SOUTH TEXAS NATIVES
A COLLABORATIVE REGIONAL EFFORT TO MEET RESTORATION NEEDS IN SOUTH TEXAS

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ABSTRACT

South Texas Natives (STN) is an initiative started in 2001 to develop and promote native plants for the restoration and reclamation of public and private lands in south Texas. At the urging of concerned conservationists and private landowners, STN has developed commercially viable sources of native seed and conducted research to discover effective restoration strategies that can be used by private landowners and government agencies to restore native plant communities. STN grew out of a strong partnership among the USDA Natural Resources Conservation Service E "Kika" de la Garza Plant Materials Center, Texas AgriLife Research, Rio Farms Inc, Caesar Kleberg Wildlife Research Institute, and private landowners of south Texas. Plant development efforts center on the release of commercially viable, multiple origin germplasms selected with an awareness of the commercial requirements for production but grounded in genetic and ecosystem function parameters. In addition to plant development efforts, extensive restoration and revegetation research is conducted by STN to develop usable methodology and much-needed guidelines for restoration in south Texas. Current restoration research emphasis centers on providing techniques for the diversification of areas dominated by invasive exotic grasses.


KEY WORDS
USDA NRCS Plant Materials Program, restoration, revegetation, Rio Grande Plains, Sand Plains, Gulf Prairies and Marshes

NOMENCLATURE
Plants: USDA NRCS (2009)
Butterfly: ITIS (2009)

Photos by Forrest S Smith
Photo opposite page: Rio Grande clammyweed attracts and provides habitat to a variety of insects and pollinators, such as this Pipevine Swallowtail (Battus philenor L. [Lepidoptera: Papilionidae]).
outh Texas (Figure 1) is home to some of the most biologically diverse native rangelands in the US. Largely privately owned, the region provides habitat to more than 250 species of birds (STWB 2009) and 1852 plants (in a single sub-area) (Jones 1982; Hatch and others 1999), and numerous mammals, arthropods, amphibians, and reptiles. Wildlife related industries, such as hunting and bird watching, contribute greatly to the south Texas economy and provide the major source of income to most ranches and small communities. Penned the “The Last Great Habitat” by Fulbright and Bryant (2002), this 12 million ha (30 million ac) area (Hatch and others 2001) faces significant threats from human population growth and resultant urbanization and habitat fragmentation; destructive disturbances from energy production, transportation, and utility infrastructure expansion; and widespread invasion and domination of native habitats by exotic grasses (Poaceae) such as buffelgrass (Pennisetum ciliare L. Link), old world bluestems (Dichanthium Willem and Bothriochloa Kuntze spp.), guineagrass (Urochloa maxima (Jacq.) R. Webster), Lehmann lovegrass (Eragrostis lehmanniana Nees), and many others.

Of critical importance for use in conservation efforts is the development of native plant germplasms and restoration methodologies. A history of overgrazing, coupled with the extensive seeding of rangelands and disturbed sites with exotic grasses (Carter 1958), has left the landscape and vegetation severely modified from its pre-settlement state. This trend in modification of the ecosystem continues rapidly through planting of exotic grasses for forage production and erosion control, disturbance and development, and quasi-naturally through invasion. Perhaps of most concern from the standpoint of biodiversity conservation is that populations of many species of plants and animals, commonly labeled as indicators of ecological health, are negatively impacted by invasive grasses (Kuvlesky Jr and others 2002; Flanders and others 2006; Ramirez-Yanez and others 2007; Sands and others 2009). Our current knowledge of ecological health indicators, plus the lack of techniques or material to restore and conserve native habitats, alarms many ecologists in the region.

This reduction in habitat quality, along with the outright loss of habitat from human population growth and urbanization, led a group of landowner-conservationists to organize the

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*Figure 1. Geographic area served by the South Texas Natives Project. Courtesy of CKWRI/Wildlife Research Technologies Laboratory*
South Texas Native Plant Restoration Project in 2001 (later renamed South Texas Natives) as a unit of the Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville (TAMUK) (Figure 2). To undertake this effort, the Institute looked to its longtime partner, the USDA Natural Resources Conservation Service (NRCS) E “Kika” de la Garza Plant Materials Center (PMC) for co-leadership in this endeavor. Strong partnerships have also been forged with Texas AgriLife Research, Rio Farms Inc, and a number of private entities and private landowners. Principal funding for the program is provided by private foundations and research grants from government agencies. Significant in-kind resources are provided by private ranches, the PMC, Rio Farms Inc, Texas AgriLife Research, and others. South Texas Natives is guided in purpose and scope by a 29-member advisory group made up of conservation, industry, agency, and ranching leaders from south Texas. Technical aspects of the program are conducted under the auspices of a 25-member technical committee comprising scientists, land managers, and agency personnel.

