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Research, part of a Special Feature on Collaborative Management, Environmental Caretaking, and Sustainable Livelihoods

Community-engaged participatory climate research with the Pyramid Lake Paiute Tribe

Schuyler Chew and *Karletta Chief*[1]

ABSTRACT. Climate change's threat to the identity, culture, economy, and livelihoods of the Pyramid Lake Paiute Tribe (PLPT) can be better understood through community-engaged participatory methods. Our research team of Indigenous and non-Indigenous scientists formed a tribal-university partnership with the PLPT Council to understand how climate change and upstream pressures threaten PLPT ecosystems, lands, and resources. The objectives are to: (1) consider how decolonizing, Indigenizing, and participatory methodologies can inform climate research engagement between scientists and Indigenous partners; (2) understand PLPT perspectives of climate change impacts and priorities for climate research; and (3) engage the PLPT community in climate change discussion. Working with the PLPT Natural Resources Department, in accordance with PLPT research protocols, we convened a community-driven climate workshop in which environmental managers and community members identified environmental challenges, affected stakeholders, and potential solutions. The workshop participants emphasized the importance of water, culturally significant species, and the role of community in climate adaptation. These community-identified priorities highlighted the need to develop interpretive climate resources for community members, including a video summary of fish ecology. Overall, our collaboration with the PLPT benefited from greater community involvement, increased awareness of PLPT commitment to climate research, an iterative engagement process, prioritization of community perspectives, and incorporation of PLPT feedback on research outcomes. From our positionality as Indigenous environmental scientists, we conclude that decolonizing, Indigenizing, and participatory action approaches to climate research with Indigenous partners should strive for accountability to community research protocols and priorities; practical and useful outcomes; and empathetic and respectful engagement with research participants.

Key Words: *climate change adaptation; decolonizing methodologies; Indigenous; participatory action research; Pyramid Lake Paiute Tribe*

INTRODUCTION

Climate change impacts on Indigenous Nations and tribes in the U.S., which are severe and add complexity to ongoing challenges, must be understood in the context of centuries-long and ongoing settler colonial, capitalist, and industrial expansion (Redsteer et al. 2013, Gamble et al. 2016, Norton-Smith et al. 2016, Whyte 2017). Indigenous Nations have been proactive in adapting their economies, agriculture, livelihoods, infrastructure, ecosystems, and community well-being to the challenges of settler colonialism and must consider how to build resilience to prolonged droughts, reduced mountain snowpack, intensifying wildfires, extreme storm events, and flooding, among other climatic shifts (Bennett et al. 2013, Cozzetto et al. 2013, Chief et al. 2016, Gamble et al. 2016, Norton-Smith et al. 2016). Considering that only a handful of 574 federally-recognized U.S. tribes have developed climate change plans, there is a critical need for Indigenous-focused climate adaptation resources (Bennett et al. 2013, Black et al. 2015, Marchand et al. 2017, Bureau of Indian Affairs 2020).

Collaboration with research partners is crucial for tribes committed to climate adaptation (Bennett et al. 2013, Whyte 2013, Williams and Hardison 2013, Whitney et al. 2020). However, tribal leaders may be cautious of researchers and institutions, which often fail to "respect Indigenous cultural contexts, histories of interactions with settler governments and researchers, and the current socio-economic and political situations in which Indigenous peoples are embedded" (Chief et al. 2016:1). Research outcomes often inequitably favor institutional priorities over the communities' own vision for self-reliance, sustainability, and adaptation (Cochran et al. 2013). Further, many Indigenous-focused climate studies "practice an extractive model in which outside researchers use Indigenous knowledge systems with minimal participation or decision-making authority from communities who hold them" (David-Chavez and Gavin 2018:1). To overcome such inequities, ethical collaboration with Indigenous Nations requires much effort on the part of researchers to ask about ethics, do more listening, follow tribal research protocols, and give back to the community (Chief et al. 2016).

Decolonizing, Indigenizing, and participatory action methodologies offer alternative paradigms for Indigenous climate research. Decolonizing methodologies refer to respectful and reciprocal approaches to research that strive to deconstruct colonizing practices and promote Indigenous self-determination (Battiste 2008, Kovach 2009, Smith 2012, Wilson 2014, Stanton 2014). In addition, Indigenizing methodologies center Indigenous approaches to research and epistemological knowledge (Tsosie and Claw 2019). Participatory action research encourages both researchers and participants to "develop goals and methods, participate in the gathering and analysis of data, and implement the results in a way that will raise critical consciousness and promote change in the lives of those involved" (Kidd and Kral 2005:187).

These approaches informed our collaborative climate research with the Pyramid Lake Paiute Tribe (PLPT), a federally recognized tribe in northern Nevada (Fig. 1). The PLPT adaptively manages a robust fishery at Pyramid Lake to preserve the threatened Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) and endangered cui-ui (*Chasmistes cujus*) for future generations. As climate change and settler colonialism in the Truckee River Basin threaten their identity, culture, economy, and livelihoods, the PLPT Council remains committed to understanding and persevering through these uncertainties.

