MONTANA'S STATE ASSESSMENT OF FOREST RESOURCES

BASE FINDINGS & GIS

METHODOLOGY

Montana Department of Natural Resources & Conservation

June 2010

CONTACT INFORMATION:
Dan Rogers
Montana Forest Stewardship Coordinator
Montana Department of Natural Resources and Conservation
2705 Spurgin Road
Missoula, MT 59804
Office: 406.542.4300
DANROGERS@MT.GOV

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Executive Summary

In 2009-2010, the Montana Department of Natural Resources and Conservation (DNRC) conducted a Statewide Assessment of Forest Resources(SAFR). This assessment model covered all forestland, regardless of ownership type and was accomplished using geographic information system (GIS) analytic techniques. It involved developing 11 separate sub-model layers based on the National State Assessment Guidance. Results of the analysis will be used to direct the future deployment of the 2008 Farm Bill programs as they relate to planning, information and education, technical assistance or financial assistance, and may be used to demonstrate the value of forests and forestry to the regional economy, environmental health, and quality of life. This analysis provides insight where future USFS State & Private Forest (S&PF) programming may be most beneficial. The project began in January, 2009 and ended in January, 2010, with recommendation by the Montana Statewide Assessment Working Group (SAWG) and approval of the State Forester. The SAWG was made up of over 40 stakeholders representing all forest ownership types and several forest interests from around the state.

Montana has significant forested acreage, primarily in larger contiguous blocks of federal Forests in Western Montana, but also in scattered ownerships throughout island mountain ranges and in the high elevation areas of southeastern Montana. This geographic split, coupled with the predominant pattern of public lands, family forest and industrial forest lands had a large influence on the watershed classifications statewide.

"Critical landscapes" in Montana are defined as watersheds that meet a pre-defined set of variables linked directly to a Federal Redesign objective and subsequent Farm Bill program authority. It is an area prioritized for direct delivery of State & Private Forestry Programs. The SAFR critical landscape final analysis was completed at the 5th code watershed level and provided unique, objective dependent scores approximately 1000 available watersheds.

Key stakeholders, forest resources, and threats to the resource vary across the state. Because of this variation, information designed to portray the region must be developed with an understanding of the differing pressures within the region. DNRC does not have a source of information that adequately shows the pattern and distribution of critical landscapes across all forest ownerships. This assessment provides greater understanding of these characteristics and a strong foundation for better forest planning and strategies in program decisions. The consumers of the assessment include DNRC state forestry agency staff as well as other partners involved in the SAFR effort.

The model results in GIS layers and maps showing watershed rankings based on any series of selected model variables. That is, a landscape can be reflected at the 5th code watershed level, ranked by whatever criteria may have been selected within the model. Not only do the results of the analysis provide a new way to describe the region's distinctiveness, they may be used to inform policy makers, stakeholders and concerned groups, as well as empower the region to communicate its unique attributes and better quantify its management challenges. Knowing where the forest resources and social values are, where they are most vulnerable, and where they are most valuable will be indispensable as the DNRC positions itself as the lead stakeholder of forestry issues in the region.

The Assessment model can help meet the challenge of diminishing funds and increasing client base by facilitating strategic outreach. Because there is limited capacity to promote stewardship of Montana's forests, it is more effective to focus energy in places where it will provide the highest return or the largest cumulative effect. In addition, as Montana develops its strategy for market competitiveness, it will need to know where the opportunities lie to sustain its most valuable and lucrative assets. The Statewide Assessment of Forest Resources will be invaluable for the DNRC as it strives to sustain healthy, productive forests, and protect the economic viability of its forestlands.

The Assessment analyzes where best to focus State & Private Forestry program resources, and therefore is a perfect complement to the Western Wildfire Risk Assessment, whose output will help focus fire suppression, prevention, and mitigation resources. These two data sets together will empower the region to market its identity more comprehensively.

SAFR Introduction, Purpose & Background

Foundations of the Montana Statewide Assessment of Forest Resources and the State and Private Forestry Redesign Initiative

The Montana State Assessment of Forest Resources is considered a critical part of the Forest Service State and Private Forestry Redesign Program, launched in 2008. The purpose of the state assessment is to provide a foundation to assist the Montana Department of Natural Resources and Conservation in prioritizing forested areas of greatest need and opportunity for stewardship and sustainable management, and developing a comprehensive long term strategy to address these needs and opportunities.

The U.S. Forest Service State and Private Forestry branch provides technical assistance and cost-share funding to every state in the nation in support of issues related to wildland fire, insects and disease, private forest stewardship and community forestry on non-federal land. In Montana, these funds are primarily administered by the DNRC through various forestry assistance programs.

The S&PF Redesign Initiative was conceived by state and federal partners in response to increasing pressures on our nation's forests and decreasing availability of resources and funds. In the face of these challenges, the USFS and state foresters determined that more progressive, large-scale strategies were needed to sustain our nation's forest resources. The purpose of the redesign initiative is "to shape and influence forest land use on a scale and in a way that optimizes public benefits from trees and forests for both current and future generations."

The new redesign approach focuses on three consensus-based national themes with accompanying strategic objectives:

Conserve working forest landscapes.

- Identify and conserve high-priority forest ecosystems and landscapes.
- Actively and sustainably manage forests.

Protect forests from harm.

- Restore fire-adapted lands and reduce risk of wildfire impacts.
- Identify, manage and reduce threats to forest and ecosystem health.

Enhance public benefits from trees and forests.

- Protect and enhance water quality and quantity.
- Improve air quality and conserve energy.
- Assist communities in planning for and reducing wildfire risks.
- Maintain and enhance the economic benefits and values of trees and forests.
- Protect, conserve and enhance wildlife and fish habitat.
- Connect people to trees and forests.
- Manage and restore trees and forests to mitigate and adapt to global climate change.

Since 2008, a portion of S&PF funding has been and will continue to be allocated through a competitive process guided by these national themes. To ensure that proposals for this funding are being focused on high-priority areas with the greatest opportunity to achieve meaningful outcomes, each state or territory that wants to receive S&PF funding must work collaboratively with the USFS and other key partners to develop the following documents:

Statewide Forest Resource Assessment – Provides an analysis of forest conditions and trends in the state and delineates priority rural and urban forest landscape areas.

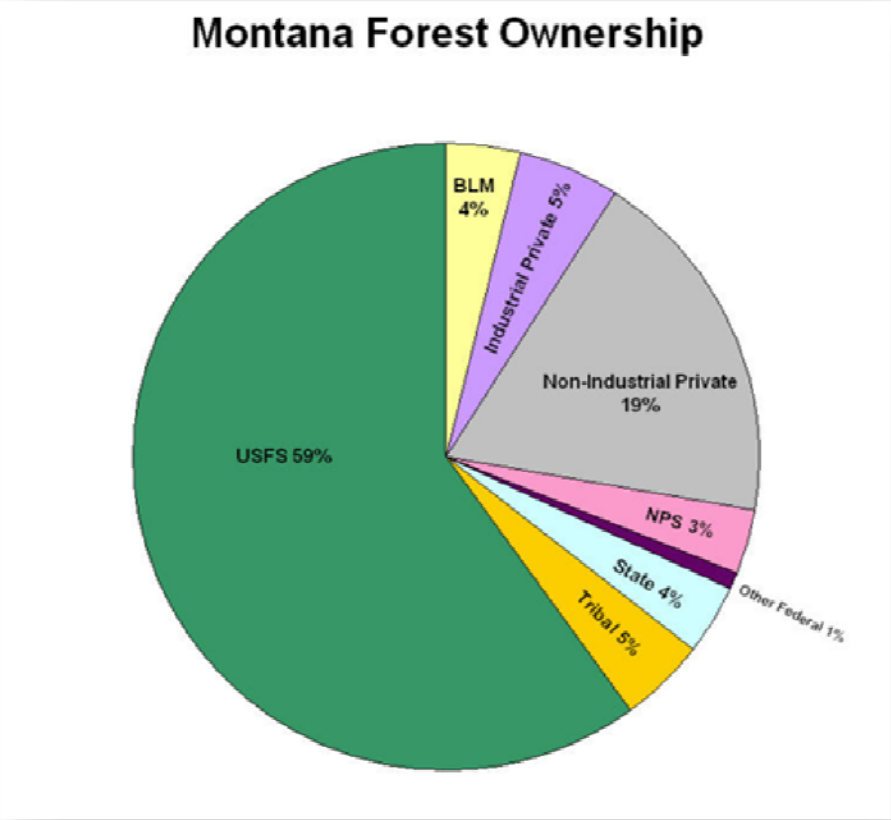
Statewide Forest Resource Strategy – Provides long-term strategies for investing state, federal and other resources to manage priority landscapes identified in the assessment, focusing on areas in which federal investment can most effectively stimulate or leverage desired actions and engage multiple partners. States that receive S&PF funds also will be asked to submit an annual report that describes how such funds were used to address the opportunities identified in the assessment and strategy, including the leveraging of funding and resources through partnerships.

According to the 2008 Farm Bill, each state is required to complete both the assessment and strategy by June 2010 in order to qualify for most S&PF funds.

BASELINE DATA FOR MONTANA

Forest Resources

Forest land occupies an estimated 23 million acres in Montana. Seventy-one percent (16.3 million acres) is publicly owned, under the jurisdiction of federal and state agencies. Of publicly owned lands, 3.4 million acres are considered “reserved” and unavailable for timber harvest. Private ownerships account for 6.2 million acres of forestland in the state, with the largest share (3.8 million acres) owned by more than 83,000 non-industrial private landowners. As such, non-industrial private lands represent the second largest ownership type in the state.



Ecologists recognize 10 different major forest types in Montana. Douglas-fir (*Pseudotsuga menziesi* var. *glauca*), lodgepole pine (*Pinus contorta*), and ponderosa pine (*Pinus ponderosa*) predominate on the forest landscape, and are the most commercially important species. The **Douglas-fir** type is found on over 7 million acres across Montana. It is well adapted to a variety of climatic conditions, and can grow as either a climax species or in codominance with ponderosa pine, grand fir, Engelmann spruce, subalpine fir, or Western larch. Douglas-fir is more shade tolerant but less fire resistant than many of its associated species, and thus has benefited from fire exclusion policies, expanding its range since the early part of the 1900s.