**PLANT DEVELOPMENT PHILOSOPHY**

Definition of the project’s regional scope is the 33 county area of south Texas. This area coincides roughly with the plant adaptation region (PAR) suggested by Vogel and others (2005). Within this area, plant communities have considerable overlap in species, and ecotypes of the plants are similar; however, they differ greatly from the same species in adjacent plant adaptation regions. Within the region defined as south Texas, habitats vary greatly because of climate, soils, and past land use history (Maywald and Doan-Crider 2008) (Figure 3). To provide restoration materials for this diverse region, our development goal is germplasm releases containing multiple collections of each species originating from, or adapted to, the major areas of potential use. In development of these “ecotype” releases, another guiding principle is to provide biologically...
viable and sustainable plant propagules with regional potential for use. This paradigmatic viewpoint mirrors that which prevails in the restoration literature of the last decade and which was pioneered by Millar and Libby (1989) who state, "if a truly native ecosystem (that is, unique local populations many of which have been extirpated) cannot be restored then restoration of something biologically viable and sustainable is far preferable to the complete loss of that ecosystem."

The development of native plant material utilizing the restoration gene pool (RGP) concept (Booth and Jones 2001) has been an important guiding principle of the program; however, our adaptation of this concept is primarily limited to the secondary RGP defined by Jones (2003). Primary RGP (population scale local material), while worthwhile at the micro-scale level, is not feasible at a regional scale. The potential ecological pitfalls of either tertiary RGP (artificial hybrids and traditional cultivars) or quaternary RGP (exotic plants) are too great in our region for their broad consideration in our project. Other guiding principles rely in part on ecologically based concepts (McKay and others 2005) and perceptions of greater natural selection ability of combinations of material originating from multiple sites (Jones and Johnson 1998), which are integrated with genetic awareness (Munda and Smith 1996). While these concepts must guide any restoration development effort, we are thoroughly grounded in the importance of having commercially and economically viable plant material available to consumers across the region. Tradeoffs between genetic and ecological concerns and production and commercialization realities are inevitable in the development of restoration plant material and are carefully evaluated on a species by species basis.

In lieu of the traditional development of one or a few dominant native species, our goal is to develop adequate releases of many species with acceptable commercial potential. This philosophy follows Call's and Roundy's (1991) viewpoint, in that concerns about biological diversity and multiple use of wild lands have directed plant development attention away from the establishment of monocultures (such as the millions of hectares of the exotic buffelgrass established in south Texas and Mexico [Cox and others 1988]) (Figure 4) and toward efforts to establish more complex synthetic communities representative of natural communities. Our program focuses on species from a variety of traditional (Clements 1916, 1928) successional states. Although concepts outlined by Clements may largely be invalid in the dynamic semi-arid rangelands of south Texas (Fulbright 2009), we suggest that generic classification of plants as invaders, mid-seral, and late-seral community members is quite valid. This traditional classification of plants lends itself well to dealing with the feasibility and specifics of establishing compatible species to create diversity (Call and Roundy 1991). Thus, our intent is to develop many different plant species from a variety of successional groups so that restoration activity is not only a mechanism for reintro-
ducing important plants but also one for re-establishment of an important ecosystem function with resiliency and adaptability through seeding. Today, the PMC and STN efforts focus on the development of species from a variety of functional and successional groups, including grasses, forbs, legumes, as well as annuals and perennials and cool- and warm-season plants. Many programs for development of restoration materials have failed because only outwardly desirable (that is, eaten by wildlife or exceptional livestock forage species) and traditionally late seral stage plants have been developed. While important to consumers, these plants lack resistance to disturbance, lack competitive ability with weedy plants, and are poorly adapted to colonizing the quintessential restoration site in the absence of symbiotic early successional “weedy” natives, soil builders, and nurse plants.