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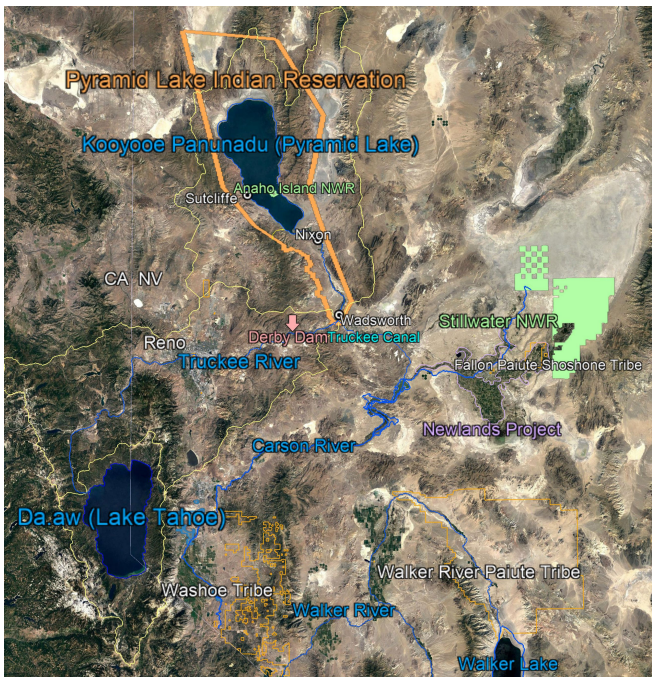
Fig. 1. Map of the Truckee River Basin and Pyramid Lake Indian Reservation. This map displays the boundaries of the upper (*Da.aw*, Lake Tahoe), middle, and lower (*Kooyooe Panunadu*, Pyramid Lake) Truckee River Basin in yellow; the Pyramid Lake Indian Reservation boundary in light orange; the Pyramid Lake Paiute Tribe's communities of Sutcliffe, Nixon, and Wadsworth, boundaries of nearby tribal nations outlined in orange; National Wildlife Refuge areas in green; the approximate boundaries of the Newlands Project are purple; and Derby Dam, Truckee Canal, Carson River, and Walker River are also shown. We recognize that this incomplete map does not fully reflect how *Kooyooe Tukadu*, *Numu*, *Nuwu*/*Nuwuvi*, *Newe*, and *Wašiw*/*Wašišiw* peoples have maintained ties to this region from time immemorial.



Throughout this paper we refer to the Pyramid Lake Paiute Tribe or PLPT, which is the tribe's contemporary title, and acknowledge that the Pyramid Lake Paiute call themselves *Kooyooe Tukadu* or cui-ui eaters. PLPT and other Indigenous peoples in the region have their own Indigenous names to people, places and living entities; e.g., *Kooyooe Panunadu* is the *Kooyooe Tukadu* name for Pyramid Lake and *Da.aw* is the *Wašiw*/*Wašišiw* name for Lake Tahoe (Fig. 1). Today, however, place names and geopolitical boundaries imposed by settler colonization are prominent: e.g., Pyramid Lake Indian Reservation, Truckee River Basin, Nevada, etc. We recognize that Figure 1 is an incomplete map and does not fully reflect how *Kooyooe Tukadu, Numu, Nuwu*/*Nuwuvi, Newe,* and *Wašiw*/*Wašišiw* peoples have maintained ties to this region from time immemorial.

Members of our research team conducted climate research focused on the PLPT and other Nevada tribes. Gautam et al. (2013) evaluated socioeconomic factors, access to resources, equity, and sustainability to conclude that PLPT is a highly resilient tribe with an adaptive capacity that could be strengthened by a diverse portfolio of management alternatives. Smith et al. (2014) conducted a comprehensive comparison of surveys with Nevada tribal members (N = 524, a majority of whom were PLPT members) and rural citizens of Nevada. Overall, tribal respondents were keenly aware of human-induced climate change, deeply concerned about environmental challenges on tribal lands, and eager for federal action on climate change (Smith et al. 2014). As a result of these findings, our research team secured federal funding from the U.S. Geological Survey Southwest Climate Adaptation Science Center and U.S. Department of Agriculture National Institute of Food and Agriculture to engage further on climate research with the PLPT.

