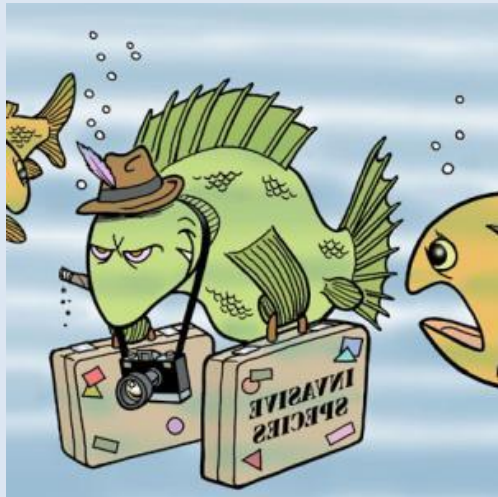


A hotspot for aquatic alien species? Evidence for recreational angling as an international pathway

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Article 13

Action plans on the pathways of invasive alien species

1. Member States shall, within 18 months of the adoption of the Union list carry out a comprehensive analysis of the pathways of unintentional introduction and spread of invasive alien species of Union concern at least in their territory, as well as in their marine waters as defined in point (1) of Article 3 of Directive 2008/56/EC, and identify the pathways which require priority action ('priority pathways') because of the volume of species or of the potential damage caused by the species entering the Union through those pathways.

Approximately 25 million anglers in Europe
(EEA, 2003)

4 million anglers in UK

Increasing popularity

Movement of COMMODITY	RELEASE IN NATURE	Biological control Erosion control/ dune stabilization (windbreaks, hedges, ...) Fishery in the wild (including game fishing) Hunting in the wild Landscape/flora/fauna "improvement" in the wild Introduction for conservation purposes Release in nature for use (other than above, e.g., fur, transport, medical use) Other intentional release
	ESCAPE FROM CONFINEMENT	Agriculture (including Biofuel feedstocks) Aquaculture / mariculture Botanical garden/zoo/aquaria (excluding domestic aquaria) Pet/aquarium/terrarium species (including live food for such species) Farmed animals (including animals left under limited control) Forestry (including reforestation) Fur farms Horticulture Ornamental purpose other than horticulture Research and <i>ex-situ</i> breeding (in facilities) Live food and live bait Other escape from confinement
	TRANSPORT – CONTAMINANT	Contaminant nursery material Contaminated bait Food contaminant (including of live food) Contaminant on animals (except parasites, species transported by host/vector) Parasites on animals (including species transported by host and vector) Contaminant on plants (except parasites, species transported by host/vector) Parasites on plants (including species transported by host and vector) Seed contaminant Timber trade Transportation of habitat material (soil, vegetation,...)
VECTOR	TRANSPORT - STOWAWAY	Angling/fishing equipment Container/bulk Hitchhikers in or on airplane Hitchhikers on ship/boat (excluding ballast water and hull fouling) Machinery/equipment People and their luggage/equipment (in particular tourism) Organic packing material, in particular wood packaging Ship/boat ballast water Ship/boat hull fouling Vehicles (car, train, ...) Other means of transport
	CORRIDOR	Interconnected waterways/basins/seas Tunnels and land bridges
SPREA	UNAIDED	Natural dispersal across borders of invasive alien species that have been introduced through pathways 1 to 5

Angling as a pathway?

Establish current awareness and biosecurity behaviour of anglers in the UK

Angling tourism as an international pathway

Desiccation tolerance and effectiveness of biosecurity



March 2011- Check Clean Dry campaign launched



STOP THE SPREAD



Are you unknowingly spreading invasive species on your water sports equipment and clothing?

Invasive species can affect fish and other wildlife, restrict navigation, clog up propellers and be costly to manage. You can help protect the water sports you love by following three simple steps when you leave the water.



CHECK Check your equipment and clothing for live organisms - particular in areas that are damp or hard to inspect.

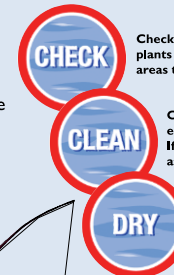
CLEAN Clean and wash all equipment, footwear and clothes thoroughly. Use hot water where possible. If you do come across any organisms, leave them at the water body where you found them.

DRY Dry all equipment and clothing - some species can live for many days in moist conditions. Make sure you don't transfer water elsewhere.

For more information go to www.nonnativespecies.org/checkcleandry



Invasive plants and animals harm the environment, reduce the quality of fishing and spread disease. Please help to stop them by following the Check, Clean, Dry code.



CHECK Check your equipment and clothing for living plants and animals. Pay particular attention to areas that are damp or hard to inspect.

CLEAN Clean and wash all clothing, footwear and equipment, especially nets, thoroughly. Use hot water where possible. If you do come across any plants and animals, leave them at the water body where you found them.

