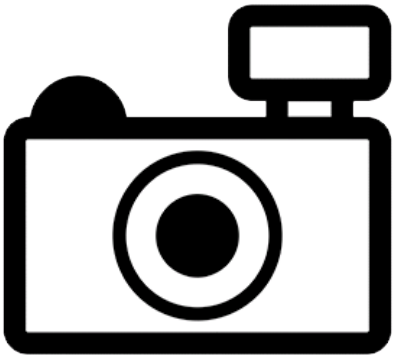
Yabby (*Cherax albidus*) (crayfish)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2011
Revised, September 2012 and September 2017
Web Version, 11/30/2017



No Photo Available

1 Native Range and Status in the United States

Native Range

From Australian Aquatic Biological (2012):

"Victoria & SA [South Australia] Southern flowing streams west Port Phillip Bay to south eastern corner SA"

Status in the United States

This species has not been reported as introduced or established in the United States. This species may be in trade in the U.S.

From Aquatic Arts (2017):

"BLUE PEARL CRAYFISH (*CHERAX ALBIDUS*) - TANK-RAISED!
Sold Out […]
Please "Choose a Variant" above before adding this crayfish to your cart. The variants we're currently offering are:
1 Blue Pearl Crayfish - 3 to 4 inch Young Adult […]
1 B-Grade Blue Pearl Crayfish - 3 to 4 inch Young Adult […]
1 Juvenile Blue Pearl Crayfish - 1+ inch […]"

Aquatic Arts only ships within the U.S.

From Washington Department of Fish and Wildlife (2017):

"Prohibited aquatic animal species. RCW 77.12.020
These species are considered by the commission to have a high risk of becoming an invasive species and may not be possessed, imported, purchased, sold, propagated, transported, or released into state waters except as provided in RCW 77.15.253. […]
The following species are classified as prohibited animal species: […]
Family Parastacidae: Crayfish: All genera except *Engaeus*, and except the species *Cherax quadricarninatus*, *Cherax papuanus*, and *Cherax tenuimanus*."

From FFWCC (2017):

"Prohibited nonnative species 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. Very limited exceptions may be made by permit from the Executive Director […]
Aquatic Invertebrates […]
Crayfish – Genus *Cherax* […]
Cherax albidus(Dalhousie Springs Yabbie)"

Means of Introduction into the United States

This species has not been reported as introduced or established in the United States.

Remarks

From CABI (2017):

"The taxonomic status of *Cherax destructor* is under debate (Souty-Grosset et al. 2006). Riek (1969) identified four species in the '*C. destructor*' species-group: *C. albidus*, *C. destructor*, *C. esculus*, and *C. davisi*. Today there is consensus that *C. esculus* and *C. davisi* do not deserve recognition at the species level and that *C. albidus* and *C. destructor* are separate taxa (Sokol, 1988; Campbell et al., 1994; Austin, 1996). However, there is some disagreement concerning at what level the latter two taxa should be recognized and even if they should be distinguished at all (Austin et al., 2003). Using morphological and morphometric data, Sokol (1988) considered *C. albidus* as a distinct species. On the contrary, basing their view on genetic evidence, Campbell et al. (1994) and Austin (1996) interpreted the taxon as a subspecies of *C. destructor*. Austin et al. (2003) even stated that *C. albidus* and *C. destructor* are synonyms. The majority of zoologists (e.g. Munasinghe et al., 2004; Nguyen et al., 2004) use the species epithet *destructor*, but, for essentially commercial reasons, Western Australian Fisheries personnel use the epithet *albidus* (e.g. Morrissy and Cassells, 1992; Lawrence and Jones, 2002)."

"The common name, yabby, is an ambiguous term since it is also used to describe other Australian *Cherax* species (other than the smooth marron, *Cherax cainii*, and the hairy marron, *Cherax tenuimanus*) and *Engaeus* spp., and is also applied to some marine Decapoda (e.g. mud

shrimp, infraorder Thalassinidea, such as the bass yabby, *Trypaea australiensis* Dana, 1852, a common species in southeastern Australia that is used as bait)."

From Department of Fisheries (2002):

"Female *C*[*herax*] *rotundus* cross-breed with male *C. albidus* to produce all-male hybrid yabbies (Lawrence et al., 1998). Extensive backcrossing of all-male hybrid yabbies with *C. albidus*, and preliminary back-crossing with *C. rotundus*, have not produced viable offspring, which effectively limits potential alterations to genetic diversity to hybrid yabbies. Male *C. rotundus* will mate with female *C. albidus* to produce a 'normal' sex ratio of 1 male:1 female (Lawrence et al., 1998)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From GBIF Secretariat (2016):

"Kingdom	Animalia
Phylum	Arthropoda
Class	Malacostraca
Order	Decapoda
Family	Parastacidae
Genus	*Cherax* Erichson, 1846
Species	*Cherax albidus* Clark, 1936"

"SPECIES | ACCEPTED"

From CABI (2017):

