- **University of Natural Resources and Applied Life Sciences; Vienna, Austria**
- **Lincoln University; Lincoln, New Zealand**

Master of Natural Resource Management and Ecological Engineering

---

Aspiring Ashes: A Human Ecological, Natural Science, and Practical Synthesis of Prescribed Fire

Master Thesis

David Emerson Connell

Advisors

Em.Univ.Prof.Dr.Rer.Nat. Harmut Gossow

Rev. Dr. Keith Morrison

Vienna, March 2008

ABSTRACT

Deutsch

In dieser Master Thesis wird versucht, Praktiken der Feuermanagement-Politik in Nordamerika mit sozio-kulturellen und bodenkulturwissenschaftlichen Aspekten zu verschneiden. Dazu bietet eine Literaturauswertung Beispiele zum Funktionieren indigener Brandanwendung, zur Unterdrückung von Wildlandfeuern in industrialisierten Kulturen, für die gegenwärtige Zunahme von katastrophalen Brandereignissen sowie über Ambitionen, das Feuermanagement zu verbessern, besonders seitens des BLM: das Ganze vor dem Hintergrund des sog. "Panarchy"-Konzeptes, kulturell wie umweltbezogen. Als konkretes Fall-Beispiel dient dann die Calcite-Ranch in Texas (Edward Plateau), auf der "prescribed burning" in den Letzten Jahren hinsichtlich seiner Auswirkungen auf die Habitateignung für verschiedene Wildtierarten diskutiert wird, mit dem Schwerpunkt Weißwedelhirsch, als Möglichkeit einer praktischen Anwendung durch Landbesitzer in dieser Gegend.

English

Prescribed fire is first examined in the human ecological sense. Four themes emerge when reading the available literature: the functionality of fire within indigenous cultures, the history of suppression within industrialized cultures, a contemporary onslaught of catastrophic fires, and a will to amend policy regarding fire. Panarchy places fire in the same template both culturally and environmentally. The Bureau of Land Management (BLM) integrated fire management policy is discussed as a move forward. Calcite Ranch is then illuminated; the fire regime and subsequent quantification of vegetation transects and their analysis. This is followed by case studies of four animals residing in the region and the effects fire has on their habitat through an estimation of the Habitat Suitability Index (HSI) values for each. Finally an in depth case study of one of the animals, the white-tailed deer, gives this work a practical application for land managers in the region.

Acknowledgements:

Every academic work rests on the shoulders of giants. I would like to start by thanking every researcher I have cited in the ensuing pages. Knowledge is power and through your work this thesis was empowered.

I also thank my family: Don Connell, Ann Connell, and Sarah Connell. ‘We built our tower strong and tall, don’t you know it had to fall someday.’ - *T.VanZandt* – Here’s to release and reorganization, panarchy of the heart; I love you. Close friends and confidantes: thank you for everything you give, know that I will always be there for you.

For my thesis advisors, I offer thanks and respect. Dr. Gossow and Rev. Dr. Morrison helped me shape this thesis into presentable form. Dr. Gossow’s prescribed fire expertise meshed with the human ecology specialty of Rev. Dr. Morrison to create this work. Thank you as well to the academic institutions of BOKU and Lincoln University.

Colleagues in the NaRMEE program, it was great going through the motions. The melting pot experiment worked - globalization of academia - I had a blast learning with y’all.

To New Zealand: thank you. Thank you Alps, thank you Sumner Forest, thank you The Works, thank you Pennyhitch, thank you Clearwater R.S., thank you Otematata, thank you MillHill, thank you Gus.

To Texas: thank you. Thank you Calcite, thank you Red Buffalo, thank you Behrens, thank you Buck in The Draw, thank you Sports Country, thank you Passerina Ridge, thank you D.W.A., thank you 10424.

To Austria: thank you. Thank you Lungau, thank you Oberleinz, thank you Maltatal, thank you Ois, thank you Salza, thank you Vienna.

Contents

Table of Contents for Maps, Tables, Graphs, Photos

1. Abstract

Prescribed fire is first examined in the human ecological sense. Four themes emerge when reading the available literature: the functionality of fire within indigenous cultures, the history of suppression within industrialized cultures, a contemporary onslaught of catastrophic fires, and a will to amend policy regarding fire. Panarchy places fire in the same template both culturally and environmentally. The Bureau of Land Management (BLM) integrated fire management policy is discussed as a move forward. Calcite Ranch is then illuminated; the fire regime and subsequent quantification of vegetation transects and their analysis. This is followed by case studies of four animals residing in the region and the effects fire has on their habitat through an estimation of the Habitat Suitability Index (HSI) values for each. Finally an in depth case study of one of the animals, the white-tailed deer, gives this work a practical application for land managers in the region.

1.1 Hypothesis

A cultural shift towards the functionality of prescribed fire can occur when the history of the dysfunctionality is confronted. This confrontation needs to happen in society using the natural sciences as examples. The fieldwork in the plant transects at Calcite as well as the case studies of fire effects on specific animals will help show the way for this realization to occur.

1.2 Thesis Introduction

A bridge between nature science and social science is a difficult one to build. All disciplines must form this bridge as the purely scientific must have a practical effect on humanity at large. Once science is transferred into humanity social science enters the equation. Human Ecology is no different; the quantifications of ecological processes must be greeted by humanity. Enter the social sciences. We perceive all ecological processes uniquely, both as individuals and as a super organism culture. Perception is a combination of ethics and values; neither ethics nor values are universal. Understanding and furthering the knowledge regarding prescribed fire in both the social science and natural science form is the goal of this thesis.

Aspiring Ashes takes this holistic approach to prescribed fire and firstly places it in the social sciences. The development of both benevolent and malignant generalizations and policies are grappled with as well. This allows prescribed burning to find its place within our culture, an important facet to ascertain. Without the knowledge of a discipline's place within humanity as a whole, science holds little hope of making a difference. With the knowledge of how prescribed burning fits in as a part of the whole, the path of how science enters into culture becomes apparent.

The human ecological prelude suggests how prescribed fire can be utilized and implemented following centuries of misinformation in the industrialized world. Once the cultural benefits of prescribed fire are illuminated, a nature science study follows which quantifies effects of prescribed fire. This study has the promise to become a fire ecology study, but temporal limitations at this point make it one of fire effects.

Any study becomes useless without practical application. Results are great but how will they affect the ecosystem at large? The final section of this project is a case study which shows how prescribed fire is useful to a native species of the study area, the white-tailed deer (*Odocoileus virginianus*). It is a bridge back to the real world, how prescribed fire effects a member of the ecosystem.

The goal of this project is a holistic approach towards understanding and furthering the knowledge of prescribed fire. We begin with the theoretical in the social sciences. Then we move to the number crunching scientific method in the natural sciences. Finally we see how this entire scheme affects an animal in the real world. A synthesis is created between the sciences and the social sciences as well as the theoretical world of academia and living ecosystems.

2. Aspiring Ashes Introduction

Prescribed fire is at an exciting juncture. A gradual revelation of the benefits of fire as a natural resource management tool permeates the contemporary body of literature. Social science argues the functionality of prescribed fire within cultures. This is validated by scientific articles regarding the regenerative aspects of fire and its biophysical role in an ecosystem. Four main concepts permeate contemporary literature regarding prescribed fire:

- the functionality of fire within indigenous cultures
- a history of suppression of fire within industrialized cultures
- a contemporary onslaught of catastrophic fires
- a necessity for industrialized cultures to amend policy regarding fire

Amalgamating the literature pertaining to prescribed fire reveals its current state and facilitates visions of future possibilities.

2.1 The Functionality of Fire within Indigenous Cultures

The body of literature regarding prescribed fire has a perspective which resonates the benefits of fire within indigenous cultures. This is a pan-human perspective. The case studies abound representing many areas of the world: Brazil (Mistry *et al.* 2005), Madagascar (Kull 2002), Australia (Russel-Smith *et al.* 1997), and America (Levy 2005). These are a handful of the numerous examples of prescribed fire's functionality within indigenous cultures.

Fire serves as a culturally constructed ecological tool within many indigenous cultures, its purpose fulfilling multiple needs making it a synergistic satisfier (Stogl and O'Hara 2001). Fire serves two roles in range management.

“First, it maintains grass dominance, avoiding range degradation from bush encroachment. Second, fire renews grassland vegetation” (Kull 2002, p12).

The motivations behind the utilization of fire as a natural resource management technique are intrinsic, instrumental, and systemic. Intrinsically, there is an overarching will to “clean” the country with fire (Mistry *et al.* 2005), (Levy 2005). Australia is no exception, where “men and women, typically under the guidance of senior custodians, set about Arri Wurlhge, ‘cleaning the country,’ moving through their clan estates, setting fire to the curing grasses” (Russel-Smith *et al.* 1997, p174).

Instrumentally, fire provides a myriad of services for the community. It is an effective technology and tool. Indigenous cultures burn for “aesthetic quality, to reduce populations of snakes and scorpions, and to facilitate movement through the vegetation” (Mistry *et al.* 2005, p365). Furthermore, fire serves as a hunting aid, “Kraho use fire to promote ‘green pick’ which attracts game to certain areas” (Mistry *et al.* 2005, p373).

Systemically, fire fills a need within an ecosystem. It is important to note that fire was a natural process long before humans began to appreciate it as a technology. This only validates its functionality. Lightning strike fires have facilitated ecosystem redistribution since prehistory. In fact, it is rational to intuit that the technology was first appreciated in this manner. Indigenous cultures embraced this systemic aspect and “emphasize the importance of ash for land management as well as other ritual and medicinal functions” (Mistry *et al.* 2005, p366).

2.2 Suppression of Fire from Industrialized Cultures

The benefits of prescribed fire, biophysically and socially, resonate through the indigenous perspective above. With such a resounding positive role in a culture and ecosystem it is surprising that industrialized cultures have not historically shared the same perspective. The historical mindset of industrialized cultures is one of fire suppression (Pyne 1982).

This policy of fire suppression is detrimental to ecosystems and cultures. An ecological example of this is in Australia, where "ecological change/deterioration is associated with the collapse of traditional fire management regimes at the regional level" (Russel-Smith *et al.* 1997, p163). The same scenario presents itself in Madagascar, where "since 1896, both the French colonial administration and the independent Malagasy state have attempted to stop burning" (Kull 2002, p10). The cultural and ecological suppression of fire is also present in the indigenous people of Brazil. A faction of Kraho men in Brazil have adopted the mindsets of the antagonists and openly criticize burning. "As a result, many early season protective and resource enhancing fire practices are not implemented and elder complain that many young are gradually loosing their traditional knowledge pertaining to fire" (Mistry *et al.* 2005, p275).

The policy of suppression becomes more confounding because use of fire as a resource management technique was witnessed by the industrialized cultures at the time of colonization. An example of this is in North America where, "documentary evidence supports claims of widespread native fires in presettlement California. There are numerous mentions of Indians setting landscape fires in the diaries of early settlers" (Levy 2005, p306). However, for various reasons the functionality of fire within a culture was not heeded. The result of this global policy is evidenced in the U.S., where "the campaign of fire suppression has proven far too successful; forests across the country are choked with thick undergrowth" (Levy 2005, p306). With a natural process suppressed and forests full of undergrowth catastrophe is eminent.

2.3 Contemporary Onslaught of Catastrophic Fires

The suppression policy has facilitated some of the most catastrophic fires in recorded history. In recent decades, it has become increasingly evident to fire researchers and land management professionals that these policies have produced vegetation more conducive to large, hard to control catastrophic fires (Babbitt and Sampson 1995). When fires start in these altered forests, "they burn hotter and spread farther than they did in presettlement times. Even an army of firefighters backed by air drops of fire-retardant chemicals, can't do much to stop these infernos" (Levy 2005, p306).

The cost of these catastrophic fires is astronomical. The U.S. spent $1.4 billion in 2002 battling seven million acres of wildfires; in 1996, when six million acres burned, the cost was $522 million (Robbins 2004). Furthermore, misplaced criticism about the effects of these catastrophic fires has put public acceptance of prescribed fire in jeopardy. An example of this occurred in Utah in 2003, where a prescribed burn on the Uinta National Forest escaped, costing nearly $3 million to extinguish and choking Utah cities with smoke for a week. "The incident drew harsh criticism from local officials and news media; fire managers worried that prescribed burning would no longer be feasible in northern Utah" (Brunson and Evans 2005, p134).

Catastrophic fires resonate in many indigenous cultures as well. This is illuminated through an interview from Brazil:

> "I know a place here that had many deer. And I feel very sorry because it shouldn't have happened. Listen, passed four years drying, drying leaves, drying grass, drying everything. And when it was the dry time the rains went away, and came the fire, came from I don't know where to this area, entered the forest. Burned everything!

> It’s because of this I don’t like to leave a place for a lot of time without burning, because one day that fire arrives, you can’t put it out. No one can put out. It finishes everything. It can enter the forest, the marsh, the fire finishes” (Mistry *et al.* 2005, p371).

The difference in the mindset of industrial versus indigenous cultures with regard to fire is evident in this account. The industrial policy historically has been to suppress fire in order to avoid catastrophe. The indigenous policy is to promote fire in order to avoid catastrophe.

2.4 Will to Amend Policy Regarding Fire

There has been a gradual realization within industrialized cultures that fire is a necessary component of the ecosystem. This is a positive sign. The ecologists warmed to the concept as they were “once wedded to strict concepts of succession and now accept fire and other disturbances such as floods and hurricanes as integral parts of the functioning of many ecosystems” (Kull 2002, p17). This realization of fire’s role within the ecosystem is backed by a cost argument that prescribed fire often may be the least expensive and/or most effective vegetation management tool available (Yoder 2004). Combining these two aspects motivates many industrialized nations to implement fire into policy. In America, for example, this resulted in a “national fire plan of 2000 that recommends actions to reduce fuel loads in western forests including prescribed burns” (Levy 2005, p205).

Changing policy is good, but there is a lack of knowledge pertaining to fire after centuries of suppression. Furthermore, the suppression has produced some of the most volatile ecosystems in terms of fuel loads. This is not the ideal situation in which to re-learning fire behavior and limits. The slightest mistake could end up costing millions of dollars and a tarnishing the emerging face of fire as a necessary management tool. Suggestions of capacity building from indigenous prescribed burning practices show possibility for accelerated learning. "We know little about the burning regime of indigenous people, although understanding traditional burning practices may help us with contemporary issues" (Mistry *et al.* 2005, p366). However, it is also becoming apparent that the policy of suppression has had a detrimental effect on indigenous knowledge pertaining to prescribed fire. "We try to mimic native burning, but we don't know precisely how often or when they burned" (Levy 2005, p304).

2.5 Synthesis

The contemporary issues pertaining to the lack of knowledge about fire as a natural resource management tool spawn from the dominant policy making culture, that of the western industrialized countries. This leaves Western civilization with the challenge to re-learn fire behavior. There is a renewed interest in fire as a resource management tool but the knowledge associated with its implementation has been ignored for such a long time that re-establishing the connectivity with fire has proved extremely difficult. There is hope, "indigenous burning can help show the way out of a very modern fire dilemma" (Levy 2005, p303).

This shines on a curious predicament for applied human ecologists: how to empower a first world culture in order to reinstate a functional human ecological tool that transcends humanity. In many ways this dilemma is the inverse of many applied human ecological ventures. Instead of empowering the dysfunctional indigenous, we need the functionality of the indigenous to empower the dysfunctional industrialized world.

Facilitating this empowerment entails a close examination of the cultural and biophysical aspects of prescribed fire. An examination into the suppression of fire reveals a creation of a modern day 'haunting' (*sensu* Gordon 1997). This haunting has detrimental effects on industrialized and indigenous cultures.

Panarchy is the dynamic process of exploitation, conservation, release, and re-organization and provides a biophysical and cultural synthesis of prescribed fire. Finally, an examination of catastrophe theory explains a key method by which avoidance of holocaust fires can be attained through pre-emptive capital redistribution, or the reduction of fuel load. The examination of prescribed fire by these three perspectives aids in the understanding of the key issues and facilitates the formulation of a strategy forward.

3. 'Haunting' Case Study: Madagascar

Contemporary fire issues make Madagascar a good case study to introduce the concept of 'haunting.' "Madagascar, an island of 587,041 km squared and home to many endemic species, has half of its vast grasslands and thousands of square kilometers of its rainforests and secondary bush consumed by fire every year" (Kull 2002, p8). The island has two climate zones, consisting of a grassland savannah on the west and a rainforest on the east. The fires consuming Madagascar are anthropogenic. Fire is used by the indigenous Tantsaha for a variety of reasons both functional and dysfunctional. On the Savannah to the west fire's functionality provides fresh growth for livestock, protects against invading pests, and serves indirectly to stimulate the economy (Linares 2005). On the rainforest side to the east fire is used for slash and burn agriculture, an unsustainable dysfunctional practice that imperils much of Madagascar's endemic biota (McConnell and Sweeny 2005).

The conflict over fire is explicitly between the Tantsaha and the Malagasy government. Since colonization in 1896, fire has been suppressed by governmental policies banning the practice (Kull 2002). The Tantsaha continue to burn. As with many enduring conflicts, the purposes behind each mindset have become skewed due to confrontational dualism. Furthermore, the dualistic nature of the conflict has perpetuated a dysfunctional suppression policy by the

Malagasy state regarding the western grassland, where fire occurs naturally (Kull 2002).

Institutions have attempted to resolve the conflict with little success (McConnell and Sweeny 2005). The hypothesized reason behind this is due to the reluctance of the state to relinquish any power in regards to fire setting policy (Kull 2002). Currently the situation is at an impasse, as a result Madagascar as a whole suffers.

3.1 Haunting Defined

'Haunting' is a replicating cultural flaw or illness. A fixation develops around this cultural flaw and the situation perpetuates. "A 'haunting' describes how that which appears to be not there is often a seething presence, acting on and often meddling with taken for granted realities" (Gordon 1997, p9). Fire represents a haunting in both industrialized and traditional cultures.

Functional cultures have embedded institutions which purge cultural flaws, thus mitigating the 'haunting'. "The campaign against the enemies of the people is seen as a form of social prophylaxis: the integrity of the body depends on the elimination of its parasites" (Flynn 1992, p193). One such institution is the 'ontological difference' which is experienced when there is a 'gap/break/joint' in objectivity. "The social imaginary vacillates in the 'gap' between memory and projection" (Wright 1992, p76). The 'gap/break/joint' is recognition of discontinuity within a culture, intuition and creativity are utilized to fill in the 'gap'. This causes a culture to intuit and rationalize the degree of usefulness of the new construction and decide on its functionality or dysfunctionality. If the new concept is functional, it is adopted; if it is dysfunctional, it is purged.

3.2 Indigenous 'Haunting'

Colonialism disempowers to the core, involving social, political and psychological disempowerment. 'Hauntings' arise in response to this disempowerment. In this instance the Tantsaha of Madagascar jumped from the Stone Age into the Industrial Revolution literally overnight during colonialism. The embedded institutions which sort out and purge cultural flaws were overwhelmed by such a drastic change. A ‘gap, break, joint’ that big in the ontological difference morphs into a “chasm”. This “chasm” sends shocks through the entire culture, making it impossible to rationalize and intuit the degrees of functionality or dysfunctionality due to the myriad of culture dumped by colonialism.

Fire became a reactionary haunting in response to the disempowerment resonated through the “chasm”. Fire was one form of technology that the Tantsaha had a greater understanding of than the French Colonialists. Furthermore, it was one of the only forms of technology that the Tantsaha possessed which the colonialists feared, it could not be ignored. This gave their haunting a reactionary tool. “67% of the islands forests have burned since 1900.” (Kull 2002, p3) The colonialists did not want the forests in 1900 for their biological diversity; they wanted the forests for ship masts and building supplies – raw materials to feed an industrial machine. The Tantsaha utilized the tool produced by their haunting and began to use it against the very people who disempowered them; the Tantsaha began to destroy the forest with fire.

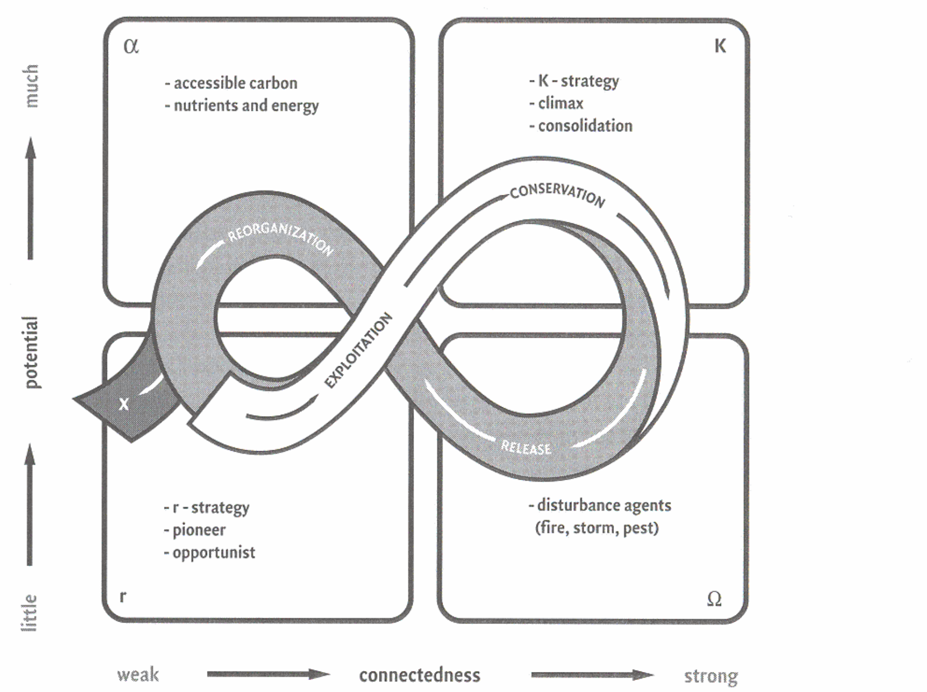
3.3 Industrialized World ‘Haunting’

The industrialized world must evaluate how to reconnect with fire and utilize it as a human ecological tool within the culture. “Nature, independent of humans, created flammable ecosystems. Prehistoric humans tamed these natural fires. Modern people deny this historical and evolutionary reality. As a result, fire has become feral, and a serious management problem” (Levy 2005, p310). By denying fire’s historical and evolutionary reality, a modern day ‘haunting’ has emerged.

The 'haunting' instigated by the colonial powers has morphed diachronically into a haunting of the colonial powers as well. In Madagascar (Kull 2002), as has been recorded in Australia (Russell-Smith *et al.* 1997), U.S. (Levy 2005), and Brazil (Mistry *et al.* 2005), governmental policy which stagnates fire has become a 'haunting'. The contemporary 'haunting' is due in part to a natural human tendency to fear fire because it is difficult to control (Wright and Bailey 1982). The nature of fire embodies chaos (Atkins 1984). Physical matter combusting in a chaotic manner, changing the face of a landscape instantaneously, is an awe inspiring sight. Fear is a natural emotion to conjure in this scenario, and is shared by indigenous mindset. The Kraho of Brazil perceive fire as being "good and bad at the same time" (Mistry *et al.* 2005, p6). By ignoring the good of fire and concentrating a perspective on the bad, contemporary policy has created its own "chasm." This "chasm", where the difference in perceived and true ontology becomes impassable, needs to be remedied for fire to return to its functional place within the culture.

4. Panarchy

The difference in the perspective of fire by indigenous and industrialized society gives a foundation for the nature of the fire dilemma and helps visualize horizons forward. These ontological differences prove to be objective and subjective, dealing with fire as a biophysical process and also a cultural mindset to which fire is coupled. Examining the 'haunting' regarding fire helps illuminate these cultural mindsets to which fire is coupled. Panarchy serves to link the biophysical process of fire and the cultural issues pertaining to fire within the same framework.



(Berkes *et al.* 2003, p17)

Figure 1: Panarchy Cycle within an Ecosystem
The dynamic process of exploitation, conservation, release and reorganization occurring in all natural ecosystems.

Panarchy is a "set of adaptive cycles starting with two traditional ecological functions, exploitation and conservation, to which are added two more to create the four-phase model of conservation, release, reorganization and exploitation" (Laughlin 2004, p125). Panarchy captures "the adaptive and evolutionary nature of adaptive cycles that are nested one within the other across space and time scales" (Gunderson and Holling 2002, p74). It is a tool which seeks a better understanding of the interaction between society and the environment (Redman 2005). Moreover, the panarchy method visualizes the way that the biophysical and cultural are coupled, which better serves the human ecological perspective.

4.1 Biophysical Panarchy

Fire acts as a facilitator of change within an ecosystem. It is not inherently malignant or benign; it is a force to be respected and understood. Ecosystems follow the panarchy cycle. Within an ecosystem there is a general exploitation of resources leading up to a peak. This can be viewed in the sense of fire as an ecosystem producing large amounts of combustible fuel. As the fuel accumulates the nutrients in the soil are exploited and the amount of herbaceous material competing for sunlight causes a leveling off of growth (Lewis *et al.* 1982). This leveling off represents the conservative phase of panarchy. Biophysically this is due to a decrease of soil nutrients and an increased use of energy competing with other plants for sunlight and soil nutrients (Hallisey and Wood 1976). Fire enters at this stage, facilitating the redistribution and reorganization in the ecosystem through a catastrophic event. The buildup of herbaceous material means there is more and more combustible material in the ecosystem. Fire, either naturally set through lightning or anthropogenically ignited, redistributes the accumulated and stagnated herbaceous growth.

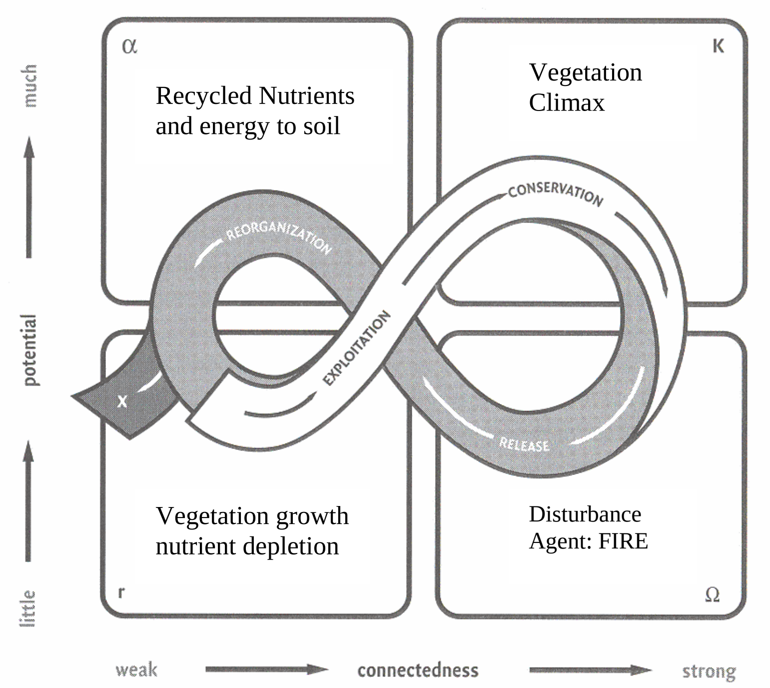


Figure 2: Biophysical Panarchy of Fire

Figure Template from:
(Berkes *et al.* 2003, p17)

Figure 2 Note: "Panarchy change is neither continuous and gradual nor consistently chaotic. Rather, it is episodic with periods of slow accumulation of "natural capital," punctuated by sudden releases and reorganizations of those legacies" (Redman 2005, p73)

The biophysical panarchy of fire is visualized in Figure 2 (Berkes *et al.* 2003, p17). This process is described well by Wright and Bailey's *Fire Ecology* (1982):

> When organic matter burns, significant ash is produced which lowers nitrogen, phosphorus, calcium, potassium, and magnesium on the forest floor. However, the elements that aren't volatized by combustion are translocated down into the mineral soil, resulting in a net gain of elements. Furthermore, the addition of calcium has a favorable effect on growth of bacteria, which ultimately produce

> more nitrogen by mineralizing organic matter. Fire aids plants in germination; the reorganization of the ecosystem begins (1982 p22).

Fire is a facilitator. It hastens the panarchy cycle through the release and reorganization phase. As Berkes and Folke (2002) argue: "disturbance (fire) is endogenous to ecosystem development, and that periods of gradual change and periods of rapid transformation coexist and compliment each other" (p129). The biophysical process of fire validates this argument. The panarchy methodology will now be transposed onto the cultural construction of fire in modernized societies and key insights into the motivations behind the suppression of fire appear.

4.2 Cultural Panarchy

The problematic issues embedded in contemporary policy pertaining to fire become clear when looked at using the panarchy visual. Moreover, one can definitely deduce the nested nature of the scenario from the biophysical to cultural level. It becomes apparent that the industrialized world culture is nearing if not teetering off the conservation phase, headed towards catastrophe.

The industrialized world is ill-prepared for the catastrophe phase of panarchy. Our conservative system is geared towards the accumulation of capital; it is seen as an inherent good. This capital accumulation is actually dysfunctional, bringing about poverty, injustice, and inequality. The collective focus is magnified on the peak of capital accumulation, the K phase in the adaptive cycle. Western society is trying intensely to continue the accumulation of capital; to sustain the exploitation. "Social and economic resilience may be created in the short term, but at the expense of loss of ecological resilience. This strategy leads to more brittle systems, and eventually to a resource crisis." (Berkes and Folke 2002, p131)

The focus on the K phase is so severe that there has been a complete disregard to the impending release and reorganization. By not visualizing the release and reorganization, ‘haunting’ has developed in contemporary society, as discussed in section 3.3. Our focus on progress has misconstrued the cyclical motion; our society is attempting to make the K phase a line of progress in a positive sloping aspect to infinity. This is dysfunctional; it is accumulating detrimental amounts of cultural capital that will make the redistribution much more catastrophic.

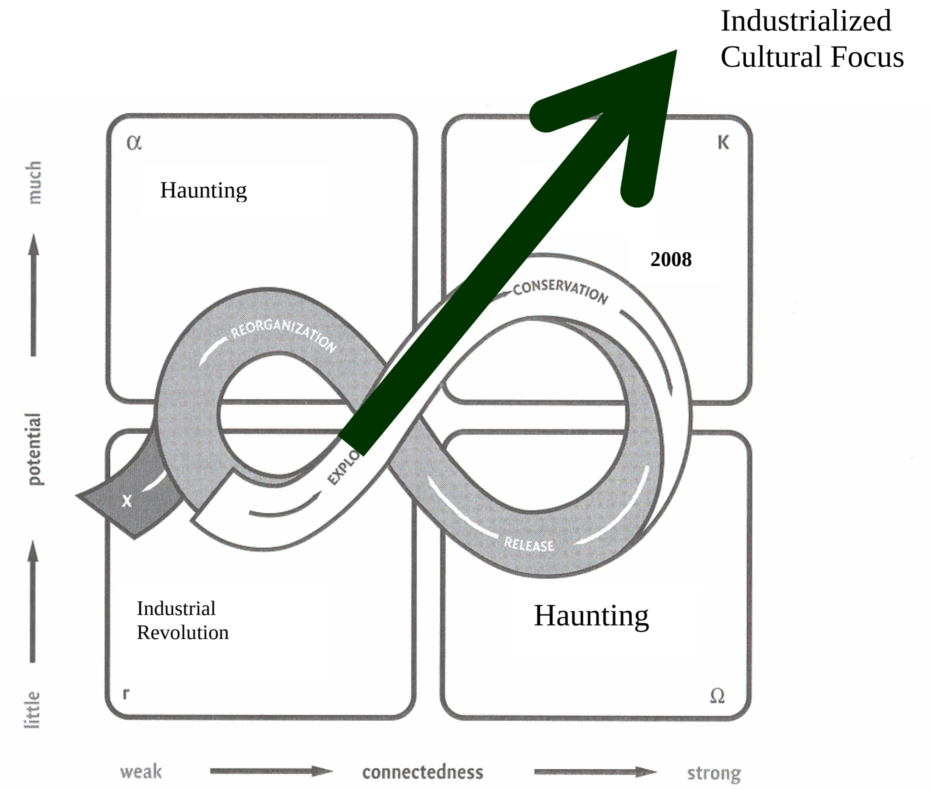


Figure 3: Cultural Panarchy of Fire within Industrialized Societies

Figure 3 explanation: The release and reorganization phases of panarchy are being ignored in industrialized cultures. The result is a focus on exploitation. The more we exploit, the more revolutionary the release and reorganization will be.

Template for Figure From
(Berkes *et al.* 2003, p17)

This 'haunting', the ignorance of the redistribution and reorganization phase is why prescribed fire has been met with so much opposition from the policymakers of western society. Processes that hint at the release and re-organization are historically ignored or purposefully stagnated in this society. "Practices of (contemporary) resource management tend to support the phases of gradual change, that is, exploitation and conservation, but strive toward avoiding rapid transformation, that is, release and reorganization." (Berkes and Folke 2002, p131) Fire is an example of this. Fire can be a perfectly functional cultural construction, allowing release and reorganization of capital in a manner that avoids catastrophe. The industrialized world must have a facilitated appreciation of this knowledge, an awareness that out of catastrophe comes release and reorganization; they must see the beauty of the catastrophe, release and reorganization.

An ecosystem with a buildup of herbaceous material would eventually purge the surplus through decomposition and composting processes (Graaf *et al.* 2004), but that is much more time consuming when compared to fire. Fire is also much more volatile. When weighing the costs of processes, decomposition is slow but safe; fire is fast but inherently much more risky. However, I argue that the ecological costs of not using fire far outweigh the ecological costs of using fire. That is why fire knowledge must be appreciated, the haunting must end. We live in a society that wants results quickly, tangibly, and permanently. I intuit that fire as a resource management tool when used correctly would resonate well within industrialized cultures.

5. Catastrophe

The increase in surplus of capital also points towards an increase in hard systems within the culture as evidenced by the conservative phase of panarchy. An exponential surplus of capital that verges upon catastrophe is dysfunctional. A functional soft system would find a method to redistribute the capital before the threat of catastrophe. A soft system amalgamates multiple perspectives for a holistic view of future opportunities (Rose 2004). Soft systems have the foresight to predict such catastrophes. Soft systems also have the necessary embedded tools to avoid them completely.

Thompson's *Rubbish Theory* speaks of the detrimental buildup of capital and the impending catastrophe that occurs in order to redistribute the capital: "before it leaves the cusp, there is a sudden catastrophic collapse in the level of credit" (Thompson 1979, p210). This catastrophe theory is easily transposed to the situation of modern fire management. The main problem is the buildup of capital, or in this instance combustible fuel. The functional process of redistributing the combustible fuel capital contains anthropogenic fires. This process has been interrupted for such a long time that entire ecosystems are on the 'cusp' before the sudden catastrophic collapse as illustrated in figure 4.

