



Rapid assessment of the distribution of marine non-native species in marinas in Scotland

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Received 19 September 2006; accepted in revised form 6 November 2006

Abstract

In August 2006, the ten largest marinas in Scotland were surveyed for the presence of seven non-native species, known to occur at other locations within the UK: the crustaceans *Caprella mutica* and *Eriocheir sinensis*, ascidians *Perophora japonica* and *Styela clava*, the green alga *Codium fragile* subsp. *tomentosoides*, and brown algae *Sargassum muticum* and *Undaria pinnatifida*. A variety of structures, including pontoon floats, chains and harbour walls were inspected to a depth of 0.5 m for the presence of these non-native species. Seven of the marinas had one or more of the target species. *C. mutica* was found at seven marinas; *C. fragile* subsp. *tomentosoides* at two marinas; *S. muticum* and *S. clava* were each found at a single marina; *E. sinensis*, *P. japonica* and *U. pinnatifida* were not found. The survey suggests that recreational boating is an important vector for the dispersal of marine non-native species, and that marinas may act as a refuge for such species. Further and regular port surveys throughout the UK are recommended to provide an effective early warning system for invasive non-native species.

Key words: Invasive species, marinas, dispersal, non-natives, rapid assessment, Scotland

Introduction

In 2004, the Marine Aliens programme (http://www.marlin.ac.uk/marine_alien/) was established to investigate the distribution, dispersal mechanisms and impacts of non-native marine invaders on indigenous species and ecosystems in the UK. Seven non-native species that pose a threat to native species and habitats listed in the UK Biodiversity Action Plan (1999) were identified in this programme: the crustaceans *Caprella mutica* Schurin 1935 and *Eriocheir sinensis* Milne Edwards 1853, the ascidians *Perophora japonica* Oka 1927 and *Styela clava* Herdman 1882, the green alga *Codium fragile* subsp. *tomentosoides* (van Goor) Silva 1955, and

the brown algae *Sargassum muticum* (Yendo) Fensholt 1955 and *Undaria pinnatifida* (Harvey) Suringar 1872.

Caprella mutica is a marine amphipod, found in high abundances on artificial structures and the associated epifauna and flora, in particular on aquaculture equipment (Willis et al. 2004). *C. mutica* has been recorded in the upper subtidal zone to depths over 13 m (Fedotov 1991). A survey of aquaculture sites on the west coast of Scotland in 2004 found *C. mutica* present at 63 % of the sites surveyed (Ashton et al. In press).

Eriocheir sinensis, the Chinese mitten crab, is a member of the IUCN world's 100 worst invaders. It burrows into soft sediment banks, causing bank erosion, it has not yet been found in Scotland.

Perophora japonica is a colonial sea squirt with a creeping growth habit, and may occupy 10% of available substrate between ~2.2 and 3.8 m depth at peak abundance in Britain (Baldock and Bishop 2001). In Britain it has not been recorded outside of Plymouth, where it is still present (Nishikawa et al. 2000, Baldock and Bishop 2001, J. Bishop, pers. comm.).

Styela clava fouls submerged structures (Minchin et al. 2006). It is distributed locally in England, Wales and Ireland, and occurs in Loch Ryan and Ardrossan Marina in Scotland (Eno et al. 1997, Bishop 2005).

Codium fragile subsp. *tomentosoides* can out-compete and displace native species of *C. fragile* to depths of 15 m (Chapman 1999), it is known from Shetland and the west coast of Scotland (Irvine et al. 1975, Hardy 1990).

Sargassum muticum may be abundant, overgrowing and shading native seaweeds, as it does on the south coast of Britain. It attaches to hard surfaces in shallow water, rarely deeper than 5 m. *S. muticum* has been recorded sparsely from the south and west coasts of England, Wales, Ireland and Northern Ireland. In Scotland, *S. muticum* occurs in Loch Ryan (Pizzolla 2005) and in the warm water plume of Hunterston deepwater port and also on the sheltered east coasts of Great Cumbræ near Largs (Dr P. Barnet, pers. comm.). It has recently been reported in Loch Fyne (F. Manson pers. comm.).

Undaria pinnatifida is a large brown alga, found on hard surfaces from low intertidal to subtidal depths of around 18 m. In Britain, it has only been recorded in marinas on the south coast of England (Fletcher and Manfredi 1995).

