Smooth Marron (*Cherax cainii*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, November 2020
Revised, November 2020
Web Version, 9/8/2021

Organism Type: Crayfish
Overall Risk Assessment Category: High

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1 Native Range and Status in the United States

Native Range

From Austin and Bunn (2010):

"This species is endemic to South-west Australia. Originally, it had a restricted distribution in the southwest of Western Australia, but has since naturally expanded its range from Esperance to Geraldton [in western Western Australia, about 1000 km] (Department of Fisheries 2008)."

Status in the United States

No information on this species in trade or in the wild in the United States was found; only information regarding captive scientific research in the United States was found.

From Shireman (1973):

"During December 1970, 200 small marron were collected from the Warren River [Western Australia], placed in oxygenated water in plastic bags, and shipped to Louisiana in insulated containers."

"Only six marron survived the winter confinement. On June 1, 1971, they were placed in a 1/20-acre pond."

"The pond was drained October 8, 1971. No marron were recovered."

"Marron probably cannot exist in south Louisiana waters because of water temperature extremes."

From Kartamulia and Rouse (1992):

"A program was initiated at Auburn University in 1986 to assess the suitability of marron for culture in the southeastern USA."

"Three thousand marron, average weight 1.2 g, were shipped from a commercial farm, Marron Waters, Int., Perth, Australia […]."

"Nine outdoor concrete tanks […], at the Fisheries Research Unit, Alabama Agricultural Experiment Station, Auburn University, were used for the study."

"At the end of the 12 week experiment, average marron survivals in the 4, 8 and 12/m^2 density tanks were 13%, 31%, and 12%, respectively […]."

"The high mortalities experienced during the last half of this experiment as temperatures reached 28 C and above were attributed to heat stress. Temperatures of 28-30 C are common in the southern United States for several months in the summer. From this experiment it appears that temperatures are critical for marron survival and that normal summer temperatures experienced throughout the southern United States appear excessive for good marron survival."

The Florida Fish and Wildlife Conservation Commission has listed all species of *Cherax* (except for *C. quadricarinatus*) as prohibited species. Prohibited nonnative species (FFWCC 2020), "are considered to be dangerous to the ecology and/or the health and welfare of the people of Florida. These species are not allowed to be personally possessed or used for commercial activities."

The following information from Washington State Legislature (2019) does not distinguish the species *Cherax cainii* from the formerly known name and distinguished species *Cherax tenuimanus*. Washington State Legislature (2019) excludes *C. tenuimanus* from being a prohibited species, however it is unknown whether *Cherax cainii* is represented as *Cherax tenuimanus* in this situation or if it is included as a prohibited species.

From Washington State Legislature (2019):

"WAC 220-640-050 Prohibited level 3 species. The following species are classified as prohibited level 3 species: […] Family Parastacidae: Crayfish: All genera except *Engaeus*, and except the species *Cherax quadricarninatus*, *Cherax papuanus*, and *Cherax tenuimanus*."

From Washington State Legislature (2020):

"Species classified as prohibited level 3 pose a moderate to high invasive risk and may be appropriate for prevention, rapid response, or other prohibited species management plan actions by the department, another agency, a local government, tribes, or the public."

From Arizona Office of the Secretary of State (2013):

"Crustaceans listed below are considered restricted live wildlife:
1. All freshwater species within the families *Astacidae*, *Cambaridae*, and *Parastacidae*.
Common name: crayfish."

From State of Nevada (2018):

"Except as otherwise provided in this section and NAC 504.486, the importation, transportation or possession of the following species of live wildlife or hybrids thereof, including viable embryos or gametes, is prohibited:
[...]
All species in the families Parastacidae, Cambaridae and Astacidae, except *Procambarus clarkia*, *Oronectes causeyi* and indigenous species of the genus *Pacifastacus*"

From Texas Parks and Wildlife (2020):

"The organisms listed here [including all species of Family Parastacidae] are legally classified as exotic, harmful, or potentially harmful. No person may possess or place them into water of this state except as authorized by the department. Permits are required for any individual to possess, sell, import, export, transport or propagate listed species for zoological or research purposes; for

aquaculture (allowed only for Blue, Nile, or Mozambique tilapia, Triploid Grass Carp, or Pacific White Shrimp); or for aquatic weed control (for example, Triploid Grass Carp in private ponds)."

From Utah Office of Administrative Rules (2019):

"Crayfish, families Astacidae, Cambaridae and Parastacidae (All species except *Cherax quadricarinatus*) are prohibited for collection, importation and possession;"

Means of Introductions in the United States

No wild introductions of *Cherax cainii* were reported.

