

Risk Assessment of *Pacifastacus leniusculus*

Name of Organism:	<i>Pacifastacus leniusculus</i> (Dana 1852) – Signal Crayfish
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
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Expert reviewer	Julian Reynolds

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About the risk assessment

This risk assessment is based on the **Non-native species Application based Risk Analysis (NAPRA)** tool (version 2.66). NAPRA is a computer based tool for undertaking risk assessment of any non-native species. It was developed by the European and Mediterranean Plant Protection Organisation (EPPO) and adapted for Ireland and Northern Ireland by Invasive Species Ireland. It is based on the Computer Aided Pest Risk Analysis (CAPRA) software package which is a similar tool used by EPPO for risk assessment.

Notes: Confidence is rated as low, medium, high or very high.
Likelihood is rated as very unlikely, unlikely, moderately likely, likely or very likely.
The percentage categories are 0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%.
N/A = not applicable.

This is a joint project by Inland Fisheries Ireland and the National Biodiversity Data Centre to inform risk assessments of non-native species for the European Communities (Birds and Natural Habitats) Regulations 2011. It is supported by the National Parks and Wildlife Service.

DOCUMENT CONTROL SHEET

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Stage 1 - Organism Information			
<i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the risk assessment?		A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.
2	Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES	<i>Pacifastacus leniusculus</i> (Dana 1852), <i>Astacus leniusculus</i> (Dana 1852), <i>Astacus klamathensis</i> , <i>Astacus trowbridgii</i> (Stimpson 1857), <i>Potamobius leniusculus</i> (Ortmann 1902) or (Bott 1950), <i>Pacifastacus leniusculus klamathensis</i> (Hobbs 1989), <i>Pacifastacus leniusculus leniusculus</i> (Hobbs 1989), <i>Pacifastacus leniusculus trowbridgii</i> (Hobbs 1989); Signal Crayfish, Californian Crayfish and Pacific Crayfish (Souty-Grosset <i>et al.</i> 2006). According to Souty-Grosset <i>et al.</i> (2006), <i>Pacifastacus leniusculus</i> "can be confused with both <i>Astacus astacus</i> and <i>Austropotamobius pallipes</i> when juveniles. It is distinguished from both adults and juveniles by the smooth nature of the chelae and the lack of a row of spines on the shoulders of the carapace behind the cervical groove. The red colour of the underside of the chelae can also be confused with that of <i>A. astacus</i> and <i>Procambarus clarkii</i> ; the white-turquoise patch on the upper side of the chelae is unique."
3	If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	N/A	
4	Describe the organism.	-	<i>Pacifastacus leniusculus</i> is "characterised by smooth body surface with absence of spines behind cervical groove, two post-orbital ridges, smooth robust claws with bright red underside and white-turquoise patch at junction of fixed and moveable finger. Body colour reddish-brown or light to dark brown" (Holdich and Sibley 2009). Total length of males is ≤ 16 cm and females is ≤ 12 cm with larger individuals occasionally recorded (Souty-Grosset <i>et al.</i> 2006). A more detailed identification is provided in Souty-Grosset <i>et al.</i> (2006).
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment for Ireland)	YES	In Ireland, a preliminary risk assessment was previously carried out. This was a prioritisation risk assessment as part of the Risk Analysis and Prioritisation for Invasive and Non-native Species in Ireland and Northern Ireland (Kelly <i>et al.</i> 2013). It designed <i>Pacifastacus leniusculus</i> as a 'high risk' invasive species.
6	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTIAL	Only a preliminary risk assessment was previously conducted in Ireland (refer to Question 5).
7	Where is the organism native?		North-western USA and south-western Canada (Souty-Grosset <i>et al.</i> 2006).

Stage 1 - Organism Information

The aim of this section is to gather basic information about the organism.

N	QUESTION	RESPONSE	COMMENT
8	What is the current global distribution of the organism (excluding Ireland)?		Austria, Belgium, Czech Republic, Denmark, England, Finland, France, Germany, Hungary, Italy, Japan, Kaliningrad (Russia), Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Scotland, Spain, Sweden, Switzerland and Wales (Global Invasive Species Database 2005).
9	What is the current distribution of the organism in Ireland?	-	This species is not present in the wild in Ireland.
10	Is the organism known to be invasive anywhere in the world?		Britain, Continental Europe (central and western), Scandinavia and Japan (reviewed in Global Invasive Species Database 2005)

Stage 2 - Detailed assessment: Section A - Entry

This section evaluates the probability of entry of an organism into Ireland. For organisms which are already present, only complete the entry section for currently active pathways of entry and potential future pathways. The entry section need not be completed for pathways which have allowed an organism to enter in the past but are no longer active.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.01	How many active/future pathways are relevant to the potential entry of this organism (n/a, very few, few, moderate number, many or very many)?	MODERATE	HIGH	
1.02	List <u>significant</u> pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.	<ol style="list-style-type: none"> 1. Food trade for humans or fish 2. Fish stocking 3. Angling 	HIGH	The 'food trade for humans and fish' and 'aquarium trade' are the principal pathways responsible for the introduction and establishment of non-native crayfish in Europe to date (Holdich 2002). Crayfish also have the potential to be inadvertently introduced as a contaminant of fish stocking and angling practices or if used as live bait for angling. In Ireland, the sole active pathway is the importation of live <i>Pacifastacus leniusculus</i> as a food item for humans. In Ireland, <i>Pacifastacus leniusculus</i> are not imported or sold as an ornamental species for aquaria. They are considered undesirable as an ornamental species as they are less colourful than other crayfish (Declan MacGabhann pers. comm.).