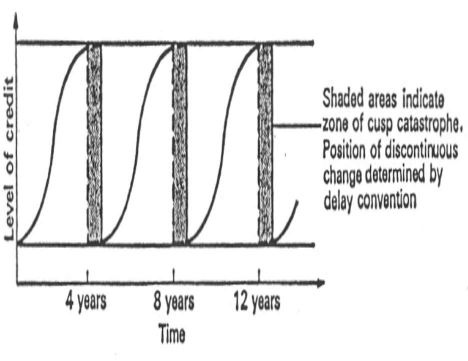


Figure 4: Catastrophe
(Thompson 1979, p212)

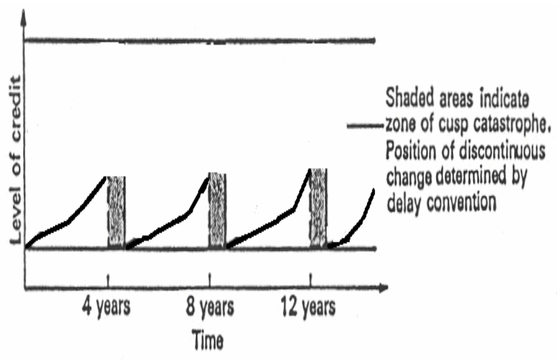


Figure 5: Catastrophe Averted:
Template (Thompson 1979, p212)

Figure 4 and 5 explanation: The difference is how much capital (be it natural capital in the form of fuel buildup or cultural capital in the form of exploitation) is built up before the catastrophe event redistributes said capital. The amount of capital accumulation determines the severity of the catastrophe.

Fire also represents the agency to avoid catastrophe. Human agency has integrated ecology in the form of prescribed burns throughout history. Instead of allowing catastrophic fuel levels to accumulate, there is a historic pan human adaptation to use fire preemptively. To utilize Thompson's mindset, a series of self induced capital redistributions (prescribed fires) ensures that the catastrophic capital redistribution (holocaust fire) does not occur. This scenario is illustrated in figure 5. This changes the structure of how parameters interact and avoids catastrophe completely (Levy 2005);(Mistry *et al.* 2005);(Kull 2002).

This catastrophe is facilitated in part by an increase in hard systems. "When the system is reaching the limits of its conservative growth, it becomes increasingly brittle and its accumulated capital is ready to fuel rapid structural changes" (Gunderson *et al.* 2002, p12). This definitely resonates for contemporary policymakers. Evidence abounds regarding the resourcefulness of utilizing fire as a natural resource management technique. However, policy historically has become engulfed by the hard system nature of the bureaucracy. Anti-fire policy phenomena occurred throughout the world. Fire suppression policy creates conflict to this day (Levy 2005);(Mistry *et al*. 2005);(Kull 2002). If the system does not adapt to the resourcefulness of fire, catastrophe is eminent. There is a slow realization by the policy makers of fire's resourcefulness, emphasized by renewed burning regimes in many places such as the national parks in the US. "Yosemite, Sequoia, and Lassen now have a policy of "fire use", where they allow lightning sparked fires to burn as long as they don't threaten developed areas" (Levy 2005, p306).

6. Conclusion and Future Research

The place of fire as a mechanism of catastrophe, release, and reorganization has been assigned. Furthermore, the nature of the cultural perception of fire has been examined. The synthesis of the two reveals the human ecological implications of modern day policy. "Collapses, and the subsequent need to innovate, create, reorganize, and rebuild, are a likely, maybe even inevitable, consequence of human interactions with nature"(Carpenter *et al*. 2002, p92). Humans definitely have the foresight to visualize the catastrophe on the horizon; it is the way we attempt to circumvent the collapse that is the distinguishing characteristic. Contemporary policy attempts to conserve; that is extinguish fires as they start, causing a prolonged buildup of capital. By and large traditional knowledge is the exact opposite: intentionally setting fires in order to redistribute capital for renewed resources (Mistry *et al.* 2005);(Kull 2002) .

The realization of the benefits of prescription burning points toward a nested soft system in the increasingly rigid hard system of contemporary policy. The change in the US policy is a step in the right direction but the larger implications are much more meaningful. I argue this because the fire policy evolution offers visualization into the soft system. Can this process not be duplicated in other areas to facilitate the end of other dysfunctional phenotypes? I believe it offers insight into a functional way to facilitate a soft systems approach in an increasingly hard system teetering on catastrophe. Much good can come of properly utilizing the example of this transition in fire policy within a relatively hard system.

6.1 Bureau of Land Management (BLM) Integrated Fire Management Policy: a Template for Progress in Prescribed Burning

There has always been a gap between policy and practice with regards to prescribed burning. Following an extremely prolific wild land fire season in the US in 1994, the government was motivated to charter a study of fire in the past two decades. A review was undertaken to "give form, substance, direction and priority to the ideas and lessons learned by wild land fire managers" (BLM 1996). The product of this study was a 45 page document that formulates what experts in the field have learned into a cohesive government policy. This policy, known as the Integrated Fire Management Policy, directs professionals to:

- Integrate wild land fire into land and resource management plans to protect, maintain and enhance natural resources
- Base fire management activities, including suppression action, on the values to be protected, cost, and land resource management objectives
- Articulate the roles and responsibilities of federal agencies in wild land/urban interface
- Ensure that federal policy is uniform and programs are implemented cooperatively and cohesively

(BLM 1996)

The BLM integrated fire management policy was first implemented on BLM public lands and remains so to this day. The early success that this policy facilitated a crossover from public domain lands to private land. Though bordered by BLM land, the Thompson Creek area of Illinois is an example of this as private citizens were involved in the implementation of a fuel reduction procedure (National Forest Service, 2003).

This private initiative has vast implications for Texas and more specifically Calcite Ranch (Calcite Ranch explained in sections 8,9,10). “Of the 172 million dry acres (excludes submerged coastal lands) in Texas, 4.5 million acres, or 2.6 percent of Texas land, was in the public domain in 1994” (Texas Environmental Center 1995, p4). The small percentage of public land in Texas means that any integrated policy must be implemented in a bottom up manner from the landowners. Prescribed burn cooperatives have been formed in Texas and hint towards the adoption of the integrated fire management policy in the private sector.

The Edwards Plateau Prescribed Burning Association (EPPBA) is a prime example of the adopted policy. From a conception in 1997 with a 30 member charter group, the EPPBA has grown to over 200 members in 2003, having conducted to date more than 75 burns on over 40,000 acres (Texas Parks and

Wildlife 2006). The stated purpose for the EPPBA resonates with the BLM's integrated fire management policy on a local level:

- Facilitating national leadership of regional prescribed fire councils and serving as a unified voice for prescribed fire.
- Advocating the ecological imperative for prescribed fire
- Emphasizing prescribed fires benefits to public health and safety
- Serving as an advocate and clearinghouse on regional and national levels. (EPPBA 2007, p2)

There are key differences in the policy of the BLM and that of the EPPBA. One must realize the charter of the EPPBA. It is a prescribed burning association and designed to promote the use of fire as a range management tool. It is the authors' belief that the EPPBA, founded in 1997, is the local extension of the ideas originally put forth in the BLM's policy relayed in 1995.

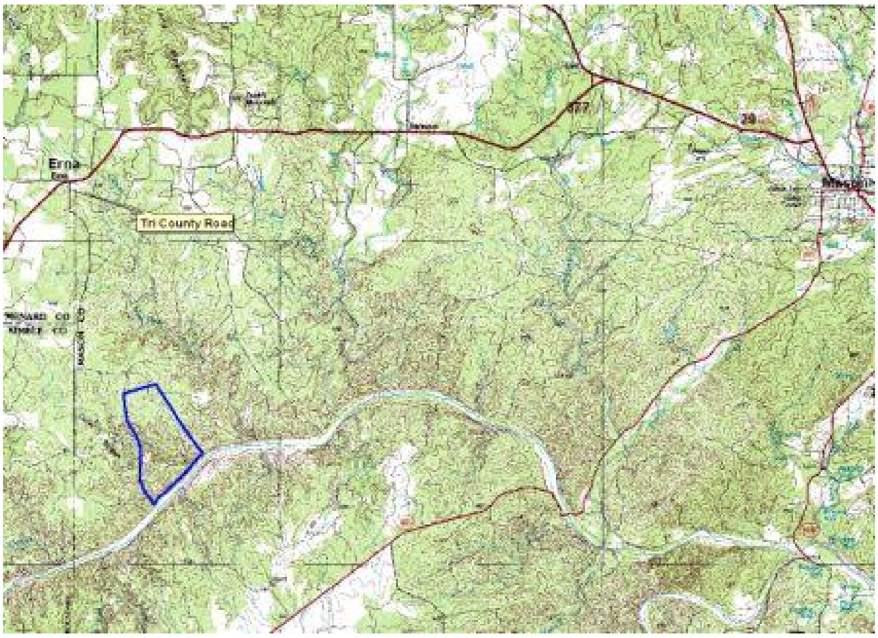
The BLM and EPPBA have implications for Calcite. It is important to note that Calcite Ranch is not a member of the EPPBA to date. The prescribed burns on the property are implemented under the care of prescribed burn manager Keith Blair of Red Buffalo, LLC. The landowners have chosen to go the private route in order to minimize liability should something go awry during a prescribed burn. There is great inherent risk involved with prescribed burning. Membership in the EPPBA is an option for the future, however. The extremely risky cedar slash burns have been completed, the regime now consists of savannah burns that are more manageable (in theory) than slash burns.

Information about the Calcite Ranch project does reach the ears of organizations like the EPPBA. The prescribed burning community is a fairly small group in Texas. Through education and capacity building this group is growing, but remains a minority in the field of land management in Texas. Success stories like Calcite Ranch can serve as educational examples for proper implementation of prescribed burns. One must have a communication pathway in order to get the message out though. The EPPBA would be a good method to share the information regarding Calcite to other land managers across the area.

Nonetheless, the knowledge of the first world regarding the effects and ecology of prescribed fire is still evolving. The first world has a specific language when validating certain processes, and that language is empirical science. The social science method used to this point in this thesis validates prescribed fire's functionality within a culture. Empirical science must now take over to validate prescribed fire's functionality within an ecosystem. Many studies claiming to be those of fire ecology are merely those of fire effects, they are not longitudinal enough to claim any ecology status. The science behind this study has the potential to become one of fire ecology, a diachronic quantification of a property involved in prescribed burning. Currently it is my belief that it would be a stretch to call this study one of fire ecology. However, with each subsequent year of data gathered, the claim of a fire ecology study becomes more and more validated.

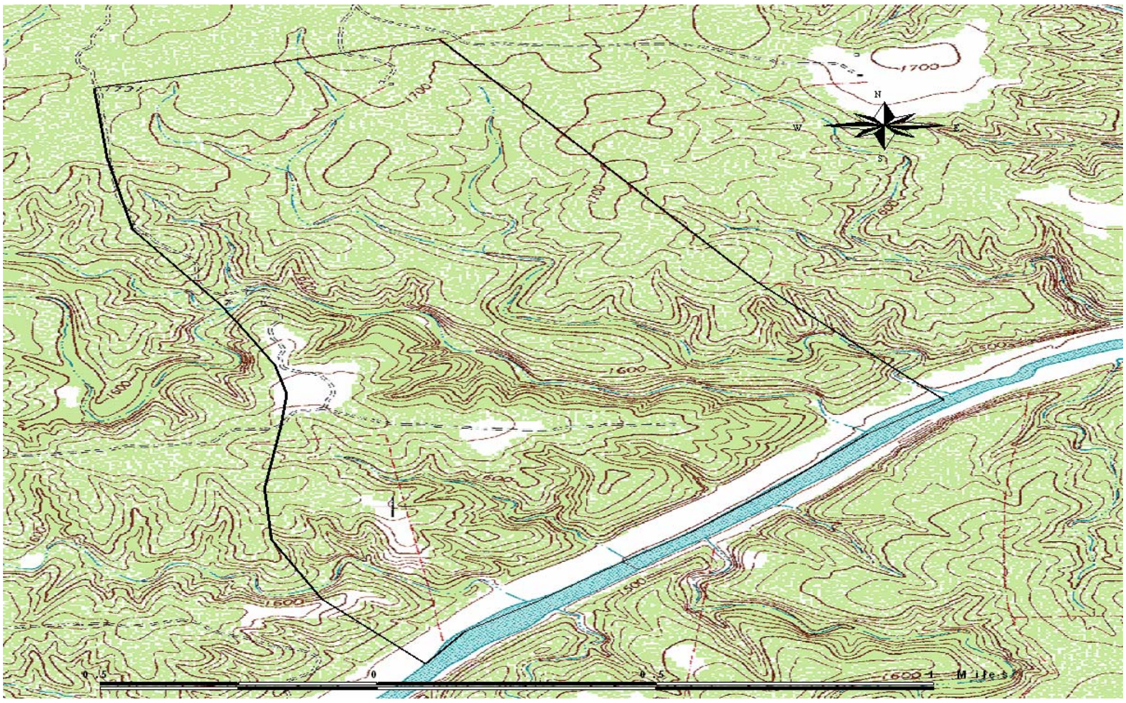
7. Calcite

The study area for this prescribed burning project is Calcite Ranch (Calcite). Calcite is located in Western Mason County in Central Texas. The history of this parcel of land resonates with the history of many ranches in Central Texas. Until the 1800's transient Indians roamed the area, the most notable of which were the Apache's and the Tonkawa's (Turner and Hester 1999). The hunter gatherer methods employed by these tribes resonated with the endemic habitat and the transient lifestyles of the low density occupants allowed the land to recover in times of overuse.



Map 1. Location of Calcite Ranch in Mason County
Calcite Ranch is highlighted in blue, one can see the Llano River comprising the southern boundary.

In the early 1800's the Republic of Texas was formed, and the land was carved out into land grants for aspiring European Colonizers intent on making a life in the New World. Mason, Texas was predominantly settled by German immigrants (King 1967). Many townships in the area still carry the German ancestral name: Fredericksburg and Lukenbach are both within a fifty mile radius of Mason, Texas. These colonizers transferred European ways onto the rangeland of Texas, and began to fence the open range and implement cattle operations. These operations were on the scale of those back in Europe in which the carrying capacity of the land was much higher for cattle per acre. It's important to note that this was largely due to ignorance, and for a couple of generations these operations thrived. However the laws of diminishing returns were in full effect, and in about a half a century the effect of the overgrazing was apparent on the land.

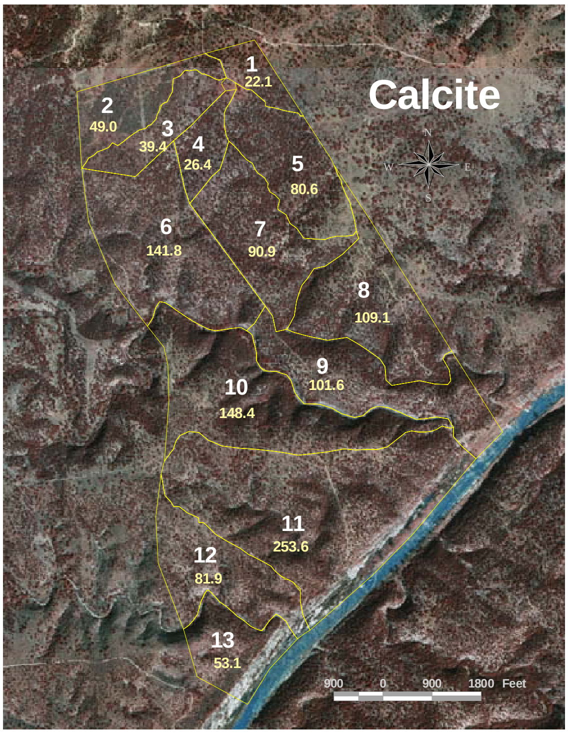


Map 2: Topography of Calcite
Calcite Ranch is within the black boundary line above

One of the best pieces of advice I received when postulating what to do for a thesis came from Rev. Dr. Keith Morrison. He urged me to focus on something close to my heart. This project is a product of that search because Calcite is the family ranch. My family purchased the 1200 acre (485 hectare) property in the early 1990's, and began an extremely aggressive habitat restoration campaign. Quantifying the process has become the science side of the thesis (Section 9). When I relay the information regarding Calcite, I am literally relaying information about my home. In August of 2007 I moved out to the family ranch, the first full time inhabitant since the Apache's and Tonkawa's; and when I'm finished with this masters degree, I will return and continue the work laid out within this report. The science being done in this thesis will not stop after the thesis is completed. We have the system set up to record data for decades to come.

This section will describe methods utilized on Calcite Ranch. The prescribed burns will be discussed, the empirical science behind the ongoing plant transects, data, and to date results. The wildlife of Calcite will also be discussed which will pave the way for an in depth case study of the white-tailed deer and the benefits of prescribed burns to the population.

8. Calcite's Burn Units



Map 3: Burn Units on Calcite
The burn units are numbered and the acreage in each listed below the unit number.

Calcite is a 1200 acre parcel of land located in Western Mason County. It was bought by the Connell family in the early 1990's and at the time was a cattle ranching operation. The story of Calcite is one repeated many times over in the Texas Hill Country. Once prized for its grazing habitat, negligent land management practices soon depleted the land of its vitality. The age old formula of head of cattle per acre was flawed to the core, and overgrazing of livestock including cows, goats and sheep left the land a shadow of its former self. Moreover, the ignorance gave way to an invasion by Ashe Juniper (*Juniperus ashei*), which is a fast growing evergreen whose water requirements are very taxing on the already fragile aquifers in the dry region.

Calcite was purchased by the Connell family and a drastic transformation has occurred. The cattle were removed and the tax exemption transferred from a livestock exemption to a wildlife exemption in 1996. This meant that the same tax benefits could be harnessed without depleting the land with cattle, all the while returning the land to better health. In 1998 the 1200 acre spread began a big transformation, as a crew of chainsaw maestro's began to hand cut all of the invasive Ashe Juniper (*Juniperus Ashei*). Following this implementation, a prescribed burning regime was established in order to promote the endemic historical habitat of Texas, the grassland savannah.

Historic accounts abound citing the rich grassland from early Texas explorers; one such example coming from Dr. Gideon Lyncecum, who traveled the frontier of Texas in the mid 1800's (Lincecum and Phillips 1984). Every step Calcite takes in this progressive land management strategy is a step towards overall ecosystem health and vitality.

8.1 Prescribed Fire at Calcite

The burning regime at Calcite has been successful and well documented. Prescribed burning, as described in the *Aspiring Ashes* section, has many benefits towards the ecosystem of a fire adaptive habitat, the Hill Country of Texas being no exception. This section will delve into the different prescribed burns applied to Calcite in successive years, their objectives, and their outcomes. The documentation process has been twofold. Plant transects were established in 2002 and are quantified every year in order to determine every species within each transect. The transects are stationary and assessed annually. Further attention to this process will be given in section 9. Furthermore, photo points have been established throughout Calcite (Appendix XIII). These serve as a tangible visual aid in assessing the diachronic change in habitat due to the burning regime. The prescribed burning at Calcite is accomplished under the care of Prescribed Burn Manager Keith Blair of Red Buffalo LLC. The following section will follow the burning regime by each successive year, the burn plans for the fires are in Appendix I.

8.2 2002 Prescribed Burns:

2002 marked the maiden year of burning on Calcite. This was following the cedar clearing and the burn itself was mainly one of slash burning. Fires which run through slash cedar are very hot and much incidental damage to other non invasive and native species of plants occurs. In this instance, many Live Oak (*Quercus virginiana*) and Spanish Oak (*Quercus texana*) were lost. However, one must keep in mind the net gain from the prescribed burning. This is an area of Texas with a 5-7 year historic natural fire regime which had been stagnated by decades of fire suppression due to policy and land use. Because of this the populations of all trees were dense, the savannah had become a forest. The lost non invasive plants simply thinned the herd, taking the weaker more fire susceptible trees and creating a more open savannah.

Prescribed Burns in 2002.

Map 4: Prescribed Burns in 2002
The 2002 prescribed burns occurred inside the red line

8.3 2003 Prescribed Burns

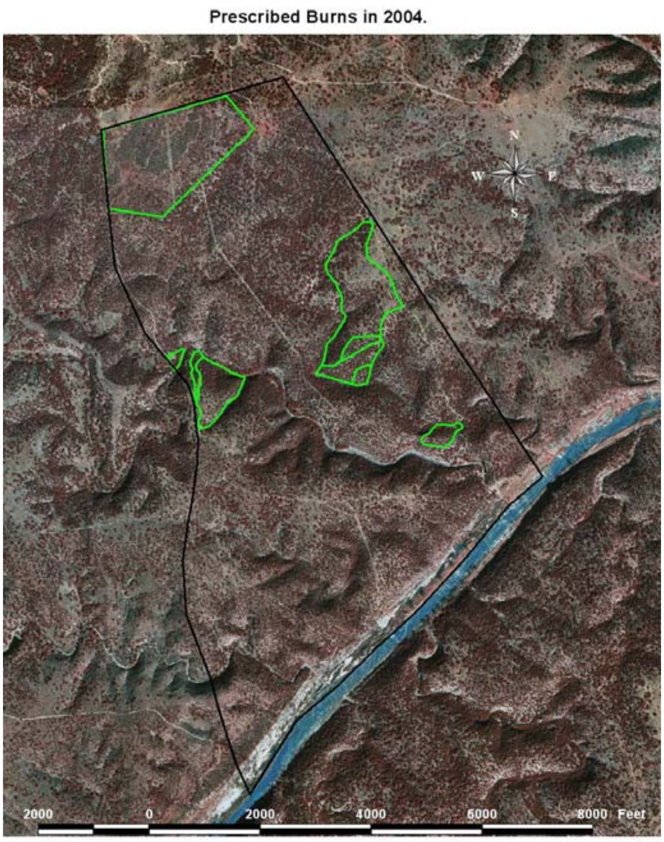
The 2003 prescription was similar to that of 2002 but in another area of Calcite. In order to properly instigate a prescribed fire regime in a savannah ecosystem all of the slash cedar had to be removed. The entire ranch was a sea of cut Ashe Juniper, as shown by the photo underneath the map.

Map 5: Prescribed Burns in 2003
The 2003 prescribed burns are highlighted in yellow

Photo 1: Ashe Juniper Slash
Keith Blair burning juniper slash at Calcite

8.4 2004 Prescribed Burns

2004 was an important year for the development of prescribed burning at Calcite because it was the first year that implemented a summer burn. In the summer months large thunderstorms cross the Texas Hill Country, and lightning abounds. Other than the infrequent monsoons there is little rain and for the most part it is a hot and dry time of year. Historically many natural fires were started during this season due to the lightning, so the return to the summer fire regime more closely mirrors what would happen naturally to the ecosystem throughout the eons.



Map 6: Prescribed Burns in 2004
The prescribed burns of 2004 are highlighted in green

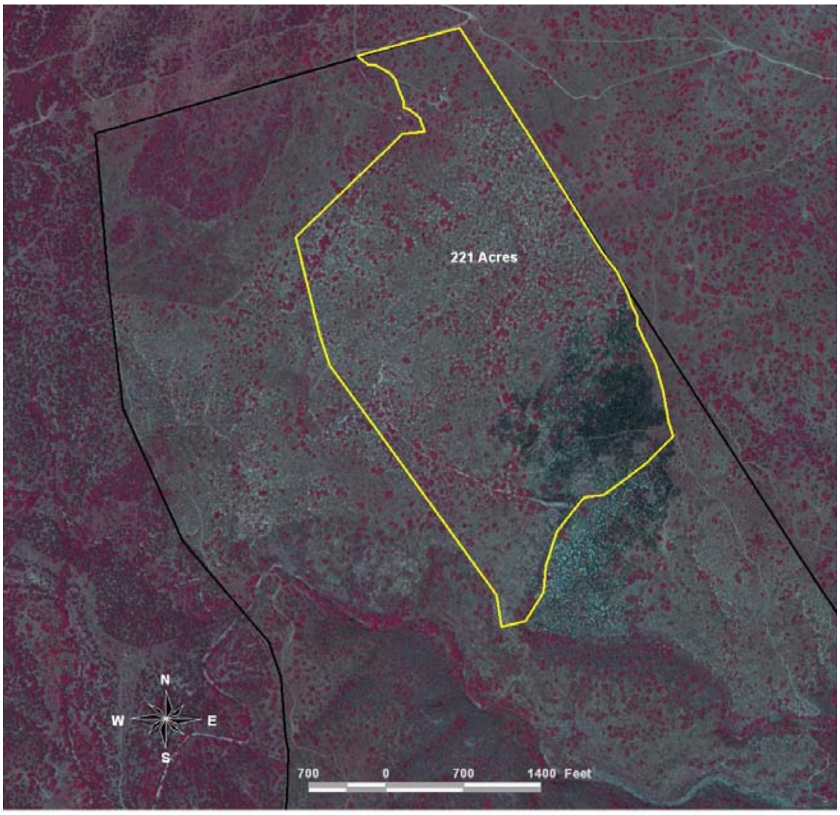
8.5 2005 Prescribed Burns

2005 was an important year for prescribed burning at Calcite as we finally made our way down to the banks of the Llano River on the southern border of the property. The steep terrain towards the river provides many challenges for a successful and safe prescribed burn. Due to the large amount of slash in this area, a winter burn was conducted because the cooler temperatures meant added safety.

Map 7: Prescribed burns in 2005
The prescribed burns of 2005 are highlighted in blue

8.6 Winter 2006-2007

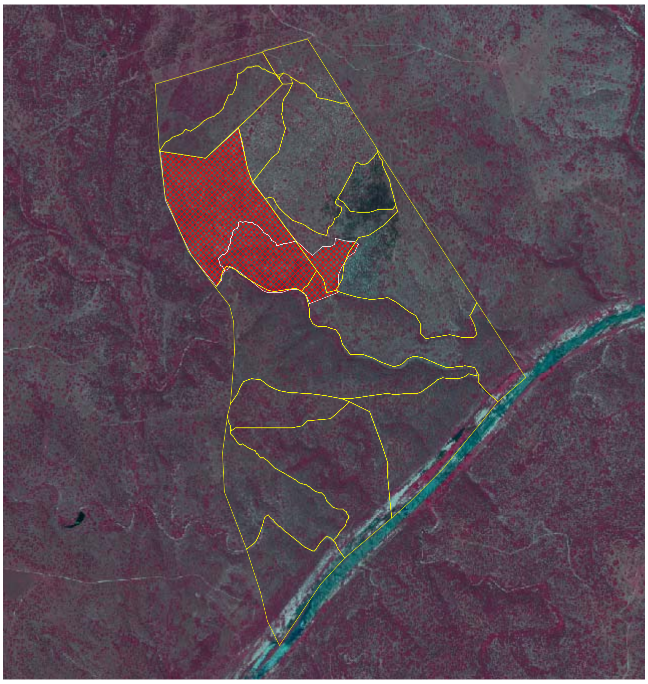
The 2006-2007 burning season at Calcite was the second time through an area, therefore creating a burning regime. The Ashe Juniper slash had been taken care of in the 2002 prescribed burning regime and this subsequent burn five years later mirrored the historic fire regime in this area of Texas exactly (Armstrong 1980).



Map 8: Prescribed burns in 2006/2007
2006/2007 burns are highlighted in yellow

8.7 2008 Prescribed Burns

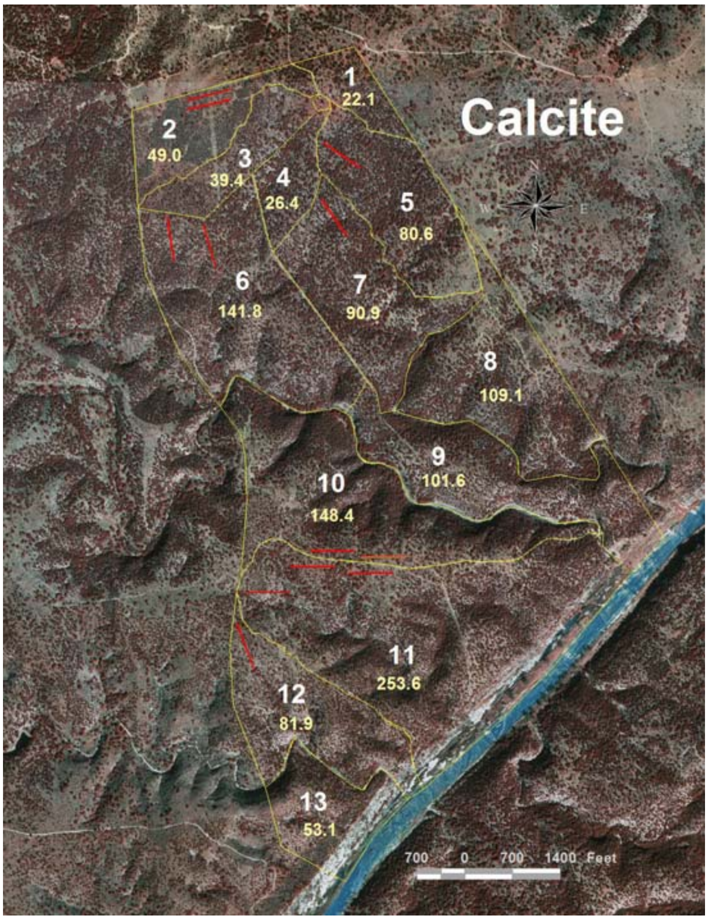
The most recent prescribed burn on Calcite occurred in February 2008. 2007 was one of the wettest years on record in the Texas Hill Country. This meant that while the herbaceous fuel load was too wet to burn in 2007, the massive buildup of grasses meant for a great augmentation of fuel for the 2008 season. This was an extremely successful fire not only from the ecosystem restoration perspective but also from a risk management perspective. With predominant west winds the 2008 prescribed burn helps protect ranch structures form possible wildfire.



Map 9: Prescribed burns in 2008
2008 burns highlighted with red checkered pattern

9. Calcite Vegetation Plots

The science of this study was completed on Calcite Ranch in Western Mason County, Texas. There are many studies which claim to be those of fire ecology when actually they are merely instruments of fire effects. A much more in depth look at an area is necessary for a fire ecology study. This is the potential of the study being done at Calcite, it is not merely a one to two year fire effects study as the science behind this presentation has been going on since 2004 and will continue long after this presentation. With every successive year there the information is gathered from the vegetation plots, a goal towards a fire ecology study is reached.



Map 10: Vegetation Transects at Calcite
Vegetation transects are highlighted in red

There are 12 different vegetation plots located at different stations. The plots represent a cross section of Calcite's habitat and ecosystem types. There are also a pair of control plots located in an area which was not cleared of Ashe Juniper and has not been treated with prescribed burning since the acquisition of the property. These control plots serve as adequate comparisons to the areas which have been re-introduced with a burning regime.

9.1 Transects

The figure below shows the layout of each plant transect at Calcite. They are 200 meters long by 10 meters wide. Within the transect an array of variables are quantified every spring. The over story trees are recorded, cataloging the diameter at breast height as well as the pole size and seedling density. Shrub density is also documented. The herbaceous layer is quantified as well as to the density and frequency of each species of plant within the layer. A range pole is also utilized in order to garner information about the composition of the transect at a certain level, which tells about the structure of the changing habitat. In this case a two meter range pole is used and anything under the two meter height is recorded.

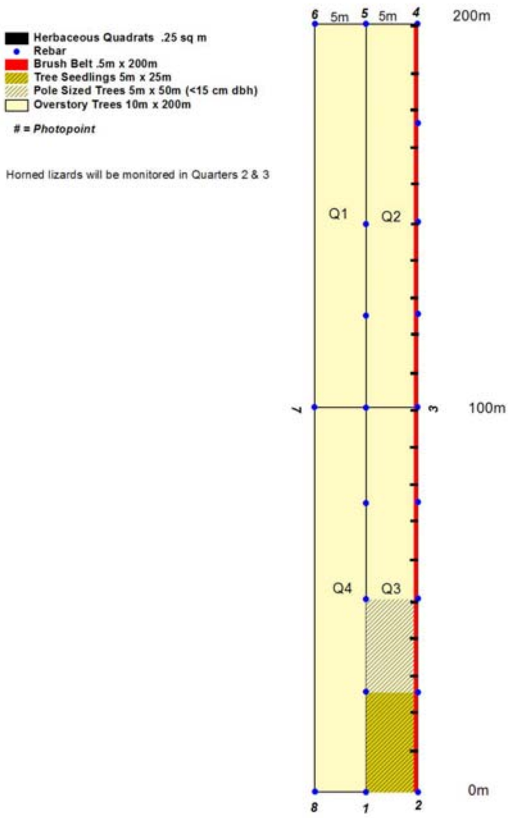


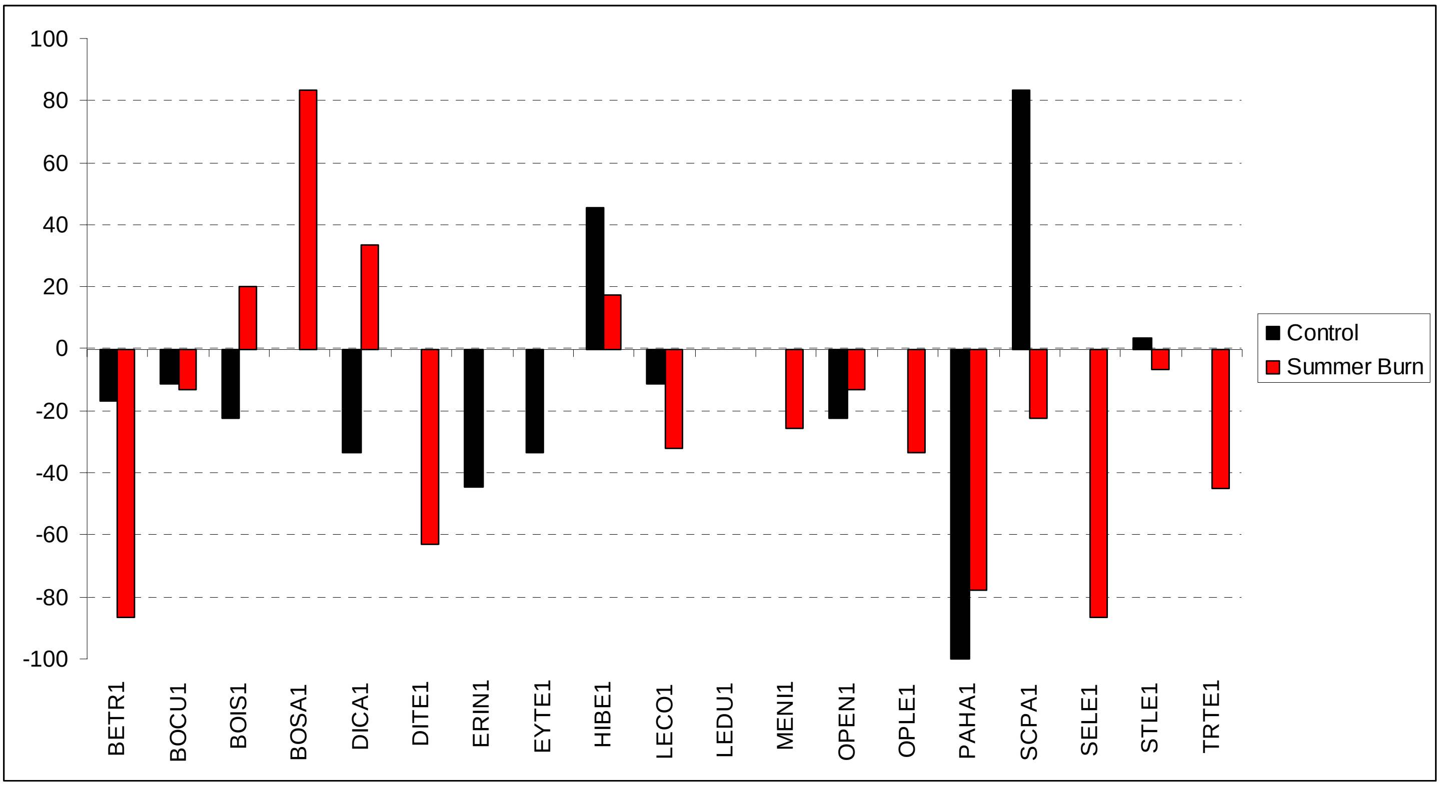
Figure 6: Vegetation Transect. Each transect is ten meters wide and 200 meters long.

