

Assessment of American Indian Forestry Research, Information Needs, and Priorities

White Paper



EXECUTIVE SUMMARY

Native American tribes manage over 56 million acres and are leaders in forestry and fire management practices despite inadequate and inequitable funding. Native American tribes are rarely considered as research partners due to historically poor relationships with non-native scientists, tribal mistrust of research, differences between Indigenous values and scientific methods, and low Indigenous representation at research institutions. Understanding tribal research needs is critical to foster successful research partnerships with underserved tribal communities. Federal agencies, universities and natural resource management organizations are looking for meaningful and appropriate research to support tribal forest management. We developed an online assessment to identify tribal natural resource professionals' 1) research needs, 2) accessibility to published research and 3) interest in participating in research. Information needs identified by our survey included forest health, water quality, culturally significant species, workforce and tribal youth development, cultural importance of water, and invasive species. Additionally, tribal members reported that postfire response and valuation, resilience, and long-term forestry, protecting and curating tribal data, and Indigenous burning were more important research needs than non-tribal members. This study can inform forestry research planning efforts and establish research priorities that are aligned with needs identified by tribal natural resource managers. This is the second tribal research needs assessment led by the Intertribal Timber Council's Research Subcommittee.

Camas flowers on the Flathead Reservation in Montana after cultural fire was returned to the landscape by the Confederated Salish and Kootenai Tribes. Photo: Serra Hoagland.

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Remembering Dr. Janet Leak-Garcia

Janet Leak-Garcia (1964-2019) believed in creative and innovative scientific approaches, protecting the land, upholding federal-tribal trust obligations, and promoting responsible and sincere relationships with tribes. Together with the Intertribal Timber Council's Research Subcommittee, she co-led our team of scientists and tribal natural resource professionals to initiate this second tribal research needs assessment to support the natural resource research needs of tribes. Janet was a passionate advocate for both tribal and wilderness research, and she devoted her efforts to creating partnerships between the U.S. Forest Service and tribes. Janet had an ability to think strategically to overcome complex land management challenges by respecting individual differences. She once wrote, "We are shaped by our myriad experiences... viewed through the lens of our own equally valid perspectives. Respect and compassion for each person's unique history, personality, circumstances, and challenges is the only one-size-fits-all answer that I know." The authors thank Janet for her leadership and commitment to this effort.

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INTRODUCTION

Tribes have always resisted settler colonialism and land loss. In the 50 years since the American Indian Movement began there has been a monumental period of tribes keeping tribal sovereignty and resistance at the forefront of many large-scale environmental issues like resistance to the Dakota Access Pipeline (Estes 2017; Whyte 2017; Wilkinson 2005). For Indigenous people and tribal communities, this period also symbolizes a call to action about Indian Country being "information deserts" where active research and scientific partnerships are lacking relative to their land management counterparts (see Rodriguez-Lonebear 2016). However, this situation creates an important opportunity for several reasons. First, the unique sovereign status of federally recognized tribes allows for discovery and innovation regarding placebased management. Second, since tribal members and their respective tribal governments are the primary stakeholder group in land management decisions this often fosters an environment where such communities are highly connected to the results of their environmental decision making (IFMAT III. 2013; IFMAT IV. 2023). This is different from land managers that work on a particular National Forest yet do not have generations of family that *live* within the National Forest system boundary and therefore directly experience the consequences of land management decisions and actions. Third, the wellbeing of Indigenous communities is often tied to the health of natural resources (e.g. Durkalec et al. 2015).

Fourth and finally, tribes manage large land bases, yet tribal communities often lack access to research to support their land management goals. One of the findings of the 3rd Indian Forest Management Assessment Team was that a "lack of coordinated research or research advocacy has led to the tribes being under-serviced by federal and academic research institutions" (IFMAT III. 2013, 137). For all these reasons, now more than ever establishing and maintaining effective and accountable tribal research partnerships is imperative.

Previous USDA Forest Service Research and Development activities include publishing a Tribal Engagement Roadmap that developed objectives and strategies for engaging with tribes on research projects. Furthermore, tribal relations Points of Contact were established for each research station within the agency, special issues on tribal forest management have been compiled (Dockry and Hoagland 2017) and ample work on enhancing relationships between researchers and tribes is making headway (Bengston 2004; Dockry, Gutterman, and Davenport 2018; Lucero and Tamez 2017; Matson et al. 2021).

The impetus for the research needs assessment primarily stemmed from the Intertribal Timber Council (ITC), a national non-profit organization established in 1976 that is a consortium of Indian Tribes, Alaska Native Corporations, and individuals dedicated to improving the management of natural resources of importance to Native American communities. The ITC operates through a board of directors with appointed delegates to the 54 member tribes and Alaska Native Corporations. The ITC is organized into committees and subcommittees. The Research Subcommittee was formed in 2010 to develop recommendations regarding research plans, priorities, and initiatives to improve natural resource and fire management and increase benefits therefrom for Indian Country. In the Research Subcommittee's charter, the first responsibility is to collate and prioritize research needs identified by tribal communities. In addition to assisting the ITC Research Subcommittee in meeting their primary objective, this study on the research and information needs of forested tribal communities may be valuable to natural resource researchers and managers with responsibility to manage lands currently or historically managed by Native Americans.

In 2011, the ITC Research Subcommittee undertook the first systematic survey to understand the needs, priorities, and impediments that tribal forest managers and decision makers faced in developing, accessing, and utilizing research (Beatty and Leighton 2012). The results of this survey

identified five priorities for research to support tribal natural resource management: water quality, fish and wildlife management, integration of traditional knowledge with western science, mechanisms to improve knowledge sharing, and invasive species. The survey identified primary impediments to the access and use of research: internet access to research results; a lack of financial and staff resources to apply research results; a lack of financial and staff resources to monitor, evaluate, and report research results, and lack of staff and financial resources to identify applicable research to address local issues. The survey also indicated that there was a lack of convenient access to subject matter experts and published literature. Finally, the survey indicated that there was strong interest by tribes to participate in research activities, most especially through establishing research priorities (something that tribes have generally not been a partner in), developing partnerships with research institutions, and securing financial and staff resources to both apply research and conduct monitoring. This paper updates and expands upon the 2011 tribal research needs assessment (Beatty and Leighton 2012).

Log landing on the Red Lake Nation in Minnesota. Forestry supports the tribal community for jobs, firewood, and ecosystem restoration. Photo: Michael Dockry.



METHODS

Development of assessment

The authors convened several face-to face-meetings and several discussions with ITC Research Subcommittee to develop the survey instrument, hereafter known as "the survey", to assess tribal natural resource professionals' level of interest in research topics, access to research, and interest in participating in research. We initiated a pilot survey to review an initial set of respondents to test the instrument and adapt the questions to meet needs over a period of two months, which resulted in eight total pilot respondents. Additionally, we ran the pilot survey by known experts, such as those involved in the previous assessment (Beatty and Leighton 2012), members of the ITC Research Subcommittee, and ITC leadership. We built our assessment following formatting from Beatty and Leighton (2012), adding in a more complete set of demographic questions and specific topics, and ample room for optional write-in responses. The survey instrument (Appendix 1) was created using the Qualtrics Online Survey Platform through the University of Minnesota and consisted of 46 questions broken down into three parts (information needs, access, and interest in participating in research).

Assessment dissemination strategy

Our outreach efforts focused on providing the survey link to natural resource professionals working in Indian Country with Native American and Alaskan Native tribes with significant forested land bases, including woodlands, rangelands, and commercial forests. Paper copies of the assessment were available for individuals to complete as requested but the electronic version of the assessment was the primary route of distribution. The survey was open for approximately 10 weeks - opening at the ITC timber symposium in June 2019 and closing on Aug 15, 2019. The assessment was distributed to attendees at the ITC annual timber symposium as paper and electronic copies. We set up a student call center at Northern Arizona University with the Weyerhaeuser Indigenous Conservation crew July 15-16, 2019. In total approximately 200 members in attendance at ITC including member tribes were notified about the survey, emails were sent to ITC member tribes' natural resources departments, and they were contacted through follow-up phone calls. To encourage individuals to participate in the survey we offered four randomly selected participants Eighth Generation blankets a gift.

Measurement

Information needs

The information needs section of the survey included questions about 67 topics which were grouped into nine broad themes. These thematic groupings were used to be consistent with the previous tribal research needs assessment conducted by Beatty and Leighton (2012). The information needs themes

were forest management (10 topics), forest economics and forest products (9 topics), forest protection (5 topics), climate adaptation (10 topics), water (6 topics), fish and wildlife (5 topics), fire (8 topics), social science (6 topics), and traditional ecological knowledge integration (7 topics). All the topics were measured on a five-point Likert-type scale from "no new information needed (1)" to "extremely important (5)." The 26 survey topics that measured forest management, forest economics and forest products, and fire were used in factor analysis (described in the data analysis subsection below).