Pathway 1 – Food trade for humans or fish

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL	VERY HIGH	Non-native crayfish, including <i>Pacifastacus leniusculus</i> , have been deliberately transferred to the wild to establish a food source for humans and fish in Europe (Holdich 2002; GB Non-Native Species Secretariat 2011). Live <i>Pacifastacus leniusculus</i> are regularly imported into Ireland via the food trade for human consumption (Declan MacGabhann pers. comm.).
1.04	How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?	VERY LIKELY	HIGH	Live <i>Pacifastacus leniusculus</i> for human consumption are principally imported to Ireland from Billingsgate Market in London, England (Declan MacGabhann pers. comm.). Although no specific information on the frequency of such imports is available, they do occur on a regular basis (Declan MacGabhann pers. comm.). However, the frequency of such imports has declined since the end of the 'Celtic Tiger' period when

Pathway 1 – Food trade for humans or fish				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				consumer demand dropped (Declan MacGabhann pers. comm.). Nevertheless, it is considered very likely that large numbers of live <i>Pacifastacus leniusculus</i> will travel by this pathway into the country. Deliberate dumping of surplus or undersized crayfish imported <i>via</i> this pathway could occur. There are no known instances of non-native crayfish being stocked in Irish waters to provide a food source for fish.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.
1.06	How likely is the organism to survive during passage along the pathway?	VERY LIKELY	VERY HIGH	The crayfish would be kept alive when moved <i>via</i> these pathways to ensure their survival. They are imported in wooden crates in a damp environment and are sometimes placed in cold storage after import (Declan MacGabhann pers. comm.).
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	VERY LIKELY	VERY HIGH	As previously mentioned, live <i>Pacifastacus leniusculus</i> are regularly imported into Ireland <i>via</i> the food trade for human consumption (Declan MacGabhann pers. comm.). It is considered very likely that <i>Pacifastacus leniusculus</i> can survive an introduction to a suitable water at any time of year. The species is established throughout Britain (Souty-Grosset <i>et al.</i> 2006) which experiences a similar climate to Ireland. It has also been demonstrated to survive and successfully breed in Ireland over a numbers of years in aquaria that were subjected to ambient outdoor temperatures (Declan MacGabhann pers. comm.).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	UNLIKELY	HIGH	Despite there being a wide range of habitats in Ireland available for colonisation, this is considered unlikely when live specimens are imported or traded for human consumption as it would necessitate escape to a suitable habitat or a deliberate act of introduction. Direct transfer is virtually assured if stocked as a fish food source. Live crayfish are considered unlikely to be imported and stocked as fish food but more likely to be discarded as surplus from the food trade. In its native habitat in North America, <i>Pacifastacus leniusculus</i> prefers low gradient streams flowing through agricultural land. It is also found in a large number of streams, lakes and in the turbid waters of major rivers (reviewed in Ibbotson and Furse 1995). In Europe, it has colonised

Pathway 1 – Food trade for humans or fish				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				lakes, ponds, rivers, canals, estuaries and streams (reviewed in Ibbotson and Furse 1995; Souty-Grosset <i>et al.</i> 2006; Holdich and Sibley 2009). In Britain, all aquatic habitats with the exception of mountainous, acidic or badly polluted areas are considered suitable for establishment (GB Non-Native Species Secretariat 2011).
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	HIGHLY LIKELY (for human consumption)	VERY HIGH (for human consumption)	As previously stated, live <i>Pacifastacus leniusculus</i> are imported into Ireland <i>via</i> the food trade for human consumption (Declan MacGabhann pers. comm.). There are no known instances of non-native crayfish being stocked in Irish waters to provide a food source for fish (so in this case a rating is given as 'very unlikely' with 'high' confidence).
1.10	Do other pathways need to be considered?	YES		

Pathway 2 – Fish stocking				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	ACCIDENTAL	VERY HIGH	There is the potential for introduction as a contaminant of illegal fish stocking from abroad (GB Non-Native Species Secretariat 2011), particularly as it is widespread in Britain and the continent (Souty-Grosset <i>et al.</i> 2006).
1.04	How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?	UNLIKELY	HIGH	It is unlikely but illegal fish stocking from foreign waters which have <i>Pacifastacus leniusculus</i> has the potential to inadvertently transfer this species to Ireland.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	HIGH	The crayfish would be moved in association with the fish to be stocked giving a high chance of survival except in conditions where the fish may prey on the crayfish during transit.