9.2 Data

The raw data recorded from the vegetation transects each year is entered into a computer program. This program is associated with the Fire Monitoring Handbook (USDI 2001) and allows the user to compute variables as they change over time in conjunction with the data entered into the program. Evaluation of this data sheds light on the consequences on the habitat types of differing wildlife following the implementation of the burning regime. A copy of the raw data is located in Appendix III.

9.3 Results

The results to date are fire effects results. A fire ecology study would need many subsequent years of data gathered as the burning regime continues. While there have been multiple years of prescribed burning at Calcite, the regime has yet to repeat itself save two times. The surface of this study is just being scratched. One must allow time for vegetation dynamics to occur. The transects have been in place since 2004, a period of five years. Ecological processes occur on a time scale independent of human time fabrications. One cannot expect a fire ecology study to be accomplished in a two year masters degree or a four year PHD. These are at best fire effects studies. There are too many variables involved to make any significant findings. These variables include but are not limited to: climate, soil, past land management practices. The data becomes more and more significant the longer the study is in effect, and following every cycle of the prescribed burning regime. These are the most significant findings to date, species selected to be in this project are those with value to the landowner and the ecosystem at large.



Graph 1: Percent Change in Canopy Cover Between Control and Summer Burned Plots

This is a 1 year post burn production from 2004/2005

The graph above depicts the percent change in canopy cover between control and summer burn plots between 2004 and 2005. The control plots are located in an ecosystem that has been left as is from the time Calcite was purchased. No cutting of the invasive Ashe Juniper has occurred in this area and no fire has been introduced as well. This serves as a baseline for all data gathered throughout the study. The summer burn area has undergone both Ashe Juniper removal and prescribed fire treatments. The information gathered is presented in table form below.

Species	Species Code	% Change in Canopy Cover 2004-2005	
		Control	Summer Burn
Berberis trifoliolata	BETR1	-16.7	-86.7
Bouteloua curtipendula	BOCU1	-11.4	-13
Bothriochloa ischaemum	BOIS1	-22.2	20
Bothriochloa saccharoides	BOSA1	0	83.3
Digitaria californica	DICA1	-33.3	33.3
Diospyros texana	DITE1	0	-63
Eragrostis intermedia	ERIN1	-44.4	0
Eysenhardtia texana	EYTE1	-33.3	0
Hilaria berlangeri	HIBE1	45.5	17.2
Leptoloma cognatum	LECO1	-11.5	-31.9
Leptochloa dubia	LEDU1	0	0
Melica nitens	MENI1	0	-25.6
Opuntia engelmannii	OPEN1	-22.2	-13.1
Opuntia leptocaulis	OPLE1	0	-33.3
Panicum hallii	PAHA1	-100	-77.8
Schedonnardis paniculatus	SCPA1	83.3	-22.2
Setaria leucopila	SELE1	0	-86.7
Stipa leuchotricha	STLE1	3.4	-6.7
Tridens texensis	TRTE1	0	-45.2

Table 1: Percent Change in Canopy Cover between Control and Summer Burned Plots.

This is a table form of the fire effects from 2005/2006. It is the same representation as in Graph 1 p. 43

9.4 Discussion

As stated before, the control plots are in areas of Calcite where none of the aggressive land management practices in the form of fire or brush clearing have occurred in the last decade. The goal of these plots in the long term is quite simply to show the effects of the year. These effects can be rainfall, temperature, or other environmental factors. If there is a similar increase or decrease in canopy cover (density) between the burned and unburned transects, one can ascertain that fire had little effect on that specific species.

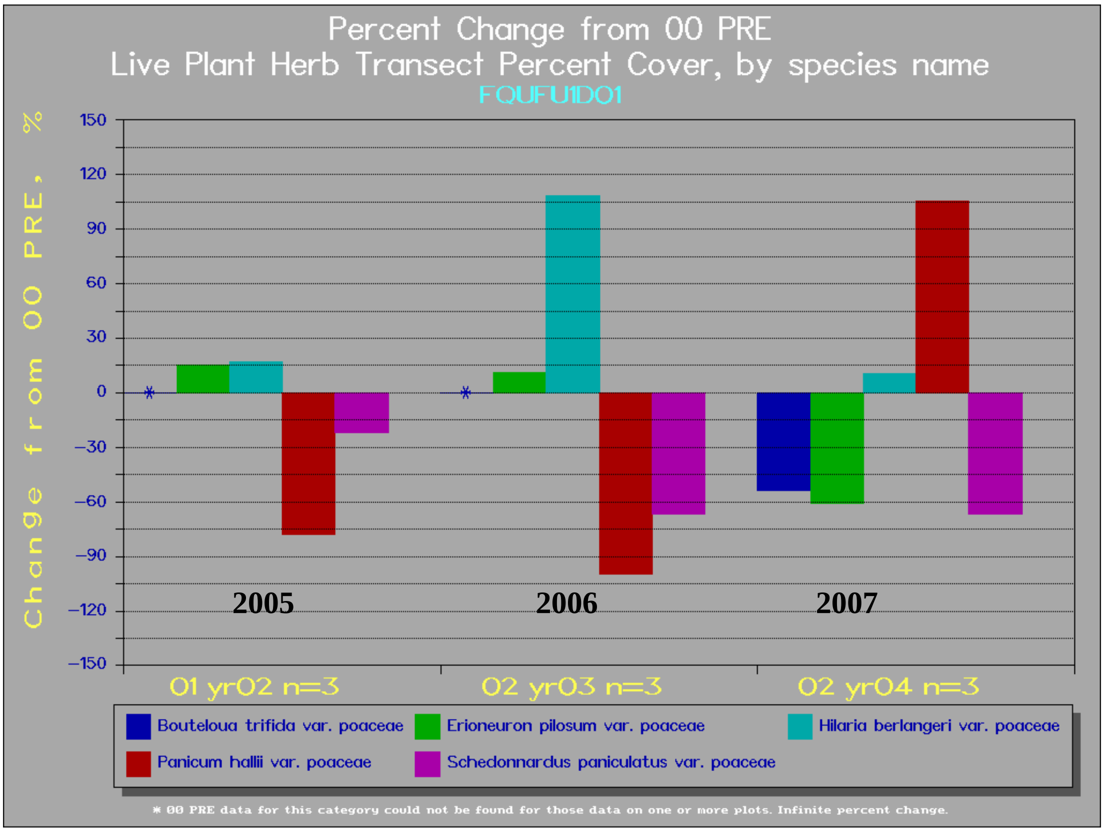
For example, there was negligible difference between the decreases of Sideoats Gamma (*Bouteloua poaceae*); species code BOCU1 in the two plots. The control transect had -11.4% change in canopy cover and the summer burn transect had -13% change. One can draw the conclusion that the Sideoats growth was not largely affected by prescribed fire.

The increases in both KR Bluestem (*Bothriochloa poaceae*) (BOIS1) and Silver Bluestem (*Bothriochloa laguroides*) (BOSA1) were expected since they are both 'disturbance' species. Collins and Barber (1985) demonstrated this in their study on the effects of disturbance on diversity using a prairie in Oklahoma as their research site. There was a large reduction in woody species in the summer burn transects at Calcite. Agarita (*Mahonia trifoliolata*) (BETR1) decreased 86.7 % from the previous year and Persimmon (*Diospyros virginiana*) (DITE1) decreased 63 % from the previous year while both had minimal decreases in the control transects. This is largely due to top kill during the prescribed burn, but many of these woody species will re-sprout. This is a prime example of a fire effects study versus a fire ecology study. As the years of data show the Agarita and Persimmon re-sprouting, the ecology side will develop.

One other significant finding is the increase in cover of Cotton Top (*Digitaria californica*) (DICA1) by 33.3 % in the summer burn transect versus a decrease by 33.3% in the control transect. Cotton Top is a preferred grazing grass by many endemic animals in the Texas Hill Country (Brown and Smith 1993). Furthermore, this grass is a favorite of Livestock. Significance in the comeback of the Cotton Top in the summer prescribed burn areas point towards a revitalization of native grasses that would have been historically consumed by cattle. The burned plots showed an increase of 270 plants/acre based upon the transect analysis. This is a sign that the native tall grass prairie is returning.

9.5 The Need for More Research

There are vague correlations to be drawn from the research on Calcite to date. However, the call for more research resonates when a third year is added to the equation. For an example, a comparison from 2005 to 2007 is assessed in Graph 2. This comparison is done with the short grass species of: Red grama *(Bouteloua trifida)*, Hall panicum*(Panicum hallii*), Hairy tridens *(Erioneuron pilosum)*, Tumble grass *(Schedonnardus panicullatus)*, and Curly mesquite *(Hilaria berlangeri)*.



(Haile 2007)

Graph 2: 3 Year Change in Short Grass Species Density at Calcite

The need for subsequent years research becomes apparent when viewing the stochastic relationships highlighted above.

The addition of a third year to the vegetation transect data demonstrates the need for subsequent years data to be added before making any concrete correlations to vegetation dynamics and fire ecology. This is not a phenomenon existing solely within this study, there are many other instances where fire effects have been inconclusive (Barclay *et al.* 2004);(Duncan *et al.* 2008);(Hobbs 1984).

Vegetation dynamics in response to a fire regime take time. If Calcite was a research station burned only once to catalogue fire effects, the data represented in Graph 1 would be seen as significant. However, because a fire regime is the method being used, decades of more data will be necessary in order to validate any sort of correlation. Tumble grass, for example, showed a two year decline of 70 and 95 percent in 2005 and 2006 respectively. This was followed by a sharp increase in 2007 of 100%. There are many inherent variables when dealing with the natural sciences and prescribed fire. There is no hermetical seal at Calcite, environmental variables abound. The only way to minimize these variables is with more data.

10. Calcite Animals

There are many indigenous animals residing at Calcite. While a comprehensive survey of all life has yet to be undertaken, the experiential observations of animals have accounted for the majority of possibilities on the Mason County list. A big part of the reason why there is an abundance of life on Calcite is due to the fact that the Llano River borders its southern boundary. The river acts as a highway for all sorts of animals not readily seen in many locations in Texas. For example the large cat: the Mountain Lion (*Puma concolor*). The Mountain Lion has been spotted at Calcite and it has very few recorded sightings in the surrounding area.

The Mountain Lion uses the river as a highway. This day and age in Texas presents a vast fragmentation of lands due to roads, fences, towns. The

Llano River is a conduit through which animals can travel without being hindranced with these modern constructions. It also provides year round water which is a rarity in this area of Texas. This attracts plenty of prey for the Mountian Lion as other species flock to the water source.

The most prevalent mammal noticeable at Calcite is the white-tailed deer (*Odocoileus virginianus*). This mammal is endemic and also offers a great economic opportunity to area landowners due to its desirability from the hunting perspective. The deer population has responded well with regard to the implementation of the prescribed burning regime. This is discussed further in sections 10.3 and 11.

Prescribed fire has lasting effects on many animals on Calcite. Determining the specific effects is an ongoing process as the habitat types change due to the burning regime. A distinction must be made between a population and a herd of animals. The animals on Calcite comprise a population, as 5/6 of the property is bordered by a low fence over which the animals can travel. Furthermore the Llano River on the southern boundary acts as a highway for animal traffic. When animals are discussed at Calcite, it is that of an animal population that is free to come and go as they please. Introductory case studies illuminate how fire is affecting animals.

10.1 Habitat Suitability Index

The habitat suitability index (HSI) provides important information for both habitat management and impact assessment. There are standards for the formatting of HSI's which are guided by the U.S Fish and Wildlife Service (US Fish and Wildlife Service 1981). The HSI comes in three different forms, that of a graph, a number, and an equation (Appendix XII). It is based on the quantitative relationship between key environmental variables and habitat suitability (Allen 1983, p1). HSI was developed in order to assess the sensitivity of wildlife to wildlife perturbations (Van Horne and Wiens 1991). The index of the HSI is a number that is formulated by computing these quantitative relationships that is between 0.0 and 1.0. The closer the index number is to 0.0, the more unsuitable the habitat. The closer the number gets to 1.0, the more suitable the habitat. It is important to note that the model represents a hypothesis of species habitat relationships and not a statement of proven cause and effect relationships (Allen 1983, p1). Therefore HSI's are calculated using best estimates, single numbers that ignore any uncertainties in the calculations (Burgman *et al.* 2001, p70).

10.2 Prescription Burning Regimes and HSI

Prescription burning has many effects on habitat. The main two effects are a decrease in cover due to the eradication of Ashe Juniper and the improvement of forage due to facilitating native grass growth. 'Prescribed burns can help improve the rangelands for deer, turkey, and other species of wildlife. It is a technique used to control spread of re-growth juniper trees and increase plant diversity in the Edwards Plateau area' (Litton and Harwell 1995, p6) Depending on the species this can be a good or bad development in the meso-habitat of Calcite. For example, if a species prefers dense cover the elimination of Ashe Juniper may have detrimental effects, thereby lowering the HSI value for that species. If a species prefers less of a monoculture of vegetation and diverse grassland from which to graze, the HSI value would be raised.

10.3 White-tailed Deer (*Odocoileus virginianus*)

There are conflicting viewpoints in the body of academic literature regarding white-tailed deer and ideal cover. This is an engrained problem with the HSI model as they are best estimates and ignore uncertainty. Short (1986) suggests that adequate cover for the deer is an 8 ha area for every 40 ha (p 3). The land management at Calcite mirrors the equation set forth by Short. However, there are other reports stating that areas of recently cleared forest lands or areas where brush has been cleared to favor grass production are inadequate for white-tailed deer (Halls 1978). One must realize that a distinction was not made by Halls regarding the percent cover left following the land clearing. Hall's assertion is contradicted yet again by the conclusion of Crawford (1984) that logging followed by fire played a major role in the westward expansion of the white-tail's range. Furthermore, grass production would indeed do the deer no good as they don't eat grasses, which are digested extremely slowly and have scant nutritional value for white-tails (Short 1975). White-tailed deer prefer forbs, as well as seeds and fruits such as acorns (Short and Epps 1976). The prescribed burning at Calcite stimulates grass growth, and also stimulates forb growth, the preferred forage of white-tailed deer.

Photo 2: White-tailed Buck at Calcite.
This ten point buck was harvested in the winter of 2005 and weighed 160 lbs.

Habitat suitability indices have been developed for the white-tailed deer. It is important to note that the white-tailed deer range is very large and encompasses a wide range of habitat types. The habitat suitability model fits with the deer in Central Texas though, as the index encompasses "tree savannah and grassland" (US Fish and Wildlife Service 1981). H.L. Short determined a habitat suitability index for the white-tailed deer in 1986. He discovered that the greater the variety of forage for the deer, the greater the suitability of habitat therein. This is an interesting prospect when compared with the prescribed burning at Calcite. Though the burning regime has definitely limited the amount of cover, it is definitely still in the 8 ha per 40 ha category. The diversity and quality of whitetail forage has greatly improved with the burning as forb density and quantity has increased. Therefore I hypothesize Calcite has a high HSI value for white-tailed deer.

10.4 Rio Grande Turkey (*Meleagris gallopavo intermedia*)

The Rio Grande Turkey is another endemic animal residing at Calcite. It is a prized game bird and a vital ecosystem indicator in Texas. Turkey thrive in areas where the ecosystem is in good health, and leave places where the ecosystem won't support them. Personal observation by the author indicates a healthy turkey population, but a look at the HSI of the Rio Grande Turkey reveals why.

Turkey as well as white-tailed deer have the ability to live in varied habitat types, as their range is widespread throughout Central Texas and America. The utilization of prescription burning creates a more open savannah habitat. This is beneficial to the turkey because clearings and savannahs provide important brood rearing, feeding, and dusting sites (Bailey *et al.* 1981). Turkey prefer habitat types with little to no dense underbrush. This is because turkey depend on their keen eyesight to detect predators and evade them (Lindzey 1967). Therefore one could deduce that the regime creating the open savannah at Calcite would be beneficial for the HSI model for Turkey in the cover category. Though Shroeder

(1985) suggests a dense mature canopy is needed for adequate cover in turkey habitat, he is speaking of the Eastern Wild Turkey (*Meleagros gallopovo*) of the deciduous forests in Appalachia. This is a distinct subspecies to the Rio Grande Wild Turkey, native of Calcite's region and much more inclined towards the savannah habitat.

(Lasley 2008)

Photo 3: Rio Grande Turkey (*Meleagris gallopavo intermedia*)

Furthermore, there can be an inferred HSI value placed on turkey regarding food availability and prescription burning. Turkey are omnivores, the average annual intake for the population consists of 90% plant and 10% animal material (Korschgen 1967). Turkey also have a varied range of forage options, this is proven by a study in Virginia where an analysis of the contents of 524 Turkey stomachs revealed over 354 species of plants, representing over 80 families (Mosby and Handley 1943). The prescribed burning at Calcite has increased plant density and variety. This points towards a higher HSI value for turkey as well because of the inclination of turkey towards many food types. Others have made the positive correlation between turkey and prescribed fire, the

National Wild Turkey Federation has spent nearly $250,000 to help fund prescribed fire as a land management tool since 2002 (NWTF, 2006).

10.5 Feral Hog (*Sus scrofa*)

The feral hog has a unique niche in the Texas hill country. Early Spanish explorers were probably the first to introduce the hog to Texas over 300 years ago; these became interbred with the European variant, 'Russian Boar,' when they were imported to Texas for hunting purposes in the 1930's (Taylor 2003). They are not a native species, and have out-competed the native Javalina (*Tayasu tajacu*) for supremacy in the area. They are, however, an exciting game animal for hunters to pursue. Therefore from a pure nature conservation perspective they are viewed as a pest, an invasive species that should be eradicated for the health of the environment. From the hunters perspective they are viewed as a resource, a game animal with an open season that can be pursued at any point in the year.

Feral hog HSI for calcite has a relatively high value. They prefer bottomland such as creeks, river, and drainages – usually found in the dense vegetation cover often associated with water (Taylor 2003). The Llano river bottom at Calcite has the highest HSI value on the property due to the habitat preferences put forth by Taylor. This HSI value is definitely around 1.0, as a plethora of wallows, pig root and other feral hog sign is evident in the river floodplain. The diet of the feral hog is ubiquitous. The destructive aspect of their eating habits, being rooting up the soil, are felt throughout the ecosystem (Taylor and Hellgren 1997). Feral hogs feed on grasses and forbs in the spring, fruits in summer and fall, and roots tubers and invertebrates throughout the year (Springer 1977).

Photo 4: Feral Hog (*Sus scrofa*) at Calcite
The vegetation and habitat of Calcite is apparent in background.

Prescribed fire has a positive effect on the HSI value of the feral hog on Calcite. The Llano River floodplain serves as a home base to the population. Whenever conditions are ideal for a trip to the tops, usually following a heavy rain making the soil more easily rooted, the hogs make the journey. Once on top the quantity and variety of forage has been augmented by the prescribed burning regime. Thus the interplay between the river bottom and improved forage above increases the suitability of feral hogs on Calcite. This has implications for the overall ecosystem health, as the activities of the invasive feral hog have far reaching consequences for other species. Population control of the feral hog is necessary with these increased HSI values due to burning so that the ecosystem can tolerate their land use practices.

10.6 Largemouth Bass (*Micropterus salmonides*)

The river ecosystem at Calcite is a unique mesohabitat when compared to the property as a whole. A wide variety of biota inhabits the river. The Llano River itself is unique as it is one of the last major waterways in Texas without a substantial dam or cataract segmenting the flow (Graves and Weiman 2002). The portion of the Llano that comprises the southern boundary of Calcite is a wide river, anywhere from 30-50 meters. There is little substrate as well as the river has gouged its path from the living limestone, creating a shallow river with deep channels cut out of the bedrock below. Many species of aquatic plants and animals thrive in the Llano, but the one at the top of the food chain (except humans) is the largemouth bass (TPWD 2007). Other fish species include catfish (*Ictiolus bubalus*), perch (*Morone americana*), carp (*Ctenopharyngodon idella*), and gar (*Lepisosreus osseus*).

Due to the sport fishing affinity towards the largemouth bass, there is much literature discussing the habitat suitability of the fish. From the available literature, one ascertains that Calcite's stretch of the Llano River has an unsuitable index value for the largemouth bass. First of all, a gravel substrate is preferred for spawning (Mraz 1964). This points towards a lower HSI value on the Llano because of the lack of substrate. Furthermore, optimal habitat for the largemouth bass are large slow moving rivers or pools of streams with soft bottoms, some aquatic vegetation, and relatively clear water (Struber *et al*. 1982). Though largemouth bass do live at Calcite, one can infer that the ideal habitat is not achieved in the Llano River due to the lack of soft bottoms. Therefore one can estimate the HSI value for the largemouth to be 0.5.

Photo 5: Largemouth Bass (*Micropterus salmonides*) at Calcite
Stretch of Llano River at Calcite in background

Prescribed fire would affect the largemouth bass HSI value on Calcite. Though the burns take place on dry land they have repercussions on the water resource. Erosion is a factor which must be considered when burning on Calcite. When a precipitation event follows a high intensity burn, substantial impacts include increased runoff, peak flows, and sediment delivery to streams and rivers (Rinne 1997). The exposed ground following a prescribed burn, once eroded and transported to the river, would lower the HSI value of the already compromised largemouth bass. This is a negative effect of the prescribed burning on an endemic species.

10.7 HSI Conclusion

HSI is a beneficial tool for wildlife management as it allows values of the ecology of an area to be compared for suitability of a species to the area. When changing the face of a landscape as with prescribed fire, it is important to keep the big picture in mind all the while measuring and determining the effects of the land management on the members of the ecosystem. It is my hypothesis that the white-tailed deer, Rio Grande turkey, and feral hog have their HSI values augmented by prescribed fire on Calcite. Though not all indices show an increase a net gain is apparent. The largemouth bass, however, has a decreased HSI value when prescribed fire.

Prescribed fire has now been discussed in both the human ecological sense and the scientific sense. It is time to bring the subject back into the real world. It then becomes a practical tool having beneficial effects on an animal, in this case the White-tailed Deer. The following case study brings this study full circle and takes it out of the libraries of academia into the living ecosystem in Texas.

11. Case Study: White-tailed Deer and Fire

11.1 Background

The aim of this chapter is to critically discuss the utilization of prescribed fire as a tool to augment white-tailed deer (*Odocoileus virginianus*) habitat in the Texas Hill Country.

Objective

The goal of this project is firstly to review pertinent scientific literature regarding White-tailed deer and prescribed fire. The synthesis of these two aspects will then illuminate the benefits of fire as a wildlife management technique which improves White-tailed deer habitat.

The review will:

1. Document the ecology, habitat requirements and feeding practices of white-tailed deer.

2. Assess the role of prescribed fire in an ecosystem

3. Combine white-tailed deer ecology and fire ecology to discuss fire as a wildlife management tool in the Texas Hill Country.

11.2 Introduction

The Texas Hill Country is comprised of the 28 million-acre Edwards Plateau, at the southern terminus of the Great Plains (See Map, Appendix V). This region has a unique combination of soils, climate, and vegetation (Doghty 2003). However, the Hill Country has an abundance of endemic natural habitat that is going into decline (Cho 2005). This decline can largely be attributed to detrimental rangeland management techniques. Exotic plants or impervious cover often replace native vegetation in the Hill Country (Roberts 2001).

White-tailed deer serve as a major economic resource for many landowners in the Texas Hill Country. Commercial hunters lease private land for white-tailed deer as 98% of Texas is privately owned (Richmond 1992). Many wildlife management techniques are designed to augment endemic habitat for the benefit of the white-tailed deer.

The Texas Prescribed Burn Board believes prescribed fire is a sound wildlife management technique towards the restoration of native habitat for the benefit of the white-tailed deer. Fire is a natural release and renewal catalyst which has been detrimentally suppressed by contemporary humans. Prescribed fire is an excellent tool that can be used economically and effectively to manage white-tailed deer habitat (Lewis *et al*. 1982).

11.3 Ecology of *Odocoileus virginianus*

White-tailed deer (*Odocoileus virginianus*) are one of the most important big game species in the United States. White-tailed deer are ungulates, or hoofed mammals, belonging to the family Cervidae. The average adult white-tailed buck weighs about 140 pounds (63 kilograms) live weight and stands 32 to 34 inches (83-84 cm) at the shoulder; does tend to be smaller than males (Beattie *et al.* 1980). White-tailed deer can run 40 miles per hour (65 kph) for short bursts, maintain speeds of 25 miles per hour (40 kph) for longer periods, and clear obstacles up to nine feet high (2.7 meters) (DePerno *et al.* 2000).

Deer are primarily browsers. Their main food staple being woody twig ends and leaves during the majority of the year though white-tailed deer will preferentially consume forbs in the spring and summer (Hayne 1984). A forb is any plant that lacks the woody stems of shrubs and trees and is not a grass.

White-tailed deer successfully live across a wide range of habitats. They can survive near the Arctic in Canada and in tropical forests of South America (Mcshea and Rappole 1992). Most male white-tailed deer live to about 6 years of age. Females tend to live about two years longer than males. The record white-tailed deer was a doe in Georgia that lived 22 years (Hayne 1984).

11.4 Habitat of *Odocoileus virginianus*

There are a myriad of aspects affecting the viability and productivity of white-tailed deer in Central Texas. Arguably the most important aspects of deer habitat are nutrition, water and shelter. Nutrition will be covered in section 11.6 which discusses feeding habits of white-tailed deer. The description of habitat in this section will be shelter or cover.

The basic cover needs for optimal white-tailed deer shelter are pointed out by Armstrong and Young (2000):

1. low-growing vegetation for adequate hiding cover, protecting fawns
2. mid-level vegetation or escape cover to provide protection from predators
3. over-story vegetation (trees/tall shrubs) to protect deer from weather extremes

The endemic habitat of Central Texas is a savannah ecosystem with oak stands. This is ideal for white-tailed deer. Furthermore, this aspect has been known for a period of time. As Michael pointed out in 1970, “prairies with riparian zones or a shrub component provide adequate cover as do tall grasses three to five feet in height.” Michael’s description fits the Texas Hill Country perfectly.

However, the endemic habitat of the Texas Hill Country is becoming rarer. Anthropogenic changes to the Texas rangeland have ushered a contemporary habitat of exotic plants and impervious cover (Roberts 2001). An example of this is the prolific rise of the Ashe Juniper, as discussed in section 13.1.

11.5 Population Densities

Table 2 (Armstrong and Young 2000) depicts the ideal population densities of white-tailed deer on the Edwards Plateau. The Edwards Plateau, Texas Hill Country and Central Texas are synonymous terms. As one can determine, the ideal carrying capacity of White-tailed deer varies within the Hill Country.

Population Recommendations (Post-season)
Eastern Plateau - 10-15 acres per deer
Central Plateau – 12-16 acres per deer
Western Plateau – 14-20 acres per deer

Table 2: Carrying capacity population densities of white-tailed deer in the Texas Hill Country: the 'plateau' refers to the Edwards Plateau, upon which the Texas Hill Country is located.

(Armstrong and Young 2000)

11.6 Food Requirements of *Odocoileus virginianus*

The Texas Hill Country has three overarching categories of plants: forbs, browse, and grass. Hammel and Litton (1981) show that white-tailed deer "prefer broadleaf herbaceous plants properly known as forbs." Common forbs of the Texas Hill Country are catalogued in Appendix VI. Browse, being the leaves and twigs of woody plants, are also important to the diet of the white-tailed deer. Common browse options are illuminated in Appendix VII.

When deer have diverse choices, they generally prefer certain forbs over most woody plants and grasses. Of the plants eaten, forbs are more digestible and have more protein available for deer than woody plants and grasses (Porter 2002). This preferential consumption of forbs is evident in the graphs in Appendix VIII, which compares plant consumption in white-tailed deer versus cattle (Armstrong and Young 2000).

Contemporarily, food is often considered insufficient in the white-tailed deer's habitat. A 150 pound deer eats an average of 10 to 12 pounds of forage a day (Young and Traweek 1999). Furthermore, from early spring to early fall a mature deer must consume over 2,200 pounds of forage to make it through the winter (Moen 1976). These requirements are becoming more and more difficult to obtain due to the detrimental effects on white-tailed deer habitat by noxious vegetation such as the Ashe Juniper. Ashe Juniper meets the cover requirements needed by white-tailed deer but dense stands provide little herbaceous forage and even less nutritional value (White and Bartman 1997).

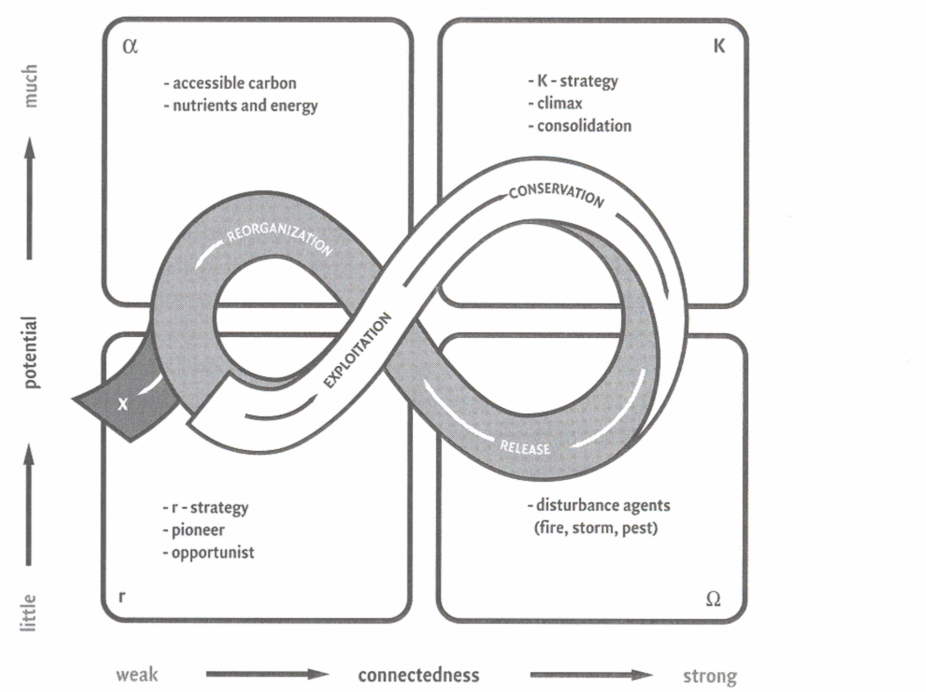
12. Fire Ecology

Fire is an intriguing and powerful force within an ecosystem. This is revealed through an explanation of the biophysical processes that occur due to fire. This process is described well by Wright and Bailey in their *Fire Ecology* (1982).

When organic matter burns, significant ash is produced. This lowers nitrogen, phosphorus, calcium, potassium, and magnesium levels due to the valorization of these elements. However, the elements that aren't volatized by combustion, namely calcium and nitrogen, are trans located into the mineral soil, resulting in a net gain of elements (Komarek 1971). Furthermore, the addition of calcium has a favorable effect on growth of bacteria, which ultimately produces more nitrogen by mineralizing organic matter. The net gain of nitrogen and elements combined with the new lack of competition for sunlight allows rapid re-growth following the fire. Due to this a single burn can increase forage production from two to four times (Lewis *et al.* 1982). The reorganization of the ecosystem begins.

12.1 Panarchy

Fire acts as a facilitator of change within an ecosystem. It is not inherently malignant or benign; it is a force to be respected. Ecosystems follow the Panarchy cycle advocated by Lance Gunderson among others. Within an ecosystem there is a general exploitation of resources leading up to a peak. This can be viewed in the sense of fire as an ecosystem producing large amounts of combustible fuel. As the fuel accumulates, the nutrients in the soil are exploited and the amount of herbaceous material competing for sunlight causes a leveling off of growth. This leveling off represents the conservative phase of Panarchy (Carpenter *et al.* 2002). Biophysically this is due to a decrease of soil nutrients and an increased use of energy competing with other plants for food. Forbs and browse become increasingly scarce for the white-tailed deer and the forage available has decreasing amounts of minerals and nutrients (Teer *et al.* 1965). Fire enters at this stage, facilitating the redistribution and reorganization in the ecosystem through a catastrophic event. The buildup of herbaceous material means there is more and more combustible material in the ecosystem. Fire, either naturally set through lightning or anthropogenically ignited, redistributes the accumulated and stagnated herbaceous growth.



(Berkes *et al.* 2003, p17)

Figure 7: Panarchy Cycle within an Ecosystem: The dynamic process of exploitation, conservation, release and reorganization occurring in all natural ecosystems.

Fire is a facilitator. It hastens the Panarchy cycle through the release and reorganization phase. As Berkes and Folke (2002) argue: "disturbance (fire) is endogenous to ecosystem development, periods of gradual change and periods of rapid transformation coexist and compliment each other." (p129) An ecosystem with a buildup of herbaceous material would eventually purge the surplus through decomposition and composting processes, but that is much more time consuming when compared to fire. Fire is also much more volatile. When weighing the costs of processes, decomposition is slow but safe; fire is fast but inherently much more risky. However, we argue that the ecological costs of not using fire far outweigh the ecological costs of using fire. An anthropogenic fire regime when utilized properly would improve the habitat for white-tailed deer by eliminating noxious plant species and promoting valuable food species such as forbs.

