

**SPECIAL SECTION****Avoiding a Macabre Future for *Macrhybopsis*—Improving Management and Conservation of Chubs****Avoiding a macabre future for *Macrhybopsis*—A special section on improving management and conservation of chubs**

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The genus *Macrhybopsis* (hereafter collectively referred to as “chubs”) represents a broadly distributed group of imperiled species. Their distribution ranges from the Rio San Fernando in the state of Tamaulipas, Mexico, to the Choctawhatchee River in the state of Florida, United States, and to the Assiniboine River in Manitoba, Canada (Figure 1). Twelve species are currently recognized (Table 1), including four that were described as recently as 2017 (Gilbert et al. 2017). Conservation status among species ranges from least concern for broadly distributed species, such as the Silver and Shoal chubs, to imperilment for species such as the Peppered and Prairie chubs. Although the Silver and Shoal chubs are broadly distributed and of least concern, both potentially include cryptic species (i.e., two or more distinct species that are classified under one name) and thus require additional research and assessment (Echelle et al. 2018). Critical or declining conservation status, coupled with only recent or incomplete species descriptions, collectively suggests that *Macrhybopsis* fishes would benefit from additional research on their ecology and implications for management and conservation.

Basic ecology is known for only a fraction of the described chubs. Early life history and reproductive biology have been studied for the Peppered Chub (Bottrell

et al. 1964), Speckled Chub (Platania and Altenbach 1998), and Sicklefing Chub (Albers and Wildhaber 2017). Reproduction by these species is considered to be pelagic broadcast spawning (PBS), in which nonadhesive eggs are broadcasted, are externally fertilized, and swell and harden with river water such that they become nearly neutrally buoyant and require minimal current velocity to remain suspended (Platania and Altenbach 1998; Hoagstrom and Turner 2015). Reproduction of other chubs has not been directly observed but is generally inferred from egg characteristics to be PBS for the Prairie, Shoal, Burrhead, and Sturgeon chubs (Worthington et al. 2018). Nothing is directly known about the reproduction of the species that were recently described by Gilbert et al. (2017), including the Mobile, Coosa, Pallid, and Gulf chubs. Silver Chub reproduction is considered to be lithopelagic broadcast spawning, which differs from PBS in that eggs are demersal (sinking) rather than nearly neutrally buoyant (Simon 1999), although direct observation of reproduction is lacking. McKenna et al. (2023, this special section) discuss new evidence that Silver Chub reproductive ecology in Lake Erie is consistent with the PBS reproductive mode. The Silver Chub also differs from all other described species based on its use of both lotic and lentic environments

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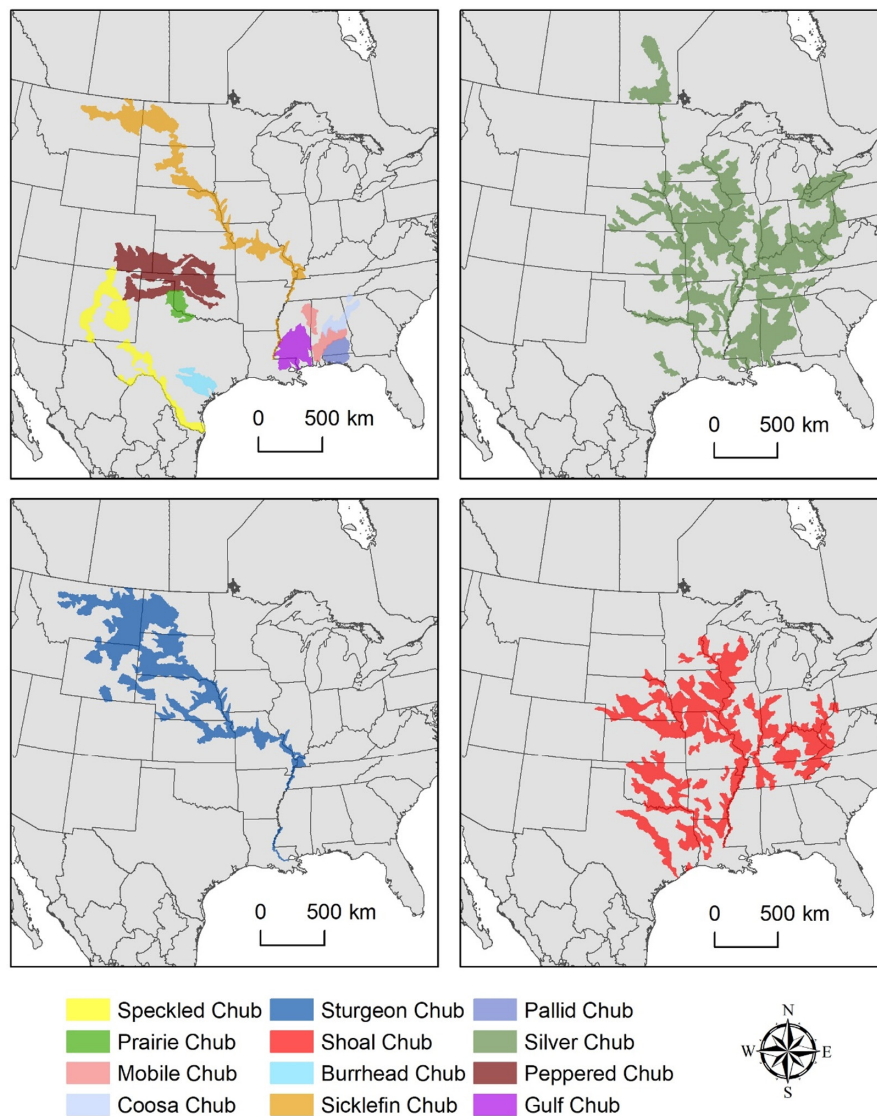
(McKenna and Kocovsky 2020). Mesohabitat associations for riverine chubs, including water velocity, water depth, and substrate associations, have been studied for the Shoal Chub (Luttrell et al. 2002; Gaughan et al. 2019) as well as the Sicklefin and Sturgeon chubs (Everett et al. 2004; Ridenour et al. 2009). Chubs primarily consume aquatic invertebrates (Worthington et al. 2018), and the Sicklefin and Sturgeon chubs represent prey items for other imperiled species, such as the Pallid Sturgeon *Scaphirhynchus albus* (Gerrity et al. 2006). Direct observation of summer movement ecology has been studied in detail only for the Prairie Chub (Steffensmeier et al. 2022).