**SELECTING NATIVE PLANTS**

Initially our group created a list of native species to guide project efforts. The selection included grasses, forbs, and shrubs from various vegetation associations found in the region and from a number of successional stages. The list has since been modified significantly and today includes 141 plant species; it serves as guide to seed collection by project personnel, committee members, and collaborators. The initial project goal was to develop seed releases of each of the species on the original plant list for south Texas. Because of constraints to commercialization of many species, this goal is a lofty one. Current technology prevents the economic production of many species, but refinement and innovation may one day make all of the species available for consumers, if such demand exists.

Shrub collections obtained by the program are sent to The Nature Conservancy’s Lennox Woods Southmost Preserve to establish germplasm seed nurseries for the benefit of shrub growers and for those seeking to harvest seed for restoration use. Restoration practices for native shrubs in south Texas have been developed by personnel from the Texas Parks and Wildlife Department and the US Fish and Wildlife Service. These methods are well refined, produce excellent results (Ewing and Best 2004), and are recommended for use in the region.

Forb and grass collections are inventoried, assigned USDA NRCS accession numbers, and stored until suitable numbers of collections of the species are assembled to begin evaluation. With perennial grasses that are primary components of native habitats of south Texas, large numbers of collections are sought. Our goal is to obtain at least 2 collections from each of the 33 counties in the project area. Breeding systems, as well as known genetic and phenotypic variation of these grasses varies greatly, thus development and evaluation strategies must be individually devised for each species. Collectors attempt to obtain seed from as many plants as possible at the field collection site (Figure 5). Often

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times, after evaluation, accessions with similar collection attributes (same ranch or soil series) are combined to simplify selection and to potentially increase genetic variability in the release. Initial genetic screening of all species would be of great worth to our work and subsequent plant development efforts nationwide. This would be helpful to ensure that the full range of genetic diversity is reflected in the ecotype release. Furthermore, it would ensure that problems, such as sterility from mismatched ploidy levels, and inbreeding and outbreeding depression, are avoided. The PMC and STN have begun to genetically evaluate some species within the program. Some grasses such as multiflower false Rhodes grass (*Trichloris pluriflora* Fourn. [Poaceae]) have widespread, habitat-diverse distributions, but as a whole appear not to have significant genetic diversity as a species (Lloyd-Reilley and others 2008). Despite this, field evaluations do reveal phenotypic differences among populations that may be important characteristics to consider in a future release.

**Grasses**

Species such as bristlegrasses (*Setaria* P. Beauv. [Poaceae]) pose unique challenges in development of usable plant material for a diverse region such as south Texas. Various species of bristlegrasses occur, and they are often important co-dominants of south Texas plant communities. Variation is high among populations in traits facilitating commercialization (reproductive ability from seed and growth habit). This variation is compounded by taxonomic and breeding biology confusion in the genus and by habitat and soil specific distribution of ecotypes and species. A mechanical blend (Catarina blend bristlegrass; Lloyd-Reilley and others 2010a) was developed to provide a commercially viable product of bristlegrass, while assuring that diverse plant material, functional from an ecological standpoint, was also provided. Other species, possessing both apomictic and sexual modes of reproduction and displaying significant phenotypic variation, are released as blends of genetically pure germplasms. Releases such as La Salle Germplasm Arizona cotontop (Smith and others 2009a) include ecotypes originating from a broad range of sites in the region that have performed well at numerous evaluation locations. Although some crossing of these ecotypes is inevitable in mixed-ecotype commercial production fields, the mostly apomictic nature of the Arizona cotontop ensures that pure strain plants should exist in commercially available material, as well as in crosses that may be adapted to intensely disturbed sites and to those sites not represented specifically by a selected ecotype in the blend. These selected accession blends can reasonably be promoted only if the components have similar statures and seed maturity dates, to avoid inadvertent selection during commercial harvest. Long-term genetic drift in these released mixtures is controlled by placing limits on the life of commercial seed production.
fields. After a predetermined time period, producers must estab-
lish new fields with Foundation Seed.

