GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

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	Name of Organism:	***Crassula helmsii*** **(Swamp Stonecrop, New Zealand Pygmy Weed, Crassula) previously known as *Tillaea***
	Objectives:	Assess the risks associated with this species in GB
	Version:	FINAL 22/03/11

N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk		Request made by GB Programme Board
2	What is the Risk Assessment area?	Great Britain	
3	Does a relevant earlier Risk Assessment exist?	YES (Go to 4)	EPPO 2006
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTLY VALID OR NOT VALID (Go to 5)	Partly valid - completed for the whole EPPO region, not specifically GB.
A	**Stage 2: Organism Risk Assessment SECTION A: Organism Screening**		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES (Give the full name & Go to 7)	*Crassula helmsii* Kirk (Cockayne). There is no evidence or suggestion that there is any other closely related alien taxon in the UK. However, there are other *Crassula* species that could be introduced into the UK and surveillance should be undertaken to check for these. There is a *Crassula* species, *C. aquatica* that is very rare (last seen in the River Shiel in 1969) that may be native or may be alien (Preston *et al.* 2002; Wiggington 1999).
6	If not a single taxonomic entity, can it be redefined?		
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	NO or Uncertain (Go to 8)	In the antipodes, *C. helmsii* is not a weed species (Dawson 1991a). If this means introduced range, then yes, it is invasive.
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?	YES or UNCERTAIN (Go to 9)	Vegetative propagation from fragments of the plant gives the plant the capacity to spread and colonise new water bodies (Dawson & Warman 1987). With its high rapid growth rate, the plant can overgrow and smother native plant populations once propagules have arrived and the colony has established. It also has the ability to colonise both aquatic and terrestrial habitats, which increases its impact.
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	*C. helmsii* is found in a wide range of aquatic habitats outside of ornamental ponds and water features (Dawson & Warman 1987). The plant can also be a contaminant of other plants for sale in Garden Centres (Gardening Which?).
10	Is the organism widely distributed in the Risk Assessment area?	NO (Go to 11)	The distribution of *C. helmsii* is shown by Preston *et al* . (2002). It is widely distributed, being found in excess of 2,000 sites, but not at the limit of its range as specified in the comments.
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	There have proved to be many such suitable habitats.
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	NO (Go to 14)	Given that *C. helmsii* can reproduce vegetatively, pollination is not essential for maintaining a population and hence there is no reliance on any species or range of species.
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.		
14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?	YES (Go to 16)	The climate in the Risk Assessment area is largely similar to the present area of distribution. *C. helmsii* is already established across the UK. In the southern hemisphere, *C. helmsii* is present in areas that have levels of precipitation from 100-550 mm in summer (November - April) and 200-3000 mm in winter (May - October). Its temperature requirements are restricted to a summer range of 20-25°C and a winter range of 0-15°C including extended periods under snow. The plant forms a 100% cover and is winter green, enabling it to outpace native species which die back each winter (Invasive Aliens in Northern Ireland). There is no dormant period. In its native range it inhabits a wide range of climatic variation, from a mean temperature of 30°C in summer to -6°C in winter; the plant is resistant down to - 6°C (EPPO).
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?		It could invade aquaculture and used to be found as a contaminant of nursery/greenhouse grown aquatic ornamentals. The author has not seen examples of this recently.
16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	YES (Go to 17)	Dawson (1994) describes how *C. helmsii* entered and established viable populations in new areas outside its original range.
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	*C. helmsii* mainly reproduces vegetatively (the ability for seed to germinate is unknown). Plant parts and turions (even single nodes of 10 mm of stem fragments) can generate new plants and are transported by natural vectors (e.g. attached to the bodies of waterfowl or by or in mud). It can also be spread via human vectors (e.g. aquarium/garden centre trade). It is very competitive and can form monospecific stands. The rate of spread is described by Dawson and Warman (1987) and can be seen by comparing the distribution map in Dawson (1994) with that in Preston *et al* . (2002). There has been a voluntary withdrawal from retail and the plant is not generally available for sale but the impact of this is not known. Precise information on the trade of this plant is lacking but it does not seem to be traded in huge quantities (EPPO). The Ornamental Aquatic Trade Organization (OATA) and the Royal Horticultural Society recommend to their members that the plant should not be sold anymore. The marginal trade of this plant would neither justify nor balance these costs.