Remarks

This ERSS was previously published in December 2017. Revisions were completed to incorporate new information and conform to updated standards.

Cherax cainii was formerly known as *Cherax tenuimanus* until 2002, when genetic studies determined they were two distinctive species. Information for this assessment was conducted using both the current scientific name and the former scientific name. Information that is found regarding *Cherax cainii* is included; information found where the species certainty is unclear is annotated accordingly.

From CABI (2019):

"The taxonomy of *Cherax* species is complex and the status of a number of species is still in dispute. The smooth marron had been known as *Cherax tenuimanus* since 1912 until genetic studies by Austin and Ryan (2002) demonstrated that *C. tenuimanus* was not a homogeneous species and comprised two genetically distinct forms. As the original description of the marron was based on specimens from the Margaret River area (Australia), the form native to this river system retains the name *C. tenuimanus* and is listed as Critically Endangered in the IUCN red list […]. The new species name *Cherax cainii* is now used for the more widespread marron species that is used in aquaculture worldwide."

From Austin and Bunn (2010):

"This species and *Cherax tenuimanus* were formerly thought to be the same species (C.M. Austin pers. comm. 2008). It has recently been proposed to re-combine these species, for functional clarity but not taxonomic similarity (Molony et al. 2006)"

From Bryant and Papas (2007):

"There are two discrete forms of marron, a smooth form and hairy form. They were considered to be sub species (Austin and Knott 1996) until 2002 when allozyme evidence indicated these forms were distinct species (Austin and Ryan 2002). The hairy form, restricted to the Margaret River system in WA, maintained the name *Cherax tenuimanus* (Smith), while the smooth and widely translocated form was given the name *Cherax cainii* (Austin). This name change is being

disputed and is currently before the International Commission on Zoological Nomenclature (Case No. 3267)."

From De Graaf et al. (2009):

"Austin & Ryan (2002) elevated the subspecies Hairy Marron [*Cherax tenuimanus*] and Smooth Marron [*Cherax cainii*] to species level based on the assumption of 'minimal interbreeding'. […] However, a large and significant body of evidence exists that interbreeding and hybridization are common between Hairy Marron and Smooth Marron, and that hybrids are fertile and viable. Despite Austin & Ryan (2002) claiming 'limited interbreeding' between Smooth Marron and Hairy Marron, 7.4% (1981) and 12.5% (1992) of their sampled marron were hybrids. Secondly, a survey of the Margaret River by Bunn (2004) in 2002 showed widespread hybridization between hairy marron and smooth marron based on morphological characteristics (Bunn et al., 2008). […] Thirdly, hybridization was also demonstrated by Imgrund (1998). […] Crossbreeding experiments at Pemberton Freshwater Research Centre showed that female hairy marron hybridized readily with male smooth marron from a range of other catchments and most of the hybrid females were fertile (Lawrence, 2007). No evidence was found for reduced viability of hybrids as little difference in growth was observed between 'pure' hairy marron and hybrid hairy marron strains (Lawrence, 2007)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2020):

"Current Standing: valid"

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Ecdysozoa
Phylum Arthropoda
Subphylum Crustacea
Class Malacostraca
Subclass Eumalacostraca
Superorder Eucarida
Order Decapoda
Suborder Pleocyemata
Infraorder Astacidea
Superfamily Parastacoidea
Family Parastacidae
Genus *Cherax*
Species *Cherax cainii* Austin and Ryan, 2002

Size, Weight, and Age Range

From Bryant and Papas (2007):

"Marron are the third largest freshwater crayfish species in the world and largest *Cherax* species, reaching a length of 380 mm and weighing up to 2.7 kg (Merrick and Lambert 1991, Molony *et al.* 2004)."

Environment

From Bryant and Papas (2007):

"The interest in marron for aquaculture purposes has led to their environmental tolerances to basic physico-chemical water parameters being relatively well known under aquaculture conditions. No tolerance data was found relating to specific conditions in the natural environment."

"Marron have a greater tolerance to salinity than the yabby (*Cherax destructor/albidus*) and redclaw (*Cherax quadricarinatus*) […] Their endemic home range occurs within flowing water (i.e. typically higher oxygen levels) habitat, which may explain why they have the least tolerance to low dissolved oxygen concentrations of the three species. Like members of *Euastacus*, marron have been observed to leave unfavorable conditions by physically removing themselves from the water (Morrissy 1978)."