From our positionality as Indigenous environmental scientists, we explore how decolonizing, Indigenizing, and participatory action research methodologies, in which Indigenous Nations and researchers participate as equal partners in climate projects, promote accountability to tribal priorities, reciprocity, and greater community investment in co-developing climate solutions. As members of a team of Indigenous and non-Indigenous university and agency scientists, we established a tribal-university climate research partnership with the PLPT Council. The objectives are to: (1) consider how decolonizing, Indigenizing, and participatory methodologies can inform climate research engagement between scientists and Indigenous partners; (2) understand PLPT perspectives of climate change impacts and priorities for climate research; and (3) engage the PLPT community in climate change discussion. We use the term community to refer to stakeholders of the PLPT, including the Pyramid Lake Paiute Tribal Chair and Council members, enrolled members, residents, staff (both Indigenous and non-Indigenous), and other individuals who engaged in the research. Through a community-engaged approach to climate research, we conducted a participatory climate change workshop, identified PLPT priorities for research, and developed an educational video. Although this project focuses on PLPT climate planning, our approach to collaboration has implications for Indigenous Nations and climate researchers.

BACKGROUND

Former PLPT Council Chair Joe Ely asserts that the *Kooyooe Tukadu* people, cui-ui, and Pyramid Lake "become the three components that give name and identity to the Pyramid Lake Paiute Tribe" and "if one of the components is lost, the identity from creation and an immemorial tradition is completely erased" (Ely 1992:62). *Kooyooe Tukadu* oral tradition tells of the Stone Mother, a tufa rock formation resembling a woman holding a basket, whose tears for her children created *Kooyooe Panunadu* or the cui-ui standing water. *Kooyooe Tukadu* Indigenous knowledges directly inform PLPT governance and natural resource management efforts, which prioritize protection of Pyramid Lake, ecosystems, and environments (Carey 2016). Concurrently, other knowledge communities from Western science remain integral to PLPT's resilient management of Pyramid Lake. Geological investigations describe that Pyramid Lake emerged from the receding waters of Pleistocene Lake Lahontan 10,000 years ago (Morrison and Frye 1965, Born and Ritter 1970). The tufa rock formations that remain central to *Kooyooe Tukadu* oral history are believed to have formed from alkaline deposition of calcium carbonate that mixed with receding waters of Lake Lahontan. Pyramid Lake is a unique

desert terminal lake fed by the Truckee River, which begins 120 miles upstream in the Sierra Nevada Mountains at Lake Tahoe. As an alkaline (pH 9.5) and moderately saline lake, the elevation of Pyramid Lake is determined by the Truckee River, perennial streams, precipitation, groundwater, and surface evaporation (Wagner and Lebo 1996).

The threats of climate change on the PLPT cannot be understood as separate from settler colonial violence upon *Kooyooe Tukadu* since the nineteenth century (Whyte 2017). John Frémont, leading an expedition in 1844, encountered the *Kooyooe Tukadu* and imposed the name Pyramid Lake for the massive tufa Pyramid formation (Wagner and Lebo 1996). Settler intrusion into *Kooyooe Tukadu* homelands culminated in the Paiute War of 1860 and led to decades of violence perpetrated by the U.S. government (Mergen 2014). Federal policies sought to sever *Kooyooe Tukadu* relationships to their lands, livelihoods, and identity. Government agents forced the community to replace traditional lifeways with agriculture and ranching. *Kooyooe Tukadu* children were forced to attend Stewart Indian School and other military-style boarding schools, which severed intergenerational bonds, disrupted the transmission of language and knowledge, and left an enduring legacy of trauma and public health crises that continue today (Mergen 2014, Winder 2017).

The *Kooyooe Tukadu* have contended with colonization of their water resources by settlers, private entities, California, Nevada, and the U.S. since the late nineteenth century. As early as 1905, the U.S. Reclamation Service (later renamed the U.S. Bureau of Reclamation) completed Derby Dam on the Truckee River, the first major irrigation project in the west (Springmeyer 2011). Derby Dam prevented water from reaching Pyramid Lake by diverting 50% of Truckee River flow to the Carson Basin via the 32-mile-long Truckee Canal to irrigate the Newlands Project (Cosens 2008, Wilkinson 2010). As a result, water quality deteriorated, the Pyramid Lake strain of Lahontan cutthroat trout was extirpated, Winnemucca Lake dried into a playa, and Pyramid Lake dropped 26.2 m (86.1 ft) by February 1967 (Wagner and Lebo 1996, Dawson et al. 2003, Wilkinson 2010, Springmeyer 2011). Upon formal establishment in 1936, the Pyramid Lake Paiute Tribal Council demanded the federal government secure tribal water rights and prevent excessive diversions at Derby Dam (Rusco 1988). The PLPT Council spent decades advocating for their entitlement to water rights through litigation, collaboration, and stakeholder negotiations. The Pyramid Lake ecosystem has recovered significantly through PLPT governance and natural resource management that prioritize preservation of Pyramid Lake over other forms of economic development of the lake's shoreline and sacred areas (Carey 2016).