"The taxonomic status of *Cherax destructor* is under debate (Souty-Grosset et al. 2006). Riek (1969) identified four species in the '*C. destructor*' species-group: *C. albidus*, *C. destructor*, *C. esculus*, and *C. davisi*. Today there is consensus that *C. esculus* and *C. davisi* do not deserve recognition at the species level and that *C. albidus* and *C. destructor* are separate taxa (Sokol, 1988; Campbell et al., 1994; Austin, 1996). However, there is some disagreement concerning at what level the latter two taxa should be recognized and even if they should be distinguished at all (Austin et al., 2003). Using morphological and morphometric data, Sokol (1988) considered *C. albidus* as a distinct species. On the contrary, basing their view on genetic evidence, Campbell et al. (1994) and Austin (1996) interpreted the taxon as a subspecies of *C. destructor*. Austin et al. (2003) even stated that *C. albidus* and *C. destructor* are synonyms. The majority of zoologists (e.g. Munasinghe et al., 2004; Nguyen et al., 2004) use the species epithet *destructor*, but, for essentially commercial reasons, Western Australian Fisheries personnel use the epithet *albidus* (e.g. Morrissy and Cassells, 1992; Lawrence and Jones, 2002)."

Crandall and De Grave (2017) recognize *C. albidus* as a distinct species from *C. destructor* in their classification of freshwater crayfishes of the world.

Size, Weight, and Age Range

From Australian Blue Yabby Aquaculture (2012):

"A female yabby never grows to the size of an adult male. The average yabby caught in dams is 7 to 10cm long and weighing 20 to 60gms."

From Height (2008):

"Yabbies can attain a maximum size of 220 g (Lawrence and Jones 2002) […]"

Environment

From Australian Blue Yabby Aquaculture (2012):

"DO (Dissolved oxygen)
Water should contain over 4ppm (parts per million) of DO, or roughly 40% saturation. […]
pH
Yabbies prefer alkaline water (pH 7.5 to 10), rarely are yabbies found in acidic water (pH below 7) as this inhibits their metabolism and respiration rate.
SALINITY
A salinity level of up to 12ppt (parts per thousand) will not affect yabbies but they will die at levels of 25ppt.
CHLORINE
Low levels of chlorine do not seem to affect adult yabbies, however juveniles do suffer at higher levels and start to die off."

From Height (2008):

"[…] yabbies appear to possess […] tolerance of lower dissolved oxygen levels (< 1 mg/L) […] (Morris and Callaghan 1998; Lawrence and Jones 2002) […]"

Climate/Range

From Australian Blue Yabby Aquaculture (2012):

"Adult yabbies can tolerate quite a large temperature range of between 1°C and 35°C. Juvenile yabbies do not survive over 30°C and the preferred temperature is between 15°C and 26°C."

Distribution Outside the United States

Native

From Australian Aquatic Biological (2012):

"Victoria & SA [South Australia] Southern flowing streams west Port Phillip Bay to south eastern corner SA"

Introduced

From Height et al. (2006):

"Yabbies (*Cherax albidus* Clark 1936) were first introduced to farm dams in Western Australia in 1932 (Morrissy and Cassells 1992) from the eastern states of Australia. Although the present distribution of yabbies in this region is uncertain, a number of breeding populations are known to exist as a result of escape from man-made impoundments […]"

From FAO (2017):

"*Cherax albidus* introduced to South Africa from unknown
Date of introduction: Unknown […]
Status of the introduced species in the wild: Established
The introduced species is established through: Natural reproduction"

"*Cherax albidus* introduced to Zambia from South Africa
Date of introduction: 1992 […]
Status of the introduced species in the wild: Probably not established"

From Monde (2016):

"*C. quadricarinatus* […] together with the other two *Cherax albidus* and *Cherax tenuimanus* were then introduced into Zambia from South Africa through a farmer known as Grubb near Livingstone in 1992 (Mikkola, 1996; Thys van den Audenaerde, 1994)."

Means of Introduction Outside the United States

From FAO (2017):

"aquaculture"

Short Description

From Invasive Species of Idaho (no date):

"Diagnostic Characteristics

- Beige or coffee to almost black in color; will turn blue in captivity over an extended period of time
- Head has four ridges which run with the body; two are very obvious
- Inner edge of claws have a mat of obvious hairs"

From Lawrence (2001):

"Since 1936, scientists and farmers have distinguished *C. albidus* from *C. destructor* using a number of morphological characteristics, the most notable being the presence of a dense mat of setae on the upper surface of the chelae and a wider areola (Clark 1936, Sokol 1988, Campbell [et al.] 1994)."

Biology

From Australian Blue Yabby Aquaculture (2012):

"The yabby is capable of living in virtually any body of fresh water including rivers, streams, dams and even some temporary waters. Yabbies actively burrow into dam walls and are very hardy creatures. They are able to withstand poor water quality, fluctuating temperatures and long periods of drought. If a particular watercourse dries up, yabbies burrow deep into the bottom until they reach moist soil, and remain there until the watercourse fills once again. They can remain this way for many months, or even years."