"Marron is the cooler climate species of the three, having a lower optimal temperature of 17.5°C and an upper optimal temperature of 24.5°C […] Morrissy [et al.] (1990) reports water temperature extremes of 8 and 26°C in the central part of the marron's natural distribution, where its abundance is highest. Survival for short periods (50% survival over 2 – 3 days) at temperatures as low as 4°C has however been stated (D, Sampey, Marron Growers Association, WA, pers.comm. 2007)."

Climate

From CABI (2019):

"Tropical/Megathermal climate [Average temp. of coolest month > 18°C [assumed to be air temperature], > 1500mm precipitation annually"

Distribution Outside the United States

Native

From Austin and Bunn (2010):

"This species is endemic to South-west Australia. Originally, it had a restricted distribution in the southwest of Western Australia, but has since naturally expanded its range from Esperance to Geraldton [in Western Australia, about 1000 km] (Department of Fisheries 2008)."

Introduced

From Austin and Bunn (2010):

"[…] it [*C. cainii*] has been widely transplanted in both natural and artificial water bodies and is now widespread throughout the South-west of Western Australia. It has been introduced to South Australia, New South Wales, Kangaroo Island off the coast of Adelaide, Queensland, and Victoria, where feral populations have become established (Austin and Ryan 2002, J. Bunn pers. comm. 2008). Two self-sustaining populations are known in Victoria, on the Mornington Peninsular [*sic*], southeast of Melbourne. Both populations occur in artificial waterbodies namely Devilbend reservoir and O.T. Dam (Bryant and Papas 2007).

In addition, this species has been translocated to […] South Africa (Lawrence and Morrissy 2000), New Zealand (McDowall 1988), Japan, Zimbabwe, China, Chile and the Caribbean (Lawrence and Morrissy 2000)."

From Bryant and Papas (2007):

"Marron were introduced onto Kangaroo Island, South Australia (SA) in the early 1980's. They quickly became established in the natural waterways and now reside in many of the permanent waters on the island (Zeidler 2000)."

From CABI (2019):

"International interest in its aquaculture potential has resulted in the species being introduced to Chile, Ecuador, Great Britain (indoor intensive culture), Malawi, New Zealand, South Africa, Zambia, Zimbabwe, Japan, southeastern and Central USA, China, the Caribbean (Morrissy et al., 1990; Alderman and Wickins, 1996) and other Australian states. Although few of these industries outside Australia have been successful, in the late 1990s *C. cainii* farming expanded rapidly in both Western Australia and South Australia."

"However, there are no reports of current populations established in the wild in these countries."

From Champion et al. (2012):

"Presence in New Zealand
All known populations eradicated, introduced in 1986."

From NIES (2020):

"Not established in Japan."

From Nunes (2016):

"Four other alien crayfish species [besides *Procambarus clarkii*] have been introduced into Africa. Three are originally from Australia: the Australian redclaw crayfish (*Cherax quadricarinatus*), the smooth marron (*Cherax cainii*) and the yabbie (*Cherax destructor*). These

three species were introduced into South Africa during the 1970s for aquaculture purposes. From there they were translocated to Zambia. The marron and the yabbie have not established wild populations, remaining confined to aquaculture facilities."

From Rudolph et al. (2007):

"The only Australian species of Parastacidae to have been introduced into Chile is *Cherax cainii*. In 1998, 16.000 specimens of *Cherax cainii* originating from Perth (southeast Australia) were introduced into Coquimbo (20°96'S 71°33'W), to evaluate their acclimation to the physicochemical characteristics of fresh waters in northern Chile, and subsequently an attempt was made to culture them commercially (J. Meruane, pers. comm.). […] Under these conditions, the acclimation of *Cherax cainii* was not successful and, as a consequence, neither was its culture."

According to FAO (2020), *Cherax tenuimanus* has been reported as introduced to the following countries: Malaysia, United Kingdom, Panama, Sweden, Germany, Belgium, New Zealand, France, New Caledonia, Egypt, and Taiwan. No information on the status of introduction in these locations was reported. FAO (2020) listed other introductions however the common name used for those introductions was "Hairy marron crayfish" and therefore that information is not included in this assessment.

