

# Southwest Tribal Climate Change Workshop

## Workshop Report

September 13-14, 2011  
Flagstaff, Arizona



December 2011

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**Suggested citation:**

Wotkyns, S. 2011. Southwest Tribal Climate Change Workshop. Report from September 2011 Workshop. Flagstaff, AZ: Institute for Tribal Environmental Professionals.

**Acknowledgements:** The USDA Forest Service Rocky Mountain Research Station provided financial support for the workshop through its joint venture agreement with the Institute for Tribal Environmental Professionals. The Southwest Tribal Climate Change Network provided considerable input regarding the workshop agenda.

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## **Introduction**

The Institute for Tribal Environmental Professionals (ITEP), in collaboration with the USDA Forest Service Rocky Mountain Research Station, hosted a workshop at Northern Arizona University (NAU) in Flagstaff, Arizona, on September 13-14, 2011, to bring together tribes in Arizona and New Mexico to discuss tribal climate change issues and concerns, strategies to address climate change impacts, and tribal resource and research needs. Approximately 60 people participated, representing nine tribes in Arizona and New Mexico, four tribal organizations, as well as federal and state agencies, non-profit organizations, and two state universities. This workshop was offered as part of the Southwest Tribal Climate Change Project that focuses on tribal climate change issues in Arizona and New Mexico.

## **About ITEP and its Climate Change Program**

Since its inception in 1992, the Institute for Tribal Environmental Professionals (ITEP) at Northern Arizona University has delivered hundreds of courses on a variety of environmental topics, provided technical assistance, and developed resources such as software and informational websites to serve federally recognized tribes throughout the United States, including Alaska Native Villages. With support from the U.S. Environmental Protection Agency, ITEP has developed training opportunities and educational resources for tribes on climate change issues, including the “Climate Change on Tribal Lands” and “Climate Change Adaptation Planning” courses, the Tribes & Climate Change website ([www4.nau.edu/tribalclimatechange/](http://www4.nau.edu/tribalclimatechange/)), the monthly Tribal Climate Change Newsletter, and the Tribal Climate Change Adaptation Plan Template. ITEP continues to develop its Climate Change Program to provide additional training, resources and assistance to tribes on climate change issues.

## **Southwest Tribal Climate Change Project**

In August 2010, ITEP and the USDA Forest Service Rocky Mountain Research Station ([www.fs.fed.us/rmrs/](http://www.fs.fed.us/rmrs/)) began a collaborative project focusing on tribal climate change issues in the Southwest. The initial goals of the project were to identify existing tribal climate change efforts being undertaken in Arizona and New Mexico, assess tribal research and information needs regarding climate change issues, develop strategies for meeting these needs, and offer a climate change workshop for tribal environmental and natural resource managers that will build knowledge about climate change issues and foster dialogue about the needs and opportunities for tribes in Arizona and New Mexico to engage in climate change planning and action. Several project activities to date include the creation and hosting of the Southwest Tribal Climate Change Network, and the development of a report, *Tribal Climate Change Efforts in Arizona and New Mexico*. Information about the project can be found at: [www4.nau.edu/itep/climatechange/tcc\\_SWProj.asp](http://www4.nau.edu/itep/climatechange/tcc_SWProj.asp). Additional project activities will be identified as the project progresses.

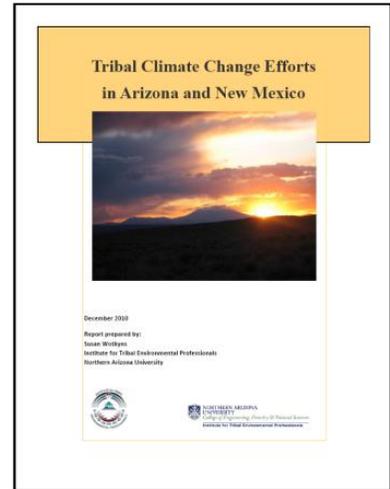
- **Southwest Tribal Climate Change Network**

ITEP hosts the Southwest Tribal Climate Change Network, established in 2011, which provides ongoing engagement among those interested in tribal climate change issues in Arizona and New Mexico. The Network provides regular input into the project’s activities

and also shares resources and information that may facilitate tribal climate change efforts. The Network is open to Arizona and New Mexico tribes and tribal organizations, governmental agencies, universities, and others interested in tribal climate change issues in Arizona and New Mexico.

- **Report: *Tribal Climate Change Efforts in Arizona and New Mexico***

ITEP researched existing climate change efforts being undertaken by tribes, organizations, and academic institutions in the USDA Forest Service Southwestern Region comprised of Arizona and New Mexico, and prepared a report for the USDA Forest Service, entitled *Tribal Climate Change Efforts in Arizona and New Mexico*. Identifying existing climate change efforts serves as a beginning point to engage in an ongoing dialogue related to research, extension, and policy needs for sustainable resource management by tribes.



**Southwest Tribal Climate Change Workshop: a Summary**

The 1½ -day Southwest Tribal Climate Change Workshop was offered as a collaboration of the Institute for Tribal Environmental Professionals and the USDA Forest Service Rocky Mountain Research Station to provide tribes in Arizona and New Mexico an opportunity to learn about and discuss climate change issues and concerns in the Southwest, to discuss strategies for addressing climate change impacts, and to identify resource and research needs of tribes related to climate change. The workshop took place on September 13 and 14, 2011, on the Northern Arizona University campus in Flagstaff, AZ, and was attended by approximately sixty people, representing nine tribes (Acoma Pueblo, Colorado River Indian Tribe, Hopi Tribe, Hualapai Tribe, Navajo Nation, Salt River Pima Maricopa Indian Community, Tohono O’odham Nation, White Mountain Apache Tribe, Zuni Tribe), four tribal organizations (Eight Northern Indian Pueblos Council, Inter Tribal Council of Arizona, Inc.; National Tribal Environmental Council; and Institute for Tribal Environmental Professionals), the USDA Forest Service, the



*Daniel Ferguson, CLIMAS, Univ. of Arizona, gave an overview of climate change in the Southwest. Photo by Stephanie Jackson.*

Bureau of Indian Affairs, Northern Arizona University, University of Arizona, and several other organizations and agencies.

The workshop included informative presentations by scientists and tribal natural resource managers, bringing different perspectives to the topics. The initial session focused on traditional ecological knowledge (TEK) and western science, their similarities and differences, and how they might be used together in understanding problems such as climate change. An overview of climate change and its impacts on the Southwest provided the participants with fundamental knowledge about how the climate has changed and is projected to change in the Southwest, and presentations about water resources and land-based resources

(forestry) served as a starting point for the ensuing facilitated small group discussions that focused on observed climate change impacts on tribal lands, strategies for addressing climate change, and other issues and opportunities. Research and resource needs were expressed and participants had the opportunity to participate in prioritizing those needs. The workshop agenda and presenter bios are available in the Appendices.



