Mesocyclops pehpeiensis (a cyclopoid copepod, no common name)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, May 2018
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1 Native Range and Status in the United States

Native Range

From Hołyńska and Nam (2000):

"The range of *Mesocyclops pehpeiensis* extends from Central Asia (South Kazakhstan, Uzbekistan) through India, Sri Lanka, South East Asia, China to the Japanese Islands (as far as Honshu) […] (for distributional data see Reid, 1994; Kawabata & Defaye, 1994; Mirabdullayev et al., 1995; Mirabdullayev, 1996; Ueda & Ishida, 1997; Ueda et al., 1997)."

Status in the United States

From Reid (1993):

"Wild populations of this species were collected in 1990 and 1991 in ricefields near Jennings, Louisiana, about 300 km west of New Orleans, and near Cleveland, Mississippi, about 400 km north of New Orleans. The species seems to be well established and probably spreading in the region."

From Díaz et al. (2006):

"The species was also found in freshwater lagoons and rice fields at several localities in the states of Louisiana and Mississippi in the southern U.S.A. Yet another population is living in greenhouse tanks and outdoor ponds holding imported ornamental aquatic plants in the District of Columbia, eastern U.S.A."

Means of Introductions in the United States

From Reid (1993):

"The populations in Louisiana and Mississippi were likely introduced, possibly either along with imported tropical aquatic plants or fish, or somehow with rice. […] Adults originally collected in New Orleans were introduced into Jennings ricefields in 1990 and into both Jennings and Cleveland ricefields in 1991 as part of mosquito-control experiments (G.G. Marten, personal communications, 1990, 1991)."

From Suárez-Morales et al. (2005):

"Reid (1996) found it in ponds of aquatic gardens in the area of Washington, D.C., attributing its presence to the importation of exotic plants."

Remarks

From Díaz et al. (2006):

"Its major synonyms are *Mesocyclops Leuckarti* [*sic*] *pehpeiensis* Hu, 1943, *Mesocyclops ruttneri* Kiefer, 1981, and *Mesocyclops* sp. (*leuckarti* group) of Marten (1989)."

"Because Hu's description [of *M. pehpeiensis*] lacked many of the details that are now understood to be important in discriminating species of this genus, the real identity of his species was resolved only recently by Guo (2000). Guo established that the species described by Kiefer (1981) as a new taxon, *M. ruttneri*, is the same as *M. pehpeiensis*."

"In Louisiana and Mississippi the species was initially reported as *Mesocyclops* sp. (*leuckarti* group) by Marten (1989), and later as *M. ruttneri* by Marten et al. (1993), Reid (1993), and Reid and Marten (1995). The District of Columbia population was also reported as *M. ruttneri* by Reid (1996)."

In addition to the accepted scientific name, the above synonyms were used in searching for evidence of species introduction and impacts.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Ecdysozoa
Phylum Arthropoda
Subphylum Crustacea
Class Maxillopoda
Subclass Copepoda
Infraclass Neocopepoda
Superorder Podoplea
Order Cyclopoida
Family Cyclopidae
Genus *Mesocyclops*
Species *Mesocyclops pehpeiensis* Hu, 1943"

"Current Standing: valid"

Size, Weight, and Age Range

From Guo (2000):

"Average length to the end of caudal rami 1.34 mm (n=10); range 1.21–1.52 mm [for females;] Average length to end of caudal rami 0.81 mm (n=7); range 0.74–0.88 mm [for males]."

Phong et al. (2008) report a mean longevity of 50.9 days across 19 female *M. pehpeiensis*.

Environment

From Suárez-Morales et al. (2005):

"*Mesocyclops pehpeiensis* has been collected from a wide variety of tropical freshwater environments. They include ricefields and urban ponds (Reid 1993, 1996). […] According to Reid (1993), this species is more an epibenthic form dwelling in the littoral zones."