Means of Introduction Outside the United States

From CABI (2019):

"Mainly for commercial aquaculture reasons, […]"

From Bryant and Papas (2007):

"In recent times, [*C. cainii*] distribution in Australia has been widely extended by the commercial aquaculture and recreational fishing industries in WA [Western Australia] (Morrissy 1978, Horwitz 1990b, Arthington and McKenzie 1997); the aquaculture industry in South Australia (Zeidler 2000), Queensland and New South Wales (Merrick and Lambert 1991); and aquaculture overseas (Smith 1988) [*sic*], Avenant-Oldewage 1993)."

From NIES (2020):

"Deliberate: As pet"

"This genus [*Cherax*] includes 45 spcies [*sic*]. Among those, several species (Marron *C. cainii*, Red claw *C. quadricarinatus*, Yabby *C. destructor*, etc.) were sold as pet in Japan."

Short Description

From Bryant and Papas (2007):

"Marron can be readily distinguished from other *Cherax* species by the presence of five keels on the dorsal surface of their head and two small spines on the telson […]"

From Bunn (2004):

"The median carina, the central ridge on the carapace, is continuous to the cervical groove in *C. tenuimanus.* In *C. cainii* the median carina does not extend to the cervical groove but is raised more prominently than in *C. tenuimanus*. The carapace, and to a lesser extent the abdomen (tail), are covered with clusters of setae in *C. tenuimanus* […] These clusters of setae are lacking in *C. cainii*, giving it the "smooth" appearance […]"

From CABI (2019):

"In females, oviduct pores are located at the base of the third or middle pair of legs, whereas in males, the genital papillae are located at the base of the fifth pair of legs, nearest the tail."

Biology

From Bryant and Papas (2007):

"In their natural environment, marron inhabit the clear, deep water reaches of permanently flowing rivers (Merrick and Lambert 1991, Mosig 1998, Wingfield 1998), preferring sandy reaches with structure (e.g. snags and rocks) for shelter (Molony *et al.* 2004). Marron are not considered to be burrowers but do excavate short unbranched burrows under structures (Clunie et al. 2002). Mosig (1998) however, reports that burrowing may occur in the banks of dams where refuge habitat is limiting. In Devilbend Reservoir, marron have been observed using multi entranced burrows in soft mud banks and under timber debris (T. Raadik, Department of Sustainability and Environment, pers.comm. 2006)."

"Marron are predated upon by cormorants, water rats, tortoises and fish (Mosig 1998, Tay et al. 2007). They are also subject to cannibalism by larger marron (Merrick and Lambert 1991), making the availability of refuge habitat is especially important for young individuals."

"Maturity under favorable conditions can be reached in two years, although is commonly three years (Merrick and Lambert 1991). Breeding occurs annually in spring, triggered by water temperature and day length (Mosig 1998). Females have been reported to carry between 95 and 900 berries (Merrick and Lambert 1991) but generally average 150 (Mosig 1998)."

"In order to reduce the risk of predation, greatest activity is observed at night when marron commonly move to shallower water to feed (Merrick and Lambert 1991). During daylight hours marron seek refuge under available habitat or in deeper water (Merrick and Lambert 1991, Mosig 1998). Marron are opportunistic feeders, consuming largely plant material but also carrion and small animals where available (Merrick and Lambert 1991)."

From Austin and Bunn (2010):

"In a recent study of breeding patterns of a population found in an impoundment dam, the majority of females released their broods form [sic] mid-November to mid-December. Furthermore, spawning occurred in late August and September (Beatty et al. 2003). It has

recently been posited, through stable isotope analysis, that this species may be a keystone species in the Hutt River, playing a key role in nutrient cycling and aquatic food web structure (Beatty 2006). This species and *C. destructor* were found to have similar diets and trophic position in summer months, although this seemed to diverge during the winter (Beatty 2006). Juveniles and adults of this species maintain a predatory strategy during both summer and winter, whereas *C. destructor* is only predatory during summer months (Beatty 2006)."

Human Uses

From Bryant and Papas (2007):

"Fisheries Victoria recently intercepted an import of live marron intended for the restaurant trade. A newspaper reported in late 2006 (Dubecki 2006) that the import was destined for two Melbourne restaurants, and was seized under the Fisheries Act. At the time of writing this report, Fisheries Victoria's policy position changed such that permits can now be issued for the restaurant trade of live marron (Paul Mainey, Fisheries Victoria, pers. comm. 2007)."

From CABI (2019):

"*C. cainii* is currently farmed in Western Australia, South Australia and New South Wales. Areas in Australia potentially suitable for farming C. cainii are determined by temperature, water supply and the presence of clay soils suitable for ponds (Lawrence et al., 1995)."

