

# Red-rim Melania (*Melanoides tuberculatus*)

## Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, March 2012

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## 1 Native Range and Status in the United States

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### Native Range

From Benson and Neilson (2017):

“Northern Africa to southern Asia”

From Van Damme and Lange (2016):

“Bangladesh; Benin; Brunei Darussalam; Burundi; China; Congo; Congo, The Democratic Republic of the; Egypt; Eritrea; Ethiopia; Gabon; India; Kenya; Lao People's Democratic Republic; Libya; Malawi; Malaysia; Mauritania; Mozambique; Namibia; Niger; South Africa; South Sudan; Sri Lanka; Sudan; Swaziland; Tanzania, United Republic of; Thailand; Timor-Leste; Uganda; Viet Nam; Yemen (North Yemen, Socotra, South Yemen); Zimbabwe”

### Status in the United States

From Benson and Neilson (2017):

“**Nonindigenous Occurrences:** Arizona; San Francisco Bay, California (Ruiz 2000); Colorado; Florida; Hawai'i; Louisiana (Dundee 1977); Montana; North Carolina; Nevada;

Oregon; Utah (USFWS 2005); and Texas (USFWS 2005). (Unconfirmed in South Dakota, Virginia, and Wyoming)”

“**Status:** Established for many years from Florida to Texas and may still be expanding its range in the West and Northeast.”

## **Means of Introductions in the United States**

From Benson and Neilson (2017):

“Imported by the aquarium industry as early as the 1930s. Some of the early known populations most likely began from local aquarium hobbyists' releases.”

From Fofonoff et al. (2003):

“*Melanoides tuberculata* was first reported in California in 1972, from a ditch in Riverside County, California. In 1988, it was collected in the Sacramento-San Joaquin Delta.”

“*Melanoides tuberculata* was first collected on the East Coast of Florida (FL) in Lake Osceola on the University of Miami campus in 1966 (Clench 1970), and by 1973 it was found in brackish water in the Pompano Canal, Fort Lauderdale (Russo 1974, cited by Roessler 1977). By 1975, this snail was abundant in mangrove areas of the Matheson Hammock-Snapper Creek area of Coral Gables, FL adjacent to Biscayne Bay. [...] The Red-Rim *Melania* reached the upper St. Johns River, FL by 1975 (USGS Nonindigenous Aquatic Species Program 2003; Florida Museum of Natural History 2013; Lee 2013). It was present in the Indian River Lagoon drainage, in the St. Lucie River and Sebastian Creek drainages (Harbor Branch Oceanographic Institution Collections).”

“*Melanoides tuberculata* was first found on the Gulf Coast of Florida in 1969 in the Hillsborough River in Hillsborough State Park (Clench 1970). This snail is now abundant in the tidal tributaries of Tampa Bay (Baker et al. 2004). In 1975, it was found to be abundant in several brackish (2.5-3.0 PSU) canals flowing into Lake Pontchartrain, in New Orleans, Louisiana (Dundee and Paine 1977).”

“*Melanoides tuberculata* was reported from the Hawaiian Islands at least as early as 1915 (Academy of Natural Sciences of Philadelphia 2013), but it may have been a prehistoric introduction to the islands.”

## **Remarks**

From Van Damme and Lange (2016):

“The species name is sometimes spelled *Melanoides tuberculatus* (see Madhyastha 2012), but this is incorrect because *Melanoides* Olivier, 1804 was clearly intended to be feminine as it was combined with the feminine specific epithet *fasciolata* in the original description.”

## 2 Biology and Ecology

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### Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2017):

“Kingdom Animalia  
Subkingdom Bilateria  
Infrakingdom Protostomia  
Superphylum Lophozoa  
Phylum Mollusca  
Class Gastropoda  
Order Neotaenioglossa  
Family Thiaridae  
Genus *Melanoides* Olivier, 1804  
Species *Melanoides tuberculatus* (Muller, 1774)”

“Taxonomic Status: valid”

### Size, Weight, and Age Range

From CABI (2017):

“*M. tuberculata* can reach up to a mean adult size of 20-40 mm depending on the morphs considered and environmental conditions (Pointier, 1989), but Murray (1975) reported individuals 70-80 mm in shell length in Texas.”