Access to research and information

Importance of access to research and information was measured using six items on a five-point scale from not at all important (1) to extremely important (5). Respondents were also asked about access to resource management and scientific information (e.g., online scientific journals, U.S. Forest Service General Technical Reports, etc.), the importance and frequency of access to scientific journals, and ways they learn about new research.

Participating in research activities

Twelve items were used to measure the importance of participating in research activities. Respondents were also asked if they have worked with any research partners (e.g., federal agencies, tribal colleges, universities) in the past.

Data analysis

In addition to descriptive statistics, we conducted data analysis in two steps. First, we conducted an exploratory factor analysis to determine the dimensions or factors of information needs, access to research and information, and participation in research activities. We conducted principal components analysis with varimax rotation to obtain factor loadings. Kaiser-Mayer-Olkin measures of 0.77 (information needs), 0.86 (access to research and information), and 0.82 (participation in research activities) demonstrate that the distribution of values across measures is adequate for conducting factor analysis.

After identifying factors or dimensions, all items within a factor or dimension were summed and divided by the number of items in the factor to create a summated variable. Thus, each summated variable represents a factor or dimension identified from factor analysis. We used Cronbach's alpha to assess internal consistency of each summated scale.

Next, we conducted t-tests to examine differences between subgroups (tribal vs. non-tribal, years worked in forestry) in the dimensions information needs, access to research and information, and participation in research activities. We used 25 years as the cut off to split the sample into two groups of roughly equal size which reflect those with <25 years and those with a longer tenure (>25

years) in forestry. We used IBM Statistical Package for the Social Sciences (SPSS) 25.0 for all statistical analyses.

Inclusion of indigenous research methods

Indigenous research methods are increasingly being employed across disciplines and incorporate Indigenous participation, knowledge, and values (Kovach 2010; Smith 1999; Wilson 2008). It is also critical that Indigenous research involves Indigenous people in knowledge production and that the research supports Indigenous goals (David-Chavez and Gavin 2018). While this study uses western social science survey methods and statistics, it incorporated Indigenous perspectives, collaboration and supports Indigenous goals. Specifically, the survey was designed to understand Indigenous perspectives on important natural resource research in an effort to guide future research towards topics of interest to tribal communities. Additionally, the research was conducted in collaboration with the Intertribal Timber Council, an intertribal organization that represents tribal interests and perspectives on forest management. The study team included American Indian lead researchers and core members and involved Indigenous youth/students. The survey was piloted with Indigenous natural resource professionals and the results were reported back to the Intertribal Timber Council for their feedback and input into the data analysis. Survey results will be shared with the Intertribal Timber Council general membership and potential research collaborators. Thus, Indigenous perspectives informed the development, analysis, and dissemination of the research results.

▼ Landscape view of the Salt River in Arizona, an important cultural landscape for tribes in the Southwest. Photo: Michael Dockry.



RESULTS

Survey respondents

Eighty-six surveys were started and 59 were completed and used in the analysis. Fortythree percent of the survey respondents were members of federally recognized American Indian tribes and 78% were male. A majority (58%) worked for their own American Indian tribe or another American Indian tribe, 12% worked for a federal agency, 12% worked for a college or university, 15% worked for "other" and 4% worked for a nongovernmental organization. Two thirds, 67%, of the survey respondents described their professional discipline as forestry while other disciplines including wildlife, botany, fire, water/air, and planning represented no more than 4% each respectively. Using the U.S. Forest Service National Forest System regional breakdowns, the largest response rate came from the Southwest region (34%), 20% from the Pacific Northwest region, 14% from the Alaska region, 12% Eastern region, 10% Intermountain region, 6% Southern region, and 4% from Pacific Southwest region (California). This broadly mirrors locations of tribal forest lands (see IFMAT IV 2023).

Information needs

Ninety-two percent of the survey respondents indicated that getting new information to improve resource management was either very important (45.8%) or extremely important (45.8%) (Table 1). The overall top-rated topics for tribal information needs were forest health (4.49 mean score), water quality (4.40 mean score), culturally significant species (4.44 mean score), workforce development/training (4.42 mean score), tribal youth development (4.40 mean score), cultural importance of water (4.32 mean score), invasive species (4.29 mean score). When asked to prioritize the most important information needs, the top 10 information needs topics were (listed in order from the most important): forest health, silviculture, water quality, workforce development/training, fish and wildlife responses to treatments, fuels management, planting/reforestation, planning, growth and yield, and invasive species (Table 2).

Table 1. Importance of getting new data to improve resource management. See Appendix 1: Question 3.

	IMPORTA	ANCE OF	GETTING NEV	N DATA TO I	MPROVE RESOL	IRCE MANA	AGEMENT
	Маал	Casua			Ranked importa	ance ^c	
	Mean	Score	Not at all	Slightly		Very	
n	score ^a	SD⁵	(1)	(2)	Moderately (3)	(4)	Extremely (5)
50	1 31	0.86	3.1	0.0	5.1	15.8	45.8

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Table 2. Top 10 overall information needs topics.Survey asked respondents to prioritize their top threeinformation needs to improve tribal forest management.See Appendix 1: Question 64.

Topic	n	Percent
Forest health	15	26.8
Silviculture	11	19.6
Water quality	9	16.1
Workforce development/training	9	16.1
Fish and wildlife response to treatments	7	12.5
Fuels management	7	12.5
Planting/reforestation	6	10.7
Planning	6	10.7
Growth and yield	6	10.7
Invasive species	5	8.9

TOP INFORMATION NEEDS TOPICS

The most important information needs themes were water, fish and wildlife, and traditional ecological knowledge integration (all topics grouped under each theme had mean scores

averaging over 4.0 on a 5-point scale) (Table 3, Table 4, and Table 5, respectively). Within the theme of water, water quality, the cultural importance of water, and water quantity (e.g. droughts and floods) were the highest rated information needs with mean scores of 4.40, 4.32, and 4.27 respectively (Table 3). Each of those topics had over 50% of respondents indicating that they were extremely important. For the fish and wildlife theme, information on culturally significant species was rated the highest with a mean of 4.44 and over 50.9% of respondents indicating it was extremely important (Table 4). The highest information needs for traditional ecological knowledge integration were tribal youth involvement (4.40 mean score) and input into decision making from elders or cultural committee, (4.31 mean score) (Table 5). None of the topics in the traditional ecological knowledge section had over 50% rated as extremely important; however, 44%-47% of respondents rated the three topics with highest mean scores as extremely important.

Table 3. Information needs related to the theme of water. Survey respondents were asked to rank the importance of new information on water-related topics to support tribal forest management. See Appendix 1: Question 6.

INFORMATION NEEDS. WATER												
		Moon	Score		Raı	nked importan	mportance ^c					
		Wiean	Score	No new info	Slightly	Moderately	Very	Extremely				
Topic	n	score ^a	SD^{b}	needed (1)	(2)	(3)	(4)	(5)				
Water quality	58	4.40	0.77	0.0	1.7	12.1	31.0	55.2				
Cultural importance of water	57	4.32	0.93	1.8	3.5	10.5	29.8	54.4				
Water quantity	56	4.27	0.86	0.0	3.6	16.1	30.4	50.0				
Precipitation timing	57	4.09	0.85	0.0	5.3	15.8	43.9	35.1				
Drought mitigation	55	4.09	0.93	0.0	7.3	16.4	36.4	40.0				
Groundwater recharge	55	4.05	1.04	1.8	5.5	23.6	23.6	45.5				

INFORMATION NEEDS: WATER

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Table 4. Information needs related to the theme of fish and wildlife. Survey respondents were asked to rank theimportance of new information related to fish and wildlife topics to support tribal forest management. See Appendix 1:Question 7.

	INFORMATION NEEDS: FISH & WIEDEITE												
		Maan		Ranked importance ^c									
Topic	n	score ^a	Score SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)					
Culturally significant species	57	4.44	0.63		0.0	7.0	42.1	50.9					
Effects from invasive species	57	4.19	0.74	0.0	1.8	14.0	47.4	36.8					
Response to treatments	57	4.18	0.85	0.0	3.5	17.5	36.8	42.1					
Effects from climate change	57	4.16	0.73	0.0	1.8	14.0	50.9	33.3					
Threatened and Endangered species	58	4.03	0.72	0.0	0.0	24.1	48.3	27.6					

INFORMATION NEEDS: FISH & WILDLIFE

Table 5. Information needs related to the theme of traditional ecological knowledge integration. Survey respondents were asked to rank the importance of new information related to the integration of traditional ecological knowledge to support tribal forest management. All topics within this theme received average scores over 4.0 (on a 1-5 scale). See Appendix 1: Question 12.