From De Graaf et al. (2009):

"Marron […] supports a large recreational fishery (20,075 license holders in 2005; de Graaf, 2006) and aquaculture industry (100 tonnes/year; Lawrence, 2007) [in Western Australia]."

From Austin and Bunn (2010):

"In a 2002 report by Molony and Bird, it is noted that, due to high fishing pressure on the dam sub-populations, there is now evidence of over-fishing. In 2000, approximately 44.8 tonnes of this species were taken by recreational fisheries (Molony and Bird 2002). Between 1990 and 2000, catches of this species decreased from approximately 8 per person to 5 per person (Molony and Bird 2002)."

"Fishing regulations of this species, such as legal size limits, fishing licences, length of fishing season, and gear restrictions have been imposed to address the declines in the catch rate of this species over the last decade (Beatty et al. 2005). It is managed under Western Australia Fisheries legislation which are currently addressing the declining catch per unit effort, through temporary closure of the fishery, rotational closure of certain water bodies, revision of the management controls to assess their effectiveness, total reduction in fishing effort, improvements to habitat status, and stocking in areas where recruitment and over-fishing are known to be a problem (Molony and Bird 2002)."

From NIES (2020):

"[…] sold as pet […]"

From Patoka et al. (2014):

"Wholesale availability [in the pet trade in the Czech Republic] Very rare"

Diseases

No OIE-reportable diseases (OIE 2020) were found to be associated with *Cherax cainii.*

From Mitchell and Kock (1988):

"Temnocephalidae (Turbellaria: Rhabdocoela) are among the most common of the symbionts. The crayfish are seldom without some of them, which may occur at high densities under natural conditions [Haswell 1893]. Depending on treatment before and conditions during the relocation of crayfish to new habitats, symbionts may be transferred with their hosts. Temnocephalans are hermaphroditic and capable of self-fertilization, so a viable population can start from a single egg.

Temnocephalans are now established on the stock of the Amanzi Marron Farm in the southern Cape [South Africa], and, while they have not been implicated in any marron mortality, they have apparently been widely distributed throughout South Africa on stock which has been sold to other farmers. One such producer in the eastern Orange Free State has suffered a severe loss amongst stock purchased from Amanzi Marron Farm, apparently resulting from heavy infestation of the symbionts. The mortality occurred between 10 and 12 weeks after delivery, and the sole survivor from his initial shipment was the only marron to have been treated for temnocephalans. […] The species found on the marron in South Africa has been identified by Cannon (The Queensland Museum, South Brisbane) as *Temnocephala chaeropsis*, a species originally described from *C. tenuimanis*."

From Patoka et al. (2015):

"[…] *Temnocephala minor* Haswell was reported from an indigenous South African river crab *Potamonautes warreni* (Calman), as well as having been introduced there via aquaculture of the crayfish *Cherax cainii* Austin (Avenant-Oldewage 1993)."

From Beatty (2005):

"*Vavraia parastacida* is a microsporidian species that is of similar appearance to *Thelohania* spp. and is known to infect *C. cainii* and *C. quinquecarinatus* in this region [Western Australia] (Langdon 1991*a*, 1991*b*)."

The following section refers to diseases of the genus *Cherax.*

From Bryant and Papas (2007):

"Australian freshwater crayfish are relatively free of diseases (Horwitz 1990b, Merrick and Lambert 1991, Mosig 1998) such as the North American crayfish plague (*Aphanomyces astaci*), which has devastated European crayfish populations (Arthington and McKenzie 1997, Mosig 1998). Endemic diseases of *Cherax* species include bacterial, fungal, protozoan and nematode infections; however, outbreaks are largely a result of intensive aquaculture where unnaturally high densities of crayfish occur (Mills 1983, Merrick and Lambert 1991). Merrick and Lambert (1991) present a summary report of pathogens, parasites and commensal organisms for the three *Cherax* aquaculture species."

Threat to Humans

No information on threat to humans was found.

3 Impacts of Introductions

From De Graaf et al. (2009):

"Smooth marron were first recorded in the lower reaches of the Margaret River [Western Australia] during the early 1980s."

"Smooth marron rapidly replaced hairy marron from the lower reaches [of the Margaret River, Western Australia] between 1980 and 1992 […]. Little historical information is available for the middle reaches but in 2000, Hairy Marron was absent from these areas […]. The only remaining significant populations of Hairy Marron are found in the upper reaches of the Margaret River. Even here, since 2000, Hairy Marron populations have always been found mixed with Smooth Marron. The proportion of Hairy Marron in the upper reaches declined sharply from ~100% in 1995 to ~30% in 2002 […]. But since this time the proportion of Hairy Marron has remained more or less stable, fluctuating around 30%."

