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# Chinese Mitten Crab (*Eriocheir sinensis*) Invasive Species Action Plan

## 1. Introduction

The risk assessment undertaken as part of the Invasive Species Ireland project prioritised *Eriocheir sinensis* for preparation of an Invasive Species Action Plan to inform actions needed to prevent establishment of this species, further spread and prevent new introductions to Ireland. The management plan also informs practitioners on appropriate methods to manage *E. sinensis* populations on the island of Ireland.

This species acquired a score of 22 out of a possible 25 from stage 1 of the risk assessment process owing, in part, to its potential impact on protected habitats and species and non-compliance with EU legislative obligations under the Water Framework and Habitats Directives. At the time of carrying out the risk assessment, *E. sinensis* was recorded in the Waterford area. These sightings provide proof of the active introduction pathways for this species to Ireland. The Central Fisheries Board has been engaged in monitoring for this species. To date, no evidence of an established population has been found. This indicates that either the population remains at a low level or the invasion was unsuccessful in this instance.

In light of the uncertainty surrounding the status of this species in Ireland and the high potential for further introductions, the focus of this Invasive Species Action Plan is to identify exclusion options and also identify management techniques. The options identified for *E. sinensis*, if implemented, will be effective for the other members of the genus *Eriocheir* and other invasive species.

## 2. Aim of this plan

The aim of this Invasive Species Action Plan is to prevent spread of *E. sinensis* in Ireland. A key requirement of this is enabling monitoring and action on this species in the Waterford area and develop rapid response protocols in partnership with state agencies, industry and academia. The plan also recommends mechanisms by which to reduce opportunities of new introductions to the island of Ireland. This management plan informs practitioners and policy makers on appropriate measures required for successful implementation and also guides on research needs on methods of eradication/control of *E. sinensis* populations.

## 3. Key priorities

### 3.1 Prevention of new introductions

- Both the Irish and UK governments should adopt the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004) and support the target of 30 states, representing 35% of the world merchant shipping tonnage required to ratify it.
- Support the development and implementation of Codes of Practice for Marina Operators, Water Users and Marine Aquaculture.

### 3.2 Enable release of funds to detect high impact invasive species early in the invasion process

- There is a clear need to make funding available to detect incursions of high impact invasive species. *E. sinensis* monitoring in Waterford was undertaken with limited budget resources. The costs associated with high impact species are significantly greater than an effective and co-ordinated rapid response.

### 3.3 Ensure rapid response to incursions by high impact invasive species

- Develop strategies and methods to control and manage mitten crab populations. Research conducted towards the removal of the *E. sinensis* will fulfil part of Ireland's obligation under the European Union Habitats Directive (CFB, 2009).

- Develop networks capable of effectively implementing measures if and when *E. sinensis* becomes introduced/established in Ireland.

### 3.4 Develop and implement monitoring programmes

- Develop methods and networks to detect incursions of *E. sinensis* in areas where they are not currently present or present at low densities.
- Monitor the initial introduction site in Waterford for mitten crab populations and establish if the species has survived the introduction phase.

## 4. Invasion history

The species is originally from Asia where it is considered a delicacy in local cuisine. Now found in Europe, where it invaded nearly a centaury ago, Mitten crabs have now spread to North America. For reasons that are not yet understood, the populations of mitten crabs in England and North America did not at first expand like those in mainland Europe. But numbers are currently rising, prompting concern.

During routine fishing trawl *E. sinensis* was first found in 2005 in the Waterford Estuary. The species was subsequently recorded from the lower reaches of the River Suir and Barrow. How exactly the *E. sinensis* arrived in Ireland is unclear but the likely means of introduction was by transport of larvae and small crabs in ship ballast water or adult crabs clinging to ship hulls. Other human mediated vectors such as the live food trade and smuggling may be possible as the mitten crab is a delicacy. Historic evidence elsewhere has shown that crabs are imported live illegally to markets but as yet there is no documented evidence of this in Ireland.

**Note:** Historic evidence from Britain suggests that *E. sinensis* has been introduced a number of times to the region. At least two of these introductions are believed to have failed (Herborg *et al*., 2005).

