U.S. Fish & Wildlife Service

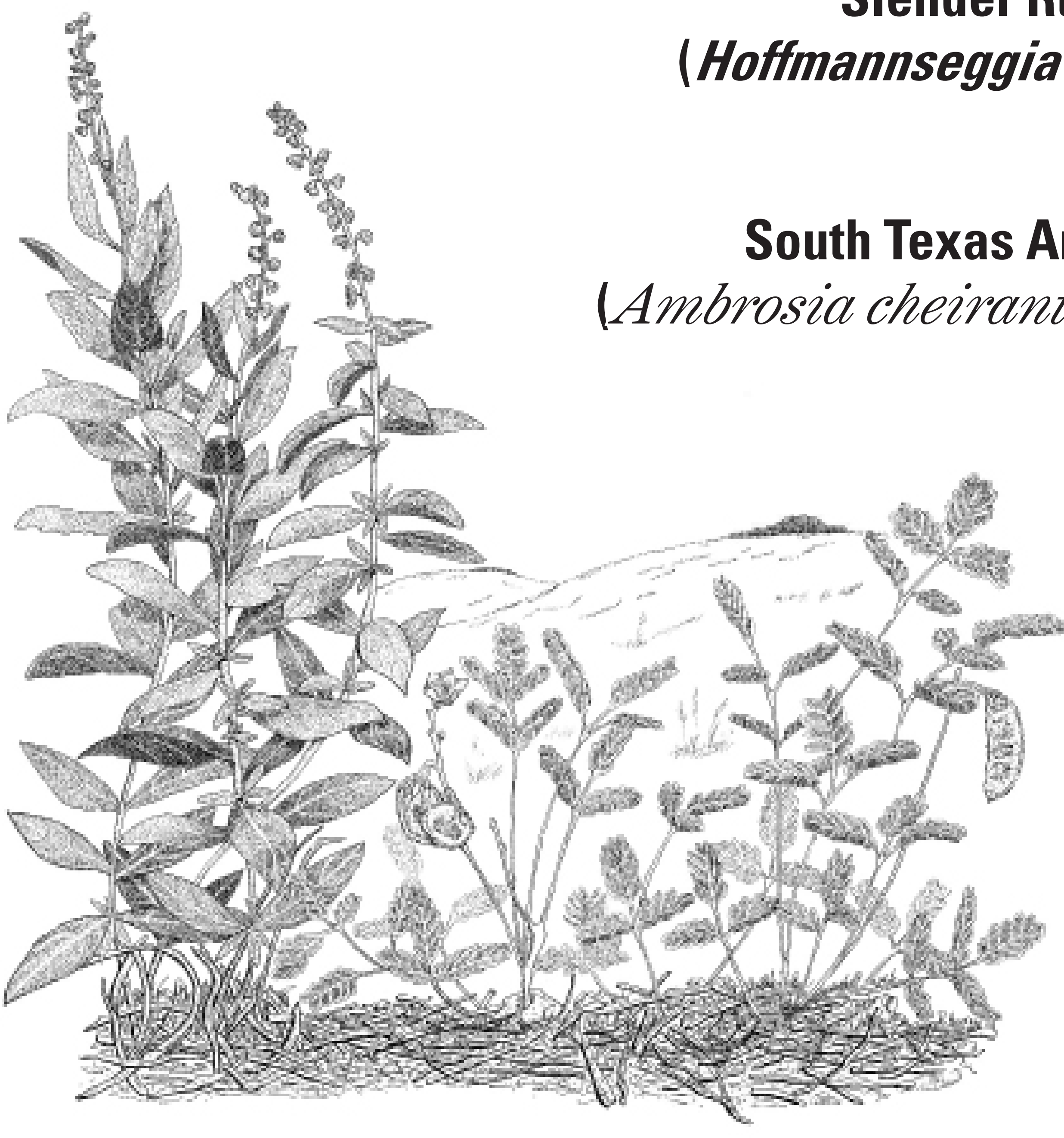
Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan:

Including

Slender Rush-Pea (*Hoffmannseggia tenella*)

and

South Texas Ambrosia (*Ambrosia cheiranthifolia*)



August 2018

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Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (*Hoffmannseggia tenella*) and South Texas Ambrosia (*Ambrosia cheiranthifolia*)

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For

Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

August 2018

Approved: ______________________________
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Date: Aug 21, 2018

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DISCLAIMER

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), requires developing recovery plans for listed species, unless such a plan would not promote a particular species' conservation. In accordance with the Endangered Species Act, Section 4(f)(1), and to the maximum extent practicable, recovery plans delineate reasonable actions that are believed to be required to recover or protect listed species. The U.S. Fish and Wildlife Service publishes recovery plans. Recover Plans are sometimes prepared with assistance from recovery teams, contractors, state agencies, and other affected and interested parties. The public reviews the plans and the U.S. Fish and Wildlife Service submits them for additional peer review before adoption. Plan objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific tasks and may not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Recovery plans represent the U.S. Fish and Wildlife Service's official position only after the Regional Director signs them. Approved recovery plans are subject to modification as dictated by new findings, species status changes, and recovery task completion.

By approving this document, the Regional Director certifies that the data used in its development represents the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in developing the plan are available in the administrative record, located at the Texas Coastal Ecological Services Field Office in Houston, Texas.

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EXECUTIVE SUMMARY

Species Status: Slender rush-pea (*Hoffmannseggia tenella*) and the South Texas ambrosia (*Ambrosia cheiranthifolia*) were both listed as endangered species by the U.S. Fish and Wildlife Service and added to the List of Endangered and Threatened Wildlife and Plants in 1985 (USFWS 1985) and 1994 (USFWS 1994), respectively. As required by state law, both species are also listed by the Texas Parks and Wildlife Department. Both species are geographically restricted to coastal shortgrass prairie habitat within Nueces and Kleberg counties, Texas. Only 8 slender rush-pea and 7 South Texas ambrosia populations remain extant with few numbers of individuals and most exist on private lands and/or have not been revisited in over 20 years.

Habitat Requirements and Limiting Factors: Both species are known from the Texas Coastal Bend within Nueces and Kleberg counties, Texas, within the Gulf Coast Prairies and Marshes Ecoregion. Native habitat includes a mix of grasses and forbs atop clay, silt, and sandy soils of the Pleistocene Delta. Both species are tied to specific drainage systems. Land conversion and habitat loss, and the alterations or abatement in current vegetation management strategies (fire, herbicide, mowing) have caused encroachment of nonnative grasses to the few remaining shortgrass prairies within this region. The genetic relationship of plants within and among populations remains an unanswered question for both species. With so few natural populations remaining across the landscape, these threats and other stochastic events could exacerbate the loss of either species or their habitat.

Recovery Strategy, Goals, Objectives, Criteria, and Actions Needed: The Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan presents the strategy, goals, objectives, criteria, and actions believed necessary to recover the rush-pea and ambrosia and to restore and maintain their shortgrass prairie habitat and its unique native flora. The strategy for rush-pea and ambrosia includes the long-term protection and management of the shortgrass prairie habitat needed by both species, and provides a roadmap for securing an adequate quantity of habitat of sufficient quality to sustain slender rush-pea and South Texas ambrosia long-term. A primary objective of this plan is to ensure that there are shortgrass prairie areas of sufficient size, number (20 populations of slender rush-pea and 15 populations of South Texas ambrosia), composition, and juxtaposition, determined by the most current biological information known for the species to support the continued existence of their populations that are able to persist and thrive in the wild. Using this strategy, the primary goal of this Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan is to ensure long-term persistence of sufficient amount and distribution of native coastal shortgrass prairie in suitable condition to support slender rush-pea and South Texas ambrosia populations and ameliorate threats such that both species can be downlisted from a status of “endangered” to “threatened” and further, recovered, or delisted, from the Federal List of Endangered and Threatened Plants.

To reach these recovery goals both species require the following actions to take place:

1. Minimize further loss or fragmentation of native shortgrass prairie habitat within Nueces and Kleberg counties, such that there is sufficient habitat to support slender rush-pea and South Texas ambrosia at levels that meet recovery goals.

2. Obtain required biological and demographical information to perform Population Viability Assessment and estimate actual Minimum Viable Population sizes for both species.

3. Actively manage shortgrass prairie conditions at all extant population (or subpopulation) sites of slender rush-pea and South Texas ambrosia to sustain both species at Minimum Viable Population levels or higher.

4. Develop reintroduction sites within the historic distribution range of slender rush-pea and South Texas ambrosia to increase the number of protected populations.

5. Determine the extent and prevent depletion of rush-pea and ambrosia seed banks.

6. Promote landowner relations and habitat management throughout the occupied and historical ranges of slender rush-pea and South Texas ambrosia in the United States.

7. Determine the genetic diversity within and among populations of rush-pea and ambrosia, and prevent its loss.

8. Determine optimal habitat requirements for slender rush-pea and South Texas ambrosia.

9. Determine and implement best management practices where possible and monitor the response of slender rush-pea and South Texas ambrosia populations to these practices.

10. Monitor long-term viability of all populations of slender rush-pea and South Texas ambrosia.

11. Increase knowledge of slender rush-pea and South Texas ambrosia abundance, distribution, and ecology.

12. Acquire long-term conservation easements where feasible, or conservation agreements, for occupied sites of slender rush-pea and South Texas ambrosia within each watershed from which the species are known.

Estimated Date and Cost of Recovery: Costs estimated to reach recovery reflect what is needed for specific recovery actions for these two shortgrass prairie species. Estimates do not include costs that agencies or other entities normally incur as part of their mission or normal operating expenses. Projecting time and cost estimates from 2017, the slender rush-pea could be fully recovered in 60 years (2078) and South Texas ambrosia could be recovered in 40 years (in 2058). The total cost of recovery for both species is $1,019,000. Cost estimates are provided in detail for the recovery action in the Implementation Schedule (Part III).

ABBREVIATIONS and ACRONYMS

ACT	Endangered Species Act
CCBG	Corpus Christi Botanical Gardens
CFR	Code of Federal Register
CPC	Center for Plant Conservation
DNA	Deoxyribonucleic acid
DOD	Department of Defense
FHWA	Federal Highway Administration
DPS	Distinct Population Segment
EO	Element of Occurrence
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FR	Federal Register
GPS	Global Positioning System
Hwy	Highway
INRMP	Integrated Natural Resource Management Plan
IPCC	Intergovernmental Panel on Climate Change
KRTA	King Ranch Training Area
LO	Landowner
MOU	Memorandum of Understanding
MVP	Minimum Viable Population
NABA-NBC	North American Butterfly Association – National Butterfly Center
NASK	Naval Air Station Kingsville
NAVY	U.S. Navy
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service
PMC	USDA Plant Materials Center
ROW	right-of-way
SABG	San Antonio Botanical Gardens
STXPRT	South Texas Plant Recovery Team
TAMUK	Texas A&M University - Kingsville
TDA	Texas Department of Agriculture
TPWD	Texas Parks and Wildlife Department
TXDOT	Texas Department of Transportation
TXNDD	Texas Natural Diversity Database
TZ	tetrazolium
USDA	U.S. Department of Agriculture
USDA-NRCS	USDA – Natural Resource Conservation Service
USDA-ARS	USDA – Agricultural Research Services
USFWS	U.S. Fish and Wildlife Service

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PART I: BACKGROUND INFORMATION

1.0 BACKGROUND

1.1 Introduction

The Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 et seq.), establishes policies and procedures for identifying, listing, and protecting species of fish, wildlife, and plants that are endangered or threatened with extinction. The Act defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The decision to list a species is based on a consideration of the five factors listed in section 4(a)(1) of the Act:

- Listing Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range.
- Listing Factor B. Overutilization for commercial, recreational, scientific, or educational purposes.
- Listing Factor C. Disease or predation.
- Listing Factor D. The inadequacy of existing regulatory mechanisms.
- Listing Factor E. Other natural or manmade factors affecting its continued existence.

To help identify and guide species' recovery needs, section 4(f)(1) of the Act directs the Secretary to develop and implement recovery plans for listed species or populations. Such plans are to include: 1) a description of management actions necessary to conserve the species or population; 2) objective, measurable criteria that, when met, will allow the species or population to be removed from the List of Endangered and Threatened Wildlife and Plants; and 3) estimates of the time and funding needed to achieve the plan's goals, including the intermediate steps to reach the goals. Recovery plans are advisory documents. Recovery recommendations contained in such plans are aimed at lessening or alleviating the threats to the species and ensuring self-sustaining populations in the wild.

The U.S. Fish and Wildlife Service (USFWS) approved a recovery plan for slender rush-pea in 1988 (USFWS 1988), but has not previously published a recovery plan for South Texas ambrosia. This new Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan (Recovery Plan) revises the 1988 slender rush-pea document and is also the first recovery plan for the South Texas ambrosia. For the remainder of the document, these species will be referred to as "rush-pea" and "ambrosia". Terms that are defined in the glossary are underlined throughout this document and can be found in Part V (p. 102).

1.2 Status of Coastal Shortgrass Prairie Ecosystem

This Recovery Plan, designed to restore populations of these two endangered plants, uses an ecosystem-based approach because both species currently inhabit patches of shortgrass prairie in two Texas Coastal Bend counties; in several cases co-occurring at the same locations. Rush-pea and ambrosia are both perennial herbaceous species growing in historically fire-dependent prairie habitat in South Texas. Both species are restricted to open grasslands where they occur in Nueces and Kleberg counties, Texas. Populations of both species occur on the fine, calcareous clays associated with Pleistocene deltas. Primary threats to both rush-pea and ambrosia stem from the present or threatened destruction, modification, and curtailment of habitat or range. This habitat loss results from conversion of native prairie to row crops, improved pastures, residential development, commercial development, and Federal installations. There is also ongoing, significant habitat degradation from encroachment as a result of nonnative, invasive pasture grasses; some localized disturbance from management techniques (mowing) and road construction, brush incursion, fire cessation; and, minimal damage from herbicide drift incidents onto highway right-of-ways (ROW). Appropriately managed mowing, fire, and grazing can assist in maintaining the shortgrass prairie habitat, but other forms of disturbance should be minimized. Drought conditions or altered rainfall distribution and resulting changes in vegetation community composition associated with climate change may exacerbate these impacts.

1.2.1 Characteristic Vegetation of the Coastal Shortgrass Prairie

All of the extant populations of rush-pea and ambrosia are found in Kleberg and Nueces counties, which lie within the Texas Coastal Bend region (Figure 1). This region also encompasses Refugio, Aransas, San Patricio, and Jim Wells counties, substantial portions of Victoria, Goliad, Bee, Live Oak counties as well as edges of Brooks and Kenedy counties (Lehman *et al.* 2005). The Texas Coastal Bend region is a subset of a larger vegetation ecoregion known as the Gulf Coast Prairies and Marshes Ecoregion (Gould 1975, Correll and Johnston 1979, Poole *et al.* 2007) (Figure 1). Three terms have been used to describe this region (see Table 1); however, we acknowledge the most current ecoregion name to be Gulf Coast Prairies and Marshes and use it throughout this document.

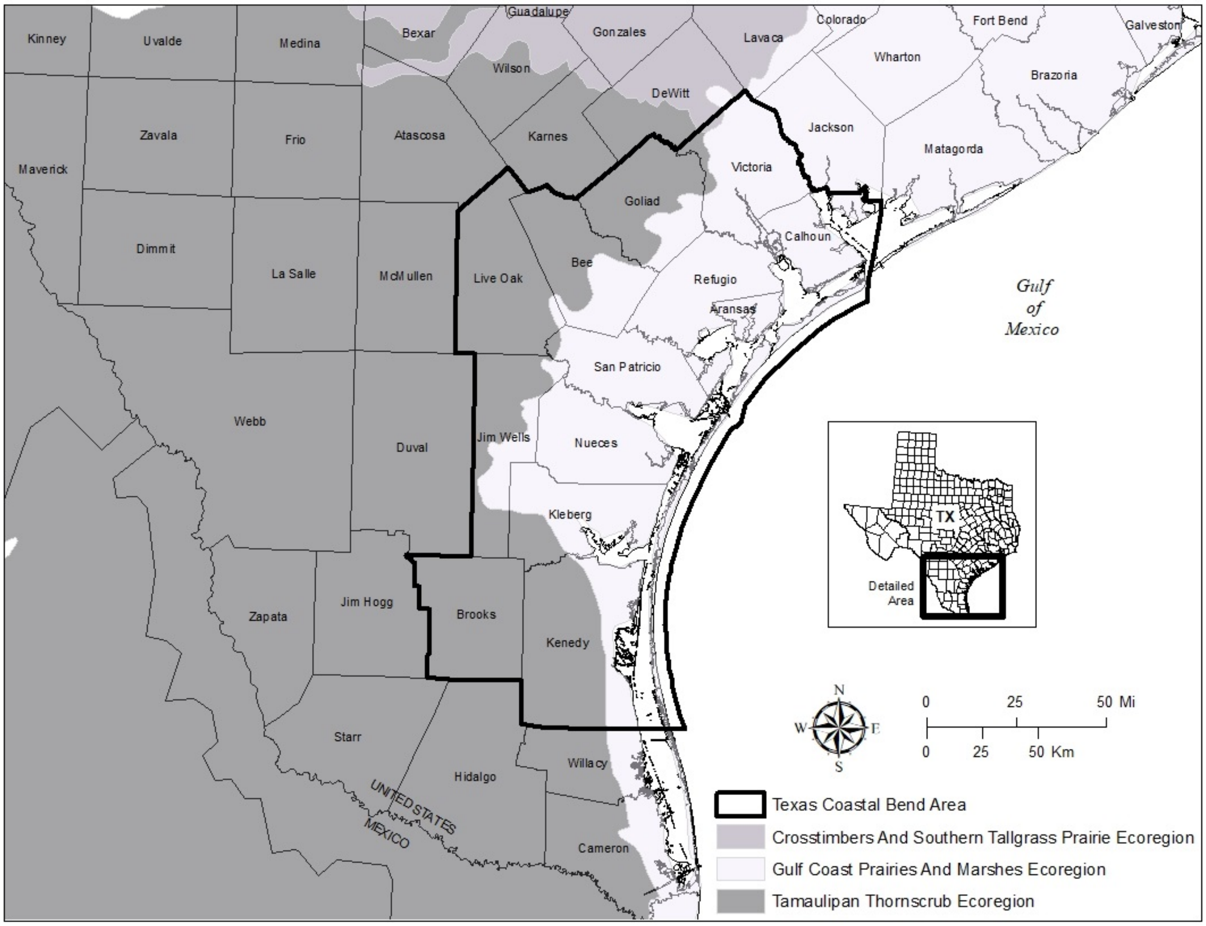


Figure 1. Gulf Coast Prairies and Marshes Ecoregion within Texas Coastal Bend Counties.

Table 1. Vegetation terms of Texas Coastal Bend.

Original Author	Classified Vegetation and associated soils included:
Hill 1901 (in Johnston 1963)	**Prairie**
Gould *et al.* 1960 (in Johnston 1963)	**Prairie**
Johnston 1963	**Kleberg clay prairies**: relics of coastal prairie on flat topography with underlying clay soils, formerly in Kleberg and Nueces counties. Prairies occupy part of the Pleistocene deltaic plain in Kleberg County. Similar small remnants could have been found in Refugio, Aransas, San Patricio, and Nueces counties due to cultivation and clearing, the rest of the area is covered with brush. Only small (sometimes only 0.25 acre), isolated patches, remain.
Gould 1975	**Gulf Prairie and Marshes**
Correll and Johnston 1979	**Gulf Prairie and Marsh**: occupies about 9.5 million acres along Texas coast and is characterized by level grasslands supporting ranching and farming. Area is of low topographic relief and upland prairie soils include heavier textured clays or clay loams, with some that are sandy loams.
Texas Natural Heritage Program 1978 (in Poole *et al.* 2007)	**Gulf Coast Prairies and Marshes Ecoregion**: most of the region is underlain by clays, silts, and sands of the Pleistocene or Holocene age.

Historically (more than 400 years ago), the shortgrass prairie of Nueces and Kleberg counties was primarily treeless grasslands, dominated by grasses and herbs or forbs (Hansmire *et al.* 1988, Lehman *et al.* 2005). Stands of shortgrass prairie were concentrated in patches among the habitat, on the underlying substrate of clay or sandy soils (see Table 2). Trees were locally abundant but confined to stream breaks and drainages (Furber 1848, in Johnston 1963).

Table 2. Historic prairie vegetation of the Kleberg Clay Prairie of the Texas Coastal Bend (Johnston 1963). Scientific and common names are derived from U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) PLANTS Database.

Grasses	
Short Grasses on clay soils	
Aristida roemeriana	purple threeawn
Bouteloua dactyloides	buffalograss
Hilaria belangeri	curly-mesquite
Panicum hallii var. *filipes*	Hall’s (or filly’s) panicgrass
Medium to Tall Grasses on sandy soils	
Cenchrus spinifex	coastal sandbur
Chloris andropogonoides	slimspike windmill grass
Desmanthus virgatus	wild tantan
Schedonnardus paniculatus	tumblegrass
Forbs	
Euphorbia albomarginata	whitemargin sandmat (rattlesnake-weed)
Evolvulus sericeus	silver dwarf morning-glory

Over time however, the composition and distribution patterns of the native vegetation within the shortgrass prairie changed. In the early 1800s when the Irish colonists arrived in the Coastal Bend, the area became a center for trade, although livestock and ranching remained its chief industries (Lehman *et al.* 2005, Long 2012). With settlement, grazing pressures increased and the natural prairie fires decreased due to active human fire suppression and decreased fuel loads resulting from over-grazing. Lack of fire on prairies allowed encroachment of woody vegetation and the concomitant decrease in grassland habitat (Johnston 1963, Lehman *et al.* 2005). Native woody species expanded their distribution across the landscape, and spread via seed dispersion by birds, other small animals, cattle, and horses (Lehman *et al.* 2005).

Land cultivation and farming continued to cause vegetation changes within the shortgrass prairie of the Coastal Bend. Farming of the Beaumont Formation clay soils that underlie the grasslands of the Coastal Bend portion of the Gulf Coast Prairies and Marshes Ecoregion began in earnest in the 1860s. The value of cotton and vegetables, including cabbage, onions, spinach, carrots, cucumbers, and turnips, as cash crops heavily dominated the local economy in the 1880s (Long 2012). Large tracts of land were cultivated with cotton, sorghum, and other crops (Lehman *et al.* 2005). Nueces County became a lead cotton producer for the state (Long 2012), while in Kleberg County a farming and dairy-dominated economy was made possible by construction of railroads (Coalson 2012). Woody habitats of the ecoregion, including live and post oak mottes and brush thickets, as well as marsh, and aquatic vegetation, experienced only minor changes in comparison to the coastal grasslands due to the difficulty in converting these areas to cropland or rangeland.

Today, only remnants of shortgrass prairie that had existed in the earlier part of the 19th century are left. The majority of land in the Coastal Bend is now primarily used for crop production, livestock grazing, and wildlife production (Hatch *et al.* 1999). About one-third of the land area has been converted into cultivated lands for sorghum, corn, and cotton. This equates to a conversion of 71 percent of Nueces County to cropland and improved pasture, and 14.7 percent of Kleberg County to cropland (USDA 2012, Texas A&M AgriLife Extension 2014). A percentage of agricultural land in Kleberg County is in pasture but the large percentage has not been converted. Additionally, land has been converted for energy production and transfer facilities; renewable energy (i.e. wind farms); and, road ROWs. Primary rangeland management practices in this area include prescribed winter burns; cattle grazing; and mechanical and chemical control, manipulation, or sculpting of brush. To provide for livestock, prevent soil erosion, and meet reclamation needs, area ranchers and state and government agencies have introduced nonnative grasses from Africa, Europe, Asia, South America, and other parts of the world (Table 3). In order to "improve" rangeland, native prairie and brush is plowed or otherwise broken up and planted to introduced grasses, often in a monoculture. Use of these plants for these purposes was pioneered in this region, and many such species were introduced prior to 1950. This practice has drastically changed the dominance structure of the vegetation communities (Lehman *et al.* 2005). These exotic grasses have become established throughout southern Texas, often exhibiting very aggressive, invasive properties, and are becoming the dominant plants in many native settings. Seeding, sprigging, and mowing of highway and pipeline ROWs to reduce erosion has helped to increase the distribution of these nonnatives into the remaining native prairie habitat.

Table 3. List of major nonnative, invasive grasses of the Texas Coastal Bend (Mahler 1982, Kuvlesky *et al.* 2002, Poole *et al.* 2007, and Poole 1988). Scientific and common names are derived from U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) PLANTS Database.

Scientific Name	Common Name
Bothriochloa ischaemum	King Ranch bluestem (yellow bluestem)
Cynodon dactylon	bermudagrass (Coastal bermudagrass)
Dichanthium annulatum	Kleberg's bluestem
Dichanthium aristatum	Angleton bluestem
Pennisetum ciliare	buffelgrass
Megathyrsus maximus	guineagrass

Currently, there are no known extant populations of rush-pea or ambrosia in Mexico. A record of ambrosia from Tamaulipas, Mexico, was collected in 1835 from a second ecoregion, the Tamaulipan Thornscrub Ecoregion (also known as the South Texas Plains, the Rio Grande

Plains, or Tamaulipan Brushlands) (Figure 1). This site was described as coastal shortgrass prairie habitat even though it was found within the Tamaulipan Thornscrub Ecoregion. Although similar in topography and sharing a number of grass, forb, and woody species, the dominant vegetative land cover differs. Instead of the vast grasslands of the Gulf Coast Prairies and Marshes Ecoregion, the Tamaulipan Thornscrub Ecoregion is dominated by spiny shrubs and trees, with grasses, forbs, and succulents also present (McGinley 2013). The flatter, deeper soils support honey mesquite (*Prosopis glandulosa*) and other woody species, sometimes found growing in dense thickets and sometimes in a savannah type of setting within a grassland matrix (McGinley 2013). So although the clay to sandy loam soils of the Tamaulipan Thornscrub Ecoregion has the potential to support ambrosia, locality information for the historic ambrosia occurrence is vague and the site was never re-verified. A second specimen thought to be ambrosia was collected from Tamaulipas in 2005 by Alberto Contreras-Arquieta and was stored at the Universidad Autónoma de Nuevo León. However, this specimen was not verified as *Ambrosia cheiranthifolia* either (A. Contreras-Arquieta, pers. comm. 2014).

Climate of the Coastal Bend varies considerably. Mean annual precipitation for Kleberg County is 69.9 centimeters (cm) (27.5 inches (in)) and there was a record rainfall in 1958 of 133.8 cm (52.66 in) (Bryan *et al*. 1987). In Nueces County, mean annual precipitation is 76.7 cm (30.2 in) and record rainfall in 1960 was 112.6 cm (44.35 in) (Bryan *et al*. 1987). Droughts interspersed with high rainfall events associated with hurricanes cause variability in precipitation. Both Corpus Christi (Nueces County) and Kingsville (Kleberg County) are within zone 9b of the USDA's plant hardiness zones, and a high number of frost-free days and high temperatures in both counties allow for a long growing season. Between 1976 and 2005, these areas experienced average annual extreme minimum temperatures ranging from -3.9 – -1.1°C (25-30°F) (USDA 2014). Generally the first frosts occur in late December (PlantMaps online 2014).

1.2.2 Watersheds of the Texas Coastal Bend

Most rush-pea and ambrosia populations are located near or along one of four unique drainage corridors in the Coastal Bend. Historically, rush-pea and ambrosia populations were more abundant and thus were likely represented along more drainage watersheds/basins. However, today rush-pea sites are found within the Petronila, Oso, Chilitipin Creek-San Fernando, and Alazan Bay-Baffin Bay creek basins; ambrosia is found within the Oso, Chilitipin Creek-San Fernando, Alazan Bay-Baffin Bay, and Santa Getrudis Creek basins. Most populations tend to be localized in remnant areas of shortgrass prairie within these drainage systems. Currently known populations of rush-pea and ambrosia are scattered in distribution and small in areal extent and numbers of plants. Therefore as a result, the shortgrass prairie habitat is greatly fragmented. All extant sites are found within a relatively small geographic area that is rapidly developing due to residential and commercial development; a scenario that could make both species vulnerable to extinction from catastrophic events. Such small, isolated populations can lose genetic diversity over time, leading to lower resiliency to stochastic events and a threat of extinction. Genetic studies have not been undertaken for either species to investigate the potential for genetic differences between plants from these four separate watersheds, therefore it is essential that populations from each system are managed and conserved long-term to preserve all possible genetic diversity. Water system improvements, drainage improvements, or water diversion projects could impact either species by leading to increases or decreases in water amounts reaching natural drainage routes, causing channelizing of natural drainage routes, and fragmenting habitat in an existing population or other potential habitat sites (USFWS 2010).

1.3 Slender Rush-Pea

1.3.1 Legal Status of the Species

History of Listing

The rush-pea was listed as an endangered species on November 1, 1985 (USFWS 1985). Critical habitat was not designated as it was believed that it might heighten the vulnerability of rush-pea populations to collection and vandalism. At the time of listing, rush-pea received a recovery priority number of 2 (Table 4), indicating that there was a high degree of threat but that recovery potential was also high. The final Recovery Plan primarily focused on two known populations of the rush-pea, one each in Nueces and Kleberg counties, Texas (USFWS 1988). On April 21, 2006, the USFWS initiated a 5-year review (USFWS 2006) of this species status which was finalized on November 11, 2008 (USFWS 2008). The 5-year review of the species' status did not recommend any change to this recovery priority number.

