

# Adaptive Capacity of Inland Fishes Workshop Summary

Convened Nov 1-2, 2023

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Cover photo: Workshop participants.



## Introduction

Adaptive capacity (AC), defined as the ability of a species to cope with or adjust to climate change, is a critical determinant of species vulnerability and has been widely applied in wildlife contexts (IPCC 2014, Thurman et al. 2020). This process can be further defined with respect to intrinsic capacities versus extrinsic constraints on AC (Beever et al. 2016, Thurman et al. 2020). Previous applications of AC to biological systems have largely occurred through climate change vulnerability assessments (CCVAs; Thurman et al. 2020), and select examples exist in wildlife applications (Beever et al. 2023, Thurman et al. 2022). However, there is little understanding and application of adaptive capacity to inland fishes given previous emphases on trait-based approaches and population-level management. Therefore, there are substantial opportunities to improve our understanding of AC for inland fishes to explore climate impacts and the mechanisms by which interventions affect AC and resulting climate vulnerability.



To promote research partnerships exploring AC applications for inland fishes, we held an interactive, in-person workshop November 1-2, 2023, in Madison, WI for 40 researchers from universities, the U.S. Geological Survey (USGS), and other research agencies/units/programs (Appendix A). The objectives of the workshop were to: (1) discuss the application of AC to inland fisheries research and stewardship; and (2) identify information gaps and stewardship challenges to cultivate future collaborations. The intended outcomes of the workshop were to: (1) produce a summary document of current understanding, research applications, emerging fisheries research, and information gaps; and (2) identify and support participant-led collaborative initiatives (e.g., synthesis efforts, research proposals, peer-reviewed publications). This document addresses the former objective by providing a summary of information collected from attendees during the workshop. The latter objective will be addressed through follow-up work on the action items addressed herein.

## Presentations

The workshop began with a series of five presentations from attendees aimed to provide a foundation to launch interactive discussions. Dr. Lindsey Thurman (USGS Northwest Climate Adaptation Science Center) opened the workshop with a presentation titled "Persist in Place or Shift in Space? Applying Assessments of Species' Adaptive Capacity to Inform Climate Adaptation Actions." Thurman provided an overview of advancements in our understanding of species' adaptive capacity and how species' attributes are synthesized in an adaptive capacity framework (Thurman et al. 2020). Further, Thurman discussed how understanding of adaptive capacity has been used to inform conservation planning in a changing climate (Thurman et al. 2022). During her presentation, Thurman highlighted two highly relevant publications that formed the foundation for many discussions of the workshop (Thurman et al. 2020, Thurman et al. 2022).

The next presentation was given by Drs. Holly Embke and Olivia LeDee (USGS Midwest Climate Adaptation Science Center), whose talk was titled "What does adaptive capacity thinking mean for managers?" Embke and LeDee discussed the relationship between sensitivity, AC, and vulnerability to provide theoretical examples of how potential adaptation strategies may work to alter sensitivity

or AC to lead to reduced vulnerability. They highlighted three species-specific examples where exposure, sensitivity, and AC were used to inform intervention options. The speakers then provided six portfolio (i.e., multi-species) approaches managers may use depending on constraints (e.g., resources, knowledge, capacity).

The final overview presentation was given by Drs. Abby Lynch and Laura Thompson (USGS National Climate Adaptation Science Center) titled "RADaptive Capacity: how does adaptive capacity intersect with other stewardship frameworks?" Lynch and Thompson discussed the intersection of the Resist-Accept-Direct adaptation triad (framework) with AC, wherein AC can inform vulnerability assessments as well as identification of potential management options (Thompson et al. 2021). In both understanding vulnerability and determining interventions, the speakers emphasized how AC can be used to identify switch points for when it is necessary to change course. 'RADaptive' capacity triggers included changes in population abundance or demography, genetics, fitness-related traits, ranges, phenology, and resource use.

Two presentations then provided case studies of how AC has been applied. One presentation, given by Dr. Ben Zuckerberg (University of Wisconsin), focused on wildlife applications in a talk titled "Promoting the adaptive capacity of winter-adapted wildlife to climate change." Zuckerberg highlighted how developing research to understand the AC of grouse and snowshoe hares has been used to inform potential management options given loss of winter and available habitat. He highlighted that, while both grouse and hares are experiencing stress due to loss of snow cover, grouse seem to be more phenotypically plastic than snowshoe hares, thus their vulnerability to climate change may be reduced.

A presentation from Drs. Chris Caudill, Matt Keefer, and Travis Seaborn (University of Idaho, University of Idaho, North Dakota State University) highlighted an aquatic example, with a talk titled "Toward empirical assessment of AC in aquatic populations across scales: from genomes to landscapes in native rainbow trout populations in Idaho." They described a large-scale (>125 collaborators) project using a combination of genetic experiments and modeling, field-based assessments, and comparative statistical modeling to predict the AC of rainbow trout in Idaho. A key finding from this work has been that thermal conditions are not always intuitive at the local scale, such that fishes may have localized refugia not easily identified by broad analyses. Further, the speakers emphasized the interconnectedness of 'biological' AC with evolutionary and social-ecological system components (Seaborn et al. 2021).