Pathway 2 – Fish stocking				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	VERY LIKELY	VERY HIGH	Refer to Pathway 1, Question 1.07.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	VERY LIKELY	VERY HIGH	Direct transfer is very likely as the crayfish would be transported in water. There are an abundance of aquatic habitats suitable for establishment of <i>Pacifastacus leniusculus</i> in Ireland (refer to response to Question 1.08, Pathway 1).
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	UNLIKELY	MEDIUM	This is considered unlikely due to the low frequency of fish stocking undertaken from abroad. However, there remains some potential for introduction <i>via</i> this pathway if the fish are sourced from a location where crayfish are present. It is likely that any such introduction would be associated with illegal stocking practices. A high proportion of fish farms in Britain are believed to have <i>Pacifastacus leniusculus</i> present and the establishment of this species in some Scottish rivers is thought to have been in association with fish stocking (GB Non-Native Species Secretariat 2011).
1.10	Do other pathways need to be considered?	YES		

Pathway 3 – Angling				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL OR ACCIDENTAL	VERY HIGH	The movement of angling equipment (particularly landing or keep nets and stink bags) from a foreign water that supports populations of non-native crayfish has the potential to inadvertently introduce this species to Ireland. In addition, if used as live bait for angling there is potential for escape.
1.04	How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?	UNLIKELY	HIGH	It is unlikely but there is an increased potential for the inadvertent spread of non-native crayfish in the absence of implementing appropriate biosecurity measures.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.
1.06	How likely is the organism to survive during passage along the pathway?	MODERATELY LIKELY	HIGH	The crayfish are moderately likely to stay alive if kept damp and cool when inadvertently carried on angling gear. This would further depend on the duration of transfer. If used as live bait for angling, survival is highly likely.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	VERY LIKELY	VERY HIGH	Refer to Pathway 1, Question 1.07.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Direct transfer is likely in association with angling gear (e.g. keep nets) which is redeployed into a receiving water. This is also the case for live bait which could be dumped after a fishing excursion.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	UNLIKELY	MEDIUM	Although unlikely, there is some potential for entry <i>via</i> this pathway if the angling gear has previously been used, and not subsequently disinfected, in a location where non-native crayfish are present. The widespread presence of <i>Pacifastacus leniusculus</i> in British angling waters and the regular movement of such anglers to Ireland to fish add to this risk.
1.10	Do other pathways need to be considered?	NO		

Overall likelihood				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.11	Estimate the overall likelihood of entry into Ireland based on all pathways (comment on the key issues that lead to this conclusion).	LIKELY	HIGH	The most likely pathway for <i>Pacifastacus leniusculus</i> to ultimately gain entry to the wild in Ireland is considered to be through the food trade for human consumption. The risk arises from live surplus or undersized crayfish being discarded into a suitable habitat. Direct escape is considered less likely (although the species is known to move overland, survive out of water, and tolerate salinities up to full seawater [J Reynolds pers. comm.]). The inadvertent transfer of <i>Pacifastacus leniusculus</i> on angling equipment from abroad to Irish freshwaters is also a risk factor because of its widespread presence in British waters and the frequency of anglers coming to Ireland to fish from such waters.

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	VERY HIGH	This species has not been recorded in the wild in Ireland to date.
2.02	How likely is it that the organism will be able to establish in Ireland based on the similarity between local <u>climatic conditions</u> and the organism's current global distribution?	VERY LIKELY	VERY HIGH	The wide range of climatic conditions experienced by <i>Pacifastacus leniusculus</i> in its introduced range in mainland Europe (where it can be both warmer and colder than in Ireland) and Britain indicates that this organism will be able to survive and establish in Ireland. The species is reported to have a temperature tolerance of between 1.4 and 3.0°C greater than the native White-clawed Crayfish (Firkins and Holdich 1993 as cited in Ibbotson and Furse 1995) and can tolerate temperatures up to 33°C (Firkins 1993). <i>Pacifastacus leniusculus</i> is established throughout Britain (Holdich and Sibley 2009; GB Non-Native Species Secretariat 2011) which experiences a similar climate to Ireland. It has also been demonstrated to survive and successfully breed in Ireland over a numbers of years in aquaria that were subjected to ambient outdoor temperatures (Declan MacGabhann pers. comm.). Further to the above, climate modelling by Gallardo and Aldridge (2013) suggests that Ireland is highly suitable for colonisation by <i>Pacifastacus leniusculus</i> .
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local <u>abiotic conditions</u> and the organism's current global distribution?	VERY LIKELY	VERY HIGH	Overall, abiotic conditions are not believed to be limiting in Ireland to prevent the establishment of <i>Pacifastacus leniusculus</i> . The species is found in a wide variety of aquatic habitats in its global range and there is an abundance of similar habitat types in Ireland suitable for establishment. As with other crayfish, acidity is likely to be the principal limiting factor (GB Non-Native Species Secretariat 2011). It requires levels of dissolved calcium in excess of 5mg l ⁻¹ which is similar to other crayfish species (Ibbotson and Furse 1995). According to GB Non-Native Species Secretariat (2011), <i>Pacifastacus leniusculus</i> "can survive in any conditions capable of supporting fish and, with respect to anoxia, can tolerate much poorer conditions. Hiley and Peay (2005) observed that signal crayfish could tolerate dissolved oxygen less than 0.5% saturated for several hours and show full recovery when conditions improved. All but the most polluted lowland waters [in the UK] could support signal crayfish and probably most upland waters, except in very acidic peatland". <i>Pacifastacus leniusculus</i> is also drought tolerant. For example, in England, live specimens were present in Ampney Brook after a c. 13 week dry period (GB Non-Native Species Secretariat 2011).

