Cyclops strenuus sibiricus (a copepod, no common name)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2022
Revised, March 2022
Web Version, 4/25/2022

Organism Type: Copepod
Overall Risk Assessment Category: Uncertain

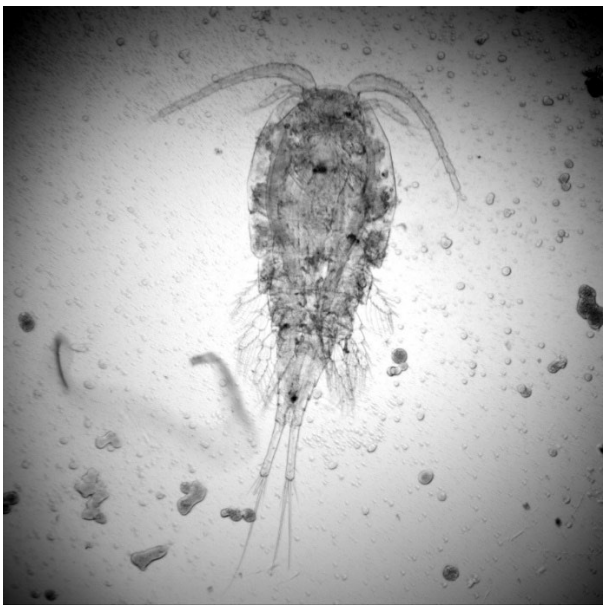

Photo: J. Connolly. Used with permission.

1 Native Range and Status in the United States

Native Range

From Hołyńska and Dimante-Deimantovica (2016):

"*Cyclops* [*strenuus*] *sibiricus* is distributed in Siberia and arctic North America; its westernmost occurrence is so far known from the Yamal Peninsula [Russia] (Lindberg 1957); occurrence in arctic Fenno-Scandinavia is possible."

Hołyńska and Wyngaard (2019) report specimens of *Cyclops strenuus sibiricus* (as *C. sibiricus*) from the Northwest Territories and Saskatchewan in Canada, Chukotka and Siberia in Russia, and five locations in Alaska: Galena, Barter Island, Umiat, Chatanika, and Point Barrow.

From Makino et al. (2003):

"In Lake Toya, an oligotrophic caldera lake in Hokkaido, Japan, the population of a cyclopoid copepod *Cyclops* cf. *sibiricus* inhabits the hypolimnion continuously in the summer (Makino & Ban, 1998)."

Status in the United States

C. s. sibiricus is reported as established in Alaska and it is assumed to be established in the Great Lakes based on collections more than 20 years apart. However, it is possible that the organism was introduced separately at two different times and failed to establish.

Hołyńska and Wyngaard (2019) report specimens of *C. s. sibiricus* (as *C. sibiricus*) from five locations in Alaska: Galena, Barter Island, Umiat, Chatanika, and Point Barrow.

From A. Scofield (U.S. Environmental Protection Agency, personal communication, 2022):

"*Cyclops sibiricus* was identified when archived specimens from the St. Mary's River [Michigan] (collected in 1972 and 1995) were re-examined. These individuals were previously identified as *Cyclops strenuus*. This is the first documentation of *C. sibiricus* in the Great Lakes basin."

C. s. sibiricus is not in trade in the United States.

From Hawaii Department of Agriculture (2019):

"RESTRICTED ANIMAL LIST (Part B)…ORDER Cyclopoida FAMILY Cyclopidae *Cyclops* (all species in genus)."

Means of Introductions in the United States

From Sturtevant et al. (2019):

"Unclear. *Cyclops strenuus* could have been introduced in ballast water, transferred with stocking programs, released with bait, discharged from live well water, transferred with recreational gear, transferred with waterfowl, or it may have dispersed via the Long Lac-Ogoki diversion project that connects the Hudson's Bay drainage to Lake Superior (Hudson et al., 1998; Grigorovich et al., 2003a, 2003b; Holeck et al., 2004; Duggan et al., 2005)."