Like Douglas-fir, the **lodgepole pine** type occurs across a wide range of conditions in Montana, and is equally prevalent both east and west of the Continental Divide. Its propensity for growing in dense, even aged stands, fire suppression policy, and drastic reduction of lodgepole pine harvest on federal lands have resulted in vast landscapes with stands in between 60 and 100 years of age. These conditions have provided the perfect environment for the current massive mountain pine beetle epidemic, which has impacted 1.2 million acres of the 4.9 million acres of the lodgepole pine forests in Montana.

Ponderosa pine occupies 3 million acres in Montana, and is found primarily in the driest forestland sites. Eighty-five percent of its Montana range is located west of the Continental Divide. East of the divide it is the dominant commercial species, and is the dominant species on non-federal lands. In contrast to Douglas-fir (with which it is codominant on many sites), Ponderosa pine has declined in its range since the beginning of the 20th century. This is due to a combination of “high-grading” harvest practices prevalent during the mid-20th century and exclusion of the low intensity, high frequency fire regime on which ponderosa pine depends to maintain ideal growing conditions.

Other, more minor conifer forest types found in Montana include **spruce-fir** (primarily composed of *Picea engelmannii* and *Abies lasiocarpa*)**, Western Larch** (*Larix occidentalis*)**, Engelmann spruce** (*Picea engelmannii*)**, Grand fir** (*Abies grandis*)**, Limber pine** (*Pinus flexilis***,** and **miscellaneous western softwoods** (including *Thuja plicata, T. heterophylla,T.mertensiana, Juniperus* o*steosperma* and *J. scopulorum*). The **hardwood** forest type is found predominantly in eastern Montana, and comprises aspen (*Populus tremuloides*), cottonwood (*Populus trichocarpa* and *P. deltoides*), box elder (*Acer negundo*), bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*), willow (*Salix spp.*), and birch (*Betula papyrifera*). Of these hardwood species, cottonwood is the most abundant, and is concentrated in riparian areas in the eastern part of the state.

Often overlooked but no less important in the composite of Montana's forestland are urban forests, riparian forests, and the windbreaks and shelterbelts common in agricultural settings. Urban forests include the trees and other vegetation growing in yards, along city streets, in parks and cemeteries, along river corridors or green belts, on school grounds and at businesses. They provide a host of benefits, including reducing soil and water pollution, moderating extreme weather and temperatures, enhancing residents' wellbeing, providing recreational opportunities, and increasing property values. Although Montana is often thought of as a rural state, 62% of the population lives in cities or towns. Urban forests offer important opportunities for these residents to connect with nature in close proximity to their day-to-day activities.

Though they represent only a fraction of the total forestland in Montana, riparian forests are often equally or more productive and biologically diverse than adjacent uplands. In many parts of eastern Montana, where riparian forests comprise the only forested habitat, they provide an important refuge for many plant and animal species. The same can be said for farmstead windbreaks or shelterbelts, which are planted intentionally with the aim of reducing undesirable effects of strong winds, controlling drifting snow and erosion, and providing wildlife habitat. Though not traditionally thought of as forestland, these agroforests provide some of the same benefits and face many of the same forest health challenges as native forest landscapes. For example, the mountain pine beetle epidemic, now widespread throughout western and central Montana, has also impacted the scotch pine (*Pinus sylvestris*), Austrian pine (*Pinus nigra*), and ponderosa pine commonly found in windbreaks and shelterbelts, while the invasive emerald ash borer continues to infest green ash, a preferred deciduous agroforest species.

Population and Demographics

Montana encompasses 147,046 square miles, 56 counties, and is the 4th largest U.S. state in terms of land mass. As of July 2009, 974,989 citizens called Montana home, making it the 44th ranked state for population. The largest city is Billings (pop. 100,148) followed by Missoula and Great Falls. Eighty-seven percent of cities and towns in Montana have less than 10,000 residents.

Population growth in the decade 1990-2000 for the state was 1.2%. During this time, growth was especially high in counties of Ravalli (3.7%), Gallatin (2.9%), Flathead (2.3%), Missoula (1.9%), and Lewis & Clark (1.5%) – counties characterized by a high level of forest cover. Not surprisingly, increasing population during this period led to an increased demand for residential home sites, particularly in the montane regions of the state. In the period corresponding to the most rapid population growth, nearly 100% of forest lands converted to non-forest uses were non-industrial private forests. Although the rate

of population growth has declined since the year 2000, most dramatically in the past two years, the extent and impact of residential development on forestland that occurred during this time period is unlikely to see a reversal. Moreover, the increasing prevalence of Timber Investment Management Organizations and industrial timber company conversions to Real Estate Investment Trusts foreshadows the massive parcelization and divestment of industrial timber lands.

As of 2007, Montana ranked 41st highest in per capita income, a substantial decline from its position of 34th in 1970. Montana's economy has historically been defined by 3 sectors: mineral resources, timber, and agriculture. The forest products industry comprises harvest and processing of sawlogs, pulp, chips, house logs, and other fiber products. In the 1990s, the forest products industry formed the 3rd largest basic industry sector, following the federal civilian government and agricultural sectors. Today, it ranks last of the eight basic industries in Montana.

Forest Products Industry: Past, Present, and Future

Intensive forest management in Montana did not begin to take place until the 1950s. Prior to this time, harvest activity was dominated by partial cuts which left much of a stand's merchantable volume in place. Wood products at this time were used to support burgeoning mining and railroad industries and in the establishment of early Montana settlements.

Two factors spurred the transition to large-scale industrial forestry in the state and the utilization of the clearcut as a widespread silvicultural tool on federal lands. One was the radical increase in demand for wood products during the building boom following World War II. The second was a large-scale spruce bark beetle epidemic in western Montana and Idaho. At that time, the dominant forest management paradigm considered old-growth, decadent stands to be unproductive. Clearcuts followed by reforestation were the preferred silvicultural practice for establishing young, vigorous, even-aged stands destined for intensive management. During the spruce beetle outbreak, clearcuts were further employed as a preventative measure and to salvage trees killed by the epidemic. The peak of clearcutting in Montana occurred in the 1960s, at nearly 40,000 acres annually.

In response to increased harvest levels, wood processing infrastructure was developed in many communities across the state, supporting numerous family wage jobs. A market previously dominated by the sawmill sector expanded to include plywood manufacturing and pulp and paper mills in the 1950s and 60s. In the 1970s particleboard and medium density fiberboard facilities were added to the basket, and a log home industry began to have a significant presence.

However, in Montana and throughout the West the significant ecological impacts associated with broad-scale clearcutting – including erosion, stream degradation, and impacts to fish and wildlife habitat – also drew the attention of a nascent environmental movement. A suite of environmental policies sought to curtail unsustainable levels and methods of harvest. By the 1990s, management emphasis on federal lands had shifted from timber harvest to a broader spectrum of ecological and amenity oriented uses. Federal lands accounted for the majority of Montana's harvest volume until the 1970s, when private lands became the leading supplier to the state's wood products industry.

In spite of the decreased volume from federal lands, harvest levels reached their historical peak in 1987 in response to increased demand and a weak U.S. dollar. Unlike the 1970s, when employment spiked in response to an expanded wood products market, employment in the timber sector did not

correspondingly increase in the 1980s. Decreases in employment during this time were attributed to the availability of new technology and increased mechanization, the need for cost savings prompted by competitive markets, and a transition to manufacturing facilities which required less labor.

The gradual decline to present conditions of Montana's timber industry began during the 1990s. Though lumber prices remained high during this period, the downturn in timber supply from federal lands meant that the industry had a difficult time responding to the demand. Montana experienced its first major loss of milling infrastructure in this time, and the wood processing capacity of the state's mills decreased by 30% during this decade. Between 1990 and 2000, Montana lost 15 sawmills. Reduction in federal timber harvest resulted in reduced capacity and production across much of the West. Nevertheless, employment in the timber industry in Montana actually increased during this period in response to growth in labor-intensive sectors (e.g. log home building), availability of raw lumber from neighboring states and Canada, high prices enabling an increase in labor to recover more value and utilize low quality timber, and an effort to reduce environmental impacts through lower impact but more labor-intensive harvesting practices. In 2000, timber industry employment peaked at over 13,000 workers across the state.

In the first decade of the 21st century, a number of factors combined to turn the tide against the industry once again. Federal timber supply remained low due to litigation, threatened and endangered species concerns, the impacts of past harvesting practices, federal budget constraints, and wildfire impacts. At the same time market prices declined, electric rates spiked, and a global recession took hold in 2001. Timber harvest volume in 2005 was less than 700 million board feet, roughly half of peak harvest levels seen in the 1960s and 1980s.

An even deeper recession took hold in 2008, and with it has come further declines in the Montana forest industry. Demand for wood products dipped sharply in sync with major declines in building construction. The closure of the state's largest pulpwood user, Smurfit-Stone Container Corporation, in 2010 represented another significant blow to the industry, particularly to operators who depended upon it as a reliable outlet for small diameter logs, slash, and mill residuals. The effects of Smurfit-Stone's closure have yet to be fully felt or estimated.

National economic forecasts predict a slow increase in consumption of wood and paper products with a gradually improving economy in 2010. However, recovery of the wood products industry in the state is expected to be hampered by continued unavailability of timber, an extended housing downturn, and the loss of Smurfit-Stone. One source of optimism is the potential to develop a biomass energy industry to fill the gap left by Smurfit-Stone, and to provide new opportunities for development of cutting edge technology and infrastructure.

Conservation Challenges and Opportunities

The current condition of Montana's forest resources reflects the significant impacts of historical disturbance regimes, Native American influences prior to European settlement, 150 years of settlement and resulting intensive resource utilization, and over 100 years of wildfire suppression. Past silvicultural practices, agriculture, excessive road building, and a legacy of abandoned mining operations have contributed to impaired watersheds across the state. Pollution continues to be a concern in many areas of the state. There are 16 sites in Montana on the EPA's National Priority List under the Superfund Program, and 11 non-attainment areas under various categories of air pollutants. Meanwhile, in recent

decades Montana has experienced wildfires of uncharacteristic size and intensity, the 2000 Bitterroot fires being the most notable example. In addition, present epidemics of mountain pine beetle and western spruce budworm are approaching unprecedented levels. Invasive species, both plant and animal, have impacted the Montana landscape in equal measure.

