2021 river basin management plans

Invasive non-native species challenge Published: October 2019

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1. Summary

After the loss and destruction of habitat, invasive non-native species are considered the second biggest threat to biodiversity worldwide.[i] Nearly one fifth of the Earth's surface is at risk of plant and animal invasions, impacting native species with serious consequences for entire ecosystems and native species.[ii]

An invasive non-native species (INNS) is any non-native animal or plant introduced outside its natural past or present distribution which can cause damage to the environment, the economy, our health and the way we live.

The economic consequences of INNS can be enormous: the cost in England is estimated at £1.3 billion per year (2009 costs).[iii]

Preventing the arrival and spread of INNS is our priority, as most species are difficult or impossible to deal with once they are established. However, the effect of INNS are often overlooked and masked by other pressures such as increased nutrients. We need to do more to recognise the impacts of INNS in our waters and understand where INNS are stopping the water environment from improving in the way we expect when we address other pressures.

Reducing the effect of climate change, nutrients and water use can help rivers and seas cope with the impacts of established invasive non-native species. Reducing the pressure from INNS, where possible, can help habitats cope with stress from other pressures.

INNS can only be addressed by working in partnership with others and at catchment and national scales. National eradication and control programmes for priority species are important to prevent for the future effect on people and the environment. When invasive species become too widespread, the best approach is to switch to protect valuable assets such as conservation sites and fisheries.

The most effective way of preventing the introduction and spread of INNS is to apply good biosecurity. Everyone who works or plays in or near water should follow the Check, Clean, Dry guidance. We are working together with the water industry to understand and reduce the risks of spread via existing and new water transfer networks.

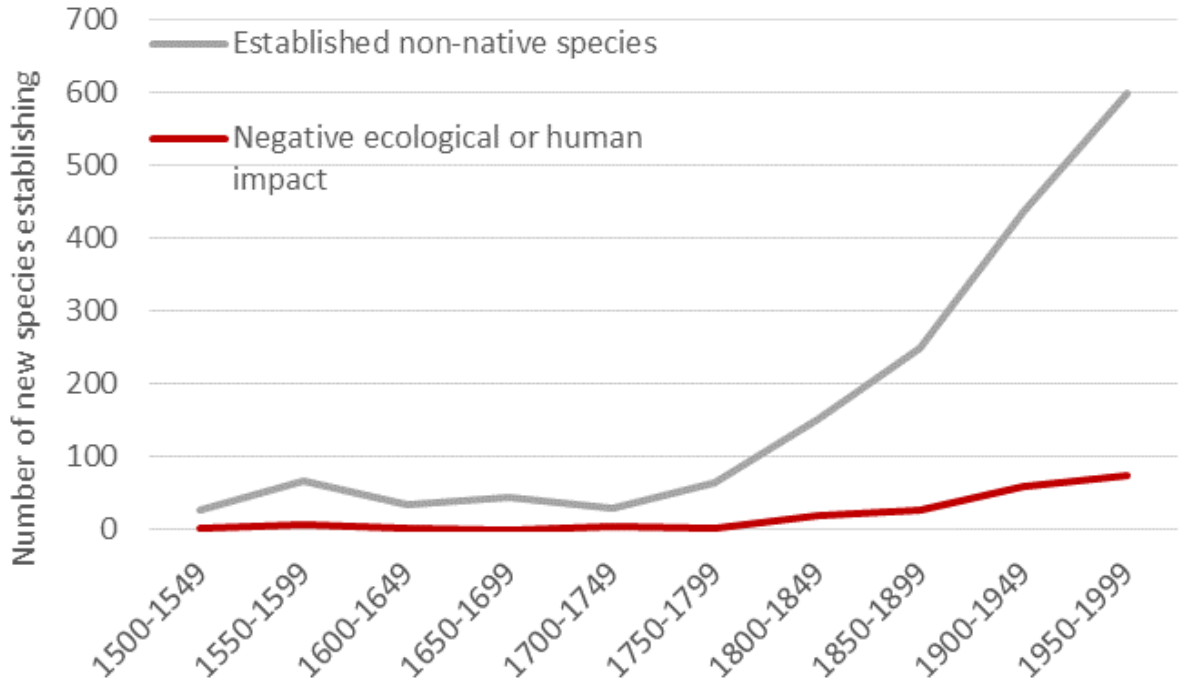
We encourage communities, local action groups and catchment partnerships to raise awareness of good biosecurity and understand how INNS affect their local environment.

2. The pressure

2.1 Evidence for the problem

The majority of non-native species are not damaging. Across all habitats, only about 10% of the non-native species in Great Britain (GB) have a negative impact and are considered invasive. However, in aquatic habitats, a greater proportion of INNS have a negative impact (for example, 40% of freshwater non-native species established in GB have a negative impact).

Figure 2. Number of established non-native species and the number that are designated as having a negative ecological or human impact against date of first arrival.iv Of the ~600 species establishing before the year 2000, around 75 are considered to have a negative impact



The annual cost associated with INNS in England is estimated at £1.3 billion per year (2009 costs).[v] These costs comprise control and eradication, structural damage to infrastructure, or loss of production because of the presence of invasive non-native species. The impact of Japanese knotweed alone was estimated to cost around £1.8 million a year in Britain, and the impacts of signal crayfish cost more than £2.5 million.

2.2 Impacts on the environment and how we measure ecological quality

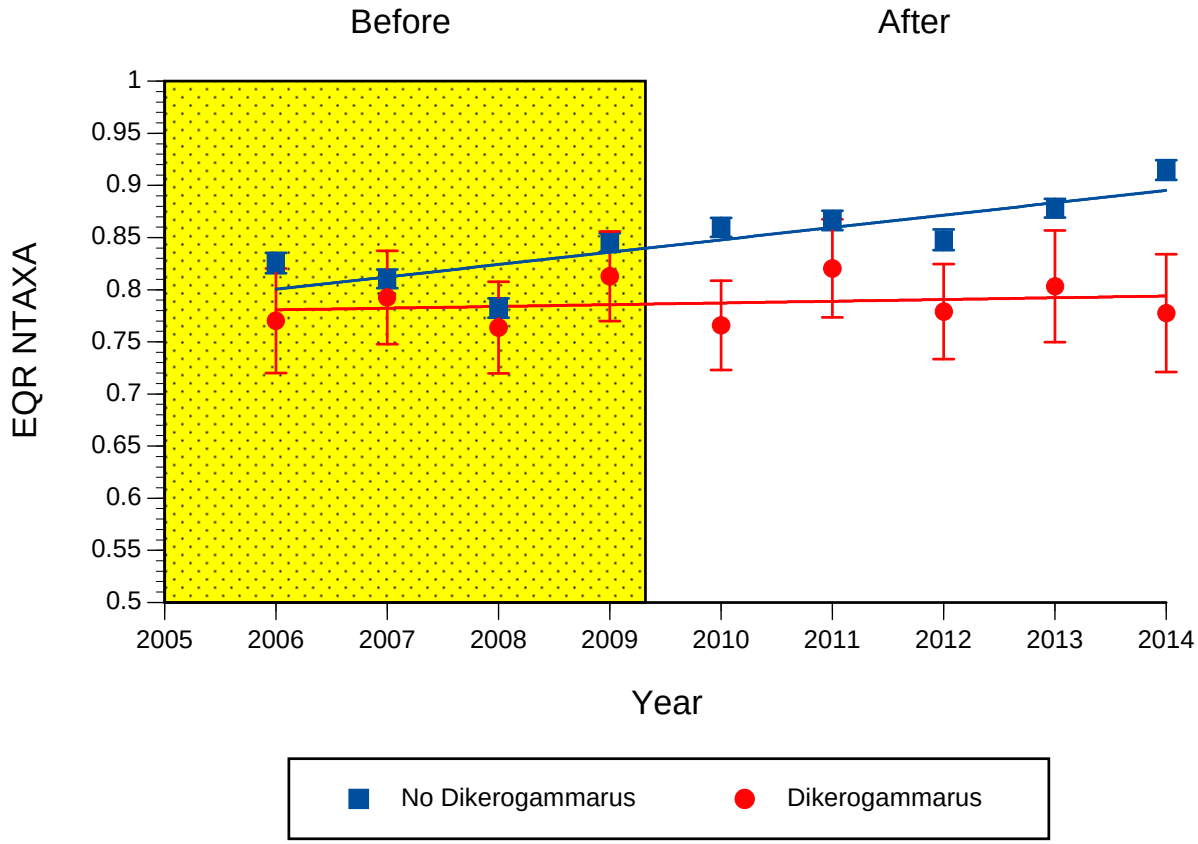
Since 2015, we have learnt more about the impacts of INNS on our waters. We now have evidence that they damage the ecology of our waters and, in addition, can affect our ability to measure the effect of other pressures such as nutrients and sediment.[vi] They can also affect the ability of our biological tools to assess the pressures that they were designed to monitor.

