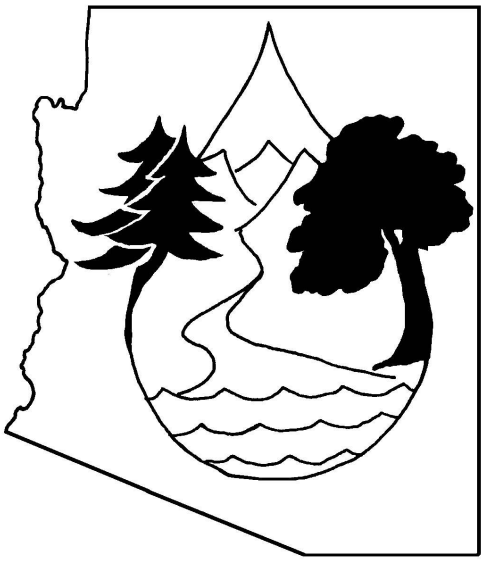
THIRTEENTH MEETING OF THE ARIZONA RIPARIAN COUNCIL

Radisson Woodlands Hotel
Flagstaff, Arizona
April 30-May 1, 1999

Ungulate Grazing in Riparian Areas



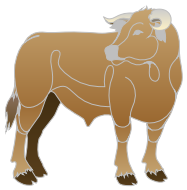
PROGRAM AND ABSTRACTS
1999

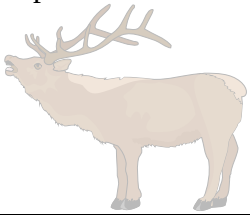
Thirteenth Annual Meeting
Arizona Riparian Council
Radisson Woodlands Hotel
Flagstaff, Arizona
April 30-May 1, 1999

UNGULATE GRAZING IN RIPARIAN AREAS

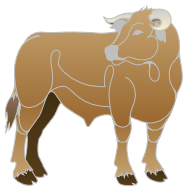
FRIDAY, April 30

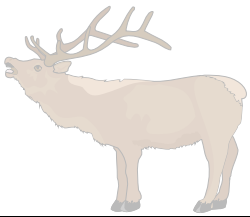
7:30-10:00	Registration
8:30-8:45	Welcome – Kris Randall, President
8:45-9:15	Overview of Elk Grazing Impacts – Rick Miller, Arizona Game and Fish Department
9:15-9:40	Endangered Species Act – Bruce Palmer, U.S. Fish Wildlife Service
9:40-10:05	Agency Obligations under the Endangered Species Act with Respect to Domestic Livestock Grazing and How Those Obligations Are Being Met – Dave Stewart, U.S. Forest Service
10:05-10:30	BREAK -- San Francisco Room
10:30-10:55	Ungulate Grazing Management Strategies in Game Management Unit 4A -- Kate Kline, U.S. Forest Service and Rick Remington, Arizona Game and Fish Department
10:55-11:30	Panel Discussion of Invited Speakers – Marty Jakle, Moderator
11:30-11:45	Business Meeting
11:45-1:00	LUNCH – Gazebo
1:00-1:15	Managing Watersheds to Improve Streams from the Mountains to Near Sea Level in Arizona -- William E. Werner, Arizona Game and Fish Department
1:15-1:30	Burro Creek: A Study in Riparian Restoration Through Livestock Management -- Michael Blanton, Bureau of Land Management
1:30-1:45	Evaluation of a Pipe-Rail Fence Exclosure to Preserve the Integrity of Springs in the Sonoran Desert and Their Significance to Mule Deer Populations – Jon D. Hanna, Arizona Game and Fish Department





1:45-2:00	Plant Community Changes Following Cattle and Elk Exclusion at Hoxworth Springs – Rebecca C. Sayers[1], Laura E. DeWald[1], and Abe E. Springer[2], [1]School of Forestry and [2]Department of Geology, Northern Arizona University
2:00-2:15	Riparian Improvement with Livestock Grazing on the Orme Ranch – Alan Kessler, Orme Ranch
2:15-2:30	Observations on Riparian Management on the Arizona Strip – Lee E. Hughes, Bureau of Land Management
2:30-2:45	BREAK – San Francisco Room
2:45-3:00	Ungulate-Fishery Interactions in Southwestern Riparian Ecosystems: Pretensions and Realities – Alvin L. Medina and John N. Rinne, U.S. Forest Service
3:00-3:15	Recent Legal Developments Surrounding Livestock Grazing in Arizona's Riparian Areas – Rolf von Oppenfeld and Richard Campbell, Team for Environmental, Science, and Technology Law Practice Group
3:15-3:30	Patterns of Riparian Tree Physiology and Growth During Dry and Wet Years – Jonathan Horton, Thomas E. Kolb, and Stephen C. Hart, School of Forestry, Northern Arizona University
3:30-3:45	Quantifying the Difference between Restoration Method and Climate in Riparian Restoration – Abe Springer[1], T. Godwin[1], and Laura DeWald[2], [1]Department of Geology and [2]School of Forestry, Northern Arizona University
3:45-4:00	Riparian Vegetation Inventories on Moenkopi Wash, Hopi Indian Reservation, Using Multispectral Airborne Scanner Data, Orthophotos, and a GIS Database – Kyle Bohnenstiehl, Land Information System Office, The Hopi Tribe
4:00-4:15	Population Biology of Arizona Sycamore: Results and Management Applications – Julie Stromberg, Department of Plant Biology, Arizona State University
4:15-4:30	Regional Relationships of Bankfull Stage in Central and Southern Arizona – Tom Moody and W. Odem, College of Engineering and Technology, Northern Arizona University
4:30-5:00	Free
5:00-6:30	Social, Kachina Room (no host cash bar)
6:30	Dinner -- Gazebo