DRY Dry all equipment and clothing - some species can live for many days in moist conditions. Make sure you don't transfer water elsewhere.



www.nonnativespecies.org/checkcleandry



2011 - Dikerogammarus haemobaphes

2014 - Dreissena bugensis

2015 - Rangia cuneata



Step One: Current biosecurity behaviour



680 responses

Representative of angling population

79% of anglers fishing once a fortnight

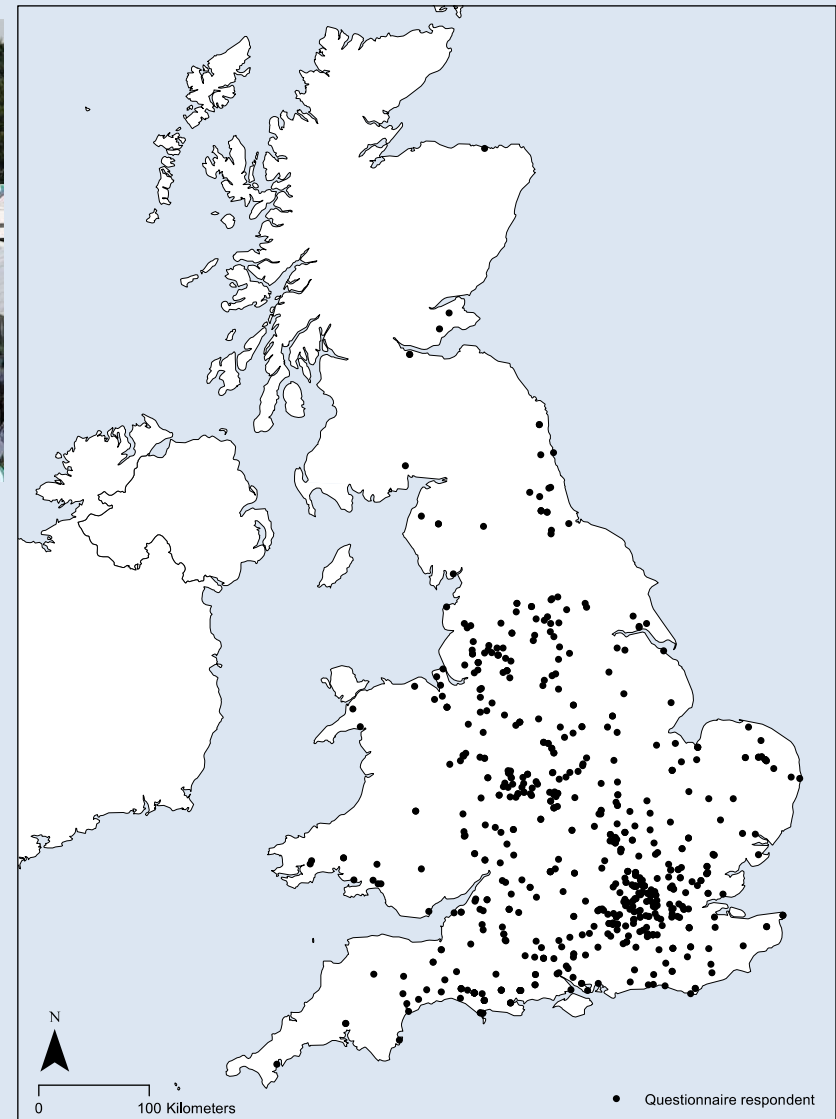


Figure . Geographic distribution of respondents to 2015 questionnaire in the United Kingdom

