

Risk Assessment of *Crassula helmsii*

Name of Organism:	<i>Crassula helmsii</i> Kirk (Cockayne) – Australian Swamp Stonecrop
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
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Expert reviewer	Jonathan Newman

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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?		<i>Crassula helmsii</i> Kirk (Cockayne), <i>Bulliarda recurva</i> (Hook. f.), <i>Crassula recurva</i> (Hook. f.) Ostenf., <i>Tillaea helmsii</i> Kirk, <i>Tillaea recurva</i> (J.D. Hook.), <i>Tillaea verticillaris</i> (Hook.f) Australian stonecrop, Australian swamp stonecrop, New Zealand pygmyweed, and swamp stonecrop (Global Invasive Species Database 2010).
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>Crassula helmsii</i> can grow as a submerged form in a maximum water of depth 3m or emergent form in aquatic environments such as ponds, wetlands, lakes, canals and slow-flowing watercourses. It also has a terrestrial form which can grow in muddy substrate along the margins of such waters. The plant can typically range from 10 - 130 cm in length. Leaves have a pointed tip, grow in opposite pairs and are somewhat fleshy in the emergent form, with a distinct collar around the stem. The submerged form grows from a basal rosette and has sparsely-leaved stems which may reach the water surface. The emergent form typically grows as stands of short densely packed stems in a water depth of 0.6 m or less. The terrestrial form has more densely arranged and shorter, succulent leaves, and grows from creeping stems. Flowers are small and white and are only produced above the water surface. (Global Invasive Species Database 2010; Inland Fisheries Ireland 2013a).
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	YES	A preliminary risk assessment was previously carried out for Ireland and Northern Ireland. This was a stage one and two risk assessment as part of <i>Ireland's National Plant Conservation Strategy - Target 10 - Managing Invasive Alien Species</i> (Botanic Gardens 2007). This assessment designated <i>Crassula helmsii</i> as a "most significant invasive plant".
6	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTLY VALID	Only a preliminary risk assessment was previously conducted in Ireland (refer to Question 5).
7	Where is the organism native?		Australia (Global Invasive Species Database 2010).
8	What is the current global distribution of the organism (excluding Ireland)?		Throughout Western Europe (Britain, Belgium, Denmark, France, Germany, Italy, Netherlands, Northern Ireland and Spain); the Russian Federation; and the south-eastern United States, New Zealand (EPPO 2007; Global Invasive Species Database 2010) and the countries listed in answer to Question 7.

Stage 1 - Organism Information

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

N	QUESTION	RESPONSE	COMMENT
9	What is the current distribution of the organism in Ireland?		Recorded in a total of 9 10km squares in the National Invasive Species Database (National Invasive Species Database 2013). This is considered to be a significant underestimate as <i>Crassula helmsii</i> is commonly found in artificial garden, golf course and other watercourses throughout Ireland (J. Caffrey pers. comm.).
10	Is the organism known to be invasive anywhere in the world?	YES	It is especially problematic in Britain and has established troublesome populations throughout Western Europe and in the south-eastern United States (Global Invasive Species Database 2010).

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)?	MANY	VERY HIGH	Horticultural and aquarium trade, boating, angling and other water-based activities.
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.	1. Horticultural and aquarium trade 2. Boating 3. Angling		<i>Crassula helmsii</i> is imported into Ireland via the horticultural and aquarium sectors for sale to the public in garden centres and pet shops. It is also sold periodically in some other retail outlets, such as supermarkets, and is available to buy on the internet. The risk of introduction by boats and anglers arises from any travel to Ireland from an infested area abroad where equipment is inadvertently contaminated with viable plant material.

Pathway 1 - Horticultural and aquarium trade

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	<i>Crassula helmsii</i> is deliberately imported for trade. It has been found as a contaminant with other traded aquatic plants in Britain (Environment Agency UK 2003).
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	VERY HIGH	<i>Crassula helmsii</i> is deliberately imported for trade and subsequently sold in a wide range of outlets in Ireland as an oxygenator / ornamental weed for artificial watercourses, garden ponds and aquaria.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	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	As the organism is distributed deliberately via trade or present as a contaminant of trade, survival is considered very likely.