POSTERS (View during breaks)

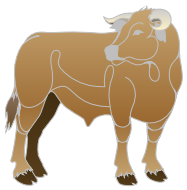
Riparian Improvement with Livestock Grazing on the Orme Ranch – Alan Kessler, Orme Ranch

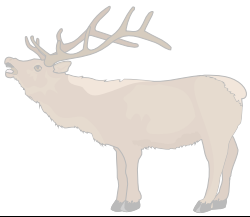
Potential Impacts of Stream Flow Diversion on Riparian Vegetation of Fossil Creek, Arizona – Rebecca Sayers and Charles Avery, School of Forestry, Northern Arizona University

An Ecological Study of *Sporobolus wrightii* (big sacaton) Riparian Grasslands in Southeastern Arizona: Implications for Management and Restoration – Ronald L. Tiller, Brantlee Spakes, Linda Kennedy, Julie Stromberg, Jean Stutz, and Duncan Patten, Department of Plant Biology, Arizona State University

Tools for Riparian Restoration - River Recovery with Livestock Grazing. Don Verner and Ann Verner, Almida Land and Cattle Company, Paulden, AZ.

Are We Ready to Measure Change in Riparian Conditions? - a Rancher's Challenge. George Yard and Sharon Yard, Y-D Ranch, Perkinsville AZ.





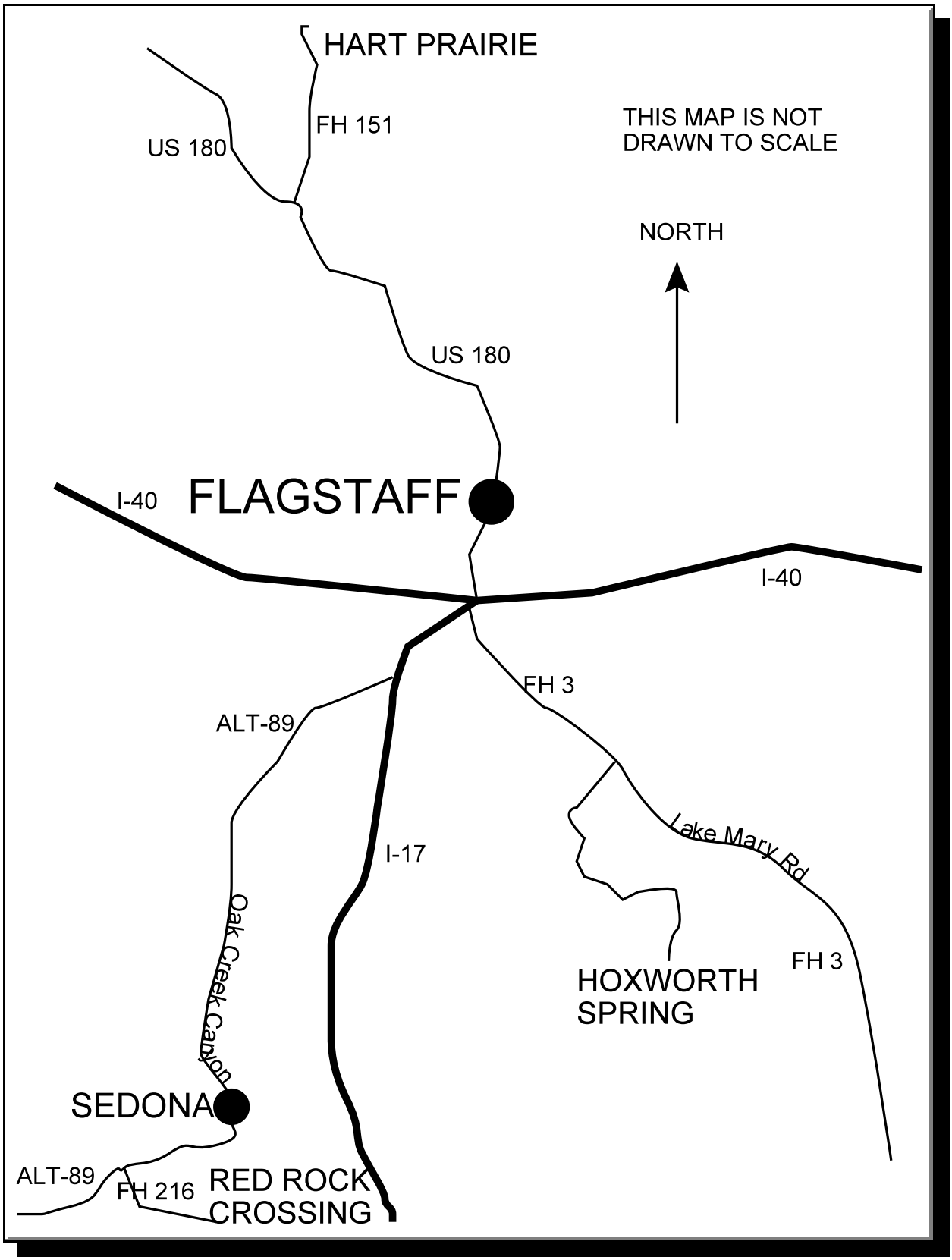
SATURDAY, May 1

FIELD TRIPS

Meet at 7:30 AM in the hotel parking lot. Please plan to bring your own lunch and water.