These challenges are further complicated by impacts associated with climate change. Though potential effects are unpredictable, current trends suggest that a warmer climate will result in greater frequency of catastrophic disturbance events, changes in precipitation patterns, and shifting vegetation distribution. Forests which are currently overstocked and stressed are less likely to be resilient under dramatically different future environmental conditions.

Perhaps most significant of the challenges facing Montana is the threat of development, fragmentation, and conversion on Montana forest lands. Together, these factors make it increasingly difficult to retain important wildlife habitat, conserve key watersheds, maintain public access to recreational opportunities, and conduct comprehensive forest management to foster both ecological and economic benefits to communities. As demand for resources and amenities on private lands increase, there is potential for increased user conflict and uncertainty over how to best manage these lands.

In the face of these challenges, there are many reasons to be optimistic about the future of Montana forests. Among the most encouraging are the numerous public-private partnerships which have developed across the state to address conservation issues. The Montana Forest Legacy Program stands out as a successful collaboration between landowners, non-profit groups, state, and federal government. At present, The Nature Conservancy and the Trust for Public Land are in the process of purchasing 310,000 acres of forestland from the Plum Creek Timber Company in western Montana. This land will gradually be turned over to federal, state, and private entities, with the goal of consolidating ownership and management, thereby enabling ongoing sustainable timber harvesting, limiting development, and preserving public access to these lands for recreation.

Montana has also made significant strides in addressing soil and water quality concerns through the Streamside Management Zone law and voluntary Water Quality Best Management Practices. In the arena of forest health, the state leverages limited federal financial assistance for forest restoration, forest pest management, and hazardous fuel reduction by partnering with Resource Conservation and Development areas, non-profit groups, and local and county governments to deliver cost-share assistance to municipalities and private landowners. Meanwhile, Montana State University Extension Forestry has contributed greatly to educating Montana's non-industrial private forest landowners regarding forest ecology, forest stewardship and management practices by means of an annual series of forest stewardship planning workshops and seminars.

The forest industry, for its part, has devoted significant energy to training its woods workers in modern stewardship practices through the Accredited Logging Professionals program delivered by the Montana Loggers Association. This commitment to land stewardship has resulted in great progress in addressing environment concerns relating to forest stand management. Montana is fortunate to have retained much of its wood harvesting and utilization infrastructure and thus provides the capacity necessary to conduct stewardship and restoration activities on forest lands.

Numerous advocacy groups also play a role in conserving working forests across Montana. These include the Montana Tree Farm System, which facilitates management plans and free sustainable forest

certification for landowners; the Montana Forest Owners Association, which represents policy interests of NIPF owners; and the Montana Wood Products Association, which represents the wood products industry and forestland owners in the public arena and helps to maintain viable infrastructure throughout the state.

Together, these opportunities give us reason to be cautiously optimistic about the future of Montana forestland and forest landowners. The State and Private Forestry Redesign Program and State Assessment of Forest Resources represent important tools in maintaining and enhancing the forest resource and ensuring its productivity and resilience for future generations.

Data Layer & Model Development –

Montana's State Assessment of Forest Resources (SAFR) is a computer model fundamentally built on the national guidance provided through USDA Forest Service State & Private Forestry and National Association of State Foresters. The model is broken down into 11 different sub-models based on the proposed 11 national objectives.

This section of the document details the data identification, acquisition, classification and weighting phases of the assessment model. Seventy-eight data layers were integrated into 11 sub-models and are described in the following section. Each individual objective was sub-modeled in order to create inherent flexibility within the model. The sub-models grew to 14 at one point but the additions were found to be duplicative of existing sub-models and thus were integrated into the original 11. The SAWG provided the primary ranking and scoring of the sub-models based on relative importance to their particular ownership type or ownership interest.

A **modified Delphi method** was used to capture SAWG input. The Delphi (pronounced dell-fy) method is a systematic, interactive forecasting method which relies on a panel of independent experts. The carefully selected experts answer questionnaires in two or more rounds. After each round, a facilitator provides an anonymous summary of the experts' forecasts from the previous round as well as the reasons they provided for their judgments. Thus, experts are encouraged to revise their earlier answers in light of the replies of other members of their panel. It is believed that during this process the range of the answers will decrease and the group will converge towards the "correct" answer. Finally, the process is stopped after a pre-defined stop criterion (e.g. number of rounds, achievement of consensus, stability of results) and the mean or median scores of the final rounds determine the results. Delphi is based on the principle that forecasts from a structured group of experts are more accurate than those from unstructured groups or individuals. Delphi has been widely used for business forecasting and has certain advantages over another structured forecasting approach, prediction markets.

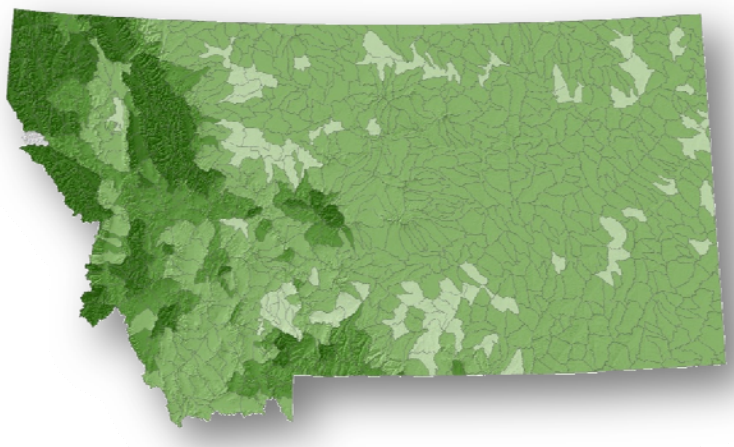
The initial survey polled the working group prior to any GIS modeling. We asked each participant to assign a 100 points to the 11 National SAWG objectives. The average scores from this weighting exercise were used initially to weight the GIS models. Participants allocated points freely and could spread them out more or less equally, or they assigned more points to some objectives and no points to others.

In keeping with the Delphi method, we replicated the weighting again later in the project timeline after the GIS analysis was completed. The data from both rounds of sub-model weighting were compared, averaged and integrated in to the model. Our hope is that this will give a more accurate survey snapshot from the SAWG, and will allow us to measure the effectiveness of the GIS analysis.

NATIONAL THEME: CONSERVE WORKING FOREST LANDS

Objective 1 – Identify and conserve high priority forest ecosystems and landscapes

In many parts of the United States, forests and other open space are being fragmented and converted to development. Forestry agencies can work with partners, stakeholders and communities to identify and protect priority forest landscapes through land acquisition, conservation easements, and land use policies. Forestry agencies can also provide technical assistance to communities to help them strategically plan for and conserve forests and other open space.



Montana's SAFR identifies important landscapes to protect and connect ecologically important forests, and open space, thus maintaining a green infrastructure, particularly around and within areas of, population growth and development.

Montana's SAFR process split the objective into two components for the purpose of weighted modeling, differentiating between urban and rural forest environments. Residential growth rates were utilized to measure both. Higher growth rates were judged as positive for urban forest environments, and negative for forest ecosystems in rural environments. Both of the components were used in weighted sum GIS model .

The "Urban" component included data representing:

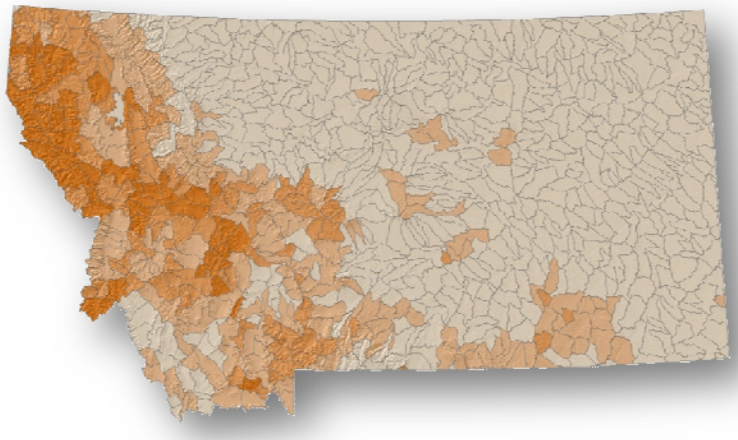
1) Urban forest program presence.
2) Urban Forest Canopy Cover.
3) Cadastral centroid residential structures.
4) Montana Cities and Towns – Residential annual growth rate 2009-2014.

The "rural" component included data representing:

1) Community forests
2) SAP forest patches
3) SAP operability
4) Public lands/conservation easements

5) Forest Producitivity
6) Residential annual growth rate 2009-2014.
7) Cadastral centroid residential structures.

Objective 2 - Actively and sustainably manage forests.



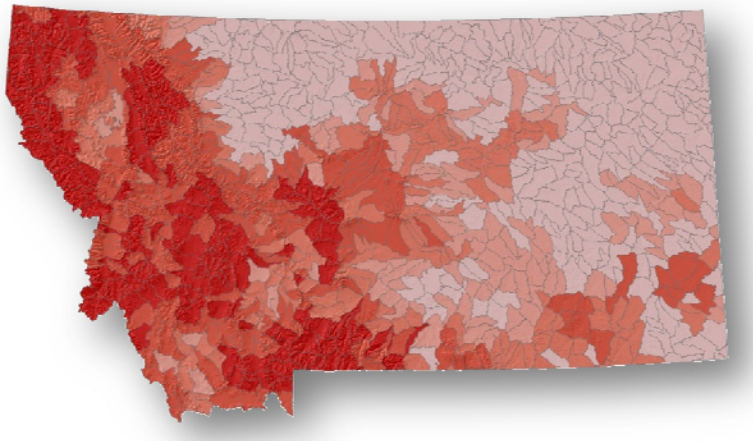
Forestry agencies and partners provide landowner assistance and incentives to sustain working forests. Providing forestry assistance to landowners can improve the economics of sustainable forest management and encourage its application. In urban and suburban areas, forest agencies can assist communities to develop sustainable forest management and green infrastructure programs.