Pathway 1 - Horticultural and aquarium trade				
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	There is no known seasonal restriction to inhibit the establishment of this organism from viable plant material. It can grow throughout the year (Centre for Aquatic Plant Management 2004) and has no dormancy period (EPPO 2007). Trade imports and purchases may occur throughout the year.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Ireland has a high density and abundance of freshwaters, many of which are suitable for the establishment of this organism as it has a wide tolerance of environmental conditions. Aquatic populations may grow in acidic, oligotrophic, eutrophic and alkaline ponds, lakes and watercourses (Global Invasive Species Database 2010). The practice of planting <i>Crassula helmsii</i> in artificial watercourses and private ponds, which are often proximal to these natural systems, and its use in aquaria, increases the likelihood of it transferring from this pathway to a suitable habitat.
1.09	Estimate the overall likelihood of entry into Ireland and Northern Ireland based on this pathway?	VERY LIKELY	VERY HIGH	It is already deliberately imported for trade.
1.10	Do other pathways need to be considered?	YES		

Pathway 2 - Boating				
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	HIGH	The overland or cross-channel movement of boats, boat trailers and boat engines from an infested to uninfested area has the potential to inadvertently spread this organism if viable plant material is attached. This includes the import of used boats from abroad.
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?	MODERATELY LIKELY	HIGH	In the absence of implementing appropriate biosecurity measures and border checks, there is an increased potential for the inadvertent spread of viable plant material overland on boating equipment from infested to uninfested waters.

Pathway 2 - Boating				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
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	HIGH	<i>Crassula helmsii</i> has a high desiccation tolerance and can regenerate from vegetative fragments as small as 5 mm in length with a single node (Centre for Aquatic Plant Management 2004). Therefore, it is very likely to survive during passage along this pathway.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	HIGH	There is no known seasonal restriction to inhibit the establishment of this organism from viable plant material. It can grow throughout the year (Centre for Aquatic Plant Management 2004) and has no dormancy period (EPPO 2007). Boat movements may occur throughout the year.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Ireland has a high density and abundance of freshwaters, many of which are suitable for the establishment of this organism as it has a wide tolerance of environmental conditions. Aquatic populations may grow in acidic, oligotrophic, eutrophic and alkaline ponds, lakes and watercourses (Global Invasive Species Database 2010). Transfer is ultimately dependent on environmental conditions and duration of transport, but survival for extended periods of time is likely (Refer to Question 1.06).
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	This pathway depends on the transfer of viable plant material surviving an overland or cross-channel journey in association with boats from an infested water abroad to an uninfested water in the country. As <i>Crassula helmsii</i> is widespread and abundant throughout most of England, particularly the south, as well as Cumbria and scattered localities in Wales and present in Northern Ireland (GB Non-Native Species Secretariat 2011), it is considered moderately likely that the organism can enter <i>via</i> this pathway. However, it should be noted that there is no specific information available on the movement of boats from infested areas abroad into Ireland.
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)?	ACCIDENTAL	HIGH	The overland or cross-channel movement of angling equipment (e.g. landing or keep net, stink bag, angling box and stand, boots, waders and live bait) from an infested to uninfested area has the potential to inadvertently spread this organism if viable plant material is attached.
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?	MODERATELY LIKELY	HIGH	In the absence of implementing appropriate biosecurity measures and border checks, there is an increased potential for the inadvertent spread of viable plant material overland on angling equipment from infested to uninfested waters.
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	<i>Crassula helmsii</i> has a high desiccation tolerance and can regenerate from vegetative fragments as small as 5 mm in length with a single node (Centre for Aquatic Plant Management 2004). Therefore, it is very likely to survive during passage along this pathway.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	HIGH	There is no known seasonal restriction to inhibit the establishment of this organism from viable plant material. It can grow throughout the year (Centre for Aquatic Plant Management 2004) and has no dormancy period (EPPO 2007). Angler movements may occur throughout the year.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Ireland has a high density and abundance of freshwaters, many of which are suitable for the establishment of this organism as it has a wide tolerance of environmental conditions. Aquatic populations may grow in acidic, oligotrophic, eutrophic and alkaline ponds, lakes and watercourses (EPPO 2007; Global Invasive Species Database 2010). Transfer is ultimately dependent on environmental conditions and duration of transport, but survival for extended periods of time is likely (Refer to Question 1.06).
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	This pathway depends on the transfer of viable plant material surviving an overland or cross-channel journey in association with angling equipment from an infested water abroad to an uninfested water in the country. As <i>Crassula helmsii</i> is widespread and abundant throughout most of England, particularly the south, as well as Cumbria and scattered

