United States Department of Agriculture
Forest Service
Coconino National Forest
Red Rock Ranger District
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Phone: (928) 282-4119
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File Code: 2230
Date: October 7, 2004

Bank One Farm and Ranch Management
Attention: Mr. Walter C. Richburg
c/o C. A. Ward Trust – Herbert B. Ward
TX1-1351, P.O. Box 2050
Fort Worth, Texas 76113-2050

Dear Walt:

This letter will serve as Amendment Two to your 2004 Annual Operating Instructions (AOI) for the Fossil Creek Allotment, documenting the livestock grazing use and management instructions for the period of time from March 1, 2004 to October 31, 2004.

Your current ten-year term permitted livestock numbers are for 477 head of cattle (cow/calf/bull) yearlong and 6 head of horses from June 1 through September 30. You're currently authorized to graze 354 head from 09/01 to 10/31, with all livestock removed from the allotment on or before 10/31/2004.

We commend you for the reduction in permitted livestock and the two times the ranch the total removal of all livestock from the allotment during the 2002-2004 grazing seasons - due to the current six-year drought. This includes your voluntary removal of all stock from the allotment on October 31, 2004. We have encouraged and approved this non-use for protection of rangeland resources. Consequently the "Non-Use Clause" (Part 2 Clause 9) requiring stocking of your allotment to 90 percent or greater each year is null and void as we continue to manage our resources during this drought period. The Forest Service will not take adverse action to your term grazing permit because your allotment's authorized livestock numbers dropped below the 90 percent use levels of your term permit.

The numbers of livestock authorized by Ranger Ken Anderson for the 2004 grazing season on your allotment is as follows: first-half application was approved for 360cattle from March 1 to August 31 and 6 horses for the months of June through September and the second-half application was approved for 354 cattle from September 1 to October 31, 2004.

Your 2004 grazing season's pasture rotation for the Fossil Creek Allotment has been amended again to the scheduled as listed on the table on the following page. This latest rotation amends the August 18, 2004 AOI schedule and the rotation proposed by your consultant (Jerry Mundell) in his August 20, 2004 letter to the District Range Staff Officer.

September 16, 2004 the District and Forest committed to regrazing Hogback Pasture as proposed, with the condition that Sycamore Basin Tank would be fenced to exclude livestock grazing for the

protection of the Chiricahua leopard frog, a listed and threatened species. Jerry Bradley talked with Ranch Foreman, Barry Brashear on August 20, 2004 and verbally committed to regrazing Hogback once the Forest constructed the exclusionary fence around the tank's south side. The District anticipated construction of this fence during the period of September 22 -29, 2004, as cattle were not scheduled to move in until October 1, 2004. This commitment was based on forage and water availability in pastures that could be grazed until the livestock leave the allotment October 31, 2004.

Because of the ongoing consultation with U. S. Fish and Wildlife Service (FWS) regarding the Recovery Plan for Chiricahua leopard frog, the FWS and the Arizona Game and Fish Department (AGFD) were very concerned that regrazing of Hogback Pasture, despite the fencing of the tank, would prove detrimental to the Chiricahua leopard frog because of indirect effects, sediments into the tanks caused by regrazing the uplands. Consequently Jerry Bradley and Barry Brashear met in the field on Friday, September 24, 2004 to determine if another alternative pasture was available to graze instead of regrazing Hogback. They determined that Upper Ed's Point Pasture was now available to graze due to the prior week's heavy rains that had filled empty stock tanks.

Following Bradley's recommendation, I directed him to cancel the regrazed of Hogback Pasture and have the ranch graze Upper Ed's Point for the same 15 day scheduled period. This decision was critical in timing as the livestock has met proper allowable use levels and needed to be moved on Monday, September 27, 2004. My decision immediately reduced the FWS and AGFD's immediate issues of direct and indirect grazing impacts to the Chiricahua leopard frog in the Hogback Pasture.

Sycamore Basin Tank and Little Buckskin Tank within the Hogback Pasture are the only two remaining occupied habitats for this population of Chiricahua leopard frog. Just one year ago these frogs occupied five tanks within the Buckskin Hills area of your allotment; this population is near extinction. The Endangered Species Act directs the Forest Service to manage for wildlife and plant species that are listed by the FWS as threatened and endangered species. My decision to not regraze Hogback eliminated the potential impacts from livestock grazing for this proposed period of use to help protect the immediate endangered frog populations. I recognize this decision caused minor impacts to ranch as the stock will have a further distance (approximately three miles verses one mile) to move when leaving Upper Ed's Point and traveling to Tanque Loma Pasture. But the decision did not change the ranch's critical shipping dates and removal of all stock by October 31. 2004. Also, we believe Hogback Pasture will benefit by not being regrazed this grazing season, allowing rangeland resource conditions to maintain and improve – taking advantage of the recent August and September precipitation.

2004 Livestock Yearlong Herd Rotations

PASTURE NAME	PLANNED GRAZE PERIOD	LIVESTOCK NUMBERS	ALLOWABLE USE PERCENT
COW HERD ROTATION			
CHALK SPRINGS	3/10-4/14	225	50
SALLEY MAE	4/15-5/12	248	50
DORENS DEFEAT	5/13-6/2	248	50
HOG BACK	6/3-6/14	352	50
MUD TANKS	6/15-7/1	352	50
PINE	7/2-7/22	352	50
TIN CAN & MANZANITA	7/23-8/11	352	50

PASTURE NAME	PLANNED GRAZE PERIOD	LIVESTOCK NUMBERS	ALLOWABLE USE PERCENT
COW HERD ROTATION			
HOUSE	8/12-8/28	352	50
PINE	8/29-9/15	352	50
MUD TANKS	9/16-9/27	352	50
UPPER ED'S POINT	9/28-10/13	352	50
TANQUE LOMA	10/14-10/22	352	50
SHIPPING	10/23-10/31	352	50
2-YEAR OLD HEIFER ROTATION			
FUNNEL	1/1-1/1	35	50
DOESKIN	1/2-1/10	35	50
LOWER SYCAMORE CANYON	1/11-3/5	35	50
UPPER SYCAMORE CANYON	3/6-4/30	35	50
SYCAMORE BASIN	5/1-6/1	35	50
YEARLING HEIFER ROTATION			
HEIFER	12/2-3/10	25	50
THIRTEEN MILE ROCK	3/11-4/15	25	50
BARRY	4/16-5/5	25	50
BULL HERD ROTATION			50
BULL	2/3-3/1	23	50
NATURAL	8/15-10/31	22	50

Grazing Strategy

Continue to graze livestock in an intensive deferred-rest rotation management strategy. Permitted livestock will be run as four separate herds as shown above: a cow herd; two heifer herds; and a bull herd. For a controlled breeding season, bulls are placed with the cow herd in early March and separated again in mid August. Fall round-up and shipping of stock to market will occur annually in late October.