INFORMATION NEEDS: TRADITIONAL ECOLOGICAL KNOWLEDGE INTEGRATION

				Ranked importance ^c					
Topic	n	Mean score ^a	Score SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)	
Tribal youth involvement	57	4.40	0.62	0.0	0.0	7.0	45.6	47.4	
Input into decision making from elders or from cultural committee	58	4.31	0.80	1.7	1.7	5.2	46.6	44.8	
Integrating (TEK) into management	57	4.19	0.97	3.5	1.8	12.3	36.8	45.6	
Input into decision making from tribal community	57	4.16	0.82	1.8	1.8	10.5	50.9	35.1	
First foods/food sovereignty	57	4.12	0.89	1.8	3.5	12.3	45.6	36.8	
Holistic, balanced management	57	4.09	0.89	1.8	1.8	19.3	40.4	36.8	
Subsistence harvesting	57	4.02	0.92	3.5	1.8	14.0	50.9	29.8	

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Within the theme of forest management, the topics of inventory, planning, silviculture, and GIS were the most important information needs identified by participants (mean scores greater than 4.0) closely followed by planting and reforestation, growth and yield, site specific information, and biomass utilization (Table 6). Information needs for the forest economics and forest products theme did not have any topics with mean scores over 4.0 and ranged from a mean of 3.65 for development of new forest products to 3.11 for certifications like FSC and SFI (Table 7). The top-rated information needs topics for the forest protection theme were forest health,

invasive species, and the Tribal Forest Protection Act/adjacent landowners with means of 4.49, 4.29, and 3.93, respectively (Table 8). Sixty one percent and 47% of respondents indicated that information on forest health and invasive species information was extremely important, respectively. Mean scores for the climate change adaptation information needs theme did not exceed 4.0 with early indications of climate change (i.e., phenology) ranking the highest followed by implementation of climate adaptation projects, adaptation/mitigation planning, and vulnerability assessments (Table 9).

Table 6. Information needs related to the theme of forest management. Survey respondents were asked to rank the importance of new information related forest management topics to support tribal forest management. See Appendix 1: Question 4.

		Maan	Casua	Ranked importance ^c					
Topic	Ν	score ^a	SCOLE SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)	
Inventory	55	4.15	0.80	1.8	1.8	9.1	54.5	32.7	
Planning	56	4.05	0.92	1.8	3.6	17.9	41.1	35.7	
Silviculture	56	4.04	0.95	3.6	1.8	16.1	44.6	33.9	
GIS	56	4.02	0.84	1.8	1.8	17.9	50.0	28.6	
Planting / reforestation	56	3.98	0.92	1.8	7.1	10.7	51.8	28.6	
Growth and yield	54	3.93	0.99	1.9	7.4	18.5	40.7	31.5	
Site specific information	54	3.87	0.89	1.9	7.4	13.0	57.4	20.4	

INFORMATION NEEDS: FOREST MANAGEMENT

^aResponses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^cUnits are percent of respondents.

 Table 7. Information needs related to the theme of forest economics and forest products. Survey respondents were asked to rank the importance of new information related forest economics and forest products topics to support tribal forest management. See Appendix 1: Question 5.

					Rank	ed important	ce ^c	
Topic	n	Mean score ^a	Score SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)
Development of new forest products	57	3.65	1.04	3.5	8.8	29.8	35.1	22.8
Milling infrastructure	56	3.57	1.09	1.8	16.1	30.4	26.8	25.0
Non-timber forest products	57	3.54	1.04	3.5	12.3	28.1	38.6	17.5
Ecosystem services markets	56	3.50	1.06	3.6	12.5	33.9	30.4	19.6
Marketing strategy/branding	56	3.48	1.18	5.4	14.3	32.1	23.2	25.0
Carbon credits and carbon markets	56	3.48	1.22	7.1	12.5	32.1	21.4	26.8
Appraisal systems	56	3.41	1.09	5.4	16.1	25.0	39.3	14.3
Recreation/tourism	55	3.16	1.15	7.3	21.8	32.7	23.6	14.5
Certifications (SFI, FSC, etc.)	57	3.11	1.16	8.8	22.8	29.8	26.3	12.3

INFORMATION NEEDS: FOREST ECONOMICS & FOREST PRODUCTS

Table 8. Information needs related to the theme of forest protection. Survey respondents were asked to rank (on a 1-5 scale) the importance of new information related forest protection topics to support tribal forest management. See Appendix 1: Question 6.

INFORMATION NEEDS: FOREST PROTECTION											
		Moon	Saara		Ran	ked importai	nce ^c				
Topic	n	score ^a	Score SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)			
Forest health	59	4.49	0.77	1.7	0.0	6.8	30.5	61.0			
Invasive species	58	4.29	0.77	0.0	1.7	13.8	37.9	46.6			
TFPA ^d adjacent landowners	56	3.93	1.01	1.8	5.4	26.8	30.4	35.7			
Trespass (fire, logging, etc.)	57	3.54	1.02	1.8	14.0	31.6	33.3	19.3			
Livestock grazing	55	3.05	1.41	18.2	21.8	14.5	27.3	18.2			

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents. ^dTFPA=Tribal Forest Protection Act.

Table 9. Information needs related to the theme of climate adaptation. Survey respondents were asked to rank the importance of new information related to climate change adaptation topics to support tribal forest management. See Appendix 1: Question 4.

	INFORMATION NEEDS: CLIMATE ADAPTATION									
		Maan	Saara		Ran	ked importan	ce ^c			
Topic	n	score ^a	SCOLE SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)		
Early indicators of changing climate (i.e. phenology)	57	4.00	1.00	3.5	1.8	22.8	35.1	36.8		
Implementation of climate adaptation projects	57	3.86	0.99	3.5	3.5	24.6	40.4	28.1		
Adaptation/ mitigation planning	56	3.84	0.99	3.6	5.4	19.6	46.4	25.0		
Vulnerability assessments	56	3.77	1.01	3.6	7.1	21.4	44.6	23.2		
Seed sourcing	55	3.75	1.00	3.6	7.3	21.8	45.5	21.8		
Range shifts	56	3.68	1.11	7.1	5.4	23.2	41.1	23.2		
Localized (downscaled) climate modeling	56	3.62	1.07	3.6	10.7	28.6	33.9	23.2		
Carbon sequestration/ credits	56	3.61	1.14	7.1	1.8	42.9	19.6	28.6		
Bioenergy	54	3.61	0.88	0.0	7.4	42.6	31.5	18.5		
Biochar	52	3.37	0.99	3.8	9.6	48.1	23.1	15.4		

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

The top three information needs within the fire theme were wildland fire management, fuels management, and Indigenous burning with mean scores of 4.3, 4.21, and 4.09, respectively (Table 10). The top-rated topics within the social science theme were workforce development and training with a mean score of 4.42 and 50.9% of respondents indicating that it was extremely important (Table 11). Federal and state partnerships had a mean score of 4.11 followed by policy with a 3.98 mean score.

Table 10. Information needs related to the theme of fire. Survey respondents were asked to rank the importance of new information related to fire topics to support tribal forest management. See Appendix 1: Question 10.

	INFC	ORMATIO	N NEEDS	: CLIMATE	ADAPTA	ATION		
		Maan	Saara		Ran	ked importan	ce ^c	
Topic	n	score ^a	Score SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)
Wildland fire management	56	4.30	0.78	0.0	3.6	8.9	41.1	46.4
Fuels management ^d	56	4.21	0.95	3.6	3.6	3.6	46.4	42.9
Indigenous burning	55	4.09	0.87	0.0	5.5	16.4	41.8	36.4
Wildland fire Prevention	55	3.96	0.98	0.0	7.3	27.3	27.3	38.2
Liability (for Rx burning)	55	3.87	0.98	1.8	7.3	21.8	40.0	29.1
Smoke management ^e	55	3.84	1.05	1.8	7.3	30.9	25.5	34.5
Post-fire response ^f	54	3.78	1.00	1.9	9.3	24.1	38.9	25.9
Salvage logging	54	3.54	1.00	1.9	13.0	33.3	33.3	18.5

Pinyon-juniper woodlands transition to ponderosa pine forests on the Santa Clara Pueblo in New Mexico near the 2011 Las Conchas Fire. Ongoing work addresses post-fire restoration and reducing fire risk to forests and



Table 11. Information needs related to the theme of social science. Survey respondents were asked to rank the importance of new information related to social science topics to support tribal forest management. See Appendix 1: Question 11.

