Written evidence submitted by the Biosecurity Research Initiative at St Catharine’s

Executive summary

1. The number of non-native invasive species in the UK and its overseas territories is among the highest globally, and likely to keep increasing fostered by climate change and global maritime trade.

2. The UK is routinely implementing risk analyses (involving hazard identification, risk assessment, management and communication) that have been effective in tackling the likely risks. Horizon scanning of emergent threats needs to be repeated at regular intervals.

3. Invasive species are the second largest threat to biodiversity after habitat loss, with top invaders in the UK including predators like the American mink, feral cats and brown rats; and ecosystem engineers like zebra mussels, Himalayan balsam, rhododendron and Japanese knotweed. Invasive species also carry pathogens and diseases that affect human (various species of cockroaches, brown rats, Muntjac and sika deer), animal (signal crayfish, grey squirrels and American bullfrog) and plant (potato blight, ash dieback, Dutch elm, alder and sudden oak diseases) health.

4. The risks of invasive species migrating to the UK under future climate change scenarios is high, particularly for the quagga mussel, Amur sleeper, Amur clam, round goby, Sosnowski’s hogweed, big sage, water milfoil, emerald ash-borer, Asian longhorn beetle, Asian hornet, processionary moth, raccoon and sacred ibis. Some of them have already established small isolated populations, demonstrating the effectiveness of horizon scanning to identify future threats.

5. To mitigate the risks of climate change, the UK should enforce current regulations and risk analyses of invasive species, promote the conservation of native habitats and species, and make sure that climate change mitigation measures (e.g. water-transfers, biofuels) do not promote the expansion of invaders.

6. The four nations should prioritize resources in prevention, the most cost-effective measure against invasion: risk analysis of emergent threats, management of pathways (e.g. ornamental trade, ballast water), border control, and quarantine facilities.

7. Rapid control and eradication follow when prevention fails. To support decision making, there is an urgent need for robust synthesis of all available evidence that is relevant to the management of invasive species.

8. The risk of trade bringing invasive species to the UK is high, as recent forecasts anticipate a 3 to 20-fold increase in the global invasion risk associated with maritime
traffic. This risk can be mitigated through trade regulation, border control and international cooperation.

9. At present, it is difficult to assess the effectiveness of EU and UK regulations because of time lags between introduction and detection of new invasive species.

10. In the event of EU exit, the List of invasive species of EU concern may not cover UK interests over time. It also creates opportunities for the UK to apply higher standards for biological security. Sharing information with other EU countries and internationally will be crucial to ensure UK’s biosecurity.

11. In conclusion, the spread of invasive species in the UK is increasing. Confronting the problem of biological invasions, particularly the unwanted introduction of contaminants, is vital for national biosecurity. Without horizon scanning to consider likely invasives and systematic reviewing of the evidence to plan responses we are likely to be ill-prepared for future arrivals.

**BioRISC**

1. We are responding to this call for written submissions as academics from the **Biosecurity Research Initiative at St Catharine’s (BioRISC)**. BioRISC is a new initiative that brings together researchers with expertise in invasive species, systematic reviews of scientific evidence (e.g. management tools for invasive species), horizon scanning, risk assessment, and modelling spread of invaders under future climate change scenarios. We will have a launch event at the Houses of Parliament in the summer of 2019 (with Lord Des Browne) and representatives of the Invasive Species Inquiry would be welcome to attend.

2. In addition to this written submission, we would welcome the opportunity to submit oral evidence to the Invasive Species Inquiry.

**How well is the UK and its overseas territories managing the impact of invasive species and controlling the risks of further invasion?**

1. The UK is a global hotspot of invasive species registering >3500 non-natives in Great Britain [https://doi.org/10.1007/s10530-015-0986-0], and >2000 in overseas territories [http://jncc.defra.gov.uk/page-3660]. This is attributed to its high habitat disturbance, dense transportation networks, mild temperate conditions, high population density and economic activity.

