PRODUCED WATER: AN OASIS FOR ARID & SEMI-ARID RANGELAND RESTORATION

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Biographical Sketch of Authors

William E. Fox is employed by the Texas Cooperative Extension at Texas A&M University in College Station. Dr. Fox received his Ph.D. from Texas A&M University with a focus on Plant Systematics. Current research and demonstration activities center around the concept of Total Resource Management. The TRM program focuses on strategic planning and its use in balancing natural resource management across ecological, economic and socio-political aspects. Dr. Fox joined the Texas A&M Water Resources Development Program in 2001 and continues to lead the environmental aspects of the program.

David B Burnett is the Director of Technology for GPRI and a member of the graduate faculty of the Petroleum Engineering Department at Texas A&M University. He has extensive experience in technology related to oil field produce water management. For the past two years he has been working with a team of scientists and engineers recovering fresh water from oil field brine and using it for beneficial purposes. Prior to that he was a Project Manager for Westport Technology developing and managing research programs for oil and gas joint ventures. He is a reservoir engineer addressing produced water issues. He has a B. S. and M.S. in Chemistry from Sam Houston State University and an MBA from Pepperdine.

Abstract

Texas A&M University has convened a research program composed of petroleum engineers along with rangeland, soils, wildlife and irrigation specialists to research the potential impact of a “new found” fresh water resource in arid and semi-arid rangelands. This fresh water resource is created from oil field produced brine, treated in the field by mobile units to remove contamination and dissolved salts and applied on rangelands.

If treatment costs are competitive with other methods of water disposal, and the water can be used in a beneficial manner, then a tremendous opportunity becomes available, both from the oil and gas operator perspective and from the community's viewpoint as well.

Treatment of produced water from oil and gas production could significantly benefit efforts to develop restoration strategies for arid and semi-arid rangelands throughout the western United States. However previous projects have not taken into account the effect of fresh water application on arid or semi-arid soils, or the effect on rangeland restoration or wildlife habitat development.

A key part of this project will be the monitoring of test plots to illustrate the beneficial uses of treated produced water from oil and gas production. Two programs are planned: 1) rangeland restoration monitoring and 2) wildlife genotoxicity monitoring. The proposed project will follow a framework for repairing damaged wildlands defined by Whisenant (1999) that includes a process-oriented approach that seeks to initiate autogenic repair and considers landscape interactions. Restoration of such degraded lands requires significant inputs outside of normal ecological succession and the use of produced water provides a significant variable to the successful implementation of rangeland restoration projects.

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Introduction

Rangelands are lands where the indigenous vegetation is predominantly grasses, grass-like plants, forbs, and/or shrubs and are managed as a natural ecosystem. Rangelands include natural grasslands, savannas, shrublands, many deserts, tundras, alpine communities, marshes and meadows. Rangelands make up approximately 47% of the Earth's terrestrial surface. In the United States, rangelands cover approximately 50% of the land area and in Texas rangelands make up approximately 60% of the area. Traditional views of rangelands center around the cowboy and the cattle he herded across the vast open spaces of the western United States. This vision of rangelands, though romantic, is a far cry from what rangelands can and are beginning to be used for.

Up until the turn of the century, rangelands really had one use; to provide forage for domestic livestock to feed a growing nation. At the beginning of the 20th century, work began to understand further the benefits and services that can be found on the nations rangelands. Much of the early work focused on understanding the flora and fauna of the rangeland systems and the patterns of change (succession) that these systems followed. All the time that this was taking place, rangelands continued to be used for there primary purpose at the time, livestock grazing. Grazing is not the only use that has stressed the ability of our Nations rangelands to resist degradation, improper use of vehicles, plowing of marginal soils and other influences have had significant impact on the resiliency of rangeland systems. These impacts have resulted in a wide array of degradation on many rangeland systems.

Many natural resource managers refer to the current degradation pattern as desertification. Desertification is the formation of desert-like conditions, largely through human actions, in areas that do not have desert climates (Holechek et. al., 1989). In many areas affected by desertification, there is a trend of declining biological productivity without a major change in climatic conditions. The UNDP recently rated the Worlds grasslands condition based on four general categories: 1) Food Production, 2) Biodiversity, 3) Carbon Storage and 4) Recreation. Their findings are disturbing at the very least (Table 1).