*Amanda Stan, NAU; Charles Murphy, Hualapai Tribe; Melvin Hunter Jr, BIA; and Pete Fule, NAU, co-presented on forest issues. Photo by Stephanie Jackson.*

### **Small Group Discussions: Climate Change Impacts and Adaptation Strategies**

The workshop included three sessions of small-group discussions in which the workshop participants were divided into five facilitated discussion groups. Notes were taken on flipcharts, and more detailed notes were recorded by assigned note-takers. Participants discussed the changes they've observed on tribal lands that might be related to changes in the climate. These observations have been grouped below into six broad categories, Weather and Extreme Events; Water Resources; Plants, Agriculture and Forestry; Wildlife; Air Quality; and Cultural Resources. Adaptation strategies to address impacts on water resources and land-based resources, ways to be involved in policy, outreach and education needs, other research and resource needs, and funding needs were discussed and are included below.

Recurrent themes that came out during the discussions were the importance and need for more education and outreach about climate change at various levels (youth, college, community, tribal leadership), for more tribal environmental and natural resource professionals, and for the development of partnerships with different entities (tribal, intertribal, university, regional, state, federal) to address climate change issues.

#### **Weather and Extreme Events**

Many participants noted changes in weather patterns and the increased occurrence of extreme weather events, such as temperature extremes, precipitation events, and dust storms.

- Temperature
  - There are more frequent extremes in temperature. Extreme temperatures above 100 degrees, and also very cold.
  - The Phoenix area experienced high temps for around 110 consecutive days.
  - There are more days when it is hot; it feels like there is less moisture, making the heat feel more intense.
  - High temperatures last longer during the year and winter is shorter.
  - Winter temperatures are getting warmer and there aren't as many freezes.
  - Colder winter temperatures have been observed in some places.
- Precipitation
  - The Southwest is experiencing drier winters and changing patterns in the monsoon.

- Less snowpack is causing less water to be available for irrigation, resulting in cultural impacts on the tribe. Snowpack on the San Francisco Peaks is not lasting as long as it used to.
- Winter weather patterns are changing; extreme snowfall with light rains that cause melting and freezing causing the Interstate to become slick.
- Rain has become fast and frequent, of shorter duration and higher intensity, and more localized. A week of rain flooded out First Mesa, impacting homes and sewer systems. Flooding has impacted the Havasupai.



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- Wind
  - Wind patterns are changing.
  - It's windy for more days, making it more difficult for native plants to survive.
  - There are more dust and sand storms.
  - Increased dust transportation is causing the snow pack to melt at a faster rate.
  - Extreme dust storms called haboobs have happened in the Phoenix area this year.
  - Sand dunes are forming and moving, sometimes into new areas. The dunes are getting bigger, and some are impacting houses.
- Tornados
  - There have been tornado warnings and tornados touching down in areas where they are rarely or never seen, including the Navajo Nation and Flagstaff area.

## Water Resources



Wetland in northern Arizona. Photo by Susan Wotkyns.

Observed impacts on water resources include the lowering of the water table, reduced surface flow, and diminished wetlands and springs. The participants suggested a wide variety of strategies to prepare for and respond to the impacts. Concerns about water resources were brought up throughout the workshop, as a reduction in available water affects so many aspects of life in the arid Southwest.

## Impacts

- Groundwater
  - Overall the water table is dropping, affecting springs that tribes depend on. Natural hanging gardens seem to be drying up. With restoration work, some

springs are coming back, but others that previously were always full have dried up.

- The lack of groundwater is a major problem that needs to be addressed.
- The quantity of snowfall has lessened, reducing groundwater recharge and impacting wells; deeper wells are being drilled to access the lower water table.
- Surface flow
  - Surface flows have been reduced by the diminished groundwater sources and by industrialization.
  - Changes in runoff are affecting the rivers, like the San Juan River, and affecting fish species.
  - The White Mountain Apache Tribe recently switched its water supply source to surface water. The tribe relies on the watershed of the surrounding mountains, but the watershed was threatened this year by the immense Wallow Fire that burned the forest within 3 miles of the watershed.
- Wetlands
  - The wetlands of the White Mountain Apache Reservation are being greatly impacted, affecting the life they support. Fish are not spawning correctly because snowmelt has changed, and deep pools that supported fish no longer exist. The Apache trout have had to be relocated.
- Water quality
  - Water quality has been impacted by mineral extraction practices and industrialization.



*Karletta Chief, Univ. of Arizona, discussed the impacts of climate change on water resources in the Southwest. Photo by Stephanie Jackson.*

### **Adaptation Strategies**

- Expand and diversify water supply
  - Develop new groundwater resources. Upgrade well sites in various areas. Alternate well site areas.
  - Develop alternative water resources.
  - Use rainwater harvesting.
- Improve groundwater recharge/ water storage
  - Consider any strategy that will increase recharge.
  - Use small rock dams, dikes, gabions, catch basin.
  - Develop an underground water storage facility.
- Reduce demand/ improve efficiency
  - Implement water conservation in buildings.
  - Switch from flood irrigation to drip irrigation.
  - Use ditch liners or pipes to prevent loss of water during irrigation.
  - Develop underground aqueducts to reduce evaporation for farming systems.
  - Fix leaks in the system; fix leaky water fixtures.



*Rain harvesting barrel can be used for collecting rainfall from a rooftop. Photo by Susan Wotkyns.*

- Regulate water usage for everyone.
- Develop pay per use system.
- Reuse water
  - Retrofit buildings with gray water systems.
  - Encourage water reuse.
- Improve/protect water quality
  - Develop other water sources to combat water contamination (i.e., arsenic).
  - Minimize exposure of wells to outside pollution by capping any drill wells and dug wells, putting boulders on them, and filling them to protect from contamination.
- Expand/enhance information used for managing water supply
  - Conduct water resources inventory to identify high-risk water resources.
  - Partner with universities on watershed studies.
  - Develop water use plans based on land use plans, to identify where demand is.
- Modify management of water supply
  - Develop flexibility in storage and water release.
  - Integrate management among tribal departments.
- Sewage systems
  - Introduce sewage lagoons into cities; these can improve water quality.
  - Create ways that waste product can become a useable material.
- Reduce erosion
  - Use waddles and straw to reduce erosion flow.
- Landscape management
  - Use drought tolerant/native dry farming seeds.
  - Implement aggressive management of forest resources (i.e., there's too much vegetation). Thinning the forests will have a water return; decreased sublimation and increased melt and recharge.
- Creative water use
  - Create bottled water for the tribe's use.
  - Sell reclaimed water to urban areas.
- Identify funding sources
  - Identify funding sources to construct/develop creative water sources/use (i.e., using USDA money to construct water meters).
- Consider cultural traditions
  - Include cultural considerations of traditional water use (i.e. implementing technology in irrigation/water use).



*Alex Cabillo, Hualapai Tribe, discussed adaptation strategies his tribe is implementing. Photo by Stephanie Jackson.*

## Plants, Agriculture and Forestry

Numerous impacts on plants, agriculture and forestry were noted related to the changing climate and reduction in water resources. The increase of invasive species and the increase in forest fire intensity and frequency were a concern to many. A variety of adaptation strategies were suggested.

