Chinese Mystery Snail (*Cipangopaludina chinensis*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2011
Revised, October 2011 and October 2016
Web Version, 3/28/2018

Photo: Amy Benson, USGS. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=1045. (October 2016).

1 Native Range and Status in the United States

Native Range

From Benson (2016):

"From Southeast Asia to Japan and eastern Russia."

Status in the United States

From Benson (2016):

"Established in San Francisco Bay, California (Ruiz 2000). Mid-Atlantic Region: Lake Erie; various ponds in Connecticut and Massachusetts; Whitewater River in Augusta, Kansas (Distler

2003); Potomac River and Chesapeake Bay, Maryland (Ruiz 2000); Cocheco River, New Hampshire; Delaware River, New Jersey; Hudson River and Niagara River, New York; Columbia River, Oregon (Apalategui 2004); Schuykill River and Susquehanna River, Pennsylvania; Annaquatucket River, Rhode Island; and a few isolated locations in Maine and Virginia."

From Kipp et al. (2016):

"Great Lakes Region: The first record of *C. chinensis malleata* [see information in Remarks on synonymy] in the Great Lakes dates from some time between 1931 and 1942 from the Niagara River, which flows into Lake Ontario (Mills et al. 1993). *Cipangopaludina chinensis malleata* occurs in Lake Erie, where it was introduced some time prior to 1968 (Wolfert and Hiltunen 1968). *Cipangopaludina chinensis* was found for the first time in Oneida Lake, which flows to Lake Ontario, in 1977-1978 (Clarke 1978, Jokinen 1992). Jokinen (1982) records occurrences of populations of *C. chinensis* in the drainages of Lake Erie, Lake Ontario and Lake Michigan, from the states of Michigan, Indiana, Ohio, Wisconsin, and New York."

From Fofonoff et al. (2003):

"*Bellamya chinensis* was introduced to the Hawaiian Islands around 1900, probably as a food item by Chinese immigrants (Cowie 1998). It was not found in a survey of coastal fresh and brackish streams in Oahu (Englund et al. 2000). It appears to be confined to fresh inland waters."

Means of Introduction into the United States

From Kipp et al. (2016):

"Mystery snails (*Cipangopaludina* spp.) have been popular aquarium species in the U.S., and their role in the aquarium/ornamental market is often invoked as the primary explanation of these species' widespread dispersal (Cordiero 2002, Havel 2011, Karatayev et al. 2009, Mackie 2000, Mills et al. 1993). *Cipangopaludina* spp. has also had a presence in live food markets, particularly in Asian markets of the Western U.S. (Mackie 2000)."

From GISD (2016):

"Recreational boaters may tranport this snail to new locations as it attaches to macrophytes which often infest boat hulls. *B. chinensis* can survive for long periods of air exposure, making transport between lakes on overland vectors such as trailered boats likely (Havel, 201[1]). Indeed, a survey of 21 lakes found that this snail was more likely to occur at sites near boat launches (Solomon et al., 2009)."

Remarks

From Kipp et al. (2016):

"Taxonomy of the introduced populations of Oriental mystery snails is confusing and there are many scientific names in use. There has also been debate regarding whether or not *C. chinensis malleata* and *C. japonica* in North America are synonymous and simply different phenotypes of the same species. […] Smith (2000) argues that *Cipangopaludina* is a subgenus of *Bellamya*; however, because most North American literature does not use the genus *Bellamya* to refer to these introduced snails, Oriental mystery snails discussed here are referred to by the name *Cipangopaludina*. Literature […] regarding the Chinese mystery snail may employ the following names: *C. chinensis*, *C. chinensis malleatus*, *C. chinensis malleata*, *Viviparus malleatus*, *V. chinensis malleatus*, *B. chinensis* and *B. chinensis malleatus*."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2016):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Lophozoa
Phylum Mollusca
Class Gastropoda
Subclass Prosobranchia
Order Architaenioglossa
Family Viviparidae
Genus *Cipangopaludina*
Species *Cipangopaludina chinensis* (Gray, 1834) – Chinese mysterysnail
Direct Children:
Subspecies *Cipangopaludina chinensis chinensis*
Subspecies *Cipangopaludina chinensis malleata* (Reeve, 1863) – Chinese mysterysnail"

"Current Standing: valid"

Size, Weight, and Age Range

From Kipp et al. (2016):

"can reach 65 mm"

"Females live up to 5 years, while males live up to 3, occasionally 4 years (Jokinen 1982, Jokinen 1992)."

Environment

From GISD (2016):

"It has been found in depths of 0.2-3 m and waters with pH of 6.5-8.4, conductivity of 63–400 µmhos/cm, and concentrations of calcium (5-97 ppm), magnesium (13-31 ppm), oxygen (7-11ppm), and sodium (2–49 ppm) (Jokinen 1982; Jokinen 1992 in Kipp & Benson, 2011). It can tolerate conditions in stagnant waters near septic tanks (Perron & Probert, 1973 in Kipp &

Benson, 2011). A recent study also suggests that *B. chinensis* is highly resistant to desiccation, giving potential for overland transport via boats (Havel, 201[1]).”