From Fofonoff et al. (2003):

“Adult snails [...] live for about 2 years (Livshits and Fishelson 1983; Rader et al. 2003; Work and Mills 2013; Bolaji et al. 2011).”

### Environment

From Fofonoff et al. (2003):

“*Melanoides tuberculata* is a predominantly freshwater snail, found in springs, streams, lakes swamps, etc. (Pointier et al. 1993[a]; Thompson 2004). It occasionally invades brackish and marine habitats, especially mangrove swamps (Roessler et al. 1977; Wingard et al. 2007; Barroso and Matthews-Cascon 2009).”

“In Biscayne Bay, Florida *M. tuberculata* occurred at 0-33 PSU and tolerated salinities up to 45 PSU, although reproduction ceased at ~18 PSU (Wingard et al. 2007). In estuaries on Oahu, Hawaii and Ceara, Brazil, the snail occurred from freshwater to 34 and 30 PSU, respectively (Englund et al. 2000; Barroso and Matthews-Cascon 2009). However, another population, in Lagos Lagoon, Nigeria, did not tolerate salinities over 25 PSU (Bolaji et al. 2011). This snail, though aquatic, is quite tolerant of desiccation – individuals survived 80-140 hours of air exposure at 25°C and 20% humidity (Weir and Salice 2012). Given the genetic diversity reported

in this species (Samadi et al. 1999; Facon et al. 2008), it is likely that local populations will vary in environmental tolerances.”

## **Climate/Range**

From Fofonoff et al. (2003):

“*Melanoides tuberculata* is a snail of warm-temperate to tropical distribution. Snails from the San Marco River, Texas tolerated temperatures of 17 to 32.5°C with little mortality, but a temperature of 13°C killed all the snails within 12 days (Mitchell and Brandt 2005). Many scattered populations in the western US, Europe, and New Zealand are confined to warm springs or thermal effluents (Duggan 2002; Rader et al. 2003; Oscoz et al. 2009).”

From Benson and Neilson (2017):

“Research has been conducted to determine the snails lethal water temperature, about 50° Celsius (120° Fahrenheit), for the disinfection fishing gear and research equipment which may inadvertently spreading snails to uninfested waters (A. Mitchell, personal communication).”

## **Distribution Outside the United States**

### **Native**

From Benson and Neilson (2017):

“Northern Africa to southern Asia”

From Van Damme and Lange (2016):

“Bangladesh; Benin; Brunei Darussalam; Burundi; China; Congo; Congo, The Democratic Republic of the; Egypt; Eritrea; Ethiopia; Gabon; India; Kenya; Lao People's Democratic Republic; Libya; Malawi; Malaysia; Mauritania; Mozambique; Namibia; Niger; South Africa; South Sudan; Sri Lanka; Sudan; Swaziland; Tanzania, United Republic of; Thailand; Timor-Leste; Uganda; Viet Nam; Yemen (North Yemen, Socotra, South Yemen); Zimbabwe”

### **Introduced**

From Van Damme and Lange (2016):

“Algeria; Australia; Bahrain; Bolivia, Plurinational States of; Brazil; Comoros; Cuba; Dominica; Ecuador (Ecuador (mainland)); Fiji; French Guiana; French Polynesia; Germany; Guadeloupe; Guyana; Honduras; Japan; Kuwait; Malta; Martinique; Mauritius (Mauritius (main island)); Mayotte; Montserrat; Nepal; Netherlands; New Caledonia; New Zealand; Panama; Papua New Guinea; Paraguay; Puerto Rico; Réunion; Saint Lucia; Samoa; Seychelles (Seychelles (main island group)); Slovakia; Spain (Spain (mainland)); Suriname; Tonga; Trinidad and Tobago; United States; Uruguay; Venezuela, Bolivarian Republic of; Wallis and Futuna”

## Means of Introduction Outside the United States

From CABI (2017):

“*M. tuberculata* recently invaded the whole inter-tropical belt mainly as a result of the trade in aquarium plants. Further invasions are therefore likely, especially of ‘improved’ morphs, in relation to the increase of trade in aquarium fishes and plants. *M. tuberculata* individuals are now for sale on the Internet due to the fact that they are often considered a beneficial addition to most aquariums, cleaning up leftover food and eating algae.”

