U.S. Fish & Wildlife Service

Fishhook Waterflea (*Cercopagis pengoi*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2024
Revised, February 2024
Web Version, 12/30/2025

Organism Type: Crustacean
Overall Risk Assessment Category: High

Photo: J. Liebig, NOAA GLERL. Public Domain. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=163 (January 2024).

1 Native Range and Status in the United States

Native Range

From Benson et al. (2024):

"Native Range: Black, Caspian, Azov, and Aral seas of Europe and Asia (Makarewicz et al. 2001)."

From Kotta (2007):

"The native distribution area of *C. pengoi* is restricted to the Ponto-Caspian region: the Caspian, Azov and Aral Seas together with lower reaches of the rivers entering to these waterbodies."

Kotta (2007) reports *Cercopagis pengoi* is native to the following countries, with water bodies given in parentheses: Kazakhstan (Aral Sea), Turkey (Lake Terkos), Bulgaria (Coastal Lakes), Romania (Black Sea, Golovita Lake, Razelm Lake), Russia (Caspian Sea).

From Kane (2003):

"*Cercopagis pengoi* is native to a large area (>3.5 million km^2) containing the Caspian and Aral Seas, the Don Estuary, and the Sea of Azov, and to coastal lakes and the Dneiper-Bug and Dniester estuaries of the Black Sea (Maclsaac and others 1999)."

Status in the United States

From Benson et al. (2024):

"Considered established in Lake Ontario [New York], establishing itself quickly (similar to the invasion patterns in Europe) in the other Great Lakes (except L. Huron and Superior) [Illinois, Michigan, New York, Ohio, Pennsylvania, Wisconsin] and other inland lakes [Michigan, New York] […]."

From Maxson et al. (2023):

"Numerous zooplankton collections in the IWW [Illinois Waterway] from 2010 – 2016 […] did not detect *C. pengoi*. *Cercopagis pengoi* was first collected in the IWW in 2017 near Western Avenue in the Lockport Pool of the Chicago Sanitary and Ship Canal and near Worth Avenue in the Calumet-Sag Channel […]. In 2021, eight additional *C. pengoi* were collected in Arnold's Barge Slip located three river kilometers upstream of the Western Avenue location […]. Additional long-term zooplankton monitoring sites along the length of the IWW near Lake Michigan to its confluence with the Mississippi River were also routinely sampled from 2010–2021; no *C. pengoi* were collected, suggesting that its distribution is currently limited to within the CAWS [Chicago Area Waterway System]."

From Cutter et al. (2023):

"*Cercopagis pengoi* was first detected in Lake Champlain 2018 [sic] but unlike [*Bythotrephes*] *longimanus* was not previously reported in any adjacent waterbodies."

No records of *Cercopagis pengoi* in live trade in the United States were found.

Regulations

Cercopagis pengoi is regulated in Idaho (IDDA 2022), Iowa (Iowa NRC 2015), New Hampshire (NHFG 2022), New York (New York DEC 2022), North Dakota (North Dakota Game and Fish Department 2023), Rhode Island (Rhode Island DEM 2022), Utah (Utah DWR 2023), Vermont (The Vermont Statutes 2017), Washington (WDFW 2022), and Wisconsin (Wisconsin DNR 2022). 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 Benson et al. (2024):

"[…] establishing itself quickly […] due to recreational boat traffic and other human activities (USEPA 2008)."

From Kane (2003):

"Individuals found in the western basin of Lake Erie likely entered the lake via the Detroit River from the upper lakes. Therefore currents could have carried individual colonizers into this area from the Detroit River."

"*Cercopagis pengoi* was most likely introduced into the Great Lakes and Baltic Sea through ballast water (Maclsaac and others 1999; Cristescu and others 2001). Since *C. pengoi* is planktonic and produces resting eggs, either of these life stages could have been transported via shipping. Furthermore, it is possible that even if ships carrying the organisms flushed their ballast tanks with saline water, the euryhaline *C. pengoi* would have survived (Maclsaac and others 1999). Given the frequent passage of ships from both lakes Ontario and Michigan through lakes Huron, St. Clair, and Erie, it is surprising that *Cercopagis* did not become established in these lakes earlier than it did."

Remarks

This ERSS was previously published in November 2017. Revisions were completed to incorporate new information and conform to updated standards.

From Kota (2007):

"*C. pengoi* may be confused with the Eurasian spiny water flea, *Bythotrephes cederstroemii. Cercopagis* is distinguished from *Bythotrephes* by the presence of the loop on the caudal process whereas *Bythotrephes* does not have such a loop."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2024):

Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Protostomia
      Superphylum Ecdysozoa
        Phylum Arthropoda
          Subphylum Crustacea
            Class Branchiopoda
              Order Diplostraca
                Suborder Onychocaudata

Infraorder Cladoceromorpha
Family Cercopagididae
Genus *Cercopagis*
Species *Cercopagis pengoi*

According to WoRMS (2024), *Cercopagis pengoi* is the current valid name for this species.

Size, Weight, and Age Range

From Benson et al. (2024):

"Body size from 1–3 mm in length without tail, 6–13 mm with tail; […]."

From Figary and Schulz (2021):

"The average dry weight of *C. pengoi* is 6.2 µg (Snyder 2004)."

Environment

From Benson et al. (2024):

"*Cercopagis pengoi* lives in brackish and freshwater lakes."

From Kotta (2007):

"*C. pengoi* has a wide tolerance to salinity (from freshwater to 17 practical salinity units (psu)) and temperature (3-38ºC) (Gorokhova et al., 2000). The highest population densities are usually found at temperatures of 16-26ºC and at salinities of up to 10 ‰ (Mordukhai-Boltovskoi and Rivier, 1987; Rivier, 1998). Both in the Caspian Sea (Rivier, 1998) and Lake Ontario (Ojaveer et al. 2001) the abundance of *C. pengoi* increases with distance from shore suggesting that this is a typical pelagic species. In the Caspian Sea, *C. pengoi* performs diurnal vertical migrations. During the daytime they sink down to 50-60 m and at night they move up to the surface. Newly-born individuals do not descend deeper than 20-30 m (Mordukhai-Boltovskoi and Rivier, 1987). However, there is no evidence of diurnal migrations of *C. pengoi* in the Baltic Sea (Krylov et al., 1999)."