2. Despite national and international regulations, records keep increasing without signs of slowing down fostered by climate change and increasing globalization [https://doi.org/10.1038/ncomms14435]. For instance, the Thames estuary has seen a sixfold increase in the number of invaders in the last century [https://doi.org/10.1007/s10530-012-0343-5].
3. Awareness of the problems associated to invasive species in the UK is high, particularly since the establishment of the Non-Native Species Secretariat (NNSS, http://www.nonnativespecies.org) that has promoted important biosecurity campaigns such as Be Plant Wise, or Check-Clean-Dry.

4. The UK is developing a strong knowledge base for the prevention and management of invaders through a combination of horizon scanning of future threats (see https://doi.org/10.1111/gcb.12603), followed by a comprehensive risk assessment of selected species to anticipate vectors and pathways of introduction, areas vulnerable to colonization, potential ecological and socio-economic impacts, and manageability (see for instance http://doi.org/10.1111/1365-2664.12348). Risk analyses need to be updated regularly to include new emergent threats.

5. Many examples of successful control of invasive species in the UK and overseas territories exist, but the evidence is scattered across multiple scientific studies and technical reports. In 2015 we conducted the first summary of evidence for the Control of Freshwater Invasive Species (https://www.conservationevidence.com/). This needs to be expanded to other habitats and taxonomic groups.

6. Assessing the effectiveness of UK invasive species regulation is complicated for several reasons. First, time lags between the introduction and actual detection of invasive species, or between introduction and impacts, makes it difficult to quantify the real number of invasive species. Second, horizon scanning focuses on species that are known to be invasive elsewhere but a quarter of all new species causing harm were not considered invasive beforehand making it difficult, if not impossible, to anticipate them. Finally, increased awareness and monitoring may actually uncover invasives that would otherwise remain unnoticed, boosting species listings.

Of those that are already in the UK, which invasive species are posing the greatest harm to: a. human health; b. animal health; c. plant health and biodiversity?

1. Top invasive species of concern in the UK include, according to the NNSS and the Environment Agency (www.nonnativespecies.org): Japanese knotweed, signal crayfish, American mink, brown rats, giant hogweed, floating pennywort, Himalayan balsam, Australian swamp-stonecrop, Chinese mitten crab, parrots feather, and topmouth gudgeon.

2. The International project RINSE (http://www.rinse-europe.eu/) added to this list: grey squirrel, harlequin ladybird, killer shrimp, zebra and quagga mussels, caulerpa algae and green sea fingers.

3. Invasive species causing the greatest human health issues include cockroaches (various species) causing food poisoning, disease-transmitting brown rats, deer (Muntjac and

4. Some examples of invasive species impacting animal health include: the signal crayfish transmitting the fungus plague that caused large-scale mortalities among ‘native’ crayfish; grey squirrels carrying a pox virus to which native red squirrels are very susceptible; and the American bullfrog carrying the Chytrid fungus that has led to worldwide amphibian decline.

5. Pathogens affecting plant health are diverse and include fungi, nematodes, bacteria and viruses. Species noted for their major impact include the ash dieback causing widespread mortality of European ash, Dutch-elm disease, alder disease, sudden oak disease and potato blight (https://bit.ly/2vudsLK). Invasive pathogens are far less well-studied in the literature than plants, vertebrates and insects despite their economic and ecological importance.

6. Invasive species causing the greatest harm to biodiversity include the American mink predating on a wide range of local wildlife, particularly ground-nesting birds and water voles; feral cats killing small birds; rats (three species) affecting seabirds, particularly in overseas territories; the ruddy duck hybridizing with native species; terrestrial plants like Himalayan balsam, rhododendron and Japanese knotweed dominating the landscape; ecosystem engineers like zebra mussels displacing native taxa in favour of other invasive invertebrates.

7. The biodiversity impacts of invasive species are especially severe in overseas territories because they comprise mostly small, isolated islands with high levels of rare and endemic species (http://jncc.defra.gov.uk/page-3660).

What are the risks of invasive non-native species migrating to the UK from future climate change?

