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| | European and Mediterranean Plant Protection Organisation | | |
| | Organisation Européenne et Méditerranéenne pour la Protection des Plantes | | |
| | | | 06-12703 FINAL |
| | **Guidelines on Pest Risk Analysis** | | |
| | **Lignes directrices pour l'analyse du risque phytosanitaire** | | |
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| | **Decision-support scheme for quarantine pests** | | |
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| **PEST RISK ANALYSIS FOR CRASSULA HELMSII** | | | |
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| **Pest risk analyst:** | | | |
| **Kirsten van der Krabben, Gritta Schrader**<br>**Panel on IAS** | | | |
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| **May 2006**<br>**Editorial modifications by EPPO Secretariat 2007-01** | | | |
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| **Stage 1: Initiation** | | | |
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| **1 What is the reason for performing the PRA?** | | Identification of a single pest | |
| **2 Enter the name of the pest** | | | *Crassula helmsii* (Kirk) Cockayne |
| **2A Indicate the type of the pest** | | plant | |
| **2B Indicate the taxonomic position** | | | Plantae - Crassulaceae |
| **3 Clearly define the PRA area** | | | EPPO region |
| **4 Does a relevant earlier PRA exist?** | | yes | For the Netherlands (van der Kraben and Schrader, 2005) |
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| **Stage 2A: Pest Risk Assessment - Pest categorization** | | | |
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| **5A If you are sure that the pest clearly presents a risk, or that in any case a full Pest Risk Assessment is required, you can omit this section and proceed directly to the main Pest Risk Assessment section.** | Go to main Pest Risk Assessment | |
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| **Section 2B: Pest Risk Assessment - Probability of introduction/spread and of potential economic consequences** | | |
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| **Note: If the most important pathway is intentional import, do not consider entry, but go directly to establishment. Spread from the intended habitat to the unintended habitat, which is an important judgement for intentionally imported organisms, is covered by questions 1.33 and 1.35.** | Go to section on establishment (intentionally imported organism) | |
| **1.2 Note down the relevant pathways, then estimate the total number of distinct pathways, by multiplying the number of relevant pathways by the number of relevant origins and the number of relevant end uses.** | Very few | - The main pathway is intentional introduction for ornamental purposes for garden ponds and aquaria.<br>This plant is not recorded in the Plant finder index, and according to the PPP index, it is only traded in 16 nurseries. The volume of trade is though to be minimal. Nevertheless, introduction for ornamental purposes in the UK and the Netherlands has led to invasions. The probability of entry for this pathway is not evaluated further.<br>- Unintentional introduction: *C. helmsii* is often found as a "contaminant" with other traded water plants (Environment Agency).<br>- Unintentional introduction: carried downstream along waterways from country to country and possibly upstream attached to boats<br>The probability of entry for this pathway is not evaluated further. |
| | | **Contaminant of other traded water plants.** |
| **1.4 Is the prevalence of the pest on the pathway at origin likely to be high, taking into account factors like the prevalence of the pest at origin, the life stages of the pest, the period of the year?** | Moderately likely | There are 2 possibilities:<br>- *C. helmsii* is cultivated in nurseries and is likely to contaminate other plants in the same nursery. It is all the more likely given that nurseries are usually specialised, and many aquatic plants will be produced in the same nursery.<br>- *C. helmsii* is invasive in the wild and might contaminate other plants in the |