	INFORMATION NEEDS: SOCIAL SCIENCE											
					Rar	ked importar	nce ^c					
Topic	n	Mean score ^a	Score SD ^b	No new info needed (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)				
Workforce development/ training	57	4.42	0.73	1.8	0.0	3.5	43.9	50.9				
Federal and state partnerships	57	4.11	0.86	0.0	7.0	10.5	47.4	35.1				
Policy	56	3.98	0.82	0.0	5.4	17.9	50.0	26.8				
Tribal governance	54	3.91	0.94	1.9	3.7	25.9	38.9	29.6				
History	57	3.89	0.90	1.8	3.5	24.6	43.9	26.3				
Tribal models of leadership ^d	54	3.83	0.95	1.9	5.6	25.9	40.7	25.9				

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents. ^d For example, specialized tribal leadership.



Factor analysis of 26 survey topics measuring information needs around the forestry-specific themes of forest management, forest economics and forest products, and fire revealed six distinct factors or dimensions with Cronbach's alpha ranging from 0.77 to 0.88 (Table 12). The six dimensions included: innovative markets and approaches (7 topics, $\alpha = 0.88$), forest operations (6 topics, $\alpha =$ 0.85), post-fire response and valuation/merchandising (4 topics, $\alpha = 0.86$), fire (5 topics, $\alpha = 0.85$), long term forestry/harvest logistics (3 topics, $\alpha = 0.77$), and Indigenous burning (1 topic, $\alpha = n/a$ because there was only one factor).

T-tests revealed significant differences between tribal and non-tribal members in four of six factors of forestry information needs (Table 13). Tribal members reported post-fire response and valuation/merchandising (means: Tribal member = 3.98, Non-tribal member = 3.29; p-value = 0.006), fire (means: tribal member = 4.31, non-tribal member = 3.79; pvalue = 0.012;), resilience, long-term forestry, post-disturbance/harvest logistics (means: tribal member = 4.00, non-tribal member = 3.46; p-value=0.011), and Indigenous burning (means: tribal member = 4.39, non-tribal member = 3.71; p-value=0.007) as more important information needs than non-tribal members.

There were also significant differences between respondents who had worked in forestry for 25 years or less and those who had worked for more than 25 years in dimensions of forest management information needs (Table 13). Respondents who had worked in forestry for 25 years or less reported innovative markets and approaches (means: 25 years or less = 3.65, more than 25 years = 3.32; p-value = 0.007), post-fire response and valuation/merchandising (means: 25 years or less = 3.90, more than 25 years = 3.28; pvalue = 0.012), and Indigenous burning (means: 25 years or less = 4.31, more than 25 years = 3.77; p-value=0.035) as more important information needs than respondents who had worked in forestry for more than 25 vears.

Table 12. Factor loadings for dimensions of forestry-specific information needs themes. Six factors (groups) emerge for forestry-specific topics and include: innovative markets and approaches; forest operations; post-fire response and valuation/merchandising; fire; long term forestry/harvest logistics; and Indigenous burning.

FACTOR LOADINGS FOR	DIMENSIONS OF I	INFORMATION NEEDS
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	Factor						
Forestry themes	Innovative markets and approaches $(\alpha = 0.88)$	Forest operations $(\alpha = 0.85)$	Post-fire response and valuation/ merchandising $(\alpha = 0.86)$	Fire $(\alpha = 0.85)$	Long term forestry/ harvest logistics (a = 0.77)	Indigenous burning (α = N/A)*	
Ecosystem services markets	0.787	0.260	0.204	0.090	0.254	0.081	
Recreation/tourism	0.766	0.054	0.133	0.383	0.032	0.004	
Carbon credits and markets	0.652	0.084	0.450	0.216	0.052	-0.136	
Certifications (SR, FSC, etc.)	0.641	0.009	0.270	0.149	0.342	0.197	
Non-timber forest products	0.605	0.343	0.170	0.155	-0.039	0.178	
Marketing strategy/branding	0.577	0.361	0.208	0.010	0.430	0.276	
Biomass utilization	0.539	0.399	0.175	0.481	0.034	-0.148	
Inventory	0.006	0.803	0.390	-0.010	0.020	0.173	
Growth and yield	0.152	0.777	0.180	-0.004	0.232	-0.144	
Silviculture	0.257	0.664	0.335	0.156	0.260	0.298	
Site specific information	0.267	0.644	-0.040	0.420	0.156	0.029	
Planning	0.309	0.610	0.044	0.407	0.072	0.286	
GIS	0.163	0.569	0.008	0.444	0.303	0.067	
Salvage logging (fire)	0.287	0.024	0.760	0.234	0.224	0.237	
Post-fire response ^a	0.330	0.161	0.734	0.289	0.061	0.087	
Milling infrastructure	0.160	0.378	0.634	0.164	0.141	0.086	
Appraisal systems	0.446	0.417	0.610	0.056	0.267	0.001	
Wildland fire management	0.186	0.126	0.229	0.808	0.136	0.042	
Fuels management ^b	0.277	0.200	0.540	0.598	-0.076	0.147	
Wildland fire prevention	0.203	0.054	0.331	0.571	0.326	0.355	
Smoke management ^c	0.296	0.126	0.395	0.558	0.178	0.159	
Liability (for Rx burning	0.129	0.208	0.188	0.548	0.406	0.412	
Roads, engineering, transportation, culverts	0.269	0.195	0.035	0.138	0.836	0.057	
Planting/reforestation	-0.046	0.305	0.407	0.209	0.642	0.039	
Salvage logging	0.239	0.232	0.486	0.312	0.496	-0.242	
Indigenous burning	0.082	0.123	0.125	0.167	0.021	0.879	

*Factor includes only one item. ^a For example, thinning, piling, under-burning, Rx burning, biomass removal. ^b For example, human health impacts, emissions, etc. ^c Burned Area Emergency Response (BAER) / Burned Area Rehabilitation (BAR) / Emergency Stabilization.

Table 13. Differences in dimensions (factors) of information needs by tribal membership and years worked in forestry. Significant comparisons between tribal member or forestry experience categories (p<0.05) are italicized.

		Tı	ribal n	nembersł	nip			Yea	rs wo	orked in f	orestry	7
	Me a	mber of tribe	Not m	a tribal ember	_		≤25 fo	years in restry	>25 fo	years in prestry	_	
		Mean		Mean				Mean		Mean		
Information need	n	score ^a	n	score ^a	t	р	n	score ^a	n	score ^a	t	р
Innovative markets and approaches	23	3.65	27	3.3	1.4	0.17	27	3.78	24	3.16	2.8	<0.01
Forest operations	22	4.12	26	3.9	1.0	0.34	27	4.02	23	3.98	0.2	0.82
Post-fire response and valuation/ merchandising	22	3.98	26	3.3	2.9	<0.01	26	3.90	23	3.28	2.6	0.01
Fire	23	4.31	26	3.8	2.6	0.01	27	4.11	23	3.97	0.7	0.49
Resilience, long term forestry, post- disturbance harvest logistics	22	4.00	27	3.45	2.6	0.01	27	3.74	24	3.64	0.5	0.66
Indigenous burning	23	4.39	24	3.7	2.8	<0.01	26	4.31	22	3.77	2.2	0.04

DIFFERENCES IN INFORMATION NEEDS BY TRIBAL MEMBERSHIP AND EXPERIENCE

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Logs harvested on the Tule River Reservation in California. Photo: Serra Hoagland.



Access to research and information

Ninety percent of survey respondents indicated that access to research on the internet was either extremely important (52%)or very important (38%) (Table 14). Access to subject matter experts and time to read and study research information was very important or extremely important for 86% and 84% of respondents, respectively. Over 50% of respondents indicated that access to research summaries, agency reports, and published scientific publications was very important. Sixty-nine percent of respondents found resource management and scientific information from online scientific journals, 62% from U.S. Forest Service General Technical Reports, 48% from Intertribal

Timber Council meetings and conferences, 45% from Society of American Foresters publications, and 40% from Intertribal Timber Council publications (Table 15). Textbooks, U.S. Forest Service Science You Can Use bulletins, Society of American Foresters meetings, and libraries were used to access information for 36%, 33%, 26%, and 22% of respondents, respectively. Optional write-in answers indicated that information was accessed sometimes through experts, coworkers, other regional meetings, and the Joint Fire Science Consortium. Respondents indicated that the most important sources of information were scientific publications and U.S. Forest Service General Technical Reports (Table 15).