"Yabbies are known as detritus feeders (rotting vegetable and animal matter); they are omnivorous although prefer a vegetarian diet. The yabby is not averse to attacking and eating its own kind, especially when the prey yabby is smaller, or soft after shedding its shell[.] To live, the yabby does not require to be immersed in water. If its gills are kept wet it can absorb oxygen from the air and can survive for many months. To breed however, the yabby must be completely immersed in water."

From Height (2008):

"[…] yabbies appear to possess a number of competitive advantages […] including: a younger age at sexual maturity (< 1 year), capable of multiple spawns (Lawrence and Jones 2002; Beatty [2005]); more aggressive behaviour (Morrissy et al. 1990; Mills et al. 1994); the ability to burrow and survive in ephemeral habitats (Beatty et al. [2005]); […] and higher behavioural plasticity (Gherardi et al. 2002a; Height and Whisson 2006). Thus, like other invasive freshwater crayfish species, yabbies show the characteristics of an r-selected species (Lawrence et al. 2002; Beatty et al. [2005])."

Human Uses

From Department of Fisheries (2002):

"Since being introduced into Western Australia from Victoria in 1932 (Morrissy & Cassells, 1992) the 'white yabby' (*C. albidus*) has formed the basis of a significant inland farm dam aquaculture industry."

From Australian Blue Yabby Aquaculture (2012):

"Yabbies are entertaining aquarium pets and very easy to keep."

"There are many edible parts to the yabby. The tail and the claw meat (about 40% of the total body weight) form the bulk of the edible flesh. The 'mustard' is the soft, orange-brown liver found in the carapace (main shell). It has a mustard flavour and connoisseurs relish it spread over the tail meat. The 'coral' is the developing ovary or egg sac, found in the carapace of the female. This turns red on cooking and is quite tasty alone, or beaten into sauces."

Diseases

From Longshaw (2011):

"White spot syndrome virus is a double stranded DNA virus in the family Nimaviridae which affects a wide range of crustacean hosts, including crayfish (Stentiford et al., 2009). […] Experimental transmission of the virus to naïve crayfish has been demonstrated using haemolymph […] from *Penaeus monodon* to *Cherax destructor albidus* by Edgerton (2004) […]"

"Picornaviridae are single stranded RNA viruses. Following a survey of yabbies by Edgerton (1999), a new picorna-like virus (*Cherax albidus* picorna-like virus (CaPV)) associated with mortalities was reported. Subsequently, Jones and Lawrence (2001) reported the same virus associated with mortality in farmed *C. albidus* in western Australia. Although prevalence was <5%, its distribution throughout the farming area was widespread."

"*Thelohania* species in crayfish are generally found within the musculature with infected animals generally appearing opaque or whitish giving rise to the common name of porcelain disease or cotton tail. […] *T. parastaci* [has been] described from *Cherax destructor albidus*, *C. d. rotundus* and *C. d. destructor* […]"

"*Vavraia parastacida* has been reported from *Cherax tenuimanus*, *C. albidus*, *Cherax quinquecarinatus* and *C. quadricarinatus* (Langdon, 1991a, 1991b; Langdon and Thorne, 1992). Infected animals apparently have a bluish colouration, particularly lateral and ventral to the tail. Similar to *Thelohania* sp. reported by Herbert (1987), infected animals are sluggish with limited tail-flick response."

"Jones and Lawrence (2001) reported a *Psorospermium* sp. in the gills, connective and neural tissues of *C. albidus* with negligible host response, in Australia."

From Edgerton (2004):

"The aim of this study was to determine susceptibility of the commercially important subspecies *C. destructor albidus* to white spot syndrome virus (WSSV), a hazard to crustaceans and currently considered to be exotic to Australia. In challenge tests by intramuscular injection, *C. destructor albidus* displayed a similar level of susceptibility to white spot disease (WSD) as *Penaeus monodon* (i.e. 100% mortality in 3 d). In one oral challenge test where *C. destructor albidus* was subjected to significant temperature stress, over 50% died of severe WSD within 14 d post challenge. All dead and moribund crayfish displayed histopathological lesions typical for WSD and gave positive results for WSSV in DNA dot blot hybridization tests. Survivors to 30 d (n = 3) showed no lesions and gave negative dot blot test results. In a second oral challenge test without temperature stress, mortality was delayed but reached 75% by 30 d. However, no typical WSD lesions were observed in the dead, dying or surviving crayfish and dot blot test results were negative."

White spot disease (caused by white spot syndrome virus) is an OIE-reportable disease.

Threat to Humans

No information available.

3 Impacts of Introductions

From Height (2008):

"Of particular concern is the impact of exotic species on native marron (*Cherax tenuimanus*) populations. Marron also compete for resources with another freshwater crayfish native to the eastern states of Australia - the congeneric yabby (*Cherax albidus*). The distribution of yabbies in Western Australia has progressively increased since their introduction and the species is classed as invasive (Morrissy and Cassells 1992; Beatty et al. [2005])."

