Arizona Forest Resource Assessment

A collaborative analysis of forest-related conditions, trends, threats, and opportunities

June 18, 2010

Arizona State
Forestry Division

ARIZONA FOREST RESOURCE ASSESSMENT

Prepared for the
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Introduction

Arizona is a land of diverse landscapes. The diversity of Arizona forests ranges from riparian gallery forests traversing the low desert to sub-alpine and montane forests above 9,000 feet in elevation (O'Brien 2002). 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 above the Mogollon Rim with distinct areas scattered throughout the rest of the state. Juniper (*Juniperus* spp.) and pinyon-juniper(*Pinusedulis-Juniperus*spp.) 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.

Land ownership within Arizona is also quite diverse. Federal and state agencies and Native American Tribes manage the majority of lands. Only a small portion is privately owned. *Arizona's Forest Resource Assessment* and *Strategy* are truly reflective of this diverse land base and draw on the strong relationships with many organizations and agencies. This collaborative "all lands" approach for the *Assessment* and *Strategy* is critical for successful near-term and long-term outcomes on the landscape.

The development of this *Assessment* and *Strategy* 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 must complete the assessment and strategy in order to qualify to receive 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 from wildfire, assist private forest landowners, promote healthy forest practices, and assist communities with their urban forests. Most of the CFAA funding received by the Arizona State Forestry Division (AZSFD) is given as grants to local organizations that provide 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 forests and citizens.

The responsibility for developing the statewide assessment and strategy belongs to the State Forester and the AZSFD. The State Forester appointed a task group with diverse representation to work with AZSFD staff to develop the *Arizona Forest Resource Assessment* and make recommendations for the *Arizona Forest Resource Strategy*.

Basic principles for the *Assessment* were 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 Arizona Forest Resource Assessment Task Group devoted hundreds of hours reviewing existing planning and assessment documents, gathering input from partner agencies and stakeholders, and discussing the classification of Arizona forest issues. The group ultimately decided to organize the state's critical forest resource issues into seven major categories:

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

As forest resource issues were identified, evaluated and classified, it became clear that there were three overarching needs that cut across all issue categories:

1. Funding to accomplish forest management activities
2. Developing the capacity to collaboratively accomplish forest management goals
3. Educating the public about forest 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 *Assessment* and *Strategy* put forth a broad array of issues, goals, and necessary actions. ***In short, these documents attempt to addresses those things that forests affect as well as those things that affect forests.*** The assessment also addresses the three national themes outlined in the Farm Bill:

1. Conserve working forest lands
2. Protecting forests from harm
3. Enhance public benefits from trees and forests

The *Assessment* provides the following information as a foundation for the *Strategy*:

- An analysis of present and future forest conditions, trends, and threats on all ownerships in the state using publicly available information.
- Identification of forest-related threats, benefits, and services consistent with the Farm Bill national themes.
- A delineation of priority rural and urban forest landscape areas that will be addressed in the *Strategy*.
- Identification of opportunities for working with neighboring states and governments to address multi-state priority areas.
- 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.

The *Strategy*:

- Outlines long-term coordinated approaches for addressing forest 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 forest 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.

Collaborative Goals for Arizona

People and Forests

- People and communities receive maximum benefits from forests and trees.
- Minimized negative impacts to trees and forests.

Ecosystem Health

- Resilient and diverse forest ecosystem structures, processes, and functions
- Progress toward landscape scale outcomes, restoration of unhealthy ecosystems, and enhanced sustainability with negative impacts.

Water and Air

- Improved water quality and quantity from forested watersheds.
- Improved health and resiliency of forested aquatic systems (riparian areas, springs, and wet meadows)
- Increased public understanding of the importance of forests to Arizona's water quality.
- Improved air quality.

Fire

- Wildland ecosystems where appropriate fire regimes maintain health and resiliency of natural vegetation.
- "Fire Adapted Communities" that provide shared stakeholder responsibility for healthy landscapes and wildfire prepared communities.
- Enhanced wildland fire management capacity in Arizona.
- An Arizona public and government leadership that is well informed about wildland fire management, science, and prevention issues.

Economics

- Realized long-term economic potential of sustainable forest products and bioenergy (while achieving Ecosystem health goals)
- Protection of areas with economic development potential related to ecosystem services.
- Community recognition of the economic importance to protecting healthy natural systems.

Climate Change

- Increased resilience of ecosystems to climate change.
- Reduced rate of future climate change through maximized carbon sequestration in Arizona forests and trees.
- Broad public and community understanding of climate change science – Arizona's variable climate and current and future impacts.

Culture

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

Table 1. Collaborative Goals for Arizona. A total of 20 broad collaborative ***Goals*** are identified for Arizona. The strategy also identifies a long list of more specific ***Objectives*** and ***Actions*** to focus ongoing work to accomplishing these goals.

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

Conclusion

Arizona forests, 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 services. However, the demands and pressures on our forests are greatly increasing in Arizona and nationwide.

The *Assessment* and *Strategy* will provide steps that will greatly 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 approach
3. Improving communication, collaboration, and leveraging of resources to address issues
4. Successfully implementing projects, programs, and initiatives across landscapes involving multiple ownerships
5. Improving the livability of communities by enhancing Arizona's urban forests
6. Enhancing the capacity of Arizona's forests to provide life-giving ecosystem services and products such as clean water, clean air, recreational experiences, traditional and non-traditional forest products, and quality habitat for wildlife.

2.0 Introduction and Background

Introduction

The forests and trees of Arizona are an invaluable asset vital to all of the state's citizens. Arizona has 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 forests and woodlands from the cottonwood bosques hugging our river courses to the subalpine firs cloaking our tallest peaks to the paloverdes shading our urban communities

To many, it comes as a surprise to learn that Arizona has more than 20 million acres of forest land. These forests provide substantial benefits or "ecosystem services" to the people of Arizona. Many of these goods and services are traditionally viewed as free benefits to society. One of many examples of such an "ecosystem service" is clean drinking water. According to the National Academies, 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 2000 , the Arizona census recorded 5.1 million people and that number is expected to double by the year 2030. 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 and Native American Tribes manage the majority of Arizona lands. Only a small portion is owned privately. Different federal agencies have responsibility for specific lands including the USDA Forest Service, USDI Bureau of Land Management, and USDI National Park Service. The USDI Bureau of Indian Affairs also assists certain tribes with the management of tribal lands. There are also forest areas under the jurisdiction of the Department of Defense. These multiple ownerships can create substantial complexity when trying to address forest issues on a larger scale that affect lands under different ownerships or jurisdictions in the same area 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. This collaboration will be critical to both the short- and long-term success of this process.

In Secretary of Agriculture Tom Vilsack's speech outlining his vision for our nation's forests, he said, "a healthy and prosperous America relies on the health of our natural resources, and particularly our forests. America's forests supply communities with clean and abundant water, shelter wildlife, and help us mitigate and adapt to climate change. Forests help generate rural wealth through recreation and tourism, through the creation of green jobs, and through the production of wood products and energy. They are a source of cultural heritage for Americans and American Indians alike. And they are a national treasure--requiring all of us to protect and preserve them for future generations." Secretary Vilsack has further articulated that the threats facing our forests don't recognize property boundaries. In developing a shared vision for our forests, we must also be willing to look across property boundaries and we must operate at a landscape-scale by taking an 'all-lands' approach. The *Assessment* and *Strategy* follow this approach. They also build upon and broaden the 2007 *Statewide Strategy for Restoring Arizona's Forests* created by the Governor's Forest Health Council.

Vast areas of the 20 million acres of Arizona's forest lands are unhealthy and vulnerable to unnatural fire because of accumulated fuels, overcrowding, and drought. In 2002, the catastrophic Rodeo-Chediski Fire burned 470,000 acres, destroyed more than 400 homes, and threatened many others. The containment and suppression costs exceeded $50 million as well as other immeasurable costs of rebuilding the communities and restoring the ecosystems destroyed by the fire.

The challenge of addressing these threats is compounded by Arizona's rapidly increasing population and shrinking 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 the importance of collaboration with agencies, organizations, and citizens working together to address similar or common issues. Such approaches are being emphasized more and more across all sectors of government and funding in the United States. Performance that demonstrates limited dollars are being used effectively to address the most important of needs now carries a great premium. It is our intent, through the implementation of this *Strategy*, that we make the best use of limited dollars to meet the greatest needs for Arizona's citizens and forest resources. Arizona will be 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 amends the Cooperative Forestry Assistance Act of 1978 and requires each state to complete a statewide forest resource assessment and a statewide forest resource strategy to receive, or continue to receive, 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 State Forestry Division (ASFD) 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 forests 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.

The State *Assessment* and *Strategy* are submitted to the U.S. Secretary of Agriculture or designee for final approval.

Federal Guidance

The National Association of State Foresters (NASF) and US Forest Service S&PF collaborated to provide specific guidance to states beyond that 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* is being developed as a separate companion document to this *Assessment* and, where possible, will complement other state and federal agency assessment and planning work.

Annual reporting will be required by the Arizona State Forestry Division (ASFD), beginning in 2011. Reporting is expected to include information about activities of ASFD 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 Resource Assessment and Strategy every five years or as required by the Secretary of Agriculture. Work will continue with partner agencies and organizations to coordinate further refinement of the ongoing assessment and strategy work.

3.0 Assessment Methodology and Outreach

Basic principles for the *Arizona Forest Resource Assessment* were identified early in the process:

1 – Build upon a strong collaborative foundation. The management of lands within Arizona is very diverse. Federal and state agencies and Native American Tribes manage the majority of Arizona lands. Only a small portion is owned privately. For any assessment or strategy to be truly reflective of this diverse land base, it must take an "all-lands" approach. It will be imperative to develop and draw upon strong relationships with many organizations and agencies. This collaboration will be critical to both the short- and long-term success of this process.

2 – Use and leverage existing work to the fullest extent possible. Substantial assessment and planning work has already been completed in Arizona by a number of 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 refine and develop 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 Task Group

In July 2009, the Arizona State Forester appointed a task group to work with ASFD staff to develop the *Assessment* and make recommendations for the *Strategy*. The Arizona Forest Resource Assessment Task Group (Task Group) was developed with the above principles in mind. The diverse composition of many existing collaborative organizations was leveraged to keep the size of the Task Group manageable. Representation was sought from all of the largest land management agencies and organizations, statewide councils and collaborative groups, statewide academic community, and non-governmental organizations.

The Task Group includes representation from these key agencies:

Arizona State Forestry Division - 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 of municipal jurisdictions.

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 beneficiaries. The primary beneficiary is the Common Schools (K-12). Revenue is generated through the sale and lease of Trust Land and products from those lands (i.e., mineral materials, water, wood products, etc.).

Arizona Game and Fish Department - Primary responsibility is to conserve, enhance, and restore all of Arizona's diverse wildlife resources and habitats through collaborative management programs focused on wildlife resources for the benefit of the public. Through resource management, the AZGFD provides recreational opportunities for wildlife enthusiasts and citizens to enjoy the diversity of wildlife found in Arizona.

Arizona Department of Agriculture - Responsible for supporting and regulating the agricultural industry in Arizona, including providing compliance assistance and conducting inspections to protect consumers and natural resources.

USDA Forest Service – A federal land management and service agency that manages approximately 11 million acres on six national forests in Arizona for a variety of resource uses. The USFS also provides assistance through the ASFD to private landowners and communities in the areas of forestry, forest health, and fire assistance through state and private forestry programs.

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. Participation of NRCS staff on this Task Group, 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 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.

The Task Group includes representation from these key collaborative groups:

Arizona Community Tree Council - A non-profit organization that promotes communication and the exchange of information about trees and the essential role trees play in the well-being of all Arizona communities. The Council is composed of representatives from individual Arizona counties, tribal communities, government agencies, professional organizations, and other individuals who have a statewide interest in the Council's mission. With a membership of nearly 500 individuals, the Council serves in an advisory capacity to the ASFD Urban & Community Forestry Program.
Arizona Forest Health Council – A statewide council appointed by the Governor to address forest issues. Composed of a broad cross-section of forest resource stakeholders, the Council is primarily tasked with implementing the *Statewide Strategy for Restoring Arizona's Forests*, which it developed and published in 2007, and integrating that strategy with the present effort.
Arizona Forest Stewardship Committee - A state-level committee that assists the Arizona State Forester with development, implementation, and oversight of cooperative forestry programs, and serves as a clearinghouse for information about landowner assistance.

The Task Group includes representation from other key sectors:

- **Academia -**The University of Arizona (UA), Arizona State University (ASU) and Northern Arizona University (NAU) are represented by the Ecological Restoration Institute (ERI) at NAU. The ERI is a research and resource management institute positioned to collaborate within the state university system to garner and share resources and expertise from these institutions.
- **Conservation NGOs -** Represented by The Nature Conservancy, this group includes many conservation organizations, such as the Sky Island Alliance, the Central Arizona Land and Water Trust, and the Desert Foothills Land Trust.

During the course of this project, many additional contributors assisted with development of both the *Assessment* and *Strategy*. Although we cannot list each one of them, their contributions are greatly appreciated.

3.2 Surveys, Workshops, and Stakeholder and Agency Outreach

The Task Group pursued several avenues for collecting information and reaching out to the broader forest community and interested stakeholders. Each Task Group member was identified as a point of contact for one or more organizations, agencies or collaborative groups, and served as a conduit for disseminating information and collecting input.

A few of the specific outreach activities included:

- **Collection of assessment and planning work** – Existing documents and plans were reviewed and summarized for possible use in the *Assessment* and *Strategy*. The Task Group wanted to acknowledge previous work and avoid replication or redundancy. If work had already been done, the Task Group tried to incorporate that information.
- **Agency and Group Presentations** – The Arizona State Forester, ASFD staff, and Task Group members gave numerous presentations and briefings about the *Assessment* and *Strategy* process and requirements to many groups and organizations. These included the Arizona Forest Health Council, Arizona Community Tree Council, Arizona Forest Stewardship Committee, Arizona State Land Department, Natural Resource Conservation Service State Technical Committee, and others. Several of these groups and organizations subsequently chose to assist the Task Group.
- **Stakeholder Workshop** – In December 2009, the Task Group hosted a stakeholder workshop in Phoenix to review proposed focus issues and gather feedback from stakeholders. Twenty-eight people attended this two-hour workshop and provided useful input.
- **Tribal Workshop** – Efforts to obtain meaningful input from Native American tribes resulted in a tribal workshop in February 2010. There were 23 participants from three of the larger Arizona tribes and the BIA. The workshop provided critical insight into tribal forest issues and prompted increased interest from tribal organizations, which resulted in additional discussion and more intensive project collaboration.
- **Land Management Organization Questionnaire** – In an effort to gather consistent input from the larger land management agencies and organizations throughout Arizona, the Task Group distributed a series of specific questions to each organization. Many land management entities were already represented on the Task Group by individuals who could help target the questionnaire within their organization and solicit a response. Other organizations were contacted directly by the Task Group and asked for input. The responses proved invaluable in helping to identify alignment of existing issues, concerns and identified strategies.

  Organizations providing responses to the questionnaire include:
  - USDA Forest Service
  - USDI National Park Service--Intermountain Regional Office
  - Arizona State Land Department
  - USDI Bureau of Reclamation

- **Online Stakeholder/Public Survey** - In December 2009, the Task Group initiated an online e-survey to gather input about critical Arizona forest resource issues that the Task Group had identified. Approximately 150 responses were submitted over a four-week period from December 2009 to January 2010. (See section 7.1 for more about the survey results)

Several successive document drafts were made available to stakeholders for review and comment. A variety of useful input was received and incorporated where possible. That feedback, along with input provided in workshops, through surveys, and by other means was used to further develop the assessment issues, and to identify appropriate strategies (See Appendix A-6).

3.3 Regional Outreach

One goal of both the *Assessment* and *Strategy* is to incorporate regional and interstate issues and concerns, and to identify common strategies where resources can be shared or leveraged. Arizona shares borders with five states in the United States and the State of Sonora in the Republic of Mexico. Additionally, Arizona is home to 21 recognized Native American tribes who have sovereignty over their reservations.

Contact was made with each of Arizona's neighboring states to share assessment information and discuss possible focus areas that might be shared across state boundary lines. Some collaboration was conducted by telephone and email. In-person contacts were made with representatives from each of the state groups during the USDA Forest Service National Assessment and Strategy meeting held in Broomfield, Colorado in November 2009. Members of the Western Forestry Leadership Coalition and the National Office of State and Private Forestry have been instrumental in helping to develop improved communication between states.

Region 3 of the USDA Forest Service proved invaluable in helping to make contact with, and gather information, from the Republic of Mexico. Shared concerns and opportunities for collaboration were identified, although much more work remains.

Outreach to the 21 sovereign Native American tribes was initiated through a focused workshop organized with help from the USDA Forest Service Region 3 Tribal Liaison and the Ecological Restoration Institute at Northern Arizona University (ERI). Additionally, the ASFD (with help from a State and Private Forestry grant) is currently embarking on an effort to develop a tribal liaison position that will continue to pursue avenues for collaboration and improved communication and understanding of tribal issues and priorities.

Results of regional, interstate and international efforts are included in Section 7.2.

4.0 Incorporation of Other Plans

Prior to this current effort, state and federal agencies, non-profit organizations, academic institutions, and collaborative groups have completed considerable analysis and planning work to address forest resource issues in Arizona. A large portion of this *Assessment* builds on these earlier activities. The following information provides an overview about many of the existing documents in Arizona that are being relied on for development of this *Assessment* and *Strategy*.

The Farm Bill legislation requires integration of several of these documents. However, many Arizona efforts go beyond the national norms and it is important for these works to 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 Urban & Community Forestry Plan**
  As the guiding document for Arizona's Urban & Community Forestry 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. The plan also describes the advisory relationship between the Arizona Community Tree Council and the State Forester in support of the ASFD'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 which 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 forest ecosystem restoration efforts. Site-specific planning and implementation remains the responsibility of each owner/management agency, generally operating within the guidelines developed within a CWPP. More than 27 CWPPs or equivalent plans have been developed and approved throughout Arizona.
- **Five-Year Nonpoint Source Management Plan**
  This plan was developed by the Arizona Department of Environmental Quality to update the state's Nonpoint Source Management Program originally developed under Section 319 of the Clean Water Act in 1989-1990. The desired outcome of this five-year plan is the restoration of water quality in lakes and streams identified as "impaired" waters, and reductions in pollutant loading to groundwater in areas where state aquifer water quality standards are being exceeded. It contains a strategic plan that describes how resources will be allocated to achieve the mission of Arizona'sNonpoint Source Program, which is: *To achieve and maintain water quality standards through the reduction of nonpoint source pollutant contributions to Arizona's surface and groundwater*. Guidance provided by the U.S. Environmental Protection Agency requires that this plan be reviewed and revised as appropriate in 2014.
- **Forest Legacy Program Assessment of Need**
  Written for the ASFD by The Nature Conservancy in Arizona, the *Assessment of Need* documents the need for a Forest Legacy Program in Arizona and includes eligibility criteria, project selection guidelines, and a definition of priority areas. The Forest Legacy Program is a USDA Forest Service program delivered through the ASFD for the purpose of identifying and protecting environmentally

important forest areas from conversion to non-forest uses through the acquisition of conservation easements. The *Assessment of Need* is incorporated within this *Assessment* by reference. Revision and updating are scheduled to begin in early summer 2010.

- **Forest Stewardship Program State Priority Plan**
  The State Priority Plan, last revised in 2007, supports implementation of the Forest Stewardship Program (FSP), which is funded by the USDA Forest Service and implemented by the ASFD. The purpose of the Forest Stewardship Program is *"to assist tribal, State Trust, and private forest land stewards to manage their forest lands and related resources; to keep those lands in a productive and healthy condition for present and future owners; and to increase the social, economic, and environmental benefits provided by those lands."* The plan includes a description of Arizona's forest resources, threats to those forest resources, and a description of program emphasis articulated through a framework of issues, objectives, strategies, and benefits.
- **Forest Stewardship Spatial Analysis Project**
  Published in November 2006, the FSP Spatial Analysis Project (SAP) was developed to provide for strategic delivery of the FSP. The SAP had two main components: 1) a historic spatial database of stewardship plan tracts, and 2) a layer-based suitability analysis. These components were used together in a Geographic Information System (GIS) analysis to identify and prioritize stewardship potential on non-industrial private forestland so as to improve the effectiveness of program delivery.
- **Statewide Strategy for Restoring Arizona's Forests**
  Prepared by the Arizona Forest Health Advisory & Oversight Councils in 2007, the *Statewide Strategy for Restoring Arizona's Forests* integrated the best available ecological, economic, and socio-political science into a strategy to achieve a fairly aspirational vision: *Healthy, diverse forest ecosystems supporting abundant populations of native plants and animals; thriving communities in attractive, forested landscapes that pose little threat of destructive wildfire; and sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values*. The *Statewide Strategy* outlined five strategic challenges, 15 recommendations, and 51 action items designed to achieve that vision across nine designated landscapes. It emphasized planning and implementation at the landscape scale and the absolute necessity of engaging industry to utilize and add value to restoration byproducts, and to offset the tremendous costs associated with ecological forest restoration.
- **State Wildlife Action Plan**
  The State Wildlife Action Plan (SWAP), previously known as the Comprehensive Wildlife Conservation Strategy, is currently being reviewed and updated by the Arizona Game and Fish Department. This diverse and comprehensive planning effort includes outreach and coordination, landscape- 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 within a 10-year timeframe.

4.2 Other Planning and Assessment Resources

In addition to the projects listed above, extensive resource-based planning and analysis has been completed or is ongoing in Arizona by numerous federal, state and local government agencies and/or non-governmental organizations. Several, but not all, of those efforts are identified below:

- **USDA Strategic Plan FY 2010-2015**
- **Arizona and Utah Regional Coordinated Resource Offering Protocol (CROP)**
- **BLM land use plans**
- **BLM rapid eco-regional assessment (in process)**
- **Four Forests Restoration Initiative**
- **Intertribal Timber Council assessment of Native American forests and forest management**
- **National forest land and resource management plans**
- **Northern Arizona Wood Supply Analysis**
- **Tribal land and resource management planning**
- **Western Mogollon Plateau Adaptive Landscape Assessment**
- **White Mountains Landscape Assessment**

A comparison and discussion of how the Arizona *Assessment* and *Strategy* align with the USDA Strategic Plan FY2010-2015 is incorporated into the *Strategy* document. The USDA Strategic Plan can be found at (http://www.ocfo.usda.gov/usdasp/sp2010/sp2010.pdf)

5.0 Arizona Forest Conditions and Trends

5.1 Overview of Arizona Forests

This discussion has been taken directly from the Forest Legacy Assessment of Need report with some edits and modifications.

The diversity of Arizona forests ranges from riparian gallery forests traversing the low desert to sub-alpine and montane forests above 9,000 feet in elevation (O'Brien 2002). 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 above the Mogollon Rim with 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. O'Brien (2002) provides more specific information (e.g., acres of specific types and ownerships, net volumes, net annual growth, annual mortality) about Arizona's forest resources (see O'Brien 2002, Table 2, p. 34).

Pre-European Settlement Vegetation and Climate

Today's forests reflect a long series of climatic and corresponding vegetative change in Arizona. A paleo-ecological study in the Potato Lake area of the southern Colorado Plateau (approximately 7,300 feet inelevation) suggests that dramatic changes occurred in the area's biota during the last 35,000 years (Anderson 1993, Anderson et al. 2000). From 35,000 to21,000 years before present (B.P.), it appears that the area was dominated by mixed conifer species, suggesting the climate was cooler and wetter than it is today. From 21,000 to 10,400B.P., likely the region's coldest period during the last glaciation, Engelmann spruce (*Piceaengelmannii*) formed almost pure stands, growing as low as 8,200 feet. Today, spruce is generally locatedabove 10,800 feet. 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 cold desert species were replaced by warm desert grasses. In lower elevation regions of the Colorado Plateau, studies from the Chaco Canyon and San Juan Basins in New Mexico and Arizona(8,000 B.P.) showed that canyons were dominated by mixed conifer forests and mesa tops were cold desert steppe (Betancourt et al. 1993).

Fire

In Southwest forests, lightning- and human-caused fires could burn for several months and cover thousands of acres, burning until extinguished by rain or depletion of fuel (Swetnam 1990, Swetnam and Baisan 1996). Dendrochronology research suggests that most Southwest forest stands, excluding spruce-fir, burned every 2 to 30 years as low-intensity, ground 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, Veblen et al. 1994). 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 (Schroeder and Buck 1970, Swetnam and Baisan 1996).

Humans 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 3,000 B.P. indicate human populations were developing more permanent settlements and shifting to a greater reliance on domesticated plants (Dean et al. 1994). Impacts on forest resources were thought to have been minimal until around the 1100s when farming, fuelwood cutting, and hunting greatly increased around larger settlements (Dahms and Geils 1997).

Prehistoric peoples used timber for fuel, tools, and construction. Their sources of timber were mainly locally based due to technology and transportation limitations. For these reasons, woodlands and riparian forests near areas of population growth were most affected (Dahms and Geils 1997). For example, Puebloan and Hispanic farmers essentially eliminated the riparian bosque along the Middle Rio Grande Valley by 1848 (Abert 1848a, Wozniak 1987). It was not until the nineteenth century, with the introduction of commercial logging, mining and railroads, that upper elevation forests were impacted.

Historic Forest Conditions

The pattern of tree distribution is influenced by environmental conditions as well as processes above and below ground. While dense woodlands could be found, ponderosa pine forests in the early nineteenth century were predominantly open with a diverse community of trees, shrubs, and perennial grasses and forbs (Abert 1848a, 1848b). 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 ponderosa pine 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 climate conditions that existed 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 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 (as reported by Dahms and Geils (1997) in *An Assessment of Forest Health in the Southwest*) are described as follow:

> *"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, 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 disturbance occurred relatively infrequently, typically with 100 or more years between major events (Baker and Veblen 1990, Schmid and Frye 1977, Veblen et al. 1994).

Riparian forests 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 species in riparian communities depend on seasonal flooding for seed

transportation and establishment, and to maintain high groundwater levels and 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 also produced significant environmental impacts, such as intensive grazing, logging and irrigation, and the introduction of diseases that threatened wildlife.

The period following the Mexican-American War of 1848 marks a significant transition from Mexican to American sovereignty in the Southwest and a time of rapid settlement. With increasing settlement came domestic livestock. In fact, by 1890, more than 1.5 million head of cattle were in the Southwest (Baker et al. 1988). By the early 1900s, grazing pressure from cattle and sheep had reached the timbered mountains, resulting in loss of vegetative cover and increased erosion. Since a 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).

Historic fire regimes were dramatically changed because livestock removed much of the fine fuel needed to carry surface fires and because fire suppression increased due the growing number of inhabitants who viewed all fire as a threat. Ultimately, the frequency and size of fires was altered by a combination of road and trail establishment, fragmentation of forest continuity, increased ignition sources, suppression of fires, and altered fuel loads. Fire suppression and exclusion began altering forest structure and fire regimes most dramatically in the early 1900s (Covington and Moore 1994). During the last century, the combination of 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 (McKenzie et al. 2004).

With the arrival of railroads in the Southwest, new industries appeared, human population grew, natural resource exploitation accelerated, and a commercial economy replaced the subsistence economy. Some other concurrent changes included altered land use and ownership patterns, depletion of forage by livestock, degradation of riparian areas, and changes in wildlife habitat (Bahre 1991, DeBuys 1985).