Climate/Range

From GISD (2016):

“It is a temperate species with a lower limit of 0 °C and upper limit of 30 °C (Kipp & Benson, 2008 in Karatayev et al., 2009), and thus cannot tolerate high summer temperatures in the United States (Karatayev et al., 2009).”

Distribution Outside the United States

Native

From Benson (2016):

“From Southeast Asia to Japan and eastern Russia.”

Introduced

From NatureServe (2015):

“It has spread across Canada, becoming well established in several locations in southern Ontario (Therriault and Kott, 2003).”

“[…] British Columbia, Ontario, Quebec, and Nova Scotia (Therriault and Kott, 2003).”

From Fofonoff et al. (2003):

“In 2009 and 2010, specimens of *Bellamya chinensis* were found in three freshwater ponds in the Netherlands. These are the first records of this snail known from Europe (Soes et al. 2011).”

Means of Introduction Outside the United States

From Soes et al. (2011):

“The way of entry into the Netherlands is probably also related to pet trade for garden ponds or aquaria.”

“Further spread from established populations may occur naturally or as a result of human activities like boating (Solomon et al. 2010).”

Short Description

From Kipp et al. (2016):

“Species of the genus *Cipangopaludina* can be identified by their relatively large globose shells and concentrically marked opercula (Burch 1980). *Cipangopaludina chinensis* has a width to height ratio of 0.74–0.82, the shell has 6.0–7.0 whorls, and the inner coloration is white to pale blue (Clarke 1981, Jokinen 1992). This species has a small and round umbilicus and the spire is produced at an angle of 65–80º (Jokinen 1992). *Cipangopaludina chinensis* exhibits light coloration as a juvenile and olive green, greenish brown, brown or reddish brown pigmentation as an adult (Clarke 1981, Jokinen 1992). In juveniles, the last shell whorl displays a distinct carina, and the shell contains grooves with 20 striae/mm between each groove (Clarke 1981, Smith 2000). Juveniles also have a detailed pattern on their periostracum consisting of 2 apical and 3 body whorl rows of hairs with long hooks on the ends, distinct ridges and many other hairs with short hooks (Jokinen 1984)."

"The shell of *C. chinensis* grows allometrically (the height increasing faster than the width) and does so at a decreased rate in comparison with *C. japonica*, such that the adult shell is less elongate than that of its congener (Jokinen 1982). The radula also may differ between *C. japonica* and *C. chinensis*, but there is so much variation even within one species that it is not a good diagnostic characteristic (Smith 2000). However, as a general guide, in one North American population, the radula of *C. chinensis* had seven small cusps on the marginal tooth and a large central cusp with four small cusps on either side (Jokinen 1982)."

Biology

From Kipp et al. (2016):

"This species is ovoviviparous (Jokinen 1992). […] Female fecundity is usually greater than 169 young in a life time, and may reach up to 102 for any given brood (Jokinen 1982). All females generally contain embryos from May to August and young are born from June through October in eastern North America in shallow water, then females begin migrating to deeper water for the winter in the fall (Jokinen 1982, Jokinen 1992, Stanczykowska et al. 1971). Females bear more young in their 4th and 5th years than in other years (Jokinen 1992)."

From NatureServe (2015):

"This species births fully developed juveniles where, in brooding adults, all stages of development occur simultaneously in utero, from newly fertilized ova to large (5 mm), fully shelled juveniles. Prezant et al. (2006) found that water-borne cues from a predatory crayfish (*Orconectes llimosus* [*sic*]) induced a doubling of the number of offspring released and these newly born snails were generally smaller, though more variable in size, and possessed a greater shell organic content than control individuals (likely response to the predator)."

From Fofonoff et al. (2003):

"These snails are prone to great population booms and busts. Predators include crayfishes (Olden et al. 2009), catfishes (Mills et al. 1993), and, probably, air-breathing predators such as gulls, raccoons, otters, etc."

From GISD (2016):

"*Bellamya chinensis* is a filter feeder and detritivore, but also browses on microalgae (Dillon, 2000).. [*sic*] Based on examination of gut contents it feeds non-selectively on inorganic-organic debris and epiphytic-benthic algae, predominantly diatoms (Jokinen, 1982). It does not feed readily on plants; snails fed on spinach were found to perform poorly compared to those fed with detritus (Mohrman, 2007 in Soes et al., 2011). Carbon stable isotope ratios of *B. chinensis* collected from one Wisconsin lake lakes [sic] suggest heavy reliance on benthic resources and little if any reliance on pelagic resources (Solomon et al., 2010), although this has not been tested."

Human Uses

From GISD (2016):

"*Bellamya chinensis* is edible and is sold in Chinese food markets in the United States (Benson, 2007). *B. chinensis* may also be useful in eliminating sewage sludge and heavy metals in rice paddy soil (Kurihara & Suzuki, 1987)."

