United States Department of the Interior
Bureau of Land Management

Draft Land Health Evaluation

Horseshoe Allotment (06235)

November 18, 2014

Agua Fria National Monument
Yavapai County, Arizona

U.S. Department of the Interior
Bureau of Land Management
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Abstract

This Land Health Evaluation is a stand-alone report designed to ascertain compliance with the Arizona Standards for Rangeland Health on the Horseshoe Allotment. As part of this Land Health Evaluation, current upland and riparian monitoring data has been collected, analyzed, and evaluated by the BLM. Overall, the allotment is in good to excellent ecological condition. All of the Arizona Standards and Guidelines for Rangeland Health have been met. Current livestock grazing management is considered to be in conformance with the set Standards and Guidelines.

1.0 Introduction

This Allotment Assessment was conducted in accordance with the direction set forth in the Washington Office Instruction Memorandum No. 98-91 and Arizona No. 99-012 for implementation of Standards for Rangeland Health and Guidelines for Grazing Administration. The purpose of the standards and guidelines is to improve the health of the public rangelands. The standards and guidelines are intended to help the Bureau of Land Management (BLM), rangeland users, and others focus on a common understanding of acceptable resource conditions and work together to achieve that vision. The Decision Record for implementation of Arizona Standards for Rangeland Health and Guidelines for Grazing Administration Environmental Assessment was approved by the Arizona State Director in April 1997 (USDI, BLM, 1997). This decision became effective upon approval of the Arizona standards and guidelines by the Secretary of Interior in April 1997. The Decision Record allowed for full implementation of Arizona Standards for Rangeland Health and Guidelines for Grazing Administration in all Arizona BLM Land Use Plans.

Definition of Standards and Guidelines

Standards of rangeland health are expressions of levels of physical and biological condition or degree of function required to have healthy, sustainable rangelands. Standards define minimum resource conditions that must be achieved and maintained. Determination of rangeland health is based upon conformance with the standards. Application of the standard to the ecological site considers the potential of the site without regard for the types or levels of use or management actions or decisions.

Guidelines, on the other hand, do consider type and level of grazing use. They are tools that help managers and permittees achieve standards and are specific to livestock grazing. Guidelines are best management practices such as grazing systems which could be used to achieve rangeland health standards.

Although the process of developing standards and guidelines applies to grazing administration, present rangeland health is the result of the interaction of many factors in addition to grazing by domestic livestock. Other contributing factors may include, but are not limited to, past land uses, land use restrictions, recreation, wildlife, rights-of-way, feral horses and burros, mining, fire, weather, and insects and disease (Arizona Standards for Rangeland Health and Guidelines for Grazing Administration, 1997).

With the commitment of BLM to ecosystem and interdisciplinary resource management, the standards for rangeland health as developed in this current process will be incorporated into management goals and objectives. The standards and guidelines for rangeland health for grazing administration, however, are not the only considerations in resolving resource issues (Arizona Standards for Rangeland Health and Guidelines for Grazing Administration, 1997).

2.0 General Description of the Allotment

The Horseshoe allotment is bisected by the Agua Fria River in SE Yavapai County, Arizona. It is about 15 miles north of Black Canyon City, two miles south of Cordes, AZ, between I-17 and the Tonto National Forest boundary to the east. Elevations range from 3300 feet to over 4600 feet and annual precipitation is about 14 inches on average. The land area is classified by the Natural Resources Conservation Service (NRCS) as part of the Mogollon Transition Area in central Arizona. This region separates the Basin and Range in southern Arizona from the Colorado Plateau in the northern part of the state. The Major Land Resource Area (MLRA) is 38-1. Geology dominates the landscape. To the west are hills of some of the oldest rocks in Arizona. Proterozoic (precambrian) granitic rocks over 1 billion years old are found exposed on the west side of the Agua Fria River. They are covered on the east side of the river by much younger volcanic rocks of the mid to late Miocene. Several basalt flows occurring between10-20 million years ago originated from vents like Joe's Hill, an extinct shield volcano on the allotment (Leighty, 1997). In general, shallow gravelly soils have formed on the highly weathered and erosive granitic rocks producing shrubby vegetation. In contrast, deep clayey soils have formed on the resistant and younger basalt mesas producing lush semi-desert grasslands (McAuliffe and King, 2010).

Riparian areas are located within major drainages of the Horseshoe Allotment. This includes the Agua Fria River, Silver Creek, Indian Creek, and Bishop Creek. There are approximately 16 miles of riparian habitat are located within the allotment. Cottonwood and Gooding's willow dominate the canopy cover. Groundcover is provided by an assortment of sedges, rushes and grasses. Many portions of the Agua Fria River and tributaries are intermittent and do not support vigorous riparian vegetation. Frequent high flow events during winter storms and monsoons often scour out vegetation in portions of the active channel.

3.0 Livestock Grazing

3.1 Grazing History

The Horseshoe Ranch was established in 1882 by William Mitchell, a wealthy mining magnate from Philadelphia. A patent was issued for 160 acres of private land on 12-16-1889. Information from 1880 to 1960 is from AZ State Land Department (ASLD) records is scarce. From 1960 through 1982 the Horseshoe Ranch, consisting of the Horseshoe allotment of the ASLD (#05-2074) and the Copper Creek allotment of the United States Forest Service (USFS), was owned and operated by Louis and Billie Wingfield. They ran between 700 and 800 cows yearlong on the ranch. From 1982 through 1990 the authorized grazing use on 25,450 acres of state lands on the Horseshoe allotment was 341 animal units (AU). In 1986 the leases were assigned to Horseshoe Ranch Inc. In 1990 the authorized grazing use on state lands was reduced to 329AUs.

In 1998 Arizona State land on the Horseshoe allotment transferred to the Bureau of Land Management (BLM) through a land exchange. The allotment became part of BLM's Agua Fria National Monument on 1-11-2000 via Presidential Proclamation #7236 under the Antiquities Act of 1906. Grazing ceased on the Horseshoe allotment in 2006. Grazing ceased on the USFS Copper Creek allotment in 2002 due to severe drought. In 2011 the AZ Game and Fish Department (AGFD) purchased the 199 acre headquarters of the Horseshoe Ranch along the Agua Fria River. In 2012 the allotments were leased to JH Cattle Company (John Holbrook) from the AGFD and grazing resumed on the Horseshoe allotment.

3.2 Current Livestock Grazing Management

Livestock are currently authorized to graze year-round within the Horseshoe Allotment. The lessee is authorized to graze 381 cattle, which equals 4572 Animal Unit Months (AUMs). The lessee has not used the full authorized amount of AUMs since obtaining the lease in 2011. Refer to Table 1 for more information about current grazing within the allotment.

Table 1. Current livestock grazing terms for the Horseshoe Allotment.

Livestock Number	Begin Date	End Date	Pubic Land %	Animal Unit Months (AUMs)
381	1-Mar	28-Feb	100%	4572

4.0 Allotment Profile

The Horseshoe Allotment consists of 29,851 acres of BLM administered lands. The Horseshoe Ranch also includes an adjacent USFS allotment on the Cave Creek District of the Tonto National Forest. The Copper Creek Allotment is about 35,899 acres. JH Cattle Co. holds both leases.

4.1 Soils and Ecological Sites

Soils on the allotment were mapped as part of the Soil Survey of Yavapai County, Western Part (AZ #637), by the Natural Resource Conservation Service (NRCS), then Soil Conservation Service (SCS), soil scientists during the 1960s and 70s. The survey was published in March 1976 as part of the National Cooperative Soil Survey (USDA, NRCS, 1976). Since the publication of this survey, soil taxonomy has evolved and current information on boundaries of both soil moisture and soil temperature regimes require an update of the information provided in the 1976 soil survey for AZ #637. Soil map unit lines may not change but soil names, soil temperature and moisture regime boundaries will change. Soils on the allotments were mapped within six major soil mapping units (map symbols are noted, ie: BmF).

Vegetation is described by ecological site for major soil mapping units on the allotment. Four ecological sites dominate the majority of the landscape of the Horseshoe allotment. All are within MLRA 38-1, the 12-16 inch precipitation zone of the Mogollon Transition Area in central Arizona.

Soil and vegetation descriptions

BmF – Barkerville cobbly sandyloam, 20-60% slope. This mapping unit consists of shallow soils mapped on hillslopes of granitic parent materials. Barkerville soil series is classified as Sandy-skeletal, mixed, mesic Aridic Ustorthents (SSSA, 2008). The soil moisture regime described by the 1976 survey is correct but the soil temperature regime is not. The entire Horseshoe allotment is actually within the Thermic soil temperature regime. During field investigations two soils were described at BLM Assessment, Inventory and Monitoring strategy (AIM) plots within this soil mapping unit. The first soil described at AIM plot GH2B (South River Pasture) would fit Lampshire soil series, a Loamy-skeletal, mixed, superactive, nonacid, thermic Lithic Ustic Torriorthents. This shallow soil occurred on a 25% south facing slope. It consisted of a gravelly sandyloam A horizon from 0-5 inches, a C horizon (extremely gravelly loamy sand) from 5-20 inches and weathered granodiorite bedrock at 20 inches. At AIM plot GH2 in the North River pasture a similar soil was described that would fit Oracle soil series, a Loamy, mixed, superactive, thermic, shallow Ustic Haplargids. This soil had a thin gravelly sandyloam A horizon from 0-2 inches, a Bt horizon (gravelly sandyloam) from 2-5 inches and an extremely gravelly sandyloam C horizon from 4-12 inches. Weathered granodiorite bedrock occurred at 12 inches. This soil showed signs of soil development due to clay elluviation probably because it occurred on a 5-15% northeast facing slope. Both soils act to produce a characteristic plant community dominated by shrubs, grasses, forbs and succulents. The ecological site present is called Granitic Hills 12-16 in.

Granitic Hills (R038XA104AZ)

This ecological site is on hillslopes at elevations from 3300 to 4600 feet on the allotment. Slopes range from 20-60%. It forms nearly all of the land area within the North and South River pastures. Soil parent material consists of 1 plus billion year old granitic rock which is highly weathered and naturally erosive. Soils are shallow, gravelly and coarse textured. They lack water holding capacity for shallow rooted plants like grasses and forbs but weathered bedrock offers good opportunities for deeper rooted species to persist in the plant community.

The Ecological Site Description (ESD) published by NRCS describes a plant community which is a mixture of warm season perennial grasses like black (*Bouteloua eriopoda*), hairy (*Bouteloua Hirsuta*) and sideoats gramas (*Bouteloua curtipendula*), purple threeawn (*Aristida purpurea var. purpurea*), cane beardgrass (*Bothriocholoa barbinodis*), bush muhly (*Muhlenbergia porteri*) and tanglehead (*Heteropogon contortus)* and perennial forbs include shrubby deer vetch (*Lotus rigidus*), desert globemallow (*Sphaeralcea ambigua*), shrubby ayenia (*Ayenia microphylla*), desert marigold (*Baileya multiradiata*) and wishbone four o'clock (*Mirabilis bigelovii*). Sub-shrubs like false mesquite (*Calliandra eriophylla*), range ratany (*Krameria erecta*), rough menodora (*Menodora scabra*) and shrubby buckwheat (*Eriogonum wrightii*) are all good forage species and sub dominant to perennial grasses in the plant community. Snake weed (*Gutierrezia sarothrae*) is a common native sub-shrub that can increase due to heavy grazing and/or climatic conditions. It is short lived and will come and go over 15 to 20 years intervals. Large shrubs and succulents are important components of the plant community. On northern aspects shrubs like turbinella oak (*Quercus turbinella*), desert buckbrush (*Ceanothus greggii*) and redberry juniper (*Juniperus coahuilensis*) dominate this functional group. On southern aspects large shrubs and

succulents like catclaw acacia (*Acacia greggii*), wait-a-bit mimosa (*Mimosa aculeaticarpa var. biuncifera*), Englemann and brownspine prickly pear (*Opuntia spp.*), hedgehog cactus (*Echinocereus spp.*), banana yucca (*Yucca bacata*) and gold flowered agave (*Agave chrysantha*) dominate this functional group. Annual grasses and forbs are common but occur in low amounts in the plant community.

Photo1. BmF soil mapping unit, Granitic Hills in the South River pasture.

CaD – Cabezon – Springerville complex, 5-25% slopes. Springerville part
SnD – Springerville – Cabezon complex, 3-30% slopes. Springerville part
Rn – Rimrock – Graham complex, 3-15% slopes. Rimrock part

The Springerville and Rimrock portion of these three mapping units consists of moderately deep to deep clayey soils (40-60 inches) formed on basalt and related parent materials. Springerville soil series is classified as a deep, Fine, smectitic, mesic Aridic Haplusterts . The textures are clay and silty clay. The soil moisture regime is correct but the soil temperature regime is not. The entire Horseshoe allotment is within the Thermic soil temperature regime. Rimrock soil is classified as moderately deep (20-40 inches), Fine, smectitic, thermic Leptic Haplotorrerts. The texture of Rimrock is cobbly clay. Both soils are vertisols with a predominance of 2:1 lattice clay minerals (smectite). The have high shrink-swell potential exhibiting deep cracking when dry and churning with an increase in volume over 20% when moist. We described a deep soil in the spillway below Boone Tank which was mapped as Springerville. Because the Horseshoe allotment is not in the Mesic soil temperature regime we believe this soil better fits the concept of Bonita soil series. Bonita is classified as a deep, Fine, smectitic, thermic Typic Haplotorrerts. This soil had an A horizon from 0-2 inches light clay in texture, a Bt1 horizon from 2-10 inches with heavy clay texture and a Bt2 horizon from 10-48 inches with very heavy clay textures and hard basalt bedrock at 48 inches. It appears that the depth to bedrock is variable across the areas mapped as these soils and ranges from 40 inches to over 60 inches. During field investigations

soil pits could not be dug deeper than 30 inches on any of the areas mapped as Springerville due to dry soils and dense clay horizons. In areas mapped as Rimrock, soils checked in the field fit well within that soil series. The ecological site is called Clayey Upland 12-16 in.

Clayey Upland (R038XA102AZ)

This ecological site is on plains and mesa tops at elevations from 3350 to 4000 feet on the allotment. It occurs as most of the level (1-3% slopes) land area within the Bull, Boone Tank, Double Tanks and New Well pastures. It occurs in complex with Volcanic Uplands in most of the moderately sloping (2-6% slopes) areas of the Joe's Hill and Lousy pastures. These soils formed from pyroclastic materials (volcanic ash, glass and tuff) on 10-20 million year old basalt flows. The bedrock under these soils is hard and un-weathered. Soils are moderately deep to deep. The soils produce a characteristic grassland plant community dominated by plant species that can tolerate soil churning and cracking (vertic). These soils take water rapidly when dry as deep cracks capture surface water and transport it down into the sub-soil. Soil surfaces are rough with a topography alternating between small basins and elevated areas trapping surface runoff on site. Cobbles are pushed to the surface as they weather from the basalt bedrock below. Clayey textures provide high water holding capacities for shallow rooted plants like perennial grasses, forbs and ephemerals. Base (cation) exchange capacities and organic matter are high, making these some of the most productive soils in the semi-desert grasslands.

The ESD describes a plant community dominated by tobosa grass (*Pleuraphis mutica*), a warm season perennial grass, which can tolerate vertic soil movement that most perennial grasses cannot. Other perennial grasses like bottlebrush squirreltail (*Elymus elymoides*) and vine mesquite (*Panicum obtusum*) can be common after a cycle of wet years but will naturally decline in drier periods. Native annual grasses and forbs of both the cool and warm season are very important in these plant communities and can produce large amounts of herbage in favorable seasons. Common warm season annuals include red sprangletop (*Leptochloa panicea var. brachiata*), six week grama (*Boutleoua barbata*) and annual threeawn (*Aristida adscenscionis*), purslane (*Portulaca spp.*) pigweed (*Amaranthus palmeri*), annual goldeneye (*Heliomeris longifolia var annua*) and morning glory (*Ipomoea costellata*). Important annuals of the cool season include little barley (*Hordeum pusillum*), Bigelow bluegrass (*Poa bigelovii*), sixweeks fescue (*Vulpia octoflora*), Indian wheat (*Plantago patagonica*), spreading fleabane (*Erigeron divergens*), tansy mustard (*Descurania pinnata*), annual mountain dandelion (*Agoseris heterophylla*) and tansyaster (*Machaeranthera spp*). Perennial forbs are minor components of the plant community but important species are blue dicks (*Dichelostemma capitatum*), bundleflower (*Desmanthis cooleyi*), wild onion (*Allium spp*.) and globe mallow (*Sphaeralcea coccinia*). Occasional subshrubs like shrubby buckwheat occur. The important succulent species include Engelmann prickly pear, brownspine and dollarjoint prickly pear (*Opuntia phaecantha and O. chlorotica*) and Whipple cholla (*Cylindropuntia whippeli*).