Current biosecurity practice

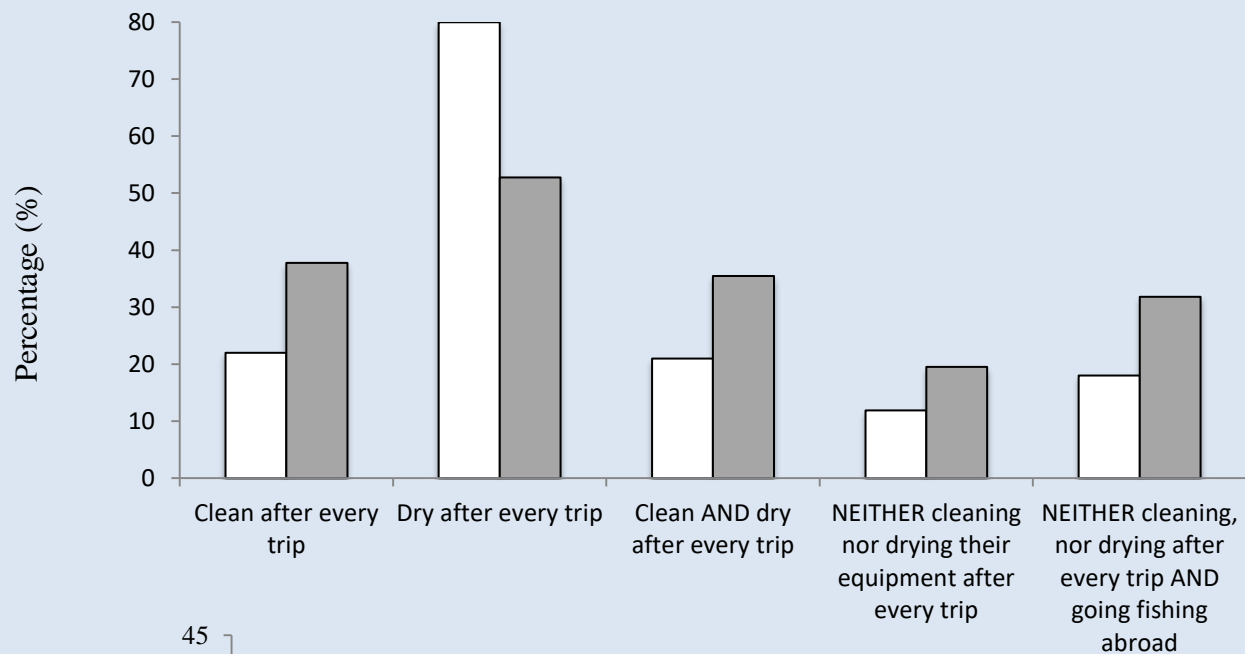


Figure. Changes in the behaviour of anglers fishing once a fortnight between 2011 and 2015. 2011 baseline from Anderson *et al.*, 2014

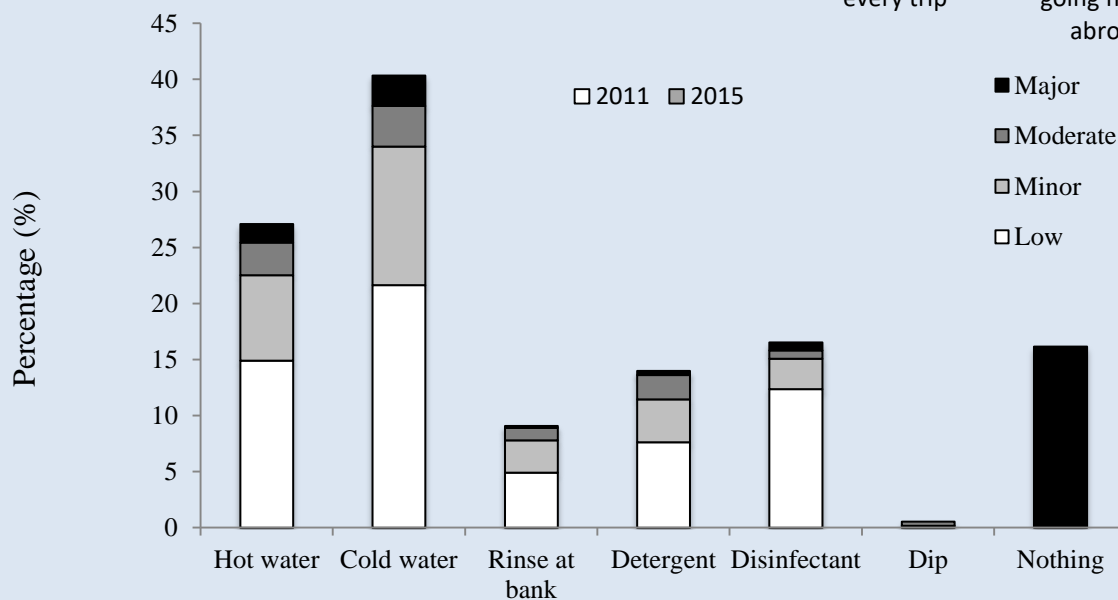


Figure. Methods used by British anglers to clean their equipment after a fishing trip. Some anglers used multiple methods so the sum of percentages is greater than 100%.

Angling behaviour and campaign awareness



Table. The awareness of the different risk anglers to the Check, Clean Dry biosecurity (%)

Risk Category	Frequency of cleaning and drying equipment	Percentage assigned to each risk category %	Knowledge of the Check, Clean Dry Campaign (%)	
			Yes	No
Low	Every trip	46.6	25.4	21.2
Minor	2-5 trips	23.4	9.8	13.6
Moderate	6+ trips	9.7	4.2	5.5
Major	Not cleaning and/or drying their equipment	20.3	8.1	12.2