"*C. pengoi* is capable of hyperosmotic regulation, and its hemolymph is hyperosmotic to surrounding water (from freshwater up to 5-8 psu). The species is osmoconformer in the very short range from 5-8 up to 17 psu."

From Maxson et al. (2023):

"[…] *C. pengoi* can invade lakes with a wide range of turbidity (4.4–105.2 NTU; Muirhead et al. 2011) […]."

Climate

From Palomares and Pauly (2020):

"Temperate"

Distribution Outside the United States

Native

From Benson et al. (2024):

"Native Range: Black, Caspian, Azov, and Aral seas of Europe and Asia (Makarewicz et al. 2001)."

From Kotta (2007):

"The native distribution area of *C. pengoi* is restricted to the Ponto-Caspian region: the Caspian, Azov and Aral Seas together with lower reaches of the rivers entering to these waterbodies."

Kotta (2007) reports *Cercopagis pengoi* is native to the following countries, with water bodies given in parentheses: Kazakhstan (Aral Sea), Turkey (Lake Terkos), Bulgaria (Coastal Lakes), Romania (Black Sea, Golovita Lake, Razelm Lake), Russia (Caspian Sea).

From Kane (2003):

"*Cercopagis pengoi* is native to a large area (>3.5 million km^2) containing the Caspian and Aral Seas, the Don Estuary, and the Sea of Azov, and to coastal lakes and the Dneiper-Bug and Dniester estuaries of the Black Sea (Maclsaac and others 1999)."

Introduced

From Kotta (2007):

"It has become invasive in eastern Europe, the Baltic Sea and the Great Lakes of North America [including in Canada]. The species was first time noted as invasive in the Tsimlyansk Reservoir in Russia in 1970 (Glamazda, 1971). In these new habitats the species has established quickly and increased in range and abundance."

"Widespread in the Baltix [sic] Sea area especially in the Baltic Proper, the Gulf of Riga, the Gulf of Finland, Vistula Lagoon and the Gulf of Bothnia [Olenin et al. 2002]"

From Birnbaum (2011):

"First findings [of *Cercopagis pengoi*] in Estonia were in southern coast of the Gulf of Finland (Muuga Bay) and the northeastern Gulf of Riga (Pärnu Bay), in 1992 (Ojaveer et al. 2000). In difference from the Gulf of Riga where the species continued its presence in 1993-1994, *C. pengoi* was not encountered in zooplankton samples in the Gulf of Finland in these years. Since 1995, the species was continuously reported from several localities in the northern and eastern Gulf of Finland (e.g., Kivi 1995, Avinski 1997, Uitto et al. 1999). At some stations, sampled in September 1995 in the Gulf of Riga, it comprised 25% of the total zooplankton biomass (Ojaveer and Lumberg 1995, Ojaveer et al. 1998). Since then the distribution area of *Cercopagis* has substantially expanded to include: 1) western Baltic and northern Baltic proper (the Gotland basin and Stockholm archipelago, west coast of the Baltic Proper, 1997, Gorokhova et al. 2000) 2) northern Baltic (Gulf of Bothnia, 1999, Andersen and Gorokhova 2004, ICES 2005.) 3) southern Baltic (Gulf of Gdansk, Vistula lagoon, 1999, Pomeranian Bay, 2004, Naumenko and Polunina 2000, Zmudzinski 1999, Bielecka et al. 2000, ICES 2005)."

"After construction of the cascades of reservoirs on the Don and Dnieper Rivers, *C. pengoi* penetrated Kakhovka, Zaporozhsk, Kremenchug, Tsimlyansk and Veselovsk Reservoirs, thus demonstrating its ability to establish permanent populations in fresh waters (Tseeb 1962, Mordukhai-Boltovskoi 1965, Glamazda 1971, Mordukhai-Boltovskoi and Galinskiy 1974, Gusynskaya and Zdanova 1978, Volovich 1978). However, until recently it was not known from the waterbodies north of Kiev (Ukraine)."

GISD (2024) reports *Cercopagis pengoi* as introduced to the following countries: Finland, Latvia, Poland, Russia, Turkey, Estonia, Germany, Lithuania, Romania, Sweden, Ukraine.

Means of Introduction Outside the United States

From Kotta (2007):

"Introductions occur either due the construction of canals between river water basins (mainly those in Russia and the Ukraine), [or] ballast water discharge (Baltic Sea and the Great Lakes) […]. All introductions are accidental."

From Birnbaum (2011):

"Presumably introduced with the ballast water and by attachment to hulls or fishing gears (Leppäkoski and Olenin 2000)."

Short Description

From Kotta (2007):

"*C. pengoi* is greyish white and almost transparent […]. The most pronounced parts of its body are the head, the second pair of antenna (containing two branches), four pairs of thoracic legs (the first leg is 3-4 times longer than other legs), abdomen, caudal process and a brood pouch in females. The head is essentially composed of a large single eye, where the amount of black pigment makes less than one half of the diameter of the eye. The length of the abdomen is about equal to that of the remaining body (the caudal process excluded). The long caudal process has a loop-like curvature at the end (Mordukhai-Boltovskoi and Rivier, 1987; Rivier 1998). Parthenogenic females of the first generation of *C. pengoi* that hatch from resting eggs are anatomically distinct from parthenogenic females of following generations. They have a short, straight caudal spine unlike the characteristically looped caudal spine of parthenogenically-produced individuals (Simm and Ojaveer, 1999)."

Biology

From Kane (2003):

"Uitto and others (1999) have shown that *Cercopagis pengoi* in European lakes eats a broad range of prey foods including 60% copepods (nauplii and copepodites of the genera *Acartia*, *Eurytemora*, and *Temora*), 20% rotifers, and 20% podonids (*Evadne nordmanni*). These three groups vary considerably in size and trophic position, thus providing evidence of a broad diet."