### Impacts

- Plants
  - Native plants are being replaced with non-native invasive species, such as tumbleweed (Russian thistle) and camel thorn.
  - Salt cedar (tamarisk), was introduced to prevent erosion, but it has now replaced native plants.
  - Russian olive is using water resources that other native plants would use. Native plants cannot survive the water level changes.
  - Wild tobacco has not grown for three years in areas where it used to grow.
  - Loss of native medicinal plants.
  - Yellow Fungus, which affects grass, has been observed on the North Rim of the Grand Canyon.
- Agriculture
  - Impacts on farmlands include loss of topsoil, poor plant growth, and drought.
  - The depth of moisture in the soil profile has changed; the Hopi previously saw moisture at 8" depth but now moisture doesn't occur until 18" depth.
  - The practice of dry land agriculture is becoming more difficult because rains are coming late.
  - There's been a noticeable change in the growing season within the last five years. Cold fronts in May have affected corn growth.
  - Changing precipitation patterns are affecting the planting cycles.
  - Corn and chili production is changing and there has been no fruit on trees for the past couple of years.
  - It seems as if the changes began 3-5 years ago. Flowers are blooming later in the season.
  - Orchards die quickly.
  - New species of insects are eating whole fields and destroying crops.
- Rangeland
  - Livestock reduction is being implemented because the main nourishment doesn't exist and there's an inadequate supply of water for livestock.
  - Too many horses are present on the Navajo Nation, and Navajo Tribal Utility Authority does not provide livestock water.
  - Cool season grasses are being lost. When they do come out, the livestock are knocking them down.
  - There's a shift on rangeland to drier species.



*Yucca plants are important to some tribes in the Southwest. Photo by Susan Wotkyns.*

- Forests

- There's been an increase in fire intensity and frequency. Fire intensity is increasing, affecting the water quality, fisheries, traditional and exotic species, salamanders, mudslides, flooding, and endangering historical sites. Grazing permits were lost because of the Wallow Fire, causing an economic impact on the tribe. More acres are burning each year.
- The increase in bark beetle is damaging trees. Pinyon production and samplings are being lost. Infestations in forests are causing the forests to die off. Santa Fe and east of Flagstaff had a high rate of pinyon mortality.
- Frost is killing pinyon trees on the Hualapai Reservation. A forest that once was a mix of pinyon and juniper is gradually shifting to strictly juniper.
- There's been a decrease in cottonwood trees in many drainages.
- The area north of the Grand Canyon is getting bigger weeds and larger trees than before.
- The tree density has decreased to the point where there is no coverage from the crowns of the trees.



*Schultz fire in the San Francisco Peaks, northern Arizona, 2010.  
Photo by Susan Wotkyns.*

### **Adaptation Strategies**

- Remove invasive species
  - Replace invasive species (such as tamarisk) with native species.
  - Deal with invasive species following fires.
- Use invasive species as resource
  - Use invasive plants (Russian olives, salt cedars) as a resource, such as for housing materials, wood, fabrication, institutional heating, "Fuels for Schools" (program where the federal government provides money to heat schools in need).
- Manage ecosystems
  - Allow ecosystems to adapt to conditions.
  - Active management of certain eco-zones is needed, for example if you remove salt cedar, put something in its place.
  - Get all the stakeholders on the same page (range, fire, and community members).
  - Address the activities that community members are participating in (such as owning cattle) that affect the landscape and plants.
- Create sustainable gardens
  - Create "waffle" gardens—incorporating rocks into the garden to obtain heat, creating depressions in the



*Susan Wotkyns*

ground to collect water, and using recycled materials are all ways to create a sustainable/recycled garden.

- Protect rangeland
  - Reduce grazing permits.
  - Control feral horses.
- Forest management
  - Implement fuel reduction.
  - Implement forest thinning. Thinning helped prevent the Wallow Fire from spreading onto White Mountain Apache Reservation. Promote thinning as source of firewood or for commercial use.
  - Implement uneven aged forest management.
  - Use prescribed burning (note: it has a negative impact on air quality).
  - Develop an aggressive fire management program, not only to improve commercial timber sector but also for ecosystem health.
  - Incorporate fire management into the planning stage, for example, checkerboard areas will help manage fires.
  - Include people with similar concerns (i.e., Intertribal Timber Council) to encourage collaboration.
  - Partner with the Forest Service; share traditional knowledge with foresters.
  - Rehabilitation projects can create jobs.
  - Plant trees.
  - Establish a greenhouse for seedling starts so if a fire occurs, the tribe will have seedlings to replace lost trees.
- Consider cultural traditions
  - Consider cultural uses for fire (Hopi, Zuni), such as pottery firing or other ceremonial ties.
  - Navajo Nation elders consider burning is a part of the natural cycle; it's an important event for wildlife/ecological health and creates flora diversity.
  - Historically, natives used to eat locusts, which were a big food source.

## **Wildlife**

Many participants noted changes in the ranges of animal species and their populations.

## **Impacts**

- Animal species are changing their ranges and moving into areas where previously they were not found. For example, wildlife such as bears and mountain lions has been coming closer to communities where people live. Accidents caused by wildlife have increased.
- Elk are wintering in different places and their territory is expanding. They are eating farmers' corn.
- Changes in habitat for the wildlife are happening at a rate that can't be controlled.
- Animals such as bobcats and bears are heading to lower elevations, while humans move to higher elevations.

- Habitats for skunks, bobcats, bears, mountain lions, and elk are changing due to changing vegetation.
- There have been changes in wildlife behavior and populations.
- Wildlife is producing less offspring, possibly because of limited vegetation.
- The mule deer population is smaller.
- The quail are producing fewer clutches per year.
- Erratic temperature changes have led eagles to abandon their eggs, impacting their overall reproduction.
- Decreasing prairie dog populations are resulting in less prey for eagles, and communities of prairie dogs are moving into populated and irrigated areas. Prairie dogs are becoming a major problem in agricultural fields.
- Changes in the ranges of birds have been observed. There are fewer songbirds, and sand hill cranes and white winged doves are moving north. Some birds are no longer seen in the community.
- Birds are getting sick with new types of diseases that were not seen before.
- Changes in species cause one population to explode and others to decline.
- Populations of bark beetles, grasshoppers, and mosquitoes have all increased.

### **Air Quality**

Several participants noted impacts on air quality, mostly an increase in particulate matter (PM) from fires and dust storms. These in turn can have an impact on human health.

### **Impacts**

- Air quality has been changing.
- The forest fires are affecting air quality in surrounding communities.
- Since the introduction of vehicles on the Reservation, there are more cars than people. The vehicles increase carbon, more firewood is burned and because of the particulate matter that is in the air, asthma has increased. Air quality is decreasing.
- There have been a lot of problems with PM because of the dust.

### **Cultural Resources**

Several participants brought up concerns about impacts on plants and animals that are used for cultural purposes.

### **Impacts**

- Strawberries are coming in earlier, causing changes associated with ceremonies.
- Cultural impacts are occurring due to the loss of native plants, especially along streams.
- The Hopi Tribe is lacking snakes for snake dances held in August.
- Tribal members traditionally made yucca baskets, but yucca is diminishing.



