Arizona Forest Action Plan

A collaborative analysis of natural resource conditions, trends, threats, and opportunities.

Arizona Department of Forestry and Fire Management

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1.0 Executive Summary

Introduction

Arizona is a land of diverse landscapes. About one-tenth of Arizona is forested, one-fourth is woodland, one-fourth is grassland, and the rest is desert shrub. Elevations above 6,000 to 7,000 feet host forests of ponderosa pine (*Pinus ponderosa*), topped in the highest areas by Douglas fir (*Pseudotsuga menziesii*) and other firs (*Abies* spp.), spruces (*Picea* spp.), and aspen (*Populus tremuloides*). From 4,500 to 7,500 feet in the northern half of the state, piñon pine (*Pinus spp*.) and juniper (*Jiniperus* spp.) predominate, while evergreen oak and chaparral grow between 4,000 and 6,000 feet in the central mountains. Plains grasses cover about one-third of the Colorado Plateau, and Sonoran or desert grasslands carpet the higher elevations of the basins. Mesquite (*Prosopis* spp.) trees and shrubs have invaded many historical grasslands in the southern part of Arizona. Cacti grow throughout the state, with the greatest variety below 2,000 feet. Foothills in the Tucson-Phoenix area carry giant saguaro cacti (*Carnegia gigantea*) of the Sonoran Desert, matched in areas of the northwest Basin and Range Province by dramatic stands of Joshua trees (*Yucca brevifolia*). Shrubs dominate the lowest portions of all areas: big sagebrush (*Artemesia tridentata*) and saltbush (*Atriplex* spp.) in the Colorado Plateau, creosote bush (*Larrea tridentata*) in the Basin and Range.

Land ownership within Arizona is also quite diverse. Federal and state agencies and Native American Tribes manage the majority of lands with only a small portion (13%) being privately owned. The Forest Action Plan (FAP) is truly reflective of this diverse land base and draws on the strong relationships with many organizations and agencies. This collaborative "all lands" approach for the FAP is critical for successful near-term and long-term positive outcomes on the landscape.

The development of the FAP was prompted by federal legislative requirements. The amended Cooperative Forestry Assistance Act of 2008 (commonly referred to as the Farm Bill) added new requirements for the states to identify priority forest landscape areas (i.e., a statewide assessment of forest resources) and highlight work needed to address national, regional, and state forest management priorities (i.e., a statewide forest resource strategy).

States were required to complete a Forest Action Plan in order to qualify for funds under the Cooperative Forestry Assistance Act (CFAA). The CFAA funds are provided to states through the State and Private Forestry (S&PF) program of the USDA Forest Service. Currently, Arizona receives several million dollars annually to protect communities at risk from wildfire, assist private forest landowners, promote sound forest practices, and assist communities with their urban forests. Most of the CFAA funding received by the Arizona Department of Forestry and Fire Management (DFFM) is provided as grants to local organizations that provide matching funds and additional planning and implementation resources. The combination of state and local efforts, along with coordination and collaboration with federal, tribal and other land management agencies, provides substantial leveraging of CFAA funds to benefit Arizona forests, woodlands, and citizens.

The responsibility for developing the Forest Action Plan belongs to the State Forester and DFFM. The State Forester appointed a task group with diverse representation to work with agency staff to develop the final *Arizona Forest Resource Assessment and Arizona Forest Resource Strategy*, and both documents were completed in June 2010.

The Farm Bill requires states to review their Forest Action Plans every 5 years. In 2015, DFFM created the *Status Report and Addendum* in which the implementation of Arizona's Forest Action Plan since 2010 was summarized. The State and Private Forestry Board introduced new "National Priorities" and required that they be included in state Forest Action Plans. As such, an Addendum was made to the Forest Action Plan, which provided an overview of the implementation summarized by the three National Priorities.

This document, the 2020 FAP, is the 10-year update to the original Forest Action Plans completed in 2010. While the 2010 *Assessment and Strategy* focused on forests and woodlands exclusively, the FAP takes an "all lands" approach and expand its scope to include the entirety of the state of Arizona. This approach has allowed for more collaboration, which lead to a better evaluation of Arizona's natural resources, threats to those resources and strategies to address these threats. As described in the Assessment Methodology and Outreach section, the 2020 update included and stakeholder review and edit. However, even though the FAP has changed and expanded some of the original ideas of the 2010 Forest Action Plan, it stays true to the basic principles identified early in the process:

1. Build upon a strong collaborative foundation
2. Use and leverage existing work to the fullest extent possible
3. Develop a strong framework for future work

Overview of Issues

The 2020 FAP, like the 2010 FAP organized the critical resource issues into eight major categories:

1. People and Landscapes
2. Ecosystem Health
3. Water
4. Air
5. Fire
6. Economics
7. Climate Change
8. Culture

As issues were identified, evaluated and classified, it became clear there were three overarching needs that cut across all of the issues:

1. Funding to accomplish land management activities
2. Developing the capacity to collaboratively accomplish land management goals
3. Educating the public about natural resource management.

It is clear that various aspects of funding, capacity and education must be considered as strategies are developed and implemented and priority/focus areas addressed.

Purposes and Uses

The FAP puts forth a broad array of issues, goals, and necessary actions. In short, it attempts to address key factors that natural resources affect as well as key factors that affect natural resources. It also addresses the three national themes outlined in the Farm Bill:

1. Conserve working forestlands,
2. Protect forests from harm,
3. Enhance public benefits from trees and forests.

The FAP provides the following information as a foundation:

- An analysis of present and future conditions, trends, and threats on all ownerships in the state using publicly available information.

- Identification of natural resource related threats, benefits, and services consistent with the Farm Bill national themes.
- An analysis of how to incorporate existing statewide plans, including Wildlife Action Plans and Community Wildfire Protection Plans, and planning for existing State Forestry programs and initiatives.
- Outlines long-term coordinated approaches for addressing resource issues and opportunities in priority landscapes.
- Describes how the state proposes to invest federal funding and other resources to address state, regional, and national management priorities.
- Identifies key partners and stakeholders for future program, agency, and partner coordination.
- Incorporates existing statewide plans including the State Wildlife Action Plan (SWAP) and Community Wildfire Protection Plans (CWPP), and
- Discusses the resources necessary for implementation.

It is intended that the plan be implemented using a "Shared
" approach whereby projects and programs are effectively implemented across multiple ownerships and jurisdictions. Given the themes and broad components, the FAP lends itself to a wide variety of applications that go beyond the state level.

Conclusion

Natural resources in Arizona, regardless of ownership, are national treasures and it is impossible to measure their values with dollars and cents. They provide a variety of critical ecosystem goods and services. However, the demands and pressures on our forests, woodlands, etc. are increasing in Arizona and nationwide, presenting challenges.

The FAP will provide steps that will assist a variety of partners and stakeholders in:

1. Taking actions that will better address priority issues
2. Receiving funding based on a broadly supported, effectively designed approaches
3. Improving communication, collaboration, and leveraging of resources
4. Successfully implementing projects, programs, and initiatives across landscapes involving multiple ownerships
5. Enhancing the capacity of Arizona's landscapes to provide life-giving ecosystem services and products such as clean water, clean air, recreational experiences, traditional and non-traditional natural products, and quality habitat for wildlife.

2.0 Introduction and Background

Introduction

The natural resources of Arizona are an invaluable asset vital to all the state's citizens. Arizona is more than the typical image of saguaro cactus in the Sonoran Desert. It is a land of diverse landscapes and diverse forests. There is an array of trees from the cottonwood-willow riparian forests and mesquite bosques hugging river courses to subalpine firs cloaking the tallest mountain peaks to paloverdes shading urban communities.

To many, it comes as a surprise to learn Arizona has more than 19 million acres of forestlands. These forests provide substantial benefits of "ecosystem services" to the people of Arizona. Many of these goods and services are traditionally viewed as free benefits from nature to society. One of many examples of such an "ecosystem service" is clean drinking water. According to the National Academies of Sciences, forests in the United States provide two-thirds of the nation's drinking water. This is an extremely critical function in an arid state undergoing rapid population growth. In 2017, the Arizona census recorded over 7 million people and population projections suggest that this number will reach 12 million by 2050. Other ecosystem services provided by forests include wildlife habitats, clean air, recreation, and renewable energy.

The management of lands within Arizona is very diverse. Federal and state agencies along with Native American Tribes manage most of Arizona's lands. Only a small portion is owned privately. Different federal agencies have responsibility for specific lands including the Forest Service, Bureau of Land Management, National Park Service, US Fish and Wildlife Service, and the Bureau of Reclamation. The Bureau of Indian Affairs assists certain tribes with the management of tribal lands. There are also areas under the jurisdiction of the Department of Defense (e.g., Fort Huachuca in Cochise County). These multiple ownerships can create substantial complexity when trying to address natural resource issues on a larger scale that affect lands under different ownerships or jurisdictions in the same region of the state. Thus, it is critical to develop and draw upon strong relationships with many organizations and agencies for any statewide assessment or strategy to be truly reflective of this diverse land base. Collaboration will be critical to both the short-term and long-term success of land management activities in our state.

Collaborative processes are all the more crucial since vast areas of the 20 million acres of Arizona's land is unhealthy and vulnerable to unnatural fire due to accumulated fuels and ongoing drought. In 2002, the catastrophic Rodeo-Chediski Fire burned 470,000 acres, destroyed more than 400 homes, and threatened many others. Containment and suppression costs exceeded $50 million as well as other immeasurable costs of rebuilding the communities and restoring ecosystems that were destroyed. With the suppression first mentality of land managers over the past 100 years future wildfires of this scale and severity are just as if not even more likely to occur.

The challenge of addressing these threats is compounded by Arizona's rapidly increasing population and limited state and municipal budgets. This stark reality helps to further emphasize the need to set funding priorities according to which landscapes and ecosystems are most critical. It also brings to light again the importance of collaboration with agencies, organizations, and citizens. Such approaches are being emphasized across all sectors of government and funding in the United States. It is our intent that we make the best use of limited dollars to meet the greatest needs for Arizona's citizens and natural resources through the implementation of the strategies in this document. Arizona will be better positioned to improve funding, demonstrate results and achieve priority outcomes.

Background

Farm Bill and Cooperative Forestry Assistance Act

Commonly referred to as the Farm Bill, the Food, Conservation and Energy Act of 2008 was enacted on June 19, 2008. This legislation amended the Cooperative Forestry Assistance Act of 1978 and required each state to complete a statewide forest resource assessment and a statewide forest resource strategy to receive, or continue to receive, federal funds under the Cooperative Forestry Assistance Act (CFAA).

The CFAA funds are provided to states through the State and Private Forestry (S&PF) section of the USDA Forest Service (USFS). Currently, Arizona receives several million dollars annually to protect communities from wildfire, assist private forest landowners, promote healthy forest practices, and assist communities with their urban forests. Most CFAA funding received by the Arizona Department of Forestry and Fire Management (DFFM) is passed through to local organizations by way of grants that require matching funds and additional implementation resources. The combination of state and local efforts along with coordination and collaboration with federal, tribal, and other land management agencies provides substantial leveraging of these funds to benefit Arizona natural resources and citizens.

To receive CFAA funding, the 2008 legislation also requires that states focus on landscape-level outcomes to achieve national private forest conservation priorities. These priorities, which are a result of the "redesign" effort within the S&PF section of the USFS, include:

- Conserve working forest landscapes
- Protect forests from threats
- Enhance public benefits from trees and forests

The amended CFAA of 2008 also requires states to identify priority forest landscape areas and highlight work needed to address national, regional, and state forest management priorities.

Federal Guidance

The National Association of State Foresters (NASF) and US Forest Service S&PF collaborated to provide specific guidance to states beyond what was provided in legislation. Their guidance identifies the following minimum requirements for the Resource Assessment:

- Provide an analysis of present and future forest conditions, trends, and threats on all ownerships in the state using publicly available information.
- Identify forest-related threats, benefits, and services consistent with the S&PF Redesign national themes.
- Delineate priority rural and urban forest landscape areas to be addressed by the state forest resource strategy.
- Work with neighboring states and governments to identify any multi-state areas that are a regional priority.
- Incorporate existing statewide plans, including Wildlife Action plans and Community Wildfire Protection Plans, and address existing S&PF program planning requirements.

Forest Resource Strategy, Annual Reporting, and Updates

The *Strategy* was developed as a separate companion document to this *Assessment* and, where possible, complemented other state and federal agency assessment and planning work. Both the *Assessment* and the *Strategy* for Arizona were completed in 2010.

The Arizona Department of Forestry and Fire Management (DFFM), beginning in 2011, required reporting of accomplishments. Reporting included information about activities of DFFM as well as activities of other agencies and organizations working toward common forest resource objectives and outcomes.

The 2008 Farm Bill requires states to update their Forest Action Plan every five years or as required by the Secretary of Agriculture. DFFM completed the required update of the Arizona Forest Action Plan in 2015. The document summarized the implementation of the Arizona Forest Action Plan since the plans' development in 2010. The update also supplied an overview of the implementation that was required by the three National Priorities section.

The 2015 Forest Action Plan update, titled: 2015 Status Report and Addendum, was a report on the 2010 Arizona Forest Resource *Assessment and Strategy* and not an actual update of the Forest Action Plan. However, the 2015 Addendum satisfied the requirements of the 2008 Farm Bill and a full update of the plan was required by 2020. This update, The Arizona Forest Action Plan (FAP), was completed in 2018 and expanded the scope beyond forests to all landscapes in Arizona. The *Strategy* and *Assessment* from the 2010 Forest Action have now been combined in the FAP.

3.0 Assessment Methodology and Outreach

Though some of the methodologies have changed the basic principles identified for the original Arizona Natural Resource Assessment, still govern how the assessment portion of the FAP was prepared:

1. **Build upon a strong collaborative foundation.** The management of lands within Arizona is very diverse. Federal and state agencies along with Native American Tribes manage most Arizona lands (83%). Only a small portion is privately owned. For any assessment or strategy to be truly reflective of this diverse land base, it must take an "all-lands" approach. It is imperative to continue to develop and draw upon strong relationships with many organizations and agencies. Collaboration is critical to both the short-term and long-term success of land management.
2. **Use and leverage existing work to the fullest extent possible.** Substantial assessment and planning work has already been completed in Arizona by many federal and state agencies, non-governmental organizations, academic institutions, and collaborative groups. This existing work should be relied on wherever possible, and not duplicated.
3. **Develop a strong framework for future work.** The short-term requirements for development of the Assessment will be met, but more importantly, these documents need to be flexible enough to continue to be refined and developed over time. As additional resources are applied and new information developed, the Assessment and Strategy will be refined and strengthened. A strong framework for this future work is critical.

3.1 Issue Work Groups

Eight (8) issue work groups were assembled for each of the resource issues identified in the previous Forest Action Plans. These issue work groups were led by one or more Arizona Department of Forestry and Fire Management staff to update the 2010 Forest Action Plan *Assessment* and *Strategy* with the above principles in mind. The composition of many existing collaborative organizations were leveraged to keep the size of the groups manageable. Representation was sought from all of the largest land management agencies and organizations, statewide councils and collaborative groups, the statewide academic community, and non-governmental organizations in order to build a strong collaborative plan. Each work group in the 2020 update provided comments to their specific resource issue in the Forest Action Plan and collaborated to complete updates or retain sections as is. Work groups met monthly to discuss each resource issue and the related goals and objectives from the 2010 plan. An online platform (Basecamp) was used to communicate with stakeholders and record plan revisions.

The groups included representation from these key agencies:

Arizona Commerce Authority - The Arizona Commerce Authority (ACA) is the leading economic development organization with a streamlined mission to grow and strengthen Arizona's economy. The ACA uses a three-pronged approach to advance the overall economy: recruit, grow, create – recruit out-of-state companies to expand their operations in Arizona; work with existing companies to grow their business in Arizona and beyond; and collaborate with entrepreneurs and companies large and small to create new jobs and businesses in targeted industries.

Arizona Department of Environmental Quality - ADEQ is a separate, cabinet-level agency that directs all of Arizona's environmental protection programs. ADEQ's mission is to protect and enhance public health and the environment in Arizona. The department does this by overseeing the state's environmental laws and authorized federal programs to prevent pollution of the air, water, and land, and to ensure clean-up of such pollution when it occurs. ADEQ's goal is to lead Arizona and the nation in protecting and enhancing the environment and improving the quality

of life for the people of our state. The agency helps Arizonans respect the balance between the natural world and the people who depend on it for sustenance, prosperity and a fulfilling quality of life.

Arizona Department of Forestry and Fire Management - Responsible for implementation of cooperative forestry programs as well as wildland fire suppression and management on approximately 22 million acres of state and private land outside incorporated communities. The agency provides services for fire prevention, urban and community forestry, forest stewardship, forest health, utilization and marketing, and has a wide variety of grants available. DFFM works closely with the US Forest Service and other partners to implement a variety of cooperative forestry and fire management programs authorized under the Cooperative Forestry Assistance Act.

Arizona Department of Transportation - The Arizona Department of Transportation (ADOT) is a multimodal transportation agency serving one of the fastest-growing areas of the country. ADOT is responsible for planning, building and operating a complex highway system in addition to building and maintaining bridges and the Grand Canyon Airport. A major component of the organization is the Motor Vehicle Division, which provides title, registration and driver-license services to the public throughout the state of Arizona. The people, who purchase fuel, drive or own private and commercial vehicles, or use transportation services fund ADOT. To build and operate the state's transportation systems, individuals and businesses invest money through fuel taxes, motor-carrier fees and vehicle title, registration and license fees.

Arizona Game and Fish Department - The mission of the Arizona Game and Fish Department is to conserve Arizona's diverse wildlife resources and manage for safe, compatible outdoor recreation opportunities for current and future generations. The Arizona Game and Fish Commission establishes policy for the management, preservation, and harvest of wildlife. The Commission makes rules and regulations for managing, conserving, and protecting wildlife and fisheries resources, and safe and regulated watercraft and off-highway vehicle operations for the benefit of the citizens of Arizona.

Arizona Nursery Association - The Arizona Nursery Association (ANA) is a professional trade organization dedicated to the promotion and advancement of the nursery industry for its members and the public they serve in Arizona. ANA works toward the solution of problems common to all in the nursery industry; conducts educational programs for the nursery industry; promotes a better understanding of nursery services, plant material and the use of garden products by the general public; cooperates with state agencies in combating horticultural pests and diseases; and encourage the nursery industry to better serve the retail customer. Annually, ANA holds the Southwest Horticulture Annual Day of Education (SHADE) conference to provide an educational opportunity to partners and professionals in the nursery industry. They also provide grant opportunities for research in Arizona's nursery and horticultural related industries. ANA is a partner of DFFM's, and routinely participates in the State's Urban and Community Forestry program.

Arizona Public Service - APS, Arizona's largest and longest-serving electricity utility, serves nearly 1.2 million customers in 11 of the state's 15 counties. With headquarters in Phoenix, APS is the principal subsidiary of Pinnacle West Capital Corp. (NYSE: PNW). Arizona Public Service Company has been powering Arizona's economic growth since its founding in 1886. Healthy, vital communities are an essential part of its vision of creating a sustainable energy future for Arizona.

Arizona State Land Department - Responsible for management and administration of 9.2 million acres of State Trust Land (13% of Arizona's land base) for 13 public beneficiaries. The primary beneficiary is the Common Schools (K-12). Revenue is generated through the sale and lease of

State Trust land and products from those lands (i.e., mineral materials, water, wood products, etc.).

Arizona State University – Sustainable Cities Network - The Network (SCN) is a vehicle for communities to share knowledge and coordinate efforts to understand and solve sustainability problems. It is designed to foster partnerships, identify best practices, provide training and information, and create a bridge between Arizona State University's research and front-line challenges facing local communities. SCN began in the Julie Ann Wrigley Global Institute of Sustainability. The Network provides practitioners with knowledge, resources, and innovations to accelerate the valley toward national leadership in sustainability.

Borderlands Restoration - Borderlands Restoration helps to reconnect wildlife, land, and people in the Arizona/Sonora Borderland region by involving people in restoring the ecosystem on which both humans and wildlife depend. This includes restoring functional physical landscape processes, growing and planting native plants, supporting springs and pollinators, and forging and maintaining bonds between people and the natural world. Habitats of rare plants and wildlife, as well as wildlife corridors, especially between isolated mountain ranges, are of special concern. Many programs that Borderlands Restoration conduct include public education and volunteer support. Borderlands Restoration partners with many conservation groups, and has been a close partner with DFFM's cooperative forestry programs in southeastern Arizona.

Desert Landscape Conservation Cooperative - The Bureau of Reclamation and the U.S. Fish and Wildlife Service have partnered to develop the Desert LCC. The Desert LCC is a bi-national, self-directed, non-regulatory regional partnership formed and directed by resource management entities as well as interested public and private entities in the Mojave, Sonoran, and Chihuahuan Desert regions of the southwestern United States and northern Mexico. Through collaborative partnerships, the Desert LCC seeks to provide scientific and technical support, coordination, and communication to resource managers and the broader Desert LCC community to address climate change and other landscape-scale ecosystem stressors.

Eastern Arizona Counties Organization - A longtime collaboration between Apache, Gila, Graham, Greenlee, and Navajo Counties was formalized in 1993 by an Intergovernmental Agreement to create the Eastern Arizona Counties Organization (ECO). The ECO Counties have progressively developed a leading role in natural resources and public lands management issues in Eastern Arizona, and for several years have implemented a comprehensive set of environmental programs including research, demonstration projects, educational forums, and public information dissemination efforts that promoted and demonstrated the stewardship-based utilization of natural resources throughout Arizona.

Ecological Restoration Institute - The Ecological Restoration Institute (ERI) is nationally recognized for mobilizing the unique assets of a university to help solve the problem of unnaturally severe wildfire and degraded forest health throughout the American West. The ERI, based in the Northern Arizona University School of Forestry in Flagstaff, AZ, works to help land management agencies and communities by providing comprehensive focused studies, monitoring and evaluation research, and technical support. The ERI is funded by a combination of programmatic state and federal funding, such as the Southwest Ecological Restoration Institutes (SWERI), and through competitive grants programs. The goals of ERI go beyond scientific discovery to the meaningful application of scientific knowledge that makes a difference for western forests.

Landscape Conservative Cooperatives - With the signing of Secretarial Order No. 3289, the Department of the Interior launched the Landscape Conservation Cooperatives (LCCs) to better integrate science and management to address climate change and other landscape scale issues. By building a network that is holistic, collaborative, adaptive, and grounded in science, LCCs are working to ensure the sustainability of our economy, land, water, wildlife, and cultural resources.

Each of the 22 LCCs brings together federal, state, and local governments along with Tribes and First Nations, non-governmental organizations, universities, and interested public and private organizations. Our partners work collaboratively to identify best practices, connect efforts, identify science gaps, and avoid duplication through conservation planning and design.

Northern Arizona University - NAU is a state university with nationally ranked programs, a high-research status, and is emerging as a leader in sustainability, science, business, green building, and cultural arts. Empowered by the Arizona Board of Regents to provide educational opportunities statewide, the university serves students at the Flagstaff campus, multiple statewide locations, and online—offering nearly 150 combined undergraduate and graduate degree programs, all distinguished by an ongoing commitment to close student-faculty relationships.

Salt River Project - The Salt River Project (SRP) is a large public power utility in central Arizona that provides electricity and water to more than 2 million people in its service area. SRP participates in a number of community outreach programs, and is recognized by the Arbor Day Foundation as a Tree Line USA utility. SRP is dedicated to the "Right Tree, Right Place" mentality as well. They also provide funding for forest treatments in northern Arizona to improve watershed health through a program called the Northern Arizona Forest Fund.

Sky Island Alliance - The Sky Island Alliance (SIA) restores the wild lands, wildlife, and waters that embody the sacred landscape of the Sky Islands. SIA works in southeastern Arizona, southwestern New Mexico, and northwestern Mexico, on lands that share a common legacy, culture and beauty. They work across the landscape, from saguaro-studded valleys to towering oak and pine covered mountains. Additionally, SIA uses science, education and advocacy to connect the binational landscapes, people, and wildlife of the Sky Islands for the benefit of all.

The Nature Conservancy - The Nature Conservancy (TNC) conserves the lands and waters on which all life depends, internationally. They work collaboratively with local groups to protect and conserve land, especially in areas that are ecologically sensitive or subject to development. They do this through land acquisition and conservation easements. TNC has helped to conserve 21 million acres in the US, and over 103 million acres, globally. Their management and conservation is based in sound science, and the conservancy employs many land managers, scientists and aspiring natural resource professionals.

University of Arizona - Established in 1885, the University of Arizona, the state's super land-grant university with two medical schools, produces graduates who are real-world ready through its 100% Student Engagement initiative. Recognized as a global leader and ranked 16th for the employability of its graduates, the UA is also a leader in research, bringing more than $580 million in research investment each year, and ranking 19th among all public universities. The UA is advancing the frontiers of interdisciplinary scholarship and entrepreneurial partnerships, and is a member of the Association of American Universities, the 62 leading public and private research universities. It benefits the state with an estimated economic impact of $8.3 billion annually.

Upper Verde River Watershed Protection Coalition - Working together to protect the Upper Verde River, the Coalition is committed to balancing the reasonable water needs of the residents of the Upper Verde River Watershed Area with protection of the base flow of the Upper Verde River to the maximum possible extent, and achieving safe-yield within the Prescott Active Management Area (AMA), by developing BMPs (best management practices) that incorporate science-based planning, utilization and conservation of all water resources within the Upper Verde River Watershed Area, and provide financial and staff resources to support the protection activities of the Coalition.

US Bureau of Indian Affairs - The United States has a unique legal and political relationship with Indian tribes and Alaska Native entities as provided by the Constitution of the United States,

treaties, court decisions and Federal statutes. Within the government-to-government relationship, Indian Affairs provides services directly or through contracts, grants, or compacts to 566 federally recognized tribes with a service population of about 1.9 million American Indian and Alaska Natives. While the role of Indian Affairs has changed significantly in the last three decades in response to a greater emphasis on Indian self-governance and self-determination, Tribes still look to Indian Affairs for a broad spectrum of services.

US Geological Survey - The US Geological Survey (USGS) is a science organization that provides impartial information on the health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, the impacts of climate and land-use change, and the core science systems that help us provide timely, relevant, and useable information. The USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. They also provide opportunities for partnership, funding, and international collaboration.

USDA Forest Service – The USDA Forest Service is a multi-faceted agency that manages and protects 154 national forests and 20 grasslands in 44 states and Puerto Rico. The agency's mission is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. The Southwestern Region is 20.6 million acres. There are six national forests in Arizona, 5 national forests and a national grassland in New Mexico, and one national grassland each in Oklahoma and the Texas panhandle. The region ranges in elevation from 1,600 feet above sea level and an annual rainfall of 8 inches in Arizona's lower Sonoran Desert to 13,171-foot high Wheeler Peak and over 35 inches of precipitation a year in northern New Mexico.

USDA Natural Resource Conservation Service - A federal agency providing both technical and financial assistance to private and tribal landowners for the conservation of natural resources and the environment. The conservation delivery system is a collaborative effort with Arizona's 41 Natural Resource Conservation Districts (NRCDs). Participation of NRCS staff on the issue groups, along with other direct communications, reinforced the important link with the **State Technical Advisory Committee** (an NRCS lead organization that provides recommendations to carry out conservation provisions of the Farm Bill).

USDI Bureau of Land Management – A federal multiple-use agency that administers 12.2 million surface acres of public land (five national monuments, three national conservation areas, two national historic trails, a portion of a national scenic trail, 47 wilderness areas and two wilderness study areas), and another 17.5 million subsurface (mineral) acres within the state. The BLM balances recreational, commercial, scientific, and cultural interests while striving for long-term protection of renewable and nonrenewable resources, including range, timber, minerals, recreation, watersheds, fish and wildlife, wilderness, wild horses and burros, and natural, scenic, scientific, and cultural values. Direction for management of public land administered by the BLM can be found in approved land use plans.

USDI Fish and Wildlife Service - The Arizona Ecological Services Office of the U.S. Fish and Wildlife Service works with public and private partners to protect federally listed endangered and threatened species, migratory birds, freshwater fish, and wildlife habitat in Arizona. The Service implements all facets of the Endangered Species Act (ESA), including listing, recovery, and delisting of native flora and fauna. It also works with the various land management agencies to ensure that their projects are in compliance with the ESA.

Western Forestry Leadership Coalition - The Western Forestry Leadership Coalition represents a unique partnership between the Council of Western State Foresters and federal government forestry leaders. The Coalition is comprised of 34 members from across the federal and state agencies of the west.

4.0 Incorporation of Other Plans

State and federal agencies, non-profit organizations, academic institutions, and collaborative groups have completed considerable analysis and planning work to address natural resource issues in Arizona. A large portion of the FAP is built upon these earlier activities. The following information provides an overview about many of the documents that were published and relied upon in the development of the FAP.

The Farm Bill legislation requires integration of several of these documents. However, many Arizona efforts go beyond the national norms and it is important that these works be incorporated. Likewise, since there are many planning efforts still ongoing, this list will likely grow substantially with time.

4.1 Existing Arizona Planning

- **Arizona Department of Forestry and Fire Management Strategic Plan**
  This guiding document lays out the goals for the next five-year period to better serve our Arizona communities and ensure the safety of the public. The mission of the plan is to manage and reduce fire risk to protect Arizona's people, communities, and wildland areas. Secondly, the plan aims to champion the health of Arizona's natural resources while providing service through strategic implementation of cooperative natural resources and fire assistance programs, development and support of statewide fire policies, and coordination of resources across all-lands and jurisdictions. There are seven goals identified in the strategic plan: Educate Public and Cooperators, Strong Forest Industry, Healthy Forests, Woodlands and Watersheds, Fire and Hazard Safe Communities – Wildlands, Fire and Hazard Safe Communities – All Hazard, Fire and Hazard Safe Communities – Structural, and Organizational Excellence and Efficiency.
- **Arizona Urban & Community Forestry Plan**
  As the guiding document for Arizona's Urban & Community Forestry (UCF) Program, this plan describes goals, objectives, and actions for a five-year period in the areas of education, public awareness, volunteerism, technical assistance, and financial assistance. This five-year plan is an important guiding document for review of program accomplishments and enables Arizona to receive Federal funding for UCF program efforts. The plan also describes the advisory relationship between the Arizona Community Tree Council and the State Forester in support of the DFFM's Urban & Community Forestry Program.
- **Community Wildfire Protection Plans**
  The Healthy Forest Restoration Act of 2003 authorized the creation of community wildfire protection plans (CWPP). Local stakeholders write CWPPs that include an evaluation of local conditions and risks from fire, and development of a plan to address all aspects of community protection and wildfire mitigation. A strategic plan as well as an action plan, the CWPP generates a broad operating framework for landowners and resource managers within the area and identifies community protection priorities. A combination of fuel management, FireWise standards, and appropriate wildfire suppression response across ownerships within and adjacent to at-risk communities will reduce threats to life and property, protect values-at-risk, and create a safe context for the use of fire in subsequent ecosystem restoration efforts. Site-specific planning and implementation remains the responsibility of each owner/management agency, generally operating within the guidelines developed by a CWPP. More than 27 CWPPs or equivalent plans have been developed and approved throughout Arizona.

- **Forest Legacy Program Assessment of Need**
  Developed for DFFM by The Nature Conservancy of Arizona, the Forest Legacy Program Assessment of Need (AON) outlines the Forest Legacy Program in Arizona and includes eligibility criteria, project selection guidelines, and a definition of priority areas. The original AON was developed in 2005, reviewed in 2016, and updated in 2020 to remain consistent with the 2017 Forest Legacy Program Implementation Guidelines. The Forest Legacy Program is a USDA Forest Service program delivered through the DFFM for identifying and protecting environmentally important forest areas from conversion to non-forest uses through the acquisition of conservation easements. The AON is in this *Assessment* by reference and is included in the appendices.

- **National Forest Stewardship Program Standards and Guidelines**
  The purpose of this document is to *"encourage the long-term stewardship of important State and private forest landscapes, by assisting landowners to more actively manage their forest and related resources."* A major component of this program is a spatial analysis of forest resource management threats and opportunities, used to delineate priority areas for delivering State & Private Forestry programs. The Forest Stewardship important forest resource areas map created for these priority areas were included in the 2010 *Assessment*, thus any updated versions will be as well.
- **State Wildlife Action Plan**
  The Arizona Game and Fish Department updated the State Wildlife Action Plan (SWAP), in 2012. This diverse and comprehensive planning effort included outreach and coordination, landscape-focused and species-focused conservation planning, identification of Species and Habitats of Greatest Conservation Need, assessment of stressors and threats to wildlife and their habitats, prioritization of conservation strategies and actions, and a prescription detailing the need for monitoring and adaptive management. The SWAP will be reviewed and revised/updated within a 10-year timeframe.

5.0 Arizona Conditions and Trends

5.1 Overview of Arizona's Forests

Arizona's forests range from riparian gallery forests along low desert rivers to sub-alpine and montane forests above 9,000 feet in elevation[1]. Forests cover roughly 27% of the state and occupy 19.4 million acres. These forests are comprised of 37 species of coniferous and hardwood trees. The majority of forestland is located north of the Mogollon Rim with several distinct areas scattered throughout the rest of the state. Juniper and pinyon-juniper woodlands are the most abundant forest type in Arizona, occupying approximately 14.8 million acres, or 20.3% of the state. The rarest and most significant in ecological terms is riparian forest, which occupies less than one-half of 1% of Arizona's land.

Pre-European Settlement Vegetation and Climate

Today's forests reflect a long series of climatic and corresponding vegetative changes in Arizona. A paleoecological study in the Potato Lake area of the southern Colorado Plateau (approximately 7,300 feet in elevation) suggests dramatic changes occurred in the area's biota during the last 35,000 years[2]. From 35,000 to 21,000 years before present (B.P.), it appears the area was dominated by mixed conifer species, suggesting the climate was cooler and wetter than it is today. The years 21,000 to 10,400 B.P. were likely the regions coldest period during the last glaciation, Engelmann spruce (*Picea engelmannii*) formed almost pure stands, growing as low as 8,200 feet. Today, this spruce is generally located above 10,800 feet. During this period, average temperatures were several degrees cooler than they are today. The transition into the Pleistocene-Holocene Epoch, and the end of the last glacial period resulted in a major restructuring of southern Colorado Plateau vegetation. On Utah's Markagunt Plateau, species common in today's mixed-conifer forests moved upslope to their current elevation range. A warmer, drier climate likely resulted in the widespread establishment of ponderosa pine (*Pinus ponderosa*) across mid-elevations of the area. At elevations between 5,200 and 6,900 feet, pinyon-juniper woodlands dominated. In the period that followed (8,000 to 4,000 B.P.), pinyon-juniper woodlands migrated into the area and warm desert grasses replaced cold desert species. In lower elevation regions of the Colorado Plateau, studies from the Chaco Canyon and San Juan Basins in New Mexico and Arizona showed canyons were dominated by mixed conifer forests and mesa tops were cold desert steppe[3].

Fire

In Southwestern forests, lightning-caused and human-caused fires could burn for several months and cover thousands of acres, burning until extinguished by rain or depletion of fuel[4]. Dendrochronology research suggests most Southwest forest stands, excluding spruce-fir, burned every 2 to 30 years as low-

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[1] O'Brien, R.A. 2002. Arizona's Forest Resources, 1999. Resource Bulletin RMRS-RB-2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Pg. 116.

[2] Anderson, R.S., J.L. Betancourt, J.I. Mead, R.H. Hevly, and D.P. Adam. 2000. Middle- and late-Wisconsin paleobotanic and paleoclimatic records from the southern Colorado Plateau, USA. Palaeogeography, Palaeoclimatology, Palaeoecology. 155:31-57.

[3] Betancourt, J.L., E.A. Pierson, K.A. Rylander, J.A. Fairchild-Parks, and J.S. Dean. 1993. The influence of history and climate on New Mexico pinyon–juniper woodlands. Managing pinyon– juniper ecosystems for sustainability and social needs. General Technical Report RM–236. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Range and Experiment Station.

[4] Swetnam, T.W. 1990. Fire history and climate in the southwestern United States. Krammes, J.S., tech. coord. Proceedings of the symposium, Effects of fire management of Southwestern natural resources; 1988 November 15–17; Tucson, AZ. General Technical Report RM–191. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Range and Experiment Station: 6–17.

intensity, ground fires. Having greater moisture, yet heavier fuel loads, spruce-fir forests burned less frequently, approximately every 35 to 150 years or more, but at higher intensities[5]. Although Native American cultures used fire for a variety of purposes, lightning ignitions during periods of high fire hazard were sufficient to produce frequent fires[6].

Historic Conditions

Environmental conditions as well as ecological processes above and below ground influenced the pattern of vegetation distribution. Ponderosa pine forests in the early nineteenth century were predominantly open with a diverse community of trees, shrubs, and perennial grasses and forbs[7]. Historic ponderosa pine forests are referred to as open and park-like with abundant herbaceous understory, although descriptions and pictures of dense stands have also been documented[8]. Records and archaeological reconstruction of historic ponderosa pine forest conditions suggest individual, clumped, or stringers of ponderosa pine in various sizes with an understory grass-herbaceous matrix[9] characterized the vegetation. The development of fire-dependent vegetation coupled with the climate conditions that existed several centuries prior to 1848 reinforced a frequent-fire regime of low-intensity burns. Frequent surface fires, disease, insects, and other regulating mechanisms maintained the balance and resilience of ponderosa pine forests in Arizona.

Conditions in historic mixed conifer forests were variable and depended on burn history. Characteristics of a mixed conifer forest in the early 1900's are described as follows:

> *"Lang and Stewart describe the mixed conifer forest on the North Kaibab Plateau (Colorado Plateau Province) in 1909. They describe most mature Douglas fir (as well as white fir and blue spruce) as "deteriorating;" they probably mean these trees were decayed, had poor crown form, broken tops, and hollow bases typical of repeatedly fire-damaged trees. Lang and Stewart also note that Douglas-fir regeneration was "healthy and vigorous;" and often dense stands of pole-sized trees covered large areas, especially on more mesic sites and under aspen."*

Because spruce-fir forests were largely unaffected by logging, livestock grazing or fire suppression, their historic conditions are fairly well known[10]. Spruce-fir forests were susceptible to major disturbances (i.e., fire and insect outbreak) but disturbance occurred relatively infrequently, typically with 100 or more years between major events[11].

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[5] Abolt, R.A.P. 1997. Fire histories of upper elevation forests in the Gila Wilderness, New Mexico via scar and stand age structure analysis. M.S. thesis, University of Arizona, Tucson. Pg. 120.

[6] Schroeder, M.F. and C.C. Buck. 1970. Fire weather handbook 360. Washington, DC: U.S. Department of Agriculture. Pg. 229.

[7] Abert, J.W. 1848a. Report of his examination of New Mexico in the years 1846–1847. 30th Congress, 1st Session, Senate Executive Document 23. Washington, DC: Government Printing Office.

[8] Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa forest structure: changes since Euro-American settlement. Journal of Forestry. 92(1):39–47.

[10] Dahms, C.W. and B.W. Geils, tech. eds. 1997. An assessment of forest ecosystem health in the Southwest. General Technical Report RM-GTR-295. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. Pg. 97.

[11] Veblen, T.T., K.S. Hadley, E.M. Nel, T. Kitzberger, M. Reid, and R. Villalba. 1994. Disturbance regime and disturbance interaction in a Rocky Mountain subalpine forest. Journal of Ecology. 82:125–135.

Riparian areas in Arizona once formed continuous corridors of lush vegetation stretching for hundreds of miles. They extended from the montane headwaters of rivers and streams down to river corridors across low-elevation deserts. Many plant species in riparian communities depend on seasonal flooding for seed transportation and establishment, high groundwater levels for saturated soils, and dense vegetation for ecosystem health. Riparian communities provided resources necessary for early human settlements, as well as permanent wildlife habitat and migratory routes for birds and mammals.

Post-European Settlement

The arrival of Europeans had a devastating effect on Native American populations, and produced significant environmental changes including; livestock grazing, logging and mining, dams and irrigation, and the introduction of diseases affecting wildlife.

The period following the Mexican-American War of 1848 marked a significant transition from Mexican to American sovereignty in the Southwest and a time of rapid settlement. With increased settlement came domestic livestock. In fact, by 1890, more than 1.5 million head of cattle were in the Southwest[12]. By the early 1900s, grazing pressure from cattle and sheep had reached the timbered mountains, resulting in loss of vegetative cover and increased erosion. After a peak in the numbers of cattle and sheep in Arizona around the time of World War I, livestock numbers declined following a severe drought in the 1950s. Today, livestock numbers are in line with the carrying capacity of the land, and many ranches are stocked conservatively.

In some areas, historic fire regimes have changed because livestock removed much of the fine fuel needed to carry surface fires and because fire suppression was instituted due to the growing number of inhabitants who viewed fire as a threat. However, ultimately, the frequency and size of fires was altered by a combination of factors - road and trail establishment, fragmentation of forest continuity, increased ignition sources, suppression of fires, and altered fuel loads. Fire suppression and exclusion began altering plant community structure and fire regimes in the early 1900s[13]. During the last century, the combination of past fire suppression and subsequent fuel accumulation has led to an increase in the frequency of large and intense fires, such as those experienced in the last several decades in the Southwest. Some forecasts indicate a warming climate will lead to at least a doubling of annual area burned in Arizona by the late twenty-first century[14].

With the arrival of railroads in the Southwest, new industries appeared, human population grew, natural resource use accelerated, and a commercial economy replaced the subsistence economy. Some other concurrent changes included altered land use and ownership patterns, depletion of forage by domestic livestock, degradation of woodland and riparian areas, and changes in wildlife habitat[15].

Arizona has continued a rapid growth trend, further stressing natural ecosystems and resources. Small-scale logging for local-use shifted to larger efforts around the 1870s with construction of the railroad and

[12] Baker, R.D., R.S. Maxwell, V.H. Treat, and H.C. Dethloff. 1988. Timeless heritage: a history of the Forest Service in the Southwest. FS–409. Washington, DC: U.S. Dept. of Agriculture, Forest Service. Pg. 208.

[13] Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa forest structure: changes since Euro-American settlement. Journal of Forestry. 92(1):39–47.

[14] McKenzie, D.; Gedalof, Z.; Peterson, D.L.; Mote, P. 2004. Climatic change, wildfire, and conservation. Conservation Biology. 18: 890-902.

[15] DeBuys, William. Enchantment and Exploitation: The Life and Hard Times of a New Mexico Mountain Range. Albuquerque, NM: University of New Mexico Press, 1985. xxii + 394 pp. Illustrated.

logging of trees for railroad ties and fuel. During these early years, a large volume of trees (70-80% in some cases) needed to be removed from the forests to make railroad operations feasible[16]. Later, when trucks became available, lighter cuts could be made typically from 30% to 60% of the available wood volume[17]. With time, logging methods have been variable with some practices being more sustainable than others. Removal of large, quality trees (i.e., high grading) has resulted in dense stands of second-growth trees, thus reducing understory herbaceous cover and increasing fire danger.

The transcontinental railroad also provided increased opportunities for tourism. Arizona's mild climate, striking archaeological ruins, and majestic scenery all led to a tremendous increase in recreation during the mid- to late-1900s. Arizona became a favorite destination for hunting, fishing, sightseeing, and bird watching. Preservation and conservation of forests and other natural communities became a focal point for citizens and public land managers. Higher visitation to remote areas and forest communities led to overuse and exploitation of resources, introduction of non-native plants and animals, increased human-caused fires, and unauthorized use of motorized vehicles. Climate change is another factor that has altered the state's forests. Recent studies indicate a warming climate has changed forest fire regimes, and is projected to continue to increase the frequency, size, and seasonal length of forest fires[18], thereby shifting the dominance and abundance of plant species across Arizona and the West.

Additionally, these and other interrelated changes throughout Arizona have altered the hydrologic function of most watersheds. Soil compaction, road construction, and reduced ground cover have led to increased erosion and flooding, often resulting in deep, incised channels referred to as gullies. Water diversions and impoundments of larger rivers have significantly modified channel dynamics, and altered habitat and vegetation establishment within the reservoirs and downstream riparian areas. To address bank stabilization and other soil stability problems, species not native to ecosystems of the Southwest, such as salt cedar (*Tamarix* spp.), were introduced to help address these problems and provide bank protection. Many of these introduced species are now considered invasive, and continue to have detrimental effects on ecosystem processes.

Current Forest Types and Distribution

Despite all these problems and concerns, the conditions and diversity of Arizona's forests remains impressive. Some of southern Arizona's forested landscapes have reached international importance because of their outstanding biological diversity. They are part of the "Madrean Archipelago," which Conservation International has recently added to its list of world biodiversity hotspots (Biodiversity Hotspots). Their significant biological diversity stems from a convergence of subtropical and temperate climatic zones, which create forest refugia and corridors for many unique animals, including the jaguar (*Panthera onca*) and thick-billed parrot (*Rhynchopsitta pachyrhyncha*).

The USDA Forest Inventory and Analysis Program (FIA) classifies forestlands into two general categories—timberland or woodland based on levels of tree stocking. Timberland is forestland where tree species traditionally used for industrial roundwood products, such as ponderosa pine and Douglas fir (*Pseudotsuga menziesii*), make up at least 10% of the stocking. Only 20% of Arizona's forestland meets

[16] Schubert, G.H. 1974. Silviculture of southwestern ponderosa pine: the status of our knowledge. Research Paper RM–123. Fort Collins, CO: U.S. Department of Agriculture, Forest Service. Pg. 71.

[17] Myers, L.A. and E.C. Martin. 1963. Fifty years progress in converting virgin southwestern ponderosa pine to managed stands. Journal of Forestry. 61(8):583–586.

[18] Westerling, A. L., Hidalgo, H. G., Cayan, D. R., Swetnam, T. W. 2006. Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity. Science.Vol. 313. no. 5789, pp. 940 – 943.

this definition[19]. The remaining portion is woodland, which indicates forestland where timber species are not present at the minimum 10% stocking level. Woodland tree species, such as pinyon and juniper, are used primarily for fuelwood, fence posts, and, in some cases, Christmas trees (e.g. pinyon pine). Forestlands are further differentiated into forest types and are often identified by the predominant tree species. Beyond these traditional forest definitions are Arizona's urban and community forests—a rapidly expanding landscape of trees and vegetation which provides healthier, more livable urban environments.

Table 2. Acreages of traditional forest types

Class	Acres
Aspen	111,293
Mixed Conifer	450,221
Pine-Oak	1,779,475
Pinyon-Juniper	13,420,572
Ponderosa	4,043,854
Riparian	328,693
	20,134,109

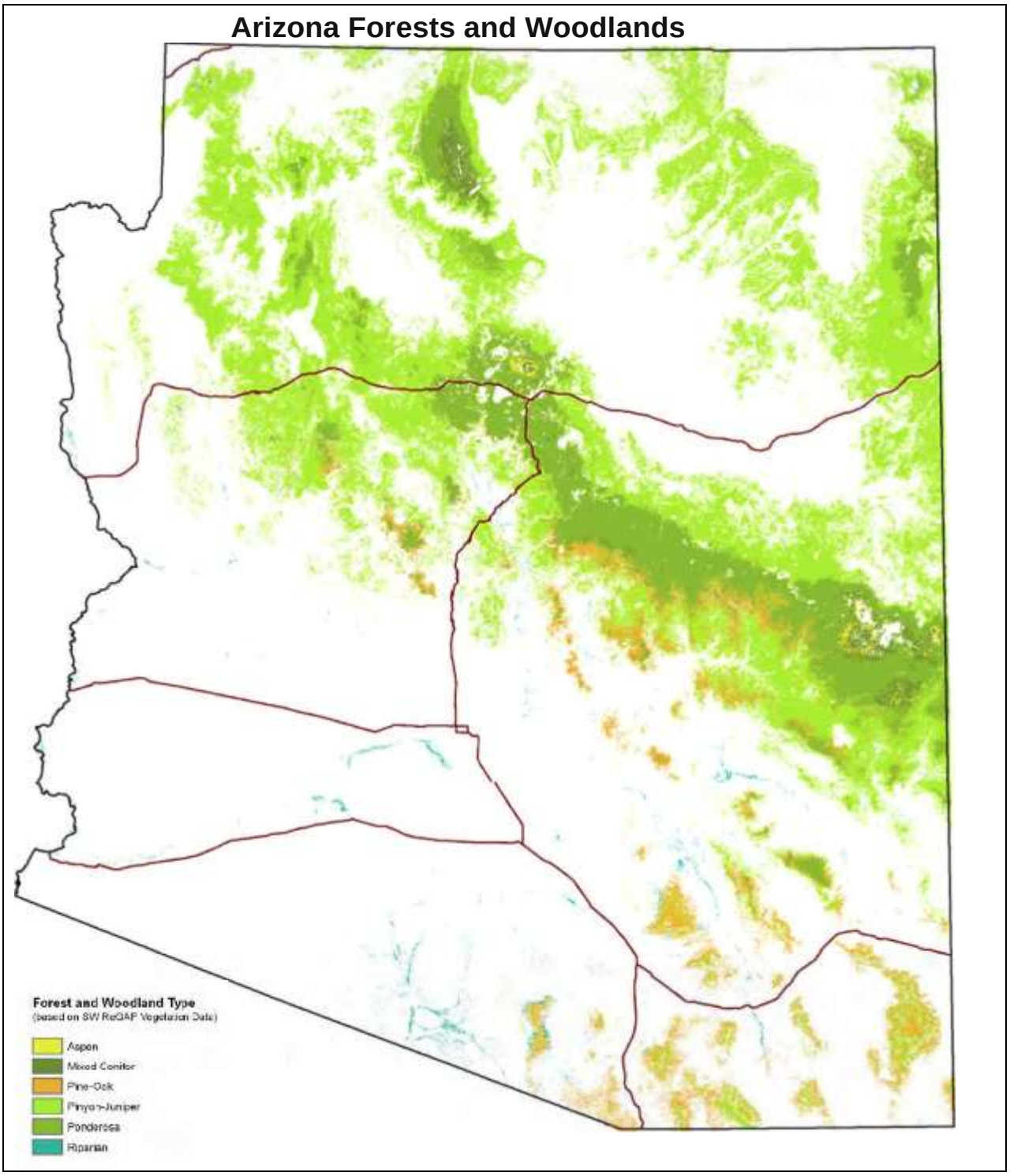
* Not enough data exists to quantify the types and species of vegetation that make up Arizona's urban forests

Vegetation communities have been described using a variety of classifications and different geographical scales. Because planning and management objectives differ, the framework selected to identify ecological units is different, as are the resultant classifications. Most forestlands in Arizona are within the Arizona/New Mexico Mountains or Plateau Ecoregions[20]. Southwestern ecosystems are further grouped into life zones[21], which are characterized by biotic community types and can be cross-referenced to the biotic communities.

[19] O'Brien, R.A. 2002. Arizona's Forest Resources, 1999. Resource Bulletin RMRS-RB-2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Pg. 116.

[20] EPA / CEC 2002. Level III Ecoregions of the Continental United States. Map. National Health and Environmental Effects Research Laboratory. U.S. Environmental Protection Agency. Revised August 2002.

[21] Carleton, J.O., W.A. Robbie, G.T. Robertson, C.L. Spann, H.G. Brown III, J. Gass, D.W. Shaw, T. Robison, W.H. Moir, D. Potter, R.A. Fletcher, R. Galeano-Popp, and G.J. Miller. 1991. General ecosystem survey. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 188 p. plus maps.


Arizona Forests and Woodlands
Forest and Woodland Type
(based on SW ReGAP Vegetation Data)
Aspen
Mixed Conifer
Pine-Oak
Pinyon-Juniper
Ponderosa
Riparian

Aspen

Trembling or quaking aspen (*Populus tremuloides*) ranges in occurrence from small discontinuous patches of tens to hundreds of acres to large, contiguous stands of thousands of acres) at elevations ranging from 5,500 feet to 11,500 feet. Aspen is a seral species in several coniferous habitat types, including spruce-fir and mixed conifer habitat types and mesic ponderosa pine forest, and in montane grasslands with fire exclusion or after heavy livestock grazing. Aspen can originate on scree slopes or active talus, where it forms small stands that are relatively persistent. Aspen can also occur as a stable or persistent forest type, but this type is most common in Utah and Colorado. Aspen occurs throughout North America, with greater abundance in the northern Rocky Mountain States and Canadian provinces, for which there is a rich literature. However, fewer studies have been published for aspen as it occurs in the Southwest. Aspen is very important from a biodiversity standpoint, either supporting many species of birds and mammals directly as forage, indirectly through the vast insect community it supports, or through the provision of structural habitat or nesting sites. Some consider aspen second only to riparian stands in biodiversity value (Smith 2006a).

Mixed Conifer Forests

Varieties of conifer species are dominant at higher elevations in mountainous regions (above approximately 7,800 ft.). At elevations between 7,800 and 10,200 ft., forests are dominated by Douglas-fir, white fir (*Abies concolor*), and blue spruce (*Picea pungens*), with ponderosa pine present at the lower end of those elevations. The spruce-fir forest is predominantly Engelmann spruce and subalpine fir (*Abies lasiocarpa*) in cooler regions and areas receiving more than 25 inches of annual precipitation. Other species present in mixed conifer forests include corkbark fir (*A. lasiocarpa* var *.arizonica*), southwestern white pine (*P. strobiformis*), Gambel oak (*Quercus gambelii*), juniper, Arizona cypress (*Cupressus arizonica*), and aspen.

The mildest climate in Arizona is found in mixed conifer forests, with average annual precipitation from 14 to 30 inches, with as much as 44 inches at higher elevations. More than half of the precipitation falls as snow and mean annual temperature ranges from 41 to 47 degrees fare height[22].

Pine-Oak

Pine-oak is made up of two principal types: pine-oak forests where oaks are common or co-dominant in mixed conifer or ponderosa forests at higher elevations, and evergreen oak woodlands where oaks dominate with a mix of conifers. This latter type occurs at mid to higher elevations (2,900 to 9,500 ft.) throughout forested areas of Arizona. The pine-oak forest type is found as patches or broad bands of mostly Gambel oak (*Q. gambelii*) throughout the mixed conifer and ponderosa forest types.

Evergreen (Madrean) oak woodland is prominent in southeastern Arizona and generally includes a diversity of evergreen oak species as well as conifers. Most of these woodlands are found in the "sky islands" of southeastern Arizona at elevations from 3,900 to 8,800 feet. They typically occupy the life zone above the desert shrub and grassland communities and below the coniferous forest. At lower elevations, oak woodlands are typically open with bunch grasses as the major understory component. At higher elevations, they are denser forests with oak and pine species intermixed.

In Arizona, a variety of oak species--Emory oak (*Q. emoryi*), Arizona white oak (*Q. arizonica*), Mexican blue oak (*Q. oblongifolia*), gray oak (*Q. grisea*), silverleaf oak (*Q. hypoleucoides*), and netleaf oak (*Q. rugosa*) grow at higher elevations in conjunction with Madrean pine species, such as Apache pine (*Pinus*

[22] USDA 2004b. Ecological Site Descriptions, U.S. Department of Agriculture, Natural Resource Conservation Service, Arizona. Accessed 2004.

engelmannii), Chihuahua pine (*P. leiophyllavar. chihuahuana*), and Arizona pine (*P. arizonica*). Arizona cypress, endemic to woodlands, is confined mainly to north-facing canyon slopes and drainages. If there is sufficient moisture, epiphytic bromeliads (*Tillandsia recurvata*) can be found on tree branches. Some of the common understory grasses include muhlys (*Muhlenbergia spp.*), cane beard grass (*Bothriochloa barbinodis*), wolftail (*Lycurus setocus*), plains love grass (*Eragrostis intermedia*), and several grama grasses (*Bouteloua spp.*). There are also several shrubs (i.e., *Salvia, Artemsia*), forbs (i.e., *Penstemon, Lupinus*), and cacti (i.e., *Ferocactus wislizeni, Opuntia spp.*) commonly found in the understory of many of these forests (Brown 1994). The abundance of species from the interior chaparral community such as point leaf manzanita (*Arctostaphylos pungens*), Wright's silk tassel (*Garrya wrightii*), and Arizona rosewood (*Vauquelinia californa*) can be occasional or frequent within the Madrean oak woodland. These and other indicative plants of chaparral are typically prominent on thin eroded soils, limestone, and near the eastern and northern range of the Madrean oak woodlands (Brown 1994).

Annual precipitation in pine-oak ranges from 16 to 30 inches at the higher elevations. There is both snow and rain with winter-summer precipitation ratios about equal[23]. Snow seldom persists more than few days at the lowest elevations.

Pinyon-Juniper

Pinyon-juniper woodlands constitute the largest forest type in Arizona. These coniferous woodlands exist in a gradient of juniper-dominated woodlands to pinyon-dominated woodlands with pinyon pine and juniper present throughout the range. They are found at elevations ranging from approximately 4,500 to 7,500 feet. Pinyon pine is the most common species in the complex with other pines including border pinyon (*Pinus discolor*) and single-leaf pinyon (*P. monophylia*). Juniper species are typically found at lower elevations than pinyons and at sites with deeper soils[24]. One-seed juniper (*Juniperus monosperma*) is the most common juniper below the Mogollon Rim. Other juniper species in Arizona include Rocky Mountain juniper (*J. scopulorum*) and Utah juniper (*J. osteosperma*) in northern Arizona, and alligator juniper (*J. deppeana*) in central and southern Arizona, although it is also associated with Madrean oak woodlands [25].

Understory vegetation is dependent primarily on rainfall and soil type. Herbaceous vegetation is the main understory component consisting of cool- and warm-season grasses including several of the grama grasses, vine mesquite (*Panicum obtusum*), Arizona fescue (*Festuca arizonica*), squirrel tail (*Elymus elymoides*), and the forbs, buckwheat (*Eriogonum spp.*) and globemallow (*Sphaeralcea spp*.). These grasses and others provide the necessary forage for livestock and wildlife. Important shrubs in the understory include cliffrose (*Cowania mexicana*), Mormon tea (*Ephedra spp.*), and mountain mahogany (*Cercopcarpus spp.*).

Annual precipitation in the pinyon-juniper communities varies from 12 to 24 inches with occasional snow precipitation. With a few exceptions the topography of the pinyon-juniper woodlands are gently rolling hills with slopes not likely to exceed 25% (USDA 2004a).

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[23] USDA 2004b. Ecological Site Descriptions, U.S. Department of Agriculture, Natural Resource Conservation Service, Arizona. Accessed 2004.

[24] Dahms, C.W. and B.W. Geils, tech. eds. 1997. An assessment of forest ecosystem health in the Southwest. General Technical Report RM-GTR-295. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Statiom. Pg. 97

[25] Brown, D.E., editor. 1994. Biotic Communities of the Southwestern United States and Northern Mexico. Salt Lake City, UT: University of Utah Press.

Ponderosa

Ponderosa pine is the most widely distributed pine in North America, extending from British Columbia, Canada to northern Mexico. Throughout its range, ponderosa pine can be found at elevations from near sea level to about 9,500 ft. Most ponderosa pine forest occurs in large contiguous patches throughout Arizona at elevations ranging from 5,500 feet to 8,500 feet. These relatively warm, dry forests are dominated by ponderosa pine, pinyon pine (*P. edulis, P. discolor*), junipers, and several oaks. Numerous grasses, like Arizona fescue, squirrel tail and mountain muhly (*Muhlenbergia montana*), and a few shrubs make for a diverse ground cover.

Ponderosa pine forest is typically bounded at the upper elevation by mixed conifer forest and at the lower elevation by grassland, pinyon-juniper forest, or chaparral, although extensive intergrading of species may occur at ecotones (boundaries along gradients of slope, elevation, aspect, and moisture). Climatological data indicate that ponderosa pine forests occupy a wide moisture and temperature gradient, with annual precipitation ranging from 20 to 35 inches, and mean annual air temperatures ranging from 41°F to 52°F, which allows for a growing season of approximately 180 days (Smith 2006b).

Riparian Forest

Arizona's riparian ecosystems range from sea level to 10,000 feet. Riparian forests exist as a component of the forests and woodlands previously described, as well as within other vegetation communities at lower elevations, including semi-desert grasslands and the Mojave and Sonoran Desert. The vegetation found along river and stream riparian corridors depends on the availability of surface and ground water throughout the year, especially during the growing season. Some riparian forests are sustained by regulated water releases from upstream reservoirs.

Factors such as elevation gradient, upland community, soil type and precipitation make riparian forests highly variable in terms of the number and types of species. At the higher elevations, typical overstory species--narrowleaf cottonwood (*Populus angustifolia*), maple (*Acer grandidentatum),* boxelder (*A.negundo*), and willows (*Salix spp.*)--occur along with montane coniferous species, such as white fir and blue spruce. The understory is comprised of various shrubs, such as thin-leaf alder (*Alnus tenuifolia*), shrub willows, and chokecherry (*Prunus virens*).

In mid- to lower elevations, a mixture of deciduous broadleaf species, such as Arizona sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), Goodding willow (*S. gooddingii*), Fremont cottonwood (*P.fremontii*) and velvet ash (*Fraxinus velutina*), dominate the forest canopy. Many riparian forests at mid- to lower elevations have been invaded by introduced salt cedar / tamarisk. Mesquite (*Prosopis spp*.) woodlands or bosques occupy many of the upper stream terraces at lower elevations. The climatic characteristics of riparian ecosystems exhibit a wide range of conditions due to large elevation differences and distributions of associated mountain ranges, highlands, and desert valleys. Riparian ecosystem topography can vary from narrow, deep, steep-walled canyon bottoms, to intermediately exposed sites with at least one terrace or bench, to exposed, wide alluvial valleys with meandering streams.

Urban and Community Forests

While not traditionally considered a forest type, Arizona's urban forests are comprised of trees and vegetation in urban areas that have a special relationship to people. Not enough data has been collected to quantify the types and species of vegetation that make up the urban forest, however, they are typically composed of a mix of native and exotic (introduced) tree species. In southern Arizona, native species include paloverde, ironwood, and mesquite trees, with exotics such as eucalyptus and various pines. Northern Arizona native trees are predominately ponderosa and pinyon-pine, oak and juniper, with

several introduced species that can handle the cooler climate--elms, poplars, and spruce. It is important to note that several species planted for landscaping purposes can escape their original planting sites and invade other areas, with Russian olive (*Elaeagnusan gustifolia*), tamarisk, and tree-of-heaven (*Ailanthus altissima*) being prime examples.

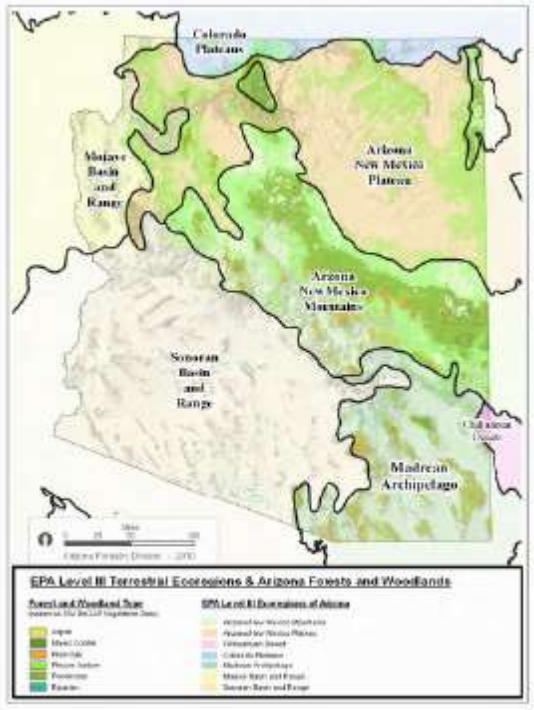
The urban forest includes urban parks, street side trees, landscaped boulevards, public gardens, washes and wetlands, greenways, and nature preserves. However, since the majority of trees making up the urban forest are located on private property, urban forests are much larger than just these public tree components.

5.2 Arizona Ecoregions and Landscapes

Ecoregions in the FAP are based on the premise that ecological regions can be identified through analysis of the patterns and composition of biotic and abiotic factors that affect or reflect differences in ecosystem quality and integrity[26]. These factors include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. Arizona ecoregions were derived from the Environmental Protection Agency (EPA)/Commission for Environmental Cooperation (CEC) classification system[27], which was derived from Omernik's framework. The EPA is using ongoing or recently completed projects, conducted in collaboration with its regional offices, state resource management agencies, and other federal agencies to refine ecoregions, define sub regions, and locate sets of reference sites. Designed to serve as a spatial framework for environmental resource management across jurisdictional boundaries, ecoregions denote areas within which ecosystems (and the type, quality, and quantity of environmental resources) are generally similar.

[26] Omernik, James M., 1995. Ecoregions: A spatial framework for environmental management. In: Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Davis, W.S. and T.P. Simon (eds.) Lewis Publishers, Boca Raton, FL. Pg. 49-62.

[27] EPA/CEC 2002. Level III Ecoregions of the Continental United States. Map. National Health and Environmental Effects Research Laboratory. U.S. Environmental protection Agency. Revised 2002.



MOJAVE BASIN AND RANGE

This ecoregion contains scattered mountains that are generally lower than those of the Central Basin and Range. Potential natural vegetation in this region is predominantly creosote bush, as compared to the mostly saltbush-greasewood and Great Basin sagebrush of the ecoregion to the north, and creosote bush-bur sage with large patches of paloverde-cactus shrub and saguaro cactus in the Sonoran Basin and Range to the south. Most of this region is federally owned and managed by the BLM. Heavy use of off-road vehicles and motorcycles in some areas has caused severe wind and water erosion problems. Grazing is authorized on some State and Federal lands in the southern desert.

ARIZONA/NEW MEXICO PLATEAU

The Arizona/New Mexico Plateau represents a large transitional region between the semiarid grasslands and low relief tablelands of the Southwestern Tablelands ecoregion in the east, the drier shrublands and woodland covered higher relief tablelands of the Colorado Plateau in the north, and the lower, hotter, less vegetated Mojave Basin and Range in the west and Chihuahuan Deserts in the south. Higher, more forest covered, mountainous ecoregions border the region on the northeast and southwest. Local relief in the region varies from a few feet on plains and mesa tops to well over 1,000 ft. along tableland side slopes.

ARIZONA/NEW MEXICO MOUNTAINS

The Arizona/New Mexico Mountains are distinguished from neighboring mountainous ecoregions by their lower elevations and an associated vegetation indicative of drier, warmer environments, which is also due in part to the region's more southerly location. Forests of spruce, fir, and Douglas fir, that are common in the Southern Rockies and the Uinta and Wasatch Mountains, are only found in a few high elevation parts of this region. Chaparral is common on the lower elevations, pinyon-juniper and oak woodlands are found on lower and middle elevations, and the higher elevations are mostly covered with open to dense ponderosa pine forests.

CHIHUAHUAN DESERTS

This desert ecoregion extends from the Madrean Archipelago in southeastern Arizona to the Edwards Plateau in south-central Texas. The region comprises broad basins and valleys bordered by sloping alluvial fans and terraces. Isolated mesas and mountains are located in the central and western parts of the region. Vegetative cover is predominantly arid-adapted grasses and shrubs, except on the higher mountains where oak-juniper woodlands occur.

MADREAN ARCHIPELAGO

Also known as the Sky Islands in the United States, this is a region of basins and ranges with medium to high local relief, typically 3,500 to 5,000 feet. Native vegetation in the region is mostly grama-tobosa-shrub steppe in the basins and oak-juniper woodlands on the ranges, except at higher elevations where ponderosa pine is predominant. The region has ecological significance as both a barrier and bridge between two major cordilleras of North America, the Rocky Mountains and the Sierra Madre Occidental.

SONORAN BASIN AND RANGE
Similar to the Mojave Basin and Range to the north, this ecoregion contains scattered low mountains and has large tracts of federally owned land, some of which is used for military training. However, the Sonoran Basin and Range is slightly hotter than the Mojave and contains large areas of palo verde-cactus shrub and giant saguaro cactus, whereas the potential natural vegetation in the Mojave is largely creosote bush.