1. Climate change will exacerbate the effects of invasive species by: 1/ intensifying the transport between donor regions and the UK; 2/ enabling warm-climate species to expand towards the north where they previously could not survive and reproduce; 3/ favoring the secondary spread of invaders through floods and strong winds; 4/ increasing the population size and fitness of current invaders thereby aggravating their impacts; and 5/ promoting land use changes and water-engineering responses (i.e. water transfers) that may favour the expansion and impact of invaders.

2. High-risk emerging/future invaders into the UK include (https://doi.org/10.1111/gcb.12603 and https://doi.org/10.1007/s10530-015-0986-0), but are not restricted to:

   ○ Insects: emerald ash-borer, Asian longhorn beetle, Asian hornet, processionary moth
Plants: Sosnowski’s hogweed, big sage, water milfoil

Aquatic organisms: quagga mussel, Amur sleeper, Amur clam, Asian shore crab, American lobster, round goby, apple snail, Asian shore crab, brush-clawed shore crab, American lobster, round goby

Animals: raccoon, sacred ibis

3. Climate-change models anticipate northward shifts in the current distribution of European invaders at a rate of 14-55 km/decade resulting in a marked increase in the level of biological invasions in the Atlantic region (see Fig. 1), which may seriously compromise the conservation of biodiversity and ecosystem services in the UK (http://doi.org/10.1111/gcb.13798).

4. Invasive species are expected to expand +15% their distribution in Europe by 2050 fostered by climate change including, among others: the knotgrass, coypu, tree of heaven, American bullfrog, topmouth gudgeon, red-eared slider, tiger mosquito, black locust, Asian clam, and zebra mussels (http://doi.org/10.1111/gcb.13798).


What actions should the UK take to mitigate the risk, or adapt to, climate migrations of invasive species?

1. In a context of changing climates, researchers and practitioners need to determine which species may become invasive, where, and the consequences they may have. Some recommendations follow.

2. Enforce the Risk Analysis of Invasive Species, comprising:
   - Regular update of horizon scanning exercises to identify future threats. The last exercise was conducted in 2014 and was effective in identifying species that became invasive in the following years, such as the quagga mussel and Asian hornet,
   - Full risk assessment of selected species to assess the likelihood and severity of the threat using standard methodologies (NNRA and/or EICAT),
○ Mapping the areas most vulnerable to first colonization and/or further spread under current and future climate conditions,

○ Risk management using standard techniques (NNRM, https://doi.org/10.1007/s10530-017-1451-z) to identify priorities for eradication and contingency planning. This tool was used in 2015 to evaluate the feasibility of eradicating 41 new and emerging species in Great Britain,

○ Risk communication to competent authorities and the general public.

3. Make sure that climate change adaptation measures (e.g. changes in crops, biofuels, water transfers) do not promote the use or expansion of invasive species.

4. Promote the conservation of habitats and biodiversity. Research has shown the potential of protected areas to provide strategic refugia to native species from the expansion of invasive species spreading under climate change (http://doi.org/10.1111/gcb.13798). The restriction of human activities within protected areas buffer the effects of climate change (https://www.nature.com/articles/nclimate2035), reduce the opportunity to invade, and promote the biotic resistance afforded by rich natural communities.

Where should the four nations prioritise resources to tackle invasive species?

1. Prevention is the most cost-effective measure to tackle invasive species. Priorities in this direction include:

   a. Management of pathways (e.g. ornamental trade, water transfer) rather than on individual species provide the most efficient way to concentrate efforts at sites where species are most likely to enter national boundaries and to intercept several potential invaders linked to a single pathway.

   b. More effective border controls and quarantine facilities. Existing border restrictions tend to focus on economic pests, rarely addressing the threat of accidentally transporting invasive species of environmental concern (http://jncc.defra.gov.uk/page-3660).

   c. Non-deliberate introductions of freshwater and marine species, mostly accidentally as contaminants (hull fouling, ballast water) and escapes (aquaculture, pet trade), should be prioritized because their eradication is difficult, expensive and rarely feasible (https://doi.org/10.1007/s10530-015-0986-0).