"The assumption that Smooth Marron was accidentally introduced in the lower reaches of the Margaret River during the early 1980s appeared consistent with the overall replacement pattern. Smooth Marron gradually displaced Hairy Marron in the lower reaches during the 1980s, followed by the middle reaches in the 1990s, and has significantly reduced Hairy Marron numbers in the upper reaches since the late 1990s."

"In order to attempt to halt the decline of hairy marron, smooth marron, *Cherax cainii*, have been actively removed, albeit on a modest scale, from pools in the upper reaches of the Margaret River since 2004. These modest efforts may have contributed to the stabilization or at least reduction in the decline of the proportion of hairy marron in the upper reaches in recent years […]."

The following information pertains to *potential* impacts from *Cherax cainii* introductions.

From CABI (2019):

"The introduction of this species [*Cherax cainii*] into new habitats is cause for concern due to their potential ability to compete with and displace native species, cause significant habitat alteration and introduce associated undesirable parasites and diseases."

From Bryant and Papas (2007):

"The disappearance of yabbies from Devilbend Reservoir [Victoria, Australia] following the introduction of marron (O'Connor 1997), may be due to competition and is cause for some concern and investigation."

From Shireman (1973):

"In Australia marron [smooth marron, *Cherax cainii*, formerly *Cherax tenuimanus*] do not compete successfully with the koonac, a smaller native crayfish. Morrissy [1970] listed koonacs already established in ponds as one of the reasons that marron did not become established. It is doubtful that marron can compete successfully with *Procambarus*. When marron and *Procambarus* were placed together in aquariums, the results were nearly the same in each case. The marron would usually remain in one corner of the aquarium while the *Procambarus* moved about freely; the marron would not compete for food; the smaller *Procambarus* constantly harassed the marron; and the marron usually died within a few weeks."

Cherax cainii may be regulated as part of the former *C. tenuimanus* species complex in Florida and Washington. *C. cainii* is regulated in Arizona, Nevada, Texas, and Utah.

4 History of Invasiveness

The history of invasiveness is classified as High. *Cherax cainii* has been introduced outside of its native range in Western and Southern Australia, where it has become established. This species has competed with native crayfish species in their introduced range, which has led to declines in native crayfish populations. This species is found in the aquarium trade in Japan and is also a popular crayfish species for aquaculture.

5 Global Distribution

Figure 1. Known global distribution of *Cherax cainii*. Observations are reported from southern Australia and Kangaroo Island. Map from GBIF Secretariat (2020). The most eastern location, near Sydney, was not used in the climate match as no information was found to represent an established population in that area.

6 Distribution Within the United States

Cherax cainii has not been found in the wild in the United States.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for the contiguous United States is generally low to medium low. Small areas of high match were found in Pacific Coast States. Medium match was found in the Southeast, in the West, and along coastal Massachusetts. Low match is found in the Midwest, Northeast, and peninsular Florida. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.006, medium (scores between 0.005 and 0.103, exclusive, are classified as medium). The following States had medium individual Climate 6 scores: California, Massachusetts, Oregon, and Washington. All remaining States scored low individual Climate 6 scores. No State received a high individual Climate 6 score.