From Anufriieva and Shadrin (2016):

"[…] thermophilic […]"

Climate/Range

From Suárez-Morales et al. (2005):

"The overall known latitudinal range of this species extends roughly from 50°N to 7°S, thus including mainly tropical areas of Asia […]"

Distribution Outside the United States

Native

From Hołyńska and Nam (2000):

"The range of *Mesocyclops pehpeiensis* extends from Central Asia (South Kazakhstan, Uzbekistan) through India, Sri Lanka, South East Asia, China to the Japanese Islands (as far as Honshu) […] (for distributional data see Reid, 1994; Kawabata & Defaye, 1994; Mirabdullayev et al., 1995; Mirabdullayev, 1996; Ueda & Ishida, 1997; Ueda et al., 1997)."

Introduced

From Reid (1993):

"Specimens of *Mesocyclops ruttneri* were first collected in Austria in a greenhouse, which had been destroyed by the time that the original description was published (Kiefer, 1981)"

From Suárez-Morales et al. (2005):

"The analysis of samples collected in two ponds of the state of Chiapas, on the Pacific coast of Mexico, yielded the identification of male and female individuals of [*M. pehpeiensis*]."

From Díaz et al. (2006):

"The species we identified was *Mesocyclops pehpeiensis* Hu, 1943. […] The collection locality was Havana City Province, Municipality Cotorro, El Cacao Reservoir, [Cuba] on 26 November 2003."

"[…] additional sampling will be necessary to verify whether *M. pehpeiensis* has established viable populations in Cuba."

From Montoliu et al. (2015):

"We found *Mesocyclops pehpeiensis* outside its native area of distribution in two very distinct localities. One was a rice paddy in the Albufera Lake Natural Park, Valencia [Spain] in the fields of L'Estell […] The other localities were two ponds in Campeche State (Mexico) […]"

From Anufriieva and Shadrin (2016):

"The East Asian freshwater cyclopoid copepods *Mesocyclops pehpeiensis* (Hu, 1943) and *Eucyclops roseus* Ishida, 1997 […] were recorded from samples collected in the water bodies of the city of Lugansk, eastern Ukraine."

"*M. pehpeiensis* was found in a warm water pool in the botanical garden in Vienna (under the name *Mesocyclops ruttneri* Kiefer, 1981, a younger synonym of *M. pehpeiensis*) and in East Crimea (Anufriieva et al., 2014)."

Means of Introduction Outside the United States

From Suárez-Morales et al. (2005):

"[…] we speculate that rather than having a "cosmopolitan" distribution, *M. pehpeiensis* was introduced into Mexico by human agency. This introduction is probably a result of an isolated event which was independent from those that are supposedly related to introductions in the United States. This record, on the Mexican Pacific coast, suggests a relatively recent and independent dispersal process because: 1) this large, conspicuous species has not been recorded previously in other parts of Mexico; the southern and central areas of the country have been surveyed for several decades (Suárez-Morales et al. 1996; Suárez-Morales & Reid 1998), including a survey on *Mesocyclops* (see Suárez-Morales & Gutiérrez-Aguirre 2001); and 2) the coastal area of Chiapas is active for aquaculture and in the last decade shipments from the Far East, including Malaysia, have delivered seed specimens to support the culturing of the Malayan prawn (*Macrobrachium rosenbergii* de Man) (C. Tovilla pers. comm.). This is likely to be a probable way of introduction for *M. pehpeiensis* in this area; also, it suggests a relatively recent event. Ballast waters and aquacultural activities are widely known to favoring introduction of exotic copepod fauna (Reid & Pinto-Coelho 1994)."

From Díaz et al. (2006):

"[…] probably introduced into […] Cuba, by humans."

From Montoliu et al. (2015):

"These authors consider rice agricultural practices to be the most probable vector for introduction and establishment of exotic ostracods. However, other factors could be involved in the introduction of this copepod in other places. Anthropogenic translocation associated with shipping activities, through ballast water discharge, is considered one of the major vectors of copepod dispersion (Karanovic & Krajicek, 2012). On the other hand, a recent Crimean record of

M. pehpeiensis has been attributed to transportation by birds (Anufriieva et al., 2014). In spite of this, we consider that *M. pehpeiensis* has spread recently in Europe and America owing to human-derived translocation, as can be inferred from the extremely small divergences in the DNA barcodes."