METHODS

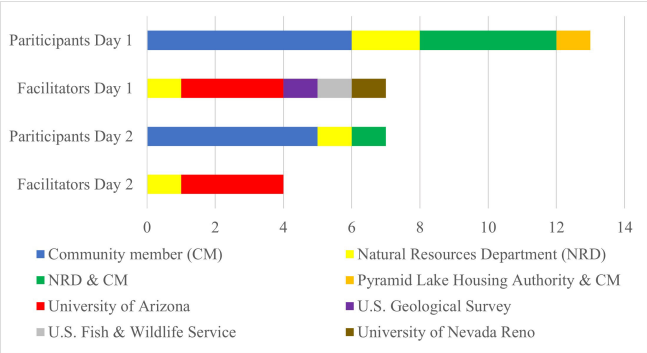
Research partnership with the PLPT

This research is approved by the Pyramid Lake Paiute Tribal Council. Lead principal investigator Karletta Chief began nurturing a partnership with PLPT in 2009 that involved learning from PLPT leaders and cultural experts, field visits, community visits, educational outreach at K–12 PLPT schools, and co-hosting workshops to identify PLPT climate research priorities. These engagements resulted in a formal research agreement established between our research team and the PLPT Council. Our research team submitted the research protocol to the University of Arizona Human Subjects Protection Program and Institutional Review Board, which deemed the project as exempt (i.e., the project qualified as human research of low-risk and thus was not subject to further federal regulations).

Participatory climate change workshop

A two-day participatory climate change workshop was co-designed by the research team and PLPT Natural Resources Department (NRD) to create a space for PLPT staff and community members to identify environmental challenges, ecological indicators, and management alternatives (Chief et al. 2015). The workshop was held in September 2013 in Nixon, Nevada, on the Pyramid Lake Indian Reservation. Three members of our research team facilitated the participatory workshop and 13 PLPT staff and community members attended (Fig. 2; Chief et al. 2015).

Fig. 2. Affiliations of workshop participants and facilitators.



The participatory workshop engaged participants in an iterative, five-step brainstorming process to identify challenges or problems affecting PLPT environment, water, and community and priorities for research (Fig. 3). Participants wrote ideas on large adhesive notes, presented their ideas to the group, collectively decided on categories, and assigned priority to the categories through anonymous voting. Participants also listed any stakeholder groups that were associated with the issues. The same activities were carried out to identify natural indicators to understand climate change and potential solutions to environmental challenges. The workshop included interactive presentations by the research team about previous climate research with the PLPT (Gautam et al. 2013, Smith et al. 2014). Three invited scientists from the U.S. Geological Survey, U.S. Fish and Wildlife Service, and University of Nevada, Reno also gave presentations on wildlife and rangeland conservation efforts at Pyramid Lake. (Gautam et al. 2013, Smith et al. 2014). We applied the priorities determined by workshop participants to guide our research and development of outreach tools. Although our research team consisted of Indigenous and non-Indigenous scientists from outside the community, we collaborated with the NRD to design an interactive workshop that highlighted the PLPT's collaborative engagement with agencies and research institutions and created opportunities for staff and community members to contribute to these ongoing natural resource research efforts.

Fig. 3. Five-step, iterative brainstorming process used at the workshop.

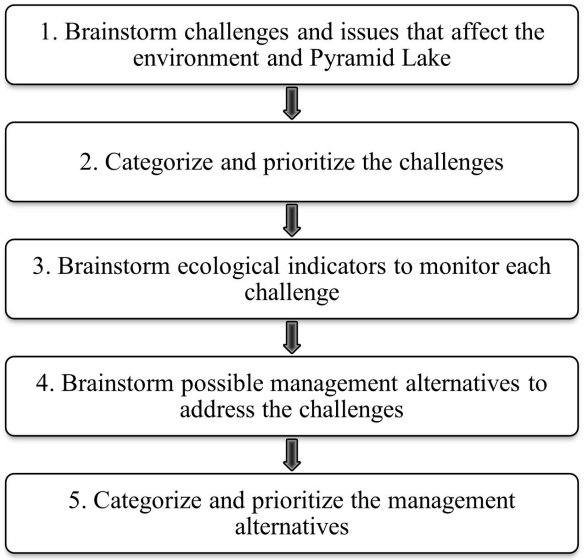
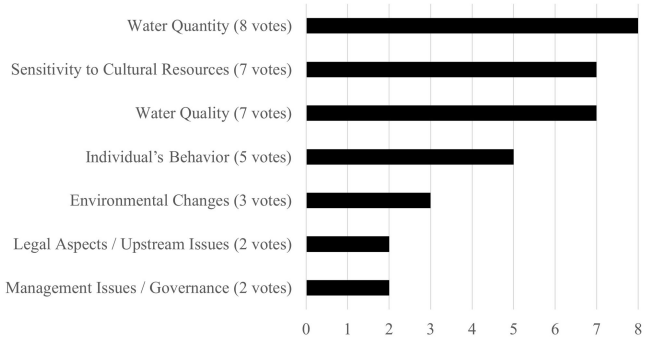


Fig. 4. Categories of issues facing Pyramid Lake ranked by workshop participants.



