



Marine Scotland Science

Best practice guidance for the control of the invasive Carpet Sea Squirt *Didemnum vexillum* on shellfish farms

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Editor's Note

The base text within this document was produced by SAMS Research Services Ltd. (SRSL) on behalf of Marine Scotland, a Directorate of the Scottish Government, and contains current best practice guidance on preventing, mitigating and managing *Didemnum vexillum* (Dvex) on shellfish farms.

This guidance is specifically written for the Scottish shellfish industry, based on the experience of other countries managing Dvex as an invasive species.

This guidance will be continually reviewed as lessons are learned from the management of Dvex in the Scottish marine environment.

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1. WHAT IS CARPET SEA SQUIRT?

The **Carpet Sea Squirt** *Didemnum vexillum* (or '**Dvex**' for short) is an invasive non-native marine species. The cream, orange or off-white colonies can form thin sheet-like mats (2-5mm thick) or extensive pendulous growths (up to 2m in length). It has a leathery, firm texture with many darker veins running through the colony. Dvex is a filter feeder and has numerous tiny pores which are scattered across the surface and are responsible for drawing water into the colony. These pores quickly close to form white dots upon disturbance or removal from the water. A few larger pores can also be seen on the surface, which is where the water exits the colony.



Figure 1.
D. vexillum growing on oyster trestles
© Dr D Minchin, Marine Organism Investigations (2016)



Figure 2.
Close up of pendulous growth form of *D. vexillum*
© Dr D Minchin, Marine Organism Investigations (2016)

2. WHY IS IT A PROBLEM?

Dvex will grow on a wide variety of living and man-made objects, including bivalves, such as mussels and oysters, which are cultivated commercially in Scotland. It can impede water exchange and can heavily foul the equipment used to grow these species, leading to increased operating costs and a reduction in the efficiency of gear such as spat collecting lines. All equipment which is either submerged for the full or some part of the tidal cycle is vulnerable to Dvex colonisation including; mooring lines, anchor chains, shellfish creels, oyster bags and trestle tables. This sea squirt will also attach directly to natural substrates (e.g. seaweed, rocks, boulders, stones and dead shells etc.) typically found on the seabed under and adjacent to commercial shellfish farms.

Dvex grows extremely fast, particularly in the summer months (July to September), when the seawater temperature in Scotland is optimum for its growth (9 - 16°C). Colonies are capable of reaching 30 cm in diameter within 21 days of settlement and can form extensive mats over the surfaces that it colonises.

Dvex can spread quickly through both a free-swimming 'tadpole' larval phase and by fragmentation. In the case of the former, maturation, release of larvae and subsequent recruitment typically occurs between 13 - 20°C. The larvae are gradually released over 3 - 5 months and are only able to settle for a few hours after release. Larvae are therefore likely to settle within a relatively short distance of the initial colony, particularly if released into a semi-enclosed sea loch for example. However, dispersal by the suspension of fragments in the water column can be far more extensive, as these can change their gross morphology into spheres, making it easier to disperse. Fragments have been recorded to survive for up to 30 days. Fragments will then typically re-attach within six hours of making contact with a hard surface.

Dvex is extremely tolerant to both fluctuations in temperature (<2 - >26°C) and salinity (26 - 30 ppt) and can withstand **short periods of exposure to air and sunshine** (for example, up to 6 hours whilst attached to mussel seed in culture bags). It is highly likely, therefore, that it will survive any over-land transfers of commercial stock or equipment between mussel or oysters farms (either attached to seed or broodstock, or stock for growing on).

Dvex does not have any natural predators that will effectively control its spread. Sea urchins and sea stars in New Zealand have shown some signs of removing 'healthy' colonies of Dvex, but the effectiveness of these species over wide areas has not been proven.

3. WHAT ARE YOUR RESPONSIBILITIES IF YOU FIND Dvex?

The Wildlife and Countryside Act 1981 is the principal domestic legislation concerning non-native species. It was amended by the Wildlife and Natural Environment (Scotland) Act 2011. This legislation enables Scotland to adopt the internationally recognised 3-stage approach to dealing with non-native species and aim to:

- **prevent the release and spread of non-native animal and plant species;**
- **ensure a rapid response to new populations can be undertaken; and**
- **ensure effective control and containment measures can be carried out when problem situations arise.**

Under the Wildlife and Countryside Act 1981 any person who 'releases or otherwise causes any animal outwith the control of any person to be at a place outwith its native range' is guilty of an offence.