Diseases

From Kipp et al. (2016):

"In Korea, this species is known to be a host to the metacercariae *Echinostoma cinetorchis*, an intestinal trematode parasitic in humans (Chung and Jung 1999). It is also a common host to larvae of echinostomes in the Kinmen islands (Chao et al. 1993)."

"In the Boston area, *C. chinensis* is a regular host to the common native parasite *Aspidogaster conchicola*, which is a first time record in North America for a gastropod acting as host to this species (Michelson 1970)."

From Harried et al. (2015):

"[…] we necropsied 147 wild-caught snails from 22 lakes across Wisconsin, finding only two CMS [Chinese mystery snail] individuals harboring trematode (flatworm) parasites. We also conducted experimental exposures using a trematode (*Sphaeridiotrema pseudoglobulus*) implicated in waterfowl die-offs and found that CMS infection levels were significantly lower than those in co-occurring snail species. Furthermore, the parasites that did successfully infect CMS were often found encased in the shells of the snails in a non-viable state."

Threat to Humans

From GISD (2016):

"*B. chinensis* is also the host for several helminth parasites that affect humans in native Asia. Thus it may serve as a vector for parasites and diseases, including human intestinal fluke (Chung & Jung, 1999; Havel, 201[1]; NAPIS, 2010). However there is little data to support this (Soes et al., 2011), and there have been no reported cases involving human intestinal fluke transmitted by *B. chinensis* in the United States (Bury et al., 2007)."

"Shells may clog the screens of water intake pipes and thus inhabit [*sic*] the flow of water (AIS, 2005). Additionally, dead and decaying shells can form large windrows on lake shores, which is viewed as a nuisance by residents in some regions (Bury et al., 2007). In the Laurentian Great Lakes, fisherman often made seine hauls containing "2 tons" of snails, which were likely *B. chinensis* or *B. japonica* (Wolfert & Hiltunen, 1968)."

3 Impacts of Introduction

From GISD (2016):

"*Bellamya chinensis* is a relatively large snail species that can reach very high densities of up to 40 per m² (Soes et al., 2011; Johnson et al., 2009). While negative impacts on native snail species and ecosystems are expected (Bury et al., 2007) very little is known about its ecological impacts and significance in invaded systems (Johnson et al., 2009; Solomon et al., 2010; Soes et al., 2011)"

"Competition: Presence of *B. chinensis* was found to cause substantial declines in the growth and abundance of native *Physella gyrina* and *Lymnaea stagnalis* snails in mesocosm experiments, probably through competition for food (Johnson et al., 2009). However such negative impacts on native gastropod assemblages have not yet been confirmed in field studies. Solomon et al. (2010) found no difference in snail assemblage structure associated with *B. chinensis* presence or abundance at the scale of an entire lake, although some native snail species tended not to occur at sites where *B. chinensis* was abundant."

"Ecosystem change: In a mesocosm experiment *B. chinensis* grazing was found to reduce algal biomass, algal species composition and increase the N: P ratio in the water column. Such effects may have important ecological consequences (Johnson et al., 2009)."

"Interaction with other invasive species: In a mesocosm experiment in Wisconsin, the dual effects of predation by an invasive crayfish (*Orconectes rusticus*) and competition by *B. chinensis* were found to have more severe impacts on native snail species than either invader alone. Due to its large size and thicker shell *B. chinensis* was less vulnerable to predation by this crayfish. The combined impact of both invasive species was found to extirpate one native snail species and reduce the abundance of a second by >95%. This may be because *O. rusticus* reduces native snail abundance via predation but has limited effects on *B. chinensis*, thus promoting additional food resources for *B. chinensis* (Johnson et al., 2009)."

"An experimental study in Washington suggests that *B. chinensis* may facilitate establishment and exacerbate the establishment success and ecological impacts of an invasive crayfish (*Orconectes virilis*) by providing an abundant prey resource (i.e. invasional meltdown). This hypothesis requires further research and testing (Olden et al., 2009)."

From Solomon et al. (2010):

"Evidence that *B. chinensis* invasions influenced native snail assemblages varied with the spatial scale of analysis. At the whole-lake scale, neither the contemporary data nor the historical comparison showed any effects of *B. chinensis* on the presence or abundance of native snails. These results are consistent with the idea that invasive species rarely extirpate their competitors (Davis 2003; Sax et al. 2007). At the more local scale of sites, the abundance of *B. chinensis* was negatively associated with that of several native species. This pattern might result from competitive effects, but might simply reflect differences in niche requirements. Teasing apart these alternative explanations is a notoriously difficult problem in community ecology, although controlled experiments can sometimes shed light on patterns observed in the field. A recent mesocosm experiment demonstrated that *B. chinensis* at densities ~10 individuals m^{-2} had stronger effects on *Lymnaea stagnalis* (reduced survival) than on *Physa gyrina* (reduced growth) (Johnson et al. 2009). In our surveys, *L. stagnalis* (but not *P. gyrina*) was one of the species that did not occur at high abundance at sites where *B. chinensis* was present […] This qualitative agreement between experimental and observational results lends some support to the idea that *B. chinensis* has had negative effects on at least some of the species with which it is negatively associated. On the other hand, any such effects are relatively subtle, in that no *B. chinensis* effect on overall assemblage structure at the site level was detectable […] On balance our results provide, at most, weak evidence that *B. chinensis* negatively impacts native snails."