5.3 Overview of Arizona's Grasslands
Around the world, grassland ecosystems have great social, economic, and ecological value. Grasslands in Arizona have changed considerably over the last 130 years.

- 31% of the state's former grasslands are in good condition with native perennial grasses and low shrub cover
- 34% are shrub-invaded but have the potential to be restored
- 26% have crossed a threshold where former grasslands have transitioned to shrub land
- 9% are now dominated by exotic species
- 4% have low shrub cover but also little to no perennial grass

This data may underestimate the extent of grassland change, particularly for grasslands imbedded within pinyon-juniper woodland and ponderosa pine forest due to tree encroachment from long-term fire suppression. Arizona's grasslands are part of a large and diverse network of grasslands found throughout the southwestern U.S. and northern Mexico. Semi-desert grasslands in central and southeastern Arizona extend into New Mexico and Sonora, Mexico. Grasslands in northern Arizona share similarities with those found in the Great Basin and Colorado Plateau in Utah, Colorado, and New Mexico. Finally, high elevation grasslands, those in alpine areas and meadows interspersed within conifer forests, are found throughout most of the mountain ranges of northern Arizona and New Mexico.

The grasslands in Arizona are generally found in semiarid climates with cold, dry winters and warm to hot summers with higher rainfall. Rainfall is seasonal with the majority of precipitation occurring during the summer with the arrival of monsoons. Since rainfall is seasonal across most of Arizona, many if not all of the grasslands experience seasonal drought. In some grassland areas, the total precipitation would be enough to support trees if it were more evenly distributed throughout the year. In many grasslands, fires is the key factor in the exclusion of trees and shrubs.

Grassland Decline
Human effects on grasslands are extensive. Fire suppression has led to the invasion of many grasslands by woody plants, mainly juniper and mesquite in Arizona. Drought has also had major effects.

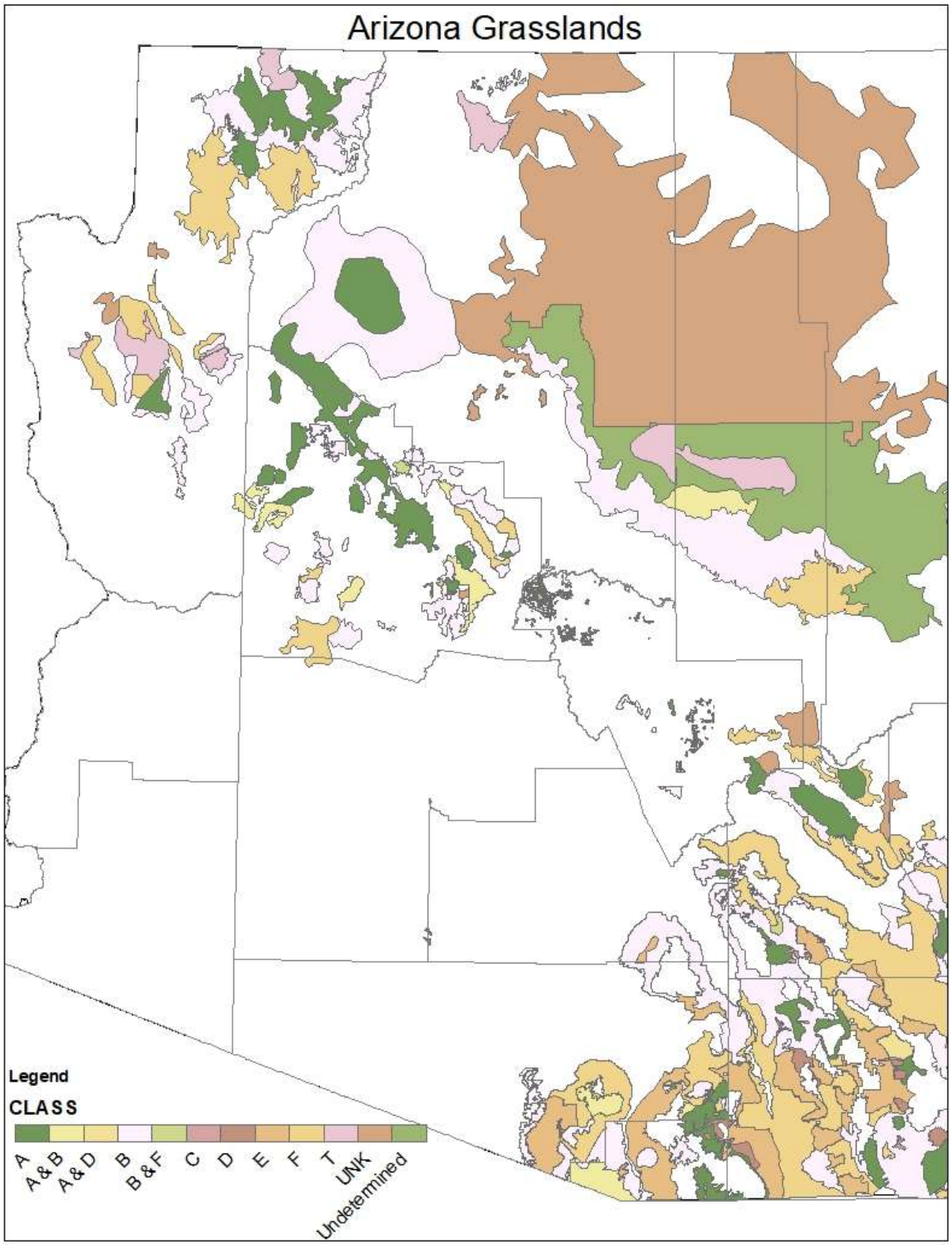
Vegetation change in grasslands has been extensive and dramatic. Native grasslands with low shrub cover now occupy only 2 million acres or 15.4% of former grassland. Roughly, three-quarters of this high-quality native grassland, or 1.4 million acres, occurs in the U.S. (13.7% of current and former U.S. grassland). Shrub encroachment has occurred on over 9.2 million acres or 70.7% of current and former grasslands. Approximately 3.8 million acres of this is restorable back to native grassland using brush management coupled with grazing rest and prescribed burns (29.2% of current and former grassland). However, shrub cover has exceeded a threshold producing a type conversion from grassland to shrub land on over 4.1 million acres or 36% of the historic extent of grasslands in the ecoregion[28].

[28] Gori, D.F., and C.A.F. Enquist. 2003. An Assessment of the Spatial Extent and Condition of Grasslands in Central and Southern Arizona, Southwestern New Mexico and Northern Mexico. Prepared by The Nature Conservancy, Arizona Chapter. 28 pp.

Interactions between drought and the introduction of non-native plants like Lehmann lovegrass (*Eragrostis lehmanniana*) have contributed to the decrease in grassland productivity in Arizona. The clumped growth form of the native perennial bunch grasses provides open spaces that allow the establishment of invading plants. This along with the fact that native grasses do poorly under drought and/or heavy grazing have played a role in non-native plants gaining a foothold[29].
However, changes in grassland composition and structure have not occurred uniformly across the region and their extent and distribution are poorly understood at a regional scale. Moreover, these changes are dynamic and ongoing. This means land managers across Arizona still have time to assess and characterize the extent of the vegetation changes in grasslands and to identify the best remaining native grasslands and restorable grasslands to manage grassland decline.

The map below depicts 12 different classes of grasslands and where they occur across Arizona. The map comes from the Nature Conservancy, where they have a full explanation of each of the different classes.

[29] Gurevitch. J., et. al., 2006. The Ecology of Plants. Sinauer Associates Inc. Chapter 18: Biomes. Pg. 435.


Arizona Grasslands
Legend
CLASS
A
A&B
A&D
B
B&F
C
D
E
F
T
UNK
Undetermined

5.4 Overview of Arizona's Deserts

The state of Arizona is home to four deserts: the Mojave Desert, Great Basin Desert, Chihuahuan Desert, and Sonoran Desert. The Mojave Desert covers a small portion of the northwest corner of the state and is characterized by a rainy winter season with hard freezes. Vegetation in the Mojave Desert consists of creosote bush (*Larrea tridentata*), low shrubs, Joshua tree (*Yucca brevifolia*), arborescent yucca, grasses, and annual flowers that bloom during wet years. The Great Basin Desert is located in the northernmost region of the state and is known for its very cold winters. Vegetation lies dormant during the cold winters, limiting plant growth to the summer season. The vegetation consists of low, small-leafed shrubs. There are no trees or cacti in the Great Basin Desert, and the environment is often dominated by big sagebrush (*Artemisia tridentatae*).

The Chihuahuan Desert is located in the southeastern corner of the state at a higher elevation than the other three deserts. The vegetation consists of ocotillo (*Fouquieria splendens*), creosote bush (*Larrea tridentata*), varying species of low shrubs, succulents, small cacti, grasses, and few trees. Precipitation is predominantly in the summer, but winter rain at the northern end of the desert can cause a springtime bloom of annual flowers. The Sonoran Desert is the largest desert in Arizona and encompasses most of the southern half of the state. The Sonoran Desert also houses the majority of the state's human population, along with over 2,000 plant species and nearly 550 species of vertebrates. Mild winters allow for trees, grasses, cacti, shrubs, and wildflowers to persist and stay in season year round[30]. Some of the key plant species include saguaro (*Carnegia gigantea*), palo verde (*Parkinsonia spp*.), and triangle-leaf bursage (*Ambrosia deltoidea*).

Precipitation in two of these deserts comes at one time period during the year. The Mojave Desert receives almost all of its rain in the winter, while the Chihuahuan Desert receives mainly summer rains. The Sonoran Desert is unique among the other deserts as it has two periods of rainfall (also known as bimodal), a winter and a summer rainy season, with very dry autumn and spring seasons separating them. As a result, the Sonoran is the greenest of Arizona's deserts, with the highest standing biomass and productivity, and is one of the most floristically diverse[31].

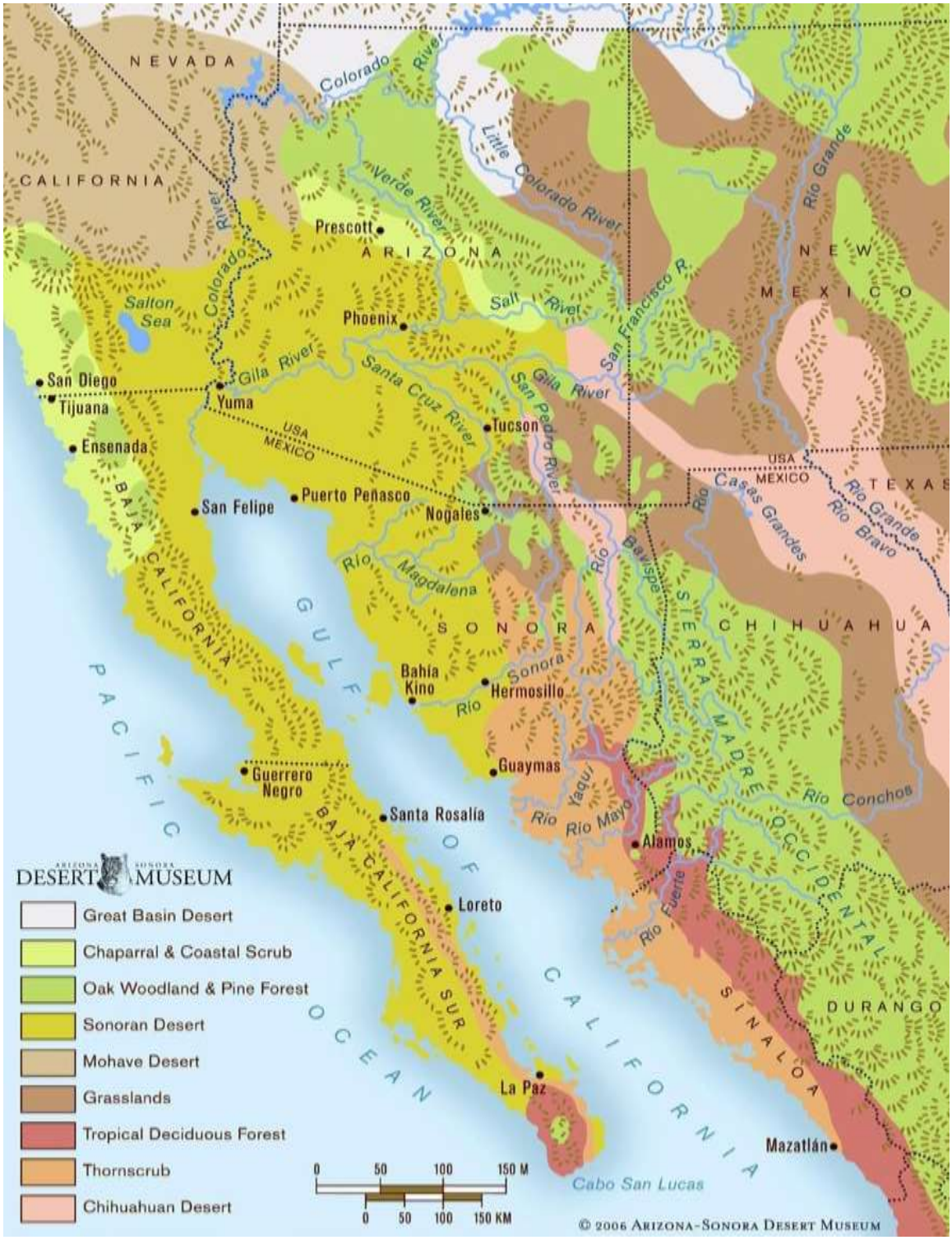
Desert Impacts

The deserts across Arizona are important areas for agriculture and seasonal livestock grazing, and they are becoming increasingly important for recreation as well. For most of human history and prehistory, human populations in deserts have been very low and centered on perennial river systems. In the last 70 plus years, however, there has been rapid growth in Phoenix and Tucson, which in turn has had some negative impacts on the surrounding ecosystems. The growth of the urban population centers strain water resources, whether it be ground water or surface water. Grazing, by both livestock and wild burros and horses, has effects in many deserts. Heavy grazing disturbs the soil and increases the opportunity for invasive plants to take hold. Annual invasive grasses like cheatgrass (*Bromus tectorum*) and red brome (*Bromus rubens*) are serious threats to the Great Basin Desert and Sonoran Desert, respectively. These species have established at such levels that they fuel wildfires in areas that traditionally did not burn. Further, buffelgrass (*Pennisetum ciliare*) is another invasive grass – a perennial bunchgrass – that has fueled wildfires in the Sonoran Desert in and around Tucson, damaging or in some cases destroying saguaros and other desert plants not adapted to fire. Use of recreational off-highway vehicles (OHVs),

[30] Dimmitt, M. (2018). Biomes & Communities of the Sonoran Desert Region. Arizona Sonora Desert Museum, http://www.desertmuseum.org/books/nhsd_biomes_.php

[31] Desert Research Institute, (n.d.). Climate of Arizona. Desert Research Institute, https://wrcc.dri.edu/narratives/Arizona.htm

common across the southwest, can be destructive to sensitive desert vegetation when users veer from established roads and trails to create new pathways. Because the vegetation holds the soil in place, the loss of vegetation through human activities leads to soil loss and erosion by wind and water. These impacts are challenging to address, but merit consideration in the context of Arizona's desert landscapes.



6.0 Critical Natural Resource Issues for Arizona

Overview

The first *Assessment's* Task Group came up with seven critical issues, which pertain to the forests of Arizona; this list has since been expanded to eight critical issues and now pertains to all landscapes in Arizona, not just forests.

Critical Issues:

1. **People and Landscapes**
2. **Ecosystem Health**
3. **Water**
4. **Air**
5. **Fire**
6. **Economics**
7. **Climate Change**
8. **Culture**

The following pages explore these eight critical issues in more detail. Each issue discussion includes a brief description and overview, a description of threats/benefits and key elements, and work to identify relevant areas of the state to focus implementation resources and future investigations.

In creating the original *Assessment*, the groups discovered concerns that affected each of the critical issues. These concerns were:

- Funding to accomplish forest management activities
- Building capacity to collaboratively accomplish forest management goals, and
- Educating the public and decision makers about forest management.

It was clear as strategies were developed and implemented various aspects of funding, capacity, and education must be considered because each of the critical issue discussions touched on these issues in one way or another.

Funding encompasses several sub-issues: government funding for project planning, design, and implementation; private investment to develop industries that can offset treatment and management costs; valuation of ecosystem services; and balancing of current investments with future cost savings (i.e., investment in fuel reduction treatments now compared to wildfire suppression costs later).

Capacity refers to the combined resources and ability of various entities cooperating to accomplish restoration and management at the landscape scale. Projects will necessarily have to increase in scale, from thousands to tens and hundreds-of-thousands of acres, and move to new and innovative approaches. Of course, funding is required to create, maintain or expand capacity, but increased capacity must be specifically addressed and integrated into overall activities.

Education of the public and decision makers is necessary to assure their support for the kinds of actions required to address each critical resource issue. Knowledge, understanding, and involvement by diverse participants is required for appropriate ecosystem management and restoration to move forward. Without an educated public, support may be tentative, litigation is more likely, and funding may be diverted to other priorities.

6.1 People and Landscapes

Critical Issue Description

Arizona's population has grown for decades at a tremendous rate, and expectations are for continued growth through mid-century and beyond. This expansion brings people into ever-closer proximity with Arizona's natural resources such as forests, woodlands, and riparian areas, allowing them to garner a broad array of benefits from these areas, yet at the same time affecting these ecosystems in many ways. What were once remote wildlands with occasional visitors are becoming backyards and crowded playgrounds to expanding suburban neighborhoods. People migrating from urban areas often begin to face new challenges such as fire, smoke, access, water supply, and land use issues. At the same time, distant metropolitan areas continue to increase demand for some of the most precious natural resource commodities.

Introduction

People have been interacting with the landscape and natural resources for thousands of years. These landscapes provide significant ecosystem goods and services to society. The vegetation contained in these areas builds soils through decomposition of biomass and protect them from erosion with basal and canopy cover. Watersheds in more productive areas provide two-thirds of the drinking water in the United States[32] and they absorb 10% of the carbon dioxide that Americans emit each year[33]. They shelter fish and wildlife, and offer aesthetic beauty and spiritual renewal for people. Natural landscapes bolster our economy through recreation and tourism, through the creation of green jobs, and through the production of renewable wood products and energy. These wild areas are part of our cultural heritage as Americans. They are a national treasure to be protected and preserved for generations to come.

Benefits, Threats, and Impacts

Benefits

- Forests, woodlands, and riparian areas are important economically for jobs and rural economies.
- Urban and community forests form the green infrastructure system on which many communities depend for aesthetics and shade.
- Improving forest health while reducing risk due to insects, disease and catastrophic wildfire, will enhance conditions with respect to traditional, cultural, and historical values.

Threats and Impacts

- Increased pressures from a rapidly expanding population-Arizona's population has doubled during the past 25 years to more than seven million people.
- Conversion of rural land to urban and suburban uses--development and sprawl.

[32] NRC, 2008. Hydraulic Effects of the Changing Forest Landscape Committee on Hydrologic Impacts of forest Management, National Research Council. 2008. Washington: National Academies Press.
[33] USDA Forest Service, 2009. Forests Absorb Carbon Dioxide. Northern Institute of Applied Carbon Science, USDA Forest Service-Northern Research Station.

- Recreation pressures on public lands will increase as private and state trust lands are developed. As opportunities for recreation are reduced on these lands due to Arizona's rapidly expanding population, public lands will be relied upon more heavily to provide recreation opportunities.
- Land ownership patterns are changing towards infrastructure and industry.
- Deforestation-type impacts occur through loss of forests to stand-replacing fire, land development, and other forested land use changes.
- Globally, it is estimated that almost 20 percent of human-caused carbon emissions are from deforestation.

Key Elements

Population

In 2017, more than seven million people lived in Arizona. Projections indicate that the population will be greater than 10 million by 2030 and nearly 16 million by 2050. Arizona has typically ranked first or second nationally in rate of population growth in recent years--between 4-5% annually for the past decade. Certain ethnic groups have also increased as a percentage of the overall population. As one example, the Hispanic population has grown from 20 percent to 25 percent of the overall total since 1940. Other groups have decreased--the Native American population has declined from 11 percent in 1940 to 4 percent in 2017. There have also been population changes relative to age during recent decades. Many Arizona counties have had increases in population of people who are 65 and older. It is important to assess the current and future impacts of population growth on resources such as water, wildlife and forest/woodland cover, as well as to develop information about future recreation trends and impacts.

Conserve Working Forests: Forest Conversion, Development, and Sprawl

Most of Arizona's population growth and associated development is occurring in suburban and rural areas that surround existing cities--areas previously characterized by forest, desert, and agricultural land. This trend in Arizona mirrors urbanization throughout the country where forests are being permanently converted to non-forest uses at a rate of 1 million acres per year.

Nationally, 262 million private forested acres belong to families and individuals (i.e. Non-industrial private forests). Many of these landowners lack the technical or financial resources to manage their lands in a way that society can fully benefit. While management planning helps families make a long-term commitment to the land, estimates suggest that only 3% of family forest owners have a written resource management plan. Working forests are also important economically for jobs and rural economies.

Changing Demographics and Values

Our country has shifted from being primarily rural to being nearly 80 percent urban and suburban dwellers, with the areas of greatest growth in the West and the coastal South. The nature of forestland ownership is also changing. The average age of forest landowners is increasing while the size of their forested parcels is rapidly decreasing. Ninety percent of landowners own fewer than 50 acres, with half of those owning 9 acres or less.

People in the United States have mixed feelings about the value they place on forests. Some desire to use forests with unlimited access or for maximum profit, while others seek to conserve and protect forests to the highest degree practicable.

Historical and Cultural Values of Forests and Sites within Forests

Although special places are inherently difficult to identify and categorize, all lands whether they are tribal, federal, state or private have many identifiable places that are considered special by various cultures, groups, and individuals. Take for example areas where families have been hunting/fishing for generations. It is difficult to identify these areas unless you are the individual or group that uses these areas.

Recreation

Statistics show that virtually every recreational activity is on the rise on Arizona public lands, including those described as unmanaged activities. Largely driven by population growth and available transportation and access, many experts view this situation as a significant threat for national forests specifically, and for forests in general. There is concern that increased demand cannot be met due to limited recreation facilities, and infrastructure. Experience provides evidence that unmanaged recreation is causing damage to resources that can be costly to mitigate. Increasing problems with invasive plants and animals may be partially attributed to recreational activity.

Arizona State Parks & Trails Accreditation

Arizona State Parks and Trails has become the first state park system in the country to achieve accreditation from the Commission for the Accreditation of Park and Recreation Agencies (CAPRA) for best practices in operation and service. CAPRA accreditation is the only national accreditation for park and recreation agencies, and is a measure of an agency's overall quality of operations, management, and service to the public. Agency staff played an integral role in reviewing, improving, and implementing policies, procedures, and plans that support the agency's mission and deliver high-quality experiences to visitors. The public benefits from accreditation by knowing the agency is adhering to best practices in the field of parks, facilities, and programs. It also demonstrates to partners and potential funders that the agency operates under such standards.

Recreation pressures are extremely high on forested lands around Grand Canyon National Park (GCNP). For example, nearly 150 trailheads on the Kaibab National Forest are in close proximity to GCNP. Roughly, 97% of the visitors to the Kaibab National Forest are Caucasian. Hispanics make up most of the remaining balance of those who provided ethnicity information in one study. Approximately 6% of the visitors are international.

Communities

Issues of concern for communities include water availability, recreation, wildfire protection, access for fuelwood gathering and other uses, smoke management, protection of wildlife and habitat, aesthetics, cultural resources, and many others. Wildland-urban interface areas (WUI) create complex relationships for surrounding forests and communities. Such relationships not only affect fuel management and wild

land fire management by government agencies, they also may influence how the agency manages vegetation with forest restoration treatments.

Communities include those of both place and interest. Communities include cities and towns that may affect or be affected by a forested area and any stakeholders with an interest in a forested area whether consumptive or passive. Some communities have expressed concerns that national forest land ownership prevents development. The U.S. Forest Service has developed an Open Space Strategy that provides broad concepts for working cooperatively with communities to address open space and development potential issues. Land exchanges are one option to address this issue.

As populations increase, community needs usually result in increased need for forest access, transportation routes, and utility corridors. These needs can contribute to forest fragmentation.

Urban and Community Forestry

Jim Skiera, International Society of Arboriculture executive director, said, "We often think of planting trees in a rural setting, overlooking that more than 80% of the population live in our cities, where additional trees can provide the greatest benefit." Urban and community forests are critical components of the human living infrastructure and people/forest connection. This forest type is a dynamic resource that provides environmental services such as improving air quality, mitigating heat, improving storm water capture, controlling erosion, and improving soils. Trees and other vegetative biodiversity provide corridors for wildlife and people. They cool cities (counteracting the urban heat island effect) and communities, save energy, affect environmental health issues,

Glendale Desert Food Forest

Part regenerative landscape part outdoor classroom, the Glendale Desert Food Forest connects residents to the Sonoran Desert's array of water wise edible plants. The city of Glendale Water Services Department packed this one of a kind amenity with over 100 edible plants. The use of plants with alternating fruiting seasons ensures year round food for people and wildlife. This hardy demonstration project consists entirely of low water use plants and survives off rainfall and minimal supplemental irrigation. The Desert Food Forest is an ideal setting for ongoing public education and outreach activities. Free classes on sustainable landscaping and growing desert edibles are led by local garden experts. The "Taste Your yard" programs encourage people to sample desert foods, such as agave syrup, prickly pear candy and pomegranate juice. Visitors can also take self-guided garden tours to delve deeper into planting their own food forests. This Public-private partnership was funded through an Arizona Department of Forestry and Fire Management grant and involved several partners, including the Glendale Public Library, Linking Edible Arizona Forests Network, Maricopa County Master Gardener program, and Trees Matter. Together, we are promoting water conservation, supporting local food production and spreading the message, "Have you yard and eat it, too!"

reduce noise pollution, strengthen social cohesion, leverage community revitalization, and add economic value.

Urban and community forests broadly include urban parks, street trees, landscaped boulevards, neighborhood parks, urban private land, commercial sites, schools and higher education facilities, public gardens, river corridors and promenades, greenways, wetlands, nature preserves, natural areas, shelter belts of trees and working trees at industrial brown field sites. They add form, structure, beauty, and breathing room to the urban design and provide places to recreate, opportunities to improve social connections, complement smart growth, and create a more walkable community. Moreover, they create environmental education opportunities for populations that do not have access to rural forests.

The current condition of urban and community forests of Arizona is of immediate concern because the percentage of urban forest cover (total vegetation covering the ground) in major metropolitan areas like Phoenix is low compared to regional standards (Tree and Shade Master Plan). Challenges to maintain these forests are:

- Limited urban forestry staff
- trees not being replanted at the same rate as they are being lost or removed
- low overall urban shade canopies
- out of date and inadequate tree standards in zoning ordinances;
- limited irrigation water resources
- educational programs eliminated or underfunded
- poor planting, maintenance, and irrigation practices
- limited community and business partnerships
- incomplete tree inventory or GIS location information
- regulatory hurdles that create disincentives for structural shade
- limited understanding by the general public of the importance of trees

Grazing/Rangeland Values

Federal and state trust lands have provided an important economic base for communities in areas where agricultural activities are important and where available private land for grazing and rangeland use is limited. Grazing leases and allotments on rural lands, including those of the national forests, are often a key component of ranching operations. National forests account for approximately 15% of all lands in Arizona and in some counties, the percentage is higher.

State and federal programs are now being used to assist landowners as well as grazing and agricultural lessees of state trust or federal lands. Assistance is provided to implement conservation-based management activities using livestock and crop production practices that provide wildlife habitat or other public benefits and preserve open space. Some examples are the NRCS Environmental Quality Incentives Program (EQIP) and the Arizona Department of Agriculture's Livestock and Crop Conservation Grant Program. Under provisions of the 2008 Farm Bill, EQIP has also become a primary source of funding for forestry work on nonindustrial private forestlands.

There has generally been a decrease of grazing activity on Arizona national forests during the last 20 years. Some national forests have had decreases in the number of active grazing allotments or permittees. One forest that has maintained a stable number of allotments and permittees had a decrease in the number

of cattle permitted to graze. According to the U.S. Forest Service, some of the reductions are attributable to prolonged drought and monitoring data showing a decline in rangeland conditions.

Education

Surveys and research indicate there is strong support for natural resource conservation education. Respondents believe that the goals of developing volunteer programs to improve forests and grasslands, and maintain trails and recreation facilities are important. In general, there is strong support for providing greater information to the public in the form of education on proper recreation use, the environmental impacts of different uses, and the economic value derived from developing and preserving natural resources. Collaboration between groups for information sharing purposes is also considered an important goal. However, programs and funding can quickly be exhausted. Information and tools that engage the general population and decision makers in stewardship of our forest and related resources will be critical.

Other Considerations/ Related Issues

- Wood for houses, furniture, paper, and other products: Ninety-two (92) percent of all trees harvested in the United States come from private forests
- Loss of markets for forest products: More than 330 wood processing mills have closed nationwide since 1997 and more than 158,000 jobs have been lost.
- Forest ecosystems contribute to the social and economic sustainability of local communities by providing places for recreation. However, we must consider that increasing numbers of people hiking, camping, and recreating within an area of limited size and resources may affect the ability of forest ecosystems to sustain such use.
- Industries, such as mining, logging, and grazing may continue to affect ecological structure and function, which, in turn, will affect the sustainability of future social and economic endeavors.

Resources - Existing and Needed

Existing Resources:

- DFFM staff and consulting foresters assist private landowners, federal agencies, and municipalities.
- Statewide and local non-governmental conservation organizations provide active engagement at the state and community level.
- State universities and institutes provide science-based support and other resources.
- Local Natural Resource Conservation Districts (NRCDs) provide technical assistance to land owners and the identification of local resource concerns and opportunities.
- Committees and councils (e.g., Arizona Forest Stewardship Committee, Governors Forest Health Council, and Arizona Community Tree Council) help direct across broad areas.

Resource Needs:

- Appropriate human resources within the DFFM, such as a Tribal Liaison position.
- Involvement and support from community leaders.
- Better information and education on the costs and benefits of ecosystem management activities including prescribed and natural fires; forest restoration; marketable value for the numerous

benefits that forested lands provide, such as clean water, wildlife habitat, aesthetics, and recreation.

- Economic data on the value of ecosystem services (need data to show the valuation of these services in Arizona so they can be included in land management planning decisions).
- Data and accurate information on the economic benefits of forest-based recreation and tourism.

Key Partners/Stakeholders

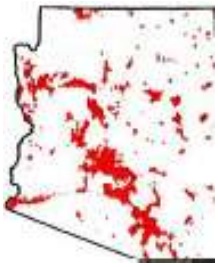
Many of the partners and stakeholders have a potential role in supporting implementation of this strategy. A few stand out as being critical to success:

- Arizona Community Tree Council
- Arizona Forest Stewardship Council
- Environmental and conservation non-governmental organizations
- Recreation associations and groups
- County supervisors, managers, planning and zoning committees
- Municipal mayors, council members, managers, planning and zoning commissions
- Developers, builders and related associations
- State universities
- USDA Forest Service
- Community Forestry Committee
- Arizona State Parks
- National Park Service
- Four Forest Restoration Initiative

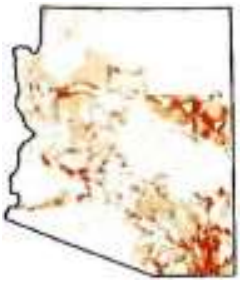
Priority Areas

Focus areas for the People and Forests issue are identified and mapped below. These focus areas were used as the initial priority areas for this issue. Additional criteria that were used to refine priority areas, or identify additional priority areas, include:

- Areas with high recreational value and use.
- Areas of wildland/urban interface (WUI) or forested areas with high development potential.
- Forest landscapes impacted by the socio-economic threats to working forests, such as the loss of private forest lands to residential, commercial, and industrial development.
- A combination of overlays that show areas of critical resource value, forest health issues, fire risk, areas where private land conversion would most likely contribute to significant fragmentation, etc.
- Urban forest areas or mapping of communities engaged in Tree City USA or other community forestry work.



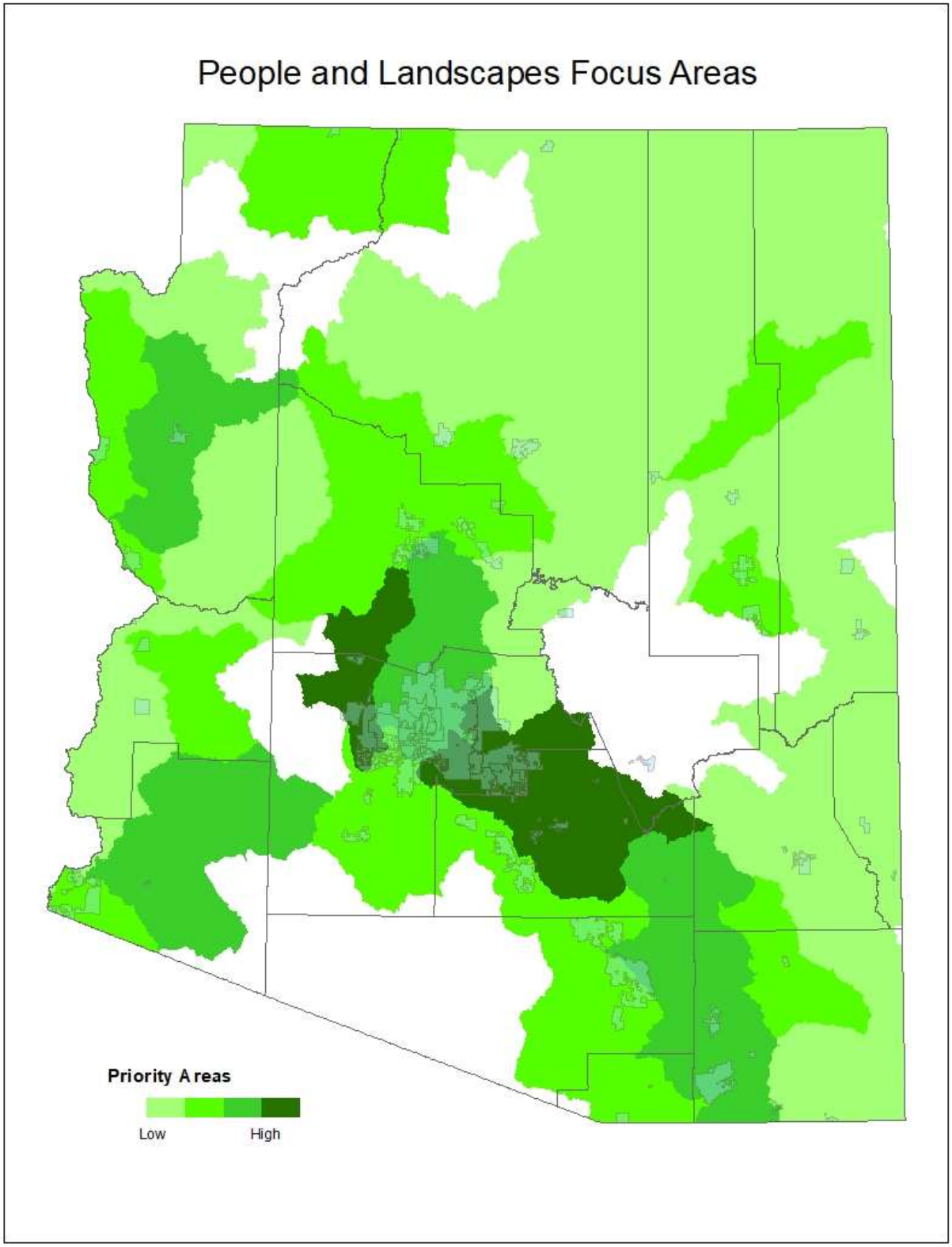
Urban Growth: Dataset developed by the Arizona Game and Fish Department for Arizona's State Wildlife Action Plan showing expansion of metropolitan or suburban areas into the surrounding environment.



Rural Development: Dataset developed by the Arizona Game and Fish Department for Arizona's State Wildlife Action Plan depicting where development has occurred in relatively isolated and sparsely populated areas.

Shade Tree Planting and Prioritization: Data set developed by DFFM depicting where in Arizona there is need for increased natural shade due to population density, lack of canopy cover, low-income, traffic proximity, sustainability, air quality, and urban heat effect.

Landscape Integrity: The Arizona Game and Fish Department developed this dataset as to help assess statewide connectivity. Landscape integrity is a measure of the landscape's naturalness, or its inverse, the level of human modification. The red depicts where human modification of the landscape is high and green is where modification is low.


People and Landscapes Focus Areas
Priority Areas
Low
High

Goals, Objectives, and Actions

The Strategy Team identified two (2) goals, nine (9) objectives, and twenty-eight (28) action items to address the People and Landscapes issue. Goals were designed to enhance the benefits people receive from natural biotic resources, and to reduce the negative effects of people on trees and forests. Objectives were designed to:

- Improve understanding of the benefits of trees and forests, and engage people in stewardship.
- Better manage recreation uses and impacts in Arizona.
- Minimize loss and fragmentation from development.

Goal 1: People and communities receive maximum benefits from Forests and Trees.

Objective 1: Connect people to trees & vegetation and improve their understanding of the benefits provided by Arizona's landscapes.	1. Develop and implement educational programs for county and community leaders, schools, and civic groups to increase public awareness regarding the benefits of vegetation on the impacts of urban heat islands, impervious surfaces, and other resource issues. 2. Improve access to trees for recreation, education, and other uses. 3. Develop and maintain data such as street-tree & canopy-cover inventories, as well as research on the interaction of people with forests, to improve knowledge of the benefits provided by forests and trees. 4. Expand collaborative efforts with academic organizations and schools to strengthen environmental education of Arizona youth.
Objective 2: Enhance urban and community forests.	1. Maintain and update the Urban & Community Forestry one-year and five-year plans to increase benefits from urban forests. 2. Engage communities, tree organizations, conservation groups, and green industry groups to identify local community needs and build local capacity. 3. Identify, fund, and encourage partnerships to facilitate stewardship in urban tree protection and planting programs. 4. Encourage and conduct educational outreach that empowers communities and schools to sustain and enhance forests and urban canopy programs. 5. Work with the Arizona Community Tree Council and communities to plant area-specific, drought-tolerant trees.
Objective 3: Improve energy conservation through tree planting and maintenance.	1. Promote tree planting as a condition for new developments and renovation projects. 2. Promote minimum tree canopy standards in public parking lots to mitigate urban heat islands. 3. Increase tree planting aimed at energy conservation in accordance with the American Forests tree canopy recommendations. 4. Encourage integration of design, management, and enforcement to increase program efficiency; and minimize impacts on ecosystems and natural areas.
Objective 4: Enhance Public Benefits from Trees and the Landscapes across Arizona.	1. Support efforts to develop and maintain regional strategies to conserve, manage, and connect people to green infrastructure. 2. Support implementation of regional green infrastructure strategies. 3. Support efforts to develop, implement and maintain state strategies to conserve, manage, and connect people to green infrastructure. 4. Encourage new research related to urban forestry including those associated with air pollution and energy conservation.

Goal 2: Minimize negative human impacts to trees and forests.

Objective 1: Increase awareness of threats to Arizona's natural resources and awareness of available tools to mitigate those threats.	1. Engage state and federal agencies, land trusts, and other conservation partners to increase awareness about threats to Arizona natural resources. 2. Develop and maintain education materials, programs, and outreach to increase awareness of available tools to address threats.
Objective 2: Engage people in environmental stewardship activities.	1. Increase awareness, coordination, and landowner participation in technical & financial assistance programs. 2. Implement reforestation, afforestation, and forest health improvement projects to enhance forested ecosystems.
Objective 3: Manage recreation impacts on forests.	1. Participate in and support public land travel management planning, implementation, and other efforts to manage impacts of outdoor recreation.
Objective 4: Minimize forest fragmentation from development.	1. Work with state and local governments on policy development and program implementation to protect forest ecosystems from fragmentation. 2. Utilize land exchange, conservation easements and fee title purchase programs (i.e. Land & Water Conservation Fund, Wetlands Reserve Program, Farm & Ranchlands Protection Program, Forest Legacy Program, etc.) to consolidate ownership and prevent fragmentation of forest lands.
Objective 5: Focus efforts in priority landscapes and areas that have been historically underserved.	1. Focus staff and resources on identified priority landscapes where long-term management will increase public benefit 2. Develop strategies for reforestation in ecosystems where invasive plants have affected the quality and quantity of water. 3. Promote conservation of priority landscapes where fragmentation negatively affect the movement of critical species. 4. Provide outreach to forest landowners in priority landscapes that have been traditionally underserved.

6.2 Ecosystem Health

Critical Issue Description

Throughout the ecosystems of Arizona, evidence of their declining health, function and sustainability is clear. Dramatic signals of unraveling ecosystems include large, uncharacteristic crown fires; effects of prolonged drought; excessive fuel buildup; vegetative loss from insects and tree pathogens; and widespread decreases in the biodiversity of both plants and animals. Evidence-based research

indicates that some Arizona ecosystems are very different from historic conditions. Key indicators include changes in nutrient cycling, decreases in species diversity, invasion by exotic species, declining watershed function, and disruption of natural fire regimes. It is essential we accurately identify the reasons for decline in the health of ecosystems and respond appropriately.

Introduction

Ecosystems provide necessary habitat for a wide variety of wildlife, as well as critical goods and services to the public. Nevertheless, evidence of declining ecosystem health is clear across Arizona. Uncharacteristic fire behavior, disease and insect outbreaks, and declining biodiversity are among the most noticeable effects. Science-based strategies are essential for restoring ecological integrity so the goods and services these ecosystems provide are sustained into the future. Stakeholder engagement and collaboration are critical elements to effectively address Arizona's Forest ecosystems at a landscape level as well asthe ability to attract a wide group of active stakeholder engagement that can work collaboratively to set priorities, secure funding, build social support and establish treatment objectives.

Key Elements

Ecosystem functions must be accurately identified to allow science-based strategies to be implemented at an accelerated pace on a landscape scale. Defining and assessing the health of complex ecosystems is not easy. Ecosystem health issues resulting from human activity, are brought to light because of human concerns, and are addressed through human intervention. We need to ensure ecological components of ecosystems are resilient to disturbances, including human activities and climate variability[34].

Ecosystem restoration must be based on sound science. This requires an understanding of how ecosystems function, how they support human use, and how policy and management affect the environment[35]. Indicators of healthy ecosystems include: 1) biological diversity, 2) biotic integrity and resilience, and 3) natural disturbances (e.g., seasonal flooding in riparian areas). These indicators accurately reflect the biological and physical aspects of a healthy ecosystem that in turn supports the human dimensions (needs and uses) of a functional ecosystem.

Natural disturbances, such as; fire, wind damage, flooding, and insect and disease kills within the ecosystem are indicators of a healthy ecosystem. Natural disturbance processes allow for the shifting of a plant communities structure and age across the landscape. Ecotone shifts are influenced at both the

[34] Apache-Sitgreaves FLMP, pg. 12. Originally published in August 1987, converted to electronic format in July 2006, updated February 22, 2008 to include Amendment 13 (wildland fire use), updated June 30, 2009 to include Administrative Correction #1
[35] Thomas, Jack Ward and Susan Huke, 1996. The Forest Service Approach to Healthy Ecosystems. Journal of Forestry, Volume 94, number 8, 1 August 1996, pp 14-18(5).

landscape and watershed scale by natural disturbance processes. The presence of a mosaic of plant communities and the variety within them provides resilience to disturbances[36].

Ecological conditions for habitat quality, distribution, and abundance contribute to self-sustaining populations of plants and animals that are interrelated and properly distributed. Appropriate conditions provide for the life history needs, distribution, and natural population fluctuations of the species within the carrying capacity of the landscape[37].

Benefits, Threats, and Impacts

Benefits:

- Enhanced native plant and animal diversity
- Wildlife habitat supports the survival and recovery of threatened and endangered species
- Improved watershed function and watershed health
- Decreased populations of invasive species
- Restored natural fire regimes and other natural disturbances (e.g., wind, insects, disease)
- Reduced occurrence of unnaturally severe fire activity
- Restored and sustainable forest vegetative structure and functions
- A wide range of sustained ecosystem services.
- Engagement of stakeholders in developing social license for treatments

Threats:

- Established populations of invasive species (plants and animals) that change vegetation dynamics
- Altered vegetation structure and composition results in a loss of ecosystem resiliency and inability to adapt to climate change
- Homebuilding and road development create fragmented landscapes and ecosystems
- Uncharacteristic fires in deserts result in mortality to cactus, shrubs, and trees that are not adapted to burning
- Large, stand-replacing wildfire occurring in forested areas

Impacts:

- Significant increases in undesirable vegetation densities
- Decreases in plant diversity and productivity
- Reduced rates of nutrient recycling,
- Increases in insects and pathogen populations,
- Significant increases in fuel loadings
- Increased invasions of non-native plant species and reduced habitat quality for native wildlife
- Vulnerable riparian areas due to decreased shallow groundwater

Key Components

[36] Coconino NF FLMP. Published August 1987, converted to electronic version 1987, Amendments added thru June 2005. Currently under revision.
[37] *Id. 1*

Wildfire

Fire research has shown fire regimes vary widely across ecosystems in Arizona. Prior to European settlement, fire (especially as influenced by climate) had the largest single impact in shaping the ecology of the Southwest. It continues today to be the greatest force controlling ecosystems. Historically, both lightning and human-caused fire would burn until extinguished by rain or until it ran out of fuel--typically when they reached an area that had recently burned. Fires could burn for months and cover thousands of acres[38]. As a result, most forest stands burned every 2 to 30 years as low intensity, area-wide fires. Pre-settlement mixed conifer forest may have burned as frequently as ponderosa pine forest[39]. With greater moisture levels and heavier fuel loads, spruce-fir forests burned much less frequently but at high, stand-replacing intensity[40].

Four Forests Restoration Initiative: 4FRI

The Forest Service created the 4FRI to address ponderosa pine forest restoration on the four National Forests in northern Arizona. The Initiative's primary objective is to assure that the science-based and socially acceptable agreements forged over the past several years result in implementation of long-term, landscape-scale forest restoration as soon as possible. The 4FRI vision is to undertake, across approximately 2.4 million acres of ponderosa pine forest, landscape-scale restoration that will support resilient and diverse forest ecosystems, populations of native plants and animals, reduced destructive wildfire threat, and sustainable forest products industries. 500,000 acres are currently "NEPA-cleared" for mechanical thinning and another estimated 450,000 to 900,000 acres are expected to be available in the future through the current Rim Country Environmental Impact Statement.

[38] Swetnam, T.W. and C.H. Baisan. 1996. Historical fire regime patterns in the southwestern United States since A.D. 1700. Allen, C.D. tech. ed. Proceedings of the 2nd La Mesa Fire symposium; Fire effects in southwestern forests. General Technical Report RM–GTR–286. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Range and Experiment Station: 11–32.

[39] Grissino-Mayer, H.D., C.H. Baisan, and T.W. Swetnam. 1995. Fire history in the Pinaleno Mountains of southeastern Arizona: effects of human-related disturbances. In DeBano, L.F., P.F. Ffolliott, A. OrtegaRubio, G.J. Gottfried, R.H. Hamre, and C.B. Edminster, tech. coords., Biodiversity and management of the Madrean Archipelago: The Sky Islands of southwestern United States and northwestern Mexico; 1994 September 19–23; Tucson, Arizona. General Technical Report RM-264. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Exp. Sta.: 399–407.

[40] *Id. 6*

Historic fire regimes changed dramatically with the coming of Euro-American settlers. Livestock removed much of the grassy fuels that carried frequent, surface fires, and roads and trails broke up the continuity of fuels and further contributed to reductions in fire frequency and size[41]. Fire suppression and reduction in the harvest of woody vegetation has contributed to the buildup of flammable materials. Fire suppression permits tree and shrub encroachment into openings and, as a result, dramatic reductions in the size of forest and mountain meadows.

Disruption of natural fire regimes has also decreased plant diversity across much of Arizona. Establishment of young plants in older stands provides a ladder fuel that carries ground level fire up into the canopy. With more stand-replacing fires, average stand age is reduced and the diversity inherent in old, mature stands is often lost.

Logging creates heavy fuels in the form of remaining limbs, treetops, and cull logs. In most areas however, these fuels have been removed by various treatments; slash disposal (pile burning or chipping), biomass utilization, prescribed fire, or firewood collection. Those areas with the greatest fire hazard are the ones with the greatest fuel accumulations, such as stands never treated or logged without subsequent slash treatment.

Due to heavy fuel accumulations and climate change, today's fires are often more intense and more difficult to contain. The overall number of fires has been increasing across the state, with larger, more damaging fires also increasing. The number of fires burning more than 10 acres in size has increased each decade since the 1930s. The average size of fires since the 1970s has ranged from 14 to 16 acres per fire, double the average size of fires in earlier decades. The size of fires in the last ten years have ranged from several hundred acres to surpassing 500,000 acres in size (e.g., Wallow Fire), burning at the landscape scale. The interaction of fire and climate are well documented, and the Southwest is expected to continue to trend toward a substantially warmer, drier climate than has been recorded[42]. This climate trend will continue to increase the length of fire seasons further beyond the summer months[43], and increase the frequency, size, and severity of forest fires[44].

The Coronado National Forest adopted a strategy for restoring fire-adapted ecosystems at a large scale (i.e., hundreds of thousands of acres). This strategy, called FireScape (developed 2006 with individual district plans created up to 2020), involves multiple partners across land ownership boundaries, using the best scientific information available, and streamlining environmental compliance processes. It will eventually be applied to each of the 12 major mountain ranges within the Coronado National Forest. The Huachuca FireScape project, which covers 400,000 acres in the Huachuca and Whetstone mountains, was recently approved and implementation has begun. Additional FireScape projects are underway in the Santa Catalina, Rincon, Chiricahua, Dragoon, and Galiuro Mountains of southeastern Arizona.

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[41] Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa forest structure: changes since EuroAmerican settlement. Journal of Forestry. 92(1):39–47.

[42] Seager R., Mingfang Ting, Isaac Held, Yochanan Kushnir, Jian Lu, Gabriel Vecchi, Huei-Ping Huang, Nili Harnik, Ants Leetmaa, Ngar-Cheung Lau, Cuihua Li, Jennifer Velez, and Naomi Naik. 2007. Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. Science 25 May 2007: Vol. 316. no. 5828, pp. 1181 – 1184.

[43] Mackenzie, Donald, Z. Gedalof, D.L. Peterson, P. Mote. 2004 Climate Change, Wildfire, and Conservation. Conservation Biology 18(4), pp 890-902.

[44] Westerling, A. L., Hidalgo, H. G., Cayan, D. R., Swetnam, T. W. 2006. Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity. Science.Vol. 313. no. 5789, pp. 940 – 943.

Insects and Pathogens

For millennia, trees of southwest has been home to numerous species of herbivorous insects, pathogenic or saprophytic fungi, and parasitic plants. These species co-evolved with their hosts as members of dynamic, interacting communities. Through their ability to cause widespread tree mortality, defoliation, decay or deformity, some of these species achieved significant ecological importance as disturbance agents. Along with fire, these agents are among the more important regulators of plant density, composition, and structure. Landscape conditions, in turn, affect the distribution and reproduction of insects and pathogens. Directly and indirectly, these species interact with other members of the ecological community influencing various ecosystem processes, providing food and creating habitat for other organisms, affecting nutrient cycling, and influencing fire behavior.

The species of primary interest in Arizona include bark beetles (*Ips* spp.), several species of defoliating insects, dwarf mistletoes (*Arceuthobium* spp.), and root decay fungi. Bark beetles and defoliators are usually present in low populations, but they will periodically increase to outbreak levels. Although populations of dwarf mistletoe and root decay fungi fluctuate, their rates of change are much slower. These species, however, are very persistent and occur annually rather than sporadically.

Significant impacts to more common species of trees and woody plants have been seen in recent years, primarily from insects and diseases related to drought. In some instances, thousands of acres of select species, such as pinyon pine, have been killed.

Introduction of invasive plant species

Invasive plant species continue to pose a challenge in ecosystems across Arizona. Control of infestations can be expensive and difficult, but the ecological consequences of no action are serious. The expansion of invasive plant populations is affecting our ability to restore native plant communities and re-establish desired conditions. If invasive plants are not kept in check, long-term negative effects to ecosystems can occur. The ecological effects include replacement of native plant species and a reduction in ground cover, which leads to loss of biodiversity, forage for livestock and wildlife, habitat, scenic quality, and soil productivity.

A recent invasive species survey in northern Arizona by the U.S. Forest Service and others determined that weed populations continue to spread affecting several forests. Goals identified for national forests in Arizona include the following:

- Prevent any new noxious or invasive plant species from becoming established using the approach of early detection and rapid response.
- Contain or control the spread of known invasive plant species and eradicate species that are the most invasive and pose the greatest threat to biological diversity and watershed condition.
- Incorporate measures to control invasive plant species into project planning, implementation, and monitoring.

Changes in forest diversity and structure:

Plant succession and disturbance are now recognized as closely connected processes that together determine vegetation dynamics. Changes in the structure of many forests in Arizona are represented by

a substantial increase in small-diameter trees (less than 16 inches DBH), an increase in medium-sized trees (16 to 24 inches DBH), and a decrease in the number of trees greater than 24 inches DBH.

Probably the largest effect on forest health in ponderosa pine stands is due to the increase in the density of small trees. This effect is expressed in several ways:

- Increased tree density reduces the abundance and diversity of understory plants.
- An increase in ladder fuels so large crown fires are now more common.
- Increased tree density reduces tree vigor resulting in susceptibility to bark beetles.
- Dense stands provide suitable conditions for rapid spread and intensification of dwarf mistletoe.
- Increased tree density results in lower water yields, which affects riparian areas and watersheds.

In addition to increased density, ponderosa pine forests are becoming uniform, with the loss of horizontal and vertical structural diversity and species composition.

Changes in Wildlife Diversity

Wildlife diversity and population health are directly linked to the quality of available habitat (food, water, cover and space). There are more than 150 species listed in the State Wildlife Action Plan[45] that are dependent on forest habitats for a portion of their life cycle, and changes outlined all have an impact on the viability of these species.

The reduced health of Arizona forests has adversely affected habitat quality for wildlife in several ways:

- The exclusion of low-intensity fire from frequent-fire systems such as ponderosa pine has created more homogenous stands that lack the mature/old-growth tree component important to many wildlife species and reduced productivity of browse and herbaceous understory plants that provide wildlife food sources.
- High-elevation wet meadows and aspen stands have been encroached by conifers.
- Flood events, ash flows, and siltation following unnaturally large and intense wildfires have impaired or severely damaged aquatic habitats for native and sport fish.
- Critical habitats for federally listed species, such as the Mexican Spotted Owl (*Strix occidentalis lucida*), have been consumed or are at increased risk from damage by wildfire.
- Fire suppression in grasslands and the woodland-grassland ecotone has allowed widespread expansion of woody species such as juniper and mesquite, decreasing habitat quality for pronghorn (*Antilocarpa americana*) and other grassland-obligate species.

Needs for improving wildlife habitat conditions include:

- Creating diverse stand conditions that reflect historical ranges of variability for different forest types.
- Creation and/or improvement of habitat quality, distribution, and abundance to support native wildlife and the recovery or stabilization of federally listed plant and animal species

[45] https://www.azgfd.com/PortalImages/files/wildlife/2012-2022_Arizona_State_Wildlife_Action_Plan.pdf, Arizona Game and Fish Department 5000 West Carefree Highway Phoenix, Arizona 85086-5000, May 2012

- Prioritization of threatened and endangered species, sensitive species, emphasis species, and comprehensive plan goals--in that order--whenever conflicts between wildlife species exist when designing structural and nonstructural improvements
- Strategic habitat improvement including: 1) prescribed burning, 2) seeding and planting of desirable browse and herbaceous forage species, 3) maintenance and development of wildlife water sources; 4) prevention and control of invasive plants, and 5) restoration of aquatic systems, springs, high-elevation wet meadows, and other key habitats.
- Inventory of riparian and aquatic habitats as well as key plant species requiring protection
- Provide improved and protected habitat for key fish and wildlife species that rely on forest and riparian communities; implement goals of the SWAP and other wildlife management strategies
- Provide three levels of habitat management for the Mexican spotted owl--protected, restricted, and other forest and woodland types--to achieve a diversity of owl habitat conditions across the landscape
- Within Mexican spotted owl protected and restricted areas, Mexican spotted owl standards and guidelines take precedence over the northern goshawk (*Accipiter gentilis*) standards and guidelines on federal forest land because they are more restrictive and lead to greater species diversity
- Cooperation with AZGFD on control of aquatic invasive plants and undesirable fish species and stocking to meet management goals for native and sport fish.
- Construction of barriers to protect key riparian areas from excessive livestock grazing impacts
- Provide and maintain developed water sources like rainfall catchments for wildlife in locations where natural sources are insufficient.
- Where fences are needed, install or upgrade to wildlife-friendly designs that facilitate habitat connectivity and reduce injuries/mortalities. Where appropriate, remove fences no longer needed for livestock operations or other purposes.

Human Needs and Uses

In Arizona, trees and forests provide several public benefits that contribute significantly to our quality of life. These benefits often are referred to as ecosystem services and can be defined as "the life-support and life-enhancing services of natural ecosystems". Primary among these services are clean and abundant drinking water, habitat to support native biodiversity, wood products, fuel and renewable energy, carbon sequestration, and diverse recreational and scenic opportunities.

In urban and community settings, vegetation serves as green infrastructure that improves air and water quality; reduces energy needs; buffers noise pollution; provides food, cover, and travel corridors for wildlife; and offers opportunities for relaxation and respite. As the human population has increased, so has use and demands on forested lands. This increased use has generated threats and impacts that adversely affect ecosystem health. Primary contributors to ecosystem decline are conversion of forestland to other uses, dramatic increase in off-highway vehicle use impacts, and the onset of human-caused wildfires.

Forested areas are highly desirable for home sites or new subdivisions. With this conversion comes a loss of productive forests, increased wildfire risk to property as more homes are "in the woods," and pressure to reduce or eliminate appropriate management activities on adjacent lands (e.g., prescribed burns and concerns about smoke). Forest fragmentation is another result of urbanization. Also important are those

areas converted from one housing density to a significantly higher density as this may lead to loss of tree canopy and the benefits to ecosystem function.

The increase in off-road vehicles (ORV) can lead to adverse impacts and degradation of all ecosystem components. Such use has increased erosion, soil compaction, spread of invasive plants, and damage to archaeological/cultural sites, disturbance to wildlife, destruction of wildlife habitat, and risks to watershed function. Managing the areas where impact is greatest will help alleviate these impacts.

Ecosystem Integrity and Resilience

Policies for ecological restoration are informed by peer-reviewed science on the quantitative side and by ethics on the qualitative side. Science by itself is inevitably value laden, and the legislative framework that established and governs our public-lands--including the legislation--is based on so-called "citizen choices"[46].

Properly designed restoration treatments will begin to develop the social capital needed to create and maintain sustainable livelihoods in Arizona's ecosystems, which are deemed a priority. Restoration projects will necessitate creating jobs include prescribed burning, reforestation and planting of understory vegetation, controlling invasive species, establishing a variety of appropriate-sized industries utilizing wood fiber, and other management activities conducive to restoration goals and objectives. Such activities can help build social capital, which will enable not only sustainable jobs and industries, but also the sustainability of ecosystem functions, and restoration decisions that are science-based and effectively placed to treat forested ecosystems at the landscape scale.

Collaborative Engagement with Stakeholders

Diverse forest ecosystems of Arizona extend beyond jurisdictional boundaries and require a collaborative approach and stakeholder engagement to affect positive change at a scale that can address ecosystem health. Engagement and support of existing large scale, multijurisdictional projects and groups provide a path to supporting ecosystem health and resilience at scale.

Other Considerations/ Related Issues

- Functioning and sustainable ecosystems contribute to sustainable economies by facilitating an infrastructure for treating, utilizing, and monitoring ecosystem components.
- Only through rigorous scientific evaluation can ecosystem management actions be identified, and an adaptive management and evaluation methodology determined and implemented.
- Applying adaptive management in ecosystem management and restoration measures include "learning by doing", implementing the best science in a timely strategy, and moving forward at the landscape scale.
- Recognizing that unnatural crown fires and other symptoms of ecosystem stress are signals that these ecosystems are at risk, we must act and act quickly.

[46] Sagoff, M. 1988. The Economy of the Earth: Philosophy, Law, and the Environment. Cambridge: Cambridge University Press.

- Ecosystem restoration efforts should follow a holistic, systematic approach, characterized by clear-thinking, local collaboration, and solid knowledge, both of the biophysical system and of the socio-political system[47].

Resources - Existing and Needed

Existing Resources

- Use existing agency plans and assessments to determine natural resource management options.
- Strong collaborative support for focused management practices across landscapes, such as forest restoration, fuel reduction, wildlife habitat and population management, and treatments to control exotic pests and invasive plants.
- When appropriate and funding is available, use potential outside sources (i.e. consultants, organizations, others) for ecosystem evaluation and other tasks to help accelerate treatments in priority areas.
- Prioritize engagement with existing collaborative like the 4FRI Stakeholders Group, the Fort Huachuca Sentinel Land Scape, The Bill Williams Mountain Restoration effort, and the Prescott Joint Chiefs Restoration Partnership.

Resource Needs

- Develop and implement effective training, education, and outreach programs to inform landowners, government officials, and the public about the benefits of resilient ecosystems.
- Develop and use the well-educated cadre of forest management professionals in Arizona to address forest threats across all lands in the state.
- Provide adequate levels of funding to vegetation management and fuel treatments.
- Develop and implement collaborative action plans to address needs of unique, high-priority ecosystems including: riparian areas, urban and community forests, deserts, grasslands, and areas threatened with type conversion by invasive plants.
- Integrate federal, state, university, and other diagnostic/research resources to support surveillance and detection efforts focused on delineating priority treatment areas and identifying science-based treatment needs.
- Reduce hazardous fuels and stand densities of unsustainable, post-settlement vegetation.
- Develop and implement integrated landscape-scale restoration, community protection, wildlife habitat and population management, and fire management strategies for forests across jurisdictional boundaries.
- Federal and state land management agencies should collaboratively develop an integrated process to design and strategically place treatments to increase efficiency, maximize benefits, and limit the negative impacts of wildfire.
- Adequately restore forest structures through mechanical or prescribed fire treatments to ensure landscapes are compatible with frequent-fire regimes.
- Implement forest management activities that will allow for reestablishment of frequent, low severity fire as a key process in ecosystems, including increased use of prescribed fire following

[47] Covington, W. W., and D. Vosick. 2003. Conclusion: Key concepts and questions in adaptive ecosystem restoration of ponderosa pine forest ecosystems. Pp. 429-431 in Ecological restoration of southwestern ponderosa pine forests, ed. P. Friederici. Washington, D.C.: Island Press.

mechanical thinning and increased management of wildland fires for restoration objectives on appropriate lands.

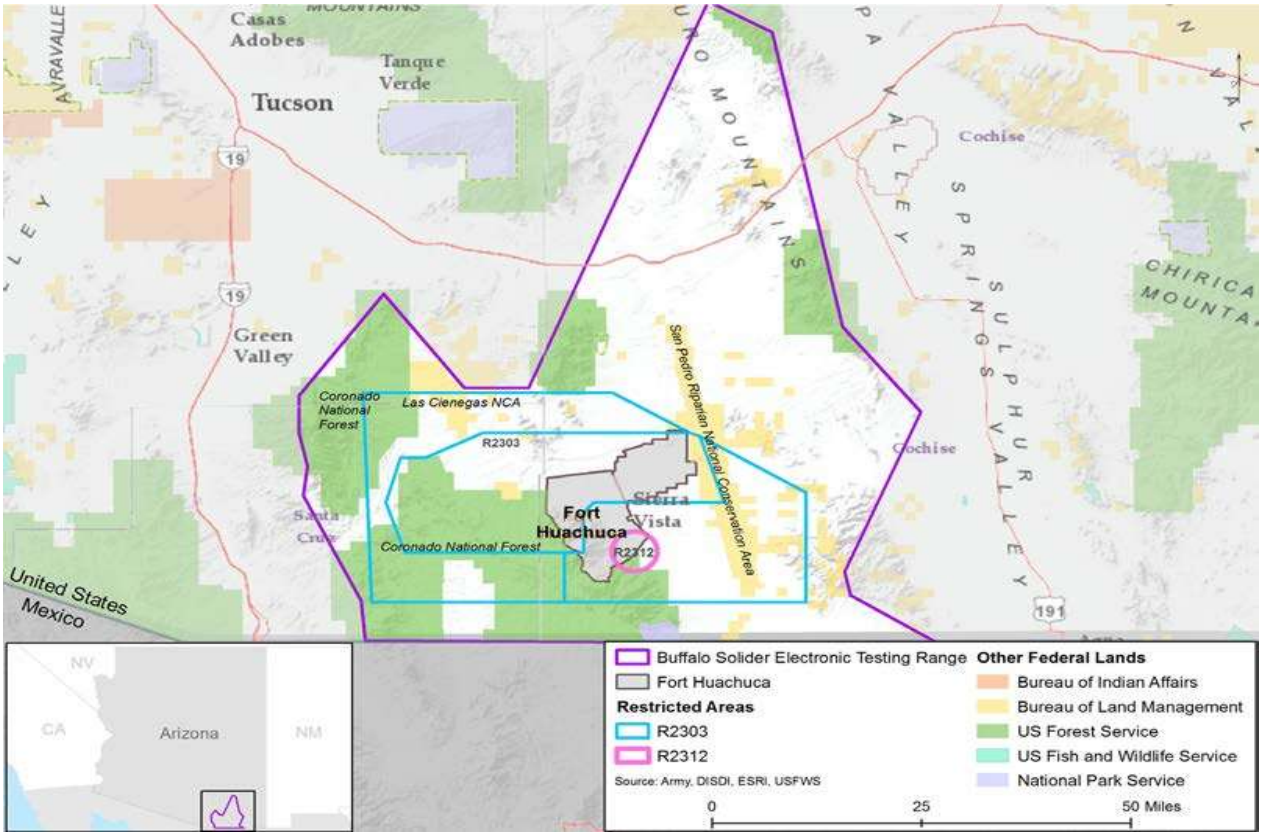
- Develop and use a collaborative, science-based, multi-entity process to help make decisions about properly designing and implementing restoration projects within the social and political framework.
- Develop funding mechanisms for the successful implementation of all aspects of ecosystem restoration activities and education projects.

Key Partners/Stakeholders

Many of the partners and stakeholders listed have a potential role in supporting implementation of this strategy. A few entities stand out as being critical to success:

- Collaborative organizations involved with ecological restoration
- Universities, research organizations, NGOs, local government officials
- USDA Forest Service (USFS)
- Bureau of Land Management (BLM)
- Arizona Game and Fish Department (AZGFD)
- Natural Resource Conservation Service (NRCS)
- Salt River Project (SRP)
- Arizona Public Service (APS)
- Arizona Department of Forestry and Fire Management (DFFM)
- Bureau of Reclamation (BOR)
- Arizona State Land Department (ASLD)
- Fish and Wildlife Service (FWS)
- National Park Service (NPS)
- National Forest Foundation (NFF)
- Four Forest Restoration Initiative Stakeholders Group (4FRI SHG)
- Natural Resources Working Group (NRWG)
- Prescott Joint Chiefs Restoration Partnership
- Fort Huachuca Sentinel Landscape

We will continue to work with these and other stakeholders in the areas identified in this section to accelerate treatments that restore ecosystem health.



