Comparing Three Common Seeding Techniques for Pipeline Vegetation Restoration: A Case Study in South Texas

By Keith A. Pawelek, Forrest S. Smith, Anthony D. Falk, Megan K. Clayton, Kason W. Haby, and Dale W. Rankin

On the Ground

- With energy production expanding in the United States, rangelands are increasingly being affected.
- We studied three different reseeding techniques for pipeline rights of way restoration on rangelands impacted by energy development in the Eagle Ford Shale play of south Texas.
- Techniques studied were 1) broadcast seeding, 2) no-till drill seeding, and 3) hydroseeding.
- Using ecotypic native seed mixes, we found that all seeding techniques resulted in successful restoration of rights of ways.
- We are working to inform landowners, oil and gas operators, and rangeland professionals of our findings.

Keywords: ecotypic native seeds, pipeline reseeding, hydroseeding, no-till drill seeding, broadcast seeding, oil and gas, Eagle Ford Shale, south Texas natives.

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The noise of the heavy equipment has finally subsided, leaving a ≥ 30-meter-wide (≥ 100-foot-wide) pipeline right of way scar cutting across your rangeland. What, if anything, should or could be done to reclaim the land for wildlife and livestock?

Recent oil and gas development in the Eagle Ford Shale of south Texas has revived an interest in native seedings on new pipeline rights of way (ROWs), especially in areas known to support a high diversity of wildlife. The Eagle Ford Shale oil and gas play is a geologic formation, roughly 400 miles long by 50 miles wide, that stretches from east Texas across south Texas and into Mexico.[1] From 2010 to 2013, more than 25,749 km (16,000 miles) of new pipeline ROWs were added in Texas.[1] Reseeding is often necessary after new pipelines are installed and oil pad sites are made. Reseeding helps speed up the recovery and minimizes the invasion of unwanted plant species on the site.[2] Without reseeding, many of these ROWs remain unproductive for long periods. For successful reseeding, landowners must know about the type of seeds and equipment that should be used to produce the desired results. South Texas Natives (STNs), the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), and Texas A&M AgriLife Extension Service conducted a project to determine the best native seeding techniques on pipeline ROWs in the Eagle Ford Shale from 2012 to 2014.

What Has Been Done in the Past

Historically, grass plantings in south Texas have been focused on establishing nonnative grasses for cattle grazing after range disturbances like pipeline installation. However, recent shifts in land use have resulted in increased interest in planting native plants to support wildlife. Research in south Texas has shown nonnative grassland habitats have decreased bird, arthropod, and forb abundance compared with native grassland sites.[3] Buffelgrass (*Pennisetum ciliare* [L.] Link), a nonnative grass that is still being planted in many pipeline reseeding projects, reduces bobwhite quail abundance and habitat quality.[3–5] Despite these findings, oil and gas companies and some landowners still use this and other nonnative grass species on pipelines because those seeds are cheaper and because of a widely held perception that introduced species are easier to establish. These exotic grass plantings are widely hypothesized to act as corridors for the further spread of nonnative grasses into adjacent native habitats in future years.[6] In south Texas, much of the development associated with the Eagle Ford Shale is impacting large areas of formerly contiguous native vegetation, called "The Last Great Habitat"[7]; thus, the spread of nonnative grasses from new ROWs to adjacent habitats is of concern.

Goals

To provide information about the use of native seeds in ongoing pipeline infrastructure installation, our goals were 1) to objectively compare three seeding techniques for the reclamation of pipeline ROWs, using available ecotypic native seeds; and 2) inform landowners and oil and gas operators of the results. For this study, we defined "ecotypic native seeds" as seed sources originating from native plants that grew within the same ecosystem as the planting site.

