Tiger Scud (*Gammarus tigrinus*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, December 2022
Revised, January 2023
Web Version, 3/5/2025

Organism Type: Amphipod
Overall Risk Assessment Category: High

Photo: Peter Koomen. Licensed under CC BY-NC-ND 4.0. Available: https://observation.org/photos/3159447.jpg (December 2022).

1 Native Range and Status in the United States

Native Range

From Ba et al. (2010):

"The gammarid *Gammarus tigrinus* Sexton, 1939 is a widespread species that occurs principally in estuaries of the northwestern Atlantic and is distributed from the St. Lawrence River in Quebec to Florida (Bousfield, 1958, 1973)."

Status in the United States

From Ba et al. (2010):

"The gammarid *Gammarus tigrinus* Sexton, 1939 is a widespread species that occurs principally in estuaries of the northwestern Atlantic and is distributed from the St. Lawrence River in Quebec to Florida (Bousfield, 1958, 1973)."

From Kipp et al. (2022):

"*Gammarus tigrinus* was first discovered in Saginaw Bay, Lake Huron, in 2002. Archived material indicates that this species was present in Lake Superior and Lake Erie in 2001. Subsequent collections revealed that it is present in all of the Great Lakes (Grigorovich et al. 2005; Kelly et al. 2006). This species has expanded its range outside the Great Lakes. It has been found in the lower Ohio River on the OH/KY border and further upriver on the OH/WV border, as well as in the upper Mississippi River near the confluence of the Ohio River and upriver to a location on the Wisconsin-Minnesota border (Grigorovich et al. 2008)."

According to Kipp et al. (2022), nonindigenous occurrences of *Gammarus tigrinus* have been reported in the following States, with range of observation years, number of watersheds (8-digit hydrologic unit), and population status where reported (one or more watersheds) in parentheses:

- Illinois (2004–2006; 1; Unknown)
- Kentucky (2004–2006; 3; Unknown)
- Michigan (1999–2012; 4; Established)
- Minnesota (1985–1985; 1; Established)
- New York (1999–2012; 1; Established)
- Ohio (2001–2016; 2; Established)
- Pennsylvania (2012–2022; 2; Established)
- West Virginia (2005–2005; 1; Unknown)
- Wisconsin (2006–2006; 1; Unknown)

No records of *Gammarus tigrinus* in trade in the United States were found.

Regulations

Gammarus tigrinus is regulated in Hawaii (HDOA 2019) via regulation applicable to all organisms in the genus *Gammarus*. Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Kipp et al. (2022):

"Very likely introduced in ballast water (Grigorovich et al. 2005). Populations of *G. tigrinus* in the Great Lakes are genetically similar to those from the Hudson River estuary (Kelly et al. 2006)."

Remarks

From Fofonoff et al. (2018):

"*Gammarus tigrinus* was reported in a survey of ship hull fouling in Vancouver Harbor, British Columbia (2007-2009, Sylvester et al. 2011). However, no details on the identification were given. These specimens could be the similar *G. daiberi*, which is established in San Francisco Bay."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2022):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Ecdysozoa
Phylum Arthropoda
Subphylum Crustacea
Class Malacostraca
Subclass Eumalacostraca
Superorder Peracarida
Order Amphipoda
Suborder Gammaridea
Family Gammaridae
Genus Gammarus
Species *Gammarus tigrinus* Sexton, 1939

According to Bellan-Santini (2004), *Gammarus tigrinus* is the current valid name for this species.

Size, Weight, and Age Range

From Shalaeva (2014):

"Average body length of a full-grown male is 10.5-12.5 mm, female 8.5-10 mm (Sexton and Cooper, 1939), from the tip of the rostrum to the insertion of telson. Body size varies greatly with temperature, salinity and type and nutritional type of food."

“Life span of *G. tigrinus* is about 2 months, depending on temperature. Overwintering animals may live for several months.”

Environment

From Shalaeva (2014):

“*G. tigrinus* is highly euryhaline (Devin and Beisel, 2007; Jensen, 2010). In its native range, it lives in brackish waters of salinities from 4 to 20 ppt (Kelly et al., 2006b) and tolerates a range of 0 to 25 ppt (Bousfield, 1973).”

“In its native range, *G. tigrinus* is essentially benthic, common in the upper portion of estuaries in both fresh and brackish waters (Bousfield, 1973; van Maren, 1978). It lives in debris, among algae (*Enteromorpha* [*Ulva*]) and hydroids (*Cordylophora*), on stakes and pilings, hard substratum or sand. It is a low intertidal (often on rocky shores in beach seeps and stream outflows), but essentially subtidal species.”

“In the American invaded range, the species mostly occurs in very shallow areas on silty sand, on *Cladophora* or in macrophyte beds (Grigorovich et al., 2005).”

“*G. tigrinus* survives [water] temperatures close to 0°C and upper temperature tolerance is 32-34°C (Kipp, 2007).”

Climate

From Shalaeva (2014):

“Populations are found in a wide range of inland and coastal ecosystems in temperate regions, indicating low habitat selectivity in its native range.”

From Fofonoff et al. (2018):

“Cold temperate-Tropical”

Distribution Outside the United States

Native

A portion of the native range for *Gammarus tigrinus* is within the United States, see section 1 for a full description.