Fort Huachuca Sentinel Landscape

Fort Huachuca Sentinel Landscape is a diverse coalition of federal agencies, state and local governments, NGOs, and private landowners that leverage their resources to protect natural and working lands. Fort Huachuca is home to the premier restricted military airspace for unmanned aircraft system training in the western U.S. A unique natural landscape around Fort Huachuca creates an electromagnetically quiet area for the Buffalo Soldier Electronic Test Range and restricted air space. The purpose of the Sentinel Landscape is to advance conservation initiatives, bolster local agricultural economies, and promote development that is compatible with Fort Huachuca's national defense and training mission.

Local, state, and federal partners are working to conserve ecosystems in Cochise, Pima and Santa Cruz counties. Conservation opportunities include cooperative projects that improve water quality and quantity, range and forest conditions, wildlife habitat, and the status of rare species. Additionally, funding, outreach, and technical assistance will help maintain working forests that enhance vital sources of water for the entire region.

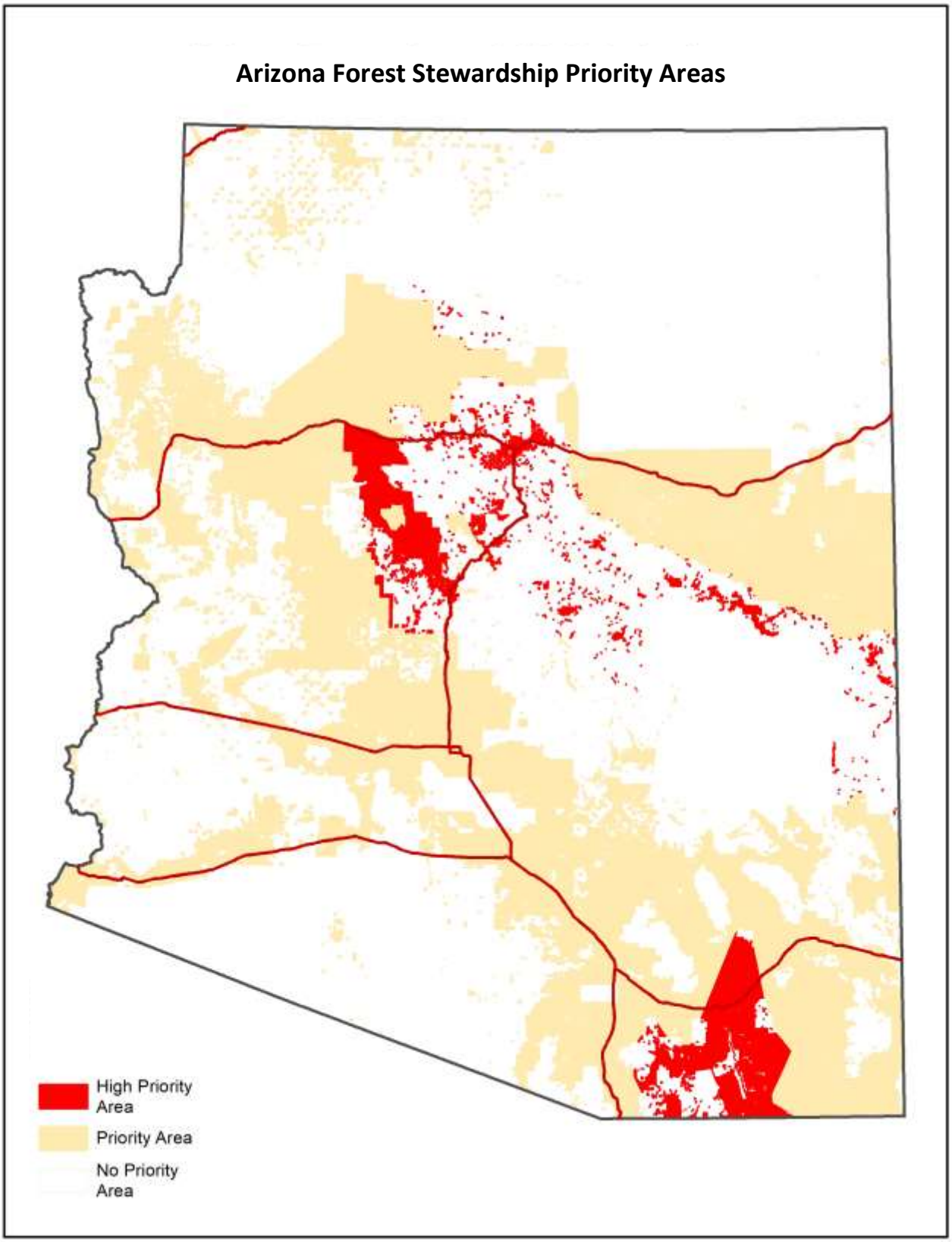
The Sentinel Landscapes Partnership agencies will continue to support the Fort Huachuca Sentinel Landscape with ongoing technical assistance and funding through the NRCS–Agricultural Conservation Easement Program, support for buffer lands through DOD's Readiness and Environmental Protection Integration (REPI) Program, and other efforts at improving the availability and quality of surface and groundwater. Together, they are ensuring that Fort Huachuca, private landowners, and endangered species can continue to call southeastern Arizona home.

Focus Areas and Priority Landscapes

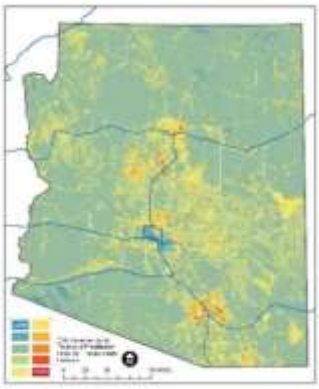
Focus areas for Ecosystem Health are identified and mapped below. The following considerations were used to refine priority area designations:

- Priority will be given to working with existing landscape scale collaborative efforts.
- Most ecosystems in Arizona are experiencing critical levels of habitat decline; some ecosystems have been heavily impacted from events such as stand-replacing wildfire. High priority should be given to ecosystem above 6,000 ft. elevation with considerable risk of stand replacing fire potential and in areas that provide watershed function to support diverse ecosystem health.
- Critical ecosystems at elevations above 4,000 feet that are at risk must be prioritized using strong science based on ecological restoration principles. This will enable critical ecosystems to receive priority treatment.
- Ecosystems below 3,000 feet must also be evaluated using the best available science to enable proper treatment prioritization and management.
- Protecting aspen stands and riparian habitat and promoting their regeneration through natural disturbances.
- Management of forest-dependent wildlife and game species (elk, deer, etc.) that provide abundant opportunities for wildlife-associated recreation.
- Enhance or restore populations of reduced or extirpated species.
- Landscapes with characteristics conducive to unnaturally large and intense crown fire must receive priority consideration for treatment.

Forest Stewardship Priority Areas (2019): Priority areas for DFFM's Forest Stewardship landowner assistance program. Forest Stewardship priority areas are landscapes considered to be of high program potential or priority. These priority areas are focused in no more than 50% of total eligible forest stewardship acres in AZ. High priority areas consist of the 4FRI footprint, Bill Williams Mountain, Prescott Joint Chiefs, and the Sentinel Landscape.

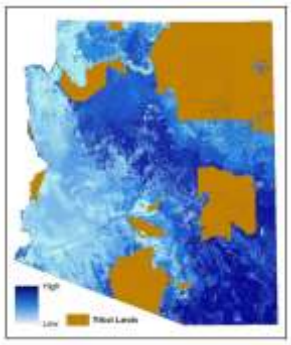

Arizona Forest Stewardship Priority Areas
High Priority Area
Priority Area
No Priority Area

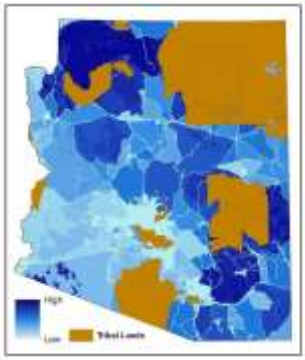
Invasive Plant Treatment Prioritization: Data gathered by DFFM to assess the Arizona landscape and identify invasive plant treatment priority areas based on management criteria.



Fire Regime Condition Class: LANDFIRE Dataset – FRCC class 3 areas. A fire regime condition class (FRCC) is a classification of the amount of departure from the natural regime and is broken into five classes.

Species of Greatest Conservation Need (SGCN): This map represents a richness index for the SGCN as defined in Arizona's State Wildlife Action Plan. The model includes the number of Tier 1a and Tier 1b species (classified by vulnerability scores) according to the following formula: Score = (Tier 1a × 2) + Tier1b. Resulting scores were rescaled from 1 - 10. Higher model scores indicate the potential for greater species richness in any area.





Unfragmented Areas: The Unfragmented Areas map is based on the existence of large, contiguous landmasses that are not fragmented by barriers, the diversity of vegetation types within those land masses, and the importance of those areas to the overall availability of any particular vegetation type within the state.

Goals, Objectives, and Actions

The Strategy Team identified two (2) goals, eight (8) objectives and thirty-five (35) actions to address the Ecosystem Health issue. The goals are general in nature because they must be applicable in most ecosystems statewide. Objectives provide a clear assessment of measurable outcomes focused on restoring or maintaining the health, resiliency, and sustainability of forest ecosystems.

To ensure accurate assessment of ecosystem health has been determined, land managers must first evaluate historic trends to determine the natural range of variability, establish and monitor reference conditions, determine appropriate treatment prescriptions, and work to mitigate potential factors or influences (wildfire, insects and diseases, invasive species, etc.) that may preclude successful management decisions. Effective monitoring and adaptive management strategies are essential to ensure ecosystems-at-risk can be restored.

Specific actions in achieving healthy, resilient, and sustainable ecosystems include the following goals:

1. Continue to develop strong collaborative support for focused management practices across integrated landscapes, such as forest restoration, fuel reduction, wildlife habitat and population management, urban community management, and treatments to control exotic pests and invasive plants
2. Protect, conserve, and enhance wildlife and fish habitat; improve habitat for selected species
3. Identify and conserve unique and high-priority ecosystems and landscapes
4. Identify and monitor threats to forests and ecosystem health
5. Protect forests and other high priority ecosystems from fragmentation and conversion to non-forest uses
6. Restore forests, deserts, and grasslands impacted by disrupted fire regimes, forest pest outbreaks, land management practices/uses, and invasive species
7. Protect watershed functions that support ecosystem services
8. Restore frequent-fire regimes as part of forest restoration measures
9. Integrate collaborative, science-based planning processes and public education into restoration programs and projects

Goal 1: Resilient and diverse forest ecosystem structures, processes, and functions.

Objective 1: Protect, conserve and enhance ecological integrity, to maintain sustainable forest ecosystems, preserve ecosystem services, avoid public safety hazards, and negative watershed impacts associated with large-scale catastrophic events.	1. Continue to work with existing landscape scale collaborative efforts and develop strong collaborative support for focused management practices, such as forest restoration, fuel reduction, wildlife habitat and population management, urban community management, and treatments to control exotic pests and invasive plants, across integrated landscapes. 2. Develop and implement effective training, education and outreach programs to inform landowners, government officials and the public about the benefits of resilient ecosystem process and functions. 3. Provide adequate levels of funding to vegetation and fuel treatments. 4. Support opportunities to accelerate treatments in priority areas to reduce the risk of catastrophic fire to protect ecosystem health and watershed function.
Objective 2: Protect, conserve, and enhance wildlife and fish habitat	1. Coordinate with the Arizona Game and Fish Department, US Fish and Wildlife Service, and others to identify and implement best management practices related to wildlife and fish habitat 2. Encourage adoption of collaborative Wildlife Principals developed by the Arizona Governor's Forest Health Council for integrating wildlife habitat and biodiversity conservation with restoration, community protection, and fire management activities. 3. Support implementation of the State Wildlife Action Plan whenever possible.
Objective 3: Identify and conserve unique high priority ecosystems and landscapes for accelerated treatments	1. Identify high priority areas that are interrelated with Arizona forest resource issues and programs. These include aquatic systems, riparian areas, deserts, rangelands, areas threatened by conversion by invasive plants, and other mixed-vegetation systems. 2. Identify and encourage collaborative partnerships between agencies and organizations with overlapping or coincident responsibilities and interests such as working groups, panels, and collaborative partnerships. 3. Develop and implement collaborative action plans to address needs of unique high priority ecosystems and to accelerate actions in these areas. 4. Support action plans to address high priority ecosystems, seek funding, and work with outside industry to implement treatments efficiently. 5. Develop and implement practices to limit the spread of exotic invasive plant species such as Buffelgrass and other emerging threats.
Objective 4: Identify and monitor threats to forests and ecosystem health that would require accelerated treatments.	1. Support development and maintenance of ongoing inventory, monitoring, and detection efforts on high priority ecosystems. 2. Integrate federal, state, university and other diagnostic/research resources to support surveillance, and detection efforts focused on delineating priority treatment areas and Identifying science based 3. Develop contingency plans for the potential impacts of climate change along with potential cost/impacts of catastrophic fire likely to occur in tandem.
Objective 5: Protect forests and other high priority ecosystems from fragmentation and conversion	1. Identify and utilize resources to work with state and local governments or policy development and program implementation to protect ecosystems from fragmentation. 2. Identify opportunities with landowners for the Forest Legacy program. 3. Identify/develop and disseminate developmental guidelines and policies. 4. Work with non-traditional partners to identify policy needs and bridge-identified gaps to accelerate treatment scope and pace.

Goal 2: Progress toward landscape scale outcomes, restoration of unhealthy ecosystems, and enhanced sustainability with limited negative impacts

Objective 1: Restore forests, deserts and grasslands impacted by current fire regimes, insect & disease outbreaks, land management practices/uses, and invasive species.	1. Use science-based approaches to evaluate, understand and protect against the impacts of existing and emerging threats such as climate change, insect and disease outbreaks or land use changes on forest health and public safety. 2. Reduce hazardous fuels and stand densities of unsustainable post-settlement trees, to prevent catastrophic losses from bark beetles and wildfire. 3. Encourage adoption of collaborative Wildlife Principals developed by the Arizona Governor's Forest Health Council for integrating wildlife conservation with restoration, community protection, and fire management activities. 4. Support and implement integrated landscape-scale restoration, community protection, wildlife habitat, population management, and fire management strategies across the state that accelerate and improve treatment efficiency. 5. Develop land-use policies and practices that support restoration, community protection, and fire management efforts. 6. Federal and state land management agencies should collaboratively develop an integrated process to design and strategically place treatments to increase efficiency, maximize benefits and limit negative impacts of insect & disease outbreaks, invasive plants and wildfire. 7. Best Management practices should be implemented to prevent the spread of invasive plant species during restoration and fire management activities. 8. Develop incentives and an ethic of personal safety to support sustainable maintenance of fuel treatments. 9. Increase coordination of forest restoration, fire management, and community protection planning and implementation across jurisdictional boundaries. 10. Encourage development of integrated long-term restoration, wildlife management, and fire management plans for all lands.
Objective 2: Restore frequent fire regimes and reduce risk of catastrophic fire as part of forest restoration measures.	1. Adequately restore forest structures through mechanical or prescribed fire treatments to ensure landscapes are compatible with frequent fire 2. Planners should work with developers to incorporate buffers, based on anticipated fire hazard, public safety, and wildlife habitats into the design of new developments to allow for maintaining of conditions in lands where natural or prescribe fires may continue or be introduced. 3. Utilize state and local codes, planning options, laws and regulations, and Growing Smarter legislation to address fire risk at the landscape scale.
Objective 3: Integrate collaborative, science based, planning processes and public education into restoration treatments	1. Develop and utilize a collaborative, science-based, multi-entity process to facilitate decisions on properly designing and implementing restoration projects within the social and political framework. 2. Facilitate the sharing of all data and analyses from all ownerships to assist natural resource agencies, county and city managers, and stakeholders in planning and implementation of forest restoration activities. 3. Undertake educational and outreach activities to increase awareness and understanding of the benefits of addressing forest health issues. 4. Develop funding mechanisms, with partners and industry, for the successful implementation of ecosystem restoration activities and education projects.

6.3 Water

Critical Issue Description

Sustainable water management is a critical challenge for the Southwest. According to the Census Bureau, Arizona grew at the nation's fifth-fastest rate in 2017, topping seven million residents for the first time. Water is a limited resource in Arizona, and drought is among the issues challenging our ability to balance water demands for agriculture, industry, and an expanding population. Less snowpack, earlier spring runoff and reduced watershed yield during the last several decades exacerbate this issue.

An understanding of the occurrences, distribution, and movement of water is essential in agriculture, forestry, botany, soil science, geology, ecology, and geomorphology. In short, water is one of the most crucial elements of the physical environment. Impacts on the quantity, quality, and distribution of Arizona's water supplies due to a changing climate are likely to be significant. The frequency of drought is projected to increase in the Southwest by the end of the century. There is also an increased chance of intense precipitation and flooding events during the monsoon season in Arizona due to greater water-holding capacity of a warmer atmosphere[48].

Groundwater use will increase in areas where surface water supplies decline. Communities are likely to tap aquifers to a greater degree to augment supplies, and declining precipitation will reduce aquifer recharge rates. Combined with increased demand due to population increases, higher crop demands, and lower soil moisture increased aquifer drawdown is likely to occur.

With multiple potential threats to water quality and quantity in Arizona's future, it

Palominas Water Recharge Project

Water replenishment efforts in Cochise County are resulting in groundwater levels are rising near two recharge facilities along the upper San Pedro River. The facilities came online in 2002 and 2014 and combine to recharge almost 1 billion gallons of water back into the aquifer each year. Thanks to this success the Cochise Conservation and Recharge Network – whose partners include the Conservancy, Cochise County, the cities of Sierra Vista and Bisbee, and the Hereford Natural Resource Conservation District — plans to launch another project at Horseshoe Draw in 2018. That project will also recharge storm water and prevent destructive flooding and erosion downstream. Given extended drought, increasing the amount of water stored in the underground aquifer is a "no regrets" strategy for both local communities and the San Pedro River.

[48] "Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure", Camacho, 59 Emory L.J. 1, 6n.9 (2009)

is extremely important that land managers focus limited resources on actions that derive the most benefit, including vegetation treatments; conservation and education; and management and policy.

Benefits, Threats, and Impacts

Benefits

- More than seven million people live in Arizona, many of whom depend on water sources generated by runoff from precipitation on Arizona's watersheds.
- Crop production on Arizona's one million acres of cropland requires a dependable supply of irrigation water.
- Arizona's aquatic ecosystems and riparian areas along streams and rivers are home to significant and diverse wildlife species, some of which are listed as endangered or threatened species. In fact, riparian ecosystems are considered an endangered ecosystem type.
- Groundwater plays a critical role in maintaining the health of riparian areas by sustaining stream and river base flows.

Threats

- Persistent drought
- Climate change resulting in variable precipitation and warming temperatures
- Overstocked forest and woodlands
- Expanding development and creation of impervious surfaces that leads to accelerated runoff
- Uncharacteristic wildfire and subsequent flooding

Impacts

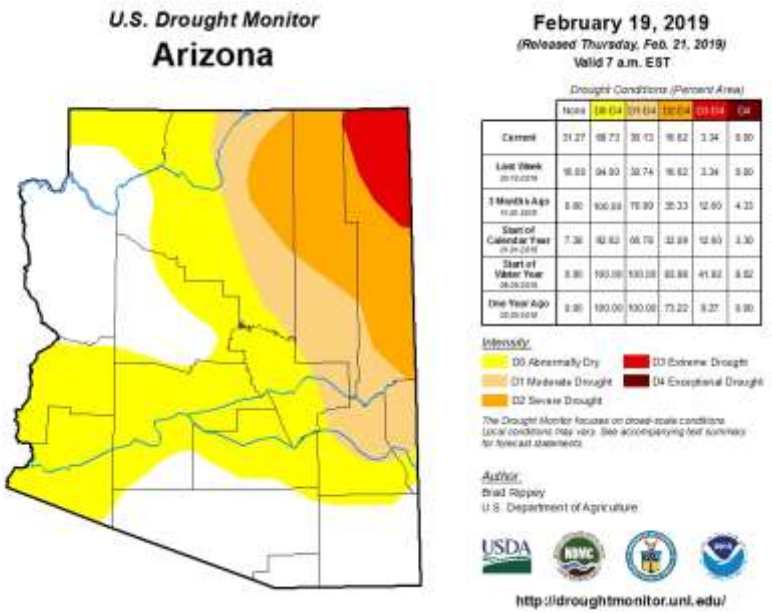
- Drought decreases availability of water for agriculture, and industrial and municipal users.
- Climate change is causing variable precipitation resulting in reduced snow pack, lower runoff, and decreased flows in drainage basins.
- Many forest stands are overly dense and therefore competing for already scarce water resources.
- Development of previously natural areas with impervious surfaces can negatively impact water quality and limit groundwater recharge.
- Uncharacteristic wildfire changes the landscape by removing natural vegetation and making the soil impervious to water (i.e., hydrophobic soils). This results in flooding and soil erosion that reduces the stability of the watershed.

Key Elements

Climate and Water

- Precipitation is typically both greater and more dependable in Arizona's upper elevations, where most of our forests occur.

- Forested lands in Arizona contribute nearly 90% of the total streamflow in the state, much of which comes during spring snowmelt[49].
- Ponderosa pine forests are the source for a substantial portion of the state's water. For example,
- while occupying only 20% of the total land surface of the Salt and Verde River basins, ponderosa pine forests account for almost 50% of the total water yield[50].
- Forestlands also contribute additional, albeit unknown quantities of groundwater recharge.
- In much of Arizona's woodlands and coniferous forests, the number of trees per acre and the canopy cover have both increased to the point where very little herbaceous ground cover remains. Much of the precipitation is intercepted by the dense canopy (evaporating back to the atmosphere) or runs off bare soil.



Drought Contingency Planning

Arizona Governor Doug Ducey signed historic legislation ratifying Arizona's Drought Contingency Plan (DCP) on Jan. 31, 2019. The legislation allows Arizona to join six other western states and Mexico in signing an inter-state water agreement and spells out ways Arizona will contribute to conserving more water from the Colorado River.

Since July 28, 2018, 40 stakeholders (DCP Steering committee) representing diverse interests from across Arizona have worked to develop what is known as the Intrastate Drought Contingency Plan. The plan balances water reductions in the state to ensure no one user takes the entire burden.

Two bills that enable Arizona to ratify the Drought Contingency Plan are:

- One that authorizes ADWR Director Tom Buschatzke to sign onto the interstate Drought Contingency Plan on behalf of Arizona.
- The other allows for certain water stakeholders within Arizona to make agreements on water usage rights and provides $30 million for Lake Mead conservation, $2 million for ground water conservation and $9 million for Pinal County agriculture infrastructure projects.

<u>Water Yield</u>

- Studies conducted in the Beaver Creek and Castle Creek watersheds show that selective forest treatments in ponderosa pine can increase water yield.
    - Untreated watersheds showed average annual water yield ranging from 2.7-5.0 inches per acre (0.225 to 0.417 acre-feet).

[49] "Water yield improvement by vegetation management: focus on Arizona"., Ffolliott et. al., 1975, Prepared for Rocky Mountain Forest and Range Experiment Station, Contract/Grant no.: US For. Ser. 16/257/CA, OWRT 14-31-0001-3803. School of renewable Natural Resources, University of Arizona, Tucson AZ. Ca. 1000 p.

[50] " Recovering rainfall", Barr, G.W. 1956, Technical Report. Department of Agricultural Economics, University of Arizona, Tucson, AZ

    - Clearing forests increased annual yield by about 0.1-0.2 acre-feet.
    - Thinning of ponderosa pine resulted in annual water yield gains of 0.61 to 1 inch per acre (0.051 to 0.083 acre-feet).
- Water yield gains from forest treatments in the Beaver Creek watersheds persisted for about six years on both cleared and thinned forested watersheds, after which gains were negligible due to new vegetation growth.
    - Areas with a northern exposure or on a deeper soil profile will generally provide increased water yields for a longer time than south-facing slopes or sites with shallow soils.
    - Increased water yields from forest treatments might be sustained using fire to manage understory vegetation. However, scientific trials have not been conducted to test this hypothesis in the Southwest.
- Treated pinyon-juniper show smaller increases in water yield because they have relatively low runoff efficiency (proportion of annual precipitation converted to measurable streamflow). Average annual water yield from untreated pinyon juniper does not exceed 1 inch per acre (0.083 acre-feet). By contrast, water yield from untreated ponderosa pine is 3 to 5 times higher[51] per acres. It is important to note the total untreated area of pinyon-juniper woodlands is 5 times more than the total area of ponderosa forests and could produce the same total water yield if treated.

Increased snowpack water equivalent, which results in enhanced soil moisture and water yield, is one potential benefit of forest thinning. There are greater accumulations of snow in openings than in adjacent forest. This is partly due to snow interception by tree branches and subsequent evaporative losses (sublimation). Small openings (60-160 feet in diameter) are optimal for snow accumulation compared to large openings (greater than 160 feet in diameter) where sun and wind exposure cause greater evaporation[52].

<u>Soils, Erosion, and Sedimentation</u>

- Soil compaction by logging equipment is a potential impact of mechanical forest management activities. Soil compaction could reduce water-holding capacity of the soil as well as infiltration rates, thereby increasing overland flow and surface erosion. If Best Management Practices (BMPs) are not followed, or suitability of equipment for various soil types, slope, and aspect is not considered during project planning and implementation, these impacts can be exacerbated.
- Lack of consistent use of BMPs to reduce erosion and sediment discharge can have downstream impacts for fish and wildlife, water treatment costs, aesthetics, reservoir storage capacity, and possibly flood flows due to deposited sediment and debris blocking channels.
    - Soil's infiltration rate and ability to store nutrients and water is decreased by erosion.
    - Biotic productivity and hydrologic function are also impacted if soil health is not protected.
- Road construction and maintenance for forest management and recreational activities can be significant sources of sediment in upland watersheds. If the location and design of roads is not carefully considered, impacts as well as the potential for obliteration are increased.

[51] "Water yield improvement by vegetation management: focus on Arizona"., Ffolliott et. al., 1975, Prepared for Rocky Mountain Forest and Range Experiment Station, Contract/Grant no.: US For. Ser. 16/257/CA, OWRT 14-31-0001-3803. School of renewable Natural Resources, University of Arizona, Tucson AZ. Ca. 1000 p.
[52] Id. Ffolliot 1975

Aquatic Systems/Riparian Areas

- Managing Arizona's forested riparian zones to optimize growth of native trees, shrubs and understory plants provide better protection against erosion for stream channels and stream banks. Water quality is enhanced by reduction of sediment and the improved ability of the riparian area to act as a natural bio-filter nutrient rich sediment.
- Where appropriate, reduction of non-native invasive riparian plants (e.g., salt cedar [*Tamarix spp.]* and Russian olive [*Elaeagnus angustifolia*] among others) will improve the ability of Arizona's riparian forests to deliver water for downstream uses.
- Many of Arizona's forested riparian areas are impaired and no longer functioning properly (as determined by Proper Functioning Condition). Rather than protecting the water quality of streams, stream banks and channels are contributing to sedimentation and reduced water quality. This is resulting from changes in their geomorphology and other issues. In some areas, invasive riparian species (e.g., salt cedar) dominate and impede delivery of water to downstream users.

Resources – Existing and Needed

Existing Resources

Federal, State, and Tribal governments that have existing staff dedicated to the regulation and scientific understanding of water resources:

- Arizona Department of Water Resources
- Arizona Department of Environmental Quality
- The University of Arizona – Arizona Geologic Survey and Water Resources Research Center
- U.S. Bureau of Reclamation
- U.S. Forest Service
- U.S. Bureau of Land Management
- Natural Resource Conservation Service
- Arizona Tribes/Bureau of Indian Affairs
- Salt River Project

Resource Needs

- Contact list for potential collaborators in lead organizations that carry out watershed, riparian, spring, and wet meadow research and restoration projects.
- Organized, collaborative programs for water outreach, education, and volunteer recruitment and activities.
- Updated Tribal, State, and Forest Service policies to support forest restoration goals and objectives for the protection and enhancement of water resources.
- Guidance documents for BMPs to protect water resources, including oversight mechanisms to ensure the application of BMPs by contractors.
- Organized and funded regional consultants/specialists in watershed processes, aquatic ecology, hydrogeology, and soil science so land managers can consult with experts when planning management activities.

- Engagement with diverse and significant water users in the stakeholder process to further educate the public.

Key Partners/Stakeholders

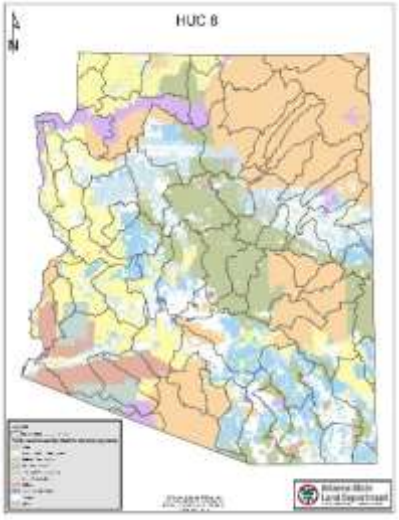
Many of the partners and stakeholders listed in the water section have a potential role in supporting implementation of this document. A few entities stand out as being critical to success:

- Arizona Department of Water Resources
- Arizona Department of Environmental Quality
- Arizona Game and Fish Department
- Upper Verde River Watershed Protection Coalition
- Forest Service Regional Office along with National Forests and Districts
- Collaborative organizations including: universities, research organizations, and NGO's
- Verde Watershed Restoration Coalition
- Prescott Creeks Preservation Association
- Gila Watershed Partnership
- Salt River Project
- Local governmental agencies

Focus Areas

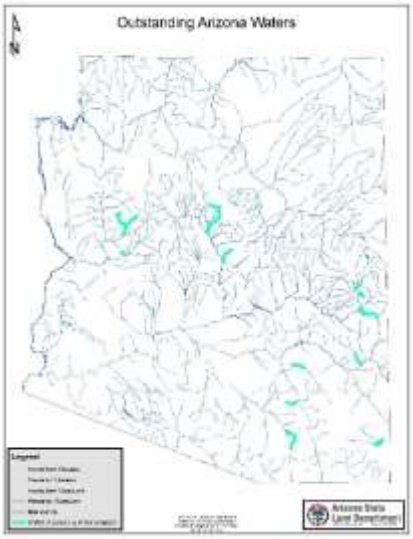
While vegetation and land use patterns often change abruptly with changes in ownership/jurisdiction, water does not. Water quality and quantity is affected by conditions and activities on every acre in the state. However, there are regions of the state where management activities will most effectively address our critical resource issues. These regions are called focus areas and priority landscapes.

The process of landscape prioritization for water began with the identification of streams and lakes that are impaired based on the ADEQ Water Assessment. Next, the Outstanding Waters of Arizona were identified to provide a comparison with impaired areas. Then Riparian areas were over-laid on top of the groundwater basins. Finally, all 8-digit Hydrologic Unit Codes (HUC) were identified along with the public land ownerships across the state. Once those maps were created, the focus area map was created showing HUCs in a color gradient. The darker colored HUCs are the watersheds where more of the map elements are present.



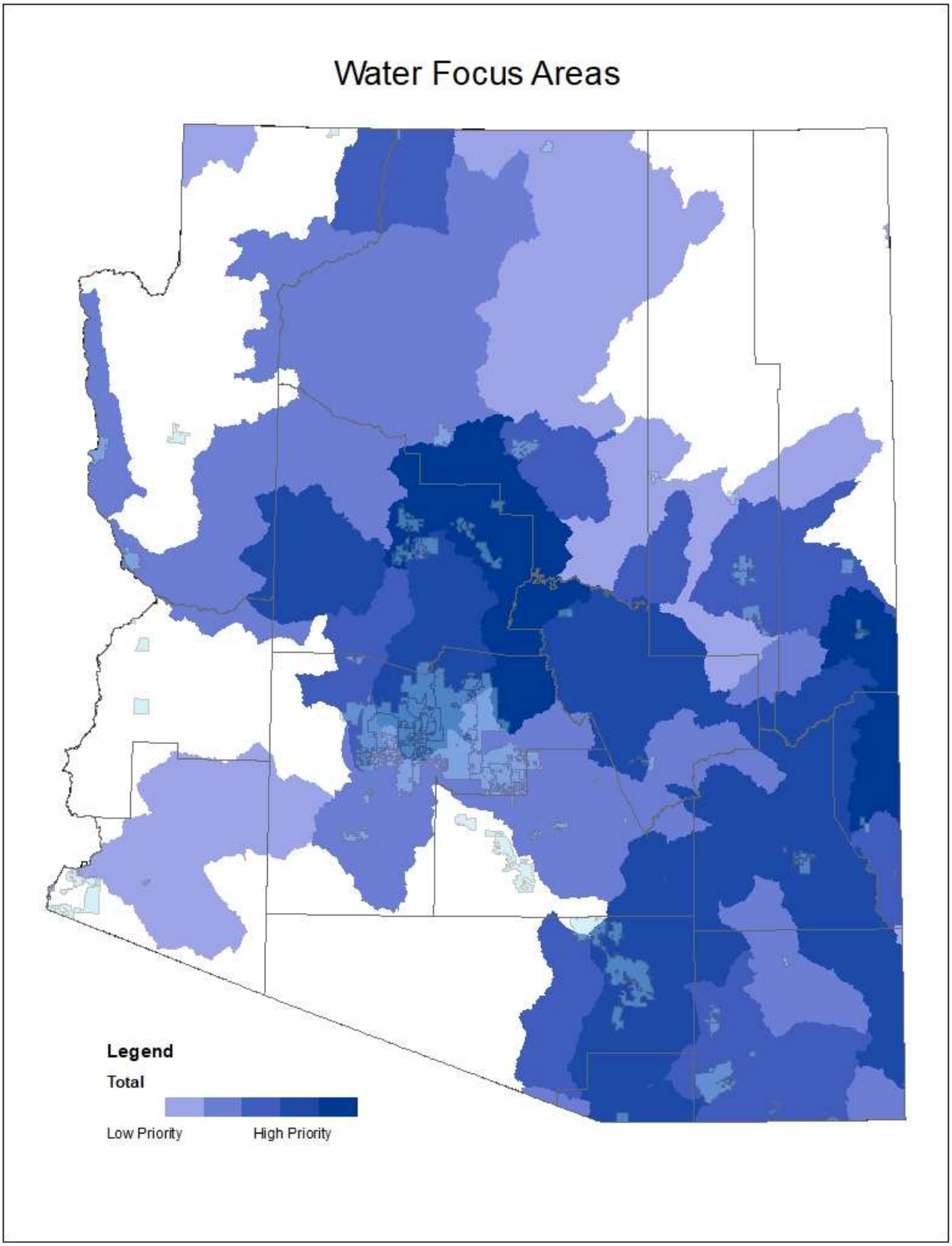
HUC 8 Watersheds: 8-digit hydrological units overlaid on land ownership. Map Provided by the Arizona State Land Department (ASLD).

Impaired Streams and Lakes: Data provided by Arizona Department of Environmental Quality (ADEQ) identifying impaired streams and lakes across Arizona. Impairment is based on presences of sediment, turbidity, *E. coli*, and heavy metals. Map Provided by ASLD.



Outstanding Waters: Outstanding Arizona Waters are designated by state rule under R18-11-112. They are waters considered exceptional water quality and or ecological or recreational resources. The data was provided by ADEQ and the map was provided by ASLD.

Riparian Areas and Groundwater Basins: Riparian areas are identified due to their vulnerability to negative impacts. Groundwater basins is an area underlain by permeable materials capable of furnishing a significant supply of groundwater to wells or storing a significant amount of water. Data and map provided by ASLD.


Water Focus Areas
Legend
Total
Low Priority
High Priority

Goals, Objectives, and Actions

The Water Resources Working Group identified three (3) goals, nine (9) objectives, and _ actions for Water. The underlying goal is to improve water quality and quantity, improve the health of wetland ecosystems, and increase public understanding of water quality issues. This will be accomplished through a variety of measures, described below:

Goal 1: Improve and maintain watershed health and watershed function statewide.

Objective 1: Protect and enhance water quality and quantity of priority watersheds (identified in this document) through enhanced resiliency and sustainability.	1. Work collaboratively to identify and develop restoration and fire management strategies for watersheds of critical importance across the state. 2. Collaboratively identify and/or develop best management guidelines (BMG).
Objective 2: Maximize positive impacts of vegetative treatments on watersheds.	1. Maintain or improve Soil Quality through use of BMPs: properly design, place, build and/or retire forest roads, use appropriate fire practices to remove duff and reestablish vegetative ground cover. 2. Support ongoing efforts to maintain or improve hydrologic function and watershed health by designing forest-thinning prescriptions to optimize snow pack accumulation, runoff and aquifer recharge and by managing understory vegetation through periodic burning. 3. Support State and Federal agency partnerships with key stakeholders on forest restoration projects 4. Appropriately monitor new and existing activities within watersheds.
Objective 3: Minimize uncharacteristic wildfire.	1. Use fuel reduction treatments to reduce excessive fuel loading to prepare fire-adapted landscapes for historic fire regimes through fuel treatment activities. 2. Design fuels treatments strategically on the landscape to effectively reduce fire risk. 3. Restore impaired ecosystems through mechanical treatments and use of fire to achieve desired effects and sustained natural fire regimes.
Objective 4: Enhance groundwater recharge and soil moisture.	1. Develop a groundwater sustainability program. 2. Mitigate the overuse of groundwater supplies by educating the public on its importance. 3. Design land management treatments to reduce runoff and increase recharge. 4. Identify high and medium priority groundwater basins. 5. Support ongoing groundwater recharge efforts and promote water conservation measures in agriculture, industrial, and municipal sectors.

Goal 2: Improve habitat and resiliency of aquatic ecosystems and riparian areas.

Objective 1: Minimize impacts of management activities to aquatic ecosystems and riparian areas.	1. Utilize BMPs and guidelines within aquatic systems. 2. Limit recreation in sensitive ecosystems especially during critical times.
Objective 2: Protect and restore aquatic ecosystems and riparian areas.	1. Coordinate implementation of management plans to insure protection of aquatic systems. 2. Use BMPs for the location, construction, operation and maintenance of transportation systems within aquatic systems. 3. Encourage, protect existing native vegetation, and supplement with native vegetation plantings or reseeding where appropriate. 4. Use BMPs for the location, construction, operation and maintenance of water improvements within aquatic systems. 5. Restore natural spring discharge by removing outdated improvements where possible. 6. Coordinate with agencies and agriculture/grazing lessees that manage water improvement projects.

Goal 3: Increase public understanding of the importance of watershed health, function, and restoration to Arizona's water resources.

Objective 1: Develop new and utilize existing information and educational materials on watershed health, function, and restoration.	1. Dispense education materials such as brochures, fact sheets, and public service announcements about watershed and riparian issues. 2. Collaboratively develop common watershed and riparian messaging for use by all agencies. 3. Develop web-based platforms to dispense information on watershed health, function, and restoration.
Objective2: Implement outreach and educational programs on watershed health, function, and restoration.	1. Develop outreach programs to communicate with community groups and leaders, schools, and the public. 2. Identify appropriate funding support to implement outreach and education programs.
Objective 3: Encourage public and stakeholder involvement.	1. Develop and implement programs to engage nonprofit organizations in watershed and riparian cleanup and planting activities.

6.4 Air

Critical Issue Description

As one of life's most crucial elements, air plays a critical role in sustaining life in Arizona. Clean air, often taken for granted, is threatened by many factors; industrial and automobile emissions, dust from uncovered/tilled soil, smoke from increasing wildfire occurrence, and forest pile burning and prescribed fire activities. These changes in air quality have resulted in widespread impacts across Arizona.

Introduction

Air pollution has been a persistent problem since the Industrial age with much of it being traced to the

Air quality affects every living thing in Arizona. As one of life's most crucial elements, air plays a critical role in sustaining Arizona's natural resources, its people and their quality of life. This element is substantially influenced by Arizona's urban and rural ecosystems.

use of fossil fuels to generate energy. Even when not used for energy generation, hydrocarbons contribute to air pollution through the release of vapors from solvents, paints, and gasoline. One of the problems with air pollution is not only the diversity of its sources but also the fact that it is made up of so many pollutants which include; carbon monoxide, sulfur dioxide, nitrogen oxides, particulate matter, ozone, and lead.

Arizona's vegetation serves to maintain and enhance air quality in several ways. Trees modify the atmosphere by absorbing carbon dioxide (providing a sink for carbon) and producing oxygen, and they clear the air by filtering dust, ash, pollen, and smoke (especially in urban areas). They also intercept wind, provide shade, and moderate air temperature. Conversely, plant life contributes to reduced air quality when smoke is produced by wildfires and other land management activities, especially prescribed burning. However, the air pollution issues we are experiencing now cannot be solved just by increasing vegetation.

Ozone

Ozone is the prime ingredient of smog in our cities and industrial areas. When routinely inhaled even low levels of ozone can cause severe respiratory problems including asthma, temporary respiratory diseases, and temporary decreases in lung capacity. Even moderately exercising healthy adults can experience 15-20% reduction in lung function. Recent studies have indicated that repeated exposure to elevated levels of ozone over a period of time can result in permanent structural damage[53]. Those who are most at risk to ozone are people who preform moderate activity during the summer months (i.e. outdoor workers).

Particulate Matter

Particulate matter (PM) is the term used for a mixture of solid particles and liquid droplets found in the air. Particles are classified into two groups PM 10 (larger than 2.5 micrometers) and PM 2.5 (smaller than 2.5 micrometers). Though PM 10 has been linked to health impacts, PM 2.5 can cause significant health

[53] "Human Exposure Modeling - Air Pollutants Exposure Model", Environmental Protection Agency, 2015, https://www.epa.gov/fera/human-exposure-modeling-air-pollutants-exposure-model

problems including; premature death, acute respiratory symptoms, aggravated asthma, bronchitis, and decreased lung function[54]. People who live in the Phoenix area are especially at risk due to several contributing factors and should heed public health warnings concerning air quality which is in part due to the number of people adjacent and the activities they perform.

Benefits, Threats, and Impacts

It is vital for the long-term health of all living things that the lands in Arizona be managed to positively affect air quality.

Benefits

- Clean air results in decreased numbers of respiratory illnesses.
- Through lowering cases of respiratory disorders linked to dirty air, clean air aids in lowering medical care costs.
- One acre of forested land absorbs six tons of carbon dioxide and puts out four tons of oxygen every day, which is enough to meet the annual needs of 18 people.
- Urban plant life reduces the impact of the urban heat island effect and lessen its impact on local weather patterns.

Threats and Impacts

- Negative effects on human health such as asthma and other respiratory diseases
- Vegetation die-off in rural and urban areas due to air pollution.
- Limited visibility due to smoke or smog.
- Acid deposition resulting in the degradation of aquatic systems, vegetation, and cultural resources (stone work).

Air Monitoring Network

The Arizona Department of Environmental Quality conducts ambient air quality monitoring throughout Arizona. Environmental parameters measured in this monitoring network include criteria pollutants (lead, ozone, particulate matter — PM10 and PM2.5, carbon monoxide, nitrogen oxides, sulfur dioxide) as well as air toxins.

Air quality monitoring networks operate in urban and rural areas throughout Arizona. They provide local air quality conditions to the public and help identify the causes of air pollution. The networks are composed of individual monitoring sites that collect ambient air quality data in a variety of settings. The results determine if public health standards are met and allow scientists to assess the effects of pollution on public health and welfare.

Key Elements

Climate and Air

- In many Arizona ecosystems there is a lack of ground cover and low soil moisture, and more so as temperatures increase. These factors contribute to wind erosion and airborne soil

[54] "Human Exposure Modeling - Air Pollutants Exposure Model", Environmental Protection Agency, 2010, https://www.epa.gov/fera/human-exposure-modeling-air-pollutants-exposure-model

particles. Vegetation helps cleanse the air by intercepting airborne particles and absorbing pollutants.

- Quality of life in desert metropolitan areas like Phoenix is degraded by the heat island effect. In these urban areas, a preponderance of concrete and asphalt absorbs and holds heat, thus dramatically increasing air temperatures in contrast to nearby rural areas. This heating and related drying can alter weather patterns, resulting in a more arid climate.
- Urban trees and forests lessen the heat island effect by cooling the air through shade and transpiration, reducing air temperatures by as much as 15 degrees and utility bills by 15-50%. The evaporation from a single large tree can produce the cooling effect of 10 room-size air conditioners operating 20 hours a day.

Smoke

- Uncharacteristic wildfires have become common in Arizona's coniferous forests, creating a situation where forests may have become a generator of greenhouse gas and other pollutants rather than a sink for carbon storage.
- When naturally ignited wildfires are managed for specific resource benefit objectives, operations result in a healthier ecosystem, which in the end will produce lower emissions than would occur with an uncharacteristically severe wildfire.
- Constraints from public intolerance of smoke and air quality restrictions may limit the application of prescribed fire to maintain and sustain Arizona's fire-adapted ecosystems.
-

AZ Smoke Management Program

The Arizona Department of Environmental Qualities' (ADEQ) Air Quality Division implements a Smoke Management Plan that works toward a reduction in smoke impacts due to prescribed/controlled burning of nonagricultural fuels with particular regard to heavy forest fuels. All state lands, parks and forests, as well as any federally managed lands in Arizona, are under the jurisdiction of ADEQ in matters relating to air pollution from prescribed burning. ADEQ's Web site contains up-to-date information on prescribed fire approvals, contact information, smoke advisories, and general information about smoke: www.azdeq.gov/environ/air/smoke/fires.html

Best Management Practices (BMPs)

Smoke management should be an important consideration when planning all prescribed burns. Smoke can obstruct visibility, which in turn can affect the safety of the personnel conducting the fire, public safety on roadways, and the recreational value of areas. Smoke can also impact public health, along with the public's reaction to prescribed burning in general. The main goals of smoke management are to reduce emissions from a fire, as well as identifying and listing smoke sensitive areas around the burn unit and what wind direction and dispersion conditions will be needed to reduce smoke impacts. This will in turn improve the dispersion of smoke, and make sure smoke plumes do not affect smoke-sensitive areas.

Burn when weather conditions are likely to produce the best dispersion:

- Burn when atmospheric conditions are best for rapid smoke dispersal; this is normally after the morning inversion layer has broken and before the evening inversion layer forms.
- Consider air pollution regulations and do not burn during pollution alerts, stagnant conditions, or ozone alert days.
- Consider down-drainage smoke flow, especially in complex terrain where downslope winds prevail at nighttime under light wind conditions.

Burn when fuel conditions are likely to produce the least amount of smoke:

- Burn with proper fuel moisture conditions.
- Use test fires prior to burning to confirm fuel conditions and smoke behavior before igniting the entire unit.
- Estimate the amount of smoke the fuels will produce.
    - Fuel type will make a difference in emission rates; fuels that have high moisture contents, high concentration of oils, or large fuel particle size will have higher rates of smoke emissions.

Utilize suitable ignition techniques for smoke management:

- Consider burning using backfires to reduce the amount of smoke produced.
- Use mass ignition techniques to create greater amounts of heat, which will create more lift for the smoke column.

Conduct post-burn mop-up to reduce nuisance smoke:

- Outline what actions will be taken after the burn to reduce residual smoke.
- If residual smoke problems from logs, brush piles, snags or stumps may occur, take steps to keep them from burning.
- If post-burn smoke could be a problem, be sure to monitor the burn unit and have personnel in place to suppress any fuels that begin to smolder.

Reduce the amount of fuels to reduce smoke emissions:

- Use periodic maintenance-type prescribed burns that follow historic natural fire return intervals.
- Perform hand or mechanized thinning of vegetation before attempting a prescribed burn.

Reduce the impact of smoke on people:

- Notify all people that could possibly be affected downwind, such as nearby residents, adjacent landowners, fire departments, and local fire control offices.
- Inform smoke sensitive persons how to avoid smoke exposure.
- Mop-upalong roads as soon as possible and pay special attention where smoke can travel downslope or down drainage.
- Use appropriate signage to inform the public about areas where smoke will impact them, such as highways, secondary roads, trails and campgrounds.
- Initiate public education or public relations efforts prior to conducting burns.

<u>Atmospheric Carbon</u>

- Carbon is sequestered in the biomass of vegetation, which prevents its release into the earth's atmosphere. Over time however, biomass will decay releasing carbon but due to Arizona's dry climate this occurs at a rather slow rate.
- Large, high intensity wildfires release massive quantities of carbon and other particulates into the atmosphere.
- Natural resource management and burning of hazardous fuels have smaller, more controlled releases of carbon than uncharacteristically severe wildfires. These smaller releases are offset in part by vegetative responses and resource benefits.

Dust

Since the start of 2008, most exceedances of the PM10 National Ambient Air Quality Standard (NAAQS) in the nonattainment areas of Arizona have been related to high wind events. High wind events, along with other meteorological conditions leading to the generation of dust can be predicted through meteorological forecasts.

Dust particles are very small and can be easily inhaled. They can enter the respiratory system and increase susceptibility to respiratory infections, and aggravate cardio-pulmonary disease. Even short-term exposure to dust can cause wheezing, asthma attacks and allergic reactions, and may cause increases in hospital admissions and emergency room visits for heart and lung related diseases.

Dust emissions can cause significant environmental impacts as well as health effects. When dust from wind erosion or human activity deposits out of the air, it may impact vegetation, adversely affect nearby soils and waterways, and cause damage to cultural resources. Wind erosion can result in the loss of valuable top soil, reduce crop yields, and stunt plant growth.

According to the Environmental Protection Agency (EPA), studies have linked particulate matter exposure to health problems and environmental impacts such as:

- Health Impacts:
    - Irritation of the airways, coughing, and difficulty breathing reducing lung function and lung cancer
    - Aggravated asthma and chronic bronchitis
    - Irregular heartbeat and increases in heart attacks
- Environmental Impacts: haze and reduced visibility
    - Reduced levels of nutrients in soils

Best management practices (BMP's) for controlling dust emissions to prevent or mitigate impacts to air quality and sources occurring within Arizona are listed below. The objective of the dust control measures are to reduce dust emissions from human activities and to prevent those emissions from impacting others.

BMP's

1. Minimize disturbed area: plan the project or activity so that the minimum amount of disturbed soil or surface area is exposed to wind or vehicle traffic at any one time.
2. Reduce vehicle speeds: establish a maximum speed limit or install traffic calming devices to reduce speeds to mitigate off-property transport of dust entrained by vehicles.

3. Minimize drop height: Drivers and operators shall unload truck beds and loader or excavator buckets slowly, and minimize drop height of materials to the lowest height possible, including screening operations.
4. High winds restriction: temporarily halt work activities during high wind events greater than 30 mph if operations would result in off-property transport.
5. Restrict access: restrict access to the work area to only authorized vehicles and personnel.

Additional BMP's

1. Wet suppression: apply water to disturbed soil surfaces, backfill materials, screenings, and other dust generating operations as necessary and appropriate considering current weather conditions, and prevent water used for dust control from entering any public right-of-way, storm water drainage facility, or watercourse.
2. Wind barrier: construct a fence or other type of wind barrier to prevent wind erosion of top soils.
3. Vegetation: plant vegetation appropriate for retaining soils or creating a windbreak.
4. Surface roughening: stabilize an active construction area during periods of inactivity or when vegetation cannot be immediately established.
5. Cover: install cover materials during periods of inactivity and properly anchor the cover.
6. Soil retention: stabilize disturbed or exposed soil surface areas that will be inactive for more than 30 days or while vegetation is being established.

Resources -Existing and Needed

Existing Resources

State agencies that have existing staff dedicated to the management of air resources:

- Arizona Department of Water Resources
- Arizona Department of Environmental Quality

Resource Needs

- Consistent with policy, develop up to date BMPs to protect air resources and establish oversight mechanisms to ensure the application of BMPs along with emission reduction techniques associated with prescribed fire applications.
- Review and update Tribal, State and National Forest System policies to support forest restoration goals and objectives for protection and enhancement of air resources.
- Identify and dedicate resources for an organized, collaborative program for air outreach, education, and volunteer recruitment and direction.

Key Partners/Stakeholders

Many of the partners and stakeholders listed have a potential role in supporting implementation of this strategy. A few entities stand out as being critical to success:

- Arizona Department of Environmental Quality
- University of Arizona
- Bureau of Land Management
- National Forest Service

- Arizona State Land Department
- Natural Resource Conservation Service
- The Nature Conservancy
- Bureau of Indian Affairs

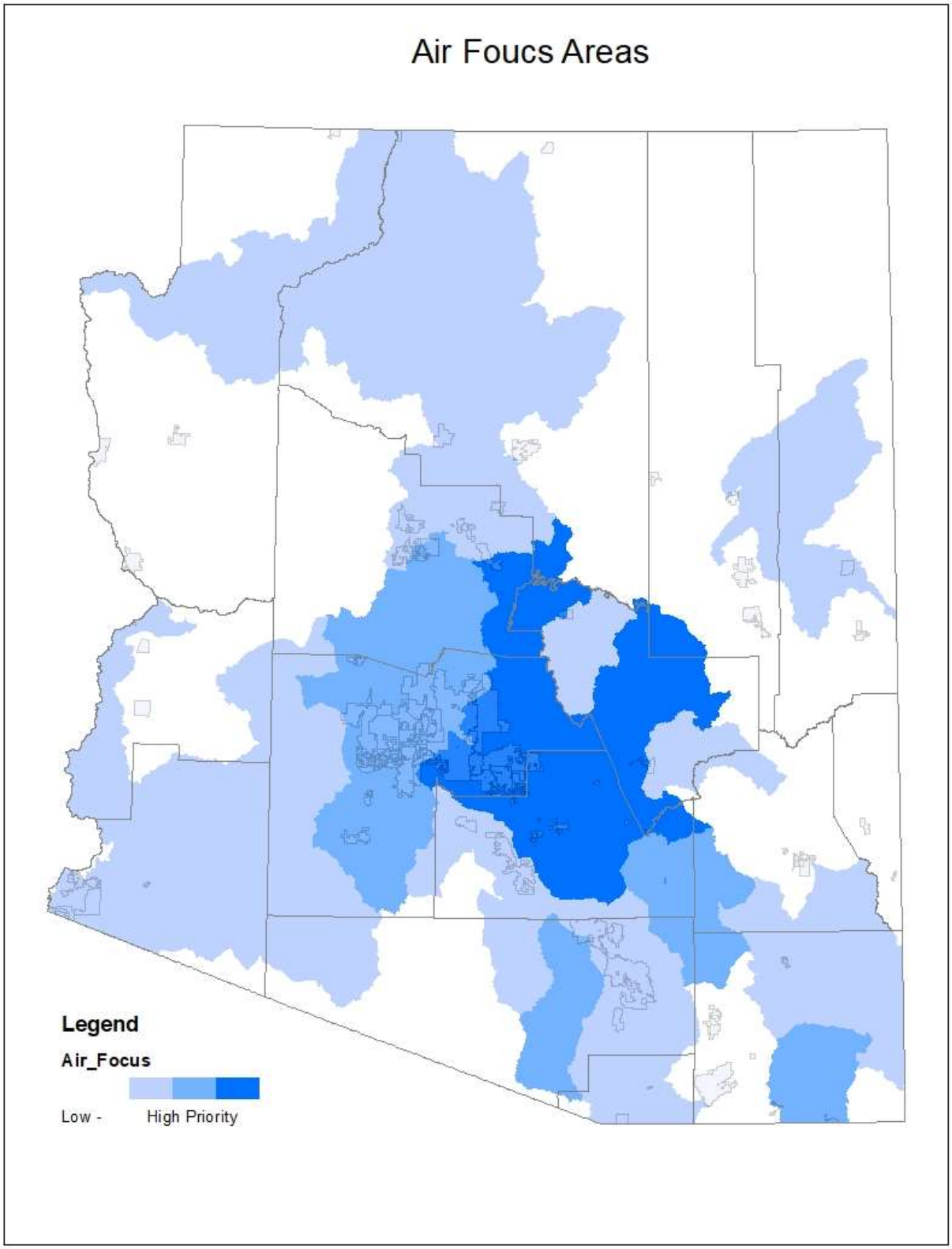
Focus Areas

Focus areas for Air were created by prioritizing HUC 8 watersheds that contained Class 1 areas, PM10 concerns, or Ozone concerns. The rational behind choosing these layers to determine priority is that they are one, the national standard, and two, if people know where there are air quality issues they are more likely to take preventative measures. Shade tree prioritization mapping was also used to determine priority areas since the main goal of this type of mapping is to improve air quality through increased biomass in urban areas. A color gradient was used based on how many of these concerns a watershed contained. Also displayed are Arizona airsheds however, they have no impact on which watersheds were prioritized.

<u>PM10 and Class 1 Areas:</u> PM10 is a classification for inhalable particles, with diameters that are generally 10 micrometers and smaller. Class 1 federal lands include areas such as national parks, national wilderness areas, and national monuments. These areas are granted special air quality protections under Section 162(a) of the federal Clean Air Act.

<u>Ozone:</u> Ozone nonattainment areas are areas considered to have air quality worse than the National Ambient Air Quality Standards as defined in the Clean Air Act Amendments of 1970.

Airsheds: An airshed is a part of the atmosphere that behaves in a coherent way with respect to the dispersion of emissions.


Air Foucs Areas
Legend
Air_Focus
Low -
High Priority

Goals, Objectives, and Actions

The Strategy Team identified two (2) goals, five (5) objectives, and nineteen (19) actions for Air. The basic approach is to improve air quality and increase public understanding of the effects of forests, trees, and fire on air quality. This will be accomplished through a variety of measures, described below:

Goal 1: Improved air quality.

Objective 1: Retain or improve health of existing forestlands.	1. Coordinate large-scale forest treatments. 2. Use science-based practices to improve forest health and resiliency. 3. Mitigate land-use changes to Arizona's diverse ecosystems and conserve important landscapes across Arizona. 4. Collaborating on urban forest management to increase tree canopy. 5. Creating and disseminating materials that describe now urban canopy cover affects air quality, particularly how an increased urban canopy intersects with the impacts of fire.
Objective 2: Improve coordination of smoke management related to wildland fire and forest restoration treatments	1. Develop GIS map data of smoke sensitive Airsheds and areas for use by land managers, fire management organizations, and the national Wildland Fire Decision Support System (WFDSS). 2. Develop improved Smoke Management Program monitoring including the use of technology such as particulate monitors and real-time cameras. 3. Develop and utilize improved fuel modeling to better predict fire behavior and inform emission calculations. 4. Create a group that functions as the now defunct Arizona Interagency Coordination Group (AICG) to improve communication and coordination between land management agencies regarding air quality issues. 5. Assist ADEQ and other partners in reviewing and updating smoke management program as needed. 6. Improve smoke monitoring processes, communication, and coordination on resource management activities including wildland and resource 7. Continue to improve smoke management database and technologies. 8. Seek various funding, information, training, and technology alternatives to assist agencies in addressing urgent smoke impacts.
Objective 3: Manage negative impacts of forest treatments on air quality to improve enhance air quality.	1. Pursue strategies to utilize wood fiber prior to burning on site. 2. Work with interagency partners to design and implement reintroduction of fire adjacent to communities (to manage intensity, duration and timing of smoke emissions from fire management activities.) 3. Design fire management and implementation activities to manage the intensity and duration of smoke impacts. 4. Develop integrated planning efforts to achieve desired outcomes from fire, utilizing CWPP's, and fire and land management plans considering private landowner and community objectives.

Goal 2: Increase public understanding of the importance and effects of fire on Arizona's air quality

Objective 1: Enhance public outreach and education regarding fire management and air quality	1. Develop interagency educational materials for distribution on the benefits of prescribed fire and its role in the ecosystem and good management practices regarding air quality. 2. Provide interagency public service announcements regarding wildland and prescribed fire and their relationship to air quality issues. 3. Coordinate key messages with other cooperators and stakeholders to ensure timely and effective messages are provided.
Objective 2: Increase interagency education of tribal smoke management/burning programs.	1. Assist ADEQ in developing relationships with tribal nations so burning across the state can be synchronized.

6.5 Fire

Critical Issue Description

Fire in Arizona is a complex issue. Current trends show increasing, severity, and occurrence of wildland fires and increasing costs for fighting and managing these fires. Although natural fire is necessary in many vegetation types, it can occur as desirable fire, undesirable fire, or as a managed tool for achieving and sustaining desired ecological conditions. We know fire is a key process in many ecosystems and reestablishing natural fire regimes where appropriate is an ongoing challenge. At the same time, protecting the safety of citizens and other important values--communities, infrastructure, and habitat for imperiled species--is a critical concern. A fundamental challenge facing Arizona is maximizing the many benefits of fire while reducing its significant costs.

Introduction

Many ecosystems in Arizona are dependent on a relatively frequent fire return interval for their existence--usually 5-30 years. However, many ecosystems and fire regimes have been altered from a natural condition due to urban encroachment, invasive plants, grazing, logging, and decades of fire exclusion. These conditions also affect the use of prescribed fire as a management tool. Climate change research poses a further threat with increased drought and longer, warmer summers lengthening fire seasons. Climatic change suggests a greater number of intense, resistant to control fires that will likely place communities and landscapes at greater risk. A foundational principle in the issue of fire is not if Arizona will burn, but when.

Key Elements

Fire is an essential natural process that provides maintenance of ecosystem health while creating significant threats to values at the same time. Wildland wildfires cost land management agencies hundreds of millions of dollars per year for suppression. However, fire is also used extensively as a cost-efficient resource management tool through the application of prescribed burning or through utilizing wildfire for resource benefit.

A wildfire is in an unplanned ignition or prescribed fire that is declared a wildfire managed for one or more objectives that can be changed as the fire spreads across the landscape. Objectives are influenced by changes in fuels, weather, topography; varying social understanding and tolerance; and involvement of other governmental jurisdictions having different missions and objectives. Initial attack on human-caused wildfire will be to suppress the fire at the lowest cost with the fewest negative consequences with respect to firefighter and public safety. However, managers will use a decision support process to guide and document wildfire management decisions. The process will provide situational assessment, analyze hazards and risk, define implementation actions, and document decisions and rationale for those decisions.

A key element in the fire equation is smoke. Smoke from wildland fires contributes significant amounts of particulates and gasses into the atmosphere. While smoke from wildfires may not always be manageable, fire managers should try to use smoke management objectives whenever possible in fire management support documents. Smoke management for all prescribed burning events is a primary factor in determining how much, when, and where such fire is allowed. Smoke can affect the local environment as

well as transporting to distant communities. In addition to temporarily reducing air quality, prescribed burning may also decrease visibility and negatively affect sensitive populations with respiratory conditions or certain health concerns. Given the knowledge that there are significant differences in the amount and duration of emissions from wildfires and prescribed burns, land managers would prefer to create smoke under optimum conditions to maximize dispersal and minimize impacts.

Mayer Fuel Break

In 2015, State Forestry and Fire installed a 270-acre fuel break west of Mayer. The project consisted of manipulating the fuel stand and removing as much vegetation as possible to change a potential fire's behavior. In 2017, the Goodwin fire, originating in the Prescott National Forest, burned roughly 20,000 acres south of Prescott. Due to fire intensity and high winds, the Goodwin fire was on track burn through Mayer before the fuel break installed in 2015 halted its advance. The fuel break allowed the fire to stop itself before moving into Mayer, thus it changed its course and headed away from the community. Fuels reduction projects, like the one in Mayer help reduce the risk of catastrophic wildfires, allow firefighters to manage suppression efforts more efficiently, and save lives.

Land managers are constantly assessing the potential for high intensity fire and planning how to manage it. By implementing appropriate steps to lessen the fuel hazard around communities and other values at risk, they reduce the threat. By developing and Community Wildfire Protection Plans (CWPP), local governments have been doing their part to reduce risk, and prepare citizens and infrastructure. Many citizens have also protected private property by adopting fire mitigation building principles and creating defensible space around their homes. Because we have chosen to live and recreate in fire-dependent ecosystems, preparation and protection at all levels is essential.

Benefits, Threats, and Impacts

Wildfire: An unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out.

Benefits

- Restores fire to its natural role in fire dependent ecosystems
- Brings improvements to ecosystem health
- Reduce risks to communities (e.g., loss of life, property and infrastructure damage, damage to economically viable natural resources)
- Promotes diversity of fire-dependent species
- Creates partnerships among federal and state agencies, tribal governments, fire departments, communities, and landowners
- Reduces accumulation of vegetation and litter that can inhibit plant growth

- Stimulates growth and reproduction of some plants, while sustaining and maintaining wildlife habitat for some animals
- Contributes to integrated management of resources (wildland fire use for resource benefit when used/coordinated with planned mechanical treatments) and potential reduction in restoration treatment costs

Threats and Impacts

- Potential for loss of life
- Property and infrastructure loss and damage
- Negative impacts to resource values
- Damage to ecosystem function, health, and diversity
- Increasing costs of suppression and management of wildfires
- Loss and/or damage to wildlife habitat
- Loss of recreation opportunities and values
- Negative impacts to local economies, cultural/heritage sites, watersheds, and air quality
- Loss of old-growth vegetation for wildlife habitat

Prescribed Fire: Any fire intentionally ignited following management actions in accordance with applicable laws, policies, and regulations to meet specific objectives.

Benefits

- Hazardous fuel reduction lowers the risk of major life-threatening wildfire and reduces the threat of substantial economic losses of resources and infrastructure.
- Prepares areas for the seeding or planting process and encourages natural regeneration by exposing mineral soil.
- Lessens the need for mechanical thinning which has a higher cost and more negative impact on soils.
- Controls the spread of disease by eliminating infected trees and parasites.
- Improves wildlife habitat by increasing browse and browse quality, opening areas for feeding and travel corridors, and stimulates vegetative ground cover.
- Improves rangelands by releasing dormant, standing vegetation resulting in increased nutritive value of subsequent re-growth.
- Restores and maintains biological communities through reintroduction of fire.

Threats and Impacts

- Air quality impacts to communities from smoke and emissions
- Risk of escape with the potential for negative impacts to communities and natural resources
- Impacts to vegetative structure that may preclude management goals and objectives from being met
- Costs of implementation (less reduced/displaced management costs)

Prescribed Fire Best Management Practices

BMPs for Planning and Burning

- Burn according to specific site and weather conditions to achieve the desired results while protecting water quality.
- Retain a light duff layer on the soil surface to allow water to slow and absorb into the ground, while still meeting the goals of the prescribed burn.
- Keep high intensity burns out of stream management zones (SMZ) unless suitable measures are used to ensure protection of water quality.
- When conditions allow, use natural or existing barriers such as roads, canals, utility rights-of-way, streams, lakes, or wetlands to minimize the need for new fireline construction.
- The type and location of firebreaks or firelines should be clearly noted on the burn plan and/or map.

BMPs for Fireline Construction

- Construct firelines only as deep and/or wide as necessary to contain the prescribed fire.
- Minimize using soil disturbing tractor-plow firelines if conditions allow.
- Construct firelines in a way that minimizes erosion and prevents runoff from directly entering waterbodies by installing and maintaining water bars, sediment traps, turnouts, or other appropriate methods.
- When site conditions or burning techniques are suitable, construct firelines along the contour and avoid straight uphill/downhill placement.
- Fireline slope should be kept to 25 percent or less if possible.
- Try to keep constructed firelines out of SMZs, marshes or other environmentally sensitive areas. If a constructed fireline is needed in these areas, avoid using heavy equipment.

BMPs for Fireline Maintenance

- Maintain erosion control structures to control runoff on firelines. Provide adequate cross-drainage where needed to avoid damming surface runoff.
- Minimize accelerated erosion into waterbodies and stabilize those areas that pose a risk to water quality.
- Clear streams and ditches of debris that was pushed in by fire equipment.
- Revegetate and/or stabilize firelines that pose a risk of accelerated erosion to waterbodies.

BMPs for Wildfire Control

- Expose no more ground surface than is necessary to control the fire.
- Protect surface waters such as streams, rivers and other waterbodies from polluted or

sediment-rich runoff.