Table 14. Importance of access to different types of information. See Appendix 1: Question 17.

INFORMATION ACCESS										
		Maan	Saara		Ra	nked import	ance ^c			
Topic	n	score ^a	Score SD ^b	Not at all (1)	Slightly (2)	Moderatel y (3)	Very (4)	Extremely (5)		
Internet access to research results	58	4.34	0.89	3.4	0.0	6.9	37.9	51.7		
Access to subject matter experts (e.g. workshops, mentoring, one-on-one discussions)	57	4.21	0.80	1.8	0.0	12.3	47.4	38.6		
Time to read and study information	56	4.16	0.85	1.8	1.8	12.5	46.4	37.5		
Access to research summaries and updates	57	4.07	0.90	3.5	1.8	10.5	52.6	31.6		
Access to agency reports and scientific publications	56	4.05	0.82	1.8	1.8	14.3	53.6	28.6		

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Table 15. Sources of information survey participants use to support tribal forest management. Survey participants were asked, "Where do you go to access resource management and scientific information" and "Which is most important source of information?". See Appendix 1: Questions 18 & 19.

	Information sources accessed		Most important information source	
Information Source	п	Percent	п	Percent
Online scientific journals	40	69.0	21	37.5
U.S. Forest Service General Technical Reports (GTRs)	36	62.1	10	17.9
Intertribal Timber Council meetings and conferences	28	48.3	5	8.9
Society of American Foresters publications	26	44.8	4	7.1
Intertribal Timber Council publications	23	39.7	2	3.6
Textbooks	21	36.2	1	1.8
U.S. Forest Service Science You Can Use bulletins	19	32.8	2	3.6
Society of American Foresters meetings and conferences	15	25.9	1	1.8
Libraries	13	22.4	3	5.4

INFORMATION SOURCES

Eighty percent of respondents indicated access to scientific journals was very or extremely important and 50% indicated they access them monthly, while only 14% accessed them weekly. Scientific journals are accessed for between 15%-22% of respondents when new research is heard about, regular scanning, when a problem arises, when beginning a new project, and when preparing reports. Only 4% indicated that they access scientific journals when writing grants. Forty-four percent of respondents learned about new research by searching the internet themselves, 35% through emailed newsletters, 26% through webinars, and 21% through science synthesis reports (by topical area). Fewer than 20%

learned about new research through the ITC or U.S. Forest Service blogs and websites and only 5% learned about research through hardcopy newsletters (see Tables 16-19).

Factor analysis of six items measuring access to research and information did not reveal multiple distinct factors (analysis not shown in tables). Therefore, we conducted t-tests for each item measuring access to research and information. There were no significant differences between tribal and non-tribal members, and between respondents who had worked in forestry for 25 years or less and those who had worked for more than 25 years in access to research and information (nonsignificant analysis not shown in tables). Table 16. Importance of access to scientific journals. See Appendix 1: Question 23.

IMPORTANCE OF ACCESS TO SCIENTIFIC JOURNALS									
		Maan	Saama			Ranked impo	ortance ^c		
Topic	n	score ^a	Score SD ^b	Not at all (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)	
Importance of access to scientific journals	55	4.07	0.79	0.0	3.6	16.4	49.1	30.9	

IMPORTANCE OF ACCESS TO SCIENTIFIC JOURNALS

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Table 17. Frequency of accessing scientific journals.See Appendix 1: Question 22.

FREQUENCY OF ACCESSING SCIENTIFIC JOURNALS

	Ν	Percent
At least weekly	8	14.3
At least monthly	28	50.0
A couple times a year or less	13	23.2
Never	3	5.4
Other*	4	7.1

*Other responses include: (1) Access is needed at specific times of forest management- validating forest-wide silviculture prescriptions, FMP updates, FIA updates; in other words, a lit review is needed at the beginning of each planning period, with access to important updates during operational times, (2) As needed, (3) I attempt to access at least weekly but am typically limited to an abstract, (4) Really only when someone I work with publishes something. Table 18. Times when participants access scientificjournals. See Appendix 1: Question 23. Participantscould select two answers.

WHEN RESPONDENTS ACCESS SCIENTIFIC JOURNALS

	Ν	Percent
When you hear about new research	30	22.2
Regular scanning	25	18.5
When a new problem arises	25	18.5
Beginning a new project	23	17.0
When preparing reports	21	15.6
Other (please explain)	6	4.4
When writing grants	5	3.7



Table 19. Best ways to learn about new research. SeeAppendix 1: Question 24. Participants could select twoanswers.

BEST WAYS TO LEARN ABOUT NEW RESEARCH

	Ν	Percent
Searching the internet yourself	25	43.9
Email newsletter	20	35.1
Webinar	15	26.3
Science synthesis reports (by topical area)	12	21.1
ITC Blog/website	10	17.5
Other*	7	12.3
U.S. Forest Service blog/website	6	10.5
Hard copy newsletter	5	8.8

*Other responses include: (1) Annual new science "roundup session" at ITC Symposium, (2) Direct conversation with research colleagues, (3) Journal of Forestry or other print materials in the bathroom, (4) Journals and scientific meetings, (5) Society of American Forester publications, (6) Talking with colleagues, (7) Word of mouth.

Restored open ponderosa pine forest on the San Carlos Apache Reservation in Arizona. Photo: Michael Dockry.

Participating in research activities

Fifty-nine percent of respondents indicated that "protecting tribal data" was extremely important and 26% indicated it was very important (Table 20). A majority of respondents (87.5%) indicated that "developing partnerships with research institutions" was very important or extremely important. Fifty percent of respondents said "curating tribal data" was extremely important. Curating tribal data is related to maintaining tribal data sets and is conceptually related to protecting tribal "data". "Establishing research priorities" was very or extremely important for 84% of respondents and 76% indicated that "securing staff and financial resources to apply research results" was very or extremely important. Eighty percent of respondents have worked with universities on research in the past, 72%have worked with federal agencies on research. 36% have worked with state agencies, and 32% have worked with nonprofits (see Table 21). Only 16% of respondents indicated that they worked with Tribal Colleges on research. Several respondents indicated in a write-in response ("other") that they have never engaged in research activities.

Tree planting in a burned area on the San Carlos Reservation in Arizona. Photo: Michael Dockry.



	11(11							
		M	C	Ranked importance ^c				
Topic	n	Mean score ^a	Score SD ^b	Not at all (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)
Protecting tribal data	54	4.41	0.84	0.0	3.7	11.1	25.9	59.3
Developing partnerships with research institutions	56	4.27	0.67	0.0	0.0	12.5	48.2	39.3
Curating tribal data	54	4.22	0.90	0.0	3.7	20.4	25.9	50.0
Securing staff and financial resources to apply research results	56	4.09	0.84	0.0	3.6	19.6	41.1	35.7
Establishing research priorities	56	4.07	0.97	5.4	0.0	10.7	50.0	33.9
Collecting data	56	3.86	0.96	0.0	8.9	26.8	33.9	30.4
Finding resources to conduct original research	55	3.84	1.05	3.6	9.1	14.5	45.5	27.3
Interpreting and analyzing data	56	3.80	0.90	0.0	7.1	30.4	37.5	25.0
Designing research studies	56	3.73	0.90	0.0	10.7	25.0	44.6	19.6
Reviewing research studies (including peer- review)	56	3.66	0.88	0.0	10.7	28.6	44.6	16.1
Presenting research results	55	3.64	0.97	0.0	12.7	32.7	32.7	21.8
Evaluating research studies	56	3.63	0.84	0.0	7.1	39.3	37.5	16.1

Table 20. Importance of tribal participation in research activities. See Appendix 1: Question 27.

TRIBAL PARTICIPATION IN RESEARCH ACTIVITIES

^a Responses based on a 5-point scale from no new information needed (1) to extremely important (5). ^b SD=Standard deviation. ^c Units are percent of respondents.

Table 21. Research partners of respondents. SeeAppendix 1: Question 31. Participants could selectmultiple options.

RESEARCH PARTNERS OF RESPONDENTS

	Ν	Percent
Universities	40	80.0
Federal agencies	36	72.0
State Agencies	18	36.0
Non-profits (for example The Nature Conservancy)	16	32.0
Other*	9	18.0
Tribal Colleges	8	16.0

*Other responses included: (1) Cooperatives - Inland Growth & Yield, Tree Improvement Coop, Intermountain Forestry Cooperative, (2) Cooperatives that include universities, federal and state agencies, tribes, and forest products industry, (3) Have not conducted research, (4) I have not, but our biology department has, (5) I have partnered for research in previous positions, but not as a Tribal employee, (6) Individual researchers/ professors, fire science consortiums, other tribal knowledge holders, (7) No, (8) No research projects yet.