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| | | nursery.<br>Water plants could be contaminated, even in countries where the plant is not recorded.<br><br>Plants are supposed to be produced under protected conditions (basins) and not in natural areas that could be infested. This pathway will not be considered further.<br><br>Nodes or turions will be the contaminants, seed germinability is unkown. |
| **1.5 Is the prevalence of the pest on the pathway at origin likely to be high, taking into account factors like cultivation practices, treatment of consignments?** | likely | There is no available treatment for the consignment.<br>Different plants may be produced in the same containers, thus other water plants may be very easily contaminated by turions or fragments which could adhere to the roots or packing of these other plants. |
| **1.6 How large is the volume of the movement along the pathway?** | major | According to CDG airport custom database, on average 30 conisgnements of aquatic plants arrive per month. The quantity of plants may vary from 100 to 7500 plants per consignments. The volume is therefore considered to be major. |
| **1.7 How frequent is the movement along the pathway?** | very frequent | According to CDG airport custom database, there are on average 30 consignments of aquatic plants per month, every month of the year. |
| **1.8 How likely is the pest to survive during transport /storage?** | very likely | The nodes or turions will remain viable. Since aquatic plants are usually transported by air over short time. |
| **1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?** | unlikely | Nodes or turions would not have enough time to grow (see previous answer). |
| **1.10 How likely is the pest to survive or remain undetected during existing phytosanitary measures?** | likely | Even if the EU legislation requires that all plants for planting, including aquatic plants, should be accompanied by a Phytosanitary Certificate, there are no specific requirements related to *C. helmsii*. There is no phytosanitary regulation for countries from the former USSR. |
| **1.10A Is the pathway being considered a commodity pathway, or natural spread?** | commodity pathway | |
| **1.11 How widely is the commodity to be distributed throughout the PRA area?** | widely | All 47 EPPO countries are likely to import aquatic plants. |
| **1.12 Do consignments arrive at a suitable time of year for pest establishment?** | yes | *C. helmsii* could regenerate at any time from nodes or turions and is resistant down to -6°C. |

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| **1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?** | likely | Aquatic plants are intended to be transferred to ponds or gardens.<br>If used for aquaria, used water can be released in natural habitats allowing the plant to escape. |
| **1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?** | likely | See previous answer. |
| **1.15 Do other pathways need to be considered?** | No | |
| **The overall probability of entry should be described and risks presented by different pathways should be identified.** | Very high | - The main pathway is intentional introduction as ornamental plants.<br>- The plant can also be a contaminant of other aquatic plants when produced in a nursery, and enter unintentionally the country. |
| **1.16 Specify the host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants) present in the PRA area.** | | This aquatic plant colonizes inland wetlands (marshes, peat bogs), coastal wetlands, continental waters (water courses, water bodies), banks of continental water, riverbanks / canal sides (dry river beds) and muddy margins of ponds. Within its native range, *C. helmsii* inhabits marginal situations in many riverine situations, however within the United Kingdom the plant has not effectively made the transition from static or slow flowing systems to more demanding habitats such as river margins. |
| **1.17 How widely distributed are the host plants or suitable habitats in the PRA area? (specify)** | very widely | Wetlands of the entire EPPO region are suitable habitats. |
| **1.18 If an alternate host is needed to complete the life cycle, how widespread are alternate host plants in the PRA area?** | irrelevant | No host needed. |

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| **1.19 Does the pest require other species for critical stages in its life cycle such as transmission, (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers) ?** | no | |
| **1.19A Specify the area where host plants (for pests directly affecting plants) or suitable habitats (for non parasitic plants) are present (cf. QQ 1.16-1.19). This is the area for which the environment is to be assessed in this section. If this area is much smaller than the PRA area, this fact will be used in defining the endangered area.** | | C*. helmsii* is suited to a wide variety of freshwater habitats.<br>These habitats occur throughout the whole EPPO area. |
| **1.20 How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the area of current distribution?** | largely similar | *C. helmsii* is already established in several EPPO countries. 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. 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 (University of Liverpool).<br><br>No information is available to assess survival capacity in extreme conditions (eg. very cold conditions, very hot conditions). |
| **1.21 How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?** | largely similar | *C. helmsii* is already established in several EPPO countries. It 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 (CEH Dorset). |
| **1.22 If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?** | irrelevant | Not relevant. |