DISCUSSION

Outcomes of participatory climate change workshop

The participatory climate change workshop offered extensive insight on the perspectives of PLPT environmental managers and community members relating to climate change. Participants identified 31 environmental challenges facing Pyramid Lake and organized them into seven categories (Fig. 4). In addition, participants identified numerous stakeholders that were impacted by and/or could help influence outcomes related to these challenges (Table 1). The table lists impacted stakeholders with an asterisk (*), influential stakeholders with a caret (^), and those who are both impacted and influential with an asterisk and caret (*^). Participants came up with 17 ecological indicators to better understand and monitor environmental challenges and organized them around three categories (Table 2). Ultimately, the participants proposed 29 potential management alternatives or solutions to the environmental issues facing Pyramid Lake and organized these solutions into eight categories (Fig. 5).

The top three categories of environmental challenges identified by workshop participants included "water quantity," "water quality," and "sensitivity to cultural resources." Although a wide variety of stakeholders were discussed in relation to the challenges, "community" was linked to all seven categories. The participants emphasized the need to monitor ecological indicators related to "water quantity," "water quality," and other "environmental changes." The top three categories of solutions proposed by the participants included "water quality," "education and outreach," and "sensitivity to cultural resources/individual behavior." The workshop results directed our research focus toward developing an educational video for community members. Specifically, the team sought to explore how climate change impacts to water quantity and water quality could affect PLPT cultural resources and livelihoods. Overall, we were and remain inspired by community members' eagerness to devise and enact innovative solutions to environmental challenges at Pyramid Lake in just two days. As such, we believe that it is important to share our research approach with a broader audience of climate resilience scholars and practitioners in the hopes that meaningful research engagement might take place in other communities.

Video of fish survival in Pyramid Lake

Based on the workshop participants' interest in water and cultural resources, we conducted a literature review on the threatened Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) and endangered cui-ui (*Chasmistes cujus*). Because the survival of these fish species has significant implications for PLPT culture and economy, we focused on how Truckee River and Pyramid Lake hydrology are linked to the life cycles of these fish. The literature review explored (1) how each species responds uniquely to temperature changes in Pyramid Lake, (2) the springtime migration habits of the cui-ui in the lower Truckee River, and (3) the ideal conditions for cui-ui spawning. We further identified ecological indicators of these species related to climate change. To share the findings with PLPT community members, we summarized the literature review in a video presentation and uploaded it to YouTube on 15 January 2014. In October 2018, the Pyramid Lake Museum & Visitor Center staff was showing the video to its visitors. The video had received over 8700 views as of February 2022.

Community-engaged frameworks for Indigenous climate research

Decolonizing methodologies, Indigenizing science, and participatory action research provide frameworks for collaborative and community-engaged Indigenous climate research. Through a decolonizing approach, we established a research partnership that prioritizes Indigenous cosmologies and frameworks and defers to Indigenous institutions regarding the protection of knowledge, sovereignty, and community well-being (Smith 2012, Chief et al. 2016). We used participatory action research methods to empower tribal citizens as active partners, enable them to identify locally-relevant solutions, and support PLPT goals of resilience, sustainability, and community well-being through collaboration at all steps of the research process (Cornwall and Jewkes 1995, Arnold and Fernandez-Gimenez 2007, Bell et al. 2012, Shirk et al. 2012). Indigenizing science is an emerging methodological approach to research that centers

Table 1. Stakeholder groups connected to the issues and challenges according to workshop participants. Impacted stakeholders are indicated with an asterisk (*), influential stakeholders with a caret (^), and those who are both impacted and influential with an asterisk and caret (*^).

Stakeholders impacted by issues*	Water quantity	Water quality	Environmental changes	Legal aspects and upstream	Sensitivity to cultural resources	Individual's behavior	Management and governance	Stakeholders who can influence outcomes^
Community	Community*	Community*	Community*	Community*	Community*	Community*	Community*	
Pyramid Lake Paiute Tribe (PLPT)	PLPT*	PLPT*	PLPT Environmental Department^	PLPT^		Requirements for PLPT administrative positions^	Tribes union lobby^	Pyramid Lake Paiute Tribe (PLPT)
Ranchers	Ranchers*	Ranchers*	Ranchers / livestock*					
Pyramid Lake fisheries	PL fisheries*	PL fisheries*						
Fish	Fish*	Fish*						
Fishing activities	Fishing activities*	Fishing activities*						
Recreation activities	Recreation activities*	Recreation activities*						
Economic stakeholders	Economic stakeholders*	Economic stakeholders*						
Farmers	Farmers*	Farmers*						
Wells	Wells*	Wells*						
Upstream users	Municipal and industrial*	Municipal and industrial*						Upstream users
	Developers upstream*	Upstream users compliance^		Reno-Sparks government^				
	Upstream users^			Truckee-Carson Irrigation District^				
Animals / wildlife			Animals / wildlife*					
Cultural resources			Cultural resources*					
Traditional artisans			Traditional artisans*					
Traditional knowledge keepers			Traditional knowledge keepers*					
Elders			Elders*^		Elders^			Elders
			Youth^		Children^			Youth
	Educators^				Native culture / heritage educators^	Department of Education^		Educators
	Truckee Meadows Water Authority^	Water treatment authorities^	Environmental management^	State Water Department^			Rural Health Authority^	Agencies
	Demand management landscapers^	Regulatory agencies^						Regulatory agencies
	Downstream users^							Downstream Users
	Reforestation groups^							Reforestation groups
	Courts^							Courts
		Emergency response^						Emergency response
			Tribes nearby^	Eastern Nevada, Las Vegas^				Network with other Tribes
			Research institutions^					Research institutions