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?	YES OR UNCERTAIN (Go to 19)	*C. helmsii's* environmental impact is massive. Mats formed by the plant choke ponds and drainage ditches. Strongly invaded waters lose their attractiveness for recreation and the mats can be dangerous to pets, livestock and children who mistake them for dry land (EPPO, but author not aware of any such instances in the UK). Loss of biodiversity is also reported. Dense mats formed by this species reduce the conservation value by the reduction or displacement of native and occasionally rare species. Large stands have the propensity to impede water flow, and biomass production in artificial stream systems is even greater than for *Elodea canadensis,* which is also known as a very invasive plant (Dawson and Warman, 1987), highlighting the potential for this plant to colonize river systems (Leach and Dawson, 1999).

19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B	SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences			
	Probability of Entry	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	very many - 4	HIGH -2	*C. helmsii* has been spread by the following pathways: through the water plant trade (nursery to garden centre (or other outlet) to garden ponds/ornamental ponds etc. and from there into the countryside (also transported as fragments inadvertently caught up with other water plants for sale), and moved from water body to water body on boats, canoes etc.; likewise for angling equipment; natural spread by animals, e.g. birds such as Canada Goose.
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	Water plant trade		
1.3	How likely is the organism to be associated with the pathway at origin?	very likely - 4		
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	very unlikely - 0	LOW - 0	*C. helmsii* is a popular water plant for ponds etc. and garden centres used to have large stocks. This situation has been changing as awareness has been raised in the water plant trade of the undesirable and invasive nature of *C. helmsii* (pers. comm. J. Newman, CEH) and hence the concentration at origin has decreased. EPPO report that according to CDG airport custom database, on average, 30 consignments of aquatic plants (presumably *C. helmsii* - EPPO does not make clear) arrived per month. The quantity of plants varied from 100 to 7,500 plants per consignment and the volume was considered to be major (no dates given).
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4		
1.6	How likely is the organism to survive or remain undetected by existing measures?	moderately likely - 2	MEDIUM -1	Assuming this question relates to the intention by nurseries rearing water plants to stop transporting *C. helmsii,* they would have to check their plants for contamination by *C. helmsii.* Given its ability to grow from fragments of stem and its overall persistence, this would be challenging.
1.7	How likely is the organism to survive during transport /storage?	very likely - 4	LOW - 0	See comment for 1.6.
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	very likely - 4	LOW - 0	See comment for 1.6.
1.9	What is the volume of movement along the pathway?	moderate - 2	MEDIUM -1	Given the transition from no restriction on sales of *C. helmsii* to a recognition of its problematic nature, sales and hence transportation have decreased.
1.10	How frequent is movement along the pathway?	often - 3	MEDIUM -1	The import of water plants for sale in the UK from such countries as the Netherlands is a busy trade and during the season (April/May to August/September), it will be regular and of high volume.
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	very widely - 4	LOW - 0	Most garden centres sell or used to sell *C. helmsii* and this would be the case across the UK.
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	very likely - 4	LOW - 0	See comment for 1.10.
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	moderately likely - 2	LOW - 0	The most likely means of transfer to a suitable habitat is by pond owners and managers transferring the plant from their pond to another water body. This could be to dispose of the weed itself or it being transferred with other species, e.g. frog spawn or fish.
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	moderately likely - 2	MEDIUM -1	This answer is based on the frequency with which the species has been found in new locations.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	similar - 3	LOW - 0	See Dawson and Warman (1987).
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	similar - 3	LOW - 0	Conditions are very similar in the Risk Assessment area (see Dawson and Warman (1987). Information on herbivores and pathogens is limited.
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	very many - 4	LOW - 0	*C. helmsii* grows on damp ground from 0.5 m above water level down to depths of 3 metres under water. *C. helmsii* has been found in ponds and lakes with natural water chemistry ranging from acid to alkaline and the plant has also been recorded in semi-saline sites (Dawson and Warman 1987). Information on herbivores and pathogens is limited.
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	LOW - 0	There is a wide range of suitable habitats available for this species across the Risk Assessment area (see Dawson and Warman 1987).
