U.S. Fish & Wildlife Service

Water Flea (*Daphnia lumholtzi*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2023
Revised, February 2023
Web Version, 4/11/2025

Organism Type: Crustacean
Overall Risk Assessment Category: High

Photo: Ruhr-University Bochum, Germany. Licensed under CC BY-NC 2.0. Available: http://invasions.si.edu/nemesis/browseDB/SpeciesSummary.jsp?TSN=-210 (January 2023).

1 Native Range and Status in the United States

Native Range

From Benson et al. (2023a):

"Tropical and subtropical lakes in east Africa, east Australia, and the Asian subcontinent of India (Havel and Hebert 1993)."

Status in the United States

From Benson et al. (2023b):

"*Daphnia lumholtzi* has been detected in 56 reservoirs in the southern and midwestern United States. The earliest record is from Texas in 1990 (Havel, pers. comm.). It has since been found in localized waters leading into major river drainages such as the: Arkansas, Cumberland, Illinois, Mississippi, Missouri, South Atlantic-Gulf, Tennessee, and Texas-Gulf. Occurrences of *D. lumholtzi* in these waters fall in the following states: **Alabama**, **Arizona**, **Arkansas**, **California**, **Florida**, **Illinois**, **Kansas**, **Kentucky**, **Louisiana**, **Minnesota/Wisconsin**, **Mississippi**, **Missouri**, **North Carolina**, **Oklahoma**, **Ohio**, **South Carolina**, **Tennessee**, **Texas**, and **Utah** (Havel and Shurin 2004; D. Jackson; J. A. Stoeckel; M. A. Pegg; J. S. Kuwabara). In August of 1999 it was discovered for the first time in the Great Lakes, Lake Erie, just north of Lakeside, Ohio (Muzinic, 2000)."

No records of *Daphnia lumholtzi* in trade in the United States were found.

Regulations

Daphnia lumholtzi is regulated in New York (New York DEC 2022), Utah (Utah DWR 2020), and Wisconsin (Wisconsin DNR 2022). It is regulated at the genus level (*Daphnia*) in Hawaii (HDOA 2019). 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. (2023a):

"It is uncertain how *D. lumholtzi* was introduced into the U.S. It is suspected that it may have been transported with shipments of Nile perch from Lake Victoria in Africa where it is a dominant zooplankter. Nile perch was originally introduced into Texas as early as 1983 (Havel and Hebert 1993). The continuing discovery of *D. lumholtzi* in new locations could be due to contaminated stockings of fish through international commercial trade. At the same time, the close proximity of affected reservoirs in Missouri and in Texas might lead to the conclusion that *D. lumholtzi* may have spread by recreational boating from the initially infested reservoirs."

"Dzialowski et al. (2000) found that non-human dispersal mechanisms had little to do with the spread of *D. lumholtzi* in Kansas. *D. lumholtzi* was not detected in small ponds inaccessible to boats, even though the ponds were within watersheds where *D. lumholtzi* was established (Dzialowski et al. 2000)."

Remarks

This ERSS was previously published in March 2018. Revisions were completed to incorporate new information and conform to updated standards.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Protostomia
      Superphylum Ecdysozoa
        Phylum Arthropoda
          Subphylum Crustacea
            Class Branchiopoda
              Subclass Phyllopoda
                Order Diplostraca
                  Suborder Cladocera
                    Infraorder Anomopoda
                      Family Daphniidae
                        Genus *Daphnia*
                          Species *Daphnia lumholtzi* G.O. Sars, 1885

According to Kotov (2018), *Daphnia lumholtzi* G.O. Sars, 1885 is the current valid name for this species.

Size, Weight, and Age Range

From Benson et al. (2023a):

"3.5 mm in length"

From Fofonoff et al. (2018):

"Female *D. lumholtzi* at 20-25 C, on average, […] lived for up to 30 days."

"[…] generation time of 6-9 days […]"

Environment

From GISD (2017):

"Most water bodies invaded by *D. lumholtzi*, reservoirs in the southern regions of the U.S., tend to be more eutrophic than lakes and reservoirs in the north."

"[…] the species can exist in waters that experience periodic pulses of salinity."

From Fofonoff et al. (2018):

"Nontidal Limnetic-Oligohaline"

“This cladoceran has also been found in inland saline lakes (e.g. Lake Texoma, OK-TX, 1.4 ppt; Work and Gophen 1995, Mobile Bay, 1.4 PSU), but the full extent of its salinity tolerance is unknown. Some *Daphnia* species can tolerate high salinities in inland salt lakes (Hairston et al. 1999), but this genus is a rare straggler in estuarine environments (Johnson and Allen 2005).”

“*Daphnia lumholtzi* survives in ice-covered lakes as resting eggs (Havel et al. 1993). Dense swarms of adult females were observed in a Kentucky reservoir, at a water temperature of 8 C (DBeaver et at. Al. 2018) [Beaver et al. 2018].”

“It appears to be more tolerant of high temperatures than most other *Daphnia* (Tifnouti et al. 1993; Fey and Cottingham 2011; Engel and Tollrian 2012).”

From GISD (2017):

“*D. lumholtzi* takes advantage of late summer thermal niches when the water temperature surpasses 25C and will subsequently continue to colonize lakes and reservoirs across North America. It has been shown, though, that *D. lumholtzi* performs poorly at water temperatures below 10C which may inhibit the range of its expansive [sic] into more northern waters (Lenon et al. 2001).”

From Frisch and Weider (2010):

“Both field observations and experimental findings suggest that there are significant genotype x environment interactions in the population in Lake Texoma [Oklahoma and Texas] that produce population responses to shifts in temperature. This may explain why the species has been able to invade areas outside its normal temperature range (i.e. Laurentian Great Lakes).”

Climate

From Fofonoff et al. (2018):

“Warm temperate-Tropical”

Distribution Outside the United States

Native

From Benson et al. (2023a):

“Tropical and subtropical lakes in east Africa, east Australia, and the Asian subcontinent of India (Havel and Hebert 1993).”

Introduced

From Fofonoff et al. (2018):

“In 2000, *Daphnia lumholtzi* was reported in the Três Irmãos reservoir, on the Tiete River (tributary of the Parana River), in Sao Paulo state, Brazil (Zanata et al. 2003). In 2003, and 2008, it was found in two floodplain lakes of the Upper Parana River, Parana State [Brazil]. It is expected to spread extensively in Brazil (Simões et al. 2009). In Mexico, *D. lumholtzi* was collected in Sonora (Elías-Gutiérrez et al. 2008), and the Presa El Salto reservoir, in Sinaloa in 2003 (Silva-Briano et al. 2010). The spotty nature of these tropical occurrences could reflect the scarcity of sampling or else a very scattered pattern of dispersal."