Table 4. Recovery Priority Numbers for slender rush-pea as outlined at the time of the original listing (U. S. Fish and Wildlife Service 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

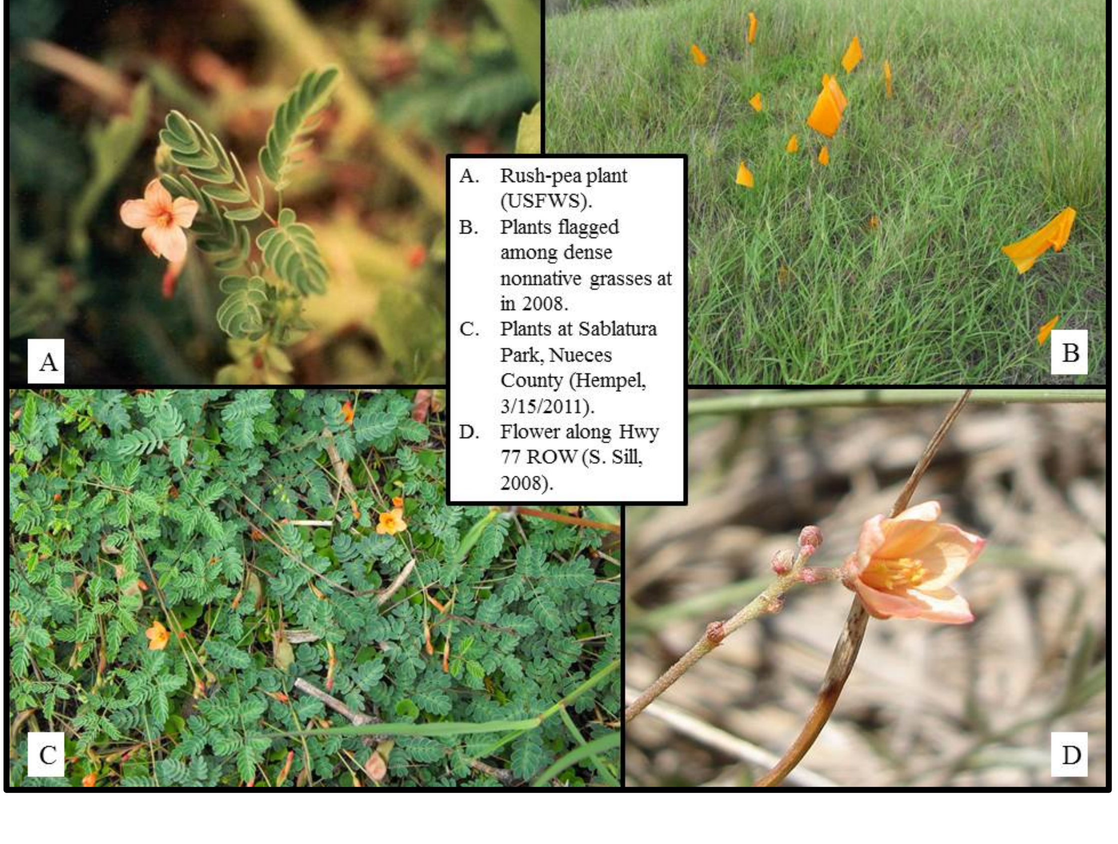
Note: DPS = Distinct Population Segment

Current Species Listing Status

Due to the initial conversion of much of Nueces County and portions of Kleberg County to row crops, and residential and industrial developments, and the continued degradation of habitat by nonnative grass species throughout its range, rush-pea is known only from remnant patches of habitat. The Texas Department of Transportation (TXDOT), city and county land managers, and private landowners manage for grass habitat on an as-needed basis at the Highway (Hwy) 77 ROW and Petronila Creek (former ROW) sites, Sablatura County Park, Bishop City Park, and St. James Cemetery. Because the projection for climate change includes a continued increase in temperature, warm-season species, including the nonnative grasses that already plague this habitat (Table 3), may be able to grow in conditions outside of their current range, thereby not providing any reprieve to rush-pea during its peak flowering season of April to November (Poole *et al.* 2007),. The level of threat is high for rush-pea, but it has a high potential for recovery due to compatibility with mowing as management and the ease with which its seeds germinate.

1.3.2 Description and Taxonomy

Rush-pea is an herbaceous perennial plant and is considered a valid taxon. The species was first collected in 1922 by L. J. Bottimer but it was not described until 1931 after F. E. Clements had collected rush-pea from a site between Robstown and Alice, Texas. Rush-peas's woody taproot gives rise to spreading stems and further into alternate and bipinnately compound leaves, ranging from 5-12 cm (2-4.7 in) (Poole *et al.* 2007) (Figure 2). Rush-pea is morphologically most similar to Watson's rush-pea (*Hoffmannseggia watsonii*), but is distinguished from the latter by fruit size, range, and preferred habitat type (Simpson 1999, Simpson *et al.* 2004).



A. Rush-pea plant (USFWS).
B. Plants flagged among dense nonnative grasses at in 2008.
C. Plants at Sablatura Park, Nueces County (Hempel, 3/15/2011).
D. Flower along Hwy 77 ROW (S. Sill, 2008).

Figure 2. Images of slender rush-pea. Note: USFWS = U.S. Fish and Wildlife Service; Hwy = highway; ROW = right-of-way.

1.3.3 Distribution

The 5-year review (USFWS 2008) determined that 2 of 10 documented collection sites (Hwy 77 and St. James Cemetery) had extant populations, 4 sites were inaccessible (no legal access to the property), 3 could not be relocated, and 1 (Petronila) appeared to be extirpated (Figure 3). As a result of work funded through a 2008-2010 Preventing Extinction cooperative agreement and other monitoring efforts, 8 populations were found to be extant (Table 5), although four of these (Hwy 77, St. James Cemetery, Bishop City Park, and a private residence in Bishop) are less than 2.5 km (1.6 miles) apart from the others and probably function as a single metapopulation. Three of the eight (Sablatura County Park, Bishop City Park, and a private residence between St. James Cemetery and Bishop City Park) are new discoveries, and the Petronila site has been temporarily recovered through suppression of the nonnative grass Kleberg bluestem with grass-specific herbicide. Although the King Ranch training area (KRTA) sites have not been visited since 1993, the populations (probably subpopulations of another metapopulation) are likely extant since we have no knowledge that habitat has been disturbed to the point that it is not suitable for rush-pea.

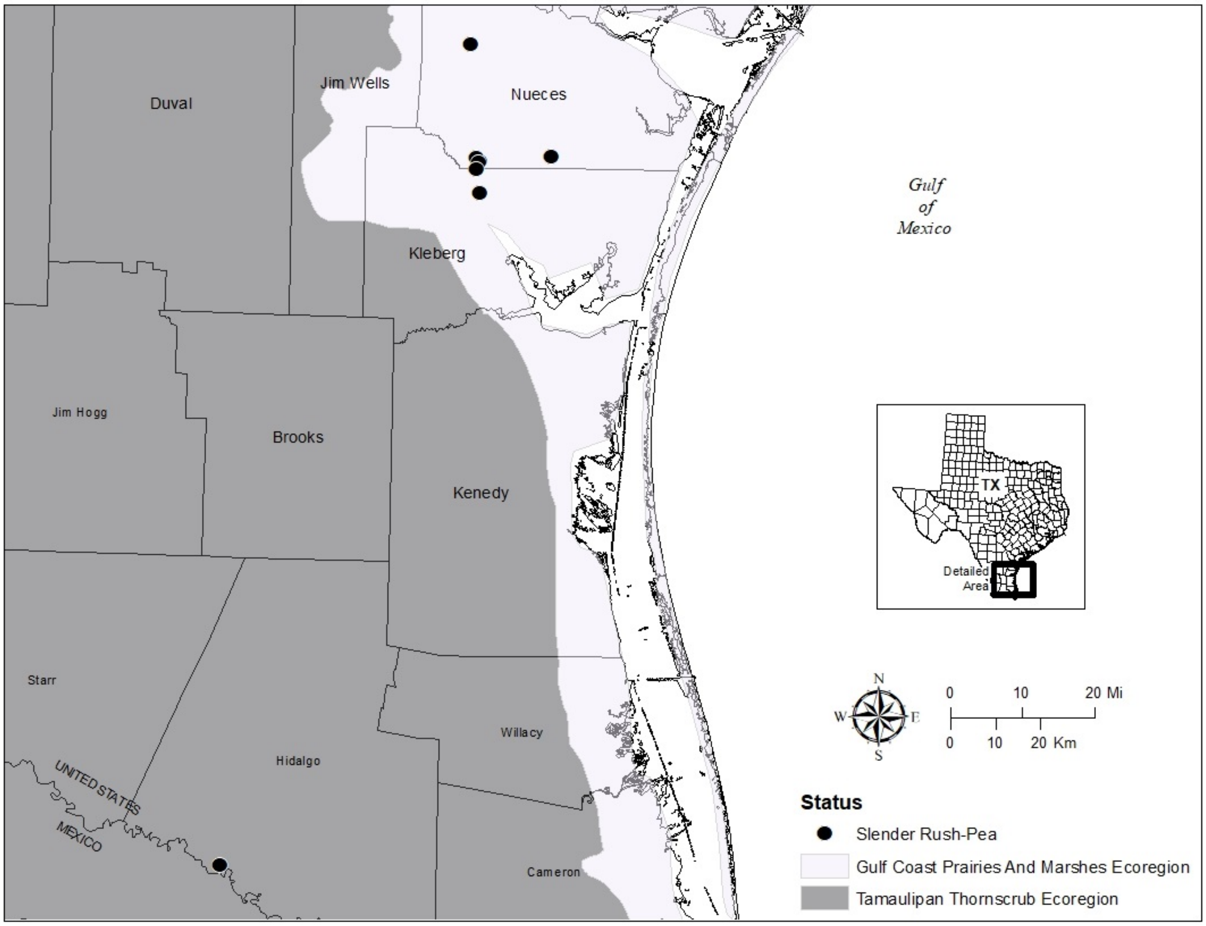


Figure 3. Map of extant slender rush-pea populations in Texas according to Texas Natural Diversity Database data (2013a; Gould 1975, Correll and Johnston 1979).

Table 5. Known historic and extant populations of slender rush-pea. The population #'s reflect only the extant populations. Element Occurrence (EO) #'s are listed in the Texas Natural Diversity Database (2013a). Watershed/basins in the table are "10 level" watersheds as designated by the U.S. Geological Survey. All other information is derived from the Slender Rush-Pea Controlled Propagation and Reintroduction Plan (U.S. Fish and Wildlife Service 2012).

Pop. #	EO #	First Observer; Observation	Last Observer, Observation	County	Site Description	Watershed/ Basin	Voucher	Population Size and Observations	Status	Ownership
1	1	Correll; 1964	USFWS, TXDOT; 2017	Nueces	20 acres of a 1,014-acre tract at Petronila Creek and SH 70 bridge ROW.	Petronila Creek	Correll 28989 (1964, LL); Correll 38906 (1970, TEX, SMU); Ajilvsgi 8239 (1982, SMU), FSU, CCM	In 1986, site contained about 100 plants. This site has been visited a number of times since 1982, with the number of plants varying probably due to observer effort. As of 2004, plants were no longer visible at the site. In 2010, site was mowed and spot-sprayed with *Select* (Reilley pers. comm.2010). In May 2011 and 2012, 194 and 303 seeds respectively, were collected by the PMC. Only 50-100 plants within 0.34 acres exist (USFWS 2012). Site was visited in Oct. 2013 to collect seeds, however habitat has not recovered from vehicular damage (and drought?), therefore few plants and no seed were observed. TXDOT installed fencing and bollards to restrict vehicles from the site (summer 2013). The Nueces County Sheriff's Department plans to patrol the area. Posted signs have also been planned for the site and will likely be put up in 2014. In March 2014, TXDOT walked the hillside where they found new plants in previously disturbed areas; plants had produced seed (C. Amy, pers. comm. 2014). In July 2016, site was very dry and overgrown with invasive grasses – plants were not doing well. A few plants could be found in spring 2017, but site is very overgrown with invasive grasses.	E	State
	3	L. J. Bottimer; 1922	L. J. Bottimer; 1922	Nueces	Robstown, along railroad tracks in city limits.	Oso Creek	Bottimer 7 (TEX)	Single specimen was collected with fruit. Numbers of plants not reported and population was never relocated.	H	Unknown

	4	F. E. Clements; 1931	F. E. Clements; 1931	Nueces	Between Robstown and Alice.	Oso Creek	Clements 199914, 199866, 199867 (TEX)	In 1922, specimen was collected, but exact location unknown. Numbers of plants not reported and population was never relocated due to the nondescript location.	H	Unknown
2	5	J. Poole; 1985	C. Amy, R. Cobb; 2017	Nueces	St. James Cemetery, Bishop	Chilitipin Creek-San Fernando Creek	Neff 88-11-4-1 (1988, TEX); Simpson 05-15-92-1 (1992, TEX)	Site has been visited frequently between 1985 and 2011. Population estimated > 1,000 plants in 1992. The population is still large but declining due to Kleberg bluestem. Experimental mowing and herbicide treatments have been completed. As of 2007, there were about 10,000 plants. About 100 seeds were collected in 2011 and are being maintained at the PMC Site has been revisited frequently between 1985 and 2011. In 2012, Dr. Rideout-Hanzak began studies on the impacts of shading. Studies to look at rush-pea's response to fire were to begin in Dec. 2012, but have not been completed. Rush-pea and ambrosia are both being investigated by Dr. Overath at this site; however, no studies were anticipated for rush-pea in 2013. Site observed in fall 2015; both rush-pea and ambrosia were present but mowing at site is infrequent – habitat is overgrown with nonnatives. Rush-pea and ambrosia were present and appeared to be thriving during site visits in 2016 and 2017. Appropriate moisture levels and mowing in the cemetery in late 2016 and what appears to be sometime in early spring in 2017 produced good growing conditions for both species.	E	Private
3	5	L. Elliott, R. O'Brien; 1993	A. Hempel, A. Strong; 2016	Nueces and Kleberg	U.S. Hwy 77 ROW on Nueces-Kleberg County line, both east and west side	Chilitipin Creek-San Fernando Creek		Population had an estimated 5,709 plants in May 2008. Herbicide spray incident occurred in September 2008 but plants were stable. Seeds were collected in May 2008. A bulldozing incident in ROW occurred in September 2009 and gravel was dumped on plants in April 2011. A Preventing Extinction grant funded the completion of a rush-pea Monitoring Plan in Nov. 2012. The plan will allow for the assessment of current population trends, will help to determine if management is beneficial, and verify unconfirmed and identify new populations. Population was monitored according to the plan in 2013 and 2016.	E	State

4		S. Maher; 2008	2016	Nueces	Private home near Bishop and cemetery. Across the creek from St. James Cemetery.	Chiltipin Creek-San Fernando Creek		First identified in 2008 with 50-100 plants. A total of 1,197 seeds were collected on May 13, 2010 and were stored at PMC. Population is stable and is within remnant shortgrass habitat. Landowner was known in 2013 but the property was sold. We no longer have access to the site therefore must request permission but plants still there as of 2016. The landowner is conservation-minded (2016). *This population is not the vacant lot discovered in 1976.*	E-Uv	Private
5		A. Hempel; 2010	R. Cobb, C. Amy; 2017	Nueces	Bishop City Park; street side and water side of the sidewalk	Chiltipin Creek-San Fernando Creek		A few plants were found in the cracks of the asphalt of a small walking path and on the water side of the path in buffalograss. The site suffers from Kleberg bluestem invasion. Seeds have been collected from this site (S. Maher, pers. comm. 2018). In December 2012, the site was overrun with grass but both rush-pea and ambrosia were present (R. Cobb, A. Miller). Plants were still alive in 2015, 2016, and 2017. The majority of plants have been found on the street side of the sidewalk but more recently, one plant was found on the water side of the sidewalk. A couple of plants were found along walking path on the interior of the park (J. Singhurst).	E	City
6		A. Hempel; 2010	R. Cobb; 2016	Nueces	Sablatura County Park	Oso Creek		This location may be the historical record for rush-pea from 1913 but location info is too vague to determine if they are the same site or not. Hundreds of plants first observed on March 19, 2010. Seeds were collected in Feb. 2011 as well as later in that year; 42 seeds and over 1,000 seeds, respectively. Seedlings were used for reintroduction plot in 2011 at NABA, in Mission, TX. A visit in Oct. 2012 found the population severely drought stressed. The area had also been mowed very short. Site visits since 2012 have confirmed the continued existence of the rush-pea at the park.	E	County
	2	F. B. Jones; 1964	F. B. Jones; 1964	Kleberg	Four miles south of headquarters, Laureles Division.	Alazan Bay-Baffin Bay	Jones 6146 (TEX, CCM)	Numbers of plants not reported. Site never revisited - no access. Site was described as pasture openings in clay loam soils. Herbarium records indicate that the EO likely includes two patches of rush-pea.	H	Private

7	7	W. Carr, L. Elliott; 1993	W. Carr, L. Elliott; 1993	Kleberg	KRTA - National Guard training area lease - both sides of intermittent creek, Bordo Nueveo Windmill, San Fernando Creek.	Alazan Bay-Baffin Bay		In 1993, two populations were located at San Fernando Creek, 3 populations at the KRTA, and one population at the Bordo Nuevo Windmill. Later in April 1993, several hundred plants with flowers and fruit were found along an intermittent creek. In May 1993, approximately 50 plants with fruit were seen across three locations. The KRTA is likely a metapopulation.	E-Uv	Private
8		C. Best, A. Hempel; 2011	M. Rice; 2015	Hidalgo	Introduced site at NABA-NBC, in Mission			**Introduced site.** Seedlings from Sablatura Park were collected in 2011 and planted in a shortgrass refugium on Oct 27-28, 2011. In July 2012, NABA biologists mowed the site and reported that native grasses along with rush-pea were doing well. As part of the Monitoring Plan, C. Best (USFWS) and J. Reilley (PMC) collected data in Jan. 2013. The NABA director reported that the plants were doing okay on site (R. Cobb, pers. comm. 2016).	E	Private

Abbreviations/Acronyms

CCM = Corpus Christi Museum of Science and History

FSU = Florida State University

KRTA = King Ranch Training Area

LL = Lundell Herbarium

NABA = North American Butterfly Association

NBC = National Butterfly Center

ROW = Right-of-way

SMU = Southern Methodist University

TAIC = Texas A&M-Kingsville

TEX = University of Texas at Austin Herbarium

TXDOT = Texas Department of Transportation

USFWS = U.S. Fish and Wildlife Service

Status

H = Historic

U = Unknown

E = Extant

E-Uv = Extant but status unverifiable due to limited access

Although rush-pea has never been reported outside of Nueces and Kleberg counties, suitable shortgrass prairie habitats range from Refugio County southward along the Gulf Coast, into northern Tamaulipas, Mexico, providing potential for its existence. The characteristic features of these habitats are vertisols supporting buffalograss-dominated vegetation (USFWS 2012). Most of this potential habitat has never been surveyed; furthermore, due to rush-pea's small stature and ephemeral emergence from a perennial rootstock, the species could have been overlooked in previous surveys. Therefore, it is possible that additional, perhaps disjunct, populations may occur elsewhere within this range. A refugium population of rush-pea has been established at the North American Butterfly Association - National Butterfly Center (NABA – NBC), Hidalgo County, Texas, using seed collected from the Sablatura County Park population, Nueces County.

1.3.4 Habitat Characteristics

Soils

Primary soils of rush-pea habitat are of the Victoria Association, occupying more than 60 percent of Nueces County (Franki *et al.* 1965). A similar proportion of Victoria soils are believed to underlie Kleberg County as well. Victoria soils are highly desirable for farming, producing some of the highest crop yields for corn and sorghum (Franki *et al.* 1965). Nevertheless, the known extant and historic sites of slender rush-pea all occur near streams, where erosion may have exposed narrow bands of subsoil or different soil types that, due to their small size, are not indicated on soil maps.

Several soil analyses have been conducted at sites where both rush-pea and ambrosia occur (Hwy 77 ROW and St. James Cemetery; see Table 6). As later noted in the ambrosia soils section 1.4.4, the results of these soils analyses were somewhat contradictory with regard to clay versus sand content (see Table 10). The population at Sablatura County Park, along Agua Dulce Creek (a tributary of Petronila Creek), was also analyzed in 2011 and was mapped as a Clareville soil. Clareville soils are loamy clays with sandy clay loam to sandy clay subsoil, are more friable and less clayey than Victoria soils, and less calcareous than Hidalgo soils (Franki *et al.* 1965). The analyses in 2011 showed that of the three sites tested, all were loam, fine sandy loam, or sand clay loam (S. Maher, pers. comm. 2014).

Historical and remnant rush-pea populations occur along drainage areas near creeks and streams and in uncultivated patches of habitat. This suggests that rush-pea may be specifically adapted to soils exposed along the erosional contours of watercourses. However, it cannot be assumed that rush-pea is naturally restricted to these riparian soils since the vast majority of uplands in these soil series in Nueces County as well as the northern portion of Kleberg County have been converted to farmland (exclusive of vast, privately-owned rangeland areas in Kleberg County where access for surveys has not been granted), so it is possible that these riparian zones are the only remaining available habitat for the species (USFWS 2012).

Table 6. Soil analyses for slender rush-pea locations.

Site	As Cited In:	Soil Observation
Sablatura County Park	Franki *et al.* 1965	Habitat is mapped as a Clareville soils which are loamy clays with sandy clay loam to sandy clay subsoil, and are more friable and less clayey than Victoria soils and less calcareous than Hidalgo soils.
	S. Maher, pers. comm. 2014	Three sites were analyzed in 2011. Textures included loam, sandy clay loam, and fine sandy loam.
Highway 77 right-of-way	Brannon *et al.*1997	Soils not classified as clayey, containing only 19-23 percent clay, and were classified as silty-loam.
St. James Cemetery	Franki *et al.* 1965	The site overlies the broad unit of Victoria clays (the soil series).
	Brannon *et al.*1997	Soils were not classified as clay and were composed of 40-41 percent sand with only 14-20 percent clay.

Vegetative Community

All rush-pea sites occur in barren openings or patches of native remnants of shortgrass prairie and are associated with both short and mid-grass species (Table 2). Additional native shortgrass species associated with rush-pea include Texas grama, curly-mesquite, and Texas wintergrass (Poole *et al.* 2007). Although rush-pea and ambrosia share similar prairie vegetation associations of the Coastal Bend (Table 2), rush-pea has specific associates (Table 7). The shortgrass prairie site with the most intact native vegetation is the St. James Cemetery, where rush-pea co-occurs with ambrosia.

Table 7. Common plant associates of slender rush-pea (U.S. Fish and Wildlife Service [USFWS] 1988[1], Poole *et al*. 2007[2], USFWS 2008[3], Texas Natural Diversity Database 2013a[4]).

Scientific Name	Common Name
Acacia spp. [1,2,3]	acacia
Ambrosia cheiranthifolia[2]	South Texas ambrosia
Amoreuxia wrightii[2]	Wright's yellowshow
Aristida spp.[2]	threeawns
Bouteloua ridgidiseta[1,2,3]	Texas grama
Buchloe dactyloides[1,2]	buffalograss
Castelia texana[1]	amargosa
Celtis laevigata[2]	sugar hackberry
Celtis pallida[1,2,3]	spiny hackberry
Condalia hookeri var. *hookeri*[1,2,3]	Brazilian bluewood
Condalia spathulata[2]	knifeleaf condalia
Desmanthus reticulatus[2]	netleaf bundleflower
Desmanthus virgatus[2]	wild tantan
Echeandia chandleri[2]	lila de los llanos, Chandler's craglily
Ferocactus setispinus[1]	barrel cactus
Galactia heterophylla[2]	Gray's milkpea
Hilaria belangeri[2]	curly-mesquite
Jatropha cathartica[1,2]	Berlandier's nettlespurge
Justicia pilosella[2]	Gregg's tube tongue
Mammillaria heyderi var. *hemisphaerica*[1]	Heyder's pincushion cactus
Menodora heterophylla[2]	low menodora
Nassella leucotricha[2]	Texas wintergrass
Opuntia engelmannii var. *lindheimeri*[2]	Texas prickly pear
Opuntia engelmannii[3]	prickly pear
Parkinsonia aculeata[1,3]	retama
Plantago rhodosperma	redseed plaintain
Prosopis glandulosa[1,2,3]	honey mesquite
Salvia coccinea[2]	blood sage
Schaefferia cuneifolia[1]	desert yaupon
Senecio tampicanus[2]	Great Plains ragwort
Stipa leucotricha[1,3]	Texas speargrass
Trichloris pluriflora[2]	multi-flowered false-rhodesgrass
Vicia sp. [2]	vetch
Yucca treculeana[1]	Spanish dagger
Zanthoxylum fagara[1]	colima
Ziziphus obtusifolia[1,3]	lotebush

1.3.5 Life History and Ecology

Reproduction and Genetics

The species is an herbaceous perennial legume, or pea, and a member of the family Fabaceae. Rush-pea has a long woody taproot, capable of forming colonies (Poole 1988). Plants generally grow in small clusters and produce multiple stems about 40 percent of the time (Rideout-Hanzak and Wester 2013). There are five small, yellow-pink to reddish orange petals per flower, which are known to bloom from April to November (Poole *et al*. 2007) but may flower as late as December (R. Cobb, pers. comm. 2013). Rush-pea flowering and fruiting have been observed during most months of the year. Flowers are only known to be open for several hours each day, normally during mid-day (Bush 1990, Poole *et al.* 2007, Dr. Patrock, pers. comm. 2014). Effective pollinators of rush-pea have not been observed in the field or in a greenhouse setting, however a generalist floral visitor was observed on rush-pea once at the St. James Cemetery (Dr. Patrock, pers. comm. 2014). Rush-pea is thought to self-pollinate as the rate of fruit set is high despite the lack of observed floral visitors (Pressly 2002). Flowers are perfect monoclinous, containing both male and female reproductive parts. Pressly (2002) demonstrated that flowers that were isolated from insects with micro-mesh cloth bags prior to anthesis still produced mature fruits with viable seeds, thereby providing additional evidence of the species' capability to self-fertilize.

Abundant fruits and viable seeds are produced in the wild and in propagated populations at the San Antonio Botanical Gardens (SABG), the USDA PMC, and NABA. The original plant material for these investigations was collected from the Hwy 77 ROW, St. James Cemetery, and Sablatura County Park site, respectively (R. Cobb, pers. comm. 2018). Fruiting has been documented from February to July (USFWS 1988); rush-pea flowers have been noted in September, November, and December therefore we can expect that plants subsequently produced fruit (R. Cobb, pers. comm. 2018). Rush-pea reproduction may be more attuned to rainfall during a particular time of year, but this could vary between individual plants and under varying environmental conditions (R. Cobb, pers. comm. 2018). Therefore, seed collections should be from all months of the year when pods are available in case there is variation across the population in terms of individuals and their tolerance levels to a variety of environmental conditions (USFWS 2016). Fruit and seed dispersal mechanisms are unknown. Seed dispersal in other legumes involves mechanical means whereby seeds are either forcibly or gradually released (dehiscence). Germination does not require a dormancy period (Pressly 2002).

Researchers from several institutions collected genetic samples from rush-pea plants, and by the end of 2006 had developed a library of clones from microsatellite-enriched DNA fragments (J. Manhart, pers. comm. 2006), but the work was never completed past this point due to a lack of funding (Overath and Grisé 2014). Genetic studies should be completed as we lack complete information on the genetic structure of rush-pea populations and reproductive biology.

1.4 South Texas Ambrosia

1.4.1 Legal Status of the Species

A 1983 status report of ambrosia provided sufficient information on biological vulnerability and threats to support preparation of the proposed rule to list ambrosia as endangered (Turner 1983). The ambrosia was listed as endangered under the Act on August 24, 1994 (USFWS 1994). The listing rule indicated that the species was believed to be vulnerable to collecting pressures and vandalism, therefore the USFWS determined that critical habitat designation was not prudent. Recovery priorities for listed species range from 1 to 18, with 1 signifying the highest recovery potential. The final listing rule for ambrosia (USFWS 1994) designated a recovery priority of 8, indicating a moderate degree of threat to the species but with high recovery potential (see Table 8).

Table 8. Recovery Priority Numbers for South Texas ambrosia as outlined at the time of listing (U.S. Fish and Wildlife Service 1983).