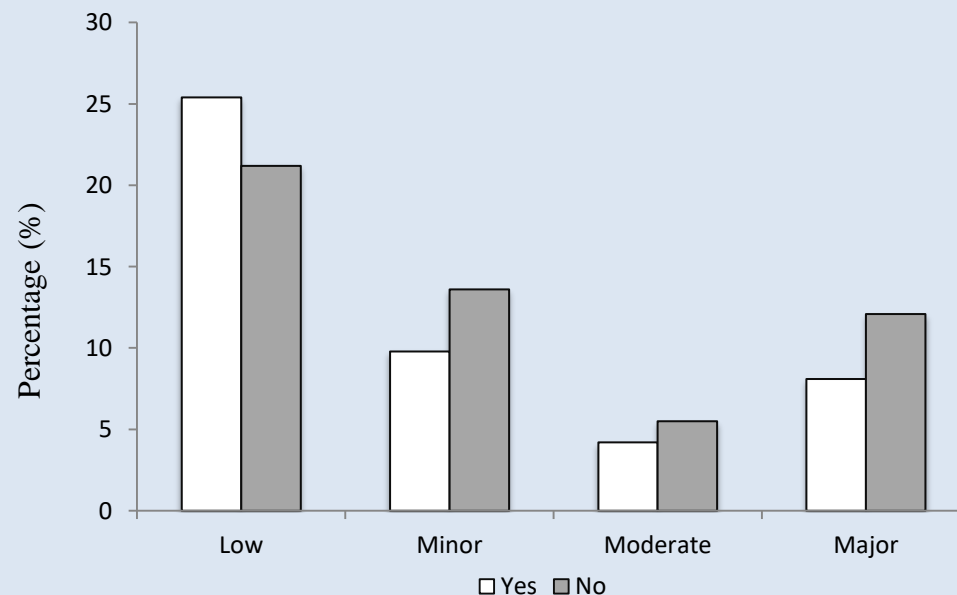


Figure. Relationship between the biosecurity risk of an angler and their knowledge of the Check Clean Dry campaign (Chi squared value 9.017, 3 df $p < 0.01$, Cramer's value 0.131 $p < 0.05$)

Step Two: Angling tourism as a pathway?

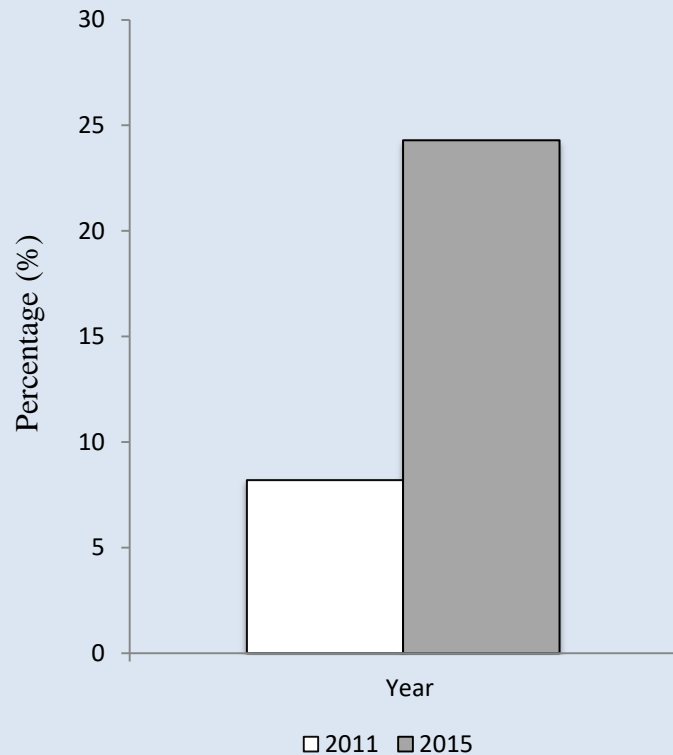
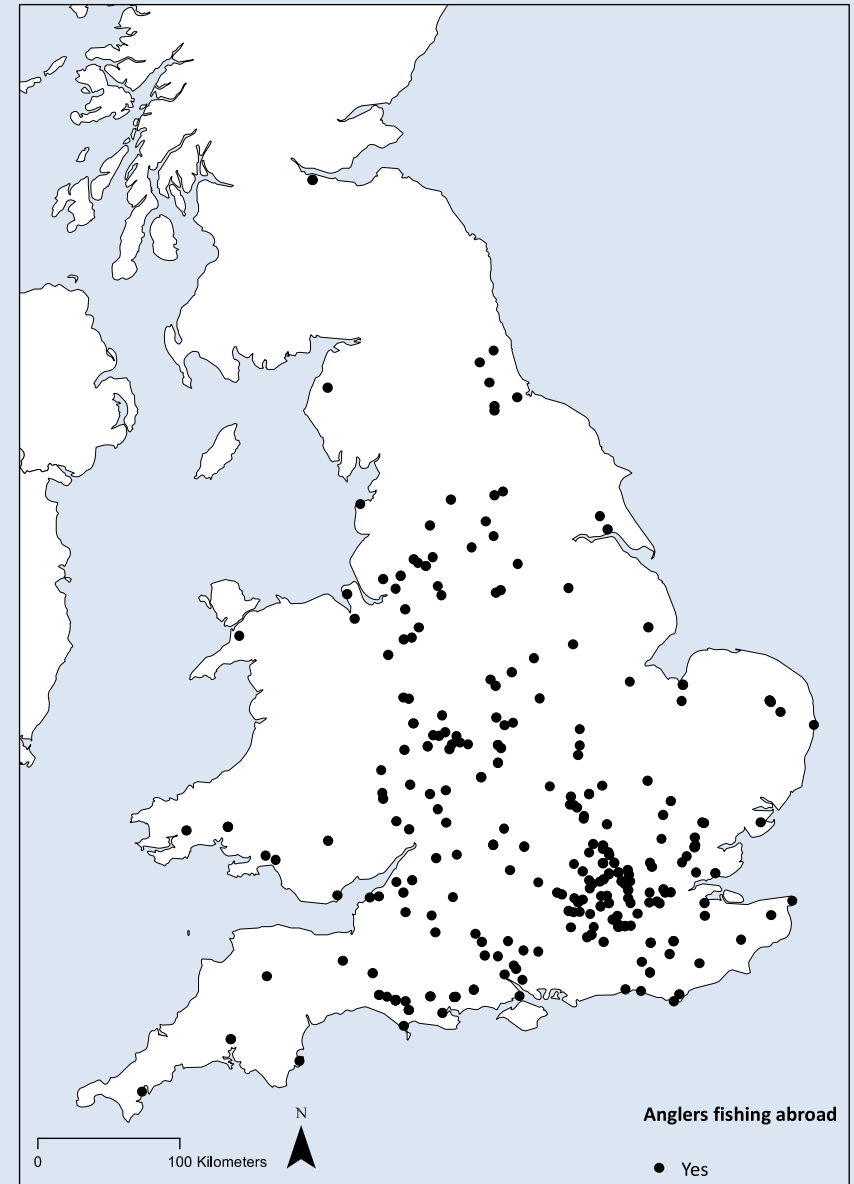