The Acts enable relevant bodies (Scottish Ministers, Scottish Natural Heritage, the Scottish Environment Protection Agency and the Forestry Commission Scotland) to make Species Control Agreements and Orders which set out measures that must be taken to control, or eradicate an invasive non-native animal or plant. A Species Control Agreement (SCA) is a voluntary agreement which may set out;

- **what must be done**
- **by whom and**
- **by when**

in order to control an invasive non-native plant or animal. They may be useful to formalise what actions are necessary and would follow discussion with the site owner. A Species Control Order (SCO) may be considered:

- **where an owner/occupier has not signed up to a SCA that has been offered**
- **where an owner/occupier has failed to comply with the terms of a SCA**
- **where the relevant body has been unable to find out the name or address of the owner or any occupier and has not therefore been able to offer a SCA or**
- **where action is considered urgent.**

If Dvex is found on your site a SCA may be developed to control the spread of Dvex to other marine locations and to contain or eradicate Dvex. The use of SCAs and SCOs will be considered on a case by case basis and informed by individual circumstance. A SCA/O may for example require you to follow particular procedures before moving stock and equipment off your farm. The Scottish Government Code of Practice on Non-Native Species is a comprehensive guide to Scottish non-natives law, including your responsibilities and the use of Species Control Orders.

<http://www.gov.scot/Publications/2012/08/7367>

4. REPORTING

If you think that you have found Dvex or something that looks similar on your farm, it is vital that you immediately report this sighting.

Reporting the presence of Dvex at the earliest opportunity will allow the relevant authority to help you take the most appropriate action to control the spread of this species throughout your farm site.

IF YOU THINK YOU'VE SEEN Dvex (OR SOMETHING LIKE IT):

- **Note the location, preferably using GPS if possible, and take photographs of the colony (both zoomed in and of the entire colony), if a camera is available.**
- **CALL Scotland's Environmental and Rural Services (SEARS) Helpline on 0845 230 2050 (info@sears.scotland.gov.uk).**
- **Adopt the precautionary approach and assume that it is Dvex, until confirmed otherwise and follow the good practice guidance, set out below.**

5. WHERE HAS IT ALREADY BEEN FOUND?

Dvex probably originates from NE Asia, but is distributed more widely, including in New Zealand, Canada, the USA, France, Ireland, and the Netherlands. More recently Dvex has been found at several sites in England, including the north coast of Kent and the south coast of England and in Holyhead, North Wales. Dvex was first detected in Scotland in 2009, with further monitoring during 2010 confirming its presence at three sites within the Firth of Clyde. In 2016 it was confirmed in Loch Creran on the west coast of Scotland.

6. WHAT CAN I DO TO PREVENT Dvex REACHING MY SITE?

One of the key measures that you can do to prevent Dvex from reaching your site is to produce an invasive non-native species biosecurity plan for your farm. This will include;

- **Appointing a person who will be responsible for biosecurity on your site (this person will be responsible for producing the biosecurity plan for invasive non-native species, staff training in monitoring and control measures, ensuring all sub-contractors/ visitors are aware of the plan and that any sightings of Dvex are reported)**
- **Assessing the risk of introducing Dvex to your farm (e.g., are the environmental conditions at your site suitable for the establishment of Dvex?)**
- **Identifying the high risk pathways (e.g., are there any activities, which could introduce Dvex to your site?)**
- **Introducing biosecurity control measures to minimise the likelihood of introducing Dvex which are effective, simple, realistic and can be easily translated into instructions for staff.**
- **Encouraging all staff and site users to continuously monitor stock and equipment for signs of Dvex, and to report any unusual sightings as soon as possible.**

See '**Further Reading**' for information on how to produce a biosecurity plan for your farm.