The management of livestock pasture moves will continue to be based upon a plant forage phenology scheme of management. Winter range pastures grazed during the winter dormancy period typically do not exceed a time period of approximately 50 days. In contrast, the allotment's summer range pastures that are grazed during the forage's active growing seasons the livestock graze period per pasture is shortened to periods of approximately 10 to 20 days.

Pasture moves will be completed with a five (5) day period. Due to the relatively small size of the allotment's pastures, gathering and movement of your permitted livestock should be completed during this five (5) day period. And it is imperative that once pasture moves occur, the livestock remain within the designated pasture. For various reasons, (i.e. pasture gates are left open, cattleguards are not maintained, fences are cut, etc.), cattle may stray from pasture to pasture. Prevention of stray livestock is the permittee's responsibility; whereby preventing grazing of adjacent allotments, grazing of your allotment's rested pastures, or regrazing of previously used pastures. Prevention of stray livestock protects the rangeland resources and the well-being of your stock.

Grazing Mitigation Measures

The following list, dictates livestock grazing mitigation measures that are specific actions required for maintenance and improvement of Mexican spotted owl habitats within the Fossil Creek Allotment. Forest Service personnel will field-check your compliance of these mitigation requirements.

1. No salt will be placed within 0.25 mile of riparian areas.

2. Salt will not be placed in non-riparian drainages in the ponderosa pine areas, unless it is being used for a watershed restoration project.

Even though Fossil Creek Allotment has little Peregrine falcon and Mexican spotted owl suitable and/or occupied habitat, below are grazing mitigation measures for the Peregrine falcon and Mexican spotted owl. Please review these attachments and understand the actions are required for management compliance; **"Mitigation for the Mexican Spotted Owl and Peregrine Falcon on Grazing Allotments for Annual Operating Plans."** and **" Mitigation for Buckhorn, Walker and Hackberry/Pivot Rock Allotments for the Mexican Spotted Owl for the 1998 AOP's."**

Resource Monitoring

Forage Utilization cages are installed annually on each grazing allotment. Where possible, the cages are located within the following four Management Areas (MA's) and they include: MA 12 (riparian); MA 5 (aspen); MA 9 (mountain meadow) and MA 3 (ponderosa pine/oak). MA 5 (aspen) does not exist on this allotment; consequently, cages will be installed in the following areas for monitoring:

Pasture Name	Management Area	Legal Description
Stehr Lake	12 (Riparian) (Fossil Creek)	T14N, R6E, Section 32, NW 1/4 SE1/4;

These forage monitoring cages will be installed in representative "key area" locations on productive soils, 0 to 15% slopes, approximately 20 to 500 acres in size, and minimum of 0.25 to 1.0 miles away from livestock water sources. The cages will monitor forage utilization on designated "key species" in "key areas" during three crucial periods of the grazing season: immediately before livestock entry; immediately after the livestock graze; and lastly at the end of the forage growing season. Reference the end of the attached Appendix B, for monitoring cage locations and monitoring data record area.

Because the Winter Pasture's riparian (MA 12) cages is immediately at the water's edge on West Clear Creek and frequently subjected to washing away during normal spring run-off and/or flood event(s), the Forest Fisheries Biologist, District Range Staff Officer and the grazing permittee will monitor this key area by inspection and survey of the riparian habitat the first week of March annually.

A Forage Utilization Spreadsheet, attached, will be completed by the grazing permittee during this 2004 grazing season. This monitoring will be completed by the ranch personnel with instruction and review from the District's Range staff Officers. The spreadsheet, identifies: individual pasture; pasture graze period; actual use livestock numbers; stage of plant growth, (fast, slow, dormant); average utilization of all forage species by pasture before livestock entry, following livestock graze and end of growing season; and identification of the pasture's "key species" and average grazing utilization percentage within the pasture's "key area(s)". The permittee will document the

individual pasture's forage utilization percentage estimates by five categories of use; no use, light, moderate, heavy and extreme. Continue to implement and monitor grazing utilization standards to attain good to excellent range conditions over time.

The monitoring of forage utilization by livestock and wildlife ungulates in the above management areas will provide an assessment of the allotment's grazing management, and permitted livestock, plus the numbers, wildlife big-game ungulates and their distribution. If upward utilization trends are observed, the District will coordinate with the grazing permittee and/or the Arizona Game and Fish Department to bring use within the Forest Land Management Plan's guidelines to promote and improve range and watershed conditions.

The allotments riparian and open water areas within Fossil Creek proper have been fenced to control livestock grazing use and management. However, these very important and diverse areas will still be closely monitored by the District Range Staff and the permittee to insure proper allowable use met and where necessary grazing is restricted. The District will coordinate with you to improve and maintain riparian vegetative communities by promoting three age classes of woody vegetation. A 20% or less utilization of woody species is acceptable as all three classes of riparian vegetation are present

Range Improvements

No range improvements are scheduled for construction on your allotment this year.

"Permittee Maintenance Responsibilities of Range Improvements" have been identified in red color on the permit maps of your term grazing permit. These improvements are to be fully maintained annually as a minimum, to comply with permit requirements. Please notify the District Range Staff Officer, 60 days prior any maintenance of improvements where heavy-duty equipment is required, i.e. maintenance of earthen-dam stock tanks, because biological and cultural surveys and clearances are required.

