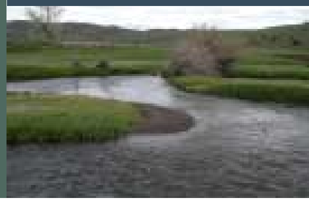
USWMP

Upper Sevier Watershed Management Plan



Prepared as part of the Upper Sevier River Community Watershed Project

Upper Sevier Watershed Management Plan

An issue identification approach involving federal, state, and local stakeholders to identify resource opportunities within the Upper Sevier River Basin South-Central, Utah

June 2004

Available

http://www.fs.fed.us/dxnf/uswmp/index.html

Table of Contents

Upper Sevier Watershed Management Plan

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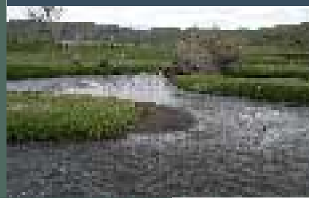
Chapter 7 - Appendices 7-1

List of Figures

List of Tables



Executive Summary

Watershed Management Plan/Assessment

The Upper Sevier Watershed Management Plan is a collaborative assessment addressing resource issues within the 1,324,999 acre Upper Sevier River Basin. Located in south-central Utah, this basin encompasses portions of Beaver, Iron, Kane, Piute, Garfield and Wayne counties. It is governed by a steering committee, composed of a diverse group of leaders concerned about the future of the basin and its resources (Appendix A).

By enganging diverse groups of stakeholders, including federal, state and local interests, to help identify priority issues within the watershed, the Upper Sevier Watershed Management Plan encourages agreement, involvement and ownership to help address complex resource issues.

The Upper Sevier Watershed Management Plan/ Assessment aims to:

- *involve diverse groups of community members representing both advocates for beneficial uses of water and potential sources of pollution from problems throughout the watershed.*
- *Create an environment that allows for thoughtful, thorough and productive discussions of issues, and encourages concensus, builds trust, invites participation and facilitates learning, creativity and planning.*
- *Provide a context and ranking for important issues within the watershed, to help guide current and future watershed management decisions.*

The initial phase of this assessment was completed in February 2003. Key issues identified within the watershed and an overall assessment for 63 resource issues are contained in this document (Chapter 4).

Critical to the success of this project was the involvement and ownership of six technical advisory committees in areas such as fire and fuels, human uses, agriculture, species and habitat, vegetation and hydrology (Appendix B).

Maps showing key issues, as identified by technical advisory committees, are included to help better understand how issues relate to one another. Over 60 technical advisory committee members provided input to the plan, and identified over 74 issues of concern within the nine Upper Sevier River Watersheds. Key issues descriptions, key issue maps and overall issue ratings are contained in Chapter 4, with additional summaries provided in Appendices D and E.

Key Issue Results

Noxious weeds and sagebrush/grasslands were addressed in seven of the nine watersheds. Other issues frequently addressed include accelerated erosion, access management, communities at risk, aspen areas, riparian vegetation and habitat, wildlife management in agricultural areas, and pinyon/juniper areas.

Riparian habitat/vegetation, mixed conifer areas, sagebursh grassland areas, noxious weeds, pinyon/juniper areas and Ponderosa Pine areas were addressed within some watersheds by more than one technical advisory committee.

The two issues most frequently addressed by more than one committee were sagebrush/grassland areas and pinyon/juniper areas. In addition, those species typically association with these vegetation types (sage grouse, prairie dog, deer) were also more likely to be addressed by species and habitat technical advisory committees. Moreover, comments provided for issues such as 'Wildlife Management in Agricultural Areas' may be directly tied to sagebrush/grassland and pinyon/juniper vegetation composition. A summary graph of priority issues addressed, watershed location and frequency addressed, is contained in Table E-1. Additional assessment information can be found in Chapter 4.

Water Quality Results

A complete Total Maximum Daily Load Analysis (TMDL) was submitted to the Environmental Protection Agency on April 1, 2004. This analysis provides a summary of the water quality assessment, issue identification, pollution load allocation and recommendations established in the TMDL development for the Upper Sevier River Basin. Four river segments and two waterbodies within the basin were listed as "impaired" under the current water quality guidelines. A summary of the TMDL/Water Quality Analysis is contained in Chapter 5.

Steering Committee Recommendations

In February and March, 2004, technical advisory committees and steering committee members finalized priority areas and goals for restoration for the Upper Sevier Watershed Management Plan.

Four priority focus areas were chosen, based on potential for restoration, water quality concerns, and opportunities for multiple partners to participate in on-the-ground improvement projects. The focus areas for this initial watershed management plan correspond to those focus areas outlined as part of the Department of Water Quality/TMDL findings (Chapter 5). Individual goals for each of the four focus areas are contained within Chapter 6. Additional goals and opportunities for all nine watersheds are outlined, based on additional technical advisory committee, state and federal agency and public meeting input.

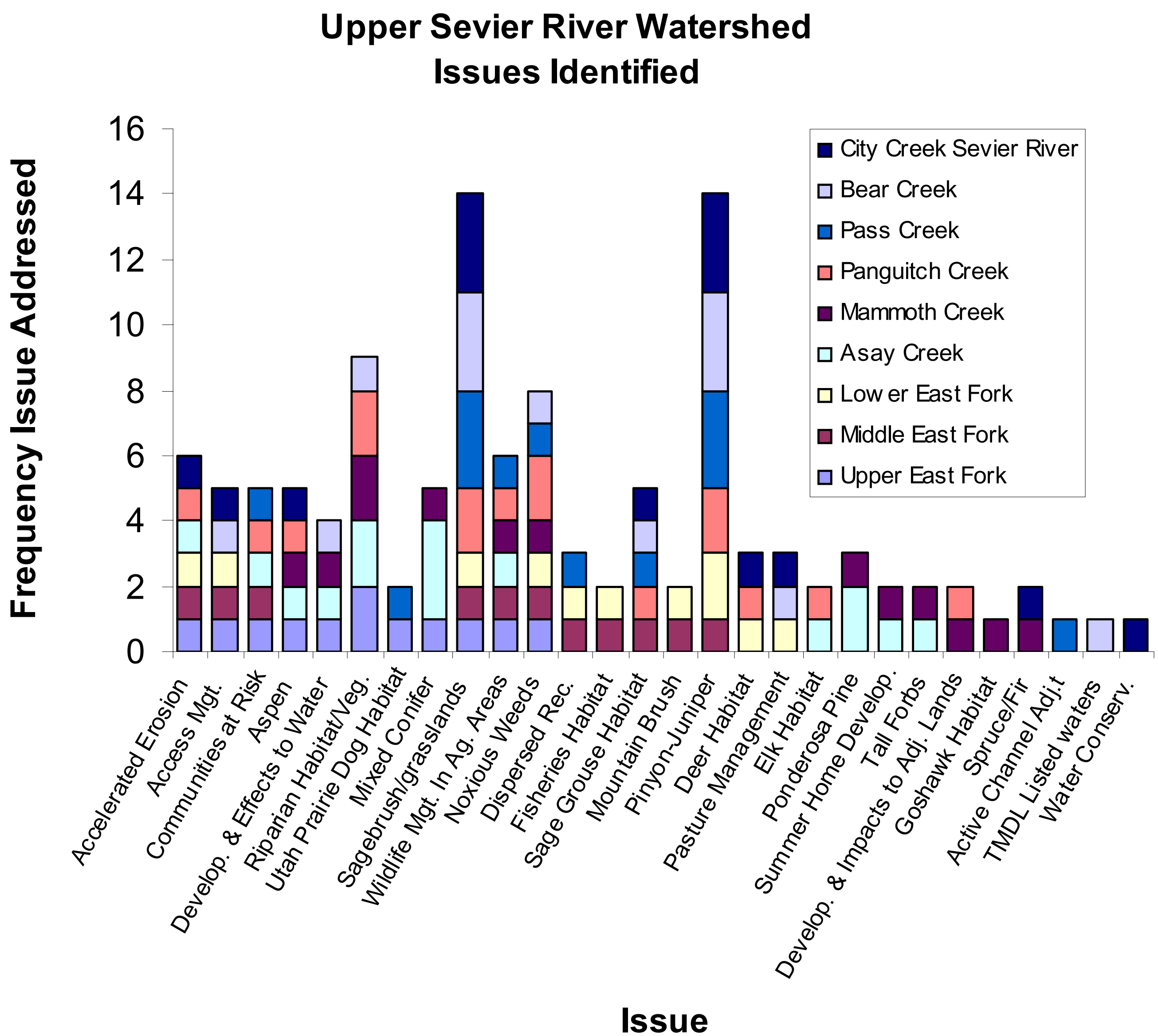
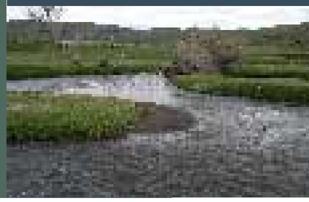
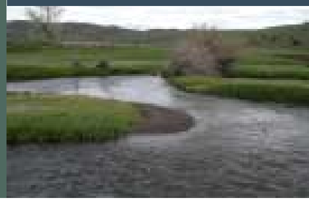


Fig. E-1. A summary of key issues addressed within the Upper Sevier Management Plan within the 9 Upper Sevier Watersheds. Note that some issues have been addressed more than once within a watershed.



Abbreviations Used

AFO - Animal Feeding Operations
ATV - All terrain Vehicle
BAT - Best Available Technology
BCI - Biotic Condition Index
BLM - Bureau of Land Management
BMP - Best Management Practices
CRMP - Coordinated Resource Management Planning
CWA - Clean Water Act
DFC - Desired Functioning Condition
DNF - Dixie National Forest
DO - Dissolved Oxygen
DOQ - Digital Orthoquad Maps
DP - Dissolved Phosphorus
DWQ - Department of Water Quality
EIS - Environmental Impact Statement
EPA - Environmental Protection Agency
ESA - Endangered Species Act
HUC - Hydrologic Cataloguing Unit
MIS - Management Indicator Species
MLRA - Major Land Resource Area
MOS - Margin of Safety
NEPA - National Environmental Protection Agency
NPA - National Park Service
NRCS - Natural Resources Conservation District
OHV - Off Highway Vehicle
PFC - Proper Functioning Condition
PJ - Pinyon/Juniper
POC - Pollutants of Concern
SCD - Soil Conservation District
SDR - Sediment Delivery Ratio
SECI - Stream Erosion Condition Index
STATSGO - State Soil Geographical Database
STORET - Storage and Retrieval
SVAP - Stream Visualization Assessment Protocol
TAC - Technical Advisory Committee
TMDL - Total Maximum Daily Load
TP - Total Phosphorous
TSI - Trophic Status Index
TSS - Total Suspended Solids
UACD - Utah Association of Conservation Districts
UCDC - Utah Conservation Data Center
UDWR - Utah Division of Wildlife Resources
USDA - United States Department of Agriculture
USFS - United States Forest Service
USGS - United States Geological Survey
USLE - Universal Soil Loss Equation
USWMP - Upper Sevier Watershed Management Plan
WQS - Water Quality Standards



Introduction and Background

Watershed Plan Description

Throughout the country, much attention has been focused on understanding biological systems at an ecosystem level, rather than from a species or site-specific level. "Ecosystem Analysis" provides a systematic way to characterize human, aquatic, riparian, and terrestrial features, conditions, processes and interactions and to estimate direct, indirect, and cumulative effects of associated land uses and activities.

Major Endeavors of the Upper Sevier River Community Watershed Project

- **Restoration and maintenance of watershed ecosystems--**including reduced erosion and improved water quality; improved flood-water retention and ground water recharge; stabilized streambanks; improved road and trail systems; and upland vegetation in advanced ecological status, except where resource objectives would require earlier successional stages.
- **Cooperation, coordination, and partnershipping--**a collaborative approach at the ground level is the only avenue to successful restoration and management within a large watershed shared by numerous landowners
- **Research** to provide the scientific basis for prescriptive project implementation, monitoring project effectiveness, and recommending adaptive management options
- **Demonstration and showcase of areas**, that through proper restoration and management, watershed-riparian areas can be maintained in healthy conditions while allowing a variety of uses.

--Upper Sevier River Community Watershed Project Business Plan, May 15, 2000--

Watersheds are hierarchical, with smaller areas described by subdividing larger areas. For the purpose of this assessment, the entire Upper Sevier River Basin, represents the largest area discussed in this plan, with smaller areas described as subbasins, watersheds and subwatersheds, respectively. The Upper Sevier "Watershed" is a 1.3

When we try to pick out anything by itself, we find it hitched to everything else in the universe."
-John Muir

million acre basin, composed of 2 subbasins (USGS 4th field Hydrologic Cataloging Unit (HUC4)), 9 watersheds (USGS 5th field level HUC), and numerous smaller subwatersheds (USGS 4th field level HUC) (Fig. 1-1). A watershed consists of a well-defined land area with a unique set of features, a system of recurring processes, and a collection of dependent plants and animals, and as such, provides an ideal setting for conducting an ecosystem analysis.

Why Cooperative Watershed Management

While past watershed management efforts traditionally focused on commodity use (water, timber, minerals, etc., and how to achieve maximum output) today's efforts have evolved with the realization that watersheds are complex, and that land use, soil and water all interact and in turn, issues within a watershed overlap. In addition watershed management is concerned with human related activities such as agricultural practices, urban runoff, private property interests, beneficial uses, and recreation, in tandem with natural watershed processes.

Involving local stakeholders is key to success in watershed management planning and assessment.

While some may argue that specialized agencies have sufficient "scientific knowledge" to conduct watershed assessments, such reliance often results in inconsistent and fragmented efforts that may overlap or conflict, and are often times difficult to undertake because they lack "buy-in" from local interests. While a top-down approach may alienate local stakeholders in the policy-making process, relying on a bottom-up approach may be equally unsuccessful, in which local stakeholders may dictate management policy. Watershed management, in which stakeholders are empowered by their participation, not only helps everyone better understand issues, but also helps develop communication and leadership skills. Joe Gelt, Water Resources Research Center, University of Arizona, summarizes the benefits of this process:

> "By working together and sharing information, stakeholders agree on ground rules to guide their participation in management activities. They come to an understanding about their particular roles and mutually agree on adopted priorities and shared responsibilities. With such broad and varied participation, the focus on environmental issues is thus broadened to also include consideration of social and cultural goals such as economic stability and quality of life issues." (2000).

The Upper Sevier Watershed Plan characterized the ecological and social conditions of the watershed by empowering stakeholders to provide a context for future decisions within the watershed.

Questions Addressed During Initial Assessment

Natural Resources within the Upper Sevier Watershed are vital to local communities, both economically and for maintaining rural lifestyles of ranching and farming. If these values are to be sustained into the future, measures must be taken now to begin improving resources within the watershed, and include:

- **Water Quality** – How will water quality and quantity be ensured for local ranchers, farmers and communities, while also providing for the needs of recreationists, fish and wildlife?
- **Riparian and Upland Vegetation** – How will streamside and upland vegetation communities - that are resilient and sustainable - be maintained or restored?
- **Fire Safety** – Can private property be protected while using fire to improve forest and rangeland health?
- **Access** – Can access be provided to ensure that roads and trails do not degrade the environment?

Context for Cooperative Plan Development

During Summer 1999, the Upper Sevier Soil Conservation District initiated a Coordinated Resource Management Planning (CRMP) effort for the Upper Sevier River Basin mainly to address water quality issues (303(d) status) along the main stem of the Sevier River (Fig. 1-2). Shortly after an assessment effort in the Fall of 1999 to determine what could be done to improve water quality in the river system, the Dixie National Forest received funds to initiate a large-scale watershed restoration project within the Upper Sevier River and the East Fork Sevier River subbasins.

With the combined effort of the Upper Sevier Soil Conservation District and the Dixie National Forest, other resource management and regulatory agencies were invited to participate, as well as private landowners and the city and county municipalities. During meetings held in February 2000 with watershed stakeholders, it was decided to merge the CRMP effort with the Upper Sevier River Project to form one large scale restoration initiative (Fig.1-3).

The Upper Sevier Watershed Project is one of 15 efforts selected nationwide by the USDA Forest Service to implement holistic watershed restoration in cooperation with land management agencies, private landowners, and other interested parties. This project, as well as this document are governed by a Steering Committee consisting of people representing those interests (Appendix A).

Watershed Level Plan Assessment

Identifying issues and concerns in the basin related to land use and the natural environment was determined the first step by the Steering Committee. Technical Advisory Committees (TACs) (Appendix B), formed under the direction of the Steering Committee, recommended that a basin-wide assessment be completed to identify social and environmental issues, as well as identify priority treatment areas.

Assessment Level Description

The four geographic levels of reviews/assessments considered for this current plan, help provide the context to appropriately implement sustainable land management. These geographic levels are:

- Broad-scale Assessments (at the basin scale, USGS 3rd level HUC)
- Mid-scale Assessments (at the subbasin scale, 4th level HUC)
- Fine-scale Assessment (Watershed level, 5th level HUC)
- Site-scale Analysis (project level, 6th level HUC, National Environmental Policy Act (NEPA) analysis) (Figure 1-1)

The Upper Sevier Watershed Management Plan is a fine-scale look at ecosystem processes. It serves to bridge the gap between broad-scale and mid-scale information and decisions at the site-specific, project analysis scale. The watershed plan is not a detailed fine-scale analysis, but rather, a review of fine-scale issues and a priority-setting tool to identify and prioritize where to do more site-specific analysis.

Document Uses

This initial watershed management plan provides an analysis and assessment of the resources at a watershed scale. Again, in most cases, it does not provide site-specific information, but rather, a strong background to assist in determining site-specific analysis. Numbers (acres, miles, etc.) reported in this review may vary when an actual analysis is completed at a smaller-scale with more site-specific on-the-ground data.

Much of the watershed has its roots in ranching and agriculture. Maintaining those uses, while ensuring water quality and integrity is a priority for the Upper Sevier Watershed.

Relationship to Federal Land Management Plans and other Documents

The Upper Sevier Watershed Management Plan tiers to other Land Management Plans. While such documents as the Forest Land Management Plan and the Bureau of Land Management Plan, provide more broad-scale guidelines, the Upper Sevier Watershed Management Plan focuses more on specific areas and issues. Recommendations within this plan are not meant to supersede those identified throughout other agency documents, but simply act as a guide to improving watershed conditions.

...all ethics so far evolved rest on the single preimse that the individual is a member of a community of interdependent parts...the land ethic simply enlarges the boundaries of the community to include soils, water, plants, and animals, or collectively: the land."

--Aldo Leopold

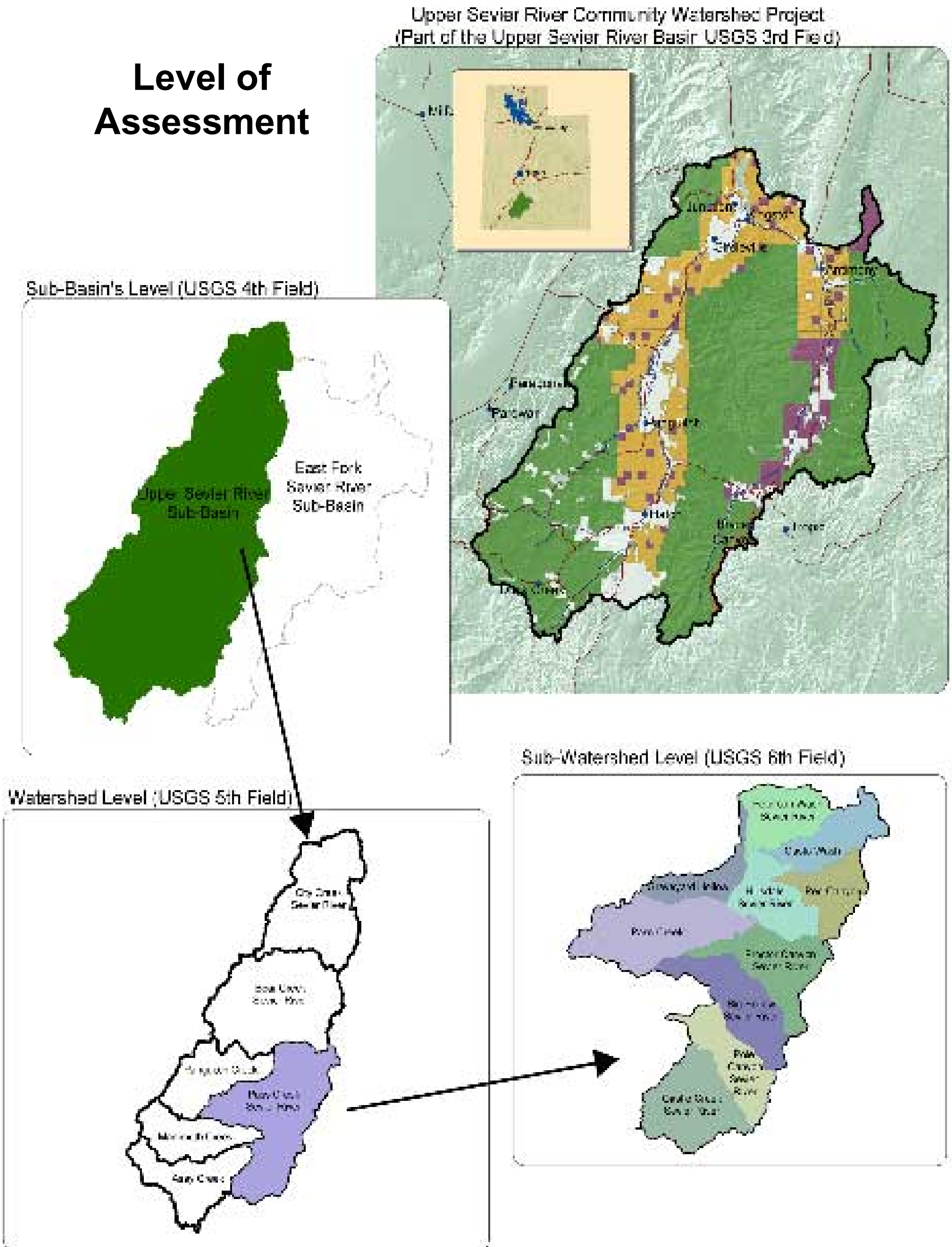


Fig. 1-1. The Upper Sevier Watershed Management Plan examines issue at the watershed level (USGS 5th field HUC). There are nine 5th field watersheds within the Upper Sevier River Basin.

Priority Water Quality Treatment Areas Identified during Initial Basin-wide Assessment, Fall 1999

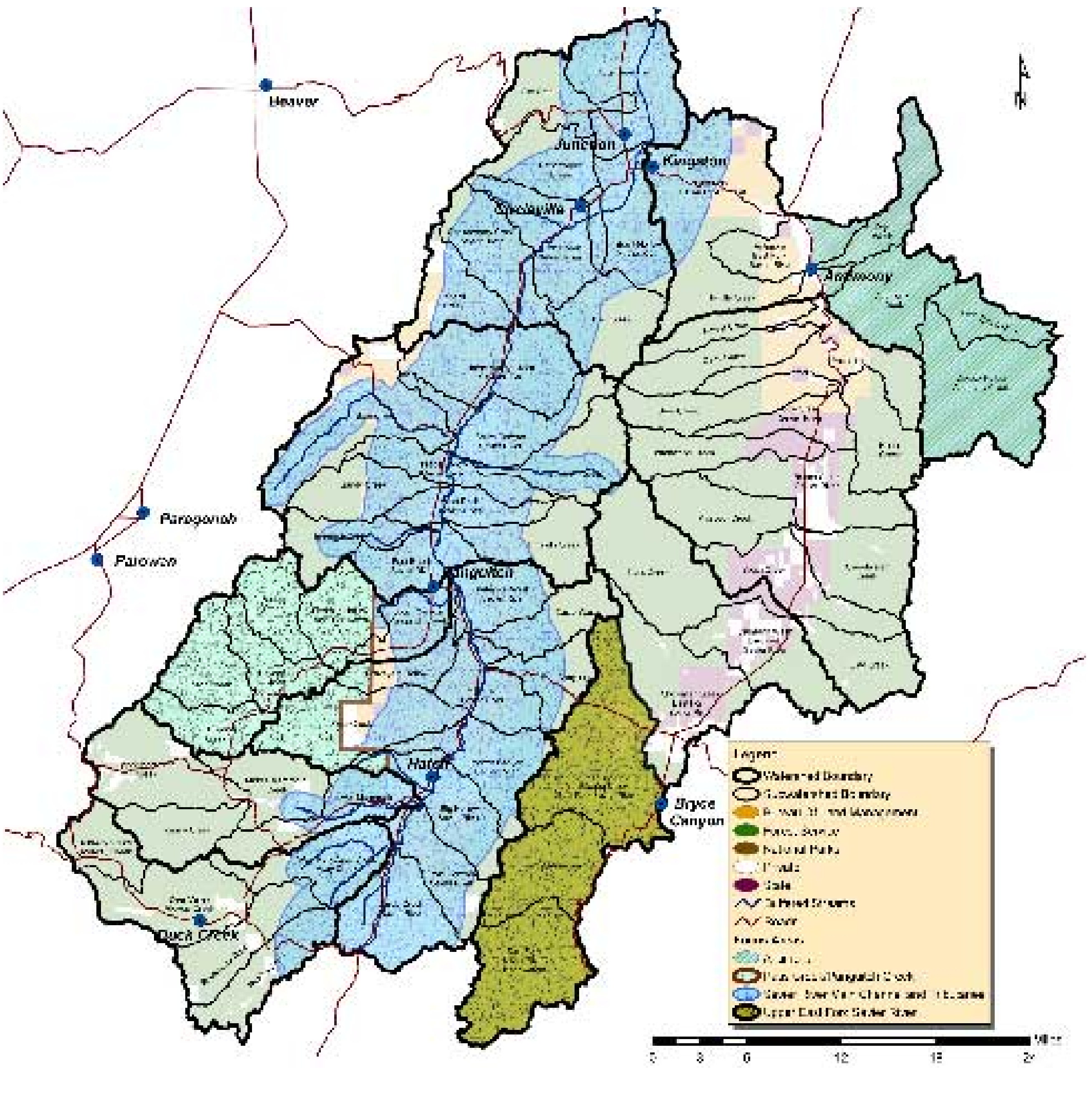


Fig. 1-2. Priority focus areas were established during the initial basin-wide assessment during Fall, 1999. Efforts continue to be placed in these areas; however, recent work has evolved into a watershed management plan to help develop priorities within the whole Upper Sevier River Basin.

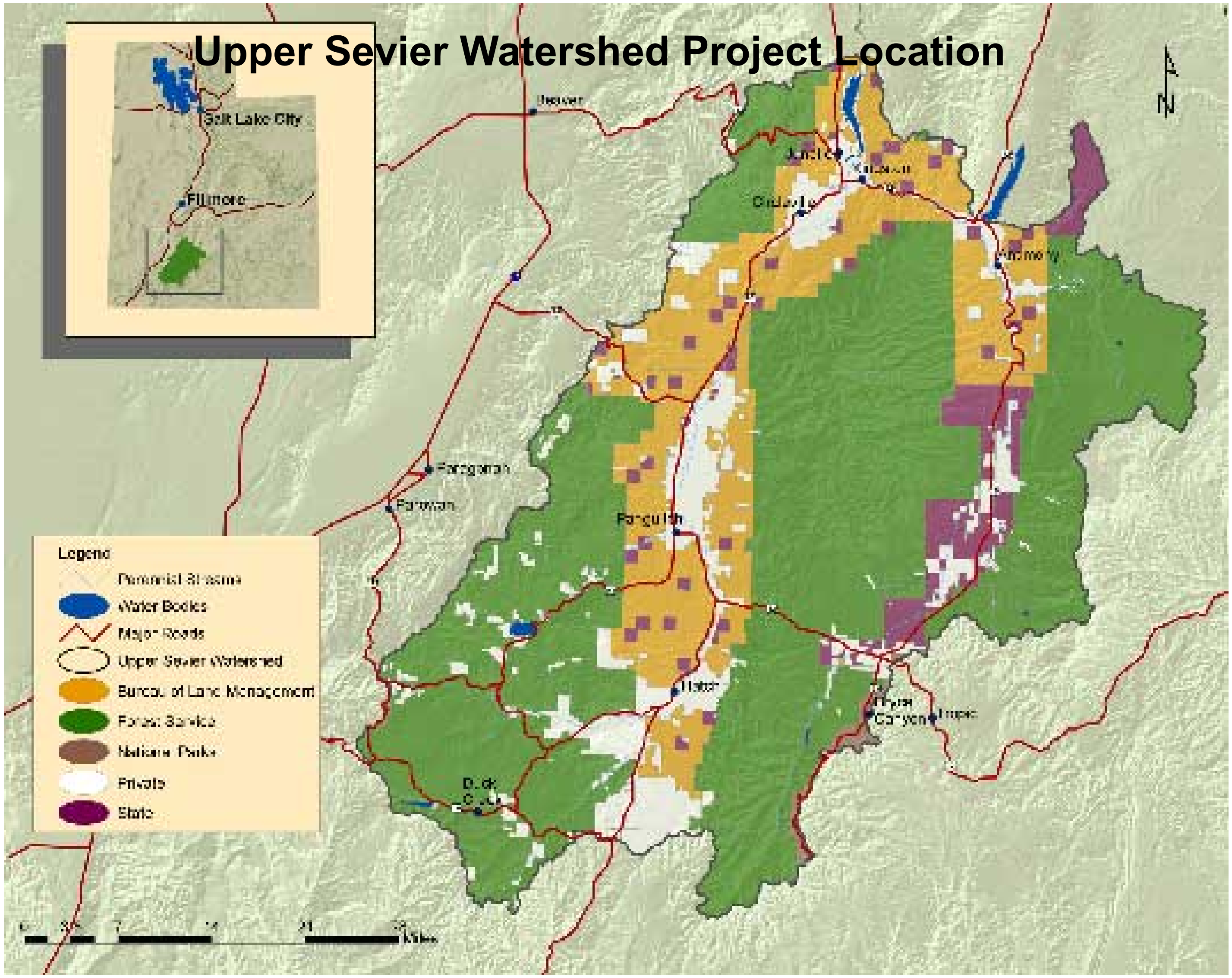
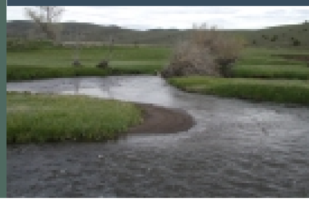


Fig. 1-3. The Upper Sevier Watershed Project is one of approximately 15 efforts selected nationwide by the USDA Forest Service to implement holistic watershed restoration in cooperation with land management agencies, private landowners, and other interested parties. The watershed, located in south-central Utah, is a 1,324,899 acre area covering the headwaters of the Sevier River in Beaver, Garfield, Iron, Kane, Piute and Wayne counties.



Basin Description

Watershed Characteristics

Physical Characteristics

General Location

The Upper Sevier River Basin (also referred to as a large watershed, composed of smaller watersheds) is a 1,324,899 acre area covering the headwaters of the Sevier River in Beaver, Garfield, Iron, Kane, Wayne and Piute Counties of south-central Utah. The upper reaches of the Sevier River drain much of the southern portions of the High Plateaus section of the Colorado Plateau Province. The Sevier River and its main tributary, the East Fork Sevier River, flow northward cutting a trough through the center of the High Plateaus section with a broad, flat north-south trending fault-controlled valley (Fig. 2-1).

Basin Location and Classification

The basin is classified according to Hydrologic Unit Cataloging (HUC). The Upper Sevier River Basin is part of the Great Basin Region (3rd Level HUC, Catalog Unit 160300) and is borderd to the south by the Lower Colorado Region, and to the East by the Upper Colorado Region (Fig. 2-2). The nine 5th level watersheds and location within the basin are shown in Fig. 2-1. Fifth and 6th level subwatershed and HUC numbers are listed in Table 2-1.

The Upper Sevier River Basin is important to local communities for commodity production as well as for recreational opportunities. People from urban areas such as the Wasatch Front (Salt Lake City area) and Las Vegas use the area mainly for recreation, while livestock grazing is among one of the oldest land uses in the region, contributing important cultural and social values to the area.

Major Land Resource Areas

Almost 94 percent of the basin is within the Wasatch and Uinta Mountains Plateau Major Land Resource Area (MLRA), while the remaining 6 percent falls within the Great Salt Lake Plateau MLRA (Fig. 2-3). MLRA's are classified by the U.S. Department of Agriculture (USDA) according to geographically associated units with dominant physical characteristics of topography, climate, hydrology, soils, land use, and potential natural vegetation.

County Location

Although 73 percent of the basin is located in Garfield County, it accounts for only 28 percent of the total county acres. Garfield County derives 20 percent of its income from agriculture. Only 9 percent of the watershed is located in Piute County (26 percent of total county acres), 8 percent in Kane County (4 percent of total county acres), 8 percent in Iron County (5 percent of total county acres), and less than one percent in Beaver and Wayne Counties (less than 1 percent of total county acres) (Table 2-2, Fig. 2-4). Major communities within the watershed include: Panguitch, Antimony, Hatch,

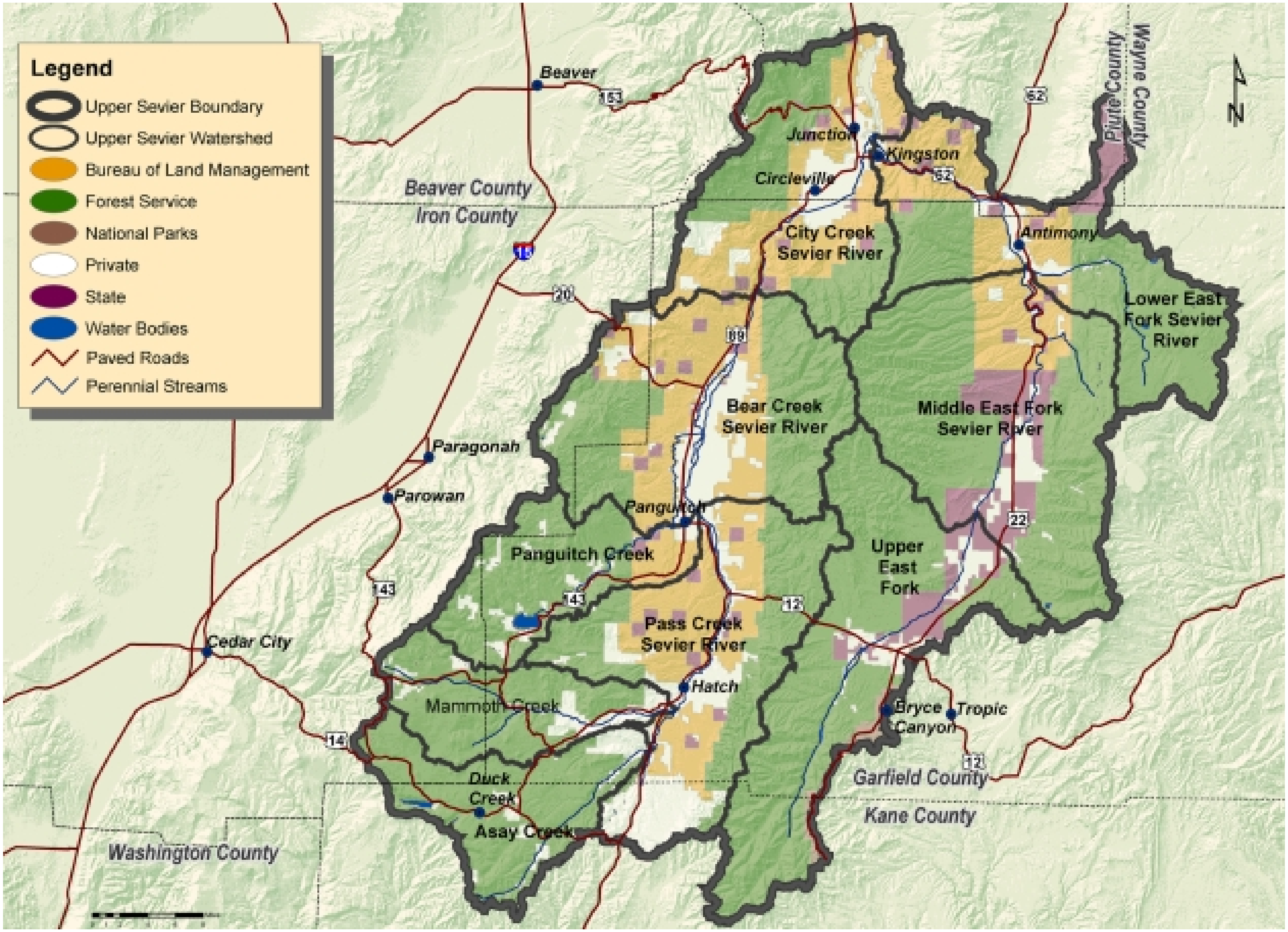


Fig. 2-1. Portions of hte basin fall within Beaver, Piute, Wayne, Garfield and Kane counties. Land ownership is diverse with sections of state, federal and private lands. There are 9 watersheds within the Upper Sevier River basin.

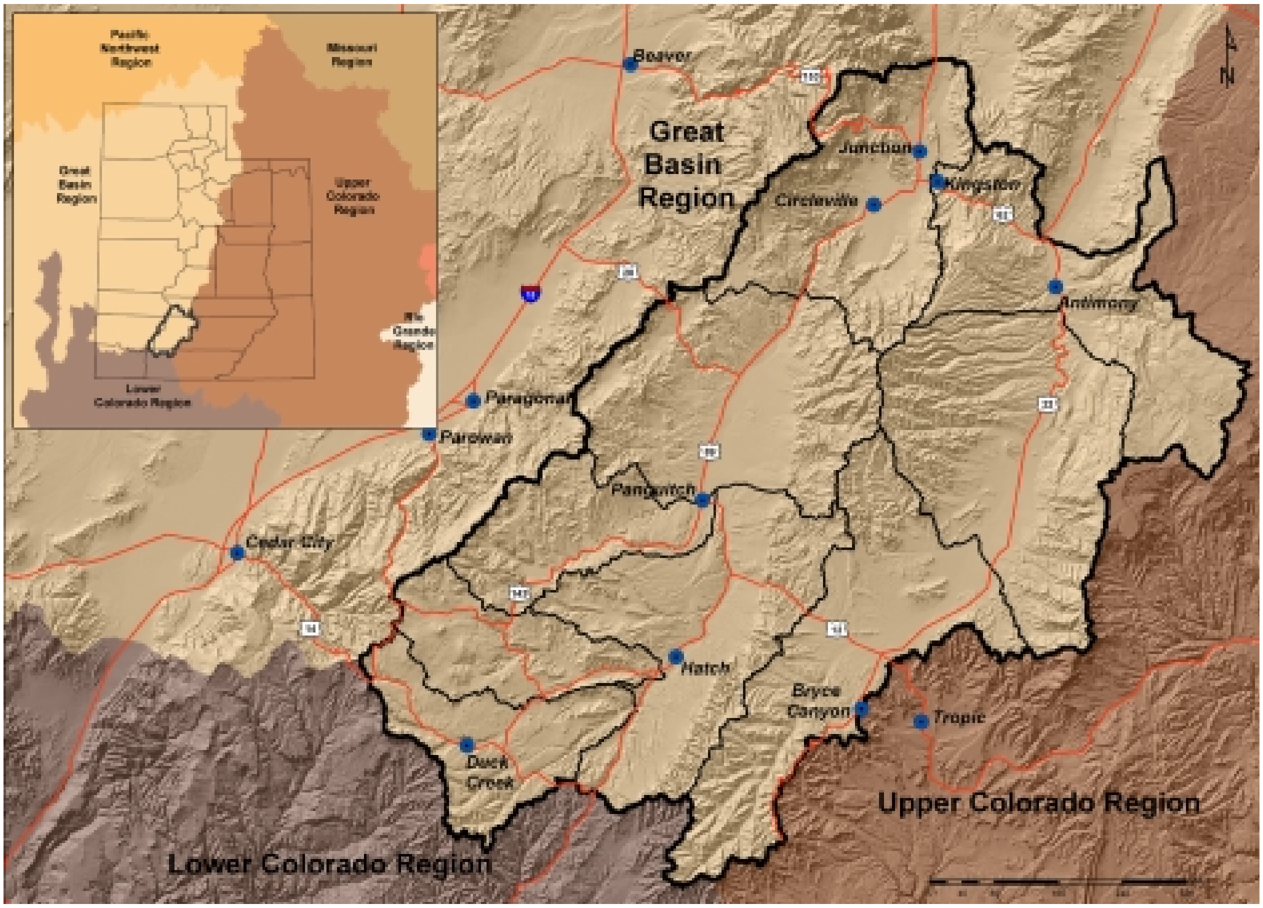


Fig. 2-2. The Upper Sevier River basin is located entirely within the Great Basin Region.

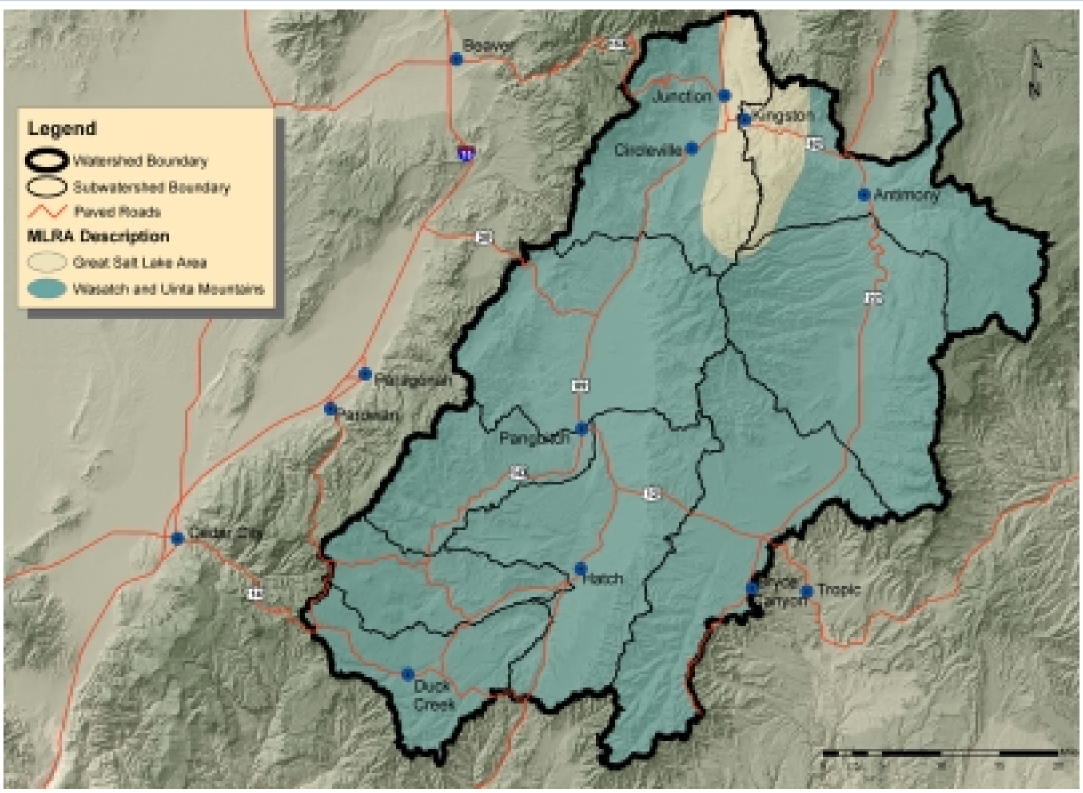


Fig. 2-3. Almost 94 percent of the Upper Sevier River Basin is within the Wasatch and Uintah Major Land Resource Areas.

3rd Level Huc/Name		4th Level Huc/Name		5th Level Huc/Name		6th Level Huc/Name	
160300	Great Basin Region	16030001	Escalante Desert-Sevier Lake	1603000101	Asay Creek	160300010101	Midway Valley-Midway Creek
						160300010102	Deer Valley-Midway Creek
						160300010103	Strawberry Creek
						160300010104	Swains Creek
						160300010105	West Fork Asay Creek-Asay Creek
				1603000102	Mammoth Creek	160300010201	Upper Mammoth Creek
						160300010202	Tommy Creek
						160300010203	Middle Mammoth Creek
						160300010204	Lower Mammoth Creek
				1603000103	Pass Creek-Sevier River	160300010301	Castle Creek-Sevier River
						160300010302	Pole Canyon-Sevier River
						160300010303	Big Hollow-Sevier River
						160300010304	Proctor Canyon-Sevier River
						160300010305	Pass Creek
						160300010306	Red Canyon
						160300010307	Hillsdale-Sevier River
						160300010308	Casto Wash
						160300010309	Graveyard Hollow
						160300010310	Peterson Wash-Sevier River
				1603000104	Panguitch Creek	160300010401	Ipson Creek
						160300010402	Blue Spring Creek
						160300010403	Haycock Creek
						160300010404	Butler Creek
						160300010405	Fivemile Hollow-Panquitch Creek
						160300010406	South Canyon-Panguitch Creek
				1603000105	Bear Creek-Sevier River	160300010501	Threemile Creek
						160300010502	East Bench-Sevier River
						160300010503	Limekiln Creek
						160300010504	West Ditch-Sevier River
						160300010505	Sandy Creek
						160300010506	Tebbs Hollow-Sevier River
						160300010507	Sanford Creek
						160300010508	Bear Creek
						160300010509	Smith Canyon-Sevier River
						160300010510	Horse Valley Creek-Sevier River
				1603000106	City Creek-Sevier River	160300010601	Eehard Creek
						160300010602	Chokecherry Creek-Sevier River
						160300010603	Birch Creek-Sevier River
						160300010604	Lost Creek
						160300010605	Cottonwood Creek
						160300010606	Burnt Hollow-Sevier River
						160300010607	City Creek
						160300010608	Piute Reservoir
				1603000203	Upper East Fork Sevier River	160300020301	East Fork Sevier River Headwaters
						160300020302	Tropic Reservoir
						160300020303	Mud Spring Creek-East Fork Sevier River
						160300020304	Showalter Creek-East Fork Sevier River
						160300020305	Hunt Creek
						160300020306	Cameron Wash-East Fork Sevier River
				1603000204	Middle East Fork Sevier River	160300020401	Clay Creek
						160300020402	South Creek
						160300020403	Sweetwater Creek
						160300020404	Prospect Creek
						160300020405	Ranch Creek-Sevier River
						160300020406	Cottonwood Creek
						160300020407	Cow Creek-Sevier River
						160300020408	Deer Creek
						160300020409	North Creek
						160300020410	Deep Creek
						160300020411	Forest Creek
						160300020412	Pacer Lake
				1603000205	Lower East Fork Sevier River	160300020501	Coyote Hollow-Antimony Creek
						160300020502	Lost Spring Draw
						160300020503	Antimony Creek
						160300020505	Dry Wash
						160300020506	Antimony-East Fork Sevier River
						160300020507	East Fork Sevier River Outlet

Table 2-1. Third through sixth level hydrologic cataloging units (HUC).

Circleville, Kingston, and Long Valley Junction. Urban-interface type subdivisions within the Dixie National Forest include those at Panguitch Lake, Mammoth Creek and Duck Creek.

County Name	Watershed Acres	County Acres	Watershed as % of County
Beaver	642.16	1682238.15	0.04%
Garfield	978322.85	3411695.58	28.68%
Iron	111691.65	2094287.04	5.33%
Kane	111240.17	2652166.74	4.19%
Piute	122641.29	466503.84	26.29%
Wayne	715.54	1560792.42	0.05%
Watershed Total	**1325253.66**	**11867683.8**	

Table 2-2. Portions of the Upper Sevier River Basin (watershed) are located in Beaver, Garfield, Iron, Kane, Piute and Wayne Counties. The basin represents less than one-third of the total acres within all counties in which it is located.

Elevation

Elevation within the Upper Sevier River Basin varies from 5,884 feet (City Creek Sevier River Watershed, Piute Resevoir Subwatershed) to 11,322 feet (City Creek Sevier River Watershed, Birch Creek Subwatershed). Gentle rolling hills alongside high altitude forests are characteristic of the Markagunt, Paunsaugunt and Aquarius Plateaus in which the watershed resides (Fig. 2-5).

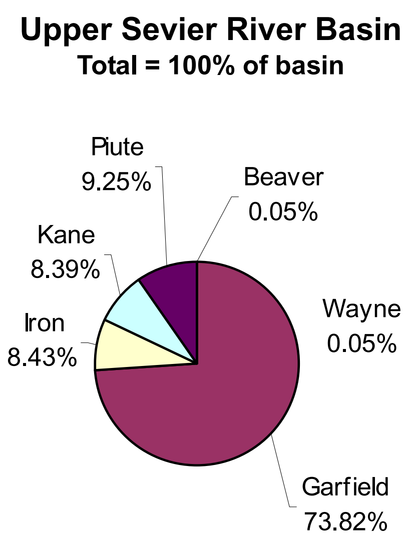


Fig. 2-4. The largest portion of the basin falls within Garfield County.

Precipitation

Precipitation ranges from 5 inches in lower elevations (~5,000 to ~6,500 ft) to more than 40 inches per year near Brian Head Peak (11,307 ft) - one of the highest points in the watershed. Although heavy thunderstorms are common throughout summer months, causing increased overland erosion, most of the annual precipitation falls as snow during winter months. Information regarding annual average maximum/ minimum temperatures, annual average snowfall and precipitation is available through the Western Regional Climate Center for seven points within the watershed (Fig. 2-6).

Geology

The Upper Sevier River Basin is within the Northern Markagunt, Southern Markagunt-Paunsaugunt Plateaus, Sevier Plateau, and Johns Valley subsections of the Utah High Plateaus and Mountains Section.

Geologically, the area consists of mixed volcanics (recent basalts, andesite, rhyolite, etc.), and Wasatch Limestone formation. Large basalt flows are present at higher elevations within the western portion of the basin (8,000+ ft.), while the lower portion of the basin (5,000 - 6,000 ft.) consists of rounded hills and broad valleys.

Rock areas consist primarily of Wasatch Formation (limestone and standstone) in the form of cliffs,

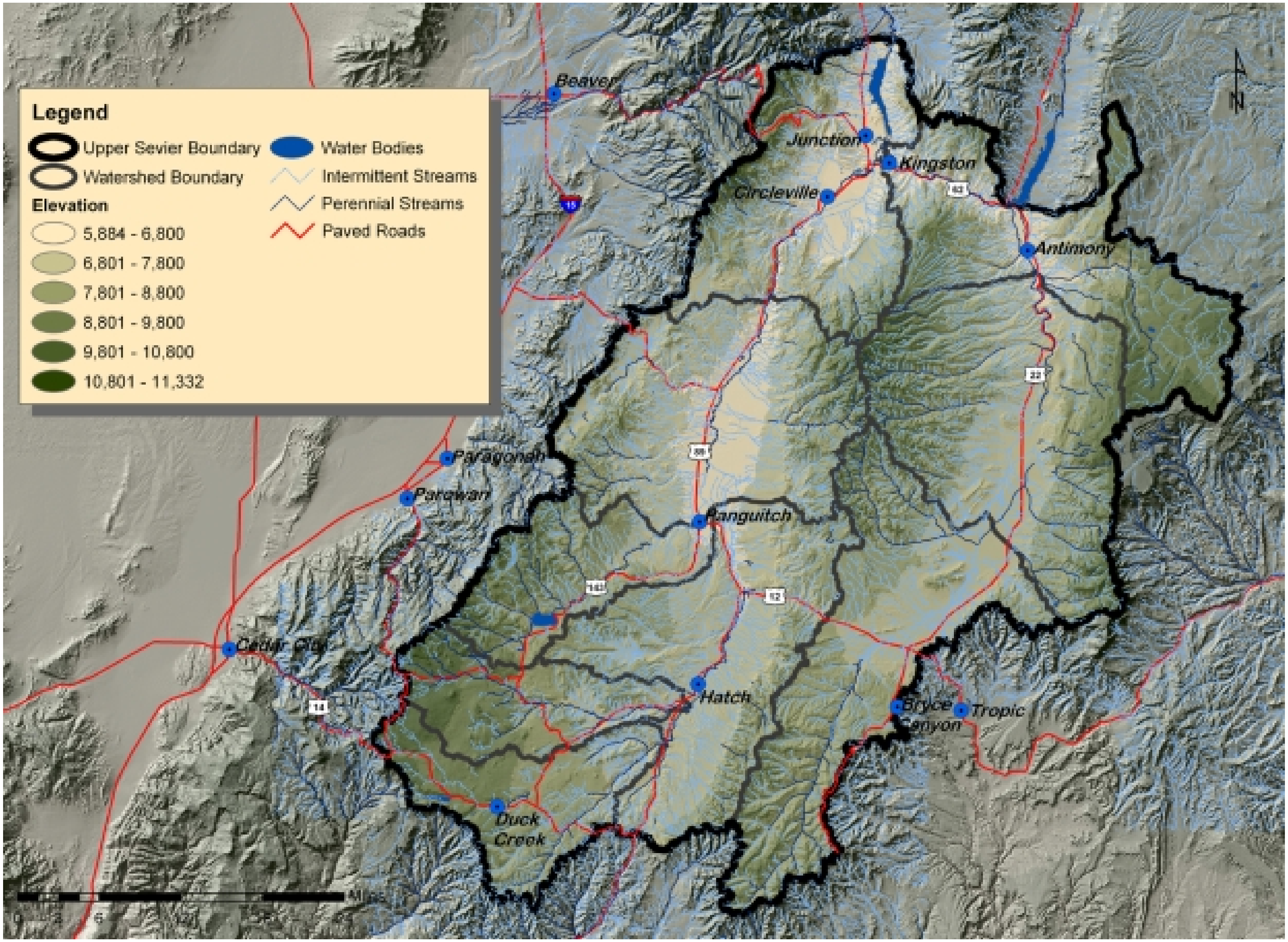


Fig. 2-5. Both the lowest and the highest points in the watershed are located within the City Creek Sevier River Watershed - the northwestern most watershed within the Upper Sevier River Basin.

escarpments and tertiary volcanic soils. Although vegetation is found in many rocky areas, it comprises no more than 10% cover. Most disturbances tend to be small and isolated except for rockslides and landslides. Under extremely windy conditions, fires may spot across rocky areas, burning patches of vegetation. Generally, however, these rocky areas act as fuel breaks.

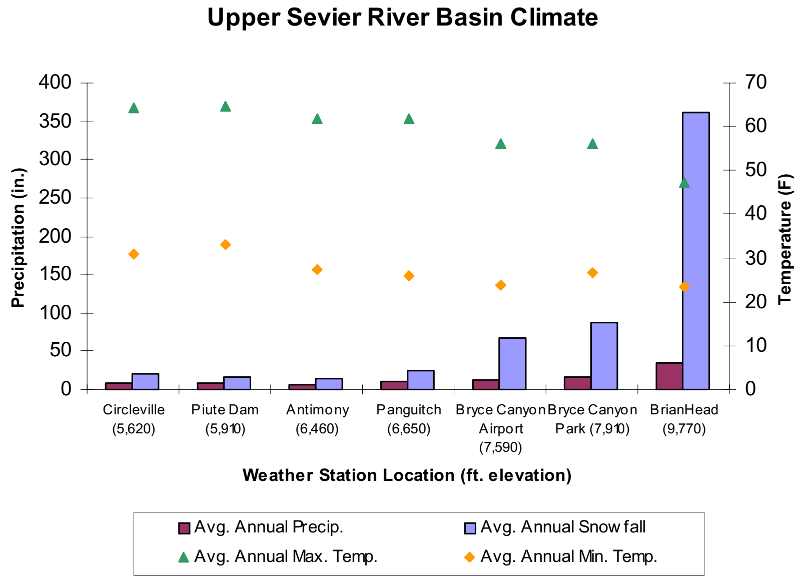


Fig. 2-6. Temperature and precipitation information for seven locations located throughout the Upper Sevier River Basin..

Soil types

Soils within the Upper Sevier River Basin are classified according to soils data and map unit delineations as part of the State Soil Geographic (STATSGO) database (Table 2-3, Fig. 2-7). This system, used throughout the country, uses unique map units to classify soil series having similar chemical and physical properties.

Erosion Processes

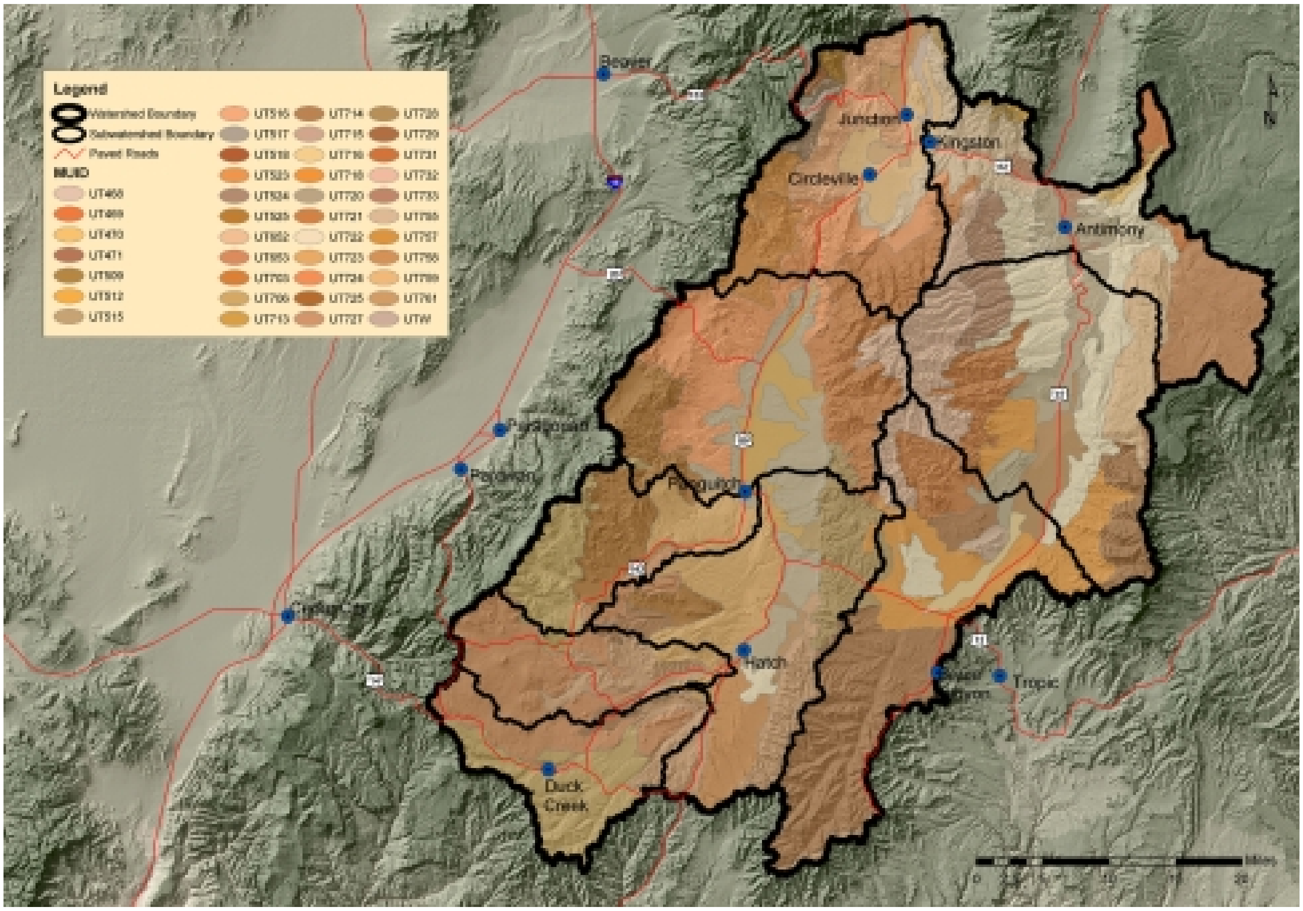
Within natural forested landscapes mass erosion such as geological creep, and to a lesser degree slump and debris avalanches, are the dominant upland erosion processes. After intense wildfire, surface erosion is a dominant factor. In valley bottoms, stream channel erosion, including both bed and bank erosion, may deposit materials into the channel, where transport, storage and deposition may influence stream integrity.

As early settlers moved into the Upper Sevier River Basin, surface erosion processes have become more prevalent in areas where road constructing, mining, timber harvesting and grazing occur. Roads have increased surface and mass erosion rates beyond those associated with natural watershed disturbances. An extensive network of roads constructed in areas such as stream bottoms and unstable landtypes has resulted in large scale mass erosion.

Vegetation

Vegetation within the basin ranges from sparse, desert-type plants in the lower elevations to stands of low growing pinyon pine and juniper in the mid-elevations. Aspen, and conifer species such as ponderosa pine, spruce and fir dominate at higher elevations (Fig. 2-8, Table 2-4).

Pinyon/juniper and Sagebrush/grass occupy 53% of the basin, and are the two dominant vegetation types.



Map Unit	Soil Group Name	Map Unit	Soil Group Name
UT728	BADLAND-ROCK OUTCROP-SYRETT	UT715	MIKIM-HENRIEVILLE-BARX
UT515	BOWEN-DACORE-AGASSIZ	UT759	MONROE-MEDBURN-GREEN RIVER
UT732	CALLINGS-BEHANIN-BEARDALL	UT720	NOTTER-BRUMAN-TRIDELL
UT731	CASTINO-ROCK OUTCROP-CIRCLEVILLE	UT729	PAHREAH-SYRETT-BADLAND
UT714	CODLEY-DESCOT-JODERO	UT469	PARKAY-FAIM-FORSEY
UT518	CONDIE-SCOUT-BICKMORE FAMILY	UT761	POGANEAB-KIRKHAM-MANASSA
UT523	CONDIE-SCOUT-DATEMAN FAMILY	UT703	ROB ROY-DOYCE-TOLMAN FAMILY
UT509	DACORE-BOWEN-ELLETT	UT524	ROCK OUTCROP-NIELSEN FAMILY-TATIYEE
UT470	DUNE LAND-BUSHVALLEY	UT727	RUKO-ROCK OUTCROP-SWAPPS
UT471	ELDGIN-HANDY	UT653	SCOUT FAMILY-NAMON FAMILY-TINGEY
UT706	FAIM-SETH-WINNEMUCCA	UT517	SCOUT-CONDIE-PARKAY
UT468	FORSEY-FAIM-PARKAY	UT525	SCOUT-LOSEE-BLANCA
UT716	FRANDSEN-PLAYAS-CODLEY	UT512	SESSIONS-MORTENSON-KAMACK
UT516	GOLSUM-TELLURA-GABICA	UT718	SHOWALTER-GUBEN-PANGUITCH
UT757	GREEN RIVER-POGANEAB-HAULINGS	UT713	TEBBS-VILLY FAMILY-ALLDOWN
UT725	HAROL-DALCAN-TOLMAN	UT724	TOLMAN-COMODORE-WALTERSHOW
UT758	HIKO PEAK-BERTELSON-TOSSER	UT723	WALTERSHOW-QUILT-VENTURE
UT755	HIKO PEAK-ROCK OUTCROP-RED BUTTE	UTW	WATER
UT722	IPSON-TRIDELL-GUBEN	UT733	WINNEMUCCA-HOODLE-CASTINO
UT652	JEMEZ FAMILY-PARKAY FAMILY-TATIYEE FAMILY	UT721	ZINZER-LUHON-TRIDELL

Fig. 2-7, Table 2-3. Map unit names, numbers and location as contained within the State Soil Geographic database (STATSGO).

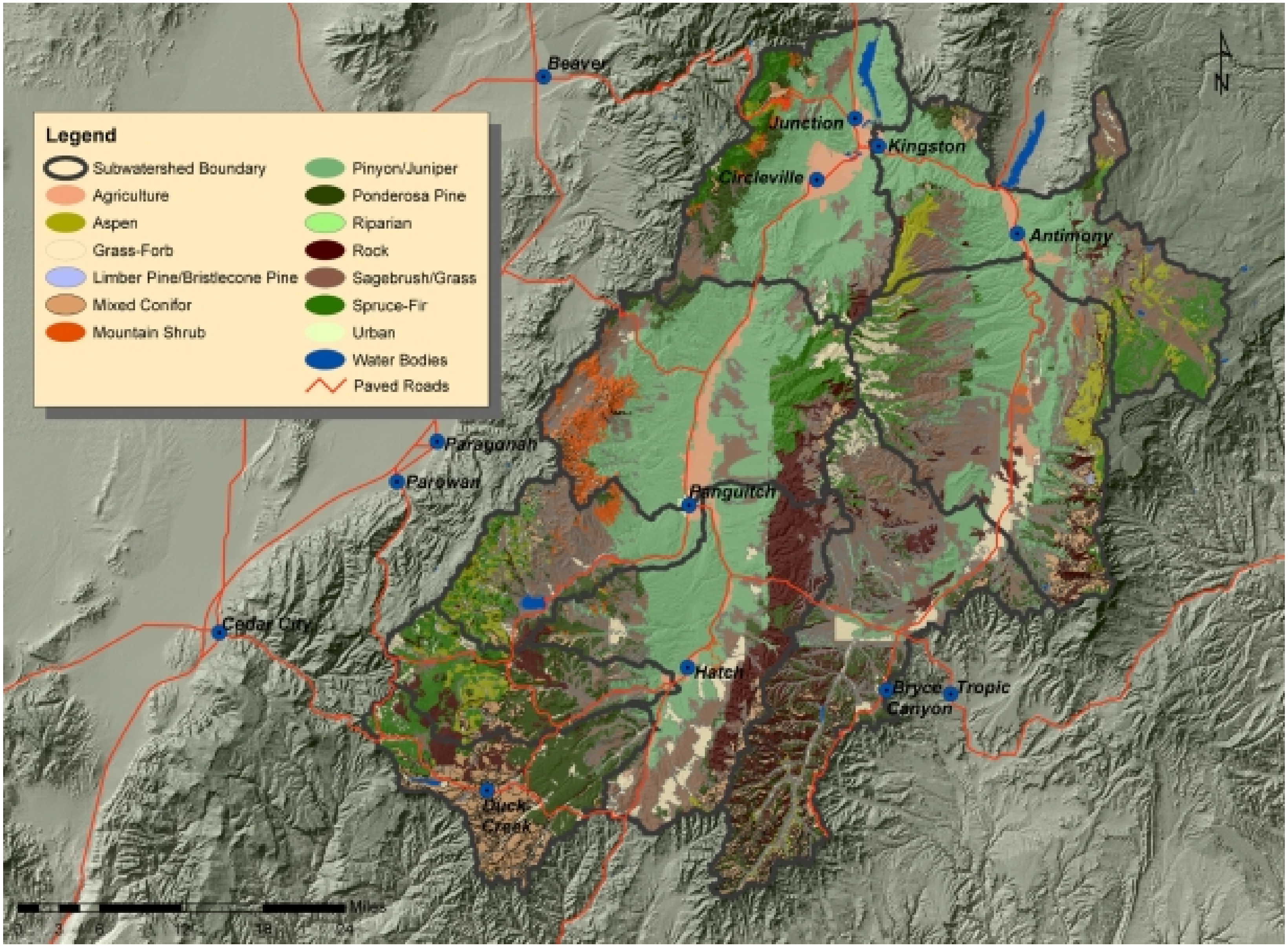


Fig. 2-8. Pinyon-juniper and sagebrush/grasslands occupy much of the basin, while ponderosa pine, aspen, spruce-fir and mixed conifer occupy areas within the higher reaches.

Noxious Weeds

Noxious weeds, as defined by law, are plants of foreign origin that can directly or indirectly injure agriculture, navigation, fish, wildlife or public health.

Noxious weeds identified within the watershed include Canada thistle, Dalmation toadflax, Musk thistle, Russian knapweed, Scotch thistle, spotted knapweed, and whitetop. Noxious weed dispersal is of concern throughout the western United States (including the Upper Sevier River Basin), and especially in agricultural areas and along travel routes.

Vegetation Type	Acres	%
Agriculture	31,316	2%
Aspen	51,843	4%
Grass/Forb	73,824	6%
Limber/Bristlecone Pine	321	0%
Mixed Conifer	102,723	8%
Mountain Shrub	25,883	2%
Pinyon/Juniper	409,256	31%
Ponderosa Pine	128,416	10%
Sagebrush/Grass	285,471	22%
Spruce/Fir	104,808	8%
Urban	1,480	0%
Other	109,558	8%
Total	**1,324,899**	**100%**

Table 2-4. Together, pinyon-juniper and sagebrush/grass cover more than 50 percent of the watershed.

Stream Miles

Intermittent and perennial streams are shown in Figure 2-5. Several sections of the Sevier River and the Upper East Fork are diverted for irrigation use, and the channels remain dry throughout much of the year. Perennial stream miles account for 12% total stream miles (636.25 miles), while intermittent streams account for 88% stream miles (4,502.76 miles) within the basin.

Water Related Land Uses

As a part of Utah's effort in developing a state water plan, the Division of Water Resources continually assesses water-related land uses within the state. This data includes the kinds and extent of irrigated crops and information on phreatophytes (plants that obtain water from the water table or the soil just below it), wet/open water areas, and residential/industrial areas.

Land Use	Acres
Irrigated	**26218.89**
Non-Irrigated	**1079.864**
Other	**217.5855**
Riparian	**898.574**
Irrigated Riparian	**7988.587**
Non-Irrigated Riparian	**564.9679**
Urban	**701.7174**
Urban/Resident	**3262.539**
Water	**4664.368**
Total	**45597.09**

Table 2-5. Water-related land uses, Division of Water Resources.

A total of 45,597 acres was devoted to water related land uses within the Upper Sevier River basin. Satellite imagery collected in 1991 by the Utah Department of Natural Resources, Division of Water Resources, shows that much of the water-related land use is located along valley floors and major stream corridors (Fig 2-7, Table 2-5).

Fish and Wildlife

Over 350 species of fish and wildlife live in the basin for all or a portion of their lives. Big game species, such and deer and elk, are important from a recreational (hunting) aspect, and also serve as management indicator species within the Dixie National Forest. Other wildlife, including wild turkey, goshawk, flicker and cutthroat trout may serve as Management Indicator Species (MIS) for state and federal agencies like the Division of Wildlife Resources, Dixie National Forest and Bureau of Land Management.

Detailed descriptions of wildlife species evaluated as part of the Upper Sevier Management Plan are contained in Chapter 3.

Fish native to the Upper Sevier River Basin include Bonneville cutthroat trout, leatherside chub, mountain sucker, speckled dace, and mottled sculpin. Non-native species such as cutthroat, brook, rainbow and brown trout have established within the basin or have been stocked as part of the Utah Division of Wildlife Resources sport fishery program.

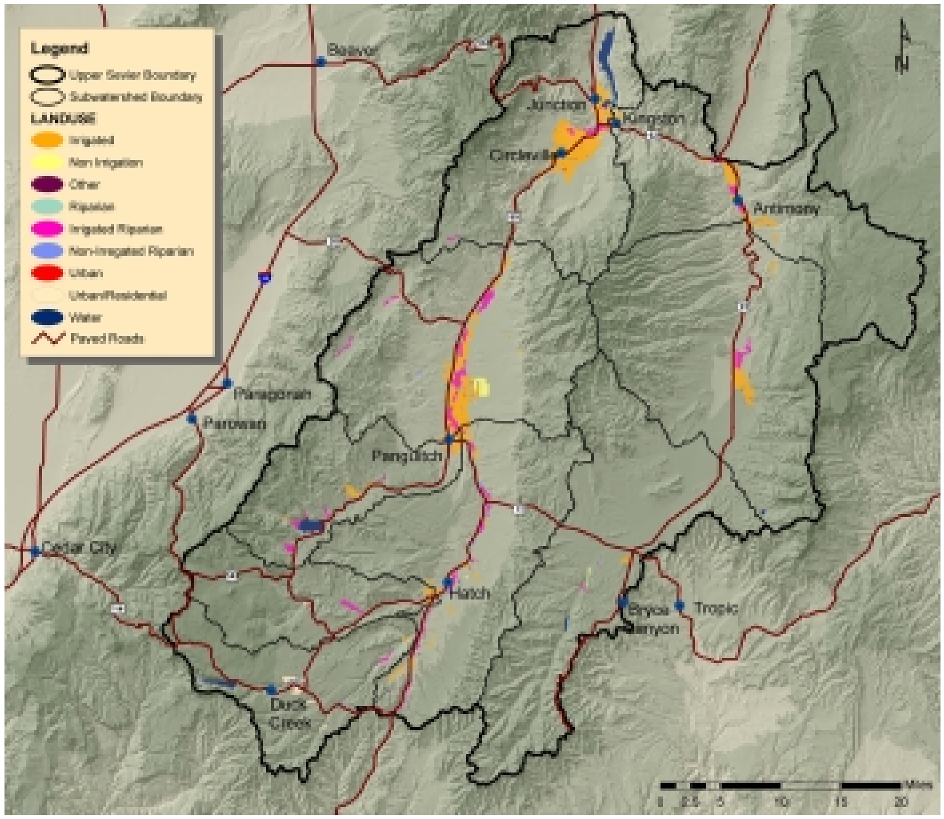


Fig. 2-7. Most of the basin-related land use occurs directly along the Upper Sevier River and Upper East Fork.

Social and Economic Settings

Settlement History

Paleoindians (12,000-5,000 B.C.) were the first inhabitants to roam the land within the Upper Sevier River basin. Remains and artifacts from this culture can be found within the basin from Garfield County north into Piute County. Evidence suggests that these Indians traveled in small groups, depending on large game and to some degree, small game and fish as a food source. However, there is no evidence to suggest that this group participated in any form of agriculture (Hinton, 1997).

Archaic people entered the basin about 9000 B.C. and migrated with the seasons, utilizing berries, seeds, badger, beaver, deer, sheep, small rodents and different types of vegetation as food. The highly mobile Archaic people were more advanced than their predecessors, utilizing animal bones for needles and constructing clothing, footwear and shelter. Most remnants of this population disappeared around 1500 B.C.

Fremont Indians lived along the Sevier River from about 800 to 1200 A.D. Within the basin, the Fremont Cultures were the first to have a strong agricultural base, growing such crops as beans, corn, and squash. Distinctive pictographs of triangular-shaped humans, wearing extravagant necklaces and clothing alongside pictographs of deer, sheep, rattlesnakes and other animals they may have harvested, suggest this group placed importance on big game harvest. The Fremont disappeared from the basin between 1200 and 1300 A.D, possibly fleeing because of drought or just evolving into other tribes within the area.

The Numic people composed of the Ute and Southern Piute Indians made the basin their home from 1300 A.D. to present. Both Utes and Piutes took advantage of what the land had to offer by hunting a lot of small game, including rodents, rabbits, squirrels, prairie dogs, and beaver. Trout from the river supplemented a large portion of their diet, while pinenuts were gathered and stored for use in winter months.

In the 1500’s Spanish conquistadors began to visit areas within the southwestern United States, and most likely the Upper Sevier River basin. Spanish explorers and traders introduced horses to the Ute Indians, making big game easier to obtain. In addition, Spanish traders kidnapped Ute women and children and sold them into slavery back in the New Mexico Territory. In turn, Ute Indians kidnapped Paiute Indians, creating hostile conditions within the basin.

The greatest force in non-Indian settlement of the Sevier River drainage was Mormon Church colonization. Mormon settlement along the Sevier River drainage during the late 1840’s to early 1860’s was based on agriculture, with dairy and open-range beef cattle within co-operative herds. From the early 1850’s to mid-1870’s dairy and open cattle ranging practices were disrupted by Indian conflicts and settlers lost considerable livestock.

Cattle numbers remained low until the late 1860’s and early 1870’s when settlers realized the profits available within the cattle industry. Railroad transportation arrival in 1869 heralded an era of rapid expansion within the cattle industry and prior community co-operative holdings were superseded by individual holdings.

Areas within the basin continue to be shaped by agriculture and livestock industries today, and many families continue to make a living in the same manner as their ancestors. Because agriculture and ranching plays a large role within the basin, number of farms and agriculture economic information is provided in Table 2-6. Information available from the U.S. Department of Agriculture (1997) classifies information by county, and not by specific watershed, but can be used as a guide to land and water use within the specific areas of the basin.

Current Population

While Utah continues to be the 4th fastest growing state in the nation, county populations within the basin have remained fairly stable over the past Century further emphasizing the cultural, economic and social values tied to resources within the basin.(U.S. Census Bureau, 1995, 2001, 2003) (Fig. 2-8).

While established towns such as Panguitch, Circleville and Junction may be considered “urban” by definition (established city), they maintain rural lifestyles because of small town size and way of living (Table 2-7).

The total population of the basin is not readily available, however, this figure can be inferred by

	County					
	Beaver	Garfield	Iron	Kane	Piute	Wayne
Farms (Number)	219	285	375	143	106	191
Land in Farms (Acres)	130994	121381	404574	175384	44504	59593
Average Size of Farm	598	426	1079	1226	420	312
Market Value of Ag Products Sold ($000s)	58525	7583	42126	3230	7216	11,200
Operators by Principal Occupation-Farming	124	116	156	66	79	100
Operators by Principal Occupation-Other	95	169	219	77	27	91

Table 2-6. Number of farms and farmland acres for counties in which portions of the Upper Sevier River Basin are located.

using 2000 U.S. Census data. Total populations for cities located within the basin, and the additional county population multiplied by the percent of the county within the basin, give a fairly accurate picture of total basin population. It is assumed that the additional county population figure represents an equal distribution of population throughout non-city areas (Table 2-7). Approximately 3,704 people reside within the Upper Sevier River Basin.

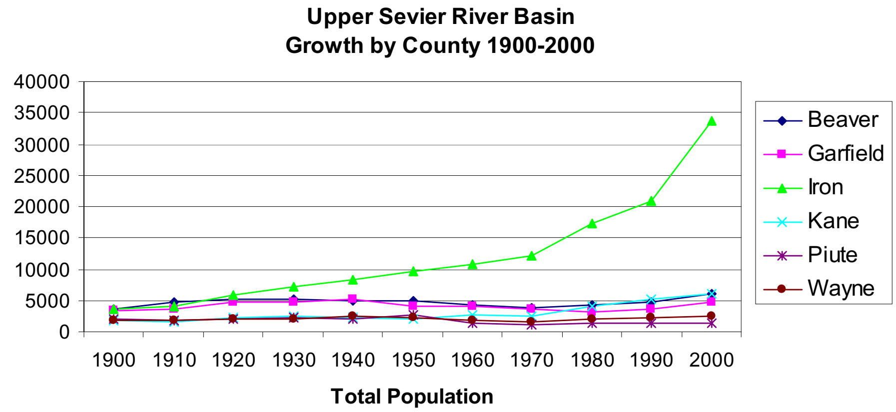


Fig. 2-8. Populations for counties in which the Upper Sevier River Basin resides, have changed little since the first of the Century, except for Iron County. Most of the growth within Iron County has occurred in urban areas, such as Cedar City, which is located outside of the basin boundaries.

Income and Employment

Garfield County, in which most of the basin resides, depends largely on tourism. With Bryce Canyon and Lake Powell, and close proximity to many other parks/attractions, the county attracts many seasonal visitors each year. The travel/hospitality industry accounts for 30.85 percent of the work force, while government at 22.45 percent and farming/ranching at 19.83 serve as the other two major work sectors. Additional employment information for Garfield County, as well as information for Beaver, Garfield, Iron, Piute and Wayne Counties are summarized in Table 2-8 and Fig. 2-9. This data is presented for informational purposes only, and is taken from actual county statistics and not weighted to conform with percent of basin located within each county.

County	Communities within Basin City	Population	Other County Population	%County w/in Basin	Inferred additional Population	Total County Population
Beaver			1283	0.04%	0.49	1283.49
Garfield	Antimony	122				
	Hatch	127				
	Panguitch	1623	1050	28.68%	301.09	2173.09
Iron			6321	5.33%	337.11	17.98
Kane			980	4.19%	41.10	1.72
Piute	Circleville	492				
	Junction	149				
	Kingston	158	267	26.29%	70.19	228.19
Wayne			1226	0.05%	0.56	0.58
Total Population						**3704.48**

Table 2-7. The total population of the watershed is estimated at 3,704 people or .56 person per square mile of the watershed.

Labor Force	County (# workers)					
	Beaver	Garfield	Iron	Kane	Piute	Wayne
Mining	38	12	58	0	0	0
Construction	109	70	882	136	3	95
Manufacturing	97	127	1743	385	2	44
TrandTrans/Utilities	455	215	2484	372	58	144
Information	0	100	127	5	0	0
Financial Activities	37	21	496	58	8	9
Profess/Business Svcs	17	15	1745	27	2	1
Ed/Health/Social Svcs	37	149	989	49	3	304
Leisure/Hospitality	388	837	1500	858	26	181
Other Services	35	20	258	220	2	20
Government	673	609	3788	698	138	293
Farm	441	538	835	69	264	461
Total Nonfarm	1886	2175	14070	2808	242	1091
Total Labor Force	**2327**	**2713**	**14905**	**2877**	**506**	**1552**

Table 2-8. Total labor force (number of workers) for Beaver, Garfield, Iron, Kane, Piute and Wayne Counties. Figures represent county totals and are not weighted by percent of basin within each respective county.

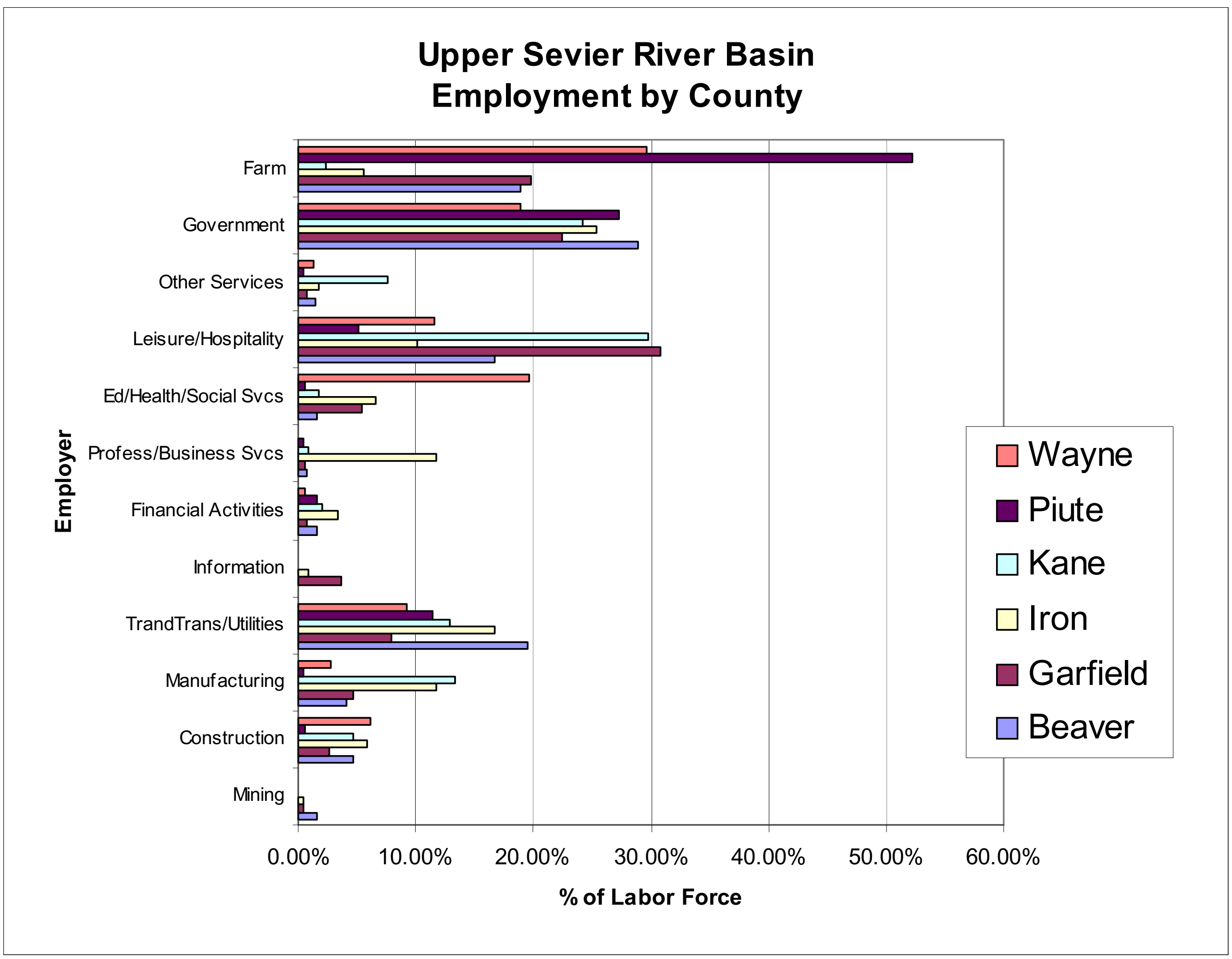


Fig. 2-9. Employers in Wayne, Piute, Kane, Iron, Garfield and Beaver Counties and percent labor force. Totals for each county equal 100 percent of labor force.

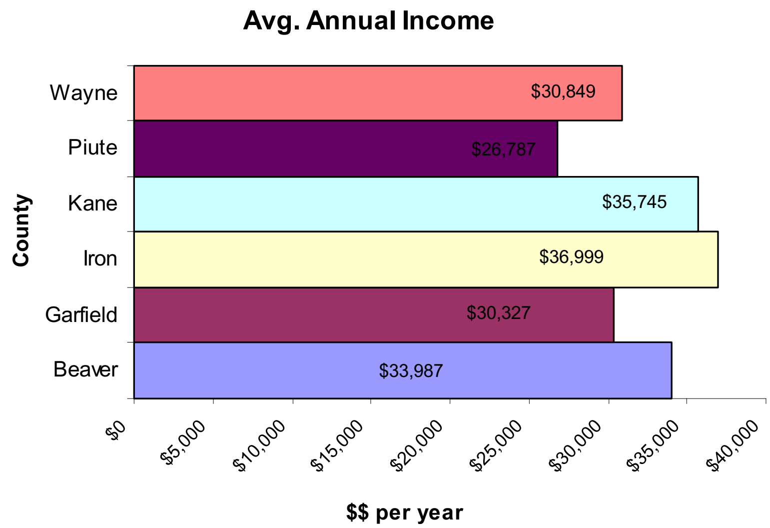


Fig. 2-10. Average annual income for Wayne, Piute, Kane, Iron, Garfield, and Beaver Counties in which the Upper Sevier River Basin resides.

Average salaries for counties located within the basin are presented in Fig. 2-10 .

Land Ownership/Use

U.S. Forest Service lands make up 61 percent of the basin (810,136 acres). Bureau of Land Management lands account for 19 percent (251,822 acres), private lands 13 percent (168371 acres), State lands 6 percent (84446 acres) and National Park Service lands, approximately 1 percent (10,478 acres) (Fig. 2-1, Fig. 2-11).

Federal lands, as well as state and private lands are utilized extensively for grazing. Federal lands are governed by the Taylor Grazing Act of 1934, and although overgrazing threatened to reduce Western rangelands to a dust bowl at the turn of the previous Century, today, use of grazing permits on public lands has allowed rangelands to recover to a more healthy condition.

Recreation

The basin is a popular destination place for those residing in the area and in communities surrounding the water-shed. Much of the private land within the basin has been developed and is utilized as summer home property by numerous local residents as well as residents from as far away as Las Vegas, Nevada and southern California.

Recreational opportunities throughout the basin include camping, hunting, wildlife viewing, fishing, bicycling, ATV riding, horse-back riding and snowmobiling in winter months. The proximity of the basin to several na-tional parks and monuments also brings visitors for picnicking, lodging, and general sight-seeing.

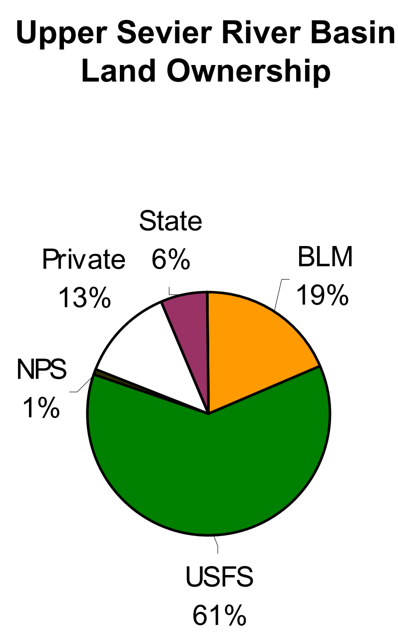


Fig. 2-11. Land ownership within the basin is diverse, with private, state, National Park Service, U.S. Forest Service and Bureau of Land Management lands represented.

Roads and Trails

Approximately 3,991 miles of paved, improved gravel and other type of roads and travel ways are found throughout the basin (Fig 2-12, Fig 2-5). Although current U.S. Forest Land and Resource Management Plan, standards and guidelines call for road densities not to exceed 2 miles per square mile of wildlife habitat, recent on-the-ground evaluations in forested areas suggest that in some areas this number may be higher. Total road miles does not take into consideration non-classified or user-created roads.

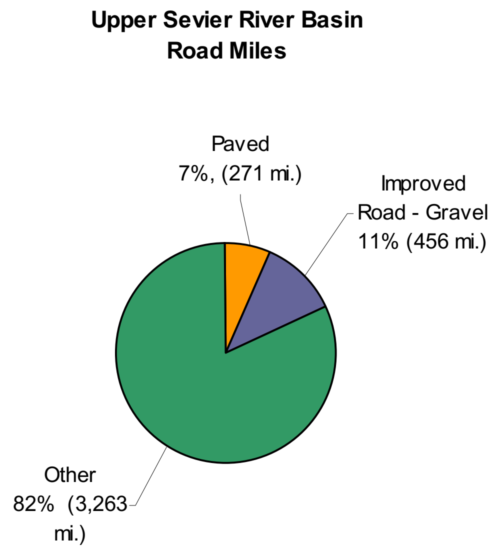
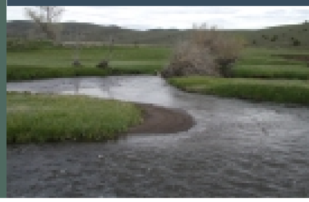


Fig. 2-12. The 3,991 total miles of road represent an average of 1.93 roads per square mile of the Upper Sevier River Basin.



Issue Development

Assessment Strategy

An assessment strategy was developed based in part, on the process described in: *"Ecosystem Analysis at the Watershed Scale* " (USFS, 1995) and *"Community Culture and the Environment: A Guide to Understanding a Sense of Place"* (EPA, 2002).

The large size of the Upper Sevier River Basin necessitated that it be broken down into smaller "sub-basins." The Upper Sevier Basin consists of two 4th field sub-basins (East Fork Sevier River and the Upper Sevier River Sub-basins). These two 4th field sub-basins are further broken down into smaller 5th field watersheds and 6th field subwatersheds. The Upper Sevier River Basin contains nine (9) 5th field watersheds and sixty-seven (67) 6th field subwatersheds (Fig. 3-1). (*Also see Chapter 2*). Maps and tables for each of the nine 5th level watersheds, describing vegetation, acreage, ownership, subwatersheds, roads,

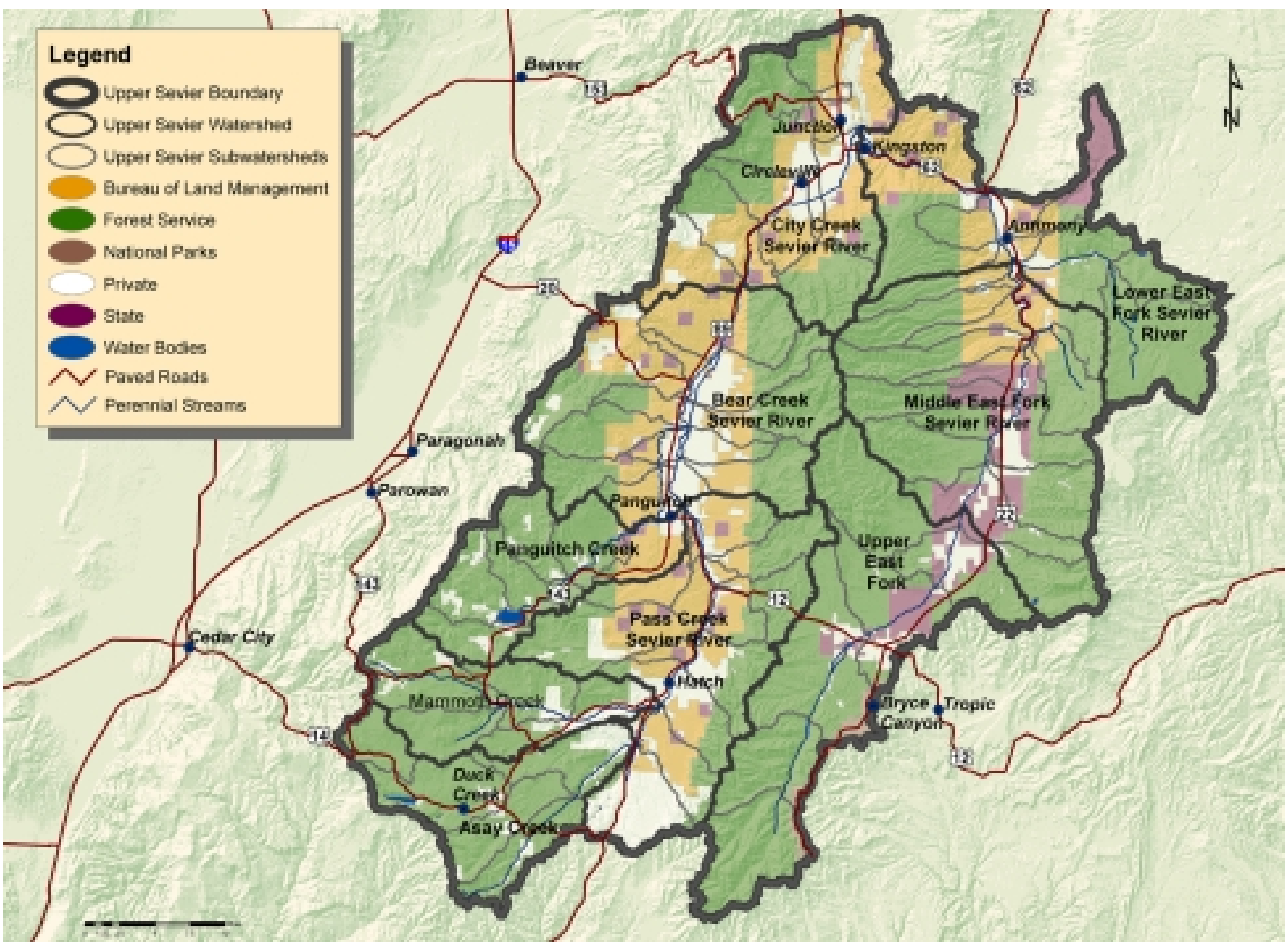


Fig. 3-1. The Upper Sevier River Basin, upon which this assessment is based, is a 1,324,899 acre area containing 9 watersheds and 67 subwatersheds.

streams and general conditions, are contained in Chapter 4, as an introduction to the 9 individual watershed discussions for each.

Technical Advisory Committees (TACs)

Collaborative Technical Advisory Committee (TAC) meetings were held with state, federal agencies, local and county government officials and private landowners, beginning in 2000. Six TAC committees were formed to discuss issues within each watershed, related to: 1) Hydrology/Water Quality; 2) Agriculture; 3) Fire; 4) Human Uses; 5) Vegetation, and 6) Wildlife.

Technical Advisory Committee members were chosen based on their unique knowledge of the watershed, and as participants in collaborative development with the Upper Sevier River Community Watershed Project. Technical Advisory Members and watershed partners, to date, have included representatives from the following interests:

- Utah Association of Conservation Districts
- Upper Sevier Soil Conservation District
- USDA Forest Service Dixie National Forest
- Bureau of Land Management
- National Park Service
- Department of Environmental Quality, Division of Water Quality
- Utah Division of Wildlife Resources
- Natural Resource Conservation Service
- Color Country Resource Conservation & Development
- Farm Service Agency
- Utah State University Extension Service
- USDA Forest Service Rocky Mountain Research Station
- Paiute Tribe of Utah
- State of Utah Division of Forestry, Fire and State Lands
- Panguitch City
- Garfield County, Iron County, Kane County
- Southern Utah University
- Private Landowners
- Garfield County School District

Characterization and Assessment of Watersheds and Subwatersheds

After the initial formation of TAC committees, issues were identified within each watershed as a foundation for the prioritizing of future analyses and projects. All six TACs identified and addressed issues related to specific resources within the Upper Sevier River Basin.

In some cases, the same issue may have been addressed from more than one technical advisory committee *(Ex: Noxious Weeds - addressed by vegetation committee and agriculture committee).* Throughout this assessment, it was not uncommon for several groups to address and/or identify similar resource issues that may be association to one particular problem (*Ex. Sagebrush/grassland - wildlife concern, hydrology concern, fire concern, agriculture concern, vegetation concern*), further strengthening the need for rehabilitation for that particular issue.

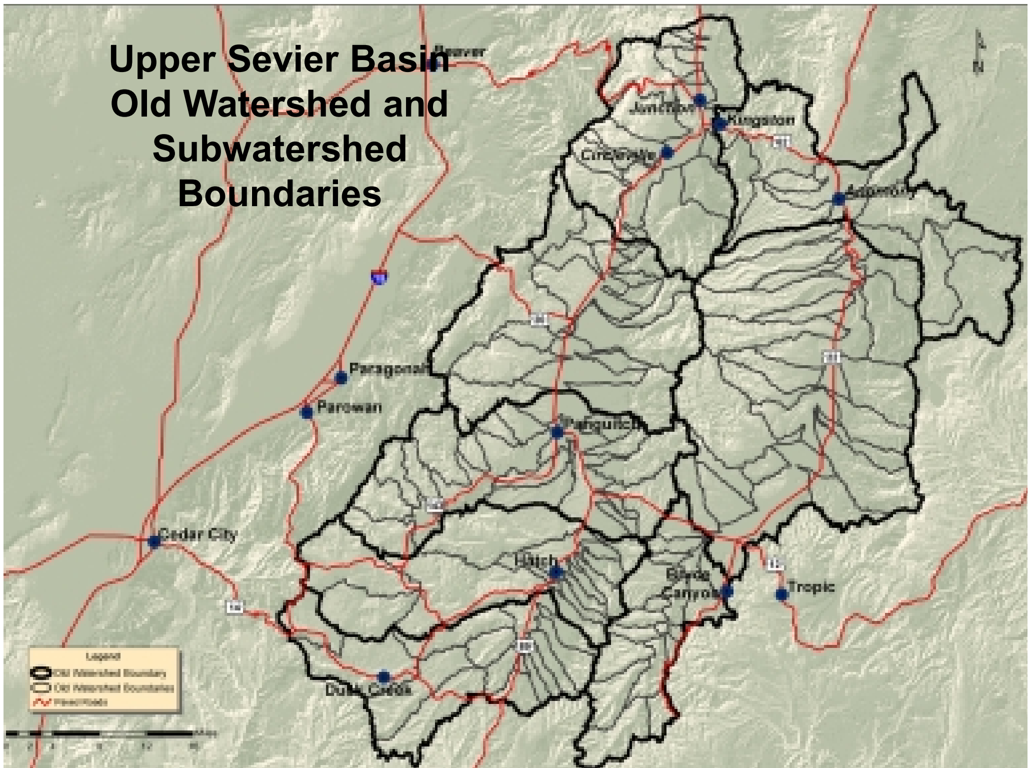


Fig. 3-2. Original projects and assessments for the Upper Sevier Basin were based on old watershed and subwatershed boundaries.

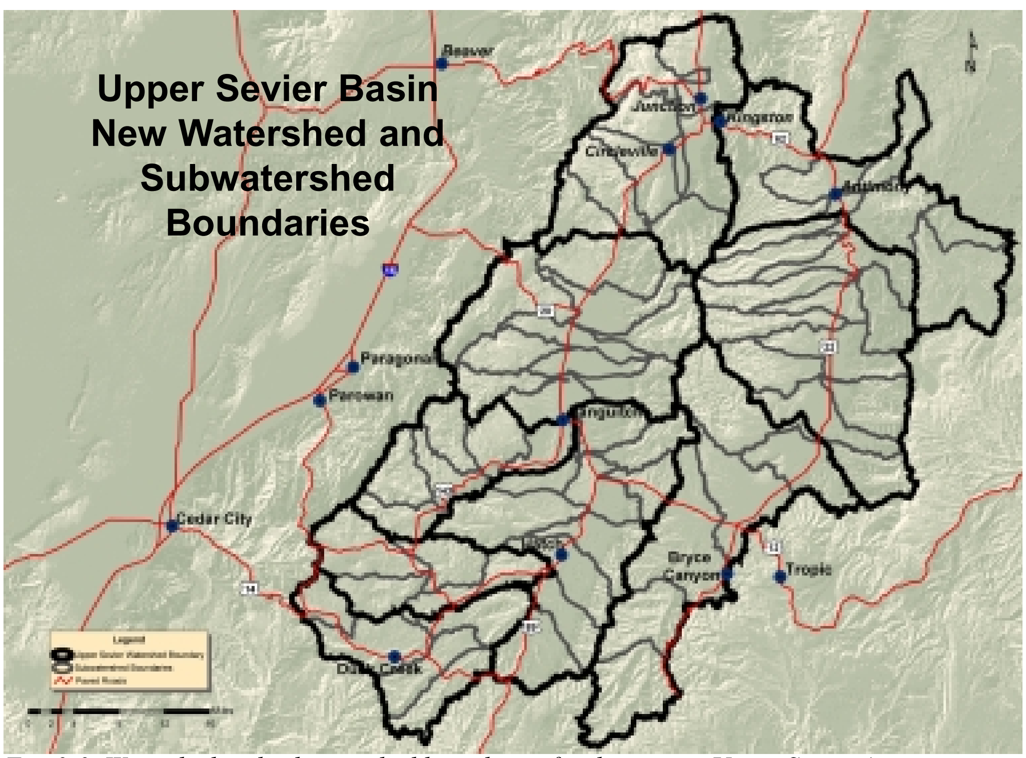


Fig. 3-3. Watershed and subwatershed boundaries for the current Upper Sevier Assessment are based on current USGS mapping standards. The current boundaries represent 9 watersheds and 67 subwatersheds.