Pathway 3 - Angling				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				localities in Wales and present in Northern Ireland (GB Non-Native Species Secretariat 2011), it is considered moderately likely that the organism can enter <i>via</i> this pathway. As there is a paucity of specific information available on the movement of anglers from infested areas into Ireland, it is considered moderately likely that the organism can enter <i>via</i> this pathway. As the plant often grows in the riparian zone of freshwaters, there is a heightened risk of plant material coming in direct contact with angling gear, notably keep nets and waders.
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).	VERY LIKELY	VERY HIGH	The primary pathway of entry into Ireland is through deliberate trade <i>via</i> the horticultural and aquarium sectors. The movement of boats and anglers from infested areas outside Ireland to the country may also facilitate entry as described previously.

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')	YES	VERY HIGH	It is locally well established in Ireland. It is recorded in a total of 9 x 10km squares in Ireland (National Invasive Species Database 2013). However, this is considered to be a significant underestimate as <i>Crassula helmsii</i> is commonly found in artificial garden, golf course and other watercourses throughout Ireland (J. Caffrey pers. comm.).
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	<i>Crassula helmsii</i> is perennial, winter-green and frost tolerant in Ireland. Based on its known climatic tolerance in its global distribution (EPPO 2007), climatic conditions are not thought to be limiting in either jurisdiction.
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	There are likely no significant overall limiting abiotic factors present in Ireland to limit its further establishment.
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	In Ireland, there is an abundance of freshwater habitats (e.g. lakes, slow flowing rivers, ponds and canals) susceptible to colonisation by <i>Crassula helmsii</i> which can facilitate its subsequent survival, development and multiplication. Separate systems are often geographically proximal.
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	VERY HIGH	Experience from infested locations in Ireland demonstrates that <i>Crassula helmsii</i> can out-compete and displace native plant species. This was most evident in the Grand Canal where a 2.2 km section near Lullymore, Co. Kildare became heavily infested with the plant within the last 10 years (Caffrey <i>et al.</i> 2012; CAISIE 2013).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	VERY LIKELY	VERY HIGH	There are no known natural predators, parasites or pathogens of this species in Ireland that will have an effect on its establishment.
2.07	How likely is it that establishment will occur despite existing management practices?	-LIKELY	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 entities of the threat from aquatic invasive species has also reduced this risk. Despite extensive and exhaustive control work conducted by Inland Fisheries Ireland (IFI) and Waterways Ireland (WI) in the Grand Canal using a variety of control methods, the plant has re-established in very low abundance some two years after treatment (Caffrey <i>et al.</i> 2013).

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
2.08	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?	MODERATELY LIKELY	MEDIUM	Complete eradication of large infestations is unlikely due to ability of the plant to regenerate from vegetative fragments but control can in the short- to medium-term reduce the abundance of established populations and their concomitant impacts (Caffrey <i>et al.</i> 2012; CAISIE 2013; Caffrey <i>et al.</i> 2013). Low density infestations have been successfully treated in Lough Corrib using double layers of light-excluding jute matting (Millane <i>et al.</i> 2012), but this has not been successful in shallow canal environments (Caffrey <i>et al.</i> 2012).
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	VERY HIGH	The ability of <i>Crassula helmsii</i> to reproduce asexually from vegetative fragments, to out-compete native plant species, to survive extended periods in damp environments out of water and its perennial nature can facilitate its establishment (EPPO 2007).
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	VERY LIKELY	VERY HIGH	Refer to Question 3.02.
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	VERY LIKELY	VERY HIGH	<i>Crassula helmsii</i> has a wide ecological tolerance which allows it to establish populations in and along the margins of many freshwater environments in Ireland. Populations can grow in and around acidic, oligotrophic, eutrophic and alkaline ponds, lakes and watercourses (EPPO 2007; Global Invasive Species Database 2010).
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	VERY LIKELY	VERY HIGH	Although reproduction is solely vegetative in Ireland, there is no evidence to suggest low genetic diversity in the founder population will inhibit any future establishment.
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	It has already demonstrated this capacity in Ireland.

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
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	N/A		
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	VERY HIGH	Refer to Questions 2.04, 2.10 and 2.12.