Photo 2. SnD soil mapping unit, Clayey Upland south of Boone Tank.

CaD – Cabezon – Springerville complex, 5-25% slopes. Cabezon part <15% slope
SnD – Springerville – Cabezon complex, 3-30% slopes. Cabezon part <15% slope
Rn – Rimrock – Graham complex, 3-15% slopes. Graham part
GsE – Graham soils 8-45% slopes. Graham part <15% slope

The Cabezon portion of the first two mapping units consists of shallow, clayey soils (< 20 inches) formed on basalt and related parent materials. Cabezon soil series is classified as a shallow Clayey, smectitic, mesic Aridic Lithic Argiustolls. The textures are clayey. The soil moisture regime is correct but the soil temperature regime is not. The entire Horseshoe allotment is within the Thermic soil temperature regime. Graham soil is classified as shallow, Clayey, smectitic, thermic Lithic Ustic Haplargids. The texture of Graham is cobbly clayloam to clay. Soil surfaces are well covered with gravels and cobbles. Cabezon should be switched to Graham to be correct taxonomically in the area. Soil investigations in the field showed many of these soils to be very shallow, cobbly clayloams to clays over hard basalt bedrock. Soil surfaces are well covered with gravels, cobbles and stones and rock outcrop makes up 1-5% of the area in these mapping units. At AIM plot VH 5 in the southern part of the Boone Tank pasture, a very shallow soil mapped as Cabezon would classify as a lithic ustic haplargid. This site had hard bedrock at 4 inches and was dominated by the colony forming, Toumey agave. On the north side of Joe's Hill a soil investigation at AIM plot CU 4B found a shallow to moderately deep, very cobbly, clayey soil similar to a series mapped on the San Carlos Apache Indian Reservation called Eskiminzen. This soil is similar to Graham but has cobbles and gravels throughout the soil profile. At AIM plot BH 1 on the northeast side of Joes Hill, soil investigations found a shallow clayey soil in complex with a deep soil like Bonita or Rimrock. The shallow component was 18 inches deep to hard basalt bedrock and fit the soil series concept of Graham very well. All of

these soils mapped on slope less than 15% fit the ecological site called Volcanic Upland 12-16" pz.

Volcanic Upland (R038XA115AZ)

This ecological site occurs on toe-slopes and ridge tops at elevations from 3350 to 4000 feet on the allotment. It occurs as most of the moderately sloping (3-15% slopes) land area within the Bull, Boone Tank, Double Tanks and New Well pastures. It occurs in complex with Clayey Uplands in most of the moderately sloping (3-15% slopes) areas of the Joe's Hill and Lousy pastures, where it can be recognized in part by its broader mix of perennial plants. These soils formed from volcanic parent materials on 10-20 million year old basalt flows. The bedrock under these soils is hard and un-weathered. Soils are shallow and very shallow. The soils produce a diverse plant community dominated by a mixture of perennial grasses and forbs, with sub dominance of sub-shrubs, large shrubs and succulents. Annual species are important in the plant community. Shallow soils, rock outcrop and high gravel and cobble cover combine to reduce the frequency of natural occurring wildfire on this site. These soils are clayey but not deep enough to exhibit vertic (cracking and churning) soil properties. They can be gravelly or cobbly throughout the soil profile. Water holding capacity is good near the soil surface for shallow rooted plants but soil depth limits total water holding capacity.

The ESD describes a plant community dominated by perennial grasses and forbs like sideoats grama, black grama, tobosa, bottlebrush squirrletail, slim tridens (*Tridens muticus*), sand dropseed (*Sporobolous cryptandrus*), cane beardgrass, curly mesquite (*Hilaria berlangeri*), purple threeawn, desert globe mallow, scarlett globemallow, blue dicks and wild onion.

Shrubs are important in the plant community and include low growing species like shrubby buckwheat, rough menodora and snakeweed and larger species like catclaw acacia and wait-a-bit mimosa. Succulents are common and include gold flower agave, Toumeyi agave (*Agave toumeyiana*) hedgehog cactus, prickly pear species, Whipple, buckhorn and pencil chollas (*Cylindropuntia acanthocarpa, and C. leptocaulis*) and banana yucca.

Photo 3. Rn soil mapping unit, Volcanic Upland at Copper trap #1, exclosure, T-2.

CaD – Cabezon – Springerville complex, 5-25% slopes. Cabezon part > 15% slope
SnD – Springerville – Cabezon complex, 3-30% slopes. Cabezon part >15% slope
VtE – Venezia – Thunderbird complex, 15-40%. Venezia part >15% slope
GsE – Graham soils 8-45% slopes. Graham part > 15% slope

The Cabezon portion of the first two mapping units consists of shallow, clayey soils (< 20 inches) formed on basalt and related parent materials. Cabezon soil series is classified as a shallow Clayey, smectitic, mesic Aridic Lithic Argiustolls. The textures are clayey. The soil moisture regime is correct but the soil temperature regime is not. The entire Horseshoe allotment is within the Thermic soil temperature regime. Venezia soil is classified as a Loamy, mixed, superactive, mesic Aridic Lithic Haplustolls. Again, the soil moisture regime is correct but the soil temperature regime is not. In filed investigations this soil concept exists but instead of being a mesic, haplustoll the classification should be a thermic ustorthent.

Graham soil is classified as shallow, Clayey, smectitic, thermic Lithic Ustic Haplargids. The texture of Graham is cobbly clayloam to clay. Soil surfaces are well covered with gravels and cobbles. Cabezon and Venezia should be switched to Graham to be correct taxonomically in the area.

Soil investigations at AIM plot CS 1 in the SE corner of the Double Tanks pasture showed two soils on a moderately steep hillslope. One was very shallow (7 inches to basalt) and clayey, similar to Graham series. The other was very shallow (6 inches) and loamy and would fit the concept of an ustorthent. This area was mapped as Venezia (incorrect soil temperature regime). At AIM plot BH 2B along the north boundary fence in the Boone Tank pasture, a shallow soil

mapped as Venezia (north exposure) fit the series concept of Graham very well. All of these soils, mapped on slopes over 15%, fit the ecological site called Volcanic Hills, clayey 12-16" pz.

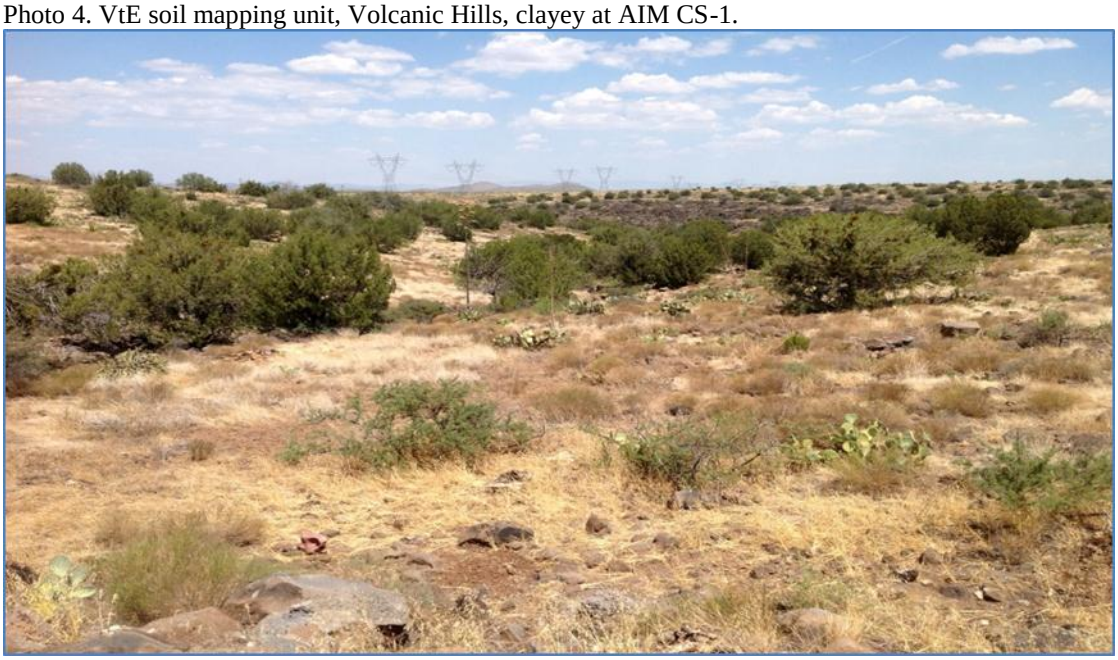
Volcanic Hills, Clayey (R038XA117AZ)

This ecological site is on hillslopes and ridges at elevations from 3350 to 4500 feet on the allotment. It occurs in complex with Volcanic Uplands as most of the moderately sloping (15-30% slopes) land area within the Bull, Boone Tank, Double Tanks and New Well pastures. It occurs in complex with Volcanic Uplands in most of the steeply sloping (15-45% slopes) areas of the Joe's Hill and Lousy pastures. These soils formed from volcanic parent materials on dissected, 10-20 million year old basalt flows. The bedrock under these soils is hard and un-weathered. Soils are shallow and very shallow. They soils produce a diverse plant community dominated by a mixture of perennial grasses and forbs, with sub dominance of sub-shrubs, large shrubs and succulents. Trees can be common on cooler aspects. Annual species are important in the plant community. Shallow soils, rock outcrop and high gravel and cobble cover combine to reduce the frequency of natural occurring wildfire on this site. These soils are clayey but not deep enough to exhibit vertic (cracking and churning) soil properties. They can be gravelly or cobbly throughout the soil profile. Water holding capacity is good near the soil surface for shallow rooted plants but soil depth limits total water holding capacity.

The ESD describes a plant community dominated by perennial grasses and forbs like sideoats grama, black grama, hairy grama, Hall's panic (*Panicum hallii*), tobosa, slim tridens, sand dropseed, cane beardgrass, bottlebrush squirrletail, bull grass (*Muhlenbergia emersleyi*), curly mesquite, purple threeawn, desert globe mallow, scarlet globemallow, blue dicks, and wild onion.

Shrubs are important in the plant community and include low growing species like shrubby buckwheat, rough menodora and snakeweed and larger species like turbinella oak, skunkbush sumac (*Rhus trilobata*), catclaw acacia and wait-a-bit mimosa. Succulents are common and include gold flower agave, hedgehog cactus, prickly pear species, Whipple, buckhorn and pencil chollas (*Cylindropuntia acanthocarpa, and C. leptocaulis*) and banana yucca. Trees of redberry juniper can be common on north aspects and netleaf hackberry (*Celtis laevigata var reticulata*) and velvet mesquite can occur on warm exposures.

Photo 4. VtE soil mapping unit, Volcanic Hills, clayey at AIM CS-1.



Four minor soil mapping units occur on the Horseshoe allotment. Two of these were labelled as rockland, a non-soil unit. The other two are upland areas of loamy soils which make up less than 1% of the allotment, but one primary and two secondary AIM plot locations were selected on one of these units.

Ro, Rr – Rockland

These two mapping units lumped all of the steep slopes of canyons that cut the basalt mesas into a miscellaneous mapping unit called Rockland. This includes the canyon slopes of the lower Agua Fria, Silver Creek, Baby Canyon, Perry Tank Canyon and Lousy Canyon. These steep walled canyons contain a high percentage of rock outcrop but in many places soils do exist and plant communities are diverse and productive. By ocular assessment some of these slopes would fit well into the ecological site concept of Volcanic Hills, clayey 12-16" pz. In other areas, primarily along the Agua Fria canyon where old lakebed sediments are still present, soils would probably be classified to family such as torriorthents / calciorthids. An ecological site developed on the San Carlos Apache Indian Reservation in a similar setting is called Basalt Hills / Sandstone Hills 12-16" pz. (R038XA118AZ).

Photo 5. Rr – Rockland mapping unit, Silver Creek north of Pueblo la Plata.

LkD – Lonti Gravelly loam, 15-30% slopes

The small area of Lonti soils occurs near the Horseshoe Ranch headquarters. Three AIM plot locations (LU-4, LU-2B and LU-5B) are located on these small areas. Lonti is classified as a Fine, mixed, superactive, mesic Ustic Haplargids. The classification is correct except the soil should be in the Thermic soil moisture regime and not Mesic. A comparable soil series which may fit this area is called Eloma. It is classified as a Clayey-skeletal, mixed, superactive, thermic Ustic Haplargids. The ecological site description for this unit is called Clayey Slopes 12-16" pz. This area was not visited during field investigations in 2014 to confirm soil series concepts.

Clayey Slopes – R038XA108AZ

This ecological site occurs on hillslopes and ridges at elevations from 3300 to 3500 feet on the allotment. Soils are fine family (Clayey) and very gravelly. They are formed in old stream alluvium deposits along the Agua Fria River and Silver Creek. This site is dominated by perennial grasses like tobosa, curly mesquite, sideoats grama and threeawn. Subdominant are sub-shrubs including false mesquite, shrubby buckwheat, range ratany and rough menodora. Succulents including prickly pear species, agave, hedgehog cactus and banana yucca are common. Large shrubs occur in lesser amounts and include catclaw acacia, wolfberry (*Lycium* spp.) and wait-a-bit mimosa. Annual forbs and grasses are plentiful in their respective seasons.

BdC – Balon Sandyloam, 0-15% slopes

Two very small areas of Balon soil occur in the eastern end of the Double Tanks pasture along the USFS boundary. There are no AIM plot locations on this soil mapping unit. Balon is classified as a Fine-loamy, mixed, superactive, mesic Ustic Haplargids. The classification is

correct except the soil should be in the Thermic soil moisture regime and not Mesic. A soil series which may fit this area is called Courtland. It is classified as a Fine-loamy, mixed, superactive, thermic Ustic Haplargids. The ecological site would be called Sandyloam Upland 12-16" pz.

Sandyloam upland – ESD has not been published in MLRA38-1.

Photo 6. Summer storm near Perry Windmill.

Climate

Temperature: Temperatures on the Horseshoe allotment are temperate; characterized by hot, dry summers and mild winters. The National Weather Service Station (WRCC # 022109) at Cordes, AZ is located at an elevation of 3770 feet two miles northwest of the allotment. It has a temperature record of 81 years from 1933 through 2013.

Figure 1.

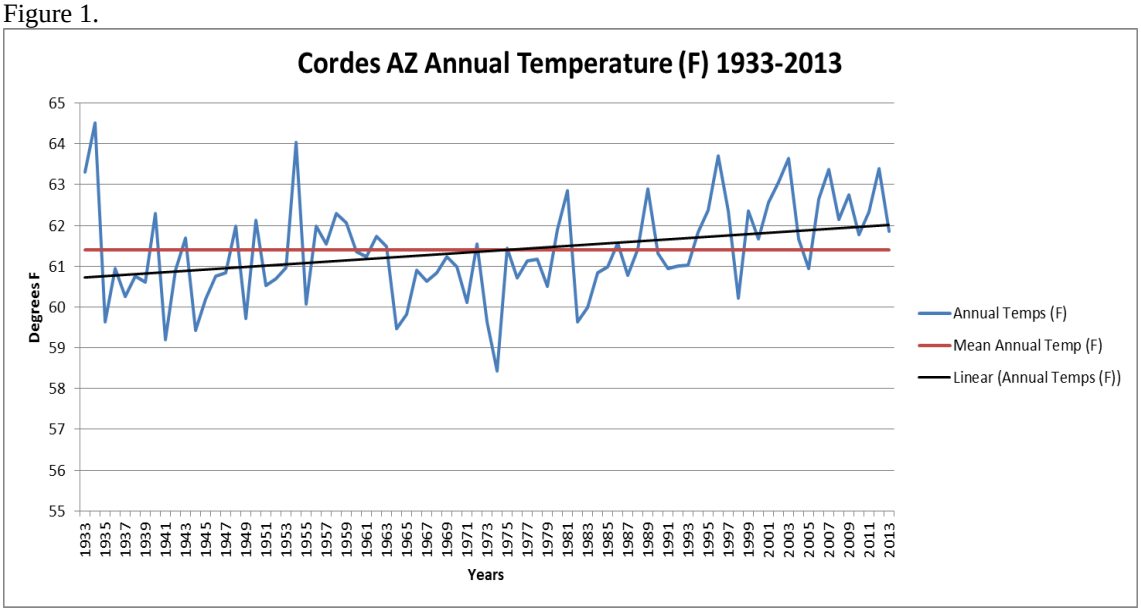


Figure 1 shows the increase in mean annual temperatures during the last 80 years. Mean annual temperatures have increased 1.3 degrees Farenheit (F) during the length of the record at Cordes, AZ.