From Kotov and Taylor (2014):

"*D. lumholtzi* was collected in a pool […] adjacent to the Paraná River, between Paraná and Santa Fe, Santa Fe Province [Argentina] on 19 February 2006 […]"

Means of Introduction Outside the United States

From Zanata et al. (2003):

"Some authors have suggested that intercontinental dispersion of cladocerans is rare, although the production of resting eggs and the parthenogenetic reproduction mode have been facilitating dispersion (Dodson & Frey, 1991). According to Havel & Hebert (1993), another dispersion agent could be the introduction into reservoirs of fishes for angling purposes. Once the species reaches the new continent, its dispersal could be by means of boats used for recreational activities."

From Kotov and Taylor (2014):

"Since *D. lumholtzi* is known to disperse by river systems, the simplest hypothesis for the immediate source of the Argentinian *D. lumholtzi* is dispersal from the Brazilian populations of the Upper Paraná River detected in 2003 (Simões et al., 2009)."

Short Description

From Fofonoff et al. (2018):

"*Daphnia lumholtzi* is morphologically distinctive. Its head-spine (helmet) is larger than that of any native species and its tail spine is equal to, or greater than, its body length. There is a depression (cervical sinus) separating the dorsal base of the head from the rest of the body. The posterior part of the head bears two projecting structures called fornices (fornix = arch or fold), which in this species are projected into sharp points. The ventral carapace bears about 10 sharp spines on each side (Havel and Hebert 1993)."

"Male *D. lumholtzi* usually have a head without a helmet, or occasionally with a small spike-shaped crest. The tail spine is about two-thirds the carapace length (Zanata et al 2003). The ephippia (resting egg capsules) of *D. lumholtzi* have a long point on each end and a dorsal surface covered with fine hairs (Havel and Hebert 1993)."

Biology

From Fofonoff et al. (2018):

"Cladocerans of the genus *Daphnia* can develop parthenogenetically from unfertilized eggs in a female's brood pouch. The juveniles have the basic form of miniature adults, and molt and grow as they feed. After a period of growth, parthenogenetic eggs are deposited in the female's brood pouch. For *D. lumholtzi* at 15-25 C, the eggs were produced at 8.7-4.7 days after birth, and took 1.9- 1.1 days to develop (Tifnouti et al. 1993). When the embryos hatch, the female molts, and a new batch of eggs are deposited in the brood pouch. A female may have several successive broods. Female *D. lumholtzi* at 20-25 C, on average, had 6.9 - 6.4 broods, consisting of 2.2-2.4 eggs each, and lived for up to 30 days. With parthenogenetic development, and a generation time of 6-9 days, *D. lumholtzi* is capable of rapid population growth (Tifnouti et al. 1993)."

"*Daphnia* spp. can reach high population densities by parthenogenetic reproduction, developing populations that are all female or female-dominated. Environmental factors such as temperature, day-length, the presence of predators, etc., appear to stimulate the production of males. Females, when fertilized, produce large resting eggs, in pairs, enclosed in a capsule formed by modifications of the brood chamber (called an ephippium). The ephippium is cast off when the female molts. It settles into the sediment, but may be stimulated to development by favorable conditions of light and temperature. Sexual reproduction of resting eggs provides a means of surviving winter, droughts, or other adverse conditions, as well as providing new genotypes for potentially altered conditions (Barnes 1983)."

"*Daphnia* sp. are filter-feeders, creating a current and filtering out phytoplankton in the water column. They have limited capacity for selective feeding (Barnes 1983), but may reduce filtering rates in the presence of large chains of diatoms, or large colonies of toxic organisms, such as cyanobacteria of the genus *Microcystis* sp. (Gifford et al. 2007; Davis and Gobler 2011)."

From Graeve et al. (2021):

"When continuously exposed to predator cues, *D. lumholtzi* head spines grow faster with every subsequent generation that we tested. Such a rapid growth of the defensive structure further enhances survival chances as the defensive effect of the head spines is thereby shifted to earlier instars."

From Benson (2023a):

"It is most likely that *D. lumholtzi* has become a successful invader because of its ability to avoid predation, not because it is a better competitor for the available food supply. Stomach samples of fish from Norris Reservoir [Tennessee] contained no *D. lumholtzi* (Goulden et al. 1995). Work and Gophen (1999) note three aspects of *D. lumholtzi* that have most likely contributed to its success as an invader in North America. […] Third, the long helmet and tail spine helps *D. lumholtzi* avoid predation."

From Frisch and Weider (2010):

“Nutrient and resource levels in lakes likely play a large role in the presence and spread of *D. lumholtzi* throughout the United States, though research on mechanism is unclear. Dzialowski et al. (2000) suggested that low resource (algae) levels aid *D. lumholtzi* invasion because it is better able to take advantage of low quality food resources than small competitors, but Havel et al. (1995) found that reservoirs invaded by *D. lumholtzi* had much higher levels of nutrients than non-invaded reservoirs. Further research is warranted to clarify discrepancies.”

Human Uses

From CABI (2023):

“Research model”

From Cáceres et al. (2014):

“In the last few decades, zooplankton (especially *Daphnia*) have emerged as a model system for examining the ecological and evolutionary roles of parasites in populations, communities and ecosystems.”

Diseases

No information was found associating *Daphnia lumholtzi* with any diseases listed by the World Organisation for Animal Health (2023).

From Searle et al. (2016):

“The fungus *Metschnikowia bicuspidata* (Duffy et al. 2010; Hall et al. 2010) is a common, environmentally transmitted parasite of the native host. When *Daphnia* ingest spores of this parasite, it penetrates the gut wall and proliferates in the host’s hemolymph. It is highly virulent; infected individuals experience reduced fecundity and reduced life span (Ebert et al. 2000; Duffy and Hall 2008). Infections are easily identified because they turn the normally transparent hosts opaque (Duffy and Hall 2008); spores are only released when infected *Daphnia* die.”

From Cáceres et al. (2014):

“[…] infection by *Pasteuria* (M.A. Duffy, unpubl. data) […]”

Threat to Humans

No information was found on threats to humans from *Daphnia lumholtzi*.

3 Impacts of Introductions

From Benson et al. (2023a):

“Studies that have compared native *Daphnia* to the exotic *D. lumholtzi* have found that competition between these species is lower than expected. *D. lumholtzi* is a tropical species, and is adapted to warmer temperatures than native North American *Daphnia*. Thus *D. lumholtzi* population sizes tend to rise in late summer when native *Daphnia* populations are dropping. Thus *D. lumholtzi* tends to fill a vacant "temporal niche" in the warmer summer months (Johnson and Havel 2001; Work and Gophen 1999; Dzialowski et al. 2000; Goulden et al. 1995; East et al. 1999). Dzialowski et al. (2000) hypothesized that by occupying a niche that was previously unexploited by *Daphnia*, *D. lumholtzi* competed with non-daphnid zooplankton otherwise able to obtain resources during that time. One such zooplankter was *Diaphanasoma*, whose population was found to be significantly lower in reservoirs of Kansas where *D. lumholtzi* had invaded (Dzialowski et al. 2000). If *D. lumholzi* has a negative impact on other native zooplankton populations in late summer, this may have a detrimental effect on fishes that depend on zooplankton at that time period but are not able to handle the spines of *D. lumholtzi*.”