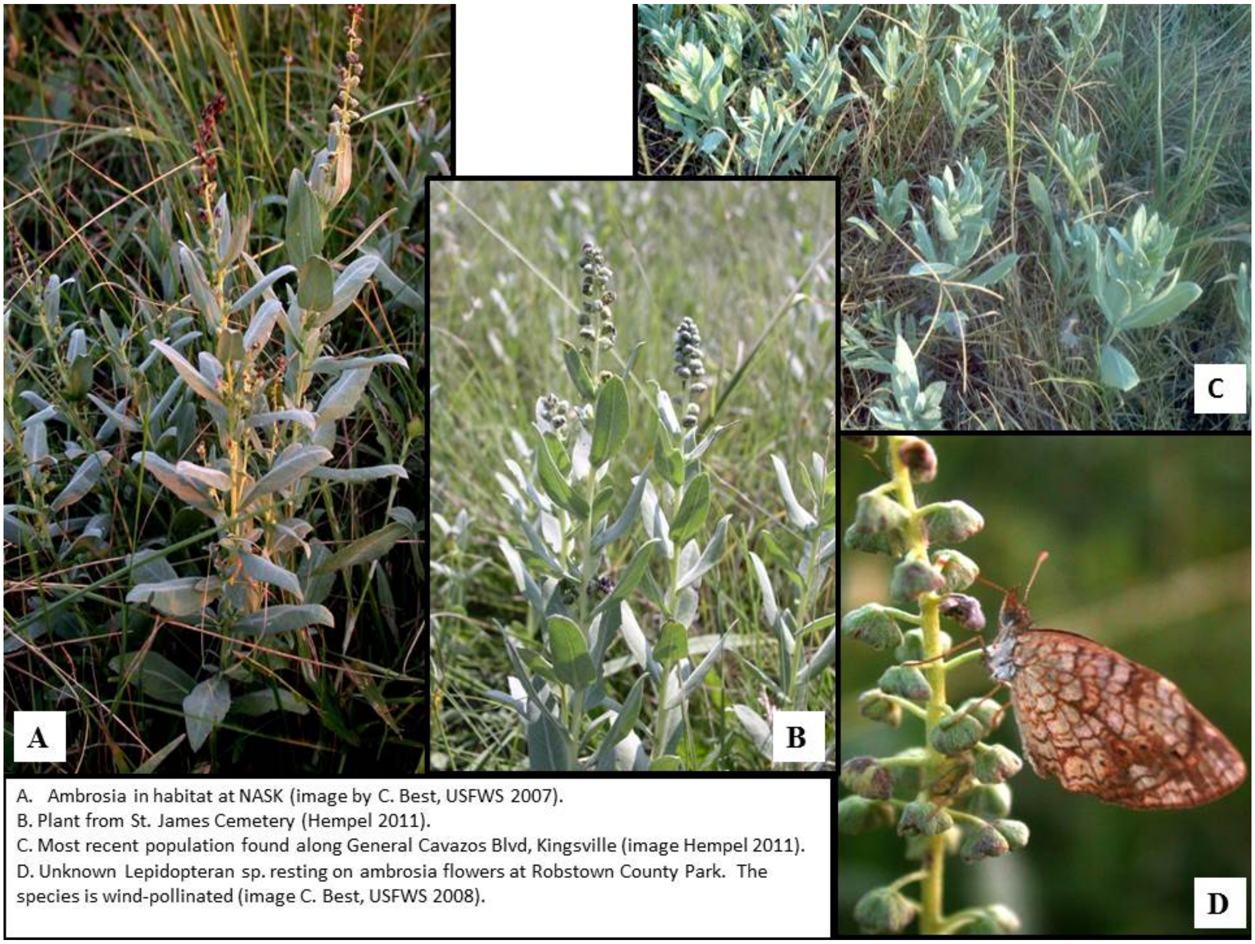
Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

Note: DPS = Distinct Population Segment

A 5-year review was conducted for the ambrosia in 2010, and is the most comprehensive status review of the species to date (USFWS 2010). Based on this status review, the continued fragmentation and conversion of Texas Coastal Bend shortgrass prairie habitat, coupled with the increasing encroachment of nonnative grass species, constitutes a high level of threat to the ecosystem throughout the region. However, these threats are moderated at extant ambrosia sites by ongoing management by the Federal government, local government, and private landowners. Given this moderated threat level, and the fact that ambrosia has been successfully propagated from cuttings, thereby providing potential restoration opportunities, the USFWS determined that the current recovery priority number of 8 for ambrosia required no change and captured the status of threats and recovery potential (USFWS 2010).

1.4.2 Description and Taxonomy

Ambrosia is an herbaceous, ashy blue-gray, rhizomatous perennial in the Asteraceae Family (sunflowers) (Figure 4). Stems of the plant stand erect and are approximately10–60 cm (3.9–23.6 in) tall. The number of individuals at any site is difficult to count due to rhizomatous growth habits that produce multiple stems from plants that are growing in closely-spaced colonies, thus inhibiting accurate stem number counts. The leaves are usually opposite at the base, and alternate above. The leaves are mostly oblanceolate or oblong-lanceolate, 2–7 cm (0.8–2.8 in) long, depending on the area of placement and the age of the stem, with the blade narrowing gradually at the base. Most leaves are unlobed and entire, although the lower and larger leaves of juvenile plants may be undulate or shallowly-pinnate. Both sides of the leaves appear whitened due to a fine and short appressed pubescence, giving the leaf an ashy, blue-gray color. The inflorescence is usually unbranched and composed of separate, inconspicuous male and female flowers. The male flowers occur in a terminal raceme 5–10 cm (2–4 in) long, composed of 10–12 small, light yellow, saucer-shaped flowers that are about 4 mm (0.16 in) broad with 4–6 acute, triangular lobes. The female flowers are in small clusters in the axils of the leaves. The fruit is an achene, somewhat angled and long with a stout beak. The fruit has 4-5 blunt spines spread across the surface (Poole *et al.* 2007). The genus Ambrosia is primarily wind pollinated.



A. Ambrosia in habitat at NASK (image by C. Best, USFWS 2007).
B. Plant from St. James Cemetery (Hempel 2011).
C. Most recent population found along General Cavazos Blvd, Kingsville (image Hempel 2011).
D. Unknown Lepidopteran sp. resting on ambrosia flowers at Robstown County Park. The species is wind-pollinated (image C. Best, USFWS 2008).

Figure 4. Images of South Texas ambrosia. Note: NASK = Naval Air Station Kingsville; USFWS = U.S. Fish and Wildlife Service.

Ambrosia is distinguished from a similar looking species, the false ragweed (*Parthenium confertum*), by its distinctive ashy-blue-gray color (S. Maher, pers. comm. 2012). Even given the distinctive color, it can be difficult to locate because taller native and introduced grasses easily obscure this species (Turner 1983). In winter, upper portions of the plant, including the inflorescence, become dry and rigid with a very characteristic silver-grey color (Bush *et al.* 1994). In spring, new foliage appears as a basal rosette with deeply-lobed leaf margins. The first ambrosia collection on record was taken by Luis Berlandier in 1835 in San Fernando, Tamaulipas, Mexico (USFWS 1993). In 1859, Asa Gray named the plant *Ambrosia cheiranthifolia* (Payne 1964). In 1932, the first collection of *Ambrosia cheiranthifolia* in the United States was taken from an area near Barreda (now Russelltown) in Cameron County, Texas, by Robert Runyon (Turner 1983).

1.4.3 Distribution

Historical or Unverified Sites of South Texas Ambrosia

Although the majority of remaining ambrosia sites are concentrated in the northern part of the range, from north central Nueces County to south central Kleberg County (Figure 5), there were historic records that indicated the range extended from Nueces County south to San Fernando, Mexico. A number of ambrosia occurrences are now considered historic because they have not been relocated in over 20 years or a confirmation of identification (or a voucher) is lacking (Table 9). A historical site is one for which a record exists, but either the site could not be re-verified after it was first reported, or the species has not been found at the site for a number of years even though surveys have been conducted and the habitat is more or less intact. These historical occurrences are discussed in more depth in the 5-year review (USFWS 2008). Two additional sites were referenced in the past, but neither has a voucher, thus are no longer considered historic or extant. One of these was in Jim Wells County but no voucher specimen confirmed its location, therefore it was impossible to relocate, and the other record was a 2005 collection from Tamaulipas, Mexico, that was never verified and is not considered an extant population site.

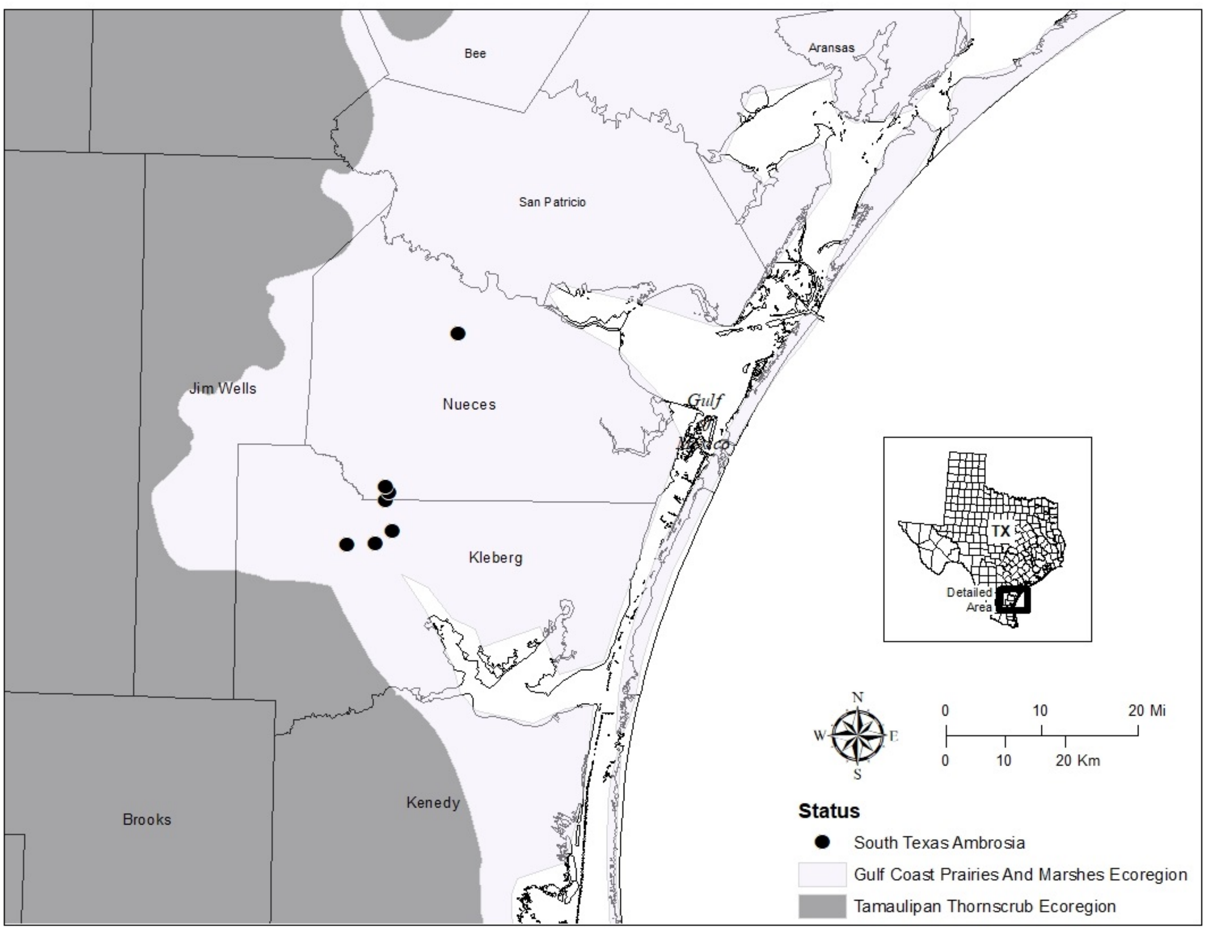


Figure 5. Map of extant populations of South Texas ambrosia in Texas from Texas Natural

Diversity Database data (2013b; Gulf Coast Prairies and Marshes Ecoregion map data online (Gould 1975, Correll and Johnston 1979)).

Extant Sites of South Texas Ambrosia

As of 2014, there are seven extant, or presumed extant, ambrosia populations from north-central Kleberg County through north-central Nueces County. One site occurs on state land, on both the north and southbound ROWs of US Hwy 77. The largest population occurs on Federal land at the Naval Air Station Kingsville (NASK). There are two sites on city or county-owned lands; the Bishop City Park and the Nueces County Park in Robstown. Two sites are located on private land, including a large population at the St. James Cemetery in Bishop and a small group of plants on a lot in Kingsville (General Cavazos Boulevard). Additionally, a National Guard training area formerly leased from a private landowner, known as the KRTA, has several sites (Table 9). These KRTA populations became inaccessible and thus unverifiable after the lease expired in the mid-1990s. Observations using Google Earth show the habitat still exists and the ambrosia is assumed to be extant. All of these separate KRTA occurrences are <1.0 kilometer (km) (3, 280 feet (ft)) apart and may therefore be a single metapopulation. The same is true for the occurrences in the St. James Cemetery, Bishop City Park, and the US Hwy 77 ROW, as well as the separate patches of ambrosia on NASK (see paragraph below). If the ambrosia is sexually reproducing, the close proximity between occurrences allows for the genetic exchange between each occurrence, or sub-population, and may mean that these sub-populations constitute at least 3 different metapopulations based on these distances. The population at Robstown and the one in Kingsville would be considered separate populations. See Section 1.4.5 for more detail on the reproductive strategy of ambrosia.

Several occurrences of the ambrosia consist of scattered sites or subpopulations that are located in close proximity to one another, with the largest being the population at NASK. The annual survey completed in November 2014 and draft management plan developed in spring 2016 by the Naval Facilities Engineering Command Southeast found that there were 30 scattered, discrete patches of ambrosia totaling 1.86 acres (Gulf South Research Corporation 2015). This population may constitute a single metapopulation based on separation distances of less than 1.0 km (USFWS 2010). Larger distances between populations or metapopulations, resulting from land cover conversion, improved pasture, and residential and commercial development, may serve as barriers for continued gene flow (NatureServe 2004).

Table 9. Known historic and extant populations of South Texas ambrosia. Population #'s reflect only the extant populations, where metapopulations are labeled with letters (i.e., a-f). Element Occurrence (EO) #'s are listed in the Texas Natural Diversity Database (2013b) and Carr (pers. comm. 2012). Watershed/basins in the table are "10 level" watersheds as designated by the U.S. Geological Survey.

Pop. #	EO #	First Observer, Observation	Last Observer, Observation	County	Site Description	Watershed/Basin	Voucher	Population Size and Observations	Status	Ownership
	1	F.B. Jones; 1968	T. Ayers and B.L. Turner; 1979	Nueces	Bank of Petronila Creek, Highway 70 crosses over bridge	Petronila Creek	Jones 7455 (1968, CCM); Turner s.n. (1979, TEX)	In 1979, found 100 plants. A 2008 survey found no plants; plants had not been seen in over 20 years. The habitat is overgrown with invasive grass and brush.	H	State
	4	M.D. Huettel, E. Szafir, and F. B. Jones; 1969	D. Price; 2004	Nueces	North side of Route 44, east of junction with State Route.24, west of Violet	Oso Creek	Szafir s.n, (1969, TEX); Huettel MH69151 (1969, TEX); Miao 89106 (1989, TEX); Carr 11569 (1991, TEX), CCM (O'Brien 1484,1986)	Found 100-1,000 stems in 1991 and 30-40 stems in 2000. Site may have been visited between 2004 and 2005 but plants were not found onsite. Two site visits in 2008 and 2009 did not find plants. Site was visited in 2010 and no plants; herbicide damage apparent at the site. Site visited in 2016 (R. Cobb, USFWS) but area is overgrown with invasive grasses.	H	State
	26	W. Carr; 1993	W. Carr; 1993	Nueces	North of Route 44 in Robstown, edge of cemetery at foot of railroad tracks	Oso Creek		In 1993 found 50 stems. Surveys done in 2000 and 2009 (A. Hempel) failed to find any plants. The City does on-site maintenance. The site was examined in 2015 but no ambrosia was located; extreme overgrowth of nonnative grasses in the area where ambrosia formerly occurred (R.Cobb pers comm. 2018).	H	State

1	6	R. O'Brien; 1988	R. Cobb, C. Amy; 2017	Nueces	St. James Cemetery	Chilitipin Creek-San Fernando Creek	Carr 11268 (1991, TEX); CCM (1988)	In 2005, found thousands of stems. A 2009 survey showed an average of 10 stems per sq. meter. This is the largest population known in Nueces County. Overath conducted fires studies (2013 and 2014) to determine effects to population density and flowering. Rush-pea and ambrosia were present and appeared to be thriving during site visits in 2016 and 2017. Appropriate moisture levels and mowing in the cemetery in late 2016 and what appears to be sometime in early spring in 2017 produced good growing conditions for both species.	E	Private
2		1993	R. Cobb, C. Best; 2016	Nueces	Hwy 77 ROW, southwest of Carreta Creek and immediately south of Nueces/Kleberg line; on both east and west sides of highway	Chilitipin Creek-San Fernando Creek		Ambrosia patch on West side of highway directly south of Caretta Creek monitored: 1,737 stems (1993). 4,201 stems (1994). 30 stems (2000). 592 stems (2002). Fire destroyed vegetation in 2008, however, this population recovered. A second patch occurs in the west ROW further south. One patch occurs in the East ROW immediately adjacent to the county line sign. Site visits in 2009 showed herbicide damage on East side and disturbance with what appears to be a decline in populations on both the east and west side of the ROW. Site observed in 2013 (A. Hempel). In spring/summer 2016, all patches were surveyed. Ambrosia plants in the east ROW patch were in good condition and spreading onto adjacent private land. West side population was doing best along fenceline. At this time, plants were in flower (R. Cobb, pers. comm. 2016).	E	State (expanding onto private land)

3	28	D. Price and L. Pressly; 2001	R. Cobb; 2016	Nueces	Nueces County Park in Robstown	Oso Creek		Sahadi initially located small number of plants in one park field. In 2006, a pilot reintroduction effort was started in another area of the park. Two new subpopulations found alongside park perimeter road in 2009. Plants looked good in 2011 in pilot site (R. Cobb, pers. comm. 2012). Found in patchy distribution along road. Overath surveyed the site in 2013, 2014, and Nov 2015. No changes in stem density/polygon were observed between 2013 and 2014; fewer stems in one polygon were observed in 2015 survey (D. Overath). Park visited in August 2016; plants were observed.	E	Municipal lands
		J. F. Sinclair; 1940	J. F. Sinclair; 1940	Kleberg	Coast near Kingsville	Upper Laguna Madre	Sinclair 42-156A (1942, TEX)	Historical record, but unable to relocate site due to inadequate location information.	H	Unknown
4	7	P. Clayton; 1991	Coastal Ecological Service Staff; 2014	Kleberg	NASK	Chilitipin Creek- San Fernando / Santa Gertrudis Creek	Carr 11413 (1991, TEX); Carr 12070 (1992, TEX)	Since 2005, systematic monitoring of NASK patches has shown number of patches ranging from 25 to 27 sites. These subpopulations are in close relative proximity (only about 1 km. apart) and may constitute a single meta-population (Garvon 2005). The 2008 survey showed impacts from invasive grasses. The 2009 survey was not completed. In 2013, there were 28 patches base-wide. A fence-to-fence survey done in November 2014 documented 30 total patches of ambrosia; reinforced the concept of a single metapopulation based on distance between patches.	E	Federal
5	19	W. Carr; 1993	W. Carr; 1993	Kleberg	KRTA	Alazan Bay- Baffin Bay		A 1993 survey found thousands or tens of thousands of stems.	E-Uv.	Private

5a	19	W. Carr; 1993	W. Carr; 1993	Kleberg	KRTA; Pinto creek	Alazan Bay-Baffin Bay		A 1993 survey found hundreds of stems.	E-Uv.	Private
5b	21	W. Carr; 1993	W. Carr; 1994	Kleberg	KRTA; Pinto pasture. Contains an east and west subpopulation.	Alazan Bay-Baffin Bay		In 1993, Carr found hundreds of stems at this site, but noted tens of thousands of stems in 1994.	E-Uv.	Private
5c	19	W. Carr; 1993	W. Carr; 1994	Kleberg	KRTA; road to Pinto Creek	Alazan Bay-Baffin Bay		Carr’s 1993 survey found hundreds of stems.	E-Uv.	Private
5d	19	W. Carr; 1993	W. Carr; 1995	Kleberg	KRTA; south towards Ramos Well	Alazan Bay-Baffin Bay		Several thousand stems.	E-Uv.	Private
5e	19	W. Carr; 1993	W. Carr; 1993	Kleberg	KRTA; southwest of Bordo Nuevo Windmill	Alazan Bay-Baffin Bay		Hundreds, but not thousands of stems.	E-Uv.	Private
5f	19	W. Carr; 1993	W. Carr; 1994	Kleberg	KRTA; road through Pinto pasture	Alazan Bay-Baffin Bay		Hundreds of stems.	E-Uv.	Private
6		A. Hempel; 2011	A. Hempel; 2016	Kleberg	Kingsville, on E. General Cavazos Blvd. west of intersection with 6th Street	Santa Getrudis Creek		At least half a dozen "patches" comprised of 100's of stems each, in an area about 250 sq. m (2,691 sq. ft.); might occupy larger area. Site was observed in Jan. 2016 and plants were still present although nonnative invasive grasses were encroaching site. Property ownership uncertain (A. Hempel, pers. comm, 2016) but For Sale signs present.	E	Private
	2	R. Runyon, 1932	R. Runyon, 1938	Cameron	near Barreda	Rio Grande / Nueces	Runyon 1440 (1932, LL, TEX0; Runyon 3291 (1938, TEX); U.S. National Herbarium (1941)	Unknown: no population size documented. Historical site has never been reconfirmed.	H	Unknown

	5	F.B. Jones; 1977	F.B. Jones; 1977	Jim Wells				Record published in Flora of Texas Coastal Bend (Jones and Jackson 1977). Locality information too vague to relocate.	H	Unknown
		L. Berlandier; 1835		Mexico	Municipio of San Fernando	Río San Fernando		First specimens of *Ambrosia cheiranthifolia* collected (No. 1513 and 3013). Specimens named in 1859 by Asa Gray (as published in Emory 1859).	H	Unknown
7		W. Carr, C. Bush, R. O'Brien, R. Cobb; 1992	R.Cobb, C. Amy; 2017	Nueces	Bishop City Park on northeast side of Carreta Creek; both sides of drainage ditch	Chilitipin Creek - San Fernando Creek		Recorded hundreds of stems in earliest surveys (no counts). Site visited in 2008 - no information. Site revisited as recently as spring 2017 and population still intact.	E	City

Abbreviations/Acronyms

CCM = Corpus Christi Museum of Science and History

Hwy = highway

KRTA = King Ranch Training Area

LL = Lundell Herbarium

ROW = Right-of-way

TEX = University of Texas at Austin Herbarium

TXDOT = Texas Department of Transportation

USFWS = U.S. Fish and Wildlife Service

Status

H = Historic

U = Unknown

E = Extant

E-Uv = Extant but status unverifiable due to limited access

1.4.4 Habitat Characteristics

Soils

Ambrosia is known to occur on various soils derived primarily from the Beaumont clay series, ranging from heavy clays to lighter-textured sandy loams typical of the Texas Coastal Plain (Turner 1983, Poole *et al.* 2007). A soil analysis has been completed for NASK, the KRTA, St. James Cemetery, and Hwy ROW 77 sites (Table 10).

Table 10. Soil analyses for South Texas ambrosia locations.

Site	As Cited In:	Soil Observation
Naval Air Station Kingsville	Garvon 2005	Soils are mainly composed of clay or sandy loams, specifically Raymondville clay loam, Hidalgo fine sandy loams, Clareville clay loam, and Czar fine sandy loam.
	Overath 2013a	Sampling of ambrosia patches on Naval Air Station Kingsville showed little or no significant difference between the soils from sites containing ambrosia populations to soils in the surrounding area. Planned to complete soil analyses to determine if textural differences along with a distinct shortgrass flora cover were different from the surrounding dominant mid-grass coastal prairie; as of December 2013, this had not been completed.
King Ranch Training Area	Texas Natural Diversity Database 2013b; W. Carr, pers. comm. 2007	Soils described as "lightly colored and textured, with a grayish silt or sand, being noticeably different from black clays on adjacent uplands."
Highway 77 Right-of-way	Brannon *et al.* 1997	Soils were classified as silty-loam not clays, containing only 19-23 percent clay.
St. James Cemetery	Franki *et al.* 1965	The site overlies the broad unit of Victoria clays (the soil series).
	Brannon *et al.* 1997	Soils were not classified as clay and were composed of 40-41 percent sand with only 14-20 percent clay.

Vegetative Community

The vegetative community for ambrosia consists of open prairies, savannas, and grasslands scattered with mesquite at elevations between 8-20 m (26–66 ft). Most of the sites where ambrosia is found contain only remnants of shortgrass prairie and are typically unplowed but mowed. Known sites are found within railroad and Hwy ROWs, cemeteries, mowed park fields, and erosional areas along creek systems. In native habitat, prairie species are often associated with ambrosia (Table 11). Rush-pea co-occurs at three sites with ambrosia (Poole *et al.* 2007) but it is not a dominant species. Several native woody plants found within and adjacent to ambrosia include honey mesquite, huisache, huisachillo, brasil, granjeno, and lotebush (USFWS 1994).

Table 11. Common plant associates specific to South Texas ambrosia (Poole *et al.* 2007[1], U.S. Fish and Wildlife Service 1994[2]).

Scientific Name	Common Name
Acacia schaffneri[2]	huisachillo
Acacia farnesiana [2]	acacia
Ambrosia psilostachya[1,2]	cuman ragweed
Bouchetia erecta[1,2]	painted tongue
Bouteloua rigidiseta[1,2]	Texas grama
Buchloe dactyloides[1,2]	buffalograss
Clematis drummondii[1,2]	Drummond's clematis
Condalia hookeri[2]	brasil
Glandularia bipinnatifida[1,2]	Dakota mock vervain
Celtis spp.	sugar hackberry[2], granjeno
Grindelia microcephala[1,2]	littlehead gumweed
Hilaria belangeri[1,2]	curly-mesquite
Hoffmannseggia tenella[1,2]	slender rush-pea
Indigofera miniata[1,2]	coastal indigo
Malvastrum coromandelianum[1,2]	threelobe false mallow
Melochia pyramidata[1,2]	pyramidflower
Nassella leucotricha[1,2]	Texas wintergrass
Parthenium hysterophorus[1,2]	Santa Maria feverfew
Prosopis glandulosa[2]	honey mesquite
Ruellia nudiflora[1,2]	violet wild petunia
Setaria leucopila[1,2]	streambed bristlegrass
Verbesina microptera[2]	Texas crownbeard
Ziziphus obtusifolia[2]	lotebush

1.4.5 Life History and Ecology

Reproduction and Genetics

More often than not ambrosia is seen reproducing vegetatively by rhizomatous regrowth in the upper portion of the soil. As a result, a single individual may be represented by several-to-hundreds of stems, depending on the age of the plant (Turner 1983). The most current scientific information suggests that ambrosia patches represent several separate individual members of a larger metapopulation, as is thought to be the case on NASK. In 2010, Overath began work on NASK ambrosia to answer a number of genetics-related questions including variation within patches (whether dominated by one or a few clones) and relatedness among patches; as well as analysis of the genotypes within patches. Overath (pers. comm. 2012) found little genetic variation among ambrosia samples collected and compared to 13 genetic markers, implying that all the separate patches on NASK are likely part of one larger population (or metapopulation). Small patches of ambrosia may be part of the same clone, but larger patches are not composed of single clones (Overath 2013b). However, these genetic studies also suggested that some NASK ambrosia patches (2013b) were reproducing sexually or that they had in the relatively recent past. Overath's genetic studies to determine the reproductive mode at other sites, including the St. James Cemetery (Nueces County), are incomplete at this time.

1.5 Threats Analyses

Current Threats to Shortgrass Prairie Ecosystem and Coastal Prairie Species

The assessment considers the threats identified in the original species listings (USFWS 1985, 1994) as well as threats documented more recently, as they appear in the rush-pea and ambrosia 5-year reviews (USFWS 2008, USFWS 2010), information from the South Texas Plant Recovery Team meetings (Jan 18, 2011, and Nov 11, 2013), and ongoing studies by academics, partners, and landowners or land managers. As outlined in the Act, all 5 listing factors are addressed in the section below (see Section 1.1 and Table 12). The greatest threats to the shortgrass prairie habitat and rush-pea and ambrosia are the loss, fragmentation, and other degradation of habitat. Currently, these species are most affected by the competitive invasion by nonnative grass species.

Table 12. Threats tracking table for slender rush-pea and South Texas ambrosia.