"*Cercopagis pengoi* can achieve densities up to 26,000/m^3 (Makarewicz and others 2001). Studies have shown that abundances are usually highest in the epilimnion in both Lake Ontario (Ojaveer and others 2001) and the Gulf of Finland (Krylov and others 1999)- Further, in order for sexual reproduction to occur, males and females must overlap spatially and temporally. All of these reasons indicate that *C. pengoi* is, to some extent, gregarious. This gregariousness may increase invasion potential by providing for greater abundances of initial colonizers."

From Benson et al. (2024):

"In addition to sexual reproduction, *Cercopagis* most commonly reproduces parthenogenically (asexually) during the summer, which allows it to quickly establish new populations with a relatively small seed population without the need for a large number of the smaller males along with females. Eggs produced in the early part of the season are delicate and very susceptible to damage, with low recruitment rates. Later in the season, as surface water temperatures decline, *Cercopagis* females switch to sexual reproduction, producing over-wintering or resting eggs (the species is also known to produce resting eggs anytime during the year when environmental conditions become inhospitable). Such resting eggs can successfully overwinter in an inactive state and replenish the population after hatching in the spring. Resting eggs are also resistant to desiccation, freeze-drying and ingestion by predators (such as other fish). They can be easily transported to other drainage basins by various vectors, particularly if they are still in the female's body (the barbed caudal spine allows attachment to ropes, fishing lines, waterfowl feathers, aquatic gear, vegetation and mud). Resting eggs can hatch regardless of whether the carrier female is alive or dead."

Human Uses

No information was found on human uses of *Cercopagis pengoi*.

Diseases

No information was found associating *Cercopagis pengoi* with any diseases listed by the World Organisation for Animal Health (2025). No information was found on diseases associated with *Cercopagis pengoi*.

Threat to Humans

From Kotta (2007):

"*C. pengoi* interferes with fisheries by clogging nets and fishing gears. Presence of the species results in economic losses at fish farms (intense clogging of nets)."

"Fishermen have complained of allergic reactions after removing *C. pengoi* from their nets."

3 Impacts of Introductions

From Cutter et al (2023):

"The invasion of *Bythotrephes longimanus* and *Cercopagis pengoi* have caused a reduction in the density of key zooplankton species and shifted seasonal peak density in some. The dominant daphniid *Daphnia retrocurva* declined during the initial years where *B. longimanus* [another nonnative zooplankton species] reached a detectable density in 2014 and 2015. *Diacyclops thomasi* similarly declined in density during these years as well as after *C. pengoi* reached detectable abundance. *D. thomasi* additionally shifted in seasonal peak abundance to earlier in June. The most dominant rotifer *Conochilus* spp. greatly declined during the years *C. pengoi* reached high density in 2018 and 2019. The changes in the population dynamics of these species occurred most notably at deep water stations, while these changes did not appear to occur at shallow stations."

From Einberg et al (2020):

"Three out of the five investigated taxa (*Bosmina spp., E. affinis and Pleopis spp*.) have exhibited declines in abundance [in the Gulf of Riga, Baltic Sea] that can be associated with predation due to the invasion of *C. pengoi*. Perhaps the most drastic changes were recorded for small-sized cladocerans, either at interannual scale (90% decline in the abundance of *Pleopis* spp.) or seasonally in the case of *Bosmina* spp., where the abundance peak occurs a few weeks earlier and is lower than before the invasion of *C. pengoi* and also for *E. affinis* (80% of abundance decline). We suggest that these declines are due to predation mortality posed by *C. pengoi*."

From Birnbaum (2011):

"*C. pengoi* tends to attach to fishing gears, clog nets and trawls, causing problems and substantial economic losses for fishermen (Leppäkoski and Olenin 2000). In the Baltic Sea, the mass development of *Cercopagis* was accompanied by the formation of a "paste" fouling fishing nets and trawls […] (Kivi 1995, Ojaveer and Lumberg 1995). Little is known about the biofouling ability of *C. pengoi* in its native area. […] Biofouling of fishing equipment by *Cercopagis* in the eastern Gulf of Finland is already a serious problem, resulting in substantial economic losses. Economic losses at a fish farm, located at the northern shore of the lower Neva Estuary (Primorsk), in 1996-1998 were at least $50 000. These losses were the result of a drastic decline in the fish catches in the Primorsk (Koivisto) area and cost of unsuccessful fishing efforts in areas with abundant *Cercopagis* due to biofouling of fishing equipment (Panov et al. 1999). The same problem was found at whitefish fisheries in the eastern Gulf of Finland (GAAS 2000), inner parts of the Archipelago Sea (K. Häkkilä, pers. comm.), northern Bothnian Sea (K.-E. Storberg, pers. comm.) and in Lithuania (I. Olenina, pers. comm.). Since 1999, the occurrence of *Cercopagis* within north-eastern range of the Lithuanian coastal zone has had severe impacts on commercial fishery by clogging gill-nets and thus drastically reducing commercial catches. Changes in food-web and energy transfer in lower trophic levels, due to the invasion of

Cercopagis will likely impact the structure of fish stocks (Gorokhova pers. comm.). If the density of *Cercopagis* does not decrease significantly in the nearest future, it may seriously affect commercial fisheries. High-risk areas are the Gulf of Finland, the Gulf of Riga, the coastal lagoons and the German Boddens, known as centres of xenodiversity, i.e., areas that host many well established non-indigenous species (Leppäkoski and Olenin 2000). Considering present intensive shipping activity, future development of new ports in the eastern Gulf and creation of new international transport and invasion corridors, the Gulf of Finland can be identified as a "hot spot" area in the Baltic Sea in terms of vulnerability to alien species and high potential of established invaders to negatively affect the ecosystems (Panov et al. 1999)."