Arizona has continued this rapid growth trend, further stressing the use of natural systems and resources. Small-scale logging for local-use shifted to larger efforts around the 1870s with construction of the railroad and harvesting of trees for railroad ties and fuel. During these early years, a large volume of trees present (70-80%) needed to be removed from the forests to make the railroad operation feasible (Schubert 1974). Later, when trucks became available, lighter cuts could be made--typically from 30% to 60% of the available volume (Myers and Martin 1963). With time, harvesting methods have been variable with some practices 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 public land managers. Higher visitation to wilderness 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 course of the state's forests. Recent studies have indicated that a warming climate has changed forest fire regimes, and is

projected to continue to increase the frequency, size, and seasonal length of forest fires (McKenzie and others 2003, Westerling and others 2006), thereby shifting the dominance and abundance of plant species across the West.

These and other interrelated changes throughout Arizona have also altered the hydrologic regime of most watersheds. Soil compaction, road construction, and reduced ground cover have led to increased erosion and flooding, often resulting in deep, incised channels. Water diversions and impoundments of larger rivers have significantly modified channel dynamics, and altered native habitat and vegetation establishment within the reservoirs and downstream riparian habitats. To address bank stabilization and other ecological problems, species not native to ecosystems of the Southwest, such as salt cedar(*Tamarix*spp.), were introduced to help "solve" these problems. Many of these introduced species are quite aggressive and invasive, and are currently having serious detrimental effects on ecosystem processes.

Current Forest Types and Distribution

Despite all these problems and concerns, the diversity of Arizona's current forests remains impressive--from compact, semi-arid gallery forests along streams, through expansive pinyon-juniper woodlands, up to mixed conifer-oak-aspen forests in mountainous areas. Some of Arizona's southern forested landscapes have attracted 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 that create forest refugia and corridors for many animals, including jaguar and thick-billed parrot.

The USDA Forest Inventory and Analysis Program (FIA) classifies forestlands into two general categories--timberland or woodland—according to the levels of tree stocking. Timberland is forestland where tree species traditionally used for industrial roundwood products, such as ponderosa pine and Douglas-fir (*Pseudotsugamenziesii*), make up at least 10% of the stocking. Only 20% of Arizona's forestland meets this definition (O'Brien 2002). 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. 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 that provide 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 at 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(EPA/CEC 2002). Southwestern ecosystems are further grouped into life zones (Carleton et al. 1991)that 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 the purposes of this *Assessment* and *Strategy*, forest lands have been differentiated into the following types, as illustrated in Figure 1 and quantified in Table 2 : aspen, mixed conifer, pine-oak, pinyon-juniper, ponderosa, and riparian.

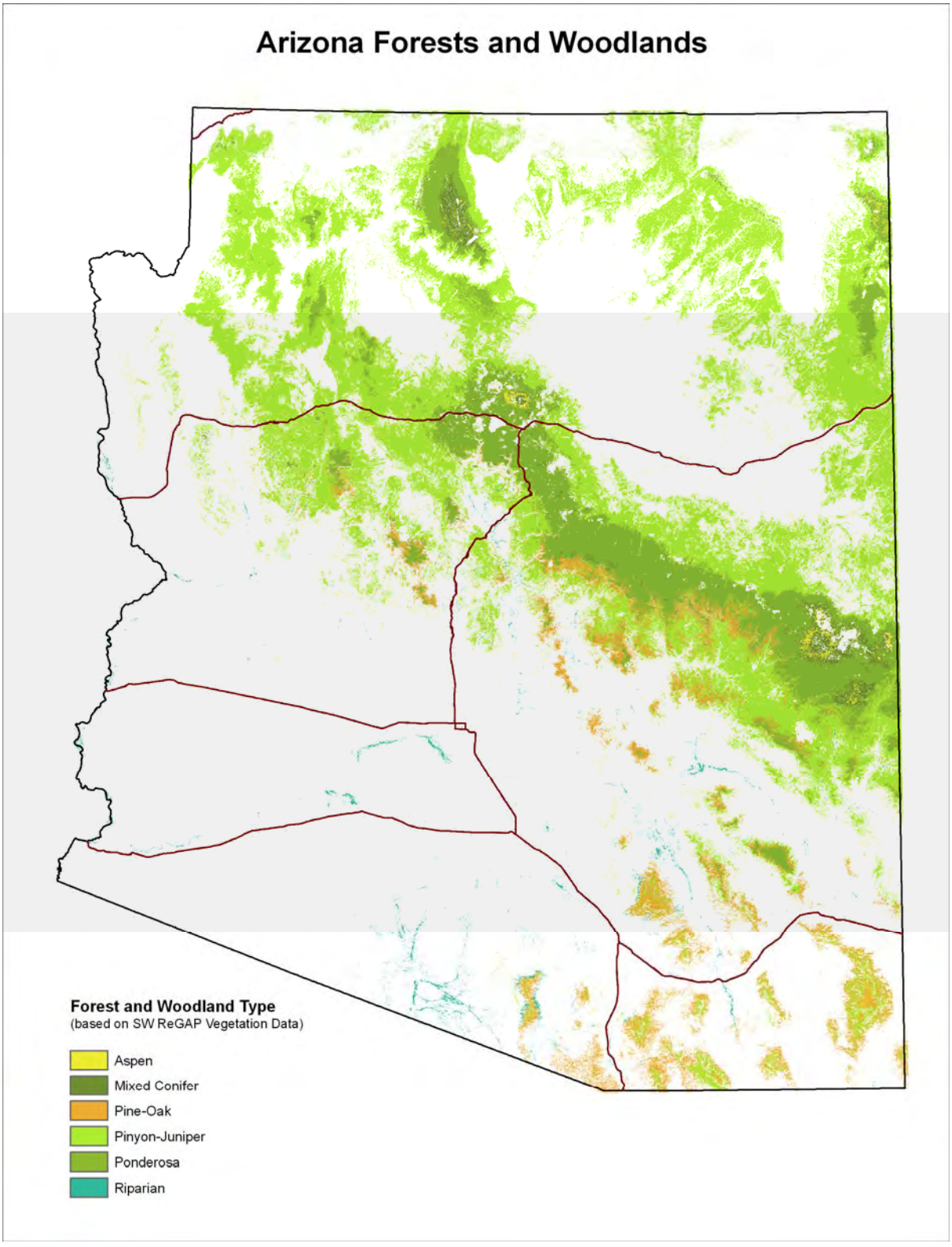


Figure 1. Arizona forests and woodlands

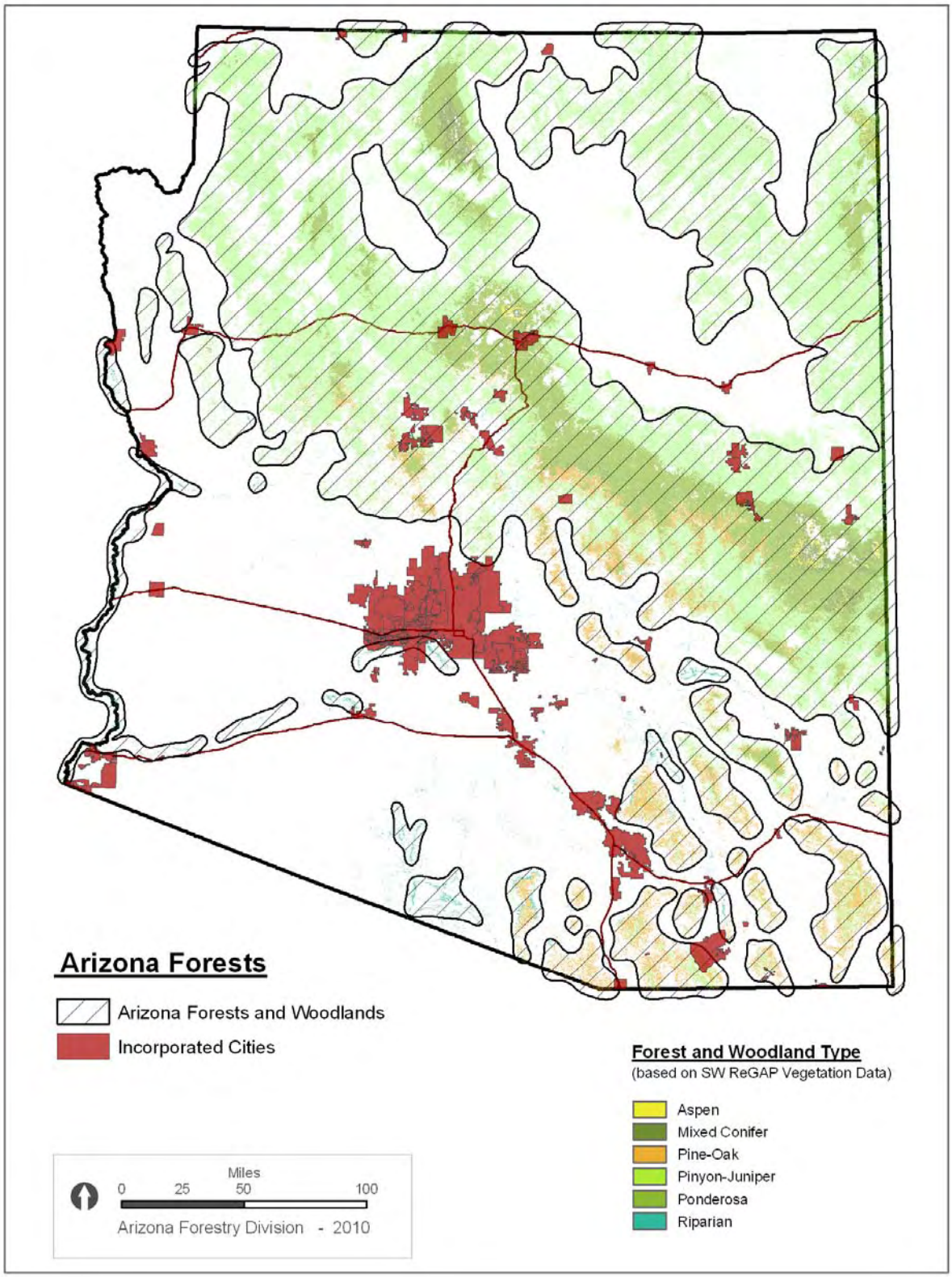


Figure 2. Arizona forests and woodland areas shown with incorporated municipalities.

Aspen

Trembling or quaking aspen (*Populustremuloides*) ranges in occurrence from small discontinuous patches of tens to hundreds of acres to large, contiguous thousands of acres) throughout Arizona, 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 better documented 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, supporting many species of birds and mammals either directly asforage, indirectly through the vast insect community it supports or through the provision of structural habitat or nesting sites. Some consider aspen to be second only to riparian areas in biodiversity value (Smith 2006a).

Mixed Conifer Forests

A variety 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 (*Abiesconcolor*), and blue spruce (*Piceapungens*), with ponderosa pine present at the lower end of those elevations. The spruce-fir forest is predominantly Engelmann spruce and subalpine fir (*Abieslasiocarpa*)in cooler regions and areasreceiving 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 (*Quercusgambelii*), juniper, Arizona cypress (*Cupressusarizonica*), and aspen.

The mildest climate in Arizona is found in mixed conifer forests, with average annual precipitation from 14 to 30 inches(USDA 2004b), with as much as 44 inches at higher elevations (USDA 2004a). More than half of the precipitation falls as snow and mean annual temperature ranges from 41 to 47 degrees F(USDA 2004b).

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 several oaks dominate with a mix of conifers. This latter type is found 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 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 primarily in the “sky islands” area 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 at low elevation and below the coniferous forest at higher elevation. 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*)--are found at higher elevations in conjunction with Madrean pine species, such as Apache pine (*Pinusengelmannii*), Chihuahua pine (*P. leiophylla*var. *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 (*Tillandsiarecurvata*) can be found on tree branches. Some of the common understory grasses include muhlys (*Muhlenbergia*spp.), cane beard grass (*Bothriochloabarbinodis*),

wolftail (*Lycurussetocus*), plains lovegrass (*Eragrostisintermedia*), and several grama grasses (*Bouteloua*spp.). There are also several shrubs (i.e., *Salvia, Artemsia*), forbs (i.e., *Penstemon, Lupinus*), and cacti (i.e., *Ferocactuswislizeni*, *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 pointleafmanzanita (*Arctostaphylospungens*), Wright's silktassel (*Garryawrightii*), and Arizona rosewood (*Vauqueliniacalifornia*) 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 ratios about equal (USDA 2004b). 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 (USDA 2004a). Pinyon pine is the most common species in the complex with other pines including border pinyon (*Pinus 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 (*Juniperusmonosperma*) 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 (Brown 1994, Gottfried 1992).

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 (*Panicumobtusum*), Arizona fescue (*Festucaarizonica*), squirreltail (*Elymuselmoides*), 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 (*Cowaniamexicana*), 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).

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, squirreltail and mountain muhly (M*uhlenbergiamontana*), 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 ecotone 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 Sonoran Desert. The vegetation found along 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 reservoirs.

Factors such as elevation gradient, upland community, soil type and precipitation, riparian vegetation make riparian forests highly variable in terms of species. At the higher elevations, typical overstory species--narrowleaf cottonwood (*Populusangustifolia*), 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 (*Alnustenuifolia*), shrub willows, and chokecherry(*Prunusvirens*).

In mid- to lower elevations, a mixture of deciduous broadleaf species, such as Arizona sycamore (*Platanuswrightii*), Arizona walnut (*Juglans major*), Goodding willow (*S.gooddingii*), Fremont cottonwood (*P.fremontii*) and velvet ash (*Fraxinusvelutina*), dominate the forest canopy. Many riparian forests at mid-tolower elevations have been taken over or are in part invaded by introduced tamarisk. 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.

Urban and Community Forests

While not traditionally considered a forest type, Arizona's urban forests comprise ecosystems 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, mesquite and cottonwood trees, with exotics such as eucalyptus, causurina, and various pines. Northern Arizona native trees are predominately ponderosa and pinyonpine, oak and juniper, with several introduced species that can make their home in 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 (*Elaeagnusangustifolia)*, tamarisk, and tree-of-heaven (*Ailanthus altissima*) being prime examples.

The urban forest includes urban parks, street 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

5.21 Ecoregions

Ecoregions used in the *Assessment* are based on the premise that ecological regions can be identified through analysis of the patterns and composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity (Wiken 1986; Omernik 1987, 1995). These phenomena 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 (EPA/CEC 2002), which was derived from Omernik (1987) and from refinements of 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 subregions, 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.

Brief descriptions of Arizona ecoregions follow. Their distribution is illustrated in Figure 3.

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. 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.

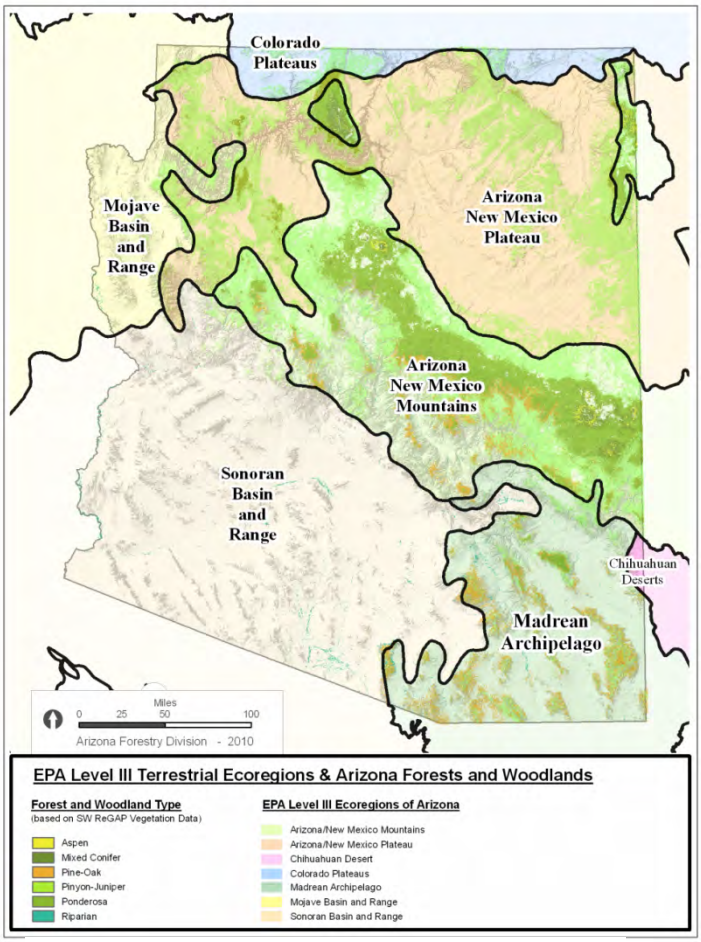


Figure 3. Ecoregions of Arizona

COLORADO PLATEAUS

Rugged tableland topography is typical of the Colorado Plateau ecoregion. Precipitous side-walls mark abrupt changes in local relief, often from 1,000 to 2,000 feet. The region is more elevated than the Wyoming Basin to the north and therefore contains a far greater extent of pinyon-juniper woodlands. However, the region also has large low lying areas containing saltbrush-greasewood (typical of hotter drier areas), which are generally not found in the higher Arizona/New Mexico Plateau to the south where grasslands are common.

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 desertic 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 grass and shrubland, 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, most of which is used for military training. However, the Sonoran Basin and Range is slightly hotter than the Mojave and contains large areas of paloverde-cactus shrub and giant saguaro cactus, whereas the potential natural vegetation in the Mojave is largely creosote bush.

5.22 Landscapes

In addition to describing Arizona in terms of ecoregions, previous assessment efforts (here referenced to the *Statewide Strategy to Restore Arizona's Forests*) have concluded that many forces, including the influences of human settlement and timber harvest, have shaped Arizona's forests into distinct landscapes, each with its own history and unique characteristics. For example, the extensive ponderosa pine forest occupying the relatively flat Western Mogollon Plateau was heavily logged during the first half of the twentieth century. Coupled with fire suppression and other forces, this led to a dramatically different forest characterized by a substantially decreased abundance of old-growth trees and a greater number of small trees, often occurring in dense stands that are more susceptible to crown fires than their widely spaced, old-growth ancestors. The flat topography that had once allowed ground fires to burn slowly, and beneficially, across the forest floor now helps the spread of crown fire across large areas, as it moves rapidly through interlocking tree canopies. Conversely, the pine and mixed-conifer forests of the Southern Sky Islands—many also heavily logged in the past century—occupy generally steeper slopes, where they have always been subject to fires of different intensities, from cool ground fires creeping down steep slopes, to crown fires spreading in patchy patterns across the rugged, mountainous topography. Differences in ecological conditions on the Mogollon Plateau and in the Sky Islands identify them as distinct landscapes that require different, locally grounded approaches to forest resource management.

The principles of landscape ecology, a rapidly developing discipline that studies large-scale patterns and processes in nature, indicate that there are a relatively small number of distinct forested landscapes in Arizona. The fates of these landscapes are largely independent, because 1) they are typically isolated from one another and 2) important processes, such as fire, drought and urban expansion, operate at scales that affect different landscapes in very different ways. For example, periodic shifts in the jet stream may bring increased moisture to southern Arizona, while the northern forests are stressed by drought. Similarly, crown fires on the Mogollon Plateau in2002 flared into the massive Rodeo-Chediski complex that restructured a half-million acres, while other forested landscapes suffered no negative effects during Arizona's worst fire season in recent history.

These examples demonstrate that there is a natural scale for planning and management of Arizona's forests. The *Statewide Strategy for Restoring Arizona's Forests* identified landscapes as those distinct areas that are linked together, internally, by key driving forces—fire, climate, and human activities—that determine forest conditions and influence their future development. In Arizona, rugged topography, variable climate, and differing fire regimes suggest that there are less than a dozen large landscapes (nine forested), each differing from one another, each characterized by a unique set of environmental conditions and ecological processes, and each on an independent trajectory into the future. Adopting a landscape perspective is an important step toward addressing forest health comprehensively because it recognizes that conditions, challenges, and solutions almost certainly vary across our state.

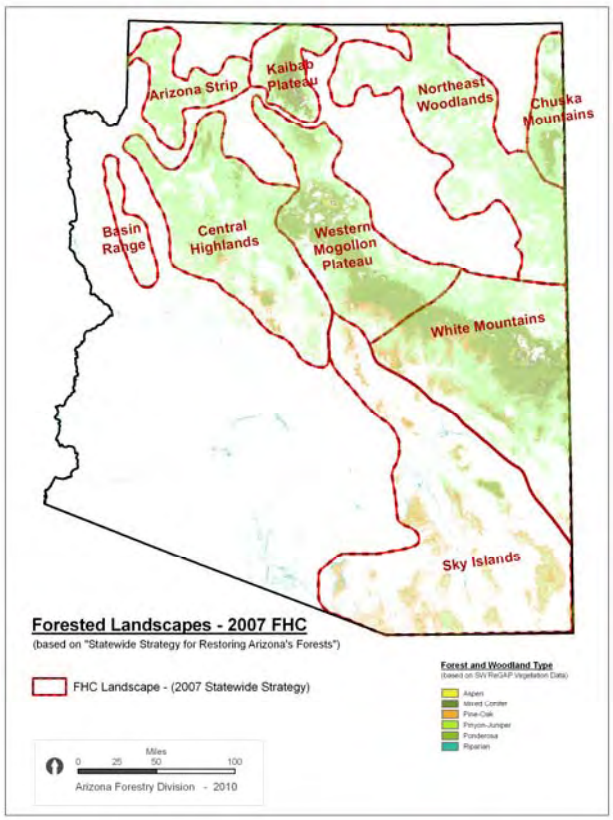


Figure 4. Arizona Forested Landscapes—2007 FHC

The 2007 ***Statewide Strategy for Restoring Arizona's Forests*** identified nine "Forested Landscapes."

- Arizona Strip
- Basin and Range
- Central Highlands
- Chuska Mountains
- Kaibab Plateau
- Northeastern Woodlands
- Sky Islands
- Western Mogollon Plateau
- White Mountains

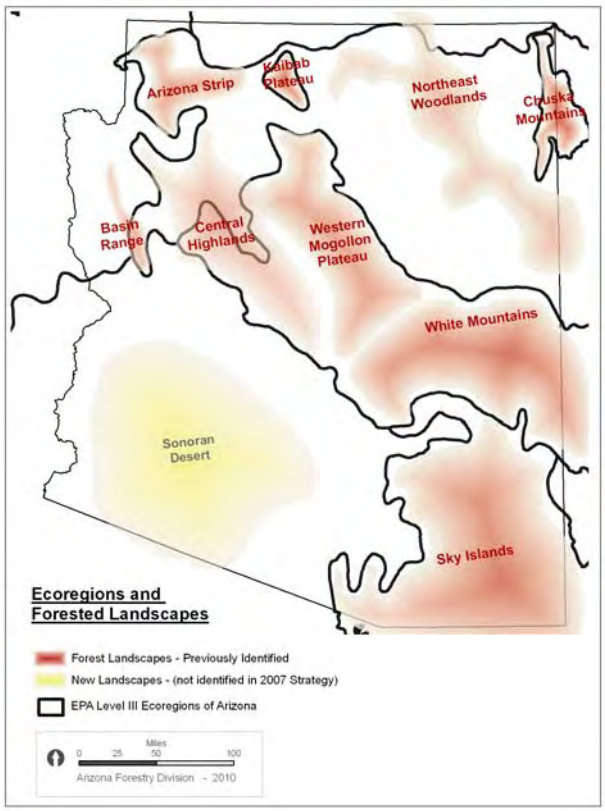


Figure 5. Arizona Forested Landscapes--2010

The nine previously identified Forest Landscapes nest within Arizona's seven EPA-designated Level III Ecoregions.

Although not traditionally known as "forestland," the newly identified ***Sonoran Desert Landscape*** is home to a wide variety of unique and very important forest ecosystems, including riparian areas and urban forests.

6.0 Critical Forest Resource Issues for Arizona

6.1 Overview

The Arizona Forest Resource Assessment Task Group devoted hundreds of hours reviewing existing planning and assessment documents, gathering input from partner agencies and stakeholders, and discussing classification of Arizona forest issues. Sections 3 and 4 describe some of the details of the outreach and data gathering efforts.

Critical Forest Resource Issues for Arizona were grouped into seven major categories:

1- People and Forests
2- Ecosystem Health
3- Water & Air
4- Fire
5- Economics
6- Climate Change
7- Culture

The following pages explore these seven critical forest 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.

As issues related to forest ecosystems were identified, evaluated and classified into the seven critical issues, it became clear that there were some overarching issues that cut across all seven critical areas. These topics were:1) funding to accomplish forest management activities, 2)building capacity to collaboratively accomplish forest management goals, and 3) educating the public and decision makers about forest management. It is clear that as strategies are developed and implemented and priority/focus areas addressed, various aspects of funding, capacity, and education must be considered. Each of the critical issue discussions touches 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 inevitable 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 hundreds-of-thousands of acres, and move to innovative approaches that may not have been tried before. 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 issue. Knowledge, understanding, and involvement by diverse participants is required for appropriate forest 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.

6.11 People and Forests

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 forests, allowing them to garner a broad array of benefits from the forests, yet affecting these ecosystems in many negative ways. What were once remote forest wildlands with occasional visitors are becoming backyards and crowded playgrounds to expanding suburban neighborhoods. People migrating from urban areas often choose to live within or adjacent to forests and thus face new challenges such as fire, smoke, forest access, water supply, and land use issues. At the same time, distant metropolitan areas continue to increase demand for some of the forest's most precious commodities.

Introduction

People have been interacting with, and dependent on, forests for thousands of years. Forests of all kinds provide significant ecosystem services to society. Forests are responsible for much of our nation's primary production--the conversion of sunlight into life-giving energy. Forests build soils and protect them from erosion. Forested watersheds provide two-thirds of the drinking water in the United States (NRC 2008) and they absorb 10% of the carbon dioxide that Americans emit each year (USDA Forest Service 2009). Forests shelter fish and wildlife, and offer aesthetic beauty and spiritual renewal for people. Forests bolster our economy through recreation and tourism, through the creation of green jobs, and through the production of wood products and energy. Forests 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

- Forest lands are important economically for jobs and rural economies.
- Urban and community forests form the green infrastructure system on which many communities depend.
- Globally, it is estimated that almost 20 percent of human-caused carbon emissions are from deforestation. In Arizona , though numbers are likely much smaller, deforestation-type impacts occur through loss of forests to stand-replacing fire, land development, and other forested land use changes. Finding ways to reduce the rate of deforestation globally, and similar impacts in Arizona, could have substantial benefits in reducing human-related carbon emissions as well as sequestering carbon in forested ecosystems.
- Improving forest health while reducing risk due to insects, disease and catastrophic wildfire, will enhance conditions on and around forests with respect to traditional, cultural, and historical values.

Threats/Impacts

- Increased pressures from a rapidly expanding population—Arizona's population has doubled during the past 25 years to more than six million people (Population Brief Arizona).
- Conversion of forestland to urban and suburban uses--development and sprawl.
- 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.
- Forestland ownership patterns are changing.

Key Elements

Population

More than six million people currently live in Arizona. Projections indicate that the population will be more 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 racial or 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 5 percent in 2000. 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 forest resources such as water, wildlife and forest 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 forested acres belong to families and individuals. 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 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 nine 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.

Recreation

Statistics show that virtually every recreational activity is on the increase on Arizona public lands, including those described as unmanaged activities. Largely fueled 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 opportunities, facilities, and infrastructure. Experience provides evidence that unmanaged recreation is also

causing damage to resources that can be very costly to mitigate. Increasing problems with invasive plants and animals may be partially attributed to recreational activity.

As opportunities for recreation are reduced on private and state trust lands due to development pressures from Arizona's rapidly expanding population, public lands will be relied on more heavily to provide recreation opportunities. For example, between 1982 and 2000, uses of Off-Highway Vehicles (OHV) increased by 109% nationwide. In 1995, a General Accounting Office study found OHV use on federal land to be generally under-managed. A study by Arizona State Parks in 2003 found that Coconino and Yavapai counties combined received 2.36 million days of OHV recreation use annually. Unmanaged recreation (specifically cross-country travel by OHVs) was declared one of four threats to the National Forest System by the Chief of the U.S. Forest Service in 2005.