From Shalaeva (2014):

“Canada […] From St. Lawrence River, Quebec, southwards”

Introduced
From Shalaeva (2014):

"The species has been introduced in different areas of […] Europe and Venezuela. Distribution of *G. tigrinus* tends to show a continuous, rather than fragmented, pattern (Ba et al., 2010). Its southernmost location is in South America, where it has been found in the Gulf of Paria and the Orinoco Delta, Venezuela (Capelo et al., 2004; Martin and Diaz, 2007), and the northernmost one in Finland (harbour of Hamina, Baltic Sea; Pienimäki et al., 2004)."

According to Shalaeva (2014), *Gammarus tigrinus* has been introduced to and is present in: Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, The Netherlands, Norway, Poland, Russia, Sweden, Switzerland, United Kingdom, Canada (Great Lakes region), and Venezuela.

Means of Introduction Outside the United States

From Ba et al. (2010):

"It was introduced into British waters by ballast water in 1931 (Sexton & Cooper, 1939) […]"

"The spread of this amphipod in European continental waters was accelerated by its intentional release into the tributary of the German River Weser in 1957 (Schmitz, 1960). In the Netherlands, this species was first recorded from the IJsselmeer in 1964 (Pinkster, 1975) and in 1975 reached the south-western part of the Baltic Sea (Schlei Fjord) probably via the 'NordOstsee-Kanal' (Bulnheim, 1976)."

"In 2006, it was found in the easternmost part of Baltic Sea (Neva Estuary) [Russia] and may well have been transported there with ballast waters from the Finnish area of the Gulf of Finland (Berezina, 2007)."

From Shalaeva (2014):

"This introduction [to IJsselmeer, Netherlands] may have been the result of a semi-intentional release by a scientist who had imported specimens from Northern Ireland for laboratory experiments (Nijssen and Stock, 1966)."

Short Description

From Shalaeva (2014):

"*G. tigrinus* has a typical amphipod body that is segmented throughout, laterally compressed, slender, evenly rounded with a curved or hook-like profile. The body consists of cephalothorax with two pairs of antennas, two eyes and mouthparts; pereon with seven pairs of appendages (pereopods) mainly designed for movement; pleon with another three pairs (pleopods) and urosome carrying three pairs of uropods. Telson is the last segment of the crustacean body. […] Body colour of the living animal is whitish to yellow/faint orange, with black patches or transverse stripes. The remarkable pattern of dark stripes on the light background gave the

species the specific name *tigrinus*. Stripes run across each segment, and two longitudinal bands along the length of the body; the lower is dark, the upper is red. The pattern disappears when specimens are preserved. The cuticle is microscopically spinulose all over, spinules more pronounced in the pleon and in the dorsal region. Mature males *G. tigrinus* typically have 2-5 groups of posterior marginal setae in the second peduncular (basal) segment of their first antennae, longer and curly second antennae, distinct setae on their pereopods (Sexton and Cooper, 1939; Grigorovich et al., 2005). Uropod 3 is long and setose. Setae are usually less curly during winter months (Jensen, 2010). A detailed description of the segments [sic] morphology and their setation can be found in Sexton and Cooper (1939). Overall, morphological differences between male and female in this species are much more noticeable than it is usual for the genus. Females have fewer setae in the antennae and pereopods (Bousfield, 1969; Grigorovich et al. 2005) and are slightly smaller than males."

Biology

From Kipp et al. (2022):

"*Gammarus tigrinus* is omnivorous. It filter feeds suspended organic matter and can also directly consume zooplankton, plants, algae, detritus, and even its own young (Hunte and Myers 1984; Grigorovich et al. 2005)."

"Reproducing adults occur in freshwater in the Great Lakes. In Saginaw Bay, reproductive females carry 32 embryos on average and populations contain many more juveniles and females than males, probably because males have shorter life spans (Grigorovich et al. 2005). *Gammarus tigrinus* often matures in a few months, reproduces quickly, and produces 3-16 generations annually (Chambers 1977; Grigorovich et al. 2005). Reproduction can be triggered at any time of year if ambient 10°C temperature increases by 15–16°C (Ginn et al. 1976)."

From Shalaeva (2014):

"*G. tigrinus* can also be described as a facultative carnivore (Savage, 2000). In Watch Lane Flash, UK, and in water bodies in the Netherlands and Germany, *G. tigrinus* has been noted to be a voracious predator (e.g. Schmitz, 1960; Fries and Tesch, 1965; Chambers, 1977; 1987; Savage, 1982; Pinkster et al., 1992). Predation by *G. tigrinus* upon other amphipods has been observed and contributes to the decline of native gammarids."

"In the Baltic area, *G. tigrinus* has often been found associated with *Dreissena polymorpha* beds (Radziejewska et al., 2009). Other invertebrate species frequently co-occurring with *G. tigrinus* are chironomid larvae, the cockle *Cerastoderma glaucum* and the gastropod *Theodoxus fluviatilis* (Orav-Kotta and Kotta, 2004; Kinzler and Maier, 2003; Kotta et al., 2013; 2014)."

"Lenz et al. (2011) collected *G. tigrinus* individuals from shore habitats dominated by the brown alga *Fucus vesiculosus*, and Kotta et al. (2014) associate the species with *Chara aspera* macrophyte communities."