Recreational boating is an important vector for the dispersal of marine species (Gollasch 2002, Floerl et al. 2005) and marinas have been described as “sheltered islands” for marine alien organisms (Bax et al. 2002). Floating pontoons represent substantial coastal habitats for marine organisms (Connell 2000). Marinas can either be the first entry point for non-natives via international yachts or they can act to provide a network of suitable habitats for the secondary spread of a species via domestic yachting activity. While marina/ port surveys have been done in England, Ireland and Wales (Welch and Lucas 2002, Minchin et al. 2006), no such survey has been done in Scotland.

The aim of the study, therefore, was to survey ten marinas in Scotland for the presence of the seven non-native species highlighted in the

Marine Aliens programme. The rate of biological invasions to a given area depends on the volume of ship traffic to a region (Ricciardi 2001), therefore, to maximise the chances of finding the non-native species, the ten largest marinas were selected.

Methods

The ten largest marinas in Scotland (Figure 1) were surveyed between the 21st and 24th August 2006 based on the method described in Pederson et al. (2003) and Minchin et al. (2006). All structures were inspected for the seven non-native species for one hour, from the surface to the depth of 0.5 m; this included pontoons, chains, harbour walls, vessel hulls and buoys. Where a non-native species was found, a sample was collected and preserved in alcohol for later identification under a stereomicroscope. The abundance of the species was categorised as low (1-5 individuals or algal surface area of up to 20 cm²), medium (5-100 individuals, or algal surface area of 20-100 cm²) or high (>100 individuals or algal surface area of over 100 cm²) at each marina.

Results and Discussion

Seven of the marinas sampled contained between one and three of the target non-native species (Figure 1; Annex). These fouled flotation structures supporting the pontoons, with the exception of *Sargassum muticum* found free-floating near pontoons in Ardrossan Marina and *C. mutica* and *Codium fragile* subsp. *tomentosoides* both fouled vessel hulls. *Caprella mutica* was found at seven marinas, including Ardrossan Marina where *S. muticum* was also found. This caprellid attaches to *S. muticum* within its native range (Kawashima et al. 1999). *C. mutica* was the most widely distributed species, occurring on east and west coasts of Scotland; it was also the most abundant species appearing in medium or high densities. *C. fragile* subsp. *tomentosoides* was found at two marinas on the east coast where it was present at low or medium abundances; *Styela clava* and *S. muticum* only occurred at Ardrossan Marina on the west coast. *S. clava* was present in medium abundance and *S. muticum* was low in abundance. No other non-native species were recognised in the survey, but samples were collected from the pontoons and preserved for future study. *Eriocheir sinensis*, *Undaria pinnatifida* and *Perophora japonica* were

not found. Their absence reflects the habitat preference of these species either for deeper water or substrates other than hard surface structures.

Further surveys should include the complete water column of the marinas and the benthos.