Another release, Dilley Germplasm slender grama (Smith
and others 2009b), has almost no phenotypic difference among
the 4 selected accessions; however, 2 accessions exhibit high lev-
els of seed dormancy, while 2 produce seed that is mostly non-
dormant. The combination of these accessions results in a seed
source with characteristics representative of the broad adapta-
tions of the grass across the region. Other grass releases, such as
Mariah Germplasm hooded windmillgrass (Lloyd-Reilley and
others 2010b), are composed of a single collection of the species,
with a unique adaptation of having a strongly stoloniferous
growth habit that makes it especially useful for road rights-of-
way revegetation and erosion control.

**FORBS**

Forbs present many challenges. Populations of annual forbs typi-
cally present little variation, but some minute characters do differ
and can make commercial seed production interesting. Rio
Grande clammyweed (Polanisia dodecandra (L.) DC. ssp.
riograndensis Iltis [Capparaceae]) accessions varied in their abili-
ty to flower and reproduce multiple times during a growing sea-
son, an ability of obvious benefit to successful commercial pro-
duction. Perennial forbs such as orange zexmenia (Wedelia texana
(A. Gray) B.L. Turner [Asteraceae]) exhibit variation in flower
height above foliage, an important consideration for mechanical
harvest. This species has one of the broadest ranges of adaptation
to dissimilar habitats of any plant evaluated. Accessions selected
originate from deep bottomland clays, to sandy loam savannas, to
gravelly hilltop ridges. A release containing ecotypes adapted to
various sites should perform better across the region, which is
characterized by landscape and habitat diversity.

Other forbs evaluated, such as Divot tallow weed blend
(Smith and others 2010), were selected for high seed yields and
quality; other than this measure, the released accessions differ
little from nonselected accessions. This blend is a mechanical
combination of 2 Plantaginaceae species, redseed plantain
(Plantago rhodosperma Decne.) and Hookers plantain (Plantago
hookeriana Fisch. & C.A. Mey.). These species strongly segregate
by soil type, making a blended seed mix easier to establish across
large areas and easier for consumers to use. In many flowering
forbs, genetic concerns may be very important. Research should
be carefully evaluated to determine if multiple ploidy levels or if
the potential for inbreeding depression exists (such as a small
original collection). In the case of species such as orange zex-
menia, limited variation in ploidy level is known to exist for the
genus, so potential for inbreeding depression is low, and inclu-
sion of numerous ecotypes of this cross-pollinated species
should result in a release with potential for favorable adaptation
to many sites.
PLANT EVALUATION AND SELECTION

The need for evaluation of plant materials is justified here by discussion of a single trait important for restoration seed products: a high proportion of the seeds produced in a common environment are full and germinate promptly, that is, are not dormant. At South Texas Natives, we refer to this trait as “high active germination.” This important attribute is an absolute necessity for the use of native plants for soil stabilization and reclamation efforts, and for restoration of areas dominated by invasive grass. This trait differs greatly among regional populations of many species. While populations possessing low seed fill and (or) high seed dormancy (“low active germination”) may be extremely fit in their native environments, their propagation and potential use by restorationists is limited. Obviously, this scenario represents a tradeoff between the restoration gene pool concept and the realities of seed industry and regional benefit. While non-seed bearing (vegetatively reproducing) ecotypes may be very useful in small-scale restoration efforts, their mass production and establishment is financially not feasible on a regional scale.

A commonly suggested method of developing restoration plant materials is to use a bulk population or convergent-divergent improvement system (Munda and Smith 1996). A limitation of this concept is that if materials of poorly adapted plants are contained in the bulk population, or are allowed to cross with more desirable genotypes of seed-producing plants, this flaw reduces the quality of the release and makes commercial seed production more difficult. By selecting against non-seed-bearing plants, thus creating smaller bulk population releases of more fit ecotypes, important attributes such as low seed dormancy and adequate seed yield can be facilitated. This approach allows for easier, more economical commercial production of the species and in turn greater use and restoration success.

In some cases, limitations to seed yields or quality of some plants can be overcome with agronomic production techniques (Lopez-Garcia and others 2007) or seed treatments (Herrera-C and others 2006). Other species, such as big bluestem (Andropogon gerardii Vitman [Poaceae]) collected from south Texas, show almost no adaptation to reproduction from seed, making development of restoration plant materials unlikely except in limited cases where transplants or vegetative divisions can be used. If the species is desired by the restorationist, more rigorous selection, breeding, or movement into a tertiary part of the restoration gene pool paradigm will be warranted (that is, the cultivar approach). This approach has been taken with switchgrass (Panicum virgatum L. [Poaceae]), a species with merits beyond traditional restoration uses, but with attributes among south Texas populations similar to big bluestem. Improvement mechanisms include recurrent selection for nondormant seeds and screening for reduced crown node elongation.