“Besides accidental introductions, it has to be noticed that *M. tuberculata* was subsequently used in 1970s and 1980s for bio control programmes in several islands of the Caribbean area (such as St Lucia, Martinique and Guadeloupe) as a competitor of *Biomphalaria* spp., the intermediate snail hosts of schistosomiasis (Prentice, 1983; Pointier et al., 1989; Pointier and Guyard, 1992; Pointier and Jourdane, 2000).”

From Fofonoff et al. (2003):

“*Melanoides tuberculata* [...] was introduced to Puerto Rico soon after 1963 (Abbott 1973), to Martinique in 1985 (Pointier et al. 2005), Dominica by 1975 (Reeves et al. 2008), Guadeloupe in 1979 (Pointier et al. 1993[a]), the US Virgin Islands in 1987 (USGS Nonindigenous Aquatic Species Program 2013). It was present and used to make ornaments in Veracruz, Mexico (Abbott 1973) and is now established in at least 12 Mexican states (Conteras-Arquieta 1998). *Melanoides tuberculatus* was collected in Panama by 1971, and in 1972, was collected from the bottom of the Miraflores Locks of the Panama Canal (USNM 734154, U.S. National Museum of Natural History 2013).”

“In South America, *M. tuberculata* was first reported from Venezuela in 1972 (Pointier et al. 1999), from Brazil in 1967 in Sao Paulo (Vaz et al. 1986, cited by Barroso and Matthews-Cascon 2009), and Argentina in 1999 (Peso et al. 2011). [...] Introductions are still occurring in the Eastern Hemisphere around the edges of its native range, including Spain (Oscos et al. 2009), Malta (Cilia et al. 2013) and New Zealand (Duggan 2002).”

## Short Description

From CABI (2017):

“*M. tuberculata* has a turreted shell with rounded body whorls that are ornamented with spiral grooves and sometimes axial undulating ribs well marked on the middle and upper whorls. The shells are pale to dark brown with numerous reddish brown flames and spots. However, characteristics of the shell (general shape, background colour, ornaments and sculptures) can vary according to the morphs considered (Facon et al., 2003). The spire is usually twice the length of the aperture or more (Morrison, 1954). The aperture is oval-shaped and the operculum is paucispiral, with the nucleus near the base (Morrison, 1954; Thompson, 1984). The head is tongue-like and constricted on its ventral side to give rise to the foot. The tentacles arise from just above this constricted area and are long and slender.”

## Biology

From Fofonoff et al. (2003):

“This snail has separate sexes, but reproduces primarily by parthenogenetic reproduction (without fertilization), with only occasional sexual reproduction, resulting in populations that are largely clonal (Samadi et al. 1999; Facon et al. 2008). Males were 20-33% of the populations in Israeli streams (Livshits and Fishelson 1983), but in other populations, males are rare or absent. Reproduction is ovoviviparous, with eggs being incubated in the female's brood pouch in the last (largest) whorl of the shell, and hatching out as small snails, 1.0 - 4.5 mm in length, with 3-6 shell whorls. The time of brooding and the size of the newborn snails decreased as the number of snails in aquaria increased. Annual fecundity is estimated at 365 embryos per year (Keller et al. 2007). The snails reach maturity at about 10-16 mm shell length, in about 3-7 months. [...] However, populations, even on small islands, such as Martinique, may vary considerably in life history patterns, as a result of multiple introductions, and occasional hybridization of mostly clonal lineages (Samadi et al. 1999; Facon et al. 2008).”

“*Melanoides tuberculata* grazes on microalgae and detritus, but does not feed on the leaves of larger plants (Miranda et al. 2012). It is eaten by crabs, fishes, and birds, as indicated by a diversity of parasites which use it as an intermediate host.”

From CABI (2017):

“Studies in Martinique and Guadeloupe Islands (Pointier et al., 1989, 1993[b]) allowed investigating life patterns of *M. tuberculata* under natural conditions. It showed that this snail has a demographic strategy characterized by a slow growth and a long life span (up to three years in some habitats). They revealed also that maximum reproduction took place during the rainy season between June and November (Pointier et al., 1993[b]), but reproduction did not completely stop during the dry season. [...] This species is active mostly at night, hiding beneath decaying plants and stones or burying themselves in the mud during the day (Livshits and Fishelson, 1983).”

