<table>
<thead>
<tr>
<th>Scientific name</th>
<th><em>Orconectes virilis</em></th>
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<tbody>
<tr>
<td>Common name</td>
<td>Virile Crayfish</td>
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<tr>
<td>Broad group</td>
<td>Invertebrate</td>
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<tr>
<td>Number of and</td>
<td>1: NL</td>
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<tr>
<td>countries wherein the species is currently established</td>
<td></td>
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<tr>
<td>Risk Assessment Method</td>
<td>GB NNRA</td>
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1. **Description**

(Taxonomy, invasion history, distribution range (native and introduced), geographic scope, socio-economic benefits)

**Taxonomy:**
Recent phylogeographic and phylogenetic studies revealed that *O. virilis* is actually a diverse species complex. The genetic analysis of European populations suggested that they represent a lineage distinct from *O. virilis* in a strict sense (Kouba et al., 2014).

**Introduced range:**
1: NL

**Other EU countries where the species is found:** UK (Kouba et al., 2014).

**Socio-economic benefits:**
The species has been commercially harvested within its native range, however it is not generally considered a crayfish of great economic importance (CABI ISC). Very rarely used in the pet trade in Europe (Chucholl, 2013).

4. **Has the capacity to assess multiple pathways of entry and spread in the assessment, both intentional and unintentional**

In some cases, introductions have been accidental (e.g., through canals, escapes from holding facilities), but most have been deliberate (for aquaculture, legal and illegal stocking, and live food trade, as aquarium pets and live bait, for snail and weed control, and as supplies for science classes) (Gherardi, 2013).

5. **Can broadly assess environmental impact with respect to biodiversity and:**

The virile crayfish is most likely responsible for the decline of macrophytes in a few canals in the Netherlands (Kouba et al., 2014) but further studies with respect to confirming and quantifying its impacts on European ecosystems are lacking. There are numerous features reported for virile crayfish.
suggesting that this taxon may become an invader with substantial impact: early maturation, relatively high fecundity, short incubation and fast growth, high aggressiveness, extensive burrowing activity, and ability to withstand low temperature. Indeed, virile crayfish showed the potential to rapidly invade new waterbodies and outcompete native congeners in North America. However, it should be kept in mind that individual studies may refer to different lineages of the species complex, thus the performance of the one living in European waters should be evaluated in detail (Kouba et al., 2014).

The impact of *Orconectes* Species (*Orconectes immunis*, calico crayfish; *O. limosus*, spinycheek crayfish; *O. virilis*, northern crayfish; and *O. juvenilis*, Kentucky River crayfish) on ecosystem services was evaluated (Lodge et al., 2012).

Provisioning services: The earliest introductions of the *Orconectes* spp. to the Palearctic were probably for human consumption, including the early introduction of *O. limosus* to Europe in 1890. However, the *Orconectes* spp. are not as highly valued as food as signal crayfish or native crayfishes, and the spread of at least one, *O. limosus*, has been unintentional as a hitchhiker with fish stocks.

Supporting services: *Orconectes* spp. are well known for causing major changes in community structure, especially via large reductions in macrophytes (*O. virilis*, *O. immunis*) (Ahern et al., 2008). In addition, unlike some native Palearctic crayfishes, *O. immunis* digs deep burrows, causing changes in sediments and allowing it to inhabit shallower habitats than native species (Chucholl 2012).

Regulating services: Burrowing in dikes by *O. virilis* increases maintenance costs and the risk of flooding (Ahern et al., 2008).

Cultural services: There is no evidence that *Orconectes* spp. provide any cultural services not previously provided by native crayfishes; to the contrary, like red swamp crayfish and signal crayfish, *Orconectes* spp. contribute to the decline of cultural values previously provided by native crayfishes by vectoring crayfish plague (Lodge et al., 2012).

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**Orconectes virilis** is reported as a threat to the Red List assessed *Austropotamobius pallipes* (EN) (IUCN Red List, GISD 2014).