“Larval and juvenile stages of fish that overlap with high *D. lumholtzi* populations are more likely to be negatively impacted by *D. lumtoltzi* due to gape limitation (Kolar and Wahl 1998). L[ie]nesch and Gophen (2001) noted that fish large enough to handle *D. lumholtzi* spines would have a new prey item with a larger overall body size than the zooplankton normally present in the later summer months. Lemke et al. (2003) studied four fish species that consumed more *D. lumholtzi* as fish size increased (blue gill, white bass, white crappie, and black crappie of Lake Chautauqua, Illinois). Silversides (*Menidia beryllina*) may be able to utilize this new prey item and survive longer during their late summer spawning period (L[ie]nesch and Gophen 2001). L[ie]nesch and Gophen (2001) hypothesized that when growing juvenile fish become capable of handling *D. lumholtzi*, the fish can grow more rapidly and reduce their risk of predation.”

From Fofonoff et al. (2018):

“Mesocosm experiments in Missouri showed that *D. lumholtzi* suppressed the increase of the native *D. parvula* in late summer and fall, but not birth rates, suggesting that the suppression of *D. parvula* resulted from increased death rates, possibly due to juvenile starvation (Johnson and Havel 2001). However, field surveys and experiments in Missouri reservoirs indicate that relations between *D. lumholtzi* and native *Daphni*a are largely complementary, with *D. lumholtzi* co-occurring with natives, and dominating in summer conditions when native species are normally scarce, while natives dominate in cooler periods, as they had prior to the *D. lumholtzi* invasion (Havel and Graham 200[6]).”

“Differential predation also plays a role in zooplankton interactions. In Lake Springfield, IL, the invasion of *D. lumholtzi* was followed by a change in species composition, with decreased abundance of native cladocerans. Kolar et al. (199[7]) speculated that competition with native cladocerans in late summer and fall, may affect spring recruitment of the native species. The species co-occur only briefly, but during this time competition, combined with differential predation, may be affecting native cladocerans, which then are overwintering or producing resting eggs, and providing next spring's generations. Predation by fishes may reinforce the effects of competition, since fishes tend to select the less spiny native cladocerans (Kolar et al. 199[7]). In experiments with mesocosms containing *D. lumholtzi*, native *D. pulex*, with and without juvenile Pumpkinseed (*Lepomis gibbosus*) fish, *D. lumholtzi* predominated at higher temperature in the presence of fish, because of its higer [sic] temperature tolerance, predator defenses, and the increasing rates of predation at higer [sic] temperatures (Fey and Herren 2014)."

"Initial research suggests that this spiny cladoceran [*D. lumholtzi*] may be altering the available food supply for juvenile fishes, potentially affecting recruitment (Swaff[a]r and O'Brien 1996; Kolar et al. 199[7]). Larval Bluegill Sunfish in laboratory feeding trials preferred the native, shorter-spined *D. magna* or *D. pulex* to *D. lumholtzi*, which were often visually rejected. Visual observation indicated that smallest fish had the greatest trouble ingesting *D. lumholtzi* (Kolar and Wahl 1998; Swaff[a]r and O'Brien 1996)."

From Havens et al. (2012):

"We found that in most of the studied lakes in Florida, *D. lumholtzi* occurred less often and at lower densities than the native *D. ambigua*. […] we found little evidence that *D. lumholtzi* can out-compete *D. ambigua*, its smaller congener, despite their co-occurrence for years in lakes with phytoplankton that is dominated by cyanobacteria, water temperatures that become very high in mid-summer, and high concentrations of suspended solids – all factors that previous research suggested would favour *D. lumholtzi*."

"Lake Jesup, in the St Johns River system, is an outlier among our results. It is the one lake where *D. lumholtzi* periodically attained very high population densities, even after periods of apparent absence from the plankton, and at higher densities than *D. ambigua* on several occasions. […] The periodic high densities of *D. lumholtzi* in Lake Jesup suggest that although Florida lakes typically do not provide conditions suitable for *D. lumholtzi* to attain high densities, there may be a potential for this to occur."

Daphnia lumholtzi has specific regulations in the following states: New York (New York DEC 2022), Hawaii (HDOA 2019), Utah (Utah DWR 2020), and Wisconsin (Wisconsin DNR 2022). See section 1.

4 History of Invasiveness

The History of Invasiveness for *Daphnia lumholtzi* is classified as High. *D. lumholtzi* is established outside of its native range and there is reliable documentation of negative impacts of introduction for some introduced populations from peer-reviewed literature. In one case in Kansas, it was found that native *Diaphanasoma* abundances saw a significant reduction after introduction of *Daphnia lumholtzi*. However, researchers have come to varying conclusions about the seriousness of other introductions, and in some cases have not observed negative impacts.

5 Global Distribution

Figure 1. Reported global distribution of *Daphnia lumholtzi*. Map from GBIF secretariat (2023). Observations are reported from Australia, India, Mexico, Tanzania, Uganda, United States, and Zimbabwe. The description of the species' native range is broad (see section 1) and may not be fully represented by these observations.

Additional georeferenced observations of *Daphnia lumholtzi* were provided in Zanata et al. (2003; Brazil), Kotov and Taylor (2014; Argentina), Simões et al. (2009; Brazil), and Silva-Briano et al. (2010; Mexico).

6 Distribution Within the United States

Figure 2. Reported distribution of *Daphnia lumholtzi* in the United States. Map from USGS (2025).

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Daphnia lumholtzi* to the contiguous United States was high in the Midwest, Northeast, Southeast, Southwest, and throughout much of California. Areas of low match were restricted to the Pacific Northwest Coast and Cascade-Sierra Mountains. The Great Basin had mostly a medium match. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.934, 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 *Daphnia lumholtzi* (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.