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	VERY LIKELY	VERY HIGH	As previously stated, there is an abundance of habitats to support the survival, development and multiplication of <i>Pacifastacus leniusculus</i> in Ireland.
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	VERY HIGH	<p>Competition will occur from existing species but based on experiences elsewhere in Europe, including Britain (Souty-Grosset <i>et al.</i> 2006; GB Non-Native Species Secretariat 2011), this is highly unlikely to prevent establishment. Fish may also provide competition for food resources, such as macroinvertebrates. <i>Pacifastacus leniusculus</i> is highly likely to out-compete the native[†] White-clawed Crayfish. In mixed populations the native crayfish can be eliminated by the crayfish plague <i>Aphanomyces astaci</i> (Schikora), which is carried by <i>Pacifastacus leniusculus</i>, or through direct competition with this species (Holdich and Domaniewski 1995; Peay and Rogers 1999; Dunn <i>et al.</i> 2009).</p> <p>([†] It is uncertain whether the White-clawed Crayfish is indigenous or may have been introduced to Ireland in medieval times or later (reviewed in Reynolds 2010). However, being the only freshwater crayfish species found in the wild in Ireland, and of international conservation importance because of this, it is referred to as a native species in this risk assessment.</p>
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	VERY LIKELY	VERY HIGH	<p>Predation is likely to occur from existing species such as perch, pike, heron, otter, mink and eels, but is highly unlikely to prevent establishment. <i>Pacifastacus leniusculus</i> is a carrier of the crayfish plague <i>Aphanomyces astaci</i> but is highly resistant to it, except when individuals are simultaneously under stress from other diseases (Souty-Grosset <i>et al.</i> 2006) or during moulting (Holdich 1988 as cited in Ibbotson and Furse 1995). The same crayfish plague has extirpated populations of White-clawed Crayfish in the Irish midlands since the 1980s (reviewed in Matthews and Reynolds 1992) but no further outbreaks have been reported. In Britain, predation by brown trout, various cyprinid fish (including carp and chub), pike and eel, mammals such as otter and mink, and predatory birds such as heron and coot have not prevented the colonisation and spread of <i>Pacifastacus leniusculus</i> (GB Non-Native Species Secretariat 2011). Indeed, the species can reach nuisance proportions in angling lakes stocked with an artificially large biomass of predatory coarse fish or trout (GB Non-Native Species Secretariat (2011).</p>

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.07	How likely is it that establishment will occur despite existing management practices?	VERY LIKELY	VERY HIGH	In general, the state management of waterways is undertaken cognisant of ensuring biosecurity measures are in place to mitigate for the spread of aquatic invasive species. An increase in awareness by some private stakeholders of the threat from aquatic invasive species has also reduced this risk. Nevertheless, it is considered likely that this species can establish despite existing management practices which can only mitigate for aspects of the establishment risk. Importation of crayfish to Ireland was thought to be prohibited under the Live Fish (restriction of importation) Order 1972 of the Fisheries Acts. However, it was recently concluded that the definition given for “fish” did not apply to freshwater crayfish and, therefore, may not be enforceable (Reynolds 2010). Nevertheless, such measures have been successful to date in preventing the establishment of non-native crayfishes in the wild in this country (Reynolds 1998).
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	UNLIKELY	HIGH	Refer to Question 2.07.
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	VERY LIKELY	VERY HIGH	<p>GB Non-Native Species Secretariat (2011) provides a comprehensive review in this regard on such campaigns conducted in Britain. Numerous examples are provided which showed that eradication campaigns or intensive control efforts are ineffective to prevent further spread or affect population abundance. Local habitat complexity and the burrowing nature of this crayfish species (Holdich and Reeve 1991; Cosgrove <i>et al.</i> 2008) may interfere with any trapping programme.</p> <p>The use of biocides (e.g. natural pyrethroids) is an option for a pond population but these are unlikely to work in a complex river catchment, or indeed in a canal or large lake (Peay <i>et al.</i> 2006; GB Non-Native Species Secretariat 2011). However, it is likely that costs for the chemical and employing manpower, lethal impacts on other water dwellers as well as legislative problems, will prohibit its widespread use (GB Non-Native Species Secretariat 2011). Such concerns, leading to conflicts and delays in issuing permits, rendered several such attempts in Britain ineffective (S Peay pers. comm. to J. Reynolds).</p>