From Van Damme and Lange (2016):

“Subpopulations may reach extremely high densities of 200-300 ind/m<sup>2</sup> in Lake Chad (Lévêque 1967) and up to 10,000 ind/m<sup>2</sup> (Pererea and Walls 1996) in sandy or gravelly sediments where the snails do not only live upon the surface but also in the top-layer (endobenthic).”

## Human Uses

From Fofonoff et al. (2003):

“In some parts of the world, *M. tuberculata* has been introduced as a biocontrol agent to control native snails (*Biomphalaria* spp.) hosting trematodes causing schistosomiasis in humans. In Martinique, deliberate introductions of this snail (starting in 1973) resulted in the local extinction of *B. glabrata* and great reductions of *B. straminea* (Pointier 2001). Similar introduction programs have been successful in St. Lucia (Prentice 1983, cited by Pointier et al. 1994),

Guadeloupe (Pointier et al. 1993[a]), Venezuela (Pointier et al. 1994), and Minas Gerais, Brazil (Guimarães et al. 2001).”

“Ornamental: *Melanoides tuberculata* is a popular aquarium snail, often sold under the name 'Malaysian Trumpet Snail'.”

From Van Damme and Lange (2016):

“It is well known that this species is eaten by molluscivorous fish, such as some cichlid species and carp, but its use as a commercially interesting food source in fish farming requires confirmation. It is sometimes used in ethnic ornaments.”

## Diseases

From Derraik (2008):

“*M. tuberculata* is an intermediate host of a number of trematode parasites such as: *Paragonimus kellicotti*, [Proctor and Gregory 1974; Madariaga et al. 2007] the Chinese liver fluke *Clonorchis sinensis*, and the Oriental lung fluke *Paragonimus westermani*; [Vaz et al. 1986; Guimarães et al. 2001] the rat lung-worm *Angiostrongylus cantonensis*; [Crook et al. 1968; Ibrahim 2007] *Loxogenoides bicolor*, *Transversotrema laruei*, and *Stictodora tridactyla*; [Ukong et al. 2007] *Gastrodiscus aegyptiacus*; [Mukaratirwa et al. 2004] Oriental eye-fluke *Philophthalmus gralli*; [Ismail and Arif 1993; Díaz et al. 2002; Mukaratirwa et al. 2005] *P. distomatosus*; [Radev et al. 2000] *Haplorchis pumilio*; [Díaz et al. 2002] *Haplorchis* sp.; [Dzikowski et al. 2003] *Centrocestus formosanus*; [Pointier 1999; Díaz et al. 2002; Levy 2004] and *Centrocestus* sp. [Dzikowski et al. 2003; Ben-Ami and Heller 2005]”

From Mitchell et al. (2007):

“The snail transmits several trematodes directly to fish and indirectly to humans and birds (Abbott 1952; Dundee and Paine 1977; Nollen and Murray 1978; Mitchell et al. 2000). Some of these include the human liver fluke *Clonorchis sinensis*, the oriental lung fluke of humans *Paragonimus westermani*, the oriental eye fluke of birds *Philophthalmus gralli*, and the gill trematode of fishes *Centrocestus formosanus*. The gill trematode encysts in the gills of many fish species and has caused serious losses among commercially raised tropical fishes (e.g., cichlids, tetras, and tropical cyprinids) in Florida (Blazer and Gratzek 1985; Mitchell et al. 2005; data of W. K. Vogelbein and R. M. Overstreet presented at the International Association for Aquatic Animal Medicine Annual Conference, 1988).”

## Threat to Humans

From CABI (2017):

“Besides its positive consequences concerning schistosomiasis, *M. tuberculata* may play the role of intermediate host for several trematode parasites of medical or veterinary importance (Murray, 1971; Jacobson, 1975; Dundee and Paine, 1977).”

### 3 Impacts of Introductions

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From Fofonoff et al. (2003):

“Competition: *Melanoides tuberculata* has a proven history of replacing some native snail species in tropical and subtropical environments, an ability that has been exploited in biocontrol programs to control snails which are hosts for schistosomiasis (Pointier et al. 1994; Guimarães et al. 2001; Pointier 2001). This competitive ability is a concern, when this snail invades water bodies which contain rare native species. So far, impacts on native marine snails in Biscayne Bay are limited, in part because this snail is concentrated in sites near the mouths of canals and other disturbed sites (Wingard et al. 2007). The central Texas springs invaded by *M. tuberculata* are habitat for a number of endemic and highly localized snail species, including *Elimia comalensis*, *Tryonia circumstriata*, *Pseudotryonia adamantia*, *Assimineia pecos*, and *Physella* spp. However, in some springs, high densities of native snails coexist with *M. tuberculata* (Karatayev et al. 2009; Ladd and Rogowski 2012). The exact mechanisms by which *M. tuberculata* displace other snail species has not been studied in detail; however, behavioral interference, food competition, and egg predation are possibilities (Ladd and Rogowski 2012).”