*Dr. Octaviana Trujillo, Northern Arizona University, spoke about traditional ecological knowledge. Photo by Stephanie Jackson.*

## Policy

The participants identified many ways that tribes can be involved in climate change policy, from the tribal level to the federal level. Some of these include developing partnerships.

- Tribes and inter-tribal level
  - Incorporate climate change in all the natural resource departments.
  - Have the tribal council pass a Tribal Climate Change Resolution. Put resolutions out for the people and community. Adopting a climate change resolution would put more climate change efforts on the tribal leaders.
  - Develop a template for a Tribal Climate Change Resolution—have ITEP create a NCAI -NIEA climate model resolution to present to the All Indian Pueblo Council or a bigger political entity. Develop an intertribal resolution or declaration on climate change impacts and broad adaptation strategies so that each tribe doesn't have to develop one separately. The resolution could include an overview of climate, and include adverse effects of pollution sources, make notice that climate is happening now, and it is a crisis now. The land needs to be emphasized—it is an endangered species—if the land goes, it will take with it all the living organisms that live on it. A copy of the resolution can be given to the tribe to get support, an advocacy letter, or some sort of declaration. Tribes could use ITEP's findings to present and create inter-tribal resolutions, which each tribe could consider.
  - Fight for tribal water rights.
  - Establish water quality standards, and more stringent water quality standards. Exercise rights for water quality and cultural sensitivity.
  - Some reservations have a “let it burn” policy. There might be room for strengthening existing policy, i.e., increasing prescribed burn area.
  - Develop payment for ecosystem services. Bring water markets to bear where downstream users pay for upland maintenance. (Currently, most of the upland areas provide the water to downstream users. Downstream users get that water for free). Example: The Santa Fe watershed is using utility fees to manage the watersheds.
  - Tribes need to form alliance—when people come together they make a bigger change, and they are more powerful.
  - Need better and clear communication from national organizations like BIE, and need them to provide resources to address the issues.
- Region
  - Develop more multicultural alliances that include Indians and non-Indians in a region to develop networking.
  - Look into cooperative agreements for big projects where we can all work together.
  - Get involved in Western Regional Partnership.
- State
  - Influence policy makers at the state level.
  - Agencies need to become more culturally sensitive.

- Federal level

- Influence policy makers at the federal level.
- Have all of the tribes approach the federal government as a unit; everyone has to be on the same page and all want it. Tribes need a unified voice to represent ALL tribes.
- Federal Consultation: gives tribes government-to-government consultation; tribes should be talking to the President. Prior to consultation meetings, tribes need to meet beforehand to understand and discuss tribal needs.
- Need to get problems to the agencies, to someone who goes to the decision-makers.
- Work with congressional representatives. Go to senators as voters.
- Advocate for green energy.
- Advocate for research for tribes covering all areas of climate and water issues. Tribes should create lists of research needs.
- Need more interdisciplinary/interagency co-management.
- Agencies need to become more culturally sensitive.
- Tribes don't need more regulations; they need more jobs.
- Modify water rights laws. In some areas, water rights laws prohibit water collection.



*John Antonio, BIA's National Climate Change Coordinator, gave an overview of BIA's climate change activities and initiatives. Photo by Stephanie Jackson.*

### **Outreach and Education Needs**

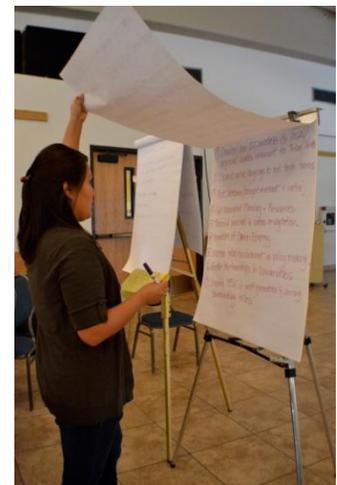
An overarching theme that emerged in the discussions was the need for more outreach and education about climate change issues and for the training and retention of tribal environmental and natural resource professionals.

- General

- Identify educational resources.
- Encourage more and diverse people to attend climate change conferences

- Youth

- Educate the youth. Challenge them to think about what climate change is and what it means to them. Make climate models/temperature projections relevant. Include hydrologic models.
- Use the native language.
- Provide hands-on learning experiences.
- High school outreach is important to catch kids early and foster an interest in land management and the environment.
- Provide camps specializing in natural resource management.
- A big brother-big sister program needs to be created



*Graylynn Hudson, ITEP, recorded information on flipchart. Photo by Stephanie Jackson.*

for tribes that build connections between the generation gap that has been created.

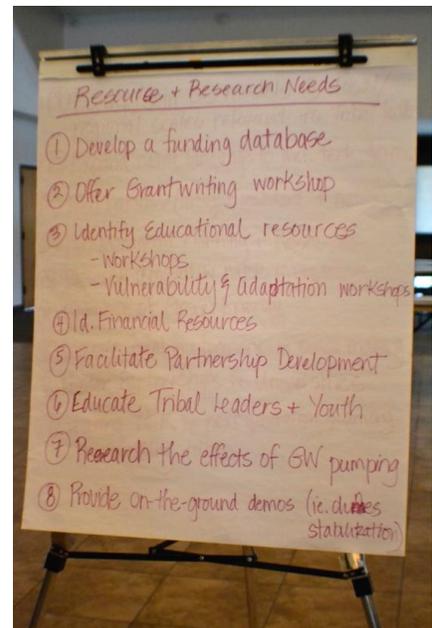
- Use “Kids in the Woods,” “America’s Great Outdoors,” and any federally funded opportunities.
- Teachers need to encourage professions for children that facilitate interactions with their outside world. Many of the children on the reservation have not been off the reservation before.
- Students need to learn science, math, and traditional knowledge to be able to enter environmental positions.
- Have tribal professionals introduce students to concepts while in school by helping develop curriculum and teaching curriculum.
- College
  - Engage graduate students to do the research.
  - Provide education regarding law and policy specific to tribal governance.
  - Offer a certificate program (certificate programs requires less time commitment than full degrees)
  - Programs are needed at tribal colleges that will increase cultural awareness.
  - Advocate for tribal students—have someone from the community recognize and advocate for those individuals pursuing a higher education.
  - Promote collaborations between tribes and colleges. Develop protocols where colleges can create stewardships for native students to collect their own data on their own land that pertains to them. That protocol would allow tribes to use their own technical staff to do the work rather than have contractors come in.
  - Tribal colleges can offer training for employment to tribal members in sustainability. Collaborations could be made, where the tribe could say what is needed and provide a study site for the college students.
- Tribal Professionals
  - Offer professional development opportunities. Support and train tribal professionals.
  - Offer workshops addressing climate change on tribal lands, vulnerability assessments, and adaptation.
  - Offer summer online courses for working professionals.
  - Offer more workshops that address collaboration on climate change. How can tribes be involved? Include United Nation climate change efforts and REDD.
  - Bring in appropriate state and federal agencies to participate in workshops; tribes need to support and collaborate on research projects with universities and federal/state agencies and to develop personal relationships.
  - Have ITEP or ITCA talk with tribe about climate change and provide one-on-one support.
  - Initiate a co-op program like SCEP or STEP for tribal agencies. Having something like these to fill open tribal agency job vacancies would be helpful.
  - Need better retention of trained tribal professionals. Have employee compensation be on par with professional positions outside the reservation.