- Minimize soil disturbance along streambanks and within SMZs or riparian buffers. Avoid crossing streams with heavy equipment unless necessary.
- Keep fire-retardant chemicals out of SMZs, riparian buffers or waterbodies as conditions allow.
- Clean and maintain firefighting equipment away from SMZs, riparian buffers or waterbodies.
- If water retention areas are constructed, they should be returned to their pre-existing grade or hydrology as close as possible after they are no longer needed.
- Stabilize and/or retire firelines and access trails or roads created to control the wildfire. Consider installing suitable water (runoff) diversions.
- Establish groundcover, re-vegetate or stabilize areas that are a considerable risk of accelerated erosion.

Resource Needs

Fiscal Allocation

- Agency budgets need to be stabilized to allow land management agencies to be proactive in approaching fire planning and treatments.
- Enhance interagency Joint Powers Agreement for transferring funds for non-suppression (fuels management, prescribed fire, prevention, education/outreach, and public information) activities.

Personnel/Response

- More personnel and resources to work across all land ownerships.
- More personnel and resources to provide adequate wildfire management response.

Training/Outreach

- Additional training opportunities for wildland firefighters.
- Continued support for the Arizona Wildfire and Incident Management Academy.
- Improve the awareness and education of private property owners that the combustibility of their property is their responsibility; more private property owners should be provided site-specific recommendations on reducing combustibility.

Science and Research

- Continuing support of research for the benefits and costs of managed wildfire and prescribed fire effects.

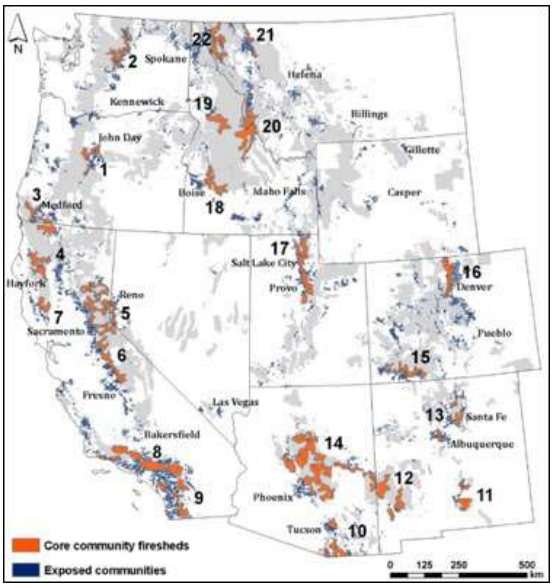
Fuels Management

- Development of additional industrial capacity to utilize biomass from treatment areas.
- Smoke and poor air quality from all fires must be addressed by working with ADEQ to stay within the state's identified requirements.

- Continue to accomplish fuel reduction work in high priority fuel and fire hazard areas.
- Establish and maintain fire-safe zones around critical infrastructure.

Fire Use

- Manage natural ignitions and/or planned ignitions to help restore natural habitat diversity and other resource benefits.



Cross-Boundary Fire Risk

Using advanced modeling tools, we can now understand cross-boundary fire risk issues across a "fireshed"—the area of fire risk around a community or other point of value—including the contributions that individual land parcels make to community wildfire risk. We can map firesheds around communities and other values to locate hotspots of fire transmission. In the Western United States, for example, scientists have mapped the core firesheds that are responsible for some 80 percent of the potential future community exposure from wildfires ignited on the National Forest System.

Core firesheds (orange) that potentially transmit fire to the exposed communities (blue) adjacent to national forests. These core firesheds account for 80 percent of the total potential fire from the National Forest System to communities in the Western United States.

Key Partners and Stakeholders

Many of the partners and stakeholders listed below have a potential role in supporting implementation of this strategy. A few entities stand out as being critical to success:

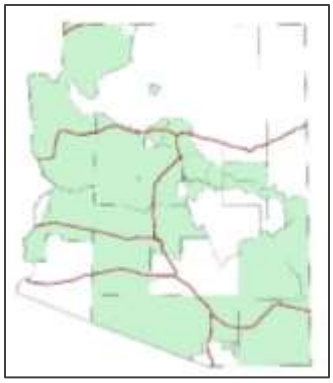
- Organizations like the Ponderosa Fire Advisory Council, and Rural Communities Fire Management Partnership
- Fire departments, fire districts, and fire management organizations
- Arizona Interagency Coordination Group (AICG)
- All federal agencies involved in fire management - USDA Forest Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, US Fish and Wildlife Service.
- All state agencies involved in fire – ADEQ, DFFM, State Land Department, and the Game and Fish Department.

Focus Areas

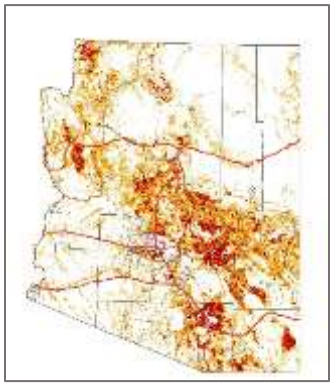
Focus landscapes for the Fire issue were developed from Four (4) primary data sets:

1) Wildfire Risk as developed in the Wildland Wide Assessment,
2) Identified Communities at Risk,
3) Community Wildfire Protection Plans, and
4) Cross-Boundary Fireshed analysis.

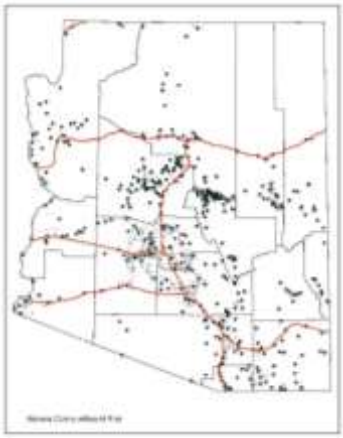
Areas of highest wildfire risk were used to create the Focus Area map. We identified the different HUC 10s across the state where wildfire risk was highest and created a gradient showing which HUCs had the most risk. The gradient runs from 2,000 acres of high wildfire risk per HUC to 110,000 acres of high wildfire risk per HUC.



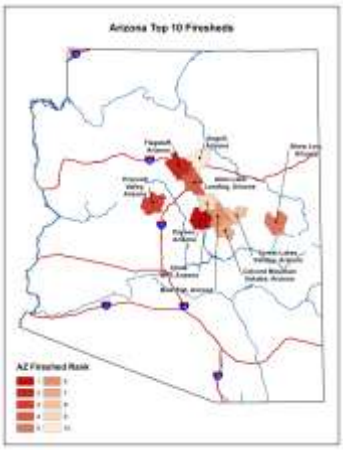
Community Wildfire Protection Plans: More than 30 CWPPs have been completed within Arizona. This data is maintained by the Arizona Department of Forestry and Fire Management (DFFM).



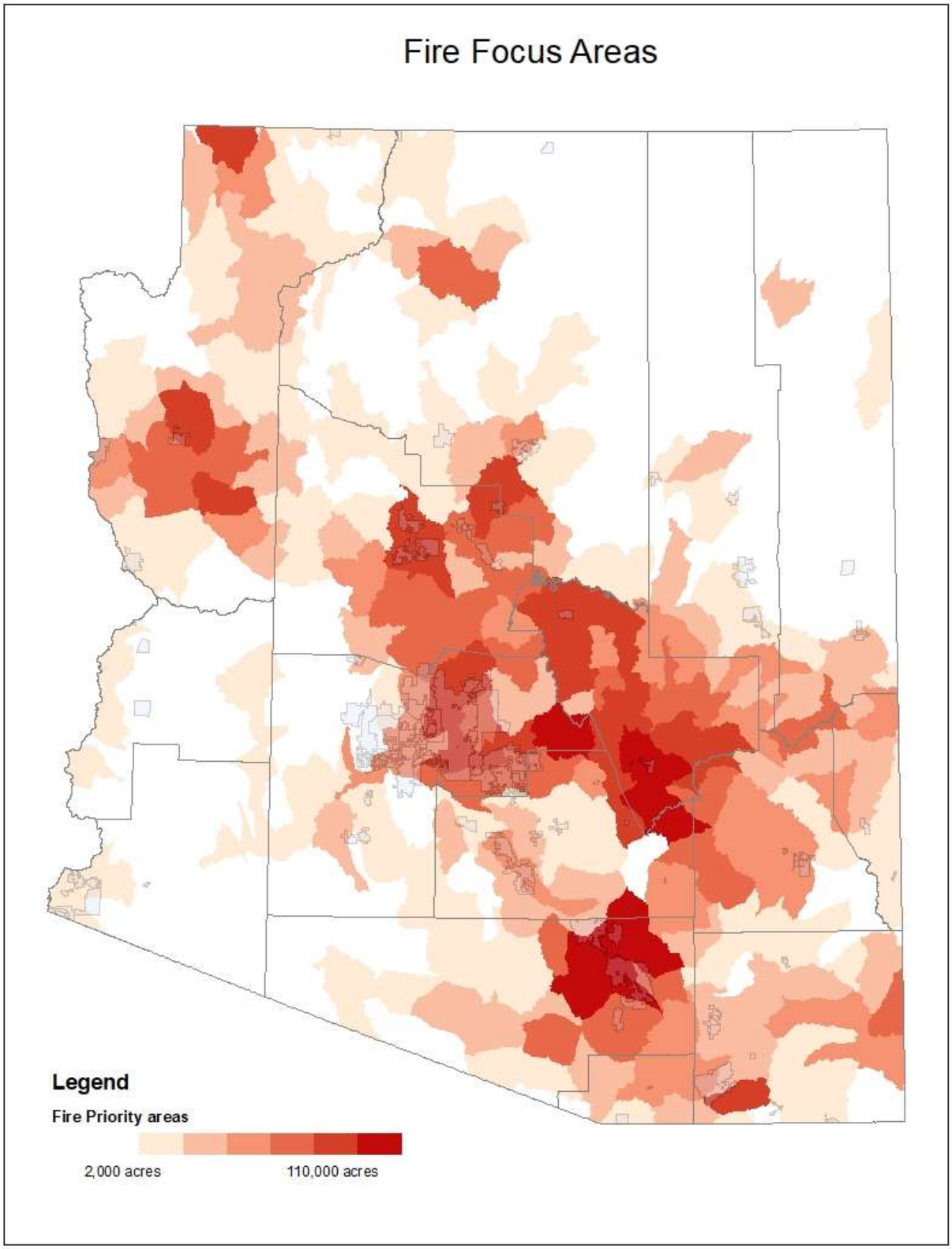
Wildfire Risk: The Arizona Wildfire Risk Assessment Portal (AzWRAP) identifies areas of high and medium risk by incorporating historical fire occurance, fire regime condition class, and fuels type. AzWRAP can be found online at arizonawildfirerisk.com



Communities at Risk: DFFM has identified over 400 communities across Arizona that are at risk from wildfire. The communities identified on the map are at medium or high risk.



Cross-Boundary Fireshed: Analysis provides a framework for assessing cross-boundary wildfire exposure using FSim simulation outputs to (1) estimate cross-boundary wildfire (2) quantify structure exposure to Arizona communities; (3) map sources of community wildfire exposure (firesheds); (4) characterize firesheds in terms of management opportunity and fuels; and (5) prioritize communities based on integration of exposure and fireshed characteristics. Results identified the top 10 firesheds in Arizona.


Fire Focus Areas
Legend
Fire Priority areas
2,000 acres
110,000 acres

Goal, Objectives, and Actions

The Strategy Team identified four (4) goals, ten (10) objectives, and forty-one (41) actions for the Fire issue.

- Bring attention to ecosystems that are no longer functioning in a healthy state due to historic fire suppression strategies.
- Assist communities that are at risk from adverse effects of wildfire.
- Establish additional fire response capacities within agencies that have responsibility for wildfire suppression.
- Provide adequate information and education to the public and government officials on fire management and suppression.

Goal 1: Wildland ecosystems where appropriate fire regimes maintain resiliency of natural vegetation.

Objective 1: Manage forest structure to restore fire regimes and minimize negative impacts from unwanted wildfire (recognizing the diversity of federal, tribal, state and private landownership in Arizona).	1. Use fuel reduction treatments to reduce excessive fuel loading to prepare fire-adapted landscapes for historic fire regimes through fuel treatment activities. 2. Design fuels treatments strategically on the landscape to effectively reduce fire risk. 3. Encourage collaborative long-term forest restoration and fire management planning by all land managers. 4. Provide adequate resources for planning & resource support during implementation of fire management strategies. 5. Restore impaired ecosystems through mechanical treatments and use of fire to achieve desired effects and sustained natural fire regimes.
Objective 2: Use appropriate application of fire to meet resource and community protection objectives	1. Develop integrated planning efforts to achieve desired outcomes from fire, utilizing CWPPs, and fire and land management plans considering private landowner and community objectives. 2. Utilize fire in fire-adapted ecosystems, ensuring acceptable intensities, timing and duration of treatments. 3. Avoid management use of fire in areas where it encourage unwanted invasive species. 4. Build capacity with responders in the highest priority areas.
Objective 3: Use best available science to define appropriate levels of fire for different ecosystems or vegetation types	1. Support research to define appropriate timing and acceptable fire intensities in various ecosystems. 2. Support research to define requirements for post fire rehabilitation. 3. Support research to identify appropriate use of fire and other management actions in areas with invasive species. 4. Support Firescape and similar programs to increase all lands fire management knowledge and expertise.

Goal 2: "Fire Adapted Communities" that provide shared stakeholder responsibility for resilient landscapes and wildfire prepared communities.

Objective 1: Assist communities in planning for and reducing wildfire risks	1. Encourage development and implementation of CWPPs or equivalent plans in areas at high risk of wildfire. 2. Build leadership capacity and support dedicated personnel to sustain implementation of CWPPs and other community wildfire planning. 3. Design and implement effective restoration and fuel treatment activities in the Wildland/Urban Interface to meet community protection objectives. 4. Integrated and collaborative development of implementation plans (CWPPs, FMPs, etc.) for an all-lands approach should be considered wherever appropriate. 5. Develop consistent fire hazard classifications for all developed and undeveloped lands using standard assessment methods. 6. Develop additional fire adapted communities that follow risk mitigation principles and support increased local scale implementation. 7. Support adoption of Wildland/Urban Interface development codes by counties and communities. 8. Promote and implement Firewise USA ™ and Ready-Set-Go Programs to increase public awareness and encourage local level responsibility. 9. Provide GIS and WUI assessment training, equipment, and support to local communities to build local capacity. 10. Focus efforts in priority firesheds where the likelihood of exposure and cross boundary fires are the highest.
Objective 2: Design and implement effective smoke management strategies and protocols.	1. Assist ADEQ in developing relationships with tribal nations so burning across the state can be synchronized. 2. Coordinate key messages with other cooperators and stakeholders to ensure timely and effective messages are provided. 3. Create a group which functions as the Arizona Fuels Committee to improve communication and coordination between land management agencies regarding air quality issues and fuels management planning.

Goal 3: Enhanced wildland fire management capacity in Arizona

Objective 1: Increase firefighting response capabilities and efficiencies.	1. Provide adequate fire preparedness and suppression funding to maintain firefighter and public safety and provide for private property and natural resource protection. 2. Collaborate with Federal, State, local and private partners to study and implement most efficient utilization of existing firefighting and fuel treatment resources. 3. Build additional initial and extended attack fire suppression and fuel treatment capacity. 4. Develop more accurate statewide wildfire reporting/statistical cause database 5. Utilize modern technologies in firefighting and dispatch systems to increase efficiencies.
Objective 2: Assure adequate wildland and prescribed fire training is provided to all necessary personnel.	1. Develop and maintain statewide wildland training needs database. 2. Develop NWCG qualified firefighting and prescribed burn personnel within the Arizona fire departments and various state and local agencies, through formal training and on-the-job task book completion. 3. Provide adequate financial support for wildland fire training opportunities within the State (Arizona Wildfire Academy, weekend workshops, community colleges) 4. Develop processes and methodology for local firefighting agencies to gain OJT wildland experience to improve skills.

Goal 4: An Arizona public and government leadership that is well informed about wildland fire management, science, and prevention issues.

Objective 1: Develop and deliver Arizona specific educational information and tools to increase citizens and community awareness of wild land fire issues and preparedness.	1. Collaboratively develop and maintain Arizona specific information, educational materials, and common messages about wildland fire to help residents of forest and other communities understand the risks inherent in living in fire-prone areas, and to educate developers and the community about steps that can be undertaken to reduce exposure to fire hazard and to improve forest health. 2. Collaboratively develop and maintain programs and methodologies for delivery of information about wildland fire issues and activities. 3. Use current technology to provide up to date educational information (social networking sites, websites etc.). 4. Collaboratively develop and maintain an organized cadre of trained individuals to provide educational opportunities to communities and public. 5. Identify adequate resources (fiscal and other) to support ongoing fire education materials and programs.
Objective 2: Increase government leadership awareness of wildland fire preparedness and appropriate actions.	1. Develop and maintain specific wildland fire materials for outreach to federal, state, county, and local government officials. 2. Develop and implement a plan to inform federal, state, county, and local officials on Arizona wildland fire preparedness and other fire issues. 3. Provide adequate funding to support government leadership outreach materials and program maintenance.

6.6 ECONOMICS

Critical Issue Description

Forests have always contributed to Arizona's economy and quality of life. Historically, forests have provided an abundance of natural resources--forage for cattle and sheep; trees for lumber, firewood, mine timbers and railroad ties; game for consumption; and water for irrigation and municipal uses. Forests have sustained a timber industry fueling a century of rural development. Although tourism, watershed protection, and evolving forest management goals have provided new challenges for rural and state economies, the importance of forests to Arizona's economy has not changed. Forests remain the economic and aesthetic foundation of many rural communities. Today, Arizonans demand more goods and services from our forests than ever before and balancing these demands presents ongoing management challenges as we strive to ensure long-term forest sustainability.

**When referencing forests, we also include woodlands, grasslands, and riparian areas.*

Introduction

Arizona forests sustained a timber industry that helped support a century of rural development. In the 1990s, changes in economic conditions, environmental concerns, an overall reduction of large trees, and a shift to recycled paper caused a sharp decline in the logging industry (Figure 1 and Table 1). The current low value of non-commercial timber has challenged government agencies on how to have these low value products removed from the forest. Select areas can still support timber sale contracts, while other areas have agencies pay loggers for thinning small-diameter trees and removing woody biomass (providing hazardous fuel reduction of non-merchantable materials). Additionally, many other treatments conducted for restoration and fuels purposes within a timber sale area add costs, which outweigh the value of the wood products removed.

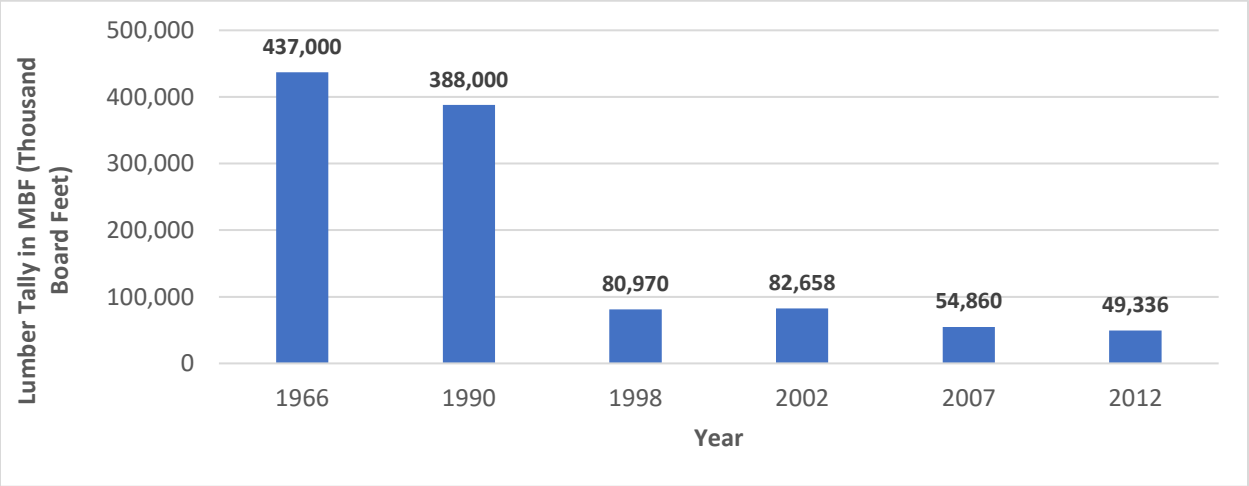


Figure 1. Lumber Production in Arizona, 1996-2012[55]

[55] Sorenson, Colin B.; Hayes, Steven W.; Morgan, Todd A.; Simmons, Eric A.; Scudder, Micah G.; McIver, Chelsea P.; Thompson, Mike T. 2016. The Four Corners timber harvest and forest products industry, 2012. Resour. Bull. RMRS-RB-21. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 62 p.

Table 1. Timber Harvest by County, 1984-2012

County	1984	1998	2002	2007	2012
	----------MBF Scribner ----------				
Apache	171,128	15,641	6,350	31,610	23,916
Coconino	150,727	15,314	14,889	14,353	32,118
Gila	931	5,405	39,960	1,960	2,729
Graham	-	-	1,100	1,100	-
Greenlee	4,623	1,515	-	-	-
Maricopa	-	-	-	-	-
Navajo	52,745	38,384	64,027	3,094	8,938
Pima	-	33	-	-	12
Santa Cruz	-	-	-	48	120
Yavapai	2,220	20	1,895	1,612	3,585
Total	382,674	76,312	128,220	53,777	71,418

Source: Sorenson, Colin B.; Hayes, Steven W.; Morgan, Todd A.; Simmons, Eric A.; Scudder, Micah G.; McIver, Chelsea P.; Thompson, Mike T. 2016. The Four Corners timber harvest and forest products industry, 2012. Resource. Bull. RMRS-RB-21. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 62 p.

Tourism, second home development, watershed protection, and evolving forest management goals have provided new challenges and opportunities for local and regional economies. The primary importance of forests to Arizona's economy is shifting from logging and resource extraction to amenity based values. Forests remain the economic and aesthetic foundation of many rural communities, especially along the Mogollon Rim. Declining ecosystem health has adversely affected economic conditions, primarily from threats associated with wildland fire activity, insect and disease activity, and forest fragmentation on private lands.

Gross domestic product (GDP) by state (millions of current dollars)

Levels

Bureau of Economic Analysis

Forestry, fishing, and related activities

Fips	Area	1997	1998	1999	2000	2001	2002	2003	2004	2005
04000	Arizona	315	367	380	371	394	400	408	411	420
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
537	546	485	482	529	555	565	556	602	659	(NA)

Legend / Footnotes:

Note-- NAICS Industry detail is based on the 2007 North American Industry Classification System (NAICS).

(NA) Not available.

Note-- Per capita real GDP statistics for 2010-2016 reflect Census Bureau midyear population estimates available as of December 2016.

Last updated: November 21, 2017 -- revised statistics for 2014-2016.

Table 2. Bureau of Economic Analysis Gross Domestic Product values; 1997-2015

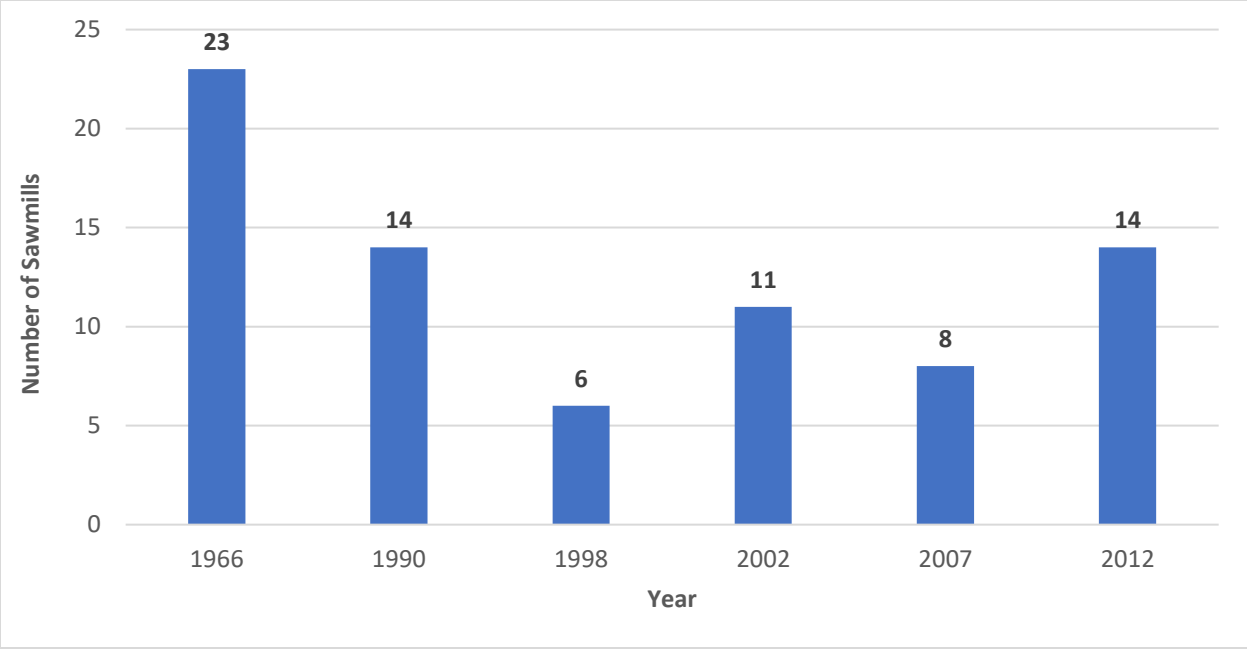


Figure 3. Operating Sawmills in Arizona, 1996-2012[55]

With continued population growth across the state, our reliance on healthy, sustainable forests is even more critical. Today, Arizonans demand more goods and services from our forests than ever before and balancing these demands and associated impacts presents ongoing management challenges as we strive to ensure long-term forest sustainability. The importance of developing infrastructure, sustained employment opportunities and markets for the by-products of forest restoration is critical in maintaining forest-based economic sustainability. There are also opportunities to solve other statewide issues, such as increasing energy needs, through development of wood-to-energy facilities.

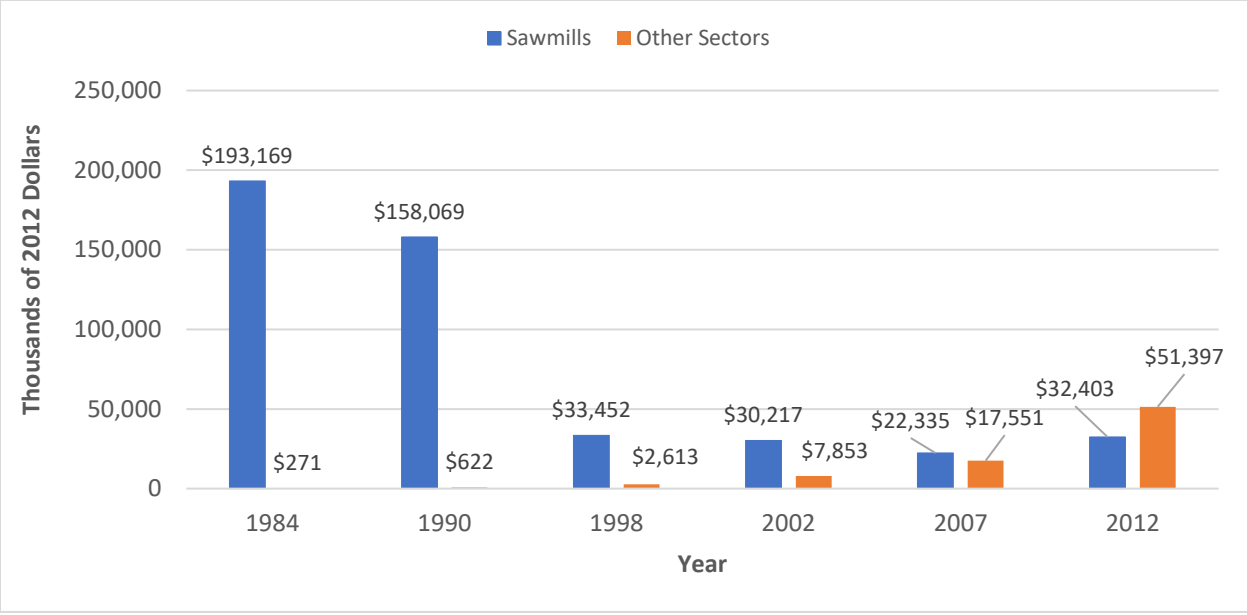


Figure 4. Finished Product Sales of Arizona's Primary Wood Products Sectors, 1984-2012[55]. Other sectors include producers of industrial fuelwood, fuel pellets, biomass energy, posts and poles, and viga logs

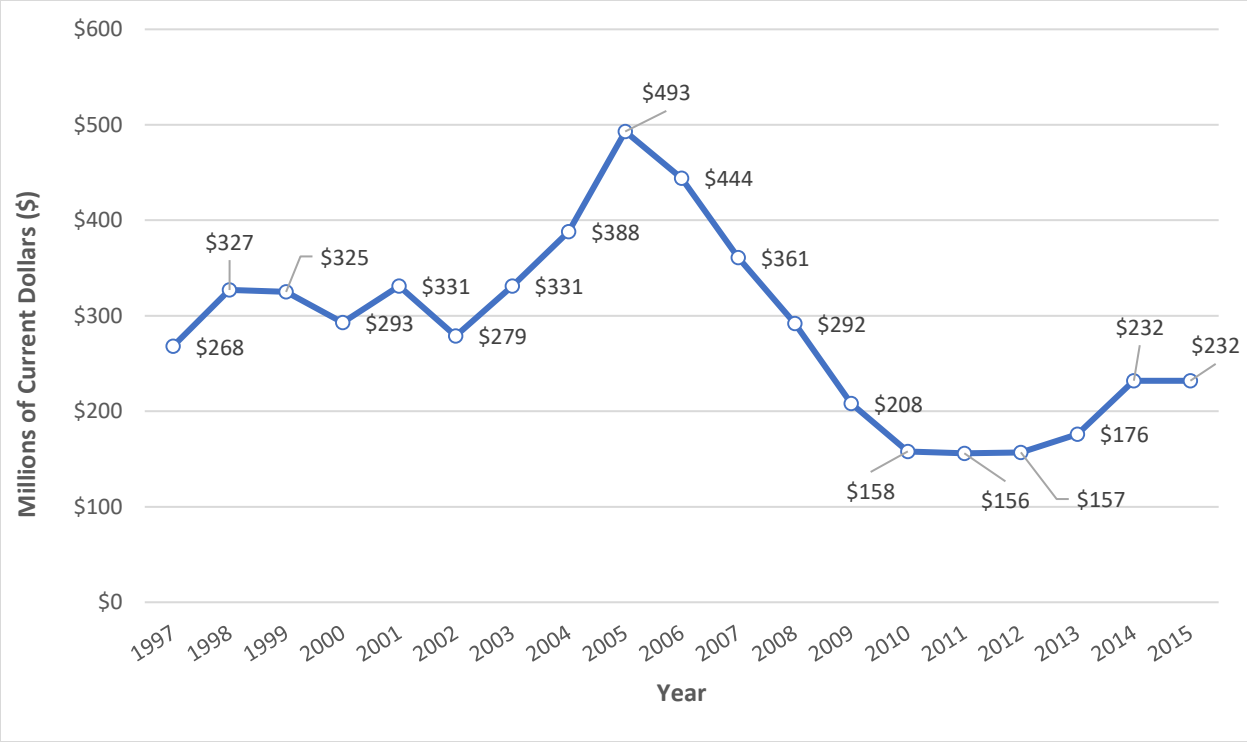


Figure 5. Gross Domestic Product (GDP) for Arizona's Wood Products Manufacturing (NAICS 321), 1997-2015[56]

Key Elements

There are four key elements related to this issue:

1. Innovative and appropriately scaled, sustainable industries that facilitate economically feasible forest restoration efforts and provide economic support to communities.
2. Industry-supported, landscape-level treatments to maintain healthy forest conditions while sustaining and promoting economic benefits support of a rural green economy (ecosystem services).
3. Development of local industry to provide reliable local markets for forest biomass.
4. Private land management and the sale of private in holdings for development.

Presently, there is inadequate logging and wood-processing infrastructure and markets to support an economically feasible, large-scale forest restoration effort. Although, some efforts have been made to initiate larger-scale management [the White Mountain Stewardship Integrated Resource Service Contract (WMSIRSC) Project[57] and the Four Forest Restoration Initiative Integrated Resource Service Contract (4FRI

[56] U.S. Bureau of Economic Analysis. Interactive Data Application. Gross Domestic Product by State. NAICS query, Wood Products Manufacturing (321)

[57] Lucas, A. M., Kim, Y. S., Greco, B., Becker, D. R., Hjerpe, E. E., & Abrams, J. (2017). Social and economic contributions of the white mountain stewardship project: Final 10-Year assessment—Lessons learned and implications for future forest management initiatives. Journal of Forestry, 115(6), 548-558.

IRSC)], there is a need to understand the effectiveness of these projects, expand successful efforts, and improve the ability to accomplish more restoration. The historical forest products industry in northern Arizona was based on large-tree logging for timber and small tree/pre-commercial thinning for pulp. The permanent closure of large-log sawmills in northern Arizona (Southwest Forest Industries in Eagar, Stone Container sawmill in Flagstaff, Kaibab Industries in Fredonia and Payson) combined with the pulp mill in Snowflake switching exclusively to recycled pulp in the mid-1990s made the market for forest logs to decline precipitously. Some small-scale industries remained, including firewood, posts and poles, pallets, vigas, specialty lumber, and the like. Remaining industries and a few new ones processed what little wood was being cut and removed by a small number of logging operations.

In the early 2000's there was the development of woody biomass manufacturing facilities in eastern Arizona. A 27MW biomass fueled electrical generating station built in Snowflake could utilize whole-tree chips generated from logging slash and grassland restoration projects. As part of the White Mountain Stewardship Project, a residential wood pellet manufacturing plant in Show Low was commissioned to utilize whitewood chips from small diameter ponderosa pine trees that were debarked in the forest.

	Acres Sold by Fiscal Year (October-1 to September 30)														
Forest/Sold or Paid	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**TOTAL**	**% by forest**
Apache/Sitgreaves	**35,773**	**14,302**	**11,140**	**6,138**	**7,597**	**9,627**	**2,200**	**12,009**	**14,482**	**13,456**	**9,761**	**16,387**	**11,106**	**163,978**	**100%**
FS sold	28,704	6,000	2,880	0	0	190	1,275	4,450	5,037	6,097	9,761	16,387	11,106	91,887	**56%**
FS paid	7,069	8,302	8,260	6,138	7,597	9,437	925	7,559	9,445	7,359	0	0	0	72,091	**44%**
Coconino	**12,300**	**17,080**	**6,050**	**4,000**	**0**	**1,300**	**380**	**20,700**	**16,669**	**16,456**	**34,717**	**7,822**	**10,451**	**147,925**	**100%**
FS sold	12,300	12,150	3,750	2,800	0	1,300	380	20,700	16,449	16,456	34,717	7,822	3,614	132,438	**90%**
FS paid	0	4,930	2,300	1,200	0	0	0	0	220	0	0	0	6,837	15,487	**10%**
Coronado	**27**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**186**	**0**	**11,500**	**0**	**11,713**	**100%**
FS sold	0	0	0	0	0	0	0	0	0	186	0	0	0	186	**2%**
FS paid	27	0	0	0	0	0	0	0	0	0	0	11,500	0	11,527	**98%**
Kaibab	**9,150**	**5,400**	**9,800**	**35,242**	**9,900**	**9,366**	**2,986**	**0**	**13,658**	**25,082**	**9,480**	**2,657**	**19,729**	**152,450**	**100%**
FS sold	9,150	5,400	9,800	35,242	400	9,366	2,986	0	13,658	25,082	8,171	2,657	2,282	124,194	**81%**
FS paid	0	0	0	0	9,500	0	0	0	0	0	1,309	0	17,447	28,256	**19%**
Prescott	**2,556**	**2,184**	**1,930**	**3,741**	**1,636**	**2,482**	**2,228**		**1,954**	**1,813**	**2,133**	**4,299**	**5,244**	**32,200**	**6%**
FS sold	2,556	2,184	1,930	3,741	1,636	2,482	2,228	0	1,954	1,813	2,133	4,299	5,244	32,200	**100%**
FS paid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0%**
Tonto	**2,138**	**4,359**	**4,724**	**2,180**	**3,577**	**11,072**	**8,009**	**7**	**2,174**	**2,018**	**1,590**	**1,425**	**3,051**	**46,324**	**100%**
FS sold	2,138	4,359	4,724	2,180	3,577	72	8,009	7	1,222	2,018	1,590	1,425	3,051	34,372	**74%**
FS paid	0	0	0	0	0	11,000	0	0	952	0	0	0	0	11,952	**26%**
TOTAL FS SOLD	**54,848**	**30,093**	**23,084**	**43,963**	**5,613**	**13,410**	**14,878**	**25,157**	**38,320**	**51,653**	**56,372**	**32,590**	**25,297**	**415,278**	**75%**
TOTAL FS PAID	**7,096**	**13,232**	**10,560**	**7,338**	**17,097**	**20,437**	**925**	**7,559**	**10,617**	**7,359**	**1,309**	**11,500**	**24,284**	**139,313**	**25%**
TOTAL ALL	**61,944**	**43,325**	**33,644**	**51,301**	**22,710**	**33,847**	**15,803**	**32,716**	**48,937**	**59,012**	**57,681**	**44,090**	**49,581**	**554,591**	**100%**

Acres of Timber Sales Sold by the US Forest Service 2005-2017[58]

Since 2005, 75% of acres awarded by the Forest Service in Arizona were contracts that the Forest Service sold, with 25% sales that the Forest Service had to subsidize the removal of forest products. The majority of the acres that have been subsidized are associated with the White Mountain stewardship contract. By the mid-2000s, several operations (Southwest Forest Products, High Desert Investment) began bidding on timber sales again in the Western Mogollon Rim area, and the White Mountain Stewardship Contract revitalized several operations in the eastern Mogollon Rim area. However, the recession of 2007-2010

[58] Source: US Forest Service TIM database, query ran February 26, 2018

affected most operations and demonstrated how a diverse business cluster of forest-based enterprises is needed to offset fluctuations in market conditions.

Currently, successful industry efforts are centered in the White Mountains, with Tri-Star Logging and Novo-BioPower creating a restoration based industry (Novo-Star) that combines saw timber products with biomass removal that is centered around a biomass fueled electrical generating station. The value-added concept displayed by Novo-Star is a model that illustrates how multiple manufacturing processes are necessary to incentivize investment in low value products. Also illustrated at the Novo-Star facility is how public policy through the Arizona Corporation Commission's Renewable Energy Portfolio can support forest restoration by allowing utility companies to purchase renewable energy from a variety of sources.

Novo BioPower

Novo BioPower is a renewable energy company engaged in biomass power generation utilizing wood waste as a primary fuel source. Novo Biopower operates a 27 megawatt biomass power plant located in Snowflake, Arizona, approximately 180 miles Northeast of Phoenix. The Novo Plant has two long-term power purchase agreements in place with Arizona Public Services (APS) and Salt River Project (SRP), Arizona's two largest electric utilities. The power plant is a key component to the 4FRI effort due to it processing much of the biomass coming off the project area.

Additionally Forest Energy, LLC; the offtake partner for the White Mountain Stewardship Project continues to operate in the White Mountains. The fiber source for Forest Energy, LLC has diversified and now includes sawmill waste from sawmills in the area and a mix of fiber from the National Forest System and tribal lands.

Restoration of forests altered by fire suppression, commercial logging, past grazing practices, mining, road building, insects and diseases, invasive species, and intensive recreation is a high priority on all forestland in Arizona. Of particular concern is the inability of forests altered by these factors to withstand otherwise natural disturbances such as fire, flooding, and insect outbreaks. There is a great need to restore self-maintaining, resilient ecosystems within the forested landscape. To accomplish this there is a need to create opportunities for an innovative sustainable industry that will facilitate economically feasible forest restoration efforts and provide economic support to communities and counties. Key to this is the identification of appropriate landscapes that would be most beneficial to development of industry. Such economic development could also partially underwrite costs to federal agencies for ramping up landscape-scale restoration.

Restored forested landscapes can serve as major attractions for a variety of amenity based services and recreation, hunting, tourism, scenic backdrops for residential homes--all of which contribute substantially to the economic vitality of Arizona. Amenity-based services include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, flood, disease, wastes, and water quality;

cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soils formation, photosynthesis, and nutrient cycling. Note that the benefits of ecosystem services are not always directly tied to the forest or woodland landscape. In the case of water quality, the beneficial users are sometimes hundreds of miles downstream in the large metropolitan areas of Phoenix. The economic value of these "ecosystem services" is considerable and may outweigh values associated with resource extraction by a factor of 100:1[59].

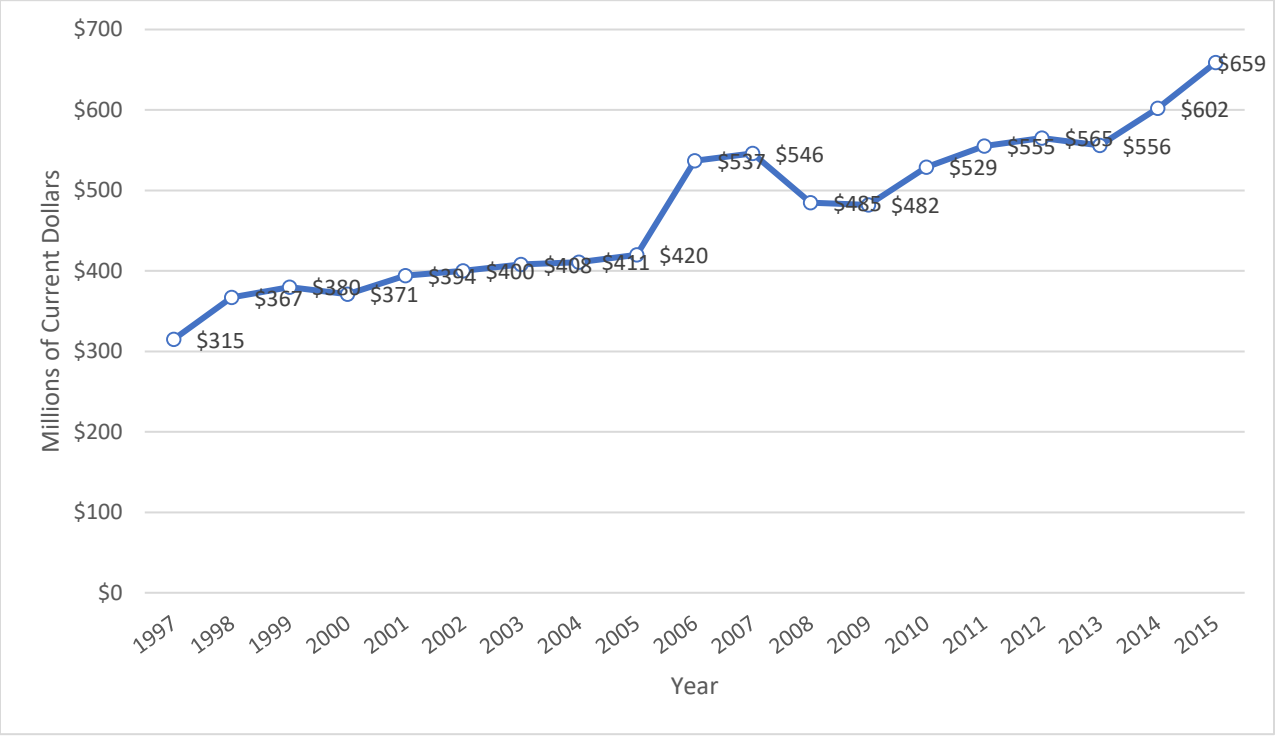


Figure 6. Gross Domestic Product (GDP) associated with Forestry, Fishing, and Related Activities (NAICS 113, NAICS 114), 1997-2015[60]

A current lack of industry poses a barrier to accomplishing economically viable treatment of these landscapes. Without treatment, these landscapes are at elevated risk for unnatural, stand replacing fires and other ecosystem health risks. Ecosystem services emanate as a continual flow of economic value from healthy forests. If healthy forests are reduced, degraded, or irreversibly damaged, the flow of ecosystem services is diminished. This reduction of ecosystem services can limit the economies of communities and businesses depending on these services. Key to this is the identification of specific landscapes that contribute to the economic well-being of local communities and/or regional entities.

Ecosystem services provided by forested lands also includes private lands and their management as an integral part. The contributions from private property are often viewed as free benefits to society. Consequently, their beneficial contributions are often overlooked in public, corporate, and individual decision-making. When forested lands are undervalued, they can be susceptible to development

[59] " Economic Reasons for Conserving Wild Nature", Science's Compass Review, Balmford et al., 2002, http://science.sciencemag.org/content/sci/297/5583/950.full.pdf

[60] U.S. Bureau of Economic Analysis. Interactive Data Application. Gross Domestic Product by State. NAICS query, Forestry, fishing, and related activities

pressures, conversion, or simple neglect. As these working forest in-holdings are removed from the contiguous forested landscape, that landscape becomes more fragmented. Impacts go beyond the private land. Consequences include the loss of public benefits or the marginalization of those benefits provided by contiguous forested landscapes. In addition to residential, commercial, and industrial development on what was forested land, and their associated influence as a new wildland urban interface, there is the expansion of utility infrastructure and transportation networks into forests.

The National Forest Foundation (NFF) announced recently that it submitted an innovative carbon offset methodology to the American Carbon Registry for approval. Once approved, the proposed methodology will allow for the generation of verified carbon offsets from forest restoration projects on National Forest lands in the southwestern U.S. This methodology is the first of its kind and will help advance forest restoration activities aimed at reducing the risk of high severity fires in the region. Using the methodology, investors will be able to financially support forest restoration activities, such as those planned under northern Arizona's Four Forest Restoration Initiative (4FRI), in exchange for verified carbon offsets[61].

Forested regions are desirable places to live and Arizona's population grew by nearly 40% from 2010 to 2015[62]. The impact of this rapid growth shows up on the landscape as urbanization--conversion of rural open space to urban use by the sale of private land parcels to accommodate development.

Benefits, Threats, and Impacts

Industry:

<u>Benefits</u>

- Wood/forest byproducts utilization
- Support jobs and the local economy
- Tool to accomplish forest management goals and objectives
- Provide a firefighting resource
- Reduced management costs
- Increased economic benefits
- Renewable energy options

<u>Threats and Impacts</u>

- Air quality reduction
- Water quality impairment
- Forest resources (erosion, roads, etc.) affected by management activities

Forest Treatments:

<u>Benefits</u>

- Reduced wildfire threat

[61] " National Forest Foundation Advances Innovative Carbon Offset Methodology for Restoring Southwestern National Forests", National Forest Foundation, Greg Peters, 2016

[62] "Arizona Population 2018", http://worldpopulationreview.com/states/arizona-population/, Retrieved March 5, 2018.

- Reduced wildfire costs
- Reduced insect and disease threat
- Ecosystem services maintained or enhanced
- Healthier wildlife habitat
- Enhanced recreational opportunities
- Healthier trees exhibiting proper growth
- Reduced watershed impacts
- Reduced invasive species threat
- Improves overall condition and health of land
- Opportunity to resolve other state-wide issues (green energy needs from biomass)
- Carbon sequestration from productive trees
- Improved water quality and quantity to downstream communities

Threats and Impacts

- Creates short-term wildfire hazards depending on treatment type
- Short-term impacts to natural resources and wildlife
- Short-term aesthetics impacts
- Reduces short-term carbon sequestration
- Short-term watershed impacts

Other considerations and related Issues

There is a direct connection between economics and several other identified forest resource issues:

- *Fire severity / community protection* - The costs of fire prevention and restoration of burned areas is an economic issue.[63] Fire suppression and prevention costs, effects on property values, and rehabilitation costs are all a consideration. There can be a short-term economic boost from reconstruction efforts, fire suppression and restoration jobs. However, there is an offsetting cost to taxpayers, insurance companies, businesses and property owners. There is a long-term economic impact associated with loss of the forest environment.
- *Water & Air Quality* - Economic impacts of water and air quality cannot be overstated. The ecosystem services of healthy watersheds and the delivery of water from forests and woodlands is a driver of economies hundreds of miles from their location.
- *People* - Discussion of this issue includes recreation and urban forestry. However, there is also a need to address the impacts and benefits of individuals who depend on forestlands for a living (i.e., ranchers, outfitter/guides, land management agency personnel, etc.).
- *Ecosystem Health* - Landscapes threatened with declining ecosystem health are also areas where industry needs and amenity values are linked.
- *Climate Change* - As climate change influences forests, there will be corresponding changes to economic issues and opportunities.

[63] Combrink, Thomas; Cothran, Cheryl; Fox, Wayne; Peterson, Jeff; Snider, Gary. 2013. A full cost accounting of the 2010 Schultz Fire. Flagstaff, AZ: Northern Arizona University, Ecological Restoration Institute. 44 p.

- *Sustainability* - Importance of developing and being able to maintain infrastructure so forest management can occur on a cost-effective basis.

Resources-Existing and Needed

Existing Resources

- Non-governmental economic development organizations like the Northern Arizona Loggers Association and the Natural Resources Working Group of the White Mountains.
- State universities and institutes that provide science-based support and other resources.
- Natural Resource Conservation Districts, which provide technical assistance to landowners and funding opportunities for practices.
- Forest products and logging industries.
- Federal, State, and local agencies involved in biomass removal and use.
- Counties where biomass is extracted and utilized.

Resource Needs

- An expanded forest products industry and additional hazardous fuel reduction contractors is essential to achieve forest management goals and objectives.
- Adoption of the Clean Resource Energy Standard and Tariff (CREST) by the Arizona Corporation Commission, which will allow for development of broader diversified energy policies.
- Economic data about the potential for carbon markets and other ecosystem services. Data must provide a value for these services so they can be promoted and included in land management planning decisions.
- Data and accurate information about the economic benefits of forest-based recreation and tourism.
- Additional information about forest product options and a potential wood products industry within the state (an expanded wood supply study).
- Economic analysis data about what it would take to develop and maintain a sustainable wood products industry that would facilitate forest management goals and objectives across the state.
- Economic data on cost avoidance related to treating Arizona forests and woodlands

Key Partners / Stakeholders

Many of the partners and stakeholders listed in this section have a potential role in supporting implementation of this strategy. A few entities stand out as being critical to success:

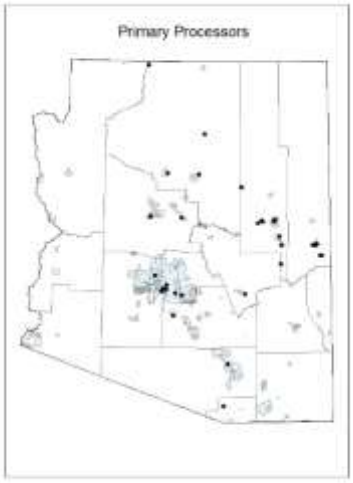
- Forest products and logging industries
- Hazardous fuel contractors
- Federal, State, and local agencies.
- Counties
- Natural Resource Conservation Districts
- Non-Governmental Organizations
- Land Grant Universities

- Natural Resources Working Group (NRWG)
- Four Forest Restoration Initiative Stakeholders group

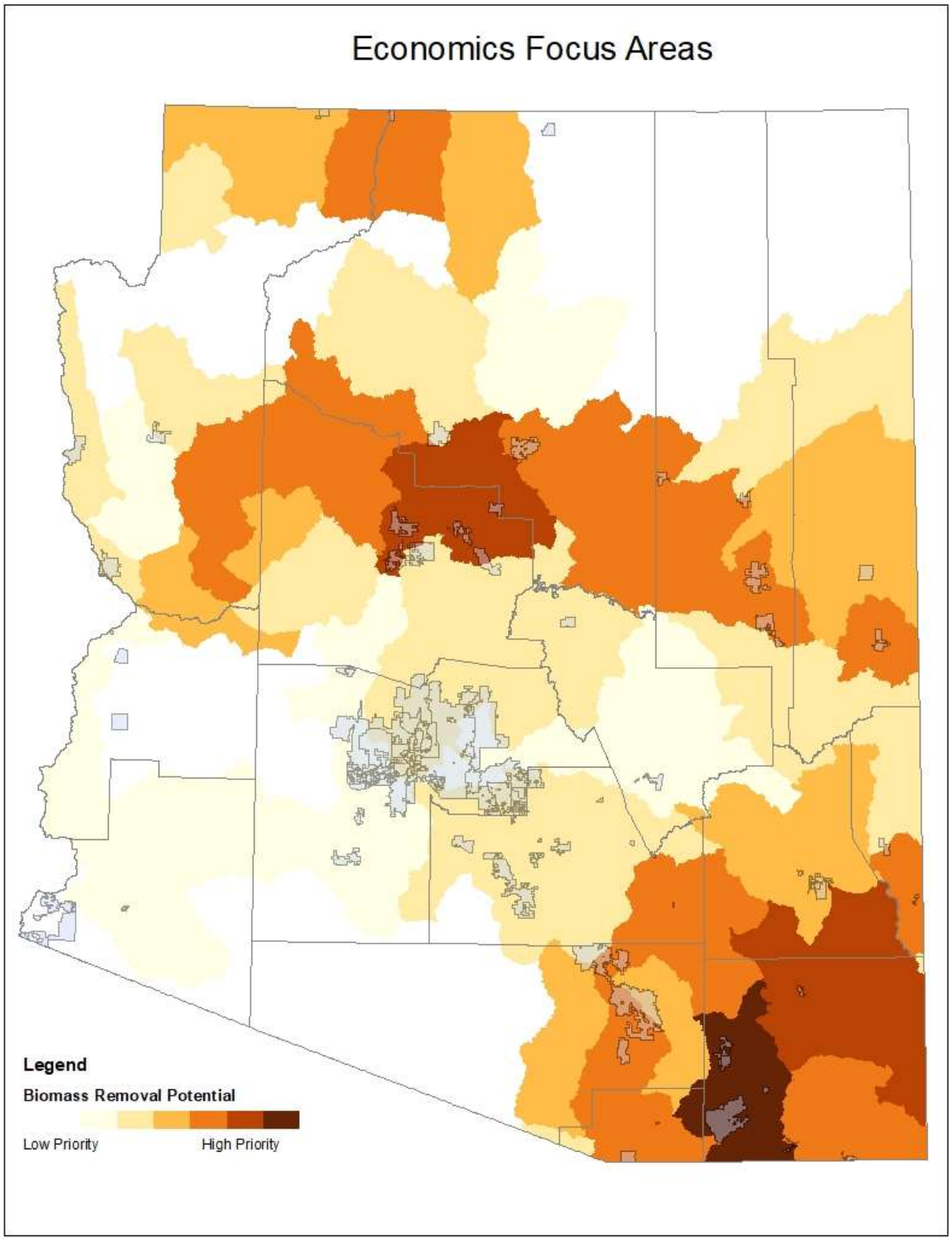
Focus Areas and Priority Landscapes

The focus areas for Economics are identified using the criteria listed below. Additionally a map of the known wood utilization centers of forest products is also included.

- Forest resources that are most beneficial (nearest, least cost, etc.) to the operation of existing sawmills and biomass utilization facilities.
- Forest landscapes that would be most beneficial to the development of new, large-scale wood products industry--one that could address the costs to federal agencies for ramping up to landscape-scale restoration.
- Areas that contribute to the economic support of local communities and/or regional entities.
- Forest landscapes that can contribute to future economic challenges and opportunities: renewable energy production, maintaining water quality, energy conservation, carbon sequestration, climate change.
- Forest land affected by the socio-economic threats to working forests from the loss of private forest lands to residential, commercial, and industrial development.



Wood Utilization Centers: The points represent businesses utilizing Arizona's forest resources in a high volume capacity.


Economics Focus Areas
Legend
Biomass Removal Potential
Low Priority
High Priority

Goals, Objectives, and Actions

The Strategy Team identified three goals, 11 objectives, and 39 action items for Economics (see Economics Strategies Matrix). The main goals were focused on/designed to:

- Realizing the long-term potential of developing sustainable forest products/bioenergy industries
- Conservation those areas with economic development potential related to ecosystem services
- Expand and support the continuation of multi-agency, collaborative projects that will be conducive to the development and support of a sustainable wood products industry
- Expand bioenergy component from forests and woodlands to the development and support of a sustainable wood products industry.
- Recognize the diversity of federal, tribal, and private landownership in Arizona and the need to collaboratively work together to address resource threats (wildfire, insect/disease, watershed condition, land conversion) that threaten and negatively impact critical forest landscapes that are economically important to all Arizonans
- Provide comprehensive program leadership, data and information for programs to address land management issues associated with the economic contributions, including ecosystem services, of forested landscapes across the state

Goal 1: Realized long-term economic potential of sustainable forest products and bioenergy (while achieving Ecosystem Health goals).

Objective 1: Develop policies, plans and incentives to encourage the development and perpetuation of forest products businesses that will diversify the economy and facilitate forest restoration activities.	1. Continue to identify appropriate programs and policies that will encourage the development and perpetuation of forest products businesses, by coordinating with county and local governments, and state and federal agencies. 2. Maintain data about current and potential Arizona economic activity related to wood product industries. 3. Continue using the Arizona Statewide Wood Energy Team to coordinate and lead the statewide approach to developing markets, infrastructure, and connecting treatment by products to markets. 4. Fund staff capacity to assist rural communities convene, recruit, and support forest products and bioenergy enterprises. 5. Ensure that wood utilization opportunities and challenges are clearly identified in CWPPs and other local and regional planning efforts. 6. State and local government entities develop policies that facilitate the siting of wood products facilities, including tax and loan incentives. 7. Work collaboratively and strategically to design and place forest management treatments to help facilitate the development of a wood products industry. 8. Develop and support incentive programs that encourage the use of restoration-generated materials by businesses across the state. 9. Explore federal contracting authorities, permitting policies and other support opportunities to attract and keep viable and appropriate fiber utilization industries that meet multi-level collaborative goals and plans.
Objective 2: Federal, state, and local units of government should identify and enhance the use of small-diameter wood and biomass generated from forest treatments wherever possible.	1. Government entities should use forest restoration treatment-generated material whenever and wherever possible. This includes use of renewable energy sources in new buildings, sediment wattles, retrofitting of existing heating systems, and use of treatment by-products for transportation applications. 2. Data about use of forest restoration treatment-generated material by federal, state, and local governments should be reported, collated, and shared. 3. State and local government entities should develop policies that facilitate the siting of wood products facilities, including tax and loan incentives.
Objective 3: Expand and support the coordination of multi-agency, collaborative, large landscape scale forest treatment projects that will be conducive to the development and support of a wood products industry.	1. Land managers should work with stakeholders to clarify the amount, availability, and location of wood and biomass across the State. 2. Identify and enhance opportunities for utilizing small-diameter wood and biomass generated from landscape scale forest treatments. 3. Develop presentation materials and information to facilitate funding support for landscape-scale restoration work.

Goal 2: Protection of areas with economic development potential related to ecosystem services.

Objective 1: Develop and maintain land use change and ecosystem services data for Arizona	1. Develop a cooperative multi-agency (natural resource) working group that can share data and prioritize opportunities to jointly focus program delivery to the highest priority landscapes. 2. Collect, assess, and maintain data about land use changes across the state - utilizing GIS and/or other technologies. 3. Collect, assess, and maintain data about realized and potential ecosystem services throughout Arizona - utilizing GIS and/or other technologies.
Objective 2: Focus and prioritize programs into communities that will experience significant urban growth, to assist local leaders in devising effective ways to grow, develop, and protect their communities while also integrating important economic contributions made by forest ecosystems and natural areas to be impacted.	1. Develop and maintain a natural resource assistance network. The network of local, state, federal, public, and private organizations will assist community leaders and landowners with the development and integration of valuable proactive management tools and technical support systems to manage growth and development to conserve, protect, and enhance important natural resources in advance of impending population growth and development. 2. Network with community leaders to promote, coordinate, and deliver information that will help community leaders, planners, and emergency response organizations address growth and the preservation of resource areas that are critical from an economic ecosystem services standpoint. 3. Increase understanding of the economic value of recreational use of our forests.
Objective 3: Prioritize/ focus program delivery and agency resources into high priority landscapes where resource threat, (wildfire, insect/ diseases, land conversion) will most likely threaten/ negatively impact critical forest landscapes across Arizona.	1. Develop and maintain data on current and expected resource threats. 2. Work collaboratively and strategically to design and place treatments to increase efficiency and maximize benefits on these priority landscapes.
Objective 4: Recognizing the diversity of federal, tribal, state and private landownership in Arizona, maintain and enhance the economic benefits and values of natural resources	1. Support the development of other emerging voluntary markets including water, habitat and green tourism. 2. Promote an understanding of the costs and benefits of all encompassing (watershed and other) property management to provide ecosystem services. 3. Encourage landowners to use restoration management techniques that result in socially accepted desired future conditions. 4. Develop and maintain a natural resource assistance network. This network of local, state, public, and private organizations can assist community leaders and private land owners with the development and integration of valuable proactive management tools and technical support systems needed to address the economic benefits of "working" landscapes. 5. Implement research to identify and quantify current and long-term key drivers, barriers and opportunities, for the supply and demand sides of both the forest products and range industries in Arizona.

Goal 3: Community recognition of the economic importance to protecting healthy natural systems.

Objective 1: Develop and maintain information about available programs, suitability of lands, and recommendations for greatest benefits and efficiencies.	1. Continue to monitor stewardship, conservation and resource protection programs and activities, and collaboratively maintain information about priority areas and opportunities.
Objective 2: Provide comprehensive program leadership, for a variety of programs to address land management issues associated with the high priority landscapes.	1. Develop a website, which incorporates available GIS-based resource data, hazard maps, agency contacts and other pertinent resource management information into a centralized system designed to address land management issues in Arizona. The Initiative would include stewardship, forest health, and wildfire prevention (public awareness and hazard mitigation) guidelines as well as contact information for fire suppression, land management, and other natural resource agencies in the region. 2. Develop and distribute fire management, forest restoration, and wildlife habitat and conservation protection Training Modules to educate the public and landowners. These modules could include videos, presentation materials, and brochures on fire prevention, invasive plants, and other forest health problems, stewardship, reforestation, wildlife management, ecosystem services, etc. 3. Provide training sessions and public workshops (i.e., Resource Management Expos) with a variety of stakeholders to promote forest stewardship, forest health, and wildfire management.
Objective 3: Recognize and promote the economic benefits of "avoided costs" on state and local budgets through enhancing ecosystem health.	1. Promote personal and community investment in Fire Adapted communities resilient to wildfires. 2. Promote employment of professional staff to address local stewardship and resource protection needs in high priority communities and regions.

6.7 Climate Change

Critical Issue Description

Arizona is often considered a land of extremes, from hot, low-elevation deserts near sea level to snow-covered alpine tundra shrouded peaks well above tree line at elevations approaching 13,000 feet. The climate across these landscapes has experienced wide swings in temperature and precipitation for thousands of years. A naturally variable climate has given rise to changes in fire frequency, wide variation in flood and drought severity, and has influenced Native American population shifts throughout the region. While climate has always been variable, rapid climate change creates cascading effects that are altering Arizona's landscapes. Recent drought conditions due to natural variability and increasing temperatures tied to rising levels or greenhouse gasses have decreased vegetative productivity, reduced water availability, caused a shift in established vegetation/wildlife ranges, and contributed to some of the largest wildfires in Arizona's history.

Though there could also be some positive impacts of climate change, the ecological changes projected to occur will be predominately negative. Virtually all natural resources in Arizona will be affected by climate change; in this report, we will focus on six factors, which are broadly represented across Arizona's diverse landscapes.

- Fire behavior/severity
- Water availability
- Wildlife habitat
- Vegetative productivity
- Ecological changes (conversion of vegetation types and relationships)
- Carbon sequestration

1. Fire behavior/severity

An increasingly hot and dry Arizona has already resulted in the lengthening of the fire season. From 1973 to 2013 the fire season across the planet has increased by 19%[64]; in the American West, this increase averaged more than 84 days longer in 2003-2012, compared to the period 1973-1982[65]. This increase has also affected the number, severity, and size of wildfires. More fuel is available for burning due to over a hundred years of fire suppression by land management agencies. Once ignited large fuel loads are resulting in very large and intense fires, which have important implications for communities, ecosystems, and air quality and fire suppression expenditures[66]. These unnaturally severe fires change the landscape drastically, imperil lives and property, and cost a lot to suppress.

Land managers in Arizona have taken several different approaches to address the issue of fire behavior and severity. One of these tools is the reduction of fuel loads through various fuels treatments. Generally,

[64] "Climate-induced variations in global wildfire danger from 1979 to 2013", Jolly et.al., Nature Communications 6, Article number: 7537 (2015), doi:10.1038/ncomms8537

[65] "Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring", Anthony LeRoy Westerling, The Royal Society Publishing, Published 23 May 2016.DOI: 10.1098/rstb.2015.0178

[66] "Climate change presents increased potential for very large fires in the contiguous United States", R. Barbero et. Al., International Journal of Wildland Fire 2015, 24, 892–899 http://dx.doi.org/10.1071/WF15083

this results in the reduction of fuels on the ground as well as ladder fuels (lower limbs and branches). These treatments may also require selectively thinning out dense stands of younger trees and protecting mature-sized trees. Fuels reduction can be accomplished using prescribed fire, biological methods (i.e. grazing), and mechanical and/or chemical treatments to remove or modify fuels. Of these methods, prescribed fire is the one with the highest potential, and the lowest cost per acre. With proper design and implementation, prescribed fire can reduce hazardous fuels, minimize invasive plants and disease, improve habitat, recycle nutrients, and promote beneficial post-fire vegetation growth.

Land managers can also take an indirect approach to fuels treatments through programs like FireWise and the Community Wildfire Protection Plan program. The FireWise program teaches people how to live with wildfire by making their homes and property fire resistant. Community programs often have three basic parts; collaboratively developed plans by local and state partners; prioritizing areas for fuels reduction; and specific recommendations that homeowners and communities can take to reduce threats to structures from wildfires. These approaches work with people to help them understand and implement steps they can take to create a more fire-resilient landscape.

2. Water availability

Global climate models project more dry days and drier soils in the future, for much of the Southwest. Along with projected warming and increased evapotranspiration, this likely means droughts will become more severe[67]. Research findings based on high emissions scenarios, suggest long-term droughts will become more common by the second half of this century, and future droughts will be much more severe than those previously recorded will.

Intensified Colorado River drought conditions are not fully due to changes in precipitation, but in part to warming, which is resulting in reduced snowpack and soil moisture, and increased evapotranspiration.

Efforts to restore Arizona's forests through thinning (e.g., 4FRI) have the potential to increase water availability and partially offset the increased evaporative demands from a warmer climate. Forest thinning may increase soil water input and ground water recharge through reduced evapotranspiration and canopy interception-sublimation. Restored forests are expected to reduce the likelihood of catastrophic wildfires that can leave sizable portions of the landscape in a more erodible state with reduced water infiltration capacities. Stream restoration efforts (e.g., Canyon Creek Restoration-Arizona Game and Fish Department) can re-connect streams to adjacent wetlands, increasing the water retained in Arizona's high elevation forests.

A reduced volume of snowpack is also an issue with some studies predicting western mountain ranges will have less by 2100[68]. This trend could have dire consequences because many areas depend heavily on snowpack for their year-round water supply. This is not to say there will no longer be any snow during the winter months but that it will melt off earlier in spring and may not be available in summer when relied upon. Many have viewed the problem of melting snowpack as inevitable and unavoidable but there are some possibilities for coping with snow shortages. Some land managers have begun restoring watersheds

[67] "Future Climate: Projected Extremes", G. Garfin et. al., 126-147, A report by the Southwest Climate Alliance., Washington, DC: Island Press, 2013.
[68] "Adapting to Climate Change: Envirnomental Law in a Warmer World", Matthew Zinn, 34 Ecology L.Q. 61, 67-68 (2007).

to store water and reduce the risk of flooding[69]. Meadows and wetlands act as natural water reservoirs and allow the more gradual release of water during dry summer months. Cloud seeding is another option that some local governments have been attempting to increase snowpack. However, its efficacy and unintended side effects in a changing climate are uncertain.