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	Refer to Question 2.12.
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	Within systems, internal spread by natural means can occur principally <i>via</i> vegetative fragmentation (EPPO 2007). Between catchments, there is a very low potential for natural spread, although it could be transferred <i>via</i> plant material attached to water fowl.
3.03	How important is the expected spread of this organism in Ireland by <u>human assistance</u> (minimal, minor, moderate, major or massive)?	MASSIVE	VERY HIGH	As <i>Crassula helmsii</i> continues to be deliberately traded, this greatly increases its potential for spread. The movement of boats and angling gear also has a high potential to inadvertently spread <i>Crassula helmsii</i> within and between watersheds. Aquatic weed control practices conducted with disregard for the associated spread of plant fragment inocula is a further risk factor in this regard.
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MODERATE	HIGH	<i>Crassula helmsii</i> is locally well established in Ireland and is spreading (e.g. in Lough Corrib [Millane <i>et al.</i> 2012] and the Grand Canal [Caffrey <i>et al.</i> 2013]). It is officially recorded in 9 x 10km squares in Ireland (National Invasive Species Database 2013). However, this is considered to be a significant underestimate as it is commonly found in artificial garden, golf course and other watercourses throughout Ireland (J. Caffrey pers. comm.). Therefore, containment, at least between catchments, is feasible if routine biosecurity measures to limit its further spread are implemented and proposed restrictions on its importation and sale are enforced. Further to this, effective methods to locally control <i>Crassula helmsii</i> now exist as demonstrated in Lough Corrib (Millane <i>et al.</i> 2012) and the Grand Canal (Caffrey <i>et al.</i> 2012). Despite this, systematic eradication is unlikely to be achieved, particularly in open systems.

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
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	0% -10%	VERY HIGH	Refer to Question 3.04.
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)?	0% -10%	HIGH	It is considered that <i>Crassula helmsii</i> will continue to spread outside its existing range, particularly if proposed restrictions on its sale are not enforced and biosecurity practices are not promoted and implemented. There exists a very low current risk of spread from Lough Corrib via angling boat movements as it is confined in one bay of the lake (Millane <i>et al.</i> 2012). The ongoing weed control programme in Lough Corrib has substantially reduced the area of lake infested by the plant (by over 90%) thus lowering its capacity for internal and external spread. However, it is considered that further internal spread will occur in this lake, albeit at a much slower rate than if no control was undertaken. Its potential for spread from small artificial waters is considered low as these are confined systems. Despite the extensive <i>Crassula helmsii</i> control operations conducted in the Grand Canal near Lullymore, Co. Kildare since 2011, the plant has since spread both east and west of the treated section (Caffrey <i>et al.</i> 2013).
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.	10 years	HIGH	In the absence of restrictions on sale and the implementation of routine biosecurity measures, significant further spread is a certainty (Refer to Question 3.06).
3.08	In this timeframe, what proportion of the area (including any currently occupied areas) is likely to have been invaded by this organism?	0% - 10%		Refer to Questions 3.06 and 3.07.
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.	-	HIGH	The majority of freshwaters in Ireland are vulnerable to the establishment of <i>Crassula helmsii</i> . These include acidic, oligotrophic, eutrophic and alkaline ponds, lakes and other watercourses such as canals and wetlands. The plant can grow up to 3 m depth and also become established along terrestrial bankside habitat associated with such waters.

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 .	RADIPLY	HIGH	The rapid spread of the plant in Britain (where it is now present at over 1,000 site since its introduction [Watson 2001 as cited in EPPO 2007]), suggests that a similar trend may occur in Ireland. However, if restrictions on sale are enforced and biosecurity measures are routinely implemented, further range extensions are likely to be slow as the principal mechanism of spread is human-mediated.