## **Breakout Discussions**

Following presentations, participants moved into a series of interactive breakout activities. The first activity was intended to allow participants to identify shared interests for further breakout work later in the day. This activity involved six stations wherein participants spent 10 min at each station to discuss a variety of questions with 1-2 participants, then rotated to another station. Questions included:

- What has inspired you from the workshop so far? What do you want to learn more about?
- What do you hope we achieve in fisheries research in the next 5 years related to AC?
- What type of collaboration (related to AC) interests you (e.g., foundational science, applied science, vulnerability assessment, synthesis)?

Following the first activity, interested participants were asked to pitch an idea they would be

interested in discussing further during the group breakout session. Approximately 10 participants shared ideas, which were synthesized into six groups for breakout discussions (see Information Gaps & Next Steps, below). During breakouts, groups were asked to develop an action plan for follow-on work based on their in-workshop discussion. Elements of the action plan included a problem/issue statement (2-3 sentences), key partners, key stakeholders/rightsholders, an objective (1-2 sentences), the approach (3-5 sentences), deliverables (2-4 sentences), time frame, and team members (including proposed responsibilities). The workshop agenda is provided in Appendix B.



## Information Gaps & Next Steps

Through this workshop, participants identified many information gaps related to increasing our understanding and application of AC in fisheries research and stewardship. For example, many participants discussed how trait-based approaches are commonly used in fisheries contexts, however they rarely consider adaptive capacity and links to climate vulnerability.

Specifically, in the last break out, participants identified several follow-on interests, including:

- Tailoring AC for freshwater organisms – POC: Holly Embke
- Habitat & AC linkages – POC: Travis Seaborn
- Cisco reintroduction & AC – POC: David “Bo” Bunnell
- AC, genetics, & small populations – POC: Amanda Ackiss & Sarah Fitzpatrick
- AC for fisheries management – POC: Cindy Chu
- Scalability of AC – POC: Lindsey Thurman

In summary, the workshop “Adaptive Capacity of Inland Fishes” brought together a diverse group of researchers spanning expertise to further our understanding and application of AC to inland fishes. From this expanded understanding and new relationships fostered AC, we anticipate multiple peer-reviewed publications as well as research proposals aimed at furthering the incorporation of AC use for inland fisheries.

## Literature Cited

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## Appendix A. Attendees

First	Last	Organization	Email
Amanda	Ackiss	USGS Great Lakes Science Center	aackiss@usgs.gov
Karen	Alofs	University of Michigan	kmalofs@umich.edu
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Ben	Zuckerberg	University of Wisconsin - Madison	bzuckerberg@wisc.edu

## Appendix B. Workshop Agenda

Day 1		
1:00 - 1:30pm	<b>Opening</b> <ul style="list-style-type: none"> <li>• Introductions</li> <li>• Goals for the workshop</li> </ul>	Doug Beard Holly Embke Olivia LeDee
1:30 - 4:30pm	<b>The Concept of Adaptive Capacity and Relevance for Inland Fishes</b>	
	How does adaptive capacity relate to known concepts and use of traits, vulnerability, exposure, sensitivity? What does adaptive capacity science look like now? (40 min.)	L. Thurman
	Questions (10 min.)	
	Adaptive capacity & wildlife applications (30 min.)	B. Zuckerberg
	Questions (10 min.)	
	Break (10 min.)	
4:30 - 5:00pm	What does adaptive capacity thinking mean for managers? (30 min.)	H. Embke, O. LeDee
	Questions (10 min.)	
5:30pm	How does adaptive capacity intersect with other stewardship frameworks? (30 min.)	A. Lynch
	Questions (10 min)	
4:30 - 5:00pm	<b>Discussion + Setting stage for next day</b>	
5:30pm	<b>Social + dinner</b>	

Day 2		
8:30 - 9:00am	<b>Refresh previous day</b>	
9:00 - 10:00am	<b>Fish Applications (virtual)</b>	T. Seaborn, M. Keefer, C. Caudill
10:00 - 10:30am	<b>Panel: Day 1 &amp; 2 speakers</b>	
10:30 - 11:30am	<b>BREAK</b>	
11:00am - 12:30pm	<b>WORKING LUNCH (speed dating)</b>	
12:30 - 1:30pm	<b>Move to breakouts</b>	
1:00 - 3:30pm	<b>Breakout work</b>	
3:30 - 4:00pm	<b>Activity to share ideas</b>	
4:00 - 4:30pm	<b>Reflection/discussion/next steps</b>	