3. Wildlife habitat

The effects of climate change on native animal populations and their habitats are expected to take many forms. The Intergovernmental Panel on Climate Change (IPCC) stated with "high confidence" that "Under all … climate change scenarios for the second half of the 21st century: (1) community composition will change as a result of decreases in the abundances of some species and increases in others; and (2) the seasonal activity of many species will change differentially, disrupting life cycles and interactions between species. Composition and seasonal change will both alter ecosystem function." In addition, "Many species will be unable to move fast enough during the 21st century to track suitable climates under mid- and high-range rates of climate change[70]." Of course, migration of species is only feasible if suitable habitat is both available and accessible. As the IPCC notes, many species will be unable to migrate due to landscape habitat fragmentation, loss of suitable habitat, lack of mobility, or because they already live at the highest available elevation. Other changes we are likely to see include: changes in the timing of breeding seasons and migrations; disassembly of current ecosystems and biological communities, and formation of new ones; and altered occurrence of wildlife disease pathogens and invasive species. In general, climate change will exacerbate many existing stressors on ecosystems and hinder many species' ability to adapt.

The complexity and uncertainty associated with climate change pose an unprecedented challenge to wildlife management agencies and organizations in planning for and addressing impacts to wildlife. The Association of Fish and Wildlife Agencies[71] (AFWA), recommends using an adaptive management approach to deal with climate impacts. AFWA's recommended adaptive approach involves assessing existing conservation actions for their effectiveness under both current and future climates. Further, in the national climate change strategy the USFWS discusses adaptation as planned, science-based management actions that can help to reduce the impacts of climate change on fish, wildlife, and their habitats[72].

Examples of existing conservation actions include:

- connecting landscapes and aquatic systems to allow for wildlife movement
- relocating species to more suitable habitat (assisted migration)
- reducing pressures from non-climate change stressors

[69] "Restoring California's Wild Watersheds", Jane Braxton Little, YES! Magazine, (2010)

[70] "Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J.T. Overpeck, and M.A. Taboada, 2014: Terrestrial and inland water systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 271-359.

[71] AFWA (Association of Fish and Wildlife Agencies). 2009. Voluntary guidance for states to incorporate climate change into state wildlife action plans and other management plans. Pg.42.

[72] USFWS (U.S. Fish and Wildlife Service). 2010. Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change. Pg. 32.

- restoring habitats and wildlife populations where appropriate
- engaging in large-scale watershed planning; surveying and monitoring wildlife populations to ensure population health and resilience
- working towards endangered species recovery
- providing information to be used in project development and planning processes to minimize impacts on wildlife
- educating the public about the importance of considering wildlife needs in all planning activities.

However, land managers must recognize that lack of staff and financial resources severely limits what agencies can accomplish alone. Hence, collaboration with partners to undertake various aspects of the work is critical and highly recommended. For example, while land management agencies have perhaps the greatest ability to maintain landscape connectivity, restore and protect natural habitats, protect water sources, and monitor natural environments, their efforts are maximized when informed by input from state fish and wildlife management agencies and other stakeholders.

Wildlife agencies monitor the status of wildlife populations and their habitats, track the health and viability of populations, research specific aspects of wildlife interactions and their relationships to habitat, conduct habitat protection and restoration projects, hold refuge populations of select species, and actively manage wildlife, through translocations or predator management, when necessary. Together these agencies work to reduce non- climate change stressors, reduce the spread and introduction of non-native or invasive species, enhance recovery of federally listed species, and keep common species common. The collective goal of these actions is to make wildlife populations as resilient as possible to the variety of environmental changes they may encounter in the future.

4. Vegetation Productivity

The warmer temperatures expected with climate change and the potential for more extreme heat will impact future vegetation productivity. Flowering is one of the more temperature sensitive phenological events for plants, and increasing temperatures are already affecting pollination and flower production. Warmer temperatures during plant reproduction in many cases reduces yield by as much as 80–90 percent from normal temperature ranges[73]. This decrease in productivity could create problems that managers do not have experience dealing with. Though the issue of decreased vegetative productivity is daunting, there are strategies already used by land managers to mitigate these impacts. These include; reintroduction of native species; lowering stocking levels; introducing ground cover species to reduce runoff and sedimentation; and minimizing pest species.

Recognition that vegetation may become less productive than it once was will require major adjustments from land managers. Managers should consider lower stocking levels (livestock, wildlife, timber, and crops) to balance production with potential future climate scenarios. Vegetation will likely begin flowering and seeding earlier in the year, so managers need to consider this as they adjust their management activities.

One of the strategies land managers can implement in the face of climate change is to restore the land back to its natural structure. In the forested areas of Arizona, this would lead to the selective removal of

[73] "Temperature extremes: Effect on plant growth and development", Hatfield et. al., Weather and Climate Extremes, Volume 10, Part A, December 2015, Pages 4-10.

small trees in "dog hair thickets" to create a more spacious, open forest where trees are not overly competing with one another for limited resources. In rangelands and desert grassland ecosystems, restoration management may result in the removal of juniper, mesquite and other woody brush species along with reseeding native grass species where appropriate.

The Southwest's climate is projected to become warmer and drier, so plant species that may have thrived in certain habitats may no longer do so. For this reason, another strategy that managers can employ is to increase the use of drought or heat tolerant plant species when reseeding after disturbances. Drought and temperature tolerance is important because it lowers the amount of water plants need to grow and does not limit the plants' productivity in extreme temperature events.

Climate change has already "very likely increased the size and number of wildfires, insect outbreaks, and tree mortality in the Southwest and will continue to do so"[74]. These fires along with extreme weather events and invasive insects are causing massive disturbances across Arizona. In anticipation of an increasingly warmer, drier climate, managers need to improve ecosystem resiliency and adaptability to disturbances. Increasing tree spacing will mitigate crown fire being transmitted through the over story limiting the fire's negative impact on the landscape. This, in turn, will limit flooding that often occurs after large fires. Overall, the best strategy going forward will be to manage plant communities for anticipated changes, minimize disturbance, and restore vegetation with coming climate change in mind.

5. Ecological changes (conversion of vegetation types)

Accelerating climate change is already causing significant shifts in the ranges of plants and animals[75]. Species, when facing drier and warmer conditions are shifting their ranges to track more favorable conditions, often poleward and to higher elevations. In the Southwest, though many species may be able to adapt by doing this, species at higher elevations (including those living in sky islands) will face significant challenges. Geography often limits movement in these ecosystems because there simply is nowhere to go. In Southwest forests, rates of ecosystem change due to climate impacts are projected to become more dramatic over the course of the 21st century.[76]. Conversion of current vegetation types to other kinds further complicates issues that are present on the landscape (i.e. increased fire activity, reduced water availability, and changing wildlife habitat).

To avoid the worst negative impacts of climate change, land managers, should:

- Increase ecosystem resiliency through paying careful attention to the structure, function, and composition of each ecosystem so key adjustments (e.g. thinning, burning, removing invasive species, improving stand diversity) can be made when needed[77]. This level of understanding may allow land managers to notice when ecosystems begin to change, allowing them to act before these changes fully take hold.

[74] "Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(A) OF the CAA", US. EPA., Dec 2009,
[75] "A Globally Coherent Fingerprint of Climate Change Across Natural Systems", Camille Parmesan & Gary Yohe, Nature 421 (January 2, 2003)
[76] "Climate change vulnerability assessment of forests in the Southwest, USA", James Thorne, et al., Climatic Change (2017). https://doi.org/10.1007/s10584-017- 2010-4
[77] "Resilience and Stability of Ecological Systems", C.S. Holling, 4 Ann. Rev. Ecology & Systematics 1-23, 1973

- Embark on restoration efforts with the key focus on allowing for evolutionary development of ecosystems under climate change. This means adjusting how restoration has currently been applied in Arizona. Instead of attempting to shift ecosystems back to historical structures, composition, and ranges of natural variability, managers need to take climate change into account and create small habitat clusters of better adapted species across the landscape, letting them link up on their own[78]. This approach allows nature to establish the level of complexity of each site with less human intervention.
- Increase habitat connectivity so wildlife are more capable of moving and shifting their permanent and seasonal habitats, to areas more similar in temperature/precipitation to their historical ranges. Landscape connectivity as a climate change adaptation strategy is being pursued in several regions across the nation and we can clearly see the benefits of connecting landscapes for improving ecosystem resiliency.
- Though assisted migration is a controversial approach in conservation, climate change presents challenges to species and ecosystems that have not been encountered before[79]. The speed of observed changes due to climate change in species habitat and life cycles is forcing changes in conservation biology thinking and practice. Many species cannot shift habitat ranges fast enough to deal with current and future rates of climate change, so land managers should begin to experiment with pilot approaches to assist migration to avoid species decline and possible extinction.

6. Carbon sequestration

Although carbon sequestration is one of the main tools in climate mitigation efforts, decreased vegetation productivity, will lessen the amount of carbon being sequestered. The increase in severe fire activity and fire season length will likely send more carbon into the atmosphere. Ecological changes may result in more carbon being sequestered in the short term (i.e. conversion of grasslands to woody brush). However, this initial boost is likely to decrease over time.

A warmer climate is expected to change how vegetation is distributed across Arizona; a major driver of this will be the increased extent and severity of disturbances[80]. This will in turn lead to lower amount of carbon sequestered by Arizona's forest and woodland ecosystems. Adverse effects are likely to be greatest in "areas where resource endowments are the poorest and the ability of land managers to respond and adapt is most limited[81]." However, some land managers may benefit from a warmer climate and/or longer growing season, which will also reduce the amount of carbon not sequestered due to potential disturbances.

Adjusting to new conditions will depend on experience, funding, and vegetation type. Specific adjustments may include:

- Planning for and aiding transitions to new conditions and habitats;

[78] "Habitat Re-Creation Strategies for Promoting Adaptation of Species to Climate Change", Jenny Hodgson, Conservation Letters, 2011
[79] "The Structure of Scientific Revolutions", Thomas Kuhn, 1962
[80] "National Forests, in Adaption Options for Climate-Sensitive Ecosystems and Resources", Joyce et al., 2008, US Climate Change Science Program, SAP 4.4
[81] "The Ghost Park", Paul Solotaroff, Men's J, 2010, Glacier National Park in Peril.

- Creating diversity by introducing new species over a range of environments;
- Enhancing genetic diversity;
- Using information about past and probable future conditions to inform activities;
- Managing to connect landscapes;
- Managing disturbed areas to restore ecological processes rather than pre-disturbance conditions and;
- Anticipating rather than reacting to weather-related events.

The key to maintaining or improving the current level of carbon sequestration in Arizona is achieving sustainability. Land managers need reduce the risks presented by climate change through sound planning, decision-making, and management. These, along with cooperation, will be critical to adapting to the changing climate; adaptation will require ongoing, adaptive learning and management.

Climate Change Mitigation

Managers and citizens can take several actions on the landscape to mitigate climate change. There are steps that can be taken to help ecosystems adapt to a changing climate. In forested ecosystems, management actions that encourage healthy, resilient forests can help avoid the loss of carbon due to unnaturally severe wildfires. Use of mechanical thinning and controlled burning have been shown to reduce fire risk and net carbon released by wildfires[82]. Thinning and burning treatment can reduce emissions of carbon dioxide by as much as 98%[83]. The overall carbon balance of a managed forest is sensitive to the eventual outcome of how the wood products are utilized, with longer-lived wood products providing the longest carbon storage benefit. Even wood harvested and burned immediately for production of electricity has a carbon benefit if the energy replaced by biomass burning would otherwise come from fossil fuels. Some of the carbon released to the Earth's atmosphere from burning of biomass and fossil fuels can be offset by land management practices that encourage carbon sequestration in vegetation and soils.

The USDA's Agricultural Research Service estimates that 20 million metric tons of carbon is currently sequestered each year in U.S. farm and grazing land soils. This estimate indicates that U.S. farms and ranches are indeed a net carbon sink, sequestering carbon in the soil and keeping it out of the atmosphere. USDA and State Department personnel estimate an additional 180 million metric tons annually could be stored in farm and range land acres. This would account for 12% to 14% of the total U.S. emissions of carbon according to the State Department.

Transformation of free-floating atmospheric carbon to fixed-state carbon stored in landscapes can be achieved through the following methods:

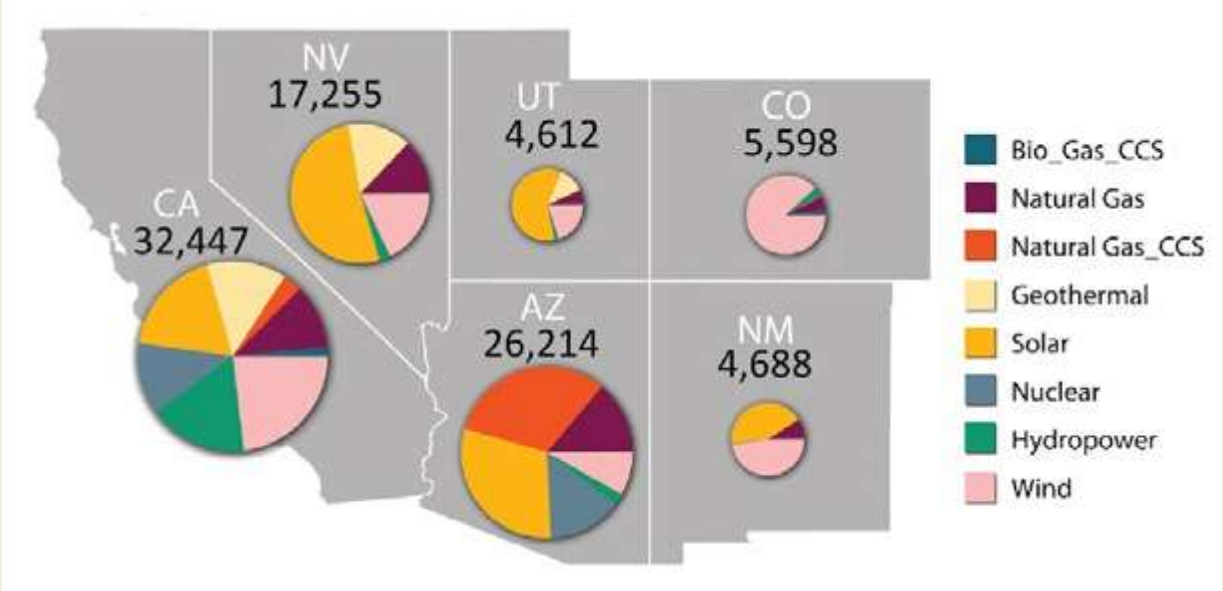
- Tree plantings
- Soil organic matter (decaying and decayed plant remains which hold carbon)
- Perennial grass plantings

[82] "The effects of a thinning treatment on carbon stocks in a northern Arizona ponderosa pine forest." Finkral and Evans, Forest Ecology and Management 255: pp 2743-2750.
[83] "Carbon protection and fire risk reduction: toward a full accounting of forest carbon offsets", Hurteau, Mathew D., G.W. Koch, and B.A. Hungate. 2008, Front. Ecol. Environ. 6, DOI: 10.1890/070187.

- Underground traps, including large bodies of water and organic soil

Landowners can receive credits in exchange for planting perennial vegetation on their land, which results in elevated levels of carbon sequestration. These credits are then sold on the Chicago Climate Exchange

Scenario for Greenhouse Gas Emissions Reductions in the Electricity Sector



Major shifts in how electricity is produced can lead to large reductions in heat-trapping gas emissions. Shown is an illustrative scenario in which different energy combinations could, by 2050, achieve an 80% reduction of heat-trapping gas emissions from 1990 levels in the electricity sector in the Southwest. For each state, that mix varies, with the circle representing the average hourly generation in megawatts (the number above each circle) from 10 potential energy sources. CCS refers to carbon capture and storage.

(CCX) for cash payments.

Carbon credits encompass two ideas:

1. The prevention and/or reduction of carbon emissions produced by human activities is kept from reaching the atmosphere by capturing and diverting them to secure storage. Methane digesters or conservation farming practices are examples to reduce to amount of carbon released into the atmosphere.
2. The removal of carbon from the atmosphere by various means such as agroforestry or perennial grasses and securely storing it in biomass and soil organic matter.

Once a carbon credit carries a market value and is legally equivalent to documented emissions reductions, two further issues arise; additionality and permanence:

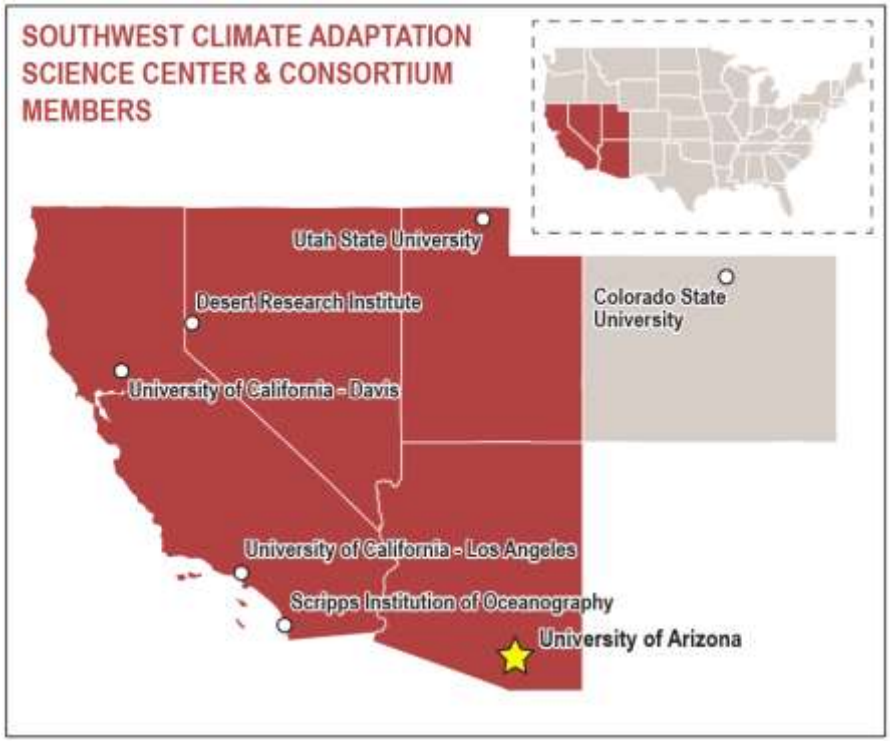
> **Additionality** refers to the certainty that some ecological offset results in new carbon fixation, rather than simply subsidizing "business as usual." Demonstrating additionality requires a baseline against which new carbon stores can be measured. Natural regeneration of abandoned farmland, for instance, could be used to offset continued fossil fuel emissions, undercutting greenhouse gas reduction goals.

Permanence is an issue because reduced emissions from a power plant or vehicle are permanent. For ecological offsets, permanence is complicated by the dynamic nature of ecosystems. Carbon stores ebb and flow with normal disturbance regimes, sometimes unpredictably in the case of fire, insect outbreak, or wind throw from severe storms.

Other Considerations

Urban Areas – Some of America's local governments have been at the forefront of the movement to address climate change. Citizens are demanding action, and continued leadership from local governments is essential to solving the issue.

- More than 40% of emissions come from commercial and residential buildings.
- Local governments are best suited to improve building codes, foster community-scale renewable energy, and create programs and incentives to increase efficiency.
- Local governments can promote the deployment of green infrastructure that reduces carbon emissions including community forest, green roofs, and parks and open space.
- Trees and landscaping are tools for reducing energy consumption.



The Southwest Climate Adaptation Science Center

The Southwest Climate Adaptation Science Center (SW CASC) was established in 2011 to provide objective scientific information, tools, and techniques that land, water, wildlife, and cultural resource managers and other interested parties can apply to anticipate, monitor, and adapt to climate change impacts in the southwestern United States. The goals of SW CASC are:

-To foster and support the highest quality climate and biological sciences research by connecting the scientific strengths of the USGS with those of the SWCASC partner institutions.

-To coordinate and collaborate with users and other providers of climate information to ensure that the research pursued by scientists results in tools, techniques, models, and actionable information to facilitate robust decision-making by resource managers, policy makers, and other stakeholders.

-To build enduring relationships with stakeholders that enable meaningful collaboration, clear communication, and effective translation of scientific results.

Key Partners/Stakeholders

Many partners and stakeholders can play roles in supporting implementation of this strategy. A few entities are especially important:

- Arizona Department of Environmental Quality (ADEQ)
- Arizona Game & Fish Department (AZGFD)
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of Energy
- U.S. Forest Service
- National Park Service (NPS)
- Fish & Wildlife Service (FWS)
- Bureau of Land Management (BLM)
- Arizona Universities
- The Nature Conservancy

Resources - Existing and Needed

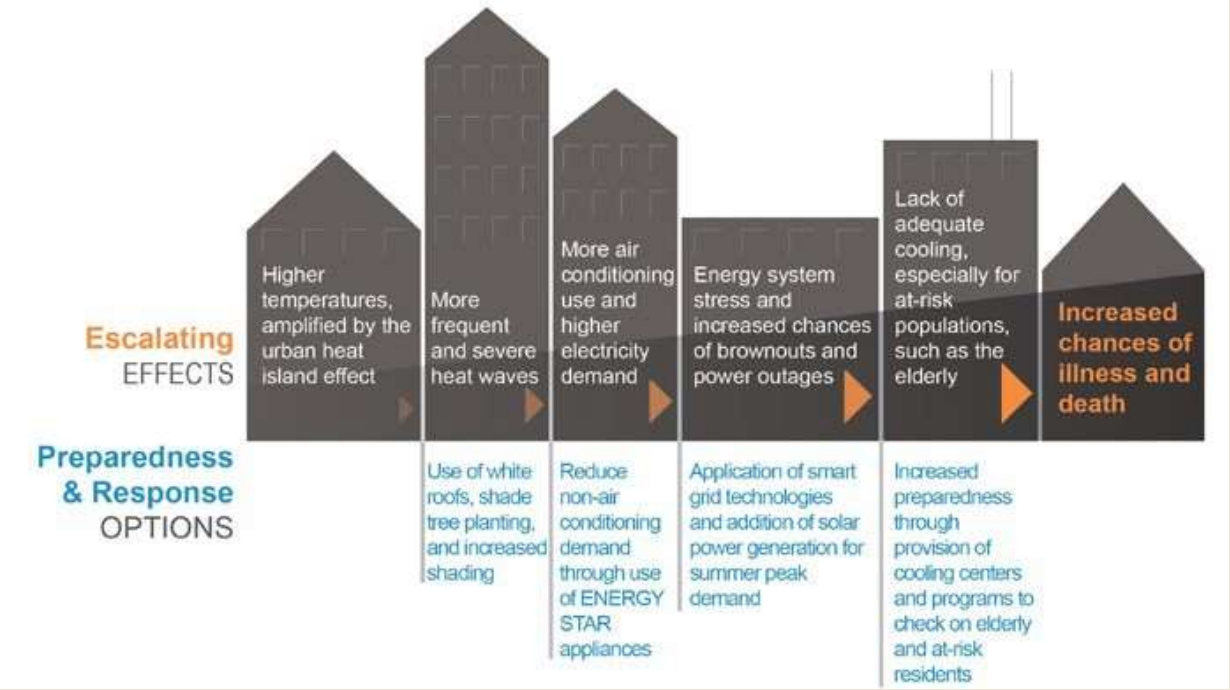
<u>Existing Resources</u>

- Agencies have mandates to incorporate climate change into their plans and activities.

<u>Resource Needs</u>

- Develop assessment tools, guidelines, and benchmarks for determining what constitutes healthy or desirable ecosystems.
- Develop an effort similar to California's adaptation program that identify and utilize high-resolution climate change projections that perform well for Arizona's unique climate in ling-term planning efforts.
- Methods to evaluate the impacts of climate change on ecosystems, and their response.
- Outreach programs to increase public awareness of climate change and its implications.
- Conduct monitoring for benchmark establishment and assessment of observed change.

Urban Heat and Public



The projected increase in heat waves in Southwest cities increases the chances that a chain of escalating effects could lead to serious increases in illness and death due to heat stress. The top of the figure provides some of the links in that chain, while the bottom of the figure provides adaptation and improved governance options that can reduce this vulnerability.

Focus Areas

An assessment developed by The Nature Conservancy[84] was used to determine the Climate Change Focus Areas. Their assessment used a categorization approach frequently used in conservation planning[85] to group temperature change and conservation importance into four classes of vulnerability. Classes were delineated above (high) and below (low) the 50th percentile.

[84] Robles, M.D. and C.E. Enquist. *In Review. Managing changing landscapes in the Southwest United States*. The Nautre Conservancy. Tucson, AZ. Pg. 45.

[85] Margules, C.R. and R.L. Pressey 2000. *Systematic Conservation Planning*. 2000. Nature Magazine, Vol. 405. Pg. 243-253.

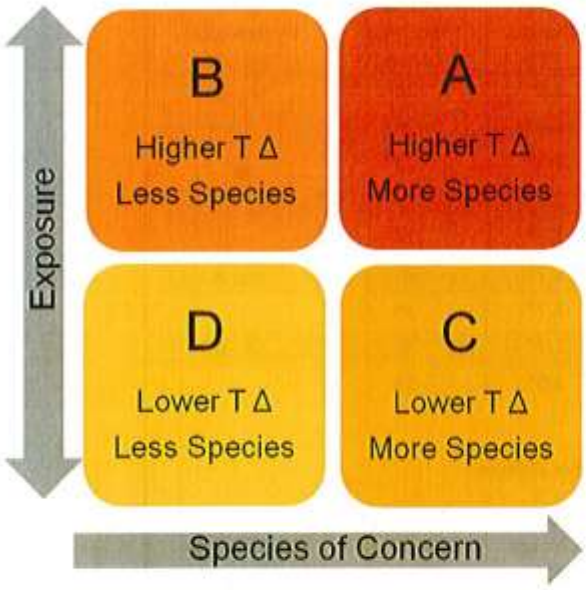


Figure 35. One way to evaluate place-based vulnerability is to group areas by climate change exposure (e.g., temperature change value) and a value of conservation importance (e.g., number of species of conservation concern). Class colors denote relative vulnerability based on values above (high) and below (low) the 50th percentile. Tan and yellow colored groups (C and D) have experienced less temperature change; rust and brown groups (A and B) have experienced higher temperature change. The rust colored group is potentially more vulnerable than the brown group (as is tan over yellow) because it hosts more species of concern. Relative vulnerability classes are as follows:
Class A--Higher Exposure-Higher Importance (Rust)
Class B--Higher Exposure-Lower Importance (Brown)
Class C--Lower Exposure-Higher Importance (Tan)
Class D—Lower Exposure-Lower Importance (Yellow)

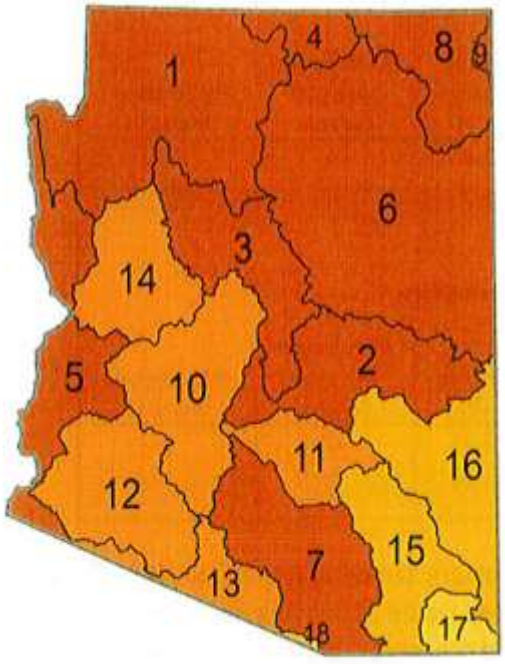


Figure 36. Map showing southwestern watersheds according to climate change vulnerability class across Arizona. Watersheds colored in rust have a high number of species of concern and rapid historic temperature increases (see Figure 39 headings for grouping criteria). Watersheds in brown also have higher temperatures but a lower number of species. Watersheds in tan and yellow experienced lower historic temperature change; tan areas have more species, yellow areas have fewer. Numbers correspond to watersheds labels in Table 2.

A. Higher Temperature Change, Higher Species Richness

Map Label	Watershed	State	Temp. Change (°F)	# Freshwater Species of Concern	Hydrological Impacts
1	Lower Colorado-Lake Mead	AZ	2.4*	29	❖, •
2	Salt	AZ	2.3*	29	❖
3	Verde	AZ	2.1*	27	•
4	Upper Colorado-Dirty Devil	UT	2.0*	12	
5	Lower Colorado	AZ	1.9*	14	
6	Little Colorado	AZ	1.7*	25	❖, •
7	Santa Cruz	AZ	1.7*	25	
8	Lower San Juan	AZ	1.7*	9	❖, •
9	Upper San Juan	NM	1.5*	14	

B. Higher Temperature Change, Lower Species Richness

Map Label	Watershed	State	Temp. Change (°F)	# Freshwater Species of Concern	Hydrological Impacts
10	Lower Gila-Agua Fria	AZ	2.2*	19	
11	Middle Gila	AZ	2.2*	10	❖, •
12	Lower Gila	AZ	2.1*	5	
13	Rio Sonoyta	AZ	1.9*	4	
14	Bill Williams	AZ	1.5*	16	

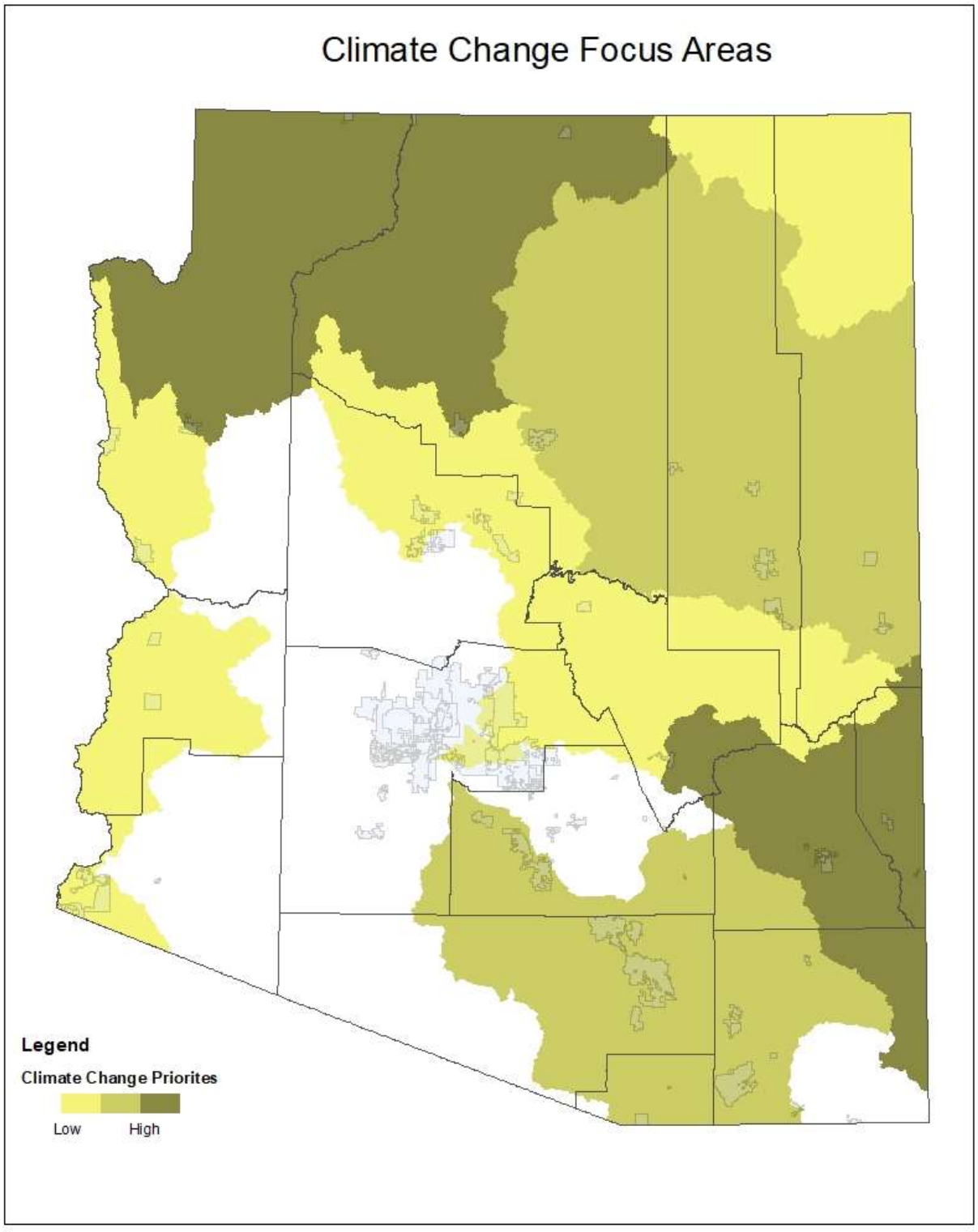
C. Lower Temperature Change, Higher Species Richness

Map Label	Watershed	State	Temp. Change (°F)	# Freshwater Species of Concern	Hydrological Impacts
15	San Pedro-Willcox	AZ	1.4*	31	
16	Upper Gila	NM	1.3*	37	❖

D. Lower Temperature Change, Lower Species Richness

Map Label	Watershed	State	Temp. Change (°F)	# Freshwater Species of Concern	Hydrological Impacts
17	Rio De Bavispe	AZ	1.3*	13	
18	Rio De La Concepcion	AZ	1.3*	9	

Table. Large watersheds in Arizona grouped by historic temperature change (1951-2006) and ranked by the number of species of concern (see Figure 34 heading for grouping criteria). Freshwater species richness values are also provided. * indicates that the 55-year temperature trend within the watershed is significant ($p < 0.05$), ❖= snowpack reductions documented (Mote et al. 2006), •= early stream flow documented (Stewart et al. 2005).


Climate Change Focus Areas
Legend
Climate Change Priorites
Low
High

Goals, Objectives, and Actions

Goal 1: Increase resilience of ecosystems to climate change.

Objective 1: Develop and maintain threats analysis for Arizona's high priority ecosystems using the best available scientific information	1. Develop threats assessment information on current and expected impacts of climate change on Arizona's ecosystems. Focus on potential impacts on to ecosystem health, impacts to water quality and quantity, and changing wildfire behavior. 2. Maintain up to date threat assessment and impact information. 3. Identify and secure resources to support development and maintenance of ongoing assessment work.
Objective 2: Develop adaptation plans for high priority ecosystems to increase resilience to climate change.	1. Encourage an all-lands approach to land, water, and fire management through effective collaboration with partners. 2. Collaboratively develop state with adaptation plans utilizing best available information. 3. Identify resources to facilitate high priority statewide management actions.
Objective 3: Manage and restore rangelands, forests, riparian areas, and other high priority ecosystems to mitigate the effects of and adapt to global climate change.	1. Implement identified collaborative statewide actions. 2. Develop wildlife conservation plans and new mitigation corridors to protect endangered and other species of concern. 3. Manage the landscape with future climate variability in mind.

Goal 2: Reduce rate of future climate change through maximized carbon sequestration.

Objective 1: Support landowners and land management practices which implement high quality mitigation practices which reduce carbon loss,	1. Increase opportunities for biomass and other wood product utilization. 2. Improve opportunities for certification of carbon sequestration and wood products on all lands.
Objective 2: Support achievement of appropriate fire regimes to maintain the health and resiliency of natural vegetation.	1. Use fuel reduction treatments to reduce excessive fuel loading to create more fire-adapted landscapes. 2. Design fuels treatments strategically on the landscape to reduce fire risk. 3. Restore impaired ecosystems through mechanical treatments and prescribed fire to achieve desired effects and sustained natural fire regimes.
Objective 3: Support continued research to understand the effects of natural resource management on carbon sequestration.	1. Identify and pursue opportunities to improve understanding of climate change science. 2. Begin distributing grants for climate change related activities.

Goal 3: Broad public and community understanding of climate change science, Arizona's variable climate, and current and future impacts.

Objective 1: Develop and maintain science-based reports specific to Arizona that document knowledge of climate exposure; species, community, and watershed vulnerability; forest adaptation strategies and their effectiveness, as well as strategies focused on increasing carbon sequestration.	1. Develop and maintain materials to address recent climate change and how it affects ecological systems and human infrastructure. 2. Develop and maintain materials to address the relationship between water and riparian forests, and conifer forest watersheds and water yield to rivers, creeks, and reservoirs. 3. Provide scenario analysis analyses of plausible climate changes, and potential outcomes for riparian areas, grasslands, and forests. Use scenarios to describe potential management effects (e.g. measurable effects to riparian systems based on increased or decreased water consumption scenarios.
Objective 2: Develop outreach and education programs to disseminate information about climate change science to the public and community leaders.	1. Identify collaborative partner agencies and organizations. 2. Collaboratively develop a statewide outreach and education plan. 3. Identify appropriate resources to implement outreach and education activities.

6.8 Culture

Critical Issue Description

Human cultures and what we now call Arizona have been inter dependent for over 10,000 years. During this time, the lands in Arizona have provided human cultures with a variety of resources including shelter, building materials, wild game, water, seasonal fruits and seeds, ceremonial plants, medicines, minerals and land for farming and livestock grazing, and source of spiritual significance. Human interaction with, and dependence upon, the land will continue to be influenced by the values, practices, and understandings of diverse social groups. While there are many shared concepts, values, and practices across social groups, there are also distinct differences requiring balance, compromise, and cooperation among competing interests. While challenging, the consideration of an array of cultural values in the management of our lands represents a more holistic and profitable approach, improving interaction and collaboration among parties.

Introduction

Anthropologist Edward Tylor defined culture as a complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society"[86]. Similarly, the Merriam-Webster Dictionary (2010) defines culture as;

a) "the integrated pattern of human knowledge, belief, and behavior that depends upon the capacity for learning and transmitting knowledge to succeeding generations", and
b) "the customary beliefs, social forms, and material traits of a racial, religious, or social group."

Restoration and sustainable management of our ecosystems go beyond integrating the best available biophysical science into planning activities. They necessitate an acknowledgment that humans are inextricably connected to the natural world and a system of values. Moreover, humans have perceptions associated with the land that vary across the landscape and a diversity of cultural groups. When a cultural group develops a social attachment to a specific location (i.e., a sense of place), they are more likely to have an opinion on and concern for ecological management in that area.

"Landscapes are the symbolic environments created by human acts of conferring meaning to nature and the environment, of giving the environment definition and form from a particular angle of vision and through a special filter of values and beliefs. Every landscape is a symbolic environment. These landscapes reflect out self-definitions that are grounded in culture ... any physical place has the potential to embody multiple landscapes, each of which is grounded in cultural definitions of those who encounter that place. Every river is more than just a one river. Every rock is more than just one rock.[87]"

It is important to recognize variability across cultural norms, individual practice, and group action. Many groups (e.g., Native American, Hispanic, Asian, African American, and Pacific Islander) should be considered and engaged when developing land management policies and activities. No single analysis can provide a comprehensive review of all variables associated with the formation and expression of cultural attributes.

[86] Tylor, 1874. Primitive culture: researches into the development of mythology, philosophy, religion, art, and custom. Vol. 1.
[87] Greider, T. and L. Garkovich. 1994. Landscapes: The social construction of nature and the environment. Rural Sociology. 59(1):1, È24.

Key Elements

- Human interaction with Arizona's landscapes will continue to be influenced by a variety of values, norms, and understandings held by diverse cultural groups.
- Arizona's demographic constitution is continually changing.
- While some social traits crosscut cultural groups, land managers must recognize and consider social differences that require a balanced approach.
- Land managers need to develop comprehensive strategies to address the demands of a growing population and changing demographics.
- Land managing agencies develop and maintain unique relationships with various cultural groups (e.g., Native American tribes, Hispanic communities), each of which may desire access to managed lands for contemporary and traditional use. Different parties may have dissimilar rights, responsibilities, and relationships, calling for a nuanced approach to land management.
- Many of the Southwest's Native American Communities maintain traditional and contemporary ties to areas across Arizona.
- This document provides:
    - An opportunity to work collaboratively in developing and implementing a regional approach involving tribes that is inclusive of tribal culture and their traditional and reservation lands.
    - An opportunity for tribes who consult and interact with other natural resource agencies to identify important landscapes and crucial issues.
    - An opportunity to provide consistency in planning information and coordination while involving tribes in the process.
- Information on cultural resources and surveys is maintained electronically on the AZSITE database, by federal land managing agencies, and at Tribal cultural resources management offices, but they do bot distribute this information. They recommend individual consultation with appropriate groups prior to beginning any ground disturbing activity.
- The National Park Service Bulletin No. 38 provides guidance for identifying and evaluating traditional cultural properties. This effort should only be conducted in close collaboration with the traditional cultures of the area.

Benefits, Threats, and Impacts

Integration of cultural values into the management of Arizona's natural resources is key to creating and maintaining healthy ecosystems. Failure to acknowledge and consider traditional cultural values can threaten or harm both relationships and resources. Examples include:

- Reduction in communication and increase in misunderstanding.
- Obstacles in meeting management goals, objectives, and proposed activities.
- Imbalanced access for cultural groups and the greater public.
- Increased tension between stakeholders.
- Reduction in agency credibility and collaboration.
- Improper or unsustainable use of resources.
- Missed opportunities for broader and more accurate interpretation.
- Introduction of legal consequences and civil liability.

Demographic Patterns and Trends

With Arizona's changing demographics, it is essential that land managers understand how various communities and social groups interact with the lands under their care.

Arizona's 2017 population was estimated to be more than 7 million. This represents a 9.8 percent increase from 2010. As of 2017, the largest census defined group in Arizona is Caucasians (54.9 percent) and the fastest growing group is Hispanic/Latino (31.4 percent). Native American populations currently comprise about 5.3 percent of Arizona's total population. Although indigenous populations are increasing, their representative proportion is consistently outpaced and shrinking[88].

The development of management policies and practices to address diverse cultural needs also requires acknowledging other demographic variables, such as age and gender, which intersect with culture.

In 2017, individuals under the age of 18 represented 23.3 percent of Arizona's population while those 65 years and older represented 17.1 percent. Arizona is shifting to an older population more rapidly than as estimated in the early 2000's.

Past and Present Land Use Trends in Arizona

During the Late Pleistocene, beginning roughly 12,000 years ago, the Southwest was much cooler and wetter than it is today. Tribes of nomadic hunter-gatherers, known as Paleo-Indians, occupied the region. Around 9,500 years ago, the environment changed and people adapted by expanding their resource base and changing into a lifestyle archaeologists call the Archaic. Approximately 2,000 years ago, sedentary cultures arose and agricultural crops, such as maize, beans, and squash became increasingly important to the Native American diet.

Spanish arrival in the Southwest during the sixteenth century initiated further dramatic change. Led first by Coronado, they explored the region, encountering, trading, and feuding with Native American tribes, such as the Zuni and Hopi. This was followed by two centuries of Spanish rule, which introduced new concepts to the area such as Christianity, taxes, and exotic goods (e.g., horses, metal knives, and livestock). Eventually, Spanish rule of the Southwest was replaced by Mexican rule. To encourage settlement, both the Spanish and Mexican governments provided large land assignments (grants of land) to potential settlers, which contrasted Native American perspectives of a shared use of the landscape[89].

The arrival of Anglo-Americans to the Southwest and Arizona in the late 1800s resulted in a third infusion to the existing Native American and Spanish-American cultural groups. "Beneath the three major cultural groups existed a diverse subcultural pattern, with each subgroup maintaining a remarkable degree of integrity exemplified by language, religion, art, and occupation."[90]

After the Civil War, railroad routes were constructed extensively across the Southwest. The railroad facilitated the establishment of industries such as mining, ranching, farming, and timber harvesting[91]." For decades, these sectors provided the foundation for employment upon which the state's predominantly

[88] United States Census Bureau, Quick Facts: Arizona, https://www.census.gov/quickfacts/fact/table/az/PST045217

[89] Baker, Robert, Maxwell, R., Treat, V., & Dethloff, H. 1998. A Timeless Heritage: A History of the Forest Service in the Southwest.

[90] *Id. 88.*

[91] *Id. 88.*

rural economy was based[92]". “Timber production in Arizona and New Mexico, estimated at some 8 million board feet in 1879 rose to ... 67 million in 1900. Cattle grazed open ranges of the forests ... estimated at 172,000 head in 1880, increased to over 1.5 million by 1890"[93]. These industries contributed to the development of specific values and lifestyles of people living off the land[94]. "The legacies of Spanish, Mexican, Indian, mining, and cattle eras are not just romanticism or myth but social and cultural patterns that are very much alive and real. Since World War II, a new dimension has been superimposed on the older social and economic patterns. Arizona and New Mexico have developed modern urban centers where high-tech and high-style dwell in strangely comfortable juxtaposition with the pueblo, the herding village, the mining town, and the wilderness"[95].

It was clear, however, that unregulated use of the Southwest's natural resources was resulting in degraded ecosystems. In 1891, Congress authorized President Harrison, under the Creative Act of 1891, to designate areas of the public domain as forest reserves to preserve timber and protect watersheds, eventually becoming national forests[96]. The creation of reserves and subsequent national forests did not end the mismanagement of ecosystems. On the contrary, balancing the numerous demands for publicly owned federal and private lands continues to be an uphill struggle, including issues such as management of wilderness areas, wildlife refuges, and research areas; keeping track of land boundaries; and controlling the use of natural resources, such as forage, timber, mineral, wildlife, water, and soil.

Of equal importance and just as challenging for land managers has been the role of private lands and their relationship with public lands. One specific challenge from the past was "those who owned private lands controlled the use of much of the adjoining public lands by their presence and their actions. For example, in northern Arizona, the exclusive possession of small scattered parcels of land with springs and wells on them effectually provided control of large tracts of adjacent dry land"[97]. Today, however, studies are showing that extractive uses on our public lands are in decline and being replaced by non-consumptive uses, such as recreation, tourism, service related industries, and restoration[98].

While this trend is generally common across the state of Arizona, there are still numerous exceptions. For example, uranium mining, while controversial, continues to be important to the economic and social framework of the Kaibab National Forest and surrounding communities[99]. Livestock grazing continues across many of Arizona's ecosystems and ownership boundaries. However, the number of permitted allotments on federal land has been in decline across the state. The Coronado National Forest indicates, "socially, a critical mass of ranches is needed to support the infrastructure, markets, and human relationships that keep ranch culture and industry alive. The future of this industry may lie in conservation ranching, carbon sequestration and emerging demands for grass-fed beef and locally produced food"[100].

Finally, it should be recognized that many individuals who worked as natural resource land managers have been Caucasian. As a result, much of the policy, management, and use of our natural resources have been

[92] Coconino National Forest, 2008. Economic and Social Sustainability Assessment. USDA Forest Service.
[93] *Id. 88.*
[94] Prescott National Forest, 2008. Economic and Social Sustainability Assessment. USDA Forest Service.
[95] *Id. 88.*
[96] *Id. 88.*
[97] *Id. 88.*
[98] Apache-Sitgreaves National Forest, 2009. Economic and Social Sustainability Assessment. USDA Forest Service.
[99] Kaibab National Forest, 2008. Social and Economic Sustainability Report. USDA Forest Service.
[100] Coronado National Forest, 2008. Social and Economic Sustainability Report. USDA Forest Service.

based on values and beliefs of white, rural America[101]. Today, land management agencies have recognized the need to structure their workforce to more effectively address the varied cultural uses and values of forests. As we move into the future, we must continue to create more opportunities for incorporating the values and beliefs of a changing population into the management of our public lands whether as a moral imperative or as directives.

Native Americans

Arizona is home to 21 federally recognized Native American tribes/nations. Collectively, they own approximately 33,716 square miles of land, which is more than one-fourth of Arizona's land mass[102].

Native Americans are recognized U.S. citizens and entitled to all of the legal rights and protections guaranteed by the Constitution. Additionally, federally recognized tribes are granted legal status by the U.S. Government as sovereign dependent nations. Federal legislation has also provided the tribes with government-to-government relationship status; rights for fishing, hunting, water use, and gaming operations; and protection of religious freedom, cultural resources, and sacred sites. Examples of legislation authorizing these rights are; National Environmental Policy Act, National Indian Forest Resources Management Act, Tribal Forest Protection Act, and Archeological Resources Protection Act.

While many of Arizona's tribes share similar perspectives on forest-related issues, they also have unique beliefs and values. There are also times when tribal values and beliefs can differ from traditional western perspectives.

"Traditional tribal values typically do not make a distinction between what is secular and what is religious. Those values are intertwined as a foundation of their culture and beliefs. Traditionalists perceive all actions and events as inter-related and believe that individuals have personal responsibilities to perpetuate all life and the harmony of the universe. Many places and sites on the Forest are considered "traditional cultural properties" that are formally recognized as physical manifestations of the values and beliefs that give tribal people their identity as a people. These special places are a living cultural landscape that are testaments to the tribal histories, values, and beliefs that must be sustained if their cultures are to survive into the future.[103]"

"The power of the supernatural is inherent in all of nature including mountains, plants, and animals, all of which are interdependent. Reciprocity regulates the persisting relationships between humans and all other beings. Sacred places may be places of prayer, places to collect material for ceremonies, places to gather medicine are places to carry out other privileged, sensitive, or confidential activities, which cannot be shored with the uninitiated. Visual aspects may in themselves be sacred. The responsibility to respect these sacred places is inherent in tribal belief systems.[104]"

"The concept of sacredness tends to conjure up thoughts of religion in the non-Indian, western mind. The term "religion," however, does not have the same meaning as in the non-Indian world; it has been adopted and used because it is the closest word we (the non-Indian, western, dominant society) have that Indian people can use when they try to explain to us their relationship with the land.[105]"

[101] Johnson, Cassandra and English, D.B.K. 2007. Visitor Diversity on National Forests-How Should Mangers Respond? In Kruger, Linda., Mazza, Rhonda., Lawrence, Kelly. (Eds.), Proceedings: National Workshop on Recreation Research and Management. USDA Forest Service Pacific Northwest Research Station. http://www.treesearch.fs.fed.us/pubs/27600

[102] University of Arizona Economic Development Research Program. Arizona Native American Tribes. Retrieved June 18, 2010, available at: http://edrp.arid.arizona.edu/tribes.html

[103] Coconino National Forest, 2008. Economic and Social Sustainability Assessment. USDA Forest Service.

[104] Apache-Sitgreaves National Forest, 2009. Economic and Social Sustainability Assessment. USDA Forest Service.

[105] Toupal, Rebecca. 2003. Cultural Landscapes as a Methodology for Understanding Natural Resource Management Impacts in the Western United States. Journal of Conservation Ecology. 7 (1): 12. http://www.consecol.org/vol7/iss1/art12

Land managers and other stakeholders interested in working with tribes must develop an accurate understanding of and respect for tribal protocols and culture. It is equally important to continuously involve tribes in "planning, implementing and monitoring" activities affecting natural resources they have identified as a concern[106]. At a 2004 forum hosted by the Coronado National Forest, tribal representatives requested more traditional knowledge be integrated into forest decision and planning processes more often, that greater attention is paid to privacy issues associated with cultural resources, and that resource issues of mutual concern be addressed through greater collaboration[107]. Other topics identified by tribes as important forest issues include, but are not limited to:

- Access to federal lands to gather traditional materials.
- Impact to special places because of Arizona's growing population.
- Restoration and maintenance of native plants used by the various tribes
- Communication between the tribes and land managers regarding agency jurisdiction, permitting, and policy.
- Advance notification about forest management activities, such as thinning and burning.

Hispanics

The Office of Management and Budget defines Hispanic and Latino individuals "as a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race"[108]. Hispanics are the largest and fastest-growing demographic group in the United States and Arizona[109]. As a result, new demands are placed on resources and land managers to acknowledge, accommodate, and incorporate a wider range of values and activities[110].

A recent report by the USFS Pacific Northwest Research Station indicated, "ethnic minorities have little awareness of the recreation opportunities available to them on public lands. Few understand the differences between the many federal, state, and local areas and managing agencies. Better information is needed to facilitate greater participation by these groups. Efforts such as multilingual materials and reaching out through community groups are necessary to deliver the needed information to the minority populations[111]."

Research from federal land management agencies in Arizona suggests adoption of the following strategies to help meet the needs of both land managers and the greater Hispanic community:

- Include facilities that can accommodate larger family groups.
- Plan or facilitate activities for multigenerational groups.
- Incorporate Spanish into printed material.

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[106] Alcoze, Thom. 2003. First Peoples in the Pines: Historical Ecology of Humans and Ponderosas. Friederici, Peter. (Ed). Ecological Restoration of Southwestern Ponderosa Pine Forests. Society for Ecological Restoration. Island Press.

[107] Coconino National Forest, 2008. Economic and Social Sustainability Assessment. USDA Forest Service.

[108] Grieco, Elizabeth M. and Rachel C. Cassidy, "Overview of Race and Hispanic Origin: 2000," Census 2000 Brief (Washington. Available at: http://www.census.gov/prod/2001pubs/cenbr01-1.pdf

[109] U.S. Census Bureau Press Release. 2008. Bernstein, Robert. U.S Hispanic Population Surpasses 45 Million Now 15 Percent of Total. http://www.census.gov/PressRelease/www/releases/archives/population/011910.html

[110] Stephen F. McCool and Linda E. Kruger, Human Migration and Natural Resources: Implications for Land Managers and Challenges for Researchers, USDA, 2003, https://www.fs.fed.us/pnw/pubs/pnw_gtr580.pdf

[111] Northwest Forest Plan—the first 10 years (1994–2003): Socioeconomic monitoring of the Okanogan-Wenatchee National Forest and five local communities, by C. Dillingham et.al., 2008., https://www.fs.usda.gov/treesearch/pubs/30458

- Employ Spanish speakers.
- Communicate with Hispanic community leaders.

The Intersection of Cultural Resources and Forest Resources

A primary management activity in Arizona that continues to gain momentum is the restoration of

overstocked stands of ponderosa pine that are at risk for crown fires. The restoration process requires the use of mechanical equipment to harvest small-diameter trees as well the application of prescribed fire to restore key ecosystem processes. An ongoing challenge for forest managers is establishing an understanding of and support for restoration-based activities among various cultural groups. For example, research indicates that many individuals understand and support the use of fire to maintain ecosystem health, yet are still concerned about the smoke generated from prescribed or natural fires[112]. Another example involves homeowners who live near forests and object to forest restoration activities[113]. As restoration treatments grow in frequency and scale, land managers will have to engage a more diverse group of stakeholders.

Arizona's growing population has brought more people into outlying, forest-adjacent areas, where they live in close proximity to longtime residents. Differences in values, perceptions, and lifestyles can be a source of tension. For example, a study funded by the Prescott National Forest found that "Newer residents were perceived not to appreciate issues about water, fire

City of Flagstaff Open Space Program

Picture Canyon Natural and Cultural Preserve is 478 acres of land sheltering nearly 800 petroglyphs, Northern Sinagua habitation sites, and other culturally significant artifacts. In 2012, the City of Flagstaff obtained Picture Canyon from State Trust land expressly to set it aside as designated open space for educational and recreational purposes. The city of Flagstaff's Open Space Program has worked with local partners to restore the natural and cultural integrity of the Preserve, host volunteer events, education the public about the importance of the area, and provide outdoor recreational. Accomplishments include restoring the riparian habitat of the Rio de Flag, refurbish or decommission trails, roads and a bridge, launch a Site Steward program at the Preserve, install interpretive signs, and provide guided tours. The award recognizes The City of Flagstaff's Open Space Program received a Government Agency award for providing and supporting volunteer efforts, partnerships and public education programming to preserve the archaeological, historical, and natural resources at Picture Canyon Natural and Cultural Preserve.

[112] Bowie, James. 2009. City of Flagstaff Citizen Survey. http://www.flagstaff.az.gov/DocumentView.aspx?DID=9188
[113] *Id. 110.*

susceptibility, and other environmental characteristics. Others were perceived to lack a land ethic that was often taught as part of the experience of growing up in these rural communities."

Some individuals, groups, and corporations are concerned about dwindling availability of land for new development. For example, a focus group study conducted by the Prescott National Forest revealed that "Some citizens in local communities have expressed concerns to the PNF for retaining National Forest lands within or adjacent to their communities to prevent development and retain open space. Verde Valley citizens want to retain the view sheds around their area as unchanged." [114]

Shifting demographics changes can contribute to social divisions based on personal connections to the landscape. While one person sees the forest as a place of peaceful reflection, another may come from a tradition of hunting. For example, "Many newer migrants and visitors place higher importance on aesthetic values and recreation while potentially lacking the historical and cultural connection to a working landscape characteristic of farmers, ranchers, and loggers". And " ... there exists a deep historical conflict among competing values that has resulted in an 'us against them' orientation where farmers, ranchers, loggers and miners view themselves as under siege from the new urban driven environmentalists.[115]"

Focus Areas and Priority Landscapes

Land managers need to develop comprehensive strategies to address the demands of growing population, demographic changes, and socially defined competition for access to forest and other ecosystems. This includes the recognition and acknowledgment of various forest users and uses, values and perceptions, socio-economic interactions, as well as developing increased collaboration among various stakeholders. "We must continue to understand what people care about and why, as well as how forests are viewed, valued, and being used by a changing public...forests and parks should be managed for all Americans to learn about, appreciate, and enjoy the natural environment and cultural resources. It is essential to remain relevant to current and future generations and encourage everyone to appreciate and support these wild places".

Cultural Resources

Issue Assessment

A primary management activity in Arizona that continues to be problematic is the challenge of balancing ecosystem health goals and objectives with the protection of archaeological resources. Fairley explains, "Archaeological resources are a particularly vulnerable part of the story because they are embedded in the very land that is threatened by wildfires and expanding residential and commercial uses[116] ". Not only do these resources help us understand past cultural uses and perspectives of the landscape, but they also

[114] Prescott National Forest, 2008. Economic and Social Sustainability Assessment. USDA Forest Service.

[115] Alm, L.R., Witt, S. 1996. The rural-urban environmental conflict in the American West: a four-state study. Spectrum: Journal of State Government. Fall: 26–36

[116] Fairley, Helen. 2003. Restoration and Cultural Resources. Friederici, Peter. (Ed). Ecological Restoration of Southwestern Ponderosa Pine Forests. Society for Ecological Restoration. Island Press.

serve as important physical and spiritual landmarks for many Native American tribes and other cultural groups.

Cultural resources can be defined *as physical evidence or place of past human activity: site, object, landscape, structure; or a site, structure, landscape, object or natural feature of significance to a group of people traditionally associated with it.*

Types of cultural resources in Arizona include:

- Archaeological resources: The remains of past human activity and records documenting the scientific analysis of these remains.
- Historic structures: Material assemblages that extend the limits of human capability.
- Cultural landscapes: Settings we have created in the natural world.
- Ethnographic resources: Sites, structures, landscapes, objects or natural features of significance to a traditionally associated group of people.

Background

Cultural resource management (CRM) can trace its beginning to the environment/conservation movement in the 1960s and 1970s.[117] In 1966, the National Historic Preservation Act (NHPA) was passed so cultural resources would be protected from damage caused by the actions of federal agencies. Because of the NHPA, the State of Arizona established the State Historic Preservation Act (SHPA) in 1982 to protect cultural resources from the activities of state agencies. During this time, the Archaeological and Historic Preservation Act of 1974 helped to fuel the creation of CRM, while creating "growth in archaeological jobs in the federal government, academia, and private sector."[118]

Federal legislation had passed earlier in 1906 under the Antiquities Act, but it was not until the 1970s when the National Park Service coined the term "cultural resources". This term came into more popular usage in 1974 after the Cultural Resource Management conference and the Airlie House conference.[119] Following these conferences, the National Park Service defined cultural resources in the Cultural Resource Management Guidelines as being:

> *"Those tangible and intangible aspects of cultural systems, both living and dead, that are valued by or representative of a given culture or that contain information about a culture…[They] include but are not limited to sites, structures, districts, objects, and historic documents associated with or representative of peoples, cultures, and human activities and events, either in the present or in the past. Cultural resources also can include primary written and verbal data for interpretation and understanding of those tangible resources."*[120]

Vegetation Treatments and Prescribed Fire Best Practices for Cultural Resources Management

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[117] Hutchings, Rich and Marina La Salle. 2012. Five Thoughts on Commercial Archaeology, http://www.academia.edu/3688649/Five_Thoughts_on_Commercial_Archaeology

[118] King, Thomas F. 2012. Cultural Resource Laws and Practice: An Introductory Guide (4th Edition). Altamira Press

[119] King, Thomas F. 2009. Our Unprotected Heritage: Whitewashing the Destruction of Our Cultural and Natural Environment. Left Coast Press.

[120] King, Thomas F. 2005. Doing Archaeology: A Cultural Resource Management Perspective. Left Coast Press, https://escholarship.org/uc/item/8sw0798v

Fire-sensitive Sites

A review of available literature on the effects on fire on cultural resources indicates that there are two categories of fire-sensitive sites. The first consists of sites known to be vulnerable to the effects of even low-temperature fires and/or light fuel loads, such as sites that contain organic materials, exposed wooden architecture, etc. The second group includes sites that have been considered less risk for fire effects in most situations, including prehistoric and historic sites with deeply buried cultural deposits; prehistoric and historic artifact scatters; and prehistoric and historic sites with non-flammable surface features. However, depending on field conditions, especially fuel loading, as well as specific site characteristics and expected fire behavior, these other site types may be fire-sensitive in certain fuels reduction projects.

Known Fire-Sensitive Site Types in Arizona:

- Historic sites with standing, or down wooden structures or other flammable features or artifacts.
- Rock art sites (depending on rock type, exposure, fuel type, and fuel loading)
- Cliff dwellings
- Prehistoric sites with flammable architectural elements and other flammable features or artifacts
- Prehistoric sites with exposed building stone of soft or porous material such as volcanic tuff
- Culturally modified trees, including aspen art and peeled/scarred trees
- Certain traditional cultural properties (based on consultation with tribes)

Other Project-Specific Fire-Sensitive Sites:

- Other sites, based on local field conditions and Forest-specific concerns
- Sites based on consultation with Tribal representatives
- Sites based on consultation with SHPO staff
- Sites based on consultation with fire management staff, fire behavior specialists or fire effects researchers

Cultural Resource PA

The Arizona Association of Conservation Districts (AACD) and the BLM are facilitating a working group to create a Cultural Resource Programmatic Agreement to identify common sense programmatic approaches that will ensure timely and cost-effective implementation of critical conservation work, while preserving Arizona's rich history and traditions, and our important cultural resources. This AACD effort, with the support of Arizona's State Historic Preservation Officer, and funding support from the BLM, will bring together key agricultural producers, state and field level agency staff, NEPA specialists, tribal representatives, and archeologists to help identify issues and solutions.

Agency cultural resource specialists will use site assessment and monitoring data, and will consult with fire management staff, to identify known and other project-specific fire-sensitive sites for individual project areas. Fire-sensitive sites officially determined not eligible for the National Register of Historic

Places do not require protection under Section 106. There may be other reasons for protecting the site; those are not explored in this document.

Standard Protection Measures

Various combinations of the following protection measures may be employed by agency personnel to

protect sites within fuels reduction projects. Agency personnel should also consult with SHPO to ensure that projects comply with State laws such as the Arizona State Historic Preservation Act.

- Prescribed burning
- Protect fire-sensitive sites:
- Exclude from project area
- Hand line
- Black line
- Wet line
- Foam retardant
- Structural fire shelter
- Remove heavy fuels from site by hand thinning
- Prevent in-situ heavy fuels that cannot be removed from ignition (e.g., flush-cut & bury stumps)
- Implement same protective measures for future maintenance burns
- Remove vegetation and tree limbs near petroglyph or pictograph sites

Protect selected other sites (option)

- Allow burning over sites without fire sensitive features or materials:
- No slash piles within site boundaries
- No ignition points within site boundaries
- No staging of equipment within site boundaries
- Allow construction of safety zones and additional lines in 100% of surveyed areas, with archaeological monitoring to ensure recorded sites are avoided.

Thinning

No thinning within site boundaries -or- allow thinning within site boundaries, provided:

- Cutting is accomplished using hand tools only
- Large diameter trees are felled away from all features
- Thinned material is hand carried outside site boundary
- No use of mechanized equipment within site boundaries
- No staging of equipment within site boundaries
- Fuelwood sales
- No fuelwood cutting or vehicles within site boundaries -or-
- Allow fuelwood cutting within sites, but do not allow vehicles within site boundaries
- Allow fuelwood cutting in areas of continuous, low-density scatters, with post-project monitoring

Post-treatment Protection Measures

In some cases, cultural resources may be impacted indirectly because of vegetation treatments and prescribed fire. Examples may include increased sheet erosion, which may displace artifacts or damage site features. Vegetation treatments may also increase the chances of cultural resources sustaining human impacts due to exposure of artifacts and site features. Cultural resources are particularly vulnerable to erosion during the first monsoon event after treatment. Various combinations of the following protection measures may be employed to minimize indirect effects.

Agency cultural specialist may conduct post-treatment site visits to assess potential of indirect effects.

Agency cultural specialist may consider protecting sites from sheet erosion by:

- Cross-falling trees upslope from a cultural resource
- Application of mulch and re-seeding with native grasses and forbs
- Installation of geo-textile cloth along arroyo and drainage edges (e.g., when a site is situated along the edge of an arroyo, the geotextile cloth can prevent the wall of the drainage being blown out during the first monsoonal event, which usually contains the greatest hydraulic forces).

Agency cultural specialist may consider protecting sites from human-sustained impacts by:

- Restricting access by installing physical barriers (natural existing materials are best, such as strategically placed boulders)
- Temporary closure of roads and trails until the treatment area is reclaimed by natural vegetation (which reduces exposure)
- Signage
- Periodic monitoring
- Periodic law enforcement patrol

Benefits, Threats, and Impacts

Benefits

- Historic and archaeological properties are tangible reminders of the people and events that molded our state.
- Archaeological sites hold the clues to 12,000 years of culture, land use, settlement, and exploration.
- Historic buildings provide character and a sense of continuity for our communities.
- Arizona's unique historic and archeological resources attract tourists from all over the world.

Threats

- Expanding population.
- Road building.
- Recreation.
- Vandalism and artifact looting.
- Natural Resource Management (fence building, fuels treatments, logging)
- Any ground disturbing activities.

Impacts

- Loss of prehistoric and/or historic properties.
- Destruction of archeological/sacred sites.
- Gentrification of culturally significant areas.
- Loss of individual connection to past ancestors.

Resources -Existing and Needed

Existing Resources

- Tribal governments have staff that can help define and address this issue.
- Federal and State land management agencies have existing staff dedicated to the management of cultural resources.
- Arizona State Historic Preservation Office (SHPO)
- Governor's Office on Tribal Relations
- Bureau of Indian Affairs (BIA)
- Chicanos Por La Causa

Resource Needs

- Data from multiple entities about management needs and strategies to address and preserve those culturally significant values associated with forested landscapes across the state.
- Better information and education from multiple entities about the various cultural values and their relationships with forest and other land management activities.

