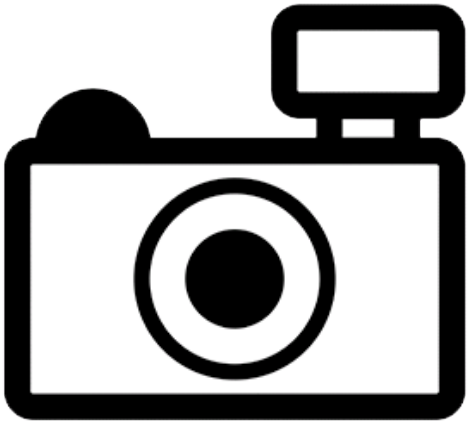
Corbicula linduensis (a clam, no common name)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, September 2011
Revised, February 2019
Web Version, 7/11/2019



No Photo Available

1 Native Range and Status in the United States

Native Range

According to Annawaty et al. (2016), *Corbicula linduensis* is endemic to Lake Lindu, Sulawesi, Indonesia.

From Djajasasmita (1975):

"The localities of the specimens examined: Lake Lindu, […]."

Status in the United States

Corbicula linduensis has not been reported as introduced or established in the United States. *C. linduensis* has not been found in trade.

Means of Introductions in the United States

Corbicula linduensis has not been reported as introduced or established in the United States.

Remarks

From Djajasasmita (1975):

"*C. linduensis*, which was abundant in Lake Lindu once and an important source of animal protein for Lindu inhabitants [Bonne and Sandground 1939], is now nearly extinct. Throughout the lake intensive surveys were carried out for collection purposes, but only one area was found in the river head of the Cumbasa outlet. The decrease of the population in the lake coincided with the introduction in 1951 of the mujair fish, *Tilapia mossambica* Peters, 1852."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Djajasasmita (1975), *Corbicula linduensis* (Bollinger, 1914) is the current and valid name of this species.

From EOL (2019):

"[Superkingdom] Eukaryota
Opisthokonta
[Kingdom] Metazoa
[Subkingdom] Bilateria
[Infrakingdom] Protostomia
Spiralia
[Phylum] Mollusca
[Class] Bivalvia
[Subclass] Heterodonta
[Infraclass] Euheterodonta
[Superorder] Imparidentia
[Order] Venerida
[Superfamily] Cyrenoidea
[Family] Cyrenidae
[Genus] *Corbicula*
[Species] *Corbicula linduensis* Bollinger 1914"

Size, Weight, and Age Range

Korniushin and Glaubrecht (2003) lists the size ranges of gravid specimens of *Corbicula linduensis* as 10.4 mm to 17.0 mm.

From Djajasasmita (1975):

"The average measurements of 11 specimens examined: length 23.2 mm; height 14.7 mm; diameter 6.2 mm."

Environment
From Glaubrecht et al. (2006):

"*Corbicula* an ideal model group for […] shelled larvae in freshwater lineages, […]."

Climate/Range
No information on climate or range was found for *Corbicula linduensis*.

Distribution Outside the United States
Native
According to Annawaty et al. (2016), *Corbicula linduensis* is endemic to Lake Lindu, Sulawesi, Indonesia.

From Djajasasmita (1975):

"The localities of the specimens examined: Lake Lindu, […]."

Introduced
Corbicula linduensis has not been reported as introduced or established anywhere outside of its native range.

Means of Introduction Outside the United States
Corbicula linduensis has not been reported as introduced or established anywhere outside of its native range.

Short Description
From Djajasasmita (1975):

"Shell thin, elongated, shining and little inflated Posterior dorsal margin higher than the anterior one. Anterior part narrowed with rounded margin, posterior part somewhat elongated and wider, with truncated margin. Ventral margin straight or slightly arched, sometimes concave at the centre. Faint obtuse ridge present on posterior part, sloping from umbo. Periostracum yellowish to blackish green, fine and densely plicated on marginal area. Concentrical ribs little distinct. Fine growth lines distinct. Lunula not distinct. Hinge teeth normal. Angle between anterior and posterior lateral teeth wide. Inner surface of valve violet, polished on margin below palliai line. Lateral and cardinal teeth light violet to whitish. Palliai line and muscle scars impressed."