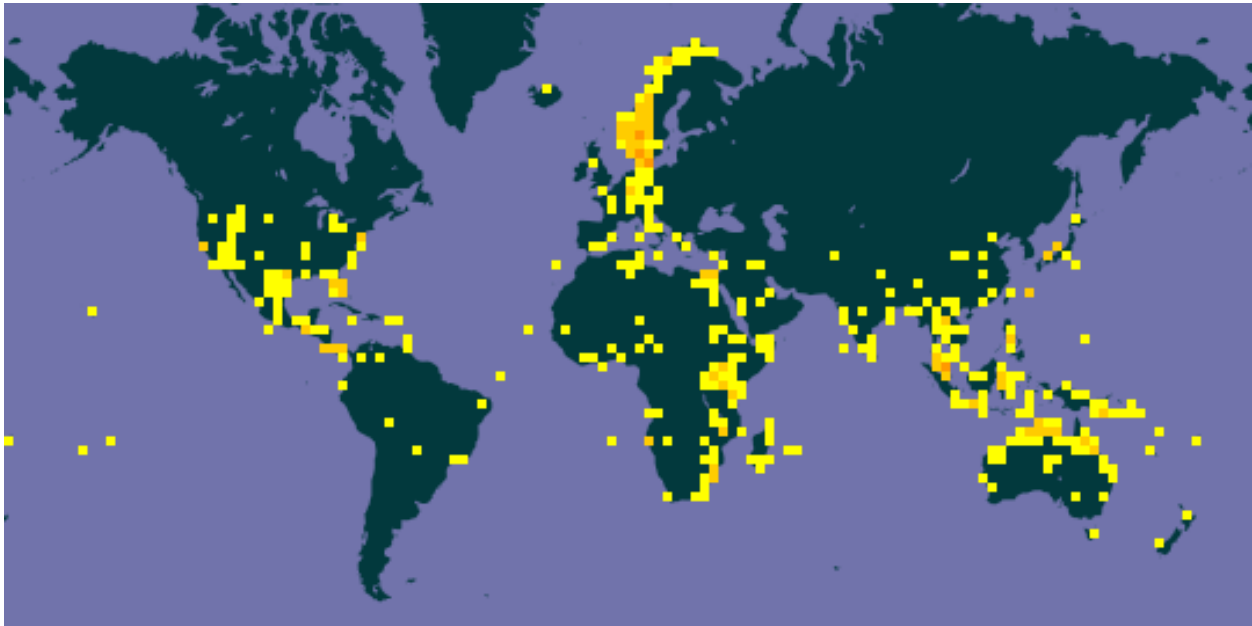
“Predation: Predation on egg masses is one possible means by which *M. tuberculata* displaces native snails. However, in experiments using eggs of *Physella* spp. from a Texas spring, predation rates were quite low (Ladd and Rogowski 2012). This snail did eat the egg masses of an endangered central Texas fish, *Etheostoma fonticola* (Fountain Darter), but at rates lower than those of most other native and introduced snails (Phillips et al. 2010).”

“Habitat Change: A novel effect of a freshwater snail invasion was observed in Tobago, where large shells of *M. tuberculata* and *Tarebia granifera* (Quilted Melania) were washed down streams into coastal waters during storms, providing a new empty-shell resource for hermit crabs (*Clibanarius tricolor* and *C. vittatus*) and drastically changing the patterns of shell use (van Oosterhout et al. 2013).”

