Aquatic, Riparian, and Wetland Ecosystem And Current Landscape Condition Assessments

San Juan and the Grand Mesa-Uncompahgre-Gunnsion National Forests, Colorado

USDA Forest Service - Rocky Mountain Region

EXECUTIVE SUMMARY

This ecological assessment is the product of a cooperative effort by the USDA Forest Service and scientists from Colorado State University and the University of Wyoming. A synthesis of the best available information about aquatic, riparian, wetland , and terrestrial ecosystems associated with the San Juan and Grand Mesa-Uncompahgre-Gunnison National Forests (SJ and GMUG NFs), and the anthropogenic influences from Euro-American settlers and more recent human activities on these resources is documented.

The assessment responds to direction from the Regional Leadership Team of the USDA Forest Service Rocky Mountain Region (Region 2) to improve the quality and consistency of forest and project planning, and overall resource management. The Leadership Team recognized that this was a difficult task given the numerous laws and directives the USFS follows and the complexity of resource management related to species viability and ecosystem integrity. As a result, the Region 2 Species Conservation Team, consisting of ecologists, botanists, and biologists, were charged with developing and implementing a process to address species conservation and ecological sustainability. This ecosystem assessment is the component of the Species Conservation Project that focuses on the ecological characteristics, influences, and condition of aquatic, riparian, wetland, and terrestrial resources on the SJ and GMUG NFs.

The development of a classification scheme, which provides an understanding of the sensitivity, abundance, and unique characteristics of aquatic, riparian, and wetland ecosystems within the SJ and GMUG NFs, the surrounding landscape, and across Region 2, is defined in this assessment. The assessment includes an analysis, which classifies small watersheds into distinct groups that differ in aquatic, riparian, and wetland resource productivity, abundance, and response to disturbance. This “ecological driver” concept provides a sound stratification of aquatic, riparian, and wetland resources on the SJ and GMUG NFs landscape as well as potentially across Region 2. A total of 24 historic and current anthropogenic influences were also analyzed in a rigorous and regionally consistent manner. Such analysis promotes consistent and efficient comparisons of influences between watersheds within a forest, among several forests, and among multiple land ownerships. A synthesis of ecological drivers and anthropogenic influences was also conducted to assess the sensitivity, importance, and management risks associated with aquatic, riparian, and wetland resources. These analyses will be valuable to help identify priority areas for restoration and monitoring, as well as development of reference conditions, program development, and refinement of management direction.

At the request of the Species Conservation Steering Committee and SJ and GMUG NFs staff, key management implications for these sensitive aquatic resources are discussed. However, specific decisions concerning management of any lands within the SJ and GMUG NFs or future management needs are not presented. Instead, the document and its conclusions should stimulate interdisciplinary discussion, enhance future analysis and monitoring efforts, and clarify resource management, and restoration opportunities.

The Current Landscape Condition assessment (CLC) describes the current status, probable trajectories and integrity or sustainability concerns of ecological areas or systems of interest within the context of the historic range of variation. The CLC addresses: 1) ecological and social-economic context (climate, physiography, vegetation, demographic trends, land ownership patterns, resource use, etc.); 2) current vegetation condition (existing composition, structure, function, spatial distribution); 3) influences on landscape condition (wildfire, insects, disease, forest management activities, invasive plant species, roads and trails, recreation and exurban development, mineral exploration and development); 4) landscape patterns; and 5) areas of special biodiversity significance.

The data used for this assessment will not only be distributed to the SJ and GMUG NFs, but also incorporated into a regional and national database for future comparisons among administrative units. Therefore this assessment provides a solid foundation of data related to aquatic, riparian, wetland and terrestrial resources for all SJ and GMUG NFs employees to use that will improve consistency in data collection and management focus in the future. The SJ and GMUG NFs Aquatic, Riparian and Wetland Assessment includes 4 chapters, including this introduction, as does the Current Landscape Condition Assessment.

Finally, the assessment results will support more effective, efficient, and consistent watershed assessments and cumulative effects analysis on the SJ and GMUG NFs and throughout Region 2. We believe that this assessment provides a common scientific foundation that the SJ and GMUG NFs and other agencies such as the Colorado Division of Wildlife can rely on for future management and planning activities. Through this effort, Region 2 and university scientists have developed a valuable partnership that will continue to pursue meaningful ecosystem studies to address key management issues throughout Region.

CHAPTER 1. INTRODUCTION

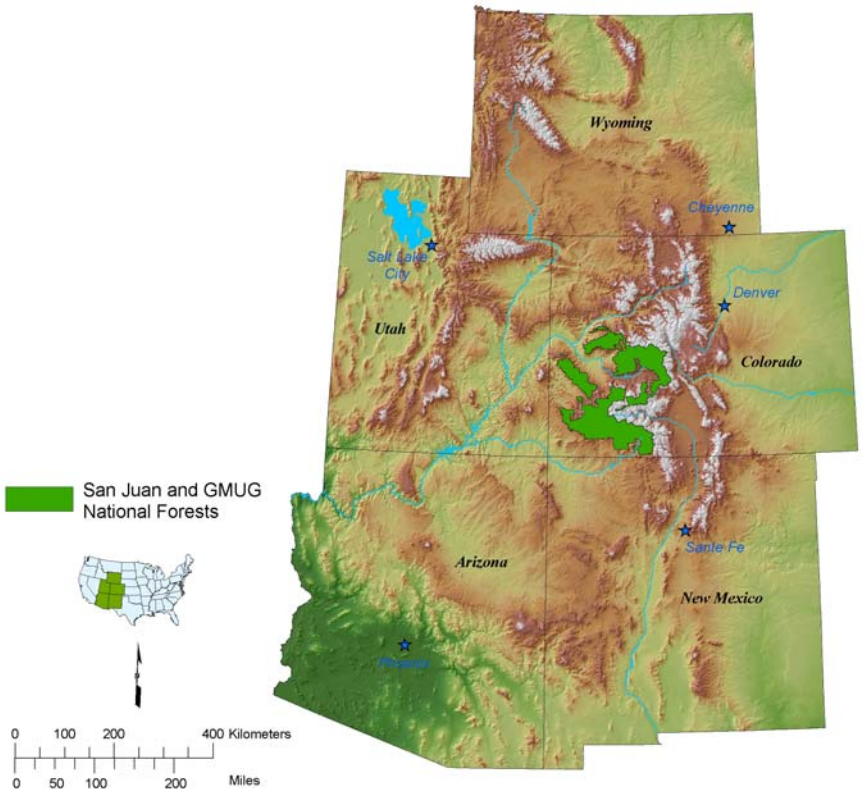
The Aquatic, Riparian, and Wetland Assessment (ARWA) and Current Landscape Condition (CLC) Assessment describe the aquatic and terrestrial ecological characteristics of lands influenced directly and indirectly by Forest planning and management on the San Juan and Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests of western Colorado. In addition, this assessment describes the anthropogenic influences from European settlers and their relationship to these ecological characteristics (Winters et al. 2004, Regan et al 2004).

These two forests encompass approximately 8,195 square miles (5.2 million acres) of the Rocky Mountain Region (Region 2) of the U.S. Department of Agriculture, Forest Service (Table 1). The analysis area is located near the geographic center of five western states: Wyoming, Utah, Colorado, Arizona, and New Mexico (Figure 1).

Table 1. Area and relative distribution for the GMUG and San Juan National Forests.

Forest Name	Acres	Sq. Miles	Percent
Grand Mesa	351,194	548	6.7%
Gunnison	1,796,022	2,806	34.0%
Uncompahgre	1,040,553	1,625	19.7%
GMUG Total	3,187,769	4,980	60.4%
San Juan	2,093,085	3,270	39.6%
Total	5,280,854	8,251	100.0%

Figure 1. The San Juan/GMUG National Forests cover approximately 8,195 square miles (5.2 million acres) of high desert plateau, montane, and alpine areas of southwestern Colorado.



ARWA Goals and Objectives

In general, ecosystem assessments are conducted in order to portray historic and current ecosystem conditions and the effects of natural and human disturbances. The San Juan and GMUG aquatic, riparian, and wetland assessment is specifically organized to answer detailed questions about the ecological environment, natural disturbance regimes, and ecosystem dynamics, effects of human disturbances, assessment limitations, data gaps, and inventory and monitoring principles. The explicit goal is to give the Forests solid information that will enhance the analysis of ecological effects, the effectiveness of conservation efforts, and the design of future studies. The main objectives are to identify critical resource values to manage degraded or threatened resources we need to restore, and to guide where we need apply our management decisions. A list of specific questions that are answered by this assessment include:

1) What are the keystone ecosystem elements (e.g., geology, climate, landform, etc.) that influence the form and function of aquatic, riparian, and wetland ecosystems?
2) What are the physical, biological, and ecological characteristics and trends of the current environment?
3) What and where are the watersheds with important and unique aquatic, riparian, and wetland characteristics? And how do they relate to the surrounding landscape?

4) What anthropogenic factors individually and cumulatively have altered aquatic, riparian, and wetland ecosystems?
5) Where do we expect the highest risk from future management activities?
6) What are the limits in application and interpretation of the assessments?
7) What major information gaps are revealed by the assessments?