Recent work from Environment Agency commissioned research[vii] has demonstrated that some species have substantial impacts on ecological classification. These impacts vary across the different elements of the ecosystem that we monitor (the

study looked at data for fish, macroinvertebrates and plants), so we may miss ecological impact at locations where we have not looked at all biological elements.

Significantly, the research showed that the presence of demon shrimp (Dikerogammarus haemobaphes) appears to constrain improvements in biological elements which were observed at uninvaded sites (figure 3).

Figure 3 Variation in mean Environmental Quality Ratio (EQR) for the freshwater macroinvertebrate index NTAXA[viii] (± standard error) with time for water bodies where demon shrimp (Dikerogammarus haemobaphes) first occurred between 2010 and 2012 compared with similar water bodies that had not been invaded. 0.8 = high/good status boundary; 0.68 = good/moderate boundary; 0.56 = moderate/poor boundary.



Further research is required to investigate this apparent pattern, building on the large and validated data set used within the study. There are many co-variables associated with the locations of demon shrimp which could be contributing factors, however, it is likely that invasive species do reduce our ability to measure improvements from programmes of measures targeting other pressures.

We would also like to do more to understand the links between good ecological function and resilience to the impacts of an INNS once it has arrived. We believe that locations with a more resilient and robust ecosystem are more able to cope with the impacts of INNS.

Within the river basin planning process, the Environment Agency recorded only 98 instances where it was confident that INNS were the reason for an individual quality element not achieving good status (RNAGS).[ix]

To address this likely underestimate of INNS as a contributing factor in not achieving good ecological status, a supporting element has been created within the classification that indicates significant INNS are present. The species selected are those which are known to cause ecological impact in all habitats within a particular water category and therefore cause a water body to be 'at risk' in all water body types (supporting info 7.1.3).

The supporting element draft results show that at over 1100 (29%) water bodies at less than good, species known to cause ecological impact are established and likely to be causing significant impacts. It is likely that INNS are a reason for not achieving good ecological status in these water bodies, and updated guidance will expect that they are recorded as such unless there are clear reasons not to do so. Around 400 of those have two or more significant INNS present, resulting in an even greater certainty of impact.

Table 1 Percent of all water bodies in England with a significant INNS present

	River	Lake	Transitional	Coastal	Total
High	0%	n/a	n/a	0%	0%
Good	13%	24%	15%	42%	17%
Moderate	28%	23%	55%	59%	28%
Poor	31%	48%	100%	100%	33%
Bad	32%	20%	50%	n/a	32%
Within all water bodies	27%	26%	48%	52%	27%
Within water bodies at less than good	29%	26%	55%	60%	29%

2.3 Impacts on people

Some invasive non-native plants impede access and enjoyment of water bodies. Japanese knotweed and Himalayan balsam have a high profile because they restrict access to river banks by walkers and anglers. Aquatic plants such as floating pennywort can prevent access to the river itself, especially for rowers and canoeists.

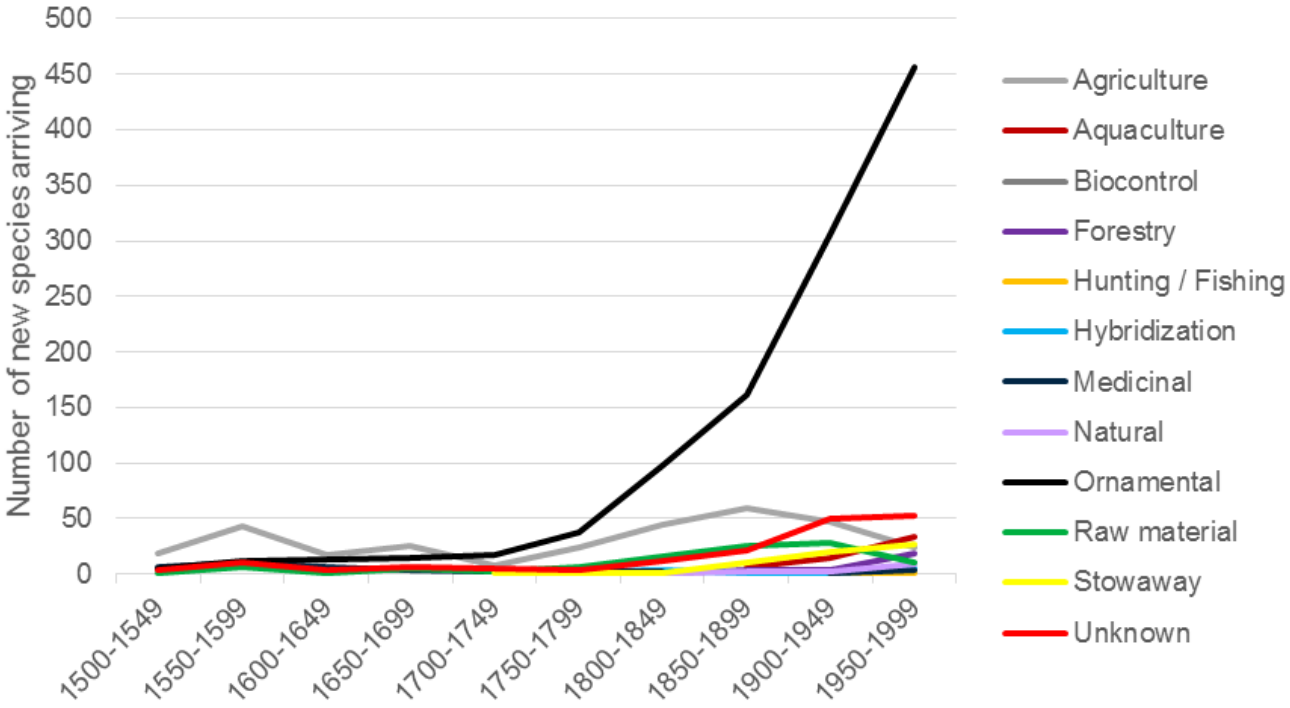
Giant hogweed is a public health nuisance because its sap causes blisters when skin is exposed to sunlight.[x] Signal crayfish and Chinese mitten crab burrow into banks and could undermine flood defences. Japanese knotweed and Himalayan balsam die-back quickly in the autumn and leave banks exposed to erosion over winter. They can all therefore cause sediment problems downstream.[xi]

2.4 Pathways

The main pathways for the introduction of non-native species to freshwater environments in Great Britain (GB) are the trade in ornamental species (for example, ornamental plants imported and sold to gardeners may later escape into the wild), aquaculture and recreational equipment. In the marine environment they are ballast water, bio-fouling on hulls and aquaculture.[xii] Some non-European species

established on the continent may spread to Great Britain (GB) by drifting on the currents. The stowaway or ‘hitchhiker’ pathway (for example species spread on recreational equipment and in boat ballast) has increased over the last 50 years and is likely to have been the pathway for many of the recent arrivals here.