In March 2002, watershed and subwatershed boundaries were re-mapped to be compatible with national USGS mapping standards. This re-mapping provided slightly large geographical areas in which to work, creating the nine watersheds (8 previous) and 67 subwatersheds (128 previous) upon which this assessment and plan is based (Fig. 3-2, 3-3). In addition, while the original assessment provided a basis for understanding watershed characteristics and the dominant processes within the subwatersheds, the magnitude of information, number of issues identified and different documentation methods made prioritizing and project planning difficult.

Goal and Objective Statements

From January through April 2003, following the re-mapping of watershed boundaries, each TAC committee members drafted goals and objectives for 1) Hydrology/Water Quality; 2) Agriculture; 3) Fire; 4) Human Uses; 5) Vegetation, and 6) Wildlife. Specific goal and objective statements were used by each TAC committee to further determine and prioritize issues within each watershed and subwatershed.

Specific goals and objectives identified by each TAC are as follows:

Hydrology/Water Quality

Goal:

Maintain or improve water quality and quantity for local needs while providing for the needs of recreation, fish and wildlife.

Objectives:

- Increase the presence of appropriate herbaceous plants and multiple age class distribution of appropriate woody plant species along the Upper Sevier River.
- Restore streams to their proper hydraulic and channel geometry (pattern, profile, cross section dimensions).
- Stabilize eroding streambanks and install in-stream cover and structures
- Establish woody riparian vegetation where needed.
- Decrease presence of sediment and Manage upland vegetation to decrease sediment flow into the Upper Sevier River.
- Work with private landowners to identify opportunities and solicit funding for water quality improvement projects.

Agriculture

Goal:

- Maintain ranching and agricultural as sustainable economic, cultural and lifestyle components of the Upper Sevier Watershed.

Objectives:

- Address potential and real conflicts between wildlife management goals and private land use.
- Work cooperatively to address potential and real competition between livestock and wildlife on public lands.
- Work cooperatively with landowners and partners to address and control noxious weeds on public and private lands. Where applicable, use best management practices for resource management to help improve range, crop, pasture, aquatic habitat and riparian vegetation.
- Work cooperatively with private landowners and irrigation companies to improve irrigation

infrastructure and irrigation efficiency.

Fire and Fuels

Goal:

Continue to protect private property while using fire to improve forest and rangeland health

Objectives:

- Implement defensible fire space zones around Wildland Urban Interface (WUI) areas.
- Use necessary tools to move vegetation communities closer to desired conditions.
- Provide education to communities at risk about the role of fire to ecosystem health.

Human Uses

Goal:

Provide for a wide variety of human uses while preventing degradation to the environment.

Objectives:

- Provide public access while ensuring that roads and trails do not degrade the environment
- Provide a wide variety of quality recreational opportunities (dispersed and developed) throughout the watershed, while protecting riparian areas.
- Encourage developments to use innovative and alternative wastewater treatment systems.
- Encourage the state to evaluate innovative and alternative wastewater systems for use with shallow soils and to incorporate reuse.
- Encourage Utah Geologic Survey to complete additional mapping in the Upper Sevier Basin to help understand the groundwater system.
- Recommend that subdivision plans are not approved until all options of decentralized wastewater treatment plants are considered.
- Provide more overseeing of subdivision wastewater feasibility studies and individual on-site soil and percolation tests.
- Recommend additional overseeing of certified soil testers.
- Recommend continued water quality studies/monitoring in areas of high human use (e.g. subdivisions).

Vegetation

Goal:

Maintain and restore desired vegetation that is resilient and sustainable.

Members of the Hydrology/Water Quality Technical Advisory Committee meet to discuss key issues within the Upper Sevier River watersheds and subwatersheds..

Objectives:

- Maintain or restore upland vegetation communities of pinyon/juniper and sagebrush/grass to provide for the needs of domestic livestock and wildlife.
- Use necessary tools to move vegetation communities closer to desired conditions.
- Recognize noxious weed invasion as a serious threat to agricultural and wild land areas, and implement integrated pest management strategies as necessary in all watersheds.
- Increase representation of aspen to more closely reflect desired conditions.

Species and Habitat

Goal:

Provide suitable habitat for a diversity of wildlife species.

Objectives:

- Decrease the amount of P/J encroachment into areas historically dominated by big sagebrush, grass and forb communities.
- Maintain a mosaic of sagebrush, grassland and woodland that provides habitat for big game, migratory birds, sensitive species and other high interest wildlife species.
- Maintain and improve critical big game winter ranges.
- Provide and protect quality fishery habitat that is capable of sustaining abundant trout and native fish populations.
- Restore riparian vegetation along the Sevier River and East Fork Sevier River, and associated tributaries.
- Use Best Management Practices for livestock management to help protect restored aquatic habitat and riparian vegetation.
- Provide quality recreational and angling opportunities throughout the watershed.

Issue Development

Based on stated goals and objectives, each TAC committee developed issues pertinent to the Upper Sevier River Basin. Overall, 63 issues were chosen as criterion upon which to rank watersheds and subwatersheds. All nine watersheds were addressed separately, by all six technical advisory committees. All 67 subwatersheds were ranked for all issues chosen by the TAC committees, based on a scale of High (H), Medium (M), Low (L) and Not Applicable (NA). Specific criterion and justification for H, M, L and NA rankings are explained below.

General guidelines were provided for each TAC committee in formulating issue rankings:

- Rely on existing data and local knowledge of watershed characteristics.
- Use ecosystem management principles
- Determine prioritization of all issues for future analysis
- Focus on assessing landscape conditions

Issue Rankings

Priority rankings (H, L, M, NA) for all 63 resource issues were determined based on these guidelines and other criterion established by individual TAC committees. Tables with all 63 resource issues for each of the 9 waterheds are contained in Chapter 4. A brief discussion and justification for rankings for all 63 key issues follows:

Fire

Communities at Risk

A high level of growth within wildland urban interface areas has placed more citizens and property "at-risk" to wildland fire. In addition, ecosystem health problems across the watershed necessitate that increased public awareness, as well as reducing hazardous fuels and restoring fire to communities and watersheds is essential. Those communities included in the Federal Register, 2001, in conjunction with the National Fire Plan, received high ratings during the issue identification process for the watershed.

Fuel Conditions

Fuel conditions within the Upper Sevier Watershed were rated according to the current fire regime class descriptions (USDA, FS, 2002). However, to standardize issue ratings for the entire watershed, Condition Classes were translated to: Condition Class 1 – (L)ow, Condition Class 2 - (M)oderate, Condition Class 3 - (H)igh, where the Condition Class rating, indicates the degree of departure from historical fire regimes (Appendix C).

Fire and Fuels is currently being addressed as one of the four issues/concerns in the Forest Service's collaborative approach to land management (Bosworth, 2003).

Human Uses

Development and Effects to Ground/Surface Water

As development of land and water resources continues, it is apparent that development of either ground water or surface water may have long-term affects connected to other ground and surface water. While long-term development of surface water can affect riparian zones and associated wildlife and vegetation habitats, groundwater development and associated water saturation can increase nutrient concentrations and affect water temperature and oxygen levels, further impacting natural ecosystems. Those areas where human activities are high, and in particular where subdivisions are reliant on septic systems, were rated as high.

Development and Impacts to Adjacent Lands

As the desire to recreate and live in more forested/wildland areas increases, fragmentation of plant and animals habitats is of concern. In addition, recreational impacts to bordering lands may also disrupt ecological processes and reduce the availability of habitats for some wildlife species.

Changes in plant and animal communities caused by increased roads and introduction of nonnative plant and animal species are also a concern in developed areas.

Development is expected to increase, especially in areas adjacent to forested lands or within private forested land. Recognizing that forested areas are attractive because they offer a "sense of place," and serve as a place to solidify family and traditional values, as well as provide valuable habitat, this issue must be addressed to ensure long-term social/biological compatibility. Those areas where habitat fragmentation and/or human uses may impact forested areas were ranked as high.

Access Management

Wildland areas previously undisturbed because of limited access are being encroached upon as more and more recreationists look to outdoor recreation and OHV use. The National Survey on Recreation and the Environment (1999-2001) reports that 17.5% of the population (36.3 million people over age 16) participated in off-highway driving, ATV or motorcycle use (Cordell, 2000). Moreover, Cordell (1999) reports a 43.8% increase in OHV use and a 34.8% increase in snowmobile use between 1982-83 and 1994-95. Ninety-five percent of the population participates in some kind of outdoor activity (USDAFS, 2000, Strategic Plan).

Impacts from off-highway vehicle use include noxious weed dispersal, fragmented habitats, soil compaction and increased erosion. In addition, user conflicts may occur between motorized and non-motorized recreationists. Those areas where the magnitude of off-highway access has the potential to disrupt natural processes/habitats, and where user conflicts may occur, were rated as high.

Developed and Dispersed Recreation
On National Forest lands alone the number of outdoor recreation visitors grew 18 times between 1946 to 2000. (Bosworth, 2003). Current predictions are that by 2100, 579 million Americans (more than double today's number) will recreate on forested lands.

As campgrounds become overcrowded and limit vehicle access, the use of dispersed and user-created sites increase. Unmanaged recreation damages riparian areas, fragments habitats and increases introduction of exotic species into recreation, agricultural and forested areas. Those areas where dispersed campsite concentrations were impacting surrounding habitats and/or where developed campsites needed long-term monitoring/improvements, were rated as high.

Unmanaged recreation is currently being addressed as one of the four issues/concerns in the Forest Service's collaborative approach to land management (Bosworth, 2003).

Vegetation Composition
Vegetative conditions within the watershed were assessed in January 2000. The assessment identified the major vegetation types within the watershed, as well as describe the Proper Functioning Condition (PFC) and Desired Future Condition (DFC). This assessment concurs to that report. Those areas furthest removed from PFC were rated as high. Following is a brief description of the overall assessment for those vegetation types rated. Detailed narratives for highest priority issues are contained in Chapter 4.

Sagebrush/Grass
Most sagebrush communities are currently outside a balanced range of structural classes, and occur as mature plants in sites with more than 15% sagebrush cover and less than 20% bare mineral soil exposed. Sagebrush communities tend to be dominated by older plants. These conditions have significantly increased within the assessment area in the last 100 years due to grazing and fire exclusion. Some areas with deeper soils and a sagebrush component that have burned over the past 10-20 years have converted to rabbitbrush. Soil stability and productivity may also be negatively affected by the loss of understory vegetation. Many valley bottoms are incised due to downcutting, lowering water tables and resulting in establishment of xeric species.

Aspen
Very few aspen clones are stable within the watershed. Those that appear to be stable generally occur on the northern portions of the watershed in more mesic sites surrounded by sagebrush. The majority of aspen clones within the watershed are currently at risk to conifer encroachment (spruce-fir, mixed conifer or ponderosa pine).

Grassland - Meadow
Continued encroachment of conifer into meadow areas is a concern within the watershed. Small mammals and insects inhabit these meadow communities and are important food source for numerous other mammal and avian species. In addition, those meadows associated with forest edge are important habitat components for numerous big game species.

Mixed Conifer - Mountain Fir
Fire exclusion has allowed much of this forest community to advance to later successional stages, favoring more shade-tolerant vegetation. Structural changes have occurred as well, creating multi-canopied stands that are more susceptible to stand replacement fire.

Oak - Mahogany - Mountain Shrub
This habitat type is scattered within the Upper Sevier Watershed primarily in the northern portion. The mountain shrub complex comprises a small amount of the Upper Sevier Watershed and most of this community type has been replaced by pinyon-juniper. This community provides good soil protection which is lost when it is invaded by other species, especially pinyon-juniper.

Pinyon - Juniper
Pinyon-juniper has increased approximately 150 to 250 percent over historical levels. The majority of stands have moved to mid-aged, mature and old structural stages. In historic sagebrush/grassland communities, decreased ground cover has resulted in inter-canopy erosion, since there is little understory vegetation to help retain the soil in these stands. Fire regimes and grazing have also played a role in vegetation composition change, diminishing value as wildlife habitat.

Ponderosa Pine
The majority of the ponderosa pine community within the watershed has been harvested, especially on slopes less than 30 to 40 percent. Early timber harvest activities focused mainly on removing larger diameter trees. In previously harvested areas, ponderosa pine stands have changed from “park-like” stands, dominated by large clumped trees, to much denser stands, dominated by smaller diameter, uniform sized trees. Only infrequent, scattered, large diameter pine remain in most of these areas. In areas where timber harvest has been light, but mainly due to the lack of fire, increased regeneration in the understory has created multi-canopied stands that are more susceptible to stand replacement fire.

Spruce - Fir
The loss of the mature spruce component from a recent spruce beetle infestation will likely increase representation of aspen and subalpine fir within the watershed. Subalpine fire and white fir are affected by root rots and insects, including fir engraver and western balsam bark beetle. Subalpine fir is currently replacing late seral aspen stands and modifying species diversity within this vegetation type. There is little indication of recent natural fire interaction in the spruce dominated areas.

Douglas-fir dwarf mistletoe, infects approximately 10-20 percent of the Douglas-fir trees. Other dwarf mistletoes infect ponderosa pine, limber pine, bristlecone pine, and white fir, but to a more limited extent.

Tall Forb
Many of the tall forb plant communities within the Upper Sevier Watershed have been lost. A few communities are becoming re-established, at a slow rate, in areas where livestock grazing has been

removed. Continued encroachment into these areas can result in the loss of meadow areas and impact riparian and streamflow regimes. Less than 10 percent of the original acreage remains and restoration is often impractical.

Noxious Weeds

Invasive noxious weeds have been described as a "...raging biological wildfire." (Dewey, 1995). In many areas weeds have become difficult to control and are spreading rapidly. Noxious weed invasion may cause enormous economic losses to agriculture and irreparable ecological damage to wildland areas. Rangelands, forests, wilderness areas, national parks, recreational sites and wildlife management areas are all at risk to noxious weed invasion.

Current noxious weeds within the watershed include Canada thistle, Dalmation toadflax, Musk thistle, spotted knapweed, scotch thistle, whitetop, and Russian knapweed.

Corridors where noxious weed invasion continues to increase and areas where noxious weeds are already established were ranked as high.

Invasive species is currently being addressed as one of the four issues/concerns in the Forest Service's collaborative approach to land management (Bosworth, 2003).

Species and Habitat

(Habitat fragmentation is currently being addressed as one of the four issues/concerns in the Forest Service's collaborative approach to land management (Bosworth, 2003)).

Many of the species descriptions used in this part of the narrative are derived from the U.S. Forest Service white paper, "*Life History and Analysis of Endangered, Threatened, Candidate, Sensitive, and Management Indicator Species of the Dixie National Forest*" (Rodriguez, et. al., 2004).

Priorities for Enhancement or Protection of:

Southwestern Willow Flycatcher Habitat

Although included in the initial Upper Sevier River Assessment, recent surveys have concluded that the Southwestern Willow Flycatcher, a species listed under the Endangered Species Act of 1973 (as amended) as endangered, does not occur within the watershed.

Utah Prairie Dog Habitat

Utah prairie dog (*Cynomys parvidens*) was accorded "endangered" status under the Endangered species Act of 1973, as amended, but was down-listed to "threatened" species status in 1984. Current declines have been attributed to habitat loss to urban development or pastureland, long-term overgrazing (contributing to lack of vegetative diversity from increasing shrubs), and fire suppression (preventing maintenance of large grassland patches). Habitats lacking vegetative diversity, and suitable and existing habitats needing treatment or protection were rated high.

Bald Eagle Habitat

The bald eagle (*Haliaeetus leucocephalus*) was listed as threatened under the Endangered Species Act of 1973, as amended. Population declines are attributed to habitat loss, mortality (shooting, trauma, poisoning, disease, electrocution from powerlines, etc.) and reduced reproduction (environmental contaminants) (USFWS, 1983). Since no bald eagle nests have been documented in the Upper Sevier Basin, habitat loss (removal of cottonwood galleries, housing development and woodcutting) along water bodies for roosting is the primary concern. Fall, winter and spring roosting habitats were rated high where use occurs and is being impacted by loss of roost trees and human influences.

Spotted Bat Habitat

Spotted bat (*Euderma maculatum*), is currently listed as a state sensitive species in Utah, and is included on the U.S. Forest Service Regional Forester's Sensitive Species list. Factors contributing to declines in populations include loss of suitable roost sites and human disturbance. In addition, human disturbances to hibernacula from cave exploration and bat banding have been found to cause significant declines in bat populations and is a concern in the Upper Sevier River Basin. Other factors attributed to declines in bat species include application of pesticides, which reduces food supply and subjects them to contaminated prey, and declines in healthy riparian areas which are important for drinking water as well as habitat for insects for this species of bat. Roosting sites and foraging areas (ponds, riparian areas) that are at risk or in need of improvement were rated high.

Townsend's Big-eared Bat Habitat

Townsend's Big-eared bat (*Corynorhinus townsendii*) is currently listed as a state sensitive species in Utah, and is included on the U.S. Forest Service Regional Forester's Sensitive Species list. A low reproductive rate, limited availability of roost sites, and human disturbance limit species populations. Roosting sites and foraging areas that are at risk or in need of improvement were rated high. Important foraging habitat includes ponds and riparian areas. Primary roosting sites include caves and lava tubes.

Flammulated Owl Habitat

Flammulated Owl (*Otus flammeolus*) is currently listed as a state sensitive species in Utah, and is included on the U.S. Forest Service Regional Forester's Sensitive Species list. Limiting factors for flammulated owls in the Upper Sevier Basin include a decrease in large diameter snags in which to nest, and an increase in forest stand densities. Past harvest of mature forests and availability of snags for nesting have reduced existing habitat, while woodcutting, facilitated by easy and abundant access, has decreased snags needed for nesting. An increase in conifer understories and subsequent closed understory canopies due to fire suppression have reduced open stands needed for foraging. Habitats were rated high where snag numbers are low, thickets are lacking or too abundant, aspen stands are being lost to conifers, and grasses, forbs, and shrubs are low (habitat for the insects on which they feed).

Three-toed Woodpecker Habitat

Three-toed Woodpecker (*Picoides tridactylus*) is currently listed as a state sensitive species in Utah, and is included on the U.S. Forest Service Regional Forester's Sensitive Species list. The current epidemic of spruce bark beetle is changing spruce-fir habitat for the three-toed woodpecker from old growth to a landscape of primarily dead trees. This woodpecker species responds numerically to beetle infestations and populations are currently high. Salvage logging, however, is removing this habitat. Aspen habitats are also important and are being lost by conifer encroachment. Habitats were rated high where spruce and aspen snags and woodpecker's primary food source (bark beetles) were at risk from timber harvest and other activities.

Northern Goshawk Habitat

The Northern goshawk (*Accipiter gentiles*) is currently listed as a state sensitive species in Utah, and is included on the U.S. Forest Service Regional Forester's Sensitive Species list. The current epidemic of spruce beetle is changing spruce-fir habitat for the northern goshawk from old growth to a landscape of primarily dead trees. Although goshawks do nest in dead trees and dead stands, this habitat will gradually become unsuitable due to lack of canopy cover and falling dead trees. Lack of fire has increased understory stand densities, which are not favorable to goshawk foraging habitat. In addition, past logging practices have removed the large diameter trees, reducing nesting habitat. Habitats for northern goshawk were rated high where numbers of large mature trees with interlocking crowns are lacking or low, snags and down logs are lacking, stand densities are predominantly high, or disturbances to nesting are occurring.

Peregrine Falcon Habitat

Peregrine Falcon (*Falco peregrinus anatum*) was formerly listed as an endangered species under the Endangered Species Act of 1973 as amended. It is currently listed as a state sensitive species in Utah, and is included on the U.S. Forest Service Regional Forester's Sensitive Species list. The primary concern for this species is human disturbance. Increasing human uses into peregrine falcon nesting habitats cause potential disturbances to young. A secondary issue is reduced riparian areas, which, in turn, reduces habitat for prey. Habitat conditions were rated high that included disturbance within one mile of a nesting cliff, and/or poor riparian conditions. Meadows and parklands in poor condition lacking grasses and forbs also contributed to high ratings for needed habitat improvements.

Sage Grouse Habitat

Sage Grouse (*Centrocecrus sp.*) populations have declined dramatically throughout their range, and within the Upper Sevier Basin. Historic records suggest that sage-grouse habitat was found in all 29 counties in Utah. Today, it is estimated that sage-grouse occupy only 50 percent of available habitat and are much less abundant (Utah Conservation Data Center, 2003). Habitat loss, fragmentation and degradation as well as conversion of sagebrush/grassland habitat into stands of exotic cheat grass through wildfire (suppression) are the primary causes of sage-grouse decline. Sage grouse habitats rated high are those with mature decadent sagebrush stands that lack an understory of grasses and forbs.

Mule Deer Habitat

Mule deer *(Odocoileus hemionus)* are the most abundant big game species within the Upper Sevier Basin, and are found in many different habitats, including coniferous forest, desert shrubs, chaparral and sagebrush/grasslands. Deer are a high visibility species within the watershed, both from a perceived negative standpoint (potential competition for food with domestic cattle and sheep) and a perceived positive viewpoint (wildlife viewing, recreational hunting). Although deer populations respond rapidly to habitat management, habitat fragmentation, destruction of habitat from urban development, human disturbance and lack of healthy vegetation composition may impact deer numbers. Habitats ranked high for mule deer consisted mostly of winter ranges being lost to development, those areas having poor browse for winter feeding, and areas consisting of old decadent sagebrush or bitterbrush or pinyon-juniper encroachment. Areas with high road densities (two miles of road per square mile) are also considered high priority.

Rocky Mountain Elk Habitat

Rocky Mountain Elk (*Cervus Canadensis*) is currently listed as a Management Indicator Species (MIS) on the Dixie National Forest, in-part because habitats required to maintain healthy populations of elk also ensure provision of habitat requirements for many other species. Mature stands of deciduous and conifer forest habitats, dense brush understory for escape and thermal cover, and uneven-aged forest stands with old-growth, herbaceous openings, and water provide necessary habitat for elk. Habitats lacking healthy grasses and forbs, and loss of aspen stands to conifers were ranked high. Very high road densities and loss of habitat from development also contributed to higher ratings.

Pronghorn Habitat
The pronghorn (*Antilocapra Americana*) is found in sagebrush/grassland habitats throughout the watershed. Pronghorn browse on shrubs, such as sagebrush, and grasses and forbs. Habitats lacking healthy grasses and forbs, as well as those lost to development or exhibiting poor sagebrush conditions and where sagebrush and grasslands have been lost to pinyon-juniper encroachment have been rated high.

Turkey Habitat
Although historical and archeological evidence suggests that wild turkeys co-existed with Native Americans in Utah, populations of Merriam's Turkey *(Meleagris gallapavo merriami)*, were first introduced in 1952, and Rio Grande (*Meleagris gallopavo intermedia*) in 1984. Public interest in wild turkeys, both from a consumptive and nonconsumptive standpoint has increased in recent years, and suitable habitat has been identified throughout the state. Habitats consisting of woody herbaceous species near water and open stands of ponderosa pine interspersed with aspen and grassy meadows, as well as sagebrush/grasslands are considered critical turkey habitat (UDWRCDC, 2003). Habitats ranked high included those lost to development, those exhibiting poor sagebrush conditions, and where sagebrush and grasslands have been lost to pinyon-juniper encroachment.

Brian Head Mountain Snail Habitat
Known distribution of Brian Head Mountain Snail (*Oreohelix parowanensis*) is currently limited to a rock slide on the southwest slope of Brian Head, above timberline at approximately 11,000 feet. Detailed habitat information is lacking, but several live individuals have been located. Because of limited locality, this population is highly susceptible to development, occurring from ski resorts in the near vicinity. Brian Head mountain snail ratings were based on potential loss of habitat from human development and uses on Brian Head Peak.

Beaver Habitat
American beaver *(Castor canadensis)* occurs throughout most of North America, and is associated with riparian areas. Historic high commercial values for pelts, and the species potential to be destructive to crops, trees, and irrigation systems, currently threaten remaining populations of beaver. However, their value as soil and water conservationists (by maintaining water tables and controlling flooding and erosion) makes them extremely important to properly functioning riparian ecosystems. Habitats include areas where woody plants, such as aspen, cottonwood, and willow occur, both for habitat and food. Areas lacking riparian shrubs and trees, and/or a variety of age classes in riparian trees and shrubs contributed to high ratings for beaver.

Boreal Toad Habitat
Boreal Toad *(Bufo boreas boreas)* is currently listed as a sensitive species in Utah. It is found at higher elevation near springs, streams, meadows, ponds and wetlands, and is often associated with beaver ponds. Habitat loss and degradation, environmental contaminants and disease may be contributing to a decline of this species throughout the watershed. In recent years, this species has been noticeably absent or greatly reduced in numbers in areas previously occupied (DWRCDC, 2003). Boreal toad habitats that were rated high were those riparian areas lacking cover (overhanging vegetation and abundant streambank vegetation)

or where toads were at risk from trampling from large ungulates.

Bonneville Cutthroat Trout Habitat

Bonneville Cutthroat Trout *(Oncorhynchus clarki utah)* is one of three native subspecies of cutthroat trout inhabiting Utah waters, and was thought to have been eliminated or hybridized until its' discovery in 1975 in a 1-mile section of stream. Bonneville cutthroat trout have been restored throughout the state and currently occupy more than 75 miles of stream habitat throughout the watershed and surrounding areas (Rodriguez, 2002). Critical habitat and a pure strain population of Bonneville cutthroat were recently affected by the 2002 Sanford fire, and population recovery is expected to be long-term. Areas where hybridization, competition with nonnative salmonids, degradation of habitat from diversions, livestock grazing, road building, fire, mining and timber harvest activities and angling have occurred or may potentially occur were rated as high.

Fisheries Habitat

Recreational fishery opportunities occur throughout much of the watershed, as well as populations of non-recreational fish and amphibians. In recent years aquatic habitats have been negatively impacted as a result of various activities within the watershed. Increased erosion and subsequent sediment transport has reduced exposed gravels for native fish spawning, broadened stream channels, created shallower waters, reduced abundance and quality of pools and increased water temperatures. Streamside vegetation, food sources and cover have also declined. High ratings were given to those areas where sensitive fish populations occurred and/or suitable habitat existed for subsequent introduction of native fish species. Highly degraded areas in need of enhancement were also rated high.

Hydrology/Water Quality

Hydrology

The Sevier River is one of the most utilized rivers in the United States. Diversion of water in the basin began in the early 1900's and continues today. Water is diverted at several points along the main stem, East Fork, and several of the smaller tributaries. Water is stored and released at Panguitch Lake, Tropic Reservoir and Otter Creek Reservoir.

Flow regimes in the Sevier River and the East Fork have changed dramatically during the past century due to diversions and water storage in reservoirs. Water is usually diverted and released from reservoirs during the irrigation months. The timing and magnitude of runoff events has been affected by reservoirs, diversions, road construction and urban development

High rankings were given to those areas where flow regimes have been altered from historic conditions and potential for restoration exists and/or to those areas that have documented water quality issues.

Individual categories rated:

- Dewatering and altered flow regimes
- Releases from Otter Creek Reservoir may be causing bank erosion along East Fork Sevier River
- Diversion of water from Castle Creek to Deer Creek has caused severe channel degradation
- Diversions along the Sevier River may be affecting sediment transport capacity and channel equilibrium
- Loss of riparian vegetation has resulted in reduced bank storage and summer streamflows

Hillslope Processes

Dominant hillsope processes include sheetwash and shallow rill erosion. Accelerated erosion occurs in areas where vegetation conditions have been removed from historic conditions. Historic grazing practices, urban development, fire suppression, road development and increased recreational use have contributed to accelerated erosion in upland areas. High rankings were used for those areas and activities having most impact within the particular subwatershed.

Individual categories rated:

- Accelerated erosion on high elevation meadows
- Accelerated erosion in pinyon-juniper and sagebrush stands
- Accelerated erosion associated with urban development
- Accelerated erosion associated with roads
- Rill and gully erosion on hillslopes
- Accelerated erosion associated with illegal ATV use

Riparian Vegetation/ Habitat

Riparian conditions within the watershed are diverse, and range from non-functioning to proper functioning condition. Although the trend is upward on most federal lands, it may be stagnant or slightly upward on private lands within the Upper Sevier Basin and adjacent to federal land areas.

Riparian areas of intermittent or perennial water are typically characterized by vegetation such as cottonwood, willow, river birch and grasses/forbs. Although these areas occupy only a small portion of the watershed, they are highly productive and heavily utilized by people and animals. Eighty-two percent of all Utah's birds use riparian areas for nesting, rearing young, migrating, and/or protection from Utah's harsh winters (PFC, DNF, 2000). Heavy use by humans and animals have eliminated or resulted in degraded riparian conditions in some areas. Roads, water diversions, timber harvest, grazing, trampling and agriculture development have influenced riparian areas, as well as encroachment of non-riparian plant species into riparian areas.

Riparian habitat loss and alteration throughout the western United States is estimated to be greater than 95 percent (Krueper 1992, as cited in Gardner, et. al., 1999). Channel erosion, dewatering, lowering of water tables, removal of beaver populations, increased water temperatures, concentrated runoff, and increased sediment transport are all problems associated with riparian degradation and are equally noted within the Upper Sevier Basin. Those areas where woody plant species and late seral herbaceous plant species are lacking along riparian corridors and/or where recruitment of woody plant species is limited, were given high priority ratings during the assessment.

Individual categories rated:

- Lack of healthy composition of riparian vegetation, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate woody plant species

Water Quality

Water quality is one of the most central issues in the management of natural systems in the 21st century. Adequate quantity and quality of water for endangered fish and other species, and for human consumption and use has been mandated under the Clean Water Act (CWA), Endangered Species Act (ESA) and numerous state and federal agency plans. Water quality is a major focus under the Upper Sevier Management Plan. Those areas where water quality standards are not being met, as well as those area where current conditions accelerate erosion and habitat degradation were given highest ratings, and will continue to receive a great deal of focus in this plan.

Individual categories rated:
- Summer home development and associated impacts (i.e., ground/surface water contamination, erosion, recreation, etc.)
- Accelerated erosion, grazing management, recreation use, roads
- TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, habitat alteration, or temperature

Channel Morphology
The Upper Sevier Basin contains a wide variety of stream channel types, and are categorized based on Rosgen, 1996. Many channels in the watershed have incised (downcut) sometime in the past, but are evolving back to their previous morphology. Bank erosion has accelerated in portions of the watershed, resulting in higher width/depth ratios and headcuts on upstream ends.

Individual categories rated:
- Active channel adjustments (vertical or lateral)
- Accelerated bank erosion
  Channelization

Agriculture
Much of the Upper Sevier Basin has been utilized as pasture lands for cattle and sheep. Heavy past use was concentrated along the Sevier River/East Fork, with development into irrigated land beginning around 1864. The cold temperatures and short growing season limit the growth of many commercial crops in the watershed, and much of the agricultural industry has been centered around growing alfalfa hay, native grasses and small grain crops for use as winter livestock feed.

The Upper Sevier Soil Conservation District was organized in 1941 to help farmers and ranchers solve their soil and water conservation problems.

Animal Feeding Operations (AFO)
Animal Feeding Operations are defined as an area where animals are confined and fed for 45 days or more in one period and vegetation is not produced in the affected area. Agricultural operation runoff can have a direct effect on water quality, especially in proximity to water bodies and stream corridors. Those areas where animal feeding operations have been identified as having an impact on water quality (TMDL Analysis) were ranked as high.

Water Conservation Concerns
Irrigation companies in the watershed have converted furrow and flood irrigation to pressurized sprinkler systems. This conversion has increased irrigation efficiency and has helped to eliminate late season water shortages. Many more opportunities for improved water delivery systems are present in the watershed to lengthen water seasons and provide better plant and economic value. Those areas where better nutrient management is needed to control excessive leaching or runoff, and those areas where opportunities exist to put more surface water into area streams and allow for more stable down stream flows, less bank cutting and better water control delivery were ranked as high.

Pasture Management
Pasture management is one means of producing more forage, reducing noxious weeds, improving riparian areas, maintaining plant diversity, and at the same time, producing healthier animals and increasing profits. Those areas where inadequate pasture management may be contributing to poor vegetative conditions, as well as affecting water quality, were ranked as high.

Wildlife Management on Private Lands
As urban development continues within the watershed, deer, elk, prairie dogs and other wildlife are becoming more of a concern on private lands due to different management goals between landowners and wildlife managers. Competition between livestock and wildlife for forage on public lands, as well as wildlife depredation on private lands and concerns over Environmental Protection Agency listing of wildlife are issues frequently addressed by landowners.

Increased wildlife damage to agriculture over the last 30 years is well documented (Decker, 1991; Jonker et al., 1998; Drake, 2002). Based on survey results of random alfalfa growers within Utah, the reported $350,000 annual loss of crops to wildlife represents 2.8% of the crop value. Expanding this sample figure to the 2.2 million tons of alfalfa harvested annually in Utah, this perceived loss amounts to $4.4 million - 9 times the amount the Utah State Legislature annually appropriates ($500,000) to reimburse crop owner depredation claims and expenses (Messmer, et. al. 1996).

Messmer, et. al. (1996) and Conover (1998) suggest incorporating strategies in management plans to adequately address wildlife damage concerns.

Areas within the watershed where privately-owned irrigated and dryland farms occur in tandem with special status wildlife populations were ranked as high.

Key Issue Descriptions
After ranking all of the resource issues within each of the nine watersheds, each TAC group was asked to provide detailed information for two-to-three high priority issues (hereinafter referred to as "Key Issues") for each watershed. Using a combination of narratives, maps and on-the-ground photos, each group identified these pertinent issue(s) and described current conditions, reference conditions and causes of change between current and reference conditions. Key issue narratives are also contained in Chapter 4, for each of the nine watersheds.

Key Issue Maps
To further understand key issues, and where they occur, TAC groups highlighted key issues on a digital orthoquad (DOQ), a detailed map showing on-the ground features such as vegetation and roads. Maps showing the key issues identified for each of the nine watersheds are also contained in Chapter 4.

Note: These maps are not intended to be used in place of a site-specific analysis, or as an exact boundary where restoration projects should occur. They are simply included as a visual representation of overall conditions within the watershed, relationship of key issues to one another, and/or high priority areas where ecological and social conditions may overlap. This information should be used as a guide, in developing on-the-ground, site-specific projects and enhancement techniques.

Water Quality Studies

Chapter 5 provides a summary of the water quality assessment, issue identification, pollution load allocation and recommendations established in the Total Maximum Daily Load (TMDL) development for the Upper Sevier Basin.

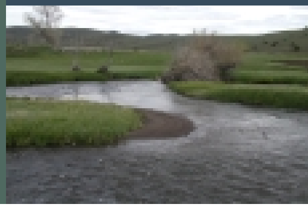
Steering Committee Recommendations

Using resource issue rankings, key issue designations and the current water quality assessment and TMDL study from Department of Water Quality, four focus areas were identified within the Upper Sevier Basin. Steering Committee approval for focus area projects and opportunities was received during May, 2004. Focus area projects and opportunities are contained in Chapter 6. While these priority focus areas (Sevier River-1, Sevier River-2, Sevier River-3 and East Fork Sevier River-4) represent only a small portion of the watershed, they contain a variety of project opportunities, for all partners engaged in watershed restoration. The Upper Sevier Community Watershed Project will place continued emphasis in these areas, while still utilizing the information contained elsewhere in this document to help identify and solicit funding for other enhancement opportunities as they occur, throughout the watershed.

Dawn Elkington, part of the GIS support staff for the Upper Sevier Management Plan and Assessment digitizes TAC committee map drawings for inclusion in the final management plan.

Chapter 4

Upper Sevier Watershed Management Plan



Watershed Description, Key Issue Descriptions and Issue Rankings

Watershed Descriptions, Issue Rankings and Key Issues

This Chapter contains the assessment portion of the Upper Sevier Watershed Management Plan, as well as more detailed maps and information for the 9 Upper Sevier Watersheds.

All 9 watersheds and associated information are organized as follows:

General Watershed Information

A short narrative for each watershed is included as an introduction to each of the 9 individual watershed assessments. Information such as land ownership, vegetation types and roads and trails is provided to help provide real spatial context for the watershed, as well as provide an extremely useful reference during pre-planning for site-specific projects. In addition, unique features and other interesting watershed information is described to help better understand a "sense of place."

Vegetation Types

Vegetation Narratives and tables include acreage and location of different vegetation types within each watershed. Vegetation types classified include aspen, grass/forb, mixed conifer, ponderosa pine, sagebrush/grass, and spruce/fir. Acreages for rock and water were lumped under a single "other" category. As a reference tool, vegetation types for each watershed and subwatershed are included in a single table, in Appendix F.

Land Ownership

Narratives, graphs, tables and maps for each of the watersheds contain information about National Park Service Lands, Bureau of Land Management Lands, State Lands, U.S. Forest Service lands and private lands. Large bodies of water were calculated as part of the State Land acres. As

--From the journal of Orville C. Pratt, camped on the Sevier River, near present day Salina:

September 26, 27, 1848

...The valley of the Sevier, where we struck it, is the finest I have seen since leaving the United States. ...Grass was so good and the water of the finest kind I ever saw. This valley of the Sevier is truly the loveliest spot, all things considered, my eyes ever looked upon. Some day or other, and that not distant, it will swarm with hundreds of our enterprising countrymen, as in truth it is, the garden of the great basin of the California Mountains.

****excerpt from: Keetch, M.R. 1967. Sevier River Basin Floods. Soil Conservation Service, Economic Research Service, U.S. Forest Service.*

a reference tool, land ownership information for all watersheds as well as subwatersheds is contained in Appendix G.

Elevation Roads and Streams

Elevation, road and stream information contained for each watershed is very general in nature. Only major streams and access routes are shown in map form. Map shading helps provide a general context for land elevation. This information provides a spacial context for the watershed, as it relates to better-known geographic areas, such as towns and major travel routes. Short narratives are included where special features and/or places of interest further define context for the watershed.

Key Issue Descriptions

As part of ranking resource issues for this watershed assessment, each TAC committee was asked to "elevate" 1 or 2 issues, and provide more detailed information, such as 1) Current Conditions, Patterns and Trends, 2) Reference Conditions, Patterns and Trends, and 3) Natural/Human Causes of Change Between Current/Reference Conditions. This information was typically captured for the two highest priority issues (as determined by H, M, L, rankings within that particular watershed and TAC). However, in some instances, a single resource issue that may be isolated to a small subwatershed area, and therefore not rank as a top priority within the watershed, was elevated simply because of the importance and immediate restoration need associated with that particular resource problem.

In some instances, TAC's only elevated one issue, or no issue at all. In another instance, equal importance values were placed on three resource problems within a TAC, and all three issues were elevated. Ideally, 12 key issues would be captured for each TAC; however, the number of issues for each watershed tended to vary from 10 resource issues identified, to 13 resource issues identified.

It is important to recognize that just because a resource issue was not elevated, does not mean that it isn't a high priority as a resource opportunity. A watershed TAC may have many resource issues that are considered priority; however, to provide an initial place to begin, and to see where issues overlap, the elevating of 1 or 2 priority issues, provided geographic regions in which restoration could be focused.

Current Conditions, Patterns, and Trends

Narratives regarding the current conditions, patterns and trends associated with an identified resource issue are based on resource specialist input, local knowledge and available past and present photographs and data. By structuring this information from a multitude of sources, "buy in" is obtained from local publics and individuals who reside within and utilize the economic resources within the watershed. In contrast, specialist input helped to elevate those issues of importance from a resource management agency perspective and other special interest groups.

Reference Conditions Patterns and Trends

The white paper, "Assessment of Major Vegetation Types Proper Functioning Condition (PFC)/ Desired Functioning Condition (DFC) for the Upper Sevier River Watershed, Private Lands, Bureau of Land Management, Dixie National Forest, Cedar Breaks National Monument, Bryce Canyon National Park, and State of Utah Lands (USDAFS, 2000)", provided the context for reference conditions, patterns and trends in this document. Other information regarding past watershed wildlife and plant species composition was obtained through other local sources, and are cited as referenced. Reference conditions, patterns and trends help understand previous watershed conditions, in comparison to current watershed conditions. While in most instances the Desired Future Condition (DFC) more closely resembles the Proper Functioning Condition (PFC), it does not always imply that conditions are worse today, than perhaps 50 to 100 years ago, and in some instances, conditions today, may be improved over those conditions at the turn of the Century.

Natural/Human Causes of Change Between Current/Reference Conditions

Local knowledge, as well as prior assessments (see above) help explain the change in conditions from what exists today within the watershed compared to what existed in the past within the watershed. This information tended to vary depending on the perspective of local partners and agency partners, lending further credence to the collaborative effort of this watershed management plan.

Key Issue Overlaps

Although each TAC group addressed its own set of issues, many key issues identified were similar and/or could be attributed to similar activities. Where appropriate, these issues have been combined into a single narrative. (For example, Pinyon/juniper and sagebrush/grasslands was addressed as a key issue by the hydrology, fire and vegetation TAC committees as a key issue for the Bear Creek Watershed and are combined into a single narrative). A summary of key issues identified for the entire Upper Sevier Basin can be found in the Executive Summary (Table E-1).

Key Issue Maps

Digital Orthoquad Maps (DOQ) were provided to each TAC committee to provide a schematic representation of the key issues chosen. Many of the issues from all of the TACs tended to be concentrated in similar areas. However, all key issues are identified separately in the map format. An overlap in a large number of issues may be a signal of the importance of that key issue for immediate restoration needs.

Note: These maps are not intended to be used in place of a site-specific analysis, or as an exact boundary where restoration projects should occur. They are simply included as a visual representation to provide a broader picture of overall conditions within the watershed, relationship of key issues to each other, and/or high priority areas where ecological and social conditions may overlap. This information should be used as a guide in developing on-the-ground, site-specific projects and enhancement opportunities.

Issue Ratings (H, M, L, NA ratings for all 63 issues identified for each Upper Sevier River Watershed)

The last section of each watershed narrative contains tables showing the exact priority ratings assigned to subwatersheds by technical advisory committees. Those issues identified by each TAC as a key issue are highlighted. The availability of resource issue ratings for the entire Upper Sevier Basin, based on collaborative input is a valuable leveraging tool to obtain partnership, agency and matching project funding. Again, an issue may be ranked as a high priority issue, and not ranked as a key issue, but still be a high priority for restoration as recognized by individual partners. The opportunity to leverage partnership support and restoration dollars may vary depending on state, local and federal interests.

Information contained in Chapter 4 is organized by watershed, beginning with the Upper Sevier River Main Stem, (Asay Creek, Mammoth Creek, etc.) followed by the Upper Sevier River East Fork (Upper East Fork, Middle East Fork and Lower East Fork).

Upper Sevier River Main Stem

- **Asay Creek**
- **Mammoth Creek**
- **Pass Creek**
- **Panguitch Creek**
- **Bear Creek**
- **City Creek**

Upper Sevier River East Fork

- **Upper East Fork**
- **Middle East Fork**
- **Lower East Fork**

Fig 4-1. Key Resource issues identified for the Upper Sevier Watershed vary based on different uses, land ownership, elevation, accessibility and vegetation types within each watershed and subwatershed. The key issues addressed in this chapter, as well as the additional issue category ratings, represent input from hydrology, vegetation, species and habitat, agriculture, fire and human uses technical advisory committees (TAC's).

ASAY CREEK WATERSHED

On June 12, 1852, a party of mountain explorers traveled through the Red Creek (Paragonah) area into the Panguitch Valley. After five more days travel, the party found themselves in the vicinity of Duck Creek, Asay Creek, and Strawberry Creek. The party reported finding, "...timber of the best quality clear of underbrush" and Swains Creek, "...about ten foot wide and one foot deep." (USDAFS, 1987). Today, the Asay Creek Watershed is one of the most widely used areas within the Upper Sevier River Basin and is noted for some of the same values as in 1852 - dense ponderosa pine forests as well as numerous clear, meandering streams. Duck Creek, Navajo Lake and Aspen Mirror Lake, all within close proximity to several established campgrounds and numerous privately-owned summer homes and cabins, are utilized for fishing and recreating during summer months. Snowmobiling and cross-country skiing remain popular, with more and more homes and cabins being occupied year-round.

Land Ownership

Forest lands dominate the Asay Creek Watershed with 78,253 acres of U.S. Forest Service land. Private (9,767 acres), Bureau of Land Management (1 acre), State of Utah (682 acres) and National Park Service (300 acres) lands encompass only a small portion of the watershed (Fig. 4-2, Fig. 4-3). The southern corner of Cedar Breaks National Monument, part of the Grand Circle of National Parks, falls within the watershed boundaries, and tourist travel along Highways14 and 143 continues to increase. Although most of the Upper Sevier River Basin falls within Garfield County, portions of Kane and Iron Counties are included within the Asay Creek Watershed boundaries. Five subwatersheds – Deer Valley-Midway Creek, Midway Valley-Midway Creek, Strawberry Creek, Swains Creek, West Fork Asay Creek-Asay Creek - make up the Asay Creek Watershed, the southernmost watershed within the Upper Sevier River Basin (Table 4-1).

Asay Creek Subwatersheds	Acres
Deer Valley-Midway Creek	23901
Midway Valley-Midway Creek	11207
Strawberry Creek	17668
Swains Creek	16817
West Fork Asay Creek-Asay Creek	19409
Total	89002

Table 4-1. They Asay Creek Watershed is composed of 5 subwatersheds.

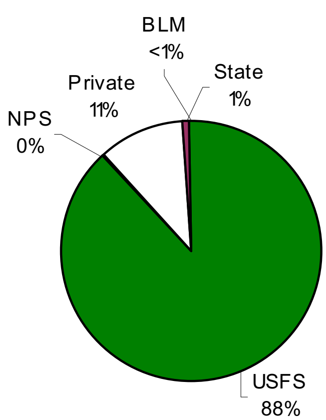


Fig. 4-2. Forested lands within the Asay Creek Watershed are heavily utilized by recreationists.

Vegetation Types

This watershed is dominated by ponderosa pine (25,738 acres) and mixed conifer (33,879 acres) forests (Fig. 4-4, Table 4-2). Currently, the mixed conifer type is occupying large areas that historically were dominated by ponderosa pine and to a lesser degree aspen. High densities of trees have increased fire risk and have been contributing to outbreaks of bark beetle infestations.

In addition, a recent spruce beetle outbreak has resulted in a 90% loss of this vegetative component. Although spruce beetle outbreaks are recognized as a natural-occurring event, the scenic values within the watershed have been negatively impacted, and dead and dying trees remain standing, further increasing fire potential.

Vegetation Type	Acres	%
Agriculture	4805	3%
Aspen	17818	11%
Grass/Forb	1180	1%
Mixed Conifer	2067	1%
Pinyon/Juniper	58539	37%
Ponderosa Pine	4075	3%
Sagebrush/Grass	43392	28%
Spruce/Fir	20870	13%
Other	4141	3%
Total	156887	100%

Table 4-2. Sagebrush/grasslands and pinyon-juniper encompass the majority of the Asay Creek Watershed.

Elevation, Roads & Streams

Mammoth Cave, located within the watershed at 8,050 feet in elevation, opens to one of the largest lava tubes in Utah, with over 2,200 feet of passage. Formed by cooling lava and flowing water, Mammoth Cave is part of the Markagunt Plateau. Interestingly, several miles after Duck Creek flows out of Aspen Mirror Lake, the creek disappears into "sink holes" and the stream continues its course underground, emerging once again in various places throughout the area. The cave is home to several bat species, including Townsend's big-eared bat, a State sensitive species.

Cedar Breaks National Monument marks the westernmost edge of the Upper Sevier River Basin.

The unique blend of extensive lava flows, green meadows and high elevation spruce forests contribute to Asay Creek's popularity, as tourists travel throughout the area via Highway 14 (which runs east-west) and Highway 143 (which runs north-south) and skirt along the edges of Cedar Breaks National Monument, towards Panguitch Lake and/or Brian Head, Utah.

ATV trail use, especially in and around private subdivisions, has further impacted the watershed, and in some cases, accelerated erosion and/or further fragmented wildlife habitats. The Virgin River Rim Trail, which runs along the pink sandstone cliffs to the south of the watershed, is considered one of the most scenic mountain bike trails in the United States, offering breathtaking views of Zion National Park and surrounding valleys.

Asay Creek and Mammoth Creek converge about 15 miles south of the town of Panguitch to form the main stem of the Sevier River. The Sevier River is the longest river completely contained within the boundaries of a single state. Beginning at a spring in the southern part of the Asay Creek watershed, the Sevier slowly winds its way north through Garfield, Piute, Sevier, and Millard counties before it ends in Sevier Lake - some 345 miles later.

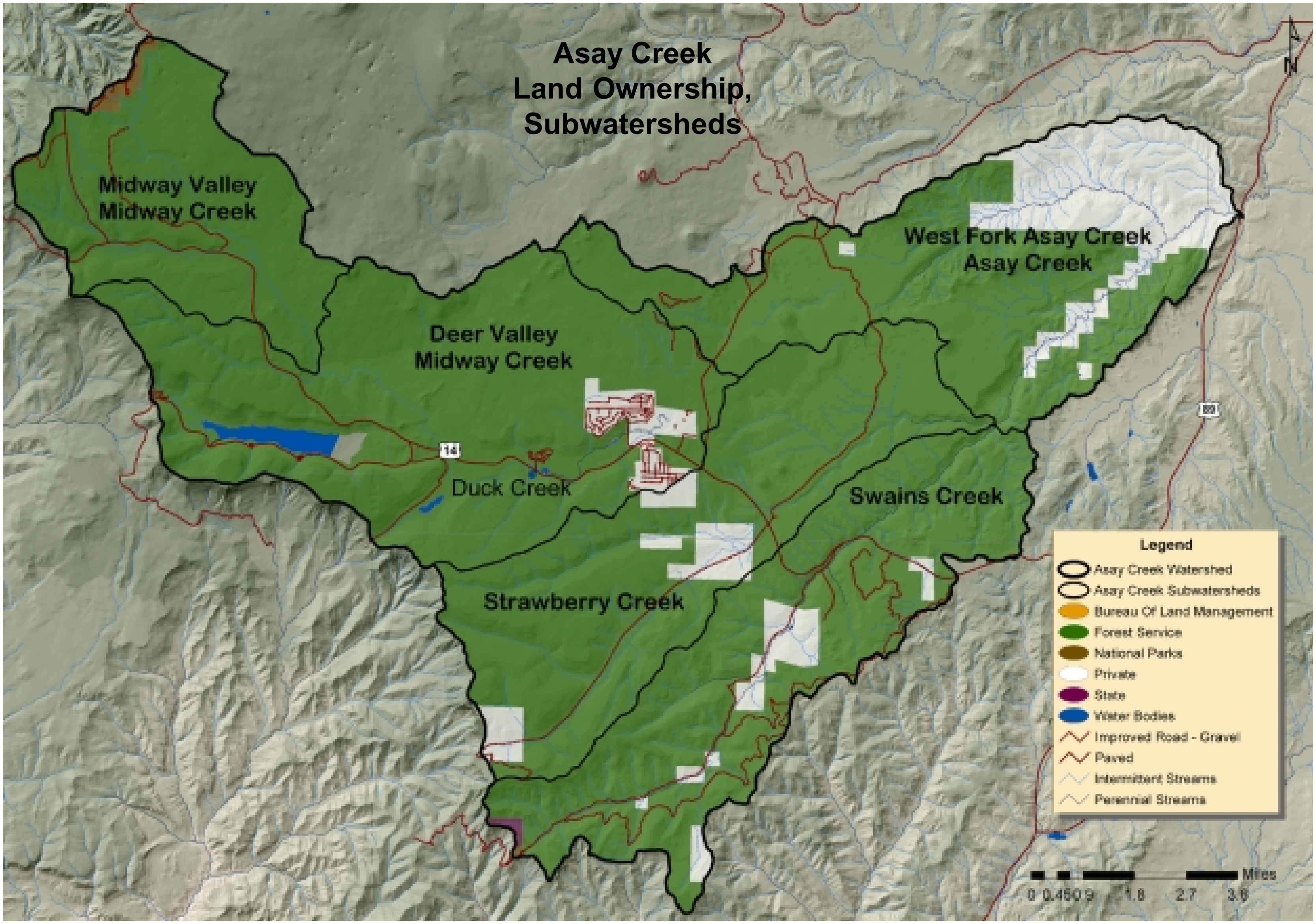


Fig. 4-3. U.S. Forest Service lands and private lands make up the majority of the Asay Creek Watershed and five subwatersheds.

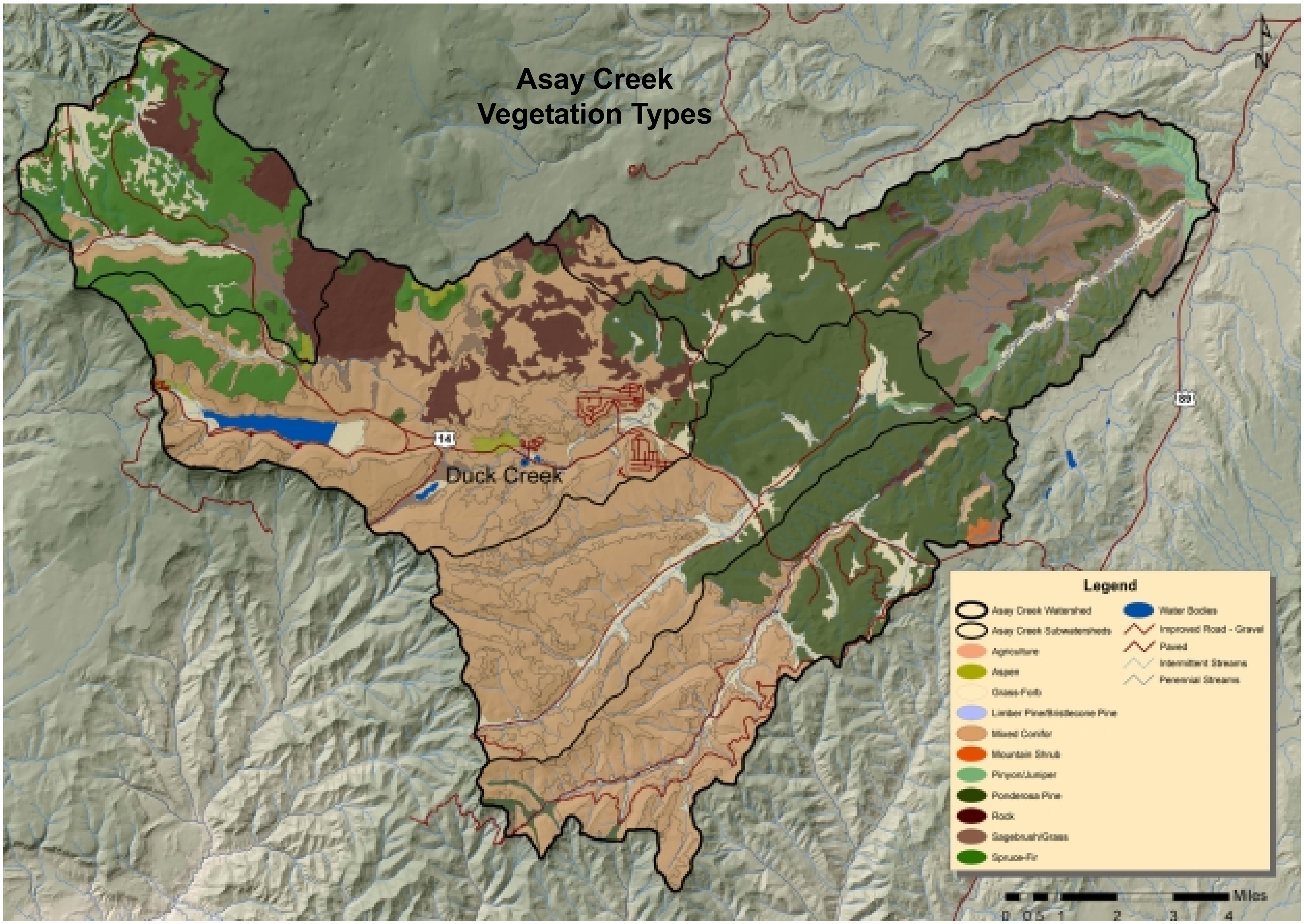


Fig. 4-4. Ponderosa pine and mixed conifer forests are the predominant vegetation types within the Asay Creek Watershed.

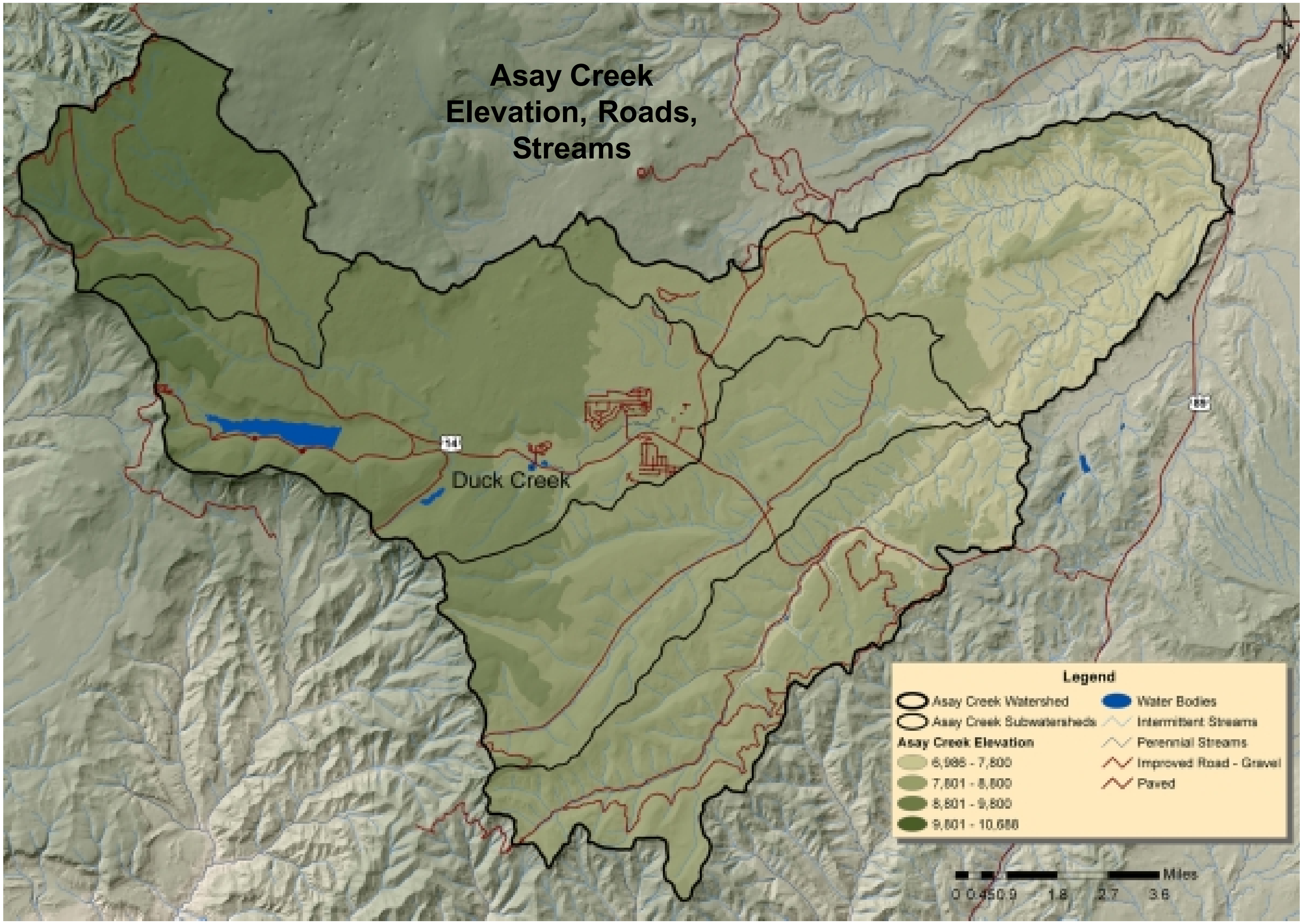


Fig. 4-5. Travel along Highway 14, through Cedar Canyon and enroute to Panguitch, Brian Head, and/or Cedar Breaks National Monument continues to increase, as tourists travel from all over the world to visit area national parks and monuments. In addition, Navajo Lake, Duck Creek Reservoir and Aspen Mirror Lake are popular recreation areas for local citizens as well as tourists.

Key Issues

Key issues identified for the Asay Creek Watershed are: 1) Access Management; 2)Aspen/Mixed Conifer - Vegetation Composition; 3) Communities at Risk to Wildfire; 4) Development and Effects to Ground/Surface Water & Summer Home Development - Hydrology; 5) Enhancement and Protection of Deer/Elk Habitat; 6) Enhancement or Protection of Riparian Habitat & Riparian Vegetation Composition; 7) Noxious Weeds; 8) Ponderosa Pine/Mixed Conifer - Vegetation Composition & Ponderosa Pine/Mixed Conifer - Fuel Conditions; 9) Tall Forbs - Vegetation Composition; 10) Wildlife Management in Agricultural Areas. (Figure 4-6). (Other issues and ratings within the Asay Creek Watershed are listed in Table 4-3.

1. Access Management

Current Conditions, Patterns and Trends

Road Densities currently exceed recommendations contained within the Dixie National Forest Land and Resource Management Plan (USFS, 1986) for hydrology and wildlife, especially in the Deer Valley, Strawberry Creek and Swains Creek Subwatersheds. High road densities along stream channels, with an increase in ATV use and dispersed camping, occur throughout much of the watershed. Increased sediment transport, degraded stream conditions, lack of riparian vegetation, and damage to adjacent upland areas through increased access occur in areas of concentrated use, and motorized use is increasing yearly. It should be noted, however, that this is a high use area, and concentrated use in this area affords a lower density of roads in other areas of the watershed. The Duck Creek Access Management Project Environmental Impact Statement (EIS) (USFS, 2002) is currently underway to help improve conditions within the watershed.

Reference Conditions, Patterns and Trends

Available roads have traditionally been used for harvesting timber, with less dispersed camping and recreating in riparian areas than is currently occurring. Access was limited to summer months, when weather conditions were favorable for travel within the forest. Once used timber roads, which were previously not a problem, today provide additional corridors for ATV movement, creating access into important wildlife habitat areas.

User-created roads increase sediment transport, fragment wildlife habitat and are confusing to the majority of the public.

Natural/Human Causes of Changes Between Current/Reference Conditions

Increased off-road use, with many user-created roads and reopening of closed roads are the primary causes of resource damage.

2. Aspen/Mixed Conifer – Vegetation Composition

Current Conditions, Patterns and Trends

Approximately 60% of quaking aspen stands have converted to stands of conifers in areas throughout the Upper Sevier River Basin (USFS, 2000). Existing aspen stands within the Midway Valley-Midway Creek, Deer Valley-Midway Creek, Strawberry Creek and Swains Creek subwatersheds are old (ranging in age from 60 to 100 years) and lack structural diversity. In pure older aspen stands, the absence of some type of disturbance has resulted in old aspen clones dying with no possible regeneration, resulting in an increase in continuous patches of mixed conifer. Aspen are important components of a healthy ecosystem, providing cover and forage for a variety of wildlife species and livestock, maintaining healthy watershed conditions, enhancing soil productivity and providing aesthetically pleasing landscapes.

Reference Conditions, Patterns and Trends

Fire has been the most important disturbance factor in aspen communities, influencing changes in structural stages and minimizing dominance by conifer species. Many stands classified today as conifer actually contain an aspen component, and would be dominated by aspen under a normal disturbance regime. Fires of mixed severity (depending on associated species) maintained vegetation mosaics and aspen dominance across much of the landscape. Structural stages consisted of approximately 40% grass/forb and seedling/saplings, 30% young, mid-age, and mature, and 30% old forest, with 85% ground cover (USFS, 2000).

The aspen component has been all but lost in this stand of mixed conifer, located within the Asay Creek watershed. Periodic fire once helped maintain vegetative conditions by supressing some plants and allowing others to regenerate.

Natural/Human Causes of Change Between Current/ Reference Conditions

Fire suppression and ungulate grazing have contributed to a decline in historic aspen stands. Ungulate grazing has reduced accumulations of fine fuels (shrub and herbaceous layers), resulting in few fire starts, occurrence of small fires, and contribution to the reduction and/or elimination of young aspen regrowth. Fire return intervals (generally 20 to 100 years) are less frequent today, allowing spruce-fir and mixed conifer types to replace previous aspen-dominated stands.

3. Communities at Risk to Wildfire

Current Conditions, Patterns and Trends

Fire regimes of frequent, small intensity fires have been altered from historic conditions, resulting in a build-up of fuels which pose a higher fire risk to area residents and fire fighters. In addition, the risk of losing key ecosystem components as well as community structures remains high, especially in developed areas along Highway 14, including areas in and around Duck Creek and Navajo Lake. Ponderosa pine forests have changed from open, park-like areas with scattered large trees to stands with dense thickets of small-diamater trees which are at risk of burning due to high amounts of fuel accumulations. Mixed conifer areas have overgrown, with high fuel loads, ladder fuels and closed canopies. Many property owners in the area remain unaware of the risk of wildland fire, and place importance on dense forest landscapes bordering their private lands.

Cooperative campaigns between various state and federal agencies encourage homeowners to provide defensible zones around their property to reduce fire risk.

Reference Conditions, Patterns and Trends

Historically, frequent small intensity fires in ponderosa pine and mixed conifer ecotypes helped reduce fuel accumulations while maintaining structural diversity and minimizing tree densities. In the absence of ground litter, with more open canopy, grasses and forbs were also maintained, serving as important soil stabilizers and reducing the likelihood of crown fires. Although beetle populations are always around at endemic levels, increased tree densities, drought conditions, and old age class structures in forested areas have left areas more susceptible to insect and disease outbreaks.

Valuable cabins are at risk to wildland fires because of vegetation in close proximity to homes.

Natural/ Human Causes of Change Between Current/Reference Conditions

An increase in urban development in this area, with high accumulations of dead and dying materials in close proximity to area residences results in a high risk to wildfire. In addition, past wildfire suppression efforts have contributed to the large fuel loads on public lands.

4. Development and Effects to Ground/Surface Water & Summer Home Development - Hydrology

Current Conditions, Patterns and Trends

There are approximately 4,163 developed lots in this area, all currently using septic tanks. They include Strawberry Valley (841 lots), Duck Creek (1450 lots), Swain's Creek (1,107 lots), and Strawberry Point - Zions View (765 lots). As development continues to increase, impacts to groundwater from poorly designed, poorly located and poorly installed septic systems may be a potential problem. Currently, the Southwest District Health Department is sponsoring a study to determine potential impacts of septic systems to groundwater.

Dispersed recreation, in areas where few or no sanitary facilities exist as well as inadequate disposal facilities at Navajo Lake, may also potentially impact ground-water. In addition, in the Deer Valley area, sporadic parking and increased recreation use on private lands is causing upland erosion and impacting area waters, by introducing pollutants and high amounts of sediment.

The number of homes within the Asay Creek Watershed continues to increase. Many are occupied year-round and are complete with all amenities, potentially impacting area ground water.

Reference Conditions, Patterns and Trends

Historically, most use of the watershed was intermittent/seasonal, with few year-round residents. Travel was limited to major roads, with little or no off-road impacts. Timber roads were often left open, because they received little if any post-harvest use, and could act as migration corridors for wildlife. Impacts from septic systems, because so few existed, were not of concern in this area.

Natural/ Human Causes of Change Between Current/Reference Conditions

Number of homes continues to increase, with many residents now living in the area year-round, greatly increasing the amount of waste disposal and water use. In addition, past users consisted of those seeking solitude which had very little impact on surrounding areas. Today, areas in and around Duck Creek and Navajo Lake are sought after by motorized recreation enthusiasts, increasing the number of user-created roads and reopening previously closed roads.

5. Enhancement or Protection of Deer/Elk Habitat

Current Conditions, Patterns and Trends

Both deer and elk summer and winter ranges are found within the Asay Creek Watershed. Deer are the most abundant big game species on and adjacent to forested lands and can be found in about every habitat type. Elk are found in isolated populations throughout the entire Upper Sevier River Basin. Both currently serve as Management Indicator Species(MIS) for the Dixie and Fishlake National Forests, partly because the distribution of forage and cover ensure provision of habitat requirements for many other wildlife species, including sensitive species such as sage grouse, goshawk, flammulated owl, three-toed woodpecker, Utah prairie dog and peregrine falcon. Deer and elk are also high-visibility species, both from a recreational hunting standpoint, and as a competitor to domestic livestock in rangeland and agricultural areas. Mule deer and elk habitat consisting of sagebrush/grassland types and mixed-conifer, aspen and ponderosa are found throughout the watershed; however high road densities, habitat fragmentation and loss of aspen understory may decrease available habitat areas. Efforts to maintain or enhance existing habitats are needed.

Mule deer habitat is found throughout much of the Asay Creek Watershed. However, meadowed areas for foraging are decreasing because of conifer encroachment, while high road densities and poor range conditions negatively impact other areas.

Reference Conditions, Patterns and Trends

Extensive sagebrush/grassland areas once occupied portions of the Asay Creek Watershed. Periodic fire disturbance maintained vegetation diversity in the mixed conifer, aspen and ponderosa pine forest types, creating mosaics within the landscape. Limited use of the watershed from recreation vehicles, with little or no winter use, left most wildlife migration corridors undisturbed. Natural processes (spruce beetle epidemics, wildfire, etc) helped support habitat for other wildlife species as well.

In some areas, livestock and big game compete for the same resources.

Natural/Human Causes of Change Between Current /Reference Conditions

Increased human uses of roads and developments increase disturbance to sensitive wildlife habitats, by interrupting migration corridors and fragmenting wildlife areas. Grazing and the introduction of elk to the watershed during the mid-20th century may have played a role in eliminating tall forb communities, riparian habitats and degrading meadows. Woodcutting has reduced snags and cover, while timber harvest has reduced large diameter ponderosa pine necessary for deer and elk cover. Fire suppression efforts during the last 100 years have encouraged high stand densities, pinyon-juniper expansion and a decrease in sagebrush age diversity, further eliminating deer habitat, forage and cover.

6. Enhancement or Protection of Riparian Habitat & Riparian Vegetation Composition

Current Conditions, Patterns and Trends

Very little bank stability exists in some areas, increasing sediment transport and degrading aquatic habitats.

Woody plant species and late seral herbaceous species are lacking along many riparian corridors, particularly along Strawberry, Swains and Asay Creeks, as well as the main stem of the Sevier River. Where woody plant species (willow and cottonwood) are present, recruitment of young is limited; the majority of plants are in a mature stage. Bank erosion has resulted in higher width/depth ratios along many stream corridors as well as increased head cuts on the upstream ends. Recreation around riparian areas has increased in recent years, especially in the vicinity of summer and recreation homes. All-terrain vehicle use has also increased. Riparian areas are of particular importance to birds, fish, amphibians, aquatic invertebrates, and other wildlife species. They provide critical breeding habitat for many southwestern neotropical birds, as well as water, shade, food and shelter for other wildlife species. Riparian areas also provide migratory routes for many bird species as well as sheltered pathways to other habitats for other wildlife species.

Reference Conditions, Patterns and Trends

Riparian vegetation in the Asay Creek Watershed most likely consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower elevations along Asay Creek and the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes.

Natural/Human Causes of Change Between Current/Reference Conditions

Changes in riparian vegetation density and diversity have resulted from a variety of land uses including livestock grazing, road encroachment and construction, channel adjustments, road construction, recreation, and cropland cultivation.

7. Noxious Weeds

Current Conditions, Patterns and Trends

Noxious weeds pose an increasing threat to native ecosystems, croplands and other plant communities within the Asay Creek Watershed. An increase in recreational vehicle use and increased traffic along Highway 14 and surrounding areas may accelerate the spread of noxious weeds. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients.

Too many access roads to one area not only look unsightly, fragment wildlife habitats, and increase erosion within a watershed, but also are likely places for noxious weed introductions. Recreational vehicles are the number one transporter of noxious weeds from one area to another.

Reference Conditions, Patterns and Trends

Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Natural/Human Causes of Change Between Current/Reference Conditions

Currently, trails and roads serve as the single-most common point of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV’s and other motorized and nonmotorized vehicles traveling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult. Movement by recreationists from watershed to watershed (possibly serving to increase noxious weeds) may pose long-term problems for resource managers as well as area landowners.

8. Ponderosa Pine – Vegetation Composition & Ponderosa Pine/Mixed Conifer – Fuel Conditions

Current Conditions, Patterns and Trends

Within the Asay Creek Watershed, the question is not if there will be a fire, but when. High fuel loads, with small age classes of ponderosa pine are at risk to an uncontrolled wildfire. The Big Wash Fire, along the Highway 14 corridor in 2002, serves as a reminder of the need to reduce fuels in the Asay Creek Watershed.

Mixed-conifer is currently over-represented within the Swains Creek and Strawberry Creek subwatersheds and is displacing remaining populations of ponderosa pine and aspen. Ponderosa pine densities are high, with even age structures of small diameter trees. Many high density ponderosa populations have recently been affected by high populations of bark beetle. An increase in mixed-conifer and high-density ponderosa pine stands around urban interface areas has left many of these areas at extreme risk to high severity wildfires. In addition, changes in vegetation structures have impacted wildlife, riparian areas, aspen stands, meadows and sagebrush communities. Large diameter ponderosa pine, with accompanying large diameter snags, provide important hiding and thermal cover for numerous wildlife species as well as nesting habitat for some bird species. The risk of stand-replacement fires within ponderosa pines is also a concern.

Reference Conditions, Patterns and Trends

Periodic fires created uneven-aged stands comprised of small even-aged groups. Fire return intervals of 5 to 25 years, with low intensity surface fires, helped maintain a variety of structural stages (PFC Assessment, 2000). Multi-age classes of different vegetation types were historically represented.

Natural/Human Causes of Change Between Current/Reference Conditions

Fire exclusion and livestock grazingv(removing fine fuels) are the primary causes of change between current and reference conditions.

9. Tall Forbs – Vegetation Compostion

Current Conditions, Patterns and Trends

Tall forb communities in association with forests and shrublands provide valuable habitat for deer, elk, turkeys, eagles, owls and a variety of small birds, insects and small mammals. These communities also decrease erosion within the watershed. However, most of the tall forb plant communities within the Upper Sevier River Basin have been lost, and few seed bases and necessary soil types remain. Isolated colonies of pollinating insects, which are dependent on these communities, are also at risk of disappearing. Reestablishment of tall forbs is considered a priority within the watershed, and currently, a 50-acre test area, adjacent to Cedar Breaks National Monument, has been established to test various restoration methods

Reference Conditions, Patterns and Trends

Tall forb communities are considered the "flower gardens" of the mountains and were historically found throughout the mountains at or above 8,000 feet in elevation. A review of potential tall forb sites on July 30, 1997 indicated that between Navajo Lake and Sidney Valley there were approximately 6,000 acres that once supported tall forb communities (2000, Assessment).

Although tall forbs once occurred throughout the entire Upper Sevier River Basin, today only a few isolated populations remain,with very few seed bases in existence.

Natural/Human Causes of Change Between Current/Reference Conditions

Fire may have played a role in maintaining tall forb communities by preventing conifers from encroaching into the parklands and meadows which are interspersed among conifer and aspen forests. Livestock grazing has removed many of the tall forb communities, allowing soil loss and severe rill and gully erosion, with future site restoration in many areas difficult, if not impossible.

10. Wildlife Management in Agricultural Areas

Current Conditions, Patterns and Trends

Wildlife damage to agricultural lands has steadily increased over the past decade. In the Asay Creek Watershed, depredation from elk is the primary concern; however, in some years deer are also likely to impact agriculture areas.

While mitigation measures such as landowner and control permits, fencing, and actual dollar reimbursements offset some of the costs, wildlife continues to have an economic impact on private agricultural lands. Other concerns expressed from landowners include the impact to land development and use by the listing (endangered, threatened, etc.) of wildlife species such as Utah prairie dog and sage grouse, and the hesitation of landowners to engage in habitat improvement projects which may further attract wildlife and result in subsequent damage to local areas. Impacts to watershed condition and range condition from elk and deer utilization during periods of drought are also a cause for concern.

Reference Conditions, Patterns and Trends

Elk were eliminated from the watershed at the beginning of the 20th century, but were reintroduced in the 1980's. Unrestricted hunting of predators as well as hunting of big game species, resolved most wildlife/landowner conflicts. Adequate winter and summer deer and elk ranges were maintained by periodic fire, further eliminating potential deer/elk conficts.

Natural/Human Causes of Change Between Current/ Reference Conditions

Restricted hunting, demand for increased, quality hunting opportunities, stricter compliance with fish and game laws, and the desire for wildlife viewing opportunities have resulted in an increase in deer and elk numbers from early settlement conditions. Drought and susbequent changes in vegetation composition within the watershed may temporarily decrease elk and deer numbers; however, these same conditions may cause deer and elk to seek additional forage opportunities on private agriculture lands, where adequate feed is available. Competition for available forage from domestic livestock has decreased range conditions in some areas, further contributing to wildlife depredation on cultivated lands.

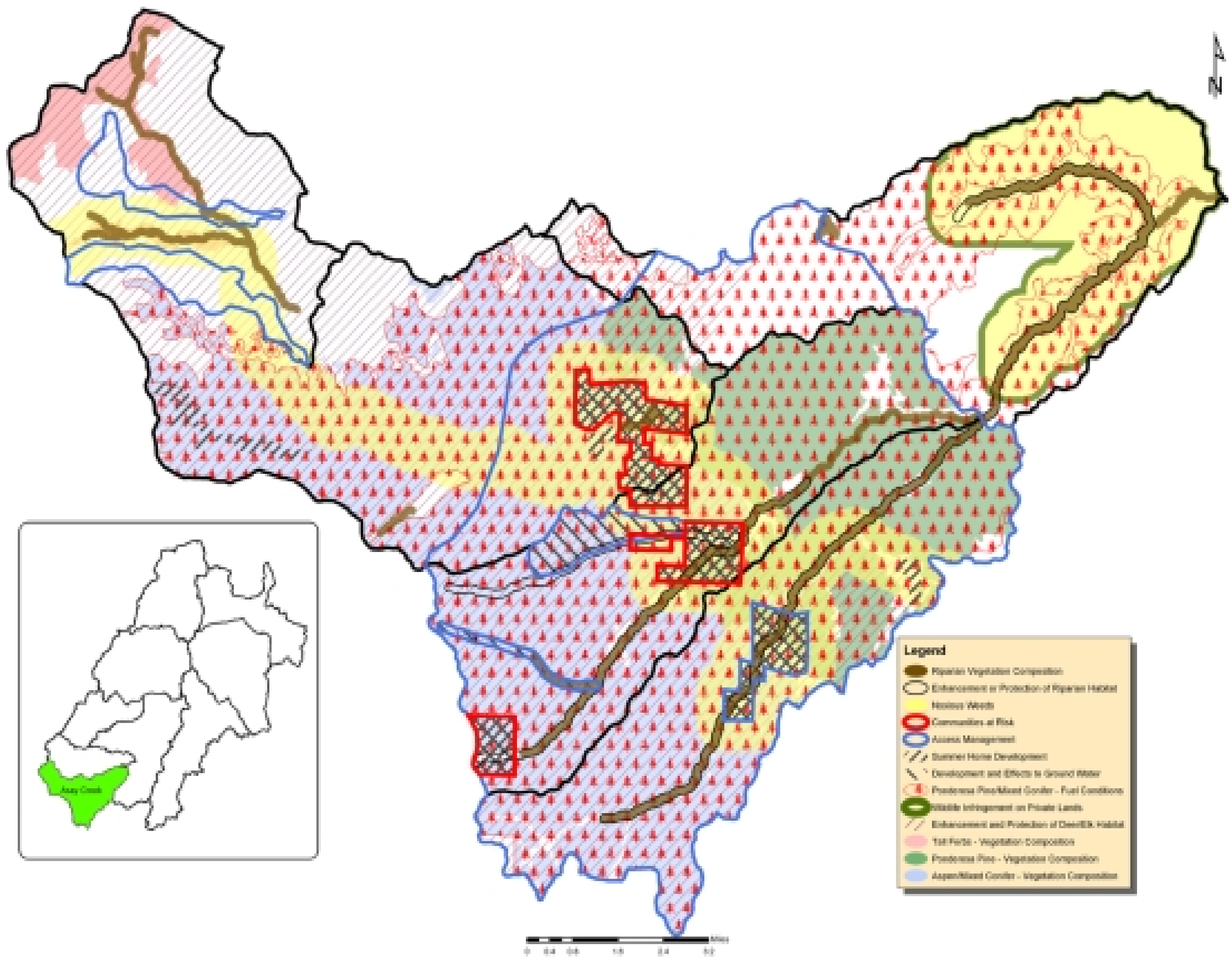


Fig. 4-6. The 13 key issues identified (descriptions included in the 10 narratives) for the Asay Creek Watershed represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees.

	Midway Valley-Midway Creek	Deer Valley-Midway Creek	Strawberry Creek	Swains Creek	West Fork Asay Creek - Asay Creek	**Total for Asay Watershed**
Hydrology/Water Quality						
Hydrology						
Dewatering and altered flow regimes	NA	NA	L	NA	NA	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	NA	NA	NA	**NA**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	H	NA	H	L	H	**M**
Hillslope Processes						
Accelerated erosion on high elevation meadows	H	M	NA	NA	L	**L**
Accelerated erosion in pinyon-juniper and sagebrush stand	L	L	NA	NA	M	**L**
Accelerated erosion associated with urban development	NA	H	H	H	NA	**M**
Accelerated erosion associated with roads	L	M	H	H	NA	**M**
Rill and gully erosion on hillslopes	NA	NA	NA	NA	NA	**NA**
Accelerated erosion associated with illegal ATV use	NA	H	H	M	NA	**M**
Riparian Vegetation						
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	L	M	H	H	H	**M**
Water Quality						
Summer home development and associated impacts (I.e., Groundwater contamination, erosion, recreation, etc.)	NA	H	H	H	L	**M**
Accelerated erosion, grazing management, recreation use, roads	NA	H	M	M	H	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	NA	H	M	M	H	**M**
Channel Morphology						
Active channel adjustments (vertical or lateral)	L	L	H	M	M	**M**
Accelerated bank erosion	M	L	H	H	M	**M**
Channelization	NA	NA	NA	NA	NA	**NA**
Agriculture						
Animal Feed Operations	NA	NA	NA	NA	NA	**NA**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	NA	L	NA	M	NA	**L**
Pasture Mgt.	L	M	NA	M	NA	**L**
Fertilizer Usage and Impacts	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	M	M	NA	M	L	**M**
Wildlife Management in Agricultural Areas	H	H	L	H	M	**H**

Table 4-3. Issue ratings for all five Asay Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

	Midway Valley-Midway Creek	Deer Valley-Midway Creek	Strawberry Creek	Swains Creek	West Fork Asay Creek - Asay Creek	**Total for Asay Watershed**
Fire						
Communities at Risk	NA	H	H	H	L	**M**
Fuel Conditions	H	H	H	H	M	**H**
Human Uses						
Development and Effects to Ground/Surface Water	NA	H	H	H	L	**M**
Development and associated recreation uses to adjacent lands	NA	H	H	H	L	**M**
Access Management	L	H	H	H	M	**H**
Developed and Dispersed Recreation	M	H	H	H	H	**H**
Vegetation						
Sagebrush - Grass	L	L	NA	L	H	**M**
Aspen	M	H	H	H	L	**H**
Grassland - Meadow	L	L	L	L	NA	**L**
Mixed Conifer - Mountain Fir	L	H	H	H	NA	**M**
Oak - Mahogany - Mountain Shrub	NA	NA	NA	NA	NA	**NA**
Pinyon - Juniper	NA	NA	NA	NA	NA	**NA**
Ponderosa	NA	M	H	H	H	**H**
Spruce - Fir	M	M	NA	NA	NA	**L**
Tall Forb	H	L	NA	NA	NA	**L**
Noxious Weeds	M	H	M	M	M	**H**
Wildlife						
Priorities for Enhancement or Protection of:						
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	NA	NA	NA	NA	L	**L**
Bald Eagle Habitat	M	M	L	L	L	**M**
Spotted Bat Habitat	M	M	M	L	L	**M**
Townsend's Big-eared Bat Habitat	M	M	M	M	H	**H**
Flammulated Owl Habitat	L	M	M	M	H	**M**
Three-toed Woodpecker Habitat	H	H	H	H	L	**H**
Northern Goshawk Habitat	H	H	H	H	H	**H**
Peregrine Falcon Habitat	H	H	H	M	M	**H**
Sage Grouse Habitat	NA	NA	NA	NA	L	**L**
Turkey Habitat	M	M	M	M	M	**M**
Deer Habitat	H	H	H	H	H	**H**
Elk Habitat	H	H	H	H	H	**H**
Pronghorn Habitat	NA	L	L	L	M	**L**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	L	M	H	H	H	**H**
Boreal Toad Habitat	NA	NA	NA	NA	NA	**NA**
Bonneville Cutthroat Habitat	NA	NA	NA	NA	NA	**NA**
Riparian Areas	L	H	H	H	H	**H**
Fisheries Habitat	NA	M	M	M	H	**M**

Table 4-3 (con't). Issue ratings for all five Asay Creek subwatersheds, as identified by technical advisory committees (TAC's). Issues highlighted in blue are addressed in detail in this section.

MAMMOTH CREEK WATERSHED

Rural social values and life-styles, in conjunction with a long heritage of ranching and farming, continue to shape areas within the Mammoth Creek Watershed. However, in recent years, the watershed has also become a popular recreation and summer use area and is noted for its scenic landscapes and popular trout fishing waters. Hiking, cycling, picnicing and ATV riding opportunities are available during summer months, while snowmobiling and cross-country skiing continue to be popular wintertime activities.

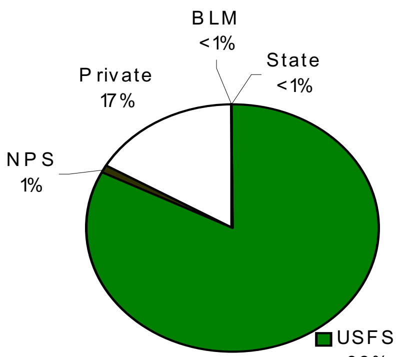


Fig. 4-7. Land ownership within the Mammoth Creek Watershed is primarily U.S. Forest Service lands.

Land Ownership

The Mammoth Creek Watershed contains only four subwatersheds – Lower Mammoth Creek, Middle Mammoth Creek, Tommy Creek and Upper Mammoth Creek – and is the smallest watershed within the Upper Sevier River Basin at only 74,776 acres (Table 4-4). While U. S. Forest Service lands dominate (61,729 acres), private land areas consisting of private ranches and homes occupy 12,402 acres. Bureau of Land Management lands (54 acres), National Park Service (541 acres) and state lands (41 acres) are also found within the watershed (Figure 4-7, 4-8).

Mammoth Creek Subwatersheds	Acres
Lower Mammoth Creek	18520
Middle Mammoth Creek	16102
Tommy Creek	14239
Upper Mammoth Creek	25906
Total	74766

Table 4-4. The four subwatersheds in the Mammoth Creek Watershed contain the least number of acres within the Upper Sevier River Basin..

Vegetation Types

Lands within the Mammoth Creek Watershed are dominated by aspen and are valued as luxuriant summer range for livestock and as prime habitat for many species of wildlife (Fig 4-9, Table 4-5). Over 30,000 acres of Englemann spruce within the Mammoth Creek and surrounding watersheds are dead or dying as a result of a recent spruce beetle epidemic. This extensive mortality is visible along many travel routes within the watershed and also creates fire safety concerns for several mountain home subdivisions. Dealing with this epidemic has generated much discussion and many questions from the public, landowners and land management agencies alike.

The Mammoth Creek Watershed is noted for its productive and colorful aspen forests.

The rim of Cedar Breaks National Monument, located along Highway 143, is over 10,000 feet above sea level, and is forested with islands of Englemann spruce, subalpine fir, bristlecone pine and aspen. In the summer, abundant meadow areas provide habitat for deer and elk, as well as numerous birds and small mammals.

Vegetation Type	Acres	%
Agriculture	452	1%
Aspen	6753	9%
Grass/Forb	4977	7%
Mixed Conifer	6985	9%
Mountain Shrub	76	0%
Pinyon/Juniper	4372	6%
Ponderosa Pine	18135	24%
Sagebrush/Grass	8980	12%
Spruce/Fir	15812	21%
Other	8225	11%
Total	74766	100%

Table 4-5. Although only a small portion of the watershed, tall forb communities are considered high priority for protection by resource personnel.

Elevation, Roads & Streams

Brian Head Peak is the highest point within the Upper Sevier River Basin at an elevation of 11,307 feet. The eroded rock formations of Cedar Breaks National Monument mark the western edge of the watershed, while spring-fed Mammoth Creek flows through the middle. Interestingly, on top of Brian Head peak stands an observation point constructed by the Civilian Conservation Corps (CCC) between 1935-1937. This rock and wooden structure is exemplary of the fine craftsmanship and architecture of the CCC, and is an often-visited spot within the watershed. The Brian Head chert rock formations found throughout the area were used extensively as a source of stone for arrowheads by early native Americans. Brian Head ski resort to the west of the peak, and part of the Beaver River Watershed, offers some of the best downhill skiing and snowboarding in southern Utah. On a typical day, you can see over 100 miles and peer into Nevada, Arizona and Utah from the top of Brian Head Peak.

From vantage points along Highway 14 and 143, visitors to the watershed can look into Cedar Breaks - a huge natural amphitheater that has eroded out of the variegated Pink Cliffs. Millions of years of sedimentation, uplift and erosion have created the deep canyon of rock walls, fins, spires and columns, spanning some three miles, and over 2,000 feet deep.

Mammoth Creek, after flowing over 20 miles through mountains and forests, intersects with the main stem of the Sevier River, near the town of Hatch, Utah. The creek is a popular spot for anglers and provides opportunities to catch wild brown trout and hatchery rainbow trout.

This structure that stands atop Brian Head Peak was built by the Civilian Conservation Corps during the depression. The still standing structure is a popular tourist spot within the watershed.

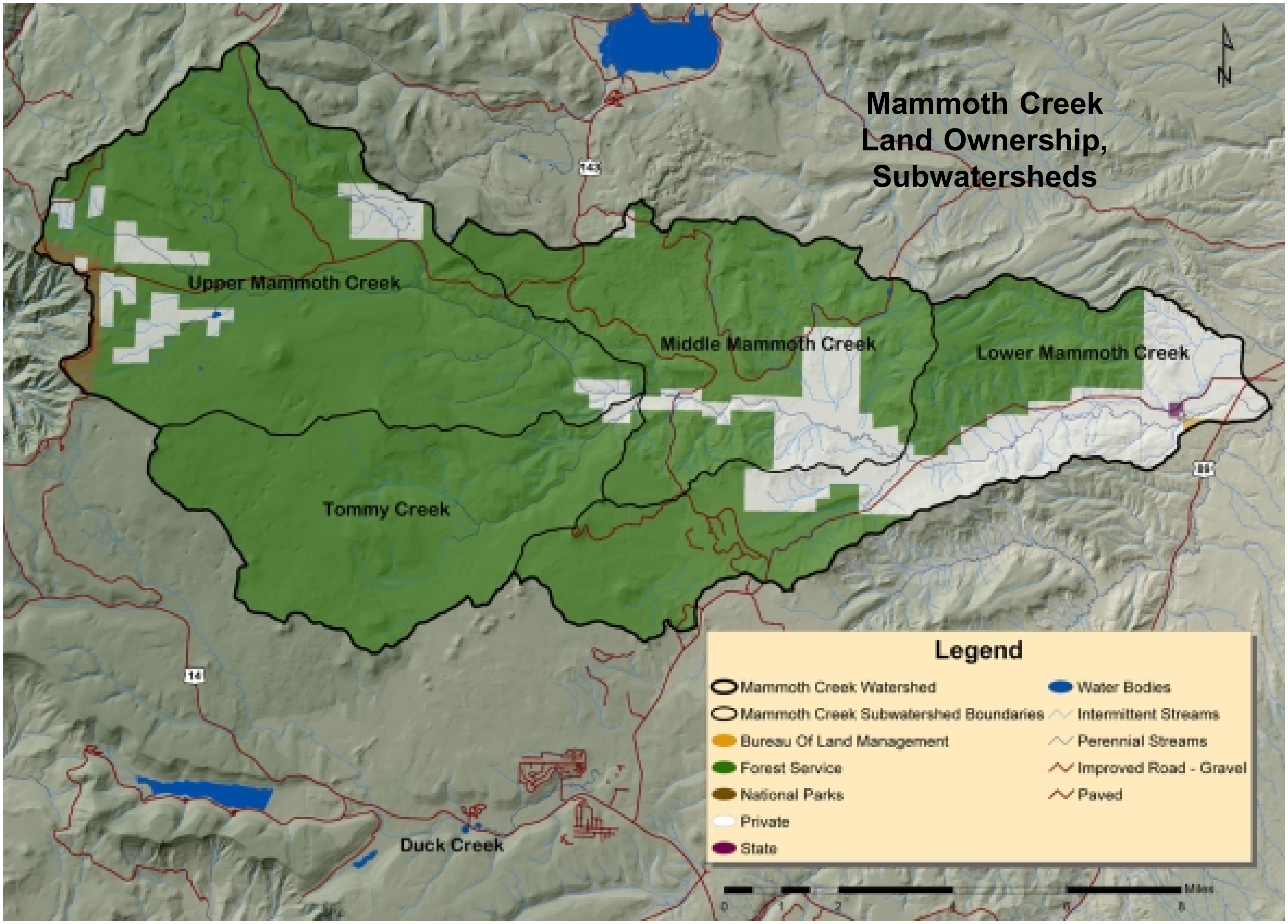


Fig. 4-8. U. S. Forest Service lands encompass eighty-two percent of the Mammoth Creek Watershed. This watershed is a popular camping, hiking and recreational use area.

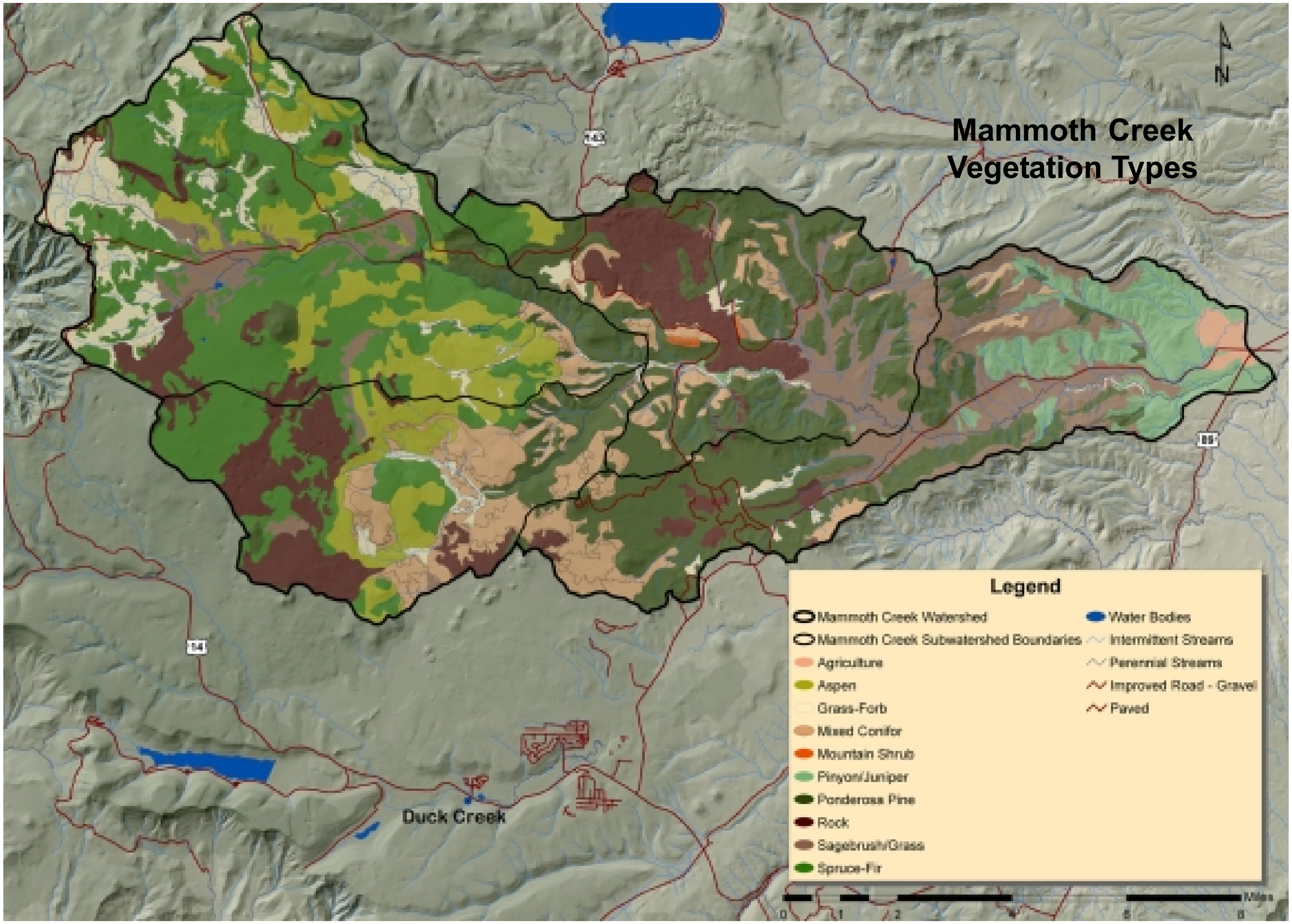


Fig. 4-9. The Mammoth Creek Watershed is highly valued for its scenic areas, with colorful high mountain meadows, portions of Cedar Breaks National Monument, abundant wildlife and dense ponderosa pine and aspen forests.

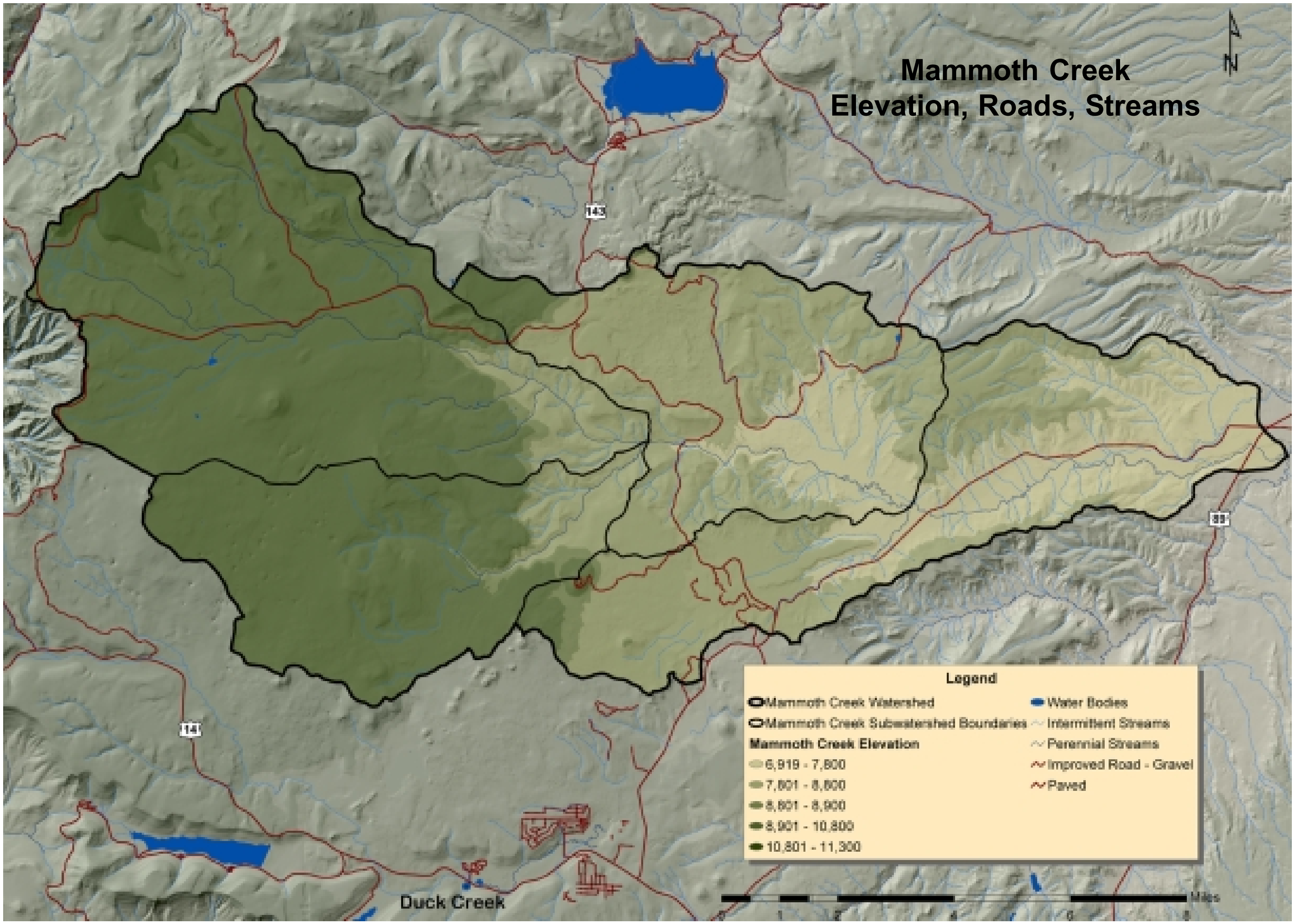


Fig. 4-10. Brian Head Peak, at 11,300 feet in elevation, is the highest point within the Upper Sevier River Watershed. Expansive high mountain tall forb meadows once dotted the watershed; however, high ungulate use has all but eliminated most of these areas.