From Height et al. (2006):

"Marron (*Cherax tenuimanus* Smith 1912) are native to the permanent rivers and streams in the south-west of WA. Yabbies (*Cherax albidus* Clark 1936) were first introduced to farm dams in Western Australia in 1932 (Morrissy and Cassells 1992) from the eastern states of Australia. Although the present distribution of yabbies in this region is uncertain, a number of breeding populations are known to exist as a result of escape from man-made impoundments, placing pressure on native marron populations as both species compete for limited resources. These competitive interactions between marron and yabbies are not well understood, particularly in the case of shelter acquisition. […] The results of this research indicate that body size is a key factor influencing shelter competition between marron and yabbies. […] While many influencing factors have been identified (burrowing, habitat type and complexity, presence of macrophytes, water depth and quality), in Western Australia, the smaller body size of yabbies compared to marron may be an important factor limiting the expansion of yabby populations in the presence of marron, especially in waterbodies where shelter is a limited resource."

From Lawrence (2001):

"Compared to other freshwater crayfish species that have caused problems by burrowing into water reservoirs and agricultural fields, *C. albidus* appears far less damaging. […] Given the widespread distribution of *C. albidus* yabbies in farm dams throughout WA [Western Australia], the low percentage of dams containing burrows and the lack of reports of farm dam banks being compromised by burrows, evidence suggests that burrowing by *C. albidus* does not damage dams."

4 Global Distribution

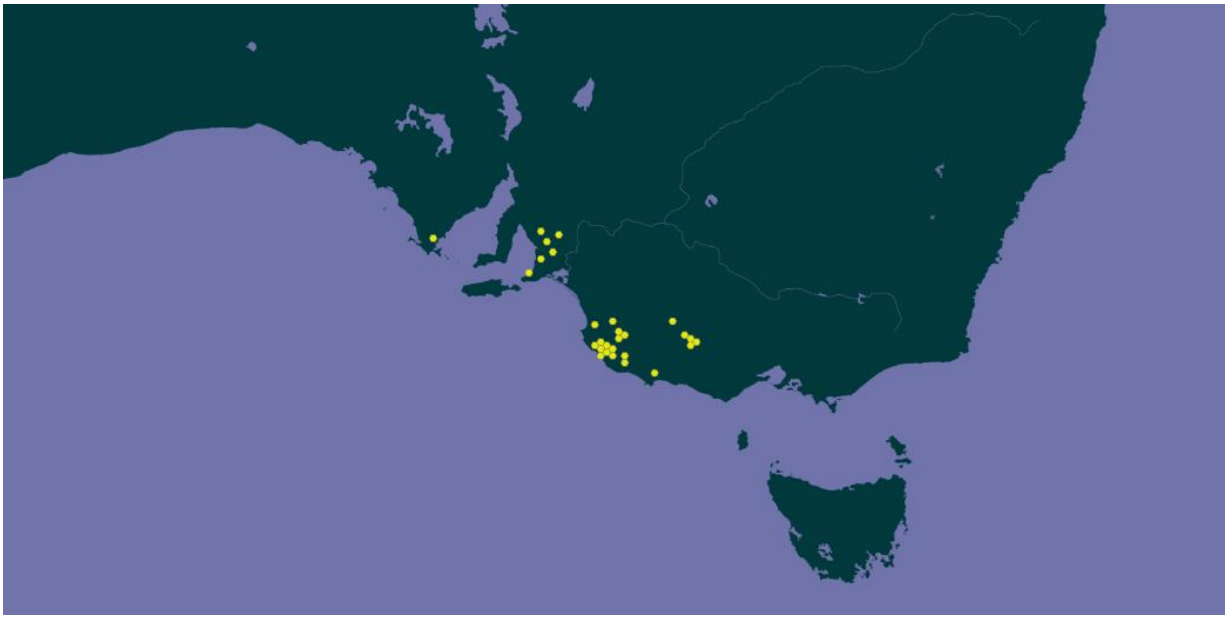


Figure 1. Known global distribution of *Cherax albidus*. Map from GBIF Secretariat (2016).

5 Distribution Within the United States

This species has not been reported as introduced or established in the United States.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was low for most of the continental United States. The maximum climate match scores were found along the west coast in California, Oregon and Washington, where climate matches were medium. Climate 6 score indicated that the contiguous U.S. has a medium climate match overall. The range of scores for a medium climate match is 0.005-0.103; Climate 6 score for *Cherax albidus* was 0.011.

