Tanglehead Ecology and Management on South Texas Rangelands

A research report of the Caesar Kleberg Wildlife Research Institute

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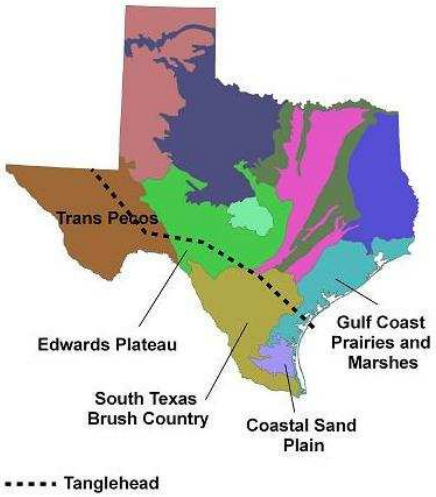
Introduction: The Status and Problem of Tanglehead in South Texas



Ecoregions of Texas where tanglehead occurs and the Northeast tanglehead boundary

In Texas, Tanglehead is primarily distributed throughout the southern and western regions of the state which includes portions of the Trans-Pecos, Edwards Plateau, South Texas Brush Country, Coastal Sand Plain, and Gulf Coast Prairies and Marshes ecoregions. Tanglehead is widely considered to be native to the United States and to Texas. Other U.S. states which tanglehead occupies include New Mexico, Arizona, California, and Hawaii.

Tanglehead is found on every major land mass between 35° N and 35° S latitude and many countries in both the New World and Old World claim that it is a native species. Wherever tanglehead originated, it likely spread early and became naturalized to many areas, adapting to the new ecosystems to the point where the ecosystem has been altered and adapted to its presence.

Whether tanglehead is native, naturalized, or exotic in South Texas, many ranchers and wildlife managers have become concerned over an obvious increase that has occurred in recent decades. The exact point at which tanglehead has increased is unclear and is likely different from ranch to ranch as the grass has moved from one ranch to another over time. The earliest reports of the increase come from southern Jim Hogg County, where an abundance of the grass was noticed about 15 years ago. Other ranches reported noticing the increase as early as 6 years ago. It is likely, however, that even the earliest reports were well after the grass began to increase in the region.

While tanglehead grows in various regions of Texas, it densely populates the Coastal Sand Plain ecoregion of South Texas, also known as the South Texas Sand Sheet. Within the tanglehead region of South Texas, the densest tanglehead occurs on the fine sandy-loam and loamy fine sand soils. These soils are found throughout Jim Hogg County, much of Duval County, and in portions of Starr, Hidalgo, Brooks, Kenedy, Kleberg, and Webb counties. Tanglehead will also occur on fine sand soils, but does not appear to grow densely or increase rapidly on them.

A typical soil occupied by dense tanglehead in South Texas

In southern Kleberg County, the composition of tanglehead increased 6-fold from 1.0% to 6.5% from 1999-2009. During the same period, Kleberg/KR bluestem, known to be highly invasive, underwent a similar 6-fold increase from 1.8% to 10.8%. This represents a significant change in composition and occurred on the periphery of the tanglehead region of South Texas. It is likely that in the heart of this region where there are an abundance of soils better suited to tanglehead, there was an even more dramatic increase over the same period.

Plant Ecology

While tanglehead can begin flowering as early as April, peak flowering in South Texas occurs from July – September. Depending on rainfall and management; however, flowering may be delayed if tanglehead has been shredded or recently burned. After September, flowering can be rainfall-dependent if drought conditions did not allowing flowering sooner. Flowering may be delayed through November and possibly even into December if adequate rainfall is received during that time and temperatures permit.

I estimate flowering to last 2 weeks, after which time seeds begin to be produced. Seed production then takes about 2-3 additional weeks. During that time, seeds slowly begin to "fill" whereby they become hardened and, at that point, are viable. The seed heads also begin to "tangle" in preparation for dropping off the parent plant.

