6.1 Threat: Invasive plants
### 6.1 Threat: Invasive plants

#### 6.1.1 Floating pennywort *Hydrocotyle ranunculoides*

Based on the collated evidence, what is the current assessment of the effectiveness of interventions for controlling floating pennywort?

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beneficial</strong></td>
<td>• Chemical control using herbicides</td>
</tr>
<tr>
<td><strong>Likely to be beneficial</strong></td>
<td>• Flame treatment</td>
</tr>
<tr>
<td></td>
<td>• Physical removal</td>
</tr>
<tr>
<td><strong>Unknown effectiveness</strong></td>
<td>• Combination treatment using herbicides and physical removal</td>
</tr>
<tr>
<td><strong>(limited evidence)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Unlikely to be beneficial</strong></td>
<td>• Biological control using co-evolved, host-specific herbivores</td>
</tr>
<tr>
<td></td>
<td>• Use of hydrogen peroxide</td>
</tr>
<tr>
<td><strong>No evidence found</strong></td>
<td>• Biological control using fungal-based herbicides</td>
</tr>
<tr>
<td><strong>(no assessment)</strong></td>
<td>• Biological control using native herbivores</td>
</tr>
<tr>
<td></td>
<td>• Environmental control (e.g. shading, reduced flow, reduction of rooting depth, or dredging)</td>
</tr>
<tr>
<td></td>
<td>• Excavation of banks</td>
</tr>
<tr>
<td></td>
<td>• Public education</td>
</tr>
<tr>
<td></td>
<td>• Use of liquid nitrogen</td>
</tr>
</tbody>
</table>
Some Aspects of Control of Freshwater Invasive Species

Beneficial

- **Chemical control using herbicides**
  A controlled, replicated field study in the UK found that the herbicide 2,4-D amine achieved almost 100% mortality of floating pennywort, compared with the herbicide glyphosate (applied without an adjuvant) which achieved negligible mortality. *Assessment: beneficial (effectiveness 80%; certainty 70%).*

  http://www.conservationevidence.com/actions/1127

Likely to be beneficial

- **Flame treatment**
  A controlled, replicated study in the Netherlands found that floating pennywort plants were killed by a three second flame treatment with a three second repeat treatment 11 days later. *Assessment: likely to be beneficial (effectiveness 60%; certainty 50%).*

  http://www.conservationevidence.com/actions/1131

- **Physical removal**
  Two studies, one in Western Australia and one in the UK, found physical removal did not completely eradicate floating pennywort. *Assessment: likely to be beneficial (effectiveness 40%; certainty 40%).*

  http://www.conservationevidence.com/actions/1126

Unknown effectiveness (limited evidence)

- **Combination treatment using herbicides and physical removal**
  A before-and-after study in Western Australia found that a combination of cutting followed by a glyphosate chemical treatment, removed floating pennywort. *Assessment: unknown effectiveness (effectiveness 70%; certainty 35%).*

  http://www.conservationevidence.com/actions/1128
Unlikely to be beneficial

- **Biological control using co-evolved, host-specific herbivores**

  A replicated laboratory and field study in South America found that the South American weevil fed on water pennywort but did not reduce the biomass. *Assessment: unlikely to be beneficial (effectiveness 20%; certainty 50%).*

  [Visit](http://www.conservationevidence.com/actions/1123)

- **Use of hydrogen peroxide**

  A controlled, replicated study in the Netherlands found that hydrogen peroxide sprayed on potted floating pennywort plants at 30% concentration resulted in curling and transparency of the leaves but did not kill the plants. *Assessment: unlikely to be beneficial (effectiveness 10%; certainty 60%).*

  [Visit](http://www.conservationevidence.com/actions/1129)

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Biological control using fungal-based herbicides
- Biological control using native herbivores
- Environmental control (e.g. shading, reduced flow, reduction of rooting depth, or dredging)
- Excavation of banks
- Public education
- Use of liquid nitrogen

Visit [www.conservationevidence.com](http://www.conservationevidence.com) for full text and references
6.1.2 Water primrose *Ludwigia* *spp.*

| Likely to be beneficial | • Biological control using co-evolved, host specific herbivores  
|                         | • Chemical control using herbicides  
|                         | • Combination treatment using herbicides and physical removal |
| Unlikely to be beneficial | • Physical removal |
| No evidence found (no assessment) | • Biological control using fungal-based herbicides  
|                                    | • Biological control using native herbivores  
|                                    | • Environmental control (e.g. shading, altered flow, altered rooting depth, or dredging)  
|                                    | • Excavation of banks  
|                                    | • Public education  
|                                    | • Use of a tarpaulin  
|                                    | • Use of flame treatment  
|                                    | • Use of hydrogen peroxide  
|                                    | • Use of liquid nitrogen  
|                                    | • Use of mats placed on the bottom of the water body |

**Likely to be beneficial**

- **Biological control using co-evolved, host specific herbivores**

A controlled, replicated study in China, found a flea beetle caused heavy feeding destruction to the prostrate water primrose. A before-and-after study in the USA found that the introduction of flea beetles to a pond significantly reduced the abundance of large-flower primrose-willow.  