Stage 2 - Detailed assessment: Section B – Establishment

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N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	VERY HIGH	<i>Pacifastacus leniusculus</i> could establish in a wide range of Irish freshwaters (refer to Question 1.08, Pathway 1). A number of key biological features facilitate this, including its polytrophic character which allows it to exploit a wide variety of food resources, and its tolerance of drought conditions, salinity, periods of low oxygen and varying climates / temperatures (reviewed in Souty-Grosset <i>et al.</i> 2006 and GB Non-Native Species Secretariat 2011). Compared to the native White-clawed Crayfish, it is larger in size, faster growing, more fecund and resistant to, but a chronic carrier of, the crayfish plague - all of which would enable it to outcompete and extirpate the native species where both would occur simultaneously (Reynolds 1998; reviewed in Holdich <i>et al.</i> 1995).
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	VERY LIKELY	VERY HIGH	The literature indicates that <i>Pacifastacus leniusculus</i> has a moderate to high capacity for spread once it is introduced to the wild. In Britain, it is spreading by natural means in all watercourses to which it has been introduced or escaped (GB Non-Native Species Secretariat 2011). Typical rates of spread are 1-2 km/year (reviewed in GB Non-Native Species Secretariat 2011), but can be greater than this (Wright and Williams 2000; Bubb <i>et al.</i> 2005). Within a particular area, it may take several years for a population to reach a maximum density, after which the rate of expansion in range can progressively increase driven by density-dependent factors (reviewed in GB Non-Native Species Secretariat 2011). If crayfish die off due to drought or a pollution event in part of a catchment, re-establishment is likely (reviewed in GB Non-Native Species Secretariat 2011). <i>Pacifastacus leniusculus</i> can walk over land and obstacles such as dams and weirs do not appear to hamper their spread (Hiley 2003).
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	VERY LIKELY	VERY HIGH	In general, crayfish are omnivorous having the ability to act as herbivores, detritivores and predators. This non-specific, polytrophic character provides good adaptability to facilitate establishment in suitable habitats with varying food resources (reviewed in Souty-Grosset <i>et al.</i> 2006). It is also tolerant of a range of environmental conditions (refer to response to Questions 2.02 and 2.03) and can occupy a variety of habitats (refer to response to Question 1.08, Pathway 1).

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	LIKELY	LOW	There is a paucity of information available to comment in detail on this. However, apparent low genetic diversity has not been any constraint on widespread colonisation so far in Scandinavia (where most <i>Pacifastacus leniusculus</i> were imported from a single source) and in Britain (GB Non-Native Species Secretariat 2011). Indeed, for comparison, low genetic variation in Irish populations of the White-clawed Crayfish has not hindered their spread in this country (Gouin <i>et al.</i> 2003).
2.14	Based on the history of invasion by this organism elsewhere in the world, how likely is it to establish in Ireland? If possible, specify the instances of invasion elsewhere in the justification box	VERY LIKELY	VERY HIGH	Based on a review of its biological character and ecological requirements in its native and introduced range, <i>Pacifastacus leniusculus</i> is very likely to establish in Ireland as climatic and abiotic conditions are considered suitable and there are a wide range of habitats available for colonisation. This is supported by its documented survival and successful reproduction in Ireland over a number of years in aquaria that were subjected to ambient outdoor temperatures (Declan MacGabhann pers. comm.).
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	UNLIKELY	VERY HIGH	Transient populations are unlikely to establish as it is considered highly probable (from the information reviewed) that reproducing populations would establish after introduction.
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	VERY HIGH	The information assembled in Section B suggests that it is very likely that <i>Pacifastacus leniusculus</i> can establish in the wild in Ireland. This is further supported by its wide-spread establishment throughout Britain, and its documented survival and ability to reproduce in Ireland in aquaria that were subjected to ambient outdoor temperatures as mentioned above.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	68 – 90 % (of 10 km squares)	VERY HIGH	<i>Pacifastacus leniusculus</i> could colonise a range of habitat types which are abundant in Ireland (refer to response to Question 1.08, Pathway 1). In Britain, potentially suitable habitats are considered to be in excess of 75% of all waterbodies (GB Non-Native Species Secretariat 2011).
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MODERATE	HIGH	The literature indicates that <i>Pacifastacus leniusculus</i> has a moderate to high capacity for natural spread within catchments once it is introduced to the wild. As previously mentioned, in Britain, it is spreading by natural means in all watercourses to which it has been introduced or escaped (GB Non-Native Species Secretariat 2011). Typical rates of spread are 1-2 km/year (reviewed in GB Non-Native Species Secretariat 2011), but can be greater than this (Bubb <i>et al.</i> 2005; Wright and Williams 2000). Within a particular area, it may take several years for a population to reach a maximum density, after which the rate of expansion in range can progressively increase driven by density-dependent factors (reviewed in GB Non-Native Species Secretariat 2011). The species has a capacity to walk over land, which may enhance its ability to spread naturally from isolated waters (Hiley 2003; reviewed in GB Non-Native Species Secretariat 2011).
3.03	How important is the expected spread of this organism in Ireland by <u>human assistance</u> (minimal, minor, moderate, major or massive)?	MODERATE TO MAJOR	HIGH	Anthropogenic-mediated spread is more likely than natural spread to increase the rate of dispersal in Ireland, especially between catchments. Indeed, spread by humans has been, by far, the principal mechanism responsible for the dispersal of this species throughout mainland Europe and Britain (Souty-Grosset <i>et al.</i> 2006; GB Non-Native Species Secretariat 2011). Inter-catchment transfers may be conducted to provide local food sources for humans or fish or the species may be transferred by anglers for use as live fish bait. It remains to be seen what level of interest there may be for Irish residents to introduce or relocate crayfish in the wild for use as a food source.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MAJOR	VERY HIGH	This depends on the response time between an introduction occurring and the reaction enacted to contain it, and on the nature of the water colonised. Containment would be feasible in a closed system such as a pond, particularly if geographical isolated from other waters. It would be very difficult in an open water system (e.g. river catchment or lake) or semi-open system such as a canal because of its ability to disperse by natural means. In general, there has been little success in containing other introduced invertebrates in Ireland.
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	NONE	VERY HIGH	This species has not been recorded in the wild in Ireland to date.
3.06	What proportion of the area in Ireland suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	N/A		This species has not been recorded in the wild in Ireland to date.
3.07	What other timeframe would be appropriate to estimate any significant further spread of the organism (10, 20, 40, 80 or 160 years)? Please comment on why this timeframe is chosen.	N/A		This species has not been recorded in the wild in Ireland to date.
3.08	In this timeframe, what proportion of the area (including any currently occupied areas) is likely to have been invaded by this organism?	N/A		This species has not been recorded in the wild in Ireland to date.
3.09	Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered.	-		Refer to Question 3.01.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.10	Estimate the overall potential for future spread for this organism in Ireland (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues .			If introduced, the potential for subsequent spread is high. This primarily depends on the amount of introductions and the character of the waters they are introduced to.