1. *Hoxworth Springs/Hart Prairie*. In the morning, we will visit riparian restoration sites at Clark Springs and *Hoxworth Springs*. We will be joined by Laura DeWald and Abe Springer of Northern Arizona University, Jeff Hink of the Coconino National Forest, and Rick Miller of Arizona Game and Fish. An Arizona Water Protection Fund grant was awarded for restoration work at this site including establishment of a stable channel configuration. Monitoring includes groundwater levels, effects of elk and cattle, and channel morphology, and revegetation. In the afternoon, we will visit *Hart Prairie* located north of Flagstaff where a Bebb willow restoration project is in progress funded by a Arizona Water Protection Fund grant. The project included restoration of natural stream flow and exclosure fencing and monitoring. C. Hart Merriam maintained a base camp in this picturesque area while he did field work for his classic description of life zones. Laura DeWald and Abe Springer will be joined by Shelley Silbert and Ed Smith of The Nature Conservancy at Hart Prairie for the afternoon portion of the trip. We will pass through Flagstaff between the two portions of the field trip so we do encourage carpooling. We will end the trip at the hotel.

2. *Oak Creek Canyon and Red Rock Crossing*, are located southwest of Flagstaff. This field trip will include several stops through the picturesque canyon to look at effects of flooding on the channel and vegetation, channel restoration efforts, and Red Rock crossing, the site of a controversial bridge proposal. It is not intended that the entire group return to Flagstaff and we will disperse from the last stop.


HART PRAIRIE
FH 151
US 180
THIS MAP IS NOT
DRAWN TO SCALE
NORTH
US 180
I-40
FLAGSTAFF
I-40
FH 3
ALT-89
I-17
Lake Mary Rd
Oak Creek Canyon
FH 3
HOXWORTH
SPRING
SEDONA
ALT-89
FH 216
RED ROCK
CROSSING

ABSTRACTS

BLANTON, M. Bureau of Land Management, Field Office, 2475 Beverly, Kingman AZ 86401.
Burro Creek: a study in riparian restoration through livestock management.

The Bureau of Land Management (BLM) manages public land on the basis of multiple use and sustained yield. This requires integrating the compatible land uses with specific resource objectives. This is accomplished through the development and implementation of activity plans. The allotment management plan (AMP) developed for the Bagdad and Burro Creek allotments, illustrates two approaches to integrating livestock grazing with riparian habitat improvement. Both approaches were aimed at reducing the impacts of livestock grazing within the sensitive riparian habitat. These AMPs were developed to change livestock management from year-long grazing to nongrowing season grazing within the riparian habitat, without adversely affecting the sensitive resource values present on the adjacent upland sites.

Riparian data collected on the Bagdad allotment between 1988 and 1998, were evaluated to determined changes resulting from nongrowing season grazing. Utilization of key vegetation species was measured in riparian and upland study sites. Age class structure of woody riparian species improved when utilization of seedlings was reduced from an average of 65% to under 10%. Utilization levels on adjacent uplands did not change significantly.

Data collected on the Burro Creek allotment from 1981 through 1998 were evaluated to determine changes, resulting from a deferred rotation livestock management system. Age class structure of woody riparian species improved when half of the riparian habitat was deferred from livestock grazing during the growing season each year.

BOHNENSTIEHL, K. Land Information System Office, The Hopi Tribe, 5200 E. Cortland Blvd. A-15, Flagstaff AZ 86004. *Riparian vegetation inventories on Moenkopi Wash, Hopi Indian Reservation, using multispectral airborne scanner data, orthophotos and a GIS database.*

The Hopi Tribe Department of Natural Resources in cooperation with the Arizona Water Protection Fund is evaluating the extent and condition of riparian vegetation along Moenkopi Wash as part of the *Talastima* Wetland Rehabilitation Project. Given the large project area, which encompasses some 52 km of stream channel, and the difficult terrain surrounding the washes, it became apparent that remote sensing would be the only practical tool for inventorying the riparian vegetation. We were fortunate to be able to acquire 15-channel multispectral airborne imagery in July 1998 from NASA/Stennis Space Center through the Commercial Remote Sensing Program/Verification & Validation Team. The ATLAS scanner collects data in 6-visible/near infrared, 2 short wave infrared, and 6 thermal infrared bands at a spatial resolution of 2.6 m. The Learjet 23 simultaneously collected 161 frames of color infrared photography at a scale of 1:8400 using a Zeiss aerial mapping camera. A pilot project area was selected and digital orthophotos were produced to create an accurate basemap for the GIS database. The ATLAS multispectral data were image matched to the orthophotobase and a riparian vegetation classification scheme along NBS/NPS guidelines. Using a hybrid manual/automated classification algorithm, we are able to determine the acreage and dominant species of the riparian vegetation with an accuracy of 90% correctly classified pixels. The results of this interpretation are stored in a GIS database and form the baseline vegetation inventory for the restoration project. Future digital and photographic data acquisitions can be image matched directly to the orthophoto base to simplify the time series analysis of the vegetation change, extent and composition. For areas outside the pilot project area, a known correction algorithm applied to the ATLAS data in conjunction with ground control obtained from USGS 7.5' Digital Raster Graphics is used to georeference the imagery. This method provides accurate acreage of vegetation extent and composition; however, absolute georeferencing is on the order of ±50 m.

HANNA, J. D. Arizona Game and Fish Department, 7200 E. University, Mesa AZ 85207.
Evaluation of a pipe-rail fence exclosure to preserve the integrity of springs in the Sonoran Desert and their significance to mule deer populations.

Because of their rarity, natural springs in the Sonoran Desert provide crucial microenvironments of free-standing water and lush vegetation. The quality of these desert springs may be a limiting factor to wildlife populations, especially during the driest times of the year. Beginning March 1998, a pipe-rail fence was used to exclude cattle from a natural spring in the Sonoran Desert 18 miles north of Phoenix, Arizona. Substantial ecological improvement of the spring was immediate. Qualitative monitoring within the exclosure was continued until July 1998, when cattle were observed inside the exclosure. Structural design and modifications are discussed to improve the integrity of the exclosure. Using survey data, inference as to the significance of these desert springs to mule deer populations is also discussed.

