

Water Quality and Indigenous Knowledge

The primary learning objectives of this module are for students to be able to:

- Analyze the relationship between Indigenous Knowledge, community values, and ecological monitoring
- Discuss how community values can be incorporated into data science

Assigned reading

Please read and be prepared to discuss “[A global assessment of Indigenous community engagement in climate research](#)” (David-Chavez and Gavin 2018). To facilitate classroom discussion, please also read the Case Study in the module below before the start of class.

Discussion (1)

In groups of 3 or 4 discuss the paper assigned before class and answer the following questions:

- In this context, what is Indigenous Knowledge? What forms does it take?
- What are the different metrics the authors use to assess Indigenous engagement in research?
- What characteristics of successful Indigenous participation in research do the authors identify? Where do the authors suggest future researchers should focus their efforts?

Record your group’s answers to the above questions. Return to the full class and have each group share their thoughts.

Case study

While Indigenous Knowledge has historically been undervalued by ecologists due to the marginalization of the communities which produce it (Rattling Leaf Sr 2022), these knowledge systems have immense inherent value and applicability to ecological problems (Kimmerer 2002, Whyte 2018). Here, we use a definition of Indigenous Knowledge as “dynamic systems of knowledge collectively held by Indigenous community members that draw from intergenerational, place-based, culturally embedded relationships and experiences” as written by Indigenous researcher Dominique David-Chavez and Michael Gavin (David-Chavez and Gavin 2018).

Indigenous Knowledge and Western scientific approaches have long been separate, parallel intellectual traditions, but the harmonization of the two can produce more effective research and management outcomes (Dawson et al., 2021). For this collaboration of knowledge systems to produce positive impacts, the research must be a joint effort; where scientists, decision-makers, and affected communities work together to define the problems and approaches to solving them.

Indigenous Knowledge and values directly inform the needs of Indigenous communities (Whyte 2018). In spite of this, there is a lack of incorporation of community input into ecological monitoring (David-Chavez and Gavin 2018). For example, the U.S. Environmental Protection Agency (EPA) has been working with tribes for decades to strengthen protection of Tribal water by monitoring water quality (e.g., water temperature, dissolved oxygen, pH, etc.), but these conservation efforts have largely failed to incorporate cultural values. Tribes are required to submit an annual Quality Assurance Action Plan (QAAP) that must describe how long-term monitoring efforts will be undertaken at each location, and how the data will be stored and analyzed. For Indigenous communities, these reports are often produced via a costly outsourcing of data analysis to scientists trained in Western scientific methods, because Tribal members may not be adequately trained in quantitative scientific methods. This results in reports that do not reflect the values of the Tribal land for which the EPA report was prepared, and disregards important qualitative metrics such as cultural and spiritual value (e.g., food and medicinal resources and ceremonial priorities).

The EPA only considers quantitative metrics of site performance when prioritizing sites for conservation. Sites with higher water quality from this perspective are thus assumed to be more important and given greater prioritization for conservation efforts, as they serve as reference points for more degraded sites. This analysis does not address the full breadth of Indigenous Knowledge, ignoring important components such as cultural and spiritual practices and traditional food gathering, as well as cultural awareness of the historical ecological conditions and biota of the area. As a result, Tribes do not have a means to communicate to the EPA what is important to them, and sites that are important culturally may not be given the same protection as those that are identified using only the EPA assessment of physical, chemical, and biological variables. In short, Western scientific approaches fail to embrace the Native world view, even when engaging Native communities in mandatory reporting procedures, and this negatively impacts research and management results.

Here we use the specific example of EPA water monitoring on a reservation to explore the relationship between data collection, Indigenous Knowledge, and community values. This case study uses a thought experiment of a fictional Indigenous community and the monitoring of its water resources as an example 10 years of

TIEE

Teaching Issues and Experiments in Ecology - Volume 19, December 2023

simulated water temperature data at five monitoring sites, each of which is in the proximity of a site of cultural importance.

