I’m responding to this in general terms rather than the specifics of all of the questions, not least as I’ve only just been made aware of the enquiry, one that is to be welcomed. My expertise is as a vet with a background in mixed species practice and a post-graduate certificate in sheep health and production. More particularly, I’ve recently gained a Master’s degree in Conservation Medicine, a course I took to improve my understanding of how ecological processes are linked to those of animal diseases, especially parasites. As a result, I am becoming more interested in how diseases move “between” species – livestock, wildlife and human. My course included aspects of invasive species (one of six recognised pressures on biodiversity) and I took the subject as one of our elective topics. In your deliberations, I would suggest contacting the Conservation Medicine department at Edinburgh, as there are people there (eg Neil Anderson) with an excellent understanding of this complex topic. My submission is not referenced, although I can provide references to support my statements should it be required.

I’m sure you have already hit the first problem within the wider problem of INNS, which is defining what is meant by INNS and then deciding if it is indeed a problem, before reaching a conclusion as to whether the problem needs a solution. It is an area full of uncertainty and contradictions perhaps best illustrated with the following fairly well-known examples as they offer glimpses of the problems that INNS create, but also the conflicts that exist in the debate.

Rabbits
An easily recognised animal that, to most people, is a normal part of the British Isles Ecosystem. It’s widely recognised that it is non-native but was introduced by the Normans (possibly the Romans). It is “classified” as vermin and can have a significant effect upon crops, especially young tree plantations. However, it has a remarkable co-existence with the endangered British blue butterfly, whose caterpillars depend upon one species of ant (Myrmica sabuleti) that cannot survive unless the ground is closely cropped by rabbits (or livestock). The advent of myxomatosis (itself an INNS) effectively removed the butterfly from the country, until recently re-introduced. So is the rabbit an invader, or just a restored ecosystem engineer? The fossil record suggests that rabbits were present prior to glaciation and such a close relationship to the butterfly supports a degree of co-evolution.

Deer
The native deer of the British Isles are roe and red (and probably fallow looking at the fossil record) with the non-natives being sika, muntjac and Chinese water deer. The sika can breed with the red, creating fertile hybrids and there are thoughts that eventually (apart from islands) the
whole UK population will be hybridised. There is little difference in appearance to the casual observer and both species have the same role in the ecosystem, so does it matter that the purity of the red is lost? From enquiries I have made there is little difference in the impact they have on forestry, with sika perhaps being more locally destructive, but the bigger red having a greater individual impact. Muntjac however are more of a problem with well recognised impacts upon understory and scrub such that bluebell woods and thickets for nightingales are lost. With the ability to breed all year round and unfortunately a human tendency to deliberately spread them, they are rising in number.

Grey Squirrel
As well as being an intra-guild competitor for resources with the red, the grey carries squirrel pox virus, which is fatal to the native red squirrel. While there are other causes of mortality, reds can only survive in regions where there are no greys, or the grey are effectively controlled. Like the deer, there may be an argument that any loss of the red will be made up by the spread of the grey, however there are arguments that the grey has an overall greater negative impact upon trees and on wild birds.

I have not been able in the sort time to write this to answer all the questions, but I have looked at some:

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

This is a good horizon-scanning question to ask. The risk is high and a good example is the blue tongue virus incursion in Northern Europe of 2006. The serotype was BTV8 a type previously found in sub-Saharan Africa. It is thought that the higher temperatures in Europe allowed the virus to migrate from the midge intestine to its salivary glands and so maintain infection in native midges. Nothing else has changed. We are seeing incursions of ticks such as *Dermacentor reticulatus*, that transmits babesiosis in dogs, in part due to poor border biosecurity, but they are able to survive in the UK owing to higher temperatures.

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

This should not be a devolved matter as Great Britain is a single land mass.

- How can the risk of trade and future trading relationships bringing non-native invasive species to the UK be mitigated?
With the ability to transport semen and embryos, seeds or spores there is no need to import entire organisms, certainly not for the average commercial buyer. Exceptions can be made that are subject to stringent testing (such as that for the Knapdale beaver release. As it is recognised that INNS create problems and that we should (either within or without the EU) ensure that it becomes more difficult for future INNS to become established. This means proper biosecurity at borders and, if the problem is to be truly addressed may be regarded as a barrier to trade. This is something that needs addressing at the EU level should we remain. The EU will have to decide if free movement/travel is a greater need compared to disease security and conservation of species.

A more simplistic solution is to ban the importation of animals for pets, especially, “exotic animals” Our native amphibians are under threat from a fungal disease – chytridiomycosis. One particular strain, *Batrachochytrium salamandrivorans* is so far, not present in the UK, but importation of pet amphibians risks the importation of this disease.

The other questions that have been asked for this enquiry are, to my mind, too simplistic, being more in the line of, “X has happened, what do we do now?”. Non-native species arrive all the time, usually by natural processes and in small numbers (rare birds being a good example). Problems arise when these species become permanently established often after being transported by human action (usually deliberate) in large numbers. What needs to be asked at the heart of this enquiry is how these releases become established. One widely accepted aspect is that of “Environmental Resistance” first suggested in the 1930s. Essentially the more complex and bio-diverse and ecosystem, the less chance an invader has of becoming established. There is a reasonable argument that the grey squirrel would not have become so readily established had the red population not been reduced by a combination of habitat destruction and systematic culling of reds to protect woodland (eg the Red Squirrel Club, set up to cull them).

There is a similar hypothesis to Environmental Resistance, related to pathogens and disease prevalence. In essence an ecosystem will contain organisms that are susceptible to or resilient to a parasite. The richer the biodiversity of the ecosystem, the less the likelihood of that parasite infecting a susceptible organism. The incidence of Lyme disease in the Eastern USA is a good example of this. It is important within this enquire that micro and macro-parasites are included with INNS for it is probable that the same ecological pressures apply to them as to their hosts. The UK has already suffered with Dutch Elm disease as an example of what can occur when a parasite is introduced to an area of naïve hosts.
The ease of travel and removal of borders is going to increase the risks of INNS in many countries and it is unlikely that those movements can be prevented completely. What we need to understand therefore is how to ensure that our ecosystem in the British Isles can be made more resilient to these incursions becoming establish populations. There also needs to be some consideration of the ethics and welfare of any control measures for many people have difficulty with any form of culling. However, the wider issues have to take precedence. The removal of reindeer and rats from South Georgia has been an excellent project, one that should be repeated on many of the UK island protectorates. I’d also suggest that the enquiry considers the impact that a native species can have when it’s population rises to an extent that it threatens other species – hedgehogs and badgers being one example, fulmar and peregrines another.

This is a good enquiry to see and I wish it well. It is an area with contentious ethics and highly complex ecology.

*April 2019*