Key Issues

Key issues identified for the Mammoth Creek Watershed are: 1) Aspen/Mixed Conifer - Vegetation Composition; 2) Communities at Risk to Wildfire; 3) Development and Effects to Ground/ Surface Water & Summer Home Development; 4) Development and Impacts to Adjacent Lands; 5) Enhancement and Protection of Goshawk Habitat; 6) Enhancement and Protection of Riparian Habitat & Riparian Vegetation Composition; 7) Noxious Weeds; 8) Ponderosa Pine - Fuel Conditions; 9) Spruce Fir - Fuel Conditions; 10) Tall Forbs - Vegetation Composition; 11) Wildlife Management in Agricultural Areas (Figure 4-11). (Other issues and ratings within the Mammoth Creek Watershed are listed in Table 4-6.)

1. Aspen/Mixed Conifer – Vegetation Composition

Current Conditions, Patterns and Trends

Approximately 60% of quaking aspen stands have converted to stands of conifers in areas throughout the Upper Sevier River Basin (USFS, 2000). Existing aspen stands within the Midway Valley-Midway Creek, Deer Valley-Midway Creek, Strawberry Creek and Swains Creek subwatersheds are old (ranging in age from 60 to 100 years) and lack structural diversity. In pure older aspen stands, the absence of some type of disturbance has resulted in old aspen clones dying with no possible regeneration, resulting in an increase in continuous patches of mixed conifer. Aspen are important components of a healthy ecosystem, providing cover and forage for a variety of wildlife species and livestock, maintaining healthy watershed conditions, enhancing soil productivity and providing aesthetically pleasing landscapes.

Reference Conditions, Patterns and Trends

Fire has been the most important disturbance factor in aspen communities, influencing changes in structural stages and minimizing dominance by conifer species. Many stands classified today as conifer actually contain an aspen component, and would be dominated by aspen under a normal disturbance regime. Fires of mixed severity (depending on associated species) maintained vegetation mosaics and aspen dominance across much of the landscape. Structural stages consisted of approximately 40% grass/forb and seedling/ saplings, 30% young, mid-age, and mature, and 30% old forest, with 85% ground cover (USFS, 2000).

Although numerous aspen stands occur throughout the Mammoth Creek watershed, many are old, with little or no new regeneration. Conifer encroachment as well as lack of fire have resulted in a decrease in aspen diversity, further affecting conditions within the watershed.

Natural/Human Causes of Change Between Current/ Reference Conditions

Fire suppression and ungulate grazing have contributed to a decline in historic aspen stands. Ungulate grazing has reduced accumulations of fine fuels (shrub and herbaceous layers), resulting in few fire starts, occurrence of small fires, and contribution to the reduction and/or elimination of young aspen regrowth. Fire return intervals (generally 20 to 100 years) are less frequent today, allowing spruce-fir and mixed conifer types to replace previous aspen-dominated stands.

2. Communities at Risk to Wildfire

Current Conditions, Patterns and Trends

Fire regimes of frequent, small intensity fires have been altered from historic conditions, resulting in a build-up of fuels which pose a higher fire risk to area residence and fire fighters. In addition, the risk of losing key ecosystem components as well as community structures remains high, especially in developed areas along Highway 14, including areas in and around Tommy Creek, Mammoth Creek, Castle Valley, Rainbow Meadows and Meadow Lakes Subdivisions. Ponderosa pine forests have changed from open, park-like areas with scattered large trees to stands with dense thickets of small-diamater trees which are at risk of burning due to high amounts of fuel accumulations. Mixed conifer areas have overgrown, with high fuel loads, ladder fuels and closed canopies. Many property owners in the area remain unaware of the risk of wildland fire, and place importance on dense forest landscapes bordering their private lands.

Reference Conditions, Patterns and Trends

Historically, frequent small intensity fires in ponderosa pine and mixed conifer ecotypes helped reduce fuel accumulations while maintaining structural diversity and minimizing tree densities. In the absence of ground litter, with more open canopy, grasses and forbs were also maintained, serving as important soil stabilizers and reducing the likelihood of crown fires. Although beetle populations are always around at endemic levels, increased tree densities, drought conditions, and old age class structures in forested areas have left areas more susceptible to insect and disease outbreaks.

Natural/ Human Causes of Change Between Current/ Reference Conditions

An increase in urban development in this area, with high accumulations of dead and dying materials in close proximity to area residences has

The desire for recreation homes amidst dense vegetation may provide privacy and a unique setting, but the close proximity of fuels and trees presents an extreme fire hazzard in some areas.

increased risk for catastrophic wildfireaddition, past wildfire suppression efforts have contributed to the large fuel loads on public lands.

3. Development and Effects to Ground Water & Summer Home Development

Current Conditions, Patterns and Trends

There are approximately 1,114 developed lots in the Ireland Meadows (36 lots), Meadow Lakes Estates (445 lots), Rainbow Meadows (90 lots), and Tommy Creek (194 lots) areas, all currently using septic tanks. As development continues to increase, impacts to groundwater may be a potential problem. Acceptable levels of coliform and nitrate levels are currently present, and the claron-limestone soils present from Duck Creek to Panguitch Lake are not suitable and conducive to septic system use (sewered systems are more desirable). Currently, the Southwest District Health Department is sponsoring a water quality study to determine potential impacts of septic systems to groundwater, and to determine long-term impacts.

The proximity of homes to critical riparian areas may increase sediment transport and introduce waste into area waters.

Dispersed recreation, in areas where few or no sanitary facilities exist, may also potentially impact groundwater. In addition, in the Deer Valley area, sporadic parking and increased recreational use on private lands are causing upland erosion and impacting area waters through increased sedimentation.

Reference Conditions, Patterns and Trends

Historically, most use of the watershed was intermittent/seasonal, with few year-round residents. Travel was limited to major roads, with little or no off-road impacts. Timber roads were often left open, because they received little if any post-harvest use, and could act as migration corridors for wildlife. Impacts from septic systems, because so few existed, were not of concern in this area.

Water sources may be contaminated from inproperly developed subdivisions.

Natural/ Human Causes of Change Between Current/Reference Conditions

The number of homes continues to increase, with many residents now residing year-round, greatly increasing the amount of waste disposal and water use. In addition, past users consisted of those seeking solitude which had very little impact on surrounding areas. Today, areas in and around Duck Creek and Navajo Lake are sought after by motorized recreation enthusiasts, increasing the number of user-created roads and reopening previously closed roads.

4. Development and Impacts to Adjacent Lands

Summer and year-round residents within the Mammoth Creek Watershed continue to increase. In addition, an overall increase in those seeking outdoor recreation, and the proximity of the watershed to established towns and national recreation areas, have magnified uses adjacent to Highway 143 and around developed recreation home areas. ATV use has also risen, with more off-road vehicles causing damage to meadows, streams and wildlife habitats. Road densities currently exceed those recommended by the Dixie National Forest Land and Resource Management Plan (USFS, 1986) and vandalism of posted road signs in closed areas is a recurring and expensive problem. In addition, increased use of the watershed may pose potential water quality problems as well as increase habitat fragmentation for wildlife species within the area.

As more and more recreationists traverse the watershed and Dixie National Forest, adjacent lands and water sources are impacted. The area around Mammoth Springs contains numerous dispersed camping sites and is constantly visited by tourists and area recreationists.

Reference Conditions, Patterns and Trends

Historically, most use of the watershed was intermittent/seasonal, with few year-round residents. Travel was limited to major roads, with little or no off-road impacts. Timber roads were often left open, because they received little if any post-harvest use, and could act as migration corridors for wildlife. Past use of the watershed consisted of those seeking solitude and having very little impact on surrounding areas.

Natural/ Human Causes of Change Between Current/Reference Conditions

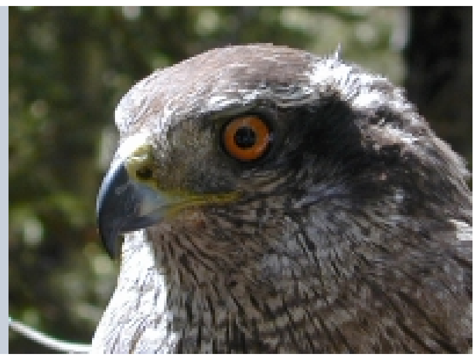
The number of homes continues to increase with many residents now residing in the area year-round. Overall recreational use of forested areas has risen considerably over the past 20 years.

5. Enhancement or Protection of Goshawk Habitat

Current Conditions, Patterns and Trends

Six goshawk territories have been documented in the Mammoth Creek Watershed since 1992. Only one of these territories was active in 2002, although no more than three of these known territories have been simultaneously active in any given year during the last decade. Existing nesting habitat for northern goshawk appears to be adequate within the watershed. However, 50 percent of these known territories have experienced high levels of insect infestations within the nest stand since 1996. The resulting tree mortality has affected stand structure and its potential to support nesting habitat for the northern goshawk.

U. S. Forest Service and Division of Wildlife Resource Biologists monitor goshawks throughout much of the Upper Sevier River Basin.



U. S. Forest Service monitoring of goshawk territories over time indicates a downward trend in goshawk populations for the Dixie National Forest (Rodriguez, 2002).

Reference Conditions, Patterns and Trends

This species is associated with coniferous and mixed forests through much of the Northern hemisphere. Nesting habitat studies demonstrate that goshawk prefer to nest in older-aged forests with variable tree species. Nest sites are typically characterized by canopy closures greater than 60%, flatter slopes (<40%), and nest trees with diameters >8 inches. Prey abundance/availability and nest habitat are the primary limiting factors for goshawks (Rodriguez 2002).

Historically, insect and disease epidemics and catastrophic wildfire maintained vegetation diversity in the mixed conifer, aspen and ponderosa pine forest types. These natural phenomena created mosaics within the landscape and limited vegetation encroachment into meadow and riparian areas. These conditions helped support habitat for northern goshawks, as well as three-toed woodpeckers, peregrine falcons, and other wildlife species.

Natural/Human Causes of Change Between Reference/Current Conditions

Drought, cold and wet early spring conditions, low prey densities, significant wind events, fire, modified landscape vegetation (e.g. fire suppression and timber harvest), and predators all affect goshawk numbers (Rodriguez 2002). Current drought conditions and widespread insect infestations (e.g. spruce bark beetle, and pine beetle) are likely impacting local populations and their habitat on the Dixie National Forest, as well as conditions within the Mammoth Creek Watershed.

6. Enhancement and Protection of Riparian Habitat & Riparian Vegetation Composition

Extensive gully erosion occurs in portions of the Mammoth Creek Watershed.

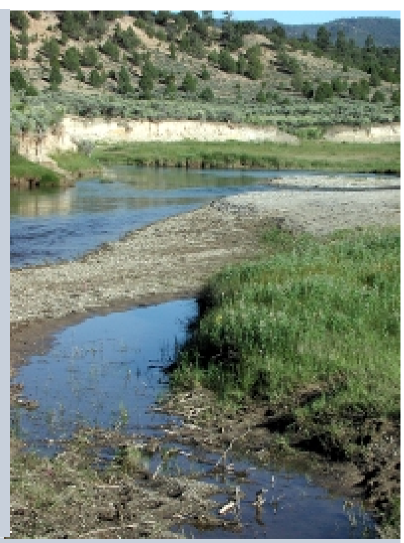
Current Conditions, Patterns and Trends

Woody plant species and late seral herbaceous species are lacking along many riparian corridors, particularly along the Sevier River, near Hatch, Upper and Lower Mammoth Creek, Pass Creek and Limestone Creek. Where woody plant species (willow and cottonwood) are present, recruitment of young plants is limited and the majority of plants are in a mature stage. Bank erosion has resulted in higher width/depth ratios along many stream corridors and increased head cuts on the upstream ends. Recreation around riparian areas has increased in recent years, especially in the vicinity of summer and recreation homes. All-terrain vehicle use has also increased. Riparian areas are of critical importance to birds, fish, amphibians, aquatic invertebrates, and other wildlife species. They provide critical breeding habitat for many southwestern neotropical birds, as well as water, shade, food, and shelter for other wildlife species. Riparian areas also provide migratory routes for many bird species, as well as sheltered pathways to other habitats for other wildlife species.

Reference Conditions, Patterns and Trends

Riparian vegetation in the Mammoth Creek Watershed most likely consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower

Changes in vegetation composition and upland grazing have increased erosion into area waters. Steep cut banks and altered flow regimes are evident throughout the watershed.



elevations along the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes.

Natural/Human Causes of Change Between Current/Reference Conditions

Changes in riparian vegetation have resulted from a variety of land uses including livestock grazing, channel adjustments, water diversions, road construction, recreation, and cropland cultivation. Intensive grazing pressure, particularly along lower Mammoth Creek and the Sevier River has resulted in higher width/depth ratios of streams. The failure of Hatch Town Dam in the mid-1900's left several feet of deposition material, causing increased channel erosion along the Sevier River.

7. Noxious Weeds

Current Conditions, Patterns and Trends

Noxious weeds pose an increasing threat to native ecosystems, croplands and other plant communities within the Mammoth Creek Watershed. An increase in recreational vehicle use and increased traffic along Highway 143 and surrounding areas may accelerate the spread of noxious weeds. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and when once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients. Noxious weeds located within water drainages are currently competing with native riparian vegetation.

More and more noxious weeds, like Canada Thistle, are being found along the Highway 143 corridor and within proximity to area waters.

Reference Conditions, Patterns and Trends

Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Natural/Human Causes of Change Between Current/Reference Conditions

Currently, trails and roads serve as the single-most common point of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV's and other motorized and nonmotorized vehicles traveling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult. Movement by recreationists from watershed to watershed (possibly serving to increase noxious weeds) may pose long-term problems for resource managers as well as area landowners.

High densities of small diameter ponderosa pine are present in many areas within the Mammoth Creek Watershed.

8. Ponderosa Pine – Fuel Conditions

Current Conditions, Patterns and Trends

Mixed-conifer is currently over-represented in areas throughout the Mammoth Creek Watershed and is displacing remaining populations of ponderosa pine and aspen. Ponderosa pine densities are high, with even age structures of small diameter trees. Many high-density ponderosa pine populations have been affected by large populations of bark beetles. An increase in mixed-conifer and high-density ponderosa pine around urban interface areas has left many of these areas at extreme risk to high severity wildfires. In addition, changes in vegetation structures have impacted wildlife, riparian areas, aspen stands, meadows and sagebrush communities. Large diameter ponderosa pines, with accompanying large diameter snags, provide important hiding and thermal cover for numerous wildlife species as well as nesting habitat for some bird species. The risk of stand-replacement fires within the ponderosa pine community is also a concern.

Tall forb communities are know n as the flower gardens of the mountains and provide habitat for a variety of wildlife.

Reference Conditions, Patterns and Trends

Periodic fires created uneven-aged stands comprised of small even-aged groups. Fire return intervals of 5 to 25 years, with low intensity surface fires, helped maintain a variety of structural stages

(PFC Assessment, 2000). Multi-age classes of different vegetation types were historically represented.

Natural/Human Causes of Change Between Current/Reference Conditions
Fire exclusion and livestock grazing (removing fine fuels) are the primary causes of change between current and reference conditions.

9. Tall Forbs – Vegetation Compostion

Current Conditions, Patterns and Trends
Tall forb communities in association with forest and shrubland communities are valuable habitat for deer, elk, turkeys, eagles, owls and a variety of small birds, insects and small mammals. However, most of the tall forb plant communities within the Upper Sevier River Basin have been lost and few seed bases and necessary soil types remain. Isolated colonies of pollinating insects which are dependent on these communities are also at risk of disappearing. Reestablishment of tall forbs is considered a priority within the watershed, and currently, a 50-acre test area, adjacent to Cedar Breaks National Monument, has been established to test various restoration methods.

Dead spruce are visible along much of the Highway 143 corridor, posing safety and fire hazzards in high traffic areas.

Reference Conditions, Patterns and Trends
Tall forb communities are considered the “flower gardens” of the mountains and were historically found throughout the mountains at or above 8,000 feet in elevation. A review of potential tall forb sites on July 30, 1997 indicated that between Navajo Lake and Sidney Valley there were approximately 6,000 acres that once supported tall forb communities (2000, Assessment).

Natural/Human Causes of Change Between Current/Reference Conditions
Fire may have played a role in maintaining tall forb communities by preventing conifers from encroaching into the parklands and meadows which are interspersed among conifer and aspen forests. Livestock grazing has removed many of the tall forb communities, contributing to soil loss and severe rill and gully erosion, with future site restoration in many areas difficult, if not impossible.

10. Spruce-Fir – Fuel Conditions

Current Conditions, Patterns and Trends
Spruce communities are currently being affected by a widespread spruce beetle outbreak. Approximately 90% of the trees are dead or dying, increasing fuel loads and placing

many areas at risk to catastrophic wildfire. An increase in spruce budworm has also been noted. With the current loss of spruce in this area, and increased mortality in the subalpine fir by root rot and insects, fuel loading may result in large, high severity, stand replacement fires. The Engelmann spruce-subalpine fir community (including aspen) provides habitat for large game species, such as mule deer and elk, as well as northern goshawk, blue grouse, woodpeckers and other neotropical birds and small mammals. Current stand compositions may negatively impact some populations of wildlife dependent on spruce-fir habitat..

Reference Conditions, Patterns and Trends

Historically, stands included both multi and single storied vegetation types, with mixed species composition. Most disturbances operated on a small scale, except for bark beetle outbreaks, which operated on a landscape scale, possibly every several hundred years, and were followed by high intensity wildfires. Mixed severity fires helped maintain vegetation mosaics and structural stages across the watershed.

Natural/ Human Causes of Change Between Current/ Reference Conditions

Agricultural lands in close proximity to wildlife habitats are often depredated during winter months and droughts or when range conditions are poor.

Historic heavy grazing during Euro-American settlement, and subsequent fire exclusion has changed vegetation patterns and processes especially in the drier communities. Fire exclusion in the mixed conifer type has resulted in an increase in Douglas fir and true firs and a decrease in aspen and ponderosa pine. Timber harvest activity has also occurred in parts of the mixed conifer type, leaving stands of mixed quality. Fire exclusion in spruce-fir since the 1850’s has probably resulted in some change in patterns across the landscape with spruce-fir stands becoming more continuous instead of being broken up by patches of aspen.

11. Wildlife Management in Agricultural Areas

Current Conditions, Patterns and Trends

Wildlife damage to agricultural lands has increased steadily over the past decade. In the Mammoth Creek Watershed, depredation from elk is the primary concern; however, in some years deer are equally as likely to impact agriculture areas.

While mitigation measures such as landowner and control permits, fencing and actual dollar reimbursements offset some of the costs, wildlife continues to have an economic impact on private agricultural lands. Other concerns expressed from landowners include the impact to land development and use by the listing (endangered, threatened, etc.) of wildlife species such as Utah prairie dog and sage grouse, and the hesitation of landowners to engage in habitat improvement projects which may further attract wildlife and result in subsequent damage to private lands and cultivated area.

Reference Conditions, Patterns and Trends

Elk were eliminated from the watershed at the beginning of the 20th century, but were reintroduced in the 1980's. Unrestricted hunting of predators as well as hunting of big game, resolved most wildlife/landowner conflicts. Adequate winter and summer deer and elk ranges were maintained by periodic fire, further eliminating potential deer/elk conficts.

Natural/Human Causes of Change Between Current/Reference Conditions

Restricted hunting, the demand for increased, quality hunting opportunities, stricter compliance with fish and game laws, and the desire for wildlife viewing opportunities have resulted in an increase in deer and elk numbers from early settlement conditions. Drought and subsequent changes in vegetation composition within the watershed may temporarily decrease elk and deer numbers; however, these same conditions may cause deer and elk to seek additional forage opportunities on private agriculture lands, where adequate feed is available. Competition for available forage from domestic livestock has decreased range conditions in some areas, further contributing to wildlife depredation on cultivated lands.

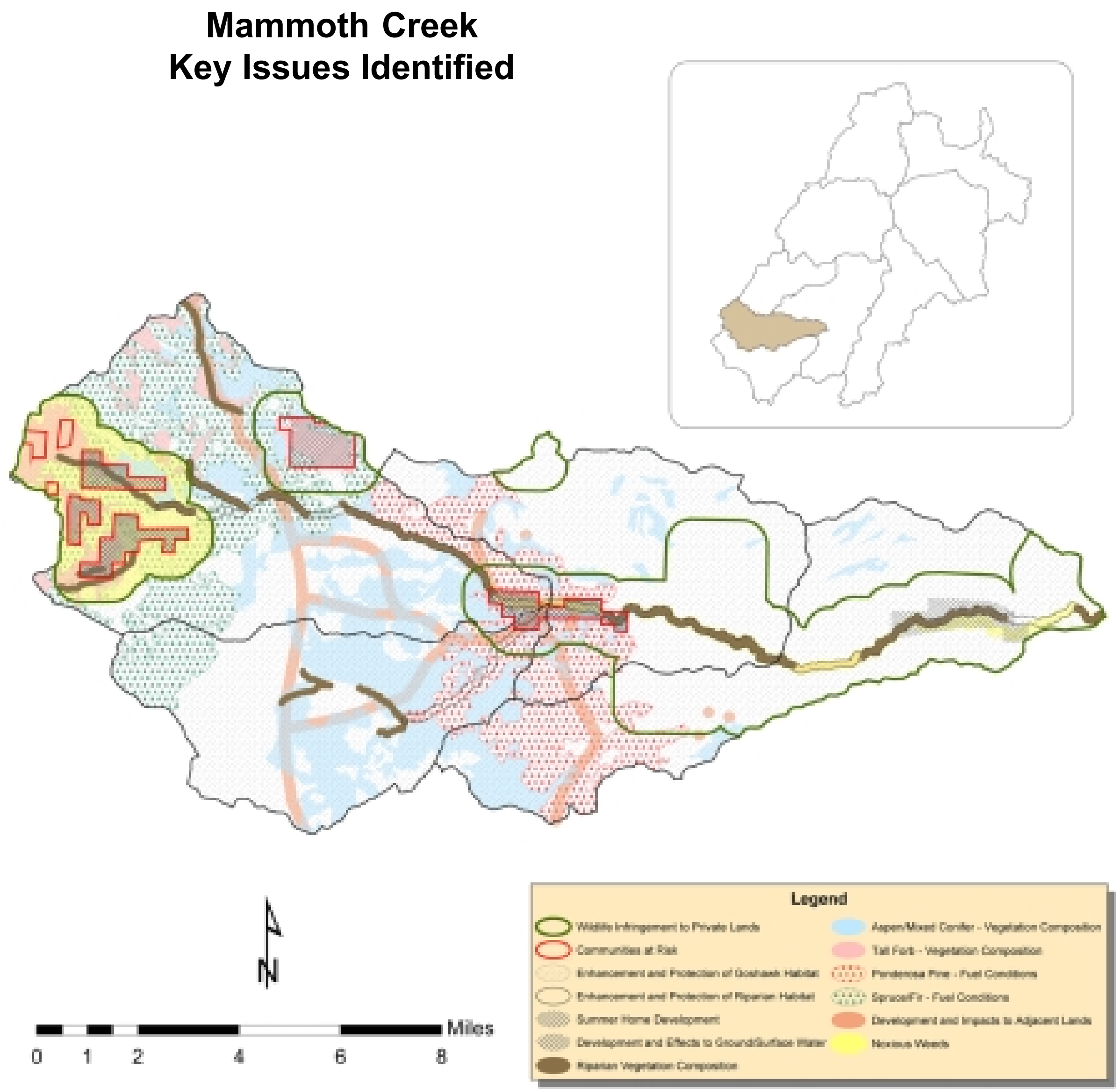


Fig. 4-11. The 13 key issues identified for the Mammoth Creek Watershed (described within the 11 Mammoth Creek Watershed narratives) represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees (TACs).

	Upper Mammoth Creek	Middle Mammoth Creek	Lower Mammoth Creek	Tommy Creek	**Total for Mammoth Creek Watershed**
Hydrology/Water Quality					
Hydrology					
Dewatering and altered flow regimes	H	NA	M	NA	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	NA	NA	**NA**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	H	NA	M	NA	**L**
Hillslope Processes					
Accelerated erosion on high elevation meadows	H	H	NA	H	**M**
Accelerated erosion in pinyon-juniper and sagebrush stand	L	NA	H	H	**M**
Accelerated erosion associated with urban development	M	NA	L	H	**L**
Accelerated erosion associated with roads	H	H	M	M	**M**
Rill and gully erosion on hillslopes	NA	NA	M	NA	**L**
Accelerated erosion associated with illegal ATV use	H	L	NA	L	**L**
Riparian Vegetation					
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	H	H	H	**H**
Water Quality					
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	H	H	H	H	**H**
Accelerated erosion, grazing management, recreation use, roads	H	H	H	H	**H**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	H	H	H	H	**H**
Channel Morphology					
Active channel adjustments (vertical or lateral)	M	H	H	M	**M**
Accelerated bank erosion	M	H	H	NA	**M**
Channelization	L	NA	L	NA	**L**
Agriculture					
Animal Feed Operations	NA	M	M	NA	**L**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	NA	H	H	NA	**M**
Pasture Mgt.	NA	H	H	NA	**M**
Fertilizer Usage and Impacts	NA	H	H	NA	**M**
Noxious Weeds	NA	H	H	NA	**M**
Wildlife Infringement on Private Lands	M	H	H	NA	**H**

Table 4-6. Issue ratings for all four Mammoth Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

	Upper Mammoth Creek	Middle Mammoth Creek	Lower Mammoth Creek	Tommy Creek	**Total for Mammoth Creek Watershed**
Fire					
Communities at Risk	H	H	M	H	**H**
Fuel Conditions	H	H	M	H	**H**
Human Uses					
Development and Effects to Ground/surface water	H	H	M	M	**H**
Development and Impacts to adjacent lands	H	H	M	M	**H**
Access Management	M	M	M	M	**M**
Developed and Dispersed Recreation	H	H	M	M	**H**
Vegetation					
Sagebrush - Grass	L	H	H	L	**M**
Aspen	H	M	M	H	**H**
Grassland - Meadow	M	M	L	L	**M**
Mixed Conifer - Mountain Fir	M	M	M	H	**H**
Oak - Mahogany - Mountain Shrub	NA	L	L	NA	**L**
Pinyon - Juniper	NA	L	M	NA	**L**
Ponderosa	M	M	M	M	**M**
Spruce - Fir	M	NA	NA	L	**L**
Tall Forb	H	NA	NA	NA	**L**
Noxious Weeds	NA	H	H	NA	**M**
Species and Habitat					
Priorities for Enhancement or Protection of:					
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	NA	M	H	NA	**M**
Bald Eagle Habitat	L	L	M	L	**M**
Spotted Bat Habitat	L	M	M	M	**M**
Townsend's Big-eared Bat Habitat	M	H	H	M	**H**
Flammulated Owl Habitat	M	H	H	M	**H**
Three-toed Woodpecker Habitat	H	M	M	H	**H**
Northern Goshawk Habitat	H	H	H	H	**H**
Peregrine Falcon Habitat	H	M	M	M	**H**
Sage Grouse Habitat	NA	L	M	NA	**L**
Turkey Habitat	M	H	H	M	**H**
Deer Habitat	M	H	H	H	**H**
Elk Habitat	M	H	M	H	**H**
Pronghorn Habitat	NA	M	L	NA	**L**
Brian Head Mountain-Snail Habitat	M	NA	NA	L	**L**
Beaver Habitat	H	M	M	M	**H**
Boreal Toad Habitat	L	L	NA	L	**L**
Bonneville Cutthroat Habitat	NA	NA	NA	NA	**NA**
Riparian Areas	H	H	H	M	**H**
Fisheries Habitat	M	H	H	M	**H**

Table 4-6(con't). Issue ratings for all four Mammoth Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

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PANGUITCH CREEK WATERSHED

Taken from the Paiute name for "big fish," Panguitch is at the heart of the Upper Sevier River Watershed. The Panguitch Valley was once the historic wintering area for the southern Paiute Tribe. Farms and ranches still dominate the valley bottom, while visitors from all over the world come to explore the beautiful red rock formations found in nearby Casto and Red Canyon. Designated trails provide opportunities to hike, mountain bike, horse-back or four-wheel on public lands.

Panguitch, Utah continues to be the gateway to several national parks and monuments, including Bryce Canyon National Park, Cedar Breaks National Monument, Zion National Park, Capitol Reef National Park and Grand Staircase-Escalante, as well as several state parks (such as Kodachrome Basin).

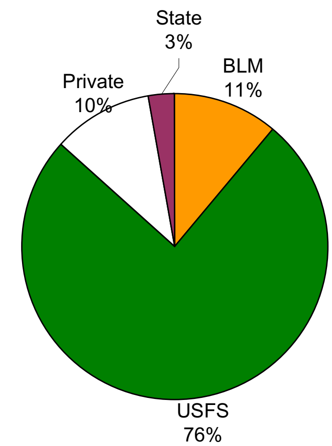

Fig. 4-12. Although the Panguitch Creek Watershed does not contain any National Park Service Lands, it is the gateway to several area national parks and monuments.

Land Ownership

U. S. Forest Service lands dominate the Panguitch Creek Watershed (63,408 acres) with private lands representing 8,809 acres (Table 4-7, Fig. 12), Bureau of Land Management administered lands (9,390 acres) and State lands (2,324 acres) are found bordering the Sevier River (Fig. 4-13). The area in and around Panguitch was first settled by Mormon pioneers in the late 1800's, and many generations of land ownership and use have continued, much as they did over 100 years ago.

Panguitch Creek Subwatersheds	Acres
Blue Spring Creek	12729
Butler Creek	13826
Fivemile Hollow-Panquitch Creek	16088
Haycock Creek	12900
Ipson Creek	16261
South Canyon-Panguitch Creek	12127
Total	83930

Table 4-7. The six subwatersheds in the Panguitch Creek Watershed consist of a variety of land ownership.

Vegetation Types

Extensive aspen forests (9,369 acres) are found throughout the watershed, which help to reduce erosion, provide scenic values and serve as important forage and cover for wildlife (Table 4-8, Fig. 4-14). From September to October, the watershed boasts beautiful fall colors, especially along Highway 143, through Cedar Breaks National Monument to Panguitch Lake. Like Mammoth and Asay Creek Watersheds, 90 percent of the Englemann spruce component has been affected by a recent spruce beetle invasion. The distribution, amount, and condition of sagebrush habitat has changed substantially since pioneers first settled the Upper Sevier River Basin. Much of this change has been a result of efforts to convert sagebrush habitat to croplands, the intensive use of some sagebrush-dominated lands by domestic livestock, and invasion of exotic weeds such as cheat grass. These changes have affected a number of wildlife species, including sage grouse - a Utah Species of Special Concern.

At over 6,000 feet in elevation, the Panguitch Valley, although providing fertile lands, has a short growing season. The Utah State University Agricultural Experiment Station is one of only two research facilities designed to study crop and vegetation issues in areas with a short growing season and/or at high elevations. Students from Utah State University conduct research to improve economical and cultural enterprises in the intermountain west, and especially within the Panguitch Creek Watershed.

Vegetation Type	Acres	%
Agriculture	669	1%
Aspen	9369	11%
Grass/Forb	4660	6%
Mixed Conifer	3040	4%
Mountain Shrub	3873	5%
Pinyon/Juniper	17129	20%
Ponderosa Pine	8416	10%
Sagebrush/Grass	23930	29%
Spruce/Fir	9224	11%
Urban	455	1%
Other	3163	4%
Total	83930	100%

Table 4-8. Extensive sagebrush/grasslands are valued as priority habitat for deer, elk, sage grouse and numerous other birds and small mammals.

Elevation, Roads and Streams

Much of the Sevier River near Panguitch, Utah is diverted and used for irrigation. Diversions pose unique problems for wildlife and land managers - streams spread out, making riparian corridors wider, sustainable fisheries are interrupted, and wildlife that depend on precious water resources must look elsewhere. However, recent riparian improvement projects along Panguitch Creek, with the cooperation of various landowners, have improved conditions within the watershed, and set examples for other landowners and resource agencies to follow.

Water from the East Fork Sevier River and Panguitch Creek continues to be utilized for agriculture, livestock, and recreation, as well as for drinking, creating a need for various stakeholders to work together to improve watershed conditions and maintain multiple use of this precious commodity.

Highway 143 is the primary route through the watershed; however, many well-traveled gravel roads occur, especially around Panguitch Lake (Fig. 4-15) .

During summer and winter months, Panguitch Lake is a popular recreation area for fishermen, boasting large rainbow trout.

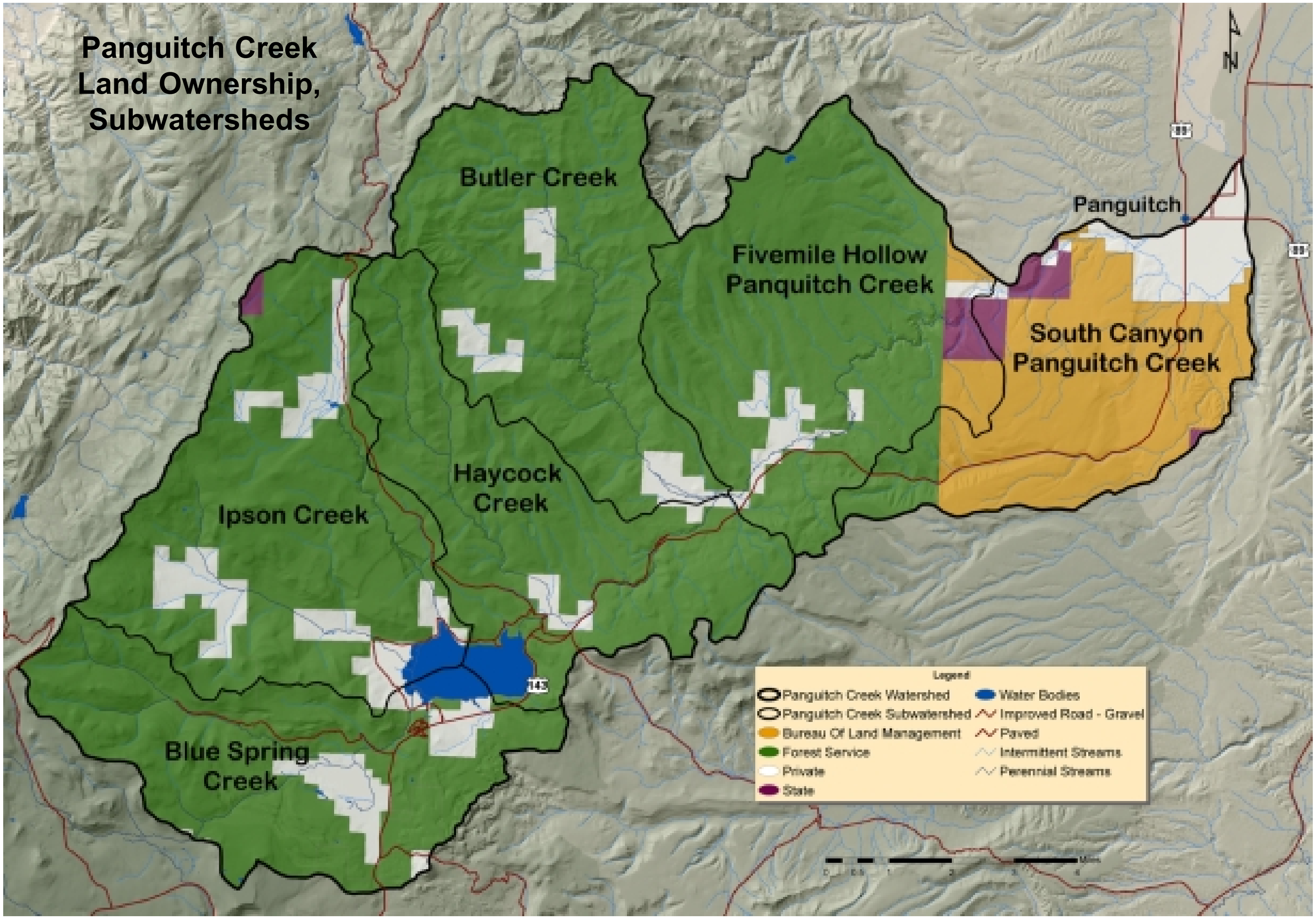

Fig. 4-13. Private lands along the Sevier River are valued as rangeland, and are used for agriculture and to build recreational homes.

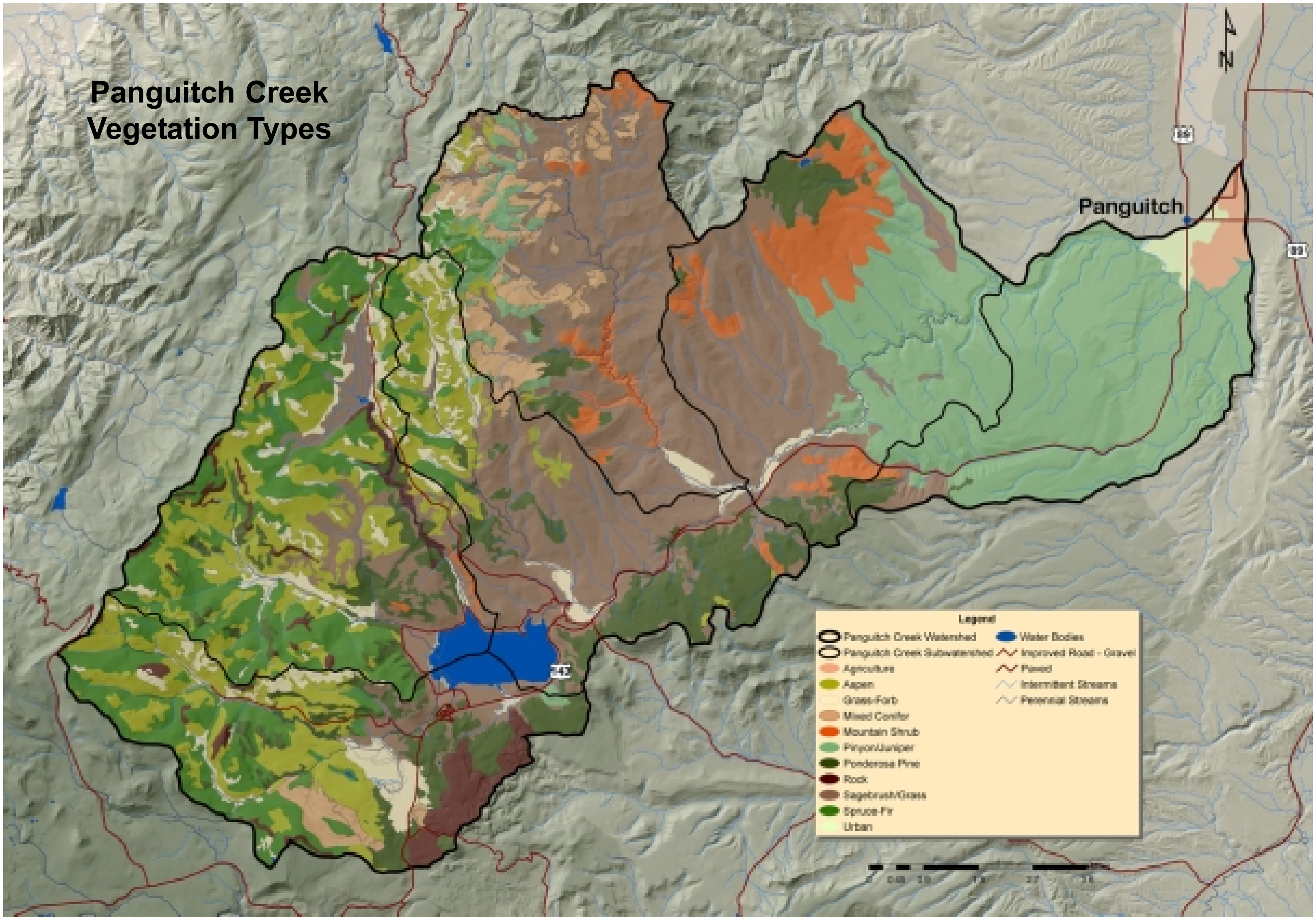

Fig. 4-14. Pinyon-juniper continues to increase throughout the Panguitch Creek Watershed. Although currently only 20% of the watershed is pinyon/ juniper, historically, this vegetation component was much lower.

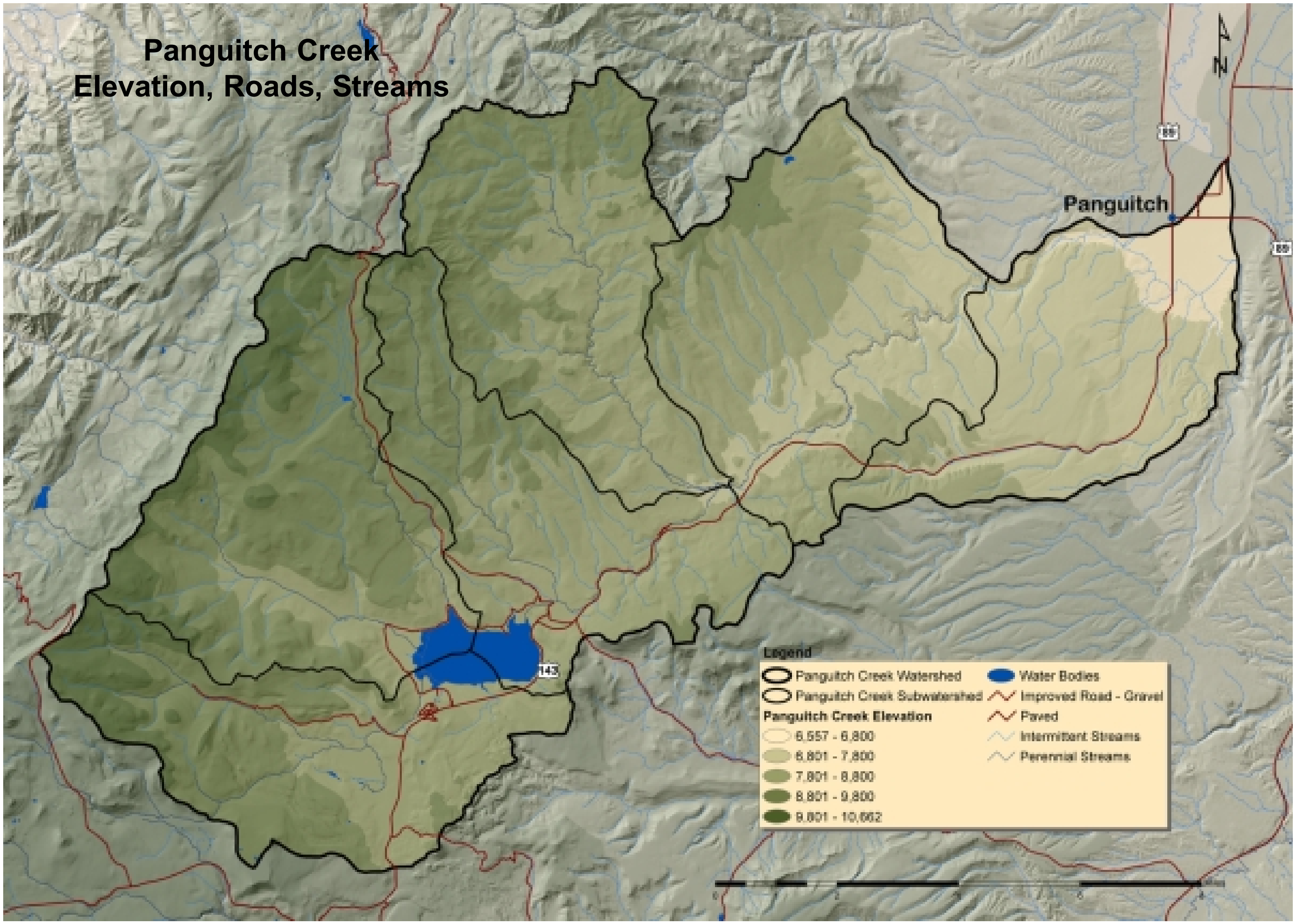

Fig. 4-15. Highway 143, running north-south between Panguitch, Utah and Duck Creek,Utah, is used extensively by tourists during summer months. The road provides access to area national parks and a variety of wildlife and vegetation types are visible along the road corridor.

Key Issues

Key issues identified for the Panguitch Creek Watershed are: 1) Accelerated Erosion; 2) Communities at Risk to Wildfire; 3) Development and Effects to Groundwater; 4) Development and Impacts to Adjacent Lands; 5) Enhancement or Protection of Deer/Elk Habitat; 6) Enhancement or Protection of Riparian Habitat & Riparian Vegetation Composition; 7) Enhancement or Protection of Sage Grouse Habitat; 8) Noxious Weeds - Vegetation and Agriculture); 9) PJ, Sagebrush-Grasslands - Fuel Conditions & Vegetation Composition; 10) Ponderosa Pine - Fuel Conditions, and 11) Wildlife Management in Agricultural Areas.(Figure 4-16). (Other issues and ratings within the Panguitch Creek Watershed are listed in Table 4-9).

1. Accelerated Erosion

Current Conditions, Patterns and Trends

The Panguitch Creek Watershed drains a portion of the Markagunt Plateau and the Western escarpment of the Paunsaugunt Plateau. Although the majority of the watershed contains gentle slopes,the areas within the Paunsaugunt Plateau contain steep, highly erodible slopes and cliffs, resulting in accelerated erosion, especially in areas of high road density and urban development. Many roads in the area are eroding due to poor location, design and maintenance, resulting in excessive soil loss and sedimentation into stream channels. In other areas where no crossings exist vehicles traverse streams causing further erosion and sedimentation. Poor drainage on some roads creates muddy conditions that vehicles avoid by driving on adjacent undisturbed areas, causing soil compaction and/or erosion, as well as wider and wider travel ways. In upland areas, accelerated erosion within historic tall forb communities and changes in vegetation composition in pinyon/juniper and spruce-fir ecotypes has exacerbated sheet and rill erosion. Recreation use is extremely heavy around Panguitch Creek and Panguitch Lake Reservoir.

Reference Conditions, Patterns and Trends

Diverse riparian vegetation historically helped maintain bank stability and natural erosion rates occurred within the watershed. Quality fisheries and

Riparain areas within the watershed are heavily impacted by human uses. In addition, upland erosion accounts for an increase in sediment transport within the watershed.

wildlife habitats existed throughout the watershed, with little or no human disturbance. Riparian areas, used extensively by a variety of wildlife, and three-quarters of all Utah's birds for nesting, rearing young, migrating, and protection, were undisturbed from roads and human uses. Productive meadowed areas and wildlife migration corridors were maintained by periodic fire and natural disturbance events, such as insects and disease, with little or no sheet or rill erosion due to vegetation holding soil in place.

Natural/Human Causes of Change Between Current/Reference Conditions

Roads not closed after timber harvest, increased urban and agricultural development, encroachment of non-native plants and changes in vegetation composition, have all played a role in accelerated erosion within the watershed.

2. Communities at Risk to Wildfire

Current Conditions, Patterns and Trends

Fire regimes of frequent, small intensity fires have been altered from historic conditions, and the risk of losing key ecosystem components as well as community structures remains high, especially in developed areas along Highway 14, and areas in and around Panguitch Lake. Mixed conifer areas have overgrown, with high fuel loads, ladder fuels and closed canopies. Approximately 90 percent of spruce trees are dead or dying as a result of a recent spruce beetle epidemic, greatly increasing the risk for wildland fires. Pinyon-juniper/mountain brush areas are outside of historic conditions and dominate many of the lower areas within the watershed, contributing to increased erosion and greater wildfire potential. Many property owners in the area remain unaware of the risk of wildland fire, and place importance on dense forest landscapes bordering their private lands.

Reference Conditions, Patterns and Trends

Year-round and recreation/ summer homes occur within the Panguitch Creek Watershed. Although many are clear of fuels, still others are at risk to wildfire due to dense vegetation in close proximity to structures.

Frequent small intensity fires in ponderosa pine and mixed conifer ecotypes helped reduced fuel accumulations while maintaining structural diversity and minimizing tree densities. In the absence of ground litter, with more open canopy, grasses and forbs were also maintained, serving as important soil stabilizers and reducing the likelihood of crown fires. Although spruce beetle populations are always around at endemic levels, increasing tree densities, drought conditions, and old age classes of trees have left areas more susceptible to insect and disease, and the current outbreak is at epidemic levels.

Natural/ Human Causes of Change Between Current/Reference Conditions

An increase in urban development in this area, as well as past fire exclusion efforts have increased high intensity wildfire potential in and around developed areas.

3. Development and Effects to Ground/Surface Water

Current Conditions, Patterns and Trends

There are approximately 750 developed lots in the Panguitch Lake area currently using septic tanks. As development continues to increase, impacts to groundwater may be a potential problem. Currently, the Southwest District Health Deparment is sponsoring a water quality study to determine potential impacts of septic systems to groundwater.

Dispersed recreation, in areas where few or no sanitary facilities exists as well as inadequate disposal facilities in established camping areas may also potentially impact groundwater. Increased dispersed recreation may also contribute to upland erosion and impact area waters, as more and more people camp and recreate near water.

Reference Conditions, Patterns and Trends

Historically, the watershed was primarily used on an intermittent/seasonal basis, with few year-round residents. Travel was limited to major roads, with little or no off-road impacts. Timber roads were often left open, because they received little if any post-harvest use, and could act as migration corridors for wildlife. Impacts from septic systems, because so few existed, were not of concern in this area.

Panguitch Lake and area streams have recently come under scrutiny because of water quality problems. High nutrient levels within the lake have prompted officials to take measures to improve water quality.

Natural/ Human Causes of Change Between Current/ Reference Conditions

The number of homes continues to increase , with many residents now residing in the area year-round, greatly increasing the amount of waste disposal and water use. In addition, past users consisted of those seeking solitude, which had very little impact on surrounding areas. Today, areas in and around Panguitch Lake are sought after by motorized recreation enthusiasts, increasing the number of user-created roads and re-opening previously closed roads.

4. Development and Impacts to Adjacent Lands

Current Conditions, Patterns and Trends

Summer and year-round residents within the Panguitch Creek Watershed continue to increase. In addition, an overall increase in those seeking outdoor recreation, and the proximity of the watershed to established towns and national recreation areas, has magnified use adjacent to Highway 143 and around developed recreation home areas. ATV use has also risen, with more off-road vehicles causing damage to meadows, streams and other habitats. Road densities currently exceed U.S. Forest Plan guidelines for the Dixie National Forest, and vandalism of posted road signs in closed areas is a recurring and expensive problem. In addition, increased use of the watershed may pose potential water quality problems as well as increase habitat fragmentation for wildlife species within the area.

Panguitch Lake attracts recreationists from all over. Impacts to water and upland areas increases as more and more people traverse the watershed.

Reference Conditions, Patterns and Trends

Historically, most use of the watershed was intermittent/ seasonal, with few year-round residents. Travel was limited to major roads, with little or no off-road impacts. Timber roads were often left open, because they received little if any post-harvest use, and could act as migration corridors for wildlife. Past use of the watershed consisted of those seeking solitude and having very little impact on surrounding areas.

Natural/ Human Causes of Change Between Current/Reference Conditions

The number of homes continues to increase with many residents now residing in the area year-round, greatly impacting surrounding areas. Overall recreational use of forested areas has risen considerably over the past 20 years.

5. Enhancement or Protection of Deer/Elk Habitat

Current Conditions, Patterns and Trends

Both deer and elk summer and winter ranges are found within the Panguitch Creek Watershed. Deer are the most abundant big game species on and adjacent to forested lands and can be found in about every habitat type within the watershed. Elk are found in isolated populations throughout the entire Upper Sevier River Basin, with a limited-entry trophy bull hunt occurring in the Panguitch Creek Watershed. Both big game animal species currently serve as management indicator species (MIS) for the Dixie and Fishlake National Forests, partly because the distribution of forage, cover, and other habitat factors required to maintain healthy populations also ensure provision of habitat requirements for many other wildlife species (including sage grouse, goshawk, flammulated owl, three-toed woodpecker, Utah prairie dog and peregrine falcon). Deer and elk are also high-visibility species, both from a recreational hunting standpoint, and as a potential competitor to domestic livestock in rangeland and agricultural areas. Mule deer and elk habitat consisting of sagebrush/grassland types and mixed-conifer, aspen and ponderosa are found throughout the watershed; however high road densities, habitat fragmentation and loss of aspen understory may decrease available habitat in both summer and winter range areas. Dry range conditions and loss of aspen to conifer encroachment is affecting summer range areas, while increased density of pinyon-juniper that lacks understory and a subsequent loss of sagebrush/grasslands is negatively affecting winter habitats. Year-round sage grouse habitat also occurs within deer and elk habitat in this watershed.

Reference Conditions, Patterns and Trends

Extensive sagebrush/grassland areas once occupied portions of the Panguitch Creek Watershed. Periodic fire disturbance maintained vegetation diversity in the mixed conifer, aspen and ponderosa pine forest types, creating mosaics within the landscape. Limited use of the watershed from recreational vehicles, with little or no winter use, left most wildlife migration corridors undisturbed. Natural processes (spruce beetle epidemics, wildfire, etc) helped support habitat for other wildlife species as well.

Natural/Human Causes of Change Between Current/Reference Conditions

Increased human uses of roads and developments create more disturbance to deer and elk in winter and summer, fragment habitats, interrupt migration corridors, and reduce habitat effectiveness. Grazing and the introduction of elk to the watershed during the mid-20th century may play a role in eliminating tall forb communities, riparian habitats and degrading meadows, all of which deer and elk depend on for food and shelter. Woodcutting has reduced snags and cover, while timber harvest has reduced large diameter ponderosa pine, necessary for deer and elk cover. Fire suppression efforts during the last 100 years have encouraged high stand densities, pinyon-juniper expansion and a decrease in sagebrush age diversity, degrading the quality of deer and elk habitat.

Sagebrush/ grasslands, as well as aspen and ponderosa pine forests, provide a variety of habitat necessary for deer and elk.

6. Enhancement and Protection of Sage Grouse Habitat

Current Conditions, Patterns and Trends

Sage grouse are currently listed on the Utah Sensitive Species List as a Species of Special Concern because of declining populations and limited distribution. Both current and historic sage grouse leks occur within the Panguitch Creek Watershed; however, current populations are declining due to loss of sagebrush/grassland habitat to pinyon-juniper expansion as well as habitat fragmentation. Vegetation diversity in sagebrush/grassland areas is lacking, and many areas have been converted into dense stands of exotic cheat grass. Where the quantity and quality of habitat has declined, sage grouse populations are vulnerable to excessive natural predation and chick survival remains low.

In some areas, decadent sagebrush, with little understory vegetation, does not provide adequate habitat for sage grouse, In this photo, some of the sagebrush is almost as tall as this biologist.

Reference Conditions, Patterns and Trends

Historical records suggest that portions of all 29 counties in Utah provided adequate habitat for sage grouse (Mitchell, 2001). Expansive sagebrush/grassland areas, maintained by periodic fire, were present prior to Euro-American settlement. Large fragments of habitat have been lost to agriculture and urban development.

Natural/Human Causes of Change Between Current/Reference Conditions

Habitat loss, fragmentation and degradation are the main causes of population decline. Vegetation range, pattern, and structure have been further impacted through intensive grazing and fire suppression, allowing increased establishment of pinyon-juniper and decreased grass and forb production.

7. Enhancement and Protection of Riparian Habitat & Riparian Vegetation Composition

Current Conditions, Patterns and Trends

Woody plant species and late seral herbaceous species are lacking along many riparian corridors, particularly along the Sevier River and tributaries, Blue Springs and Panguitch Creek. Where woody plant species (willow and cottonwood) are present, recruitment of young plants is limited, and the majority of plants are in a mature stage. Bank erosion has resulted in higher width/depth ratios along many stream corridors and increased head cuts on the upstream ends. Recreation around riparian areas has increased in recent years, especially in the vicinity of summer and recreation homes. All-terrain vehicle use has also increased. Riparian areas are of critical importance to birds, fish, amphibians, aquatic invertebrates, and other wildlife species. They provide critical breeding habitat for many

In many parts of the watershed, riparian vegetation is lacking, causing an increase in water temperatures and a decrease in overall water quality.

southwestern neotropical birds as well as water, shade, food and shelter for other wildlife species. Riparian areas also provide migratory routes for many bird species, and sheltered pathways to other habitats for other wildlife species.

Reference Conditions, Patterns and Trends

Riparian vegetation in the Panguitch Creek Watershed most likely consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower elevations and along the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes.

Natural/Human Causes of Change Between Current/Reference Conditions

Changes in riparian vegetation have resulted from a variety of land uses including livestock grazing, channel adjustments, water diversions, road construction, recreation, and cropland cultivation.

8. Noxious Weeds – Vegetation Composition & Agriculture

Current Conditions, Patterns and Trends

Noxious weeds pose an increasing threat to native ecosystems, croplands and other plant communities within the Panguitch Creek Watershed. An increase in recreational vehicle use and increased traffic along Highway 143 and surrounding areas may accelerate the spread of noxious weeds. Currently, dalmation toadflax, Canada thistle, spotted knapweed, musk thistle and cheat grass are all found around Panguitch Lake. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients. Nox-

Canada thistle, a difficult to eradicate noxious weed, is prevalent throughout the Panguitch Creek Watershed, especially around Panguitch Lake.

ious weeds, moved by sheep along drainages within the watershed, are currently competing with native riparian vegetation.

Reference Conditions, Patterns and Trends

Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Natural/Human Causes of Change Between Current/Reference Conditions

Currently, trails and roads serve as the single-most common point of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV's and other motorized and nonmotorized vehicles traveling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult. Movement by recreationists from watershed to watershed (possibly serving to increase noxious weeds) may pose long-term problems for resource managers as well as area landowners. Implementing noxious weed plans into current forest plans and enforcing weed-free closures may play a role in slowing weed dispersal.

Where natural fires once helped maintain vegetation types, today, resource managers may rely on prescribed fire to help maintain proper vegetative conditions.

9. Ponderosa Pine – Fuel Conditions

Current Conditions, Patterns and Trends

Mixed-conifer is currently over-represented in areas throughout the Panguitch Creek Watershed and is displacing remaining populations of ponderosa pine and aspen. Ponderosa pine densities are high, with even age structures of small diameter trees. Many high-density ponderosa pine populations have been affected by large populations of bark beetles. An increase in mixed-conifer and high-density ponderosa pine around urban interface areas has left many of these areas at extreme risk to high severity wildfires. Large diameter ponderosa pines, with accompanying large diameter snags, provide important hiding and thermal cover for numerous wildlife species as well as nesting habitat for some bird species. The risk of stand-replacement fires within ponderosa pine ecotypes is also a concern.

Reference Conditions, Patterns and Trends
Periodic fires created uneven-aged stands comprised of small even-aged groups. Fire return intervals of 5 to 25 years, with low intensity surface fires helped maintain structural stages (PFC Assessment, 2000). Multi-age classes of different vegetation types were historically represented.

Natural/Human Causes of Change Between Current/Reference Conditions
Fire exclusion and livestock grazing (removing fine fuels) are the primary causes of change between current and reference conditions.

10. Pinyon-Juniper, Sagebrush-Grasslands – Fuel Conditions & Vegetation Composition

Current Conditions, Patterns and Trends
Pinyon-juniper encroachment into historic sagebrush/grassland communities has reduced ground cover, decreased grassland species diversity, eliminated portions of prime mule deer and livestock winter range and increased wildfire risk in areas of high pinyon-juniper densities, such as the Fivemile Hollow-Panguitch Creek, and South Canyon-Panguitch Creek subwatersheds. In addition, many sagebrush areas are decadent, with even age classes of old individuals and excessive crown canopies. Erosion has increased due to little understory vegetation to help retain soil. Disrupted sagebrush/grassland communities occur within all six Panguitch Creek Watershed subwatersheds.

Sagebrush/grassland areas have been altered from historic conditions, with many areas showing a conversion to rabbitbrush.

Reference Conditions, Patterns and Trends
Pinyon-juniper historically occupied rocky edges, outcrops and slopes within the watershed. Periodic, low intensity fires (10 to 30 years) helped maintain pinyon-juniper density and diversity, while preventing encroachment into other vegetation types. Mixed age classes of sagebrush with less than 15% canopy cover were dominant prior to Euro-American settlement. Patchy vegetation patterns, with several age and canopy classes of

sagebrush and grasses, were present and maintained by periodic fire, approximately every 20-40 years.

Natural/Human Causes of Change Between Current/Reference Conditions

Competition for available moisture and high ungulate use have substantially reduced the grass-forb component in mature and old, dense pinyon-juniper stands. Pinyon-juniper distribution has also increased because of recent fire suppression efforts. Chainings were conducted in the 1960's and 1970's on private, U.S. Forest Service and BLM lands to promote grass-forb communities; however, lack of additional disturbance, has allowed pinyon-juniper to re-establish on these sites. Lack of fire and extensive grazing has decreased sagebrush/grassland vegetation diversity.

11. Wildlife Management in Agricultural Areas

Current Conditions, Patterns and Trends

Wildlife damage to agricultural lands has increased steadily over the past decade. In the Panguitch Creek Watershed, depredation from elk is the primary concern; however, in some years deer are equally as likely to impact agriculture areas.

While mitigation measures such as landowner and control permits, fencing and actual dollar reimbursements offset some of the costs, wildlife continues to have an economic impact on private agricultural lands. Other concerns expressed from landowners include the impact to land development and use by the listing (endangered, threatened, etc.) of wildlife species such as Utah prairie dog and sage grouse, and the hesitation by landowners to engage in habitat improvement projects which may further attract wildlife and result in subsequent damage to local areas.

Farms and ranches in the Panguitch Creek Watershed may be heavily impacted by area deer and elk when resource conditions are not fully functioning.

Reference Conditions, Patterns and Trends

Elk were eliminated from the watershed around the first of the 20th century, but were reintroduced in the 1980's. Unrestricted hunting of predators as well as big game, resolved most wildlife/landowner conflicts.

Adequate winter and summer deer and elk ranges were maintained by periodic fire, further eliminating potential deer/elk conficts.

Natural/Human Causes of Change Between Current/ Reference Conditions

Restricted hunting, the demand for increased quality hunting opportunities, stricter compliance with fish and game laws, and the desire for wildlife viewing opportunities have resulted in an increase in deer and elk numbers from early settlement conditions. Drought and subsequent changes in vegetation composition within the watershed may temporarily decrease elk and deer numbers; however, these same conditions may cause deer and elk to seek additional forage opportunities on private agricultural lands, where adequate feed is available. Competition for available forage from domestic livestock has decreased range conditions in some areas, further contributing to wildlife depredation on cultivated lands.

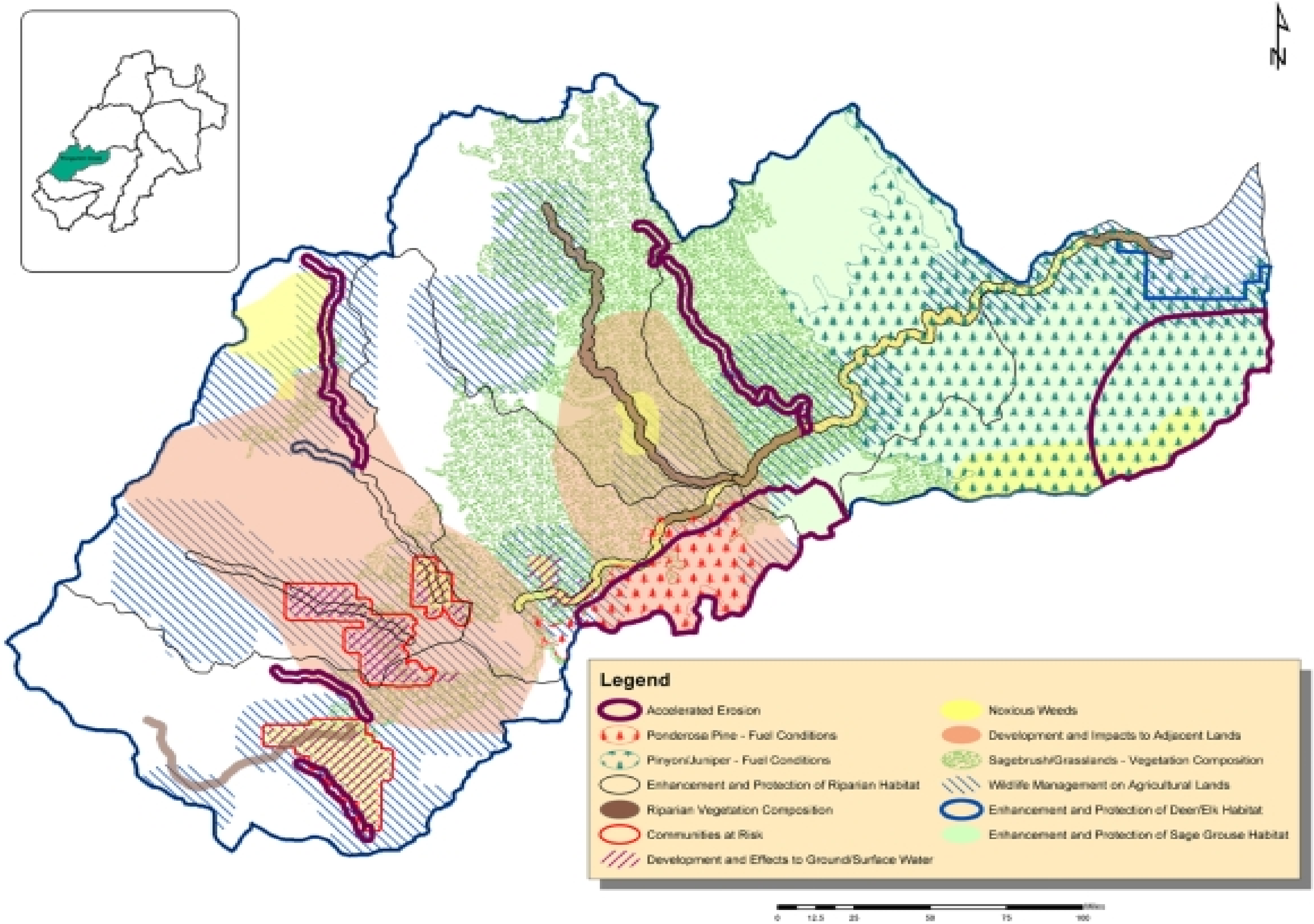

Fig. 4-16. The 13 key issues identified for the Panguitch Creek Watershed (as described in the 11 narratives) represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees (TACs).

	Blue Spring Creek	Ipson creek	Haycock Creek	Butler Creek	Fivemile Hollow-Panguitch Creek	South Canyon Panguitch Creek	**Total for Panguitch Creek Watershed**
Hydrology/Water Quality							
Hydrology							
Dewatering and altered flow regimes	H	NA	H	H	NA	H	**H**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	H	NA	NA	NA	NA	NA	**L**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	NA	NA	NA	L	**L**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	M	NA	NA	M	M	L	**L**
Hillslope Processes							
Accelerated erosion on high elevation meadows	L	NA	M	NA	M	NA	**L**
Accelerated erosion in pinyon-juniper and sagebrush stand	NA	NA	L	H	M	H	**M**
Accelerated erosion associated with urban development	NA	M	NA	NA	NA	NA	**L**
Accelerated erosion associated with roads	H	H	H	NA	M	H	**H**
Rill and gully erosion on hillslopes	M	NA	M	L	NA	NA	**L**
Accelerated erosion associated with illegal ATV use	NA	NA	NA	NA	NA	NA	**NA**
Riparian Vegetation							
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	M	M	H	M	H	**H**
Water Quality							
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	H	H	L	NA	NA	NA	**M**
Accelerated erosion, grazing management, recreation use, roads	L	NA	NA	NA	NA	L	**L**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	H	H	H	H	H	H	**H**
Channel Morphology							
Active channel adjustments (vertical or lateral)	H	L	L	H	M	L	**M**
Accelerated bank erosion	H	NA	NA	H	M	L	**M**
Channelization	L	NA	L	H	NA	NA	**L**
Agriculture							
Animal Feed Operations	NA	NA	L	NA	NA	L	**L**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	L	L	L	L	L	M	**M**
Pasture Mgt.	M	M	M	M	M	H	**H**
Fertilizer Usage and Impacts	NA	L	NA	NA	NA	L	**L**
Noxious Weeds	M	M	M	M	M	M	**M**
Wildlife Management in Agricultural Areas	H	H	H	H	H	H	**H**

Table 4-9. Issue ratings for all six Panguitch Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

	Blue Spring Creek	Ipson creek	Haycock Creek	Butler Creek	Fivemile Hollow-Panguitch Creek	South Canyon Panguitch Creek	**Total for Panguitch Creek Watershed**
Fire							
Communities at Risk	H	H	M	M	M	H	**M**
Fuel Conditions	H	H	H	H	H	H	**H**
Human Uses							
Development and Effects to Ground/surface Water	H	H	H	M	M	H	**H**
Development and impacts to adjacent lands	M	H	H	M	M	H	**H**
Access Management	M	H	M	M	L	H	**H**
Developed and Dispersed Recreation	H	H	H	L	L	H	**H**
Vegetation							
Sagebrush - Grass	M	H	H	H	H	M	**H**
Aspen	H	H	M	M	NA	L	**M**
Grassland - Meadow	L	L	L	L	NA	L	**L**
Mixed Conifer - Mountain Fir	M	M	L	L	L	L	**M**
Oak - Mahogany - Mountain Shrub	L	L	L	L	M	L	**M**
Pinyon - Juniper	L	NA	L	L	M	H	**M**
Ponderosa	NA	M	M	L	L	L	**M**
Spruce - Fir	M	H	M	NA	NA	NA	**M**
Tall Forb	M	NA	NA	NA	NA	NA	**L**
Noxious Weeds	H	H	H	M	M	M	**H**
Species and Habitat							
Priorities for Enhancement or Protection of:							
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	H	L	H	M	NA	M	**M**
Bald Eagle Habitat	H	L	H	L	L	M	**M**
Spotted Bat Habitat	H	H	M	L	L	M	**M**
Townsend's Big-eared Bat Habitat	M	M	M	M	M	L	**M**
Flammulated Owl Habitat	H	H	H	L	L	L	**M**
Three-toed Woodpecker Habitat	H	H	H	L	L	L	**M**
Northern Goshawk Habitat	H	H	H	M	M	L	**H**
Peregrine Falcon Habitat	M	M	M	M	M	M	**M**
Sage Grouse Habitat	L	L	H	H	H	M	**H**
Turkey Habitat	M	M	L	M	M	M	**M**
Deer Habitat	H	H	H	H	H	H	**H**
Elk Habitat	H	H	H	H	H	M	**H**
Pronghorn Habitat	NA	NA	L	M	M	M	**M**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	M	M	M	H	H	H	**H**
Boreal Toad Habitat	NA	NA	NA	NA	NA	NA	**NA**
Bonneville Cutthroat Habitat	NA	NA	NA	NA	NA	NA	**NA**
Riparian Areas	H	H	H	H	H	H	**H**
Fisheries Habitat	H	H	H	M	M	M	**H**

Table 4-9 (con't). Issue ratings for all six Panguitch Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

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PASS CREEK SEVIER RIVER WATERSHED

One of the most prominent features within the Pass Creek Watershed is the reddish-orange Claron formation hoodoos. Red Canyon, Casto Canyon and Losee Canyon are all formed from the sixty million year old formations, which are characterized by dry, sparsely vegetated, sloping terrain, intricate deep-cut canyons, ridges and spires, and river valleys separated by high plateaus.

Red Canyon, managed by the Dixie National Forest, is a popular destination spot for tourists. Located on Highway 12, the Red Canyon area boasts spectacular scenery and camping, in addition to hiking, horseback riding, ATV and biking trails.

Red Canyon lies directly along State Highway 12, recently named an All-American Road. This east–west course links such famous attractions as Bryce Canyon and Capitol Reef National Parks and Grand Staircase–Escalante National Monument. A new visitors center is scheduled to open Spring 2004. The new center, complete with a bookstore, trip-planning area for visitors, cultural and nature exhibits, artisan gallery and demonstrations, and ranger programs will help visitors better understand resource issues within the Upper Sevier River Basin.

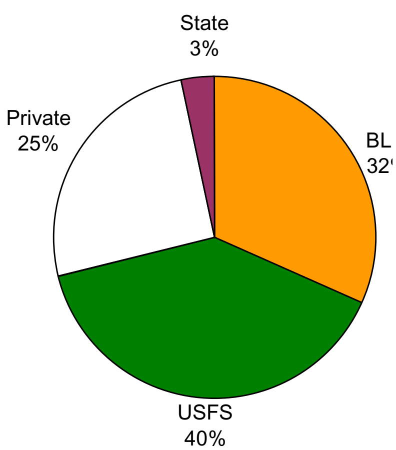

Fig. 4-17. Twenty-five percent of the land within the Pass Creek Watershed is private, with ranches and farms scattered all along the Upper Sevier River.

Highway 89 runs north-south through the watershed, paralleling the Upper Sevier River. Numerous ranches and farms are found along the highway and throughout the Panguitch Valley. The Panguitch Valley at approximately 6,500 feet elevation has a consistently short growing season, impacting the types of crops grown within the watershed.

Land Ownership

The Pass Creek Watershed contains the largest percentage of private land (44,252 acres) within the Upper Sevier River Basin (Fig. 4-17, Fig. 4-18). U. S. Forest Service lands (68,635 acres), Bureau of Land Management administered lands (55,104 acres) and state lands (5,944 acres) are found bordering the privately-owned sections.

Farms and ranches dot much of the area along the Upper Sevier River, and around the small communities of Hatch and Hillsdale. Although this area has seen an increase in tourism in recent years, ranching and agriculture continue to be the primary enterprises, and much of the land

Pass Creek Subwatersheds	Acres
Big Hollow-Sevier River	20059
Castle Creek-Sevier River	22610
Casto Wash	14169
Graveyard Hollow	9756
Hillsdale-Sevier River	15677
Pass Creek	29033
Peterson Wash-Sevier River	14828
Pole Canyon-Sevier River	15498
Proctor Canyon-Sevier River	19845
Red Canyon	12461
Total	173935

Table 4-10. The ten Pass Creek Watersheds are known for the geological Claron formation hoodoos.

continues to be managed and owned by descendents of those that first settled the land in the 1870's.

The Pass Creek Watershed is composed of 10 subwatersheds, ranging in size from 9,756 acres (Graveyard Hollow subwatershed) to 29,033 acres (Pass Creek subwatershed) (Table 4-10).

Vegetation Types

Ponderosa pine, noted for both its scenic and timber value, are found throughout forested areas within the watershed; however, many areas throughout the west have seen a recent decline in ponderosa pine through timber harvest and fire suppression. Although some trees may grow to be 600 years old, 4 feet in diameter and over 180 feet tall, most of the ponderosas within the Red Canyon area are relatively young, and are composed of even-age class stands.

Pinyon-juniper areas and sagebrush/grasslands are found within lower elevations of the watershed, along the length of Panguitch Valley . Many of the historic sagebrush-grasslands have been converted to agricultural lands, and riparian areas within the watershed are heavily grazed. Small populations of mountain shrub, mixed conifer, grass/forb, aspen and spruce-fir are also found within the watershed (Table 4-11, Fig. 4-19).

Vegetation Type	Acres	%
Agriculture	2930	2%
Aspen	779	0%
Grass/Forb	13646	8%
Mixed Conifer	6115	4%
Mountain Shrub	1593	1%
Pinyon/Juniper	62495	36%
Ponderosa Pine	15909	9%
Sagebrush/Grass	38456	22%
Spruce/Fir	153	0%
Other	31858	18%
Total	173935	100%

Table 4-11. The large expanses of sagebrush/grassland within the watershed provide habitat for Utah prairie dog and sage grouse, as well as elk and deer. Maintaining diversity within the sagebrush/grass and pinyon-juniper vegetation types, is listed as a priority by many of the technical advisory committees.

Of special interest within this watershed is the Red Canyon Botanical Area, located near Red Canyon. This area is home to seven plant species that are found together nowhere else in the world - reveal paintbrush (*Castilleja parvula var. revealii*), yellow-white cryptantha (*Cryptantha ochroleuca*), least spring parsley (*Cymopterus minimus*), Widtsoe buckwheat (*Eriogonum aretioides*), Claron pepperplant (*Lepedium montanum var. claronense*), Red Canyon beardtongue (*Penstemon btracteatus*) and Maguire campion (*Silene petersonii*). These plants can be found growing on soils that are rich in calcium carbonate (limestone) and are called calciphiles or "limestone lovers". These rare plants have become adapted to the severe environmental conditions that are found in the Red Canyon area – shallow soils, extreme changes in temperature from summer to winter, summer thunderstorms, intense sunlight, and a variable supply of moisture. The U.S. Forest Service established the Red Canyon Botanical Area in 2001 to allow researchers to study these unique plant species and to enable the public to enjoy them as well. Because the distribution of these unique plants is closely tied to underlying soil structure, destruction of habitat is a major concern.



Seven unique plants are found within the Red Canyon Botanical area, nestled among stately ponderosa pines.

Elevation, Roads & Streams

Utah's only All-American Road traverses the Pass Creek Watershed. The byway begins south of Panguitch on Highway 89 and runs east and north to Torrey at the junction of Highway 24. This scenic stretch passes through portions of the Dixie National Forest, Bryce Canyon National Park, Red Canyon, the historic Burr Trail and Grand Staircase-Escalante National Monument (Fig. 4-20). The byway, one of only 20 All-American Roads in the United States, possesses archaeological, cultural, historical, natural, recreational and scenic qualities of national significance.

The Red Canyon Mountain Bike Trail, which begins at the Red Canyon Visitor Center and ends 5.5 miles later where the Great Western Trail Begins, is one of the newest additions along Highway 12. The paved trail is for non-motorized vehicles and winds past the Red Canyon campground, and amidst the red-rock hoodoos. The Red Rock Mountain Trail project was conducted by Utah Department of Transportation in conjunction with Garfield County, and officials are hoping to work with local landowners for property easements to continue the trail into Bryce Canyon National Park.

The recently completed bicycle and foot path, within the Red Canyon area, may eventually connect to other recreational trails.

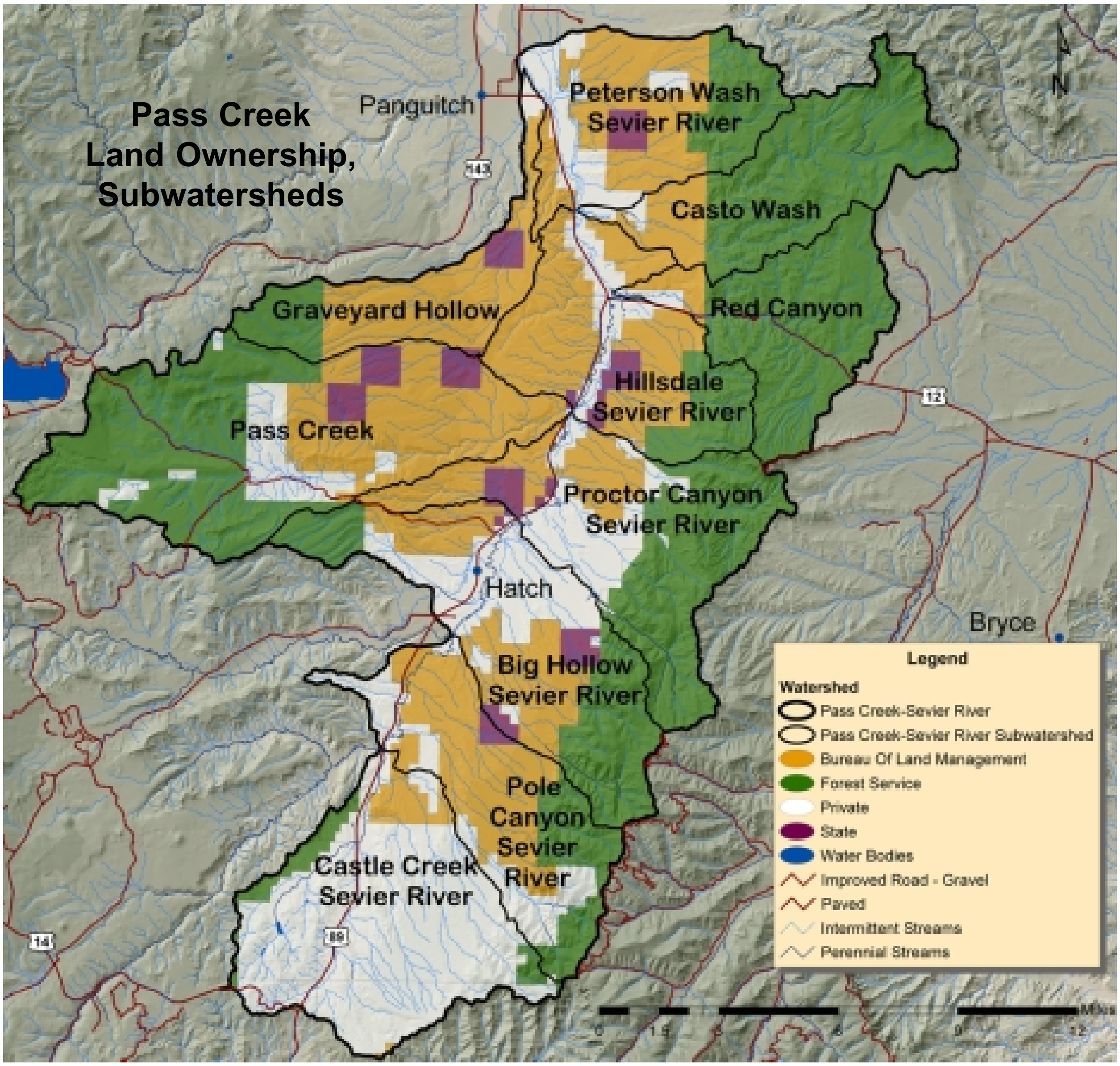

Fig. 4-18. Most of the agricultural lands along the Sevier River have been owned by generations of pioneer families.

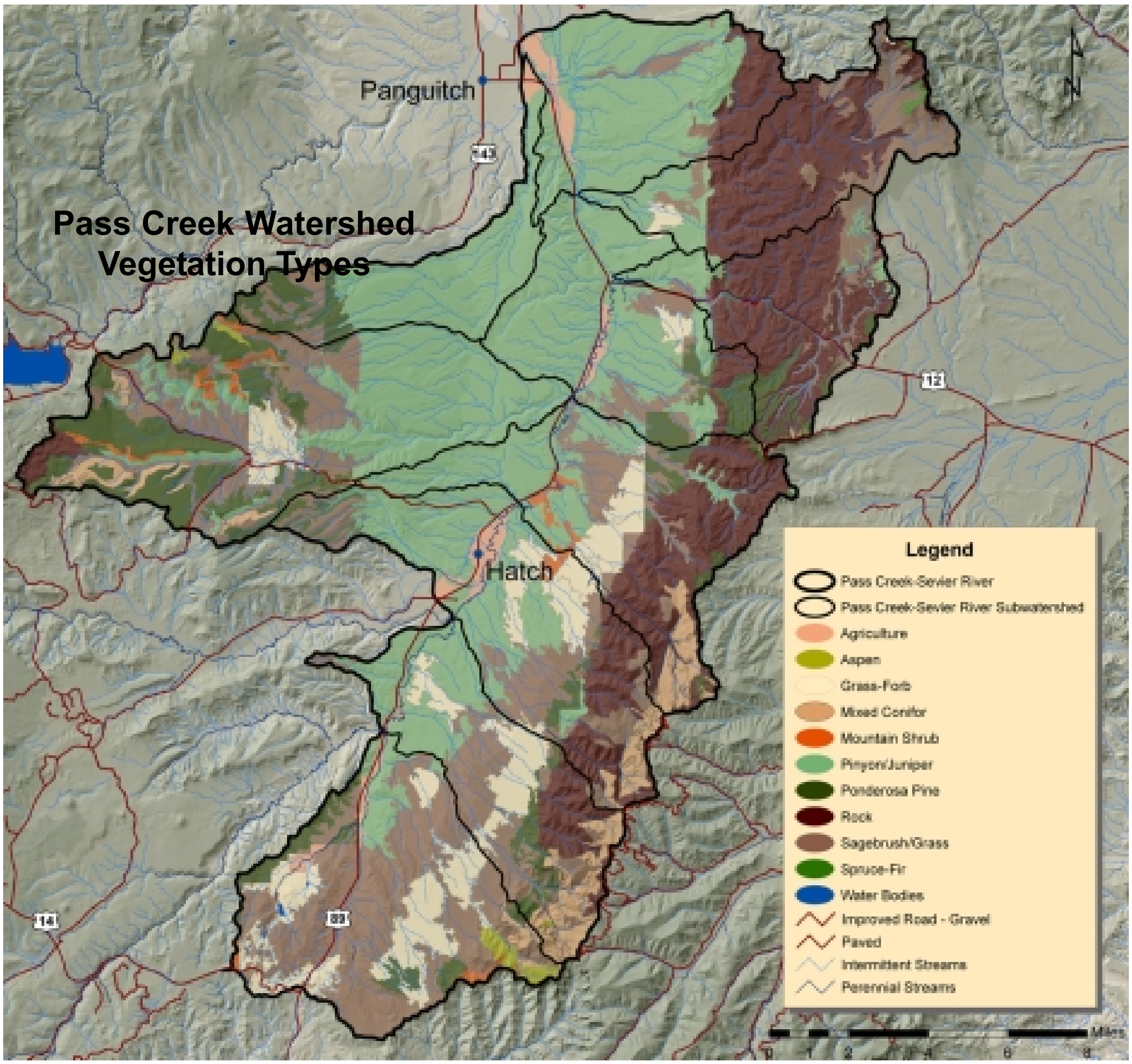

Fig. 4-19. Ponderosa pine, sagebrush/grasslands and pinyon-juniper are the dominant vegetation types within the Pass Creek Watershed.

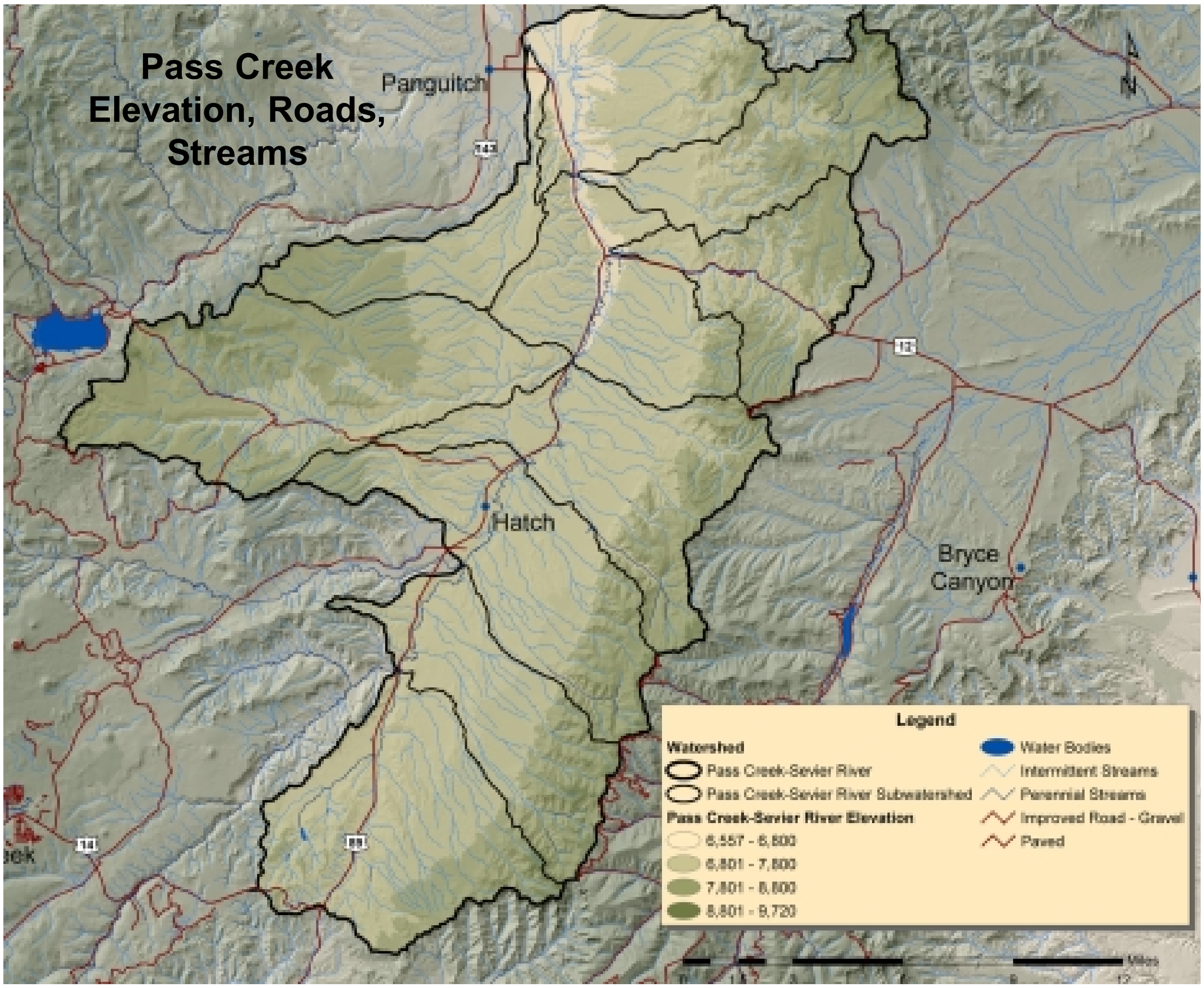

Fig. 4-20. Highway 12, recently named an All-American Road, boasts over 1.5 million travelers each year, en-route to area National Parks. The main stem of the Sevier traverses north-south through the watershed and is heavily utilized for grazing and agricultural enterprises.

Key Issues

Key issues identified for the Pass Creek Watershed are: 1) Active Channel Adjustments; 2) Communities at Risk to Wildfire; 3) Developed and Dispersed Recreation; 4) Development and Effects to Ground/Surface Water; 5) Enhancement or Protection of Sage Grouse Habitat; 6) Enhancement and Protection of Utah Prairie Dog Habitat; 7) Noxious Weeds; 8) PJ, Sagebrush/ Grasslands - Fuel Conditions, Vegetation Composition & Accelerated Erosion; and 9) Wildlife Management in Agricultural Areas (Figure 4-21). (Other issues and ratings within the Pass Creek Watershed are listed in Table 4-12)

1. Active Channel Adjustments

Woody plant species and late seral herbaceous species are lacking throughout all subwatersheds where they historically would be present Where woody plant species (willow and cottonwood) are present, recruitment of young plants is limited and the majority of plants are in a mature stage. Bank erosion has resulted in downcutting along many stream corridors and increased head cuts on the upstream ends. Stream channelization, from road construction, has eliminated riparian vegetation and straightened stream reaches, compromising channel stability. Loss of upland vegetation cover has resulted in accelerated sheet and rill erosion into streams.

Reference Conditions, Patterns and Trends

Prior to European settlement, stream channels in this watershed were most likely in dynamic equilibrium, and experienced natural erosion processes. Streambanks consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower elevations along the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes. Natural stream meandering dissipated stream flow energy. Adequate ground cover from native upland vegetation reduced and slowed overland flows.

Natural/Human Causes of Change Between Current/Reference Conditions

Bonneville cutthroat trout were once found in portions of the Sevier River drainage; however, now only a few populations remain.

Changes in channel stability have resulted from a variety of land uses including livestock grazing, water diversions, road construction, recreation, and cropland cultivation.

2. Communities at Risk to Wildfire

Current Conditions, Patterns and Trends

Fire regimes of frequent, small intensity fires have been altered from historic conditions, and the risk of losing key ecosystem components as well as community structures remains high, especially in developed areas within the Hillsdale and Pass Creek subwatersheds. Ponderosa pine forests have changed from open, park-like areas with scattered large trees to stands with dense thickets of small-diamater trees which are at risk of burning due to high amounts of fuel accumulations. In areas were sagebrush occurs, plants are decadent, with even age classes of old individuals and excessive crown canopies. Drought conditions coupled with high fuel loads threaten even small communities.

Reference Conditions, Patterns and Trends

Historically, periodic fires affected vegetative communities by regulating structure, composition and patterns of mixed conifer and sagebrush/ grassland areas. Sagebrush/ grass communities most likely dominated the watershed. Frequent small intensity fires in ponderosa pine and mixed conifer ecotypes helped reduce fuel accumulations while maintaining structural diversity and minimizing tree densities.

In areas where natural fire has been eliminated, prescribed fire may be needed to reduce the risk of catastrophic wildfire, especially around established communities.

Natural/ Human Causes of Change Between Current/Reference Conditions

Fire suppression efforts, as well as an increase in recreational homes and recreational use of forested areas has resulted in large accumulations of vegetation around established communities.

3. Developed and Dispersed Recreation

Current Conditions, Patterns and Trends

The close proximity of vegetation to individual homes demonstrates the need for fire prevention education and defensible space.

Recreational use of forests, grasslands and riparian areas continues to increase. Areas along the Upper Sevier River and tributaries are utilized for recreation and fishing. Dispersed recreation has increased in the Pass Creek Watershed in areas closest to Panguitch Lake.

Associated impacts from dispersed recreation include vegetation loss through trampling of stream banks and upland areas, disposal of litter along travel corridors, improper human waste disposal, and increased foot/recreational vehicle traffic traveling to and from sensitive soil, wildlife and vegetation areas.

As ATV use becomes more popular, there is a need to educate users of potential impacts to sensitive areas within the watershed.

Reference Conditions, Patterns and Trends

Historically, most use of the watershed was minimal, with most use associated with ranchers moving cattle and timber harvesting. Human impacts within the watershed were limited to agricultural activities, with little or no recreational use.

Natural/ Human Causes of Change Between Current/Reference Conditions

Recreational use of forested areas has risen considerably over the past 20 years. As established camping areas become crowded, more and more recreationists look to dispersed areas to avoid human interactions. Accessibility by four-wheel drive and ATV's allows recreationists to travel in areas once undisturbed.

4. Development and Effects to Ground/Surface Water

Current Conditions, Patterns and Trends

There are approximately 1,164 developed lots in the Bryce Woodlands (722 lots), Long Valley Estates (220 lots), and Tod's Junction Area (222 lots), all currently using septic tanks. As development continues to increase, impacts to groundwater may be a potential problem. Acceptable levels of coliform and nitrate levels are currently present in some areas; however these areas may not be suitable for septic system use (sewered systems are more desirable). Currently, the Southwest District Health Department is sponsoring a water quality study to determine potential impacts of septic systems to groundwater, and to determine long-term impacts.

The Sevier River and tributaries are heavily utilized for a variety of purposes, from recreation to agriculture. Careful planning of future water use will provide long-term benefits to the watershed.

Dispersed recreation, in areas where few or no sanitary facilities exist, may also potentially impact groundwater through increased sedimentation and presence of human waste.

Reference Conditions, Patterns and Trends

Historically, most use of the watershed was used on an intermittent/seasonal basis, with few year-round residents. Travel was limited to major roads, with little or no off-road impacts. Timber roads were often left open, because they received little if any post-harvest use, and could act as migration corridors for wildlife. Impacts from septic systems, because so few existed, were not of concern in this area.

Natural/ Human Causes of Change Between Current/Reference Conditions

The number of homes continues to increase with many residents now residing in the area year-round, greatly increasing the amount of waste disposal and water use. In addition, past users consisted of those seeking solitude, which had very little impact on surrounding areas. Today, the area is highly used for recreation by off-road vehicle enthusiasts, increasing the number of user-created roads and re-opening previously closed roads.

5. Enhancement or Protection of Sage Grouse Habitat

Current Conditions, Patterns and Trends

Sage grouse are currently listed on the Utah Sensitive Species List as a Species of Special Concern. Both current and historic sage grouse leks are known to occur within the Pass Creek Watershed. However, sage grouse populations are declining due to sagebrush/grassland habitat loss to pinyon-juniper expansion, extensive grazing and dewatering of streams and area springs. Mule deer, elk, antelope and Utah prairie dog also depend on once expansive sagebrush/grassland habitat and forage within the Pass Creek Watershed. Vegetation diversity in sagebrush/grassland areas is currently lacking, and many areas are dominated by more aggressive non-native grass species. Where the quantity and quality of habitat has declined, sage grouse populations are vulnerable to excessive natural predation and chick survival remains low.

Decadent sagebrush, with little understory vegetation, occurs throughout much of the Pass Creek Watershed.

Reference Conditions, Patterns and Trends
Historic records suggest that portions of all 29 counties in Utah provided adequate habitat for sage grouse (Mitchell, 2001). Expansive sagebrush/grassland areas, maintained by periodic fire were present prior to Euro-American settlement. Large fragments of habitat have been lost to agriculture and urban development.

Natural/Human Causes of Change Between Reference/Current Conditions
Habitat loss, fragmentation and degradation are the main causes of population declinein sagebrush communities. Vegetation range, pattern and structure have been further impacted through intensive grazing and fire suppression, allowing increased establishment of pinyon-juniper and decreased grass and forb production.

6. Enhancement and Protection of Utah Prairie Dog Habitat

Current Conditions, Patterns and Trends
Utah prairie dog was listed as endangered under the Endangered Species Act of 1973 as amended, due to a decline in colony size and numbers. The status was changed to "threatened" in 1984, where it currently remains. Utah prairie dog is found in only a 10-county area of southwestern Utah, and is the western-most prairie dog in the United States, and the one with the smallest range. While it is estimated that 95,000 Utah prairie dogs existed in the 1920's, today only 5,000 or 6,000 remain in isolated populations throughout southwest Utah, including within the Pass Creek Watershed (Day, 2001).

Utah prairie dogs are found thoroughout the Upper Sevier River basin.

Reference Conditions, Patterns and Trends
Prior to 1920, Utah prairie dogs dominated areas within Pine and Buckskin Valleys in Beaver and Iron Counties, as far north as Nephi, south to Bryce Canyon National Park and east to the foothills of the Aquarius Plateau. The main concentrations of colonies now occur only in eastern Iron County, western Garfield County, and along portions of the East Fork and the main stem of the Sevier River.

Natural/Human Causes of Change Between Current/Reference Conditions
Decreases in grass/forb type plant communities, coupled with pinyon-juniper expansion, and the introduction of a deadly plague have reduced the colony size of many remaining prairie dog populations, necessitating long-term recovery efforts. Lack of periodic fire, preventing maintenance of large grassland patches, and the removal of shrub cover and accompanying reseeding with non-native plant species, (such as smoothe brome) have

reduced vegetation diversity and forage plant species diversity within historic prairie dog ranges. Currently coordinated efforts between private landowners, Bureau of Land Management, Division of Wildlife Resources and Garfield and Kane Counties are pursuing the creation of new Utah prairie dog habitat and the improvement of existing habitat, as well as developing Habitat Conservation Plans for various counties.

7. Noxious Weeds

Current Conditions, Patterns and Trends

Noxious weeds pose an increasing threat to native ecosystems, croplands and other plant communities within the Pass Creek Watershed. An increase in recreational vehicle use and increased traffic on Highway 89 as well as Highway 12, is accelerating the spread of noxious weeds. Established populations of Russian knapweed and whitetop are already found along many travel corridors. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients. Noxious weeds located within water drainages are also competing with native riparian vegetation.

Russian knapweed, once estabished, is difficult to eradicate.

Reference Conditions, Patterns and Trends

Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Natural/Human Causes of Change Between Current/Reference Conditions

Currently, trails and roads serve as the single-most common point of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV's and other motorized and nonmotorized vehicles traveling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult. Movement by recreationists from watershed to watershed (possibly serving to increase noxious weeds) may pose long-term problems for resource managers as well as area landowners.

8. PJ, Sagebrush-Grasslands - Fuel Conditions, Vegetation Composition, Accelerated Erosion

Current Conditions, Patterns and Trends

Pinyon-juniper encroachment into historic sagebrush/grassland communities has reduced ground cover, decreased grassland species diversity eliminated portions of prime mule deer and livestock winter range and increased wildfire risk in areas of high pinyon-juniper densities. In addition, many sagebrush areas are decadent, with even age classes of old individuals and excessive crown canopies. Surface erosion has increased due to little understory vegetation to help retain soil.

Pinyon-juniper expansion is a concern to wildlife and land managers, as well as landowners, within the lower portions of the watershed. Increased surface erosion within this vegetation type greatly affects water quality.

Reference Conditions, Patterns and Trends

Pinyon-juniper historically occupied rocky edges, outcrops and slopes within the watershed. Periodic, low intensity fires (10 to 30 years) helped maintain pinyon-juniper density and diversity, while preventing encroachment into other vegetation types. Mixed age classes of sagebrush, with less than 15% canopy cover were dominant prior to Euro-American settlement, and probably dominated the watershed. Patchy vegetation patterns, with several age and canopy classes of sagebrush and grasses, were present and maintained by periodic fire, approximately every 20-40 years.

Natural/Human Causes of Change Between Current/Reference Conditions

Competition for available moisture and high ungulate use have substantially reduced the grass-forb component in mature and old, dense pinyon-juniper stands. Pinyon-juniper distribution has also increased because of recent fire suppression efforts. Chainings were conducted in the 1960's and 1970's on private, forested and BLM lands to promote grass-forb communities; however, lack of additional disturbance, has allowed pinyon-juniper to re-establish on these sites.

9. Wildlife Management in Agricultural Areas

Current Conditions, Patterns and Trends

Wildlife damage to agricultural lands has increased steadily over the past decade. Deer and elk continue to impact area ranches throughout the entire watershed by competing with livestock for available forage, destroying fences, and depredating stored winter crops. Utah prairie dogs present problems in the Castle Creek and Big Hollow subwatersheds, by destroying cash crops.

While mitigation measures such as landowner and control permits, fencing and actual dollar reimbursements offset some of the costs, wildlife continue to have an economic impact on private agricultural lands. Other concerns expressed from landowners include the impact to land development and use by the listing (endangered, threatened, etc.) of wildlife species such as Utah prairie dog and sage grouse, and the hesitation of landowners to engage in habitat improvement projects which may further attract wildlife and result in subsequent damage to private lands and cultivated areas.

Projects like the Coyote Hollow habitat improvement project, protect riparian and rangeland areas from deer, elk and livestock, while providing access to water. Deer and elk may compete with livestock (and vice-a-versa) for the best available forage and water.

Reference Conditions, Patterns and Trends
Unrestricted hunting of predators as well as big game hunting, resolved most wildlife/landowner conflicts. Adequate winter and summer deer and elk ranges were maintained by periodic fire, further eliminating potential deer/elk confiicts.