Flowering tanglehead

At one collection site in Duval County, tetrazolium tests revealed seeds were 92% viable just before falling off the parent plants. They are then dormant for a short but unknown period of time which prevents seeds from germinating before the onset of winter. After this point, seeds will readily germinate once adequate soil temperature and moisture is reached. Once on the ground, changes in humidity and temperatures cause the seed awns to twist, effectively drilling the seed into the ground. Once in the ground, the awn is detached and the seed is prepared for germination.

Australian researchers hypothesize that seed is short-lived, however, this is based on seed stored at room temperature which revealed germination rates of 61% at 39 months and 4% at 53 months. Seed would likely remain viable a considerable shorter period when stored in the soil, but no studies have been done under these conditions. Late last year, I started a seed burial study in hopes of quantifying the viability. I will continue to monitor viability at 6 months and 1 year post-burial to determine how many seeds remain capable of germination after that time. This information will help determine if research should focus on breaking the seed cycle and reducing populations due to seeds not being replaced.

Winter Survival

There are several theories as to why tanglehead has increased. One such hypothesis attributes the increase to milder winters in recent decades. Both the 2009/2010 and the 2010/2011 winters produced temperatures that many considered unusually cold for South Texas.

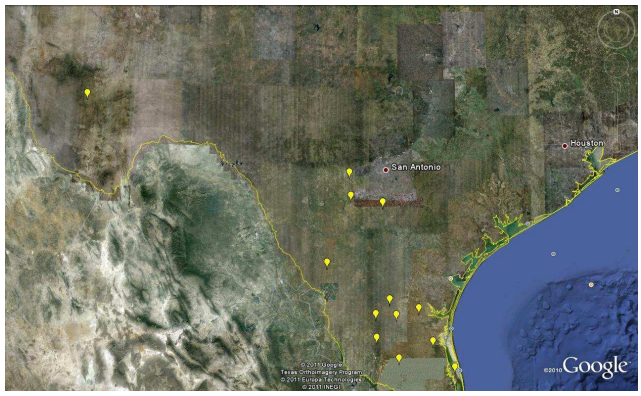
In February 2011, a cold front was predicted to hit South Texas. In anticipation of this, a number of individual tanglehead plants in at the Bomer Research Area in Duval County were monitored in an attempt to determine if and how much mortality occurred during these events. Prior to the cold front warm temperatures resulted in tanglehead plants producing a small amount of green leaf material at the base of the plant. In this way, it was determined that plants were alive prior to the cold front. 96 mature plants (>2" basal diameter), and 62 seedlings (<2" basal diameter) were marked. The cold front dropped temperature in the low-mid 20's for 4 nights, in the 30's for 2 days, and the 40's for 1 day.

In March 2011, I revisited these areas and determined that 100% (96/96) of the mature plants and 97% of the seedlings (60/62) survived the front. All of the seedlings were plants that had germinated late summer and fall of 2010. Amazingly, many of these seedlings were smaller than the maximum size yet most still managed to survive the cold temperatures, even after already having gone through most of the winter period. While it is still possible that warmer climates may benefit tanglehead, it is clear that much more severe winter weather than recent years would be necessary to significantly reduce populations.

Genetics

Another hypothesis of the increase of tanglehead in South Texas is that there has been an exotic genotype introduced. The term for this is "cryptic invasion" and has been scientifically established in only one grass species, common reed, in which a European genotype has become invasive in areas of the U.S. If this type of invasion has occurred in South Texas, a likely source for the exotic genotype would be Australia given the shared history between the two.

I feel it is important to attempt to address this hypothesis. Although the status of tanglehead does not affect the need for management in South Texas, the status does have the ability to impact how natural resource agencies view the problem and devote their resources. I have attempted to compare the genetics of populations of tanglehead throughout Texas. The method I am using examines the chloroplast DNA of the plant cell. This method is feasible for me given the work load and budget that I currently have but has no guarantee of success. If unsuccessful, it will be necessary to develop microsatellite markers, a more rigorous method that would require a PhD student to accomplish due to the time and money that would be involved in the endeavor.