HORTON, J. L.*, T. E. KOLB, and S. C. HART. School of Forestry, Northern Arizona University, Flagstaff, AZ 86011-5018 USA. *Patterns of riparian tree physiology and growth during dry and wet years.*

Riparian forests are a threatened, yet valuable, ecosystem in the southwestern United States. The objective of this study was to understand how the dominant vegetation of southwestern riparian forests responds to inter-annual fluctuations in water availability caused by the El Niño Southern Oscillation. At the Hassayampa River, Arizona, seven transects were established along a gradient of depth to ground water. During both the 1997 and 1998 growing seasons, depth to ground water and soil water content were monitored at each transect. Leaf gas exchange, leaf $\delta^{13}C$, water potential, canopy condition, branch elongation, and radial growth were measured on two native species, *Populus fremontii* and *Salix gooddingii*, and the exotic, *Tamarix chinensis*. Drought-induced water stress was observed in several parameters for both native species but not *Tamarix* in 1997, and this water stress was correlated to differences in ground water availability. In contrast, little water stress occurred in 1998, a wetter year because of a strong El Niño event. Compared to 1997, all species in 1998 had greater radial and branch growth, lower canopy dieback, lower $\delta^{13}C$, higher foliar nitrogen concentration and higher predawn water potentials and rates of leaf gas exchange.

HUGHES, L. E. USDI Bureau of Land Management, Arizona Strip Field Office, 345 E. Riverside Dr., St. George UT 84790. *Observations on riparian management on the Arizona Strip.*

The Virgin River, Kanab Creek, Paria River (barely a creek), and numerous springs that all occur on the Strip all have some management on them. In the early 1990s inventories were done on all the creek and river systems. Trend measurement areas were set up on all creek and river systems and photopoints have been done for a while on fenced springs. Methods of measurement on the river riparian systems include weight and then later structure transects on the woody regeneration zone on the river systems. Weight estimate is used on the wet herbaceous zone. A complete study (hydrology, soils, vegetation) of the Virgin River was done by a team of which I worked with in doing structure transects in the vegetation in 1994. An earlier preliminary study (soils, geomorphology, and vegetation) of riparian vegetation using the weight estimate was done in 1991. Some of the study sites, which have been remeasured and rephotographed, are the subject of discussion.

The parameter of interest is the woody regeneration zone along the rivers and the competition between exotics (tamarisk, mainly) and measurements done seem to indicate, at this point, that the willow can increase or maintain itself in competition with the tamarisk when not grazed.

KESSLER, A. Orme Ranch, HC 63 Box 3042, Mayer AZ 86333. *Riparian improvement with livestock grazing on the Orme Ranch.*

Improvements in upland and riparian areas were brought about by implementation of time-control grazing, using the holistic management model on the Orme Ranch. Since 1982, our philosophy has been to:

Use an interdisciplinary team approach to set goals, objectives, and monitor progress.
Have a detailed future desired landscape description.
Use livestock as a tool to achieve our landscape objectives.

Our emphasis has been on managing uplands in order to increase infiltration and slow runoff by improving soil surface condition and increasing ground cover. It has been our experience that as upland conditions improve there is a corresponding yet faster improvement in riparian areas. Riparian areas have been crossed by new pasture fences but none have been excluded from grazing or isolated in a riparian pasture. The objectives for the riparian areas are an important consideration in grazing planning.

Number of livestock varies each year based on management objectives and forage production. The base number of livestock has increased from 260 in 1981 to 500 in 1998. The number of animals being grazed at one time has fluctuated from a low of 250 to a high of 950. It is necessary to have this flexibility when using livestock as a tool.

The riparian areas have improved because they have benefitted from both increased animal impact and more rest. Specific examples of improvements on Dry Creek, West Estler, and Ash Creek will be illustrated through documentation and photos.

KLINE, K.[1], and R. REMINGTON[2]. [1]Apache-Sitgreaves National Forest, Chevelon-Heber Ranger District, PO 968, Overgaard AZ 85933 and [2]Arizona Game and Fish Department, Region I, HC 66, Box 57201, Pinetop AZ 85935 *Ungulate grazing management strategies in Game Management Unit 4A.*

During 1998, the Arizona Game and Fish Department and USDA Forest Service conducted a joint analysis of ungulate grazing capacity on National Forest land within Game Management Unit 4A. The intent of the analysis was to agree upon a forage distribution between wild ungulates (elk, deer, antelope) and livestock. This presentation will review the analysis process, the resulting forage distribution, and planned Forest Service and Game and Fish Department management activities to address ungulate impacts to watershed and riparian conditions.

MEDINA, A. L., and J. N. RINNE. USDA Forest Service, Rocky Mountain Research Station, 2500 S. Pine Knoll Drive, Flagstaff AZ 86001. *Ungulate-fishery interactions in Southwestern riparian ecosystems: pretensions and realities.*

Riparian ecosystems of the Southwest have recently been the focus of intense scientific and political controversy. The issues are as much debated by scientists in forums, as in the courtrooms or corridors of justice. Many of these discussions are not necessarily aimed at achieving a resolution based on best available information, but rather to establish claims to the resources. Intensive scrutiny of the scientific literature clearly reveals the inadequate scientific database of native fisheries, ungulate influences, and their interaction within riparian ecosystems. In the absence of this knowledge, the "quick draw" is to assume that Southwestern riparian ecosystems function much like those of northern regions of the USA, further assuming that salmonid ecology is applicable to native fishes. In the midst of these assertions, are indifference for the collective influences of exotic introductions of fish, ungulates, and plants. These three key components are the essence of our discussion. The current state of knowledge implicates grazing as the principal factor impacting native fishes, however, no direct linkage has yet been established. Livestock have influenced riparian ecosystems since the late 1800s, but in recent time elk have demonstrated similar but confounding effects on fish habitats that precludes apportionment of blame. The number of livestock grazing riparian habitats has plummeted linearly with some populations of native fishes, yet elk have thrived exponentially.