Study Site and Climatic Conditions

The planting site was located on the Dobie Ranch in the heart of the Eagle Ford Shale play in Live Oak County, Texas, about 96.56 km (60 miles) south of San Antonio. In spring 2012 (February 27), we planted 0.07 hectare (0.18 acre) plots on three different ecological sites using the three most widely used seeding methods for pipeline reseeding: 1) broadcast seeding, 2) no-till drill seeding, and 3) hydroseeding (Figs. 1–3). The same native seed mix, comprising primarily ecotypic native seed selections developed for use in south Texas,[8] was seeded using each of the three methods randomly assigned to a plot on each ecological site: 1) Pavelek clay loam—a shallow gravelly loam over hard caliche; 2) Choke silty clay loam—a deep, calcareous fine sandy loam or sandy clay loam; and 3) Rosenbrock clay—a deep, fertile clay loam.[8] The NRCS ecologic site descriptions, as well as range inventories in areas adjacent to the ROW, were used to determine which native species should be included in the seed mix. The 23 plant species and seed varieties selected for the seed mix are listed in Table 1. Twenty of the seed sources used in the mix are germplasm releases or potential releases originating from south Texas (e.g., ecotypic by our definition). The other three seed sources ("Texoka" buffalo grass, Borden County germplasm sand dropseed, and Van Horn green sprangletop) did not originate from south Texas but have been successful when planted in the region in past plantings. The commercial cost of the seed mix used was $308.75 per hectare ($125 per acre). Native vegetation adjacent to the pipeline on the Pavelek clay loam is dominated by purple three awn (*Aristida purpurea* Nutt. var. *purpurea*) silver bluestem (*Bothriochloa saccharoides* (Sw.) Rydb.) and prickly pear (*Opuntia engelmannii* Salm-Dyck ex Engelm. var. *lindheimeri* (Engelm) Parfitt & Pinkava). The land adjacent to the Choke silty clay loam site is made up of mixed brush and a few grasses (six-weeks grama [*Bouteloua barbata* Lag.]; slim tridens [*Tridens muticus* Torr.] Nash var. *muticus*), and beaked panicgrass (*Panicum anceps* Michx.). The land adjacent to the Rosenbock clay site is predominantly mesquite (*Prosopis glandulosa* Torr.), plains bristlegrass (*Setaria vulpiseta* [Lam.] Roem. & Schult.), and prickly pear. Rainfall on the site was very favorable following sowing, and the site received a total of 176 mm (6.94 inches) in the first 3 months after planting.

Planting Preparations

The pipeline installation was completed in winter 2011. Other than a few cool season broadleaf weeds, the site was bare and had received a light rain prior to planting. To minimize early competition with emerging cool-season weeds, treatment plots were sprayed in late February with 2,4-D amine and glyphosate herbicide at a rate of 0.438 L/ha (6 ounces per acre), and 1.60 L/ha (22 ounces per acre), respectively, 4 days before sowing.

Planting Methods

Seeding rates for each planting method were calibrated according to equipment manufactures recommendations, and costs were calculated using market prices. The planting methods used were as follows:

Figure 1. Broadcast seeding. Photo by Forrest Smith.

Figure 2. Native seed drill seeding. Photo by Keith Pawelek.

Broadcast

Seed was broadcasted with a broadcast seeder driven by Power Take Off (PTO) and packed using a Brillion cultipacker. The cost was $25 to $75 per hectare ($10–$30/acre) (see Fig. 1).

Broadcast seeding was selected as a planting method because it is one of the most common methods used for reseeding ROWs, and it is inexpensive and fast. Broadcast seeding utilizes a slinging seeder that throws the seed out on the ground surface. We chose to follow the broadcast seeding with a cultipacker to ensure good seed-to-soil contact, which is a critical step often overlooked by contractors. The disadvantages of broadcast seeders include difficulties of calibrating equipment accurately, uneven distribution of seed over a planting area due to various seed sizes and weights, and distribution (waste) of seed beyond the boundaries of the planting site.

Native Seed Drill

Seed was drill planted with a Truax Flex-2 range drill. The cost was $60 to $135 per hectare ($25–$55/acre) (see Fig. 2).

The second method we evaluated was drill seeding, using a Truax Flex II no-till native seed drill. This seed drill was equipped with three seed boxes in order to plant seeds of various sizes included in the seed mix. These separate boxes enable different seeds to be mixed in the appropriate boxes to ensure they are being metered and distributed correctly. The chaffy seed box is designed to accurately meter and plant fluffy seeded species in the mix, which can otherwise be difficult to plant. The cool-season annual box can be used to plant the

Figure 3. Hydroseeder. Photo by Forrest Smith.