Tanglehead genetic collections in Texas

Interestingly, the wet year in 2010 allowed me to observed 2 distinct varieties of tanglehead growing in the same area in Jim Hogg County. The less common variety, "Leafy" tanglehead (#2 in picture) produces much more leaf material and is a lighter shade of green. The more common variety, "Stemmy" tanglehead (#1 in picture) produces tall and thin appearing plants with much more robust stem material and is a deeper shade of green. While the stemmy variety was more abundant and seemed to initiate flowering a little earlier, both varieties appeared to have done well in 2010. With many varieties of grasses, even seemingly large phenotypic differences (appearance) such as these often do not translate to a genetic difference. Plant material was collected from both varieties and will be analyzed for genetic differences along with the material from other Texas populations.

Two varieties of tanglehead in Jim Hogg County, TX

Grazing

The most common complaint about tanglehead in South Texas is the poor forage quality and preference. In addition, ranchers have reported tanglehead being nearly unpalatable to cattle unless actively managed with burning or other disturbance. This is in direct conflict with reports of tanglehead in more central and western regions of Texas, where tanglehead is often a decreaser in grazing systems and is a desired range plant. There are many potential reasons for this conflict, including genetic plant differences. However, until a genetic difference is proven, I lean toward an environmental hypothesis. Colder climes and different soils in these regions likely produces less optimal growing and reproducing conditions for tanglehead which, in turn, can produce a plant that is generally more palatable and preferred by cattle in those areas.

Tanglehead in Australia and India is also well known as poor quality forage, but does appear to be readily eaten by cattle. Fire is a common tool in Australia for restoring tanglehead grasslands and is used along with deferred grazing to restore overgrazed tanglehead grasslands. Constant use of fire in Australia may explain why cattle do appear to graze it more readily there. The cattle in the tanglehead region of Australia may also be more accustomed to eating tanglehead than are cattle in South Texas, where more palatable exotic grasses are often found for cattle to forage.

In South Texas, most grazing regimes do not appear to damage tanglehead grasslands. In Australia, grazing carrying capacity for heavy tanglehead areas are 1 cow/ 7 acres – 1 cow/10 acres. These stocking rates are often the maximum rates of grazing on many South Texas ranches. With shifting land uses toward a wildlife emphasis on

operations, many more ranches are stocking a much lighter rate or removing cattle completely.

In 2010, a very wet year in South Texas, one ranch in Jim Hogg County with a small cow-calf herd, supplemented the grazing with Mexican steers to attain close to a 1 cow/ 4 acre stocking rate. This stocking rate after late winter burning was able to damage tanglehead plants and to open up bare ground between the plants. For quail management, creating bare ground in tanglehead grasslands is an important goal because it increases the availability of areas that were formerly inaccessible to quail because of the thick growth of the grass. I hope to better quantify the habitat effects that this grazing intensity has with a recently initiated experiment on this ranch.

Disking

Disking is a common practice on ranches in South Texas that manage for wildlife. Numerous scientific studies have shown that winter disking produces a flush of forbs the following spring and summer when moisture is available. Disking can also break up thick monocultures of pasture grasses and create bare ground, which is important for bobwhite quail in particular. The value of disking is debatable in semiarid environments, such as South Texas. However, in my experience with tanglehead I am convinced that the productivity and density of this grass produces a situation whereby disking can be an effective wildlife management tool.