Figure 4. Number of established non-native species arriving through different pathways against date of first arrival[xiii]



Over the last century, species arrivals from temperate Asia and North America have increased, arriving directly or coming in via Europe.[xiv] We are currently experiencing an invasion of species from the Ponto-Caspian region of Eastern Europe, whose movement through Europe has been facilitated by navigation links between major rivers, such as the Rhine-Main-Danube canal, which opened in 1992.[xv]

Invasive non-native species occur in all types of water body and in all areas of England. Many have been established and spreading for some time. For instance, the first records of Japanese knotweed in the wild in the UK are from 1886 and the first records of Chinese mitten crab are from 1935.[xvi] Others like the killer shrimp are newer to the UK.[xvii]

The main way that non-native species already in Britain spread are:

- ‘Natural’ or unaided spread through a water body from an existing population
- Assisted spread by human action from an existing population
- Repeat introductions from outside the UK.

Case study: Multiple likely introduction pathways of Carpet sea squirt (*Didemnum vexillum*)

- By commercial shipping, for instance. as hull and sea-chest fouling on ships, or fouling of towed hulks, rafts and pontoons
- As colony fragments on trawls, nets, shellfish dredges and other fishing gear of inshore fishing boats
- By pleasure craft, for instance as hull, anchor and rope fouling on recreational small boats
- By transfer of contaminated shellfish to new growing areas
- As colony fragments in the waste from shellfish processing plants
- As larvae or fragments of colonies carried over short distances by tidal currents or in ballast water
- As colonies attached to flotsam carried by tidal currents

From the GBNNSS national risk assessment[xviii]

2.5 Interaction with other pressures

The impacts of INNS can be affected by other pressures on the environment. In addition to the specific interactions of other pressures on INNS, the stress caused by other pressures can mean that the ecosystem is more vulnerable to the impacts of INNS.

2.6 Nutrients

Nutrient pressure, such as phosphorous and nitrogen pollution from agriculture, can exacerbate the impacts of invasive non-native plant species and allow them to become dominant. Managing and reducing nutrient pressure can help mitigate the impacts of invasive species such as floating pennywort.

2.7 Sediment

Some invasive species, such as signal crayfish and Himalayan balsam can change sediment dynamics and can therefore impact on invertebrate diversity and fish spawning habitat.[xix] Invertebrates such as signal crayfish and Chinese mitten crab burrow into banks and disturb substrate; riparian plans such as Japanese knotweed and Himalayan balsam die-back quickly in the autumn and leave banks exposed to erosion over winter.

2.8 Physical Modification

INNS can have direct impacts on the physical environment by burrowing, creating homogeneous riparian habitats and altering flow. Poor physical condition can give INNS an advantage over other species, further increasing their impact. It's important when controlling INNS to consider restoration of habitats and vegetation cover.

2.9 Chemistry

There are risks to INNS control arising from changes in regulations around herbicides such as glyphosate. In some areas chemical control is the preferred approach and can be the approach that poses least risk to other species.

2.10 Climate

Our changing climate will have a significant impact on INNS.

Sleeper species (non-native species not considered invasive which are currently in the wild or kept in horticulture, aquaculture and the pet trade) could become invasive. For example, summer temperatures may be currently too low to allow successful breeding but this may change in the future.

Some species which are previously benign will become invasive over the next 50 years as temperature rises. We are also likely to see an increase in the spread of species already here, due to a combination of low flows and associated nutrient loads allowing species such as floating pennywort to thrive and extreme events assisting spread.

There will be a continuation of the climate assisted spread of species native to Britain and Europe.[xx] These species are not considered non-native if they are spreading naturally from their native range, but could have some impacts.

Some native species could become more invasive, especially in habitats subject to other pressures.

2.11 Population growth

Increase in populated areas and recreational activity will increase the risk of introduction and spread of INNS. This introduction and spread can be slowed by embedding good biosecurity within recreational areas and promoting Check Clean, Dry[xxi] and Be Plantwise[xxii].

2.12 Plastics

Plastics and other litter can transport INNS to new places. This is especially important in the marine environment, where storms and other natural events can dislodge large structures such as pontoons and jetties which already have established colonies of flora and fauna. They can then drift for long distances over which the species would not ordinarily be able to travel.[xxiii]

2.13 Who is involved?

Enhancing biosecurity to reduce the spread and impacts of INNS is a key component of Defra's 25 year plan goals and targets.[xxiv] Work in the aquatic environment to prevent and slow spread will contribute to the 25 year plan goals of 'clean and plentiful water' and 'thriving plants and wildlife'.

The GB Non-Native Species Secretariat (NNSS) oversees the implementation of the GB strategy.[xxv] The strategy provides a strategic framework within which the actions of government departments, their related bodies and key stakeholders can be better co-ordinated.

The GB non-native species secretariat commissions risk assessments for invasive species that are evidence based and peer reviewed before approval by the GBNNS Programme Board, which represents the relevant governments and agencies of England, Scotland and Wales.

The Environment Agency support the GB strategy by eradicating named species with restricted distributions as agreed by the GB programme Board. We apply good biosecurity to our own work; and also promote good biosecurity to pathways that we regulate such as the transfer and movement of waste and water. All our actions within river basin planning are aligned with the GB strategy.

The Environment Agency has powers that allow them (along with the other "environmental authorities" Natural England and Forestry Commission) to enter into Species Control Agreements or Species Control Orders for the purposes of controlling INNS. A Code of Practice published by Defra in July 2017 indicates that these powers should only normally be used to help the eradication programmes[xxvi].

The Environment Agency do not have a general duty to manage invasive non-native species, but manage some species to protect assets and deliver duties with regards flood risk management, navigation and protecting the ecological and fisheries quality of watercourses. We also manage invasive species on our estate to avoid nuisance to neighbouring landowners, such as Japanese knotweed. Through our Fisheries role, we regulate where INNS fish species may be kept for the purpose of managing fisheries.

The United Kingdom Technical Advisory Group on the Water Framework Directive (UKTAG)[xxvii] alien species group uses a combination of GB risk assessments and expert judgement to assign a species to a Water Framework Directive (WFD) impact category. High impact species (see Section 7.1.1) are those that must be considered in status assessment and as pressures in the river basin management plans. Other species are categorised as moderate, low and unknown impact. These other species are still important, but are not considered specifically in classification. New species will arrive and we are learning more about existing species, so the high impact list is under continual review.