From Olden et al. (2013):

"Knowledge of how invasive species may affect bacterial diversity, abundance, and associated processes are important to understand potential impacts on ecosystem function. […] Here we observed a shift in bacterial community composition and decreased community variability in the water column under high *Bellamya* filtration rates, but no change in total abundance. […] *Bellamya* may interact directly with microbial populations by utilizing bacteria as a food source, resulting in a community shift when bacteria respond with different growth rates. Alternatively, *Bellamya*-bacterial interactions may be indirect, mediated by the production of large quantities of fecal and pseudo-fecal material that differentially affect the composition, activity, and growth of bacterial taxa."

From Kipp et al. (2016):

"Chinese mystery snail is a regulated invasive species in Minnesota (MN Administrative Rules, 6216.0260 Regulated) and a restricted species in Wisconsin (NR40.05: Restricted)."

4 Global Distribution

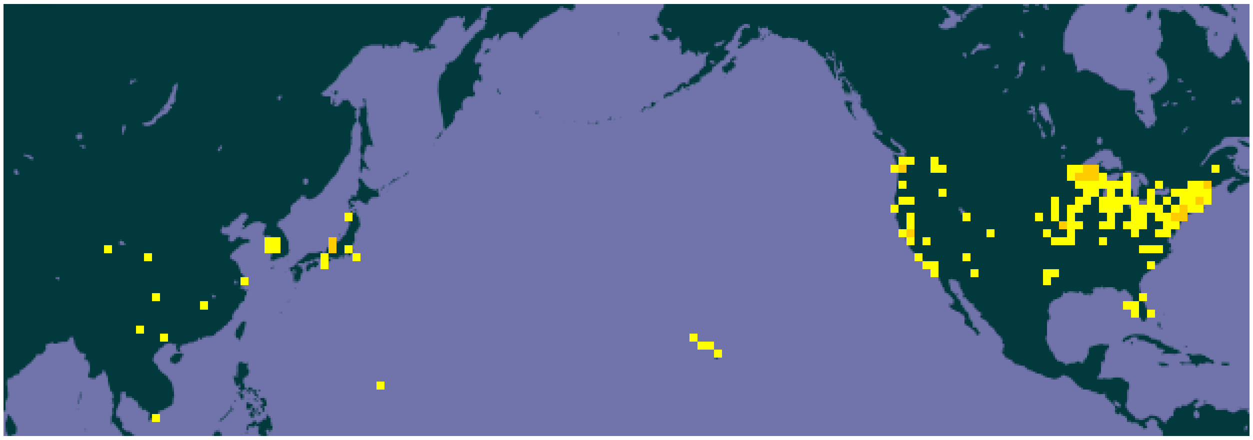

Figure 1. Known global distribution of *C. chinensis*. Map from GBIF (2016). U.S. locations provided by GBIF (2016) were omitted from climate matching if they did not agree with U.S. distribution from Kipp et al. (2016; see Section 5).

5 Distribution Within the United States

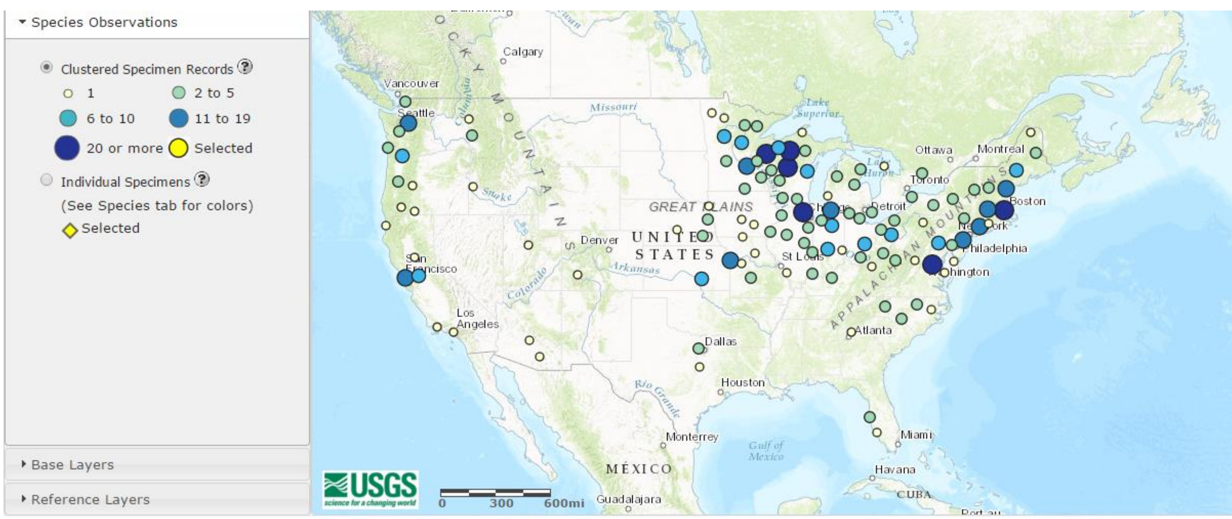

Figure 2. Known distribution of *C. chinensis* in the United States. Map from Kipp et al. (2016).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high along the East Coast, throughout the Midwest, and in significant parts of the West. Medium matches occurred in the South-Central U.S. and in the western Plains and eastern Rocky Mountain regions. Small patches of medium-low climate match were apparent in the Southwest and in the Rocky Mountains. Climate 6 score indicated that the U.S. has a high climate match. The range for a high climate match is 0.103 and greater; Climate 6 score of *C. chinensis* is 0.964.