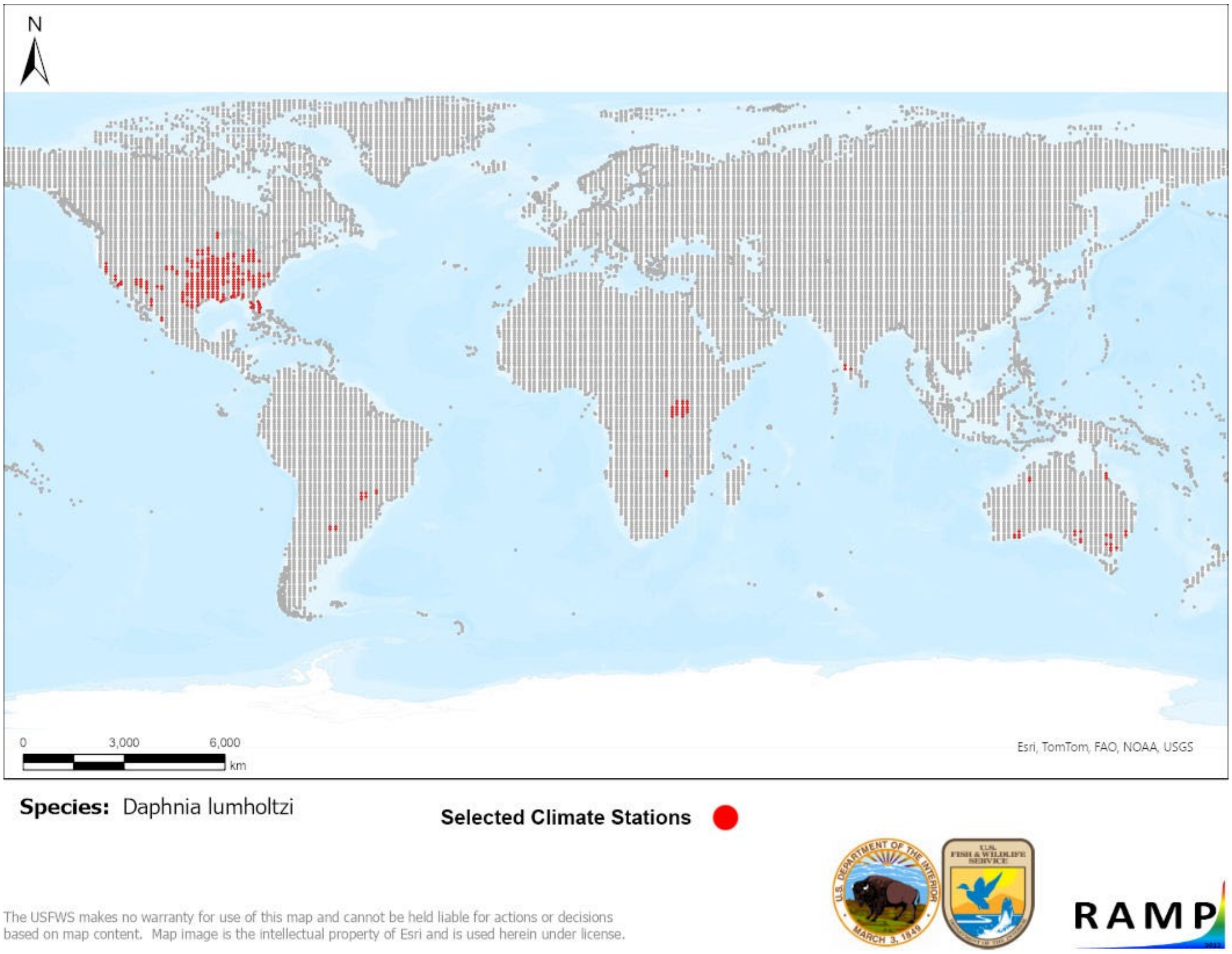

Figure 3. RAMP (Sanders et al. 2023) source map of the world showing weather stations selected as source locations (red; United States, Canada, Uganda, Zimbabwe, Australia, Mexico, Tanzania, Argentina, Brazil, and India) and non-source locations (gray) for *Daphnia lumholtzi* climate matching. Source locations from GBIF Secretariat (2023), Zanata et al. (2003), Kotov and Taylor (2014), Simões et al. (2009), and Silva-Briano et al. (2010). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