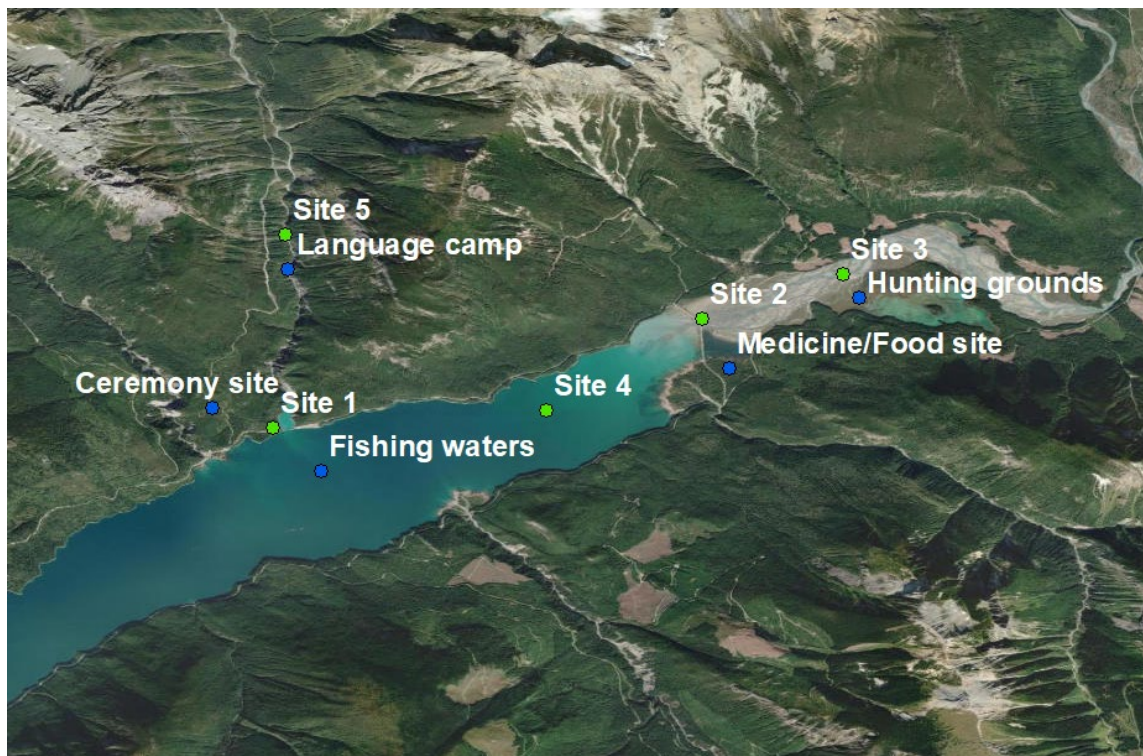


Figure 1: Map of the cultural sites and associated monitoring stations in this fictional case study.

In this case study, members of the fictional Indigenous community were surveyed, with each being asked to rank the five sites based on perceived importance in terms of cultural and spiritual value. The fictional land in this case study represents a target ecosystem and community with cultural values and Indigenous Knowledge for ecological monitoring and management, with the poll representing one possible way of identifying community values.

Two plots were then made to visualize the data: water temperature of each site over time (Figure 2a) and the average ranking of each site's cultural importance plotted against average water temperature (Figure 2b). Water temperature is a convenient aspect of water quality to monitor because it is easy and inexpensive to measure, and it has wide-ranging effects on the biology and chemistry of the system. For example, the solubility of dissolved oxygen (an important resource for aquatic organisms) decreases with increases in water temperature, which can play an important role in making bodies of water less suitable for certain aquatic organisms. Likewise, increases in water

TIEE

Teaching Issues and Experiments in Ecology - Volume 19, December 2023

temperature can lead to certain organisms growing faster, or having altered sex ratios; for example, some turtles produce more female offspring in warm water. In general, an increase in water temperature may be associated with a decrease in water quality or habitat suitability for culturally important organisms. However, water temperature is only one of many parameters that interact to shape water quality. Think to yourself: are there other important qualitative or quantitative metrics of water quality that are important for you to use water resources? Which of these would be easy to measure for an EPA report? Which might be better characterized by Indigenous Knowledge or personal knowledge of a system?