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| **1.23 How likely is establishment to be prevented by competition from existing species in the PRA area?** | unlikely | 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.<br>Studies have shown that biomass production in artificial stream systems is even greater than for *Elodea canadensis* known as a very invasive plant (Dawson and Warman, 1987), highlighting the potential for this plant to colonize river systems (Leach and Dawson, 1999). |
| **1.24 How likely is establishment to be prevented by natural enemies already present in the PRA area?** | unlikely | No natural enemy has been identified in the part of the PRA area where the plant is already established. There are no known control agents for this plant.<br>It can be eaten by grass carp when the infestation is small, but *C. helmsii* is not its preferred food (Dawson and Warman 1987). Dense infestations cause severe fluctuations in dissolved oxygen contents of the water and the fish will not survive (CEH Centre for Aquatic plant Management). |
| **1.25 To what extent is the managed environment in the PRA area favourable for establishment?** | Highly favourable | Managed environments such as artificial canals and ponds are highly favourable to the plant. |
| **1.26 How likely are existing control or husbandry measures to prevent establishment of the pest?** | Very unlikely | There are no existing control or husbandry measures that will prevent establishment. Some EPPO countries have monitoring programme for aquatic ecosystems but such programmes have not prevented the establishment of the plant. |
| **1.27 How likely is it that the pest could be eradicated from the PRA area ?** | unlikely | The plant reproduces vegetatively very efficiently, eradication is very difficult for small infestations and almost impossible in water bodies with heavy infestations.<br>It would be possible to eradicate it if measures are taken at a very early stage. This implied regular monitoring in wetlands.<br>For instance, it may be still possible to eradicate it where it is locally present: Belgium, Denmark, France. In Germany and in the Netherlands, it is already spreading. In England, it seems too widespread to be eradicated, it can only be managed. |

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| **1.28 How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?** | very likely | Dispersal is mainly ensured by vegetative reproduction. Small fragments (as small as a single node on 10 mm of stem) can produce new plants. These small fragments are readily transported by water, mud or by wildlife to new sites. In addition, asexual reproduction is achieved via the production in autumn (in UK) of short shoots with very short internodes called turions. The turions are produced apically, and float around the water surface. *C. helmsii* has the ability to produce roots and lateral shoots from many of its nodes, particularly when stressed.<br>*C. helmsii* occurs in different growth-forms (Dawson & Warman, 1987).<br>The plant assimilates $CO_2$ for 20 hours of the day when submerged due to the possession of crassulacean acid metabolism and can therefore grow throughout the year (CEH Centre for Aquatic Plant Management). There is no dormancy period. Such a metabolic adaptation confers an advantage on plants growing where the supply of inorganic carbon for photosynthesis is deficient or limited during the day (Dawson & Warman, 1987). |
| **1.29 How likely are relatively small populations or populations of low genetic diversity to become established?** | very likely | Studies of genetic variation of isoenzymes suggest that only one introduction occurred in Britain, and that plants growing along the River Murray are the likely source of the British population (Dawson, 1994). |
| **1.30 How adaptable is the pest? Adaptability is:** | high | The distribution of *C. helmsii* in Australia and Europe shows that the species is suited to a wide variety of freshwater habitats. The species is also widespread in the USA and in New Zealand. |
| **1.31 How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances, if possible)** | often | *C. helmsii* is a native species of Australia and New Zealand and is reported to be invasive or potentially invasive in Florida and North Carolina. *C. helmsii* is locally present in Belgium, Denmark, France, Germany, the Netherlands. *C. helsmii* is widespread in the United Kingdom. It has always been intentionally introduced.<br>It has been introduced in 2 continents in the other hemisphere from its area of origin. |
| **1.32 Even if permanent establishment of the pest is unlikely, how likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment) ?** | very likely | Permanent establishment is possible. |
| **1.33 How likely is the pest to spread rapidly in the PRA area by natural means?** | likely | Local dispersal is mainly ensured by vegetative reproduction. Plant parts and turions (even single nodes of 10 mm of stem fragments) can generate new plants and are transported by waterflow and mud. It can also be spread attached to animals (cattle) and |