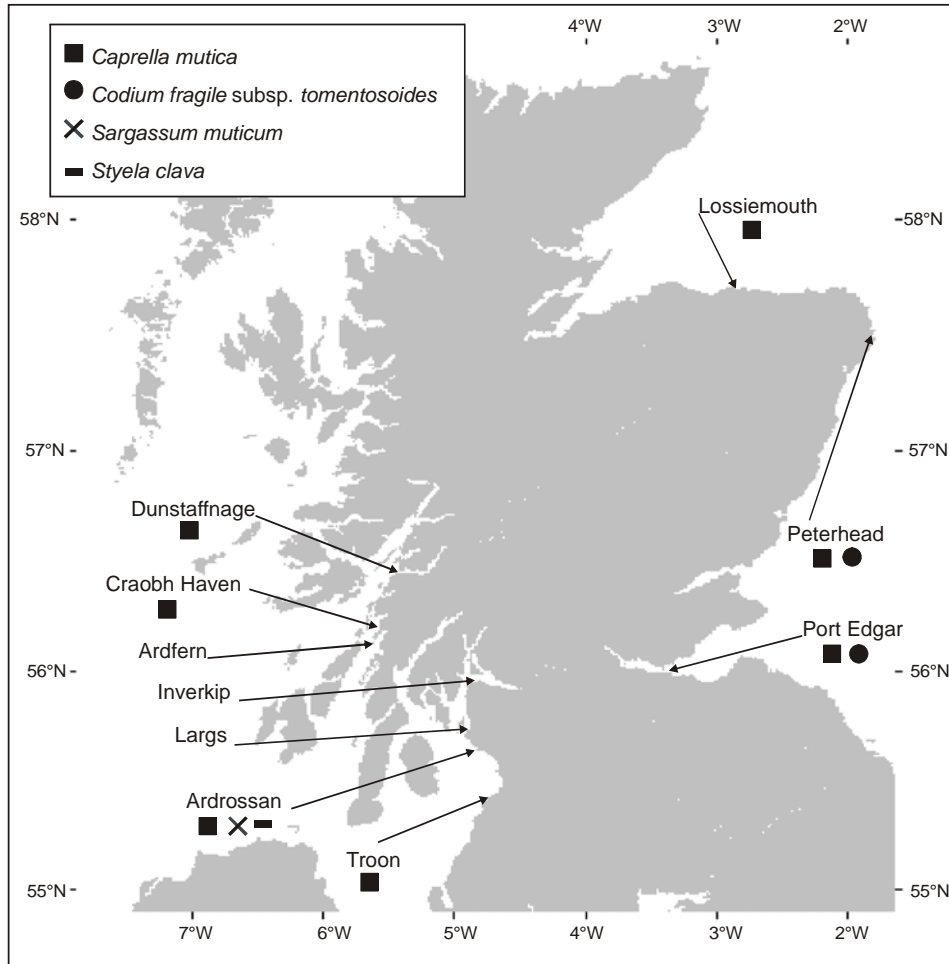


Figure 1. Location of marinas sampled in Scotland and distribution of non-native species.

The findings reveal five new localities for *C. mutica* in Scotland and two for *C. fragile* subsp. *tomentosoides* on the east coast of Scotland. *S. clava* was already known from Ardrossan Marina (Bishop 2005, M. Davis pers. comm.). *S. muticum* has been known from north and south of Ardrossan Marina, but not from where it was found in this study; either of these nearby populations could be the source for the *S. muticum*.

Without surveys the range and abundance of species can not be assessed (Ruiz et al. 2000, Herborg et al. 2003), their potential impact (Parker et al. 1999) and predicted expansion is

uncertain (Arbaciauskas 2002, Telesh and Ojaveer 2002). Frequent monitoring also enables some ability to deduce source regions, vectors and rates of introduction (Cohen 2004). Early identification of non-native species is critical for successful eradication (Simberloff 2003, Tsutsui and Suarez 2003, Anderson 2005, Hewitt et al. 2005). This survey shows that marinas provide suitable habitat for non-native species in Scottish waters. Recreational yachting activity may be an important vector for the spread of these species (Ashton et al. 2006). The new records of non-native species found in this survey at selected Scottish marinas demonstrates the need for more

regular and expanded studies. Most usually the number of non-native species identified in an area underestimates the real numbers present (Ruiz et al. 1997). This survey demonstrates the need for more detailed port surveys throughout Britain, from which future introductions can be evaluated (Ross et al. 2003) and to aid better-informed decisions in managing the problems of invasive non-native species (Cohen 2004).

Acknowledgements

We are grateful to all the marina officers who permitted access to their pontoon structures. Thanks to P. Barnet, J. Bishop, M. Davis, F. Manson for species distribution information and an anonymous reviewer for comments on the manuscript. This work was funded by Esmée Fairbairn Foundation Marine Aliens project (Reference EN/04-0395).

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Annex

Location of non-native species at recreational yachting marinas in August 2006 in Scotland (see text for definitions of absent -, low +, medium ++ and high +++ abundances)

Marina	Location coordinates		Coast (E/W)	No. of Berths	<i>Caprella mutica</i>	<i>Styela clava</i>	<i>Codium fragile</i> subsp. <i>tomentosoides</i>	<i>Sargassum muticum</i>
	Latitude, °N	Longitude, °W						
Inverkip	55°54.5'	04°53.0'	W	600	-	-	-	-
Largs	55°46.6'	04°51.4'	W	700	-	-	-	-
Ardrossan	55°38.4'	04°49.1'	W	250	++	++	-	+
Troon	55°33.2'	04°42.0'	W	300	+++	-	-	-
Port Edgar	55°59.7'	03°24.6'	E	350	++	-	+	-
Peterhead	57°29.4'	01°47.2'	E	150	++	-	++	-
Lossiemouth	57°43.3'	03°16.4'	E	80	++	-	-	-
Ardfern	56°11.0'	05°31.8'	W	80	-	-	-	-
Craobh Haven	56°12.9'	05°33.4'	W	250	+++	-	-	-
Dunstaffnage	56°11.0'	05°31.8'	W	150	+++	-	-	-