed in light of the results.

This document will be reviewed annually to comply with any new national or international recommendations. The target species list will be reviewed and amended in according to any new guidelines.

Baseline survey schedule the year 2013

Baseline survey	Phase I	February 2013
	Phase II	August 2013
Report for Phase I		May 2013
Full report for Phase I and II		January 2014

Monitoring survey schedule as planned for the year 2014 and onwards

Monitoring surveys	June – Sept 2014

Then annually at the same time of the year.

*Table 4. Methods used for baseline survey. * see section 5 for explanation*

ID no.	Monitoring site	Survey method	Baseline survey (P1/P2)	Monitoring phase
1 - 4	Loch of Stenness sluice gates, West Mainland Orkney Brig O Waithe Bridge Bu Point, Stromness sewage works Moaness Pier, Hoy	Rapid assessment Scrape sample Settlement panel Temperature Salinity	P1 and P2 P1 and P2 P2 P1 and P2 P1 and P2	YES YES YES YES YES
5 & 6	The Hurdles SMS Coln	ROV visual search	P1	NO
7 - 9	Navigation buoys: Vanguard Gutter Sound The Grinds	Rapid assessment Scrape sample Settlement panel Temperature Salinity	P1 and P2 P1 and P2 P2 P1 and P2 P1 and P2	YES YES NO YES YES
10	Location in close proximity to STS2 and STS3	Benthic sample Salinity Temperature	P1 P1 P1	YES* YES YES
11	Location in close proximity to STS3 and STS4	Benthic sample Salinity Temperature	P1 P1 P1	YES* YES YES
12 - 14	Clestrain Sound Middle of Scapa Flow Hoxa Sound	Phytoplankton tow Zooplankton tow Temperature Salinity	P1 and P2 P1 and P2 P1 and P2 P1 and P2	YES YES YES YES

6 Recording and reporting of results

Survey and monitoring results will be reported locally and nationally.

Local reporting system

A full annual report on the methods, analyses and results of baseline survey and on-going monitoring will be prepared by Marine Environment Unit of Marine Services. Results on the on-going monitoring will be verbally reported and presented at least every six months to the Orkney Marine Environment Protection Forum. Members of this forum include NatureScot, Scottish Environment Protection Agency, Royal Society for the Protection of Birds and Repsol Sinopec Resources UK Limited.

National and International reporting system

All high-risk species or invasive non-native species recorded during the baseline survey and during on-going monitoring will be reported to the Marine Invasive Non-Native Species: Scottish Working Group and to the GB Non-Native Species Secretariat. Other non-native species will be reported through the Orkney Biodiversity Records Centre (OBRC) and AquaNIS. The OBRC then submits the records to the NBN network.

7 Contingency Plan

Response to an introduction of INNS will depend on the species detected and be proportionate to the threat posed. In the event that one of the species on our High Impact species list is found we will follow a GB High Priority response guidance on the action required. A flow diagram of steps taken is presented in Figure 1. Explanation of each step is explained here:

Identification.

All Orkney Islands Council Harbour Authority (OICHA) NNS monitoring samples are identified by taxonomic laboratory. If INNS has been reported to OICHA, specimens or photos are required to enable the confirmation of species identification. If it is not possible to identify the species from the information provided, the Marine Environmental Scientist will visit the site of introduction to collect specimens or water sample for environmental DNA testing. If required, samples will be sent to expert taxonomist or taxonomic laboratory for verification, or water samples sent for molecular analysis.

Reporting.

Report the presence of the species to ‘Scottish Marine Invasive Non-native Species Group’ and to the ‘GB Non-Native Species Secretariat’.

Internal meetings within OICHA to discuss the introduction and completion of briefing document to the Orkney Islands Council. Any relevant stakeholders and organisation will be contacted and informed of the introduction and on the plan of action.

Isolate / Contain.

Once the identification has been confirmed the area of the INNS introduction should be contained if possible. Depending on species this could for example include restricting vessel access to an area or lifting equipment out of the water as a precautionary measure. This is an initial response before a comprehensive survey (see below) has been completed.

Survey the distribution of the INNS.

To enable appropriate response, it is important to know the distribution of the INNS and whether it has established a population in the area. The type of survey, samples collected, and the urgency of the survey will depend on the species, location and on time of the year.

Risk assessment.

If a risk assessment on the INNS recorded has not already been completed by GB NNSS, an in-house risk assessment within the OICHA will be carried out in collaboration with GB NNSS. The risk assessment is used to advice decision on what action to take, along with input from experts, stake holders and from Orkney Islands Council.

The GBNN Species Secretariat has already prepared risk assessments most of the species which pose the biggest threat. Table 5 details which risk assessments relevant to Orkney have been completed.

Table 5. Risk Assessments and their availability at GB NNSS.

High Impact Species	GB NNSS Risk Assessment
Crepidula fornicata, Slipper limpet	Yes
Didemnum vexillum, Carpet sea squirt	Yes
Eriocheir sinensis, Chinese mitten crab	Yes
Ficopotamus enigmatus, Australian tubeworm	No
Hemigrapsus sanguineus, Asian shore crab	Yes
Hemigrapsus takanoi, Asian shore crab	No
Homarus americanus, American lobster	Yes
Spartina anglica, Common cord grass	No
Styela clava, Leathery sea squirt (In-progress)	Yes
Undaria pinnatifida, Japanese kelp	Yes
Urosalpinx cinerea, American oyster drill	Yes

An example of a Risk Assessment is presented in Appendix 4.

Species Action Plan.

When the distribution and level of establishment of the species is known and the risks associated with the species are understood a Species Action Plan will be developed. The Scottish Marine Invasive Non-native Species Group's Best Practice Guidance on species Containment, Control, or Eradication will inform the development and implementation of a species action plan with input from the GB Non-Native Species Secretariat.