## 5. Nomenclature

**Common name:** Chinese mitten crab

**Also known as:** Chinese freshwater edible crab

**Synonyms:** *Eriocheir japonicus*, *Eriocheir leptognathus*, *Eriocheir rectus*

## 6. Identification

Ireland does not have any native species of freshwater crab. *E. sinensis* has a square shaped carapace (Figure 1A) which can reach a width of 5 -7cm, but the maximum carapace width of the adult mitten crab is approximately 10 cm . Claws equal size (Figure 1B) with the key identification feature being the hair-like “mittens” covering (Figure 1C), especially well developed in male individuals. They have eight sharp pointed walking legs (Figure 1D); no swimming legs. The colour varies from yellow to brown, rarely purple. After reaching a size exceeding approximately 10-20 mm in carapace width, the male and female crabs can be differentiated by the shape of the abdomen which in the female is rounded and occupies most of the area of the thorax. In the male, the abdomen is narrower and shaped like an inverted funnel (Gollasch, 2006).

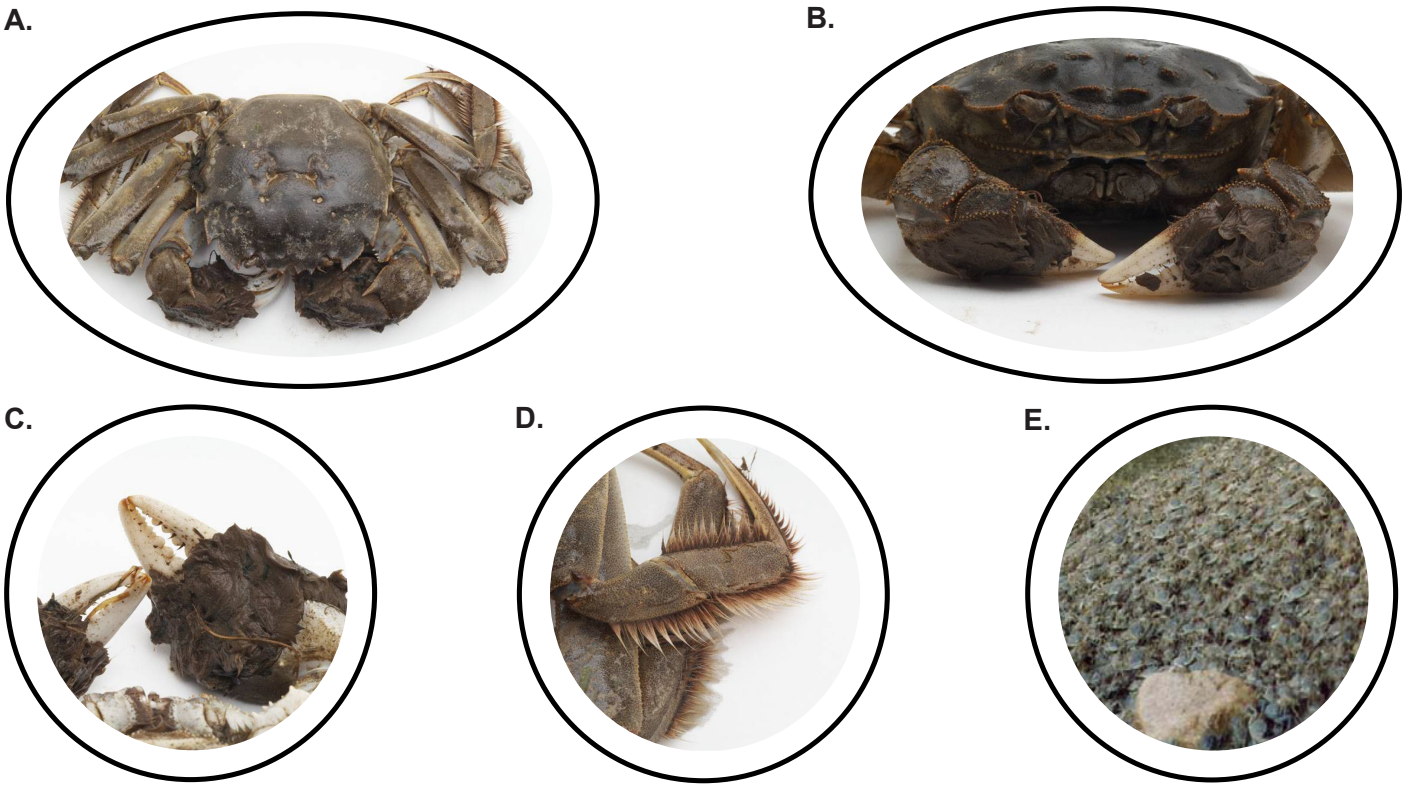



**Figure 1: A.** Adult *E. sinensis* detailing front view; **B.** dorsal view showing claw size; **C** characteristic "mittens" covering claw with white tips; **D.** adult pointed walking leg; **E.** Juvenile crabs during mass migration in Geesthacht, Germany. Photo credit: A-D: Non-Native Species Secretariat and The Food and Environment Research Agency; E: Stephan Gollasch, www.gollaschconsulting.de (Gollasch, 2006).

*E. sinensis* is adept at climbing and walking on land during migration and/or to bypass obstructions (Figure 1E) and juveniles are known to burrow into soft riverbanks to escape predation and desiccation during low tides. *E. sinensis* spends most of its life history (Figure 2) in rivers, but must migrate to the sea to breed. Once the crabs have mated the males are thought to die, leaving the females to brood the eggs. In the spring the eggs hatch into larvae and after about six to seven weeks these metamorphose into juvenile crabs, which then migrate back up the river into freshwater to complete the life cycle.