Factor analysis of the 12 survey items measuring participation in research activities revealed three factors: research design and communication (5 items, $\alpha = 0.91$), research sovereignty (5 items, $\alpha = 0.81$), and research priorities (1 item, $\alpha = n/a$ because there was only one factor). One item was removed due to loading on multiple factors (see Table 22 for this factor analysis).

There were no significant differences between tribal and non-tribal members in any of the factors of participation in research activities (Table 23). However, there were significant differences between respondents who had worked in forestry for 25 years or less and those who had worked for more than 25 years. Respondents who had worked in forestry for 25 years or less reported research design and communication (means: 25 years or less = 4.07, more than 25 years = 3.38 p-value = 0.002), research sovereignty (means: 25 years or less = 4.44, more than 25 years = 3.95; pvalue = 0.004), and research priorities (means: 25 years or less = 4.22, more than 25 years = 3.54; p-value = 0.001) as more important than respondents who had worked in forestry for more than 25 years (Table 23).

To further analyze any differences between tribal and non-tribal members, we conducted t-tests on each item measuring participation in research activities. While there were no significant differences between tribal and nontribal members at the factor level, this analysis identified differences between tribal and nontribal members in two items: protecting tribal data and curating tribal data. Tribal respondents reported protecting tribal data (means: tribal member = 4.74, non-tribal member = 4.20), and curating tribal data (means: tribal member = 4.52, non-tribal member = 4.00) as more important than nontribal respondents (analysis not shown). Table 22. Factor loadings for dimensions of participation in research activities.

FACTOR LOADINGS FOR DIMENSIONS OF PARTICIPATION IN RESEARCH ACTIVITIES

	Factor						
	Research design and						
Forestry themes	$\begin{array}{l} communication\\ (\alpha = 0.91) \end{array}$	Research sovereignty $(\alpha = 0.81)$	Research priorities $(\alpha = 0.64)$				
Interpreting and analyzing data	0.908	0.245	0.064				
Collecting data	0.875	0.220	0.034				
Evaluating research studies	0.700	0.127	0.602				
Presenting research results	0.693	0.372	0.324				
Designing research studies	0.657	0.204	0.564				
Protecting tribal data	0.028	0.842	0.124				
Curating tribal data	0.236	0.780	0.178				
Securing staff and financial resources to apply research results	0.344	0.689	0.130				
Developing partnerships with research institutions	0.233	0.668	0.097				
Finding resources to conduct research	0.117	0.573	0.478				
Establishing research priorities	0.049	0.288	0.874				
Reviewing research studies (including peer review)*	0.617	0.076	0.668				

*Item removed due to high factor loading on two factors.

Table 23. Differences in dimensions (factors) of participation in research activities by tribal membership and years worked in forestry. Significant comparisons between tribal member or forestry experience categories (p<0.05) are italicized.

DIFFERENCES IN RESEARCH PARTICIPATION BY TRIBAL MEMBERSHIP AND EXPERIENCE

		Tribal membership					Years worked in forestry					
	Mer a	nber of tribe	No n	t a tribal 1ember	_		≤25 fo	years in prestry	>25 fo	years in restry	_	
Participation in research		Mean		Mean	_			Mean		Mean	_	
activities	n	score ^a	n	score ^a	t	р	n	score ^a	n	score ^a	t	р
Research design/ communication	23	3.90	27	3.59	1.4	0.16	27	4.07	24	3.38	3.3	<0.01
Research sovereignty	23	4.38	27	4.06	1.8	0.08	27	4.44	24	3.95	3.0	<0.01
Research priorities	23	4.04	27	3.76	1.4	0.17	27	4.22	24	3.54	3.7	<0.01

^aResponses based on a 5-point scale from no new information needed (1) to extremely important (5).



Giant sequoias with fire scars on the Tule River Reservation in California. Photo: Serra Hoagland.



DISCUSSION

The vast majority of survey respondents indicated that research information is important for them to do their jobs as natural resource professionals. The top-rated research topics (forest health, water quality, culturally significant species, workforce development/training, tribal youth development, cultural importance of water, and invasive species) are all topics that support long-term forest sustainability that goes beyond healthy ecosystems to include healthy cultural connections to those resources and inter-generational continuity. When asked to rate the most important information needs for tribal forestry (Table 2) the priorities were also practical, applied, and support on-theground tribal natural resource management (including developing natural resource professionals for future management). This illustrates values held by many tribes to support management of culturally important resources and youth development to support tribal lands and waters.

Broadly, when survey responses are looked at within each theme, the highest rated topics are also important for on-the-ground management. For example, within the forest management theme, inventory, planning, silviculture, and GIS were the most important information needs. These are basic components of on-theground forest management. In forest protection, forest health and invasive species were highly ranked as was wildland fire management, fuels management for the fire theme. In summary, information needs for tribal forest management seem to focus on the immediate and practical issues that foresters need to deal with in their daily jobs.

Lake Superior and boreal forest on the Grand Portage Band of Lake Superior Chippewa Reservation in Minnesota. Photo: Michael Dockry.



Highly ranked policy and social science topics also seem to support on-the-ground management. For example, the Tribal Forest Protection Act and federal and state partnerships were both rated highly. The inclusion of the Tribal Forest Protection Act shows the importance of policy on the practical applications of forest management across boundaries. It also indicates the extreme importance of lands adjacent to tribal lands. This is because all lands were once tribal lands and tribes typically understand their responsibilities to maintain ecosystems across the landscape irrespective of jurisdiction. It also indicates that the management of adjacent lands can have a profound impact on tribal lands and tribes are looking to mitigate negative impacts (like uncontrolled wildfire and insect or disease outbreaks) emanating off reservation. The topic of the Tribal Forest Protection Act has been important for tribes for decades and having it rated as an important information need in our survey indicates that there are still many questions about its impact and implementation.

The cultural aspects of forest management were also ranked highly by survey respondents. The cultural importance of water, Indigenous burning, and workforce development all recognize the importance of culture in forest management and the need to both train youth and to train professionals with the competence and knowledge to understand tribal forest management practices and goals.

Finally, climate change was an important information need but it did not rank as high as some of the practical on-the-ground topics as described above. This could be because there is already a lot of information and work in this area or because climate change is a long-term problem and there are more important information needs to manage current on-theground issues that respond to mitigating or adapting to climatic factors. It may also be that climate change is something that permeates many of the information needs prioritized in the survey and was not seen as a stand-alone topic. In other words, information on climate change is important but not as important as information on more specific topics like forest health, for example.

These responses help make sense of the statistical differences seen in the factor analysis and comparison between tribal and non-tribal members and between respondents who worked in forestry for less than 25 years and more than 25 years. For example, tribal members reported that post-fire response and valuation, resilience and long-term forestry, and Indigenous burning were more important than non-tribal member respondents. This is a gap that has been seen in other research on tribal forestry where non-tribal members had different understandings of tribal goals for forest management than tribal members (IFMAT 1993; 2003; 2013; 2023) although that gap has been closing. In our survey, the practical aspects of responding to fires and maintaining forest value is critical to maintain forest management activities. The long-term nature of Indigenous land tenure also is extremely important to tribal members because their culture, history and future depends on a resilient forest. Tribes are not going to pack up and move to another area if their lands are poorly managed, they live

directly with the decisions and management outcomes for generations. Finally, there is a lot of literature on Indigenous burning but the tribal members in our survey rated the research needs of higher importance than nontribal members. Perhaps this is because of the deep connection and knowledge held within Indigenous communities that the tribal members view current literature as limited in relation to that vast knowledge. This could also indicate that tribal members are keying in on differences between Indigenous burning practices and prescribed fire used in modern forestry systems.

Protecting and curating tribal data were also rated more important information needs by tribal members than non-tribal members. Data protection and data curation (displaying and/or sharing data) broadly fall under the term data sovereignty (Kukutai and Taylor 2016; Walter and Suina 2019). There is a movement for Indigenous people across the country and world to control their own data (see Harry 2011; Lovett et al. 2019; Rodriguez-Lonebear 2016; Tsosie 2019). This issue is extremely important in forest management but has received less attention than data sovereignty in medical fields. The higher rating by tribal members is an indication of the importance of this to tribal communities and the future of tribal natural resources. It can be seen as a push back against further disposition of tribal assets-this time data. Critical questions for researchers to consider in conducting research include: who owns the data, who controls data distribution, how will the data be used, and what happens if the tribe no longer wishes to be a part of a research program? While not documented in the literature, many tribal

natural resource professionals have stories about how tribal data has been misused, misinterpreted, or misappropriated. Discussions around data sovereignty and new research on this topic can help support tribal management.