Figure. Percentage of anglers that fished fortnightly, that NEITHER checked, nor dried their equipment and fish abroad.



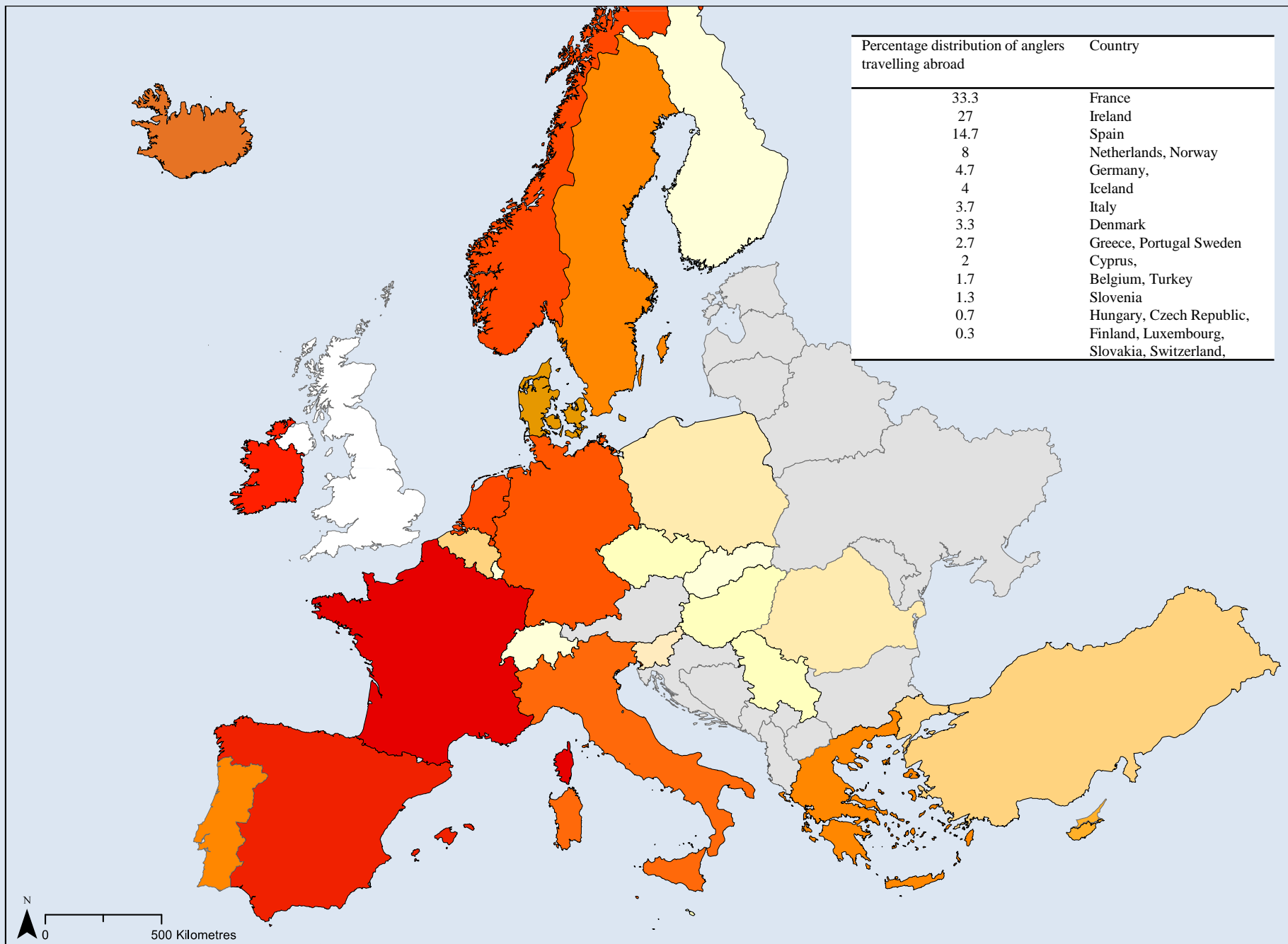


Figure. Volume of UK angler travelling to Europe for for fishing

French study sites

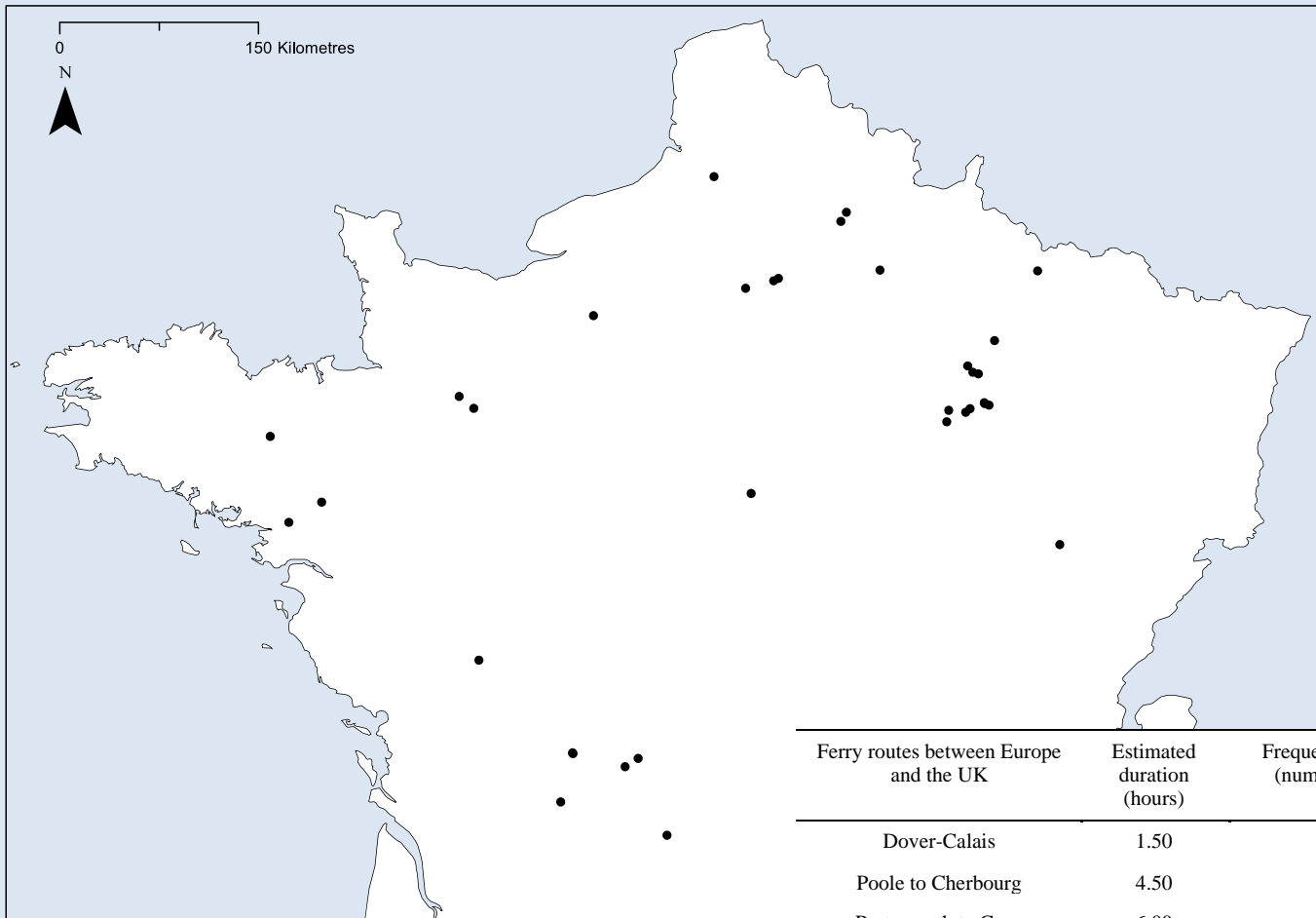


Table. Duration and frequency of ferry link between the UK and France

Ferry routes between Europe and the UK	Estimated duration (hours)	Frequency of ferries (number per day)	Number of cars per ferry
Dover-Calais	1.50	23	520-1059
Poole to Cherbourg	4.50	1	590
Portsmouth to Caen	6.00	4	600-800
Portsmouth to Cherbourg	3.00	2	235
Portsmouth to Le Havre	3.45	1	160-200
Portsmouth to St Malo	8.00	1-2	580
Plymouth to Roscoff	5.00	5	470