Table 1. UNDP rating of the worlds grassland conditions (UNDP et. al., 2000)

World Grassland Conditions		
Category	**Rating**	**Trend**
Food Production	Fair	Declining
Biodiversity	Fair	Declining
Carbon Storage	Good	Declining
Recreation	Good	Declining

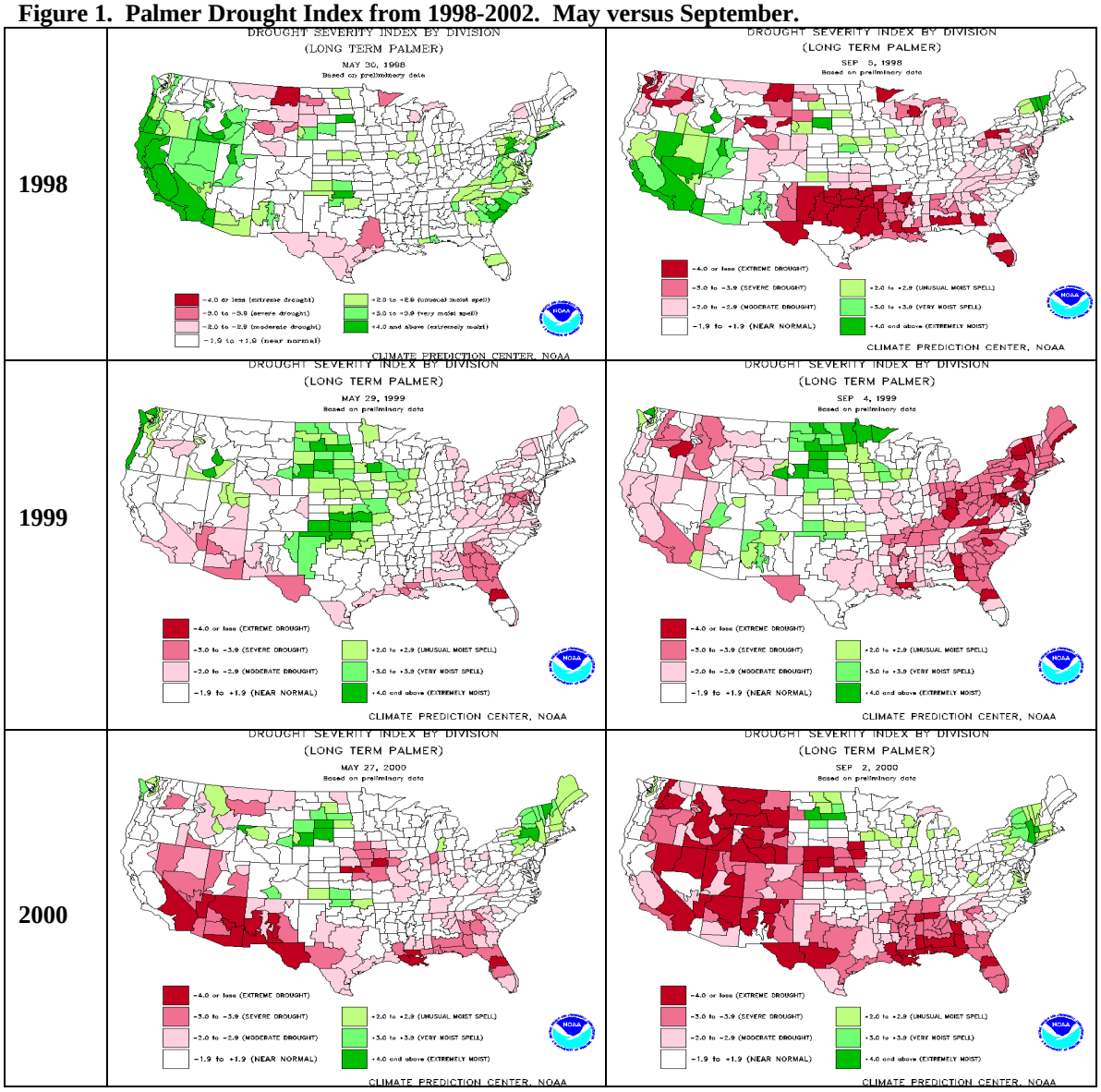
One of the major efforts worldwide is to identify opportunities to reverse the declining trend in rangeland systems. There are a multitude of efforts ranging for development of criteria and indicators to measure rangeland health (SRR, 2002), to major