Precipitation: Precipitation on the Horseshoe Allotment is bimodal in pattern with approximately 55% of the annual amount coming in the cool season (Oct.-Mar.) and 45% coming in the warm season (Apr.-Sept.). The Cordes AZ NOAA station has a precipitation record spanning 88 years from 1926 through 2013.

Figure 2.

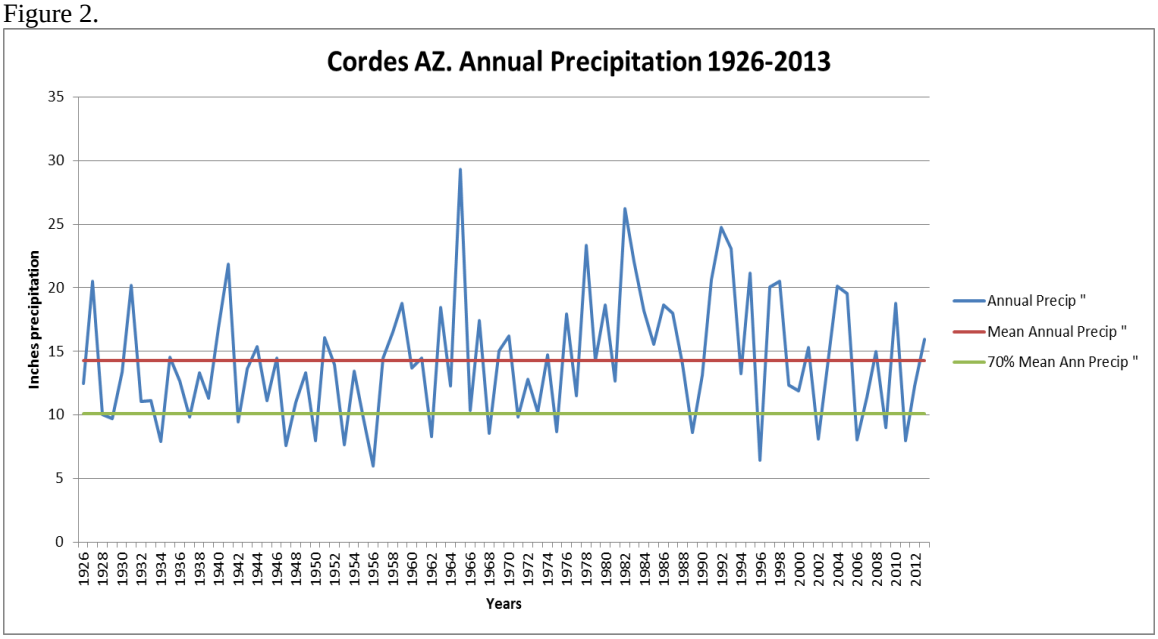


Figure 2 shows annual precipitation, mean annual precipitation (14.3 inches) and drought year (70% of mean annual, SRM 2008) precipitation for the 88 years recorded at Cordes, AZ. Since

1996, five years out of seventeen have been below 70% of mean annual precipitation or in severe drought. Compare that to the 1950s drought where four out of eight years were severe drought.

One difference between the drought of the 1950s and that of the 2000s is the increase in mean monthly temperatures. From Figures 3 and 4 compare temperature and precipitation from 1941-56 to 1996-2013 during the cool season (Oct.-Mar.). Temperatures have increased 2 degrees F during this period. The shift to milder winter temperatures causes the growing season to back up in the spring. Plants green up earlier and run out of soil moisture earlier in the spring. The spring summer drought period formerly was May and June, now it is April, May and June. This coupled with higher summer temperatures has resulted in significant perennial grass mortality especially in dry winters like the winter of 2010-11(McAuliffe and King, 2010).

Figure 3.

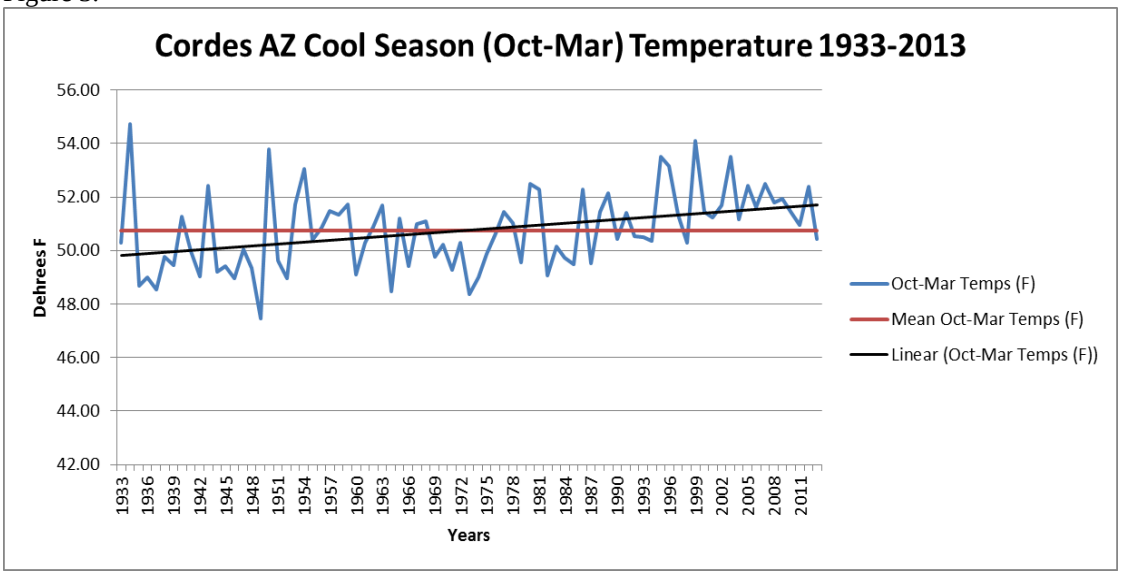
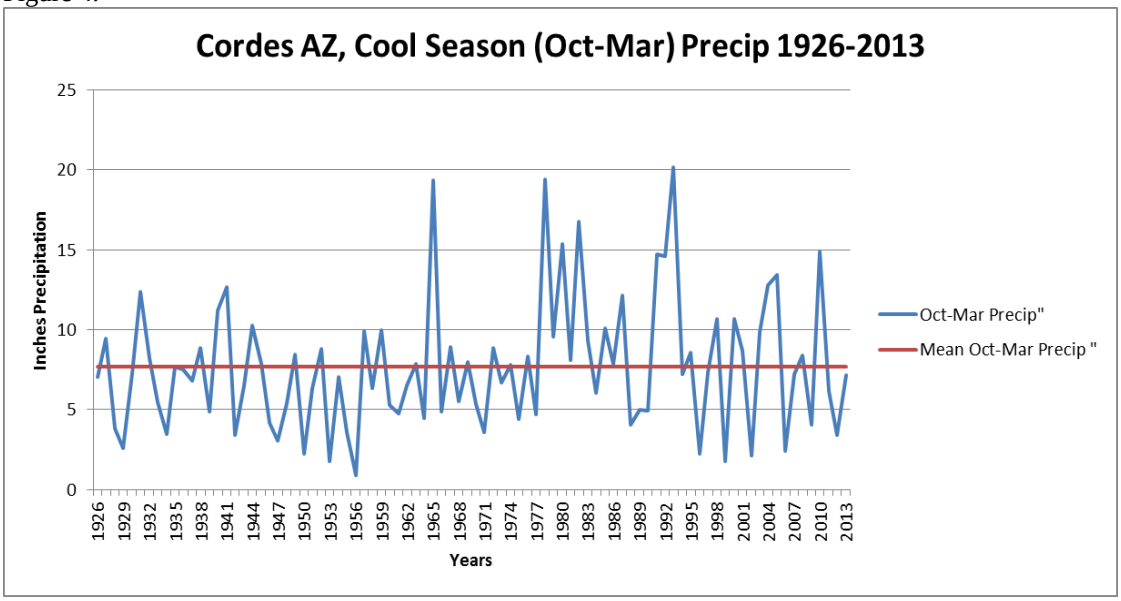


Figure 4.



From Figures 3 and 4 compare temperature and precipitation from 1941-56 to the era of 1996-2013 during the warm season (Apr.–Sept.).

Figure 5.

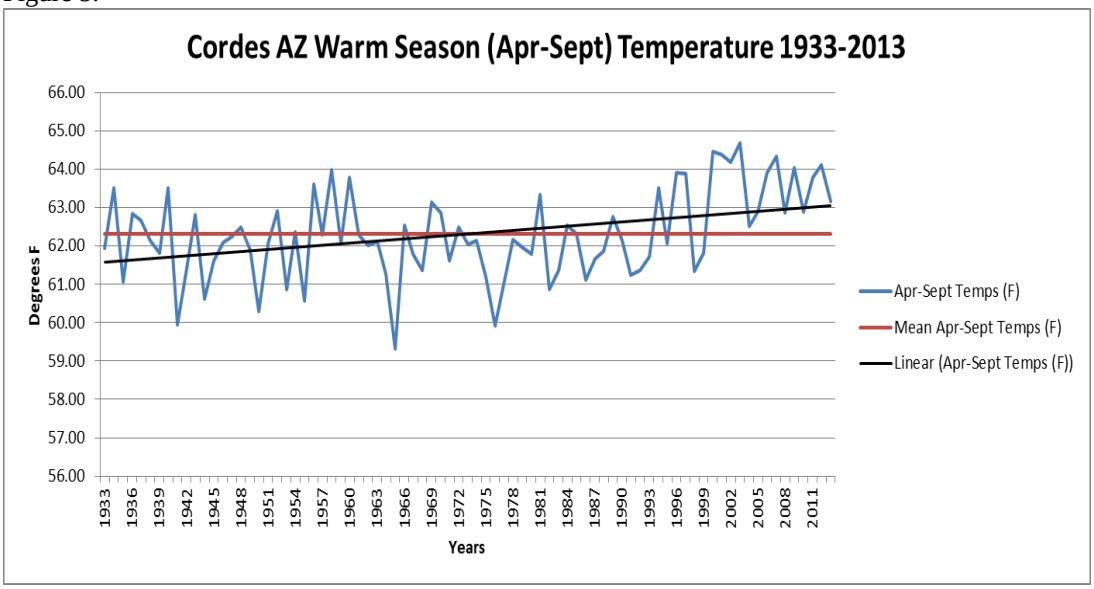
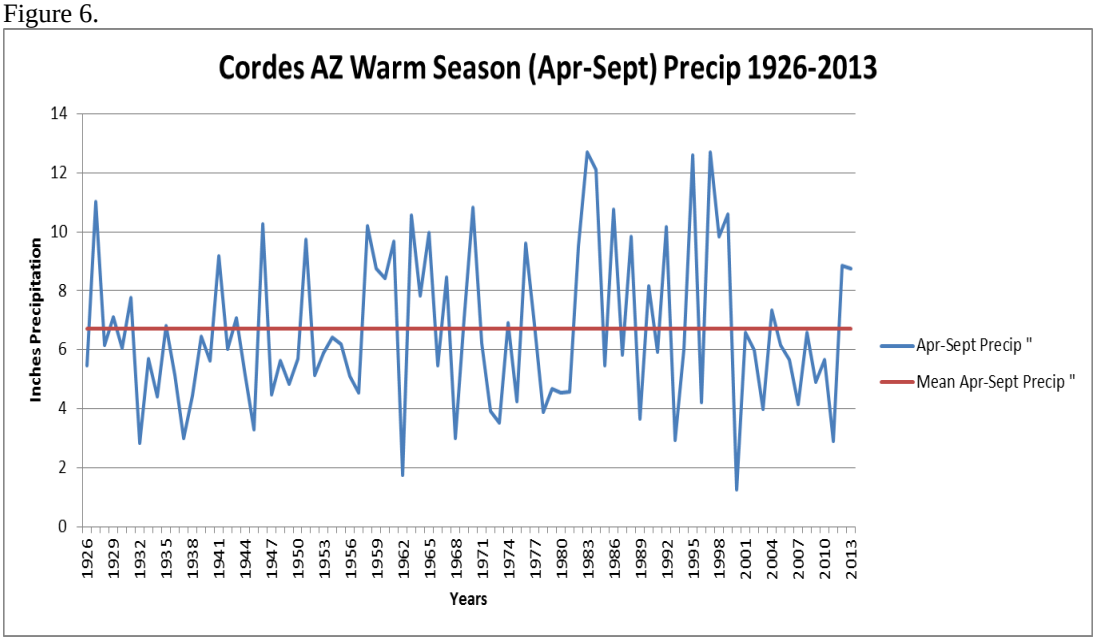


Figure 6.



Figures 5 and 6 illustrate how much cooler it was in the summer during the 50s drought than now. Also note the loss of summer rainfall from the year 2000 on. This combination of higher summer temperatures (greater evaporation and transpiration) and less summer rainfall during the past 14 years has resulted in less cover and production of perennial warm season plants like tobosa grass (*Pleuraphis mutica*). In addition the variance (coefficient of variation) in cool season precipitation has increased from 53% to 56% during the past 17 years at Cordes, AZ. The variance in warm season precipitation has increased from 40% to 44% at this location. An

increase in variability in seasonal precipitation can place further stress on plants and animals trying to cope with increasing temperatures and drought.

Maricopa County Flood Control District (MCFCD, #5730) maintains a weather station for precipitation at Sunset Point Rest Area on I-17. This record spans 31 years from 1982 through 2013. The mean annual precipitation at this location is 14 inches.

Figure 7.

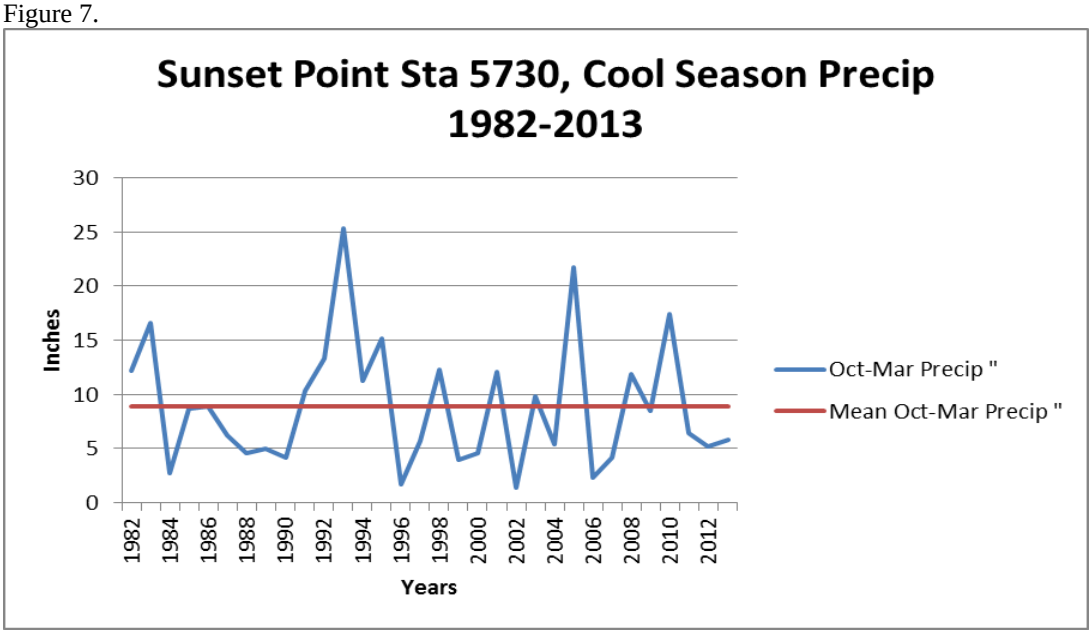
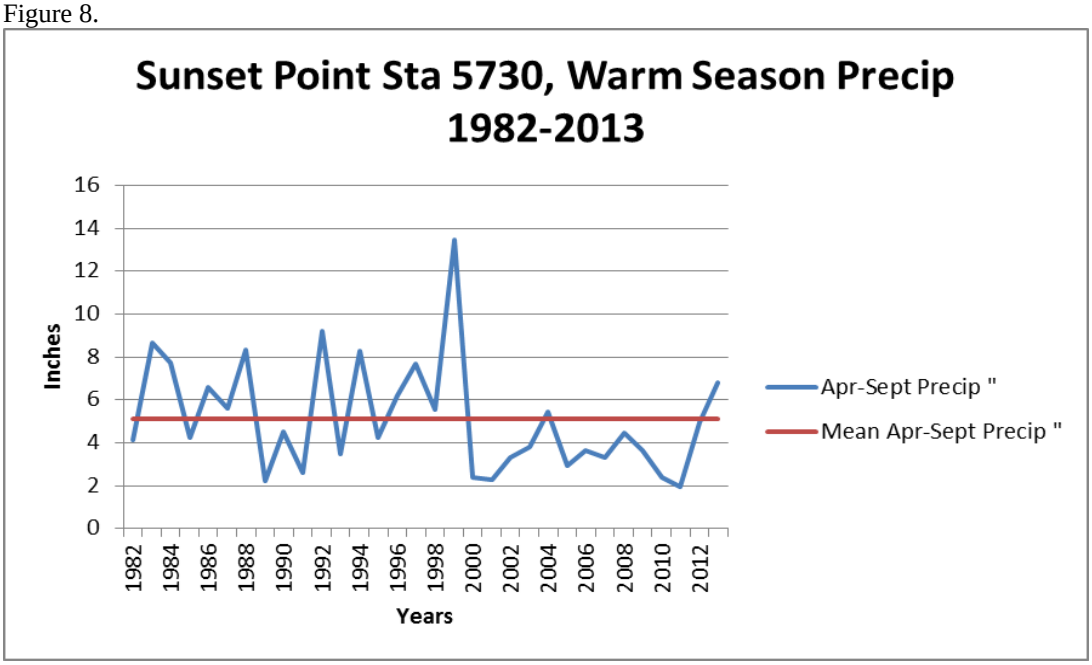


Figure 8.