From Anufriieva and Shadrin (2016):

"Long-distance transportation by birds, probably, is the more plausible explanation for their appearance in Lugansk [Ukraine]."

Short Description

From Guo (2000):

"Antennula 17-segmented with groups or rows of spinules on segment 1, 4, 5 and 7–13 and segment 17 with one deep notch. Antennary basis with caudal spinule pattern of *M. leuckarti* (Claus, 1857; Van de Velde, 1984), row of 6–7 spinules at level of medial setae and 2–4 spinules near distal margin. Maxillulary palp without spinules. Maxillar syncoxa shows frontally distinct rows of spinules. Medial distal margin of P1 basis without spine. Distal margin of connecting plate of P4 with two large acute outgrowths, medial expansion of P4 basis naked. Pediger 5 without hairs laterally and dorsally. Seminal receptacle with two short lateral arms, slightly curved at their ends 35 and transverse ducts from copulatory pore slightly V-shaped. Caudal rami without hairs on medial margin and armed with spinules at bases of lateral and external terminal setae."

Biology

From Phong et al. (2008):

"Females […] mated more than once. Multiple mating resulted in increased egg production."

"[…] the present study demonstrated that 3 or 4 matings were ordinary for *Mesocyclops*. Depending upon the species and quantity of sperm, a *Mesocyclops* female typically produces 3 to 8 clutches, and then subsequent remating occurs to produce additional egg clutches."

Phong et al. (2008) report a mean clutch size of 90.6 eggs (sample size=100) and mean interclutch period of 1.5 days (sample size=27) for female *M. pehpeiensis*.

From Chang and Hanazato (2005):

"[…] large[-bodied copepod] genera including *Mesocyclops* […] are voracious predators that feed on a wide range of zooplankton prey from rotifers to cladocerans (Williamson 1986; Gliwicz and Umana 1994; Brandl 1998a, 1998b; Rao and Kumar 2002; Chang and Hanazato [2003]; Kumar and Rao 2003). The predacious copepods often account for a greater mortality of herbivorous zooplankton than do zooplanktivorous fish (Blumenshine and Hambright 2003)."

From Hwang et al. (2009):

"The predatory copepod, *Mesocyclops pehpeiensis*, is numerically abundant and exerts major predation pressures on different cladoceran species in tropical and subtropical freshwater systems. We investigated in the laboratory the responses of 4 cladoceran species: *Scapholeberis kingii*, *Ceriodaphnia cornuta*, *Moina macrocopa*, and *Daphnia similoides* to the copepod *Mes. pehpeiensis*. […] The presence of the copepod severely suppressed the population growth trajectories of all 4 cladoceran species tested. […] With the exception of *S. kingii*, the other 3 cladocerans reproduced earlier in the copepod treatment. The neonate size at hatching and maximum body sizes reached by the 3 cladocerans (except *S. kingii*) in treatments were larger than those in the controls."

Human Uses

From Díaz et al. (2006):

"*Mesocyclops pehpeiensis* is a good candidate species for biological control. Marten (1989) reported that, in experimental containers in New Orleans, *M. pehpeiensis* thrived and was second only to *Macrocyclops albidus* in aggressively preying upon larvae of *Aedes albopictus* [Asian tiger mosquito]. Moreover, it was more resistant to desiccation and more tolerant of high water temperatures than *M. albidus*. […] Like several other cyclopoid species tested, *M. pehpeiensis* was unharmed by *Bacillus thuringiensis* (B.t.i.) or larviciding oil; it was less sensitive than *Macrocyclops albidus* or *Acanthocyclops vernalis* to permethrin (Marten et al. 1993)."

Diseases

No information available. No OIE-listed diseases have been reported in this species.

Threat to Humans

No information available.

3 Impacts of Introductions

From Montoliu et al. (2015):

"[…] the consequences or ecological impacts of *M. pehpeiensis* introduction could be very important. […] *Mesocyclops pehpeiensis* is also an omnivorous tactile predator that naturally may influence the density and species composition of its preys (cladocerans, rotifers and dipteran larvae) (Dieng et al., 2003; Nagata & Hanazato, 2006; Sarma et al., 2013). These alien predatory cyclopids may change the zooplankton composition in their new habitats, further destabilizing the ecosystems and opening ways for new incomers (Anufriieva et al., 2014). To date, this has not been studied to our knowledge."