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| | | possibly transported by wading birds but this remains unproven. |
| **1.34 How likely is the pest to spread rapidly in the PRA area by human assistance?** | very likely | The plant can be accidentally dispersed by human activities by escaping from garden centres, by transfer from pond to pond by anglers and their equipment (on fishing kit, waders etc.), by boats and gears, by children pond dipping (Leach and Dawson, 1999) and on people's boots. (Watson, 2001).<br>Human activities are the major factor of spread. |
| **1.35 How likely is it that the spread of the pest could be contained within the PRA area?** | unlikely | In most EU countries, as for instance in Germany and the Netherlands, herbicide application in aquatic environments/biotopes is generally prohibited. Attempts to control *C. helmsii* by cutting or clearing failed (in the UK as well as in first trials in the Netherlands) because, inevitably, fragments were left behind and were able to regenerate. |
| **The overall probability of introduction and spread should be described. The probability of introduction and spread may be expressed by comparison with PRAs on other pests.** | Very high | The plant has already entered the PRA area and is established.<br>*C. helmsii* has been introduced intentionally as an ornamental plant and is still for sale in Europe. The introduction to areas of the EPPO region where it is currently not present is very likely.<br>The plant has shown ability to spread, as for instance in the UK.<br>The plant is spread both by natural means (see 1.33) and with human activities over long distances (see 1.34).<br>The probabilities of introduction and spread are very high. |
| **1.36 Based on the answers to questions 1.16 to 1.35 identify the part of the PRA where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.** | | *C. helmsii* has broad climatic amplitude (it occurs in Australia, New Zealand and has established in USA and in several European Countries (Belgium, France, Germany, the Netherlands and United Kingdom).<br>It can be assumed that wetlands, slow-flowing or standing freshwater (e.g. ponds, lakes, reservoirs, canals, ditches) of the EPPO region define the endangered area.<br>The endangered area is the whole EPPO area, with a question mark to the Mediterranean area and the Eastern part of the region. The plant is absent from these areas and we do not have enough information about how it could potentially behave there. |
| **2.0 For the following questions, will you be considering all hosts/habitats together or specific case(s)?** | All hosts/habitats together | |

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| **2.1 How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?** | minimal | The plant could affect irrigation ditches and canals and increase the production costs. |
| **2.2 How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area?** | minimal | The plant is not known to affect crops. |
| **2.3 How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?** | minor | The plant could affect irrigation ditches and canals and increase the production costs. |
| **2.4 How great a reduction in consumer demand is the pest likely to cause in the PRA area?** | No judgment | Not relevant. |
| **2.5 How important is environmental damage caused by the pest within its current area of distribution?** | massive | It causes major problems in nature reserves and recreation areas. It forms a 100% cover and smothers other plants.<br>The impact on flora is not easily predictable. A study in North West England suggests that there is no net reduction of 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.<br>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, *C. helmsii* excluding *Ludwigia palustris* and *Galium debile* (Dawson and Warman 1987).<br>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).<br>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 |

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| | | provide food for many invertebrates, this kind of effect may have a serious impact on freshwater invertebrate populations.<br><br>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). |
| **2.6 How important is the environmental damage likely to be in the PRA area (see note for question 2.5)?** | major | Same impacts as in the UK are expected in the PRA area, especially in the endangered area. |
| **2.7 How important is social damage caused by the pest within its current area of distribution?** | major | The mats formed by the plant choke ponds and drainage ditches. Strongly invaded waters lose their attractiveness for recreation and flooding may be caused. The mats can be dangerous to pets, livestock and children who mistake them for dry land. |
| **2.8 How important is the social damage likely to be in the PRA area?** | major | Same impacts as in the UK are expected in the PRA area, especially in the endangered area. |
| **2.9 How likely is the presence of the pest in the PRA area to cause losses in export markets?** | minor | *C. helmsii* is often found as a "contaminant" with other traded water plants (Environment Agency) But exports of aquatic plants are supposed to be low.<br>Need more information on the production of aquatic plants in the EPPO area. |
| **2.9A As noted in the introduction to section 2, the evaluation of the following questions may not be necessary if any of the responses to questions 2.2, 2.3, 2.4, 2.6 or 2.8 is "major or massive" or "likely or very likely". In view of these responses, is a detailed study of impacts required?** | no | |
| **2.15A Do you wish to consider the questions 2.1 to 2.15 again for further hosts/habitats?** | No | |