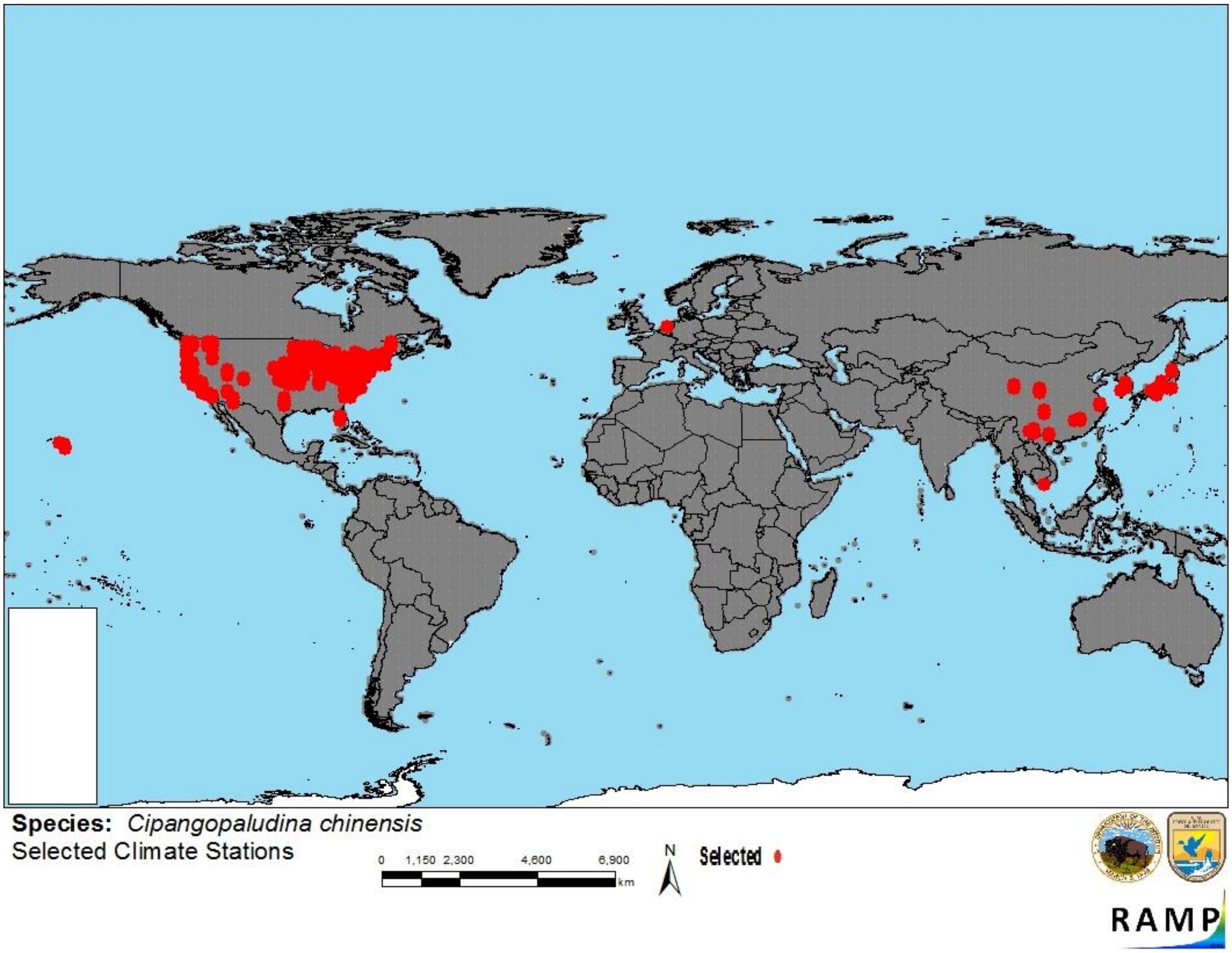

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *C. chinensis* climate matching. Source locations from GBIF (2016) and Kipp et al. (2016). Additional location in The Netherlands provided by Soes et al. (2011).

