Havasu Canyon Watershed

Rapid Watershed Assessment Report June, 2010

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Arizona Department of Agriculture
Arizona Department of Environmental Quality
Arizona Department of Water Resources
Arizona Game & Fish Department
Arizona State Land Department
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Havasu Canyon Watershed
15010004
8-Digit Hydrologic Unit
Rapid Watershed Assessment

Section 1: Introduction

Overview of Rapid Watershed Assessments

A Rapid Watershed Assessment (RWA) is a concise report containing information on natural resource conditions and concerns within a designated watershed. The "rapid" part refers to a relatively short time period to develop the report as compared to a more comprehensive watershed planning effort. The “assessment” part refers to a report containing maps, tables and other information sufficient to give an overview of the watershed including physical characteristics and socioeconomic trends.

The assessments involve the collection of readily available quantitative and qualitative information to develop a watershed profile, and sufficient analysis of that information to generate an appraisal of the conservation needs of the watershed. These assessments are conducted by conservation planners, using Geographic Information System (GIS) technology. Conservation Districts and other local leaders, along with public land management agencies, are involved in the assessment process.

An RWA serves as a communication tool between the Natural Resources Conservation Service (NRCS) and partners for prioritizing conservation work in selected watersheds. RWAs serve as a platform for conservation program delivery, provide useful information for development of NRCS and Conservation District business plans, and lay a foundation for future cooperative watershed planning.

The Havasu Canyon RWA was requested by the Coconino Natural Resource Conservation District (NRCD) via a letter to the NRCS State Conservationist. As stated in the letter, the primary purpose of the assessment is to “improve our understanding of the watershed as a whole” and to “identify and prioritize future conservation work.”

General Description of the Havasu Canyon Watershed

The Havasu Canyon Watershed is located in northern Arizona, and it is the entryway to the south rim of the Grand Canyon National Park (Figure 1-1). Total land area is approximately 1.88 million acres. Land ownership is primarily private, state trust, and federal land administered by the U.S. Forest Service and the National Park Service. The Havasupai Reservation and a portion of the Hualapai Reservation are also located within the watershed.

Major land uses in the watershed include range and forest. Recreational uses are also important activities both on federal and Tribal lands.

Major towns and cities include the City of Williams and Supai Village. Conservation assistance is provided through the Coconino and Hualapai Natural Resource Conservation Districts. The U.S. Department of Agriculture (USDA) Service Centers that

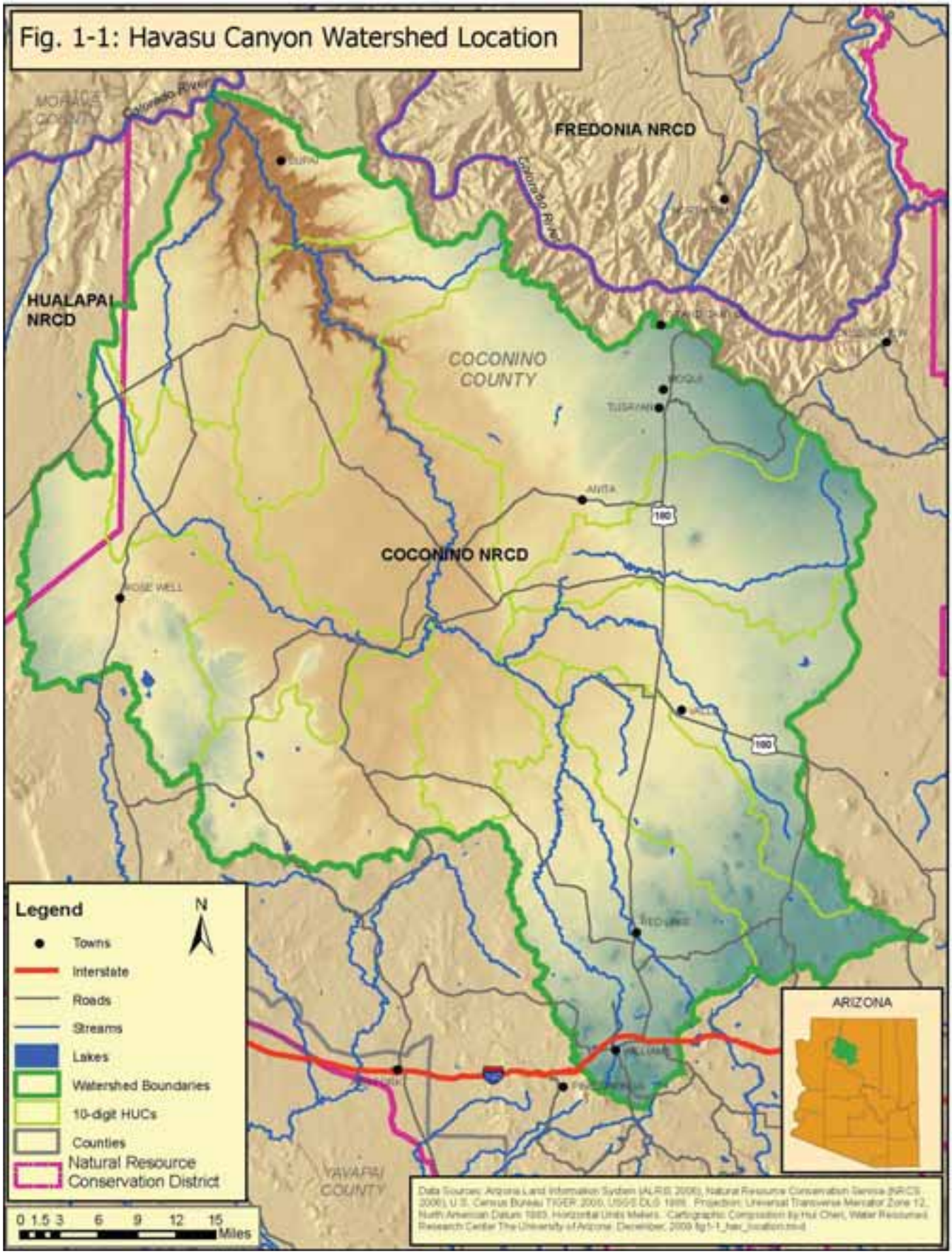


Fig. 1-1: Havasu Canyon Watershed Location
FREDONIA NRCD
HUALAPAI NRCD
COCONINO COUNTY
COCONINO NRCD
YAVAPAI COUNTY
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
Natural Resource Conservation District
N
0 1.5 3 6 9 12 15
Miles
ARIZONA

serve the area are located in Flagstaff and Kingman, Arizona.

Resource concerns in the watershed include soil erosion (sheet and rill and streambank), water quantity (runoff and flooding), noxious and invasive plants, and inadequate quantities & quality of feed and water for both wildlife and domestic animals (NRCS, 2010).

For the upland areas, the primary concern relates to maintaining and improving the condition and productivity of the land. This includes implementing conservation practices to protect soil from erosion and excessive runoff, improve the health of the vegetative communities, and enhance habitat for wildlife.

For the lower areas below the rim, the main concern relates to flooding and streambank erosion within the Village of Supai. This includes installing gabions and other streambank protection measures, as well as measures to reduce the impact of periodic flooding on structures, trails and other infrastructure in the Village.

Section 2: Physical Description

Watershed Size

The Havasu Canyon Watershed covers approximately 1,877,120 acres (2,933 square miles), representing about 1.0% of the state of Arizona. The watershed has a maximum width of about 67 miles east to west, and a maximum length of about 85 miles north to south.

The drainage area for the Havasu Creek watershed is approximately 3,000 square miles. Elevations in the drainage area range from over 10,400 ft to about 1,870 ft at the Colorado River. The headwaters are near Williams, Arizona and most of the drainage area is thin, poorly developed soils over limestone that supports desert grassland and upland pinyon-juniper woodlands (U.S. Army Corps, 2009).

There are numerous small reservoirs and livestock tanks throughout the Havasu Creek drainage area which provide public and livestock water supplies. The town of Williams manages five reservoirs in the headwaters. While Havasu Creek is ephemeral throughout most of its length, about three miles upstream of Supai, Uqualla Point (formerly called Havasu Springs) discharges a steady flow of approximately 70 cubic feet per second. The springs issue from the Redwall Limestone and are the main groundwater discharges from the "Coconino Trough" structural feature. The flow from the springs is heavily mineralized and forms spectacular travertine features in the stream channel. Larger waterfalls, such as Havasu and Mooney Falls, are relatively permanent features of Havasu Canyon and are controlled by the combination of Redwall Limestone and massive travertine deposits (U.S. Army Corps, 2009).

The lower portion of the drainage area includes the Havasupai Indian Reservation. The Havasupai village of Supai is located in a relatively wide reach of Havasu Canyon, bounded on both sides by nearly vertical rock walls that extend several hundred feet to the plateau above (U.S. Army Corps, 2009).

The Havasu Canyon Watershed was delineated by the U.S. Geological Survey and has been subdivided by the NRCS into smaller watersheds or drainage areas. Each drainage area has a unique hydrologic unit code number (HUC) and a name based on the primary surface water feature within the HUC. These drainage areas can be further subdivided into even smaller watersheds as needed. The Havasu Canyon Watershed is an 8-digit HUC of 15010004 and contains the following 10-digit HUCs (Figure 2-1):

- 1501000401 Rogers Draw-Farm Dam Tank
- 1501000402 Spring Valley Wash
- 1501000403 Red Horse Draw
- 1501000404 Miller Wash
- 1501000405 Cataract Creek
- 1501000406 Sandstone Wash
- 1501000407 Monument Wash
- 1501000408 Heather Wash
- 1501000409 Upper Havasu Creek
- 1501000410 Middle Havasu Creek
- 1501000411 Lower Havasu Creek

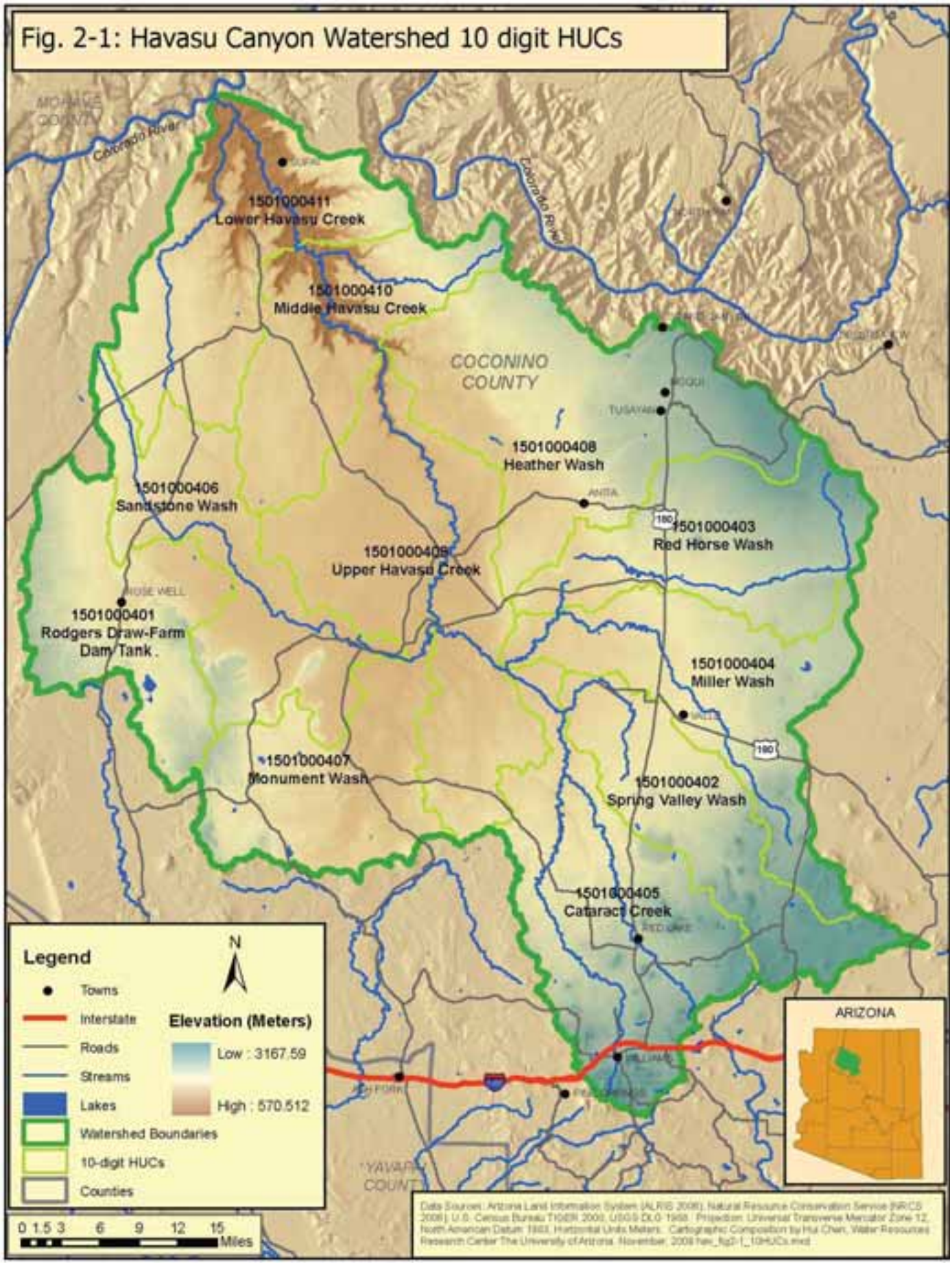


Fig. 2-1: Havasu Canyon Watershed 10 digit HUCs
1501000411
Lower Havasu Creek
1501000410
Middle Havasu Creek
COCONINO
COUNTY
1501000408
Heather Wash
1501000406
Sandstone Wash
1501000403
Red Horse Wash
1501000409
Upper Havasu Creek
1501000401
Rodgers Draw-Farm
Dam Tank
1501000404
Miller Wash
1501000407
Monument Wash
1501000402
Spring Valley Wash
1501000405
Cataract Creek
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
Elevation (Meters)
Low : 3167.59
High : 570.512
N
0 1.5 3 6 9 12 15
Miles
ARIZONA

Geology

Havasu Canyon Watershed is within the Coconino Plateau region of Arizona. Geology at the land surface is dominated by the Kaibab Limestone Formation. The Kaibab Formation is found across northern Arizona, southern Utah, east central Nevada, and southeast California (Figure 2-2). Part of the Colorado Plateau, this formation was laid down in the Early Permian around 250 million years ago (Chronic, 1983), and in the Havasu Canyon Watershed it forms the Coconino Plateau. There is a lack of well established drainage on the Coconino Plateau due to the nature of the geology. Because limestone dissolves easily, precipitation sinks down through underground channels that have gradually widened along fractures and caverns in the Kaibab Formation.

The Kaibab Formation consists of gray to tan colored cherty limestone with components of shale and sandstone. Within this geological layer exists many marine fossils including coral (Grand Canyon Explorer, 2010). The Kaibab forms the top of the sedimentary sequence exposed by the mile-deep Grand Canyon, which was formed by the downcutting of the Colorado River. Beneath the Kaibab Formation, other sedimentary rocks exposed in the Grand Canyon include older shales, sandstones, limestones and mudstones.

Although the sedimentary rock formations have remained as flat layers across the region, there is some deformation present due to faulting. High angle, nearly vertical faults, striking north-east, south-west, cut across almost all of the various aged rock layers. The Bright Angel Fault is one of the most well known faults exposed at land surface and also along the Bright Angel Trail in the Grand Canyon.

Volcanic rocks, basalt flows and cinder cones form the watershed's boundaries to the south-east and south-west. Pumice and cinders are light weight, and are quarried as aggregate for construction across the watershed.

Soils

Soils within the Havasu Canyon Watershed are diverse and formed as the result of differences in climate, vegetation, geology, and physiography. Detailed soils information for the watershed is available from the Natural Resources Conservation Service (NRCS) within the following Soil Surveys: "Soil Survey of the Hualapai-Havasupai Area, AZ, Parts of Coconino, Mohave, and Yavapai Counties," and "Soil Survey of Coconino County Area, AZ, Central Part." Soils data and maps from these Soil Surveys can be accessed through the NRCS Web Soil Survey website: http://websoilsurvey.nrcs.usda.gov.

Common Resource Areas

The USDA Natural Resources Conservation Service (NRCS) defines a Common Resource Area (CRA) as a geographical area where resource concerns, problems, or treatment needs are similar (NRCS 2006). It is considered a subdivision of an existing "Major Land Resource Area" (MLRA). Landscape conditions, soil, climate, human considerations, and other natural resource information are used to

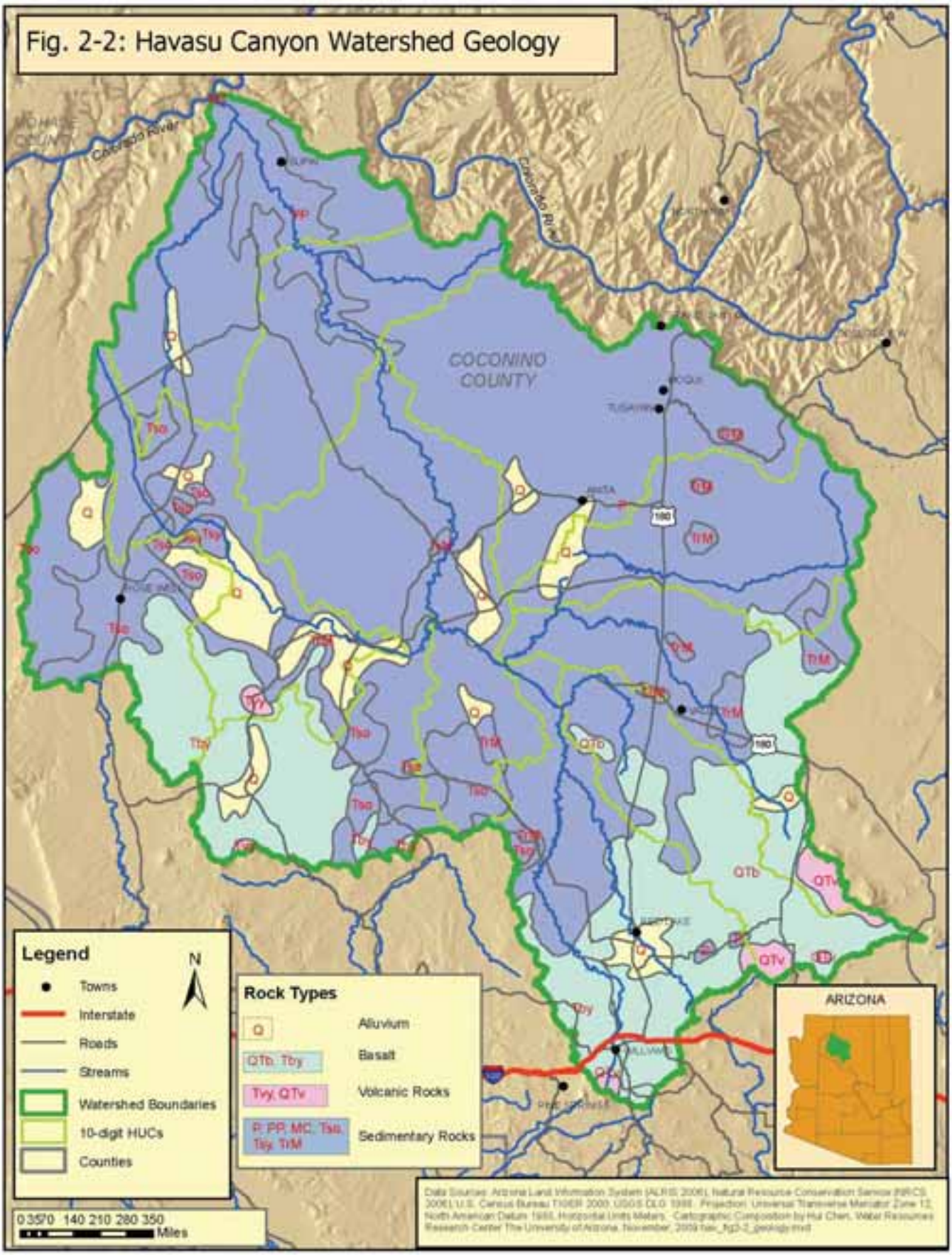


Fig. 2-2: Havasu Canyon Watershed Geology
COCONINO COUNTY
Colorado River
Legend
Towns
Interstate
Roads
Streams
Watershed Boundaries
10-digit HUCs
Counties
N
Rock Types
Q
Alluvium
QTb, Tby
Basalt
Tvy, QTv
Volcanic Rocks
P, PP, MC, Tso, Tay, TrM
Sedimentary Rocks
ARIZONA
0 35 70 140 210 280 350
Miles

determine the geographic boundaries of a Common Resource Area.