E.g. Red List assessed species 9: CR = 1; EN = 1; VU = 4; DD = 1; LC = 2;

- *Austropotamobius pallipes* EN
9. Includes possible effects of climate change in the foreseeable future

Observation. *O. virilis* occurs naturally in many regions of the USA and Canada and has also been introduced into other regions in North America and into Chihuahua, Mexico. It is able to survive severe winters in its home range. In Europe it has become established at one site in the Netherlands and is beginning to spread (Pöckl *et al.*, 2006). It is now established in one area of the River Lee catchment in England (Ahern *et al.*, 2008). Crayfish populations appear to be highly resistant, if not positively responsive, to drought conditions (Adams & Engelhardt, 2009, Flinders & Magoullick, 2005). In the Yampa River, *O. virilis* showed a significant growth advantage with warming water temperatures, which may facilitate expansion of their range, abundance and ecological impact (Rahel & Olden, 2008, Whitledge & Rabeni, 2002). Virile crayfish was able to exploit the drought conditions in the Yampa River, increasing their abundance in explosive fashion. Crayfish in the Ozark Plateau of Missouri and Arkansas (U.S.A.) provide an example in which climate warming could favour a common species over species of conservation concern. A widespread species, *O. virilis*, occurs at the periphery of the Ozark Plateau (Rahel & Olden, 2008). *O. virilis* has a major growth advantage at warm temperatures, and there is concern that warming will allow this species to expand its range and cause the extinction of two endemic species.

Tolerance experiments: Maximum daily food consumption rates has been shown to increase most steeply from 18 to 22°C (Whitledge & Rabeni, 2002). Virile crayfish become more active above 15°C (Rabeni, 1992, Richards *et al.*, 1996) and is likely to benefit from prolonged periods of sustained water temperatures over 16°C after climate change. Higher water temperatures during the drought also likely improved their capacity for reproduction, recruitment, and range expansion (Rahel & Olden, 2008). The data indicate that rising global temperatures associated with climate change can have the potential to increase the sensitivity of aquatic
animals to heavy metals in their environment (Khan et al., 2006). *O. virilis* show a pronounced thermal acclimation response (Claussen, 1980), and other studies confirm crayfish are among the most heat tolerant species (Spoor, 1955). Other studies suggest increased susceptibility to water acidification, overall by post-moult crayfish. Warmer temperatures may decrease survival of *O. rusticus* juveniles but improve their growth rates, leading to enhanced fecundity and competitive ability (Mundahl & Benton, 1990). The study also suggests that the species success in expanding its range may depend, in part, on the species ability to adjust to new thermal conditions occupied by other species of crayfish.

**11. Documents**


Lodge DM, Deines A, Gherardi F, Yeo DC, Arcella T, Baldridge AK, Barnes


Whitledge GW, Rabeni CF. 2002. Maximum daily consumption and respiration rates at four temperatures for five species of crayfish from Missouri, USA (*Decopoda, Orconectes* spp.) *Crustaceana* **75**: 1119-1132.

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Notes
The virile crayfish *Orconectes virilis* is the most widespread crayfish species in USA and Canada. In Europe its distribution is restricted - it was first recorded in 2004 and is found only in the Netherlands (where became widespread) and UK (only in the River Lee catchment). The species identity is not clear, recent phylogeographic and phylogenetic studies suggest that the European population represent a lineage distinct from *O. virilis* in North America in a strict sense. No socio-economic benefits of the species in Europe were reported.

GB NNRA: medium risk and high level of confidence.

Some recent information about the species environmental impact, impact
on ecosystem services (of *Orconectes* species), and impact on threatened species, as well as results of studies on the effects of climate change are added. Based on the collected information we suggest the risk assessment to be considered as compliant to the minimum standards with increased level of uncertainty because of unclear species identity.

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<tr>
<th>Outcome</th>
<th>Compliant</th>
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