Sturtevant et al.'s (2019) discussion of *C. strenuus* includes those specimens from the St. Marys River now re-identified as *C. s. sibiricus*, along with other specimens of *C. strenuus* collected from Lake Superior.

Remarks

The taxonomic authorities used in this ERSS are defined in the SOP for the ERSS process and can be found online (https://www.fws.gov/fisheries/ANS/species_erss.html). The ERSS follows the chosen taxonomic authority for copepods and other crustaceans (World Register of Marine Species; Walter and Boxshall 2022a) in treating *Cyclops strenuus sibiricus* as the valid scientific name for the subject taxon. However, there is substantial uncertainty surrounding the taxonomy of *Cyclops* species and several recent publications recognize *C. sibiricus* as the valid scientific name. Information searches for this assessment used the valid name according to Walter and Boxshall (2022a), *Cyclops strenuus sibiricus*, and the synonym *C. sibiricus*. *C. canadensis* was synonymized with *C. s. sibiricus* (as *C. sibiricus*) by Hołyńska and Wyngaard (2019), but Walter and Boxshall (2022b) continue to recognize it as an accepted species and so information pertaining specifically to *C. canadensis* was not used to inform this ERSS.

From Hołyńska and Wyngaard (2019):

"*Cyclops* has a long history in copepod systematic studies. While it is relatively easy to distinguish this group from other cyclopid genera, delineation of the species and the evolutionary lineages within the genus have always posed serious problems. Their conservative gross morphology, local varieties and different ecophenotypes observed in species with fragmented ranges (e.g., in *C. abyssorum* and *C. scutifer* G.O. Sars, 1863) have resulted in a "fluid taxonomy," in which the taxonomic position of many forms and the number of putative species have changed substantially among different authors [e.g., 45 (sub)species by Lindberg, 1957, vs. 23 species by Einsle, [1996]]."

From Hołyńska (2008):

"The morphology of a large majority of the taxa [in the genus *Cyclops*] so far described [60 (sub)species – Lindberg 1957; Dussart and Defaye 2006] is poorly known and their taxonomic positions remain obscure. The evolutionary history of this predominantly Palearctic group seems to be strongly influenced by pleistocene and post-pleistocene climatic and hydrological changes, and the extent of morphological divergence between *Cyclops* lineages, in comparison to those in more widely distributed cyclopid genera, is often very low. The systematics of the group was further complicated by an erroneous typological species concept (for critique of the typological approach see Nilssen 1979) which, neglecting the morphological and ecological plasticity of species, has resulted in a jungle of names (in Central and Southern Europe alone 20 subspecies, ecotypes and local forms of *Cyclops abyssorum* have already been described) and rendered understanding the biology of the group very difficult."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Walter and Boxshall (2022a):

"Animalia (Kingdom) > Arthropoda (Phylum) > Crustacea (Subphylum) > Multicrustacea (Superclass) > Hexanauplia (Class) > Copepoda (Subclass) > Neocopepoda (Infraclass) >

Podoplea (Superorder) > Cyclopoida (Order) > Cyclopida (Suborder) > Cyclopidae (Family) > *Cyclops* (Genus) > *Cyclops strenuus* (Species) > *Cyclops strenuus sibiricus* (Subspecies)"

"Status accepted"

Size, Weight, and Age Range

According to Connolly et al. (2022), twelve female specimens of *C. s. sibiricus* (as *C. sibiricus*) ranged in body length from 1.44–1.73mm.

Environment

From Loskutova and Kononova (2015):

"[…] characteristic of small cold-water bodies."

Hołyńska and Wyngaard (2019) report specimens of *C. s. sibiricus* (as *C. sibiricus*) from lakes and pools, including a "grassy roadside pool" in Alaska.

From Makino et al. (2003):

"This '*C.* cf. *sibiricus*' is distributed in large oligotrophic lakes in Japan and regarded as a northern stenotherm copepod (Mizuno & Takahashi, 1991)."

"The average habitat temperature was 5–6 °C for all these copepodites in May, gradually increased toward October when habitat temperature reached 10–11 and 8–9 °C for [early copepodite life stages] and [late copepodite life stages], respectively."