When evaluating populations of a species, we strive to select, assemble, and release a germplasm of important plant species possessing attributes that meet the conservation need justifying the plant’s development. These needs are diverse and range from restoration of biodiversity, to providing species competitive to invasive exotic grasses, to providing plants for stabilization of highway rights-of-way. Habitats within south Texas also are characterized as diverse. Thus we strive to develop germplasm releases with multiple origins, possessing known adaptation to important sites, but with potential for adaptability to others. To meet these needs a systematic process of evaluation is conducted. For a single plant species, this involves 3 principle phases: initial evaluation, advanced evaluation, and release and commercialization.

Initial Evaluation
We evaluate accessions at the earliest stages of our work (Figures 6 and 7). Original field collections must be able to be...
cleaned to a degree that will facilitate mechanical planting. Species that cannot be reasonably processed to this point have little chance of being commercially produced, or in-demand by consumers because they cannot easily be planted. Plant characteristics such as seed ejection, extreme lodging, decumbent growth forms, or need for shaded habitats are also noted, and collectively or individually may leave the species’ development doubtful. Initial estimates of seed yields and seed quality are devised or experimentally determined. Because we select against poor adaptation for seed fill or germination in this stage, laboratory analysis of seed viability is often conducted on the original seed collections. This evaluation is not a true evaluation of individual accessions (because seeds were not produced in a common environment in time or space), but it does give an indication of divergence or convergence among the regional population for the trait, and of the potential, or lack thereof, for development of the plant. A thorough literature review of the species breeding biology, natural distribution, and limitations to use (such as an archaic designation as a noxious native weed) should be completed before significant development work with a species is undertaken.

Next in the initial evaluation effort is the production of greenhouse transplants of each accession (Figure 8). We select against accessions with poor seed fill, as well as prolonged seed dormancy depending on the duration of growth allowed in the greenhouse before transplanting. Replicated plots of each accession are transplanted at multiple evaluation sites based on the natural distribution of the plant in the region. This multi-site evaluation is important, as selection based on data from a single location could very easily result in the selection of material adapted to only a single location and that performs poorly elsewhere. Common metrics of plant performance (survival, growth...
vigor, development stage, biomass production, seed production, growth habits) are recorded on the experimental plots for 2 to 3 y, and seed is collected and tested for quality. At the conclusion of the initial evaluation, data are analyzed by site. In most cases, different superior accessions are identified at each evaluation site. Selections are guided by the breeding biology, natural distribution and habitat attributes of the species, and finally by the evaluation data collected. Often, the superior performing accession(s) from each evaluation site are selected, as are any populations with exceptional performance at all sites, or with unique adaptations that could increase the utility of the release (for example, extremely high seed quality).

Advanced Evaluation

In this phase of evaluation we produce seed of the selected accessions for future experiments, and rigorously assess the commercialization potential of the plant. Original seed from the wild collections or vegetative divisions of the initial evaluation plots is used to increase each selected accession. All increases of accessions are spatially isolated (+275 m [900 ft]) to ensure genetic integrity of the selected materials. These increase fields are commonly 0.1 to 0.4 ha (0.25 to 1 ac) in size and are managed and harvested intensively to evaluate seed yield potential, harvest and production techniques, and pest control issues. Herbicide tolerances, fertility requirements, and management techniques useful for seed production are commonly screened, too (Figure 9). Flowering and maturity dates and plant stature are closely monitored to determine if production of the selected accessions is possible in a common field or if segregated production and subsequent mechanical blending of the accessions will be required in a release. Seed harvested from these fields is used in research and trial planting by project personnel and collaborators to assess the performance of the selections and to determine recommendations for use of the species by restorationists (for example, seeding rates, season of seeding, and timelines for establishment). Poor performance of the species in field plantings may lead to efforts to reevaluate the material and selections or to discontinue efforts to develop the species. Good performance in these plantings provides confirmation of adequate development and selection and provides further justification for release of the plant for commercialization. Our advanced evaluation process requires 1 to 3 y on average.