Local Action Groups were given 1.5 million in grant aid by Defra between 2011 and 2015 to help set themselves up and deliver Water Framework Directive and GB Strategy outcomes. Local Action Groups deliver control, monitoring, training and awareness-raising of invasive non-native species[xxviii].

Local Action Group Spraying herbicide to control Parrot's feather (*Myriophyllum aquaticum*) Photo credit: Catherine Chatters, Hampshire Wildlife Trust

The RAPID (Reducing and Preventing Invasive Alien Species Dispersal) is a three-year European Union LIFE project (2017-2020) which aims to establish frameworks for regional coordination of INNS management. Regional management plans (RIMPs) are now available which bridge the gap between national level actions and Local Action Groups.[xxix]

Many stakeholders are involved in delivering actions to prevent introduction and spread of INNS, and to control existing species. Recreational groups such as the Angling Trust and British Canoeing work to understand the risks that their activities could pose, and work with their members to ensure they have good awareness of biosecurity. Many groups contribute to the Check, Clean, Dry partnership[xxx] and help deliver the campaign.

2.13.1 Legislation

There are many parts of English legislation that are relevant to INNS. There is a comprehensive list on the GB Non-Native Species Secretariat webpages.[xxxi]

The Environmental Audit Committee is investigating the impacts of INNS and issues around their management.[xxxii] This may lead to recommendations for changes to existing statutory roles of organisations or legislation. The committee expects to report in late 2019.

The Defra consultation on Management measures for widely spread Invasive Alien Species (IAS) in England and Wales[xxxiii] is also due to complete in late 2019 and sets out the proposed management measures for 14 species subject to the Invasive Alien Species Regulation which have been identified as being widely spread in

England and Wales. We have captured the proposals in that consultation in this narrative within section 7.1.4.

2.13.2 Water Companies and other organisations

Water Companies are more involved in INNS management since the last river basin planning cycle. In the most recent set of water company business plans, all water companies are committed to delivering better understanding of the risks that their activities pose in relation to INNS and the water environment.

Measures work best when delivered with others and at a catchment scale. There are good examples of INNS coordination via catchment partnerships. For example, in Yorkshire, the Wildlife Trust lead the Yorkshire Invasive Species Forum which brings together partners including the local catchment partnerships to share a vision for INNS management which allows members to deliver catchment and wider aims through their local actions.

2.14 Evidence gaps: risk of deterioration

The Environment Agency estimates that more than 70% of water bodies across all surface water categories in England are at risk of deterioration because of invasive non-native species (lakes 85%, rivers and transitional waters 71% and coastal waters 56%). During the last 6 years we have seen demon shrimp establish and spread across the majority of England, causing measureable ecological impact.

The risk assessment included the impacts of climate change, and we expect those impacts to continue to be a risk, causing measureable deterioration in more water bodies.

2.14.1 New research

During the last 6 years, we have commissioned research to better understand the links between INNS, their ecological impacts, and how those impacts are picked up in our assessments of ecological status.

We still need to do more to understand the findings that the impacts of INNS can constrain improvement when measures are in place for other pressures.

We have also supported research into the more effective methods of applying biosecurity. The research is ongoing, and as a result of the research, using hot water to wash has been included in the Check, Clean Dry guidance as a good practice measure.

2.14.2 Main evidence gaps regarding control measures

We need to do more to understand:

- What measures are required to mitigate the impacts of invasive species, especially in situations where it is not technically feasible to control or eradicate?
- How to identify species that are likely to become invasive, especially in the context of a changing climate

- The pathways of spread of INNS into and within GB, and the best ways to slow the spread along those pathways, including assessing the most effective methods of enhancing biosecurity, such as the use of biocides.

We are looking to investigate options provided by DNA to monitor the arrival of spread of INNS, especially in places expensive or difficult to sample.

We should continue to research biocontrol measures, and maintain effort to understand how those bio-controls already released are impacting on the INNS they target, and if the ecosystems they have invaded show any recovery.

3. Addressing the challenge: current control measures

3.1 Evidence for control measures

Control or eradication of an invasive species once it is established is often extremely difficult and costly, while prevention and early intervention have been shown to be more successful and cost-effective. The key aims of the GB strategy are:

- prevention
- early detection, surveillance, monitoring, rapid response
- long term management and control
- building awareness and understanding.

We commissioned work to assess the risk of new species arriving.[xxxiv] This allowed us to explore prevention measures and predict where our most vulnerable sites are. The evidence provided by this work shows that we should expect about two new species to arrive per year, some of which will have significant impacts.[xxxv]

For some species that are new to the UK, it is appropriate to eradicate populations as we find them. The Environment Agency is currently coordinating eradication programmes for top-mouth gudgeon, white river crayfish, South American water primrose and various-leafed water milfoil. For widespread species, control measures taken at the local level to give space to vulnerable habitats or species could be appropriate where eradication is not possible. For most widespread species, control is not technically feasible. Section 7.1.4 describes appropriate measures for each species on the high impact list.

For most species, our best approach is to slow their spread. A national campaign, led by Defra and called ‘Check, Clean, Dry’, promotes the most effective ways to avoid spreading non-native species.[xxxvi]

The rapid response to killer shrimp (case study, Section 5) shows that joint action with all sectors can have a positive impact on slowing the spread of invasive non-native species.

Good evidence is emerging on the pathways of entry for species to England. We need to do more to implement controls along these entry pathways as part of our obligations under the Invasive Alien Species Regulation.

Since the last plan, there has been work to understand when is it appropriate to eradicate or control a species. The method uses expert consensus and incorporates effectiveness, practicality, cost, impact, acceptability, window of opportunity and likelihood of re-invasion.[xxxvii] The method can be applied to any species.

Collating information on invasive non-native species and their distributions has progressed well since the formation of the Non-Native Species Information Portal[xxxviii] which contains information on over 3000 non-native species and links to their distributions. For 300 invasive non-native species, the portal contains more detailed information on the species including identification and risk analysis. Improved availability of information has allowed strategic and national approach to preventing, responding and controlling invasive non-native species.

The local action groups have engaged at the catchment level and delivered good outcomes, especially in awareness of biosecurity, Check, Clean, Dry, and training in how to identify and tackle established and new outbreaks of invasive non-native species, which allows rapid response and in improving the amenity value of their catchments.

3.2 Control measures acting in combination with other pressures

Successfully slowing the spread of invasive non-native species allows improvements from other pressures to be realised, leaving native communities more resilient to damage from non-native species. It also allows more time for research on the best control measures for the invading species and, in some cases, for developing biological controls. Reducing other pressures and increasing resilience of the aquatic environment is our best control measure after prevention of arrival and spread. For established species whose impacts are increased by elevated nutrients (for example floating pennywort), reducing nutrient load will decrease the impact and control costs of those species.

3.3 Are our current control measures sufficient to achieve our objectives?

Our current controls will only be partly successful. Many established species cannot be controlled and will continue to spread. Some species will become more invasive as a result of the changing climate. Applying better biosecurity through the ‘Check, Clean, Dry’ campaign and reducing escapees from garden ponds through the ‘Be Plantwise’ campaign should slow the spread and arrival of invasive species but their spread is nonetheless inevitable in the long-term.

We are working with others to make the national water infrastructure more biosecure, and to make sure that new water transfers do not add to the current risk of spread of INNS.

It should be possible to contain and eradicate a few selected species and it is likely that biological controls could be developed for a few species. We can reduce the overall impact of invasive species by eliminating and controlling a small number of them and slowing the spread of others. However it is certain that this pressure will have an increasing impact on our water bodies.