We acknowledge your cleaning of Buzzard and Stehr Tanks within your winter range of the allotment.

Restocking of Allotment Following Rangeland Resource Recovery from Drought

Non-use - complete rest from livestock grazing is the most efficient way to recover rangeland resources on your allotment. The duration of our current drought has stressed and induced mortality in forage plant communities to a degree that multiple years of non-use may be needed to sustain and improve root reserves, crowns and underground stems.

Forage plants must improve and recover their vigor and occur at a frequency and density levels that ensures plant litter and protective residual vegetation for soil stabilization. Plant vigor "relates as relative robustness of a plant, in comparison to other individuals of the same species. Vigor is reflected primarily by the size of the plant and its parts in relation to the age and environment in which it is growing", (Society of Range Management 1998). Vigorous forage plants should have many long leaves with several seed stalks, be hard to pull up, and have a good root system. Non-use will also promote the presence of a high successional and diverse plant community consisting of both warm and cool season forage species.

Good plant vigor criteria for common forage grass species present on your allotment include:

- Sideoats grama, (Bouteloua curtipendula), leafy with leaf length 8-12 inches, and numerous tall seed stalks per plant;
- Blue grama, (Bouteloua gracilis), leafy with leaf length 7-9 inches, and numerous tall seed stalks with three or more spikes per stalk;
- Hairy grama, (Bouteloua hirsuta), leafy with leaf length 7-9 inches, and numerous tall seed stalks with three or more spikes per stalk;
- June grass, (Koeleria cristata), leafy with leaf length 8-12 inches, and numerous tall seed stalks per plant;
- Western wheat grass, (Pascopyrum smithii), leafy with leaf length 7-9 inches, and numerous tall seed stalks per plant;
- Tobosa, (Hilaria jamesii), leafy with leaf length 7-8 inches, and numerous tall seed stalks per plant; and
- Curley mesquite, (Hilaria belangerii), leafy with leaf length 7-8 inches, and numerous tall seed stalks per plant.

Other indicators of improved range conditions that will be monitored before restocking include:

- A well dispersed accumulation of litter;
- Establishment of vigorous perennial plant species on bare soil – erosion pavement;
- Desirable (i.e. Black grama, Vine mesquite, June grass, and wheat grass species) and intermediate (other grama species, sand drop seed, and squirrel tail) forage plant species becoming more abundant and each species represented by all forms of age classes;
- Desirable and intermediate forage plants invading bare ground and stands of undesirable plant (snake weed); and
- Several years of vigorous growth on browse species (Fourwing salt bush, winter fat and buck brush).

Attached is an excellent reference to managing livestock during drought conditions, it is: "Rangeland Management Before, During, and After Drought. Dr. Larry Howery. University of Arizona, Cooperative Extension, July 1999. This document will be helpful in future discussions and management decisions as we manage for drought and restocking of Fossil Creek Allotment.

Monitoring of the allotment's range conditions in the future is critical in determination of restocking the allotment. During the monitoring process you are encouraged to request collaboration and input from other range specialists such as consultants, State Universities, the County Extension Service, Arizona Department of Agriculture and the National Resource Conservation Service. Prior to restocking of your allotment, we will collaboratively review the present grazing management criteria objectives and strategies to ensure long term productivity of the allotment is being fulfilled in the interim of a full allotment analysis and NEPA assessment anticipated in calendar year 2007. Interim management instructions and practices can be made to better fit future conditions and management within future AOI's.

Appeal Rights

Grazing permittees have appeal rights. Annual Operating Plan is appealable and subject to review under 36 CFR 251.82(a)(3), grazing and livestock term permits issued under 36 CFR part 222, subpart A. Appealable decisions apply to written decisions of Forest Service line officers related to issuance, denial, or administration of written instructions to comply and use National Forest System lands.

Permit Compliance

This 2004 Annual Operating Instructions (AOI) is a part of the Term Grazing Permit, as provided for in Part 2, section 8(a). If you fail to comply with any of the terms and conditions of specified in Parts 1, 2, and 3 of your Term Grazing permit, the Forest Service may suspend or cancel your permit, in part or in whole, after written notice to you. This is found within Part 1, Section 3, of your Term Grazing Permit. This AOI is in compliance with the standards and guidelines found within the Coconino National Forest's Land Management Plan.

These Annual Operating Instructions have been reviewed by the District wildlife biologists and found consistent with the endangered species Act, as amended and with all conditions agreed to in consultation with the US Fish and Wildlife Service.

Wildland Fire Prevention

Caution must be used during all ranch activities that could potentially start a fire. All ranch vehicles must be equipped with an axe, shovel, and water bucket. Any internal combustion engine tools and equipment require inspection by qualified Forest fire personnel prior to use on National Forest Lands. All open camp and branding fires require a ten foot fire ring cleared down to mineral soils. All state and local fire restrictions and regulations must be observed. Report all fires to the Ranger District Offices at; Sedona (5928/282-4119), Happy Jack (928/354-2216), Blue Ridge (928/477-2255) and the Flagstaff Zone Dispatch Office at (928/526-0600).

Prescribed Burning

No prescribed burning is scheduled for your allotment this year. The District will coordinate with you in future burn projects to insure that range improvements are protected and other resources are properly accounted for.

Walt, this AOI covers all instructions and actions as discussed during your recent meetings, field reviews and phone conversations with Jerry Bradley. If you have questions or comments regarding these instructions and requirements, please contact Jerry Bradley

Sincerely

/s/ William E. Stafford Jr., ADFR

For
RAQUEL R. POTURALSKI
Acting District Ranger

Enclosures
cc: Cecelia Overby, Carol Boyd - S.O.; and
Larry Sears, - Mogollon Rim R.D.

Allotment Name: Fossil Creek Year: 2004 .