Montana's SAFR identifies viable and high potential working forest landscapes where landowner assistance programs, such as Forest Stewardship can be targeted to yield the most benefit in terms of economic opportunities and ecosystem services. Assessment and strategies also identify opportunities for multi-landowner, landscape scale planning and landowner aggregation for access to emerging ecosystem service markets.

NATIONAL THEME: PROTECT FORESTS FROM HARM

Objective 3 – Restore fire-adapted lands and reduce risk of wildfire impacts

The strategic management of wildfires is crucial to the health of our nation's forests, the safety of our citizens and the contributions of forests to our economy. Montana's SAFR identifies areas where management can significantly reduce the risk of catastrophic wildfire while enhancing multiple associated forest values and services.

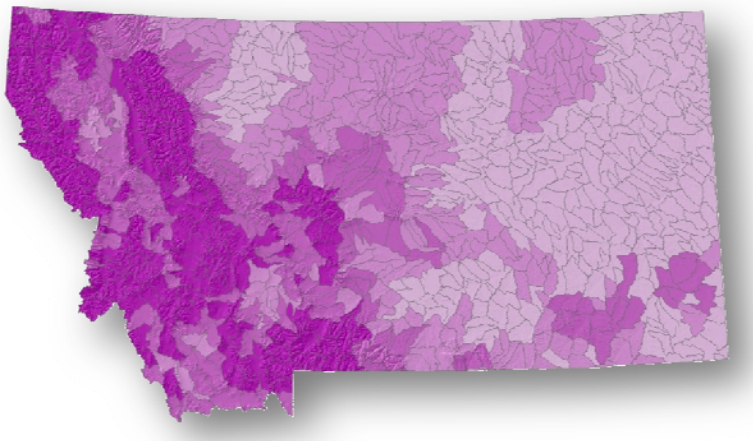


Many forest ecosystems are dependent on fire for their health and sustainability. Decades of fire suppression and a changing climate have disrupted natural fire regimes, resulting in fuel buildup, loss of biological diversity, changed species composition, and loss of some fire-dependent species. The SAFR identifies areas where these effects of fire exclusion can feasibly be mitigated or

countered through sound management, particularly where there are opportunities for federal, state and community partnerships.

Objective 4 – Identify, manage and reduce threats to forest and ecosystem health

A healthy forest landscape has the capacity for renewal and for recovery from a wide range of disturbances, while continuing to provide public benefits and ecosystem services. Threats to forest health include insects, disease, invasive plant and animal species, air pollution, and climate change.

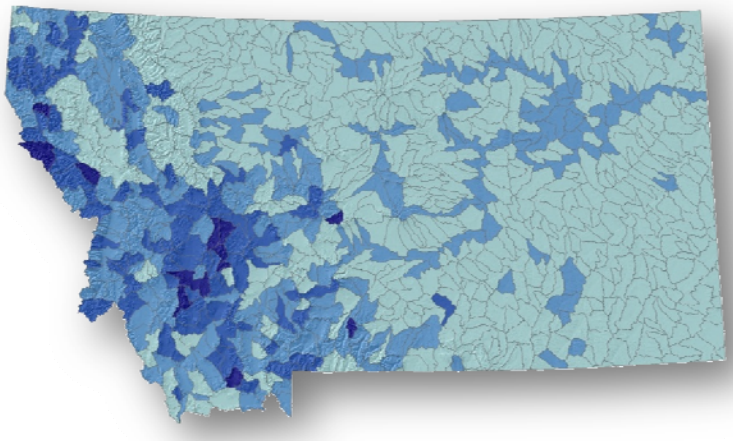


Montana's SAFR identifies high value forest landscape areas that are especially vulnerable to existing or potential, forest health risk factors, where forest management practices are most likely to prevent and mitigate impacts. The SAFR identifies areas where management could successfully restore impacted forests.

NATIONAL THEME: ENHANCE PUBLIC BENEFITS FROM TREES AND FORESTS

Objective 5 – Protect and enhance water quality and quantity

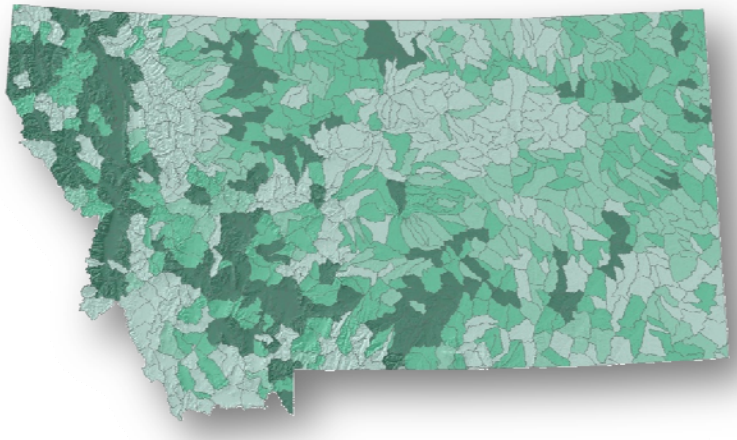
Forests and forestry practices can help protect, restore, and sustain water quality, water flows, and watershed health. Healthy urban and rural forested watersheds absorb rainfall and snow melt, slow storm runoff, recharge aquifers, sustain stream flows, and filter pollutants.



Montana's SAFR identifies watersheds where continued forest conservation and management is important to the future supply of clean municipal drinking water, or where restoration or protection activities will improve or restore a critical water source.

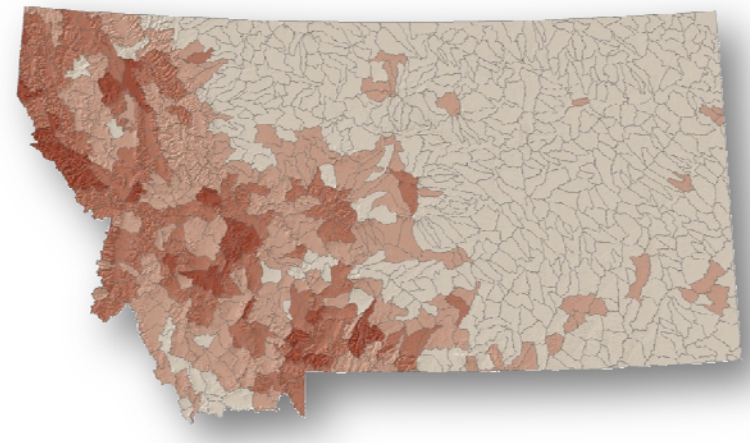
Objective 6 – Improve air quality and conserve energy

Urban and exurban forest cover, including agroforests can improve air quality, reduce energy consumption and produce biomass for energy production. Montana's SAFR identifies areas where management or restoration of the urban or exurban forest canopy will have significantly positive and measurable impact on air quality and produce substantial energy savings.



Objective 7 – Assist communities in planning for and reducing wildfire risks.

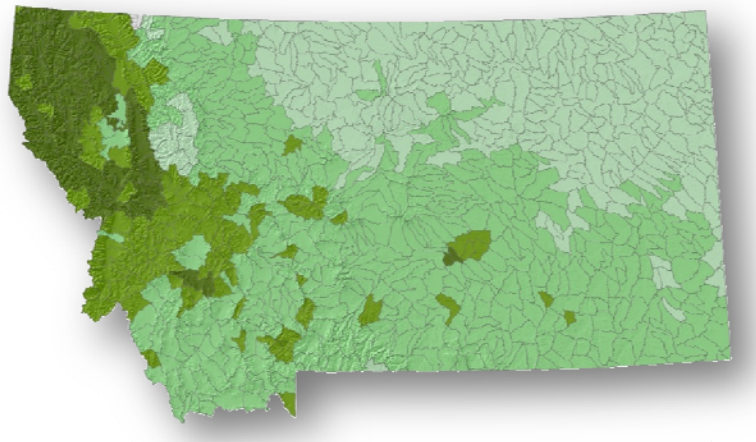
Forestry programs assist communities in identifying wildfire risks, developing Community Wildfire Protection Plans (CWPPs), and promoting FIREWISE and other risk reducing policies and actions. Some communities are especially prone to loss of life and property from wildfire. Local or state laws, regulations and ordinances, landowner attitudes and priorities, and public policies all play important roles in managing fire risk near communities. Montana's SAFR identifies communities where State and Private programs can substantially mitigate the risk of catastrophic wildfire occurrence and associated risks to human safety and property.



The SAFR incorporates existing CWPPs and identify communities in especially vulnerable areas that need a CWPP.

Objective 8 – Maintain and enhance the economic benefits and values of trees and forests

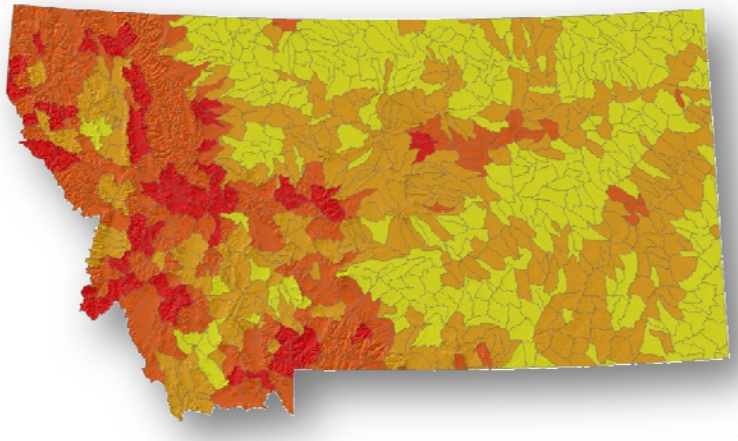
Montana's SAFR identifies forest landscape areas where there is a real, near term potential to access and supply traditional, non-timber, and/or emerging markets such as those for biomass or ecosystem services. These might be areas where necessary infrastructure currently exists, is planned or developing, where group certification of landowners has created market supply aggregation potential, or where retention and management of forest cover presents a money saving alternative to an engineered fix – such as a water filtration facility. Strengthening and developing new market opportunities for forest products and benefits provide incentives for forest stewardship and conservation.