2. Recent meta-analyses have investigated the attributes that make species invasive, factors affecting establishment and their impacts, but few similar syntheses exist for the effectiveness of management and regulations (but see https://doi.org/10.1111/j.1365-2664.2011.01979.x). Of the syntheses that do
investigate management, most concentrate on eradication or management after an invasion has taken place (e.g. [https://bit.ly/2ZIszpM](https://bit.ly/2ZIszpM), [https://bit.ly/2DEf7tv](https://bit.ly/2DEf7tv)), while relatively few focus on how best to prevent invasion in the first place. Many of these syntheses are now out-of-date and need to be updated. In addition, comprehensive synthesis of evidence may reveal solutions that a review of single species may miss.

**How can the risk of trade and future trading relationships bringing non-native invasive species to the UK be mitigated?**

1. Shipping accounts for 80% of world trade, and a recent study projects global maritime traffic to lead to a 3- to 20-fold increase in global invasion risk, especially of marine organisms ([https://www.nature.com/articles/s41893-019-0245-y](https://www.nature.com/articles/s41893-019-0245-y)). The UK is particularly vulnerable to this emerging threat, because it holds some of the most important international ports in cargo volume, and global warming may favour the survival of transported contaminants in UK waters and overseas territories.

2. Non-deliberate introductions, particularly from Asia and North America, was responsible for about 80% of new introductions into the UK and neighbouring countries between 2000 and 2015 and likely to be responsible of future colonizers ([https://doi.org/10.1007/s10530-016-1278-z](https://doi.org/10.1007/s10530-016-1278-z)). The on-going intensification of trade and shipping with SE Asia may further intensify the challenge posed by unwanted introductions.

3. Research has shown that trade regulation effectively addresses the risks of invasion. For instance, the 2007 regional ban of wild-bird trade in Europe to prevent the spread of avian flu and other diseases sharply reduced the fluxes of global bird trade and therefore risk of invasion in Europe ([https://doi.org/10.1126/sciadv.1700783](https://doi.org/10.1126/sciadv.1700783)).

**How effective have the European Union’s Invasive Alien Species Regulations been at addressing and tackling invasive species?**

1. The cumulative number of invasive species globally keeps increasing without signs of abatement suggesting that regulations (both EU and UK’s) have not been effective enough to keep up with increasing rates of global trade and slow down invasive species accumulation, especially those arriving accidentally, such as invertebrates and pathogens ([https://www.nature.com/articles/ncomms14435](https://www.nature.com/articles/ncomms14435)).

2. An exception is the Biosecurity Act in New Zealand adopted in 1993, which represents the most stringent national law against invasive species introductions. Arrival rates of invasive plants clearly dropped following its enactment ([https://www.nature.com/articles/ncomms14435](https://www.nature.com/articles/ncomms14435)), which has been related to the use of white-lists of permitted species that requires any unlisted species to be fully risk assessed before entry into the country is allowed. Most other comprehensive national
regulations including the European and the British ones, are based on blacklists of unwanted species.

3. The effectiveness of EU and UK regulations, based on black lists of unwanted species, is compromised by the fact that a quarter of new invasive species were not known as problematic in their country of origin and therefore unlikely identified through traditional horizon scanning (https://doi.org/10.1073/pnas.1719429115).

**In the event of EU exit, how should the UK establish its replacement for the European Commission’s scientific forum to update the species list of concern?**

As we conclude in a letter published in the journal Nature (Brexit threatens Biosecurity, Nature 567, 4611), biosecurity is likely to be seriously compromised by the United Kingdom’s exit from the European Union (https://www.caths.cam.ac.uk/brexit-threatens-biosecurity):

1. It will take time to replicate the EU environment protection system;
2. We shall no longer be able to access the relevant data systems and will not be able to participate in the decision-making;
3. The EU exit will disrupt scientific research programmes;
4. There is the potential for the EU List of invasive species of concern to diverge from UK interests over time. This also creates opportunities for a UK prioritisation.

April 2019