In the book Texas Quails (page 289), F. Hernandez, R. M. Perez, and F. S. Guthery present 4 simple guidelines if you decide to disk:

1) Areas with >85% is covered with grass and the grass is >30” in height
2) Disk within 150-200’ of woody cover
3) Disk sandy/ sandy loams soils and not loam or clay soils
4) Disk between first freeze in fall and last freeze in spring to reduce grass cover

When disking tanglehead landscapes, it is important to focus disking effort on the densest and largest areas of tanglehead. These are the areas that will receive the most benefit, if any, from disking. Many areas that do not have tanglehead or have a relatively low amount of tanglehead do not need disking to promote more diversity or create bare

ground. Disking such areas could result in wasted time and diesel. Tanglehead commonly grows and increases in a very patchy pattern whereby colonies of various sizes and individual plants are dotted throughout a landscape. These areas are not good areas to focus disking operations because there is often diverse vegetation and bare ground between these patches. If and when that same landscape becomes more of a monoculture of tanglehead, there is likely a much higher benefit to disking.

The size at which a dense area of tanglehead needs to reach to benefit from disking is unknown and probably depends on a variety of landscape factors. Simply put, however, the larger the area covered by tanglehead and the denser it is, the more benefit will likely be gained from disking. Individual managers should decide whether tanglehead grows in a way that presents a problem for quail. Collecting and analyzing quail harvest data or covey call count data may help determine if this situation is occurring.

Another important consideration is the size and weight of the disk used. Tanglehead and other dense bunchgrasses require a heavy enough disk to uproot and kill the mature plants. If established plants are not killed, they will come back quicker than seedlings and the benefit of disking decreased.

Burning

Fire and grazing are the most common ways to manipulate vegetation on a landscape scale. Fire is commonly practiced in the tanglehead region of Australia and is well known as a way to restore tanglehead grasslands when intensive grazing decreases tanglehead and promotes even less palatable grasses.

In a recently completed winter burning study in Jim Hogg County, results show that, when burned with no grazing, tanglehead increased 19.6% from February to July while on unburned areas, tanglehead increased only 6.4%. Of all the vegetation data collected, the most interesting result was the seedling response on burned areas which showed an average of 212 seedlings/m^2 while unburned areas averaged 0.4 seedlings/m^2. This response has never been documented in the U.S. but is similar to Australian studies, which have shown seedling rates of 300/m^2 where the above ground litter was removed (e.g. burned), compared to 3 seedlings/m^2 where it was not removed (i.e. not burned).

Tanglehead seedlings germinating after a winter fire

For many ranches, burning is a very active part of their grazing, brush, and wildlife management. When burning in the tanglehead region, I would recommend taking the following measures to ensure tanglehead does not become problematic:

1) If tanglehead is not present before the burn, look for it after. If you are unable to readily identify it by the leaves and growth form, be sure to look for it during the

peak flowering period (Sept.- Oct.). If detected early, removing plants from an area is relatively easy and inexpensive.

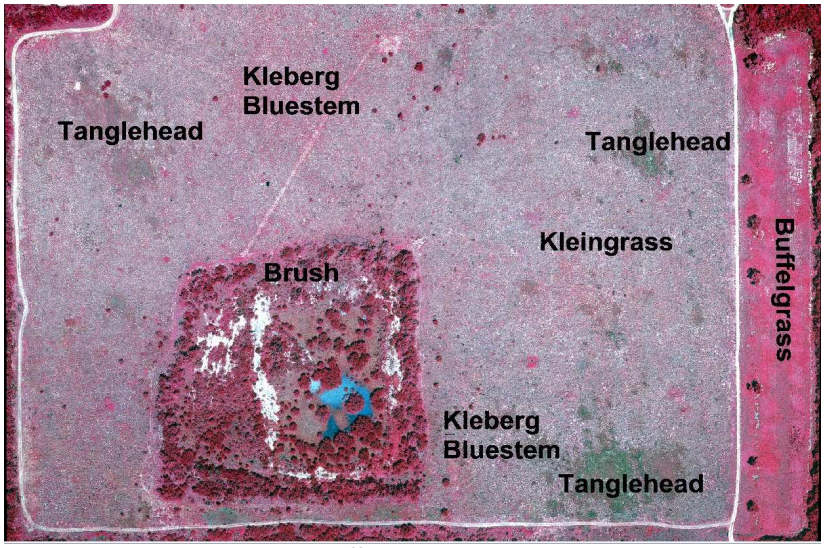
2) Follow up fire with further management. Depending on the size of the area being managed practices such as grazing or spraying herbicides may be effective at controlling the seedling response and resulting expansion of tanglehead after a burn.
3) Burn monocultures of tanglehead. Burning tanglehead is often necessary to increase its palatability to cattle. Areas that are already dominated by tanglehead can be burned without risk of further spread.