- Community
  - Educate the community about climate change impacts.
  - Broaden climate change conversation to include the whole community.
  - Provide field trips on tribal lands for tribal members.
  - Hold future workshops on Indian Country, where more tribal members can be included and it is easy access for political figures in the tribe. By having workshops on tribal lands, local revenue is increased.
  - Educate the tribe to bring correlation between TEK and technology regarding water.
  - Further promote prescribed burns through education and outreach to tribal public.
- Tribal Leadership
  - Educate tribal leaders about climate change. Collect more information on climate change impacts. This will secure more funding and programs.
- Federal and state agencies
  - Educate federal and state agencies about traditional ecological knowledge (TEK).

### Other Resource and Research Needs

A variety of other resource and research needs were identified, including needs for data sharing, demonstration projects, water- and forest-related research, and partnership development.

- General
  - Need to do implementation, not research. The land is going to become inhabitable if we wait for research results.
  - Tribes need better access to expertise.
  - People from around the world want the opportunity to learn from Indigenous people. How do we create a model community that will incorporate ecotourism, art, food, tribal sustainability?
  - Collect oral histories.
  - Develop database of contractors who can work with tribes to develop climate change vulnerability assessments, adaptation plans.
- Data
  - Need data sharing. Tribes need access to data collected by government agencies. Need data that is easily accessible and easy to use.
  - Develop central repository of data.
  - Better coordination of information management on a large scale is a huge need.



*Flipchart listing some of the needs identified during the workshop. Photo by Stephanie Jackson.*

- Need to consider tribal sovereignty; tribes may not want to release information, and they want control over how it's going to be used.
- Demonstration projects
  - Need more on the ground demonstration studies instead of funding just academic studies.
- Identifying community priorities
  - Research community priorities (include adults, elders, and leaders). When designing research, tailor to the community, for example, consider the average reading level. Some people may not understand technical terms so it requires explaining research in a way that makes sense to the person/participants. Include cultural committee to ensure tribe is protected. The current timeline for approving research is about 2-3 years. Know your audience and tailor to your audience.
- Water
  - Need region-wide watershed studies.
  - Need groundwater modeling.
  - Need water management planning.
  - A mechanism or system to reduce evaporation is needed.
  - Need basin-wide authority; need a substantive vision.

- Plants, Agriculture and Forestry
  - Do natural resources inventory.
  - Need research on pinyon-juniper (PJ) forests, which is the dominant type of forest on a lot tribal lands—there's been little research on PJ. Does thinning PJ provide hydrologic benefits?
  - Need better modeling for fire behavior based on different climate change temperature/precipitation scenarios. It would be very beneficial to know what a catastrophic fire would do, especially regarding Mexican spotted owl habitat or butterflies, for that matter.
  - Study invasive plants and how to respond to those invasive plants.
  - Research ways to use invasive plants (Russian olives, salt cedars) as a resource, such as housing materials, wood, fabrication, institutional heating, "Fuels for Schools" (program where the federal government provides money to heat schools in need). Historically natives used to eat locusts, which were a big food source. Resources such as these that are presenting themselves need to be investigated and utilized. Culturally, do we let grasshoppers eat the fields that were planted or use the grasshoppers as a renewable food resource? How will seed sources for crops be sustained? Will cultures shift back into dryland farming?



*Pinyon-juniper forests are being impacted. Photo by Susan Wotkyns.*

- Wildlife
  - Monitoring would be helpful. Information gathering on species, i.e., on birds, such as relative abundance, species absence/presence. Photo stations are best because changes in species distribution patterns can be readily seen and photos are much more impactful than just raw statistical data.
- Green building
  - Research new construction techniques. Require site rehabilitation costs be developed into construction projects. Storm water pollution plans need to be incorporated. Leave as much vegetation as possible in place at construction site. Allow for communal space, like community gardens.
  - Integrate old technology with new technology (such as building methods).
  - Develop “green” construction codes.
- Partnerships
  - Develop partnerships with various entities.
  - Form stronger collaborations.
  - Partner with NPS, with USFS and multiple states and counties.
  - Need collaboration of tribes and universities on research projects.
  - Need collaboration of tribes and state.
  - Seek volunteer groups that are open to traditional values in urban areas.
  - Involve the community.

## **Funding Needs**

Many participants conveyed funding-related concerns, including the need for funding to support their work and assistance in identifying funding sources and writing grant proposals.

- Funding to support tribes
  - Need funding resources to support work.
  - Need funding for staffing.
  - Federal funding projects need to be long term to maintain sustainability.
  - Tribes need funding resources to attend climate change conferences.
- Identifying funding opportunities
  - Identify financial resources.
  - Develop a funding database for tribes.
- Writing grants
  - Provide grant-writing workshops for tribes.
  - Tribe needs a grant writer.
  - Grant writing program to help tribes write effective proposals.
  - Grant application process needs to be more supportive of tribal needs. Are RFPs culturally sensitive?
  - Develop a template to present to multiple agencies asking them for funding and guidance. “My tribe is asking you to honor this and this is why.” Issues need to be compiled and presented to headquarters, and a commitment is needed from the agencies. If the tribe were given funding from the federal agencies rather than the government being contracted, the tribe could create their own jobs.

- Funding sources
  - Need better access to funding.
  - Pursue federal and non-profit grant opportunities.
  - Develop a tribal trust fund. Have the tribe set up a tribal trust fund to help protect children of the future. Create an Environmental Trust Fund. Tribes need to be proactive and positive. Can the tribe's gaming commission set up a trust fund?
  - Have tribes come together and be the funding source. Create an endowment? Provide matching funds. Some tribes have water right settlements—can these be used to create a bigger pool of funding?
  - Amend tax codes to create funding.
  - Can land claims or land restoration funds be used to generate funding? If so, set aside that funding for college scholarships.

### **Prioritization of Needs**

One of the outcomes of the workshop was the prioritization of the needs expressed by the workshop participants during the small group discussions. This prioritization by the workshop participants will help ITEP, the USDA Forest Service, and other organizations and agencies determine the focus of future projects.

Following the last small-group discussion, ITEP staff quickly reviewed the flip charts for needs expressed during the discussions. ITEP listed a total of 36 needs on flipcharts and posted these for the workshop participants to review. Each participant was given three colored stickers and was asked to place the stickers by those needs they thought were a priority. ITEP later tallied these; see Appendix 3 for the list of needs that were included in the prioritization exercise.

The needs identified as the highest priorities were:

- Educate tribal leaders and youth (21 votes)
- More tribal environmental and natural resource professionals (21 votes)
- Water management planning and resources (18 votes)
- Climate change resolution to tribal entities (template) (16 votes)

The prioritization was flawed in that there was little time for ITEP to review the flipcharts and list the needs, and there was no time to review the detailed written notes; thus, some needs identified during the discussions were inadvertently not included in the needs prioritization list. The workshop organizers had not anticipated the large volume of material that was generated from the discussions. In retrospect, a better approach might have been to compile the list of needs following the workshop and then ask the workshop participants to prioritize the needs using an online survey.