Recreation pressures are extremely high on forested lands around Grand Canyon National Park (GCNP). For example, there are nearly 150 trailheads on the Kaibab National Forest alone that are in close proximity to the GCNP. It's also interesting that roughly 97% of the visitors to the Kaibab NF are white. Hispanics make up most of the remaining balance of those who provided ethnicity information. 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 wildland 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 population increases, community needs usually result in increased need for forest access, transportation, 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 urban temperature, improving storm water run-off, 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, 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 walkable community. 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 metropolitan areas like Phoenix are low compared to regional standards (Tree and Shade Master Plan). Challenges to maintain these forests are: inadequate forestry staffs; trees not being replanted at the same rate as they are being lost or removed; currently low overall urban shade canopies; out of date and inadequate tree standards in zoning ordinances; limited water resources; educational programs eliminated or underfunded; poor planting, maintenance, and irrigation practices; limited community and business partnerships; incomplete tree inventory or GIS information; regulatory hurdles that create disincentives for structural shade; and a limited understanding by the general public of the importance of trees.

Grazing/Rangeland Values
Federal and state lands have provided an important economic base for communities in some 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 such activities. 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 individual landowners as well as grazing and agricultural lessees of state or federal lands. Assistance is provided to implement conservation-based management alternatives using livestock and crop production or reduction practices that provide wildlife habitat or other public benefits and preserve open space. Some examples of these are the Environmental Quality Incentives Program (EQIP), Wildlife Habitat Improvement Program, and 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 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 drought.

Debate continues about trends and impacts regarding grazing on public forest land. A downward fluctuation of grazing acres available could negatively affect some ranching operations, especially in areas where there is little private grazing land available. If ranching is no longer viable, additional fragmentation of habitat and loss of open space on private lands may occur as land uses change. Land managers must weigh potential benefits against potential impacts caused by grazing. Some groups are interested in comparing the production value of ranching and grazing allotments with other uses. More emphasis is now being placed on the open space and wildlife values of these activities.

Education
Surveys and research indicate there is strong support for conservation education. Respondents believe that the goals of developing volunteer programs to improve forests and grasslands, and maintain trails and 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 natural resources. Collaboration between groups for information sharing purposes is also considered an important goal. It is recognized that 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.

Children

In the past, children in the United States spent a great deal of time outdoors, which fostered a deeper understanding of the value and interrelationships of natural resources. As population shifted to urban environments, a disconnect was been created where children, regardless of ethnic background, no longer understand how natural resources are connected to their daily lives, nor do they have the same access to recreation opportunities in parks and forests. Research indicates this is not just a phenomenon isolated to urban areas, and that all demographics and cultural sections of society are at risk (Charles et al. 2009).

Today, children are spending more time playing video games and watching television than playing outdoors, a phenomenon that author Richard Louv calls, "nature deficit disorder." In a speech about today's youth, former Forest Service Chief Gail Kimbell explained that the "Detachment from nature tragically translates into a shaky future for sustainable forests and healthy public lands. Any plan to sustain healthy, productive ecosystems must ensure that people remain socially connected to them"(Kimbell2007).

Recognizing this disconnect, the U.S. Forest Service established a grant program entitled "More Kids in the Woods" to help reintroduce kids to the natural world through interactive programs involving forested ecosystems (Kimbell 2007, USDA press release 2007.) Many of the national forests in Arizona have recognized the importance of getting kids back into the woods by establishing specific policies and programs that target youth (Coconino NF 2008, Kaibab NF 2008).

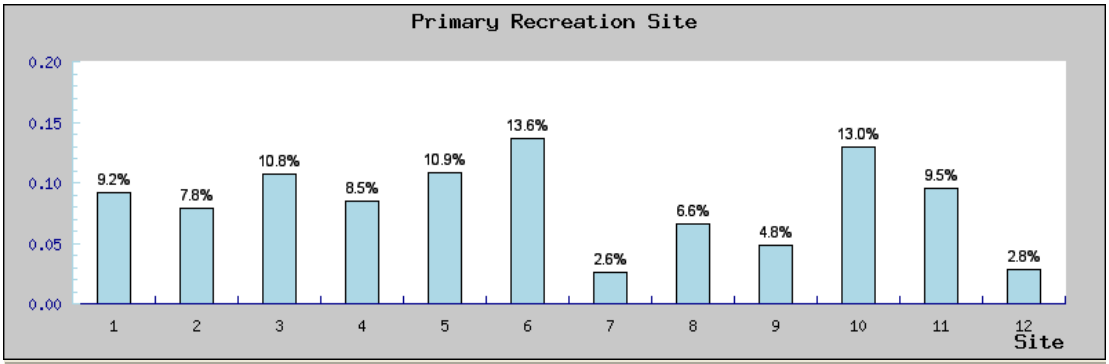
Other Considerations/ Related Issues

- Wood for houses, furniture, paper, and other products: Ninety-two 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 a place to recreate. 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 experiences.
- Industries, such as mining, timber harvest, and livestock grazing may affect ecological structure and functions, which, in turn, will affect the sustainability of future social and economic endeavors.

The following bullets summarize a survey done for the U.S. Forest Service Southwestern Region by the University of New Mexico in 2008. They reflect region-wide responses.

1. **Access**: Respondents were supportive of a goal for developing and maintaining trail systems for non-motorized recreation, but not so for motorized off-highway vehicles. A large share thought designating some existing recreation trails for a specific use and designating wilderness areas were important goals.
2. **Preservation/Conservation**: Conserving forests and grasslands to protect water resources (important = 66%); protecting ecosystems and wildlife habitats (important = 89%); and preserving the ability to have a 'wilderness' experience (important = 85%) were all considered particularly important objectives.
3. **Economic Development**: There appears to be strong support for the goal of restricting resource extraction (mineral/oil removal and timber harvesting). Not surprisingly, individuals did not consider the goal of obtaining permits for these activities and commercial recreation to be important. Slightly more than half considered providing natural resources to support local communities a somewhat important or important goal. There was strong consensus that developing a national policy to guide natural resource development was an important goal. There was little consensus on the goal of expanding commercial recreation.
4. **Natural resource management**: As noted above, while respondents considered developing a national policy to guide natural resource development to be an important goal, most felt that making actual management decisions at the local, rather than national, level was important (74%). Consistent with this, individuals also considered using public advisory committees to be an important objective. Individuals also felt that multi-use management, increasing the size of public lands, and increasing law enforcement activities on public lands were important objectives. While there was support for the goals of introducing a recreation fee to support public land and allow public land managers to trade public lands for private lands, support for this objective was less strong than that of the other natural resource management objectives.

Survey Results: Which Southwestern Region national forest or grassland, shown on this map, did you visit ***most frequently*** for recreation in the past 12 months?



1. Apache-Sitgreaves National Forest (AZ or NM)	7. Kaibab National Forest (AZ)
2. Carson National Forest (NM)	8. Lincoln National Forest (NM)
3. Cibola National Forest (NM)	9. Prescott National Forest (AZ)
4. Coconino National Forest (AZ)	10. Santa Fe National Forest (NM)
5. Coronado National Forest (AZ)	11. Tonto National Forest (AZ)
6. Gila National Forest (NM)	12. Cibola National Grasslands (in NM, OK, and TX)

Figure 6. Primary Recreation Sites in National Forests in Arizona and New Mexico

Roughly half of 6,452 survey respondents indicated that they either did not visit a national forest or grassland in the Southwestern Region, or they left this question blank.

PEOPLE AND FORESTS - FOCUS AREAS

Focus landscapes for the *People and Forests* critical issue were derived using four sets of data developed by the Arizona Game and Fish Department (AZGFD) in October, 2009 for their Strategic Wildlife Action Plan. The data sets were Urban Growth, Rural Development, Motorized Recreation Off-Trail, and Non-motorized Recreation Off-Trail. All of these data sets depicted *Stress Potential* for wildlife, ranging from low to high. The focus landscapes for Forests and People are a composite of the areas classified as *High Stress Potential* in each data set. While it is recognized that human impacts of some type occur on all of Arizona's forest lands, the focus landscapes are those areas where human impacts are greatest.

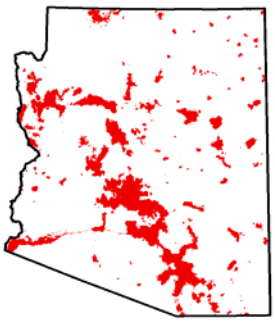


Figure 7. Urban Growth - Dataset developed by Arizona Game and Fish Department for Arizona's State Wildlife Action Plan.

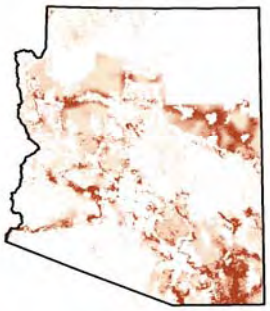


Figure 8. Rural Development - Dataset developed by Arizona Game and Fish Department for Arizona's State Wildlife Action Plan.

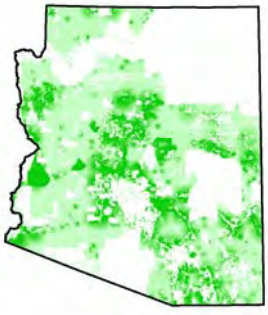


Figure 9. Motorized Off-trail Recreation - Dataset developed by Arizona Game and Fish Department for Arizona's State Wildlife Action Plan.

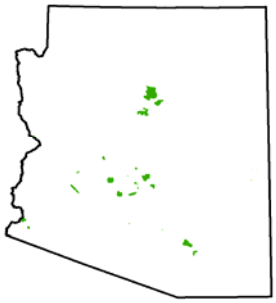


Figure 10. Non-motorized Off-trail Recreation - Dataset developed by Arizona Game and Fish Department for Arizona's State Wildlife Action Plan.

The Forest and Woodlands Mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

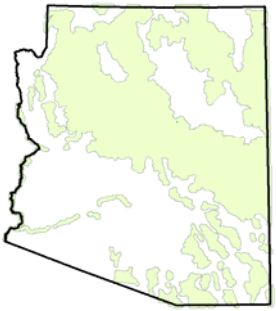


Figure 11. Forest and Woodlands Mask- A generalized map overlay depicting the area of forest and woodland vegetation cover in Arizona. This layer was derived from the Southwest Regional Gap Analysis data of 2005.

Figure 12. EPA/CEC Ecoregions- EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state. This layer is not used to inform the development of each specific issue overview map, but as a tool for identifying critical need across the state, and as a framework for future analysis. (See Section 8 for information about how the Ecoregions are used.)

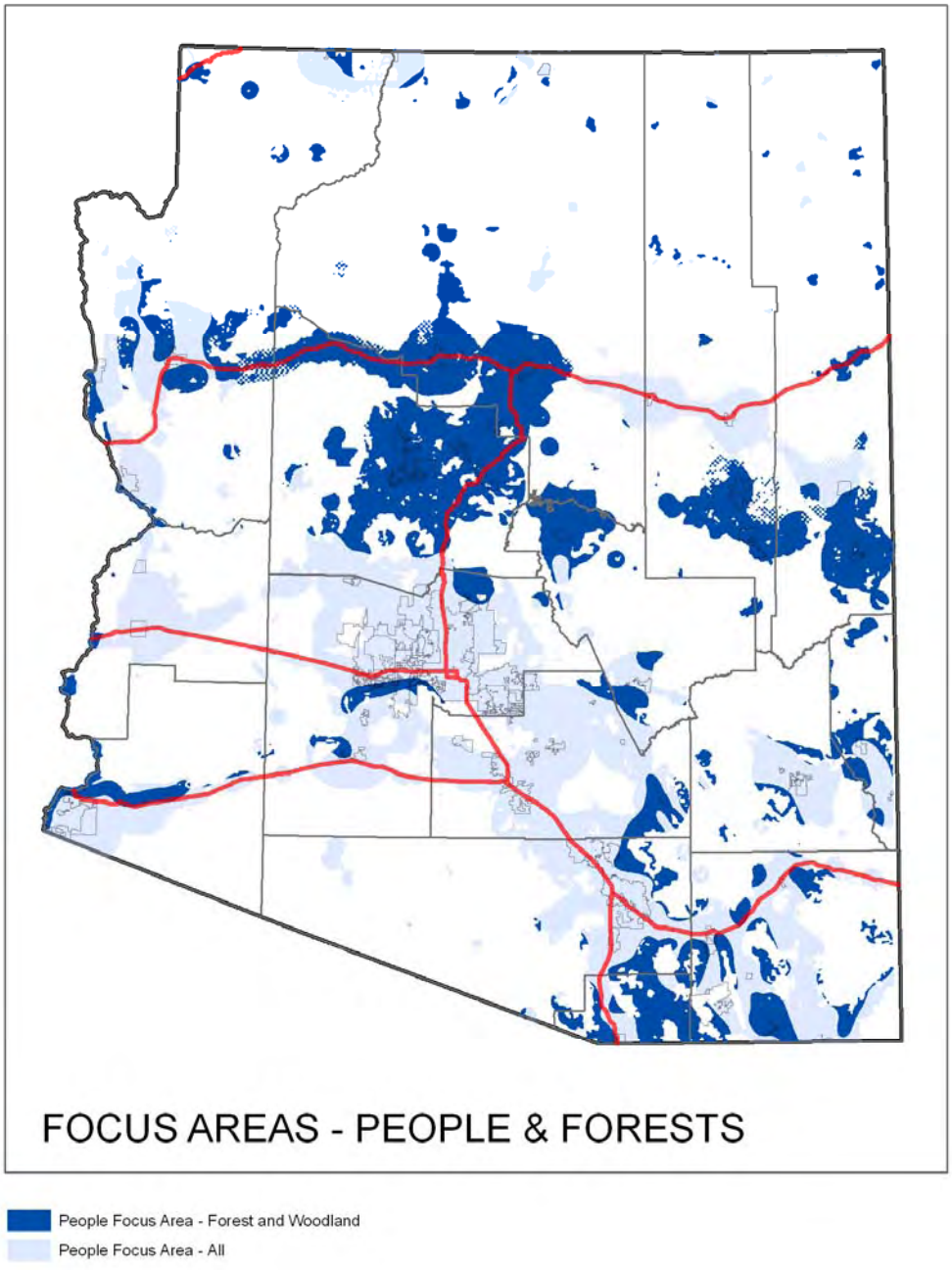

FOCUS AREAS - PEOPLE & FORESTS
People Focus Area - Forest and Woodland
People Focus Area - All

Figure 13.

6.12 ECOSYSTEM HEALTH

Critical Issue Description

Throughout the forest ecosystems of Arizona, evidence of their declining health, function and sustainability is readily apparent. Dramatic signals of unraveling forest 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 forest ecosystems are very different from historic conditions. Key indicators include changes in nutrient cycling, decreases in understory species diversity, increased invasion by exotic species, and disruption of natural fire regimes. It is essential that Arizonans accurately identify the reasons for decline in the health of forest ecosystems and respond appropriately.

Introduction

Forested ecosystems provide necessary habitat for a wide variety of wildlife, as well as critical goods and services to the citizens of Arizona. Nevertheless, evidence of declining forest and woodland ecosystem health is readily apparent throughout the state. Uncharacteristic fire behavior, disease and insect outbreaks, and declining biodiversity are among the most noticeable effects of declining forest conditions. Science-based strategies are essential for restoring ecological integrity so that the goods and services that ecosystems provide are sustained into the future.

The *Assessment* of forested ecosystems in Arizona focuses on the need for a scientific basis for conducting forest health projects, provides a context for planning ecosystem restoration, and contributes to an understanding of the physical, biological, and human dimensions of these ecosystems. For the purposes of this statewide *Assessment*, forest health is defined as:

> *" a condition wherein a forest has the capacity across the landscape for renewal, for recovery from a wide range of disturbances, and for retention of its ecological resiliency, while meeting current and future needs of people for desired levels of values, uses, products, and services "*(Twery and Gottschalk 1996).

Key Elements

Ecosystems must be accurately identified to enable 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 result from human activity, are brought to light because of human concerns, and are addressed through human intervention. We need to ensure that ecological components of forests are resilient to disturbances, including human activities and climate variability (Apache-Sitgreaves FLMP, p. 12).

Ecosystem restoration must be based on sound science. This requires an understanding of how ecosystems function, how they support and tolerate human use, and how policy and management affect the environment (Thomas and Huke 1996).

Indicators of healthy ecosystems include: 1) biological diversity, 2) biotic integrity and resilience, and 3) ability to support human needs and uses. These three indicators accurately reflect the biological, physical, and human dimensions required for sustaining ecosystems.

Natural disturbance processes allow for shifting of a plant communities structure and age across the landscape. Ecotone shifts are influenced at both the landscape and watershed scale by natural disturbance processes. The presence of a mosaic of plant communities and variety within them provides resilience to disturbances(Coconino NF LMP).

Ecological conditions for habitat quality, distribution, and abundance contribute to self-sustaining populations of plants and animals that are interrelated and well-distributed. Appropriate conditions provide for the life history needs, distribution, and natural population fluctuations of the species within the carrying capacity of the landscape (Apache/Sitgreaves FLMP, p. 12).

Benefits, Threats, and Impacts

The *benefits* of science-based restoration measures are numerous, including:

- Enhanced native plant and animal diversity
- Maintained habitat for the survival and recovery of threatened and endangered species
- Improved watershed functions
- Decreased populations of invasive species
- Restored natural fire regimes and other natural disturbances (e.g., wind, insects, disease)
- Reduced occurrence of unnatural crown fires
- Restored and sustainable forest vegetative structure and ecosystem functions
- Sustained ecosystem services.

Through evidence-based research, scientists have learned that some southwestern ecosystems are no longer sustainable because of significant changes that occurred during the previous century.

Impacts of these century-long changes include:

- Significant increases in tree densities
- Decreases in understory species diversity and productivity
- Reduced rates of nutrient recycling,
- Increases in insects and tree pathogen populations,
- Significant increases in forest fuel concentrations
- Increased invasions of non-native plant species and loss of native animal species
- Aspen decline and lack of successful aspen regeneration
- Vulnerable riparian areas due to decreased shallow groundwater and climate change

All of these changes have effects that are predicted to continue and, in some cases, to increase in the foreseeable future. These current and future *threats* include:

- Increased populations of invasive species (plants and animals)are changing vegetation dynamics
- Altered forest vegetation structure and composition results in a subsequent loss of ecosystem resiliency and inability to adapt to climate variability
- Homebuilding and road development create fragmented landscapes and ecosystems
- Uncharacteristic fires in desert ecosystems now move upslope into forested ecosystems
- Large, stand-replacing wildfire occur in spruce/fir, mixed conifer, and ponderosa pine forests

Assessment of Key Components of Ecosystem Health

Fire: Research has shown that fire regimes vary widely across the various 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 potential force controlling ecosystems. Historically, both lightning and human-caused fire would burn until extinguished by rain or until they ran out of fuel--typically when they reached an area that had recently burned. Fires could burn for months and cover thousands of acres (Swetnam 1990, Swetnam and Baisan 1996). As a result, most forest stands

(except spruce-fir) burned every 2 to 30 years as low intensity, area-wide fires. Pre-settlement mixed-conifer forest could have burned as frequently as ponderosa pine forest (Grissino-Mayer et al. 1995). With greater moisture levels and heavier fuel loads, spruce-fir forests burned much less frequently but at high, stand-replacing intensity (Grissino-Mayer et al. 1995, Veblen et al. 1994).

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 forest fuels and further contributed to reductions in fire frequency and size (Covington and Moore 1994). Fire suppression and reduced timber harvest have contributed to the buildup of organic materials (fuel) on the forest floor. Fire exclusion also permits tree and shrub encroachment into openings and, as a result, dramatic reductions in the size of meadows.

Disruption of natural fire regimes has also decreased the diversity of forested stands across much of Arizona's landscape. Establishment of young trees in older stands provides a ladder fuel that carries ground-level fire 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, tree tops, and cull logs. In most areas however, these fuels have been removed by various treatments--slash disposal (pile burning or chipping), prescribed fire (underburning), or firewood collection. Those areas with the greatest fire hazard are the ones with the greatest fuel accumulations, such as stands never logged or logged without subsequent fuel treatment.

Due to heavy fuel accumulations and climate change, fires that occur now are often more intense and more difficult to contain. The overall number of fires has been decreasing across the state, and larger, more damaging fires are 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., Rodeo-Chediski 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 (Seageret al. 2007). This climate trend will increase the length of fire seasons during the summer months, and increase the frequency, size, and severity of forest fires (McKenzie et al. 2003, Westerling et al. 2006).

In 2006, 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, 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. Additional FireScape projects are underway in the Santa Catalina, Rincon, Chiricahua, Dragoon, and Galiuro mountains

Forest Insects and Pathogens: For millennia, trees of southwestern forests have been host 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 forest density, composition, and structure. Forest conditions, in turn, affect the distribution and reproduction of forest 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, several species of defoliating insects, dwarf mistletoes, 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 affect forests annually rather than periodically (episodically).

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

Increased introduction of invasive/exotic species: Invasive and exotic species continue to increase at an alarming rate in rangelands, forests, and riparian ecosystems. Control of infestations has been difficult, and the ecological consequences have been serious. Rapid expansion of exotic weed populations is a great deterrent to restoring native plant communities and re-establishing historic conditions. If exotic plants are not kept in check, long-term devastating effects to forest ecosystems can occur. The ecological effects include replacement of native plant species and reduction in ground cover, which leads to loss of biodiversity, forage, habitat, scenic quality, and soil productivity**.**

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

- Prevent any new noxious or invasive weed species from becoming established.
- Contain or control the spread of known weed 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 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 large 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 Arizona ponderosa pine 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
- Since most of the increase is in smaller trees, there is an increase in ladder fuels so that crown fires, once rare in ponderosa pine, are now common
- Increased tree density reduces tree vigor resulting in susceptibility to bark beetles, particularly during drought
- Dense, multi-storied stands provide suitable conditions for rapid spread and intensification of dwarf mistletoe
- Increased density results in lower water yields, which has a negative effect on riparian areas and watersheds.

In addition to increased density, ponderosa pine forests have tended to become more uniform, with the loss of horizontal and vertical structural diversity and species composition.

Changes in Wildlife Diversity: Wildlife diversity and population health is directly linked to the quality of available habitat. There are more than 150 species listed in the State Wildlife Action Plan that are dependent on forest habitats for a portion of their life cycle, and changes outlined throughout this *Assessment* all have an impact on the viability of each of these species.

Probably the largest effect on wildlife populations in Arizona forest habitats is due to the loss or conversion of forest habitats to other uses. This effect is expressed in several ways:

- Increased urban, residential or commercial development
- Habitat fragmentation in forests due to roads, campsite, housing
- Unregulated or improper management of recreation in forests
- Forest management practices that may result in conversion from one vegetation type to another
- Invasive species that may alter habitat types and cause conversion from one habitat type to another or may cause complete loss of certain habitats
- Unnatural fire regimes that have changed from high-frequency, low-intensity wildfire to low-frequency, high-intensity wildfire and can cause significant stress to all forest wildlife species.

In addition to habitat loss or conversion issues in forests, wildlife populations can be unsustainable within a given forest habitat—a situation that may hinder recovery or promote conversion to some forest habitats. Some changes will favor one or more species, allowing them to flourish and increase in numbers. Other species negatively impacted by that type conversion may experience sharp declines in populations or become locally or regionally extirpated.

Needs for improving wildlife habitat conditions include:

- Creation and/or improvement of habitat quality, distribution, and abundance to support the recovery and/or stabilization of federally listed plant and animal species
- 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
- Habitat improvement to increase and include: 1) prescribed burning, 2) seeding and planting of desirable browse and herbaceous species, 3) water development, and 4) creation of wildlife openings
- Location, survey, and 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 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, the Mexican spotted owl standards and guidelines take precedence over the northern goshawk standards and guidelines on federal forest land
- Cooperation with AZGFD on population control of aquatic plants and undesirable fish species
- Permit fish stocking to meet state fisheries management goals

- Construction of adequate exclosures to protect key riparian areas from livestock grazing where rest rotation or time control grazing fails to provide adequate protection
- Design water developments that consider small game and nongame needs and escape devices
- Require fencing that will meet wildlife standards and consideration of local species needs.

Human Needs and Uses: In Arizona, trees and forests provide a number of 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 wood and renewable energy, carbon sequestration, and diverse recreational and scenic opportunities.

In urban and community settings, trees and forests also serve as a kind of 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 in Arizona, 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 of off-road 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. Forest fragmentation is another result of urbanization. Also important are those areas that may be converted from one housing density to a significantly higher density within developed areas as this may also lead to loss of canopy and the benefits it provides to ecosystem function.

The dramatic increase in off-road vehicles (ORV) in unmanaged areas can lead to adverse impacts and degradation of all ecosystem components. Such use has increased erosion, soil compaction, spread of invasive species, damage to cultural sites, disturbance to wildlife, destruction of wildlife habitat, and risks to watershed function. Along with fire and fuels, invasive species and loss of open space, this issue is one of the U.S. Forest Service's "four threats." Managing the areas where impact or potential impact is greatest, in addition to educational efforts, will help alleviate these impacts.

Ecosystem Integrity and Resilience: Policies for ecological restoration (*Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.* Society for Ecological Restoration International 2004; *Ecosystem restoration involves holistic actions taken to modify an ecosystem to achieve desired, healthy, and functioning conditions and processes*.) are informed by 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"(Sagoff 1998).

Properly designed restoration treatments will begin to develop the cultural capital needed to create and maintain sustainable livelihoods in Arizona's ponderosa pine forests and other ecosystems deemed a priority. Restoration projects will necessitate creating many jobs that go beyond tree cutting--projects including prescribed burning programs, reforestation and planting of understory vegetation, controlling invasive species, establishing a variety of appropriate-sized industries utilizing wood fiber, and other management activities that are conducive to restoration goals and objectives. Such activities can help build a social capital that will enable not only sustainable jobs and wood-related industries, but the continual

sustainability of ecosystem functions, and restoration decisions that are science based and effectively placed to treat forested ecosystems at the landscape 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 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 falling apart, we must act and act quickly.
- 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 (Covington and Vosick 2003).

Focus Areas and Priority Landscapes

- Most forested ecosystems in Arizona are experiencing critical levels of habitat decline; some ecosystems have been destroyed from impacts such as stand-replacing wildfire. We must be expedient in implementing ecological restoration in order to protect remaining ecosystems.
- Critical forest 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.
- Forest ecosystems below 3,000 feet and urban forests statewide must also be evaluated using the best available science to enable proper treatment prioritization and management.
- All forested ecosystems in Arizona that are adjacent to communities, and are within the Wildland-Urban Interface, often have issues from both recreational uses of the forest and unwanted wildfire.
- There are several threatened and endangered and sensitive species that rely on forests as important habitat.
- Promoting aspen regeneration is a key priority in associated ecosystems.
- Management of forest-dependent wildlife and game species (elk, deer, etc) at sustainable levels.
- Restore populations of reduced or extirpated species, including potentially predator reintroduction.
- Forested landscapes with contiguous vegetative structure and characteristics conducive to stand-replacing crown fire must receive priority consideration for treatment.
- Land use patterns and policies that increase fragmented ownership and constraints to ecological restoration and health must receive priority for revision.

ECOSYSTEM HEALTH - FOCUS AREAS

Focus landscapes for the Ecosystem Health critical issue were derived using three sets of data--1) LANDFIRE FRCC (Fire Regime Condition Class), 2) AZGFD Species and Habitat Conservation Guide, and 3) U.S. Forest Service National Insect and Disease Risk Map. The focus landscapes for Ecosystem Health are a composite of areas with the highest classification in each of these layers. While it is recognized that all ecosystems are important, the focus landscapes are those areas where impacts and opportunities are greatest.