From Ba et al. (2010):

"It is dominant in intertidal and subtidal benthic habitats including reeds, algae, hard or soft substratum, and sand (Bousfield, 1958, 1973; van Maren, 1978). In its native range, this euryhaline species lives in both fresh and brackish water (Bousfield, 1973), whereas in coastal waters it is restricted to shallow lagoons, bays, and estuaries. Being a bottom dwelling omnivore, *G. tigrinus* is relatively tolerant to pollution and has a much greater reproductive capacity in oligohaline waters than many native gammarid species (Pinkster, 1975; Pinkster et al., 1977). […]. Unlike some epiphytic amphipods, *G. tigrinus* is unlikely to disperse by algal rafting (Myers, 1993)."

Human Uses

From Shalaeva (2014):

"Animal feed, fodder, forage > Fishmeal"

"Animal feed, fodder, forage > Live feed"

Diseases

No information was found associating *Gammarus tigrinus* with any diseases listed by the World Organisation for Animal Health (2022).

From Rolbiecki and Normant (2005):

"Metacercariae of *Maritrema subdolum* Jägerskiöld, 1909 were noted during morphometric studies of *G. tigrinus* collected in October 2004 in the Gulf of Gdańsk (Poland)."

From Shalaeva (2014):

"*G. tigrinus* has been shown to be an intermediate host to the acanthocephalan *Paratenuisentis ambiguus* […]"

Threat to Humans

No information was found on threats to humans from *Gammarus tigrinus***.**

3 Impacts of Introductions

From Kipp et al. (2022):

"***Realised:*** In many wetland habitats along the Great Lakes' perimeter *G. tigrinus* is already the second most abundant amphipod after *G. pseudolimnaeus* (Grigorovich et al. 2005).

From Shalaeva (2014):

"In 2008-2010, *G. tigrinus* was the most dominant species in nearshore zones of both Vistula Lagoon and Vistula Delta [Baltic Sea] (Dobrzycka-Krahel et al., 2013), while native gammarid species went totally extinct. Similarily [sic], following the invasion of *G. tigrinus*, *G. salinus* almost disappeared from Koiguste Bay, Estonia (Herkul et al., 2009) and *G. duebeni* from Watch Lane Flash, UK (Savage, 1982)."

"One of the reasons for this native gammarid retreat to occur is the fact that *G. tigrinus* proved to be competitively superior to the majority of native gammarids in Europe (Pinkster et al., 1992; Grabowski et al., 2006; Orav-Kotta et al., 2009; Kotta et al., 2006; 2010; Sareyka et al., 2011). Due to its ecological plasticity, aggressiveness and fast reproduction, *G. tigrinus* competes successfully for food and space with native gammarid species, forcing them to leave their preferred habitats and increasing exposure to fish predation (Orav-Kotta et al., 2009; Kotta et al., 2010; 2011). For example, in the Gulf of Finland, the omnivorous *G. tigrinus* is able to outcompete and replace native herbivorous *Gammarus* species (Packalén et al., 2008)."

"*G. tigrinus* invasions have also been accompanied by the simultaneous introduction of alien parasites (Leppakoski, 2002). *G. tigrinus* has been shown to be an intermediate host to the acanthocephalan *Paratenuisentis ambiguus*, which definitive host is the American eel *Anguilla rostrata* (Samuel and Bullock, 1981; Taraschewski et al., 1987; Morozinska-Gogol, 2008; 2009). This acanthocephalan seems to have been introduced with *G. tigrinus* into Europe, where its final European host is *A. anguilla* (Thielen, 2005; Taraschewski, 2006). During the 1990s, both exotics had spread into River Rhine, with *G. tigrinus* dominating the amphipod fauna and *P. ambiguus* dominating the intestinal helminth community of local eels (Sures and Streit, 2001)."

"Although *G. tigrinus* can function as a detritivore and shred decaying leaf material, it is not able to compensate for the activity of native species, which replacement has led to a decrease of at least 66% in the rate of leaf litter recycling (van der Velde et al., 2000, Piscart et al., 2011)."

From Fofonoff et al. (2018):

"Trophic Cascade- The high abundance, high fecundity, and intermediate trophic position of *G. tigrinus* has led to complicated trophic interactions. At a site in the Gulf of Finland, replacement of *G. duebeni* and *G. zaddachi* by the more carnivorous *G. tigrinus* has led to increased algal biomass (Packalén et al. 2008)."

"Experiments suggest that *Gammarus tigrinus* competes with the native amphipod *G. salinus* in pebble habitats in Baltic waters, under predation by predatory fish *Gasterosteus aculeatus* (Three-spined Stickleback). The introduced amphipod has a higher reproductive rate, which compensates for increased predation, but the native species decreases in abundance, because of the intensified predation (Kotta et al. 2010). The two amphipod species tended to avoid one another, but the presence of *G. tigrinus* had a greater effect on habitat choice by *G. salinus*. However, this effect was weak and variable (Kotta et al. 2011). *Gammarus tigrinus* have greater fecundity than native *G. duebeni* in Koiguste Bay, Gulf of Riga. The combination of high

fecundity and predation on juvenile amphipods favors *G. tigrinus* (Janes et al. 2015). *Gammarus tigrinus* displaced the native amphipods (*G. salinus*, *G. oceanicus G. zaddachi*) from shallow waters dominated by vascular plants, moving them to deeper areas vegetated with seaweeds (Reisalu et al. 2016)."

Gammarus tigrinus is regulated in Hawaii (HDOA 2019). See section 1.