Key Partners & Stakeholders

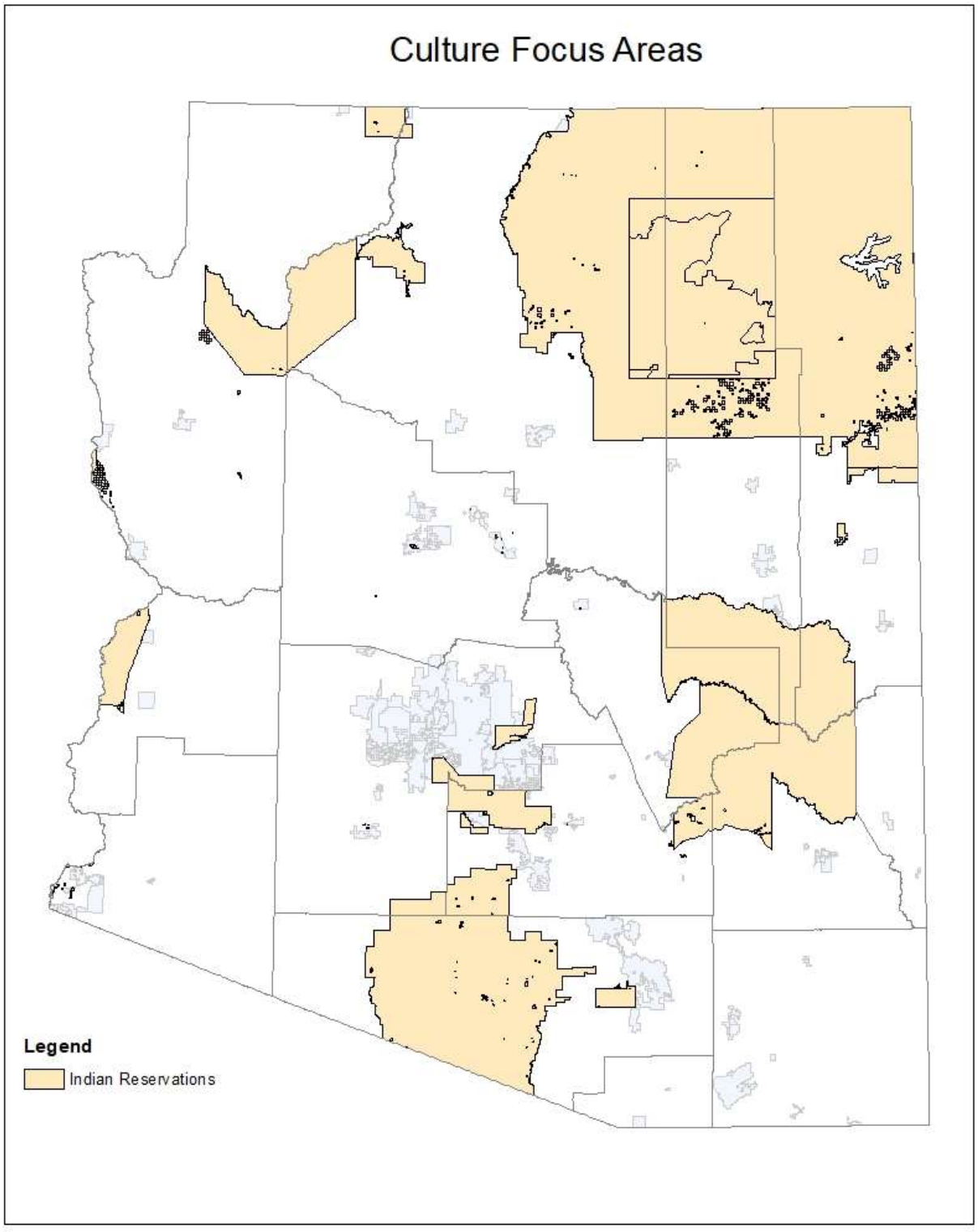
Many of the partners and stakeholders listed below have a potential role in supporting implementation of this strategy. A few entities stand out as being critical to success:

- Tribal governments within Arizona
- Key state agencies (e.g., State Historic Preservation Office, Governor's Office on Tribal Relations)
- Bureau of Indian Affairs (BIA)

Priority Areas

Criteria used to define priority areas, or identify additional priority areas, include:

- Areas within Tribal boundaries (reservations).
- Currently known and to be discovered cultural sites (includes State Historic Preservation Office and State Museum process).
- Landscapes where various cultural groups indicate a specific attachment or desire to be consulted on management issues and actions
- Areas defined by the mapping of Terrestrial Ecoregions Level Ill -Arizona, where scientific information indicates high priority ecosystems


Culture Focus Areas
Legend
Indian Reservations

Goals, Objectives, and Actions

The Strategy Team identified two (2) goals, five (5) objectives, and thirteen (13) action items for Culture. The goals were designed to:

- Improve communication between all land management agencies, tribes, and other cultural groups
- Develop effective collaborative mechanisms for sharing resources, priorities, policies, and management strategies.

The objectives are designed to:

- Build trust, communication networks, and problem-solving strategies among land management agencies and cultural groups
- Improve and develop a broader understanding of various cultures' perspectives as they relate to natural resource issues and land management decisions
- Educate people involved in land management activities about the role and importance of cultural perspectives in the planning and decision-making process
- Where appropriate, share data and implementation strategies to leverage successful outcomes
- Improve information sharing about available resources to address the needs of Native American tribes/nations and other cultural groups in Arizona.

Goal 1: Improved communication between all land management agencies, indigenous tribes, and other cultural groups about varying perspectives and beliefs related to forests, trees, and other natural resources.

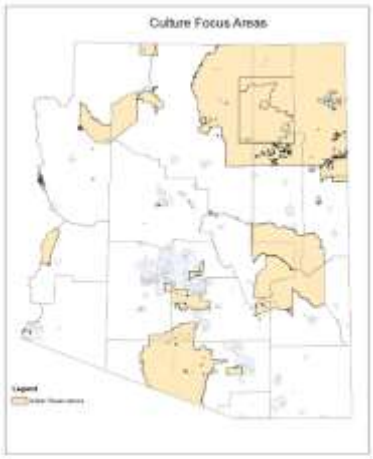
Objective 1: Build trust, communication networks, and problem-solving strategies between land management agencies, communities, and stakeholders about the diverse cultural perspectives of forest users and Indigenous Tribes,	• Develop adequate tribal liaison staffing within the state and federal natural resource agencies to facilitate the ability to address the cultural perspectives associated with the management and protection of forest resources. • Facilitate the development of appropriately structured work groups to share information and develop strategies to identify, protect and address cultural issues associated with forested lands and their management. • Develop a monitoring system to ascertain the effectiveness of strategies developed above. Utilize adaptive management to ensure forest management policy and planning integrates the needs of the state's changing demographics.
Objective 2: Improve broader understanding of various cultural perspectives as they relate to forest resources, fire management, and other natural resource issues.	• Encourage and facilitate improved information sharing by indigenous tribes and diverse cultural groups to inform others about varying natural resource perspectives. • Expand research on how various cultural groups perceive and interact with the state's forests, trees, and other natural resources, including the urban forest environment.
Objective 3: Educate the public, government officials, and community leaders about the role and importance of cultural perspectives in restoration, sustainable forest and wood products businesses, fire management, and community protection needs and responsibilities.	• Develop and implement an education program for local, state and federal government decision makers, schools, and others about the importance of culture in the forested environment, including the urban forest environment. • Identify appropriate human and fiscal resources to effectively accomplish public outreach.

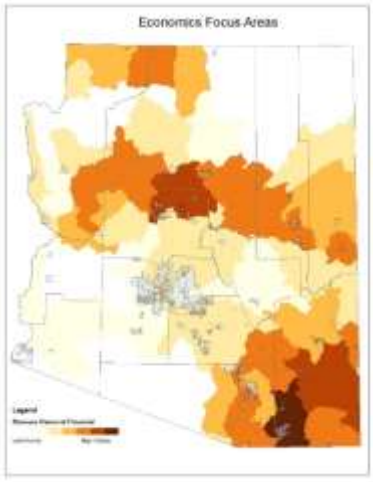
Goal 2: Effective collaboration mechanisms for sharing of information about resources, priorities, policies, and management strategies between Tribes and non-Tribal organizations.

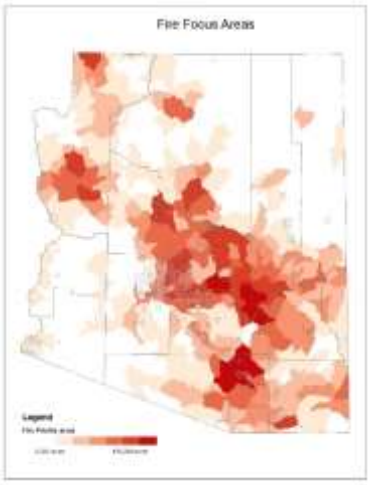
Objective 1: Where appropriate, share data and implementation strategies to leverage successful outcomes on tribal and adjacent lands with similar management objectives.	• Enhance collaborative approaches to collection and sharing of data, utilizing existing planning models, leveraging funding sources, and sharing implementation opportunities. • Recognize or encourage BIA and Tribal management plans and implementation strategies that take an all-lands or collaborative approach. • Promote development of management plans that are sensitive to culturally significant areas, traditional uses and accessibility to diverse groups (public lands, lands with conservation easements, etc.) • Recognize and communicate tribal implementation of NEPA processes when undertaking forestland management and integrated resource planning.
Objective 2: Improve information sharing about available resources to address needs of indigenous tribes and other Cultural groups in Arizona.	• Coordinate collaborative outreach efforts to share information about federal and state resources and programs available to tribes and varying cultural groups. • Evaluate the need for non-traditional materials and other strategies to improve communication and message delivery.

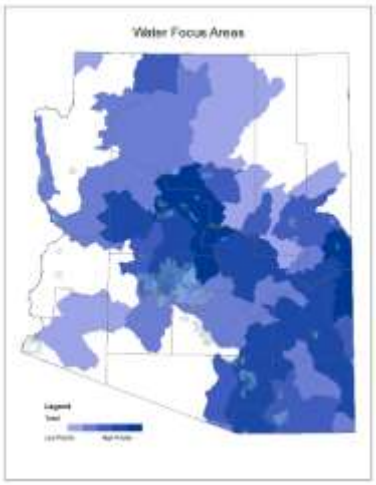
7.0 Arizona Priority Areas

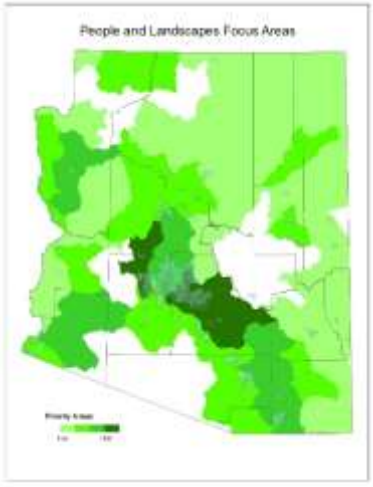
Specific resource issues for Arizona were identified and explored in section 6 above. Several crosscutting statewide themes were identified and eight issue maps were developed to identify focus areas for the eight specific topics. These focus area maps are a starting point. They will be used to help communicate possible implications of issues and actions, as an aid in developing needed strategies, and as a tool to identify synergistic opportunities to leverage resources. These maps were revised for this update and will continue to be updated over time as better information is gathered and evaluated.

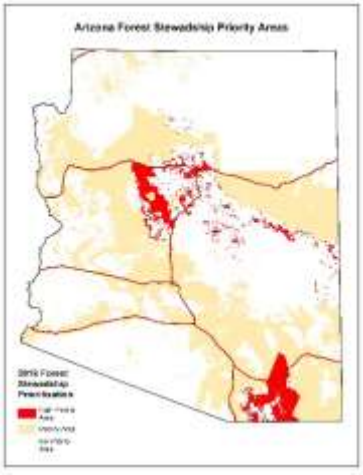












8.0 Collaboration Across Landscapes

For decades, land managers in Arizona have worked in collaboration to reduce impacts to natural resources and improve conditions across the state. When the 2008 Farm Bill asked the states to assess forest conditions and develop strategies to address impacts and threats, we found it was only natural to make it a collaborative effort. With the expansion of the scope of this update to all lands, we broaden this collaborative effort to include even more entities.

This comes at an ideal time since other agencies, federal and state, are embarking on similar collaborative efforts. Take for example the 2014 Farm Bill; it gave the Forest Service tools to get more work done on the ground (e.g. the Good Neighbor Authority or GNA). As of June 2018, the Forest Service has signed 163 GNA agreements on 59 national forests in 25 States to complete a variety of restoration activities. The 2018 omnibus bill further expanded the GNA and other authorities, enabling more work across boundaries.

The National Resource Conservation Service (NRCS) also has a program to foster collaboration across ownership boundaries called the Regional Conservation Partnership Program (RCPP). The RCPP brings together a wide array of local and national partners, including Native American tribes/nations, nonprofit organizations, state and local governments, private industry, conservation districts, water districts, universities and many others to complete conservation activities in selected priority areas. The RCPP is a platform for partners to engage with organizations that, while they may share common resource stewardship goals, may not have experience working with farmers, ranchers, and landowners in a given community. So far, more than 2,000 partners are engaged in locally led conservation efforts through the RCPP.

The Arizona Conservation Partnership (ACP) is comprised of 12 state and federal agencies collaborating over a multitude of issues. ACP provides a framework for accomplishing landscape scale conservation work using a collaborative approach that will maintain, restore and enhance Arizona's economic and environmental quality of life. The partnership will provide leadership, and encourage collaboration, information sharing and coordinated action for the benefit of Arizona's citizens and visitors. The group's main goal is to help local organizations get funding for projects by bringing them into contact with different agencies.

A steady increase in collaboration capacity and recent breakthroughs in science, mapping, and technology are providing new tools for planning investments to reduce threats and improve conditions. These new authorities and advances in technology will be implemented by:

- Working to set priorities and co-manage risk across broad landscapes. The most effective approach to management is shared stewardship of the environment, shared ownership of the challenges presented, and a shared commitment to meeting those challenges. As the scale of natural resource issues grows the scale of coordinated planning needs to expand accordingly. We envision each agency taking a leading role in convening stakeholders to discuss issues affecting the environment. The FAP can provide guidelines for coordinating activities across jurisdictional boundaries.
- Using new tools to conduct targeted investment planning. Advances in remote sensing, information science, simulation tools, and mapping technologies have enabled scientists to complete new national resource assessments. Based on the assessments, researchers have developed tools for evaluating risk and making land management investments at scales where

the payoffs are highest. These tools for scenario investment planning give stakeholders the science-based capacity to find opportunities for lasting improvements in land conditions by making the corresponding targeted investments.

- Focusing our work on broad outcomes. Outputs are valuable indicators of program accomplishments, but outputs alone do not tell us whether we have achieved large-scale outcomes. We envision joining partners and stakeholders to identify desired outcomes and the key performance indicators for measuring them.
- Capitalizing on the authorities created by recent legislation. The 2018 omnibus bill gave DFFM new authorities to help expedite work, including new categorical exclusions, expanded GNA, and 20-year stewardship contracting. We will use every authority we have to get more work done on the ground.
- Using all available tools for active management. We will use every authority and tool we have to do more work on the ground, including timber sales, mechanical fuel reduction treatments, and carefully managed fire, working with partners and stakeholders to choose the right tools.

All this collaboration is part of a conceptual framework for making strategic investments across landscapes for outcomes desired by all. Through shared work, state and federal agencies along with local organizations have unprecedented opportunities to co-manage risk and achieve positive outcomes at the most appropriate scales. The key is working together to convene stakeholders for planning at landscape scales. The partners can use scenario investment planning as a tool for assessing risk, evaluating the tradeoffs, and managing risk through targeted investments in areas with the highest payoffs. We envision outcomes that include resilient landscapes, flourishing communities, and fewer wasted resources.

Success will depend on taking a co-learning and co-designing approach together with partners and stakeholders. As envisioned in this document, we hope to help partners interconnect all conservation interests into a network for sustaining Arizona's natural resources into the future. We believe every agency has a role to play in helping partners and stakeholders come together to co-manage risk, use new tools to better target investments, focus on outcomes at the right scale, and recalibrate our land management system so it works better for people, both now and for generations to come.

9.0 National Priorities

The diversity of Arizona forests range from riparian gallery forest in the low elevation deserts to sub-alpine and montane forests above 9000 feet in elevation. This diversity of Arizona's landscape presents many natural resource management challenges. The fact that Arizona's forestlands cover approximately 27% of the State and are mostly managed by Federal, Tribal, and State entities presents the additional challenge for Arizona's Department of Forestry and Fire Management to deal with threats from insects and disease, urbanization, invasive species, and wildfire. It is extremely important that we work together to conserve, enhance and protect our forests and the FAP provides a foundation for this not only on forestlands but on all lands within Arizona.

To further this effort the US Forest Service and State Foresters developed three (3) national priorities and 11 objectives. This section highlights the priorities and objectives and examines how Arizona is integrating them into the FAP.

National Priorities and Objectives:

1. Conserve Working Forest Landscapes
    - 1.1 Identify and conserve high priority forest ecosystems and landscapes.
    - 1.2 Actively and sustainably, manage forests.
2. Protect Forests from Harm
    - 2.1 Restore fire-adapted lands and reduce risk of wildfire impacts.
    - 2.2 Identify, manage, and reduce threats to forest and ecosystem health.
3. Enhance Public Benefits from Trees and Forests
    - 3.1 Protect and enhance water quality and quantity.
    - 3.2 Improve air quality and conserve energy.
    - 3.3 Assist communities in planning for and reducing forest health risks.
    - 3.4 Maintain and enhance the economic benefits and values of trees and forests.
    - 3.5 Protect, conserve, and enhance wildlife and fish habitat.
    - 3.6 Connect people to trees and forests, and engage them in environmental stewardship activities.
    - 3.7 Manage trees and forests to mitigate and adapt to global climate change.

Conserve

Conserving working forests and sustainable ecosystems. Fire, insects, disease and invasive plants all act as important disturbance agents in Arizona ecosystems. Fire suppression has altered the occurrence, severity and intensity of fire. This may have contributed to increased insect and disease activity in certain forest types. Noxious weeds and invasive plants are spreading at an alarming rate, displacing native species and disrupting the normal function of ecosystems.

National Objectives	Measures
Identify and conserve high priority forest ecosystems and landscapes	# of stewardship (and practice) plans developed # of acres surveyed, treated, monitored # of prioritization maps developed
Actively and sustainably, manage forests	# of GNA agreements entered into # of grants awarded to partners # of technical assists to landowners

Protect

Reducing threats to Arizona's forestlands from wildfires, invasive species and forest pests. In addition to lives and property, Arizona wildfires threaten the forests and consequently the many benefits they provide. Proper land management can drastically decrease the risk of loss in the event of a wildfire. While prescribed fire is one example of a management tool, many people do not realize the benefits of fire. Additionally, with the increasing number of people moving to the Wildland Urban Interface (WUI) risks for catastrophic wildfire damage also increase. Research tells us that most of these people are unaware of their increased wildfire risks. Continued work to educate the public (which includes property owners, land managers, city planners, etc.) on wildfire risk mitigation and defensible space practices is needed.

National Objectives	Measures
Restore fire-adapted lands and reduce risk of wildfire impacts.	$ of funding directed to hazardous fuel reduction # of plans developed # of projects ready for implementation # of acres surveyed, treated, monitored # of communities recognized # of new and revised CWPP's % CWPP plans implemented Increased firefighter safety and fire suppression capacity
Identify, manage, and reduce threats to forest and ecosystem health	# of grants awarded to partners # of technical assists to landowners # of acres surveyed, treated, monitored # of insect and disease technical bulletins developed and distributed

Enhance

Improving the health and productivity of Arizona's natural resources. Forests provide sustainable supplies of clean water to the majority of our citizens. Maintaining healthy forest watersheds and riparian forests in rural areas and protecting forest cover in developing areas are essential to ensuring safe and available water. Climate variability, increased drought frequency and changes in precipitation patterns demand increased awareness and management of our natural resources to - protect drinking water sources, sustain stream flows, protect aquatic wildlife species and reduce sedimentation and water treatment costs.

National Objectives	Measures
Protect and enhance water quality and quantity	# of plans developed in priority watersheds # of acres surveyed, treated, monitored # of acres treated in riparian areas # of presentations given in priority areas
Improve air quality and conserve energy	# of burns conducted # of smoke management inputs into burn plans

Assist communities in planning for and reducing forest health risks	# of public service announcements # of social media posts # of grants awarded # of technical assists provided # of plans developed
Maintain and enhance the economic benefits and values of trees and forests	# of hours dedicated towards wood utilization # of acres awarded to contractors # of information sessions provided
Protect, conserve, and enhance wildlife and fish habitat	# of stewardship plans developed # of engagements with AZGFD # of grants awarded to improve habitat
Connect people to trees and forests, and engage them in environmental stewardship activities	# of UCF grants awarded # of funding awarded and leveraged # of workshops conducted # of community assists # of volunteer hours from community partners # of TCUSA communities
Manage trees and forests to mitigate and adapt to global climate change	# of plans developed with climate change threats addressed # of workshops conducted # of grants applied for and awarded

10.0 Conclusion and Next Steps

10.1 Conclusion

With the completion of the second edition of Arizona's Forest Action Plan we once again move into the beginning of the implementation phase. The FAP constitutes a road map for diverse stakeholders to collaboratively address issues and opportunities across Arizona. In the process to complete the FAP, strong and productive relationships have been forged. These working relationships constitute the foundation upon which the successful implementation of the FAP will occur.

10.2 Future Actions

A diverse collaborative body representing the jurisdictions, users, and interested parties in the landscapes across Arizona assisted in the developed the FAP. Given the impressive outcomes of this collaborative effort, the State Forester is committed to sustaining and building upon this effort going forward. A key goal will be to expand the collaborative engagement of all interested and affected entities, but especially agencies (including U.S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, Arizona State agencies, and all Tribal agencies) and organizations having jurisdictional and management responsibilities of natural resources within the state.

Plans are being formulated for the groups to continue meeting periodically to shepherd the implementation, monitoring, reporting, and adaptation of the FAP. The groups will be charged to solicit specific actions of all partners and stakeholders, to incorporate new information, and to complete the goals, objectives, and actions.

While the legislative mandate in the 2008 Farm Bill is a formal revision at five-year intervals or as required by the Secretary of Agriculture, we consider these to be dynamic and living documents where implementation will be monitored, assessed, reported, and adapted on a continuing basis. As indicated by the results of monitoring and assessment, the FAP will continue to be revised to address evolving issues and opportunities.

Appendix A-1: Glossary

Additionality	Refers to the certainty that a carbon offset results in new carbon fixation, rather than simply subsidizing "business as usual".
Afforestation	Planting seeds or trees to make a forest on land that is not forested, or which has never been a forest.
Airshed	A geographical area within which all of the down-slope air flow has a common exit location.
Amenity-based services	Ecosystem services that include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, flood, disease, wastes, and water quality; cultural services that provide recreational, aesthetic and spiritual benefits; and supporting services such as soils formation, photosynthesis and nutrient cycling.
Baseline	A set of conditions (e.g. pre-European settlement conditions, quantity of carbon sequestered) against which the conditions at a given point in time can be measured and compared.
Before present (BP)	More than 12,000 years ago.
Biomass energy	The energy embodied in organic matter ("biomass") that is released when chemical bonds are broken by microbial digestion, combustion, or decomposition. A wide range of fuels are derived from biomass, including ethanol, biodiesel, biogas, and solid biofuels such as wood, sawdust, grass cuttings, domestic refuse, charcoal, agricultural waste, non-food energy crops, and dried manure.
Biodiversity / biological diversity	Biological variety of the kind that preserves species and their DNA. R. H. Whittaker categorized it, in 1972, as alpha, the number of species in an ecosystem; beta, the diversity between ecosystems; and gamma, the diversity of entire regions. Depleted biodiversity leads to population crashes, declines in genetic variability, and extinctions.
Biotic integrity	The diversity of species and composition, as well as the overall health and intactness of ecosystems.
Biotic resilience	The ability of a biological entity, e.g. an ecosystem, to recover quickly from disruption.
Bosque	Areas of gallery forest found along the flood plains of stream and riverbanks in the southwestern United States – The name is derived from the Spanish word for woodlands.
Carbon bank or sink	Sites that absorb or store carbon.
Carbon monoxide	An odorless, very poisonous gas that is a product of incomplete combustion of carbon, which is highly toxic to humans and animals.
Carbon offset	A financial instrument aimed at a reduction in greenhouse gas emissions. Carbon offsets are measured in metric tons of carbon dioxide-equivalent (CO_2e) and may represent six primary categories of greenhouse gases.[1] One carbon offset represents the reduction of one metric ton of carbon dioxide

	or its equivalent in other greenhouse gases through carbon sequestration by, for example, a forest.
Carbon sequestration	The process of capturing carbon dioxide from the atmosphere through biological, chemical or physical processes. It has been proposed as a way to mitigate accumulation of greenhouse gases in the atmosphere, which are released by burning fossil fuels.
Capacity	The combined resources and ability of an entity to accomplish a specified goal or task – (e.g. restoration and management at a landscape scale, enhancement of an urban forestry program).
Chaparral	An evergreen shrub community adapted to dry seasons.
Chicago Climate Exchange (CCX)	CCX is North America's only voluntary, legally binding greenhouse gas (GHG) reduction and trading system for emission sources and offset projects in North America and Brazil. CCX employs independent verification, includes six greenhouse gases, and has been trading greenhouse gas emission allowances since 2003. The companies joining the exchange commit to reducing their aggregate emissions by 6% by 2010.
Class I Areas	Those areas with the highest sensitivity to air quality. Where air quality is better than the national standards, Class I allows the least increase in pollutants compared to Class II that allows more and Class III that allows the most.
Collaborative	*n.* A group of people with diverse representation from different entities (e.g. agencies, organizations, academia, etc.) that works cooperatively on a common cause. *Adj*. A method or approach to problem solving and project development.
Communities At Risk	A descriptive label for communities that is based upon their level of risk to uncharacteristic, high-intensity wildfire.
Community	An assemblage of populations living in a stated area. The extent of a community is limited only by the requirement of a uniform species composition.
Community Wildfire Protection Plans (CWPP)	A plan that evaluates local conditions and risks from wildfire, as well as fire suppression resources, and develops a plan to address all aspects of community protection and wildfire mitigation.
Dendrochronology	The study of tree rings and how they relate to our environment – oftentimes used to examine climate history.
Diversity	The relative degree of abundance of wildlife species, plant species, communities, habitats, or habitat features per unit of area.
Ecological forest restoration	The science of restoring an ecosystem to a more stable and sustainable condition in which it previously existed.
Ecoregion	An ecologically- and geographically-defined, relatively large area of land or water that contains characteristic, geographically distinct assemblages of natural communities

	and species, similar topography, geology, climate, and other environmental factors.
Ecosystem	A complete, interacting system or unit of organisms in a space considered together with their environment, e.g., a marsh, a watershed, a lake, etc. A flow of energy leads to clearly defined food and feeding relationships, biological diversity, and biogeochemical cycles (i.e., exchange of materials between living and nonliving parts) operating as an integrated system.
Ecosystem health	The ability of an ecosystem to remain productive, resilient, and stable over time, and to withstand the effects of periodic natural or human-caused stresses such as drought, insect attack, disease, climatic changes, flood, resource management practices, and resource demands.
Ecosystem integrity	The completeness of an ecosystem that, at multiple geographic and temporal scales, maintains its characteristic diversity of biological and physical components, spatial patterns, structure, and functional processes within its approximate range of historic variability. These processes include disturbance regimes, nutrient cycling, hydrologic functions, vegetation succession, and species adaptation and evolution. Ecosystems with integrity are resilient and capable of self-renewal in the presence of the cumulative effects of human and natural disturbances.
Ecosystem services	Amenities provided by ecosystems, such as food, air, water, wildlife, timber, and fiber; recreational, aesthetic and spiritual benefits; and supporting services such as soils formation, photosynthesis and nutrient cycling.
Ecotone	The transitional zone between adjacent biotic communities, often with unique nutrients and ecological relationships.
Endemic	Native or confined to a certain region; having a comparatively restricted distribution.
Epiphytic	Of plants that grow on, but are not nourished by, another plant.
Farm Bill	The Food, Conservation, and Energy Act of 2008.
Fire Regime Condition Class	An interagency, standardized tool for determining the degree of departure from reference condition vegetation, fuels and disturbance regimes - Assessment of FRCC can help guide management objectives and set priorities for treatments.
FireWise standards	Standards for building materials and structural characteristics, as well as the makeup and arrangement of vegetation and flammable materials that provide an increase in defensible space and resistance to wildfire.
Forest health	The ability of forest ecosystems to remain productive, resilient, and stable over time and to withstand the effects of periodic natural or human-caused stresses such as drought,

	insect attack, disease, climatic changes, flood, resource management practices, and resource demands.
Forest offset	A carbon offset that is provided by a forest.
Forest restoration	See “ecological forest restoration”.
Fragmentation	Interrupting the continuity of an ecosystem with roads, fences, utility corridors, clearings, and/or land use changes that reduce or compromise its value to wildlife or other uses.
Global climate change	A change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average.
Green economy	An economy that stems from activities to improve the environment (e.g. solar-powered energy production, wind-powered energy production, recycling, energy conservation, utilization of renewable energy versus fossil fuels, etc.)
Green infrastructure	Infrastructure that reduces carbon emissions including community forestry, green roofs, and parks and open space.
Heat island	A metropolis where summertime air temperatures are 3 to 8 degrees Fahrenheit warmer than the temperatures in the surrounding countryside, primarily due to increased heat absorption and storage by structures and paved areas devoid of vegetation – often described as a bubble that gets cooler as you move further from the urban core.
Impervious surface	A surface that cannot be passed through (e.g., by water or air).
Incident Command System (ICS)	A standardized, on-scene, all-hazards incident management approach that allows for the integration of facilities, equipment, personnel, procedures, and communications and operates within a common organizational structure and processes.
Landscape	A large geographical area that may span considerable variation in topography, watersheds, flora and fauna, land use and jurisdictions.
Landscape ecology	The study of spatial and temporal variety (heterogeneity) in the structure, dynamics, and relations of plants, animals (including people), and landscape elements at a large scale.
Latillas	Small-diameter poles laid on top of vigas (larger diameter logs or poles laid under the latillas at a 90° angle) to form a roof on a building.
Leakage	A situation where a carbon-offset project indirectly causes increased emissions outside the defined boundaries of the project itself - sometimes referred to as secondary effects or displacement.
Madrean Archipelago/ Madrean oak woodland	Also known as the Sky Islands in the United States, this is a region of basins and ranges with medium to high local relief, typically 1,000 to 1,500 meters. Native vegetation in the region is mostly grama-tobosa shrubsteppe in the basins and oak-

	juniper woodlands on the ranges, except at higher elevations where ponderosa pine and other conifers are predominant.
Malpai Borderlands	A region along the U.S.-Mexico border and the Arizona-New Mexico state line. The extreme southeast corner of Arizona and the southwest corner of New Mexico describe the general vicinity. It includes areas inside the U.S. states of Arizona and New Mexico as well as the Mexican states of Chihuahua and Sonora.
Montane	Of or relating to mountains and their ecosystems.
Nonattainment days	Days when air quality does not meet minimum quality standards as required by the Clean Air Act of 1963 as amended, and specified by the US Environmental Protection Agency.
Open Space Strategy	A strategy developed by the USDA Forest Service which provides broad concepts for working with communities cooperatively to address open space and potential development issues.
Pathogenic or saprophytic fungi	Pathogenic fungi cause diseases in living organisms while saprophytic fungi decompose non-living tissue.
Paleoecology	The branch of ecology that deals with the interaction between ancient organisms and their environment.
Pleistocene and Holocene epochs	The Holocene is a geological epoch, which began approximately 12000 years ago and continues to this day. The Pleistocene is the epoch from 2.588 million to 12,000 years.
PM10	Term used to describe airborne particulate matter with an aerodynamic diameter of 10 micrometers or less.
Prescribed fire	Planned ignition in a predetermined or approved/prepared area - fire ignited by management action under certain, predetermined conditions to meet specific objectives related to hazardous fuels or habitat improvement.
Rangeland	Grasslands, shrublands, woodlands, wetlands, and deserts that are grazed by domestic livestock or wild animals
Restoration byproducts	Products generated by the implementation of an ecosystem restoration project.
Restoration of natural capital	Natural capital is the extension of the economic notion of capital (manufactured means of production) to goods and services relating to the natural environment. Natural capital is thus the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future. For example, a stock of trees or fish provides a flow of new trees or fish, a flow, which can be indefinitely sustainable. Natural capital may also provide services like recycling wastes or water catchment and erosion control. Since the flow of services from ecosystems requires that they function as whole systems, the structure and diversity of the system are important components of natural capital.

Riparian	Adjacent to a river or stream - Riparian zones exchange organic matter between wet and dry habitats and regulate erosion, sedimentation, temperature, and nutrients.
Sedimentation	The movement of sediment into streams and other bodies of water because of soil erosion within a watershed.
Smart growth	A continuous planning process to guide the preservation, development, or redevelopment of a neighborhood, community, or region to promote the goals and ambitions of its residents when facing growth pressure - quality of life, infrastructure, and land use are typically key considerations in the process.
Sonoran Joint Venture (SJV)	A partnership involving a diversity of organizations and individuals from throughout the southwestern United States and northwestern Mexico that share a common commitment to the conservation of all bird species and their habitats.
Species richness	The number of different species in a given area - the fundamental unit in which to assess the homogeneity of an environment.
Sulfur dioxide	A chemical compound with the formula SO2 that is produced by volcanoes and from the burning of fossil fuels like coal and petroleum products and forms sulfuric acid when combined with precipitation (acid rain).
Sustainable	A condition that is stable and resilient and that can maintain itself in the face of disturbance over time.
Timberland	Forestland where tree species such as ponderosa pine (*Pinus ponderosa)* and Douglas fir (*Pseudotsuga menziesii*) traditionally used for industrial roundwood products, make up at least 10% of the stocking.
Traditional cultural properties	Places that are formally recognized as physical manifestations of the values and beliefs that give tribal members their identity as a people.
Tree canopy (urban or rural)	The layer of leaves, branches, and stems of trees that cover the ground when viewed from above.
Tree City USA	A national program that provides direction, technical assistance, public attention, and national recognition to communities for their urban and community forestry programs.
Understory	The trees and other vegetation living below a forest canopy.
Urban and community forests	Forests in an urban setting - broadly includes trees in urban parks, along streets and landscaped boulevards, in neighborhood parks, on urban private land, at commercial sites, schools and higher education facilities, in public gardens, river corridors and promenades, as well as greenways, wetlands, nature preserves, natural areas, shelter belts of trees and working trees at industrial brown field sites.

vigas	Logs or poles that form the support structure for latillas (smaller diameter poles laid on top of the vigas at a 90° angle) to form a roof on a building.
Watersheds	An area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.
Water yield	The volume of water runoff from a watershed, including groundwater outflow.
Western Forestry Leadership Coalition	A unique partnership between 34 state and federal government forestry leaders across the West to address critical resources issues across ownerships and jurisdictions.
Wildfire Hazard Severity	The severity of a wildfire hazard, determined using a checklist adopted from the wildfire hazard severity analysis developed by the National Fire Protection Association (NFPA) Forest and Rural Fire Protection Technical Committee. NFPA 299 Standard for the Protection of Life and Property from Wildfire, 1997, is the basis for the wildfire hazard severity evaluation.
Wildland fire	A fire that is caused by unplanned ignitions of natural or human sources and burns vegetative fuel.
Woodland	Forestland where timber species are not present at the minimum 10% stocking level. Woodland tree species such as pinyon (*P. edulis*) and juniper (*Juniperus spp.)* are used primarily for fuelwood, fence posts and in some cases, Christmas trees.

Appendix A-2: Abbreviations and Acronyms

4FRI	4 Forests Restoration Initiative

A

ACTC -	Arizona Community Tree Council
ADEQ -	Arizona Department of Environmental Quality
ADOT -	Arizona Department of Transportation
AMP -	Allotment Management Plan
ANA -	Arizona Nursery Association
APS -	Arizona Public Service
ASNF -	Apache Sitgreaves National Forest
ASU-SCN -	Arizona State University – Sustainable Cities Network
AWIMA -	Arizona Wildfire and Incident Management Academy
AZGFD -	Arizona Game and Fish Department
AZPFC -	Arizona Prescribed Fire Council
AZSMD -	Arizona Smoke Management Database
AZSMP -	Arizona Smoke Management Program
AZUTM -	Arizona Urban Tree Monitoring
AzWRAP -	Arizona Wildfire Risk Assessment Portal

B

BCAP -	Biomass Crop Assistance Program
BLM -	Bureau of Land Management
BMP -	Best Management Practices

C

CAGCS -	Central Arizona Grassland Conservation Strategy
CCG -	Community Challenge Grant
CFAA -	Cooperative Forestry Assistance Act
CNF -	Coronado National Forest
COF -	Coconino National Forest
CWPP -	Community Wildfire Protection Plan

D

DFFM -	Department of Forestry and Fire Management
DLA -	Defense Logistics Agency
DLCC -	Desert Landscape Conservation Cooperative
DUF -	Diverse Urban Forests

E

E-BAM -	Environmental Beta Attenuation Monitor
ECO -	Eastern Arizona Counties Organization

EIS -	Environmental Impact Statement
ERI -	Ecological Restoration Institute
ESA -	Endangered Species Act

F

FAP -	Forest Action Plan
FEPP -	Federal Excess Property Program
FIA -	Forest Inventory Analysis
FWPP -	Flagstaff Watershed Protection Project

G

GIS -	Geographic Information System

H

HOA -	Home Owners Association
HUCS -	Hydrological Unit Codes

I

IMT -	Incident Management Team
IPG -	Invasive Plants Grants

K

KFHF -	Kaibab Forest Health Focus
KNF -	Kaibab National Forest

L

LCC -	Landscape Conservation Cooperative
LRMP -	Land Resource Management Plan

M

MOU -	Memorandum of Understanding

N

NASF -	National Association of State Foresters
NAU -	Northern Arizona University
NEPA -	National Environmental Policy Act
NFWF -	National Fish and Wildlife Foundation
NGO -	Non-Governmental Organization
NRCD -	Natural Resource Conservation District
NRCS -	Natural Resources Conservation Service
NWCG -	National Wildfire Coordination Group

P

PAWUIC -	Prescott Area Wildland Urban Interface Commission
PNF -	Prescott National Forest

R

RMRS -	Rocky Mountain Research Station
RSG -	Ready, Set, Go!

S

S&PF -	State and Private Forestry
SAF -	Society of American Foresters
SCAT -	San Carlos Apache Tribe
SHADE -	Southwest Horticulture Annual Day of Education
SIRC -	Southwest Interdisciplinary Research Center
SRP -	Salt River Project
SWCC -	Southwest Coordination Center
SWERI -	Southwest Ecological Restoration Institutes

T

TACCIMO -	Template for Assessing Climate Change Impacts and Management Options
TCB -	Tucson Clean and Beautiful
TEP -	Tucson Electric Power
TNC -	The Nature Conservancy
TNF -	Tonto National Forest
TREE -	Tree Resource Enhancement and Engagement
TSAP -	Timber Sale Action Plan

U

UA -	University of Arizona
UCF -	Urban and Community Forestry
UFRI -	Urban Forest Resources Inventory
USBR -	United States Bureau of Reclamation
USDA -	United States Department of Agriculture
USDA FSA -	US Department of Agriculture – Farm Service Agency
USFS -	United States Forest Service
USFWS -	United States Fish and Wildlife Service
USGS -	United States Geological Survey
UTT -	Urban Tree Talk Newsletter

V

VFD -	Volunteer Fire Department
VWRC -	Verde Watershed Restoration Coalition

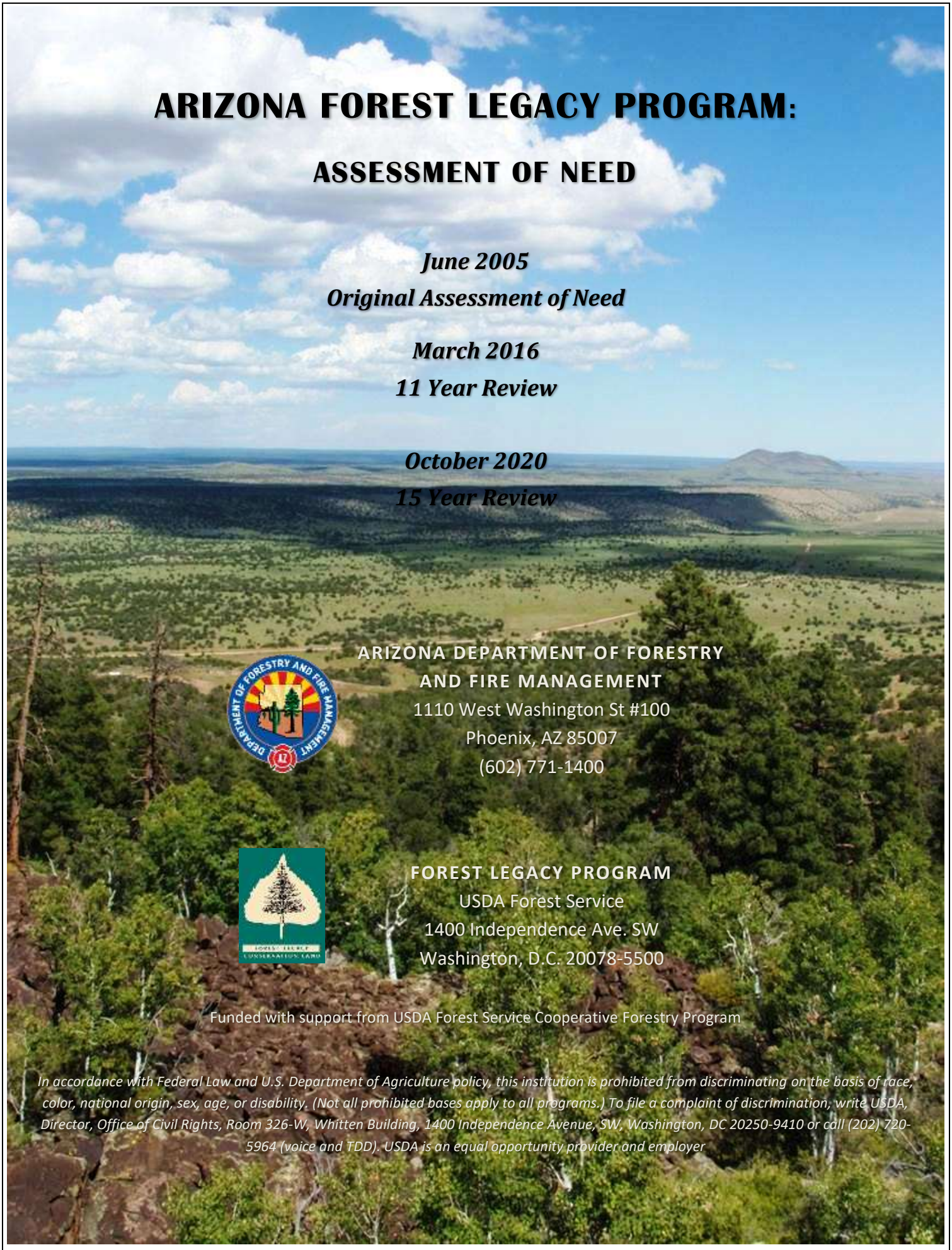
W

WBBI -	Western Bark Beetle Initiative
WCG -	Western Competitive Grant
WFDSS -	Wildland Fire Decision Support System
WFLC -	Western Forestry Leadership Coalition
WMG -	Watershed Management Group
WRAP -	Watershed Restoration Plan
WUI -	Wildland Urban Interface

Y

YARDS -	Youth Achieving Resource Development Skills

Appendix A-3: Arizona Forest Legacy Program: Assessment of Need



ARIZONA FOREST LEGACY PROGRAM:

ASSESSMENT OF NEED

June 2005

Original Assessment of Need

March 2016

11 Year Review

October 2020

15 Year Review

ARIZONA DEPARTMENT OF FORESTRY AND FIRE MANAGEMENT

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FOREST LEGACY PROGRAM

USDA Forest Service

1400 Independence Ave. SW

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Arizona Forest Legacy Program:

Assessment of Need

Original (2005) Assessment of Need prepared by The Nature Conservancy – Arizona Chapter

15 Year (2020) Review provided by Arizona Department of Forestry and Fire Management and The Nature Conservancy – Arizona Lands Program

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Executive Summary

Introduction

Arizona's original Assessment of Need (AON) was prepared in 2005, under contract by The Nature Conservancy for the Arizona State Land Department (ASLD), which at the time included Arizona Department of Forestry and Fire Management (DFFM). Since the original AON, DFFM has become a separate entity from the Arizona State Land Department. Input for the 2005 AON was done in conjunction with the Arizona State Land Department, Arizona Forest Stewardship Committee, and U.S. Forest Service, Region 3 National Forest System. This report is submitted to the U.S. Forest Service as a review and amendment to Arizona's Forest Legacy Assessment of Need.

Among the amendments to the 2005 AON are:

1. Updating of project eligibility to remain consistent with the 2017 Forest Legacy Program Implementation Guidelines.
2. Revising of the Maps to better identify Forest Legacy Areas
3. Acknowledgement of changes in species listing on Federal Threatened and Endangered species lists
4. Update on wood fiber processing capacity in Arizona, across the identified Forest Legacy Areas
5. Updates to the listing of Land Trust organizations in Arizona
6. Removal of Appendix E. List of all of the U.S. Department of Interior Fish and Wildlife Service's listed endangered (E), threatened (T), candidate (C) or of special concern (SC) species, the Bureau of Land Management's (BLM) sensitive species (S), the United States Forest Service's (USFS) sensitive species (S), as well as Arizona Game and Fish Department's Wildlife of Special Concern in Arizona (WSC) species that exist within private forest land by county.
7. Removal of Appendix I. Economic data, forest descriptions and demographics by County

Besides document formatting and required updates, no significant changes have been made to the AON.

Arizona's Forest Resources

The diversity of Arizona's forests range from semi-arid riparian gallery forests to sub-alpine and montane forests, spanning roughly 27% of the state and covering an area of 19.4 million acres. These forests are comprised of conifers and hardwoods with approximately 35 tree species and range in elevation from approximately 300 to 3,700 meters. The majority of forest land is located above the Mogollon Rim with discrete patches in southeastern Arizona's mountain islands. Pinyon-juniper and pure juniper woodlands are the most abundant forest type in Arizona, occupying approximately 14.8 million acres or 20.3% of the state. The rarest and most significant in ecological terms is riparian forest, which occupies less than one-half a percent of Arizona's land.

While timber production has historically been and the primary function and most consumptive use of Arizona's forests, forest land serves other anthropogenic purposes such as recreation, tourism, mining, and grazing. More importantly, forest lands contribute to the overall functioning of ecosystems by playing a vital role in cycling water and nutrients, filtering pollutants, discharging oxygen, and providing habitat for humans and biological diversity, alike.

Trends in Forest Land Conversion

Explosive population and economic growth over the last 35 years have resulted in major changes for Arizona. From 1970 to 2000 Arizona's population grew by 3.37 million a 188% increase. Growth has increased even more dramatically in the last four years with the current population estimated at 5.44 million, making Arizona the second fastest growing state in the United States.

Some impacts of this rapid population growth include ranch and forest land conversion to low-density development, increase demands on forest resources, fragmentation by roads and fences, and interruption or degradation of ecological services. In economic terms, net income from farming and ranching dropped from $565 million in 1970 to $377 million in 2000, while the services and professional industry which includes construction, real estate and trade,increased 48% during the same time period.

Arizona's Forest Legacy Program

The primary goals for the Arizona Forest Legacy Program are: (1) protect important private forest from conversion to non-forest such as development and ex-urban growth; (2) maintain the ecological integrity of Arizona's forests with the purpose of protecting watershed functions, such as ground water recharge, as well as protect native plant and wildlife habitat; and (3) maintain forest integrity in order to protect cultural, public and economic values associated with traditional forest uses such as timber harvest, livestock ranching, and recreational opportunities.

To reach these goals several program objectives have been identified:

- Reduce forest fragmentation through protection of ecologically and publicly important private forest land by focusing on large forested blocks.
- Maintain watershed functions and protect water supply by protecting forests in the upper watershed and streams.
- Protect wide ranging, rare, threatened, and/or endangered plant and wildlife habitat.
- Protect important historical and cultural sites.
- Promote forest stewardship through partnerships.

Arizona's Forest Legacy Areas

Private forest land identified in the Assessment of Need for inclusion in a Forest Legacy Area under the Forest Legacy Program must meet the following minimum criteria:

- Environmentally important forest areas, which include areas important for scenic, recreational, riparian, ecological, cultural, or traditional forest uses, and
- Threatened by conversion to non-forest uses.

For the purposes of the Arizona Forest Legacy Program, forest land is defined as:

- Lands stocked with at least 10% tree cover of any size (at maturity, the trees must be greater than 8 feet in height). Ten percent stocked, when viewed from a vertical direction, equates to an aerial canopy cover of leaves and branches of 25% or greater.
- The minimum area for classification is 1 acre, owned by an individual or by an organized group of individuals.

In accordance with the Forest Legacy Program Guidelines, the definitions of 'threats of conversion' and 'important forests' are further clarified. To this end, threatened forests are defined as any forest at risk of conversion to non-forest uses by roads and/or human developments. Important forests are defined as those forests that include one or more of the following values:

- Riparian Areas
- Fish and wildlife habitat and corridors
- Known threatened and endangered species
- Timber, and other forest commodities
- Scenic resources
- Public recreation opportunities
- Known cultural resources
- Other ecological values

Using the above definitions of forest, threatened forests, and important forests, it was determined that all non-industrial private forest within Arizona are threatened and important and therefore eligible for

inclusion in the Forest Legacy Program. County boundaries were selected to delineate the Forest Legacy Areas, resulting in 15 Forest Legacy Areas for Arizona.

Prioritization Process

Four criteria were selected for use in the prioritization process for evaluating competing Forest Legacy Program projects. The criteria listed in *priority* order are:

1) The significance of ecological, public, and/or economic values on the property
2) The viability and importance of the site to other forest lands
3) Immediacy of threats to the site
4) Local support and presence of partners and/or matching funding

To aid the prioritization process for identifying environmentally important forests at risk of non-forest conversion, three spatially explicit data sets were created to identify areas of high public and ecological value as well as areas of road and development threats within private forest lands. The *public value* spatial layer evaluates private forest lands in the context of values that the general public may place on public lands and cultural resources. The two key components of public value are (1) presence of or proximity to areas with cultural and historical resources, and (2) proximity to public recreation opportunities. The *ecological value* spatial information was created to assess private forest land in the context of threatened, endangered, and common species locations and habitat requirements, as well as to evaluate their importance to ecological functioning of an area and overall biodiversity of the region. Finally, the *development threat* spatial layer represents the degree to which an area has been impacted by human development as well as identifies the boundaries of that impact. This spatial layer was a combination of road impacts and current housing density.

Field verification of these spatial layers was conducted for two weeks in April 2004, and was targeted to areas where *public value*, *ecological value*, and *development threat* intersected. During field reconnaissance approximately 2,400 miles, 25 conservation areas, 6 National Forests, and 18 riparian areas were visited along with representatives from each of the four forest types and development threats.

Based upon the spatial analyses and field assessment, recommendations for private forest land priorities are as follows:

- Areas classified as having rural housing density or only road impact near Prescott, Flagstaff, Heber to Show Low along highway 260, Sonoita, Elgin, Green Valley, and Kingman should be prioritized for Forest Legacy Program funds due to their imminent conversion by development.
- Riparian forest along perennial water represents a small proportion of the total forest in Arizona, yet a disproportionately high number of species depend on them. Riparian forests are some of the most biologically diverse and rich communities in Arizona. Given their dwindling extent and high value, these areas should be a top priority.

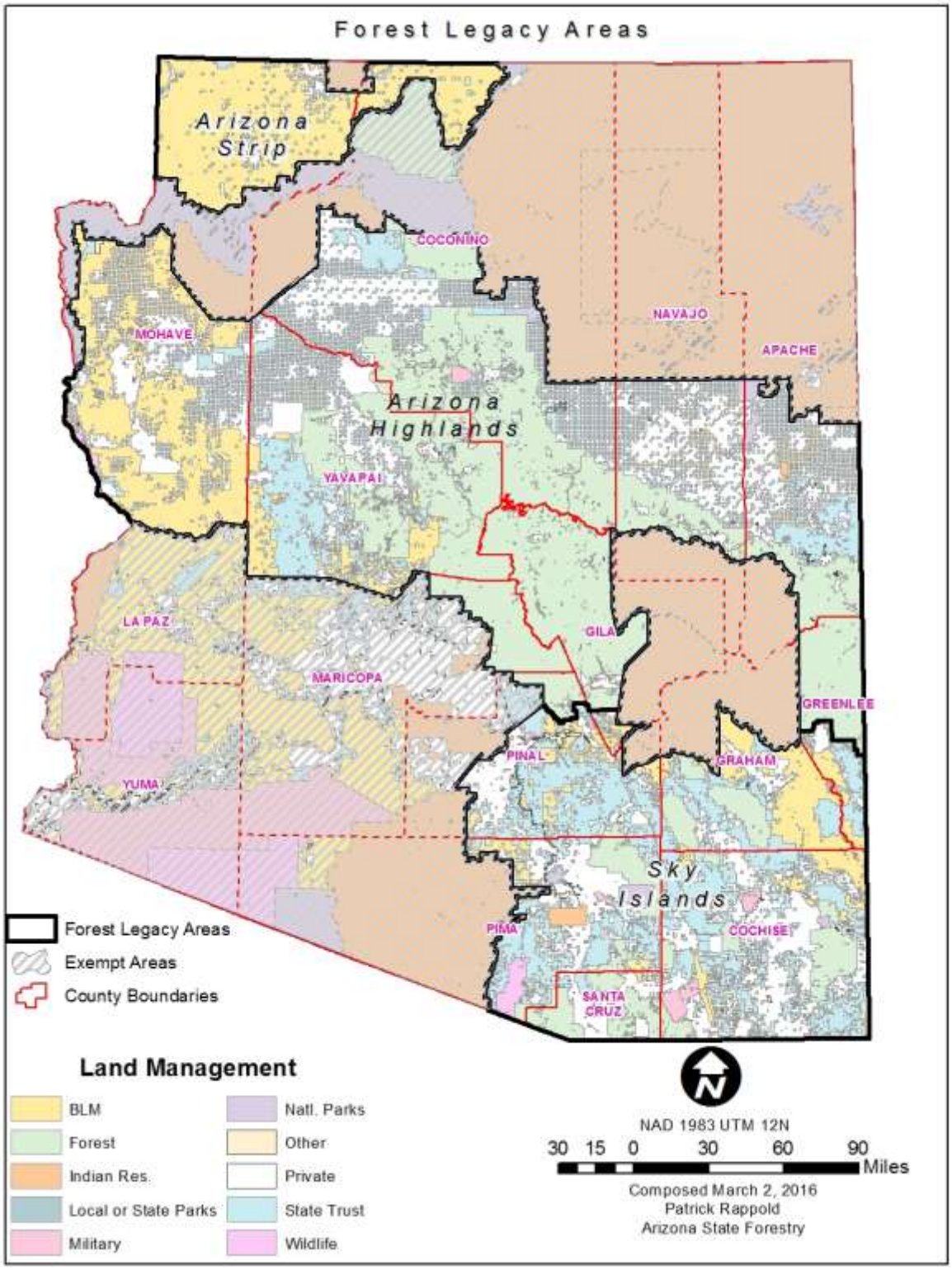

Figure 1. Map of Forest Legacy Areas

Section 1

I. Forest Legacy Program in Arizona

In 2003, Arizona expressed interest in participating in the U.S. Forest Service Forest Legacy Program. The Forest Legacy Program was authorized under Section 1217 of Title XII of the Food, Agriculture, Conservation and Trade Act of 1990 (P.L. 101-624:104 stat.3359; 16 U.S.C. 2103c), also referred to as the 1990 Farm Bill amended the Cooperative Forestry Assistance Act (CFAA) of 1978, as amended, (16 U.S.C. 2101 et. seq.). The CFAA provides authority for the U.S. Secretary of Agriculture (Secretary) to provide financial, technical, educational, and related assistance to states, communities, and private forest landowners. The 1990 Farm Bill further directs the Secretary to establish the Forest Legacy Program (FLP) to protect environmentally important forest areas that are threatened by conversion to non-forest uses. In 2003, Congress appropriated $68.3 million towards 42 Forest Legacy projects, bringing the total number of projects funded by the FLP to 179.

The purpose of the FLP is to identify and protect environmentally important forest areas that are threatened by conversion to non-forest uses. The FLP seeks to promote forest land protection and other conservation opportunities on non-industrial privately-owned forests. Additional benefits include the protection of important scenic, cultural, and recreational resources; preservation of traditional forest uses such as timber management, grazing, and hunting; and conservation of riparian areas, wildlife habitat, and other precious ecological values. Appropriated funds are used to administer the program and support conservation easements on both purchased and donated lands and interests in lands meeting the purposes of the FLP program. The FLP is entirely voluntary and is based on the principle of willing sellers and willing buyers.

In order to participate in the FLP, DFFM submits this AON documenting the need for a FLP in Arizona, establishing eligibility criteria, setting selection guidelines, and identifying priority areas. Areas identified for consideration under the FLP meet the minimum criteria based upon the FLP purpose and guidelines (USDA 2003a). The minimum criteria for establishing Forest Legacy Areas are as follows:

- Environmentally important forest areas, which include areas important for scenic, recreational, riparian, ecological, cultural, or traditional forest uses, and are
- Threatened by conversion to non-forest uses.

Only non-industrial private forest is considered for participation in the FLP administered by the DFFM. Non-industrial private forest (NIPF) is defined as:

- Lands with existing tree cover and other lands including crop land, pasture land, surface-mined lands, and non-stocked forest lands that are scheduled for conversion to tree cover.

Further clarifications for NIPF as defined by Arizona's Forest Stewardship Committee (AFSC) include:

- "...lands with existing tree cover..." are defined as lands stocked with at least 10% tree cover of any size (At maturity, the trees must be *"tree form"* which is defined as greater than eight (8) feet

in height).

- Ten percent stocked, when viewed from a vertical direction, equates to an aerial canopy cover of leaves and branches of 25% or greater (NRI 1997).
- The minimum area for classification as NIPF is 1 acre, owned by an individual or by an organized group of individuals. Strips of trees must have a crown width of at least 120 feet except for windbreaks, which must have a crown width of at least 60 feet at maturity. **There is no minimum width requirement for riparian forest land.**
- Unimproved roads and trails, streams, and clearings in forest areas are classified as NIPF if less than 120 feet wide.
- "...other lands including crop land, pasture land, surface-mined lands, and non-stocked forest lands that are scheduled for conversion to tree cover" are eligible only if the trees that are naturally regenerated or planted are capable of survival without supplemental irrigation once they are established. Established is defined as three years after they are planted.

In order to assure program-wide success, each project budget will include a minimum nonfederal contribution of 25%. The nonfederal cost-share may consist of: (1) the value of land, or interest in land, dedicated to the FLP that is not paid for by the Federal government; (2) nonfederal costs associated with program implementation; and (3) other nonfederal costs associated with a grant or other agreement that meets FLP purpose (USDA 2003a).

II. Arizona's Forests and Woodlands

A. Historical Perspective

Pre-European Settlement

Climate

In order to place forests of today in context, a brief discussion of the history regarding Arizona's forests is presented. A paleoecological study in the Potato Lake area (approximately 2220 m in elevation) of the southern Colorado Plateau suggested that dramatic changes have occurred in the area's biota over the last 35,000 years (Anderson 1993, Anderson et al. 2000). From 35,000 to 21,000 years before present (B.P.) it appeared that the area was dominated by mixed conifer species suggesting the climate was cooler and wetter than it is today. Between 21,000 to 10,400 B.P., likely the coldest time during the last glaciation, Engelmann spruce (*Picea engelmannii)* formed almost pure stands, growing as low as 2,500 meters. Today, spruce is generally located above 3300 meters. The transition into the Pleistocene-Holocene and end of the glaciation period resulted in a major reorganization of southern Colorado Plateau vegetation. On Utah's Markagunt Plateau, species common to today's mixed-conifer forests moved upslope to their elevation range of present-day. The warmer climate likely resulted in the widespread establishment of ponderosa pine (*Pinus ponderosa*) across the mid-elevations of the area. At elevations between 1,600 and 2,100 m, pinyon-juniper woodlands dominated. In the period that followed (8,000 to

4,000 B.P.) pinyon-juniper woodlands migrated into the area and cold deserts were replaced by warm desert grasses.

In lower elevation regions of the Colorado Plateau, studies from the Chaco Canyon and San Juan Basins in Arizona (8,000 B.P.) showed that canyons were dominated by mixed conifer forests and the mesa tops were cold desert steppe (Betancourt et al. 1993)

Fire

In the Southwestern forests, lightening and human-caused fires could burn for several months and covered thousands of acres, burning until extinguished by rain or depletion of fuel (Swetnam 1990, Swetnam and Baisan 1996). Dendrochology research suggests that most Southwest forest stands, excluding spruce-fir, burned every 2 to 30 years as low-intensity fires. Having greater moisture yet heavier fuel loads, spruce-fir forests burned less frequently, on the order of every 35 to 150 years or more, but at higher intensities (Abolt 1997, Grissino-Mayer et al. 1995, and Veblen et al. 1994). Although native cultures used fire for a variety of purposes, lightening ignitions during periods of high fire hazard were sufficient to produce frequent fires (Schroeder and Buck 1970, Swetnam and Baisan 1996).

Demographics and Forest Resources

Humans have been an integral component of Arizona's forest ecosystems for more than 10,000 years although precise regional population estimates do not exist (Dean et al. 1994). Archaeological records from around 300 B.P. indicate human populations were developing more permanent settlements and shifting to greater reliance on domesticated plants (Dean et al. 1994). Impacts on forest resources were thought to have been minimal until around the 11th century when farming, fuelwood cutting, and hunting greatly increased around the larger settlements (Dahms and Geils 1997). The arrival of Europeans had a devastating impact on the native populations as well as regional environmental impacts such as intensive irrigation and introduction of diseases that threatened wildlife.

The prehistoric uses of timber resources were fuel, tools, and construction and were mainly used locally due to technology and transportation limitations. For these reasons the woodlands and riparian forests near areas of population growth were most affected (Dahms and Geils 1997). For example, along the Middle Rio Grande Valley, the riparian bosque had been essentially eliminated by Puebloan and Hispanic farmers before 1848 (Abert 1848a, Wozniak 1987). It was not until the 19th century with the introduction of commercial logging, mining, and railroads that the upper elevation forests were impacted.

Historic Forest Conditions

In the early 19th century, dense woodlands could be found, but forests were predominately open with a diverse community of trees, shrubs, and perennial grasses and forbs (Abert 1848a, 1848b). The pattern of tree distribution is influenced by ecosystem condition as well as processes above and below ground. Historic ponderosa pine forests are often referred to as open and park-like with abundant herbaceous understory although descriptions and pictures of dense stands have also been documented (see Woolsey 1911, Covington and Moore 1994). Records and archaeological reconstruction of historic forest conditions

suggest that the vegetation was characterized by individual, clumped, or stringers of ponderosa pine in various sizes with an understory grass-herbaceous matrix (Dahms and Geils 1997). The development of fire-dependent vegetation coupled with the typical climate of several centuries prior to 1848 reinforced a frequent fire regime of low-intensity burns (Covington and Moore 1994). Frequent surface fires, disease, insects, and other regulating mechanisms kept the ponderosa pine forest in balance.

Conditions of historic mixed conifer forests are variable and depend on time since and severity of the most recent burn. Historical conditions of mixed conifer forest as reported in *An Assessment of Forest Health in the Southwest* (Dahms and Geils 1997) describe the following:

> "Lang and Stewart[1] describe the mixed conifer forest on the North Kaibab Plateau (Colorado Plateau Province) in 1909. They describe most mature Douglas fir (as well as white fir and blue spruce) as "deteriorating"; they probably mean these trees were decayed, had poor crown form, broken tops, and hollow bases typical of repeatedly fire-damaged trees. Lang and Stewart also note that Douglas-fir regeneration was "healthy and vigorous"; and often dense stands of pole-sized trees covered large areas, especially on more mesic sites and under aspen."

Because historic spruce-fir forests had little impact from logging, grazing, or fire suppression, their historic conditions are fairly well known (Dahms and Geils 1997). Spruce-fir forests were susceptible to major disturbances (i.e. fire and insect outbreak) but they occurred relatively infrequently with 100+ years between major events (Baker and Veblen 1990, Schmid and Frye 1977, Veblen et al. 1994).

Riparian forests once formed continuous corridors of lush vegetation covering hundreds of miles and are also found as components of montane communities. They stretch from the headwaters of rivers and streams down to the lower elevation deserts. Many species in the riparian communities depend on flooding for seed transportation and establishment. Riparian communities provided resources necessary for early human settlements as well as permanent wildlife habitat and migratory routes for birds and mammals.

Post-European Settlement

The period following the Mexican-American War of 1848 marks a significant transition from Hispanic to American sovereignty in the Southwest and a time of rapid settlement. With the increasing settlers came cattle herds; by 1890, more than 1.5 million head of cattle were in the Southwest (Baker et al. 1988). By the early 1900s, livestock grazing pressures had reached the mountainous and timbered areas resulting in vegetation cover loss and increased erosion. Since the peak in the numbers of cattle and sheep in Arizona, around the time of World War I, livestock numbers have been declining (Dahms and Geils 1997).

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[1] An unpublished report titled Reconnaissance of the Kaibab National Forest, unpublished survey report circa 1910 on file Williams, AZ: U.S. Department of Agriculture, Forest Service, Kaibab National Forest.

Historic fire regime was dramatically changed because livestock removed much of the fine fuel needed to carry surface fires and fire suppression increased because of the growing number of inhabitants who viewed fire as a threat. Ultimately, the frequency and size of fires were altered by roads and trails, fragmented forest continuity, the suppression of fire, and low fuel loads. Fire exclusion began altering forest structure and fire regime in the early 1900s (Covington and Moore 1994). Over the last century, the combination of fire suppression and fuel accumulation has led to the occurrence of large and intense fires such as experienced in the last several decades in the Southwest.

With the arrival of the railroad to the Southwest, new industries appeared, human population grew, natural resource exploitation accelerated, and the commercial economy replaced the subsistence economy. Some other concurrent changes included altered land use patterns, depletion of forage for livestock, degradation of riparian areas, and changes in forest communities and wildlife habitat (Bahre 1991, DeBuys 1985). Arizona has continued to grow since this time, further stressing natural systems and resources.

Small scale logging for local-use shifted to larger efforts around the 1870s with the construction of the railroad and harvesting of railroad ties. During these early years, large volumes (70-80%) needed to be removed from the forests to make the operation feasible (Schubert 1974). Later, when trucks were available lighter cuts could be made - typically 30 to 60% of the available volume (Myers and Martin 1963). Over time, harvesting methods have been variable with some practices more sustainable than others. Removal of the 'large quality' trees have resulted in some dense stands of younger trees thus reducing understory herbaceous cover and increasing fire danger.

The transcontinental railroad also provided increased opportunities for tourism. Arizona's mild climate, striking archaeological ruins, and majestic scenery all led to a tremendous increase in recreation during the mid to late 1900s. Arizona became a favorite destination for hunting, fishing, sightseeing, and bird watching. Preservation and conservation of forests and other natural communities became a focal point for public land managers. Higher visitation to wilderness areas and forest communities led to the overuse and exploitation of resources, introduction of non-native plants, increased human-caused fires, and unauthorized use of motorized vehicles.

These and other interrelated widespread changes in Arizona have also altered the hydrologic regime of most every watershed. Soil compaction, road construction, and reduced ground cover have led to increased erosion and flooding, often resulting in deeply cut incised channels. Water diversions and impoundments on the larger rivers have significantly modified channel dynamics and altered native habitat and vegetation establishment. To address bank stabilization and other ecological problems, species not native to the ecosystems of the Southwest, like salt cedar (*Tamarix* spp.) were introduced to help "solve" these issues. Some of these introduced species are quite aggressive, competing with native plants for resources and are currently having detrimental impacts on ecosystem processes.