CLC Goals and Objectives

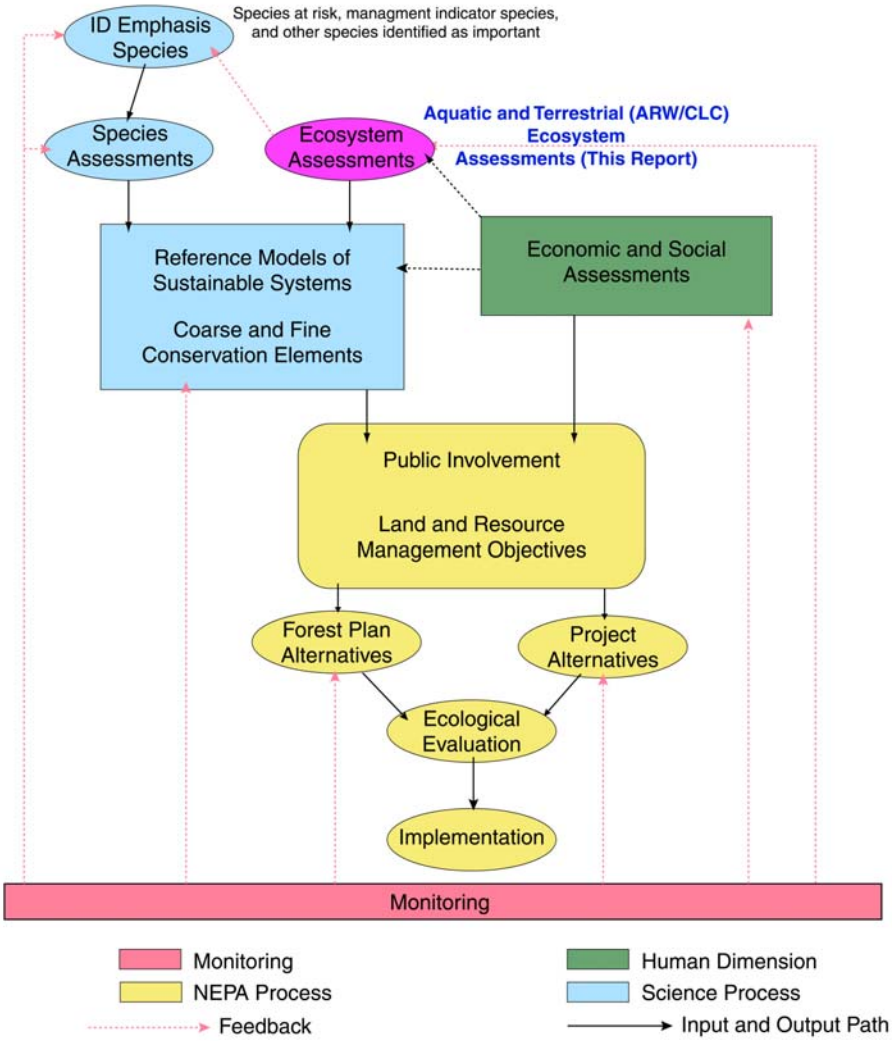
The goal of this assessment is to describe the current ecological condition and to provide an ecological evaluation with particular consideration of the current condition in context of the historic range of variation. This assessment includes descriptions of biophysical patterns, dynamics, interactions, future trends, and implications of past management activities on resource conditions across multiple scales. The assessment will also illustrate the unique ecological characteristics of the forest. By synthesizing information on how physical and biological features of the environment, natural disturbances, and human actions influence ecosystem processes, structure and composition, this assessment should help inform the development of programs to conserve species and design projects to manage for sustainable resource conditions. Questions that can be answered by this assessment include:

1) What aspects of the social and economic environment are important in interpreting the current and future ecological condition?
2) What are the physical, biological, and ecological characteristics of the current environment?
3) What are the natural disturbance regimes and ecosystem dynamics of these systems?
4) How have Euro-American settlement, land use practices and management activities affected these systems?
5) What are the limits in application and interpretation of the assessments?
6) What are the major information gaps revealed by the assessments?
7) What are the essential characteristics of a practical implementable inventory and monitoring system designed to detect changes in system conditions relevant to species conservation concerns?

The Species Conservation Project Assessment Process

Together, both the ARWA and CLC Assessment are constituents of the comprehensive Region 2 Species Conservation Project (SCP). The SCP process combines the results of Forest aquatic, riparian, wetland, and terrestrial assessments in the region with species assessments to show species-ecosystem relationships and thus enhance immediate and long term species conservation efforts, both locally and regionally (Figure 2). It is important to note that the ecosystem assessments are a valuable management tool independent of the species assessments, and will be more apparent as the reader understands the results. Of primary importance in this process is the idea of providing a consistent and defensible process to be used for Forest Plan level as well as project level decisions.

Figure 2. The Species Conservation Project (SCP) conceptual model. The ARWA and CLC Ecosystem Assessment are one element of the overall SCP model in Region 2.



Relationship to Forest Planning

The National Forest Management Act of 1976 (90 Stat 2949 et seq; 16 U.S.C. 1601-1614, 1976) provides the basis for the development of the SCP process, and supporting elements and integration into both forest and project planning. The Act, in part, requires the Forest Service to "…provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives." In addition "…fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." The assessment process provides an approach that allows us to measure, evaluate, and interpret both natural processes and human influences that support these goals. The resulting assessment documents are not planning documents because they do not resolve issues or determine policy (Jensen et al. 2001). Instead, the ARWA and CLC Assessment are intended to contribute to the resolution of issues and provide a foundation

for policy discussion and determination. Therefore the ARWA and CLC Assessment for the San Juan and GMUG will include:

1) Summaries of existing condition (CLC) and ecological characterization (ARWA).
2) Identification of important and unique habitat(s) that may influence the development of plan alternatives.
3) Identification of risks and sensitivity of watersheds and vegetation communities.
4) Delineate the distribution of habitats and ecological communities from regional ecosystem perspectives.
5) Identification of areas suitable or critical for the maintenance and/or improvement of rare habitat and communities.

These assessments do not:

1) Quantify the condition of plants and animal communities at a local or site level scale.
2) Identify the thresholds for impacts.
3) Provide results suitable to application at local or site-level project scales.
4) Make changes in land allocation as specified by existing forest plans and area resource plans.
5) Serve as a decision document.

Relationship to Program and Project Development

The assessment results will further inform Forest management actions by using a multi-scale evaluation of physical and biological resources.

Aquatic, riparian, and wetland assessments can:

1) Identify the highest priority watersheds for restoration and reintroduction of native species.
2) Identify reference watersheds and conditions to support monitoring.
3) Characterize relative impacts to important resource values.
4) Assist in the development of funding requirements at the watershed level.
5) Identify watersheds at risk and sensitive watersheds, and critical aquatic, riparian and wetland areas suitable for program level planning and activity.

The terrestrial CLC assessments can:

1) Provide common baseline information of terrestrial vegetation dynamics and conditions.
2) Provide a scientific basis for discussions with community leaders at local, state and federal levels regarding ecological processes and how they influence the landscape.
3) Increase the effectiveness of the Accelerated Watershed Restoration Program by:
   (a) Improving fire risk classifications.
   (b) Providing a sound basis for management activity prioritization.
   (c) Enhancing understanding of native disturbance processes that affect ecological processes.

(d) Providing scientific basis for planning.

4) Provide multi-scale baseline information for project planning and provide mechanism to prioritize restoration work on the Forest.

The ARWA and CLC Assessment

Forest Service specialists and outside collaborators have developed protocols to guide the preparation of both the ARWA and CLC Assessment that are elements of SCP. (Winters et al. 2004 and Regan et al 2004). These protocols describe the structure of assessments and their goals. ARWA are designed to characterize the influence of current and historic management activities on aquatic, riparian, and wetland ecosystems that include and extend beyond Forest Service administrative areas. The ARWA relate anthropogenic influences to specific variables that drive the function of aquatic, riparian, and wetland systems. It provides managers with important insights into the sensitivity of ecosystem components to both natural and human disturbances. It reveals areas of opportunity and areas at risk.

The GMUG has augmented the ARWA by examining a number of physical factors, anthropogenic influences (historic management activities), and aquatic related values to address current condition and trend. The analysis was done at the 6th level Hydrologic Unit Code (HUC) scale (sub-watershed) for lands within the proclaimed boundaries of the GMUG NFs only, a scale analogous to the "Management Scale" to be described in the next section.

Current Landscape Condition (CLC) assessments examine current social, physical, biological, and disturbance settings for a given area. These characteristics may be measured against historic settings to understand the influence of current and historic anthropogenic activities and their influence on terrestrial ecosystems. The measures also provide insight into opportunities for ecosystem maintenance and restoration. The GMUG has augmented the CLC by synthesizing the findings to evaluate the effects to species evaluated during the plan revision from current conditions and past management to identify needed future management direction for species conservation.

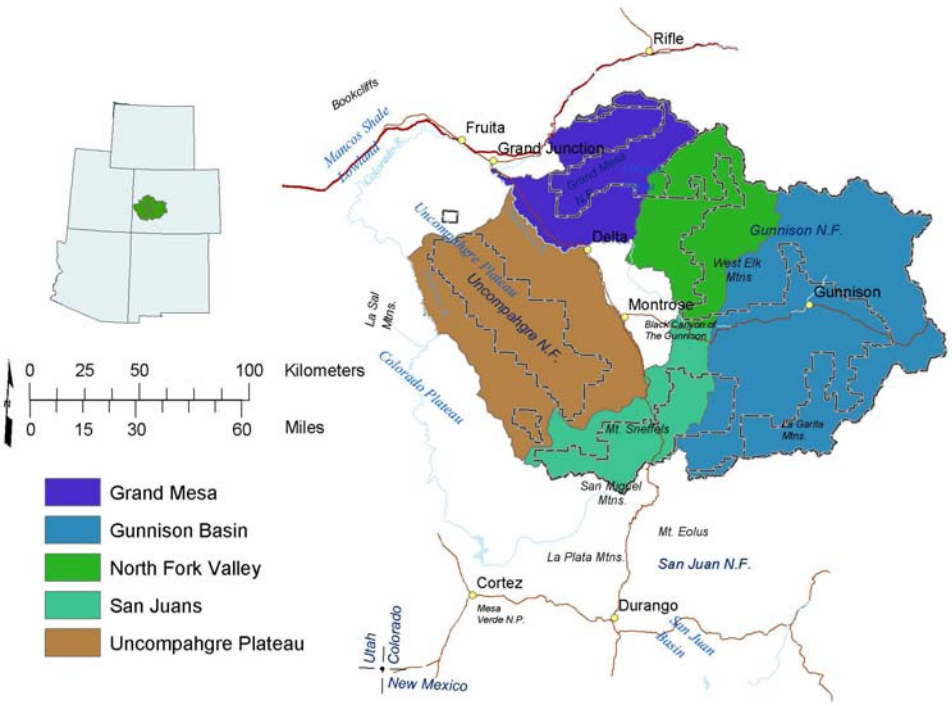
The GMUG Geographic Area Assessments

The GMUG Forest Plan revision process currently includes the development of Geographic Area Assessments (GAA). These assessments include five geographic areas that were based on watershed and socio-economic boundaries (Figure 3). The GAA areas were developed strictly for the Forest Planning process prior to the ARWA analysis, and are retained to maintain consistency with that process. They do not coincide with the watershed concept described previously, because they incorporate boundaries that include social values. GAAs provide a description of the current conditions of lands and resources within each area and include a comparison of these conditions to desirable conditions. GAAs will:

1) Identifies key socio-political and management issues to focus the analysis.
2) Describe current conditions relating to key issues within the Geographic Areas (GA).

3) Outline historic conditions to help identify the type of changes within the GA.
4) Outline important trend and likely future conditions within the GA.
5) Synthesize and interpret information within the GA.
6) Define opportunities and include recommendations for the respected GA

Figure 3. GMUG forest plan revision Geographic Areas (GA).