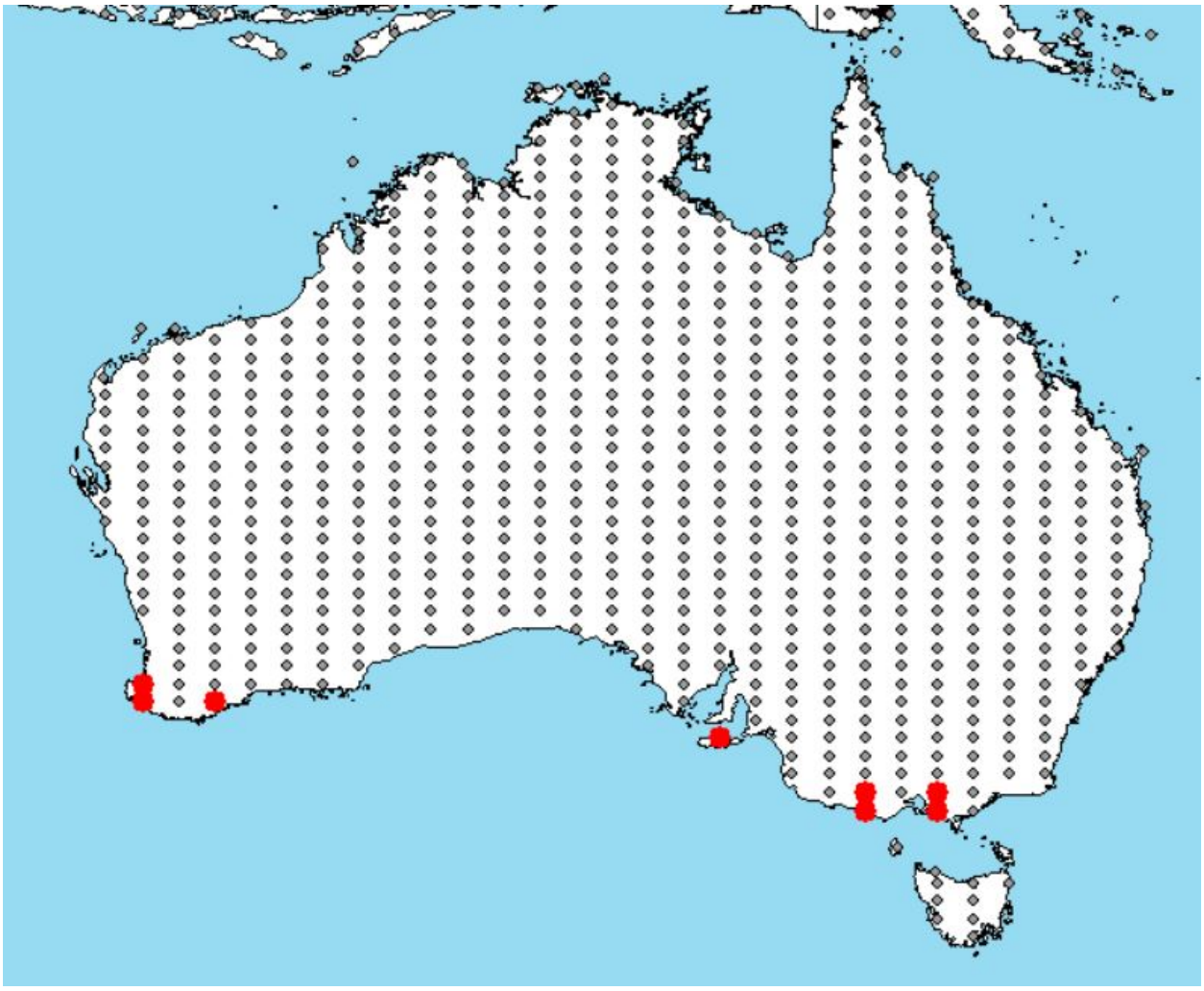

Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in Australia selected as source locations (red; Australia) and non-source locations (gray) for *Cherax cainii* climate matching. Source locations from GBIF Secretariat (2020). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