MOODY, T., and W. ODEM. College of Engineering and Technology, Box 15600, Northern Arizona University, Flagstaff AZ 86011. *Regional relationships of bankfull stage in central and southern Arizona.*

Natural channels are created and maintained by the forces of the water and sediment of their watersheds balanced against the resistance of channel bed and bank material. Researchers in other regions of the country have suggested that the flows that create and maintain natural channels are moderate, frequent events with recurrence intervals of one to two years (Leopold, L. B., M. G. Wolman, and J. P. Miller. 1964. *Fluvial processes in geomorphology*. Freeman, San Fransisco, CA). These flows have been termed "bankfull" because they correspond to the point of incipient flooding; where flows overtop the channel and spread across the floodplain. In other regions bankfull discharge has been equated with effective discharge or the flow that carries the greatest volume of sediment over time (Andrew, E. D. 1980. Effective and bankfull discharges of streams in the Yampa River Basin, Colorado and Wyoming. *J. Hydrol.* 46.). In light of this, bankfull stage has both physical and process meaning. The use of bankfull stage could provide a consistent point of reference for assessing and describing a range of natural channel forms and processes.

Over the past two years the College of Engineering and Technology at Northern Arizona University in Flagstaff, Arizona, has been researching regional relationships of bankfull stage in natural channels in central and southern Arizona. Bankfull stage has been identified at 66 sites, representing ephemeral, intermittent, and perennial stream channels in central and southern Arizona. Recurrence intervals for these bankfull flows varies from one to two years, consistent with other work. Five hydrophysiographic provinces, based on relationships of bankfull cross-sectional area and watershed area, have been identified. These provinces are based on eight-digit Hydrologic Units as defined by the U.S. Geological Survey and can be described geographically as follows:

C. Middle Salt and middle and lower Verde River watersheds.
D. Upper Gila and Salt River watersheds.
E. Upper and lower San Pedro River watersheds.
F. Agua Fria and western Santa Cruz River watersheds.
G. Eastern Santa Cruz River watershed.

The regional relationships are similar to others identified in the western U.S. but reflect the variability of the region (Leopold, L. B. 1994. *A view of the river.* Harvard Press, Cambridge MA). The regional and hydrophysiographic provinces should provide valuable tools in understanding channel forming processes and field identification of bankfull stage in the natural channels of this arid region.

SAYERS, R., and C. AVERY. Northern Arizona University, School of Forestry, Box 15018, Flagstaff AZ 86011. *Potential impacts of stream flow diversion on riparian vegetation of Fossil Creek, Arizona.*

A vegetation study was conducted on a diverted and an undiverted reach of Fossil Creek in central Arizona. Modified Daubenmire plots were installed to study three aspects of the riparian vegetation: percent ground cover of herbaceous plants; tree growth rates; and community structure. Comparisons between reaches were made using one-way ANOVA.

Percent ground cover of herbaceous vegetation differed significantly between reaches; specifically, more ground cover of vegetation occurred in the undiverted reach by approximately 10%. Tree growth rates did not differ significantly between reaches for any sampled species, which included *Alnus oblongifolia*, *Fraxinus velutina*, and *Platanus wrightii*. Community structure was found to differ slightly between reaches. Specifically, *Fraxinus velutina* dominated the undiverted reach, while *Salix* spp. tended to dominate in the diverted reach. Understory species also differed between reaches.

These results suggest that the diversion dam has had some impacts on the riparian vegetation at Fossil Creek. However, there were not any large differences between reaches, suggesting that the impacts are not as extreme as first hypothesized.

SAYERS, R. C.[1], L. E. DEWALD[1], and A. E. SPRINGER[2]. Northern Arizona University, [1]School of Forestry, Box 15018 and [2]Department of Geology, Box 4099. Flagstaff, AZ 86011. *Plant community changes following cattle and elk exclusion at Hoxworth Springs.*

Wet meadows with perennial streams occur rarely on upland areas of the Colorado Plateau. Where perennial streams exist, they are typically supported by ground water discharging through either seeps or springs. Hoxworth Springs, located approximately 15 miles southeast of Flagstaff and 3 miles upstream from Upper Lake Mary, supports about a 3,000-foot reach of a perennial stream. Similar to many wet meadow systems, Hoxworth Springs has been impacted by channel manipulation and heavy cattle and elk grazing.

Ungulate exclosures were built around the perennial stream as part of a larger scale restoration plan for Hoxworth Springs. A 300-acre cattle exclosure was constructed in 1994, and a 3-acre elk and cattle exclosure (total exclosure) was installed in July 1996. This 3-acre exclosure was extended to approximately 5-acres in September 1998 to include the source of the springs.

Monitoring of the riparian vegetation associated with the restoration activities began in the summer of 1997. This documentation provides information on vegetation changes, rates of change, and the interactions between plant species involved. Monitoring is being conducted along a series of transects through the restoration area, including three transects in each of the ungulate exclosure areas: no exclosure, cattle only exclosure, and the total exclosure. These transects allow monitoring of the vegetation responses to the removal of different grazing pressures. Within each grazing exclosure, each transect also includes a cross-sectional area across the stream channel, as well as upland and riparian areas. Comparisons among these transects will document changes occurring in the different upland and riparian areas.