4 History of Invasiveness

Gammarus tigrinus has been introduced to interior drainages within the United States and Canada from its native range along the Atlantic Coast of North America. Additionally, extensive introductions have occurred across northwestern Europe and in Venezuela. Introductions have primarily occurred through shipping transport and natural dispersion via canals; however, deliberate releases have also occurred. Introductions have resulted in established populations throughout its introduced range. *G. tigrinus* can tolerate a broad range of environmental conditions. Peer-reviewed studies demonstrate that *G. tigrinus* has caused changes to macroinvertebrate communities where introduced, displacing native gammarids and altering other community processes. *G. tigrinus* has also acted as a host for nonnative parasites, notably introducing parasites to European eels (*Anguilla anguilla*). Negative impacts of introduction have been documented in peer-reviewed literature for this species, therefore the history of invasiveness is classified as High.

5 Global Distribution

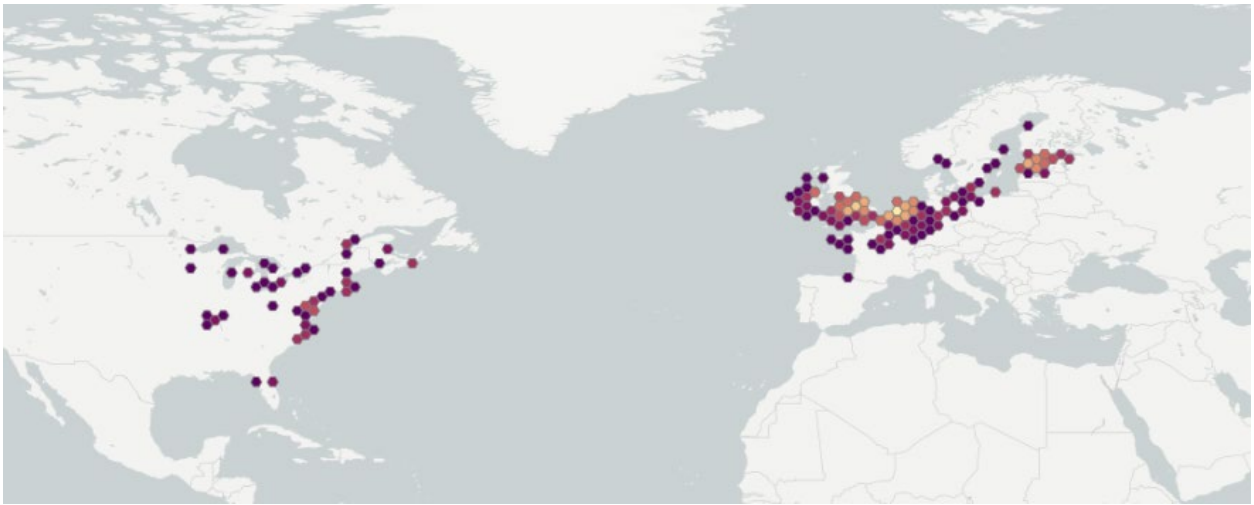

Figure 1. Reported global distribution of *Gammarus tigrinus*. Map from GBIF Secretariat (2022). Observations are reported from North America (United States and Canada) and northwestern Europe (Netherlands, United Kingdom, Estonia, Belgium, Germany, France, Finland, Norway, Sweden, Denmark, Poland, and Ireland).

A georeferenced observation was not found for the reported introduction to the Gulf of Paria in Venezuela.