Threats	Affected Species	Recovery Criteria Numbers	Recovery Actions
***Listing Factor A**: Present or threatened destruction, modification, or curtailment of its habitat or range*			
Lack of knowledge	Both	2	3.1.1. Study soils and underlying geology.
Land conversion; habitat fragmentation	Both	2	3.1.3.1. Study the response to current natural disturbance and land use practices.
Land conversion	Both	2	3.1.3.2. Study the response to past natural disturbance and land use practices.
Land conversion; habitat fragmentation	Both	2	3.1.3.4. Investigate the fire ecology of both species and their habitat.
Habitat fragmentation	Both	1, 2	3.2.1. Analyze the demographic structure of all populations.
Habitat fragmentation	Both	1	3.2.3. Determine the primary means of reproduction in the wild.
Habitat fragmentation	Both	1, 2	5. Cooperatively work with landowners and land managers to restore additional shortgrass prairies sites located in one or more of the drainage areas from which rush-pea and ambrosia are known to co-occur.
Habitat fragmentation	Ambrosia	1	7.1. Develop a USFWS-approved controlled propagation and reintroduction plan for ambrosia.
Habitat fragmentation	Both	1	7.6.1. Develop a long-term monitoring program to assess success of reintroductions or introductions.
Habitat fragmentation	Both	1	7.7. Use information gained from the long-term monitoring program to adjust both species' reintroduction plans.
Land conversion	Both	2	8.1. Develop any necessary educational or outreach materials.
Land conversion	Both	2	8.2. Provide educational and outreach materials to landowners and land managers.
Land conversion	Both	2	8.3. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.

***Listing Factor D**: Inadequacy of existing regulatory mechanisms*			
Inadequacy of existing regulations	Rush-pea	1	7.2. Adhere to guidelines established in the Slender Rush-pea Controlled Propagation and Reintroduction Plan (USFWS 2012).
Inadequacy of existing regulations	Both	1, 2	7.3. Appoint a coordinating team to help plan and oversee the reintroduction programs.
Inadequacy of existing regulations	Both	1, 2	7.4. Incorporate reintroduction into applicable agency land management plans.
Inadequacy of existing regulations	Both	1	10.1. Maintain the STXPRT to help review the status of both species and assess the effectiveness of the management plans and other recovery tasks.
***Listing Factor E**: Other natural or manmade factors affecting its continued existence*			
Small population size; Lack of knowledge	Both	1	3.1.2. Determine the plant community structure for both species.
Climate change	Both	2	3.1.3.3. Study the response of both species and their habitat to seasonal or periodic cyclical events including drought, extreme heat events, freezes, and flooding.
Limited knowledge of pollination biology	Both	1	3.2.4. Study pollination biology; determine effective pollination requirements. If outcrossing is occurring, determine effective pollinators.
Small population size	Both	1	3.2.5. Study seed production and dispersal.
Small population size	Both	1	3.2.6. Study seedling recruitment.
Small population size	Both	1	4. Survey for additional populations of rush-pea and ambrosia.
Small population size	Both	1	5.3. Introduce experimental populations of rush-pea and ambrosia.
Small population size	Rush-pea	1	6.1. Ensure seed is collected and banked from each rush-pea site, including newly discovered populations.
Small population size	Rush-pea	1	6.2.1. Ascertain whether any changes in a rush-pea refugium system are needed, including any need for additional refugia.
Small population size	Both	1	9.1. Investigate both species' population genetics to ensure long-term persistence.
Small population size	Both	1, 2	9.2. Develop traditional MVP estimates for both species.

Small population size	Both	1, 2	9.3. Reassess the MVP size when new information is made available.
Lack of knowledge	Both	1, 2	10.2. Revise the Recovery Plan as needed.
			Multiple Listing Factors
A., D.	Both	1, 2	1.1.1. Maintain contact with all landowners or land managers each year.
A., D.	Both	2	1.1.2. Educate landowners about the extreme rarity and significance of both the ecosystem and species' on their property.
A., D.	Both	2	1.1.3. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, easement, and conservation agreements.
A., D.	Both	1	1.2.1. Cooperate with willing landowners to determine short- and long-term land use goals and their effects on both species.
A., D.	Both	1, 2	1.2.2. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers.
A., D.	Both	1, 2	1.2.3. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management.
A., D.	Both	2	1.3.1. Work with regulatory agencies (DOD-NASK, TXDOT, TPWD, USDA-NRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat.
A., E.	Both	1	2.1.1. Monitoring plan will include abundance measures to ascertain plant abundance and spread.
A., E.	Both	All	2.1.2. Monitoring plan will include measurements of habitat condition and ecological integrity, and note conservation status of sites.
A., E.	Both	2	2.2. Use the approved monitoring plans to annually monitor ambrosia and rush-pea, their habitat, management actions, and threats at extant sites.
A., E.	Both	All	2.3. Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites.

A., E.	Both	2	3.1.3.5. Study both beneficial and detrimental interactions with other species (includes invasive species).
E.	Both	2	3.2.2. Characterize phenology and assess the most vulnerable stages of life cycle.
A., E.	Both	1	3.2.7. Study population genetics to determine the genetic diversity within and among populations.
A., D.	Both	2	5.1.1. Cooperate with willing landowners to determine the best means possible for providing permanent protection and active habitat management of a site/s to maintain native shortgrass prairie. Conservation management could be implemented through cooperation with a Federal, state, municipal government, or NGO, or one in which the landowners or manager agrees upon.
A., E.	Both	2	5.2. Carry out restoration, including reintroductions, at a site/s such that it hosts a complement of the native shortgrass prairie grasses and forbs commonly associated with rush-pea and ambrosia.
A., E.	Both	1	6.3.1. Study cultivation requirements.
A., E.	Ambrosia	1	6.4. Continue experimentation with seed germination and effectiveness of ambrosia propagation from seed.
A., E.	Ambrosia	1	6.5. Continue vegetative propagation of ambrosia for purposes of reintroduction.
A., E.	Both	1	7.5. Perform experimental plantings at selected natural sites as pilot projects.
D., E.	Both	1, 2	10.3. Develop a post-recovery monitoring plan when appropriate.

Abbreviations/Acronyms

DOD-NASK = Department of Defense – Naval Air Station Kingsville

MVP = Minimum Viable Population

NGO = Non-governmental organization

STXPRT = South Texas Plant Recovery Team

TPWD = Texas Parks and Wildlife Department

TXDOT = Texas Department of Transportation

USDA-NRCS = U.S. Department of Agriculture – Natural Resource Conservation Service

USFWS = U.S. Fish and Wildlife Service

Recovery Criteria Key:

1 = South Texas ambrosia – downlisting and/or delisting criteria 1

2 = South Texas ambrosia – downlisting and/or delisting criteria 2

1 = Slender rush-pea – downlisting and/or delisting criteria 1

2 = Slender rush-pea – downlisting and/or delisting criteria 2

1.5.1 Factor A: The Destruction, Modification, or Curtailment of Habitat or Range

Habitat Loss and Conversion of Shortgrass Prairie in Kleberg and Nueces Counties
As is true of most counties within the Gulf Coast Prairies and Marshes, Nueces and Kleberg counties have experienced significant land cover changes. Few remnant sites of shortgrass prairie exist in Nueces County today; most habitat has been converted into row crops and improved pastures (intentionally planted with nonnative grasses), or otherwise urbanized (USFWS 2008, USFWS 2010). The extent of shortgrass prairie loss in Kleberg County is not as clear. Both counties are major cotton and sorghum producers (Haile and Brezina 2012). Conversion to these crops constitutes a total loss of native habitat because production of cotton and sorghum entails annual plowing, planting, harvesting, and tilling; practices that do not allow the persistence of native vegetation. Within Nueces County, between 60 and 70 percent of the land has been converted to row crops (Long 2012). Although a substantial part of northern Kleberg County has also been converted to row crops, a much larger portion of this county (mostly the southern half) remains rangeland; albeit, the condition of the native vegetation on this rangeland is unknown. Rangeland in Kleberg County supports cattle production and wildlife habitat; land uses that are not incompatible with the continued existence of native shortgrass prairie species. Additional land uses in both counties that have contributed to habitat loss include residential and commercial development; the impact from this type of land use being greater in Nueces County due to the more numerous and larger population centers.

Habitat Degradation and Fragmentation – Introduction and Competition of Nonnative Grasses
Currently, the primary threat to the continued existence of native shortgrass prairie species in the Texas Coastal Bend and their habitat is the continuing spread and habitat degradation caused by the invasion of nonnative grasses. Numerous grass species from Africa and Asia were introduced into much of Texas and Mexico in the 20th century for rangeland improvement, erosion control, re-vegetation of plowed or graded areas, or to be used as fodder (Gabbard and Fowler 2006, Lyons *et al.* 2013). Some of these exotic grasses were also seeded into highway ROWs, although current specifications by TXDOT call for the use of native grasses (see Table 3). Nonnative species threaten the integrity of the native shortgrass prairie of this region; some species like buffelgrass, have reportedly caused widespread displacement and decline of native herbaceous species (Lyons *et al.* 2013). Since their original introductions into this part of the country, these grass species have expanded their ranges from the highway ROW's, rangelands, and urban landscapes where they were originally planted (Strong 2012) and are now well established throughout most of the region.

Most, if not all, rush-pea and ambrosia sites have at least one species of introduced, nonnative grass present, and in some cases population sites are overgrown with dense monospecific stands of nonnative grasses. Land conversion and planting of nonnatives to reduce erosion have resulted in only remnant strips of suitable shortgrass prairie habitat where both species can persist. Therefore, extant populations of both listed plant species in Nueces County now only remain on small pieces of land that have not undergone disking and deep plowing, such as cemeteries, highway ROWs, and municipal parks.

Introduced grasses exhibit highly invasive characteristics including rapid growth, tall growth form, and in combination with a lack of disease and pests, they can out-shade and out-compete rush-pea for light, water, space, and nutrients (Pressly 1998). The shallow, fibrous roots of many grass species such as Kleberg bluestem allow quicker absorption of moisture and nutrients than is capable by tap-rooted species, such as rush-pea, which must wait for deeper moisture penetration (D'Antonio and Mahall 1991). Pressly conducted two experiments to test hypotheses regarding competition and shading. In her root competition (nutrient absorption) study with rush-pea, results showed that plants taken from the PMC and grown in conjunction with Kleberg bluestem, suffered a rate of mortality at 93 percent. Pressly suggested that the faster growing grasses absorbed nutrients more quickly than the native rush-pea, contributing to a higher growth rate in the nonnative grasses. Pressly (2002) alluded to potential allelopathic properties of Kleberg bluestem, which may have been a factor that hindered rush-pea growth, an observation supported by research showing Kleberg bluestem inhibits seed germination of other South Texas forbs (Kuvlesky *et al.* 2002). A second part of Pressly's study investigated effects of shading rush-pea using greenhouse shadecloth with the goal of comparing the differences in petiole heights and lengths between non-shaded (controls) and shaded treatments, as well as differences in growth patterns (Pressly 2002). Non-shaded plants grew in a prostrate manner while the petioles of the shaded plants grew upwards; however, rush-pea did not show significant mortality at 30, 40, and 50 percent shading (Pressly 2002).

A tailored herbicide application has shown to be suitable to control select invasive grasses in some Texas prairie habitats (Simmons *et al.* 2007). McCloughan *et al.* (2017) investigated four control treatments on invasive grasses and the implications for rush-pea management. The four treatments included: prescribed burn; weed-eating to remove above-ground competing vegetation; herbicide to remove above- and below-ground competition; and, a control (no treatment). Results of the study show that rush-pea appears to be a resilient species with high survival regardless of treatment; plastic in morphological expression; and, able to adapt to changing environmental conditions. Prescribed burns produced plants with the longest stem length and greatest number of main stems over other treatments. These results could suggest that burning rush-pea offers the plant a temporary advantage since there's more height and mass to compete for sunlight. By the season following a summer burn, the prescribed burning treatment produced more leaves than the control but less than either the herbicide or weed-eating treatments (although both had been in place longer). In the control treatment, rush-pea did not show higher mortality than any of the three treatments but did exhibit fewer stems, leaves, flowers, and fruits. McCloughan *et al.* (2017) suggested implementation of an active and aggressive prescribed burn plan, where possible. In instances where burning might not be practical or in severe drought, McCloughan *et al.* (2017) recommended the use of herbicides, mowing, or weed-eating as a fire surrogate. Since perennial grasses can return to pre-burn state within two to four years, burn cycles should be planned for every two years for rush-pea populations. Because the researchers could only burn once, they recommended a long-term study of fire and fire surrogates to determine trends over time and response under drought versus wet conditions. A true determination of burning effects on regeneration requires a longer term study that includes plant diversity and age structure within the rush-pea populations. Data collection methods should be consistent. Future studies should investigate the diversity in the micro-site surrounding rush-pea plants to determine the effects of prescribed burn on the vegetative community and on rush-pea's regeneration. As for ambrosia, only anecdotal evidence suggests that nonnative grasses out-shade plants. We lack sufficient research and results to confirm that nonnatives also compete with ambrosia for light, space, and nutrients.

All extant populations of rush-pea and ambrosia in Nueces County now remain only on small pieces of land that have not undergone disking and deep plowing, such as cemeteries, highway ROWs, and municipal parks. The extant and accessible Kleberg County rush-pea population is found on a remnant piece of shortgrass prairie on a highway ROW. The ambrosia co-occurs with the rush-pea in this highway ROW area and is also found on another road ROW in Kingsville. In contrast to the rush-pea that is only known from small tracts, the ambrosia also occurs in a number of scattered patches on the federally owned NASK. Both species were documented on rangeland adjacent to a creek on a large private ranch immediately south of the NASK as recently as the 1990s, but their continued existence there has not been reconfirmed since 1993 due to lack of access for surveys. Besides causing the direct loss of plants and underlying habitat at sites within both counties, land cover conversions whether to cropland, improved pasture, or development can also have more long-term and indirect effects on remaining populations by reducing genetic diversity (associated with range contraction) and loss of genetic exchange between populations that have become isolated (USFWS 2008, USFWS 2010).

Habitat Degradation – Modification of Natural Fire Regimes

Alteration of natural fire regimes has resulted in invasion of prairie sites by native and nonnative woody species as well as potentially aiding the spread of nonnative grasses (Mahler 1982, USFWS 1988, Ruth 2000). Fire was an integral part of the grassland ecosystem by naturally restricting the growth of woody species as well as stimulating growth of prairie grasses and forbs. This natural process is thought to have played the central role in the formation of the Great Plains grasslands (Scheintaub *et al.* 2009) as well as other grasslands within the United States. However, fire suppression which came into vogue when Europeans settled in the Coastal Bend, combined with other anthropogenic activities like grazing cattle, significantly altered the natural landscape. Cattle grazing had the additive effect of decreasing fuel loads, thereby altering the fire frequency. Combined, human activities and fewer fires allowed for nonnatives and woody species to compete more effectively for light and nutrient availability than the native grassland species, including the rush-pea and ambrosia. Using fire as a management tool for both encroaching woody species and nonnative grasses is being evaluated for both rush-pea and ambrosia.

Ambrosia's response to fire was seen through formal studies (Overath *et al.* 2014, Rideout-Hanzak and Wester 2014) and incidental and prescribed burn events in 2008 and 2009. A subpopulation of ambrosia along the southbound Hwy 77 ROW burned to ground level on June 30, 2008 from an unintentional fire (Hempel 2008). For several months following this roadside burn, Hempel gathered global positioning system (GPS) points for ambrosia and other vegetation at the site. Plants were again monitored in mid-October and ambrosia had recovered significantly (Hempel 2008). Prior to the roadside fire, the dominant grass was Kleberg bluestem and subsequent monitoring at the site showed that although the ambrosia was among the first plants to show a positive response post-burn, the aggressive, invasive Kleberg bluestem had overgrown the native vegetation within a relatively short time; however, the burn did not appear to change the dynamic between the native and exotic vegetation. Long-term monitoring has not been undertaken to determine the full response and effects of this fire on ambrosia. In 2009, prescribed burns were carried out on select fields of NASK (R. Riddle, pers. comm. 2009); however, we do not have the data that details the species' response. These incomplete results suggest that fire, whether prescribed or natural, does not appear to kill ambrosia plants but may act to stimulate new growth (USFWS 2010). In the St. James cemetery, Overath *et al.* (2014) looked at the effects of mowing and burning on ambrosia density and reproduction. Burns were carried out by Dr. Rideout-Hanzak. Results indicated that fire had little effect on flowering and/or the individuals as a whole.

Landscape management tools such as the application of prescribed fire, herbicide use, and mowing have been applied to combat nonnative species. However, these efforts have had mixed results, often because the native grassland species share similar physiological and phenological characteristics with the invading nonnative species, thereby making management difficult (Pollak and Kan 1996, Smith and Knapp 1999, DiTomaso *et al*. 2001, and Lesica and Martin 2003). Restorative fire practices, whether the fires are a natural occurrence or occur as prescribed fires, may not be effective in managing nonnative grasses in the shortgrass prairie. Biologically, nonnative grasses are better equipped to respond to fire since they are both warm and cool season growers; therefore, managing by fire can provide an opportunity for their growth.

Habitat Degradation – Herbicide Use

Widespread herbicide applications in the Texas Coastal Bend occur on row-crop fields before or during planting to maximize crop productivity, or in fall to facilitate harvesting. Any remaining shortgrass prairie patches that occur near crop fields could be negatively affected by overspray or drift. However, cropland occurs adjacent only to the Hwy 77 ROW populations of both species, and potentially to the KRTA ambrosia population, so herbicide drift is not considered to be a widespread threat. A herbicide drift incident occurred in 2008 along the east side of Hwy 77 at the top of the ROW slope near the fenceline and affected ambrosia plants demonstrated a color change at the tips of plants, yet no plants died (Hempel 2008). Herbicide use on cropland or to maintain ROWs could constitute a threat to any undiscovered populations that may occur close enough to receive significant amounts of overspray. Within Texas, herbicide applications and permits are regulated by the Texas Department of Agriculture (TDA). The TDA Endangered Species Program is a state-wide program to help manage pesticide use in endangered species habitats. By working with the Environmental Protection Agency (EPA), TPWD, and the USFWS, the TDA has organized regional teams to help identify where suitable habitat occurs and to compile information about land use, crops grown, and chemicals typically applied in the immediate vicinity (TDA 2014). However, at this time there are no regional teams within Nueces and Kleberg counties and therefore no current attempts to protect rush-pea and ambrosia sites via this team approach.

Herbicides are also used in other environments from which rush-pea and ambrosia are known, including suburban and urban areas where these chemicals can be applied on lawns, parks, and golf courses such as the NASK, St. James Cemetery, or the city or county park locations. Herbicides are also used to control woody species in rangeland (Scrifes *et al.* 1981) and in bodies of water to control aquatic weeds (Folmar *et al.* 1979) and have the potential to be used in rangeland throughout the range of rush-pea and ambrosia. Depending on the type of application (hand or broadcast), restricting the effect of the agent can be difficult since both the native grassland species and nonnative grasses share similar physiological and phenological characteristics (Pollak and Kan 1996, Smith and Knapp 1999, DiTomaso *et al*. 2001, and Lesica and Martin 2003). Across the two-county area, we lack information on how widespread herbicide damage to the shortgrass prairie ecosystem has been.

Habitat Degradation – Mowing, Disturbance, and Grazing

Mowing and grazing can be effective tools for use across the Texas Coastal Bend to manage remaining native shortgrass prairie habitat. However, other activities like highway construction, ROW and pipeline maintenance procedures, and excavation for utility lines have caused localized disturbance for rush-pea and ambrosia. These types of activities should be minimized within shortgrass prairie habitat as they can directly disturb plants and the seed bank. Disturbance has been noted on the US 77 ROW populations for rush-pea and ambrosia including incidents of stockpiling of equipment and/or material on plants (C. Best pers. comm. 2011); tire ruts and tracks near utility poles and fences (A. Hempel pers. comm. 2009); and, ROW construction work.

Mowing

Mowing is an important tool for management and conservation of prairie vegetation (Wilson and Clark 2001) and occurs on all known rush-pea and ambrosia sites, however, the frequency and blade height vary between sites. Mowing is a non-selective tool used to manage both nonnative and native prairie species, but adjusting mowing heights can target specific species (Hover and Bragg 1981, Mitchell *et al.* 1996). Mowing may generally increase the clonal growth of some nonnatives and grasses (van Mierlo and van Groenendael 1991, Hansson and Persson 1994, and Zechmeister *et al.* 2003), but regular mowing can continuously suppress nonnative growth enough to allow slower-growing natives an opportunity to persist in the same area. Proper timing and frequency of mowing should be examined on a site-by-site and species-by-species basis to provide the most effective means of management.

Impacts from mowing set at lower heights have been observed at the St. James Cemetery. Damage associated with equipment tracking through the population, and from piling of cleared brush onto plants, was also observed at the cemetery in the past (A. Hempel, pers. comm. 2012). Subsequently, TPWD recommended a mowing height of no less than 15 cm (6 in) which was incorporated into cemetery grounds-keeping procedures (Perez 1992). A Memorandum of Understanding (MOU) between TXDOT and TPWD includes recommendations about mowing frequency and heights for rush-pea populations along Hwy 77 ROW. That agreement called for mowing four times per year, as well as keeping a strip mowed every six weeks between May through December (USFWS 2008).

A regular mowing schedule that allows ambrosia to grow and flower and that does not cut the plant too low to the ground on too frequent a basis, as well as prompt removal of cut material, may constitute one of the more effective management tools for ambrosia. Regular mowing may increase the density of clonal stands (Grahl 1994) and may prove especially important to the management of ambrosia. Two studies on NASK showed the effects of varied mowing regimes on ambrosia subpopulations. A study carried out by Carol Bush (Corpus Christi Botanical Gardens (CCBG) botanist) and associates observed that ambrosia plants in the NASK's monthly mowing treatment (one of four study treatments) were hardier than plants under a weekly mowing regime, suggesting that areas mowed weekly would benefit from less frequent mowing, especially under the hot, dry conditions of the summer months (Bush *et al.* 1994). Both Bush *et al*. (1994) and Garvon (2005) concluded that mowing NASK subpopulations at certain heights at a reduced frequency allowed ambrosia to flower and helped to reduce competitive pressures from invading nonnative grasses. Current management practices on the NASK involve frequent mowing at low mowing heights, thereby discouraging growth and blooming of ambrosia. Anecdotal observation at other sites in addition to the NASK, including St. James Cemetery, Hwy ROW, and Bishop City Park also suggest that ambrosia might be healthiest when mowing frequencies are reduced. Mowing treatments should be assessed on a site-by-site basis.

Shortgrass prairie species, including rush-pea and ambrosia, can suffer ill effects from non-management of thatch (cut material, i.e. hay) generated by mowing. Problems can arise when cuttings of grass and forbs are allowed to lay atop live material, including scenarios where hay is cut and baled but bales are not promptly removed. On NASK, a few subpopulations are located in fields that were commercially hayed. At the St. James Cemetery, grass overgrowth in a big field with numerous rush-pea and ambrosia plants became so dense that it was cut for hay and baled (Figure 6), however the bales were left in place in the field instead of being removed quickly (A. Hempel, pers. comm. 2012). Cuttings can cover rush-pea, ambrosia, and other underlying native species; reduce the photosynthetic processes; increase heat caused through degradation process of the hay; and, increase plant susceptibility to disease by creating an imbalance in the bacteria and mold counts. Removing cut material within a few days and then raking and removal of the thatch may be an adequate resolution in avoiding these deleterious effects. Effective thatch maintenance involves regular mowing regimes that are designed to be site-specific. Problems can occur when mowing is irregular allowing grasses to become tall and/or dense, creating an excess of thatch. To date, ambrosia management plans do not provide site-specific guidance for mowing schedules and blade height (with some exceptions on the NASK), or for thatch management, however land managing entities should consider developing management plans that include these tools.

Figure 6. Thatch atop slender rush-pea and South Texas ambrosia habitat (St. James Cemetery). (Photo: Hempel 2011).

Grazing

Unlike mowing, grazing is not occurring at any of the known listed plant sites although it is reasonable to assume that grazing is taking place across a large portion of the remaining rangeland in Kleberg County. Horses were only recently (within the last few years) removed from a NASK pasture with ambrosia, however observations prior to their removal showed that horses preferred other vegetative types, not ambrosia, thus decreasing its competition with nonnative grasses. Grazing animals may also prefer foraging on nonnative grasses (Parker and Hay 2005), creating openings for recruitment of native grass seedlings. Despite the beneficial impacts, rotating grazing animals on different habitats or allowing animals to roam across a landscape can have negative effects including the spread of unwanted nonnative seeds into new areas through their droppings, by trampling, digging, and plowing up of plants (Hobbs and Huenneke 1992). Livestock can also transfer soils and seeds into intact habitats such as the shortgrass prairie. In fact, the huge increase in livestock numbers attributed to European settlers has been implicated in the decline of native perennial grasses and their replacement with nonnative grasses (Moore 1970; Mack 1981, 1989). Altering the timing of mowing and grazing when the listed species is dormant so as to avoid the most sensitive part of either plant's life cycle (flowering or fruiting) could help to alleviate these threats.

Habitat fragmentation - Loss of genetic diversity

Due to the loss and conversion of shortgrass prairie habitat, the remaining patches, including those with rush-pea and ambrosia, are often widely separated across the two-county area and remaining shortgrass prairie species in these patches are frequently reduced in number. The reproductive capabilities of some shortgrass prairie species are likely negatively impacted by the lack of genetic exchange between populations.

1.5.2 Factor B: Overuse for Commercial, Scientific, or Educational Purposes

At the time when rush-pea and ambrosia were listed in 1985 and 1994, respectively, overutilization of either species for commercial and/or recreational purposes was not a threat. Turner (1983) had postulated that ambrosia may contain compounds possessing anti-tumor agents with the potential to be manufactured for future use (USFWS 2008), however there have not been any collection incidents recorded to date. Federal regulations (50 CFR 17.61) make it unlawful to sell or to offer for sale in interstate or foreign commerce any endangered plant. There is no evidence of commercial use of rush-pea and ambrosia, and therefore this is not a threat.

Although seed and plant material have been collected for both species to use in biological studies, collection pressure on either species is not considered a threat. Rush-pea seeds have been collected from Petronila Creek (194 seeds in 2011; 330 seeds in 2012); St. James Cemetery (100 seeds in 2011); Hwy 77 ROW (802 seeds in 2008 and an estimated 1,000 in 2013); a private residence near Bishop (1,197 seeds in year 2010); and Sablatura County Park (two collections of 42 and several thousand seeds in year 2011) (USFWS 2012). Some of the seeds collected have been banked at refugia locations. One such collection has allowed for the establishment of plants into a shortgrass prairie refugium site NABA-NBC in Hidalgo County in 2011. The objective of these seed collection efforts was to obtain representative samples of the extant genetic diversity without harming wild populations and was done in accordance with the Center for Plant Conservation (CPC) guidelines. Ambrosia seeds have been collected but have proven difficult to germinate and have not been used to produce seedlings for reintroduction into ex-situ habitats. Seed collecting procedures from the CPC outline the strict protocols used to collect seeds and reintroduce plants into an ex-situ habitat. The CPC and the USFWS mandate procedures for propagating seeds and plant material (2000 FR 65). An approved propagation and reintroduction plan was developed for rush-pea but a plan for ambrosia should be developed prior to transplantations. Given these measures, and that seed collection has not been a threat for either species in the past, we do not consider that overutilization for commercial, recreational, scientific, or educational use to be a current threat to rush-pea or ambrosia.

1.5.3 Factor C: Disease or Predation

Observations of rabbit herbivory were noted on four rush-pea plants at the Petronila site (Poole 1986). Although it is possible that cottontails (*Sylvilagus floridanus*) and jackrabbits (*Lepus californicus*) might be concentrated in remnant patches of native prairie in Nueces County, information on these species' abundance and distribution is not known. Also, evidence, anecdotal or otherwise, about the effects of grazing or browsing, are poorly documented for rush-pea. Bean or pea weevils of the beetle family Bruchidae have been collected from rush-pea seed at Petronila Creek, Sablatura County Park, and Hwy 77 ROW. No observable damage to rush-pea plants was found. Plants may at times be susceptible to insect predation but effects have not been documented; therefore, disease and predation are not currently known to be a threat to rush-pea.

Since the listing of ambrosia in 1994, the occurrence of disease has not been recorded for this species. Beetle seed predation has been observed at 1 site in 2000 and 2001 (TXNDD 2013b).

Hempel (2008) noted that seeds collected at this site for the purpose of reintroduction were quickly damaged by insects. Because ambrosia seeds have not been frequently collected, it is unknown whether insect predation would happen to seeds collected at other sites. Although high rates of seed predation have been recorded within the family Asteraceae (Pickering 2009), it is an unlikely threat to ambrosia (USFWS 2008). Damage to stems or rhizomes of plants from severe trampling associated with grazing was considered possible in situations where livestock had access to ambrosia (i.e., the NASK site) but the plant was untouched by the horses pastured at the NASK site, suggesting that it may be unpalatable (USFWS 2010). Therefore, based on available information, disease and predation are not considered a threat to ambrosia.

1.5.4 Factor D: Inadequacy of Existing Regulations Mechanisms

Federal Law

Section 9(a)(2)(B) of the Act prohibits an endangered plant species to be removed and reduced to possession or to be maliciously damaged or destroyed in areas under Federal jurisdiction, or to destroy endangered plants on non-federal areas in knowing violation of state law or regulations or in the course of any violation of a state criminal trespass law. The Act does not provide protection for plants on private lands unless it is in violation of state law although some protections may be recommended via section 7 consultation if a project on private land has a Federal nexus. Only one population of ambrosia occurs on Federal land; there are no rush-pea populations known to exist on Federal land.