From Benson et al. (2024):

"*Cercopagis pengoi* is a consumer of other zooplankton. As such it competes with other planktivores of the Great Lakes, including the alewife (*Alosa pseudoharengus*) and rainbow smelt (*Osmerus mordax*) (Bushnoe et al. 2003). Its long spine makes it less palatable to planktivorous fish. For these reasons *C. pengoi* could have a serious effect on the food supply of planktivores. For example, yearling alewife compete directly with *C. pengoi* because they are planktivorous, and cannot consume *C. pengoi* due to the caudal appendage. Once alewife reach their first year they are large enough to handle the caudal appendage (Bushnoe et al. 2003). *Cercopagis pengoi's* establishment in Lake Ontario in 1998 corresponded with the lowest alewife populations in twenty years (Makarewicz et al. 2001)."

"A 2002 study of the food web impacts of *C. pengoi* showed that the depth at which *C. pengoi* exists is depleted of small organisms (<0.15 mg) (Benoit et al. 2002). It is unclear as to whether this is due to predator evasion or *C. pengoi* consumption, but in either case the smaller organisms are forced into deeper, cooler strata, causing growth rate changes (Benoit et al. 2002). The full impact of *C. pengoi* on the food web has not yet been extensively studied."

From GISD (2024):

"*C. pengoi* affects resident zooplankton communities by selective predation in Lake Ontario (Benoit et al. 2002); Gulf of Riga (Ojaveer et al. 1999, 2004); Gulf of Finland (Uitto et al. 1999; Lehtiniemi & Gorokhova 2008). Its invasion and populations in the Baltic Sea correlate to significant declines in small, cladoceran prey species *Bosmina coregoni maritime*, *Evadne nordmanni*, and *Pleopsis polyphemoides* (Kotta et al. 2006). A similar decrease in the abundance of copepods, including key species *Eurytemora affinis*, in the Gulf of Finland is believed to be caused by *C. pengoi* as well (Lehtiniemi & Gorokhova 2008)."

"Additionally, this large cladoceran tends to attach to fishing gears, clogs nets and trawls, causing problems and ultimate economic losses for fishermen. Reports of their fouling and costly impacts have come from the Gulf of Finland, the Neva Estuary, the Archipelago Sea, the Northern Bothnian Sea, and on the coasts of Lithuania (Birnbaum 2006 and references therein). Its effects on the food-web and energy transfer in lower trophic levels are likely to cause problems with fish stocks (E. Gorokhova pers. comm., in Birnbaum 2006; Ojaveer et al. 2001). Anecdotal evidence suggests that it can cause allergic reactions in fisherman who clean remains from nets (Leppäkoski & Olenin 2000; ICES 2002)."

4 History of Invasiveness

The History of Invasiveness for *Cercopagis pengoi* is classified as High. There are records of nonnative introductions that have resulted in established populations in North America, Europe, and Asia. There is documented information about the impacts of these introductions including competition with other zooplankton species, impacts to planktivorous fish, and interfering with fisheries by clogging of nets. There is a possibility it can cause an allergic reaction in humans. The negative impacts have been documented from reliable, peer-reviewed sources.

5 Global Distribution

Figure 1. Reported global distribution of *Cercopagis pengoi*. Map from GBIF Secretariat (2024). Observations are reported from northern Europe and the Great Lakes region of North America. Locations in Lakes Superior and Huron were excluded from climate matching analysis because they do not represent established populations.

Additional georeferenced locations in Europe and Asia were provided by Critescu et al. (2001; Romania, Russia, Ukraine), Lazareva (2019; Russia), Bielecka et al. (2000; Poland), and Ojaveer and Lumberg (1995; Estonia, Kazakhstan). These points do not represent the full extent of the native and introduced ranges of *C. pagoi*.

