Scientific name	*Orconectes limosus*
Common name	Spiny-cheek Crayfish
Broad group	Invertebrate
Number of and countries wherein the species is currently established	9: AT, UK, FR, DE, IT, LV, LT, NL, PL
Risk Assessment Method	GB NNRA
Links	http://www.nonnativespecies.org/downloadDocument.cfm?id=53
1. Description (Taxonomy, invasion history, distribution range (native and introduced), geographic scope, socio-economic benefits)	Other EU countries where the species is found (8): Belgium, Croatia, Czech Republic, Hungary, Luxemburg, Romania, Serbia, Slovakia, Spain (Holdich *et al.*, 2009, Kouba *et al.*, 2014). Socio-economic benefits: Potential use by fishery managers as a food supplement in UK. Rarely used in the pet trade (Chucholl, 2013).
4. Has the capacity to assess multiple pathways of entry and spread in the assessment, both intentional and unintentional	The crayfish introductions in some cases 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).
6. Can broadly assess environmental impact with respect to ecosystem services	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 has been assessed (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*,). 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, 2013). Regulating services: Burrowing in dikes by *O. virilis* increases maintenance costs and the risk of flooding. 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).
8. Includes status (threatened or protected) of species or habitat under threat	The occurrence of *A. astacus* (VU, IUCN) and *O. limosus* in a number of lakes in Poland has been documented (Holdich *et al.*, 2009), and suggests that *O. limosus* is gradually displacing *A. astacus* by direct competition rather than disease. In Croatia the rapid spread of *O. limosus* through the Danube River catchment has adverse effects on the populations of *A. leptodactylus* (LC, IUCN) (Holdich *et al.*, 2009). *Orconectes limosus* has extended its distribution in the Danube River catchment and was recorded for the first time in the Romanian sector in 2008 (Pârvulescu *et al.*, 2009). From 2009 to 2011, the relative abundances of *O. limosus* steadily increased, while the native *A. leptodactylus* dramatically decreased in abundance. Currently, 70-90% of *A. leptodactylus* have been replaced by *O. limosus*. The presence of *A. astaci* DNA was detected in at least 32% of the invasive and 41% of the native crayfish coexisting in the Danube River. Furthermore, *A. astaci* was also detected in *A. leptodactylus* captured about 70 km downstream of the *O. limosus* invasion front. *O. limosus* expanded downstream at a rate of ca. 15 km per year. Assuming a steady rate of expansion, *O. limosus* may invade the highly protected Danube Delta area (UNESCO Biosphere Reserve and World heritage site) in the next years, even without long-distance dispersal (Pârvulescu *et al.*, 2012) (Pârvulescu, personal communication). The

	crayfish plague pathogen has already been detected in local populations in the Danube Delta, as neither crayfish mass mortalities nor alien crayfish species have been reported from the region (Schrimpf *et al.*, 2012). It was suggested that *Aphanomyces astaci* may have reached the Delta by long-range passive dispersal of infected hosts or pathogen spores, or by gradually infecting populations of native crayfish in upstream regions of the Danube in a stepping-stone manner, or may have already persisted there (Schrimpf *et al.*, 2012). In any case, the presence of this pathogen in the Lower Danube River may become a threat to conservation of European crayfish and to freshwater biodiversity in many regions of southeastern Europe, at present considered "crayfish plague-free". Furthermore, in the section from Iron Gate II (rkm 863) to Calarasi-Silistra (rkm 375) alone, there are more than 35 Natura 2000 Sites of Community Importance (SCI) (5 on Romanian side and 30 on Bulgarian side) (http://natura2000.moew.government.bg/, http://natura2000.ro/), which may be affected by the invasion of *O. limosus* and the crayfish plague pathogen.
9. Includes possible effects of climate change in the foreseeable future	Climate matching: effect of climate, invasive species, and disease on the distribution of native European crayfishes has been examined (Capinha *et al.*, 2013). The model included the native crayfish in Europe and three North American plague-carrying crayfish species (*O. limosus*, *P. leniusculus*, and *P. clarkii*). The authors anticipate that *P. clarkii*, but not the other invasive alien crayfish, will enlarge its distribution range in both accessible (areas within basins where a given species is currently established) and inaccessible areas. This result has been confirmed by a behavioral study that analyzed antagonism, at different temperatures, of dyads composed of the same three species (Gherardi, 2013). All other conditions being equal, *P. clarkii* was dominant over the other species at the highest temperature analyzed (27°C), which corresponds to the maximum temperature expected at the latitudes of the study area (central France) in the next 80 years under the more pessimistic greenhouse gas-emission scenario. On the contrary, at that temperature, *O. limosus* will become less active, which may be a strategy to avoid thermal shocks, and *P. leniusculus*, being likely more vulnerable to high temperatures, will become less competitive. *Procambarus clarkii* is thus expected to exclude the other crayfish from the areas of syntopy and to dominate the future European watersheds. Ultimately, this might lead to impoverished biodiversity, simplified food webs, and altered ecosystem services