The ARWA, CLC and GAA Multi-scale Geographic Setting

Both the ARWA and CLC Assessment are organized by geographic scale. Concepts of scale provide important variation in perspective and understanding of ecosystem function by following a broad scale approach that characterizes local to regional ecological settings. The ARWA protocol is based on a hierarchical arrangement of hydrologic units (Maxwell et al. 1995), and the CLC protocol is based on a hierarchical arrangement of land-cover based ecological units (e.g., vegetation). These two scale frameworks are generally complimentary, although their goals are not necessarily the same. The GAA are unique to the GMUG and incorporate watershed boundaries as well as socio/political boundaries

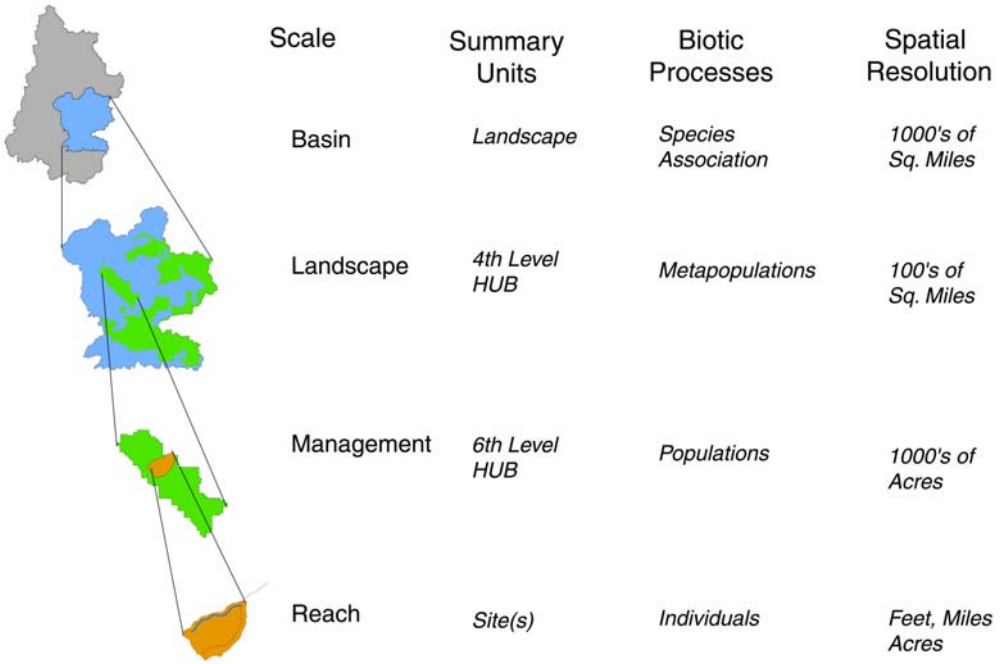
The ARWA Scale Framework: Ecological Scales

The ARWA protocol follows concepts defined by the National Hierarchical Framework of Aquatic Ecological Units in North America (Maxwell et al. 1995) and the National

Watershed Boundary Dataset's Federal Standards for Delineation of Hydrologic Unit Boundaries (FGDC 2002).

The aquatic ecological unit hierarchy delineates aquatic ecosystems into seven hierarchical categories including: subzones, regions, subregions, basins, subbasins, watersheds, and subwatersheds. The National Watershed Boundary Dataset defines hydrologic unit boundaries that may be adapted to fit the National Hierarchical Framework by defining four hierarchical scales. These four scale categories include, in descending order: basin, landscape, management, and reach scales (Figure 4).

Figure 4. The watershed-based broad-scale configuration for aquatic, riparian, and wetland assessments.

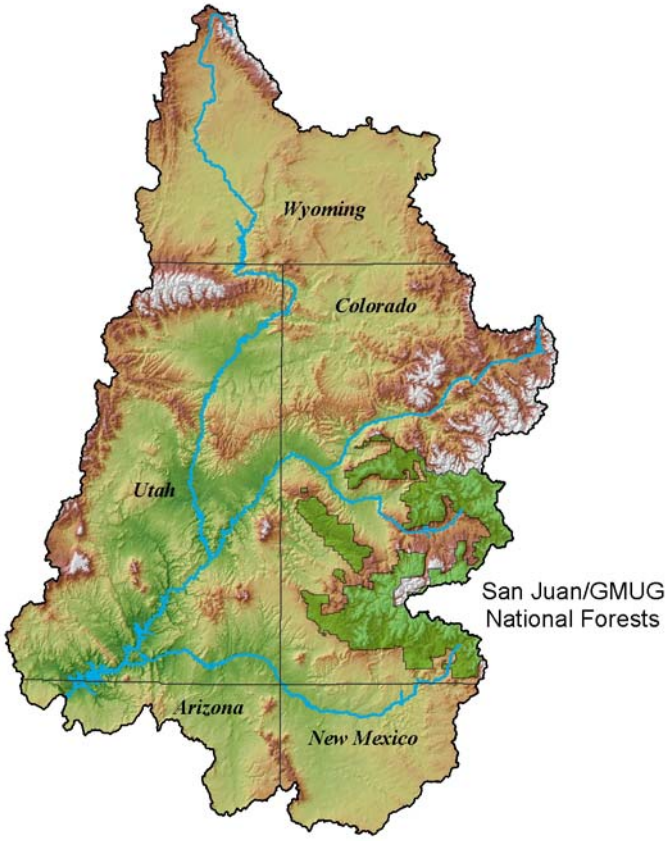


Basin Scale

The San Juan and GMUG National Forests are located completely within the approximately 114,000 square miles of the Upper Colorado River Basin (Steeves and Nebert 1994) (Figure 5). Principal rivers that drain the basin include the Colorado, Green, Gunnison, San Juan, and Dolores Rivers. River basins are ecologically distinguished mainly by differences in aquatic, riparian, and wetland species assemblages and hydrologic relationships. For example, the rivers in the mountains of the Upper Missouri River Basin contain Yellowstone cutthroat trout, while the Middle Missouri and Upper Colorado River basins have greenback and Colorado River cutthroat trout, respectively. Similar distinctions apply to mollusks, invertebrates, warmwater plains fishes, and some riparian and wetland plants. All the river systems in this basin eventually flow into the Colorado River. The river basin assessment in this report constitutes a template for conducting this and future assessments. Results from the

ARWA across the National Forest system will be comparable and provide a context for managing native species across the entire basin (e.g., Colorado River Cutthroat trout).

Figure 5. The San Juan and GMUG National Forests are located completely within the approximately 114,000 square miles of the Upper Colorado River Basin. The area comprises the basin scale.



Landscape Scale

The landscape scale is the aggregation of 4th level hydrologic unit boundaries (HUBs) that intersect the San Juan and GMUG National Forests (Figure 6). Analysis at this scale considers the magnitude of anthropogenic influences, summarized to each of the eighteen 4th level HUBs that comprise the landscape (Table 2). In total, the area includes approximately 22,258 square miles of high desert, montane and alpine uplands of Western Colorado and Eastern Utah. Principal rivers that drain these lands include the Gunnison, San Juan, Uncompahgre, San Miguel, Mancos, Animas, Piedra, and Dolores Rivers. Each river drains ultimately into the Colorado River (Figure 7). We can make two important comparisons at this scale, including:

1) The relative abundance of ecological conditions within the National Forest boundary as opposed to outside.
2) The relative amount of management activity within and outside of the National Forest boundary.

Figure 6. The aquatic, riparian, and wetland landscape scale for the San Juan and GMUG National Forests includes approximately 22,258 square miles (14,245,187 acres). The area is defined by aggregating eighteen 4th level watersheds that intersect the administrative areas of the GMUG.

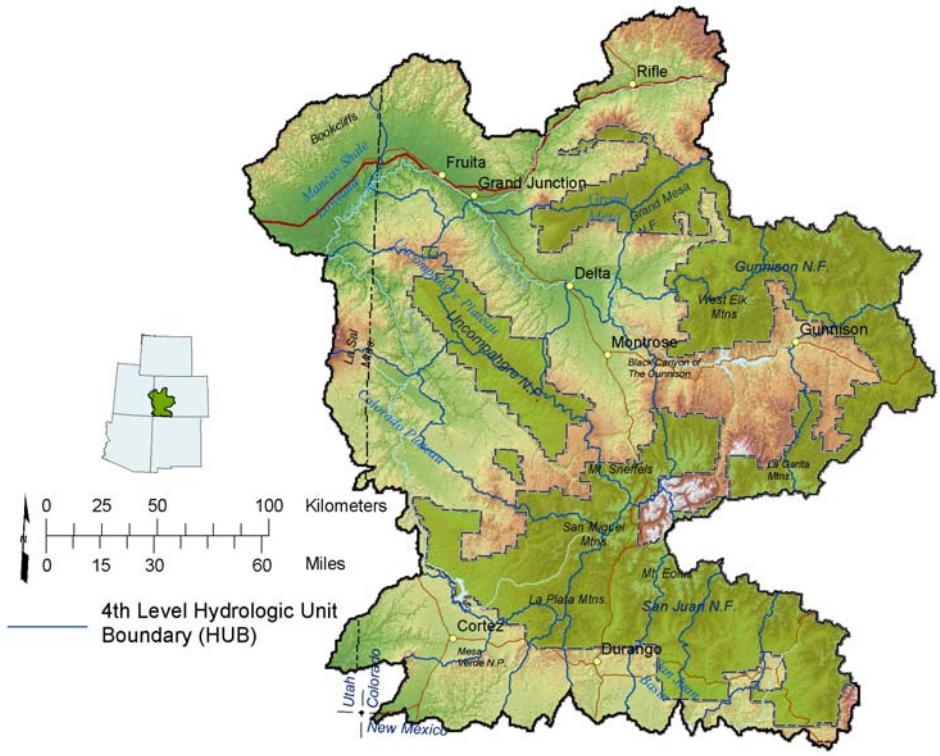


Table 2. Eighteen 4th level HUBs comprise the San Juan and GMUG ARWA landscape scale.