"[…] adult populations were distributed between 20 and 40 m deep in May and June. Thereafter, they migrated downward until August (or September for 1995), and then migrated upwards."

"The WMDs [weighted mean depths] of nauplii were 30–40 m deep in 1993 and 1994, and at 20–30 m deep in 1995 and 1996."

Climate

From Loskutova and Kononova (2015):

"[…] arctic species […]"

From Hołyńska and Wyngaard (2019):

"[…] East Palearctic species […]"

Distribution Outside the United States

Native

From Hołyńska and Dimante-Deimantovica (2016):

"*Cyclops sibiricus* is distributed in Siberia and arctic North America; its westernmost occurrence is so far known from the Yamal Peninsula [Russia] (Lindberg 1957); occurrence in arctic Fenno-Scandinavia is possible."

Hołyńska and Wyngaard (2019) report specimens of *C. s. sibiricus* (as *C. sibiricus*) from the Northwest Territories and Saskatchewan in Canada, and Chukotka and Siberia in Russia.

From Makino et al. (2003):

"In Lake Toya, an oligotrophic caldera lake in Hokkaido, Japan, the population of a cyclopoid copepod *Cyclops* cf. *sibiricus* inhabits the hypolimnion continuously in the summer (Makino & Ban, 1998)."

Introduced

There are no records of introduction of *C. s. sibiricus* outside of the United States.

Means of Introduction Outside the United States

There are no records of introduction of *C. s. sibiricus* outside of the United States.

Short Description

From Hołyńska and Wyngaard (2019):

"Since the 1980s, it has become standard in copepod taxonomy to include the "microcharacters" (spinule ornamentation of the limbs, seta setulation, integumental pore signature) along with the classic gross characters (limb segmentation, body proportions). Interestingly, these fine structures frequently show less intraspecific variation than the morphometric characters and correlate well with other (gross) morphological features, molecular markers and the presence of reproductive isolation (Baribwegure & Dumont, 2003; Fiers & Van de Velde, 1984; Karaytug, 1999; Krajíček et al., 2016; Van de Velde, 1984)."

Hołyńska and Dimante-Deimantovica (2016) provide a dichotomous key to identify *C. s. sibiricus* (as *C. sibiricus*), among other *Cyclops* species. Only the final set of characteristics in the key is presented below.

From Hołyńska and Dimante-Deimantovica (2016):

"P4 coxopodite seta not reaching beyond distalmost point of medial expansion of P4 basipodite (♀, ♂). Intercoxal sclerites of P3−P4 (sometimes also P2) with hairs on caudal surface (♀). P5, distal (second) segment: apical seta short, 1.6−2.3 times as long as segment (♀). Caudal surface ornamentation of P4 coxopodite: groups "B" and "E" present (for coding of the spinule groups

see Fig. 3D [in source material]) (♀, ♂)"

Biology

From Makino et al. (2003):

"Seasonal changes in the vertical distribution of *C.* cf. *sibiricus* corresponded to the vertical profiles of water temperature. During the winter circulation period in which temperature was 3-4 °C, the population was scattered broadly throughout the whole water column both day and night. In May when thermal stratification was not yet completely developed the population began to be concentrated between 20 and 40 m deep, and, except in 1994, a part of the population reached just below the lake surface at night. During the summer stratification period, although very limited number of individuals were found in the samples collected in the epilimnion, most of the population were distributed below the thermocline both day and night. The upper limit of the distribution of this main population corresponded to the depth where water temperature was *c.* 14 °C, and became deeper with the gradual downward shift of the thermocline."

Human Uses

No information on human uses was found for *C. s. sibiricus*.

Diseases

No records of OIE-reportable diseases (OIE 2022) were found for *C. s. sibiricus*.

No information was found on diseases of *C. s. sibiricus*.

Threat to Humans

No information on threats to humans was found for *C. s. sibiricus*.

3 Impacts of Introductions

Although *C. s. sibiricus* has been recorded as introduced into the St. Marys River, Michigan, in the United States, there is no information available on impacts of that introduction.