Objective 9 – Protect, conserve, and enhance wildlife and fish habitat

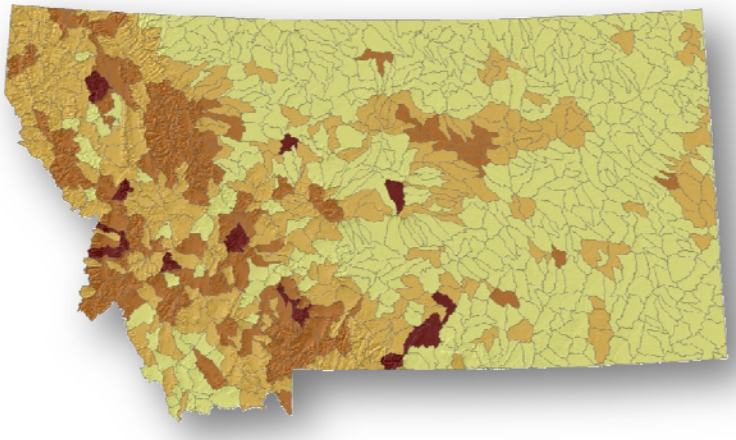
Protection, conservation, and restoration of forested wildlife habitat are critical to maintaining and enhancing the rich biodiversity of our nation. Major threats to fish and wildlife habitat include the patchwork of public-private ownership, threats associated with urbanization, and uncharacteristic wildfire.

Montana's SAFR identifies forest landscapes that represent or contribute to viable wildlife habitats (contiguous or connected), contain high species richness, endemism, and/or that represent core habitat for focal conservation species (i.e. species of concern, threatened and endangered species or keystone species that are representative of a healthy ecosystem). Montana's SAFR incorporates the Aquatic and Terrestrial data composites from the Montana Fish, Wildlife & Parks Crucial Areas Model.



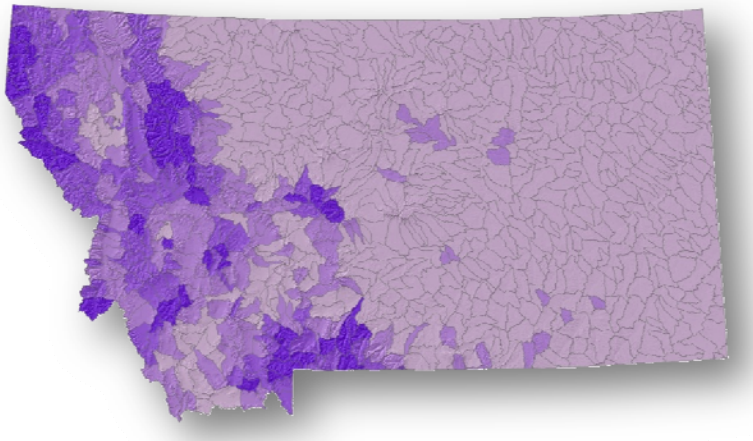
Objective 10 – Connect people to trees and forests, and engage them in environmental stewardship activities

Our nation's federal, state, urban and private forests are the natural backyards for many communities and serve as society's connection to nature. Assessments and resource strategies can attempt to conserve and enhance a green infrastructure that effectively connects people with their natural environment. Resource strategies can include programs that provide opportunities for children, teens and adults to recreate while gaining an appreciation for the importance of forests and open space with respect to the health, security and well-being of society.



Objective 11 – Manage and restore trees and forests to mitigate and adapt to global climate change

America's forests offset a significant portion of the nation's annual carbon emissions. Additional climate change mitigation benefits could be achieved through partnerships and management measures. These measures include supporting the development of markets for carbon offsets, utilizing woody biomass for energy, wood product substitution, and promoting tree growth in urban areas. Assessments should identify opportunities for promoting carbon emissions offsets through forestry. The important benefits that forests provide, such as biodiversity, wildlife habitat, and water storage and flows are affected by climate change. Forest range, type and composition are projected to change significantly– with corresponding changes in wildlife habitat, biodiversity, water flows, and fire regimes.

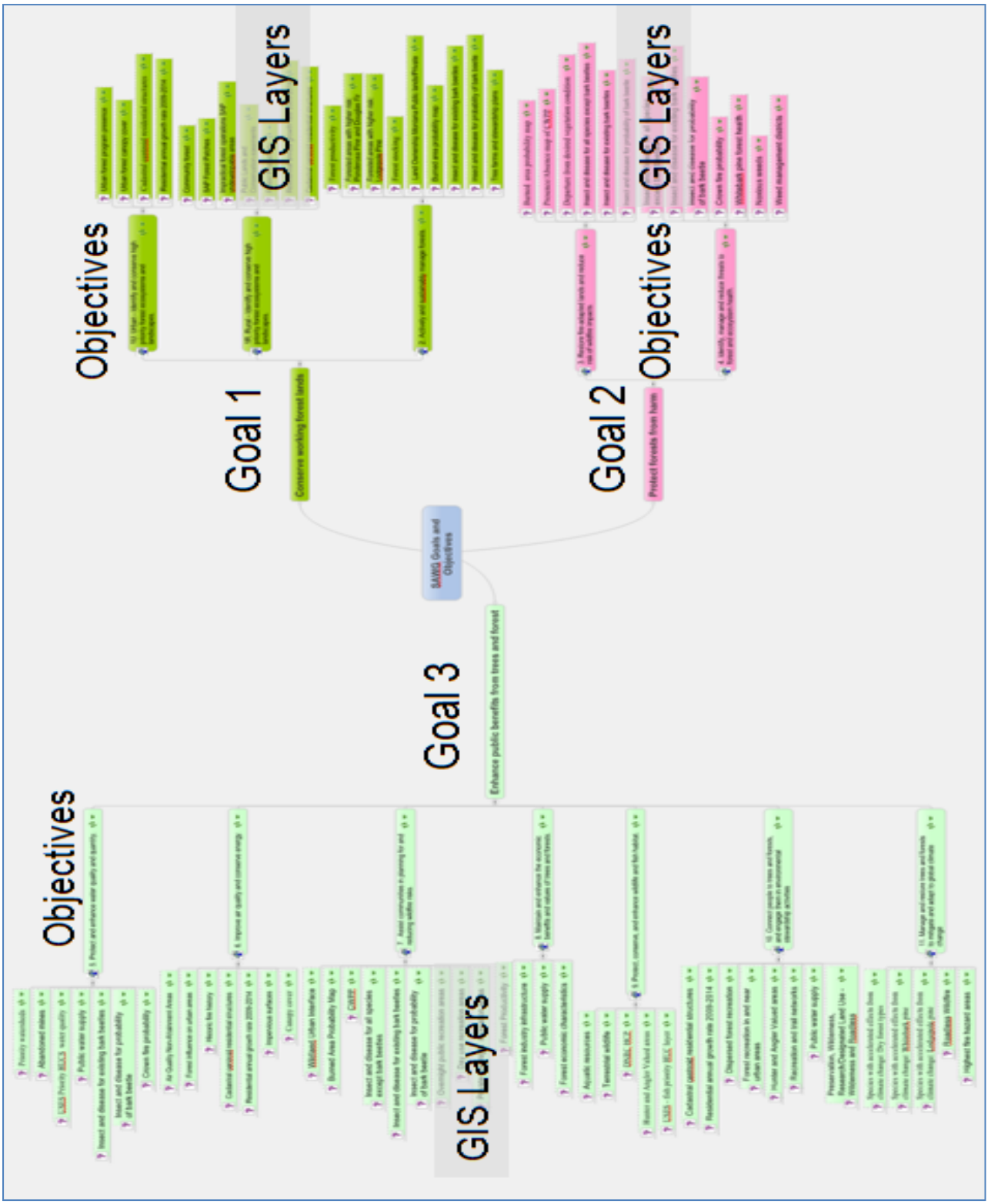


WEIGHTING METHOD

Figure 1 shows a graphic schematic of the goals, objectives and the source GIS data layers for each objective. The internal weighting structure of the state assessment model is crafted on the premise that model results may be weighted and displayed by independent objectives the outermost tier in Figure 1 labeled GIS Layers), goal-based data sets (the 3 labeled goals in Figure @) or as an aggregate (represented in the center of Figure @ as a blue box). Accordingly, the data weighting was accomplished at each of the subsequent levels, but with different types of weightings.

The aggregate and goal level weightings recommended by the SAWG group were value driven based on relative importance of the objectives for each members ownership type, ownership interest, and professional experience. In order to keep the final results objective, and minimize subjective values, these were stand alone exercises, and the mapped results and modeling used unweighted averages at these two levels.

Figure 1



A snapshot weighting survey for the 11 objectives was administered to the SAWG early in the planning process, prior to any GIS modeling. This was repeated at the end of the planning process (results shown in figure 2).