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| **2.16 Referring back to the conclusion on endangered area (1.36), identify the parts of the PRA area where the pest can establish and which are economically most at risk.** | likely | The habitats at risk are wetlands, slow-flowing or standing freshwater. Running waters could also potentially be invaded according to studies (Leach and Dawson, 1999).<br>The areas at risk is:<br>The plant is already present in Belgium, France, Germany, the Netherlands and is very invasive in United Kingdom. It is thought to be able to be invasive in Switzerland, Austria and the Czech Republic. It is considered potentially invasive in Denmark according to Nobanis.<br>There are question marks about survival of the plant under very cold winter conditions and dry and hot conditions. |
| **2.16A Estimation of the probability of introduction of a pest and of its economic consequences involves many uncertainties. In particular, this estimation is an extrapolation from the situation where the pest occurs to the hypothetical situation in the PRA area. It is important to document the areas of uncertainty and the degree of uncertainty in the assessment, and to indicate where expert judgement has been used. This is necessary for transparency and may also be useful for identifying and prioritizing research needs. It should be noted that the assessment of the probability and consequences of environmental hazards of pests of uncultivated plants often involves greater uncertainty than for pests of cultivated plants. This is due to the lack of information, additional complexity associated with ecosystems, and variability associated with pests, hosts or habitats.** | | - Volumes of trade of *C. helmsii* sold for ornamental purposes<br>- Volumes of other aquatic plants potentially contaminated.<br>- There are question marks about survival of the plant under very cold winter conditions and dry and hot conditions. |

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| **Evaluate the probability of entry and indicate the elements which make entry most likely or those that make it least likely. Identify the pathways in order of risk and compare their importance in practice.** | | The species has already entered the EPPO region.<br>The key pathway is its intentional introduction as an ornamental plant for aquaria and garden ponds.<br>Another pathway has been identified: the plant is unintentionally introduced as a contaminant of other aquatic plants.<br>Natural spread along water ways has also been identified. |
| **Evaluate the probability of establishment, and indicate the elements which make establishment most likely or those that make it least likely. Specify which part of the PRA area presents the greatest risk of establishment.** | | The species has already established in some parts of the EPPO region.<br>*C. helmsii* is able to survive in a variety of different aquatic habitats, acid to alkaline waters, even in semi-saline sites, on damp ground and in water down to depths of 3 m. In the Southern hemisphere, it can withstand a wide range of climatic variations: mean temperatures from 30°C in summer to –6°C in winter, precipitation levels from 100 - 550 mm in summer (November-April) to 200 – 3000 mm in winter (May-October).<br>Therefore, establishment of *C. helmsii* is very likely in many countries within the EPPO region. It is already established (Belgium, Germany, France) and invasive (the Netherlands, the United Kingdom) in the EPPO region.<br>Uncertainties remain on the survival of the plant under very cold winter conditions and dry and hot conditions. |
| **List the most important potential economic impacts, and estimate how likely they are to arise in the PRA area. Specify which part of the PRA area is economically most at risk.** | | - Loss of biodiversity: Dense mats formed by this species reduce the natural value of nature reserves among others by displacement of native (and rare) species.<br>- The mats formed by the plant choke ponds and drainage ditches. Strongly invaded waters lose their attractiveness for recreation and flooding may be caused. The mats can be dangerous to pets, livestock and children who mistake them for dry land.<br><br>Removal of *C. helmsii* from invaded waters is very costly and regular management costs will arise as well. The economic benefit of the introduction of this plant as an ornamental aquatic plant is outweighed by the loss of recreational and natural value of the area and by the high costs for control. |