Indigenous approaches and epistemological knowledge (Tsosie and Claw 2019). By collaborating with the PLPT NRD to design the workshop, we found that community members were given space to discuss environmental challenges and solutions based on their own culturally-informed understandings of connections between the people, fish, lands, and waters.

We sought to build upon the PLPT Council's longstanding commitment to adaptive planning through a research partnership centered around PLPT oversight, community engagement, transparency, and trust building (Fig. 6). This diagram illustrates our iterative process of collaboration, with blue arrows depicting research actions taken by our team, yellow arrows reflecting steps taken to revise our research after review by the PLPT Council, and green arrows representing research actions that received PLPT Council approval. We submitted a formal research agreement detailing the specifics of the project and subsequent research materials to the PLPT Interdisciplinary Review Team (IDT) for review and approval by PLPT Council. The iterative process began with obtaining a letter of support from the Chair of the PLPT Council.

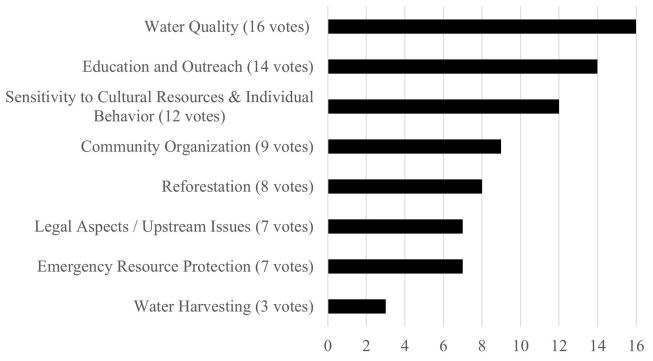
All research-related discussions took place between the research team and a liaison designated by the PLPT NRD. Transparency was emphasized through updates and presentations to the PLPT Council, NRD, and community. All summaries of the research were submitted for review and approval by IDT and the PLPT Council prior to sharing with external entities.

Further, we endeavored to conduct research *by and with* rather than *for or about* the PLPT community. This shifted our attention to building local capacity among community members and PLPT staff to contribute to PLPT climate research, maintaining credibility and trust with the PLPT Council, and putting knowledge to use for social change through practical outcomes, e.g., reports to PLPT leadership and the educational video (Wulfhorst et al. 2012). Tribal participatory research provided further insight to our approach as we sought to involve community members, protect tribal interests, and promote tribal autonomy over management decisions (Fisher and Ball 2003, Chief et al. 2016). Considering how Indigenous partners can be taken advantage of when they are treated merely as sources of data, we prioritized community-driven research through the participatory climate change workshop. Further, our iterative process of engagement and oversight (Fig. 6) pushed us to remain accountable to PLPT Council's research priorities and consider each participant's contribution to the research as significant and worthy of respect (Battiste 2008, Wilson 2008, Kovach 2009, Ferreira and Gendron 2011, Williams and Hardison 2013, Datta et al. 2015, Klenk et al. 2017).

Table 2. Ecological indicators to monitor issues and challenges according to workshop participants.

Category	Ecological indicator
Water quantity	Lake level Snow pack Spring flow rate and duration Water table height Upstream reservoir storage
Water quality	Water temperature Dissolved oxygen Concentration of calcium carbonate Total dissolved solids Nutrients Cyanotoxins (blue-green algae)
Land cover change, habitat loss, environmental changes	Bird count, wildlife census Botanical census Annual migration count of cui-ui Benthic surveys CREEL - count of fishing (stations) Particulate matter, aerosols

Fig. 5. Categories of potential solutions ranked by workshop participants.



Improving PLPT participation in research activities

Throughout the course of the study, more and more community members and staff contributed to the research in new and robust ways. Initial engagement was solely with PLPT NRD staff members who assisted with recruiting participants, logistical support, and PLPT community engagement expertise. At the workshop, attended by PLPT staff and community members, the quality of engagement shifted from consultation (e.g., planning and workshop development) to collaboration and knowledge coproduction (e.g., brainstorming and prioritizing research foci). Increased participation led to a greater breadth and depth of information about climate change impacts and adaptation capacity. Further, broad participation by many constituents of the community shed greater light on how climate change affects specific stakeholders. This finding encouraged us to consider interviews and focus groups with a diversity of PLPT stakeholders.