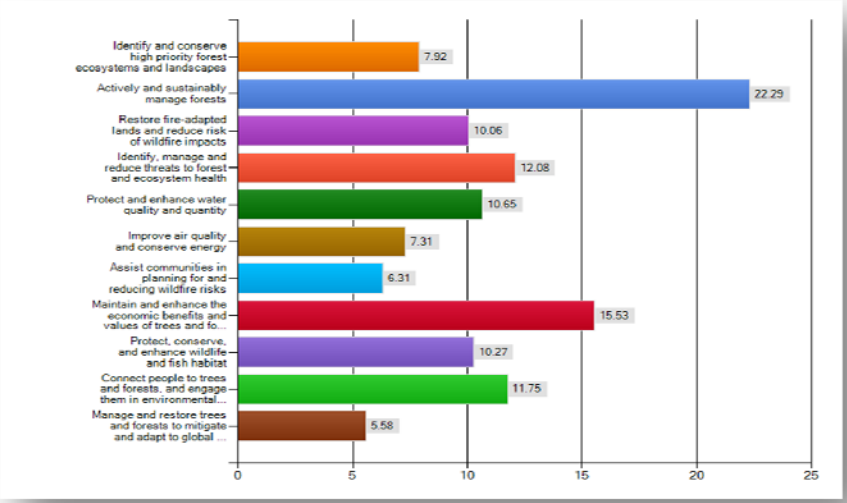
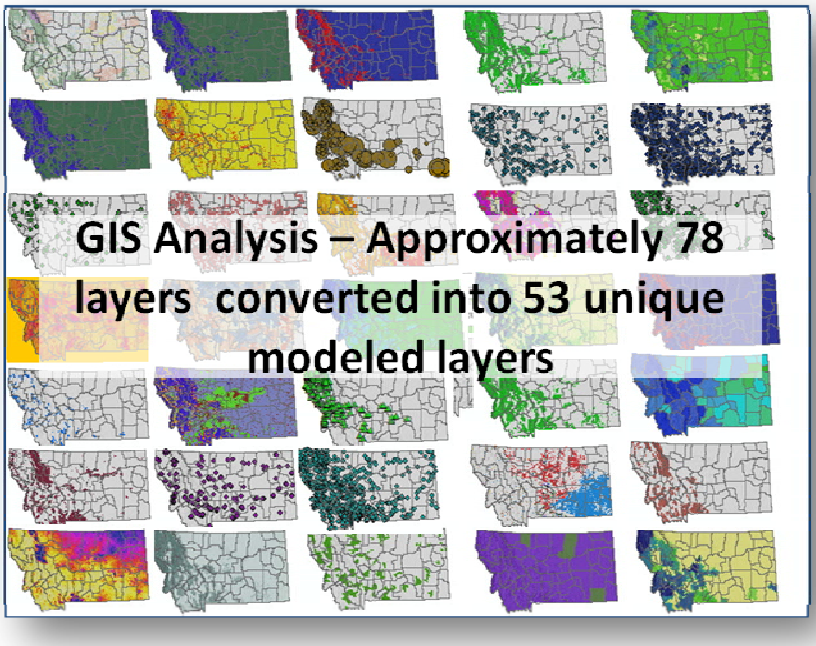


Figure 2

Each "weighting exercise" participant was allocated 100 points to distribute to the pre-identified data sets. The point allocation was averaged and used to determine a percentage basis for modeling data sets. This method is characterized as capturing the SAWG "popular vote" at this juncture in the process. Our hope was that this would give a more accurate survey snapshot from the SAWG, and will allow us to measure the effectiveness of the GIS analysis. The intent is for future surveys of the SAWG to capture changing trends or to keep apprised of changing priorities. The initial survey polled the working group prior to any GIS modeling. In keeping with the Delphi method, we replicated the weighting again later in the project timeline after the GIS analysis was completed and collaborative meetings were held. The data from both rounds of sub-model weighting were compared.

At the objective level of the model a more objective data driven weighting was applied, GIS layers making up each objective were weighted according to their relative importance, geographic scale and quality of the source data. Between 3 and 9 GIS analysis layers formed the basis for each objective. A working group within the SAWG met in a series of WebEx enabled conference calls and reviewed data and weighted data layers to form the basis for calculating a weighted average for each of the 11 objectives.



In both instances, (1) the aggregate snapshot of the SAWG or "popular vote", and (2) the weighting of GIS layers making up each objective, we asked each participant to assign 100 points among each component. A weighted average score from this weighting exercise was then calculated. Participants were allowed to allocate points freely and could spread them out more or less equally, or they assigned more points to some components and no points to others, as long as they summed to 100.

In the instance (2) the weighting of GIS layers making up each objective, some level of subjectivity was involved, weighting the importance of one GIS layer against others. In most GIS analysis, this is done by a GIS analyst within the GIS modeling environment. In this instance, we implemented a graphical user interface and off the shelf GIS software to allow flexibility and on-the-fly weighting of the GIS layers by managers. This process, using CommunityViz suitability modeling tools is described below.

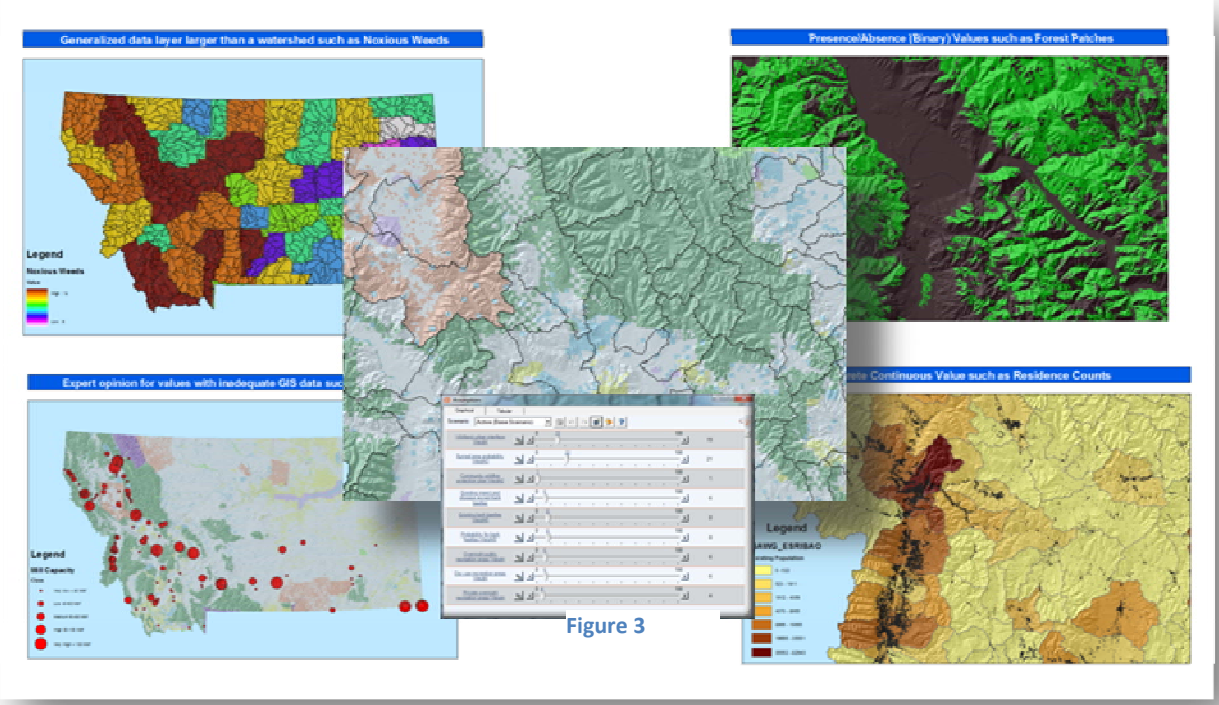


Figure 3

The geographic scale and quality of the source data were handled by GIS analysts, with advice from the SAWG working group prior to building the model. Not all GIS data layers were developed at the same geographic scale, nor were they of the same quality of development. Figure 3 illustrates some of these differences. Some data was developed at the county level (upper left example for noxious weeds), others were small detailed areas (upper right example of forest cover derived from aerial and satellite imagery). Some were modeled from detailed data (lower right example of socio demographic data from a commercial database built on marketing and census data), and others from expert opinion (lower left example of mill capacity from DNRC service foresters). In order to compare and aggregate data while minimizing bias, we chose to limit the upper end of the weighting range of some layers, such as the generalized county GIS data in order to make it comparable. It may be an important layer from a values perspective, but mapping inequalities require it be reduced in importance simply because of its resolution and quality. The potential mathematical bias of using multiple layers was handled by normalizing all GIS analysis to actual counts or percent of watershed. This also neutralized slight differences in the size and shape of the watersheds.

Modeling Environment

We developed a final model that dynamically weighted the 5th-code watershed polygons for the entire state of Montana, utilizing the suitability model and analysis wizard of CommunityViz, an extension to ArcView developed and maintained by Placeways, LLC. The weighted model may be applied by DNRC decision-makers using different combinations of objectives and/or themes for a given funding process using slide bar enabled assumptions. The data may be weighted with different scored values for different objectives on a dynamic basis, and modified to suit the decision process or grant criteria evaluation for management and policy decisions.

Watersheds at the 5th level hydrologic unit codes (HUCS) were selected as the unit of analysis. Several considerations went into this selection. Watersheds are a unit that has ecological meaning defined by topographic characteristics as a watershed. They are a natural boundary irrespective of ownership or legal jurisdiction. For some rural socioeconomic considerations they serve as the best example of a rural neighborhood than any other established and authenticated GIS layer available. They were developed and are maintained by the US Soil Conservation Service and U.S. Geological Survey, and were developed with standards and standardized procedures by resource experts, and also cleaned in a topological sense by GIS experts. They were also the unit of analysis for several important GIS layers developed by the US Forest Service that we used in many of the objectives, such as crown fire potential and departure from desired conditions.

Watersheds were the best established GIS layer that fit the type of questions and level of decision making required by the managers using the decision support tool. There was desire to use some level of localized data aggregation, but not at such a high degree of granularity to mislead analysis and give a false sense of accuracy. For example impervious surface or urban forest cover is often derived at a 30 meter cell size resolution from unsupervised classification of Landsat satellite imagery. A decision about the accuracy of an individual pixel made up of concrete, asphalt, and grass with an overstory of hardwood tree canopy is more accurate when aggregated to a larger watershed metric than at the raw data level.

We also needed polygon units of analysis that were not made up of thousands of features. There are approximately 1,000 5th code watersheds in Montana. This was a small enough data set to maintain adequate performance in the dynamic weighting calculations in CommunityViz and fit the appropriate decision timeframe and framework of a manager operating the tool in a dynamic setting. It takes less than a minute to make a modification in the weightings for one objective, up to about 5 minutes to update the entire model including aggregation to the goal and overall aggregate level of analysis.

Maintenance and operating costs were also part of the development logic. Figure 4 was extracted from the process notes for the insect and disease threat objective. The middle column describes the GIS analysis, which will be reviewed and updated annually or as needed. The weighting of GIS layers into the aggregate score for the objective is done in the system using slider bar variable assignments.