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.01	How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?	MODERATE TO MAJOR	MEDIUM	There has been little documentation of economic loss due to <i>Pacifastacus leniusculus</i> , with more focus on ecological effects (Sibley 2000), except in Sweden where the indigenous Noble Crayfish has been further decimated due to the introduction of <i>Pacifastacus leniusculus</i> in 1969 and the concomitant spread of the crayfish plague (Sibley 2000; Bohman <i>et al.</i> 2006). In England, the perceived value and use of some recreational fisheries has been reduced as a result of crayfish interfering with angling bait (GB Non-Native Species Secretariat 2011). The burrowing activity of <i>Pacifastacus leniusculus</i> has been known to undermine riverbanks, increasing erosion and siltation (Guan 1994; Sibley 2000; Harvey <i>et al.</i> 2011). (Peay <i>et al.</i> 2009) has shown that <i>Pacifastacus leniusculus</i> may reduce levels of salmonid alevins and juveniles in Yorkshire and has modelled the financial cost of controlling a spreading population by trapping versus the impact on salmonid stocks. Management costs were found to increase annually, and greatly exceeded the costs of restocking salmonids They also exceeded the costs of biocide eradication (S Peay, PhD Thesis, University of Leeds 2013).
4.02	How great has the economic cost of the organism been in Ireland from the <u>time of introduction to the present</u> ? Exclude any costs associated with managing the organism from your answer.	N/A		This species has not been recorded in the wild in Ireland to date.
4.03	How great is the economic cost of the organism likely to be in the <u>future</u> in Ireland? Exclude any costs associated with managing the organism from your answer.	MODERATE	MEDIUM	The burrowing activity of <i>Pacifastacus leniusculus</i> has the potential to cause bankside erosion and collapse, and to block irrigation or drainage channels as a result. The biggest impact is likely to be an increased cost of maintaining channelised rivers and canals due to this burrowing activity, and habitat restoration on other rivers with soft substrates (GB Non-Native Species Secretariat 2011). Some recreational fisheries may be negatively impacted by the species interfering with angling bait or reducing the perceived value of a colonised fishery (GB Non-Native Species Secretariat 2011). There is concern that there may be direct impacts on the recruitment of salmon and trout through <i>Pacifastacus leniusculus</i> preying on or competing with juvenile fish (Griffiths <i>et al.</i> 2004; Peay <i>et al.</i> 2009; GB Non-Native Species Secretariat 2011). Indeed, the impact on salmonids may be of greatest urgency to fisheries interests in Ireland (J. Reynolds pers. comm.).

Stage 2 - Detailed assessment: Section D - Impact				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.04	How great have the economic costs of managing this organism been in Ireland from the <u>time of introduction to the present</u> ?	N/A		This species has not been recorded in the wild in Ireland to date.
4.05	How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?	MODERATE	MEDIUM	This would depend of the level of establishment and spread, if introduced. It would be vitally important to minimise any impact to the native White-clawed Crayfish that could be caused, either directly or indirectly, by <i>Pacifastacus leniusculus</i> . This mitigation could perhaps be achieved by containment.
4.06	How important is environmental harm caused by the organism within its global distribution?	MAJOR	VERY HIGH	<p>In Europe, the principal environmental harm caused by <i>Pacifastacus leniusculus</i> is its impact on indigenous crayfish populations. Both the Noble and White-clawed Crayfish have been extirpated from numerous waters through direct competition and / or succumbing to the crayfish plagues carried by <i>Pacifastacus leniusculus</i> (Sibley 2000; Souty-Grosset <i>et al.</i> 2006; Bohman <i>et al.</i> 2006). Indeed, Holdich and Sibley (2009) report that the prediction that the White-clawed Crayfish would disappear from all 10 km squares nationally by 2034 (Sibley 2003) looks like becoming a reality in south-west England. Negative impacts have also been documented for benthic fish (Guan and Wiles 1997), aquatic invertebrates (Nyström <i>et al.</i> 1999; Stenroth and Nystrom 2003; Crawford <i>et al.</i> 2006) and macrophytes (Nyström <i>et al.</i> 1999; Nystrom and Strand 1996). Recent notable research indicates that macroinvertebrate numbers and taxon richness are inversely correlated with <i>Pacifastacus leniusculus</i> densities and crayfish removals have had positive impacts on macroinvertebrate numbers and taxon richness (Moorhouse <i>et al.</i> 2014).</p> <p>The burrowing activity of <i>Pacifastacus leniusculus</i> can undermine banks, increasing erosion and siltation (Guan 1994; Sibley 2000; Harvey <i>et al.</i> 2011). These modifications to habitat can be expected to have consequences for some species of fishes (Griffiths <i>et al.</i> 2004).</p>