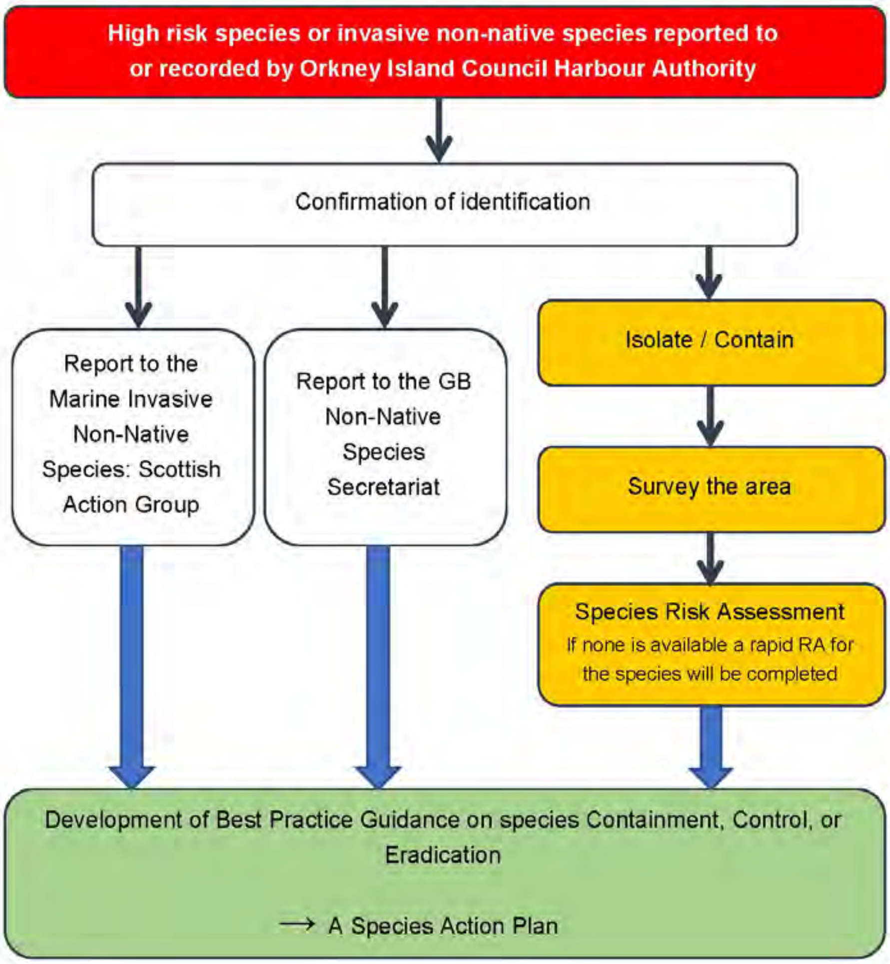


Figure 1. Contingency Plan flow diagram

8 Case Studies

In this chapter we present two case studies on eradication of invasive non-native species. First case study is on the eradication of *Didemnum vexillum* in Holyhead marina in Wales and is taken from their monitoring report (Holt, R.H.F. and Cordingley, A.P., 2011). Second case study is of freshwater animal, American Signal Crayfish (*Pacifastacus leniusculus*) this example has been taken from Williams *et al* (2012) The Economic Cost of Invasive Non-Native Species on Great Britain.

***Didemnum vexillum* eradication in Holyhead marina**

The non-native sea squirt *Didemnum vexillum* was discovered in the marina in Holyhead Harbour by MSc student Kate Griffith from the School of Ocean Sciences in the summer of 2008. Subsequent surveys in the British Isles located this species in Largs (west Scotland), Plymouth and Dartmouth (south-west England), Solent (south England) and Malahaide and Carlingford Lough in the republic of Ireland. Virtually all instances of this species were found in marinas implicating leisure craft as the prime vectors.

The Countryside Council for Wales (CCW) responded by surveying its distribution and extent in the wider harbour. It appeared to be confined to living on the floating pontoon structures and chains anchoring the marina in place. Later in the year a feasibility study for its eradication drew evidence from other eradication programmes around the World – particularly from New Zealand – and on the basis of a potential success an eradication programme was initiated. The eradication pilot started in October 2009, using plastic wrappings and bags to isolate, smother and kill the sea squirt by inducing a stagnation reaction around the pontoons. Later in the year, once appropriate FEPA permissions had been obtained, the eradication process was accelerated by adding calcium hypochlorite to the bags and wraps. Although very labour intensive this process apparently worked well; the pontoons were treated in batches of up to 60 floats at a time and cleared of virtually all marine life. The entire marina (over 530 pontoons and associated mooring chains) and around 100 surrounding swinging moorings were treated through the winter and finally cleared by the end of May 2010.

As part of the quality assurance measures during the eradication programme, inspection of the marina and other structures in Holyhead Harbour during late winter and early spring, revealed no trace of *D. vexillum* on any of the structures within the marina. However, in May 2010, diving surveys revealed a colonial didemnid sea squirt, with many of the characteristics of *D. vexillum*, growing on the ferry terminals and Tinto aluminium jetty. Once the summer had progressed sufficiently to find larvae-producing specimens this was confirmed to be a native species – this misidentification issue highlighted the difficulty in identifying *D. vexillum*.

In late August and early September 2010 a few small colonies confirmed to be *D. vexillum* were found in the marina during a routine survey and plans were initiated to re-treat these few small areas. In early October 2010, immediately before the eradication work recommenced, further survey work revealed large numbers of very small colonies and rapidly growing larger colonies over a much larger proportion of the marina than had been detected earlier. By early January 2011 it was evident that CCW had neither the funds nor time remaining while sea temperatures were sufficiently low to suppress larval production to re-run an improved eradication programme. It was therefore decided to re-direct funds and effort towards improving biosecurity and monitoring including the building of a prototype quarantine berth and self-antifouling pontoons. In the meantime CCW will be raising funds for a full-scale and much improved eradication attempt for the winter of 2011-2012.

Estimated cost (over 10yrs)
£385,000 in first 3yrs, ongoing monitoring after 3yrs estimated to be £20,000/yr. Total eradication cost over 10yrs approx. £525,000
Total cost if 'do nothing' approx. £6,875,625 (impact to local mussel industry)

Reference:
Holt, R.H.F. and Cordingley, A.P. (2011). Eradication of the non-native carpet ascidian (sea squirt) *Didemnum vexillum* in Holyhead Harbour: Progress, methods and results to spring 2011. CCW Marine Monitoring Report No. 90

Signal Crayfish (*Pacifastacus leniusculus*)

The American signal crayfish was introduced to Britain in the late 1970s primarily to farm for food. However, they quickly escaped or were deliberately released and spread rapidly across England and Wales. The distribution is currently limited in Scotland, though increasing.

The signal crayfish is larger than the native white-clawed crayfish, and out-competes the native crayfish, as well as carrying a crayfish plague that kills the native species. Signal crayfish burrow into riverbanks, increasing erosion as well as affecting wild fish stocks (bullhead, stone loach, salmonids and other angling species) whose eggs are predated. White-clawed crayfish are not native to Scotland, although there are two introduced populations in Scotland (Peay 2006). However, control measures are still undertaken for signal crayfish due to their effects on fisheries and economically important species, such as salmon.

There are known populations of signal crayfish in the Upper Clyde, the Kirkcudbrightshire Dee catchment (including Loch Ken), the River Earn (Ribbens and Graham 2004) and the North Esk catchment (Peay et al. 2006). No specific costs could be found for control measures in these areas, although one project in Loch Ken was said to cost £90,000. (Attempts to obtain more details of the cost of signal crayfish to Loch Ken were not forthcoming.) Therefore, if it is assumed that five management projects are carried out each year at the same average cost as England (£32,574) (as this is based on a larger sample size), then management costs in Scotland can be estimated at £162,870. Other economic costs are attributable to the presence of signal crayfish in Great Britain, such as the loss of aesthetic value related to native white-clawed crayfish and damage to river banks through burrowing. However, no data could be identified that valued white clawed crayfish or the amount of damage done to river banks, even though some figures were available on the costs of bank restoration work. The data that was available is summarised to give the following totals of annual costs to the economy due to the presence of signal crayfish.

Table 5. Total annual costs to the economy due to presence of signal crayfish.

	England	Scotland	Wales	GB
Management	£776,000	£163,000	£363,000	£1,302,000
River Bank Restoration	£100,000	£50,000	£50,000	£200,000
Angling	£550,000	£325,000	£125,000	£1,000,000
Research	£112,000	£38,000	£37,000	£187,000
Total	£1,538,000	£576,000	£575,000	£2,689,000

Reference:
Williams, F; Eschen, R; Harris, A.; Djeddour, D; Pratt, C; Shaw, RS; Varia, S; Lamontagne-Godwin, J; Thomas, SE; Murphy, ST. The Economic Cost of Invasive Non-Native Species on Great Britain. November 2010. CABI Project No. VM10066

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APPENDIX 1. High Risk species list for marine invasive non-native species monitoring.