To calibrate the GIS layer weightings, we gathered input from resource experts and DNRC staff on sub model weighting. The process included collaborative in-person and web-based weighting sessions and also incorporated a dedicated wiki, using SocialText Enterprise Wiki; WebEx GIS enabled conference calls; ArcGIS online; ArcGIS Explorer; ArcGIS Server; and online surveys implemented in SurveyMonkey.

It was necessary to adjust categories so all individual layers have the equivalent number of classes and score ranges per class. This is a time consuming and costly step, requiring much more extensive GIS processing prior to compiling the scored model. In a dynamic decision support process, this also translates into a much longer lag period between adjusting the weights and seeing the results. To increase dynamic performance and ease of use, we implemented the decision support system using the CommunityViz add on to ESRI ArcGIS for the final weighting and sub model normalization. CommunityViz accomplishes the normalization by dividing each watershed value by the largest value present in that sub model column among all watersheds. This normalizes the score for each watershed and converts it to a value between 0 and 100 (or 0-1 in decimals), avoiding the need to process each layer component with the same number of categories or scoring ranges.

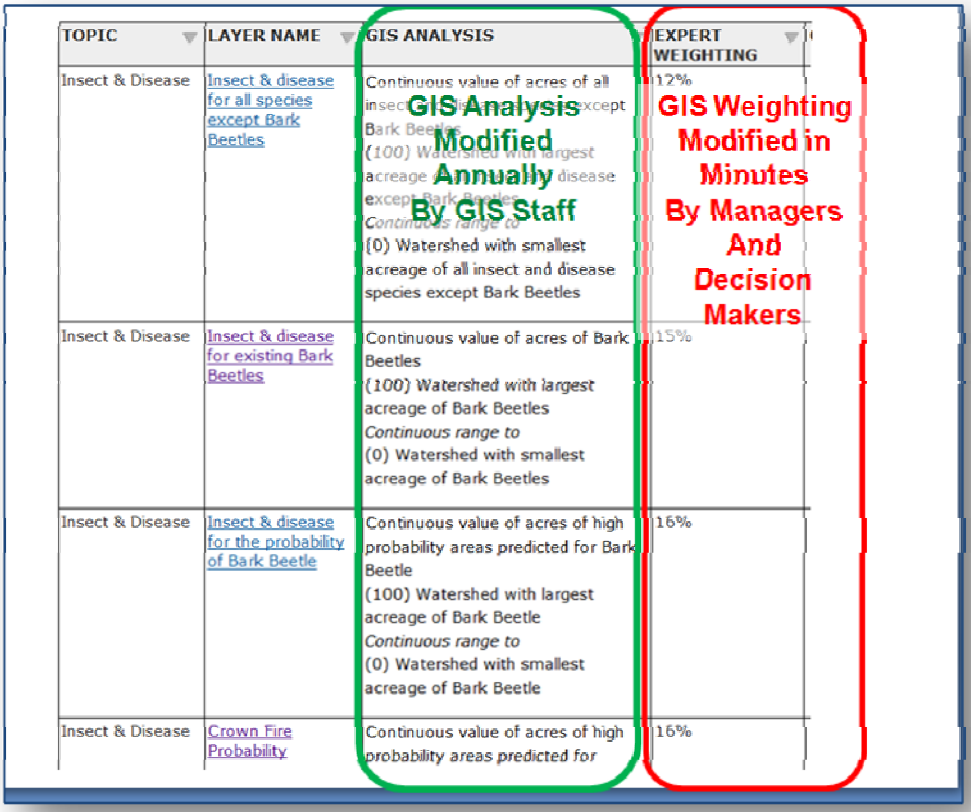


Figure 4

The decision support system allowed dynamic weighting of the 11 national objectives integrated with GIS. The system allows the State Forester or other decision-makers to modify the weighting of the 11 national objectives to customize the decision for a given funding criteria. We intend to implement the decision support model in a manager's dashboard tool using ArcView and CommunityViz. It will run on a standalone desktop or portable computer without the need to have an Internet connection to operate the model. Running the model requires adjusting slider bars to adjust the weighting for any layers desired for a given decision support instance, and viewing the maps and charts that result from the weighted model.

Priority Landscapes in Montana

The Assessment model allows for displaying results from several perspectives and resolutions. The model provides the ability to define critical landscapes and drill into data in a way that exposes threats and opportunities on the landscape. These watersheds can be standalone displayed as defined by the 11 objectives/sub-models, or can be aggregated to the three national themes, or can be viewed as a whole cumulative average. The results display priority landscapes in the state based on pre-selected resource or social values(i.e. sub-models).

Through the use of scenario building in CommunityViz, we can perform raw comparisons of critical watersheds with Assessment results from neighboring states to identify areas of commonality. These may be areas of interest for future watershed planning or integrated program outreach.

Conserve Working Forest Lands

Working forests may be defined as forests managed in such a way as to provide economic, environmental and social services in a sustainable fashion. Forestry agencies and partnering organizations can provide technical assistance and financial incentives to help keep working forests working – providing public benefit from our forests, while achieving supplies of wood products and jobs for rural communities.

A related challenge in Montana comes from forest fragmentation or conversion by development. Impacts of fragmentation include wildlife habitat degradation, public access issues, and increased challenges of providing public services and fire protection for ex-urban developments. Fragmentation also includes "parcelization," or the fracturing of large singular ownerships into numerous smaller ones. These trends have significant implications for Montana's social and environmental future.

Forestry agencies and partners can provide landowner assistance and incentives to help keep working forests working. Through the use of tools like land acquisition, conservation easements, and assisting in the development of land use policies, DNRC will improve the economics of, and encourage sustainable forest management.

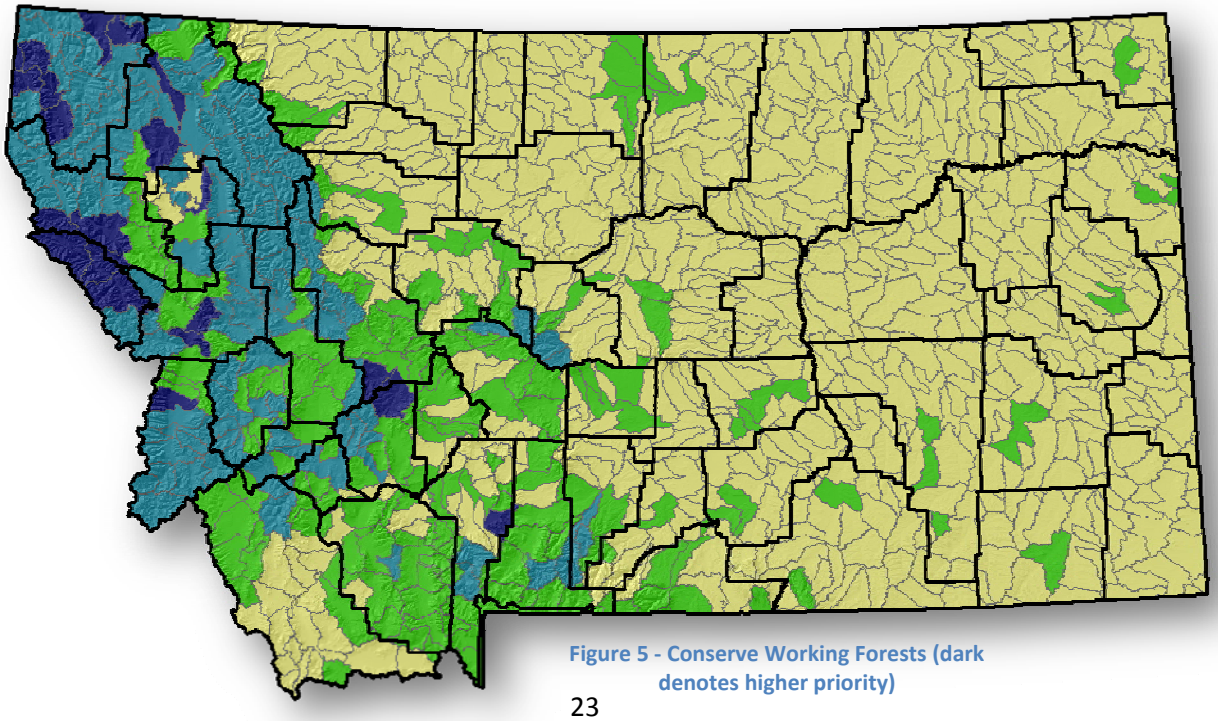


Figure 5 - Conserve Working Forests (dark denotes higher priority)

Protect Forests From Harm

A healthy forest landscape has the capacity for renewal and for recovery from a wide range of disturbances, while continuing to provide public benefits and ecosystem services. Threats to forest health include insects, disease, invasive plant and animal species, air pollution, and climate change. While wildfire may be viewed as a threat, it is really uncharacteristic wildfire that truly changes ecosystem dynamics at a landscape level. Wildfires replicating historic fire regimes are crucial to the health of Montana's forests, the safety of Montanans and the contributions of forests to Montana's economy. Many forest ecosystems are dependent on fire for their health and sustainability. Decades of fire suppression and a changing climate have disrupted natural fire regimes. This directly results in enhanced fuel buildup, loss of biological diversity, changed species composition, and loss of some fire-dependent species.

The Assessment model identifies high value forest landscape areas that are especially vulnerable to existing or potential, forest health threats. These are areas where stewardship of our forests may prevent or mitigate impacts - areas where management could restore impacted forests. The model prioritizes areas where there are opportunities for cross boundary partnerships in planning and managing forests while enhancing associated forest values and ecosystem services.