Invasive species presence

20 of 34 fisheries contained at least one invasive species, Over 15 different species

Species (Common name)	Species (Latin Name)	Present in UK	Eradication program
Plants			
Canadian waterweed	<i>Elodea canadensis</i>	Yes	Yes for similar species <i>L. grandiflora</i>
Creeping water primrose	<i>Ludwigia peploides</i>	No	
Curly waterweed	<i>Lagarisphon major</i>	Yes	
Nuttalls waterweed	<i>Elodea nuttallii</i>	Yes	
Parrots feather	<i>Myriophyllum aquaticum</i>	Yes	
Shrimp			
Bloody-eyed mysid	<i>Hemimysis anomala</i>	Yes	
Caspian slender mysid	<i>Limnomysis benedeni</i>	No	
Gammarus roselii	<i>Gammarus roselii</i>	No	
Mollusc			
Asian clam	<i>Corbicula fluminea</i>	Yes	
Zebra mussel	<i>Dreissena polymorpha</i>	Yes	
Crayfish			
American crayfish	<i>Pacifastacus leniusculus</i>	Yes	
Red swamp crayfish	<i>Procambarus clarkii</i>	Yes	
Spiny cheeked crayfish	<i>Orconectes limnosus</i>	Yes	
Fish			
Black bullhead catfish	<i>Ameriurus melas</i>	No (found in Essex fishery in 2014 but eradicated)	
Top mouth gudgeon	<i>Pseudorasbora parvas</i>	Yes	Yes



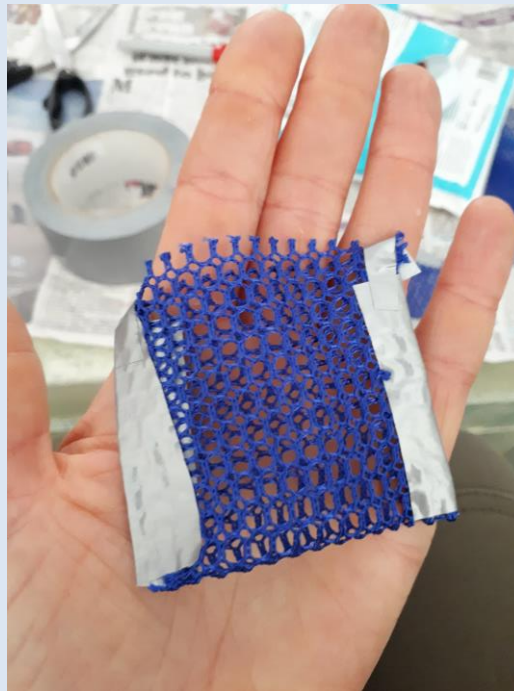
Lack of biosecurity



3 out of 34 fisheries

Brown in colour - degraded

Step 3: Desiccation tolerance



Step 3: Desiccation tolerance

Table. Different treatment scenarios for desiccation experiments

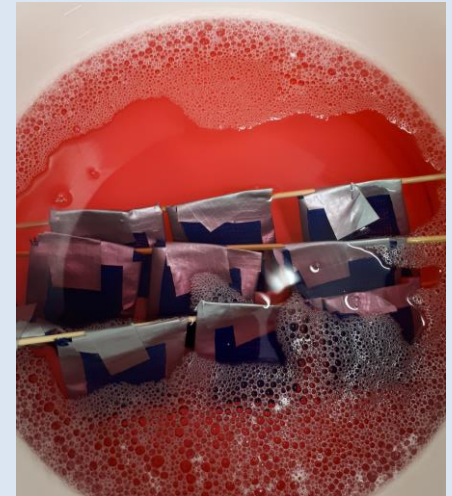
Treatment	1 hour	1 day	2 day	4 day	8 day	16 day
Control	10	10	10	10	10	10
No biosecurity	10	10	10	10	10	10
Dry only	10	10	10	10	10	10
Hot water only (45°C 2minutes)	10	10	10	10	10	10
Hot water only (45°C 15minutes)	10	10	10	10	10	10
Hot water and dry	10	10	10	10	10	10
Virkon (2minutes)	10	10	10	10	10	10
Virkon (2seconds)	10	10	10	10	10	10