### **Workshop Evaluations**

At the conclusion of the workshop, ITEP received 42 evaluation forms completed by the workshop participants. The lodging accommodations (Courtyard Marriott) and training facility (Du Bois Center, Northern Arizona University) received mostly “Very Good” and “Excellent” ratings. Most of the respondents rated the amount and difficulty of material covered, and the

spacing of daily activities, as “Just Right.” Most “Agreed” or “Strongly Agreed” that the workshop content was relevant to tribal concerns, what they learned will be useful in their jobs in the next 6 months, and that they would recommend the workshop to others.

A sampling from the many comments written on the evaluation forms:

- *The presenters did not speak above the audience and were genuine.*
- *Varied info on different aspects of climate change.*
- *Everything was set up right. It was very professional and paced right to where I did not lose interest.*
- *Climate change affects every person on Earth. Climate change education needs to be done for tribal leaders and decision makers.*
- *It motivates me to continue to inform kids about climate change concerns & how it will affect the communities, families, and resources.*
- *This is a very important, urgent issue.*

Suggestions for improving/changing the workshop included changes in the amount of presentation vs. small group discussion time (suggestions went both ways—some wanted more presentations, others wanted more discussion time); length of workshop (longer); more topics; more depth on topics; more group participation; more time for small groups to report back to large group; more participation by government agencies and other entities; tabletop exercises to provide examples of adaptation/mitigation strategies; location (in Indian country to view impacts directly, to have tribal council members and/or community members participate, to do field trips; in New Mexico); send out a pre-workshop survey to identify topics to focus on in workshop. Several respondents also suggested offering a climate change workshop geared at tribal leaders/decision-makers.

Topic suggestions for future workshops include the following:

- Overview of what climate change is, why it is an issue globally, and the local impacts
- Extreme weather events
- Impacts on wildlife, especially endangered species
- Impacts on different eco-regions within the Southwest
- Invasive species, agriculture, soils
- Forests—bark beetle, plant community changes
- Ecosystems—carrying capacity, adaptive management
- Water resources—basic hydrology, impacts on surface water, water quality, groundwater, precipitation. Have an entire workshop focus on climate change and water resources.
- Tribal case studies—tribal efforts to address climate change, successes, challenges
- Specific examples of what tribes can do; actionable steps, specific demo projects, steps with specific agencies, specific political steps

- Climate change adaptation and mitigation process—steps to start the process on federal, state, and tribal levels
- Western science and traditional culture teachings, to make information suitable to science world
- Green energy
- Development of climate change documents; resolutions/declarations, climate change vulnerability assessments, adaptation plans, mitigation plans
- Examples of interagency agreements
- Train-the-trainer: training model (PowerPoint) and facilitator training, for professionals to convey information to their communities and council
- Climate change outreach and education; curricula for K-12
- Climate change policy—federal, international
- Cultural sensitivities—to educate federal agencies about tribal traditions, sensitivities
- International climate change issues, United Nations work on climate change
- Funding: sources of funding for climate change education for tribes, implementation of climate change plans; grant writing

## Appendix 1: Workshop Agenda

# Southwest Tribal Climate Change Workshop

September 13-14, 2011

Flagstaff, AZ

Du Bois Conference Center, NAU

Day 1 -- Tuesday, September 13, 2011

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7:45 AM      **Check in - Coffee, tea and assorted pastries**

8:00 AM      **Invocation**      Clayton Honyumptewa, Hopi Tribe

### **Welcome and Opening Remarks**

#### **Introduction of Workshop Participants**

Dr. Laura Huenneke: Vice President for Research, NAU

Ann Marie Chischilly: Executive Director, Institute for Tribal Environmental Professionals, NAU

Carol Raish: USDA Forest Service, Rocky Mountain Research Station

**Overview of agenda** – Sue Wotkyns, Climate Change Program Manager, ITEP, NAU

9:00 AM      **Traditional Ecological Knowledge and Western Science**

Larry Mason: University of Washington, retired; Forestry Consultant

Dr. Karen Jarratt-Snider: Applied Indigenous Studies, NAU

Dr. Octaviana Trujillo: Applied Indigenous Studies, NAU

*This session focuses on traditional ecological knowledge and western science, their similarities and differences, and how they might be used together in understanding problems such as climate change. This session will include a powerpoint presentation that shares what was learned from a TEK/western science workshop held last year; native perspectives on the issue; and a facilitated discussion with the participants.*

10:30 AM      **Break**

10:45 AM      **Small Group Discussion: Observed Climate Change Impacts on Tribal Lands**

Dr. Karen Jarratt-Snider, Dr. Octaviana Trujillo, and Larry Mason

*Participants will break out into 5 groups to discuss the changes they've observed on tribal lands that could be related to changes in the climate. Each group will list these on flip chart pages.*

- 11:30 AM      **Lunch (on your own)**
- 12:45 PM      **Climate Change in Indian Country: Challenges and Opportunities**  
John Antonio: BIA, National Climate Change Coordinator
- Overview of BIA's climate change activities and initiatives*
- 1:15 PM      **Climate Change--Global to Southwest**  
Dan Ferguson: University of Arizona, CLIMAS
- Presentation provides an overview of climate change, with an emphasis on how the climate is changing in the Southwest.*
- 2:15 PM      **Climate Change Adaptation and Mitigation**  
Dr. Karen Jarratt-Snider: NAU Applied Indigenous Studies
- A native perspective on climate change adaptation and mitigation.*
- 2:30 PM      **Break**
- 2:45 PM      **Water: Issues and Opportunities (45 minutes)**  
Dr. Karletta Chief: University of Arizona, Soil Water Environmental Science Dept.  
Alex Cabillo: Hualapai Tribe, Water Resources Manager  
Laura Watchempino: Pueblo of Acoma, consultant
- This session will include an overview of how climate change is impacting water resources in the Southwest, followed by examples of impacts on tribes and strategies tribes are taking to address these impacts.*
- 3:30 PM      **Small Group Discussion (45 minutes).**  
*Participants will break out into 5 groups to discuss the following questions. Responses to the questions should be recorded on flip chart pages. A spokesperson should be selected for the group.*
- 1) *What adaptation strategies can be used to address the problem?*
  - 2) *What kind of policy and programmatic solutions can tribes engage in and at what level (tribal, regional, national, international) to address the issues?*
  - 3) *What kind of resources and research would be most helpful to tribes?*
- 4:15 PM      **Small Groups report back (30 minutes)**

*A spokesperson from each small group will give a summary of the responses to the discussion questions.*

4:45 PM **Announcements, Reimbursement Forms** - Christy Nations, ITEP

5:00 PM **Adjourn**

## Day 2 -- Wednesday, September 14, 2011

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7:45 AM **Check in** - Coffee, tea, and assorted pastries

8:00 AM **Overview of Day 2** - Sue Wotkyns, ITEP

8:15 AM **Land-based Resources: Issues and Opportunities** (45 minutes)