The differences between professionals with more experience and less experience is harder to explain. Professionals with fewer years of experience were more interested in information on new and innovative markets, post-fire response and valuation, and Indigenous burning. This could be for several reasons. First, there may be an overlap between tribal members who have fewer years of experience, as these are topics of interest to tribal members. It could also mean that these are really new areas of research that will help forestry practitioners in the future-new markets or more information on Indigenous burning. For younger professionals, these topics could be seen as the future of forest management and information is needed to ensure tribal forestry continues. For the more experienced professionals, these topics could be already known to them (e.g., they know a lot about Indigenous burning) or that they already have as much information as they need on these topics to do their jobs.

We recognize that this assessment has several limitations. The survey respondents represent a relatively low sample size and there is no way to calculate a response rate because the survey link could be used by anyone, and no personally identifiable information was associated with the survey. While there was a good breakdown of regional responses, there were not enough responses to analyze the data to see if there were regional differences in research needs. We also recognize that this assessment instrument and analysis may generally conflict with Indigenous values and knowledge systems that don't separate and prioritize individual natural resource topics. However, this is an important quantitative attempt at summarizing gaps in information and research needs of tribal forested communities.

▼ Maple sap collection on the Passamaquoddy Reservation in Maine. Photo: Michael Dockry.





CONCLUSIONS

Tribes have thousands of years of place-based knowledge. Their relationship with the environment depends on a rich knowledge of tradition, experiences, and practices. That knowledge is sacred and has tremendous meaning to tribal people, often reflecting evidence of significant events that have occurred across space and time. Many tribes tell stories, sing songs, and say prayers that remind them of a time before human beings to acknowledge that animals and plants were here first. It is with their help and guidance, that tribal people survived and thrived for thousands of years. It is told by many Elders that it is now our responsibility to care for those that cannot care for themselves. This research will help tribes and researchers find topics and areas of collaboration to solve some of the most important issues in tribal forestry and natural research management. We recommend that researchers reach out to local tribes to explore mutual interests, build longterm relationships, and combine resources. If researchers work with tribes with respect, honesty, humility, and openness new information will be created that will support natural resource management throughout North America.

Aspen on the Mescalero Apache Reservation in New Mexico. Photo: Serra Hoagland.

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Appendix 1: ITC Research Needs Survey Instrument

The Intertribal Timber Council (ITC) Research Subcommittee is conducting a survey to identify information needs to support tribal forest and natural resource management. The results will be used by tribes, agencies, and researchers to focus their research and collaborative efforts on the most important topics to support tribal resource management.

This survey should take 15-20 minutes and asks for your input about three topics: 1) information needs; 2) information access; and 3) tribal participation in research activities. If you have questions or would like a paper copy please contact: **NAME REDACTED** by May 3, 2019. Survey results will be reported at the 2019 ITC Annual Symposium. The survey is anonymous, and responses will not be attributed to you individually. The raw survey data will be housed by the ITC board of directors and the ITC research subcommittee. At the end of the survey, you will be given an opportunity to add an email address to be entered into a drawing for one of four Eighth Generation blankets. Your survey responses will not be associated with the email. Thank you for your participation in this survey!

Part 1: Information needs to improve tribal forest management

Please share your insights about your information needs for the following questions:

Question 1. Getting new information to improve resource management on your reservation is:

- Extremely important (1)
- Very important (2)
- Moderately important (3)
- Slightly important (4)
- No new information needed (5)
- No opinion (6)

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Roads, Engineering, Transportation, Culverts (1)	0	0	0	0	0	0
Silviculture (2)	0	0	0	0	0	0
Salvage logging (3)	0	0	0	0	0	0
Planting/reforestation (4)	0	0	0	0	0	0
GIS (5)	0	0	0	0	0	0
Inventory (6)	0	0	0	0	0	0
Planning (7)	0	0	0	0	0	0
Growth and yield (8)	0	0	0	0	0	0
Biomass utilization (9)	0	0	0	0	0	0
Site specific information (10)	0	0	0	0	0	0
Optional write-in response (11)	0	0	0	0	0	0

Question 2. Please rate the importance of new information for forest management:

Question 3. Please rate the importance of new information about forest economics and forest products:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Ecosystem services markets (1)	0	0	0	0	0	0
Marketing strategy/branding (2)	0	0	0	0	0	0
Development of new forest products (3)	0	0	0	0	0	0
Certifications (SFI, FSC, etc.) (4)	0	0	0	0	0	0
Non-timber forest products (5)	0	0	0	0	0	0
Appraisal systems (6)	0	0	0	0	0	0
Carbon credits and carbon markets (7)	0	0	0	0	0	0
Milling infrastructure (8)	0	0	0	0	0	0
Recreation/tourism (10)	0	0	0	0	0	0
Optional write-in response (9)	0	0	0	0	0	0

Question 4. Please rate the importance of new information for these forest protection topics:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Forest health (1)	0	0	0	0	0	0
Invasive species (2)	0	0	0	0	0	0
Trespass (fire, logging, etc.) (3)	0	0	0	0	0	0
Tribal Forest Protection Act/adjacent landowners (4)	0	0	0	0	0	0
Livestock grazing (5)	0	0	0	0	0	0
Optional write-in response (6)	0	0	0	0	0	0

Question 5. Please rate the importance of new information for these climate adaptation topics:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Carbon sequestration/carbon credits (1)	0	0	0	0	0	0
Bioenergy (2)	0	0	0	0	0	0
Biochar (3)	0	0	0	0	0	0
Early indicators of changing climate (i.e. phenology) (4)	0	0	0	0	0	0
Seed sourcing (5)	0	0	0	0	0	0
Range shifts (6)	0	0	0	0	0	0
Localized (downscaled) climate modeling (7)	0	0	0	0	0	0
Vulnerability assessments (8)	0	0	0	0	0	0
Adaptation/mitigation planning (9)	0	0	0	0	0	0
Implementation of climate adaptation projects (10)	0	0	0	0	0	0
Optional write-in response (11)	0	0	0	0	0	0

Question 6. Please rate the importance of new information about water:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Water quality (1)	0	0	0	0	0	0
Water quantity (e.g. floods and droughts) (2)	0	0	0	0	0	0
Groundwater recharge (3)	0	0	0	0	0	0
Precipitation timing (4)	0	0	0	0	0	0
Drought mitigation (5)	0	0	0	0	0	0
Cultural importance of water (6)	0	0	0	0	0	0
Optional write-in response (7)	0	0	0	0	0	0

Question 7. Please rate the importance of new information about fish and wildlife:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Threatened and Endangered species (1)	0	0	0	0	0	0
Culturally significant species (2)	0	0	0	0	0	0
Response to treatments (3)	0	0	0	0	0	0
Effects from climate change (4)	0	0	0	0	0	0
Effects from invasive species (5)	0	0	0	0	0	0
Optional write-in response (6)	0	0	0	0	0	0

Question 8. Please rate the importance of new information about fire:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Wildland fire management (1)	0	0	0	0	0	0
Liability (for Rx burning) (2)	0	0	0	0	0	0
Wildland fire Prevention (3)	0	0	0	0	0	0
Indigenous burning (4)	0	0	0	0	0	0
Salvage logging (5)	0	0	0	0	0	0
Fuels management (thinning, piling, under-burning, Rx burning, biomass removal) (6)	0	0	0	0	0	0
Burned Area Emergency Response (BAER) / Burned Area Rehabilitation (BAR) / Emergency Stabilization (7)	0	0	0	0	0	0
Smoke management (human health impacts, emissions, etc.) (8)	0	0	0	0	0	0
Optional write-in response (9)	0	0	0	0	0	0

Question 9. Please rate the importance of new information about social science:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Tribal models of leadership (specialized tribal leadership)(1)	0	0	0	0	0	0
Tribal governance (2)	0	0	0	0	0	0
Federal and state partnerships (3)	0	0	0	0	0	0
Policy (4)	0	0	0	0	0	0
History (5)	0	0	0	0	0	0
<i>Workforce development/training</i> (6)	0	0	0	0	0	0
Optional write-in response (7)	0	0	0	0	0	0

Question 10. Please rate the importance of new information for cultural and traditional ecological knowledge (TEK) integration:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Input into decision making from elders or from cultural committee (1)	0	0	0	0	0	0
Input into decision making from tribal community (2)	0	0	0	0	0	0
Holistic, balanced management (3)	0	0	0	0	0	0
Tribal youth involvement (4)	0	0	0	0	0	0
First foods/food sovereignty (5)	0	0	0	0	0	0
Subsistence harvesting (6)	0	0	0	0	0	0
Integrating (TEK) into management (7)	0	0	0	0	0	0
Optional write-in response (8)	0	0	0	0	0	0

Question 11. Here's the list of information needs you listed as extremely important or very important to improving forest management on your reservation. If you had to prioritize, what do you see as the top 3 information needs to improve tribal forest management? (You can only select three). [Qualtrics presented each survey respondent with a list of their choices to choose three of their top information needs].