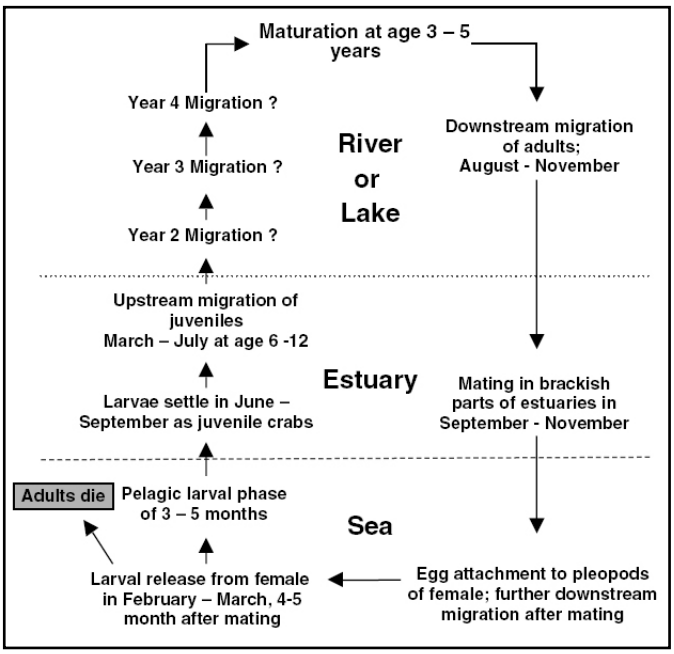



**Figure 2.** Proposed life cycle for *E. sinensis* from Herborg *et al.*, 2005.

## 7. Impacts

**This species has been nominated as among 100 of the "World's Worst" invaders.**

When population densities are high, *E. sinensis* is known to cause considerable damage to soft sediment banks through burrowing which increases erosion and might affect flood defences. Burrowing activities of crabs result in damages of dikes, river embankment erosion. Clogging of water intake filters of e.g. industrial cooling water supply and drinking water plants during mass occurrences (Gollasch, 2006)

*E. sinensis* is known to prey heavily on native species including invertebrates and fish species. In Ireland, there is concern that the species may impact on the native and endangered White Clawed Crayfish as well as fish species such as the protected Twaite Shad. Additional negative impacts, such as loss of biodiversity and recruitment of commercial species are expected.

The Mitten Crab is also an intermediate host for the mammalian lung fluke *Paragonimus ringer*, known to infect humans. Human can become infected with the parasite through ingestion. The fluke settles in the lungs and other parts of the body, and can cause significant bronchial or, in cases where it migrates into the brain and/or muscles, neurological illnesses. To date, no human health effects are reported from Europe (Gollasch, 2006).

There are economic impacts associated with introduction of this species. To date, in Germany, the species is known to have cost at least 80 million Euro in monetary value (Gollasch, 2006).