As with many diminutive fishes in large rivers, challenges for the management of *Macrhybopsis* fishes center on understanding how environmental change affects distribution and abundance. In particular, the effects of

### Impact statement

Twelve recognized species in genus *Macrhybopsis* are distributed across Canada, Mexico, and the United States. Most chubs have elevated conservation concerns at international, national, or state/province levels, but management intervention might reverse their trajectory of decline.

fragmented longitudinal connectivity, flow regime alteration, modified channel morphology, and interactions with nonnative species are of primary concern (Worthington et al. 2018). Evidence suggests that fragmentation by dams and other barriers has negatively



**FIGURE 1** Historical native distributions of 12 recognized *Macrhybopsis* fishes in North America, modified from NatureServe (2010). Modifications include the addition of species described by Gilbert et al. (2017). See Table 1 for scientific names and conservation status information.

**TABLE 1** Conservation status of chubs in the genus *Macrhybopsis* according to the U.S. Endangered Species Act (ESA), the Canadian Species at Risk Act (SARA), the American Fisheries Society (AFS; from Jelks et al. 2008), the International Union for the Conservation of Nature (IUCN), and NatureServe. Asterisks signify instances in which a political unit (state or province) assigns high conservation priority (e.g., vulnerable, imperiled, endangered, or species of greatest conservation need) to populations within its boundaries.

Species	ESA/SARA	AFS	IUCN	NatureServe
Specked Chub <i>M. aestivalis</i> *	Not listed	Threatened	Least concern–decreasing	Vulnerable (G3)
Prairie Chub <i>M. australis</i> *	Under review (ESA)	Vulnerable	Vulnerable–unknown	Vulnerable (G3)
Mobile Chub <i>M. boschungii</i>	Not listed	Not evaluated	Not evaluated	Not listed
Coosa Chub <i>M. etnieri</i> *	Not listed	Vulnerable	Not evaluated	Vulnerable (G3)
Sturgeon Chub <i>M. gelida</i> *	Under review (ESA)	Vulnerable	Least concern–stable	Vulnerable (G3)
Shoal Chub <i>M. hyostoma</i> *	Not listed	Not listed	Least concern–stable	Secure (G5)
Burrhead Chub <i>M. marconis</i>	Not listed	Not listed	Least concern–stable	Apparently secure (G4)
Sicklefin Chub <i>M. meeki</i> *	Under review (ESA)	Vulnerable	Least concern–stable	Vulnerable (G3)
Pallid Chub <i>M. pallida</i>	Not listed	Vulnerable	Not evaluated	Vulnerable (G3)
Silver Chub <i>M. storeriana</i> *	Endangered (SARA)	Not listed	Least concern–stable	Secure (G5)
Peppered Chub <i>M. tetranema</i> *	Endangered (ESA)	Endangered	Endangered–decreasing	Critically imperiled (G1)
Gulf Chub <i>M. tomellerii</i>	Not listed	Not evaluated	Not evaluated	Not listed