Natural/Human Causes of Change Between Current/Reference Conditions
Restricted hunting, the demand for increased quality hunting opportunities, stricter compliance with fish and game laws, and the desire for wildlife viewing opportunities have resulted in an increase in deer and elk numbers from early settlement conditions. Drought and subsequent changes in vegetation composition within the watershed may temporarily decrease elk and deer numbers; however, these same conditions may cause deer and elk to seek additional forage opportunities on private agricultural lands, where adequate feed is available. Competition for available forage from domestic livestock has decreased range conditions in some areas, further contributing to wildlife depredation on cultivated lands. Available habitat for deer, elk and Utah prairie dog has been lost through pinyon-juniper and mixed conifer encroachment into sagebrush/grasslands, aspen and open meadow areas.

Pass Creek
Key Issues Identified

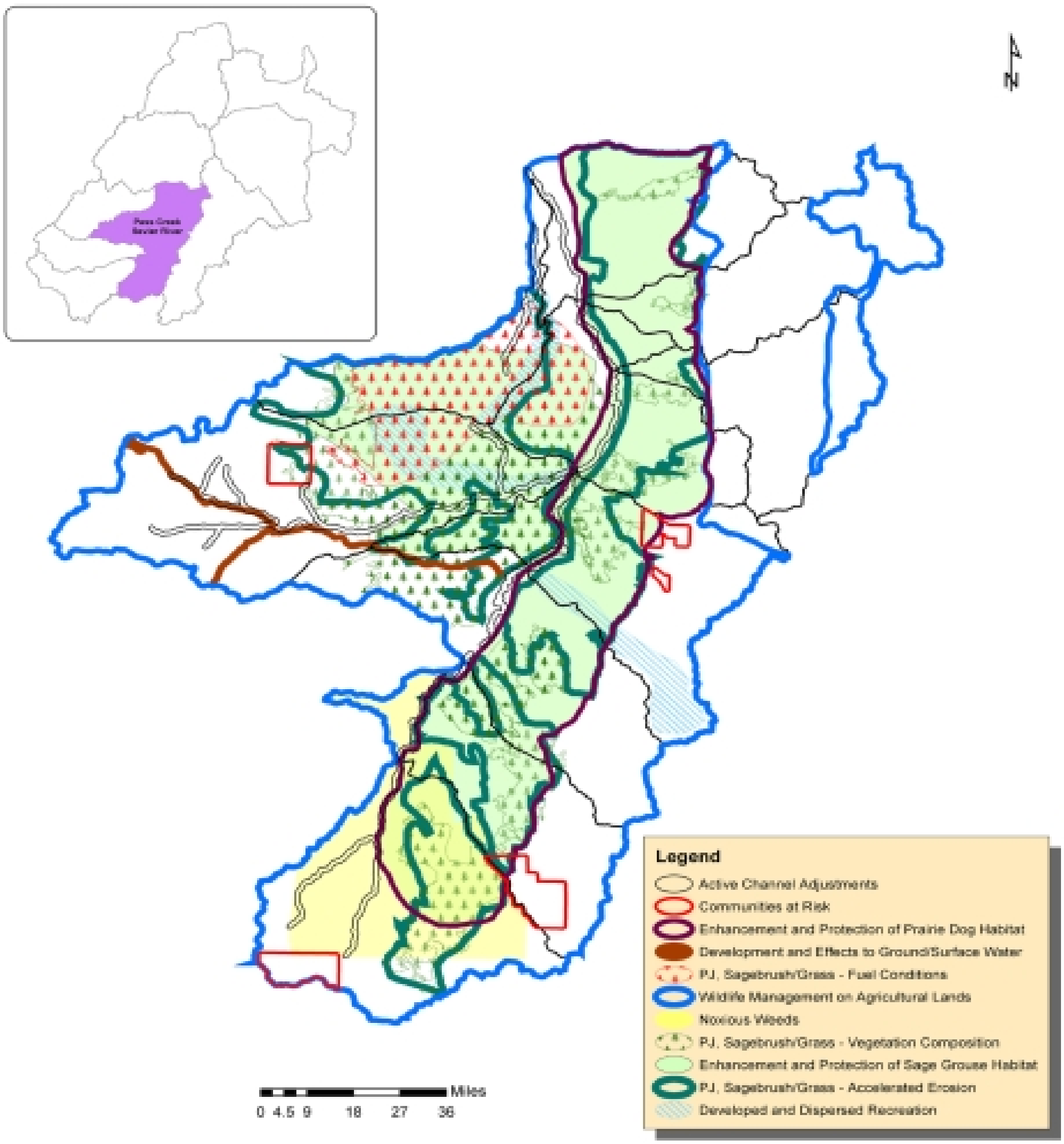

Fig. 4-21. The 11 key issues identified for the Pass Creek Watershed (as discussed in the 9 narratives) represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees (TACs).

	Peterson Wash-Sevier River	Casto Wash	Red Canyon	Graveyard Hollow	Hillsdale Sevier River	Pass Creek	Proctor Canyon-Sevier River	Big Hollow-Sevier River	Pole Canyon-Sevier River	Castle Creek-Sevier River	**Total for Pass Creek Watershed**
Hydrology/Water Quality											
Hydrology											
Dewatering and altered flow regimes	H	NA	NA	NA	L	NA	M	NA	NA	L	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	H	NA	NA	NA	M	NA	L	L	NA	M	**L**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	H	NA	NA	NA	M	M	M	M	M	M	**M**
Hillslope Processes						*NA*					
Accelerated erosion on high elevation meadows	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion in pinyon-juniper and sagebrush stands	H	M	M	H	H	H	M	M	M	M	**M**
Accelerated erosion associated with urban development	M	NA	M	NA	L	NA	NA	L	NA	NA	**L**
Accelerated erosion associated with roads	M	M	M	NA	M	M	M	M	M	M	**M**
Rill and gully erosion on hillslopes	H	M	M	M	M	H	M	M	M	M	**M**
Accelerated erosion associated with illegal ATV use	M	M	M	H	M	M	NA	M	M	M	**M**
Riparian Vegetation											
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	L	M	M	M	H	M	H	M	M	**M**
Water Quality											
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	M	NA	L	NA	L	NA	M	M	M	M	**L**
Accelerated erosion, grazing management, recreation use, roads	M	M	H	H	M	H	M	M	M	M	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	H	NA	NA	NA	H	NA	H	H	L	NA	**M**
Channel Morphology											
Active channel adjustments (vertical or lateral)	H	H	H	H	M	H	M	H	M	H	**H**
Accelerated bank erosion	H	H	H	H	M	H	M	H	M	M	**M**
Channelization	M	NA	NA	NA	NA	NA	M	NA	H	NA	**L**
Agriculture											
Animal Feed Operations	L	NA	NA	NA	L	NA	NA	NA	NA	NA	**L**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	L	NA	NA	NA	M	NA	L	L	NA	L	**L**
Pasture Mgt.	L	NA	NA	NA	M	NA	M	M	NA	M	**L**
Fertilizer Usage and Impacts	L	NA	NA	NA	M	NA	L	L	NA	NA	**L**
Noxious Weeds	M	NA	H	NA	H	M	M	M	M	M	**M**
Wildlife Management in Agricultural Areas	H	M	M	H	M	H	H	H	H	H	**H**
Fire											
Communities at Risk	L	L	L	L	H	H	H	H	H	H	**H**
Fuel Conditions	M	M	M	H	H	H	H	H	H	M	**H**
Human Uses											
Development and Effects to Groundwater	L	L	H	L	H	L	H	H	M	M	**M**
Development and associated recreation uses to adjacent lands	NA	L	L	NA	L	L	L	L	L	L	**L**
Access Management	M	M	M	H	L	M	L	L	L	L	**M**
Developed and Dispersed Recreation	M	M	H	L	L	M	L	L	L	L	**M**

Table. 4-12. Issue ratings for all 10 Pass Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

	Peterson Wash-Sevier River	Casto Wash	Red Canyon	Graveyard Hollow	Hillsdale Sevier River	Pass Creek	Proctor Canyon-Sevier River	Big Hollow-Sevier River	Pole Canyon-Sevier River	Castle Creek-Sevier River	**Total for Pass Creek Watershed**
Vegetation											
Sagebrush - Grass	H	H	H	M	M	H	H	M	H	H	**H**
Aspen	L	NA	NA	NA	NA	M	L	L	L	L	**L**
Grassland - Meadow	H	H	H	NA	H	M	H	H	H	H	**H**
Mixed Conifer - Mountain Fir	L	L	L	L	L	M	L	L	L	L	**M**
Oak - Mahogany - Mountain Shrub	L	L	L	M	L	M	L	L	L	M	**M**
Pinyon - Juniper	M	L	L	H	M	H	H	H	M	M	**H**
Ponderosa	L	L	M	L	L	M	L	L	L	L	**M**
Spruce - Fir	NA	NA	NA	NA	NA	L	NA	L	NA	NA	**L**
Tall Forb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	M	M	H	L	M	M	M	M	H	M	**H**
Species and Habitat											
Priorities for Enhancement or Protection of:											
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	H	M	M	L	H	L	H	H	H	M	**H**
Bald Eagle Habitat	M	M	L	L	H	M	H	H	M	M	**H**
Spotted Bat Habitat	M	M	H	M	M	M	M	M	M	M	**H**
Townsend's Big-eared Bat Habitat	M	M	H	M	M	M	M	M	M	M	**H**
Flammulated Owl Habitat	NA	M	H	NA	L	H	L	M	NA	M	**M**
Three-toed Woodpecker Habitat	NA	NA	NA	NA	NA	NA	L	L	NA	NA	**L**
Northern Goshawk Habitat	L	H	H	L	M	H	M	M	L	M	**M**
Peregrine Falcon Habitat	M	M	M	L	M	L	M	M	M	M	**M**
Sage Grouse Habitat	H	H	M	H	M	H	H	M	H	H	**H**
Turkey Habitat	M	L	M	M	M	L	H	M	M	M	**M**
Deer Habitat	M	H	M	H	M	H	H	H	H	H	**H**
Elk Habitat	L	M	M	H	M	H	M	M	M	M	**H**
Pronghorn Habitat	H	H	M	H	M	H	M	M	L	L	**H**
Brian Head Mountain-Snail Habitat	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	**L**
Beaver Habitat	L	L	L	L	L	L	L	M	L	L	**M**
Boreal Toad Habitat	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	**L**
Bonneville Cutthroat Habitat	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	**L**
Riparian Areas	L	L	L	L	M	L	M	M	H	H	**M**
Fisheries Habitat	M	NA	NA	NA	H	NA	H	H	H	L	**M**

Table. 4-12 (cont).. Issue ratings for all 10 Pass Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

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BEAR CREEK WATERSHED

The Bear Creek Watershed is home to native Bonneville cutthroat trout, sage grouse, Utah prairie dog and portions of the Panguitch Lake and Mt. Dutton elk herds. The historic Fishlake cutoff of the Spanish Trail, used by settlers in the 1850's through 1870's, traverses the watershed, and has paved the way for more modern roads and trails.

Cattle have been grazed throughout the Bear Creek Watershed since pioneers first settled the area in the mid-1800's.

Prior to 1860, Bear Valley probably looked much different, and remained relatively free of human use. In 1864, pioneers from Beaver and Parowan decided to cross the valley, creating the road (now Highway 20) that is still used today. These sturdy pioneers were the first Panguitch settlers and quickly set about utilizing the water from the Sevier. However, hostile Indians forced the settlers to abandon their crops and return to Beaver and Parowan. Panguitch was not resettled until 1871, when upon return, settlers found their crops and buildings just as they had left them. Today, ranchers utilize Bear Valley for livestock grazing. This valley continues to be the most direct route to Panguitch, Utah, from major transportation corridors, like Interstate 15.

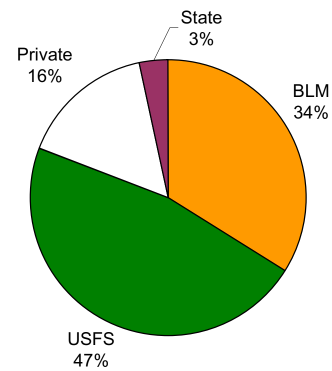


Fig. 4-22. Bureau of Land Management and private lands are found along the Upper Sevier River and make up portions of all ten subwatersheds.

Land Ownership

Several private homesteads, claimed after the Homestead Act of 1871, exist in the Bear Creek Watershed within Forest Service boundaries, and are still used today by area residents. There are 30,380 acres of private land within the watershed, as well as Bureau of Land Management (64,175 acres), U.S. Forest Service (88,522) and State lands (67,074 acres) (Fig 4-22, Fig. 4-23). Ten subwatersheds are found in the Bear Creek Watershed (Table 4-13).

Much of the U. S. Forest Service land within the watershed remains remote, with little access and few users. However, use remains high along the Upper Sevier River and Highway 89 corridor.

Bear Creek Subwatersheds	Acres
Bear Creek	33684
East Bench-Sevier River	14329
Horse Valley Creek-Sevier River	30218
Limekiln Creek	17034
Sandy Creek	15262
Sanford Creek	19150
Smith Canyon-Sevier River	21732
Tebbs Hollow-Sevier River	12877
Threemile Creek	13208
West Ditch-Sevier River	11658
Total	189152

Table 4-13. The Bear Creek Watershed is composed of 10 subwatersheds.

Vegetation Type	Acres	%
Agriculture	9430	5%
Aspen	37	0%
Grass/Forb	4459	2%
Mixed Conifer	5102	3%
Mountain Shrub	15497	8%
Pinyon/Juniper	95446	50%
Ponderosa Pine	4881	3%
Sagebrush/Grass	25563	14%
Spruce/Fir	17398	9%
Urban	687	0%
Other	10652	6%
Total	189152	100%

Fig. 4-14. With only 37 acres, the aspen component has been all but lost in this watershed. Pinyon-juniper and sagebrush/grasslands dominate (50% and 14%, respectively) areas within Bear Creek.

Vegetation Types

Pinyon-juniper woodlands are most often represented as a transition between forested and grassland ecosystems. However, in recent years, pinyon-juniper woodlands have invaded forest and grassland areas, possibly due to heavy grazing, fire suppression, exotic species introduction or drought. The spread of pinyon-juniper has resulted in a decrease of perennial grasses and other forage type plants and has also resulted in increased erosion within many of the Upper Sevier River Watersheds. Over 95,000 acres of pinyon-juniper are found within the Bear Creek Watershed, most likely displacing sagebrush/grasslands (currently 25,563 acres) in some areas (Table 4-14, Fig. 4-24). Sagebrush-grasslands provide important habitat for upland game birds and small mammals and are important habitat for deer and elk.

The aspen component in the Bear Creek Watershed is low (37 acres); however, isolated patches, which are classified as other vegetation types may exist throughout the Dixie National Forest. Much of the aspen component has been lost to mixed-conifer encroachment. Grass/forb, mixed conifer, mountain shrub, ponderosa pine, and spruce/fir are also found in various parts of the watershed's ten subwatersheds.

The geologically unique Smith Canyon area is home to abundant wildlife, including black bear, cougar and deer.

Elevation, Roads & Streams

Many agricultural crops are grown within the lower portions of the watershed, despite the short growing season and high altitude (approx. 6,600 feet.) (Fig. 4-25) The Utah State University Experiment Station, located in Panguitch, Utah, serves as one of only two research facilities designed to study crop and vegetation issues in areas with a short growing season and/or at high elevations. Students from Utah State University conduct research to improve economic and cultural enterprises in the intermountain west.

The small town of Panguitch sits on the border of the Panguitch Creek and Bear Creek Watersheds. This small town, which lies between the Paunsagunt and Markagunt Plateaus is often referred to as a "crossroads of the west," with roads leading to several area national parks, as well as Salt Lake City, Utah, Las Vegas, Nevada and Lake Powell, Utah.

Little Creek Peak to the West and Mount Dutton to the East, support huntable populations of big game.

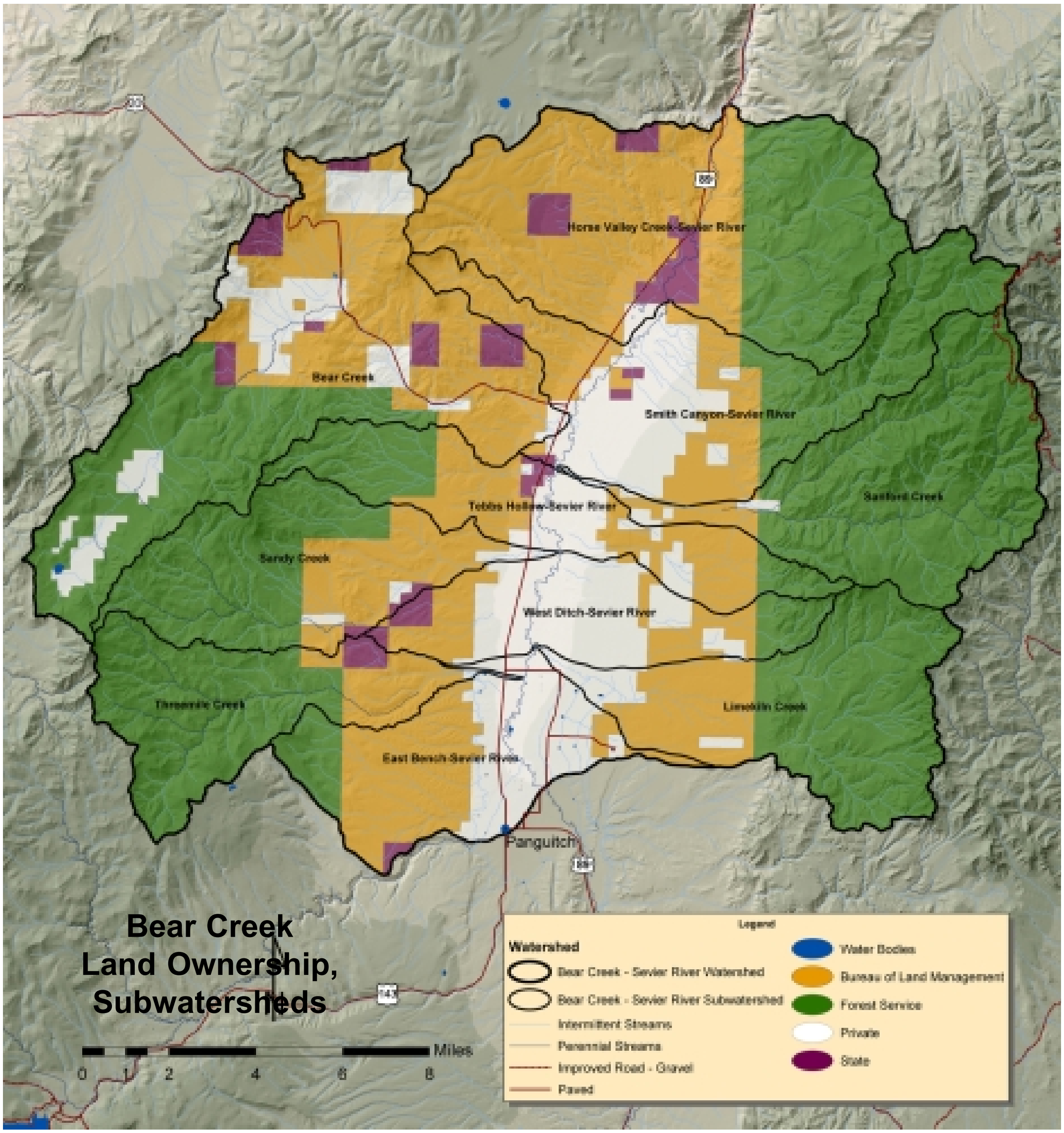


Fig. 5-23. Bureau of Land Management lands make up much of the land ownership within the Pass Creek (55,104 acres), Bear Creek (64, 175 acres), and City Creek (59,525 acres) Watersheds.

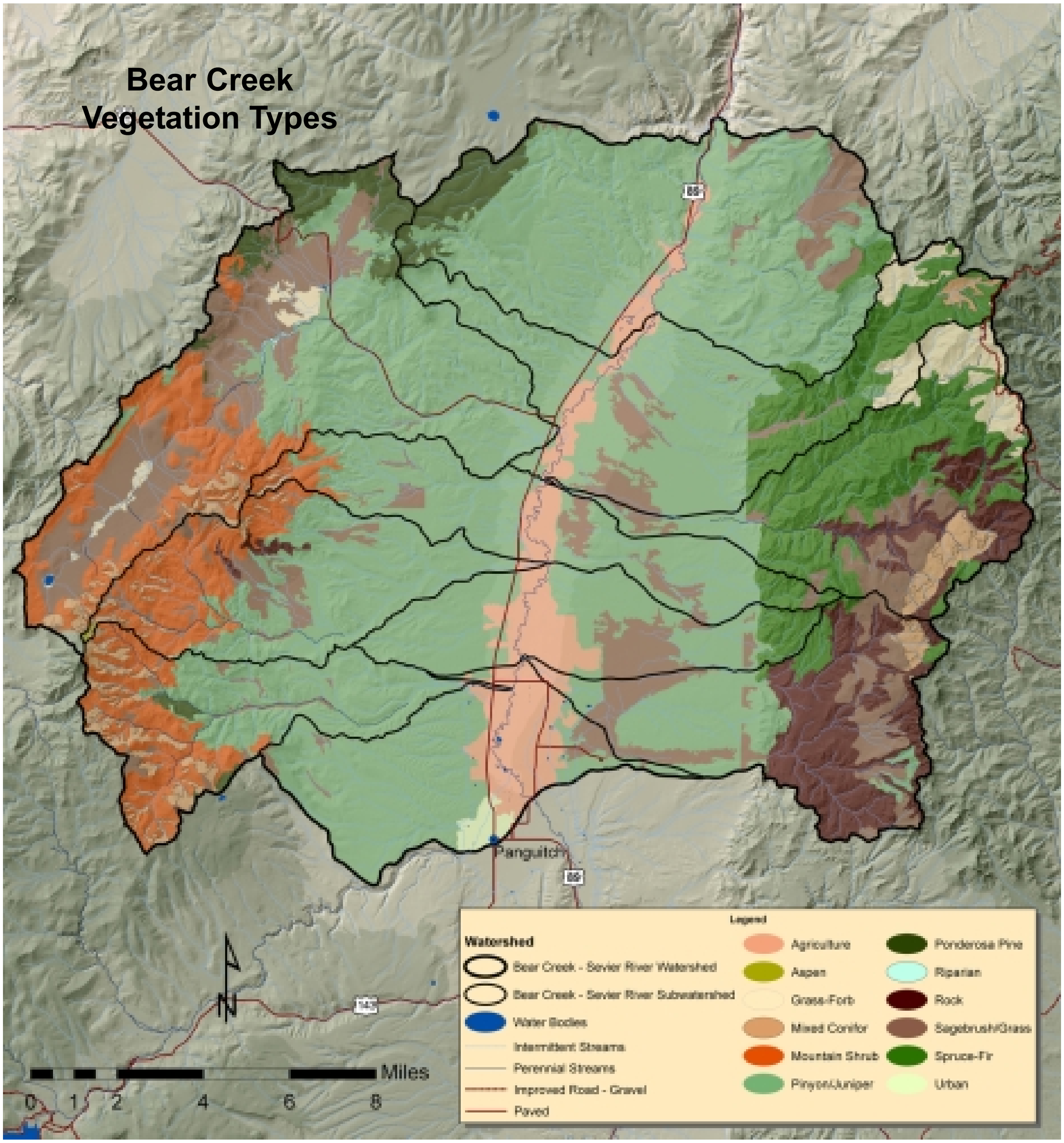


Fig. 4-24. Sagebrush/grasslands and pinyon-juniper dominate areas within the Panguitch Valley.

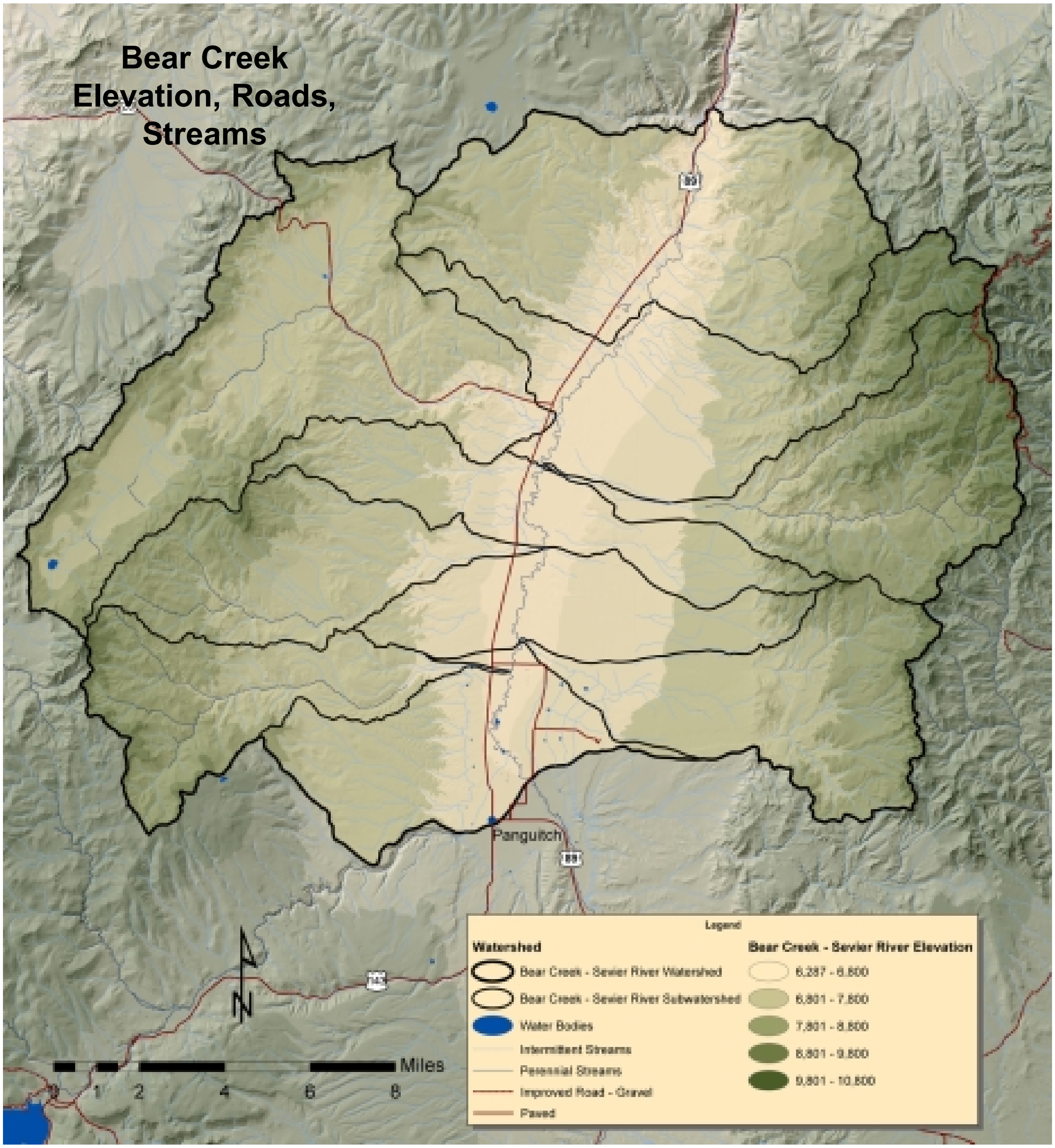


Fig. 4-25. Highway 89 runs north-south through the Bear Creek Watershed. Highway 20, historically used by pioneers to cross from Parowan to the Panguitch Valley, is still the quickest route to Highway 89 and Panguitch, Utah, from Interstate 15.

Key Issues

Key issues identified for the Bear Creek Watershed are: 1) Access Management; 2) Enhancement and Protection of Riparian Habitat; 3) Enhancement or Protection of Sage Grouse Habitat; 4) Noxious Weeds; 5) Pasture Management; 6) Pinyon-juniper, Sagebrush-Grasslands - Accelerated Erosion, Vegetation Composition, Fuel Conditions, and 7) TMDL listed and potentially listed waters (Figure 4-26). (Other issues and ratings within the Bear Creek Watershed are listed in Table 4-15.

1. Access Management

Current Conditions, Patterns and Trends

High road densities along stream channels, with an increase in ATV use and dispersed camping, occur throughout portions of the Bear Creek Watershed. Increased sediment transport, degraded stream conditions, lack of riparian vegetation, and damage to adjacent upland areas through access occur in areas of concentrated use, and motorized use is increasing yearly. In recent years, antler collecting has increased travel in roadless areas.

Reference Conditions, Patterns and Trends

Available roads have traditionally been used for harvesting timber, with less dispersed camping and recreating in riparian areas than is currently occuring. Access was limited to summer months, when weather conditions were favorable for travel within the forest. Once used timber roads, which historically were not a problem, today provide additional corridors for ATV movement, creating access into critical wildlife and habitat areas.

An adequate road network exists in parts of the watershed; however, user-created roads and access management are a problem, especially when adjacent to riparian areas.

Natural/Human Causes of Changes Between Current/Reference Conditions

Increased off-road use on public lands is the primary access management concern.

2. Pasture Management

Current Conditions, Patterns and Trends

Grazing has been an integral part of lands within the Bear Creek Watershed since pioneers first settled the area around Hatch (~1872). Today's grazing practices are much better than those of the past: better pasture management increases productivity, maintains vegetation diversity, discourages native weed introduction, and leaves critical riparian areas intact. Effective pasture management practices include developing pasture management plans, rotating animals through pastured areas, limiting herd size, fencing livestock from riparian areas, maintaining browse species diversity, and leaving trees and shrubs within pastures and near stream banks.

Inadequate bank stability (right), decreases pasture productivity, encourages native weed invasion, increases sediment transport, and provides little or no habitat for fish and wildlife that utilize riparian areas.

Reference Conditions, Patterns and Trends

Prior to Euro-settlement, free-range grazing was limited to native animals such as deer and elk. Extensive grasslands, forbs and sagebrush/pinyon-juniper ecotypes, maintained by periodic fire, existed on many lower elevation sites within the Bear Creek Watershed. Abundant and diverse riparian grasses, willow and cottonwood occurred along stream channels. Loamy soils facilitated water run-off, reducing erosion and maintaining plant species diversity.

Natural/Human Causes of Change Between Current/Reference Conditions

The USU Panguitch farm provides opportunities for landowners and youth to conduct demonstration projects to improve agricultural and ranching enterprises throughout the west.

Prior to 1950, driven by the desire to homestead and utilize an apparant abundance of natural resources, little or no management occurred. Pasture management was first recognized in the 1950's, but is just beginning to be seen as a means to increase productivity, while minimizing destruction to rangelands and riparian areas.

3. Enhancement and Protection of Riparian Habitat

Current Conditions, Patterns and Trends

Intact riparian systems occur along Three-mile Creek where biologists and landowners have worked together on vegetation projects, cattle exclusions and reintroduction of native Bonneville cutthroat trout.

Woody plant species and late seral herbaceous species are lacking along many riparian corridors, particularly along the Sevier River and its tributaries. In addition, most of the water within this section is removed and used for irrigation. Bonneville cutthroat trout have been reintroduced into Sandy Creek, Three Mile Creek and Sanford Creek and some exclosures built to exclude cattle; however, all efforts need to be made to improve riparian areas and allow fish to re-establish. Leatherside chub, a nongame Utah Species of Special Concern is also found within the Three Mile Creek area.

During the Sanford Fire in 2002, some riparian areas along Sanford Creek were burned. Increased upland sediment flow and increased stream temperatures also destroyed a pure strain of Bonneville cutthroat trout. Lack of riparian vegetation will limit future native fish introductions into Sanford Creek. In other areas throughout the watershed, where woody plant species (willow and cottonwood) are present, recruitment of young plants is limited; the majority of plants are in a mature stage. Bank erosion has resulted in higher width/depth ratios along many stream corridors and increased head cuts on the upstream ends.

Bank erosion has resulted in higher width/depth ratios along many stream corridors.

In the mid-1990's wildlife managers reintroduced native Bonneville cutthroat trout to Three Mile Creek and installed a cement barrier near the

Forest Service boundary to keep non-native fish from the area. Today, surveys show that these efforts have paid off, and native cutthroat trout are found throughout the drainage once again. In addition, leatherside chub, a nongame 'Utah Species of Special Concern' is also found within the Three Mile Creek area.

Riparian areas are of critical importance to birds, fish, amphibians, aquatic invertebrates and other wildlife species. They provide critical breeding habitat for many southwestern neotropical birds, as well as water, shade, food and shelter for other wildlife. Riparian areas also provide migratory routes for many bird species, and sheltered pathways to other habitats for other wildlife species.

Reference Conditions, Patterns and Trends

Riparian vegetation in the Bear Creek Watershed most likely consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower elevations along the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes. Native Bonneville cutthroat trout, as well as other nongame fish species inhabited the area.

Natural/Human Causes of Change Between Current/ Reference Conditions

Changes in riparian vegetation have resulted from a variety of land uses including livestock grazing, channel adjustments, water diversions, road construction, recreation, and crop-land cultivation. Changes in upland vegetation (through fire suppression) have increased sediment transport within the watershed.

Inadequate sage grouse habitat consisting of even age class sagebrush with little understory vegetation, exists throughout much of the watershed.

4. Enhancement or Protection of Sage Grouse Habitat

Current Conditions, Patterns and Trends

Sage grouse are currently listed on the Utah Sensitive Species List as a Species of Special Concern. Historic sage grouse leks are known to occur within the Bear Creek Sevier River watershed; however, only one remaining active lek is found in the Panguitch Valley. Sage grouse populations are currently declining due to loss of sagebrush/grassland habitat and pinyon-juniper expansion. Mule deer, elk, antelope and Utah prairie dog also depend on once expansive sagebrush/grassland habitat within the watershed. Vegetation diversity in sagebrush/grassland areas is currently lacking, and many areas are dominated by more aggressive non-native grass species. Where the quantity and quality of habitat has declined, sage grouse populations are vulnerable to excessive natural predation and chick survival remains low.

Reference Conditions, Patterns and Trends

Historic records suggest that portions of all 29 counties in Utah once provided adequate habitat for sage grouse (Mitchell, 2001). Expansive sagebrush/grassland areas, maintained by periodic fire were present prior to Euro-American settlement. Large fragments of habitat have been lost to agriculture and urban development.

Natural/Human Causes of Change Between Reference/Current Conditions

Areas where riparian vegetation is lacking, become likely spots for weed establishment, and once introduced, will outcompete remaining native vegetation.

Habitat loss, fragmentation and degradation are the main causes of population decline. Vegetation range, pattern and structure have been further impacted through intensive grazing and fire suppression, allowing increased establishment of pinyon-juniper (displacing sagebrush habitat on which sage grouse depend) and decreased grass and forb production.

5. Noxious Weeds

Current Conditions, Patterns and Trends

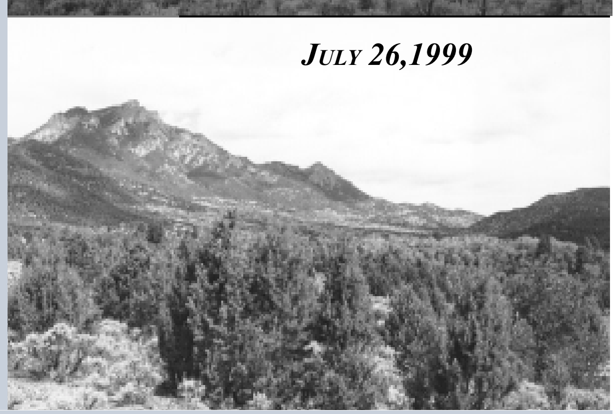
Noxious weeds pose an increasing threat to native ecosystems, croplands and other plant communities within the Bear Creek Watershed. An increase in recreational vehicle use and increased traffic around Piute Reservoir and surrounding areas may accelerate the spread of noxious weeds. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients. In areas where vegetation communities have been altered through grazing or fire suppression, noxious weeds, such as whitetop and Canada thistle are already becoming established in riparian areas. Weeds are currently competing with native riparian vegetation.

Reference Conditions, Patterns and Trends
Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Natural/Human Causes of Change Between Current/Reference Conditions
Currently, trails and roads serve as the single-most common point of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV's and other motorized and nonmotorized vehicles traveling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult. Movement by recreationists from watershed to watershed (possibly serving to increase noxious weeds) may pose long-term problems for resource managers as well as area landowners.

6. PJ, Sagebrush-Grasslands – Accelerated Erosion, Fuel Conditions, Vegetation Composition

Current Conditions, Patterns and Trends
Pinyon-juniper encroachment into historic sagebrush/grassland communities has reduced ground cover, decreased grassland species diversity, eliminated portions of prime mule deer and livestock winter range, and increased wildfire risk in areas of high pinyon-juniper densities. In addition, many sagebrush areas are decadent, with even age classes of old individuals and excessive crown canopies. Sheetwash erosion has increased due to little understory vegetation to help retain soil.



Pinyon-juniper encroachment into historic sagebrush grasslands has increased wildland fire potential, decreased grassland species diversity, increased overland erosion and eliminated habitat for numerous wildlife species.

Reference Conditions, Patterns and Trends

Pinyon-juniper historically occupied rocky edges, outcrops and slopes within the watershed. Periodic, low intensity fires (10 to 30 years) helped maintain pinyon-juniper density and diversity, while preventing encroachment into other vegetation types. Mixed age classes of sagebrush with less than 15% canopy cover were dominant prior to Euro-American settlement. Patchy vegetation patterns, with several age and canopy classes of sagebrush and grasses were present and maintained by periodic fire, which occurred approximately every 20-40 years.

Natural/Human Causes of Change Between Current/Reference Conditions

Competition for available moisture and high ungulate use have substantially reduced the grass-forb component in mature and old, dense pinyon-juniper stands. Pinyon-juniper distribution has also increased because of recent fire suppression efforts. Chainings were conducted in the 1960's and 1970's on private, Forest Service and BLM lands to promote grass-forb communities; however, lack of additional disturbance, has allowed pinyon-juniper to re-establish on these sites. Sagebrush-Grassland decline is attributed to lack of disturbance (periodic fire) as well as pinyon-juniper encroachment.

7. Total Maximum Daily Load (TMDL) Listed and Potentially Listed Waters

Note: Water quality problems within the Upper Sevier River Basin are covered in detail in Chapter 5. All potentially listed waters are considered priority areas for enhancement; however TMDL listed areas for the Bear Creek Watershed were elevated because water quality problems within this watershed are directly correlated to other issues listed as priority (PJ - Sagebrush/Grasslands & Pasture Management).

Current Conditions, Patterns and Trends

The main stem of the Sevier River is currently listed as impaired by the Department of Water Quality, Division of Water Quality, for high levels of phosphorous, sediment and habitat alteration (2004, Utah Dept. of Enviromental Quality).

Sections of the Upper Sevier River are currently listed as impaired due to high levels of phosphorous, sediment and habitat alteration.

Excessive phosphorus causes an increase in algae growth, thereby decreasing the dissolved oxygen available for cold water fish species, while high levels of sediment from erosion impairs fish habitat and their ability to spawn.

Reference Conditions, Patterns and Trends

Riparian vegetation in the Bear Creek Watershed most likely consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower elevations along the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, supported normal flow regimes, and decreased nutrient eutrophication potential. Native Bonneville cutthroat trout, as well as other nongame fish species perused the area.

Natural/Human Causes of Change Between Current/Reference Conditions

Changes in riparian vegetation have resulted from a variety of land uses including livestock grazing, channel adjustments, water diversions, road construction, recreation, and cultivation. Changes in upland vegetation through fire suppression have increased sediment transport within the watershed, while upstream urban development and grazing have altered stream flows and contributed to decreased water quality.

Bear Creek
Key Issues Identified

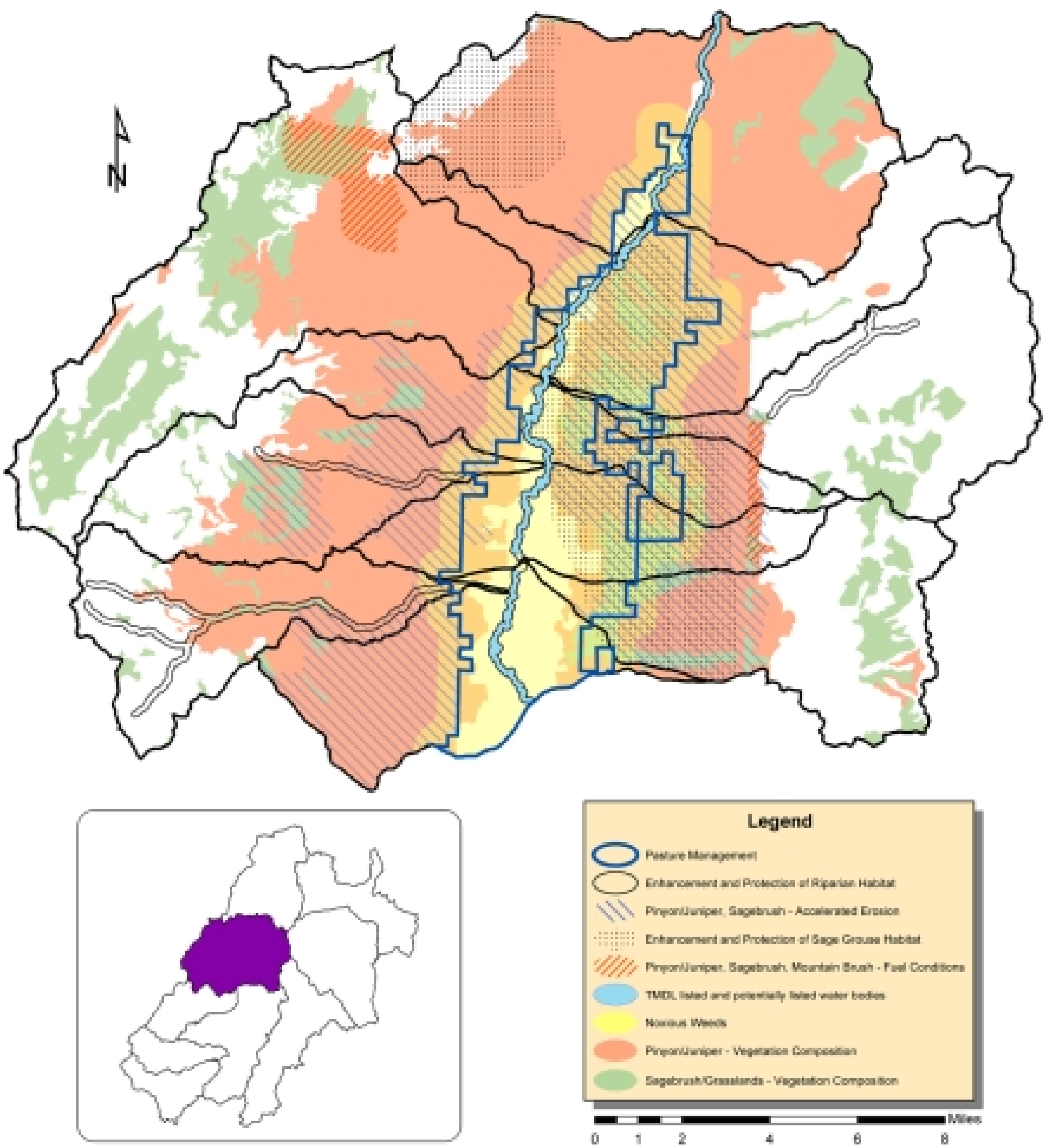


Fig. 4-26. The nine key issues identified for the Bear Creek Watershed represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees (TACs).

	Horse Valley Creek-Sevier River	Smith Canyon-Sevier River	Sanford Creek	Bear Creek	Tebbs Hollow-Sevier River	Sandy Creek	West Ditch-Sevier River	Threemile Creek	East Bench-Sevier River	Limekiln Creek	**Total for Bear Creek Watershed**
Hydrology/Water Quality											
Hydrology											
Dewatering and altered flow regimes	NA	L	M	NA	NA	L	H	M	NA	NA	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	M	H	NA	NA	M	NA	H	NA	M	NA	**M**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	H	M	L	M	H	NA	H	L	M	M	**M**
Hillslope Processes											
Accelerated erosion on high elevation meadows	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion in pinyon-juniper and sagebrush stand	H	H	H	H	H	H	H	H	H	H	**H**
Accelerated erosion associated with urban development	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion associated with roads	L	L	H	L	M	M	M	M	M	M	**M**
Rill and gully erosion on hillslopes	M	H	H	H	H	H	H	H	H	H	**H**
Accelerated erosion associated with illegal ATV use	M	M	M	M	M	M	M	M	M	M	**M**
Riparian Vegetation											
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	H	M	M	H	M	H	M	H	M	**H**
Water Quality											
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	NA	NA	NA	NA	NA	NA	NA	NA	M	NA	**NA**
Accelerated erosion, grazing management, recreation use, roads	M	M	M	L	M	M	H	M	M	H	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	H	H	M	M	H	M	H	M	H	M	**H**
Channel Morphology											
Active channel adjustments (vertical or lateral)	M	H	M	NA	H	M	H	M	H	M	**M**
Accelerated bank erosion	M	H	L	NA	H	L	H	M	M	M	**M**
Channelization	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Agriculture											
Animal Feed Operations	NA	NA	NA	NA	NA	NA	L	NA	L	NA	**L**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	L	M	M	NA	M	NA	M	NA	L	NA	**M**
Pasture Mgt.	M	L	NA	NA	M	M	H	NA	M	NA	**M**
Fertilizer Usage and Impacts	L	L	NA	NA	L	NA	H	NA	M	NA	**L**
Noxious Weeds	H	H	H	H	M	M	H	NA	H	M	**H**
Wildlife Management in Agricultural Areas	M	M	H	H	M	M	H	H	H	H	**H**
Fire											
Communities at Risk	L	L	L	L	L	L	L	L	M	L	**L**
Fuel Conditions	M	M	M	M	M	M	M	M	M	M	**M**
Human Uses											
Development and Effects to Ground/Surface Water	L	M	L	L	H	L	H	L	H	L	**M**
Development and associated recreation uses to adjacent lands	L	L	L	L	L	L	L	L	M	L	**L**
Access Management	L	M	M	L	L	L	L	L	M	M	**M**
Developed and Dispersed Recreation	L	L	L	L	L	L	L	L	M	M	**L**

Table 4-15. Issue ratings for all ten Bear Creek subwatersheds, as identified by technical advisory committees (TACs). Issues highlighted in blue are addressed in detail in this section.

	Horse Valley Creek-Sevier River	Smith Canyon-Sevier River	Sanford Creek	Bear Creek	Tebbs Hollow-Sevier River	Sandy Creek	West Ditch-Sevier River	Threemile Creek	East Bench-Sevier River	Limekiln Creek	**Total for Bear Creek Watershed**
Vegetation											
Sagebrush - Grass	H	H	H	H	M	M	M	L	M	H	**H**
Aspen	NA	L	M	H	NA	H	NA	NA	NA	NA	**M**
Grassland - Meadow	NA	NA	NA	M	NA	NA	NA	NA	L	NA	**L**
Mixed Conifer - Mountain Fir	L	H	H	M	L	H	NA	M	NA	M	**M**
Oak - Mahogany - Mountain Shrub	L	L	NA	M	L	M	NA	M	L	M	**L**
Pinyon - Juniper	H	H	M	H	M	H	L	H	H	H	**H**
Ponderosa	NA	NA	L	M	NA	L	L	L	NA	L	**L**
Spruce - Fir	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Tall Forb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	M	L	NA	H	L	M	H	M	L	L	**M**
Species and Habitat											
Priorities for Enhancement or Protection of:											
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	L	NA	NA	NA	NA	**L**
Utah Prairie Dog Habitat	M	M	H	H	H	L	H	M	M	H	**H**
Bald Eagle Habitat	L	M	M	L	M	L	H	L	H	L	**M**
Spotted Bat Habitat	L	M	M	M	L	L	L	M	M	L	**M**
Townsend's Big-eared Bat Habitat	L	M	M	L	L	L	L	L	L	L	**M**
Flammulated Owl Habitat	NA	L	L	L	L	L	NA	L	NA	L	**L**
Three-toed Woodpecker Habitat	NA	L	L	NA	L	NA	L	NA	NA	L	**L**
Northern Goshawk Habitat	L	L	L	L	L	L	L	NA	L	L	**L**
Peregrine Falcon Habitat	M	M	H	H	L	L	L	L	L	L	**M**
Sage Grouse Habitat	M	H	M	L	H	L	H	L	M	H	**H**
Turkey Habitat	M	M	M	M	L	H	L	H	L	L	**M**
Deer Habitat	H	H	H	M	H	H	M	M	H	M	**H**
Elk Habitat	M	L	M	M	L	M	L	M	L	L	**M**
Pronghorn Habitat	L	H	H	L	H	L	H	L	L	M	**H**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	L	M	M	M	L	L	L	M	L	NA	**M**
Boreal Toad Habitat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Bonneville Cutthroat Habitat	NA	NA	H	NA	NA	H	NA	H	NA	NA	**L**
Riparian Areas	M	M	H	H	L	H	M	H	L	NA	**H**
Fisheries Habitat	L	M	H	M	L	H	M	H	L	L	**M**

Table 4-15(cont). Issue ratings for all ten Bear Creek subwatersheds, as identified by Technical Advisory Committees (TACs). Issues highlighted in blue are addressed in detail in this section.

CITY CREEK WATERSHED

Kayakers enjoy the scenery near Kingston Canyon.

Prior to the Mormon pioneers that settled this area in 1864, Piute Indians and other native cultures roamed the land for over 10,000 years. Evidence of these peaceful prehistoric inhabitants is still found in the area around Kingston Canyon. For the early homesteaders that settled in the valley, raising potatoes and livestock proved fruitful, thanks to plentiful water from the Sevier River. Farms and ranches still dot the area, carrying on the traditional roles of their ancestors.

Visitors now use the Kingston Canyon portion of the Sevier River for kayaking and rafting while enjoying the scenic rock formations that form the canyon walls, while Piute Reservoir is noted for its trout fishing waters and providing winter habitat for ducks and geese.

Land Ownership

Circleville, Utah was the first established town within the Upper Sevier River Watershed, and is the largest town in Piute County. Settled in 1864, water from the Sevier is still diverted today for ranching and irrigation much in the same manner as when the town was first established.

The majority of private lands (26,526 acres) within the watershed are centered around the town of Circleville. Bureau of Land Management lands are located adjacent to private lands and encompass 59,525 acres. State land parcels (8,944 acres) are scattered throughout the watershed. The City Creek Watershed contains only 64,992 acres of Forest Service lands (Fig. 4-27, Fig. 4-28).

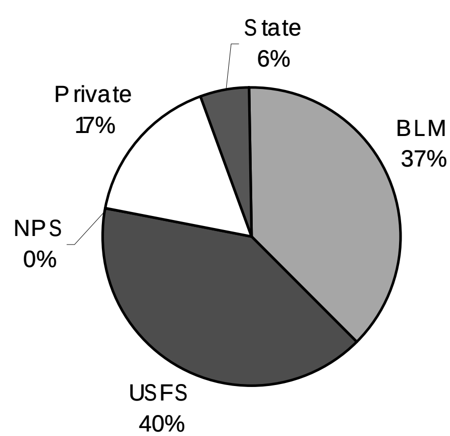


Fig. 4-27. Bureau of Land Management lands and U.S. Forest Service lands make up a large portion of the City Creek Watershed and eight subwatersheds.

Vegetation Types

Pinyon-juniper woodlands (88,676) and sagebrush/grasslands (17,958 acres) dominate much of the watershed, with only small areas of aspen (2,312 acres), grass/forb (2,361 acres), and mixed conifer (2,349).

City Creek Subwatersheds	Acres
Birch Creek-Sevier River	19987
Burnt Hollow-Sevier River	19108
Chokecherry Creek-Sevier River	19963
City Creek	15956
Cottonwood Creek	15970
Echard Creek	15898
Lost Creek	23009
Piute Reservoir	29095
Total	158986

Table 4-16. The eight City Creek Subwatersheds comprise a total of 158986 acres.

Ponderosa Pine (14,317) and spruce/fir (12,294) are found at higher elevations within the watershed (Table 4-17, Fig.4-29).

The watershed contains an abundance of mature vegetation in both the pinyon-juniper and sagebrush communities, which has suppressed understory plant species and contributed to erosion processes. Aspen is currently declining within the watershed, while noxious weeds continue to increase.

Elevation, Roads & Streams

The Sevier River is one of the most utilized rivers in the United States. Diversion of water in the basin began in the late 1800's and continues today. In the City Creek Sevier River portion of the watershed, the river provides irrigation water for farms and ranches, opportunities for fishing and recreation, and drinking water. These past and present uses, along with natural-occurring events, help shape the river we see today and are the basis for much of the land settlement within the watershed.

Vegetation Type	Acres	%
Agriculture	10853	7%
Aspen	2312	1%
Grass/Forb	2361	1%
Mixed Conifer	2349	1%
Mountain Shrub	3119	2%
Pinyon/Juniper	88676	56%
Ponderosa Pine	14317	9%
Sagebrush/Grass	17958	11%
Spruce/Fir	12294	8%
Urban	339	0%
Other	4408	3%
Total	158986	100%

Table 4-17. The City Creek Watershed contains the largest percentage of agricultural lands within the Upper Sevier River Basin. In addition, much of the public land within the watershed is grazed by area ranchers.

Highway 62 and Highway 89 intersect just south of Junction and west of Kingston (Fig. 4-30). The watershed is bounded by the Tushar Mountains on the west and Mount Dutton on the south-east. The recent paving of portions of Highway 62 across the City Creek Sevier River Watershed and Lower East Fork Sevier River Watershed has increased travel and use in areas along this corridor.

Agriculture is an integral part of the Upper Sevier River's history. Agricultural lands and pastures dot the landscape throughout the watershed.

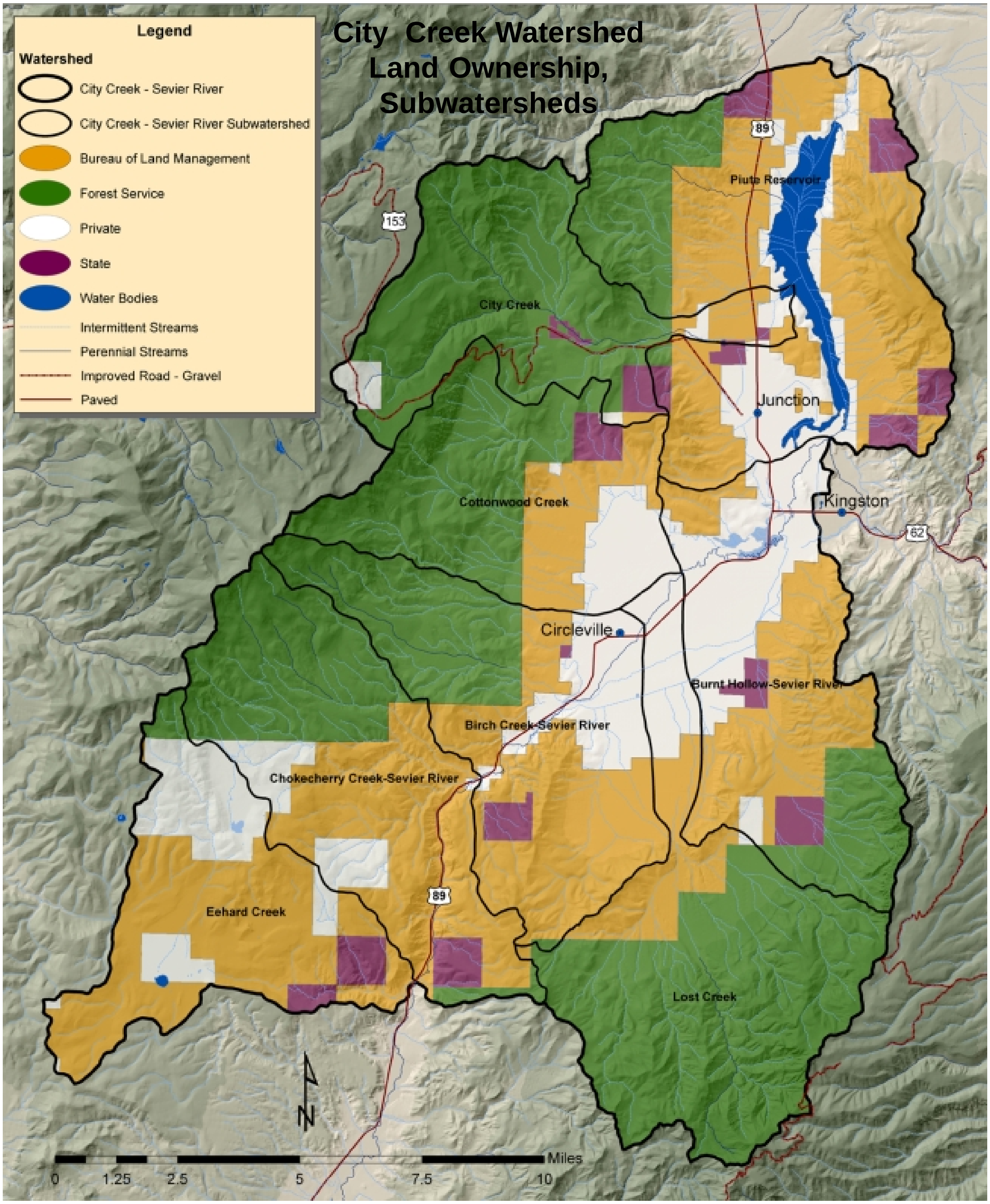


Fig. 4-28. The town of Circleville was one of the first established areas within the Upper Sevier River Watershed. Today, small rural communities exist up and down the Sevier River.

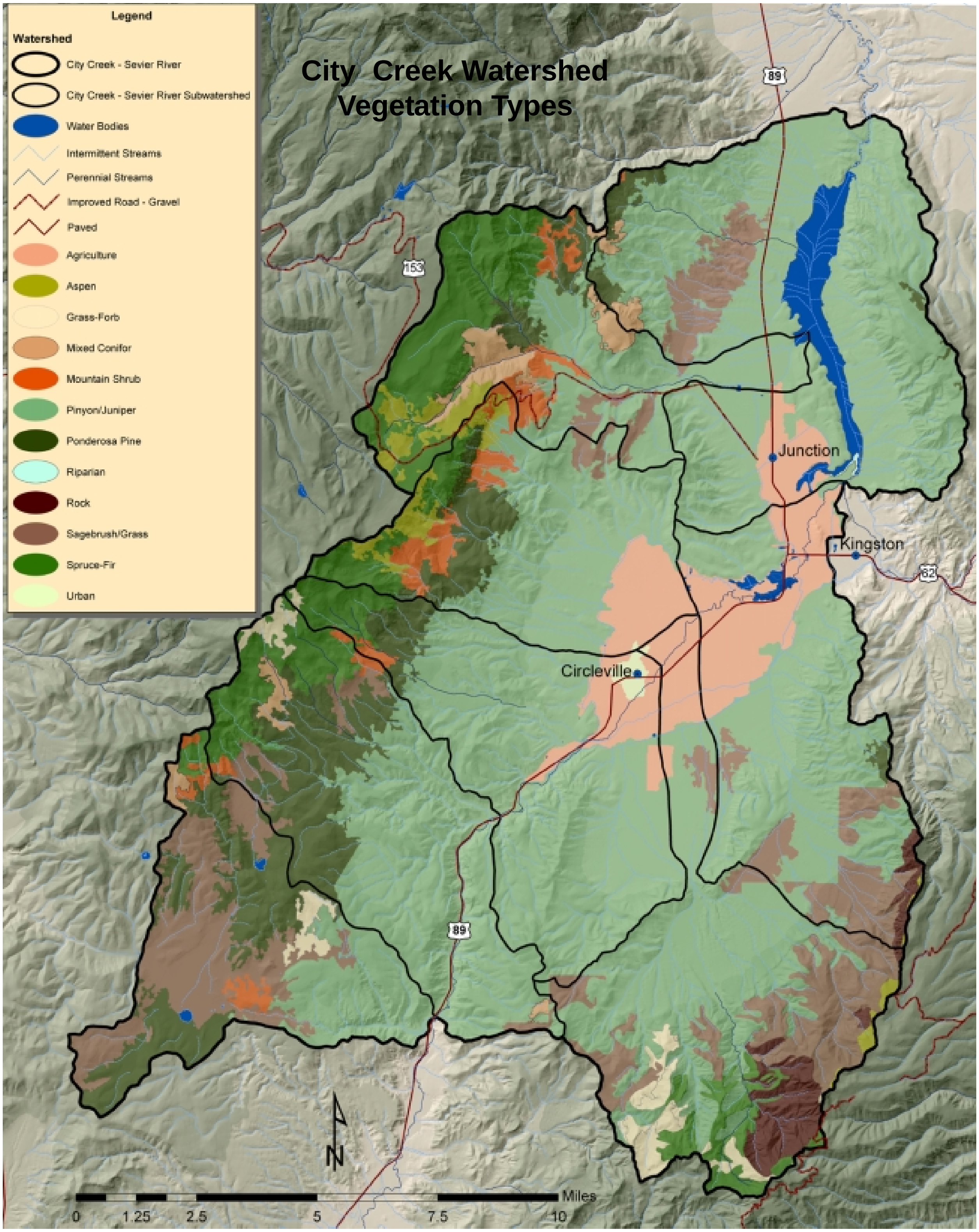


Fig. 4-29. The pinyon-juniper woodlands and sagebrush/grasslands that dominate the majority of the City Creek Watershed once occupied less area. Grazing and lack of fire have changed the species composition within these vegetation types.

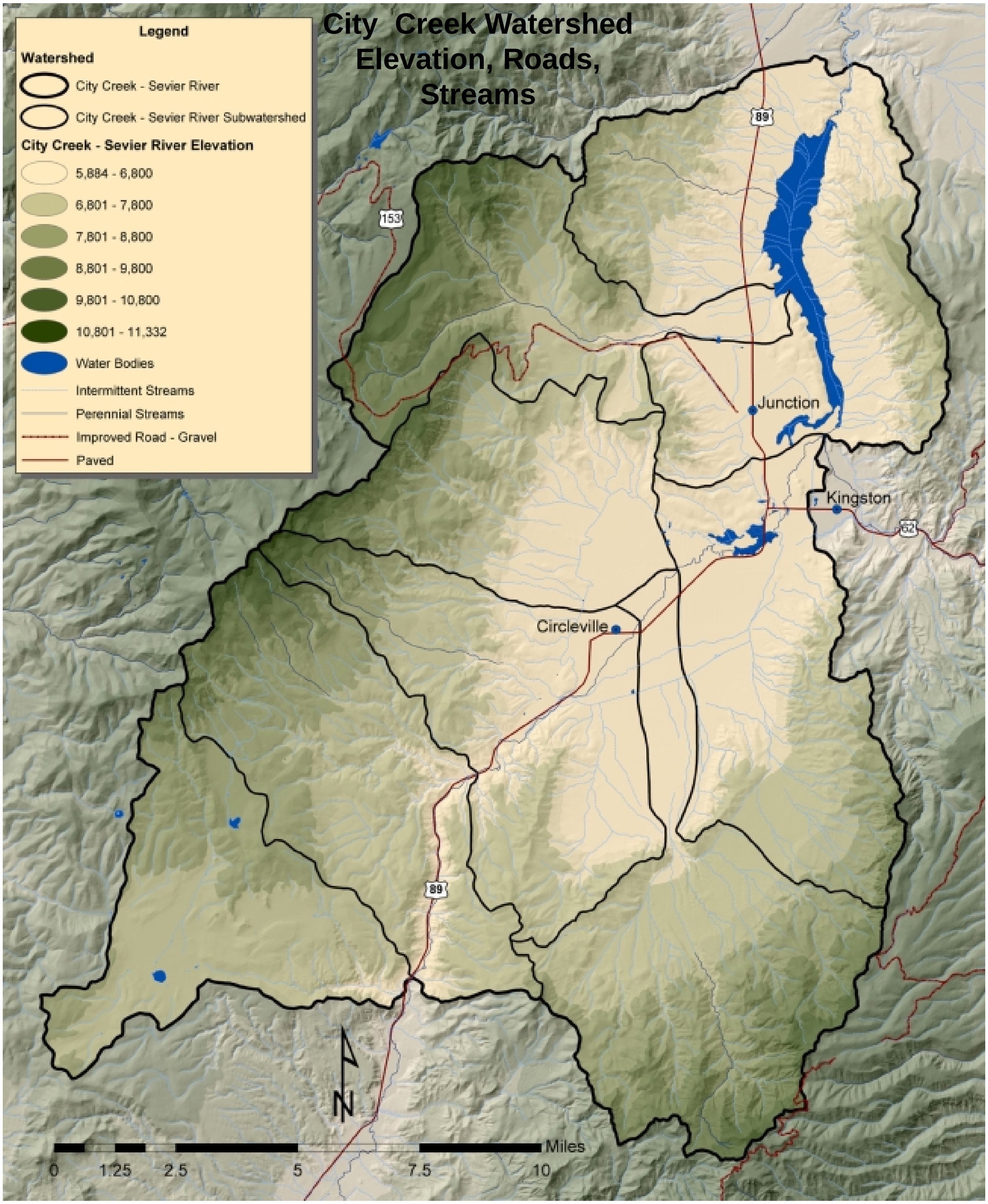


Fig. 4-30. Many of the routes established today were once used by pioneers to move cattle and supplies from areas along the I-15 corridor. The lower elevations within the watershed are used for farming and recreational use.

Key Issues

Key issues identified for the City Creek Watershed are: 1) Accelerated Erosion; 2) Access Management; 3) Aspen/Spruce-Vegetation Composition; 4) Enhancement/Protection of Deer Habitat; 5) Enhancement/Protection of Sage Grouse Habitat; 6) Pasture Management; 7) PJ, Sagebrush/Grassland-Accelerated Erosion, Vegetation Composition, Fuel Conditions; 8) Water Conservation Concerns. (Figure 4-31). (Other issues and ratings within the City Creek Watershed are listed in Table 4-18).

1. Accelerated Erosion

Current Conditions, Patterns and Trends

Heavy recreation and grazing use in the Dog Valley, Birch Creek and City Creek areas within the City Creek Watershed are contributing to stream degredation. High road densities and their proximity to streams are contributing to increased runoff and sediment transport, decreasing soil stability and removing riparian vegetation buffers. Many streams show increased bank erosion, resulting in decreased water quality and fisheries habitat.

Reference Conditions, Patterns and Trends

Expansive and diverse riparian grasses, along with willow and cottonwood complexes, were present prior to changes in water management in the 1880's. Concentrated grazing impacts historically removed much of the streamside vegetation; however, grazing practices today continue to improve. Very few roads and trails or dispersed recreation existed along riparian areas, with little or no streambank utilization, and until recently there were no off-road impacts from recreational vehicles. Natural erosion rates were thought to occur within the watershed.

Lack of riparian vegetation along the Sevier River exacerbates erosion and stream degredation.

Natural/Human Causes of Change Between Current/ Reference Conditions

Increased recreational use of roads and riparian areas, more off-road vehicle use, and past grazing practices have decreased riparian vegetation diversity, accelerated upland erosion, and decreased aquatic habitat.

2. Access Management

(Note: This issue was identified by the Human Uses TAC committee, even though it was recognized as low priority in this watershed. However, the overall trend of increased off-road vehicle use, with accompanying increased impacts, warrants its inclusion in this section).

Current Conditions, Patterns and Trends

High road densities along stream channels, with an increase in ATV use and dispersed camping, occur throughout many portions of the watershed. Increased sediment transport, degraded stream conditions, lack of riparian vegetation, and damage to adjacent upland areas through increased access are of some concern. ATV use on the Piute and Fremont ATV trails continues to increase (approximately 3000/yr.), further impacting adjacent lands. Use of ATV's on public lands overall has also increased, especially from local residents who may utilize vehicles both for recreation and during ranching activities. In some areas, old roads which were almost completely obliterated have been re-opened as ATV trails, because of increased ATV use.

Unlimited access and trash disposal may degrade riparian and upland areas.

Reference Conditions, Patterns and Trends

Available roads have traditionally been used for harvesting timber, with less camping and recreating on public lands than is currently occurring. Few resource and user conflicts occurred from these types of activities, with little or no damage to riparian and upland vegetation. Roads and trails were adequate for needed uses.

Natural/Human Causes of Change Between Current/ Reference Conditions

Increased recreational use of roads, riparian and upland areas, with more off-road vehicle access, has decreased vegetation diversity, accelerated upland erosion, and reduced riparian vegetation and aquatic habitat. Previously designed roads, although adequate for historic uses, are considered inadequate for current uses, and need to be redesigned, engineered and maintained.

Spruce trees are currently invading areas once dominated by aspen, and if left unchecked, will outcompete this vegetation component.

Note the additional road created as a short-cut around tall vegetation.

3. Aspen/Spruce – Vegetation Composition

Current Conditions, Patterns and Trends

Vegetational structural changes have occurred throughout much of the watershed, with an advance to more late successional, shade tolerant plant species. Mixed conifer and spruce-fir have become evident within the City Creek Watershed, displacing much of the quaking aspen and migrating into grasslands, sagebrush and riparian areas. Early seral species, such as aspen, are old (ranging in age from 60 to 100 years) and lack structural diversity, with little or no understory vegetation. Fire potential and insect and disease activity have increased as a result of high tree densities.

Reference Conditions, Patterns and Trends

Stands included both multi and single storied vegetation types, with a mixed composition of vegetation. Most disturbances operated on a small scale, except for bark beetle outbreaks which operated on a landscape scale, possibly every several hundred years, and were followed by high intensity wildfires. Mixed severity fires (generally every 20 to 100 years) helped maintain vegetation mosaics and structure stages across the watershed and helped maintain aspen dominance by minimizing conifer encroachment. Typical stand structures consisted of multi-layered canopies with a range of tree sizes and species, providing habitat for northern goshawk, flammulated owl, wild turkey, large ungulates and several species of neotropical migratory birds.

Much of the remaining aspen within the City Creek Watershed is old, with little or no regeneration occurring.

Natural/Human Causes of Change Between Current/ Reference Conditions

Grazing has reduced accumulations of fine fuels (shrubs and herbaceous layers), resulting in fewer fire starts and smaller fires, and has also contributed to the reduction and elimination of young aspen regrowth. Additionally, fire exclusion efforts have reduced vegetation diversity.

4. Enhancement or Protection of Deer Habitat

Current Conditions, Patterns and Trends

Deer are the most abundant big game species on and adjacent to Forest Service lands and can be found in most habitat types within the watershed. Deer currently serve as a management indicator species for the Dixie and Fishlake National Forests, partly because the distribution of forage, cover and other habitat factors required to maintain healthy populations also ensure provision of habitat requirements for many other wildlife species, including sensitive species such as sage grouse, goshawk, flammulated owl, three-toed woodpecker, Utah prairie dog and peregrine falcon. Deer are also a high-visibility species, both from a recreational hunting standpoint, and as a potential competitor to domestic livestock in rangeland and agricultural areas. Mule deer summer range habitat consist-

Pinyon-juniper has expanded into much of the historic deer winter and summer range.

ing of sagebrush/grassland types and mixed-conifer, aspen and ponderosa pine are found throughout the watershed; however high road densities, habitat fragmentation and loss of aspen understory may decrease available habitat areas. Dry range conditions, an increase in density of pinyon-juniper with little or no understory, and a subsequent loss of sagebrush/grasslands are negatively affecting deer populations. Historical year-round sage grouse habitat occurs within deer summer range habitat areas within the watershed.

Reference Conditions, Patterns and Trends

Extensive sagebrush/grassland areas once occupied portions of the City Creek Watershed. Periodic fire disturbance maintained vegetation diversity in the mixed conifer, aspen and ponderosa pine forest types, creating mosaics within the landscape. Limited use of the watershed from recreation vehicles, with little or no winter use, left most wildlife migration corridors undisturbed. Natural processes (spruce beetle epidemics, wildfire, etc) helped support habitat for other wildlife species.

Natural/Human Causes of Change Between Current/Reference Conditions

Increased human uses of roads and developments create more disturbance to deer in winter and summer, fragment habitats, interrupt migration corridors and reduce habitat effectiveness. Livestock grazing may play a role in eliminating tall forb communities, riparian habitats and degrading meadows, all of which deer depend on. Woodcutting has reduced snags and cover, while timber harvest has reduced large diameter ponderosa pine necessary for deer cover. Fire suppression efforts during the last 100 years have encouraged high stand densities, pinyon-juniper expansion and a decrease in sagebrush age diversity, degrading the quality of deer habitat.

5. Enhancement and Protection of Sage Grouse Habitat

(Note: The sage grouse population found within this watershed resides primarily in the Bear Creek Watershed, although a small portion falls within the City Creek Watershed. Enhancement and protection of sage grouse habitat, occuring in the northern portion of Echard Creek Subwatershed is considered high priority. Thus, a discussion on sage

grouse is included here, in City Creek Watershed

Current Conditions, Patterns and Trends

Sage grouse are currently listed on the Utah Sensitive Species List as a Species of Special Concern due to declining populations and limited distribution. Both active and historic sage grouse leks occur within the City Creek Watershed, with a viable population existing in the lower portion of the Echard Creek Subwatershed. Sage grouse populations are declining due to loss of sagebrush/grassland habitat from pinyon-juniper expansion and habitat fragmentation. Vegetation diversity in sagebrush grassland areas is lacking, and many areas have been converted into dense stands of exotic cheat grass. Where the quantity and quality of habitat has declined, sage grouse populations are vulnerable to excessive natural predation and chick survival remains low.

Sage grouse leks were once abundant throughout the City Creek Sevier River watershed. Now only a few historic leks remain.

Reference Conditions, Patterns and Trends

Historical records suggest that portions of all 29 counties in Utah once provided adequate habitat for sage grouse (Mitchell, 2001). Expansive sagebrush/grassland areas, maintained by periodic fire were present prior to Euro-American settlement. Large fragments of habitat have been lost to agriculture and urban development.

Natural/Human Causes of Change Between Current/Reference Conditions

Habitat loss, fragmentation and degradation are the main causes of population decline. Vegetation range, pattern, and structure have been further impacted through intensive grazing and fire suppression, allowing increased establishment of pinyon-juniper (displacing habitat on which sage grouse depend) and decreased grass and forb production.

6. Pasture Management

Current Conditions, Patterns, Trends

Grazing has been an integral part of lands within the City Creek Watershed since pioneers first settled the area around Hatch (~1872). Today's grazing practices are much better than those of the past: better pasture management increases productivity, maintains vegetation diversity, discourages native weed introduction, and leaves critical riparian areas intact. Effective pasture management practices include developing pasture management plans, rotating animals through pastured areas, limiting herd size, fencing livestock from riparian areas, maintaining browse species diversity, and leaving trees and shrubs within pastures and near stream banks.

Reference Conditions, Patterns and Trends
Prior to Euro-settlement, free-range grazing was limited to native animals such as deer and elk. Extensive grasslands, forbs and sagebrush/pinyon-juniper ecotypes, maintained by periodic fire, existed on many lower elevation sites within the City Creek Watershed. Abundant and diverse riparian grasses, willow and cottonwood occurred along stream channels. Loamy soils facilitated water run-off, reducing erosion and maintaining plant species diversity.

Natural/Human Causes of Change Between Current/Reference Conditions
Prior to 1950, driven by the desire to homestead and utilize an apparent abundance of natural resources, little or no management occurred. Pasture management was first recognized in the 1950's, but is just beginning to be seen as a means to increase productivity, while minimizing destruction to rangelands and riparian areas.

7. PJ, Sagebrush-Grasslands – Accelerated Erosion, Vegetation Composition, Fuel Conditions

Current Conditions, Patterns and Trends
Pinyon-juniper encroachment into historic sagebrush/grassland communities has reduced groundcover, decreased grassland species diversity, eliminated portions of prime mule deer and livestock winter range and increased wildfire risk in areas of high pinyon-juniper densities. In addition, many sagebrush areas are decadent, with even age classes of old individuals and excessive crown canopies. Sheetwash erosion has increased due to little understory vegetation to help retain soil.

Reference Conditions, Patterns and Trends
Pinyon-juniper historically occupied rocky edges, outcrops and slopes within the watershed. Periodic, low intensity fires (10 to 30 years) helped maintain pinyon-juniper density and diversity, while preventing encroachment into other vegetation types.

Rabbitbrush and pinyon-juniper dominate areas around Piute Reservoir.

Mixed age classes of sagebrush with less than 15% canopy cover were dominant prior to Euro-American settlement, and probably dominated the watershed. Patchy vegetation patterns, with several age and canopy classes of sagebrush and grasses were present and maintained by periodic fire, which occurred approximately every 20-40 years.

Natural/Human Causes of Change Between Current/Reference Conditions

Competition for available moisture and high ungulate use has substantially reduced the grass/forb component in mature and old, dense pinyon-juniper stands. Pinyon-juniper distribution has also increased because of recent fire suppression efforts. Chainings were conducted in the 1960's and 1970's on private, U.S. Forest Service and BLM lands to promote grass-forb communities; however, lack of additional disturbance has allowed pinyon-juniper to re-establish on these sites.

8. Water Conservation Concerns

Current Conditions, Patterns and Trends

Agriculture continues to be an important economic industry within the City Creek Sevier River Watershed. Today, water dispersal methods and application rates could be improved with more efficient water delivery systems. Current drought conditions in the western United States, as well as an increased demand to meet water quality and application standards, necessitate that water loss be minimized through practices such as lining irrigation ditches, land leveling and more efficient sprinkling systems.

Reference Conditions, Patterns and Trends

While agriculture has been conducted within the watershed since the mid-1800's, the watering methods of today are more efficient. Prior to Euro-American settlement, natural flood plains existed throughout the lower elevations within the watershed, maintaining large grassland areas.Water diversion for irrigation use has only occurred during the past 150 years.

Natural/Human Causes of Change between Current/Historic Conditions

Stream flows in some areas of the City Creek Watershed may be reduced because of the transition of aspen to subalpine fir in the upper reaches of the watershed. Increased use of water for commodity and recreational purposes has also altered natural flows and decreased water delivery throughout the area.

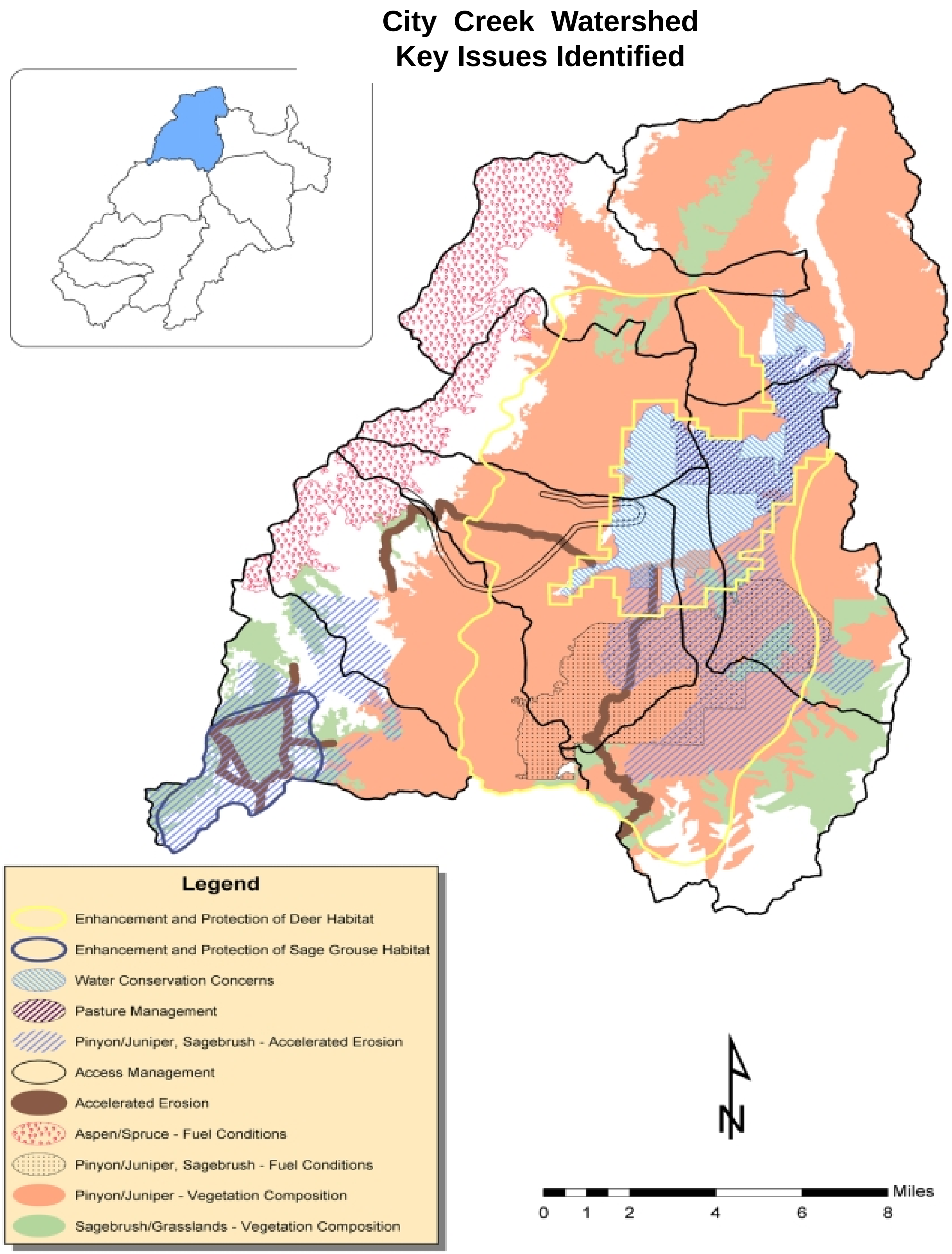


Fig. 4-31. The 8 key issues identified for the City Creek Watershed represent input from fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees.

	Piute Reservoir	City Creek	Cottonwood Creek	Birch Creek-Sevier River	Burnt Hollow-Sevier River	Chokecherry Creek-Sevier River	Echard Creek	Lost Creek	**Total for City Creek-Sevier River Watershed**
Hydrology/Water Quality									
Hydrology									
Dewatering and altered flow regimes	NA	L	H	M	H	M	M	NA	**M**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	H	M	H	M	M	NA	**M**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	M	L	M	NA	M	M	M	M	**M**
Hillslope Processes									
Accelerated erosion on high elevation meadows	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion in pinyon-juniper and sagebrush stand	M	M	M	M	M	M	M	M	**M**
Accelerated erosion associated with urban development	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion associated with roads	M	M	M	M	M	M	M	M	**M**
Rill and gully erosion on hillslopes	M	M	M	M	M	M	M	M	**M**
Accelerated erosion associated with illegal ATV use	M	M	M	M	M	M	M	M	**M**
Riparian Vegetation									
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	M	M	M	M	M	M	M	H	**M**
Water Quality									
Summer home development and associated impacts (I.e., Ground/Surface Water contamination, erosion, recreation, etc.)	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion, grazing management, recreation use, roads	M	M	M	M	M	M	M	M	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	M	H	L	L	L	NA	NA	NA	**L**
Channel Morphology									
Active channel adjustments (vertical or lateral)	M	M	M	L	L	L	L	M	**L**
Accelerated bank erosion	M	M	M	L	L	L	L	M	**L**
Channelization	NA	M	NA	NA	NA	NA	NA	NA	**L**
Agriculture									
Animal Feed Operations	H	L	L	M	L	NA	NA	L	**M**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	L	L	H	H	H	M	H	H	**H**
Pasture Mgt.	H	M	H	H	H	H	H	H	**H**
Fertilizer Usage and Impacts	M	M	H	H	H	NA	NA	H	**M**
Noxious Weeds	M	L	NA	M	M	L	L	M	**M**
Wildlife Management in Agricultural Areas	L	L	L	M	M	H	M	M	**M**

Table 4-18. Priority ratings for all eight City Creek subwatersheds, as identified by technical advisory committees. Issues highlighted in blue are addressed in detail in this chapter.

	Piute Reservoir	City Creek	Cottonwood Creek	Birch Creek-Sevier River	Burnt Hollow-Sevier River	Chokecherry Creek-Sevier River	Echard Creek	Lost Creek	**Total for City Creek-Sevier River Watershed**
Fire									
Communities at Risk	L	L	L	L	L	L	L	L	**L**
Fuel Conditions	L	M	M	M	L	L	M	M	**M**
Human Uses									
Development and Effects to Ground/Surface Water	M	L	L	M	L	L	L	L	**M**
Development and associated recreation uses to adjacent lands	L	L	L	M	L	L	L	L	**M**
Access Management	L	L	L	M	L	L	L	M	**M**
Developed and Dispersed Recreation	M	L	L	L	L	L	L	M	**M**
Vegetation									
Sagebrush - Grass	H	H	M	H	H	H	H	H	**H**
Aspen	NA	M	M	H	M	M	M	M	**M**
Grassland - Meadow	NA	NA	NA	NA	NA	L	L	L	**L**
Mixed Conifer - Mountain Fir	M	M	M	M	L	M	L	L	**M**
Oak - Mahogany - Mountain Shrub	L	M	M	H	L	M	M	L	**M**
Pinyon - Juniper	H	H	H	H	H	H	M	H	**H**
Ponderosa	L	M	M	M	NA	M	L	NA	**M**
Spruce - Fir	L	M	L	L	L	M	L	L	**M**
Tall Forb	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	H	NA	L	H	H	M	M	H	**H**
Wildlife									
Priorities for Enhancement or Protection of:									
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	L	NA	L	L	L	L	NA	L	**L**
Bald Eagle Habitat	M	L	L	L	L	L	L	L	**M**
Spotted Bat Habitat	L	L	L	M	L	L	L	M	**M**
Townsend's Big-eared Bat Habitat	L	L	L	M	L	L	L	M	**M**
Flammulated Owl Habitat	L	L	L	L	L	L	L	L	**L**
Three-toed Woodpecker Habitat	L	M	M	M	L	M	L	L	**M**
Northern Goshawk Habitat	L	M	L	L	L	L	L	L	**M**
Peregrine Falcon Habitat	L	L	L	M	L	L	L	M	**M**
Sage Grouse Habitat	NA	NA	NA	L	L	NA	H	NA	**L**
Turkey Habitat	L	M	L	M	L	L	L	M	**M**
Deer Habitat	L	H	H	H	H	M	M	H	**H**
Elk Habitat	L	L	M	M	M	M	M	H	**M**
Pronghorn Habitat	NA	NA	NA	L	NA	NA	L	NA	**L**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	L	L	L	L	L	L	L	M	**M**
Boreal Toad Habitat	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Bonneville Cutthroat Habitat	NA	NA	NA	H	NA	NA	NA	NA	**L**
Riparian Areas	L	L	L	H	M	L	L	M	**M**
Fisheries Habitat	L	L	L	H	L	L	L	L	**M**

Table 4-18 (cont). Priority ratings for all eight City Creek subwatersheds, as identified by Technical Advisory Committees. Issues highlighted in blue are addressed in detail in this chapter.

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UPPER EAST FORK WATERSHED

The Upper East Fork watershed, located in the southeastern most portion of the Upper Sevier River watershed, is part of the Paunsaugunt Plateau. Six subwatersheds, encompassing 187,493 acres represent a variety of land ownership and uses (Fig. 4-33), as well as vegetation types.

Points of interest within the watershed include Bryce Canyon National Park and Tropic Reservoir. Highway 12, recently named an All-American Road, traverses east-west across the watershed, and the campgrounds and scenic vistas along the route are popular stops for tourists from all over the world.

Land Ownership

Land ownership within the Upper East Fork is diverse, with State (15,991 acres), U.S. Forest Service (149,294 acres), Bureau of Land Management (232 acres), National Park Service (9,637 acres) and private lands (12,343 acres) (Table 4-19, Fig. 4-33). While U.S. Forest Service lands dominate in the upper portion of the watershed, private agriculture lands and state lands are found in the lower sections, near transportation corridors. Most of the water from the East Fork is diverted and used for irrigation for land near Tropic, Utah, located outside the Upper Sevier River watershed boundaries. Both sheep and cattle are grazed on portions of public land withinthis area.

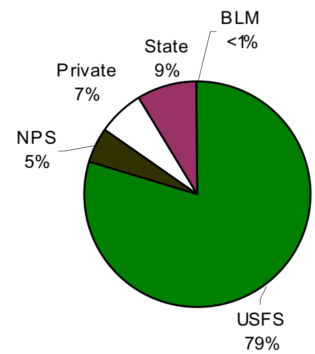


Fig. 4-32. The six subwatersheds within the Upper East Fork watershed are composed of state, federal, park service and private lands.

Upper East Fork Subwatersheds	Acres
Cameron Wash-East Fork Sevier River	23700
East Fork Sevier River Headwaters	30581
Hunt Creek	33989
Mud Spring Creek-East Fork Sevier River	45114
Showalter Creek East Fork Sevier River	31106
Tropic Reservoir	23230
Total	187720

Table 4-19. The 6 subwatersheds in the Upper East Fork Watershed make up 187720 acres.

Vegetation Type	Acres	%
Aspen	2787	1%
Grass/Forb	17590	9%
Mixed Conifer	29433	16%
Pinyon/Juniper	18361	10%
Ponderosa Pine	30346	16%
Sagebrush/Grass	56667	30%
Spruce/Fir	2940	2%
Other	29597	16%
Total	187720	100%

Table 4-20. Ponderosa pine and sagebrush are the dominant vegetation types in the Upper East Fork watershed.

Vegetation Types

Ponderosa pine forests, nestled among Claron (geologic feature) formation pinnacles and amphitheaters, provide uniqueness to the area (Table 4-20). Because of the high rate of erosion from soft sedimentary rocks, continual freeze-thaw cycles and summer thunderstorms within this higher elevation watershed, established vegetation plays an important role in soil stabilization. However, the unstable substrate and high evaporation rates result in fairly shallow vegetation root bases.

Aspen, mixed conifer, spruce-fir and sagebrush are also found throughout the watershed with sagebrush being the dominant vegetation type (Fig 4-34).

Elevation, Roads & Streams

The first road within the watershed was built by Ebenezer Bryce in the late 1800's to retrieve firewood and timber from the high plateaus of Bryce Canyon. Today this same route is part of Highway 63 to Bryce Canyon National Park, bringing over 1.5 million visitors annually to the park (Fig. 4-35).

Numerous ATV, bicycle, hiking and horesback trails, like the Straight Canyon Trail, are located within the scenic Upper East Fork watershed.

ATV enthusiasts as well as bicyclists, hikers and horseback riders also use this route to access portions of the Great Western ATV trail - a 1,737 mile-long byway crossing five states through federal, state and private land. The naming of Highway 12 as an All-American Road will likely influence the number of future visitors throughout this area.

Other improved roads in the area include the Tom Best Springs Road, which intersects Highway 12 and journeys northeast to the historic Widstoe settlement and connects with Highway 63.

The highly erosive Claron formation soils and weather have carved the unique canyons and amphitheaters that make up Bryce Canyon National Park and much of the surrounding area. Arches, carved by water run-off, are abundant in the Upper East Fork Sevier River watershed.

Recreation use within the Upper East Fork continues to increase, via an improved road which runs south and parallel to the East Fork Sevier River.

Located on the northernmost point of the watershed, Adams Head Peak (elev. 10,426) is one of the survey points used by Major John Wesley Powell's expedition in the 1800's. Agriculture and tourism remain the primary economic industries along John's Valley and the lower portions (elev ~7,500) of the Upper East Fork Watershed (Fig. 4-35).

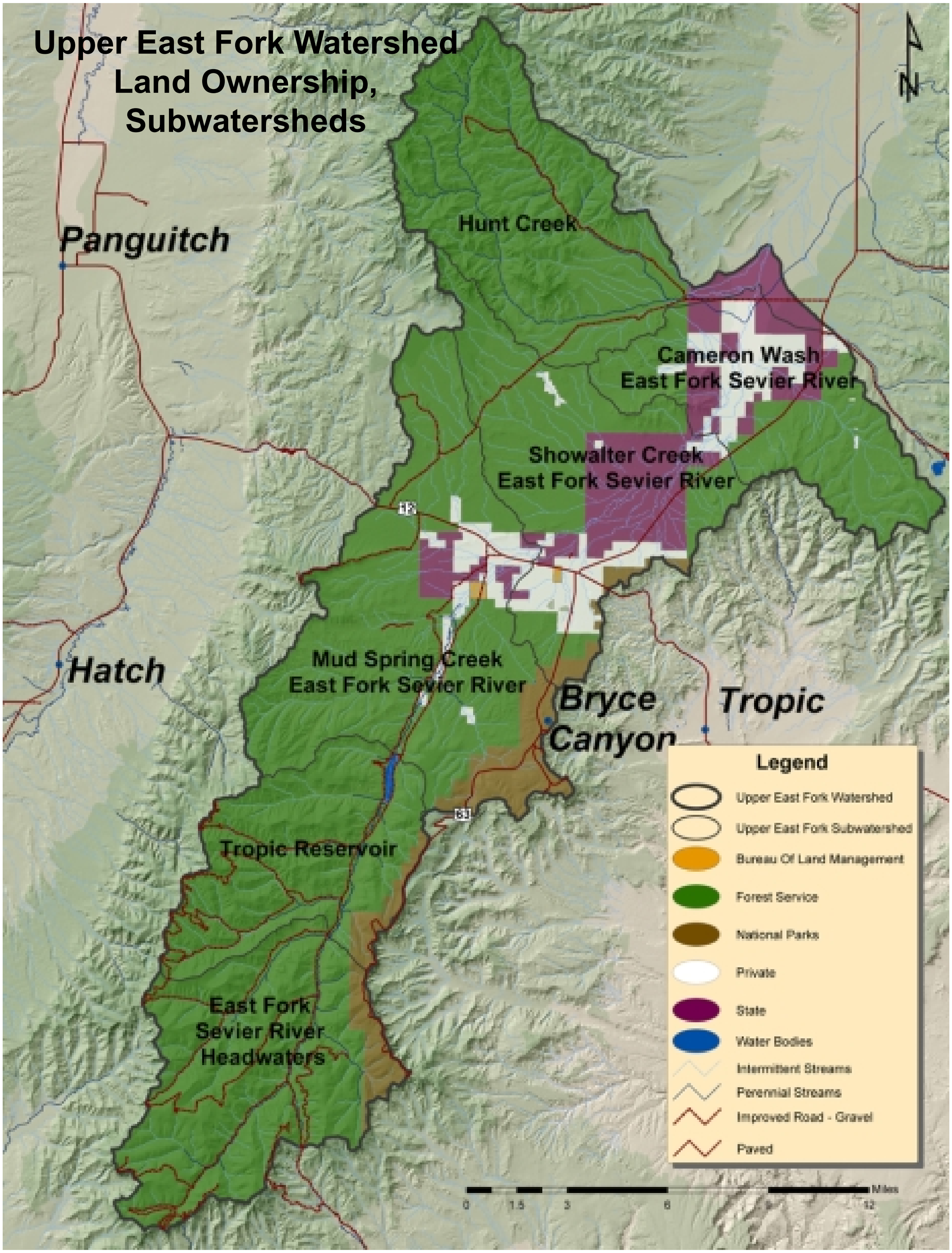


Fig. 4-33. The six subwatersheds that make up the Upper East Fork watershed are dominated by forested lands. The lush ponderosa pine forests and proximity to Bryce Canyon National Park make this a popular destination spot for outdoor enthusiasts.

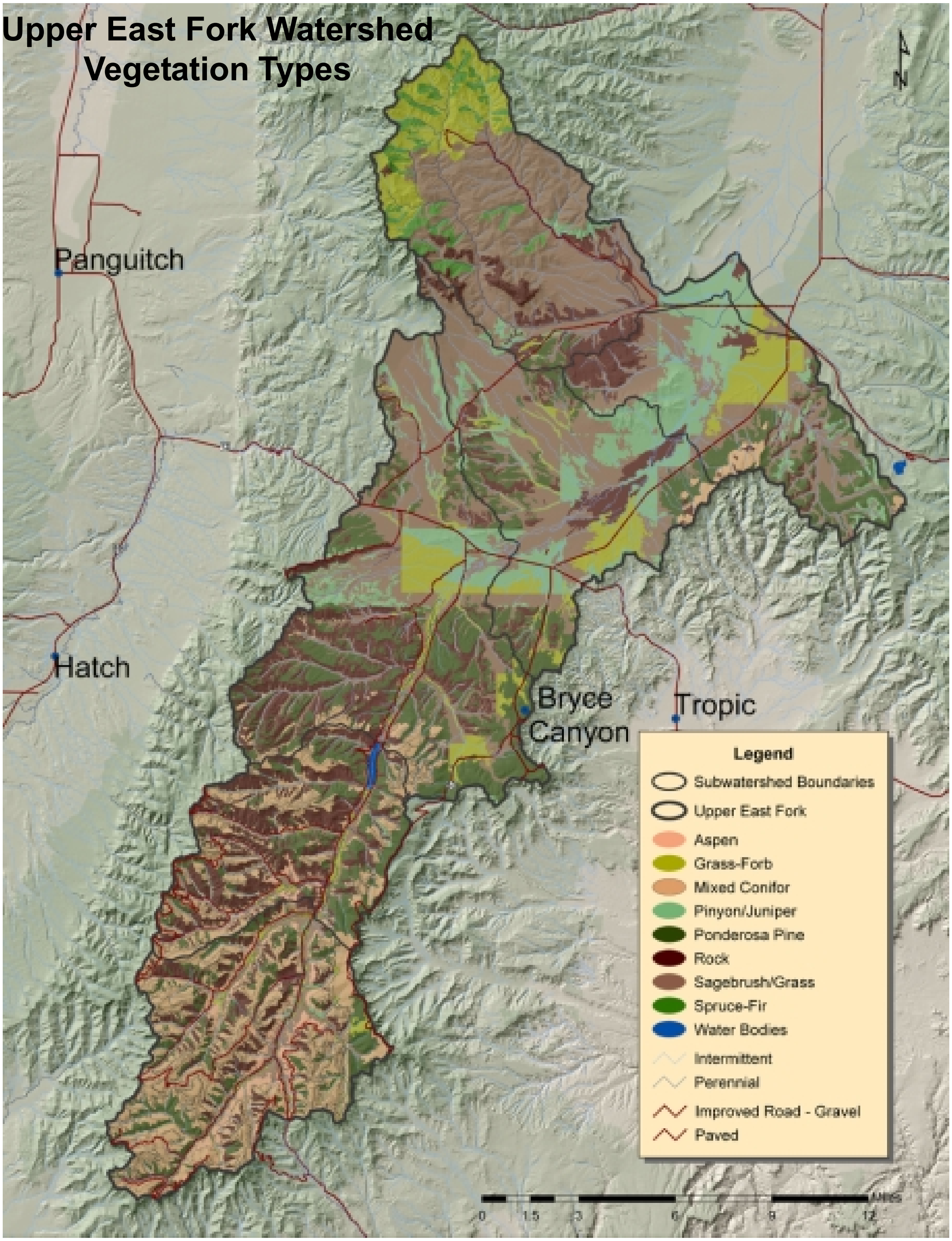


Fig. 4-34. The Upper East Fork watershed supports the largest population of ponderosa pine within the Upper Sevier River watershed. The distinctive soils and vegetation in this area are homes to such unique organisms as boreal toad, beaver, flammulated owl, northern goshawk, Utah prairie dog, as well as mule deer, Rocky Mountain elk and antelope.

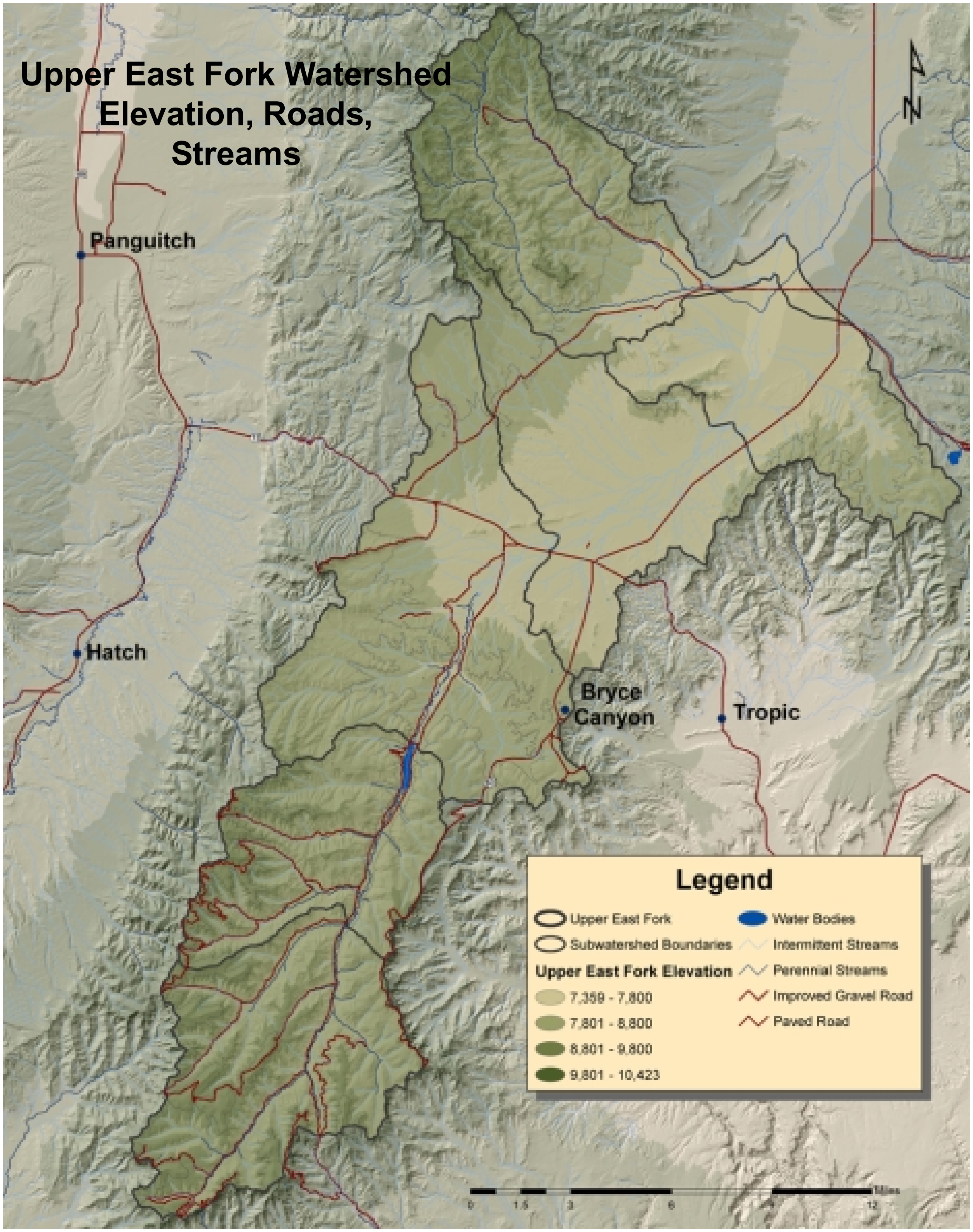


Figure 4-35. Two major highways support over 1.5 million tourists annually that visit Bryce Canyon National Park, or travel enroute to other area National Parks.