4 History of Invasiveness

The history of invasiveness for *C. s. sibiricus* is Data Deficient. *C. s. sibiricus* has been introduced and become established outside of its native range in the United States but any impacts of this introduction remain unknown. There is also no trade history associated with this species.

5 Global Distribution

Figure 1. Known global distribution of *Cyclops strenuus sibiricus*. Observations are reported from northern North America, northern Russia, and northern Japan. Map from Esri (2022) based on locations provided by Makino et al. (2003), Hołyńska and Wyngaard (2019), GBIF Secretariat (2022), and Connolly et al. (2022).

6 Distribution Within the United States

Figure 2. Known distribution of *Cyclops strenuus sibiricus* in the contiguous United States. Map from Esri (2022) based on locations reported by Connolly et al. (2022).

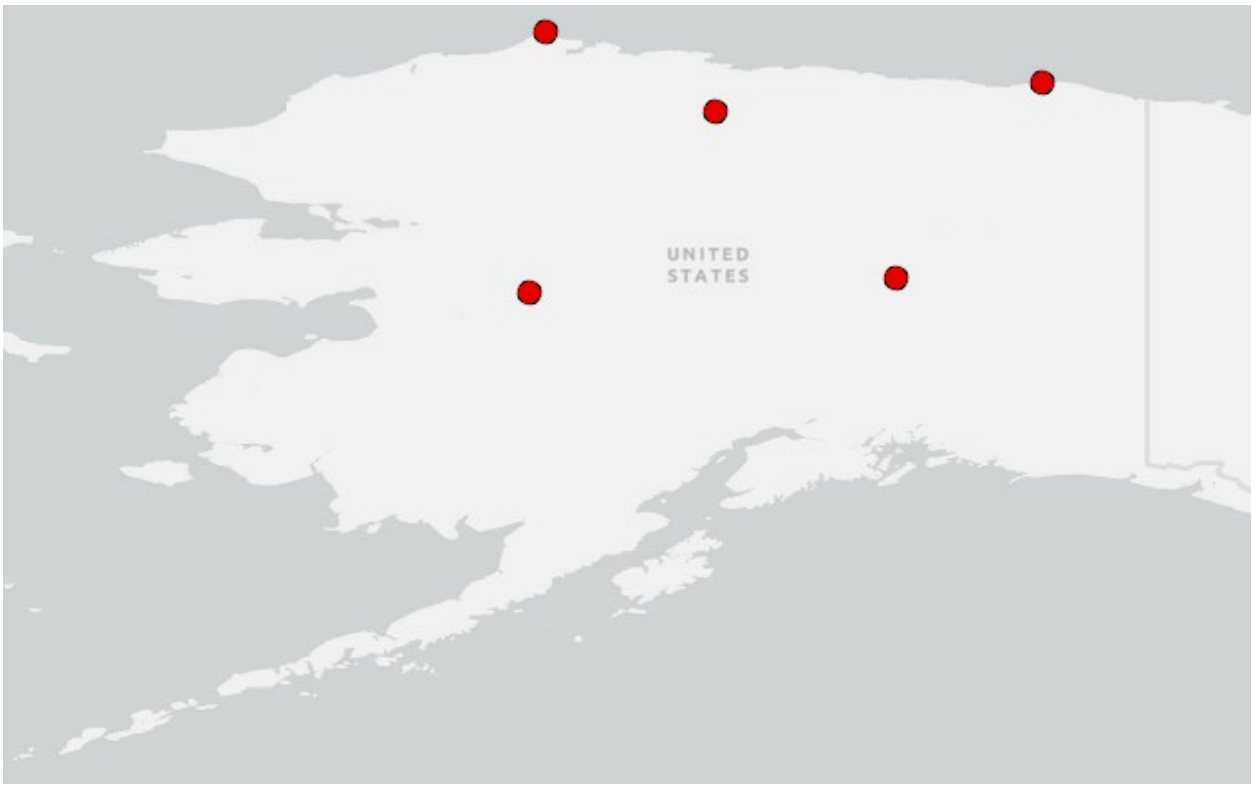

Figure 3. Known distribution of *Cyclops strenuus sibiricus* in Alaska. Map from Esri (2022) based on locations provided by Hołyńska and Wyngaard (2019).