B. Forest Types and Distribution

The diversity of Arizona's forests range from semi-arid riparian gallery forests to subalpine and montane forests, spanning roughly 27% of the state and covering an area of 19.4 million acres (O'Brien 2002).

Several of these forested communities have international importance because of their outstanding biological diversity and are part of the greater geographic region referred to as the Madrean Archipelago, which has recently been added to Conservation International's list of the world's hotspots for biodiversity (Andrew Smith, personal communication). The great biological diversity stems from the convergence of subtropical and temperate climate zones that create forest corridors for many migratory animals.

In the most general sense the USDA Forest Inventory and Analysis Program classifies forest lands into two major categories – timberland or woodland – based on levels of stocking. Timberland is forest land with tree species such as ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) traditionally used for industrial roundwood products, that make up at least 10% of the stocking. Only 20% of Arizona's forest land meets this definition (O'Brien 2002). The remaining portion is woodland, comprising all other forest lands where timber species are not present at the minimum stocking level. Woodland tree species such as pinyon (*P. edulis*) and juniper (*Juniperus* spp.) are used primarily for fuelwood, fence posts and in some cases, Christmas trees. Forest lands are further differentiated into forest types and are often identified by the predominant tree species.

Throughout time, vegetation communities have been described using a variety of classifications and at different geographical scales. Because planning and management objectives differ, the framework to identify ecological units is different, as are the resultant classifications. Most of the forest lands in Arizona are within the Arizona – New Mexico Mountains Semi-Desert – Open Woodland – Coniferous Forest – Alpine Meadow Province (Bailey et al. 1994). Southwestern ecosystems are grouped into life zones (Carleton et al. 1991) which are characterized by biotic community types and can be cross-referenced to the biotic communities described by Brown and Lowe (1977, 1980) and Brown (1994). For Arizona's Assessment of Need purposes, forest lands have been aggregated into four major forest community types – mixed conifer forests, pinyon-juniper woodlands, riparian forests, and Madrean oak woodlands.

It is important to note that forest statistics can vary depending on the source of the information, sampling method, accuracy of the data, and the definition of forest land. Therefore, the Arizona AON will report state-wide figures based on information obtained from the Forest Inventory and Analysis (FIA) Program and documented in *Arizona's Forest Resources, 1999* (O'Brien 2002). While all county level and forest type (conifer, pinyon-juniper woodland, Madrean oak woodland, and riparian forest) figures are based on our spatial analyses. The discrepancy in data reporting is because the geospatial data to accompany the FIA report was not available at the time the AON was developed, therefore, Arizona GAP vegetation data (1998) was used as the primary source in our spatial analyses for identifying forest lands in Arizona. Appendix A identifies the aggregation of the forest vegetation types that comprise the mixed conifer forests, pinyon-juniper woodlands, riparian forests, and Madrean oak woodlands and crosswalks them with biotic communities (Brown 1994). Identification of riparian forest was enhanced with spatial data from the Arizona Game and Fish Department (AZGFD 1994). Again, county level and forest type statistics will be based on the information generated from spatial analyses using the combined GAP and AZGFD vegetation data. For a complete list of geospatial information used in developing the AON see Appendix B.

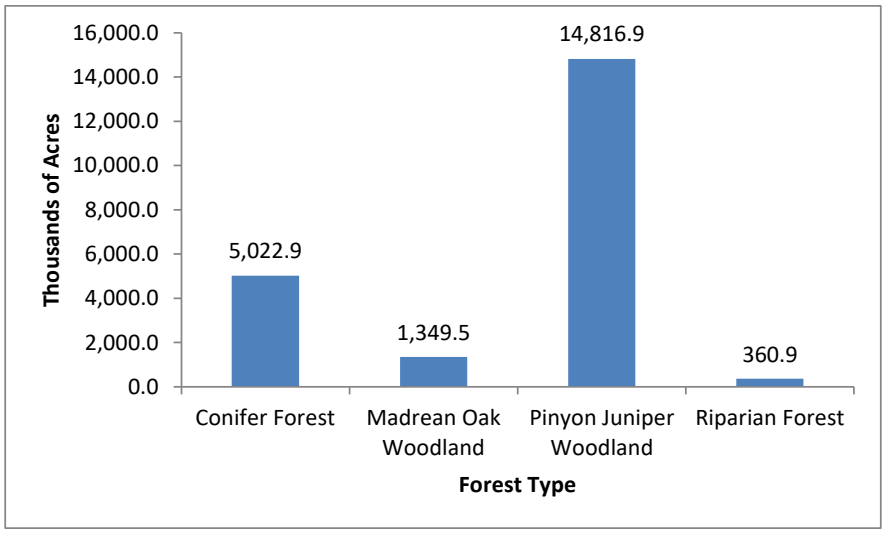

Figure 2. Thousands of acres by forest type in Arizona (based on GAP vegetation and AZGDF data)

Arizona forests are comprised of conifers and hardwoods with thirty-seven tree species (Appendix C) ranging in elevation from approximately 300 to 3,700 m. The majority of forest land is located above the Mogollon Rim with discrete patches in southeastern Arizona's mountain islands (Figure 1). Pinyon-juniper and pure juniper woodlands are the most abundant forest type in Arizona, occupying approximately 14.8 million acres or 20.3% of the state (Chart 2). The rarest and most significant in ecological terms is riparian forest, occupying less than one-half a percent of the land in Arizona. Ground water pumping and conversion to non-forest uses currently threaten the riparian forests and habitat they support.

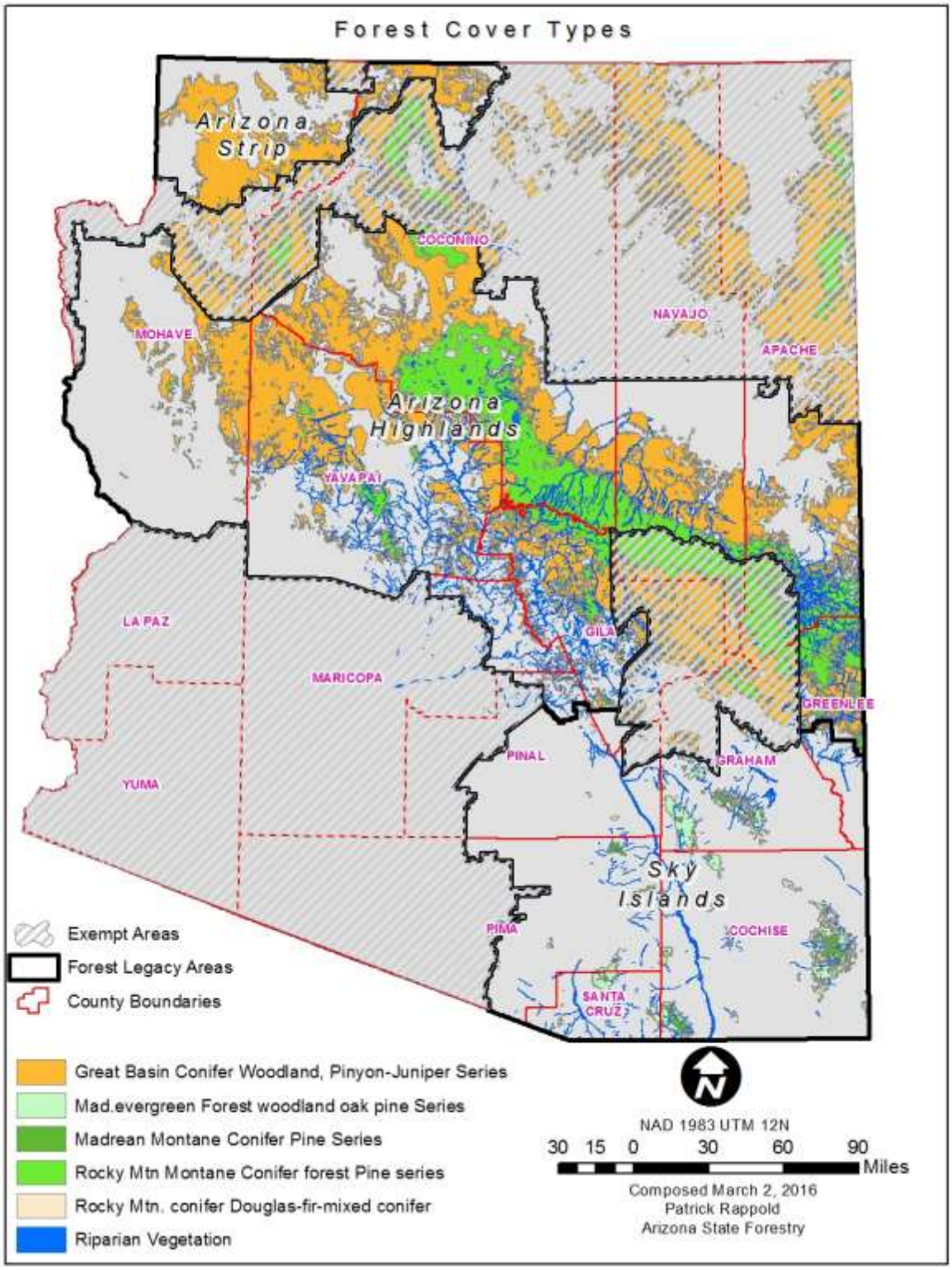

Figure 3. Forest Cover Types

Mixed Conifer Forests

In Arizona, ponderosa pine forests comprise the largest portion of the mixed conifer forest, approximately 86%. Ponderosa pine (*Pinus ponderosa*) is the most widely distributed pine in North America, extending from British Columbia, Canada to Durango, Mexico. Throughout its range, ponderosa pine can be found at elevations from sea level to about 2,750 m. In Arizona, most of the ponderosa pine forest is between 1650 and 2,760 m. At slightly higher elevations (above approximately 2400 m) a variety of conifer species are present. At elevations between 2,400 and 3,100 m forests are dominated by Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), white fir (*Abies concolor)*, and blue spruce (*Picea pungens*).In the cooler regions and areas receiving more than 635 mm of annual precipitation, the spruce-fir forest is predominantly Engelmann spruce (*Picea engelmannii*), with co-dominant species of subalpine fir (*Abies lasiocarp).* Other species that are present in mixed conifer forests include corkbark fir (*A. lasiocarpa* var. *arizonica*), Southwestern white pine (*P. strobiformis*), Gambel oak (*Quercus gambelii*), juniper, Arizona cypress (*Cupressus arizonica),* and aspen (*Populus tremulodies*). Aspens occur in small, transient patches in mixed conifer forests and because they are shade intolerant, they eventually succumb to competition as conifers close the canopy.

The mildest climate in Arizona is found in mixed conifer forests, with average annual precipitation from 430 to 760 mm (USDA 2004b) and as high as 1100 mm in the higher elevations (USDA 2004a). More than half of the precipitation falls as snow and the mean annual temperature ranges from 5 to 8 degrees Celsius (USDA 2004b).

Madrean Oak Woodland

Evergreen oak woodland, characterized by wet summers and mild winters, extends from the Sierra Madre of Mexico into southeastern Arizona and Southwestern New Mexico and ranges in elevation from 880 to 2,300 m (Brown 1994) and up to the top of Mount Graham at 3,260 m (USDA 2004b). The Madrean oak woodlands in Arizona generally include evergreen oak species as well as conifer species. Most of the woodlands are found primarily in “sky islands” of southeastern Arizona at an elevation gradient (1,200 to 2,700 m) above the desert shrub and grassland communities at low elevations but below the coniferous forests at the higher elevations. At the lower elevations, the woodlands are typically open with bunch grasses as the major understory component. At the higher elevations they are denser forests with oak and pine species intermixed. Madrean oak woodland’s northern range is in central Arizona where it occurs above or within the drier interior chaparral, and below and along drainages within the drier and cold tolerant Great Basin conifer woodland (Brown 1994).

Figure 4. Madrean Oak Woodland

In Arizona, a variety of oak species such as Emory oak (*Quercus emoryi*), Arizona white oak (*Q. arizonica*), Mexican blue oak (*Q. oblongifolia*), gray oak (*Q. grisea*), silverleaf oak (*Q. hypoleucoides*), and netleaf oak (*Q. rugosa*) are found at higher elevations in conjunction with Madrean pine species such as Apache pine (*Pinus engelmannii*), Chihuahua pine (*P. leiophylla* var. *chihuahuana*), and Arizona pine (*P. arizonica*). Arizona cypress, endemic to the woodlands, is confined mainly to north-facing canyon slopes and drainages. If there is sufficient moisture, epiphytic bromeliads (*Tillandsia recurvata*) can be found on tree branches. Some of the common understory grasses include muhlys (*Muhlenbergia* spp.), cane beard grass (*Bothriochloa barbinodis*), wolftail (*Lycurus setocus*), plains lovegrass (*Eragrostis intermedia*), and several of the grama grasses (Boutelous spp.). There are also several shrubs (i.e., Salvia, Artemsia), forbs (i.e., Penstemon, Lupinus) and cacti (i.e., Ferocactus wislizeni, and Opuntia spp.) commonly found in the understory of many of these forests (Brown 1994).

The abundance of scrub land species from the interior chaparral community such as pointleaf manzanita (*Arctostaphylos pungens*), Wright's silktassel (*Garrya wrightii*), and Arizona rosewood (*Vauquelinia californ*ia) can be occasional or frequent within the Madrean oak woodland. These and other indicative plants of chaparral are typically prominent on thin eroded soils, limestone, and near the eastern and northern range of the Madrean oak woodlands (Brown 1994).

Annual precipitation ranges from 400 to 750 mm at the higher elevations. There is both snow and rain precipitation with winter-summer ratios about equal (USDA 2004b). Snow seldom persists more than few days at the lowest elevations.

Pinyon-Juniper Woodlands

Pinyon-juniper woodlands constitute the largest forest type in Arizona, both on public and private land. These coniferous woodlands exist in a gradient of juniper dominated woodlands to pinyon dominated woodlands with pinyon pines and junipers present throughout the range. Specifically, they are found at elevations ranging from approximately 1,370 to 2,300 m (USDA 2004a). Pinyon (*Pinus edulis)* is the most common species in the complex with other pines including border pinyon (*P. discolor*) and Arizona single-leaf pinyon *(P. californarium* subspp. *fallax*). Juniper species are typically found at lower elevations than pinyons and at sites with deeper soils (Dahms and Geils 1997). One-seed juniper (*Juniperus monosperma*) is the most common juniper below the Mogollon Rim. Other juniper species that are found in Arizona include Rocky Mountain juniper (*J. scopulorum*) and Utah juniper (*J. osteosperma*) in northern Arizona, and alligator juniper (*J. deppeana*) in southern Arizona which is also associated with Madrean oak woodlands (Brown 1994, Gottfried 1992).

Figure 5. Pinyon-Juniper Woodlands

Understory vegetation is dependent primarily upon rainfall and soil type. Herbaceous vegetation is the main understory component consisting of cool and warm season grasses and forbs such as several of the grama grasses (*Bouteloua* spp.), vine mesquite (*Panicum obtusum*), Arizona fescue (*Festuca arizonica*), squirrel tail (*Elymus elmoides*), buckwheats (*Eriogonum* spp.), and globemallows (*Sphaeralcea* spp.). These and other grasses provide the necessary forage for livestock and wildlife. Important shrubs in the understory include cliffrose (*Cowania mexicana*), Mormon tea (*Ephedra* spp.), and mountain mahogany (*Cercopcarpus* spp.).

Annual precipitation varies from 300 to 600 mm with occasional snow precipitation. With a few exceptions the topography of the pinyon-juniper woodlands are gently rolling hills will slopes not likely to exceed 25% (USDA 2004a).

Riparian Forest

Arizona's riparian ecosystems range from sea level to 3,050 m. Riparian forests exist as a component of the forest and woodlands previously discussed in addition to other vegetation communities at lower elevations like the semi-desert grasslands and Sonoran desert. The vegetation found along riparian corridors is dependent upon availability of water throughout the year or at least during the growing season. Some riparian forests are sustained by regulated water from dam release or reservoirs.

Figure 6. Riparian Forest

Due to elevation gradient, upland community, soil type, and precipitation, riparian vegetation is highly variable. At the higher elevations, typical overstory species of narrowleaf cottonwood (*Populus angustifolia*), maple (*Acer grandidentatum*), boxelder (*Acer negundo*), and willows (*Salix* spp.) will occur along with montane coniferous species, white fir and blue spruce. The understory is comprised of various shrubs such as thin-leaf alder (*Alnus tenuifolia*), shrub willows, and choke cherry (*Prunus virens*). In the mid- to lower elevations, a mixture of deciduous broadleaf species such as Arizona sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), Goodding willow *(Salix gooddingii*), Fremont cottonwood (*Populus fremontii*), and velvet ash (*Fraxinus velutina)* dominate the forest canopy. Many of the riparian forests at the mid to lower elevation have been taken over or are in part invaded by introduced tamarisk (*Tamarix* spp.). Mesquite (*Prosopis* spp.) woodlands or bosques occupy many of the upper terraces at lower elevations.

The climatic characteristics of riparian ecosystems exhibit a wide range of conditions due to large elevation differences and distributions of associated mountain ranges, highlands, and desert valleys. Riparian ecosystem topography can vary from narrow, deep, steep-walled canyon bottoms, to intermediately exposed sites with at least one terrace or bench, to exposed, wide valleys with meandering streams.

C. Forest Landowners

The majority of forest lands (42%) are administered by USDA Forest Service, 6% by DFFM, 10% are private, 31% are tribal lands, and the remaining 10% are other public. Ownership of the riparian forests and

pinyon-juniper woodlands are almost equally divided between public and private whereas the mixed conifer forest and Madrean oak woodlands are primarily in public ownership.

Arizona does not report any industrial private forests (IPF) which are forest lands owned by timber-industry corporations. Non-industrial private forests (NIPF), which are held by individuals or private corporations, account for 10% of the state's timber and woodlands. The NIPF land is primarily used by landowners for cattle ranching. Based on state, organization, and agency records, it is difficult to quantify the number of private forest landowners in Arizona. It can be inferred based on Arizona's growing population and demand for development that a reduction in private forest land acres has occurred over the last half century. Additional information regarding trends in forest land can be found in the Forest Land Conversion section below.

D. Timber and Wood Products

Today, Arizona's forest lands comprise an estimated 19.4 million acres with an estimated 1.8 million acres, or 9%, reserved from utilization for wood products (O'Brien 2002). Reserved forests have been set aside as wilderness areas, National Parks and Monuments, and other similar areas. Timber management is permitted on the remaining 17.6 million acres of non-reserved forest lands of which all state and private forest lands are considered.

The earliest Southwest forest inventory was conducted by Woolsey in 1910, however, these and other early inventories were not comprehensive of the southwest thus it is difficult to make comparisons in acreage, densities or productivity prior to the 1950s when the U.S. Department of Agriculture, Forest Service began conducting inventories. An inventory of tree density conducted in mixed conifer forests in Arizona and New Mexico found 20.8 trees/acre in 1962 and 93.6 trees/acre in 1985/1987. These changes coincided with an increase in mixed conifer forests and a decrease in ponderosa pine and aspen forests (Johnson 1994). However, having more trees is not necessarily good from a natural resource manager's perspective. As forests grow more dense and homogenous, forest fire characteristics change as does wildlife habitat. With fire largely eliminated from western forests in the last century and harvests far below growth levels, these fire-adapted ecosystems have become at risk to stand replacing fires as well as forests dominated by vegetation in the mid-succession stages (Johnson et al. 2000).

Because of the importance of wood products in the economy, the FIA Program of the Forest Service provides additional summary information for 3.6 million acres of non-reserved timberland in Arizona (O'Brien 2002). The FIA includes statistics on biomass, volume, and growth of forest land, which is necessary to consider when discussing harvest, removal, and mortality. As an example of forest growth and removal (timber harvest) figures for the Intermountain West (includes Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Utah, and Wyoming), Figure 7 depicts the decreasing trend in removals while net growth continues to increase. While these figures are not readily available for Arizona, the trend is similar. The following discussion includes additional details that are Arizona specific.

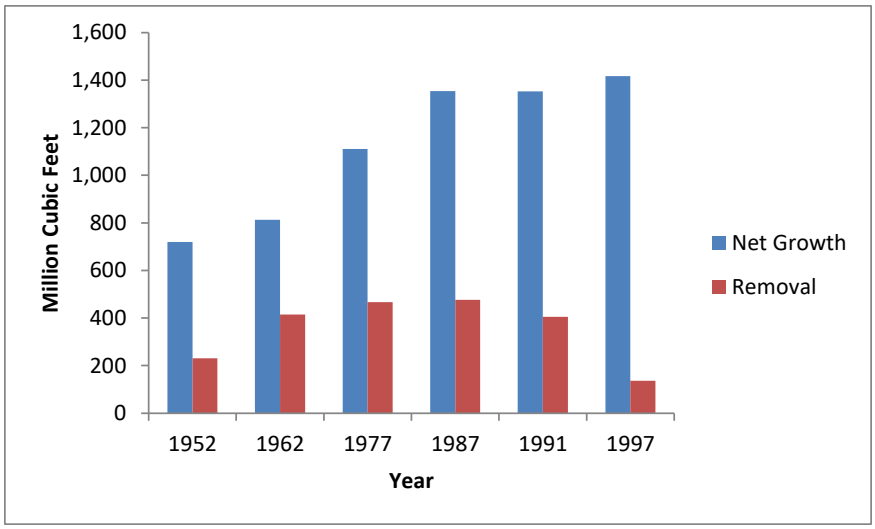

Figure 7. National Forest Net Growth and Removals, Interior West - 1952-1997. Reproduced with permission from M. Johnson. 2000. US Forest Service

To give an idea of Arizona's overall stand structure, 71% of the forest area is characterized as sawtimber, which are large tree stands with at least 10% stocking of live trees in which more than half of the stocking is from live trees with a diameter 127 mm (5.0 inches) or greater (O'Brien 2002). Relatively few stands (4%) are composed of saplings and seedlings. This pattern is consistent across land ownership. For both public and private forest lands, the pinyon-juniper woodlands is the greatest contributor to sawtimber. When considering timberland and woodland collectively, most stand characteristics are skewed toward the dominant forest type – pinyon-juniper (see O'Brien 2002).

Current timber product information is also collected by the FIA Units. For Arizona, the total volume of roundwood produced for 2002 is 12.6 million cubic feet of which 8.0 million cubic feet is from private land (this figure includes tribal forest lands) (USDA 2002). One third of Arizona's timberland, is dominated by ponderosa pine sawtimber stands and is NIPF (this figure includes tribal lands). Ponderosa pine accounts for 76% of the total sawtimber volume as well as a majority of the poletimber and sapling/seedling stand types. Tree removals were primarily for timber products (92%) with the remainder split between fuelwood and logging residue. Sawlogs accounted for the largest component (69%) of the growing stock removed, followed by pulpwood (22%). The remainder is categorized as miscellaneous wood products (O'Brien 2002). Other lands, primarily Indian Tribal Trust lands, supplied 59% of the volume removed and National Forests contributed 41%. Although ponderosa pine contributed to over 84% of the volume, overall, each individual species such as Douglas-fir, true fir, and spruce contributed proportionally to its share of the total inventory.

E. Insect Impacts

Numerous species of insects, fungi, and parasitic plants have co-evolved with trees of Southwestern forests. However, trees that are closer together tend to be more susceptible to disease and insect attack

than trees more widely spaced (Sartwell and Steven 1975). Some of these species have the ability to cause widespread tree mortality, defoliation, decay, or deformity thus acting as natural disturbance agents. These agents along with fire are some of the most important regulators of forest condition. In turn, forest condition affects the distribution and reproduction of forest insects and pathogens (Dahms and Geils 1997).

In Arizona, the species of particular interest include the numerous species of bark beetles and defoliating insects, dwarf mistletoes (*Arceuthobium*), and root decay fungi. Bark beetles are generally host specific and are present usually in low numbers but will periodically increase to outbreak levels. Rapid tree mortality is the result of successful bark beetle attacks unless the damage is restricted to only a portion of the bole (Stark 1982). Western spruce budworm (*Choristoneura occidentalis*) and western tent caterpillar (*Malacosoma californicum*) are the two main defoliating insects in Arizona. Spruce and fir trees are the principle host for western spruce budworms and can become completely defoliated when outbreaks persist for several years (Linnane 1986). The western tent caterpillar feeds on Aspen foliage and can result in extensive defoliation, growth loss, top kill, or mortality (Jones et al. 1985). Moreover, research has demonstrated that bark beetles, mountain pine beetle, Douglas-fir beetle, spruce budworm, and dwarf mistletoe are pests that tend to increase in denser forests (see Johnson 1994).

III. Arizona's Forest Resources (non-timber)

Timber production has historically been and likely will always be the primary function and definitively the most consumptive use of Arizona's forests. However, forest land serves other anthropogenic purposes such as recreation, tourism, mining, and grazing. Perhaps more importantly, forest lands contribute to the overall functioning of ecosystems by playing a vital role in the watershed. Arizona's forest lands, often surrounded by semi-arid landscapes, provide critical habitat to a suite of forest obligate wildlife.

A. Recreational, Cultural, and Scenic Resources

Recreation and tourism use of forest lands has been steadily increasing for many western states, Arizona in particular. Recreation is one of the primary uses of Arizona's forests, offering opportunities such as sightseeing, hiking, cross country skiing, bird watching, hunting, horse-back riding, and fishing. Most any place in Arizona (non-tribal areas) is within 8 km of land open to the public for a variety of recreational activities. There are over 3.8 million acres designated as wilderness within Arizona (a portion of this would be classified by the U.S. Forest Service as reserved forest land) and several thousand more acres managed specifically for resource protection (i.e., Area of Critical Environmental Concern, National Conservation Areas).

Not only do the forests draw many out of town visitors, many Arizonians use the forests for cool retreats in the summer. The Arizona State Parks recently released data showing that two-thirds of Arizonians consider themselves trail users. Millions of out-of-state visitors also use Arizona's trails each year. In April

2004, Arizona Senators McCain and Kyle, introduced the Arizona Trail Feasibility Study Act. This bill would authorize the Secretaries of Agriculture and Interior to conduct a joint study to determine the feasibility of designating the Arizona Trail as a National Scenic or National Historic Trail. The trail covers 790 miles of public lands, mountains, canyons, deserts, forests, historic sites, and communities. The Trail begins at the Coronado National Memorial on the U.S.-Mexico border and ends in the Bureau of Land Management's Arizona Strip District on the Utah border. The corridor for the Arizona Trail encompasses the wide range of ecological diversity in the state, and incorporates a host of existing trails into one continuous trail.

The Southwest is an area rich is history and culture. Hundreds of landmarks throughout Arizona document the lives and traditions of Native Americans including some of the larger tribes such as the Navajo, Hopi, and Zuni. Once a part of Mexico, Arizona has many roots in Hispanic cultures and descendents. In the more recent past, historical records and artifacts from the pioneer days, gold rush, and dust bowl are documented throughout the state.

Cultural resources have been recorded through systematic surveys by the Arizona State Museum, the State Historic Preservation Office and others. Other resources have been recorded without a formal or recorded survey. These resources can encompass such items ranging in magnitude from a bone fragment, pottery shard, or bead to a well, wall foundation, or village. Cultural resources are recorded in a multitude of ways across the landscape. Details to the specific location and resource content is confidential. As one might expect, there is a greater likelihood that archeological artifacts will be found near (historic) permanent water sources. Based on information provided by the Arizona State Museum (ASM), the number of acres where cultural resources have been identified forest lands is provided in Table 1).

Table 1. Number of acres of known cultural resources on private forest lands (ASM 2004)

Forest Type	Forest Acres with Cultural Resources
Mixed Conifer Forest	3,298,616
Madrean Oak Woodlands	989,876
Pinyon-Juniper Woodlands	8,066,582
Riparian Forest	307,377

Visual resources include scenic roads, wild and scenic rivers, and national parks, forests, and trails. These select designations focus on not only the actual feature themselves but also include thousands of acres in the viewshed[2] of these scenic roads. Arizona Department of Transportation reports 22 designated parkway, scenic, or historic roads. Just under half of these special designation roads pass through forest lands. Outstanding examples include the Kaibab Plateau-North Rim Parkway which begins at Jacob Lake and traverses thorough pine, fir, and aspen forests or the Historic Route 66 which tells a tale of an emerging state and nation. The White Mountain Scenic Road passes through dense ponderosa pine

[2] The landscape which can be seen from the vantage of a particular viewpoint.

forested mountains, stretching across the Mogollon Rim while the Dry Creek Scenic Road offers spectacular panoramic views of Red Rock Country.

Streams in the desert Southwest and the riparian communities they support are a unique and important resource in Arizona. Although there are only a few free-flowing rivers remaining in Arizona, many stretches support mixed deciduous and cottonwood-willow gallery forests, offering a distinct contrast to the surrounding uplands. These relic communities are adapted to early Tertiary climates and have retreated to pockets where the warm temperate climate persists together with suitable water regimes. Even though 980 miles of river segments have been identified as suitable for wild and scenic river designation in the last decade, only the Verde River, designated in 1984, has been officially named a scenic river area (22.2 miles classified as wild and 18.3 miles as scenic). In addition to the scenic beauty of these lush areas, rivers and lakes (primarily manmade) they provide ample recreation activities such as rafting, kayaking, tubing, jet skiing, boating, and fishing.

B. Geologic Features and Mineral Resources

Arizona has some of the most impressive and striking geologic landscapes. From the Basin and Range Province in southern Arizona, up the Mogollon Rim to the mountainous Central Highlands, and across the Colorado Plateau Province in the north, 2 billion years of geologic events are evident. In each province, geology has played the dominant role in the character and structure of mountains, canyons, valleys, and cliffs. In the Basin and Range Province, desert valleys are surrounded by mountain ranges of different structural patterns and rock composition. Several “mountain-building episodes” occurred through cracking and jointing, and crushing and upward thrusting as a result of continents colliding (Chronic 1983). The Central Highlands, a diagonal swath through the middle of the state is a transition zone between the southern and western Basin and Range and the Colorado Plateau provinces and exhibits features of both. Ranges in the Central Highlands are typically clustered, narrow, shallow, with few basins. The Colorado Plateau resembles a layering of flat-topped strata separated by cliffs and steep slopes.

The geological history of Arizona is described over four eras, the Proterozoic, Paleozoic, Mesozoic and Cenozoic History, in several excellent resources (see Chronic 1983, Smiley et al. 1984, Nations and Stump 1996). Common sedimentary rocks of Arizona include sandstone, shale, conglomerate, limestone and caliche; common igneous rocks include granite, monzonite, basalt, andesite, dacite, and rhyolite; metamorphic rocks common to Arizona are marble, quartzite, greenstone, gneiss, and schist. The Colorado Plateau reveals a coherent geological history of 600 million years and more. The Grand Canyon through which the Colorado River runs, is the most popular and famous geological feature in the Colorado Plateau. Others include Sunset Crater, Painted Desert, Kaibab Plateau, Marble Canyon, and the Vermilion Cliffs. One of the most distinctive features of the Central Highlands is the Mogollon Rim. Other interesting geological features include Oak Creek Canyon, Verde Valley, Superstition Mountains, and the Salt River Canyon. The Basin and Range Province is were most of the copper mining occurs. Some noteworthy geological features in this province include Sand Tank Mountains, Dos Cabezas Mountains, Chiricahua

Mountains, the lower Colorado River floodplain, Black Mountains, San Pedro River Valley, Hualapai Mountains, and Katchners caverns (Chronic 1983).

Mining in Arizona began in earnest during the 1870s and 1880s. Arizona led the nation in value of non-fuel minerals produced for many years, primarily because of the abundance of copper and copper-related minerals (AZGS 2004). About 65% of the nation's copper is mined in Arizona. While copper mining dominates the mineral output, precious metals (gold and silver) contributed 2% of the state's total mineral production (Goerold 1989). In 1998, Arizona produced $3.03 million worth of energy and mineral commodities (Phillips et al. 2000). The mining industry in Arizona is dominated by the following five companies: ASARCO, AZCO, Cambior, Grupo Mexico, and Phelps Dodge. Other metallic commodities produced, listed in order of decreasing value, include gold, silver, molybdenum, and lead. Non-metallic (industrial or construction related) minerals produced include sand and gravel, crushed stone, clay, cement, gypsum, lime, perlite, pumice, and salt. Arizona's turquoise, peridot, petrified wood, azurite, and malachite are world-famous (AZGS 2004). Arizona produces energy resources such as coal and small quantities of petroleum and natural gas. Uranium output is extracted from several underground mines near the rims of the Grand Canyon. There are also several thousand thermal springs and wells throughout the state with a higher concentration south of the 20^{o}C ground-water isotherm (Witcher et al. 1982).

C. Grazing

Nearly all of Arizona's woodlands -- pinyon-juniper, juniper, Madrean oak, and mesquite woodlands -- are considered rangelands. All forest and woodland communities were historically or are currently used for grazing (Conner et al. 1990). Grazing occurs on private land as well as public land under a fee permit system. Cattle are the primary livestock grazers but sheep, goats, horses, and burros are also found in smaller herd sizes throughout the state.

The woodlands are primarily used for grazing during the winter and cattle are moved to higher mixed conifer forests during the summer. Numerous studies have documented the impact of grazing in riparian areas (see Kauffman et al. 1983, Elmore and Kauffman 1994, and Ohmart 1996) thus, a concerted effort has been made to reduce the number of livestock and the time in which cattle graze in these fragile habitats.

D. Watershed Resources

Arizona's forest lands, whether it is in large landscapes across the Mogollon Rim or in the isolated mountain islands of Southeastern Arizona, are of critical importance to the economy, wildlife, and watershed. As the population of Arizona increases, the demand for water also increases. Over the last several decades, water has become the most *significant* and fragile resource in Arizona.

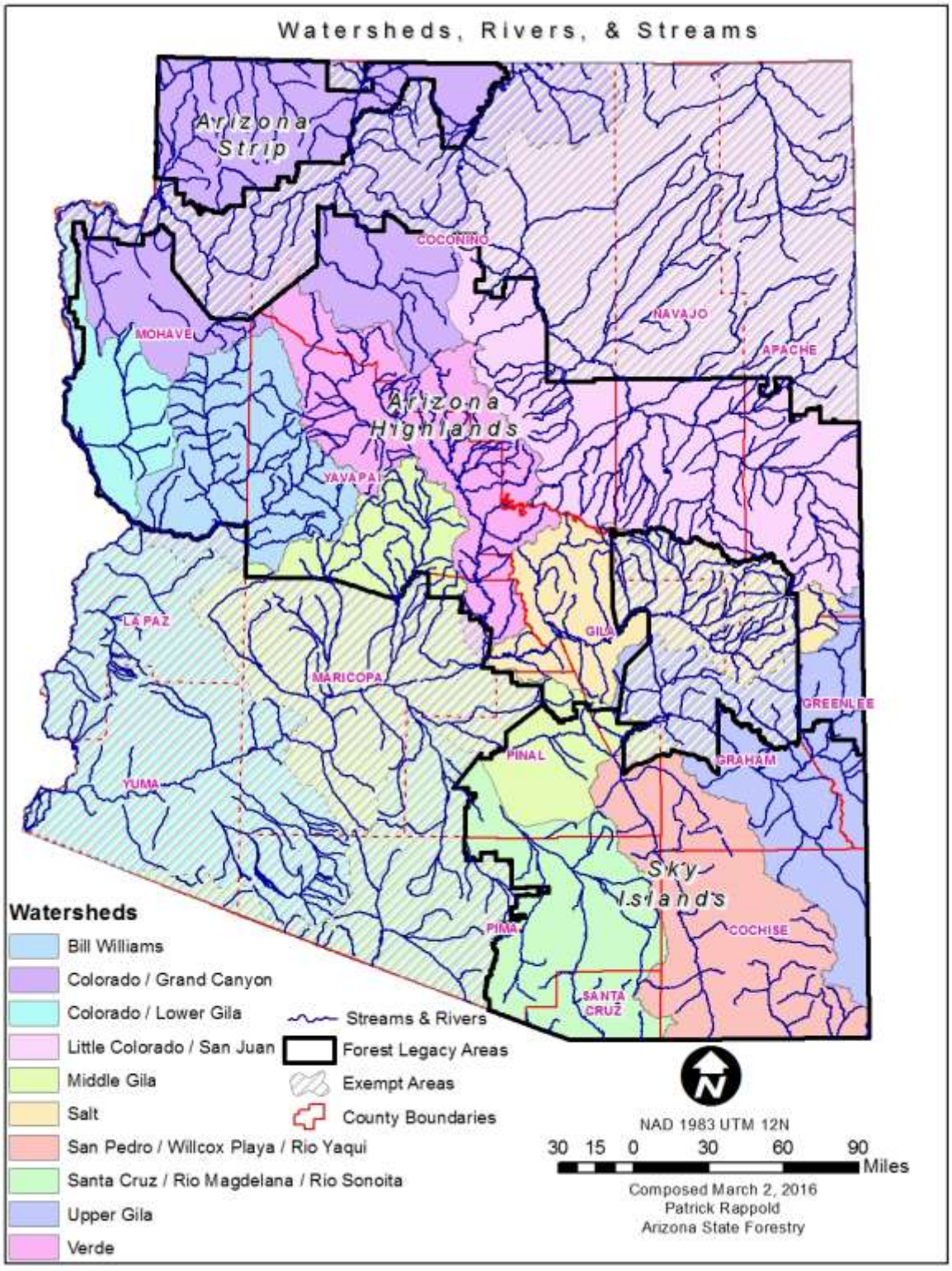

Figure 8. Watershed, stream, and river map

Most of the streams in Arizona have their headwaters in mixed conifer forests and are often perennial; watershed management of this forest type is essential to numerous economical and ecological resources. Lower in elevation, particularly in the Madrean oak and pinyon-juniper woodlands, there are few perennial streams, most flow only during snow melt and following heavy monsoon rains as groundwater in the woodlands is typically deep and in limited supply (USDA 2004b). The Southeastern Arizona watersheds of the oak woodland are important for municipal and domestic water for communities such as Safford and Tombstone (USDA 2004b). Much of the runoff from the oak woodlands around the Mogollon Rim contributes to the Salt and Verde Rivers, which supply much of the Phoenix basin.

The Arizona Watershed Program (AWP) is a joint initiative and research network for public agencies and private groups interested in obtaining more water for future economic growth while maintaining the state's watersheds in good condition. The primary focus of the AWP is to work with the USDA Forest Service, their cooperators, and others to obtain and extrapolate research findings on water yield improvement to large-scale watershed management practices designed to increase water yields by manipulating vegetative cover. This collaborative program was the focus of watershed research in Arizona through the 1960s, 1970s, and into the early 1980s (USDA 2004a).

E. Fish and Wildlife Habitat

Wildlife communities tended to be more diverse prior to European settlement (Covington et al. 1994). Changes in community structure and composition as well as size have lead to some species bieng extripated, others have declined, and some have even increased. Species that prefer open forests such as Grace's warbler (*Dendroica graciae*), Western wood-pewee (*Contopus sordidulus*), and chipping sparrow (*Spizella passerina*) may have declined (Finch et al. 1977).

From information provided by the Arizona Game and Fish Department, 391 federal and state threatened and endangered species and agency sensitive species have been identified on private forestlands. Of the threatened, endangered, and sensitive species, there are 230 plants, 131 vertebrates, and 40 invertebrates. Thirty-two different endangered species occur on private forest land, 14 threatened, and 10 species are proposed as candidates for listing. Cochise County has the highest diversity and number of occurrences of these special status species and Yuma County the lowest.

Mixed Conifer Forest

The more open canopies in woodland, ponderosa pine, and mixed conifer forests favor wildlife species such as deer, bighorn sheep (*Ovis canadensis*), songbirds, and small rodents. Game animals occurring in mixed conifer forest include elk (*Cervus elphus*), mule deer (*Odocoileus hemionus*), black bear (*Ursus americanus*) and wild turkey (*Meleagris gallopavo*). Some raptures such as the Northern goshawk (*Accipiter gentilis atricapillus*) prefer forests with more closed canopies; others such as the Mexican spotted owl (*Sirix occidentalis lucida*) prefer habitats with vertical structure, as provided in steep canyons or tall, diverse forests. Other birds on upper elevation forests include bald eagles (*Haliaeetus leucocephalus*), great horned owl (*Bubo virginianus)* Northern three-toed woodpecker (*Picoides tridactylus*), and Williamson sapsucker (*Sphyrapicus thryoideus*). The listing of Mexican spotted owl and other threatened species such as the Northern Goshawk, curtailed timber harvesting in the early 1990s.

Madrean Oak Woodland

In Arizona, the principle habitat for white-tailed deer (*Odocoileus virginianus*) and coati (*Nasua nasua*) is Madrean oak woodlands. Indicative mammals of the Madrean oak woodland include yellow-nosed cotton rat (*Sigmodon ochrognathus*), Southern pocket gopher (*Thomomys umbrinus*), and Apache squirrel (*Sciurus nayaritensis*). Other characteristic fauna include Montezuma quail (*Cyrtonyx montezumae*), Mexican jay (*Aphelocoma ultramarina*), blue grouse (*Dendragapus obscurus*), ridgenose rattlesnake (*Crotalus lepidus*), and Clark's spiny lizard (*Sceloporus clarkii*).

Pinyon-Juniper Woodland

Several native ungulates -- deer, elk, and pronghorn antelope (*Antilocapra americana*) -– depend on the understory grasslands of this forest type for forage. Small mammals characteristic of the pinyon-juniper woodland include several species of skunks, badgers (*Taxidea taxus*), pinyon mouse (*Peromyscus truei*), Arizona grey squirrel (*Sciurus aruzibebsus*), and grey fox *(Urocyon cinereoargenteus*). The open spaces between trees makes excellent hunting areas for numerous raptors like the Cooper's hawk (*Accipiter cooperii*), Northern harrier (*Circus cyaneus*), and red-tailed hawk (*Buteo jamaicensis*). Only a few bird species are closely associated with the pinyon-juniper woodland they include pinyon jay (*Gymnorhinus cyanocephalus*), gray flycatcher (*Empidonax wrightii*) and gray vireo (*Vireo vicinior*).

Riparian Forest

Perennial sources of water in the semi-arid Southwest are vital to Arizona's biological richness. In Arizona and New Mexico, over 65% of the animals depend on riparian habitats during all or part of their life cycles (Dahms and Geils 1997). Some riparian obligate species include beaver (*Castor canadensis*), leopard frogs (*Rana* spp.), and numerous waterfowl.

Many mammals i.e., coati, ring-tailed cat (*Bassariscus astutus*), and deer use protective cover of riparian forests as migratory corridors. Several species of bats, particularly myotises, inhabit riparian forests. Most of Arizona's native fish depend on the overstory canopy to keep water temperatures and dissolved oxygen optimal. Some common native fish include several species of dace (*Rhinichthys* spp.), suckers in the genus *Catostomus*, and several species of chub (*Gila* spp.).

Arizona Partners In Flight reports that approximately 238 of the more than 500 species of birds found in Arizona are neotropical migrants (AZGFD 2004). While not all bird migrants in Arizona use riparian corridors as migratory routes, this is the predominate pathway for some of the more illusive species like the Southwestern willow flycatcher (*Empidonax traillii extimus*) and Abert's towhee (*Pipilo aberti*) and familiar birds such as hummingbirds, swallows, warblers, and orioles.

F. Forest Soils and Productivity

Volcanic basalt and cinders are the most common soil parent materials in Arizona (57%), although sedimentary soils (43%) are also found throughout Arizona's forests. The topography of Arizona's forests

are characterized by extensive flat, rolling mesas, intermixed with steeper, mountainous terrain, and a diversity of slope and aspect combinations (USDA 2004a).

Mixed Conifer Forest

Mollic Eutoboralfs are the most extensive soils in mixed conifer forests. These soils are moderately deep to deep, stony to cindery, vary in origin, well drained, and have textures ranging from loam to clay (USDA 2004b). The deep soil materials allow for deep water penetration and storage. The physical properties of the soil, and thus its moisture-retaining capacity, play an important role in the development of ponderosa pine, possibly more than the chemistry of the soil itself (USDA 2004a). Increased water at a site and high water tables associated with springs tends to increase site productivity regardless of the soil type and landform (USDA 2004a).

Madrean Oak Woodland

Ustolls, ustalfs, and aqualfs are the common soils in the Madrean oak woodland mesic temperature regime. The Ustolls can be very shallow to moderately deep, have a medium to fine texture, and be gravelly and cobbly. Ustalfs tend to be deep, fine textured and range in percent composition of gravel. Aqualfs are also deep but very gravelly and fine textured (USDA 2004b).

Pinyon – Juniper Woodland

The soils in the pinyon-juniper woodlands are mostly Haplustalfs and Argiustolls with a smaller portion covered by Haplustolls (USDA 2004b). Soils are derived from basalt, limestone, and sandstone parent material and vary in texture, depth, and mineralogy (USDA 2004a).

Riparian Forest

The surrounding uplands, parent material, and soils influence the riparian soils. At the higher elevations riparian soils generally consist of consolidated or unconsolidated alluvial sediments from parent materials of the surrounding uplands. Soil depths are variable and depend upon stream gradient, topographic setting, and parent materials. Soils on the flood plains at lower elevations consist of recent depositions, tend to be uniform within horizontal strata, and exhibit little development (USDA 2004a).

IV. Forest Trends and Threats

The USDA Forest Service has been providing figures for forest area since 1953 with estimates back to 1630, which are based on partial inventories, or estimates from surveyors' data (see Smith et al. 2001 p. 65 for further details on forest area information resources). It is important to note that the figures reported here are based on gross estimates and make comparisons over time difficult because of the variety of sampling design and intensity, and survey standards and definitions used over time. In 1938, an estimated 20.1 million acres of total forest area were reported by the U.S. Congress and in 1997, the USDA Forest Service estimated 19.4 million acres; a loss of 3.4% in forest land (USDA 2003b). An estimated 1.3

million acres of private timberland was reported in 1953 (36.4% of all timberland in 1953) and by 2002, the area declined by 18.2% to 1.1 million acres. This loss far exceeds the loss of 2.6% in total timberland for all owners (USDA 2003b).

During this same time period (1953-2002), the net volume of all growing stock on private timberland grew from 148 to 1,941 million cubic feet, an increase of over 1,200% (USDA 2003b). When comparing this to the increase of 29.7% in net volume of growing stock for all land owners, it becomes evident that forest land is being cleared for timber products and most likely development.

In the 2002-2003 Annual Report, the ASLD documents over 4 million acres in state forest land. These lands are managed to maximize and sustain income but also to enhance wildlife, watershed, range and open space values. The ASLD also provides technical, educational, and financial support to private landowners in the management of their forest lands. Arizona participates in several of the cooperative forestry programs and assisted 1,112 landowners during the 2002-2003 fiscal year bringing the total acres of private forest with cooperative forestry management plans to 1,136,800 (ASLD 2003).

The National Association of State Foresters summarizes information for all state and private forests across the United States. Arizona's forestry funding support for 2002 was a fraction of the other four-corner states, totaling under $4 million dollars compared to 25.6 million average for the other three states (NASF 2002). In Arizona, like most other western states, fire control, prevention, and management are the largest expenditures for forestry programs.

A. Demographics

Increasing population and economic growth over the last 35 years has had, and will continue to have consequences for natural ecosystems in Arizona. Unless profound efforts are made to conserve lands of strategic importance to biodiversity and environmental sustainability rather than plowing them under for housing and paving them over for commercial development projects, the wild and scenic landscapes that support wildlife and the human spirit will cease to exist.

From 1970 to 2000 Arizona's population grew by 3,370,362 people, a 188% increase (U.S. Census Bureau 2000). That growth has increased even more dramatically in the last four years with the current population now estimated at 5,435,675 people, making Arizona the second fastest growing state in the U.S. behind Nevada. Based on current rates of population growth, Arizona's projected population for 2050 is 11.2 million people; see Figure 9 (U.S. Census Bureau 2000).

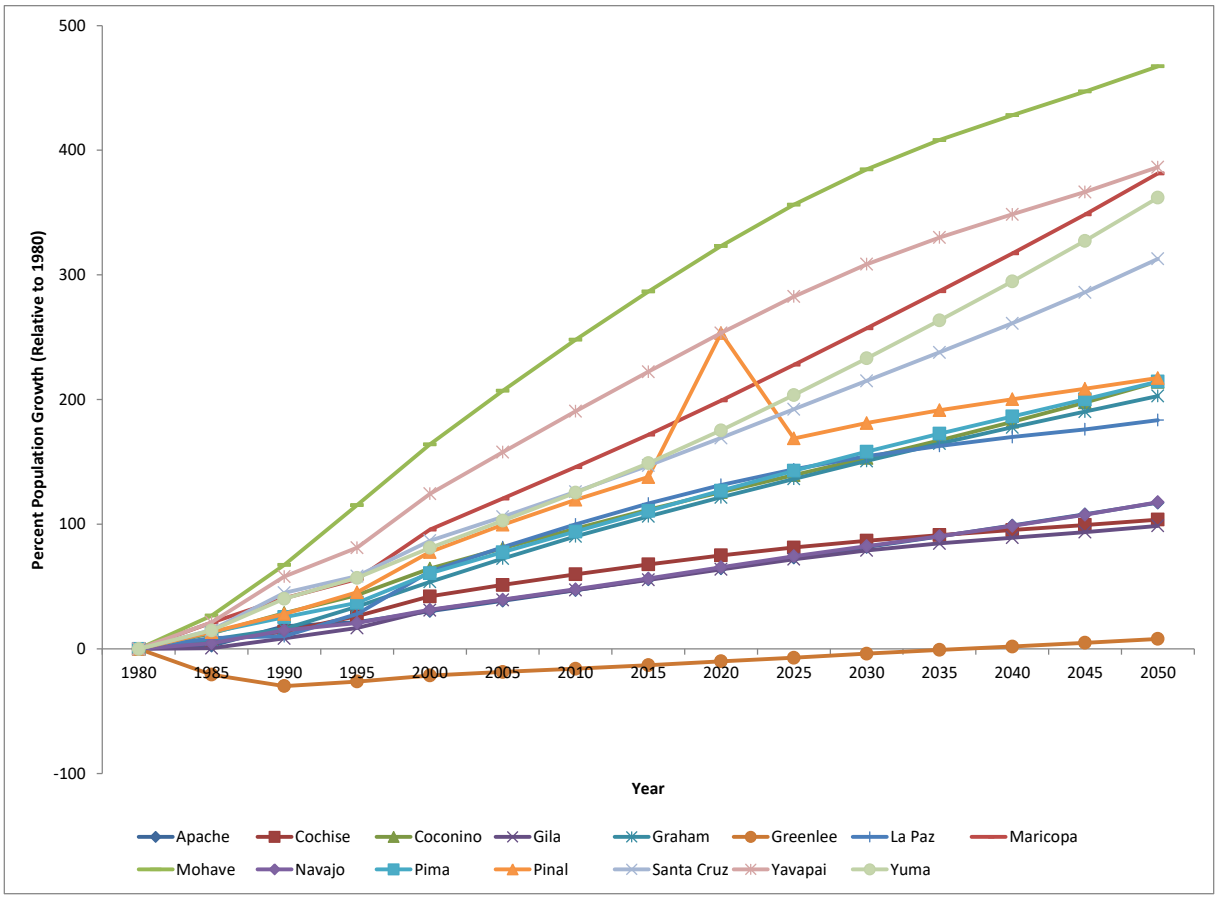

Figure 9. Actual and projected percent population growth relative to 1980, by county (1980-2050)*

B. Changes in the Economy and Forest Land Conversion

A report by the American Farmland Trust, *Strategic Ranchland in the Rocky Mountain West Mapping the Threats to Prime Ranchland in Seven Western States,* found that over 1.3 million acres of Arizona's best ranchland is at risk of being converted to low-density development in the next 20 years (AFT 2004). This land is not only economically important to Arizona, but is ecologically and culturally important as well. Net income from farming and ranching dropped from $565 million in 1970 to $377 million in 2000 – a decrease of 33% (Figure 10). Compared to other industry sectors, the farming and agriculture industry has had a net loss of new income between 1970 and 2000 while the services and professional industry which includes construction, real estate and trade has increased new income during this same time period by 48% (Figure 11). And while all other segments of Arizona's economy have been booming, the farm sector has lost nearly 5,000 jobs in the last 30 years.

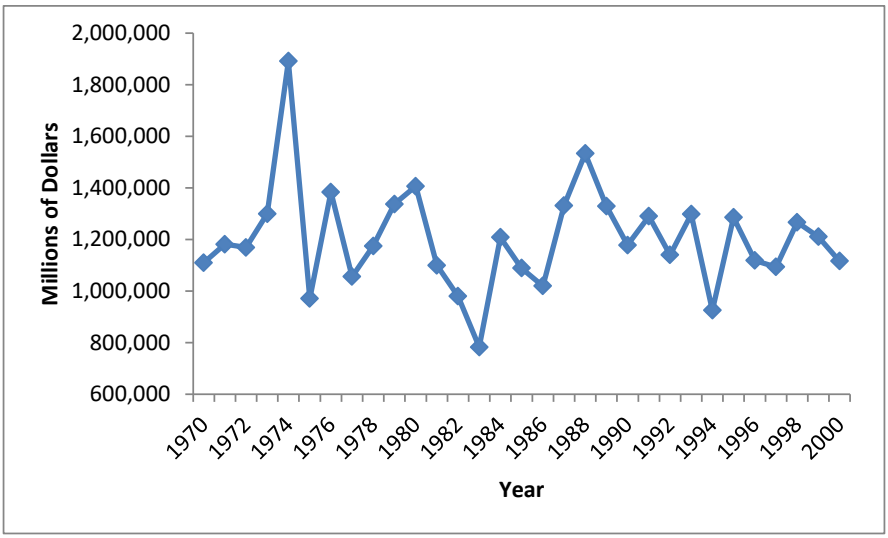

Figure 10. Labor earnings from farming and ranching in Arizona; 1970-2000. Source: Headwaters Economics, Economic Profile System

Furthermore, due to a variety of circumstances including drought, fire suppression, climate change, and falling beef prices, ranching as a livelihood has been declining in the latter half of the 20th century. For these reasons and others such as overgrazing, many publicly owned, privately leased grazing allotments are not being re-issued. Consequently, many ranchers are selling their land to others who often subdivide the land into smaller parcels for development.

Agriculture has a long history in Arizona. In fact, cattle, cotton, and citrus make up three of the "Five C's" that have long been considered the driving force behind Arizona's economy. As the top industry in Arizona, agriculture (which includes ranching and forestry) produces over 18% of the nation's lettuce crop; in fact agriculture and related industries contribute over $4.5 billion dollars to state reserves (AFT 2004). Despite these impressive numbers, however, some of the best agricultural lands in Arizona are being lost to unplanned sprawling development. Due to drought and falling prices for beef, many Arizona farmers have begun to sell their water rights and irrigated land to nearby communities, especially as land and water sales are becoming more profitable than agriculture itself. A similar pattern is reflected in the higher elevation forestlands.

The Grand Canyon State faces many problems typical of states with a successful economy: an influx of new citizens building primary and secondary homes in and near fast growing cities like Phoenix and Tucson. As urban areas grow and sprawl, city dwellers seek cooler forest elevations for reprieve from the desert heat as well as for the recreational opportunities. Many of these second homes are built upon subdivided forest land parcels, offering low-density rural development with roads and fences fragmenting the landscape. In the American Farmland Trust report, *Strategic Ranchland in the Rocky Mountain West Mapping the Threats to Prime Ranchland in Seven Western States* (2004), Pinal County was identified as 1 of 25 counties in the seven western Rocky Mountain States with strategic ranchlands most at risk.

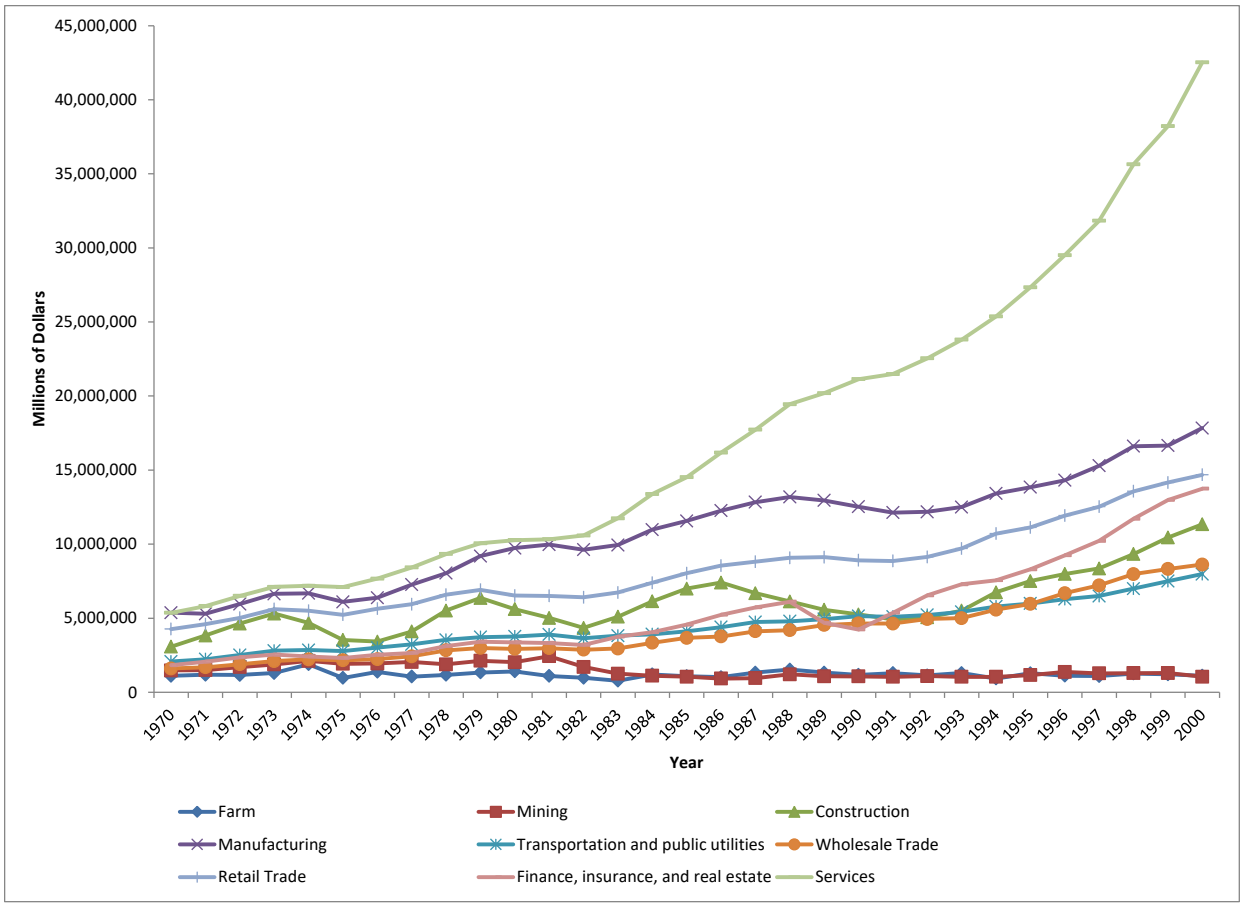

Figure 11. Labor earnings by industry sector; 1970-2000. Source: Headwaters Economics, Economic Profile System

Private forest land near smaller communities found at higher elevations are also quickly being subdivided, sold, and developed. Open space in the White Mountains and Verde Valley are selling at a premium price. From Century 21 listings in the White Mountains, land is ranging in price from $10,000 to $30,000 per acre. Residential building permits for the City of Show Low were 174 in 2001 compared to the surrounding towns of Snowflake with 46 permits and Pinetop-Lakeside with 56 permits (White Mountain Regional Development Corporation 2004). In the Prescott area, construction of new single-family homes has been steadily increasing; in 1996 there were 241 permits granted and by 2002, that number increased to 636 permits issued (City Data.com 2004). Similar trends are occurring in Prescott Valley and Chino Valley. Information from these sources also indicates that the average cost of new single-family homes has more than doubled over this six-year time frame. Based upon site visits and real estate searches, areas around Heber and Overgaard are actively growing but because these towns are unincorporated, accessing building permit records was not feasible. Other small towns such as Sonoita and Elgin are also growing by converting open space into low-density housing yet approximate figures are not available.

C. Resources Most Vulnerable

Many natural and cultural resources are at risk of degradation, destruction, or elimination. Some of the resources most vulnerable to forest conversion or fragmentation include forest obligate animals and their vegetation community habitats, ecosystem processes such as decomposition and infiltration, and archeological sites in riparian forests. Numerous other ecological and economical resources in private forestland are also susceptible to damage or depletion once conversion of forest land to non-traditional forest uses commences.

Regular economic and environmental analyses point to the diminishment of Arizona's natural resources and scenic lands:

> "The State of the Environment for 2002 published by the Sierra Club reports that development consumes one acre an hour in Maricopa County and one acre every two hours in Pima County. As we continue this pace of conversion of land from natural habitat to the built environment we threaten the natural resources we value"
>
> – Arizona Open Land Trust

> "The American West is undergoing rapid land use change, especially on the 170,000 square miles of grazed grasslands and woodlands in private ownership. These lands, rather than the higher elevation public lands managed by federal agencies, hold most of the biodiversity of our region. And yet, as they are rapidly developed and fragmented, their value as large intact wildlands is being immeasurably diminished. A recent study of land subdivision and habitat fragmentation in northern Arizona – commissioned by the Arizona Cattle Growers' Association – reveals just how much is currently being lost. Since 1959, 2.2 million acres of private lands in northern Arizona along the I-40 corridor have been platted or sold."
>
> – Center for Sustainable Environments, Northern Arizona University

V. Protection of Arizona's Forest Lands

A. Protected Forest Land in Arizona

Almost half (46%) of Arizona's forest land is managed by the Department of Agriculture or Interior and has some level of natural resource conservation. The Gap Analysis Program (available online at http://www.gap.udaho.edu/handbook) assigns a management status category to the land units irrespective of land ownership. The ranking system consists of four categories (Scott et al. 1993) that relate to the strength of designation with respect to maintenance of biodiversity values:

Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of

natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (*e.g.*, logging) or localized intense type (*e.g.*, mining). It also confers protection to federally listed endangered and threatened species throughout the area.

Status 4: There are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout.

Based on a spatial analyses of the Arizona Gap management status, 2.3 million acres of forestlands are identified as offering protection status. As a forest type, pinyon-juniper woodlands represent 69.3% of the acres with protection status of Gap 1 and 2. Within any given forest type, Madrean oak woodlands has the largest percent of total forest land in protection status Gap 1 and 2 (19.9%), and mixed conifer forest has the smallest (7.6%) amount of land afforded Gap protection status 1 and 2.

In Arizona, The Nature Conservancy (TNC) identified over 8.1 million acres of forest habitat for conservation during their ecoregional assessments. Of this forest habitat identified, 23% (1.85 million acres) have Gap status 1 or 2. Of this selected forest habitat, 9.0% is in private ownership.

B. Conservation Easements in Arizona

Numerous conservation easements are held by a variety of land trust organizations, local, state, and federal agencies, and other interested parties concerned with preservation of open space and natural ecosystems. Through various means, land trusts have conserved over 3.2 million acres in the United States (Land Trust Alliance 1998). While each entity holding conservation easements may have information regarding the total number of acres conserved, there is no statewide clearinghouse of such information nor would this information be partitioned according to the forest types identified within the AON, thus, only a few examples are provided below. According to the latest records for The Nature Conservancy's (TNC) Arizona chapter, 42,000 acres of private land have conservation easements held by TNC. The Malpai Borderlands Group holds conservation easements on 75,000 acres of private land in southeastern Arizona and southwestern New Mexico. Grand Canyon Trust holds conservation easements on 12,500 acres, primarily in northern Arizona. While the Trust for Public Land is active in Arizona, they work primarily with

local land trusts, which in turn hold the conservation easements. Thirteen percent of Arizona is State Trust Lands and information regarding conservation easements on this land is not available.

Land trusts are nonprofit organizations, as described in 501(c) of the Internal Revenue Code of 1986 that protect land by working with landowners who wish to donate or sell fee title or conservation easements to maintain conservation values associated with the land (USDA 2003a).

The following are some of the land trusts and conservation organizations working individually and collectively to preserve land for the protection and sustainability of Arizona's rich bio-diversity, wildlife habitats, scenic and recreational areas, and economic diversification:

Arizona Open Land Trust
1915 E Camino Miraval
Tucson, AZ 85718-4950
Phone: (520) 577-8564
Founded: 1978
www.aolt.org

The Arizona Open Land Trust (AOLT) protects Southern Arizona's vanishing western landscapes and wildlife habitat by acquiring and managing sensitive lands, and supporting their mission through appropriate legislation, public education, and outreach. The trust operates in Pima, Pinal, Santa Cruz and Cochise counties

Black Mountain Conservancy
PO Box 7192
Cave Creek, AZ 85327-7192
Phone: (480) 575-5835
Founded: 2000
www.blkmtnconservancy.org

The Black Mountain Conservancy is a nonprofit, 501(c)(3) volunteer organization dedicated to preserving, in perpetuity, the undeveloped land on and around Black Mountain. The vision of the Conservancy is to protect, preserve, and restore for the public benefit, a unique mountain for current and future generations.

Cascabel Hermitage Association
6146 N Canyon Road
Benson, AZ 85602-8333
Phone: (520) 212-2473
www.cascabelhermitage.org

The Cascabel Hermitage Association (CHA) acquires and holds real property in trust under the Saguaro-Juniper Covenant, makes the land available for solitary meditation, and holds conservation easements. It

thereby provides a Sonoran desert wildlands habitat for fully interfaith solitary contemplation, as well as other solitary educational and creative activities that require sustained concentration and stillness.

Central Arizona Land Trust
PO Box 1050
Prescott, AZ 86302-1050
Phone: (928) 445-7790
Founded: 1989
www.centralazlandtrust.org

The Central Arizona Land Trust is a private, non-profit organization established in 1989. They seek to preserve ranchlands, open space and the scenic and wildlife values of central Arizona in partnership with landowners who wish to protect their land in perpetuity.

Desert Foothills Land Trust
PO Box 4861
Cave Creek, AZ 85327-4861
Phone: (480) 488-6131
Founded: 1991
www.dflt.org

The Desert Foothills Land Trust was established to protect and preserve the unique and sensitive land areas of the Sonoran desert foothills containing the Carefree, Cave Creek, New River and far North Scottsdale communities. As a non -profit, volunteer organization, the Trust protects land through gift, purchase, bequest, and conservation easement for the edification and enjoyment of current and future generations. The Trust works to ensure the survival of the unique plant and wildlife of the fragile Sonoran desert.

Diablo Trust
PO Box 31239
Flagstaff, AZ 86003-1239
Phone: (520) 523-0588
Founded: 1993
www.diablotrust.org

The Diablo Trust, a not-for-profit 501 (c) (3) corporation, is an Arizona Land Management Team and National Reinventing Government Laboratory. Covering 426,000 acres of mixed ownership property, the Trust began in 1993 when two long-time Arizona ranches, the Bar-T-Bar and the Flying M Ranch, asked people for ideas to assist them in the protection of open spaces and healthy habitats. Today the Trust provides a forum for the community to actively participate in a land stewardship process. Additionally, the ranch lands provide "hands-on" proving grounds for new, collaborative land management ideas.

Grand Canyon Trust -Flagstaff - Headquarters
2601 N. Fort Valley Road
Flagstaff, Arizona 86001
Phone: (928) 774-7488
www.grandcanyontrust.org

Grand Canyon Trust focuses its conservation work in the canyon country of the Colorado Plateau. Here lies the nation's greatest concentration of national parks and monuments, evidence of the special status society has conferred on this spectacular region. Their mission is to protect and restore the Colorado Plateau – its spectacular landscapes, flowing rivers, clean air, diversity of plants and animals, and areas of beauty and solitude.