Table 1. Seed selection for native planting in Live Oak County, Texas, during Spring 2012

Common name	Scientific name	Variety	Percent of the seed mix	Pure Live Seed pounds planted per acre
Sideoats grama	*Bouteloua curtipendula*	South Texas germplasm	7	0.70
Arizona cottontop	*Digitaria californica*	La Salle germplasm	15	0.60
Buffalograss	*Buchloe dactyloides*	Texoka	2	0.32
Silver bluestem*	*Bothriochloa laguroides* ssp. *torreyeana*	PMC experimental	Trace	
Multiflowered false rhodesgrass	*Trichloris pluriflora*	Hidalgo germplasm	2	0.05
False rhodesgrass	*Trichloris crinita*	Kinney germplasm	2	0.05
Plains bristlegrass	*Setaria vulpiseta*	Catarina blend	15	0.60
Texas grama	*Bouteloua rigidiseta*	Atascosa germplasm	Trace	
Little bluestem*	*Schizachyrium scoparium* var. *scoparium*	STN experimental	2	0.14
Sand dropseed	*Sporobolous cryptandrus*	Borden County germplasm	2	0.04
Pink pappusgrass	*Pappophorum bicolor*	Maverick germplasm	15	0.90
Whiplash pappusgrass	*Pappophorum vaginatum*	Webb germplasm	5	0.30
Hooded windmillgrass	*Chloris cucullata*	Mariah germplasm	10	0.12
Shortspike windmillgrass	*Chloris x subdolistachya*	Welder germplasm	2	0.02
Slender grama	*Bouteloua repens*	Dilley germplasm	10	1.60
Halls panicum	*Panicum hallii* var. *fillipes*	Oso germplasm	2	0.04
Hairy grama	*Bouteloua hirsuta* var. *hirsuta*	Chaparral germplasm	2	0.08
Green sprangletop	*Leptochloa dubia*	Van Horn	2	0.07
Awnless bushsunflower†	*Simsia calva*	Bee germplasm	1	0.02
Deer pea vetch	*Vicia ludoviciana* var. *texensis*	Hoverson germplasm	1	0.16
Hookers plantain*	*Plantago hookeriana*	STN-561 germplasm	1	0.10
Redseed plantain*	*Plantago rhodosperma*	STN-496 germplasm	1	0.10
Prairie acacia†	*Acacia angustissima* var. *angustissima*	Rio Grande germplasm	1	0.02
		Total	100	6.2

* Indicates seed not yet commercially available.
† Indicates seed available but in limited quantities.

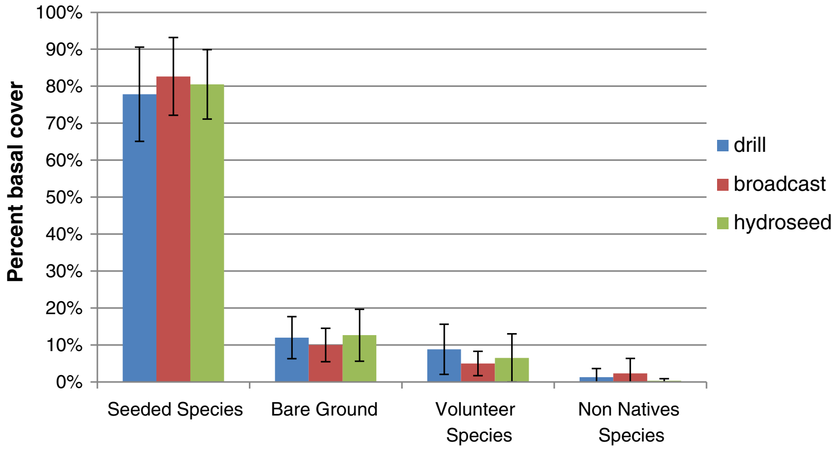

Figure 4. Percent basal cover by seeding method, Fall 2012.

slick- or hard-seeded species in the mix. This drill is also equipped with depth bands on the disk openers to ensure that the seed is planted no deeper than the recommended seeding depth, which is quarter inch or less, for most native species planted. Another option utilized on this drill was no-till straight coulters, which simply cut through the debris that might be present on the pipeline allowing for better placement of the seed, thus minimizing soil disturbance.

Hydroseeding

The seeds were mixed with Second Nature Wood Fiber Blend Hydraulic Mulch in water and applied with a Finn T-120Hydro-seeder. The cost was $1,358 per hectare ($550+/acre) (see Fig. 3).

Hydroseeding dispenses seed by using an emulsification of water and mulch sprayed out evenly on the surface of the ground. Historically, hydroseeding was a method that was used on steep slopes and areas where conventional planting equipment (drills, broadcast seeders, and tractors) could not be used. A perceived advantage of hydroseeding is the mulch layer, which helps retain moisture and limits soil erosion on the site. Disadvantages include the high cost associated with the mulch materials, the logistics of having water and mulch available in close proximity to the planting sites, and difficulty of accurate calibration. In our hydroseeding trials, we used *Second Nature Wood Fiber Blend Hydraulic Mulch*, which is a combination of 70% thermally refined wood fiber and 30% high-quality cellulose fiber. The mulch was applied by using a Finn T-120 HydroSeeder at a rate of 1667.25 kg/ha (1,500 pounds per acre); both seed and mulch were applied in one application.