Both Figures 7 and 8 show the decline in seasonal precipitation at Sunset Point. Summer precipitation has crashed since the year 2000. It is clear from the existing climatic data that

drought conditions prevail on the Horseshoe allotment. This data must be considered when evaluating trends in plant and animal communities over the past 17 years.

5.0 Wildlife Resources/Special Status Species

The Horseshoe Allotment is home to an abundance of wildlife. The large numbers of wildlife and rich diversity of species is attributed to the variety of vegetative communities. Vast desert grasslands are intersected by ribbons of riparian forests. This juxtaposition of ecosystems creates unique habitat characteristics rare in many portions of Arizona and supports a diverse assemblage of species. Many species are BLM sensitive or identified as either candidates for listing or proposed as threatened under the Endangered Species Act (Table 2).

Table 2. Special Status Species found in, and in the vicinity of, the Horseshoe Allotment within the Agua Fria National Monument (AZGFD 2014).

Name	Common Name	FWS	USFS	BLM	State
Agave toumeyana var. bella	Toumey Agave				SR
Agosia chrysogaster chrysogaster	Gila Longfin Dace	SC		S	
Aquila chrysaetos	Golden Eagle	BGA		S	
Buteogallus anthracinus	Common Black-Hawk				WSC
CH for Gila intermedia	Designated Critical Habitat for Gila chub				
Catostomus clarkii	Desert Sucker	SC	S	S	
Cicindela oregona maricopa	Maricopa Tiger Beetle	SC			
Coccyzus americanus	Yellow-billed Cuckoo (Western U.S. DPS)	PT	S		WSC
Gila intermedia	Gila Chub	LE			WSC
Gila robusta	Roundtail Chub	C*	S		WSC
Gopherus morafkai	Sonoran Desert Tortoise	C*	S		WSC
Lithobates yavapaiensis	Lowland Leopard Frog	SC	S	S	WSC
PCH for Thamnophis eques megalops	Proposed Critical Habitat for Northern Mexican gartersnake				
Rhinichthys osculus	Speckled Dace	SC		S	
Thamnophis eques megalops	Northern Mexican Gartersnake	PT	S		WSC

The Horseshoe Allotments is found within Game Management Unit (GMU) 21. Wildlife species found within the allotment include large mammals such as pronghorn, mule deer, white-tailed deer, mountain lion, black bear, coyote, as well as various rodents, bats, and other small mammals. To date 197 bird species have been recorded in the area and portions of the Horseshoe Allotment are designated as an Important Bird Area by the Audubon Society.

The yellow-billed cuckoo has been proposed to be listed as threatened under the Endangered Species Act. A riparian dependent bird species, the yellow-billed cuckoo as has been document breeding within the area and is proposed. Critical habitat has been proposed in the area as of

August 2014 (FWS-R8-ES-2013-011; 4500030114). Nesting has been documented within the allotment.

Herpetofauna are also common within the Horseshoe allotment. A diverse number of snakes, lizards, frogs, toads, and turtles can be found within all habitat types. The Mexican gartersnake (Thamnophis eques megalops), a riparian dependent snake, has been documented within the Agua Fria River as recently as the 1980s. Critical habitat has been proposed within the main stem of the Agua Fria River as of July 2013 (FWS-R2_ES-2013-0022; 4500030113). The FWS proposed rule states that the Mexican gartersnake proposed critical habitat is considered as being within the geographical area currently occupied by the species. The areas are proposed under sections 3(5)(A)(i) of the Act because they are essential for conservation of the northern Mexican gartersnake. The lowland leopard frog, a native BLM Sensitive Species, occurs in the area. Other native riparian dependent herpetological wildlife species occur in the area such as the canyon tree frog and Sonoran mud turtle. The non-native bullfrog also occurs in the area.

Both native and non-native fish species have been documented in the streams and creeks within the Horseshoe allotment. This includes the endangered Gila chub (Gila intermedia) which occupies Silver Creek and has been designated as critical habitat for the species in 2005 (FWS-RIN 1018-AG16). Longfin dace (BLM Sensitive Species), desert sucker (BLM Sensitive Species), are other native species that occur within the Allotment. Non-native games fish include the green sunfish and fathead minnow but larger sport fish are not typically found within the allotment.

6.0 Vegetation Resources

6.1 Noxious Weeds/ Invasive Weeds

Invasive annual forbs and grasses are common on clayey soils on the Horseshoe allotment. They include filaree, red brome, wild oats, foxtail barley and tumble mustard. These are all cool season annual species and to some degree, have blended with the populations of native, winter, annual grasses and forbs. Two species on the allotment, red brome and wild oats provide very high and continuous fine fuel loads in springs with above average precipitation. Wildfires, like those in 2005, fueled by these species and coupled with drought, have had serious consequences on native plant communities in the tobosa grasslands on Perry Mesa. On the southwest end of Perry Mesa black mustard (*Brassica nigra*) is beginning to spread.

Fire management is critical to mitigating the effects of these species. Active fire suppression should be mandatory in areas where wild oats and black mustard are spreading to limit the size of disturbance. Targeted grazing should be evaluated to help reduce fine fuel loads in this area during “El Nino” winters (Rangelands, 2012).

6.2 Vegetation Inventory and Monitoring

MLRAs
The broad climatic/geographic zones, MLRAs, correspond to geographic provinces or ecosystems. MLRA 35 is the Colorado Plateau, MLRA 40 is the Sonoran Desert, MLRA 38 the Mogollon transition area, and so on. A set of ecological site descriptions are developed for each

precipitation zone in each MLRA. This information is gathered throughout the course of soil surveys by range specialists working with soil scientists (USDA, NRCS, 1997).

Ecological sites
An ecological site is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation (SRM 2008). Ecological sites are described with written narratives of the sites' physical characteristics, soils and natural vegetation. A potential native plant community is described for each ecological site including the percent composition of each species and plant functional group in the plant community. Information about potential native plant communities is developed from historic information and tempered with the best plant communities found for each ecological site. Best refers to the highest cover, annual production and diversity of life-forms encountered to date and is not related to land use. They are the recommended basic unit of rangeland classification (USDA, NRCS, 1997).

Composition
The proportion of an individual plant species as shown on NRCS ecological site descriptions is the composition by weight of annual production. Composition is determined by using several methods including Dry-weight Rank, Double sampling, and ocular estimates. All of these methods are described in the Arizona range literature (Ruyle, 1997; Smith, et al. 2012; USDA, NRCS,1997).

Production
Annual production of the plant community is shown on NRCS ecological site descriptions with ranges from dry to wet years. Production is expressed as the above ground biomass of leaves, twigs, flowers and fruits produced in a year in lbs/ac. on an air dry basis. Production can be determined using several techniques including Double sampling, Comparative yield and ocular estimates. These methods are well described in the range literature (Ruyle, 1997 and Smith et al. 2012).

Ground Cover
Ground cover is the percentage of the ground surface that is covered by bases of perennial plants, gravel and rock and litter. It is measured using the Line point sampling in the AIM plot protocol (150 points recorded) or by using points welded on the frequency frame in the Pace-frequency format for monitoring (300 points).

Foliar Cover
Foliar cover is the percentage of the ground surface that is covered by the canopy of perennial plants. It is measured using the Line point sampling in the AIM plot protocol (150 points recorded).

Distribution of cover
Distribution or arrangement of plant cover on the site is the pattern of both basal and foliar cover. It can be a sensitive indicator to thresholds where soil erosion can accelerate or when perennial plant communities may not be able to recover. It is measured using canopy gap measurements in the AIM plot protocol (150 meters of line intercept for canopy gaps).

Vegetative Trend

Vegetative trend is the direction plant communities take over time. Trend can be measured in several ways. Both foliar cover and shrub density can be recorded over time in the AIM protocol using line point and belt sampling. These data can be compared to subsequent readings to determine trend towards meeting land health objectives. The AIM protocol is the new method being put in use by BLM in Arizona and elsewhere across the country. Frequency is another method which has been used on the allotment. Frequency in a pace transect format can yield sensitive information about directions or trends in plant communities. The pace-frequency format developed at the University of Arizona is described in the Arizona range literature (Ruyle, 1997 and Smith et al. 2012).

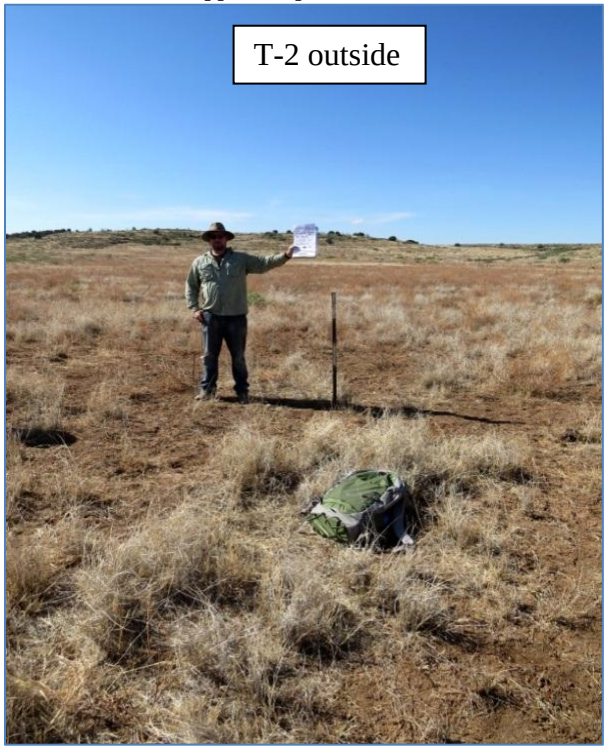
The most important thing in any vegetation monitoring is to keep sampling techniques the same from year to year and to ensure measurements are confined to a single soil or ecological site. Two range trend monitoring locations on the Horseshoe allotment were visited in 2014. Each consists of a small (1 acre) exclosure with 100 quadrat pace-frequency transects installed inside and outside. The exclosures were constructed and transects installed in fall of 1994. They were re-read in 1996 but not since. The first location is called T-2 and is located in Copper Trap #1 on Clayey Upland ecological site. The second location is in the NE corner of Joe's Hill pasture near Perry Mesa Tank. It is called T-3 and is located on a complex of Clayey Upland / Volcanic Upland ecological sites. Table 3 and 4 show the result of re-reading transects at T-2 and T-3 after an 18 year interval. Change can be interpreted from this kind of data but not trend (minimum of three data points). There is no way to know what happened in the last 18 years. Monitoring must be done often enough to separate out casual factors and determine normal fluctuations in plant communites over time. The exclosures at these locations offer a means of separating climate impacts on the plant community from grazing impacts. The exclosures should be maintained, rain gauges installed and recorded seasonally and the AIM protocol used both inside and outside to continue monitoring. Point cover data will be valid across both methods, frequency will not be.

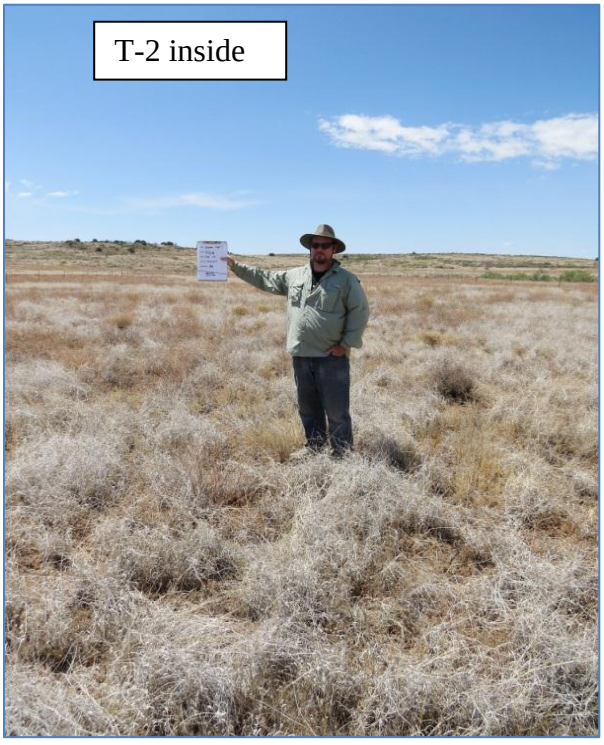
Tables 3 and 4. Inside and outside Copper Trap Exclosure. Dry weight rank method used for data collection.

Copper Trap #1, T-2 Outside Exclosure							
	% frequency				% composition		
	1994	1996	2014		1994	1996	2014
Cover category							
Bare ground	19	60	34				
Gravel		5	3				
Rock	7	10	6				
Litter	56	14	52				
Live basal	18	11	4				
Shrub/succulent							
mesquite	1						
shrub buckwheat							
snakeweed	13	2			7		0
prickly pear							
Perennial grass							
tobosa	87	92	56		14		37
vine mesquite		2					
squirrletail	14				3		0
Perennial forb							
bundleflower							
ragweed		3	5		0		1
vetch / lotus							
Annual grasses	100	30	90		41		7
Annual forbs	41	85	100		4		21
ann goldeneye	1	0	82		0		35

Copper Trap #1, T-2 Inside Exclosure							
	% frequency				% composition		
	1994	1996	2014		1994	1996	2014
Cover category							
Bare ground	34	60	25				
Gravel		16	4				
Rock	14	8	9				
Litter	41	11	51				
Live basal	11	5	11				
Shrub/succulent							
mesquite	1						
shrub buckwheat	4	6	1		1		0
snakeweed	15	4			5		0
prickly pear	1		1				
Perennial grass							
tobosa	85	93	84		50		56
vine mesquite		0					
squirrletail	8				3		0
Perennial forb							
bundleflower			3				
ragweed							
vetch / lotus		5					
Annual grasses	99	45	100		32		13
Annual forbs	38	95	100		5		24
ann goldeneye	4	0	77		0		13

Photos 7 and 8. Copper Trap #1, outside and inside exclosure.





Due to the time between readings it is difficult to look at the data from T-2 and draw conclusions. It appears that basal cover of tobosa has declined significantly outside the exclosure and increased back to some more normal amount inside. Inside the exclosure, basal cover went from 11% in 1994 to 4% in 1996, just two years. The decade prior to 1994 was the wettest on record in Arizona's climate history and by 1994 levels of basal cover were high. 1996 was a severe drought year and in both transects basal cover declined. Basal cover declined outside the exclosure from 18% to 11% and inside from 11% to 4%. These transects are only 200 feet apart. This could mean that there are dynamics in tobosa basal cover that are not well understood. There has been very little grazing in Copper Trap #1 for the past 9 years. Without monitoring data and land use records throughout this period it is impossible to draw conclusions from the results. An Upland Range Health assessment done on the area outside the exclosure showed the area as meeting Standard 1 and with biotic integrity still intact.

Tables 5 and 6. Inside and outside Joes Hill Exclosure. Dry weight rank method used for data collection.