Level of Impact	In Loch of Stenness	In Scapa Flow	Established in Scotland (North Sea)	Common Name	Latin Name	Plant or Animal (P/A)	Habitat	Reason for impact classification level
High Impact	NO	NO	YES	Chinese mitten crab	*Eriocheir sinensis*	A	R/T/C	Evidence of major impacts: ecological and economic consequences
	NO	NO	NO	Marine tubeworm	*Ficopomatus enigmaticus*	A	T/[C]	
	NO	NO	YES	Slipper limpet	*Crepidula fornicata*	A	T/C	Spreads rapidly. Well documented impacts. Two records from Scotland, 1988 and 2001.
	NO	NO	YES	Colonial tunicate	*Didemnum* spp. (non-native)	A	C	
	NO	NO	NO	Asian shore crab	Hemigrapsus sanguineus	A	C	
	NO	NO	NO	Asian shore crab	Hemigrapsus takanoi	A	C	
	NO	NO	YES	American lobster	*Homarus americanus*	A	T/C	One records from Scotland, Moray Firth from 2001.
	NO	YES	YES	Leathery sea squirt	*Styela clava*	A	T/C	Spreads rapidly. Well documented impacts: ecological and economic consequences.
	NO	NO	NO	American oyster drill	*Urosalpinx cinerea*	A	T/C	Slow and limited natural dispersal.
	NO	NO	YES	Common cord-grass	*Spartina anglica*	P	T/C	Spreads rapidly, very invasive. Well documented adverse ecological impacts.
	NO	NO	YES	Japanese kelp	*Undaria pinnatifida*	P	T/C	
Moderate Impact	YES	YES	YES	Jenkin's spire shell	*Potamopyrgus antipodarum*	A	R/L/T/C	Spreads rapidly. Well documented impacts: ecological and economic consequences.
	NO	YES	YES	Japanese skeleton shrimp	*Caprella mutica*	A	T	
	NO	NO	YES	Pacific oyster	*Magallana gigas*	A	T/C	
	NO	YES	YES	Red seaweed	*Bonnemaisonia hamifera*	P	T/C	
	NO	NO	NO	Marine alga	*Gracilaria vermiculophylla*	P	C	
Low Impact	NO	NO	YES	Marine copepod	*Acartia tonsa*	A	C	
	NO	NO	NO	Magellan mussel	*Aulacomya ater*	A	C	Very restricted distribution.
	NO	NO	NO	Bamboo worm	*Clymenella torquata*	A	T/C	Long established with very restricted distribution.
	NO	NO	YES	Marine amphipod	*Corophium sextonae*	A	T/C	Well dispersed but with apparently negligible effects.
	NO	YES	YES	Barnacle species	*Elminius modestus*	A	T/C	Spreads rapidly, very invasive. Well documented impacts, evidence of ecological impacts.
	NO	YES	NO	Marine polychaete	*Goniadella gracilis*	A	C	
	NO	NO	NO	Marine hydrozoan	*Gonionemus vertens*	A	C	
	NO	NO	NO	Marine polychaete	*Marenzellaria viridis*	A	T/C	
	NO	NO	NO	American hard-shell clam	*Mercenaria mercenaria*	A	T/C	Long established. Well documented. But current populations are thought to be very low.
	NO	NO	YES	American piddock	*Petricola pholadiformis*	A	T/C	
	NO	NO	NO	Zuiderzee or dwarf crab	*Rhithropanopeus harrisii*	A	T/C	
	NO	NO	YES	Manilla clam	*Ruditapes philippinarum*	A	T/C	One record in Scotland from Skye in 2014.
	NO	NO	NO	New Zealand flat oyster	*Tiostrea lutaria*	A	T/C	Very restricted distribution. Very slow dispersal rate.
	NO	NO	NO	Red seaweed	*Agardhiella subulata*	P	T/C	
	NO	NO	NO	Captain pike's weed	*Pikea californica*	P	T/C	Very restricted distribution and limited by temp.
	NO	NO	YES	Japanese weed	*Sargassum muticum*	P	T/C	Spreads rapidly. Recorded on the West coast of Orkney from 2019 onwards.

OIC Harbour Authority Ballast Water Management Policy for Scapa Flow *10 December 2013*

Orkney Marine Environmental Protection Committee / Forum *29 Apr 2014, 29 Nov 2017 and 20 Apr 2023*

Level of Impact	In Loch of Stenness	In Scapa Flow	Established in Scotland (North Sea)	Common Name	Latin Name	Plant or Animal (P/A)	Habitat	Reason for impact classification level
Unknown impact	NO	NO	NO	Sea spider	*Ammothea hilgendorfi*	A	T/C	
	NO	NO	YES	Barnacle species	*Balanus amphitrite*	A	C	One record in Scotland from Shetland in 1988.
	NO	NO	NO	Marine hydroid	*Clavopsella navis*	A	T	
	NO	NO	YES	American jack knife clam	*Ensis leei*	A	T/C	
	NO	NO	NO	Marine copepod	*Eusarsiella zostericola*	A	T/C	
	NO	YES	YES	Orange striped sea anemone	*Diadumene lineata*	A	T/C	
	NO	NO	NO	Marine tubeworm	*Hydroides dianthus*	A	T/C	
	NO	NO	NO	Marine tubeworm	*Hydroides ezoensis*	A	T/C	
	NO	NO	NO	Marine tubeworm	*Neodexiospira brasiliensis*	A	T/C	
	NO	NO	NO	Kuruma prawn	*Penaeus japonicus*	A	T/C	
	YES	YES	YES	Soft-shelled clam	*Mya arenaria*	A	T/C	
	NO	NO	NO	Dark false mussel	*Mytilopsis leucophaeta*	A	T/C	
	NO	NO	NO	Marine tubeworms	*Pileolaria berkeleyana*	A	T/C	
	NO	NO	NO	Marine mollusc	*Pinctada imbricata radiata*	A	T/C	
	NO	NO	YES	Red seaweed	*Anthithamniolle spirographidis*	P	T/C	
	NO	NO	NO	Red seaweed	*Anthithamniolle ternifolia*	P	T/C	Two records from Outer Hebrides.
	NO	YES	YES	Red seaweed	*Asparagopsis armata*	P	T/C	
	NO	NO	NO	Wright's Golden Membran Weed	*Chrysymenia wrightii*	P	T/C	
	NO	YES	YES	Green seaweed	*Codium fragile subspp. tomentosoides*	P	T/C	
	NO	YES	YES	Oyster thief	*Colpomenia peregrina*	P	T/C	
	NO	NO	YES	Diatoms	*Coscinodiscus wailesii*	P	T/C	
	NO	NO	NO	Red seaweed	*Grateloupia doryphora*	P	T/C	
	NO	NO	NO	Red seaweed	*Grateloupis filicina var. luxurians*	P	T/C	Several records from the West Coast of Scotland.
	NO	NO	YES	Marine diatom	*Odontella sinensis*	P	C	
	NO	NO	NO	Diatoms	*Pleurosigma simonsensii*	P	T/C	
	NO	YES	YES	Red seaweed	*Melanothamnus harveyi*	P	T/C	
	NO	NO	NO	Red seaweed	*Solieria chordalis*	P	T/C	
	NO	NO	NO	Diatoms	*Ethmodiscus punctiger*	P	T/C	
	NO	NO	NO	Diatoms	*Thalassiosira tealata*	P	T/C	

Habitat classification: R, rivers; L, lakes; T, transitional waters; C, coastal waters (Scapa Flow and Loch of Stenness - designated as coastal waters)

Reference: UK Technical Advisory Group on the Water Framework Directive. (2021). *Revised classification of aquatic alien species according to their level of impact. Version 8.*

APPENDIX 2. Proposed ballast water management policy – Selection of Monitoring sites

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ORKNEY ISLANDS COUNCIL

PROPOSED BALLAST WATER MANAGEMENT POLICY

SELECTION OF MONITORING SITES

Briefing Note Reference. P1565_BN3072_Rev1

Issued 21 September 2012

Metoc Limited
Exchange House
Liphook
Hants GU30 7DW
United Kingdom

Tel: +44 (0) 1428 727800
Fax: +44 (0) 1428 727122

E-mail: metoc.information@intertek.com
Web Site: www.metoc.co.uk

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1 INTRODUCTION

Intertek METOC (METOC Ltd.) has prepared this briefing note to provide scientific and practical justification for the Orkney Islands Council (OIC) to aid the construction of a monitoring programme within Scapa Flow, Orkney Islands. The proposed monitoring programme is designed to support the implementation of the proposed Ballast Water Management Policy (BWMP). At each of the proposed monitoring sites the presence of non-native species, if any, will be periodically quantified to determine the potential impacts from the proposed BWMP.