NASK is the only federally-owned land supporting ambrosia and is managed by the U.S. Department of Defense (DOD). The Sikes Act Improvement Act of 1997 requires implementation of an Integrated Natural Resource Management Plan (INRMP) to provide "integrated fish and wildlife management, land and forest management, wetland resources, and enforcement of natural resource laws and regulations without interfering with the military readiness or mission." Under section 7 of the Act, other Federal agencies are required to consult with the USFWS on projects that they fund, authorize, or permit that may disturb suitable native habitat or reduce the number of individuals of any listed species, including rush-pea and ambrosia. Reasonable and prudent measures that are outlined under a section 7 consultation can help to produce additional benefits to a federally-listed species by increasing the interest levels and coordination of other Federal agencies. For example, the USFWS with the assistance of a contractor, state agencies, academic collaborators, and other affected and interested parties prepared a management plan for NASK (Garvon 2005). This management plan was the result of the Navy's desire to work with the USFWS through measures outlined in its INRMP that would help avoid potential future land use restrictions. Per management plan recommendations, the USFWS has assisted in monitoring the NASK for ambrosia each fall since 2006. The management plan has not been amended since its creation in 2005; however, Project 9 in the 2013 Final INRMP would update the 2005 management plan by implementing surveys and data collection and include development of recommendations for mowing and prescribed burn regimes (Navy 2013; p. 3-55). This management plan should be updated with any information that becomes available regarding ambrosia, including recent pertinent information on the species' reproductive nature or its response to management practices.

State Law

Under Chapter 88 of the Texas Parks and Wildlife Code, any Texas plant that is placed on the Federal list as endangered is also required to be listed by the state in the same manner; therefore, both ambrosia and rush-pea are listed as endangered by TPWD. The state prohibits taking and/or possessing listed plants for commercial sale from private land except by permit, and sale of all or any part of an endangered, threatened, or protected plant from public (state or local government owned) land. Scientific permits are required for purposes of collection of endangered plants or plant parts from public lands for scientific or education purposes. State-owned land on which ambrosia and rush-pea occur include the TXDOT-controlled ROW of Hwy 77 as well as a population of rush-pea at a second highway ROW site where State Hwy 70 ROW crosses Petronila Creek. Although ambrosia historically also occurred at this Petronila Creek ROW site, it has not been observed there in over 20 years.

A highway expansion and relocation project along Hwy 77 was recently completed (in 2017) as improvements were made to Hwy 77 to bring it to interstate standards (it is now part of the Interstate-69 corridor). The Federal Highway Administration (FHWA) determined that upgrades to Hwy 77 would not have a significant impact on the human or natural environment (FHWA 2012), however this development did have potential to further fragment habitat and increase the likelihood of impacts from catastrophic events. To ameliorate impacts, the USFWS recommended that orange construction fencing be installed during construction activities and future surveys where rights-of-entry have not been granted, be implemented (FHWA 2012). During construction, a change in plans for an access road resulted in additional consultation to avoid impacts to the ambrosia patch at Caretta Creek. The additional conservation recommendations were instituted and, to date, no adverse impacts to ambrosia have been noted.

The three remaining sites with either rush-pea or ambrosia or both are on municipal lands at Bishop City Park, Sablatura County Park, or Nueces County Park in Robstown. According to Title 5, Chapter 88 of the Parks and Wildlife Code (1981), State law describes “public” lands as those owned by the state or a local governmental entity. The regulations state that “the department shall issue a permit to a qualified person to take endangered, threatened, or protected plants or parts thereof from public land for the purpose of propagation, education, or scientific studies”. Plants found on park property are also protected by the State as it is unlawful for any person to willfully mutilate, injure, destroy, pick, cut, remove, or introduce any plant life except by permit issued by the Director (Texas Administrative Code 2016).

Private Lands

The Act does not provide protection for plants on private lands unless an action is in violation of state law (trespass laws) or there is a Federal nexus for a project located on private lands. The KRTA is the privately-owned land supporting ambrosia that has not been accessible in more than 25 years and habitat conditions and threats are unknown. A recently discovered population of ambrosia in the city of Kingsville occurs on a privately-owned vacant lot and no official plant counts or monitoring have taken place at this site. The St. James Cemetery in the town of Bishop supports both listed plant species. Coordination with the St. James Parish of the Catholic Diocese of Corpus Christi, landowner of the St. James Cemetery, has provided opportunities to perform monitoring and to make management recommendations. Of all the sites known to support either species, the cemetery's native habitat is the best remaining example of the native shortgrass prairie species assemblage. Although long-term protection is not guaranteed at the cemetery, the land manager has indicated that no development of gravesites is planned within the next 100 years in the portion of the property where both species primarily occur. Observations within the past several years have shown rush-pea to be growing next to older, existing graves and in the undeveloped area in the more northwestern part of the cemetery. Although comprehensive surveys and mapping of the two listed plants was not ever completed in the cemetery, these recent observations may indicate that the rush-pea is spreading into more manicured parts of the property. The habitat and threats at these sites are unknown. In 2008, a private residence near the town of Bishop and the St. James Cemetery was identified with rush-pea. Seeds were collected and are being stored at the PMC. The current landowner has agreed to mow the area. The property is currently for sale and when the sale is finalized, any further work at the site would require landowner permission to access.

1.5.5 Factor E: Other Threats

Genetic Drift and Limited Genetic Diversity

The rarity of both species and loss of genetic diversity because of fragmentation could lead to genetic drift which can restrict genetic variability, reducing the species' ability to overcome environmental stresses, especially during stochastic events or in response to climate change, and could render the populations vulnerable to extirpation and extinction (Shaffer 1981). The remaining accessible extant populations of both species are found in remnant patches surrounded by row-crop agriculture, ranching, and residential and commercial construction. This scenario of small, disjunct populations found on remnant, fragmented habitats could potentially be contributing to genetic drift. Due to the continued existence of a large area of ranchland on the southeastern side of the both species' Coastal Bend range, it is possible that the species may exist in a natural setting of shortgrass prairie that is maintained by grazing and prescribed burns (known management practices on this rangeland), however the presence or absence of populations, condition of the plants, and any knowledge of the genetic makeup of these populations may be unverifiable due to limited site accessibility.

The limited geographic range of both species may be expected to result in a lower genetic diversity due to a lack of gene flow through the dispersal of pollen, ramets, or seed between populations or sub-populations (in the case of ambrosia) (Poole *et al.* 2007). The fragmented and patchy nature of these existing populations could limit potential for cross-pollination and thereby restrict genetic variability and reduce the species' ability to overcome environmental stresses from stochastic events. Certain management and habitat changes may also reduce the genetic diversity of ambrosia among populations if the species' ability to flower and/or produce seed is affected, or if the plant is only able to reproduce asexually. The spread of nonnative grasses, in conjunction with a lack of management, may also isolate populations, thereby further reducing genetic diversity.

Small Population Size

Small population size can cause genetic inbreeding and inbreeding depression. Where populations are experiencing isolation from other populations, self-fertilization (selfing) may occur. Typically, species that characteristically self-fertilize may be less susceptible to inbreeding depression than outbreeding (outcrossing) species. In plants, this relationship is not always so straightforward. As a self-pollinating species, rush-pea may be more threatened by the inbreeding impacts that are related to small population sizes than would be ambrosia, a species that potentially reproduces both sexually and asexually. Genetic inbreeding and inbreeding depression are potential threats to the small populations of rush-pea and ambrosia but we have no evidence that this has actually occurred.

Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g. temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g. habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Climate change may act alone or synergistically with both habitat fragmentation and the invasion of nonnative species. Pollen and fossil evidence shows that species in the past responded to changing climates by altering their distributions via dispersal and migration (Davis and Shaw 2001, Pearson and Dawson 2005). Small, isolated remnants of suitable habitat limit options of dispersing to areas with preferred climatic conditions (Opdam and Wascher 2004). Surrounding habitat destruction from development and agriculture divides continuous habitats which could reduce the number of individuals if plants are unable to shift due to geographic barriers created by inhospitable conditions. Furthermore, climate change is predicted to increase the spread of invasive species, including those nonnative plants that out-compete native varieties (Archer and Predick 2008). The Fifth Assessment Report of the IPCC (2013) projects the following changes by the end of the 21st century, relative to the 1986 and 2005 climatic averages: most land areas will experience warmer and/or fewer cold days and nights; warmer and/or more frequent hot days and nights; an increase in the frequency and/or duration of warm spells and heat waves; and a likely increase in the frequency, intensity, and/or amount of heavy precipitation in mid-latitude land masses; and, a likely increase in the intensity and/or duration of droughts on a regional to global scale.

All known rush-pea and ambrosia sites occur in specialized habitats in small, isolated populations (or subpopulations) distributed over a rapidly developing, restricted geographic area. As a result, the species may be vulnerable to localized catastrophic events such as drought or flooding, as well as to broader climate changes that could decrease suitable habitat, make conditions more conducive to exotic grass invasion, or alter pollinator phenology. However, it is unlikely that this is a concern for rush-pea and ambrosia as they appear to be self-fertilizing and wind-pollinated, respectively.

1.6 Past and Current Conservation Measures

To date, conservation measures for rush-pea and ambrosia have included: 1) propagation and reproductive efforts; 2) surveys; 3) seed collection; 4) management; and 5) research.

1. Propagation Studies:

In 2008, the USFWS obligated funding (originating from the USFWS Recovery Initiative's Preventing Extinction grants) to the Nueces County Soil and Water Conservation District through a cooperative agreement in order to carry out recovery actions for the rush-pea that included collecting, banking, and increasing of seeds from wild populations; controlled propagation; and establishment of refugia populations. The project also provided for development of a monitoring protocol for rush-pea and for a reintroduction plan. This agreement was amended to add tasks and funding in 2010, with a work extension granted through 2014. The Director of the PMC served as the Project Officer for this cooperative effort between the USFWS, PMC, Texas A&M University-Kingsville (TAMUK), TXDOT, SABG, and the NABA-NBC.

The Slender Rush-Pea Controlled Propagation and Reintroduction Plan, produced under the cooperative agreement mentioned above, summarized the history as well as current status of propagation efforts; see USFWS 2012 for more detail.

Ambrosia was successfully propagated from root cuttings taken by the SABG from the Nueces County Park in Robstown (Price 2007). The plants grown from these cuttings then served as donor material for a 2006 introduction into a pilot area created within the same park. Researchers planted 200 1-year old plants in the fall of 2006 that increased to 300 plants by 2007. Results of the introduction showed that watering of seedlings was essential to the success of starting the ambrosia. Tall grasses and other nonnatives impacted ambrosia's establishment and reduced the growth in the individual size of plants as well as the overall stem counts in the initial year following planting. When these species were removed from the experimental plot, ambrosia was successful in producing abundant fruits (burs) and also began to expand into other areas of the plot by clonal growth (USFWS 2010). In 2007 and 2008, Hempel used the Nueces County Park in Robstown to study the germination capabilities of ambrosia. See Hempel pers. comm. (2010, in USFWS 2008) for her methodology and results.

2. Surveys:

Biologists from the USFWS, TPWD, and a botanical consultant (formerly a TAMUK professor), have undertaken site visits to accessible sites for rush-pea, including those populations on state, municipal, and private lands at Petronila Creek; along Hwy 77 ROW; Bishop City Park; Sablatura County Park; and St. James Cemetery; on an irregular basis in order to monitor site and population conditions and to get a rough estimate of population size.

The USFWS, TPWD, TXDOT, and other agencies, academia, and interested parties have coordinated to complete annual surveys of patch size (areal extent of patches), habitat and population condition, and a cursory assessment of population size of ambrosia on NASK since 2005. Other sites (Hwy 77 ROW, Bishop City Park, the Nueces County Park, and St. James Cemetery) have been assessed for various aspects of population health and size on irregular schedules. Observations in drought years have shown a significant decrease in the number of stems, but a realistic number is difficult to record. Recent observations indicate that ambrosia is reproducing largely via asexual reproduction; producing clones. Therefore, the current practice of counting plants by stems may not be appropriate because it is difficult to say where one plant starts and ends. Survey techniques and data collection practices should be continually reviewed and updated in appropriate management plans. Protection of all existing populations is essential and funding should be allocated to survey for additional populations.

In addition to the existing monitoring efforts, increasing survey efforts could result in finding additional wild populations. Any additional populations discovered as a result of surveys should also be protected. These surveys should be attempted annually by the USFWS and/or by partners including, TPWD, TXDOT, PMC, and other organizations, at all accessible sites to monitor population size and conditions, and the status of existing and new threats.

3. Seed Collection:

About 49 percent of all federally-listed species have fewer than 5 extant wild populations and in addition, nearly 74 percent of those remaining wild populations contain fewer than 100 individuals (Kennedy 2004). Populations with such decreased individual numbers are at a higher risk for inbreeding depression and are also likely to have reduced viability due to fluctuations in gene frequencies; therefore, these species are at a higher risk for extinction and impacts from environmental events (Kennedy 2004). Older methods of conservation simply tried to conserve the species in situ. Since sufficient amounts of habitat might be lacking or the habitat that is available may be too fragmented to maintain the genetic integrity of the species, a better approach may be to collect seed for seed banking and replanting of seeds or seedlings into restored habitat, new population sites, refugia, or *ex-situ* populations. For rush-pea, seeds have been collected from all populations. Seed collection efforts are summarized in Table 13, detailing seed collection and conservation efforts.

Table 13. Summary of extant populations of slender rush-pea and conservation efforts undertaken at these sites (USFWS 2012).

Site Name	TXNDD EO # / EO_ID	County	Current Status	Seed Bank (Unless noted all seed held at PMC	Refugium
Petronila Creek	1/4744	Nueces	From 50 to 100 individuals in about 0.14 hectares (0.34 acres); Kleberg bluestem temporarily suppressed.	291 seeds collected May 2011 (194 seeds left); 330 seeds collected May 9, 2012.	97 seeds (May 2011 collection) produced 69 live plants now in seed increase at isolated nursery.

St. James Cemetery	5/6517	Nueces	Population estimated >10,000 in 1992, still large but in decline due to competition from Kleberg bluestem. Site last surveyed in 2017.	±2,000 seeds collected from SABG greenhouse plants; ±50 seeds collected off SABG plants Fall 2009; ±50 seeds collected off SABG plants in 2010; ± 100 seeds collected in 2011 from the cemetery.	None. Plants were grown and held by the SABG. Plants were later transferred to the PMC in 2009. All plants lost vigor over the years and died.
U.S. Hwy 77	5/6517	Kleberg	Population had an estimated 5,709 plants on May 28, 2008. Apparently stable despite herbicide drift September 2008, bulldozing in ROW September 2009, and gravel dumping April 2011.	802 seeds collected May 28, 2008 (from estimated total of 29,000 seeds); unknown number of pods collected April 15, 2011 from the gravel dump site; ±1,000 seeds collected March 2013.	320 seedlings (produced from the 802 seeds collected May 28, 2008) planted in experimental plots at PMC, ± 50 percent survival. PMC plot replanted in Dec 2013 (from seeds collected in March 2013).
Bishop City Park	n/a	Nueces	Population extant, size unknown, intense competition from Kleberg bluestem.	6 seeds collected on July 8, 2015.	None.
Bishop private residence	n/a	Nueces	Stable population in remnant shortgrass at private residence across creek from St. James Cemetery, accessed with permission from owner (site now under new ownership). Site currently is for sale.	1,197 seeds collected on May 13, 2010	None.
Sablatura County Park	n/a	Nueces	Population of many hundreds discovered Mar 19, 2010.	48 seeds collected Feb 17, 2011; several thousand collected in 2011.	539 seedlings (from later 2011 collection) planted in shortgrass prairie refugium on Oct 27-28, 2011 at NABA-NBC, Mission, TX.

Abbreviations/Acronyms

EO = Element of Occurrence

Hwy = Highway

NABA-NBC = North American Butterfly Association – National Butterfly Center

PMV = Plant Materials Center

ROW = Right-of-way

SABG = San Antonio Botanical Gardens

TXNDD = Texas Natural Diversity Database

USFWS = U.S. Fish and Wildlife Service

With regard to ambrosia, attempts to germinate from seeds have been largely unsuccessful. The PMC analyzed some seeds before attempting to germinate but found low seed fill with poor germination rate (USFWS 2013) suggesting long-term storage of seeds in a seed bank may not be possible. Currently, ambrosia plants are only propagated from root cuttings and are being housed at the SABG and at Mercer Arboretum.

4. Management:

The Texas Department of Transportation and TPWD currently have an MOU that attempts to avoid any (or all) impacts to rush-pea and ambrosia on ROWs. This includes any mowing, maintenance, or new ROW projects. More information on the MOU can be found in section 1.5.1.

Ambrosia management and associated actions have included: development of management plans with NASK, TPWD, and TXDOT; management activities (i.e. mowing); and seed collection management.

Management Plans: Currently, the only site with an official management plan for ambrosia is the NASK through the Navy's INRMP and its 2005 management plan. The Final INRMP (Navy 2013) included projects and management strategies to support the goals and objectives established for rare, threatened, and endangered species, including those addressing ambrosia. Project 9 in the INRMP provided for continued annual monitoring for ambrosia to determine the areal extant cover on NASK (Navy 2013). Data collected during these surveys would then be used to update the 2005 management plan and the mowing recommendations and prescribed burn regimes (Navy 2013). New information, such as data on the reproductive nature of ambrosia or its response to management practices, will be used to update the management plan. Maintenance of hay fields and associated thatch also needs to be addressed in management plans. The TPWD and TXDOT currently have an MOU for protection of ambrosia on state land. The MOU attempts to "maintain, reduce, or avoid the potential environmental….effect of a ROW highway project or maintenance" (TPWD 2014). The Texas Park and Wildlife Department is responsible for providing recommendations that "will protect fish and wildlife resources to local, state, and federal agencies that approve, permit, license, or construct development projects" and to provide "information on fish and wildlife resources to any local, state, and federal agencies or private organizations that make decisions affecting those resources" (TPWD 2014). Beside the MOU, TXDOT mows the Hwy 77 ROW to maintain the grass height, aids in biological surveys for both rush-pea and ambrosia on-site, and coordinates with the USFWS for projects occurring within the ROW so as to avoid potential impacts.

Ongoing management at all other accessible ambrosia sites consists of mowing done by landowner/land managers to keep some type of uniform plant height or otherwise control vegetation growth, so the benefit to the ambrosia is incidental and not planned. This maintenance activity on the part of landowners is not necessarily undertaken to conserve shortgrass prairie plants including rush-pea and ambrosia, but it may well be the primary reason that this vegetation is able to persist in the face of encroachment by invasive nonnative grasses and native woody vegetation. Research by Bush *et al.* (1994) at NASK indicates that occasional cutting may be beneficial to the ambrosia, provided that mower blade height and drought conditions are taken into consideration. Ambrosia may respond positively to some other management actions, however activities such as soil disturbance through continual plowing, some applications of herbicides, or the complete removal of disturbance (e.g. lack of mowing encouraging overgrowth by invasive grasses) may lead to its extirpation.

Management Activities: Mowing takes place on NASK, the Hwy 77 ROW, St. James Cemetery, Bishop City Park, Sablatura County Park, and the Nueces County Park in Robstown, where mowing frequency and height of mower blades differs from site to site. We have no knowledge that any of these sites has mowing with management of the rush-pea and ambrosia as the primary objective or with the species and their habitat in mind. For ambrosia, prior to mowing it is important to first identify whether ambrosia plants at the site are flowering or contain seed that has not been liberated from the plant in order to assure that the plants have some opportunity for cross-pollination and sexual reproduction. To assure this, outreach activities should continue with NASK environmental staff as well as developing conservation partnerships with state, county, and city employees responsible for roadside and/or parkland maintenance employees to integrate best management plans for the maintenance of ambrosia sites.

Management of Seed Collection: The objective of seed collection is to obtain representative samples of the extant genetic diversity without harming wild populations in accordance with the CPC guidelines. The CPC guidelines provide that, within each population or sub-population, seeds can be collected from all reproductive individuals if there are less than 50, and from at least 50 if more than 50 reproductive individuals are present (Guerrant Jr. *et al.* 2004). More frequent, less intense collection is preferable and entails collecting up to 10 percent of seeds from each population not more than 3 times per year every 10^{th} year from populations that can be readily accessed. However, if sites cannot be accessed as frequently, then collecting up to 25 percent of seeds not more than once per year is appropriate. Only in extreme cases, where a site might become extirpated within 5 years, is 100 percent of available seed collection considered to be allowable from a given population.

5. Research:

Dr. Rideout-Hanzak, TAMUK, initiated a study to investigate the competition and effectiveness of various management scenarios on rush-pea. For more information see section 1.5.1. No further studies for rush-pea have been undertaken.

Since ambrosia was listed in 1994, propagation and reproductive investigations have been carried out and findings are available in the South Texas Ambrosia 5-Year Review (USFWS 2010). Along with the INRMP for the ambrosia population on NASK, the 5-year review also provides detail on management strategies for the ambrosia including the effects of mowing and fire; both discussed in section 1.5.1. Grisé and Overath (2016) conducted fire studies for ambrosia on St. James Cemetery in 2013 and 2014 to investigate the effects of fire on population density and flowering. Their studies suggest that there is little statistical difference between burned and unburned plots and stem density per polygon. Their study findings also suggest that fire (burned versus unburned plots) has little effect on the flowering events of ambrosia.

PART II: RECOVERY PROGRAM

The following sections present a strategy to recover the rush-pea and ambrosia and to restore and maintain their shortgrass prairie habitat and its unique native flora. This recovery strategy includes objective and measurable recovery criteria to achieve downlisting and delisting of these two plants, as well as site-specific management actions to monitor and reduce or remove threats, as required under Section 4 of the Act. The Recovery Plan also addresses the five statutory listing and recovery factors (section 4(a)(1) of the Act or section 1.1 of this document) to demonstrate how the recovery criteria and actions will lead to removal of both plant species from the lists of Threatened and Endangered Species.

2.1 Recovery Strategy

The USFWS's goal in developing and implementing recovery plans is to improve the status of listed species to the point that protection under the Act is no longer required. The strategy for recovery of rush-pea and ambrosia includes the long-term protection and management of the shortgrass prairie habitat needed by rush-pea and ambrosia, and provides a roadmap for securing an adequate quantity of habitat of sufficient quality to sustain them long-term.

A primary objective of this plan is to ensure that there are shortgrass prairie areas of sufficient size, number (20 populations of rush-pea and 15 populations of ambrosia; see sections below), composition, and juxtaposition, determined by the most current biological information known for the species, to support rush-pea and ambrosia populations that are able to persist and thrive in the wild. Under current conditions, both species occur on remnant portions of land, and this occupied habitat is generally in disjunct locations as a result of the aggressive spread of nonnative, invasive grasses and conversion of much of their habitat into row crops, developed areas, and improved pasture. At a minimum, long-term protection of these remnant portions of habitat is required for these species to be maintained at the status quo. A priority recovery need includes continuing outreach to private landowners and other property owners (TXDOT, NASK, and municipal governments) and attempting to secure long-term conservation easements or agreements. Most of the shortgrass prairie habitat within the geographic range of both species is privately owned and it may not be possible to acquire, via fee title or conservation easement, these areas for long-term conservation. Therefore, landowner coordination and cooperative conservation efforts are especially important. In order to maintain genetic and ecological diversity, at least one population with sufficient numbers of individuals, in each watershed (or drainage system) should be protected long-term. Every extant population within its watershed should also be represented in seed collections and in refugia establishments, augmentation, or reintroduction efforts.

Adequate quality of habitat at any given population site refers to the habitat's ability to meet the needs of the species such that at least the Minimum Viable Population (MVP) goal can be met at the site. For the habitat to be considered in good condition within the area occupied by the shortgrass prairie species, it should be devoid of nonnative grass species to the greatest extent possible and it should include the composition of native grasses and forbs outlined in sections

1.3.4. and 1.4.4. Additionally, through the application of continued active management, shortgrass prairie should be able to maintain the aforementioned conditions for the next 60 and 40 years for rush-pea and ambrosia, respectively (see Timelines for Recovery section). High priority recovery actions that can improve or maintain the quality of habitat include management such as studies to investigate timing and effectiveness of mowing; other methods to prevent and control nonnative grasses and invading woody vegetation; best management practices to minimize habitat and soil disturbance as well as contraindicated herbicide use. Research needed to understand management implications includes studies to determine response of nonnative grasses, as well as rush-pea and ambrosia, to fire and different mowing regimes, and genetics work on both species to determine genetic relationships within and among populations.

Timelines for Recovery

For both species, we anticipate that by 1) securing long-term conservation of the current and potential habitat within its natural range and drainage systems; 2) proper management of these sites; 3) filling in the biological and ecological data gaps; and, 4) determining and then maintaining the MVP at each site, recovery, as reflected by delisting, can be attained within the next 60 and 40 years for rush-pea and ambrosia, respectively.

For rush-pea, we foresee that delisting will take at least 60 years from the time this Recovery Plan is published (Strong 2016). There are few populations of rush-pea within its geographic range, and the largest and most robust known population is on private land. With the exception of a small patch population in a residential lot in the town of Bishop and sites on a large private ranch south of the NASK, other populations are on state-owned land (Hwy 77 and Hwy 70 at Petronila Creek ROWs) or municipal land (Bishop City Park and Sablatura County Park). With regard to threats, rush-pea has been shown to suffer negative effects from competition when surrounded by Kleberg Bluestem, the most prevalent invasive grass at rush-pea sites. Unlike ambrosia, none of the rush-pea populations are managed under a binding agreement such as the Navy’s INRMP. Securing long-term conservation easements and agreements will also be difficult since the private land includes a cemetery, a residential yard, and areas on a private ranch. Therefore, given the current remnant status of the shortgrass prairie habitat, the increasing invasion by nonnative grasses, the needs of the species, and the difficulty in obtaining long-term protection, we foresee that delisting for rush-pea will take at least 60 years.

Ambrosia appears to be a hardy species that has responded well to small disturbance events, including accidental fires. Therefore, it is anticipated that with even slight improvements in the current management conditions, the populations will likely recover. The most widespread population of ambrosia is found on federal NASK property where the species is managed under an INRMP outlining a management scenario. The Service should assist the Navy to update their INRMP to include the best protocols for mowing timing and frequency, and include an easy-to-follow mowing schedule for contract crews. The most robust population at the St. James Cemetery is not under any long-term protection. Securing long-term conservation easements and fee title agreements on other sites, including private lands, will take time and energy and is dependent on cooperation and coordination, if possible at all. Therefore, it is appropriate to assume that recovery for ambrosia will take at least 40 years (Strong 2016). Given the few opportunities for long-term management and conservation of the native shortgrass prairie, quality habitat needs to be restored, managed, and protected long-term to ensure ambrosia can be delisted within 40 years.

These recovery timelines, as indicated in this plan, should be reassessed periodically to ensure that recovery is still feasible and attainable. New information on either species should predicate any adjustments to the MVP and recovery timeframes as well.

Minimum Viable Populations

Estimating a MVP size is one approach for determining an abundance goal for recovery purposes. A conventional MVP, as outlined in Pavlik's guidelines (1996), uses the biological and demographical information known about a species to estimate a MVP size (or individual and population numbers) in order to prevent extinction. A conventional MVP has not been calculated for rush-pea or ambrosia as we do not possess the entirety of the baseline data needed to perform these calculations. However, Tables 14 and 15 were derived using adaptations of Pavlik's 1996 guidelines used to calculate MVP's for these species. This MVP will serve as the basis for population objectives until there is sufficient data to conduct a population viability analysis (PVA) and estimate an actual MVP size. Each characteristic (i.e. longevity, breeding system, etc.) appears in the first column; rush-pea and ambrosia are either more closely related to the life history characteristic in column A or column B or somewhere in the midst of the continuum between A and B. A trait in column A would have MVPs near 50 individuals; species with traits in Column B would have MVPs upwards of 2,500 individuals. The **bold** letters in Tables 14 and 15 indicate the life history characteristic chosen for rush-pea and ambrosia. Using the best scientific information available for each species, the South Texas Plant Recovery Team (STXPRT) determined applicable characteristics for each species and estimated MVP values (listed in parenthesis) (USFWS 2013). The recommendations could change with the introduction of additional information on reproductive biology, gene flow, and/or population size, density, and distribution.

<u>Slender Rush-pea</u>

As indicated in **bold** letters in Table 14, rush-pea is a perennial, selfing, herbaceous plant with relatively low fecundity and low survivorship. Reproduction is by seed only, with seeds having a long-term viability. Environmental variation is considered high in the Texas Coastal Bend and the dynamic shortgrass community where rush-pea is found has, and continues to, undergo succession. Given that the STXPRT (in 2013) determined five characteristics in Table 14 that require more individuals and four characteristics requiring fewer, it is rational to estimate the MVP for rush-pea at an intermediate value.

Table 14. Method for Determining the Minimum Viable Population (MVP) for slender rush-pea (adapted from Pavlik 1996). The bold letters in Tables 14 and 15 indicate the life history characteristic, if known. Estimated MVP values are listed in parenthesis.