6 Distribution Within the United States

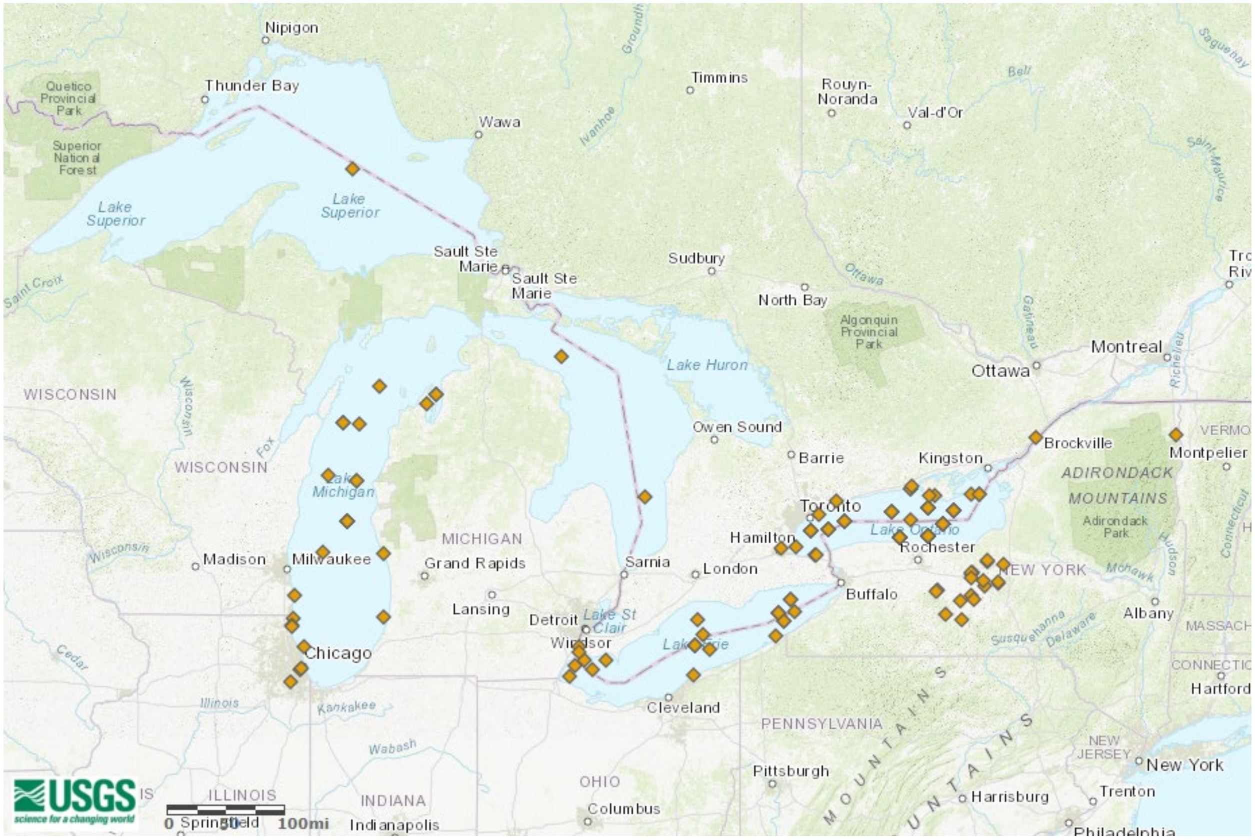

Figure 2. Reported distribution of *Cercopagis pengoi* in the United States. Map from Benson et al. (2024). Observations are reported from Illinois, Wisconsin, Michigan, Ohio, New York, Pennsylvania. Locations in Lakes Superior and Huron were excluded from climate matching analysis because they do not represent established populations.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Cercopagis pengoi* to the contiguous United States was generally medium to high. Areas of high climate match were found in the Great Lakes Region, the Northeast, the Midwest, and sporadically in small patches across the Western States. Areas of medium climate match were found primarily in the South, central Great Plains region, Colorado Plateau, and Great Basin. Areas of low climate match were found in the Southeast, particularly in more coastal areas, and along the West Coast. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.732 indicating that Yes, there is establishment concern for this species. 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 *Cercopagis pengoi* (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.

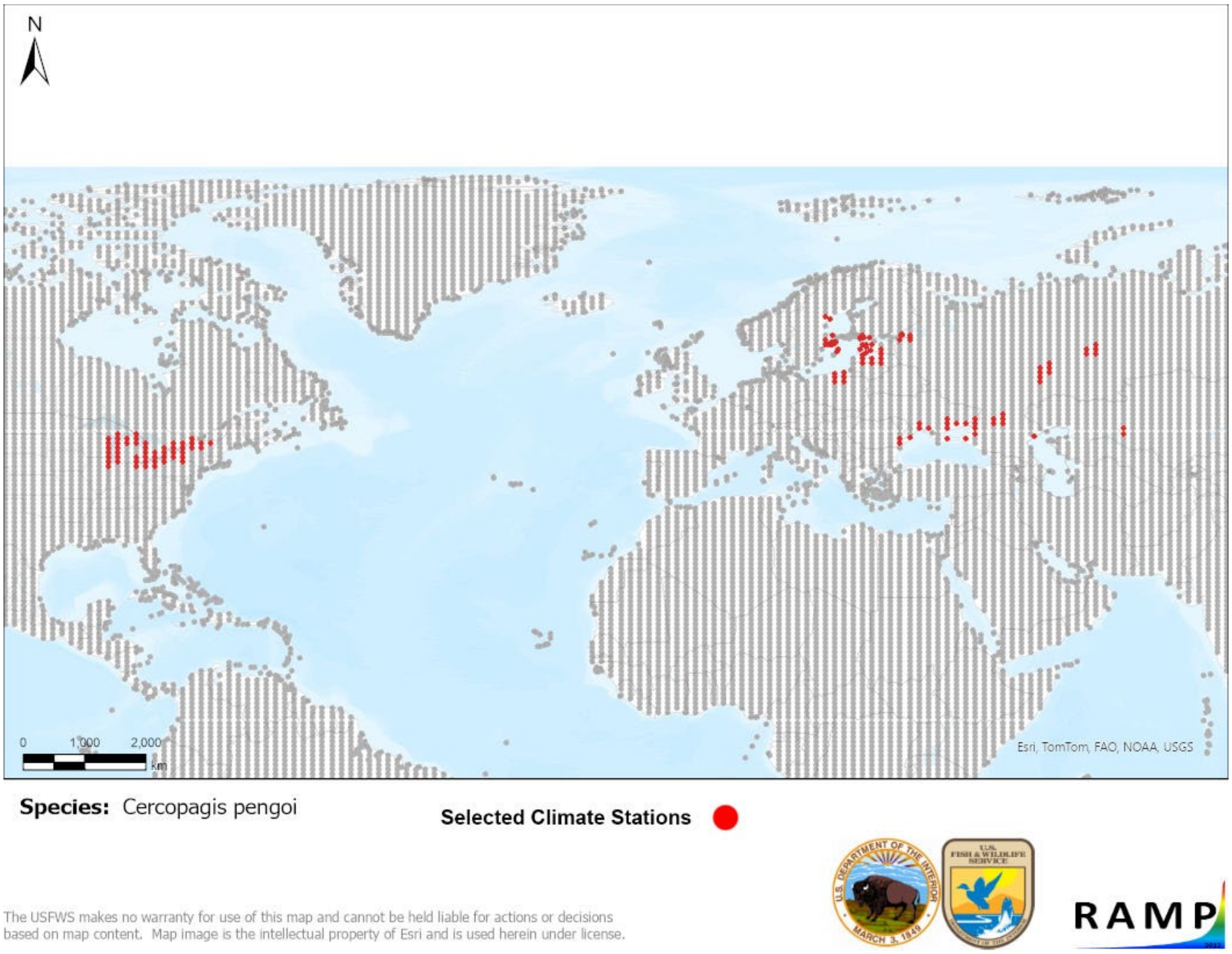

Figure 3. RAMP (Sanders et al. 2024) source map showing weather stations in North America, Europe, and western Asia selected as source locations (red; United States, Canada, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland, Ukraine, Romania, Kazakhstan) and non-source locations (gray) for *Cercopagis pengoi* climate matching. Source locations from GBIF Secretariat (2024), Critescu et al. (2001), Lazareva (2019), Bielecka et al. (2000), and Ojaveer and Lumberg (1995). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