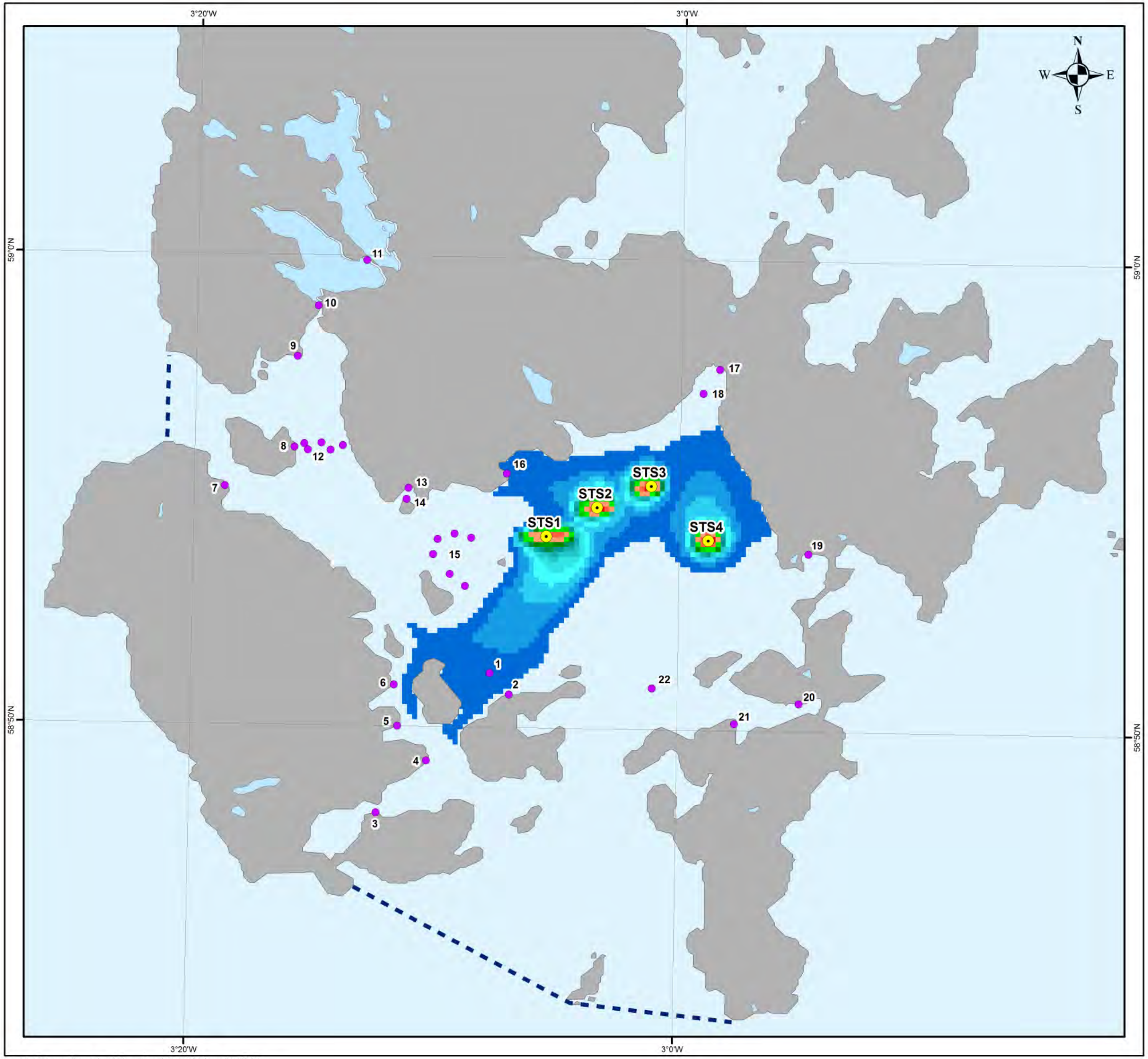
2 MONITORING SITE SELECTION

Intertek METOC previously modelled the impacts of discharging exchanged ballast water in Scapa Flow (1), under the proposed BWMP using ship-to-ship (STS) transfers. In addition, Figure 2-1 presents a composite plot of concentration. It is made up from the maximum concentration within each grid cell resulting from a discharge at any of the four STS locations being considered (STS1, STS2, STS3 and STS4). Figure 2-1 does not depict any specific moment in time but represent the worst-case impacts across the model domain over the entire model run duration (60 days). The colours and contour bands have been selected for clarity and are not indicative of actual concentrations. The presentation (i.e. colours) of results is not associated with the Hydrodynamic Connectivity Index used in previous reports (1). Modelling artifacts (i.e. limitations of the modelling process that no reflect real impacts) have been removed from the data in Figure 2-1.

OIC have provided the locations of existing infrastructure within Scapa Flow that could be used as monitoring sites, see Table 2-1 and Figure 2-1. These have been considered and where appropriate should be utilised in the monitoring programme in order to minimise the introduction of new objects in Scapa Flow, which may support a “stepping stone” movement of species. The use of existing structures also decreases costs and increases practicality of the proposed monitoring programme.

Table 2-1: Existing Infrastructure provided by Orkney Islands Council

ID No	Name	Easting	Northing
1	Navigational buoy, Flotta	334892	996692
2	Heyspan Pier, Flotta	335654	995840
3	Longhope Pier, Hoy	330390	991189
4	Navigational buoy, Hoy	332379	993238
5	Lyness Pier, Hoy	331243	994614
6	Navigational buoy, East of Hoy	331108	996244
7	Moaness Pier, Hoy	324435	1004116
8	Gangsti Pier, Graemsay	327190	1005635
9	Outflow pipe, Stromness	327317	1009219
10	Brig O Waithe Bridge, Stenness	328150	1011212
11	Bridge with sluice gates between Loch of Stenness and Loch of Harray, West Mainland Orkney	328954	1013522
12	Submerged Obstruction, East of Graemsay	327573	1005767
		328255	1005797
		329103	1005689
		328616	1005514
		327719	1005524
13	Houton Pier, Houton	331691	1004005
14	Navigational buoy in Houton Bay, Houton	331617	1003572
15	Wrecks, Cava (depth range 35-20m)	333920	1000132
		333321	1000611
		332663	1001388
		332843	1001986
		333516	1002196
		334174	1002031
16	Swanbister Pier, Swanbister	335580	1004574
17	Scapa Pier, Scapa	344014	1008656
18	Navigational buoy, Scapa Bay	343356	1007714
19	St Mary's Pier, St Mary's	347499	1001358
20	Burray Pier, Burray	347110	995451
21	St Margaret's Hope Pier, South Ronaldsay	344553	994673
22	Navigational buoy, Hoxa	341307	996079