“Parasite-Predator Vector: *Melanoides tuberculata* is a host to 37+ parasites in its native range and has been a vector for at least 3 trematodes (*Centrocestus formosanus*; *Haplorchis pumilio*; *Philophthalmus gralli*) which have been introduced to the Western Hemisphere, and the US, including central Texas. These parasites develop in snails, then fishes, with birds and mammals as their final hosts (Karatayev et al. 2009; Alves-Pinto et al. 2011). No harmful parasites were found in a survey of *M. tuberculata* in Biscayne Bay, Florida. However, the 3 introduced Asian trematodes, *C. formosanus* and *P. gralli* are found in *M. tuberculata* in central Texas springs and streams. *Centrocestus formosanus* infects the gills of fishes and can cause extensive fish mortality. This trematode is a threat to several local endemic fishes, including the endangered Fountain Darter (Karatayev et al. 2009; Ladd and Rogowski 2012).”

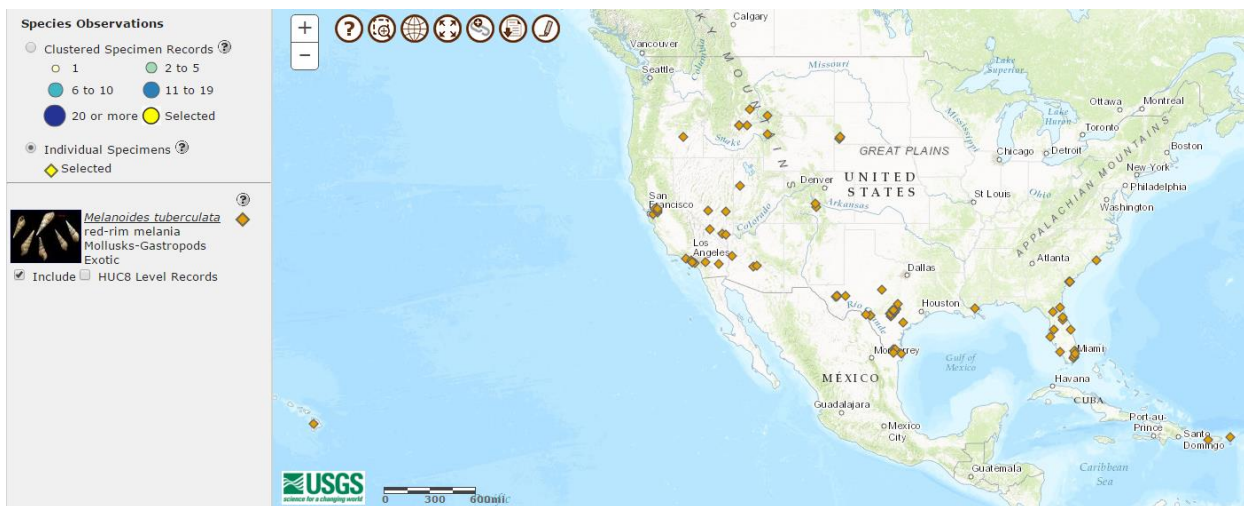


## 4 Global Distribution



**Figure 1.** Reported global distribution of *M. tuberculata*. Map from GBIF (2016). Locations outside of those countries listed under Distribution Outside the United States (above) were not included in climate matching.