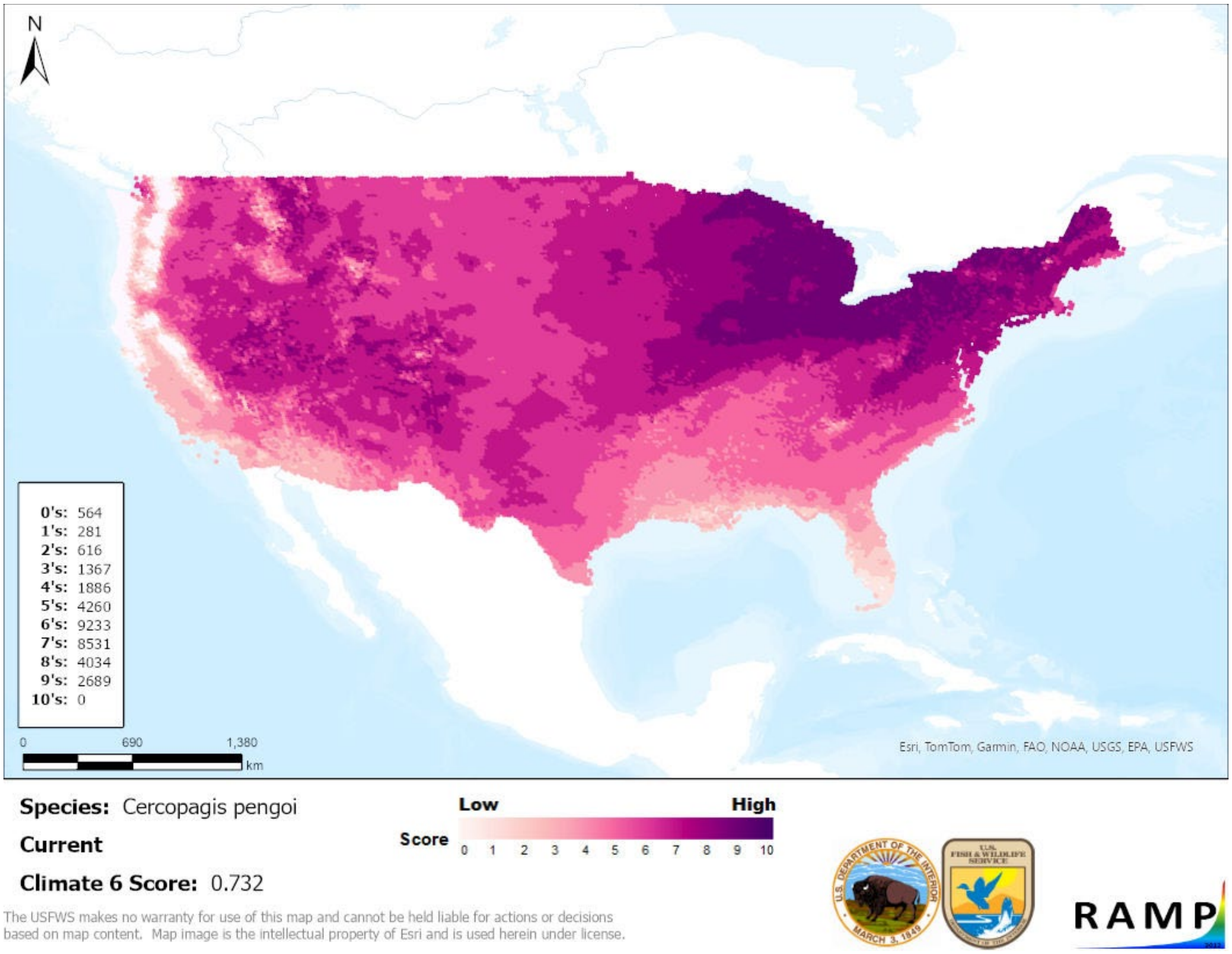

Figure 4. Map of RAMP (Sanders et al. 2024) climate matches for *Cercopagis pengoi* in the contiguous United States based on source locations reported by GBIF Secretariat (2024), Critescu et al. (2001), Lazareva (2019), Bielecka et al. (2000), and Ojaveer and Lumberg (1995). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Cercopagis pengoi* is classified as Medium. Information on the biology, ecology, and range description of this species is available from reliable sources. There was a lack of georeferenced observations to use in the climate matching analysis representing potentially large portions of the species' native range. This reduced certainty in the interpretation of the results. Information on the nonnative populations of *Cercopagis pengoi* and impacts in the introduced range was readily available. Multiple scientifically credible sources documented negative impacts of introductions.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Cercopagis pengoi, Fishhook Waterflea*,* is a crustacean that is native to Black, Caspian, Azov, and Aral Seas of Europe and Asia. This species has broad environmental tolerance with populations in both brackish and freshwaters. *C. pengoi* can reproduce parthenogenetically and sexually and can produce resting eggs. In the 1990s, *Cercopagis pengoi* was introduced and spread in the Baltic Sea and then in the Great Lakes of North America. Since then, it has established populations in the Great Lakes Region, as well as the adjacent New York Finger Lakes Region. Ballast water and fouled fishing gear are the predominant vectors for *Cercopagis pengoi* introduction and spread; it can also spread through canal systems. Introduced populations have been repeatedly associated with declines in native zooplankton and planktivorous fish, sometimes changing community trophic structure. Additionally, biofouling of fishing gear by *Cercopagis pengoi* can result in considerable economic costs. The History of Invasiveness for *Cercopagis pengoi* is classified as High due to the established non-native populations and documented negative impacts of introductions. The climate matching analysis for the contiguous United States indicates establishment concern for this species. Locations with the highest climate match included areas surrounding the Great Lakes, Northeast, and Midwest. There were medium to high climate matches across most of the contiguous United States. The Certainty of Assessment for this ERSS is classified as Medium. Information was available from reliable sources, however, there was a potentially large gap in representation of the native range in the climate matching analysis. The Overall Risk Assessment Category for *Cercopagis pengoi* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see Section 4): High**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): Medium**
- **Remarks, Important additional information: Parthenogenetic**
- **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.

Benson A, Maynard E, Raikow D, Larson J, Makled TH, Fusaro. 2024. *Cercopagis pengoi.* Nonindigenous Aquatic Species Database. Gainesville, Florida: U.S. Geological Survey. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=163 (January 2024).