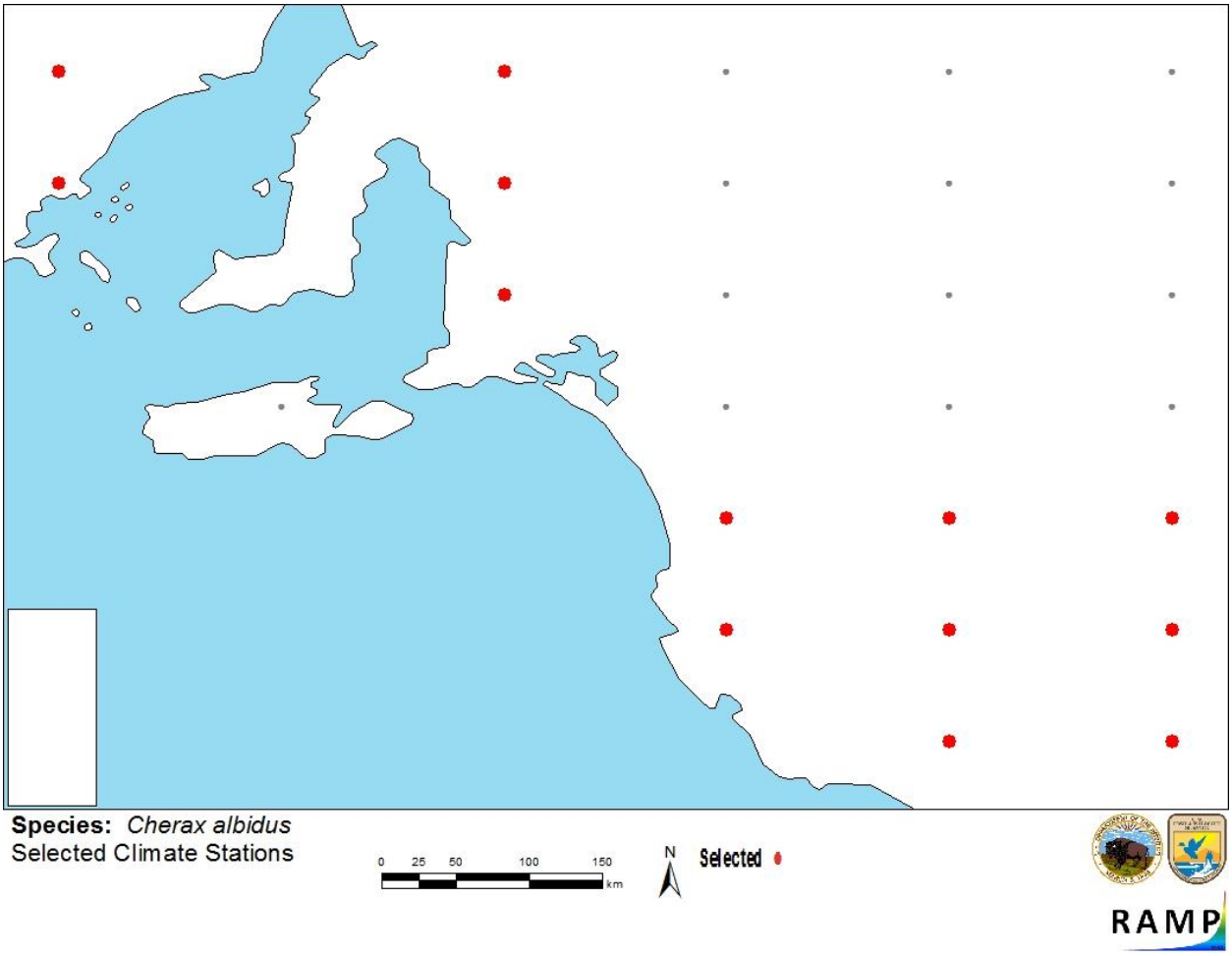


Figure 2. RAMP (Sanders et al. 2014) source map showing weather stations in South Australia and Victoria, Australia, selected as source locations (red) and non-source locations (gray) for *Cherax albidus* climate matching. Source locations from GBIF Secretariat (2016).