## 8. Distribution and spread potential

*E. sinensis* can spread naturally along connected waterbodies. Given that Ireland's main waterbodies are either connected by natural river corridors and/or canals, in addition to the species ability to walk over land and migrate over long distances, there is a high potential for island wide distribution for this species.

The species also has a planktonic stage in its life cycle which can facilitate further distribution. It is predicted that if the species becomes established in an Irish waterbody it will easily spread throughout the island of Ireland. To date, surveys conducted by the Central Fisheries Board have found no evidence of an established population.

The average rate of range expansion upstream per river system in the UK during the peak period of range expansion (1995–1998) was 49 km per year. This is lower than values at the time of peak spread in northern Europe (562 km per year) and southern France (104 km per year) (Herborg *et al.*, 2005). The average overall annual rate of spread upstream is also much lower in the UK (16 km per year) in comparison to northern Europe (196 km per year) (Herborg *et al.*, 2005).

Evidence presented by Herborg *et al.,* (2005) suggests that *E. sinensis* is adapted to drier periods and the proliferation of the population in the UK benefited from dry climatic conditions allowing slow river flows which could have resulted in greater larval retention through reduced wash out to the ocean. The summer of 2008 saw many parts of Ireland affected by heavy rain and flooding. Rainfall totals were above normal everywhere and were more than twice the average in the east and southeast of the country (Lennon and Walsh, 2009). This may have contributed to the failure of the invasion.

## 9. Prevention of new introductions

### Action 1. Ireland and the United Kingdom adopt and support measures to ensure success of the International Ballast Water and Sediments Convention

The International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004) stipulates that all ships carrying ballast water must install a treatment system by 2016. As of October 2008, 16 Parties representing 14.24% of the world's merchant shipping tonnage had ratified the convention. Currently, Ireland and the United Kingdom have adopted voluntary measures under the OSPAR Agreement 2008-10 on the Application of the D1 Ballast Water Exchange Standard (OSPAR, 2008). While this represents a significant step in minimising the risks associated with the ballast water pathway, both governments should adapt the IMO convention and support the target of 30 states, representing 35% of the world merchant shipping tonnage required to ratify this Convention.

### Action 2. Enforcement and raise awareness of legislative powers

Legislation is already in place to prevent the release of invasive species in both Northern Ireland and the Republic of Ireland:

Northern Ireland - under Article 15 (1) of The Wildlife (Northern Ireland) Order 1985 (under review) if any person releases or allows to escape into the wild any animal which (a) is of a kind which is not ordinarily resident in and is not a regular visitor to Northern Ireland in a wild state; or (b) is included in Part I of Schedule 9, he shall be guilty of an offence.

Republic of Ireland - under Section 52 (7) of The Wildlife (Amendment) Act 2000 it is an offence to

a) turn loose, willfully allow or cause to escape any species of wild animal or the spawn (offspring) of such wild animal or wild bird or the eggs of such wild bird,

b) transfers any species of wild animal or the spawn of such wild animal or wild bird or the eggs of such wild bird from any place in the State to any other place in the State for the purpose of establishing it in a wild state in such other place.

### Action 3. Amend existing legislation

Some experts based in the UK and elsewhere have recommended investigation of establishing a fishery for this species. This is not viewed as desirable for the island of Ireland. It is possible that this could be counterproductive and encourage the deliberate introduction of the species to other river catchments outside of the primary site of introduction. Although there is no evidence of *E. sinensis* being imported or transported around Ireland for the purposes of establishing a fishery, a precautionary approach is nonetheless required. To this end, legislation should be strengthened to ensure a total ban on import, sale and possession of *E. sinensis*. To this end:

- *E. sinensis* should be added to Schedule 9 Part I of the Wildlife (Northern Ireland) Order 1985.
- The Minister of the Environment in the Republic of Ireland has power to prohibit the possession or introduction of any species that may be detrimental to native species. *E. sinensis* should be brought to the attention of the Minister and the required prohibition enacted.

### Action 4. Highlight, support and promote Invasive Species Codes of Practice

A priority action to prevent the spread and release of invasive species is to promote the uptake of the Invasive Species Codes of Practice and support these with literature and information leaflets for both industry and the general public.