NE Joe's Hill, T-3 Outside Exclosure							
	% frequency				% composition		
	1994	1996	2014		1994	1996	2014
Cover category							
Bare ground	58	70	35				
Gravel	1	1	0				
Rock	12	8	9				
Litter	21	8	49				
Live basal	8	11	6				
Shrub/succulent							
shrub buckwheat	21	16	10		12		5
snakeweed	45	2	13		19		7
prickly pear	4	1	5		3		3
catclaw acacia	6	5	6		3		4
Perennial grass							
tobosa	56	65	57		30		37
threeawn	1	1	1				
curly mesquite			7				
vine mesquite	3				1		
squirrletail	3	6					
Perennial forb							
blue dicks	1						
ragweed		1	4				0.5
hairy goldaster			4				0.5
globemallow			1				1
Annual grasses	97	8	100		27		27
Annual forbs	47	44	100		5		7

NE Joe's Hill, T-3 Inside Exclosure							
	% frequency				% composition		
	1994	1996	2014		1994	1996	2014
Cover category							
Bare ground	54	70	26				
Gravel	3	0	2				
Rock	9	9	6				
Litter	23	6	62				
Live basal	10	15	4				
Shrub/succulent							
shrub buckwheat	6	11	10		3		4
snakeweed	42	1	6		20		3
prickly pear	2	1	8		2		4
catclaw acacia	2	7	4		1		1
Perennial grass							
tobosa	73	66	51		45		32
threeawn	1						
curly mesquite							
vine mesquite							
squirrletail	2		2				
Perennial forb							
blue dicks	1		2				
ragweed							
hairy goldaster			3				2
globemallow							
Annual grasses	96	30	100		25		38
Annual forbs	40	63	100		5		17

Photo 9. NE corner Joe's Hill, T-3 outside exclosure.

Photo 10. NE corner Joe's Hill, T-3 inside exclosure.

The data in Table 10 show little difference inside and outside although the pictures look different. Note the loss in snakeweed after the wet decade ending in the early 1990s. Inside the exclosure it went from 42% to 1% frequency in two years, outside from 45% to 2%. It illustrates how the short-lived (10 years), increaser snakeweed reacts to climate and drought in the plant community. Basal cover of tobosa has declined in both transects but is not different inside and out. This location is only 0.1 miles from Perry Mesa tank, one of the few reliable ponds on the allotment. It has received grazing pressure in the past couple of years. As with T-2 this location should be maintained as a monitoring location and upgraded to the AIM protocol.

Utilization

Utilization is the amount of the current year annual production of above ground biomass grazed by animals. It is expressed as percentage by weight (not volume). Utilization measurements are outlined in several Arizona rangeland references (USDA, NRCS, 1997; Smith et al. 2007; and USDI, BLM, 1996).

Utilization transects were completed in areas that had been grazed by livestock during the summer of 2014. The methodology used is called "Grazed-class". 100 plants were sampled in a pace-transect format. Height-weight relationships for forage species were developed from un-grazed plants in the field. The cow herd (150) was in the Double Tanks pasture during April to July. The herd was moved onto the Forest allotment the end of July when utilization measurements were made. Utilization was judged on forage species within 0.25 miles of water at three locations, Copper Corrals, Bishop Well and Copper Tank in the Copper Trap #1. Table 10 shows the results of these measurements.

Table 7. Horseshoe Allotment utilization.

Horseshoe Allotment, end of season grazing utilization			
	Grazing utilization expressed as percent by weight		
Key Forage Species	**Double Tanks, Bishop well**	**Double Tanks, AIM CS 1**	**Copper Trap 1, T-2 (outside exc)**
Tobosa	5	0	5
Sideoats grama	10	25	
Black grama	20	31	
Curly mesquite	18		
Red threeawn	21	29	
Sand dropseed	34	50	
Rough tridens		34	
Squirrletail	20		
Shrub buckwheat	15	10	3
Globemallow	50	49	0
Ecological Site	Clayloam upland	Clayey slopes	Clayey upland

Results show light to moderate level of grazing use at three locations, close to livestock water supplies, throughout the four month grazing season. Grazed plants will be able to recover as these pastures will not be grazed again for 12-18 months.

6.3 AIM Plots

Thirty two AIM plot locations were randomly selected on the Horseshoe allotment and vegetative measurements were taken in 2012. Seventeen primary AIM plots were selected for repeat measurements on the allotment. Fifteen backup AIM plots can be used as needed to monitoring progress in meeting land health objectives. All AIM plots were visited in 2012 and soil cover / vegetation measurements including, ground cover, foliar cover, basal and canopy gap and shrub density were made. All primary AIM plots were assessed for Rangeland Health in 2012 or 13. Four primary AIM plots were re-assessed and four backup AIM plots were assessed for Rangeland Health during field studies in 2014.

7.0 Riparian Resources

Riparian resources within the Horseshoe Allotment were assessed in the Agua Fria River, Silver Creek, Bishop Creek and Indian Creek. Quantitative methods assessed species composition, utilization, bank alteration, greenline to greenline width, wetland stability, and ecological ratings. Qualitative monitoring of riparian areas, PFC assessments, are summarized respective to each respective riparian segment.

Riparian monitoring was carried out using BLM Technical Reference 1737-23 Multiple Indicator Monitoring (MIM) of Stream Channels and Streamside Vegetation, 1737-8 Greenline riparian-wetland monitoring: Riparian area management, and BLM Technical Reference 1737-11 Process for Assessing Proper Functioning Condition (PFC). These monitoring methods were selected because they are widely accepted and quantitative methods such as 1737-23 and 1737-8 inform PFC assessments which are qualitative.

The MIM protocol is a quantitative assessment designed for monitoring stream banks, stream channels, and streamside riparian vegetation. The MIM protocol integrates annual grazing use and long-term trend indicators allowing for evaluation of livestock grazing management. Woody species transects were adopted from technical reference 1737-8 to supplement the MIM protocol in some areas. This was done to capture broader flood plain characteristics for woody species composition. It was only conducted when the greenline to greenline width assessed in the MIM protocol was too narrow to capture additional riparian obligate species in abandoned channels or on terraces.

The Proper Functioning Condition (PFC) assessment is a qualitative assessment that determines the on-the-ground condition of a riparian area; termed PFC, the protocol is used to assess how well the physical processes are functioning. The protocol is a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of riparian-wetland areas. When in a proper functioning state, a riparian area will exhibit resiliency that will allow a riparian-wetland area to hold together during high-flow events with a high degree of reliability. High resiliency allows an area to maintain or produce desired values, such as fish habitat, neotropical bird habitat, or forage, over time. Riparian-wetland areas that are not functioning properly may not sustain these values.

8.0 Land Health Standards, Management Evaluation, and Conclusions

The following are the Arizona Land Health Standards:

Standard 1 - Upland Sites
Upland soils exhibit infiltration, permeability and erosion rates that are appropriate to soil type, climate and landform (ecological site).

Standard 2 - Riparian –Wetland Sites
Riparian-wetland areas are in proper functioning condition.

Standard 3 - Desired Resource Conditions
Productive and diverse upland and riparian-wetland plant communities of native species exist and are maintained.

8.1 Management Evaluation

Upland Sites and Desired Resource Conditions

Photo 11. Range Health Assessment at AIM plot BH 2B, Volcanic Hills, clayey, Boone Tank pasture.

Rangeland Health Assessments must be made on upland ecological sites using the procedures outlined in the interagency handbook "Interpreting Indicators of Rangeland Health" Version 4 (USDI, BLM, 2005) or subsequent versions. Seventeen indicators which apply to three attributes of the range ecosystem are rated to determine the ecological status of the area. The three attributes are Site and Soil Stability, Hydrologic Function, and Biotic Integrity. Ratings are based on the preponderance of evidence. Rangeland Health Assessments done by BLM in 2012 and 13 were not performed using reference area information as none had been published by NRCS for major ecological sites on the allotment.

Field investigations in 2014 found that some of the AIM plot locations actually crossed ecological site boundaries complicating prior assessments. Upland Rangeland Health (RH) Assessments were made at all 17 primary AIM plot locations in the winter of 2012 and 2013 by BLM staff. Four primary AIM plot locations and four secondary AIM plot locations were assessed in the summer of 2014 by BLM, TNC, AGFD and Robinett Rangeland Resources (RRR) LLC to determine ecological site designations and use RH reference area information being developed by NRCS. Two additional areas of Clayey Uplands on the northern part of the allotment were assessed in 2014 as this ecological site was under-represented in the AIM plot random design. Draft NRCS range health reference worksheets were used by RRR LLC for Clayey Upland and Volcanic Hills, Clayey ESDs.

Table 8 shows the summary of upland range health assessments by ecological site for Granitic Hills, Clayey Uplands, Volcanic Uplands and Volcanic Hills, Clayey on the Horseshoe allotment.

Table 8. Horseshoe Allotment Summary of Upland Rangeland Health Assessments

Horseshoe Allotment Summary of Upland Rangeland Health Assessment							
Aim plot / Location	Pasture	Ecological Site	Soil & Site Stability	Hydrologic Function	Biotic Integrity	Range Health Assessment	Notes
not AIM	Copper Trap1	Clayey Upland	Stable	Functioning	Intact	Meets standard 1	
not AIM	Boone Tank	Clayey Upland	Stable	Functioning	Intact	Meets standard 1	
not AIM	Bull	Clayey Upland	Stable	Functioning	Intact	Meets standard 1	
Lim 5B	Joe's Hill	Clay Up/Volc Upland	Stable	Functioning	Intact	Meets standard 1	
BH 1, CU part	Joe's Hill	Clayey Upland	Stable	Functioning	At risk	Meets standard 1	Fire-drought invasive annuals
Lim 3	Joe's Hill	Clay Up/Volc Upland	Stable	Functioning	Intact	Meets standard 1	
BH 6	Lousy	Clay Up/Volc Upland	Stable	At risk	At risk	Does not meet UHS 1	Arch site, cultivated area
GH 2	N. River	Granitic Hills	Stable	Functioning	Intact	Meets standard 1	lehmann lovegrass present
GH 2B	S. River	Granitic Hills	Stable	Functioning	Intact	Meets standard 1	lehmann lovegrass present
VH 5	Boone Tank	Volcanic Upland	Stable	Functioning	Intact	Meets standard 1	Agave toumeyana site
CU 4B	Joe's Hill	Volcanic Upland	Stable	Functioning	At risk	Meets standard 1	Fire-drought invasive annuals
BH 1, VU part	Joe's Hill	Volcanic Upland	Stable	Functioning	At risk	Meets standard 1	Fire-drought invasive annuals
Lim 1	Joe's Hill	Volcanic Upland	Stable	Functioning	At risk	Meets standard 1	Fire-drought invasive annuals
Lim 4	Joe's Hill	Volcanic Upland	Stable	Functioning	Intact	Meets standard 1	
Lim 5	Lousy	Volcanic Upland	Stable	Functioning	Intact	Meets standard 1	
Bh 2B	Boone Tank	Volcanic Hills, clay	Stable	Functioning	Intact	Meets standard 1	
CS 1, VH part	Double Tank	Volcanic Hills, clay	Stable	Functioning	Intact	Meets standard 1	
BH 4	Joe's Hill	Volcanic Hills, clay	Stable	Functioning	Intact	Meets standard 1	
BH 5	Joe's Hill	Volcanic Hills, clay	Stable	Functioning	Intact	Meets standard 1	
CU 2	Lousy	Volcanic Hills, clay	Stable	Functioning	Intact	Meets standard 1	

Upland Range Health Assessments done at 19 locations on the Horseshoe allotment from 2012 to 2014 show that the vast majority of the allotment meets Rangeland Standard Number 1, Upland soils exhibit infiltration, permeability and erosion rates that are appropriate to soil type, climate and landform (Ecological site). One range health assessment on Volcanic Upland on the Horseshoe allotment did not meet standard 1. This site appears to be a former cultivated field associated with one of numerous archaeological sites on Perry Mesa. Gullies and rills on the site are thought to be associated with past cultivation.

Desired Resource Conditions

Desired plant communities for dominant ecological sites on the Horseshoe allotment are described by evaluating field vegetation data collected from AIM plot locations and Range trend monitoring locations. These data were then compared to reference conditions from published NRCS ESDs.

Clayey Upland 12-16" pz.

Photo 12. Perry Mesa, Clayey Uplands in good ecological condition. Looking south to the New River Mountains.

This ecological site is described by NRCS as a warm season (C-4) grassland dominated by tobosa with an important component of native annual grasses and forbs (both cool and warm season species). Shrubs, sub-shrubs, succulents and other plant functional groups are all minor components of the potential native plant community. McAuliffe and King (2010) used repeat aerial photography to document a history of land use and vegetative changes over time on Black Mesa. Their study site, located a few miles to the southwest of the Horseshoe allotment, consisted of a complex of Clayey Upland and Volcanic Upland ecological sites (Rimrock – Graham soil mapping unit). Although they recognized variability in the soils (rockiness) they did not recognize two ecological sites as occurring on the mesa. Their conclusions were that the potential plant community on Black Mesa consisted of tobosa grassland with few shrubs, but with a sizeable component of prickly pear species. McAuliffe and King found the largest component of prickly pear on the rockiest areas (the Volcanic Upland part of the complex) on Black Mesa. The ESD for Clayey Upland (R038XA102AZ) shows a plant community with tobosa> native annual forbs and grasses> perennial forbs> other perennial grasses> shrubs and succulents. Succulents like the prickly pear species can make up from 0 to 5% of the species composition by weight. Annual production on this site varies from 600 lbs/ac (air dry) in drought years to 2000 lbs/ac in wet years as shown on the NRCS ESD.

At present nearly all of the areas of this site on the Horseshoe allotment in the Bull, Boone Tank, Double Tanks and New Well pastures are similar in condition to the potential plant community as described in the ecological site description. Non-native annual forbs and grasses now occur everywhere on the allotment. These species include filaree (*Erodium cicutarium*), red brome (*Bromus rubens*), wild oats (*Avena fatua*), foxtail barley (*Hordeum leporinum*) and tumble mustard (*Sysimbrium spp*.). In most places these species have blended with the native annual component of the plant community. In the Lousy and west side of the Joe's Hill pasture, wild oats has become dominant on areas of this site and tobosa grass cover is greatly reduced. In the same two pastures large shrubs like catclaw acacia and mimosa are increasing on some areas of

this site from adjacent areas of Volcanic Uplands with shallow soils. The loss of tobosa and increase in dominance by invasive annuals (especially wild oats) has been investigated on Black Mesa to the southwest of Joe's Hill (McAuliffe and King, 2010). On Black Mesa high fine fuel loads after the (El Nino) wet winter of 2005, wildfire and severe drought and high temperatures from 1995 through 1998 resulted in tremendous loss of tobosa cover. Prescribed fire around Joe's Hill during the same time period coupled with the movement of wild oats (SW prevailing winds) from Black Mesa appears to be the casual factor in the vegetative change occurring in these two pastures on the Horseshoe allotment. Tobosa has low palatability for grazing livestock. In addition hese areas have experienced very little grazing use during the past 10 years and it appears that vegetative change is being driven by the interaction of fires (both prescribed and wild), drought and the presence of invasive annual grasses.

In areas of Clayey Upland in the northern part of the allotment prescribed fires in both 2010 and 2012 burned with high fuel loads and were followed by dry years resulting in loss of tobosa cover. In some areas large bare patches are interspersed with tobosa patches. Bestelmeyer and colleagues (2006) found that soil aggregate stability was significantly reduced in bare patches as compared to tobosa grass patches on the Jornada Experimental Range in the Chihuahuan Desert. In this same area on clayey soils, monitoring has shown bare patches to be persistent and tobosa basal cover of 4% after drought could recover to 10% with more normal precipitation (Bestelmeyer, 2014).

Table 9.

Cover categories	Present %	Stdev	NRCS ESD
Foliar Cover tobosa	18.6	10.1	25-45%
Bare Ground	32.3	6.7	15-25%
Basal Cover	5.2	5.3	8-15%
Total Litter	45.7	10.1	25-45%
Gravel /rock	10.0	11.3	0-25%

Table 9 shows the relationship of cover categories found in the field (present) to those shown on the NRCS ESD. The desired plant community for the Clayey Upland ecological site should be tobosa grassland with a sizeable component of native annual forbs and grasses.

Desired Resource Conditions are shown in Table 10 for Clayey Upland ecological site on the Horseshoe allotment. These show a range in values from disturbance like fire, back to equilibrium conditions and from drought to average year precipitation.

Table 10.

Categories	Objective
Foliar Cover tobosa	15-45%
Bare Ground	15-30%
Basal Cover	4-10%
Total Litter	25-45%
Gravel /rock	2-25%
Annual Production	600-2000 lbs/ac

Volcanic Upland 12-16" pz.

Photo 13. Volcanic Upland in good ecological condition, Bull pasture. Prescribed fire in 2010.