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?	MAJOR	MEDIUM	The tangible costs are difficult to accurately quantify. Dense growths of <i>Crassula helmsii</i> can impede angling, restrict the passage of boats and increase flood risk by inhibiting drainage and require measures to be implemented to protect or restore impacted species or habitats. In addition, dense surface mats can prove dangerous for livestock and pets (EPPO 2007). The cost of control of <i>Crassula helmsii</i> in the UK has been estimated at between €1.45 and €3 million based on the treatment of 500 sites over a period of 2-3 years (Leach and Dawson 1999). The economic cost of control annually in the UK is estimated at £3 million (Williams <i>et al.</i> , 2010).
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.	MINIMAL	MEDIUM	Excluding any costs associated with managing <i>Crassula helmsii</i> , the economic costs in Ireland to date has been minimal primarily as a result of its limited distribution.
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	This is difficult to accurately quantify (see Question 4.01 for an overview of known economic impacts likely to occur should <i>Crassula helmsii</i> spread in the country). The rapid spread of the plant in Britain suggests that a similar trend may occur in Ireland. In Britain, by 2001, it was recorded at over 1,000 sites since its introduction [Watson 2001 as cited in EPPO 2007] and the most recent records for the UK indicate that the plant is now present at 1,858 sites (https://data.nbn.org.uk) which is considered to be an underestimate (J. Newman pers. comm.). This is likely to be the case in the absence of biosecurity and restrictions on the sale of the plant. Currently, the most extensive infestation of <i>Crassula helmsii</i> in Ireland is present in the Grand Canal (Lullymore, Co. Kildare), where the plant has recently spread extensively both east and west of the 2.2 km area originally infested (Caffrey <i>et al.</i> 2013). The systemic establishment of the plant throughout this 132 km waterway may occur in the absence of further control and monitoring with knock-on socio-economic implications for boating and angling. It is worth noting that recreational boating is estimated to be worth €70 million to the Irish economy (Martin 2012) and the economic value of recreational angling to Ireland (including sea angling) is estimated at €755 million per annum (Inland Fisheries Ireland 2013b). There may also be financial implications if conservation goals such as those specified in the EC Habitats Directive and the EU Water Framework Directive are placed under threat.

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> ?	MODERATE	VERY HIGH	The estimated cost of control, research and rehabilitation operations to manage <i>Crassula helmsii</i> has been in the region of €350,000, with the majority of this spent on controlling the plant in the Grand Canal in 2011 and 2013 (Caffrey <i>et al.</i> 2012).
4.05	How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?	MAJOR	HIGH	The projected annual cost to manage <i>Crassula helmsii</i> is difficult to quantify. However, the cost of controlling the plant in the UK has been estimated at between €1.45 and €3 million based on the treatment of 500 sites over a period of 2–3 years (Leach and Dawson 1999, Williams <i>et al.</i> , 2010).
4.06	How important is environmental harm caused by the organism within its global distribution?	MAJOR	VERY HIGH	<i>Crassula helmsii</i> has a very negative effect on water bodies, out-competing the indigenous vegetation and removing habitat for various animal species, mainly invertebrates (Dawson and Warman 2007 as cited in GB Non-Native Species Secretariat 2011).
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.	MODERATE	VERY HIGH	To date, this has been minimal as a result of the limited distribution of the plant in the region. However, in the Grand Canal at Lullymore, native plant species have been locally extirpated by dense growths of <i>Crassula helmsii</i> (Caffrey <i>et al.</i> 2012; CAISIE 2013). There is also evidence to suggest that the plant altered macroinvertebrate communities and reduced species diversity at this location (Bulfin 2012), but further studies are required to elucidate this in more detail; and it may negatively influence the foraging behaviour of fish (e.g. Rudd [Bulfin 2012]). A conservationally important Natterjack Toad breeding pond near Lough Gill, Co. Kerry also came under threat recently from an extensive infestation of <i>Crassula helmsii</i> . As the Natterjack Toad is an EC Habitats Directive Annex 2 listed species, this required the initiation of control and remediation works to protect the habitat (Inland Fisheries Ireland 2012). Native plant species were also displaced at this site by <i>C.helmsii</i> .
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MAJOR	HIGH	If <i>Crassula helmsii</i> establishes in other suitable freshwaters in Ireland, detrimental impacts on biodiversity as outlined in answer to Question 4.07 are highly likely. There may also be implications for the classification of ecological status under the EU Water Framework Directive and the conservation status of certain species and habitats and under the EC Habitats Directive.