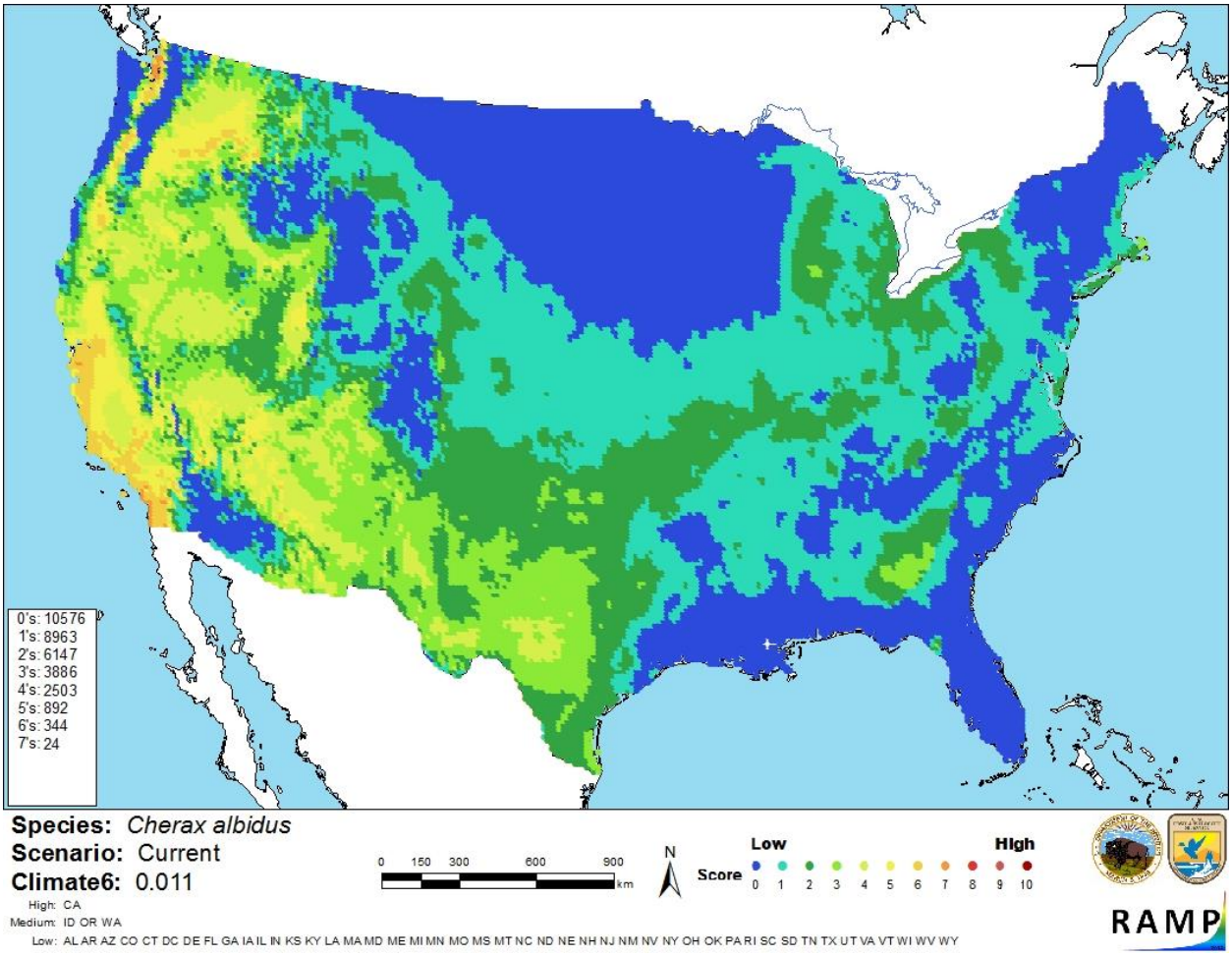


Figure 3. Map of RAMP (Sanders et al. 2014) climate matches for *Cherax albidus* in the contiguous United States based on source locations reported by GBIF Secretariat (2016). 0=Lowest match, 10=Highest match.

The "High", "Medium", and "Low" climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

Information is available on the biology, ecology, and distribution of *Cherax albidus*. However, much of the information available comes from literature published by aquaculture and aquarium businesses and by government agencies, rather than peer-reviewed literature from scientific journals. Taxonomic uncertainty exists around whether *C. albidus* should be considered as a unique species or as a subspecies of *C. destructor*. Additionally, limited information is available

on impacts of introduction of *C. albidus* and claims of invasiveness are not well substantiated. Certainty of this assessment is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Cherax albidus is a crayfish native to the Australian states of South Australia and Victoria. It has been introduced in Western Australia, South Africa, and Zambia for aquaculture purposes. *C. albidus* is also present in the aquarium trade, including in the United States. Multiple states have listed *C. albidus* as a prohibited species, disallowing possession and importation into the state. *C. albidus* is thought to compete with the native *C. tenuimanus* in Western Australia, but scientific evidence appears limited and one peer-reviewed study found that *C. albidus* was unable to displace *C. tenuimanus* from shelters consistently. *C. albidus* was also found to cause minimal damage to infrastructure through burrowing compared to other crayfish species. Climate match of *C. albidus* to the contiguous U.S. was medium, with the most suitable climate occurring on the Pacific Coast. The overall risk assessment for *Cherax albidus* is uncertain because no scientifically rigorous studies have yet attributed adverse impacts to introduced *C. albidus*.

Assessment Elements

- **History of Invasiveness: None Documented**
- **Climate Match: Medium**
- **Certainty of Assessment: Low**
- **Important Additional Information: Susceptible to white spot disease, an OIE-reportable disease.**
- **Overall Risk Assessment Category: Uncertain**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

Aquatic Arts. 2017. Blue pearl crayfish. Available: https://aquaticarts.com/products/blue-pearl crayfish. (September 2017).

Australian Aquatic Biological. 2012. Crayfish list – freshwater crayfish of Australia (January 2012). Available: http://www.aabio.com.au/crayfish-list/. (September 2012).