The Havasu Canyon Watershed is comprised of seven Common Resource Areas (Figure 2-3 and Table 2-1).

The uppermost portion of the watershed in the vicinity of the City of Williams is comprised of CRA 39.1 “Mogollon Plateau Coniferous Forests.” Elevations range from 7000 to 10,400 feet and precipitation averages 20 to 35 inches per year. Vegetation includes ponderosa pine, Gambel oak, Arizona walnut, sycamore, Douglas fir, blue spruce, Arizona fescue, mountain muhly, muttongrass, pine dropseed, and dryland sedges.

The soils in CRA 39.1 have a mesic to frigid soil temperature regime and a typic ustic to udic ustic soil moisture regime. The dominant soil orders are Alfisols, Mollisols, Vertisols, and Entisols. Moderately deep and deep, medium, and moderately fine-textured, soils occur on mountains. Deep and moderately deep, gravelly, medium to fine-textured soils occur in mountain meadows. Shallow to deep, gravelly, cobbly, and stony, fine-textured soils occur on basaltic plains, mesas and hills. Deep, coarse to moderately fine-textured soils occur on plains. Shallow, gravelly, cobbly, and stony, medium, and fine-textured soils occur on plains, mesa tops, and cinder cones.

Below the coniferous forest occurs CRA 35.7 “Colorado Plateau Woodland – Grassland” with elevations ranging from 5000 to 7000 feet and precipitation averaging 14 to 18 inches per year. Vegetation includes one-seed juniper, Colorado pinyon, Stansbury cliffrose, Apache plume, four-wing saltbush, Mormon tea, sideoats grama, blue grama, black grama, galleta, bottlebrush squirreltail, and muttongrass.

The soils in CRA 35.7 have a mesic soil temperature regime and an aridic ustic soil moisture regime. The dominant soil orders are Vertisols and Mollisols. Shallow to deep, gravelly, cobbly and stony, fine-textured, soils occur on basaltic plains, mesas and hills.

Also located in the upper reaches of the watershed in the vicinity of Grand Canyon Village is CRA 35.8 “Colorado Plateau Ponderosa Pine Forests.” Elevations range from 6800 to 8500 feet and precipitation averages 17 to 25 inches per year. Vegetation includes ponderosa pine, white fir, aspen, pinyon, juniper, Gambel oak, and big sagebrush.

The soils in CRA 35.8 have a mesic to frigid soil temperature regime and a typic ustic soil moisture regime. The dominant soil orders are Alfisols and Mollisols. Moderately deep fine-textured soils and shallow gravelly loamy-textured soils occur on plateaus.

Below the ponderosa forest occurs CRA 35.6 “Colorado Plateau Pinyon-Juniper-Sagebrush” with elevations ranging from 5,500 to 7,000 feet and precipitation averaging 13 to 17 inches per year. Vegetation includes pinyon, juniper, big sagebrush, cliffrose, Mormon tea, muttongrass, prairie junegrass, squirreltail, western wheatgrass, and blue grama.

The soils in CRA 35.6 have a mesic soil temperature regime and an aridic ustic

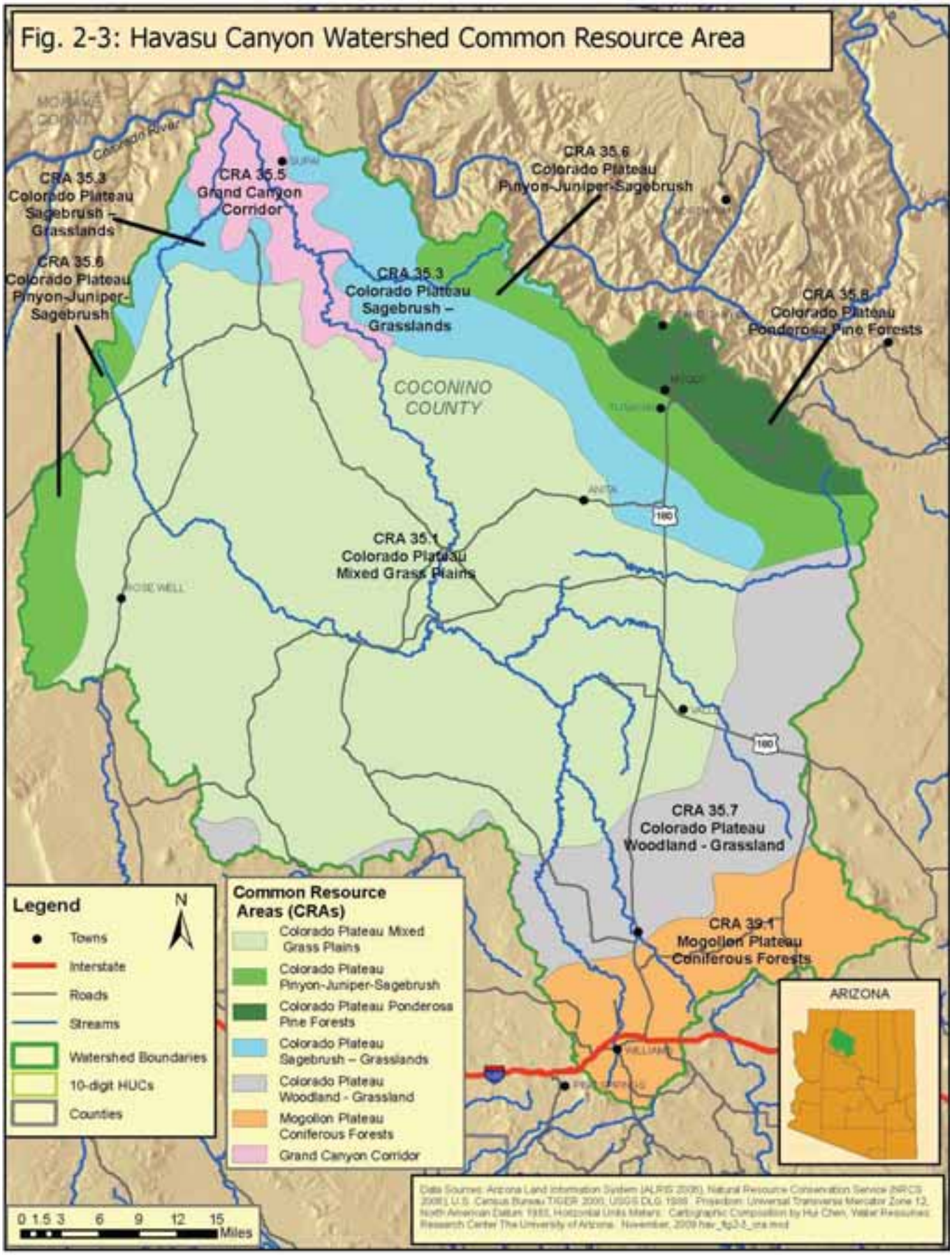


Fig. 2-3: Havasu Canyon Watershed Common Resource Area
CRA 35.3
Colorado Plateau
Sagebrush –
Grasslands
CRA 35.5
Grand Canyon
Corridor
CRA 35.6
Colorado Plateau
Pinyon-Juniper-Sagebrush
CRA 35.3
Colorado Plateau
Sagebrush –
Grasslands
CRA 35.6
Colorado Plateau
Pinyon-Juniper-
Sagebrush
CRA 35.8
Colorado Plateau
Ponderosa Pine Forests
COCONINO
COUNTY
CRA 35.1
Colorado Plateau
Mixed Grass Plains
CRA 35.7
Colorado Plateau
Woodland - Grassland
CRA 39.1
Mogollon Plateau
Coniferous Forests
Legend
Towns
Interstate
Roads
Streams
Watershed Boundaries
10-digit HUCs
Counties
N
Common Resource
Areas (CRAs)
Colorado Plateau Mixed
Grass Plains
Colorado Plateau
Pinyon-Juniper-Sagebrush
Colorado Plateau Ponderosa
Pine Forests
Colorado Plateau
Sagebrush – Grasslands
Colorado Plateau
Woodland - Grassland
Mogollon Plateau
Coniferous Forests
Grand Canyon Corridor
ARIZONA
0 1.5 3 6 9 12 15
Miles

soil moisture regime. The dominant soil orders are Mollisols and Vertisols. Shallow, gravelly, cobbly and stony, medium and fine-textured soils occur on plains and mesa tops and cindery soils occur on cinder cones. Shallow to deep, gravelly, cobbly and stony, fine-textured soils occur on basaltic plains, mesas and hills.

The majority of the middle portion of the watershed is comprised of CRA 35.1 "Colorado Plateau Mixed Grass Plains" with elevations ranging from 5100 to 6000 feet and precipitation averaging 10 to 14 inches per year. Vegetation includes *Stipa* species, Indian ricegrass, galleta, blue grama, fourwing saltbush, winterfat, and cliffrose.

The soils in CRA 35.1 have a mesic soil temperature regime and an ustic aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Deep, coarse to moderately fine-textured soils occur on plains. Shallow, gravelly, cobbly and stony, medium and fine-textured soils occur on plains, mesa tops and cinder cones.

The lower portion of the watershed above the rim is comprised of CRA 35.3 "Colorado Plateau Sagebrush-Grasslands." Elevations range from 4,500 to 6,000 feet and precipitation averages 10 to 14 inches. Vegetation includes Wyoming big sagebrush, Utah juniper, Colorado pinyon cliffrose, Mormon tea, fourwing saltbush, blackbrush Indian ricegrass, needle and thread, western wheatgrass, galleta, black grama, blue grama, and sand dropseed.

The soils in CRA 35.3 have a mesic soil temperature regime and an ustic aridic soil moisture regime. The dominant soil orders are Aridisols and Entisols. Shallow, medium, and fine-textured soils and rock outcrops occur on plateaus and plains. Shallow, gravelly, and cobbly, moderately coarse to fine-textured soils and rock outcrop occur on hills and mountains.

Below the rim in the vicinity of Supai Village occurs CRA 35.5 "Grand Canyon Corridor" characterized by extreme vertical escarpments and strong aspect differences over short distances. Elevations range from 1600 to 4500 feet and precipitation averages 6 to 10 inches per year. Vegetation includes Mormon tea, blackbrush, prickly pear, cholla, big galleta, and threeawns.

The soils in CRA 35.5 have a thermic to mesic soil temperature regime and a typic aridic soil moisture regime. The dominant soil orders are Entisols and Aridisols. Very shallow to very deep, variable textured and gravelly loamy-textured, soils and Rock outcrop occur on canyon escarpments, mesas, and structural benches.

All of the above Common Resource Areas occur within the Colorado Plateau Physiographic Province which is characterized by a sequence of flat to gently dipping sedimentary rocks eroded into plateaus, valleys, and deep canyons. Sedimentary rock classes dominate the plateau with volcanic fields occurring for the most part near its margin.

Table 2-1: Havasu Canyon Watershed – Common Resource Areas

Common Resource Area Type	Area (sq. mi.)	Percent of Watershed
35.1 Colorado Plateau Mixed Grass Plains	1642	56%
35.3 Colorado Plateau Sagebrush - Grasslands	276	9%
35.5 Grand Canyon Corridor	120	4%
35.6 Colorado Plateau Pinyon-Juniper-Sagebrush	227	8%
35.7 Colorado Plateau Woodland - Grassland	354	12%
35.8 Colorado Plateau Ponderosa Pine Forests	99	3%
39.1 Mogollon Plateau Coniferous Forests	216	7%

Data Sources: GIS map layer "cra_a_az". Arizona Land Information System (ALRIS 2004). Natural Resource Conservation Service (NRCS 2006)

Slope Classifications

Slope, as well as soil characteristics and topography, are important when assessing the vulnerability of a watershed to erosion. Less than 10% of the Havasu Canyon Watershed has a slope greater than 15%, while 65% of the watershed has a slope less than 5%.

The Red Horse Wash Watershed has the least amount of slope, with only 3% of its area over 15% slope, and 82% less than 5% slope. The Lower Havasu Creek Watershed has the greatest amount of slope, with 33% of the area greater than 15% slope, and only 45% less than 5% slope (Table 2-2 and Figure 2-4).

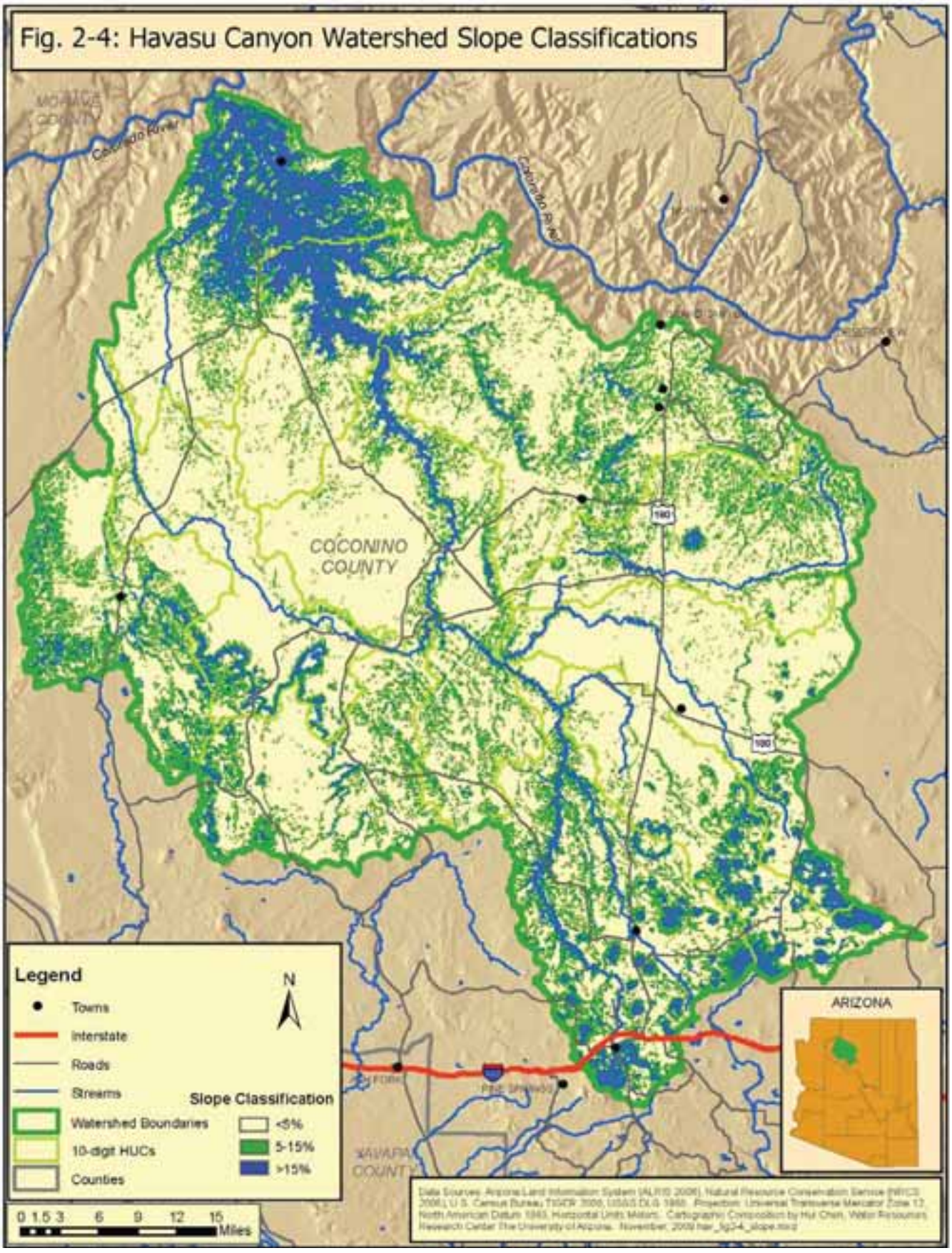


Fig. 2-4: Havasu Canyon Watershed Slope Classifications
COCONINO COUNTY
Colorado River
Legend
Towns
Interstate
Roads
Streams
Watershed Boundaries
10-digit HUCs
Counties
Slope Classification
<5%
5-15%
>15%
N
0 1.5 3 6 9 12 15
Miles
ARIZONA

Table 2-2: Havasu Canyon Watershed Slope Classifications.

10-digit Watershed Name	Area (sq. mi.)	Percent Slope		
		< 5%	5-15%	>15%
Rodgers Draw-Farm Dam Tank-1501000401	218	54%	38%	7%
Spring Valley Wash-1501000402	205	67%	21%	12%
Red Horse Wash-1501000403	239	69%	28%	3%
Miller Wash-1501000404	251	82%	13%	5%
Cataract Creek-1501000405	326	51%	36%	14%
Sandstone Wash-1501000406	243	80%	15%	5%
Monument Wash-1501000407	216	70%	26%	4%
Heather Wash-1501000408	381	66%	29%	5%
Upper Havasu Creek-1501000409	357	76%	20%	4%
Middle Havasu Creek-1501000410	220	63%	20%	18%
Lower Havasu Creek-1501000411	277	43%	24%	33%
Havasu Canyon Watershed	2933	65%	25%	10%

Data Sources: Derived from DEM, obtained from U.S. Geological Survey, October, 2008 http://seamless.usgs.gov/

Streams, Lakes and Gaging Stations

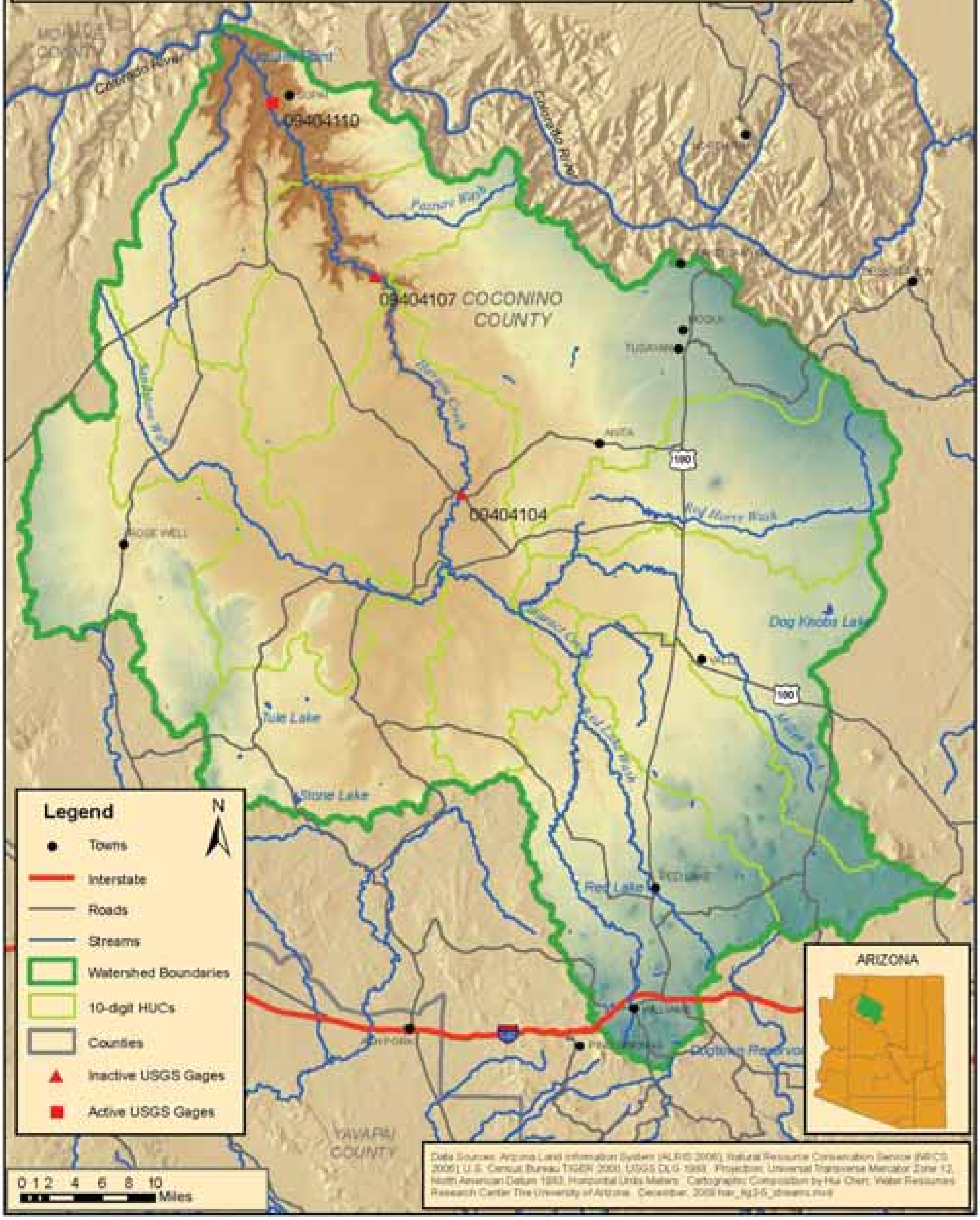
The three locations of active and inactive gaging station within the Havasu Canyon Watershed, are shown in Figure 2- 5 and in Table 2-3.1. The locations are Cataract Creek at Redlands Crossing near Valle, Cataract Creek below Heather Wash near Supai, AZ, and Havasu Creek at Supai, AZ. The Havasu Creek at Supai site has an annual mean stream flow of 64.2 cubic feet per second (cfs). To access these real-time gages, go to: http://waterdata.usgs.gov/az/nwis/rt

The two gages located on Cataract Creek were recently installed by the U.S. Geological Survey, in cooperation with the Havasupai Tribe, for the purpose of flood warning for Supai Village. The Cataract Creek at Redlands Crossing near Valle gage (installed 2008) submits a warning when flow reaches 3,000-4,000 cfs. This station transmits information real-time every hour and every 15 minutes or less for event flows. Notifications are sent to the National Weather Service and directly to the Havasupai Tribe. This station monitors stage for 70% of the watershed above Supai.