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	N/A	LOW - 0	As *C. helmsii* spreads by vegetative means, pollinators are considered non-essential.
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	moderately likely - 2	MEDIUM -1	Prior to its arrival in the UK, it would have been difficult to predict how well it would compete with other aquatic plants. Given that it can grow as an amphibious species, the ability to survive periods of drying out and drawdown give the plant a distinct advantage.
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	very likely - 4	LOW - 0	Waterfowl apart, there are no herbivores that could impact seriously on the plant. Information on pathogens is not known but it would be reasonable to suppose that pathogens are unlikely in the Risk Assessment area.
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	very likely - 4	LOW - 0	Management often involves either raking or cutting, breaking up the *Crassula* plants and aiding spread.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	very likely - 4	LOW - 0	Herbicide control could be effective (subsequently found to be difficult to achieve). Mechanical control is likely to exacerbate the problem and, Grass Carp apart, the plant has not been considered for biological control.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	widespread - 4	LOW - 0	Where water plants are reared or sold it was very common, though it is now less commonly found.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	LOW - 0	Vegetative reproduction.
1.26	How likely is it that the organism's capacity to spread will aid establishment?	very likely - 4	LOW - 0	*C. helmsii* can be spread by a fragment of the plant (Dawson 1994).
1.27	How adaptable is the organism?	very adaptable - 4	LOW - 0	See Dawson and Warman (1987).
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	very likely - 4	LOW - 0	Before its rapid spread around the UK and its maintenance of high vigour, this would have been predicted on the basis of other species with similar life form, *Elodea canadensis, Hydrilla verticillata* and *Lagarosiphon major* (elsewhere in world).
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	few - 1	MEDIUM -1	*C. helmsii* is spreading elsewhere in Europe and now in the south-east states of the USA.
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	very likely - 4	LOW - 0	The large number of sites, many with no management, would make control difficult. It has been very difficult to eradicate the plant even from a single site, partly because it is difficult to kill and partly because in so doing it may be necessary to kill everything else.
1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	N/A	LOW - 0	*C. helmsii* has established itself all over the UK and it is here to stay.
	Spread	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	rapid - 3	LOW - 0	Relative to other plant species, *C. helmsii* spreads rapidly.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	rapid - 3	LOW - 0	National distribution through Garden Centres (Gardening Which?).
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	very difficult - 4	LOW - 0	It might be possible to prevent spread into areas currently free of the species by stopping the import and sale of *C. helmsii.* It is not known over what distances natural dispersal can be affected.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.			All freshwater habitats except those with medium to high flow (Dawson & Warman 1987).

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	Economic loss is primarily as a result of maintenance required for flood risk alleviation.
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	moderate - 2	MEDIUM -1	Management of the pest is very expensive: one recent estimate puts the cost of control of *C. helmsii* at between 1.45 and 3 million Euros, based on the treatment of 500 sites over a period of 2-3 years (Leach and Dawson, 1999).
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	minimal - 0	LOW - 0	The plant is unlikely to affect producer profits.
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	minimal - 0	LOW - 0	The plant causes minimal reduction in consumer demand.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	very unlikely - 0	LOW - 0	Unaware of any loss in export markets as a result of the plant.
2.10	How important would other economic costs resulting from introduction be? (specify)	moderate - 2	LOW - 0	If there was a concerted effort to deal with *C. helmsii* there would need to be substantial research and planning and coordination.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	major - 3	LOW - 0	*C. helmsii* 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 1987).