Australian Blue Yabby Aquaculture. 2012. The yabby. Available: http://www.blueyabby.com/the-yabby. (September 2012).

CABI. 2017. *Cherax destructor* (yabby) [original text by Uma Sabapathy Allen]. Invasive Species Compendium. CAB International, Wallingford, U.K. Available: http://www.cabi.org/isc/datasheet/89134. (September 2017).

Crandall, K. A., and S. De Grave. 2017. An updated classification of the freshwater crayfishes (Decapoda: Astacidea) of the world, with a complete species list. Journal of Crustacean Biology 37(5):615-653.

Department of Fisheries. 2002. The introduction and aquaculture of non-endemic species in Western Australia: the 'rotund' yabby *Cherax rotundus* and the all-male hybrid yabby: a discussion paper. Fisheries Management Paper 160, Department of Fisheries, Perth, Australia.

Edgerton, B. F. 2004. Susceptibility of the Australian freshwater crayfish *Cherax destructor albidus* to white spot syndrome virus (WSSV). Diseases of Aquatic Organisms 59(3):187-193.

FAO. 2017. Database on introductions of aquatic species. FAO, Rome. Available: http://www.fao.org/fishery/introsp/search/en. (September 2017).

FFWCC (Florida Fish and Wildlife Conservation Commission). 2017. Prohibited species list. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Available: http://myfwc.com/wildlifehabitats/nonnatives/regulations/prohibited/. (September 2017).

GBIF Secretariat. 2016. GBIF backbone taxonomy: *Cherax albidus* Clark, 1936. Global Biodiversity Information Facility, Copenhagen. Available: https://www.gbif.org/species/4648606. (September 2017).

Height, S. G. 2008. Behavioural responses of Australian freshwater crayfish (*Cherax tenuimanus* and *Cherax albidus*) to water-borne odours. Doctoral thesis. Curtin University of Technology, Perth, Australia.

Height, S. G., B. Marsh, and G. J. Whisson. 2006. The influence of gender, size, life-stage and prior residence on shelter acquisition by marron (*Cherax tenuimanus*) and yabbies (*Cherax albidus*). Freshwater Crayfish 15:79-86.

Invasive Species of Idaho. No date. Yabby crayfish. Invasive Species/Noxious Weeds Program, Idaho State Department of Agriculture, Boise, Idaho. Available: https://static1.squarespace.com/static/564b8c9ae4b0459b2b8187a3/t/56c7b50a746fb93e2271333c/1455928587907/Yabby+Crayfish.pdf. (September 2017).

Lawrence, C. S. 2001. Morphology and incidence of yabby (*Cherax albidus*) burrows in Western Australia. Fisheries Research Report [Western Australia] 129:1-26.

Longshaw, M. 2011. Diseases of crayfish: a review. Journal of Invertebrate Pathology 106:54-70.

Monde, C. 2016. Impact of natural and anthropogenic factors on the trophic interactions of molluscivores and *Schistosoma* host snails. Doctoral thesis. Wageningen University, Wageningen, The Netherlands.

Sanders, S., C. Castiglione, and M. Hoff. 2014. Risk Assessment Mapping Program: RAMP. U.S. Fish and Wildlife Service.

Washington Department of Fish and Wildlife. 2017. WAC 220-12-090 classification – nonnative aquatic animal species. Washington Department of Fish and Wildlife, Olympia, Washington. Available: http://wdfw.wa.gov/ais/wac.html. (September 2017).

10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

Austin, C. M. 1996. Systematics of the freshwater crayfish genus *Cherax* Erichson (Decapoda: Parastacidae) in northern and eastern Australia: electrophoretic and morphological variation. Australian Journal of Zoology 44:259-296.

Austin, C. M., T. T. T. Nguyen, M. M. Meewan, and D. Jerry. 2003. The taxonomy and evolution of the *Cherax destructor* complex (Decapoda: Parastacidae) re-examined using mitochondrial 16S sequence. Australian Journal of Zoology 51:99-110.

Beatty, S. J., D. L. Morgan, and H. S. Gill. 2005b. Role of life history strategy in the colonisation of Western Australian aquatic systems by the introduced crayfish *Cherax destructor* Clark, 1936. Hydrobiologia 549:219-237.

Campbell, N. J. H, M. C. Geddes, and M. Adams. 1994. Genetic variation in yabbies *Cherax destructor* and *C. albidus* (Crustacea : Decapoda : Parastacidae), indicates the presence of a single highly sub-structured species. Australian Journal of Zoology 42:745-760.

Clark, E. 1936. The freshwater and land crayfishes of Australia. Memoirs of the Natural Museum of Victoria 10:5-58.

Edgerton, B. 1999. A review of freshwater crayfish viruses. Freshwater Crayfish 12:261-278.