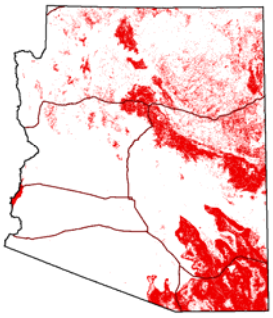


Figure 14. Fire Regime Condition Class - LANDFIRE dataset – FRCC class 3 areas.

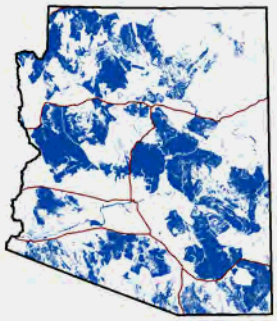


Figure 15. AZGFD Species and Habitat Conservation Guide - Developed as part of the State Wildlife Action Plan, this map layer identifies key habitats for wildlife conservation potential in Arizona at a landscape/statewide scale. Values range from 1 to 6. The highest values (5 and 6) were extracted for this analysis.

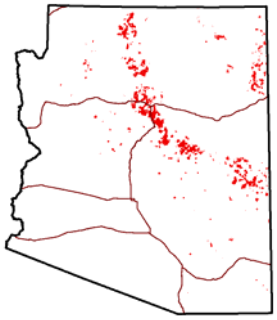


Figure 16. U.S. Forest Service National Insect and Disease Risk Map - This 2006 product identifies forest areas where 25% or more of the standing, live volume of trees greater than 1" in diameter are expected to die in the next 15 years.

The Forest and Woodlands mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

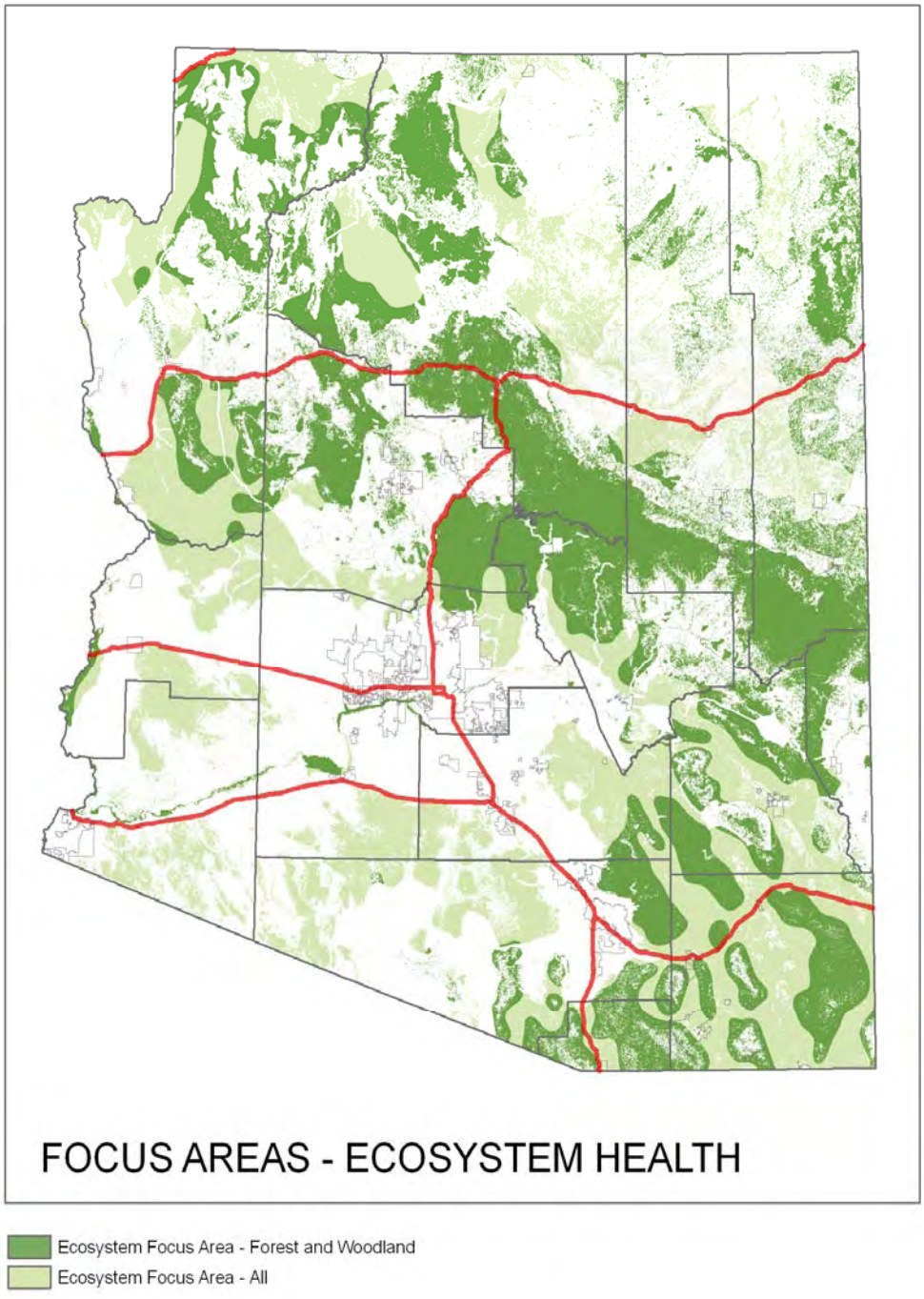


Figure 17.

6.13 WATER AND AIR

Critical Issue Description

As two of life's most important elements, water and air play critical roles in the sustainability of a vibrant Arizona. Water is scarce in Arizona. A decline in precipitation during the last several decades has brought about earlier spring runoff and reduced watershed yield. Drought continues to challenge our ability to balance increasing demands for water from agriculture, industry, and an expanding population. Likewise, clean air, often taken for granted, is threatened by many factors--industrial and auto emissions, dust from uncovered soil, smoke from increasing wildfire occurrence and forest management activities. These changes related to water and air have resulted in widespread forest impacts--tree mortality due to fire and drought, reduced air quality and ecosystem diversity, degraded water quality, and increased soil erosion.

Introduction

The quality of the air, and the quality and quantity of water, affect every living thing in the state. As two of life's most important elements, water and air play critical roles in sustaining Arizona's natural resources and its people and their quality of life. Both of these elements are substantially influenced by Arizona's urban and rural forests.

Compared to most of the nation, water is scarce in Arizona. Average annual precipitation during the past 30 years has ranged from less than 3 inches in the driest deserts to as high as 25-40 inches at higher elevations, with half the state receiving less than 10 inches and ponderosa pine forests receiving between 20 and 30 inches. Not only is average precipitation lower than most other parts of the country, the timing and amount of precipitation received annually is highly variable. In this setting, watershed protection, enhancement, and conservation are extremely important. Forests enhance watershed conditions and, in turn, water quality by stabilizing soils and reducing erosion. Trees bind the soil; absorb or deflect the through fall of rain, snow, sleet,and hail; filter toxins from water; and reduce runoff, flooding, and sediment deposit after storms. A dependable supply of clean water is imperative for agricultural uses as well as for Arizona's six-million-plus citizens and millions of visitors.

Arizona's forests also serve to 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, Arizona's forests contribute to reduced air quality when smoke is produced by wildfires and other management activities, especially prescribed burning.

Benefits, Threats, and Impacts

Arizona's vast forests are all important components of the state's watersheds and airsheds. It is vital for the long-term health of all living things that Arizona's forests be managed to positively affect air quality and water quality and quantity.

Benefits

- More than six million people live in Arizona, many of whom depend on drinking water sources that are generated by runoff from precipitation on forested watersheds
- Crop production on Arizona's one million acres of cropland requires a dependable supply of clean water
- Wildlife and livestock require a dependable supply of clean water

- One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen every day This is enough to meet the annual needs of 18 people (Why Trees)
- Urban forests reduce the impact of the urban heat island effect and lessen its impact on weather patterns.

Threats and Impacts

- Poor watershed conditions
- Inadequate water supply
- Effects of wildland fire smoke

Key Elements

Water

Climate and Water

- Precipitation is both greater and more dependable in Arizona's upper elevations, where the majority of its forests occur.
- Forested lands in Arizona contribute nearly 90% of the total streamflow in the state, much of which comes during spring snowmelt (Ffolliot 1975).
- Ponderosa pine forests, in particular, are the source for a large 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 (Barr 1956).
- Forest lands also contribute additional, unknown quantities of groundwater recharge.
- In much of Arizona's coniferous forests, the number of trees per acre and the canopy cover have both increased to the point where little ground cover remains. Much of the precipitation is intercepted by the dense canopy or runs off of bare soil.

Water Yield

- Studies conducted in the Beaver Creek and Castle Creek watersheds show that 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).
  - Clearing forests increased annual yield by about 0.1-0.2 acre-foot.
  - 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 that grew and used the available water.
  - 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 through the use of fire to manage understory vegetation. However, scientific trials have not been conducted to test this hypothesis in the Southwest.
- Treated pinyon-juniper woodlands have not shown significant increased 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. (Ffolliott 1975)
- 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 (Ffolliot 1975).

- Initial water yield increases of 15-40% are realistic when the basal areas of a ponderosa pine forest is reduced by 30- 100%, depending on soil type (Baker 2003). These increases may be caused in part by changes in one or more of the following hydrologic factors:
    1. reduced interception losses
    2. reduced transpiration (use of water by vegetation)
    3. changes in the hydrologic properties of the soil surface and forest floor
    4. more efficient conversion of the snowpack to stream flow.

Soils, Erosion, and Sedimentation

- Soil compaction by logging equipment is a potential impact of certain forest management activities. Soil compaction could reduce water-holding capacity of the soil as well as infiltration capacity, 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 the planning and implementation, impacts can be exacerbated.
- Lack of consistent use of Best Management Practices (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 blocking channels.
    - Soil's infiltration capacity and ability to store nutrients and water are diminished 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.

Aquatic Systems/Riparian Areas

- Managing Arizona's forested riparian zones to optimize growth of trees and understory plants will provide better protection against erosion for stream channels and stream banks. Water quality will be enhanced by reduction of downstream sediment and the improved ability of the riparian area to act as a bio-filter.
- Where appropriate, reduction of high water use invasive riparian plants (i.e., tamarisk and Russian olive [*Elaeagnusangustifolia*]) will improve the ability of Arizona's riparian forests to deliver water for downstream uses.
- Many of Arizona's forested riparian areas are no longer functioning properly. Instead of protecting the water quality of Arizona's streams through filtration and prevention of streambank erosion, they contribute to sedimentation and reduced water quality due to changes in geomorphology of stream channels. In some areas, invasive riparian species (i.e., tamarisk) use large amounts of water and may be reducing stream flows and delivery of water to downstream users.

Air

Climate and Air

- In many Arizona ecosystem there is a lack of ground cover and soil moisture, and all the more so as temperatures increase. These factors contribute to wind erosion and airborne particles. Trees help cleanse the air by intercepting airborne particles and absorbing pollutants.

- Quality of life in desert metropolitan areas 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 (Benefits of Urban Trees).

Smoke and Other Air Pollutants

- Uncharacteristic wildfires have become common in Arizona's coniferous forests, creating a situation where Arizona's 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 resource benefit, operations are designed to result in 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 fire-adapted ecosystems.
- Trees improve air quality by cleaning the air. They remove dust and particulates, and absorb ozone, carbon monoxide, sulfur dioxide, and other pollutants(ISA Pamphlet 1991).

Atmospheric Carbon

- Carbon is sequestered in living trees, thus preventing its release into the earth's atmosphere. It is released slowly as dead wood decays.
- Old-growth trees and mature forests are significant carbon sinks over time.
- Large, high intensity wildfires release large quantities of carbon and other particulates into the atmosphere.
- Forest management and burning of hazard 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.

Focus Areas

While vegetation and land use oftentimes change abruptly with changes in ownership/jurisdiction, air and water do not. Water quality and quantity, as well as air quality, are 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*.

Water

Landscape Prioritization

The process of landscape prioritization for water began with the identification of waters that are ***impaired*** based on the presence of sediment, turbidity, and *E. coli*. Once that was accomplished, the next step was to identify the hydrologic units with 8-digit Hydrologic Unit Codes (HUC) that contain these ***impaired waters***.

The 8-digit hydrologic units and ***impaired waters*** they contain are as follows:

1) Grand Canyon (15010002)
    a. ***Impaired water*** – Colorado River in Parashant Canyon (suspended sediment and selenium)
2) Paria (14070007)
    a. ***Impaired water*** – PariaRiver from Utah border to Colorado River (*E. coli* and suspended sediment)
3) Upper Verde (15060202)
    a. ***Impaired water*** – Verde River (turbidity and sediment)
    b. ***Impaired water*** – Oak Creek from headwaters to Spring Creek (*E. coli*)
4) Tonto (15060105)
    a. ***Impaired water*** – Tonto Creek (*E. coli* and nitrogen)
    b. ***Impaired water*** – Christopher Creek from headwaters to Tonto Creek (*E. coli* and phosphorus)
5) Upper Little Colorado (15020002)
    a. ***Impaired water*** – Little Colorado River from Silver Creek to Carr Wash (sediment and *E. coli*)
    b. ***Impaired water*** – Little Colorado River from "unnamed reach" to Lyman Lake (turbidity and sediment)
6) Little Colorado Headwaters (15020001)
    a. ***Impaired water*** – Nutrioso Creek from Nelson Reservoir to Picnic Creek (turbidity and sediment)
    b. ***Impaired water*** – Little Colorado River from west fork of Little Colorado River to Camero Creek (turbidity and sediment)
7) San Francisco (15040004)
    a. ***Impaired water*** – Blue River from Strayhorse Creek to the San Francisco River (*E. coli*)
    b. ***Impaired water*** – San Francisco River from Blue River to Limestone Gulch (*E. coli*)
8) Upper Gila – San Carlos Reservoir (15040005)
    a. ***Impaired wat***er – Gila River from BonitaCreek to YumaWash (*E. coli* and sediment)
9) Lower San Pedro (15050203)
    a. ***Impaired water*** – San Pedro River from Aravaipa Creek to the Gila River (selenium and *E. coli*)

The 8-digit hydrologic units listed above were identified as ***critical focus areas***.

The next step in the process was to designate the 4-digit hydrologic units that contained the ***critical focus areas*** (Grand Canyon, Colorado, San Juan, Little Colorado, Verde/Salt, Upper Gila, and the Santa Cruz/San Pedro) as ***focus basins***.

Finally, forest cover was overlaid on the ***focus basins*** to identify the landscapes where events (e.g. wildfires) and activities (e.g. restoration thinning, managed fires) could impact water quantity and quality. These forested areas are the ***priority landscapes*** within each ***focus basin***.

Air Quality

Landscape Prioritization

Steps in the prioritization of landscapes for air quality were as follows:

1. Identification of (a) those areas with the highest sensitivity to air quality, i.e. ***Class I Areas*** (12 such areas in Arizona: Grand Canyon National Park, Sycamore Canyon Wilderness, Petrified Forest National Park, Pine Mountain Wilderness, Mazatzal Wilderness, Mount Baldy Wilderness, Sierra Ancha Wilderness, Superstition Wilderness, Galiuro Wilderness, Saguaro National Park, and Chiricahua Wilderness), and (b) ***populated areas with high sensitivity*** to smoke from wildfires and managed fires (e.g., Camp Verde, Flagstaff, Payson, Prescott, Sedona, Show Low, and Williams).
2. The next step was to add in the ***PM10 Non-attainment areas*** (areas that exceed the federal limit for particulate matter, including Phoenix, Globe-Superior-Winkelman-Mammoth, Yuma, Ajo, Rillito, Nogales, Paul Spur, and Douglas).
3. The third step was to identify the ***focus airsheds*** within which the ***areas of concern*** are located (Colorado River, Upper Colorado River, Verde River, Little Colorado River, Lower Salt River, Upper Gila River, and Gila River). *Areas of Concern* are those areas identified in #1 and #2 above, including the ***Class I Areas*** and the ***PM10 Non-attainment areas***.
4. Lastly, forest cover was overlain on the ***focus airsheds*** to identify the ***priority landscapes*** within each airshed where events (e.g., wildfires) and activities (e.g., restoration thinning, managed fire) would impact air quality.

WATER & AIR - FOCUS AREAS

Focus landscapes for the *Water & Air* were derived as follows: For *Water*, the identification of waters that are ***impaired*** based on the presence of sediment, turbidity and E. coli was used to identify the hydrologic units with 8-digit Hydrologic Unit Codes (HUC) that contain these ***impaired waters***. The next step in the process was to designate the 4-digit hydrologic units that contained these ***critical focus areas.*** For *Air*, smoke sensitive areas, identified collaboratively with the Arizona Smoke Management Program, were buffered by 15 miles to indicate areas of greatest concern.

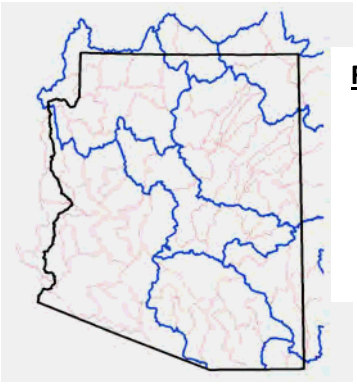


Figure 18. Arizona Watersheds -4-digit and 8-digit hydrologic units.

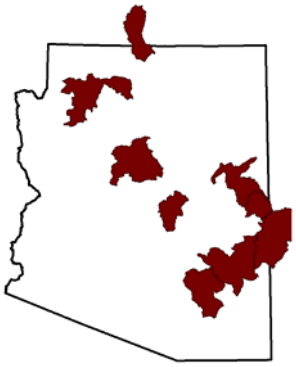


Figure 19. Impaired Water Areas- 8-digit hydrologic units identified as impaired based on the presences of sediment, turbidity, and *E. coli*.

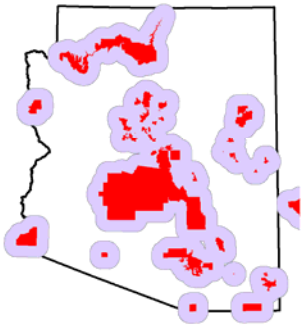


Figure 20. Smoke Sensitive Areas - Area identified with the highest sensitivity to air quality, i.e. Class 1 Areas and populated areas with high sensitivity to smoke from wildfires and managed fires. Developed in collaboration with the Arizona Department of Environmental Quality and the Interagency Smoke Management Program.

The Forest and Woodlands mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

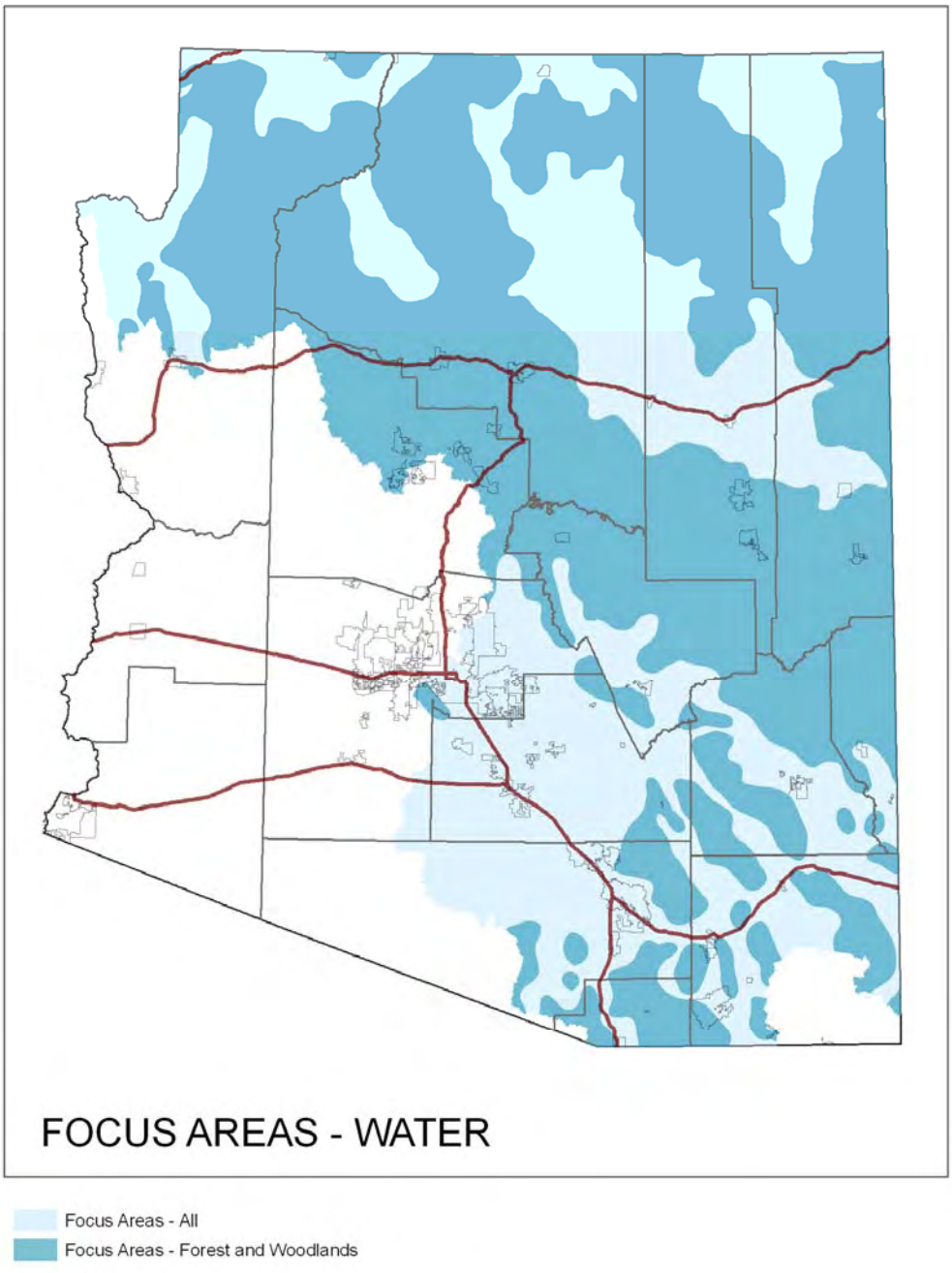


Figure 21.

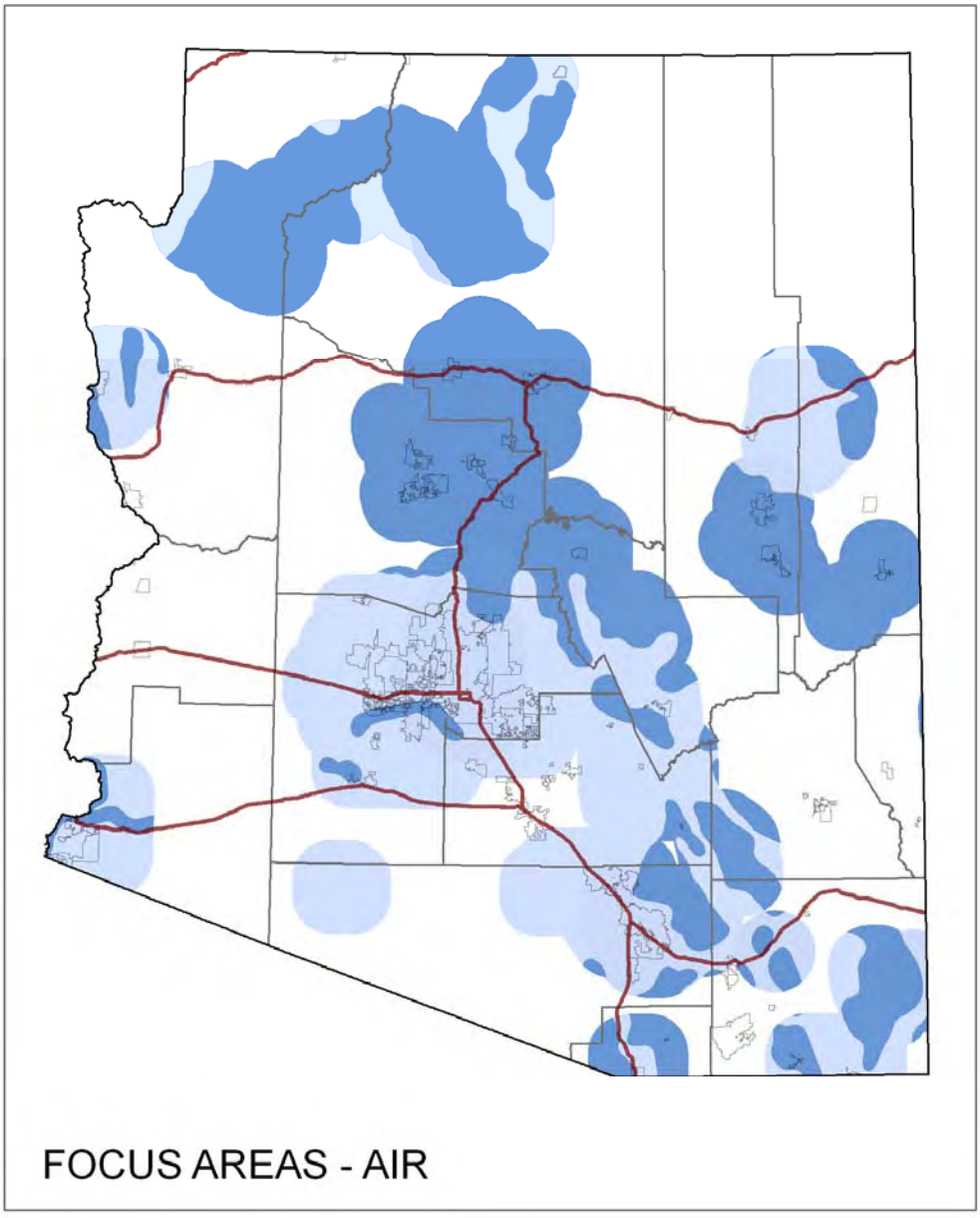

FOCUS AREAS - AIR
AZ Smoke Sensitive Areas - Forest and Woodland
AZ Smoke Sensitive Areas - All

Figure 22.

6.14 FIRE

Critical Issue Description

Fire in Arizona is a complex issue. Recent trends show increasing size and severity of wildland fire occurrence and increasing costs for fighting and managing these fires. Although natural fire is necessary in many forest 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 forest 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

Most forest, woodland, and grassland 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 an ecologically acceptable 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 poses a further threat with increased drought and longer, warmer summers lengthening fire seasons. Climatic change portends a greater number of hotter, more intense and more difficult to control fires that will likely place communities and landscapes at greater risk. A foundational principal in the issue of fire is not ***if*** Arizona forests will burn but ***when***, and will we be ready.

Key Elements

Fire as an essential natural process provides significant contributions to maintenance of ecosystem health while creating significant threats to values at risk at the same time. Wildland fires (unplanned ignitions) 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 (planned ignitions) or through management of wildland fires (along with appropriate suppression) for resource benefit.

Another key element in the fire equation is smoke. Wildfires contribute significant amounts of particulates and gasses to the atmosphere. While wildfire smoke cannot be managed, smoke management for all prescribed burning events is a primary factor in determining how much, when, and where such fire is allowed. Smoke will affect the local environment and the people living there. In addition to temporarily reducing air quality, prescribed burning can also decrease visibility and negatively affect individuals with respiratory conditions or certain health concerns. Given the knowledge that there are significant differences in the amount and quality of emissions from wildfires and from 2nd or 3rd re-entry maintenance burns for ecosystem health, land managers would prefer to create smoke under optimum conditions to maximize dispersal and minimize impacts.

National and state land managers are constantly assessing the potential for catastrophic fire and planning how to prepare for and manage it. By implementing appropriate steps to reduce the fuel hazard around communities and other values at risk, they reduce the threat. By developing and implementing *Community Wildfire Protection plans*, local governments have been doing their part to reduce risk, and prepare citizens and infrastructure. Many citizens have also protected private property by adopting FireWise building standards 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.