Key Issues

Key issues identified for the Upper East Fork Watershed are: 1) Accelerated Erosion; 2) Access Management; 3) Communities at Risk to Wildfire; 4) Decrease in Historic Aspen Stands - Fuel Conditions; 5) Development and its Effects to Ground Water; 6) Enhancement or Protection of Riparian Habitat; 7) Wildlife Management in Agricultural Areas/ Enhancement or Protection of Utah Prairie Dog Habitat; 8) Shade Tolerant Vegetation - Fuel Conditions; 9) Noxious Weeds; 10) Sagebrush/Grassland Areas - Vegetation Composition. (Fig. 4-36). (Other issues and ratings within the Upper East Fork Watershed are listed in Table 4-21).

1. Accelerated Erosion

Current Conditions, Patterns and Trends

Very little bank stability exists in the East Fork Sevier River, Tropic Reservoir, Hunt Creek and Cameron Wash subwatersheds and is contributing to unnatural flow regimes. Many streams have been dewatered, and/or diverted, and lack native riparian vegetation such as willow and cottonwood.

Reference Conditions, Patterns and Trends

Expansive and diverse riparian grasses, along with willow and cottonwood complexes, were present prior to changes in water management in the 1880's. Large populations of beaver in the headwaters also helped maintain natural stream flows and helped reduce sediment transport. Very few roads and trails or dispersed camping existed along riparian areas, with little or no stream bank utilization and thus little or no streambank erosion.

Natural/ Human Causes of Change Between Current/Reference Conditions

Development of irrigation systems has greatly impacted riparian areas by dewatering and altering stream flows. Currently, dispersed camping and road building in some areas have increased sediment flow, compacted soils, removed vegetation, and altered natural flow regimes. Changes in upland vegetation composition have also increased sediment transport into the watershed, further altering streambank stability. Accessibility of riparian areas to livestock has compacted soils and removed critical streamside vegetation.

2. Access Management

Current Conditions, Patterns and Trends

High road densities along stream channels, with an increase in ATV use and dispersed camping, occur throughout much of the watershed. Increased

Accelerated erosion occurs throughout much of the watershed, increasing downstream sediment transport.

sediment transport, degraded stream conditions, lack of riparian vegetation, and damage to adjacent upland areas through access management are of special concern, with an increasing amount of illegal ATV use noted.

Reference Conditions, Patterns and Trends

Highly erosive soils, coupled with high road densities, are responsible for much of the erosion in riparian and upland areas.

Historically, available roads were used for harvesting timber, with less camping and recreating occurring in riparian areas. Few resource and user conflicts occurred from these types of activities, with little or no damage to riparian and upland vegetation. Roads and trails were adequate for needed uses.

Natural/Human Causes of Change Between Current/ Reference Conditions

Increased recreational use of roads and riparian areas, with more off-road vehicle access, has decreased vegetation density and diversity, accelerated upland erosion, and reduced condition of riparian vegetation and aquatic habitat. Poorly designed, engineered and maintained trails (although adequate for historic uses) today introduce high amounts of sediment into aquatic ecosystems, further degrading nongame and recreational fishery opportunities.

3. Communities at Risk to Wildfire

Current Conditions, Patterns and Trends

Communities along the Highway 12 corridor, especially near Ruby's Inn and Bryce Canyon, are at increased risk to wildfire. Fire regimes of frequent, small intensity fires have been altered from historic conditions and the risk of losing key ecosystem components as well as community structures remains high. Ponderosa pine forests have changed from open, park-like areas with scattered, large trees to thick stands with dense thickets of small diameter trees, which are at risk of burning due to high amounts of fuel accumulations. Understory forbs and grasses are dominated by pinyon-juniper and decadent sagebrush and shrubs.

Reference Conditions, Patterns and Trends

Frequent small intensity fires in ponderosa pine ecotypes, helped reduced fuel accumulations, while maintaining structural diversity and minimizing tree density. In the absence of ground litter, and more open canopy, grasses and forbs were also maintained, serving as importing soil stabilizers. Communities of black silver, mountain big sagebrush and big sagebrush occurred in pure or mixed stands, with fire as the major disturbance factor. Mosaics of sagebrush vegetation types supported populations of big game and upland game birds.

Natural /Human Causes of Change Between Current /Reference Conditions

Lack of fire, climatic changes and urbanization have all contributed to vegetation changes along the Highway 12 corridor. However, the increase in urban development in this area, and past fire exclusion efforts may increase high intensity wildfire potential in and around established areas.

4. Fuel Conditions - Decrease in Historical Aspen Stands

Current Conditions, Patterns and Trends

Many aspen stands within the drainage are old, (ranging in age from 60 to 100 years), and lack structural diversity. In pure mature aspen stands, the absence of some type of disturbance has resulted in old clones dying with no possible regeneration. Aspen are important components of a healthy ecosystem, providing cover and forage for a variety of wildlife and livestock, maintaining watershed conditions, enhancing soil productivity and providing aesthetically pleasing landscapes. Extensive aspen forests occur in the Tropic Reservoir and East Fork Sevier River subwatersheds.

Reference Conditions, Patterns and Trends

Productive and extensive aspen forests occurred throughout much of the Upper Sevier River Watershed, and are known as some of the most impressive aspen forests in the western United States. Historically fire return intervals (generally 20 to100 years) helped maintain aspen dominance by minimizing conifer encroachment and influencing stand diversity and composition (USFS, 1998).

Natural/Human Causes of Change Between Current/ Reference Conditions

Exclusion of fire, coupled with ungulate grazing, have contributed to a decline in the extent of aspen stands. Wildlife grazing has reduced accumulations of fine fuels (shrubs and herbaceous layers), resulting in fewer fire starts and smaller fires, and has also contributed

Extensive aspen forests once occurred throughout much of the Upper Sevier River watershed. Conifer encroachment threatens to replace many historic stands within the Upper East Fork.

to the reduction and elimination of young aspen regrowth. Stand replacing treatments have traditionally been too small in size and limited in distribution to effectively perpetuate quaking aspen and control densities of white, subalpine and Douglas-fir at the landscape and larger scales.

5. Development and Effects to Ground Water

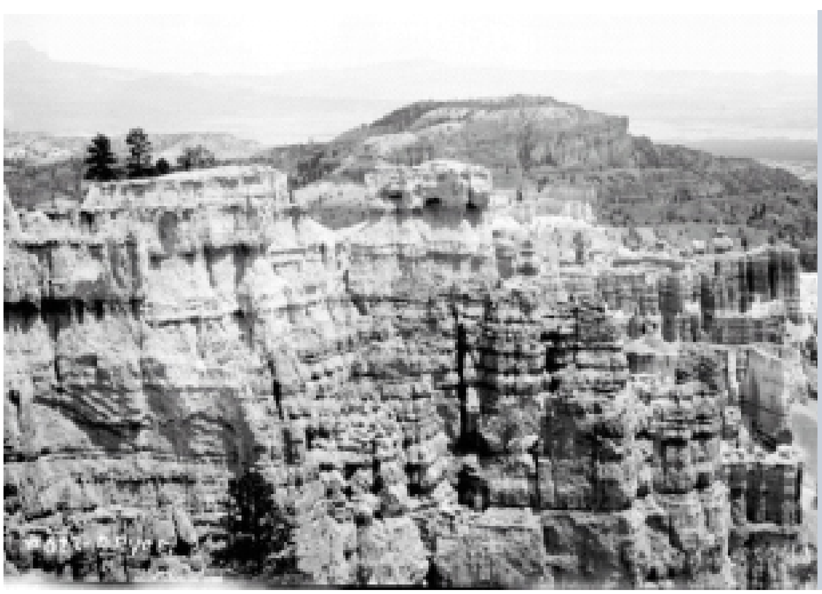
Current Conditions, Patterns and Trends

Current waste disposal systems and long-term sewage management are limited as more high-occupancy commercial developments and private property summer homes expand along the Highway 12 corridor, just outside of Bryce Canyon National Park. Improper waste disposal, both within developed and dispersed camping areas, continues to rise.

Numerous developments and tourist attractions have sprouted up around the entrance to Bryce Canyon National Park.

Reference Conditions, Patterns and Trends

When Bryce Canyon was designated as a National Park in 1928, few facilities existed, except for the park lodge. Traffic into and out of the park was shuttled from Cedar City



Although Bryce Canyon National Park still looks much the same as it did over 50 years ago, the area surrounding the park has changed, as more and more developments cater to the increasing number of tourists utilizing the area. (*Photo courtesy: R.D. Adams Collection, Ph.11 Special Collections Gerald R. Sherratt Library Southern Utah University Cedar City, Utah.*)

over an improved road. The rugged, but highly erosive country remained fairly untouched until tourism and recreation in National Parks became a national past time.

Natural/ Human Causes of Change Between Current/Reference Conditions

Human uses and developments continue to expand within the Upper East Fork Watershed. Existing hotels are growing, and new hotels are being built on private property near the park entrance, other developments include a newly developed shuttle system, privately owned campgrounds, more shopping and guided tours, and a new western town tourist attraction. Property purchases for commercial and personnel development continue to increase. The public's interest in national parks and associated attractions, continues to grow, with annual tourist projections at 1.5 million per year for Bryce Canyon. Expanded bicycle and ATV trails within the area attract tourists from all over the world, necessitating a greater need for properly managed waste disposal systems.

6. Enhancement and Protection of Riparian Habitat & Riparian Vegetation Composition

Current Conditions, Patterns and Trends

In the Upper East Fork Watershed, riparian shrubs and trees, such as willow and cottonwood, are lacking or consist of very old, decaying plants, with little or no regeneration or plant diversity. Wildlife, especially birds associated with riparian areas, are currently declining. In the Hunt Creek area, decadent cottonwood and willow galleries and/or young age classes occur, with little or no riparian grasses. Cameron Wash, Showalter Creek, Mud Springs Creek Subwatersheds have little or no cottonwood, willow or riparian grasses, and where present, lack diversity and vigor. Riparian areas in the Tropic Reservoir and East Fork Sevier Subwatersheds are dominated by mid-seral grass species, such as Kentucky bluegrass, creating very little bank stability and contributing to unnatural flow regimes. Many critical streams have been dewatered, and/or diverted. Amphibian and fishery populations, reliant on quality riparian habitat, have declined or been eliminated from the watershed. Of special concern are isolated populations of Arizona Willow (*Salix arizonica*), a regional sensitive plant species, and declining amphibian species, such as

In riparian areas along the Upper East Fork that still have vegetation, grasses dominate, with few native woody plant species present.

Boreal Toad (*Bufos bureas boreas*), located in the Upper East Fork Sevier River headwaters.

Reference Conditions, Patterns and Trends

Multi-age class cottonwood galleries and dense, diverse age-class willow complexes were present throughout the watershed prior to changes in water management in the 1880's. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported natural flow regimes. Large populations of beaver in the headwaters also helped maintain natural stream flows. Numerous bird and amphibian species frequented or depended on large expanses of riparian habitat.

Natural/Human Causes of Change Between Current/Reference Conditions

Irrigation systems within the watershed have greatly impacted riparian areas. Grazing practices and previous attempts at dryland farming have resulted in a vegetation change to rabbitbrush as the dominant plant species. Currently dispersed camping and road building in riparian areas have increased sediment flow, compacted soils, removed vegetation, and altered natural flow regimes. Elimination of beaver in historic areas has also reduced and altered stream flows, negatively affecting streamside vegetation survivability. Removal of willow to increase stream flow by decreasing plant water use (a common, but erroneous practice in the mid-50's), left many areas devoid of riparian vegetation, and at risk to invasion by non-native plant species.

Relocating prairie dogs onto public lands and restoring desired habitat within the Upper East Fork watershed is a high priority for wildlife management personnel.

7.Wildlife Management in Agricultural Areas & Enhancement or Protection of Utah Prairie Dog Habitat

Current Conditions, Patterns and Trends

Utah prairie dog was listed as endangered under the Endangered Species Act of 1973 as amended, due to a decline in colony size and numbers. The status was changed to "threatened" in 1984, where it currently remains. Many of the remaining endemic populations of

Utah prairie dog are found on private lands within southwest Utah, although some re-established populations are located on state and federal lands within the Upper East Fork Watershed. Maintaining some populations on private lands is deemed necessary until long-term relocation efforts onto public lands are more successful. Prairie dogs are considered an agricultural pest and are unwanted inhabitants of cultivated lands. Permits are currently issued by the Utah Division of Wildlife Resources to reduce populations on private lands, but population expansion to these areas continues to create numerous conflicts. Potential prairie dog habitat occurs throughout most of the watershed.

Reference Conditions, Patterns and Trends

Prior to 1920, Utah prairie dogs dominated areas within Pine and Buckskin Valleys in Beaver and Iron counties, as far North as Nephi, south to Bryce Canyon National Park and east to the foothills of the Aquarius Plateau. The main concentrations of colonies now occur only in east Iron County and along portions of the East Fork and the main stem of the Sevier River. The presence of well-drained, deep soils in the Upper East Fork Valley, with abundant grass/forb complexes, provided ideal prairie dog habitat. These highly valued land areas also provide ideal growing conditions for agricultural crops.

Natural/Human Causes of Change between Current/Reference Conditions

Past poisoning campaigns, decreases in grass/forb type plant communities, pinyon-juniper expansion, and the introduction of a deadly plague have reduced prairie dog numbers and colony size. Agricultural expansion on private lands, coupled with decreased forage availability on public lands, may encourage prairie dogs to utilize the most readily-available habitat, sometimes on or near cultivated lands. Exclusion of fire has resulted in pinyon-juniper encroachment into sage/grass areas, while historic grazing practices have contributed to a loss in species diversity and accelerated erosion within prairie dog habitat. Reseeding with non-native plant species, such as smoothe brome has reduced vegetation diversity and forage plant species diversity within historic prairie dog ranges.

Sagebrush and grasslands are decreasing because of pinyon-juniper expansion. In the Upper East Fork area, critical wet meadow areas are re-establishing with pinyon-juniper, increasing soil erosion, and decreasing riparian vegetation diversity.

8. Fuel Conditions - Shade Tolerant Vegetation

Current Conditions, Patterns and Trends

Vegetational structural changes have occurred throughout much of the watershed, with an advance to more late successional, shade tolerant plant species. Mixed conifer and spruce-fir components are more evident within the landscape and are migrating into grasslands, sagebrush and riparian areas. Stands of early seral species, such as aspen, are old, ranging in age from 60 to 100 years, and lack structural diversity, with little or no understory vegetation. Increased tree density within the mixed-conifer and spruce-fir types has resulted in an increase in insect and disease activity.

Reference Conditions, Patterns and Trends
Historically fire return intervals (generally 20 to100 years) helped maintain aspen dominance by minimizing conifer encroachment and influencing stand diversity and composition (USFS, 1998). Typical stand structures consisted of multi-layered canopies with a range of tree sizes and types, providing excellent habitat for northern goshawk, flammulated owl, wild turkey, large ungulates and several species of neotropical migratory birds.

Natural/Human Causes of Change Between Current/Reference Conditions
Exclusion of fire and ungulate grazing have contributed to a decline in the extent of aspen stands and a subsequent increase in more shade tolerant plant species. Wildlife grazing has reduced accumulations of fine fuels (shrubs and herbaceous layers), resulting in fewer fire starts and smaller fires, and has also contributed to the reduction and elimination of young aspen. Stand replacing treatments have traditionally been too small in size and limited in distribution to effectively perpetuate quaking aspen and control densities of white, subalpine and Douglas fir at the landscape and larger scales.

Canada thistle, one of the many noxious weeds found throughout the Upper East Fork watershed, is often difficult to control once established.

9. Noxious Weeds
Current Conditions, Patterns and Trends
Noxious weeds are being introduced to the watershed at an alarming rate. Noxious weeds are introduced and spread by a variety of means, including in livestock hay and feed, on ATVs and other vehicles, and possibly via animals (both wild and domestic). Numerous small patches of noxious weeds are currently found along primary routes within the watershed, especially in and around Bryce Canyon National Park. Others have been introduced illegally and/or legally. Much of the general public remains unaware of their role in noxious weed dispersal and local laws are lenient in dealing with weed dispersal problems. An increase in noxious weeds may decrease rangeland values, destroy desired recreation areas and adversely impact riparian areas and other plant and animal communities. Numerous chemical control agents are available, but increased regulations limit their use, and are oftentimes ineffective for large, established populations of noxious weeds.

Although many biological controls are readily available, they too have limited use, especially when weeds have spread over a large area.

Reference Conditions, Patterns and Trends

Many noxious weeds were first introduced into the United States by Euro-American settlers, either intentionally (as ornamentals), or accidentally. Native plants have evolved in the absence of noxious weeds, in close relationships with other local plant and animal communities. Historically, noxious weed spread was slow or non-existent because of limited seed dispersal and the ability of native plants to outcompete exotic species.

Natural/Human Causes of Change between Current/Reference Conditions

Changes in land use in the past century have created open niches in which noxious weeds easily establish, while increased roads and trails further compound the problem. Today, noxious weeds outcompete native plants, and once established spread rapidly. Increased ATV and off-road use and stricter environmental chemical use regulations also contribute to this growing problem. Early detection of noxious weed outbreaks and education remain the most effective methods to prevent noxious weed establishment, and although education materials are available, much of the public remains unaware of this potential problem.

10. Vegetation Composition - Sagebrush/Grasslands

Current Conditions, Patterns and Trends

Excessive crown canopies with even age classes of decadent sagebrush have resulted in a major loss of understory species and an increase in bare ground area, especially in the Mud Springs, Showalter and Cameron Wash Subwatersheds. Black sage, important winter wildlife forage, currently dominates many sites where effective soil moisture is limited. Native grasses have been replaced with high densities of exotic species such as smooth brome and crested wheatgrass. Forbs are lacking throughout the watershed, with viable seed sources no longer available. Lack of vegetative cover and overland flow from rain is causing surface soil erosion and deposition into riparian areas. In some areas, where wildfires have occurred, sagebrush areas have regrown to rabbitbrush.

Reference Conditions, Patterns and Trends

Mixed age classes of sagebrush, with less than 15% canopy cover were dominant prior to Euro-American settlement. Patchy vegetation patterns, with several age and canopy classes of sagebrush and grasses were present and maintained by periodic fire, approximately every 20-40 years. Soil stability and productivity remained fairly intact, with little or no bare mineral soil exposed.

Natural/Human Causes of Change between Current/Reference Conditions

Exclusion of fire has resulted in pinyon-juniper encroachment into sage/grass areas, while historic grazing practices have contributed to a loss in vegetative species diversity and accelerated erosion within the watershed.

Upper East Fork Watershed
Key Issues Identified

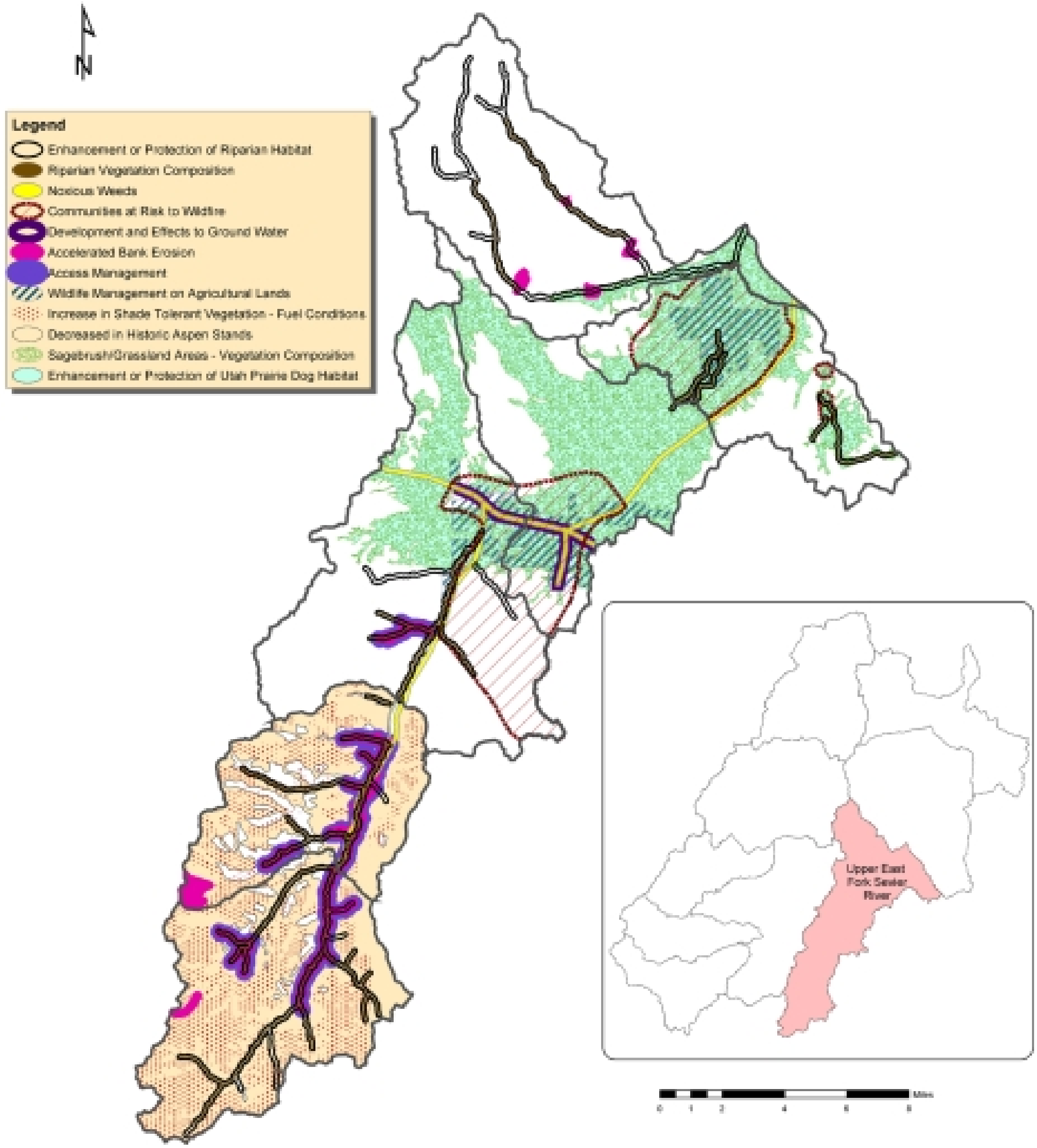


Fig. 4-36. The ten key issues identified for the Upper East Fork Watershed represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees.

	Hunt Creek	Cameron Wash - East Fork Sevier River	Showalter Creek - East Fork Sevier River	Mud Spring Creek - East Fork Sevier River	Tropic Reservoir	East Fork Sevier River Headwaters	**Total for Upper East Fork**
Hydrology/Water Quality							
Hydrology							
Dewatering and altered flow regimes	L	M	M	L	L	L	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	NA	NA	NA	NA	**NA**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	M	M	M	M	H	H	**M**
Hillslope Processes							
Accelerated erosion on high elevation meadows	NA	NA	NA	NA	NA	M	**L**
Accelerated erosion in pinyon-juniper and sagebrush stand	M	M	L	L	M	NA	**L**
Accelerated erosion associated with urban development	NA	NA	NA	L	NA	NA	**L**
Accelerated erosion associated with roads	M	H	M	M	H	H	**M**
Rill and gully erosion on hillslopes	NA	M	M	M	L	L	**L**
Accelerated erosion associated with illegal ATV use	NA	M	M	M	M	M	**M**
Riparian Vegetation Composition							
Lack of healthy composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	M	H	H	H	H	**H**
Water Quality							
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion, grazing management, recreation use, roads	M	M	L	M	H	H	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	M	L	L	M	H	H	**M**
Channel Morphology							
Active channel adjustments (vertical or lateral)	H	M	M	H	H	M	**M**
Accelerated bank erosion	L	M	M	L	H	M	**M**
Channelization	L	NA	NA	L	L	L	**L**
Agriculture							
Animal Feed Operations	NA	L	L	NA	NA	NA	**L**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	NA	L	L	L	NA	NA	**L**
Pasture Mgt.	NA	L	L	L	L	L	**L**
Fertilizer Usage and Impacts	L	L	L	NA	NA	NA	**L**
Noxious Weeds	L	H	H	H	H	H	**H**
Wildlife Management on Agricultural Lands	H	H	H	H	H	H	**H**

Table 4-21. Priority ratings for all six Upper East Fork subwatersheds, as identified by technical advisory committees.

	Hunt Creek	Cameron Wash - East Fork Sevier River	Showalter Creek - East Fork Sevier River	Mud Spring Creek - East Fork Sevier River	Tropic Reservoir	East Fork Sevier River Headwaters	**Total for Upper East Fork**
Fire							
Communities at Risk	L	H	H	H	L	L	**M**
Fuel Conditions	L	H	H	H	H	H	**H**
Human Uses							
Development and Effects to Groundwater	L	H	H	H	L	L	**M**
Development and associated recreation uses to adjacent lands	L	M	M	H	NA	M	**M**
Access Management	L	M	H	H	H	H	**H**
Developed and Dispersed Recreation	L	L	H	M	NA	M	**M**
Vegetation							
Sagebrush/Grass	H	H	H	H	H	H	**H**
Aspen	M	L	L	L	H	H	**M**
Grassland - Meadow	M	M	M	L	L	L	**L**
Mixed Conifer/Mountain Fir	NA	L	L	M	H	H	**M**
Oak/Mahogany/Mountain Shrub	L	L	M	L	NA	NA	**L**
Pinyon/Juniper	H	M	H	M	L	L	**M**
Ponderosa	M	M	L	H	H	H	**M**
Spruce/Fir	NA	NA	NA	NA	NA	NA	**NA**
Tall Forb	NA	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	L	M	M	L	NA	NA	**L**
Species and Habitat							
Priorities for Enhancement or Protection of:							
Southwestern Willow Flycatcher Habitat	M	L	M	M	H	H	**M**
Utah Prairie Dog Habitat	H	H	H	H	L	L	**M**
Bald Eagle Habitat	M	M	H	M	M	L	**M**
Spotted Bat Habitat	M	M	M	M	M	M	**M**
Townsend's Big-eared Bat Habitat	M	M	M	M	M	M	**M**
Flammulated Owl Habitat	L	M	M	M	M	M	**M**
Three-toed Woodpecker Habitat	L	L	NA	L	M	H	**L**
Northern Goshawk Habitat	M	L	L	M	M	H	**M**
Peregrine Falcon Habitat	H	M	M	M	M	M	**M**
Sage Grouse Habitat	H	H	H	M	L	L	**M**
Turkey Habitat	H	M	M	M	M	M	**M**
Deer Habitat	H	M	M	H	H	H	**H**
Elk Habitat	L	L	M	H	M	H	**M**
Pronghorn Habitat	M	H	H	H	L	L	**M**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	H	L	L	M	H	H	**M**
Boreal Toad Habitat	NA	NA	NA	L	H	H	**M**
Bonneville Cutthroat Habitat	NA	NA	NA	NA	NA	NA	**NA**
Riparian Areas	H	M	M	M	H	H	**H**
Fisheries Habitat	L	M	M	M	H	H	**M**

Table 4-21 (con't). Priority ratings for all six Upper East Fork Subwatersheds, as identified by technical advisory committees.

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MIDDLE EAST FORK WATERSHED

(Previously called John's Valley).

The pioneer Widstoe cemetery reminds visitors of the Middle East Fork's pioneer past.

Pioneers first settled the Middle East Fork area in the 1870's. Although few of the origianl towns and home-steads exist today, many local ranches are run today by ancestors of pioneer families living nearby. The Middle East Fork Watershed is the largest Watershed within the Upper Sevier River Basin, with over 218,875 acres. Numerous ATV trails occur throughout the watershed, making it a popular destination for summer recreationists and fall deer and elk hunters.

Land Ownership

Forested lands (146,396 acres) dominate much of the Middle East Fork Watershed, while BLM (23,449 acres), State (28,399 acres) and Private lands (12,630 acres) comprise the remainder (Fig. 4-37, Fig. 4-38). In the early 1900's the town of Widstoe, located at the mouth of Sweetwater Creek adjacent to John's Valley, boasted 1,100 people, with alfalfa, grain and head lettuce as the primary cash crops. However, unpredictable weather and a 10-year drought cycle forced most residents from Widstoe, and by 1935, only 17 families remained. John's Valley and Widstoe are named after John A. Widstoe, a dry farming expert. Agriculture and grazing still comprise the primary economic industries within the Middle East Fork Watershed, but most residents reside outside the watershed in Antimony, and/or other nearby towns. The Middle East Fork contains 12 subwatersheds (Table 4-22, Fig. 4-38).

Vegetation Types

Large stands of aspen, ponderosa pine and mixed conifer dominate forested lands on the east and west sides of John's Valley, providing habitat for populations of mule deer, elk, and northern goshawk (Table 4-23, Fig. 4-39). Sagebrush steppe is dominant throughout the valley bottoms. Recently, the Sanford Fire, (which burned in 2002) created a mosaic of burned and unburned areas, allowing regeneration of old decadent aspen stands. However, many steep north facing slopes, now devoid of understory vegetation, may contribute to high levels of erosion and sediment transport within the watershed.

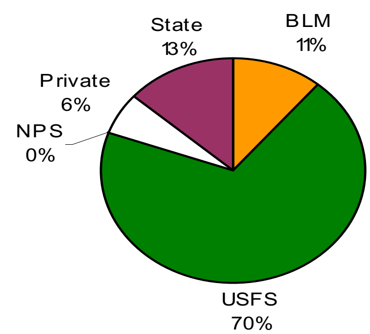


Fig. 4-37. U.S. Forest Service Lands make up the majority of the Middle East Fork Watershed.

Middle East Fork Subwatersheds	Acres
Clay Creek	16574
Cottonwood Creek	15771
Cow Creek - Sevier River	11116
Deep Creek	15884
Deer Creek	18041
Forest Creek	10067
North Creek	17117
Pacer Lake	21786
Prospect Creek	18807
Ranch Creek-Sevier River	24273
South Creek	21400
Sweetwater Creek	20036
Total	210875

Table 4-22. The Middle East Fork is the largest watershed with 210,875 total acres. Subsequently it contains the most subwatersheds.

Elevation, Roads and Trails

Highway 22, which runs north and south through John's Valley is the only paved road within the Middle East Fork Watershed (Fig. 4-40). Numerous ATV trails traverse the watershed, especially in the area around Pine Lake. The 20 unit Pine Lake campground is utilized extensively during summer months by off-road recreation enthusiasts. On the east side of Highway 22, access to the Griffin Top, Escalante, and scenic vistas such as Powell and Henderson Point, are gained via rough gravel roads, ATV and foot trails.

Vegetation Type	Acres	%
Agriculture	2139	1%
Aspen	11580	5%
Grass/Forb	18406	9%
Limber/Bristlecone Pine	309	0%
Mixed Conifer	13633	6%
Mountain Shrub	1608	1%
Pinyon/Juniper	63064	30%
Ponderosa Pine	6601	3%
Sagebrush/Grass	64299	30%
Spruce/Fir	17827	8%
Other	11409	5%
Total	210875	100%

Table 4-23. Unique to this watershed are limber and bristlecone pine.

The Upper East Fork Sevier River is dewatered below Tropic Reservoir (Upper East Fork Watershed) until it enters Black Canyon, near Antimony, Utah. In this area, Highway 22 runs directly parallel to the river, increasing sediment transport into the East Fork (the road was paved only a few years ago). The Division of Wildlife Resources and Bureau of Land Management, as well as landowners within the Black Canyon area, have spent considerable time and money improving riparian and stream conditions within this area. Limited stream access attracts fishermen in search of trophy brown trout.West of Highway 22 the Cottonwood Road provides access to Mt. Dutton. Wood gathering and fall hunting are the primary uses of this area. The 2002 Sanford Fire removed much of the vegetation from this area, and erosion in and along the road may be a potential problem.

Approximately 4,000 feet difference in elevation exists between the grasslands in Johns Valley to the upper plateaus of the Griffin Top and Boulder mountain (approx. 6,500 to 10,500 feet elevation).

Thousand year old bristlecone pines occur along high baren ridges within the Middle East Fork watershed.

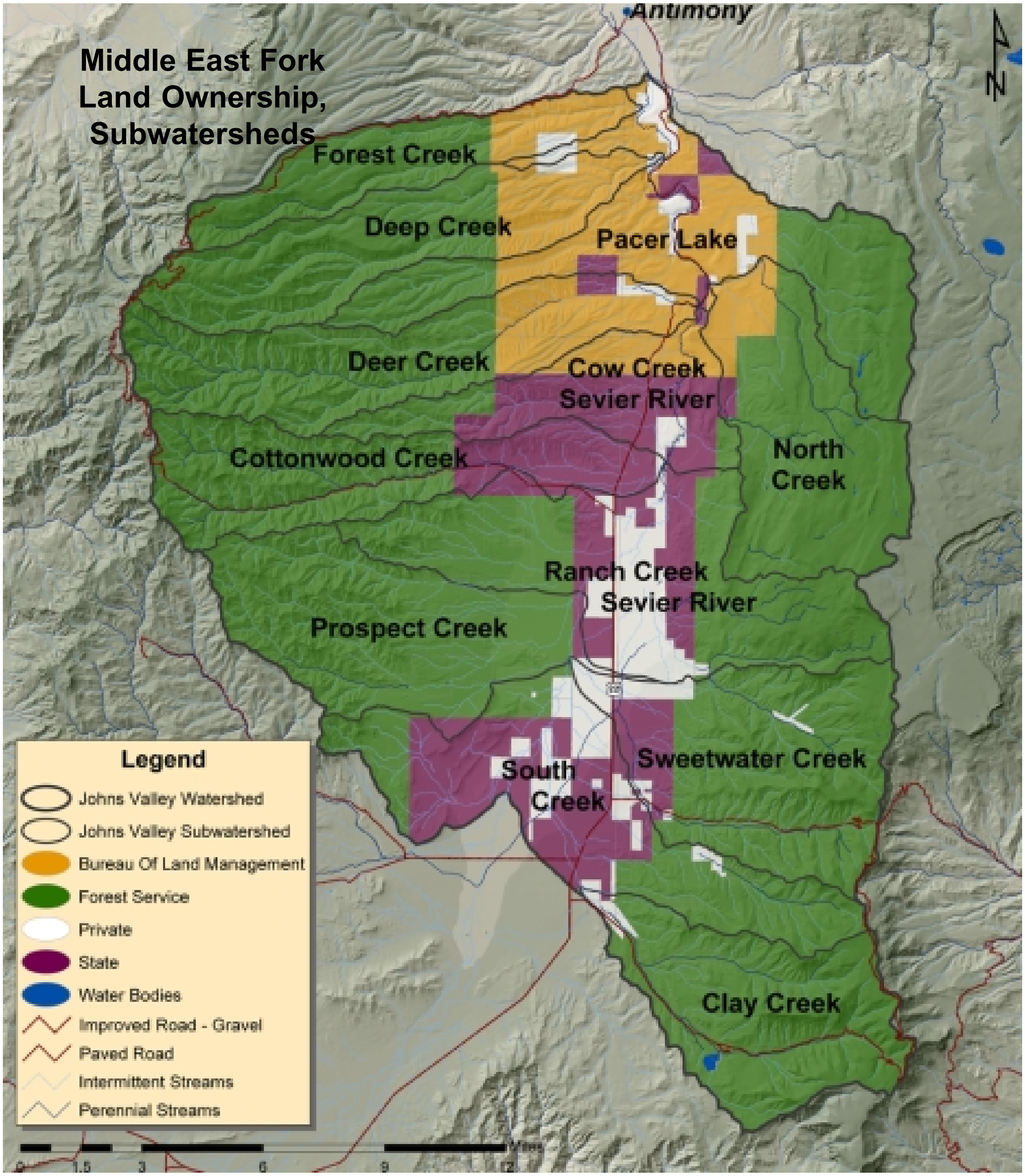


Fig. 4-38. State, private and Bureau of Land Management lands lay along the main Upper East Fork Sevier River corridor. Climactic changes and use of water for irrigation, has changed vegetation structural diversity and impacted riparian areas within the twelve subwatersheds.

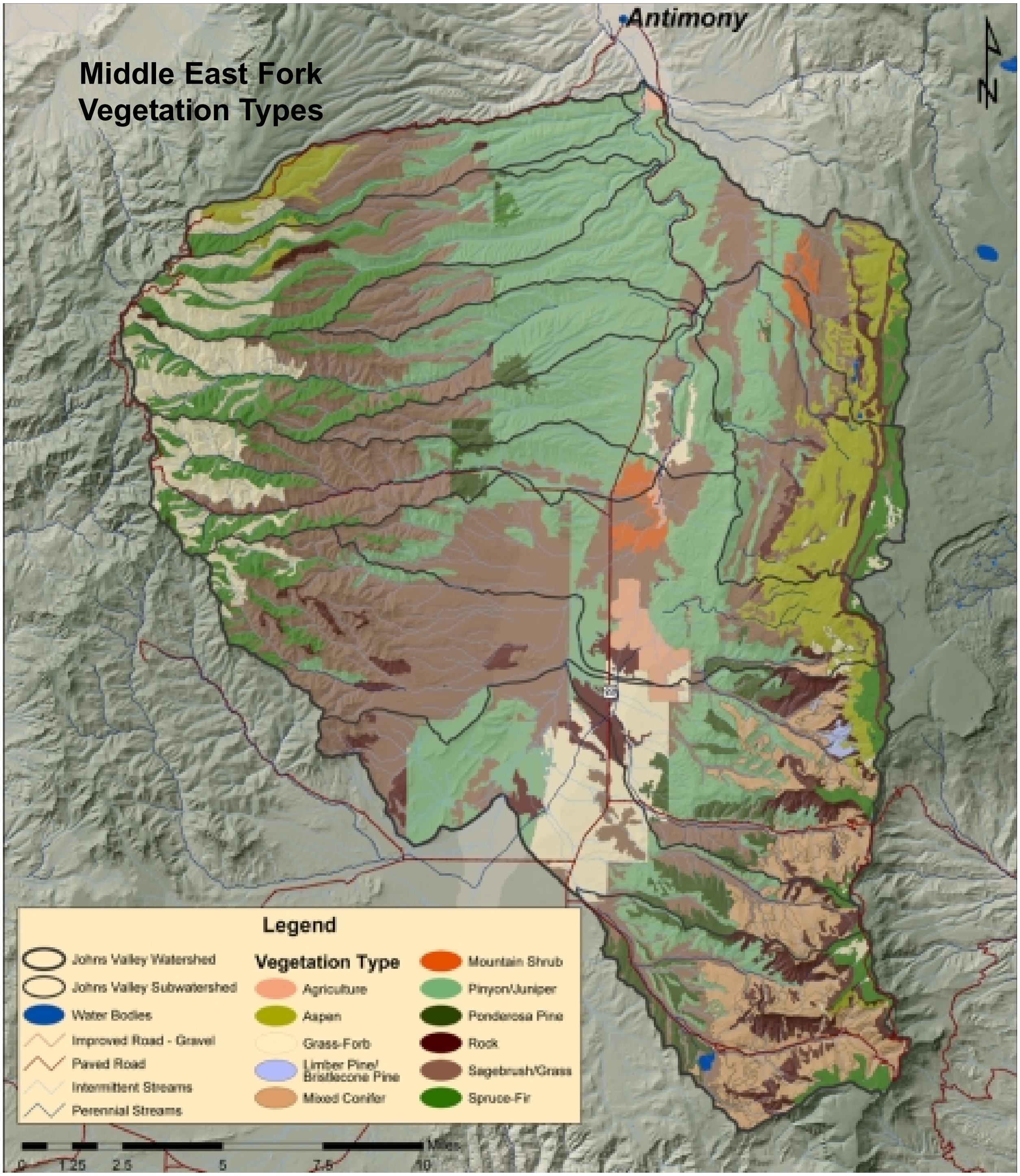


Fig. 4-39. Pinyon-Juniper and Sagebrush-grasslands dominate much of the Middle East Fork Watershed.

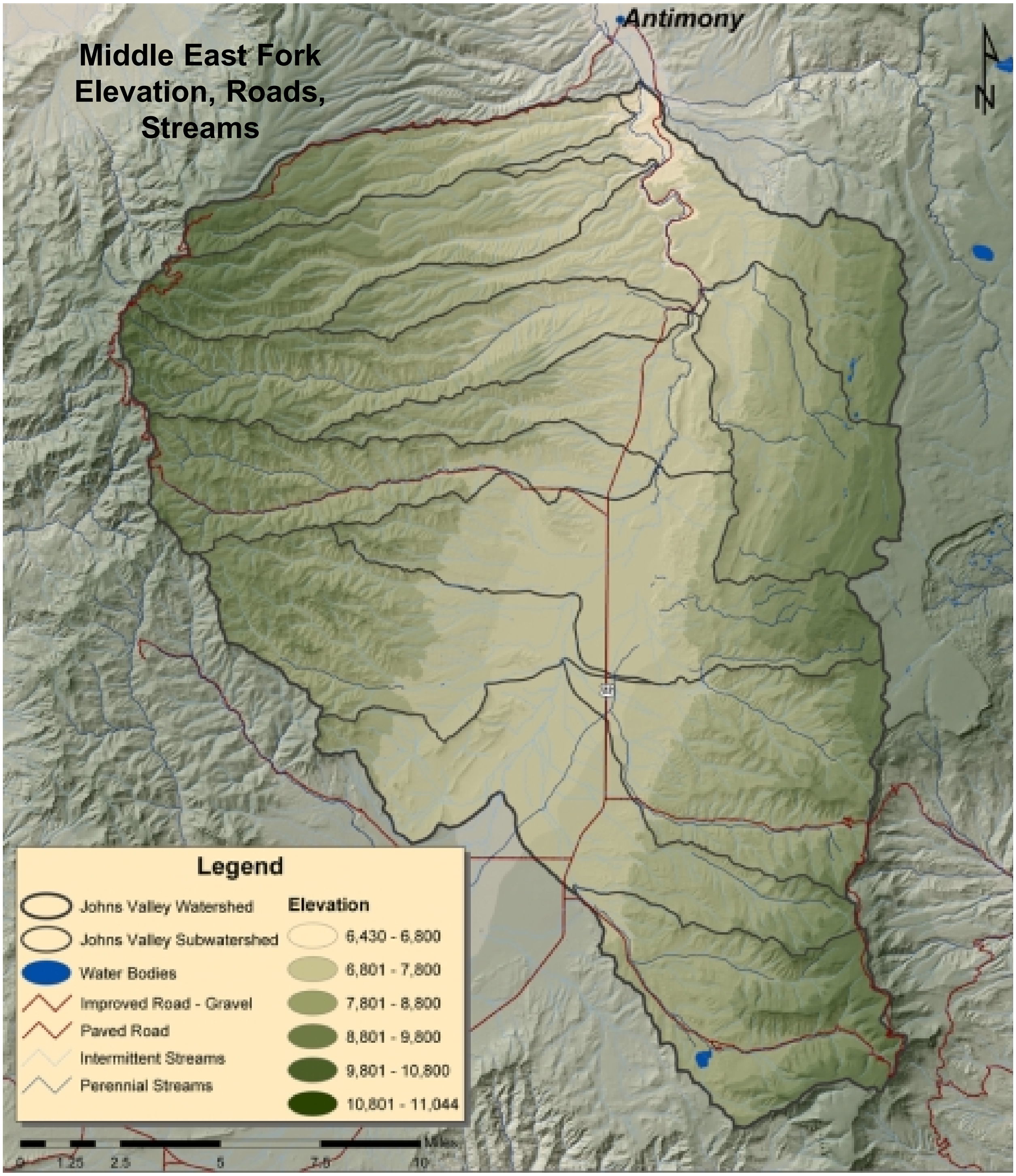


Fig. 4-40. At 6,430 to 6,800 feet elevation, the agricultural lands through the Middle East Fork Watershed are utilized for raising crops and grazing cattle. The recent paving of Highway 22 has increased traffic throughout the area.

Key Issues

Key issues identified for the Middle East Fork Watershed are: 1) Accelerated Erosion; 2) Access Management; 3) Communities at Risk to Wildfire; 4) Dispersed Recreation; 5) Enhancement or Protection of Sage Grouse Habitat; 6) Enhancement or Protection of Fisheries Habitat; 7) Mountain Brush Species - Fuel Conditions & Sagebrush/Grassland Areas - Vegetation Composition; 8) Noxious Weeds; 9) Pinyon-Juniper - Vegetation Composition; 10) Riparian Vegetation Composition; 11) Wildlife Management in Agricultural Areas. (Fig. 4-41). (Other issues and ratings within the Middle East Fork Watershed are listed in Table 4-24).

1. Accelerated Erosion

Current Conditions, Patterns and Trends

Accelerated erosion occurs throughout most of the Middle East Fork Watershed. Many streams lack riparian vegetation and/or stable soil bases. Changes in upland vegetation composition, resulting in little understory grasses/forbs, has decreased soil stability, causing an increase in sediment deposition and erosion to area streams. Unnatural flow regimes and deeply downcut banks exist along most of the major perennial streams. Roads parallel to stream drainages within the City, Sweetwater, and Cottonwood areas, contribute to increased runoff and sediment transport, while heavy ATV use impacts areas in Clay and Sweetwater Subwatersheds.

Reference Conditions, Patterns and Trends

Extensive rill and gully erosion occurs throughout the Middle East Fork watershed, increasing sediment transport into critical riparian areas.

Expansive and diverse riparian grasses, along with willow and cottonwood complexes, were present prior to changes in water management in the 1880's. Historically, concentrated grazing impacts removed much of the streamside vegetation; however, current grazing practices are resulting in improved condition of riparian areas. Large populations of beaver in stream headwaters also help maintain natural flows and reduced sediment transport. Very few roads and trails or dispersed camping historically existed along riparian areas, with little or no streambank utilization. Impacts from off-road recreation vehicles have recently begun to occur. Natural erosion rates (rather than accelerated erosion) were thought to occur within the watershed.

Natural/Human Causes of Change Between Current/Reference Conditions

In recent years, this area has seen a shift in land use from agriculture to tourism, and subsequently an increase in roads and recreation use along riparian areas. Although a shift in grazing use from sheep to cattle may help decrease upland erosion, the trampling impact from cattle grazing in riparian areas continues to impact area streams. Fire suppression, historical overgrazing and a shift to seeded monocultures on private agricultural lands have increased decadent sagebrush and pinyon-juniper, resulting in increasing overland erosion.

2. Access Management

Current Conditions, Patterns and Trends

High road densities along stream channels, with an increase in ATV use and dispersed camping, occur throughout much of the watershed. Increased sediment transport, degraded stream conditions, lack of riparian vegetation, and damage to adjacent upland areas through access management are of special concern. Portions of this watershed exist within an inventoried roadless area (Deep, Deer and Pacer subwatersheds); user created trails that bisect the watershed are associated with increasing illegal ATV use.

Although numerous ATV trails exist throughout the Middle East Fork watershed, ATV use in roadless areas, trail blazing and cross-country use is increasing.

Reference Conditions, Patterns and Trends

Available roads have traditionally been used for harvesting timber, with less camping and recreating in riparian areas than is currently occurring. Few resource and user conflicts occurred from these types of activities, with little or no damage to riparian and upland vegetation. Roads and trails were adequate for needed uses.

NaturalHuman Causes of Changes Between Current/Reference Conditions

Increased recreational use of roads and riparian areas, with more off-road vehicle access, has decreased vegetation density and diversity, accelerated upland erosion, and reduced condition of riparian vegetation and aquatic habitat. Much of this use occurs along the Cottonwood Road, primarily during hunting season and via access to Mt. Dutton. Poorly designed, engineered and maintained trails (although adequate for historic uses) today introduce high amounts of sediment into aquatic ecosystems, further degrading fishery opportunities.

3. Communities at Risk to Wildfire

Current Conditions, Patterns and Trends

Fire regimes of frequent, small intensity fires have been altered from historic conditions and the risk of losing key ecosystem components as well as community structures remains high, especially along Route 22, through John's Valley. Ponderosa pine forests have changed from open, park-like areas with scattered large trees, to stands with dense thickets of small diameter trees which are at risk of burning due to high amounts of fuel accumulations. Understory forbs and grasses are being dominated by pinyon-juniper, decadent sagebrush and other shrub types.

Reference Conditions, Patterns and Trends

Historically, frequent small intensity fires in ponderosa pine ecotypes helped reduce fuel accumulations, while maintaining structural diversity and minimizing tree density. In the absence of ground litter, and more open canopy, grasses and forbs were also maintained, serving as important soil stabilizers. Communities of black silver, mountain big sagebrush and big sagebrush occurred in pure or mixed stands, with fire as the major disturbance factor. Mosaics of sagebrush vegetation types supported populations of big game and sage grouse.

Natural/Human Causes of Change Between Current/Reference Conditions

Past fire exclusion efforts as well as climatic changes and increased urbanization have all contributed to vegetation changes throughout John's Valley, all of which have contributed to increased wildfire risk.

4. Dispersed Recreation

Current Conditions, Patterns and Trends

Recreational use of forests, grasslands and riparian areas continues to increase. Although established campgrounds occur throughout the Upper Sevier River Basin, the desire to seek solitude in more primitive areas has increased dispersed camping throughout the Middle East Fork Watershed. Many areas along the Cottonwood Creek Road are utilized in the fall, primarily during hunting season, when ATV's, horses, camptrailers and four-wheel drive vehicles descend upon available open dispersed camping spots along the road. The associated impacts from dispersed rec-

Pine Lake campground, located ne near numerous ATV trail access points, is a popular place for recreationists. The small campground is often full during summer months, and overflow camping occurs throughout this area, as well as other portions of the watershed.

reation include vegetation loss through trampling of stream banks and upland areas, disposal of litter along travel corridors, improper human waste disposal, and increased foot/recreation traffic traveling to and from fragile riparian areas.

Reference Conditions, Patterns and Trends

Less human use of forests, grasslands and riparian areas occurred, primarily because of lack of access. Few trails and roads existed, and those in existence were used mostly for moving livestock, gathering wood and/or limited hunting. Densely vegetated riparian areas hindered travel along these corridors, while existing recreation areas were adequate for desired uses.

Pinyon-juniper encroachment into sage grouse habitat threatens much of the remaining sagebrush type within the Middle East Fork. Many known lek sites have been abandoned because of degraded conditions.

Natural/ Human Causes of Change Between Current/ Reference Conditions

Urbanization has fragmented and parcelized many sections of land, making it more difficult to get away from other users. Increased access to wildland areas by ATV and all-wheel drive vehicles has changed the way recreationists enjoy forested lands, and made more areas accessible for use.

5. Enhancement or Protection of Sage Grouse Habitat

Current Conditions, Patterns and Trends

Both current and historic sage grouse leks are know to occur within the Middle East Fork Watershed. However, sage grouse populations are declining due to sagebrush/grassland habitat loss to pinyon-juniper expansion. Mule deer, elk, antelope and Utah prairie dog also depend on once expansive sagebrush/grassland habitat within the Middle East Fork area. Vegetation diversity in sagebrush grassland areas is currently lacking, and many areas are dominated by more aggressive non-native grass species. Where the quantity and quality of habitat has declined, sage grouse populations are vulnerable to

Sage grouse were once abundant throughout much of the Upper Sevier River watershed, especially in John's Valley.

natural predation and chick survival remains low.

Reference Conditions, Patterns and Trends

Located on a predominantly western slope, extensive sagebrush/grassland areas once occurred within the Middle East Fork. A vegetation composition of mixed sagebrush types (mountain, big, black) and ages, as well as native grasses and forbs, were maintained by periodic fire disturbance and dominated many of the lower elevation areas within the watershed.

The East Fork Sevier River, through the Black Canyon area, is considered a trophy fishery. Recently, as a result of the Sanford Fire, existing trout populations were impacted, necessitating long-term fishery restoration efforts.

Natural/Human Causes of Change Between Current/Reference Conditions

Past treatment efforts within sagebrush/grassland areas focused on resource commodity uses (farming, ranching, grazing, timber harvest), removing vegetation from within natural ranges. Vegetation range, pattern, and struture has been further impacted through intensive grazing and fire, allowing increased establishment of pinyon-juniper and decreased grass and forb production.

6. Enhancement or Protection of Fisheries Habitat

Current Conditions, Patterns and Trends

The Middle East Fork Watershed is dewatered throughout most of the length of John's Valley. However, remnant populations of pure strain Bonneville cutthroat trout occur in several tributary streams, while other streams contain viable habitat and are important for native cutthroat trout reintroductions. Once water again enters the Middle East Fork Sevier River channel near Black Canyon, this river serves as an important sport fishery, with populations of trophy brown trout, rainbow and cutthroat trout present. Intense

While fish rely on riparian vegetation for habitat, many bird species also use these same areas for breeding and rearing young.

flooding, following the 2002 Sanford Fire, deposited large amounts of debris and silt into many tributary streams including Deep, Deer and Cottonwood Creeks and the East Fork Sevier River, destroying riparian habitat and eliminating much of the remaining fish populations and habitat. Of special concern within the Deep Creek area is the near loss of a remnant genetic stock of native Bonneville cutthroat trout. Stabilization projects in the Black Canyon area provide potential for long-term fisheries restoration.

Reference Conditions, Patterns and Trends
Native nongame species such as sculpin, speckled dace and leatherside chub (a Utah 'Species of Special Concern') inhabited areas of the East Fork. Bonneville cutthroat trout were once abundant throughout the watershed. Coarser stream substrate and natural stream meanders reduced sediment transport and maintained more natural flow regimes than currently occurs.

Natural/Human Causes of Change Between Current/Reference Conditions
Water diverted for agriculture and grazing since settlement in the early 1900's has decreased riparian and fisheries habitat. Some tributaries, such as Ranch Creek, have been rerouted from the natural stream channel to facilitate water use on farm homesteads, further eliminating or limiting fisheries potential.

Even age classes of bitterbrush and big sage/ mountain sage have resulted in more bare ground areas and increased erosion within the Middle East Fork Watershed.

7. Fuel Conditions - Mountain Brush Species & Sagebrush/Grassland Areas

Current Conditions, Patterns and Trends
Excessive crown canopies with even age classes of decadent bitterbrush, and big sage/ mountain sage have resulted in a major loss of understory vegetation and an increase in bare ground area. Black sage, important winter wildlife forage, currently dominates many sites where effective soil moisture is limited. Native grasses have been replaced with high densities of exotic species such as smooth brome and crested wheatgrass. Forbs are lacking throughout the watershed, with viable seed sources no longer available. Lack of

vegetative cover and overland flow from rain is causing surface soil erosion and deposition in riparian areas. In some areas, where wildlfires have occurred, sagebrush has regrown to rabbitbrush. Mountain brush species are the primary staple of wintering big game and other wildlife species, such as sage grouse.

Reference Conditions, Patterns and Trends

Mixed age classes of sagebrush, with less than 15% canopy cover, were dominant prior to Euro-American settlement. Patchy vegetation patterns, with several age and canopy classes of sagebrush and grasses, were present and maintained by periodic fire, (approximately every 20-40 years). Soil stability and productivity remained fairly intact, with little or no bare mineral soil exposed.

Natural/Human Causes of Change Between Current/Reference Conditions

Exclusion of fire has resulted in pinyon-juniper encroachment into sagebrush/grassland areas. Small, dense pondorosa pines have also displaced mountain brush ecotypes. Loss in vegetation species diversity and accelerated erosion within some areas of the watershed may be the result of high-intensity grazing throughout the valley.

8. Noxious Weeds

Current Conditions, Patterns and Trends

As recreationists move from watershed to watershed via improved dirt and gravel roads, noxious weeds are transported incidentally into these areas. Once established, noxious weeds are almost impossible to erradicate.

Noxious weeds pose an increasing threat to native ecosystems, croplands and other plant communities within the Middle East Fork Watershed. Various populations of Canada thistle, scotch thistle, whitetop, and Russian knapweed are found along the Highway 12 corridor, near Widstoe Junction, and/or along the Tom Best Springs Road. Bull thistle is found extensively throughout the Middle East Fork and Upper East Fork Watersheds. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients.

Reference Conditions, Patterns and Trends

Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Once confined to higher elevations, pinyon-juniper now occur throughout lower elevation areas and are replacing sagebrush/ grassland ecotypes.

Natural/Human Causes of Change Between Current/ Reference Conditions

Currently, trails and roads serve as the singlemost common points of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV's and other motorized and nonmotorized vehicles travelling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult to accomplish.

9. Pinyon-Juniper - Vegetation Composition

Current Conditions, Patterns and Trends

Pinyon-juniper encroachment into historic sagebrush/grassland communities has reduced ground cover, decreased grassland species diversity and eliminated portions of prime mule deer and livestock winter range. Erosion has increased due to little understory vegetation to help retain soil, with an increased wildfire risk in areas of high pinyon-juniper densities.

Reference Conditions, Patterns and Trends

Pinyon-juniper historically occupied rocky ridges, outcrops and slopes within the watershed. Periodic, low intensity fires (10 to 30 years) helped maintain pinyon-juniper density and diversity, while preventing encroachment into other vegetation types. The pinyon-juniper habitat is important for wildlife species such as pinyon jay, gray viero, black-throated gray warbler, juniper titmouse and pinyon mouse. Rocky Mountain juniper typically occurs in riparian areas and in ponderosa pine and mixed conifer stands. Pinyon-juniper is typically found below the mixed conifer and ponderosa pine communities, interspersed with sagebrush, oak, and mountain brush. Pure pinyon stands occur at moderate elevation.

***BEFORE**: Riparian corridors within Hunt Creek contained diverse riparian plants prior to the Sanford Fire, 2002.*

Natural/Human Causes of Change Between Current/Reference Conditions

Competition for available moisture and high ungulate use have substantially reduced the grass forb component in mature and old, dense pinyon-juniper stands. Pinyon-juniper distribution has also increased because of recent fire suppression efforts. Chainings were conducted in the 1960's and 1970's on private, forested and BLM lands to promote grass forb communities, however, lack of additional disturbance, has allowed pinyon-juniper to re-establish on these sites.

10. Riparian Vegetation Composition

Current Conditions, Patterns and Trends

The 2002 Sanford Fire and subsequent flooding left much of the riparian area along Deer, Deep, Forest and Cottonwood Creeks devoid of riparian vegetation. Although regeneration potential exists, ungulate grazing may heavily impact newly sprouting plants. Where cottonwoods are present, they have little age class diversity - they are either old stands or (where burned), are new sprouts. Many areas along East Fork Sevier River have little or no riparian vegetation.

Reference Conditions, Patterns and Trends

Riparian areas long Deer, Deep, Forest and Cottonwood Creeks were thick and brushy, complete with willows, alder, riparian grasses and cottonwood galleries in the lower drainages.Multi-age class cottonwood galleries and dense, diverse age-class willow complexes were present along the Upper East Fork area and tributaries prior to changes in water management in the 1880's. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream tempera-

***AFTER**: Hunt Creek, as well as Deep, Deer, Cottonwood and the East Fork Sevier River, were hard-hit by the Sanford Fire, 2002.*

tures, and supported normal flow regimes.

Natural/Human Causes of Change Between Current/Reference Conditions

The large scale Sanford Wildfire (78,000 acres), and subsequent flooding events, removed much of the established riparian vegetation. Lack of upland vegetation resulted in large depositions of sediment into riparian areas.

Agriculture continues to be the primary economic industry within the Middle East Fork. However, many agricultural lands are impacted by nearby deer and elk.

Increased recreation near riparian areas, especially in the Clay, Sweetwater and South Creek Subwatersheds, as well as livestock grazing and water diversion for irrigation, have all played a role in eliminating riparian habitat. Removal of willow to increase stream flow by decreasing plant water use (a common, but erroneous practice in the mid-1950's), left many areas devoid of riparian vegetation, and at risk to invasion by non-native plant species.

11. Wildlife Management in Agricultural Areas

Current Conditions, Patterns and Trends

Agriculture lands, bordered on the east and west by forested lands, are currently impacted by deer and elk. Deer and elk populations in the Mt. Dutton area (west) and Boulder Mountain area (east) provide hunting opportunities such as general deer, antlerless elk, spike elk, and trophy elk. Although deer numbers are down from recent years, demand for wildlife mitigation permits from area landowners has risen, with an increasing number of landowners and acres impacted (2003, pers. comm., DWR).

Reference Conditions, Patterns and Trends

Agriculture lands in John's Valley were developed around the beginning of the 20th century, when low populations of deer and elk were found throughout the valley. Unrestricted hunting of predators, as well as big game, resolved most wildlife/landowner conflicts. Adequate winter and summer deer and elk ranges were maintained by periodic fire, further eliminating deer/elk conficts with private agricultural lands.

Natural/Human Causes of Change Between Current/ Reference Conditions

Restricted hunting, the demand for increased, quality hunting opportunities, as well as stricter compliance to fish and game laws, has resulted in an increase in deer and elk numbers from early settlement conditions. Drought and changes in vegetation composition within the watershed may temporarily decrease elk and deer numbers; however, these same conditions may cause deer and elk to seek additional forage opportunities on private agricultural lands, where adequate feed is available.

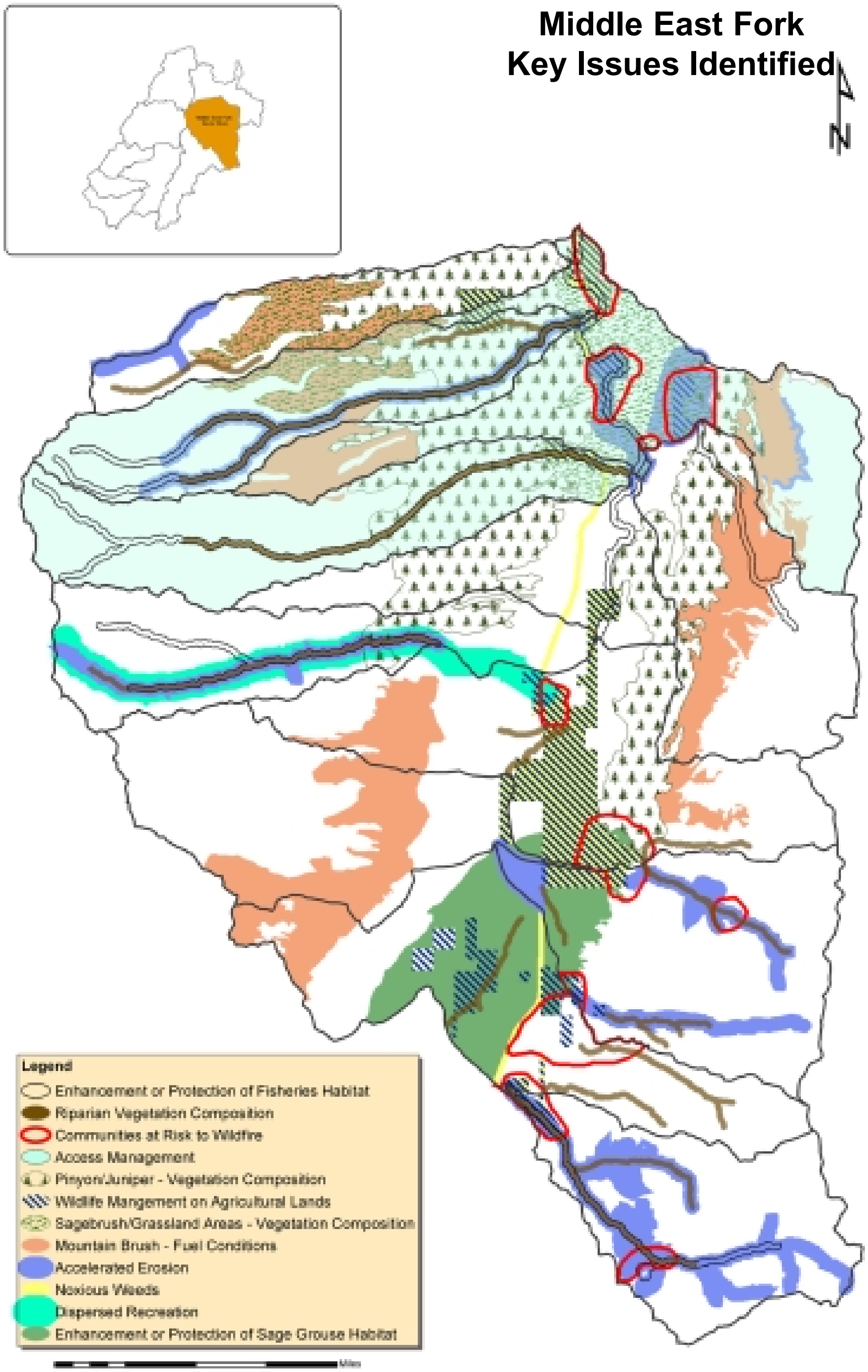


Fig. 4-41. The 12 key issues identified for the Middle East Fork Watershed represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees.

	Forest Creek	Deep Creek	Pacer Lake	Deer Creek	Cow Creek Sevier River	Cottonwood Creek	North Creek	Ranch Creek Sevier River	Prospect Creek	Sweetwater Creek	South Creek	Clay Creek	**Total for Middle East Fork**
Hydrology/Water Quality													
Hydrology													
Dewatering and altered flow regimes	NA	NA	M	NA	NA	NA	M	M	NA	M	M	M	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	H	H	M	H	L	H	L	M	L	L	M	M	**M**
Hillslope Processes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion on high elevation meadows	NA	NA	M	NA	NA	NA	H	L	NA	M	NA	NA	**L**
Accelerated erosion in pinyon-juniper and sagebrush stands	M	M	M	M	M	L	H	M	H	H	M	H	**M**
Accelerated erosion associated with urban development	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion associated with roads	L	NA	M	L	NA	M	NA	M	L	M	M	M	**L**
Rill and gully erosion on hillslopes	NA	H	M	L	NA	M	NA	M	L	M	M	M	**M**
Accelerated erosion associated with illegal ATV use	NA	NA	L	M	NA	NA	NA	M	NA	H	M	M	**L**
Riparian Vegetation Composition													
Lack of healthy composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	H	M	H	M	H	M	H	M	H	H	H	**M**
Water Quality													
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion, grazing management, recreation use, roads	H	H	H	NA	M	H	H	M	NA	H	M	H	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	NA	H	M	M	L	L	NA	NA	NA	NA	NA	NA	**L**
Channel Morphology													
Active channel adjustments (vertical or lateral)	M	M	M	M	M	L	M	H	M	H	M	H	**M**
Accelerated bank erosion	L	NA	M	NA	M	L	NA	H	L	M	M	M	**L**
Channelization	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Agriculture													
Animal Feed Operations	L	L	L	L	L	L	L	H	L	L	L	L	**M**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	L	H	L	L	L	L	L	H	L	L	L	L	**M**
Pasture Mgt.	H	H	L	H	H	H	L	H	L	L	L	L	**M**
Fertilizer Usage and Impacts	L	L	L	L	L	L	L	L	L	L	L	L	**L**
Noxious Weeds	H	H	H	H	H	H	H	H	H	H	H	H	**H**
Wildlife Management in Agricultural Areas	H	H	H	H	H	H	H	H	H	H	H	H	**H**
Fire													
Communities at Risk	NA	NA	NA	NA	NA	NA	NA	NA	NA	H	H	H	**L**
Fuel Conditions	H	L	M	L	M	L	H	H	L	H	H	H	**M**
Human Uses													
Development and Effects to Groundwater	NA	NA	L	NA	L	NA	L	M	NA	M	M	M	**L**
Development and associated recreation uses to adjacent lands	NA	NA	L	NA	L	NA	L	L	NA	L	M	L	**L**
Access Management	M	M	M	M	L	L	M	L	L	L	M	M	**M**
Developed and Dispersed Recreation	L	L	M	M	L	M	M	L	L	L	M	L	**L**

Table 4-24. Priority ratings for all twelve Middle East Fork Subwatersheds, as identified by technical advisory committees. Issues highlighted in blue are addressed in detail in this chapter.

	Forest Creek	Deep Creek	Pacer Lake	Deer Creek	Cow Creek Sevier River	Cottonwood Creek	North Creek	Ranch Creek Sevier River	Prospect Creek	Sweetwater Creek	South Creek	Clay Creek	**Total for Middle East Fork**
Vegetation													
Sagebrush/Grass	H	H	H	H	H	H	H	H	H	H	H	H	**H**
Aspen	M	M	L	NA	M	M	H	M	M	M	M	H	**M**
Grassland - Meadow	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Mixed Conifer/Mountain Fir	NA	NA	NA	NA	NA	M	L	L	NA	L	M	H	**L**
Oak/Mahogany/Mountain Shrub	NA	NA	NA	NA	NA	H	NA	NA	NA	M	NA	NA	**L**
Pinyon/Juniper	H	H	H	H	H	H	H	H	M	H	M	NA	**H**
Ponderosa	NA	NA	NA	NA	NA	L	L	L	NA	H	M	H	**L**
Spruce/Fir	H	H	L	M	NA	L	NA	NA	NA	NA	NA	NA	**L**
Tall Forb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	NA	NA	L	NA	L	NA	NA	H	L	M	M	NA	**L**
Species and Habitat													
Priorities for Enhancement or Protection of:													
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	NA	NA	M	L	H	L	M	H	H	M	H	H	**H**
Bald Eagle Habitat	L	L	M	L	L	M	M	M	M	M	M	M	**M**
Spotted Bat Habitat	L	M	M	M	M	M	M	M	M	M	M	M	**H**
Townsend's Big-eared Bat Habitat	L	M	M	M	M	M	M	M	M	M	M	M	**H**
Flammulated Owl Habitat	M	M	L	L	L	M	M	L	M	H	M	H	**M**
Three-toed Woodpecker Habitat	L	L	M	L	L	H	H	M	L	H	M	H	**H**
Northern Goshawk Habitat	M	M	H	M	M	H	H	H	M	H	L	H	**H**
Peregrine Falcon Habitat	L	L	M	M	M	M	M	M	M	M	M	H	**H**
Sage Grouse Habitat	H	M	M	M	H	H	M	H	H	H	H	H	**H**
Turkey Habitat	M	M	M	M	M	H	M	M	M	M	L	M	**H**
Deer Habitat	H	M	H	H	H	H	H	H	M	H	H	M	**H**
Elk Habitat	M	H	H	H	H	M	M	M	H	M	M	M	**H**
Pronghorn Habitat	NA	NA	M	L	M	M	M	H	H	H	H	H	**H**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	M	M	M	M	M	M	M	M	L	M	L	H	**M**
Boreal Toad Habitat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**
Bonneville Cutthroat Habitat	NA	H	NA	H	NA	h	H	H	L	L	L	L	**M**
Riparian Areas	M	H	H	H	M	H	H	H	M	M	M	H	**H**
Fisheries Habitat	M	H	H	H	M	H	H	H	M	M	M	H	**H**

Table 4-24 (con't). Priority ratings for all twelve Middle East Fork Subwatersheds, as identified by technical advisory committees. Issues highlighted in blue are addressed in detail in this chapter.

LOWER EAST FORK WATERSHED

(Previously named Antimony Watershed)

Antimony and Kingston, two rural farming communities, are both located along Highway 62, within the Lower East Fork Watershed. Early settlers in the area utilized the riparian grasses to raise cattle and subsequently grow alfalfa. The chemical element antimony (stibnite), discovered in Antimony Canyon, was sold and used by settlers to strengthen lead and other metals. The Upper Sevier River, from Antimony to Kingston, is a popular recreation area for local waterfowl hunters and fishermen. Otter Creek Reservoir, located outside the watershed, and Piute Reservoir, located within the City Creek Watershed, are popular recreation destinations for boaters and fishermen. Highway 62, between the two reservoirs, runs parallel to the Upper Sevier River, and is heavily utilized by recreation vehicles during summer months.

Good riparian areas are found along some sections of the Upper East Fork Sevier River, especially in the Black Canyon and Kingston Canyon areas.

Land Ownership

U.S. Forest Service (89,907 acres), Bureau of Land Management (39,890) and state lands (15,826) make up the majority of the watershed, with only 11,261 acres of private land occurring in this watershed (Fig. 4-42). Public access from BLM and state lands to areas along the Upper East Fork Sevier River has increased throughout this area. Numerous habitat improvement projects have been conducted in this watershed, on BLM, Utah Division of Widlife Resources and private lands. Six subwatersheds encompassing 156,887 acres are located within the Lower East Fork (Fig. 4-43, Table 4-25).

Lower East Fork Subwatersheds	Acres
Antimony Creek	21845
Antimony-East Fork Sevier River	18878
Coyote Hollow-Antimony Creek	38018
Dry Wash	14522
East Fork Sevier River Outlet	52653
Lost Spring Draw	10970
Total	156887

Table 4-25. The six subwatersheds in the Lower East Fork occupy 156,887 acres.

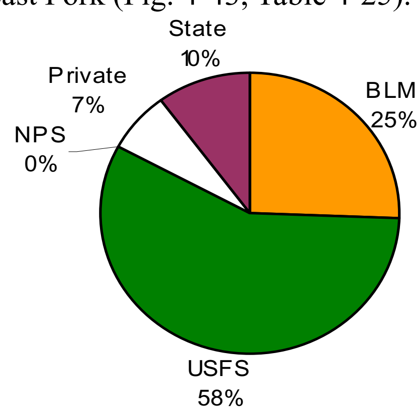


Fig. 4-42. U.S. Forest Service lands dominate land ownership within the six Lower East Fork subwatersheds.

Vegetation Types

Pinyon-juniper (58,538 acres) and sagebrush grasslands (43,391 acres) dominate the valley areas within the Lower East Fork. In the higher elevations, aspen (17,818 acres), intermixed with mixed conifer (2,067 acres) and ponderosa pine (4,074) provide valuable habitat for deer and elk. Lower elevation pinyon-juniper/sagebrush grasslands provide important winter forage for numerous wildlife species, including deer, elk, and sage grouse (Table 4-26, Fig. 4-44).

Vegetation Type	Acres	%
Agriculture	4805	3%
Aspen	17818	11%
Grass/Forb	1180	1%
Mixed Conifer	2067	1%
Pinyon/Juniper	58539	37%
Ponderosa Pine	4075	3%
Sagebrush/Grass	43392	28%
Spruce/Fir	20870	13%
Other	4141	3%
Total	156887	100%

Table 4-26. Historic sagebrush/grasslands and pinyon-juniper communities occur in the Lower East Fork Sevier River; however, in recent years many sagebrush/grasslands have been displaced through pinyon-juniper expansion.

Elevation, Roads & Streams

Highway 22 travels through Black Canyon (northwest corner of the Middle East Fork Watershed) to Kingston, running parallel to the Upper East Fork Sevier River, the road increases sediment transport in some areas within the watershed. However, the area from Kingston Canyon to Antimony continues to support good riparian and wetland habitat. Several important wild trout streams are contained within the watershed, including Antimony Creek and Pole Canyon.

Riparian areas along some sections of the Upper Sevier River contain diverse assemblages of grasses and woody vegetation.

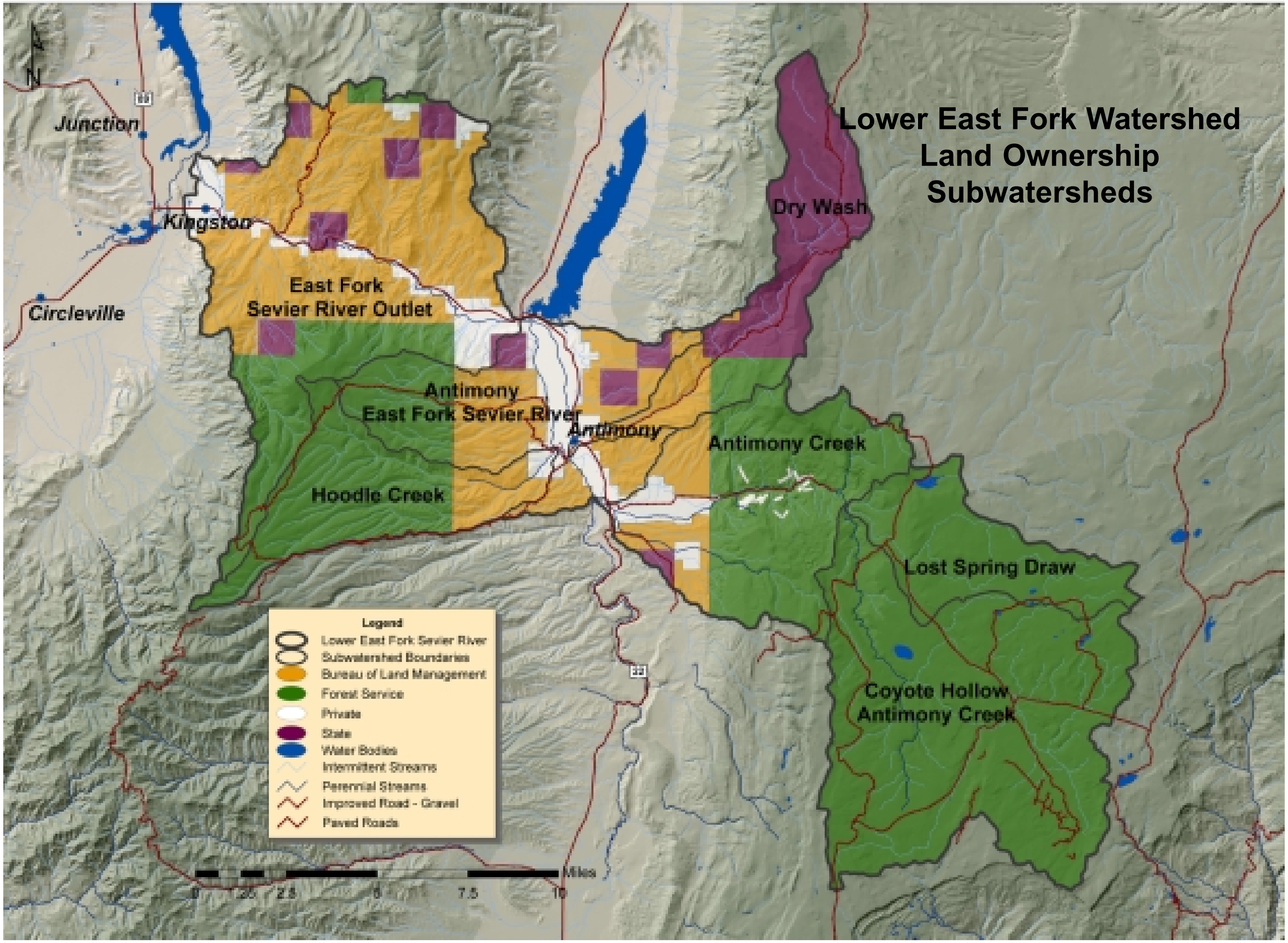


Fig. 4-43. Recreational opportunities, including fishing and hunting, occur along the East Fork Upper Sevier River, within the Lower East Fork Watershed.

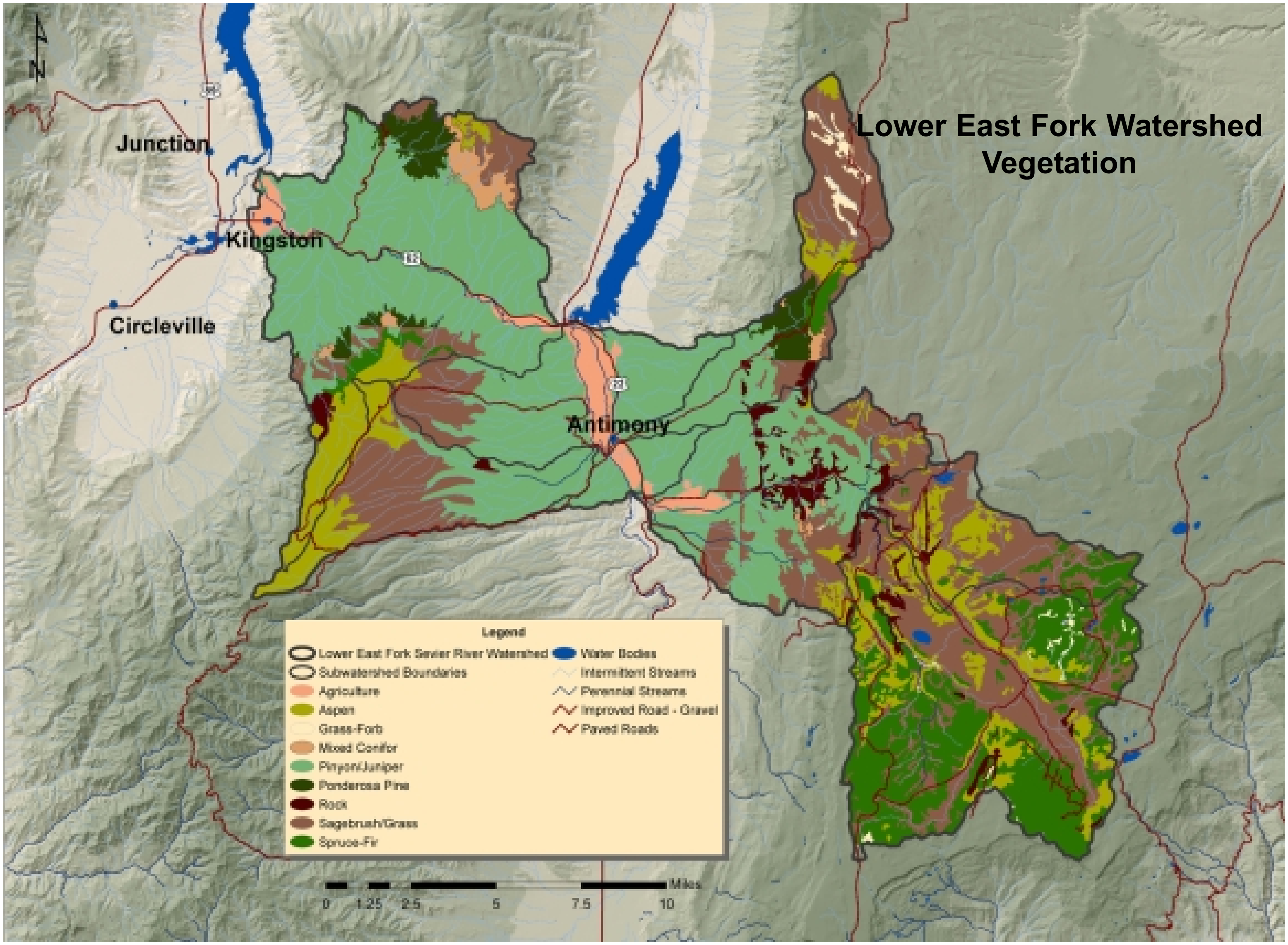


Fig. 4-44. Pinyon-juniper dominates much of the Lower East Fork Watershed.

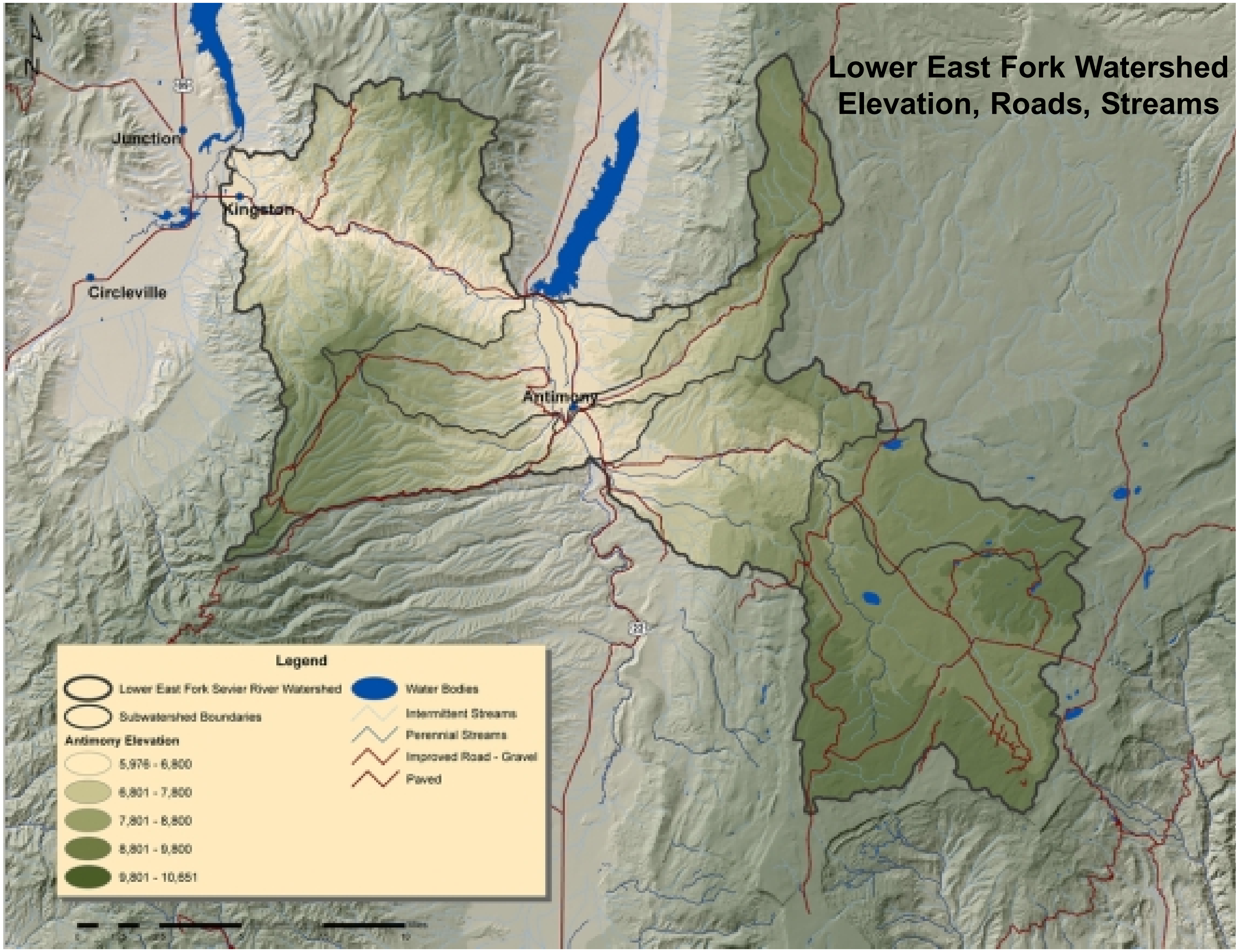


Fig. 4-45. Lowland areas along the East Fork Sevier River are utilized for grazing and agricultural . Healthy herds of Rocky Mountain elk and mule deer are found in higher elevations within the watershed.

Key Issues

Key issues identified for the Lower East Fork Watershed are: 1) Access Management; 2) Dispersed Recreation; 3) Enhancement or Protection of Deer Habitat; 4) Enhancement or Protection of Fisheries Habitat; 5) Mountain Brush Species - Fuel Conditions, Vegetation Composition - Sagebrush/Grassland Areas, Mountain Brush Species 6) Noxious Weeds; 7) Pasture Management; 8) Pinyon-Juniper - Fuel Conditions, Vegetation Composition & Accelerated Erosion; 9) Riparian Vegetation Composition. (Fig. 4-46). (Other issues and rating within the Lower East Fork Watershed are listed in Table 4-27).

1. Access Management

Current Conditions, Patterns and Trends

The construction of Highway 89, and subsequent channelization of areas along the Upper East Fork have impacted riparian habitats in addition to providing additional access to the area. Increased ATV use and dispersed camping, especially in areas around Circleville Canyon, Antimony Canyon and Kingston Canyon have increased sediment transport, degraded stream conditions and may accelerate damage to adjacent upland areas. User-made trails, with an increased number of recreationists into pristine areas, such as Antimony Canyon, will likely bring long-term changes to the watershed.

ATV and recreation use of forested lands is increasing.

Historic Conditions, Patterns and Trends

Available roads have traditionally been used for harvesting timber, with less camping and recreating in riparian areas than is currently occurring. Few resource and user conflicts occurred from these types of activities, with little or no damage to riparian and upland vegetation. Roads and trails were adequate for needed uses. Lack of major highways limited visitor access to remote areas.

Natural/Human Causes of Changes Between Current/Reference Conditions

Increased recreational use of roads and riparian areas, with more off-road vehicle access, has decreased vegetation density and diversity, accelerated upland erosion, and reduced condition of riparian vegetation and aquatic habitat in some areas. Development and associated impacts on habitat is a concern in the Antimony and Kingston Canyon areas. Roads developed to move livestock are also found throughnout this watershed and may not be adequately placed to minimize impacts to natural resources.

2. Dispersed Recreation

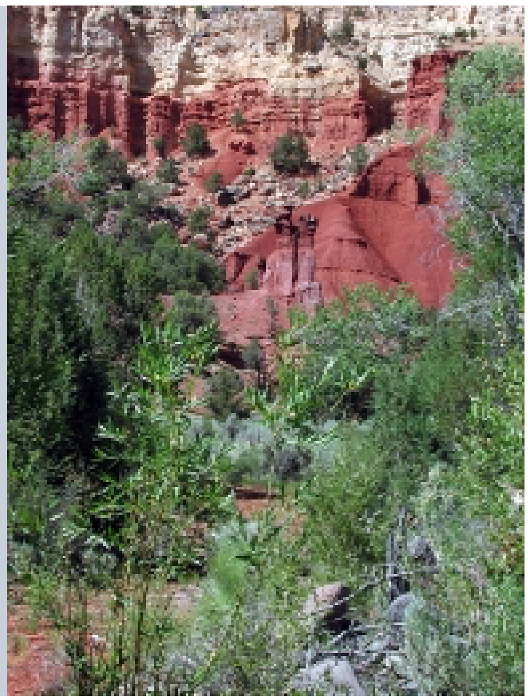
Current Conditions, Patterns and Trends

Recreation use of forests, grasslands and riparian areas continues to increase. The desire to seek solitude in more primitive areas has increased dispersed camping throughout the Lower East Fork, especially in Antimony Canyon and forested areas adjacent to Otter Creek Reservoir. The associated impacts from dispersed recreation include vegetation loss through trampling of stream banks and upland areas, disposal of litter along travel corridors, improper human waste disposal, and increased foot/recreation traffic traveling to and from fragile areas.

Reference Conditions, Patterns and Trends

Less human use of forests, grasslands and riparian areas occurred in the past, primarily because of lack of access. Few trails and roads existed, and those in existence were used mostly for moving livestock, gathering wood and/or limited hunting. Densely vegetated riparian areas hindered travel along these corridors, while existing recreation areas were adequate for desired uses.

Picturesque canyon formations and lush vegetation attracts recreationists to Antimony Canyon.



Natural/Human Causes of Change Between Current/ Reference Conditions

Urbanization has fragmented and parcelized many sections of land, making it more difficult to get away from other users. Increased access to wildland areas by ATV and all-wheel drive vehicles has changed the way recreationists enjoy public lands and made these areas more accessible for use.

3. Enhancement or Protection of Deer Habitat

Current Conditions, Patterns and Trends

In mid-elevation areas within the Lower East Fork, pinyon-juniper is expanding and impacting critical deer winter ranges. In general the pinyon-juniper community lacks vegetative diversity and browse species, and has little or no understory. Pinyon-juniper is

The five-mile prescribed burn is one method that managers can use to improve habitat conditions for wildlife.

also replacing sagebrush communities that may provide the only food available for wintering deer.

Reference Conditions, Patterns and Trends

Sagebrush and pinyon-juniper communities occurred within historic ranges, with good understory cover and a diversity of grasses, forbs, and brush (which are browse species for deer). Habitat was maintained by periodic fire, which supported a diversity in wildlife species, and few roads, homes and human uses occurred during summer and winter months.

Natural/Human Causes of Change Between Current/ Reference Conditions

Past treatment efforts within sagebrush grassland areas focused on resource commodity uses (farming, ranching, grazing, timber harvest), removing vegetation from within natural ranges. Vegetation range, pattern, and structure have been further impacted through intensive grazing and fire, allowing increased establishment of pinyon-juniper and decreased grass/forb production.

4. Enhancement or Protection of Fisheries Habitat

Current Conditions, Patterns and Trends

Several high value riparian and stream habitats occur within the Lower East Fork. The East Fork Sevier River, in the Antimony area and through Kingston Canyon, supports good riparian and wetland habitats, while other riparian areas along the East Fork are in poor condition due to a lack of willow, cottonwood, and other woody plant species. Important

Antimony Creek supports a self-sustaining wild trout fishery.

riparian habitat also occurs along Pole and Antimony Creeks. Currently Antimony Creek supports an excellent self-sustaining wild trout fishery, with good fishery habitat that needs to be protected from activities which may impact this fishery. Pole Creek also supports a wild trout fishery, but needs some riparian and fish habitat rehabilitation. The Sanford Fire, which burned in 2002, and subsequent downstream sediment transport, has impacted many sections along the Lower East Fork Sevier River, necessitating further streambank stabilization and water quality monitoring. Riparian and wetland areas provide habitat for the highest diversity and abundance of wildlife species in the Lower East Fork Watershed, and need to be protected or enhanced.

Reference Conditions, Patterns and Trends

Nongame fish species such as sculpin, speckled dace and leatherside chub (a Utah 'Species of Special Concern"), inhabited areas of the East Fork. Bonneville cutthroat trout were once abundant throughout the watershed. Coarser stream substrate and natural stream meanders reduced sediment transport and maintained more natural flow regimes than currently occurs. Prior habitat improvement projects along the Upper East Fork, on BLM, private and state-owned property have increased fishery habitat and fishing opportunities.

Natural/Human Causes of Change Between Current/Reference Conditions

Water diverted for agriculture and grazing since settlement in the early 1900's has been a factor in eliminating riparian habitat. However, a high number of roads developed in recent years are impacting riparian areas. Development and associated impacts are a concern in the Antimony and Kingston Canyon areas. Years of fire suppression, followed by an intense wildfire and flooding (Sanford Fire in 2002) left many upland areas in poor condition, and erosion and sediment transport under these conditions is extreme.

5. Fuel Conditions and Vegetation Composition - Sagebrush/Grassland Areas & Mountain Brush Species

Current Conditions, Patterns and Trends

Black sage, important winter wildlife forage, currently dominates many sites where effective soil moisture is limited. Native grasses have been replaced with high densities of exotic species such as smooth brome and crested wheatgrass. Forbs are lacking throughout the watershed, with viable seed sources no longer available. Lack of vegetative cover and overland flow from rain is causing surface soil

Sagebrush provides important cover and forage for a variety of wildlife.

erosion and deposition in riparian areas. In some areas, where wildfires have occurred, sagebrush has regrown to rabbitbrush. Mountain brush species are the primary staple of wintering big game and other wildlife species, such as sage grouse.

Reference Conditions, Patterns and Trends

Mixed age classes of sagebrush, with less than 15% canopy cover were dominant prior to Euro-American settlement. Patchy vegetation patterns, with several age and canopy classes of sagebrush and grasses were present and maintained by periodic fire, which occurred approximately every 20-40 years. Soil stability and productivity remained fairly intact, with little or no bare mineral soil exposed.

Natural/Human Causes of Change Between Current/Reference Conditions

Exclusion of fire has resulted in pinyon-juniper encroachment into sage/grass areas. Small, dense pondorosa pines have also displaced mountain brush ecotypes. Loss in vegetation species diversity and accelerated erosion within some areas of the watershed may be the result of high-intensity grazing throughout the valley.

6. Noxious Weeds

Current Conditions, Patterns and Trends

The potential for noxious weed introduction within the Lower East Fork Watershed is high, as recreation use increases along Highways 62 and 22, and along other highly traveled corridors. Recreational vehicles often act as weed vectors, transporting weeds great distances from their initial source, and once established, reduce forage production and compete with native plant and animal species for sunlight, moisture and nutrients.

User made ATV trails not only look unsightly, but are a likely place for introduction of noxious weeds.

Reference Conditions, Patterns and Trends

Historically, limited populations of noxious weeds occurred within the watershed. Infested livestock feed most likely introduced noxious weeds to the area; however, most populations remained small or were outcompeted by native vegetation. Noxious weed establishment on disturbed sites, such as in livestock, agricultural or mechanical treatment areas (chainings) was typically noted, but with limited dispersal.

Natural/Human Causes of Change Between Current/Reference Conditions

Currently, trails and roads serve as the single-most common points of noxious weed invasion, providing channels for weeds to migrate into more remote rangelands, agricultural and forested areas (USDAFS, 2002). Horses (if utilizing infected hay), ATV's and other motorized and nonmotorized vehicles travelling in recreation and roaded areas, act as vectors for noxious weeds, making wide-spread control difficult to accomplish.

7. Pasture Management

Current Conditions, Patterns and Trends

Grazing has been an integral use of lands within the Lower East Fork area since pioneers first settled in the late 1800's. Although today's grazing practices are much better than those of the past, better pasture management is still needed to ensure long-term use within the watershed. Newer pasture management practices increase productivity, maintain vegetation diversity, discourage weed introduction, and leave riparian areas intact. Effective pasture management practices include developing pasture management plans, rotating animals through pastured areas, limiting herd size, fencing livestock from riparian areas, maintaining browse species diversity, and leaving trees and shrubs within pastures and near stream banks intact.

Good pasture management involves providing limited access of ungulates to critical riparian areas.

Reference Conditions, Patterns and Trends

Extensive grasslands, forbs and sagebrush/pinyon-juniper ecotypes, maintained by periodic fire, existed on many lower elevation sites within the Lower East Fork Watershed. Abundant and diverse riparian grasses, willow and cottonwood occurred along stream channels. Loamy soils facilitated water run-off, reducing erosion and maintaining plant species diversity and vigor. Prior to Euro-American settlement, free-range grazing was limited to native animals such as deer and elk.

Natural/Human Causes of Change Between Current/Reference Conditions

Prior to 1950, little or no pasture management occurred, driven by the desire to homestead and utilize an apparent abundance of natural resources. Pasture management was first recognized in the 1950's, but is just beginning to be seen as a means to increase productivity, while minimizing destruction to rangelands and riparian areas.

8. Pinyon-Juniper - Fuel Conditions, Vegetation Composition & Accelerated Erosion

Current Conditions, Patterns and Trends

Pinyon-juniper encroachment into historic sagebrush/grassland communities has reduced ground cover, decreased grassland species density and diversity, resulting in elimination of portions of prime mule deer and livestock winter range. Erosion has increased due to little understory vegetation to help retain soil, with an increased wildfire risk in areas of high pinyon-juniper densities. Areas of particular concern include: Antimony, East Fork Sevier River Outlet; Antimony East Fork Sevier River; Hoodle Creek and Antimony Creek.

Reference Conditions, Patterns and Trends

Pinyon-juniper historically occupied rocky redges, outcrops and slopes within the watershed. Periodic, low intensity fires (10 to 30 years) helped maintain pinyon-juniper density

Exclusion of fire during the past 50 years has resulted in a change in vegetation types in some areas. Pinyon-juniper expansion to sagebrush grasslands has decreased forage, increased upland erosion and resulted in high fuel conditions.

and diversity, while preventing encroachment into other vegetation types. The pinyon-juniper habitat is important for wildlife species such as pinyon jay, gray viero, black-throated gray warbler, juniper titmouse and pinyon mouse. Rocky Mountain juniper typically occurs in riparian areas and in ponderosa pine and mixed conifer stands. Pinyon-juniper is typically found below the mixed conifer and ponderosa pine communities, interspersed with sagebrush, oak, and mountain brush. Pure pinyon stands occur at moderate elevations.

Natural/Human Causes of Change Between Current/Reference Conditions

Competition for available moisture and high ungulate use have substantially reduced the grass forb component in mature and old, dense pinyon-juniper stand. Pinyon-juniper

distribution has also increased because of recent fire suppression efforts. Chainings were conducted in the 1960's and 1970's on private, forested and BLM lands to promote grass-forb communities; however, lack of additional disturbance, has allowed pinyon-juniper to re-establish on these sites.
Fire suppression, historical overgrazing and a shift to seeded monocultures has increased decadent sagebrush and pinyon-juniper, increasing overland erosion.

10. Riparian Vegetation Composition

Current Conditions, Patterns and Trends

Cottonwood galleries and willow have been lost or are decadent within riparian areas along the East Fork Sevier River Outlet, Antimony Creek, and Antimony, East Fork Sevier River. In some areas, willows have deliberately been cleared, and along the East Fork water diversions and willow clearings have reduced vegetation diversity in riparian communities. Pinyon-juniper expansion along Antimony Creek has decreased natural stream side vegetation.

The Lower East Fork contains stream in a variety of conditions, from fully functioning to non-functional.

Reference Conditions, Patterns and Trends

Extensive willow complexes were most likely present along the Upper East Fork area and tributaries prior to changes in water management in the 1880's. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes.

Natural/Human Causes of Change Between Current/Reference Conditions

Changes in riparian vegetation have resulted from a variety of land uses, including water diversions, livestock grazing, channel adjustments, road construction, recreation, and cultivation.

Reference Conditions, Patterns and Trends

Extensive willow complexes were most likely present along the Upper East Fork Watershed and tributaries prior to changes in water management in the 1880's. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported more normal flow regimes than currently occurs.

Near Antimony, Utah, grazing along the Upper East Fork has been extensive. Pasture management is an essential tool for increasing range productivity and protecting critical natural resources.

Natural/Human Causes of Change Between Current/Reference Conditions

Changes in riparian vegetation have resulted from a variety of land uses, including water diversions, livestock grazing, channel adjustments, road construction, recreation, and cultivation.

In winter, much of the East Fork is dewatered along Kingston Canyon to maintain flows in Otter Creek and Piute Reservoirs.