### Action 5. Public sector bodies adopt Invasive Species Codes of Practice

All public sector organisations should lead by example and adopting Invasive Species Codes of Practice in their relevant work areas. This is a key priority to the success of each of the codes. Government agencies

should also incorporate the sentiment of the codes into tenders and procurement procedures and ensure that suppliers are abiding by the codes, where possible.

## 10. Detection and rapid response

Reports of *E. sinensis* in the Waterford area highlight the need for early detection of introductions. Detection of new mitten crab populations to sites outside the Waterford area and an assessment of whether or not this species has and established population in Ireland is designated as a high priority.

Development and implementation of early detection networks should incorporate training of regional fisheries officers and those working on waterbodies on the identification of this and other invasive species, raising awareness of the potential impacts, the importance of biological records and associated standards and develop an awareness of the Alien Watch function of the Invasive Species Ireland website.

An additional component of the early detection and ability to deliver on rapid response is the adequate resourcing of the Alien Watch section of the site. This should be done in partnership with the two biodiversity record centres on the island of Ireland. The goal here is to ensure that a report to the website triggers action on the ground and that there are cost effective mechanisms in place to verify or discount reports.

Early detection will requires an adequate level of information flow to the general public and key stakeholders. The Invasive Species Ireland website should be the focal point for dissemination of current information.

### Action 6. Monitor status of Waterford site

It is essential to fully establish the status of the incursion of *E. sinensis* into the Waterford area. The following actions are recommended to support this programme of works and to support the wider development and implementation of response to *E. sinensis*:

a) Develop and implement a cooperative monitoring program for the Waterford area with extension to the island of Ireland as a whole.
b) Develop standard sampling methods and protocols.
   *Considerations include:* bycatch, impacts to other species, nocturnal behaviour.
   *Suggested methods:* traps, trawls, seines, snorkel surveys, settling plates.
c) Implement the guidelines in the Monitoring and Surveillance document.

### Action 7. Reduce risk of human-assisted spread

While the primary pathways of introduction for this species appear to be accidental in nature, actions are required to address intentional introduction pathways. Measures effective for this species will also achieve success on other invasive species. These include:

a) Develop/implement education and outreach program to provide information about regulations, enforcement efforts, penalties and negative impacts.
b) Encourage development of comparable/compatible regulations, enforcement and education programs throughout the island of Ireland.
c) Increase awareness of the importance of environmental crime and its enforcement with the judicatory, the PSNI, An Gardai Siochana and their counterparts in Britain.
d) Fully implement and support with relevant materials Invasive Species Codes of Practice.
e) Identify areas of large populations and support ban of ballast water uptake in these areas.

## 11. Reduce negative impacts and develop strategies for population control

At present, there have been no successful eradication attempts for *E. sinensis*. This highlights the importance of adequately resourcing the exclusion strategy developed in this document. However, should these efforts be unsuccessful, control and containment measures should be enacted as a priority. This will limit economic and environmental impacts owing to the introduction of this highly invasive species.

Control of this species may be difficult because of its abundance, ubiquity, high reproductive rate, and wide range of physiological tolerances (GISD, 2009). Control strategies should be based on best practice identified through direct consultation with experts based in Britain, continental Europe and North America. It is likely strategies will involve the use of physical control methodologies and not the use of chemical substances. Possible avenues that could be trialled include traps, trawling and deployment of physical or electric barriers. These methodologies are not always completely effective and as such, an adaptive management approach, coupled with research and development should be taken. It is recommended that crab behaviour, environmental tolerances and preferences, migratory behaviour and recruitment dynamics are investigated with the view to informing the development of a more effective management strategy.

### Action 8. Develop methods to reduce impacts of *E. sinensis* and evaluate potential control methods that take advantage of biology and life history

Our ability to effectively control or eradicate *E. sinensis* is still very limited. No cases of fully successful eradication have been identified. In light of this, research is required on control and exclusion techniques as well as preferred habitat if and when this species becomes established in Ireland.

a) Assess exclusionary measures such as traps and barriers.
b) Assess preferred habitats and habitat requirements to facilitate targeting of control programmes.
c) Assess reducing local populations through environment modifications.
d) Improve understanding of biology and life history, migratory behaviour, recruitment dynamics, reproductive biology, feeding ecology.
e) Evaluate the value, risks and impacts of trapping, fishing, and other appropriate methods.
f) Evaluate the value, risks, options and impacts of a contract fishery.