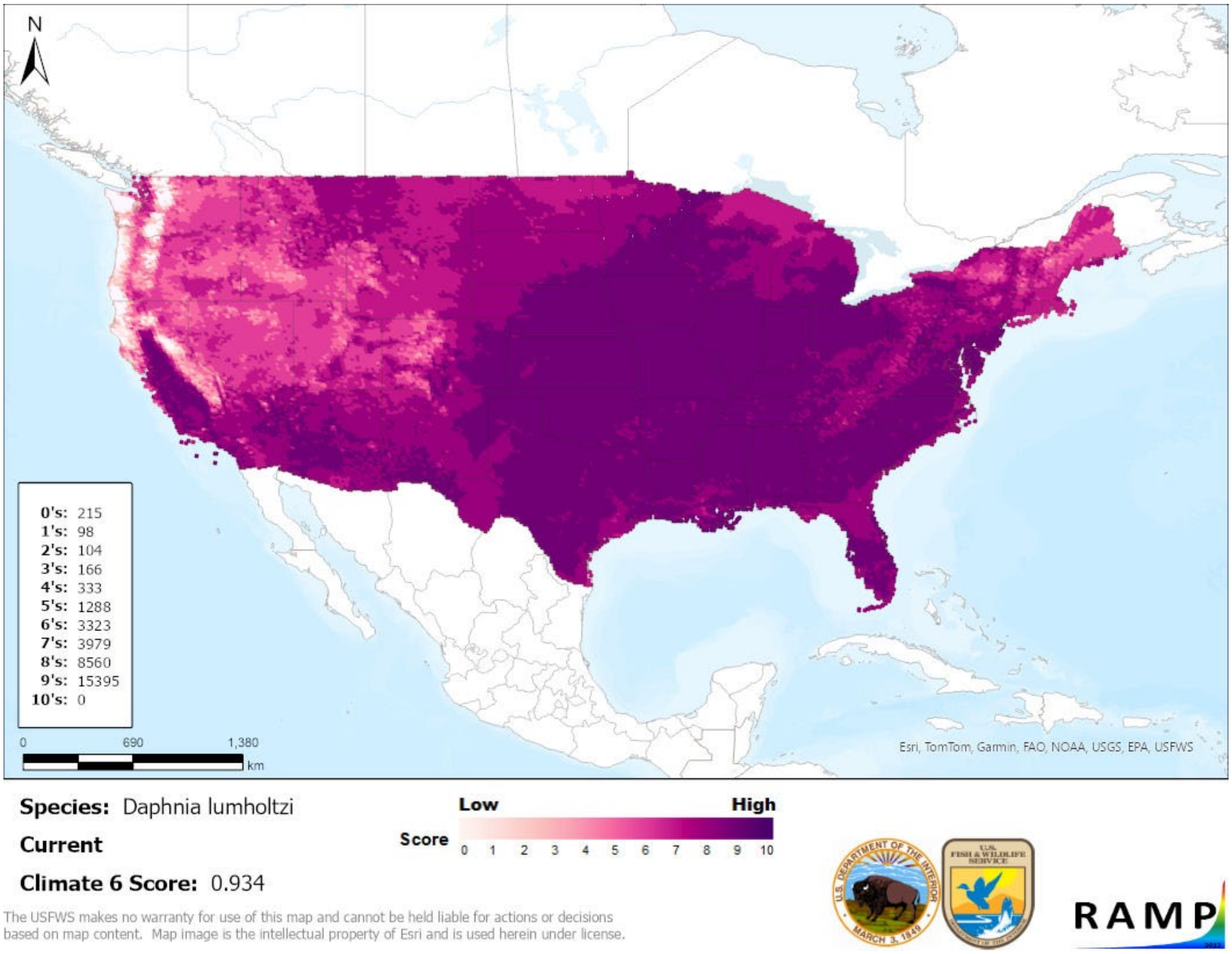

Figure 4. Map of RAMP (Sanders et al. 2021) climate matches for *Daphnia lumholtzi* in the contiguous United States based on source locations reported by GBIF Secretariat (2023), Zanata et al. (2003), Kotov and Taylor (2014), Simões et al. (2009), and Silva-Briano et al. (2010). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

Information on the biology and ecology of *D. lumholtzi* is available. The distribution in the United States where introduced is well-described, but few data exist on the distribution of *D. lumholtzi* outside the United States, including from the native range. Several peer-reviewed studies have been published on the impacts of *D. lumholtzi* invasion, but authors of these studies have come to varying conclusions about the seriousness of these impacts. The Certainty of Assessment is classified as Medium.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Daphnia lumholtzi is a cladoceran native to parts of Africa, Asia, and Australia. It has become established in numerous locations in the United States, as well as scattered locations in Mexico, Brazil, and Argentina. *D. lumholtzi* has been associated with declines in the zooplankton *Diaphanosoma*. Although competition between *D. lumholtzi* and native *Daphnia* in the United States is reduced by differences in phenology, competition can occur in certain circumstances. *D. lumholtzi* is less available to juvenile fish predators than native *Daphnia* because of its larger size and prominent spines. The History of Invasiveness for this species is classified as High. *D. lumholtzi* is regulated in four States. The climate matching analysis for the contiguous United States indicates establishment concern for this species. The climate match was high across much of the contiguous United States. However, the Certainty of Assessment has been reduced to Medium due to varying conclusions about the seriousness of the impacts of introduction, and lack of impacts of introduction in some cases. The Overall Risk Assessment Category for *D. lumholtzi* 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: 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.

Benson A, Maynard E, Raikow D, Larson J, Makled TH, Fusaro A. 2023a. *Daphnia lumholtzi*. Nonindigenous Aquatic Species Database. Gainesville, Florida: U.S. Geological Survey. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=164 (January 2023).

Benson A, Maynard E, Raikow D, Larson J, Makled TH, Fusaro A. 2023b. *Daphnia lumholtzi* G.O. Sars, 1885. Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database, and Ann Arbor Michigan: NOAA Great Lakes Aquatic Nonindigenous Species Information System. Available: https://nas.er.usgs.gov/queries/greatLakes/FactSheet.aspx?Species_ID=164&Potential=N&Type=0&HUCNumber=DGreatLakes (January 2023).

CABI. 2023. *Daphnia lumholtzi* [original text by J. Stoeckel]. CABI Invasive Species Compendium. Wallingford, United Kingdom: CAB International. Available: http://www.cabi.org/isc/datasheet/107777 (January 2023).

Cáceres CE, Tessier AJ, Duffy MA, Hall SR. 2014. Disease in freshwater zooplankton: what have we learned and where are we going? Journal of Plankton Research 36(2):326–333.

Fofonoff PW, Ruiz GM, Steves B, Simkanin C, Carlton JT. 2018. *Daphnia lumholtzi*. National Exotic Marine and Estuarine Species Information System. Edgewater, Maryland: Smithsonian Environmental Research Center. Available: https://invasions.si.edu/nemesis/species_summary/-210 (January 2023).

Frisch D, Weider LJ. 2010. Seasonal shifts in genotype frequencies in the invasive cladoceran *Daphnia lumholtzi* in Lake Texoma, U.S.A. Freshwater Biology 55:1327–1336.

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Daphnia lumholtzi* Sars, 1885. Copenhagen: Global Biodiversity Information Facility. Available: http://www.gbif.org/species/2234817 (January 2023).

[GISD] Global Invasive Species Database. 2017. Species profile: *Daphnia lumholtzi*. Gland, Switzerland: Invasive Species Specialist Group. Available: http://www.iucngisd.org/gisd/speciesname/Daphnia+lumholtzi (January 2023).

Graeve A, Janßen M, Villalba de la Pena M, Tollrian R, Weiss LC. 2021. Higher, faster, better: Maternal effects shorten time lags and increase morphological defenses in *Daphnia lumholtzi* offspring generations. Frontiers in Ecology and Evolution 21(9):1–9.

Havens KE, Beaver JR, East TL, Work K, Phlips EJ, Cichra MF, Croteau AC, Rodusky AJ, Fulton RS III, Rosati TC. 2012. The outcome of the invasion of Florida lakes by *Daphnia lumholtzi*. Freshwater Biology 57(3):552–562.

[HDOA] Hawaii Department of Agriculture. 2019. Non-domestic animal import rules. Hawaii Administrative Rules Chapter 4-71.

[ITIS] Integrated Taxonomic Information System. 2023. *Daphnia lumholtzi* G. O. Sars, 1885. Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=684652#null (January 2023).

Kotov A. 2018. *Daphnia (Daphnia) lumholtzi* G.O. Sars, 1885. World register of marine species. Available: https://www.marinespecies.org/aphia.php?p=taxdetails&id=1302534 (January 2023).

New York [DEC] Department of Environmental Conservation. 2022. Prohibited and regulated invasive species. 6 New York Codes, Rules and Regulations 575.3.

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

Searle CL, Cortez MH, Hunsberger KK, Grippi DC, Oleksy IA, Shaw CL, de la Serna SB, Lash CL, Dhir KL, Duffy MA. 2016. Population density, not host competence, drives patterns of disease in an invaded community. The American Naturalist 188:554–566.

[USFWS] U.S. Fish and Wildlife Service. 2024. Standard operating procedure: how to prepare an "Ecological Risk Screening Summary." Version 3. Available: https://www.fws.gov/media/standard-operating-procedures-how-prepare-ecological-risk-screening-summary-2024 (March 2025).

[USGS] U.S. Geological Survey. 2025. Point distribution map: *Daphnia lumholtzi*. Nonindigenous Aquatic Species Database. Gainesville, Florida: U.S. Geological Survey. Available: https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=164 (March 2025).

Utah Division of Wildlife Resources. 2020. Collection, importation, possession (CIP). Administrative rule R657-3.

Wisconsin Department of Natural Resources. 2022. Invasive species identification, classification and control. Wisconsin Administrative Code NR 40.