Release and Commercialization

At conclusion of a successful advanced evaluation, and once adequate seed quantities are obtained for commercial producers to establish fields, release documents for the germplasm are prepared. Project personnel work closely with commercial seed producers to initiate production and to provide considerable technical assistance to growers. Large-scale seed production of the components of the release is continued, so that adequate amounts of seed are available to meet commercial demands in case of early failures. In this stage, additional trial and demonstration plantings are conducted to inform potential consumers about the release and to further define the area of adaptation, potential uses, and limitations of the germplasm (Figures 10 and 11). After release, another 1 to 2 y is required to successfully commercialize most species so that they are available in limited quantities to consumers (Figure 12).

REVEGETATION AND RESTORATION SCIENCE

While development of native plant materials for south Texas is a major goal of STN and the PMC, much work is also needed in the disciplines of revegetation science and restoration ecology. Extensive scientific and practical backgrounds and knowledge of native plant revegetation and restoration on rangelands exists for much of the US and adjacent regions of the desert southwest; however, little empirical knowledge of native plant restoration exists for south Texas. Almost all rangeland restoration research in south Texas during the past century focused on the establishment and development of exotic grass species for livestock forage production. A few empirical studies have compared the planting of native grasses in south Texas (from seed obtained from wild populations) with plantings of the exotic buffelgrass for forage production (Gonzalez and Dodd 1979). Other early efforts at restoration employed the use of maladapted native plant seed; although this seed was taxonomically the same species as those native to the region, subsequent plants were ecotypically dissimilar and established or persisted poorly. The past use of these maladapted ecotypes in many government-sponsored programs and by landowners resulted in widespread planting failures and was aptly named a farce and a charade (Pogue 2001), even by members of the seed industry. The choice of planting mate-

Figure 9. Initial seed increase fields of selected accessions of 6 native grasses at Rio Farms. One of 12 similar fields currently managed by South Texas Natives and Rio Farms.
Figure 10. Demonstration project site after planting in September 2008.

Figure 11. Demonstration project site 7 mo after planting, May 2009.

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rals has been suggested as the fundamental component of rangeland rehabilitation, reclamation, and restoration projects (Jones and Johnson 1998).

Other historical restoration and revegetation research in south Texas focused on germination and propagation of woody plants whose restoration was necessitated by loss of habitat for wildlife in the Lower Rio Grande Valley because of urbanization (Everitt 1983a, b, 1984; Fulbright and others 1986a, b; Vora 1989; Ewing and Best 2004). This research led to successful germination techniques, useful planting techniques, and improved monitoring efforts that resulted in extremely effective restoration of woody plant communities. The lesson to be learned is that restoration success can be achieved by thorough examination of intricacies of native plant species and development of economical methods to restore them.

An awareness of the ecological processes and plant–plant and plant–habitat interactions is imperative to restoration success in south Texas. As is the case with many regions, south Texas is plagued by a variety of invasive exotic grasses; a single restoration site hosts 17 different invasive exotic grass species (Falk and others 2009). The plant–plant interactions between native and introduced grasses are currently the greatest limiting factor to successful restoration in the region, despite well-adapted seed sources. Methods to suppress invasive exotic grasses in south Texas with herbicides (Ruffner and Barnes 2008; Tjelmeland and others 2008) show promise, but reinvasion is typically inevitable from surrounding populations. Recent work (Falk and others 2009) hints that the establishment of diverse, multi-species communities (successional, functional, and species groups) by planting native seed mixes may initially suppress the reinvasion of exotic grasses. Past work has shown that few, if any, of the native herbaceous plants in south Texas individually have season-long competitive ability with buffelgrass or Kleberg bluestem (Smith and others 2009c). Seed mixtures of multiple species and functional groups, however, especially those with at least seasonal competitive ability (for example, annuals, early successional grasses, and large stature forbs) with exotics may provide acceptable restoration results, create more suitable habitat for wildlife, and sustain biodiversity. The planting of dicots and maintenance of stands with monocot-specific herbicides may also have successful implications for improvement of exotic grass monocultures and promoting ecosystem function for wildlife. Long-term field studies are necessary to evaluate the success and persistence of these efforts.