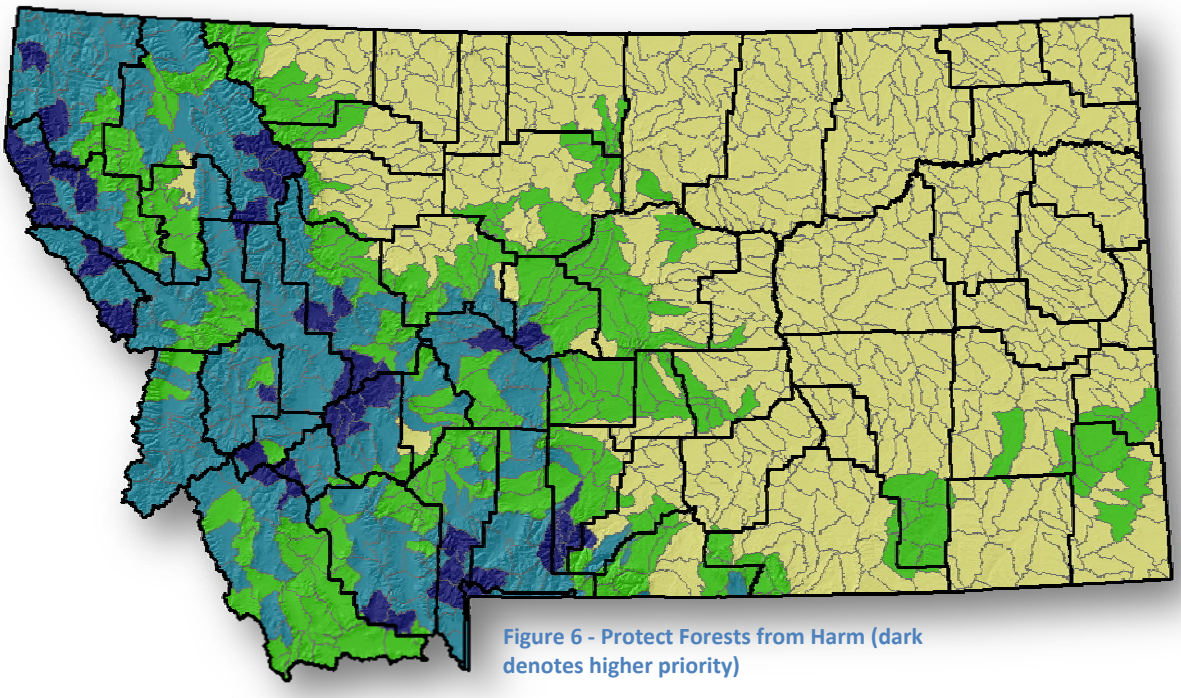


Figure 6 - Protect Forests from Harm (dark denotes higher priority)

Enhance Public Benefits from Trees and Forests

Healthy trees and forest ecosystems are ecological life-support systems providing a range of goods and services that are vital to human health and livelihood. These public benefits can be called ecosystem services**.** These goods and services are traditionally viewed as free benefits to society; things like wildlife habitat, water quality and quantity and carbon storage. When they lack a formal market, these natural assets are traditionally absent from society's balance sheet. Their critical functions are often overlooked in public, corporate, and individual decision-making.

When our forests are undervalued they are increasingly susceptible to development pressures and conversion. The Assessment model prioritizes watersheds where S&PF programming, cooperative

partnerships and planning can maximize economic and social values from our forest ecosystems, thus promoting conservation and more responsible decision-making.

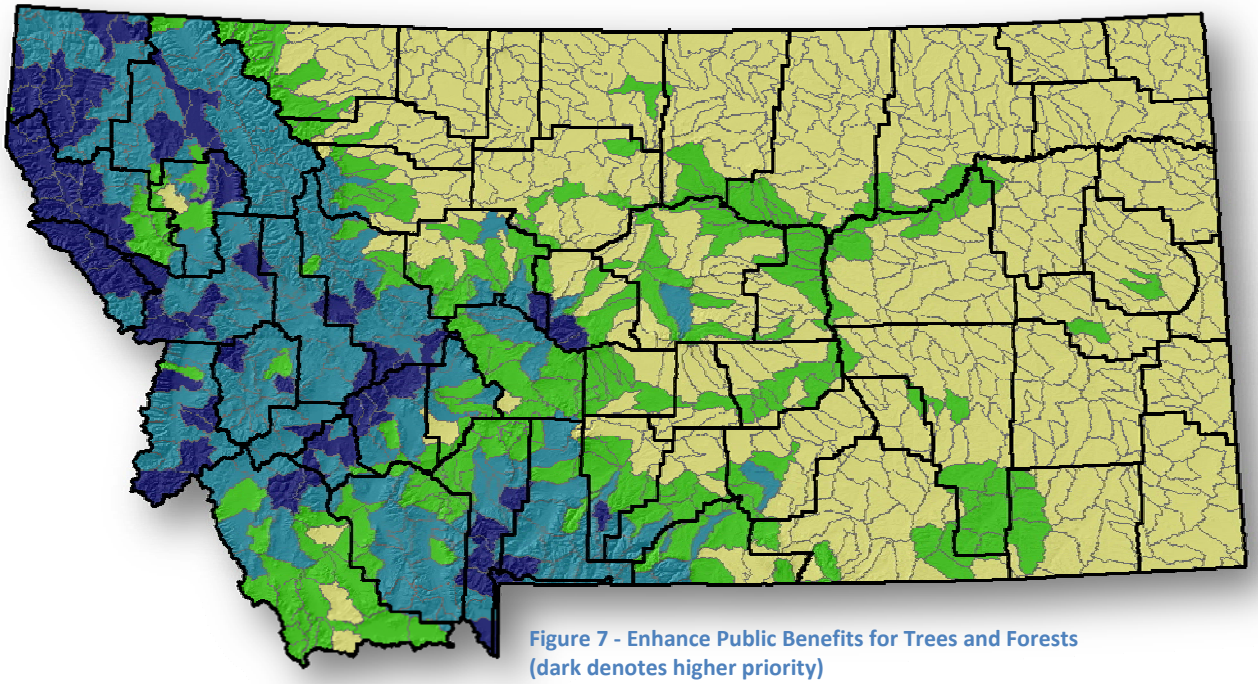
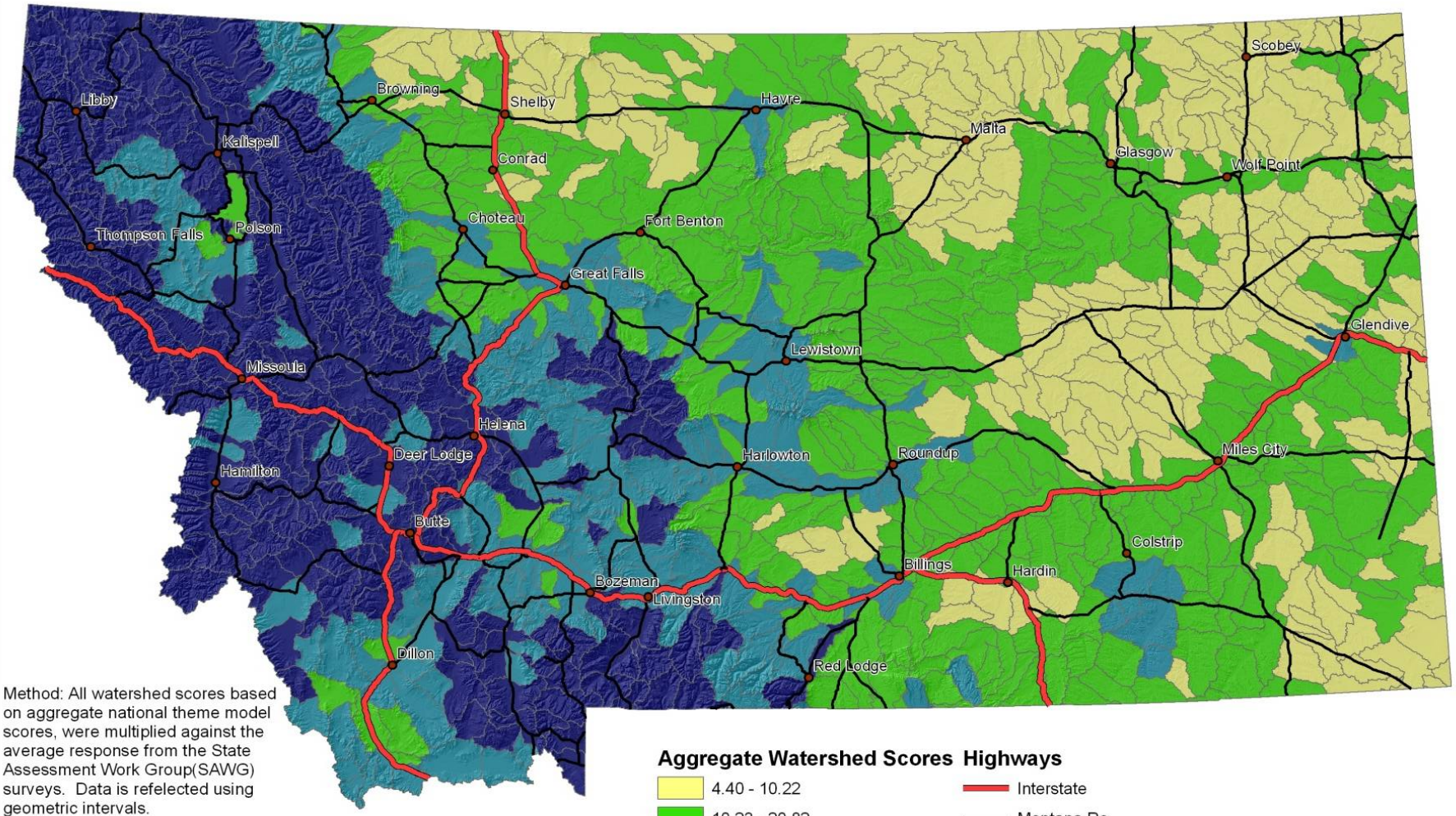


Figure 7 - Enhance Public Benefits for Trees and Forests (dark denotes higher priority)

Final Aggregate Map of Montana Priority Areas

Montana DNRC modeled 78 separate data sets, weighted them according to the 11 sub-models, averaged by three national themes to create one, final aggregate "Critical Landscapes" map. While this map may never be used solely to direct program outreach, it does represent the model's ability to classify and display watershed values at an aggregate level.

Aggregate Watersheds based on 2010 SAWG Survey



APPENDICES

The two primary appendices supporting the methodology can be downloaded at:
http://www.socialtext.net/data/workspaces/dnrc_sawg/attachments/statewide_assessment_methodology_and_response_strategy:20100617192553-0-18520/original/State_Assessment_Model_appendices.pdf

Appendix A – Weighting Methodology

Appendix B – Metadata