Spread and Increase

In the fall of 2011, I will complete a GPS-based study in Duval County examining the rate of spread of tanglehead in an unmanaged grassland. The goal of this study is to determine how fast tanglehead will spread during different times of year. I hope to give landowners an estimate of how much time it will take for tanglehead to dominate the vegetation community on their lands.

Remote Imagery Detection of Invasive Grasses

I have roughly outlined the areas where tanglehead occurs in South Texas, however, I have also been attempting to develop a more accurate, widespread, and efficient system of detecting tanglehead and communicating how widespread tanglehead has become in the region. I have been working with the USDA Agriculture Research Service in an effort to determine exactly how detectable tanglehead and exotic invasives are on South Texas rangelands. We will conduct a pilot study looking at the reflectance measurements of several target grass species. These measurements will tell us how distinguishable these grasses are from each other and from common native grass species on color-infrared imagery. If successful, remote sensing could be a viable option for detecting and quantifying invasive grasses.



Natural color imagery showing visual differences between various grasses at a Duval Co. site

Herbicides

With shifts in land use trending toward wildlife operations and away from cattle, many landowners have reduced grazing pressure or removed grazers completely from their lands. As with guineagrass and other exotic invasives, tanglehead is capable of producing large amounts of biomass which can become problematic for wildlife, especially quail which prefer certain amounts of bare ground in their habitat. In these situations, herbicides may be a viable alternative or may be able to supplement grazing practices for effective wildlife management. Herbicides also have the advantage of being selective in their application, allowing managers more flexibility in targeting specific areas at specific times.

I've recently initiated a series of experiments looking at evaluating herbicides for use on tanglehead. In 2009, I sprayed the chemical imazapyr, which is the active ingredient in herbicides such as Imazapyr 2SL® and Powerline®. Imazapyr is a soil sterilant, killing all vegetation in the area it is sprayed and will keep vegetation out until the soil can break down the chemical which in the case of imazapyr is 3-6 months depending on the concentration sprayed. Imazapyr was sprayed on a ranch in Duval County that was just starting to see patches of tanglehead. In the fall of 2009 we sprayed all the tanglehead we could find. Imazapyr took about 2 weeks to work down into the soil before being taken in by the roots and finally killing the plants. By the following spring, some forb species were already coming back on those areas, although the diversity of forbs was still depressed. No tanglehead has since been seen on the areas that were sprayed and now that the manager knows what to look for, a prevention program is in place to keep tanglehead out.

Imazapyr is a relatively expensive chemical and may only be economically feasible for small scale patch control of tanglehead. I am currently planning to initiate an efficacy experiment evaluating different rates of imazapyr to see if a low rate can be found that is effective on tanglehead while being more cost-effective for land owners. This may also make the herbicide more feasible to spray on larger scales.

Tractor and sprayer

Glyphosate, on the other hand, is a relatively cheap chemical that could potentially be cost-effective on a large scale if effective on tanglehead. Glyphosate is the active ingredient in Roundup®, Mad Dog®, Glyphosate 4®, and similar products. Research is currently evaluating both the timing and rates of glyphosate on tanglehead. In October of 2009, I sprayed Mad Dog Plus® (41% glyphosate with surfactant) at a rate of 48 oz./acre on plots in Jim Hogg County. When I went back a few weeks later, they appeared to be weakened but not killed. The winter of 2009-2010 was unusually cold and the following spring all tanglehead plants were dead and no seedlings were observed. In the Fall of 2010, I repeated the experiment using 3 different rates of the same glyphosate herbicide- 24, 48, and 64

oz./acre- and applied it to 2 plots that were burned late winter 2010 and 2 plots that were burned late winter 2009.