From Anufriieva and Shadrin (2016):

"Species composition variation of copepods may have significant effects on population, community, and ecosystem dynamics (Hausch et al., 2013). *Mesocyclops pehpeiensis* is a

predator form, which naturally influences the density and species composition of their preys: cladocerans, rotifers, and dipteran larvae (Sarma et al., 2013). This cyclopid may change the zooplankton composition in its new habitats, destabilizing ecosystems and opening doors for new incomers (Richardson, 2011)."

4 Global Distribution

Figure 1. Known global distribution of *Mesocyclops pehpeiensis*, reported from the United States and Mexico. Map from GBIF Secretariat (2017). Only a small percentage of the occurrences reported by GBIF Secretariat (2017) are georeferenced, accounting for the small number of occurrences shown on the map. For the climate matching analysis, occurrence locations from other sources were used to supplement the georeferenced occurrences in GBIF Secretariat (2017).

5 Distribution Within the United States

Figure 2. Known distribution of *Mesocyclops pehpeiensis* in the United States, reported from Louisiana, Mississippi, and Washington, D.C. Map from USGS (2018). The status noted for each of the reported occurrences is "collected". Reid (1993) reports that the Missouri and Louisiana populations are established; in the absence of additional evidence that the Washington D.C. collection represents an established population, this occurrence was excluded from the climate matching analysis.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2018; 16 climate variables; Euclidean distance) was high in the south-central United States including the Gulf Coast from western Florida to eastern Texas, southern California, and the Upper Midwest except for Minnesota. The climate match was medium throughout much of the remainder of the contiguous U.S., with low matches occurring only in eastern New England, along the Pacific coast north of San Francisco, and small scattered areas of the Interior West. Climate 6 score indicated that the contiguous U.S. has a high climate match overall. Scores of 0.103 and greater are classified as high match; Climate 6 score for *M. pehpeiensis* was 0.385.