World Organisation for Animal Health. 2023. Animal diseases. Paris: World Organisation for Animal Health. Available: https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-diseases/ (January 2023).

Zanata LH, Espíndola ELG, Rocha O, Pereira RHG. 2003. First record of *Daphnia lumholtzi* (Sars, 1885), exotic cladoceran, in São Paulo State (Brazil). Brazilian Journal of Biology 63:717–720.

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.

Barnes RD. 1983. Invertebrate zoology. Saunders, Philadelphia.

Beaver JR, Renicker TR, Tausz CE, Young JL, Thomason JC, Wolf ZL, Russell AL, Cherry MA, Scotese KC, Koenig DT. 2018. Winter swarming behavior by the exotic cladoceran *Daphnia lumholtzi* Sars, 1885 in a Kentucky (USA) reservoir. BioInvasions Records 7:43–50.

Davis TW, Gobler CJ. 2011. Grazing by mesozooplankton and microzooplankton on toxic and non-toxic strains of *Microcystis* in the Transquaking River, a tributary of Chesapeake Bay. Journal of Plankton Research 33:415–430.

Dodson, SI, Frey DG. 1991. Cladocera and other Branchiopoda. Pages 723–786 in Thorpe JH, Covich AP, editors. Ecology and classification of North American freshwater invertebrates. San Diego, California: Academic Press.

Duffy MA, Cáceres CE, Hall SR, Tessier AJ, Ives AR. 2010. Temporal, spatial, and between-host comparisons of patterns of parasitism in lake zooplankton. Ecology 91:3322–3331.

Duffy MA, Hall SR. 2008. Selective predation and rapid evolution can jointly dampen effects of virulent parasites on *Daphnia* populations. American Naturalist 171:499–510.

Dzialowski AR, O'Brien WJ, Swaffar SM. 2000. Range expansion and potential dispersal mechanisms of the exotic cladoceran *Daphnia lumholtzi*. Journal of Plankton Research 22:2205–2223.

East TL, Havens KE, Rodusky AJ, Brady MA. 1999. *Daphnia lumholtzi* and *Daphnia ambigua*: population comparisons of an exotic and a native cladoceran in Lake Okeechobee, Florida. Journal of Plankton Research 21:1537–1551.

Ebert D, Lipsitch M, Mangin KL. 2000. The effect of parasites on host population density and extinction: experimental epidemiology with *Daphnia* and six microparasites. American Naturalist 156:459–477.

Elías-Gutiérrez M, Jerónimo FM, Ivanova NV, Valdez-Moreno M, Hebert PDN. 2008. DNA barcodes for Cladocera and Copepoda from Mexico and Guatemala, highlights and new discoveries. Zootaxa 1839:1–42.

Engel K, Tollrian R. 2012. Competitive ability, thermal tolerance and invasion success in exotic *Daphnia lumholtzi*. Journal of Plankton Research 34:91–97.

Fey SB, Cottingham KL. 2011. Linking biotic interactions and climate change to the success of exotic *Daphnia lumholtzi*. Freshwater Biology 56:2196–2209.

Fey SB, Herren CM. 2014. Temperature-mediated biotic interactions influence enemy release of nonnative species in warming environments. Ecology 95:2246–2256.

Gifford SM, Rollwagen-Bollens G, Bollens SM. 2007. Mesozooplankton omnivory in the upper San Francisco Estuary. Marine Ecology Progress Series 348:33–46.

Goulden CL, Tomljanovich D, Kreeger D, Corney E. 1995. The invasion of *Daphnia lumholtzi* Sars (Cladocera, Daphniidae) into a North American reservoir. Pages 9–38 in Hamilton SW, White DS, Chester EW, Scott AF, editors. Clarksville, Tennessee: Austin Peay State University, The Center for Field Biology. Proceedings of the sixth symposium on the natural history of the lower Tennessee and Cumberland River Valleys.

Hairston NG, Perry LJ Jr, Bohonak AJ, Fellows MQ, Kearns C, Engstrom DR. 1999. Population biology of a failed invasion: paleolimnology of *Daphnia exilis* in upstate New York. Limnology and Oceanography 44:477–486.

Hall SR, Smyth R, Becker CR, Duffy MA, Knight CJ, MacIntyre S, Tessier AJ, Cáceres CE. 2010. Why are *Daphnia* in some lakes sicker? Disease ecology, habitat structure, and the plankton. BioScience 60:363–375.

Havel JE, Graham JL. 2006. Complementary population dynamics of exotic and native *Daphnia* in North American reservoir communities. Archiv fur Hydrobiologie 167:245–264.

Havel JE, Hebert PDN. 1993. *Daphnia lumholtzi* in North America: another exotic zooplankter. Limnology and Oceanography 38:1837–1841.

Havel JE, Mabee WR, Jones JR. 1995. Invasion of the exotic cladoceran *Daphnia lumholtzi* into North American reservoirs. Canadian Journal of Fisheries and Aquatic Sciences 52:151–160.

Havel JE, Shurin JB. 2004. Mechanisms, effects, and scales of dispersal in freshwater zooplankton. Limnology and Oceanography 49:1229–1238.

Johnson WS, Allen DM. 2005. Zooplankton of the Atlantic and Gulf coasts. Baltimore: Johns Hopkins Press.

Johnson JL, Havel JE. 2001. Competition between native and exotic *Daphnia*: *in situ* experiments. Journal of Plankton Research 23(4):373–387.

Kolar CS, Boase JC, Clapp DF, Wahl DH. 1997. Potential effect of invasion by an exotic zooplankton, *Daphnia lumholtzi*, Journal of Freshwater Ecology 12:521–530.

Kolar CS, Wahl DH. 1998. Daphnid morphology deters fish predators. Oecologia 116:556–564.

Lemke AM, Stoekel JA, Pegg MA. 2003. Utilization of the exotic cladoceran *Daphnia lumholtzi* by juvenile fishes in an Illinois River floodplain lake. Journal of Fish Biology 62:938–954.

Lenon JT, Smith VH, Williams K. 2001. Influence of temperature on exotic *Daphnia lumholtzi* and implications for invasion success. Journal of Plankton Research 23(4):425–434.

Lienesch PW, Gophen M. 2001. Predation by inland silversides on an exotic cladoceran, *Daphnia lumholtzi*, in Lake Texoma, U.S.A. Journal of Fish Biology 59:1249–1257.

Muzinic CJ. 2000. First record of *Daphnia lumholtzi* Sars in the Great Lakes. Journal of Great Lakes Research 26(3):352–354.

Silva-Briano M, Arroyo-Bustos G, Beltrán-Álvarez R, Adabache-Ortiz A, de la Rosa RG. 2010. [Daphnia *CtenoDaphnia lumholtzi* G. O. Sars, 1885 (Crustacea: Cladocera); an exotic cladoceran in Mexico]. Hidrobiológica 20:275–280.