7 Climate Matching

Summary of Climate Matching Analysis

The overall climate match throughout the contiguous United States is high with most of the country having a medium to high match. Some areas of low match were found but isolated to the west coast and southeastern States. The highest match was found around the Great Lake States. The overall Climate 6 score (Sanders et al. 2021; 16 climate variables; Euclidean distance) for the contiguous United States was 0.385, high (scores of 0.103 and greater are classified as high). Most States had a high individual Climate 6 score. Alabama, Arkansas, California, Delaware, the District of Colombia, Florida, Georgia, Louisiana, Mississippi, Oklahoma, Rhode Island, South Carolina, and Texas had low individual Climate 6 scores. Arizona, Kentucky, North Carolina, Nevada, Oregon, Tennessee, and Washington had medium individual Climate 6 scores. Certainty in the interpretation of the results of the climate match is lowered because of the large native range of this organism and the lack of source points.

Figure 4. RAMP (Sanders et al. 2021) source map showing weather stations in North America, Russia, and Japan selected as source locations (red; Japan, Russia, Canada, and the United States) and non-source locations (gray) for *Cyclops strenuus sibiricus* climate matching. Source locations from GBIF Secretariat (2022), Makino et al. (2003), Hołyńska and Wyngaard (2019), and Connolly et al. (2022). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