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| **The risk assessor should give an overall conclusion on the pest risk assessment and an opinion as to whether the pest or pathway assessed is an appropriate candidate for stage 3 of the PRA: the selection of risk management options, and an estimation of the pest risk associated.** | | *Crassula helmsii* is already introduced in several countries in the PRA area and evidence shows that the species is able to establish in a variety of aquatic habitats to become a pest, thereby reducing the natural and recreational value of the area. Control is very difficult and expensive.<br>The overall conclusion is that *C. helmsii* is an appropriate candidate for stage 3 of the PRA. |

**Stage 3: Pest risk Management**

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| **3.1. Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combination an acceptable risk?** | no | |
| **Pathway 1** | | **Trade of the plant for ornamental purposes** |
| **3.28. Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?** | yes | • publicity<br>As the problem is huge in some EPPO countries (UK, The Netherlands), publicity should be produced to inform the public about the threats and encourage to report monitor/survey the area, report findings and to have good practices that will not allow the spread of the plant.<br><br>• monitoring/surveillance<br>Eradication and monitoring/surveillance should be organized where the plant is known to be present but not widespread (France, Belgium; Germany) and also where the plant is established (UK, The Netherlands).<br>Sites should be monitored regularly at intervals of 3-6 months for at least 5 years following an apparent elimination of *C. helmsii*. Treated and adjacent areas must be carefully examined for developing shoots or small buried rhizomes.<br>• emergency plan<br>o quick eradication response when the plant is found<br><br>• Management and containment where it is established<br>In the countries where it is widespread such as the UK and the Netherlands, the plant should be managed (identification of potential biological agents and experiments, mechanical control,…)<br>• declaration that *Crassula helmsii* is a quickly spreading alien invasive plant,<br>• obligations to report findings<br>• prohibition of planting<br>• prohibition of movement<br>• prohibition of sale<br>• prohibition of holding |

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| **3.29. Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?** | yes | see measures cited in 3.28 |
| **3.30. Taking each of the measures identified individually, does any measure on its own reduce the risk to an acceptable level?** | yes | Prohibition of import, trade, planting, holding and movement of the plant in the EPPO countries is the most efficient measure.<br><br>However, where the plant is established, there is a need to monitor and to manage it.<br>Possible management actions depend on the level of infestation (see 3.28) |
| **3.31. For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?** | no | The plant can not be managed if new individual plants are constantly re-introduced. |
| **3.33. Estimate to what extent the measures (or combination of measures) being considered interfere with trade.** | | Precise information on the trade of this plant is lacking. However, it does not seem to be traded in huge quantities. Other aquatic non-invasive plants could be proposed to substitute for this plant. The Ornamental Aquatic Trade Organization (OATA) and the Royal Horticultural Society recommend to their members that the plant should not be sold anymore. |
| **3.34. Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.** | | 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).<br>The marginal trade of this plant would neither justify nor balance these costs. |
| **3.35. Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with trade, are cost-effective and have no undesirable social or environmental consequences?** | yes | Eradication and monitoring/surveillance in the countries where it is present but not very widespread.<br><br>Management, monitoring/surveillance, publicity, obligation of reporting findings in the countries where it is invasive and widespread. |
| **3.36. Envisage prohibiting the pathway** | yes | Prohibition of import, trade, planting, holding and movement of the plant. Trade within the EPPO countries should also be prohibited. |
| **3.37. Have all major pathways been analyzed (for a pest-initiated analysis)?** | yes | |

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| **3.1. Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combination an acceptable risk?** | no | |