Pasture Name	Graze Period Planned	Graze Period Actual	Livestock Numbers	*Plant Growth	**Before Livestock	**After Livestock	**End of Growing Season	**Key Species	% Use on Key Area	LMP Mgmt Area
COW HERD ROTATION										
CHALK SPRINGS	3/10-4/14		225							11
SALLEY MAE	4/15-5/12		248							11
DORENS DEFEAT	5/13-6/2		248							7
HOG BACK	6/3-6/14		352							7
MUD TANKS	6/15-7/1		352							7
PINE	7/2-7/22		352							7
TIN CAN & MANZANITA	7/23-8/11		352							7
HOUSE	8/12-8/28		352							7
PINE	8/29-9/15		352							7
MUD TANKS	9/16-9/27		352							7
UPPER ED'S POINT	9/28-10/13		352							7
TANQUE LOMA	10/14-10/22		352							7
SHIPPING	10/23-10/31		352							7
2-YEAR OLD HEIFER ROTATION										
FUNNEL	1/1-1/1		35							7/11
DOESKIN	1/2-1/10		35							7/11
LOWER SYCAMORE CYN.	1/11-3/5		35							11
UPPER SYCAMORE CYN.	3/6-4/30		35							7/11
SYCAMORE BASIN	5/1-6/1		35							7/11

***D = Dormant S = Slow Growth F = Fast Growth**

****N = No use (0-10%) L = Light use (11-25) M = Moderate Use (26-50%) H = Heavy Use (51%-70%) E = Extreme Use (71+%)**

Allotment Name: Fossil Creek Year: 2004 .

Pasture Name	Graze Period Planned	Graze Period Actual	Livestock Numbers	*Plant Growth	**Before Livestock	**After Livestock	**End of Growing Season	**Key Species	% Use on Key Area	LMP Mgmt Area
YEARLING HEIFER ROTATION										
HEIFER	12/2-3/10		35							11
THRITEEN MILE ROCK	3/11-4/15		35							7
BARRY	4/16-5/5		35							7
BULL HERD ROTATION										
BULL	2/3-3/1									11
NATURAL	8/15-10/31									7

***D = Dormant S = Slow Growth F = Fast Growth**

****N = No use (0-10%) L = Light use (11-25) M = Moderate Use (26-50%) H = Heavy Use (51%-70%) E = Extreme Use (71+%)**

Grazing Allotment Annual Operating Mitigation Instructions for Mexican Spotted Owl

The following mitigation measures would apply for Buck Springs, Bar-T-Bar, Willow Valley, Baker Lake/Calf Pen, Apache-Maid, Beaver Creek, Lost Eden, Fossil Creek, Buckhorn, 13 Mile Rock, Walker Basin, and Hackberry/Pivot Rock Allotments.

The purpose of the mitigation measures is to improve and protect habitat for prey species such as birds and small mammals in sensitive areas, and to protect nesting birds from disturbance associated with gathering or construction activities. Thank you for your cooperation.

1. Follow these guidelines to meet the intent of the grazing guidelines listed in the Mexican Spotted Owl Recovery Plan:

   A. Continue to monitor grazing use by livestock and wildlife in "key grazing" areas such as riparian areas (MA12), meadows (MA9), pine/oak types (MA3), and aspen (MA5). If cattle show an increasing utilization trend, then change management strategies to reduce the trend. If wild ungulates show an increasing utilization trend, the Forest Service will work with the Game and Fish Department to reduce this trend.

   B. Continue to implement and enforce grazing utilization standards to attain good to excellent range conditions in "key areas" over time.

   C. Continue to restore good conditions to degraded riparian communities by maintaining or promoting three age classes in woody vegetation. If the mid-age class is absent, 5% utilization or less is required to promote three structural stages. If all three classes are present, utilization of 20% or less of woody vegetation is acceptable.

2. To reduce animal concentrations and trampling of vegetation which may impact prey species forage and cover, follow these guidelines for placing salt, mineral blocks or food supplements.

   A. Do not place these items in riparian areas, mountain meadows, or non riparian drainages in ponderosa pine unless being used for a watershed restoration project.

   B. Do not place these items in spotted owl habitat or near peregrine falcon nesting areas. The attached map shows areas (shown as mitigation) where salt, supplemental feeding, or mineral blocks should not occur.

   C. Rotate salt and mineral supplement sites regularly.

3. To eliminate potentially disturbing activities in spotted owl habitat or near peregrine nesting areas during their breeding season, do not allow the following types of activities in areas displayed in red on the map between March 1 and August 31 without prior consultation with the District Range Staff.

   A. Spring branding or fall gathering.

   B. Construction activities such as; new construction of fences, corrals, or buildings, or cleaning or construction of tanks.

Mitigation For Chiricahua Leopard Frogs

Live fish, crayfish, bullfrogs, leopard frogs, salamanders, or other aquatic organisms shall not be moved among livestock tanks or other aquatic sites.

If a site is identified as occupied by Chiricahua leopard frogs, water shall not be hauled to the site from another aquatic site or tank that supports leopard frogs, bullfrogs, crayfish, or fish. When water is needed, such as for a bentonite application, all precautions shall be taken (use of fish screens of 1/8 inch or smaller mesh and adding bleach or use of municipal water source) to ensure that fish, bullfrogs, and their tadpoles, and crayfish are not moved among tanks.

If the chytrid fungus is detected and/or leopard frogs are found on the allotment, the permittee shall take precautions to minimize disease transmission and translocation of aquatic organisms. All equipment (front-end loader, shoes, waders, shovels, fence posts, etc.) used at an aquatic site shall be flushed clean of all dirt, mud, and debris, rinsed in a ten percent bleach solution, and allowed to thoroughly dry before coming into contact with another aquatic site.

All ranch hands, construction personnel, and others implementing the proposed action shall be given a copy of these terms and conditions, and informed of the need to comply with them.

At least 60 days prior to maintaining or cleaning out livestock tanks, the permittee shall inform the Coconino of planned activities. Authorized personnel shall survey the tank for Chiricahua leopard frogs and if frogs are found, shall work with the U.S. Fish and Wildlife Service to develop and implement a plan to minimize take of frogs. Measures to minimize take should include salvage and temporary holding of frogs, limiting disturbance and work areas to the minimum area practicable, leaving stands of emergent vegetation in place, and/or measures to minimize the likelihood of disease transmission. Plans to minimize take shall be approved by the USFWS.