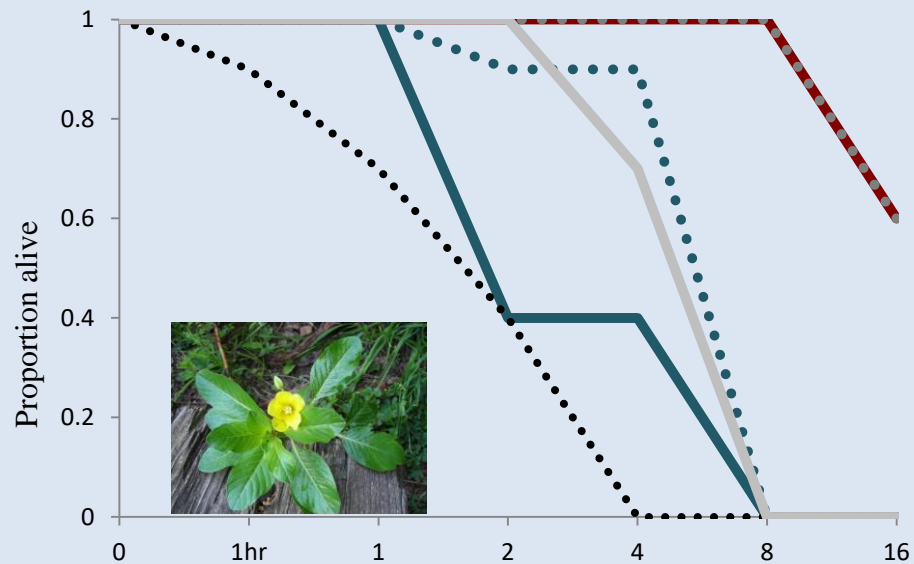
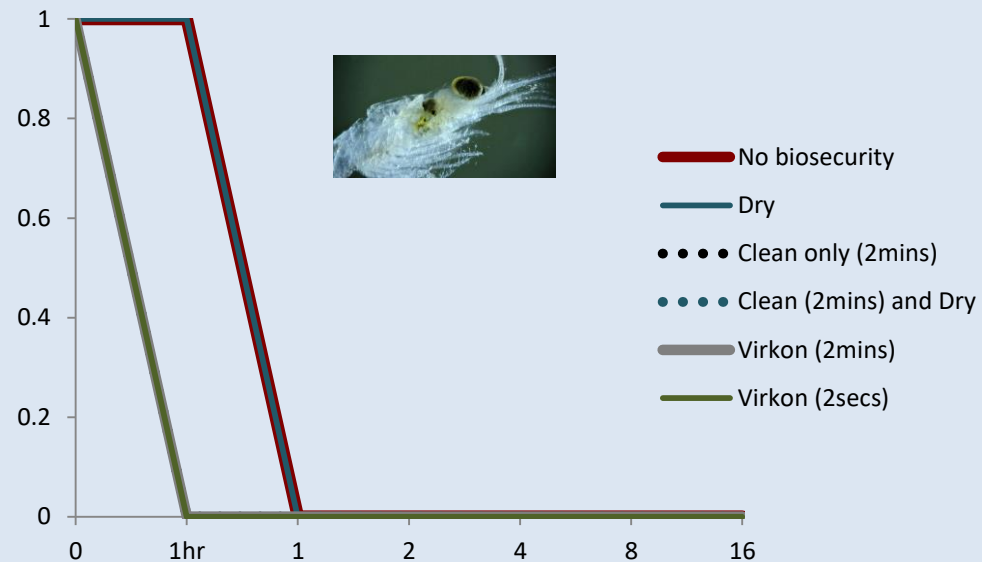
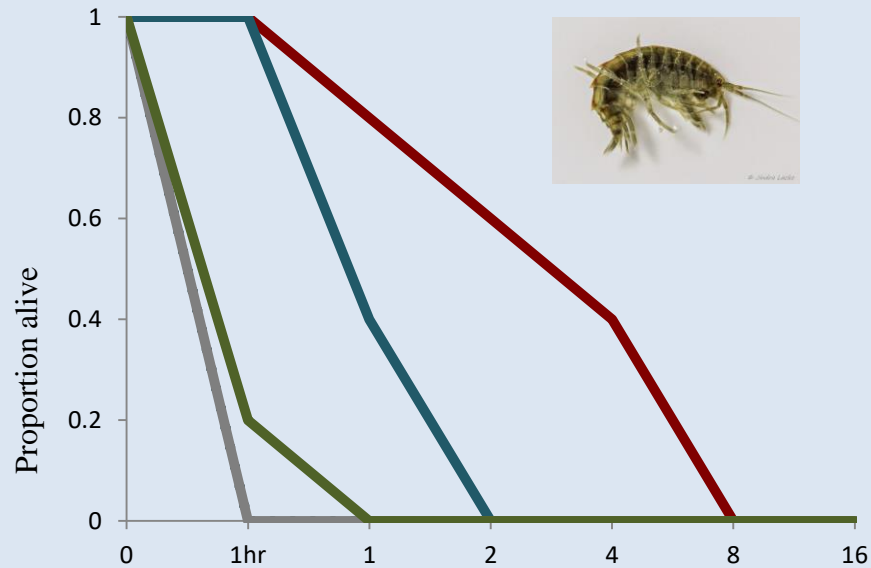
Temperature controlled room (18°C), humidity (56-60%)

Survival:

Invertebrates: mobility

Plant – MINI PAM II Waltz and Opti-Sciences Chlorometer





Virkon and hot water
ineffective against
L. grandiflora

Drying

Conclusions



Awareness campaign seems to have had some effect...but still not enough

First evidence to suggest angling tourism an international pathway for invasive species

Many fisheries hot-spots for invasive species – stepping stones with no biosecurity

Hot water is not the solution– what else is there?



Questions?

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