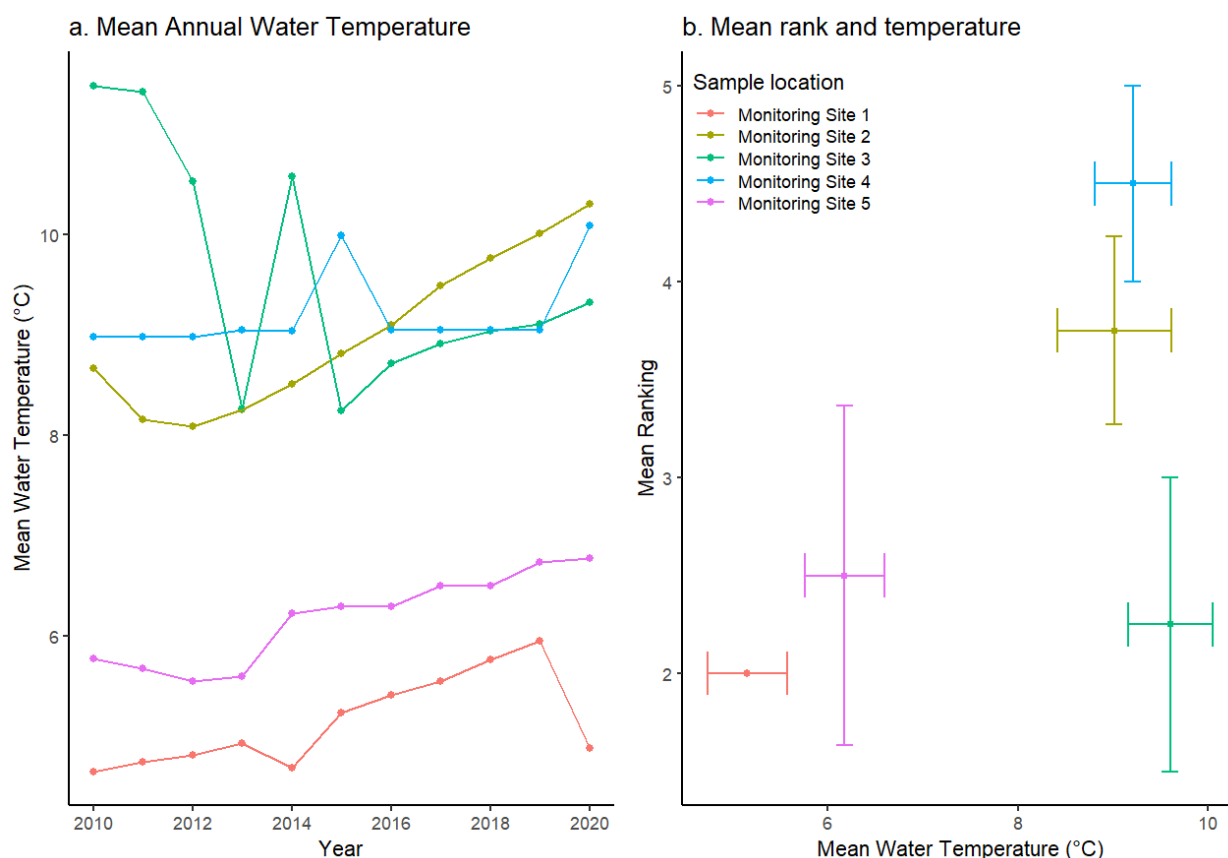


Figure 2a: Time series of water temperature at each site over time. Figure 2b: Mean water temperature plotted against mean site ranking (1 lowest, 5 highest). The horizontal line through each point represents the standard error of the temperature observation, and the vertical line is the standard error of the community ranking.