All three exclosure areas are dominated by grasses and herbaceous forbs, both native and introduced. Rushes, ferns, and shrubs are also present, but to a much lesser extent. Only two years of monitoring have been completed, but already general trends can be seen from 1997 to 1998. In 1997, all three exclosure areas were dominated by introduced grasses, mainly *Poa pratensis* (Kentucky bluegrass). In 1998, however, native grasses became more dominant in the no exclosure and cattle exclosure areas, and became more common (although not dominant) in the total exclosure. Native forbs became more common than introduced forbs in the total exclosure area, while introduced forbs seemed to thrive in the no exclosure and cattle exclosure areas. Further details and interpretation of these results will be presented. Some of the transect data trends do not appear to be consistent with overall visual impressions of biomass in each of the three exclosure areas. Therefore in 1999, in addition to the transect data, biomass data will also be collected. Although general, these trends from the data analyzed thus far suggest rapid rates of change in response to grazing exclosure in riparian areas.

SPRINGER, A.E.[1], T.N. GODWIN[1], and L.E. DEWALD[2]. [1]Department of Geology, Box 4099, Northern Arizona University, Flagstaff AZ 86011 and [2]School of Forestry, Box 15018, Northern Arizona University, Flagstaff AZ 86011. *Quantifying the difference between restoration method and climate in riparian restoration.*

The arid Southwest has a climate that is highly variable and is typically dominated by extreme events, making it difficult to distinguish climatic variability from degree of success of restoration of hydrologic function in riparian areas. It has been estimated that 7 to 10 years of climatic data are necessary to determine the average value of a hydrologic variable (Baker, M. B., Jr. 1986. Effects of ponderosa pine treatments on water yield in Arizona. *Water Resources Research* 22:67-73). For this reason, riparian restoration projects in the Southwest involving hydrologic systems require multiple years of observation before analysis of hydrological success can be quantified and distinguished from other land management activities such as grazing reductions and fire management.

A rare, high-elevation Bebb willow-mixed graminoid riparian community dominates Hart Prairie on the west side of San Francisco Mountain. Water is supplied to a shallow, perched groundwater system only by snow melt from the watershed above the riparian community. Since 1996, hydrologic parameters have been measured in association with hydrologic function restoration activities to observe changes into and out of the shallow groundwater system which supplies the riparian community. Precipitation as rainfall is measured using a heated tipping bucket rain gauge, and as snowfall with a sonic snow depth sensor. Surface-water discharge out of the watershed is measured with a stage gage on an H-flume. Subsurface flow is observed through a network of shallow wells, tensiometers, and time-domain reflectometer stations which measure groundwater levels, soil-matric pressure, and soil moisture, respectively. Air and soil temperature are measured at a weather tower. Two pressure transducers with data loggers are installed at the base of two Bebb willow trees observing diurnal fluctuations in ground-water level which will be used to calculate evapotranspiration rates.

During the three years of hydrological monitoring, there has been one historically low precipitation year, and one year each slightly above and below normal compared to regional precipitation measurements. There are significant temporal and spatial variations in the distribution of moisture during the growing season. The arrangement of the instrumentation has been optimized to capture these variations regardless of climatic intensity. The resulting data are sufficient to describe hydrological variability relative to the climatic variability observed to date.

STEWART, D. Director of Rangeland Management, USDA Forest Service, Southwestern Region, Albuquerque NM. *Agency obligations under the Endangered Species Act with respect to domestic livestock grazing and how those obligations are being met.*

Livestock grazing is a legitimate and authorized use of the National Forest System under federal statutes. The Southwestern Region authorizes domestic livestock grazing through approximately 1550 permits on approximately 1380 grazing allotments throughout the Region. Approximately 800 of these allotments are believed to contain either occupied or potential habitat for federally listed threatened or endangered species. Under the Endangered Species Act (ESA), the Forest Service is required to consult with the USDI- Fish and Wildlife Service (FWS) on activities which overlap with habitat for species protected under the ESA. Many of the federally listed species are dependent upon riparian and aquatic systems as their primary habitats. Until recently, the Forest Service has lacked completing consultation for most livestock grazing activities within the Southwestern Region.

This lack of consultation has been the source of several pieces of litigation, through the federal court system, challenging the agency with respect to the requisite consultations or the lack thereof. In the past, completing consultation for livestock grazing activities has been a slow and often contentious process between the Forest Service (FS) and FWS and has often taken up to several years to complete for just one grazing allotment. Consequently, only a small percentage of livestock grazing activities have completed consultations. Without the required consultation, livestock grazing activities could be at risk with many associated legal, social, and political ramifications. To resolve this dilemma, the FS has collaborated with the FWS to developed more effective and cooperative processes for completion of specific consultations required under Section 7 of the ESA.

In the short term (up to 3 years) the FS is completing consultation for ongoing livestock grazing activities by combining consultations for large numbers of grazing allotments at one time. The FS, in concert with FWS, has completed consultation on several hundreds of allotments within the past year through one combined process. Many of the allotments in this process (321) concluded consultation informally when needed protective measures, determined through the use of regionally established Guidance Criteria and a consultation team, were immediately implemented through FS administration of existing grazing permits. This process also allowed for *no effect* determinations on another 619 allotments. Only 22 allotments were determined to be having *adverse affects* on species and were subject of formal consultation and a biological opinion (BO) issued by FWS.

Over the longer term (3-10 years), the FS is consulting on grazing activities through National Environmental Policy Act (NEPA) analyses prepared to consider how continued grazing activities should be authorized through the issuance of new term grazing permits. This process also employs the concept of regionally established Guidance Criteria, interagency consultation teams, and a high degree of interagency collaboration. The net effect of these consultations is believe to be greatly improved habitats for federally listed species especially within important riparian and aquatic habitats within the Mogollon Rim high country of Arizona and elsewhere throughout the Southwestern Region.