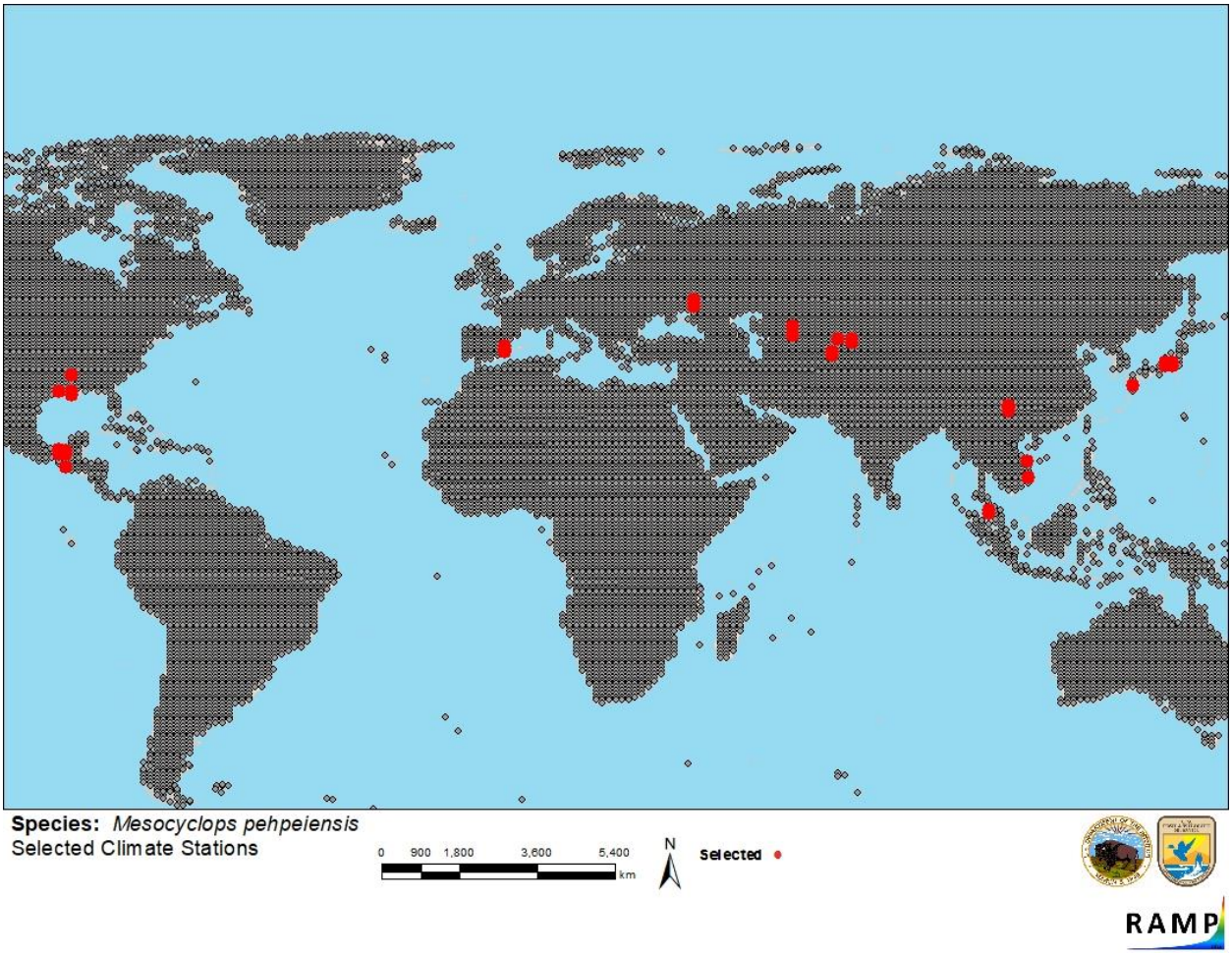

Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations selected as source locations (red; United States, Mexico, Spain, Ukraine, Uzbekistan, China, Vietnam, Malaysia, Japan) and non-source locations (gray) for *Mesocyclops pehpeiensis* climate matching. Source locations from GBIF Secretariat (2017) and USGS (2018). Additional source locations from Lim and Fernando (1985; Malaysia), Mirabdullayev (1996; Uzbekistan), Ueda et al. (2007; Japan), Guo (2000; China), Chang and Hanazato (2005; Japan), Nam et al. (2005; Vietnam), Suárez-Morales et al. (2005; Mexico), Montoliu et al. (2015; Mexico, Spain), and Anufriieva and Shadrin (2016; Ukraine). No occurrence information was available for Kazakhstan, India, Sri Lanka, or several countries in Southeast Asia, where *M. pehpeiensis* is reported to be native (Hołyńska and Nam 2000). Additionally, collection locations in Washington, D.C., Austria, and Russia were not included in the climate matching source locations because establishment could not be confirmed.