13. Benefits of Prescribed Fire to White-tailed deer Ecology

Prescribed fire is a wildlife/rangeland management technique that has been utilized for eons all over the world. However, recently the beneficial processes inherent of fire have been stagnated due to a pan-human fire suppression policy (Wright and Bailey 1982). “Nature, independent of humans, created flammable ecosystems. Prehistoric humans tamed these natural fires. Modern people deny this historical and evolutionary reality. As a result, fire has become feral, and a serious management problem”. (Levy 2005, p310) Fire has been absent for many decades across the majority of the Texas Hill Country. Once re-established, fire promotes white-tailed deer habitat by reducing noxious species of plants such as the Ashe Juniper and promoting beneficial forage plants such as forbs.

13.1 Reduction of Noxious Plants with Fire: Ashe Juniper

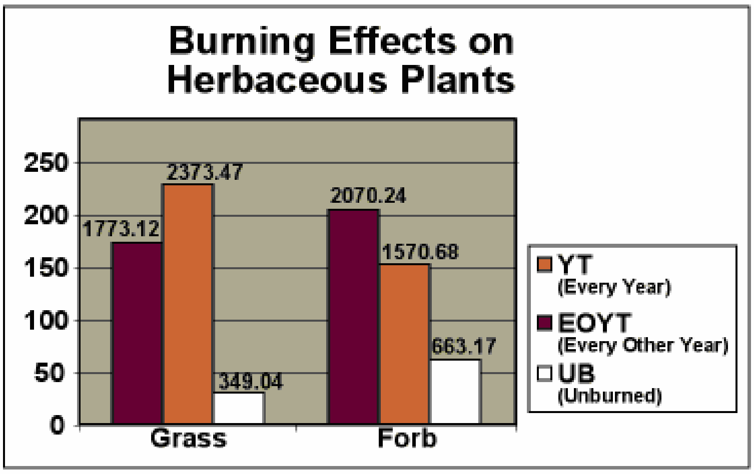
Ashe Juniper started to impact on Texas’ native habitat coinciding with the arrival of the Europeans. In the 19th century, Texas’ habitat consisted of a grassy savannah where stands of trees were interspersed with large open areas or prairies that were burned periodically by wildfires or Indians (Roemer 1995). Ashe Juniper was historically controlled by this natural and anthropogenic fire regime. Europeans, however, viewed fire as detrimental to their wooden structures, farmlands, fences, and grazing lands. Fire was suppressed and Ashe Juniper began to encroach upon the savannah. The increase of Ashe Juniper coupled with overgrazing livestock in Central Texas has caused poor wildlife habitat, reduced carrying capacity, and a lowered water table.

However, there is hope. Ashe Juniper is not a fire tolerant species. Re-growth of Ashe Juniper less than 2 feet tall can be readily controlled by prescribed burning (Lewis *et al.* 1982). By instigating a fire regime as a wildlife management technique the Ashe Juniper encroachment ceases and restoration of native habitat preferential to white-tailed deer is facilitated.

13.2 Promotion of Preferred Forage Plants with Fire

Fire promotes forage for white-tailed deer. It is a known observation that in general, white-tailed deer are seen foraging more frequently on burned sites than adjacent unburned sites (Hallisey and Wood 1976). However, in many areas fire suppression has led to a decrease in forage quality and subsequently quantity. Fire retarded areas are increasingly transformed into unpalatable browse that grows out of reach of deer (Freedman 1983). This is due largely to the fact that as a plant puts on new growth, the first shoots are tender and palatable but become replaced with non-digestible fibers such as cellulose as the plant matures (Gladfelter 1984).

As illuminated in 11.3, the preferred forage of white-tail deer are forbs. A study on the effects of prescribed fire on forb production was initiated in Oklahoma in 1988 and assessed in 1998. This study shows a drastic increase in forb growth in areas where prescription burns are utilized.



(Stevens 2000)

Graph 3: Burning Effects on Herbaceous Plants
The increase in forb density is most apparent in areas burned every other year.

Forb density (Graph 3) was higher in the every other year burned than the unburned and every year burned. Furthermore, a number new of species of forbs appeared, including *Desmodium*, *Lespedeza*, *Ambrosia*, *Helianthus*, and *Croton* (Stevens 2000).

14. Precautions when Re-establishing fire as a Wildlife Management Tool

The decline of endemic habitat preferential to the white-tailed deer in the Texas Hill Country has been assessed. Furthermore, the benefits of fire as a wildlife management tool have been discussed. Promotion of an anthropogenic fire regime towards the improvement of white-tailed deer habitat is a sound method. However, it is important to realize that fire is a volatile management tool and certain precautions need to be adhered to in order to utilize fire safely and effectively. This precautionary stance is doubly important in areas that have been devoid of fire for decades such as the Texas Hill Country. Large fuel loads have been allowed to build up in the absence of fire that lead to catastrophic fires if proper burning techniques and caution are not embodied in the process. One must receive knowledge about prescription burning before attempting to burn independently. Anything else is arrogant and negligent, and dire consequences can result.

15. Recommendations

- Prescribed fire should be utilized more actively in the wildlife management of the white-tailed deer as prescribed fire:
  - Promotes beneficial forage plants
  - Reduces noxious invasive plants
- The economic motivation of providing improved deer habitat for hunting leases will serve as a catalyst for a movement towards the return to endemic Texas Hill Country habitat.
- Armstrong (1980) recommends a burning cycle of 7-10 years in the Texas Hill Country. This resonates with historical data regarding fire ecology as well as biophysical findings of ecosystem recovery from fire.
- Re-establishing a fire regime in an area is a risk inherent task that should not be taken lightly. Porter (2004) suggests to mitigate these risk issues by formulating a burn plan which:
  - Forces one to thoroughly plan a burn
  - Forces one to define and understand when fire can accomplish certain goals
  - Forces an understanding of when it is not safe to burn
  - Prepares contingencies for problematic situations that might develop
  - Helps recognize knowledge, equipment, and preparation limitations for a prescribed burn
  - Helps minimize liability when the plan is adhered to because it demonstrates knowledge about fire

- Education, continued research, and monitoring is central to the long term effectiveness of the re-introduction of fire as a wildlife management tool. Classes should be offered to share the knowledge in this re-emerging field.

16. Discussion

This thesis is a synthesis. The ultimate message is that there is much more work to be done. Fire is a dynamic process, writing about it in depth requires one to quantify and qualify. Voids filled in the vast web of academia are done with disclaimers, for there are many variables involved in the cultural and scientific side of prescribed burning.

There have been strides made towards these voids in this thesis. Understanding the cultural flaws that led to the haunting regarding fire is an important realization. Once people understand why a situation has presented itself, it enables them the opportunity to change. Change does not always manifest itself physically. Mental change can bring much good as well. A change in a cultural mindset leads to physical change in society at large. There are contemporary hints that this change is occurring; facilitating the correct path is the next challenge.

The science of plant transects involved in this thesis serves as a secondary motivator towards this change. Qualitative social sciences are useful, but without the quantitative hard sciences serving as proof, the message is often lost or misconstrued. That is the purpose of the plant transects at Calcite. One must have ammunition in order to start a revolution. The current fire effects study will over time evolve into a fire ecology study. We live in a world of science. It is impossible to argue against the virtues of prescribed burning when the proof is presented in the contemporary language of truth – science. With each subsequent year these transects are quantified, the significance of the findings gains importance.

The white-tailed deer case study serves as a connector back to the natural ecosystem. People become motivated when they can see tangible results. Social science resides in the qualitative, science the quantitative, but the white-tailed deer resides in Texas. It is not a construction of the human mind in an attempt to describe the world. It does not live on a library bookshelf or in a computer. It is an animal, and the reality of how prescribed fire benefits this animal in Central Texas brings this thesis back into the real world.

17. Summary of Results

- Panarchy places fire in the same template both culturally and environmentally.
- The Bureau of Land Management (BLM) integrated fire management policy is discussed as a move forward. The public land policy can be utilized in the predominantly private lands of Texas utilizing a bottom up approach though landowner cooperation.
- Calcite Ranch is an aspiring fire ecology research station in Central Texas. The vegetation transects quantify fire effects.
- Case studies of four animals residing in the region and the effects fire has on their habitat through an estimation of the Habitat Suitability Index (HSI) values for each. The white-tailed deer, feral hog, and Rio Grande Turkey habitat suitability index is augmented by prescribed fire. The largemouth bass HSI value is lessened with the implementation of prescribed fire.
- An in depth case study regarding the ecology of the white-tailed deer and prescribed burning management techniques serves as an educational tool promoting the implementation of prescribed fire regimes in the Texas Hill Country.

18. References

Albini, F.A. (1985) *A Model for Fire Spread in Wildland Fuels through Radiation*. Combustion Science and Technology. Volume 42, Issues 5&6. Pages 229-258.

Albini, F.A. (1986) *Wildland Fire Spread by Radiation – a model including fuel cooling by Natural Convection.* Combustion Science and Technology. Volume 45, Issues 1&2, February. Pages 101-113.

Allen, A.W. (1983) *Habitat Suitability Index Models: Beaver*. U.S. Fish and Wildlife Service. FWS/OBS 82/10.30 Revisited. 20p.

Atkins, P.W. (1984) *The 2nd Law: Energy, Chaos, and Form.* Scientific American Books New York.

Armstrong, W. E. (1980). Impact of prescribed burning on wildlife. In: White, Larry D., ed. *Prescribed range burning in the Edwards Plateau of Texas: Proceedings of a symposium; 1980 October 23; Junction, TX*. College Station, TX: Texas Agricultural Extension Service, The Texas A&M University System: 22-26.

Armstrong, W.E.; and Young, E.L. (2000). *White-tailed Deer Management in the Texas Hill Country.* Texas Parks and Wildlife.

Babbitt, B. and N. Sampson. (1995) *To Take Up the Torch*. American Forests 101:17.

Beattie, K. H., C. J. Cowles, and R. H. Giles. (1980). Estimating illegal kill of deer. *in* R. L. Hine and S. Nehls, editors. *White-tailed deer population management in the north central states.* Proceedings of a Symposium held at the 41st Midwest Fish and Wildlife Conference, Urbana, Illinois, USA. Pages 65-71.

Bailey, R.W; Davis, J.W; Frampton, J.E; Gwyn, J.V; and Shugars, J. (1981) Habitat Requirements for the Wild Turkey in the Southeast Piedmont. P 14-23. In P.T Bromley and R.L Carlton, eds. *Habitat Requirements and Habitat Management Of the Wild Turkey in the Southeast*. Richmond, Virginia.

Barclay, Angela D; Betancourt, Julio L.; and Allen, Craig D. (2004) *Effects of Seedling Ryegrass (Lolium multiflorum) on Vegetation Recovery following Fire in a Ponderose Pine (Pinus Ponderosa) Forest.* International Journal of Wildland Fire. Vol 13 p183-194.

Berkes, Fikret and Folke, Carl. (2002) 'Back to the Future: Ecosystem Dynamics and Local Knowledge.' In Gunderson, Lance H.; Holling, C.S. (eds) *Panarchy: Understanding Transformations in Human and Natural Systems.* P. 121-146. Island Press, Washington D.C.

Berkes, Fikrit; Colding, Johan; and Folke, Carl. (2003). *Navigating Social-Ecological Systems: building resilience for Complexity and Change.* Cambridge University Press. Cambridge U.K.

Brown, Joel R. and Smith, Jerry W. (June 1993) *How Herbivory effects grazing tolerant and sensitive Grasses in a Central Texas Grassland: Integrating plant response across Hierarchical levels*. Oikos. Vol 67. No 2.

Brunson, Mark W. and Evans, Jessica. (Apr/May 2005). *'Badly Burned? Effects of An Escaped Prescribed Burn on Social Acceptability of Wildland Fuels Treatments.'* Journal of Forestry. Bethesda: Vol 103, Iss. 3; pg. 234, 5 pgs.

Burgman, Mark A.;David R Breininger; Duncan, Brean W; Ferson, Scott. (Feb 2001). *Setting Reliability Bounds on Habitat Suitability Indices*. Ecological Applications. Vol 11. No. 1. p. 70-78.

Carpenter, Stephen R.; Brock, William A. ; Ludwig, Donald. (2002) 'Collapse, Learning And Renewal.' In Gunderson, Lance H.; Holling, C.S. (eds) *Panarchy: Understanding Transformations in Human and Natural Systems.* P. 173-193. Island Press, Washington D.C.

Cho, Helen. (July 2005). *Helping Mother Nature; At the Cibolo Nature Center, preservation is always on the brain*. Texas Monthly. Austin: Vol 33, Iss. 7; pg. 1.

Collins, Scott L. and Barber, Susan C. (January 1986) *Effects of Disturbance on Diversity in a mixed Grass Prairie. Journal of Plant Ecology*. Springer, Netherlands. Vol 64 No 2-3.
.

Cottrell, William H. (2004) *The Book of Fire*. Mountain Press Publishing Company. Missoula, Montana.. SD421.C7142004.

Crawford, Hewelitt S. (1984) Habitat Management. In Halls, Lowell K ed. *White-tailed Deer, Ecology and Management*. Harrisburg P.A: Stackpole Books. P629-646.

DePerno, C. S.; J. A. Jenks; S. L. Griffin; and L. A. Rice. (2000). *Female survival rates in a declining white-tailed deer population*. Wildlife Society Bulletin 28:1030-1037.

Doughty, Robin W. (May 2003) *Birds of the Texas Hill Country*. The Condor. Lawrence: Vol. 105, Iss. 2; pg. 395.

Duncan, R Scott.; Anderson, Corinna B.; Sellers, Heather N.; and Robbins, Erin E. (2008) *The effect of fire on rare and endemic plants of a Southeastern Glade Ecosystem*. Restoration Ecology. Vol.16 no.1. p39-49.

Edwards Plateau Prescribed Burning Association. (2007) Taylor, C.A ed. *Newsletter*. Vol. 9 No. 1. Sonora, Texas.

Flynn, B. (1992) *Political Philosophy at the closure of metaphysics.* Humanities Press, London.

Freedman, June D. (1983). *The historical relationship between fire and plant succession within the Swan Valley white-tailed deer winter range, western Montana*. Missoula, MT: University of Montana. 139 p. Dissertation.

Giddens, A. (1990) *The Consequences of Modernity*. Polity Press, Cambridge.

Gladfelter, L. (1984) Midwest agricultural region. Pages 427-440 *in* L. K. Halls, editor. *White-tailed deer: ecology and management*. Stackpole Books, Harrisburg, Pennsylvania, USA.

Gordon, A. F. (1997) *Ghostly matters: Haunting and the Sociological Imagination.* University of Minnesota Press. Minneapolis.

Graaf, Mary Anne; Six, Johan; Harris, David; Blum, Herbert; Kessel, Chris. (Nov 2004) '*Decomposition of soil and plant carbon*' Global Change Biology. Oxford. Vol. 10, Iss. 11.

Graves, John and Meinzer, Wyman. (2002) *Texas Rivers*. University of Texas Press Austin, Texas.

Gunderson, Lance H. and Holling, C.S.; (2002) *Panarchy, understanding transformations in Human and natural systems.* Island Press. Washington D.C.

Gunderson, Lance H.; Holling, C.S.; Pritchard, Lowell Jr.; and Peterson, Garry D. (2002) 'Resilience of Large-Scale Resource Systems. In Gunderson and Pritchards' (eds) *Resiliance and the Behavior of Large Scale Systems*. P. 3-20. Scientific Community on Problems of the Environment (SCOPE). Island Press, Washington DC.

Haile, Kimberley (2007) *Grass and Woody plant response to Summer Prescribed Burning at Calcite Ranch.* Texas A&M University. College Station.

Hallisey, Dennis M.; Wood, Gene W. (1976) *Prescribed fire in scrub oak habitat in central Pennsylvania*. Journal of Wildlife Management. 40(3): 507-516.

Halls, L.K. (1978) *White-tailed deer*. P. 43-65. In J.L Schmidt and D.L Gilbert. Game Animals of North America. Stackpole books, Harrisburg, PA.

Harmel, D. E. and G. W. Litton. (1981) *Deer management in the Edwards Plateau of Texas*. Texas Parks and wildlife Dept. PWD 7000-86. Austin. 21 pp.

Hayne, D. W. (1984) *Population dynamics and analysis. Pages 203-210 in L. K. Halls, editor*. White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Hobbs, R.J. (1984) *Markov models in the study of post fire succession in Heathland Communities*. Plant Ecology. Vo. 56 no 1.

Johnson, EA and Miyianishi, Kyioko. (2001) *Forest Fires: Behaviors and Ecological Effects*. Academic Press. London, England.

King, Irene Marschall. (1967) *John O Meusebach, German Colonizer in Texas*. University of Texas Press, Austin and London.

Komarek, E. V. (1971) *Effects of fire on wildlife and range habitats.* In: Prescribed burning symposium: Proceedings; 1971 April 14-16; Charleston, SC. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 46-53.

Korschgen, L.J. (1967) Feeding Habits and Food. P137-198. In Hewitt, O.H Editor: *The Wild Turkey and its management*. The Wilderness Society, Washington D.C.

Kull, Christian A. (April 2002) *Madagascar's Burning Issue*. Environment. Washington: Vol. 44 Iss. 3. Pg. 8.

Laughlin, Dianna. (2004) '*Panarchy: Understanding Transformations in Human and Natural Systems'*. Journal of the Community Development Society. Columbus. Vol. 34, Iss. 2; pg. 125.

Lasley, Greg. (2008) *Photo of Rio Grande Turkey* (*Meleagris gallopavo intermedia*). Copyright Greg Lasley photography. Austin, Texas.

Levy, Sharon. (April 2005) *Rekindling Native Fires*. Bioscience**.** Washington: vol. 55 Iss. 4; pg. 303.

Lewis, C.E, Grelen, H.E, Probasco, G.E. (1982) *Prescribed burning in southern forest And rangeland improves forage and its use*. Journal of Applied Forestry. Vol. 6, p 19-25.

Linares, Olga F. (Jun 2005). '*Isle of Fire: the Political Ecology of Landscape Burning In Madagascar*.' The Geographical Journal. London. Vol 171; p. 180.

Lincecum, Jerry Bryan and Phillips, Edward Hake. (1984) *Adventures of a Frontier Natrualist: The Life and Times of Dr. Gideon Lincecum*. Texas A&M University Press, College Station.

Lindzey, J.S. (1967) Highlights of Management. P 245-260. In Hewitt, O.H., *The Wild Turkey and its Management*. The Wilderness Society, Washington D.C.

Litton, George W and Harwell, Feilding. (1995) *Rio Grande Turkey Habitat Management*. Texas Parks and Wildlife Publications. Austin, Texas.

McConnell, William and Sweeney, Sean P. (Sept 2005) '*Challenges of Forest Governance in Madagascar*.' The Geographical Journal. London. Vol. 171; p. 223.

McShea, W. J., and J. H. Rappole. (1992) *White-tailed deer as a keystone species within forested habitats of Virginia*. Virginia Journal of Science 43:177-186.

Michael, E. D. (1970) *Activity patterns of white-tailed deer in south Texas*. Texas Journal of Science 21:417-438.

Mistry, Jayalaxshmi; Berardi, Andrea; Andrade, Valeria; Kraho, Txicapro; Kraho, Phocrok; Leonardos, Othon. (June 2005) *Indigenous fire management in the cerrado of Brazil: the case of the Kraho of Tocantins.* Human Ecology: an Interdisciplinary Journal, v.33 i3 p365 (22).

Moen, A. N. (1976) *Energy conservation by white-tailed deer in the winter*. Ecology. 57:192-198.

Mosby, H.S and Handley, C.O. (1943) *The Wild Turkey in Virginia, its status, Life History, and Management*. Division of the Game Commission, Richmond Virginia.

Mraz, D. (1964) *Observation on large and smallmouth bass nesting and early life History*. Wisconsin Conservation Department. Res. Rep. 11.

National Forest Service. (2003) *Thompson Creek fuels reduction step by step. National database of state and local wildfire mitigation programs*. National Forest Service, Southern Research Station. Asheville, North Carolina.

National Wild Turkey Federation. (2006) *Prescribed Fire helps National Forests in Sunshine State*. National Wild Turkey Federation Press Release. Edgefield, South Carolina.

O'Sullivan, Antoinette C. (September 1997) *Cellulose: The Structure Slowly Unravels*. Cellulose Journal. Springer, Netherlands. Volume 4 Number 3. 173-207.

Porter, Mike. (Oct 2002). *Forbs and their importance in White-tailed deer diets*. Ag News and Views. Ardmore, Oklahoma.

Porter, Mike. (Feb 2004) *Virtues of a well written prescribed burning plan.* Ag News And Views. Ardmore, Oklahoma.

Pyne, S.J. (1982) *Fire in America: A Cultural History of Wildland and Rural Fire*. Princeton University Press: Princeton NJ.

Redman, Charles L. (Mar 2005) '*Resilience Theory in Archaeology*'. American Anthropologist. Vol 107, Iss. 1 Pg. 70.

Richmond, Joshua. (Aug, 1992) *Lone Star State Creates Conservation Partnership Texas Hill Country Bioreserve*. Christian Science Monitor. Boston, Mass.

Robbins, Jim. (Feb 8, 2004) *Critics Say Forest Service Battles Too Many Fires.* New York Times. New York, N.Y. pg.1.14.

Roberts, Luela P. (Sept/Oct, 2001) *Deep in the heart of Texas*. Endangered Species Update. Ann Arbor: Vol 18, Iss. 5; pg. S14, 2pgs.

Roemer, F. (1995) *Roemer's Texas, 1845-1847*. Eakin Press. Austin. 308 pp.

Rose, Jeremy. (2004) '*Soft systems methodology as a social science research tool.*' Systems Research and Behavioral Science. Vol. 14, Iss 4.

Russel-Smith, Jeremy; Lucas, Dianne; Gapindi, Minnie; Gunbunuka, Billy; Kapirigi, Nipper; Namingum, George; Lucas, Kate; Guiliani, Pina; Chaloupka, George. (1997) *Aboriginal Resource Utilization and Fire Management Practice in Western Arnhem Land, Monsoonal Northern Australia: Notes for Prehistory, Lessons for the Future.* Human Ecology. 25, 2, p.159.

Schroeder, R.L. (1985) *Habitat Suitability Index Models: Eastern Wild Turkey*. U.S. Fish And Wildlife Service. Biology Report 82 (10.106).

Short, H.L. (1975) *Nutrition of Southern Deer in Different Seasons*. Journal of Wildlife Management. 39(2) : 321-329.

Short, H.L; and Epps, E.A. (1976) *Nutrient quality and digestability of seeds and fruits in Southern forests.* Journal of Wildlife Management. 40(2): 283-289.

Short, H.L. (1986) *Habitat Suitability Index Models: White tailed deer in the Gulf of Mexico and South Atlantic coastal plains.* U.S. Fish and Wildlife Service Biological Report 82 (10.23) 36pp.

Springer, M.D. (1977) *Ecologic and economic impacts of Wild Hogs in Texas. In G.W. Wood, ed. Research and management of wild hog populations*. Clemson University. Georgetown, South Carolina.

Stevens, Russell. (2000*) Results of a long-term demonstration of the effects of prescribed fire*. Ag News and Views. Ardmore, Oklahoma.

Stogl, Sigrid and O'Hara, Sabine (2001) *Preferences, Needs, and Sustainability.* International Journal of Sustainable Development. Vol. 4. No. 1.

Struber, R.J; Gebhart, G; Maughan, O.E. (1982) *Habitat Suitability Index Models: Largemouth Bass*. U.S Department of Interior Fish and Wildlife Service. FWS/OBS-82/10.16. 32p.

Taylor, R.B.; Helgren, E.C. (1997) *Diet of feral hogs in the western south Texas plains.* Southwestern naturalist. Vol 42 No.1 p33-39.

Taylor, Rick. (2003) *The Feral Hog in Texas*. Texas Parks and Wildlife Dept. Austin Texas.

Teer, J. G., J. W. Thomas, and E. A. Walker. (1965) *Ecology and management of white-Tailed deer in the Llano Basin of Texas*. Wildl. Monog. No. 15. 62 pp.

Texas Environmental Center. (1995) *Texas Environmental Almanac*. Texas Center for Policy Studies. Rice University, Houston.

Texas Parks and Wildlife. (2006) *Prescribed Burning Associations in Texas*. Texas Parks and Wildlife publications. Austin, Texas.

Texas Parks and Wildlife Department. (2007) *Largemouth Bass* (*Micropterus salmonides*). Texas Parks and Wildlife Dept. Austin, Texas.

Thompson, M. (1979*) Rubbish Theory: The creation and destruction of value*. Oxford University Press. Oxford, England.

Turner, Ellen Sue and Hester, Thomas R. (1999) *A Field guide to Stone Artifacts of Texas Indians.* Gulf Publishing, Houston Texas.

U.S. Bureau of Land Management. (1996) *Cabinet Secretaries Endorse Integrated Wildland Fire Policy*. BLM Press Release. Office of Public Affairs. Washington D.C.

USDI National Park Service. (2001) *Fire Monitoring Handbook*. Boise (ID): National Interagency Fire Center. 288p.

U.S. Fish and Wildlife Service. (1981) *Standards for the development of Habitat Suitability index models for use in the Habitat Evaluation Procedures*. USDI Fish and Wildlife Service. Division of Ecological Services. ESM 103.

Van Horne, Beatrice; Wiens, John A. (1991) *Forest and Bird Habitat Sustainability Models and The Development of General Habitat Models*. Colorado State University Press. Fort Collins Colorado.

White, G. C., and R. M. Bartmann. (1997) Density dependence in deer populations. Pages 120-135 *in* W. J. McSheas, H. B. Underwood, and J. H. Rappole, editors. *The science of overabundance: deer ecology and population management.* Smithsonian Institution Press, Washington, D. C., USA.

Wright, Henry A., and Bailey, Aurthur W. (1982) *Fire Ecology: United States and Southern Canada.* John Wiley and Sons Publishing, New York.

Wright, W. (1992). *Wild Knowledge, science, language, and social life in a fragile Enviroment.* University of Minnesota Press, Minneapolis.

Yoder, Jonathan (Nov 2004) '*Playing with fire: endogenous risk in resource management*' American Journal of Agricultural Economics, v86 i4 p933(16)

Young, E.L. and M. S. Traweek. (1999). *White-tailed deer population trends*. Federal Aid In Wildl. Rest. W-127-R-7. Project No. 1. Texas Parks and Wildlife Dept. Austin. 64 pp.

Appendix

Appendix I: Prescribed Burn Plans for Calcite

Prescribed Burn Plan

Prepared by: Keith Blair Signature:_________________

Date: 1-15-2003

County: Mason Acres: 350 Landowner: Don & Ann Connell

Address: P.O. Box 39 Driftwood, Texas 78619 CR 162 #850 Phone: pager 512-606-2786 r 512-858-7360

A. Record of Previous Burning:

Date: Unknown Results:_____________________

B. Description of Area:

1. Live Fuels: Type, density, size Live oak to 20 feet
2. Dead Fuels: Type, model, volume 1hr at 1000 lbs/acre, and10hr, 100hr & 1000 hr fuels in cedar piles
3. Topography rolling to steep terrain
4. Potential vegetation Oak savannah & medium grassland Range Sites: NA
5. Previous treatments Historic Grazing and recent cedar control

C. Purpose(s) of Burn: reduce hazardous fuels

D. Specific Objectives: Consume 90% of brush piles

E. Preburn Factors:

1. Fire guards to plow, mow, etc.(Figure 1): Perimeter; NoneInterior Natural fire breaks, such as creeks, should be assessed prior to burn to determine whether they will function as breaks.
2. Crew size: minimum = 3 Equipment needs minimum= 1 pumper, 1 ATV, hand tools, 30 gallons of torch fuel (60:40)

3. Protection needs(buildings, power lines, oil/gas etc)__A mineral soil line should be maintained around all structures at all times.

4. Ignition procedures : Ignite each pile as prescription is met.

5. List smoke sensitive areas (see map): _none

6. Regulations that apply: TNRCC and County Burn Bans

7. Notifications: Fire Department_SO 915-347-5252

   Adjoining Landowners__to be notified by landowner

   TNRCC San Antonio 210-490-3096

   Other

8. Special precautions: crew safety- provide adequate drinking water and monitor condition of individuals

Burn Crew:

1. Fire Boss Keith Blair
2. Pumper Cody Lunsford
3. Ignition Keith Blair
4. ATV Martin Blair

Prescribed Burn Plan

Prepared by:__Keith Blair__Signature:___________________

_________Date:__7-19-2004

County:___Mason_______ Acres:___90__Landowner:__Don & Ann Connell___________

Address:__P.O. Box 39 Driftwood, Texas 78619 CR 162 #850_____Phone:_ pager 512-606-2786 r 512-858-7360

A. Record of Previous Burning:

Date:__Unknown______Results:_____________________

B. Description of Area:

1. Live Fuels: Type, density, size_Live oak to 20 feet_____________________

____

6. Dead Fuels: Type, model, volume__1hr at 1000 lbs/acre, and10hr, 100hr & 1000 hr fuels scattered_______
7. Topography_rolling terrain_____________________________________

   ____
8. Potential vegetation Oak savannah & medium grassland Range Sites: ___________redland and low stony hill
9. Previous treatments___Historic Grazing and recent cedar control__________________________________

C. Purpose(s) of Burn: reduce hazardous fuels___________________________

____

F. Specific Objectives: Consume 90% of brush piles

G. Preburn Factors:

1. Fire guards to plow, mow, etc.(Figure 1): Perimeter; None-new fenceline Interior none .
2. Crew size: minimum = 4 Equipment needs minimum= 1 pumper, 2 ATV, hand tools, 30 gallons of torch fuel (60:40)
3. Protection needs(buildings, power lines, oil/gas etc)__A mineral soil line should be maintained around all structures at all times.

5. Ignition procedures : Establish blackline on North and west side then ring.
5. List smoke sensitive areas (see map): none
6. Regulations that apply: TNRCC and County Burn Bans
7. Notifications: Fire Department SO 325-347-5252

Adjoining Landowners to be notified by landowner
TNRCC San Antonio 210-490-3096
Other
8. Special precautions: crew safety- provide adequate drinking water and monitor condition of individuals

H. Burn Crew:

5. Fire Boss Keith Blair
6. Pumper Orlando DeLaGarza
7. Ignition Keith Blair
8. ATV Martin Blair, Ed Shannon

Prescribed Burn Plan

Prepared by:__Keith Blair__Signature:___________________

_________Date:_June 29, 2005

County:___Mason_______ Acres:___25__Landowner:__Don & Ann Connell__________

Address:__P.O. Box 39 Driftwood, Texas 78619 CR 162 #850_____Phone:_ pager 512-606-2786 r 512-858-7360

A. Record of Previous Burning: Date:__2001______Results:__good on 1-hr fuels___________________

B. Description of Area:

1. Live Fuels: Type, density, size_Live oak to 20 feet_____________________________________

10. Dead Fuels: Type, model, volume__1hr at 2,000 lbs/acre, and10hr, 100hr & 1000 hr fuels scattered_______
11. Topography_rolling terrain____
12. Potential vegetation Oak savannah & medium grassland Range Sites: ___________redland and low stony hill
13. Previous treatments___Historic Grazing and recent cedar control________________________________

C. Purpose(s) of Burn: reduce hazardous fuels____

H. Specific Objectives: Consume 90% of brush piles

I. Preburn Factors:

1. Fire guards to plow, mow, etc.(Figure 1): Perimeter; hand clear east fenceline__Interior BL around house .
2. Crew size: minimum = 4__Equipment needs minimum= 1 pumper, 1 ATV, hand tools, 2 backpack sprayers, 15 gallons of torch fuel (60:40)
3. Protection needs(buildings, power lines, oil/gas etc)__A mineral soil line should be maintained around all structures at all times.

6. Ignition procedures : Establish blackline on North and east side, then ignite strips perpendicular to the wind in order to control fire behavior.
5. List smoke sensitive areas (see map): _none
6. Regulations that apply: TNRCC and County Burn Bans
7. Notifications: Fire Department_SO 325-347-5252

Adjoining Landowners__to be notified by landowner__
TNRCC San Antonio 210-490-3096
Other____________________________________

8. Special precautions: crew safety- provide adequate drinking water and monitor condition of individuals

I. Burn Crew:

9. Fire Boss________Keith Blair
10. Pumper/Suppression_________Orlando DeLaGarza & Tyler Hawkins
11. Ignition__________Keith Blair
12. ATV __Martin Blair

Prescribed Burn Plan

Prepared by: Keith Blair Signature:___________________

___________Date: 11-21-2005

County: Mason Acres: 150 Landowner: Don & Ann Connell

Address: Sping Hollow Road/Tri County Road Phone: pager 512-606-2786 r 512-858-7360

A. Record of Previous Burning:

Date: Unknown Results:______________________

B. Description of Area:

1. Live Fuels: Type, density, size Live oak to 20 feet

14. Dead Fuels: Type, model, volume 1hr at 1500 lbs/acre, and10hr, 100hr & 1000 hr fuels in slash

15. Topography rolling to steep terrain

16. Potential vegetation Oak savannah & medium grassland Range Sites: NA

17. Previous treatments Historic Grazing and recent cedar control

C. Purpose(s) of Burn: reduce hazardous fuels

J. Specific Objectives: Consume 90% of slash

K. Preburn Factors:

1. Fire guards to plow, mow, etc.(Figure 1): Perimeter; NoneInterior Natural fire breaks, such as creeks, should be assessed prior to burn to determine whether they will function as breaks.

2. Crew size: minimum = 4 Equipment needs minimum= 1 pumper, 1 ATV, hand tools, 30 gallons of torch fuel (60:40)

3. Protection needs(buildings, power lines, oil/gas etc) A mineral soil line should be maintained around all structures at all times.

7. Ignition procedures : Ignite each pile as prescription is met.

5. List smoke sensitive areas (see map): none

6. Regulations that apply: TCEQ and County Burn Bans

7. Notifications: Fire Department SO 325-347-5252

Adjoining Landowners to be notified by landowner

TCEQ San Antonio 210-490-3096

Other

8. Special precautions: crew safety- provide adequate drinking water and monitor condition of individuals

J. Burn Crew:

13. Fire Boss Keith Blair
14. Pumper David and Jean, Tyler
15. Ignition Keith Blair
16. ATV Martin Blair, Ed Shannon

Prescribed Burn Plan

Prepared by: Keith Blair Signature:___________________

___________Date: 09-01-2007

County: Mason Acres: 205 Landowner: Don & Ann Connell

Address: Sping Hollow Road/Tri County Road Phone: 512-606-2786 r 512-858-7360

A. Record of Previous Burning:

Date: Unknown Results:______________________

B. Description of Area:

1. Live Fuels: Type, density, size Live oak to 30 feet

18. Dead Fuels: Type, model, volume 1hr at 3,500 lbs/acre,
19. Topography rolling to steep terrain
20. Potential vegetation Oak savannah & medium grassland Range Sites: NA
21. Previous treatments Cedar control and slash burns

C. Purpose(s) of Burn: control seedling cedar

L. Specific Objectives: kill 90% of seedling cedar

M. Preburn Factors:

1. Fire guards to plow, mow, etc.(Figure 1): Perimeter; None Interior Natural fire breaks, such as creeks, should be assessed prior to burn to determine whether they will function as breaks.
2. Crew size: minimum = 4 Equipment needs minimum= 1 pumper, 1 ATV, hand tools, 30 gallons of torch fuel (60:40)
3. Protection needs(buildings, power lines, oil/gas etc) A mineral soil line should be maintained around all structures at all times.