Rank	4th level HUB	National Forest	4th level HUB Name	Acres	Sq. Miles	Percent
1	14010005		Colorado Headwaters-Plateau	1,998,348	3,122	14.0%
2	14020002	**GMUG**	Upper Gunnison	1,543,036	2,411	10.8%
3	14030002	**GMUG**	Upper Dolores	1,381,647	2,159	9.7%
4	14020005	**GMUG**	Lower Gunnison	1,064,086	1,663	7.5%
5	14030003	**GMUG**	San Miguel	995,742	1,556	7.0%
6	14030001	**GMUG**	Westwater Canyon	933,861	1,459	6.6%
7	14020006	**GMUG**	Uncompahgre	714,738	1,117	5.0%
8	14020003	**GMUG**	Tomichi	705,059	1,102	4.9%
9	14080104	**SJ**	Animas. Colorado	702,036	1,097	4.9%
10	14020004	**GMUG**	North Fork Gunnison	620,473	969	4.4%
11	14030004	**SJ**	Lower Dolores	591,992	925	4.2%
12	14080101	**SJ**	Upper San Juan	583,052	911	4.1%
13	14020001	**SJ**	East-Taylor	490,726	767	3.4%
14	14080202	**SJ**	Mcelmo	459,777	718	3.2%
15	14080107	**SJ**	Mancos	448,023	700	3.1%
16	14080102	**SJ**	Piedra	432,475	676	3.0%
17	14080101	**SJ**	Upper San Juan	370,102	578	2.6%
18	14080105	**SJ**	Middle San Juan	210,014	328	1.5%
	Total			14,245,187	22,258	100.0%

Management Scale

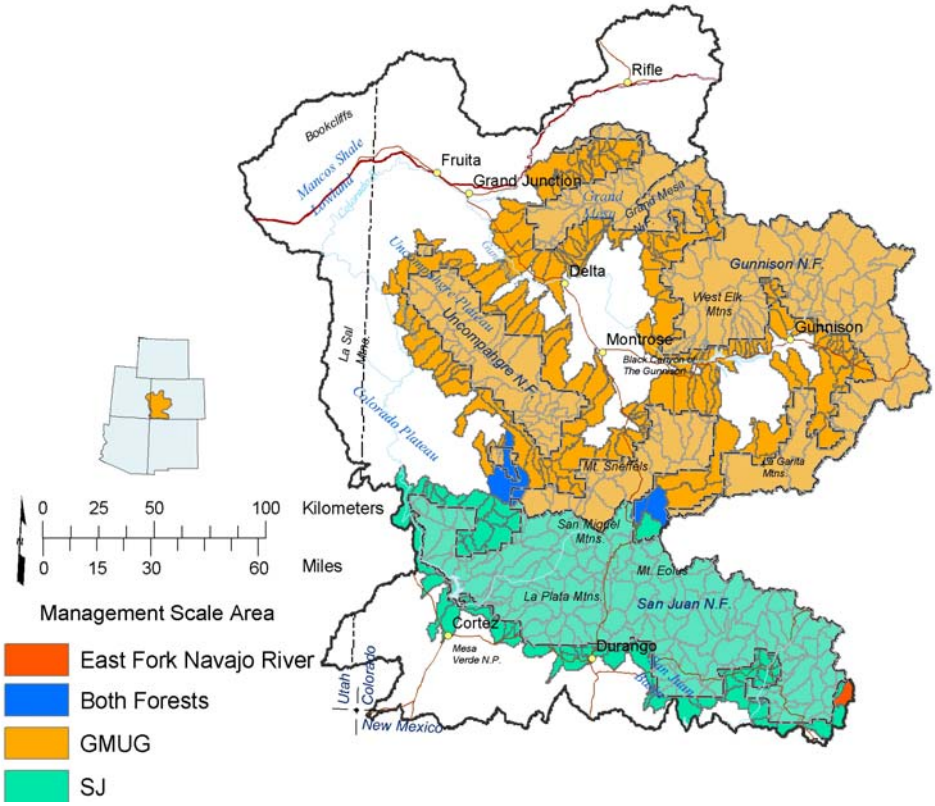
The ARWA management scale is based on 6th level sub-watersheds or HUBs. The gross management scale area is defined by the collection of 6th level watersheds that fall entirely within, or have a portion of their area, intersect the National Forest boundary.

Three hundred eighty-one 6th level HUBs intersect or are adjacent to HUBs intersecting the Forests (Table 3 and Figure 7). These 381 HUBs comprise the management scale for the Forests. These 381 HUBS range in size from a maximum area of 109,340 acres (170.8 sq. miles) to a minimum area of 1,736 acres (2.7 sq. miles). The average HUB area is 21,875 acres (34.2 sq. miles).

Table 3. The 381 HUBs that define the ARWA management scale include HUBs distinct to each Forest, three common to each and one external HUB. The HUB 140801010501 (East Fork Navajo River) falls between the eastern-most edge of the San Juan Forest and the Continental Divide.

Forest	Count	Acres	Hectares	Sq. Miles
San Juan	151	2,781,672	1,125,703	4,346
GMUG	226	5,431,815	2,198,177	8,487
Common to Both	3	107,822	43,634	168
External but Included	1	13,268	5,369	21
Total	**381**	**8,334,577**	**3,372,883**	**13,023**

Figure 7. 381 6th level HUBs make up the combined the San Juan and GMUG ARWA management scale area.



At the management scale, the aquatic, riparian, and wetland assessment refines the analysis conducted at the landscape scale, and is the most intensive of this process. This scale constitutes the appropriate scale for addressing the relationship of ecological drivers at a "management" size as well as quantifying the distribution of anthropogenic activities related Forest service activities. Preliminary assessments of risk, sensitivity and abundance related to ecological conditions are also most appropriate at this scale. Other ecological drivers, such as extent of glacial activity and stream gradient, are added to the climate and geology drivers to extend the analysis, and additional data are integrated to better understand the following:

1) Distribution of high-value aquatic, riparian, and wetland ecosystems such as major wetland complexes;
2) Sensitivity of watersheds and their aquatic, riparian, and wetland ecosystems to disturbances;
3) Extent of natural and human disturbances and their effects on aquatic, riparian, and wetland ecosystems;
4) Historic and current conditions of aquatic, riparian, and wetland ecosystems; and
5) Physical and biological restoration priorities for degraded aquatic, riparian, and wetland ecosystems.

Reach/Site Scale

Because of the intensive effort needed to collect and synthesize data, this aquatic, riparian, and wetland assessment does not include analyses at the reach/site scale. However, the conditions identified at the landscape and in particular the management scale set the "context" for stratifying reach/site analysis. The identification of clusters of similar 6th level watersheds should provide the basis for stratification of inventory and monitoring programs at the reach/site level. The identification of the range of anthropogenic influences within a cluster, both independently and cumulatively should also help focus efforts in determining the reach/site effects of management activities on ARW resources.

The CLC Scale Framework: Ecological Scales

The CLC assessment protocol also uses a multi-scale hierarchical analysis framework of ecological units (ECOMAP 1993). The ECOMAP mapping framework was designed to assist with forest-level analysis and planning (Bailey 2004). This framework defines ecological units based on biotic and environmental factors that affect or express energy, moisture, and nutrient gradients that regulate the structure and function of ecosystems. The descending hierarchy of region, sub-region, landscape, and land-unit define the CLC scale framework applied in this assessment. These scales roughly correspond to the basin, landscape, management, and reach/site scales used in the ARWA scale framework. The CLC landscape scale should not be confused with the ARWA landscape scale. Figure 8 illustrates the hierarchical arrangement of scales that define CLC scale framework.

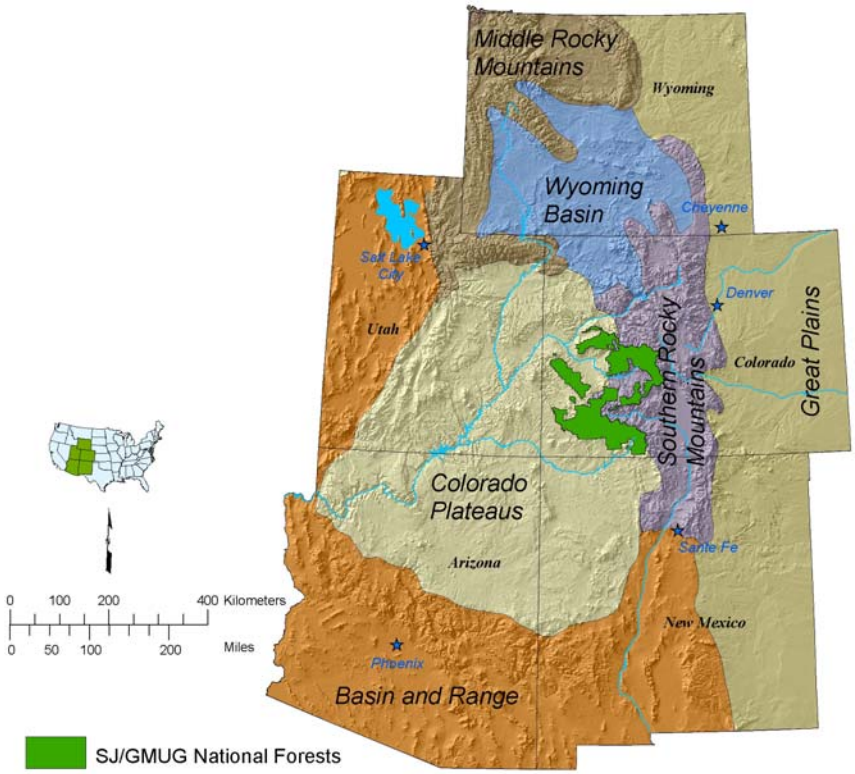
Regional Scale

Provinces are similar in scope to the basin scale of the ARWA protocol and they provide further subdivision below the province unit (Figure 9). Provinces typically cover areas from 1,000 to 10,000 square miles.

Figure 8. The ECOMAP based hierarchical scale arrangement for the GMUG and San Juan CLC Assessment. The regional scale includes the Colorado Plateau and the Southern Rocky Mountains provinces. The subregion scale provides regional context for analysis and the landscape scale sharpens the focus to analysis at the forest level (similar in scope to the ARWA management scale). Site level activity is applied at the landunit scale.

Scale	Summary Units	Biotic Processes	Spatial Resolution
Regional	*Province*	*Complexes*	*1000's of Sq. Miles*
Subregion	*Subsections*	*PNC*	*100's of Sq. Miles*
Landscape	*LTA/Forest*	*Plant Assoc.*	*1000's of Acres*
Landunit	*Patch*	*Individuals*	*Feet, Miles Acres*

Figure 9. The San Juan and GMUG National Forests are included in the Colorado Plateau and Southern Rocky Mountains ECOMAP (1993) provinces.

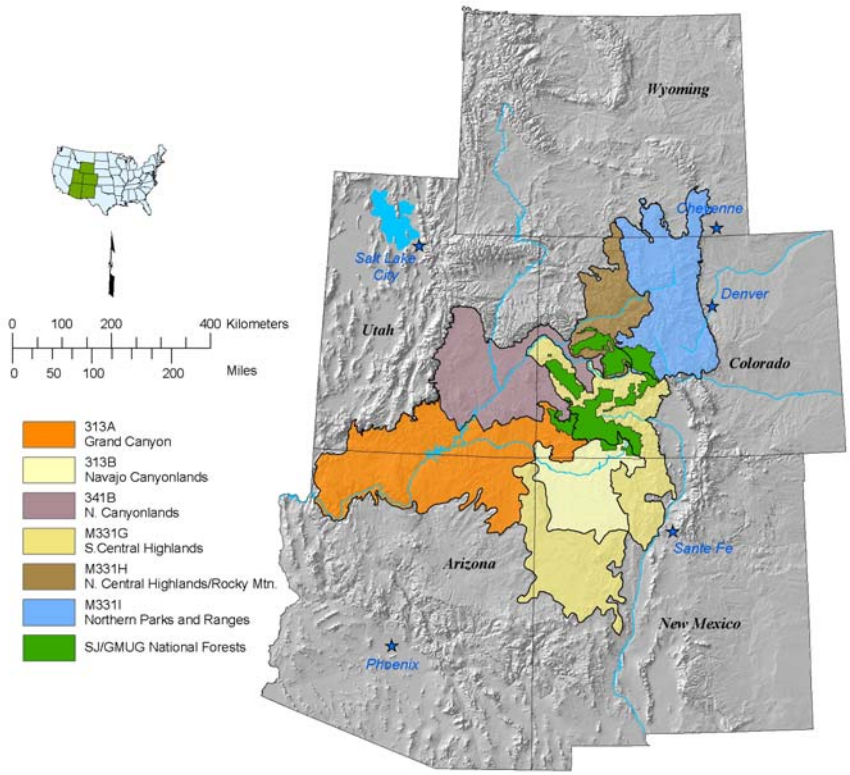


Subregion Scale

The CLC subregion for the Forests is initially based on ECOMAP sections that intersect these Forests and some contiguous sections that do not. The intent was to build an ecosystem unit similar in scale and utility to the ARWA landscape scale.