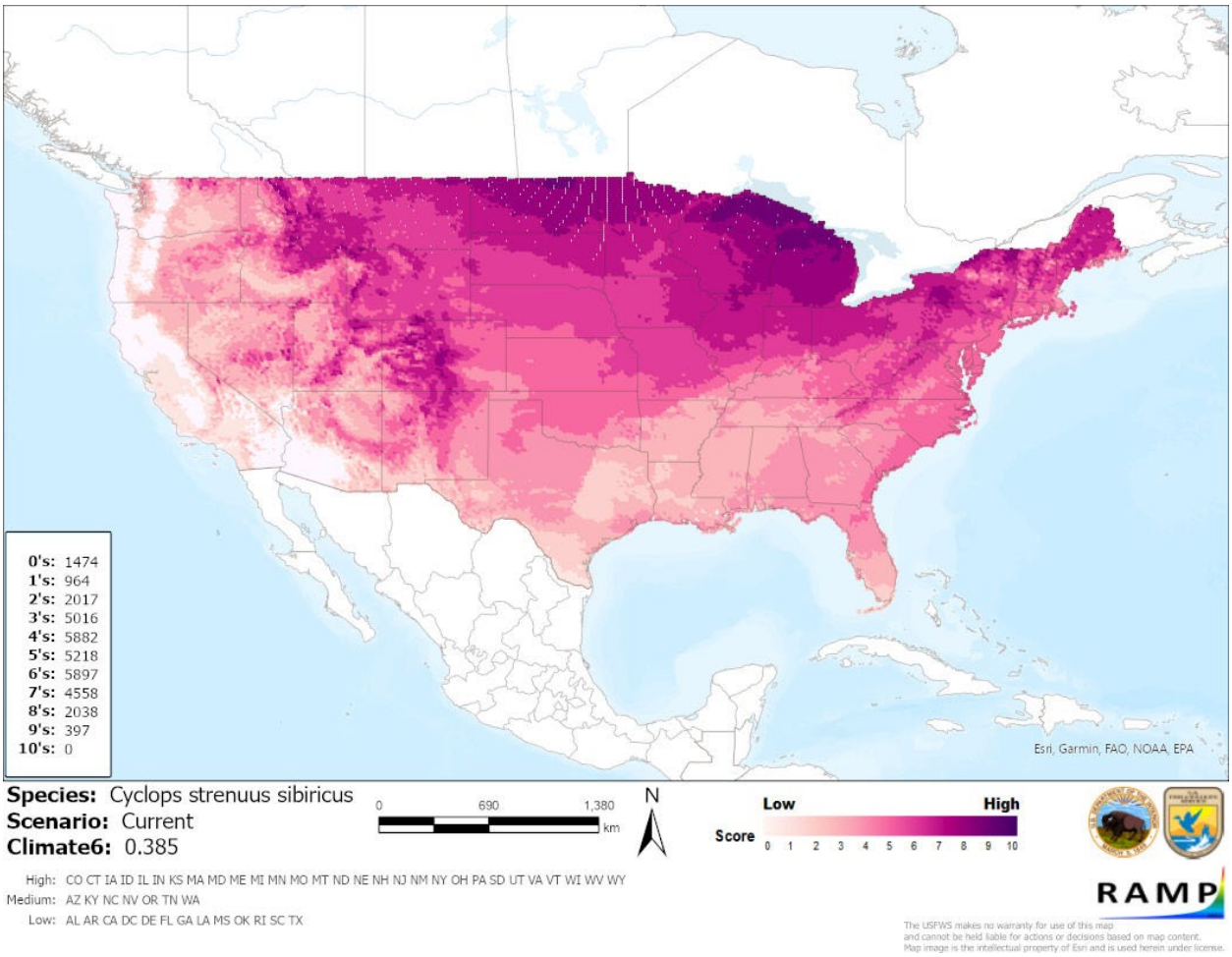

Figure 5. Map of RAMP (Sanders et al. 2021) climate matches for *Cyclops strenuus sibiricus* in the contiguous United States based on source locations reported by GBIF Secretariat (2022), Makino et al. (2003), Hołyńska and Wyngaard (2019), and Connolly et al. (2022). Counts of climate match scores are tabulated on the left. 0/Light Pink = Lowest match, 10/Dark Purple = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

8 Certainty of Assessment

The certainty of this assessment is low. Although *C. s. sibiricus* has been introduced outside of its native range into the St. Marys River in the Great Lakes region of the United States, there is no information on impacts of that introduction. There is also a general lack of knowledge in the scientific literature about this subspecies biology, habitat preferences, and distribution within its native range, with only a handful of occurrences found during the literature search that could be used to inform the climate matching analysis. Certainty in the interpretation of the results of the climate match is lowered because of the large native range and the lack of source points. Finally, there is substantial taxonomic uncertainty surrounding *C. s. sibiricus* and other members of the genus *Cyclops*.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Cyclops strenuus sibiricus is a copepod native to parts of Russia, Siberia, Japan, and arctic North America. There is significant taxonomic confusion in the scientific literature around species and subspecies in the genus *Cyclops*. This report follows the taxonomic authorities chosen for the ERSS process in referring to this copepod as *C. s. sibiricus*, but several recent literature sources refer to it as *Cyclops sibiricus*. *C. s. sibiricus* has been introduced outside of its native range into the St. Marys River in the Great Lakes region of the United States, where it was collected in both the 1970s and 1990s. There is no information in regard to the impacts that this introduction has had, and therefore the history of invasiveness is classified as Data Deficient. The overall climate match for the contiguous United States was High with a majority of States having a high individual Climate 6 score and the highest match being found around the Great Lakes. However, the certainty in the interpretation of the results of the climate match is lowered because of the large native range and lack of source points for the climate match. The certainty of assessment is Low because of the taxonomic confusion associated with this species and the general lack of information available. The overall risk assessment category for *Cyclops strenuus sibiricus* is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 4): Data Deficient**
- **Overall Climate Match Category (Sec. 7): High**
- **Certainty of Assessment (Sec. 8): Low**
- **Remarks, Important additional information: Some information for this ERSS was derived from sources treating this organism as *C. sibiricus*.**
- **Overall Risk Assessment Category: Uncertain**

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.

Baribwegure D, Dumont HJ. 2003. The integumental pore signature of *Thermocyclops schmeili* (Poppe & Mrázek, 1895); *Thermocyclops dybowskii* (Landé, 1890); *Thermocyclops hooki* Löffler, 1968; *Thermocyclops incisus* Kiefer, 1932 and *Thermocyclops inopinus* (Kiefer, 1926). Hydrobiologia 505:15–30.

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