The Cataract Creek below Heather Wash near Supai, AZ gage (installed 2009) provides four hours of warning time when flow reaches 4,000 cfs. This station monitors stage for 85% of the watershed above Supai. The Havasu Creek at Supai, AZ gage (installed 1995) is located 1.5 miles above Supai Village and monitors stream flow every 15 minutes. This station provides a one hour warning which is not enough lead time for flood events that require evacuation.

The Chalender SNOTEL (Snow Telemetry) site (installed 2009) is located in the headwaters of the Havasu Canyon Watershed near Williams, Arizona. This station is part of a state-wide system of snow survey sites operated and maintained by the NRCS as part of the USDA Cooperative Snow Survey and Streamflow Forecasting

Fig. 2-5: Havasu Canyon Watershed Streams, Canals and Lakes



program. The Chalender SNOTEL site provides near real-time snow water equivalent, precipitation, temperature, and other climatic data. To access this site, go to: http://www.wcc.nrcs.usda.gov/snotel/Arizona/arizona.html

Table 2.3.2 lists major lakes and reservoirs in the Havasu Canyon

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Watershed, as well as their watershed position, surface area, elevation, and dam name. Dog Knobs Lake in the Miller Wash Watershed is the largest surface water body in the watershed, with an area of about 178 acres. Table 2-3.3 lists the major streams and their lengths. Stream lengths range from 76 miles for Havasu Creek to 16 miles for Spring Valley Wash.

Table 2-3.1: Havasu Canyon Watershed USGS Stream Gages and Annual Mean Stream Flow

USGS Gage ID	Site Name	Begin Date	End Date	Annual Mean Stream Flow (cfs)
09404104	Cataract Creek at Redlands Crossing near Valle	8/17/2008	11/25/2009	-
09404107	Cataract Creek below Heather Wash near Supai, AZ	1/6/2009	7/16/2009	-
09404110	Havasu Creek at Supai, AZ	9/1/1995	3/18/2010	64.2

Data Sources: USGS website, National Water Information System http://waterdata.usgs.gov/nwis/
Note: Data is only available for USGS gage 09404110.

Table 2-3.2: Havasu Canyon Watershed Major Lakes and Reservoirs

Watershed	Lake Name (if known)	Surface Area (acres)	Elevation (feet above mean sea level)	Dam Name (if known)
Rodgers Draw-Farm Dam Tank-1501000401	-	6	1851	-
	Rodgers Tank	7	1848	-
	Farm Dam Tank	10	1711	-
	-	14	1728	-
	-	58	1851	-
	-	494	1845	-
Spring Valley Wash-1501000402	Moritz Lake	47	2162	-
	Howard Lake	55	1870	-
Red Horse Wash-1501000403	-	6	2160	-
	Yaeger Bly Tank	9	1857	-
Miller Wash-1501000404	Wagner Tank	11	1773	-
	Dog Knobs Lake	178	1952	-
Cataract Creek-1501000405	City Reservoir	5	2128	-
	Little KY Tank	6	1943	-
	Red Lake	8	1979	-
	Threemile Lake	8	2034	-
	Boulin Tank	11	2130	-
	Santa Fe Reservoir	12	2103	Railroad Dam
	K4 Tank	13	1942	
	Cataract Lake	38	2076	West Cataract Creek Dam

Watershed	Lake Name (if known)	Surface Area (acres)	Elevation (feet above mean sea level)	Dam Name (if known)
	Smoot Lake	50	1936	-
	Kaibab Lake	61	2073	Kaibab Dam
	Dogtown Reservoir	70	2155	Dogtown Dam
Sandstone Wash-1501000406	-	6	1713	-
	-	16	1716	-
Monument Wash-1501000407	-	7	1757	-
	-	19	1676	Markham Dam
	Horse Lake	38	1803	-
	Schafers Tank	40	1818	-
	Tule Lake	108	1825	-
	Stone Lake	153	1790	-
Heather Wash-1501000408	Rain Tank	8	1989	-
	-	9	2039	-
	-	88	1732	-
	-	91	2038	-
	-	117	1836	-
Upper Havasu Creek-1501000409	-	-	-	-
Middle Havasu Creek-1501000410	Number Eleven Tank	8	1737	-
Lower Havasu Creek-1501000411	Kaufman Tanks	14	1718	-

Data Sources: GIS data layer "Lakes", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), February 7, 2003 http://www.land.state.az.us/alris/index.html

Table 2-3.3: Havasu Canyon Watershed Major Streams and Lengths.

Stream Name	Watershed	Stream Length (miles)
Spring Valley Wash	Spring Valley Wash	16
	Cataract Creek	
Pasture Wash	Middle Havasu Creek	19
Little Coyote Canyon	Lower Havasu Creek	29
Red Lake Wash	Cataract Creek	29
Red Horse Wash	Red Horse Wash	40
	Miller Wash	
Miller Wash	Miller Wash	45
	Cataract Creek	
Cataract Creek	Upper Havasu Creek;	53
	Cataract Creek	
Sandstone Wash	Sandstone Wash	54
	Upper Havasu Creek	
	Monument Wash	
Havasu Creek	Lower Havasu Creek	76

Stream Name	Watershed	Stream Length (miles)
	Upper Havasu Creek	
	Miller Wash	
	Cataract Creek	
	Middle Havasu Creek	
	Heather Wash	

Data Sources: GIS data layer "Streams", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), October, 10, 2002, ESRI data layer "dtl_streams", 2007
http://www.land.state.az.us/alris/index.html

Land Cover

The Riparian Vegetation map (Figure 2-6) and Land Cover map (Figure 2-7) were created from the Southwest Regional GAP (GAP Analysis Project) land cover map (Lowry et. al, 2005). According to the GAP Analysis Project, only one of the ten types of riparian areas occurs within the Havasu Canyon Watershed. Invasive Southwest Riparian Woodland and Shrubland areas encompass approximately 53 acres (0.08 sq. mi.), and are found only in the Lower Havasu Creek Watershed (Table 2-4). Professional knowledge of the watershed, however, identifies the correct community as "North American Warm Desert Riparian Woodland and Shrubland", because although altered and invaded by tamarisk, this community is still dominated by native cottonwood and willow.

Within the Havasu Canyon Watershed, Table 2-5 identifies the "evergreen forest" and "sparsely vegetated/barren" as the most common land cover types over the entire watershed, encompassing 43% and 40% of the watershed, respectively. The next most common type of land cover is "Grassland/Herbaceous" encompassing 9% of the watershed. Note: There are a total of 26 GAP vegetation categories present within the Havasu Canyon Watershed boundary. Some of these categories occur only in small concentrations, and are not visible at the small scale in which the maps are displayed. Some of the vegetation categories were re-grouped in order to increase the legibility of the map. In collaboration with NRCS, staff was able to create a total of 10 grouped GAP vegetation categories, as shown on Table 2-5.

Table 2-4: Havasu Canyon Watershed Riparian Vegetation (acres) by 10 Digit Watershed.

Riparian Vegetation Community	Invasive Southwest Riparian Woodland and Shrubland
Lower Havasu Creek-1501000411	53[1]

Data Sources: GIS data layer "newgapveg", Southwest Regional GAP Vegetation (SWGAP), 2005
http://earth.gis.usu.edu/swgap/
[1]Note: Other watersheds contain no riparian habitat.

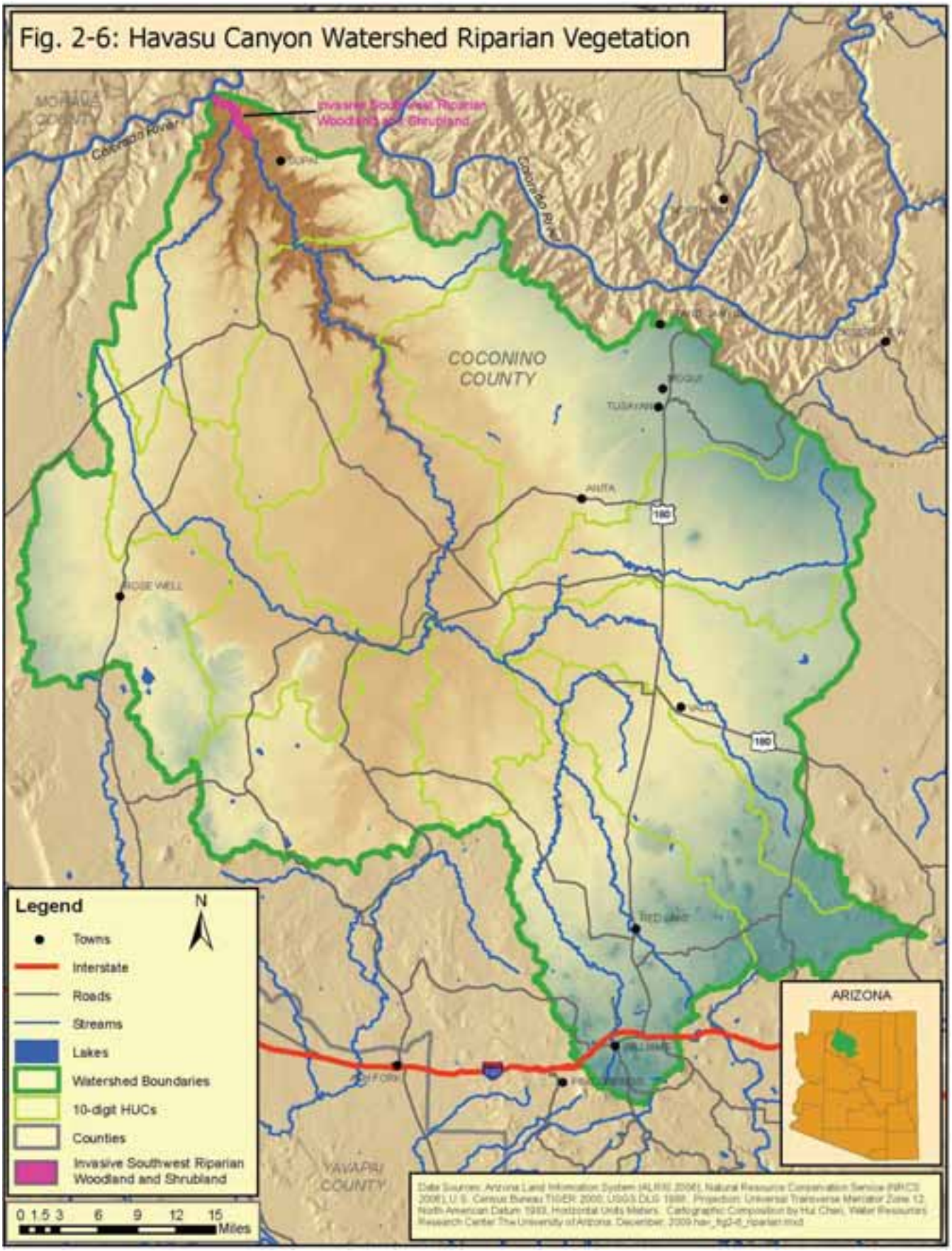


Fig. 2-6: Havasu Canyon Watershed Riparian Vegetation
Invasive Southwest Riparian Woodland and Shrubland
Colorado River
COCONINO COUNTY
YAVAPAI COUNTY
Legend
N
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
Invasive Southwest Riparian Woodland and Shrubland
0 1.5 3 6 9 12 15
Miles
ARIZONA

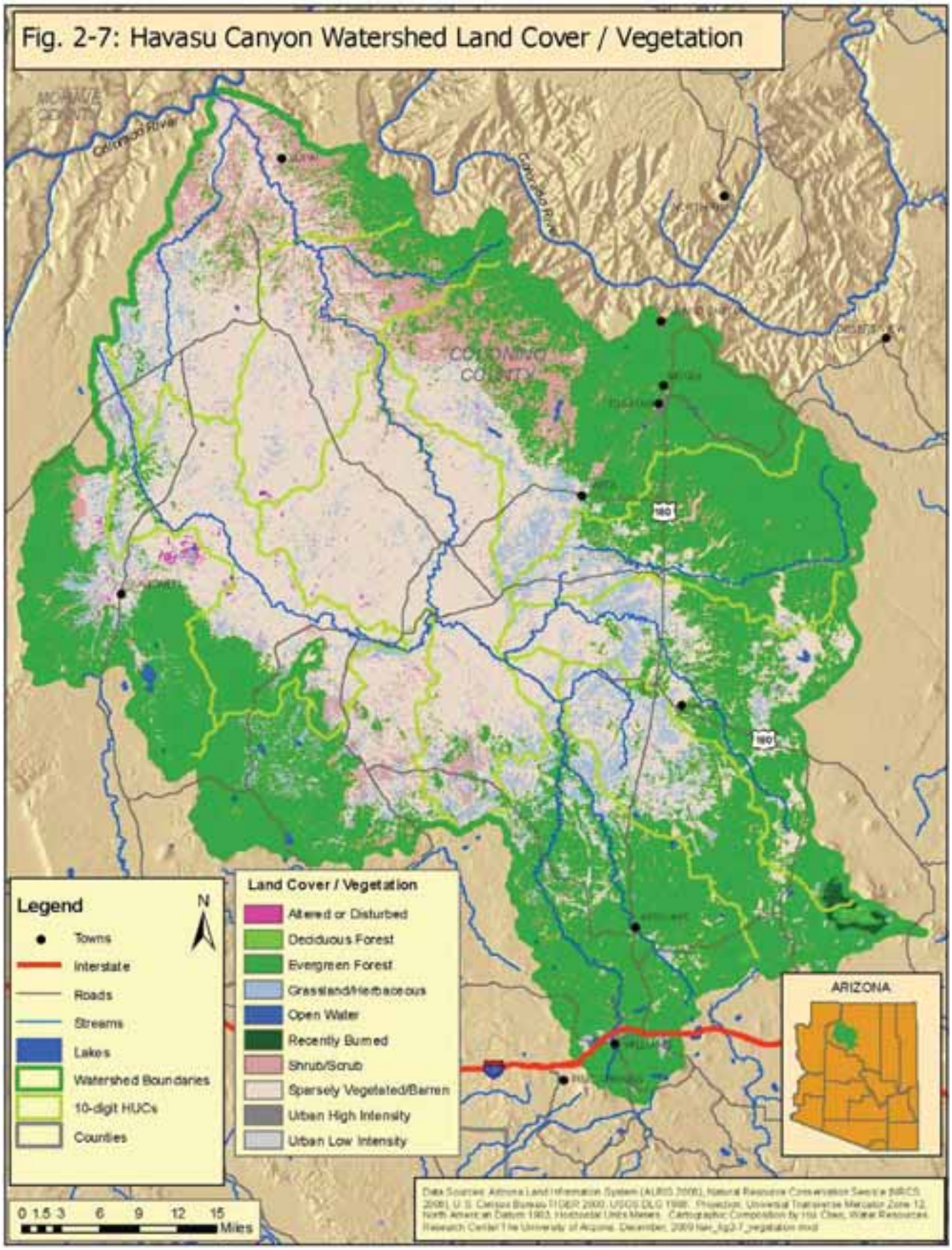


Fig. 2-7: Havasu Canyon Watershed Land Cover / Vegetation
Legend
N
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
Land Cover / Vegetation
Altered or Disturbed
Deciduous Forest
Evergreen Forest
Grassland/Herbaceous
Open Water
Recently Burned
Shrub/Scrub
Sparsely Vegetated/Barren
Urban High Intensity
Urban Low Intensity
ARIZONA
0 1.5 3 6 9 12 15
Miles

Table 2-5: Havasu Canyon Watershed Southwest Regional GAP Analysis Project Land Cover, Percent of 10-digit Watershed (Part 1 of 2).

Land Cover/Vegetation	Rodgers Draw-Farm Dam Tank-1501000401	Spring Valley Wash-1501000402	Red Horse Wash-1501000403	Miller Wash-1501000404	Cataract Creek-1501000405	Sandstone Wash-1501000406
Altered or Disturbed	1%	-	<1%	<1%	<1%	<1%
Deciduous Forest	-	1%	-	<1%	<1%	-
Evergreen Forest	64%	50%	75%	47%	74%	21%
Grassland/Herbaceous	10%	16%	6%	10%	9%	11%
Open Water	<1%	<1%	<1%	<1%	<1%	<1%
Recently Burned	-	2%	-	1%	-	-
Shrub/Scrub	4%	1%	3%	1%	1%	3%
Sparsely Vegetated/Barren	21%	31%	17%	41%	15%	64%
Urban High Intensity	-	<1%	-	<1%	1%	-
Urban Low Intensity	-	-	-	-	<1%	-
Area (sq.mi.)	218	205	239	251	325	243

Table 2-5: Havasu Canyon Watershed Southwest Regional GAP Analysis Project Land Cover, Percent of 10-digit Watershed (Part 2 of 2).

Land Cover/Vegetation	Monument Wash-1501000407	Heather Wash-1501000408	Upper Havasu Creek-1501000409	Middle Havasu Creek-1501000410	Lower Havasu Creek-1501000411	Havasu Canyon
Altered or Disturbed	<1%	<1%	<1%	<1%	<1%	<1%
Deciduous Forest	-	-	-	-	-	<1%
Evergreen Forest	55%	58%	3%	17%	14%	43%
Grassland/Herbaceous	13%	7%	8%	3%	7%	9%
Open Water	<1%	<1%	<1%	<1%	-	<1%
Recently Burned	-	-	-	-	-	<1%
Shrub/Scrub	7%	16%	4%	18%	25%	8%
Sparsely Vegetated/Barren	25%	19%	84%	61%	55%	40%
Urban High Intensity	-	<1%	-	-	-	<1%
Urban Low Intensity	-	-	-	-	-	<1%
Area (sq.mi.)	216	381	357	220	277	2933

Data Sources: GIS data layer "Southwest Regional GAP Program", originated by Southwest Regional GAP program, 2005. http://ftp.nr.usu.edu/swgap/

Meteorological Stations, Precipitation and Temperature

For the years 1961-1990, the average annual precipitation for the Havasu Canyon Watershed was about 18 inches (WRCC, 2004) (Table 2-6). Cataract Creek Watershed receives the most rainfall with about 25 inches of annual rain on average, while Lower Havasu Creek Watershed receives the least rainfall with an average of 13 inches annually.

None of the local meteorological stations have temperature data available for the watershed. Active meteorological stations in the watershed are located in Figure 2-8.

Floods in the region are can result from localized thunderstorm activity and/or the result of more generalized rainfall from regional storms. In both cases, precipitation may vary significantly within relatively small distances. Flash floods may occur on one small watershed while adjacent watersheds receive virtually no precipitation. Rainfall on an existing snowpack can greatly increase runoff. Due to the drainage area's extreme relief, sparse vegetation, and dynamic weather patterns, floods along Havasu Creek typically occur with little or no warning. In the last 100 years at least 16 major floods have coursed through the reservation. On the basis of evidence presented in the 1996 study, it is unlikely that a flood exceeding the estimated 25-year recurrence interval has occurred along Havasu Creek since 1910 (USGS, 1996).

The latest flood occurred in August 2008. The rainfall at the Havasupai Reservation was light but 4-7 inches fell throughout the rest of the watershed. As this water collected in the washes and creeks, significant flooding began to occur on Saturday, August 16th. The floods moved a significant amount of sediment and debris and re-routed the channel in many places. During the event, a relatively small holding pond, referred to as Redlands Dam, located about 45 miles upstream from Supai Village, was overtopped and failed (U.S. Army Corps, 2009).