This ecological site is described by NRCS as a diverse plant community dominated by perennial grasses (including tobosa) with an important component of native annual grasses and forbs (both cool and warm season species). Sub-shrubs, large shrubs, perennial forbs and succulents are important components of the potential native plant community. McAuliffe and King (2010) used repeat aerial photography to document a history of land use and vegetative changes over time on Black Mesa. Their study site, located a few miles to the southwest of the Horseshoe allotment, consisted of a complex of Clayey Upland and Volcanic Upland ecological sites (Rimrock – Graham soil mapping unit). Although they recognized variability in the soils (rockiness) they did not recognize two ecological sites as occurring on the mesa. Their conclusions were that the potential plant community on Black Mesa consisted of tobosa grassland with few shrubs, but with a sizeable component of prickly pear species. McAuliffe and King (2010) found the largest component of prickly pear on the rockiest areas (the Volcanic Upland part of the complex) and little to no large shrub (catclaw and mimosa) cover on Black Mesa in their earliest photos. They conclude that large shrubs that are present today, invaded the gently sloping area of Clayey Upland / Volcanic Uplands on top of the mesa from the adjacent steep slopes of Volcanic Hills. They suggest this was due to increased grazing use of Black Mesa from 1940 through 2009 due to increasing density of water facilities over this time. This analysis may not hold true in the southern part of Perry Mesa on the Horseshoe allotment. Here the development of livestock water is primitive (3 dirt tanks) and the density of livestock water is very low compared to Black Mesa. The Volcanic Uplands in this part of Perry Mesa all have sizeable components of large shrubs. Perhaps the reasons for increase in large shrubs are driven by climate (warming) rather than by livestock grazing pressure. The ESD for Volcanic Upland (R038XA115AZ) shows a plant community dominated by perennial grasses, sub-shrubs, perennial forbs and with native annual forbs and grasses making up from 5 to 30% of the species composition by weight. Large

shrubs like catclaw and mimosa can make up from 4-7% and succulents like prickly pear can make up from 2 to 4% of the species composition by weight. Annual production of the plant community varies from 300 lbs/ac (air dry) in drought years to over 1300 lbs/ac in wet years.

At present nearly all of the areas of this site on the Horseshoe allotment in the Bull, Boone Tank, Double Tanks and New Well pastures are similar in condition to the potential plant community as described in the ecological site description. Non-native annual forbs and grasses now occur everywhere on the allotment. In most places these species have blended with the native annual component of the plant community. In the Lousy and west side of the Joe's Hill pasture wild oats has become dominant on areas of this site and perennial grass cover is greatly reduced. In the same two pastures large shrubs like catclaw acacia and mimosa appear to be increasing on areas of this site. The loss of perennial grasses and forbs and increase in dominance by invasive annuals (especially wild oats) has been investigated on Black Mesa to the southwest of Joe's Hill (McAuliffe and King, 2010). Prescribed fire around Joe's Hill during the same time period coupled with the movement of wild oats (SW prevailing winds) from Black Mesa appears to be the casual factor in the vegetative change occurring in these two pastures on the Horseshoe allotment. These areas have experienced very little grazing use during the past 10 years and it appears that vegetative change is being driven by the interaction of fires (both prescribed and wild), drought and the presence of invasive annual grasses.

Table 11.

Foliar cover by plant functional group			
Functional group	Present mean	Stdev	NRCS ESD
Large Shrubs	4.3	2.9	2-3%
Sub-shrubs	1.1	1.4	2-5%
Snakeweed	4.0	4.5	0-1%
Tobosa	7.5	4.5	5-15%
Other Per. Grass	1.4	1.5	5-15%
Perennial forb	2.4	2.4	1-10%
N. Annual grass	11.6	6.9	1-20%
N. Annual forb	3.1	3.4	1-15%
Succulents	2.7	2.1	0-2%
Trees	0.8	1.5	0.00
Red brome	9.9	6.6	0.00
Wild oats	1.8	3.9	0.00

Table 11 shows summary data from 16 Volcanic Upland sites where foliar cover data was collected from AIM plots on the Horseshoe allotment. It also compares this data to that shown on the NRCS ESD for Volcanic Upland (R038XA115AZ).

Table 12.

Cover categories	Mean	Stdev	NRCS ESD
Foliar Cover, per grass/sub shrub	16.4	5.8	15-30%
Bare Ground	20.0	7.0	5-55%
Basal Cover	2.6	2.0	2-5%
Total Litter	48.4	14.1	10-40%
Gravel /rock	25.9	18.4	25-60%

Table 12 shows the relationship of cover categories found in the field (present) to those shown on the NRCS ESD. The desired plant community for the Volcanic Upland ecological site should be a diverse community with perennial grasses > native annual forbs and grasses> sub-shrubs> large shrubs> perennial forbs> succulents.

Desired Resource Conditions are shown in Table 13 for Volcanic Upland ecological site on the Horseshoe allotment. These show a range in values from disturbance like fire, back to equilibrium conditions and from drought to average year precipitation.

Table 13.

Categories	Objective
Foliar Cover per grass/sub shrub	15-30%
Bare Ground	5-55%
Basal Cover	2-5%
Total Litter	10-40%
Gravel /rock	20-60%
Annual Production	300-1300 lbs/ac

Volcanic Hills, Clayey 12-16" pz.

This ecological site is described by NRCS as a diverse plant community dominated by perennial grasses (including tobosa) with an important component of native annual grasses and forbs (both cool and warm season species). Sub-shrubs, large shrubs, trees, perennial forbs and succulents are important components of the potential native plant community. McAuliffe and King (2010) used repeat aerial photography to document a history of land use and vegetative changes over time on Black Mesa. Their study site, located a few miles to the southwest of the Horseshoe allotment, consisted of a complex of Clayey Upland and Volcanic Upland ecological sites (Rimrock – Graham soil mapping unit). In their assessment of historic vegetative conditions they determined that the steeper slopes associated with the top of Black Mesa always had a diverse plant community including shrubs, succulents and trees.

The ESD for Volcanic Hills, Clayey (R038XA117AZ) shows a plant community dominated by perennial grasses, sub-shrubs, perennial forbs and with native annual forbs and grasses making up from 5 to 20% of the species composition by weight. Large shrubs species are numerous and can make up from 5-10% and succulents like prickly pear, banana yucca and agave can make up from 3 to 8% of the species composition by weight. Trees are common on north exposures and can be 0-5% of the composition by weight. Annual production of the plant community varies

from 700 lbs/ac (air dry) in drought years, 1200 in average rainfall years to 2000 lbs/ac in wet years.

Photo 14. Volcanic Hills, Clayey in good ecological condition. Near Bob's tank in Joe's Hill pasture.

At present nearly all of the areas of this site on the Horseshoe allotment in the Bull, Boone Tank, Double Tanks and New Well pastures are similar in condition to the potential plant community as described in the ecological site description. In some places large shrubs like catclaw acacia, velvet mesquite (*Prosopsis velutina*) and mimosa appear to be increasing on areas of this site. This is probably due to climatic warming as these species sprout vigorously after fire and livestock grazing does not appear to have been heavy enough to affect the plant community on these steep and rocky slopes. On north exposures at the higher elevations of this site, redberry juniper may be increasing as plant communities have many young trees in them. Fire may be important in the management of this tree species.

Table 14.

Foliar cover by plant functional group			
Functional group	Mean	Stdev	NRCS ESD
Large Shrubs	5.8	5.3	5-15%
Sub-shrubs	4.7	3.7	1-10%
Snakeweed	12.7	10.3	0-2%
Tobosa	4.2	3.0	5-10%
Other Per. Grass	6.7	3.0	10-20%
Perennial forb	2.5	2.3	1-5%
Annual grass	3.3	3.5	0-15%
Annual forb	1.9	2.1	0-5%
Succulents	5.0	4.7	1-10%
Trees	2.7	4.2	0-10%
Red brome	15.0	9.8	0
Wild oats	0.2	0.3	0

Table 14 shows the relationship of cover categories found in the field (mean %) on 8 Volcanic Hills, Clayey sites to the same categories as shown on the NRCS ESD.

Table 15.

Cover categories	Mean	Stdev	NRCS ESD
Foliar Cover, p grass/s shrub	28.3	12.8	20-30%
Bare Ground	10.5	9.1	5-20%
Basal Cover	3.4	1.9	3-6%
Total Litter	43.6	13.6	10-45%
Gravel /rock	36.7	17.1	25-60%

Table 15 shows the summary data from 8 Volcanic Hills, Clayey sites where foliar cover data were collected from AIM plots on the Horseshoe allotment. It also compares these data to that shown on the NRCS ESD for Volcanic Hills, Clayey (R038XA117AZ). The desired plant community for the Volcanic Hills, Clayey ecological site should be a diverse community with perennial grasses > sub-shrubs > large shrubs > native annual forbs and grasses > perennial forbs > succulents > trees.

Desired Resource Conditions are shown in Table 16 for Volcanic Hills, Clayey ecological site on the Horseshoe allotment. These show a range in values from disturbance like fire, back to equilibrium conditions, from drought to average year precipitation and from north to south aspects.

Table 16.

Cover categories	Objectives
Foliar Cover p grass/s shrub	20-30%
Bare Ground	5-20%
Basal Cover	2-5%
Total Litter	10-45%
Gravel /rock	25-60%
Annual production	670-2000

Granitic Hills 12-16" pz.

This ecological site is described by NRCS as a diverse plant community dominated by perennial grasses and forbs. Sub-shrubs, large shrubs, succulents and trees are important components of the potential native plant community. Due to shallow, coarse textured soils this ecological site has a minor component of native annual grasses and forbs.

The ESD for Granitic Hills (R038XA104AZ) shows a plant community dominated by perennial grasses, sub-shrubs and large shrubs. Perennial forb species are numerous and can make up from 1-6% of the species composition by weight. Succulent species like prickly pear, banana yucca, hedgehog and cholla can make up from 1 to 10% of the species composition by weight. Trees are common on north exposures and are from 0-10% of the species composition by weight. Native annual forbs and grasses make up less than 5% of the species composition by weight. Annual

production of the plant community varies from 335 lbs/ac (air dry) in drought years, 720 in average rainfall years to 1600 lbs/ac in wet years.

At present the areas of this site on the Horseshoe allotment are similar in condition to the potential plant community as described in the ecological site description except that plant functional groups perennial grasses and sub-shrubs have switched dominance. Sub-shrubs are now dominant and perennial grasses sub dominant. Since grazing has not been a recent factor in the North and South River pastures this switch is probably due to steep declines in warm season precipitation and increasing summer temperatures over the past 17 years. The dominant sub-shrubs are cool season plants while the dominant perennial grasses are warm season plants. Wait-a-bit mimosa appears to be increasing in areas of this site. This may be driven by increases in winter temperatures. It is probably not related to historic livestock grazing or lack of fire in the area as it appears to be a region-wide trend and mimosa sprouts vigorously after fire.

Photo 15. Granitic Hills in good ecological condition. North and south aspects in the South River pasture.

Table 17.

Functional group	Mean	NRCS ESD
Large Shrubs	12.4	10-20%
Sub-shrubs	13.6	6-15%
Snakeweed	6.3	1-5%
Perennial Grass	4.3	2-15%
Perennial forb	1.9	1-3%
Annual grass	0	0-5%
Annual forb	0.7	0-3%
Succulents	2.6	1-5%
Trees	2.7	1-6%
Red brome	18.7	0
Wild oats	0	0

Table 17 shows the relationship of cover categories found in the field (mean %) on 2 Granitic hills sites to the same categories as shown on the NRCS ESD.

Table 18.

Cover category	Mean	Stdev	NRCS ESD
Foliar Cover, p grass/s shrub	24.2	12.3	10-30%
Bare Ground	19.3	6.6	10-50%
Basal Cover	0.6	0.9	2-5%
Total Litter	47.6	11.8	20-50%
Gravel / rock	36.0	4.2	25-60%

Table 18 shows the summary data from 2 Granitic Hill sites where foliar cover data were collected from AIM plots on the Horseshoe allotment. It also compares these data to that shown on the NRCS ESD for Granitic Hills (R038XA104AZ). The desired plant community for the Granitic Hills ecological site should be a diverse community with perennial grasses > sub-shrubs > large shrubs > perennial forbs > succulents > trees > native annual forbs and grasses.

Desired Resource Conditions are shown in Table 19 for Granitic Hills ecological site on the Horseshoe allotment. These show a range in values from disturbance like fire, back to equilibrium conditions, from drought to average year precipitation and from north to south aspects.

Table 19.

Cover category	Objectives
Foliar Cover, p grass/s shrub	10-30%
Bare Ground	10-50%
Basal Cover	1-5%
Total Litter	20-50%
Gravel / rock	25-60%
Annual production	335 - 1600

Clayey Slopes 12-16” pz.

This ecological site is described by NRCS as a diverse plant community dominated by perennial grasses (including tobosa) with an important component of native annual grasses and forbs (both cool and warm season species). Sub-shrubs, large shrubs, trees, perennial forbs and succulents are important components of the potential native plant community.

The ESD for Clayey Slopes (R038XA108AZ) shows a plant community dominated by perennial grasses, sub-shrubs, perennial forbs and with native annual forbs and grasses making up from 2 to 20% of the species composition by weight. Large shrubs species are can make up from 1-10% and succulents like prickly pear, banana yucca and agave can make up from 1 to 5% of the species composition by weight. Trees are common on north exposures and can be 0-5% of the composition by weight. Annual production of the plant community varies from 360 lbs/ac (air dry) in drought years, 800 lbs/ac in average rainfall years to 1450 lbs/ac in above average years.

Table 20.

Foliar cover by plant functional group		
Functional group	Mean	NRCS ESD
Large Shrubs	13	1-7%
Sub-shrubs	1	1-5%
Snakeweed	2	1-5%
Tobosa	13.1	10-15%
Other Per. Grass	5.7	5-15%
Perennial forb	4	0-5%
Annual grass	0.6	0-10%
Annual forb	0.6	0-10%
Succulents	4.1	1-5%
Trees	5.1	0-2%
Red brome	17.3	0
Wild oats	0	0

Table 20 shows the relationship of cover categories found in the field (mean %) on 3 Clayey Slopes sites to the same categories as shown on the NRCS ESD.

Table 21.

Summary Category	**Percent**	**NRCS ESD**
Foliar Cover, p grass/s shrub/forb	22.2	15-30%
Bare Ground	24.2	5-35%
Basal Cover	3.3	6-12%
Total Litter	46.4	15-65%
Gravel / rock	16.4	35-60%

Table 21 shows the summary data from 3 Clayey Slopes sites where foliar cover data were collected from AIM plots on the Horseshoe allotment. It also compares these data to that shown on the NRCS ESD for Clayey Slopes (R038XA108AZ). The desired plant community for the Clayey Slopes ecological site should be a diverse community with perennial grasses > sub-shrubs > large shrubs > native annual forbs and grasses > succulents > perennial forbs > trees.

Desired Resource Condition's are shown in Table 22 for Clayey Slopes ecological site on the Horseshoe allotment. These show a range in values from disturbance like fire, back to equilibrium conditions, from drought to average year precipitation and from north to south aspects.

Table 22.

Summary Category	**Objectives**
Foliar Cover, p grass/forb/s shrub	15-30%
Bare Ground	5-35%
Basal Cover	3-8%
Total Litter	15-65%
Gravel / rock	35-60%
Annual production	360-1450

Riparian Resources

Proper Functioning Condition Assessments

Proper functioning conditions assessments were conducted in the Horseshoe Allotment since the early 1990s. Assessments have been conducted on all designated riparian areas within the Horseshoe allotment. Many of the segments were determined to be Functional at Risk (FAR). Causal factors for the "at risk" were livestock, particularly in the 1990s, and the Cave Creek Complex fire which impacted Silver Creek in 2005 and the years after.

Table 23. Proper Functioning Condition Assessments.