ORKNEY ISLANDS COUNCIL MARINE SERVICES

Potential footprint from proposed STS operations

Legend

- Existing Infrastructure
- STS Locations
- Harbour Limits
- Inland Water bodies

Impact

Greater

Lesser

Date	Tuesday, April 22, 2014 10:30:58
Projection	British_National_Grid
Spheroid	Airy_1830
Datum	D_OSGB_1936
Data Source	ESRI, OSOD
File Reference	J:\P1565\Mxd\Monitoring_points\Baseline_Survey\Max_STS_v1.mxd
Created By	Emma White
Reviewed By	Ian Charlton
Approved By	Chris Mooij

ORKNEY ISLANDS COUNCIL

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3 RECOMMENDATIONS

Our recommendations for monitoring locations are made on the basis of a targeted programme based on five primary sites. These sites provide reasonable coverage of impacted areas, proximity to Loch of Stenness (Special Area of Conservation (SAC)) and Scapa Flow in general.

This programme could be extended to include a further five secondary sites if necessary.

Recommended primary sites are:

- A new location in close proximity to STS2 and STS3
- Brig O Waithe Bridge (10)
- Wrecks, Cava (15)
- Navigational Buoy, Hoxa (22)
- Submerged Obstruction, East of Graemsay (12)

Recommended secondary sites are:

- Bridge between Loch of Stenness and Loch of Harray (11)
- Outflow Pipe, Stromness (9)
- Navigation Buoy, East of Hoy (6)
- Navigational Buoy, Flotta (1)
- A new location between STS3 and STS4

These sites are selected to support quantitative assessment of species distribution in Scapa Flow. Loch of Stenness is a designated SAC and therefore we suggest that the Brig O Waithe Bridge is selected as a monitoring site to determine if non-native species enter the Loch of Stenness under the proposed BWMP. In addition, it would be desirable to monitor at the divide between Loch of Stenness and Loch of Harray to determine the geographical extent of non-native species if they were to enter the Loch of Stenness. The Outflow at Stromness would also be desirable to monitor given its close proximity to the Loch of Stenness.

We have identified the Wreck at Cava; the Submerged Obstruction east of Graemsay and the navigation buoy east of Hoy, as practical sites for monitoring potential non-native species in Scapa Flow. These three sites are in the located in the predicted pathway of ballast water leaving Scapa Flow. We recommend that a monitoring site should be implemented between STS2 and STS3 to encapsulate the region with a higher degree of risk than the majority of Scapa Flow. A monitoring site between of STS3 and STS4 would also be desirable.

We recommend that the navigational buoy at Hoxa should be monitored due to allow for environmental variation within Scapa Flow. Scapa Flow is highly sensitive to variations in wind conditions. Under certain wind conditions the discharge plume could extend further to the south. Therefore, by including this monitoring site any non-native species in the south of Scapa Flow can be quantified. Moreover, a monitoring site at the navigation buoy at Flotta would improve spatial coverage of Scapa Flow.

These monitoring sites outlined in this note have been selected to provide data in the potentially most impacted areas of Scapa Flow and to provide good spatial coverage.

4 REFERENCES

1) Intertek METOC, Habitats Regulation Appraisal Appropriate Assessment Scapaflow Discharge, 14th May 2012,P1565_RN2788_Rev2

APPENDIX 3. Didemnum vexillum Risk Assessment

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Information about GB Non-native Species Risk Assessments

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species where there is often a lack of firm scientific evidence. It also strongly promotes the use of good quality risk assessment to help underpin this approach. The GB risk analysis mechanism has been developed to help facilitate such an approach in Great Britain. It complies with the CBD and reflects standards used by other schemes such as the Intergovernmental Panel on Climate Change, European Plant Protection Organisation and European Food Safety Authority to ensure good practice.

Risk assessments, along with other information, are used to help support decision making in Great Britain. They do not in themselves determine government policy.

The Non-native Species Secretariat (NNSS) manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. Risk assessments are carried out by independent experts from a range of organisations. As part of the risk analysis process risk assessments are:

- Completed using a consistent risk assessment template to ensure that the full range of issues recognised in international standards are addressed.
- Drafted by an independent expert on the species and peer reviewed by a different expert.
- Approved by an independent risk analysis panel (known as the Non-native Species Risk Analysis Panel or NNRAP) only when they are satisfied the assessment is fit-for-purpose.
- Approved for publication by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP.

To find out more about the risk analysis mechanism go to: www.nonnativespecies.org

Common misconceptions about risk assessments

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted:

- Risk assessments consider only the risks posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Risk assessments are about negative impacts and are not meant to consider positive impacts that may also occur. The positive impacts would be considered as part of an overall policy decision.
- Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based.
- Completed risk assessments are not final and absolute. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Draft risk assessments are available for a period of three months from the date of posting on the NNSS website*. During this time stakeholders are invited to comment on the scientific evidence which underpins the assessments or provide information on other relevant evidence or research that may be available. Relevant comments are collated by the NNSS and sent to the risk assessor. The assessor reviews the comments and, if necessary, amends the risk assessment. The final risk assessment is then checked and approved by the NNRAP.

*risk assessments are posted online at:
https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51
comments should be emailed to nnss@fera.gsi.gov.uk

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

For more information visit: www.nonnativespecies.org

	Name of Organism:	***Didemnum sp. (Ascidiacea, Tunicata)***	
	Objectives:	Assess the risks associated with this species in GB	
	Version:	FINAL 22/03/11	
N	**QUESTION**	**RESPONSE**	**COMMENT**
1	What is the reason for performing the Risk Assessment?	The organism has invaded a new area, other than the Risk Assessment area	Request made by GB Programme Board
2	What is the Risk Assessment area?	Great Britain	
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
A	**Stage 2: Organism Risk Assessment SECTION A: Organism Screening**		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	NO (Go to 6)	At present, there is some controversy regarding the taxonomic relationships of the *Didemnum* species reported in the literature. Two species have been formally named: *Didemnum vexillum* described from New Zealand (Kott, 2002) and *Didemnum vestum*, described from the US east coast (Kott, 2004), based on morphological characteristics. Species of the genus *Didemnum* that are possibly different but related to *D. vexillum* and *D. vestum* have been recorded from France and the Netherlands (*D. lahillei* or *D. helgolandicum*), the U.S. west coast (*D. carnulentum*), New England (US) (*D. lutarium*), British Columbia, and recently from Ireland and Japan (*D. pardum*). These organisms have not yet been formally compared to either *D. vexillum* or *D. vestum* in the published literature, so they are provisionally called *Didemnum* sp. However, Stefaniak *et al.* (2009) and Lambert (2009) have demonstrated that some, if not all, of these are *D. vexillum*, and this is now the generally accepted name for the globally invasive cool-temperate species. Nevertheless, identification to species is extremely difficult.
6	If not a single taxonomic entity, can it be redefined?	YES (Go to 7)	The genus *Didemnum* is relatively easily distinguished from other colonial ascidians. However, there are relatively few diagnostic characteristics at the morphological level that can be used to identify the species, and there is great variability in these characteristics. Some mitochondrial DNA analyses have been carried out to identify conspecifics, but the results are not yet published.
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 9)	*Didemnum* sp. has successfully invaded habitats in Europe, New Zealand, the USA and Japan; see, for example, Coutts (2002), Minchin and Sides (2006), Bullard *et al.* (2007), Coutts and Forrest (2007), Osman and Whitlatch (2007).
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		Additional comment: *Didemnum* sp. has a short larval dispersal phase, duration typically several hours, but can spread by fragments of the parent colony breaking off to form new colonies (Coutts, 2002). These fragments may be carried further than the larvae by man-aided transport giving the
9	Does the organism occur outside effective containment in the Risk Assessment area?	NO (Go to 11)	
10	Is the organism widely distributed in the Risk Assessment area?		
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	Approximately 120 major marinas and 40 commercial harbours containing water of suitable salinity and temperature exist throughout the Risk Assessment area (Reeds, 2007). A further 40 marinas and 15 commercial harbours in Scotland may be suitable to support *Didemnum* sp. colonies but the water may not be sufficiently warm for the ascidian to breed (minimum temperature 15ºC).
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	NO (Go to 14)	
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.		
14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?	YES (Go to 16)	*Didemnum* sp. has been recorded in harbours and marinas in New Zealand (Coutts, 2002), northern France and the Netherlands (Gittenberger, 2007) and the Republic of Ireland (Minchin and Sides, 2006) that have similar climate, salinity and water temperature to many potential receptor sites in Great Britain.