6 Distribution Within the United States

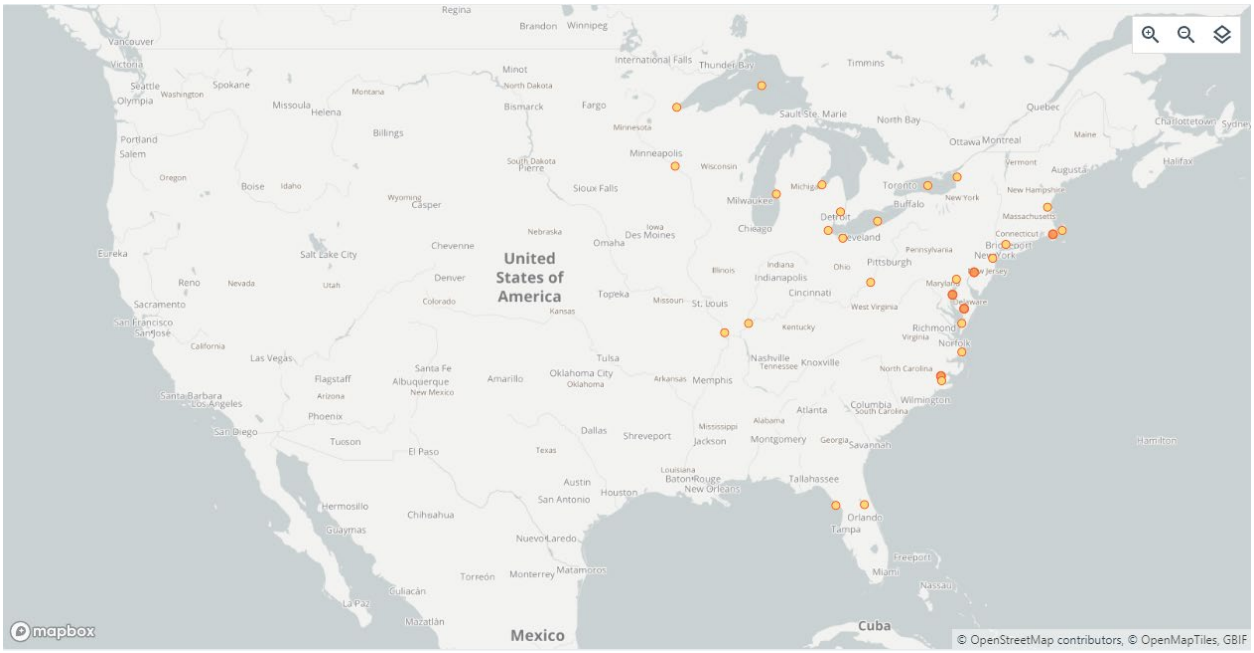

Figure 2. Reported distribution of *Gammarus tigrinus* in the United States. Map from GBIF-US (2022). Observations are reported along the Atlantic coast from Maine to Florida, in the Great Lakes basin, and in the Mississippi and Ohio River drainages.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Gammarus tigrinus* in the contiguous United States was generally high from the Atlantic Coast where this species is native, westward to the eastern Great Plains region. Ares of high match were also found scattered throughout the Rocky Mountains and Colorado Plateau. Medium matches were found from the Great Plains region westward with isolated areas also found in the interior Southeast. Low matches were restricted to the coastal Pacific Northwest, throughout much of California, and in southern Nevada. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.751, indicating that Yes, there is establishment concern for this species outside its native range. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

Projected climate matches in the contiguous United States under future climate scenarios are available for *Gammarus tigrinus* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.

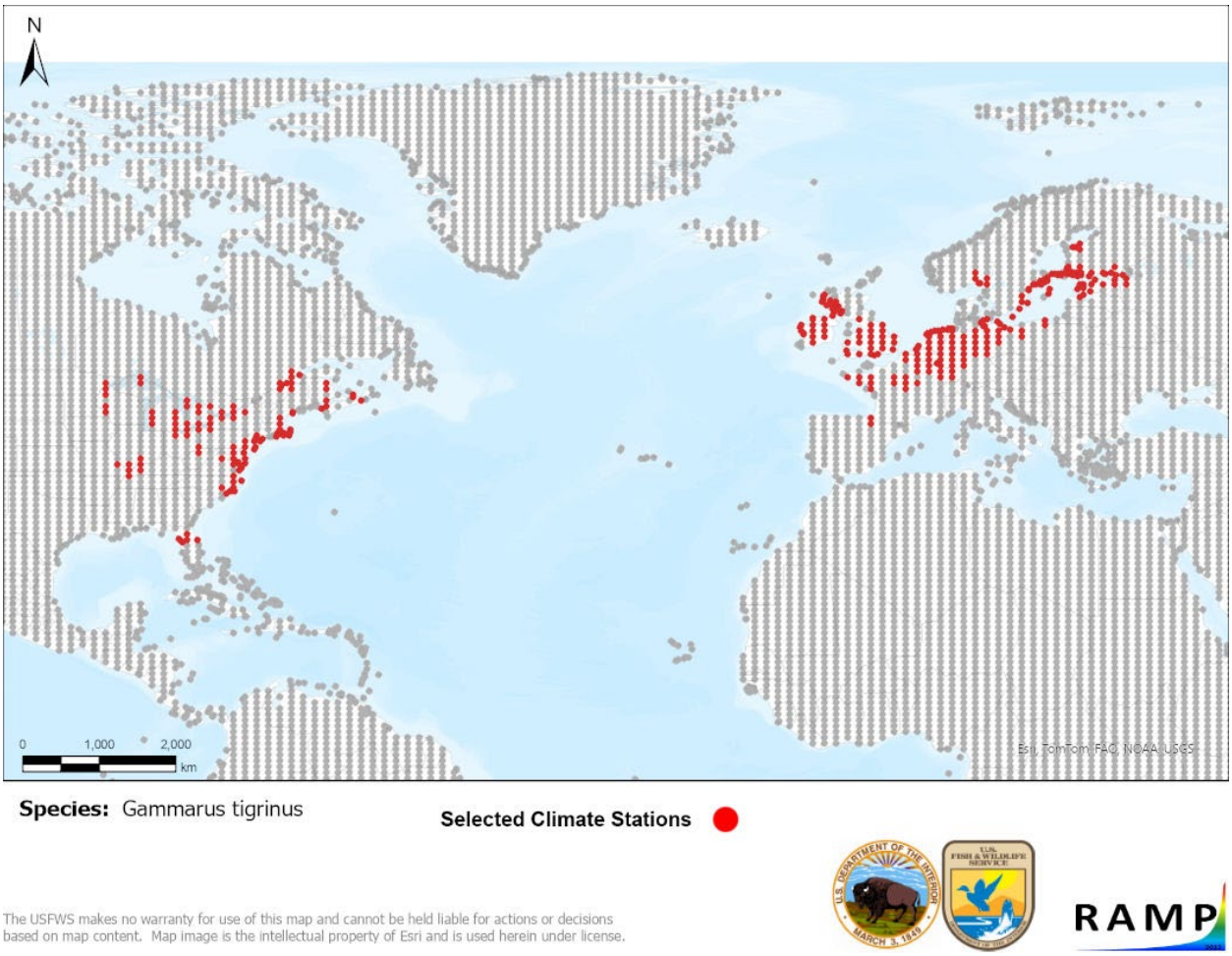

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in eastern North America and northwestern Europe selected as source locations (red; Canada, United States, Spain, Netherlands, United Kingdom, Estonia, Latvia, Belgium, Germany, France, Finland, Norway, Sweden, Denmark, Poland, Russia, and Ireland) and non-source locations (gray) for *Gammarus tigrinus* climate matching. Source locations from GBIF Secretariat (2022). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