4. Future challenges and proposed actions and outcomes

4.1 Actions to close the evidence gaps

Over the last six years, implementing the EU Invasive Alien Species Regulation has prompted research and action, especially around pathways of invasion and our understanding of species not yet here which are likely to cause harm.

We will support research to understand the findings that the impacts of INNS can constrain improvement when measures are in place for other pressures and ensure that our monitoring data and information are available to all.

We are part of the UK DNA working group on INNS and steer and support research into the options provided by DNA to monitor the arrival of spread of INNS, especially in places expensive or difficult to sample.

We support others to help address these evidence gaps:

- how to identify species that are likely to become invasive, especially in the context of a changing climate
- the pathways of spread of INNS into and within GB, and the best ways to slow the spread along those pathways. This includes assessing the most effective methods of enhancing biosecurity, such as the use of biocides.

4.2 Proposed RBMP measures

We need to do more to recognise the impacts of INNS in our waters and understand where INNS are stopping the water environment from improving in the way we expect when we address other pressures.

4.3 Reducing the impacts of climate change, nutrients and water use

These actions can help rivers and seas cope with the impacts of established invasive non-native species. Reducing the pressure from INNS, where possible, can help habitats cope with stress from other pressures.

4.4 Prevention

Preventing the arrival and spread of INNS is our priority, as most species are difficult or impossible to deal with once they are established. We can do this by focussing on the key pathways by which INNS arrive and spread. There is a role for all sectors to consider how their activities can be made more biosecure. INNS can only be addressed by working in partnership with others and at catchment and national scales. We are working together with the water industry to understand and reduce the risks of spread via existing and new water transfer networks.

The most effective way of preventing the introduction and spread of INNS is to apply good biosecurity. Everyone who works or plays in or near water should follow the Check, Clean, Dry guidance.

4.5 National eradication and control programmes for priority species

These are important to prevent future impacts for people and the environment. There is also a role for regional eradication and control in catchments which are outside of current distributions or are more vulnerable to invasion.

4.6 Local action

We encourage communities, local action groups and catchment partnerships to raise awareness of good biosecurity and understand the impacts of INNS on their local environment and how they can help.

4.7 Existing measures

The following ongoing measures are available to us to manage the pressure of INNS within River Basin Planning:

- Enabling actions and legislation to enforce actions in the EU Invasive Alien Species Regulation.
- Using existing and new legislative powers, including the Import of Fish (England and Wales) Act 1980 and the Wildlife and Countryside Act 1981.
- GB level co-ordination of invasive non-native species actions, including species risk assessments, action plans and rapid responses.
- Non-Native Species Secretariat co-ordination of alert system, species records, and the Non-Native Species Information Portal.
- The Environment Agency and Natural England and partners will implement rapid responses to contain and eradicate new invasions, where practicable. Support national response to new high impact invasive non-native species.
- Management to reduce the further spread of certain species or to reduce their impact where eradication is technically infeasible. Supported by nationally agreed action plans.
- Management of invasive non-native species at selected protected sites by Natural England.
- Defra and partners' R&D to develop biological control, prevention measures, rapid responses to new invasions, methods for managing established invasions and improving biosecurity.
- Defra and the Non-Native Species Secretariat work with others to raise public awareness of the risk of transferring non-native species accidentally and of 'preventative approaches'.
- Working in partnership with NGOs and local stakeholders to influence recreational water users to slow the spread of invasive non-native species by promoting the 'Check, Clean, Dry' messages.
- Support local action groups and catchment partnerships to undertake action on invasive non-native species.

4.8 Measuring success

Where we control or eradicate species we need to demonstrate that our effort has been successful. This may take a number of years, especially with eradication

programmes, as it is hard to detect small populations, and programmes for plant species need to deal with new growth from seed banks over time.

We can measure where actions to control a species have kept a species within an existing distribution or slowed the spread of the species (a good example of this is killer shrimp, described in section 5).

Measuring success for actions designed to prevent introduction and spread is difficult. There are a number of indicators and ambitions within existing plans and targets.

The Joint Nature Conservation Committee (JNCC) biodiversity indicators include a measure of change in the coverage across GB of 190 established INNS. Trends in this indicator show an increase in the number of freshwater and marine species established across 10% or more of land area (or 10% of coastline for marine species) from 2010 – 2017 compared to 2000 – 2009, whilst the numbers of terrestrial species have remained constant.

There are indicators of INNS pressure and prevention within Defra's 25 year plan.[xxxix] The first of the indicators looks to measure 'abatement of the number of INNS entering and establishing' and uses the JNCC indicator as an interim measure. The second indicator aims to assess the distribution of INNS, plant pests and diseases. A method for measuring the entry and establishment of INNS has not yet been finalised.

5. Case studies

Case study: Slowing the spread. Response to killer shrimp (*Dikerogammarus villosus*)

In 2010, the first record of the killer shrimp in Great Britain was first discovered 2010 at Grafham Water. The shrimp originates from the Black Sea region and is known to spread easily and rapidly and cause significant impacts on the ecology.

There are no feasible means of control or eradication. The approach taken was to contain the shrimp at the sites where it was found. The Environment Agency co-ordinated response via a national group, representing all stakeholders.

Actions by Anglian Water, local clubs and businesses, Royal Yachting Association and its Green Blue initiative, anglers and site owners kept the shrimp contained to Grafham Water. There were no new discoveries for a year.

Later discoveries and their containment involved more organisations including the Broads Authority in England.

The Environment Agency now runs a risk based monitoring programme to detect the shrimps at locations most likely to be colonised.

In 2019 the species remained contained at five locations in the UK. Slowing the spread of this species has allowed our native ecology nearly 10 years to respond to improvements in other pressures and become more resilient.

© Anglian Water / Grafham Water Sailing Club

6. Choices

Question 1: What can be done to address the challenge of INNS in the environment?

Question 2: How would you promote Check, Clean, Dry to all recreational users of water, including those who are not in clubs/attend events?

Question 3: Are there any barriers stopping you adopting good biosecurity when you are in or near water?

7. Contacts

If you have any feedback or comments on the evidence contained in the summary then please contact:

enquiries@environment-agency.gov.uk

8. Supporting information

8.1.1 UKTAG high impact species

Table 2. High impact species identified by UKTAG. The list is fixed between RBMP cycles, any changes are added to a waiting list and can be used operationally within a cycle. Updated lists are published on the UKTAG website.[xl]