*Assessment: likely to be beneficial (effectiveness 60%; certainty 50%).*

http://www.conservationevidence.com/actions/1135
Chemical control using herbicides

A controlled, replicated laboratory study in the USA found that the herbicide triclopyr TEA applied at concentrations of 0.25% killed 100% of young cultivated water primrose within two months. A before-and-after field study in the UK found that the herbicide glyphosate caused 97% mortality when mixed with a non-oil based sticking agent and 100% mortality when combined with TopFilm. A controlled, replicated, randomized study in Venezuela, found that use of the herbicide halosulfuron-methyl (Sempra) resulted in a significant reduction in water primrose coverage without apparent toxicity to rice plants. Assessment: likely to be beneficial (effectiveness 80%; certainty 60%).

http://www.conservationevidence.com/actions/1139

Combination treatment using herbicides and physical removal

A study in the USA found that application of glyphosate and a surface active agent called Cygnet-Plus followed by removal by mechanical means killed 75% of a long-standing population of water primrose. A study in Australia found that a combination of herbicide application, physical removal, and other actions such as promotion of native plants and mulching reduced the cover of Peruvian primrose-willow by 85–90%. Assessment: likely to be beneficial (effectiveness 70%; certainty 55%).

http://www.conservationevidence.com/actions/1140

Unlikely to be beneficial

Physical removal

A study in the USA found that hand pulling and raking water primrose failed to reduce its abundance at one site, whereas hand-pulling from the margins of a pond eradicated a smaller population of water primrose at a second site. Assessment: unlikely to be beneficial (effectiveness 30%; certainty 50%).

http://www.conservationevidence.com/actions/1138
No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Biological control using fungal-based herbicides
- Biological control using native herbivores
- Environmental control (e.g. shading, reduced flow, reduction of rooting depth, or dredging)
- Excavation of banks
- Public education
- Use of a tarpaulin
- Use of flame treatment
- Use of hydrogen peroxide
- Use of liquid nitrogen
- Use of mats placed on the bottom of the waterbody

6.1.3 Skunk cabbage *Lysichiton americanus*

<table>
<thead>
<tr>
<th>Likely to be beneficial</th>
<th>No evidence found (no assessment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Chemical control using herbicides</td>
<td></td>
</tr>
<tr>
<td>● Physical removal</td>
<td></td>
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<tr>
<td>● Biological control using co-evolved, host-specific herbivores</td>
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<td>● Combination treatment using herbicides and physical removal</td>
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</tr>
<tr>
<td>● Environmental control (e.g. shading, or promotion of native plants)</td>
<td></td>
</tr>
<tr>
<td>● Public education</td>
<td></td>
</tr>
<tr>
<td>● Use of a tarpaulin</td>
<td></td>
</tr>
<tr>
<td>● Use of flame treatment</td>
<td></td>
</tr>
<tr>
<td>● Use of hydrogen peroxide</td>
<td></td>
</tr>
<tr>
<td>● Use of liquid nitrogen</td>
<td></td>
</tr>
</tbody>
</table>
Likely to be beneficial

Chemical control using herbicides

Two studies in the UK found that application of the chemical 2,4-D amine appeared to be successful in eradicating skunk cabbage stands. One of these studies also found glyphosate eradicated skunk cabbage. However, a study in the UK found that glyphosate did not eradicate skunk cabbage, but resulted in only limited reduced growth of plants. *Assessment: likely to be beneficial (effectiveness 60%; certainty 50%).*

http://www.conservationevidence.com/actions/1102

Physical removal

Two studies in Switzerland and the Netherlands, reported effective removal of recently established skunk cabbage plants using physical removal, one reporting removal of the entire stock within five years. A third study in Germany reported that after four years of a twice yearly full removal programme, a large number of plants still needed to be removed each year. *Assessment: likely to be beneficial (effectiveness 65%; certainty 55%).*

http://www.conservationevidence.com/actions/1101

No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Biological control using co-evolved, host-specific herbivores
- Biological control using fungal-based herbicides
- Biological control using native herbivores
- Combination treatment using herbicides and physical removal
- Environmental control (e.g. shading, or promotion of native plants)
- Public education
- Use of a tarpaulin
- Use of flame treatment
- Use of hydrogen peroxide
- Use of liquid nitrogen
### 6.1.4 New Zealand pigmyweed *Crassula helmsii*