Lower East Fork Watershed Key Issues Identified

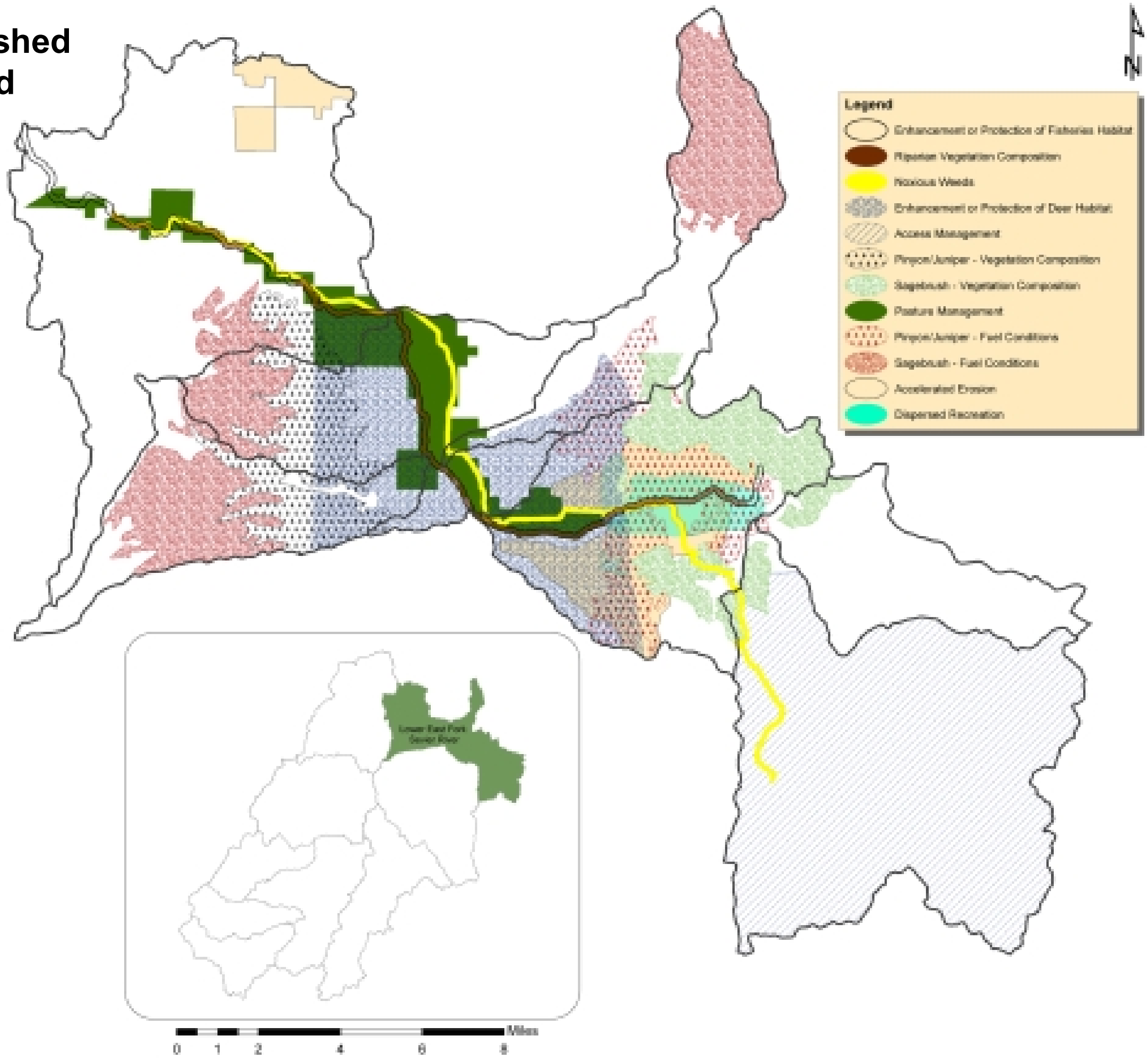


Fig. 4-46. The ten key issues identified for the Upper East Fork Watershed represent input from agriculture, fire, human uses, hydrology, species and habitat, and vegetation technical advisory committees.

	East Fork Sevier River Outlet	Antimony East Fork Sevier River	Hoodle Creek	Dry Wash	Antimony Creek	Lost Spring Draw	Coyote Hollow Antimony Creek	**Total for Lower East Fork**
Hydrology/Water Quality								
Hydrology								
Dewatering and altered flow regimes	NA	H	NA	NA	M	NA	NA	**L**
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River	H	NA	NA	NA	NA	NA	NA	**L**
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation	NA	NA	NA	NA	NA	NA	NA	**NA**
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium	NA	NA	NA	NA	NA	NA	NA	**NA**
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows	M	M	NA	NA	M	NA	M	**L**
Hillslope Processes								
Accelerated erosion on high elevation meadows	NA	NA	NA	NA	NA	M	H	**L**
Accelerated erosion in pinyon-juniper and sagebrush stand	H	H	H	NA	H	NA	NA	**M**
Accelerated erosion associated with urban development	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion associated with roads	M	L	NA	M	M	L	M	**M**
Rill and gully erosion on hillslopes	NA	M	M	L	L	NA	M	**L**
Accelerated erosion associated with illegal ATV use	NA	NA	NA	NA	M	L	M	**L**
Riparian Vegetation Composition								
Lack of healthy composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate wood plant species	H	M	NA	L	H	M	M	**M**
Water Quality								
Summer home development and associated impacts (I.e., groundwater contamination, erosion, recreation, etc.)	NA	NA	NA	NA	NA	NA	NA	**NA**
Accelerated erosion, grazing management, recreation use, roads	M	M	NA	M	M	NA	M	**M**
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature	H	H	NA	NA	M	NA	L	**M**
Channel Morphology								
Active channel adjustments (vertical or lateral)	M	L	NA	NA	M	NA	L	**L**
Accelerated bank erosion	M	M	H	H	M	NA	M	**M**
Channelization	M	NA	NA	NA	NA	NA	NA	**L**
Agriculture								
Animal Feed Operations	NA	L	NA	NA	NA	NA	NA	**L**
Water conservation concerns (Sprinkler vs. Flood Irrigation)	M	M	NA	NA	M	L	NA	**L**
Pasture Mgt.	H	H	NA	L	H	L	L	**M**
Fertilizer Usage and Impacts	L	M	NA	NA	M	L	NA	**L**
Noxious Weeds	H	H	L	L	H	L	L	**M**
Wildlife Management in Agricultural Areas	M	H	L	L	H	L	L	**M**

Table 4-27. Priority ratings for all seven Lower East Fork Subwatersheds, as identified by technical advisory committees. Issues highlighted in blue are addressed in detail in this chapter.

	East Fork Sevier River Outlet	Antimony East Fork Sevier River	Hoodle Creek	Dry Wash	Antimony Creek	Lost Spring Draw	Coyote Hollow Antimony Creek	**Total for Lower East Fork**
Fire								
Communities at Risk	H	H	M	H	H	L	L	**M**
Fuel Conditions	M	M	M	H	H	M	H	**H**
Human Uses								
Development and Effects to Groundwater	H	L	L	M	M	L	NA	**M**
Development and associated recreation uses to adjacent lands	M	L	L	M	H	M	NA	**M**
Access Management	NA	M	L	M	H	M	M	**M**
Developed and Dispersed Recreation	NA	M	L	M	H	M	M	**M**
Vegetation								
Sagebrush/Grass	M	NA	M	H	M	H	H	**M**
Aspen	NA	NA	NA	NA	L	H	H	**L**
Grassland - Meadow	NA	NA	NA	L	L	L	NA	**L**
Mixed Conifer/Mountain Fir	NA	NA	NA	NA	NA	NA	NA	**NA**
Oak/Mahogany/Mountain Shrub	H	M	M	M	M	L	NA	**M**
Pinyon/Juniper	NA	NA	NA	H	H	L	NA	**L**
Ponderosa	H	H	H	H	H	L	NA	**H**
Spruce/Fir	NA	NA	NA	NA	L	H	M	**L**
Tall Forb	NA	NA	NA	NA	NA	NA	NA	**NA**
Noxious Weeds	H	H	NA	NA	H	L	NA	**M**
Species and Habitat								
Priorities for Enhancement or Protection of:								
Southwestern Willow Flycatcher Habitat	NA	NA	NA	NA	NA	NA	NA	**NA**
Utah Prairie Dog Habitat	NA	NA	NA	H	NA	H	H	**M**
Bald Eagle Habitat	M	M	M	L	M	L	NA	**M**
Spotted Bat Habitat	M	M	M	M	M	L	M	**M**
Townsend's Big-eared Bat Habitat	M	M	M	M	M	L	M	**M**
Flammulated Owl Habitat	L	M	M	L	M	L	L	**M**
Three-toed Woodpecker Habitat	L	L	L	L	L	M	M	**M**
Northern Goshawk Habitat	L	L	L	L	M	M	M	**M**
Peregrine Falcon Habitat	L	L	L	L	M	M	M	**M**
Sage Grouse Habitat	NA	L	H	M	H	H	M	**M**
Turkey Habitat	M	L	M	M	M	M	M	**M**
Deer Habitat	H	H	H	H	H	M	M	**H**
Elk Habitat	H	H	M	H	H	M	H	**H**
Pronghorn Habitat	NA	NA	NA	NA	L	M	M	**L**
Brian Head Mountain-Snail Habitat	NA	NA	NA	NA	NA	NA	NA	**NA**
Beaver Habitat	M	M	M	L	M	L	M	**M**
Boreal Toad Habitat	NA	NA	NA	NA	NA	NA	NA	**NA**
Bonneville Cutthroat Habitat	NA	NA	NA	NA	NA	NA	NA	**NA**
Riparian Areas	H	H	M	M	H	M	H	**H**
Fisheries Habitat	H	H	M	M	H	L	H	**H**

Table 4-27 (con't). Priority ratings for all seven Lower East Fork Subwatersheds, as identified by technical advisory committees. Issues highlighted in blue are addressed in detail in this chapter.

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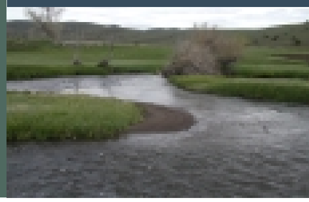
Chapter 5



TMDL/Water Quality Analysis

Water Quality

This chapter provides a summary of the water quality assessment, issue identification, pollution load allocation and recommendations established in the Total Maximum Daily Load development for the Upper Sevier Basin. The complete TMDLs, submitted to the EPA on April 1, 2004, are provided in Appendix H.

Water Quality Standards

This section addresses water quality impairments for streams and lakes within the Upper Sevier Basin through the establishment of Total Maximum Daily Loads (TMDLs) for pollutants and sources of concern. Segments of the Upper Sevier River have been listed on the 2002 303(d) list of impaired waters (Fig. 5-1). The State of Utah has designated these waterbodies as coldwater (3A) fisheries and impairment of this designated use exists due to a number of pollutants and sources, including habitat alteration, total phosphorus (TP), and total suspended sediments (TSS) and low dissolved oxygen (DO). Upper Sevier River waterbodies and their associated impairment are listed in Table 5-1. While there is one point source in the basin (Mammoth Fish Hatchery) the primary sources are habitat degradation from agricultural activities, nonpoint source pollution from rangeland, summer home development, septic systems, recreational activities, and urban runoff.

Impaired Waters

Utah's Year 2002 303(d) list identifies Panguitch Lake, Navajo Lake and three segments of the Sevier River as being impaired due to water quality numeric exceedences. Impaired waterbodies and pollutants of concern are listed in Table 5-1.

Waterbodies were originally listed on the 303(d) list as low priority for TMDL development. However, the Sevier River TMDL was targeted for completion in 2004 due to the active planning efforts in the watershed guided by local stakeholder groups and the establishment of the watershed as one of the USFS Large-scale Watershed Projects. The completion of this TMDL will not preclude the development of high priority TMDLs that are scheduled for completion.

The listing is based on an intensive water quality survey completed in 1996-1997 by DWQ. The beneficial uses, as designated by the State of Utah (DWQ, 2000b), for the Sevier River are:

- 2B Protected for secondary contact recreation such as boating, wading, or similar uses.
- 3A Protected for cold water species of game fish and other coldwater aquatic life, including the necessary aquatic organisms in their food chain.

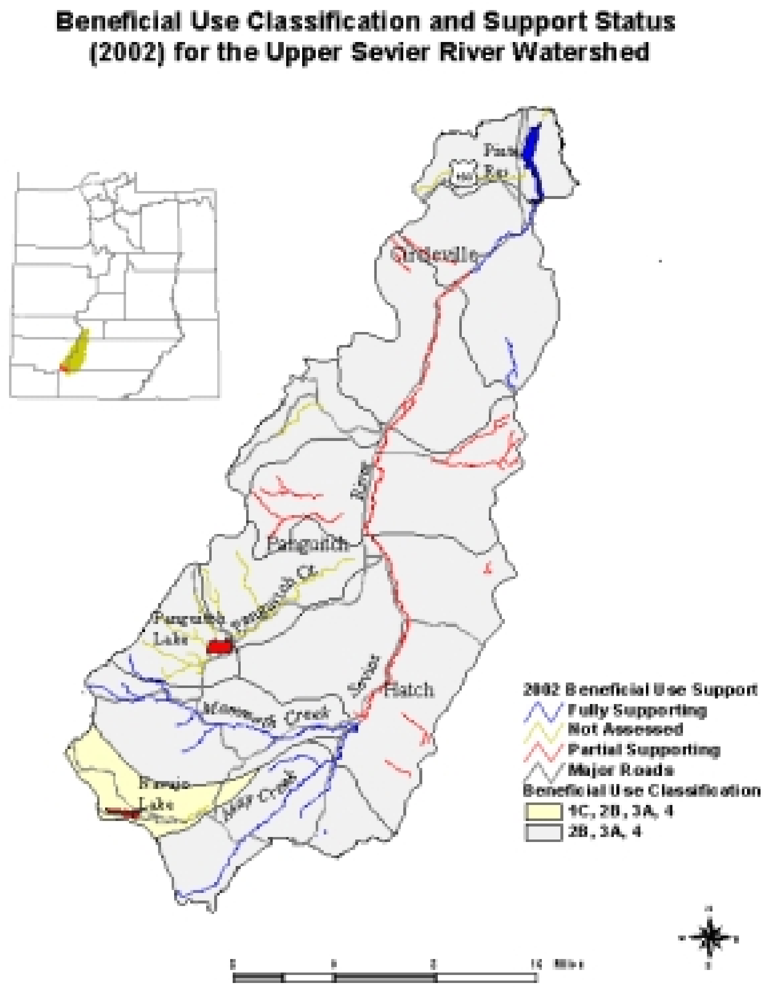


Fig. 5-1 Beneficial use classification and support status (2002) for the Upper Sevier River Watershed.

Waterbody	Waterbody ID	Impaired Use	Cause of Impairment	Priority
Sevier River and tributaries from Circleville Irrigation Diversion upstream to Horse Valley Diversion	UT16030001-005	3A	Habitat Alteration, TSS, TP	Low
Sevier River and tributaries from Horse Valley Diversion upstream to Long Canal Diversion excluding Panguitch Creek, Bear Creek, and their tributaries	UT16030001-007	3A	Habitat Alteration, TSS, TP	Low
Sevier River and tributaries from Long Canal to Mammoth Creek confluence	UT16030001-012	3A	Habitat Alteration, TSS, TP	Low
Panguitch Lake	UT16030001-005	3A	Total Phosphorus, Low DO	Low
Navajo Lake	UT16030001-005	3A	Low DO	Low

Table 5-1. Impaired waterbodies and pollutants of concern (2002 303d List).

3C Protected for nongame fish and other aquatic life, including the necessary aquatic organisms

in their food chain;

3D Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.

4 Protected for agricultural uses including irrigation of crops and stock watering

Water Quality Standards and Impairments

Utah water quality standards (Utah WQS) (State of Utah, 2000, UAC R317-2) and the 303(d) listing criteria (UDEQ - DWQ, 2002) provide the criteria to make an initial assessment of water quality conditions. The Utah water quality standards establish a narrative criteria for coldwater fishery (Class 3A) waters (Table 5-2). While additional designated uses exist for the waters of the Upper Sevier River, 3A classification carries the strictest criteria for the pollutants of concern (POCs).

DWQ lists any waterbody assessed as 'partially supporting' or 'not supporting' its beneficial uses on the 303(d) list with the exception of those waterbodies for which a TMDL study has already been completed and approved by the EPA. According to DWQ's assessment of the Upper Sevier River, segments of the river are not meeting beneficial uses associated with coldwater fishery (3A) . The 303(d) listing criteria provide guidance on evaluating beneficial use support status based on the number of violations of the water quality criterion as listed in Table 5-3.

Table 5-4 displays the monitoring stations and the number and percentage of samples exceeding the criterion of 0.05 mg/l for total phosphorus. This information was compiled from data collected during 1996-97.

Target Parameters	Criterion Maximum Concentration
Total Suspended Solids*	35 mg/L
Total Phosphorus*	
-Streams	0.05 mg/l
-Lakes	0.025 mg/l
Dissolved Oxygen	
-Lakes	4.0 mg/l

*Pollution Indicators. TSS criterion no longer part of the State of Utah Water Quality Standards

Table 5-2. Utah Water Quality Criteria for Class 3A Waters.

Linkage Analysis

Upper Sevier River

The State of Utah Division of water Quality adopted pollution indicator values for TSS and TP of 35 mg/l and 0.05 mg/l, respectively. Recently, narrative criteria for TSS were removed from state water quality standards (UDEQ, 2003). While exceeding these values did not automatically prompt listing on the 303d list, additional information was required to validate impairments. In March and November of 1996, the Division of Water Quality sampled macroinvertebrates and developed metrics using the Biotic Condition Index (BCI). The average BCI for the site near Circleville (STORET # 494945) was 65.5 or "Poor" rating, indicating tolerance to sediment and nutrients which supports the water chemistry data. Impairment based on "Habitat Alteration" was determined by the Upper Sevier Watershed Steering Committee as the primary cause of instream impairment and potential sources of sediment from streambank erosion. Sedimentation and siltation affect fisheries and aquatic resources by covering and eliminating gravel spawning beds, covering fish eggs (which reduces oxygen supply and survival of eggs and fry), and reducing the amount of habitat available for aquatic invertebrates that are an important part of the food chain.

An assessment of the fishery performed by the Utah Division of Wildlife Resources (Kimball, 1998)

Degree of Use Support	Conventional Parameter	Toxic Parameters
Full	Criterion exceeded in less than two samples and in less than 10% of the samples if there were two or more exceedences.	For any one pollutant, no more than one violation of criterion.
Partial	Criterion was exceeded two times, and criterion was exceeded in more than 10% but not more than 25% of the samples.	For any one pollutant, two or more violations of the criterion, but violations occurred in less than or equal to 10% of the samples.
Non-support	Criterion was exceeded two times, and criterion was exceeded in more than 25% of the samples.	For any one pollutant, two or more violations of the criterion, and violations occurred in more than 10% of the samples.
Non-Support (3A Lakes)	Any lake profile with >50% of water column below the 4.0 mg/l DO criterion.	

Table 5-3. 303(d) criteria for assessing beneficial use support.

STORET	Location	Number Exceeding Criterion	Number of Samples	% Exceeded	Mean Conc. (mg/l)	Support
494945	Circleville Canyon	11	20	55%	0.09	Non-Support
494964	Sevier above Sanford Ck.	7	16	44%	0.079	Non-Support
494966	Sevier R. East of Panguitch	4	14	29%	0.075	Non-Support
494963	Sevier R. at U12 Crossing	6	18	33%	0.063	Non-Support
494970	Mammoth Creek	5	15	33%	0.051	Non-Support
494990	Asay Creek	3	16	19%	0.021	Partial Support

Table 5-4. Exceedence report for total phosphorus for selected stations 1996-97.

also found that conditions were inadequate to support a viable fishery in most areas of the Upper Sevier River: "Based on the electroshocking surveys and the long-term personal knowledge of regional fishery biologists, UDWR recognizes that trout populations, recruitment, and yearly survival in the main Sevier River above Annabella Diversion, lower Asay Creek, lower Mammoth Creek…and other basin water bodies are well below the standards necessary for these waters to be considered supporting a cold water game fishery."

During the development of this TMDL the DWQ modified its water quality standards in 2003 by removing the statewide criterion of 35 mg/l TSS for coldwater fisheries due to concerns that it may not be appropriate for all coldwater fisheries statewide. Therefore, this TMDL will address TSS as it relates to "Habitat Alteration" and associated impacts on the existing biological community (e.g. macroinvertebrates).

Panguitch Lake

A major problem experienced in Panguitch Lake is oxygen depletion in the water column. This problem stems largely from decomposition of macrophytes and phytoplankton, which represent a considerable biological oxygen demand in the hypolimnion where they settle. When stratified, the hypolimnion has the potential to become anoxic through much of the profile. Historic fish kills have also occurred due to the lack of oxygen in the water column.

According to the period of record for the deepest site on Panguitch Lake (594948) approximately 86% of the depth integrated samples gathered from 1980 to the present exceed the state criterion for total phosphorus of 0.025 mg/l.

Similarly, dissolved oxygen minimum values are not being met for Panguitch Lake to support a coldwater fishery. In the years from 1997 to 2003, 27% to 56% of the water column was below the 4.0 mg/l criterion (mean of 41%).

Diatom flora in Panguitch Lake was identified as part of the Clean Lakes Study and was found to be highly productive and diverse. The dominance of diatom species such as *Stephanoiscus minutula* and the dominance of Cyanophyta such as Aphanizomenon and Anabaena is particularly indicative of eutrophic conditions.

Navajo Lake

The main problem experienced at Navajo Lake is oxygen depletion under winter ice. This problem stems largely from decomposition of macrophytes and algae; macrophytes grow rather profusely during most summers. The dissolved oxygen depletion under winter ice is not a recent problem in Navajo Lake; it dates back to initial formation behind the dike over 60 years ago (DWQ, 1996).

While some historic dissolved oxygen data exist for Navajo Lake, most sampling has occurred during the summer months when the lake is well mixed and exhibits high DO values. However, according to the Utah Division of Wildlife Resources, some degree of fish mortality occurs each year during the winter months as the shallow lake ices over and macrophyte decay depletes the dissolved oxygen (Hepworth, 2003). Management of the fishery has included the piping of spring water into the lake to increase dissolved oxygen levels and create a refuge for trout to over-winter. However, measurements of dissolved oxygen near the spring outfall which range between 4-6 mg/l drop rapidly within a 50 foot radius of the spring to below 1 mg/l. Trout survival is highest during years when spring flow is high and more oxygen rich water is entering the lake and when Utah chub population (and thus competition with trout for refuges) is low. Rotenone treatment of the chub population has resulted in higher trout survival over the winter months (Hepworth, 2003).

Upper Sevier River

Surface and Groundwater Hydrology

The headwaters of the Upper Sevier River primarily originate from the high Markagunt Plateau and are formed by the confluence of Asay and Mammoth Creeks near the town of Hatch. From there the river flows generally north through the Panguitch Valley, through Circleville Canyon and into Circleville Valley where it is fully utilized for irrigation. Inflows to Paiute Reservoir are primarily composed of flow from the East Fork Sevier River and recharge in the channel of the Sevier River.

With the exception of the irrigation season, flows are greater at the downstream station near Circleville (Fig. 5-2). An average of approximately 68,400 acre-ft of water is diverted from the river and its tributaries in the Panguitch Valley during the irrigation season. According to a study by the Utah Department of Natural Resources (1993), of this irrigation water, approximately 33% or 22,950 acre-feet is consumed by crops. The remaining irrigation water discharges to streams and groundwater as tailwater, valley fill recharge and leakage from canals (11,110 acre-ft, 21,500 acre-ft, and 12,840 acre-ft, respectively). With the exception of a small stream section near Hatch, the length of the Upper Sevier River through Panguitch Valley is a gaining stream. The river is heavily influenced by irrigation diversions particularly near Panguitch, where several complete diversions are operated (Fig. 5-3).

In addition, the entire flow of Panguitch Creek is diverted and used for irrigation southeast of the town of Panguitch. As a result, much of the flow in the channel downstream of Panguitch is recharge from groundwater and tailwater from irrigation. Several areas of irrigation return flow from fields were identified during SVAP surveys and were present throughout the length of the valley associated with flooded pastures.

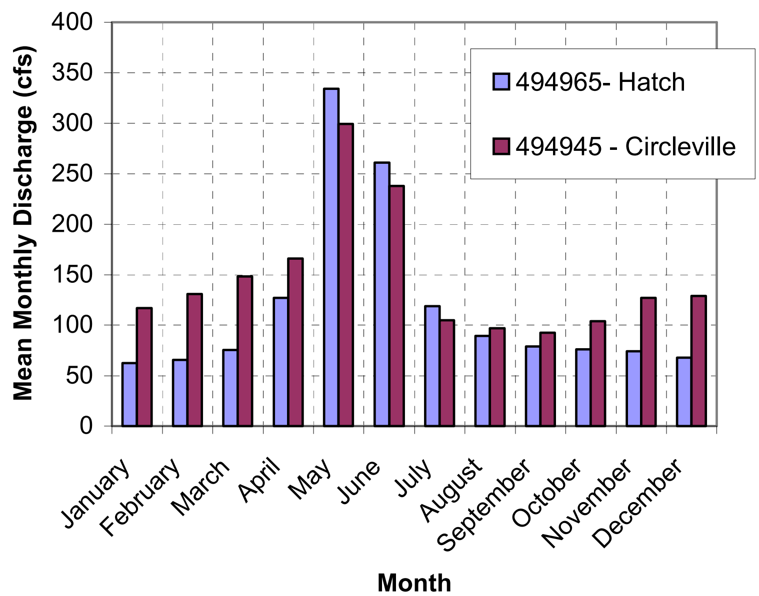


Fig. 5-2. Available flow data for the Upper Sevier River, showing the mean monthly discharge for two stations on the river, located near Hatch in the upper watershed and the lower river in Circleville Canyon.

Nonpoint Sources of Pollution

Natural Sources

Within natural forested landscapes mass erosion such as geological creep, and to a lesser degree slump and debris avalanches, are the dominant upland erosion processes. After intense wildfire, surface erosion is a dominant factor.

In valley bottoms, stream channel erosion, including both bed and bank erosion, may deposit materials into the channel, where transport, storage and deposition may influence stream integrity. Prior to European settlement, stream channels in this watershed were most likely in dynamic equilibrium, and experienced natural erosion processes. Stream riparian habitat most likely consisted of mosaics of thick willows and late seral grasses. Cottonwood and willow communities were present at lower elevations along the Sevier River. Expansive and diverse riparian grasses, along with willow and cottonwood, helped reduce sediment influx, maintained coarser stream substrate, contributed to cooler stream temperatures, and supported normal flow regimes. As with sediment, natural sources of nutrients exist in every watershed, derived from parent material, sediment and inputs from organic matter deposited in or near streams. While headwater streams tend to

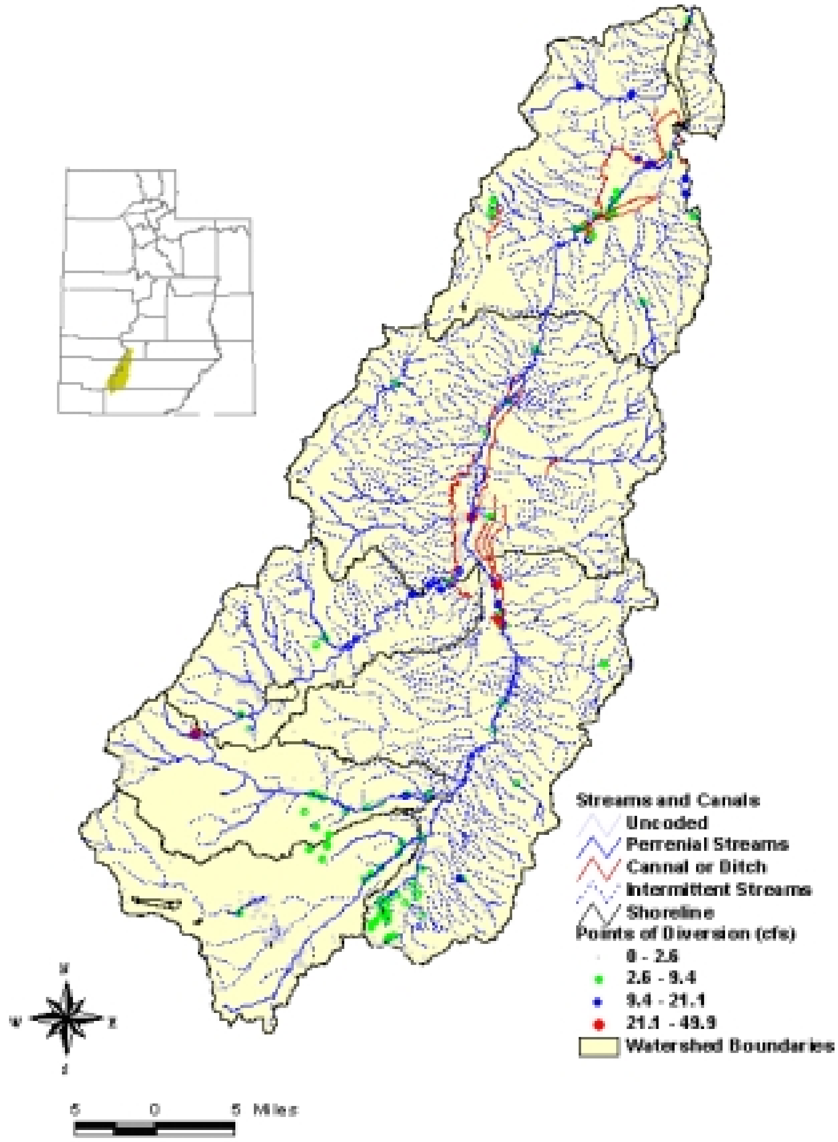


Fig. 5-3. Irrigation diversions on the Upper Sevier River and tributaries (DWR, 2003).

be less productive than lower elevation rivers, historical accounts of the Upper Sevier River area suggest streams and lakes in the area were productive and contained abundant fish.

Human Sources

As early settlers moved into the Upper Sevier River area, surface erosion processes have become more prevalent in areas where road constructing, mining, timber harvest and grazing occur. Roads have increased surface and mass erosion rates beyond those associated with natural watershed disturbances. An extensive network of roads constructed in areas such as stream bottoms and un-stable land types has resulted in large scale mass erosion. Like roads, livestock grazing and silviculture can alter the hydrology of a watershed, reducing protective vegetation and infiltration, and increasing the magnitude of runoff events. Grazing and recreation in stream channels and riparian areas reduces the stability of banks and results in erosion of bank materials to the channel and receiving waterbodies. In addition to sources from erosion, nutrient enrichment from livestock waste can result from grazing in the stream channel, flood irrigation of pasture land and runoff from animal feeding operations.

Fig. 5-4. Stream reaches assessed using the Stream Visual Assessment Protocol (SVAP).

An extensive survey using the Stream Visualization Assessment Protocol or SVAP (USDA, 1998) was completed in October of 2002 on a total of 65 stream miles on the Upper Sevier River and Mammoth Creek (Fig. 5-4). Selected results pertaining to streambank condition are contained in Table 5-6. In addition to SVAP additional erosion information was derived using the Streambank Erosion Condition Index or SECI (USDA,). SECI is essentially an erosion hazard index used to estimate bank erosion in combination with simple measurements such as bank height, length, and soil bulk density. Results of the SECI survey are included in Appendix I.

Reach	Channel	Riparian	Bank	Fish Cover	Invertebrate Habitat	Riffle
1	6.3	8.6	8.3	9	10	8
2	9	3	5	10	7	8
3	3	3	2	4	2	3
4	10	9	10	10	10	7
5	8	5	3	5	7	3
6						
7	9	10	10	10	10	8
8	8	1	3	5	6	10
9	6	1	7.5	1	1	5
10	7	8	9	10	10	9
11	4.5	1	2	4	3	8
12	5.3	2.3	4.1	2.5	5.6	
13	4.7	4.7	3.7	6	8	8.3
14	4.7	6.3	5.7	4.3	5.3	6
15	7.3	4.7	4	4.3	4.6	4
16	6.3	5	8	4.5	6.5	9
17	8	4	7	5	7	7
18	7.6	3.8	6.5	4	6	6
19	7.5	6.3	5.5	4.5	3.5	2.5
20	3	1	2.5	4	6	4
21	8	7	7	8	7	4
22	3	3	3	5	7	4
23	8	4	5	5	7	2
24	7	2	1	3	1	4
25	8	8	5	3	3	8
26	2	1	1	2	3	2
27	2	1	1	2	1	2
28	7	4	6	2	1	1
29	2	1	3	3	3	2
30	3	1	4	3	4	5
31	6	1	1	1.5	1.5	3
32	6	1	1.5	1	1	3
33	6	1	2	1	1	3

Table 5-5. Selected SVAP scores for reaches along Mammoth Creek and the Upper Sevier River.

In addition, waterbody assessments were developed by the Watershed Steering Committee in 1997 and are summarized in Appendix H. These assessments rated the current conditions and feasibility for restoration and recommended BMPs for improvement of water quality and habitat.

A major concern in the upper watershed tributaries is the concentration of summer home development near streams and lakes. The Human Uses work group for the Upper Sevier Community Watershed Project identified key issues associated with human uses in the watershed. The group estimated approximately 4,163 developed lots in the Strawberry Valley (841), Duck Creek (1450), Swain's Creek (1,107), and Strawberry Point - Zions View (765) subdivisions, all currently using septic tanks. In the Mammoth Creek watershed they identified approximately 1,114 developed lots in the Ireland Meadows (36), Meadow Lakes Estates (445), Rainbow Meadows (90), and Tommy Creek (194) areas. As development continues to increase, impacts to surface and groundwater from poorly designed, located and installed septic systems may be a potential problem particularly since the claron-limestone and volcanic substrates present from Duck Creek to Panguitch Lake are not suitable and conducive to septic system use. Dispersed recreation associated with these developments, in areas where few or no sanitary facilities exists, may also potentially impact surface and groundwater. While local effects of these developments may occur in surface waters, monitoring data are inadequate to determine loading to tributaries and the effects to the mainstem of the Sevier River is uncertain. In addition, use of tributary flow for irrigation (e.g. Panguitch and Mammoth Creek) may reduce the loading from these sources.

Point Sources of Pollution

There is only one point source in the Upper Sevier Watershed (a*rea referred to as Basin in this repor*t). Located on lower Mammoth Creek, the Mammoth Creek Fish Hatchery is operated by the State of Utah Division of Wildlife Resources. The Mammoth Creek Fish Hatchery is currently out of production due to contamination by whirling disease. The facility went off-line on July 22, 2002 and will remain under investigation to determine sources of contamination of the disease.

	Flow (cfs)	TP (mg/l)	TP Load (kg/day)
Mean	3.03	0.11	0.77
Max	4.1	0.24	1.67
Min	2	0.06	0.4

*Based on monthly sampling from 5/1996-4/1997 and 7/2001-6/2002

*Table 5-6. Summary statistics for Mammoth Creek Fish hatchery**

Discharge from the facility varies only slightly, with a mean of 3 cfs (Table 5-6). The yearly load of TP, based on monthly averages from the available data set, is approximately 299 kg/year. This represents approximately 33% of the TP load in Mammoth Creek near its confluence with the Upper Sevier River at station 494970. Outfall data is the only data available for the facility; therefore, phosphorus load into the facility from spring sources cannot be determined. Additionally data upstream of the facility is incomplete and loading capacity of the stream cannot be determined at this time. Therefore, loading from the hatchery will be discussed in terms of its relative contribution to the total phosphorus entering the Sevier River at the mouth of Mammoth Creek.

Water Quality Analysis

Total Phosphorus

Mean total phosphorus concentrations and loads were calculated by sorting data by month and obtaining monthly averages (see Appendix J for summaries). Loads are highest during April and May, which corresponds with the spring runoff (Fig. 5-5). The sharp drop in loading in the middle and lower river during June may reflect the effect of irrigation diversions reducing flows and concentrations due to land application. Loads remain low in the upper river the remainder

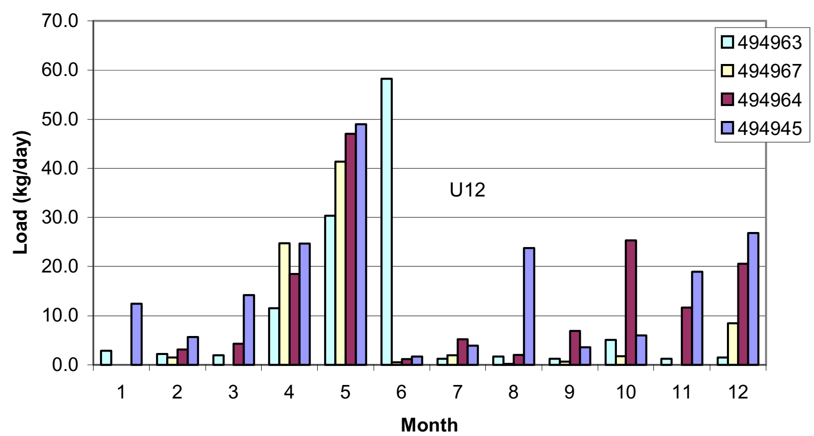


Fig. 5-5. Mean total phosphorous laods for selected station on the Upper Sevier River.

of the year while higher loads in the lower river reflect irrigation return flows and streambank erosion from higher fall stream flows. In addition, levels may increase in downstream reaches as a result of over-wintering of livestock in the Panguitch Valley.

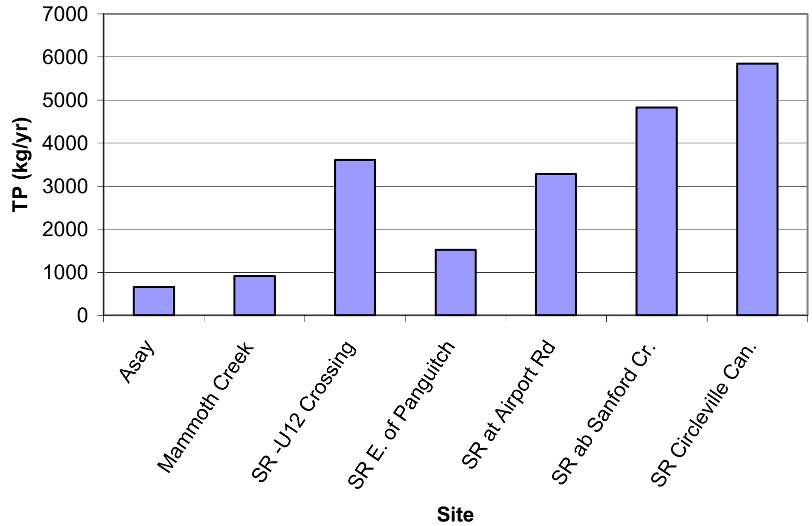


Fig. 5-6. Annual phosphorus loads for selected stations on Mammoth Creek and the Sevier River.

Annual loads were calculated by averaging monthly loads and multiplying by 365 days in the year. In general, loads increase with downstream reach. The exception to this trend occurs at 494963 (Sevier River at U12 Crossing) in June that may be due to higher flows in this reach that is located upstream from major irrigation diversions. The site 494966 (Sevier River East of Panguitch) is located below a major diversion that accounts for the lower TP loads observed at this site (Fig. 5-6).

Dissolved phosphorus appears in surface waters usually from sources of organic nutrient enrichment such as a wastewater treatment plant, animal feedlot waste, or other point source discharge. Examination of ratios of dissolved to total phosphorus concentrations can be used to indicate whether sources are predominantly organic in nature as is the case when high ratios are found in surface water. Ratios were calculated for selected sites on the Upper Sevier River, Asay and Mammoth Creeks (Fig. 5-7).

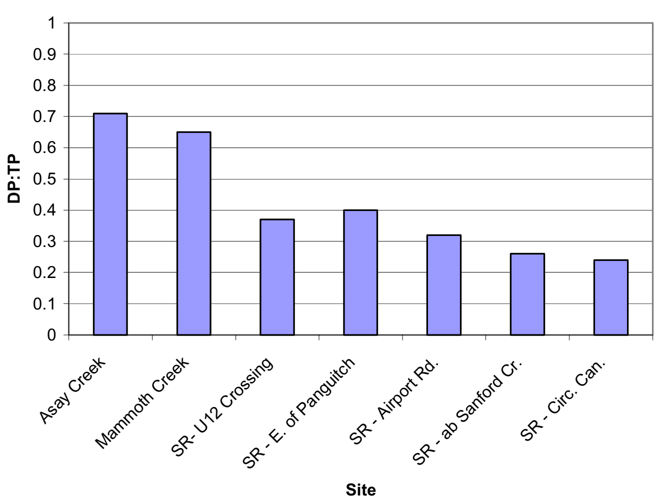


Fig. 5-7. Dissolved to Total Phosphorus ratios at selected sites within the Sevier River Watershed.

Ratios of DP to TP were low (0.24) in the lower river suggesting that TP was not readily bio-available but adhered to soil or sediment particles. Conversely ratios in Mammoth and Asay Creeks were high (0.65) indicating organic enrichment related to sources such as the Mammoth Fish Hatchery, grazing and high numbers of septic systems from home development in both the Asay and Mammoth creek watersheds.

In addition to dissolved to total phosphorus ratios, correlations between TP and Total Suspended Solids (TSS) were graphed (Fig. 5-8). While the relationship between TSS and TP is not particularly strong for the entire dataset (R2 = .45) the majority of high phosphorus measurements (> 0.05 mg/l) occur when TSS is also high. Analysis of the dataset for Asay Creek (494990) reveals a similar relationship between TSS and TP (R2 = 0.49) while Mammoth Creek (R2 = 0.002) did not bear a relationship,

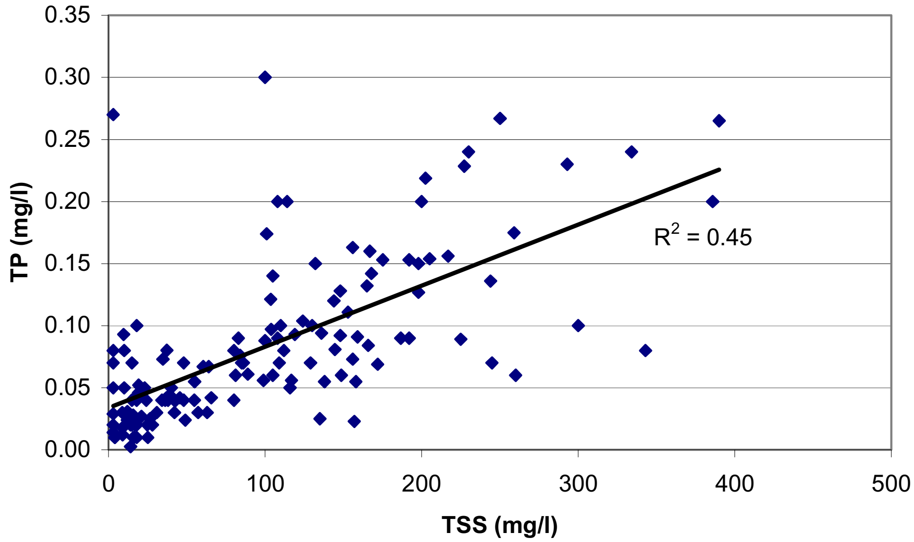


Fig. 5-8. Correlation of Total Phosphorus to Total Suspended Solids at Station 494945 (Circleville Canyon)

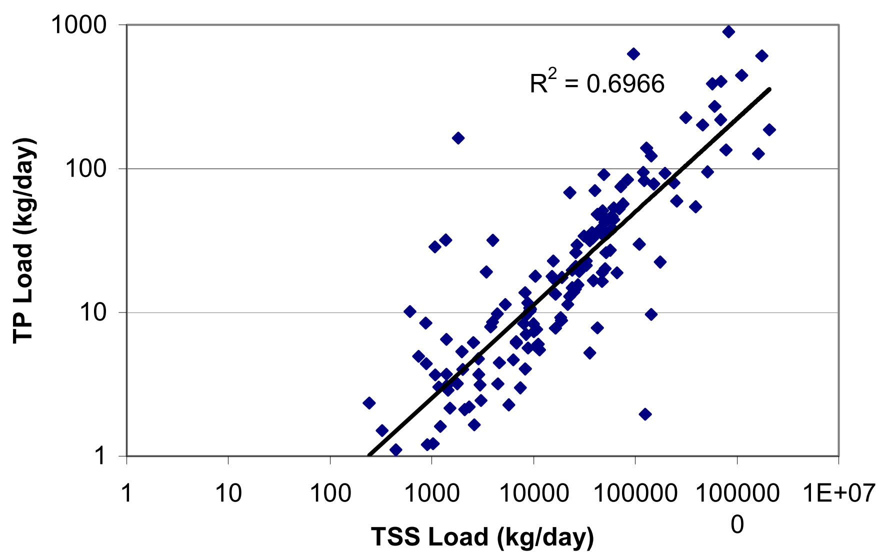


Fig. 5-9. Regression analysis of total phosphorous and total suspended solids at Station 494945 (Circleville Canyon)

thus indicating that TP concentrations are not likely a function of sediment-borne phosphorus, but primarily organic in nature.

In addition, regression analysis of the relationship between TP load and TSS load (Fig. 5-9) provides stronger evidence that high loads of TP are flow related and associated with high sediment loads.

TSS

Mean total suspended solids (TSS) concentrations and loads were calculated by sorting data by month and obtaining monthly averages (see Appendix K for summaries). Loads are highest during April and May, which corresponds with the spring runoff (Fig. 5-10). The sharp drop in loading in the middle and lower river during June may reflect the effect of irrigation diversions reducing flows and concentrations due to land application of river water. Loads remain low in the upper river the remainder of the year while higher loads in the lower river reflect irrigation return flows and streambank erosion from higher fall stream flows.

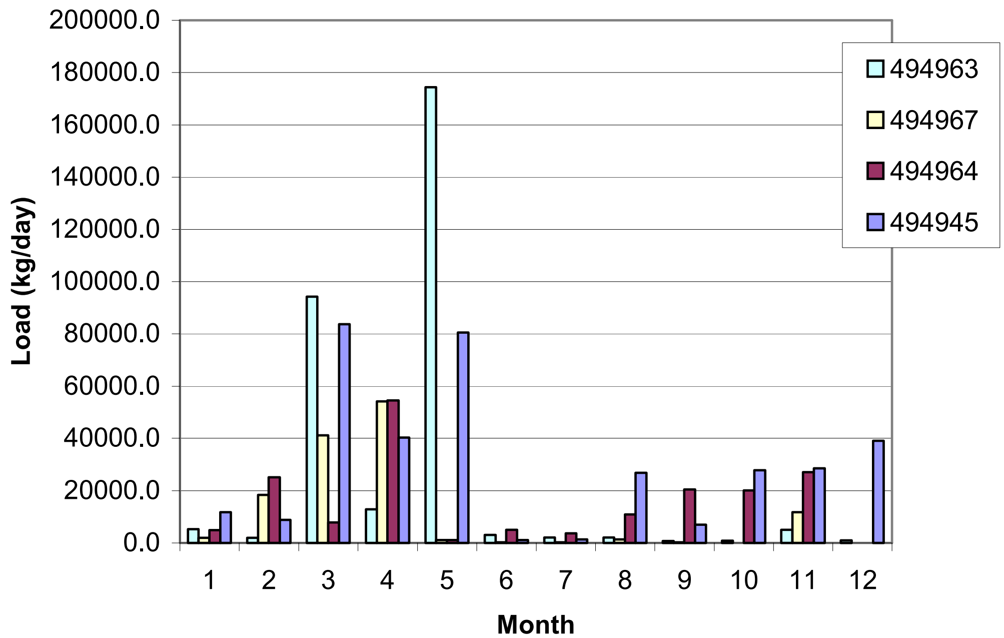


Fig. 5-10. Mean total suspended solids loads for selected stations on the Upper Sevier River

As is typical of streams with snowmelt-dominated hydrographs, TSS values generally peak in the months of spring runoff as tributary inflows and bank erosion from high flows contribute sediment to the system. A notable exception can be seen in May values, where irrigation withdrawals not only affect discharge, but also the TSS load. Peaks in TSS load early in March and April may be a result of low elevation snowmelt mobilizing sediment from valley bottoms and foothill rangeland. The lower river (represented by 494964 and 494945), exhibits an increase in TSS load as stream flows increase in the lower river after irrigation season. In this situation, streambank and in-channel erosion is most likely occurring from increased flows from groundwater recharge and fall storm events. However, analysis of the correlation between flow and TSS concentrations for the period of record at 494945 did not show TSS to be well correlated to flow (R2 =.28)

TSS Concentrations at 494963 were highly variable from year to year. Data from 1996-7 averaged 46 mg/l while 2001-2 data averaged 1008 mg/l TSS (with several dates exceeding 1500 mg/l). It is not recommended that TMDLs be based on TSS data for waters in this basin. TSS doesn't actually reflect the overall sediment load present in the stream and therefore, TMDL endpoints related to TSS will not be established in this study.

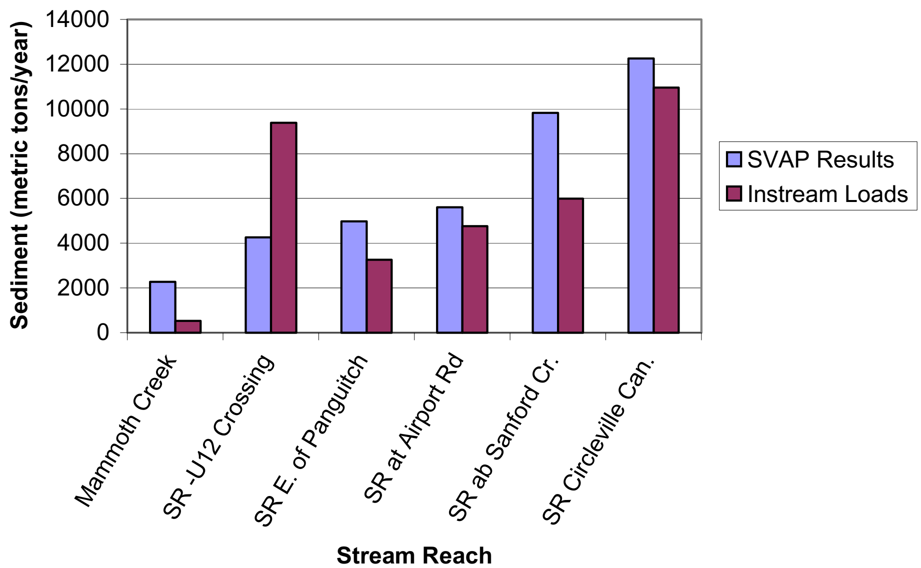


Fig. 5-11. Estimated cumulative contribution of sediment from streambank erosion along Mammoth Creek and the Sevier River.

Relative increases in sediment as TSS as measured in instream loads from water quality data mirror the increases predicted during the survey using SECI protocol. While the SECI estimates the total amount of sediment delivered to the stream from the volume of material being lost each year, TSS only measures the suspended fraction of sediment transported in the stream. The estimates of streambank erosion would be expected to be higher since not all of the material entering a stream would be suspended in the water column but comprise bed load as well. Since the SECI survey was incomplete and did not include other tributaries we would expect the sediment contribution to be much greater. The site at SR at U12 crossing exhibited extremely high TSS values in the 2001-02 intensive sampling season that is responsible for the spike in TSS load at this site. In addition, numerous irrigation withdrawals in the area upstream of Panguitch may regulate the amount of TSS in the river since in some cases the withdrawals are complete dry dams and the water is flooded onto fields to the east of the Valley. The monitoring station 494966 (Sevier River East of Panguitch) is one such site, located below a complete diversion that had resulted in lower observed stream flow and loads for both TSS and phosphorus.

Habitat Alteration

Stream habitat conditions on the Sevier River have long been a concern and a major contributor to the impairment of the fishery. Eroding banks, sedimentation, and a lack of woody vegetation are readily apparent causes of habitat alteration on the river. These conditions prompted the Steering Committee to organize a stream survey using the Stream Visual Assessment Protocol (SVAP) developed by the NRCS. Utilized in a number of watersheds around the state, SVAP is a generalized tool integrating primarily visual assessments of physical, biological, and chemical condition of streams. Although not a monitoring tool, the protocol is well suited to comparing a given stream reach to a potential reference site or ranking reaches for restoration priority. In addition to compiling information fish habitat, macroinvertebrates, vegetation, nutrient impacts, channel condition, and hydromodification, the teams also completed the Stream Erosion Condition Index (SECI) forms that provided some estimation of sediment delivery to the river from eroding streambanks. SVAP scores and SECI erosion estimates for the 65 miles of stream surveyed are contained in Appendix J. Scores for elements in SVAP that are most indicative of habitat alteration are listed in Table 5-5.

Note that reaches 1-8 are located on Mammoth Creek and reaches 9-33 extend from the confluence of Mammoth and Asay Creeks to Circleville canyon (see Fig. 5-4).

In the SVAP, "channel condition" is categorized by human altered streams (berms, dikes, riprap, channelization, etc.) and streams exhibiting excessive lateral cutting, incisement, or aggregation. Regardless of the particular activity or hydrologic effects to the channel, this rating addresses the level of channel alteration from a natural channel. The average score for channel condition for reaches on the Sevier River was 5.6 (Poor to Fair). Reaches upstream from Panguitch that scored poorly in this category typically were impacted by the presence of Highway 89 that constrains the floodplain and in places the river is channelized and bermed. Channel condition is impaired in the lower reaches due mostly to excessive lateral movement and stream downcutting, although in some areas riprap and other attempts at containing the channel have been attempted.

The scores for "riparian zone" reflect the extent to which the floodplain is vegetated (10 = at least 2 active channel widths on each side of stream) or denuded of natural vegetation (1= less than 1/3 channel width and/or not regenerating). For this element, the word natural means plant communities with (1) all appropriate structural components and (2) species native to the site or introduced species that function similar to native species at reference sites. The average score for the riparian zone for reaches on the Sevier River was 3.3 (Poor). In all but a few cases, the majority of the Sevier River has very little natural vegetation on its floodplain, particularly in the lower river where there is an absence of regeneration, heavy grazing pressure, and an incised channel that has isolated the stream from its historic floodplain.

"Bank stability" is the existence of, or the potential for, detachment of soil from the upper and lower stream banks and its movement into the stream. This element primarily incorporates bank height and deep-rooted vegetation for determination of scoring. The average score for bank stability for reaches on the Sevier River was 4.2 (Poor). Since this element depends on the presence of deep-rooted plants, the lack of bank stability can be directly related to the absence of a natural or functioning riparian zone.

"Fish Cover" measures availability of physical habitat for fish. The potential for the maintenance of a healthy fish community and its ability to recover from disturbance is dependent on the variety and abundance of suitable habitat and cover available. The average score for fish cover for reaches on the Sevier River was 3.7 (Poor). This average reflects a typical stream reach which would have 3-4 types of fish cover, and for reaches on the Sevier River these would typically include riffles, undercut banks, boulder/ cobbles, and occasional deep pools and large woody debris.

Similar to fish cover, "invertebrate habitat" measures the number of substrates available for insects and invertebrates to occupy. Substrate refers to the stream bottom, woody debris, or other surfaces on which invertebrates can live. Optimal conditions include a variety of substrate types within a relatively small area of the stream. The average score for insect habitat for reaches on the Sevier River was 4.3 (Poor), which would translate to approximately 3 types of substrate, comprised primarily of coarse gravel, cobble, and undercut banks.

"Riffle Embeddedness" measures the degree to which gravel and cobble substrate are surrounded by fine sediment. It relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation. The average score for riffle embeddedness for reaches on the Sevier River was 4.7 (Poor). This score is indicative of a system in which sedimentation from tributaries and bank erosion and hydro-modification (irrigation withdrawals) have resulted in excessive bed load of sediment and fines.

In general, the reaches assessed using the SVAP, describe a stream heavily impacted by grazing and roads that has resulted in de-vegetation of the riparian zone, unstable banks, channelization and a stream that lacks in-stream habitat for insects and fish due to excessive sediment. Deriving value from the SVAP assessment requires the establishment of reference conditions for all or some of the elements of the protocol. One such potential reference site would be found on reach 7 on lower Mammoth Creek. Although impacted by other factors such as nutrient enrichment from upstream sources which is reflected in its final rating of "Fair", (there were no "Good" condition reaches identified in this survey) this may be a feasible reference site for the habitat elements listed in Table 5-6. Lower Mammoth Creek above highway 89 is relatively un-impacted by human activity such as grazing since its floodplain is isolated by the highway and steep canyon walls. The suitability and appropriate indicator elements will be further discussed below when endpoints for habitat alteration are determined (see below).

Water Quality Targets and Endpoints

Total Phosphorus

Total phosphorus loads were calculated using DWQ data from the intensive monitoring surveys completed in 1996-97 and 2001-02. Data were sorted by month, concentrations were multiplied by flow and a conversion factor, and monthly loads were summed to obtain a yearly instream load. Loading capacity was calculated in the same fashion by substituting the state criterion of 0.05 mg/l where data exceeded that criterion. Load reductions necessary to ensure that state standards are not violated are summarized in Table 5-7.

Although, Total Suspended Solids (TSS) loads were calculated using DWQ data from the intensive monitoring surveys completed in 1996-97 and 2001-02 (Table 5-8), as previously discussed TSS endpoints will not be established to evaluate the restoration of water quality defined endpoints. Data were sorted by month, concentrations were multiplied by flow and a conversion factor, and monthly

Station	TP Conc. (mg/l)	TP Load (kg/yr)	TP Load Capacity	Reduction (kg/yr)	% Reduction
Asay Creek at Mouth	0.021	665	574	92	14
Mammoth Cr. FH	0.11	299	135	164	55
Mammoth Cr. at Mouth	0.048	945	654	291	31
Sevier @ U12	0.023	1871	1528	343	18
Sevier E. of Panguitch	0.033	1525	931	594	39
Sevier @ Airport Road	0.046	2564	1536	1028	40
Sevier R. AB Sanford Cr.	0.062	3999	2078	1921	48
Sevier (Circleville Can.)	0.079	5846	2583	3263	56

Table 5-7. Annual total phosphorous concentrations, loads, loading capacity, and load reduction.

Station	TSS Conc. (mg/l)	TSS Load (Mton/yr)	TSS Load Capacity	Reduction (Mton/yr)	% Reduction
Asay Cr.	40	940	466	474	50
Mammoth Cr.	21	521	326	195	37
Sevier @ U12	501	9378	1459	7919	84
Sevier E. of Panguitch	44	3268	735	2533	78
Sevier @ Airport Road	69	4769	1727	3042	64
Sevier R. AB Sanford Cr.	88	5992	1626	4366	73
Sevier (Circleville Can.)	189	10967	1911	9056	83

Table 5-8. Total suspended solids loads and loading capacity at selected stations.

loads were summed to obtain a yearly instream load. Loading capacity was calculated in the same fashion by substituting the old state criterion of 35 mg/l where data exceeded that criterion. Load reductions necessary to ensure that state narrative standards for 3A coldwater fisheries are not violated were determined but are presented here as support information that excessive TSS are present in impaired waterbodies.

TMDL Allocations

Total Phosphorus

Point Sources

Mammoth Creek Fish Hatchery is currently the only point source in the Upper Sevier Basin. Measured loads are relatively constant and average 299 kg/year. This load represents approximately 33% of the load in Mammoth Creek measured at the mouth. In addition, Mammoth Creek Fish Hatchery contributes approximately 16% of the load in the Upper Sevier River as measured at the U12 crossing (494963). While reduction in total phosphorus from the hatchery may not have a profound effect on instream loads and concentrations in the Sevier River, the hatchery is a major contributor to the load in Mammoth Creek that, though not listed for TMDL development, does exceed the phosphorus criterion in 33% of the dataset.

The Mammoth Creek Fish Hatchery ceased production due to an infestation with whirling disease in July of 2002, which corresponds with the end of the dataset used in TMDL. Additional discharge data after production stopped is inadequate to assess the relative contribution of the facility while not feeding and rearing trout. Also, a lack of upstream or inflow data precludes the accurate estimation of the facility's phosphorus contribution to Mammoth Creek. Some data exist for a site located above the hatchery located at the USGS Station (494979) from the period of 11/2002 to 7/2003 which indicate that concentration in Mammoth Creek is low with a mean total phosphorus of 0.028 mg/l. Stream flow data from the USGS

station were obtained and phosphorus loads estimated to be approximately 500 kg/year TP. Although the dataset above the hatchery is incomplete, limited data suggest that instream concentrations are low and upstream loads are consistent with load estimates for nonpoint sources in the watershed (~650 kg/year TP). Sources of total phosphorus downstream of the facility are limited since Mammoth Creek enters a canyon above its confluence with the Sevier River and grazing is absent in that reach.

The newly designed facility is not expected to change in terms of its production level, inflows or outflows, since these are determined largely by their spring water source. The facility will be rebuilt to limit the infestation of whirling disease and will likely utilize a microfiltration system (Wilson, 2004). This system may reduce total phosphorus entering the plant but currently it is unknown what concentration, if any of particulate-bound phosphorus is contributing load to the hatchery. It has been determined by dye studies that surface waters are infiltrating the spring source for the hatchery (Wilson, 2004). Ultimately, extensive monitoring must occur to estimate this load and to determine the hatcheries contribution to the waste load.

Based on the historical load contribution of the hatchery to Mammoth Creek and the Upper Sevier River (33% and 16% of TP load, respectively), it is recommended that in the future a permit limit be established to protect the fishery in the receiving waterbodies. As a future source of total phosphorus, a wasteload allocation will need to be determined to assess the contribution of the facility to the instream total phosphorus load. Since insufficient data exist to impose this permit limit at this time, its determination will require additional monitoring to assess the water quality of inflows to the facility, sampling upstream of the hatchery and continued monitoring downstream of its discharge. During the process of design for the new facility, it is recommended that the DWR employ best available technology (BAT) for the reduction of total phosphorus in the hatchery's effluent. Some of these BAT may include floating and/or low phosphorus feed and proper management and/or upgrade of settling basins for removal of solids and phosphorus from the effluent.

Nonpoint Sources

As mentioned above, nonpoint sources of phosphorus include natural background sources from the weathering of parent material and organic matter delivered to the streams as soil and plant litter. The movement of nutrients such as phosphorus through a watershed is a complex process since plant and algal uptake plays a strong role in the cycling of nutrients. In addition, the nature of the Sevier River watershed is such that water is continually diverted and land applied and returning to the channel via overland flow and shallow groundwater return flows. In the process, phosphorus (as well as TSS) loads and concentrations can be reduced when irrigation water from the river is distributed to crops.

Water from Panguitch Creek watershed, which is a major portion of the watershed, does not enter the Sevier River via its channel, but is completely consumed by irrigation for the majority of the year. Upon irrigation application, TSS settles out and phosphorus binds with soils or is consumed by crop uptake. As a result, data from stations along the Sevier River in Panguitch Valley may represent the contribution of very localized sources of irrigation return flow, grazing, and streambank erosion occurring between major irrigation withdrawals on the River. Similarly, a station such as 494966 (East of Panguitch) which are located downstream of a major irrigation diversion may not be suitable for calculating an instream load and relating it to land uses and determining an allocation for the watershed upstream. The diffuse nature of sources such as grazing precludes the ability to present allocations in great detail. Consequently, contributions from pollution sources are allocated on a watershed scale since land use is dispersed and essentially uniform. However, priority areas are identifiable in terms of streambank erosion and sediment from upland source, discussed below.

Primary mechanisms of phosphorus delivery from cattle to streams include direct deposition in streams and on streambanks and return flows from flooding of pasture utilized for grazing and/or fertilized with manure. In an effort to estimate contributions of total phosphorus from grazing, cattle numbers were obtained from the landowners in the watershed and were divided by subwatershed (Dodds, 2003). The total number of animals in each watershed varies by season as cattle are moved from summer to winter range, as well as into and out of the watershed. The numbers and loading estimates presented here are based on the numbers of animal in close proximity to a stream or the river with full access to the stream channel. The numbers of animals by reach for each month of the year are summarized in Table 5-9. The location of the sub-watersheds and reaches are shown in Figure 5-12.

Literature values for phosphorus content of manure were used to calculate the gross production of TP from cattle (NRCS,1999), to which an assumed delivery ratio of 10% was applied to estimate the contribution of the total load to the river (Koelsch and Shapiro, 1997).

Overall, it was estimated that approximately 2037 kg/year of total phosphorus is attributed to the presence of cattle in the Sevier River upstream of Circleville Canyon. The load from

Month/Reach	1	2	3	4	5	6	7	8	Total
Jan	50	650	250	100	700	0	250	0	**2000**
Feb	50	650	250	100	700	0	250	0	**2000**
Mar	50	650	250	100	700	0	250	0	**2050**
Apr	50	450	250	100	850	0	250	0	**3000**
May	200	250	450	100	900	250	250	400	**4200**
Jun	200	250	300	1700	600	250	500	400	**4200**
Jul	200	250	300	1700	600	250	500	400	**4200**
Aug	200	250	300	1700	600	250	500	400	**4200**
Sep	200	250	300	1500	500	250	500	400	**3900**
Oct	50	600	250	500	500	0	500	400	**2800**
Nov	50	650	250	200	700	0	350	100	**2300**
Dec	50	650	250	200	700	0	250	100	**2200**

Table 5-9. Cattle numbers by month, stream reach, and subwatershed.

Figure 5-12. Reaches assessed for cattle numbers and loading estimates.

Reach	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Load
1	3.4	3.1	3.4	3.3	13.6	13.1	13.6	13.6	13.1	3.4	3.3	3.4	**90.1**
2	44.1	39.8	44.1	29.5	16.9	16.4	16.9	16.9	16.4	40.7	42.6	44.1	**368.5**
3	16.9	15.3	16.9	16.4	30.5	19.7	20.3	20.3	19.7	16.9	16.4	16.9	**226.5**
4	6.8	6.1	6.8	6.6	6.8	111.5	115.3	115.3	98.4	33.9	13.1	13.6	**534.1**
5	47.5	42.9	47.5	55.8	61	39.4	40.7	40.7	32.8	33.9	45.9	47.5	**535.4**
6	0	0	0	0	16.9	16.4	16.9	16.9	16.4	0	0	0	**83.7**
7	16.9	15.3	16.9	16.4	16.9	32.8	33.9	33.9	32.8	33.9	23	16.9	**289.8**
Total	**132.2**	**119.4**	**132.2**	**124.7**	**149.2**	**236.2**	**244.1**	**244.1**	**216.5**	**159.3**	**141.1**	**139**	**2037.8**

Table 5-10. Load summaries from cattle by month for subwatersheds and river reach.

grazing sources represents approximately 35% of the total measured annual load at the lowest STORET station of 494945. The monthly load contributions from cattle in each reach are shown in Table 5-10. (Note: Panguitch Creek was not included in the assessment since the stream is diverted into sprinkler systems during the majority of the year and does not likely contribute a load from cattle due to the seasonality of grazing in the Panguitch Creek watershed).

Septic Systems

The highest concentrations of summer home development occur in the Asay Creek/Sevier River Headwaters, Mammoth Creek and Panguitch Creek watersheds. Since Panguitch Creek is diverted and land applied for the majority of the year, its load to the mainstem of the Sevier River is negligible. Asay and Mammoth Creeks therefore represent the main tributaries with septic system sources. Simple methods were used to estimate the contribution of systems in these watersheds. The number of developed lots in each area was estimated as part of the Upper Sevier River Community Watershed Project. Assuming an average occupancy of 2.5 persons for 6 months of the year and applying a loading rate of 5 kg/person/year TP (Sarac et al, 2001), the phosphorus content of septic effluent was estimated. Based on best professional judgment a 20% failure rate was applied to these calculations to generate a load for the septic systems in the Mammoth and Asay Creek watersheds to the upper Sevier River. Results of these estimations are presented in Table 5-11.

Total Phosphorus Allocation

The Sevier River is listed as impaired for 3 river segments (see above). Therefore, appropriate water quality stations were selected to determine loading for each reach and to represent compliance points for future monitoring and assessment purposes. Two STORET stations on the Upper Sevier were obvious choices (494945- Sevier River in Circleville Canyon, and 494964 - Sevier River above Sanford Creek) since they are located at the most downstream point of their respective listed river segments (Sevier River and tributaries from Circleville Irrigation Diversion upstream to Horse Valley Diversion and Sevier River from Horse Valley Diversion upstream to Long Canal Diversion, respectively.) The STORET site located East of Panguitch (494966) is not adequate for determining loads and allocations for the segment from the Long Canal Diversion upstream to the confluence with Mammoth Creek since it is located below the diversion and is therefore not representative of the instream loads for that reach. Therefore, 494963 located upstream at the U12 crossing was selected for load calculations and the determination of allocations for this listed segment. For lack of better information on phosphorus content of sediment delivered to the Sevier River, the proportions of the

Waterbody	Upstream Load	WLA	Grazing/ Animal Waste	Septic Systems	Streambank Erosion	Upland Erosion	Measured Load
Asay Creek	-	-	83.7	520	n.a.	n.a.	665
Mammoth Creek	-	299	290	140	89	127	945
Sevier River from Long Canal to Mammoth Creek	1510	-	90	-	108	163	1871
Sevier River - Horse Valley Div. to Long Canal Div.	1525	-	1129	-	538	807	3999
Sevier River -Circleville Irrigation Div. to Horse Valley Div.	3999	-	535	-	739	1108	5846

Table 5-11. Annual total phosphorus load allocations (units are in kg/year).

sediment load from streambank erosion and upland erosion were utilized to partition the remaining TP load after other sources were estimated. Allocations for total phosphorus in the Sevier River are also listed in Table 5-11.

Allocations for total phosphorus load reductions were also estimated for each impaired river segment, including Mammoth Creek and Asay Creek, where feasible (Fig. 5-12). These estimates are based on load reductions achievable through implementation and management practices designed to address major sources (see Implementation Plan for greater detail on recommended BMPs). Where applicable, the influence of upstream load reductions are integrated into the allocation of load reductions within the downstream reach. One area where this was not applied was for the reach extending from Horse Valley Diversion upstream to the Long Canal Diversion. This segment is effectively isolated from the upper river by a series of complete diversions in the vicinity of Panguitch and its flow and instream load is primarily derived from sources within the reach. Therefore, an 18% reduction in TP load was applied to the existing loads below the diversion to estimate the effect of upstream load reductions on the middle segment of the river.

Implementation endpoints and priority areas for BMPs associated with these reductions are discussed in the Implementation Strategy. Note that load reductions proposed for the Sevier River from the Long Canal to the confluence with Mammoth exceeds the actual reductions calculated to meet the loading capacity. This is an added margin of safety since the load for this reach was calculated at station 494963 (U12 Crossing) which is not at the lowest point on the impaired reach and therefore additional implementation is recommended to account for the downstream load not represented in the dataset. The reductions for septic systems were not assessed in this study since it is unclear as to the connectivity between areas such as Duck Creek in the headwaters and the station at 494990 (Asay Creek at mouth). Many of these headwater streams are intermittent and as is the case with Duck Creek, flows are influenced by sinks and underlying volcanic rock and lava tubes.

Total Suspended Solids

Land erosion in the Sevier River watershed was estimated using the Universal Soil Loss Equation (USLE). The USLE (Wischmeier and Smith, 1978) is the most common and best known method to estimate gross annual soil loss from upland erosion. The USLE is an index method having factors that represent how climate, soil, topography, and land use affect soil erosion caused by raindrop impact and surface runoff.

Waterbody	Current Load	Up-stream Reduction	Point Source	Septic Systems	Grazing/ Animal Waste	Streambank Erosion	Upland Erosion	Loading Capacity
Asay Creek	665	-	-	n.a.				574
Mammoth Creek	945	-	*	70	145	45	31	654
Sevier River from Long Canal to Mammoth Creek	1871	382			116	63		1528
Sevier River from Horse Valley Diversion to Long Canal Diversion	3999	275			841	403	402	2078
Sevier River -Circleville Irrigation Diversion to Horse Valley Diversion	5846	1921			401	554	387	2583

* Currently no load reduction is recommended due to insufficient data. The load reductions are therefore distributed among other sources of nonpoint sources.

Table 12. Estimated load redution for impaired river segments (units in kg/yr).

Rather than explicitly representing the fundamental processes of detachment, deposition, and transport by rainfall and runoff, the USLE represents the effects of these processes on soil loss. These influences are described in the USLE with the equation:

where, A is estimated soil loss in tons/hectare for a given storm or period; R is a rainfall energy factor; K is a soil erodibility factor; LS is a slope-length, slope steepness factor; C is vegetative cover factor; and P is a conservation practice

$$A = (R)\,(K)\,(LS)\,(C)\,(P)$$

factor. The USLE factors for the Sevier River watershed were estimated based on available GIS data. The 30-meter digital elevation model was used to derive slope-length and slope steepness and the NRCS STATSGO soils database was used to derive the soil erodibility factor. The results of the USLE analyses for the entire watershed are shown in Figure 5-13. Sediment yield to the river was extrapolated from soil erosion estimates using literature values for the Sediment Delivery Ratio (SDR) based on watershed size (Vanoni, 1975). Sediment delivery by subwatershed is presented in Table 5-13. Note that the total load delivered upstream of Circleville Canyon is not a simple sum of all component watersheds but is rated using the SDR, which is inversely proportional to the size of the watershed.

The erosion results of USLE (before applying the SDR) are displayed in Figure 5-13 in tons of sediment per acre per year. Areas with the highest rates of erosion occur in the foothill rangeland

Subwatershed	Sediment Load (Mt/yr)
Asay Creek	8577
Bear Creek	27933
Bear Valley Junction	67861
Big Hollow	50012
Blue Springs	3746
Butler Creek	6244
Casto Canyon	4799
Clear Creek	3803
Duck Creek	2108
Echard Creek	24351
Graveyard Hollow	22558
Haycock Creek	4225
Limekiln Creek	12864
Lower Mammoth Creek	10272
Middle Mammoth Creek	6017
Mud Spring	21678
Panguitch Creek	9032
Pass Creek	17251
Peterson Wash	34104
Pole Canyon	70087
Proctor Canyon	65381
Red Canyon	27032
Sandy Creek	11694
Sanford Creek	13447
Smith Canyon	23582
South Canyon	17682
Spry	24937
Strawberry Creek	1497
Sunset Cliffs	17219
Swains Creek	1574
Tebbs Hollow	23396
Threemile Creek	12527
Tommy Creek	1205
Upper Mammoth Creek	1143
Upper Midway Creek	842
Upper Sevier Headwaters	7343
Total Upstream of 494945 (Circleville Canyon)	178941

Table 5-13. Sediment delivery by subwatershed.

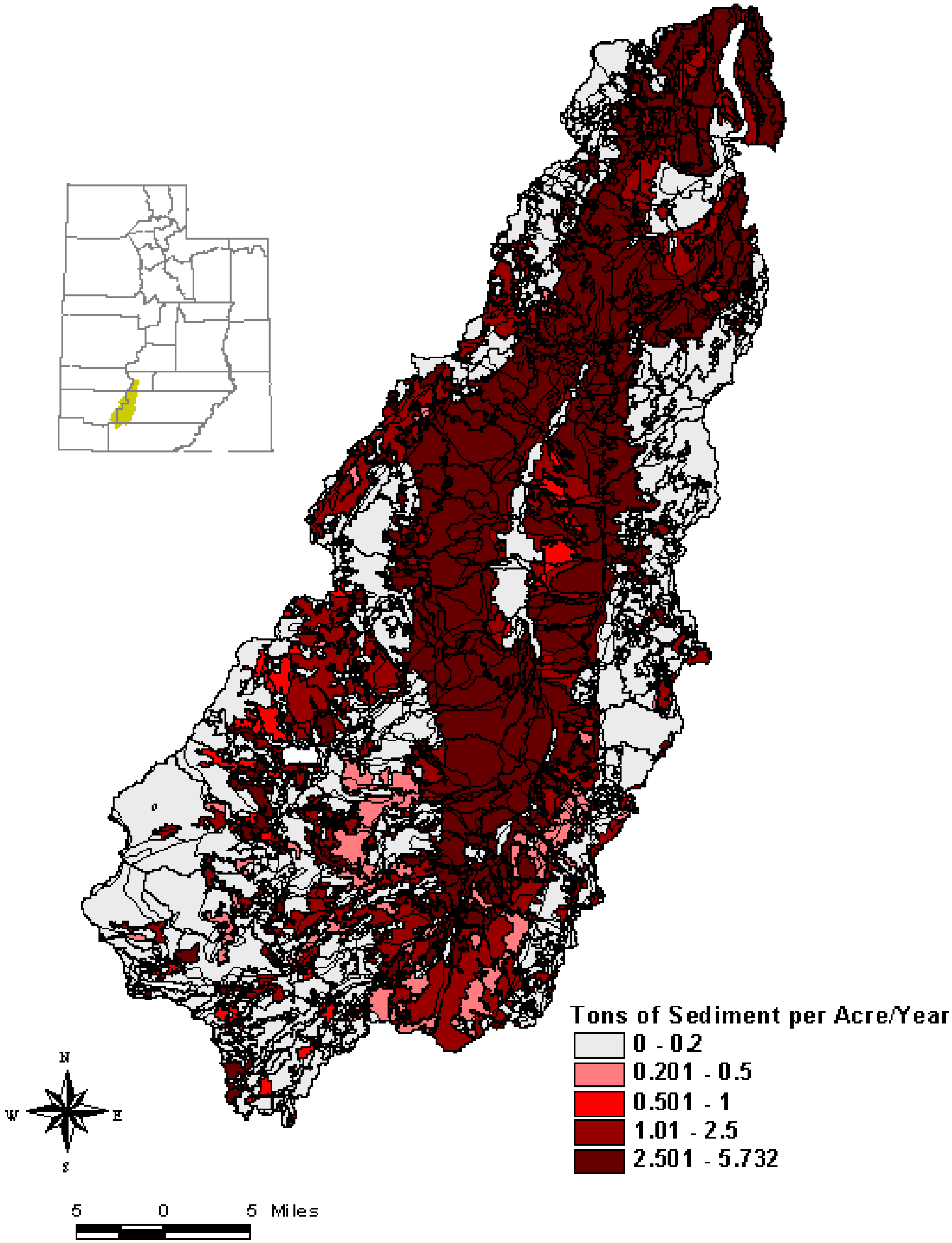


Figure 5-13. Sediment delivery rates (USLE model results).

where soils are highly erodible, conditions are arid and ground cover poor.

Streambank Erosion

Streambank erosion was estimated while performing the SVAP survey applying the Stream Erosion Condition Index (SECI) to the streambank length and average bank height for each reach to determine the volume and mass of bank material lost each year (Table 5-14).

Relating the estimates for the erosion sources directly to instream TSS loads is not possible since water quality grab sampling only measures the fraction of the total sediment load that is in the water column. Furthermore, the sampling protocol used is not a depth and cross-section integrated sample

Reach	Length (ft)	Bank Height (ft)	Erosion Severity	LRR Index Value	Slight Erosion Length	Moderate Erosion Length	Sev Eros Len
1	6302	2.5	Slight	2	6302	0	0
2	11634	4	Moderate	7	0	11634	0
3	18455	4	Severe	10	0	0	184
4	3314	3	Slight	1	3314	0	0
5	15157	3.5	Severe	9	0	0	151
6	16667	3	Severe	9	0	0	166
7	7575	4	Slight	2	7575	0	0
8	4462	1.8	Severe	10	0	0	44
9	2802	5	Severe	11	0	0	28
10	5715	2	Slight	0.5	5715	0	0
11	8153	3.5	Severe	11.5	0	0	81
12	12828	4	Moderate	6.75	0	12828	0
13	13540	3	Moderate	7.25	0	13540	0
14	3402	4	Slight	4	3402	0	0
15	11283	3	Moderate	8	0	11283	0
16	5669	3	Slight	3.3	5669	0	0
17	4272	4	Moderate	6.5	0	4272	0
18	12825	2.5	Moderate	8.25	0	12825	0
19	19905	3	Moderate	6.75	0	19905	0
20	5325	5	Moderate	8.5	0	5325	0
21	9692	3	Moderate	5	0	9692	0
22	12369	5	Severe	9	0	0	123
23	9633	3.5	Moderate	8	0	9633	0
24	16086	5	Severe	10	0	0	160
25	4564	3	Slight	2	4564	0	0
26	25144	6	Severe	11.5	0	0	251
27	15791	2.5	Severe	10	0	0	157
28	10367	4	Severe	10	0	0	103
29	10955	4	Severe	10.5	0	0	109
30	9039	3	Severe	9.5	0	0	90
31	12795	2.5	Severe	10.5	0	0	127
32	7470	2.5	Severe	9.5	0	0	74

Table 5-14. Upper Sevier Streambank Erosion Condition Inventory (October, 2001).

Sediment Source	Delivered Load (Mt/yr)	Ratio of Total	Instream Load as TSS (Mt/yr)
Streambank Erosion	122626	0.41	3713
Upland Erosion	178941	0.59	5343
Total	301567	1	9056

Table 5-15. Sediment allocation at Circleville Canyon.

and may not be representative of the true suspended load of sediment in streams. Therefore, total sediment delivery from estimates of upland and streambank erosion was summed and their relative contributions were applied to TSS loads in the river at the watershed outlet in Circleville Canyon (Table 5-15). Allocations by impaired river segment are not presented here, since no specific TSS load reductions are proposed for the watershed. Therefore, allocations on a watershed scale are presented here for purposes of relative contributions of major sources of sediment.

Habitat Alteration

Results of the habitat assessment from the SVAP survey discussed in this document indicate that the primary impairments of stream habitat are related to streambank erosion, excessive sediment, and nutrient enrichment in the Sevier River. The result of these impacts has been the decline of a once productive fishery and the aquatic life necessary to support the fishery. Therefore, a measurable endpoint for habitat alteration would be the shift in the aquatic macroinvertebrates from sediment and nutrient tolerant species to species indicative of a system unimpaired by sediment and excess phosphorus. Since the SVAP is not a monitoring tool, numeric shifts in habitat scores cannot be utilized to track improvement. However, future SVAP surveys, though inadequate for trend analysis, should demonstrate improved habitat scoring if implementation and management practices are successful, particularly in the areas of bank stability, fish and invertebrate habitat, and riparian zone condition. Since habitat alteration, sedimentation, and total phosphorus sources are strongly linked to grazing and other land management issues, implementation recommendations are intended for primary sources of concern in the stream corridor.

Margin of Safety and Seasonality

A margin of safety (MOS) is a mechanism used to address the uncertainty of a TMDL. The MOS is a required part of the TMDL development process. There are two basic methods for incorporating the MOS (EPA, 1991). One is to implicitly incorporate the MOS using conservative model assumptions to develop allocations. The other is to explicitly specify a portion of the total TMDL as the MOS, allocating the remainder to sources. For the Upper Sevier Basin TMDL, the MOS was included implicitly in the calculation of the loading capacity used to determine TMDLs. Instead of basing the load capacity on the hydrology data and the maximum criterion of 0.05 mg/l TP to determine maximum allowable loads, this analysis only utilized the criterion to replace data that exceeded the criterion, thus retaining data with concentrations below the criterion. This resulted in a lower allowable instream load than if the maximum criterion were used for all substitutions in the dataset. The MOS may be adjusted based on additional sampling of runoff events and further evaluation of the seasonality of loading.

Implementation Strategy

Point sources

The Mammoth Creek Fish Hatchery represents a significant load to Mammoth Creek and the Upper Sevier River. Water quality data exceed the pollution indicator of 0.05 mg/l in 33% of the samples downstream of the hatchery. It is therefore recommended that the permit limit be determined at a level necessary to meet water quality standards. Implementation strategies for the remaining needed load reductions will be achieved through stream restoration and best management practices (discussed below). Currently, the Mammoth Creek Fish Hatchery is off-line but the Division of Wildlife Resources is planning to upgrade the hatchery to prevent contamination from whirling disease. The design for the facility is not yet complete, therefore final phosphorus load limits will be integrated into the facilities permit after adequate monitoring is completed to determine its contribution to the load in Mammoth Creek and the Upper Sevier River.

Nonpoint Sources

As discussed above, the major sources of phosphorus and sediment loading to the Sevier River occur as a result of management activities in the floodplain associated with agriculture, a land use that covers only 15% of the watershed. The Upper Sevier River Steering Committee is currently developing a restoration strategy for the entire watershed, which includes all Federal, State and Private lands. This implementation strategy is designed to guide restoration and management on private lands adjacent to the impaired reaches of the Sevier River. With few exceptions, the Sevier River, from its headwaters at the confluence of Asay and Mammoth Creek, is essentially uniform in its land use, management and habitat condition. Appropriate management practices will have to be tailored to specific situations and management needs, however the following restoration strategy is proposed for the impaired reaches of the river:

1. **Grazing management**: This could include a combination of timing, duration, and fencing to protect streambanks from trampling and limit the introduction of animal waste into canals, ditches and streams. Riparian fencing and pasture rotation are appropriate practices to protect sensitive areas and allow for controlled access to forage. Off-site watering could be provided for cattle that congregate in or near streams or other channels adjacent to pastures.

2. **Streambank restoration**: The re-establishment of woody, deep-rooted vegetation such as willows and sedges is recommend for the majority of the Sevier River from its headwaters to Circleville Canyon. The potential for bank stabilization and erosion control is high since the water table is typically high throughout the year. Practices could include willow pole planting, willow mats, temporary juniper revetments, and other soft bio-engineering techniques. These restoration projects would have to be coupled with grazing management, development of off-site water sources, and permanent or temporary electric fencing to allow for recovery of riparian vegetation. In some cases which were identified during the SVAP survey bank erosion was so severe that the installation of hard structures such as rock barbs or weirs rock may be necessary to direct flow away from re-vegetating stream banks.

3. **Irrigation efficiency and buffers:** In order to reduce the amount of runoff containing sediment and nutrients from field under flood irrigation, it is recommended that irrigation efficiency projects be implemented on fields and pastures adjacent to the Sevier River and its tributaries. Where applicable, vegetative buffers should also be developed to filter nutrients and moderate loss of flood irrigation.

Implementation Endpoints

The following implementation goals and endpoints are based on estimations of the load allocations for each impaired reach and the necessary level of restoration and management necessary to meet water quality standards. Priority status for potential projects was derived from information gathered during the SVAP survey. Results are summarized in Appendix K.

Mammoth Creek

Endpoints for restoration activities include 8 miles of streambank and riparian restoration. This should include a combination of fencing of the riparian corridor, revegetation, and riparian pasture management to control the timing and duration of cattle access to the stream corridor. Project priority should be placed on potential implementation in Reaches 3,5,6, and 8 (see SVAP map above) which exhibited severe erosion rates and poor vegetation structure and canopy cover.

In addition, since this TMDL did not fully address the loading from septic systems in the Upper Mammoth Creek watershed, it is strongly recommended that continues monitoring and inspection of septic systems and their potential impacts to surface and groundwater be evaluated in conjunction with implementation.

Sevier River From the Long Canal Diversion Upstream to Mammoth Creek

Recommended endpoints for implementation include 12.5 miles of streambank restoration to reduce sediment and total phosphorus from erosion and unrestricted grazing in the stream corridor. In addition, fishery habitat in several reaches in this segment are impacted by channelization and berming in proximity to Highway 89, which may require the restoration of natural meanders and riffle/pool structures for fishery habitat. Priority areas for streambank stabilization, fencing and revegetation include the following reaches: 9,11,12,13,15,18,20, and 22.

Sevier River from Horse Valley Diversion Upstream to Long Canal Diversion

This reach, which includes Panguitch Valley, holds the greatest concentration of cattle in the Upper Sevier, as well as receiving the majority of irrigation on pasture/hayland. Therefore, endpoints include the establishment of riparian buffers along 10 of the 13 miles of stream contained in this reach. Several areas in this segment require the additional installation of in-stream structure such as rock barbs and weirs to protect banks, particularly where downcutting and lateral movement is most severe. Reach 25 which was placed in an easement for endangered species of wildflowers and a small section located on the USU Experimental farm demonstrate the potential for the re-establishment of riparian vegetation through planting and the exclusion of cattle from the stream channel. Additional buffers should be placed in areas where flood irrigation returns enter the stream and/or irrigation canals and ditches. Flood irrigation efficiency, where feasible, should be identified and implemented to reduce the erosion of animal waste and sediment from pastures near the river.

Sevier River from Circleville Canyon Upstream to Horse Valley Diversion

This segment of the Upper Sevier River exhibits uniformly severe streambank erosion and poor to virtually absent riparian vegetation. In order to meet the endpoints of the TMDL for this reach it is recommended that 8 miles of streambank reconstruction and re-vegetation be implemented. The majority of this reach will require the installation of hard structures to stabilize severely eroding banks and allow for the re-establishment of riparian vegetation.

Selection Criteria

In addition to the above criteria for priority projects, it is further recommended that implementation proceed initially in the upper watershed where the highest potential for the improvement of the fishery exists. These areas should include Mammoth Creek and the Sevier River from Hatch downstream through the upper Panguitch Valley. In the SVAP survey, these areas exhibited the greatest potential for fish and invertebrate habitat, as well as greatest potential for the establishment of riparian vegetation.

Evaluation and Monitoring Plan

An evaluation and monitoring plan will be implemented to document progress in achieving improved water quality conditions, to review effectiveness of BMP's, and to provide feedback on the direction of overall watershed health. Based upon the results of this monitoring program management strategies and implementation, priorities may change under the direction of the project sponsors. The Division of Water Quality has a strong commitment to demonstration of success of these pollution prevention and remediation strategies, but a limited monitoring budget. The use of volunteer monitoring conducted by watershed stakeholders must be a part of the overall monitoring strategy to develop a more comprehensive assessment of water quality conditions. Studies that present water quality and stream health on a point-in-time basis, before and after project implementation, can be conducted quickly and relatively inexpensively.

Panguitch Lake

Surface and Groundwater hydrology

There are no known groundwater studies of Panguitch Lake or its watershed. The lake basin is probably resting on either limestones or extrusives of the Claron Formation or possibly a basal unit of Brian Head Group, all of which have been demonstrated to produce flowing wells and large springs on the Markagunt Plateau (Gregory, 1949; Doelling, 1975). Limestones underlie much of the area and the Karst (sinkhole) topography in some areas points to the possibility of solution channels and groundwater movement through limestone solution channels. The amount of infiltration into and exfiltration of water from the lake basin is not known.

Springs supply a large percentage of the water in the tributaries to Panguitch Lake. Springs supply virtually all of the water to Blue Spring Creek except for snowmelt runoff. They also supply significant amounts to Castle, Bunker, Clear and Skoots Creeks. Virtually all of the Ipson Creek water after snowmelt runoff is over originates from springs in the upper part of the canyon immediately below Horse Lake.

The Markagunt Plateau contains the headwaters of the Sevier River and contributes more to the river's flow than does any other single plateau of the High Plateaus. Most of the streamflow in the high elevation streams of the watershed occurs during spring runoff from snowmelt. The major

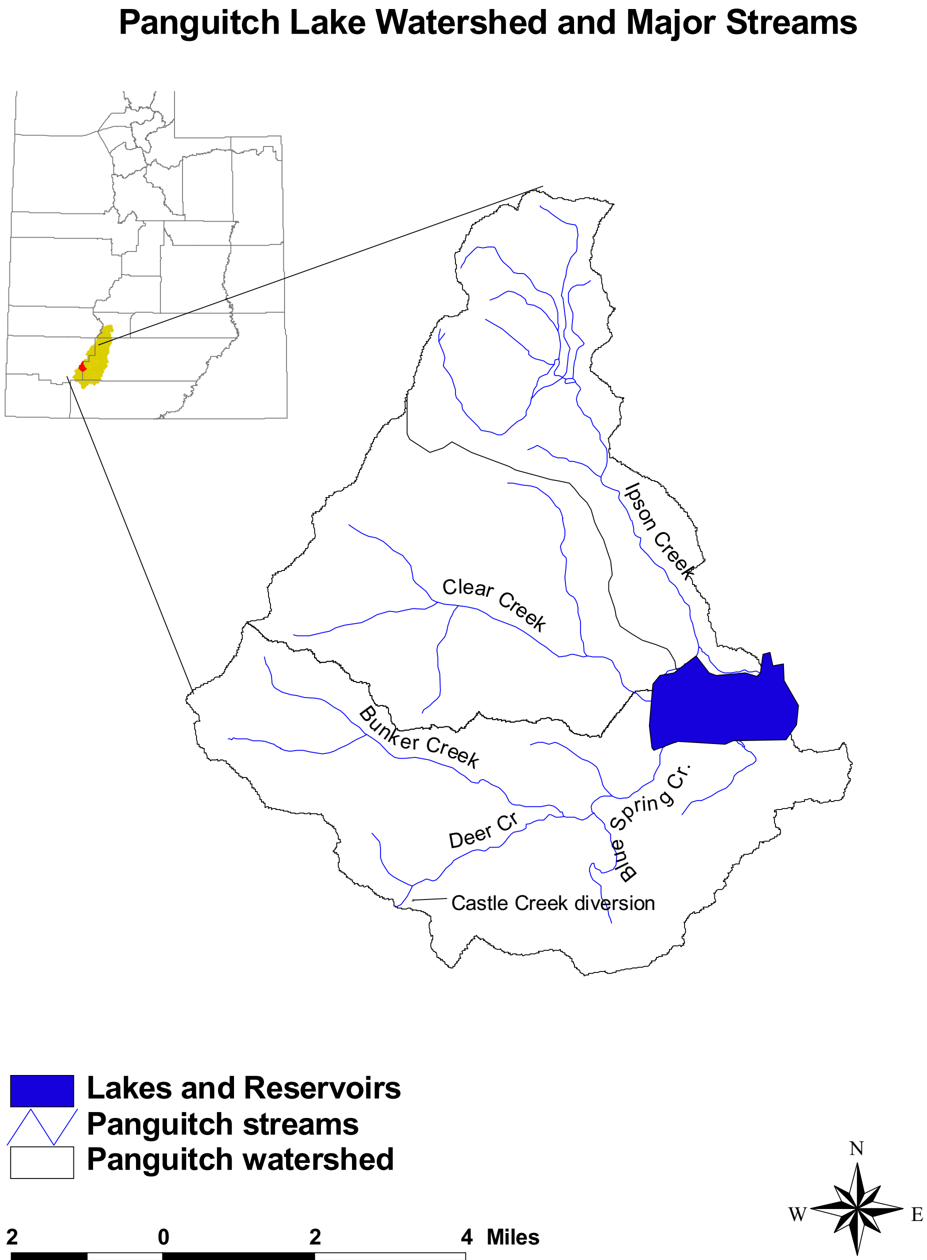


Fig. 5-14. Panguitch Lake watershed and major streams.

tributaries to Panguitch Lake include Blue Spring Creek, Clear Creek, and Ipson Creeks which contribute 12,560, 2731, 1557, and 1257 acre feet per year of the surface flow, respectively. A trans-basin diversion from Castle Creek outside the basin provides a majority of the flow to Deer Creek (a tributary to Blue Spring Creek) thus the high proportion of the streamflow attributed to that watershed.

Nonpoint Sources of Pollution

The Clean Lakes Study delineated and described nonpoint sources and loading from subbasins of the Panguitch Creek watershed (Fig. 5-14)

Ipson Creek

The Ipson Creek subbasin is the smallest of the three tributaries to Panguitch Lake. It encompasses 3,047 hectares (7,530 acres) and occupies the northwestern part of the basin and includes Horse Valley. It covers 25 percent of the basin's total area but supplies only 10 percent of the inflow. Slopes are steep in the lower 6 miles of the stream channel, which is narrow with nearly vertical cliffs. Summer home development is occurring on the slopes in the lower half-mile of the canyon with waste disposal primarily in on-site systems. Cattle are grazed in the lower 6 miles of the sub-drainage and sheep are grazed in Horse Valley. A light duty road from the north shore road runs 10 miles along the east side of the subbasin to and through Horse Valley. Vegetation in the subbasin includes fir-spruce-aspen at higher elevations on north facing slopes. At lower elevations ponderosa pine, juniper, pinyon pine, sagebrush, forbs, shrubs, and grasses are dominant. Horse Valley is covered with grasses, sagebrush, and forbs. Riparian vegetation is good in the lower 6 miles of the subbasin.

Clear Creek

Clear Creek is primarily used for recreation, grazing and summer home development. It comprises approximately 29% of the area of the watershed but only 19% of the flow to the lake. Water from Clear Creek is used for irrigation on meadows west of the lake and flow usually only reaches the lake as spring runoff from snowmelt. Vegetation in the basin is primarily spruce-fir-aspen with ponderosa on south facing slopes. Understory of shrubs, grasses and forbs is good to excellent as are riparian areas in the watershed.

Deer Creek

Due to a trans-basin diversion Deer Creek also contains some of the watershed of Castle Creek. The ditch connecting the watersheds has eroded a deep channel in the steep slope between the watersheds. As a result riparian vegetation is absent and erosion is severe due to high flows. The effects of the extra discharge from the ditch can also be observed in streambank erosion along Deer Creek. The subbasin, which contains 7 percent of the total land area in the basin, produces a disproportionate 29 percent of the total tributary inflow due to the trans-basin diversion.

Bunker Creek

The Bunker Creek subbasin includes the Bunker Creek drainage above its confluence with Deer Creek. About 5 miles of unimproved roads and four-wheel-drive trails exist in the subbasin. Cattle graze throughout the subbasin, which is covered by a spruce-fir-aspen forest with associated grasses, forbs and shrubs. The lower quarter mile of stream crosses a grass meadow at the west end of Blue Spring Valley. Riparian vegetation is good to excellent except in the meadow. Lower Bunker Creek and Deer Creek below their confluence include the meadow area west of Blue Spring Creek's confluence with Bunker Creek. Its streambanks are unstable with very little riparian vegetation. The meadow soils are composed of easily eroded lake bottom sediments that are easily sloughed off into the streams. Vegetation is of meadow grasses and forbs. Cattle are grazed each summer on the Blue Spring Valley meadow which is under private ownership.

Lower Bunker Creek before and after restoration

Blue Spring Creek

The Blue Spring Creek subbasin includes the southern part of Blue Spring Valley and the surrounding hillsides, as well as the high altitude drainages of Bunker, Deer, and Castle Creeks. This is the largest in the study area, encompassing 4,287 hectares (10,595 acres). It occupies only 35 percent of the basin's land area, yet supplies 75 percent of the stream inflow to Panguitch Lake. The source of water is primarily Blue Spring which exhibits uniform flow, resulting in more stable streambanks than Bunker Creek's throughout Blue Spring Valley. The hillsides above the meadow are spruce-fir-aspen forests with some ponderosa pine at lower elevations. Riparian vegetation is good but consists primarily of grasses. Some summer homes are located in the south end of Blue Spring Valley. Water from Blue Spring Creek irrigates the meadows at the southwest corner of the lake. The USFS Panguitch Lake Campground and Guard Station are in the lowest part of the subbasin. Some summer homes are also in the subbasin immediately above the lake. Riparian vegetation below Blue Spring Valley is good. Vegetation is spruce-fir-aspen on north facing slopes and ponderosa pine on south facing slopes.

The Clean Lakes Study identified that a majority of phosphorus loading to Panguitch Lake is delivered to the lake via Blue Springs Creek. Examination of the Blue Springs Creek watershed indicates that the source of most of the phosphorus is naturally-occurring, phosphorus-laden soils in the upper watershed related to erosion in Bunker and Deer Creeks. Riparian vegetation is of high quality in some reaches while in other areas it was identified as poor to nonexistent. The lower section of Blue Springs Creek on the National Forest is of high quality as is the Bunker Creek section on the forest above the Blue Springs meadow. The Clean Lakes Study identified areas of Bunker Creek and Deer Creek from the confluence of Bunker Creek on the private property including the forest up to the transbasin diversion from Castle Valley is of poor to nonexistent riparian quality. This poor condition was due to overgrazing on the private and forest sections and severe floods in 1983-84. Large volumes of water diverted from Castle Valley caused excessive erosion in those reaches.

Since the original Clean Lakes Study a number of successful restoration projects have been implemented in the area near the confluence of Deer and Bunker Creeks (See Photos, above).

The Clean Lakes phase II Study (1989) estimated that below restoration projects TSS concentrations were reduced from 71 mg/l to 3 mg/l and total phosphorus loads were reduced by 73 kg/year. Recent data (see loading analysis below) indicate that the contribution of total phosphorus from Blue Springs Creek has been reduced by 124 kg/year.

According to the Clean Lakes Study, soil sample analysis indicates that many soils on the upper watershed are extremely high in phosphates. Phosphorus levels in Panguitch Lake can be directly attributed to the transport of upper watershed soils through erosion during spring runoff. The additional phosphorus supplied to the lake results in an accelerated rate of eutrophication. Late summer and winter algae blooms with dense macrophyte (weed) growth cause adverse water quality conditions. Spring snowmelts contribute large flows responsible for most erosion. But as was previously mentioned, good riparian vegetation on stream sections such as upper Bunker Creek, effectively hold the soils and prevent most erosion. The large and excess stream flows diverted into the Blue Springs system were contributing substantially to the high phosphorus in Panguitch Lake by eroding away large section of stream banks prior to restoration.

Other minor streams include the other nine subbasins, some very small intermittent stream drainages, the lake, and its surrounding shoreline drainage area. Land unaccounted for in the previous subbasin descriptions has some grazing and is highly used for recreational purposes. Vegetation in the shoreline drainage area is primarily sagebrush, pine, and juniper with a poor cover of associated grasses, forbs, and shrubs.

Nonpoint sources of total phosphorus originate primarily from sediment from streambank erosion, summer home development, and cattle grazing. While cattle grazing has decreased, summer home development has increased significantly, from ~300 at the time of the Phase I Clean Lakes Study to over 750 developed lots today. This increase of septic systems and recreation likely offset some of the nutrient reductions achieved through restoration activities such as installation of fish cleaning stations, streambank restoration in the Blue Spring Creek watershed, and public education.

Point Sources

Currently, no point sources exist within the Panguitch Lake watershed.

Lake Status

The Carlson Trophic Status Index is often used to classify or predict the productivity of a lake compared to typical lakes and is determined by three indicators, chlorophyll a, secchi depth and total phosphorus concentrations. The latter two are typically used as surrogates for the most important indicator of lake productivity, which is chlorophyll a.