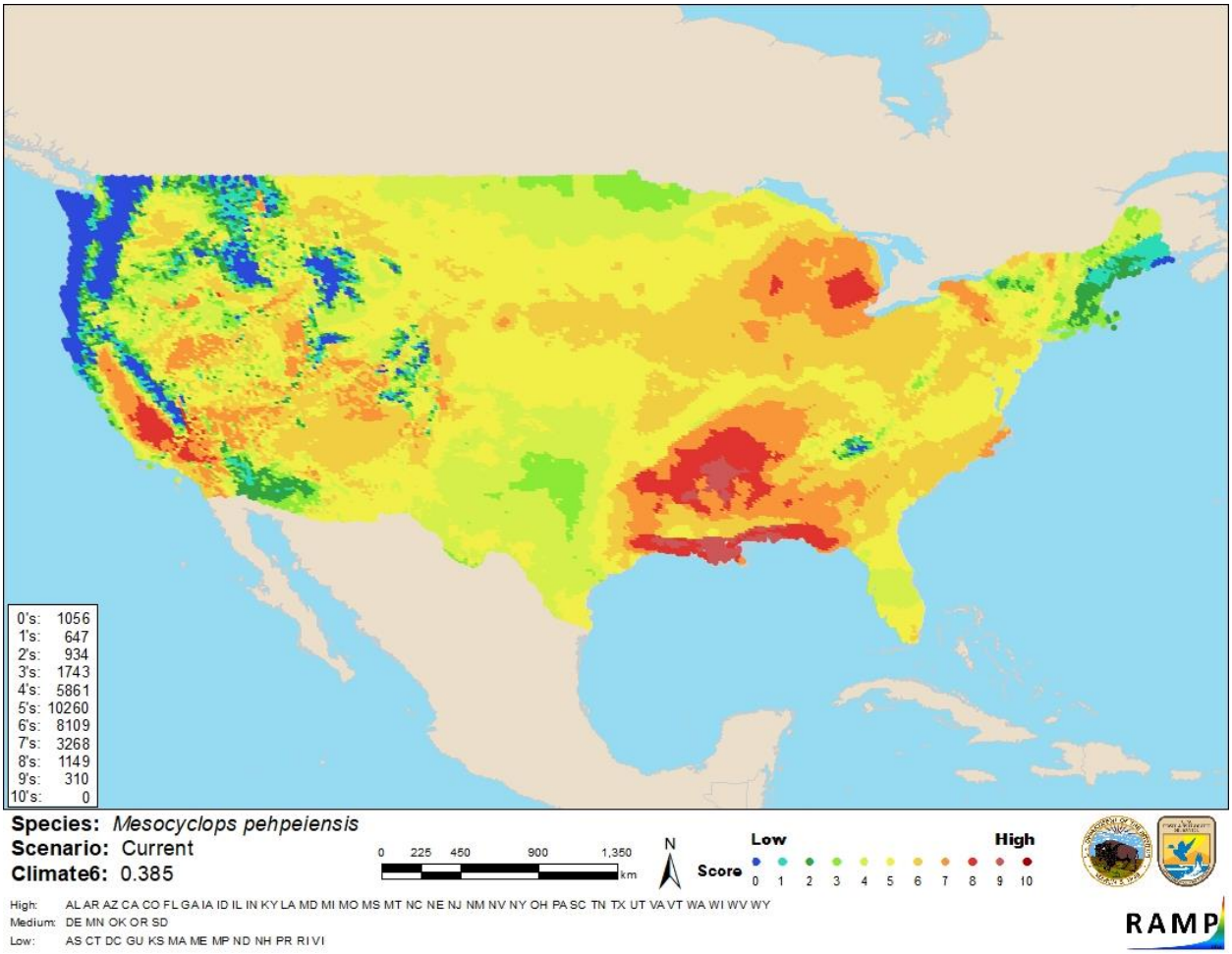

Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Mesocyclops pehpeiensis* in the contiguous United States based on source locations reported by GBIF Secretariat (2017), USGS (2018), Lim and Fernando (1985), Mirabdullayev (1996), Ueda et al. (2007), Guo (2000), Chang and Hanazato (2005), Nam et al. (2005), Suárez-Morales et al. (2005), Montoliu et al. (2015), and Anufriieva and Shadrin (2016). 0=Lowest match, 10=Highest match. Counts of climate match scores are tabulated on the left.

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

Information is available on the biology and ecology of *Mesocyclops pehpeiensis*. A decent body of peer-reviewed literature exists for this species. However, its native distribution is not well

documented through georeferenced occurrences. Introductions may be difficult to track given the small size of the species, lowering the assessor's confidence that all of the introduced distribution has been documented. Despite several confirmed introductions, little research has examined the impact of these introductions. Certainty of this assessment is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Mesocyclops pehpeiensis is a cyclopoid copepod native to much of Asia. Introductions have been documented in Europe and North America, including in the U.S. states of Louisiana and Mississippi, and in Washington, D.C. Multiple authors have expressed concern about potential impacts of introduction of this large predatory copepod, but impacts have yet to be documented. Climate match to the contiguous U.S. is high overall, with the south-central U.S., the Great Lakes, and southern California highlighted as particularly suitable climates for *M. pehpeiensis*. Because of the lack of documented impacts of introduction, the overall risk assessment category for *M. pehpeiensis* is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Low**
- **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.

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