Agua Fria River Segment	Length (BLM/Private)	Year	Rating	Comments
1N	3.3/0.6	1991	Satisfactory	
		1995	FAR N/A	
		1998	FAR Upward trend	Urbanization within watershed and road crossing
		2013	FAR Upward trend	Ground water pumping and drought
1M	3.0/0	1991	Satisfactory	
		1998	FAR Upward trend	
		2006	FAR N/A	
Bishop Creek Segment	**Length (BLM/Private)**			
42A	2.0/0	2006	PFC	
		2013	PFC	
Indian Creek Segment	**Length (BLM/Private)**			
44A	2.1/0	1992	Unsatisfactory	
		1995	FAR NA	Stable Condition
		1998	FAR Upward trend	
		2013	FAR NA	Ground water pumping, drought
Silver Creek Segment	**Length (BLM/Private)**			
43A	3.0/0	1992	Satisfactory	
		1995	FAR Upward trend	
		1998	FAR Upward trend	
		2013	FAR Downward Trend	High Sediment Loading from CCC Fire
43B	2.0/0	1992	Unsatisfactory	Cattle Use Casual Factor
		1995	FAR NA	

Agua Fria River Segment	Length (BLM/Private)	Year	Rating	Comments
		1998	FAR Upward trend	
		2013	FAR Downward	Sediment from Cave Creek complex fire
43C	2	1995	FAR NA	Stable Condition
		1998	FAR Upward trend	
		2003	FAR Downward Trend	
		2005	PFC	
		2013	FAR NA	Sediment form Cave Creek Complex Fire
***FAR: Functional At risk, NA: Not Apparent, PFC: Proper Functioning Condition**				

Multiple Indicator Monitoring

Representative Designated Monitoring Areas (DMAs) were selected within the Agua Fria River, Indian Creek, and designated critical habitat within Silver Creek. MIM was not performed at Bishop Creek due to a lack of adequate riparian components to conduct the protocol. At each of the MIM plots, bank stability, bank alterations, greenline width, greenline herbaceous and woody vegetation attributes were recorded. These indicators are used to determine if riparian objectives within the RMP are met and to inform quantitative PFC assessments. In the case of critical habitat within Silver Creek, MIM is used to document livestock use within the creek and establish if thresholds set forth by the USFWS Biological Opinion (2241-0-05-F-0785) have been exceeded.

The greenline is a linear grouping of live perennial vascular plants, embedded rock, or anchored wood above the waterline on or near the water's edge. Species composition includes both the perennial vegetation rooted within the frame as well as the mature overstory hanging over the plot. Generally, stream banks are dominated by native grasses, sedges and other riparian obligate species. Woody species include all age classes of willow, cottonwood, seep willow, velvet ash, and other riparian obligate trees with a minor component of salt cedar. In narrow riparian systems such as Indian and Silver Creek, only MIM was used to determine woody species composition. In the broad channel of the Agua Fria River, woody species transects were also conducted to capture trees outside the narrow greenline in PFC segment 6235-1N (Table 23).

Table 24. MIM Greenline Composition Percentages for the Agua Fria River.

PLANT SPECIES COMPOSITION	Common Name	Species Plant Code	Greenline Composition
Agua Fria River 6235-1N: 2012	Seep Willow	BASA4	5.8%
	Spike Rush	ELPA3	4.6%
	Deer Grass	MURI2	0.3%
	No Greenline	NG	0.3%
	Cottonwood	POFR2	44.0%
	Rock	RK	26.5%
	Gooding's willow	SAGO	5.5%
	Three Square	SCPU3	5.1%
	Salt cedar	TARA	0.0%
	Wood	WD	0.1%
	Cattail	TYPHA	8.0%

Table 25. Greenline Composition Percentages for Silver Creek.

PLANT SPECIES COMPOSITION	Common Name	Species Plant Code	Greenline Composition
Silver Creek 6235-1C: 2013	Sedge	CAREX	0.8%
	Spike Rush	ELPA3	18.4%
	Velvet Ash	FRVE2	15.6%
	Deer Grass	MURI	31.3%
	No Greenline	NG	0.0%
	Cottonwood	POFR2	2.5%
	Rock	RK	8.3%
	Three Square	SCPU3	20.7%
	Wood	WD	2.5%

Table 26. MIM Greenline Composition Percentages for Indian Creek.

PLANT SPECIES COMPOSITION	Common Name	Species Plant Code	Greenline Composition
Indian Creek 6235-44A: 2013-2014	Spike Rush	ELPA3	12.8%
	Velvet Ash	FRVE2	24.1%
	Juniper	JUOS	2.5%
	Deer Grass	MURI2	8.5%
	No Greenline	NG	1.3%
	Rock	RK	7.3%
	Gooding's Willow	SAGO	20.0%
	Salt cedar	TARA	0.2%
	Wood	WD	0.1%
	Velvet Mesquite	PRVE	17.4%
	Sycamore	PLWR2	5.4%
	Spiny Hackberry	CEEH	0.2%
	Fremont Barberry	MAFR3	0.2%
	Bermuda grass	CYDA	0.1%

Table 27. MIM woody species age class percentages.

Woody Species Transects Agua Fria River 6235-1N: 2013	Seedling	Young	Mature
AGE CLASS TOTALS	87	73	74
% of TOTAL	37	31	32

Stubble height, an important indicator of use, found that all plots exhibited a "none to slight" use of palatable herbaceous species (Table 13). Spike Rush (*Eleocharis palustris*), deer grass (*Muhlenbergia rigens*), common three square (*Schoenoplectus pungens*), were commonly encountered palatable species that were measured. Although not a preferred browse species, cattail (*Typha* sp.) measurements were also recorded. These water adapted plants are necessary to provide bank stabilization and habitat for many wildlife species.

Table 28. MIM Stubble Height Median and Mean for all key species.

	Stubble Height			
	MedianSH all key species (cm)	*Average SH for all key species (cm)*	*Dom key species for SH*	*Avg Ht of dom key species*
Agua Fria River 6235-1N: 2012	100.00	105.5	TYPHA	163.57
	n=	38	14	
	95% conf Int1	17.2		22
	95% CI2	**0.96**		
Silver Creek 6235-1C: 2013	25.00	41.9	MURI2	82.93
	n=	81	27	
	95% conf Int1	7.4		10
	95% CI2	**0.96**		
Indian Creek 6235-44A: 2013-2014	41.50	41.8	MURI2	63.63
	n=	32	16	
	95% conf Int1	8.3		5
	95% CI2	**0.96**		

Woody riparian plants contribute to stream banks stability and provide important habitat for wildlife species. Livestock are known to browse on woody species which inhibits recruitment (Leonard et al. 1997). Woody species use is a MIM indicator of grazing utilization on woody species along stream banks. MIM results in all riparian areas within the Horseshoe allotment indicated a slight (0-20%) use (Table 29). This is expected give livestock have not had access to riparian areas within the allotment since 2005.

Table 29. MIM Woody Species Use, Stream bank alteration, and Woody Species Age Class percentages. Confidence intervals are listed in bold.

	Woody Use	Streambanks			Woody Species Age Class		
	Woody Species Use - all woody species (%)	*Streambank Alteration (%)*	*Streambank stability(%)*	*Streambank cover (%)*	*Percent seedlings*	*Percent Young*	*Percent Mature*
Agua Fria River 6235-1N: 2012		0%	93%	44%	54%	46%	0%
	0	49	81	81	245	238	11
		0%	*	*	1		
	5%	**6%**	**5%**	**5%**	**7%**	**7%**	**7%**
Silver Creek 6235-1C: 2013	4.8%	0%	86%	86%	56%	19%	25%
	7	74	74	74	10	4	6
		0%	*	*	1		
	5%	**6%**	**5%**	**5%**	**7%**	**7%**	**7%**
Indian Creek 6235-44A: 2013-2014	10.0%	0%	99%	19%	13%	73%	13%
	44	64	84	84	2	14	2
		0%	*	*			
	5%	**6%**	**5%**	**5%**	**7%**	**7%**	**7%**

Stream bank stability, ecological status rating and wetland rating are determined qualitatively by observing whether the stream banks are depositional or erosional; whether they are covered or uncovered; and whether any type of instability is occurring (i.e. fracturing, slumping, sloughing, or eroding) and the type of vegetation growing along the greenline. For the bank to be considered covered, the stream bank must be covered by at least either 50% foliar cover of perennial vegetation, 50% cover of cobbles 15cm or greater, 50% cover of anchored large woody debris 10 cm diameter or greater, or 50% cover of a combination of the three. These parameters are used to determine ecological status, wetland rating and site stability.

Riparian Desired Resource Conditions

Desired Plant Community for Silver Creek riparian: Overstory dominated by native riparian obligate trees including Fremont cottonwood (*Populus fremontii),* Gooding's willow (*Salix gooddingii),* net leaf hackberry (*Celtis reticulate)* and Arizona sycamore (*Platanus wrightii*). Multiple age-classes of riparian trees are present to provide recruitment for maintenance and recovery. The age class distribution should be >15 percent seedlings, > 15 percent young, and >15 percent mature (age class according to BLM Tech Reference 1737-23). Herbaceous riparian streambank vegetation dominated by three square (*Schoenoplectus pungens*), spikerush (*Eleocharis palustris*), cattail (*Typha latifolia),* and common reed (*Phragmites australis*).

Desired Plant Community for Indian Creek riparian: Overstory dominated by native riparian obligate trees including Fremont cottonwood (*Populus fremontii*), Gooding's willow (*Salix gooddingii*), velvet ash (*Fraxinus velutina*) and Arizona sycamore (*Platanus wrightii*). The age class distribution should be >15 percent seedlings, > 15 percent young, and >15 percent mature (age class according to BLM Tech Reference 1737-23). Herbaceous riparian streambank vegetation dominated by three square sedge (*Schoenoplectus pungens*), cattail (*Typha latifolia*), and common reed (*Phragmites australis*).

Desired Plant Community for the Agua Fria River: In areas that are less prone to scouring and where there is sufficient soil development and soil moisture the Desired Plant Community consists of herbaceous riparian streambank vegetation dominated by three square sedge (*Schoenoplectus pungens*), and spikerush (*Eleocharis* spp.). The riparian overstory is dominated by native riparian obligate tree species including Gooding's willow (*Salix gooddingii),* velvet ash (*Fraxinus velutina*), and Fremont cottonwood (*Populus fremontii).* The age class distribution should be >15 percent seedlings, > 15 percent young, and >15 percent mature (age class according to BLM Tech Reference 1737-23).

Desired Plant Community for Bishop Creek riparian: Overstory dominated by native riparian obligate trees including Fremont cottonwood (*Populus fremontii),* Gooding's willow (*Salix gooddingii),* net leaf hackberry (*Celtis reticulate)* and Arizona sycamore (*Platanus wrightii*). Multiple age-classes of riparian trees are present to provide recruitment for maintenance and recovery. The age class distribution should be >15 percent seedlings, > 15 percent young, and >15 percent mature (age class according to BLM Tech Reference 1737-23). Herbaceous riparian streambank vegetation dominated by three square (*Schoenoplectus pungens*), spikerush (*Eleocharis palustris*), cattail (*Typha latifolia),* and common reed (*Phragmites australis*).

8.2 Conclusions

Standard 1 - Upland sites

Standard 1 is being met across the Horseshoe Allotment. Overall, plant communities found on the various ecological sites within the allotment are in good ecological condition and support adequate soil stability and hydrologic function. Some areas of the allotment have Red Brome and other non-native invasive plants within the upland plant communities. This is a common occurrence within most plant communities across Arizona; however, these areas will need special attention as management moves forward due to the impact that invasive species can have on soil stability and hydrologic function. Other areas of the allotment have moved to a late successional state, which has allowed woody species (e.g. Catclaw acacia) to become dominate. These areas will also need special attention as management moves forward because of the impact that they can have on soil stability and hydrologic function. Overall, there is no indication that current livestock grazing is having negative impacts on the upland areas of the allotment.

Standard 2 - Riparian and wetland sites

Standard 2 is being met across the Horseshoe Allotment. PFC data shows that riparian areas are being impacted due to high sediment loading from the upland areas of the allotment from the Cave Creek Fire. Sediment loading will likely continue to decrease as upland and riparian areas become vegetated and stable. PFC data also shows that groundwater pumping and drought are likely having an impact on Indian Creek. MIM data shows that the riparian resources within the allotment have good age class diversity, including excellent recruitment numbers. MIM data also shows that there is good biodiversity of desired species within riparian areas. MIM data also shows good recruitment of riparian vegetation, good stream bank stability, and low stream bank alteration. Livestock grazing that doesn't allow hot season grazing will likely continue to benefit riparian areas found within the allotment. Overall, there is no indication that current livestock grazing is having any negative impacts on the riparian areas within the allotment.

Standard 3 - Desired Resource Conditions

Standard 3 is being met in most of the upland areas on the Horseshoe Allotment. The area of Clayey Uplands and Volcanic Uplands in the western part of Joe's Hill and in the Lousy pastures are being compromised by drought, fire and the invasion of non-native annuals especially wild oats, red brome and black mustard. These species affect the ability of plant functional groups like perennial grasses, sub-shrubs and perennial forbs to recover on these two ecological sites after disturbance like drought and fire.

Standard 3 is being met in all of the riparian areas within the allotment. Riparian areas within the allotment should be dominated by native woody and herbaceous vegetation, which they currently are. The age class distribution of native riparian vegetation should be >15 percent seedlings, > 15 percent young, and >15 percent mature (age class according to BLM Tech Reference 1737-23). Looking at the MIM data, all of the riparian areas within the allotment meet, or are making significant progress towards meeting vegetation distribution percentages.

9.0 Management Recommendations

Fire management should include aggressive suppression of all wildfires especially in the southwestern part of the allotment where non-native and invasive annuals are spreading. Targeted grazing could be evaluated in this area to break up the continuity of fine fuels resulting from heavy infestations of wild oats, red brome and black mustard.

The livestock water developments across much of the allotment are dirt tanks which are not reliable sources. Efforts should be made to develop reliable water sources including water wells, catchments and storage tanks with pipelines and troughs. Effective livestock grazing management is only possible with reliable sources of water spaced evenly across the accessible (for cows) areas of rangeland.

The proposed grazing system using one herd moving in rotation through pastures should be adopted. Rest periods after a pasture is grazed should be from 12 to 24 months depending on climatic conditions and forage plant recovery. The system should allow flexibility in livestock grazing use and accommodate longer rest periods that might be needed after severe disturbance like fire.

Actual use records including animal numbers, dates in pastures should be turned into the BLM within 15 days of the end of the grazing season, or when the permittee removes their cattle.

Utilization studies should be conducted each year at random locations within a half mile of available water at the end of the grazing period or the end of the grazing year (May-June).

An adaptive management process should be codified within the CRM framework to allow for yearly review of all activities on the allotment and to incorporate monitoring results into the process to refine applied management. Long term monitoring should be repeated accordingly to management goals.

10.0 List of Preparers

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11.0 Interagency Review

An interagency review of the rough draft version of this LHE was completed by the Horseshoe-Copper Creek Coordinated Resource Management Plan Land Use Committee. The committee was comprised of members from various state and federal natural resource management agencies. Comments provided to the BLM from the rough draft review were incorporated into this draft LHE.