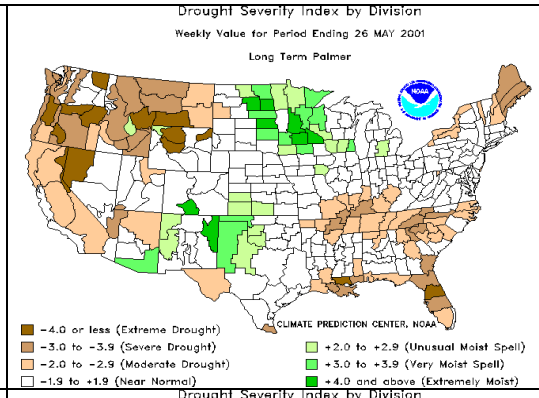
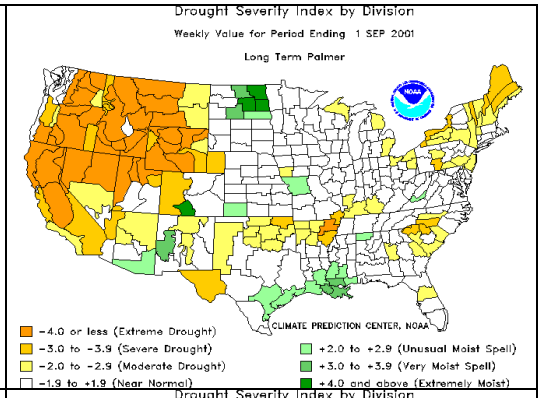
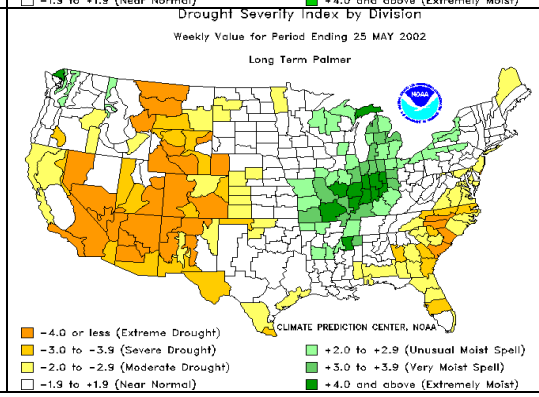
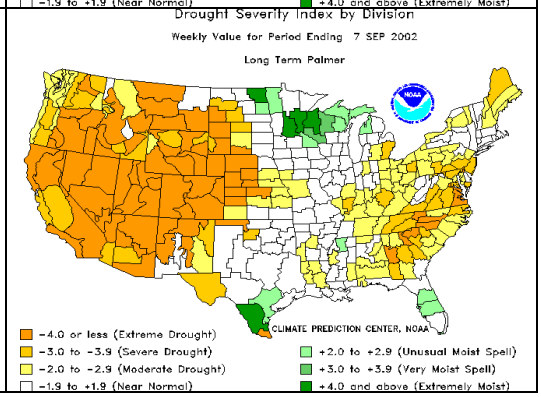
restoration projects such as the Everglades restoration project involving billions of dollars. It is hard to miss something like the restoration project in the Everglades, but we are faced with similar problems in many of the western states.

Drought

Drought is defined as prolonged dry weather generally when precipitation is less than 75% of average annual amount (SRM, 1974). Droughts have a tremendous impact on the "health" of rangeland systems. For example, vegetation recovery in the Great Plains following the drought of the 1930's required 5-15 years even under light or no grazing (Holechek et. al., 1989). Drought is a major influence on western rangelands and has caused significant impact and loss of benefits and services, both economic and ecological. Figure 1 illustrates the recent occurrence of drought in the United States and shows an area where beneficial use of treated produced water might apply.