### Action 9. Develop understanding of negative impacts on ecology, banks and agriculture

a) Improve understanding of biology, life history, environmental tolerances, critical habitats of mitten crabs, and species at risk from mitten crabs.
b) Monitor/evaluate impacts to agriculture.
c) Monitor/evaluate impacts to banks.
d) Evaluate current and potential impacts to recovery and restoration efforts.

### Action 10. Evaluate other control methodologies

As previously stated, there is a need to develop effective methodologies to eradicate *E. sinensis* populations. It is recommended that research is conducted on chemical and biological control techniques for this species. Efforts should be made to establish networks with experts based outside of Ireland to ensure sharing of best practice and current knowledge.

## 12. Resourcing the plan

**Action 11. Ensure adequate resources are in place to facilitate implementation of this plan**

Resourcing this plan will require making funds available for the continued monitoring of the Waterford area until *E. sinensis* have been ruled out/in, implementation of preventative measures, resourcing the development of rapid response capabilities, funding the implementation of a programme of measures to prevent impacts should *E. sinensis* be confirmed in Ireland and the funding of research of *E. sinensis* ecology, biology and behaviour in Ireland to better inform management.

### 12. 1 Monitoring

While the status of *E. sinensis* in the Waterford area is unclear, there is a need to continue monitoring this site for the next 5 years. This should be done in partnership with local stakeholders such as fisheries and anglers which represents the best value for money given the current uncertainty surrounding *E. sinensis* at this site. Should *E. sinensis* be confirmed, a full delimitation survey will be required. Details of contingency costs are given in Section 14.2 below.

### 12.2 Exclusion

Effective resourcing of the exclusion and pre-invasion options recommended in this plan will help to minimise costs associated with introductions of *E. sinensis*. The exclusion strategy as outlined can be divided into two broad categories: pre border action and border control actions. Pre border actions focus on the education and awareness with the general public, live food trade sector and customs officials. Border control actions involve materials and staff time necessary for the implementation of this strategy are estimated to be less than £10,000 (€12,000).

### 12.3 Contingency

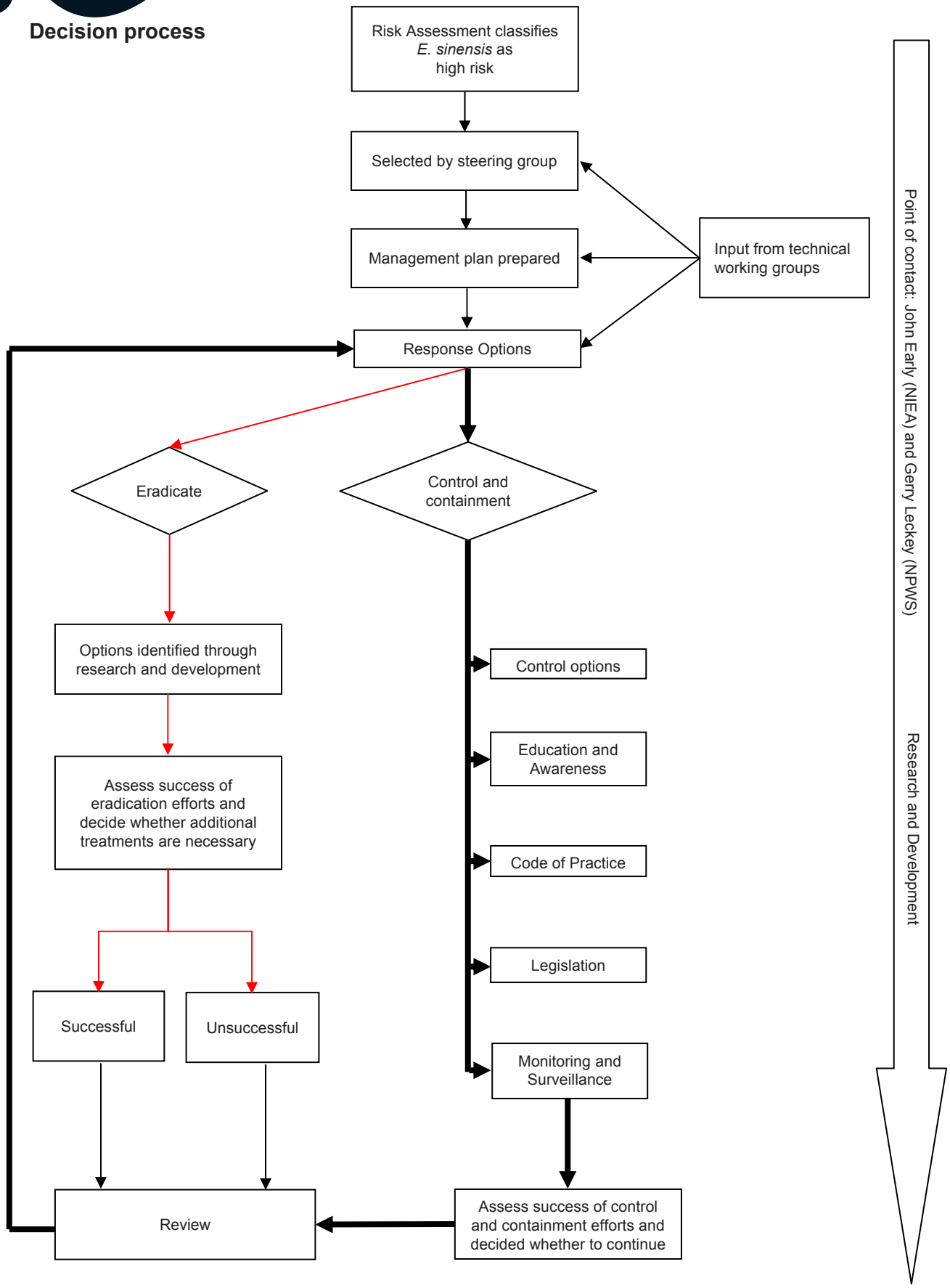
Should a population of *E. sinensis* be confirmed in Ireland, the contingency plan will need to be implemented. The costs associated with contingency will vary according to the scale of the incursion and site specific parameters such as right of access.