Sections are the first terrestrial scale below the ECOMAP province and typically cover areas up to about 1,000 square miles. They are described by characteristic geomorphology, geology, climate, soils, potential natural vegetation, and potential natural communities. Forest management and other anthropogenic activities along with natural disturbance can affect the character and function of sections. Six ECOMAP sections intersect the San Juan and GMUG National Forests (Figure 10). The area spanned by these six sections is more than adequate to the needs of most wide-ranging terrestrial species and brings into focus the larger complex of dry to wet vegetation communities of the Colorado Plateau and Southern Rocky Mountains provinces.

Figure 10. Six ECOMAP sections intersect the San Juan and GMUG National Forests. The portions of sections far from these National Forests are minimally influenced by management on those Forests.



The broad geographic setting formed by the six sections intersecting the Forests requires some approach to eliminate the portions of sections minimally influenced by Forest management and well beyond the scope of the analysis. As a consequence the assessment team aggregated the relevant subsections to form a subregion scale. ECOMAP subsections are defined by the characteristics of geomorphology, geology, and potential communities as sections, but subsections as ecological entities, are more responsive to changes in climate, soils, vegetative, and animal community than sections.

Twenty-seven subsections intersect the Forests (Figure 11). These 27 subsections are constituents of the sections but more directly relevant to National Forest management. The team added an additional 19 subsections to ensure adequate consideration of systems that both influence the Forests and are influenced by Forest management. The resulting area defined by these subsections is broad enough to provide adequate ecological context for the consideration of wide-ranging terrestrial species and ecological processes that could influence management of the Forests. Just as the aggregation of 4th level watersheds in the ARWA forms a landscape scale, these 46 subsections form a subregion scale for this CLC Assessment (Figure 12 and Table 4).

Figure 11. Twenty-seven subsections intersect the San Juan and GMUG National Forests.

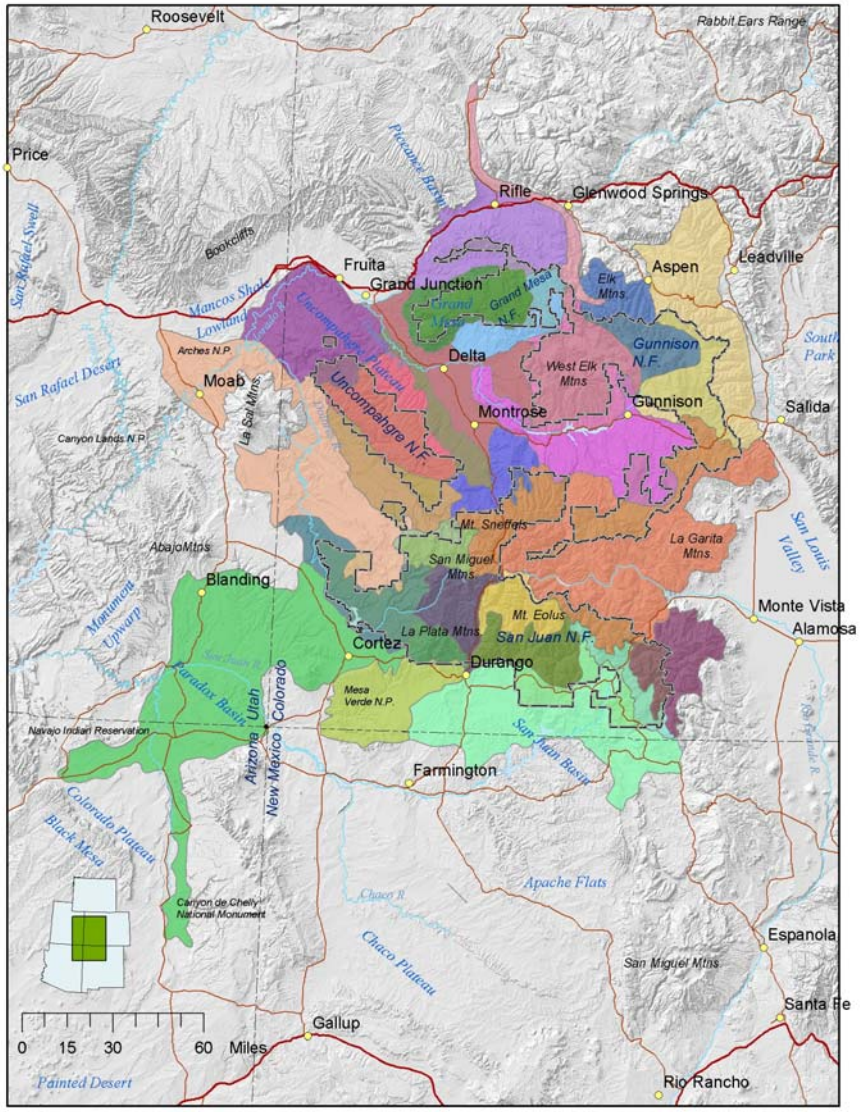


Figure 12. Nineteen subsections have been added to the 27 subsections that intersect the San Juan and GMUG. The 19 subsections were added to take in important subsections and provide a comprehensive geographic context.

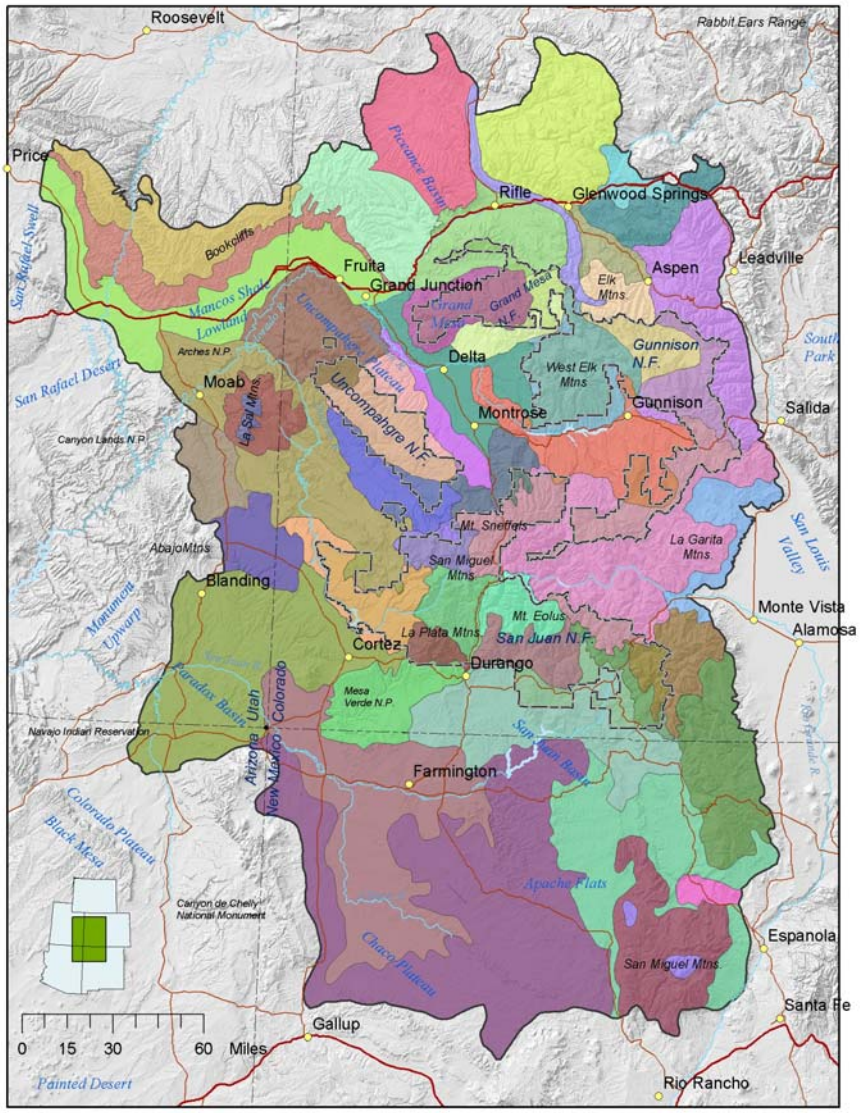


Table 4. The forty-six ECOMAP subsections aggregated to form the CLC subregion scale for the GMUG and San Juan CLC Assessment.

SubSection	Section Name	Acres	Hectares	Sq Miles
313Aa	Grand Canyon	535,102	216,548	836
313Ab		1,995,409	807,513	3,118
313Ac		536,428	217,085	838
313Bc	Navajo Canyon lands	2,082,085	842,590	3,253
313Bd		3,516,363	1,423,022	5,494
313Bm		1,384,139	560,141	2,163
331J	Northern Rio Grande Basin	105,031	42,505	164
341Ba	Northern Canyon Lands	543,149	219,805	849
341Bb		46	18	0
341Bd		1,436,402	581,291	2,244
341Be		385,636	156,062	603
341Bg		229,280	92,786	358
341Bk		282,563	114,349	442
341Bl		48,827	19,760	76
341Bn		337,233	136,473	527
341Bo		1,233,952	499,363	1,928
M331Ga	South-Central Highlands	776,028	314,048	1,213
M331Gb		432,022	174,833	675
M331Gc		808,651	327,249	1,264
M331Gd		350,179	141,713	547
M331Gf		272,207	110,158	425
M331Gi		594,165	240,450	928
M331Gk		875,042	354,117	1,367
M331Gm		1,011,198	409,217	1,580
M331Gn		262,894	106,389	411
M331Go		1,749,144	707,853	2,733
M331Gq		259,061	104,838	405
M331Gr		307,765	124,548	481
M331Gt		161,396	65,314	252
M331Gu		2,270,872	918,989	3,548
M331Gv		433,767	175,539	678
M331Hd	North-Central Highlands and Rocky Mountains	1,101,687	445,837	1,721
M331Hf		153,117	61,964	239
M331Hg		216,024	87,422	338
M331Hh		368,854	149,270	576
M331Hj		179,684	72,715	281
M331Hl		702,537	284,307	1,098
M331Hm		298,311	120,722	466
M331Hn		720,772	291,686	1,126
M331Hp		484,514	196,076	757
M331Ik	Northern Parks and Ranges	1,219,353	493,455	1,905
M331Iw		474,395	191,981	741
M341Bb	Northern Canyon lands	761,659	308,232	1,190
M341Bc		893,921	361,757	1,397
M341Bd		699,305	282,999	1,093
M341Bg		631,752	255,661	987
Total		34,121,920	13,808,650	53,316

Landunit Scale

Forest planning and management at the Forest level requires a finer scale than subsections. Landtype Associations (LTAs) typically ranging in size from one thousand to tens of thousands of acres provide a suitable summary unit for analysis at the landunit scale.