Data Collection

Basal cover of vegetation was estimated by using the step point method.[9] Each plot was sampled by using three transects of 100-step points. We also used 0.25 m^2 quadrats to estimate plant density, following the methods described by the NRCS, modifying the number of samples taken for plot size.[10] Twenty-five randomly placed quadrats were used to count the number of emerging or established plants per quadrat for density estimates. Sampling was conducted in June and October 2012 and 2013.

Results

Three months after seeding, all planting methods had resulted in more than 60% basal coverage by seeded plant species. Basal cover increased to over 70% coverage of seeded plant species by the fall of the planting year (Fig. 4). All methods achieved plant densities at least two and a half times the NRCS Range Planting Standard minimum seeded plant densities for successful stand establishment ratings of half a

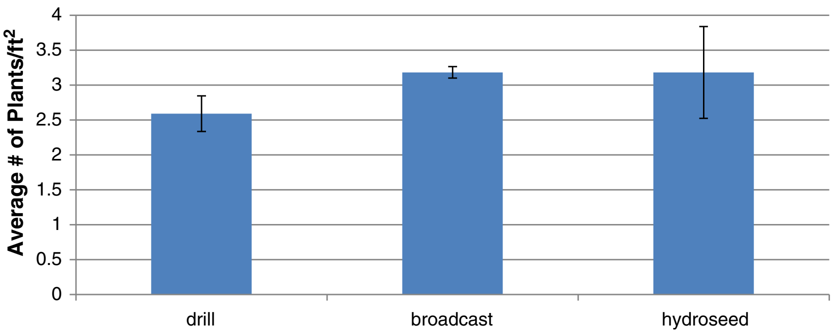

Figure 5. Seeded plant density by planting method, Fall 2012.

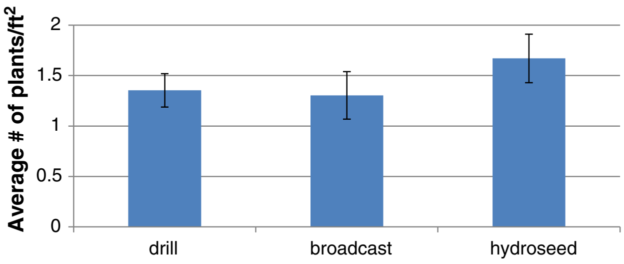

Figure 6. Seeded plant density by planting method, Fall 2013.

plant per square foot (Fig. 5).[10] By 1.5 years after planting, the seeded species had greater than 80% basal cover on all treatments. By fall 2013, plant density of seeded species in all treatments had decreased, likely because of increased plant size and competition; however, the density of seeded species remained well above the successful stand ratings of the NRCS (Fig. 6). Our measurements suggested that all planting methods produced similar results, and there were only minor differences in basal plant cover or plant density among planting methods by 2 years after seeding. Our observations suggested no effect of planting methods on establishment. We observed a slight difference in reclamation seeding results by ecologic sites in 2012, with the shallow ridge site having 10% to 15% lower basal cover than the sandy loam or fertile clay loam sites (Fig. 7). However, by the end of 2013, we observed only minor differences in basal cover among the sites (Fig. 8).

Discussion

Following disturbance from the pipeline installation, the question still looms: "Is there a need to replant?" Espeland found that a revegetation seed mix is critical to exclude weeds and that a native seed mix can help prevent the introduction of invasive exotic species.[11] Falk, in work conducted in South Texas from 2008 to 2010 on abandoned croplands surrounded by nonnative species, indicated that seeding was beneficial in reducing the establishment of nonnative plants and that without seeding, little natural regeneration of native plant communities occurred.[2] Our findings agreed with these conclusions in that 90% of the basal vegetation cover documented in the treatment plots was provided by the species that were planted. Additionally, observations outside the experimental area (ROWs either not seeded or seeded with mixes of nonecotypic seeds) indicated that without reseeding, adjacent sites were void of vegetation cover for up to 1 year, and marginally vegetated 2 years after pipeline installations were complete. These sites were clearly vulnerable to erosion and invasion by nonnative species due to large amounts of bare ground and lack of competitive vegetation. Once the unplanted sites did establish cover, it was minimal and remained mostly weedy annual species or volunteering native grasses from the adjacent reseeded stands. Newman and Redente found that even 20 years after seeding, the species that were originally seeded can comprise greater than 65% of the total biomass.[12] Our results documented that use of an ecotypic native seed mix can quickly restore pipeline ROW vegetation and provide competitive vegetative cover. We suggest such establishment minimizes the potential for negative effects of rangeland disturbance associated with bare ground.