STROMBERG, J. Plant Biology Department, Arizona State University, Box 871601, Tempe AZ 85287-1601. *Population biology of Arizona sycamore: results and management applications.*

Arizona sycamore (*Platanus wrightii*) is a dominant tree species in the mixed-broadleaf series of the Interior Riparian forest. It grows along ephemeral to perennial streams in Arizona, New Mexico, Texas, and Mexico, at elevations from about 400 to 2,000 m. I examined the influence of stream flow regime and watershed variables on recruitment events, size structure, and growth rates of Arizona sycamore at several river reaches in southern and central Arizona.

Establishment. Annual flood patterns influence sycamore establishment. Seedlings established in years with large winter floods, high spring flows, and high annual flows. Summer floods were negatively correlated with seedling establishment. Vegetative sprouts established more frequently than did seedlings. Sprout production also was positively correlated with winter flooding and high stream flows.

Establishment periods were episodic and irregular, reflecting high temporal variability in flood patterns. On average, seedlings established about once every six years. Commonly, however, long intervals (10 to 20 years) elapsed with no apparent establishment. Seedlings were abundant at many sites following the winter/spring floods of 1993 and 1995 in channel margins eroded by flood waters. Sycamore established contemporaneously with other pioneer species, including Bonpland willow (*Salix bonplandiana*) and Fremont cottonwood (*Populus fremontii*).

These results affirm the need to maintain rivers in a free-flowing state to facilitate establishment of Arizona sycamore and other pioneer species. This study also underscores the need to consider a suite of factors that influence seedling establishment when assessing effects of management activities. In studies conducted in the 1970s, many researchers identified livestock grazing as a key factor reducing the abundance of juvenile sycamores. Results of this study suggest that unsuitable flood patterns during this period may have played a role, as well. *Size and age structure.* Size and age structure varied with watershed size. Rivers draining larger watersheds (e.g., Oak Creek) were dominated by juveniles (mean stem diameter of 10 cm). Rivers draining small watersheds, such as Garden Canyon, were dominated by larger and older trees. These quantitative relationships between sycamore size structure and watershed size may provide a reference against which managers can assess a particular sycamore population for "healthy" age structure. Along headwater streams, infrequent regeneration need not raise red flags. Conversely, dominance by old individuals at sites with large watersheds should trigger a need to investigate causes of low seedling numbers.

Growth rates. Moisture availability limits the growth of many Arizona sycamore. Trees in ephemeral, deep-groundwater reaches grew about 30% slower than those in reaches with perennial flow and/or more stable and shallower groundwater. Trees growing on the floodplains and terraces at ephemeral sites with large seasonal groundwater declines are under the greatest water stress. Sycamore populations in such sites would be adversely effected by management actions that result in declines in stream flow rate or alluvial aquifer levels.

TILLER, R.L., B.E. SPAKES, L.J. KENNEDY, J.C. STROMBERG, J.C. STUTZ, and D.T. PATTEN. Department of Plant Biology, Arizona State University, Box 871601, Tempe, Arizona 85287-1601. *An ecological study of* Sporobolus wrightii *(big sacaton) riparian grasslands in southeastern Arizona: Implications for management and restoration.*

Grasslands dominated by big sacaton, *Sporobolus wrightii*, once occupied millions of acres of fragile riparian ecosystems in the Southwest and provided erosion control, forage for livestock, and habitat for wildlife. Today, big sacaton covers an estimated 5% of its former range. There is a growing interest among land managers in conservation and restoration of this grassland community. A multi-year study is being conducted on extant and former sacaton riparian grasslands in southeastern Arizona in order to acquire the ecological information necessary to understand the processes, variables, and relationships that allow for regeneration and maintenance of these grasslands. Objectives include determination of establishment and maintenance requirements of *S. wrightii* and elucidation of mycorrhizal relationships. Knowledge gained from field studies and from laboratory and greenhouse experiments is being tested in field restoration efforts in abandoned agricultural lands.

Seed germination, seedling emergence, and seed bank studies have shown that sacaton produces large numbers of viable seed capable of emerging from grassland soils under conditions of adequate moisture and temperature. The results suggest that sacaton may germinate in greatest abundance during the monsoon season and have greatest success in flood plain environments that allow for deposition of fine-grained sediments. However, seedling survivorship appears minimal and occurs infrequently in the field. Descriptive studies examining the relationship of big sacaton to a suite of abiotic and biotic variables, including depth to groundwater, inundation frequency, soils, and associated vegetation are underway at twenty-three sites at six streams. Based on the results of these studies, strategies for evaluating the restoration potential of abandoned agricultural fields to sacaton grasslands will be developed.

There are strong indications of a mutualistic relationship between big sacaton and arbuscular mycorrhizal (AM) fungi. Changes in levels of fungal colonization in roots were associated with changes in phenology of the host plant, which indicates exchange of nutrients and photosynthates. We found fifteen species or distinct morphotypes of AM fungi associated with *S. wrightii*, including two species as yet undescribed. In a greenhouse experiment, seedlings inoculated with AM fungi from a lower floodplain terrace produced more tillers and greater biomass than seedlings inoculated with AM fungi from an upper terrace or than uninoculated control plants. Pre-inoculation of greenhouse-grown sacaton has also shown potential to benefit transplants of *S. wrightii*. Pre-inoculated sacaton seedlings transplanted into an abandoned agricultural field had more tillers at the end of their first growing season than uninoculated transplants.

To facilitate the exchange of information gained in this study and in other research and management efforts, a web page is under construction which incorporates a data base of bibliographical references, project plans, and contacts for sacaton-related information. We hope to enhance our understanding of the ecology, natural recovery, and restoration potential of this riparian grassland community and facilitate more effective conservation, management and restoration.