Characteristic:	A. 50 Individuals	B. 2,500 individuals	Rationale:
Longevity	**Perennial** (1,000)	Annual	Rush-pea is generally a short-lived perennial species. The South Texas Plant Recovery Team (STXPRT) estimated that the lifespan may be 4-5 years. The STXPRT estimated that rush-pea was more closely tied to the characteristic in Column A.
Breeding system	**Selfing** (250)	Outcrossing	Pressly's (2002) research demonstrated that self-fertilization is possible for rush-pea. Dr. Patrock (pers. comm. 2014) observed a single instance of a floral visitor on rush-pea at the St. James Cemetery. He indicated that there's a high likelihood that rush-pea self-fertilizes due to the lack of floral visitation; small blooms; and, short duration of bloom period. Effective pollinators are not known and whether cross-pollination is taking place needs to be studied. The STXPRT estimated that rush-pea is more closely tied to the characteristic in Column A.
Growth form	Woody	**Herbaceous** (2,500)	Rush-pea is only herbaceous, not a known woody species. Therefore, it is more closely tied to the characteristic in Column B.
Fecundity	High	**Low** (2,000)	Rush-pea typically produces 2-4 seeds per pod (legume) (Poole *et al.* 2007), but may produce 10+ pods per year. The STXPRT estimated that the species had a lower fecundity.
Ramet Production	Common	**Rare or none** (2,500)	Ramets are not produced in rush-pea; therefore, the species' characteristic is tied to Column B.
Survivorship	High	**Low** (1,000)	The survivorship of rush-pea is unknown. However, to make a conservative estimate, the STXPRT decided to estimate that the survivorship of rush-pea is low.

Seed duration	**Long** (250)	Short	Seed duration of a hard seeded legume, like rush-pea, is typically long.
Environmental Variation	Low	**High** (2,500)	The climatic conditions of the Texas Coastal Bend are extremely variable, therefore high environmental variation is appropriate.
Successional Status	**Climax** (250)	Seral or ruderal	There is some disturbance in the shortgrass prairie community but it seems that it is not a true climax community in terms of reaching stability. The habitat is more closely related to climax than seral or ruderal.

In order for the STXPRT to estimate the number of mature individual plants needed for a viable population, all of Pavlik's characteristics (9 in total) were combined and averaged (Table 15); this final average was rounded to determine that a minimum of 1,500 mature individual plants at each population were needed for rush-pea to preclude extinction within 60 years.

Table 15. Summation of the minimum number of mature individuals plants at each population for slender rush-pea, depending on the life history characteristic.

Characteristic	*Number of Individuals Needed per Population*
Perennial	1,000
Selfing	250
Herbaceous	2,500
Low Fecundity	2,000
No Ramet Production	2,500
Low Survivorship	1,000
Long Seed duration	250
High Environmental Variation	2,500
Climax successional species	250
Total	12,250
Average (**rounded**)	1,360 (**1,500**)

South Texas Ambrosia
As indicated in **bold** letters in Table 16, ambrosia is a perennial, herbaceous plant with relatively low fecundity and low survivorship. The species does not often reproduce by seed and seeds do not remain viable for extended periods of time. Environmental variation is high and the dynamic shortgrass community where ambrosia is found has undergone succession. Given that six

characteristics in Table 16 require more individuals, and three characteristics require fewer individuals, it is rational to estimate the MVP for ambrosia at an intermediate value.

Table 16. Minimum Viable Population for South Texas ambrosia. Adapted from Pavlik (1996). Rationales for each characteristic were discussed with South Texas Plant Recovery Team (STXPRT) members and can be found below. Source STXPRT meeting on November 20, 2013 (USFWS 2013)

Characteristic:	A. 50 Individuals	B. 2,500 individuals	Rationale:
Longevity	**Perennial** (50)	Annual	Ambrosia is a perennial species; therefore Column A is most appropriate.
Breeding system	Selfing	**Outcrossing** (2,500)	Most evidence suggests that ambrosia reproduces vegetatively.
Growth form	Woody	**Herbaceous** (2,000)	This species is herbaceous
Fecundity	High	**Low** (2,000)	May only produce one seed per flower head therefore, the fecundity is low.
Ramet Production	**Common** (50)	Rare or none	Species does not reproduce often by seed.
Survivorship	High	**Low** (2,000)	The survivorship of ambrosia is low, therefore Column B is most appropriate.
Seed duration	Long	**Short** (1,500)	Seeds do not remain viable for an extended period of time.
Environmental Variation	Low	**High** (2,500)	The climatic conditions of the Texas Coastal Bend are extremely variable, therefore there's high environmental variation.
Successional Status	**Climax** (250)	Seral or ruderal	There is some disturbance in the shortgrass prairie community but it seems that it is not a true climax community in terms of reaching stability. The habitat is more closely related to climax than seral or ruderal.

In order for the STXPRT to estimate the number of mature individual plants needed for a viable population, all of Pavlik's characteristics (9 total; see Table 16 above) were combined and averaged (Table 17). This final average was rounded to determine that a minimum of 1,500 mature individual plants at each population were needed for ambrosia to avoid extinction.

Table 17. Minimum number of mature plant stems at each population for South Texas ambrosia.

Characteristic	*Number of Individuals Needed per Population*
Perennial	50
Outcrossing	2,500
Herbaceous	2,000
Low Fecundity	2,000
Ramet Production is common	50
Low Survivorship	2,000
Short Seed duration	1,500
High Environmental Variation	2,500
Climax successional species	250
Total	12,850
Average (**rounded**)	1,430 (**1,500**)

Since ambrosia is a clonal species, the STXPRT applied a correction factor to the population estimate (unlike rush-pea). The STXPRT estimated that conservatively ambrosia will produce 10-15 stems per plant per year in periods with good to adequate precipitation events. Climatic conditions will cause stem production to vary between years; under poor conditions, ambrosia is likely to produce 5 stems per year and under good conditions, ambrosia might produce 10 stems per year. Therefore, after applying this correction factor, estimated number for each population would range between 7,500 – 15,000 stems to avoid extinction (see below).

The following further explains the correction factor used for ambrosia:

Under poor conditions, ambrosia might produce 5 stems per year:

(1,500 individuals) x (5 stems per year) = 7,500 stems per year

Under good or adequate conditions, ambrosia might produce 10 stems per year:

(1,500 individuals) x (10 stems per year) = 15,000 stems per year

Background to the Recovery Plan

In the 1988 Slender Rush-pea Recovery Plan, overarching objectives rather than specific recovery criteria were designated. These objectives included management of existing plants and their habitat to protect them from destruction resulting from human activities and to maintain, through management, healthy populations at levels sufficient to downlist, and eventually delist the species. Objectives included: maintenance of existing populations through cooperation with landowners and habitat management; provision of permanent USFWS or conservation organizations' protections for the known populations; establishment of additional populations in natural habitats; obtaining the biological information needed for effective management; and developing public support for the preservation of the species (USFWS 1988). Although some of

these objectives have been partially accomplished, none have been fulfilled to the extent that they would ensure the continued existence of the rush-pea.
Many of the overarching objectives from the 1988 Slender Rush-pea Recovery Plan are the same as those for ambrosia, given that both species share the same habitat conditions. Therefore, this document constitutes the revised Recovery Plan for rush-pea and the first recovery plan for the ambrosia.

2.2 Recovery Goals

Ensure long-term persistence of native coastal shortgrass prairie in adequate extent, distribution, and condition to support rush-pea and ambrosia populations at levels that both species can be 1) downlisted from a status of 'endangered' to 'threatened' and subsequently 2) ultimately removed, or delisted, from the Federal List of Endangered and Threatened Plants (50 CFR 17.12). Recovery criteria form the basis from which to gauge whether the species should be reclassified to threatened (downlisted) or delisted (recovered).

2.3 Recovery Objectives and Criteria

When considering if a species warrants downlisting or delisting, the USFWS considers whether the species meets the definition of endangered or threatened. The Act (1973) refers to a threatened species as, "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" and refers to an endangered species as "any species that is in danger of extinction throughout all or a portion of its range." Recovery objectives are the parameters (demographic, threat reduction or elimination, or other vulnerabilities or biological and ecological factors) which, when taken together, characterize the conditions under which a species may be reclassified or delisted. Criteria are standards for measurement of the parameters needed to determine that a species has achieved its recovery objectives and may then be reclassified or delisted. All criteria must be objective and measurable (Act 4(f)(1)(B)(ii)).

2.3.1 Recovery Objectives

This Recovery Plan contains objectives to secure the rush-pea and ambrosia perpetually in the wild. These objectives are not necessarily in order of importance but include:

1. Minimize further loss or fragmentation of native shortgrass prairie habitat within Nueces and Kleberg counties, such that there is sufficient habitat to support rush-pea and ambrosia at levels that meet recovery goals.

2. Obtain required biological and demographical information to perform PVA and estimate actual MVP sizes for both species.

3. Actively manage shortgrass prairie conditions at all extant population (or subpopulation) sites of rush-pea and ambrosia to sustain both species at Minimum Viable Population levels or higher.

4. Establish reintroduction sites within the geographic range of rush-pea and ambrosia to increase the number of protected populations.

5. Determine the extent and prevent depletion of rush-pea and ambrosia seed banks.

6. Promote landowner relations and habitat management throughout the occupied and historical ranges of rush-pea and ambrosia in the United States.

7. Determine the genetic diversity within and among populations of rush-pea and ambrosia, and prevent its loss.

8. Determine optimal habitat requirements for rush-pea and ambrosia.

9. Determine and implement best management practices (in particular mowing and invasive species control) where possible and monitor the response of rush-pea and ambrosia populations to these practices.

10. Monitor long-term viability of all populations of rush-pea and ambrosia.

11. Increase knowledge of rush-pea and ambrosia abundance, distribution, and ecology.

12. Acquire long-term conservation easements where feasible, or conservation agreements, for occupied sites of rush-pea and ambrosia within each watershed from which the species are known.

2.3.2 Recovery Criteria

Along with the statutory requirements for recovery criteria to be "objective and measurable", they too should evaluate the current and future condition of a species, reflecting the species' needs for resiliency, redundancy, and representation across its geographic range, a principle collectively known as the "3R's" (Shaffer and Stein 2000, Carroll *et al.* 2010, Wolf *et al.* 2015). Criteria should represent areas of significant geographic, genetic, or life history variation (Carroll *et al*. 2010, Wolf *et al*. 2015). Resiliency refers to the capacity of a population to withstand environmental stochasticity, and addresses threats abatement and recovery of ecologically effective populations. Redundancy spreads potential risks to the species among multiple populations to minimize the potential loss of the species from catastrophic events. Representation is having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Together, the 3R's comprise the essential characteristics that contribute to a species' ability to sustain populations in the wild over time (Carroll *et al*. 2010, Wolf *et al*. 2015).

The STXPRT met on January 11 and 12, 2016, to determine appropriate downlisting and delisting criteria for both rush-pea and ambrosia. Given the scientific information available for both species, the STXPRT determined that it was necessary to conserve the potential genetic variations occurring within each of the drainage systems where extant populations are found and include additional populations that are restored, augmented, or created. The downlisting and delisting criteria below include both the STXPRT's MVP estimates (described in Section 2.1 above) and the number of sites needed per drainage per species. The recovery criteria in Sections 2.3.2.1 and 2.3.2.2. reflect these determinations. Natural populations, as the term is used below, include those that are wild and pre-existing where plants have been found during survey efforts. Based on the extant number of populations for rush-pea (eight in total), the STXPRT estimated that having a minimum of 15 populations in total with an estimated 1,500 mature individual plants per population, distributed as five populations within each of the three drainage systems would provide appropriate representation for downlisting. The delisting criteria state that rush-pea requires a total of 20 populations; so 5 additional (above the downlisting criteria) populations. The downlisting and delisting criteria can include populations within any drainage or a combination of drainages to meet this criterion. For ambrosia, the STXPRT recommended for downlisting that a minimum of three populations exist within each drainage system (nine populations in total). To delist ambrosia, the STXPRT recommended increasing the numbers of populations needed per drainage above the downlisting criteria to include at least three additional populations per drainage or genetically distinct populations (15 populations in total).

Slender Rush-Pea Recovery Criteria

Implementation of the actions in this Recovery Plan should protect, conserve, and restore the rush-pea to a status where it could be considered for downlisting in 35 years, with potential delisting within 60 years. Anecdotal evidence (repeated observations) suggests that rush-pea responds well to mowing, at least in part due to its small stature that makes it less likely to be damaged by mower blades. There are anecdotal observations which suggest a positive correlation between increased effects from mowing and a more open and less invaded shortgrass prairie but more study is needed. Rush-pea is likely more sensitive than ambrosia to the negative impacts of shading and competition from tall nonnative grasses, and more vulnerable to stochastic events although a comparison study needs to be completed. Although rush-pea has proven easy to grow from seed and has been planted in experimental fashion in two refugia where it receives some level of care, there have not been any experimental plantings into existing wild populations. Therefore it is unknown whether augmentation or reintroduction will work. There are few known extant populations and a number of those are in close geographic proximity to each other, perhaps allowing easy genetic flow between each sub-population; these occurrences are potentially parts of one metapopulation. The population near the Oso Creek drainage is likely historic so efforts should be focused on securing populations within the other drainages. The low numbers of populations, small population sizes, widely separated geographic distribution (except for the metapopulation), degraded habitat due to invasive grasses and woody species, and uncertainty regarding the success of the species in reintroductions could make meeting the recovery criterion for rush-pea more difficult than for ambrosia. Therefore, we believe it will take longer to reach rush-pea's down- and delisting goals compared with ambrosia.

Downlisting Criteria 1: To downlist rush-pea, 15 populations should have an estimated 1,500 mature individual plants per population. Downlisting may be possible if each of these populations is stable or increasing over the next 35 years. The extant populations (eight total), as well as any that may be restored, augmented, or created, should be maintained with at least five natural populations located in the drainage systems (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins) where the species is known to naturally occur to ensure genetic representation.

Justification: Because rush-pea populations were historically known from four main drainage systems, and are currently found in three of those, to maintain the genetic diversity of the species, and to provide adequate representation and genetic resiliency throughout the species range, it is necessary to protect at least one population in each drainage system throughout its range.

Downlisting Criteria 2: Each rush-pea site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie habitat should contain species commonly associated with rush-pea (Table 7). As is true with ambrosia, prolific and aggressive nonnative grasses should not constitute more than small patches within each high quality shortgrass prairie site and invasive grasses and woody species should not be spreading throughout the site or inhibiting growth and reproduction of rush-pea. Each rush-pea site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat conditions and to minimize and control threats over a period of 35 years.

Justification: The continual encroachment of nonnative grasses into rush-pea's range remains the preeminent threat to the species. As is true for ambrosia (see Justification for Ambrosia's Downlisting Criteria 2), it is unlikely that the nonnative grasses within the Texas Coastal Bend shortgrass prairie will be fully eradicated. The continued existence of rush-pea, ambrosia, and their co-occurring suite of native shortgrass prairie species is possible only through ongoing and intense management (control of nonnatives and native woody plants). Greenhouse experiments where Kleberg bluestem and rush-pea were planted together demonstrated that rush-pea does poorly when the nonnative Kleberg bluestem grows densely around it (Pressly 2002). Rush-pea remains extant at the Petronila Creek population site in the presence of Kleberg bluestem and the absence of active management, although the plant has barely survived. It has even shown modest increases following mowing and applications of grass-specific herbicides in the recent past. With active, on-going management and populations being monitored at least annually as directed for this species using USFWS-approved plans, downlisting may be possible within the 35-year time frame.

Delisting Criteria 1: A minimum of 20 populations are necessary for delisting and should have at least 1,500 mature individual plants per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 60 years. All existing populations, including those that have been restored, created, or reintroduced, are protected and a minimum of five natural populations are extant within each drainage system (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins).

Justification: Because all known rush-pea populations have been found in association with drainages and the populations are limited to drainage systems in Nueces and Kleberg counties, it is important to keep at least five populations per drainage system stable. In comparison to ambrosia, rush-pea is more sensitive to habitat encroachment from nonnatives (see Section 2.1 for more details) therefore the STXPRT recommended that both the downlisting and delisting requirement be more stringent. This criterion will help to maintain the genetic integrity and provide species' representation throughout its range. Because we lack information on the long-term impacts of invasive species on Texas Coastal Bend shortgrass prairie, meeting the 60-year time requirement as well as an MVP standard will indicate that the species has achieved stability over a fairly long term period, although it likely will need active management. If the MVP standard and the Delisting Criteria 2 (below) are met prior to the 60-year benchmark, the timeframe itself will not preclude consideration of a recovery designation.

Delisting Criteria 2: Populations will be protected long-term (protection in perpetuity being optimum) through fee title acquisition, conservation easements, or conservation or management agreements. Species-specific, USFWS-approved annual monitoring and management plans will guide these efforts. Each population site should have high quality shortgrass prairie habitat (see rush-pea's Downlisting Criteria 1 for a description).

Justification: Only remnants of shortgrass prairie habitat support rush-pea. Because these are privately-owned or in state or municipal/county government ownership, and not necessarily managed for rare species, formal long-term agreements for management of the species and its habitat are necessary to ensure the continued existence of the species in native conditions at these sites. The persistence of rush-pea in its current locations may be due to these sites being some of the only occupied patches of shortgrass prairie habitat that were not plowed or built over in the species' range. There is a likelihood that the species may still occur on private ranches in Kleberg County but due to lack of access, the extent or condition of shortgrass prairie in this part of the range is unknown. Since the only access to rush-pea populations is in habitat that is highly fragmented and has been subjected to a number of disturbances, information is lacking on what constitutes a "healthy" rush-pea site with regard to the percent cover of nonnatives or woody species. All long-term agreements and easements should include management strategies for removal and control of nonnatives, and should update these strategies as new information becomes available. With ongoing active management and monitoring of these sites, delisting is possible within a 60-year time frame.

South Texas Ambrosia Recovery Criteria

If recovery criteria are achieved within downlisting and delisting timeframes, it may be possible to downlist the ambrosia within 20 years of implementation of this plan with full recovery possible in 40 years (Strong 2016).

Ambrosia is readily propagated from cuttings, easily established in garden or field settings, and persists in the field with application of active management, thereby enhancing its conservation potential. Although information is lacking on the genetics, the relationship of individuals within and among populations, and the species' mode of reproduction; in the wild, ambrosia does propagate easily, helping in establishing refugia, creating introduced populations, or augmenting existing populations. The species can also benefit from active management techniques, as evidenced by ambrosia's positive response to fire and mowing (Section 1.5.1.). However, some discretion is required when managing with mowing since frequent mowing and low height of mower blades can produce negative outcomes as well (Section 1.5.1.). The species establishment in three refugia to date, and its persistence at seven extant natural sites, leads us to believe that the species has high potential for recovery with the application of active management, and in some cases restoration, of shortgrass prairies. Although the levels of protection for ambrosia vary across the different land ownerships, the largest population of ambrosia exists on federally-owned land. In addition to protection on Federal lands, three small patches of ambrosia are found on a state highway ROW where the TPWD requires permits to collect any plant material and where TXDOT consults under the Act with the Service as well as coordinating with TPWD. The county park that supports ambrosia has shown a willingness to protect it as evidenced by their pilot reintroduction project. The species has persisted in the St. James Cemetery under existing management regimes since it was first reported there.

In light of these positive factors, a potential timeframe of 20 years to downlist and 40 years to delist the ambrosia is considered attainable, so long as appropriate active management and conservation at the population site can be assured.

<u>Downlisting Criteria 1</u>: A recommended minimum of nine populations are necessary for downlisting and should have at least 7,500-15,000 mature stems per population. Each population should be stable or increasing over the next 20 years. The extant populations (seven total), as well as any that may be restored, augmented, or created, should be maintained with at least one natural population located in each of the drainage systems (Oso, Chililpitin Creek-San Fernando, Alazan Bay-Baffin Bay, and Santa Getrudis Creek basins) where the species is known to naturally occur to ensure genetic representation.

<u>Justification</u>: Extant ambrosia occurrences have been documented from sites that lie within the four afore-mentioned drainage basins. A fifth basin, Petronila Creek, also had a documented population however it is now considered historic because surveyors have been unable to locate the plants and it was last seen over 20 years ago, and the site is overgrown with nonnative grasses and woody vegetation. It is improbable that any

genetic material will become available from this basin. Although we do not yet fully understand the genetic composition of ambrosia because results of genetic studies are incomplete, we believe that it is necessary to maintain a minimum of one natural population per each of the four drainage systems throughout ambrosia's range to ensure genetic representation. Keeping representation in each drainage basin, having an increase from the known populations (seven) to nine populations would maintain the genetic diversity and provide redundancy in the case of a stochastic event (i.e. drought, disturbance). Ambrosia is known to reproduce vegetatively in the wild and in cultivation, but the role of sexual reproduction in the wild is not well understood. Early results of genetic analysis indicate that patches of ambrosia on NASK are multiple clones (Grisé and Overath 2016). Based on the evidence collected to date, we are considering plants or patches of plants occurring within a 1.0 km (3,280 ft) radius of each other as potential clones, allowing easy access for genetic flow between each sub-population. Therefore, this site would constitute as a single metapopulation, due to the likelihood of them being genetically related.

With regard to population size requirements for ambrosia's recovery criterion, the MVP of 7,500-15,000 mature stems per population was calculated using existing data and Pavlik's methodology (Pavlik 1996) (see Table 16). As more detailed information on ambrosia becomes available, a PVA should be developed and an actual MVP size determined. In order to ascertain whether the species is meeting the current MVP requirement, a methodology to count plants was needed. Separating individual plants in the field has been shown to be difficult, due to the clonal nature of the species. Therefore, stem counts were deemed to be the most effective method to estimate plant abundance in any given year. The STXPRT decided a correction factor of 5 or 10 stems per individual per year should be applied in order to account for stem production in years with poor or good environmental conditions, respectively (Section 2.1). This downlisting criterion will be met when populations have maintained the estimated MVP (based on stem counts) for at least 20 years.

Downlisting Criteria 2: Each ambrosia site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has the same characteristics as described above (see rush-pea's Downlisting Criteria 2). Although ideal high quality shortgrass prairie habitat would be located in unplowed/undisturbed habitat areas, this scenario means only remnant pieces of land in Nueces County which has been largely converted to cropland, and is restricted in Kleberg County to areas that can be accessed for plant surveys. As a consequence, existing patches of shortgrass prairie may need intensive restoration or habitat may need to be created on areas that are currently devoid of vegetation due to previous land use. Unplowed/undisturbed habitats should be sought out and restored as a priority before attempting creation of new habitat amidst disturbed shortgrass prairie. Prolific and aggressive nonnative grasses and woody species should not constitute more than small patches within each high quality shortgrass prairie site and these undesirable species should not be spreading throughout the site or inhibiting growth and reproduction of ambrosia. Each ambrosia site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat and to minimize and control threats over a period of 20 years.

Justification: The encroachment of nonnative grasses into all native shortgrass prairie within ambrosia's range remains the primary threat to the species. Eradication of these nonnative grasses throughout the specie's range is not currently realistic, however control of the spread of these grasses within a population site is possible through continued persistent, and sometimes intensive management. From field observations, we know that ambrosia can co-exist with Kleberg bluestem, the most prevalent invader in its habitat, if the bluestem does not dominate the plant community and instead only constitutes a scattered representation. Due to the aggressive spread of invasive grasses throughout South Texas and their resistance, and sometime positive response to control techniques (mowing, fire, and herbicide) and stochastic events (drought, disturbance), it is likely that they are present at all ambrosia habitat sites. We lack information from the literature or from field observations on a measureable percent composition of native and nonnative species that constitutes a high quality shortgrass prairie habitat and viable ambrosia site. We realize the tenuous relationship between natives and nonnatives within this ecosystem due to competition for space, water, light, and nutrients and therefore believe that a viable shortgrass prairie site that supports an ambrosia population can include small, isolated, dense stands of nonnative grasses. To maintain such ambrosia populations in this condition, we believe that active management will be required. Due to the expectancy that nonnative grasses will continue to pose a threat over the long-term, a USFWS-approved annual monitoring plan should guide active management on ambrosia sites over a 20-year period.

Delisting Criteria 1: A minimum of 15 populations are necessary for delisting and should have at least 7,500-15,000 mature stems per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 40 years. All extant populations, as well as any that are restored or created in the future, should remain secure. Also, a minimum of one natural population or genetically distinct population is extant within each drainage system (Oso, Chililpitin Creek-San Fernando, Alazan Bay-Baffin Bay, and Santa Getrudis Creek basins).

Justification: Given the justification for Downlisting Criteria 1, an additional 20-year period of species-specific annual monitoring of these populations will show that the ambrosia has maintained the specified abundance (7,500 – 15,000 stems per population) in each of the extant populations. Also, an increase from the known ambrosia populations of seven to 15 populations, distributed throughout the known range, and also meeting the stem abundance criteria, would maintain the genetic integrity of the species and provide redundancy in the case of a stochastic event (i.e. drought, disturbance). Although we do not yet fully understand the genetic composition of ambrosia because results of genetic studies are still preliminary, we believe that it is necessary to maintain a minimum of three natural populations per each of the four drainage systems throughout ambrosia's range to ensure genetic representation.

Delisting Criteria 2: At least seven of the populations that meet the delisting MVP minimum will be protected long-term (protection in perpetuity being optimum) via fee title acquisitions, conservation easements, or conservation agreements. These agreements will be between the USFWS, TPWD, or conservation organizations and landowners or land managers controlling areas with suitable habitat who carry out active management under USFWS-approved monitoring and management plans. See rush-pea's description of high-quality habitat.

Justification: There are so few extant ambrosia populations that it is essential to conserve all existing populations. Additionally, at least one additional restored or created site will serve as assurance population for ambrosia, rush-pea, and other representative shortgrass prairie species in perpetuity. Commitment to long-term protection under Federal, state, or NGO stewardship, or under private landowner stewardship that is guaranteed by conservation easements or agreements is needed to insure that some populations will be protected long-term. Habitat management and monitoring plans are necessary to insure that invading nonnative grasses and native and nonnative woody plants do not degrade the habitat quality at ambrosia populations. As previously explained, we believe that nonnative grasses and woody plants should not constitute more than a minimal representation of the plant cover within the site. Nonnative grasses and woody species are known to encroach into native shortgrass prairie habitat quickly. Therefore, all long-term agreements and easements should have updated management strategies for removal and control of nonnative grasses and woody species.

2.4 Narrative of Recovery Actions

1. Habitat protection and management of all known population sites of both species in the United States.

1.1. Establish positive working relationships with landowners and land managers of all known sites.

The USFWS will lead the effort to contact landowners and land managers of all sites. Partner and strengthen relationships with local landowner groups and organizations to explore collaborative options for delisting. Cooperative partnerships between the USFWS and landowners are critical to the survival of the species. By developing a spirit of cooperation and commitment among landowners, conservation organizations, and state and Federal agencies, the necessary conservation goals can be achieved.

1.1.1. Maintain contact with all landowners or land managers each year.

Landowners and land managers of all sites should be notified of the presence or potential presences of either species on or near their property, every 2-3 years, in addition to the condition of plants and quality of shortgrass prairie. Contact will be through one-on-one contact by the USFWS as well as written notification. Current and potential (in the cases of generational change-overs) landowners will be included in these notifications. The notification should explain the Act and its protections for the species. The USFWS will explain to the landowner/land manager about the section 7 consultation process; that if they are provided with funds to permit, fund, or carry out a project on their private lands, an intra-USFWS section 7 consultation will be needed.

1.1.2. Educate landowners about the extreme rarity and significance of both the ecosystem and species on their property.

Educate landowners about the extreme rarity and significance of the populations on their property. The rarity and importance of the species, as well as the unique nature of the surrounding natural community, should be expressed to landowners. The USFWS should continue to make personal contacts and one-on-one meetings with area landowners annually to inform them of the need for additional surveys, review the sorts of studies and activities that might be expected in efforts to conserve the species, and outline the technical and other types of assistance available to achieve these needed actions. Landowners should be reassured about conservation agencies' concerns and plans, and informed of how Federal and state endangered species laws apply to their land use goals.

1.1.3. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, conservation easements, and conservation agreements.

Encourage the establishment of long-term stewardship and conservation of the shortgrass prairie habitat. Stewardship opportunities should be addressed in long-term management strategies. Owners of property with known populations should be encouraged to protect the species and be commended for their efforts.

1.2. Cooperate with landowners and land managers to develop and implement management plans that address landowner and species goals.

Work with landowners to develop and implement management plans for the species that mesh with the landowner's own short- and long-term land use goals. Well-designed management plans should be developed cooperatively among Federal, state, city, county, and private landowners. These plans should address short- and long-term goals for protection and management of populations found on their lands, maintenance of shortgrass prairie habitat, and land use goals of the landowner. Any assistance required by the landowner for specific species or shortgrass prairie management tasks should be provided or allocated by conservation agencies. Implementation goals, fiscal needs, resources, and responsibilities should be clear. The USFWS will inform landowners/land managers of funding sources. The USFWS and partners will leverage funds for site-management to assist landowners.