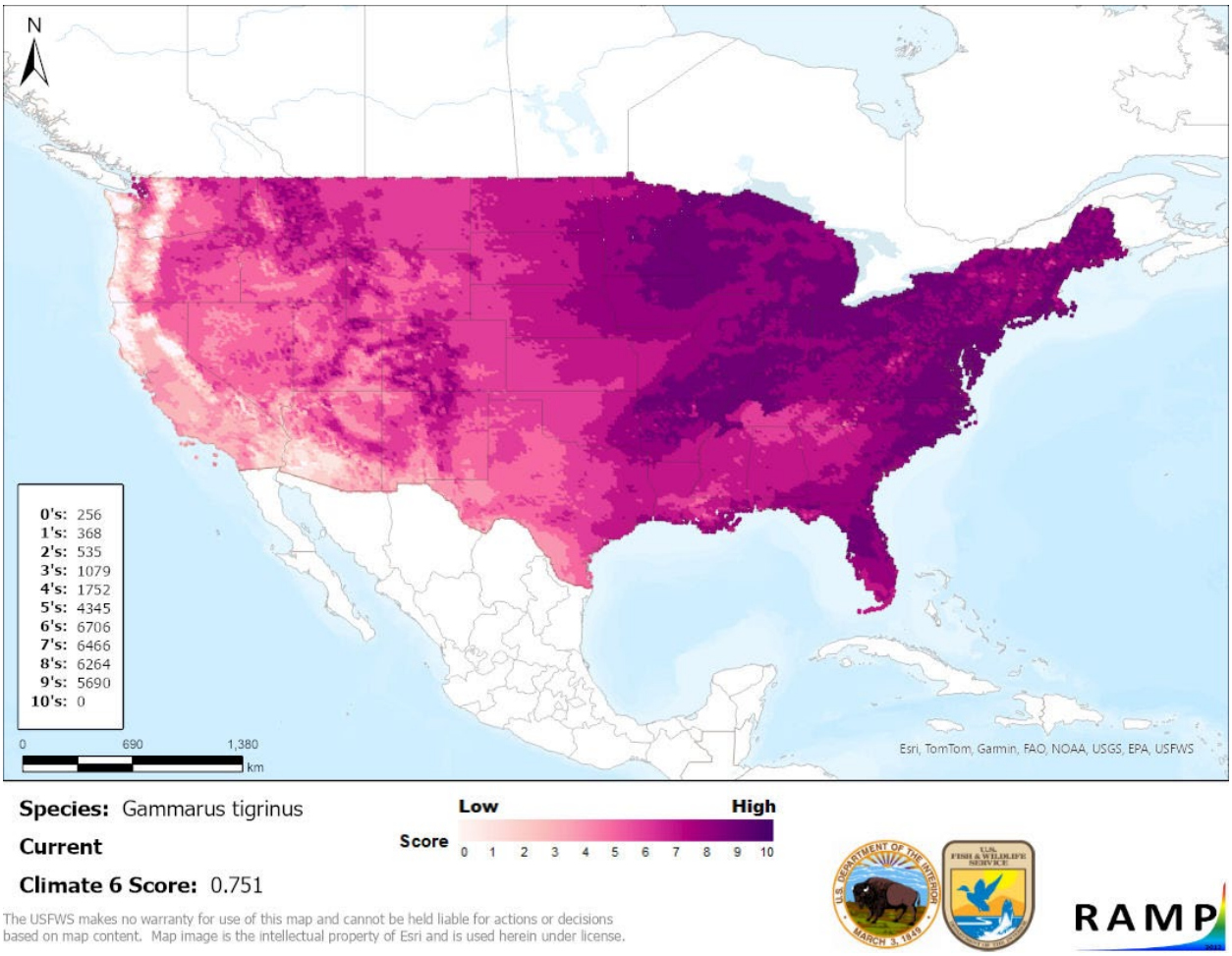

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Gammarus tigrinus* in the contiguous United States based on source locations reported by GBIF Secretariat (2022). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The certainty of assessment is High. There is quality information available about the biology, ecology, and distribution of *Gammarus tigrinus*. Records of introduction and nonnative establishment were found. Information on the history of invasiveness and negative impacts of introduction was readily available from scientific sources during this assessment.

9 Risk Assessment

Summary of Risk to the Contiguous United States

The Tiger Scud (*Gammarus tigrinus*) is a euryhaline amphipod native to estuaries along the Atlantic Coast of North America. *G. tigrinus* tolerates a wide range of environments, and has been introduced to other parts of North America, Europe, and South America, mainly via ship ballast water. The importation of *G. tigrinus* is regulated in Hawaii. The History of Invasiveness is classified as High. *G. tigrinus* has caused changes to macroinvertebrate communities where

introduced, displacing native gammarids. *G. tigrinus* has also acted as an intermediate host for nonnative parasites introduced to European eels (*Anguilla anguilla*). The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. Areas of high match were found in the eastern half of the contiguous United States, including the native range, and in patches in the Western Mountains and Colorado Plateau. The Certainty of Assessment is High. The Overall Risk Assessment Category is High.