15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?		Additional comment - It can become established in marinas and harbours e.g. Coutts (2002), Gittenberger (2007) and Minchin and Sides (2006) and in aquaculture facilities - for example, it has been reported overgrowing oyster bags on intertidal trestles in Clew Bay, County Mayo (http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/htm/ire_clewbay.htm) and South Galway Bay, County Galway (http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/htm/ire_galway.htm), Ireland.
16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	YES (Go to 17)	See for example, Coutts (2002), Minchin and Sides (2006), Gittenberger (2007), Coutts and Forrest (2007), Valentine *et al.* (in press (a)).
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	The larval phase of *Didemnum* sp. is typically only several hours, so natural dispersal is of local importance only. However, it can spread by fragments of the parent colony breaking off to form new colonies, and these fragments
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?	YES OR UNCERTAIN (Go to 19)	It can blanket the sea bed (Valentine *et al.,* 2007), and affect fisheries and shellfisheries, see for example, Bullard *et al.* (2007), Morris *et al.* (in press), Mercer and Whitlatch (in press).
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	Examples of the potential harm that this organism can cause are given in Coutts (2002), Coutts and Forrest (2007), Valentine *et al.* (2007), Carman *et al.* (in press), Mercer and Whitlatch (in press).
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B	SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences			
	Probability of Entry	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	many - 3	LOW - 0	Seven pathways: 1) By commercial shipping, e.g. as hull and sea-chest fouling on ships, as fouling of towed hulks, rafts and pontoons. 2) As colony fragments on trawls, nets, shellfish dredges and other fishing gear of inshore fishing boats. 3) By pleasure craft, e.g. as hull, anchor and rope fouling on recreational small boats. 4) By transfer of contaminated shellfish to new growing areas. 5) As colony fragments in the waste from shellfish processing plants. 6) As larvae or fragments of colonies carried over short distances by tidal currents or in ballast water. 7) As colonies attached to flotsam carried by tidal currents.
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	Hull and sea-chest fouling of commercial ships.		
1.3	How likely is the organism to be associated with the pathway at origin?	very likely - 4	MEDIUM -1	Colonies thrive in the protected environment of harbours and marinas (which are often adjacent to harbours); commercial ships visit these harbours and remain long enough for larvae to settle (seasonal) or fragments of a colony to be drawn into the sea-chests. *Didemnum* spp. brood larvae within the colonial tunic (Kott, 2002; 2004) and these are released when close to settlement; the free-living stage generally lasts less than a few hours, so transport of settled, metamorphosing larvae is possible, but ballast water is an unlikely vector for the free-swimming larvae.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	likely - 3	MEDIUM -1	Distribution is disjunct. Where present, the colonies are usually dense and widespread.
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	LOW - 0	It is extremely difficult to eradicate, see Coutts and Forrest (2007).
1.6	How likely is the organism to survive or remain undetected by existing measures?	very likely - 4	LOW - 0	It is not well known at present and can easily be missed in rapid surveys. In addition, once detected, it is extremely difficult to eradicate, see Coutts and Forrest (2007).
1.7	How likely is the organism to survive during transport /storage?	very likely - 4	LOW - 0	It is very robust and difficult to kill (Coutts and Forrest, 2007).
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	likely - 3	LOW - 0	The larval stage generally lasts less than a few hours, so it is an unlikely to spread far and may settle in or on the vector near to the parent colony (Valentine, in press (b)). Fragments of the colony can rapidly form new colonies in or on the vector (Coutts, 2002). The didemnid *Diplosoma listerianum* (the only didemnid studied in this respect) can store exogenous sperm and thereby produce outcrossed progeny for some weeks in reproductive isolation following sperm uptake (Bishop, 1998; Bishop & Ryland, 1991), for instance as a single colony on a vector. If *D. vexillum* stores sperm in this way, it is possible that after a suitable brooding period (typically a few weeks), a single colony could release progeny whilst in transit or at the destination, and thereby found a new population.
1.9	What is the volume of movement along the pathway?	moderate - 2	MEDIUM -1	The volume of movement is variable. Commercial shipping may be free of *Didemnum* sp. or well fouled with it; see, for example, the barge Steel Mariner described in Coutts (2002) and Coutts and Forrest (2007).
1.10	How frequent is movement along the pathway?	often - 3	MEDIUM -1	This depends upon the shipping routes and docking frequency of the commercial ships.
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	very widely - 4	LOW - 0	All harbours and adjacent marinas are potential receptor habitats. The conditions necessary for *Didemnum* sp. to become established are similar to those required by *Styela clava* (Davis *et al.* , 2007). There are approximately 120 major marinas and 40 commercial harbours containing water of suitable temperature (>15ºC; Valentine *et al.,* in press (a); in press (b)) for *Didemnum* sp. to become established throughout the Risk Assessment area (Reeds, 2007; Davis *et al.* , 2007). A survey of harbours and marinas for *Styela clava* (Davis *et al.* , 2007) found that most of these 160 sites contained water of suitable salinity (>20 psu; Bullard and Whitlatch, in press). A further 40 marinas and 15 commercial harbours in Scotland have suitable salinity to support *Didemnum* sp. colonies but the water temperature, although sufficient for *Didemnum* sp. to grow (14-18ºC; Gittenberger, 2007) may not be sufficient for it to breed (minimum temperature 15ºC; Valentine *at al., 2009*). In fact, no populations of *Styela clava* were found north of Latitude 55º 38' N on the west coast and 53º 34' N on the east coast of Great Britain (Davis *et al.* , 2007) and this will probably be the limit of distribution for *Didemnum* sp.; nevertheless, it is possible that insolation could increase the summer water temperatures of some shallow bays sufficiently for *Didemnum* sp. to breed north of these limits.