7. CONTROLLING Dvex ON SHELLFISH FARMS

Once Dvex is confirmed on a shellfish farm there are two objectives:

- 1. To stop the spread of Dvex to new marine locations and farms**
- 2. To control or manage the Dvex on the farm**

If Dvex is found on your farm, it could be managed with a range of treatment options. Management options will be dependent upon site layout, environmental conditions and site operations.

Reporting Dvex quickly will allow Marine Scotland to assess control methods for your site

before it becomes fully established and gives the best chance of removing Dvex from

your farm. This may include a Species Control Agreement.

PLEASE REMEMBER TO BE VIGILANT AT ALL TIMES, REGULARLY MONITOR YOUR EQUIPMENT/ INFRASTRUCTURE, REPORT IMMEDIATELY AND BE PREPARED TO ACT FAST IF YOU SEE SIGNS OF Dvex.

8. FURTHER READING

Cottier-Cook, E.J. (2016). Best practice guidance for the control of *Didemnum vexillum*. A report by SRS� for Marine Scotland, pp. 17

Payne, R.D., Cook, E.J. and Macleod, A. (2014). Marine Biosecurity Planning – Guidance for producing site and operation-based plans for preventing the introduction of non-native species. Report by SRS� Ltd. in conjunction with Robin Payne to the Firth of Clyde Forum and Scottish Natural Heritage 39 pp. www.snh.gov.uk/docs/A1294630.pdf

Carmen, MR, Lindell, S, Green-Beach, E, Starczak, VR (2016). Treatments to eradicate invasive tunicate fouling from blue mussel seed and aquaculture socks. *Management of Biological Invasions* 7: 101-110.

Denny, CM (2008). Development of a method to reduce the spread of the ascidian *Didemnum vexillum* with aquaculture transfers. *ICES Journal of Marine Science* 65: 805-810.

Nimmo, F., Cook, E. J., Moxey, A. P., Hambrey, J. and Black, K. (2012). Cost-benefit analysis of management options for *Didemnum vexillum* (carpet sea squirt) in Scotland. Report by Hambrey Consulting in association with the Scottish Association for Marine Science and Poseidon Aquatic Resource Management to the Scottish Government. Tender Ref: Cr/2011/16. pp. 69 <http://www.scotland.gov.uk/Resource/0038/00388277.pdf>

Piola, RF, Dunmore, RA, Forrest, BM (2010). Assessing the efficacy of spray delivered ‘eco-friendly’ chemicals for the control and eradication of marine fouling pests. *Biofouling*, 26: 187-203.

Scottish Government (2012). Non-Native Species Code of Practice. ISBN: 9781780459301. www.gov.scot/Publications/2012/08/7367

9. IDENTIFICATION INFORMATION

GB Non Native Species Secretariat. Invasive sea-squirt *Didemnum vexillum* wanted poster (Scotland); <https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=180>

GB Non Native Species Secretariat. *Didemnum vexillum* identification sheet. <https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=364>

10. IMAGES OF *DIDEMNUM VEXILLUM*



Figure 1.
D. vexillum growing on oyster trestles
© Dr D Minchin, Marine Organism
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Figure 2.
Close up of pendulous growth form of *D. vexillum*
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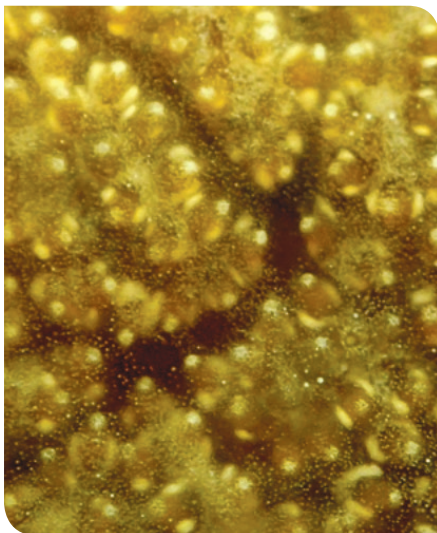


Figure 3.
Close-up of small white dots
marking the individuals in the
colony and darker channels running
across the surface of *D. vexillum*
© Dr D Minchin, Marine Organism
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Figure 4.
D. vexillum colony attached to rope,
Firth of Clyde
© C. Beveridge, SAMS



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