Rangeland Management Before, During, and After Drought

7/99 AZ1136
THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRIULTURE
TUCSON, ARIZONA 85721

LARRY HOWERY
Assistant Rangeland Management Specialist
School of Renewable Natural Resources

This information has been reviewed by university faculty.
ag.arizona.edu/pubs/natresources/az1136.pdf

Introduction

Rangeland and livestock management in the southwestern U.S. presents many formidable challenges. Environmental regulations, cattle prices, and drought are just a few factors that contribute to the management challenges of the range-livestock industry. Although rangeland and livestock managers have little control over any of these variables, drought may be the least controllable or predictable.

Drought is defined by the Society for Range Management as "…prolonged dry weather when precipitation is less than 75% of the average amount" (SRM 1989). Using this criterion, drought occurred with the following frequency over a 40-year period from 1944-1984: 43% of the time in the southwestern U.S., 27% of the time in the southern great plains, 21% of the time in the northern great plains, and 13% of the time in the northwestern U.S. (Holechek et al., 1998). It is obvious that when it comes to drought in the southwestern U.S., it is not a question *if* drought will occur, but rather when will it occur, how long will it last, and *are you prepare*d? Livestock operators must plan for drought as a normal part of the range-livestock business.

Principles of Drought and Range-Livestock Management

Ranchers depend upon the natural production of rangeland grass and other forage plants to feed their free-ranging livestock. In reality, ranchers utilize domestic livestock to market the forage that is produced on the range. When you think about drought management from this viewpoint, it becomes obvious why it is important to have an understanding of how drought affects rangeland for-age production, and more importantly, how your management practices can help buffer the consequences of drought when it comes.

Drought Affects Individual Plants

• General Plant Response

Drought or water stress affects virtually every physiological and biochemical process in plants (Hanselka and White 1986). As water stress progresses, cell division slows down, enzyme levels decline, and chlorophyll formation may cease. Leaf stomata close, slowing transpiration and photosynthesis, which in turn, slows shoot and leaf growth. Buds of perennial grasses may be damaged to such a degree that they cannot produce shoots (i.e., for-age) in subsequent years. Seed heads may not develop, or, extra-dry soil conditions may prohibit seed germination altogether. In extreme cases, carbon dioxide assimilation ceases, senescence is induced, and plants die.

• Root and Shoot Growth

To survive, perennial plants must accumulate both above ground (shoot growth) and below ground (root growth) biomass through the processes of photosynthesis, transpiration, and respiration. During drought, healthy root systems are essential to extract remaining soil moisture. Under extreme drought conditions, however, limited soil

moisture may be inadequate to support shoot growth. When shoot growth is limited, adequate carbohydrates (i.e., plant food) may not be manufactured to re-place roots that normally die back a little each year. The combined effect of drought is a downward spiral where roots are unable to extract moisture and minerals from the soil, which, in turn, limits shoot growth and food production of plants. In severe cases, widespread plant death may occur across parched landscapes.

Rangeland Condition and Drought

Although all rangelands are adversely affected by drought regardless of condition, rangeland in fair or poor condition is more adversely affected and recovers more slowly than rangeland in good or excellent condition (Fig. 1). There are several reasons for this. Higher range condition ratings may mean higher diversity of plants that possess different growing seasons (e.g., warm and cool sea-son plants) and rooting habits (e.g., shallow-, medium-, and deep-rooted plants). This increases opportunities for plant communities to exploit the various temperature and soil moisture regimes that occur across arid and semi-arid rangelands (Fig. 2). With improved range condition there is usually adequate cover (i.e., vegetation, litter, rocks) to prevent accelerated soil erosion. Better soil stability improves the capacity of range sites to retain soil moisture and grow the kinds and amounts of plant species they are inherently capable of producing. ate grazing causes little reduction in root growth or plant vigor (Fig. 3). For example, moderately grazed grasses can continue to extract soil moisture even when it drops as low as 1-2% (Hanselka and White 1986). On the other hand, heavy grazing can cause plants to permanently wilt when there is still 6-8% soil moisture available. Frequency of grazing refers to the number of times individual plants are grazed during the growing season. Frequency of grazing is closely related to grazing intensity because the probability of a plant being grazed more than once increases with higher stocking rates. Plants that are grazed repeatedly while photosynthetically active may have little or no opportunity to grow new leaf material between successive defoliations and become stressed for similar reasons described for grazing intensity. Timing of grazing deals with the time of year that plants are grazed, and therefore, their physiological or morphological stage of development. Plants are more susceptible to grazing during certain times of their life cycle. For example, many native perennial grasses are most sensitive to grazing from the late boot to early head-

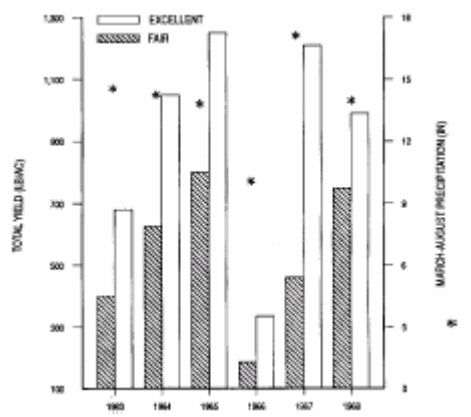

Figure 1. The influence of range condition (excellent vs. fair) and drought on perennial grass and forb production (lb/acre) on a clayey range site near Cottonwood, South Dakota (Hanson et al., 1978).