Dr. Pete Fule: NAU School of Forestry

Dr. Amanda Stan: NAU School of Forestry

Charles Murphy: Hualapai Tribe, Forestry Department

Melvin Hunter: BIA, Forestry

*This session will include an overview of how climate change is impacting forests and other land-based resources in the Southwest, followed by examples of impacts on tribes and strategies tribes are taking to address these impacts.*

9:00 AM **Small Group Discussion** (45 minutes)

*Participants will break out into 5 groups to discuss the following questions. Responses to the questions should be recorded on flip chart pages. A spokesperson should be selected for the group.*

- 1) *What adaptation and mitigation strategies can be used to address the problem?*
- 2) *What kind of policy and programmatic solutions can tribes engage in and at what level (tribal, regional, national, international) to address the issues?*
- 3) *What kind of resources and research would be most helpful to tribes?*

9:45 AM **Small Groups report back** (30 minutes)

*A spokesperson from each small group will give a summary of the responses to the discussion questions.*

10:15 AM **Break**

10:30 AM **Key Themes and Research/Resource Needs** – Sue Wotkyns, ITEP

*Brief summary of the key themes of the workshop and the research and resource needs that were identified.*

**Prioritize the Research and Resource Needs – All  
Workshop Participants**

*All of the participants will be given three colored stickers which they will place on the flipcharts to indicate the three research/resource needs that they think are a priority. Following the workshop, ITEP and the USDA Forest Service will use this information to identify possible projects to undertake that will help tribes address climate change issues.*

11:30 AM **Closing Remarks** – Mehrdad Khatibi, ITEP and Carol Raish, USFS

**Workshop Evaluations**

**Invocation** Clayton Honyumptewa, Hopi Tribe

12:00 PM **Adjourn**

## **Appendix 2: Presenters Bios**

### **John E. Antonio Sr.**

John Antonio is a member of the Pueblo of Laguna Tribe. He currently is the National Climate Change Coordinator for the Bureau of Indian Affairs, Office of Trust Services, in Washington, DC. John served two terms (4 years) as Governor, Pueblo of Laguna, January 1, 2007 through January 1, 2011, and also served two terms on the Laguna Tribal Council in the 1990's. He has worked 32 years in natural resources management including: Native American Liaison, for the U.S. Fish and Wildlife Service; Area Wildlife Biologist for the Bureau of Indian Affairs; Director of the Navajo Fish and Wildlife Department; Supervisory Wildlife Biologist for the Navajo Fish and Wildlife; and Environmental Scientist for the Council of Energy Resource Tribes. He is Co-founder and past President, Vice-President, Secretary, Treasurer, and Board Member of the Native American Fish and Wildlife Society. He also served as the Chairman of the Southwest Tribal Fisheries Commission.

John has served as a past member on various Advisory Committees including: New Mexico State University, President's Advisory Council for Native American Affairs; NMSU Advisory Council for the Department of Fisheries and Wildlife Sciences; Southwest Indian Polytechnic Institute Natural Resources Program Advisory Council; New Mexico Ecology Education Association Advisory Council; New Mexico Museum of Natural History and Science, Citizen's Advisory Council; Native American Fish and Wildlife Society, Education Advisory Council; Coordinator,

Southwest Region Native American Natural Resources Youth Practicum; Governor Bill Richardson's New Mexico DWI Task Force. He currently serves on the American Eagle Foundation's Bald Eagle Grant Advisory Team.

John received various awards during his career including: New Mexico State University, Centennial Celebration Outstanding Alumni; New Mexico State University, Distinguished Alumni (award ceremony October 28, 2011); Bureau of Indian Affairs, Special Achievement Awards; U.S. Fish and Wildlife Service, Special Achievement Awards; Native American Fish and Wildlife Society, Chief Sealath Award. He received a Bachelor of Science in Agriculture and Wildlife Science from New Mexico State University in 1975. He and his wife Phyllis have been married for 36 years and they have two sons, two daughters and three grandsons.

### **Alex Cabillo**

Alex Cabillo is a Hualapai Tribal member who is currently employed as the Tribe's Water Resource Manager. He is a former Tribal Council Member. He has worked on Hualapai water resource preservation and conservation issues for over a decade. On the reservation, water quality monitoring occurs at over 54 surface and ground water sites; this is to ensure that the waters are within acceptable limits of the tribes' water quality standards and designated uses. Alex is responsible for conducting source water assessment and protection plans of the different aquifers on the reservation. To aid in the protection of the ground water resources for future generations, a Ground Water Overlay Protection Ordinance was developed and ratified into

tribal law for the tribe. He manages a multi-year wetland demonstration pilot project that involves monitoring wetland water quality and the sampling of macro invertebrates, to establish baseline information correlated to wetland health and functionality. The primary focus is climate change impacts (drought) and trying to forecast the extent of the impacts and development of adaptive strategies from a proactive approach, rather than reactive.

### **Karletta Chief**

Dr. Karletta Chief is an Assistant Professor and Assistant Specialist in the Department of Soil, Water, and Environmental Sciences at the University of Arizona in Tucson, AZ. The goal of her research is to improve our understanding, tools, and predictions of watershed hydrology, unsaturated flow in arid environments, and how natural and human disturbances affect soil hydrology through the use of physically based methods. Karletta's research also focuses on how indigenous communities will be affected by climate change and collaborated in an interdisciplinary group of scientists including hydrologists, system dynamic modelers, and social scientists to determine how hydrological models can be improved to identify and mitigate risks to these vulnerable populations. Dr. Chief is originally from Black Mesa, AZ and grew up on the Navajo Nation. Dr. Chief graduated from Page High School in 1994 and is a first generation college graduate. She received a B.S. and M.S. in Civil and Environmental Engineering from Stanford University in 1998 and 2000. As a National Science Foundation Doctoral Fellow, she received her Ph.D. in Hydrology and Water Resources in the School of Engineering at the University of Arizona (UA) in 2007. Her Ph.D. minor was Soil, Water, and Environmental Science. Dr. Chief was awarded the John Rainer American Indian Leadership Award, Stanford University Minority Alumni Task Force Featured Alumni, University of Arizona Centennial Doctoral Student Award, Arizona Hydrological Society Scholar, and 2010 American Indian Science and Engineering Society "Most Promising Engineer/Scientist of the Year."

### **Dan Ferguson**

Daniel Ferguson is the program director for the Climate Assessment of the Southwest (CLIMAS) housed in The University of Arizona's Institute of the Environment. CLIMAS, one of NOAA's Regional Integrated Sciences and Assessments (RISA) programs, has an explicit mission to connect climate science to decision making in the Southwest. Dan directs the day-to-day operations of the CLIMAS program, including outreach and assessment efforts with stakeholders throughout the region. In addition to his management responsibilities, Dan's research focuses on three related areas: communication of science for decision making; methods and processes for building partnerships to address climate-related issues in society; and climate impacts and adaptation strategies in Indian Country. Prior to his research appointment at the University of Arizona in 2005, Dan spent several years in Fairbanks, Alaska managing the science management offices for the National Science Foundation's Arctic System Science program and the affiliated Human Dimensions of the Arctic System program.