Figure 1. Palmer Drought Index from 1998-2002. May versus September.



2001		
2002		

It is quite obvious that much of the western United States as well as a major portion of the east has been cycling through an extended period of drought. In many of these areas, oil and gas production may provide an opportunity for use of treated produced water for beneficial purposes to restore rangeland habitat.

Restoring Rangelands via Treated Produced Water

Most healthy ecosystems, including rangeland systems, have built in mechanisms for repair (Whisenant, 1999). These mechanisms may come in the way of resistance to disturbance or resiliency from disturbance. However, just like the human immune system, once a threshold is crossed, the system becomes "sick." Once an ecosystem becomes "sick" it requires some form of assistance to recover, if possible, to its previous state.

Traditional restoration has focused on the use of modifying soils to meet the needs of certain species. The soil modifications usually center on rapid alteration of the soil through some form of physical, chemical or biological attributes (i.e. liming, fertilization, etc.). Though it would be desirable to affect such methodology in preparing rangeland soils for restoration, it is seldom realistic in these types of systems (Whisenant, 1999).

The current focus where treated produced water will be used in restoration efforts on rangelands centers on working within the natural biotic community (use of native seedbank to reestablish vegetation). Augmented water resources (treated produced water) will be used to increase the response of the native species. Though this approach requires a longer time frame for recognition of impact, the approach provides the opportunity for the system to begin autogenic repairs (Whisenant, 1999). This approach

to restoration requires significant planning and patience, but the results should approach more natural conditions.

Initial activities will focus in two areas: 1) remediation of soils and 2) restoration of degraded rangeland systems (Figure 2 & 3, respectively).

Figure 2. Rangeland soils spoiled through the release of saltwater directly onto the soil. (Photograph by W.E. Fox).

Figure 3. Degraded rangeland system with loss of vegetation impacting erosion and soil stability. (Photograph by W.E. Fox).

The goal of the restoration project is not instant gratification which is often the case for many prior restoration activities. The process requires time and patience, but the results should provide for a more stable rangeland system that does not require constant human inputs to maintain the restoration (as is the case in the use of bermudagrass on mine spoils).

The Restoration Process

After assessing the status of the site, the team must develop strategies within the bounds of current technology to repair the site and redirect the vegetation change. This is an ongoing process that may require reassessment of the objectives to meet the overall goals of the landscape repair plan. The restoration process will focus on two major ecological attributes: 1) landscape structure and 2) landscape function. Landscape structure refers to the distribution, not the movement, of energy, materials and species in

relation to the sizes, shapes, numbers, kinds and configurations of landscape elements (Forman & Godron, 1986). Landscape function refers to the flow of energy, materials, water and species among the various parts of the landscape. There are eight major guidelines that will be followed in the restoration process (Whisenant, 1999):

- Treat causes rather than symptoms of the degradation
- Emphasize process repair over structural replacement
- Design repair actions at the proper scale
- Design landscapes to increase retention of limiting resources
- Design spatial variation into landscapes
- Design landscapes to maintain the integrity of primary processes
- Design linkages into landscapes
- Design propagule donor patches into landscapes

Most restoration activities require that we minimize energy inputs through management actions. Therefore, the objectives should include fully functional rangelands that are eventually self-repairing. The focus of our restoration project requires that the programs be diverse, adaptable and eventually self-organizing so that we may accept the ecological realities of change that may occur in the future (Lister, 1998). The restoration activities developed will focus on programs that identify benefits for the potential goods and/or services that can be derived from the system. In the case of our current program, enhancement of wildlife habitat will be a major objective.

The Oasis

Treated brine water from oil and gas production provides a valuable resource that has yet to be tapped. As a resource, this water could potentially provide an extremely valuable service in the restoration programs across much of the western United States that has been impacted by a series of severe droughts. The restoration of sustainable arid and semi-arid rangeland systems can benefit from this untapped resource. However, it is important to remember in the development of any program such as this that we must include the communities/stakeholders that may be impacted. Regulations must be addressed, the local public must have the opportunity to gain knowledge about the process and accept its uses and provide input and the economic mechanisms or incentives must be developed for producers to begin to capture this untapped resource.

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