Stage 2 - Detailed assessment: Section D - Impact				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.07	How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation	N/A		This species has not been recorded in the wild in Ireland to date.
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MAJOR	HIGH	<p>As previously mentioned, <i>Pacifastacus leniusculus</i> has the capacity to extirpate the native White-clawed Crayfish in Ireland through direct competition, transmitting the crayfish plague or a combination of both (Reynolds <i>et al.</i> 1998; Reynolds 2010). The White-clawed Crayfish is an EU Habitat's Directive protected Annex 2 listed species and is classified as vulnerable and rare in the IUCN Red List of threatened animals. It is also recognised to be of national importance, with legislation enacted to protect it under the Wildlife Act 1976 in Ireland.</p> <p>Further to this, native fish, aquatic invertebrate and macrophyte communities are likely to be under threat where <i>Pacifastacus leniusculus</i> becomes established. This includes salmonid fish in spawning and nursery habitats (Griffiths <i>et al.</i> 2004; GB Non-Native Species Secretariat 2011) and other fish species such as Stoneloach (Guan and Wiles 1997) which may be affected by competition for resources or predation. GB Non-Native Species Secretariat (2011) report that where <i>Pacifastacus leniusculus</i> have replaced White-clawed Crayfish and have much higher biomass, a very large reduction of wild brown trout and salmon recruitment was observed. Fish that depend on macrophytes for spawning and cover, such as Roach, are expected to decline, unless they are using vegetation that is less palatable to <i>Pacifastacus leniusculus</i> (reviewed in Ibbotson and Furse 1995; GB Non-Native Species Secretariat 2011). Impacts on juvenile lamprey are possible due to predation in spawning gravels of the ammocoete larvae in river silts, or indirectly due to burrowing of banks and excessive siltation, but there is no direct evidence so far (GB Non-Native Species Secretariat 2011).</p> <p>Conservationally important plant species, notably charophytes, may also be impacted as they are used as a food source (Nystrom and Strand 1996; Nyström <i>et al.</i> 1999). In addition, <i>Pacifastacus leniusculus</i> may</p>

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				reduce the abundance, diversity or richness of some aquatic invertebrates such as Non-biting Midge, Stone Fly or True Fly larvae, as well as leeches and snails (Nyström <i>et al.</i> 1999; Stenroth and Nystrom 2003; Crawford <i>et al.</i> 2006). Juvenile freshwater Pearl Mussels could potentially be affected by <i>Pacifastacus leniusculus</i> either directly by predation or indirectly through burrowing and concomitant siltation (GB Non-Native Species Secretariat 2011).
4.09	How important has alteration of ecosystem function* caused by the organism been in Ireland from the time of introduction to the present? *e.g. habitat change, nutrient cycling, trophic interactions	N/A		This species has not been recorded in the wild in Ireland to date.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?	MAJOR	HIGH	As 'ecosystem engineers', crayfish in general have the ability to alter ecosystem function through food-web or habitat modification (Jones <i>et al.</i> 1997). The degree of change would likely depend on the extent of colonisation. The high population densities that can be attained by <i>Pacifastacus leniusculus</i> in invaded ecosystems may increase the potential for ecosystem function to be altered.
4.11	How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.	N/A		This species has not been recorded in the wild in Ireland to date.
4.12	How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?	MODERATE TO MAJOR	HIGH	The establishment of <i>Pacifastacus leniusculus</i> may have detrimental impacts to native White-clawed Crayfish populations in Ireland (refer to response to Question 4.08). This may have implications for the classification of ecological status under the EU Water Framework Directive (WFD) and conservation status under the EU Habitats Directive. Indeed, some waters in Britain have failed to meet the requirements of good ecological status under the WFD because of the presence of <i>Pacifastacus leniusculus</i> (reviewed Sibley <i>et al.</i> 2009).