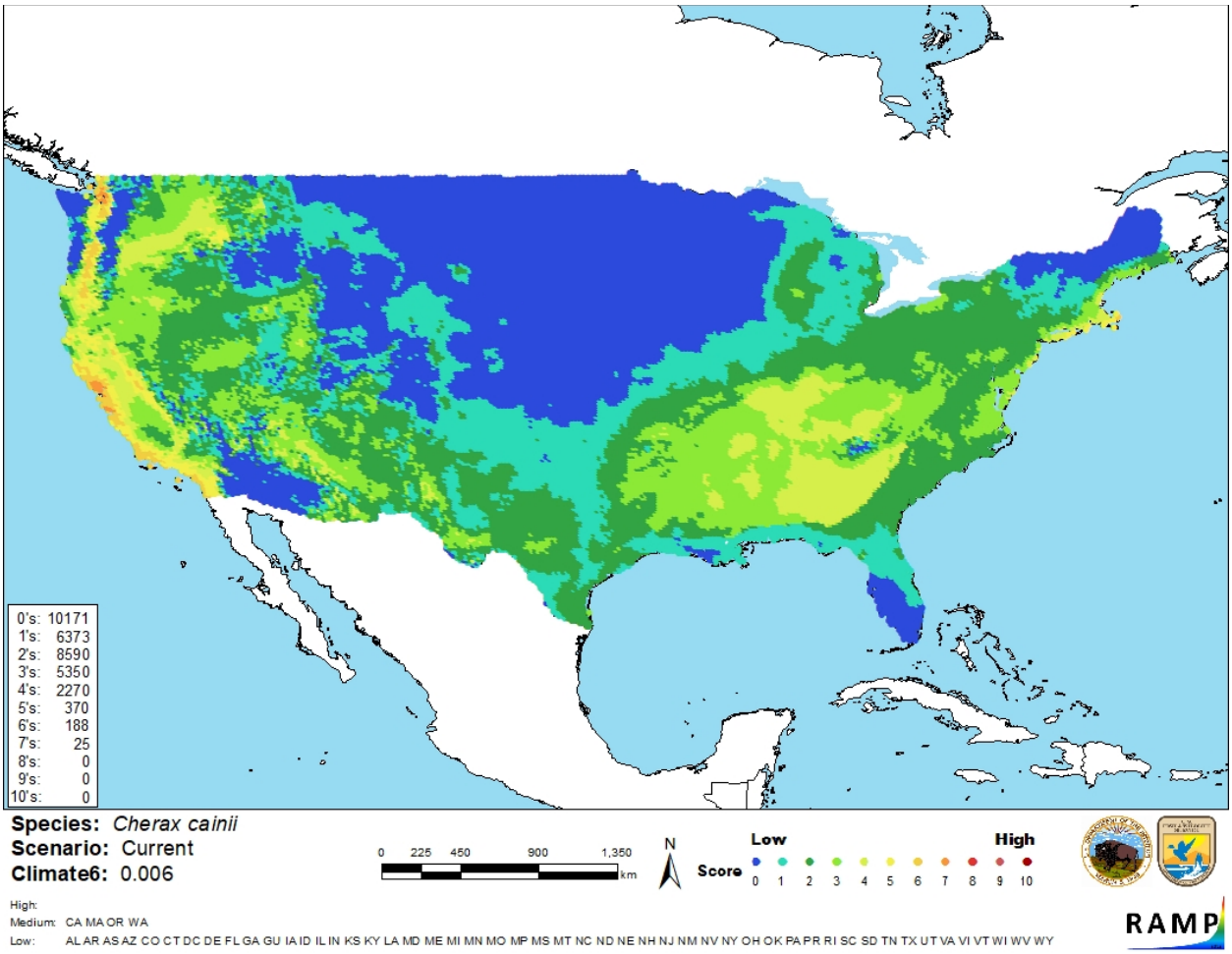

Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *Cherax cainii* in the contiguous United States based on source locations reported by GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

8 Certainty of Assessment

The certainty of assessment is Medium. Adequate information is available on the biology, ecology and distribution of this species. Negative impact information is available from one peer-reviewed study. Potential impact information is available from other publications. Due to

taxonomic discrepancies caused by distinguishing *Cherax cainii* as an individual species from *Cherax tenuimanus*, the certainty of assessment can only be Medium.

9 Risk Assessment

Summary of Risk to the Contiguous United States

The Smooth Marron, *Cherax cainii,* is a large, freshwater crayfish species native to Southwestern Australia. This species was formerly considered *Cherax tenuimanus* until the two were determined two individual species in 2002. The history of invasiveness is classified as High. *Cherax cainii* has naturally expanded from its native range, and been purposely introduced outside of its native range in Southern Australia. The introductions of this species have led to established populations. In one area of introduction, negative impacts have been reported such as outcompeting native crayfish, leading to significant population declines. *Cherax cainii* is found in the aquarium trade in Japan and is also farmed at aquaculture facilities. Studies were conducted on the aquaculture potential of *C. cainii* in the southern United States in the late twentieth century, but mortality was high in both experiments and the climate was deemed unsuitable for *C. cainii* in aquaculture in the United States. *Cherax cainii* is listed as a prohibited species in Arizona, Florida, Nevada, Texas, and Utah, and may be regulated in Washington. The overall climate match category for the contiguous Unites States is Medium. Areas of high match were found along the West Coast. Medium to low match was found throughout the remaining contiguous United States. The certainty of assessment is Medium due to taxonomic uncertainty caused by distinguishing *Cherax cainii* and *Cherax tenuimanus* as two distinct species in 2002. The overall risk assessment is High.

Assessment Elements

- **History of Invasiveness (Sec. 4): High**
- **Overall Climate Match Category (Sec. 7): Medium**
- **Certainty of Assessment (Sec. 8): Medium**
- **Remarks, Important additional information:** *Cherax cainii* recently became a distinguished species from *Cherax tenuimanus*.
- **Overall Risk Assessment Category: High**

10 Literature Cited

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 11.

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