Biology
From Glaubrecht et al. (2006):

"[…] prolonged incubation of large embryos with well-developed shells"

"All *Corbicula* species endemic to Sulawesi […] were found to be endobranchous, i.e. to incubate their young in their inner demibranchs at least until the stage of juveniles with straight-hinged shells (D-shaped), thus being ovoviviparous."

From Korniushin and Glaubrecht (2003):

"[…] prolonged incubation in the maternal gills, with juvenile shells reaching up to 1.3 mm in length and with a well-developed hinge in *C. linduensis* Bollinger, 1914 from the Lindu River system."

"Most of the available gravid specimens of this species contained in their inner demibranchs about 10–35 juveniles with a shell length of up to 1.5 mm […]. Two adults carried several hundred small (0.27 mm long) larvae in their inner demibranchs […]; in one adult both small and large offspring were found together occupying different water tubes […]. Small larvae aggregated in groups of 10–20 specimens of approximately the same size […]. In contrast, large juveniles lay separately, and their sizes varied, although no size classes were distinguishable […]. SEM study showed very strong development of interlamellar septae, especially in later stages of incubation. In brooding specimens of this species the entire demibranch was thicker than in other studied *Corbicula*. Some interlamellar septae were not complete, forming elevations and/or bridges of tissue in the interlamellar space […]. Another peculiarity of *C. linduensis* was the tight contact between epithelium of septae and incubated juveniles, cylindrical epithelial cells were noticeable in this area […].

Histological sections of inner demibranchs have also shown strong development of interlamellar septae, which were con-siderably thicker than any other studied taxon […]. At the same time, the epithelium of these septae was somewhat lower, and the mucous cells were apparently not so abundant […] compared to those species of *Corbicula* with other types of brooding. Small larvae of *C. linduensis* […] were similar to those in other incubating species of *Corbicula*, while the large juveniles had a protruding umbo and well-developed hinge indicating their advanced stage of development […]. Juveniles of this type are defined as 'umbonal' […]. Pores on the internal shell surface and dissoconch sculpture consisting of coarse irregular concentric striations and very fine radial ribs were also noteworthy […]. All cardinal teeth (c1–c4) were present in juveniles at size of 0.7 mm, c2 and c3 were bent but not yet divided in two parts, as in adult shells [Korniushin and Glaubrecht 2002]; connection between cardinal and anterior lateral teeth were observed […]. Histological sections of intrabranchial juveniles in advanced developmental stages showed well-differentiated organs, e.g. ctenidia and foot […]. We conclude from the great difference in size and the absence of intermediate stages that the D-shaped larvae and the juveniles with a developed hinge occasionally found together in *C. linduensis* belonged to successive clutches indicating the existence of sequential brooding in this taxon. The initial stages of intramarsupial development in this species were the same as in the other incubating *Corbicula*, but juveniles remain in gills until they reach rather advanced stages. Probably, only a small proportion of the offspring reach these stages, while development of other larvae is suppressed. The considerable size increase during the intrabranchial development of the larvae and the advanced developmental stage of juveniles by the time of their release, as observed in *C. linduensis*, again indicate the provision of nourishment other than yolk. Deeply modified tissue of the interlamellar septae may be the source of such nourishment. The fact that the

mucous cells are not proliferating in this species seems important, suggesting other nutritive sources than mucus. Thus, we have several indications that matrotrophy might play a more important role in the larval development of this taxon, but its exact mechanism is still not clear. In addition, brood-cannibalism may occur."

"According to life-history theory, species of *Corbicula* incubating their young generally exhibit a k-strategy, i.e. producing fewer numbers of offspring but having increased parental care, when compared to other oviparous and ovoviviparous bivalve taxa in marine and limnic habitats. This trend is most pronounced in *C. linduensis* that were found to have the largest size and the most restricted number of released juveniles."