2.12	How important is environmental harm likely to be in the Risk Assessment area?	major - 3	LOW - 0	It causes major problems in nature reserves and recreation areas. It forms a 100% cover and smothers other plants. The impact on flora is not easily predictable. A study in North West England suggests that there is no net reduction in the numbers of plant species, but there is a reduction of germination rates of native species, an increase in the proportion of emergent or marginal species and a reduction in aquatic species of open water. Smaller marginal plants such as some water Callitriche spp. seem bound to be smothered, and competition for space seems likely to cause a reduction in green algae of the class Charophyceae. The rare starfruit Damasonium alisma, one of the rarest plants in UK, is thought to be threatened by C. helmsii (Watson, 2001). Moreover, Leach and Dawson (1999) state that in an artificially managed lake (Priors Down Lake, Stalbridge, Dorset), evidence suggests changes in floral dominance, with C. helmsii excluding Ludwigia palustris and Galium debile (Dawson and Warman 1987). A recent investigation at a well-monitored pond on Castlemorton Common Site of Special Scientific Interest, near Malvern in Worcestershire (England) found evidence that it was also affecting the breeding success of the specially protected great crested newt Triturus cristatus. The pond also supported breeding populations of smooth newt Triturus vulgaris, palmate newt Triturus helveticus and common frog Rana temporaria (Watson, 1999). There are other possible consequences for wildlife. One study in England has shown a significant reduction in the population of the diatom Synedra delicatissima caused by C. helmsii, although the precise mechanism of this impact is unclear. Since freshwater algae provide food for many invertebrates, this kind of effect may have a serious impact on freshwater invertebrate populations. One recent estimate puts the cost of control of C. helmsii at between 1.45 and 3 million Euros, based on the treatment of 500 sites over a period of 2-3 years (Leach and Dawson, 1999). [EPPO 2006] C. helmsii has still the potential to spread to a large number of water bodies many of which are of high biodiversity value, e.g. more Lake District lakes, Scottish lochs and the Welsh lakes (Snowdonia, Anglesey etc.).
2.13	How important is social and other harm caused by the organism within its existing geographic range?	minor - 1	LOW - 0	Overall, it is of minor harm although significant disruption occurs to angling and other water based recreation.
2.14	How important is the social harm likely to be in the Risk Assessment area?	minor - 1	LOW - 0	The plant is unlikely to be anything other than of minor importance.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	very unlikely - 0	LOW - 0	There are no closely related species that could be so affected. *C. aquatica* has not been recorded for a number of years.
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	very likely - 4	LOW - 0	None has been observed since the plant's arrival (Dawson 1991a). Although there is no active research underway for a bio-control agent, CABI Bioscience are planning a quick survey in New Zealand and Australia (perhaps including Tasmania) in late November 2009, or at least to set up the necessary collaborations with CABI's current contacts in the antipodes. Prospects for a bio-control agent are uncertain as it appears that nobody has looked for natural enemies and the plant is not well known in this region. Being both submerged and emergent presents challenges as the plant could be protected from a herbivore that is terrestrial and vice versa.
2.17	How easily can the organism be controlled?	very difficult - 4	LOW - 0	Chemical control is most likely means of control but the range of herbicides available is restricted (Dawson 1989a; Dawson & Henville 1991) and diaquat is no longer available.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	very unlikely - 0	LOW - 0	Chemical control on a repeated basis is damaging to other plants, most of which are more sensitive to the herbicide than *C. helmsii* , but it is unlikely that there will be biological control systems present where *C. helmsii* is a problem. Other solutions including the use of plastic sheeting/geotextiles to block light and infilling of ponds are also very destructive to existing habitats and species.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	unlikely - 1	LOW - 0	None reported.
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur			High profile water bodies either in terms of angling, flood risk or other water users.

Summarise Entry	very likely - 4	LOW - 0	Water plant trade; disposal of excess plant growth; natural means.
Summarise Establishment	very likely - 4	LOW - 0	Vegetative spread and adaptability to different types of water bodies.
Summarise Spread	rapid - 3	LOW - 0	Still and slow flowing water bodies across the UK.
Summarise Impacts	major - 3	LOW - 0	Impact on biodiversity followed by flood risk, angling and other water users.
Conclusion of the risk assessment	HIGH -2	LOW - 0	The high volume of plant trade has guaranteed that the plant has been imported widely into the UK. Its ability to grow from fragments of stem has enabled it spread from ponds and ornamental pools etc. into the wild. It is very difficult to control, hence there has been no check on its spread. Resistance to restrictions on sale of the plant by the plant trade have exacerbated the problem.
Conclusions on Uncertainty		LOW - 0	*C. helmsii* is well studied and the information on which the assessment is based is sound. Further investigation is needed to understand in more detail how the plant is dispersed in the wild. Research is badly needed into effective means of control that have minimal collateral damage.

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