Simões NR, Robertson BA, Lansac-Tôha FA, Takahashi EM, Bonecker CC, Velho LFM, Joko CY. 2009. Exotic species of zooplankton in the Upper Paraná River floodplain, *Daphnia lumholtzi* Sars, 1885 (Crustacea: Branchiopoda). Brazilian Journal of Biology 69:551–558.

Swaffar SM, O'Brien JW. 1996. Spines of *Daphnia lumholtzi* create feeding difficulties for juvenile bluegill sunfish (*Lepomis macrochirus*). Journal of Plankton Research 18:1055–1061.

Tifnouti A, Pourrio R, Rougier C. 1993. Influence de la temperature sur le developpement et la fecondite de quatre especes de Cladoceres. Planctoniques (Crustaces) en presence de ressources naturelles. Annales de Limnologie 29:3–13.

Work K, Gophen M. 1995. Invasion of *Daphnia lumholtzi* (Sars) into Lake Texoma (USA). Archiv fur Hydrobiologie 133:287–303.

Work KA, Gophen M. 1999. Factors which affect the abundance of an invasive cladoceran, *Daphnia lumholtzi*, in U.S. reservoirs. Freshwater Biology 42:1–10.

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 (2023), Zanata et al. (2003), Kotov and Taylor (2014), Simões et al. (2009), and Silva-Briano et al. (2010).

Under the future climate scenarios (figure A1), on average, high climate match for *Daphnia lumholtzi* was projected to occur in the Appalachian Range, California, Colorado Plateau, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Northern Plains, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, and Southwest regions of the contiguous United States. Areas of low climate match were projected to occur in the Northern Pacific Coast region and along the Cascade mountain range and Sierra Nevada. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.931 (model: MPI-ESM1-2-HR, SSP5, 2085) to a high of 0.960 (model: GFDL-ESM4, SSP5, 2085). 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 (0.934, figure 4) falls within 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, Great Basin, Northeast, and Western Mountains 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 California saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, Gulf Coast, Mid-Atlantic, Northern Pacific Coast, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, 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 magnitude and geographic extent of decreasing climate match was larger in time step 2085 than 2055 under both scenarios, SSP3 and SSP5.

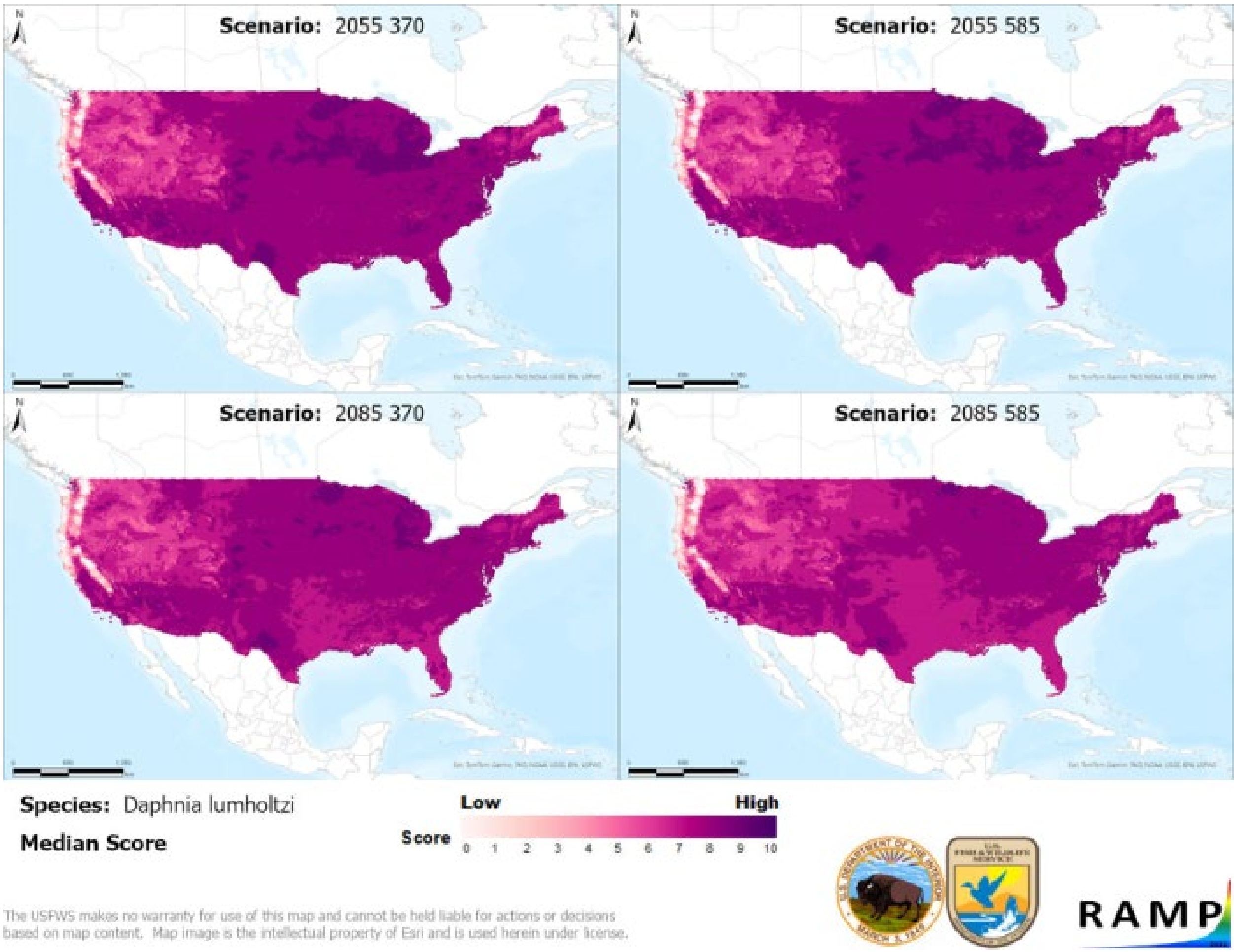

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Daphnia lumholtzi* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023), Zanata et al. (2003), Kotov and Taylor (2014), Simões et al. (2009), and Silva-Briano et al. (2010). 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.