1.2.1. With willing landowners, determine short- and long-term land use goals and their effects on both species.

Short-term management should be identified promptly to sustain the species and the shortgrass prairie habitat while long-term management plans, requiring results from research, should be developed as the recovery efforts continue. Short-term plans should include an inventory of each population location and condition, as well as identification and prompt removal (with landowner approval) of easily corrected threats. To guarantee the long-term survival of the species, the goal of a long-term plan for all populations is to ensure that viable, self-perpetuating populations persist in conjunction with landowner land use goals. Therefore, the involvement and endorsement of many landowners and land managers will be necessary. Short- and long-term management plans as well as the effects of common land use management practices should initially be assessed on an annual basis. These plans should be adapted to include new biological and/or management information as it becomes available. All interested parties, including agencies, landowners, land managers, researchers, etc., should be involved in their review and revision to benefit from each other's knowledge and expertise.

1.2.2. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers.

With landowner cooperation, simple site evaluations should be made for each population, detailing and evaluating its present condition and any obvious actions that should be taken to prevent decline. Following the initial evaluation, a short-term plan should be developed in cooperation with the landowner, with practices designed to protect against threats and maintain the population until comprehensive long-term management strategies can be developed. Management actions should be minimal to avoid harm due to a lack of information about the species. As information becomes available about critical needs and the plant's responses to management actions, tasks should be incorporated that will effectively allow habitat conservation or improvement, preservation of population integrity, and possible restoration following disturbances.

Already established management plans such as the DOD's INRMP on NASK should be used to provide management strategies for ambrosia. Additional management plans should be developed for both species where landowners and land managers approve. Plans should be adaptive and therefore, routinely assessed (with a goal to review on an annual basis) and updated with new biological, ecological, and management information. Encourage consultation between planners and the USFWS, TPWD, and other agency staff.

1.2.3. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management.

All populations and the shortgrass prairie habitat should be monitored on a regular basis to assess management practices and the overall status of the species; annual monitoring is encouraged. During the initial stages of recovery, monitoring may be more frequent and should include visits during flowering, fruiting, dispersal, and establishment. If possible, all populations should be monitored at the same time using the same methodology. Monitoring should provide the basis for evaluations of stability, reproductive success, and effectiveness of management activities. Comparisons should be made between populations on a regular basis to help differentiate normal population fluctuations from conditions that reveal stress or decline. If monitoring reveals a significant decline in the population due to management practices or the lack thereof, all parties should be notified. Management revisions should be a coordinated effort and should be developed to alleviate and reverse the decline.

1.3. Enforce applicable laws and regulations.

All management and biological studies should strictly adhere to existing regulations.

1.3.1. Work with regulatory agencies (DOD– NASK, TXDOT, TPWD, USDA-NRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat.

Enforce applicable laws and regulations. All Federal and state laws concerning commercial trade, permits, collecting, interagency consultation, and federally-reviewed activities that might threaten the species should be enforced. If willing, landowners and land managers should be assisted in posting signage on their property to discourage trespassing and encouraged to enforce trespassing laws if doing so will assist in addressing threats to the species.

2. Monitor both species on an annual basis.

2.1 Develop a monitoring plan for ambrosia.

Develop a comprehensive monitoring plan for ambrosia to track changes in abundance, distribution, reproductive output, and vigor of the species and the habitat as well as responses to management actions, threats, and habitat changes.

2.1.1. Monitoring plan will include population assessment and abundance measures to ascertain plant abundance and spread.

Abundance measures are crucial to track population fluctuations on an annual basis and to relate such changes to climate, management, threats, or other factors. Such measures should include a “red flag” trigger when abundance drops a set percentage, that attention will be focused on alleviating the causes if possible.

Abundance measures will also determine whether and when the MVP estimate is reached and has remained stable. Abundance goals should be routinely reviewed to ensure that monitoring is based on the best scientific and commercial data available to ambrosia.

2.1.2. Monitoring plan will include measurements of habitat conditions, ecological integrity, and conservation status of sites.

A well-designed plan includes pertinent data about the habitat at each ambrosia site, including only historic sites with precise location coordinates. Vegetation transects at each site could provide data on native plant community and species composition including frequency, dominancy, and abundance. Additional data outside these transects should be collected to provide information about encroaching nonnatives and woody species, changes in land use practices, and implications for future monitoring and management action. Data on the occurrence and severity of threats should be collected at each site so effective management and conservation goals can address each threats and ameliorate when possible.

2.2. Use the approved monitoring plans to annually monitor rush-pea and ambrosia, their habitat, management actions, and threats at extant sites.
Monitoring plans will be used to: confirm the locations and assess abundance of plants, especially whether and when a MVP has been attained as well as any critical changes in abundance; significant changes in individual distribution within the population; the condition of the habitat and plants; and, response to management, threats, and climate. Analysis of monitoring data may elucidate if and what type of management actions are needed, and any additional research needs revealed by newly observed ecological or biological interactions. The action lead for the monitoring plans should be identified well in advance of the actual monitoring.

2.3. Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites.

Historic sites that contain precise enough location information such as GPS (Global Positioning System) coordinates that are within tenths of miles from road intersections, etc., that can be relocated (and not simply county locations), should be assessed to determine if shortgrass prairie habitat remains and is intact. These historic sites could be used as potential reintroduction sites.

3. Initiate studies to gather biological information needed for effective management and recovery of rush-pea and ambrosia.

Most information available to date is based on qualitative observation. Additional information is necessary to evaluate limiting factors, determine life history, and prescribe management activities.

3.1. Determine specific habitat requirements (specifically limiting factors).

Characterization of the habitat where both species now naturally occur will help in evaluating the potential for recovery. These data could help in locating additional populations, selecting appropriate reintroduction sites, and identifying management activities needed for preservation.

3.1.1. Study soils and underlying geology.

A detailed characterization of the geology, soils, and hydrology in the areas where the species occurs should be compiled. These studies may reveal unrecognized patterns or small scale irregularities that need to be taken into consideration when developing management plans or selecting suitable reintroduction sites. The studies should also help to maintain current vegetation and habitat characteristics at each site, locate additional populations, and create and restore experimental and reintroduced populations. Analysis of soils sustaining the species, particularly of parameters critical to plant growth, such as parent material, texture, porosity, pH, soil water potential, and nutrient level, is a necessary step. A comparative summary and evaluation should be performed for all known sites to determine any critical factors.

3.1.2. Determine the plant community structure for both species.

Understanding the community features, variability, and dynamics of vegetation in areas where the species occurs could help in locating additional populations. This information is necessary for planning management of existing sites, searching for additional populations, and evaluating habitat for future reintroduction efforts. Careful documentation and measurement of plants present in the habitat throughout the growing season as well as across several years may reveal diagnostic features. Documentation of relative dominance, density, frequency, and constancy is important baseline information necessary for evaluating the status of the area and managing protected sites over time.

3.1.3. Study community dynamics/ecology.

Information is needed about changes in historical community conditions, their cause(s) and impacts on the species, and how the community responds to various management activities and disturbance. Characterization of seasonal events, such as rainfall and temperature regime, is required. The influence of seasonal or periodic processes, including fire, drought, freeze, and flooding events should be evaluated. The study of positive and negative interactions with other species (herbivory, disease, seed dispersal, and influences on seed bank conditions) is necessary for the formulation of management plans to address maintenance and restoration, as well as for assessment of reintroduction feasibility.

3.1.3.1. Study the response to current natural disturbance and land use practices.

Successful management of the species and the shortgrass prairie habitat will require that current knowledge and understanding of the activities that are occurring across the landscape that are impacting or could potentially impact the plants.

3.1.3.2. Study the response to past natural disturbance and land use practices.

Successful management of the species will require knowledge of the plant's responses to various natural events and land use activities. Comparative observation of known populations and analyses of history of land use, management, and disturbance would be helpful. A comparative study will provide at least a preliminary indication of the effects of different disturbances and management practices.

3.1.3.3. Study the response of both species and their habitat to seasonal or periodic cyclical events including drought, extreme heat events, freezes, and flooding.

The impact of cyclical or more infrequent events, such drought, freezes, heat waves, and flooding events should be evaluated for effects on mortality, dispersal, and reproduction. The plant's life cycle or periods of growth and mortality should be investigated in response to these events.

3.1.3.4. Investigate the fire ecology of both species and their habitat.

Fire, once a very important part of the coastal shortgrass prairie community, is now largely absent and therefore could be a very important cause of the decline of both species. We have only limited data on how each species responds to fire, particularly prescribed burning, and when it is most efficient to burn (as target nonnative species may respond differently depending on seasonality of burns). Prescribed burning may help to further stop encroachment of habitat from woody species.

3.1.3.5. Study both beneficial and detrimental interactions with other species.

Depending on the species, beneficial or detrimental interactions are possible. Provisions may need to be made in management plans when certain critical interactions are identified. We should specifically emphasize the need to study and implement the most appropriate measures to manage the impact of introduced (nonnative), invasive grasses. This should include controlled, replicated field trials using grass-specific herbicides to suppress nonnative grasses at existing sites. Effective eradication of grasses, such as Kleberg bluestem and King Ranch bluestem, may require repeated, well-timed applications of herbicide over a period of months. Treated areas should be re-seeded with native shortgrass species. If grass-suppression is shown to be beneficial, this could lead to effective, larger-scale restoration of existing populations threatened by invasive grasses. A cost analysis should be developed to determine the most cost-effective management strategies. Landowners, land managers, and partners should be informed of the best management measures most appropriate to control nonnative invasive grasses on their property.

3.2. Study population dynamics.

The status of populations in terms of stability, viability, and reproductive biology (type of reproduction, phenology, pollination biology, seed biology and dispersal, etc.) needs further analysis. Studies are necessary to evaluate the condition and stability of existing populations and to assist in formulating effective management plans.

3.2.1. Analyze the demographic structure of all populations.

Demographic studies of all sites could prioritize conservation needs among the sites based on the time, effort, and funding needed for conservation. Determining viable population structure may take many years because populations occur in an environment subject to climatic extremes. Populations should be visited several times during the year, preferably during flowering, fruiting, dispersal, germination, and establishment, to determine percent success at each stage. Studies should provide information needed to assess the demographic stability of populations, and should develop recommendations and targets for numbers of individuals of various ages needed to maintain a population. Viable population structure data will aid in long-term management needs and strategies such as demographic augmentation and the desired demographic structure for newly established populations.

3.2.2. Characterize phenology and assess the most vulnerable stages of life cycle.

General times of flowering are known for both species, but the relationship to weather and fluctuation as affected by climate (drought, late frosts, etc.) are unknown. Plants may be more susceptible to natural and human-made disturbances during certain phenological phases. Identifying critical times in the natural history of the species, and determining the cause and frequency of mortality and its importance to population survival, are vital to the development of monitoring and management plans.

3.2.3. Determine the primary means of reproduction in the wild.

For ambrosia, clonal production may be the primary form of population growth. Several studies are in progress to determine whether ambrosia also reproduces sexually. Additional studies are needed to document sexual and asexual reproduction scenarios, and the contribution to the reproductive output of the species. This information is needed before long-term management of wild populations, a cultivation program, or restoration and recovery work, would be successful. Currently the only way to maintain this species ex-situ is with living collections. We lack the data on the genetic diversity of the species in order to make knowledgeable choices about which plants to maintain in living collections

Although Pressly (2002) showed that rush-pea is self-compatible, the contribution of this self-fertilization to the reproductive output of the species is unknown. Research needs to be conducted to determine the types and contributions of all reproductive methods to this species. As vegetative reproduction has not been noted in this species, seeds could continue to be collected from wild populations and maintained for future reintroduction projects. Procedures for seed collection such as the amount of seed to collect, from which populations, how often, etc. should be reviewed and assessed on a routine basis to ensure that collecting pressures do not become an issue (consult the CPC guidelines).

3.2.4. Study pollination biology and determine effective pollination requirements and effective pollinators.

Little is known of rush-pea's pollination biology aside from one observation of a generalist insect visitor to the flower. Other information suggests that rush-pea is a successful self-fertilizing species. If there is any cross-pollination occurring in this species, then the specific mechanisms (insect, wind, etc.), insect visitors or pollinators, pollen development, pollen predation, pollen viability, and other aspects of pollination biology are necessary to determine as failure of any aspect of the pollination system could cause a reduction in normal fruit production.

Ambrosia is wind pollinated and the impact of taller grasses and woody species may have some impact on the efficiency of wind transport of pollen. More detailed study of the sexual reproduction of the plant may indicate if this is an additional concern.

3.2.5. Study seed production and dispersal.

The amount and variation in seed production should be examined as well as seed longevity, viability, dormancy (if any), and germination requirements. Dispersal mechanism(s) and dispersal distances of seed should also be studied as well as the presence of seed banks and their dynamics. Losses of seed crops due to disease and possible predation should be monitored. This information is needed for cultivation programs, restoration, and reintroduction planning.

3.2.6. Study seedling recruitment.

The relationship between seed production, seed reserves (seed banking, longevity), and rates of seedling recruitment should be established. Changes in rates of recruitment with different site conditions and optimum conditions for seedling recruitment should also be determined. This information is necessary for determining management needs for regenerating populations.

3.2.7. Study population genetics to determine the genetic diversity within and among populations.

As new populations are located and before reintroduction projects are initiated, the need for genetic information becomes invaluable. Such information is useful for measuring the amount of genetic diversity of individuals within and among populations, the degree of total genetic diversity between all populations, and the genetic distance between two populations. In addition, information on the rate of gene flow between populations, as well as quantitative information on reproduction modes (self-fertilization versus out-crossing versus vegetative cloning) will help guide long term conservation strategies for both species.

4. Survey for additional populations of rush-pea and ambrosia.

As more information about the habitat and biology of each species becomes available, determining areas capable of supporting the species may be more predictable. Models, maps, and other tools will be developed showing the vegetative and edaphic characteristics of occupied sites. This information will help to determine where coastal shortgrass prairie habitats currently might remain intact and/or where the species could be located. These potential areas are a high priority to survey and engage in stewardship efforts. These surveys should be performed to locate existing and new populations and for use as potential reintroduction sites in Texas.

5. Cooperatively work with landowners and land managers to restore additional shortgrass prairie sites located in one or more of the drainage areas from which rush-pea and ambrosia are known to co-occur.

5.1. Locate and acquire (fee title or permanent conservation easement) an area containing patches of existing shortgrass prairie (even if in degraded state) for purposes of restoration and long-term shortgrass prairie conservation.

Because of habitat fragmentation there are few known locations of shortgrass prairie and even fewer with permanent protection. In order to achieve recovery for these species, additional shortgrass prairies should be located and restored. Using available native seed sources would provide significant opportunities for habitat restoration. Once restored, such locations would be ideal reintroduction sites for rush-pea and ambrosia.

5.1.1. Cooperate with willing landowners to determine the best means possible for providing permanent protection and active habitat management of sites to maintain native shortgrass prairie. Conservation management could be implemented through cooperation with a Federal, state, municipal government, or NGO, or one in which the landowner or manager agrees upon.

Long-term ownership and management for conservation purposes are often more secure in the hands of government agency or non-governmental organization. Agreements for habitat management can often be spread amongst such agencies and organizations.

5.2. Carry out restoration, including reintroductions, at this site (5.1) or other sites such that a complement of the native shortgrass prairie grasses and forbs commonly associated with rush-pea and ambrosia are present.

Restoration and management of the native shortgrass prairie vegetation community could help to preclude encroachment of nonnative grass and growth of woody species into these sites. Each site should be looked at on a case-by-case basis to determine which method of management is best (such as herbicide application, mowing, prescribed burning, etc.). Additional sites, such as those slated for reintroduction, should also be restored and managed to conserve the integrity of the native shortgrass prairie vegetation community.

5.3. Introduce experimental populations of rush-pea and ambrosia.

Seek private landowners or other land managers who are willing to conserve or restore shortgrass prairie sites on their land or at refugium populations. Using data obtained from habitat characterization studies, habitat can be restored to be as similar as possible in species composition, including animal components (pollinators, dispersers, etc.). After development and the landowner's cooperation to support these efforts and approval of rush-pea and ambrosia reintroduction plans, the species could be reintroduced at the site. With appropriate planning, reintroductions could be considered at both wild and refugium sites.

6. Establish seed or propagule banks and *ex-situ* (botanical garden, refugium, research institute, etc.) populations for each species. These banks and *ex-situ* populations will be established using approved reintroduction plans for both species (see Recovery Action 7 below).

Seed banks and cultivated conservation collections at secure botanical facilities should be established to prevent extinction of the species and extirpation of their wild populations and to provide material for future restoration activities or research. Use responsible seed collection guidelines, outlined by the CPC, to prevent harming the wild populations. If long-term storage is an option, periodic testing and any necessary propagation should also be done by the facility. If seed storage is not an option, a genetically representative collection of cultivated plant materials may be necessary. All cultivated and seed storage material should be housed with responsible institutions that maintain scientifically accurate records of provenance, number of propagules, cultivation and storage methods. Due to the small population sizes of each species and the threats from nonnative grasses and stochastic events, seed collection, banking, and propagation are important tools in both species recovery.

6.1. Ensure seed is collected and banked from each rush-pea site, including newly discovered populations.

Methods of seed collection and information to obtain during collections should follow the USFWS-approved, Controlled Propagation and Reintroduction Plan (USFWS 2012). Rush-pea can reproduce in as little as 6 months to produce abundant, viable seed both in the wild and in cultivation; therefore, all propagation for seed banking, seed increase, refugia, augmentation, and reintroduction will be from seeds rather than by vegetative means (USFWS 2012).

6.2. Continue to monitor and document conditions at all existing rush-pea refugia.

Monitor and maintain accurate records of rush-pea refugia sites, including information from the source populations (such as location, date collected, collector(s), number of propagules collected, any post-collection treatment, type and length of storage, post-storage treatment, etc.), seeds collected from refugia (with similar documentation), and the distribution or use of those seeds (including amount and date delivered) to seed banks, augmentation sites, and reintroduction sites, etc. In the cases where experimental trials have been conducted, document the methods and results. Monitoring efforts should be more frequent (maybe weekly for a month, biweekly for a season, then followed by monthly for the first year) for new refugium sties and may include presence/absence surveys. Over time, monitoring efforts should be adjusted to fit the life span of the species. These monitoring efforts should document numbers of flowers and fruits (to compare to monitored natural sites to determine adequate reproduction), invasive plants, response to climate (drought, freezing, or rainfall), insect herbivores, and insect visitors, and pollinators (USFWS 2012).

6.2.1. Ascertain whether any changes in a rush-pea refugium system are needed, including any need for additional refugia.

Detailed monitoring records should be kept and used to determine the success of the species at the refugia. Additional refugia may be deemed necessary if: threat levels increase; a revised MVP determines that populations are not viable; or, other circumstances where introduction into refugia was not successful. If an introduction is not successful, at either a refugium or an introduction site, detailed data and analysis should compiled and reviewed before future introductions are attempted.

6.3. Once reintroduction plans are developed and approved, propagate, and maintain both species for reintroduction.

Propagation using seed, cuttings, or other techniques, such as tissue culture, should be investigated and documented for use in propagating plants for reintroduction. More likely for ambrosia, clonal techniques present challenges in maintaining needed levels of genetic variability for natural populations. However, if done correctly, these techniques may be used in producing materials for research and restoration activities with minimal impact on wild populations. Plant material may be available from a conservation facility (i.e. SABG or similar institutions) for reintroduction efforts. Only seed, not vegetative material, should be used for reintroduction work with rush-pea.

6.3.1. Study cultivation requirements.

Off-site cultivated collections and seed banks should be established, and additional studies are needed to provide a successful long-term management program for both natural and cultivated populations. Propagation techniques need to be documented along with detailed information on propagule sources and numbers, collection dates, storage locations, etc. All *ex-situ* plants or populations should also have similar information documentation.

6.4. Continue experimentation with seed germination and effectiveness of ambrosia propagation from seed.

As with rush-pea, determine seed requirements for successful propagation of seed. More than one seed storage and preservation facility should be willing to preserve and store seeds long-term, as well as perform research on propagation techniques which would give important insights into habitat and management needs.

6.5. Continue vegetative propagation of ambrosia for purposes of reintroduction.

Anecdotal evidence suggests that ambrosia is not successfully propagated by seed. Therefore, it is important to future reintroduction and management that we continue to collect and maintain healthy plants for uses of reintroduction. However, the most available and current information on the genetic variability of ambrosia should be used in determining future reintroduction and management needs. Vegetation propagation techniques, particularly those that maintain or result in genetic diversity of propagules, should be developed.

7. Conduct a reintroduction program on public and private lands where there are willing partners.

Evaluate and document the success of different cultivation techniques, site preparation, and other management techniques based on research, and assess any additional information necessary to attempt reintroduction. If reintroduction is feasible, a USFWS-approved Propagation and

Reintroduction plan should be developed and implemented for ambrosia. This should provide for all phases of reintroduction, including site selection, site preparation, monitoring, and short- and long-term management strategies, particularly the effective management (eradication and prevention) of nonnative, invasive grass species. Reintroduced populations for both species should not be considered successful until they are established, reproductively active, self-perpetuating, and demonstrated to be demographically and genetically viable.

7.1. Develop a USFWS-approved controlled propagation and reintroduction plan for ambrosia.

Develop a USFWS-approved controlled propagation and reintroduction plan that provides reference to the existing germination studies controlled propagation efforts completed for ambrosia; and refugia, augmentation, and reintroduction of the species. The plan should follow the USFWS and the National Marine Fisheries Services (NMFS) Policy on Controlled Propagation, published on September 20, 2000 (FR 65 56919). Collection procedures will strictly follow the CPC guidelines so as to not deplete seeds from the wild. Measures of success for reintroductions and augmentations should be determined before such work begins.

7.2. Adhere to the guidelines established in the Slender Rush-pea Controlled Propagation and Reintroduction Plan (USFWS 2012).

The purpose of the plan is to provide guidance on the following activities: establishment of refugia populations; production of individuals for research and technology development; production of individuals for supplementing (augmentation) extant populations; and production of individuals for reintroduction to suitable habitat within the species' historic range. Determine measures of success for reintroduction.

7.3. Appoint a coordinating team to help plan and oversee the reintroduction programs.

Careful coordination and good communication are necessary to minimize repeats of research projects and activities on wild or reintroduced populations, to maximize the use of limited research funding and cultivated materials, and to avoid having activities from one study interfere with monitoring efforts or other research studies. Landowners, Federal and state agencies, NGOs, and researchers will need to carefully plan and coordinate field activities and lab investigations, working in teams and sharing data whenever possible.

7.4. Incorporate reintroduction into applicable agency land management plans.

If reintroduction sites are established on Federal or state lands, agencies should work closely with the coordinating team to incorporate the established reintroduction program into their land and resource management plans.

7.5. Perform experimental planting at a selected natural site as a pilot project.

Augmentation and reintroduction of plant populations are costly and labor-intensive, and rely on extensive research to select the proper natural habitat and prepare adequate amounts of demographically and genetically suitable propagative material. Pilot projects are essential to determine the time, cost, feasibility, and to determine the effectiveness of the full-blown study design prior to its execution. Each pilot project should contain realistic goals and measurable objectives that take into consideration the biological constraints and challenges, site protection and access, financial support throughout the life of the project, and should address technical and logistical concerns (USFWS 2012).

7.6. Using results from Action 7.5, reintroduce populations on private and public lands, where possible.

7.6.1. Develop a long-term monitoring program to assess success of reintroductions or introductions.

While similar to monitoring natural populations, reintroductions or introductions require more intensive monitoring in order to be able to accurately determine success or failure and the reasons for it. Reintroduction monitoring needs to be more frequent, at least initially, as most mortality occurs then. Also, measures of growth, not often necessary in established natural populations, are needed to help measure success. Once the plants have reached maturity, evidence of seedlings or new stems (in the case of ambrosia) and their eventual maturity will need to be carefully monitored to assess reintroduction success.

7.7 Use information gained from the long-term monitoring program to adjust both species' reintroduction plans.

As reintroduction is a relatively new tool in the recovery of these species, new information can be used to update the reintroduction plans. This should be on a regular basis.

8. Develop an education and outreach program.

8.1. Develop any necessary educational or outreach materials.

Develop educational materials for use in raising public awareness and appreciation for the unique habitat needs of the coastal shortgrass prairie and the two endangered South Texas plants found within them. Materials should be current and focus on the community itself, the ecosystem processes (fire), and habitat management guidelines. Materials could include brochures, photos, posters, and digital media. Outreach opportunities with schools, environmental programs, landowner contact programs/groups, native plant groups, and private conservation organizations would benefit from these materials.

8.2. Provide educational and outreach materials to landowners and land managers.

Provide information to landowners and land managers of extant and potential sites to demonstrate the importance of intact shortgrass prairie habitat for other wildlife as well as the species at hand. The preferred method to deliver outreach materials should be in person; however, providing them electronically may be sufficient. Materials should include landowner benefits and funding opportunities, where appropriate.

8.3. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.

Educational materials should be provided to interested parties. This may have a profound impact on the current and/or long-term management or land use decisions. Providing these materials early to these groups will allow sufficient opportunities for integration of conservation into their land use planning needs.

9. Conduct Population Viability Analyses (PVA) and update the existing MVPs for each species based on current biological and ecological information.

9.1. Investigate both species' population genetics to ensure long-term persistence.

A species that is sufficiently represented across its range will reduce its overall risk of extinction. Representation of sufficient populations for both species from across the known geographic range of the species should be determined, and are especially desirable because of their contribution to the genetic diversity of the species.

9.2. Develop traditional MVP estimates for both species.

Although the current estimates of MVP are based on the best scientific and commercial data available for both species, a more traditional MVP analysis should be conducted when long-term monitoring has provided needed data. Guidance should be sought from MVP specialists to determine what factors are most important to monitor as well as the frequency of monitoring. The clonal nature of ambrosia will always make the MVP for this species more problematic.

9.3. Reassess the MVP size when new information is made available.

Established MVP assessments should be routinely updated as new information on the species distribution, status, population abundance, and characters (see Pavlik's table) become available.

10. Review and track recovery.

10.1. Maintain the STXPRT to help review the status of both species and assess the effectiveness of the management plans and other recovery tasks.

We are committed to assessing the progress of both species towards recovery and collaborating with partners to accomplish this. The USFWS will determine if current goals remain appropriate for the conservation needs and requirements of the species and its habitat. We will collaborate with partners to continue monitoring populations. These plans should be adapted to include new biological and/or management information as it becomes available.

10.2. Revise the Recovery Plan as appropriate.

The Recovery Plan can and should be, rewritten or simply updated as needed to address changing habitat conditions, threat status, or discovery of new and substantial bio/ecological information that could impact the recovery objectives, criteria, and actions.

10.3. Develop a post-delisting monitoring plan when appropriate.

Section 4(g)(1) of the Act requires that the USFWS monitor the status of all recovered species for at least five years following delisting. In keeping with this mandate, a post-delisting monitoring plan should be developed by the USFWS in cooperation with TPWD, additional Federal, state, and local governments, academic institutions, and other appropriate entities, along with members of the STXPRT. This plan should outline indicators that will be used to assess the status of the delisted species (considering population and threat monitoring), develop monitoring protocols, and evaluate factors that may trigger consideration for relisting.

PART III: IMPLEMENTATION

The following implementation schedule (Table 18) outlines priorities, potential or responsible parties, and estimated costs for the specific actions for recovering the shortgrass prairie as well as its listed species, rush-pea and ambrosia. It is a guide to meeting the goals, objectives, and criteria from Section II Recovery Program, of this Recovery Plan. The schedule: 1) lists the specific recovery actions, corresponding outline numbers, the action priorities, and the expected duration of actions; 2) recommends agencies or groups for carrying out these actions; and 3) estimates the financial costs for implementing of the actions. These actions, when complete, should accomplish the recovery of both the rush-pea and ambrosia and restoration of the shortgrass prairie habitat.

3.1 Responsible Parties and Cost Estimates

The recovery of rush-pea and ambrosia is dependent upon the voluntary cooperation and collaboration of many organizations and individuals. The implementation schedule below identifies agencies and other potential "responsible parties" (private and public) to help implement the recovery of these species. Responsible parties are those entities who may voluntarily participate in implementation of particular actions listed within this Recovery Plan. Examples of participation include, but are not limited to, providing funding, technical assistance, staff time, project planning, or any other means of implementation; however this Recovery Plan does not commit any "responsible party" to carry out a particular recovery action or to expend the estimated funds. It is only recognition that particular groups may possess the expertise, resources, and opportunity to assist in the implementation of recovery actions. Although collaboration with private landowners and others is called for in the Recovery Plan, no one is obligated by this plan to any recovery action or expenditure of funds. Likewise, this schedule is not intended to preclude or limit others from participating in this recovery program.

Projecting time and cost estimates from 2017, the slender rush-pea could be fully recovered in 60 years (2078) and South Texas ambrosia could be recovered in 40 years (in 2058). The total cost of recovery for both species is $1,019,000. The cost estimates provided are not intended to be a specific budget but are provided solely to assist in planning. The total estimated cost of recovery, by priority, is provided in the Executive Summary. The schedule provides cost estimates for each action on an annual or biannual basis. Estimated funds for agencies included only project-specific contract, staff, or operations costs in excess of base budgets. They do not include ordinary operating costs (such as staff) for existing responsibilities.