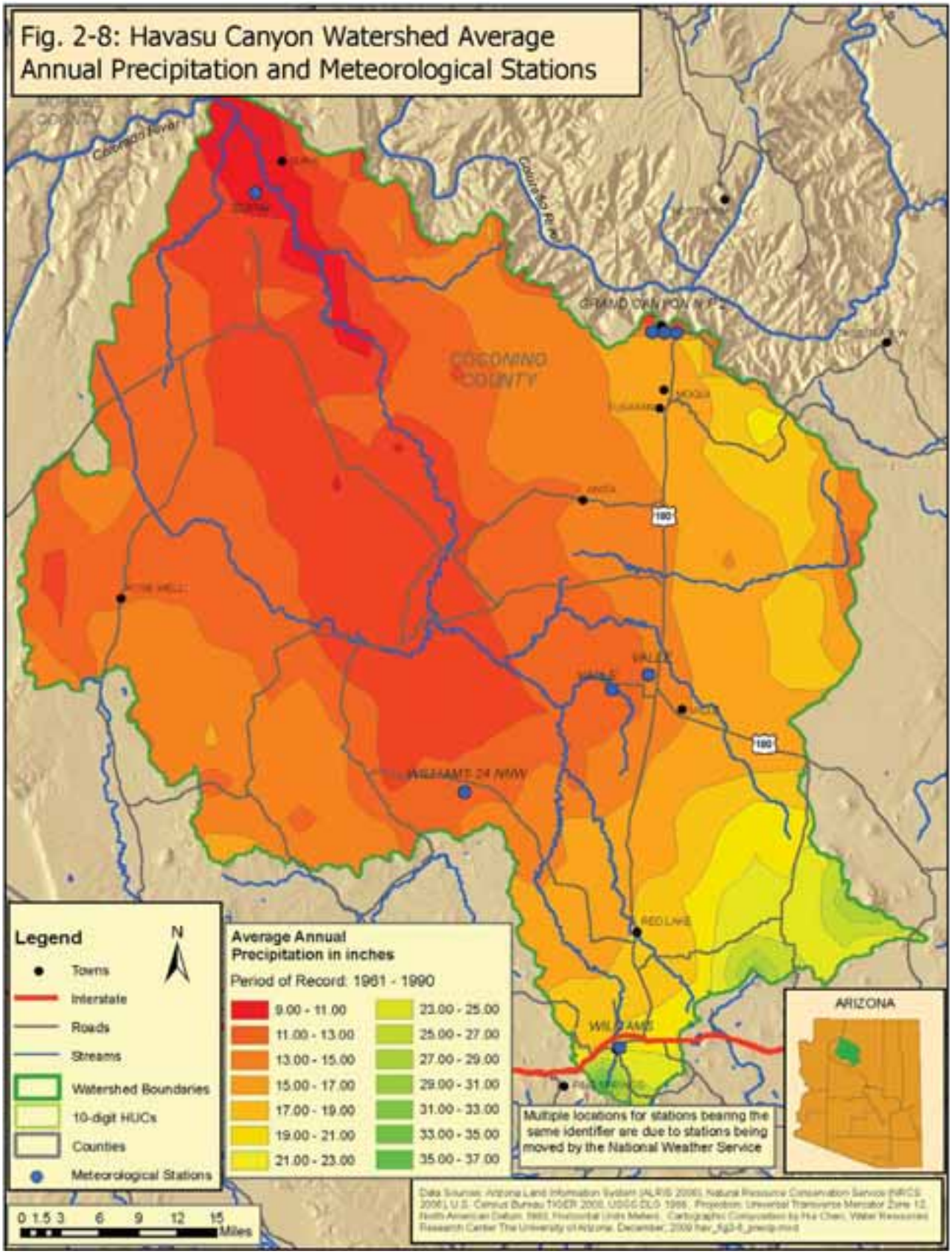


Fig. 2-8: Havasu Canyon Watershed Average Annual Precipitation and Meteorological Stations
COCONINO COUNTY
Colorado River
GRAND CANYON N P
WILLIAMS 24 NNW
Legend
Towns
Interstate
Roads
Streams
Watershed Boundaries
10-digit HUCs
Counties
Meteorological Stations
N
Average Annual Precipitation in inches
Period of Record: 1961 - 1990
9.00 - 11.00
11.00 - 13.00
13.00 - 15.00
15.00 - 17.00
17.00 - 19.00
19.00 - 21.00
21.00 - 23.00
23.00 - 25.00
25.00 - 27.00
27.00 - 29.00
29.00 - 31.00
31.00 - 33.00
33.00 - 35.00
35.00 - 37.00
Multiple locations for stations bearing the same identifier are due to stations being moved by the National Weather Service
ARIZONA
0 1.5 3 6 9 12 15
Miles

Table 2-6: Havasu Canyon Watershed Meteorological Stations, Temperature and Precipitation.

Watershed	Meteorological Stations	Temperature (°F)*			Precipitation (in/yr)		
		Ave. Ann. Min.	Ave. Ann. Max.	Avg	Avg.Min.	Avg.Max.	Weighted Average
Rodgers Draw-Farm Dam Tank-1501000401		-	-	-	13	19	16
Spring Valley Wash-1501000402	Valle	-	-	-	15	31	23
Red Horse Wash-1501000403		-	-	-	15	21	18
Miller Wash-1501000404	Valle Airport	-	-	-	13	31	22
Cataract Creek-1501000405	Williams	-	-	-	13	37	25
Sandstone Wash-1501000406		-	-	-	13	17	15
Monument Wash-1501000407		-	-	-	13	19	16
Heather Wash-1501000408	Grand Canyon Airways	-	-	-	13	23	18
	Grand Canyon N P 2	-	-	-			
	Grand Canyon NATL PARK	-	-	-			
Upper Havasu Creek-1501000409	Willams 24 NNW	-	-	-	11	17	14
Middle Havasu Creek-1501000410		-	-	-	13	19	16
Lower Havasu Creek-1501000411		-	-	-	9	17	13
Havasu Canyon Watershed		-	-	-	9	37	18

Data Sources: GIS data layer "precip_a_az" Water and Climate Center of the NRCS (1998); GIS data layer "NWS_Stations" Western Regional Climate Center (WRCC), Temperature data. July 15, 2004; http://www.wrcc.dri.edu/summary/climsmaz.htm

**None of the Meteorological Stations has records by Western Regional Climate Center.*

Land Ownership/Management

There are 6 different land ownership/management entities in the Havasu Canyon Watershed (Figure 2-9 and Table 2-7). Private Land is the largest category, representing about 40% of the watershed, followed by the State Trust Land with about 26%, and National Forest Land with about 21%. The Havasupai Indian Reservation, a portion of the Hualapi Indian Reservation, Grand Canyon National Parks, and the Bureau of Land Management, comprise smaller amounts of land in the watershed.

Table 2-7: Havasu Canyon Watershed Land Ownership/Management (Percent of each 10-digit Watershed).

Watershed	Land Owner						Area (sq.mi.)
	National Park	Indian Reservation	State Trust	Private	National Forest	BLM	
Rodgers Draw-Farm Dam Tank-1501000401	-	22%	21%	57%	-	-	218
Spring Valley Wash-1501000402	-	-	17%	30%	52%	-	205
Red Horse Wash-1501000403	-	-	20%	11%	68%	-	239
Miller Wash-1501000404	-	-	20%	58%	22%	-	251
Cataract Creek-1501000405	-	-	22%	43%	35%	-	326
Sandstone Wash-1501000406	-	8%	18%	74%	-	-	243
Monument Wash-1501000407	-	-	36%	64%	-	-	216
Heather Wash-1501000408	11%	6%	31%	6%	45%	1%	381
Upper Havasu Creek-1501000409	-	1%	55%	44%	-	-	357
Middle Havasu Creek-1501000410	5%	35%	26%	33%	<1%	-	220
Lower Havasu Creek-1501000411	4%	52%	10%	34%	-	-	277
Havasu Canyon	2%	11%	26%	40%	21%	<1%	2933

Data Sources: GIS data layer "ownership", Arizona State Land Department, Arizona Land Resource Information System (ALRIS), October 27, 2007; GIS data layer "SGID_U024_LandOwnership.shp" Utah GIS Portal, November 2006 http://www.land.state.az.us/alris/index.html; http://agrc.its.state.ut.us/

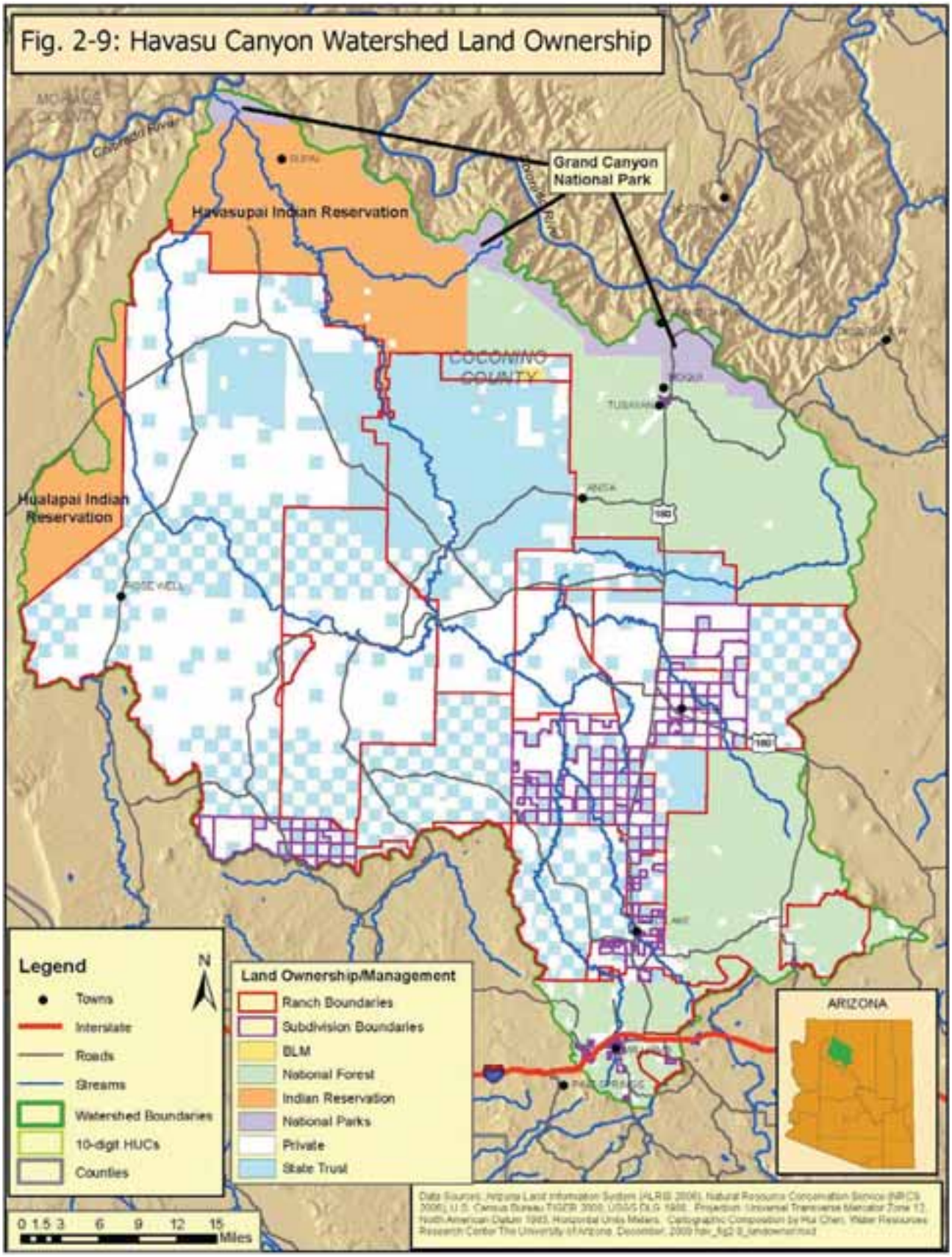


Fig. 2-9: Havasu Canyon Watershed Land Ownership
Grand Canyon National Park
Havasupai Indian Reservation
Hualapai Indian Reservation
COCONINO COUNTY
Legend
Towns
Interstate
Roads
Streams
Watershed Boundaries
10-digit HUCs
Counties
N
Land Ownership/Management
Ranch Boundaries
Subdivision Boundaries
BLM
National Forest
Indian Reservation
National Parks
Private
State Trust
ARIZONA
0 1.5 3 6 9 12 15
Miles

Land Use

The Land Use map (Figure 2-10) was created from the Southwest Regional GAP Analysis Project land cover map (Lowry et. al, 2005).

The land use condition during the early 1990's was determined using the National Land Cover Dataset (NLCD).

The NLCD classification contains 21 different land cover and use categories (USGS, NLCD Land Cover Class Definitions); however, these categories have been consolidated into six land cover types (Figure 2-10 and Table 2-8). The groupings for the land cover categories are:

- Crop, which includes confined feeding operations; cropland and pasture; orchards, groves, vineyards, nurseries and ornamental horticulture; other agricultural land (No measureable cropland exists in the watershed).
- Forest, includes areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25-100 percent of the cover
- Water, identifies all areas of surface water, generally with less than 25% cover of vegetation/land cover
- Range, which includes herbaceous rangeland; mixed range; shrub and brush rangeland.
- Recently burned
- Developed (high density & low density) includes residential areas; commercial and services; industrial and commercial complexes; mixed urban or built-up land; other urban or built-up land; strip mines quarries and gravel pits; transportation, communication and utilities.

The most common land cover type is "range" which makes up 57% of the watershed. "Forest" is the next most common land cover type with 43% of the total area.

Mines - Primary Ores

Table 2-9 and Figure 2-11 show the types of ores being mined in the Havasu Canyon Watershed. The most common type of ore is pumice with 23 mines (Ward, J.S. and Associates. 1973). Other common known ore types are sand and gravel, copper, manganese, lead, and uranium.

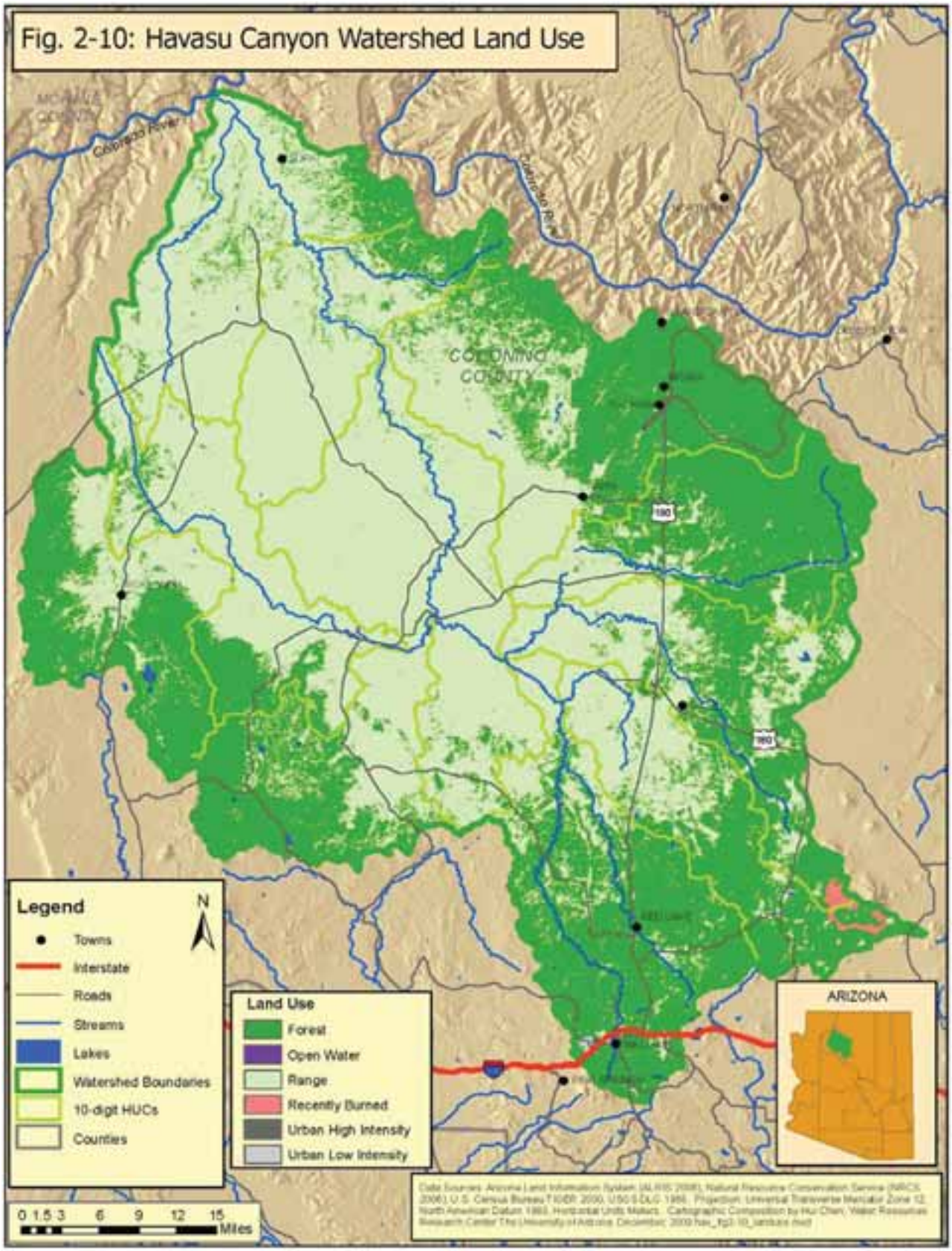


Fig. 2-10: Havasu Canyon Watershed Land Use
Colorado River
COCONINO COUNTY
Legend
N
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
Land Use
Forest
Open Water
Range
Recently Burned
Urban High Intensity
Urban Low Intensity
ARIZONA
0 1.5 3 6 9 12 15
Miles

Table 2-8: Havasu Canyon Watershed Land Use, Percent of 10-digit Watershed

Watershed	Open Water	Range	Forest	Urban High Intensity	Recently Burned	Urban Low Intensity	Area (sq.mi.)
Rodgers Draw-Farm Dam Tank-1501000401	<1%	36%	64%	-	-	-	218
Spring Valley Wash-1501000402	<1%	47%	51%	<1%	2%	-	205
Red Horse Wash-1501000403	<1%	25%	75%	-	-	-	239
Miller Wash-1501000404	<1%	52%	47%	<1%	1%	-	251
Cataract Creek-1501000405	<1%	25%	74%	1%	-	<1%	326
Sandstone Wash-1501000406	<1%	79%	21%	-	-	-	243
Monument Wash-1501000407	<1%	45%	55%	-	-	-	216
Heather Wash-1501000408	<1%	42%	58%	<1%	-	-	381
Upper Havasu Creek-1501000409	<1%	96%	3%	-	-	-	357
Middle Havasu Creek-1501000410	<1%	83%	17%	-	-	-	220
Lower Havasu Creek-1501000411	<1%	86%	14%	-	-	-	277
Havasu Canyon Watershed	<1%	57%	43%	<1%	<1%	<1%	2933

Data Sources: GIS data layer "Southwest Regional GAP Program", originated by Southwest Regional GAP program, 2005. http://ftp.nr.usu.edu/swgap/

Table 2-9: Havasu Canyon Watershed Mines – Primary Ores

Ore Type	Total Number of Mines
Uranium	1
Lead	1
Manganese	1
Copper	4
Sand & Gravel	8
Pumice	23

Note: If a mine contains more than one ore, only the major ore is noted. Data Source: "mines" Arizona Land Information Service, 2006.