affected the distribution of chubs (Winston et al. 1991; Luttrell et al. 1999; Dudley and Platania 2007; Perkin and Gido 2011). The effects of habitat fragmentation are particularly detrimental when combined with extreme low-flow periods brought on by drought (Perkin et al. 2013, 2015a) or stream dewatering (Perkin et al. 2015b). Evidence from the imperiled Peppered Chub suggests that recruitment is linked to flow regime characteristics and minimal thresholds in discharge magnitude (Wilde and Durham 2008; Perkin et al. 2019). Broad-scale analyses of occurrence for multiple chubs point to flow regime alteration as a driver of population declines, including those of Sicklefin Chub (Dieterman and Galat 2004), Sturgeon Chub (Welker and Scarnecchia 2006), Shoal Chub (Rodger et al. 2016), and Prairie Chub (Mollenhauer et al. 2021). Modified channel morphology caused by artificial structures and dredging activity affects the distribution of Shoal, Sicklefin, and Sturgeon chubs in the Missouri River basin (Paukert et al. 2008; Ridenour et al. 2009), whereas elsewhere in the Great Plains simplified channels likely increase the downstream transport of ichthyoplankton (i.e., drifting eggs and larvae; Dudley and Platania 2007; Worthington et al. 2014). Invasion by nonnative species such as the Grass Carp *Ctenopharyngodon idella* is concerning for Silver Chub in the Great Lakes because of potential spawning habitat overlap (McKenna et al. 2023). In the upper Brazos River of Texas, riparian zone invasion by nonnative salt cedar *Tamarix* spp. alters channel morphology and increases evapotranspiration (Mayes et al. 2019), both of which threaten the natural flow regime characteristics that regulate Shoal Chub occurrence (Nguyen et al. 2021).

During the 2020 virtual meeting of the American Fisheries Society (AFS), a special symposium titled “Ecology

and Conservation of the Chubs: Integrating Past Declines, Present Research, and Future Challenges for Fishes in the Genus *Macrhybopsis*” was held to bring together research efforts focusing on chub conservation and management. The nine papers included in this special section cover topics that are central to improving the management of chubs, including cryptic species occurrence among broadly distributed chubs, basic ecology, and management challenges related to habitat fragmentation and flow regime alteration. McKenna (2023, this special section) presents a spatially explicit model for Silver Chub habitat in Lake Erie to inform management decisions, while McKenna et al. (2023) define the spatial distribution of spawning habitats for Silver Chub in Lake Erie. Elbassiouny et al. (2023, this special section) address the potential for cryptic species within the broadly distributed Silver Chub, suggesting that the Lake Erie population represents a unique conservation unit. Together, these papers will inform Canadian efforts related to the recovery of Silver Chub under the Species at Risk Act. Wildhaber and Alberts (2023, this special section) expand basic ecological knowledge by linking trophic ecology and habitat selection for Sicklefin and Shoal chubs in the Missouri River. Steffensmeier et al. (2023, this special section) develop a method for incorporating movement ecology into models describing the distribution of Prairie Chub in the Red River of the South. Perkin et al. (2023b, this special section) study longitudinal variation in size distributions of Silver Chub in the Arkansas and Ohio River basins and provide implications for management of longitudinal connectivity. Wedgeworth et al. (2023, this special section) and Perkin et al. (2023a, this special section) study flow–recruitment relationships for the Prairie Chub and

the Shoal Chub, respectively, and separately report positive correlations between streamflow variability and hatch success in regulated rivers. Nguyen et al. (2023, this special section) show that drought-mediated changes in flow regime cause reduced occurrence of pelagic-spawning species such as the Shoal Chub, with implications for managing populations under increasingly dry conditions in southern Great Plains rivers.

We hope that the papers included in this special section will inspire future work on the ecology and management of chubs. If the goal is to improve the conservation status of chubs, then identifying and reducing the factors that contribute to the trajectory of decline and mitigating their effects will be beneficial. Mitigation includes the possibility of reestablishing species into formerly occupied portions of their range after the cause(s) of decline have been managed. Because chubs inhabit large rivers that often transcend geopolitical boundaries, transboundary collaboration and cooperation at international and interstate levels will be necessary (Labay et al. 2019). Special symposia held at AFS annual meetings and special sections in AFS journals represent effective mechanisms for developing and disseminating research and management at these scales.

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## CONFLICT OF INTEREST STATEMENT

The authors have declared no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ETHICS STATEMENT

This research followed the ethical guidelines for publication of fisheries research provided by American Fisheries Society.

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