## 5 Distribution Within the United States

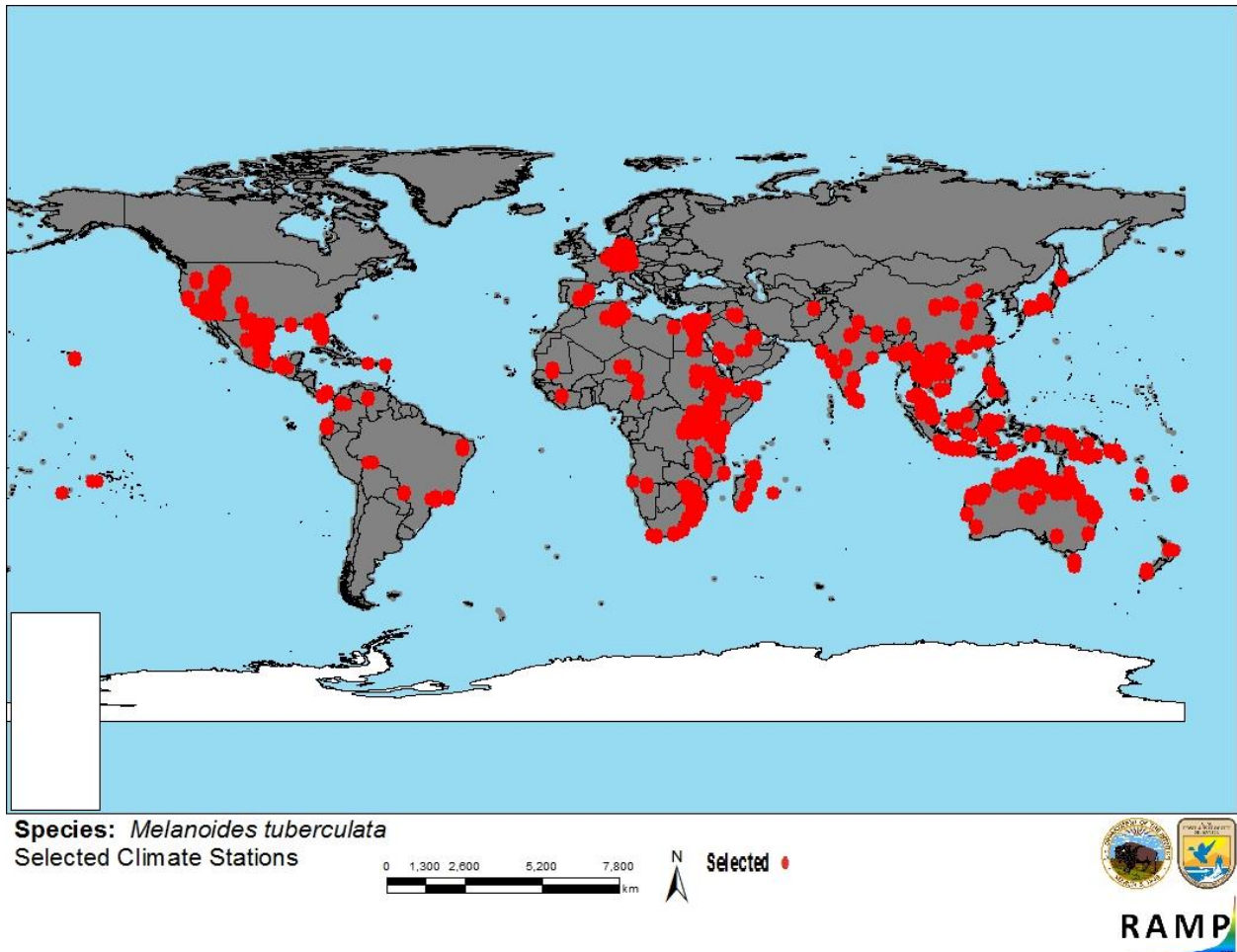


**Figure 2.** Known distribution of *M. tuberculata* in the United States. Map from Benson and Neilson (2017). Locations in South Dakota, North Carolina, and the U.S. Virgin Islands have not been confirmed to represent established populations, and therefore were excluded from the climate matching analysis.