8. Ignition procedures : Establish blacklines on downwind side of proposed headfire.
5. List smoke sensitive areas (see map): _none
6. Regulations that apply: TCEQ and County Burn Bans
7. Notifications: Fire Department_SO 325-347-5252

Adjoining Landowners__to be notified by landowner__
TCEQ San Antonio 210-490-3096
Other__________
8. Special precautions: crew safety- provide adequate drinking water and monitor condition of individuals

K. Burn Crew:

17. Fire Boss________Keith Blair
18. Pumper____Martin Blair____
19. Ignition__________Keith Blair
20. ATV/Gator ___Mike Day, David Connell

Prepared by: Keith Blair Signature:____________________

____________Date: 12-01-2006

County: Mason Acres: 205 Landowner: Don & Ann Connell

Address: Sping Hollow Road/Tri County Road Phone: pager 512-606-2786 r 512-858-7360

A. Record of Previous Burning:

Date: Unknown Results:______________________

B. Description of Area:

1. Live Fuels: Type, density, size Live oak to 20 feet

22. Dead Fuels: Type, model, volume 1hr at 3,500 lbs/acre, and10hr, 100hr & 1000 hr fuels in slash of house pasture
23. Topography rolling to steep terrain
24. Potential vegetation Oak savannah & medium grassland Range Sites: NA
25. Previous treatments Historic Grazing and recent cedar control

C. Purpose(s) of Burn: reduce hazardous fuels, control seedling cedar

N. Specific Objectives: Consume 90% of slash, remove 90% of 1-hr fuels, kill 90% of seedling cedar

O. Preburn Factors:

1. Fire guards to plow, mow, etc.(Figure 1): Perimeter; NoneInterior Natural fire breaks, such as creeks, should be assessed prior to burn to determine whether they will function as breaks.
2. Crew size: minimum = 4 Equipment needs minimum= 1 pumper, 1 ATV, hand tools, 30 gallons of torch fuel (60:40)
3. Protection needs(buildings, power lines, oil/gas etc) A mineral soil line should be maintained around all structures at all times.

9. Ignition procedures : Establish blacklines on downwind side of proposed headfire.
5. List smoke sensitive areas (see map): _none
6. Regulations that apply: TCEQ and County Burn Bans
7. Notifications: Fire Department_SO 325-347-5252

Adjoining Landowners__to be notified by landowner__

TCEQ San Antonio 210-490-3096

Other__________

8. Special precautions: crew safety- provide adequate drinking water and monitor condition of individuals

L. Burn Crew:

21. Fire Boss________Keith Blair
22. Pumper____Martin Blair____
23. Ignition__________Keith Blair
24. ATV/Gator __Mike Day, David Connell

Appendix II: Species List Plants of Calcite

COMMON	GENUS	SPECIES	NATIVE	SP_CODE
american water willow	Justicia	americana	TRUE	JUAM1
Wild Petunia	Ruellia	nudiflora	TRUE	RUNU1
Wooly tidestromia	Tidestromia	lanuginosa	TRUE	TILA1
Skunkbush	Rhus	aromatica	TRUE	RHAR1
Little-leaf Sumac	Rhus	microphylla	TRUE	RHMI1
Hoffm	Bifora	americana	TRUE	BIAM1
Poison Hemlock	Conium	maculatum	FALSE	COMA1
queen anne's lace	Daucus	carota	FALSE	DACA1
Little carrot	Daucus	pusillus	TRUE	DAPU1
Water-pennywort	Hydrocotyle	umbellate	TRUE	HYUM1
Water-pennywort	Hydrocotyle	verticillata	TRUE	HYVE1
Beggar's Ticks	Torilis	arvensis	TRUE	TOAR1
Antelope-horns	Asclepias	asperula	TRUE	ASAS1
Bearded swallowwort	Cynanchum	barbigerum	TRUE	CYNA1
Purple Milkweed Vine	Matelea	biflora	TRUE	MABI1
plateau milk vine	Matelea	edwardensis	TRUE	MAED1
Green Milkweed vine	Matelea	reticulata	TRUE	MARE1
Western ragweed	Ambrosia	psilostachya	TRUE	AMPS1
Lazy Daisy	Aphanostephus	ramosissimus	TRUE	APRA1
Aster	Aster	species	TRUE	ASSP2
Hierba del Marrano	Aster	subulatus	TRUE	ASSU1
Roosevelt Weed	Baccharis	neglecta	TRUE	BANE1
texas greeneyes	Berlandiera	texana	TRUE	BRTE1
Malta Star-Thistle	Centaurea	melitensis	FALSE	CEME1
least daisy	Chaetopappa	asteroides	TRUE	CHAS1
Dwarf White Aster	Chaetopappa	bellidifolia	TRUE	CHBE1
Hairy golden aster	Chrysopsis	villosa	TRUE	CHVI1
Chicory	Cichorium	intybus	TRUE	CIIN1
Golden-Wave	Coreopsis	basilis	TRUE	COBA1
Coreopsis	Coreopsis	tinctoria	TRUE	COTI1
Parralena or Dogweed	Dyssodia	pentachaeta	TRUE	DYPE1
Fleabane	Erigeron	species	TRUE	ERSP1
flathead rabbittobacco	Evax	prolifera	TRUE	EVPR1
Flathead Rabbits Tobacco	Evax	verna	TRUE	EVVE1
Indian Blanket	Gaillardia	pulchella	TRUE	GAPU1
Pincushion Daisy	Gaillardia	suavis	TRUE	GASA1
Cat-foot	Gnaphalium	obtusifolium	TRUE	GNOB1
Sneezeweed	Helenium	quadridentatum	TRUE	HEQU1
Sticky Granite-daisy	Heterotheca	stenophylla	TRUE	HEST1
Wooly-white	Hymenopappus	scabiosaeus	TRUE	HYSC1
Slender-leaf Hymenoxys	Hymenoxys	linearifolia	TRUE	HYLI1
wild lettuce	Lactuca	canadensis	FALSE	LACA1
wildlettuce	Lactuca	ludoviciana	TRUE	LALU1
Skeleton-plant	Lygodesmia	texana	TRUE	LYTE1
false ragweed	Parthenium	hysterophorus	TRUE	PAHY1
White Rock-Lettuce	Pinaropappus	roseus	TRUE	PIRO1
Prairie cone flower	Ratibida	columnifera	TRUE	RACU1
Bush Sunflower	Simsia	calva	TRUE	SICA1
Tall Goldenrod	Solidago	altissima	TRUE	SOAL1
Sow-Thistle	Sonchus	asper	FALSE	SOAS1
Sow-Thistle	Sonchus	oleraceus	TRUE	SOOL1
Navajo Tea	Thelesperma	simplicifolium	TRUE	THSI1
Cowpen Daisy	Verbesina	encelioides	TRUE	VEEN1
Western Ironweed	Vernonia	baldwinii	TRUE	VEBA1
Zexmania	Wedelia	hispida	TRUE	WEHI1
Agarita	Berberis	trifoliolata	TRUE	BETR1
White Heliotrope	Heliotropium	tenellum	TRUE	HETE1
pepper weed	Lepidium	austrinum	TRUE	LEAU1
Pepperwort	Lepidium	virginicum	TRUE	LEVI1
Silver Bladderpod	Lesquerella	argyraea	TRUE	LEAR1
Low Bladderpod	Lesquerella	densiflora	TRUE	LEDE1
Engelmann's Bladderpod	Lesquerella	engelmannii	TRUE	LEEN1

COMMON	GENUS	SPECIES	NATIVE	SP_CODE
Twist-flower	Streptanthus	platycarpus	TRUE	STPL1
Nipple cactus	Coryphantha	sulcata	TRUE	COSU1
Lace Cactus	Echinocereus	reichenbachii	TRUE	ECRE1
cactus sp	Echinocereus	species	TRUE	ECSP2
Claret-cup	Echinocereus	triglochidiatus	TRUE	ECTR1
Fishhook cactus	Ferocactus	species	TRUE	FESP1
prickly pear	Opuntia	edwardsii	TRUE	OPED1
Engelmans Pricklpear	Opuntia	engelmannii	TRUE	OPEN1
Pencil cactus	Opuntia	leptocaulis	TRUE	OPLE1
Lindheimer Prickly Pear	Opuntia	lindheimeri	TRUE	OPLI1
cactus seedling	Opuntia	seedling	TRUE	OPSP2
Venus' Looking Glass	Triodanis	perfoliata	TRUE	TRPE1
Clammy-Weed	Polanisia	dodecandra	TRUE	PODO1
Rusty Black-haw	Viburnum	rufidulum	TRUE	VIRU1
Sandwart	Arenaria	benthamii	TRUE	ARBE1
Day Flower	Commelina	erecta	TRUE	COER1
Texas Bindweed	Convolvulus	equitans	TRUE	COEQ1
silky evolvulus	Evolvulus	nuttallianus	TRUE	EVNU1
silky evolvulus	Evolvulus	sericeus	TRUE	EVSE1
Morning Glory	Ibervillea	lindheirmeri	TRUE	IBLI2
Morning Glory	Ipomoea	lindheimeri	TRUE	IPLI1
Bindweed	Ipomoea	trichocarpa	TRUE	IPTR1
Yellow stonecrop	Sedum	nuttallianum	TRUE	SENU1
Buffalo Gourd	Cucurbita	foetidissima	TRUE	CUFO1
balsam-gourd	Ibervillea	lindheimeri	TRUE	IBLI1
Ashe juniper	Juniperus	ashei	TRUE	JUAS1
ashe juniper	Juniperus	asheii	TRUE	JUAS2
Redberry Juniper	Juniperus	pinchotii	TRUE	JUPI1
Plateau sedge	Carex	edwardsii	TRUE	CAED1
cedar sedge	Carex	planostachys	TRUE	CAPL1
Texas persimmon	Diospyros	texana	TRUE	DITE1
Persimmon	Diospyros	texana	TRUE	DITE2
Mormon-Tea	Ephedra	antisyphylitica	TRUE	EPAN1
Three-Seeded Mercury	Acalypha	lindheimeri	TRUE	ACLI1
Cardinal feather	Acalypha	radians	TRUE	ACRA1
Wild Mercury	Argythamnia	humilis	TRUE	ARHU1
Wild Mercury	Argythamnia	species	TRUE	ARSP1
heart leaf spurge	Chamaesyce	cordifolia	FALSE	CHCO1
Bush Croton	Croton	fruticulosus	TRUE	CRFR1
Prairie-tea	Croton	monanthogynus	TRUE	CRMO1
Texas croton	Croton	texensis	TRUE	CRTE1
hill country wild mercury	Ditaxis	aphoroides	TRUE	DIAP1
Spurge	Euphorbia	cyathophora	TRUE	EUCY1
Ridgeseed Euphorbia	Euphorbia	glyptosperma	TRUE	EUGL1
Euphorbia	Euphorbia	indivisa	TRUE	EUIN1
Snow-on-the-Mountain	Euphorbia	marginata	TRUE	EUMA1
eyebane	Euphorbia	prostata	TRUE	EUPR1
Leaf-flower	Phyllanthus	polygonoides	TRUE	PHPO1
Noseburn	Tragia	ramosa	TRUE	TRRA1
Catclaw	Acacia	greggii	TRUE	ACGR1
Catclaw Acacia	Acacia	roemeriana	TRUE	ACRO1
Leadplant	Amorpha	species	TRUE	AMSP1
Nuttall's Milk-vetch	Astragalus	nuttallianus	TRUE	ASNU1
Rush Pea	Caesalpinia	jamesii	TRUE	CAJA1
Lindheimer's Senna	Cassia	lindheimeri	TRUE	CALI1
Senna	Cassia	roemeriana	TRUE	CARO1
Butterfly Pea	Clitoria	mariana	TRUE	CLMA1
Golden Dalea	Dalea	aurea	TRUE	DAAU1
Purple Dalea	Dalea	lasiathera	TRUE	DALA1
Dwarf Dalea	Dalea	nana	TRUE	DANA1
Bundleflower	Desmanthus	illinoiensis	TRUE	DEIL1
Kidney wood	Eysenhardtia	texana	TRUE	EYTE1
Milkpea	Galactia	heterophylla	TRUE	GAHE1
Texas bluebonnet	Lupinus	texensis	TRUE	LUTE1
bur clover	Medicago	minima	TRUE	MEMI1
bur clover	Medicago	polymorpha	FALSE	MEPO1
Catclaw Sensitive Briar	Mimosa	bi	TRUE	MIBI1

COMMON	GENUS	SPECIES	NATIVE	SP_CODE
Mesquite	Prosopis	glandulosa	TRUE	PRGL1
Snoutbean	Rhynchosia	senna	TRUE	RHSE1
Sensitive Briar	Schrankia	sp	TRUE	SCSP1
Mountain Laural	Sophora	secundiflora	TRUE	SOSE1
vetch	Vicia	leavenworthii	TRUE	VILE1
Deer Pea Vetch	Vicia	ludoviciana	TRUE	VILU1
Plateau Live Oak	Quercus	fusiformis	TRUE	QUFU1
Resprout live oak	Quercus	fusiformisresp	TRUE	QUFU2
Live Oak sprout	Quercus	fusiformus	TRUE	QUFU9
Lacey Oak	Quercus	laceyi	TRUE	QULA1
Blackjack Oak	Quercus	marilandica	TRUE	QUMA1
White Shin Oak	Quercus	sinuata	TRUE	QUSI1
Post Oak	Quercus	stellata	TRUE	QUST1
centaury	Centaurium	calycosum	TRUE	CECA1
Lady Bird's Centaury	Centaurium	texense	TRUE	CETE1
Blue-curls	Phacelia	congesta	TRUE	PHCO1
Ratany	Krameria	lanceolata	TRUE	KRLA1
Annual Pennyroyal	Hedeoma	acinoides	TRUE	HEAC1
Mock Pennyroyal	Hedeoma	drummondii	TRUE	HEDR1
Horehound	Marrubium	vulgare	TRUE	MAVU1
Spearmint	Mentha	spicata	FALSE	MESP1
Purple Horsemint	Monarda	citriodora	TRUE	MOCI1
Mealy sage	Salvia	farinacea	TRUE	SAFA1
Skullcap	Scutellaria	drummondii	TRUE	SCDR1
Big Bluestem	Andropogon	gerardi	TRUE	ANGE1
Rain lily	Cooperia	drummondii	TRUE	CODR1
Green Lily	Schoenocaulon	texanum	TRUE	SCTE1
Yucca	Yucca	constricta	TRUE	YUCO1
Twistedleaf yucca	Yucca	rupicola	TRUE	YURU1
Wild onion	Allium	drummondii	TRUE	ALDR1
Meadow Flax	Linum	pratense	TRUE	LIPR1
Yellow Flax	Linum	rigidum	TRUE	LIRI1
Rock flax	Linum	rupestre	TRUE	LIRU1
Stick-leaf	Mentzelia	oligosperma	TRUE	MEOL1
plateau loosestrife	Lythrum	ovalifolium	TRUE	LYOV1
Thryallis	Thryallis	angustifolia	TRUE	THAN1
indian mallow	Abutilon	fruticosum	TRUE	ABFR1
mallow	Abutilon	incanum	TRUE	ABIN1
Winecup	Callirhoe	involucrata	TRUE	CAIN1
Creeping yellow sida	Sida	filicaulis	TRUE	SIFI1
Lindheimer's sida	Sida	lindheimeri	TRUE	SILI1
Velvet-leaf Mallow	Wissadula	holosericea	TRUE	WIHO1
Devil's Claw	Proboscidea	louisianaca	TRUE	PRLO1
China-berry	Melia	azedarach	FALSE	MEAZ1
snail seed	Cocculus	carolinus	TRUE	COCA1
Texas Mulberry	Morus	microphylla	TRUE	MOMI1
Elbow-bush	Forestiera	pubescens	TRUE	FOPU1
Western Primrose	Calylophus	hartweggii	TRUE	CAHA1
Scarlet Gaura	Gaura	coccinea	TRUE	GACO1
Stemless Evening Primrose	Oenothera	triloba	TRUE	OETR1
Yellow Wood-Sorrel	Oxalis	dillenii	TRUE	OXDI1
wood-sorrel	Oxalis	drummondii	TRUE	OXDR1
White Prickly Poppy	Argemone	albiflora	TRUE	ARAL1
Slender-lobe passionflower	Passiflora	tenuiloba	TRUE	PATE1
Pigeon-berry	Rivina	humilis	TRUE	RIHU1
Plantain	Plantago	helleri	TRUE	PLHE1
Sycamore	Platanus	occidentalils	TRUE	PLOC1
Crag Lily	Anthericum	torreyi	TRUE	ANTO1
Threeawn	Aristida	pansa	TRUE	ARPA1
Purple threeawn	Aristida	purpurea	TRUE	ARPU1
Wright's threeawn	Aristida	wrightii	TRUE	ARWR1
Merrill bluestem	Bothriochloa	edwardsiana	TRUE	BOSP1
King Ranch bluestem	Bothriochloa	ischaemum	FALSE	BOIS1
Silver bluestem	Bothriochloa	saccharoides	TRUE	BOSA1
Sideoats Grama	Bouteloua	curtipendula	TRUE	BOCU1
Hairy grama	Bouteloua	hirsuta	TRUE	BOHI1
Texas grama	Bouteloua	rigidiseta	TRUE	BORI1

COMMON	GENUS	SPECIES	NATIVE	SP_CODE
One-flower grama	Bouteloua	uniflora	TRUE	BOUN1
Rescue grass	Bromus	unioloides	FALSE	BRUN1
Buffalo grass	Buchloe	dactyloides	TRUE	BUDA1
Sandbur	Cenchrus	incertus	TRUE	CEIN1
Hooded windmill grass	Chloris	cucullata	TRUE	CHCU1
Tumble Windmillgrass	Chloris	verticillata	TRUE	CHVE1
Bermuda grass	Cynodon	dactylon	FALSE	CYDA1
Arizona Cottontop	Digitaria	californica	TRUE	DICA1
Barnyard grass	Echinochloa	crusgalli	FALSE	ECCR1
Barnyard grass	Echinochloa	walteri	TRUE	ECWA1
Canada wild rye	Elymus	canadensis	TRUE	ELCA1
Stink Grass	Eragrostis	cilianensis	FALSE	ERCI1
Plains lovegrass	Eragrostis	intermedia	TRUE	ERIN1
Plumegrass	Erianthus	species	TRUE	ERSP2
Texas cupgrass	Eriochloa	sericea	TRUE	ERSE1
Hairy tridens	Erioneuron	pilosum	TRUE	ERPI1
Tanglehead	Heteropogon	contortus	TRUE	HECO1
Curly mesquite	Hilaria	berlangeri	TRUE	HIBE1
Green Sprangletop	Leptochloa	dubia	TRUE	LEDU1
Fall Witchgrass	Leptoloma	cognatum	TRUE	LECO1
LIMNODEA	Limnodea	arkansana	TRUE	LIAR1
Perennial Ryegrass	Lolium	perenne	TRUE	LOPE1
Muhly	Muhlenbergia	involuta	TRUE	MUIN1
Muhly	Muhlenbergia	reverchonii	TRUE	MURE1
aparejograss	Muhlenbergia	utilis	TRUE	MUUT1
Witchgrass	Panicum	capillare	TRUE	PACA1
Klein Grass	Panicum	coloratum	FALSE	PACO1
Hall's panicum	Panicum	hallii	TRUE	PAHA1
Vine Mesquite	Panicum	obtusum	TRUE	PAOB1
Switchgrass	Panicum	virgatum	TRUE	PAVI1
Dallis Grass	Paspalum	dilatatum	FALSE	PADI1
Vaseygrass	Paspalum	urvillei	TRUE	PAUR1
Carolina Canarygrass	Phalaris	caroliniana	TRUE	PHCA1
Tumble grass	Schedonnardus	paniculatus	TRUE	SCPA1
Little bluestem	Schizachyrium	scoparium	TRUE	SCSC1
Knotroot bristlegrass	Setaria	geniculata	TRUE	SEGE1
Plains bristlegrass	Setaria	leucopila	TRUE	SELE1
Southwestern bristlegrass	Setaria	scheelei	TRUE	SESC1
tall dropseed	Sporobolus	asper	TRUE	SPAS1
Sand Dropseed	Sporobolus	cryptandrus	TRUE	SPCR1
Purple dropseed	Sporobolus	purpurascens	TRUE	SPPU1
dropseed	Sporobolus	species	TRUE	SPSP1
Texas Winter grass	Stipa	leucotricha	TRUE	STLE1
White Tridens	Tridens	albescens	TRUE	TRAL1
Slim tridens	Tridens	muticus	TRUE	TRMU1
Texas Tridens	Tridens	texensis	TRUE	TRTE1
Eastern Gama	Tripsacum	dactyloides	TRUE	TRDA1
6 week fescue	Vulpia	octiflora	TRUE	VUOC1
Shining Melic	Melica	nitens	TRUE	MENI1
Wild Buckwheat	Eriogonum	annuum	TRUE	ERAN1
Star-scaled Cloak fern	Astrolepis	integerrima	TRUE	ASIN1
Alabama Lip Fern	Cheilanthes	alabamensis	TRUE	CHAL1
Rough Lip Fern	Cheilanthes	horridula	TRUE	CHHO1
Cliff Brake Fern	Pellaea	ovata	TRUE	PEOV1
moss rose	Portulaca	halimoides	TRUE	POHA1
Purslane	Portulaca	umbracticola	TRUE	POUM1
Flame-Flower	Talinum	auranticum	TRUE	TAAU1
brook weed	Samolus	valerandi	TRUE	SAVA1
copeland cloak fern	Notholaena	copelandii	TRUE	NOCO1
purple cliff brake	Pellaea	atropurpurea	TRUE	PEAT1
Purple Leatherflower	Clematis	pitcheri	TRUE	CLPI1
Old Man's Beard	Clematis	drummondii	TRUE	CLDR1
Javelina Bush	Condalia	ericoides	TRUE	COER2
condelia	Condalia	hookeri	TRUE	COHO1
Blue-wood	Condalia	obovata	TRUE	COOB1
Lotebush	Ziziphus	obtusifolia	TRUE	ZIOB1
Texas Almond	Prunus	minutiflora	TRUE	PRMI1

COMMON	GENUS	SPECIES	NATIVE	SP_CODE
Buttonbush	Cephalanthus	occidentalis	TRUE	CEOC1
Bedstraw	Galium	virgatum	TRUE	GAVI1
Cut-leaf Gilia	Gilia	incisa	TRUE	GIIN1
Baby's Breath	Hedyotis	nigricans	TRUE	HENI1
Wafer-Ash	Ptelea	trifoliata	TRUE	PTTR1
Dutchman's Breeches	Thamnosma	texana	TRUE	THTE1
Texas Prickly-ash	Zanthoxylum	clava-herculis	TRUE	ZACL1
Western Soapberry	Sapindus	drumondii	TRUE	SADR1
Coma	Bumelia	lanuginosa	TRUE	BULA1
bluehearts	Buchnera	floridana	FALSE	BUFL1
Narrow leaf conobea	Leucospora	multifida	TRUE	LEMU1
Snapdragon Vine	Maurandya	antirrhiniflora	TRUE	MAAN1
Monkey-Flower	Mimulus	glabratus	TRUE	MIGL1
Mullein	Verbascum	thapsus	TRUE	VETH1
Meadow spike moss	Selaginella	apoda	TRUE	SEAP1
false nightshade	Chamaesaracha	coniodes	TRUE	CHCO2
jimson weed	Datura	inoxia	TRUE	DAIN1
WOLFBERRY	Lycium	berlandieri	TRUE	LYBE1
Purple ground cherry	Physalis	lobata	TRUE	PHLO1
Yellow ground cherry	Physalis	viscosa	TRUE	PHVI1
Silver Leaf nightshade	Solanum	elaeagnifolium	TRUE	SOEL1
Texas Nightshade	Solanum	triquetrum	TRUE	SOTR1
Hackberry	Celtis	reticullata	TRUE	CERE1
American Elm	Ulmus	americana	TRUE	ULMA1
Cedar elm	Ulmus	crassifolia	TRUE	ULCR1
Scarlet Spiderling	Boerhavia	coccinea	TRUE	BOCA1
Spiderling	Boerhavia	linearifolia	TRUE	BOLI1
Pellitory	Parietaria	obtusa	TRUE	PAOB2
pellitory	Parietaria	pensylvanica	TRUE	PAPE1
White Brush	Aloysia	gratissima	TRUE	ALGR1
Prairie verbena	Verbena	bipinnatifida	TRUE	VEBI1
Gray Vervain	Verbena	canescens	TRUE	VECA1
Texas vervain	Verbena	halei	TRUE	VEHA1
Low Verbena	Verbena	pumila	TRUE	VEPU1
Frog-fruit	Phyla	incisa	TRUE	PHIN1
Caltrop	Kallstroemia	californica	TRUE	KACA1

Appendix III: Raw Data from Plant Transects

Special Thanks to Keith Blair, Kimberley Haile, and Tyler Hawkins for the data collection

Appendix IIIa. Fire Managers Handbook program code key. The data collected is put in the FMH format, not excel. This table shows the key for deciphering FMH lingo.

Burn Status	BURN_CTRL	Burn Unit	Change date	Check date	Index code	PLOT KEY	PLOT #	PLOT_ID	SITE VISIT
00 PRE	B	10	20030423 09:12:28	20070715 07:48:19	FQUFU1D01	FQUFU1D01 100 PRE B	1	AAAA	5/20/2002
00 PRE	B	10	20030423 09:12:33	20070715 07:48:19	FQUFU1D01	FQUFU1D01 200 PRE B	2	AAAB	5/21/2002
00 PRE	B	12	20030423 09:12:39	20070715 07:48:20	FQUFU1D01	FQUFU1D01 300 PRE B	3	AAAC	5/22/2002
00 PRE	C	11	20040907 09:06:29	20070715 07:48:20	FQUFU1D01	FQUFU1D01 400 PRE C	4	AAAD	5/27/2002
00 PRE	C	11	20040810 12:17:39	20070715 07:48:20	FQUFU1D01	FQUFU1D01 500 PRE C	5	AAAE	5/27/2002
01 yr02	B	10	20040613 19:11:44	20070715 07:48:20	FQUFU1D01	FQUFU1D01 101 yr02B	1	AAAG	6/9/2004
01 yr02	B	10	20040629 14:09:37	20070715 07:48:20	FQUFU1D01	FQUFU1D01 201 yr02B	2	AAAH	6/10/2004
01 yr02	B	12	20040810 12:17:27	20070715 07:48:20	FQUFU1D01	FQUFU1D01 301 yr02B	3	AAAI	6/11/2004
00 PRE	B	3	20040827 11:34:05	20070715 07:48:20	FQUFU1D01	FQUFU1D01 700 PRE B	7	AAAJ	7/2/2004
00 PRE	C	11	20040810 12:17:41	20070715 07:48:20	FQUFU1D01	FQUFU1D01 600 PRE C	6	AAAF	5/28/2002
00 PR01	C	11	20040906 07:00:47	20070715 07:48:19	FQUFU1D01	FQUFU1D01 500 PR01C	5	AAAL	6/10/2004
00 PR01	C	11	20050604 18:00:42	20070715 07:48:19	FQUFU1D01	FQUFU1D01 400 PR01C	4	AAAK	6/11/2004
00 PR01	C	11	20040907 09:07:32	20070715 07:48:19	FQUFU1D01	FQUFU1D01 600 PR01C	6	AAAM	6/16/2004
00 PRE	B	3	20040917 06:00:11	20070715 07:48:20	FQUFU1D01	FQUFU1D01 800 PRE B	8	AAAN	7/7/2004
00 PRE	B	3	20040919 12:47:08	20070715 07:48:20	FQUFU1D01	FQUFU1D01 900 PRE B	9	AAAO	7/7/2004
00	C	4	20040920	20070715	FQUF	FQUFU1D01	10	AAA	7/8/2

PRE			19:52:58	07:48:20	U1D01	1000 PRE C		P	004
Burn Status	BURN_CTRL	Burn Unit	Change date	Check date	Index code	PLOT KEY	PLOT #	PLOT_ID	SITE VISIT
00 PRE	C	6	20040920 16:09:13	20070715 07:48:20	FQUFU1D01	FQUFU1D011200 PRE C	12	AAAR	7/8/2004
01 yr02	B	3	20050603 09:05:43	20070715 07:48:21	FQUFU1D01	FQUFU1D01701 yr02B	7	AAAS	5/31/2005
01 yr02	B	3	20050605 16:37:18	20070715 07:48:21	FQUFU1D01	FQUFU1D01801 yr02B	8	AAAT	6/1/2005
01 yr02	B	3	20050606 12:00:46	20070715 07:48:21	FQUFU1D01	FQUFU1D01901 yr02B	9	AAAU	6/2/2005
00 yr02	C	6	20060411 10:40:21	20070715 07:48:20	FQUFU1D01	FQUFU1D011100 yr02C	11	AAAW	6/6/2005
00 yr02	C	4	20060411 10:40:10	20070715 07:48:20	FQUFU1D01	FQUFU1D011000 yr02C	10	AAAV	6/2/2005
02 yr03	B	3	20060825 08:29:19	20070715 07:48:21	FQUFU1D01	FQUFU1D01702 yr03B	7	AAAY	7/8/2006
02 yr03	B	3	20070615 11:42:33	20070715 07:48:21	FQUFU1D01	FQUFU1D01802 yr03B	8	AAAZ	7/7/2006
00 yr02	C	6	20060411 10:40:33	20070715 07:48:20	FQUFU1D01	FQUFU1D011200 yr02C	12	AAAX	6/7/2005
02 yr03	B	3	20070628 10:14:11	20070715 07:48:21	FQUFU1D01	FQUFU1D01902 yr03B	9	AABA	7/7/2006
00 yr03	C	4	20070715 07:49:22	20070715 07:48:43	FQUFU1D01	FQUFU1D011000 yr03C	10	AABB	7/7/2006
00 yr03	C	6	20070715 07:50:03		FQUFU1D01	FQUFU1D011200 yr03C	12	AABC	7/7/2006
00 yr03	C	6	20070715 07:49:43		FQUFU1D01	FQUFU1D011100 yr03C	11	AABD	7/9/2007
00 yr04	C	6	20070715 07:50:33		FQUFU1D01	FQUFU1D011200 yr04C	12	AABF	6/25/2007
00 yr04	C	6	20070715 07:50:24		FQUFU1D01	FQUFU1D011100 yr04C	11	AABG	6/25/2007
00 yr04	C	4	20070802 07:28:20		FQUFU1D01	FQUFU1D011000 yr04C	10	AABE	6/25/2007

Appendix IIIb: Herb Data from Calcite Transects. The herb data is important because it directly correlates with the quantity of white-tailed deer forage available.