LTAs in this assessment will be used to provide a broad context for plant associations but they will not be used as a primary summary unit. Instead, landunit scale analysis on the Forests will use alternative approaches to LTAs. At the same time, LTAs will be used in the CLC Assessment to define broad contexts for plant associations and communities.

Stand Scale

The stand scale is a fine-scale level beyond the scope of the CLC Assessment.

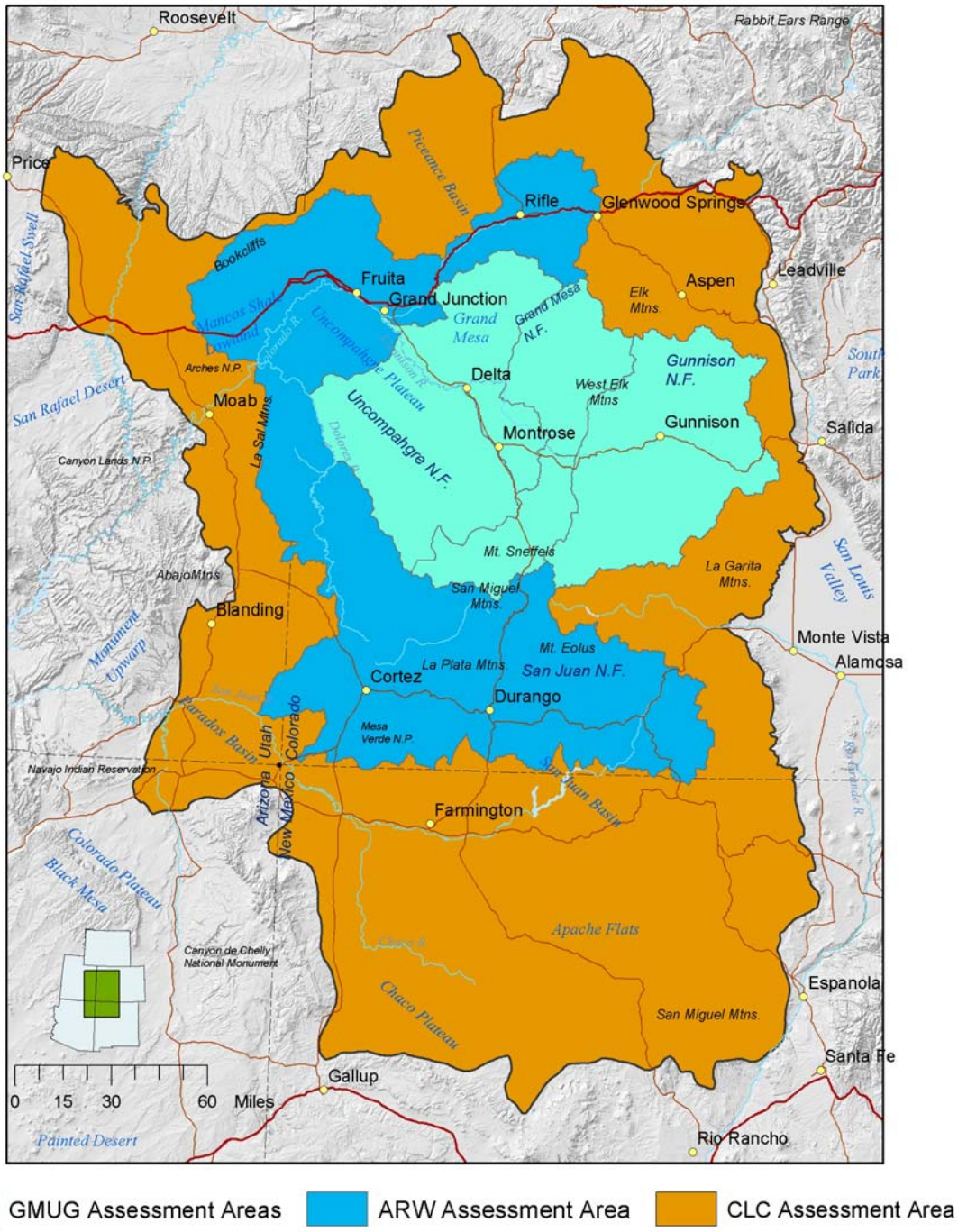
GMUG Geographic Area Assessment Framework

Geographic Area Assessment (GAA) on the GMUG is an additional way of portraying the link between the broad-scale forest assessment and project-level analysis. Under the CLC portion of the assessment, current vegetation conditions, wildlife habitat structural stages, Potential Natural Vegetation (PNV), and natural and management influences on vegetation will be described. Natural disturbance regimes and management influences will be described by dominate cover-type in the geographic areas and then relate to how those influences are affecting current vegetative and wildlife habitat conditions and trends in the future. Based upon current conditions and future trends, potential effects to various wildlife species dependent upon those habitats will be completed.

Combined Assessments and Geographic Framework

The assessment of the Greater Study Area is defined by combining the ARWA landscape scale with the CLC subregion scale (Figure 13). The Greater Study Area extends from the Painted Desert of northeastern Arizona to the Rabbit Ears Range of west-central Colorado. The area is about 275 miles wide and 350 miles long. This area constitutes the logical extent of the landscape needed to characterize the ecological conditions found within the National Forests addressed in these assessments.

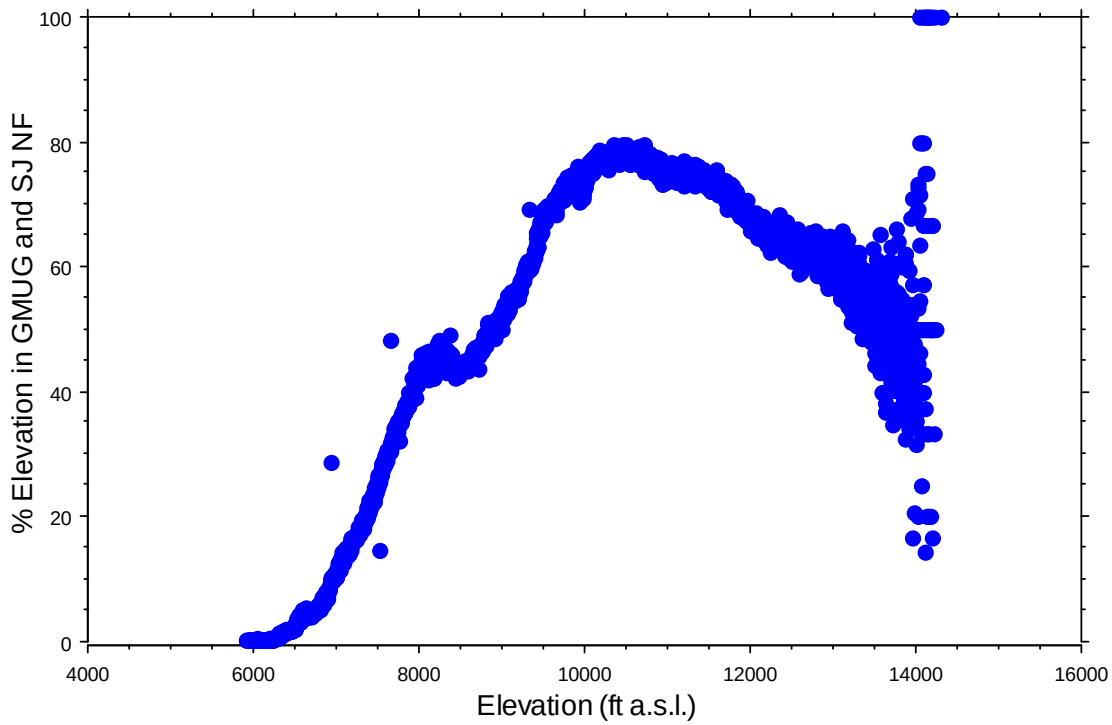
Figure 13. The total area encompassed by the three assessments. The GMUG assessment area is included in the area of the other two.



Physiographic Setting of Resources

The physiography of the San Juan and GMUG area is complex and diverse compared to most other areas of the Rocky Mountain Region of the USDA Forest Service. This analysis encompasses portions of the Southern Rocky Mountain and Colorado Plateau physiographic provinces. The elevation in these forests range from approximately 4,900' to over 14,200'. The lowest elevation values are found in the western portion of the study area, and outside the GMUG and San Juan National Forests. A significant proportion of the higher elevations (e.g., > 8,000') are within the GMUG and San Juan National Forests (Figure 14). Therefore, the management strategies on the GMUG and San Juan National Forests address issues within mostly montane, subalpine, and alpine ecosystems. The xeric lowlands to the south and west are largely outside of the management of these National Forests. Most of the lowland areas are managed by the Bureau of Land Management (BLM).

Figure 14. The percentage of elevational area within the GMUG and San Juan National Forests.



Differences in geology, vegetation, and climate characteristics are as dramatic as the range of elevation within the assessment area. Numerous periods of geologic uplift and erosion, volcanism, glaciation and climatic differences all contribute to this complexity.

The area has been influenced by several periods of uplift and erosion. The study area includes a wide variety of sedimentary, metamorphic, and igneous rock types (Figure 15), ranging in age from Precambrian crystalline rocks to unsorted Quaternary deposits of glacial, colluvial, and alluvial origin (Figure 16). The differences in geology result in different conditions related to aquatic productivity and sediment production.

Figure 15. Geology of the San Juan and GMUG National Forests.