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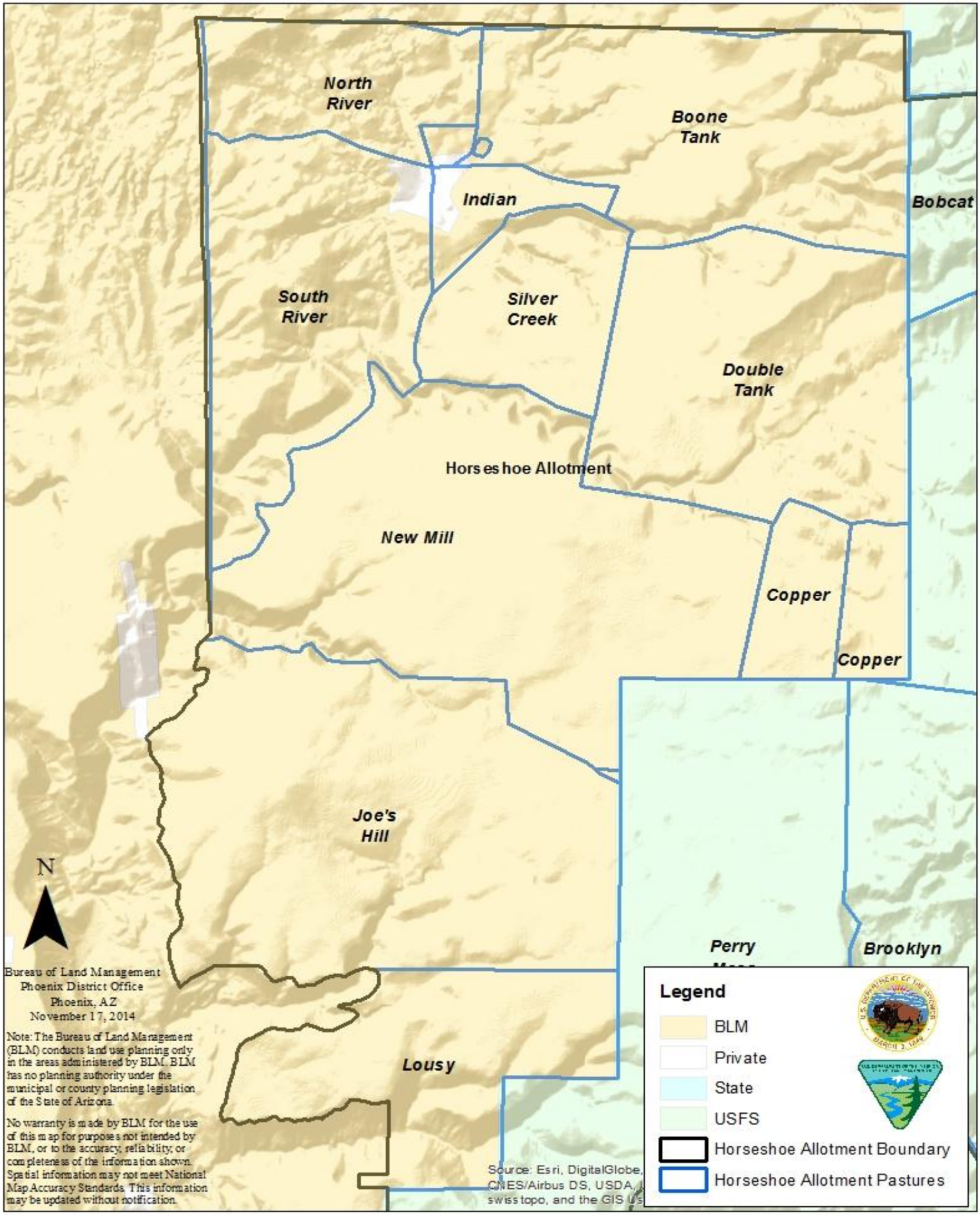
13.0 Maps

Map 1. Horseshoe Allotment with Pasture Locations



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November 17, 2014

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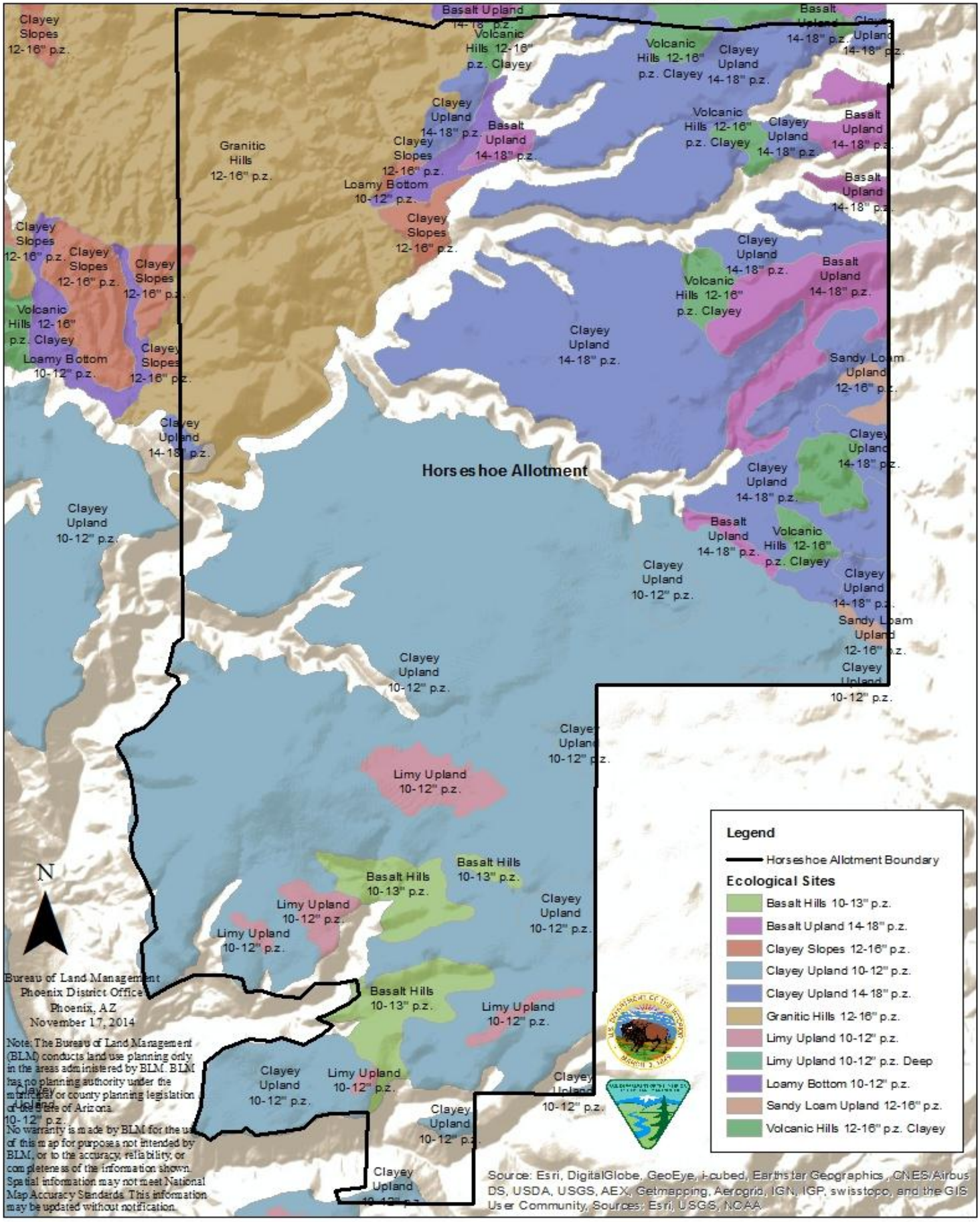
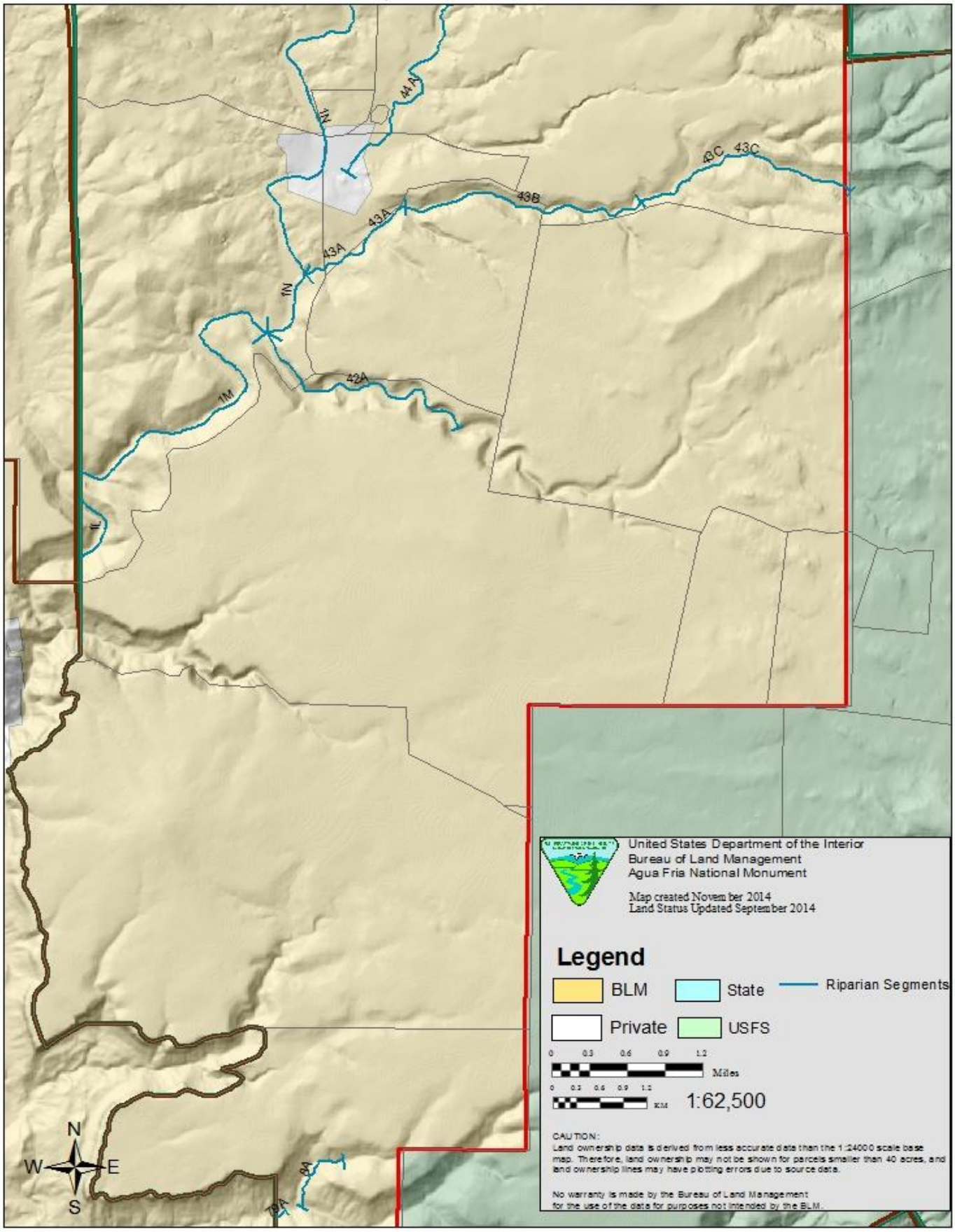
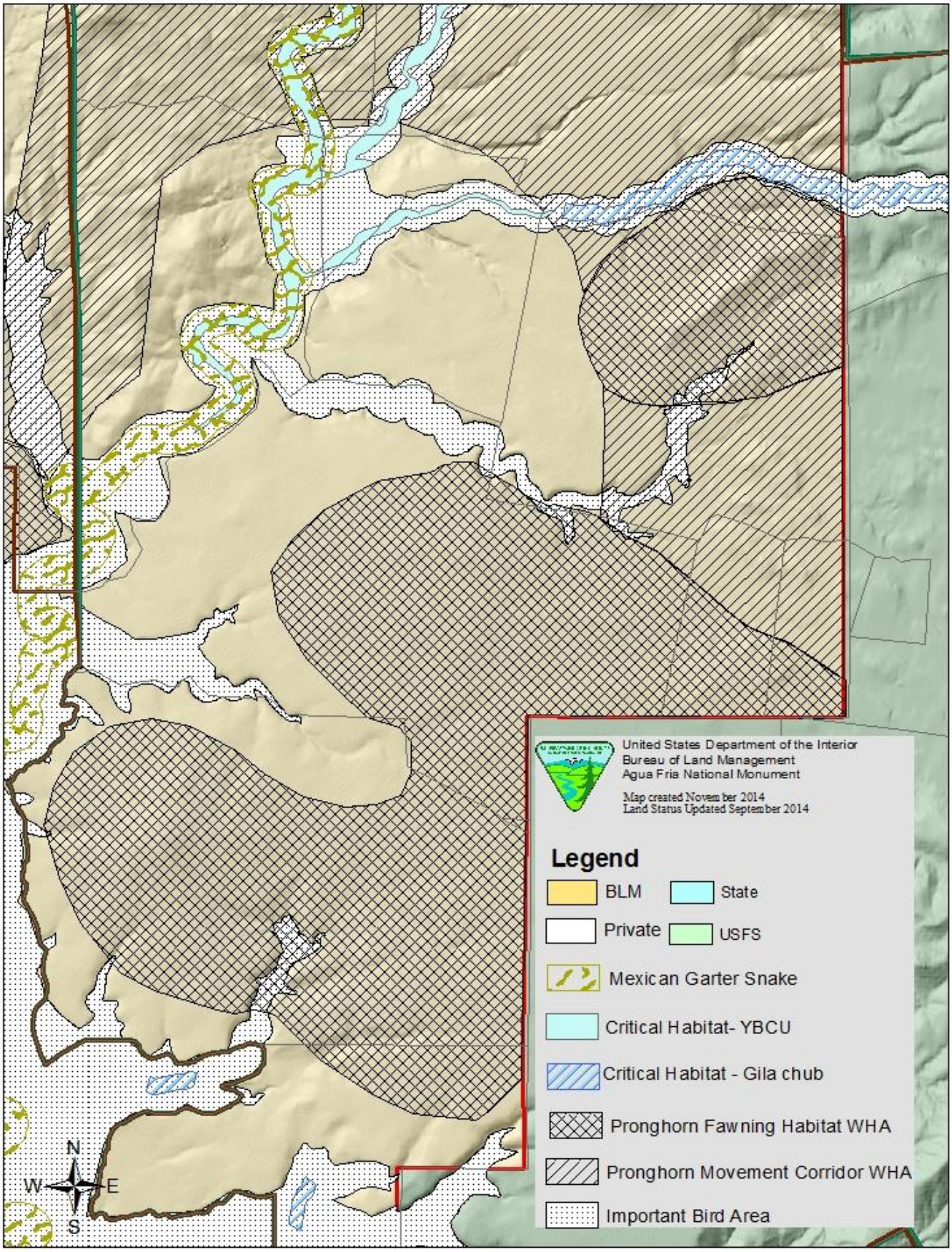
Map 2. Horseshoe Allotment Major Ecological Sites



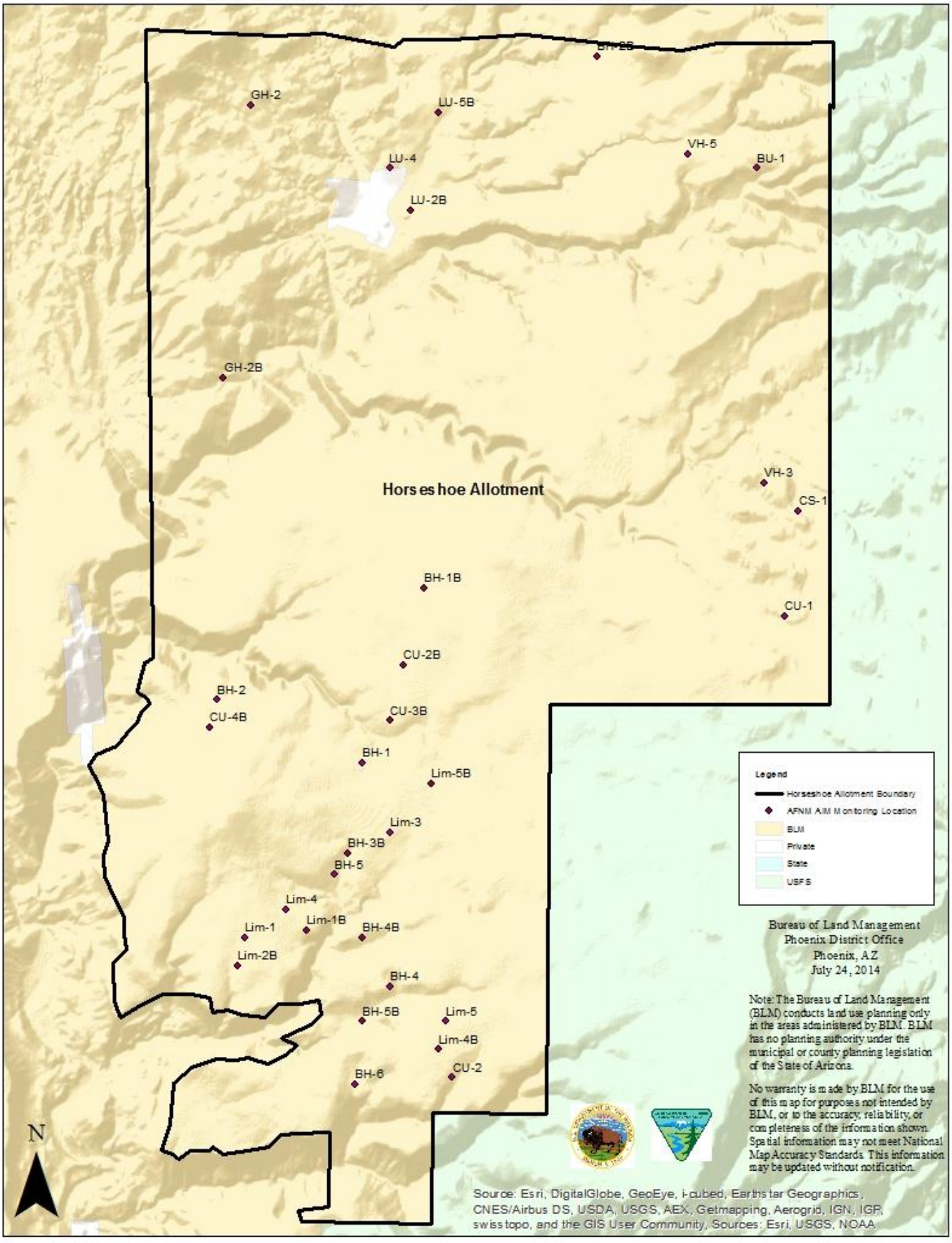
Map 3. Riparian Resources



Map 4. Wildlife Special Designation Areas



Map 5. Horseshoe Allotment AIM Monitoring Locations



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