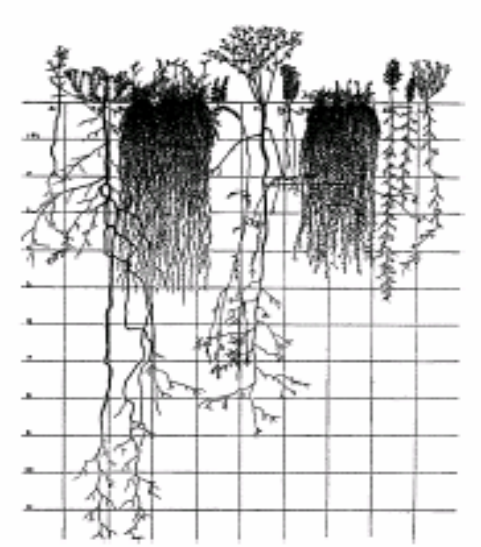

Figure 2. Roots of different grassland plants draw their moisture from different soil layers (Stefferud 1948). Roots of some native plants extend to depths of 20 feet or more. Al, narrow-leafed 4-o'clock *(Allionia linearis*); Kg, prairie false boneset *(Kuhnia gultinos*a); Bg, blue grama *(Bouteloua gracilis*); Mc, globemallow *(Malvastrum coccineu*m); Pt, a legume *(Psoralea tenuiflor*a); Ss, *(Sideranthus spinulosis*); Bd, buffalo grass *(Buchloe dactyloide*s); Ap, western ragweed *(Ambrosia psilostachy*a); and Li, skeleton weed *(Lygodesmia junce*a).

Intensity, Frequency, and Timing of Grazing

The degree to which drought impairs the range's potential for future forage production depends on the intensity, frequency, and timing of grazing. Range-livestock managers can control each of these factors through their management practices.

The phrase, "intensity of grazing" refers to the number of animals and duration of grazing on a particular pasture (i.e., stocking rate). Heavily grazed pastures show greater reductions in forage production during drought than lightly or moderately grazed pastures. Excessive removal of green leafy material during the growing season reduces root growth and replacement, decreasing the ability of plants to harvest solar energy and soil moisture needed for maintenance and growth. Conversely, moderate grazing causes little reduction in root growth or plant vigor (Figure 3). For example, moderately grazed grasses can continue to extract soil moisture even when it drops as low as 1-2% (Hanselka and White 1986). On the other hand, heavy grazing can cause plants to permanently wilt when there is still 6-8% soil moisture available.

Frequency of grazing refers to the number of times individual plants are grazed during the growing season. Frequency of grazing is closely related to grazing intensity because the probability of a plant being grazed more than once increases with higher stocking rates. Plants that are grazed repeatedly while photosynthetically active may have little or no opportunity to grow new leaf material between successive defoliations and become stressed for similar reasons described for grazing intensity.

Timing of grazing deals with the time of year that plants are grazed, and therefore, their physiological or morphological stage of development. Plants are more susceptible to grazing during certain times of their life cycle. For example, many native perennial grasses are most sensitive to grazing from the late boot to early heading stage. (Fig. 4). This is when meristems (i.e., growing points) in many rangeland grasses become elevated and are most susceptible to removal by grazing animals. Once meristems are removed, plants must initiate growth from basal buds which requires much more of the plant's energy than regrowth from meristems. Plants that are continually forced to regrow from buds may reduce or even eliminate the production of new buds which can limit for-age production in subsequent years.

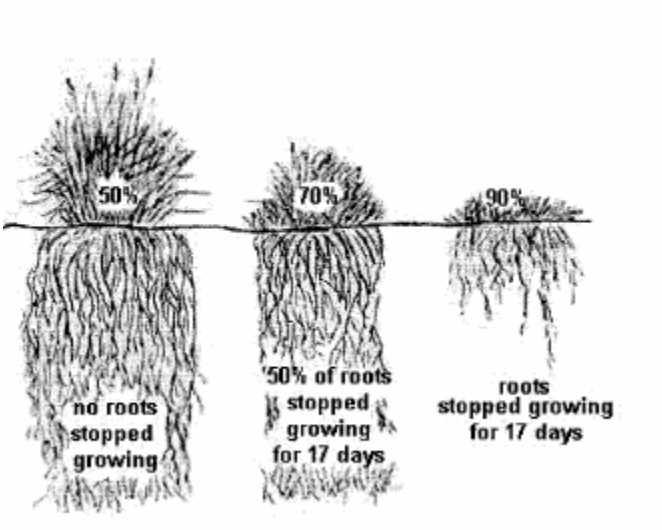

Figure 3. Root development in relation to top removal (Leithead 1979).

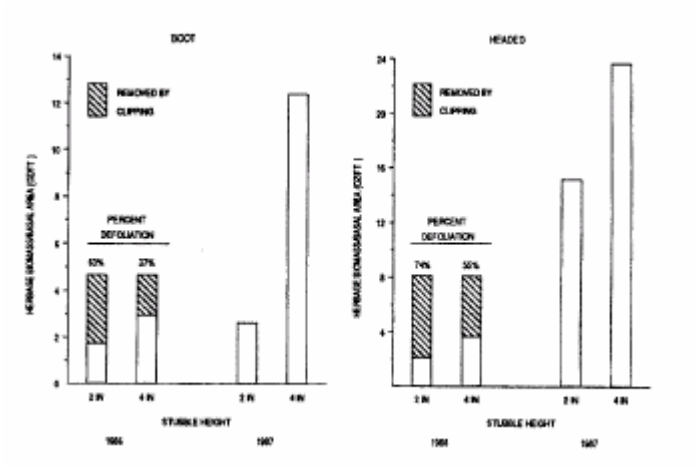

Figure 4. Herbage yield in 1987 in relation to herbage removed in 1986 (Reece et al., 1991). Precipitation was above average in both years. Needle-and-thread *(Stipa comata*) plants were clipped to a 2- or 4-inch stubble height. Plants were clipped only once on May 15 (late boot stage) or on June 15 (fully headed stage). *Notice that pro-duction was greatly reduced in 1987 significantly when plants were clipped to a 2-inch height during the "boot" stage in 1986.*

Management Before Drought

Advance Planning is Critical

Planning for the "next" drought must occur in advance because management options decline as drought intensifies. The primary goal in every drought management plan should be to protect rangeland plants before and during drought years so that fast recovery can be achieved in years of higher precipitation. Each individual operation should tailor a drought management plan in accord with the ranch's unique vegetation, topography, and management objectives.