VERNER, D., and A. VERNER, Almida Land and Cattle Company, Paulden AZ. *Tools for riparian restoration - river recovery with livestock grazing.*

In 1987 the Verde Ranch along with the Prescott NF adopted Holistic Grazing Management (HGM) as the preferred livestock management style. A key part of HGM is to define, manage, improve the landscape, and to sustain the production necessary to meet the financial requirements of the business. The Verde Ranch includes about 8 miles of the Verde River, most of which flows through land administered by the Chino Ranger District. The grazing use of three pastures that include portions of the river was guided by the same principles and concerns as all the upland pastures. After a few years of trial and error, the planned use of river pastures came down to grazing periods of 2 weeks or less with all the cattle. The dormant season grazing was for periods of 60-100 days with fewer number of cattle. We found that the riparian habitats and the dry rangeland sites responded much faster in all but a few upland sites.

von OPPENFELD R. R., and R. T. CAMPBELL. von Oppenfeld, Hiser & Freeze, P.C., TESTLAW, 4201 N 24th St, Ste 300, Phoenix AZ 85016. *Recent legal developments surrounding livestock grazing in Arizona's riparian areas.*

Livestock grazing along riparian areas is an increasingly controversial activity in Arizona and throughout the western United States. As a result, the laws that affect livestock grazing in riparian areas have been subject to rapid change in the federal courts and in the Arizona Legislature. Because the law regarding cattle grazing in riparian areas is in flux it may be difficult to know what the law requires and prohibits. This paper will provide useful and timely information to those interested in livestock grazing in riparian areas in Arizona and elsewhere.

One of the issues this paper will discuss is the possible requirement that those who wish to have their livestock graze in Arizona's riparian areas first obtain a federal Clean Water Act "certification." This article will track the development of this issue which started in late 1996, when the United States District Court for the District of Oregon held that pollution of a creek and river located in a National Forest in Oregon caused by cattle grazing constituted a "discharge" of a pollutant under the Clean Water Act and thus required state Clean Water Act Section 401 certification (which requires state certification for any applicant applying for a federal license or permit for any activity that may result in a discharge of pollutant into waters of the United States; *Oregon Natural Desert Ass'n v. Thomas*, 940 F. Suppl. 1534 [D. Or. 1996]).

In response to the Oregon case, the Arizona Legislature passed a law in 1997 that created a grazing best management practices (BMPs) advisory committee to develop and recommend voluntary BMPs for surface water grazing activities. However, shortly after passage of this law, the Oregon District Court decision was reversed by the 9th Circuit of Appeals (*Oregon Natural Desert Association v. Dombeck 1998 WP *407711 [9th Cir. (Or.)]*). In response to this reversal, House Bill 2471 was introduced into Arizona's 44th Legislative Session in January 1999 which would modify the surface water quality general grazing permit requirements relating to voluntary BMPs for grazing activities established in 1997.

As demonstrated above, the law in regard to this issue is ever changing. This paper will provide those interested in livestock grazing in Arizona's riparian areas an up-to-date report on the progress of relevant legislative and case law developments on this issue.

WERNER, W. E. Arizona Game and Fish Department, 2221 W. Greenway Rd., Phoenix, AZ 85023. *Managing watersheds to improve streams from the mountains to near sea level in Arizona.*

Arizona Game and Fish Department is involved in a number of initiatives to better manage watersheds and associated fish and wildlife and their habitat within those watersheds. Those initiatives, while independent, cover an area from the Continental Divide in New Mexico to the northern Gulf of California. Nested within those watersheds are more focussed efforts to better manage natural resources, including fish and wildlife habitat, at a sub-watershed scale. The Little Colorado River Multi-Objective Management Planning Process (LCRMOM), in northwestern New Mexico and northeastern Arizona, is an effort to manage for multiple objectives including important stream functions. The LCRMOM provides review, endorsement, and support for locally lead efforts to improve various watershed functions. Within the Little Colorado watershed, several multi-disciplinary efforts to better manage surface water for the benefit of the stream, associated riparian habitats, and end users are underway. Within a setting of fully or over allocated water rights, collaborative planning and management efforts may provide one of the only means to secure improved base flows. Projects with sediment management objectives are anticipated as well. Efforts to manage effects of ungulate grazing on riparian areas and streams are anticipated. Efforts on the Little Colorado River are intended to integrate with efforts of the Glen Canyon Dam Adaptive Management Workgroup, a multi-disciplinary process working to integrate multiple objectives in operation one of the major dams on the Colorado River. Downstream, the Lower Colorado River Multi-Species Conservation Program is an effort to develop a long term conservation strategy for upwards of 100 listed and sensitive species along the Colorado River below Glen Canyon Dam. Efforts to restore ecosystem function by restoring natural processes and direct restoration of habitat are underway along the Bill Williams, Salt, and Gila Rivers. Watershed scale planning is underway in the Verde River watershed. Participation in watershed initiatives provides a means to integrate fish and wildlife management principles into natural resource management and is an important element in fish and wildlife conservation and recovery planning in Arizona.

YARD, G., and S. YARD. Y-D Ranch, Perkinsville AZ. *Are we ready to measure change in riparian conditions? - a rancher's challenge.*

It would appear to us that issues related to grazing of riparian areas, its management and monitoring be performed to identify the direct and indirect linkages between livestock, other ungulates, and fishes. This needs could best be met through an adaptive management process in which permittees, other stakeholders, resource managers and scientists collaborate to seek better information to guide management decisions.

Experimentation on several sites is necessary to define the range of effects, which may be negative or positive. We found that several years of resting a riparian area greatly changed the habitats, but may have resulted in loss of habitat for the spikedace. Changes in habitat conditions may be viewed as positive or negative, depending on the point of view or the needs of the native flora or fauna.

NOTES