- For very small scale introductions that are detected early and a rapid response initiated, costs associated could be quite low. In the first instance, where suitably trained volunteers and agency staff are engaged in the programme costs are estimated to fall within band 1 of the scale i.e. less than £10,000 (€12,000). This would only hold true for minor introductions on isolated river systems and in reality is unlikely to occur.
- For more widespread introductions, costs incurred will be greater. It is anticipated that if the introduction is beyond a certain critical point agencies will need to assess if private contractors will be required to carry out the eradication programme. This programme should run for a number of years with resources given over to monitoring for decrease in population size and eventual removal. Personnel costs will be greater. For such a scenario the estimated cost is >£100,000 (€120,000) in the first year with costs decreasing in subsequent years until eradication. The control programme should be run for a number of years with systems in place to ensure that no further introductions are taking place.

## 13. Recommended actions and timetables

| No. | Action | Responsibility | Time Scale |
|---|---|---|---|
| 1 | Ireland and the United Kingdom adopt and support measures to ensure success of the International Ballast Water and Sediments Convention | UK and Irish Governments | As soon as possible and support once in place. |
| 2 | Enforcement and raise awareness of legislative powers | State agencies in partnership with relevant stakeholders | Initiate in 2009 |
| 3 | Amend existing legislation | State agencies | 2009 - 2010 |
| 4 | Highlight, support and promote Invasive Species Codes of Practice | State agencies, Invasive Species Ireland, relevant stakeholders | Initiate in 2009 |
| 5 | Public sector bodies adopt Invasive Species Codes of Practice | All public bodies | 2009 |
| 6 | Monitor status of Waterford site | State agencies in partnership with stakeholders such as academia and fisheries | 2009 - 2013 |
| 7 | Reduce risk of human-assisted spread | State agencies in partnership with stakeholders such as academia and fisheries | 2009 - 2011 |
| 8 | Develop methods to reduce impacts of *E. sinensis* and evaluate potential control methods that take advantage of biology and life history | State agencies in partnership with stakeholders such as academia and fisheries | To be undertaken should a population of *E. sinensis* be confirmed/ found |
| 9 | Develop understanding of negative impacts on ecology, banks and agriculture | State agencies in partnership with stakeholders such as academia and fisheries | To be undertaken should a population of *E. sinensis* be confirmed/ found |
| 10 | Evaluate other control methodologies | State agencies in partnership with stakeholders such as academia and fisheries | To be undertaken should a population of *E. sinensis* be confirmed/ found |
| 11 | Ensure adequate resources are in place to facilitate implementation of this plan | State agencies | 2009 |

## 14. Decision process




Primary decision process

Decision process following further research and development of eradication methodologies

## 15. Template management plan

Use this template to help formulate a management plan outlining how you are going to proceed and what you will need.