1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	very likely - 4	LOW - 0	The organism is most likely to arrive on or in the ship as established colonies or fragments of colonies; both are capable of establishing new colonies throughout the year. In addition, if the ship travels through cold deep water into the shallow warm water of a harbour, the temperature shock may trigger synchronised spawning which would provide the high-density inoculum of larvae necessary to give a high probability of successful establishment of colonies in the new habitat.
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	N/A		
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	very likely - 4	LOW - 0	Transported colonies may readily fragment and disperse into the new habitat. Synchronised spawning could increase the probability of successful establishment of the organism in the new habitat.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	very similar - 4	LOW - 0	*Didemnum* sp. has been recorded in New Zealand (Coutts, 2002), Carlingford Lough, Clew Bay (County Mayo), Malahide Estuary and South Galway Bay in the Republic of Ireland (Minchin and Sides, 2006), in Brest and Le Havre in northern France, and Grevelingen and Oosterschelde in The Netherlands (Gittenberger, 2007). These sites experience similar climatic conditions to much of England and Wales.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	similar - 3	LOW - 0	Larval recruitment on the New England coast occurs at temperatures of 14-20ºC (Valentine *et al.* , 2009), water temperatures found around the coast of England and Wales in summer. The majority of harbours and marinas in northern France, the Netherlands and Eire exhibit similar abiotic factors such as salinity, temperature, dissolved oxygen, substrate type and availability, and exposure, to those in England and Wales. Water temperatures in Scottish harbours may be considerably lower.
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	very many - 4	LOW - 0	*Didemnum* sp. thrives in the protected environment of harbours and marinas (Coutts, 2002; Minchin and Sides, 2006; Gittenberger, 2007) with high salinity (Bullard and Whitlatch, in press), and on the seabed (Valentine *et al.,* 2007). Approximately 120 major marinas and 40 commercial harbours (see 1.11) containing water of suitable salinity (>20 psu; Bullard and Whitlatch, in press) and temperature (>15C; Valentine *et al.* , in press (b)) are available as potential receptors in Great Britain; some of the 55 harbours and marinas in Scotland may also be suitable. There are also extensive areas of suitable seabed available throughout the 10,000 km of coast line in the Risk Assessment area.
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	LOW - 0	The organism thrives in the protected environment of harbours and marinas with high salinity (Bullard and Whitlatch, in press), and on the seabed (Valentine *et al.* , 2007). These habitats are widespread around the 10,000 km of coast of Great Britain (see 1.11).
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	N/A		
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	very likely - 4	LOW - 0	*Didemnum* sp. overgrows sessile competitors and is capable of completely encapsulating them (Carman *et al.* , in press).
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	very likely - 4	LOW - 0	*Didemnum* sp. has few predators. In experiments, Asian shore crab (*Hemigrapsus sanguineus*), common spider crab (*Maja squinado*) and purple sea urchin (*Paracentrotus lividus*) all consumed frozen *Didemnum* sp. (Guida *et al.,* in press), green sea urchins (*Strongylocentrotus droebachiensis*) were observed to graze on fresh *Didemnum* sp. (Epelbaum *et al.,* in press) but the caloric content (390-420 cal per gram wet weight of *Didemnum* sp.) is low compared to many other food organisms (Guida *et al* ., in press) and it is therefore less likely to be selected by predators. Although the common periwinkle (*Littorina littorea*) appeared to consume stressed *Didemnum* sp. in the field, it showed no preference for healthy *Didemnum* sp. in the laboratory (Carmen *et al.* in press).
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	N/A		There are no apparent differences in habitat management between the potential source areas and the Risk Assessment area.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	very likely - 4	LOW - 0	There are no controls to prevent the ingress of marine fouling organisms and, even if there were, it is unlikely that they could prevent the opportunistic introduction of this organism as shown by Coutts (2002) and Minchin and Sides (2006).
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	frequent - 3	LOW - 0	All European and New Zealand records are for sheltered marinas and harbours, see Coutts (2002), Minchin and Sides (2006) and Gittenberger (2007). It has also been reported overgrowing oyster bags on intertidal trestles in Clew Bay, County Mayo (http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/htm/ire_clewbay.htm) and South Galway Bay, County Galway (http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/htm/ire_galway.htm), Ireland.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	LOW - 0	*Didemnum* sp. larvae are held in the colony tissue and released, as competent larvae, only a few hours before settlement (Kott, 2002; Valentine *et al.* , in press (a)). This reduces the loss of larvae by predation. Furthermore, restricted dispersal of short-duration competent larvae promotes local recruitment and consequent local population increase. In addition, fragments that break off a colony can start a new colony (Coutts, 2002; Valentine *et al.* , in press (a)).
1.26	How likely is it that the organism's capacity to spread will aid establishment?	very likely - 4	LOW - 0	See, for example, Coutts (2002), Minchin and Sides (2006), Coutts and Forrest (2007), Valentine *et al.* (in press (a)).
1.27	How adaptable is the organism?	moderately adaptable - 2	MEDIUM -1	It is capable of living at a range of temperatures, salinities and depths (Bullard and Whitlatch, in press: Valentine *et al.* , in press (a)), but will not breed at temperatures <15ºC and exhibits reduced survival at salinity <20 psu.

1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	likely - 3	MEDIUM -1	No information is available on this aspect of establishment, but small colonies appear to survive (e.g. Gittenberger, 2007), and can be established by fragments of parent colonies, suggesting that low genetic diversity will not prevent establishment. In the laboratory, the didemnid *Diplosoma listerianum* (the only didemnid studied in this respect) can survive for at least fifteen years through asexual reproduction (J. D. D. Bishop, pers. comm.).
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	moderate number - 2	LOW - 0	Populations in New Zealand (Coutts, 2002), Ireland (Minchin and Sides, 2006), France and The Netherlands (Gittenberger, 2007), Holyhead (Holt *et al.*, 2009) and Plymouth (J. D. D. Bishop, pers. comm.) all appear to have arrived by man-aided transport. Transport on the hulls of leisure craft is implicated in the recent occurrences at Holyhead and Plymouth; considerable numbers of leisure craft travel from Ireland (where *D. vexillum* is established) to Holyhead, and from France to Plymouth.
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	very likely - 4	LOW - 0	A variety of eradication techniques was applied to recently arrived colonies in New Zealand but all failed (Coutts and Forrest, 2007). Local eradication in the in the early stages of establishment seems possible, but this requires early detection of arrival. Holyhead Marina might provide a trial of this; suitable techniques are assessed by Kleeman (2009).
1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	N/A		