Historically, TSI values for Panguitch Lake have demonstrated that it is primarily an eutrophic to mesotrophic system with high levels of primary productivity (measured as chlorophyll a). While TSI values have dipped below 40 (the threshold between meso-and oligotrophy) in 2000 - 2003, there is no discernible trend whether the system is improving or degrading based on TSI values (Fig. 5-15). Secchi depth and TP TSI values were plotted for comparison (Fig. 5-16). While no trends in these alternate measures of trophic status are apparent, there appears to be less variation in their values, particularly in recent years in which chlorophyll a TSI varies widely. Additional monitoring will be helpful to determine whether there is a downward trend in TSI values and improved trophic status.

Similarly, in lake concentrations of phosphorus (Figure 5-17) do not appear to indicate a definite trend. Depth integrated TP concentrations for the period from 1990-2002 at the deep site above the dam (594948) record fluctuate widely, ranging from 0.012 mg/l to 0.230 mg/l. Mean concentration for the dataset was 0.066 mg/l. Similarly, average depth integrated total phosphorus for both lake sampling sites averages approximately 0.066 mg/l.

Biological conditions

Algae - The Clean Lakes Study (1983) found that phytoplankton types and numbers indicated

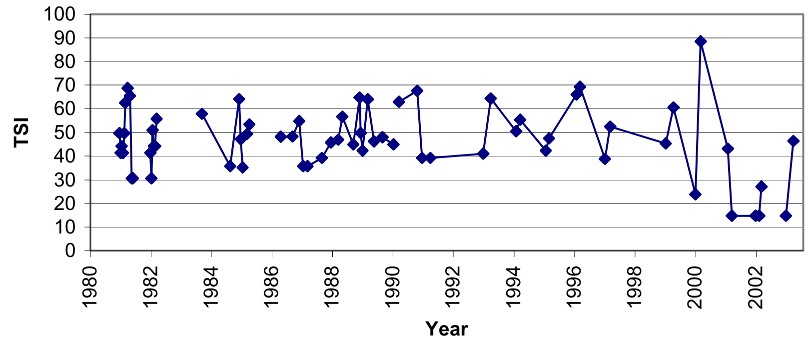


Fig. 5-15.Carlson Chlorophyll a TSI Value by year for Panguitch Lake above dam (1990 to 2003) -594548.

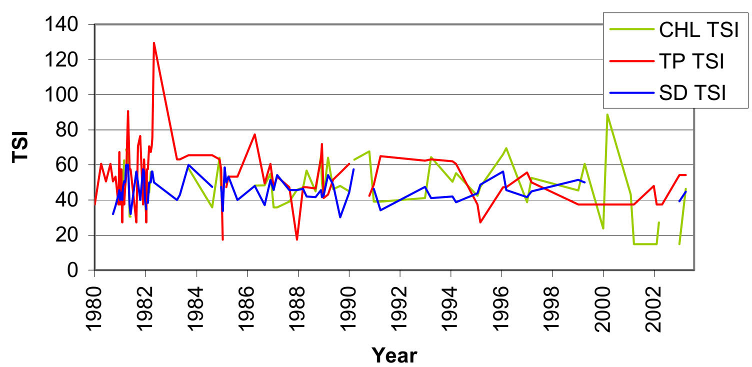


Fig. 5-16. Carlson Chlorophyll a, TP and Secchi Depth TSI Values from Pangitch Lake (1990-2003) - 594545

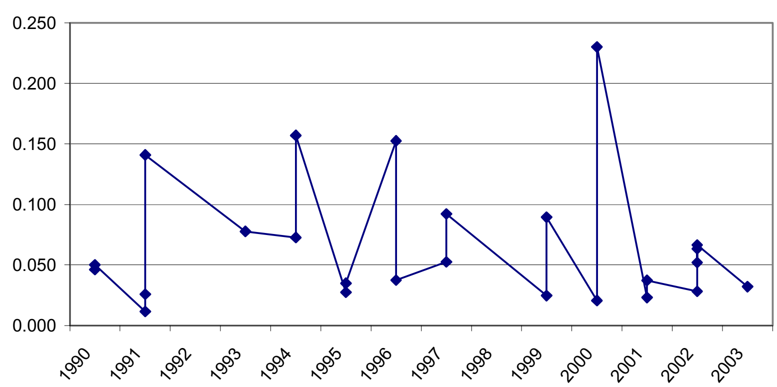


Fig. 5-17. Average total phosphorus concentrations in Panguitch Lake above dam (1990-2003) - 594948.

Panguitch Lake was an eutrophic system. Algal indicators of this eutrophy, Anabaena, Aphanizomenon and Microcystis are abundant in the lake in late summer and fall. According to the Clean Lakes Study, considerable variation in species and numbers was observed at different times but indications were strong that the lake was eutrophic. Similarly, phytoplankton data from samples collected in 2000 and 2002 suggest that Panguitch Lake is still dominated by Cyanophyta species, and exhibit low bulk densities of Chlorophyta species. Aphanizomenon and Microcystis are still the dominant phytoplankton found in the lake.

Macrophytes - Five species of rooted aquatic macrophytes were found in Panguitch Lake during the study, small beds of *Polygonum coccineum* and *Ranunculus aquatilis* occurred in shallow areas on the north, east and southeast shores of the lake with extensive beds of the two species occupying the shallow western shoreline of the lake. In places, the two species occur up to 600 feet from the shoreline. Two species of Potamogeton, *P. filiformis* and *P. Pectinatus* occurred throughout the macrophyte beds with *P. coccineum* and *R. aquatilis* and extended 100 to 200 feet farther out into deeper water beyond the Polygonum and Ranunculus beds. *Myriophyllum spicatum* was found in the boat dock areas and along steeper shorelines as well as the deep water border of the macrophyte beds. There was not a great difference between areas of macrophyte coverage in 1981 and 1982. Fluctuating water levels along the shorelines of reservoirs helps to explain the lower species diversity in reservoirs when comparing them to natural lakes. Panguitch Lake can have a 3 to 8 feet fluctuation in water level annually. As the water drops, the Polygonum and Renunculus areas are replaced by grasses in the newly exposed shore areas.

Water Quality Analysis

The Clean Lakes Study found the highest sediment, nitrogen and phosphorus loading rates were found in the southwestern area of the basin. The highest occur in the lower Bunker Creek subbasin, which had a serious soil and bank erosion problem as it transverses a meadow near its confluence with Blue Spring Creek. The Deer Creek and upper Blue Springs Creek subbasins also exhibited high sediment, nitrogen and phosphorus generation rates. Deer Creek suffers erosion in its upper reaches up to the Castle Valley ditch area and in its lower reaches near the confluence with Bunker Creek. Blue Spring Creek experienced somewhat lower but still high loading rates as it traverses the old lakebed meadow. The Clean Lakes Study found that its erosion problem is minimal compared to that in adjacent Bunker Creek. Since the Clean Lakes Study a number of successful restoration projects have been implemented to address the sediment and phosphorus sources near the confluence of Deer and Bunker Creeks.

The Clean Lakes Study found that orthophosphorus values were high and indicates that a high fraction of the total phosphorus actually measured in the lake water is available for algal growth. Although the Study suggested that total phosphorus loads can be attributed to sediment born (inorganic) phosphorus, data from that study demonstrate that the majority of the total phosphorus load is comprised of the more organically derived and bio-available fractions of orthophosphorus. Recent data also demonstrates that the majority of the total phosphorus load is composed of bio-available dissolved phosphorus (Fig. 5-18).

Although the Clean Lakes Study was based on a greater sampling frequency, the data is over 20 years old, not representative of current loading or land use in the watershed. Therefore, recent data were compiled to estimate annual loading information and mean inflow concentrations (Table 5-16).

Annual loads for the tributaries of Blue Springs, Clear and Ipson Creeks are 448, 31, and 48 kg/year, respectively for a total load of 526 kg/year. For this dataset, Blue Springs Creek provides 85% of the total phosphorus load to the lake compared to the 58% estimated in the Clean Lakes Study. This loading is lower than the 571 kg/year estimated in the original Clean Lakes Study. It is uncertain whether this discrepancy is a function of improved conditions in the watershed or error associated with the dataset, since there is not a complete year round dataset to estimate loading. In addition, much of the seasonal data has been collected during the last few years, which have been marked by drought conditions and lower than normal stream flows.

Figure 5-18. Ratios of dissolved to total phosphorus in tributaries to Panguitch Lake (1990-2003).

Samples collected between 1990 and 2003 were sorted by month, and yearly loads estimated for stations displayed in Figure 5-19. As mentioned above, several months of data are not available for some sites particularly in the early spring when peak runoff typically occurs.

Load allocations were estimated for major sources of phosphorus in the watershed. These include

Tributary	Mean TP (mg/l)	Annual Load (kg/yr)	Mean Flow (cfs)	% Total
Blue Springs Cr.	0.045	447.6	11.1	85.1
Clear Cr.	0.048	31.4	0.7	5.9
Ipson Cr.	0.053	47.6	1	9
Total	-	526	-	100

Table 5-16. Mean inflow phosphorus concentration and loading (1990-2003).

grazing, septics and sources of sediment. Grazing contributions were estimated from information on grazing allotments on the Dixie National Forest and on private lands. The total number of animals in each watershed varies by season as cattle are moved from summer to winter range, as well as into and out of the watershed. The numbers and loading estimates presented here are based on the numbers of animals in close proximity to a stream or the river with full access to the stream channel. Literature values for phosphorus content of manure (~0.02 kg/day/animal) were used to calculate the gross production of TP from cattle (NRCS,1999), to which an assumed delivery ratio of 10% was applied to estimate the contribution of the total load to the river (Koelsch and Shapiro, 1997). In addition, numbers for animals grazing below the high water line on the lakebed were obtained and a higher delivery rate of 50% was applied. It is assumed that when inundated by high water, these areas will provide a higher rate of phosphorus loading to the lake. The 70 cattle, which spend 120 days each year on the lakebed meadows contribute an additional 92 kg/year total phosphorus to the lake in addition to the loading from the tributaries.

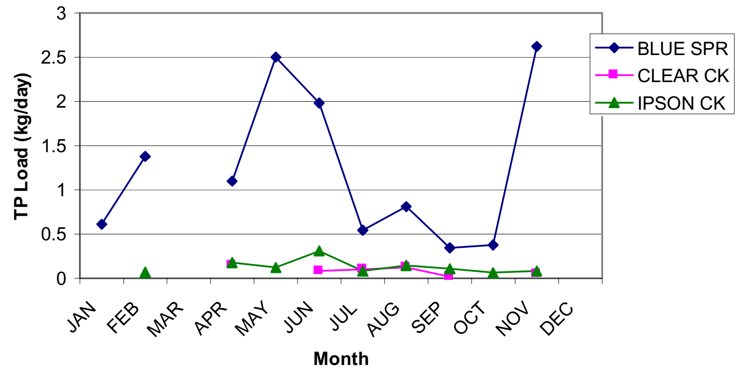


Figure 5-19. Mean monthly total phosphorus loads for tributaries to Panguitch lake (1990-2003).

Source	Ipson and Clear Creeks	Blue Springs Creek	Blue Springs Meadows	Total	% of Total
Sheep	22	2		25	5
Cows		18	82	100	19
Septics				117	22
Upland/streambank erosion				284	54
Total Measured Load				526	100

Table 5-17. Phosphorus allocations by watershed and source type.

Simple methods were used to estimate the contribution of systems in these watersheds and include the following: The number of developed lots in each area was estimated as part of the Upper Sevier River Community Watershed Project. Assuming an average occupancy of 2.5 persons for 6 months of the year and applying a loading rate of 5 kg/person/year TP (Sarac et al, 2001), the phosphorus content of septic effluent was estimated. Based on best professional judgment a 20% failure rate was applied to these calculations to generate a load for the septic systems in the Blue Springs, Clear, and Ipson Creek drainages. Results of these estimations are presented in Table 5-17.

Internal Loading

Sediments have been likened to the "memory" of a lake or reservoir for its previous trophic state. Lakes that are oligotrophic tend to remain that way, despite increasing loadings of phosphorus from the watershed, while eutrophic lakes tend to resist efforts at restoration by making up for reductions in external phosphorus loading by calling on their accounts of sediment phosphorus stored during previous months or years. However, not all sediments "bank" their phosphorus with the same efficiency. The efficiency depends on the chemical mechanisms responsible for storing phosphorus in a particular lake sediment.

Possible storage mechanisms can be broadly categorized into four forms: exchangeable-P, iron-P, apatite-P, and organic-P. The first form is the most readily lost from the sediments, but pool sizes are often relatively small. The majority of iron-P represents a much larger pool of stored phosphorus in many lake and reservoir sediments, and the size of this pool is highly correlated with the rate of release of phosphorus from lake sediments at times when the water overlying such sediments is anaerobic. This form of P also has sediment if sediment is suspended into the water column by winds, spring runoff, or overturn of the lake water column. Apatite-P may form in calcium-rich sediments from decaying algae or iron-P, but it is often more closely associated with inputs of suspended solids eroded from the watershed. Once formed, it is permanently removed from circulation with the overlying water or algae. Organic-P consists predominantly of highly unavailable phosphorus associated with humus, although a smaller fraction may become available for circulation after a sufficient period for decomposition.

The sediment chemistry outline above suggests that the deep lake sediment could support low to moderate rates of P release under anaerobic conditions. Laboratory incubations of intact sediment cores that aerobic P release averaged 0.2 mg/m2-day over a 45 day period, while P release under anaerobic conditions increased to 14 mg/m2-day. These rates must be related to the hydrologic regime of the reservoir in order for predictions to be made of the exact corresponding impact. However, they may be compared to estimate release rates of 8-12 mg/m2-day for the lower reaches of the arms of Flaming Gorge Reservoir and Deer Creek Reservoir, or 15-50 mg/m2-day for some eutrophic Canadian and European lakes. Not only are the Panguitch values relatively small, but the "equilibrium" concentration of P maintained by the sediments with the overlying water is much lower (300-350 ug/l) than that observed for other intermountain reservoir sediments.

In general, the Clean Lakes Study asserted that sediments of Panguitch Reservoir indicate that the potential for internal phosphorus loading is relatively low, provided that the reservoir is managed properly. If the central basin can be prevented from becoming anoxic, P release can be expected to be quite low, and the reservoir should return to a much lower trophic state than was observed in the early 1970s or in the early decades of this century. In addition the Study claimed that the actual trophic state would depend primarily on the rate of external P loading and if loads were reduced anaerobic conditions near the sediment water interface and thus sediment loading would be minimal.

$$P = \frac{W'}{zQ + v_s} = \frac{W'}{9.404}$$ where

P = Inlake TP concentration (mg/l)
W' = Areal loading rate ($g/m^2/yr$)
z = Mean lake depth (m) = 6.4 m
Q = O/V (where O= lake outfall and V=lake volume*) = 0.66
v_s = $k_s z$ (net settling velocity in m/year) = 5.18 m/yr
k_s = $Q^{0.5}$ = 0.81

Fig. 5-20. Phosphorus Response Model.

Lake Modeling

Source	Load (kg/yr)	Loading rate ($g/m^2/yr$)[1]
Tributaries	526	0.103
Other drainage	78	0.015
Precipitation	51	0.01
Grazing in lake bed	92	0.02
Internal sediment loading	2158	0.424
Total	2822	0.5542

[1]Obtained by dividing load by lake area (5.09×10^6 m^2).
[2]Utilized as W' in Vollenwieder model equation

Table 5-18. Loading estimates for Vollenweider model.

The Vollenweider model (1976) was utilized to analyze the phosphorus loading and compare loading rates to observed in-lake phosphorus concentrations. The basic equation and model inputs for Vollenweider's phosphorus response model are summarized in Figure 5-20. The model is useful in relating the inputs of phosphorus to a lake to the in-lake concentration of total phosphorus. Conversely, loading rates can be estimated from the in-lake concentrations and compared to measured loads from tributaries and other sources.

Utilizing this response model and the aerial loading rate from measured tributary loads results in a predicted in-lake concentration (P) of 0.014 mg/l, much lower than the observed mean concentration measured in the dataset from 1990-2003 of 0.066 mg/l. Conversely, predicted aerial loading from the observed in-lake TP concentration (3159 kg/yr) was much higher than the loading estimated from stream sampling data (526 kg/yr). Internal lake sediment loading rates and literature atmospheric loading rates were applied to the total aerial loading rate in an effort to account for the higher observed lake concentrations. The Clean Lakes Study measurement of sediment samples estimated that sediment loading ranges from 0.073 to 5.11 g/m2/yr under aerobic and anaerobic conditions, respectively. Adjustments were made to the duration and lake area under anaerobic conditions utilizing lake bathymetry, lake profile data, and best professional judgment. These included the estimation that anaerobic conditions occurred on average approximately 85 days/year over only 30% of the lake area. Based on these considerations, a sediment loading rate of 0.4244 g/m2/yr was utilized for the phosphorus response model. A summary of the loading estimates is included in table 7.

Model results yielded a predicted in-lake concentration of 0.059 mg/l TP which is comparable to the observed mean concentration of 0.066 mg/l. The sediment loading rate corresponds to 2158 kg/yr which is approximately 4 times that of tributary loading. Therefore, it is likely that with current internal loading Panguitch Lake will continue to exhibit high in-lake concentrations of TP, continued algae blooms, and re-suspension of phosphorus from anaerobic sediments.

Implementation Strategy

The following represents a suite of management and restoration options for the improvement of the water quality and fishery of Panguitch Lake. These recommendations are based on analysis that suggests that limited opportunities exist for achieving load reductions from tributaries and nonpoint sources and that internal sediment loading is the dominant source of phosphorus to the lake. However, fishery management alternatives associated with lake treatment for the removal of phosphorus will require extensive review by Division of Wildlife Resource staff to determine the appropriate measures that should be taken.

Option 1: Chemical Precipitation of Phosphorus.

Lake restoration through chemical treatment has been demonstrated to be a successful method for the reduction of in-lake P concentrations (SDPR, 2003; Welch and Cook; 1999). Usually treatment consists of the application of alum (aluminum sulfate) or lime (calcium hydroxide and/or calcium carbonate), which bind with phosphorus in the water column, forming precipitates which settle to the lake bottom. In the case of alum, an aluminum hydroxide floc forms after application, which reacts with phosphorus creating an insoluble form aluminum phosphate. Once settled on the bottom this floc can also react with and stabilize sediment phosphorus. Lime application supersaturates the water with $Ca2+$ and precipitates phosphorus as hydroxyapatite. In addition, lime can also induce the flocculation of phytoplankton and the removal of biomass from the euphotic zone. Both resulting precipitates are resistant to re-suspension or release of soluble phosphorus under anaerobic conditions. The effectiveness of these methods depends on a variety of conditions and depend largely on the control of additional sources from tributaries. In a study of eutrophic lakes in Canada, Prepas, et al (2001) found that successive treatments with lime improved water quality for up to 7 years, reducing in-lake phosphorus concentrations between 70 - 91%, Chlorophyll a concentrations were reduced 93% after 6 years of treatment. In addition, phosphorus release rates from sediment were reduced 77% during the winter and 37% during the summer. Similarly, alum treatment has been shown to be effective on a number of U.S. lakes, controlling phosphorus for an average of 8 years and reducing internal phosphorus loading by more than 80% (Welch and Cooke,1999).

Additional information would be required to determine the appropriate treatment and application rates to treat Panguitch Lake. Typically, chemical treatment is a cost effective method of reducing lake phosphorus and internal loading, particularly compared to the cost-benefit ratio associated with nonpoint source restoration projects. Since the eutrophic loading rate from tributaries is currently very low, the likelihood of achieving the in-lake phosphorus endpoints from watershed restoration and BMPs is low. Therefore, it is recommended that the Division of Wildlife Resources adopt this option as an approach to reducing the internal loading of phosphorus and meeting water quality endpoints in Panguitch Lake.

Option 2: BMP Implementation

Restoration activities should also be pursued in the Panguitch Lake tributaries to reduce, where feasible, phosphorus and sediment loading to the lake. Chemical treatment of lakes was most successful in cases where external loading was low (Welch and Cooke, 1999). Therefore, reasonable effort should be made to implement the following restoration activities.

1. Since the number of summer homes has increased in the watershed to over 700 developed lots, it is recommended that the Upper Sevier River Steering Committee work with local Health Department officials to assess the impact of on-site systems and identify where systems could be improved or replaced.
2. Streambank restoration efforts should continue particularly in the Blue Spring Creek watershed, which contributes the highest load of phosphorus to the lake. Streambank restoration should include grazing management strategies to control the timing and duration of cattle

access to limit the degradation of stream habitat from grazing.

3. Prohibit grazing in lakebed. Grazing below the high water line as lake levels drop during the summer is a major concern for many lakes in the state since animal wastes are readily introduced into the lake when lake levels rise and cover the grazed meadows.

TMDL Water Quality Targets and Endpoints

The primary recommended endpoints for Panguitch Lake based on water quality standards are mean in-lake concentrations of total phosphorus of 0.025 mg/l, and dissolved oxygen above 4.0 mg/l in greater than 50% of the water column. Secondary endpoints should include a shift from blue-green dominated algal populations and a Carlson Trophic Status Index less than 50 (Mesotrophy). Using the phosphorus response model (Vollenweider, 1976), an in-lake concentration of 0.025 mg/l corresponds to a loading rate of 0.235 g/m2/yr or 1196 kg/year. Current external TP loading is 655 kg/yr, a rate well below the modeled value of 1196 kg/yr necessary to produce the desired in-lake concentration of 0.025 mg/l to support beneficial uses based on State water quality standards. Current loading estimates, which includes sediment loading estimates, of 2822 kg/year would require a reduction of greater than 60% total phosphorus to meet this goal.

Source	Current Load	BMPs	Load Reduction
Grazing in lake bed	92 kg/yr	Exclude cows from lake bed	92 kg/yr
Internal Loading	2158 kg/yr	Chemical lake treatment	1675 kg/yr
Total			1767 kg/yr

Table 5-19. Implementation endpoints and load reductions.

In the Clean Lakes Study, phosphorus loadings in the drainage basin were evaluated with the objective of estimating the reduction in phosphorus loading which might be possible if a rather "complete" program of Best Management Practices (BMPs) were implemented in the basin. The final recommendations of the Study operated under the assumption that if BMPs were implemented that the reductions would be enough to shift the trophic status to a more mesotrophic status. However, the study did not include internal loading into the total loading estimate for the lake.

It is evident that to achieve the in lake concentration necessary to improve the fishery and meet water quality standards, a greater load reduction must be achieved. Therefore, implementation endpoints might include a combination of feasible management practices and need to include lake treatment for phosphorus removal. Table 5-19 represents a scenario where chemical treatment and elimination of grazing in the lake bed are the primary recommended options for implementation.

Margin of Safety and Seasonality

A margin of safety (MOS) is a mechanism used to address the uncertainty of a TMDL. The MOS is a required part of the TMDL development process. There are two basic methods for incorporating the MOS (EPA, 1991). One is to implicitly incorporate the MOS using conservative model assumptions to develop allocations. The other is to explicitly specify a portion of the total TMDL as the MOS, allocating the remainder to sources. For the Panguitch Lake TMDL, the MOS was included explicitly by allocating 5 percent of the load capacity to the MOS for the given parameter of concern. Therefore, only 95 percent of the target load was allocated to nonpoint sources. The MOS may be adjusted based on additional sampling of runoff events and further evaluation of the seasonality of loading.

Monitoring Plan

Panguitch Lake is currently listed as impaired due to high levels of total phosphorus (TP). The data that were used to list the lake were instantaneous readings for TP at several depths in the lake profile. In the future it will be useful to obtain TP readings collected during periods of anaerobic conditions to better characterize the loading associated with sediment releases of TP during the winter and summer and to assess progress towards meeting water quality goals. Furthermore, data for this TMDL were averaged over various periods of time to evaluate seasonal loads from tributaries. Additional analysis of the timing of loading events is recommended to further refine management efforts and assess whether water quality targets and endpoints are being met. Future monitoring in a process of evaluation and refinement of TMDL endpoints is recommended.

Navajo Lake

View of Navajo Lake and dike.

Surface and Groundwater hydrology

Navajo Lake was created several thousand years ago after a lava flow cut off the natural surface flow of the uppermost part of Duck Creek in the Sevier River Drainage. The lake is unique in that groundwater accounts for most of the inflow and all of the outflow. Sinks located on the east end of the lake are the principal outlets; no surface outflow exists for the lake. Sinkholes in the east end of the lake drained the lake completely in low water years before construction of a north-south dike, just west of major sinkholes on the east end of the lake basin (see Photo).

The dike has been raised in stages beginning in about 1933. It was last raised to 5.2 m (17 ft) in 1945. The dike allows the lake to be maintained near 4 to 5 m (13-16 ft) deep; however evaporation and seepage, and release of irrigation water via a pipe outlet, still drop the water level a few feet below the dike spillway level by late summer in most years.

Subterranean flow from a considerably large area to the north contributes flow into the lake via seepage, solution channels in limestone, and perhaps tubes and fractures in basalt layers. A large portion of the annual inflow enters during spring snowmelt and runoff. Several springs along the north shore are solution-channel springs, which appear to be connected to sinkholes in basins immediately to the north, which flow mainly during snowmelt or heavy storm runoff and add large quantities of water during wet years. These springs and seeps dry up rapidly after the peak of spring runoff. Navajo Lake Spring on the west end, and Elderberry Spring and Larson Spring on the southwest side of the lake are the only perennial springs feeding the lake. By late summer in a normal year, flow rates are less than 0.1 cfs in Elderberry and Larson Springs and less than 1 cfs in Navajo Lake Spring.

The entire subsurface area of Navajo Lake is interlaced with limestone solution cavities and solution channels and lava tubes. Water flows, not only out of the east end sink holes, likely feed small seeps and springs located west of Cascade Spring on the steep face at the head of the Virgin River basin. The outlet of the lake is via sinkholes east of the dike and other seepage from the lake bottom; there is no surface outflow from the lake basin. The flow into the Navajo Lake sinks reappears in Cascade Spring to the south and Duck Creek Spring to the east. The percentage of flow is approximately 60% to Duck Creek Spring and 40% to Cascade Spring. The amount of flow into the sinks is dependent on the water's elevation head above the sinks. The flow is approximately 30 cfs when the elevation of the water above the sinks is 9 m (30 ft) (about the maximum lake depth in historical times). The basin drainage into the lake, as alluded to before, consists of subsurface travel from areas lying outside of the basin's topographical boundaries. Since inflow and outflow of Navajo Lake basin is mostly subterranean, a normal water budget is not possible. During maximum spring runoff in 1993, it is estimated that approximately 80 cfs was coming into the lake. Of this, only about 25% was in measurable surface inflow.

Human Sources

The Navajo Lake watershed is 100% Forest Service Land with some private in-holdings utilized for summer home development. General recreation use and grazing are potential, but are limited sources of nonpoint nutrient pollution. The campgrounds and summer homes around the Lake are on total containment systems for waste removal. The Navajo Lodge, however, has a septic system with leach fields that are submerged during unusually high lake levels.

Point Sources

Currently, no point sources exist within the Navajo Lake watershed.

Water Quality Analysis

As mentioned earlier, there are very few measurable sources of inflow to the lake. The few surface tributaries were monitored when significant flow existed. The outflow is entirely seepage and subterranean flow, largely through the natural sinks in the east end of the lake. Cascade and Duck Creek Springs were sampled to add more information to the USGS studies, showing these as major outflow recipients via Navajo Lake sinks. Major springs were also sampled to determine the water quality of inflows to the lake. They include the following STORET sites:

Cascade Spring (495125) - Located over the ridge approximately 2 km (1.2 mi) south of the Navajo Lake Sinks. The flow in Cascade Spring is largely from the Navajo Lake Sinks.

Duck Creek Spring (594675). Located adjacent to Highway 14,4.8 km (3 mi) east of Navajo Lake. Part of this flow originates from the Navajo Lake Sinks.

Boy Scout Spring (594689). Located on the west end of Navajo Lake. Only one flow measurement, 0.5 cfs, was recorded during the study period in June 1993. Flow was less than 0.1 cfs after that time and not sampled.

Navajo Lake Spring (594691). Spring just to the west of Navajo Lake. Pipeline captures most of the flow after inlet renovation in 1994. It was submerged during most of 1993 by the high lake level.

Larson Spring (594695). Located on east side of Navajo Lake Lodge. Provides potable water to the lodge and rental cabins. Flow is continuous year-round, but less than 0.2 cfs except during the spring and early summer when it flows up to 1 cfs.

There are other sources of inflow to the lake that in general, cannot be sampled. These consist of underlake springs and springs adjacent to the lake that flow only during heavy snowmelt. Four of these springs deserve mention. First, Roaring Spring comes from a solution channel about 20 m (70 ft) up the hillside. It is located along the north shore approximately 0.5 km (0.75 mi) east of the lodge. Roaring Spring may flow up to 20 cfs or so during spring runoff. This spring drains a considerable portion of the watershed just above the lake, as the flow is short-lived each spring. West of Roaring Spring is another similar solution channel spring that flowed about 2 cfs during the first two sampling trips in June. Another spring, Breathing Spring, is located about 0.9 km (1.5 mi) from the lodge along the north shore. Breathing Spring is submerged and appears to be an important source of oxygenated water under the winter ice. It has been observed that fish congregate around this spring to escape from the low oxygen conditions that sometimes occur in the lake during ice cover. The fourth spring is located near the dike on the north shore. It is also submerged and is reported to be foul-smelling and devoid of oxygen. A sulfide smell is sometimes detectable around this part of the lake. Both of the last two springs were submerged beneath 6 to 9 m (20 to 30 ft) of water during the sampling period and could not be identified nor sampled.

Parameter
Temperature (C)
Dissolved Oxygen (mg/l
Field pH
Sp. Conductivity (umhos
Flow (cfs)

Table 5-20. Water Quality in Cascade Spring and Duck Creek (Averages for 1993).

Table 5-20 gives the averages for samples collected from Cascade Spring and Duck Creek Spring.

The 1964 USGS report identified Navajo Lake Sink outflow water as dividing about 40% to Cascade Spring and making up essentially all of the flow there, and 60% to Duck Creek Spring and making up half or less of the flow there.

Year	Total Phosphorus			Dissolved Oxygen			Chlorophyll a		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1997	0.029	0.005	0.058	8.92	7.95	10.49	1.67	1.4	1.8
1999	0.01	0.01	0.01	9.63	8.7	11.4	2.42	1.8	3.6
2001	0.01	0.01	0.01	9	7.38	10.5	0.2	0.2	0.2
2003	0.012	0.01	0.029	8.7	6.46	9.9	0.3	0.2	0.5

Table 5-21. Water quality for all three lake sites by year, 1997-2003.

In general, water quality in the lake and in the outflows of the lake is good with Total Phosphorus (TP) and Total Nitrogen (TN) concentrations typical of a high quality oligotrophic lake. Since most of the inflows could not be measured or sampled, accurate nutrient loadings to the lake cannot be determined. However, nutrient levels in two perennial springs, Navajo Lake and Larson Springs are probably indicative of the water quality of the inflows; generally TN was less than 0.22 mg/l and TP was less than 0.02 mg/l.

Lake data

The Clean Lake Study summarizes the dissolved oxygen concentration for the years of 1993-4 and found that DO did not drop below 7 mg/l. The mean concentration was 8.5 mg/l for all three stations on the lake. These stations include "Above the Dam" (594681), "Mid-Lake" (594682), and the "Upper End" (594683). Data from the years 1997-2003 compare with data from the Clean Lakes study and are summarized in Table 5-21.

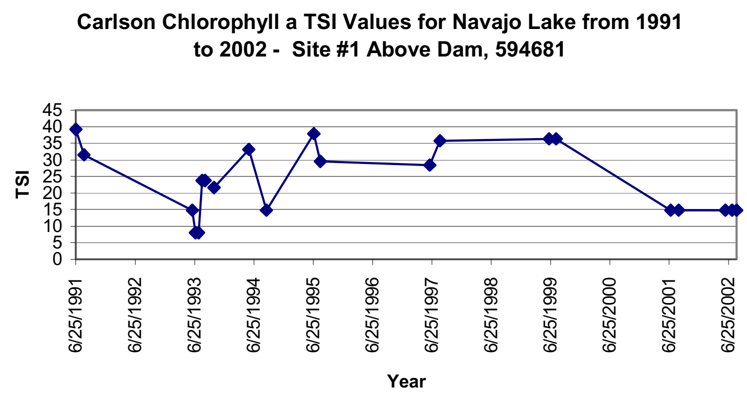
Overall, dissolved oxygen was stable for all sampling dates since the lake does not stratify, but remains well mixed due to its shallow depth. Often during the summer months, the oxygen concentrations demonstrate super-saturation due to the macrophytes actively producing oxygen in the shallow lake. No data exist to confirm whether diel fluctuations occur in the water column when plants respire at night, nor are there recent winter data to demonstrate conditions of low dissolved oxygen. As mentioned previously, continual observation by DWR personnel has established that few refuges with sufficient DO exist for overwintering trout and that Navajo Lake frequently exhibits winter fish kills (Hepworth, 2003).

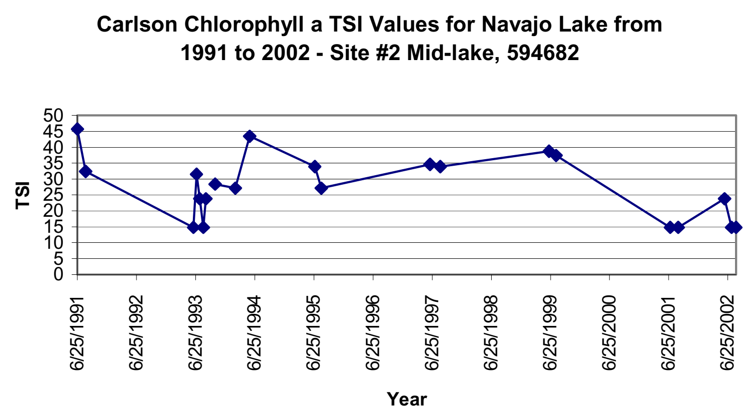
In short, very little fluctuation in temperature or dissolved oxygen occurs in the profiles, again due to the lake being shallow and well-mixed. No recent winter data exist to determine if winter depletion of dissolved oxygen is occurring.

The Carlson Trophic Status Index is often used to classify or predict the productivity of a lake compared to typical lakes and is determined by three indicators, chlorophyll a, secchi depth and total phosphorus concentrations. The latter two are typically used as surrogates for the most important indicator of lake productivity, which is chlorophyll a.

Historically, TSI values for Navajo Lake have demonstrated that it is primarily an oligotrophic lake, with very little primary production in the form of phytoplankton (measured as chlorophyll a). The Clean Lake Study determined that total phosphorus is sufficient to support higher phytoplankton growth but that long winters and a short growing season may limit their growth. Typically, the TSI values for TP indicate the lake to be somewhat mesotrophic while the chlorophyll a TSI demonstrates a predominantly oligotrophic system. The chlorophyll a TSIs for all available data at the three sampling locations are summarized in Figure 21.

In summary, the water quality of Navajo Lake is very high; it is oligotrophic to slightly mesotrophic year-to-year as nutrient, water depth and other conditions vary. The major management problem is the occasional depletion of oxygen under winter ice from the decomposition of abundant macrophytes. During the sampling period of the Clean Lakes Study, low DO levels were found only near the bottom under ice in February of 1994, but fair to good levels of oxygen were still available in the water column. Deeper than normal water depth and limited macrophyte growth the prior summer contributed to this condition.





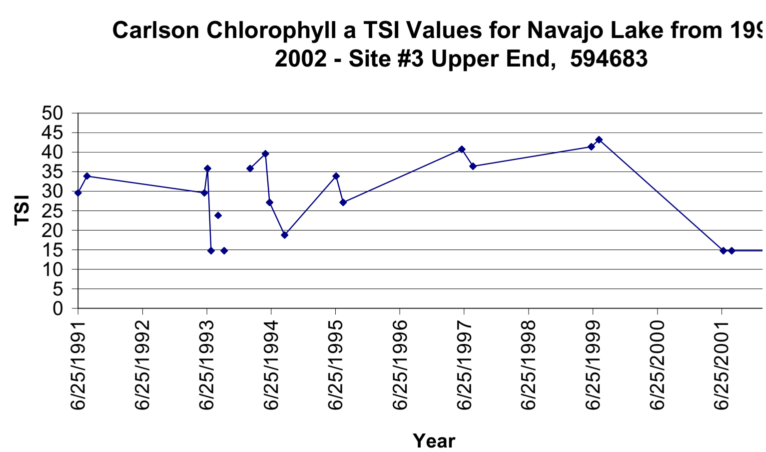


Fig. 5-21. Chlorophyll a TSI by year for three sampling locations (1991-2002)

TMDL Water Quality Tar-

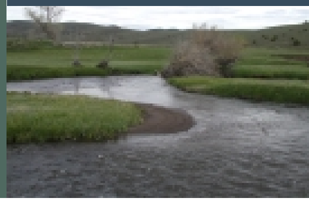
gets and Endpoints

Since the conditions in Navajo Lake and the potential for winter fish kills are independent of nutrient loads, in-lake or inflow water quality, no nutrient loading targets are recommended for this TMDL. The primary water quality target is to meet the 4.0 mg/l dissolved oxygen minimum criteria in the water column to ensure that suitable habit is provided to support the fishery during ice-free periods. Currently, Navajo Lake is meeting this criterion and is in full support of its water quality standards during this designated period. Since winter fish kills are not a function of human caused pollution but a natural occurrence due to lake morphology and macrophyte abundance, it is recommended that Navajo Lake be de-listed for dissolved oxygen. The Division of Wildlife Resources may decide to manage the lake as a year-round fishery and implement strategies to mitigate for the loss of adequate fish habitat; however, this TMDL will not recommend endpoints to that effect. Options for achieving such fishery management goals are discussed below in the implementation strategy. In order to facilitate de-listing, this study recommends the development of site-specific language in Utah's water quality standards exempting the dissolved oxygen criterion for Navajo Lake is such action is required.

No allocations are recommended for this TMDL since the endpoints are not determined by measurable loads, but by the attainment of the minimum concentration of 4.0 mg/l DO necessary to support the fishery. It has been determined that sources of pollutants in the watershed are minimal and are not a contributing factor to impairment.

Monitoring Plan

Navajo Lake was listed as impaired for low dissolved oxygen. The data used to establish the listing is not currently available for the winter months. However, fishery managers have observed frequent fish kills as a result of low dissolved oxygen in the winter. In the future it will be useful to obtain DO profiles to assess the management strategies that may be put in place to maintain the fishery, characterize the situation and assess progress towards meeting water quality goals. Future monitoring in a process of evaluation and refinement of ensuring that water quality criteria are met during other times of the year is also recommended.



Steering Committee Recommendations

Initial Focus Area Recommendations
In February and March, 2004, technical advisory committees and steering committee members finalized priority areas and goals for restoration for the Upper Sevier Watershed Management Plan.

Four priority focus areas were chosen, based on potential for restoration, water quality concerns, and opportunities for multiple partners to participate in on-the-ground improvement projects. After much discussion, the focus areas for this initial watershed management plan corresponds to those focus areas outlined as part of the Department of Water Quality/TMDL findings (Fig. 6-1).

For the four focus areas (Sevier River - 1, Sevier River - 2, Sevier River -3, and East Fork Sevier River - 4), goals have been developed, based on actual acreages identified in the assessment portion of this plan (See Chapter 4). Target goals have been identified for years 2005-2010. A comparison of actual acres, problems identified and target goals are contained for each focus area in Tables 6-1 through 6-4, respectively).

Incorporation of Public Input
A public meeting and openhouse held in Panguitch, Utah during February 2004 provided an opportunity for interested partners and citizens within the watershed to suggest other goals and opportunities watershed restoration. Many of the comments expressed at this meeting are similar to those captured throughout the watershed assessment and plan development. Additional comments are contained for the four focus areas, as well as for each of the nine watersheds, throughout this chapter. Comments are organized as they pertain to specific technical advisory committees (hydrology/water quality, human uses, fire, vegetation, agriculture and species and habitat).

Utility of Plan
Individuals, partners and governing agencies are encouraged to continue to identify projects throughout the watershed, and to use the assessment portion of the plan as "leverage" to garner support and funding. Projects within the focus areas will be coordinated through the Upper Sevier River Watershed Coordinator to assist in restoring watershed health to these areas. Watershed Coordinator assistance will also be available for those projects outside of the focus areas; however, more emphasis should be placed on agency and/or partner initiation of the project.

This plan denotes a starting point for restoration focus areas. These focus areas will not impede upn any potential project identified elsewhere in the watershed, but will offer an opportunity to develop defined large scale restoration objectives.

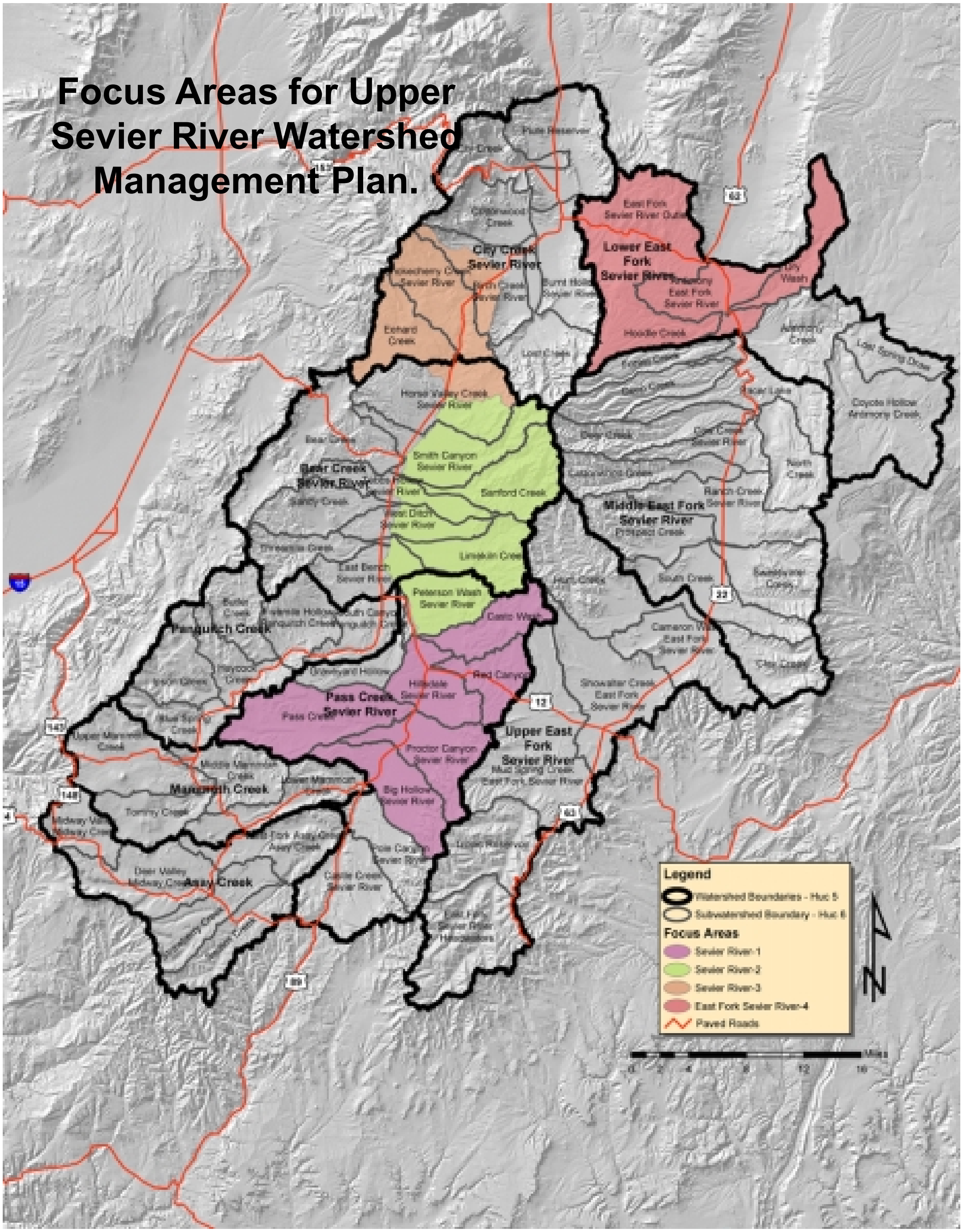


Fig. 6-1. The four focus areas for this initial watershed management plan are Sevier River-1, Sevier River-2, Sevier River-3 and East Fork Sevier River-4. The focus areas contain opportunities for multiple-partnership projects.

Focus Area - Sevier River 1

Eight treatment goals were identified through the steering committee process for the Focus Area - Sevier River 1 (Table 6-1). Key issues identified and land ownership for Focus Area - Sevier River 1 are identified in Figure 6-2 & 6-3, respectively.

Steering Committee Recommendations

Key Issues, Focus Area - Sevier River 1	Acres identified through USWMP Key Issue Process	Treatment Goals 2005-2010 (Acres)
Active Channel Adjustments - Restoring woody vegetation and stream channel function	3,440	400
Communities at Risk to Wildfire	1,523	400
Enhancement and Protection of Prairie Dog Habitat	25,642	2,000
Enhanced Wildlife Management on Agricultural Lands	92,671	10,000
Pinyon/Juniper, Sagebrush/Grasslands - ecosystem treatment for improvements to fuel conditions, vegetation composition and accelerated erosion areas*	69,088	10,000
Evaluate Developed and Dispersed Recreation	6,632	1,000
Enhancement and Protection of Sage Grouse Habitat	42,062	5,000

*Acres for 4 issues were combined (PJ - Sagebrush/Grass - Fuel Conditions, 6,000 acres; PJ - Vegetation Comp., 24,374 acres, PJ - Sagebrush/Grass - Vegetation Comp., 7,848 acres, PJ,Sagebursh/Grass - Accelerated Erosion, 30,864 acres)

Table. 6-1. Comparison of actual acres identified through the issue identification process of the Upper Sevier Watershed Management Plan and Steering Committee treatment goals for implementation. - Focus Area - Sevier River 1.

Additional Goals & Opportunities Identified Through Public Input Process

Agriculture

- Identify cooperative landowners and implement major stream channel and bank stabilization work on at least 2,500 feet per year of the Sevier River that maintains riparian vegetation and restores proper stream channel dimensions and function. Install instream structures (weirs, rock barbs, juniper revetments, etc.), where appropriate, to protect streambanks.
- Identify cooperative landowners to conduct irrigation efficiency projects in upper 2 miles of reach to reduce irrigation return flows (approx. 300 acres of crop and pasture). Install berms to reduce overland flow to the river
- Improve irrigation efficiency on approximately 600 acres of crop and pasture
- Install approximately 5 miles of irrigation conveyance

Human Uses

- Cooperate with local health department to inspect and identify sources of phosphorus pollution from on-site systems. Reduce pollution from on-site systems associated with summer home development.

- Develop interpretive OHV signing and mapping
- Discourage the use of deep trench on-site wastewater systems.
- Disperse information on proper use of public lands
- Encourage innovative and alternative wastewater treatment systems and incorporate reuse.

Species and Habitat

- Identify appropriate locations to establish new Utah prairie dog colonies as outlined in the Utah Prairie Dog Recovery Plan.
- Implement cooperative projects between UDWR and SITLA on SITLA property, near Hatch, Utah to improve fish habitat, riparian vegetation conditions, water quality and to reduce stream bank erosion on 2 miles of Asay Creek.
- Increase trout abundance to a minimum of 100 pounds per acre of stream
- Install riparian fencing and plant willows and cottonwoods in areas above cabins to Mammoth Creek and below cabins near hatch (approx. 4 miles)
- Install wildlife and livestock water improvements to reduce wildlife infringement on private lands
- Maintain and/or improve active/historic sage grouse habitats
- Maintain and/or improve critical big game winter ranges
- Work with landowners to relocate and control populations of prairie dogs on private lands

Vegetation

- Coordinate with BLM & SITLA to conduct a prescribed burn south of Panguitch on the South Canyon Allotment.
- Encourage grazing management to reduce upland erosion
- Identify landowners and treat 1200 acres of sagebursh/grasslands of BLM land
- Implement appropriate grazing practices in grass/forb communities to increase ground cover and species composition
- Implement thinning treatment to reduce mature sagebrush and invigorate vegetative health on 500 acres of BLM and/or SITLA lands. Treat mechanically or with fire and reintroduce appropriate grasses/forbs in upland areas on BLM/SITLA lands.

Hydrology & Water Quality

- Treat and reseed 1000 acres of sagebrush/grass on BLM land over the next five years
- Treat mechanically or with fire and plant/seed appropriate shrubs on 2500 acres of upland areas on BLM lands.
- Treat p/j and reintroduce grasses/forbs and shrubs on active/historical sage grouse habitats on approximately 1200 acres of BLM land
- Treat p/j and reintroduce grasses/forbs on 1000 acres of BLM land over the next five years
- Used prescribed burn on approximately 5000+ acres in the South Canyon watershed to enhance wildlife habitat and improve overall rangeland health.
- Continue monitoring to determine impacts of Mammoth Creek Fish Hatchery
- Install check dams in Cameron Wash to control erosion
- Install snow fencing for harvest water and to restore upland vegetation
- Limit grazing above Long Valley Canal diversion to control downcutting, channel incision and reestablishment of floodplain.
- Maintain in-stream phosphorus concentration below 0.05 mg/l total phosphorus. Reduce phosphorus load by ~290 kg/year
- Provide new public access to 10 miles of stream where restoration work has been implemented over the next 5 years

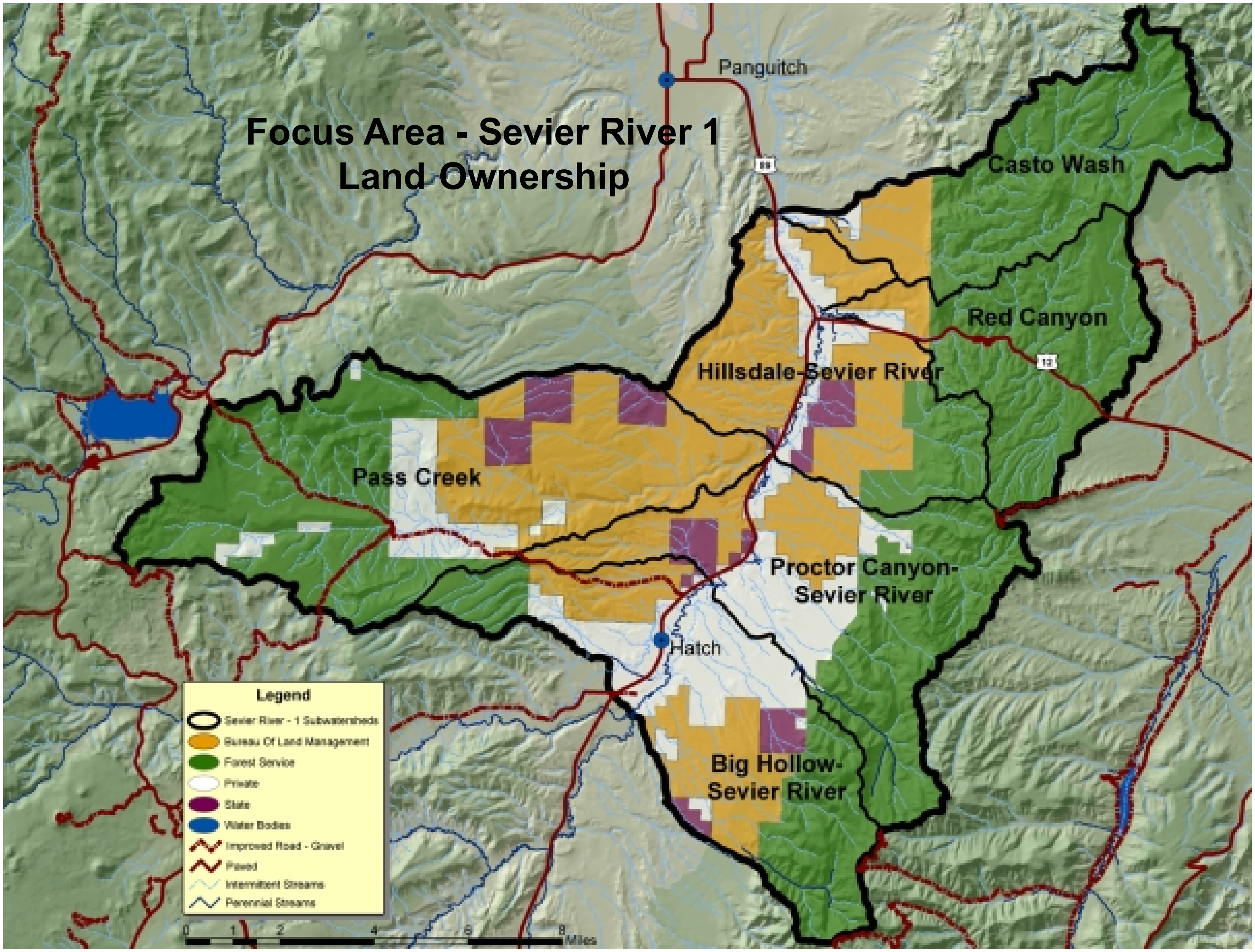


Fig. 6-2. Sevier River - 1 - Land Ownership

Focus Area - Sevier River 1
Key Issues

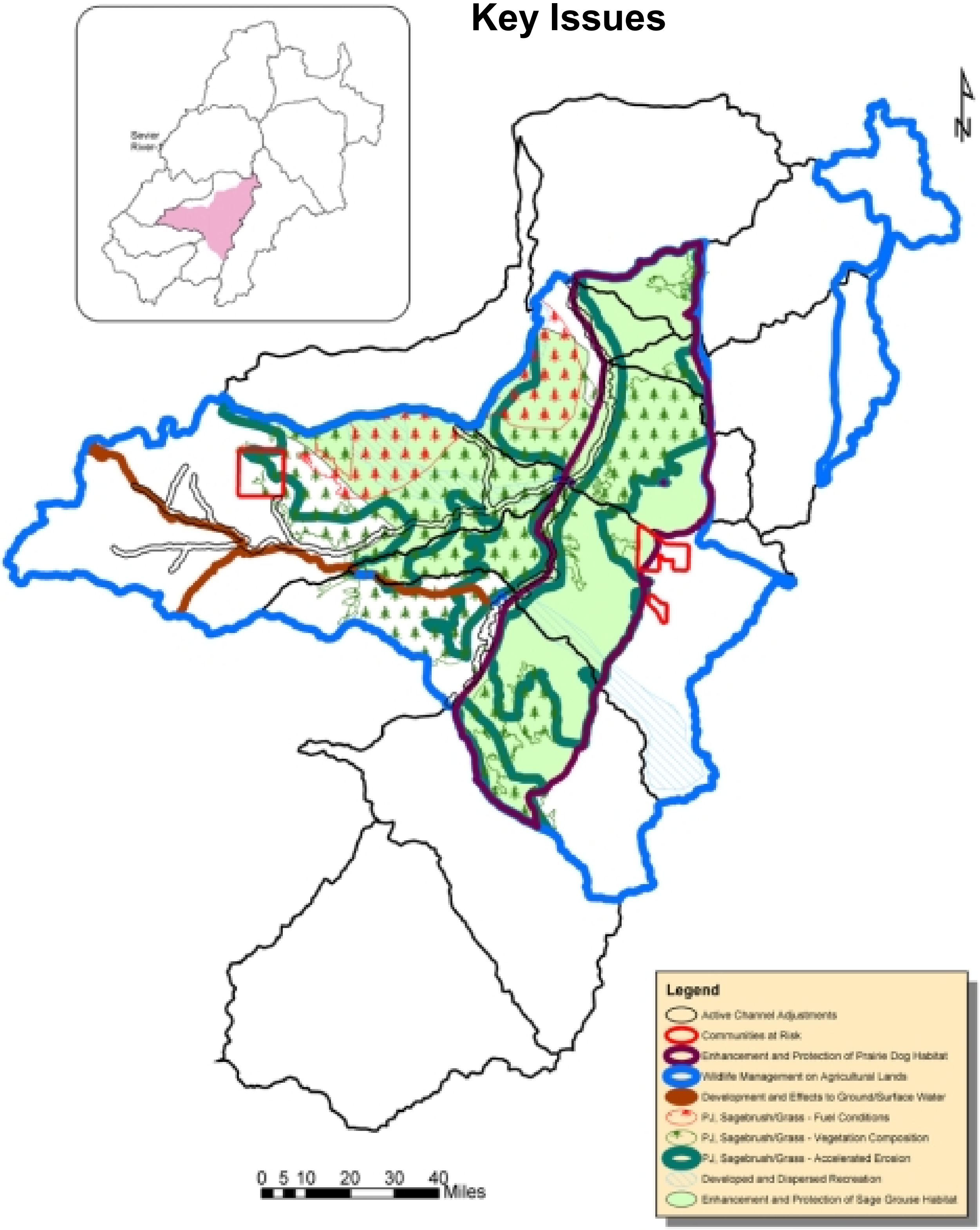


Fig. 6-3. Sevier River - 1 - Key Issues.

Focus Area - Sevier River 2

Seven treatment goals were identified through the steering committee process for the Focus Area - Sevier River 2 (Table 6-2). Key issues identified and land ownership for Focus Area - Sevier River 2 are identified in Figure 6-4 & 6-5, respectively.

Steering Committee Recommendations

Key Issues, Focus Area - Sevier River 2	Acres identified through USWMP Key Issue Process	Treatment Goals 2005-2010 (Acres)
Enhancement and Protection of Riparian Habitat - Restore woody vegeation and stream channel function - address TMDL listed and potentially listed waters*	42062	300
Pasture Management	15,684	4,000
Enhancement and Protection of Prairie Dog Habitat	8,567	1,000
Wildlife Infringement on Private Lands	14,409	3,000
Pinyon/Juniper, Sagebrush/Grasslands - ecosystem treatment for improvements to fuel conditions, vegetation composition and accelerated erosion areas**	76,196	10,000
Noxious Weeds	25,724	3,000
Enhancement and Protection of Sage Grouse Habitat	27,945	3,000

*Acres for 3 issues were combine (Enhancement and Protection of Riparian Habitat, 1,214 acres; Active Channel Adjustments - 327 acres; TMDL listed and potentially listed water bodies - 747.46 acres)

**Acres for 4 issues were combined (PJ-Sagebrush/Grass -Mountain Brush - Fuel Conditions, 714 acres; PJ - Vegetation Comp., 30,584 acres, PJ-Sagebrush/Grass - Vegetation Comp., 12,427 acres, PJ,Sageburshl/Grass - Accelerated Erosion, 32,469 acres)

Table. 6-2. Comparison of actual acres identified through the issue identification process of the Upper Sevier Watershed Management Plan and Steering Committee treatment goals for implementation - Focus Area - Sevier River 2.

Additional Goals & Opportunities identified through Public Input Process

Agriculture

- Identify areas for feasible irrigation efficiency projects to reduce runoff and nutrients to the river
- Identify cooperative landowners to conduct irrigation efficiency projects in upper 2 miles of the Sevier River to reduce irrigation return flows (approx. 300 acres of crop and pasture). Install berms to reduce overland flow to the river
- Identify landowners and treat 1200 acres of sagebursh/grasslands of BLM land
- Improve irrigation efficiency on approximately 500 acres of crop and pastureland each year for the next 5 years
- Install approx. 4 miles of irrigation conveyance
- Install offsite water development and electric fencing to reduce grazing impacts to stream

- Work with landowners and partners to control noxious weeds on private/public lands

Human Uses

- Conduct a suitability analysis for dispersed camping on 10 miles of riparian habitat
- Develop interpretive OHV signing/mapping for 10 miles of trail
- Discourage the use of deep trench on-site wastewater systems

Species and Habitat

- Continue work with DWR to improve 3 miles of stream habitat in Left Fork Sanford Creek
- Identify appropriate locations to establish new Utah prairie dog colonies as outlined in the Utah Prairie Dog Recovery Plan.
- Increase trout abundance to a minimum of 100 pounds per acre of stream
- Reintroduce grasses, forbs and shrubs on active/historic sage grouse habitats
- Treat 2000 acres of sagebrush grasslands on BLM lands over the next 5 years to improve historic and active sage grouse habitats
- Treat pinyon/juniper and reseed and plant deer browse shrubs on 3,000 acres of BLM/Forest Service land.
- Work with landowners to relocate and control populations of prairie dogs on private lands

Vegetation

- Recommend fencing and grazing management practices to allow riparian vegetation to develop in areas with lower banks and widened channel
- Treat mechanically or with fire and plant/seed appropriate shrubs on 2500 acres of upland areas on BLM lands.

Hydrology/Water Quality

- Allow vegetation to re-establish along upper reach of Sevier River below Sanford wash where depositional materials occur
- Identify cooperative landowners and implement major stream channel and bank stabilization work on at least 2,500 feet per year of the Sevier River that maintains riparian vegetation and restores proper stream channel dimensions and function. Install instream structures (weirs, rock barbs, juniper revetments, etc.), where appropriate, to protect streambanks.
- Maintain instream phosphorus concentrations below 0.05 mg/l total phosphorus. Reduce phosphorus load by ~3200 kg/year.
- Conduct stabilization work on at least 2,000 feet per year of the Sevier River that establishes and maintains riparian vegetation and restores proper stream channel dimensions and function.

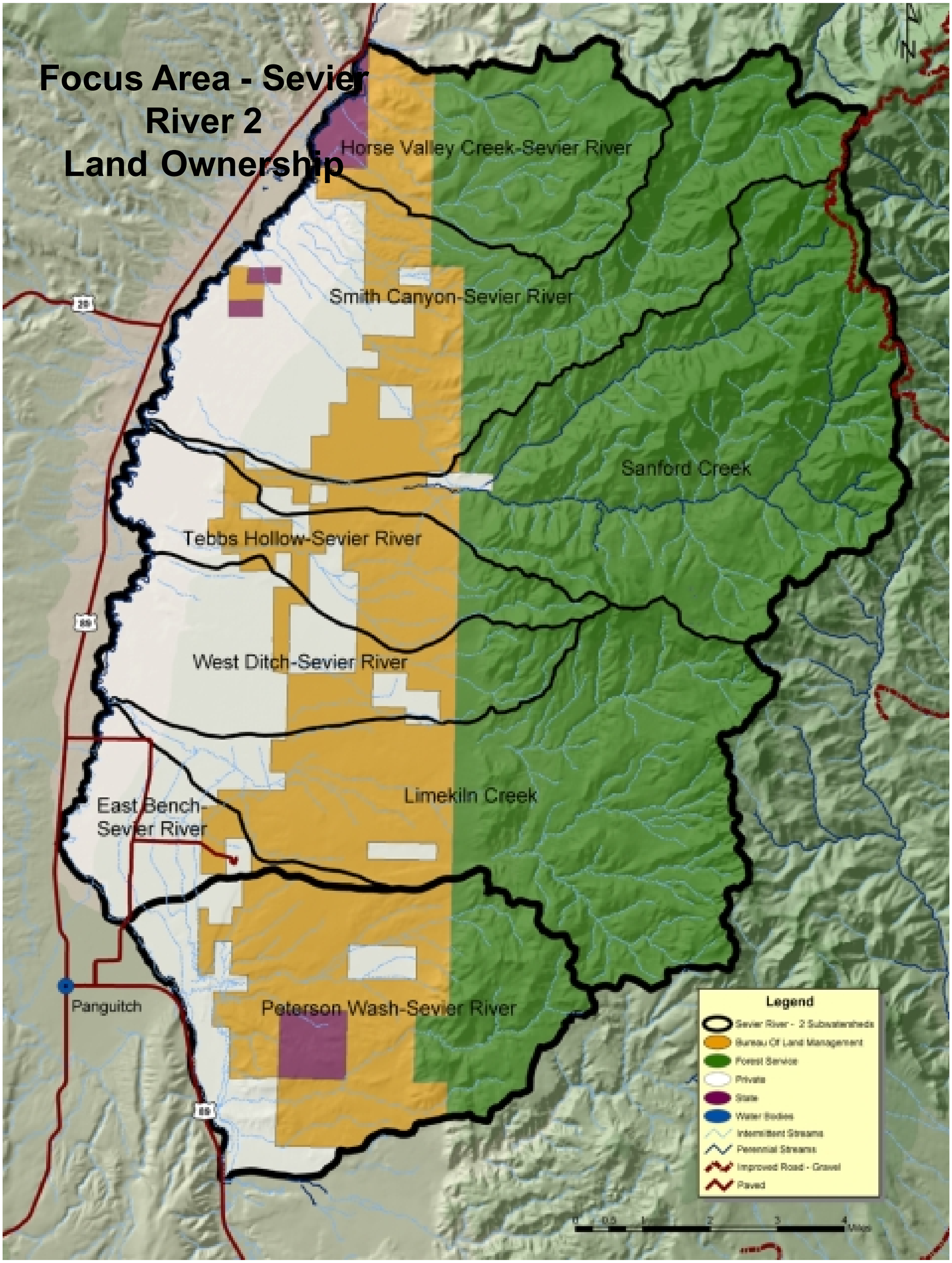


Fig. 6-4. Sevier River - 2 - Land Ownership.

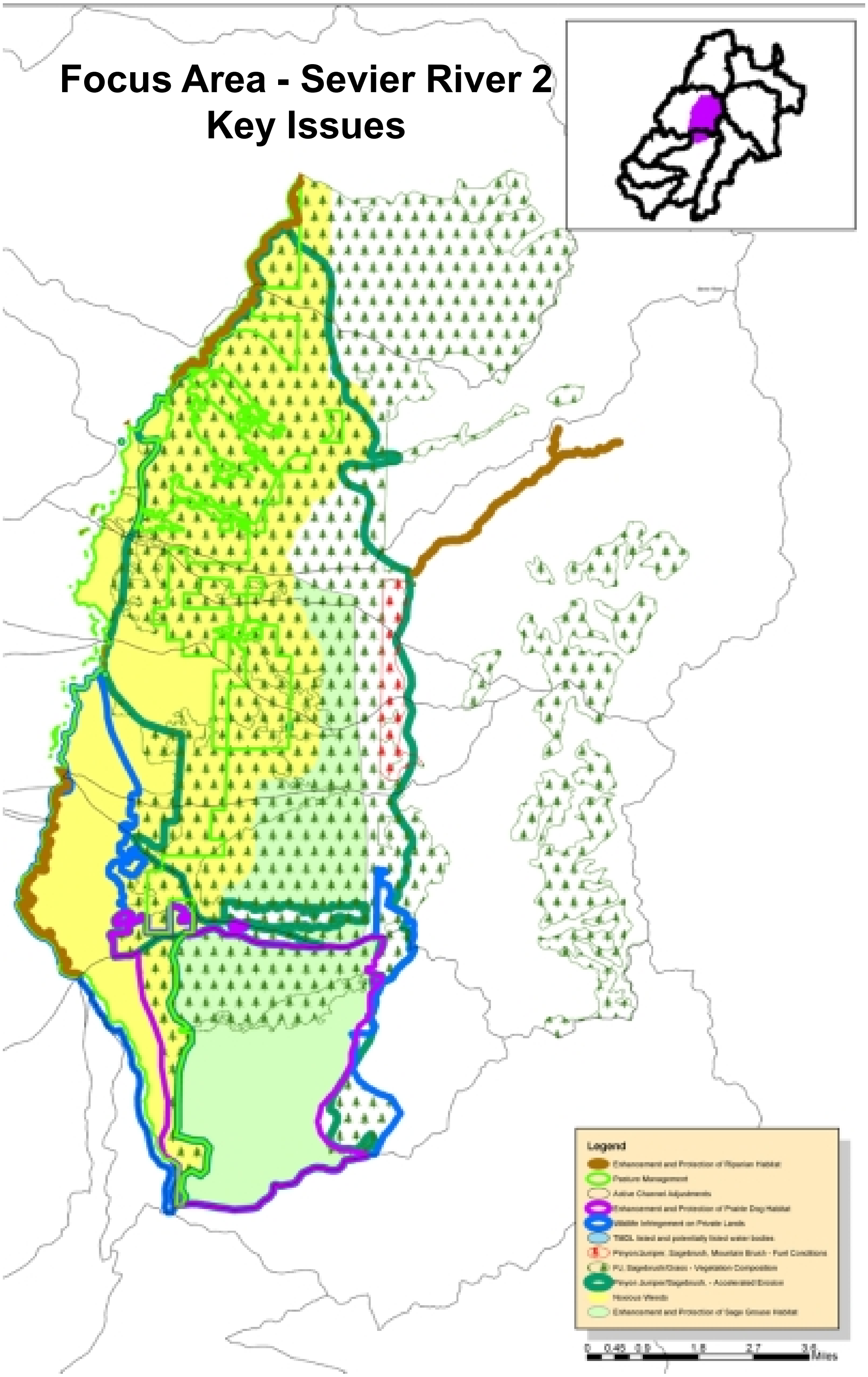


Fig. 6-5. Sevier River 2 - Key Issues.

Focus Area - Sevier River 3

Seven treatment goals were identified through the steering committee process for the Focus Area - Sevier River 3(Table 6-3). Key issues identified and land ownership for Focus Area - Sevier River 3 are identified in Figure 6-6 & 6-7, respectively.

Steering Committee Recommendations

Key Issues - Focus Area - Sevier River 3	Acres identified through USWMP Key Issue Process	Treatment Goals 2005-2010 (Acres)
Enhancement and Protection of Deer Habitat	11,616	2,000
Enhancement and Protection of Sage Grouse Habitat	5,231	1,500
Enhancement and Protection of Riparian Habitat - Restore woody vegetation and stream channel function - address TMDL listed and potentially listed waters*	547	100
Noxious Weeds	199	100
Access Management	583	100
Aspen/Spruce - Fuel Conditions	3,574	500
Pinyon/Juniper, Sagebrush/Grasslands - ecosystem treatment for improvements to fuel conditions, vegetation composition and accelerated erosion areas**	50,044	7,000

*Acres for 2 issues were combine (Enhancement and Protection of Riparian Habitat, 273 acres; TMDL listed and potentially listed water bodies - 273 acres)

**Acres for 5 issues were combined (PJ-Sagebrush/Grass - Fuel Conditions, 1869 acres; PJ - Vegetation Comp., 19,719 acres, PJ - Sagebrush/Grass - Vegetation Comp., 19,719 acres, PJ, Sagebursh/Grass - Accelerated Erosion, 10,531 acres; Accelerated Erosion - 1651 acres)

Table. 6-3. Comparison of actual acres identified through the issue identification process of the Upper Sevier Watershed Management Plan and Steering Committee treatment goals for implementation - Focus Area - Sevier River 3.

Additional Goals & Opportunities identified Through Public Input Process

Agriculture

- Identify areas for feasible irrigation efficiency projects to reduce run off and nutrients
- Treat noxious weeds near agricultural/urban areas

Vegetation

- Burn approximately 5,000+ acres of pinyon/juniper to enhance wildlife habitat and improve rangeland health

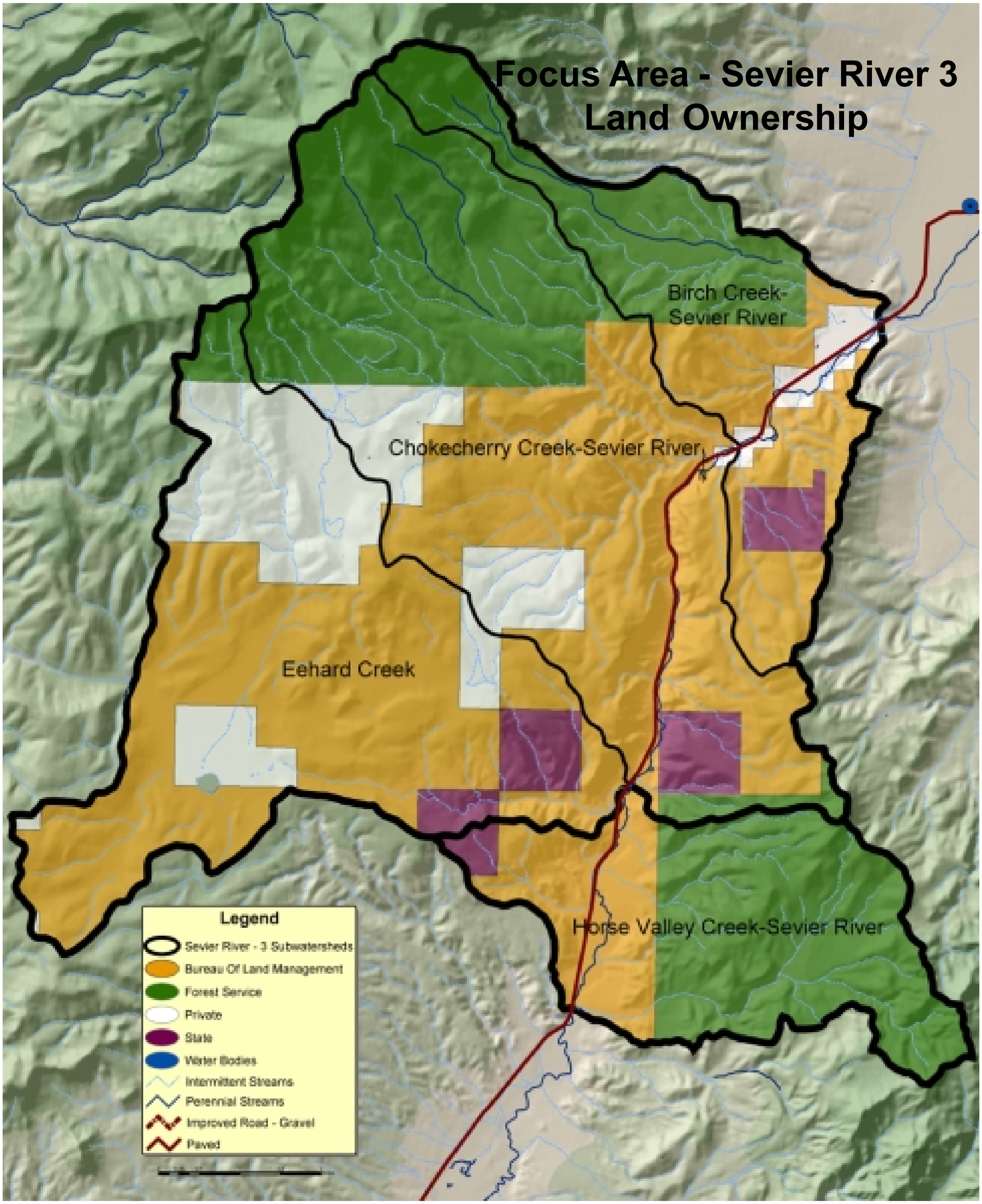


Fig. 6-6. Sevier River 3 - Land ownership..

Focus Area - Sevier River 3
Key Issues

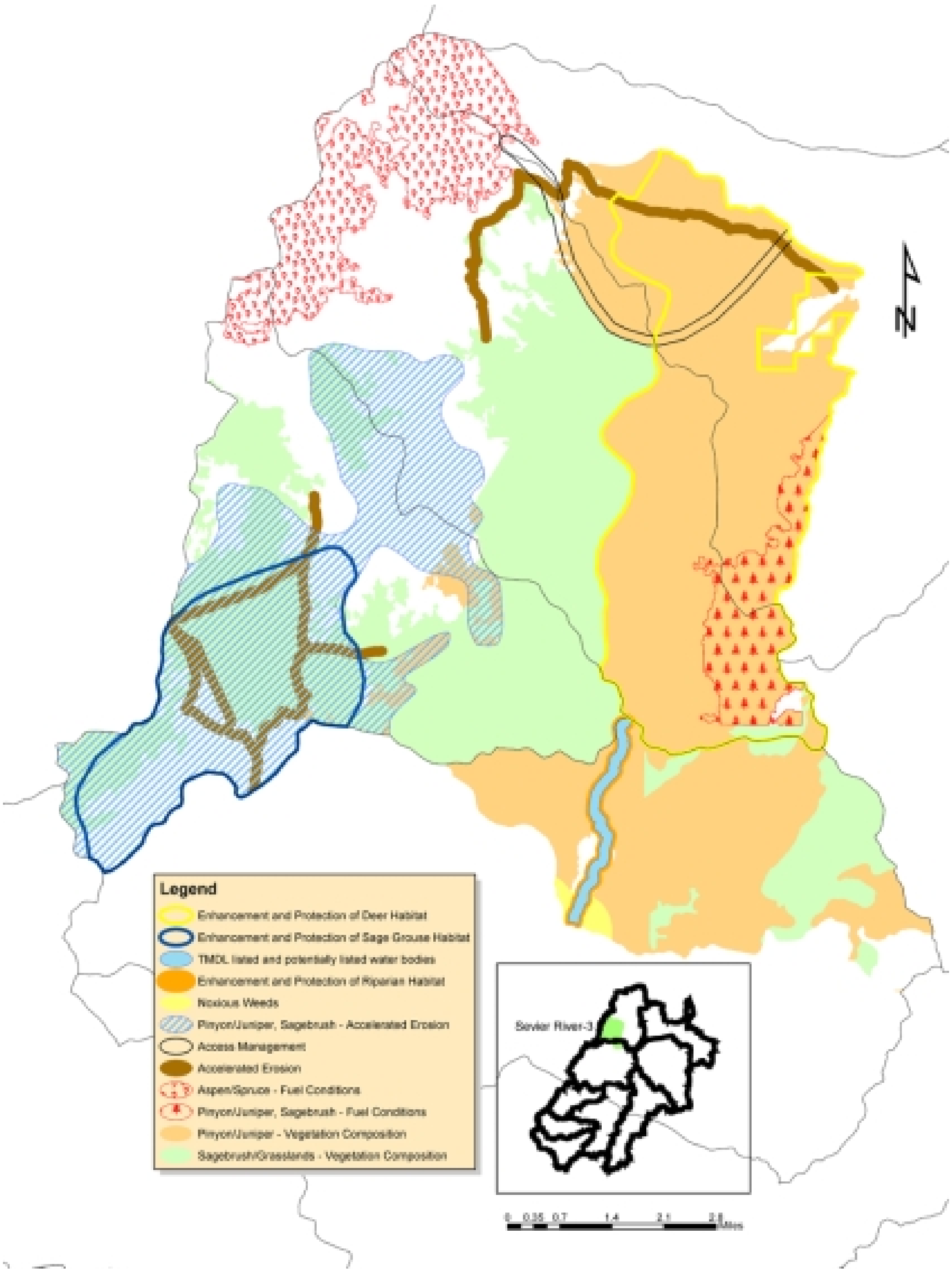


Fig. 6-7. Sevier River 3 - Key Issues.

Focus Area - East Fork Sevier River - 4

Five treatment goals were identified through the steering committee process for the Focus Area - East Fork Sevier River - 4 (Table 6-4). Key issues identified and land ownership for Focus Area - East Fork Sevier River -4 are identified in Figure 6-8 & 6-9, respectively.

Steering Committee Recommendations

Key Issues, Focus Area 4 - East Fork Sevier River	Acres identified through USWMP Key Issue Process	Treatment Goals 2005-2010 (Acres)
Riparian Vegetation Composition	1,044	300
Noxious Weeds	1,172	300
Enhancement or Protection of Deer Habitat	12,659	3,000
Pinyon/Juniper, Sagebrush/Grasslands - ecosystem treatment for improvements to fuel conditions, vegetation composition and accelerated erosion areas*	27,809	6,000
Pasture Management	8,824	2,000

*Acres for 5 issues were combined (PJ-Sagebrush/Grass - Fuel Conditions, 1621 acres & 15,469 acres; PJ-Sagebrush/Grass Vegetation Comp., 8,263 acres & 458 acres; PJ-Sagebursh/Grass - Accelerated Erosion, 1,995 acres)

Table. 6-4. Comparison of actual acres identified through the issue identification process of the Upper Sevier Watershed Management Plan and Steering Committee treatment goals for implementation - Focus Area 4 - East Fork Sevier River.

Additional Goals & Opportunities identified Through Public Input Process

Agriculture

- Identify cooperative landowners and implement major stream, fishery habitat riparian restoration and fencing work of at least 2,000 feet per year on the East Fork Sevier River above the Antimony diversion.
- Identify cooperators for fishery habitat and grazing management projects
- Work with two landowners immediately below Otter Creek Reservoir to implement fencing and stream and riparian restoration work, and to secure matching non-federal funds for implementing work.

Human Uses

- Evaluate 3 miles of riparian habitat to determine suitability for dispersed camping
- Manage dispersed camping, recreation, OHV use in channel causing bank erosion
- Relocate 1 mile of road in the Antimony Creek floodplain

Species and Habitat

- Continue stream restoration, fish habitat, riparian enhancement and fencing work on DWR and BLM lands in Black Canyon

- Implement stream fishery habitat and riparian enhancement work on Utah Division of Wildlife Resources (UDWR) property on 3,500 feet of the East Fork Sevier River in Kingston Canyon.
- Increase trout abundance to a minimum of 100 pounds per acre of stream.
- Treat and reintroduce grasses, forbs and shrubs on critical big game winter range on approximately 1000 acres
- Treat pinyon/juniper and reintroduce grasses, forbs and shrubs on critical big game winter ranges on 3000 acres of BLM critical mule deer winter range

Vegetation

- Establish upland vegetative ground cover on the Mt. Dutton fire to minimize sediment and ash runoff and flash flooding into the East Fork Sevier River.

Hydrology/Water Quality

- Address upstream sources of phosphorus which cause algae growth in East Fork Sevier from water from Otter Creek Reservoir
- Fence and manage grazing along 1 mile above Otter Creek Reservoir outfall to reduce erosion from bank trampling
- Identify 2 Wyden Amendment Projects to decreasing sediment caused by past mining activity in Antimony Creek
- Increase meander of channelized reach below Otter Creek Reservoir and stabilize banks with willow planting
- Treat tamarisk and Russian olive where appearing

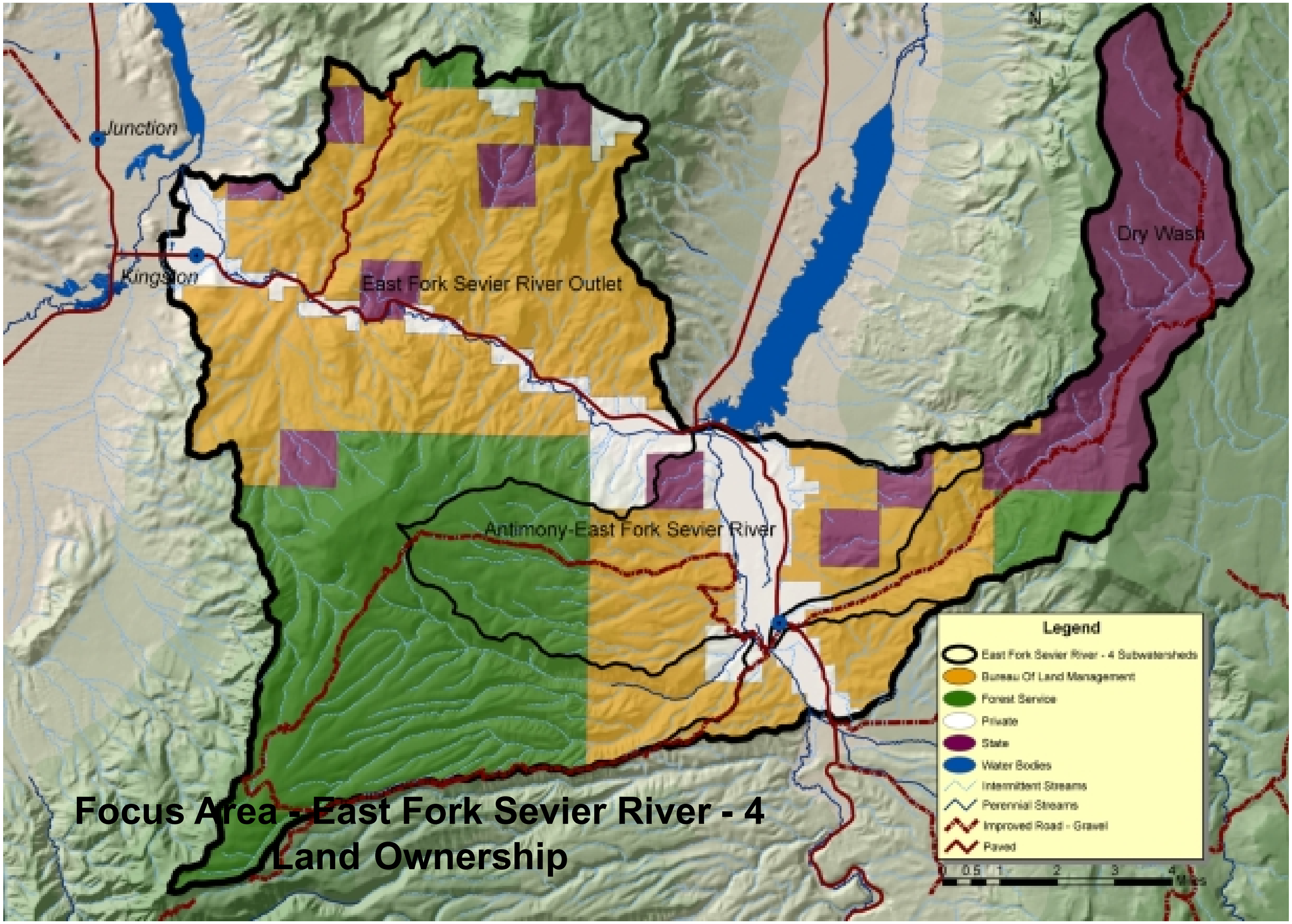


Fig. 6-8.Upper East Fork Sevier River - 4 Focus Area

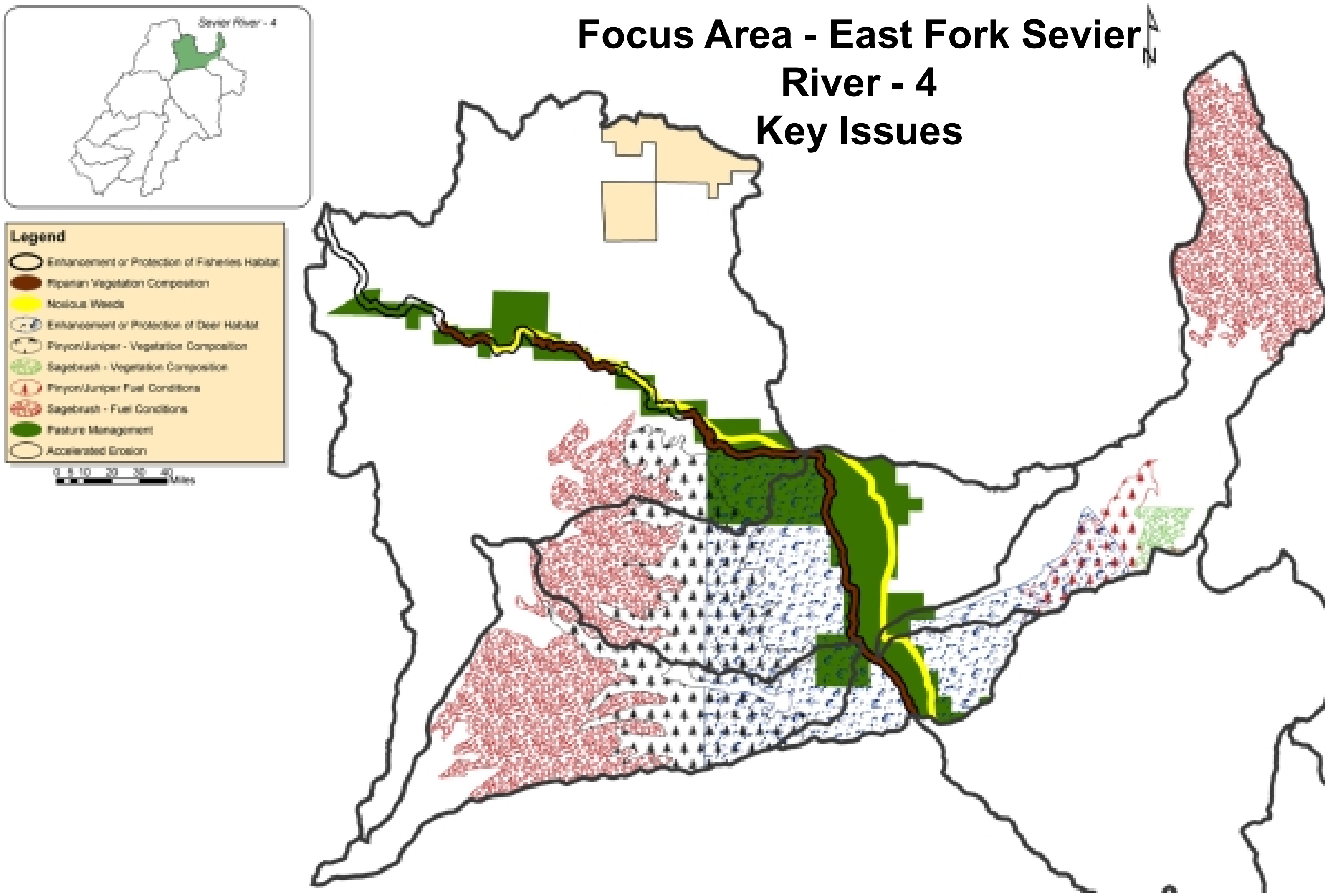


Fig. 6-9. East Fork Sevier River - 4 - Key Issues.

Additional Opportunities Identified Through the Public Input Process

Asay Creek Watershed

- Build up or relocate road where impinging on wetland to reduce erosion in Lars Fork
- Conduct on-the-ground surveys to identify future projects
- Continue road obliteration as part of Duck/Swains Access Project
- Continue water quality studies/monitoring
- Decommission/close 30 miles of roads within Strawberry Creek/Swains Creek watersheds.
- Discourage use of deep trench on-site wastewater systems. Continue monitoring of onsite system (feasibility of combined and/or lagoon systems)
- Encourage innovative and alternative wastewater treatment systems and incorporate reuse
- Establish defensible fire space (300 feet) on 3 miles of forested lands adjacent to private lands
- Establish OHV routes and mapping for 40,000 acres
- Implement 2,000 acres of dispersed camping regulations/improvements for the Mammoth Springs area.
- Improve 2 miles of riparian habitat in Upper Mammoth Creek
- Investigate causes of lost topsoil and grass community in meadows
- Maintain cattle exclosures along creek
- Maintain high standards of private land livestock grazing
- Move snowmobile parking area away from stream to reduce fuel introduced to surface water from fueling area
- Plant willows and conduct project maintenance along approx. 2 miles of Lars Fork
- Regenerate 2,000 acres of aspen
- Restore 50 acres of tall forb habitat

Mammoth Creek

- Continue monitoring to determine impacts of Mammoth Creek Fish Hatchery
- Continue water quality studies/monitoring. Inspect and monitor onsite systems associated with summer home development
- Cooperate with local health department to inspect and identify sources of phosphorus pollution from on-site systems. Reduce pollution from on-site systems associated with summer home development.
- Discourage use of deep trench on-site wastewater systems. Continue monitoring of onsite system (feasibility of combined and/or lagoon systems)
- Encourage innovative and alternative wastewater treatment systems and incorporate reuse
- Identify cooperative landowners and implement major stream, fishery habitat and riparian restoration work of at least 5,000 feet per year on the Sevier River.
- Implement 2,000 acres of dispersed camping regulations/improvements for the Mammoth Springs area.
- Implement stream, fishery habitat and riparian enhancement work on Lower Mammoth Creek
- Improve 2 miles of riparian habitat in Upper Mammoth Creek
- Increase trout abundance to a minimum of 100 pounds per acre of stream.
- Install approximately 3.5 miles of irrigation conveyance
- Maintain instream phosphorus concentration below 0.05 mg/l total phosphorus. Reduce

phosphorus load by ~290 kg/year

- Manage sheep grazing in upper meadows in areas where there is excessive animal waste and willow suppression from overgrazing.
- Re-establish riparian vegetation along lower 5.5 miles of Mammoth Creek (within reach)
- Regenerate 2,000 acres of aspen
- Restore 50 acres of tall forb habitat
- Work with landowners to control noxious weeds on private/public lands
- Work with landowners to provide grazing management such as off-site water. Install fencing along 2.5 miles of reach (middle section).
- Work with landowners to relocate and control populations of prairie dogs on private lands

Panguitch Creek

- Burn approximately 5000+ acres in the South Canyon watershed to enhance wildlife habitat and improve overall rangeland health.
- Chemically treat Panguitch lake (lime or alum) to reduce internal loading of phosphorus from sediments. Conduct study to determine appropriate level and are of lake treatment to reduce sediment loading
- Coordinate with BLM & SITLA to complete a prescribed burn south of Panguitch on the South Canyon Allotment.
- Develop interpretive OHV signing and mapping
- Disperse information on proper use of public lands
- Encourage innovative and alternative wastewater treatment systems and incorporate reuse.
- Fivemile Hollow - Panguitch Creek
- Haycock Creek
- Identify cooperative landowners and implement major stream channel and bank stabilization work on at least 2,000 feet per year of the Sevier River that maintains riparian vegetation and restores proper stream channel dimensions and function.
- Implement appropriate grazing practices in grass/forb communities to increase ground cover and species composition
- Install cross drains along Bunker Creek road
- Regenerate aspen stands utilizing available tools
- Reintroduce grasses, forbs and shrubs on active/historic sage grouse habitats
- Resurface road and install drainage along 2-3 miles of road
- Resurface road to reduce erosion
- Stabilize banks in Deer Creek and lower Bunker Creek to mitigate effects of transbasin diversion
- Stabilize headcuts in upper Ipson Creek
- Stabilize headgate at lower end and reinforce or pipe water to storage ponds
- Treat pinyon/juniper and reseed and plant deer browse shrubs on 3,000 acres of BLM/Forest Service land.
- Treat/reseed 2000 acres of sagebrush/grasslands on BLM/Forest Service land.

Pass Creek Sevier River

- Note: Pole Proctor and Graveyard Hollow have opportunities listed that are covered under Sevier River 1. No additional opportunities, not listed above, have been identified.

Bear Creek

Note: Many of the opportunities listed for the Beark Creek Watershed are listed under Sevier River 2. Other opportunities are as follows:

- Implement 100 acres of noxious weed treatment
- Stabilize areas of higher gradient and allow vegetation to develop where lower gradients favor floodplain development
- Treat 1000 acres of pinyon/juniper, sagebrush/grassland to move area towards desired future conditions

City Creek Watershed

- Identify areas for feasible irrigation efficiency projects to reduce run off and nutrients

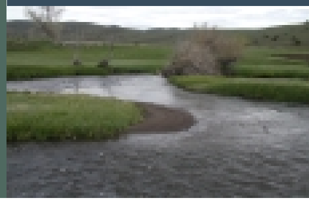
Upper East Fork Sevier River

- Conduct a suitability analysis for dispersed camping on 10 miles of riparian habitat
- Continue work with DWR to improve 3 miles of stream habitat in Left Fork Sanford Creek
- Decommission 20 miles of roads within the Clay Creek watershed
- Develop interpretive OHV signing/mapping for 30 miles
- Discourage the use of deep trench on-site wastewater systems
- Disperse information on proper use of national forest by increasing visitor contacts 200 percent
- Encourage innovative and alternative wastewater treatment systems and incorporate reuse
- Evaluate 10,000 acres of roads for future access management
- Identify appropriate locations to establish new Utah prairie dog colonies as outlined in the Utah Prairie Dog Recovery Plan.
- Identify areas for feasible irrigation efficiency projects to reduce runoff and nutrients to the river
- Identify cooperative landowners and implement stream channel and bank stabilization work on at least 2,000 feet per year of the Sevier River that establishes and maintains riparian vegetation and restores proper stream channel dimensions and function.
- Implement ½ mile channel stabilization in Cameron Wash
- Install a cattle exclosure on 30 acres of land purchase
- Maintain instream phosphorus concentrations below 0.05 mg/l total phosphorus. Reduce phosphorus load by ~3200 kg/year.
- Plant willows and manage cattle exclosures
- Relocate Pine Lake Campground out of the floodplain
- Restore 1,000 acres of sagebrush/grassland, pinyon/juniper to properly functioning condition on SITLA and FS lands
- Restore 150 acres sage grouse habitat in the lower reaches of Cameron Wash watershed
- Stabilize headcuts in Blubber Creek
- Treat 2000 acres of sagebrush grasslands on BLM lands over the next 5 years to improve historic and active sage grouse habitats
- Treat pinyon/juniper in critical big game winter ranges to reintroduce grasses, forbs and shrubs on 100 acres of BLM and Forest Service lands
- Use available tools (fire, thinning, logging) to manage 2,000 acres of ponderosa pine
- Use mechanical treatments and/or fire to increase aspen representation within the watershed and encourage regeneration of young aspen (1000 acres).
- Work with landowners and partners to control noxious weeds on private/public lands
- Work with landowners to relocate and control populations of prairie dogs on private lands

Middle East Fork Sevier River

- Complete TMDL to determine endpoints and implementation strategy
- Conduct a suitability analysis for dispersed camping in riparian habitat
- Conduct sagebrush/grassland vegetation treatment projects to improve wildife habitat and reduce upland erosion
- Continue stream restoration, fish habitat, riparian enhancement and fencing work on DWR and BLM lands in Black Canyon
- Control management of sheep grazing in lower watershed outside of burn
- Decommission 20 miles of roads within the Clay Creek watershed
- Develop interpretive OHV signing to reduce bank erosion
- Establish upland vegetative ground cover on the Mt. Dutton fire to minimize sediment and ash runoff and flash flooding into the East Fork Sevier River.
- Establish upland vegetative ground cover on the Mt. Dutton fire to minimize sediment and ash runoff and flash flooding into the East Fork Sevier River.
- Evaluate 25 miles of roads for future access management
- Evaluate 3 miles of riparian habitat to determine suitability for dispersed camping
- Evaluate roads for future access management
- Identify 2 Wyden Amendment Projects to decreasing sediment caused by past mining activity in Antimony Creek
- Identify cooperative landowners and implement major stream, fishery habitat riparian restoration and fencing work of at least 2,000 feet per year on the East Fork Sevier River above the Antimony diversion.
- Implement livestock management practices and intall fencing to help protect and encourage riparian vegetation
- Implement stream fishery habitat and riparian enhancement work on Utah Division of Wildlife Resources (UDWR) property on 3,500 feet of the East Fork Sevier River in Kingston Canyon.
- Improve ¼ mile of road crossings in Cottonwood Creek
- Increase trout abundance to a minimum of 100 pounds per acre of stream.
- Provide new public access to 10 miles of stream where restoration work has been implemented, over the next 5 years.
- • Re-construct bridge, where road crosses Cottonwood Creek
- Relocate 1 mile of road in the Antimony Creek floodplain
- Relocate Pine Lake Campground out of the floodplain
- Re-seed 100 acres following the 2002 Sanford Fire
- Restore 1,000 acres of sagebrush/grassland, pinyon/juniper to properly functioning condition on SITLA and FS lands
- Restrict grazing through 2004 with continued monitoring of burned areas
- Treat and reintroduce grasses, forbs and shrubs on critical big game winter range onapproximately 1000 acres
- Treat pinyon/juniper and reintroduce grasses, forbs and shrubs on critical big game winter ranges on 3000 acres of BLM critical mule deer winter range
- Use available tools (fire, thinning, logging) to manage 2,000 acres of ponderosa pine
- Use mechanical treatments and/or fire to increase aspen representation within the watershed and encourage regeneration of young aspen (1000 acres).

- Work with two landowners immediately below Otter Creek Reservoir to implement fencing and stream and riparian restoration work, and to secure matching non-federal funds for implementing work.
- Encourage clean up of mine sites along Antimony Creek
- Provide for dispersed camping sites away from water



Appendices

Appendix A. Steering Committee members for the Upper Sevier River Community Watershed Project/Plan.

Name	Title	Agency
Allen Henrie	Chairman	Upper Sevier River Soil Conservation District
Clayton Ramsey	Project Coor.	Color County RC&D
Craig Axtell	Superintendent	Bryce Canyon National Park
Danny Perkins	President	Long Canal Irrigation Company President
Doug Messerly	Regional Supervisor	Division of Wildlife Resources
George Jolley	Chairman	Piute County Farm Service Agency
Jim Harris	TMDL Coor.	Utah Department of Environmental Quality
Kevin Heaton	Extension Agent	Utah State University
Kevin Eldredge	Mayor	Hatch
Paul Morgan	Piute Co. Commission	Piute Co.
Rex Smart	Kanab Field Office Manager	Bureau of Land Management
Richard Jaros	Soils and Water Program Manager	U.S. Forest Service
Ron Wilson		Forestry, Fire and State Lands
Ron Torgerson	Renewable Resource Specialist	State of Utah Trust Lands
Bob Russell	Forest Supervisor	Dixie National Forest
Tyce Palmer	Zone Five Coordinator	Utah Association of Conservation Districts
Vane Campbell	Area Conservationist	Nature Resources Conservation Serfvice
Wayne Thomas	District Engineer	Utah Department of Environmental Quality
Dennis Stowell	Iron Co. Commission	Iron County
Ricky Dalton	Mayor	Junction
Janet Oldham	Mayor	Panguitch
Mira Loy Ott	County Committee Chair	Garfield Co. Farm Services Agency
Maloy Dodds	Garfield Co. Commissioner	Garfield Co.
Joe Dalton	Mayor	Circleville
Mark Habbeshaw	Kane Co. Commission	Kane County
Liz Thomas	Field Attorney	Southern Utah Wilderness Alliance

Appendix B. Technical Advisory Committee Members for the Upper Sevier Watershed Management Plan.