So far in 2011, very little regrowth of tanglehead has been observed on any sprayed plots compared to controls. A few plants survived in the areas burned in 2009 because there was more rank material that may have shielded plants from the glyphosate. With drought conditions setting in, monitoring of this experiment will have to continue until after significant rainfall is received to fully evaluate effectiveness. Currently, the rate of 48 oz./acre appears slightly more effective than 24 oz./acre but no difference has been observed between 48 and 64 oz./acre. The optimal rate may ultimately fall between 24-36 oz./acre but further research would be needed to test this hypothesis.

The product used in this experiment was 41% glyphosate. More concentrated glyphosate products would require a lower rate per acre while less concentrated products would require a higher rate. Many herbicides, including glyphosate herbicides act through absorption into leaf material. Therefore, it is also important to spray when leaf material is green and actively growing.

I am currently working with the Texas A&M Extension Agency on an herbicide experiment that they have initiated. This experiment will evaluate different spring application rates of glyphosate, imazapyr, Velpar®, and Pastora® for their effectiveness on tanglehead. This will provide valuable information on effectiveness of a variety of herbicides and will allow us to compare the effectiveness of spring and fall applications.

Summary

As I learn more about tanglehead in South Texas, I've become convinced that there are wildlife management options available in environments where it dominates. I'm also convinced that there are better and more cost-effective options that research can produce. While tanglehead aggressively spreads like an exotic invader, it does not posses a wind-blown seed such as buffelgrass and Kleberg bluestem, produces seeds only once per year, and appears vulnerable to herbicides. These limitations, along with others that may be discovered, can be exploited to control tanglehead populations where they've become a management concern.

Based on results from studies, observations from South Texas, and study of available literature, it is clear that the issue we face with tanglehead in South Texas and the way tanglehead behaves is more similar to tanglehead in Australia than it is to other parts of the U.S. Australia has a long history of tanglehead research for cattle management. Therefore, the mistakes and successes of Australian management can provide South Texas with a basis and direction for wildlife and cattle research and management.

Future of Tanglehead Research in South Texas

If moisture conditions permit this summer a graduate project will examine the effects of summer burning on tanglehead. If initiated, this study could allow us to compare winter and summer burn regimes for tanglehead seedling response and plant vigor. If reduced on summer burns, this may provide an alternative for managers who must burn for cattle but are also concerned about further encroachment of tanglehead.

In Australia, the focus on land use is still primarily cattle based and the land is managed with that goal in mind. As a result, many research studies have been completed evaluating different ways to increase production, specifically live weight gain, of cattle. Burning, brush/tree removal, and the introduction of exotic legumes are the most common management practices. However, these management practices have also led to decreased biodiversity, an abundance of woody weeds, and soil degradation.

The future of tanglehead research needs to continue in 3 distinct areas: 1) Evaluating cost-effective herbicides and application timing, 2) Native legume introduction, and 3) Plant population dynamics and physiology. Exotic legume introduction in Australia has led to increased forage quality but has also led to undesirable consequences that are likely damaging to wildlife. The E. Kika de la Garza Plant Materials Center has recently selected accessions of native prairie acacia and is currently increasing the seed stock. When available, research should evaluate interseeding this species in tanglehead and exotic grasslands. This could provide a benefit to both cattle and wildlife populations in these areas. As with many of the exotic invasive grasses in South Texas, there is much we do not understand about the ecology of tanglehead. Understanding basic properties such as seed vigor, optimal soil conditions, and carbohydrate sequestration can provide valuable clues when implementing future research studies concerning management practices.

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