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
4	TRUE	1	AAAU	VECA1
1	TRUE	8	AABH	BOSA1
1	TRUE	2	AAAA	HIBE1
1	TRUE	1	AAAA	LESP1
2	TRUE	7	AAAA	STLE1
3	TRUE	2	AAAA	STLE1
4	TRUE	12	AAAA	STLE1
4	FALSE	55	AAAA	BRUN1
5	TRUE	2	AAAA	STLE1
5	FALSE	12	AAAA	BRUN1
6	TRUE	8	AAAA	HIBE1
6	TRUE	2	AAAA	ARWR1
6	TRUE	3	AAAA	STLE1
6	TRUE	2	AAAA	SIFI1
6	FALSE	13	AAAA	PLHE1
6	TRUE	1	AAAA	ERPI1
6	TRUE	3	AAAA	LIPR1
6	TRUE	1	AAAA	MASP1
7	TRUE	1	AAAA	VEHA1
7	TRUE	1	AAAA	BOCU1
7	TRUE	10	AAAA	PLHE1
7	FALSE	15	AAAA	BRUN1
7	FALSE	6	AAAA	LESP1
7	FALSE	7	AAAA	EVPR1
8	TRUE	6	AAAA	STLE1
8	TRUE	4	AAAA	BRUN1
8	FALSE	1	AAAA	PLHE1
8	FALSE	1	AAAA	VUOC1
9	TRUE	3	AAAA	STLE1
9	FALSE	14	AAAA	BRUN1
10	TRUE	3	AAAA	SIFI1
10	FALSE	45	AAAA	PLHE1
10	TRUE	4	AAAA	HIBE1
10	TRUE	2	AAAA	ERPI1
10	TRUE	11	AAAA	SEAP1
11	TRUE	4	AAAA	HIBE1
11	TRUE	1	AAAA	RACU1
11	TRUE	4	AAAA	SIFI1
11	FALSE	25	AAAA	PLHE1
11	FALSE	15	AAAA	MEMI1
11	TRUE	5	AAAA	PAHA1
11	FALSE	3	AAAA	LESP1
11	FALSE	9	AAAA	BRUN1
12	TRUE	4	AAAA	HIBE1
12	TRUE	2	AAAA	SIFI1
12	FALSE	45	AAAA	PLHE1
12	FALSE	19	AAAA	LESP1
13	TRUE	6	AAAA	VEHA1
13	TRUE	8	AAAA	STLE1
13	TRUE	1	AAAA	SIFI1
13	FALSE	55	AAAA	PLHE1
13	FALSE	6	AAAA	MEMI1
13	TRUE	3	AAAA	HIBE1
14	TRUE	18	AAAA	STLE1
14	FALSE	8	AAAA	EVPR1
14	FALSE	5	AAAA	BRUN1
14	FALSE	1	AAAA	PLHE1
14	TRUE	2	AAAA	SIFI1
15	FALSE	45	AAAA	PLHE1
15	TRUE	4	AAAA	ERPI1
15	TRUE	2	AAAA	HIBE1
15	FALSE	2	AAAA	LESP1
15	FALSE	10	AAAA	SEAP1
16	TRUE	10	AAAA	STLE1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
17	FALSE	15	AAAA	EVPR1
17	TRUE	7	AAAA	PAHA1
17	FALSE	3	AAAA	PLHE1
17	FALSE	50	AAAA	SEAP1
17	TRUE	2	AAAA	CRMO1
18	TRUE	10	AAAA	HIBE1
18	FALSE	60	AAAA	PLHE1
18	FALSE	2	AAAA	LESP1
18	TRUE	1	AAAA	EUIN1
18	FALSE	11	AAAA	EVPR1
19	TRUE	4	AAAA	STLE1
20	TRUE	9	AAAA	STLE1
20	FALSE	11	AAAA	BRUN1
1	TRUE	2	AAAB	STLE1
20	TRUE	1	AAAA	PAHA1
1	TRUE	4	AAAB	PLHE1
1	TRUE	1	AAAB	EVPR1
1	TRUE	65	AAAB	LIAR1
1	TRUE	1	AAAB	HIBE1
1	TRUE	2	AAAB	EUIN1
1	FALSE	8	AAAB	SCDR1
2	TRUE	70	AAAB	LIAR1
2	FALSE	25	AAAB	VUOC1
2	TRUE	1	AAAB	SPCR1
2	TRUE	2	AAAB	CEIN1
2	TRUE	1	AAAB	EUIN1
2	FALSE	16	AAAB	EVPR1
2	FALSE	5	AAAB	PLHE1
3	TRUE	21	AAAB	LIAR1
3	TRUE	1	AAAB	ERPI1
3	TRUE	1	AAAB	ARWR1
3	FALSE	35	AAAB	EVPR1
3	TRUE	1	AAAB	CRMO1
3	TRUE	1	AAAB	EUIN1
3	TRUE	2	AAAB	BOCU1
4	TRUE	6	AAAB	CAPL1
4	FALSE	3	AAAB	CAPL1
4	TRUE	1	AAAB	STLE1
5	TRUE	12	AAAB	CAPL1
5	FALSE	2	AAAB	BRUN1
5	TRUE	1	AAAB	STLE1
5	TRUE	3	AAAB	LIAR1
6	TRUE	11	AAAB	STLE1
6	TRUE	2	AAAB	HIBE1
6	FALSE	6	AAAB	VUOC1
7	TRUE	3	AAAB	BOCU1
7	TRUE	4	AAAB	ERPI1
7	FALSE	22	AAAB	PLHE1
7	FALSE	2	AAAB	VUOC1
7	TRUE	2	AAAB	THSI1
7	TRUE	8	AAAB	LIAR1
7	FALSE	29	AAAB	EVPR1
7	TRUE	1	AAAB	STLE1
8	TRUE	36	AAAB	THSI1
8	TRUE	9	AAAB	HIBE1
8	FALSE	5	AAAB	VUOC1
8	TRUE	1	AAAB	SIFI1
8	FALSE	2	AAAB	EVPR1
8	FALSE	2	AAAB	BRUN1
9	TRUE	2	AAAB	SELE1
9	FALSE	3	AAAB	BRUN1
10	TRUE	3	AAAB	ARWR1
10	TRUE	5	AAAB	THSI1
10	FALSE	8	AAAB	PLHE1
10	TRUE	2	AAAB	ERPI1
10	TRUE	12	AAAB	LIAR1
11	TRUE	8	AAAB	THSI1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
11	TRUE	2	AAAB	BOHI1
11	FALSE	23	AAAB	PLHE1
11	TRUE	1	AAAB	ERPI1
11	TRUE	5	AAAB	CAPL1
11	FALSE	2	AAAB	EVPR1
11	FALSE	1	AAAB	LEVI1
12	TRUE	7	AAAB	ARWR1
12	TRUE	2	AAAB	STLE1
12	TRUE	3	AAAB	THSI1
13	TRUE	2	AAAB	ARWR1
13	TRUE	2	AAAB	STLE1
13	TRUE	3	AAAB	THSI1
13	FALSE	1	AAAB	LEVI1
13	TRUE	1	AAAB	BOCU1
13	FALSE	4	AAAB	BRUN1
14	TRUE	12	AAAB	STLE1
14	TRUE	1	AAAB	HIBE1
14	FALSE	3	AAAB	BRUN1
14	FALSE	4	AAAB	VUOC1
14	TRUE	1	AAAB	LIAR1
15	FALSE	4	AAAB	EVPR1
15	TRUE	1	AAAB	PAHA1
15	TRUE	3	AAAB	ARWR1
15	TRUE	1	AAAB	HIBE1
15	TRUE	1	AAAB	VEHA1
15	TRUE	3	AAAB	EUIN1
15	FALSE	3	AAAB	PLHE1
16	TRUE	2	AAAB	PAHA1
16	TRUE	2	AAAB	LIAR1
16	TRUE	5	AAAB	ARWR1
16	TRUE	1	AAAB	THSI1
16	TRUE	2	AAAB	EUIN1
16	FALSE	17	AAAB	EVPR1
16	FALSE	5	AAAB	PLHE1
16	TRUE	1	AAAB	CEIN1
16	TRUE	1	AAAB	CHVI1
17	TRUE	3	AAAB	STLE1
17	TRUE	1	AAAB	UNGR2
18	TRUE	1	AAAB	BOCU1
18	TRUE	4	AAAB	STLE1
18	TRUE	2	AAAB	UNGR2
19	TRUE	4	AAAB	HIBE1
19	FALSE	10	AAAB	PLHE1
19	TRUE	2	AAAB	STLE1
19	TRUE	3	AAAB	BOCU1
1	TRUE	1	AAAC	PAHA1
19	TRUE	1	AAAB	SIFI1
1	TRUE	2	AAAC	BOCU1
1	TRUE	6	AAAC	HIBE1
1	TRUE	1	AAAC	STLE1
1	FALSE	1	AAAC	LEVI1
1	FALSE	2	AAAC	EVPR1
2	TRUE	4	AAAC	ARPU1
2	TRUE	2	AAAC	ERPI1
2	TRUE	2	AAAC	PAHA1
2	TRUE	2	AAAC	SCDR1
2	FALSE	8	AAAC	EVPR1
3	FALSE	10	AAAC	BRUN1
3	FALSE	13	AAAC	EVPR1
3	TRUE	2	AAAC	SCDR1
3	TRUE	1	AAAC	SIFI1
3	FALSE	10	AAAC	MEMI1
3	FALSE	15	AAAC	LIAR1
3	TRUE	1	AAAC	ERIN1
3	FALSE	2	AAAC	CRTE1
4	TRUE	2	AAAC	BOCU1
4	FALSE	6	AAAC	BRUN1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
4	FALSE	3	AAAC	VUOC1
4	FALSE	4	AAAC	EVPR1
4	FALSE	6	AAAC	PLHE1
4	TRUE	6	AAAC	SCDR1
4	TRUE	1	AAAC	ERPI1
5	TRUE	5	AAAC	ARPU1
5	TRUE	2	AAAC	SIFI1
5	TRUE	2	AAAC	CAPL1
5	TRUE	1	AAAC	BOCU1
5	TRUE	2	AAAC	ERPI1
5	TRUE	4	AAAC	STLE1
5	FALSE	3	AAAC	LIAR1
5	FALSE	9	AAAC	PLHE1
5	TRUE	1	AAAC	SCDR1
5	TRUE	1	AAAC	MEMI1
6	TRUE	4	AAAC	ERPI1
6	FALSE	3	AAAC	BRUN1
6	FALSE	25	AAAC	PLHE1
6	FALSE	10	AAAC	EVPR1
6	TRUE	1	AAAC	BOCU1
6	TRUE	3	AAAC	VECA1
6	TRUE	3	AAAC	MEMI1
6	FALSE	6	AAAC	LEVI1
6	FALSE	7	AAAC	LIAR1
6	FALSE	6	AAAC	DAPU1
6	TRUE	1	AAAC	SIFI1
7	TRUE	3	AAAC	ERIN1
7	FALSE	5	AAAC	VUOC1
7	TRUE	3	AAAC	STLE1
7	TRUE	1	AAAC	ASSP2
8	TRUE	2	AAAC	BOCU1
8	FALSE	6	AAAC	BRUN1
8	FALSE	5	AAAC	VUOC1
8	FALSE	3	AAAC	MEMI1
8	FALSE	3	AAAC	EVPR1
8	FALSE	5	AAAC	PLHE1
8	TRUE	1	AAAC	STLE1
8	TRUE	2	AAAC	LIAR1
9	TRUE	1	AAAC	BOCU1
9	TRUE	4	AAAC	ERPI1
9	TRUE	1	AAAC	HIBE1
9	FALSE	105	AAAC	PLHE1
10	TRUE	12	AAAC	LIAR1
10	TRUE	7	AAAC	STLE1
10	FALSE	1	AAAC	EVPR1
10	TRUE	1	AAAC	UNKF1
11	FALSE	65	AAAC	MEMI1
11	TRUE	1	AAAC	VECA1
11	TRUE	1	AAAC	SAFA1
11	TRUE	1	AAAC	ERIN1
11	FALSE	9	AAAC	LIAR1
11	TRUE	2	AAAC	ERPI1
11	FALSE	10	AAAC	BRUN1
11	TRUE	1	AAAC	SEAP1
12	TRUE	1	AAAC	HIBE1
12	FALSE	30	AAAC	PLHE1
12	FALSE	15	AAAC	MEMI1
12	FALSE	3	AAAC	BRUN1
12	FALSE	7	AAAC	LIAR1
12	TRUE	1	AAAC	ERPI1
12	FALSE	10	AAAC	EVPR1
13	TRUE	4	AAAC	STLE1
13	FALSE	14	AAAC	BRUN1
13	TRUE	2	AAAC	IBLI1
13	TRUE	2	AAAC	PAOB2
14	TRUE	4	AAAC	HIBE1
14	TRUE	1	AAAC	ERIN1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
14	FALSE	4	AAAC	EVPR1
14	TRUE	1	AAAC	SCDR1
14	FALSE	3	AAAC	LIAR1
14	TRUE	1	AAAC	CRMO1
15	TRUE	5	AAAC	ERPI1
15	FALSE	9	AAAC	LIAR1
15	FALSE	1	AAAC	VUOC1
15	FALSE	95	AAAC	PLHE1
15	FALSE	23	AAAC	EVPR1
15	TRUE	2	AAAC	VECA1
15	TRUE	1	AAAC	PHPO1
15	FALSE	2	AAAC	LEVI1
16	TRUE	10	AAAC	STLE1
16	TRUE	1	AAAC	ERPI1
17	TRUE	5	AAAC	HIBE1
17	FALSE	3	AAAC	LIAR1
1	FALSE	15	AAAD	EVPR1
18	TRUE	3	AAAC	STLE1
1	FALSE	7	AAAD	PLHE1
1	TRUE	2	AAAD	BOTR1
1	FALSE	9	AAAD	VUOC1
1	FALSE	14	AAAD	LIAR1
1	TRUE	1	AAAD	CRMO1
2	TRUE	14	AAAD	CAPL1
2	TRUE	7	AAAD	STLE1
2	FALSE	3	AAAD	LIAR1
3	FALSE	3	AAAD	LIAR1
3	TRUE	3	AAAD	STLE1
3	FALSE	30	AAAD	EVPR1
3	FALSE	14	AAAD	PLHE1
3	FALSE	1	AAAD	LIRU1
3	FALSE	2	AAAD	SCDR1
3	TRUE	3	AAAD	HIBE1
4	FALSE	36	AAAD	EVPR1
4	FALSE	35	AAAD	PLHE1
4	TRUE	1	AAAD	STLE1
4	FALSE	3	AAAD	LIAR1
4	FALSE	12	AAAD	VUOC1
4	FALSE	1	AAAD	LIRU1
4	TRUE	1	AAAD	BORI1
6	FALSE	2	AAAD	SCDR1
7	TRUE	1	AAAD	HIBE1
7	TRUE	1	AAAD	SIFI1
7	FALSE	17	AAAD	VUOC1
7	FALSE	22	AAAD	PLHE1
7	TRUE	1	AAAD	PHPO1
7	FALSE	6	AAAD	EVPR1
7	TRUE	1	AAAD	ARPU1
7	FALSE	2	AAAD	LIAR1
7	FALSE	1	AAAD	SCDR1
8	TRUE	1	AAAD	ARPU1
8	TRUE	7	AAAD	STLE1
8	FALSE	4	AAAD	MEMI1
8	TRUE	1	AAAD	PHPO1
8	FALSE	4	AAAD	EVPR1
8	FALSE	8	AAAD	PLHE1
8	TRUE	1	AAAD	SIFI1
8	FALSE	25	AAAD	VUOC1
9	TRUE	2	AAAD	HIBE1
9	TRUE	2	AAAD	ERPI1
9	FALSE	65	AAAD	PLHE1
9	FALSE	3	AAAD	MEMI1
9	FALSE	1	AAAD	SIFI1
9	TRUE	5	AAAD	PHPO1
9	FALSE	5	AAAD	LIAR1
9	FALSE	2	AAAD	LIRU1
10	TRUE	1	AAAD	BOCU1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
10	FALSE	4	AAAD	MEMI1
10	TRUE	1	AAAD	VEHA1
10	TRUE	2	AAAD	CRMO1
10	FALSE	4	AAAD	EVPR1
11	TRUE	1	AAAD	ARPU1
11	TRUE	4	AAAD	HIBE1
11	TRUE	1	AAAD	ERPI1
11	TRUE	1	AAAD	VUOC1
11	FALSE	15	AAAD	MEMI1
11	FALSE	25	AAAD	PLHE1
11	TRUE	1	AAAD	PHPO1
11	FALSE	17	AAAD	EVPR1
12	TRUE	5	AAAD	STLE1
13	TRUE	5	AAAD	HIBE1
13	FALSE	13	AAAD	MEMI1
13	FALSE	31	AAAD	PLHE1
13	TRUE	1	AAAD	VEHA1
13	FALSE	1	AAAD	BRUN1
13	FALSE	15	AAAD	LIAR1
13	FALSE	1	AAAD	THSI1
13	TRUE	1	AAAD	STLE1
13	FALSE	3	AAAD	VUOC1
13	TRUE	1	AAAD	SIFI1
14	TRUE	3	AAAD	PHPO1
14	TRUE	1	AAAD	VEHA1
14	FALSE	6	AAAD	PLHE1
14	FALSE	7	AAAD	EVPR1
14	FALSE	2	AAAD	CRMO1
14	FALSE	2	AAAD	SCDR1
14	FALSE	3	AAAD	VUOC1
14	TRUE	2	AAAD	CAPL1
14	TRUE	2	AAAD	ARPU1
15	TRUE	4	AAAD	STLE1
15	FALSE	12	AAAD	MEMI1
15	TRUE	2	AAAD	ERIN1
15	TRUE	1	AAAD	SPCR1
15	FALSE	1	AAAD	BRUN1
16	FALSE	23	AAAD	BRUN1
16	FALSE	8	AAAD	MEMI1
16	FALSE	3	AAAD	VUOC1
17	FALSE	29	AAAD	EVPR1
17	TRUE	1	AAAD	ERPI1
17	FALSE	5	AAAD	MEMI1
17	TRUE	1	AAAD	ARPU1
17	TRUE	3	AAAD	BOTR1
17	FALSE	3	AAAD	PLHE1
18	TRUE	4	AAAD	STLE1
18	FALSE	10	AAAD	LIAR1
18	FALSE	2	AAAD	BRUN1
18	FALSE	2	AAAD	PLHE1
18	FALSE	4	AAAD	VUOC1
19	FALSE	69	AAAD	PLHE1
19	FALSE	4	AAAD	LIAR1
19	FALSE	3	AAAD	VUOC1
19	FALSE	2	AAAD	THSI1
19	TRUE	1	AAAD	BOTR1
20	TRUE	1	AAAD	ERPI1
20	TRUE	2	AAAD	BOTR1
20	FALSE	7	AAAD	LIAR1
20	FALSE	2	AAAD	SCDR1
20	FALSE	23	AAAD	EVPR1
1	TRUE	2	AAAE	HIBE1
20	FALSE	13	AAAD	PLHE1
1	TRUE	6	AAAE	ARPU1
1	FALSE	6	AAAE	LEDE1
1	TRUE	4	AAAE	SIFI1
1	TRUE	2	AAAE	CAPL1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
2	FALSE	7	AAAE	PLHE1
2	TRUE	4	AAAE	STLE1
2	TRUE	2	AAAE	HIBE1
2	FALSE	6	AAAE	EVPR1
2	FALSE	2	AAAE	CRMO1
2	TRUE	1	AAAE	SIFI1
3	TRUE	3	AAAE	BOCU1
3	TRUE	2	AAAE	HIBE1
3	FALSE	2	AAAE	CRMO1
4	FALSE	11	AAAE	LIAR1
4	TRUE	3	AAAE	HIBE1
4	TRUE	3	AAAE	TOAR1
4	FALSE	2	AAAE	CRMO1
4	FALSE	8	AAAE	EVPR1
4	FALSE	2	AAAE	PLHE1
4	FALSE	4	AAAE	VUOC1
4	TRUE	5	AAAE	CRMO1
5	TRUE	6	AAAE	STLE1
5	TRUE	5	AAAE	HIBE1
5	FALSE	1	AAAE	PLHE1
5	FALSE	1	AAAE	TOAR1
6	TRUE	9	AAAE	STLE1
6	TRUE	1	AAAE	SPCR1
7	TRUE	2	AAAE	STLE1
7	TRUE	3	AAAE	ARPU1
8	TRUE	14	AAAE	STLE1
8	TRUE	2	AAAE	CEIN1
8	TRUE	4	AAAE	HIBE1
8	TRUE	1	AAAE	SIFI1
8	FALSE	17	AAAE	PLHE1
8	FALSE	4	AAAE	LIRU1
8	FALSE	1	AAAE	VEHA1
8	FALSE	2	AAAE	BRUN1
9	TRUE	6	AAAE	STLE1
9	FALSE	4	AAAE	PLHE1
10	TRUE	1	AAAE	RACU1
10	TRUE	2	AAAE	VEHA1
10	FALSE	1	AAAE	LEDE1
10	TRUE	3	AAAE	CEIN1
10	FALSE	2	AAAE	BRUN1
10	TRUE	4	AAAE	STLE1
10	TRUE	2	AAAE	HIBE1
10	FALSE	15	AAAE	PLHE1
11	TRUE	2	AAAE	RACU1
11	FALSE	75	AAAE	PLHE1
11	TRUE	3	AAAE	HIBE1
11	TRUE	1	AAAE	ERPI1
11	FALSE	1	AAAE	LIAR1
11	TRUE	4	AAAE	PHPO1
11	FALSE	4	AAAE	LEDE1
11	FALSE	2	AAAE	LEVI1
11	TRUE	2	AAAE	SIFI1
12	TRUE	6	AAAE	VEHA1
11	TRUE	1	AAAE	MOCI1
12	TRUE	1	AAAE	SIFI1
12	FALSE	87	AAAE	PLHE1
12	TRUE	1	AAAE	CEIN1
12	FALSE	5	AAAE	LEDE1
12	FALSE	2	AAAE	LEVI1
12	FALSE	2	AAAE	TOAR1
12	TRUE	4	AAAE	PHPO1
13	FALSE	3	AAAE	PLHE1
13	FALSE	10	AAAE	LIAR1
13	TRUE	2	AAAE	STLE1
13	TRUE	1	AAAE	ERPI1
13	FALSE	2	AAAE	LEDE1
13	FALSE	1	AAAE	LEVI1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
14	TRUE	4	AAAE	VEHA1
14	TRUE	2	AAAE	SIFI1
14	TRUE	4	AAAE	CEIN1
14	FALSE	40	AAAE	PLHE1
14	FALSE	25	AAAE	EVPR1
14	TRUE	1	AAAE	HIBE1
14	TRUE	2	AAAE	STLE1
14	TRUE	1	AAAE	CAPL1
14	TRUE	1	AAAE	TRRA1
14	FALSE	1	AAAE	LEVI1
15	TRUE	10	AAAE	STLE1
15	TRUE	4	AAAE	VEHA1
15	FALSE	8	AAAE	MEMI1
15	FALSE	6	AAAE	EVPR1
15	TRUE	1	AAAE	SIFI1
15	FALSE	1	AAAE	BRUN1
16	TRUE	3	AAAE	STLE1
16	TRUE	1	AAAE	MEMI1
16	TRUE	1	AAAE	PACA1
16	FALSE	1	AAAE	SPCR1
17	FALSE	3	AAAE	LEDE1
17	TRUE	2	AAAE	VEHA1
17	TRUE	3	AAAE	SIFI1
17	FALSE	39	AAAE	PLHE1
17	FALSE	5	AAAE	MEMI1
17	FALSE	7	AAAE	BRUN1
17	TRUE	2	AAAE	CEIN1
17	TRUE	4	AAAE	STLE1
17	FALSE	6	AAAE	VUOC1
17	TRUE	1	AAAE	MOCI1
18	TRUE	2	AAAE	STLE1
18	TRUE	1	AAAE	SIFI1
19	TRUE	13	AAAE	STLE1
19	FALSE	7	AAAE	MEMI1
19	FALSE	1	AAAE	PAOB2
19	FALSE	3	AAAE	BRUN1
20	FALSE	17	AAAE	BRUN1
20	FALSE	30	AAAE	PLHE1
20	FALSE	2	AAAE	EVPR1
20	TRUE	5	AAAE	STLE1
1	TRUE	4	AAAF	ELCA1
20	FALSE	2	AAAE	PAOB2
1	TRUE	4	AAAF	STLE1
1	FALSE	16	AAAF	BRUN1
2	TRUE	2	AAAF	STLE1
2	TRUE	2	AAAF	ELCA1
2	FALSE	7	AAAF	BRUN1
2	TRUE	1	AAAF	SELE1
3	TRUE	1	AAAF	OXDR1
3	TRUE	2	AAAF	LIAR1
4	TRUE	4	AAAF	STLE1
4	TRUE	4	AAAF	HIBE1
4	FALSE	35	AAAF	PLHE1
4	FALSE	1	AAAF	EVPR1
4	FALSE	12	AAAF	BRUN1
4	FALSE	6	AAAF	LIAR1
4	FALSE	1	AAAF	LEDE1
4	FALSE	3	AAAF	VUOC1
4	TRUE	1	AAAF	SIFI1
5	TRUE	7	AAAF	STLE1
5	TRUE	2	AAAF	BRUN1
5	TRUE	1	AAAF	TRRA1
6	TRUE	9	AAAF	STLE1
6	TRUE	2	AAAF	RACU1
7	TRUE	8	AAAF	STLE1
7	FALSE	6	AAAF	BRUN1
8	TRUE	2	AAAF	ARPU1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
8	TRUE	6	AAAF	CEIN1
8	TRUE	3	AAAF	SEAP1
8	FALSE	25	AAAF	PLHE1
8	FALSE	2	AAAF	VUOC1
8	TRUE	2	AAAF	THSI1
8	TRUE	2	AAAF	SIFI1
9	TRUE	13	AAAF	HIBE1
9	TRUE	1	AAAF	ARPU1
9	TRUE	4	AAAF	STLE1
9	TRUE	3	AAAF	SIFI1
9	FALSE	14	AAAF	PLHE1
9	FALSE	4	AAAF	EVPR1
9	FALSE	1	AAAF	THSI1
10	TRUE	7	AAAF	CAPL1
10	TRUE	6	AAAF	STLE1
10	FALSE	2	AAAF	BRUN1
11	TRUE	17	AAAF	HIBE1
11	TRUE	1	AAAF	BORI1
11	FALSE	17	AAAF	PLHE1
11	TRUE	1	AAAF	STLE1
11	TRUE	2	AAAF	SIFI1
11	FALSE	6	AAAF	EVPR1
12	TRUE	7	AAAF	ARPU1
12	TRUE	1	AAAF	BOHI1
12	TRUE	4	AAAF	HIBE1
12	FALSE	12	AAAF	PLHE1
12	FALSE	2	AAAF	EVPR1
13	TRUE	2	AAAF	BORI1
13	TRUE	3	AAAF	BOHI1
13	TRUE	4	AAAF	ARPU1
13	FALSE	13	AAAF	EVPR1
13	TRUE	2	AAAF	SIFI1
13	TRUE	1	AAAF	LIRU1
14	TRUE	6	AAAF	ARPU1
14	TRUE	1	AAAF	BORI1
14	TRUE	3	AAAF	STLE1
14	FALSE	31	AAAF	PLHE1
14	TRUE	2	AAAF	LIRU1
14	TRUE	1	AAAF	SEAP1
14	TRUE	1	AAAF	SIFI1
14	FALSE	6	AAAF	EVPR1
15	TRUE	5	AAAF	CAPL1
15	TRUE	2	AAAF	STLE1
16	TRUE	3	AAAF	CAPL1
16	TRUE	3	AAAF	STLE1
17	TRUE	2	AAAF	STLE1
17	TRUE	3	AAAF	BOCU1
17	TRUE	1	AAAF	VEHA1
17	TRUE	1	AAAF	CAPL1
18	TRUE	2	AAAF	ERPI1
18	TRUE	2	AAAF	ARPU1
18	TRUE	2	AAAF	CAPL1
18	TRUE	1	AAAF	BOCU1
19	TRUE	3	AAAF	CAPL1
19	TRUE	2	AAAF	BOCU1
19	FALSE	1	AAAF	SCDR1
19	FALSE	1	AAAF	PLHE1
1	TRUE	2	AAAG	STLE1
20	TRUE	5	AAAF	CAPL1
1	TRUE	6	AAAG	HIBE1
1	TRUE	1	AAAG	PAHA1
1	TRUE	1	AAAG	OPLE1
1	TRUE	1	AAAG	EUIN1
1	TRUE	1	AAAG	LEVI1
1	TRUE	1	AAAG	OXDI1
1	TRUE	1	AAAG	SIFI1
1	TRUE	2	AAAG	CEIN1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
2	TRUE	1	AAAG	UNGR2
3	TRUE	2	AAAG	STLE1
4	TRUE	12	AAAG	STLE1
5	TRUE	5	AAAG	STLE1
5	TRUE	1	AAAG	SELE1
5	TRUE	1	AAAG	PAOB1
6	TRUE	4	AAAG	STLE1
6	TRUE	2	AAAG	HIBE1
6	TRUE	2	AAAG	BORI1
6	TRUE	1	AAAG	SIFI1
6	TRUE	2	AAAG	PAHA1
7	TRUE	1	AAAG	SIFI1
7	TRUE	3	AAAG	STLE1
7	TRUE	1	AAAG	BOCU1
8	TRUE	5	AAAG	STLE1
8	TRUE	2	AAAG	PAHA1
8	TRUE	1	AAAG	TRRA1
9	TRUE	2	AAAG	STLE1
9	TRUE	4	AAAG	CAPL1
9	TRUE	1	AAAG	SIFI1
9	TRUE	2	AAAG	OXDI1
9	TRUE	1	AAAG	EUIN1
10	TRUE	5	AAAG	HIBE1
10	TRUE	1	AAAG	SENU1
10	TRUE	2	AAAG	SIFI1
10	TRUE	2	AAAG	PLHE1
10	TRUE	2	AAAG	BRUN1
10	TRUE	2	AAAG	LEVI1
10	TRUE	4	AAAG	UNKF1
11	TRUE	3	AAAG	STLE1
11	TRUE	1	AAAG	LEVI1
11	TRUE	6	AAAG	BRUN1
11	TRUE	1	AAAG	VUOC1
11	TRUE	1	AAAG	OXDI1
11	TRUE	1	AAAG	SIFI1
11	TRUE	8	AAAG	HIBE1
12	TRUE	6	AAAG	ARWR1
12	TRUE	3	AAAG	HIBE1
12	TRUE	6	AAAG	LEVI1
12	TRUE	7	AAAG	UNKF1
12	TRUE	1	AAAG	OXDI1
12	TRUE	2	AAAG	SIFI1
12	TRUE	2	AAAG	VEHA1
13	TRUE	6	AAAG	UNKF1
13	TRUE	1	AAAG	SIFI1
13	TRUE	4	AAAG	STLE1
13	TRUE	8	AAAG	HIBE1
14	TRUE	4	AAAG	STLE1
14	TRUE	1	AAAG	SIFI1
14	TRUE	1	AAAG	MOCI1
15	TRUE	5	AAAG	HIBE1
15	TRUE	3	AAAG	ERPI1
15	TRUE	1	AAAG	SIFI1
15	TRUE	2	AAAG	PLHE1
15	TRUE	1	AAAG	STLE1
16	TRUE	4	AAAG	STLE1
17	TRUE	3	AAAG	CRMO1
17	TRUE	2	AAAG	EVPR1
17	TRUE	3	AAAG	LIAR1
17	TRUE	1	AAAG	EUIN1
17	TRUE	1	AAAG	TRRA1
18	TRUE	12	AAAG	HIBE1
18	TRUE	1	AAAG	SIFI1
19	TRUE	2	AAAG	BORI1
19	TRUE	5	AAAG	STLE1
20	TRUE	5	AAAG	STLE1
1	TRUE	2	AAAH	ERPI1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
1	TRUE	1	AAAH	STLE1
1	TRUE	3	AAAH	ARWR1
1	TRUE	2	AAAH	CRMO1
1	TRUE	1	AAAH	TRRA1
1	TRUE	1	AAAH	LIAR1
2	TRUE	2	AAAH	LIAR1
2	TRUE	3	AAAH	STLE1