Wildland Fire: unplanned ignitions from natural or human sources. Wildland fire may be concurrently managed for one or more goals (suppression or resource benefit) and these may change as the fire spreads across the landscape.

Benefits

- Restores fire to its natural role in fire dependent ecosystems
- Brings improvements to ecosystem health (where appropriate/burns not severe)
- Reducing 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
- Can contribute 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 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
- Habitat loss and damage
- Loss of recreation opportunities and values
- Negative impacts to local economies
- Negative impacts to watersheds
- Negative impacts to air quality
- Loss of old-growth vegetation for wildlife habitat
- Negative impacts to cultural/heritage sites

Prescribed Fire: Planned ignition in a predetermined or approved/prepared area. Fire ignited by management action under certain, predetermined conditions to meet specific goals and objectives related to hazardous fuels or habitat improvement.

Benefits

- Hazardous fuel reduction--One of the most important reasons for prescribed burning is to reduce naturally occurring and excessive fuels within forested areas, particularly those forests in close proximity to urbanizing areas. Reduction of forest fuels reduces the risk of major life-threatening wildfire and reduces the threat of substantial economic losses of resources and infrastructure. It is one of the most effective elements of any fire prevention and management program.
- Site preparation for revegetation--Prescribed fire is one of the most environmentally sound and least expensive methods of preparing areas for the seeding or planting process, and for encouraging natural regeneration by exposing the mineral soil.

- Mechanical thinning followed by burning --While mechanical removal of trees is an alternative to prescribed burning for fuel reduction and ecological restoration, its use is considerably more expensive, it typically has more negative impacts (soil disturbance), and fails to return valuable nutrients to the soil. Prescribed fire as a management tool can be used alone or in combination with mechanical treatment s.
- Disease control--Certain pathogens that reduce growth in pines and other tree species can be controlled or eliminated by the use of prescribed burning.
- Wildlife habitat improvement--Fire and wildlife species co-evolved with time. Like historical, low-severity natural fire and unlike high-severity wildfires, prescribed fire is rarely lethal to most forms of wildlife. However, it does have profound effects on them. Fire is an efficient and economical tool for improving habitat for many wildlife species. Some of the effects of prescribed burning include:
  - Increase in browse and browse quality
  - Opening vegetation for feeding and travel corridors
  - Stimulates and/or releases ground cover growth
- Rangeland improvement--Prescribed fire eliminates standing dead forage and provides livestock and wildlife with new green forage of higher nutritive value. Fire releases nutrients from dormant, standing vegetation for a brief period of time resulting in somewhat increased nutritive value of subsequent re-growth. The blackened surface generally greens up earlier than non-burned areas, thus providing earlier grazing.
- Biological community restoration and maintenance--For many southwestern plant species, fire is beneficial for regeneration and enhanced growth, thus demonstrating the essential role of fire in their continued existence. Without fire, fire-intolerant species will out-compete fire-adapted species resulting in a far less diverse and productive plant community.

Threats and Impacts

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

Focus Areas and Priority Landscape Areas

- Every Arizona resident is affected by wildfire either directly or indirectly (i.e., reduced air quality, economics, insurance rates, recreation opportunities, area closures, increased costs to suppress wildfires, water quantity and quality, etc.).
- Health of ecosystems throughout Arizona is also affected both negatively and positively by wildfire. Wildfires in forested areas of Arizona that have heavy accumulations of fuel can have serious negative impacts to the ecosystem by burning at highly intense levels, thereby destroying important habitat, reducing biodiversity, damaging soils, and increasing erosion. Nevertheless, the appropriate use of fire is essential for ecological health.
- Identify economically efficient ways to treat priority forested landscapes within Arizona using an interagency approach

FIRE - FOCUS AREAS

Focus landscapes for the Fire issue were developed from two primary data sets: 1) Wildfire Risk as developed in the 2004 Arizona Wildland Urban Interface Assessment report, and 2) Identified Communities at Risk. Areas of highest wildfire risk (classified as 9 or above on a scale of 15) were combined with a dataset developed by buffering the community point data by five miles. Areas that fall within either of these categories are considered as the initial focus areas for the Fire issue.

Note: It is expected that data produced by the West wide Wildfire Risk Assessment, currently being developed, may replace one or both of these datasets to identify areas of greatest concern.

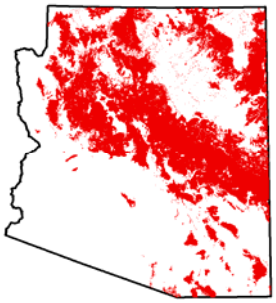


Figure 23. Wildfire Risk -The 2004 Arizona Wildland Urban Interface Assessment incorporated a number of components, such as historical fire occurrence, fire regime condition class, and fuel types to identify areas of highest risk. (A classification of 9 or above – on a scale of 1-15 were extracted for this analysis).

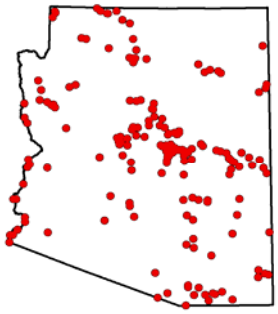


Figure 24.Communities at Risk - Data maintained by the Arizona State Forestry Division. The State Forester works with the Arizona Interagency Coordination Group to identify communities to include on this list. There are currently 192 communities at risk of wildfire in Arizona. A five-mile buffer was identified around each community (currently a point dataset) to indicate areas of concern.

Figure 25. Community Wildfire Protection Plans - More than 30 Community Wildfire Protection plans (CWPP) have been completed, or are in development, within Arizona. This data is maintained by the Arizona State Forestry Division. (This data was not used in the current geospatial analysis, but will be critical to identify priority areas and potential partners.

The Forest and Woodlands mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

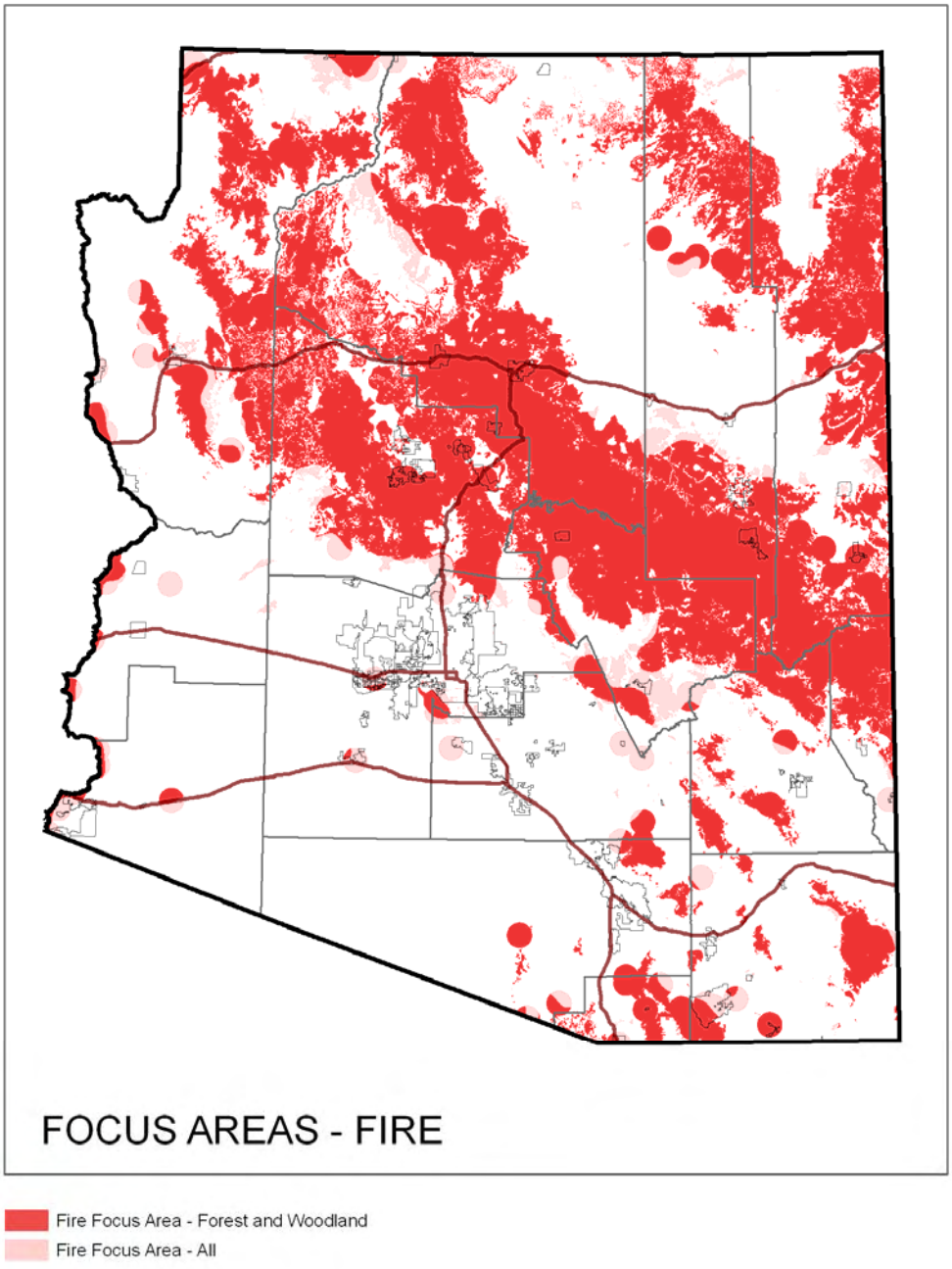


Figure 26.

6.15 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 more recently 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.

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 at the last pulp mill caused a sharp decline in the logging industry. The current low value of non-commercial timber has forced government agencies to pay loggers for thinning small-diameter trees and removing woody biomass (hazardous fuel reduction).

Tourism, second home development, watershed protection, and evolving forest management goals have recently 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. Declining ecosystem health has adversely affected economic conditions, primarily from threats associated with wildland fire activity.

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 successful implementation of forest management activities.

Urban and community forests have been, and continue to be, very important to the economic structure and land value of cities and towns across Arizona. They cool cities and communities, save energy, affect environmental health issues, reduce noise pollution, strengthen social cohesion, leverage community revitalization, and add economic value to our communities. There is a need to continue to work with communities, city planners, the Arizona Community Tree Council, and state and local governments to expand and improve the development and perpetuation of urban and community forests across the state and the economic benefits they provide.

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 forest treatments to maintain healthy forest conditions while sustaining and promoting economic benefits currently derived from these forested landscapes--support of a rural green economy (ecosystem services).
3. Economic issues related to urban forestry.
4. Economic issues associated with private land management and the associated transfer 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 with the White Mountain Stewardship Contract (WMSC) Project (this project is ongoing and some costs are being partially deferred through goods for services contracts), there is a need to expand these efforts and improve the ability to accomplish more restoration across larger landscapes for longer time periods at less cost to the government.

The historical forest products industry in northern Arizona was based on large-tree logging for timber and small tree/pre-commercial thinning for pulp. When the sawmill in Eagar closed and the pulp mill in Snowflake went exclusively to recycled pulp in the mid-1990s, the market for forest logs declined precipitously. Some small-scale industries hung on, including firewood, posts and poles, pallets, vigas, cants, specialty lumber, and the like. Remaining industries and a few new ones processed what little wood was being cut and removed by logging operations. Even though an energy pellet mill in Show Low, renewable biomass energy plants in Eagar and Snowflake, and a new sawmill in Ash Fork opened, most harvesting operations still cost the Forest Service money to issue. By the mid-2000s, several operations (Southwest Forest Products, Cooley Timber) 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 country. However, the recession of 2007-2010affected most operations and demonstrated the need for large-scale, but appropriately sized, industry to bid on the increased fiber generated by landscape-scale restoration efforts.

Restoration of forests altered by fire suppression, commercial logging, grazing, mining, road building, exotic pests, invasive species, and intensive recreation is a high priority on all forestland in Arizona. Of particular concern is the inability of forests damaged by these stresses to withstand otherwise beneficial 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 element is the identification of appropriate landscapes that would be most beneficial to development of industry. Such economic development could also address partially underwriting costs to federal agencies for ramping up to landscape-scale restoration.

These same forested landscapes suffering from declining forest health serve as a major attraction for a variety of amenity based services and activities--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. The economic value of these "ecosystem services" is considerable and may outweigh values associated with resource extraction by a factor of 100:1 (Balmford et al. 2002).

A current lack of adequate innovative industry poses a barrier to accomplishing economically viable treatment of these landscapes. Without treatment these landscapes are at high 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 destroyed, the flow of ecosystem services is also diminished. This reduction of ecosystem services can adversely affect the economies of communities and businesses that depend on these services. Key to this element is the identification of landscapes that contribute to the economic recovery and/or support of local communities and/or regional entities.

Urban forestry can play a vital role in the flow of ecosystem services within communities. Key elements, such as, improved air quality, vegetative biodiversity, cooling capabilities, reduced noise pollution and community revitalization, all add economic value to communities. Urban trees offer many environmental, sociological, and economic benefits to communities and are an important part of the valued infrastructure. Traditional methods for calculating these values have focused on the replacement cost of individual trees, but newer computer models can also evaluate the functional values of trees in cities, including air pollution removal, energy savings, storm water runoff, and carbon sequestration and storage. Other values tied to urban trees include real estate values, recreation, health benefits, psychological well-being, and aesthetic appeal. These are harder to quantify but are still important from an economic standpoint.

In Arizona, there are currently 22 cities certified under the Tree City USA program, and several others working toward certification status. Continuing to develop and expand these programs is important because most cities have diminishing tree canopies due to expanding development and lack of replacements. Threats are focused on urban heat, energy consumption, and air pollution. "Heat island" effects can be analyzed by the percent of impervious surface and tree canopy and weather data that can determine average annual days with temperatures greater than 90 degrees. Energy consumption can also be linked to the heat index and to areas with low or high amounts of impervious surface. For example, cities or areas with low impervious surface and a higher number of days greater than 90 degrees would rank higher for energy demand. Air quality, or the amount of nonattainment days annually, can be measured and used as an indicator where tree planting efforts should be increased.

Links between urban forestry and environmental education opportunities are strong. An educated society that understands and appreciates the importance of forest management will be more likely to endorse and support the economic benefits of forest management projects.

Ecosystem services provided by forested lands also includes private lands and their continued management as an integral part of the forest infrastructure. The contributions from private property are often viewed as free benefits to society. Consequently, their critical contributions are often overlooked in public, corporate, and individual decision making. When forested lands are undervalued, they can be susceptible to development pressures, conversion, or simple neglect. As these working forest in-holdings are abandoned or disappear from the contiguous forested landscape, that landscape becomes fragmented. Impacts go beyond the private land. Consequences include the loss of public benefits associated with private forests or the marginalization of those values 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 urban interface, there is the expansion of utility infrastructure and transportation networks.

Forested regions of Arizona are desirable places to live and Arizona's population grew by 29% from 2000 and 2008(Arizona Department of Commerce).The impact of this rapid growth shows up on the landscape as urbanization--conversion of rural open space to urban use. Rapid growth stimulates the selling of private land parcels to accommodate development.

Benefits, Threats, and Impacts

Industry

Benefits

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

Threats and Impacts

- Use/consumption of natural resources
- Air quality
- Water quality
- Forest resources (erosion, roads, etc.) affected by management activities

Recreation and Other Amenity Considerations

Benefits

- Supports local, statewide and national economy
- Provide jobs
- Get people out in the woods
- Avenue for environmental education
- Critical component to the human living infrastructure

Threats and Impacts

- Requires infrastructure
- Negative impacts to natural resources
- Increasing with population

Forest Treatments

Benefits

- Reduced wildfire threat
- Reduced insect and disease threat
- Healthier wildlife habitat
- Enhanced recreational opportunities
- Healthier trees exhibiting faster growth
- Reduced watershed impacts
- Reduced invasive species threat
- Improves overall health of land
- Opportunity to resolve other state wide issues (energy needs)
- Carbon sequestration
- Enhancement and mitigation to urban environment

Threats and Impacts

- Creates short-term wildfire hazards
- Potential impacts to natural resources
- 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. 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, business 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.
- 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 (ie, ranchers, outfitter/guides, land management agency personnel, etc.).
- Ecosystem Health – Landscapes threatened with declining ecosystem health issues 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.
- Sustainability - Importance of developing and being able to maintain infrastructure so forest management can occur on a cost effective basis.

Focus Areas and Priority Landscapes

Focus areas for prioritization in economics involves identifying the following attributes:

- Forested landscapes that are most beneficial (nearest, least cost, etc.) to the operation of existing sawmills and biomass utilization facilities.
- Forested landscapes that would be most beneficial to the development of new, appropriately scaled industry, and that could address the costs to federal agencies for ramping up to landscape-scale restoration.
- Forested landscapes that contribute to the economic recovery and/or support of local communities and/or regional entities.
- Forested landscapes that can contribute to solving future economic challenges, such as renewable energy production, displacement of fossil fuels, energy conservation, reduced $C0_2$ emissions, increased carbon sequestration.
- Forested landscapes impacted by the socio-economic threats to working forests from the loss of private forest lands to residential, commercial, and industrial development.
- Areas of greatest recreational use.
- Urban forest areas or communities engaged in Tree City USA or other urban forestry work. This could be combined with an analysis that ranks needs for urban forestry to address heat sinks, air pollution, and energy consumption. Computer models (American Forest's CityGreen, U.S. Forest Service's UFORE and STRATUM) could be used to evaluate the functional value of trees in cities.

ECONOMICS - FOCUS AREAS

Focus landscapes for the *Economics* issue were developed from several datasets centered around four distinct categories: Industry (existing wood producers), Ecosystem Services (recreation, wildlife species of economic and recreational importance, insect and disease risk), Population Centers (Urban growth areas), and Private Forest Opportunities (Private forests within areas of identified conservation concern)

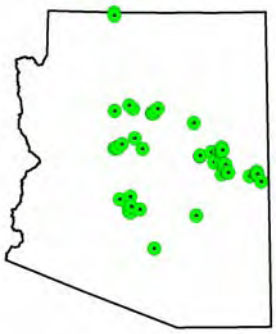


Figure 27. Wood Producers - This inventory of wood producers and related businesses in Arizona was developed by ForestERA.

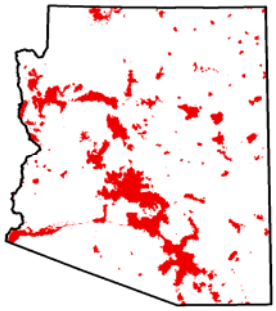


Figure 28. Urban Growth - Dataset developed by AZGFD for Arizona's State Wildlife Action Plan.

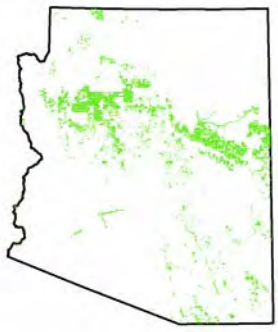


Figure 29. Public Values/Cultural and Recreational – Developed for the Forest Legacy Assessment of Need - 2005

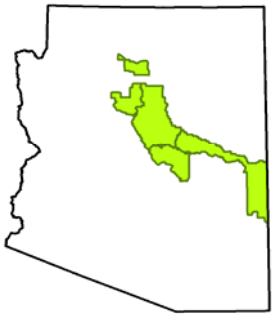


Figure 30. Small Wood Supply Analysis Area – Forest ERA (this area is also being used to define the Four Forests Restoration Initiative area – a landscape scale collaborative restoration effort.)

Other data layers used to identify the Economics Focus Area:

- Motorized and Non-motorized Recreation (AZGFD)
- Species of Recreational Interest (AZGFD)
- Insect and Disease Risk Map (USFS)
- Private Forests in TNC Conservation Areas (*Forest Legacy Assessment of Need*)

The Forest and Woodlands mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

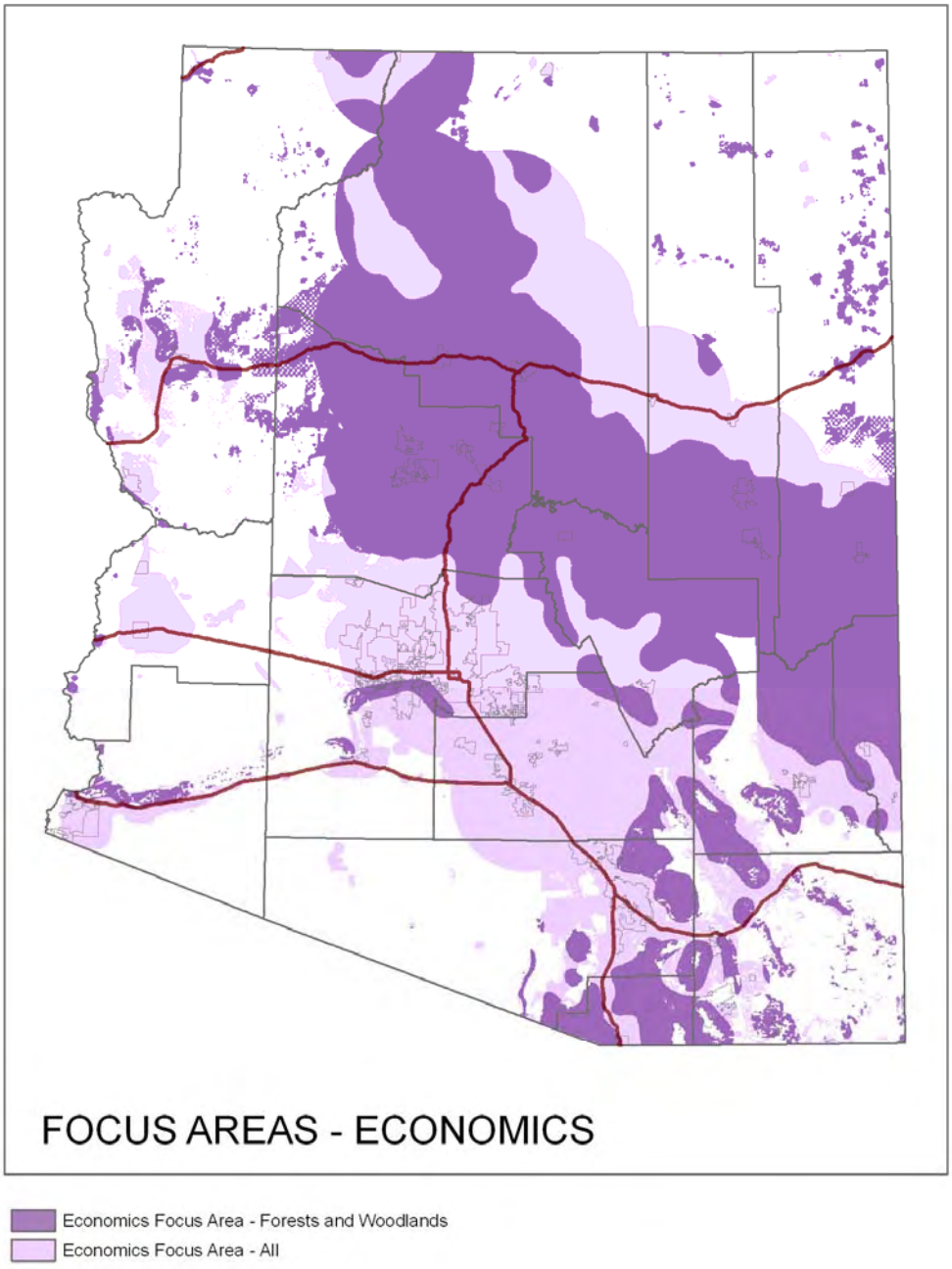


Figure 31.

6.16 CLIMATE CHANGE

Critical Issue Description

Arizona's climate 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. Recent changes in temperature and precipitation over several decades, caused in part by human activity, have increased the severity of forest insect outbreaks and have contributed to some of the largest wildfires in Arizona's history. While climate has always been variable, rapid climate change creates cascading effects of tree mortality, increased catastrophic disturbance, and shifting zones of suitable habitat that could alter Arizona's forested landscapes dramatically.

Introduction

Arizona is often considered a land of extremes--hot, low-elevation deserts near sea level; ribbons of riparian forest, springs, and cienegas embedded in expansive forests and grasslands; cool, snow-covered alpine tundra shrouded peaks well above tree-line at elevations approaching 13,000 feet. Another related characteristic of Arizona's environment is its highly variable climate, which is well represented by the two frequently repeated local quotes, "It's a dry kind of heat (or cold)," and "If you don't like the weather, wait ten minutes."

Arizona is characterized by a rich climatological record that scientists have been able to extract from tree rings and river and lake sediments, with a high-quality temperature and precipitation timeline that extends back almost 1,000 years. In fact, Arizona lays claim to being the birthplace of the science of dendrochronology, the study of tree rings and how they relate to our environment (Bradley 1999). This long-term record indicates that precipitation and temperature have varied widely through time, and have influenced vegetation, rivers, and the use of this landscape by humans (Betancourt 2003).

Key Elements

It is now widely accepted that the interior western United States has recently experienced higher temperatures than other parts of North America, and Arizona is consistently warmer than many other areas when comparing the last decades' average temperatures to the past 100 year average. While the global average temperature has risen one degree Fahrenheit during the past 150 years, Arizona and other parts of the Southwest have risen more than 2°F(Saunders and others 2008).

The effect of this temperature rise has been documented in several areas important to the structure and function of forested ecosystems. With rising temperatures, wildfires have become more frequent, started earlier in the spring, lasted longer, and become harder to control. Also, winter snowpack is smaller, spring snowmelt has begun earlier, with streams running earlier than historic records (Saunders and others 2008, Mackenzie and others 2003, Westerling and others 2006). Warming temperatures have also impacted hunting and fishing opportunities as rivers, fish, and other wildlife respond to warmer and drier conditions. The skiing and recreation industries are also been affected (Saunders and others 2008)

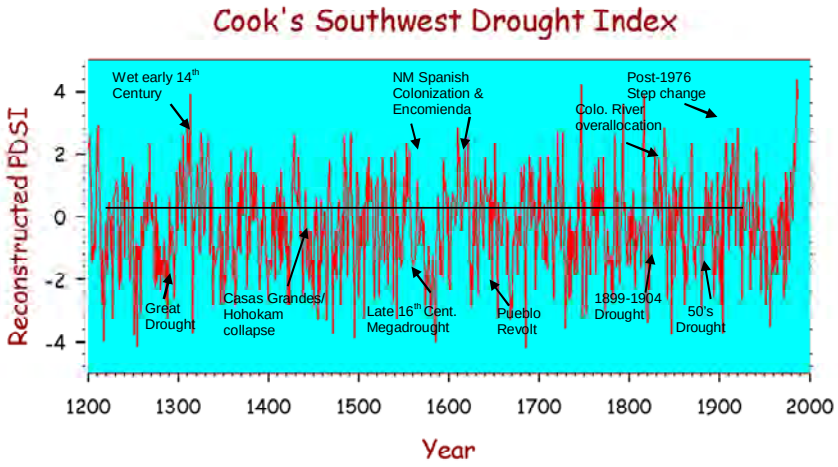


Figure 32. Cook's Southwest Drought Index. Data from tree-ring chronology reconstructions have been used to estimate relatively dry and wet periods during the past 800 years. Data from Cook et al. 1999, Gray et al. 2003

Insect outbreaks and associated tree mortality in many forested ecosystems have increased region wide in recent years. While some of this forest die-off is due to lack of fire in fire-adapted ecosystems and other management choices, recent widespread and severe tree mortality due to insect outbreaks in the pinyon and ponderosa pine forest types, such as that documented in 2002-2003, has been attributed to higher temperatures (Breshears and others 2005).