<table>
<thead>
<tr>
<th>Based on the collated evidence, what is the current assessment of the effectiveness of interventions for controlling <em>Crassula helmsii</em>?</th>
</tr>
</thead>
</table>
| **Beneficial** | ● Chemical control using herbicides  
● Decontamination to prevent further spread |
| **Likely to be beneficial** | ● Use lightproof barriers to control plants  
● Use salt water to kill plants |
| **Unknown effectiveness (limited evidence)** | ● Use a combination of control measures |
| **Unlikely to be beneficial** | ● Use dyes to reduce light levels  
● Use grazing to control plants  
● Use hot foam to control plants  
● Use hydrogen peroxide to control plants |
| **No evidence found (no assessment)** | ● Alter environmental conditions to control plants (e.g. shading by succession, increasing turbidity, re-profiling or dredging)  
● Biological control using fungal-based herbicides  
● Biological control using herbivores  
● Bury plants  
● Dry out waterbodies  
● Physical control using manual/mechanical control or dredging  
● Plant other species to suppress growth  
● Public education  
● Surround with wire mesh  
● Use flame throwers  
● Use hot water  
● Use of liquid nitrogen |
**Beneficial**

- **Chemical control using herbicides**

  Seven studies in the UK, including one replicated, controlled study, found that applying glyphosate reduced *Crassula helmsii*. Three out of four studies in the UK, including one controlled study, found that applying diquat or diquat alginate reduced or eradicated *C. helmsii*. One small trial found no effect of diquat on *C. helmsii* cover. One replicated, controlled study in the UK found dichlobenil reduced biomass of submerged *C. helmsii* but one small before-and-after study found no effect of dichlobenil on *C. helmsii*. A replicated, controlled study found that treatment with terbutryne partially reduced biomass of submerged *C. helmsii* and that asulam, 2,4-D amine and dalapon reduced emergent *C. helmsii*. Assessment: beneficial (effectiveness 78%; certainty 75%).


- **Decontamination to prevent further spread**

  One controlled, replicated container trial in the UK found that submerging *Crassula helmsii* fragments in hot water led to higher mortality than drying out plants or a control. Assessment: beneficial (effectiveness 80%; certainty 70%).

  [http://www.conservationevidence.com/actions/1308](http://www.conservationevidence.com/actions/1308)

**Likely to be beneficial**

- **Use lightproof barriers to control plants**

  Five before-and-after studies in the UK found that covering with black sheeting or carpet eradicated or severely reduced cover of *Crassula helmsii*. Assessment: likely to be beneficial (effectiveness 65%; certainty 50%).

  [http://www.conservationevidence.com/actions/1294](http://www.conservationevidence.com/actions/1294)

- **Use salt water to kill plants**

  Two replicated, controlled container trials and two before-and-after field trials in the UK found that seawater eradicated *Crassula helmsii*. Assessment: likely to be beneficial (effectiveness 80%; certainty 45%).

  [http://www.conservationevidence.com/actions/1288](http://www.conservationevidence.com/actions/1288)
Unknown effectiveness (limited evidence)

- **Use a combination of control methods**
  One before-and-after study in the UK found that covering *Crassula helmsii* with carpet followed by treatment with glyphosate killed 80% of the plant. 
  *Assessment: unknown effectiveness (effectiveness 75%; certainty 30%).*
  
  http://www.conservationevidence.com/actions/1313

Unlikely to be beneficial

- **Use dyes to reduce light levels**
  One replicated, controlled study in the UK found that applying aquatic dye, along with other treatments, did not reduce cover of *Crassula helmsii*. 
  *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 53%).*
  
  http://www.conservationevidence.com/actions/1293

- **Use grazing to control plants**
  One of two replicated, controlled studies in the UK found that excluding grazing reduce abundance and coverage of *Crassula helmsii*. The other study found that ungrazed areas had higher coverage of *C. helmsii* than grazed plots. 
  *Assessment: unlikely to be beneficial (effectiveness 23%; certainty 43%).*
  
  http://www.conservationevidence.com/actions/1301

- **Use hot foam to control plants**
  One replicated, controlled study in the UK found that treatment with hot foam, along with other treatments, did not control *Crassula helmsii*. A before-and-after study in the UK found that treatment with hot foam partially destroyed *C. helmsii*. 
  *Assessment: unlikely to be beneficial (effectiveness 20%; certainty 50%).*
  
  http://www.conservationevidence.com/actions/1286

- **Use hydrogen peroxide to control plants**
  One controlled tank trial in the UK found that hydrogen peroxide did not control *Crassula helmsii*. 
  *Assessment: unlikely to be beneficial (effectiveness 0%; certainty 50%).*
  
  http://www.conservationevidence.com/actions/1281
No evidence found (no assessment)

We have captured no evidence for the following interventions:

- Alter environmental conditions to control plants (e.g. shading by succession, increasing turbidity, re-profiling or dredging)
- Biological control using fungal-based herbicides
- Biological control using herbivores
- Bury plants
- Dry out waterbodies
- Physical control using manual/mechanical control or dredging
- Plant other species to suppress growth
- Public education
- Surround with wire mesh
- Use flame throwers
- Use hot water
- Use of liquid nitrogen

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