Stage 2 - Detailed assessment: Section D - Impact				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.13	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within its global distribution?	MODERATE	HIGH	In Sweden, the indigenous Noble Crayfish (traditionally used widely as a luxury food) has been decimated due to the introduction of <i>Pacifastacus leniusculus</i> in 1969 and the concomitant spread of the crayfish plague (Sibley 2000; Bohman <i>et al.</i> 2006). In England, the perceived value and use of some recreational fisheries has been reduced as a result of crayfish interfering with angling bait (GB Non-Native Species Secretariat 2011). The burrowing activity of <i>Pacifastacus leniusculus</i> has been known to undermine riverbanks, increasing erosion (Guan 1994; Sibley 2000). However, specific harm to social or human health has not been documented in this regard.
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	N/A		This species has not been recorded in the wild in Ireland to date.
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	MINIMAL	HIGH	This species is not known to successfully interbreed with the White-clawed Crayfish or other species.
4.16	How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	MAJOR	VERY HIGH	<i>Pacifastacus leniusculus</i> is exploited and commercially farmed as a food source throughout Europe and was originally introduced to the continent as a substitute to replace declining native crayfish stocks (Souty-Grosset <i>et al.</i> 2006). This species is a chronic carrier of the crayfish plague (Souty-Grosset <i>et al.</i> 2006) and could spread it to the native White-clawed Crayfish. It is known as a non-specific prey item of the invasive North American Mink (GB Non-Native Species Secretariat 2011) which is already established in the Irish wild. <i>Pacifastacus leniusculus</i> has transferred North American species of Branchiobdellid parasites and of <i>Psorospermium</i> to native European crayfish (Souty-Grosset <i>et al.</i> 2006).
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	MINIMAL	HIGH	All known or potential impacts have been covered elsewhere in this document.

Stage 2 - Detailed assessment: Section D - Impact				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.18	How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?	MAJOR	HIGH	Natural control by other organisms is unlikely to affect expected impacts (e.g. displacement of the native White-clawed Crayfish, reduction of biodiversity). As previously mentioned, predation is likely to occur from existing species, but is highly unlikely to prevent establishment and has not prevented the colonisation and spread of <i>Pacifastacus leniusculus</i> in Britain (GB Non-Native Species Secretariat 2011). It is a carrier of the crayfish plague but is highly resistant to it except when individuals are simultaneously under stress from other diseases (Souty-Grosset <i>et al.</i> 2006) or during moulting (Holdich 1988 as cited in Ibbotson and Furse 1995).
4.19	Indicate any parts of where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas.	-		Potential economic, environmental and social impacts are possible wherever <i>Pacifastacus leniusculus</i> could establish. There are an abundance of such waters in Ireland. The conservation status of waters which hold native White-clawed crayfish stock would be directly threatened and this may also be the case for salmonid fish species, lamprey, the pearl mussel and some keystone plant species such as Charophytes. Bank erosion and concomitant siltation may also occur where the species establishes (e.g. in canals).
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MAJOR	VERY HIGH	The primary potential impact of <i>Pacifastacus leniusculus</i> in Ireland is the threat it poses to the native White-clawed Crayfish, and to a lesser extent other conservationally important species, if abundant populations establish in the wild in Ireland. The structural integrity of river or pond banks may also be affected in colonised areas, and there is potential for impact on salmonid recruitment.

Stage 2 - Detailed assessment: Section E - Conclusion

This section requires the assessor to provide a score for the overall risk posed by an organism, taking into account previous answers to entry, establishment, spread and impact questions.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
5.01	Estimate the overall risk of this organism in Ireland (noting answers given in 1.11, 2.16, 3.10 & 4.20).	MAJOR	VERY HIGH	This crayfish species has the potential to seriously threaten the conservation of the native White-clawed Crayfish populations and to a lesser extent other conservationally important species in Ireland. Salmonid recruitment may be impacted. The structural integrity of river or pond banks may also be affected in colonised areas.

Stage 2 - Detailed assessment: Section F – Additional questions

This section is used to gather information about the potential effects of climate change on the risk posed by an organism. It is also an opportunity for the risk assessor to highlight high priority research that could help improve the risk assessment.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
6.01	What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	-	MEDIUM	Climate change is expected to increase water temperatures over time in Ireland, with increased periods of drought in summer and higher rainfall in winter leading to more flooding events (Desmond <i>et al.</i> 2008). This is unlikely to have a negative effect on the establishment of <i>Pacifastacus leniusculus</i> and may favour it as the species is drought resistant and has a broad temperature tolerance. Indeed, increasing water temperatures may favour growth as the optimum water temperatures for growth are between 20 and 25°C, with a maximum tolerance of 33°C (Firkins 1993). Climate change modelling (a year 2050 scenario) by Gallardo and Aldridge (2013) suggest that Ireland will be highly suitable for colonisation by <i>Pacifastacus leniusculus</i> (and indeed is already suitable). Gallardo and Aldridge (2013) also consider the effects of climate change on the crayfish plague, suggesting that their survival may increase in a scenario of warmer temperatures.
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	UNKNOWN	LOW	
6.03	What aspects of the risk assessment are most likely to change as a result of climate change		HIGH	The establishment and invasive potential of <i>Pacifastacus leniusculus</i> may increase in Ireland as outlined in response to Question 6.01.
6.04	If there is any research that would significantly strengthen confidence in the risk assessment, please note this here. If more than one research area is provided, please list in order of priority.	YES	HIGH	Specific information on the amount and frequency of <i>Pacifastacus leniusculus</i> imports to Ireland for the food and ornamental trades would be useful to strengthen the pathways section of this risk assessment. If this species is found to be entering Ireland for the aquarium trade, a specific pathway analysis for this should be added to this document.

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