Raising awareness of PLPT climate change research

Increased participation in the research activities also raised awareness of the project throughout the community. Shortly after the workshop, the PLPT NRD co-hosted a climate change training workshop for Great Basin tribes with the Institute for Tribal Environmental Professionals. PLPT staff organized a day-long visit to various PLPT facilities and presented at length about the PLPT's longstanding adaptation efforts to restore their fishery and ecosystem. Engaging with multiple research partners reflects the PLPT's progressive approach to adaptation planning through collaboration. These efforts increased awareness, participation, and buy-in of adaptation efforts among PLPT community stakeholders.

Building trust through iterative engagement and oversight

Throughout this study, it was important to consider our positionalities as Indigenous environmental scientists who are highly motivated to work with Indigenous communities to support practical and culturally relevant solutions to tribal environmental issues. In this way, Indigenous environmental scientists and their allies are providing key leadership for decolonizing and Indigenizing the questions, methodologies, and outcomes centered in research (e.g., Harangody et al. 2022). As more community members and staff contributed their expertise and knowledge to the study, our research team strove to iteratively build greater trust and transparency with PLPT leadership (Fig. 6). Although the Chair of the PLPT Council provided a letter of support for the project in 2012, we put a hold on all research activities when the IDT was established in 2014 and submitted a formal research agreement detailing the specifics of the project for review and approval by PLPT Council. We gave presentation updates to the PLPT Council, submitted research materials for approval, and requested extensions of the research agreement when necessary. These protocols encouraged us to remain accountable to the PLPT Council's research priorities.

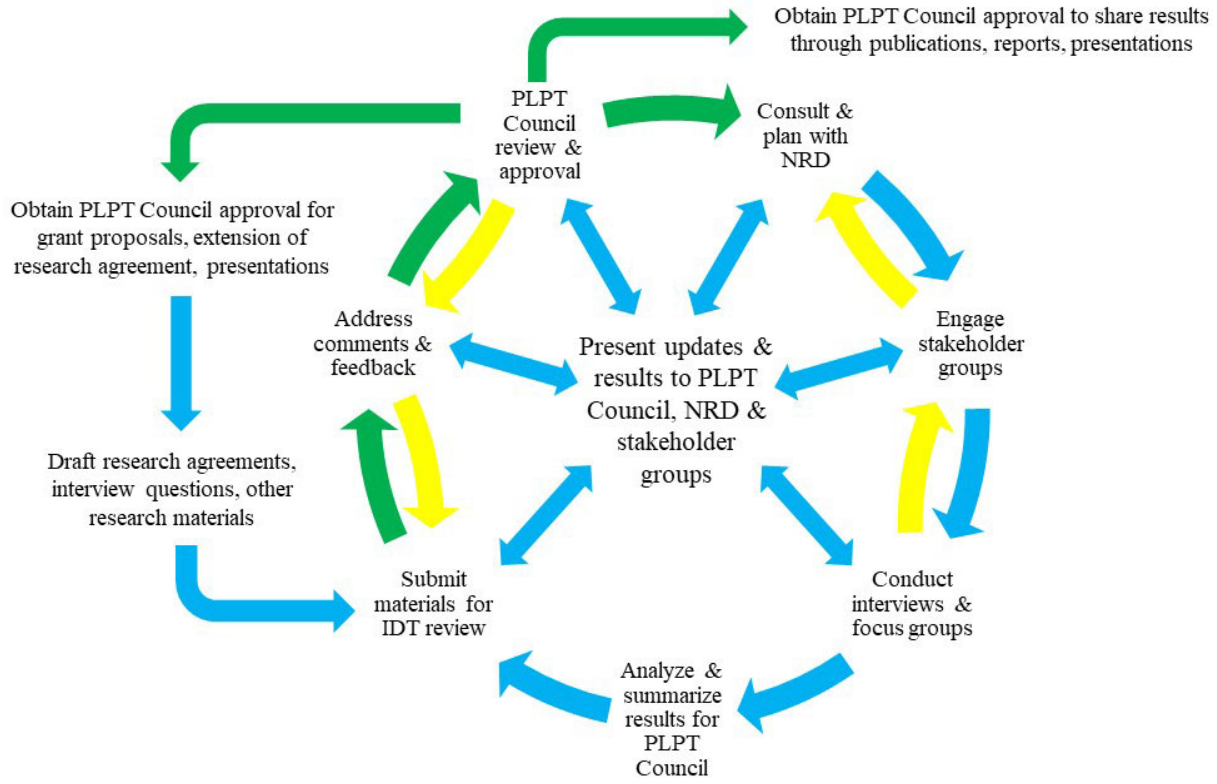
Prioritizing research through PLPT community perspectives