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Birnbaum C. 2011. NOBANIS – invasive alien species fact sheet – *Cercopagis pengoi*. Online database of the European Network on Invasive Alien Species – NOBANIS. Available: https://www.nobanis.org/globalassets/speciesinfo/c/cercopagis-pengoi/cercopagis-pengoi.pdf (January 2024).

Cristescu ME, Hebert PD, Witt JD, MacIsaac HJ, Grigorovich IA. 2001. An invasion history for *Cercopagis pengoi* based on mitochondrial gene sequences. Limnology and Oceanography 46(2):224–229.

Cutter ZA, Mihuc TB, Myers LW. 2023. Invasion of *Bythotrephes longimanus* and *Cercopagis pengoi* in Lake Champlain: impacts on the native zooplankton community. Diversity 15:1112.

Einberg H, Klais-Peets R, Pollumäe A, Ojaveer H. 2020. Taxon-specific prey response to the invasion of a pelagic invertebrate predator, revealed by comparison of pre- and post-invasion time series. Journal of Plankton Research 42:714–726.

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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 (2024), Critescu et al. (2001), Lazareva (2019), Bielecka et al. (2000), and Ojaveer and Lumberg (1995).

Under the future climate scenarios (figure A1), on average, high climate match for *Cercopagis pengoi* was projected to occur in the Great Lakes region of the contiguous United States. This was reduced to primarily medium match in the 2085 SSP5 scenario. Areas of low climate match were projected to occur in the California, Gulf Coast, Northern Pacific Coast, Southern Atlantic Coast, and Southern Florida regions. Central areas of the contiguous United States and the Western Mountains mainly had medium matches, with the matching being slightly lower in the 2085 time step. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.150 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.649 (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 (0.732, 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 one or more time step and climate scenarios, areas within the Colorado Plateau saw a moderate increase in the climate match relative to current conditions. No large increases were observed regardless of time step and climate scenarios. Under one or more time step and climate scenarios, areas within the Appalachian Range, Colorado Plateau, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Southeast, Southern Atlantic Coast, Southern Plains, and Southwest saw a large decrease in the climate match relative to current conditions. The areas of large decrease were more widespread at time step 2085 under both SSP3 and SSP5 scenarios. Additionally, areas within California, the Great Basin, Northern Plains, and Western Mountains regions 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).

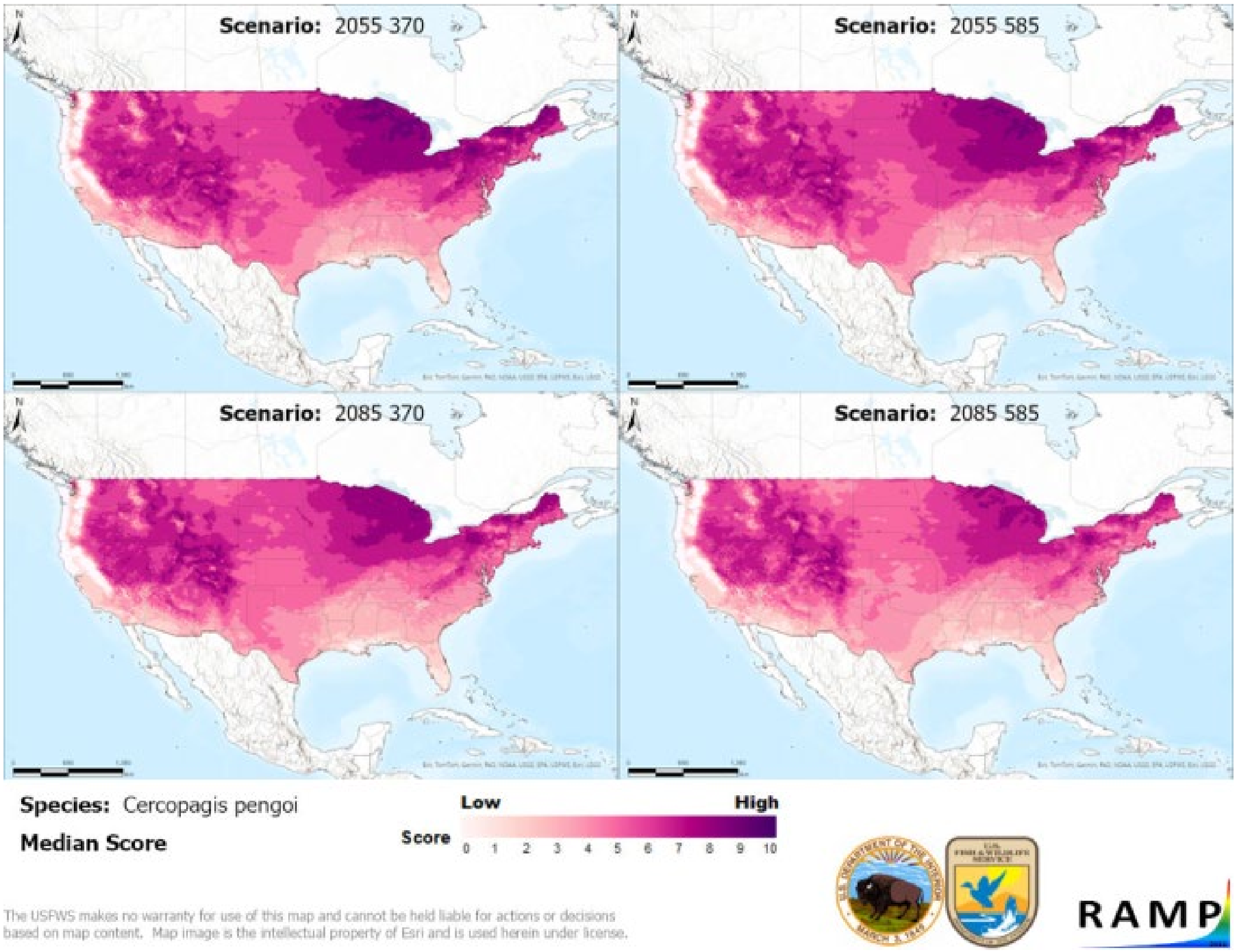

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Cercopagis pengoi* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2024), Critescu et al. (2001), Lazareva (2019), Bielecka et al. (2000), and Ojaveer and Lumberg (1995). 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.