	(Gherardi, 2013). Tolerance experiments: increased temperature may increase metal toxicity and mortality of ectotherms, including *Orconectes* spp (Sokolova & Lannig, 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). Critical thermal minima and maxima for a similar species, *O. rusticus*, are calculated as 9.7 and 14.7 ^{o}C, respectively. Observation: Crayfish populations appear to be highly resistant, if not positively responsive, to drought conditions (Flinders & Magoulick, 2005).
11. Documents information sources	**Capinha C, Larson ER, Tricarico E, Olden JD, Gherardi F. 2013.** Effects of climate change, invasive species, and disease on the distribution of native European crayfishes. *Conservation Biology* **27:** 731-740. **Chucholl C. 2013.** Invaders for sale: trade and determinants of introduction of ornamental freshwater crayfish. *Biological Invasions* **15:** 125-141. **Flinders C, Magoulick D. 2005.** Distribution, habitat use and life history of stream-dwelling crayfish in the Spring River drainage of Arkansas and Missouri with a focus on the imperiled Mammoth Spring crayfish (*Orconectes marchandi*). *The American midland naturalist* **154:** 358-374. **Gherardi F. 2013.** Crayfish as global invaders: distribution, impact on ecosystem services and management options. *Freshwater Crayfish* **19:** 177-187. **Holdich D, Reynolds J, Souty-Grosset C, Sibley P. 2009.** A review of the ever increasing threat to European crayfish from non-indigenous crayfish species. *Knowledge and Management of Aquatic Ecosystems***:** 11. **Khan M, Ahmed S, Catalin B, Khodadoust A, Ajayi O, Vaughn M. 2006.** Effect of temperature on heavy metal toxicity to juvenile crayfish, *Orconectes immunis* (Hagen). *Environmental toxicology* **21:** 513-520. **Kouba A, Petrusek A, Kozák P. 2014.** Continental-wide distribution of crayfish species in Europe: update and maps. *Knowledge and Management of Aquatic Ecosystems***:** 05. **Lodge DM, Deines A, Gherardi F, Yeo DC, Arcella T, Baldridge AK, Barnes**

	MA, Chadderton WL, Feder JL, Gantz CA. 2012. Global introductions of crayfishes: evaluating the impact of species invasions on ecosystem services. *Annual Review of Ecology, Evolution, and Systematics* **43:** 449-472. **Pârvulescu L, Paloş C, Molnar P. 2009.** First record of the spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817)(Crustacea: Decapoda: Cambaridae) in Romania. *North-Western Journal of Zoology* **5:** 424-428. **Pârvulescu L, Schrimpf A, Kozubíková E, Cabanillas Resino S, Vrålstad T, Petrusek A, Schulz R. 2012.** Invasive crayfish and crayfish plague on the move: first detection of the plague agent *Aphanomyces astaci* in the Romanian Danube. *Diseases of Aquatic Organisms* **98:** 85. **Schrimpf A, Pârvulescu L, Copilas-Ciocianu D, Petrusek A, Schulz R. 2012.** Crayfish plague pathogen detected in the Danube Delta- a potential threat to freshwater biodiversity in southeastern Europe. *Aquatic Invasions* **7:** 503-510. **Sokolova IM, Lannig G. 2008.** Interactive effects of metal pollution and temperature on metabolism in aquatic ectotherms: implications of global climate change. *Climate research (Open Access for articles 4 years old and older)* **37:** 181. See also the Irish risk analysis report (http://nonnativespecies.ie/risk-assessments/).
Main experts	Teodora Trichkova Merike Linnamagi
Other contributing experts	Belinda Gallardo Lucian Parvulescu
Notes	The spiny-cheek crayfish *Orconectes limosus* has been reported from 17 EU countries. Currently it is expanding rapidly its range to South and East Europe, especially through the Danube River, being real and potential threat to the native populations of *Astacus leptodactylus* in the main channel, *Astacus astacus* and *Austropotamobius torrentium* in the tributaries. There are no socio-economic benefits of the species reported in Europe, except as a food supplement in fishery. GB NNRA: medium risk and low level of uncertainty. Some recent data on more pathways of crayfish introduction in Europe, on the impact on ecosystem services, on the impact on protected species and

	habitats, and 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 risk from medium to high in Europe scale.
Outcome	Compliant