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Discussion (2)

Examine the above figures and answer the following questions individually:

- What visual evidence is there for rising temperatures, and how could you confirm this? What cultural sites are associated with the rising trendlines? Are these trends potentially concerning for the community?
- Describe the axes of Figure 2b. What relationships can you identify between the axes? Are the sites that were identified as most important based on water quality also most important to the community? How much uncertainty is there surrounding these observations, and how might that affect decision making?

Returning to the small groups:

- Using the answers from the above two questions, assess the trajectory of the sites identified as most important, and if the water quality at those sites is of potential concern.
- Using the scale in Figure 3, identify the level of community participation in the above scenario. Discuss any positive or negative consequences of the level of community participation that you identified.

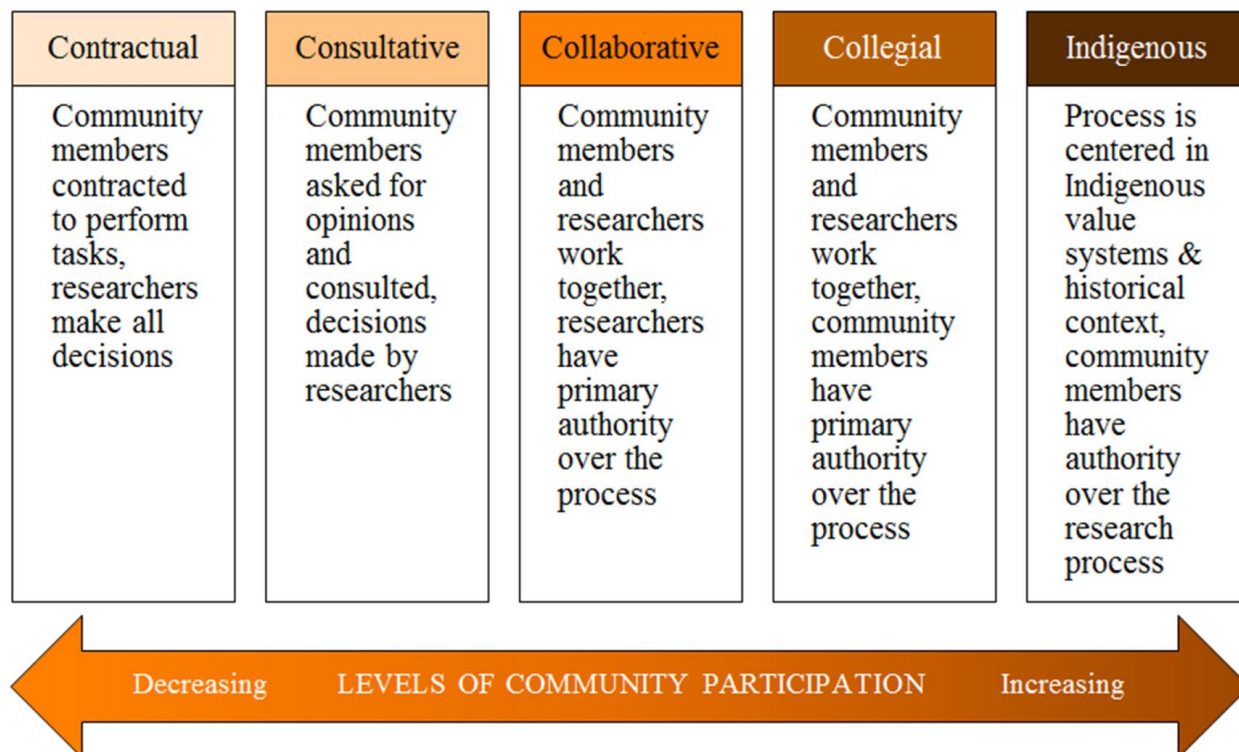


Figure 3: Scale of the level of community participation in a research project.

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- Rattling Leaf Sr, J. 2022. What is Traditional Ecological Knowledge and why does it matter? *Frontiers in Ecology and the Environment* 20:3. <https://doi.org/10.1002/fee.2465>
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