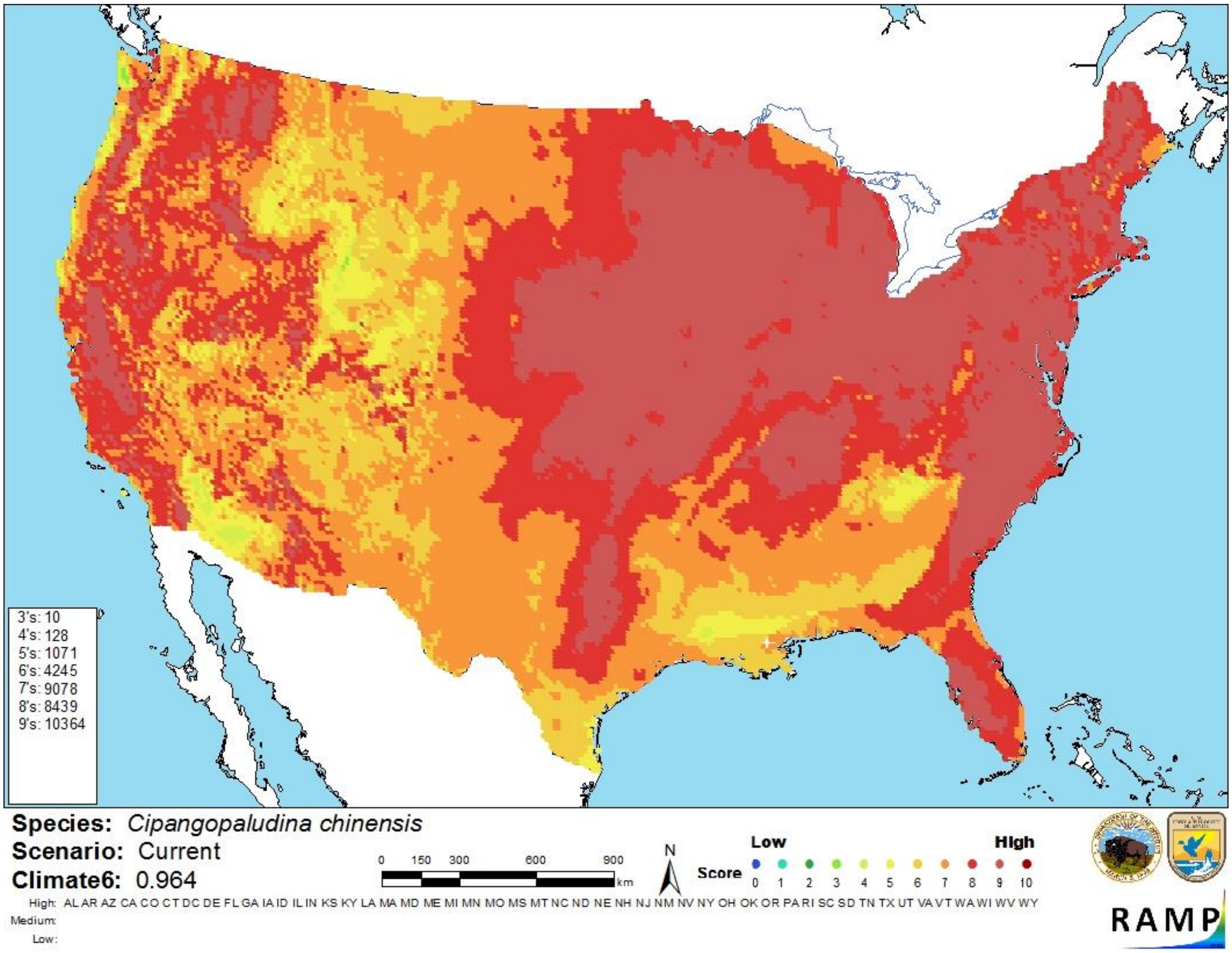

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *C. chinensis* in the continental United States based on source locations from GBIF (2016), Kipp et al. (2016), and Soes et al. (2011). 0= Lowest match, 10=Highest match. Counts of climate match scores are tabulated on the left.

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 readily available on the biology and distribution of *C. chinensis*, despite lingering taxonomic confusion. Impacts of introductions of this species have received some research attention. While more research is desirable to quantify impacts and investigate potential impacts that have been suggested and not yet tested, there is sufficient evidence to assess the risk posed by this species to the continental U.S. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

C. chinensis is a large snail native to Southeast and East Asia that is now established in many locations across the U.S. *C. chinensis* has been shown to depress or exclude populations of native snails locally and to alter bacterial community composition. Synergistic negative effects have been observed on native snails when both *C. chinensis* and invasive crayfish are present. The species can also clog water intake pipes and be a nuisance on lakeshores. *C. chinensis* is a common aquarium species, is consumed by humans, and can be transported accidentally by overland transport of boats, so the risk of spread is high. Climate match to the continental U.S. is high. Overall risk posed by this species is high.

Assessment Elements

- **History of Invasiveness: High**
- **Climate Match: High**
- **Certainty of Assessment: High**
- **Overall Risk Assessment Category: High**

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.

Benson, A. 2016. *Cipangopaludina chinensis*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=1044. (October 2016).

Fofonoff, P. W., G. M. Ruiz, B. Steves, and J. T. Carlton. 2003. *Bellamya chinensis*. National Exotic Marine and Estuarine Species Information System. Available: http://invasions.si.edu/nemesis/browseDB/SpeciesSummary.jsp?TSN=70329. (October 2016).