We measured little difference between the results achieved using the three planting methods. In this instance, when done correctly, each method was highly effective. Past research has also shown that broadcast seeding methods can be just as effective as drill seeding when done correctly.[12,13] Wilson et al. found that drill seeding had significantly better plant establishment 2 years after planting but that broadcast seeding resulted in better establishment in the initial year after planting.[14] All of these results indicate that both drill seeding and broadcast seeding can be successfully used to re-establish native plants. Little research has been done to directly compare hydroseeding with drill or broadcast seeding in controlled settings, but the process is essentially broadcast seeding in an emulsification with mulch, and our research indicated it was just as effective as the other methods.

We recommend that care be taken to select the proper equipment for each specific ROW site. In this project, use of the hydroseeder or the broadcast seeder followed by a packer resulted in similar plant establishment as with the native seed drill. However, the expense of a hydroseeder and the inconsistent results observed by other practitioners using a broadcast seeder should be considered. With the variations of terrain along pipelines, it is highly possible that more than one piece of equipment should be used for different sites. For example, hydroseeding in drainages or on steep slopes could be highly beneficial to reduce runoff and erosion, but the expense may limit its use on the entire ROWs.

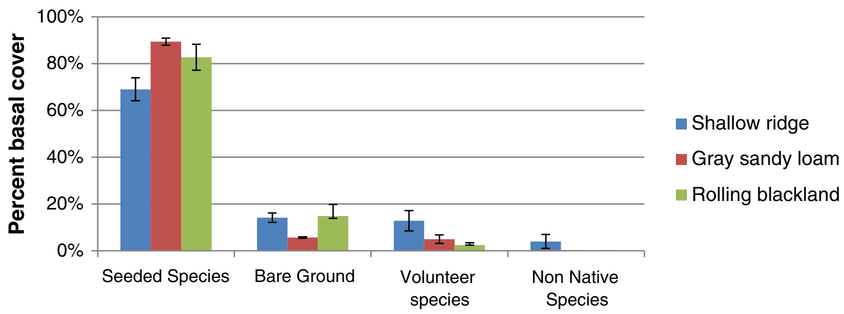

Figure 7. Percent basal cover in each ecologic site, Fall 2012.

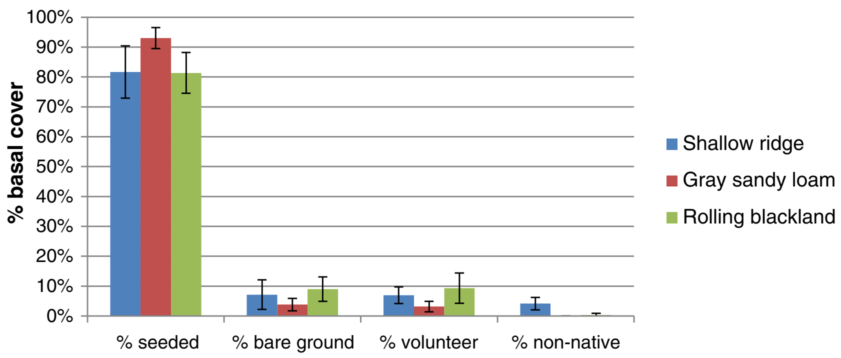

Figure 8. Percent basal cover in each ecologic site, Fall 2013.

Conclusion

In our case study, we demonstrated that three common planting methods can be used to successfully reseed native plants to ROWs on three different ecologic sites on the Dobie Ranch when using a diverse, ecotypic native seed mix. This and a number of similar projects indicate that rangeland reseeding using ecotypic native seeds can substantially enhance rangeland recovery following intensive disturbances and provide competitive vegetation cover shown to slow invasion by nonnative grasses. As rangeland scientists and practitioners, it will be beneficial for us to recognize and communicate the importance of other range seeding concerns when dealing with ROWs, such as proper seed selection, seed bed preparation, equipment calibration, and deferral from livestock grazing and other disturbances until the reseeded plants are well established. Successful native seedings on ROWs should help ensure long-term ecologic benefits by maintaining diverse plant communities on rangelands that nationwide are increasingly impacted by various forms of disturbance as a result of increased energy exploration and production.