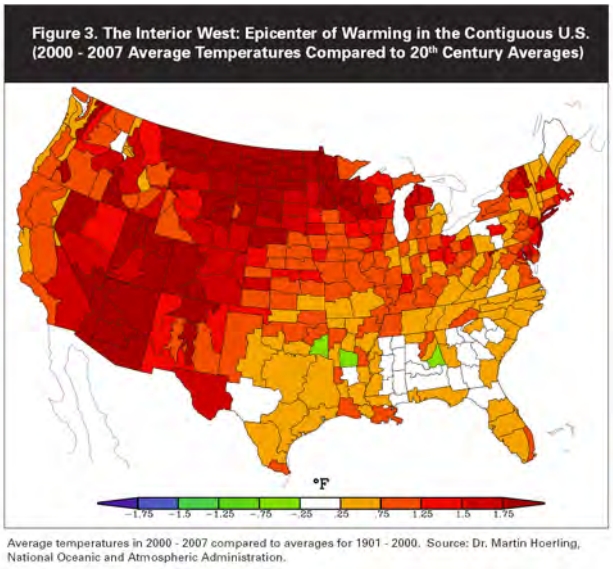


Figure 33.The southwestern United States has warmed disproportionately more than other parts of the United States. Arizona's average temperature approaching or exceeding a 2°F increase during 2000-2007 compared to the period 1901-2000. Figure from Saunders et al. 2008.

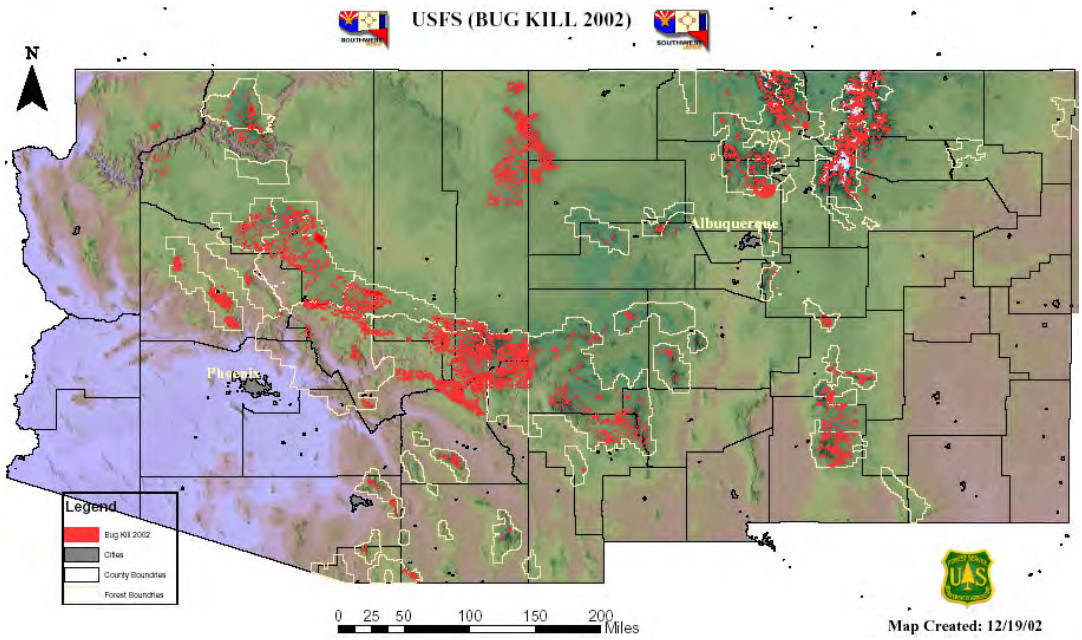


Figure 34.Estimated tree mortality locations in 2002 derived from the U.S. Forest Service annual aerial detection survey. Areas in red indicate where observers in aircraft detected dead coniferous trees. This figure indicates relatively large areas compared to detection surveys from other years (USFS 2002).

Summary of climate change effects on forested ecosystems and people:

- More forest trees have been dying during the recent drought than during the 1950s drought, probably due to warmer temperatures (Breshears and others 2005).
- There is a 50-year trend of declining winter snowpack and earlier spring snowmelt.
- Forest fires from the last 20 years are larger, more severe in their effects, and more frequent.
- Fire seasons are longer, and fires are harder to control.

Climate Change Mitigation

There is some good news, however, in that there are several things people can do to reduce, avoid or mitigate further warming of the Earth's atmosphere by reducing their release of carbon dioxide. In addition, there are steps we can take 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 uncharacteristic wildfires. Use of mechanical thinning (chainsaws, feller-bunchers, etc.) and controlled burning have been shown to reduce fire risk and net carbon released by wildfires (Finkral and Evans 2008, Hurteauet al. 2008). Thinning and burning treatments that reduce the risk of large, uncharacteristic crown fires can reduce emissions of carbon dioxide by as much as 98% (Hurteau and others 2008). The overall carbon balance of a managed forest is sensitive to the eventual outcome of how the wood products harvested from the forest are utilized, with longer-lived wood products providing the longest carbon storage benefit (Finkral and Evans 2008). However, even wood that is harvested and burned immediately as biomass for the production of electricity has a carbon benefit if the energy replaced by biomass burning

would otherwise come from fossil fuels (coal, petroleum oil, natural gas).Some of the carbon that is released to the Earth's atmosphere from burning of biomass and fossil fuels can be offset by land management practices that encourage plants to grow, absorb, and store carbon (i.e., ***sequestration***, a process that also occurs in dead wood and intact soils).

1. It is estimated that almost 20 percent of human caused carbon emissions are from deforestation. Finding ways to reduce the rate of deforestation globally and afforest land could have substantial benefits in reducing human-related carbon emissions.
2. Given the difficulties with some proposals for boosting forest carbon, it seems prudent to support approaches that have few environmental drawbacks and many collateral benefits.
3. Preventing forest conversion, replanting or restoring cleared or degraded forests, and lengthening rotations enjoy support from a wide variety of stakeholders, as these strategies also protect biodiversity, open space, water quality, outdoor recreation, and other increasingly threatened public values.
4. Eighty-three percent of the sequestration projects reported under the U.S. Department of Energy's 1605(b) program in 2004 involved tree planting (U.S. Department of Energy 2006).

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 bank" or sink, sequestering carbon in the soil and keeping it out of the atmosphere. USDA and State Department personnel estimate that an additional 180 million metric tons annually could be stored in farm and range land acres. This would account for 12 to 14 percent of the total U.S. emissions of carbon according to the State Department.

Transformation of free floating atmospheric carbon to a fixed-state carbon 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
- Underground traps, including large bodies of water and organic soil accumulating

Landowners can receive credits in exchange for planting perennial vegetation on their land which results in high levels of carbon sequestration. These credits are then sold on the Chicago Climate Exchange (CCX) for cash payments.

Carbon credits encompass two ideas:

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

But in addition, 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 a forest 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 by definition permanent. For forest offsets, permanence is complicated by the dynamic nature of ecosystems. Carbon stores ebb and flow during forest succession and with normal disturbance regimes, sometimes unpredictably in the case of fire, insect outbreak, or windthrow.

Accounting for ***leakage***, sometimes referred to as *secondary effects* or *displacement* is also a consideration. Leakage occurs when a project indirectly causes increased emissions outside the defined boundaries of the project itself. If an offset buyer pays to preserve forestland that is in imminent danger of paving over, for instance, but the development merely moves to a neighboring parcel, no net sequestration results.

Other Considerations and related Issues

E**conomic Impacts–** There are potentially broad and variable economic impacts to Arizona as a result of climate change, both positive and negative. There are direct effects on:

- Agricultural sector-- length of growing season, availability of water for irrigation, and pest outbreaks.
- Human infrastructure and expenditures--higher temperatures increase the use of air conditioning, and increased evaporation decreases water supplies and increases costs.
- Fire severity/community protection--increasing severity and frequency of wildfires, and increased length of fire seasons (Westerling et al. 2006).

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

- More than 40% of greenhouse gas emissions come from commercial and residential buildings.
- Local governments are best suited to improve building codes, foster community-scale renewable energy, and create other programs and incentives to increase efficiency and reduce energy use in buildings and houses.
- Local governments can promote the deployment of **green infrastructure** that reduces carbon emissions including community forestry, green roofs, and parks and open space.
- Trees and landscaping are used as tools for reduction energy consumption and avoided energy purchase and production costs.

Focus Areas and Priority Landscapes

An assessment developed by The Nature Conservancy (Robles and Enquist, in review) was used to determine the Climate Change Focus Areas. Their assessment used a categorization approach frequently used in conservation planning (Margules and Pressey 2000) to group temperature change and conservation importance into four classes of vulnerability (Figures 35 and 36). Classes were delineated by values above (high) and below (low) the 50th percentile.

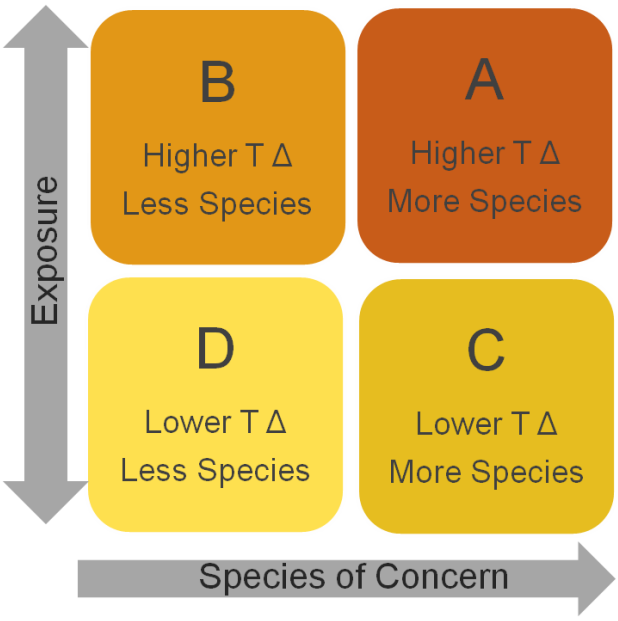


Figure 35. One way to evaluate place-based vulnerability is to group areas by climate change exposure (e.g., temperature change value) and a value of conservation importance (e.g., number of species of conservation concern). Class colors denote relative vulnerability based on values above (high) and 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)

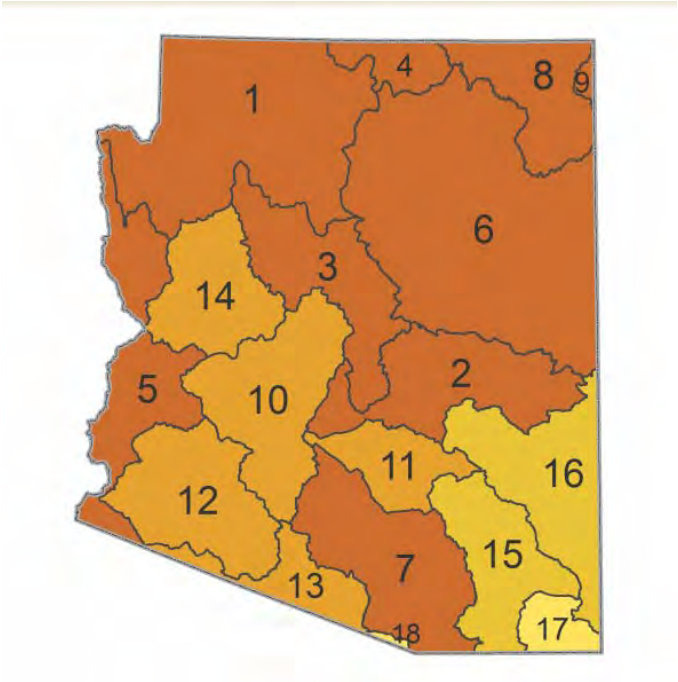


Figure 36. Map showing southwestern watersheds according to climate change vulnerability class across Arizona. Watersheds colored in rust have a high number of species of concern and rapid historic temperature increases (see Figure 39 headings for grouping criteria). Watersheds in brown also have higher 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 3. 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

Focus landscapes for the Climate Change issue were identified directly from data being developed by The Nature Conservancy. Southwestern watersheds according to climate change vulnerability. Classes A and C were identified as initial focus areas.

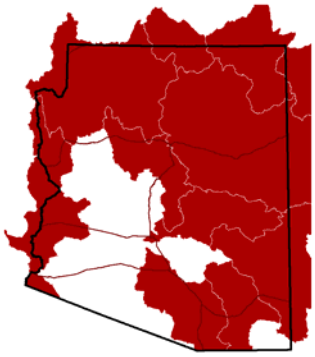


Figure 37. Vulnerable Watersheds - Developed by the Nature Conservancy, this dataset identifies watersheds according to climate change vulnerability class. Classes A and C were used directly to identify initial focus areas for climate change.

The Forest and Woodlands mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

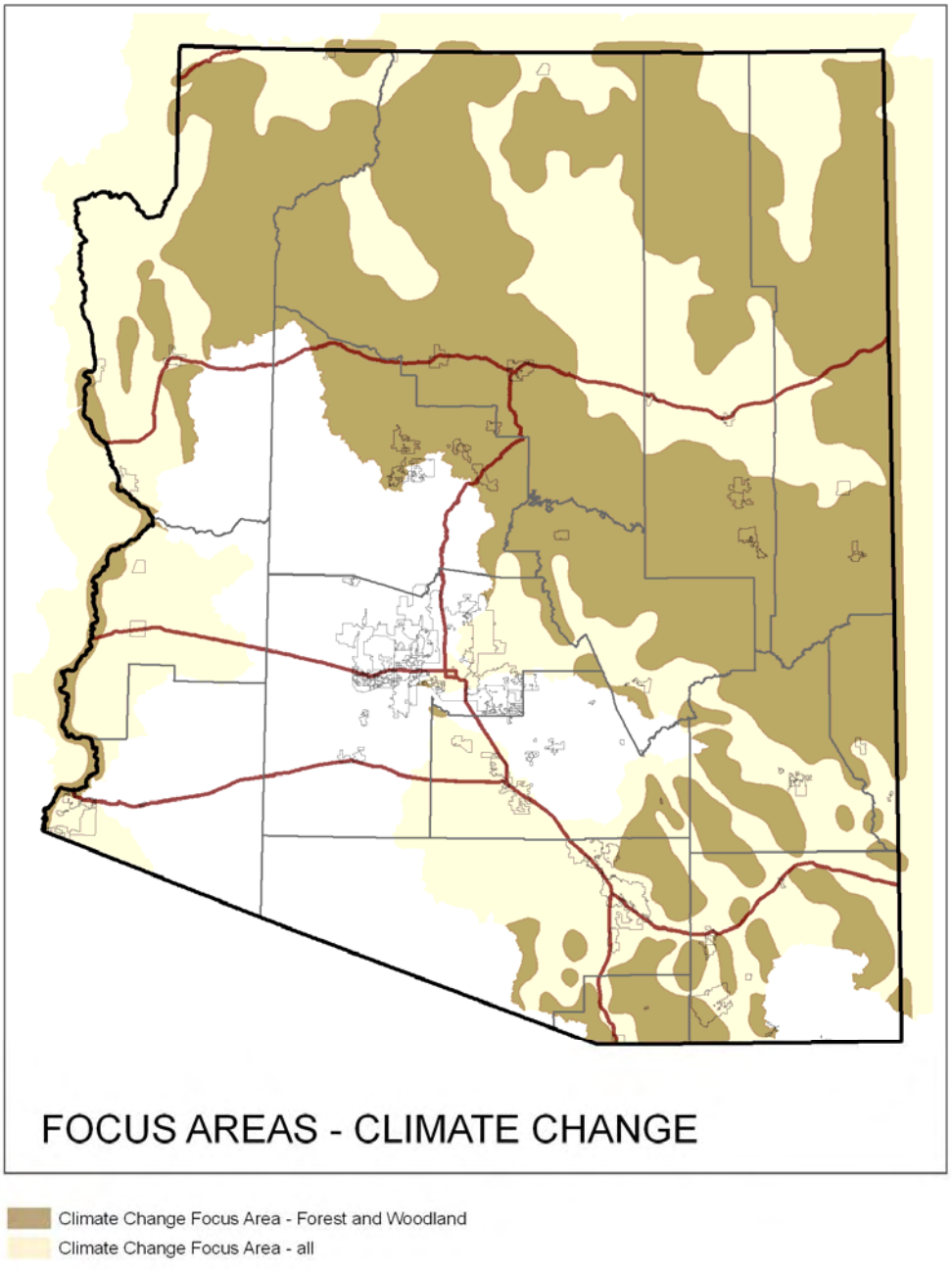


Figure 38.

6.17 CULTURE

Critical Issue Description

Human cultures and Arizona's forests have been inter-dependent for over 10,000 years. During this time, forests 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 grazing, and as a source of spiritual renewal. Human interaction with, and dependence upon, forests will continue to be influenced by the specific set of values, norms, and beliefs held by different cultural groups. While there are many shared beliefs, values and uses across cultural groups, there are also distinct differences that require a balance among competing interests. While challenging, the integration of an array of cultural values in the management of our forests represents a more holistic approach and helps increase the interaction and collaboration between groups.

Note: Developing an accurate description of the Culture issue, and identifying related resource needs, presents a unique set of challenges. The issue was first raised with the Assessment Task Group in early 2010 during a workshop involving a number of Native American Tribes. Tribal representatives clearly articulated that the current natural resources approach being pursued by most state and federal agencies, and other partners, does not adequately acknowledge the varying beliefs and perspectives of our area's diverse cultures.

The Task Group agreed to take on this challenge and pursue improved understanding of the various cultures represented in Arizona. This section is a first attempt to outline the need for improved communication and collaboration across all populations. The process will take time, and the Assessment will take numerous revisions before it truly reflects an accurate picture.

The strategy to address these needs will identify next steps. However, in simple terms, "we don't know what we don't know". The path may change course as we follow it and we will need the help of many individuals along the way to stay on course. The following issue description is simply an attempt to take the first step down that path. We will continue to encourage feedback and will strive to improve this document and our understanding at every opportunity.

Introduction

Anthropologist Sir Edward Tylor (1874) defined culture as follows, "Culture or civilization, taken in its wide ethnographic sense, is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society"(Tylor, p. 1). 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 forested 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 to a system of values. Moreover, humans have perceptions associated with forests that vary across location and among cultural groups. Lastly, when a cultural group develops an emotional attachment to a specific location (i.e., a sense of place), they are more likely to have an opinion and concern for a given management action 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 (Greider and Garkovich, 1994, pp.1-2).*

Information reported in this *Assessment* are derived from the best available research, however, it is important to recognize that there are always variances in individual and group behavior and cultural norms. While this section focuses on a few specific cultural groups, there are many other recognized groups (e.g., Asian, Afro-American, Pacific Islander) that must be considered when developing forest management policies and activities. Finally, this analysis does not attempt to provide a comprehensive review of all variables associated with the formation and expression of cultural attributes.

Key Elements

- Human interaction with Arizona's forests will continue to be influenced by the specific sets of values, norms, and beliefs held by different cultural groups in Arizona.
- Arizona's demographics are continually changing.
- While there are many shared commonalities across cultural groups, there are also distinct differences that require forest managers to balance various interests.
- Land managers need to develop comprehensive strategies to address the demands of a growing population and changing demographics.
- Land management agencies often have unique relationships with various cultural groups (Native American, Hispanic, etc.) that may desire a significant degree of contemporary and traditional use areas on a forest. Different parties occasionally have different legal responsibilities and relationships on specific issues.
- Many tribes in Arizona have both economic and social ties to forests. The *Assessment* and *Strategy* provides:
  - An opportunity to work collaboratively in developing and implementing a regional approach involving tribes that is inclusive of tribal culture and their lands.
  - An opportunity for tribes who consult and interact with other natural resource organizations to identify critical landscapes and issues.
  - An opportunity to provide consistency in planning information and coordination while involving tribes in the process.
- The State Historic Preservation Office (SHPO) maintains maps of historical and cultural sites, but they do not distribute them due to confidentiality. They recommend individual consultation with appropriate groups prior to beginning any activity.
- In National Park Service Bulletin 38 traditional cultural properties are defined and evaluated for the most part by standard operating procedures. Bulletin 38 provides specific criteria for determination/designation of traditional cultural properties.

Benefits, Threats, and Impacts

Integration of cultural values into the management of Arizona's forest resources is a key attribute in creating and maintaining healthy ecosystems. Potential threats or negative impacts (with benefits being the opposite) that could result from ignoring cultural values and uses of forest resources include:

- Increased potential for disagreement and misunderstanding of proposed management goals, objectives, and activities.
- Increased conflict between the various cultural groups using Arizona's forests.
- Decreased social capital and collaborative interactions.
- Unsustainable use of forest resources by cultural groups that have not been appropriately considered in forest planning and management efforts.

Demographic Patterns and Trends

With Arizona's changing demographics, it is essential that forest planners and managers maintain updated and consistent monitoring of the various ethnic and racial groups using and visiting forests, and an understanding of these various cultures. Failing to develop management policies and activities that address different cultural needs will require recognizing that there are of plethora of demographic variables, such as age and social class that interact with culture (Chavez 2000, Roberts et al. 2009).

Arizona's population was estimated to be more than 6.5 million in 2008, an increase of 26.7 percent from 2000. Caucasians were the largest ethnic group with 86.5 percent of the population. The largest increase for minority groups has been in the Hispanic/Latino population, which represented 30.1 percent of Arizona's population in 2008. Native American populations have continued to increase with time, and in 2008 they represented 4.9% of Arizona's total population. However, as a percentage of the total population, Native Americans have continued to decline on yearly basis (U.S. Census Bureau Quick Facts 2008).

In 2000, individuals under the age of 18 represented 26.3 percent of Arizona's population while those 65 years and older represented 13.3 percent. By 2030, numbers are projected to decrease slightly for those less than 18 years to 24.3 percent while individuals 65 years and older are expected to grow to 22.1 percent of the population (U.S. Census Bureau Population Division 2000).

Past and Present Land Use Trends

During the Late Pleistocene, roughly 15-10,000 years ago, the Southwest was much cooler and wetter than today. The region was occupied by tribes of nomadic hunter-gathers, known as Paleo-Indians. Around 10,000 B.P., the landscape and people changed, with Paleo-Indians being replaced in the Archaic Period by the Desert and Cochise cultures. By the year300 B.C., the great Puebloan cultures (Mogollons, Hohokam, and Anasazi) arose, and by 250 A.D. agricultural crops, such as maize, beans, and squash arrived in the region. Spanish arrival in the Southwest during the sixteenth century initiated further dramatic change. Led first by Coronado, they explored the region, encountering 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 leadership. To encourage settlement, both the Spanish and Mexican governments provided large land assignments (grants of land) to potential settlers, which contrasted with existing Native American perspectives that favored a shared use of the landscape (Baker et al. 1998).

The arrival of Anglo-Americans to the Southwest and Arizona in the late 1800s resulted in a third infusion to the existing Indian 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"*(Baker et al. 1998, p. 20).

After the Civil War, railroad lines were constructed extensively across the Southwest. The railroad facilitated the establishment of industries such as mining, ranching, farming, and timber harvesting (Baker et al, 1998). *"For decades, these sectors provided the foundation for employment upon which the state's predominantly*

rural economy was based" (Coconino National Forest 2008, p.29). *"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 thousand head in 1880, increased to over 1.5 million by 1890"* (Baker et al. 1998, p. 1). These industries contributed to the development of specific values and lifestyles of people living off the land (Prescott National Forest, 2008). *"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"* (Baker et al. 1998, p. 28).

It was clear, however, that unregulated use of the Southwest's natural resources was resulting in degraded ecosystems. In 1891, Congress authorized the President, under the Creative Act of 1891, to designate particular areas of the public domain as forest reserves to preserve timber and protect watersheds, eventually becoming national forests (Baker et al, 1998). The creation of reserves and subsequent national forests did not end the mismanagement of forested ecosystems. On the contrary, balancing the numerous demands (e.g., Multiple Use - Sustained Yield Act of 1960) for publicly owned forest ecosystems and private lands continues to be an uphill struggle, including issues such as management of wilderness areas, wildlife refuges, and research natural areas; keeping track of forest land boundaries; and controlling the use of forest resources, such as grazing, timber, mining, recreation, water, and soil.

Of equal importance and just as challenging for land managers has been the role of private forest 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"* (Baker 2008, p. 45). Today, however, studies are showing that, at a national level, extractive natural resource industries on our national forests are in decline and are being replaced by non-consumptive uses, such as recreation, tourism, service-related industries, and forest restoration (Apache Sitgreaves NF, 2009, Coconino NF 2008, Coronado NF, 2008, Kaibab NF, 2008, Prescott NF, 2008).

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 Kaibab National Forest and surrounding communities (2008 KFSESR p.8). Livestock grazing continues across many of Arizona's forested ecosystems and ownership boundaries. However, the number of permitted allotments on federal forests has been in decline across the state. The Coronado National Forest indicates that *"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"* (Coronado NF 2008, p. 29).

Finally, it should be recognized the majority of 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 based on values and beliefs of white, rural America (Johnson, 2005). 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 forests whether as a moral imperative or as directives, such as Executive Order 12898 (Clinton 1994), that

instructed federal agencies to identify differential consumption of natural resources by minorities and low-income populations.

Native Americans

Arizona is home to 21 federally recognized tribes/nations. Collectively, they own approximately 33,716square miles of land, which is more than one-fourth of Arizona's land mass (University of Arizona).

Native American's are recognized U.S. citizens and entitled to all of the legal rights and protections established in 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 all of Arizona's tribes share similar perspectives on many forest-related issues, they also have their own unique set of beliefs and values. There are also times when tribal values and beliefs can be at odds with predominate Euro-American perspectives of the world.

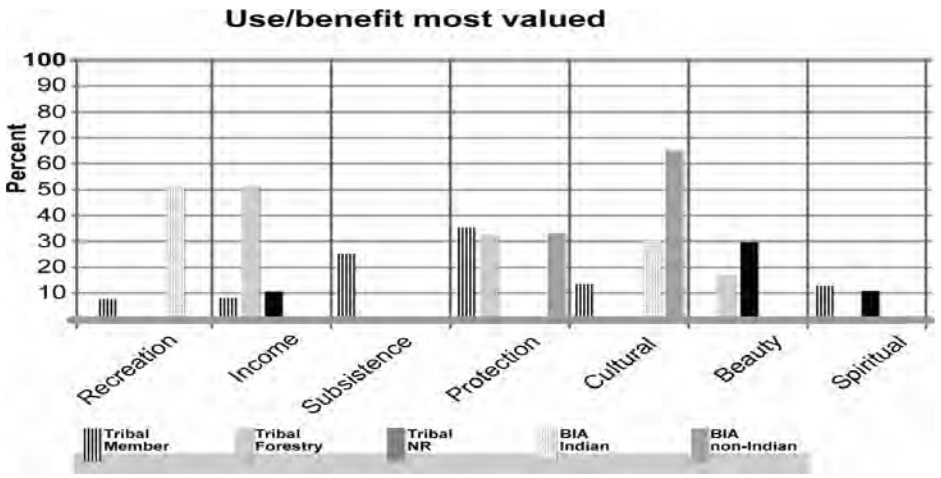
> *"Traditional tribal values typically do not make a distinction between what is secular and what is religious. Those values are intertwined as a foundation of their culture and beliefs. Traditionalists perceive all actions and events as inter-related and believe that individuals have personal responsibilities 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 considered to be 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."* (Coconino NF 2008, p. 62)
>
> *"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 or places to carry out other privileged, sensitive, or confidential activities which cannot be shared with the uninitiated. Visual aspects may in themselves be sacred. The responsibility to respect these sacred places is inherent in tribal belief systems."* (Apache-Sitgreaves NF 2008, p.57).
>
> *"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." (*Toupal, R. S. 2003, Appendix 2).