GBIF (Global Biodiversity Information Facility). 2016. GBIF backbone taxonomy: *Cipangopadulina chinensis* Reeve, 1863. Global Biodiversity Information Facility, Copenhagen. Available: http://www.gbif.org/species/2292567. (October 2016).

GISD (Global Invasive Species Database). 2016. Species profile: *Cipangopaludina chinensis*. IUCN Invasive Species Specialist Group, Gland, Switzerland. Available: http://www.iucngisd.org/gisd/speciesname/Cipangopaludina+chinensis. (October 2016).

Harried, B., K. Fischer, K. E. Perez, and G. J. Sandland. 2015. Assessing infection patterns in Chinese mystery snails from Wisconsin, USA using field and laboratory approaches. Aquatic Invasions 10(2):169-175.

ITIS (Integrated Taxonomic Information System). 2016. *Cipangopaludina chinensis* (Gray, 1834). Integrated Taxonomic Information System, Reston, Virginia. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=70329#null. (October 2016).

Kipp, R. M., A. J. Benson, J. Larson, and A. Fusaro. 2016. *Cipangopaludina chinensis malleata*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida, and NOAA Great Lakes Aquatic Nonindigenous Species Information System, Ann Arbor, Michigan. Available: http://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=1045&Potential=N&Type=0&HUCNumber=DgreatLakes. (October 2016).

NatureServe. 2015. *Cipangopaludina chinensis*. NatureServe Explorer: an online encyclopedia of life [web application], version 7.1. NatureServe, Arlington, Virginia. Available: http://explorer.natureserve.org. (October 2016).

Olden, J. D., L. Ray, M. C. Mims, and M. C. Horner-Devine. 2013. Filtration rates of the non-native Chinese mystery snail (*Bellamya chinensis*) and potential impacts on microbial communities. Limnetica 32(1):107-120.

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

Soes, D. M., G. D. Majoor, and S. M. A. Keulen. 2011. *Bellamya chinensis* (Gray, 1834) (Gastropoda: Viviparidae), a new alien snail species for the European fauna. Aquatic Invasions 6(1):97-102.

Solomon, C. T., J. D. Olden, P. T. J. Johnson, R. T. Dillon Jr., and M. J. Vander Zanden. 2010. Distribution and community-level effects of the Chinese mystery snail (*Bellamya chinensis*) in northern Wisconsin lakes. Biological Invasions 12:1591-1605.

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.

AIS (Aquatic Invasive Species). 2005. Chinese mystery snail. Available: http://www.in.gov/dnr/files/CHINESE_MYSTERY_SNAIL.pdf. (March 2011).

Apalategui, E. 2004. Alien invaders: 81 non-native species lurk in Columbia. The Daily News (November 6).

Benson, A. 2007. *Bellamya* (*Cipangopaludina*) *chinensis*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. Available: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=1044. (March 2011).

Burch, J. B. 1980. A guide to the fresh water snails of the Philippines. Malacological Review 13(1-2):121-144.

Bury, J. A., B. E. Sietman, and B. N. Karns. 2007. Distribution of the non-native viviparid snails, *Bellamya chinensis* and *Viviparus georgianus*, in Minnesota and the first record of *Bellamya japonica* from Wisconsin. Journal of Freshwater Ecology 22(4):697-703.

Chao, D., L. C. Wang, and T. C. Huang. 1993. Prevalence of larval helminths in freshwater snails of the Kinmen Islands. Journal of Helminthology 67(4):259-264.

Chung P. R., and Y. Jung. 1999. *Cipangopaludina chinensis malleata* (Gastropoda: Viviparidae): a new second molluscan intermediate host of a human intestinal fluke *Echinostoma cinetorchis* (Trematoda: Echinostomatidae) in Korea. Journal of Parasitology 85(5):963-964.

Clarke, A. H. 1978. The Asian apple snail *Cipangopaludina chinensis* (Viviparidae) in Oneida Lake, New York. Nautilus 92(3):134.

Clarke, A. H. 1981. The freshwater molluscs of Canada. National Museum of Natural Sciences, National Museums of Canada, Ottawa, Canada.

Cordeiro, J. R. 2002. Proliferation of the Chinese mystery snail, *Cipangopaludina chinensis malleata* (Reeve, 1863) throughout Connecticut [Abstract]. Page 37 *in* R. T. Dillon, editor. Program and abstracts of the 68th neeting of the American Malacological Society, Charleston, South Carolina. Available: http://www.malacological.org/meetings/archives/2002/2002_abs.pdf.

Cowie, R. H. 1998. Patterns of introduction of non-indigenous non-marine snails and slugs in the Hawaiian Islands. Biodiversity and Conservation 7:349-368.

Davis, M. A. 2003. Biotic globalization: does competition from introduced species threaten biodiversity? Bioscience 53:481-489.

Dillon, R. T., Jr. 2000. The ecology of freshwater molluscs. Cambridge University Press, Cambridge.