Stocking Rate

Stocking rate, because of its relation to grazing intensity and frequency, is considered the most important of all range management decisions (Holechek et al., 1998). Stocking rates should be calculated to leave enough standing residual vegetation (i.e., plant material from previous year's growth) after the grazing season to protect the soil and ensure sustainable forage production. Although it is obviously impossible to grow forage without rain, residual vegetation and associated litter (i.e., detached plant material) can improve the effectiveness of rainfall received and reduce drought impacts in several ways. To illustrate,
after a raindrop reaches the soil surface it either: 1) soaks into the soil (infiltration and percolation), 2) evaporates, or 3) runs off. Infiltration and percolation are critical to forage production because water must penetrate the soil profile before it can be used by a plant's root system. Residual vegetation facilitates infiltration and percolation by reducing evaporation losses (i.e., residual vegetation lowers soil surface temperatures), protecting the soil from erosion (i.e., residual vegetation provides more soil cover and less bare ground), and providing a favorable micro-climate for seedling growth (i.e., residual vegetation is a source of organic matter). The converse is true for over-grazed areas. Hence, residual vegetation left ungrazed is not wasted because it enhances the ability of the land to endure drought conditions and to be more productive in the long-term.

In a perfect world, you could reduce stocking rates to prevent excessive grazing during dry times, and increase stocking rates to take advantage of more abundant forage during high precipitation years. However, this may not be practical in unpredictable arid environments because cattle numbers must be determined before forage production for the next growing season is known. Fluctuating cattle prices further complicate the feasibility of flexible stocking rates. To deal with this uncertainty in southeastern Arizona, Martin and Cable (1974) recommended a constant stocking rate at or below 90% of the average long-term carrying capacity, with appropriate reductions during prolonged severe droughts. They ascertained the 90% stocking level during a 10-year-study where cattle utilized 40% of the available key forage production, (leaving behind approximately 60% of the annual production as residual vegetation). The 40% utilization level resulted in improved range condition, economic stability, and permitted a gradual increase in stocking rate.

Grazing System

Every grazing management plan should include a proper grazing system that promotes stable or improved range condition. Grazing system decisions, like stocking rate decisions, are site specific and must consider the unique vegetation, topography, and management goals and objectives for the range. Grazing systems should be planned to give grazed areas periodic deferment or rest, and to set aside ungrazed areas to be used during drought emergencies. No grazing system will be biologically or economically sustainable if stocking rates exceed forage supply. Holechek et al. (1998) discusses several grazing systems that have been implemented in the southwestern U.S.

Watch for Drought Signs

No one can predict droughts. Even meteorologists, with all their sophisticated equipment, have difficulty pinpointing when droughts will occur within a particular geographical region. Drought is not obvious during the initial stages, but is easily observed after reaching full impact. Good managers recognize potential drought signs and take action *before* this occurs. This process begins with keeping good records to track monthly trends in a few key environmental variables.

Rainfall is obviously the most important variable to monitor. Install several rain gauges in strategic locations on the range. Permanent vegetation monitoring sites are good places to install rain gauges. Placing a known amount of light machine oil or transmission fluid in the rain gauge will help prevent recent rainfall from evaporating and facilitate periodic monitoring. Placing a known amount of antifreeze will prevent precipitation from freezing during colder months. Subtract the inches of oil, trans-mission fluid, or antifreeze placed in the gauge before taking a rainfall reading.

Soil moisture readings taken from 3 rooting depths of key forage species (e.g., 6 inches, 1 foot, and 3 feet) will indicate whether various key forage species have adequate moisture for growth. Squeeze the soil in your hand. Does it form a ball? If so, you probably have adequate soil moisture for growth. If it doesn't form a ball, but your hand feels cool, you probably have some soil moisture left. If the soil is completely dry and blows away, there is likely not enough moisture to sustain plant growth.

Plant growth can be monitored by placing a small exclosure (sometimes called a utilization cage) in a pasture. A utilization cage can be used to estimate forage production in a particular year (and pasture) without grazing. Periodically measure and record the height of key forage species within the cage. Every inch of growth equates to pounds of forage available for animal consumption. To estimate the average forage production within a pasture, you will need to clip, dry, and weigh forage from several small sample plots (Interagency Monitoring Manual, 1996). Utilization cages must be moved every year to prevent accumulation of decadent plant material which can bias yearly forage production estimates.

Low **air temperatures** occurring several nights in a row during the growing season can greatly slow plant growth and mimic drought conditions. Several nights of less than 60 ^{0}F may slow growth of warm-season plants (e.g., blue grama, side oats grama), while several nights of less than 40-50 ^{0}F may slow growth of cool season plants (e.g., western wheatgrass, needle grasses). On the other hand, prolonged hot daytime temperatures can increase evapotranspiration and accelerate drought conditions.

Although some of these measurements may appear crude, they can provide a harbinger of drought when considered collectively and compared to monthly trends over several years. The more years of data you can collect, the better idea you will have of how key environmental variables will affect your operation. Keep in mind that while drought is generally considered below average rainfall for an entire year across a broad geographic area, drought conditions may also occur *locally* when timing or amount of rainfall is unfavorable for plant growth, or where temperatures are abnormally low or high. This is why it is important to monitor monthly trends in environmental variables at several key locations.

Management During Drought

Ranchers should consider a variety of management options to minimize the effects of drought. The more options you have, the greater flexibility there will be to survive drought conditions. Following is a summary of drought management suggestions (adapted from Hanselka and White 1986, unless otherwise indicated). Although there is no "cookbook" approach to drought management, many of these points are *range management principles* that can be applied to all ranches. Other suggestions may not be practical for some operations for a variety of reasons (e.g., legality, costs, and benefits). No one knows better than the ranch manager what will or will not work on a particular ranching enterprise. The following is merely a laundry list for consideration.