Common name	Species	Group	Habitat	GB Risk Assessment
Freshwater mollusc - Asiatic clam	*Corbicula fluminea*	Animal	Freshwater	Yes
Freshwater amphipod	*Dikerogammarus haemobaphes*	Animal	Freshwater	Yes
Freshwater amphipod	*Dikerogammarus villosus*	Animal	Freshwater	Yes
Zebra mussel	*Dreissena polymorpha*	Animal	Freshwater	Yes
Quagga mussel	*Dreissena rostriformis bugensis*	Animal	Freshwater	Yes
Mysid crustacean	*Hemimysis anomala*	Animal	Freshwater	No
Virile crayfish	*Orconectes virilis*	Animal	Freshwater	Yes
North American signal crayfish	*Pacifastacus leniusculus*	Animal	Freshwater	Yes
Red swamp crayfish	*Procambarus clarkii*	Animal	Freshwater	Yes
Goldfish	*Carassius auratus*	Fish	Freshwater	No
Common Carp	*Cyprinus carpio*	Fish	Freshwater	Pending
Topmouth gudgeon	*Pseudorasbora parva*	Fish	Freshwater	Yes
Water Fern	*Azolla caroliniana*	Plant	Freshwater	Yes
Water fern	*Azolla filiculoides*	Plant	Freshwater	Yes
Australian swamp stonecrop	*Crassula helmsii*	Plant	Freshwater	Yes
Nuttall's pondweed	*Elodea nuttallii*	Plant	Freshwater	Yes
Floating pennywort	*Hydrocotyle ranunculoides*	Plant	Freshwater	Yes
Curly water-thyme	*Lagarosiphon major*	Plant	Freshwater	Yes
Water primrose	*Ludwigia grandiflora*	Plant	Freshwater	Yes
Floating primrose willow	*Ludwigia peploides*	Plant	Freshwater	Yes

American skunk-cabbage	*Lysichiton americanus*	Plant	Freshwater	Yes
Parrot's feather	*Myriophyllum aquaticum*	Plant	Freshwater	Yes
Two-leaf water-milfoil	*Myriophyllum heterophyllum*	Plant	Freshwater	Pending
Japanese knotweed	*Fallopia japonica*	Plant	Riparian	Yes
Giant knotweed	*Fallopia sachalinensis*	Plant	Riparian	Yes
Japanese knotweed/ Giant knotweed hybrid	*Fallopia* x *bohemica*	Plant	Riparian	No
Gunnera manicata & tinctoria	*Gunnera spp.*	Plant	Riparian	Yes
Giant hogweed	*Heracleum mantegazzianum*	Plant	Riparian	Pending
Himalayan balsam	*Impatiens glandulifera*	Plant	Riparian	Pending
Himalayan knotweed	*Persicaria wallichii*	Plant	Riparian	Yes
Rhododendron	*Rhododendron ponticum* (+ hybrids)	Plant	Riparian	Yes
Chinese mitten crab	*Eriocheir sinensis*	Animal	Freshwater/ Brackish	Yes
Gulf wedge clam	*Rangia cuneata*	Animal	Freshwater/ Brackish	Yes
Marine tubeworm	*Ficopomatus enigmaticus*	Animal	Brackish	No
Slipper limpet	*Crepidula fornicata*	Animal	Marine	Yes
Colonial tunicate	*Didemnum* spp. (Non-native)	Animal	Marine	Yes
Asian shore crab	*Hemigrapsus sanguineus*	Animal	Marine	Yes
Asian shore crab	*Hemigrapsus takanoi*	Animal	Marine	Yes
American lobster	*Homarus americanus*	Animal	Marine	Yes
Leathery sea squirt	*Styela clava*	Animal	Marine	No
American oyster drill	*Urosalpinx cinerea*	Animal	Marine	Pending
Common cord-grass, Townsend's grass or rice grass	*Spartina anglica*	Plant	Marine	Pending
Japanese kelp	*Undaria pinnatifida*	Plant	Marine	Pending

8.1.2 Invasive non-native species and classification

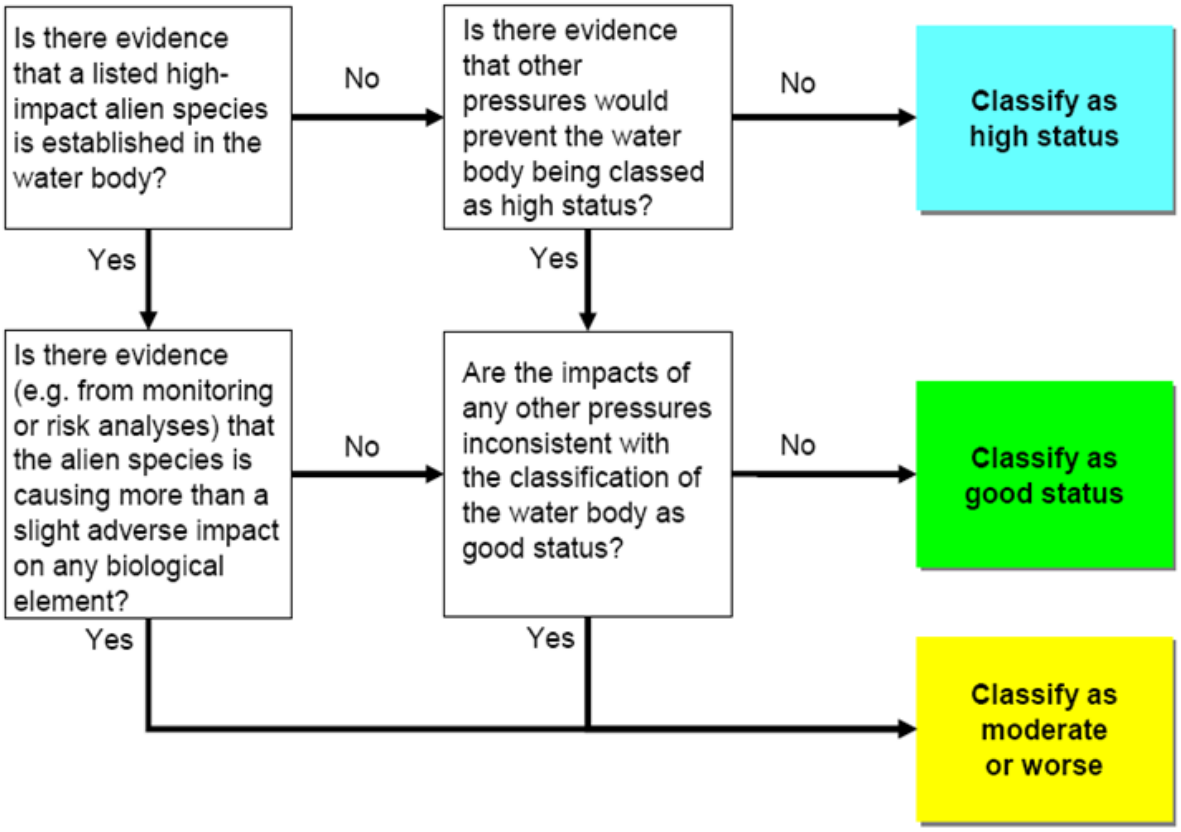
UKTAG[xli] places alien invasive species in Great Britain on one of four lists –high impact, moderate impact, low impact, or unknown impact - in relation to the risks they pose to the water environment.[xlii] A separate list containing only high-impact species is compiled for Northern Ireland and the Republic of Ireland (Ecoregion 17).

The high impact species list used within classification is fixed at the start of each river basin planning cycle and published in the standards documents and directions. However, the impact lists are regularly updated. The full listings across all impact categories are intended to help prioritise efforts to monitor and assess risks; prevent or contain introductions; and attempt eradication. It's important to note that the impact lists are not a comprehensive list of all aquatic invasive species, or of all invasive species that may affect aquatic ecosystems

Species designated as high impact are included in assessments of ecological status within England. All high status waters are screened for the presence of established high impact species, if present, the status class is downgraded to good.

We do not assess invasive non-native species impacts at good status where high impact species are established. The UKTAG guidance recommends that there should be further assessments at these waters and that they should be downgraded to moderate status where the high impact species has more than a slight impact. We do not plan to apply this further assessment until we have an improved understanding of the impacts of INNS on the ecology of our waters and the way in which we measure ecological status.