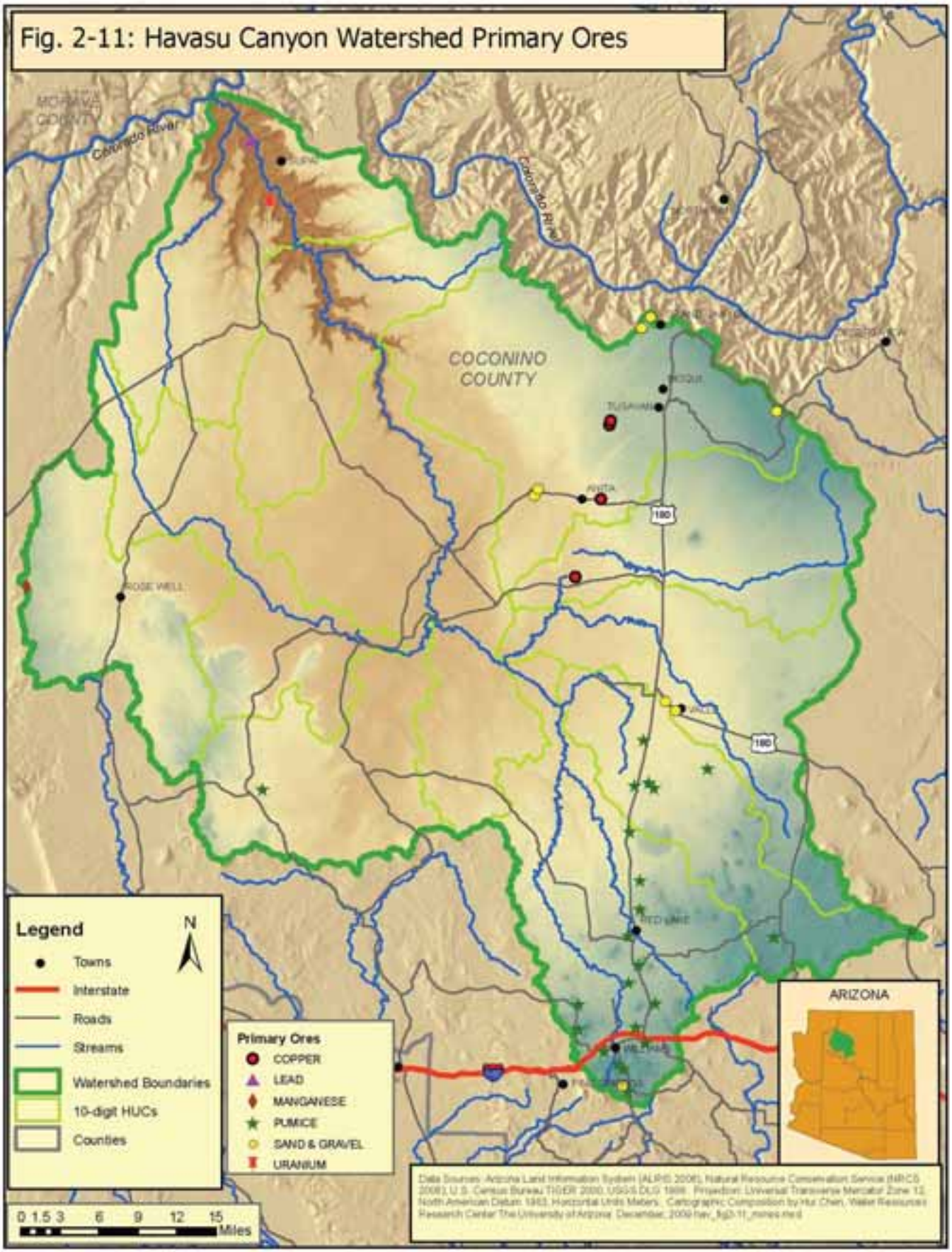


Fig. 2-11: Havasu Canyon Watershed Primary Ores
COCONINO COUNTY
Colorado River
Colorado River
180
180
Legend
N
Towns
Interstate
Roads
Streams
Watershed Boundaries
10-digit HUCs
Counties
Primary Ores
COPPER
LEAD
MANGANESE
PUMICE
SAND & GRAVEL
URANIUM
ARIZONA
0 1.5 3 6 9 12 15
Miles

Section 3: Resource Concerns

Introduction

Conservation Districts and other local leaders, along with NRCS and other resource management agencies, have identified priority natural resource concerns for this watershed. These concerns can be grouped under the broad resource categories of Soil, Water, Air, Plants, or Animals (SWAPA). Refer to Table 3-1 for a listing of priority resource concerns by land use within the Havasu Canyon Watershed.

Soil Erosion

Soil erosion from water and wind is a concern on rangelands within the watershed. The sandy soils of this watershed are highly susceptible to erosive forces. This condition is exacerbated in areas where vegetative cover has been reduced due to prolonged drought and other factors. Havasu Creek has experienced repeated flooding events resulting in excessive stream bank erosion. Most recently, a major storm occurred during August 2008 which produced heavy runoff and severe stream bank erosion within Havasu Canyon.

Soil erosion is defined as the movement of soil from water (sheet and rill or gully) or wind forces requiring treatment when soil loss tolerance levels are exceeded. Sheet and rill erosion is a concern particularly on rangeland in areas of shallow soils and poor vegetative cover. Soil loss results in reduced water holding capacity and plant productivity. Gully erosion can be a significant problem in areas of steep slopes and deep soils. Loss of vegetative cover and down-cutting of streams contribute to gully formation. Wind erosion is locally significant where adequate vegetative cover is not maintained.

Conservation practices applied to address this resource concern are generally those that help improve vegetative cover, stabilize sites, and control water flows. Practices may include critical area planting, deferred grazing, grade stabilization structures, prescribed grazing, range planting, stream channel stabilization, tree and shrub establishment, water and sediment control basins, windbreak establishment, and wildlife upland habitat management.

Water Quality

The Arizona Department of Environmental Quality (ADEQ) assesses surface water quality to identify which surface waters are impaired or attaining designed uses and to prioritize future monitoring. Strategies must be implemented on impaired waters to reduce pollutant loadings so that surface water quality standards will be met, unless impairment is *solely* due to natural conditions.

Once a surface water has been identified as impaired, activities in the watershed that might contribute further loadings of the pollutant are not allowed. Agencies and individuals planning future projects in the watershed must be sure that activities will not further degrade these impaired waters and are encouraged through grants to implement strategies to reduce loading. One of the first steps is the development

Table 3-1: Havasu Canyon Watershed Priority Resource Concerns by Land Use

Resource Category	Rangeland Concerns	Forest Concerns
Soil Erosion	✓ Sheet & Rill ✓ Streambank	✓ Sheet & Rill
Soil Condition	✓ Rangeland Site Stability	
Water Quantity	✓ Excessive Runoff & Flooding	
Plant Condition	✓ Plant Productivity, Health & Vigor ✓ Noxious & Invasive Plants	✓ Plant Productivity, Health & Vigor ✓ Noxious & Invasive Plants
Fish & Wildlife	✓ Inadequate Food & Water ✓ Habitat Fragmentation	✓ Inadequate Food & Water ✓ Habitat Fragmentation
Domestic Animals	✓ Inadequate Quantities & Quality of Feed & Forage ✓ Inadequate Stock Water	✓ Inadequate Quantities & Quality of Feed & Forage ✓ Inadequate Stock Water

(NRCS, 2010)

of a Total Maximum Daily Load (TMDL) analysis to empirically determine the load reduction needed to meet standards.

The 2008/*2006 Status of Ambient Surface Water Quality in Arizona* indicates that there are no "impaired" or "not attaining" surface waters in the Havasu Canyon Watershed (ADEQ, 2008) (see Figure 3-1).

Water Quantity

Excessive runoff and flooding is a resource concern within the watershed. Many factors contribute to this condition, including the presence of shallow soils and poor vegetative cover in many areas. As stated under the soil erosion concern, Havasu Creek has experienced repeated flooding events, including the monsoon of August 2008, which resulted in flood damages to homes, campgrounds, trails, and other infrastructure within Supai Village. Conservation practices applied to address this resource concern are generally those that restore or maintain adequate vegetative cover on the watershed, or control water flow in channels. Practices may include brush management, deferred grazing, floodwater diversions, prescribed grazing, range planting, stream channel stabilization, tree and shrub establishment, water and sediment control basins, and wildlife upland habitat management.

Air Quality

There are no known air quality concerns in the watershed (Figure 3-2).

Environmental Sites

There are no environmental Superfund or WQARF sites located in the Fort

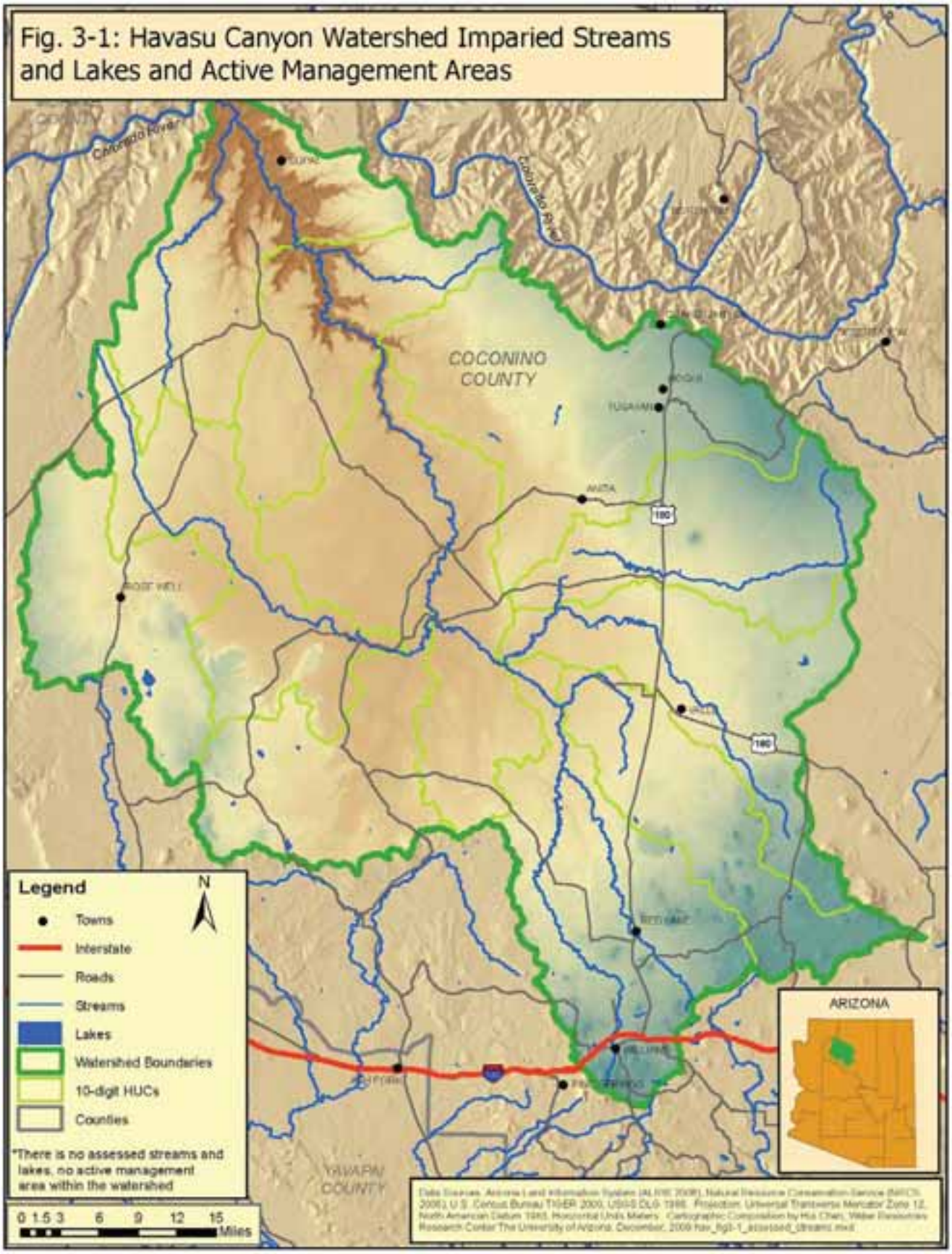


Fig. 3-1: Havasu Canyon Watershed Imparied Streams and Lakes and Active Management Areas
Colorado River
COCONINO COUNTY
YAVAPAI COUNTY
ANITA
TUSAYAN
Legend
N
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
*There is no assessed streams and lakes, no active management area within the watershed
0 1.5 3 6 9 12 15
Miles
ARIZONA

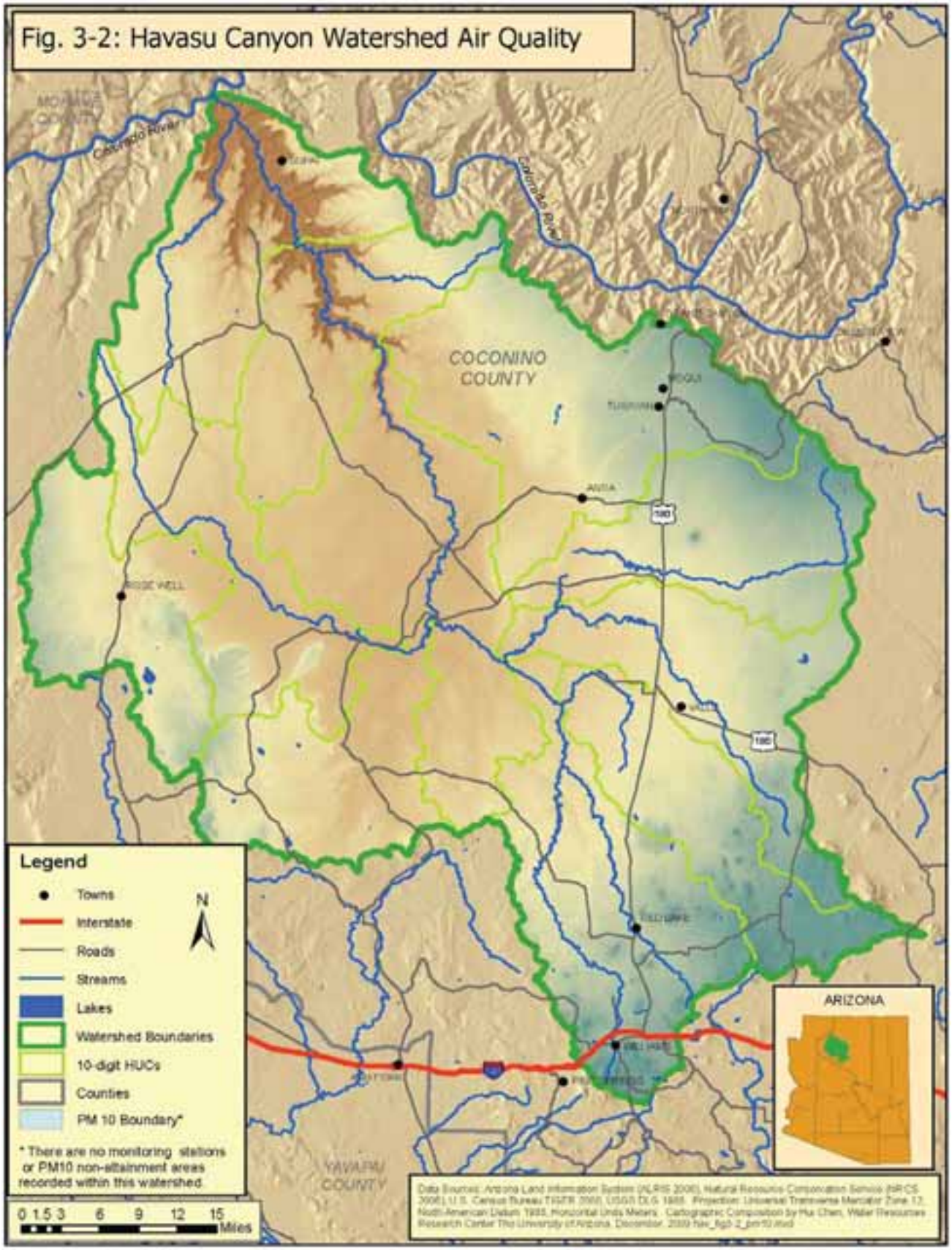


Fig. 3-2: Havasu Canyon Watershed Air Quality
COCONINO COUNTY
YAVAPAI COUNTY
Colorado River
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
PM 10 Boundary*
* There are no monitoring stations or PM10 non-attainment areas recorded within this watershed.
N
0 1.5 3 6 9 12 15
Miles
ARIZONA

Havasu Canyon Watershed (Figure 3-3).

Plant Condition

Plant condition is a resource concern whenever plants do not manufacture sufficient food to continue the growth cycle or to reproduce. Plant condition is a concern on rangelands and forest lands within the watershed as a result of the effects of prolonged drought and other factors.

Conservation practices applied to address this resource concern are generally those that maintain or improve the health, photosynthetic capability, rooting and reproductive capability of vegetation. Practices may include brush management, critical area planting, deferred grazing, fencing, prescribed grazing, prescribed burning, range planting, and wildlife upland habitat management.

Noxious and Invasive Plants

This concern relates to the invasion of unwanted and unproductive plant species. Pinyon and juniper encroachment, as well as increases in other invasive and noxious weeds, have decreased land productivity and exacerbated the wildfire danger on rangelands and forest lands within the watershed.

Noxious and invasive plants are a resource concern whenever these species cause unsuitable grazing conditions for livestock or wildlife and due to their potential to out-compete native species which are generally preferred for wildlife habitat value. Increases in noxious and invasive plants can result from drought and other causes.

Conservation practices applied to address this resource concern are generally those that control the establishment or reduce the population of noxious and invasive plant species. Practices may include brush management, deferred grazing, fencing, forest stand improvement, pest management, prescribed burning, prescribed grazing, and wildlife upland habitat management.

Drought and Wildfire

The desert Southwest, including Havasu Canyon Watershed, has been in an extended drought since 1996. Drought conditions continue to persist, leading to high vegetation stress, high fire potential, and deteriorating range conditions. The Climate Assessment for the Southwest (CLIMAS) website (www.climas.arizona.edu) and the Arizona Department of Water Resources website (www.azwater.gov/azdwr/StatewidePlanning/Drought) provide information on drought status.

Domestic Animal Concerns

Domestic animal concerns occur whenever the quantity and quality of food are not adequate to meet the nutritional requirements of animals, or adequate quantity and quality of water is not provided. This is a concern on rangelands within the watershed when changes in species composition resulting from drought and other factors reduce the availability of suitable forage.

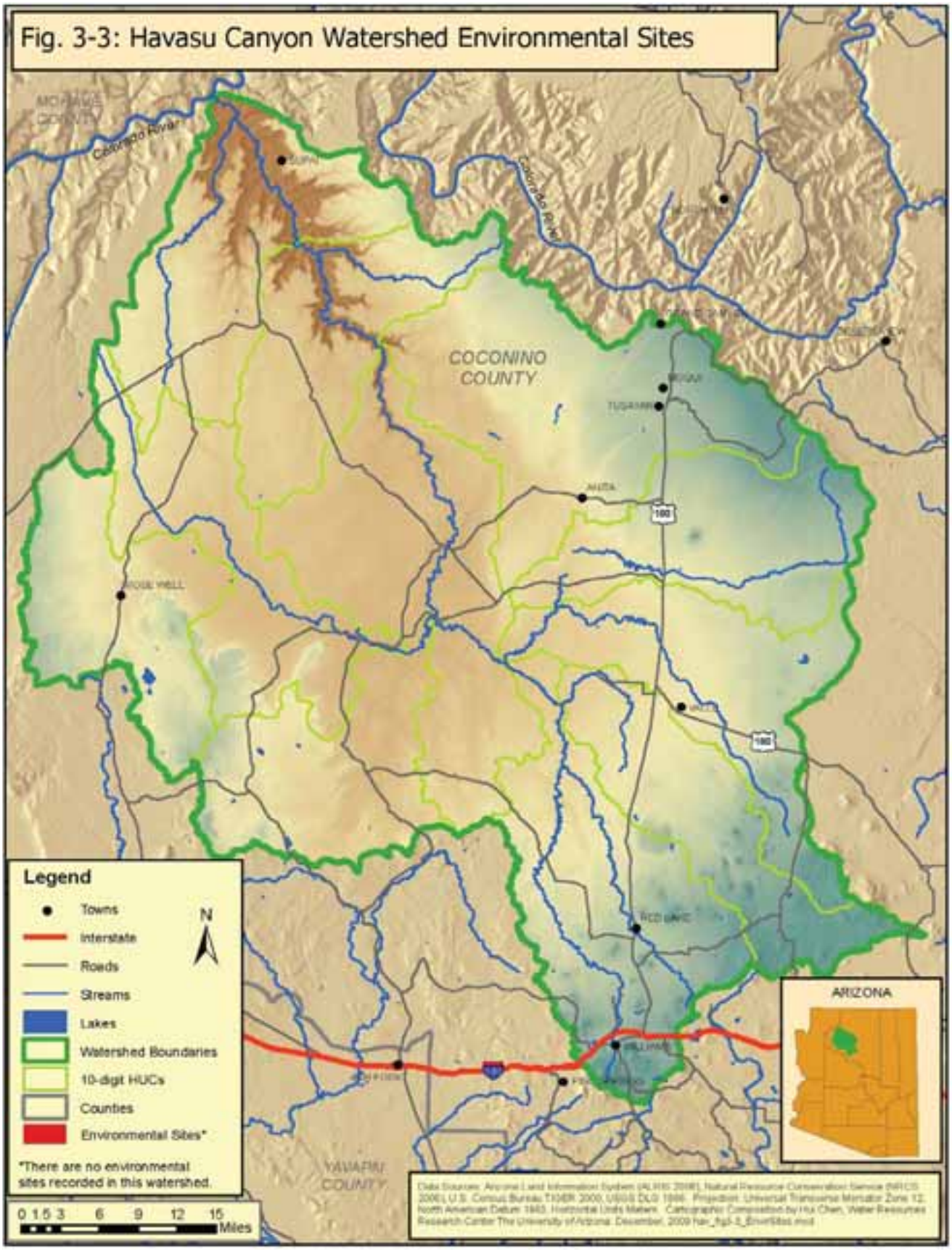


Fig. 3-3: Havasu Canyon Watershed Environmental Sites
COCONINO COUNTY
YAVAPAI COUNTY
Colorado River
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
Environmental Sites*
*There are no environmental sites recorded in this watershed.
N
0 1.5 3 6 9 12 15 Miles
ARIZONA

Conservation practices applied to address this resource concern are generally those that maintain or improve the quantity, quality, and diversity of forage available for animals, reduce the concentration of animals at existing water sources, and insure adequate quantity and reliability of water for the management of domestic animals. Practices may include brush management, deferred grazing, fencing, pest management, prescribed burning, prescribed grazing, pipelines, ponds, range planting, watering facility, and wildlife upland habitat management.