Rangeland/Forage Management

1) Continue to monitor and maintain plant vigor and range condition to the extent possible.
Drought increases the rate of natural die-off of plant roots. However, healthy vigorous perennial grasses with a good root system suffer less damage and maintain production longer into drought. They also recover more quickly once rainfall occurs.
2) Monitor utilization of preferred plants (sometimes called "key forage" species).
Moderate use of key forage plants can serve as a warning to determine when livestock moves or adjustments are needed. Careful monitoring of utilization levels of these plants can help avoid the critical mistake of over-utilizing an entire pasture when plants are drought-stressed.
3) Provide adequate, accessible, good-quality water.
Poor quantity and quality of water can decrease animal distribution, intake, and performance. The University of Arizona Cooperative Extension 5 A well-.designed pipeline system with a good source of clean water is the best way to ensure that adequate water is strategically located throughout the range. Consider hauling water to areas with adequate forage if good quality water is not available during drought (Bartlett et al., 1994).
4) Use emergency forage that has been set aside for drought conditions.
Rest pastures specifically for this purpose. Buy and store hay or other feeds while plentiful and inexpensive. Dense cactus growth in certain areas may present an opportunity for cactus to be burned to provide emergency feed (e.g., cholla, prickly pear). Keep in mind that high rainfall years may present an opportunity to seed abandoned fields or barren areas with adapted forage plants that can be used during emergency drought conditions.

Livestock Management

1) Develop an annual (flexible) timetable for making decisions
on stocking rates, livestock movements, range improvement practices, supplementation, and marketing in relation to seasonal patterns in forage production and quality. Evaluate several options pertaining to each of these factors. For example, you may need to drastically alter your grazing management plan during drought by moving animals out of pastures early, or by reducing your herd, but you may be able to graze pastures that have received localized rainfall. Every drought will result in a different set of circumstances so it pays to monitor each situation and adjust your management practices accordingly.
2) Use range management techniques to distribute livestock more uniformly.
Herding, drifting, and strategic placement of salt, supplements, along with water developments, and strategic fencing can be used to promote better animal distribution.
3) Determine the amount of money that can be spent on animal feed and supplements.
During extreme droughts, determine if it is economical to implement "substitute feeding" of hay or other supplements in a drylot. This relieves grazing pressure on plants that are already stressed and reduces energy expenditure of animals searching for scarce rangeland forage. See Sprinkle (1998) for recommendations on rangeland supplementation during drought.
4) Select and cull cows and replacement heifers on the basis of behavioral characteristics.
Some individual animals use only a very small amount of the available range, while others use the range more extensively (Howery et al., 1996). These behaviors are apparently passed from mother to offspring and may be used as a basis to select or cull cows and replacement heifers based on desirable and undesirable behavioral traits (Howery et al., 1998).
5) Once drought is recognized, reduce the herd as soon as possible so it is in balance with forage supply.
Market prices tend to be highest at the beginning of a regional drought. If stocking has historically been heavy, the number of animals removed will probably need to be greater than in areas where light or moderate stocking has been implemented.

- Sell before animals have lost excessive weight so that sufficient rangeland forage is available to carry the breeding herd.
- Sell weaned calves, inferior or nonbreeding cows, low fertility bulls, and inferior heifers that will not contribute to building the herd.
- Wean early so that productive cows can regain condition and cycle sooner. This prevents delays or reductions in breeding and calving activities. Animal condition is one of the most important factors in next year's breeding success. Weaning also reduces forage demand and decreases nutrient requirements because dry animals eat less than lactating animals.

Management After Drought

After drought finally breaks, surviving plants may grow to above average heights and produce a legion of seed stalks. Drought-induced mortality thins plant communities and reduces competition for nutrients and moisture. This gives the surviving plants an opportunity to become more productive and vigorous. Although surviving plants may be more vigorous after drought breaks, total forage production may actually be lower than normal because there are less plants per unit area (Reece et al., 1991). This trend may continue for several years following severe droughts.

After drought, the color green can have a profound psychological effect, tempting you to deviate from your best-laid drought recovery plans. However, you should resist the temptation to restock to pre-drought levels no matter how "green" the range appears. Animals graze forage, not acres, and stocking rates considered to be moderate during a "normal" precipitation year may be heavy during and following dry years. Overgrazing after drought will damage surviving plants and ultimately require a much longer period of rest and recovery than with conservative, incremental restocking strategies. The year following drought should be devoted as much as possible to improving plant vigor and restoring protective residual vegetation and plant litter. Pastures most likely to provide the largest increases in forage production should receive highest priority.

Grazing management practices that benefit plant recovery in the years immediately following drought (listed in order of efficacy) include (adapted from Reece et al., 1991):
1) Rest pastures for an entire growing season or more following severe droughts.
Complete rest is the most effective and fastest way to achieve range recovery
2) Use pastures only when key forage species are dormant for one or more growing seasons.
The dormant season is typically the least harmful time to graze perennial grasses.

3) Use pastures when the least desirable species are green and palatable.
By manipulating timing of grazing in this way, you can shift grazing pressure away from key forage plants. For example, animals are likely to prefer green (but less desirable) plants over key forage plants when they are dormant.
4) Defer grazing until after key forage species have produced mature seed.
After herbaceous plants produce mature seed, they are usually not as highly prized by livestock. Perennial grasses can generally tolerate grazing better during this period because they have completed their life cycle for the current growing season.
5) Graze early growth after perennial grasses have reached the 4 to 5 leaf stage.
As this phrase suggests, this is when perennial grasses have produced at least 4-5 leaves during the vegetative stage. Perennial grasses are usually more tolerant of grazing during this period because their growing points have not been elevated. Animals should be removed from the grazing unit before key forage plants reach the early heading/late boot stage.

Summary

Droughts are a guaranteed but unpredictable phenomenon in the southwestern U.S. occurring, on average, about 4 out of every 10 years. Successful management depends on anticipating that drought will occur and planning in advance how to deal with it. Advance planning is critical because it allows you to consider a variety of options and make decisions early to avoid crisis situations. Delays in decision making often leads to intensification of the problem, economic loss, and long-term damage to rangeland resources.

There is no cookbook approach for proper drought management. It really boils down to the fact that sound range management practices that sustain or improve range condition will ultimately result in good drought management. Well-planned grazing practices that promote conservative forage use while sustaining high vigor of desirable plants is good insurance against drought.

Acknowledgements

Many thanks to Drs. Robert Kattnig, Richard Rice, George Ruyle, and Jim Sprinkle who reviewed an earlier draft of this manuscript. Their comments and suggestions greatly improved the paper.

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