Figure 5. Outline of recommended procedure for taking into account the impact of alien species in classification decisions. Note: reference to 'slight adverse impact' is a reference to the good/moderate ecological status boundary, as defined in terms of modifications to the values of biological quality elements, UKTAG



8.1.3 Significant species used for the supporting information associated with each water body

The risk from these species is such that if they are present in the catchment then they are likely to be established in the water body and having an impact.

Table 3 Significant species used for the supporting information associated with each water body

Species	water body type	2015 Risk assessment category when present in water body
Pacifastacus leniusculus (signal crayfish)	Rivers and Lakes	At risk
Dikerogammarus villosus (killer shrimp)	Rivers and Lakes	At risk
Dikerogammarus haemobaphes	Rivers and Lakes	Was Probably at risk – but evidence since 2015 has increased the known risk.[xliii]

(demon shrimp)		
Dreissena bugensis (quagga mussel)	Rivers and Lakes	At risk
Ludwigia grandiflora (creeping water primrose),	Rivers and Lakes	At risk
Hydrocotyle ranuculoides (floating pennywort)	Rivers and Lakes	At risk
Ludwigia peploides (floating primrose willow)	Rivers and Lakes	Not assessed (new to the list for cycle 3) GB risk assessment indicates the ecological impact is significant
Myriophyllum heterophyllum (two-leaf water-milfoil)	Rivers and Lakes	Not assessed (new to the list for cycle 3). GB risk assessment indicates the ecological impact is significant
Crassula helmsii (Australian swamp stonecrop)	Lakes	At risk
Pseudorasbora parva (topmouth gudgeon)	Lakes	At risk
Spartina anglica (common cord-grass)	TRAC	At risk
Crepidula fornicata (slipper limpet),	TRAC	At risk
Styela clava (leathery sea squirt)	TRAC	At risk
Didemnum spp. (colonial tunicate)	TRAC	At risk
Homarus americanus (American lobster)	TRAC	Not assessed (new to the list for cycle 3) GB risk assessment indicates the ecological impact is significant
Hemigrapsus sanguineus (Asian shore crab)	TRAC	Not assessed (new to the list for cycle 3). GB risk assessment indicates the ecological impact is significant
Hemigrapsus takanoi (Asian shore crab)	TRAC	Not assessed (new to the list for cycle 3). GB risk assessment indicates the ecological impact is significant

8.1.4 Appropriate measures for UKTAG high impact Invasive Non-Native Species

There may be other reasons, such as public health, flood risk and amenity value which mean it is appropriate to take action above that recommended in this list.

	Actions (to achieve good)	**Actions (no deterioration)**
Freshwater amphipod (*Dikerogammarus villosus*)	Improve habitat and reduce other pressures	Contain at known locations and slow the spread
Freshwater amphipod (*Dikerogammarus haemobaphes*)	Improve habitat and reduce other pressures	Slow the spread
Zebra mussel (*Dreissena polymorpha*)	Improve habitat and reduce other pressures	Slow the spread
Quagga mussel *Dreissena rostriformis bugensis*	Improve habitat and reduce other pressures	Slow the spread
Mysid crustacean (*Hemimysis anomala*)	Improve habitat and reduce other pressures	Slow the spread
Virile crayfish (*Orconectes virilis*)	Control at protected areas if appropriate. Improve habitat and reduce other pressures	Slow the spread
North American signal crayfish (*Pacifastacus leniusculus*)	Control at protected areas if appropriate. Eradicate in areas where feasible and benefits are sustainable. Improve habitat and reduce other pressures	Slow the spread
Red swamp crayfish (*Procambarus clarkii*)	Control at protected areas if appropriate. Improve habitat and reduce other pressures	Slow the spread
Goldfish (*Carassius auratus*)	Control at protected areas if appropriate	No action
Common carp (*Cyprinus carpio*)	Control at protected areas if appropriate	No action
Topmouth gudgeon (*Pseudorasbora parva*)	Eradicate at known locations in accordance with the species action plan	Slow the spread
Water fern (*Azolla filiculoides* and *Azolla caroliniana*)	Consider control where it is preventing achievement of good. Reduce other	Slow the spread

	pressures, particularly nutrients.	Release Azolla weevil as required
Australian swamp stonecrop (*Crassula helmsii*)	Control at protected areas if appropriate and where there is good evidence that it is preventing achievement of good. Reduce other pressures, particularly nutrients.	Slow the spread Develop biological control agents
Nuttall's pondweed (*Elodea nuttalli*i)	Reduce other pressures, particularly nutrients.	Slow the spread
Floating pennywort (*Hydrocotyle ranunculoides*)	Control and eradicate in accordance with the action plan. Reduce other pressures, particularly nutrients.	Slow the further spread Develop biological control agents
Curly water-thyme (*Lagarosiphon major*)	Control at protected areas if appropriate. Reduce other pressures, particularly nutrients.	Slow the spread
Water primroses (*Ludwigia grandiflora, Ludwigia peploides*)	Eradicate at known locations, in accordance with the species action plan. Reduce other pressures, particularly nutrients.	Slow the spread
American skunk-cabbage (*Lysichiton americanus*)	Control at protected areas if appropriate. Reduce other pressures, particularly nutrients.	Eradicate isolated populations
Parrot's feather (*Myriophyllum aquaticum*)	Control at protected areas if appropriate. Reduce other pressures, particularly nutrients.	Slow the spread Consider eradicating isolated populations
Two-leaf water-milfoil (*Myriophyllum heterophyllum*)	Eradicate at known locations, in accordance with the species action plan. Reduce other pressures, particularly nutrients	Slow the spread
Japanese knotweed (*Fallopia japonica*)	Control at protected areas if appropriate	Slow the spread Test efficacy of biological control agents

Giant knotweed (*Fallopia sachalensis*)	Control at protected areas if appropriate	Slow the spread Develop biological control agents.
Japanese knotweed/ Giant knotweed hybrid (*Fallopia* x *bohemica*)	Control at protected areas if appropriate	Slow the spread Develop biological control agents.
Gunnera manicata & tinctoria (*Gunnera* spp.)	Control at protected areas if appropriate and where there is good evidence that it is preventing achievement of good	Slow the spread
Giant hogweed (*Heracleum mantegazzianum*)	Generally slow the spread and control at selected protected areas. Develop biological control agents.	Slow the spread
Himalayan balsam (*Impatiens glandulifera*)	Control at protected areas if appropriate and where there is good evidence that it is preventing achievement of good	Slow the spread Develop biological control agents.
Himalayan knotweed (*Persicaria wallichii*)	Control at protected areas if appropriate and where there is good evidence that it is preventing achievement of good	Slow the spread
Rhododendron (*Rhododendron ponticum*)	No action	Slow the spread
Chinese mitten crab (*Eriocheir sinensis*)	Eradicate in areas where feasible and benefits are sustainable	Slow the spread
Gulf wedge clam (*Rangia cuneata*)	Consider control where there is good evidence that it is preventing achievement of good	Slow the spread. Develop biological control agents.
Marine tubeworm (*Ficopomatus enigmaticus*)	No action	Slow the spread
Slipper limpet (*Crepidula fornicata*)	No action	Slow the spread
Colonial tunicate (non-native *Didemnum* spp.)	No action	Slow the spread