Species of Concern

In 1990 Arizona voters created the Heritage Fund, designating up to $10 million per year from lottery ticket sales for the conservation and protection of the state's wildlife and natural areas. The Heritage Fund allowed for the creation of the Heritage Data Management System (HDMS) which identifies elements of concern in Arizona and consolidates information about their status and distribution throughout the state. (Arizona Game & Fish website, 2010)

The Havasu Canyon Watershed contains 25 species of mammal, bird, plant, invertebrate or amphibian, that are listed as protected under the U.S. Endangered Species Act (ESA), or by BLM, USFS, or the State of Arizona (Table 3-2). The watershed contains two species, the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) and the Hualapai Mexican Vole (*Microtus mexicanus hualapaiensis*), that are ESA listed as in imminent jeopardy of extinction.

Table 3-2. Havasu Canyon Watershed Species of Concern and Endangered Species Classifications and Observations[(1)]

Common Name	Scientific Name	USEASA (2)	USFS (3)	BLM (4)	State (5)
Northern Goshawk	*Accipiter gentilis*	SC	S	S	WSC
Western Burrowing Owl	*Athene cunicularia hypugaea*	SC		S	
Ferruginous Hawk	*Buteo regalis*	SC		S	WSC
Swainson's Hawk	*Buteo swainsoni*			S	
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	LE	S		WSC
American Peregrine Falcon	*Falco peregrinus anatum*	SC	S	S	WSC
Bald Eagle	*Haliaeetus leucocephalus*	SC	S	S	WSC
Osprey	*Pandion haliaetus*			S	WSC
Mexican Spotted Owl	*Strix occidentalis lucida*	LT	S		WSC
Maricopa Tiger Beetle	*Cicindela oregona maricopa*	SC	S		
Spotted Bat	*Euderma maculatum*	SC		S	WSC
Arizona Myotis	*Myotis occultus*	SC			

Common Name	Scientific Name	USEASA (2)	USFS (3)	BLM (4)	State (5)
Hualapai Mexican Vole	*Microtus mexicanus hualapaiensis*	LE			WSC
Long-legged Myotis	*Myotis volans*	SC			
Ruby's Milk-vetch	*Astragalus rusbyi*		S		
Western Fairy Slipper	*Calypso bulbosa*				SR
Grand Canyon Evening-primrose	*Camissonia specuicola ssp. hesperia*	SC			
Tusayan Rabbitbrush	*Chrysothamnus molestus*	SC	S		
Arizona Bugbane	*Cimicifuga arizonica*	SC	S		HS
Clustered Barrel Cactus	*Echinocatus polycephalus var. polycephalus*				SR
Grand Canyon Cottontop Cactus	*Echinocactus polycephalus var. xeranthemoides*				SR
Fickeisen Plains Cactus	*Pediocactus peeblesianus var. fickeiseniae*	C	S		HS
Flagstaff Beardtongue	*Penstemon nudiflorus*		S		
Grand Canyon Rose	*Rosa stellata ssp. abyssa*	SC	S	S	SR
Tusayan Flame Flower	*Talinum validulum*	SC			SR

(1) Status definitions as listed by the Arizona Game and Fish Department, Heritage Database, March 8, 2010.
http://www.azgfd.gov/w_c/edits/species_concern.shtml.

(2) (USEA) Federal U.S. Status
ESA Endangered Species Act (1973 as amended)
US Department of Interior, Fish and Wildlife Service:
LE Listed Endangered: imminent jeopardy of extinction.
LT Listed Threatened: imminent jeopardy of becoming Endangered.

Candidate (Notice of Review: 2008):
C Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

SC Species of Concern. The terms "Species of Concern" or "Species at Risk" should be considered as terms-of-art that describe the entire realm of taxa whose conservation status may be of concern to the US Fish and Wildlife Service, but neither term has official status (currently all former C2 species).

(3) USFS US Forest Service (1999 Animals, 1999 Plants: corrected 2000)
US Department of Agriculture, Forest Service, Region 3
S Sensitive: those taxa occurring on National Forests in Arizona which are considered sensitive by the Regional Forester.

(4) BLM US Bureau of Land Management (2008 Animals, 2008 Plants)
US Department of Interior, BLM, Arizona State Office

S Sensitive: those taxa occurring on BLM Field Office Lands in Arizona which are considered sensitive by the Arizona State Office.

(5) State Status
NPL Arizona Native Plant Law (1993)
Arizona Department of Agriculture

HS Highly Safeguarded: no collection allowed.

SR Salvage Restricted: collection only with permit.

WSC Wildlife of Special Concern in Arizona. Species whose occurrence in Arizona is or may be in jeopardy, or with known or perceived threats or population declines, as described by the Arizona Game and Fish Department's listing of Wildlife of Special Concern in Arizona (WSCA, in prep).

Resource Concern Summary

The Coconino NRCD and other resource experts have identified priority resource concerns for this watershed. For the upland areas, the primary concern relates to maintaining and improving the condition and productivity of the land. This includes implementing conservation practices to protect soil from erosion and excessive runoff, improve the health of the vegetative communities, and enhance habitat for wildlife.

For the lower areas below the rim, the main concern relates to flooding and streambank erosion within the Village of Supai. To address these concerns, the Havasupai Tribe is implementing a "Plan to Reduce Harm from Hazards in the Havasu Baja." This includes installing gabions and other streambank protection measures, as well as measures to reduce the impact of periodic flooding on structures, trails and other infrastructure in the Village.

Perhaps the most notable resource in the Havasu Canyon Watershed is its scenic beauty. People from all over the world come to visit the famous falls known for their turquoise colored waters. There is a multitude of small travertine falls throughout Havasu Canyon, with the Havasu Falls being called one of the most beautiful and photographed waterfalls in the world.

Tourism is the main source of revenue for the Havasupai Tribe and a major source of employment in the area. The town receives on average 20,000 visitors per year. The Tribe offers a campground and a small lodge where visitors can rent rooms. The Tribe also operates a diner and general store.

Channel stability, maintaining desired flow, and flooding protection are all important concerns to sustain tourism and protect these national treasures.

The Havasu Canyon Watershed also has important wildlife resources to protect and conserve, including three federally listed species; the Mexican spotted owl (*Strix occidentalis lucida*), the Southwestern Willow Flycatcher (*Empidonax traillii extimus*), and the Hualapai Mexican Vole (*Microtus mexicanus hualapaiensis*).

Conservation Progress/Status

The mission of the Coconino NRCD states, in part, "To provide a means for people to work together for natural

resource conservation and development." Since its establishment in the 1940s, the District and its Cooperators have accomplished numerous conservation projects within the Havasu Canyon Watershed to address the identified priority resource concerns.

Over the years, ranchers within the watershed have taken an active role in implementing conservation projects designed to improve the health and productivity of the land, to enhance soil condition and water infiltration, and to restore wildlife habitat. This has included installing such conservation practices as fencing necessary for prescribed grazing. Water developments and brush management are other conservation practice commonly used to facilitate prescribed grazing and also for upland wildlife habitat management. Brush management primarily involves removing pinyon and juniper (PJ) trees in climax grassland vegetation communities.

Perrin Ranch, for example, has opened up the PJ overstory on an estimated 6,000+ acres within the watershed. This has been accomplished through fuel wood harvesting, along with burning and other methods of PJ removal. Babbitt Ranches has accomplished another estimated 6,000 acres of PJ treatment on the CO Bar Ranch. Other neighboring ranches have also completed PJ treatment, along with numerous other conservation practices, on several thousand acres within the watershed.

Many of these conservation projects have been accomplished by the ranchers on their own using private resources without benefit of any technical or financial assistance from the NRCS.

Conservation progress for the previous five years in the Havasu Canyon Watershed has focused on addressing the following primary resource concerns:

- ✓ Soil Erosion – Sheet and Rill
- ✓ Water Quantity – Excessive Runoff and Flooding
- ✓ Plant Condition – Productivity, Health and Vigor
- ✓ Fish and Wildlife – Inadequate Quantities and Quality of Feed and Water
- ✓ Domestic Animals – Inadequate Quantities and Quality of Feed and Water

The following table (Table 3-3) presents conservation accomplishments in this watershed during fiscal years (FY) 2005 through 2009, according to the NRCS Progress Reporting System. This listing represents only conservation practices completed with NRCS assistance. As stated above, ranchers within the watershed have accomplished much additional conservation work on their own.

Table 3-3: Havasu Canyon Watershed Conservation Treatment Applied

Havasu Canyon Watershed (15010004) Conservation Treatment Applied	FY05-09 TOTAL
Brush Management (code 314) (acres)	464
Fence (code 382) (feet)	24,135
Pipeline (code 516) (feet)	60,683
Prescribed Grazing (code 528) (acres)	69,492
Upland Wildlife Habitat Management (code 645) (acres)	17,391

Section 4: Census, Social and Agricultural Data

This section discusses the human component of the watershed and the pressure on natural resources caused by humans and by population change.

Population Density, 1990

Census block statistics for 1990 were compiled from information prepared by Geo-Lytics (Geo-Lytics, 1998). These data were linked with census block data and used to create a density map (Figure 4-1) through a normalization process using a grid of 7 km squares. This process involves calculating density per census block and intersecting it with the grid, which is then used to calculate the number of people and thus density per grid square.

Table 4-1 shows the tabulated minimum, maximum and mean number of people per square mile in 1990 for each watershed. In 1990, the mean population density for the entire watershed was about 2 people per square mile. Cataract Creek, which contains the City of Williams, had the highest population mean with 8 people per square mile, and a maximum of 1,062 people per square mile. Middle Havasu Creek Watershed had the lowest density with a mean of only about 0.004 people per square mile.

Population Density, 2000

The Census Block 2000 statistics data were downloaded from the Environmental Systems Research Institute (ESRI) website (ESRI Data Products, 2003) and are shown in Table 4-2.

A population density map (Figure 4-2) was created from these data. The mean population density in 2000 was 2 people per square mile. Cataract Creek and Heather Wash had the highest mean population density with 10 and 5 people per square mile, respectively. Cataract Creek had the highest maximum density of 1,166 people per square mile.

Population Density Change, 1990-2000

The 1990 and 2000 population density maps were used to create a population density change map. The resulting map and table (Figure 4-3 and Table 4-3) show population increase or decrease over the ten year time frame. Overall, mean population density increased by about 0.4 people per square mile during this ten-year time period. Cataract Creek had the largest increase in mean population at 2. Three watersheds had decreases in mean population density.

Housing Density, 2000 and 2030

The Watershed Housing Density Map for the years 2000 and 2030 were created with data developed by David M. Theobald (Theobald, 2005). Theobald developed a nationwide housing density model that incorporates a thorough way to account for land-use change beyond the “urban fringe.”

Exurban regions are the “urban fringe”, or areas outside suburban areas, having population densities greater than 0.68 – 16.18 ha (1.68 – 40 acres) per unit. Theobald stresses that exurban areas are increasing at a much faster rate than urban sprawl, are consuming much more land, and are having a greater impact on ecological health, habitat

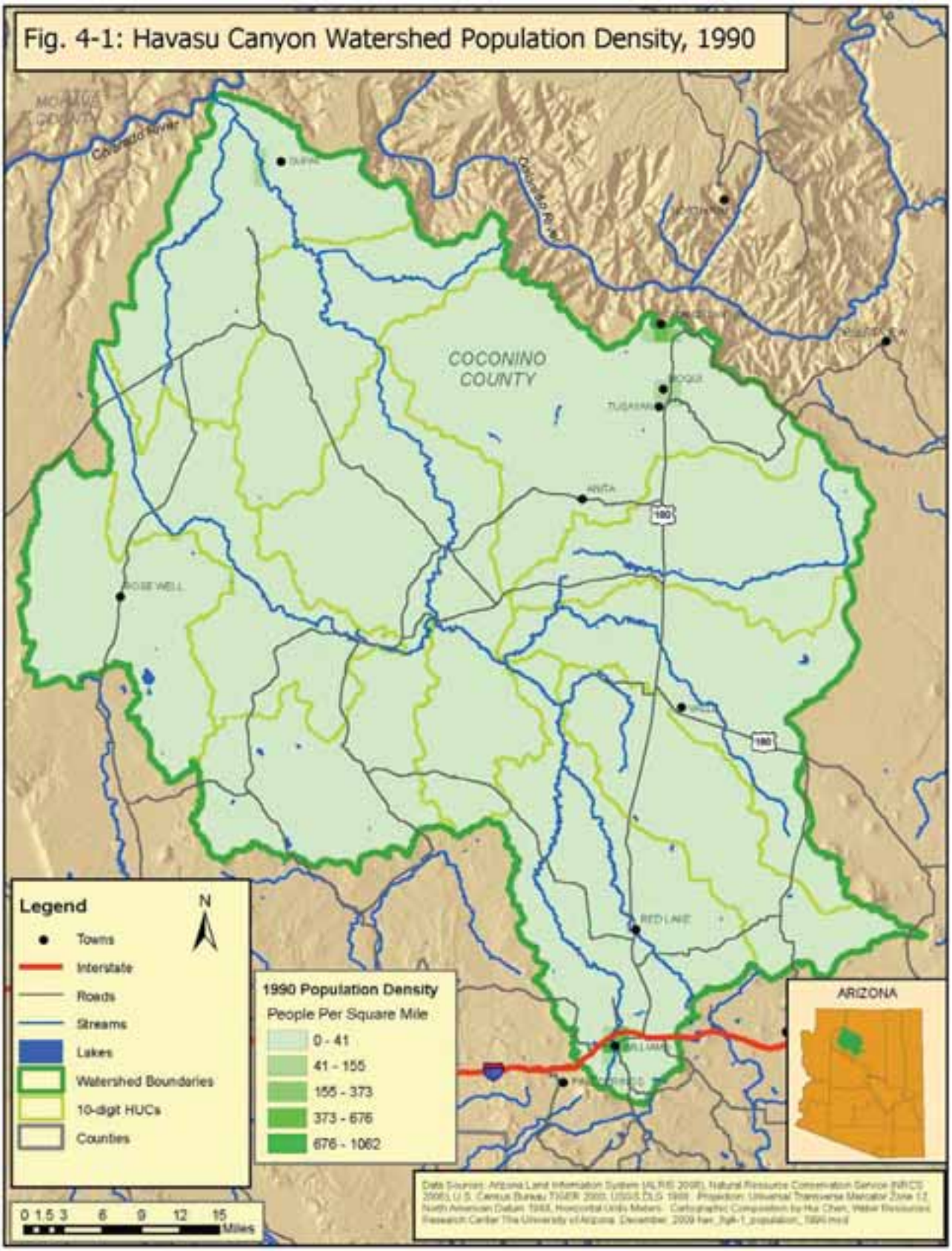


Fig. 4-1: Havasu Canyon Watershed Population Density, 1990
COCONINO COUNTY
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
N
1990 Population Density
People Per Square Mile
0 - 41
41 - 155
155 - 373
373 - 676
676 - 1062
ARIZONA
0 1.5 3 6 9 12 15
Miles

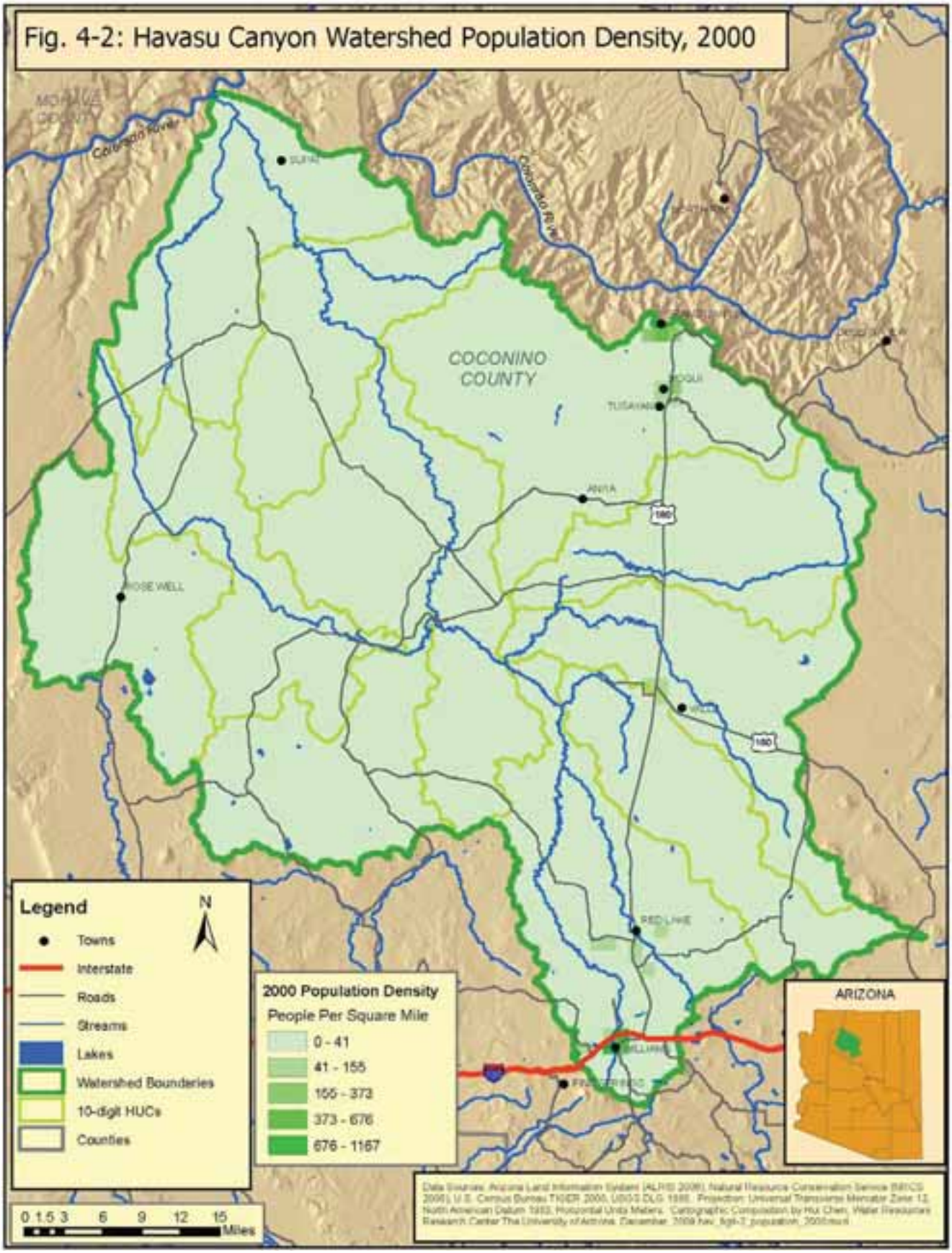


Fig. 4-2: Havasu Canyon Watershed Population Density, 2000
COCONINO COUNTY
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
N
2000 Population Density
People Per Square Mile
0 - 41
41 - 155
155 - 373
373 - 676
676 - 1167
ARIZONA
0 1.5 3 6 9 12 15
Miles

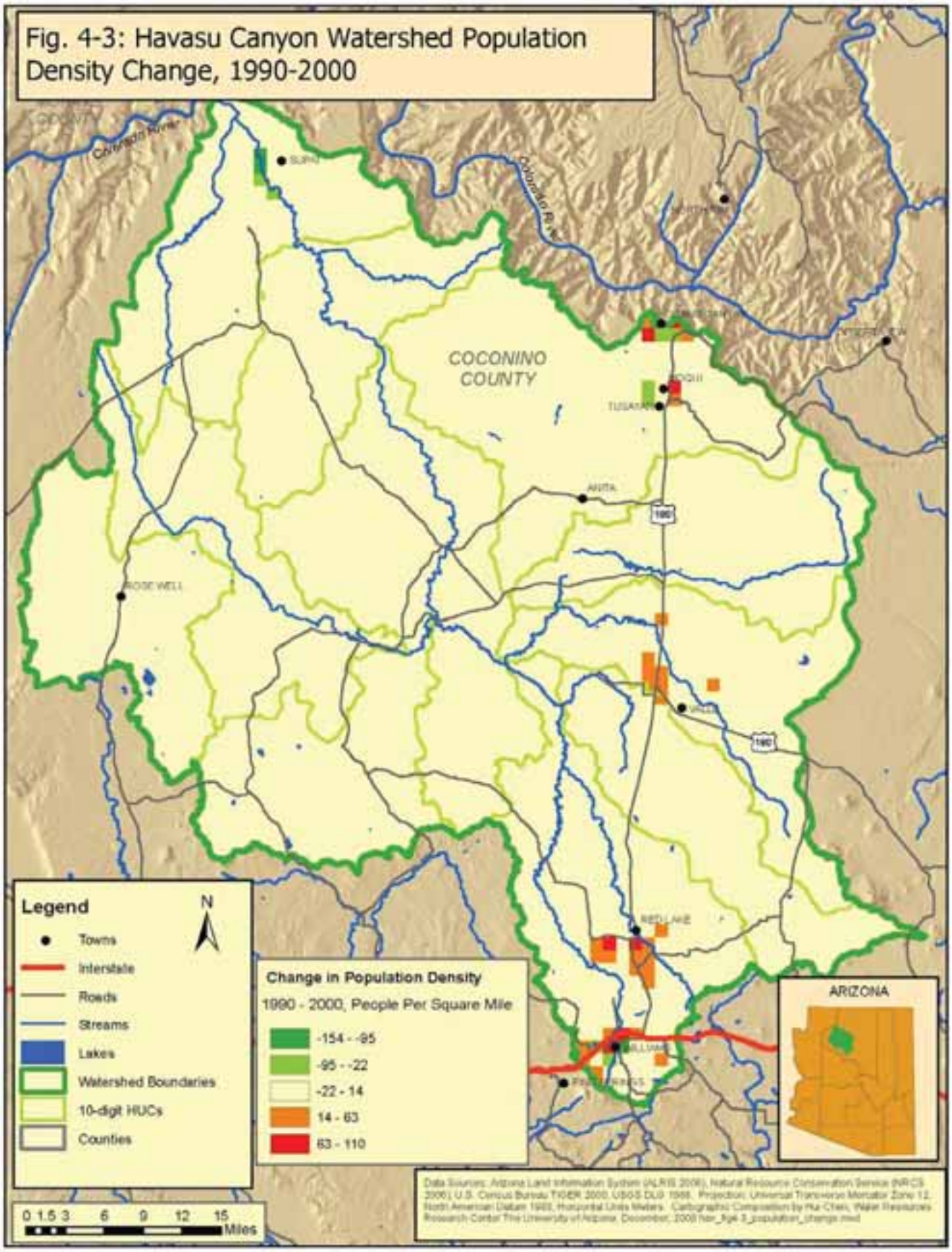


Fig. 4-3: Havasu Canyon Watershed Population Density Change, 1990-2000
COCONINO COUNTY
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
N
Change in Population Density
1990 - 2000, People Per Square Mile
-154 - -95
-95 - -22
-22 - 14
14 - 63
63 - 110
ARIZONA
0 1.5 3 6 9 12 15
Miles

fragmentation and other resource concerns.