Forest land managers and other stakeholders interested in working with tribes must develop an accurate understanding and respect for tribal protocols and culture. It is equally important to continue to involve tribes in "planning, implementing and monitoring" activities affecting forest resources they have identified as a concern (Alcoze 2003, p. 55). Specifically, at a forum held by Coronado National Forest in 2004, invited tribes requested more traditional uses and knowledge be integrated into forest decision and planning processes, increased scrutiny into the protection of privacy issues associated with cultural resources, and a desire to collaborate on resource issues of mutual concern (Coronado NF 2008). A few other topics identified by tribes as important forest issues include, but are not limited to:

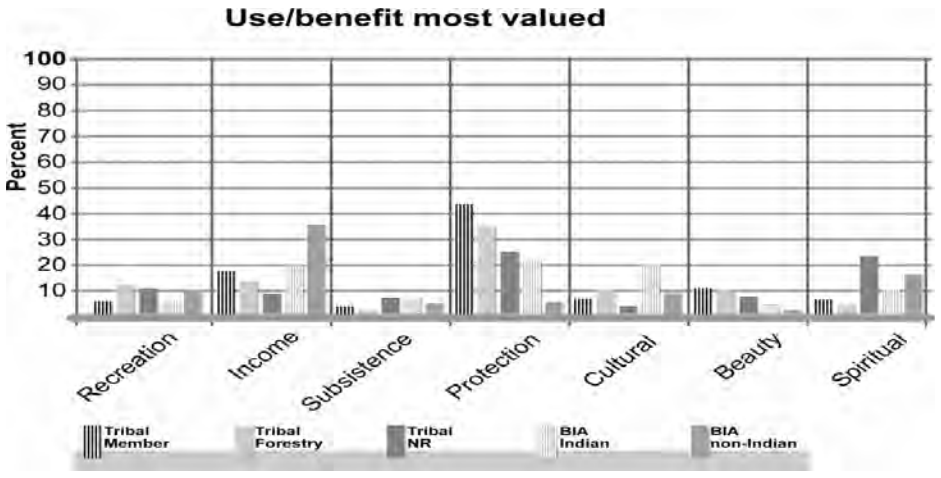
- Access to gather traditional materials on national forest lands free of charge
- Concerns about Arizona's growing population and the subsequent impacts on important sites
- Restoration and maintenance of native plants used by the various tribes
- Concern about federal policies that would restrict tribal access to traditional gathering areas

- Increased communication between the tribes and land managers regarding agency jurisdiction, permitting, and policy requirements
- Advanced information about forest management activities, such as thinning and burning (Apache-Sitgreaves NF 2009, Coconino NF, 2008, Kaibab NF 2008, Coronado NF 2008, Prescott NF, 2008).

Figure 39. Comparison of Tribal Forest-related Values in 1991 and 2001



2001 Tribal surveys of forest values



1991 Tribal surveys of forest values

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"* (Grieco 2003, p.2). Hispanics are the largest and fastest-growing ethnic group in the United States (U.S. Census Bureau 2008). As a result, new demands are being placed on forest resources and managers to accommodate a wider range of values and activities (McCool and Kruger 2003).

Despite these facts, a report by the USFS Pacific Northwest Research Station indicated that "*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."* (Burns 2008, p. 135)

Research from Arizona's national forests suggests adoption of the following strategies to help ensure Hispanic and land management needs are met:

- Facilities that can accommodate larger family groups.
- Planning activities for multigenerational groups.
- Personalization of materials in Spanish.
- Employing bilingual employees.
- Communicating with Hispanic community leaders.

Interactions of Culture 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 unnatural 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 ecosystem processes. An ongoing challenge for forest managers will be building understanding and support for restoration-based activities across various cultural groups. For example, research indicates that many individuals understand and support the use of fire to maintain ecosystem health, but have concerns about the smoke generated from prescribed or natural fire (Coconino NF 2008, Bowie 2009). Conflict can also arise between homeowners living adjacent to forests who object to forest restoration activities (McCool and Kruger 2003, p. 16). As restoration treatments scale-up across larger landscapes, land managers will be required to work with a broader array of stakeholders about forest management activities.

A growing population has also resulted in more people moving into forested areas where their values and lifestyles are often at odds with long-time residents (McCool and Kruger 2003). For example, a study funded by the Prescott National Forest found that *"Newer residents were perceived not to appreciate issues about water, fire 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."* (Prescott NF 2008, p. 22)

Another conflict is a concern about the limited land available 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 in order to prevent development and retain open space. Verde Valley citizens, in particular, want to retain the viewsheds around their area as unchanged."* (Prescott NF 2008, p. 26)

Shifting demographics can also create a cultural divide between individuals engaged in traditional land uses and those interested in non-commodity uses of the forest (i.e., logging and ranching versus hiking and wildlife viewing). 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"* (McCool and Kruger 2003) 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."* (Almand Witt 1996, p.26)

Another challenge is balancing forest ecosystem health goals and objectives with the protection of archaeological resources. Fairley explains that *"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"* (Fairley 2008, p. 388). Not only do these resources help us understand past cultural uses and perspectives of the landscape, but they serve as important physical and spiritual landmarks for many Native American tribes and other cultural groups (Fairley, 2008, p. 392).

Finally, there is also growing conflict among the various recreation activities occurring on forests. As population has increased so have the types of recreation activities, such as biking, birding, OHV driving, backpacking, developed camping, hunting and fishing, wildlife viewing, hiking, equestrian use, geo-caching, paintballing, and visits to archeological sites. Because forest lands are finite, users are finding it increasingly difficult to have adequate space to engage in their given recreational activity without their experience being impacted by a different use (Coconino NF 2008).

Focus Areas and Priority Landscapes

Land managers need to develop comprehensive strategies to address the demands of growing population, changing demographics, and increased conflicts on forest ecosystems. This includes assessing the type of forest users and uses, values and perceptions of forests, socio-economic interactions, as well as developing increased collaboration between various forest stakeholder groups (McCool and Kruger 2003, Coronado NF 2008). *"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"* (Roberts 2009, p.8).

CULTURE - FOCUS AREAS

Initial Focus Areas for the Culture issue were identified as Native American reservations. Focus areas for this issue will be refined as more information is gathered.

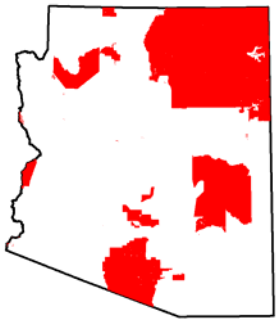


Figure 40. Tribal Lands – Native American Reservations

The Forest and Woodlands mask was used to classify each critical issue dataset. **Forest** and **Non-Forest** focus areas are shown on each issue overview map to help identify important areas that may not fall with traditional forest types. EPA Level III Ecoregions of the United States were used as a framework for delineating landscapes across the state.

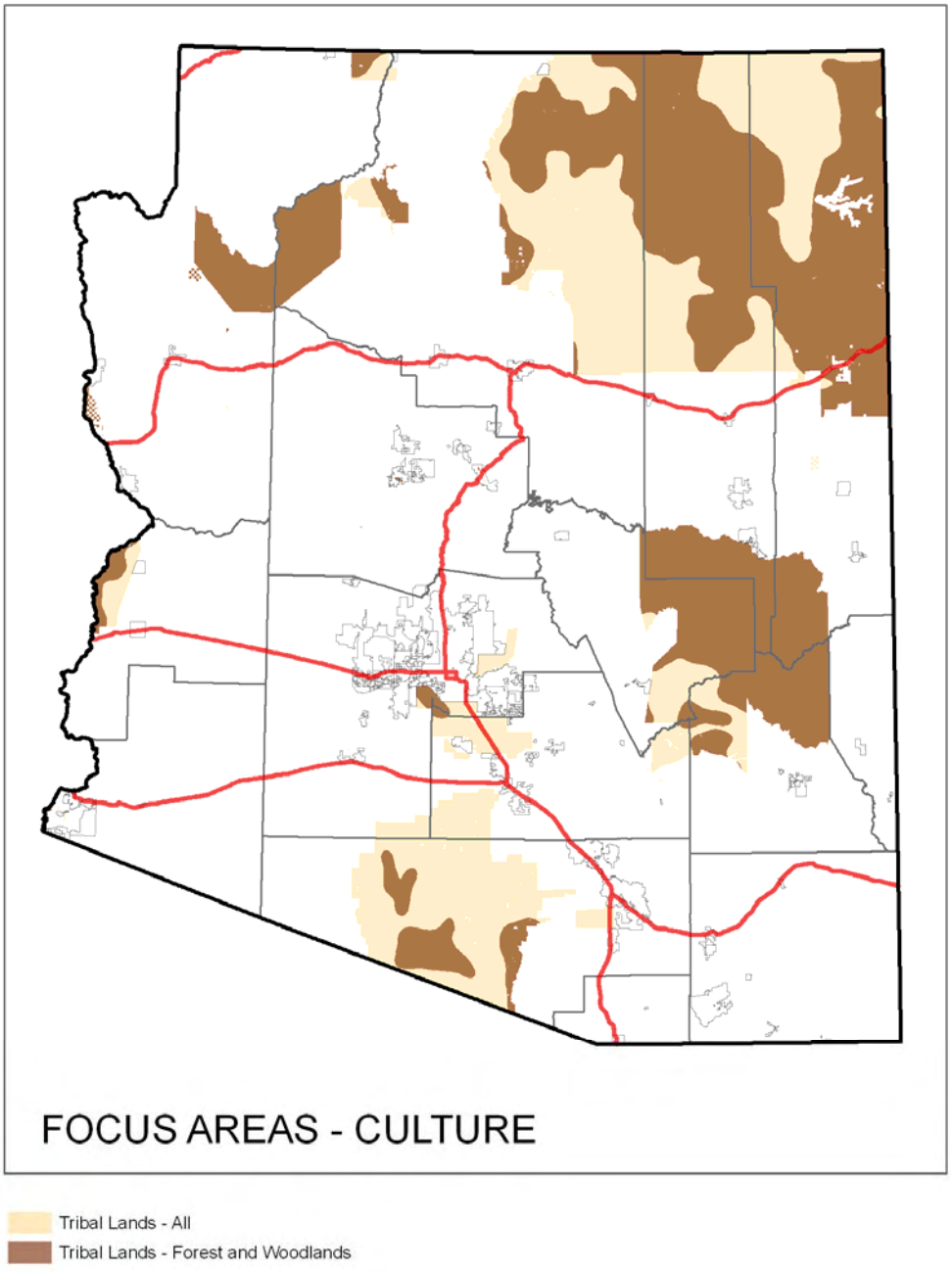


Figure 41.

7.0 Identified Synergies and Opportunities

7.1 Arizona Land Management Agencies and Collaborative Organizations

Efforts to bring together a collaborative task group, present outreach to Arizona stakeholders, and incorporate existing planning and assessment work are described in sections 3 and 4 above. Results of those efforts are promising, although work remains.

Task Group members brought much to the table in terms of expertise and institutional knowledge from their respective organizations. Extended outreach to land management organizations provided a better understanding of existing planning work and reinforced the importance of many of the forest resource issues described in this document.

Effective collaboration, however, takes time and resolve. The relatively short timeframe for developing this *Assessment* has proved challenging. All organizations have limited human resources and time while opportunities for important collaborative work seem to multiply. Efforts and successes of the Task Group and others in Arizona highlight the need for this collaborative work to continue. Management direction and commitment by all partners and stakeholders will be necessary to achieve possible results.

Land Management Questionnaire - Results

In early 2010 a questionnaire was distributed to the largest Arizona land management agencies and organizations to gather information about existing planning work, identify common concerns, and gather feedback on the critical issues identified by the Assessment Task Group. The questionnaire focused on these four elements:

1. Issues previously identified
2. Strategies previously identified
3. Feedback on six Critical Arizona Forest Issues identified by the task group (later expanded to seven issues)
4. Identification of Other Important Issues

Well-thought responses were received from several organizations and the input proved invaluable in helping to identify alignment of existing issues, concerns, and response strategies.

Organizations providing responses to the questionnaire include:

- USDA Forest Service – responses from each of the six national forests in Arizona
- USDI National Park Service – Intermountain Regional Office
- Arizona State Land Department
- USDI Bureau of Land Management – Arizona State Office
- USDI Bureau of Reclamation

7.2 Regional, Interstate, and International Opportunities

Arizona is home to millions of acres of public land including parks, forests, wilderness areas, wildlife refuges, grasslands, and others. These public lands are managed by several different agencies including the Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, U.S. Forest Service, and Arizona State Parks. Arizona is also home to 21 federally recognized tribes, several of whom have substantial acreage of forested lands. Many of these managed lands and many of the forest resource issues we face in Arizona cross state, national or sovereign boundaries.

Although political borders can sometimes complicate issues and their resolution, identification of common goals and challenges can often strengthen an effort by focusing additional resources. Cooperative working relationships across all borders aid in the efficient allocation of resources and sustainability of forest lands.

Arizona borders California and Nevada to the west, Utah to the north, New Mexico and Colorado to the east, and the Republic of Mexico to the south. To gain an understanding of how the Arizona Forest Resource Issues align with the efforts of these governmental entities, the Task Group contacted neighboring states and reviewed their draft assessment documents. (Table 4 shows a simplified matrix of this review.)

Although the exact terminology and issue description may vary, several common concerns are apparent. The issues involving people, ecosystem health, economics, water, and fire all show strong correlation with adjoining states. This section addresses some of these common issues and challenges.

Arizona Assessment	New Mexico	Utah	Colorado	Nevada	California
People and Forests	● - Fragmentation - Development - Green Infrastructure	● - Urban & Community Forestry	● - 3 National Themes	● - WUI development - Land Mgmt access - Community Forestry	● -People and Communities
Ecosystem Health	● - Forest Health - Fish and Wildlife Habitat	● - Forest Health - Wildlife	● - 3 National Themes	● - Forest Pests/ Pathogens - Riparian Systems - Habitat Management	● - Forest / Forest Health - Wildlife
Climate Change	⊙ (Acknowledged)	⊙ (Acknowledged)	⊙ (Acknowledged)	● - Climate Change	● - Climate Change
Economics	● - Economic Potential	○	● - 3 National Themes	● - Economic Opportunity - Fragmentation	● - People & Communities
Culture	⊙ (Acknowledged)	○	○	○	○
Water	● - Water Quality & Supply	● - Water Quality	● - Water & Watersheds	● - Water Quality/ Quantity	● - Water
Air	○	○	○	○	○
Fire	● - Wildfire Risk	● - Wildland Fire	● - 3 National Themes	● - Wildfire Scale/ Intensity	● - Wildfire
Other Major Issues Identified:	- Rangeland	- Riparian Areas	- Wildlife habitat - Invasive species	- Rangeland analysis - Land management threat	- Range Management
Common Issues Identified along Arizona Border:	Yes	No	No	No	No

Key: ● - Issues correspond significantly, ⊙ - Issue acknowledged but not a major focus, ○ - No corresponding reference identified

Table 4. Alignment of Arizona's forest resource issues with assessment and strategies being developed by neighboring states. (Based on draft information prior to completion of all assessments)

Key Interstate Issue Alignment

People: Issues related to increasing development pressure, forest access, changing land use, fragmentation, and urban and community forestry are common. Forested environments are key recreation resources across the region and Arizona shares similar forested recreational opportunities and management issues with several neighboring states.

Ecosystem Health: Fish and wildlife habitat, forest health, ecosystem services, riparian systems, invasive species, and related issues are common to most southwestern states. Wildlife habitat decreases with urban development and deteriorating forest health with the indirect consequences of habitat loss being devastating to ecosystems and conservation efforts. The spread of exotic and native pests and disease within and between states is a growing management concern. Opportunities for spread are due to unregulated transportation of goods, such as firewood, agricultural, and nursery products. Movement of soil on vehicles and hiking boots can transport a variety of noxious weeds. There is great value in working jointly with adjoining states to address this issue.

Fire: Wildfire concerns are pervasive. Risks increase with drought conditions and warming temperature trends, and areas of concern include densely populated areas in the wildland/urban interface (WUI), critical infrastructure, and other common values at risk. The suite of wildfire-related issues in the region mirrors those found on all sides of the border. Fire respects no boundaries and will continue to be a local, regional, and national issue for the foreseeable future.

Water: Drought conditions and water shortages are affecting most western states. Water quality continues to be a common management issue and shortages are compounded by warming temperatures and increasing demand brought on by the needs of a growing population.

Economics: Federal, state, and local budgets cannot adequately address all of the issues at hand. All states are struggling to identify economic processes to drive sustainable actions on the ground.

Beyond Arizona: Key International Issues and Opportunities

The Forest Resource Assessment Task Group also worked with U.S. Forest Service personnel and others to help identify international issues that Arizona might share with the Mexican State of Sonora. (Table 5 shows a simplified matrix of this review.)

	People & Forests	Ecosystem Health	Climate Change	Economics	Culture	Water	Air	Fire
Identified International Alignment	○	●	○	○	○	●	●	●

Though there is not an assessment and strategy process being developed for Mexican states, identified concerns align with several Arizona forest resource issues.

Key: ● - Issue Alignment Identified ○ - No corresponding issue identified

Table 5. Comparison of Arizona Forest Resource Assessment Issues with Issues of Concern in Mexico

Threats to Forests

Mexico's forests play a significant role in the global environment. Thus, deforestation is both a national concern and an international one. For example, degradation of upland and riparian areas of the Rio Laja Watershed in Guanajuato has resulted in poorer wintering habitats and breeding grounds for migratory birds en route from the United States or Canada. Poor forestry practices threaten Mexico's natural

resources, including supplies of timber and other forest products. In addition, invasive species and urbanization jeopardize forest areas. Protected natural areas often do not have sufficient resources to address these threats, creating additional challenges for the conservation of many of the country's most valuable natural areas and resources.

As neighbors, the United States and Mexico share many natural resources challenges, such as the threat of invasive species and uncontrolled wildland fire. Recognizing that the health of Mexico's forests affects the United States, the U.S. Forest Service collaborates with its Mexican counterparts to sustain and better manage natural resources. The U.S. Agency for International Development, the U.S. Forest Service, Mexico's Ministry of Environment and Natural Resources and National Forest Commission, and other partners work together on specific projects including community forestry, migratory species, forest monitoring, protected area management, and fire management. For more than 20 years, the two nations have worked side by side to improve natural resource management and conserve biodiversity. In addition, Mexico and the United States have continued to exchange scientific and technical expertise in forest management, wildlife, protected areas, migratory species, and watershed management.

Fire Management

For more than 15 years, fire management professionals in the United States and Mexico have worked to improve their knowledge of fire ecology and to strengthen fire management through training and technical assistance in fire prevention, suppression, response, and restoration. Spanning more than two decades, the Fire Management Working Group of the North American Forest Commission has shared technology and research and has trained firefighters through bilateral cooperation in actual wildfire crises.

Wildland forest fire constitutes a significant threat to biodiversity and forests in Mexico. As a result of the devastating wildfires in Mexico in 1998, the United States fire community and Mexican counterparts (including the Mexican Ministry of Environment and Natural Resources and the Mexico National Forest Commission) developed a comprehensive fire program to improve Mexico's capacity in fire management. With support from the U.S. Agency for International Development, coordinators from the two countries strengthened the capacity to manage wildland fire through formal classroom training and demonstrations, technical exchange, workshops, conferences and assessments. For the past nine years, the U.S. Forest Service has helped Mexico's effort to advance its professional capacity in wildland fire management through the development of a training curriculum modeled after the U.S. Forest Service's fire management training curriculum. Courses are conducted in partnership with federal agencies, such as the National Forest Commission and the National Commission for Natural Protected Areas, and increasingly include the participation of experts from nongovernmental organizations, local government officials, and, in some instances, participants from other Latin American countries.

In 2000, training in the Incident Command System began and this has strengthened mobilization and coordination of federal, state, and local actions. In 2004, the first Wildland Fire Behavior course was initiated in Mexico. The course teaches fire behavior and fuels management concepts as well as critical techniques that improve the effectiveness of firefighting efforts and the safety of fire fighters. Recognizing the role that local people play in fire management, in 2006 a basic firefighting curriculum was initiated to support Mexico's efforts to provide standardized training to entry-level firefighters and community brigades.

Fire has played a natural role in maintaining the diversity and productivity of the native vegetation of the Malpai Region for millennia. The best evidence for the history of fire comes from fire scars in the rings of ponderosa pine trees. Researchers from the University of Arizona Tree Ring Laboratory have collected fire history data from trees across the Southwest--from Sonora, Mexico to southern Colorado, and including

mountains in the Malpai area. All of these trees tell the same story: fire burned across this country routinely every five to ten years, with only occasional spans greater than 15 years with no fire. In fact, during a dry year following wet years, which can also be determined from tree rings, extensive fires burned in virtually every mountain range across the Southwest simultaneously. Evidence for the pervasive historic influence of fire is also found in the sediments of boggy cienega wetlands in valley bottoms, where charcoal fragments preserved for thousands of years support the conclusion that fires burned frequently across the valleys from one mountain range to another.

One of the important ecological roles of fire was to prevent woody species, such as mesquite and juniper, from encroaching into and spreading across grasslands. Perennial grasses re-sprout vigorously following fire, keeping grassland productivity high, but fire kills most tree and shrub seedlings. It is common for deer, pronghorn antelope, and even bighorn sheep to move into recently burned areas to feed on the abundant new growth.

Sonoran Joint Venture

The Sonoran Joint Venture (SJV) is 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. The mission of the SJV is to conserve the unique birds and habitats of the region. They strive to integrate the strategies, goals, and objectives of existing regional, national, and international bird conservation plans and programs into a single strategic effort that will address the unique regional bird conservation needs.

Forest Health/Invasive Species

Forest insects and diseases, and invasive species, can weaken the structure and health of a forest, causing millions of dollars of damage and rendering a nation's forests more susceptible to fire and other threats. Therefore, the United States and Mexico have focused on ways to prevent and control the damage of existing and potential native and exotic pests and pathogens. Working together, scientists from both countries observe pests under natural conditions and perform field experiments. The two nations place strong emphasis on sharing information, researching effective bio-control, developing measures to manage habitats, and conducting cooperative training.

Forest Insects and Diseases Working Group

The spread of insect infestations and disease increase with unregulated cross-border activity and movement. The Forest Insects and Diseases Working Group of the North American Forest Commission maintain a list to identify exotic insects and pathogens that can cause significant damage to North American forests. The Exotic Forest Pest Information System for North America contains data on candidate pests, ratings, and pest information. The Working Group also collaborates with Mexican colleagues on gypsy moth, sudden oak death, dwarf mistletoe, bark beetle, and other threats to forest health.

Migratory Species/Habitat Management

In cooperation with The Nature Conservancy, Ducks Unlimited, Audubon Society, Bat Conservation International, Pronatura Noroeste and other partners, the U.S. Forest Service works to ensure sound natural resource management for species of highest conservation concern and their wintering habitats. The U.S. Forest Service helps improve ecosystems and biodiversity and identify important habitat areas for migratory birds in the United States, Latin America, and the Caribbean. Protecting and restoring ecosystems includes: stabilizing streambeds, re-vegetating disturbed areas, construction for wetlands improvement, watershed analysis and restoration, eco-regional planning, and ecological fire management.

Pollution

Pollution concerns include air, water, and trash. In testimony to the U.S. House of Representatives, a former forest supervisor discussed the impacts of illegal border activity on national forest lands. There are 1.5 million acres of national forest lands within 50 miles of the United States-Mexican border, and managing these lands is of significant concern. For example, issues caused by cross-border violators in the Cleveland National Forest in California include the creation of new trails, abandoned campfires, and large amounts of trash.

Wildlife

Barrier fences and walls being constructed along the Arizona-Mexico border to reduce illegal activities are causing considerable environmental concern. Human activity (vehicular traffic, amplified noise, artificial lighting) associated with the barrier can affect how animals behave, which may lower survival rates (US Mexico Border Wall, 2009). Biologists have reported that the fence could threaten wildlife and significantly alter movement patterns and connectivity of wildlife populations. Species with small populations will be broken into smaller isolated groups that may endanger some species by making them more susceptible to disease, extreme weather events, and predators.

Regional Focus Areas

Area 1 and Area 2
Eastern California-Southern Nevada-Arizona Border

Cross-state concerns in this area include the Colorado River, renewable energy sources, recreation opportunities, and wildlife management. At this time there are no areas identified as high priority by any of these states.

Figure 42.

The Colorado River Basin is the largest watershed in the American Southwest, spanning about 1,450 miles through portions of seven western states from the Rocky Mountains in Colorado to the Gulf of California. The threats to this ecosystem are numerous. Dams created to hold water for irrigation and residential use have altered the flow of water, thereby blocking migratory paths for fish and changing water temperatures. Very little of the Colorado River actually flows to the Gulf of California because much of it is siphoned off in Arizona and southern California for residential and irrigation needs. Drought conditions and increased population have amplified the water shortage issue and water disputes have developed as demands exceed the supply available from the Colorado River. Modification of the natural flow of the river has also created loss of wetlands and habitat for native species and altered the Colorado River aquatic ecosystem (Colorado Plateau Land Use History North America). In the Colorado River Delta area, wetlands have been reduced by 80 percent due to water management practices and wetland restoration has become critical for many bird (USFS 2005)and fish species.

Area 3. Arizona–Utah Border
Cross-state concerns include wildfire, recreation opportunities, wildlife habitat management, and water quality and ecosystem health. The Cedar City Priority Area in Utah's Forest Resource Assessment abuts Arizona's northern border and aligns with the Colorado Plateau landscape area. At this time we have not identified any issue-based priority areas that correspond to the Cedar City Priority Area, but based on cross-state management needs we would look at ways to help address priority issues in Utah.

Area 4. Arizona–New Mexico Border
Cross-state concerns include wildfire, economic opportunities, wildlife habitat management, water quality, and ecosystem health. Several common priority areas straddle this interstate boundary. These include areas of the Arizona-New Mexico Mountains to the north and the Malpai Borderlands area to the south. There will continue to be an ongoing need to communicate and coordinate with New Mexico to develop and expand mutual strategies to jointly address common cross state issues.

Area 5. Arizona–Mexico Border
To the south, Arizona borders the State of Sonora in the Republic of Mexico. The national forest boundary abuts with the Mexican border and there are several common forest issues shared between Arizona and Mexico. Management of border issues is a significant concern for the U.S. Forest Service. These include pollution, fire activity from illegal immigration, and movement of wildlife, along with insect and disease transportation into the United States.

7.3 Online Outreach

As part of developing this *Assessment*, the state worked closely with known stakeholders to gauge the level of support for the Task Team's efforts on the critical issues required to manage Arizona's forested landscapes. To assess the level of support, an online survey was distributed to all known stakeholders and each stakeholder was asked to pass the survey on to any other interested party in an attempt to maximize the outreach potential. The Task Group received 146 valid surveys. Six critical issues were assessed, since the Culture issue had not been developed at the time of the survey. Participants were asked to rate the importance of each of the six issues from 1 to 10 with 10 being the most critical. By and large participants agreed with the Task Team's proposed issues (see Table 6 below), with the lowest average score associated with Climate Change (7.20) and the highest average score associated with Ecosystem Health (9.30).

Issue	People &Forest	Ecosystem Health	Water and Air	Climate Change	Economics	Fire
Mean Score	8.74	9.30	8.63	7.20	8.28	8.79
Std. Deviation	1.499	1.026	1.454	2.576	1.639	1.560

Table 6. Levels of Stakeholder Support for Critical Issues Identified in the *Assessment*

In addition, the Task Team wanted to understand the stakeholder's view about the relative importance of each issue related to each other. So a question was developed allowing the participants to allocate $100 between each of the issues. Each participant could allocate whatever amount they desired up to the $100 to a given issue. As illustrated in Table 7, Ecosystem Health and Fire were the issues that most stakeholders felt were important enough to allocate large portions of the $100. On the other end of this spectrum were Climate Change and Economics. While not definitive, the answers to this question lead towards a conclusion that relative to each other Ecosystem Health is the most important of the six critical issues, and Climate Change is of lowest concern at this time.