Name	Title	Agency
Hydrology		
Chris Butler	Hydrologist	U.S. Forest Service
Dale Deiter	Hydrologist	U.S. Forest Service
Joni Brazier	Hydrologist	U.S. Forest Service
Harry Judd	State TMDL Coor.	Utah Department of Water Quality
Jim Harris	Sevier River Watershed TMDL Coor	Utah Department of Water Quality
Joni Brazier	Hydrologist	U.S. Forest Service
Dave Pace	Richfield Zone Coor.	Utah Association of Conservation Districts
Rich Jaros	Soil and Water Program Manager	U.S. Forest Service
Mark Muir	Hydrologist	U.S. Forest Service
Agriculture		
Verl Bagley	Piute Co. Extension Agent	Utah State University
Kevin Heaton	Garfield Co. Extension Agent	Utah State University
Tyce Palmer	Zone Five Coordinator	Utah Association of Conservation Districts
Tom Jarmen	District Conservationist	Natural Resources Conservation Service
Lynn Kitchen	District Conservationist	Natural Resources Conservation Service
Jack Soper	Garfield Co. Extension Agent, retired	Utah State University
Mike Tebbs	Rancher	Garfield Co.
Eldon Frandsen		Natural Resources Conservation Service
Lee Wolsey		Natural Resources Conservation Service
Fire		
Pete Goetzinger	Assistant Fire Management Officer	U.S. Forest Service
Taiga Rohrer	Fire Management Officer	U.S. Forest Service
Brett Fay	Fire Management Officer	U.S. Forest Service
Kim Soper	Fire Management Officer	U.S. Forest Service
Tracy Swenson	Fuel Technician	U.S. Forest Service
Keith R Adams	Assistant FMO	U.S. Forest Service
Dandy Pollock	Fuels Specialist	U.S. Forest Service
Paul Briggs	Fuels Specialist	Bureau of Land Management
Earl LeVanger	Kane Co. Fire Warden	Utah State Forestry and Fire
Larry LeForte	So. Utah Fire Ops coordinator	Utah State Forestry and Fire
Jeff Hickerson	Fuels Specialist	Zion National Park
Henry Bastian	Fuels Specialist	Zion National Park
Clair Jolley	Fuels Specialist	Bureau of Land Management
Human Uses		
Bryan Carter	OHV Manager	U.S. Forest Service
Rachel Kennon	Recreation Specialist	U.S. Forest Service
Max Molyneux	Landscape Architect	U.S. Forest Service
Wayne Thomas	Environmental Engineer	Utah Department of Environmental Quality
Noelle Meier	Landscape Architect	U.S. Forest Service
Cindy Calbaum	Recreation Specialist	U.S. Forest Service
Bill Booker	Recreation Specialist	Bureau of Land Management
Bill Dawson	Environmental Engineer	Utah Department of Environmental Quality
Alan Henrie	Manager	Panguitch City
Kristin Legg	Recreation/Hydrology	Bryce Canyon National Park

Appendix B (cont). Technical Advisory Committee (TAC) Members for the Upper Sevier Watershed Management Plan.

Name	Title	Agency
Species and Habitat		
Donald Auer	Habitat Specialist	Utah Division of Wildlife Resources
Jake Schoppe	Wildlife Biologist	U.S. Forest Service
Lisa Church	Wildlife Biologist	Bureau of Land Management
Lisa Young	Wildlife Biologist	U.S. Forest Service
Lydia Allen	Wildlife Biologist	U.S. Forest Service
Nate Yorgason	Wildlife Biologist	U.S. Forest Service
Stan Beckstrom	Fisheries Habitat Biologist	Utah Division of Wildlife Resources
Steve Brazier	Fisheries Biologist	U.S. Forest Service
Adam Bronson	Wildlife Biologist	Utah Division of Wildlife Resources
Vegetation		
Randy Beckstrand	Range Conservationist	Bureau of Land Management
Jeff Bott	Forester	U.S. Forest Service
Phil Eisenhauer	Silviculturist	U.S. Forest Service
David Keefe	Supervisory Forester	U.S. Forest Service
Ron Larson	Forester	Forestry, Fire and State Lands
Tom Simper	Range Conservationist	Natural Resources Conservation Service
Tom Jarman	District Conservationist	Natural Resources Conservation Service
Ron Torgerson	Renewable Resource Specialist	Utah School and Institutional Trust Lands
Art Patrtridge	Range Management Specialist	U.S. Forest Service
Kristi Hatch		Natural Resources Conservation Service
Evan Boshell	Range Management Specialist	U.S. Forest Service
Steve Smith	Range Management Specialist	U.S. Forest Service

CONDITION CLASS

Condition class descriptions: Condition classes are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of exotic plant species, insects and disease (introduced or native), or other past management activities.

Condition class	**Attributes**	**Example management options**
Condition Class 1	• Fire regimes are within or near an historical range. • The risk of losing key ecosystem components is low. • Fire frequencies have departed from historical frequencies by no more than one return interval. • Vegetation attributes (species composition and structure) are intact and functioning within an historical range.	Where appropriate, these areas can be maintained within the historical fire regime by treatments such as fire use.
Condition Class 2	• Fire regimes have been moderately altered from their historical range. • The risk of losing key ecosystem components has increased to moderate. • Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This results in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns. • Vegetation attributes have been moderately altered from their historical range.	Where appropriate, these areas may need moderate levels of restoration treatments, such as fire use and hand or mechanical treatments, to be restored to the historical fire regime.
Condition Class 3	• Fire regimes have been significantly altered from their historical range. • The risk of losing key ecosystem components is high. • Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns. • Vegetation attributes have been significantly altered from their historical range.	Where appropriate, these areas may need high levels of restoration treatments, such as hand or mechanical treatments. These treatments may be necessary before fire is used to restore the historical fire regime.

Hann, W.J. & Strohm, D.J. 2003. Fire Regime Condition Class and Associated Data for Fire and Fuels Planning: Methods and Applications. in Fire, Fuels Treatments, and Ecological Restoration: Conference Proceedings; April 16-18, 2002. RMRS-P-29. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. pp. 397-433.

Appendix D. Key Issues Identified for all 9 Upper Sevier River Watersheds.

	Upper East Fork Sevier River	Middle East Fork Sevier River	Lower East Fork Sevier River	Asay Creek Sevier River	Mammoth Creek Sevier River	Pass Creek Sevier River	Panguitch Creek Sevier River	Bear Creek Sevier River	City Creek Sevier River
Fire									
Communities at Risk	X	X		X	X	X	X	X	
Fuel Conditions	X	X	X	X	X	X	X	X	X
Human Uses									
Development and Effects to Ground/Surface Water	X			X	X	X	X	X	
Development and Impacts to Adjacent Lands					X		X		
Access Management	X	X	X	X				X	
Developed and Dispersed Recreation		X	X			X		X	
Vegetation Composition									
Sagebrush - Grass	X	X	X			X	X	X	X
Aspen	X			X	X				
Grassland - Meadow									
Mixed Conifer - Mountain Fir				X	X				
Oak - Mahogany - Mountain Shrub									
Pinyon - Juniper		X	X			X		X	X
Ponderosa				X					
Spruce - Fir									
Tall Forb				X	X				
Noxious Weeds							X		
Species and Habitat									
Priorities for Enhancement or Protection of:									
Southwestern Willow Flycatcher Habitat									
Utah Prairie Dog Habitat	X					X			
Bald Eagle Habitat									
Spotted Bat Habitat									
Townsend's Big-eared Bat Habitat									
Flammulated Owl Habitat									
Three-toed Woodpecker Habitat									
Northern Goshawk Habitat					X				
Peregrine Falcon Habitat									
Sage Grouse Habitat		X				X		X	X
Turkey Habitat									
Deer Habitat			X	X			X		X
Elk Habitat				X			X		
Pronghorn Habitat									
Brian Head Mountain-Snail Habitat									
Beaver Habitat									
Boreal Toad Habitat									
Bonneville Cutthroat Habitat									
Riparian Areas	X			X	X		X	X	
Fisheries Habitat		X	X						

Appendix D (cont). Key Issues Identified for all 9 Upper Sevier River Watersheds.

	Upper East Fork Sevier River	Middle East Fork Sevier River	Lower East Fork Sevier River	Asay Creek Sevier River	Mammoth Creek Sevier River	Pass Creek Sevier River	Panguitch Creek Sevier River	Bear Creek Sevier River	City Creek Sevier River
Hydrology/Water Quality									
Hydrology									
Dewatering and altered flow regimes									
Releases from Otter Ck. Res. may be causing bank erosion along E. Fork Sevier River									
Diversion of water from Castle Creek to Deer Creek has caused severe channel degredation									
Diversions along the Sevier R. may be affecting sediment transport capacity and channel equilibrium									
Loss of riparian veg. has resulted in reduced bank storage and summer streamflows									
Hillslope Processes									
Accelerated erosion on high elevation meadows									
Accelerated erosion in pinyon-juniper and sagebrush stands			X					X	X
Accelerated erosion associated with urban development									
Accelerated erosion associated with roads									
Rill and gully erosion on hillslopes									
Accelerated erosion associated with illegal ATV use									
Riparian Vegetation									
Lack of health composition of riparian veg, defined by the presence of late seral herbaceous plants and multiple age class distribution of appropriate woody plant species	X	X	X	X	X	X	X		
Water Quality									
Summer home development and associated impacts (I.e., Ground/Surface Water contamination, erosion, recreation, etc.)				X	X	X			
Accelerated erosion, grazing management, recreation use, roads	X	X					X		X
TMDL listed and potentially listed water bodies due to nutrients, sediment, phosphorous, DO, habitat alteration, or temperature								X	
Channel Morphology									
Active channel adjustments (vertical or lateral)									
Accelerated bank erosion									
Channelization									
Agriculture									
Animal Feed Operations									
Water conservation concerns (Sprinkler vs. Flood Irrigation)									X
Pasture Management			X					X	X
Fertilizer Usage and Impacts									
Noxious Weeds	X	X	X	X	X	X	X	X	
Wildlife Management on Agricultural Lands	X	X		X	X	X	X		

Appendix E. Total acres/miles identified as priority issues for all 9 Upper Sevier River Watersheds.

Watershed	TAC Group	Key Issue	Acres/(mi.) Identified
Upper East Fork			
	Hydrology	Accelerated Erosion	3503
	Human Uses	Access Management	2601
	Fire	Communities at Risk to Wildfire	27732
	Vegetation	Aspen - Vegetation Composition	45016
	Human Uses	Development and Effects to Ground Water	631
	Species and Habitat	Enhancement and Protection of Riparian Habitat	159 (mi)
	Species and Habitat	Enhancement and Protection of Utah Prairie Dog Habitat	50973
	Fire	Shade Tolerant Vegetation - Fuel Conditions	23684
	Agriculture	Noxious Weeds	3278
	Hydrology	Riparian Vegetation Composition	108 (mi)
	Vegetation	Sagebrush/Grassland Areas - Vegetation Composition	50973
	Agriculture	Widlife Infringement on Private Lands	10811
Middle East Fork			
	Hydrology	Accelerated Erosion	9973
	Human Uses	Access Management	55607
	Fire	Communities at Risk to Wildfire	7942
	Human Uses	Dispersed Recreation	1854
	Species and Habitat	Enhancement or Protection of Sage Grouse Habitat	11861
	Species and Habitat	Enhancement or Protection of Fisheries Habitat	100 (mi)
	Fire	Mountain Brush Species - Fuel Conditions	24604
	Agriculture	Noxious Weeds	10127
	Vegetation	Pinyon/Juniper - Vegetation Composition	32177
	Hydrology	Riparian Vegetation Composition	104 (mi)
	Vegetation	Sagebrush/Grassland Areas - Vegetation Composition	11696
	Agriculture	Wildlife Infringement on Private Lands	10665
Lower East Fork			
	Human Uses	Access Management	37381
	Human Uses	Dispersed Recreation	2967
	Species and Habitat	Enhancement and Protection of Deer Habitat	20875
	Species and Habitat	Enhancement and Protection of Fisheries Habitat	37 (mi)
	Fire	Mountain Brush Species	15471
	Agriculture	Noxious Weeds	2357
	Agriculture	Pasture Management	10154
	Fire	Pinyon/Juniper - Fuel Conditions	11019
	Vegetation	Pinyon/Juniper - Vegetation Composition	8264
	Hydrology	Pinyon/Juniper, Sagebrush - Accelerated Erosion	10723
	Hydrology	Riparian Vegetation Composition	25 (mi)
	Vegetation	Sagebrush/Grassland Areas - Vegetation Composition	8263
Panguitch Creek			
	Hydrology	Accelerated Erosion	7596
	Fire	Communities at Risk to Wildfire	2834
	Human Uses	Development and Effects to Ground/Surface Water	2372
	Human Uses	Development and Impacts to Adjacent Lands	23474
	Species and Habitat	Enhancement and Protection of Deer/Elk Habitat	82044
	Species and Habitat	Enhancement and Protection of Sage Grouse Habitat	31448
	Species and Habitat	Enhancement and Protection of Riparian Habitat	43 (mi)
	Vegetation/Agriculture	Noxious Weeds	5889
	Fire	Pinyon/Juniper, Sagebrush - Fuel Conditions	15920
	Fire	Ponderosa Pine - Fuel Conditions	2159
	Hydrology	Riparian Vegetation Composition	22 (mi)
	Vegetation	Sagebrush/Grasslands - Vegetation Composition	23422
	Agriculture	Wildlife Infringement on Private Lands	35492

Appendix E (cont). Total acres/miles identified as priority issues for all 9 Upper Sevier River Watersheds.

Watershed	TAC Group	Key Issue	Acres/(mi.) Identified
Asay Creek			
	Human Uses	Access Management	43851
	Vegetation	Aspen/Mixed Conifer - Vegetation Composition	35709
	Fire	Communities at Risk	2121
	Human Uses	Development and Effects to Ground/Surface Water	4815
	Species and Habitat	Enhancement and Protection of Deer/Elk Habitat	60207
	Species and Habitat	Enhancement and Protection of Riparian Habitat	56 (mi)
	Agriculture	Noxious Weeds	30137
	Vegetation	Ponderosa Pine - Vegetation Composition	14449
	Fire	Ponderosa Pine/Mixed Conifer - Fuel Conditions	65615
	Hydrology	Riparian Vegetation Composition	71 (mi)
	Hydrology	Summer Home Development	4205
	Vegetation	Tall Forbs - Vegetation Composition	2568
	Agriculture	Wildlife Infringement on Private Lands	9925
Pass Creek Sevier River			
	Hydrology	Accelerated Erosion	56911
	Hydrology	Active Channel Adjustments	102 (mi)
	Fire	Communities at Risk	4259
	Human Uses	Developed and Dispersed Recreation	7857
	Human Uses	Development and Effects to Ground/Surface Water	1290
	Species and Habitat	Enhancement and Protection of Sage Grouse Habitat	70136
	Species and Habitat	Enhancement and Protection of Utah Prairie Dog Habitat	47775
	Agriculture	Noxious Weeds	18631
	Fire	Pinyon/Juniper - Fuel Conditions	12182
	Vegetation	Pinyon/Juniper - Vegetation Composition	31178
	Vegetation	Sagebrush/Grasslands - Vegetation Composition	14572
	Agriculture	Wildlife Infringement on Private Lands	152301
Mammoth Creek			
	Vegetation	Aspen/Mixed Conifer - Vegetation Composition	13738
	Fire	Communities at Risk	3046
	Human Uses	Development and Effects to Ground/Surface Water	2912
	Human Uses	Development and Impacts to Adjacent Lands	5540
	Species and Habitat	Enhancement and Protection of Goshawk Habitat	74766
	Species and Habitat	Enhancement and Protection of Riparian Habitat	40 (mi)
	Agriculture	Noxious Weeds	7741
	Fire	Ponderosa Pine - Fuel Conditions	8267
	Hydrology	Riparian Vegetation Composition	37 (mi)
	Fire	Spruce Fir - Fuel Conditions	10730
	Hydrology	Summer Home Development	2884
	Vegetation	Tall Forb - Vegetation Composition	3731
	Agriculture	Wildlife Infringement on Private Lands	26479
City Creek Sevier River			
	Hydrology	Accelerated Erosion	2512
	Human Uses	Access Management	979
	Fire	Aspen/Spruce - Fuel Conditions	12562
	Species and Habitat	Enhancement and Protection of Deer Habitat	48504
	Vegetation	Pinyon/Juniper - Vegetation Composition	88676
	Hydrology	Pinyon/Juniper, Sagebrush - Accelerated Erosion	24996
	Fire	Pinyon/Juniper, Sagebrush - Fuel Conditions	12816
	Vegetation	Sagebrush/Grasslands - Vegetation Composition	17923
	Agriculture	Pasture Management	4365
	Agriculture	Water Conservation Concerns	11904
Bear Creek			
	Species and Habitat	Enhancement and Protection of Riparian Habitat	52 (mi)
	Species and Habitat	Enhancement and Protection of Sage Grouse Habitat	26649
	Agriculture	Noxious Weeds	39061
	Agriculture	Pasture Management	25014
	Vegetation	Pinyon/Juniper - Vegetation Composition	95445
	Hydrology	Pinyon/Juniper, Sagebrush - Accelerated Erosion	47644
	Fire	Pinyon/Juniper, Sagebrush, Mountain Brush - Fuel Cond.	3720
	Vegetation	Sagebrush/Grasslands Areas - Vegetation Composition	25443
	Hydrology	TMDL listed and potentially listed waters	29 (mi)

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Appendix F. Vegetation types (acres) by watershed and subwatershed, for entire Upper Sevier River basin. *(This table is a two-page spread.)*

Watershed/subwatersheds	Vegetation				
	Agriculture	Aspen	Grass-Forb	Limber Pine/Bristlecone Pine	Mixed Conifer
Asay Creek					
Deer Valley-Midway Creek		342.31	1106.08		14298.28
Midway Valley-Midway Creek		63.98	1796.29	12.31	491.97
Strawberry Creek			1456.33		9853.06
Swains Creek			1273.99		8389.07
West Fork Asay Creek-Asay Creek	38.59		903.64		770.23
Total	**38.59**	**406.29**	**6536.33**	**12.31**	**33802.61**
Bear Creek Sevier River					
Bear Creek	7.3	2.56	769.98		959.68
East Bench-Sevier River	3679.53				
Horse Valley Creek-Sevier River	1029.83		46.8		
Limekiln Creek	236.1		71.98		375.42
Sandy Creek	77.54	34.65			442.4
Sanford Creek	23.39		2278.03		1170.4
Smith Canyon-Sevier River	1202.63		1292.18		312.27
Tebbs Hollow-Sevier River	941.18				90.1
Threemile Creek	58.06				1749.05
West Ditch-Sevier River	2174				
Total	**9429.56**	**37.21**	**4458.97**		**5099.32**
City Creek Sevier River					
Birch Creek-Sevier River	1707.54		47.55		
Burnt Hollow-Sevier River	4379.3	75.26			2.48
Chokecherry Creek-Sevier River			386.63		417.53
City Creek	22.71	976.71	4.57		1412.48
Cottonwood Creek	1956.07	980.66			0.92
Echard Creek			438.13		175.3
Lost Creek	1348.85	268.68	1483.93		0
Piute Reservoir	1438.26				328.46
Total	**10852.73**	**2301.31**	**2360.81**		**2337.17**
Lower East Fork Sevier River					
Antimony Creek	784.27	924.68	11.9		180.36
Antimony-East Fork Sevier River	2558.17	95.12			
Coyote Hollow-Antimony Creek		6089.49	425.31		
Dry Wash	81.31	1100.67	740.8		252.63
East Fork Sevier River Outlet	1380.75	3994.08			1634.21
Hoodle Creek	0.11	3041.94	1.54		
Lost Spring Draw		2516.74	0.65		
Total	**4804.61**	**17762.72**	**1180.2**		**2067.2**
Mammoth Creek					
Lower Mammoth Creek	451.96		280.79		1724.91
Middle Mammoth Creek		206.9	368.7		1481.23
Tommy Creek		2066.14	420.96		3305.25
Upper Mammoth Creek		4479.99	3838.99		473.24
Total	**451.96**	**6753.03**	**4909.44**		**6984.63**

Appendix F. Vegetation types (acres) by watershed and subwatershed, for entire Upper Sevier River basin. *(This table is a two-page spread.)*

Mountain Shrub	Pinyon/ Juniper	Ponderosa Pine	Riparian	Rock	Sagebrush/ Grass	Spruce-Fir	Urban	Water	Grand Total
		1568.9		3559.28	583.93	1972.14		423.76	**23854.68**
		86.32		1835.19	596.03	6295.49			**11177.58**
	72.46	6205.8		47.66	22.78				**17658.09**
113.61		6783.85		86.94	123.51				**16770.97**
	1100.83	11077.96		507.29	5010.64				**19409.18**
113.61	**1173.29**	**25722.83**		**6036.36**	**6336.89**	**8267.63**		**423.76**	**88870.5**
6363.4	13486.97	2565.94	101.41	0.81	9259.75				**33517.8**
0.1	9385.92				576.57		687.06		**14329.18**
	24345.41	1965.43			2233.63	597.3			**30218.4**
	4644.59			6915.93	3990.06	799.43			**17033.51**
4336.86	8293.51			315.81	1761.23				**15262**
	1124.36			3303.64	2271.85	8978.52			**19150.19**
	11747.65	19.96			1720.55	5436.78			**21732.02**
731.72	9134.03				1306.05	673.88			**12876.96**
4043.51	6405.14	303.36		11.3	631.82				**13202.24**
	6877.7			2.96	1691.36	911.96			**11657.98**
15475.59	**95445.28**	**4854.69**	**101.41**	**10550.45**	**25442.87**	**17397.87**	**687.06**		**188980.28**
145.5	15657.95	959.47			67.82	1090.74	308.3		**19984.87**
	11289.51	153.77		413.63	2794.01				**19107.96**
247.3	10906.65	4549.55			960.89	2493.91			**19962.46**
1007.11	5472.98	1069.96			607.81	5345.25		21.6	**15941.18**
1219.61	8098.17	1936.37			338.36	1418.24	13.72		**15962.12**
476.65	3613.02	4808.88			6049.1	256.91			**15817.99**
	11209.74			1907.37	5099.11	1674.51	16.69		**23008.88**
14.34	22427.72	815.12	253.09		2005.45			1812.71	**29095.15**
3110.51	**88675.74**	**14293.12**	**253.09**	**2321**	**17922.55**	**12279.56**	**338.71**	**1834.31**	**158880.61**
	11233.75			1996.88	6632.59	9.38			**21773.81**
	13468.25	10.22			2746.24				**18878**
	72.6			964.49	12643.97	17609.3			**37805.16**
	3823.29	1518.8		283.65	6090.6	606.36			**14498.11**
	25364.61	2545.57		410.22	3306.82	845.48			**39481.74**
	4529.53			94.72	5503.66				**13171.5**
	46.83			391.57	6129.5	1547.59			**10632.88**
	58538.86	**4074.59**		**4141.53**	**43053.38**	**20618.11**			**156241.2**
	4247.07	6727.92		606.6	4480.51				**18519.76**
75.91	125.04	8003.81		2691.06	2589.89	558.97			**16101.51**
		1498.76		3321.8	256.44	3369.57			**14238.92**
		1903.94		1604.09	1653.5	11862.74			**25816.49**
75.91	**4372.11**	**18134.43**		**8223.55**	**8980.34**	**15791.28**			**74676.68**

Appendix F (cont). Vegetation types (acres) by watershed and subwatershed, for entire Upper Sevier River basin.*(This table is a two-page spread.)*

	Vegetation				
Watershed/subwatersheds	**Agriculture**	**Aspen**	**Grass-Forb**	**Limber Pine/Bristlecone Pine**	**Mixed Conifer**
Middle East Fork Sevier River					
Clay Creek		152.43	250.21		6459.54
Cottonwood Creek	30.24		2990.95		0.39
Cow Creek-Sevier River	81.68		589.99		
Deep Creek		270.43	2427.35		
Deer Creek			3129.24		
Forest Creek	0	1663.04	647.37		
North Creek		4070	276.04		68.83
Pacer Lake	170.86	2361.64	11.18		
Prospect Creek	3.61		820.33		
Ranch Creek-Sevier River	1664.66	2373.99	531.56		242.1
South Creek			4602.21		2051.83
Sweetwater Creek	187.68	688.11	2105.77	308.08	4804.59
Total	2138.73	11579.64	18382.2	308.08	13627.28
Panguitch Creek					
Blue Spring Creek		3028.17	1369.91		585.2
Butler Creek		295.47	467.89		2384.5
Fivemile Hollow-Panquitch Creek			214.51		4.17
Haycock Creek		1669.94	1026.78		63.99
Ipson Creek		4375.15	1580.6		0.39
South Canyon-Panguitch Creek	669.38				
Total	669.38	9368.73	4659.69		3038.25
Pass Creek Sevier River					
Big Hollow-Sevier River	938.45		2199.56		1010.55
Castle Creek-Sevier River	456.92	542.16	5277.73		387.3
Casto Wash			352.28		
Graveyard Hollow	212.33				
Hillsdale-Sevier River	373.4		405.33		
Pass Creek		210.67	1341.11		1159.65
Peterson Wash-Sevier River	843.17				
Pole Canyon-Sevier River	106.21	24.44	2383.63		2103.88
Proctor Canyon-Sevier River			1685.76		1386.68
Red Canyon					67.33
Total	**2930.48**	**777.27**	**13645.4**		**6115.39**
Upper East Fork Sevier River					
Cameron Wash-East Fork Sevier River			2705.45		767.67
East Fork Sevier River Headwaters		2352.58	1124.91		16641.7
Hunt Creek			6371.33		
Mud Spring Creek-East Fork Sevier River			3841.65		2492.87
Showalter Creek-East Fork Sevier River			3065.86		463.51
Tropic Reservoir		434.28	475.57		9017.17
Total		**2786.86**	**17584.77**		**29382.92**
Grand Total	**31316.04**	**51773.06**	**73717.81**	**320.39**	**102454.77**

Appendix F (cont). Vegetation types (acres) by watershed and subwatershed, for entire Upper Sevier River basin.*(This table is a two-page spread.)*

Mountain Shrub	Pinyon/ Juniper	Ponderosa Pine	Riparian	Rock	Sagebrush/ Grass	Spruce-Fir	Urban	Water	Grand Total
	1859.23	1631.88		2545.45	2332.96	1301.32			**16533.02**
391.59	3352.54	502.79		18.71	5864.53	2619.6			**15771.34**
	7074.4	525.05			2839.51	5.54			**11116.17**
	5597.14	104.57		253.49	3515.53	3715.44			**15883.95**
	6674.21	328.84		78.01	4224.89	3606.11			**18041.3**
	3858.79	5.63		52.2	2937.84	902.59			**10067.46**
291.7	4552.19	126.38		1192.63	5192.13	1210.33			**16980.23**
343.49	10247.3	21.79		880.96	6792.17	956.54			**21785.93**
	1511.12			935.09	13809.59	1727.45			**18807.19**
581.62	8219.12	272.42		827.24	9257.47	258.54			**24228.72**
	5965.96	1264.38		1855.97	5518.95	140.29			**21399.59**
	4151.71	1817.37		2762.92	2013.61	1176.9			**20016.74**
1608.4	63063.71	6601.1		11402.67	64299.18	17620.65			**210631.64**
	45.54	2127.4		1285.22	1027.13	2917.12		341.98	**12727.67**
859.98	950.46	411.1		3.34	8107.48	324.6			**13804.82**
2829.64	5668.98	1306.63		0.09	6063.47				**16087.49**
64.38	68.46	2944.81		0.02	5887.6	657.84		512.73	**12896.55**
84.43		1398.06		668.8	2493.98	5298.64		345.78	**16245.83**
33.37	10396.01	227.92			345.2		454.94		**12126.82**
3871.8	17129.45	8415.92		1957.47	23924.86	9198.2	454.94	1200.49	**83889.18**
189.2	7424.96	899.35		3087.99	4308.83				**20058.89**
266.66	1396.2	1695.04			12579.07				**22601.08**
	1845.37			8294.25	3524.04	152.77			**14168.71**
4	6881.27	1660.06			998.28				**9755.94**
	11063.54	1556.02		746.25	1531.98				**15676.52**
728.69	11196.82	6970.38		672.84	6752.35				**29032.51**
	11004.55			2251.85	728.35				**14827.92**
	4184.88	989.38		1974.97	3729.92				**15497.31**
403.92	5882.74	932.33		7103.15	2450.48				**19845.06**
	1614.16	1205.66		7725.65	1848.12				**12460.92**
1592.47	**62494.49**	**15908.22**		**31856.95**	**38451.42**	**152.77**			**173924.86**
	5392.65	4294.17		2748.23	7778.59				**23686.76**
	231.87	4477.75		3413.92	2280.43				**30523.16**
	2298.72	455.27		3527.12	18398.43	2938.13			**33989**
	4214.98	12289.17		8845.66	13413.21				**45097.54**
	6142.77	4455.32		3453.94	13394.54	1.62			**30977.56**
	69.71	4330.7		7461.27	1289.23			141.56	**23219.49**
	18350.7	**30302.38**		**29450.14**	**56554.43**	**2939.75**		**141.56**	**187493.51**
25848.29	**409243.63**	**128307.28**	**354.5**	**105940.12**	**284965.92**	**104265.82**	**1480.71**	**3600.12**	**1323588.46**

Appendix G. Land ownership (acres) by watershed and subwatershed, for entire Upper Sevier River basin.

Watershed/subwatersheds	Ownership (acres)							
	BLM	USFS	Intermittent waters	NPS	Private	State	Water	Total
Asay Creek								
Deer Valley-Midway Creek		22112.68	200.07		1196.22		392.31	23901.28
Midway Valley-Midway Creek		10928.78		277.97				11206.75
Strawberry Creek		16153.11			1514.78			17667.89
Swains Creek	0.67	15314.66		22.34	1389.87	89.75		16817.29
West Fork Asay Creek-Asay Creek		13743.33			5665.93			19409.26
Total	**0.67**	**78252.56**	**200.07**	**300.31**	**9766.8**	**89.75**	**392.31**	**89002.47**
Bear Creek Sevier River								
Bear Creek	13085.4	12382.48	13.88		6131.88	2069.96		33683.6
East Bench-Sevier River	6533.75	1642.13			5976.14	177.1		14329.12
Horse Valley Creek-Sevier River	16634.51	11236.49			283.97	2063.4		30218.37
Limekiln Creek	3990.79	11891.12			1151.59			17033.5
Sandy Creek	4797.15	9632.05			581.93	250.76		15261.89
Sanford Creek	903.7	17790.72			455.79			19150.21
Smith Canyon-Sevier River	7091.87	7897.22			6425.7	317.22		21732.01
Tebbs Hollow-Sevier River	5502.56	4429.91			2689.1	255.33		12876.9
Threemile Creek	2343.84	10333.29			100.65	430.28		13208.06
West Ditch-Sevier River	3291.86	1286.87			6583.63	495.6		11657.96
Total	**64175.43**	**88522.28**	**13.88**		**30380.38**	**6059.65**		**189151.62**
City Creek Sevier River								
Birch Creek-Sevier River	9331.19	6413.28			3683.57	558.92		19986.96
Burnt Hollow-Sevier River	7908.39	3740.22			6432.18	1027.18		19107.97
Chokecherry Creek-Sevier River	9114.66	8123.67			2074.16	650.66		19963.15
City Creek	986.37	13314.8			1003.04	616.57	34.86	15955.64
Cottonwood Creek	3520.03	9460.43			2433.34	556.41		15970.21
Eehard Creek	10180.02	421.39	30.3		4291.75	974.31		15897.77
Lost Creek	3287.09	17495.01			2226.74			23008.84
Piute Reservoir	15197.45	5022.12			4381.01	2249.32	2245.24	29095.14
Total	**59525.2**	**63990.92**	**30.3**		**26525.79**	**6633.37**	**2280.1**	**158985.68**
Lower East Fork Sevier River								
Antimony Creek	3468.81	15848.92			2167.73	359.81		21845.27
Antimony-East Fork Sevier River	8694.6	4560.8			4021.15	1601.47		18878.02
Coyote Hollow-Antimony Creek		38018.28						38018.28
Dry Wash	2401.17	1504.14			187.45	10429.48		14522.24
East Fork Sevier River Outlet	25326.38	19115.48			4885.57	3325.8		52653.23
Lost Spring Draw		10860.13	81.08				29.01	10970.22
Total	**39890.96**	**89907.75**	**81.08**		**11261.9**	**15716.56**	**29.01**	**156887.26**
Mammoth Creek								
Lower Mammoth Creek	53.67	11609.14			6816.26	40.84		18519.91
Middle Mammoth Creek		13222.51			2879.01			16101.52
Tommy Creek		14119.79			119.14			14238.93
Upper Mammoth Creek		22777.92		540.8	2587.2			25905.92
Total	**53.67**	**61729.36**		**540.8**	**12401.61**	**40.84**		**74766.28**

Appendix G (cont). Land ownership (acres) by watershed and subwatershed, for entire Upper Sevier River basin.

Watershed/subwatersheds	Ownership (acres)							
	BLM	USFS	Intermittent waters	NPS	PRIVATE	STATE	WATER	Total
Middle East Fork Sevier River								
Clay Creek		16108.53			359.28	24.8	81.81	16574.42
Cottonwood Creek		11438.22			60.24	4272.99		15771.45
Cow Creek-Sevier River	2483.4	2335.26			399.79	5897.69		11116.14
Deep Creek	3722.39	11921.39			240.24			15884.02
Deer Creek	4492.69	12830.67			297.82	420.04		18041.22
Forest Creek	2369.05	7444.6			253.77			10067.42
North Creek	2012.84	14829.46			3.82	271.09		17117.21
Pacer Lake	8368.75	10556.99			1690.79	1169.45		21785.98
Prospect Creek		18109.25			170.42	527.53		18807.2
Ranch Creek-Sevier River		14915.29			4489.34	4868.7		24273.33
South Creek		9314.18			3272.26	8813.7		21400.14
Sweetwater Creek		16592.32			1392.68	2051.29		20036.29
Total	23449.12	146396.16			12630.45	28317.28	81.81	210874.82
Panguitch Creek								
Blue Spring Creek		10857			1536.62		335.5	12729.12
Butler Creek		12620.29			1205.46			13825.75
Fivemile Hollow-Panquitch Creek	789.83	14006.57			905.09	386.01		16087.5
Haycock Creek		11957.87			446.77		494.99	12899.63
Ipson Creek		12983.4			2833.78	118.65	325.32	16261.15
South Canyon-Panguitch Creek	8600	982.45			1880.84	663.53		12126.82
Total	**9389.83**	**63407.58**			**8808.56**	**1168.19**	**1155.81**	**83929.97**
Pass Creek Sevier River								
Big Hollow-Sevier River	5982.16	6948.26			6197.85	930.73		20059
Castle Creek-Sevier River	1285.3	1560.51			19764.23			22610.04
Casto Wash	2050.65	11751.77			366.3			14168.72
Graveyard Hollow	6701.02	2116.15			290.69	648.09		9755.95
Hillsdale-Sevier River	9397.39	3182.3			2261.37	835.44		15676.5
Pass Creek	9452.54	14307.21			3429.67	1843.24		29032.66
Peterson Wash-Sevier River	7359.31	3623.93			3198.35	646.34		14827.93
Pole Canyon-Sevier River	7536.99	3614.06			4076.3	271.08		15498.43
Proctor Canyon-Sevier River	4544.7	10210.37			4320.59	769.38		19845.04
Red Canyon	793.8	11320.72			346.4			12460.92
Total	**55103.86**	**68635.28**			**44251.75**	**5944.3**		**173935.19**
Upper East Fork Sevier River								
Cameron Wash-East Fork Sevier River		14585.13			4751.2	4364.04		23700.37
East Fork Sevier River Headwaters		28427.42		2153.53				30580.95
Hunt Creek		31744.96			37.12	2207.04		33989.12
Mud Spring Creek-East Fork Sevier River	163.98	35464.24		4469.97	3252.67	1762.96		45113.82
Showalter Creek-East Fork Sevier River	68.97	17616.91	41.76	1418.47	4302.29	7657.56		31105.96
Tropic Reservoir		21455.53		1595.76			178.72	23230.01
Total	**232.95**	**149294.19**	**41.76**	**9637.73**	**12343.28**	**15991.6**	**178.72**	**187720.23**
Grand Total	**251821.69**	**810136.08**	**367.09**	**10478.84**	**168370.52**	**79961.54**	**4117.76**	**1325253.52**

Appendix H (cont). Data tables for water quality, Asay Creek at U89 Crossing – 494990.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
4/24/1985		130	0.04	96	0.04	30533	12.7
5/22/1985		248.3	0.01	62	0.03	37664	18.2
7/10/1985		78	0.03	14	0.03	2672	5.7
8/7/1985		55.9	0.04	16	0.04	2188	5.5
9/4/1985		58.6	0.03	3	0.02	430	2.9
10/1/1985		73.4	0.0025	18	0.02	3232	3.6
10/29/1985		63.8	0.01	3	0.008	468	1.2
12/3/1985		55.6	0.0025	3	0.01	408	1.4
1/29/1986		50.2	0.01	13	0.02	1597	2.5
3/12/1986		40.3	0.01	28	0.04	2761	3.9
4/22/1986		87.5	0.007	36	0.03	7707	6.4
6/4/1986		88	0.0025	19	0.02	4091	4.3
7/8/1986		79.3	0.0025	9	0.02	1746	3.9
8/19/1986		48.4	0.0025	3	0.008	355	0.9
9/30/1986		64.8	0.0025	12	0.02	1902	3.2
11/12/1986		58.4	0.0025	5	0.02	714	2.9
12/17/1986		49.8	0.007	8	0.059	975	7.2
2/3/1987		47.9	0.01	16	0.02	1875	2.3
3/18/1987		39	0.01	24	0.03	2290	2.9
4/29/1987		104.9	0.01	45	0.04	11549	10.3
6/24/1987		86.2	0.0025	4	0.01	844	2.1
8/5/1987		59	0.0025	18	0.02	2598	2.9
9/15/1987		63	0.0025	4	0.02	617	3.1
11/10/1987		59.7	0.0025	3	0.02	438	2.9
12/15/1987		52	0.005	3	0.01	382	1.3
1/26/1988		39.3	0.0025	3	0.03	288	2.9
3/7/1988		30	0.02	3	0.05	220	3.7
4/20/1988			0.02	73	0.02		
6/1/1988		102.3	0.0025	3	0.08	751	20
8/3/1988		68	0.0025	77	0.02	12810	3.3
9/7/1988		35	0.0025	3	0.02	257	1.7
10/26/1988		16.8	0.009	3	0.006	123	0.2
12/7/1988			0.008	3	0.0025		
1/25/1989		20.5	0.018	3	0.02	150	1
3/1/1989		39	0.007	48	0.029	4580	2.8
4/12/1989		50.2	0.013	58	0.026	7123	3.2
5/18/1989		50.8	0.011	3	0.017	373	2.1
6/21/1989		41	0.0025	3	0.025	301	2.5
9/6/1989		31.9	0.011	7	0.01	546	0.8
10/18/1989		36	0.0025	6	0.0025	528	0.2
11/30/1989		21	0.0025	22	0.008	1130	0.4
1/10/1990		30.4	0.011	23	0.018	1711	1.3
3/6/1990		25.1	0.009	36	0.03	2211	1.8
4/11/1990		26	0.011	20	0.037	1272	2.4
5/2/1990		56.1	0.0025	23	0.039	3157	5.4
6/13/1990		39.7	0.015	4	0.106	389	10.3
9/5/1990	0.04	29.5		10	0.042	722	3
10/16/1990	0.008	29.9		9	0.02	658	1.5
1/16/1991	0.02	4.5		48	0.05	528	0.6
2/27/1991	0.011	25		33	0.034	2018	2.1

Appendix H (cont). Data tables for water quality, Asay Creek at U89 Crossing – 494990.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
4/24/1985		130	0.04	96	0.04	30533	12.7
5/22/1985		248.3	0.01	62	0.03	37664	18.2
7/10/1985		78	0.03	14	0.03	2672	5.7
8/7/1985		55.9	0.04	16	0.04	2188	5.5
9/4/1985		58.6	0.03	3	0.02	430	2.9
10/1/1985		73.4	0.0025	18	0.02	3232	3.6
10/29/1985		63.8	0.01	3	0.008	468	1.2
12/3/1985		55.6	0.0025	3	0.01	408	1.4
1/29/1986		50.2	0.01	13	0.02	1597	2.5
3/12/1986		40.3	0.01	28	0.04	2761	3.9
4/22/1986		87.5	0.007	36	0.03	7707	6.4
6/4/1986		88	0.0025	19	0.02	4091	4.3
7/8/1986		79.3	0.0025	9	0.02	1746	3.9
8/19/1986		48.4	0.0025	3	0.008	355	0.9
9/30/1986		64.8	0.0025	12	0.02	1902	3.2
11/12/1986		58.4	0.0025	5	0.02	714	2.9
12/17/1986		49.8	0.007	8	0.059	975	7.2
2/3/1987		47.9	0.01	16	0.02	1875	2.3
3/18/1987		39	0.01	24	0.03	2290	2.9
4/29/1987		104.9	0.01	45	0.04	11549	10.3
6/24/1987		86.2	0.0025	4	0.01	844	2.1
8/5/1987		59	0.0025	18	0.02	2598	2.9
9/15/1987		63	0.0025	4	0.02	617	3.1
11/10/1987		59.7	0.0025	3	0.02	438	2.9
12/15/1987		52	0.005	3	0.01	382	1.3
1/26/1988		39.3	0.0025	3	0.03	288	2.9
3/7/1988		30	0.02	3	0.05	220	3.7
4/20/1988			0.02	73	0.02		
6/1/1988		102.3	0.0025	3	0.08	751	20
8/3/1988		68	0.0025	77	0.02	12810	3.3
9/7/1988		35	0.0025	3	0.02	257	1.7
10/26/1988		16.8	0.009	3	0.006	123	0.2
12/7/1988			0.008	3	0.0025		
1/25/1989		20.5	0.018	3	0.02	150	1
3/1/1989		39	0.007	48	0.029	4580	2.8
4/12/1989		50.2	0.013	58	0.026	7123	3.2
5/18/1989		50.8	0.011	3	0.017	373	2.1
6/21/1989		41	0.0025	3	0.025	301	2.5
9/6/1989		31.9	0.011	7	0.01	546	0.8
10/18/1989		36	0.0025	6	0.0025	528	0.2
11/30/1989		21	0.0025	22	0.008	1130	0.4
1/10/1990		30.4	0.011	23	0.018	1711	1.3
3/6/1990		25.1	0.009	36	0.03	2211	1.8
4/11/1990		26	0.011	20	0.037	1272	2.4
5/2/1990		56.1	0.0025	23	0.039	3157	5.4
6/13/1990		39.7	0.015	4	0.106	389	10.3
9/5/1990	0.04	29.5		10	0.042	722	3
10/16/1990	0.008	29.9		9	0.02	658	1.5
1/16/1991	0.02	4.5		48	0.05	528	0.6
2/27/1991	0.011	25		33	0.034	2018	2.1

Appendix H (cont). Data tables for water quality, Asay Creek at U89 Crossing – 494990

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
6/5/1991	0.024	51.8		12	0.037	1521	4.7
7/31/1991	0.005	74.8		6	0.024	1098	4.4
9/18/1991	0.005	15.8		16	0.017	618	0.7
10/30/1991	0.005	20		36	0.022	1762	1.1
1/8/1992	0.005	14		39	0.028	1336	1
2/19/1992	0.005				0.032		
4/9/1992	0.028	20			0.06		2.9
5/20/1992	0.01			21	0.017		
7/15/1992	0.005			4	0.005		
10/14/1992	0.005			13	0.021		
11/18/1992	0.045	36.7		34	0.064	3053	5.7
2/3/1993	0.005	44		30	0.01	3229	1.1
3/17/1993	0.018			109	0.005		
4/4/1996	0.005	44		14	0.01	1507	1.1
4/25/1996	0.005	55		8	0.01	1076	1.3
5/8/1996	0.005	70		8.8	0.01	1507	1.7
5/22/1996	0.01	52.2		8.8	0.03	1124	3.8
6/6/1996	0.005	45		11.2	0.01	1233	1.1
6/19/1996	0.01	42		10.4	0.01	1069	1
7/8/1996	0.01	38		12.4	0.01	1153	0.9
8/21/1996	0.005	25		4.8	0.005	294	0.3
9/18/1996	0.01	47		4	0.005	460	0.6
10/30/1996	0.005	45		4	0.06136	440	6.8
12/10/1996	0.01434	30		7.2	0.005	528	0.4
1/29/1997	0.0279	19		11.2	0.01994	521	0.9
2/25/1997	0.005	35		17.2	0.01433	1473	1.2
3/19/1997	0.01751	16		68.7		2689	
4/9/1997	0.01223	35		5.6	0.005	480	0.4
4/23/1997		60		58.8	0.0542	8632	8
5/7/1997		15		38.4		1409	
5/21/1997		58		25.2	0.08203	3576	11.6
6/5/1997		14		7.6		260	
7/11/2001	0.01	18.2		110	0.08	4898	3.6
8/15/2001	0.01	41		9.2	0.01	923	1
9/13/2001	0.01	25		112	0.02	6850	1.2
10/18/2001	0.01	18		110	0.01	4844	0.4
11/15/2001	0.01	25		8	0.01	489	0.6
12/6/2001	0.01	40.4		9.6	0.023	949	2.3
1/16/2002	0.01	35.7		112	0.01	9782	0.9
2/27/2002	0.01	29.8		102	0.022	7437	1.6
3/27/2002	0.01	21		96	0.02	4932	1
4/10/2002		36.9					
5/1/2002	0.01	22		92	0.01	4952	0.5
6/12/2002	0.01	36.4		4	0.02	356	1.8

Appendix H (cont). Data tables for water quality, Mammoth Creek at U89 Crossing – 494970.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
9/8/1976				10	0.05		
10/13/1976			0.02	5	0.05		
1/19/1977			0.03		0.07		
2/9/1977			0.02	20	0.16		
3/23/1977			0.1				
5/25/1977			0.07	10	0.06		
7/28/1977				75	0.1		
9/28/1977				60	0.07		
12/7/1977				15			
1/11/1978		7		15	0.05	257	0.9
3/8/1978		11.9	0.03	80		2329	
5/10/1978				20	0.07		
7/12/1978		20		10		489	
9/6/1978			0.04	30	0.07		
11/14/1978				5	0.08		
3/21/1979			0.11	1			
5/16/1979				34	0.28		
7/18/1979		45		1	0.05	110	5.5
8/15/1979		29	0.03	2	0.05	142	3.5
11/28/1979		12.5	0.04	3	0.07	92	2.1
6/17/1980			0.02		0.02		
10/29/1980		58.2	0.01		0.025		3.6
1/14/1981		80	0.01		0.06		11.7
2/19/1981			0.03		0.025		
4/15/1981			0.04		0.025		
6/17/1981		28.9					
10/22/1981		31.6					
12/17/1981		26					
2/24/1982				56	0.07		
4/14/1982				94	0.15		
5/19/1982				160	0.15		
7/21/1982				3	0.07		
9/16/1982				7	0.1		
11/10/1982				7	0.15		
1/5/1983				25	0.11		
3/1/1983				36	0.1		
4/26/1983				231	0.1		
6/21/1983				144	0.06		
8/2/1984			0.01	63	0.07		
8/29/1984			0.005	17	0.07		
4/24/1985			0.05	58	0.07		
5/22/1985		203	0.04	60	0.06	29799	29.8
7/10/1985			0.03	9	0.97		
9/4/1985		33.6	0.02	3	0.03	247	2.5
10/1/1985		11.6	0.02	3	0.04	85	1.1
10/29/1985		16.2	0.02	3	0.03	119	1.2
12/3/1985		24.4	0.03	3	0.04	179	2.4
1/29/1986		19.3	0.04	9	0.05	425	2.4
3/12/1986		24.2	0.03	11	0.04	651	2.4
4/22/1986		27.5	0.04	45	0.07	3028	4.7

Appendix H (cont). Data tables for water quality, Mammoth Creek at U89 Crossing – 494970.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
6/4/1986		164	0.04	33	0.06	13241	24.1
7/8/1986		22	0.03	10	0.05	538	2.7
8/19/1986		33.1	0.01	10	0.04	810	3.2
9/30/1986		21.2	0.02	8	0.07	415	3.6
11/12/1986		26.1	0.03	18	0.05	1149	3.2
12/17/1986		17	0.2	7	0.565	291	23.5
2/3/1987		15.4	0.05	11	0.06	414	2.3
3/18/1987		4.5	0.04	18	0.06	198	0.7
4/29/1987		116.1	0.11	198	0.18	56241	51.1
6/24/1987		45.9	0.01	5	0.04	561	4.5
8/5/1987		22	0.03	18	0.04	969	2.2
9/15/1987		13	0.01	15	0.06	477	1.9
11/10/1987		30	0.01	3	0.04	220	2.9
12/15/1987		13	0.04	3	0.04	95	1.3
1/26/1988		16.7	0.04	88	0.05	3595	2
3/7/1988		41	0.07	3	0.1	301	10
4/20/1988		20	0.03	3	0.04	147	2
6/1/1988		232.7	0.0025	3	0.06	1708	34.2
8/3/1988		59	0.03	277	0.009	39984	1.3
9/7/1988		42	0.01	3	0.05	308	5.1
10/26/1988		55	0.02	3	0.04	404	5.4
12/7/1988			0.05	17	0.05		
1/25/1989		31.5	0.049	3	0.062	231	4.8
3/1/1989		22	0.038	3	0.012	161	0.6
4/12/1989		66	0.036	90	0.035	14533	5.7
5/18/1989		29	0.019	18	0.012	1277	0.9
6/21/1989		21	0.025	6	0.056	308	2.9
9/6/1989		18	0.031	16	0.036	705	1.6
10/18/1989			0.023	3	0.013		
11/30/1989			0.006	22	0.0025		
1/10/1990			0.039	11	0.049		
3/7/1990			0.033	16	0.065		
4/11/1990			0.051	10	0.077		
5/2/1990			0.033	32	0.076		
6/13/1990			0.015	9	0.042		
9/5/1990	0.056			74	0.115		
10/16/1990	0.024			14	0.04		
1/16/1991	0.05			66	0.11		
2/27/1991	0.04			17	0.067		
6/5/1991	0.03			42	0.077		
7/31/1991	0.045			12	0.068		
9/18/1991	0.027			14	0.038		
10/30/1991	0.029			59	0.092		
1/8/1992	0.046			56	0.076		
4/4/1996	0.03	17		14	0.04	582	1.7
4/25/1996	0.04	21		7.6	0.05	390	2.6
5/8/1996	0.03	91.8		44.8	0.04	10062	9
5/22/1996	0.03	60		15.2	0.03	2231	4.4

Appendix H (cont) . Data tables for water quality, Mammoth Creek at U89 Crossing – 494970.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
6/6/1996	0.02	20.6		8.8	0.06	444	3
6/19/1996	0.02	11		4	0.03	108	0.8
7/8/1996	0.03	8		25.6	0.06	501	1.2
8/21/1996	0.02	4		4	0.02	39	0.2
9/18/1996	0.03	8		4	0.03	78	0.6
10/29/1996	0.03552	9		4	0.10461	88	2.3
12/10/1996	0.02776	8		4	0.03719	78	0.7
1/29/1997		9		7.6		167	
2/25/1997	0.01513	9		7.6	0.03073	167	0.7
3/19/1997	0.03714	6		48.4		710	
4/9/1997	0.02178	11		5.6	0.02434	151	0.7
4/23/1997		42		74.4	0.09814	7645	10.1
5/7/1997		50		258		31561	
5/21/1997		90		34	0.11458	7487	25.2
6/5/1997		18		12.4		546	
7/11/2001	0.024	32.4		62	0.063	4915	5
8/15/2001	0.03	13.1		16.8	0.043	538	1.4
9/13/2001	0.02	13.7		58	0.031	1944	1
11/15/2001	0.021	13.7		16	0.024	536	0.8
12/6/2001	0.031	15		14.8	0.043	543	1.6
1/16/2002	0.054	8.2		4	0.04	80	0.8
2/27/2002	0.146	8.2		4	0.049	80	1
3/27/2002		7.4					
3/28/2002	0.01			4	0.046		
4/10/2002		6.5					
5/1/2002	0.021	54.3		4	0.034	531	4.5
6/12/2002	0.031	4		4	0.044	39	0.4

Appendix H (cont) . Data tables for water quality, Sevier River at U12 Crossing - 494963.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
11/17/1980			0.01		0.05		
1/27/1981			0.3		0.3		
5/5/1981				13	0.1		
1/12/1982				53	0.07		
5/11/1982				395	0.2		
4/4/1996	0.005	69		22	0.03	3714	5.1
4/25/1996	0.005	70		12	0.02	2055	3.4
5/8/1996	0.01	125		107.2	0.07	32784	21.4
5/23/1996	0.01	60		28.8	0.02	4228	2.9
6/4/1996	0.005	30		11.2	0.02	822	1.5
6/18/1996	0.005	25		6.4	0.01	391	0.6
7/8/1996	0.01	25		33.6	0.02	2055	1.2
8/20/1996	0.005	20		9.2	0.01	450	0.5
9/18/1996	0.005	45		6	0.01	661	1.1
10/29/1996	0.005	56		6.8	0.06799	932	9.3
12/11/1996	0.005	59		7.2	0.01006	1039	1.5
1/28/1997	0.005	60		35.6	0.0194	5226	2.8
2/25/1997	0.01007	52		14.8	0.01737	1883	2.2
3/18/1997	0.03221	77		192		36170	
4/8/1997	0.005	73		19.6	0.01402	3501	2.5
4/24/1997		259		104	0.08072	65901	51.1
5/6/1997		238		341		198559	
5/21/1997		288		83.6	0.12473	58906	87.9
6/5/1997		136		24.8	0.51989	8252	173
7/11/2001	0.032	96.6		1660	0.962	392322	227.4
8/15/2001	0.024	39.2		38.4	0.03	3683	2.9
9/13/2001	0.01	56		1592	0.01	218117	1.4
10/18/2001	0.01	30		1661	0.01	121913	0.7
11/15/2001	0.01	50.8		40	0.01	4971	1.2
12/6/2001	0.01			40	0.033		
1/16/2002	0.01			1610	0.025		
2/27/2002	0.01			1728	0.01		
3/28/2002	0.01	34		1830	0.023	152226	1.9
4/10/2002	0.01	43.4		12.4	0.032	1317	3.4
5/1/2002	0.01	85.6		1880	0.01	393722	2.1
6/12/2002	0.01	26.2		4	0.01	256	0.6

Appendix H (cont) . Data tables for water quality, Sevier River East of Panguitch - 494966.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
5/9/1996	0.01	81.6		113.2	0.06	22599	12
5/23/1996	0.01	90		9.2	0.01	2026	2.2
6/4/1996	0.005	1		7.2	0.02	18	0
6/18/1996	0.005	1.5		14.8	0.04	54	0.1
7/8/1996	0.01	2		9.2	0.03	45	0.1
8/20/1996	0.005	0.5		24	0.02	29	0
9/18/1996	0.005	0.6		8.8	0.01	13	0
10/29/1996	0.005	1		12.4	0.0732	30	0.2
12/11/1996	0.005	65		4	0.0126	636	2
1/28/1997	0.01184			25.2	0.0113		
2/25/1997	0.005	50		20.8	0.0182	2544	2.2
3/18/1997	0.02785	35		160		13701	
4/8/1997	0.01095	38		119.6	0.0256	11119	2.4
4/23/1997		110		348	0.255	93655	68.6
5/21/1997		240		156	0.8815	91600	517.6
6/5/1997		35		22		1884	
7/11/2001	0.024	25		12780		781680	129.7
8/15/2001	0.141	1.5		11.2	0.025	41	0.1
9/13/2001	0.01	6		13130	0.028	192741	0.4
10/18/2001	0.01	1.5		12855	0.021	47176	0.1
11/15/2001	0.01	5		10	0.01	122	0.1
12/6/2001	0.01	12		12	0.043	352	1.3
3/28/2002	0.01	37.2		14	0.025	1274	2.3
4/10/2002		1.8					
5/1/2002	0.01	4		16	0.01	157	0.1
6/12/2002	0.01	1		4	0.01	10	0

Appendix H (cont) . Data tables for water quality, Sevier River at Airport Road Crossing - 494967.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
5/8/1996	0.01	100		210	0.12	51378	29.4
5/22/1996	0.01	30.7		20	0.02	1502	1.5
6/4/1996	0.005	14.8		4.8	0.02	174	0.7
6/18/1996	0.01	7		4	0.02	69	0.3
7/8/1996	0.01	13		8.4	0.06	267	1.9
8/20/1996	0.01	3		34	0.02	250	0.1
9/18/1996	0.005	13		42.4	0.02	1349	0.6
10/29/1996	0.01025	9.5		11.6	0.07348	270	1.7
12/10/1996	0.01129	85		56.8	0.04051	11812	8.4
1/28/1997	0.005			24	0.005		
2/25/1997	0.005	29		26.4	0.0208	1873	1.5
3/18/1997	0.02985	43		175		18410	
4/8/1997	0.01062	40		10.4	0.01705	1018	1.7
4/24/1997		115		288.7	0.16994	81227	47.8
5/6/1997				455			
5/21/1997		206		162.7	0.13354	82000	67.3
6/3/1997		35		24		2055	

Appendix H (cont) . Data tables for water quality, Sevier River at Sanford Road Crossing - 494964.

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
4/4/1996	0.005	9		50	0.03	1101	0.7
4/25/1996	0.005	10		15.6	0.01	382	0.2
5/8/1996	0.01	150		102	0.06	37433	22
5/22/1996	0.01	51		13.6	0.02	1697	2.5
6/4/1996	0.005	28.7		7.6	0.03	534	2.1
6/18/1996	0.005	31.5		11.2	0.02	863	1.5
7/8/1996	0.01	25		32	0.03	1957	1.8
8/24/1996	0.005	24.4		75.2	0.03	4489	1.8
9/18/1996	0.005	60		120.4	0.08	17674	11.7
10/29/1996	0.02163	90		180.7	0.22918	39789	50.5
12/10/1996	0.01874	105		154.4	0.13597	39664	34.9
1/28/1997	0.005			44.4	0.03952		
2/25/1997	0.01128	50		40	0.02553	4893	3.1
3/18/1997	0.03204	55		321		43194	
4/8/1997	0.01415	70		87	0.10854	14900	18.6
4/23/1997		120			0.18582		54.6
5/6/1997				205			
5/21/1997		224		260	0.23441	142488	128.5
6/5/1997		50		20		2447	
7/11/2001	0.02	71.3		46	0.049	8024	8.5
8/15/2001	0.032	9.73		112	0.092	2666	2.2
9/13/2001	0.01	35		48	0.023	4110	2
10/18/2001	0.01	8		52	0.01	1018	0.2
11/15/2001	0.01	72		114	0.066	20081	11.6
12/6/2001	0.024	52		115	0.049	14631	6.2
1/16/2002	0.01			48	0.059		
2/28/2002	0.01			52	0.044		
3/28/2002	0.01	52		56	0.034	7124	4.3
4/10/2002		36.2					
5/2/2002	0.01	10		60	0.01	1468	0.2
6/13/2002	0.01	19.7		4	0.01	193	0.5

Appendix H (cont) . Data tables for water quality, Sevier River 2.5 Miles South of Circleville – 494945

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
6/3/1976		110		110		29603.5	
7/15/1976		49		20		2397.6	
8/12/1976		40	0	15		1467.9	
9/9/1976		38		15	0.07	1394.5	6.5
10/14/1976		94		80	0.04	18398.2	9.2
12/2/1976		101			0.24		59.3
1/19/1977		93	0	100	0.3	22753.1	68.3
3/23/1977		75	0				
5/25/1977		38	0	15	0.04	1394.5	3.7
7/28/1977		34		105	0.14	8734.3	11.6
9/28/1977		33		15	0.02	1211.1	1.6
11/16/1977		78	0	86	0.07	16411.6	13.4
12/7/1977		88		60		12917.9	
1/11/1978		88		105	0.06	22606.3	12.9
3/8/1978		96	0	585		137399.5	
5/10/1978		128		230	0.24	72027.1	75.2
5/22/1978		288					
7/11/1978		69	0	10		1688.1	
9/5/1978		36	0	25		2201.9	
9/6/1978		36	0	10	0.05	880.8	4.4
11/15/1978				260	0.06		
1/17/1979		56			0.11		15.1
3/21/1979		56	0.1	28		3836.2	
5/16/1979		514		76	0.5	95572.9	628.8
11/28/1979		162	0	10	0.08	3963.4	31.7
6/18/1980		733	0	460	0.5	824935.1	896.7
10/28/1980		191	0.1		0.03		11.7
1/15/1981		158	0		0.05		19.3
2/19/1981		149	0		0.03		9.1
4/15/1981		89	0		0.03		5.4
6/18/1981		78		15	0.03	2862.5	4.8
8/19/1981		187			0.03		11.4
10/22/1981		128		135	0.03	42276.8	7.8
12/17/1981		131		132	0.15	42306.1	48.1
4/14/1982		163		1730	0.55	689908.8	219.3
5/19/1982		235		799	0.35	459380.6	201.2
7/21/1982		78		18	0.1	3435	19.1
9/16/1982		144		114	0.2	40162.9	70.5
11/10/1982		186		108	0.2	49146.7	91
1/5/1983		140		24	0.04	8220.5	13.7
3/2/1983		259		2550	0.2	1615839	126.7
4/26/1983		347		2448	0.22	2078255	186.8
6/21/1983		####		686	0.24	1745482	610.7
8/2/1984		178	0	1780	0.31	775171.9	135
8/29/1984		216	0	969	0.18	512077.3	95.1
4/24/1985		316	0.4	780	0.35	603031.1	270.6
5/22/1985		385	0.2	334	0.24	314604.7	226.1

Appendix H (cont) . Data tables for water quality, Sevier River 2.5 Miles South of Circleville – 494945

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
7/10/1985		104	0	36	0.04	9160	10.2
8/7/1985		93	0	25	0.01	5688.3	2.3
9/4/1985		104	0	42	0.03	10686.6	7.6
10/1/1985		110	0	34	0.04	9150.2	10.8
10/29/1985		106	0	63	0.03	16338.2	7.8
1/28/1986		31.9	0.1	81	0.06	6321.7	4.7
3/11/1986		150	0.1	144	0.12	52846	44
4/22/1986			0	40	0.05		
6/4/1986		160	0.2	386	0.2	151100.3	78.3
7/10/1986			0	18	0.02		
8/20/1986		5	0		0.19		2.3
10/2/1986		133	0	48	0.07	15618.9	22.8
11/13/1986		136	0	116	0.05	38597.1	16.6
12/17/1986		146	0.1	100	0.09	35720	31.4
2/4/1987		143	0.1	198	0.15	69272.2	52.5
4/28/1987		171	0.2	200	0.2	83672.8	83.7
6/25/1987		99.6	0	18	0.04	4386.2	9.7
8/4/1987		115	0.1	85	0.07	23915.2	19.7
9/16/1987		70.1	0	23	0.05	3944.6	8.6
11/11/1987		145	0	130	0.1	46117.9	35.5
12/16/1987		186	0.1	3	0.07	1365.2	31.9
1/26/1988		146	0	3	0.08	1071.6	28.6
3/7/1988		167	0.2	293	0.23	119713.2	94
4/21/1988		247	0	3	0.27	1812.9	163.2
6/1/1988		304	0	343	0.08	255109	59.5
8/3/1988		99	0	591	0.04	143146.5	9.7
9/8/1988		83	0	3	0.05	609.2	10.2
10/27/1988		101	0	3	0.02	741.3	4.9
12/8/1988		124	0.1	109	0.07	33067.9	21.2
1/26/1989		93	0.1	157	0.02	35722.4	5.2
2/28/1989		106	0	421	0.12	109180.7	29.8
4/11/1989		92	0	37	0.04	8328.1	9.5
5/18/1989		69	0	49	0.02	8271.9	4.1
6/21/1989		33	0	3	0.03	242.2	2.3
9/7/1989		40	0	12	0.03	1174.4	3
10/19/1989			0	7			
11/29/1989			0	225	0.09		
1/9/1990		99	0	136	0.09	32940.6	22.8
3/7/1990		110	0	245	0.07	65935.1	18.8
4/12/1990		55	0	19	0.05	2556.7	6.2
5/3/1990		44	0	14	0	1507.1	0.3
6/13/1990		40	0	192	0.09	18789.7	8.8
9/6/1990	0.1	42		101	0.17	10378.4	17.9
10/16/1990	0	44		14	0.02	1507.1	2.2
1/17/1991	0	92		167	0.16	37589.1	36
2/28/1991	0	95		217	0.16	50436.1	36.3
6/5/1991	0	122		158	0.06	47160.1	16.4
7/31/1991	0	30		19	0.04	1394.5	3.1
9/18/1991	0	44		3	0.01	322.9	1.5
10/30/1991	0	65		28	0.02	4452.8	3.2

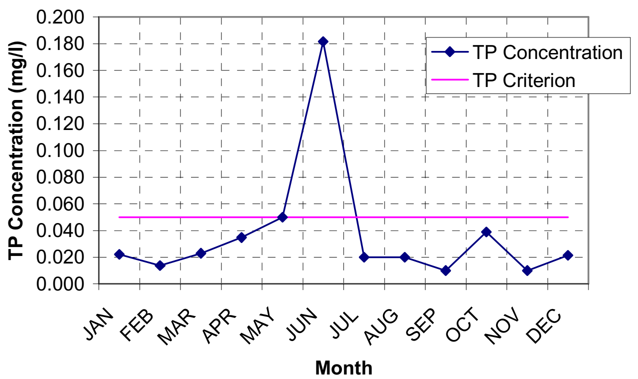
Appendix H (cont) . Data tables for water quality, Sevier River 2.5 Miles South of Circleville – 494945

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
1/9/1992	0	85		48	0.04	9982	8.3
2/19/1992	0	105		148	0.13	38019.7	32.9
4/9/1992	0.1	78		250	0.27	47708.2	51
5/20/1992	0	163		153	0.11	61015.1	44.3
7/15/1992	0	33		84	0.08	6781.9	6.1
10/14/1992	0	49		12	0.02	1438.6	2.9
11/18/1992	0	123		198	0.13	59583.8	38.2
2/3/1993	0	106		99	0.06	25674.3	14.5
3/17/1993	0	198		808	0.11	391412.4	54.3
5/5/1993		643		704	0.28	1107495	445.2
6/9/1993		600		390	0.27	572497.8	389
8/18/1993		98		39	0.04	9350.8	10.5
9/22/1993		91		9	0.02	2003.7	4
11/10/1993		191		104	0.1	48598.7	45.3
1/12/1994		151		205	0.15	75733.6	56.9
2/23/1994		154		83	0.09	31272.1	33.9
4/6/1994		127		166	0.08	51578.6	26.1
5/11/1994		103		64	0.07	16127.8	16.9
6/15/1994		56		21	0.03	2877.2	3.7
7/27/1994		41		9	0.01	902.8	1.2
9/7/1994		66		148	0.09	23898.1	14.9
10/20/1994		125		192	0.15	58717.7	46.8
11/30/1994		122		168	0.14	50144.9	42.4
1/24/1995		129		89	0.06	28089.1	19.3
3/8/1995		137		581	0.28	194739.8	92.8
4/19/1995		193		259	0.18	122296.8	82.6
5/30/1995		500		567	0.33	693603.2	403.7
7/12/1995		326		300	0.1	239274.7	79.8
8/28/1995		133		80	0.08	26031.5	26
10/18/1995				110	0.1		
12/6/1995				112	0.08		
1/31/1996		32		108	0.09	8455.4	7
3/13/1996		35		129	0.07	11046.3	6
4/4/1996	0	32		38	0.04	2975	3.1
4/25/1996	0	50		24.8	0.02	3033.7	2.4
5/9/1996	0	75		54.8	0.04	10055.4	7.3
5/23/1996	0	61		30.8	0.03	4596.6	4.5
6/4/1996	0	50		8.8	0.03	1076.5	3.7
6/18/1996	0	31.7		4	0.01	310.2	0.8
7/8/1996	0	25		16.8	0.02	1027.6	1.2
8/20/1996	0	20.4		148.7	0.06	7421.6	3
9/18/1996	0	25		186.7	0.09	11419.4	5.5
10/29/1996	0	58		37.2	0.08	5278.7	11.4
12/10/1996	0	150		124	0.1	45506.2	38.1
1/28/1997	0	60		103.6	0.12	15207.9	17.8
2/25/1997	0	55		65.6	0.04	8827.2	5.7
3/18/1997	0	63		417		64273.9	
4/8/1997	0	70		144.7	0.08	24781.3	13.9
4/23/1997		145		404	0.35	143320.2	122.5
5/6/1997		160		228		89250.9	
5/21/1997		260		202.5	0.22	128812	139.2
6/5/1997		65		15.2		2417.2	
7/9/1997	0.1	37		9.6	0.09	869	8.4
8/14/1997		85		227.3	0.23	47269	47.5
10/1/1997		125		252		77067	
11/5/1997	0	104		38.8		9872.4	
12/17/1997	0	90		202.4		44566.8	
2/11/1998	0	65		42.4	0.04	6742.8	6.3
3/26/1998	0			1840	1.07		
6/10/1998	0			244	0.14		

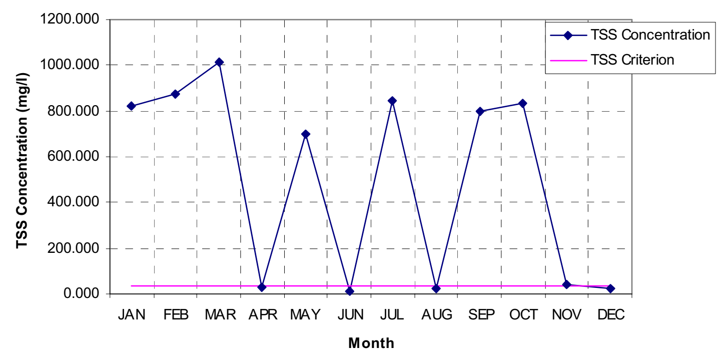
Appendix H (cont) . Data tables for water quality, Sevier River 2.5 Miles South of Circleville – 494945

Date	Dissolved Phosphorus (mg/l)	Flow (cfs)	Ortho-phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	TSS Load (kg/day)	TP Load (kg/day)
9/8/1999		36		26.4	0.03	2325.2	2.2
11/16/1999		155		57.2	0.03	21691.3	11.4
1/19/2000		204		119	0.09	59393	46.4
3/15/2000		150		138	0.06	50644	20.2
5/17/2000				156	0.07		
7/19/2000		44.5		34.7	0.07	3777.9	7.9
9/13/2000		14		16.4	0.01	561.7	0.3
10/25/2000				348			
4/18/2001				570	0.54		
6/20/2001				15.2	0.02		
7/11/2001	0			404	0.29		
8/15/2001	0	64.5		165	0.13	26037.6	20.8
9/13/2001	0	67.5		15.8	0.01	2609.3	1.7
10/18/2001	0	25		18	0.01	1101	0.6
11/15/2001	0	112.2		172	0.07	47214.9	18.9
12/6/2001	0	70		159	0.09	27230.3	15.6
1/16/2002	0			552	0.13		
2/28/2002	0			580	0.06		
3/28/2002	0	115.8		620	0.08	175654.1	22.4
4/10/2002	0	46.6		15.6	0.03	1778.6	3.2
5/2/2002	0	80		640	0.01	125264.5	2
6/13/2002	0	45.2		4	0.01	442.3	1.1
7/31/2002		15.7		55	0.06	2112.6	2.1
11/13/2002		71.3					

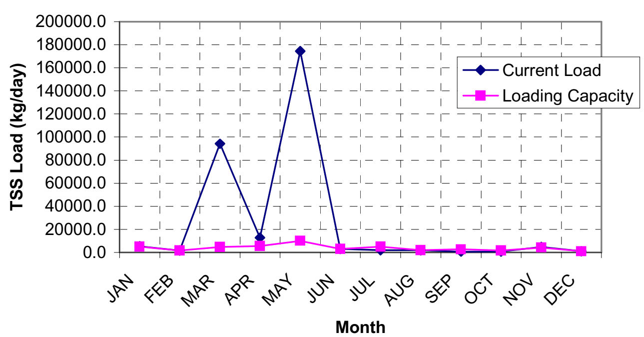
Mean Monthly Total Phosphorus Concentration



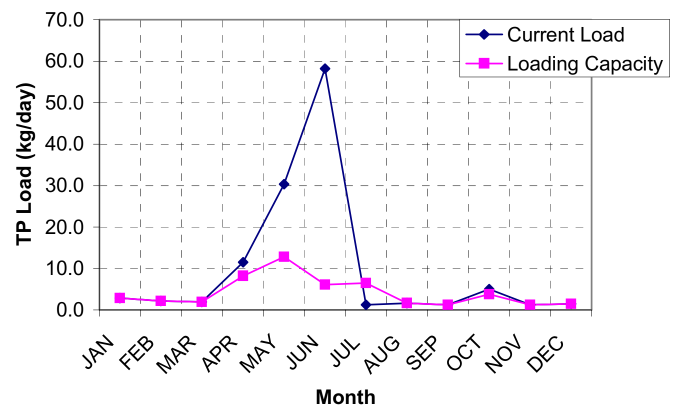
Mean Monthly TSS Concentration for Station 494963

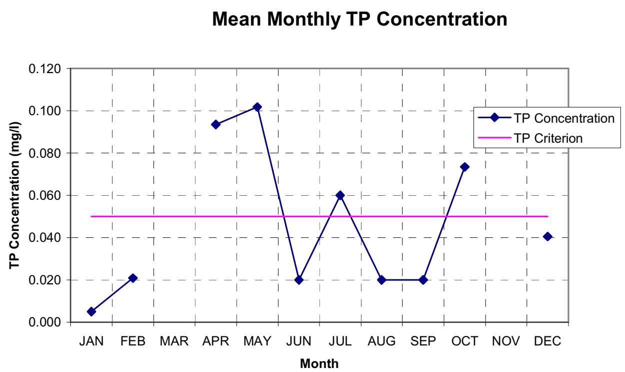


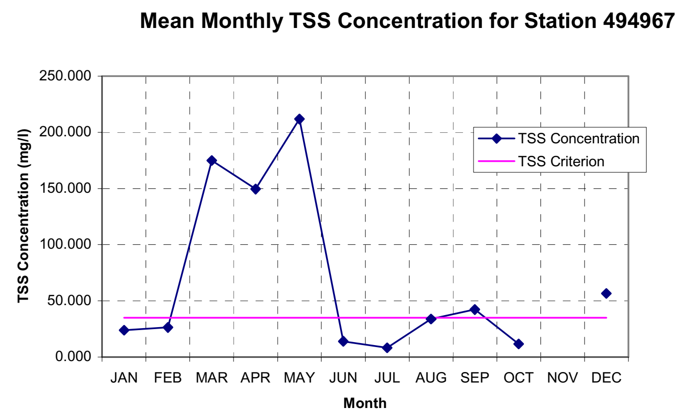
Mean TSS Load by Month for Station 494963

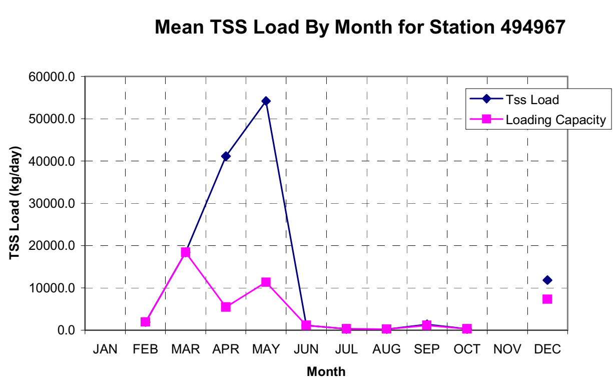


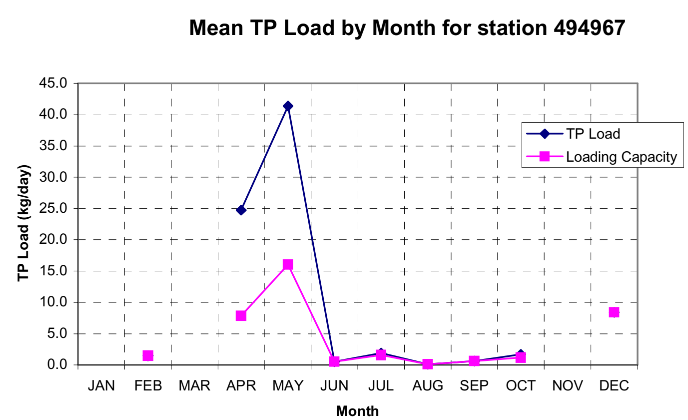
Mean Total Phosphorus Load by Month for station 494963





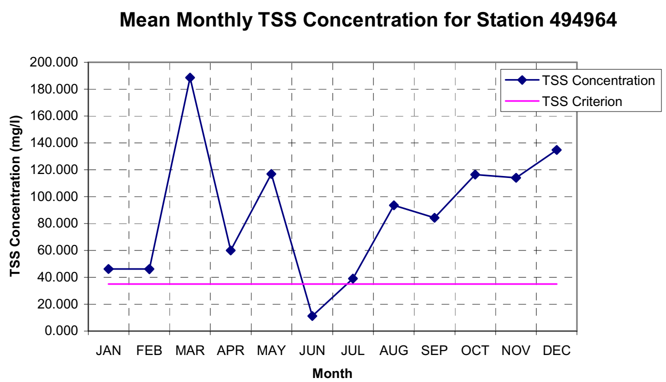


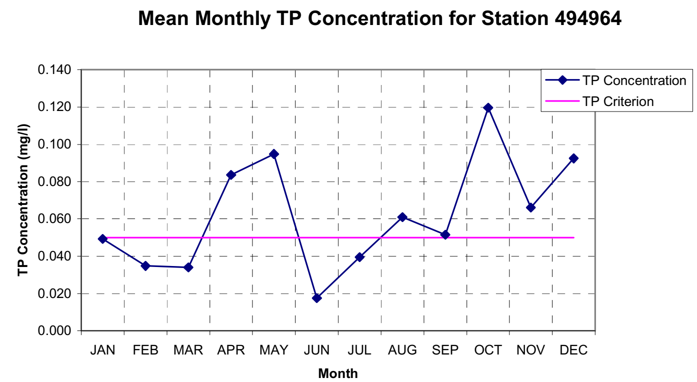


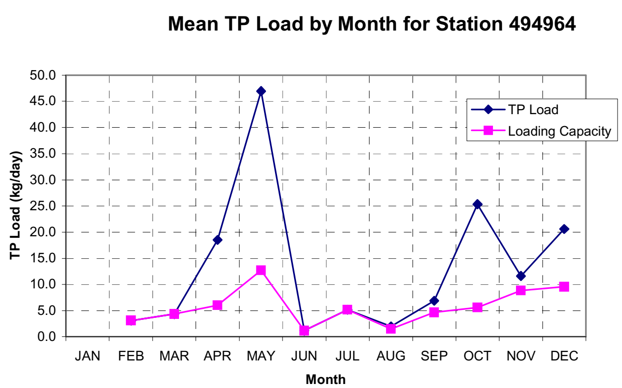


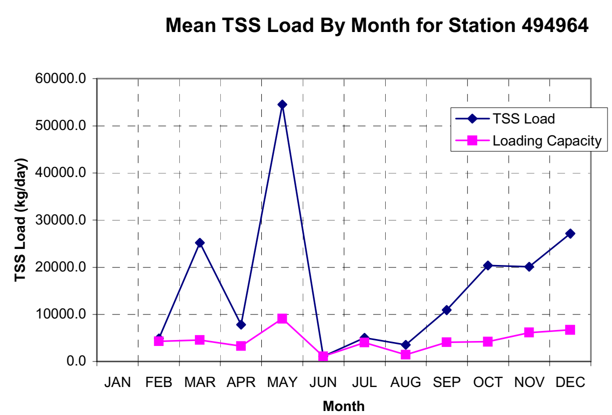
Appendix I (cont). Graphs for water quality, Sevier River at Panguitch Airport Road - 494967.

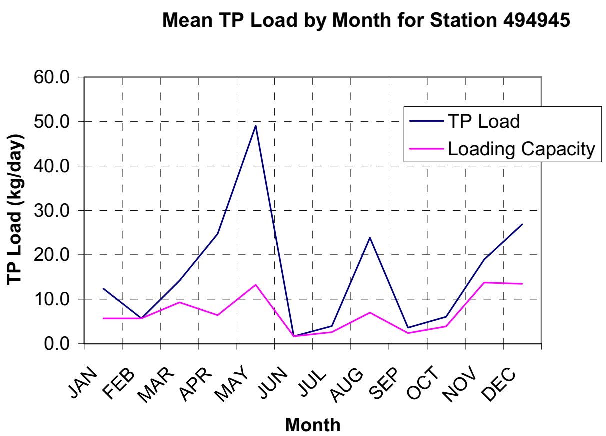
Appendix I (cont). Graphs for water quality. Sevier RIver above Sanford Creek - 494964.

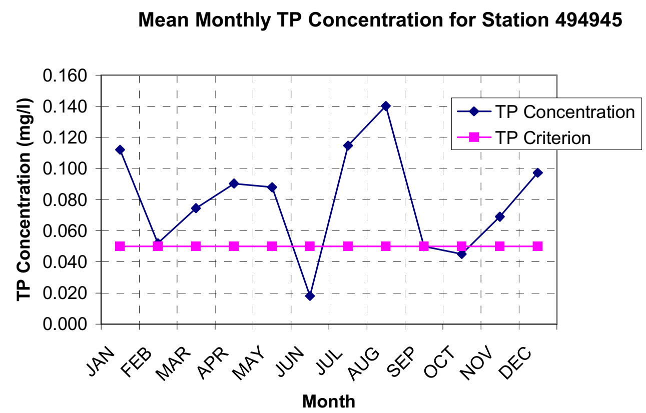


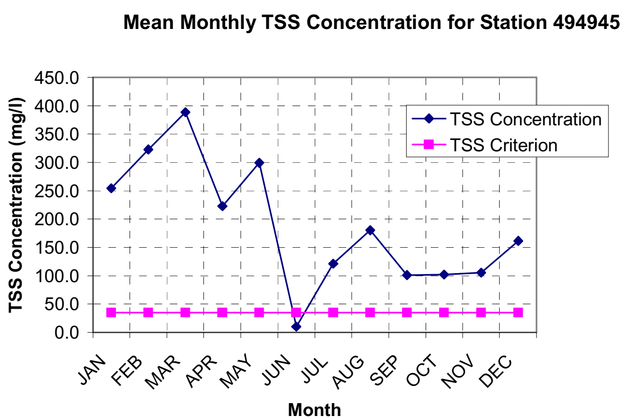


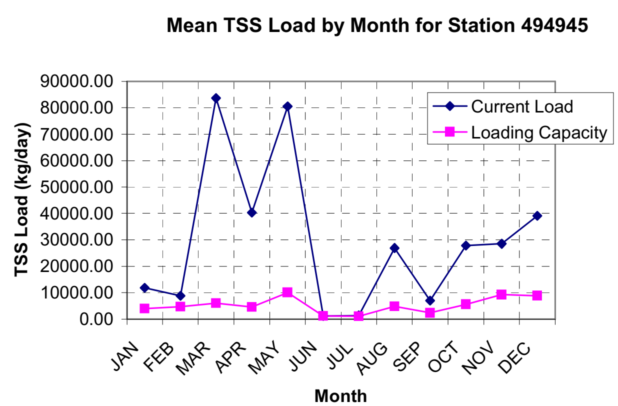












Appendix I (cont). Graphs for water quality. Sevier River in Circleville Canyon - 494945.

Appendix J. SVAP and SECI Tables.

Reach	Channel Condition	Hydrologic Alteration	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrichment	Fish Barriers	Fish Cover
1	6.3	9.3	8.6	8.3	10	10	10	9
2	9	9	3	5	7	8	10	10
3	3	3	3	2	7	7	10	4
4	10	10	9	10	9	10	10	10
5	8	7	5	3	7	5	3	5
6								
7	9	10	10	10	7	4	10	10
8	8	9.5	1	3	8	3	6	5
9	6	7	1	7.5	8	4	10	1
10	7	7	8	9	8	4.5	10	10
11	4.5	5	1	2	6	2	10	4
12	5.3	9	2.3	4.1	5.8	5	10	2.5
13	4.7	9	4.7	3.7	7	4.3	9.7	6
14	4.7	5	6.3	5.7	7.7	6.7	10	4.3
15	7.3	9	4.7	4	8	8	1	4.3
16	6.3	7	5	8	8	8.5	10	4.5
17	8	9.5	4	7	8	8	10	5
18	7.6	9	3.8	6.5	6.3	7.5	9	4
19	7.5	7.8	6.3	5.5	7.8	6.8	8.5	4.5
20	3	5	1	2.5	5	5	5	4
21	8	7	7	7	5	5	10	8
22	3	5	3	3	5	4	3	5
23	8	6	4	5	4	3	3	5
24	7	5	2	1	4	5	10	3
25	8	7	8	5	7	4	3	3
26	2	5	1	1	4	4	3	2
27	2	5	1	1	4	4	10	2
28	7	7	4	6	6	7	5	2
29	2	7	1	3	6	5	10	3
30	3	7	1	4	6	5	6	3
31	6	7	1	1	6	5	9	1.5
32	6	7	1	1.5	6	5	9	1
33	6	7	1	2	6	5	5	1

Appendix J (cont). SVAP and SECI Tables.

Reach	Channel Condition	Hydrologic Alteration	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrichment	Fish Barriers	Fish Cover
1	6.3	9.3	8.6	8.3	10	10	10	9
2	9	9	3	5	7	8	10	10
3	3	3	3	2	7	7	10	4
4	10	10	9	10	9	10	10	10
5	8	7	5	3	7	5	3	5
6								
7	9	10	10	10	7	4	10	10
8	8	9.5	1	3	8	3	6	5
9	6	7	1	7.5	8	4	10	1
10	7	7	8	9	8	4.5	10	10
11	4.5	5	1	2	6	2	10	4
12	5.3	9	2.3	4.1	5.8	5	10	2.5
13	4.7	9	4.7	3.7	7	4.3	9.7	6
14	4.7	5	6.3	5.7	7.7	6.7	10	4.3
15	7.3	9	4.7	4	8	8	1	4.3
16	6.3	7	5	8	8	8.5	10	4.5
17	8	9.5	4	7	8	8	10	5
18	7.6	9	3.8	6.5	6.3	7.5	9	4
19	7.5	7.8	6.3	5.5	7.8	6.8	8.5	4.5
20	3	5	1	2.5	5	5	5	4
21	8	7	7	7	5	5	10	8
22	3	5	3	3	5	4	3	5
23	8	6	4	5	4	3	3	5
24	7	5	2	1	4	5	10	3
25	8	7	8	5	7	4	3	3
26	2	5	1	1	4	4	3	2
27	2	5	1	1	4	4	10	2
28	7	7	4	6	6	7	5	2
29	2	7	1	3	6	5	10	3
30	3	7	1	4	6	5	6	3
31	6	7	1	1	6	5	9	1.5
32	6	7	1	1.5	6	5	9	1
33	6	7	1	2	6	5	5	1

Appendix K. Waterbody Assessments. *(This table is a two-page spread.)*

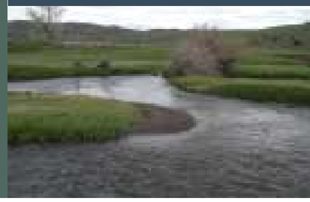
Waterbody Description		Use Class/Support	HUC Unit	Size mi/ac	303(d) list for TMDL	Pollutant or Stressor		Causes or source
						303(d) list	Evaluation	
Navajo Lake	UT-00078	2B/NA, 3A/PS, 4/FS	16030001	714	Yes	Dissolved Oxygen		Macrophyte decomposition
Asay Creek and tributaries from cnfl/w Sevier River	1	2B/NA 3A/PS, 4/FS	16030001		No		Sediments, bacteria	Development, septic tanks, erosion (silviculture, grazing, fires)
Duck Creek and tributaries	2	1C/NA, 2B/NA, 3A/NA, 4/NA	16030001		No		Sediments, bacteria	Development, septic tanks, erosions (grazing silviculture), recreation
Mammoth Creek and tributaries from cnfl/w Sevier River	3	2B/NA, 3A/FS, 4/FS	16030001		No		Nutrients, sediments, bacteria	Extensive development, septic tanks, fish hatchery, erosion (roadways, grazing), recreation
Panguitch Lake	UT-00086	2B/NA, 3A/NA, 4/FS	16030001	1248	Yes	phosphorus dissolved oxygen, total macrophytes		Nutrients, fill & drain, macrophytes, construction, agriculture, silviculture
Tributaries above Panguitch Lake	4	2B//NA, 3A/NA, 4/NA	1603001		No		Sediments, nutrients, bacteria	Development, transbasin water diversion, septic tanks, grazing, recreation
Panguitch Creek and tributaries to Panguitch Lake	5	2B/NA, 3A/NA, 4/NA	16030001		No		Sediments, nutrients	Development, dewatering, erosion (stream morphology and habitat)
Sevier River and tributaries from Long Canal to tributaries	6	2B/NA, 3A/NA, 4/NA	16030001		No		Sediments, nutrients	Erosion (grazing, stream morphology, development), development, land speculation
Sevier River from Horse Valley Bridge Diversion to Long Canal Diversion (excluding Bear and Panguitch Creek)	7	2B/NA, 3A/FS, 4/FS	16030001				Sediments, nutrients, total dissolved solids, temperature	Grazing practices, erosion (irrigation practices, stream morphology and habitat), municipal lagoons, pasture feeding with flood action and in riparian areas
Bear Creek and tributaries from the cnfl/w Sevier River	8	2B/NA, 3A/NA, 4/NA	16030001		No		Sediments, nutrients	Erosion (stream morphology, grazing), vegetative mgt
Sevier River from Circleville Irrigation Diversion to Horse Valley Bridge Diversion	9	2B/NA, 3A/PS, 4/FS	16030001		Yes	Sediment, habitat, total phosphorous		Agricultural grazing and irrigation, hydromod and habitat mod, erosion

Appendix K. Waterbody Assessments.

USFS	BLM lands (2)	Private Lands (3)	Feasible Solution	Comment
Uplands in good condition	No BLM		In-lake solutions	
Stream/Riparian poor to moderate condition - low risk, highly eroded	Kanab BLM	Vegetative cover at moderate risk	1) BMP's erosion control, riparian protection/restoration, 2) BMP's erosion control, riparian protection/restoration; 3) planning and zoning, brush mgt., off site watering, grazing mgt.	DWR 3A, Upper/PS, lower/NS, Potential development from SITLA lands
Excellent stream and riparian conditions - low risk	No BLM	Development, septic tanks	1) BMP's erosion control.	DWR 3A/FS
Stream/Riparian:Moderate to good riparian risk in upper zone with relatively low riparian risk in lower zone; Upland meadows: poor condition-accelerated erosion	Minimal lands, Kanab BLM	Spotty, poor to fairly good for riparian and range with good potential for improvement, septic tanks	1) BMP's as needed, 2) BMP's as needed, 3 Planning and zoning, vegetative restoration to increase	DWR 3A upper/FS lower/NS
	No BLM	Septic tanks		
Stream/Riparian: Moderate condition; Uplands: good condition	No BLM	Speptic tanks	1) BMP's as needed in range and riparian, 3) planning and zoinging, grazing mgt, recreation	DWR 3A/FS, Phase 1 & II Clean Lake area
Stream/Riparian: Moderate condition; Uplands: moderate-good condition		Poor to fair stream morphology and habitat	1) Vegetative alteration, BMP's as needed in riparian and range;riparian restoration and protection	DWR 3A, Upper/PS, mid/FS, Lower/NS
Stream/Riparian: poor to moderate condition	Poor to fair at best, area is highly erosive and poor vegetative cover	Poor conditions for vegetative cover with good potential	1), 2), 3) Reestablish grasses and vegetative cover in uplands; fish cover structures and riparian restoration as needed	DWR 3A/NS, Sage grouse habitat, potential development from SITLA lands
No USFS	Poor vegetative cover in upland area area, Kanab BLM	Riparian habitat poor, stream morphology poor	2), revegetation and PMP's as needed; 3) improve irrigation efficiency, grazing develop off stream, waering, restore and protect riparian corridor	DWR 3A/NS Ck contains Bonneville CTT. Lef Fk Sanford Ck and Sandy Ck planned for reestablishing Bonneville cutthroat trout, sage grouse habitat
Stream/Riparian: Poor conditions; Uplands moderate condition	Needs vegetative management, Kanab BLM	Grazing practices, stream morphology and habitat	2) Revegetation and mgt; 3) Grazing mgt, riparian restoration and protection	Leather side chub habitat, sage grouse habitat area, lower section is improving riparian
	Kanab BLM	Grazing practices	2) Grazing has been removed and vegetation is improving	DWR 3A/NS

Chapter 8

Upper Sevier Watershed Management Plan



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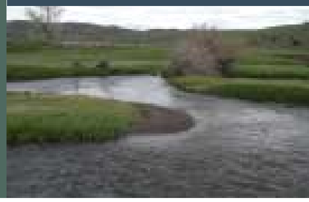

Memorandum of Understanding between Upper Sevier River Community Watershed Partners.

Memorandum of Understanding

Among the:

Dixie National Forest
Bureau of Land Management
Utah Division of Wildlife Resources
Bryce Canyon National Park
Paiute Indian Tribe of Utah
U.S. Fish and Wildlife Service
Utah State University Extension Service
Utah Department of Environmental Quality
Upper Sevier Soil Conservation District
Garfield County
Kane County
Antimony Town
State of Utah School and Institutional Trust Lands Administration
Utah Association of Conservation Districts
Utah Division of Forestry, Fire and State Lands Lands
Color Country RC&D
Natural Resources Conservation Service
Panguitch City
Iron County
Hatch Town
Circleville Town

This Memorandum of Understanding (MOU) is entered into by the Unites States Forest Service (USFS) Dixie National Forest; Bureau of Land Management (BLM) Kanab and Richfield; Bryce Canyon National Park (NPS); Unites State Fish and Wildlife Service (FWS); Utah Divisions of Wildlife Resource (UDWR); State of Utah School and Institutional Trust Lands Administration (SITLA); Utah Division of Forestry, Fire, and State Lands (UDFFSL); Paiute Tribe of Southern Utah; Color Country Resource Conservation and Development Council (RC&D); Utah State University Extension Services (USU Extension); and the Utah Association of Conservation Districts (UACD). These partners are referred to as the Cooperators.

PURPOSE

The purpose of the Upper Sevier River Community Watershed Project is to foster collaborative relationships between local governments, state and federal land management agencies, private landowners, Paiute Indian Tribe of Utah, and non-governmental organizations that are interested in restoring the natural resources within the Upper Sevier watershed. This MOU provides a mechanism by which the Cooperators can develop and implement comprehensive assessment and monitoring programs for the Upper Sevier River Watershed and, wherever feasible, provide a unified approach to the management and restoration of the natural resources within the watershed .

GOALS

1. Work cooperatively to better understand and manage in a comprehensive manner, the natural resources within the watershed.

2. Utilize and share expertise between the respective Cooperators for the purpose of natural resource restoration.

3. Foster a better understanding of resource issues between the public and resource management agencies.

4. Provide support and expertise to develop and environmental education program for primary, secondary, undergraduate and graduate students.

5. Work cooperatively to leverage funds and seek grant opportunities for the purpose of improving resource conditions within the watershed.

6. Establish consistent protocols for the collections, storage, and use of information and data gathered by the Cooperators within the watershed.

To achieve the purpose and goals stated above, the Cooperatees agree to work collaboratively, and with all other appropriate public or private agencies, organizations, of individuals. Recognizing that the Cooperators have different responsibilities and missions, this MOU promotes, wherever feasible, efforts to: coordinate data collections, surveys, and research; share resource expertise across jurisdictions; promote involvement of teachers and students in the management and monitoring of natural resources; and identify potential source of funding to support programs initiated under this MOU.

STATEMENT OF MUTUAL BENEFITS AND INTERESTS

The USFS is responsible for managing the resources of the Upper Sevier River Watershed and its headwaters that are within the Dixie National Forest in order to provide for their protection and use by current and future generations.

The BLM is responsible for managing resources pertaining to the Upper Sevier River Watershed that are within the jurisdictional boundaries of the Kanab and Cedar City Field Offices. The BLM provides for the protections and management of natural resources for current and future generations.

The NPS is responsible for managing the Upper Sevier River resources within Bryce Canyon National Park in order to ensure their preservation and protection for future generations. The NPS has specific policies related to the preservation of water quality and other resources in conjunction with other state and federal agencies.

The FWS is the principal Federal agency responsible of conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people.

SITLA is an independent agency of the State of Utah which manages Utah Trust Lands exclusively for the benefit of Utah's schools and 11 other public institutions.

The UDFFSL utilizes the principles of stewardship and ecosystem management to assist non-federal landowners in management of their natural resources; provides wildland fire protection for non-federal landowners; and optimizes the benefits from ecosystem based, multiple-use management of resources held in the public trust.

USU Extension consists of both Cooperative Extension and Continuing Education. It utilizes research and technology to enhance the quality of the environment through better understanding of and building on agriculture and forestry's links with soil, water, air and biotic resources.

The RC&D works with residents within the watershed to improve their economy and the environment through conservation, development and better utilization of their natural resources.

The Utah Division of Wildlife Resources (UDWR) is the regulatory authority for fish and wildlife in the state of Utah. The UDWR regulates hunting, fishing and trapping and promotes recreational, educational, scientific, and aesthetic enjoyment of fish and wildlife.

The UACD provides unified leadership to achieve a more productive Utah in cooperation with property owners and users, in harmony with a sustainable quality environment for urban and rural citizens. Through this, the UACD promotes the long-term conservation and development of Utah's natural resources.

The Paiute Tribe of Utah consists of the Shivwits, Indian Peaks, Kanosh, Koosharem, and Cedar bands. The headquarters, located in Cedar City, Utah provided health, social services, and economic development projects for tribal members. A major role is also providing tribal perspective to local, federal and State agency development projects.

The Cooperators seek to improve efficiency of programs by combining their efforts, where possible, to foster better working relationships, and to promote a better understanding of the ecological resources and interrelationship within the Upper Sevier River Watershed. By doing so, the Cooperators expect to establish themselves as the recognized authority for the Upper Sevier River Watershed.

THE COOPERATORS AGREE TO THE FOLLOWING:

Geographic Scope of MOU

The 1.2 million acre watershed is generally bounded by the following geographic features: Highway 12/89 junction to the south, Cedar Breaks National Monument to the west, Bryce Canyon National Park to the east, and Paiute and Otter Creek Reservoirs to the north.

Development and Implementation of a Comprehensive Watershed Assessment, Implementation Plan and Monitoring Program

1. Utilize the final approved Upper Sevier River Community Watershed Plan document as a guide, resource, and funding tool when prioritizing watershed projects and programs.

2. Utilize Geographic Information Systems (GIS) to develop a universally accessible platform for the input, storage, and retrieval of data.

3. Utilize a standard approach to assess resource condition and issue association with the restoration of natural resources within the watershed.

4. Coordinate and integrate programs and projects across jurisdictional boundaries in order to most effectively realize resource benefits.

5. Pursue internal and external funding sources, partnerships, etc., to meet the goals and objectives of this MOU.

6. Provide technical and logistical support between Cooperators, and for outside entities when practicable.

7. Utilize research and academic organizations to assist in the development of a sound, defensible monitoring program.

AdministrationCoordinating Committee

1. Made up of one individual, with decision-making authority, from each of the Cooperators.

2. Responsible for recommending direction and priorities to the Upper Sevier River Steering Committee.

3. Meets at least every two months to evaluate the accomplishments, overall direction, and implementation of this agreement.

Steering Committee

1. Responsible for overall direction and project implementation. The committee determines which projects will be implemented, where the work will be done, and when it will be accomplished.

2. Considers recommendations from the Technical Advisory Teams and Coordinating Committee when developing annual programs of work.

3. Responsible for developing partnerships at the local and national level.

4. Comprised of representatives for each of the entities listed as Cooperators under this MOU.

Technical Advisory Committees

1. Responsible for resource assessments, project development.

2. Comprised of resource specialists, private landowners, and interested individuals that are knowledgeable about resource issues.

3. Recommend implementation projects to improve resource conditions in the watershed.

4. The following resource areas are represented by the TACs: Agronomy; Human Resources; Information, Education and Funding; Rangeland Vegetation; Upland Vegetation; Water Quality; ripar-

ian; Wildlife and Fisheries

THE COOPERATORS MUTUALLY AGREE AND UNDERSTAND THAT:

1. Specific work projects or activities that involve the transfer of funds, services, or property among the Cooperators will require the execution of separate agreements of contracts, contingent upon the availability of funds. Each subsequent agreement or arrangement involving the transfer of duns, services, or property among the Cooperators must comply with all applicable statues and regulations, including those applicable to procurement activities, and must be independently authorized by appropriate statutory authority.

2. This MOU does not restrict the Cooperators from participating in similar activities or arrangements with other public or private agencies, organizations, or individuals.

3. Records, data, and other information acquired, developed, collected, or documented under this agreement shall be the property of the originating agency.

4. Nothing in this MOU obligated the Cooperator to either expend funds of enter into any contract of other obligations.

5. This MOU may be modified or amended upon written request of any party hereto and the subsequent written concurrence of all the Cooperators. Cooperator participation in the MOU may be terminated with a 60-day written notice of any party to the other Cooperators. Otherwise, this MOU will remain in effect; its terms executable only by the signatories hereto.

6. Any party, in writing, may terminate this instrument in whole, or in part, at any time before the date of expiration.

7. This instrument is neither a fiscal nor a funds obligation documents. Any endeavor involving reimbursement, contribution of funds, or transfer of anything of value between the parties to this instrument will be handled in accordance with applicable laws, regulations, and procedures including those for Government procurement and printing.

8. This instrument is executed as of the last date shown below and expires no later than December 31, 2005, at which time it is subject to review and renewal, or expirations.

Signatures

Dixie National Forest

Bureau of Land Management

State of Utah School and Institutional Trust Lands Administration

Utah Division of Wildlife Resources

Utah Association of Conservation Districts

Paiute Indian Tribe of Utah

U.S. Fish and Wildlife Service

Color Country RC&D

Natural Resources Conservation Service

Panguitch City

Iron County

Kane County

Hatch Town

Circleville Town

Bryce Canyon National Park

Utah Division of Forestry, Fire and State Lands

Utah State University Extension Service

Utah Department of Environmental Quality

Upper Sevier Soil ConservationService

Garfield County

Utah Department of Environmental Quality

Antimony Town