Distler, D. A. 2003. Occurrence of the mystery snail *Cipangopaludina chinensis* (Gastropoda: Viviparidae) in the Walnut River basin, Kansas. Transactions of the Kansas Academy of Science 106:215.

Englund, R. A., K. Arakaki, D. J. Preston, S. L. Coles, and L. G. Eldredge. 2000. Nonindigenous freshwater and estuarine species introductions and their potential to affect sportfishing in the lower stream and estuarine regions of the south and west shores of Oahu, Hawaii. Hawaii Biological Survey, Bishop Museum, Honolulu.

Havel, J. E. 2011. Survival of the exotic Chinese mystery snail (*Cipangopaludina chinensis malleata*) during air exposure and implications for overland dispersal by boats. Hydrobiologia 668(1):195-202.

Johnson, P. T. J., J. D. Olden, C. T. Solomon, and M. J. Vander Zanden. 2009. Interactions among invaders: community and ecosystem effects of multiple invasive species in an experimental aquatic system. Oecologia 159:161-170.

Jokinen, E. H. 1982. *Cipangopaludina chinensis* (Gastropoda: Viviparidae) in North America, review and update. Nautilus 96(3):89-95.

Jokinen, E. H. 1992. The freshwater snails (Mollusca: Gastropoda) of New York State. The University of the State of New York, The State Education Department, The New York State Museum, Albany, New York.

Karatayev, A. Y., L. E. Burlakova, V. A. Karatayev, and D. K. Padilla. 2009. Introduction, distribution, spread, and impacts of exotic freshwater gastropods in Texas. Hydrobiologia 619:181-194.

Kurihara, Y., and T. Suzuki. 1987. Removal of heavy metals and sewage sludge using the mud snail, *Cipangopaludina chinensis malleata* REEVE, in paddy fields as artificial wetlands. Water Science and Technology 19(12):281-286.

Kipp, R. M., and A. Benson. 2011. *Cipangopaludina chinensis malleata*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. Available: http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1045. (July 2010).

Mackie, G. L. 2000. Introduction of molluscs through the import for live food. Pages 305-313 *in* R. Claudi, and J. H. Leach, editors. Nonindigenous freshwater organisms: vectors, biology and impacts. CRC Press LLC, Boca Raton, Florida.

Michelson, E. H. 1970. *Aspidogaster conchicola* from fresh water gastropods in the USA. Journal of Parasitology 56(4):709-712.

Mills, E. L., J. H. Leach, J. T. Carlton, and C. L. Secor. 1993. Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. Journal of Great Lakes Research 19(1):1-54.

NAPIS (National Agricultural Pest Information System). 2010. Chinese mystery snail (*Cipangopaludina chinensis*) pest tracker. National Agricultural Pest Information System. Available from: http://pest.ceris.purdue.edu/searchpest.php?selectName=IGDUAFA. (July 2010).

Olden, J. D., E. R. Larson, M. C. Mims. 2009. Home-field advantage: native signal crayfish (*Pacifastacus leniusculus*) out consume newly introduced crayfishes for invasive Chinese mystery snail (*Bellamya chinensis*). Aquatic Ecology 43:1073-1084.

Prezant, R. S., E. J. Chapman, and A. McDougall. 2006. In utero predator-induced responses in the viviparid snail *Bellamya chinensis*. Canadian Journal of Zoology 84:600-608.

Ruiz, G. M., P. W. Fofonoff, J. T. Carlton, M. J. Wonham, and A. H. Hines. 2000. Invasion of coastal marine communities in North America: apparent patterns, processes, and biases. Annual Review of Ecology and Systematics 31:481-531.

Sax, D. F., J. J. Stachowicz, J. H. Brown, J. F. Bruno, M. N. Dawson, S. D. Gaines, R. K. Grosberg, A. Hastings, R. D. Holt, M. M. Mayfield, M. I. O'Connor, W. R. Rice. 2007. Ecological and evolutionary insights from species invasions. Trends in Ecology and Evolution 22:465-471.

Smith, D. G. 2000. Notes on the taxonomy of introduced *Bellamya* (Gastropoda: Viviparidae) species in northeastern North America. Nautilus 114(2):31-37.

Solomon et al. 2009 [*Source material did not provide full citation for this reference.*]

Stanczykowska, A., E. Magnin, and A. Dumouchel. 1971. Study of 3 *Viviparus malleatus* (Gastropoda: Prosobranchia) populations of the Montreal region. Part 1: growth, fecundity, biomass and annual production. Canadian Journal of Zoology 49(11):1431-1441.

Therriault, T. W. and E. Kott. 2003. *Cipangopaludina chinensis malleata* (Gastropoda: Viviparidae) in southern Ontario: an update of the distribution and some aspects of life history. Malacological Review 35/36(1/2):111-121.

Wolfert, D. R., and J. K. Hiltunen. 1968. Distribution and abundance of the Japanese snail *Viviparus japonicus*, and associated macrobenthos in Sandusky Bay, Ohio. Ohio Journal of Science 68(1):32-40.