Human Uses

From Djajasasmita (1975):

"*C. linduensis*, which was abundant in Lake Lindu once and an important source of animal protein for Lindu inhabitants [Bonne and Sandground 1939], […]"

Diseases

No information on diseases for *Corbicula linduensis* was found. **No OIE-reportable diseases (OIE 2019) were found to be associated with *C. linduensis*.**

Threat to Humans

No information on *Corbicula linduensis* threats to humans was found.

3 Impacts of Introductions

Corbicula linduensis has not been reported as introduced or established outside of their native range.

4 Global Distribution

Figure 1. Map of Lake Lindu, Sulawesi, Indonesia. According to Annawaty et al (2016) and Djajasasmita (1975), *Corbicula linduensis* is endemic to Lake Lindu. Map from Google Maps (2019). No georeferenced observations were available for *Corbicula linduensis* to use in selecting source locations for the climate match. Source points for the climate match were chosen to represent Lake Lindu.

5 Distribution Within the United States

Corbicula linduensis has not been reported within the United States.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for the contiguous United States is uniformly low. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.000, low (scores between 0.000 and 0.005, inclusive, are considered low). All States received low individual climate 6 scores. There were no areas of high or medium match anywhere in the contiguous United States. No georeferenced locations were available for climate matching, so the collection location reported in the literature was used to choose source points.