Theobald estimates that the exurban density class has increased at a much faster rate than the urban/suburban density classes. Theobald's model forecasts that this trend will continue and may even accelerate by 2030. This indicates that development patterns are shifting more towards exurban, lower density, housing units, and are thereby consuming more land. He suggests that exurban development has more overall effect on natural resources because of the larger footprint and disturbance zone, a higher percent of impervious surfaces, and higher pollution because of more vehicle miles traveled to work and shopping.

Figure 4-4 and Table 4-4, Havasu Canyon Watershed Housing Density for 2000, identifies that about 63% of housing is located in "rural" areas, while about 35% is located in "undeveloped private" areas. Figure 4-5 and Table 4-5, Havasu Canyon Watershed Housing Density for 2030, projects "rural" areas remaining the same at 63% and "undeveloped private" areas being reduced to 34%.

Table 4-1: Havasu Canyon Watershed 1990 Population Density (people/square mile)

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Rodgers Draw-Farm Dam Tank-1501000401	218	0	2	0.02
Spring Valley Wash-1501000402	205	0	13	0.4
Red Horse Wash-1501000403	239	0	6	0.04
Miller Wash-1501000404	251	0	31	0.4
Cataract Creek-1501000405	326	0	1,062	8
Sandstone Wash-1501000406	243	0	0.6	0.01
Monument Wash-1501000407	216	0	1	0.02
Heather Wash-1501000408	381	0	676	5
Upper Havasu Creek-1501000409	357	0	0.04	0.005
Middle Havasu Creek-1501000410	220	0	0.01	0.004
Lower Havasu Creek-1501000411	277	0	155	1
Havasu Canyon Watershed	2933	0	1,062	2

Note: Adjacent watersheds may share a grid square. Data Sources: Census block statistics for 1990 were compiled from a CD prepared by Geo-Lytics (GeoLytics, Inc.1998. Census 1990. Census CD + Maps. Release 3.0

Table 4-2: Havasu Canyon Watershed 2000 Population Density (people/square mile)

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Rodgers Draw-Farm Dam Tank-1501000401	218	0	0.3	0.02
Spring Valley Wash-1501000402	205	0	45	1
Red Horse Wash-1501000403	239	0	10	0.1
Miller Wash-1501000404	251	0	67	2
Cataract Creek-1501000405	326	0	1,166	10
Sandstone Wash-1501000406	243	0	0.09	0.007
Monument Wash-1501000407	216	0	3.0	0.03
Heather Wash-1501000408	381	0	645	5
Upper Havasu Creek-1501000409	357	0	2	0.02
Middle Havasu Creek-1501000410	220	0	2	0.6
Lower Havasu Creek-1501000411	277	0	2	1
Havasu Canyon Watershed	2933	0	1,166	2

Note: Adjacent watersheds may share a grid square. Data Sources: Census block statistics for 2000 were compiled from a CD prepared by Geo-Lytics (GeoLytics, Inc.1998. Census 2000. Census CD + Maps. Release 3.0).

Table 4-3: Havasu Canyon Watershed Population Density Change 1990 – 2000 (people/square mile)

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Rodgers Draw-Farm Dam Tank-1501000401	218	-2	0.3	-0.0007
Spring Valley Wash-1501000402	205	-7	41	0.7
Red Horse Wash-1501000403	239	-1	10	0.06
Miller Wash-1501000404	251	-2	41	1
Cataract Creek-1501000405	326	-95	107	2
Sandstone Wash-1501000406	243	-0.6	0.09	-0.006
Monument Wash-1501000407	216	-1	3	0.01
Heather Wash-1501000408	381	-122	110	0.06
Upper Havasu Creek-1501000409	357	-0.04	2	0.02
Middle Havasu Creek-1501000410	220	-0.02	2	0.6

10-digit Watershed Name	Area (sq. miles)	Population Density (people/sq.mi.)		
		Min	Max	Mean
Lower Havasu Creek-1501000411	277	-154	2	-0.3
Havasu Canyon Watershed	2933	-154	110	0.4

Note: Adjacent watersheds may share a grid square. Data Sources: Derived from data from the GIS data used for tables 4-1 and 4-2.

Table 4-4: Havasu Canyon Watershed Housing Density 2000 (Percent of Watershed)

10-digit Watershed Name	Housing Density				
	Undeveloped Private	Rural	Exurban	Suburban	Urban
Rodgers Draw-Farm Dam Tank-1501000401	100%	0	0	0	0
Spring Valley Wash-1501000402	31%	50%	19%	0.07%	0
Red Horse Wash-1501000403	67%	27%	5%	0	0
Miller Wash-1501000404	10%	90%	0	0	0
Cataract Creek-1501000405	29%	29%	39%	1%	2%
Sandstone Wash-1501000406	100%	0	0	0	0
Monument Wash-1501000407	71%	29%	0	0	0
Heather Wash-1501000408	32%	66%	2%	0.03%	0.4%
Upper Havasu Creek-1501000409	67%	33%	0	0	0
Middle Havasu Creek-1501000410	23%	77%	0	0	0
Lower Havasu Creek-1501000411	11%	89%	0	0	0
Havasu Canyon Watershed	35%	63%	2%	0.05%	0.1%
Havasu Canyon Watershed (sq.mi.)	1027	1842	59	1	4

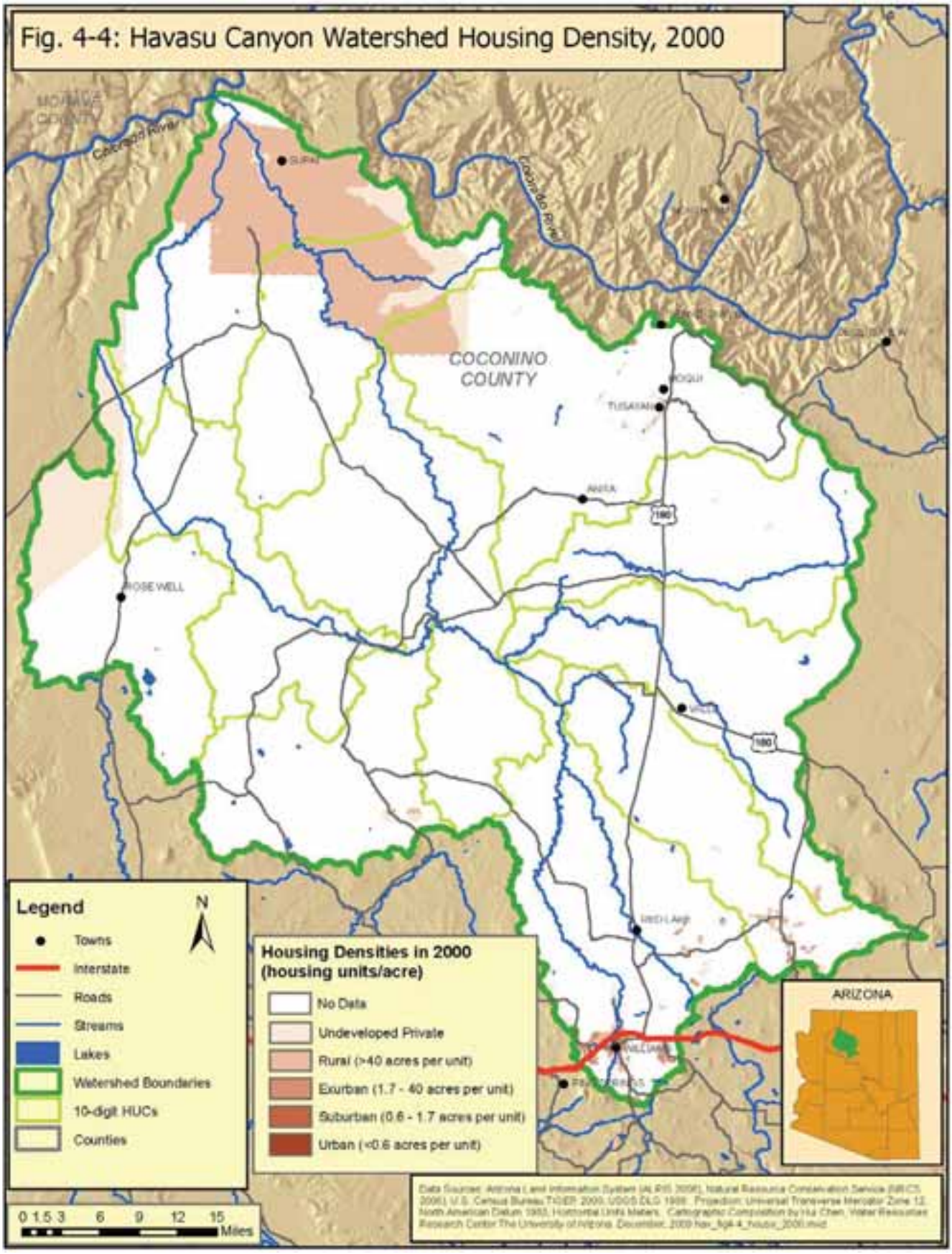


Fig. 4-4: Havasu Canyon Watershed Housing Density, 2000
COCONINO COUNTY
Colorado River
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
N
Housing Densities in 2000 (housing units/acre)
No Data
Undeveloped Private
Rural (>40 acres per unit)
Exurban (1.7 - 40 acres per unit)
Suburban (0.6 - 1.7 acres per unit)
Urban (<0.6 acres per unit)
ARIZONA
0 1.5 3 6 9 12 15
Miles

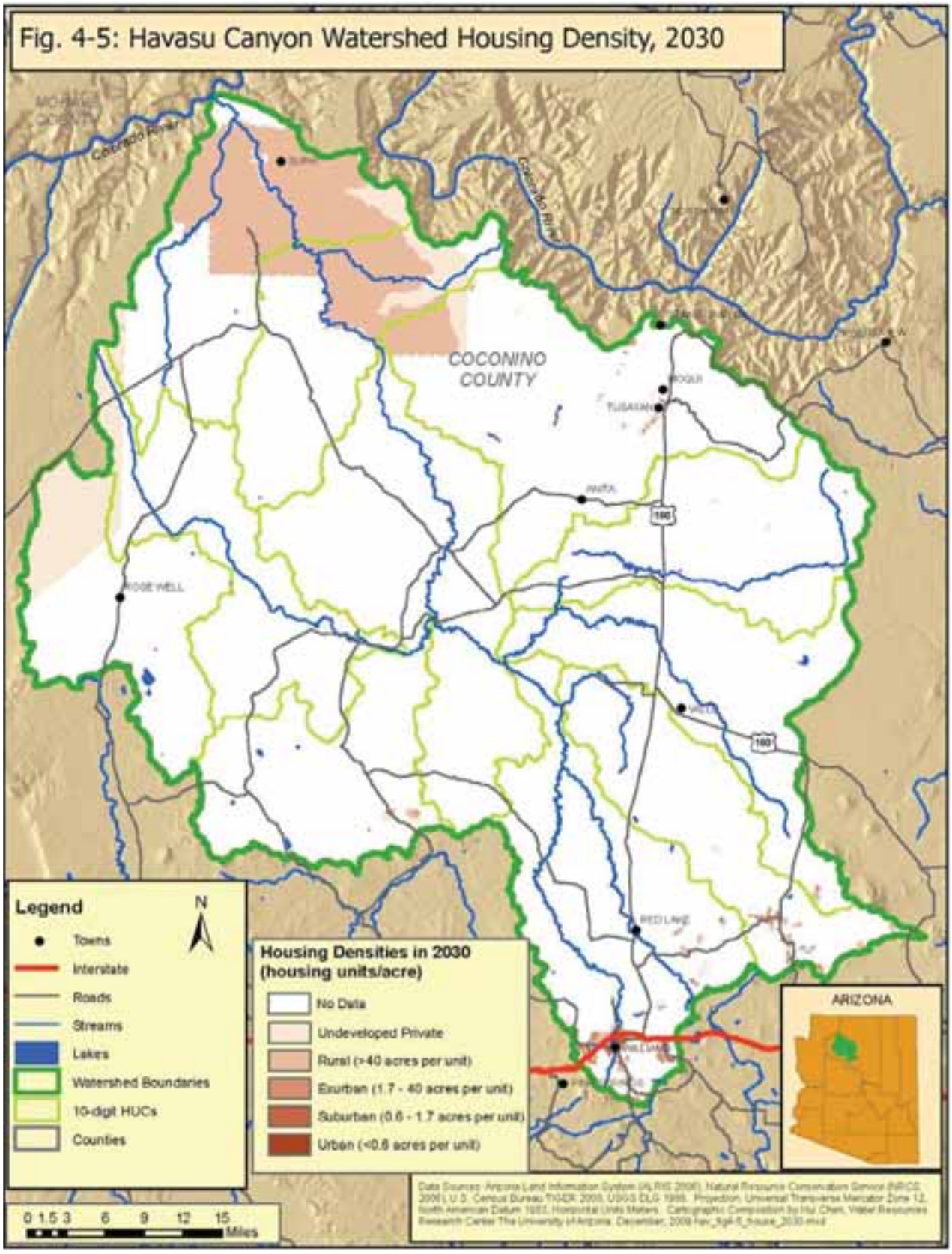


Fig. 4-5: Havasu Canyon Watershed Housing Density, 2030
COCONINO COUNTY
Legend
Towns
Interstate
Roads
Streams
Lakes
Watershed Boundaries
10-digit HUCs
Counties
N
Housing Densities in 2030 (housing units/acre)
No Data
Undeveloped Private
Rural (>40 acres per unit)
Exurban (1.7 - 40 acres per unit)
Suburban (0.6 - 1.7 acres per unit)
Urban (<0.6 acres per unit)
ARIZONA
0 1.5 3 6 9 12 15
Miles

Table 4-5: Havasu Canyon Watershed Housing Density 2030 (Percent of Watershed)

10-digit Watershed Name	Housing Density				
	Undeveloped Private	Rural	Exurban	Suburban	Urban
Rodgers Draw-Farm Dam Tank-1501000401	100%	0	0	0	0
Spring Valley Wash-1501000402	14%	41%	45%	0.07%	0
Red Horse Wash-1501000403	57%	38%	5%	0	0
Miller Wash-1501000404	10%	73%	17%	0	0
Cataract Creek-1501000405	23%	30%	39%	6%	3%
Sandstone Wash-1501000406	100%	0	0	0	0
Monument Wash-1501000407	53%	36%	11%	0	0
Heather Wash-1501000408	30%	68%	2%	0.04%	0.4%
Upper Havasu Creek-1501000409	67%	33%	0	0	0
Middle Havasu Creek-1501000410	23%	77%	0	0	0
Lower Havasu Creek-1501000411	11%	89%	0.01%	0	0
Havasu Canyon Watershed	34%	63%	3%	0.3%	0.1%
Havasu Canyon Watershed (sq.mi.)	1002	1845	74	7	4

Havasu Canyon Watershed Agricultural Statistics

Arizona is known as one of the most productive and efficient agricultural regions in the world, with beauty that also provides the food and fiber to sustain life in the desert. Arizona is also one of the most diverse agricultural producing states in the nation, producing more than 160 varieties of vegetables, livestock, field crops and nursery stock. The climate, natural resources, agribusiness infrastructure and farm heritage help make agriculture a $9.2 billion dollar industry employing more than 72,000 individuals.

According to the United States Department of Agriculture's 2007 Census, most farms in the Havasu Canyon Wash Watershed are relatively small family farms located in the Village of Supai. Ninety-six percent of all farms in the watershed are less than 1,000 acres in size, and 84% are less than 50 acres (Table 4-6 and Figure 4-6). Of the 34 farms that have pasture and rangeland, 26 have 100 or more acres (Table 4-7 and Figure 4-7). There are 24 current grazing leases in the Havasu Canyon watershed (Arizona Department of Agriculture, 2010). Of the 27 farms that harvest crops, 100% are 49 acres or less in size (Table 4-8 and Figure 4-8).

The NASS (National Agricultural Statistics Service, United States Department of Agriculture) has farm data by zip code. We used the U.S. Census Bureau ZIP Census Tabulation Areas (ZCTA) to generate zip code maps of the watershed. A typical 5-digit ZCTA (there are 3-digit ZCTAs as well) is typically nearly identical to a 5-digit U.S. Postal Service ZIP code, but there are some distinctions. Unlike ZIP codes, ZCTA areas are spatially complete and they are easier to map. The Bureau created special `XX ZCTAs (ZCTAs with a valid 3-digit ZIP but with "XX" as last two characters of the code) which represent large unpopulated areas where it made no sense to assign a census block to an actual ZIP code. Similarly, HH ZCTAs represent large bodies of water within a 3-digit zip area. There is typically no population in either an XX or HH ZCTA.