Issue	People & Forest	Ecosystem Health	Water and Air	Climate Change	Economics	Fire
Mean Amount Allocated	18.22	31.67	16.28	12.61	13.84	25.84
Std. Deviation	15.74	20.03	9.01	10.08	11.00	16.94

Table 7. Stakeholders Level of Relative Importance for Critical Issues Identified in the *Assessment*

The final questions were open-ended questions designed to see if there was an issue that was missing or if any significant changes needed to be made to the identified issues. We received several comments that can be viewed upon request. After review by the Task Group, all of the comments were considered components of the issues presented, and language was incorporated into the draft report to explain how these issues fit into the current structure. Finally, to get an idea of distribution of participants, we asked for a zip code. The following map indicates the geographic coverage of responses from this survey.

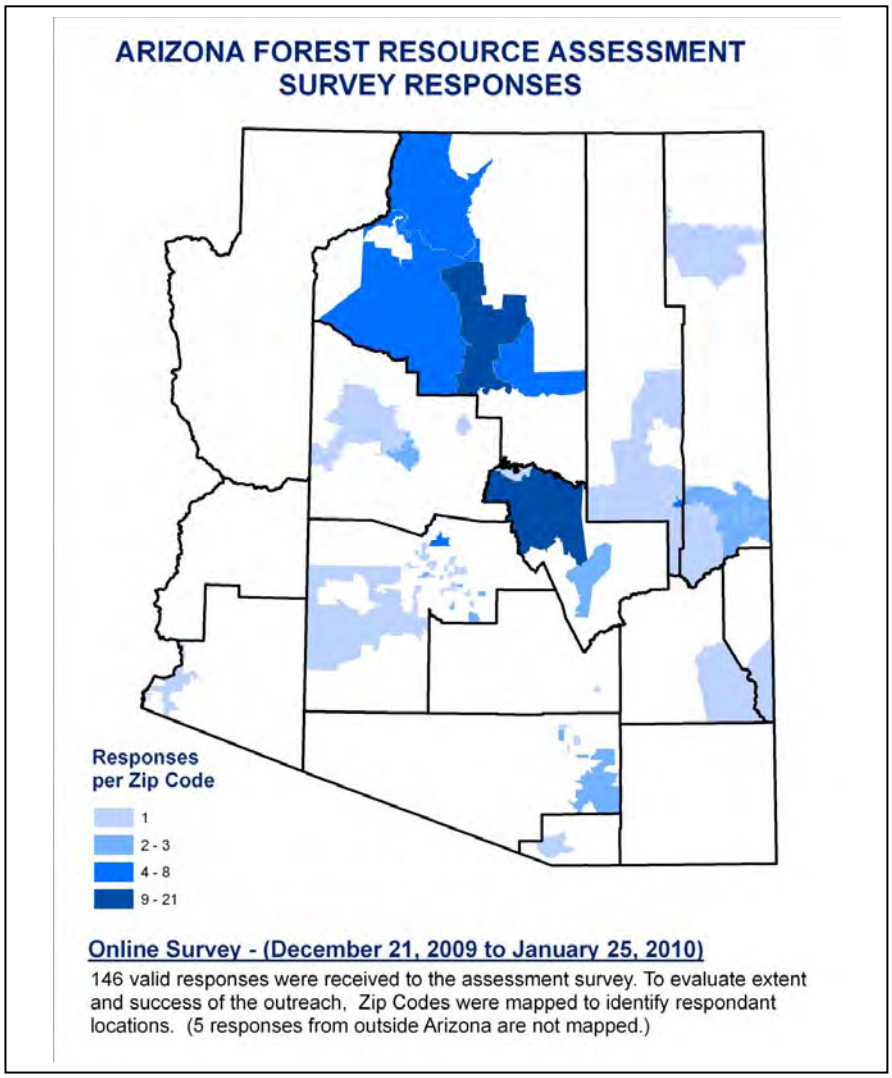


Figure 43. Map of *Assessment* Survey Responses

8.0 Arizona Priority Areas

Specific Forest Resource Issues for Arizona were identified and explored in section 6 above. Several cross-cutting statewide themes were identified and eight issue maps were developed to identify focus areas for the seven specific topics. (Two maps were developed for the "Water & Air" issue.)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 and leverage resources. The maps will be revised over time as better information is gathered and evaluated.

8.1 Focus Area Maps

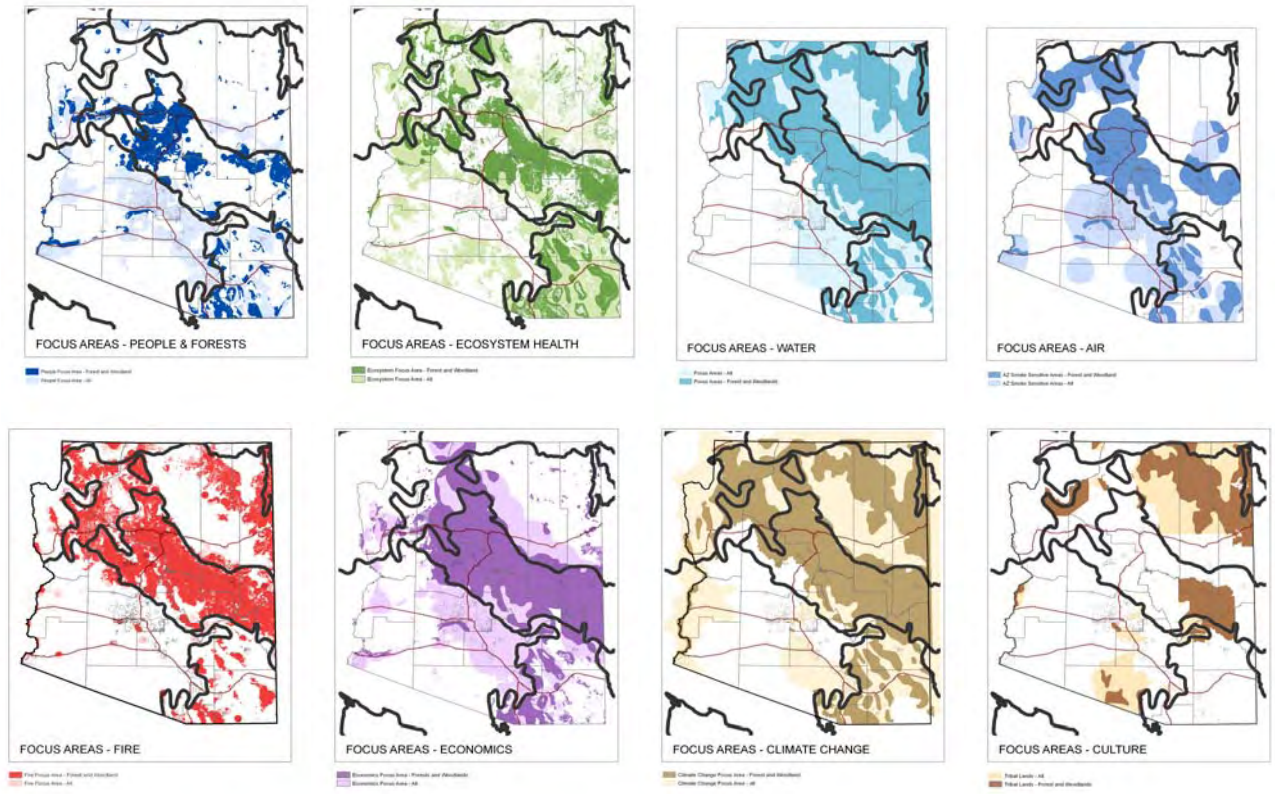


Figure 44. Focus area maps showing alignment with EPA Level III Ecoregions.

8.2 Landscapes

Opportunity Matrix / Alignment with Identifed Issues

Ecoregion / Landscape	People	Fire	Ecosystem	Economics	Water	Air	Climate	Culture
AZ/NM Mountains	L-H	H	H	L-H	M-H	L-H	H	L-H
Central Highlands	H	H	H	M	M	H	H	L
Western Mogollon Plateau	H	H	H	H	H	H	H	L
White Mountains	M	H	H	H	H	M	H	H
Chuska Mountains	L	H	H	L	H	L	H	H
Kaibab Plateau	L	H	H	H	H	H	H	L
AZ/NM Plateau	L	M-H	M	L	H	L-M	H	L-H
Northeast Woodlands	L	H	M	L	H	L	H	H
Arizona Strip	L	M	M	L	H	M	H	L
Sonoran Basin and Range	H	L	M	M	L	M	L	M
Sonoran Desert	H	L	M	M	L	M	L	M
Mojave Basin and Range	L	M	M	M	L	L	L	L
Basin and Range	L	M	M	M	L	L	L	L
Colorado Plateau	L	L	M	M	H	L	L	H
Chihuahuan Desert	M	L	L	M	L	L	M	L
Madrean Archipelago	M	H	H	M	H	H	H	L
Sky Islands	M	H	H	M	H	H	H	L

Matrix Explanation: Provides broad scale opportunity priorities by the eight identified issues with "Higher to Lower" opportunity ratings. Ratings are applied to each of Arizona's 7 Level III Ecoregions and also to each of the 9 "Forested Landscapes" identified in the 2007 Statewide Strategy for Restoring Arizona's Forests. More site specific opportunities may be derived by referring directly to the Focus Area Maps (Section 8.1) or through local and regional analysis.

Figure 45. Opportunity Matrix/Alignment with Identified Issues

9.0 Conclusion and Next Steps

9.1 Conclusion

While completion of this first edition of *Arizona's Forest Resource Assessment* and *Strategy* brings the development phase to a close, it signifies the beginning of the implementation phase. The *Assessment* and *Strategy* constitute the road map for diverse stakeholders to collaboratively address issues and opportunities across Arizona's forest landscapes. In the course of the "collaborative journey" to complete the *Assessment* and *Strategy*, strong and productive relationships have been forged. These working relationships constitute the foundation upon which successful implementation of the *Assessment* and *Strategy* will occur.

9.2 Future Actions

The *Assessment* and the *Strategy* were developed by a diverse collaborative body representing the jurisdictions, users, and interested parties in the forested lands of Arizona. Given the impressive outcomes of this collaborative effort, the State Forester is committed to sustaining it in some fashion and to build on this initial effort in the future. 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 for forested lands within the state.

Plans are being formulated for a collaborative group to continue meeting periodically to shepherd the implementation, monitoring, reporting, and adaptation of the *Assessment* and *Strategy*. The group will be charged to solicit specific actions of all partners and stakeholders, to incorporate new information, and to complete the strategy matrix. Actions will also monitor implementation of the strategy and recommend or develop adjustments as necessary, and further develop performance outcomes and measures.

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, the ASFD considers these to be dynamic and living documents whose implementation will be monitored, assessed, reported, and adapted on a continuing basis. As indicated by the results of monitoring and assessment, both the *Assessment* and *Strategy* will continue to be revised to address evolving issues and opportunities.

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Appendix A-2: 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 (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 river banks in the southwestern United States – The name is derived from the Spanish word for *woodlands*.
carbon bank or sink	sites that soak up 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 more or less 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	(sometimes called a bioregion) 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 that are 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 before present (BP) covering the world's recent period of repeated glaciations.
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
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 as a result 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 SO_2 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
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-3: Acronym Dictionary

ACTC	Arizona Community Tree Council
ADA	Arizona Department of Agriculture
ADEQ	Arizona Department of Environmental Quality
AFSC	Arizona Forest Stewardship Committee
ASLD	Arizona State Land Department
AZGFD	Arizona Game and Fish Department
AZSFD	Arizona State Forestry Division
BLM Arizona	Bureau of Land Management
BP	before present (>12,000 years ago)
CFAA	Cooperative Forestry Assistance Act
CLIMAS	Climate Assessment for the Southwest - A program of the University of Arizona established to assess the impacts of climate variability and longer-term climate change on human and natural systems in the Southwest.
CWPP	A Community Wildfire Protection Plan (CWPP) evaluates local conditions and risks from fire, and develops a plan to address all aspects of community protection and wildfire mitigation.
DBH	diameter at breast height
EQIP	Environmental Quality Incentives Program
FHC	Arizona Forest Health Council
ForestERA	Forest Ecosystem Restoration Analysis
FLMP or LMP	Forest Land Management Plan or Land Management Plan
FRCC	Fire Regime Condition Class
FSP	Forest Stewardship Program
GIS	Geographic Information System -
LCCGP	Livestock and Crop Conservation Grant Program

NASF	National Association of State Foresters
TNC	The Nature Conservancy
NEPA	National Environmental Policy Act
OHV	Off Highway Vehicle
ORV	off road vehicle
RMRS	Rocky Mountain Research Station
S&PF	State and Private Forestry
SHPO	State Historic Preservation Office
SWAP	State Wildlife Action Plan
USDA	United States Department of Agriculture
USFS	USDA Forest Service
WHIP	Wildlife Habitat Improvement Program
WMSC	White Mountain Stewardship Contract
WUI	Wildland/Urban Interface
ACTC	Arizona Community Tree Council

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Arizona Forest Legacy Program: Assessment of Need

June 2005

Photo: Flagstaff, Arizona; The Nature Conservancy

ARIZONA STATE LAND DEPARTMENT

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

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Arizona Forest Legacy Program: Assessment of Need

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EXECUTIVE SUMMARY

Introduction

In 2003, Arizona expressed interest in participating in the U.S. Forest Service Forest Legacy Program. The purpose of the Forest Legacy Program is to identify and protect environmentally important private forest areas that are threatened by conversion to non-forest uses. Additional benefits of the program 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, with a mandatory 25% non-federal match, 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 Forest Legacy Program. The Forest Legacy Program is entirely voluntary and is based on the principle of willing sellers and willing buyers.

In order to participate in the Forest Legacy Program, the Arizona State Land Department, as Arizona's lead forestry agency, submits this Assessment of Need documenting the need for a Forest Legacy Program in Arizona, establishing eligibility criteria, setting selection guidelines, and identifying priority areas. Arizona's Assessment of Need was prepared under contract by The Nature Conservancy in conjunction with the State Land Department, Arizona Forest Stewardship Committee, and USDA Forest Service, Region 3 Arizona National Forests. This report is submitted to the USDA Forest Service by the Arizona State Land Department for approval into the Forest Legacy Program.

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 m. The majority of forestland 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 the primary function and most consumptive use of Arizona's forests, forestland serves other anthropogenic purposes such as recreation, tourism, mining, and grazing. More importantly, forestlands 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 Forestland 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

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estimated at 5.44 million, making Arizona the second fastest growing state in the United States. Its population is expected to double again in the next 25 years.

Some impacts of this rapid population growth include ranch and forestland conversion to low-density development, increased 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 forestland by focusing on large forested blocks.
- Protect riparian forest habitat in large or small blocks. Resource values are independent of parcel size in riparian settings
- 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 forestland 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, forestland 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 areal canopy cover of leaves and branches of 25% or greater.
- The minimum area for classification is 5 acres, owned by an individual or by an organized group of individuals.

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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 private forest within three Forest Legacy Areas is threatened and important and therefore eligible for inclusion in the Forest Legacy Program. The three Forest Legacy Areas are Arizona Strip FLA, Arizona Highlands FLA and Sky Islands FLA. These FLAs are depicted in Map 1.

Prioritization Process

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

1) Ecological and Environmental values,
2) Site viability
3) Threat immediacy
4) Local support and presence of partners and/or matching funding
5) Contribution to larger conservation strategy or importance to other protected forestlands
6) Public values

These criteria are included in an evaluation table entitled "Forest Value and Threat Criteria Prioritization Process" (Figure 7).

To aide 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 forestlands. The *public value* spatial layer evaluates private forestlands 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 *environmental value* spatial information was created to assess private forestland 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*, *environmental value*, and *development threat* intersected.

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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 forestland 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.

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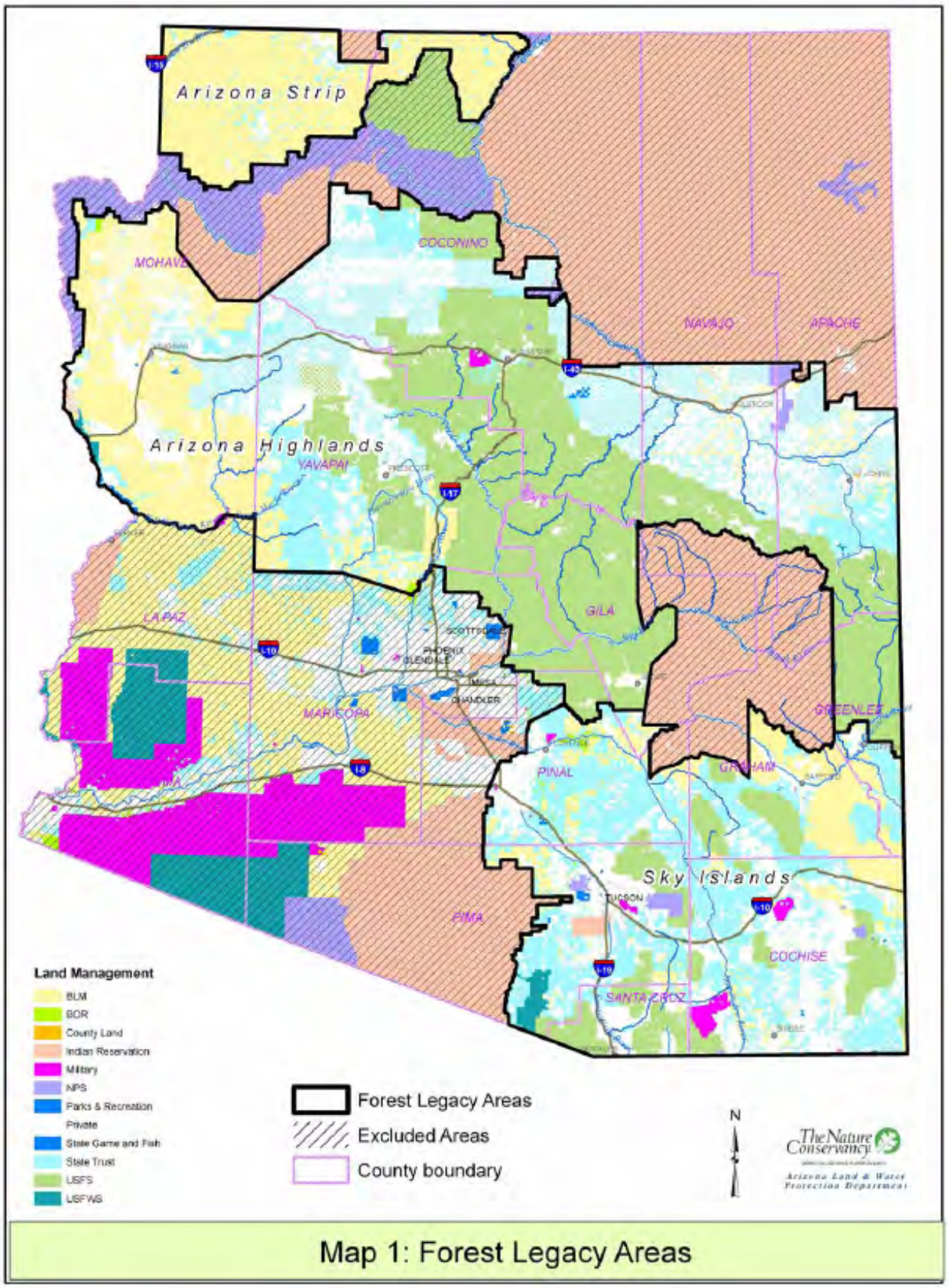

Map 1: Forest Legacy Areas

Appendix A-5: Stakeholder Input and Public Comments

Throughout the process of developing the *Assessment* and *Strategy*, the Task Group pursued opportunities for collecting information and comments from interested publics and stakeholders. The most significant efforts included an online stakeholder/public survey and two workshops. This survey and workshops focused on the critical Arizona Forest Resource Issues identified by the Task Group. There were also other opportunities for individuals to read and comment on the draft documents.

All comments received were evaluated and incorporated into the document composition process as editorial changes, additional context, or information to be considered. A summary of some of the comments received follows. The comment summaries are grouped into two categories: 1) comments about the issues (based on brief issue descriptions and summary presentations), and 2) comments about the written document drafts and overall process. All the comments received are retained in the project record.

Comments About the identified Critical Arizona Forest Resource Issues (based on brief issue summaries)

There were many positive comments that reinforce the original six identified issues. Based on stakeholder input, the seventh issue *Culture* was added after survey and public workshops had been completed. Examples of reinforcing comments include:

- Looks good.
- I think they are broad enough to take in virtually all the most important (but more specific) issues.
- I think these issues hit the mark as general categories
- The issues are good

A number of comments highlight the interrelated nature of the identified issues:

- An emphasis on ecosystem health will have a direct influence on fire costs, water, air, and other ecosystem services.
- Define them more clearly and articulate how intertwined they are to the public. For example, if money is spent on ecosystem health (increasing forest resilience), it will likely assist with climate change, water & air, people & forests, and fire.
- I think ecosystem health and fire are related---if you get one in line (ecosystem health), then the fire issue is solved (fire is a tool to attain ecosystem health). Ecosystem health is also tied to economic health---products created to attain ecosystem health.
- I feel many are inter-related (i.e. ecosystem health affects fire, water & air, etc.).

A variety of input was received regarding Climate Change:

- Climate change and invasive species, especially buffelgrass, are part of the fire problem.
- Eliminate the unknown Climate Change category.
- Climate change is very important, but it is global so how to help but to educate.

- Although climate change is an important consideration and should not be ignored, I think it can be addressed through ecosystem health.

Several comments recommended more focus on *wildlife,* which is included under the *Ecosystem Health* umbrella:

- Sixth issue, which would be wildlife.
- More emphasis on wildlife. Consider adding as a separate issue or creating strong link with statewide wildlife plan.
- Please see the Wildlife Principles from the Governor's Forest Health Council.
- I didn't see anything about the animals that live in the forest. Protecting them is far more important to me than protecting the 'rights' of hunters, for example. Hunting should be allowed only in very limited and remote areas of the forest.

More than one comment suggests separating *Water* and *Air* into separate issues:

- These are the critical issues, but I don't agree with lumping water and air as the same issue, especially when addressing the budget. They are not the same and require distinct objectives and approaches to manage.
- I would separate water and air. I feel all conservation efforts to protect our water resources is needed. I feel the temporary smoke due to prescribed burns are necessary and far out weight the discomfort from the smoke.

Many comments focused on the need to consider educational components of these issues:

- Education, though I assume a portion of each critical issue would be spent on education. It is important that the young people of Arizona understand the value our public lands contribute, in a whole system based approach.
- How about education of our young children at an early age. Growing up in the Midwest in the 60's it was a big hit. Being that I am a Certified Arborist, and a member of the AZ. Community Tree Council, is there anything that I can do by volunteering my services?
- Not necessarily a forest resource, but I feel education of forest issues is an important item that must be included in the final recommendations.
- Public and decision-maker education needs to be made explicit in the critical issue narratives, rather than implicit. It is by addressing people's perceptions about the forest that management objectives can be better conceived and achieved.

Several suggestions helped identify gaps in the original issue descriptions. Many of these items were better addressed as more supporting content was developed for each issue. Several items will need additional attention in future document refinement:

- Grazing and wildlife, but they can come with healthy forests; just show them as a bi-product of good forest management.
- I don't think you captured the impacts of people on the Forest well---motorized recreation is out of control and is damaging both upland and riparian areas. You did not mention the impacts of grazing (both cattle and non-native elk) into the restoration.
- I don't think you gave the economic aspect of the problem proper discussion, especially the increased consumption of wood products with increased population.
- I think recreation demand is not emphasized adequately in the people and forests issue.
- Invasive species.
- My only concern is these issues seem to be very broad and there are many ways of looking at them to solve them.
- Soils and grazing
- The conflict between motorized and non-motorized uses of the forest is a social issue that affects ecosystem health.

In addition, a variety of other comments were received. Examples include:

- 'Restoration' of forested ecosystems should focus on making them resilient and should use an adaptive management approach.
- Biggest threat is unmanaged recreation ... especially with huge impacts from large population centers like Phoenix.
- Fire should be a component of one or more of the other five, not its own category. Historic fire regimes or those reflecting current environmental conditions should be the focus. A new paradigm allocating resources to fire management should replace the
- I am assuming that OHV issues fall under one or more of these categories, but I believe that this is an issue that requires significant attention.
- I would add forest connectivity, green corridors, if not the forest becomes and needs to be treated as an aquarium.
- More importance put on urban issues, especially canopy cover and the importance of trees in the urban setting.
- The 'issues' statements are unclear about what the specific issue is and thus my valuation reflects that uncertainty.
- The issue of values of place, the amenity value that a community derives from a location that provides access to the forest for residents' activities is a critical component that may need to be addressed.
- The communication of what to evaluate is not always clear or direct. Too general.

Comments about various iterations of the written document drafts and overall process. (There were numerous exchanges of technical information – proper citations, typographical corrections, and various "wordsmithing" suggestions – that normally go into refinement of a large document. Though very important to completion of the document, they are not listed here). Examples of more substantive comments include:

- Question the statement of decades of declining precipitation and long-term drought. Unclear how less precipitation results in changes described in last sentence.
- The statement, "A decline in precipitation over the last several decades … "is in conflict with the Swetnam's research showing that since the late 1970s is has been unusually wet. This was from a 1998 article which would have been at the beginning of our current drought cycle. Even if there was a decline in precipitation, it would not result in an earlier spring runoff, but just a shorter duration.
- Overall, this is a very impressive document and covers a wide set of issues. I'm pleased to see some good background on how current conditions evolved, and also a section on the emerging challenge of climate change.
- Debate continues on trends and impacts regarding grazing on public forest land. A downward fluctuation of grazing acres available could negatively affect the viability of ranching, especially in areas where there is little private land available. If ranches go out of business, there could be an unintended consequence that fragmentation of habitat and loss of open space on private lands will occur. Land managers must weigh these benefits and potential consequences against potential impacts caused by grazing. The key lies in effective rangeland and grazing management.
- Look at USGS statewide recharge model, PRISM climate model.
- GRACE satellite gravity data gives information on amount of groundwater in storage. Contact Matt Garcia of Arizona Hydrologic Information System
- New climate change impacts study on downscaling global climate circulation models to Salt/Gila River Basin - contact Kathy Jacobs at U of A.
- Climate change is a component of climate.
- More emphasis on recreation impacts - particularly off road use.
- Eliminate or significantly limit transfer of landownership from federal to private. – i.e. maintain federal ownership and state ownership at current level or increase their ownerships. This could provide a greater level of control of usage.
- Coordinate forest issues specifically with elements of each county plan.
- Include riparian forests, native and non-native in assessment. Such as, Cottonwood and Willow and Mesquite gallery forests.
- Regulation of rivers has had an important impact on riparian forests as does climate change.
- Restoration must be driven by increasing product (wood) values, i.e. w/market development, energy development.
- Manage forests to increase water discharge.
- Analyze existing urban/interface tree concentration to determine long term ecosystem health.
- It may be desirable to have the smoke from a prescribed burn rather than in devastation of a wildfire.
- Better growth management planning to not impact existing hydrologic functions of forests, or promote growth in riparian forests.
- Landscape scale forest restoration to mitigate hydrologic impacts of climate change.
- Address the economic impact of small wood usage. i.e. biomass as fuel. This will impact cost of wildfire mitigation.
- Manage forests to minimize fire hazard.
- Use appropriate prescribed fire techniques to minimize smoke issues.
- Where will the State receive the monies to spend on these critical elements?