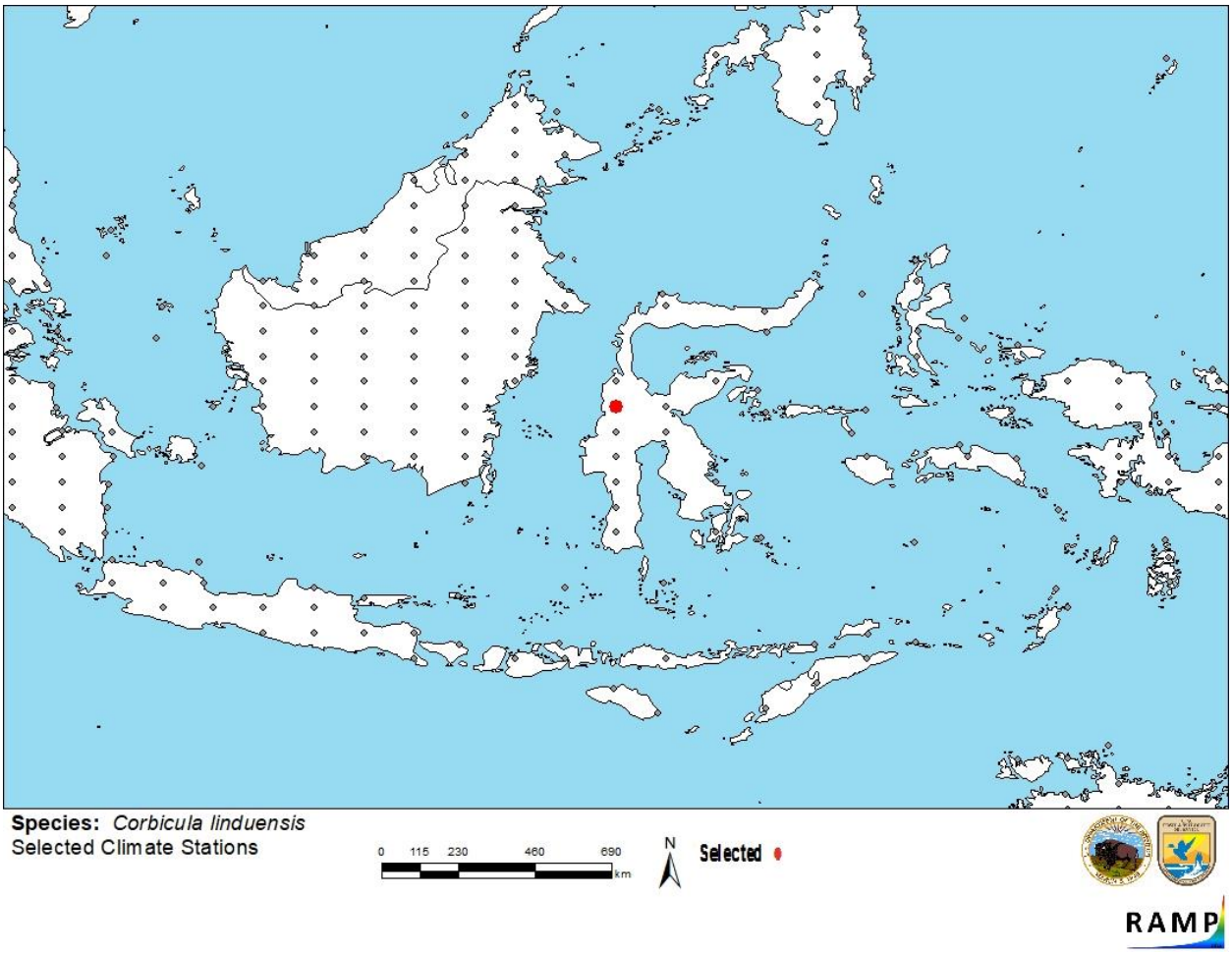


Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in Sulawesi, Indonesia selected as source locations (red) and non-source locations (gray) for *Corbicula linduensis* climate matching. Source locations from Annawaty et al. (2016) and Djajasasmita (1975).