Current efforts to develop restoration methodology for the region include research, trial, and demonstration efforts region-wide. Ten rangeland demonstration plantings, funded by private landowners, make up one such project. The plantings utilize a seed mixture of 10 plant releases that are, or soon will be, commercially available to consumers. These plantings can be used by agency personnel, private landowners, and seed dealers to show those interested in rangeland restoration activities the potential benefits and expectations of the practice. Vegetation data are collected biannually from this series of demonstration plantings and will be used to refine recommendations for site preparation, seed mix composition, and season of seeding to landowners and land managers in future years (Figure 13).

Another project, also in collaboration with private landowners and part of a doctoral student’s work, is evaluating various seed mixtures and subsequent maintenance treatments to sustain biodiversity and create habitat for the economically important Bobwhite Quail (Colinus virginianus) in areas dominated by buffelgrass and Kleberg’s bluestem (Graham 2009). A master of science student’s project is also underway in which a 34-species seed mix, weighted in composition by functional groups of native plants that are competitive with exotic grasses, is being evaluated for potential to prevent exotic grass invasion of areas without existing seedbanks of competitive native

Figure 12. Commercial seed production field of South Texas Natives Project release of Dilley Germplasm slender grama.
plants (Falk and others 2009) (Figure 14). Research plantings have been conducted to also refine seed mixture composition and performance on state-owned highway rights-of-way in the region (Lund and others 2008). Significant work is ongoing with the Texas Department of Transportation to refine methods to revegetate highway rights-of-way using native seed. This potential use of native seed sources represents one of the largest sectors of use of our plant releases and impacts thousands of acres of habitat annually in the region.

Other novel techniques, for instance the use of transplants of herbaceous plants to restore small patches of disturbed habitat (such as that impacted in the production of fossil fuels and wind energy), are being studied. The realm of microsymbiot interactions among native and exotic plants (Hickman and others 2009), assemblages of native plants (Lucero and others 2008), and their habitats, is being aggressively studied by STN with a number of collaborators. This important ecosystem component has largely been ignored in revegetation and restoration science but may well prove to be one of the most important considerations for future successful restoration in highly disturbed landscapes such as south Texas. Evaluation of many often-recommended techniques to re-establish microsymbiots to restoration sites (such as the addition of soil, root material, or hay) has demonstrated little benefit in our experimental trials. Current work focuses on the development and evaluation of plant-specific inoculums for several important native grass species. Additional studies to classify native and exotic plant microsymbiot communities are underway with collaborators at Oklahoma State University in Stillwater.

Restoration by reseeding mixes of adapted native plants after efforts to suppress existing exotic plants and their seedbanks, followed by management using herbicides, grazing, and prescribed fire, shows indications of providing an effective restoration option for south Texas. On many lands, careful stewardship and cessation of destructive management practices alone will facilitate the natural restoration and sustainability of native plant communities and biodiversity. Artificial restoration efforts will necessarily employ active treatments such as reseeding in some instances, but just as important, conditions do not always necessitate the addition of seed or the expense associated with planting it. The intricacies and nuances of this synergistic approach are in the early stages of development, but future discovery will be spurred onward by what many believe is the inevitable loss in the coming decades of millions of hectares of native habitat to development and to exotic grasses. The consequences, in terms of biodiversity and economic prosperity of the region with the escalating losses in native flora and fauna, are too great to stand idly by and do nothing. We hope to provide suitable native plants and restoration methodology to reverse these downward trends already apparent in south Texas, before the damage becomes so great that the area can no longer sustain life for plants, animals, and people.
Restoration planting methodology experiments are ongoing as part of the South Texas Natives efforts across south Texas. Development of techniques to restore native grasses and forbs to exotic grass-dominated landscapes is a critical conservation concern in south Texas. This photo shows one such effort in which a 34-species native seed mix is being studied for this use.

Government agencies and private landowners desperately need native plant material and assistance that programs such as these and South Texas Natives can provide. Effective partnerships among stakeholders and agencies advance these efforts immeasurably. To further native plant restoration success and conservation of biodiversity in Texas, effective programmatic support, legislatively appropriated, would do much.

This is Caesar Kleberg Wildlife Research Institute Manuscript 10–119.

REFERENCES