Gherardi, F., P. Acquistapace, B. A. Hazlett, and G. Whisson. 2002a. Behavioural responses to alarm odours in indigenous and non-indigenous crayfish species: a case study from Western Australia. Marine and Freshwater Research 53:93-98.

Height, S. G., and G. J. Whisson. 2006. Behavioural responses of Australian freshwater crayfish (*Cherax cainii* and *Cherax albidus*) to exotic fish odour. Australian Journal of Zoology 54:399-407.

Herbert, B. 1987. Notes on diseases and epibionts of *Cherax quadricarinatus* and *C. tenuimanus* (Decapoda: Parastacidae). Aquaculture 64:165-173.

Jones, J. B., and C. S. Lawrence. 2001. Diseases of yabbies (*Cherax albidus*) in Western Australia. Aquaculture 194:221-232.

Langdon, J. S., 1991a. Description of *Vavraia parastacida* sp. nov. (Microspora: Pleistophoridae) from marron, *Cherax tenuimanus* (Smith), (Decapoda: Parastacidae). Journal of Fish Diseases 14:619-629.

Langdon, J. S. 1991b. Microsporidiosis due to a pleistophorid in marron, *Cherax tenuimanus* (Smith), (Decapod: Parastacidae). Journal of Fish Diseases 14:33-44.

Langdon, J. S., and T. Thorne. 1992. Experimental transmission *per os* of microsporidiosis due to *Vavraia parastacida* in the marron, *Cherax tenuimanus* (Smith), and yabby, *Cherax albidus* Clark. Journal of Fish Diseases 15:315-322.

Lawrence, C. S., J. I. Brown, and J. E. Bellanger. 2002. Morphology and occurrence of yabby (*Cherax albidus* Clark) burrows in Western Australian farm dams. Freshwater Crayfish 13:253-264.

Lawrence, C. S., and C. Jones. 2002. *Cherax*. Pages 635-669 *in* D. M. Holdich, editor. Biology of freshwater crayfish. Blackwell Science, Oxford, London.

Lawrence, C. S., N. M. Morrissy, J. E. Bellanger, and Y. W. Cheng. 1998. Enhancement of yabby production from Western Australian farm dams. Fisheries Research and Development Corporation Report No 94/75.

Mikkola, H. 1996. Alien freshwater crustacean and indigenous mollusc species with aquaculture potential in eastern and southern Africa. Southern African Journal of Aquatic Science 22:90-99.

Mills, B. J., N. M. Morrissy, and J. V. Huner. 1994. Cultivation of freshwater crayfishes in Australia. Pages 217-289 *in* J. V. Huner, editor. Freshwater crayfish aquaculture in North America, Europe and Australia: families Astacidae, Cambaridae and Parastacidae. Food Products Press, New York.

Morris, S., and J. Callaghan. 1998. The emersion response of the Australian yabbie *Cherax destructor* to environmental hypoxia and the respiratory and metabolic responses to consequent air-breathing. Journal of Comparative Physiology B 168:389-398.

Morrissy, N. M., and G. Cassells. 1992. Spread of the introduced yabbie *Cherax albidus* Clark, 1936 in Western Australia. Fisheries Research Report – Fisheries Department of Western Australia 92:27.

Morrissy, N. M., L. H. Evans, and J. V. Huner. 1990. Australian freshwater crayfish: aquaculture species. World Aquaculture 21:113-122.

Munasinghe, D. H. N., C. P. Burridge, and C. M. Austin. 2004. The systematics of freshwater crayfish of the genus *Cherax* Erichson (Decapoda: Parastacidae) in eastern Australia re-examined using nucleotide sequences from 12S rRNA and 16S rRNA genes. Invertebrate Systematics 18:215-225.

Nguyen, T. T. T., C. M. Austin, M. M. Meewan, M. B. Schultz, and D. R. Jerry. 2004. Phylogeography of the freshwater crayfish *Cherax destructor* Clark (Parastacidae) in inland Australia: historical fragmentation and recent range expansion. Biological Journal of the Linnean Society 83:539-550.

Riek, E. F. 1969. The Australian freshwater crayfish (Crustacea: Decapoda: Parastacidae), with the description of new species. Australian Journal of Zoology 17:855-918.

Sokol, A. 1988. Morphological variation in relation to the taxonomy of the *destructor* group of the genus *Cherax*. Invertebrate Taxonomy 2:55-79.

Souty-Grosset, C., D. M. Holdich, P. Y. Noel, J. D. Reynolds, and P. Haffner. 2006. Atlas of crayfish in Europe. Muséum national d´Histoire naturelle, Paris, France.

Stentiford, G. D., J.-R. Bonami, and P. Alday-Sanz. 2009. A critical review of susceptibility of crustaceans to Taura syndrome, Yellowhead disease and White Spot Disease and implications of inclusion of these diseases in European legislation. Aquaculture 291:1-17.

Thys van den Audenaerde, D. F. 1994. Introduction of aquatic species into Zambian waters, and their importance for aquaculture and fisheries. ALCOM Field Document 24:1-29.