Asian shore crabs (*Hemigrapsus sanguineus, Hemigrapsus takanoi*)	No action	Slow the spread
American lobster (*Homarus americanus*)	No action	Slow the spread
Leathery sea squirt (Styela clava)	No action	Slow the spread
American oyster drill (Urosalpinx cinerea)	No action	Slow the spread
Common cord-grass, Townsend's grass or ricegrass (*Spartina anglica*)	Control at protected areas if appropriate	Slow the spread
Japanese kelp (*Undaria pinnatifida*)	No action	Slow the spread

9. References

[i] CBD Invasive Alien Species Introduction: http://www.biodiv.org/programmes/cross-cutting/alien/default.aspx

[ii] Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services 6 May 2019 https://www.ipbes.net/sites/default/files/downloads/spm_unedited_advance_for_posting_htn.pdf

[iii] The Economic Cost of Invasive Non-native Species to the British Economy. (CABI, 2010). http://www.nonnativespecies.org/downloadDocument.cfm?id=487

[iv] Updated 2017. Methodology set out in: Roy, H.E., Preston, C.D. Harrower, C.A., Rorke, S.L., Noble, D., Sewell, J., Walker, K. Marchant, J. Seeley, B., Bishop, J., Jukes, A., Musgrove, A., Pearman, D., Booy, O. (2014) GB Non-native Species Information Portal: documenting the arrival of non-native species in Britain. Biological invasions http://dx.doi.org/10.1007/s10530-014-0687-0

[v] The Economic Cost of Invasive Non-native Species to the British Economy. (CABI, 2010). http://www.nonnativespecies.org/downloadDocument.cfm?id=487

[vi] Gallardo, B., Dodd, J., Aldridge, D.A. 2012 A Preliminary Assessment of the Impact of Dikerogammarus villosus on Ecological status for the Water Framework Directive. Cambridge Environmental Consultants; Fielding, N, Constable, A. 2012 Signal Crayfish – Evidence of Ecological Impact Internal report – EA East Anglia;

Linking the presence of invasive alien species to measures of ecological quality. Environment Agency project number SC170007. Colin Harrower, J. Iwan Jones et al. 2018

[vii] Linking the presence of invasive alien species to measures of ecological quality. Environment Agency project number SC170007. Colin Harrower, J. Iwan Jones et al. 2018

[viii] WHPT NTATA index is described in the technical documents here: http://wfduk.org/resources/rivers-invertebrates-general-degradation

[ix] Environment Agency Catchment Planning System 21st March 2019 (Counts of numbers of reasons for not achieving good status and not numbers of water bodies in England) Source Data: Analysed Pressure and Business_Probable_Confirmed 21-03-2019 (Selection 1 Base Data)

[x] The dangers of giant hogweed sap - https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?pageid=152

[xi] For an example of Crayfish damage see here: http://www.cainbioengineering.co.uk/case-studies/canal-case-study-signal-crayfish-damage-repair-kennet-emcor/

For a review of sediment transport including influences of INNS: Wilkes Martin A., Gittins Joshua R., Mathers Kate L., Mason Richard, Casas-Mulet Roser, Vanzo Davide, Mckenzie Morwenna, Murray-Bligh John, England Judy, Gurnell Angela, Jones J. Iwan. Physical and biological controls on fine sediment transport and storage in rivers. WIREs Water 2018. https://doi.org/10.1002/wat2.1331

[xii] Non-Native Species in Great Britain: establishment, detection and reporting to inform effective decision making. Helen E. Roy, et al. Defra 2012.

[xiii]Updated 2017. Methodology set out in: Roy, H.E., Preston, C.D. Harrower, C.A., Rorke, S.L., Noble, D., Sewell, J., Walker, K. Marchant, J. Seeley, B., Bishop, J., Jukes, A., Musgrove, A., Pearman, D., Booy, O. (2014) GB Non-native Species Information Portal: documenting the arrival of non-native species in Britain. Biological invasions http://dx.doi.org/10.1007/s10530-014-0687-0

[xiv] Ibid

[xv] Labata, F., Piscart, C, Fontana, B, 2011 First records, pathways and distributions of four new Ponto-Caspian amphipods in France. Limnologica 41 290– 295

[xvi] GBNNSS risk assessment for Chinese mitten crab – https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=51

[xvii] GBNNSS killer shrimp alert pages https://secure.fera.defra.gov.uk/nonnativespecies/alerts/index.cfm

[xviii] https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=238

[xix] Wilkes Martin A., Gittins Joshua R., Mathers Kate L., Mason Richard, Casas-Mulet Roser, Vanzo Davide, Mckenzie Morwenna, Murray-Bligh John, England Judy, Gurnell Angela, Jones J. Iwan. Physical and biological controls on fine sediment transport and storage in rivers. WIREs Water 2018. https://doi.org/10.1002/wat2.1331

[xx] Example of climate assisted spread of Heteroptera species http://www.britishbugs.org.uk/HetNews/HetNews23_Spring2016.pdf

[xxi] http://www.nonnativespecies.org/checkcleandry/

[xxii] https://secure.fera.defra.gov.uk/nonnativespecies/beplantwise/

[xxiii] https://science.sciencemag.org/content/357/6358/1402

[xxiv] https://www.gov.uk/government/publications/25-year-environment-plan

[xxv] https://secure.fera.defra.gov.uk/nonnativespecies/home/index.cfm

[xxvi] https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=1567

[xxvii] UKTAG is a partnership of the UK's statutory environmental and conservation agencies (comprising Environment Agency, Scottish Environmental Protection Agency, Natural Resources Wales, Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage). UKTAG provides coordinated advice on the science and technical aspects of the WFD and makes recommendations to the UK's government administrations on the standards for implementing the Directive.

[xxviii] Assessing the achievements of Local Action Groups in tackling invasive non-native species Defra, 2015 https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=1417

[xxix] http://www.nonnativespecies.org/index.cfm?pageid=632

[xxx] http://www.nonnativespecies.org/index.cfm?sectionid=140

[xxxi] http://www.nonnativespecies.org//index.cfm?pageid=67

[xxxii] https://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/inquiries/parliament-2017/invasive-species-17-19/

[xxxiii] https://consult.defra.gov.uk/wildlife-management/invasive-alien-species-management-measures/

[xxxiv] Gallardo, B. and. Aldridge, D.C 2012 Mapping Ponto Caspian Invaders in Great Britain. Cambridge Environmental Consultants.

[xxxv] Gallardo, B., Dodd, J., Aldridge, D. A. 2013 Review of the ecological impact and invasion potential of Ponto Caspian invaders in Great Britain Cambridge Environmental Consultants. https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=1175

[xxxvi] http://www.nonnativespecies.org/checkcleandry/index.cfm

[xxxvii] Risk management to prioritise the eradication of new and emerging invasive non-native species Booy, O., Mill, A.C., Roy, H.E. et al. Biol Invasions (2017) 19: 2401. https://doi.org/10.1007/s10530-017-1451-z

[xxxviii] http://www.nonnativespecies.org/factsheet/index.cfm

[xxxix] https://www.gov.uk/government/consultations/25-year-environment-plan-measuring-progress

[xl] http://wfduk.org/resources/classification-alien-species-according-their-level-impact-revised-list

[xli] http://wfduk.org/stakeholders/uktag

[xlii] http://wfduk.org/resources/classification-alien-species-according-their-level-impact-revised-list

[xliii] Linking the presence of invasive alien species to measures of ecological quality. Environment Agency project number SC170007. Colin Harrower, J. Iwan Jones et al. 2018