Question 12. Please explain what the specific information needs are for each of your top 3 topics listed above [Question 11]. For example, if silviculture was your top information need, please tell us what silvicultural information you need, such as black ash silviculture to mitigate the impacts of emerald ash borer. [Respondents were given space to write why they picked the top three research needs topics].

Question 13. Do you have any other comments about information needs for tribal forest management that we should know about?

Part 2: Access to information

Question 14. Please answer the	following questions	regarding your ac	cess to information	: How
important is it to your job to ha	ve:			

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Internet access to research results (1)	0	0	0	0	0	0
Access to subject matter experts (e.g. workshops, mentoring, one- on-one discussions) (2)	0	0	0	0	0	0
Access to published scientific literature (3)	0	0	0	0	0	0
Access to agency reports and scientific publications (4)	0	0	0	0	0	0
Access to research summaries and updates (5)	0	0	0	0	0	0
<i>Time to read and study information</i> (6)	0	0	0	0	0	0
Optional write-in response (7)	0	0	0	0	0	0

Question 15. Where do you go to access resource management and scientific information (check all that apply)?

• Online scientific journals (1)

- o U.S. Forest Service General Technical Reports (GTRs) (2)
- \circ U.S. Forest Service science you can use bulletins (3)
- Libraries (4)
- Textbooks (5)
- \circ Society of American Foresters publications (6)
- \circ Society of American Foresters meetings and conferences (11)
- Intertribal Timber Council publications (7)
- Intertribal Timber Council meetings and conferences (9)
- \circ Other (8)

Question 16. Of these sources, which is the most important source of information?

• Online scientific journals (1)

- U.S. Forest Service General Technical Reports (GTRs) (2)
- \circ U.S. Forest Service science you can use bulletins (3)
- Libraries (4)
- Textbooks (5)
- Society of American Foresters publications (6)
- Society of American Foresters meetings and conferences (7)
- Intertribal Timber Council publications (8)
- \circ Intertribal Timber Council meetings and conferences (9)
- \circ Other (10)

Question 17. Why are [sources picked in question 16] the most important sources of information for you?

Question 18. ITC has heard that access to scientific journals is important for its membership. How important is access to scientific journals to you?

- Extremely important (1)
- Very important (2)
- Moderately important (3)
- Slightly important (4)
- \circ No new information needed (5)
- \circ No opinion (6)

Question 19. How often do you access scientific journals (pick one)?

- At least weekly (2)
- At least monthly (3)
- \circ A couple times a year or less (4)
- \circ Never (5)
- \circ Other (please explain) (6

Question 20. When do you access journals (pick all that apply)?

- Beginning a new project (1)
- Regular scanning (2)
- When a new problem arises (3)
- \circ When you hear about new research (4)
- When writing grants (5)
- When preparing reports (6)
- \circ Other (please explain) (7)

Question 21. What are the best ways for you to learn about new research (pick two)?

- ITC Blog/website (1)
- \circ U.S. Forest Service blog/website (2)
- Email newsletter (3)
- \circ Hard copy newsletter (4)
- \circ Webinar (5)
- \circ Science synthesis reports (by topical area) (6)
- \circ Searching the internet yourself (8)
- \circ Other (7)

Question 22. Do you have any suggestions on how to improve your access to research?

Part 3: Participating in research activities.

Question 23. Please answer the following questions about your involvement in research activities: Please indicate how important you think it is for tribes to engage in the following activities:

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	No new information needed (5)	No opinion (6)
Designing research studies (1)	0	0	0	0	0	0
Reviewing research studies (including peer-review) (2)	0	0	0	0	0	0
Evaluating research studies (3)	0	0	0	0	0	0
Collecting data (4)	0	0	0	0	0	0
Interpreting and analyzing data (5)	0	0	0	0	0	0
Presenting research results (6)	0	0	0	0	0	0
Establishing research priorities (7)	0	0	0	0	0	0
Finding resources to conduct original research (8)	0	0	0	0	0	0
Securing staff and financial resources to apply research results (9)	0	0	0	0	0	0
Developing partnerships with research institutions (10)	0	0	0	0	0	0
Protecting tribal data (11)	0	0	0	0	0	0
Curating tribal data (12)	0	0	0	0	0	0
<i>Other</i> (13)	0	0	0	0	0	0

Question 24. Have you partnered with any of the following partners on research projects (check all that apply):

- Non-profits (for example The Nature Conservancy) (1)
- Universities (2)
- Tribal Colleges (3)
- Federal agencies (4)
- State Agencies (5)
- \circ Other (please list) (6)

Question 25. Which is your preferred research partner and why?

Question 26. Where does your research funding come from (please check all that apply)?

 \circ Non-profits (for example The Nature Conservancy) (1)

• Universities (2)

 \circ Tribal Colleges (3)

- \circ Federal agencies (4)
- State Agencies (5)

 \circ Other (please list) (6)

Question 27. Are elders present and actively involved in the research process?

- Yes (1)
- No (2)
- Sometimes (4)
- \circ I don't know (3)

Question 28. Are tribal youth or students involved in the research process?

- Yes (1)
- No (2)
- Sometimes (4)
- \circ I don't know (3)

Question 29. If yes [on question 28], please explain how elders or youth are involved in research?

Question 30. How important are research protocols (e.g. research agreements and research review boards) for tribal communities?

- Extremely important (1)
- \circ Very important (2)
- \circ Moderately important (3)
- Slightly important (4)
- Not at all important (5)
- \circ No opinion or don't know (6)

Question 31. Does your tribe or the tribe you work for have a research protocol or formalized process to guide research?

Yes (1)
No (2)
Under development (3)
L dark brow (4)

• I don't know (4)

Question 32. Do you have any thoughts about tribal research protocols, research agreements, or research review boards you would like to share with us?

Question 33. Is there anything else you would like us to know about tribal participation in research activities?

Question 39. Finally, is there anything else you would like us to know about tribal information needs, access to information, or research participation?

Part 4. Demographic Information

In the final section of this survey, we will ask you a short series of questions so we can understand more about you and your work.

Question 40. Are you a member of a federally recognized tribe?

Yes (if so, what tribe?) (1)
 No (2)
 Other (4) ______
 Prefer not to answer (3)

Question 41. Choose one or more races that you consider yourself to be:

- White (1)
- Black or African American (2)
- \circ American Indian or Alaska Native (3)
- Asian (4)
- \circ Native Hawaiian or Pacific Islander (5)
- \circ Other (6)

Question 42. What is your gender?

- Male (1)
- Female (2)
- Prefer to self-identify as: (4)
- \circ Prefer not to answer (5)

Question 43. What state do you live in?

Question 44. What year were you born?

Question 45. How many years have you been practicing forestry (or natural resource profession)?

Question 46. Who do you work for?

- \circ Your own tribe (1)
- \circ Another tribe (2)
- \circ State agency (3)
- Federal agency (4)
- College or University (6)
- \circ Non-governmental organization (NGO) (7)
- Other (5)

Question 47. What is your current position (please indicate your job title)?

Question 48. Which best represents your position (select as many as applicable)?

- Tribal elected official (1)
- Tribal staff (2)
- BIA staff (3)
- \circ Other federal agency staff (4)
- Student (5)
- \circ Contractor (6)
- \circ Other (7)

Question 49. What best describes your discipline?

- Forestry (1)
- Wildlife (2)
- \circ Fisheries (3)
- Botany (4)
- \circ Fire (5)
- Range (6)
- Hydrology (7)
- \circ Environmental (water/air) (8)
- Planning (9)
- Cultural resources/Archaeology (10)
- \circ Other (11)

Thank you for completing our survey and supporting ITC's work! If you would like to be entered into a drawing for one of four Eighth Generation Blankets, please follow this link to provide your email anonymously: [link to option survey to add email]

If you do not wish to enter your email, please click the blue arrow below to finish the survey.