### **Peter Fulé**

Dr. Peter Fulé is a Professor in the School of Forestry, Northern Arizona University. His research interests are fire ecology, ecological restoration, and climate/fire interactions in the southwestern USA, Mexico, and the Mediterranean. His work focuses on application of tree-ring

analysis and simulation modeling to study long-term patterns of the relationships among fire regimes, climate patterns, and forest dynamics.

### **Melvin Hunter Jr.**

Melvin Hunter Jr. is a member of the Hualapai Tribe located in Peach Springs, AZ. He is a 2010 Graduate of Northern Arizona University School of Forestry, with an emphasis in fire ecology, and is employed by the Bureau of Indian Affairs – Truxton Cañon Agency – Branch of Fire Management as a Forester/Acting Fuel's Specialist. Melvin's interest in wildland fire began in 2005 during a prescribed burn within a ponderosa pine stand. As the fire rolled across the landscape he was concerned of how far the flame would travel on the opposite side of an unburned hill. He hiked to the top and watched the fire come to a halt. This sparked an interest of how independent vegetations respond with fire behavior, which led to studying shifts in vegetations at ecotones in response to wildland fire. As a resource manager, he strives to meet the mission of the BIA and focuses on developing the youth of our tribes.

### **Karen Jarratt-Snider**

Karen Jarratt-Snider, Ph.D. is a Political Scientist and Assistant Professor in the Department of Applied Indigenous Studies at Northern Arizona University and a faculty research associate with the Institute for Tribal Environmental Professionals at NAU. Her areas of research and teaching interests include Indigenous Environmental Justice, USDA Forest Policy and Indigenous Peoples, Federalism-American Indian Intergovernmental Relations, Tribal Administration, Tribal Community-Based Participatory Research Models, Federal Indian Policy and Law, and STEM Education for Indigenous Students, and Sustainable Economic Development and Indigenous Entrepreneurship.

Prior to joining the faculty of the Department of Applied Indigenous Studies at Northern Arizona University, Dr. Jarratt-Snider was a member of the faculty in the Department of Southwest Studies and American Indian Studies at Fort Lewis College and the Senior Research Analyst with the American Indian Policy Institute at Arizona State University, where she was engaged in community-based research with indigenous nations throughout Arizona.

### **Larry Mason**

Larry Mason has a B.S. in Forest Management, an M.S. in Silviculture and Forest Economics along with 40 years of experience in forest industry, forest policy, and forestry research. His early career was spent on the Olympic Peninsula in Washington where he owned and operated a sawmill and logging company. For the last 15 years, he was a forestry research scientist at the University of Washington with focus on Forest Systems Analysis, Life Cycle Analysis, Bioenergy Development, and Forest Products Manufacture and Marketing. He is a frequent presenter at forestry conferences and symposia and has published more than 30 journal articles, working papers, and legislative reports. He is no stranger to Indian Country having worked with individual tribes, the BIA, and the Intertribal Timber Council (ITC) on numerous projects. In 2011, Larry received the Earle R. Wilcox Memorial Award for Outstanding Service to Indian Forestry. In 2010, Mr. Mason retired from the UW and continues his work as the

principle consultant for Alternate Dimensions Inc. and a member of the national Indian Forest Management Assessment Team (IFMAT).

### **Charles A. Murphy**

Charles Murphy has been working as the Forest Manager for the Hualapai Tribal Forestry Department since 1985. He is responsible for a BIA contract involving forest development, timber sale planning and administration, and forest inventories. He received a B.S. in Forestry from Northern Arizona University in 1982, and a M.S. in Forest Management from NAU in 1988. His thesis project; Developed Ponderosa Pine Growth model for Hualapai Forest.

### **Amanda Stan**

Dr. Amanda Stan is a Postdoctoral Research Associate, in the School of Forestry, Northern Arizona University. Dr. Stan is a biogeographer, with interests in applying tree-ring techniques to studies of population dynamics and disturbance processes in forests. She completed her Ph.D. at the University of British Columbia in Vancouver, Canada. Dr. Stan recently received funding from the USDA's National Institute of Food and Agriculture to support an integrated project that links research on forest fire ecology of the Hualapai tribal lands with educational and extension activities to assist the Tribe in adapting and managing their forest lands under a changing climate.

### **Octaviana V. Trujillo**

Dr. Octaviana Trujillo (Yaqui) is the founding chair and professor of the Applied Indigenous Studies Department at Northern Arizona University in Flagstaff, Arizona. She is working with the American Indian Higher Education Consortium (AIHEC) and Tribal Colleges and Universities on climate change and Native science curriculum with support from the National Science Foundation. Professor Trujillo is a member of the national advisory council to the Environmental Protection Agency (EPA). Other professional service includes the Advisory Circle of the University of Winnipeg's new Master's of Indigenous Sustainable Development. Dr. Trujillo recently accepted a Visiting Fellow appointment at the Ludwig-Maximilian University, Rachel Carson Center for Environment and Society in Munich, Germany. She provided lectures at the center's annual Global Environment Summer Academy.

### **Laura Watchempino**

Laura Watchempino assisted with the development of water quality standards for the Pueblo of Acoma. She served on the Acoma Water Commission prior to becoming a water quality specialist for the Haaku Water Office. She was responsible for the management of water quality data collection and interpretation for the Water Office from 2000-2009. Laura continues to participate in water resource protection activities at Acoma.

### Appendix 3: Ranking of Needs

Number of votes	Needs
21	Educate Tribal Leaders and Youth
21	Need more tribal professionals: interns/co-ops, certificates for professionals, outreach to high school students during school year and summer, summer institute, assist tribal colleges w/starting environmental degree programs, outreach to youth about TEK
18	Water management planning and resources
16	Resolution to Tribal Entities(NCAI,NIEA,etc)
9	Facilitate Partnership Development
8	Provide on the ground demos (i.e. dune stabilization)
6	Increase Tribal involvement in policy making
6	Field trips on tribal lands
5	Foster Partnerships with universities
5	Partner w/trustee federal agencies to have field work performed by tribal members
4	Continue SW Tribal Climate Change Network: do follow-up workshops, bring in appropriate federal/state agencies
3	Grant writing workshop
3	Develop and Join CC models @ local/regional scales relevant to Tribal lands
3	Long term monitoring of species
2	Develop a funding database
2	Sharing TEK with next generation and among surrounding tribes
2	Survey community including elders on climate change concerns
2	Foster better communication across disciplines/organizations
2	Models of future change
1	Financial Resources
1	Expand native language to include technical terms
1	Food database (drought resistant and native)
1	Tamarisk removal with native re-vegetation
1	Promotion of Green energy
1	Training on international climate change issues: how can tribes be involved? What is REDD?
1	Foster sharing of data
1	Natural resource inventory
	Identify Educational resources: workshops, vulnerability and adaptation workshops
	Research the effects of groundwater pumping
	Foster partnerships between USFS and 4FRI initiative and tribes
	more training on climate change
	Collect more info on CC impacts
	Develop policies with "teeth" so tribes can enforce them(but not too specific)
	Vegetation modeling
	More studies on Juniper
	Juniper removal