Research priorities were directly informed by the workshop. Community members and staff determined "water quantity," "water quality," and "sensitivity to cultural resources" as three main environmental challenges. "Community" was the most common stakeholder group discussed. The top-ranked ecological indicators included "water quantity," "water quality," and "environmental changes." Finally, "water quality," "education and outreach," and "sensitivity to cultural resources and individual behavior" were the top three categories of potential solutions. In response to these priorities, we shifted our attention to creating educational resources that explore how climate change impacts to water might impact cultural resources and livelihoods. Our literature review video offered interpretive climate resources that demonstrate how future changes in local climate can affect Pyramid Lake ecology.

Implications for future PLPT climate change planning

The results of this study have direct relevance to PLPT efforts to understand and respond to climate change. Broad community participation in climate research provides a more robust picture of impacts to livelihoods and operations. Collaboration with multiple research partners has been critical to the PLPT Council's approach to climate planning. Directives that originate from the PLPT Council can foster widespread community buy-in of

Fig. 6. Iterative process of community engagement and PLPT Council oversight. The blue arrows represent research actions taken by our team, yellow arrows represent steps taken to revise our research after review by the PLPT Council, and green arrows represent research actions that received PLPT Council approval.



adaptation planning and encourage stakeholder groups to collaborate on, commit to, and implement future strategies. Several Indigenous Nations have approached this process by passing a formal climate change resolution in council, establishing committees with diverse community representatives, and seeking input from elders and knowledge holders (Swinomish Office of Planning and Community Development 2010 Swinomish Climate Change Initiative Climate Adaptation Action Plan, Community of Newtok 2011, Oglala Lakota Nation 2012 Oyate Omniciye Oglala Lakota Plan, Confederated Salish and Kootenai Tribes of the Flathead Reservation 2013 CSKT Climate Plan).

The staff and community members who participated in this research contributed a wealth of knowledge that could be used to establish a baseline of information regarding the climate change planning needs of PLPT. Some areas of focus for future research include water resource issues, cultural concerns, environmental change, upstream issues, management and operations, and impacts on individual livelihoods. Workshop participants contributed many relevant conclusions about how PLPT might consider a response to climate change and were eager to advance these initiatives in the community. Although we anticipated that water, environmental, and ecological issues would be key discussion topics in the workshop, participants also raised issues related to community activism, power dynamics, intergenerational transmission of *Kooyooe Tukadu* knowledge, and prioritization of solutions that maintain interrelationships between the people, fish, lands, and waters. Significantly, these findings laid the framework for continued collaboration with the NRD, including a series of interviews and focus groups we conducted with diverse PLPT stakeholder groups about their experiences adapting to climate change and the role of *Kooyooe Tukadu* Indigenous knowledges in climate resilience, the results of which may be shared publicly pending PLPT Council review and approval.

CONCLUSION

Our study of PLPT climate change adaptation is unique in its focus on community engagement through a formal research partnership. Decolonizing, Indigenizing, and participatory action methodologies were critical to our collaborative partnership with the PLPT Council. We engaged PLPT environmental managers and community members with participatory action methods at a community workshop to identify top priorities for climate adaptation research. The participants' emphasis on community stakeholders as connected to all challenges facing Pyramid Lake was a crucial finding. Further, participants' concern for water, environmental, and cultural issues inspired us to creatively share our research with the community through a video summary of fish ecology. Engagement with the PLPT improved throughout the course of this collaborative study because of several factors, including greater participation by NRD staff and community members, increased awareness of the PLPT Council's commitment to

climate research, our iterative process of PLPT oversight, prioritization of community perspectives on climate change research, and incorporation of PLPT feedback on research outcomes.

This study may offer insight to Indigenous Nations considering climate change research partnerships and to researchers considering how to respectfully engage with Indigenous Nations. We emphasize that collaborative approaches to Indigenous climate research require effort on the researchers' part to remain accountable to the community's priorities and protocols for research; maintain empathy and respect for research participants; and strive for outcomes that are practical and return agency to the community. This study further highlights the need for practitioners who are committed to the decolonization of climate research with Indigenous Nations. We remain hopeful that an emerging body of scholarship on Indigenous resilience has begun to situate climate change in the context of settler colonialism, capitalism, and industrialization. We believe that Indigenous Nations play an active role in guiding their youth as the next generation of climate activists who will empower their communities toward resilience through a blending of climate science and Indigenous knowledges. Despite settler colonial attempts to disrupt Indigenous persistence in the Truckee River Basin, the Pyramid Lake Paiute Tribe has upheld their relationships between the *Kooyooe Tukadu* people, fish, waters, and lands through a collaborative approach to natural resource management that will be critical for responding to climate change.

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Data Availability:

Data/code sharing is not applicable to this article because no data/code were analyzed in this study.

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