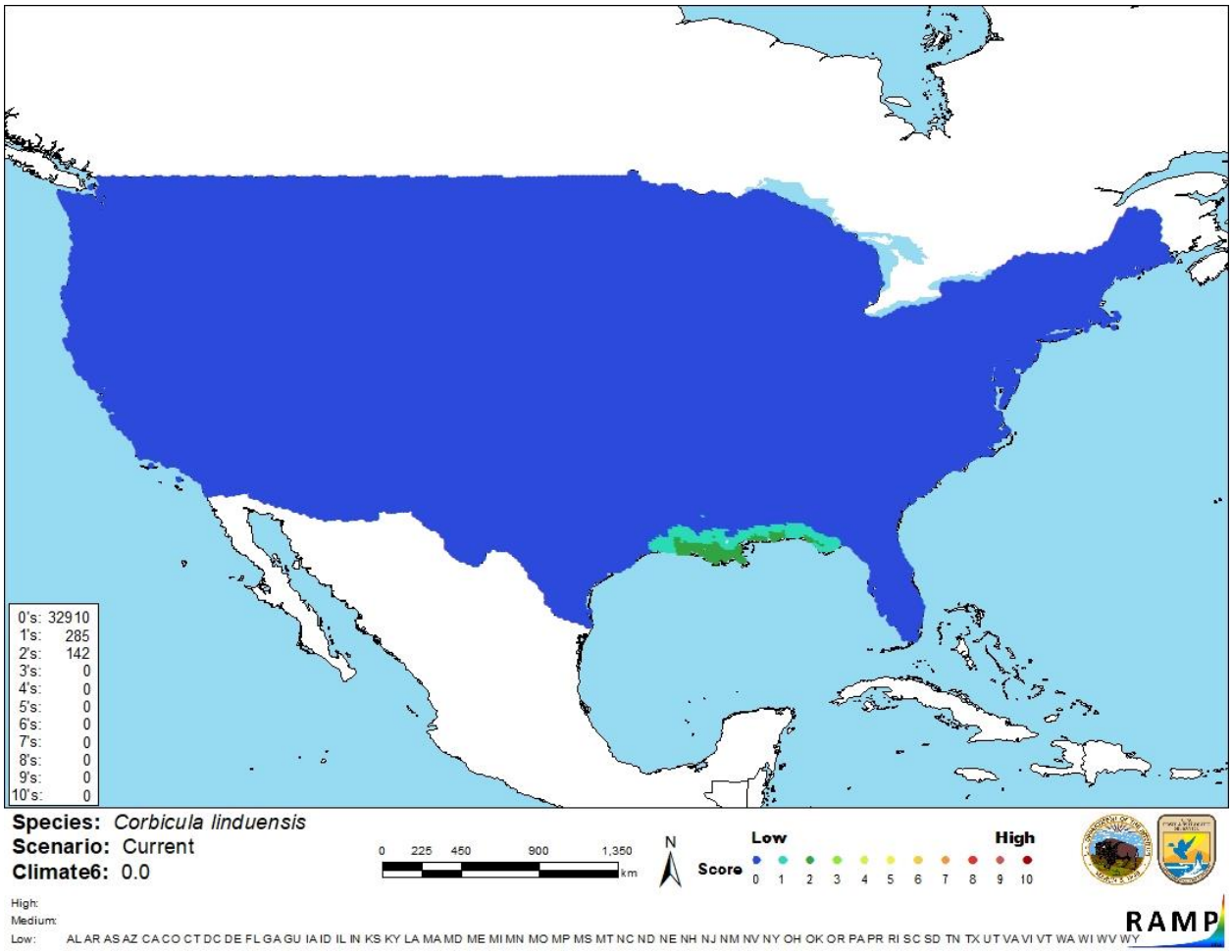


Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *Corbicula linduensis* in the contiguous United States based on source locations reported by from Annawaty et al. (2016) and Djajasasmita (1975). 0 = Lowest match, 10 = Highest match.

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≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

Certainty of assessment for *Corbicula linduensis* is low. Minimal information is available on this species. *C. linduensis* has not been reported as introduced or established anywhere outside of their native range so impacts of introduction cannot be determined.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Corbicula linduensis is a freshwater bivalve, endemic to Lake Lindu in Sulawesi, Indonesia. This species was once abundant in Lake Lindu and is now close to extinction due to the introduction of an invasive fish to the lake. It was an important source of protein locally. *Corbicula linduensis* has not been reported as introduced or established anywhere outside of their native range, therefore history of invasiveness is uncertain. The climate match for the contiguous United States is low with all states receiving low climate scores. There were no areas of high or medium match within the contiguous United States. No georeferenced locations were available for climate matching, so the collection location reported in the literature was used to select source points for the climate match. The certainty of assessment is low. The overall risk of assessment for *Corbicula linduensis* is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): Uncertain**
- **Climate Match (Sec. 6): Low**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information:** The *Corbicula linduensis* population is severely impacted by an introduced fish.
- **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.

Annawaty, A., D. Wowor, A. Farajallah, D. Setiadi, and B. Suryobroto. 2016. Habitat preferences and distribution of the freshwater shrimps of the genus *Caridina* (Crustacae: Decapoda: Atyidae) in Lake Lindu, Sulawesi, Indonesia. HAYATI Journal of Biosciences 23:45–50.

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EOL (Encyclopedia of Life). 2019. *Corbicula linduensis*. Available: https://eol.org/pages/12005299/names. (February 2019).

Glaubrecht, M., Z. Feher, and T. von Rintelen. 2006. Brooding in *Corbicula madagascariensis* (Bivalvia, Corbiculidae) and the repeated evolution of viviparity in corbiculids. Zoologica Scripta 35(6):641–654.

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Korniushin, A. V., and M. Glaubrecht. 2003. Novel reproductive modes in freshwater clams: brooding and larval morphology in Southeast Asian taxa of *Corbicula* (Mollusca, Bivalvia, Corbiculidae). Acta Zoologica 84:293–315.

OIE (World Organisation for Animal Health). 2019. OIE-listed diseases, infections and infestations in force in 2019. Available: http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2019/. (February 2019).

Sanders, S., C. Castiglione, and M. Hoff. 2018. Risk assessment mapping program: RAMP, version 3.1. U.S. Fish and Wildlife Service.

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.

Bonne, C., and J. H. Sandground. 1939. Echinostomiasis in Celebes veroorzaakt door het eten van zoetwatermosselen. Geneesk. Tijdschr. Ned.-Ind. 3k:3016–3031.

Korniushin, A. V., and M. Glaubrecht. 2002. Phylogenetic analysis based on the morphology of viviparous freshwater clams of the family Sphaeriidae (Mollusca, Bivalvia, Veneroida). Zoologica Scripta 31:415–459.