| Pathway 2 | | Contaminant of traded aquatic plants |
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| **3.2. Is the pathway that is being considered a commodity of plants and plant products?** | yes | |
| **3.10. Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest** | no | |
| **3.11. Can the pest be reliably detected by a visual inspection of a consignment at the time of export during transport/storage or at import?** | yes | When the plant is found as a contaminant of other aquatic plants it is likely to be as nodes or turions which can be very small and cannot easily be recognized. Visual inspection is not reliable. |
| **3.12. Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?** | no | Not relevant |
| **3.13. Can the pest be reliably detected during post-entry quarantine?** | no | Not realistic |
| **3.14. Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?** | no | Any treatment could also have an effect on the consignment imported. |
| **3.15. Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)** | no | Not relevant |
| **3.16. Can infestation of the consignment be reliably prevented by handling and packing methods?** | no | Very small nodes or turions of *C. helmsii* could be contaminants. These could not reliably be removed while packing the traded aquatic plants. |
| **3.17. Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?** | no | Even if only sold for aquaria, the plant could be released in nature and will be able to threaten the environment.<br>The plant is perennial and resists temperatures as low as -6°C. Whenever introduced, it has the ability to become invasive. |
| **3.18. Can infestation of the commodity be reliably prevented by treatment of the crop?** | no | If the treatment kills *C. helmsii*, it will also have a strong negative effect on the traded aquatic plant. |
| **3.19. Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)** | no | Not relevant. |

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| **3.20. Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions, sterilized growing medium...)?** | yes | Separated containers for aquatic species having the ability to regenerate vegetatively.<br>If ornamental aquatic plants were produced in separated containers where *Crassula helmsii* is absent, infestation of the commodity would be prevented. |
| **3.21. Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?** | no | *C. helmsii* has no dormancy period. Nodes or turions of the plant could contaminate at every time of the year. |
| **3.22. Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?** | yes | No certification scheme for aquatic plants known. |
| **3.23. Is the pest of very low capacity for natural spread?** | no | |
| **3.24. Is the pest of low to medium capacity for natural spread?** | no | |
| **3.25. Is the pest of medium capacity for natural spread?** | no | |
| **3.26. The pest is of medium to high capacity for natural spread** | yes | pest-free place of production,<br>or pest free area. |
| **3.27. Can pest freedom of the crop, place of production or an area be reliably guaranteed?** | no | |
| **3.28. Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?** | yes | Monitoring/surveillance of aquatic ecosystems and eradication when the plant is detected. |
| **3.29. Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?** | yes | pest-free place of production,<br>or pest free area<br>or plants grown in protected conditions |
| **3.30. Taking each of the measures identified individually , does any measure on its own reduce the risk to an acceptable level?** | yes | pest-free place of production<br>or plants grown in protected conditions |
| **3.31. For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?** | no | |
| **3.33. Estimate to what extent the measures (or combination of measures) being considered interfere with trade.** | yes | These measures will interfere with the production and trade of ornamental aquatic plants. |

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| **3.34. Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.** | | The costs of implementation of the suggested measures include costs for informing producers and applying the law. These measures are cost-effective regarding the environmental, social and management costs. |
| **3.35. Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with trade, are cost-effective and have no undesirable social or environmental consequences?** | yes | Pest-free place of production<br>or plants grown in protected conditions |
| **3.36. Envisage prohibiting the pathway** | no | |
| **3.37. Have all major pathways been analyzed (for a pest-initiated analysis)?** | yes | |
| **3.40. Indicate the relative importance of pathways** | | Trade of the plant for ornamental purposes: high risk<br>Contaminant of traded aquatic plants: high risk |
| **3.41. All the measures identified as being appropriate for each pathway or for the commodity can be considered for inclusion in phytosanitary regulations in order to offer a choice of different measures to trading partners.** | | |
| **3.42. In addition to the measure(s) selected to be applied by the exporting country, a phytosanitary certificate (PC) may be required for certain commodities. The PC is an attestation by the exporting country that the requirements of the importing country have been fulfilled. In certain circumstances, an additional declaration on the PC may be needed (see EPPO Standard PM 1/1(2): Use of phytosanitary certificates)** | | |
| **Conclusion of Pest Risk Management.**<br>**Summarize the conclusions of the Pest Risk Management stage. List all potential management options and indicate their effectiveness. Uncertainties should be identified.** | | **Intentional introduction as an ornamental plant**<br>Prohibited<br>(see also recommendations for internal measures)<br><br>**Unintentional introduction: "contaminant of other plants"**<br>The plants should be grown in protected conditions (separate containers)<br>Pest-free place of production<br>Pest-free area for *Crassula helmsii* |

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