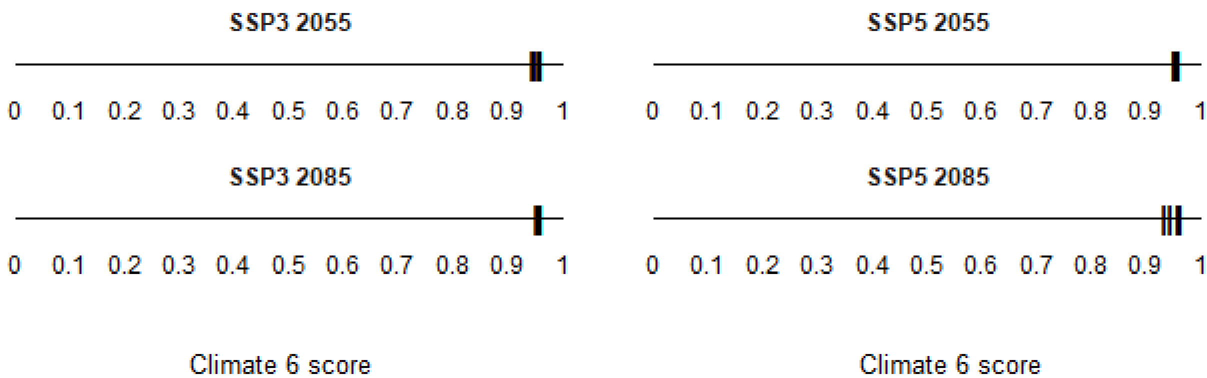

Figure A2. Comparison of projected future Climate 6 scores for *Daphnia lumholtzi* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018;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

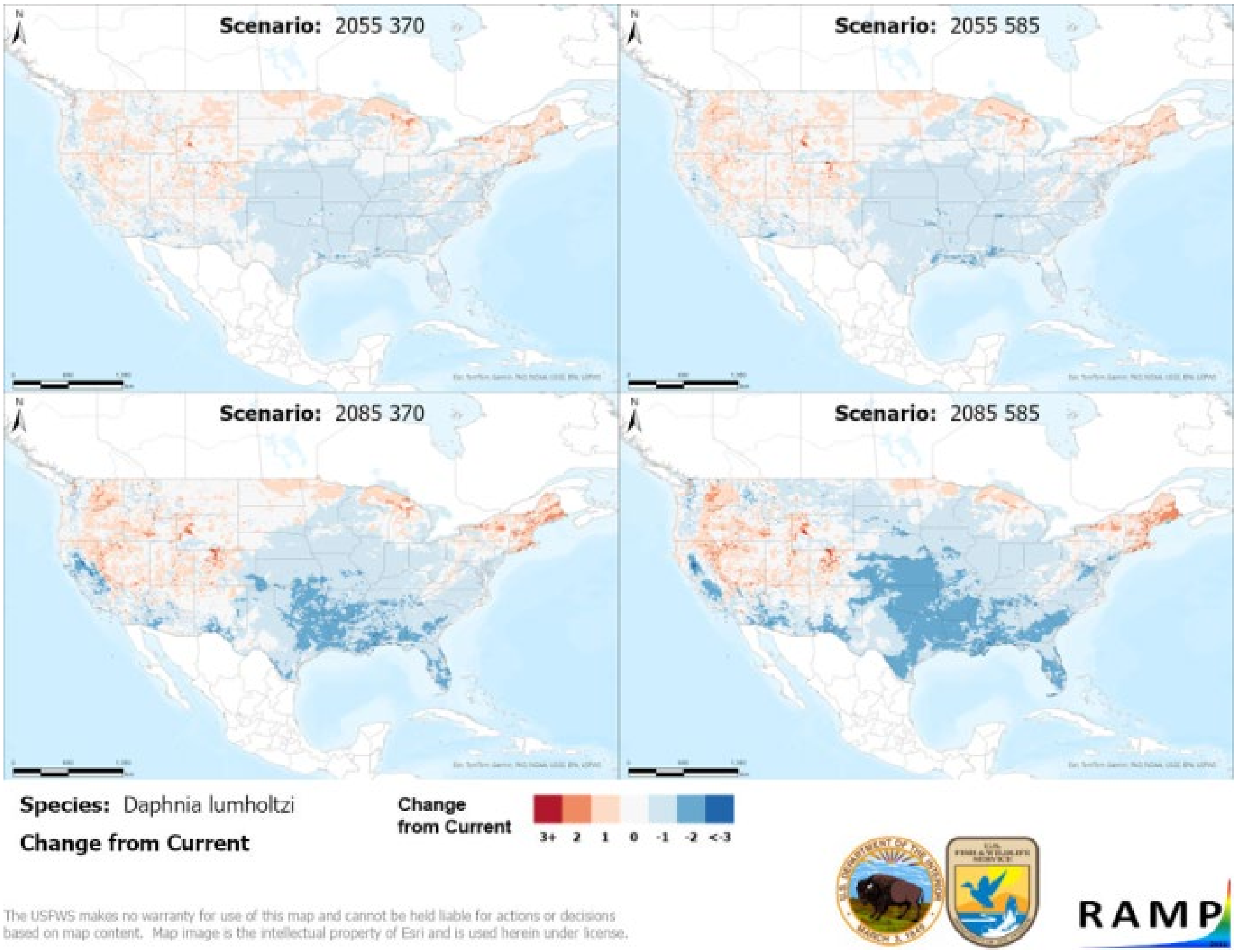

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Daphnia lumholtzi* based on source locations reported by GBIF Secretariat (2023), Zanata et al. (2003), Kotov and Taylor (2014), Simões et al. (2009), and Silva-Briano et al. (2010). 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.

Literature Cited

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Daphnia lumholtzi*. Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2286691 (January 2023).

[IPCC] Intergovernmental Panel on Climate Change. 2021. Climate change 2021: the physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder P, Kessler M. 2017. Climatologies at high resolution for the Earth land surface areas. Scientific Data 4:170122.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder HP, Kessler M. 2018. Data from: Climatologies at high resolution for the earth's land surface areas. EnviDat. Available: https://doi.org/10.16904/envidat.228.v2.1.

Kotov AA, Taylor DJ. 2014. *Daphnia lumholtzi* Sars, 1885 (Cladocera: Daphniidae) invades Argentina. Journal of Limnology 73(2):369–374.

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

Silva-Briano M, Arroyo-Bustos G, Beltrán-Álvarez R, Adabache-Ortiz A, de la Rosa RG. 2010. [Daphnia *CtenoDaphnia lumholtzi* G. O. Sars, 1885 (Crustacea: Cladocera); an exotic cladoceran in Mexico]. Hidrobiológica 20:275–280.

Simões NR, Robertson BA, Lansac-Tôha FA, Takahashi EM, Bonecker CC, Velho LFM, Joko CY. 2009. Exotic species of zooplankton in the Upper Paraná River floodplain, *Daphnia lumholtzi* Sars, 1885 (Crustacea: Branchiopoda). Brazilian Journal of Biology 69:551–558.

Zanata, LH, Espíndola ELG, Rocha O, Pereira RHG. 2003. First record of *Daphnia lumholtzi* (Sars, 1885), exotic cladoceran, in São Paulo State (Brazil). Brazilian Journal of Biology 63(4):717–720.