Appendix IIIc: Plant Transect Raw Data, Tree Cover at Calcite

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
4	TRUE	1	AAAU	VECA1
1	TRUE	8	AABH	BOSA1
1	TRUE	2	AAAA	HIBE1
1	TRUE	1	AAAA	LESP1
2	TRUE	7	AAAA	STLE1
3	TRUE	2	AAAA	STLE1
4	TRUE	12	AAAA	STLE1
4	FALSE	55	AAAA	BRUN1
5	TRUE	2	AAAA	STLE1
5	FALSE	12	AAAA	BRUN1
6	TRUE	8	AAAA	HIBE1
6	TRUE	2	AAAA	ARWR1
6	TRUE	3	AAAA	STLE1
6	TRUE	2	AAAA	SIFI1
6	FALSE	13	AAAA	PLHE1
6	TRUE	1	AAAA	ERPI1
6	TRUE	3	AAAA	LIPR1
6	TRUE	1	AAAA	MASP1
7	TRUE	1	AAAA	VEHA1
7	TRUE	1	AAAA	BOCU1
7	TRUE	10	AAAA	PLHE1
7	FALSE	15	AAAA	BRUN1
7	FALSE	6	AAAA	LESP1
7	FALSE	7	AAAA	EVPR1
8	TRUE	6	AAAA	STLE1
8	TRUE	4	AAAA	BRUN1
8	FALSE	1	AAAA	PLHE1
8	FALSE	1	AAAA	VUOC1
9	TRUE	3	AAAA	STLE1
9	FALSE	14	AAAA	BRUN1
10	TRUE	3	AAAA	SIFI1
10	FALSE	45	AAAA	PLHE1
10	TRUE	4	AAAA	HIBE1
10	TRUE	2	AAAA	ERPI1
10	TRUE	11	AAAA	SEAP1
11	TRUE	4	AAAA	HIBE1
11	TRUE	1	AAAA	RACU1
11	TRUE	4	AAAA	SIFI1
11	FALSE	25	AAAA	PLHE1
11	FALSE	15	AAAA	MEMI1
11	TRUE	5	AAAA	PAHA1
11	FALSE	3	AAAA	LESP1
11	FALSE	9	AAAA	BRUN1
12	TRUE	4	AAAA	HIBE1
12	TRUE	2	AAAA	SIFI1
12	FALSE	45	AAAA	PLHE1
12	FALSE	19	AAAA	LESP1
13	TRUE	6	AAAA	VEHA1
13	TRUE	8	AAAA	STLE1
13	TRUE	1	AAAA	SIFI1
13	FALSE	55	AAAA	PLHE1
13	FALSE	6	AAAA	MEMI1
13	TRUE	3	AAAA	HIBE1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
17	FALSE	15	AAAA	EVPR1
17	TRUE	7	AAAA	PAHA1
17	FALSE	3	AAAA	PLHE1
17	FALSE	50	AAAA	SEAP1
17	TRUE	2	AAAA	CRMO1
18	TRUE	10	AAAA	HIBE1
18	FALSE	60	AAAA	PLHE1
18	FALSE	2	AAAA	LESP1
18	TRUE	1	AAAA	EUIN1
18	FALSE	11	AAAA	EVPR1
19	TRUE	4	AAAA	STLE1
20	TRUE	9	AAAA	STLE1
20	FALSE	11	AAAA	BRUN1
1	TRUE	2	AAAB	STLE1
20	TRUE	1	AAAA	PAHA1
1	TRUE	4	AAAB	PLHE1
1	TRUE	1	AAAB	EVPR1
1	TRUE	65	AAAB	LIAR1
1	TRUE	1	AAAB	HIBE1
1	TRUE	2	AAAB	EUIN1
1	FALSE	8	AAAB	SCDR1
2	TRUE	70	AAAB	LIAR1
2	FALSE	25	AAAB	VUOC1
2	TRUE	1	AAAB	SPCR1
2	TRUE	2	AAAB	CEIN1
2	TRUE	1	AAAB	EUIN1
2	FALSE	16	AAAB	EVPR1
2	FALSE	5	AAAB	PLHE1
3	TRUE	21	AAAB	LIAR1
3	TRUE	1	AAAB	ERPI1
3	TRUE	1	AAAB	ARWR1
3	FALSE	35	AAAB	EVPR1
3	TRUE	1	AAAB	CRMO1
3	TRUE	1	AAAB	EUIN1
3	TRUE	2	AAAB	BOCU1
4	TRUE	6	AAAB	CAPL1
4	FALSE	3	AAAB	CAPL1
4	TRUE	1	AAAB	STLE1
5	TRUE	12	AAAB	CAPL1
5	FALSE	2	AAAB	BRUN1
5	TRUE	1	AAAB	STLE1
5	TRUE	3	AAAB	LIAR1
6	TRUE	11	AAAB	STLE1
6	TRUE	2	AAAB	HIBE1
6	FALSE	6	AAAB	VUOC1
7	TRUE	3	AAAB	BOCU1
7	TRUE	4	AAAB	ERPI1
7	FALSE	22	AAAB	PLHE1
7	FALSE	2	AAAB	VUOC1
7	TRUE	2	AAAB	THSI1
7	TRUE	8	AAAB	LIAR1
7	FALSE	29	AAAB	EVPR1
7	TRUE	1	AAAB	STLE1
8	TRUE	36	AAAB	THSI1
8	TRUE	9	AAAB	HIBE1
8	FALSE	5	AAAB	VUOC1
8	TRUE	1	AAAB	SIFI1
8	FALSE	2	AAAB	EVPR1
8	FALSE	2	AAAB	BRUN1
9	TRUE	2	AAAB	SELE1
9	FALSE	3	AAAB	BRUN1
10	TRUE	3	AAAB	ARWR1
10	TRUE	5	AAAB	THSI1
10	FALSE	8	AAAB	PLHE1
10	TRUE	2	AAAB	ERPI1
10	TRUE	12	AAAB	LIAR1
11	TRUE	8	AAAB	THSI1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
11	TRUE	2	AAAB	BOHI1
11	FALSE	23	AAAB	PLHE1
11	TRUE	1	AAAB	ERPI1
11	TRUE	5	AAAB	CAPL1
11	FALSE	2	AAAB	EVPR1
11	FALSE	1	AAAB	LEVI1
12	TRUE	7	AAAB	ARWR1
12	TRUE	2	AAAB	STLE1
12	TRUE	3	AAAB	THSI1
13	TRUE	2	AAAB	ARWR1
13	TRUE	2	AAAB	STLE1
13	TRUE	3	AAAB	THSI1
13	FALSE	1	AAAB	LEVI1
13	TRUE	1	AAAB	BOCU1
13	FALSE	4	AAAB	BRUN1
14	TRUE	12	AAAB	STLE1
14	TRUE	1	AAAB	HIBE1
14	FALSE	3	AAAB	BRUN1
14	FALSE	4	AAAB	VUOC1
14	TRUE	1	AAAB	LIAR1
15	FALSE	4	AAAB	EVPR1
15	TRUE	1	AAAB	PAHA1
15	TRUE	3	AAAB	ARWR1
15	TRUE	1	AAAB	HIBE1
15	TRUE	1	AAAB	VEHA1
15	TRUE	3	AAAB	EUIN1
15	FALSE	3	AAAB	PLHE1
16	TRUE	2	AAAB	PAHA1
16	TRUE	2	AAAB	LIAR1
16	TRUE	5	AAAB	ARWR1
16	TRUE	1	AAAB	THSI1
16	TRUE	2	AAAB	EUIN1
16	FALSE	17	AAAB	EVPR1
16	FALSE	5	AAAB	PLHE1
16	TRUE	1	AAAB	CEIN1
16	TRUE	1	AAAB	CHVI1
17	TRUE	3	AAAB	STLE1
17	TRUE	1	AAAB	UNGR2
18	TRUE	1	AAAB	BOCU1
18	TRUE	4	AAAB	STLE1
18	TRUE	2	AAAB	UNGR2
19	TRUE	4	AAAB	HIBE1
19	FALSE	10	AAAB	PLHE1
19	TRUE	2	AAAB	STLE1
19	TRUE	3	AAAB	BOCU1
1	TRUE	1	AAAC	PAHA1
19	TRUE	1	AAAB	SIFI1
1	TRUE	2	AAAC	BOCU1
1	TRUE	6	AAAC	HIBE1
1	TRUE	1	AAAC	STLE1
1	FALSE	1	AAAC	LEVI1
1	FALSE	2	AAAC	EVPR1
2	TRUE	4	AAAC	ARPU1
2	TRUE	2	AAAC	ERPI1
2	TRUE	2	AAAC	PAHA1
2	TRUE	2	AAAC	SCDR1
2	FALSE	8	AAAC	EVPR1
3	FALSE	10	AAAC	BRUN1
3	FALSE	13	AAAC	EVPR1
3	TRUE	2	AAAC	SCDR1
3	TRUE	1	AAAC	SIFI1
3	FALSE	10	AAAC	MEMI1
3	FALSE	15	AAAC	LIAR1
3	TRUE	1	AAAC	ERIN1
3	FALSE	2	AAAC	CRTE1
4	TRUE	2	AAAC	BOCU1
4	FALSE	6	AAAC	BRUN1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
4	FALSE	3	AAAC	VUOC1
4	FALSE	4	AAAC	EVPR1
4	FALSE	6	AAAC	PLHE1
4	TRUE	6	AAAC	SCDR1
4	TRUE	1	AAAC	ERPI1
5	TRUE	5	AAAC	ARPU1
5	TRUE	2	AAAC	SIFI1
5	TRUE	2	AAAC	CAPL1
5	TRUE	1	AAAC	BOCU1
5	TRUE	2	AAAC	ERPI1
5	TRUE	4	AAAC	STLE1
5	FALSE	3	AAAC	LIAR1
5	FALSE	9	AAAC	PLHE1
5	TRUE	1	AAAC	SCDR1
5	TRUE	1	AAAC	MEMI1
6	TRUE	4	AAAC	ERPI1
6	FALSE	3	AAAC	BRUN1
6	FALSE	25	AAAC	PLHE1
6	FALSE	10	AAAC	EVPR1
6	TRUE	1	AAAC	BOCU1
6	TRUE	3	AAAC	VECA1
6	TRUE	3	AAAC	MEMI1
6	FALSE	6	AAAC	LEVI1
6	FALSE	7	AAAC	LIAR1
6	FALSE	6	AAAC	DAPU1
6	TRUE	1	AAAC	SIFI1
7	TRUE	3	AAAC	ERIN1
7	FALSE	5	AAAC	VUOC1
7	TRUE	3	AAAC	STLE1
7	TRUE	1	AAAC	ASSP2
8	TRUE	2	AAAC	BOCU1
8	FALSE	6	AAAC	BRUN1
8	FALSE	5	AAAC	VUOC1
8	FALSE	3	AAAC	MEMI1
8	FALSE	3	AAAC	EVPR1
8	FALSE	5	AAAC	PLHE1
8	TRUE	1	AAAC	STLE1
8	TRUE	2	AAAC	LIAR1
9	TRUE	1	AAAC	BOCU1
9	TRUE	4	AAAC	ERPI1
9	TRUE	1	AAAC	HIBE1
9	FALSE	105	AAAC	PLHE1
10	TRUE	12	AAAC	LIAR1
10	TRUE	7	AAAC	STLE1
10	FALSE	1	AAAC	EVPR1
10	TRUE	1	AAAC	UNKF1
11	FALSE	65	AAAC	MEMI1
11	TRUE	1	AAAC	VECA1
11	TRUE	1	AAAC	SAFA1
11	TRUE	1	AAAC	ERIN1
11	FALSE	9	AAAC	LIAR1
11	TRUE	2	AAAC	ERPI1
11	FALSE	10	AAAC	BRUN1
11	TRUE	1	AAAC	SEAP1
12	TRUE	1	AAAC	HIBE1
12	FALSE	30	AAAC	PLHE1
12	FALSE	15	AAAC	MEMI1
12	FALSE	3	AAAC	BRUN1
12	FALSE	7	AAAC	LIAR1
12	TRUE	1	AAAC	ERPI1
12	FALSE	10	AAAC	EVPR1
13	TRUE	4	AAAC	STLE1
13	FALSE	14	AAAC	BRUN1
13	TRUE	2	AAAC	IBLI1
13	TRUE	2	AAAC	PAOB2
14	TRUE	4	AAAC	HIBE1
14	TRUE	1	AAAC	ERIN1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
14	FALSE	4	AAAC	EVPR1
14	TRUE	1	AAAC	SCDR1
14	FALSE	3	AAAC	LIAR1
14	TRUE	1	AAAC	CRMO1
15	TRUE	5	AAAC	ERPI1
15	FALSE	9	AAAC	LIAR1
15	FALSE	1	AAAC	VUOC1
15	FALSE	95	AAAC	PLHE1
15	FALSE	23	AAAC	EVPR1
15	TRUE	2	AAAC	VECA1
15	TRUE	1	AAAC	PHPO1
15	FALSE	2	AAAC	LEVI1
16	TRUE	10	AAAC	STLE1
16	TRUE	1	AAAC	ERPI1
17	TRUE	5	AAAC	HIBE1
17	FALSE	3	AAAC	LIAR1
1	FALSE	15	AAAD	EVPR1
18	TRUE	3	AAAC	STLE1
1	FALSE	7	AAAD	PLHE1
1	TRUE	2	AAAD	BOTR1
1	FALSE	9	AAAD	VUOC1
1	FALSE	14	AAAD	LIAR1
1	TRUE	1	AAAD	CRMO1
2	TRUE	14	AAAD	CAPL1
2	TRUE	7	AAAD	STLE1
2	FALSE	3	AAAD	LIAR1
3	FALSE	3	AAAD	LIAR1
3	TRUE	3	AAAD	STLE1
3	FALSE	30	AAAD	EVPR1
3	FALSE	14	AAAD	PLHE1
3	FALSE	1	AAAD	LIRU1
3	FALSE	2	AAAD	SCDR1
3	TRUE	3	AAAD	HIBE1
4	FALSE	36	AAAD	EVPR1
4	FALSE	35	AAAD	PLHE1
4	TRUE	1	AAAD	STLE1
4	FALSE	3	AAAD	LIAR1
4	FALSE	12	AAAD	VUOC1
4	FALSE	1	AAAD	LIRU1
4	TRUE	1	AAAD	BORI1
6	FALSE	2	AAAD	SCDR1
7	TRUE	1	AAAD	HIBE1
7	TRUE	1	AAAD	SIFI1
7	FALSE	17	AAAD	VUOC1
7	FALSE	22	AAAD	PLHE1
7	TRUE	1	AAAD	PHPO1
7	FALSE	6	AAAD	EVPR1
7	TRUE	1	AAAD	ARPU1
7	FALSE	2	AAAD	LIAR1
7	FALSE	1	AAAD	SCDR1
8	TRUE	1	AAAD	ARPU1
8	TRUE	7	AAAD	STLE1
8	FALSE	4	AAAD	MEMI1
8	TRUE	1	AAAD	PHPO1
8	FALSE	4	AAAD	EVPR1
8	FALSE	8	AAAD	PLHE1
8	TRUE	1	AAAD	SIFI1
8	FALSE	25	AAAD	VUOC1
9	TRUE	2	AAAD	HIBE1
9	TRUE	2	AAAD	ERPI1
9	FALSE	65	AAAD	PLHE1
9	FALSE	3	AAAD	MEMI1
9	FALSE	1	AAAD	SIFI1
9	TRUE	5	AAAD	PHPO1
9	FALSE	5	AAAD	LIAR1
9	FALSE	2	AAAD	LIRU1
10	TRUE	1	AAAD	BOCU1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
10	FALSE	4	AAAD	MEMI1
10	TRUE	1	AAAD	VEHA1
10	TRUE	2	AAAD	CRMO1
10	FALSE	4	AAAD	EVPR1
11	TRUE	1	AAAD	ARPU1
11	TRUE	4	AAAD	HIBE1
11	TRUE	1	AAAD	ERPI1
11	TRUE	1	AAAD	VUOC1
11	FALSE	15	AAAD	MEMI1
11	FALSE	25	AAAD	PLHE1
11	TRUE	1	AAAD	PHPO1
11	FALSE	17	AAAD	EVPR1
12	TRUE	5	AAAD	STLE1
13	TRUE	5	AAAD	HIBE1
13	FALSE	13	AAAD	MEMI1
13	FALSE	31	AAAD	PLHE1
13	TRUE	1	AAAD	VEHA1
13	FALSE	1	AAAD	BRUN1
13	FALSE	15	AAAD	LIAR1
13	FALSE	1	AAAD	THSI1
13	TRUE	1	AAAD	STLE1
13	FALSE	3	AAAD	VUOC1
13	TRUE	1	AAAD	SIFI1
14	TRUE	3	AAAD	PHPO1
14	TRUE	1	AAAD	VEHA1
14	FALSE	6	AAAD	PLHE1
14	FALSE	7	AAAD	EVPR1
14	FALSE	2	AAAD	CRMO1
14	FALSE	2	AAAD	SCDR1
14	FALSE	3	AAAD	VUOC1
14	TRUE	2	AAAD	CAPL1
14	TRUE	2	AAAD	ARPU1
15	TRUE	4	AAAD	STLE1
15	FALSE	12	AAAD	MEMI1
15	TRUE	2	AAAD	ERIN1
15	TRUE	1	AAAD	SPCR1
15	FALSE	1	AAAD	BRUN1
16	FALSE	23	AAAD	BRUN1
16	FALSE	8	AAAD	MEMI1
16	FALSE	3	AAAD	VUOC1
17	FALSE	29	AAAD	EVPR1
17	TRUE	1	AAAD	ERPI1
17	FALSE	5	AAAD	MEMI1
17	TRUE	1	AAAD	ARPU1
17	TRUE	3	AAAD	BOTR1
17	FALSE	3	AAAD	PLHE1
18	TRUE	4	AAAD	STLE1
18	FALSE	10	AAAD	LIAR1
18	FALSE	2	AAAD	BRUN1
18	FALSE	2	AAAD	PLHE1
18	FALSE	4	AAAD	VUOC1
19	FALSE	69	AAAD	PLHE1
19	FALSE	4	AAAD	LIAR1
19	FALSE	3	AAAD	VUOC1
19	FALSE	2	AAAD	THSI1
19	TRUE	1	AAAD	BOTR1
20	TRUE	1	AAAD	ERPI1
20	TRUE	2	AAAD	BOTR1
20	FALSE	7	AAAD	LIAR1
20	FALSE	2	AAAD	SCDR1
20	FALSE	23	AAAD	EVPR1
1	TRUE	2	AAAE	HIBE1
20	FALSE	13	AAAD	PLHE1
1	TRUE	6	AAAE	ARPU1
1	FALSE	6	AAAE	LEDE1
1	TRUE	4	AAAE	SIFI1
1	TRUE	2	AAAE	CAPL1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
2	FALSE	7	AAAE	PLHE1
2	TRUE	4	AAAE	STLE1
2	TRUE	2	AAAE	HIBE1
2	FALSE	6	AAAE	EVPR1
2	FALSE	2	AAAE	CRMO1
2	TRUE	1	AAAE	SIFI1
3	TRUE	3	AAAE	BOCU1
3	TRUE	2	AAAE	HIBE1
3	FALSE	2	AAAE	CRMO1
4	FALSE	11	AAAE	LIAR1
4	TRUE	3	AAAE	HIBE1
4	TRUE	3	AAAE	TOAR1
4	FALSE	2	AAAE	CRMO1
4	FALSE	8	AAAE	EVPR1
4	FALSE	2	AAAE	PLHE1
4	FALSE	4	AAAE	VUOC1
4	TRUE	5	AAAE	CRMO1
5	TRUE	6	AAAE	STLE1
5	TRUE	5	AAAE	HIBE1
5	FALSE	1	AAAE	PLHE1
5	FALSE	1	AAAE	TOAR1
6	TRUE	9	AAAE	STLE1
6	TRUE	1	AAAE	SPCR1
7	TRUE	2	AAAE	STLE1
7	TRUE	3	AAAE	ARPU1
8	TRUE	14	AAAE	STLE1
8	TRUE	2	AAAE	CEIN1
8	TRUE	4	AAAE	HIBE1
8	TRUE	1	AAAE	SIFI1
8	FALSE	17	AAAE	PLHE1
8	FALSE	4	AAAE	LIRU1
8	FALSE	1	AAAE	VEHA1
8	FALSE	2	AAAE	BRUN1
9	TRUE	6	AAAE	STLE1
9	FALSE	4	AAAE	PLHE1
10	TRUE	1	AAAE	RACU1
10	TRUE	2	AAAE	VEHA1
10	FALSE	1	AAAE	LEDE1
10	TRUE	3	AAAE	CEIN1
10	FALSE	2	AAAE	BRUN1
10	TRUE	4	AAAE	STLE1
10	TRUE	2	AAAE	HIBE1
10	FALSE	15	AAAE	PLHE1
11	TRUE	2	AAAE	RACU1
11	FALSE	75	AAAE	PLHE1
11	TRUE	3	AAAE	HIBE1
11	TRUE	1	AAAE	ERPI1
11	FALSE	1	AAAE	LIAR1
11	TRUE	4	AAAE	PHPO1
11	FALSE	4	AAAE	LEDE1
11	FALSE	2	AAAE	LEVI1
11	TRUE	2	AAAE	SIFI1
12	TRUE	6	AAAE	VEHA1
11	TRUE	1	AAAE	MOCI1
12	TRUE	1	AAAE	SIFI1
12	FALSE	87	AAAE	PLHE1
12	TRUE	1	AAAE	CEIN1
12	FALSE	5	AAAE	LEDE1
12	FALSE	2	AAAE	LEVI1
12	FALSE	2	AAAE	TOAR1
12	TRUE	4	AAAE	PHPO1
13	FALSE	3	AAAE	PLHE1
13	FALSE	10	AAAE	LIAR1
13	TRUE	2	AAAE	STLE1
13	TRUE	1	AAAE	ERPI1
13	FALSE	2	AAAE	LEDE1
13	FALSE	1	AAAE	LEVI1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
14	TRUE	4	AAAE	VEHA1
14	TRUE	2	AAAE	SIFI1
14	TRUE	4	AAAE	CEIN1
14	FALSE	40	AAAE	PLHE1
14	FALSE	25	AAAE	EVPR1
14	TRUE	1	AAAE	HIBE1
14	TRUE	2	AAAE	STLE1
14	TRUE	1	AAAE	CAPL1
14	TRUE	1	AAAE	TRRA1
14	FALSE	1	AAAE	LEVI1
15	TRUE	10	AAAE	STLE1
15	TRUE	4	AAAE	VEHA1
15	FALSE	8	AAAE	MEMI1
15	FALSE	6	AAAE	EVPR1
15	TRUE	1	AAAE	SIFI1
15	FALSE	1	AAAE	BRUN1
16	TRUE	3	AAAE	STLE1
16	TRUE	1	AAAE	MEMI1
16	TRUE	1	AAAE	PACA1
16	FALSE	1	AAAE	SPCR1
17	FALSE	3	AAAE	LEDE1
17	TRUE	2	AAAE	VEHA1
17	TRUE	3	AAAE	SIFI1
17	FALSE	39	AAAE	PLHE1
17	FALSE	5	AAAE	MEMI1
17	FALSE	7	AAAE	BRUN1
17	TRUE	2	AAAE	CEIN1
17	TRUE	4	AAAE	STLE1
17	FALSE	6	AAAE	VUOC1
17	TRUE	1	AAAE	MOCI1
18	TRUE	2	AAAE	STLE1
18	TRUE	1	AAAE	SIFI1
19	TRUE	13	AAAE	STLE1
19	FALSE	7	AAAE	MEMI1
19	FALSE	1	AAAE	PAOB2
19	FALSE	3	AAAE	BRUN1
20	FALSE	17	AAAE	BRUN1
20	FALSE	30	AAAE	PLHE1
20	FALSE	2	AAAE	EVPR1
20	TRUE	5	AAAE	STLE1
1	TRUE	4	AAAF	ELCA1
20	FALSE	2	AAAE	PAOB2
1	TRUE	4	AAAF	STLE1
1	FALSE	16	AAAF	BRUN1
2	TRUE	2	AAAF	STLE1
2	TRUE	2	AAAF	ELCA1
2	FALSE	7	AAAF	BRUN1
2	TRUE	1	AAAF	SELE1
3	TRUE	1	AAAF	OXDR1
3	TRUE	2	AAAF	LIAR1
4	TRUE	4	AAAF	STLE1
4	TRUE	4	AAAF	HIBE1
4	FALSE	35	AAAF	PLHE1
4	FALSE	1	AAAF	EVPR1
4	FALSE	12	AAAF	BRUN1
4	FALSE	6	AAAF	LIAR1
4	FALSE	1	AAAF	LEDE1
4	FALSE	3	AAAF	VUOC1
4	TRUE	1	AAAF	SIFI1
5	TRUE	7	AAAF	STLE1
5	TRUE	2	AAAF	BRUN1
5	TRUE	1	AAAF	TRRA1
6	TRUE	9	AAAF	STLE1
6	TRUE	2	AAAF	RACU1
7	TRUE	8	AAAF	STLE1
7	FALSE	6	AAAF	BRUN1
8	TRUE	2	AAAF	ARPU1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
8	TRUE	6	AAAF	CEIN1
8	TRUE	3	AAAF	SEAP1
8	FALSE	25	AAAF	PLHE1
8	FALSE	2	AAAF	VUOC1
8	TRUE	2	AAAF	THSI1
8	TRUE	2	AAAF	SIFI1
9	TRUE	13	AAAF	HIBE1
9	TRUE	1	AAAF	ARPU1
9	TRUE	4	AAAF	STLE1
9	TRUE	3	AAAF	SIFI1
9	FALSE	14	AAAF	PLHE1
9	FALSE	4	AAAF	EVPR1
9	FALSE	1	AAAF	THSI1
10	TRUE	7	AAAF	CAPL1
10	TRUE	6	AAAF	STLE1
10	FALSE	2	AAAF	BRUN1
11	TRUE	17	AAAF	HIBE1
11	TRUE	1	AAAF	BORI1
11	FALSE	17	AAAF	PLHE1
11	TRUE	1	AAAF	STLE1
11	TRUE	2	AAAF	SIFI1
11	FALSE	6	AAAF	EVPR1
12	TRUE	7	AAAF	ARPU1
12	TRUE	1	AAAF	BOHI1
12	TRUE	4	AAAF	HIBE1
12	FALSE	12	AAAF	PLHE1
12	FALSE	2	AAAF	EVPR1
13	TRUE	2	AAAF	BORI1
13	TRUE	3	AAAF	BOHI1
13	TRUE	4	AAAF	ARPU1
13	FALSE	13	AAAF	EVPR1
13	TRUE	2	AAAF	SIFI1
13	TRUE	1	AAAF	LIRU1
14	TRUE	6	AAAF	ARPU1
14	TRUE	1	AAAF	BORI1
14	TRUE	3	AAAF	STLE1
14	FALSE	31	AAAF	PLHE1
14	TRUE	2	AAAF	LIRU1
14	TRUE	1	AAAF	SEAP1
14	TRUE	1	AAAF	SIFI1
14	FALSE	6	AAAF	EVPR1
15	TRUE	5	AAAF	CAPL1
15	TRUE	2	AAAF	STLE1
16	TRUE	3	AAAF	CAPL1
16	TRUE	3	AAAF	STLE1
17	TRUE	2	AAAF	STLE1
17	TRUE	3	AAAF	BOCU1
17	TRUE	1	AAAF	VEHA1
17	TRUE	1	AAAF	CAPL1
18	TRUE	2	AAAF	ERPI1
18	TRUE	2	AAAF	ARPU1
18	TRUE	2	AAAF	CAPL1
18	TRUE	1	AAAF	BOCU1
19	TRUE	3	AAAF	CAPL1
19	TRUE	2	AAAF	BOCU1
19	FALSE	1	AAAF	SCDR1
19	FALSE	1	AAAF	PLHE1
1	TRUE	2	AAAG	STLE1
20	TRUE	5	AAAF	CAPL1
1	TRUE	6	AAAG	HIBE1
1	TRUE	1	AAAG	PAHA1
1	TRUE	1	AAAG	OPLE1
1	TRUE	1	AAAG	EUIN1
1	TRUE	1	AAAG	LEVI1
1	TRUE	1	AAAG	OXDI1
1	TRUE	1	AAAG	SIFI1
1	TRUE	2	AAAG	CEIN1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
2	TRUE	1	AAAG	UNGR2
3	TRUE	2	AAAG	STLE1
4	TRUE	12	AAAG	STLE1
5	TRUE	5	AAAG	STLE1
5	TRUE	1	AAAG	SELE1
5	TRUE	1	AAAG	PAOB1
6	TRUE	4	AAAG	STLE1
6	TRUE	2	AAAG	HIBE1
6	TRUE	2	AAAG	BORI1
6	TRUE	1	AAAG	SIFI1
6	TRUE	2	AAAG	PAHA1
7	TRUE	1	AAAG	SIFI1
7	TRUE	3	AAAG	STLE1
7	TRUE	1	AAAG	BOCU1
8	TRUE	5	AAAG	STLE1
8	TRUE	2	AAAG	PAHA1
8	TRUE	1	AAAG	TRRA1
9	TRUE	2	AAAG	STLE1
9	TRUE	4	AAAG	CAPL1
9	TRUE	1	AAAG	SIFI1
9	TRUE	2	AAAG	OXDI1
9	TRUE	1	AAAG	EUIN1
10	TRUE	5	AAAG	HIBE1
10	TRUE	1	AAAG	SENU1
10	TRUE	2	AAAG	SIFI1
10	TRUE	2	AAAG	PLHE1
10	TRUE	2	AAAG	BRUN1
10	TRUE	2	AAAG	LEVI1
10	TRUE	4	AAAG	UNKF1
11	TRUE	3	AAAG	STLE1
11	TRUE	1	AAAG	LEVI1
11	TRUE	6	AAAG	BRUN1
11	TRUE	1	AAAG	VUOC1
11	TRUE	1	AAAG	OXDI1
11	TRUE	1	AAAG	SIFI1
11	TRUE	8	AAAG	HIBE1
12	TRUE	6	AAAG	ARWR1
12	TRUE	3	AAAG	HIBE1
12	TRUE	6	AAAG	LEVI1
12	TRUE	7	AAAG	UNKF1
12	TRUE	1	AAAG	OXDI1
12	TRUE	2	AAAG	SIFI1
12	TRUE	2	AAAG	VEHA1
13	TRUE	6	AAAG	UNKF1
13	TRUE	1	AAAG	SIFI1
13	TRUE	4	AAAG	STLE1
13	TRUE	8	AAAG	HIBE1
14	TRUE	4	AAAG	STLE1
14	TRUE	1	AAAG	SIFI1
14	TRUE	1	AAAG	MOCI1
15	TRUE	5	AAAG	HIBE1
15	TRUE	3	AAAG	ERPI1
15	TRUE	1	AAAG	SIFI1
15	TRUE	2	AAAG	PLHE1
15	TRUE	1	AAAG	STLE1
16	TRUE	4	AAAG	STLE1
17	TRUE	3	AAAG	CRMO1
17	TRUE	2	AAAG	EVPR1
17	TRUE	3	AAAG	LIAR1
17	TRUE	1	AAAG	EUIN1
17	TRUE	1	AAAG	TRRA1
18	TRUE	12	AAAG	HIBE1
18	TRUE	1	AAAG	SIFI1
19	TRUE	2	AAAG	BORI1
19	TRUE	5	AAAG	STLE1
20	TRUE	5	AAAG	STLE1
1	TRUE	2	AAAH	ERPI1

FRAME	LIVE	TALLY	PLOT_ID	SP_CODE
1	TRUE	1	AAAH	STLE1
1	TRUE	3	AAAH	ARWR1
1	TRUE	2	AAAH	CRMO1
1	TRUE	1	AAAH	TRRA1
1	TRUE	1	AAAH	LIAR1
2	TRUE	2	AAAH	LIAR1
2	TRUE	3	AAAH	STLE1

Appendix IV: Calcite Animals Species Lists

IVa: Mammals of Calcite

Family	Genus	Species	Common Name	County Known	Calcite Known
Antilocapridae	Antilocapra	americana	Pronghorn		
Bovidae	Bos	bison	American Bison		
Canidae	Canis	rufus	Red Wolf	Y	
Canidae	Canis	latrans	Coyote		Y
Canidae	Urocyon	cinereoargenteus	Common Gray Fox	Y	Y
Canidae	Vulpes	vulpes	Red Fox		
Castoridae	Castor	canadensis	American Beaver		upstream?
Cervidae	Odocoileus	virginiananus	White-tailed Deer	Y	Y
Dasypodidae	Dasypus	novemcinctus	Nine-banded Armadillo	Y	Y
Didelphidae	Didelphis	virginiana	Virginia Opossum	Y	Y
Erethizontidae	Erethizon	dorsatum	North American Porcupine	Y	Y
Felidae	Lynx	rufus	Bobcat	Y	Y
Felidae	Puma	concolor	Mountain Lion	Y	Y
Geomyidae	Geomys	texensis	Llano Pocket Gopher	Y	
Geomyidae	Thomomys	bottae	Botta's Pocket Gopher	Y	
Heteromyidae	Chaetodipus	hispidus	Hispid Pocket Mouse	Y	
Heteromyidae	Perognathus	merriami	Merriam's Pocket Mouse	Y	
Leporidae	Lepus	californicus	Black-tailed Jackrabbit	Y	Y
Leporidae	Sylvilagus	floridanus	Eastern Cottontail	Y	Y
Leporidae	Sylvilagus	aquaticus	Swamp Rabbit		
Leporidae	Sylvilagus	audubonii	Desert Cottontail		

Mephitidae	Conepatus	leuconotus	Hog-nosed Skunk	Y	Y
Mephitidae	Mephitis	mephitis	Stripped Skunk	Y	
Mephitidae	Spilogale	gracilis	Western Spotted Skunk	Y	
Mephitidae	Spilogale	putorius	Eastern Spotted Skunk	Y	
Molossidae	Tadarida	brasiliensis	Brazilian Free-tailed Bat	Y	
Muridae	Baiomys	taylori	Northern Pygmy Mouse	Y	
Muridae	Microtus	ochrogaster	Prairie Voe		
Muridae	Microtus	Pinetorum	Woodland Vole		
Muridae	Neotoma	leucodon	Eastern White-throated Woodrat	Y	
Muridae	Neotoma	micropus	Southern Plains Woodrat		
Muridae	Peromyscus	attwateri	Texas Mouse	Y	
Muridae	Peromyscus	leucopus	White-footed Mouse	Y	Y
Muridae	Peromyscus	maniculatus	Deer Mouse	Y	
Muridae	Peromyscus	pectoralis	White-ankled Mouse	Y	
Muridae	Reithrodontomys	montanus	Plains Harvest Mouse	Y	
Muridae	Reithrodontomys	fulvescens	Fulvous Harvest Mouse		
Muridae	Sigmodon	hispidus	Hispid Cotton Rat	Y	Y
Mustelidae	Mustela	vison	American Mink	Y	
Mustelidae	Mustela	frenata	Long-tailed Weasel		
Mustelidae	Taxidea	taxus	American Badger	Y	Y
Myocastoridae	Myocastor	coypus	Nutria		Y
Procyonidae	Bassariscus	astutus	Ringtail	Y	Y
Procyonidae	Nasua	narica	White-nosed Coati		Tri County Rd
Procyonidae	Procyon	lotor	Northern Raccoon	Y	Y
Sciuridae	Cynomys	ludovicianus	Black-tailed Prairie Dog	Y	
Sciuridae	Sciurus	niger	Eastern Fox Squirrel	Y	Y
Sciuridae	Spermophilus	mexicanus	Mexican Ground Squirrel	Y	
Sciuridae	Spermophilus	variegatus	Rock Squirrel	Y	Y
Soricidae	Notiosorex	crawfordi	Desert Shrew		
Suidae	Sus	scrofa	Feral Pig	Y	Y
Talpidae	Scalopus	aquaticus	Eastern Mole	Y	
Tayassuidae	Pecari	tajacu	Collared Peccary		
Ursidae	Ursus	americanus	American Black Bear		
Vespertilionidae	Antrozous	pallidus	Pallid Bat		
Vespertilionidae	Corynorhinus	townsendii	Townsend's Bid-eared Bat		
Vespertilionidae	Lasiurus	borealis	Eastern Red Bat	Y	
Vespertilionidae	Lasiurus	cinereus	Hoary Bat		
Vespertilionidae	Lasiurus	xanthinus	Western Yellow Bat		
Vespertilionidae	Myotis	velifer	Cave Myotis	Y	
Vespertilionidae	Nycticeius	humeralis	Evening Bat		
Vespertilionidae	Pipistrellus	hesperus	Western Pipistrelle		
Vespertilionidae	Pipistrellus	subflavus	Eastern Pipistrelle		

IVb: Birds of Calcite

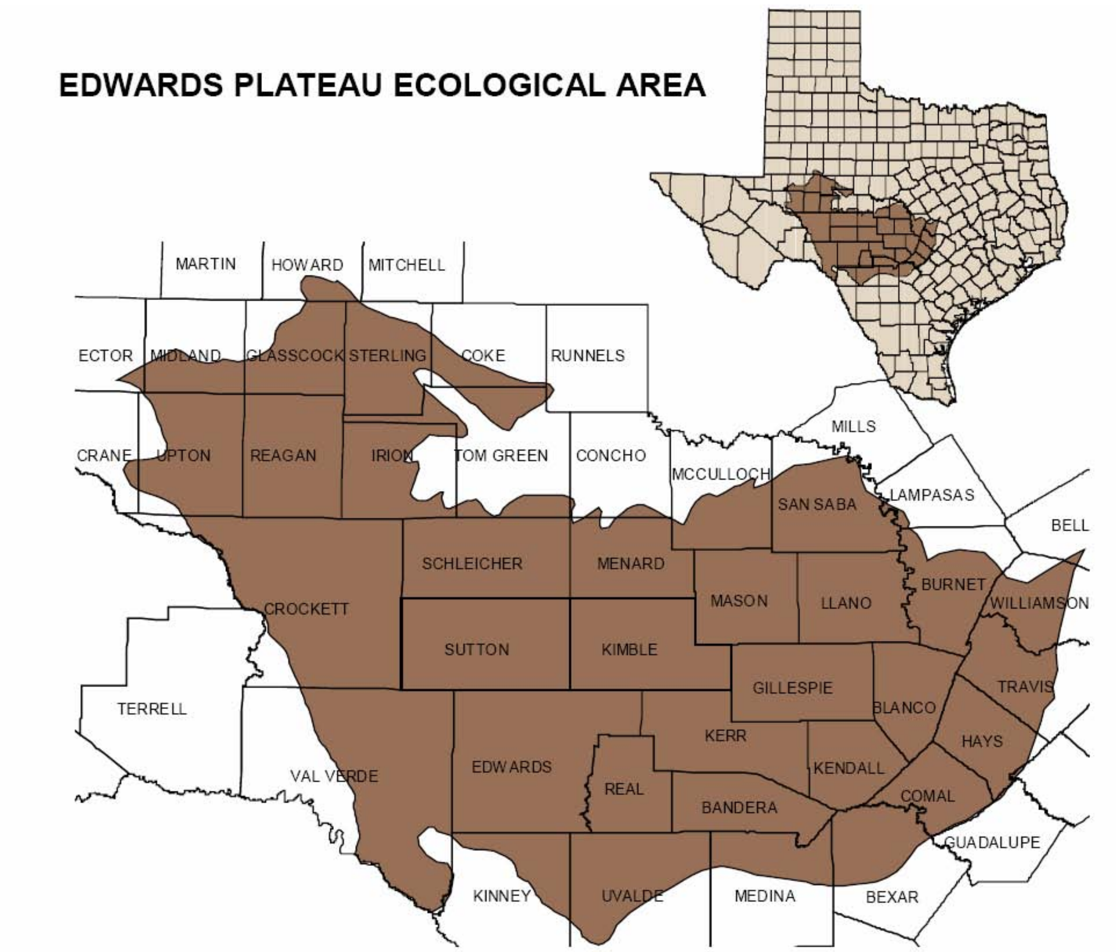
Common Name	**Scientific Name**
Pied-billed Grebe	Podilymbus podiceps
American White Pelican	Pelecanus erythrorhynchus
Double-crested Cormorant	Phalacrocorax auritus
Great Blue Heron	Ardea herodias
Great Egret	Ardea alba
Little Blue Heron	Egretta caerulea
Cattle Egret	Bubulcus ibis
Green Heron	Butorides virescens
Snowy Egret	Egretta thula
Wood Duck	Aix sponsa
Green-winged Teal	Anas crecca
Mallard	Anas platyrhynchos
Blue-winged Teal	Anas discors
American Wigeon	Anas americana
Black Vulture	Coragyps atratus
Turkey Vulture	Cathartes aura
Osprey	Pandion haliaetus
Mississippi Kite	Ictinia mississippiensis
Bald Eagle	Haliaeetus leucocephalus
Northern Harrier	Circus cyaneus
Sharp-shinned Hawk	Accipiter striatus
Cooper’s Hawk	Accipiter cooperii
Red-shouldered Hawk	Buteo lineatus
Swainson’s Hawk	Buteo swainsoni
Red-tailed Hawk	Buteo jamaicensis
Zone-tailed Hawk	Buteo albonotatus
Northern Caracara	Caracara cheriway
American Kestrel	Falco sparverius
Peregrine Falcon	Falco peregrinus
Wild Turkey	Meleagris gallopavo
Northern Bobwhite	Colinus virginianus
American Coot	Fulica americana
Sandhill Crane	Grus canadensis
Killdeer	Charadrius vociferus
Greater Yellowlegs	Tringa melanoleuca
Solitary Sandpiper	Tringa solitaria
Spotted Sandpiper	Actitis macularia
Upland Sandpiper	Bartramia longicauda
Whimbrel	Numenius phaeopus