**Site Manager(s)/Owner(s):** _____
**Site Name(s):** _____
**Central grid reference:** _____

**License to proceed with plan acquired?** **Yes** ☐ **No** ☐

**Site details**

| | |
|---|---|
| **Address:** | |
| **Telephone:** | |
| **Email:** | |
| **Agencies/persons involved:** | |
| **Date:** | |
| **Species of concern:** | |

**Invasion history**

| | |
|---|---|
| **Date of introduction:** | |
| **Original location of introduction:** | |
| **Date of first report to competent authority:** | |
| **Method of introduction:** | |
| **Additional information on introduction event:** | |

**Site information**

| | |
|---|---|
| **Total site area:** | |
| **Total area colonised:** | |
| **Total area of relevant habitats:** | |

| **Designation** | **On site** | **Near site** | **None present** |
|---|---|---|---|
| **Details:**<br><br>Establish if there is a requirement to apply for a license/notify before proceeding with plan. | | | |

| **Rare and threatened species** | **On site** | **Near site** | **None present** |
|---|---|---|---|
| **Red Data Book or BAP species:** | | | |
| **Other rare or threatened species:** | | | |

**Current identified impacts**

| Impacts | Minimal | Moderate | Severe |
|---|---|---|---|
| | | | |

**Human sensitivities/vested interests at site**

| Issue | Human receptor |
|---|---|
| | |

**Identify requirements and best practice for collaboration with stakeholders**

| |
|---|
| |

**Actions and resources**

| Management options | Responsibility | Date to undertake |
|---|---|---|
| | | |

| Resources needed | Responsibility | Date to undertake |
|---|---|---|
| | | |

**Monitoring and evaluation**

| Name of person/s | Date to undertake | Report to | Additional treatments date (if required) |
|---|---|---|---|
| | | | |

## 16. Additional considerations for undertaking a management plan

1. Confirm identification of species. Refer to recognised experts to confirm identification, if required.

2. Develop and produce a site specific management plan. Use the template provided in this document to guide you. A key part of this will involve surveying and producing a distribution map indicating the species distribution on the site.

3. Consider all designated sites on or nearby the management area. You may need to apply for a license under nature conservation legislation to proceed and/or undertake an Appropriate Assessment under the terms of Article 6 of the Habitats Directive. Remember that actions taken outside a designated site may have an impact on a nearby designated site and are thus subject to the same considerations.

4. Consider surrounding properties and households. Talk to adjacent land owners and make them aware of the issues and what you plan to do. It may not be possible but always attempt to get their support. Control programmes will have a higher chance of success with support from the local community. Raise awareness of the issues and ensure alerts are placed in appropriate media e.g. the Invasive Species Ireland website.

5. Consider if you can successfully and safely carry out the work or if professional practitioners, with relevant training and certificates should undertake the work. Also consider if the programme can be co-ordinated with voluntary clubs and local societies and ensure their support and understanding of the issues.

6. Remember relevant health and safety legislation and procedures.

7. Identify if sufficient resources are/will be available to complete the work within the planned timescale. If work will take more than 1 year to complete, ensure you have sufficient funds to complete the work.

8. Monitor for missed animals/reintroduction during site visits. If applicable, ensure new members of staff are aware of the action plan and report sightings.

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The Invasive Species Ireland Project is undertaken, in partnership, by EnviroCentre and Quercus.

www.envirocentre.co.uk

www.quercus.ac.uk

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Northern Ireland Environment Agency
www.ni-environment.gov.uk
An Agency within the Department of the Environment
www.doeni.gov.uk

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

www.ni-environment.gov.uk

www.npws.ie

For more information on the Invasive Species Ireland Project please see the website at www.invasivespeciesireland.com

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