References

1. Railroad Commission of Texas, 2014. Eagle Ford Shale information. Available at: http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/eagle-ford-shale/. Accessed 27 August 2014.
2. Falk, A.D., T.E. Fulbright, F.S. Smith, L.A. Brennan, A.J. Ortega-Santos, and S. Benn. 2013. Does seeding a locally adapted native mixture inhibit ingress by exotic plants? *Restoration Ecology* 21(4):474-480.
3. Flanders, A.A., W.P. Kuvlesky, D.C. Ruthven, R.E. Zaiglin, R.L. Bingham, T.E. Fulbright, F. Hernandez, and L. Brennan. 2006. Effects of invasive exotic grasses on south Texas rangeland breeding birds. *The Auk* 123(1):171-182.
4. Natural Resource Conservation Service, USDA, 2014. The PLANTS Database, 2014. Available at: http://plants.usda.gov/core/profile?symbol=PECI. 2014 Accessed 15 September 2014.
5. Sands, J.P., L.A. Brennan, F. Hernandez, W.P. Kuvlesky, J.F. Gallagher, D.C. Ruthven, and J.E. Pittman. 2009. Impacts of bufflegrass (*Pennisetum ciliare*) on a forb community in south Texas. *Invasive Plant Science and Management* 2(2):130-140.
6. Goertz, S. 2013. Driving mechanisms of old work bluestems invasion on Rob and Bessie Welder Wildlife Refuge: a long-term study. [M.S. Thesis]. Kingsville, TX, USA: Texas A&M-Kingsville.
7. Fulbright, T.E., and F. Bryant. 2002. The last great habitat. Caesar Kleberg Wildlife Research Institute Special Publication CKWRI. Kingsville, TX: Texas A&M University-Kingsville.
8. Smith, F.S., J. Lloyd-Reilley, and W. Ocumpaugh. 2010. South Texas natives: a collaborative regional effort to meet restoration needs in south Texas. *Native Plants Journal* 11(3):252-268.
9. Evans, R.A., and R.M. Love. 1957. The step-point method of sampling-a practical tool in range research. *Journal of Range Management* 10:208-212.
10. United States Department of Agriculture, and Natural Resources Conservation Services. Texas. 2013. Conservation practice standard range planting (Acre) code 550. Available at: http://efotg.sc.egov.usda.gov/references/public/TX/Texas550_specification_Revised2014.pdf
11. Espeland, E.K. 2014. Choosing a reclamation seed mix to maintain rangelands during energy development in the Bakken. *Rangelands* 36(1):25-28.
12. Newman, G.J., and E.F. Redente. 2001. Long-term plant community development as influence by revegetation techniques. *Journal of Range Management* 54:717-724.
13. De Puit, E.J., and J.G. Coenenberg. 1979. Methods for establishment of native plant communities on topsoiled coal stripmine soils in the Northern Great Plains. *Reclamation Review* 2:75-83.
14. Wilson, S.D., J.D. Bakker, J.M. Christian, X. Li, L.G. Ambrose, and J. Waddington. 2004. Semiarid old-field restoration: is neighbor control needed? *Ecological Applications* 14(2):476-484.

Authors are Assistant Director, South Texas Natives, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, 700 University BLVD, MSC 218, Kingsville, TX 78363 (Pawelek, keith.pawelek@tamuk.edu); Dan L. Duncan Endowed Director, South Texas Natives and Texas Natives Seeds Projects, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville (Smith); Research and Evaluations Coordinator, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville (Falk); Assistant Professor and Extension Range Specialist, Texas A&M Agrilife Extension Service, 10345 Highway 44 Corpus Christi, TX 78406-1412 (Clayton); Rangeland Management Specialist, Natural Resources Conservation Service, Edwards Region Grazing Lands Conservation Initiative, 257 Hwy. 173 North Ste. A, Hondo, TX 78861 (Haby); and Atascosa County Extension Agent, Agriculture and Naturals Resources, Texas AgriLife Extension Service, 1003 Oak Street Jourdanton, Texas 78026 (Rankin). *Support provided by the Word family of Dobie Ranch. This is publication number #15-108 of the Caesar Kleberg Wildlife Research Institute.*