Wilson's Snipe	Gallinago wilsonii
American Woodcock	Scolopax minor
Sora	Porzana carolina
White-winged Dove	Zenaida asiatica
Mourning Dove	Zenaida macroura
Common Ground-Dove	Columbina passerina
Eurasian Collared Dove	Streptopelia decaocto
Yellow-billed Cuckoo	Coccyzus americana
Greater Roadrunner	Geococcyx californianus
Eastern Screech-Owl	Otus asio
Great Horned Owl	Bubo virginianus
Short-eared Owl	Asio flammeus
Common Nighthawk	Chordeiles minor
Common Poorwill	Phalaenoptilus nuttallii
Chuck-will's-widow	Caprimulgus carolinensis
Chimney Swift	Chaetura pelagica
Ruby-throated Hummingbird	Archilochus colubris
Black-chinned Hummingbird	Archilochus alexandri
Belted Kingfisher	Ceryle alcyon
Green Kingfisher	Chloroceryle americana
Ringed Kingfisher	Ceryle torquata
Golden-fronted Woodpecker	Melanerpes aurifrons
Ladder-backed Woodpecker	Picoides scalaris
Northern Flicker	Colaptes auratus
Least Flycatcher	Empidonax minimus
Eastern Phoebe	Sayornis phoebe
Vermilion Flycatcher	Pyrocephalus rubinus
Ash-throated Flycatcher	Myiarchus cinerascens
Western Kingbird	Tyrannus verticalis
Eastern Kingbird	Tyrannus tyrannus
Scissor-tailed Flycatcher	Tyrannus forficatus
Olive-sided Flycatcher	Contopus cooperi
Yellow-bellied Flycatcher	Empidonax flaviventris
Purple Martin	Progne subis
Northern Rough-winged Swallow	Stelgidopteryx serripennis
Western Scrub-Jay	Aphelocoma californica
Common Raven	Corvus corax
Carolina Chickadee	Poecile carolinensis
Black-crested Titmouse	Baeolophus bicolor
Verdin	Auriparus flaviceps
Bushtit	Psaltriparus minimus
Cactus Wren	Campylorhynchus brunneicapillus
Rock Wren	Salpinctes obsoletus
Canyon Wren	Catherpes mexicanus
Carolina Wren	Thryothorus ludovicianus
Bewick's Wren	Thryomanes bewickii

Marsh Wren	Cistothorus palustris
House Wren	Troglodytes aedon
Golden-crowned Kinglet	Regulus satrapa
Ruby-crowned Kinglet	Regulus calendula
Blue-gray Gnatcatcher	Polioptila caerulea
Eastern Bluebird	Sialia sialis
Western Bluebird	Sialia mexicana
Hermit Thrush	Catharus guttatus
American Robin	Turdus migratorius
Gray Catbird	Dumetella carolinensis
Northern Mockingbird	Mimus polyglottos
Sage Thrasher	Oreoscoptes montanus
Townsend’s Solitaire	Myadestes townsendi
Cedar Waxwing	Bombycilla cedrorum
Loggerhead Shrike	Lanius ludovicianus
European Starling	Sturnus vulgaris
Bell’s Vireo	Vireo bellii
Yellow-throated Vireo	Vireo flavifrons
Warbling Vireo	Vireo gilvus
Red-eyed Vireo	Vireo olivaceus
Orange-crowned Warbler	Vermivora celata
Nashville Warbler	Vermivora ruficapilla
Yellow Warbler	Dendroica petechia
Yellow-rumped Warbler	Dendroica coronata
Black-throated Green Warbler	Dendroica virens
Common Yellowthroat	Geothlypis trichas
Wilson’s Warbler	Wilsonia pusilla
Yellow-breasted Chat	Icteria virens
Summer Tanager	Piranga rubra
Northern Cardinal	Cardinalis cardinalis
Pyrrhuloxia	Cardinalis sinuatus
Blue Grosbeak	Guiraca caerulea
Painted Bunting	Passerina ciris
Lazuli Bunting	Passerina amoena
Dickcissel	Spiza americana
Spotted Towhee	Pipilo maculatus
Canyon Towhee	Pipilo fuscus
Cassin’s Sparrow	Aimophila cassinii
Rufous-crowned Sparrow	Aimophila ruficeps
Chipping Sparrow	Spizella passerina
Field Sparrow	Spizella pusilla
Brewer’s Sparrow	Spizella breweri
Clay-colored Sparrow	Spizella pallida
Vesper Sparrow	Pooecetes gramineus
Lark Sparrow	Chondestes grammacus
Black-throated Sparrow	Amphispiza bilineata

Savannah Sparrow	Passerculus sandwichensis
Grasshopper Sparrow	Ammodramus savannarum
Song Sparrow	Melospiza melodia
Lincoln's Sparrow	Melospiza lincolnii
Swamp Sparrow	Melospiza georgiana
White-throated Sparrow	Zonotrichia albicollis
White-crowned Sparrow	Zonotrichia leucophrys
Harris's Sparrow	Zonotrichia querula
Dark-eyed Junco	Junco hyemalis
Red-winged Blackbird	Agelaius phoeniceus
Western Meadowlark	Sturnella neglecta
Common Grackle	Quiscalus quiscula
Bronzed Cowbird	Molothrus aeneus
Brown-headed Cowbird	Molothrus ater
Orchard Oriole	Icterus spurius
Scott's Oriole	Icterus parisorum
House Finch	Carpodacus mexicanus
Pine Siskin	Carduelis pinus
Lesser Goldfinch	Carduelis psaltria
American Goldfinch	Carduelis tristis
House Sparrow	Passer domesticus

Appendix V: Map of Texas Hill Country



Appendix VI: Common Forbs of the Texas Hill Country (Armstrong and Young 2000)

Preferred Forbs

Arrowleaf	*Sida Sida rhombifolia*
Blue curls	*Phacelia congesta*
Bur-Clover	*Medicago hispida*
Dayflower	*Commelina erecta*
Engelmann's daisy	*Engelmannia pinnatifida*
Evening Primrose	*Calylophus berlandieri*
Four O'clock	*Allionia spp*.
Indian Mallow	*Abutilon incanum*
Knotweed Leaf-flower	*Phyllanthus polygonoides*
Lambs-quarters	*Chenopodium album*
Mat Euphorbia.	*Euphorbia serpens*
Maximillian sunflower	*Helianthus maximiliani*
Redseed Plantain	*Plantago rhodosperma*
Spiderwort	*Tradescantia spp.*
Texas bluebell	*Eustoma grandiflorum*
Texas filaree	*Erodium texanum*
Trailing Lespedeza	*Lespedeza procumbens*
Velvet Bundleflower.	*Desmanthus velutinus*
Wild Lettuce	*Lactuca spp.*
Winecup	*Callirhoe digitata*
Winecup	*C. involucrate*

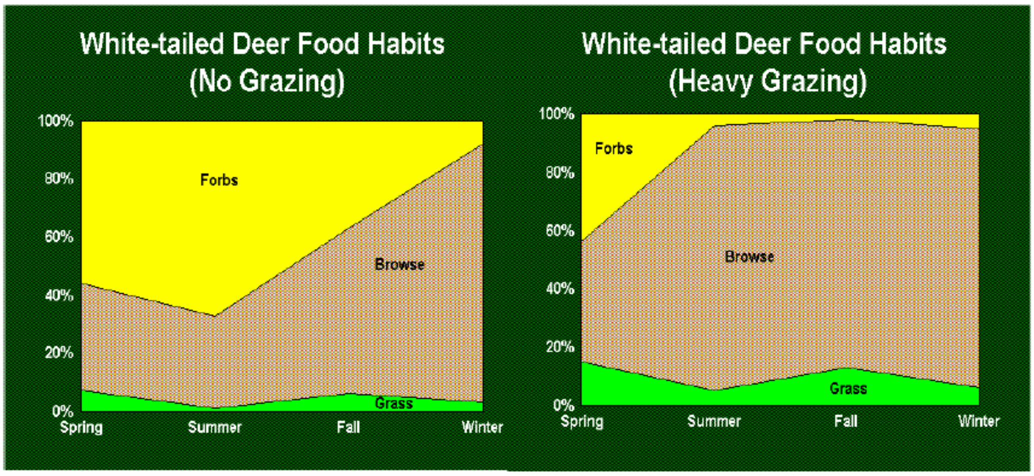
Appendix VII: Browse of the Texas Hill Country (Armstrong and Young 2000)

Preferred Browse

Carolina buckthorn var. caroliniana	*Rhamnus caroliniana*
Cedar elm	*Ulmus crassifolia*
Chinaberry	*Melia azedarach*
Cockspur hawthorne	*Crataegus crusgalli*
Downy viburnum	*Viburnum rufidulum*
Littleleaf leadtree	*Leucaena retusa*
Slippery elm	*Ulmus rubra*
Texas kidneywood	*Eysenhardtia texana*
Texas madrone	*Arbutus texana*
Texas mulberry	*Morus microphylla*
Texas oak var. texana	*Quercus shumardii*
Texas sophora	*Sophora affinis*
True mountainmahogany	*Cercocarpus montanus*
White honeysuckle	*Lonicera albiflora* var. *albiflora*
Wright pavonia	*Pavonia lasiopetala*

Appendix VIII: Cattle Versus Deer Consumption Graphs (Armstrong and Young 2000)

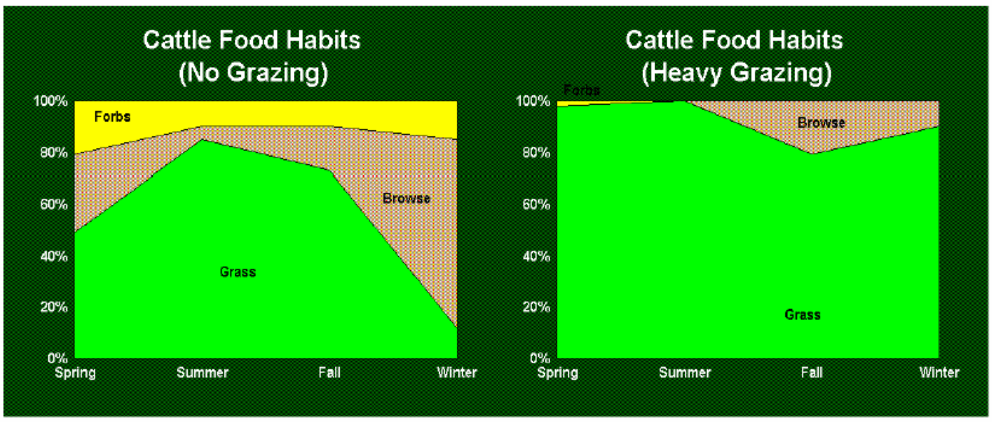
Deer



White-tailed deer prefer forbs when available. As forbs become unavailable deer shift their diets to browse. Even on overgrazed ranges, less than 15 percent of their diet is grass. They live on basically <u>two kinds</u> of forages: forbs and browse.

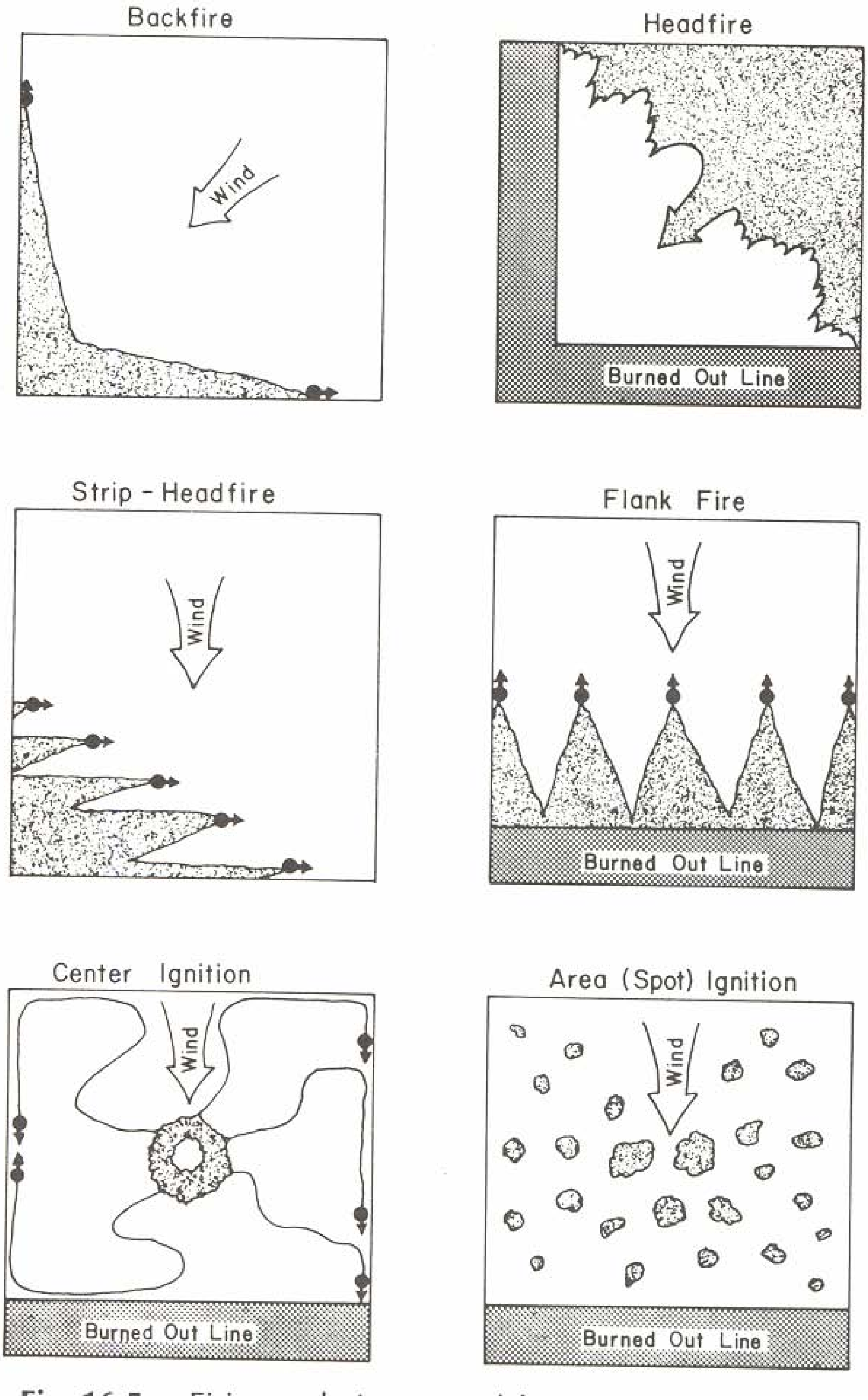
.

Cattle

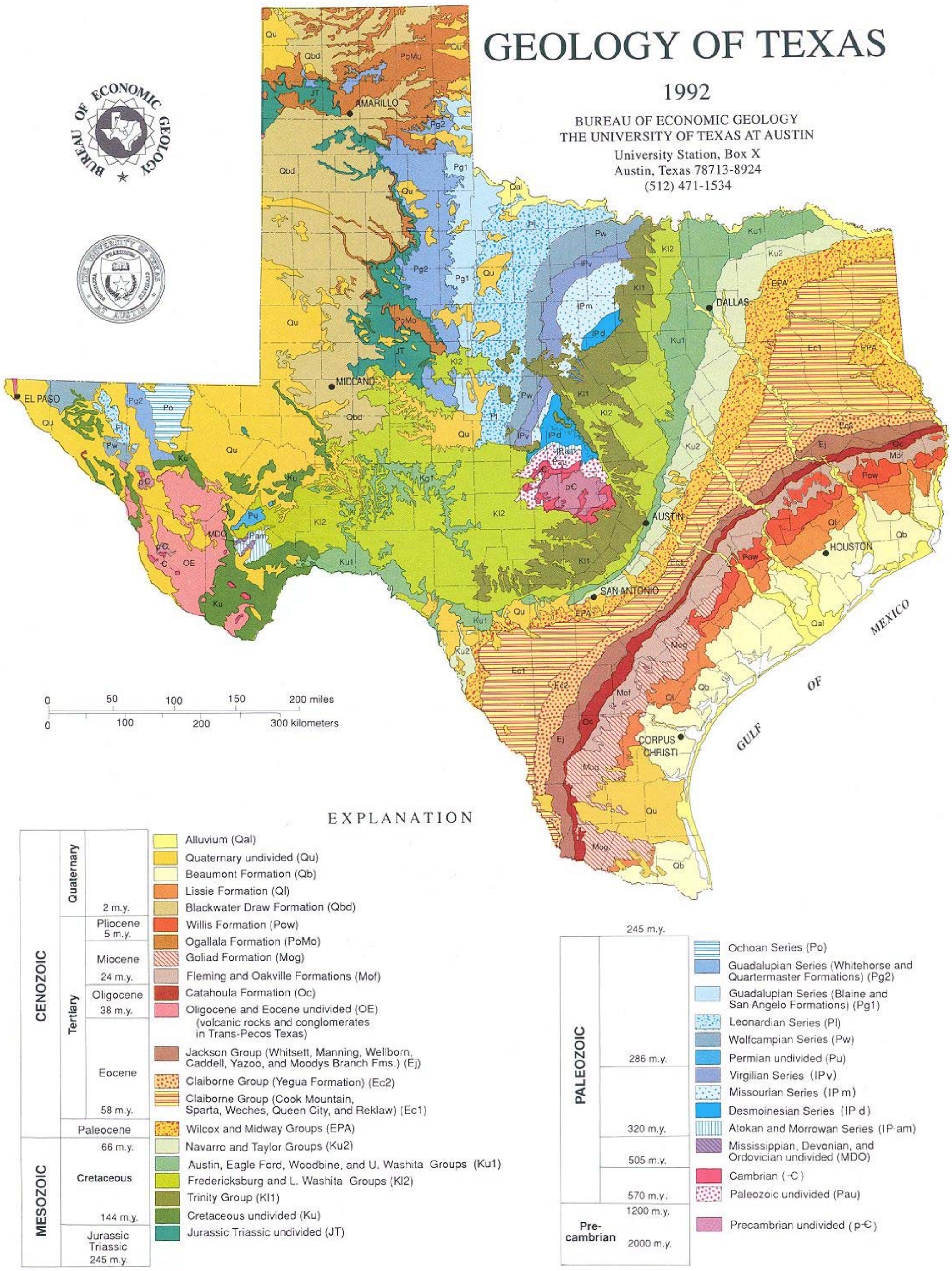


Cattle will consume some forbs and browse. However, they eat mostly grass. The consumption of grass results in better forb and browse production. They live on <u>three kinds</u> of forages.

Appendix IX: Prescribed Burning Techniques (Wright and Bailey 1982)



Appendix X- Geological Map of Texas

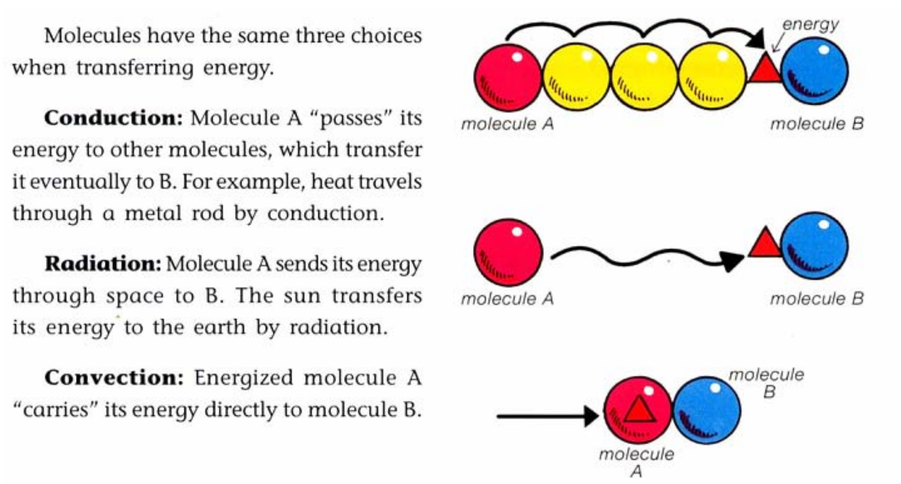


Appendix XI: Fire Physics

Fire is a release of energy. Molecules and atoms undergo an interaction that results in combustion. All states of matter are involved in the process of fire be it solid, liquid or gas.

Bonded atoms or molecules are important to the combustion reaction of fire. For example water is a conglomerate of two atoms of Hydrogen and one atom of Oxygen. Water is the major flame suppressant, putting enough water on a fire causes it to extinguish. However, Oxygen, which is an integral part of water, aids in the combustion of materials. Without the two hydrogen atoms to form H2O, one would be faced with blowing oxygen onto a fire, which wouldn't suppress it at all, quite the opposite one would be faced with a massive augmentation of the fire. Oxygen is fuel to a fire.

There is a transfer of energy involved in any reaction; fire's combustion reaction is no different. The transfer of energy is known to happen in three ways, convection, conduction, and radiation. Conduction is where molecules transfer energy along a chain and eventually the energy ends up at another molecule somewhere down the line (Johnston and Miyianishi 2001, p481). An example of this is how heat travels down a metal rod. Convection happens when an energized molecule comes in direct contact with another molecule and transfers the energy (Albini 1986, p.101). An example of this is a stovetop element heating up a teapot in order to boil water. Finally, radiation is the process by which a molecule sends its energy through space in order to transfer energy. (Albini 1985, p230) The primary example of radiation energy is the sun heating the earth. The process that fire uses to transfer energy is not limited to one of conduction, convection, or radiation. In fact all three play an important part in the combustion reaction and energy transfer involved in fire. Whether it is the direct action of convection transfer that allows the fire to spread, the indirect radiation energy transfer which dries out wet fuels close to the fire making them more susceptible to the conduction, or convection ignition; all three energy transfer models are utilized by fire.



Conduction, Radiation, Convection

(Cottrell 2004, p9)

Plants and Fire

Plants grow with photosynthesis. Photosynthesis takes the energy from the sun and creates a complex sugar. This takes the form of cellulose, which can be described as a long stringy molecule composed of 20,000 sugar molecules (O'Sullivan 1997, p174). Cellulose is high in energy, being made from sugar molecules, and therefore is very susceptible to energy transfers such as the combustion reaction. All the black seen after a burn is largely carbon, the by product from sugar burning.

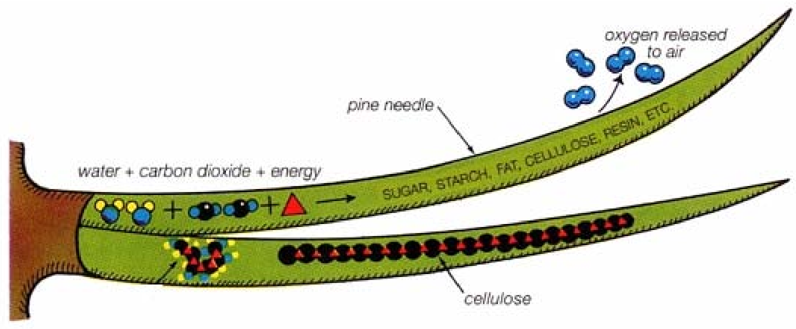


Figure: Cellulose

(Cottrell 2004, p11)

The chemical reaction of fire

The combustion reaction is a chemical reaction. The process is created when fuel and oxygen combine with an external energy source to create fire. This external source of energy is the catalyst, the agent which starts the fire. Opportunity can be ripe for a fire in a certain area but without the catalyst nothing will happen. Fuels are Ubiquitous, and oxygen makes up a grand percentage of the earths atmospheric gas. The external energy source is the key. The most common type of fire catalyst is lightning, volcanoes, and humans.

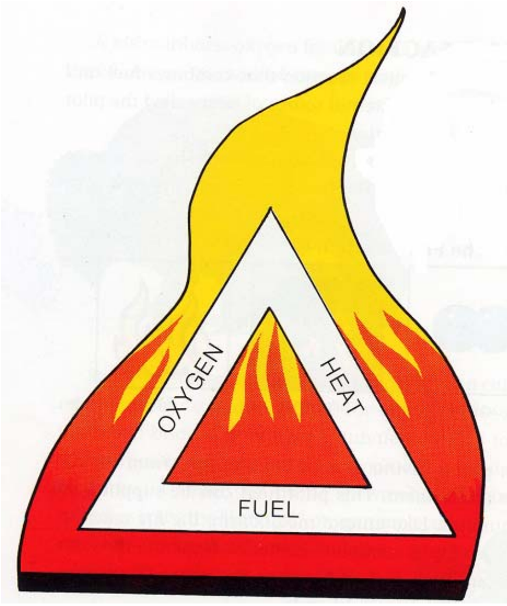


Figure: Fire Triangle
Fire needs all three of oxygen, fuel, and heat. Take away one side of the fire triangle and the flame is extinguished.
(Cottrell 2004, p16)

Fire, Flame, Combustion

It is important to make the distinction between fire and flame. Fire is the chemical reaction of combustion (Cottrell 2004, p17). There are two types of combustion, non-flaming and flaming. Glowing and flames are only visible during flaming combustion. Glowing combustion can be divided into glowing and smoldering. Glowing combustion usually occurs at or below the earth's surface with such fuels like peat, duff, roots and stumps. The key is the oxygen exchange, glowing and smoldering combustion consumes fuel solids, while flaming combustion consumes fuel gasses. This is exampled by the process of a tree burning. The leaves, rich in sugar forming cellulose and resign are highly combustible, and will go up in a flaming reaction. As this continues and the leaves are consumed, the trunk and roots are left, which undergo the glowing combustion reaction. This happens after the potential gases stored in the tree are released.

Flame

In order to describe the physics of the flame, envision a bottle filled with hot fuel gasses. The glass of the bottle serves as the point of contact for the exchange between fuel and oxygen. The diagram of a burning candle illustrates well the process of flaming combustion and the structure of the flame.

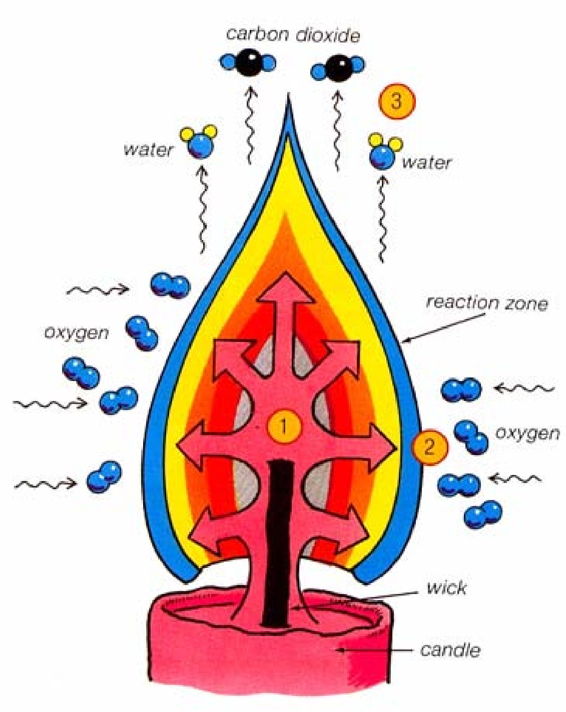


Figure: Flame Structure

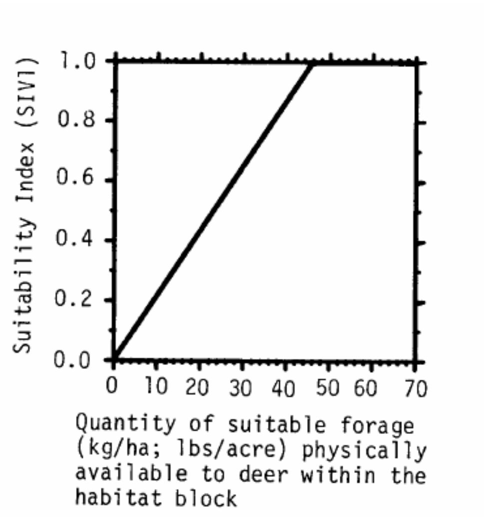
(Cottrell 2004, p20)

Pyrolysis

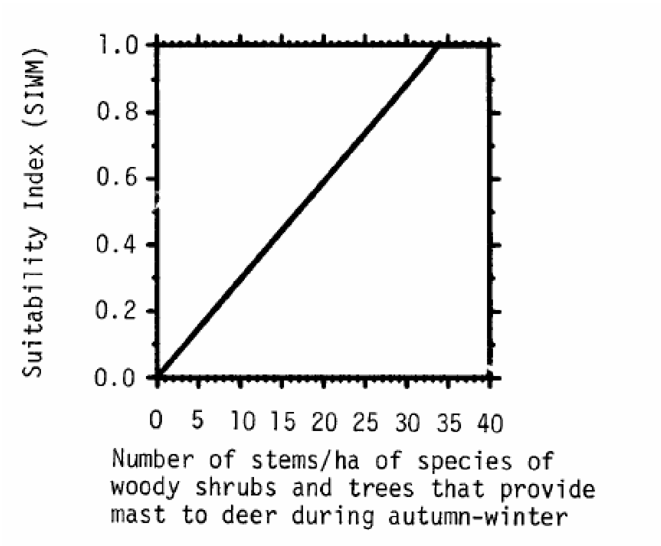
Pyrolysis is the process that creates smoke. Literally means heat divided (Cottrell 2004, p22). When fuel is pyrolyzed fuel chains are divided into smaller and smaller fragments making the fuel easier to burn. The large fuel molecules are split into fragments two to four carbons long. The by products of this reaction are carbon dioxide and water. This is why larger fuels smolder, their combustion molecules are too large to support ignition. Once ignition does occur, the pyrolysis is greatly decreased, as most all molecules are volatized.

Appendix XII: Habitat Suitability Index Graphs

Appendix XIIa. White-tailed Deer HSI Graphs (Short 1986)

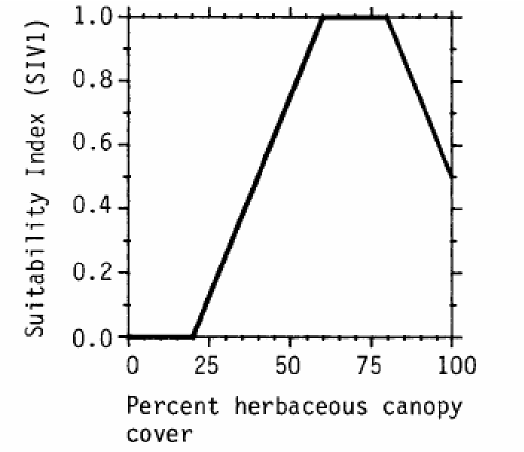


SI values increase as the quantity of suitable forage increases within the habitat. The quantity of suitable forage has increased on Calcite with the prescribed burning regimes.

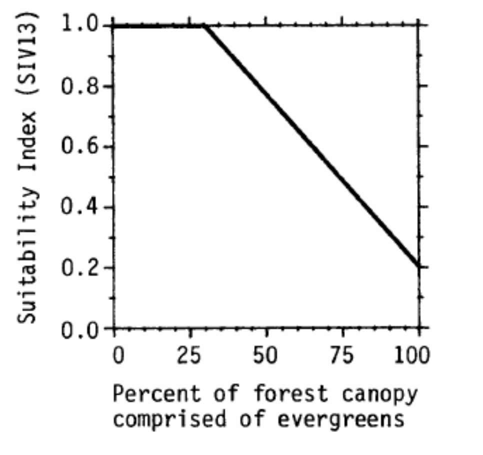


SI values for Winter Mast increase as the number of stems of suitable woody shrubs and trees increase within a hectare of habitat.

Appendix XIIb. Turkey HSI Graphs (Schroeder 1985)

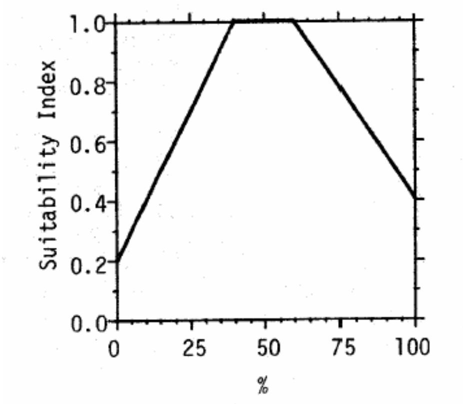


A certain percentage of canopy cover is beneficial to the habitat of turkey, however there is a limit and the canopy cover will then be detrimental to the population.

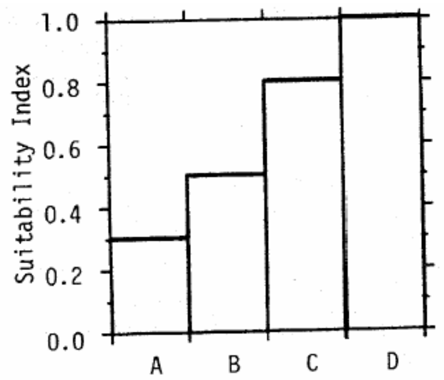


The larger the percentage of forest canopy that is comprised of evergreens, the lower the HSI value for turkey becomes. This is important pertaining to Calcite because before the removal of Ashe Juniper trees there was a 75-80% cover of evergreens, therefore the removal of evergreens completely raised the HSI value.

Appendix XIIc. Largemouth Bass HSI Graphs (Struber *et al.* 1982)



Percent bottom cover (e.g., aquatic vegetation, logs, and debris) within pools, backwaters, or littoral areas during summer. The Llano River, being bedrock substrate, has very little percentage of bottom cover (10-15%), this is unsuitable for largemouth bass.



Substrate composition within riverine pools and backwaters or lacustrine littoral areas. (Embryo)

A) Boulders and bedrock predominate (≥ 50%)
B) Sand (0.062-2.0 mm) predominates
C) Silt and clay (0.0-0.004 mm) predominate
D) Gravel (0.2-6.4 cm) predominates

The bedrock substrate of the Llano River is also seen as unsuitable habitat for embryo largemouth bass.

Appendix XIII. Calcite Photopoints

Pre Burn 204

Right after Burn 2004

Post Burn 2005

Pre Burn 2006


Right after Burn 2006

Post Burn 2007