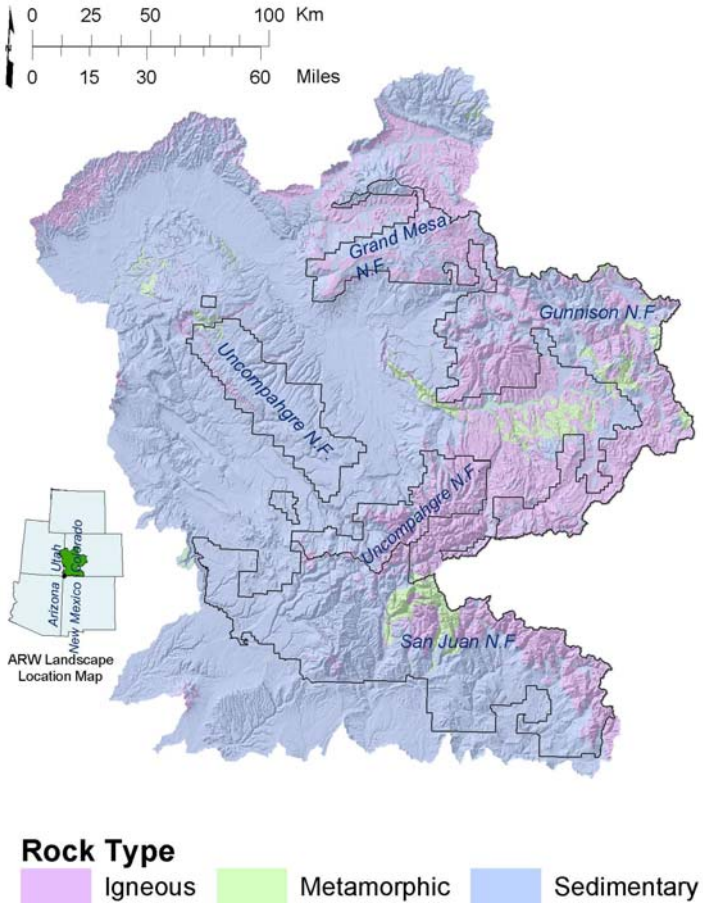
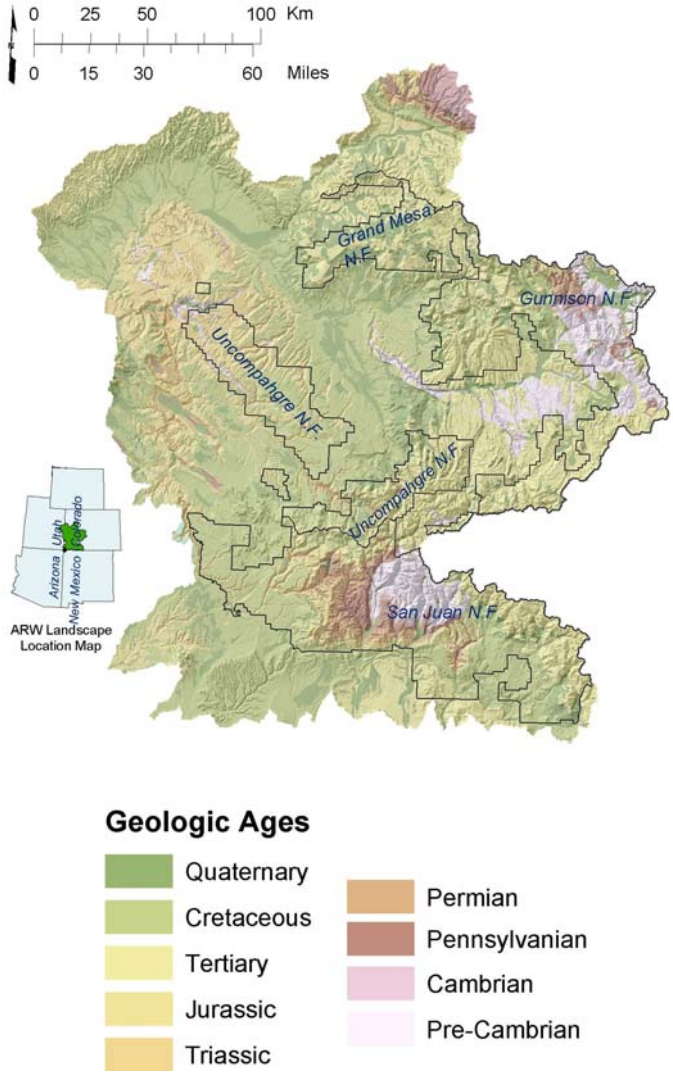


Figure 16. The geologic ages of rock units within the assessment area.



The USDA Forest Service administers 5.2 million of the 14,245,187 acres comprising the ARWA landscape scale. A majority of the lands administered by the Forest Service are located in the central and eastern portions of the landscape scale. Elevation of this portion of the landscape scale ranges from ~4,100' to ~14,200'. A majority of the area outside of the national forest administrative boundary is below 6,000'. The surficial rocks tend to be sedimentary units with maximum ages of ~300 million years. The uplift of the Colorado Plateau during the Laramide orogeny created a varied topography of canyons, mesas, and plateaus.

Climate in this portion of the study area tends to be semi-arid, with a precipitation regime driven largely by monsoonal influence. The non-Forest Service lands have significantly less precipitation than the higher elevation areas administered by the U.S. Forest Service (Figure 17). Rainfall constitutes a vast majority of the annual precipitation driving the hydroclimatic regime of the non-Forest Service lands within the ARWA landscape area (Figure 18). However, stream systems within the National Forest boundaries are influenced to a large extent by annual snowmelt events.

Figure 17. Mean annual precipitation (mm) of the San Juan and GMUG National Forests.

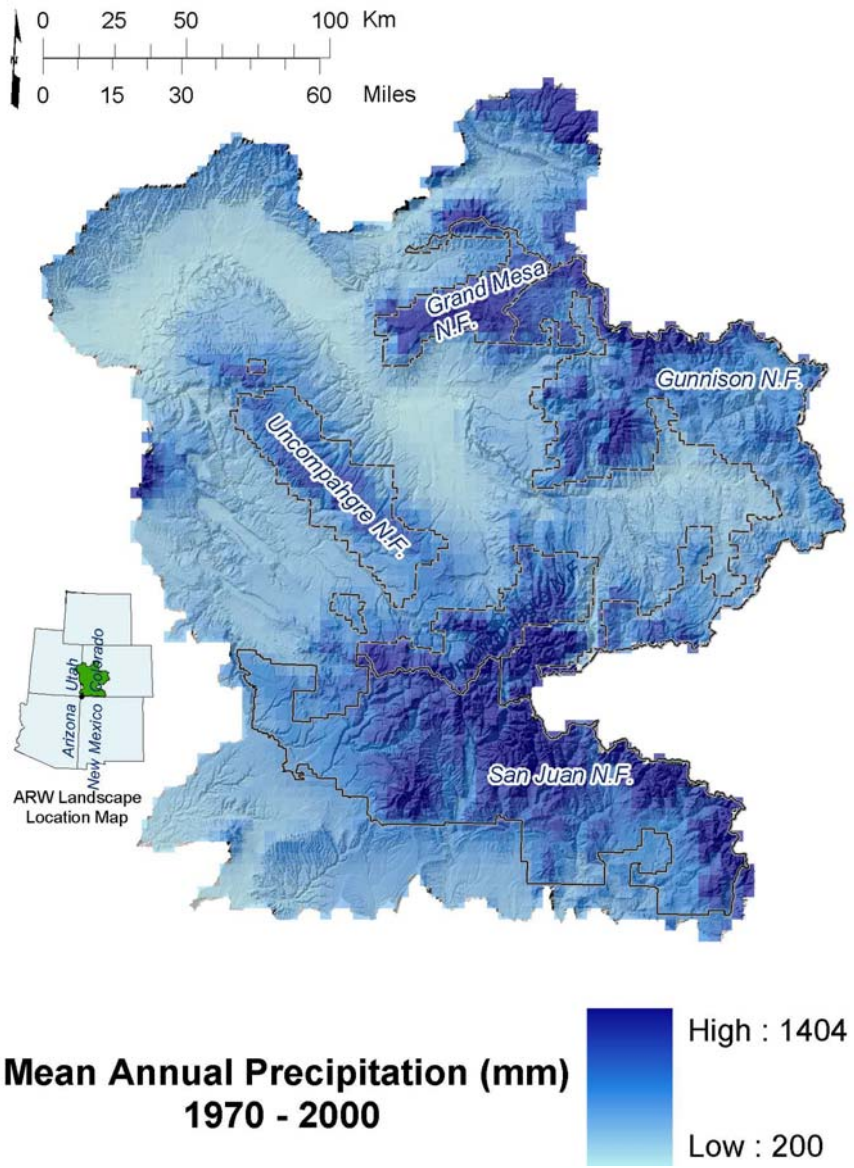
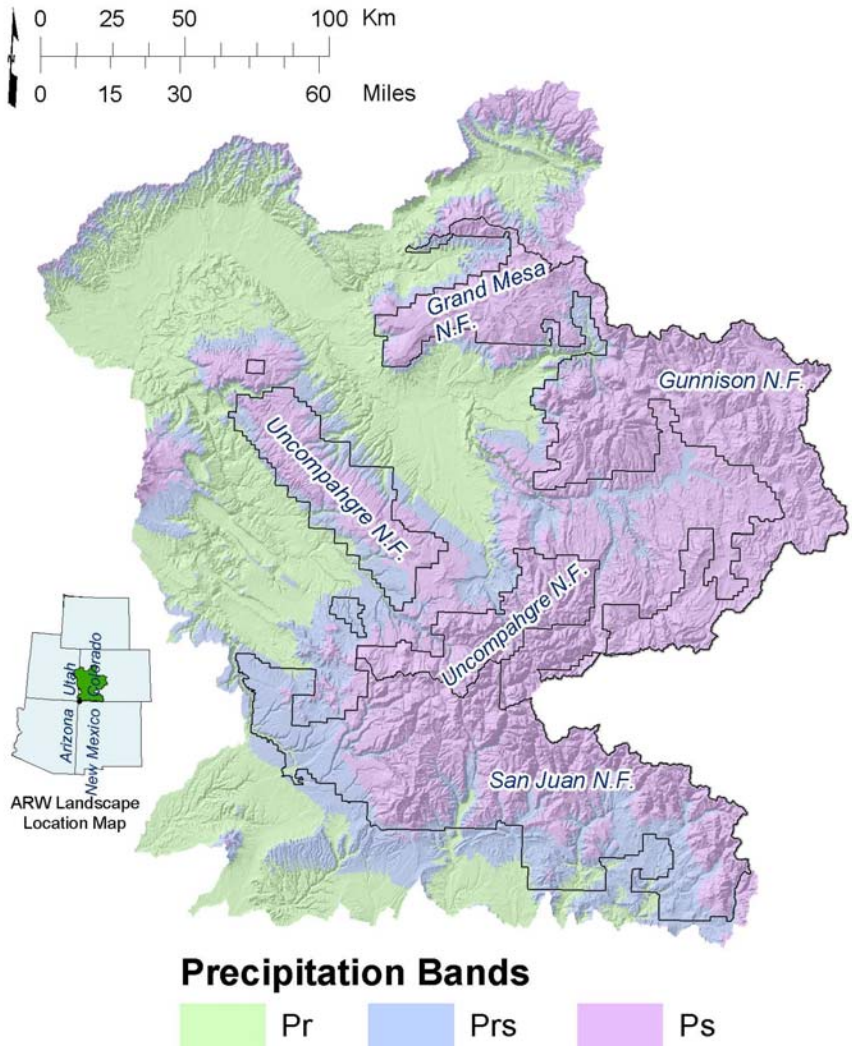