Stage 2 - Detailed assessment: Section D - Impact

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.09	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	MODERATE	MEDIUM	Deemed moderate due to its relatively limited occurrence in Ireland. Refer to Question 4.07 for an outline on the alteration to habitat and impact to native species caused by <i>Crassula helmsii</i> . There is a paucity of information available to elucidate the impact of this invasive species on nutrient cycling and trophic interactions in Ireland.
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	Any further spread of <i>Crassula helmsii</i> in Ireland will likely see similar impacts on ecosystem function to those already observed, with the local extirpation of native plant species the most discernible impact observed (refer to Questions 4.07 , 4.08 and 4.09 for more information).
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.	MINOR	HIGH	There has been no decline in official conservation status to date in Ireland likely as a result of the relatively limited occurrence of <i>Crassula helmsii</i> in the country. However, the invasion of <i>Crassula helmsii</i> in the Grand Canal poses a potential threat to its conservation status under its designation as a proposed Natural Heritage Area (pNHA). In addition, its recent discovery in Lough Corrib, an SAC, also poses a potential threat to overall Water Framework Directive (WFD) ecological status and to conservationally important EC Habitats Directive Annexe I habitat i.e. <i>Chara</i> spp. present in the lake. Further to this, the extensive establishment of the plant in a Natterjack toad breeding pond near Lough Gill, Co. Kerry, has posed a direct threat to the conservation of this EC Habitats Directive Annex 2 listed species (Inland Fisheries Ireland 2012).
4.12	How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?	MAJOR	HIGH	There is a strong likelihood based on known impacts in other jurisdictions (e.g. Britain) that future invasions of <i>Crassula helmsii</i> will result in substantial detrimental impacts to native habitats and species in Ireland. This may result in the downgrading of ecological status under the WFD and have implications for Natura 2000 sites (e.g.in the Grand Canal [a pNHA] and Lough Corrib [SAC]) should a significant expansion in its range occur.
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?	MINIMAL	HIGH	

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
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	MINIMAL	HIGH	
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	VERY HIGH	Highly unlikely - there is no evidence for this.
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)?	MINIMAL	VERY HIGH	
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	VERY HIGH	
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?	MINIMAL	HIGH	<i>Crassula helmsii</i> is not naturally controlled by any predator, parasite or pathogen in Ireland.
4.19	Indicate any parts of Ireland 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.		HIGH	As stated previously, many freshwaters in Ireland are suitable for the establishment of this organism as it has a wide tolerance of environmental conditions. It is highly likely that impacts similar to that seen in the Grand Canal (near Lullymore) and abroad (e.g. in Britain) will occur.
4.20	Estimate the overall potential impact of this organism in Ireland and Northern Ireland. Use the justification box to indicate any key issues.	MAJOR	VERY HIGH	Its wide environmental tolerance and the experience of the invasion of <i>Crassula helmsii</i> in the Grand Canal (where a 2.2 km section of the waterway became heavily infested requiring extensive and costly control [Caffrey <i>et al.</i> 2012]) clearly indicate that this invasive species has the potential to cause significant ecological, environmental and socio-economic impacts should it become established in other freshwaters in Ireland.

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 and 4.20).	MAJOR	VERY HIGH	This non-native species poses a major risk to native biodiversity, native ecosystems and conservation goals as well as having the potential to cause negative socio-economic impacts due to its capacity to spread rapidly and establish dense infestations.

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?		LOW	<i>Crassula helmsii</i> has a wide temperature tolerance in its native and introduced ranges (from -6 C to 30 C). It is largely confined to areas that have levels of precipitation from 200 to 3000 mm in winter (May-October) and 100 to 550 mm in summer (November-April). It can survive extended periods of desiccation and under snow (reviewed in EPPO 2007). Therefore, climate change in the foreseeable future is not anticipated to have a significant effect on this plant in Ireland. This is supported by global climate and regional environmental niche modelling which both project that there will be little change in the suitable range for <i>Crassula helmsii</i> in the island of Ireland by 2080 (based on the International Panel on Climate Change high emissions climate change scenario) (Kelly <i>et al.</i> 2014).
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	100	LOW	This is because as stated above, climate change in the foreseeable future is not considered to have a significant effect on this plant in Ireland.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change?		MEDIUM	None.
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.			Some research on the control and ecological impacts of <i>Crassula helmsii</i> has been carried out by Inland Fisheries Ireland and by other research bodies since it was discovered (e.g. Caffrey <i>et al.</i> 2012; Millane <i>et al.</i> 2012; CAISIE 2013). This research has been used in compiling the risk assessment for this species. Further research on the effects of the plant on native biodiversity and ecosystem function in Ireland would strengthen this risk assessment.

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