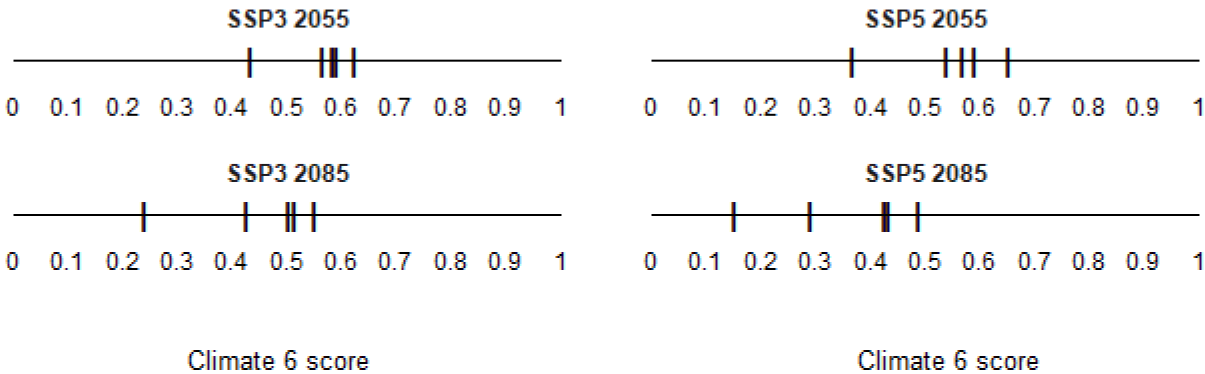

Figure A2. Comparison of projected future Climate 6 scores for *Cercopagis pengoi* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; 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.

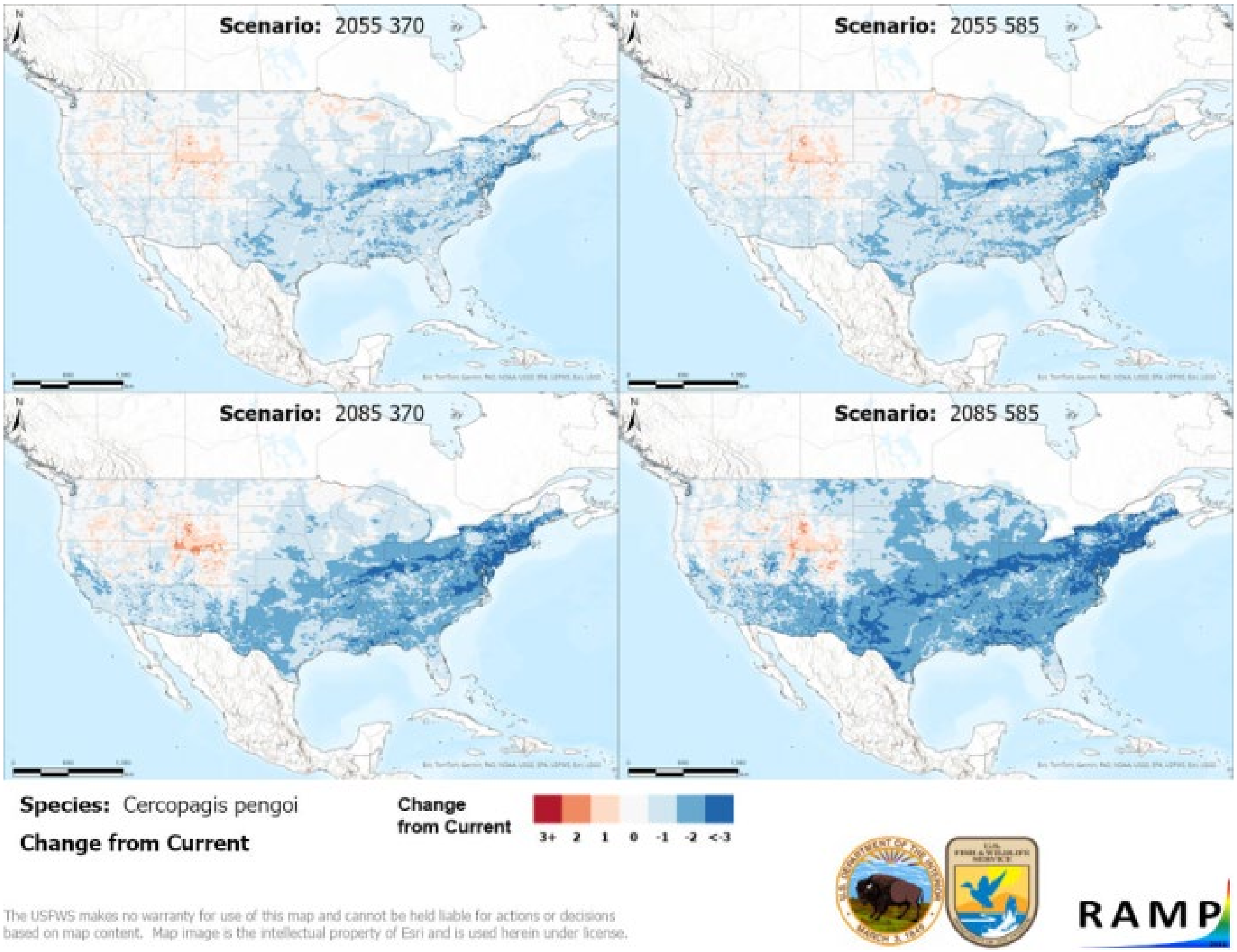

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Cercopagis pengoi* based on source locations reported by GBIF Secretariat (2024), Critescu et al. (2001), Lazareva (2019), Bielecka et al. (2000), and Ojaveer and Lumberg (1995). 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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