McDowell Sonoran Land Trust
PO Box 14365
Scottsdale, AZ 85267-4365
Phone: (480) 998-7971
Founded: 1990
www.mslt.org

Since 1990, the McDowell Sonoran Land Trust has worked through the citizens of Scottsdale to protect the McDowell Mountains and adjacent Sonoran Desert through lands donations and acquisition. Today, preservation of the original 16,460 acres of the McDowell Sonoran Preserve is almost complete and the Trust is starting to focus on the acquisition and preservation of an additional 19, 940 acres of mountain and desert lands.

The Nature Conservancy, Arizona Field Office
1510 Fort Lowell Road
Tucson, AZ 85719
Phone: (520) 622-3861

The Nature Conservancy's mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. For more than 35 years, The Nature Conservancy in Arizona has been working locally with communities, businesses and the people providing hope for the preservation of our land, our water, our way of life. A few of the ways by which we achieve our mission include, but are not limited to land acquisition, conservation easements, debt for nature swaps and conservation trust funds. The Nature Conservancy's work in Arizona is varied and stretches across five landscapes: the Apache Highlands, Arizona and New Mexico Mountains, Colorado Plateau, Mojave Desert, and Sonoran Desert.

Southeast Arizona Land Trust
PO Box 116
Sonoita, AZ 85637-0116
Phone: (520) 455-5592
Founded: 1994

The focus of Southeast Arizona Land Trust is on protecting and/or restoring 142,000 acres of land roughly south of Tucson and east of Tohono O'Odham Reservation.

Superstition Area Land Trust
PO Box 582
Apache Junction, AZ 85217-0582
Phone: (480) 983-2345
Founded: 1993
www.azsalt.org

The Superstition Area Land Trust's primary mission is to assure the long-term conservation, preservation and management of natural open spaces surrounding the Superstition Wilderness Area in Pinal and Gila counties through education, advocacy, land acquisition, federal and state lands protection and other conservation actions.

Trust for Public Land
409 E. Palace Avenue
Santa Fe, NM 87501
Phone: (505) 988-5922
www.tpl.org

The Trust for Public Land is a national non-profit land conservation organization headquartered in San Francisco. TPL's mission is to conserve land for people to enjoy as parks, gardens, and natural areas, ensuring livable communities for generations to come. Working with Arizona communities, leadership and landowners since 1980, TPL has helped preserve almost 200,000 acres of urban open space, sites of cultural and historic significance, working lands and wilderness.

Verde Valley Land Preservation Institute
PO Box 2226
Sedona, AZ 86339-2226
Phone: (928) 821-3905
www.verdevalleylpi.org

Verde Valley Land Preservation Institute is an Arizona nonprofit corporation operating within the Verde Valley of Arizona for the purpose of acquiring, managing and enhancing the natural open space in the Verde Valley region. Their mission is to develop and implement immediate and long-range strategies to preserve and enhance the natural open space of the Verde Valley. The Institute will ensure a public collaborative process involving scientific research, education, planning, and land acquisition, management, development, and preservation techniques.

Western Arizona Land Trust
49614 Highway 60
Wickenburg, AZ 85390
Phone: (928) 684-2772

The Wilderness Land Trust
PO Box 1420
Carbondale, CO 81623
Phone: (970) 963-1725
wildernesslandtrust.org

The Wilderness Land Trust has actively assisted the Bureau of Land Management with projects in four Arizona desert wilderness areas: Mount Tipton, Muggins Mountains, Swansea, and Wabayuma Peak. The BLM manages approximately 1.3 million acres of primarily desert wilderness areas in Arizona. All told, the WLT has been involved in protecting almost 1,000 acres of land in eleven separate transactions.

The Southwest Forest Alliance
P.O. Box 1948
Flagstaff, AZ 86002
Phone: (928) 774-6514
www.swfa.org

A Flagstaff based forest advocacy group that since 1994 has focused on grassroots organizing within the environmental community in Arizona and New Mexico. The Southwest Forest Alliance was formed to develop a scientifically based vision for restoring degraded forest ecosystems and to seek public support for this vision. These efforts have focused on the protection of old growth forests and damaged watersheds. An integral part of the SWFA's campaign includes public education and grassroots organization within local forest dependent communities. The SWFA mission is to chart a new course for public lands management and protection in Arizona and New Mexico focusing on restoration of degraded ecosystems through scientific research, helping forest dependent communities become self-sustaining, and increasing public awareness and involvement in land management issues.

Ecological Restoration Institute
P.O. Box 15017
Flagstaff, AZ 86011
Phone: (928) 523-7182
www.eri.nau.edu

The Ecological Restoration Institute is an independent research branch of Northern Arizona University. Since 1970, the ERI has been a pioneer in conducting research and disseminating information about restoration treatment outcomes, strategies, and techniques in the Southwest. ERI's work has greatly benefited from partnerships with the Bureau of Land Management, Forest Service, Native American tribes, and other land managers, as well as with an array of communities and academic researchers. As a result, they have gained a great deal of practical knowledge about the planning, implementation, and monitoring of restoration projects in Southwestern ponderosa pine forests.

American Farmland Trust-Rocky Mountain Region
PO Box 1417
Fort Collins, CO 80524
Phone: (800) 370-4879
www.farmland.org

American Farmland Trust is a private, nonprofit farmland conservation organization founded in 1980 to stop the loss of productive farm and ranch land and to promote farming practices that led to a healthy environment. Its action-oriented programs include public education, technical assistance in policy development and demonstration farmland protection projects. Farms and ranches in the Rockies produce everything from tender beef to prize-winning peaches, in addition to providing scenic open spaces and habitat for wildlife that residents cherish. Sadly, much of this land is under siege. Thousands of acres of high quality agricultural land and wildlife habitat in the Rockies are squandered and fragmented each year due to low-density, scattershot rural subdivisions and 35-acre ranchettes.

The Sonoran Institute
7650 E. Broadway, Suite 203
Tucson, AZ 85710
Phone: (520) 290-0828
www.sonoran.org

Over the past decade, the Sonoran Institute has assisted dozens of communities throughout Western North America, helping them realize conservation and other community goals. The Institute's community stewardship work creates lasting benefits including healthy landscapes, vibrant economies, and livable communities that embrace conservation as an integral element of their economies and quality of life.

In carrying out its mission, the Sonoran Institute 1) helps communities understand their economy within the context of global, regional, and local economic and demographic trends, 2) helps communities make an inventory of natural and cultural assets that may be affected by growth and development, 3) helps communities tailor land-use policies, conservation plans, and collaborative land management strategies to meet local needs and 4) helps communities implement economic development strategies that do not compromise natural amenities and community values.

Sierra Club-Southwest Field Office
202 E. McDowell Rd, Suite 277
Phoenix, AZ 85004
Phone: (602) 254-9330
www.arizona.sierraclub.org

The Arizona chapter of the Sierra Club was founded in 1965. The most recent priorities for the Club include:

- Protecting endangered species, wildlife and their habitat
- Improving Growth Management and Limiting Urban Sprawl

- Preserving and Protecting Arizona Wilderness areas
- Protecting the old growth Ponderosa pine ecosystem
- Eliminating unsustainable livestock grazing on public lands
- Protecting Arizona's New National Monuments

Greater Flagstaff Forests Partnership
1300 S. Milton Road, Suite 218
Flagstaff, AZ 86001
Phone: (928) 226-0644
www.gffp.org

The Greater Flagstaff Forests Partnership is a non-profit alliance of 26 environmental and governmental organizations dedicated to researching and demonstrating approaches to forest ecosystem restoration in the ponderosa pine forests surrounding Flagstaff, Arizona. The Partnership was formed through a cooperative agreement between the U.S. Forest Service and the Forest Foundation in 1998. The Partnership's three primary goals are to:

- Restore natural ecosystem structures, function, and composition of ponderosa pine forests.
- Manage forest fuels to reduce the probability of catastrophic fire.
- Research, test, develop, and demonstrate key ecological, economic, and social dimensions of restoration efforts.

Section 2

I. Eligibility Criteria for Forest Legacy Areas

According to the FLP Implementation guidelines, "Eligibility Criteria are a set of factors developed by the State lead agency, in consultation with the State Forest Stewardship Coordinating Committee (SFSCC), to evaluate geographic areas to determine if they contain significant environmental values to be considered an 'important forest area' and contain 'threats' of conversion to be eligible as a Forest Legacy Area" (USDA 2003a, p. 4). In accordance with these guidelines, TNC, in conjunction with the AFSC, clarified several definitions used in the FLP guidelines in order to tailor the program to Arizona's forest needs. The first definition is what constitutes a forest (for definition see Section I, Forest Legacy Program in Arizona). The last two definitions deal with defining 'threats' of conversion as well as 'important forest areas' for private forest land. Threatened forests are defined as any forest at risk of conversion to non-forest use by roads and/or human developments. Important forests are defined as those forests that include one or more of the following values:

- Riparian areas
- Fish and wildlife habitat and corridors
- Known threatened and endangered species
- Timber, and other forest commodities
- Scenic resources
- Public recreation opportunities
- Known cultural resources
- Other ecological values.

II. Arizona's Forest Legacy Areas

Using the above definitions of forest, threatened forest, and important forest, along with map layers showing areas with high environmental values, public values and development threats we propose three Forest Legacy Areas (FLA) for Arizona. The selection of these FLAs take into account that there are extensive areas of the state, that are not suitable by virtue of their ownership or their ecological condition. For example, Indian reservations and trust lands are protected through the trust relationship between the U.S. Department of Interior and the tribe. The extensive heart of the Sonoran Desert in southwestern Arizona is largely in public ownership or is within an Indian reservation or does not meet other criteria and thus is not included.

The three Forest Legacy Areas proposed are the Arizona Strip, Arizona Highlands and Sky Islands.

Arizona Strip: This FLA includes pinyon-juniper woodlands that are part of the larger, intact natural landscape of the Colorado Plateau. It is generally defined as the area north of the Grand Canyon National Park and the Kaibab National Forest, and west of the Navajo Indian Reservation. Subunits of the FLA are Mohave and Coconino counties.

Arizona Highlands: This FLA covers the most extensively forested region of the state. It includes the ponderosa pine forests of the Mogollon Plateau, the mixed conifer and high elevation riparian systems of the White Mountains, the forested mountains of west-central Arizona, and important riparian forests along central Arizona rivers such as the Verde, Salt, Little Colorado, Blue and Bill Williams. Forest types include conifer, pinyon juniper and riparian. The area is roughly bounded on the north by the Lake Mead National Recreation Area, the Hualapai Indian Reservation, Grand Canyon National Park and the Navajo Indian Reservation and on the south by La Paz County, Maricopa, Pinal and Gila Counties. Private lands within the Tonto National Forest, and the southern portion of Apache Sitgreaves National Forest are included. Subunits of this FLA are Mohave, Yavapai, Coconino, Maricopa, Gila, Navajo, Apache and Greenlee counties.

Sky Islands: Southeast Arizona is characterized by basin and range topography and it contains some of the state's most diverse forest habitats including mixed conifer, pinyon juniper, madrean oak woodlands and riparian. Its proximity to subtropical Mexican forests accounts for the area's high biological diversity, with many forest species reaching their northernmost limits. Important riparian forest systems include the San Pedro, Santa Cruz, and Gila Rivers and many of their tributaries and headwater areas. The FLA includes the eastern portions of Pinal and Pima counties, Gila County south of Tonto National Forest, Graham County south of the San Carlos Apache Indian Reservation, Greenlee County south of the Apache/Sitgreaves national Forest, and all of Santa Cruz County and Cochise County.

Within these three areas, all private forestlands that meet the four basic eligibility criteria are eligible for FLP participation. Individual proposals for protecting properties with FLP funding would be ranked according to the Forest Value and Threat Criteria Prioritization Process (Table 2).

A. Project Eligibility Criteria

A proposed projects eligibility to be included in the FLP include the minimum requirements below:

- **It is within, or partially within, a designated FLA;**
- **The parcel must be private or tribal non-trust allotment land and at least 5 acres in size;**
- **It has a minimum of 75 percent forestland or a documented plan that includes sufficient landowner capacity to reforest to at least 75 percent forestland;**
- **It can be managed consistent with the purpose for which it was acquired by the FLP;**
- **The landowner is willing to sell or donate the interest in perpetuity and acknowledges that the conservation easement will be held by a government entity if Federal funds are used for the acquisition;**
- **The landowner must be a willing participant and agree to have a Landowner Forest Stewardship Plan (LFSP) written for the property;**
- **The parcel must be an environmentally important forest area and must be threatened by conversion to non-forest uses.**

Once a project is judged to be eligible it will be scored and ranked in accordance with the criteria and weighting factors summarized in the evaluation form that follows. Six overarching criteria were selected

for use in the prioritization process for evaluating competing FLP projects. The criteria listed in priority order are:

- Ecological and Environmental values,
- Site viability and importance to other forestlands,
- Threat immediacy,
- Contribution to larger conservation strategy,
- Public values,
- Local support and presence of partners and/or matching funding.

The criteria can be ranked by assessing a variety of factors that contribute to each of the criteria. These factors are found in the Forest Value and Threat Criteria Prioritization Process table (Table 2).

Table 2. Forest Value and Threat Criteria Prioritization Process

Forest Value Criteria	Weight (3,2,1)	Score (1-5)	Weighted Score (Weight x Score)	Conversion Threat Criteria	Weight (3,2,1)	Score (1-5)	Weighted Score (Weight x Score)
Riparian Forest Example	3	4	12				
Riparian Forest	3			Immediacy	3		
Forest Condition	2			Road Impact	1		
Threatened, Endangered, Rare, Sensitive Species	3			Housing Density	2		
Critical Habitat	2			Subdivision Platted			
Contribution to other Conservation Program	2			Censu Block Change	2		
Protected Area Inholding	2			Property for Sale	3		
Watershed/Aquifer Recharge	3			**Total Threat of Conversion**	**11**		
Movement Corridor	2						
Total Environment and Ecological Values	**19**						
Large Block (>100 ac.)	3						
Proximity of Protected Land (>1,000 ac.)	2						
Readiness	3						
Time Limitations	2						
Affordability (Per acre Cost)	2						
Total Site Visibility Value	**12**						
Local Support	3						
Matching Funds	3						
Other Conservation Planning or Partners	3						
Total Project Support	**9**						
Scenic	2						
Recreation	2						
Cultural	2						
Economic	2						
Total Public Values	**8**						
Total Weighted Score							

Weighting factors are rated 1, 2, and 3 with 3 being the highest priority. Weighting totals reflect the relative importance of each of the evaluation categories. For example, the environmental and ecological value total weight of 19 gives the highest of the six categories. The weighting factors given above are provisional and may be modified as they are tested.

Where spatial data layers are available, criteria will be mapped in FLAs and compounded in a composite map that shows areas with a color coding system. For example properties that lie in a designated conservation area which also incorporates public values are reflected in the colorcoding of the FLA maps, as are those forests that lie in TNC conservation areas. Some map layers are not at present incorporated into the composite maps but these may be developed as the program matures and the rating criteria adjusted to reflect this improved knowledge.

Criteria lacking in spatial data layers will be evaluated according to guidelines developed by the Forest Stewardship Committee as part of the individual project evaluation process. Weightings will be reviewed and revised as necessary by the Forest Stewardship Committee. For example, critical habitat designations for threatened or endangered species are evolving as new species are listed or designations take place. Likewise the presence or absence of threatened, endangered or sensitive species on a property may also be fluid and open to new information being brought to the ranking process.

To assess a particular property's over-all ranking for FLP funding, priority will be given to areas of high forest value first regardless of the degree of threat. Threat criteria will play a secondary role in assessing over-all project ranking as illustrated by the following matrix:

High Value High Threat Priority 1	High Threat Low Value Priority 3
High Value Low Threat Priority 2	Low Value Low Threat Priority 4

Environmental and Ecological Factors

Environmental or ecological factors to be assessed about a proposal include: presence of riparian forest; forest condition; presence of threatened, endangered or sensitive species; critical habitat designated for listed species; designated conservation area; watershed or aquifer recharge area or wildlife movement corridor. Priority will be given to riparian forest and examples of other high quality forest types. Forest values also include the presence of priority wildlife such as threatened, endangered, sensitive, and species of concern as well as designated critical habitat for listed species. The presence of wildlife movement corridors where documented is also a significant value. Other special attributes that would influence

ranking include forestlands overlying water supply aquifers or contribution to watershed conditions. Building upon previous conservation planning efforts will be advantageous thus, giving higher priority to those projects that are within a pre-existing local, regional, or global conservation plan. Examples include: at a 48 local scale, areas that fall within the Pima County Sonoran Desert Conservation Plan; at a regional scale, areas within The Nature Conservancy's ecoregionally based portfolio of conservation areas; and at a global scale areas within the globally recognized biodiversity hotspot of the Madrean Archipelago.

The viability and importance of the site to other forest lands

Large blocks of land have higher ecological integrity due to their ability to maintain ecosystem level processes such as hydrologic cycling and natural fire regimes. They can also offer greater social and economic benefits due to their size. For these reasons, priority will be given to those private parcels that add to existing protected lands, such as county parks, state parks, national forests, national parks, wilderness areas, and/or other public land managed for natural resources. Likewise, priority will be given to properties which grouped together become a large intact forest block compared to smaller isolated parcels of forest land.

Local support and presence of partners and/or matching funding (Project Support)

With Arizona's increasing population and the recent boom in ex-urban development there are many areas of private forest at risk of development. Given the limited funds of the FLP, it is important to leverage funds and encourage support offered through local partnerships. To this end, higher priority will be ascribed to those projects that demonstrate local support and/or provide matching funds.

Immediacy of threats to the site (Threat Immediacy)

The immediacy of road and development threat to a site is a key factor in determining overall priority level. Areas that are under imminent threat of development and possess high ecological, public, or economic values will receive higher priority. However, ecological value can decrease while the threat (and cost) of private forestland increases with increasing proximity to existing developments. Thus, it is important to give priority to projects with high ecological, public, or economic value that can be protected within the timeline of the FLP process. Such projects should be carefully evaluated to determine the feasibility of success. This strategy provides protection to properties with the greatest ecological, public, and economic value at the lowest price.

Public values

Public values include scenic and recreational benefits provided by the site, as well as the presence of cultural resources such as archaeological or historic sites. The importance of the private forest to the local economy through local timber harvest, ranching, and traditional forest uses is also a public value.

B. Goals and Objectives of Arizona's FLP

The main goals for the Arizona FLP are (1) protect important private forest from conversion to non-forest uses through development and ex-urban growth; (2) maintain the ecological integrity of Arizona's forests

with the purpose to protect watershed functions for instance ground water recharge, as well as protect native plant and wildlife habitat; and (3) maintain forest integrity in order to protect cultural and public values within the forests in addition to economic values associated with traditional forest uses such as timber harvest, livestock ranching, and recreational opportunities.

To reach these goals several program objectives have been identified:

- Reduce forest fragmentation through protection of ecologically and publicly important private forest land by focusing on large forested blocks
- Maintain watershed functions and protect water supply by protecting forests in the upper watersheds, along ephemeral streams, around springs, and the entire length of perennial reaches
- Protect wide ranging, rare, threatened, and/or endangered plant and wildlife habitat
- Protect important historical and cultural sites
- Promote forest stewardship through working together with private, federal, and state land managers to achieve these goals

III. Assessment of Need Information Gathering Processing

A. Spatial Information and Analysis

To aide the prioritization process for identifying environmentally important forests at risk of non-forest conversion, three spatially explicit data sets were used to identify areas of high public and ecological value as well as areas of road and development threats within private forest lands. These data sets were a result of spatial analyses using a Geographic Information System (ArcView 3.3). The forest types were delineated using GAP vegetation (1998) and riparian vegetation information from the Arizona Game and Fish Department (AZGFD 1994). Land ownership information was acquired from the Arizona Land Resource Information System (Figure 8, ALRIS 1998).

The *public value* spatial layer was intended to evaluate private forestlands in context of values that the general public may place on public lands and cultural resources. The two key components of public value are described as (1) presence of or proximity to areas with cultural and historical sites and (2) proximity to public recreation opportunities. Cultural importance was based on information from the Arizona State Museum, which identified acres of cultural resources by township/section map units. Areas within 8 km of public land with recreation opportunities (i.e., parks, wilderness areas, National Forests, and BLM land) were also defined as having public value. The combination of culturally and recreationally important areas within private forestlands is referred to as public values and is shown.

The *environmental value* spatial information was based on over six years of planning effort by The Nature Conservancy to identify areas for conservation in Arizona. The network of conservation areas in each of the five ecoregions that converge in Arizona identify and represent the diversity of species, communities, and ecological systems within an ecoregion including but not limited to forest resources. The conservation

portfolio was created to capture the context of threatened, endangered, and common species locations and habitat requirements (including wildlife corridors), as well as to evaluate their importance to ecological functioning of an area, and overall biodiversity of the region. This spatial data was then used to select and display private forest holdings that occur within the portfolio of conservation sites. Thus the supporting mapping does not display the conservation portfolio per se but identifies private forests that occur within the portfolio.

The *development threat* spatial layer shows areas that have been heavily impacted by human development. This spatial layer was a combination of 1) road impacts, based on road size (i.e., interstate, dirt road) and their ecological impacts (Theobold 2003, Figure 8); 2) estimated current housing density, based on aerial photography (from 1994 to present) from which areas with structures were identified as rural, mixed, or urban. [Mike Fisher, with the Bureau of Land Management, created this digital information to assist land management agencies in natural resource planning.]; 3) Mohave County assessor data (Mohave County GIS Department); 4) Coconino County subdivision data (Coconino County GIS Department); and 5) Pima County assessor data (Pima County GIS Department).

Table 3. Description of road buffer widths used in the *Threats of Development* layer

Road Description	Total Buffer Width (m)
Primary: limited access or interstate highway	1000
Primary: other U.S. or State highway	500
Secondary: state and county	200
Local	200
Vehicular: four-wheel drive	30

Given that the information used to create the public, ecological, and threat spatial layers was obtained from various sources using a variety of survey methods, were collected and recorded using different spatial scales, with unknown accuracy, it was important to field verify those aspects of the data that were feasible. To this end, a sample of private forest lands were visited to check the accuracy of GAP vegetation and Arizona Game and Fish Department riparian vegetation. In addition, housing density was assessed and its relationship to biotic integrity was qualitatively determined.

Other spatial data analyzed and incorporated in the Assessment of Need included locations (skewed up to five miles) of threatened, endangered, and sensitive species and other species of special concern on private forest lands. This information was provided by the Arizona Game and Fish Department and under agreement will remain confidential. Exact species locations and maps of these species are not provided in the AON. The Arizona Forest Health program, a collaborative project of the US Forest Service and University of Arizona Cooperative Extension, provided spatial data of insect damage to Arizona's forests.

B. Field Validation

Field verification was conducted for two weeks in April 2004, and was targeted to areas where *public value*, *ecological value*, and *development threat* intersected. Over the course of our trips, approximately 2,400 miles, 25 conservation areas, 7 National Forests, and 18 riparian areas were visited along with several representatives from each of the four forest types and the different types of development threats. Regarding the vegetation spatial information, observations from the field assessment suggest the following: mixed conifer forests were identified accurately most often, with pinyon-juniper woodlands fairly accurate as well. The accuracy of riparian forests was highly variable, either riparian forests were not identified or they were misidentified as another vegetation type. With additional information such as presence of perennial water or native fish used in conjunction with the vegetation layer, the accuracy of identifying riparian forests increased substantially. Finally, Madrean oak woodlands appeared to be the least well identified vegetation community, often misidentified as mesquite or unidentified all together. Field observations of the development threats revealed this layer to be fairly accurate in terms of properly identifying housing density and road size. Assessment of the impact of the housing density on biotic integrity suggested that areas with mixed or urban housing density are too heavily impacted in their present state to be of significant conservation value. Either singularly or in combination, rural housing density or road impacted areas still had relatively intact forest communities. We also noted that rural areas near booming communities appeared to be at the highest risk for development.

Based on field validation and observations, maps contained within the AON should be used as a *general guide* for assisting in prioritizing private forest lands, public values, ecological values, and development threats, not a *definitive map* of their locations.

Recommendations for priorities are as follows:

- Riparian forest along perennial water represents a small proportion of the total forest in Arizona, yet a disproportionately high number of species depend on them. Riparian forests are some of the most biologically diverse and rich communities in Arizona. Given their dwindling extent and high value, these areas should be the top priority.

- Areas classified as having rural housing density or only road impact near Kingman, Prescott, Chino Valley, Flagstaff, Heber to Show Low along Highway 260, Sonoita, Elgin, and Green Valley should be prioritized for Forest Legacy Program funds due to their imminent conversion by development.

IV. Arizona's Forest Legacy Area Descriptions

Each FLA is summarized as follows: a general description of the area with key land managers and rivers identified; a brief description of the vegetation communities contained within the FLA; a list of species with special status on private forest lands; discussion of the ecological and public values; and a tally of acres threatened by development. Each FLA description also contains an overview of the growth and development patterns within the particular FLA. All of the tables and figures presented in this section are courtesy of the Sonoran Institute's Economic Profile System (Sonoran Institute 2000). The descriptive information for each county was adapted from the Arizona Department of Commerce county profiles (2003). Finally, there is a description of the Forest Legacy Program priority goals and objectives for each FLA. The goals and objectives are not intended to be an exhaustive list but rather they represent items in need of conservation based upon spatial analyses and field assessments.

During the development of the Assessment of Need, the contractor worked in conjunction with the ASLD, the AFSC, the US Forest Service and others. The public review process and comments are provided in further detail and outlined in Section 3; see Public Review and Comments.

While the ecological and public values vary for each FLA, the strategies for protection and conservation are the same for all counties. They are as follows:

1) Implementation of a conservation easement program that focuses on protecting priority forest land.
2) Leverage other funding sources for forest land protection and conservation easements.
3) Hold forest land conservation easement conference in an effort to identify conservation partners, become aware of priorities of other organizations and individuals, and to build upon on-going forest land protection efforts.
4) Establish conservation partnerships in order to facilitate easement acquisition.
5) Develop site specific forest stewardship plans.

Similarly, the public benefits derived from identifying these FLAs are also the same for each FLA and they are as follows:

1) Protection of watershed and water quality and quantity for human use.
2) Protection of valuable plant and wildlife habitat.
3) Protection of traditional forest uses (timber harvest, livestock ranching, and recreation) and cultures.
4) Protection of scenic landscapes and aesthetics.
5) Reduction of wildland-urban interface issues

A. Arizona Strip Forest Legacy Area

The Arizona Strip FLA consists of the portions of Mohave and Coconino counties located north of Grand Canyon National Park, Lake Mead National Recreation Area and Kaibab National Forest. The predominant forest and woodland ownership in the Arizona Strip is Bureau of Land Management land with 1,158,313 acres followed by Arizona state trust lands with 71,210 acres and then by privately owned land with 59,651 acres.

Vegetation Patterns

Vegetation within the Arizona Strip FLA is a mixture of Mohave Desert scrub on its western edge, Great Basin grasslands bordering the pinyon-juniper woodlands that occur over much of the areas. The pinyon-juniper woodlands cover about 1,276,912 acres in the FLA with 1,145,839 acres occurring on Bureau of Land Management. There are approximately 71,125 acres of pinyon-juniper on Arizona State trust lands and 58,706 acres on private land. About 7,572 acres of mixed conifer forest and 4,902 acres of riparian forest occur on Bureau of Land Management. On private lands there is about 935 acres of riparian forest. Ecological and public values are associated with the extensive area of BLM Forestland and the private forest inholdings. These areas are used for recreation and also support other public values such as cultural resources. There is a concentration of ecological values associated with the Virgin River riparian area and also in the north central portion of the FLA. See Map 5. Appendix E provides complete information on occurrences of federally listed species, sensitive species and species of concern by county.

Growth and Development Patterns

The Arizona Strip is separated from the remainder of the state by the Grand Canyon and is remote. Population growth that is occurring in Mohave County and in Coconino County is occurring around the population centers of Kingman, Flagstaff and Sedona with little growth pressure occurring in most of the Arizona Strip FLA. A growth corridor and pressure for development does exist along the I-15 corridor and the Virgin River between St. George and Las Vegas. The locations of private forests also coincide with increased levels of road construction and these areas also have public values due to their proximity and integration with public lands. See Map 6.

For a more complete discussion of Coconino and Mohave county resource values and demographics please see Appendix I which contains information on forest resources, land tenure, threats assessment for all Arizona Counties.

Goal and Objectives

1) Protect riparian forest values along the Virgin River and associated use by riparian obligate species such as the federally listed Southwestern Willow Flycatcher and native fish species.
2) Protect traditional forest uses, recreational and ranching uses by focusing attention on privately owned pinyon-juniper woodlands in the north central portion of the FLA.
3) Prevent fragmentation of public pinyon-juniper woodlands and creation of WUI issues by protecting private woodlands from unplanned development.

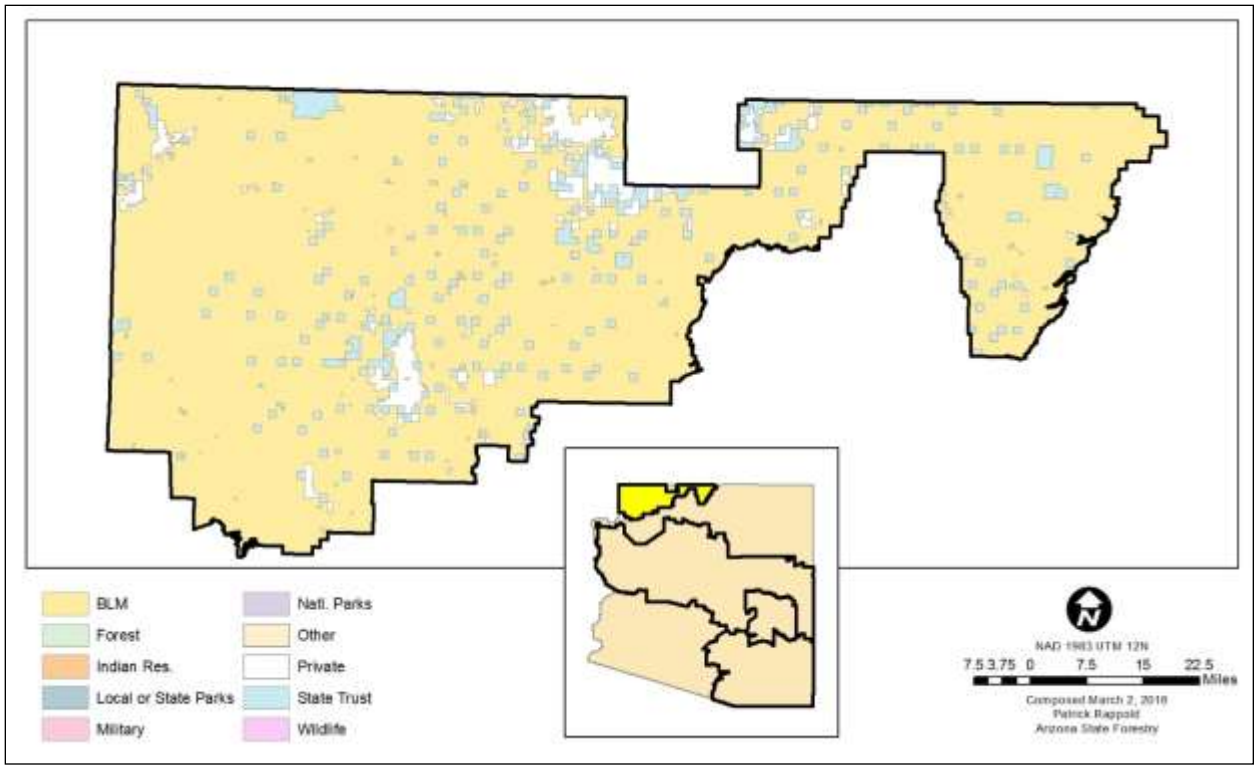

Figure 12. Arizona Stip Forest Legacy Area

B. Arizona Highlands Forest Legacy Area

General Description

The Arizona Highlands FLA encompasses a swath that traverses the central highlands of Arizona from Nevada to New Mexico. It captures portions of the Arizona-New Mexico Mountains, Colorado Plateau, Apache Highlands and the Mohave Desert ecoregions. Elevations range from 482 feet at Lake Havasu City, Arizona on the Colorado River in western Mohave County to 12,643 feet at Humphrey's Peak north of Flagstaff in Coconino County.

The FLA consists of the Mohave County south of Grand Canyon National Park; all of Yavapai County; Coconino County south of Grand Canyon National Park; the northeastern portions of Maricopa and Pinal Counties; Gila County, except for its extreme southern corner; Navajo County located south of the Navajo Indian Reservation and North of the White Mountains Apache Indian Reservation; Apache County south of the Navajo Indian Reservation; and that portion of Greenlee County that contains the Apache/Sitgreaves National Forest.

The predominant ownership in the Arizona Highlands FLA is Federal with Bureau of Land Management ownership totaling 3,426,572 acres most of which is located in Mohave County. USDA Forest Service ownership totaling 8,846,457 acres in Yavapai County, southern Coconino County, western Gila County,

eastern Maricopa County, the southern parts of Apache and Navajo Counties and all of Greenlee County in the FLA. The remaining portion of the FLA is a mix of state trust lands with 3,776,256 acres and private lands with 6,382,323 acres. The state trust lands and private lands often occur in a checkerboard pattern and thus their fates are closely related.

Vegetation Patterns

The extreme variations of altitude, precipitation, soil types and terrain contribute to exceptional diversity and interspersion of habitat types. In general, the pattern follows elevation zones with Mohave desert scrub in the low western portion of the FLA ranging up through Great Basin grasslands as elevation increases moving to the east. As elevations continue to increase the pinyon-juniper woodlands become predominant. Moving further to the east in Yavapai County and western Coconino County the vegetation types shift to chaparral in the southern lower elevations with a transition to Great Basin grasslands and then to pinyon-juniper woodlands and finally mixed conifer forests as elevation increases. This same pattern continues across southern Coconino, Navajo and Apache Counties. The mixed conifer forest being the predominant forest type with fringes of pinyon-juniper woodlands to the north grading out into Great Basin grasslands along the I 40 corridor and north into the Navajo Reservation.

There are a total of 10,382,804 forested acres in the Arizona Highlands FLA. Federal, state and local agencies own and manage 7,886,239 acres and 2,480,878 acres are in private ownership. There are a total of 3,030,794 acres of mixed conifer forest, 123,543 acres of madrean oak woodland, 7,005,536 acres of pinyon-juniper woodland and 222,931 acres of riparian forest. Private lands contain 134,434 acres or 4.4% of the mixed conifer, 16,937 acres or 13.7% of the madrean oak woodland, 2,254,401 acres or 32% of the pinyon-juniper woodlands and 75,106 acres or 33.7% of the riparian forest.

Interspersed with the upland deserts, grasslands and forests are the major rivers of the Arizona Highlands and their tributary streams. These include the Bill Williams and Santa Maria rivers in Southern Mohave County, Verde River, Salt River, Black, Blue, White, Little Colorado and Aqua Fria Rivers as well as their numerous tributaries. These rivers support extensive riparian forests and these are of exceptional value due to the great diversity of wildlife that depend on riparian forests in Arizona.

The forests of the Arizona Highlands FLA support raptors such as Mexican spotted owl, American peregrine falcon, ferruginous hawk, northern goshawk, osprey, American bald eagle, and black hawk. Southwestern willow flycatcher, Yuma clapper rail is federally listed endangered riparian obligate species and Western yellow-billed cuckoo is a candidate species for listing. Aquatic species include the federally listed razorback sucker, Gila topminnow, loach minnow and spikedace, as well as lowland and Chiricahua leopard frogs.

Growth and Development Patterns

The Arizona Highlands contains some of the most rapidly growing areas in the state. Since 1970 Mohave and Yavapai counties have grown by 130 thousand or 494% and 131 thousand or 350% respectively. Although some of the growth in Mohave County occurred in the Arizona Strip FLA along the I-15 corridor, most occurred in the vicinity of Kingman and Bullhead City. These growth rates for Mohave and Yavapai

counties exceeded that of the state average growth rate. During the same period Coconino County grew by 67 thousand or 137% and Navajo County grew by 50 thousand or 103%. Although this rate of growth was slower than the state average it exceeded the national average. Apache County grew by 36 thousand, a 111% increase and Gila County by 21 thousand, a 74% increase during the period. Although Maricopa and Pinal counties were very rapidly growing counties the portions of these counties that lie within the Arizona Highlands are predominantly within the Tonto National Forest. Greenlee County is the only county that lost population since 1970, losing approximately 1,900 people or 18% of its population.

Within the FLA, growth is occurring around Kingman and Bullhead City in the west, around Prescott, Prescott Valley, Chino Valley and Paulden and along the Highway 69 corridor between Cordes Junction and Prescott in Yavapai County. In Coconino county growth is focused around Flagstaff and adjacent to the boundaries of the Coconino National Forest. Sedona is also a growth center. In the eastern portion of the FLA the greatest growth is occurring in the White Mountain communities of Heber, Showlow, Pinetop-Lakeside, Greer, and Springerville. These areas are experiencing boom conditions for real estate sales and values and are popular spots for retirement and recreational second homes. It is paradoxical that while the White Mountains area is considered in this document to be a high priority for program attention, land exchange proponents are seeking the disposition of national forestland for development purposes through land exchanges adjacent to communities such as Showlow.

Throughout much of the Arizona Highlands the rapid pace of development and the pattern of development are contributing to a serious and growing set of wildland-urban interface issues. Flagstaff and the White Mountain Communities are essentially large growing inholdings within the National Forests and their vulnerability to fire is increasingly obvious every fire season. The proposed Forest Legacy Program can be used to offset this vulnerability to some extent by providing protected private areas as a buffer between the public forest and developed cities, towns and residential areas.

Another disturbing pattern of development is becoming common in the Arizona Highlands Forest Legacy Area. That is the rapid conversion of large ranches to forty-acre subdivisions. This has become a favored development strategy by land investors and speculators because it requires a minimal investment in development infrastructure and long term involvement in the outcomes of the development. The value of the initial investment increases substantially due to the reduction of parcel size with a related increase in per acre value. This type of speculation also takes advantage of the checkerboard pattern of state trust land and private land that exists across most of the Arizona Highlands. Arizona law allows each of the forty-acre parcels to be split five times without application of any subdivision requirements. The land use pattern being created on the private lands thus will contribute to a growing crisis in wildland-urban interface management conflicts. This development pattern carried to its logical end will restrict management through the use of natural processes, such as fire on much of the 1,421,977 acres of state trust forests and woodlands in the FLA.

<u>Goals and Objectives</u>

1. Protect private riparian forests and associated public values such as recreation, watershed and aquifer functions, and ecological values such as breeding bird and native fish habitat and other

wildlife use along perennial and near perennial streams. Of particular significance are the Bill Williams and its tributaries, the Verde River and its tributaries, Salt River and tributaries and the Little Colorado and its tributaries.

2. Reduce fragmentation of publicly owned pinyon-juniper forests and retain management options by protecting private forests that are interspersed throughout the FLA.

3. Sustain traditional pinyon-juniper forest uses such as gathering of firewood, fence posts, and pinyon nuts, as well as hunting, birdwatching and other recreational uses by protecting the vast pinyon-juniper woodlands that occur throughout much of the FLA.

4. Reduce fragmentation of the National Forests by protecting private inholdings and private forests located in areas adjacent to National Forest boundaries through the use of conservation easements.

5. Manage wildland-urban interface issues by protecting key private forestlands from development adjacent to National Forest boundaries.

6. Maintain the highest quality natural areas by protecting private forest and woodlands within Nature Conservancy designated conservation areas.

7. Maintain wildlife movement corridors between the mixed conifer forest of the high elevations, across the mid elevation pinyon-juniper to large functional grassland units by focusing attention on undeveloped private lands along known wildlife corridors.

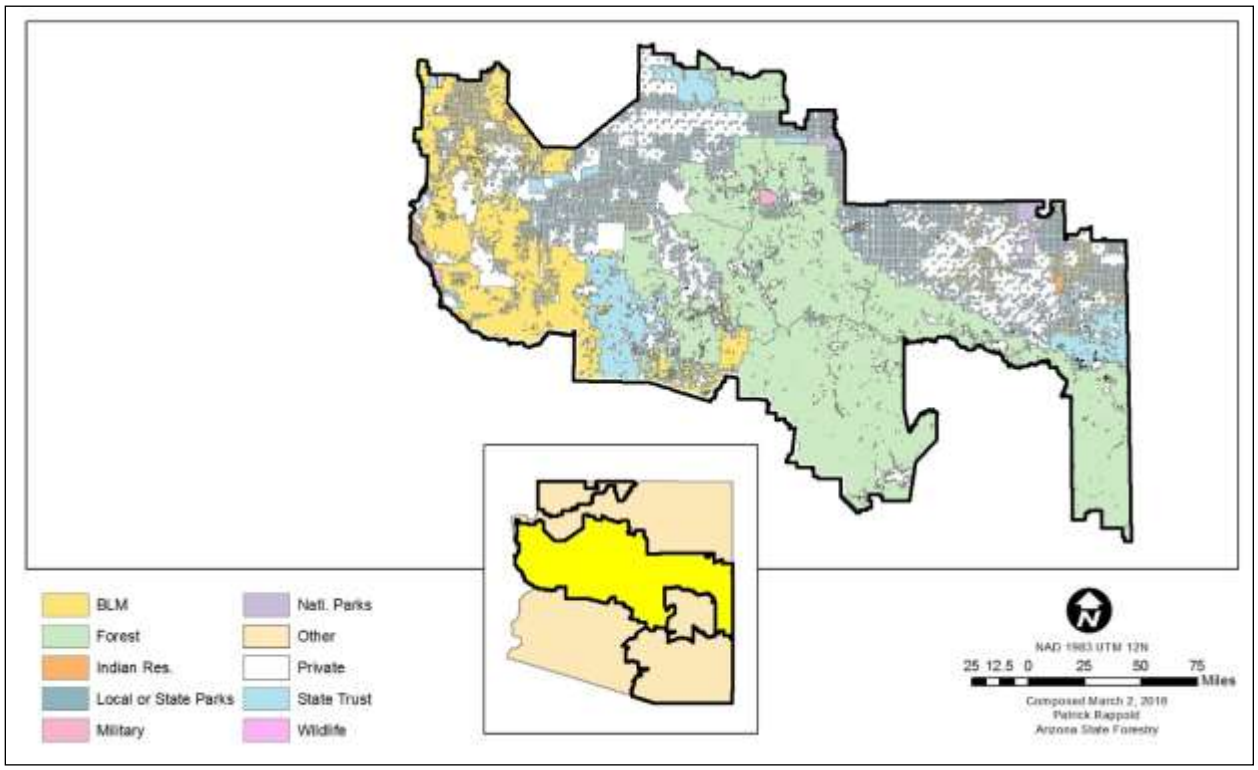

Figure 13. Arizona Highlands Forest Legacy Area

C. Sky Islands Forest Legacy Area

General Description

The Sky Islands FLA consists of the southeastern portion of Pinal County; the eastern half of Pima county; all of Santa Cruz county and Cochise County; as well as the extreme southern corner of Gila County; Graham County south of the San Carlos Apache Reservation; and Greenlee County south of the Apache/Sitgreaves National Forest. The FLA contains the Coronado National Forest, which occurs as eleven distinct districts, which total 1,647,324 acres. Bureau of Land Management holdings are concentrated in a band across the northern edge of the FLA although scattered holdings occur elsewhere such as along the San Pedro River and east of the San Pedro River. BLM holdings total 1,831,745 acres within the Sky Islands FLA. The Arizona State Land Department is the largest landowner and manager in the FLA with 4,055,529 acres and private lands comprise the second largest ownership at 3,656,575 acres.

Vegetation Patterns

The Sky Islands FLA contains portions of two ecoregions. The Sonoran Desert Ecoregion covers the western half of the FLA and the Apache Highlands covers the eastern half of the area. The Sonoran Desert transitions into the semi-desert grasslands and madrean oak woodlands of the Apache highlands as elevations increase to the south and east.

At the higher elevations of the Sky Islands, mixed conifer forests grade up into spruce-fir forest on mountain peaks. The mixed conifer forest transitions to madrean oak woodland as elevation drops. The forested mountains and foothills are connected across the basins by semi-desert grasslands or Sonoran desert scrub at lower elevations. The basin bottoms are traversed by streams such as the San Pedro and Santa Cruz Rivers that flow from southeast to the northwest where they join with the Gila River that runs from east to west along the northern edge of the Sky Islands FLA. Associated with these rivers are the cottonwood willow riparian gallery forests and the mesquite bosques (forests) that cover the riparian terraces along many of the stream systems.

Forested areas within the FLA total 1,377,458 acres or about 37.7% of the total area of the FLA. Mixed conifer comprises 137,515 acres of which 2,727 acres are in private ownership. Madrean oak woodland is the most extensive forest type with 1,114,908 acres of which 99,637 acres or about 8.9 % in private ownership. Pinyon-juniper is the least extensive with 29,814 acres in total of which 7,727 acres or about 25.9% in private ownership. Riparian forest comprises 95,221 acres of which 46,038 or about 48% in private ownership. Much of the Sky Islands FLA is part of a greater geographical region referred to as the Madrean Archipelago which was recently added to Conservation International's list of the world's hotspots for biological diversity (Andrew Smith personal communication).

The mixed conifer forests are vital habitat for animals such as the Mount Graham red squirrel and Pinaleno Mountain snail. This FLA's forestlands are home to a large array of species ranging from the endangered

to the Mexican spotted owl to the Southwestern willow flycatcher. Several species of bats and hummingbirds migrate through this area while some animals, like the tropical kingbird (Tyrannus melancholicus) and jaguar reach their northern limits in these forests. Federally listed endangered plant species such Kearney's blue star (Amsonia kearneyana) and Huachuca water umber (Lilaeopsis schaffneriana, var. recurvata) are also found here.

The riparian gallery forests along perennial water or near perennial stream reaches are vital to a large number of aquatic species such as the Sonoran and desert suckers, Apache trout (Oncorhynchus apache), roundtail chub, spikedace (Meda fulgida), speckled dace, longfin dace (Agosia chrysogaster), and loach minnow, as well as the Chiricahua and lowland leopard frogs. These forests are vital as habitat for many riparian obligate bird species such as the federally listed endangered southwestern willow flycatcher as well as a host of other riparian obligate birds such as the Western yellow-billed cuckoo, yellow warbler, summer tanager, black hawk, gray hawk, and zone-tailed hawk.

In Pinal County there are 61 species that are threatened, endangered, sensitive or of special concern. In Cochise county there are 153 species that are threatened, endangered, sensitive or of special concern. Santa Cruz County has 121 species that are threatened, endangered, sensitive or of special concern. In Pima County there are 99 species that are threatened, endangered, sensitive or of special concern. Likewise in Greenlee County there are 44 species at risk or of concern, Graham County has 69 such species and Pinal County there are 61 species at risk or of concern.

Ecological and public values are concentrated around the riparian areas and at the North end of the Chiricahua Mountains and in eastern Greenlee County associated with the Gila River and the San Francisco River. There is also a cluster of ecological and public values private forest that occurs on the West side of the Mule Mountains in the Upper San Pedro basin.

Growth and Development Patterns

Growth in the Sky Islands FLA is of special concern due to the increasing effects of population expansion on scarce water resources and their related effects on stream and riparian systems. Growth has been increasing around population centers such as Tucson, Benson, Sierra Vista and Casa Grande. Large master planned developments arise on the landscape seemingly overnight and create satellite communities that become growth centers on their own and displace native forest and woodlands.

Although an enormous amount of growth has occurred and still continues in the desert lands around Tucson there is an increasing amount of suburban development in the higher elevations of Southeast Arizona. This growth is being fueled by the economic factors such as Fort Huachuca in the San Pedro Basin (the largest single employer in Southern Arizona) and by the favorable climate that is drawing retirees in increasing numbers. The highest value lands and the most desirable lands for development are the madrean oak woodlands that surround the protected Sky Islands.

In the Sky Islands FLA the Santa Cruz, San Pedro, and Gila rivers and their tributaries are greatly threatened or impacted to some degree by urbanization. Most of the Santa Cruz River downstream of Santa Cruz County was lost as a fully functioning system from the 1940's. It is now essentially a dry riverbed with the

remaining riparian values throughout the reach in Pima and Pinal counties dependent on the discharges of effluent from Pima County's wastewater treatment plant. In Santa Cruz County the Santa Cruz River retains its riparian forest in the headwaters in the San Rafael Valley because the valley has been spared development thusfar. In the reach downstream of Nogales to Tubac effluent discharges from the International Wastewater Treatment plant just north of the Mexico Border contribute significant flows to the river. The upper San Pedro River in Cochise County is under threat from rapid urbanization in the Sierra Vista subwatershed. The lower San Pedro in northern Cochise County, Pima and Pinal counties has been substantially impacted by excessive water use related to agricultural irrigation and mining withdrawals. In the San Pedro River basin, programs are underway to protect groundwater and surface flows and considerable progress has been made in protecting riparian forestlands through acquisition of fee title ownership and conservation easements by Bureau of Land Management, Bureau of Reclamation, The Nature Conservancy, Pima County and others. However, much work remains to be done.

Goals and Objectives

1. Prevent fragmentation of riparian corridors and protect to the greatest extent possible riparian and aquatic wildlife habitat.

2. Protect wildlife movement corridors between the mixed conifer forests in Forest Service hands through the privately owned madrean oak woodlands to protect the forest connections with the grasslands and riparian forests.

3. Protect aquifer recharge areas and important watersheds through the use of conservation easements to limit development on private forestlands.

SECTION 3

Project Development Process

The Arizona Forest Legacy program is proposed to be implemented following the eight step process described in the Project Development Process that follows.

Arizona Forest Legacy Program
Project Development Process

Step 1: Distribute Request for Proposals (RFP)……..**January 15th**

A request will be put out to land trusts, county & municipal governments, and other interested parties announcing the program, providing general information including eligibility criteria, and publicizing the application deadline of May 1st.

Step 2: Application Period……..……..…..**January 15th to April 15th**

Applications will be accepted throughout this period. Preliminary assessment of eligibility may be done during this time as a prerequisite to the project evaluation period.

Step 3: Project Application Review & Evaluation……..……**April 15th to May 15th**
The Forest Legacy Subcommittee of the Arizona Forest Stewardship Committee (AFSC) will review, rate, and rank applications during this time. Their findings and recommendations will then be presented to the AFSC for consideration and approval action.

Step 4: AFSC Application Review & Prioritization…….. **May 15th to June 1st**
The AFSC will consider the findings and recommendations of the Forest Legacy Subcommittee, and take action to approve, disapprove, or table applications. Afinal ranking of projects will be made at this meeting.

Step 5: Notification of Applicants……**June 1st to June 15th**
Applicants will be notified of the status of their project applications. Top-ranked applicants will be encouraged to "partner up" with a conservation organization to assist in the gathering of baseline information for their parcel, and to begin due diligence work.

Step 6: Obtain Landowner Options……**August 1st to September 1st**
The state FLP Coordinator will work to obtain an option(s) from the highest ranked one-to-three applicants. Granting of an option by the landowner will be a determining factor in final selection for submission to the Forest Legacy Information System (FLIS).

Step 7: State Project Prioritization & Submission……..…..**September 1st to September 15th**
Following the collection of additional information on parcel characteristics, eligibility, and the resolution of landowner options, the AFSC will do a final prioritization of up to three (3) parcels for entry into the (FLIS).

Step 8: Submission of Application(s) to USFS Region……..…..**October 1st to October 15th**

One-to-three priority applications are forwarded to the Southwestern Regional Office of the USDA Forest Service for funding consideration. Landowner(s) whose applications have been forwarded to the Forest Service will be notified and subsequently kept informed.

Section 4

Public Review and Comments

The public review process consisted of a detailed review by the Arizona State Forest Stewardship Committee (AFSC), as well as several other formal and informal outreach and communication venues. The primary vehicle for review was through the AFSC which is composed of 25 members representing the following entities: Arizona Association of Conservation Districts, Arizona Cooperative Extension, Arizona Department of Agriculture, Arizona Department of Environmental Quality, Arizona Department of Transportation, Arizona Game and Fish Department, Arizona State Land Department, Bureau of Land Management, Bureau of Indian Affairs, Four Corners Sustainable Forests Partnership, The Nature Conservancy, Natural Resource Conservation Service, Northern Arizona University, San Carlos Apache Tribe, Sierra Club, University of Arizona, USDA Farm Services Agency, U.S. Fish and Wildlife Service, U.S. Forest Service, and private land owners. AFSC's role is to function in a supporting and advisory capacity,

providing assistance and recommendations to the State Forester regarding the development, implementation, monitoring, and updating of the Forestland Enhancement Program State Priority Plan and the State Forest Stewardship Plan. Similarly, the AFSC acted in an advisory capacity, providing recommendations and support during the AON development and commenting on earlier drafts of the AON. There are many benefits in using the AFSC as the primary sounding board for the AON process; one is that the diversity of committee members representing various affiliations provides an opportunity to reach an even broader audience. The represented organizations each have a unique set of clientele and networking avenues. As a AFSC member, each participant represents a constituency and acts on their behalf. It was through these existing channels of communication and framework that the AON and the FLP was presented to an extensive audience.

More specifically, on March 24th 2004 the AFSC was presented with information about the Forest Legacy Program and the Assessment of Need to be developed for Arizona. Some of the presentation and discussion topics included: the eligibility criteria, FLA boundaries, project evaluation criteria, and the spatial data sets used to be used in generating information for the AON. Committee members provided valuable feedback that was considered during the AON development process and incorporated into the AON. One such comment resulted in a more liberal definition of forest lands. Other suggestions included comments on the project evaluation criteria such as maintenance of wildlife corridors, identifying critical habitat for threatened and endangered species, and weighting traditional uses more highly in the project selection criteria process.

Earlier drafts of the AON were made available to all members of the AFSC and comments were received from four members. In general, the comments were editorial in nature with requests for clarification on some timber statistics and historical information. There were no incongruities with the approach, direction, or tone of the document. The AFSC feedback was carefully considered and as appropriate, incorporated into the final AON document.

Other outreach activities included contacting the Region 3 Forest Service Public Affairs Media Officer to create awareness that Arizona would be participating in the FLP in the near future. To this end each of the six National Forest supervisors and seven of the Forest Service land resource personnel in Arizona were contacted to provide input on environmentally important private forests that were contained within or adjacent to the Forest boundaries (Appendix G). Responses were received from the Tonto and Apache-Sitgreaves National Forests. This information was incorporated into the FLA within which they occurred. Other regional Forest Service personnel also provided comments and suggestions.

Informal public outreach also occurred with many different agencies and organizations during the course of compiling information and preparing the AON. Through conversations, agencies and organizations were informed about the FLP in Arizona. The following are some of the entities contacted: the Arizona Department of Commerce, Arizona Game and Fish Department, various divisions in the State Land Department such as Land Information, Title and Transfer and Natural Resources, Trust for Public Land, Arizona State Museum, University of Arizona Cooperative Extension's Arizona Forest Health Program, National Park Service Rivers, Trails & Conservation Assistance, Sonoran Institute, and Bureau of Land Management. The Nature Conservancy's Arizona chapter featured an article about the upcoming Forest

Legacy Program in their donor newsletter (distributed to 3,300 members) and in their spring newsletter (distributed to 25,000 members). See Appendix H as an example of one such article.

While an appropriate public outreach effort was undertaken, continual efforts will be engaged to disseminate and receive information to and from the public. The hope that the Forest Legacy Program is just the beginning of a positive dialogue with all agencies, organization, and individuals interested in forest land in Arizona.

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Appendix A. Vegetation communities comprising forest types for Arizona's Forest Legacy Program

Arizona Forest Legacy Program-Forest Type	Gap vegetation categories (1998)	Biotic Communities (Brown 1994)
Madrean Oak Woodland	Encinal Mixed Oak	Madrean Evergreen Woodland
	Encinal Mixed Oak-Mesquite	Interior Chaparral
	Encinal Mixed Oak-Mexican Mixed Pine	
	Encinal Mixed Oak-Mexican Pine-Juniper	
	Encinal Mixed Oak-Pinyon-Juniper	
	Encinal Mixed Oak/Mix Chapparal/Semidesert Grassland-Mix Scrub	
Pinyon-Juniper Woodland	GB Big Sagebrush-Juniper-Pinyon	Great Basin Conifer Woodland
	GB Juniper	
	PJ (Mixed)/Mixed Chapparal-Scrub	
	PJ-Shrub/Ponderosa Pine-Gambel Oak-Juniper	
	PJ/Sagebrush/Mixed Grass-Scrub	
	Pinyon-Juniper (Mixed)	
	Pinyon-Juniper-Mixed Grass-Scrub	
	Pinyon-Juniper-Mixed Shrub	
	Pinyon-Juniper-Shrub Live Oak-Mixed Shrub	
Mixed Conifer	Arizona Cypress	Subalpine Conifer Forest
	Douglas Fir-Mixed Conifer	Rocky Mountain and Madrean Montane Conifer Forest
	Englemann Spruce-Mixed Conifer	
	Ponderosa Pine	
	Ponderosa Pine-Gambel Oak-Juniper/Pinyon-Juniper Complex	
	Ponderosa Pine-Mixed Conifer	

		Ponderosa Pine-Mixed Oak-Juniper	
		Ponderosa Pine/Pinyon-Juniper	
		Ponderosa Pine-Mixed Conifer/Shrub Live Oak	
		GB Riparian Forest/Mixed Riparian Scrub	
		GB Riparian/Cottonwood-Willow Forest	
		Int. Riparian/Cottonwood-Willow Forest	
		Int. Riparian/Mesquite Forest	
		Int. Riparian/Mixed Broadleaf Forest	
		Son. Riparian/Cottonwood-Mesquite Forest	Montane Riparian Forest/Wetlands
Riparian Forests	←→	Son. Riparian/Cottonwood-Willow Forest	Plains and Great Basin Riparian Forest/Wetlands
		Son. Riparian/Leguminous Short-Tree Forest/Scrub	Riparian Deciduous Forests and Woodlands
		Son. Riparian/Mesquite Forest	Sonoran Riparian Deciduous Forest and Woodlands
		Son. Riparian/Mixed Broadleaf Forest	
		Son. Riparian/Mixed Riparian Scrub	
		Cottonwood-Willow*	
		Mesquite*	
		Conifer Oak*	
		Mixed Broadleaf*	
		Tamarisk and Russian Olive*	

* From AZ Game and Fish Department riparian vegetation 1993-1994

Appendix B. Complete list of spatial layers used in the Assessment of Need preparation and analyses.

Spatial Layer	Source of Information
Arizona GAP Vegetation	Arizona Gap Analysis Program (GAP). U.S. Geological Survey
Conservation Areas	The Nature Conservancy, Arizona Chapter
County Boundaries	ALRIS, Arizona State Land Department
Cultural Information	Arizona State Museum
Ecological Value	The Nature Conservancy, Arizona Chapter
Housing Density	Bureau of Land Management, State Office
Insect Outbreak	USDA Forest Service
Land Ownership	ALRIS, Arizona State Land Department
Perennial Water	ALRIS, Arizona State Land Department
Public Value	The Nature Conservancy, Arizona Chapter
Recreation Opportunities	The Nature Conservancy, Arizona Chapter
Riparian Vegetation	ALRIS, Arizona State Land Department
Development Threat	The Nature Conservancy, Arizona Chapter
Road Impact	The Nature Conservancy, Arizona Chapter
Roads (all classes)	ALRIS, Arizona State Land Department
Scenic Roads	ALRIS, Arizona State Land Department
Special Status Species	Arizona Game and Fish Department

Appendix C. Tree species in Arizona's timberland (T) or woodland (W)

Alligator juniper (*Juniperus deppeana*) W

Apache pine (*Pinus engelmannii*) T

Arizona cypress (*Cypressus arizonica*) T

Arizona pinyon pine (*Pinus edulis* var. *fallax*) W

Arizona white oak (*Quercus Arizonica*) W

Aspen (*Populus tremuloides*) T

Bigtooth maple (*Acer grandidentatum*) W

Blue spruce (*Picea pungens*) T

Border pinyon (*Pinus discolor*) W

Boxelder (*Acer negundo*) T

California juniper (*Juniperus californica*) W

Chihuahua pine (*Pinus leiophylla*) T

Corkbark fir (*Abies lasiocarpa* var. *arizonica*) T

Cottonwood (*Populus* sp.) T

Desert ironwood (*Olneya tesota*) W

Douglas-fir (*Pseudotsuga menziesii*) T

Emory oak (*Quercus emoryi*) W

Engelmann spruce (*Picea engelmannii*) T

Gambel oak (*Quercus gambelii*) W

Mexican blue oak (*Quercus oblongifolia*) W

Mexican pinyon pine (*Pinus cembroides*) W

New Mexico locust (*Robinia neomexicana* var. *neomexicana*) W

Oneseed juniper (*Juniperus monosperma*) W

Ponderosa pine (*Pinus ponderosa*) T

Rocky Mountain juniper (*Juniperus scopulorum*) W

Rocky Mountain maple (*Acer glabrum*) W

Redberry juniper (*Juniperous erythrocarpa*) W

Silverleaf oak (*Quercus hypoleucoides*) W

Singleleaf pinyon (*Pinus monophylla*) W

Southwestern white pine (*Pinus strobiformis*) T

Subalpine fir (*Abies lasiocarpa*) T

Tamarisk (*Tamarix* sp.) W

Twoneedle pinyon (*Pinus edulis*) W

Utah juniper (*Juniperus osteosperma*) W

Velvet mesquite (*Prosopis velutina*) W

Western honey mesquite (*Prosopis glandulosa* v. *torreyana*) W

White fir (*Abies concolor*) T

Appendix D. Private forest acres by county for each forest type

County	Forest Type	Acres
Apache		
	Conifer Forest	6,722
	Madrean Oak Woodlands	0
	Pinyon Juniper Woodlands	337,766
	Riparian Forest	3,469
	Total	**347,957**
Cochise		
	Conifer Forest	272
	Madrean Oak Woodlands	66,905
	Pinyon Juniper Woodlands	0
	Riparian Forest	9,530
	Total	**76,707**
Coconino		
	Conifer Forest	78,710
	Madrean Oak Woodlands	0
	Pinyon Juniper Woodlands	658,534
	Riparian Forest	960
	Total	**738,204**
Gila		
	Conifer Forest	5,273
	Madrean Oak Woodlands	2,311
	Pinyon Juniper Woodlands	11,807
	Riparian Forest	2,642
	Total	**22,034**
Graham		
	Conifer Forest	0
	Madrean Oak Woodlands	2,351
	Pinyon Juniper Woodlands	844
	Riparian Forest	6,085
	Total	**9,279**
Greenlee		
	Conifer Forest	2,821
	Madrean Oak Woodlands	3,517
	Pinyon Juniper Woodlands	8,998
	Riparian Forest	2,344
	Total	**17,680**
LaPaz		
	Conifer Forest	0
	Madrean Oak Woodlands	0
	Pinyon Juniper Woodlands	0
	Riparian Forest	1,805
	Total	**1,805**
Maricopa		
	Conifer Forest	0
	Madrean Oak Woodlands	0
	Pinyon Juniper Woodlands	190

	Riparian Forest	12,257
	Total	**12,447**
Mohave		
	Conifer Forest	985
	Madrean Oak Woodlands	2,234
	Pinyon Juniper Woodlands	297,122
	Riparian Forest	20,862
	Total	**321,204**
Navajo		
	Conifer Forest	18,720
	Madrean Oak Woodlands	0
	Pinyon Juniper Woodlands	399,116
	Riparian Forest	23,777
	Total	**441,613**
Pima		
	Conifer Forest	760
	Madrean Oak Woodlands	4,511
	Pinyon Juniper Woodlands	0
	Riparian Forest	6,844
	Total	**12,115**
Pinal	Conifer Forest	0
	Madrean Oak Woodlands	5,306
	Pinyon Juniper Woodlands	354
	Riparian Forest	9,822
	Total	**15,483**
Santa Cruz		
	Conifer Forest	0
	Madrean Oak Woodlands	16,855
	Pinyon Juniper Woodlands	0
	Riparian Forest	4,307
	Total	**21,162**
Yavapai		
	Conifer Forest	23,269
	Madrean Oak Woodlands	12,686
	Pinyon Juniper Woodlands	625,902
	Riparian Forest	4,062
	Total	**665,919**
Yuma		
	Conifer Forest	0
	Madrean Oak Woodlands	0
	Pinyon Juniper Woodlands	0
	Riparian Forest	2,419
	Total	**2,419**

Appendix F. Private forest acres that contain environmentally important values for each county

County	Number of Threatened, Endangered, Sensitive, Special Concern Species	Conservation Area (acres)	Public Value (acres)	Threat by Road / Development (acres)
Apache	55	5,540	352,044	95, 194
Cochise	153	49,350	69,817	21,401
Coconino	87	137,887	556,511	150,174
Gila	66	8,731	22,254	13,598
Graham	69	4,263	10,853	4,630
Greenlee	44	11,409	14,783	3,920
La Paz	22	675	2,408	117
Maricopa	48	2,567	12,768	5,890
Mohave	73	90,361	269,979	77,093
Navajo	24	43,793	479,983	11,330
Pima	99	3,812	12,464	8,031
Pinal	61	7,272	16,346	8,871
Santa Cruz	121	13,124	21,473	10,702
Yavapai	74	254,226	548,861	126,366
Yuma	13	796	3,340	2,000

Appendix G. Letter sent to Arizona National Forest supervisors, sent via email March 12, 2004

Dear Forest Supervisor:

The Arizona State Land Department has expressed interested in participating in the federal Forest Legacy Program (FLP). The FLP was established in 1990 by the U.S. Forest Service to protect environmentally sensitive forestlands. This federal program partners the Forest Service with the state lead agency [Arizona State Land Department] to provide funding to states to assist them in securing conservation easements on private forestlands threatened with conversion to non-forest uses. There are currently 33 states and territories active in the FLP and the 2003 budget appropriations were $68 million, earmarked for 43 projects. This entirely voluntary program was designed to encourage the protection of privately owned forestlands. *For more information visit the FLP web site at:* http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml

To participate in the FLP, a state needs to develop an Assessment of Need (AON) in consultation with the State Forest Stewardship Coordinating Committee. The Nature Conservancy was awarded the contract to prepare the Arizona Assessment of Need by the Arizona State Land Department. The AON must document the State's need for a Forest Legacy Program, establish eligibility criteria, set guidelines, and identify priority areas for protection. Such areas must, at a minimum, meet the following criteria:

- Environmentally important forest areas, which include areas important for scenic, recreational, riparian, ecological, cultural, or traditional forest uses, and be
- Threatened by conversion to non-forest uses.

Due to the short time frame of this project (30 June 2004), we are requesting your assistance to identify priority forestlands. Specifically, we are interested in learning about existing in-holdings and adjacent forestlands that are currently threatened by conversion to non-forest uses. We are also interested in information regarding whether conservation easements already exist or if the USFS is planning on purchasing certain parcels; such information would be helpful in our analysis. Any information you could share would be appreciated, however, spatially explicit information would be most useful. We hope to have this information gathered by the end of March so we can include is information in the Assessment of Need. Please feel free to contact us. We will follow-up this email with a phone call during the week of March 29th.

Thank you for your assistance in the Forest Legacy Program.

Sincerely,
The Nature Conservancy, Arizona Chapter
Heather Schussman, Fire Science Specialist, 520-622-3861 x3440, hschussman@tnc.org
Dana Backer, Conservation Ecologist, 520-622-3861 x3473, dbacker@tnc.org