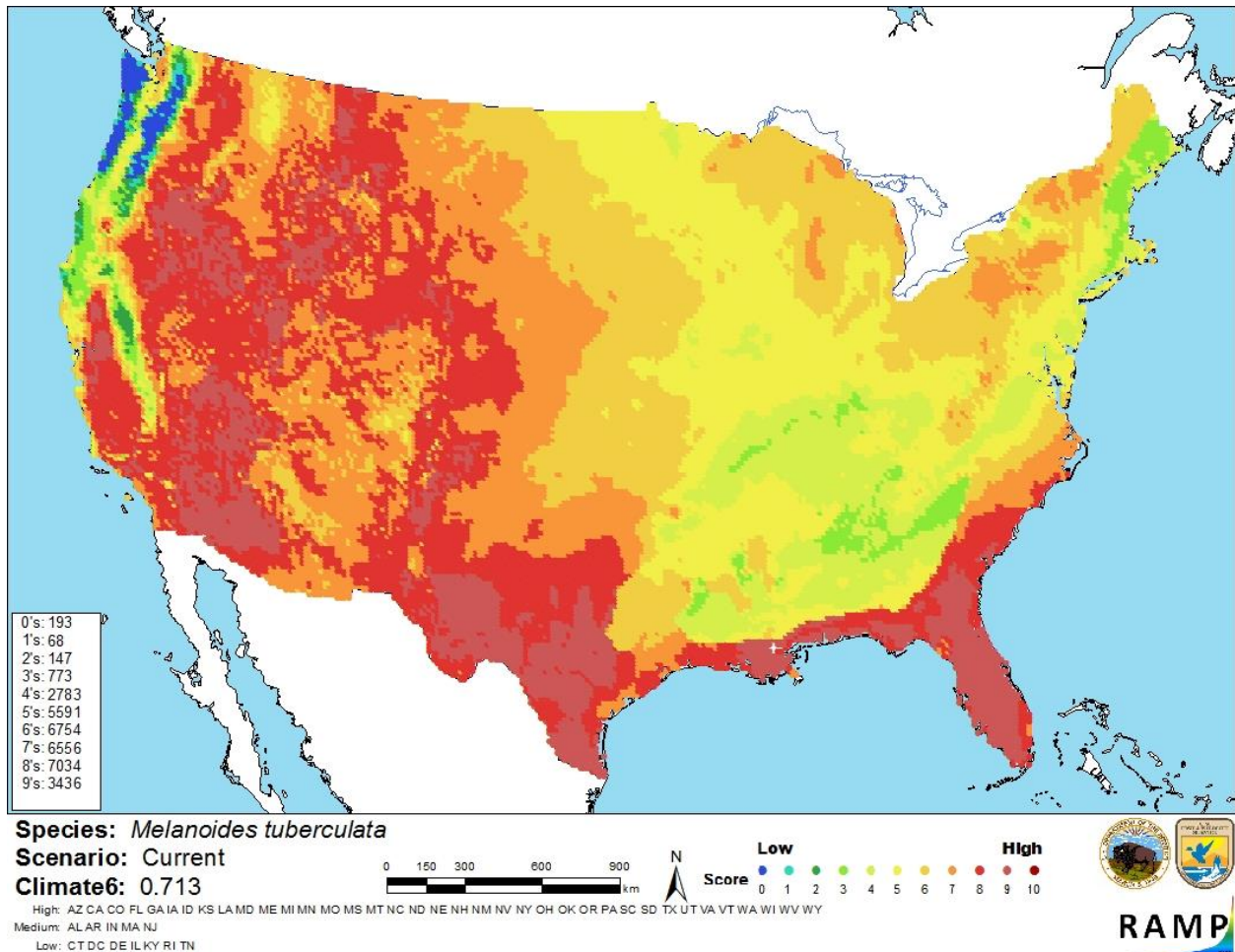
## 6 Climate Matching

### Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) for *M. tuberculatus* was high across much of the western U.S, along the Gulf Coast, and along the southeast Atlantic Coast. Most of the eastern U.S. showed a medium match with low matches in the coastal Pacific Northwest. Climate 6 proportion indicated a high match for the contiguous U.S. Proportions greater than 0.103 indicate a high match; the Climate 6 proportion of *M. tuberculatus* was 0.713.



**Figure 3.** RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *M. tuberculatus* climate matching. Source locations from GBIF (2016) and Benson and Neilson (2017).



**Figure 4.** Map of RAMP (Sanders et al. 2014) climate matches for *M. tuberculatus* in the contiguous United States based on source locations reported by GBIF (2016) and Benson and Neilson (2017). 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
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
$\geq 0.103$	High

## 7 Certainty of Assessment

Ample information is available on the distribution, biology, and ecology of *M. tuberculatus*. While more published research on impacts of *M. tuberculatus* introduction would be desirable, there is sufficient research available to lend confidence to assessment of the history of invasiveness. Certainty of this risk assessment is high.

## 8 Risk Assessment

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### Summary of Risk to the Contiguous United States

*Melanooides tuberculatus* is a snail native to the African and Asian continents. The species has become established in North and South America, Europe, and Oceania, primarily through the aquarium trade and intentional introduction as biocontrol for native snails that host trematodes that can cause schistosomiasis. In the U.S., *M. tuberculatus* is particularly well established along the Gulf Coast from Florida to Texas. The species carries numerous parasites of significance to humans, endangered fish species, and commercially-produced fish species. *M. tuberculatus* has successfully outcompeted native snail species. Climate match to the contiguous U.S. is high, with nearly all locations showing at least a medium match. Overall risk posed by *M. tuberculatus* is high.

### Assessment Elements

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

## 9 References

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**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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## 10 References Quoted But Not Accessed

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**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.**

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