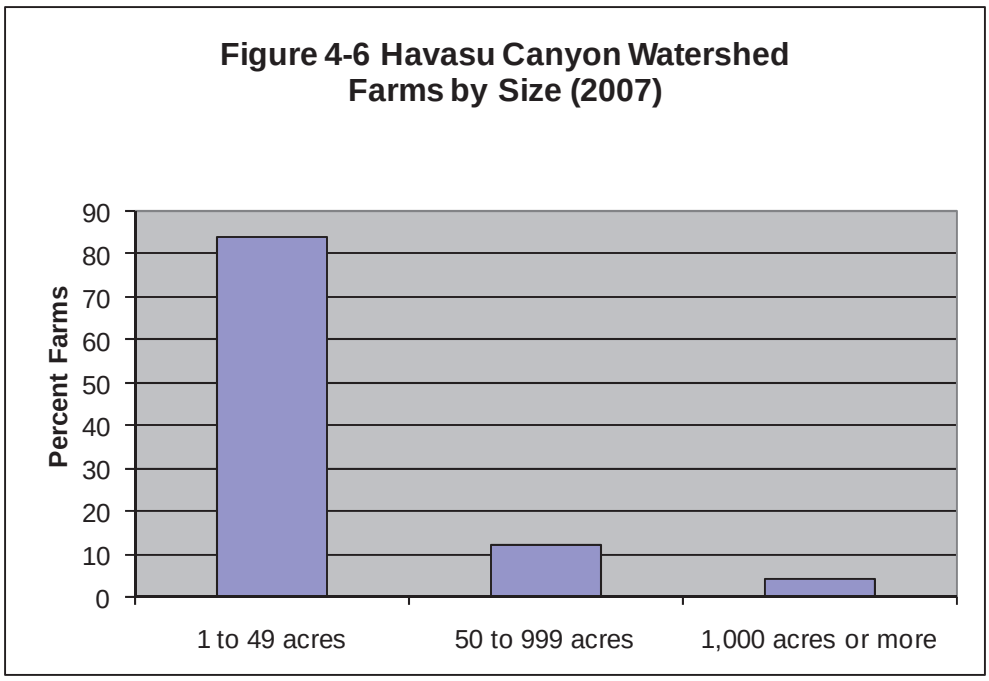
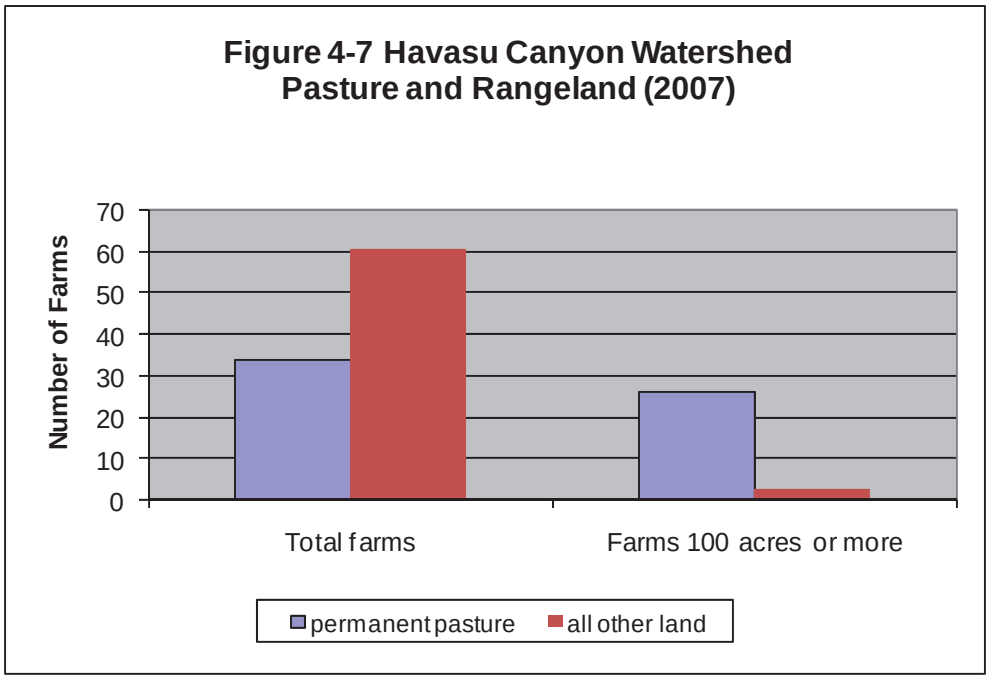


Table 4-6: Havasu Canyon Watershed Farms by Size (2007)

All farms	1 to 49 acres	50 to 999 acres	>1000 acres
111	84%	12%	4%

NASS defines a "farm" as an operation with at least $1000 in agricultural sales from agriculture. Percents rounded. Data source: NASS (National Agricultural Statistics Service, United States Department of Agriculture)



Category	Total farms	Farms 100 acres or more
Permanent pasture and rangeland	34	26
All other land	61	3

Grazing lands are the USDA Pastureland, as defined by NASS, includes cropland used only for pasture or grazing, woodland pastured, and other pastureland and rangeland.
Percents rounded. Data source: NASS (National Agricultural Statistics Service, United States Department of Agriculture)

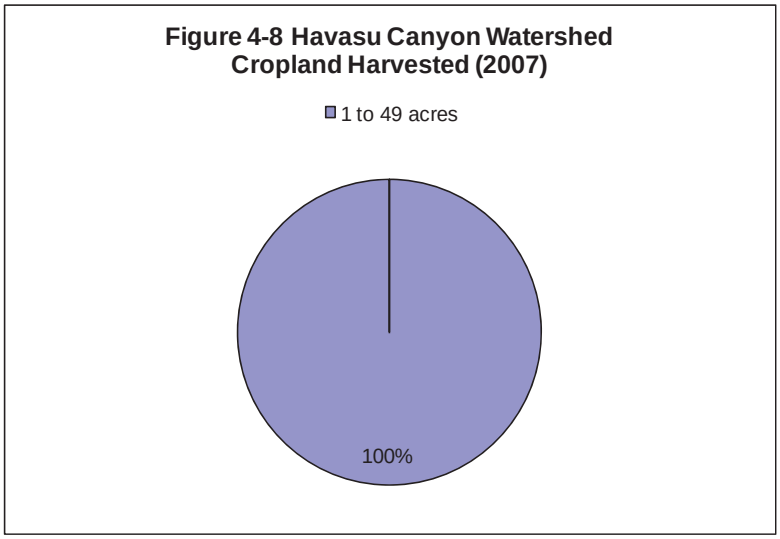


Table 4-8: Havasu Canyon Watershed Cropland Harvested (2007)

Total farms	1 to 49 acres	50 to 499 acres	>500 acres
27	100%	0%	0%

According to the NASS, "harvested cropland" includes all land from which crops were harvested, including: cut hay; all land in orchards; citrus groves; and, nursery and greenhouse crops. Land from which two or more crops were harvested was counted only once even though there was more than one use of that land. Percents rounded. Data source: NASS (National Agricultural Statistics Service, United States Department of Agriculture).

Section 5: Resource Assessment Tables

The following Resource Assessment Tables summarize current and desired future natural resource conditions for the Havasu Canyon Watershed. The tables present information on benchmark and future conservation systems and practices, qualitative effects on primary resource concerns, and estimated costs for conservation implementation. Conservation District board members, NRCS conservationists, and other people familiar with conservation work in the watershed were consulted for estimating current and future natural resource conditions.

The tables show three levels of conservation treatment (Baseline, Progressive, Resource Management System) for the major land use within the watershed (range). **Baseline** is defined as a low level of conservation adoption with landowners who are typically not participating in conservation programs. There may be, however, a few practices that have been commonly adopted by all landowners in this watershed. **Progressive** is defined as an intermediate level of conservation adoption with landowners who are actively participating in conservation programs and have adopted several practices but not satisfying all of the Quality Criteria in the NRCS Field Office Technical Guide. **Resource Management System** (RMS) is defined as a complete system of conservation practices that addresses all of the Soil, Water, Air, Plant, and Animal (SWAPA) resource concerns typically seen for this land use in this watershed.

The results of the assessment are presented in two parts. Part 1 (Assessment Information) summarizes the conservation practices at each treatment level and the quantities of practices for current benchmark conditions and projected future conditions. Part 1 also displays the four primary resource concerns, along with individual practice effects and an overall Systems Rating (ranging from a low of 1 to a high of 5) indicating the effectiveness of the conservation system used at each treatment level. Part 2 (Conservation Cost Table) summarizes the installation, management, and related costs by conservation practice and treatment level for the projected future conditions by federal and private share of the costs. Part 2 also displays the benchmark and future conservation conditions status bars.

Credit goes to NRCS in Oregon for development of the template for these Resource Assessment Tables.

WATERSHED NAME & CODE	HAVASU CANYON - 15010004				LANDUSE ACRES	1,258,000		
LANDUSE TYPE	RANGE				TYPICAL UNIT SIZE ACRES	50,000		
ASSESSMENT INFORMATION					CALCULATED PARTICIPATION	20%		
	Benchmark Conditions	Future Conditions			RESOURCE CONCERNS			
Conservation Systems by Treatment Level	Total Units	Existing Unchanged Units	New Treatment Units	Total Units	Soil Erosion – Streambank	Water Quantity – Excessive Runoff, Flooding, or Ponding	Plant Condition – Productivity, Health and Vigor	Domestic Animals – Inadequate Quantities and Quality of Feed and Forage
Baseline				**System Rating ->**	**0**	**0**	**0**	**0**
No Conservation Practices being applied at this level	0	0	0	0	0	0	0	0
Total Acreage at Baseline	**629,000**	**503,200**	**0**	**503,200**				
Progressive				**System Rating ->**	**0**	**0**	**0**	**0**
Fence (ft.) 382	33,211	26,569	6,642	33,211	1	1	1	1
Pipeline (ft.) 516	33,211	26,569	6,642	33,211	1	1	1	1
Total Acreage at Progressive Level	**314,500**	**251,600**	**62,900**	**314,500**				
RMS				**System Rating ->**	**3**	**3**	**4**	**4**
Brush Management (ac.) 314	15,725	15,725	6,290	22,015	1	1	3	3
Fence (ft.) 382	166,056	172,698	59,780	232,478	1	1	1	1
Pipeline (ft.) 516	166,056	172,698	59,780	232,478	1	1	1	1
Prescribed Grazing (ac.) 528	314,500	314,500	125,800	440,300	3	3	5	5
Upland Wildlife Habitat Management (ac.) 645	15,725	15,725	6,290	22,015	3	3	5	1
Total Acreage at RMS Level	**314,500**	**314,500**	**125,800**	**440,300**				

WATERSHED NAME & CODE	HAVASU CANYON - 15010004	LANDUSE ACRES	1,258,000
LANDUSE TYPE	RANGE	TYPICAL UNIT SIZE ACRES	50,000
CONSERVATION COST TABLE		CALCULATED PARTICIPATION	20%

Conservation Systems by Treatment Level	FUTURE	FEDERAL				PRIVATE		
	New Treatment Units	Installation Cost 50%	Management Cost - 3 yrs 100%	Technical Assistance 20%	Total Present Value Cost	Installation Cost 50%	Annual O & M + Mgt Costs 100%	Total Present Value Cost
Progressive								
Fence (ft.) 382	6,642	$9,963	$0	$1,993	$11,956	$9,963	$399	$11,689
Pipeline (ft.) 516	6,642	$26,569	$0	$5,314	$31,883	$26,569	$1,063	$31,170
Subtotal	**62,900**	**$36,532**	**$0**	**$7,306**	**$43,839**	**$36,532**	**$1,461**	**$42,859**
RMS								
Brush Management (ac.) 314	6,290	$377,400	$0	$75,480	$452,880	$377,400	$7,548	$410,079
Fence (ft.) 382	59,780	$89,670	$0	$17,934	$107,604	$89,670	$3,587	$105,199
Pipeline (ft.) 516	59,780	$239,121	$0	$47,824	$286,945	$239,121	$9,565	$280,531
Prescribed Grazing (ac.) 528	125,800	$94,350	$0	$18,870	$113,220	$94,350	$0	$94,350
Upland Wildlife Habitat Management (ac.) 645	6,290	$0	$24,531	$4,906	$27,174	$0	$8,177	$13,134
Subtotal	**125,800**	**$800,541**	**$24,531**	**$165,014**	**$987,823**	**$800,541**	**$28,877**	**$903,294**
Grand Total	**188,700**	**$837,073**	**$24,531**	**$172,321**	**$1,031,662**	**$837,073**	**$30,338**	**$946,153**

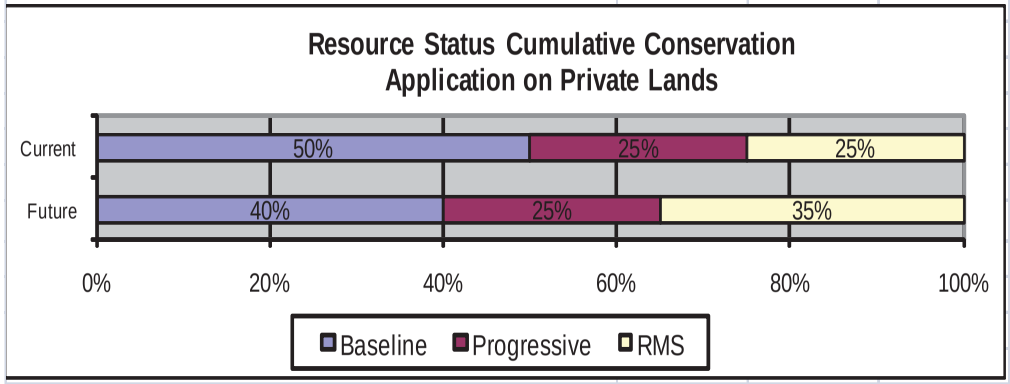


Chart Refers To	
Landuse Type	RANGE
Calculated Participation Rate	20%

Average PV Costs per Ac		
System	Federal	Private
Prog	$0.70	$0.68
RMS	$7.85	$7.18

WATERSHED NAME & CODE	HAVASU CANYON - 15010004				LANDUSE ACRES	807,000		
LANDUSE TYPE	FOREST				TYPICAL UNIT SIZE ACRES	50,000		
ASSESSMENT INFORMATION					CALCULATED PARTICIPATION	20%		
	Benchmark Conditions	Future Conditions			RESOURCE CONCERNS			
Conservation Systems by Treatment Level	Total Units	Existing Unchanged Units	New Treatment Units	Total Units	Soil Erosion – Sheet and Rill	Plant Condition – Productivity, Health and Vigor	Fish and Wildlife – Inadequate Food	Domestic Animals – Inadequate Quantities and Quality of Feed and Forage
Baseline			**System Rating ->**		**0**	**0**	**0**	**0**
No Conservation Practices being applied at this level	0	0	0	0	0	0	0	0
Total Acreage at Baseline	**403,500**	**322,800**	**0**	**322,800**				
Progressive			**System Rating ->**		**0**	**0**	**0**	**0**
Fence (ft.) 382	21,305	17,044	4,261	21,305	1	1	1	1
Pipeline (ft.) 516	21,305	17,044	4,261	21,305	1	1	1	1
Total Acreage at Progressive Level	**201,750**	**161,400**	**40,350**	**201,750**				
RMS			**System Rating ->**		**4**	**4**	**3**	**3**
Fence (ft.) 382	106,524	110,785	38,349	149,134	1	1	1	1
Pipeline (ft.) 516	106,524	110,785	38,349	149,134	1	1	1	1
Prescribed Grazing (ac.) 528	201,750	201,750	80,700	282,450	5	5	1	5
Upland Wildlife Habitat Management (ac.) 645	10,088	10,088	4,035	14,123	5	5	5	1
Total Acreage at RMS Level	**201,750**	**201,750**	**80,700**	**282,450**				

WATERSHED NAME & CODE	HAVASU CANYON - 15010004	LANDUSE ACRES	807,000
LANDUSE TYPE	FOREST	TYPICAL UNIT SIZE ACRES	50,000
CONSERVATION COST TABLE		CALCULATED PARTICIPATION	20%

	FUTURE	FEDERAL				PRIVATE		
Conservation Systems by Treatment Level	New Treatment Units	Installation Cost 50%	Management Cost - 3 yrs 100%	Technical Assistance 20%	Total Present Value Cost	Installation Cost 50%	Annual O & M + Mgt Costs 100%	Total Present Value Cost
Progressive								
Fence (ft.) 382	4,261	$6,391	$0	$1,278	$7,670	$6,391	$256	$7,498
Pipeline (ft.) 516	4,261	$17,044	$0	$3,409	$20,453	$17,044	$682	$19,995
Subtotal	**40,350**	**$23,435**	**$0**	**$4,687**	**$28,122**	**$23,435**	**$937**	**$27,494**
RMS								
Fence (ft.) 382	38,349	$57,523	$0	$11,505	$69,028	$57,523	$2,301	$67,485
Pipeline (ft.) 516	38,349	$153,395	$0	$30,679	$184,073	$153,395	$6,136	$179,959
Prescribed Grazing (ac.) 528	80,700	$60,525	$0	$12,105	$72,630	$60,525	$0	$60,525
Upland Wildlife Habitat Management (ac.) 645	4,035	$0	$15,737	$3,147	$17,432	$0	$5,246	$8,425
Subtotal	**80,700**	**$271,443**	**$15,737**	**$57,436**	**$343,163**	**$271,443**	**$13,682**	**$316,394**
Grand Total	**121,050**	**$294,878**	**$15,737**	**$62,123**	**$371,285**	**$294,878**	**$14,620**	**$343,888**

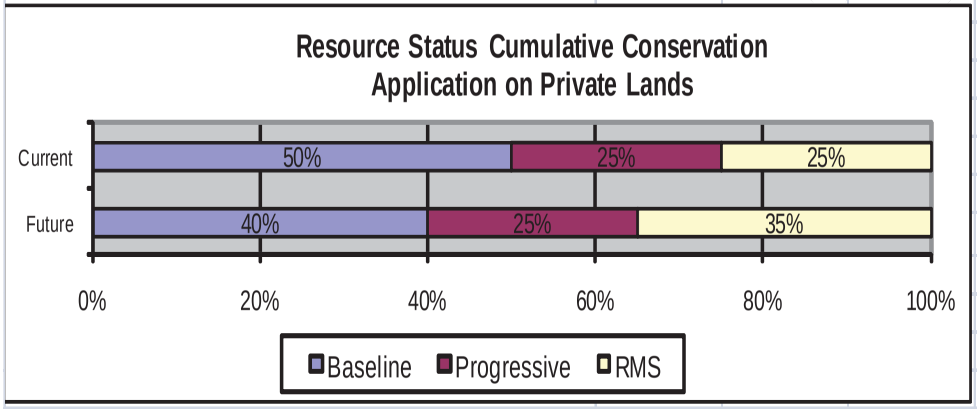


Chart Refers To	
Landuse Type	FOREST
Calculated Participation Rate	20%

Average PV Costs per Ac		
System	Federal	Private
Prog	$0.70	$0.68
RMS	$4.25	$3.92

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GLOSSARY

Drainage Basin	A region or area bounded by a topographic divide and occupied by a drainage system, also known as a watershed.
Drought	There is no universally accepted quantitative definition of drought. Generally, the term is applied to periods of less than average precipitation over a certain period of time; nature's failure to fulfill the water wants and needs of man.
Flood	A flood is an overflow or inundation that comes from a river or other body of water and causes or threatens damage. It can be any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. It is also a relatively high flow as measured by either gage height or discharge quantity.
Ground Water	The supply of fresh and saline water found beneath the Earth's surface which is often used for supplying wells and springs. Because ground water is a major source of drinking water, there is a growing concern over areas where leaching agricultural or industrial pollutants are contaminating ground water.
Soil Moisture Regimes	**Aridic** is a soil moisture regime that has no water available for plants for more than half the cumulative time that the soil temperature at 50 cm (20 in.) below the surface is >5°C (41° F.), and has no period as long as 90 consecutive days when there is water for plants while the soil temperature at 50 cm (20 in.) is continuously >8°C (46°F.). **Udic** is a soil moisture regime that is neither dry for as long as 90 cumulative days nor for as long as 60 consecutive days in the 90 days following the summer solstice at periods when the soil temperature at 50 cm (20 in.) below the surface is above 5°C (41° F.). **Ustic** is a soil moisture regime that is intermediate between the aridic and udic regimes and common in temperate subhumid or semiarid regions, or in tropical and subtropical regions with a monsoon climate. A limited amount of water is available for plants but occurs at times when the soil temperature is optimum for plant growth.
Soil Orders	A soil order is a group of soils in the broadest category. In the current USDA classification scheme there are 12 orders, differentiated by the presence or absence of diagnostic horizons.
Soil Temperature Regimes	**Hyperthermic** is a soil temperature regime that has mean annual soil temperatures of 22°C (72°F.) or more and >5°C (41° F.) difference between mean summer and mean winter soil temperatures at 50 cm (20 in.) below the surface. **Thermic** is a soil temperature regime that has mean annual soil temperatures of 15°C (59°F.) or more but <22°C (72°F.), and >5°C (41° F.) difference between mean summer and mean winter soil

	temperatures at 50 cm (20 in.) below the surface. **Mesic** A soil temperature regime that has mean annual soil temperatures of 8°C (46°F.) or more but <15°C (59°F.), and >5°C (41° F.) difference between mean summer and mean winter soil temperatures at 50 cm (20 in.) below the surface.
Surface Water	Water on the earth's surface. Lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, wetlands, marshes, inlets, canals, and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or non-navigable, and including the beds and banks of all watercourses and bodies of surface water, that are wholly or partially inside or bordering the state or subject to the jurisdiction of the state; except that waters in treatment systems which are authorized by state or federal law, regulation, or permit, and which are created for the purpose of waste treatment.
Watershed	The area of land that contributes surface run-off to a given point in a drainage system and delineated by topographic divides.

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