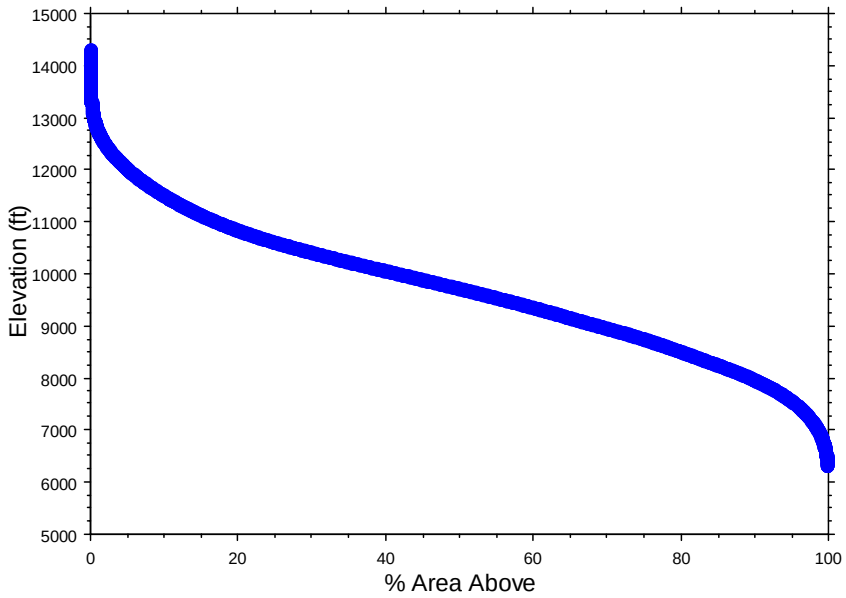
Figure 18. Precipitation bands of the San Juan and GMUG National Forests: Pr is rain; Prs is rain and snow; and Ps is snow.



The Grand Mesa, Uncompahgre and Gunnison National Forests are administered as a single unit collectively referred to as the GMUG. These Forests comprise the central, northern and northeastern portions of the assessment area (Figure 7). Within these Forests, elevation ranges from 5,800 to 14,309' at the summit of Uncompahgre Peak (Figure 19). Figure 20 and Figure 21 illustrate the geologic distribution and relative ages on the GMUG.

The Grand Mesa National Forest is characterized by large mesas and broad valleys created by fluvial processes. Lower elevations are underlain by Cretaceous sedimentary rocks. The Grand Mesa, Battlement Mesa, and the Flattops are capped by basaltic flood lava which produces a unique topography (Day and Bove 2004). The Grand and Battlement Mesas were likely covered by small icecaps during the Quaternary (Yeend 1969).

Figure 19. The distribution of elevation in feet within the GMUG.



The Gunnison and southeastern portions of the Uncompahgre National Forest are characterized by mountainous topography. On the Gunnison National Forest, the Laramide orogeny uplifted the Precambrian basement rock subsequently exposed by glacial and fluvial erosion processes. Permian and Pennsylvanian aged sedimentary rocks flank the Precambrian basement rock to the north and south. Igneous rocks of Tertiary age associated with post-Laramide volcanism are interbedded with Cretaceous and younger sedimentary units. This combination of rock types and ages are evident in the western and southern portions of the Gunnison National Forest and the eastern portion of the Uncompahgre National Forest (Day and Bove 2004).

Figure 20. Geology of the GMUG.

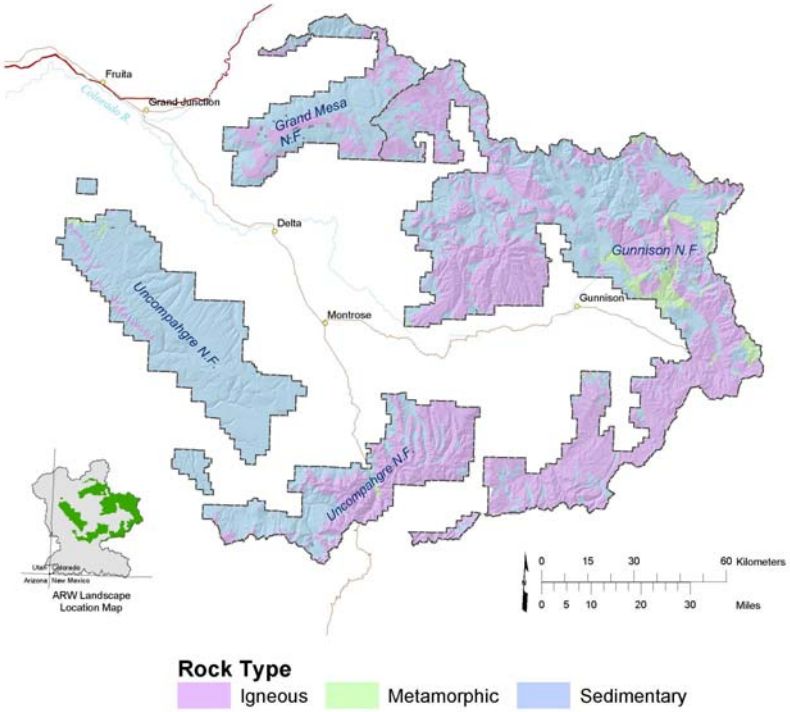
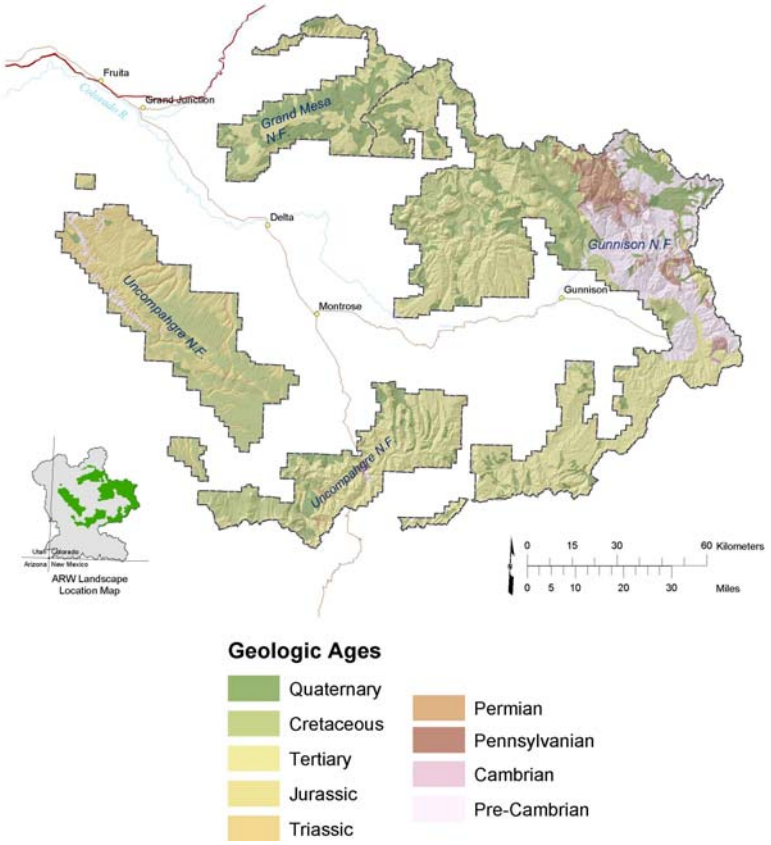


Figure 21. The geologic ages of rocks in the GMUG.



The Uncompahgre Plateau comprises the western portion of the Uncompahgre National Forest. This area is characterized by a narrow band of uplifted Precambrian basement rock and Tertiary volcanics on the southwestern portion of the plateau. The rest of the plateau is underlain by sedimentary units of Triassic and younger ages. Larger streams have incised into the predominately metamorphic Precambrian basement rocks on the northeastern flanks of the plateau.

The complexity of the climate of the GMUG is reflected by the wide range of vegetation types found on these Forests. The lower elevations contain upper-Sonoran type vegetation associated with a semi-arid climate (Day and Bove 2004). Pinyon-juniper vegetation is found at mid-elevations, while the higher elevations contain montane, subalpine, and alpine vegetation types. Quaternary glaciation has influenced many of the valleys at higher elevations. Snowfall is the predominant precipitation type influencing the hydroclimatic regime of the GMUG (Figure 22.).

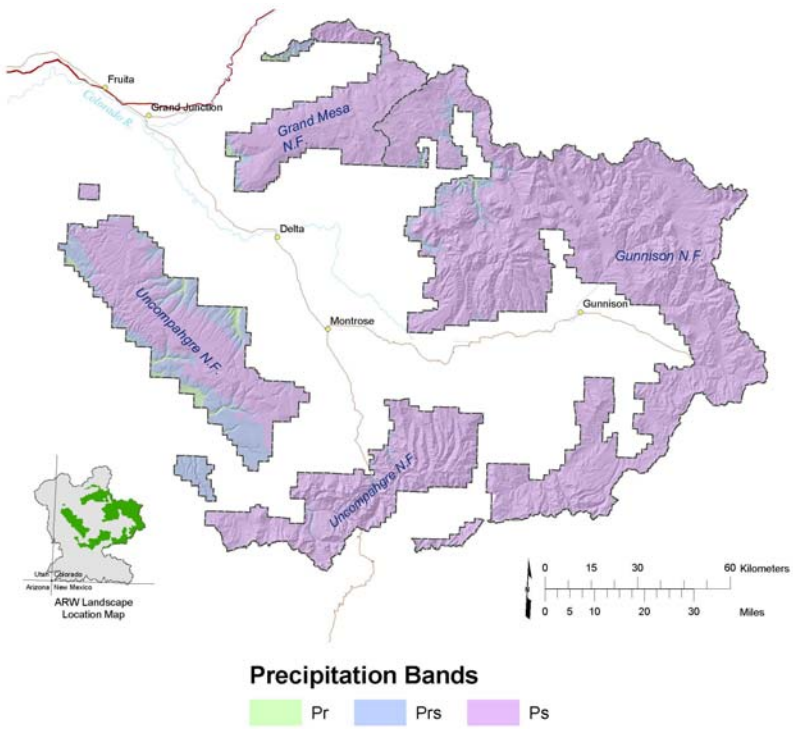



Figure 22. The precipitation types in the GMUG: Pr is rain; Prs is rain and snow; and Ps is snow.