Assessment Elements

- **History of Invasiveness (see section 4): High**
- **Establishment Concern (see section 7): Yes**
- **Certainty of Assessment (see section 8): High**
- **Remarks, Important additional information: None**
- **Overall Risk Assessment Category: High**

10 Literature Cited

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in section 11.

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11 Literature Cited in Quoted Material

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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Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by GBIF Secretariat (2022).

Under the future climate scenarios (figure A1), on average, high climate match for *Gammarus tigrinus* was projected to occur in the Appalachian Range, Great Lakes, Mid-Atlantic, Northeast, and Southern Atlantic Coast regions of the contiguous United States. Small areas of high match were also found in the Western Mountains and Colorado Plateau. Areas of low climate match were projected to occur in California, the Northern Pacific Coast, and Southwest regions. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.28 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.673 (model: MPI-ESM1-2-HR, SSP5, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.751, figure 4) falls above the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario. Under all time step and climate scenarios only minor or no increases in the climate match relative to the current match were observed. Under one or more time step and climate scenarios, areas within the Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Northern Plains, Southeast, and Southern Plains saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, California, Colorado Plateau, Great Basin, Northern Pacific Coast, Southern Atlantic Coast, Southern Florida, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. Additional, very small areas of large or moderate change may be visible on the maps (figure A3). The degree of decrease was greater for SSP5 than SSP3, and greater in 2085 than 2055 projections.

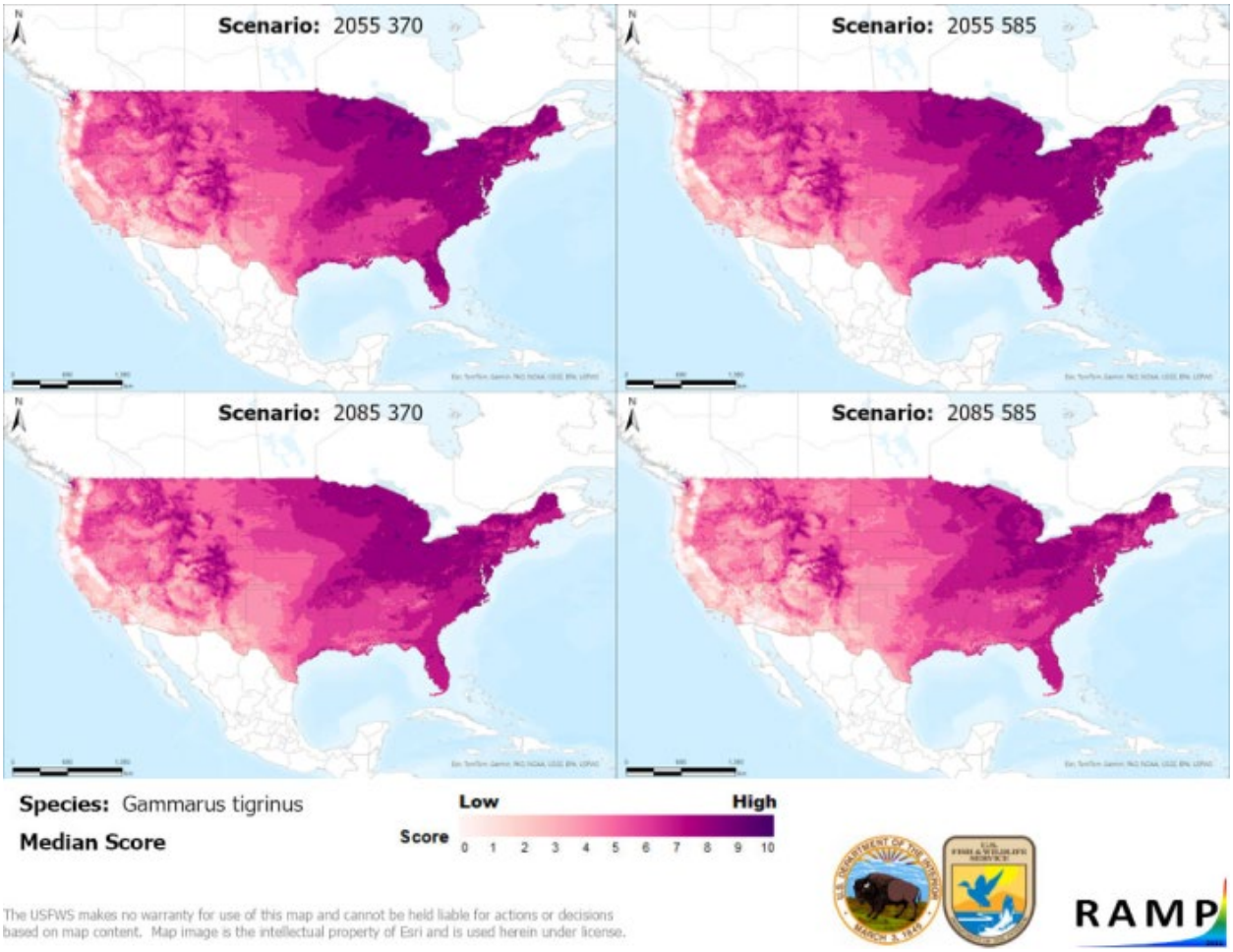

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Gammarus tigrinus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2022). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