	Spread	RESPONSE	UNCERTAINTY	COMMENT
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	very slow - 0	LOW - 0	The larval stage generally lasts less than a few hours so larvae are unlikely to spread far from the parent colony by natural means (Valentine *et al.* , in press (b)). Fragments of the colony can form new colonies, but usually settle near the parent colony (Coutts, 2002; Valentine *et al.* , 2009). Fragments suspended in the water column develop spherical morphology and can survive for many days, 60% for 18 days and 15% for 30 days (Carman, 2008). Fragments can attach to a suitable substrate within 6 hours of coming into contact with it (Bullard *et al.* , 2007). Thus natural transport of fragments may spread the organism considerable distances if suitable currents are present.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	very rapid - 4	LOW - 0	Fragments of the colony can form new colonies, but usually settle near the parent colony (Coutts, 2002) unless transported by main-aided vectors such as shipping. So, once established in a harbour or marina, fouled commercial and recreational boats (e.g. Minchin and Sides, 2006) can rapidly transport the organism long distances, rapidly increasing its distribution. Fragments suspended in the water column can survive for many days, 60% for 18 days and 15% for 30 days (Carman, 2008). Fragments can attach to a suitable substrate within 6 hours of coming into contact with it (Bullard *et al.* , 2007). Thus transport of fragments by shipping may rapidly spread the organism considerable distances.
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	very difficult - 4	LOW - 0	As the organism inhabits habitats directly connected to the open sea, containment will be extremely difficult. Furthermore, as it lives at depths of between 1 m (Bullard and Whitlatch, in press) and 65 m (Valentine *et al.* , in press (a)) containment and eradication usually involve divers, which makes the project both difficult and expensive (Coutts and Forrest, 2007).
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.	Harbours, marinas and sheltered bays and coastline in the Risk Assessment area are endangered.	LOW - 0	Initially, in excess of 160 sites around the coast are at risk of ingress and establishment of *Didemnum* sp. Once established, it may spread to numerous neighbouring sites.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	major - 3	MEDIUM -1	Not measured at present, but New Zealand has a green-lipped mussel farming industry worth an estimated NZ$ 150 million per year (Davis and Davis, 2008) that is now considered to be at risk, suggesting that potential economic loss can be very important.
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	major - 3	MEDIUM -1	Shellfish landings are most likely to be affected as *Didemnum* sp. is known to blanket shellfish and reduce their growth rate, if not kill them. Landings from the wild in Great Britain in 2004 mainly involve mussels (12,074 tonnes worth £2 million), Queen scallops (5,151 tonnes worth £1.9 million) and scallops (22,356 tonnes worth £34 million). Shellfish farms produced oysters (855 tonnes), mussels (22,300 tonnes), Queen scallops (45 tonnes) and scallops (10 tonnes) worth £19.7 million in total (data from www.shellfish.org.uk/shellfish_production.htm). Therefore, a total of approximately £57.6 million (at 2004 rates) is at risk. It is not possible to predict how much this total is realistically at risk, or the timescale involved, as dispersal and establishment are stochastic processes.
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	major - 3	MEDIUM -1	*Didemnum* sp. will reduce the yield and quality of the shellfish produced for market which will reduce producer profits. Infestation of a region might also reduce the potential for or value of seed-mussel export. It will also reduce natural recruitment of wild shellfish populations by consuming the spat. The extent of the profit reduction cannot be estimated at present.
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	moderate - 2	LOW - 0	Consumer demand will be reduced by the presence of the organism if existing quality and price cannot be maintained, which is likely to be the case.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	moderately likely - 2	MEDIUM -1	Export markets are unlikely to take shellfish produced in an area that has extensive colonies of *Didemnum* sp. in case fragments of the organism are transported with the shellfish. Infestation of a region might also reduce the potential for or value of, for example, seed-mussel export
2.10	How important would other economic costs resulting from introduction be? (specify)	moderate - 2	MEDIUM -1	There will be a cost to the public purse if the government were to support monitoring to ascertain the distribution of the organism, research to find control techniques for it, outreach publicity to warn fishermen and boat owners, and any campaign to convince the export market of the safety of the product. As an example, mussel farming in New Zealand is worth an estimated NZ$500 million; since August 2005, when *Styela clava* was detected in Auckland harbour (Davis and Davis, 2006), Biosecurity New Zealand has spent approximately NZ$2 million on research and surveillance to determine its geographical spread (Bissmire and Stratford, in press; Gust and Graeme, in press).
2.11	How important is environmental harm caused by the organism within its existing geographic range?	major - 3	LOW - 0	The organism has affected extensive areas of the Georges Bank fishing grounds (Gulf of Maine, USA) where marine communities have been blanketed by it and destroyed (Valentine *et al.* , in press (a); Mercer and Whitlatch, in press). Species richness and biodiversity are reduced in habitats where *Didemnum* sp. becomes established (Lengyel *et al.,* in press; Dijkstra and Harris, in press*)* . This will have significant effects on designated environmentally sensitive areas.
2.12	How important is environmental harm likely to be in the Risk Assessment area?	massive - 4	MEDIUM -1	Once established, the organism can have a disastrous effect on the habitat (Valentine *et al.* , in press (a); Mercer and Whitlatch, in press; Lengyel *et al.* , in press; Dijkstra and Harris, in press). If introduced into Special Areas of Conservation (SACs), *Didemnum vexillum* could have a disastrous effect on species diversity leading to habitat destruction.
2.13	How important is social and other harm caused by the organism within its existing geographic range?	moderate - 2	HIGH -2	Not measured at present, but it is unlikely to be as significant as the environmental harm. Social harm is most likely to impact upon fishing communities, small boat owners and marina operators, and communities dependent on aquaculture.
2.14	How important is the social harm likely to be in the Risk Assessment area?	moderate - 2	HIGH -2	This cannot be estimated at present, but it is unlikely to be as significant as the environmental and economic harm.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	very unlikely - 0	MEDIUM -1	The organism is not known to hybridise with other species at present.
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	very likely - 4	MEDIUM -1	No natural enemies are known at present. See section 1.21.
2.17	How easily can the organism be controlled?	very difficult - 4	LOW - 0	Control appears feasible given very early detection and rapid response. Once the organism has spread significantly, experience to date suggests that it cannot be controlled, see sections 1.30 and 2.3. Most attempts to control it involve removal by divers; these have had limited success as one small fragment missed by the divers can start a new colony.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	likely - 3	MEDIUM -1	Control measures attempted in New Zealand included smothering habitats with uncontaminated dredge spoil or geotextile fabric, wrapping affected piles with plastic, water blasting, air drying, and dosing with acetic acid or chlorine (Coutts and Forrest, 2007). All these techniques would adversely affect the habitat.

2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	unlikely - 1	MEDIUM -1	Its nutritional and caloric value is low (Guida *et al.*, in press) and few organisms presented with it will consume it (Epelbaum *et al.*, in press). Mercer and Whitlatch (in press) reported that an epibenthic polychaete, *Lepidonotus squamatus*, and an infaunal polychaete, *Eusyllis lamelligera*, were only found within the blanket of *Didemnum* sp., but the significance of this observation is unclear. Lengyel *et al.* (in press) reported that the abundance of the polychaetes *Nereis zonata* and *Harmothoe extenuata* increased significantly in areas covered by *Didemnum* sp., but this was thought to be because the polychaetes live beneath the tunicate blanket and thus avoid predation by fish.
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur	Shellfisheries, harbours and sheltered bays in the Risk Assessment area.	HIGH -2	Economic, environmental and social impacts are most likely to occur in shellfisheries in the Risk Assessment area. Environmental and social impacts will occur in harbours, marinas and sheltered bays in the Risk Assessment area. Some/many categories of biogenic reefs of conservation importance might be vulnerable (e.g. Sabella, Modiolus).

Summarise Entry	very likely - 4	LOW - 0	
Summarise Establishment	very likely - 4	LOW - 0	
Summarise Spread	rapid - 3	MEDIUM -1	
Summarise Impacts	massive - 4	LOW - 0	
Conclusion of the risk assessment	HIGH -2	LOW - 0	This organism presents a high risk to the Risk Assessment area because: entry appears to inevitable, although the stochastic nature of marine introductions makes quantitative prediction of probability difficult; establishment is very likely in a large number of receptor habitats and cannot, at present, be controlled, and spread will then occur. The consequences of introduction will be negative and will mainly impact on local economy and environment; the impacts will probably be sufficient to require government action.
Conclusions on Uncertainty			The risk assessment is based on the reported effect of *Didemnum* sp. in other ecosystems. Nevertheless, wherever it is found it appears to be an efficient invader and aggressive competitor. The main uncertainty is associated with the entry phase. Given that Great Britain is a major player in the international shipping trade, it is inevitable that non-indigenous marine species will enter commercial harbours. Control can only be achieved by stopping establishment and/or spread, and the probability of this is low.

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