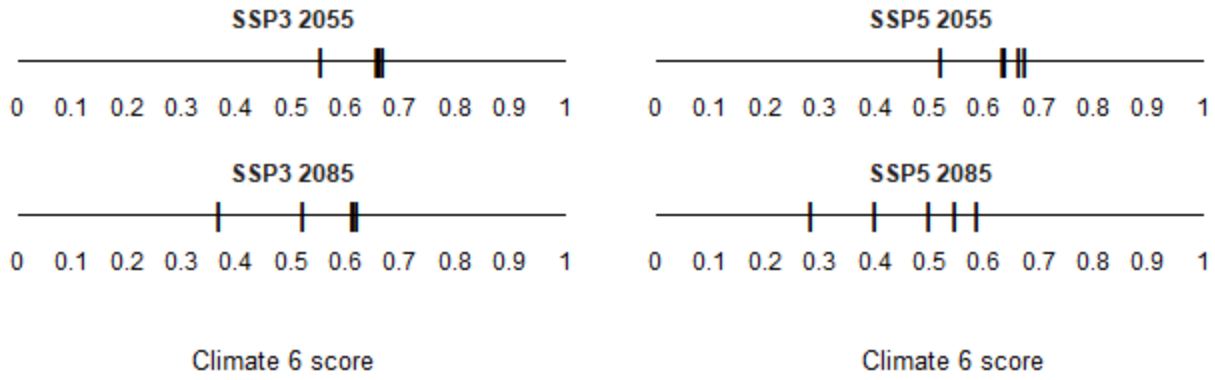

Figure A2. Comparison of projected future Climate 6 scores for *Gammarus tigrinus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.

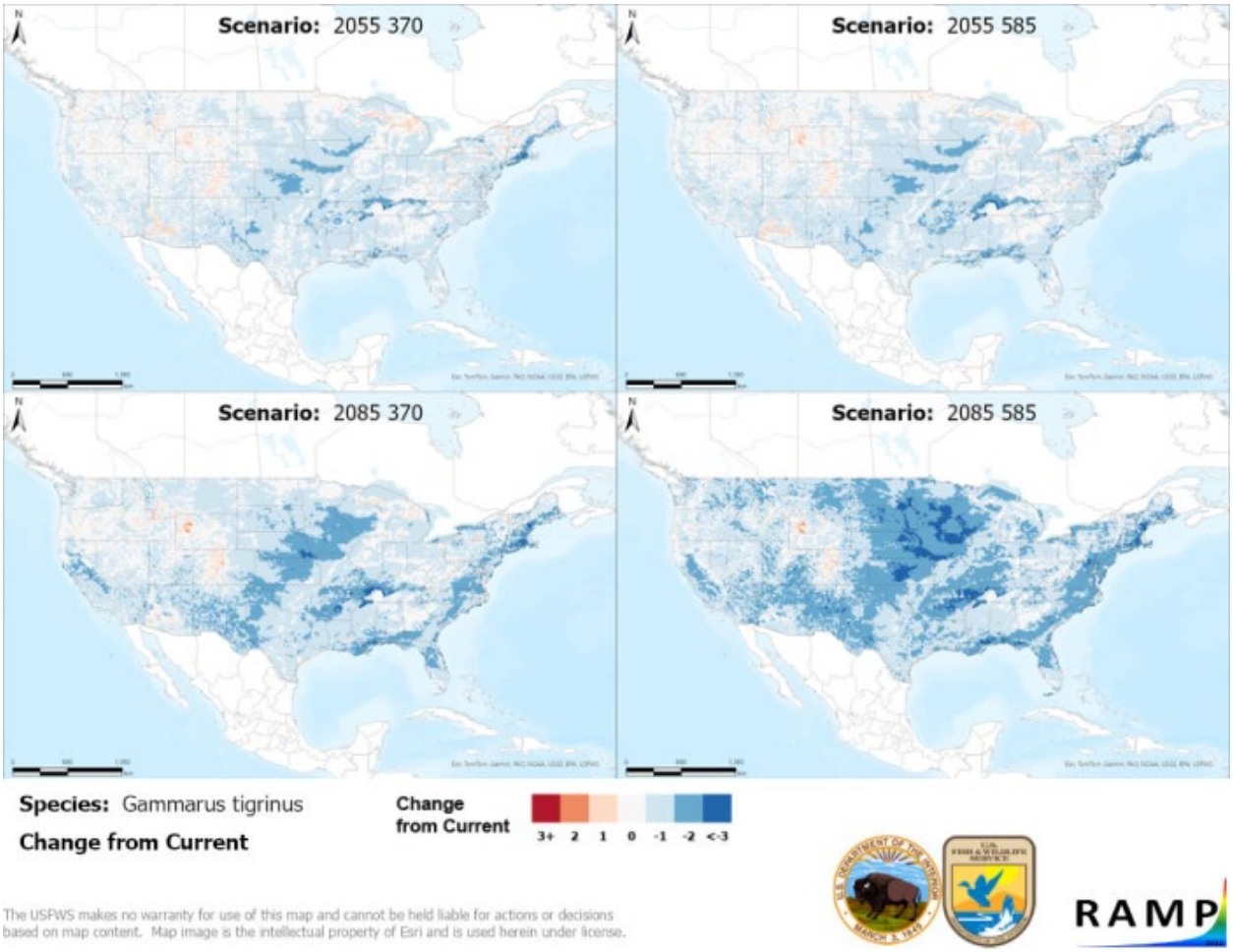

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Gammarus tigrinus* based on source locations reported by GBIF Secretariat (2022). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

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