3.2 Recovery Action Priorities and Abbreviations

Priorities in column 1 of the following Implementation Schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population or habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

The assignment of these priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented.

Table 18. Recovery implementation table.

Priority No.	Action No.	Action Description	Target Species	Threats	Is the USFWS the lead? If no, then who is the lead?	Action Duration (Years)	Responsible Parties in addition to USFWS	Cost Estimate by FY (by $1,000s)												
								Total Cost ($1,000s)	FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	FY 26-30	FY 31-35	FY 36-40	FY 41-45	FY 46-50	FY 51-55	FY 56-60
1	1.1.1.	Maintain contact with all landowners or land managers each year.	Both	A, D	Yes; along with TPWD.	Annual	TPWD, USDA-NRCS, PMC, TAMUK	120	10	10	10	10	10	10	10	10	10	10	10	10
2	1.1.2.	Educate landowners about the ecosystem and species' on their property.	Both	A, D	Yes; along with TPWD.	Continual	TPWD, USDA-NRCS, PMC	(Costs accounted for in 1.1.1)												
2	1.1.3.	Encourage long-term stewardship of habitat at these sites.	Both	A, D	Yes; along with TPWD.	Continual	TPWD, USDA-NRCS, PMC, NASK	(Costs accounted for in 1.1.1)												
2	1.2.1.	Determine short- and long-term land use goals and the effects on both species.	Both	A, D	Yes; along with TPWD.	Periodic	LO, land managers, TPWD, NASK	25	5		5		5		5		2.5		2.5	

1	1.2.2.	With cooperating landowners, develop and implement management plans that are beneficial to the species and acceptable by the landowner and land manager.	Both	A, D	Yes; along with TPWD.	Up to 60 years	Academics, LO, land managers, TPWD, TXDOT, USDA-NRCS, PMC	50	6	4	4	4	4	4	4	4	4	4	4	4
1	1.2.3.	Develop monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management .	Both	A, D	Yes	5 years	LO, land managers, TPWD, TXDOT, USDA-NRCS, PMC	20	20											
2	1.3.1.	Work with regulatory agencies to ensure existing regulations are used to provide adequate protection of current habitat.	Both	A, D	Yes; along with TPWD.	Continual	TPWD, TXDOT; intra-USFWS, LO, land managers, NASK	50	5	5	5	5	5	5	5	5	2.5	2.5	2.5	2.5

1	2.1.	Develop monitoring plan for ambrosia (Actions 2.1.1. and 2.1.2.).	South Texas ambrosia	A, E	Yes; along with TPWD.	1	TPWD, NASK, LO, land managers, TAMUCC, TAMUK	10	10											
1	2.2.	At extant sites, use the approved monitoring plans to annually monitor rush-pea and ambrosia, habitat, management actions, and threats.	Both	A, E	Yes; along with TPWD and NASK.	Annual	TPWD, NASK, LO, land managers, TAMUCC, TAMUK	50	5	5	5	5	5	5	5	5	2.5	2.5	2.5	2.5
3	2.3.	At historic sites, monitor species and biotic communities, and assess ecological integrity and conservation status.	Both	A, E	Yes; along with TPWD.	Annual	TPWD, LO, land managers, academics	50	5	5	5	5	5	5	5	5	2.5	2.5	2.5	2.5
3	3.1.1.	Study soils and underlying geology.	Both	A	No; academics	1	academics, LO, land managers, TAMUCC	14	14											
3	3.1.2.	Determine the community structure.	Both	E	No; academics	3-5+	academics, LO, land managers, TAMUCC, TAMUK	14	14											
2	3.1.3.1.	Study response to natural disturbance and current and past land use practices.	Both	A	No; academics	3-5+	academics, LO, land managers	14	14											
3	3.1.3.2	Study response to natural disturbance and past land use practices.	Both	A	No; academics	3-5+	academics, LO, land managers	(Costs accounted for in 3.1.3.1)												

3	3.1.3.3.	Study response of both species, as well as the habitat, to seasonal and periodic cyclical events including drought, extreme heat events, freezes, and floods.	Both	E	No; academics	≥ 3	LO, land managers, academics, TPWD, TAMUK, NASK, Robstown County Park	10	10											
1	3.1.3.4.	Investigate the fire ecology of both species and their habitat.	Both	A	No; academics	≥ 3	Academics, NASK, LO, land managers, PMC, TAMUCC	10	10											
1	3.1.3.5.	Study both beneficial and detrimental interactions with other species.	Both	A, E	No; TPWD and academics	≥ 3	academics, LO, land managers	2	2											
3	3.2.1.	Analyze the demographic structure of all populations.	Both	A	No; academics	Periodic (multiple times per year);10 years total	academics, LO, land managers	50	40	10										
3	3.2.2.	Characterize phenology and assess the most vulnerable stages of life cycle.	Both	E	No; academics and ES	2	academics, LO, land managers	(Costs accounted for in 3.2.1)												
2	3.2.3.	Determine the primary means of reproduction in the wild.	Both	A	No; academics	3	academics, LO, land managers, USDA-NRCS, PMC	(Costs accounted for in 3.2.1)												

3	3.2.4.	Study pollination biology and determine effective pollination requirements and effective pollinators.	Both	E	No; academics and ES	2+	academics, LO, land managers	(Costs accounted for in 3.2.1)												
2	3.2.5.	Study seed production and dispersal.	Both	E	No; academics	2-3 yrs	academics, LO, land managers	(Costs accounted for in 3.2.1)												
2	3.2.6.	Study seedling recruitment.	Both	E	No; academics	2-3 yrs	academics, LO, land managers	(Costs accounted for in 3.2.1)												
2	3.2.7.	Study population genetics to determine the genetic diversity within and among populations.	Both	A, E	No; academics , ES, and others.	6	academics, LO, land managers, TAMUCC (currently underway)	12	10	2										
1	4	Search for additional populations.	Both	E	Yes	5-10 yrs.	academics, LO, land managers, USFWS, TPWD	50	30	20										

1	5.1.1.	Cooperate with willing landowners to determine the best means possible for providing permanent protection and active habitat management of population sites to maintain native shortgrass prairie. Conservation management could be implemented through cooperation with a Federal, state, municipal government, or NGO, or one in which the landowner or manager agrees upon.	Both	A, D	Yes	20-60	academics, LO, land managers, USFWS, TPWD	60	10		10		10		10		10		10	
2	5.2.	Carry out restoration at this site, including reintroductions, such that it hosts a complement of the native shortgrass prairie grasses and forbs commonly associated with both species.	Both	A, E	Yes; ES	≥ 10 years	academics, LO, land managers, USFWS, TPWD	100	50	50										
2	5.3	Introduce experimental populations of rush-pea and ambrosia	Both	E	Yes; ES	Continual	LO, land managers	45	5	5	5	5	5	5	2.5	2.5	2.5	2.5	2.5	2.5

1	6.1	Ensure seed has been collected and banked from each site, including newly discovered populations.	Slender rush-pea	E	Yes; along with TPWD, PMC, and academics	1	academics, LO, land managers, USDA-NRCS PMC, USDA-ARS, SABG, CCBG	12	12											
3	6.2.1.	Ascertain whether any changes in refugia systems are needed, including any need for additional refugia.	Slender rush-pea	E	No; academics	3-5 yrs	academics, LO, land managers, USDA-NRCS, PMC, NABA-NBC, CCBG	5	5											
2	6.3.1.	Study cultivation requirements.	Both	A, E	No; academics	4 years propagate; then as needed	academics, LO, land managers, CCBG, USDA-NRCS, PMC	20	10	5	5									
3	6.4.	For ambrosia, continue experimentation with seed germination and effectiveness of propagation from seed.	South Texas ambrosia	A, E	No; academics	5+	LO, land managers, SABG, USDA-NRCS, PMC, other *ex-situ* possibilities	12	12											
2	6.5.	Continue vegetative propagation for purposes of reintroduction.	South Texas ambrosia	A, E	No; academics	≥20 years	USDA-NRCS PMC, SABG, other *ex-situ* possibilities	10	2.5	2.5	2.5	2.5								
2	7.1.	Develop a USFWS-approved controlled propagation and reintroduction plan.	South Texas ambrosia	A	Yes	1-2 years	LO, land managers, academics, USDA-NRCS, PMC, CCBG,	8	8											

							SABG, others													
2	7.2.	For rush-pea propagation, adhere to guidelines established in the Slender Rush-pea Controlled Propagation and Reintroduction Plan.	Slender rush-pea	D	Yes	Continual, 10 years	LO, land managers, academics, PMC, SABG, CCBG, other *ex-situ* possibilities, others	20	10	10										
2	7.3.	Appoint a coordinating team to help plan and oversee the reintroduction programs.	Both	D	Yes	10-20 years	TPWD, LO, land managers, academics, USDA-NRCS, PMC, NABA-NBC	10	4	2	2	2								
2	7.4.	Incorporate reintroduction into applicable agency land management plans.	Both	D	Yes	Periodic	NASK, TPWD, TXDOT	2	2											
2	7.5.	Perform experimental planting at a selected natural site as a pilot project.	Both	A, E	Yes	5	NASK, TPWD, academics, LO, land managers, USDA-NRCS, PMC	8	8											

2	7.6.1.	Develop a long-term monitoring program to assess success of reintroductions or introductions at all sites where this work has been undertaken.	Both	A	Yes	Continual	NASK, TPWD, academics, LO, land managers, others	52	5	5	5	5	5	5	5	5	3	3	3	3
2	7.7.	Use information gained from the long-term monitoring program to adjust both species reintroduction plans.	Both	A	Yes	Periodic	TPWD, LO, land managers, others, academics	5	1		1		1		1		0.5		0.5	
1	8.1.	Develop any necessary outreach materials.	Both	A	Yes; along with TPWD	Continual	academics, LO, land managers, others	29	10	5	5	2	2	1	1	1		1		1
3	8.2.	Provide information to landowners and land managers developed in Task 8.1.	Both	A	Yes; along with TPWD	Continual	academics, LO, land managers, others	12	5	1	1	1	1	1		1		0.5		0.5
1	8.3.	Provide outreach materials to other interested parties.	Both	A	Yes; along with TPWD, NRCS, academics	Continual	academics, LO, land managers, others	10	2.5	2.5	2.5	2.5								

2	9	Conduct a PVA and update the existing MVPs for each species based on current biological and ecological information (includes Actions 9.1, 9.2, and 9.3).	Both	E	Yes	Continual	TPWD, LO, land managers, academics	(Costs accounted for in 9.1, 9.2, 9.3)												
2	9.1.	Investigate both species' population genetics to ensure long-term persistence.	Both	E	Yes	1-5 years	TPWD, LO, land managers, academics, TXDOT, others	50	50											
2	9.2.	Develop traditional MVP estimates for both species.	Both	E	Yes	Periodic	TPWD, LO, land managers, academics, TXDOT, others	15		3		3		3		3		1.5		1.5
2	9.3.	Reassess MVP size when new information is made available.	Both	E	Yes	Periodic	TPWD, LO, land managers, academics	(Costs accounted for in 9.2)												
2	10.1.	Maintain STXPRT to help review status of the species and assess the effectiveness of the management plans and other recovery tasks.	Both	D	Yes	Continual	TPWD, LO, land managers, academics, others	12	1	1	1	1	1	1	1	1	1	1	1	1
3	10.2.	Revise the Recovery Plan as appropriate.	Both	E	Yes	Continual	TPWD, LO, land managers, academics, others	5		2.5		2.5								

2	10.3.	Develop a post-delisting monitoring plan when appropriate.	Both	D, E	Yes	1	TPWD, LO, land managers, academics, others	20								10				10

Abbreviations/Acronyms

CCBG = Corpus Christi Botanical Gardens

FY = Fiscal Year

LO = Landowner

MVP = Minimum Viable Population

NABA-NBC = North American Butterfly Association – National Butterfly Center

NGO = Non-governmental organization

PVA = Population Viability Analysis

PMC = Plant Materials Center

SABG = San Antonio Botanical Gardens

STXPRT = South Texas Plant Recovery Team

TAMUCC = Texas A&M University – Corpus Christi

TAMUK = Texas A&M University - Kingsville

TXDOT = Texas Department of Transportation

USDA – ARS = U.S. Department of Agriculture – Agricultural Resource Service

USFWS = U.S. Fish and Wildlife Service

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PART V: APPENDICES

Appendix A – Glossary of Terms

The Glossary of Terms defines technical and/or biological terms that are underlined throughout the plan. A page number will follow the definition to denote where in the Recovery Plan the term can be found.

TERM	DEFINITION
Achene	dry, one-seeded fruit that does not open to release the seed
Allelopathic	secretion of substances into the environment by an organism that is harmful to other organisms
Anthesis	the period when a flower is receptive to fertilization
Appressed pubescence	having fine short hairs arranged so they are facing each other
Bimodal	having two distinct probability peaks
Bipinnately	plant leaflets of themselves divided into smaller leaflets
Climax succession	late, relatively stable stage of ecological succession
Clonal	a population of genetically identical individuals
Endangered Species	"…any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man." U.S. Congress 1988
ex-situ population	conserving a population "off-site", or outside of natural habitat to remove from threats
Fodder	food for cattle or livestock
Friable	soil that is easily broken into smaller and smaller pieces
Genotype	the genetic composition of a cell, organism, or individual (Wikipedia 2012)

Herbicide drift	the movement of herbicide from the target area to areas where herbicide application was not intended (Dexter 1993)
Improved pastures	that have been planted with specific foraging species
Inflorescence	complete flower head of a plant including stems, stalks, bracts, and flowers
Microsatellite-enriched DNA	repeating sequences of 2 to 6 base pairs in DNA that may be used as genetic markers in kinship and population studies (Wikipedia 2012)
Minimum Viable Population	the fewest individuals required for a specified probability of survival over a specified period of time (Pavlik 1996; Mace and Lande 1991); see Population Viability Analysis
Monoclinous	having both male and female reproductive parts in the same flower (bisexual, hermaphrodite)
Mottes	a small stand of trees on a prairie
Oblanceolate	lance-shaped; with the thin end at the base
Perennial herbaceous	a plant that lives two or more years, surviving each winter as underground storage or perennating organs (like bulbs, corms, rhizomes, or stem and root tubers)
Phenology	the study of the effects of climate on living organisms. Includes seasonal events like flowering, migration, and growing seasons, and long-term effects as well
Pinnate	on a compound leaf; having leaflets arranged on either side of the stem, typically in pairs opposite each other
Pleistocene deltas	deltaic plain laid down primarily by the Nueces and San Antonio Rivers during the Pleistocene or Ice Age (Lehman *et al.* 2005, p. 8)
Population Viability Analysis	statistical models used to predict the probability of extinction of a population after a specified period of time
Raceme	unbranched, indeterminate type of inflorescence bearing flowers with pedicels (short floral stalks) along its axis

Ramets	an individual, genetically-identical plant reproduced as a clone of the parent plant
Rhizomatous	underground stem that grows horizontally and, through branching, acts as an agent of vegetative reproduction when they root at intervals
Ruderal	early stage of succession (colonization); plant that grows on or around human dwellings, agricultural land, or wastelands
Scarification	degradation of an impervious seed coat by physical, chemical, or biological means to allow imbibition
Seral	an intermediate developmental stage in ecological succession (Wikipedia 2013)
Shortgrass prairie	landscape that included relatively treeless stream bottoms and uplands dominated by blue grama and buffalo grass, two warm-season grasses that flourish under intensive grazing.
Sprigging	vegetative planting by placing sprigs (section of stem with crowns and roots that is cut from a rhizome or stolon) at spaced intervals in furrows/holes (University of Tennessee 2007)
Staminate	a flower possessing only male parts (filament and anther; the androecium)
Stratification	seed treatment consisting of maintaining specific conditions, such as temperature and moisture levels, for specified periods of time. Treatment method is required for seeds that need a period of chilling before they germinate.
Subsoil	the layer of soil beneath the topsoil and above the parent material
Thatch	a loose, intermingled organic layer of dead and living shoots, stems, and roots that develops between the zone of green vegetation and the soil surface. Thatch build up begins when turf produces organic debris faster than it can be broken down. Those parts of grass plants that are the most resistant to decay — stem nodes, crowns, fibers of

	vascular tissues, and roots — make up the bulk of thatch (Peter Landschott, accessed online 1/16/2014). Thatch in this plan is the drying layer of grass and other plant debris that lay atop the surface of a field when mowed.
Threatened Species	"…any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." United States Congress 1988
Undulate	having a wavy surface or edge
Vertisols	clay-rich soils that shrink and swell with changes in moisture content

Appendix B – Comments on the Draft Recovery Plan and our Responses

Public Review

A draft of this Recovery Plan was published and distributed for review to all interested parties. The USFWS published a notice in the Federal Register on June 01, 2017 (82 FR 25299) to announce that the document was available for public review and comment. The comment period lasted for 60 days and closed on July 31, 2017. An electronic version of the draft Recovery Plan was also posted on the USFWS's Southwest Region website (*https://www.fws.gov/southwest/es/ElectronicLibrary_Main.cfm*) and the Species Profile websites (*https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=3331* and *https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=5298*).

Peer Review

We asked individuals from The Nature Conservancy, Caesar Kleberg Wildlife Research Institute, Trinity University, the University of Texas – Rio Grande Valley, and Texas A&M University to serve as independent peer reviewers of the document. We received comments from four reviewers. Criteria used for selecting peer reviews included their expertise in plant conservation biology, botany, genetics, land use or management relative to shortgrass prairies, threats facing this ecosystem, and propagation/reintroduction methods. The qualifications of the peer reviewers are in the administrative record for this Recovery Plan.

Public Comments Received

We received 1 set of comments on the draft Recovery Plan from an individual citizen. We did not receive any comments from Federal, State, local, or Tribal entities.

Responses to Comments

A summary of all comments received and our responses is included in Table 19 below. The USFWS reviewed all comments received for substantive issues and new information, and we have amended the final Recovery Plan as appropriate. The USFWS acknowledges the peer review and public comments and the great care with which individuals and organizations responded to the draft Recovery Plan. The USFWS recognizes that external participation is essential to the task of recovering South Texas ambrosia and slender rush-pea. The final Recovery Plan is the product of many years of work on the part of the South Texas Plant Recovery Team and numerous Federal, State, and local organizations, as well as individual citizens from Texas.

Some comments provided were supportive of the Recovery Plan overall and offered constructive advice that has substantially improved the plan. Some commenters suggested editorial changes to the text of the document and we have incorporated suggestions as appropriate. Some commenters suggested additions and clarifications, and we tried to clarify the document and have accommodated these suggestions as appropriate. The remaining comments were taken into consideration in the final version of the Recovery Plan, and specific responses are provided below (Table 19). Comments are categorized based on the section of the Recovery Plan they pertain to: Status of Coastal Shortgrass Prairie Ecosystem (Part I, Section 1.2); Slender Rush-Pea (Part I, Section 1.3); Threats Analysis (Part I, Section 1.5); Conservation Measures (Part I, Section 1.6); Recovery Strategy (Part II, Section 2.1); Recovery Objectives and Criteria (Part II, Section 2.3); Recovery Action Narrative (Part II, Section 2.4; and Implementation (Part III).

Table 19. Responses to peer review and public comments.

Submitted by	**Comment**	**Our Response**
Status of Coastal Shortgrass Prairie Ecosystem (Part I, Section 1.2)		
The University of Texas - Rio Grande Valley	The commenter requests clarification of Figure 5 in the document, which shows a population of ambrosia in Cameron County, TX, but the text states extant populations are found in Kleberg and Nueces counties.	We have revised language within the final Recovery Plan to indicate that this site in Cameron County was described as coastal shortgrass prairie habitat even though it was found within the Tamaulipan Thornscrub Ecoregion. Although similar in topography and sharing a number of grass, forb, and woody species, the dominant vegetative land cover differs. Instead of the vast grasslands of the Gulf Coast Prairies and Marshes Ecoregion, the Tamaulipan Thornscrub Ecoregion is dominated by spiny shrubs and trees, although grasses, forbs, and succulents are also present (McGinley 2013). The flatter, deeper soils support honey mesquite (*Prosopis glandulosa*), and other woody species, sometimes found growing in dense thickets and sometimes in a savannah type of setting within a grassland matrix (McGinley 2013). So although the clay to sandy loam soils of the Tamaulipan Thornscrub Ecoregion has the potential to support ambrosia, locality information for the historic ambrosia occurrence was vague and was never re-verified.
Caesar Kleberg Wildlife Research Institute	The commenter suggests soil series of impact with citation as per the USDA-NRCS would be a useful inclusion in this discussion at some point.	In both the draft and final Recovery Plan, we address specific soils for each species under sections 1.3.4 and 1.4.4.
The University of Texas - Rio Grande Valley	The commenter asks why a location of ambrosia is marked on Figure 5 in Cameron County within Tamaulipan thornscrub ecoregion, but the text states locality information for this occurrence was vague and never re-verified.	In both the draft and final Recovery Plan, sufficient explanation was provided in the text regarding this occurrence and its status.
Slender Rush-Pea (Part I, Section 1.3)		
Caesar Kleberg Wildlife Research Institute	The commenter questions whether there is genetic evidence to suggest that rush-pea is morphologically most similar to Watson's rush-pea (*Hoffmannseggia watsonii*).	Simpson et al. (2004) conducted analyses to determine the interspecific relationships within the genus, evidence for evolution due to interspecific hybridization, and patterns of character evolution. This study represents the best available information and additional extensive genetics work has not been completed to date.

Submitted by	Comment	Our Response
Caesar Kleberg Wildlife Research Institute	The commenter questions how many potential acres of shortgrass prairie could rush-pea exist on, given current knowledge of site characteristics and soil mapping.	This information is not currently available. In the final Recovery Plan, we have included the need to map acres of potential shortgrass prairie habitat under Recovery Action 4.
The University of Texas - Rio Grande Valley	The commenter suggests including soil effervescence test results from Sablatura County Park or not including text.	We considered this comment and have deleted this text from the final Recovery Plan due to its irrelevancy to the overall discussion on soils.
The University of Texas - Rio Grande Valley	The commenter recommends clarifying in the text if Texas wintergrass is a midgrass or tallgrass.	We considered this comment and have deleted the adjective for Texas wintergrass from the final Recovery Plan. According to the Native Prairie Association of Texas (2004) and Texas Parks and Wildlife Department (both accessed in 2018), they do not mention the Texas wintergrass as one of the prominent tallgrass prairie species.
Threats Analysis (Part I, Section 1.5)		
Trinity University	The commenter states that the invasive species problem needs to be included in the Table. The Service states in the text the need to reduce Kleberg bluestem. The commenter states that there is a lot that can be done on this front to include research, implementations, and education. They recommend placing this information under land use, conversion.	We considered the threat of nonnative invasive grass species in the draft Recovery Plan under Recovery Action 3.1.3.5. We expanded upon this action in the final Recovery Plan to include more education with landowners, land managers, and partners about site-specific measures to control nonnative, invasive grasses.
The University of Texas - Rio Grande Valley	The commenter questions whether it is necessary to include Action 3.2.4 (study pollination) given the known pollination mechanisms of rush-pea and ambrosia.	Ambrosia is a wind-pollinated species. It's likely that rush-pea is either obligately or facultatively self-pollinating, however little is known about the species pollination biology. Therefore, it's important to understand the mechanisms of pollination and any specific pollinators and their foraging ranges and habitat needs. These recovery actions are further described in Section 2.5, Narrative of Recovery Actions.
The University of Texas - Rio Grande Valley	The commenter suggests including seed viability and seed predation under Action 3.2.5 in Table 13.	In both the draft and final Recovery Plans, we consider the need to investigate seed viability and seed predation in the Narrative of Recovery Actions sections, under Recovery Action 3.2.5.
The University of Texas - Rio Grande Valley	The commenter suggests including estimates (percentages), if known, of shortgrass prairie that remain in each county.	The information presented in the draft and final Recovery Plans represents the best available commercial and scientific data. In both the draft and final Recovery Plans, we have included the need for

Submitted by	Comment	Our Response
		identification of acres of shortgrass prairie habitat under Recovery Action 4.
Caesar Kleberg Wildlife Research Institute	The commenter asks if any estimate of land cover change at large scales has been done recently? E.g. is habitat change still occurring?	The information presented in the draft and final Recovery Plans represents the best available commercial and scientific data. We have updated the final Recovery Plan to include the need for identification of acres of shortgrass prairie habitat under Recovery Action 4.
Trinity University	The commenter expresses the concern that the KRTA has not been accessed in almost 25 years.	The King Ranch Training Area is privately owned land. We have made multiple attempts to contact the landowner and build a relationship, however without landowner permission, we do not have access to survey private lands.
Conservation Measures (Part I, Section 1.6)		
The University of Texas - Rio Grande Valley	The commenter suggests moving the discussion of mowing recommendations to either Part II or Part III as it is not a current management activity.	We did not make this change. Mowing can be considered an effective management tool when applied appropriately. Therefore, we considered the discussion of mowing in both the body recovery plan as well as specifically within the recovery actions.
Recovery Strategy (Part II, Section 2.1)		
Trinity University	The limited amount of shortgrass habitat within geographic range of species is privately owned and not possible to acquire. This commenter suggests that this needs to be improved.	In both the draft and final Recovery Plans, we state that landowner coordination and cooperative conservation is imperative and we acknowledge that for recovery of the species, we need long-term protection. The Narrative of Recovery Actions in Section 2.5 outlines the step-wise process for reaching the down- and delisting goals for ambrosia and rush-pea, as best as possible.
The University of Texas - Rio Grande Valley	The commenter requests providing a biological basis for the period of recovery for 60 and 40 years, for rush-pea and ambrosia respectively.	In coordination with the STXPRT, we projected an estimated time to recovery based on our thorough review and understanding of the species biology; acknowledgement of any data gaps; and, feasibility of implementation of recovery actions. In both the draft and final Recovery Plan, the timelines to reach recovery for rush-pea and ambrosia are discussed in Part II under the section "Timelines for Recovery". . We have provided a reference in the final Recovery Plan for this information (see Strong 2016).

Submitted by	Comment	Our Response
The University of Texas - Rio Grande Valley	This correction factor for ambrosia is based on stems per year, but MVP size includes individuals older than one year, thus with much more stems. The commenter recommends providing clarity on the MVP size for ambrosia.	The MVP for ambrosia was estimated in coordination with the STXPRT and represents the best available scientific information.
Recovery Objectives and Criteria (Part II, Section 2.3)		
Trinity University	The commenter suggests placing the recovery objectives in order of importance.	In both the draft and final Recovery Plans, we prioritize specific recovery actions in the Implementation Schedule (Table 18 of the final Recovery Plan), which acts as the guide to meeting the goals, objectives, and criteria of this Recovery Plan.
Caesar Kleberg Wildlife Research Institute	The commenter asks if a more developed plan for reintroduction sites within the geographic range of rush-pea and ambrosia is available, based on appropriate soils.	In both the draft and final Recovery plans, we state that a Controlled Propagation and Reintroduction Plan was developed in 2012 for rush-pea only. Recovery Action 7.1 identifies the need to develop a final Recovery Plans, a controlled propagation and reintroduction plan for ambrosia.
Narrative of Recovery Actions (Part II, Section 2.4)		
Caesar Kleberg Wildlife Research Institute	The commenter suggests genetic considerations for establishment of populations for restoration, and research to better refine and expand restoration options would be useful.	In both the draft and final Recovery Plans, we considered the need to study the population and species genetics under Recovery Actions 3.2.7. (Study population genetics to determine the genetic diversity within and among populations) and 9.1. (Investigate both species' population genetics to ensure long-term persistence).
Trinity University	The commenter requests that an explanation of the commitment of USFWS in meeting recovery be provided, and states that the text is passive.	We are committed to monitoring the populations and will collaborate with partners in order to accomplish this task.
Trinity University	The commenter requests the USFWS to explain the current monitoring plan for rush-pea.	The monitoring plan for rush-pea was developed in 2012 (see Strong 2012).
Trinity University	The commenter requests that the responsible party to monitor the ambrosia be provided.	In both the draft and final Recovery Plans, the responsible parties and timelines for development of a monitoring plan for Ambrosia are provided in the Recovery Implementation Table (Table 18 in the final Recovery Plan).

Submitted by	Comment	Our Response
Trinity University	The commenter suggests surveying for additional populations of rush-pea and ambrosia.	In both the draft and final Recovery Plans, we included the need for surveying for additional populations under Recovery Action 10.1.
Implementation (Part III)		
Trinity University	The commenter suggests that the following sentence would be a good place to be explicit about what USFWS is mandated/can do; "The USFWS has neither the authority nor the resources to implement many of the proposed recovery actions".	We have deleted this sentence from the final Recovery Plan and have added language to emphasize that implementation of recovery actions is voluntary, and voluntary participation may occur through various means.

Abbreviations/Acronyms

Ambrosia = South Texas ambrosia

KRTA = King Ranch Training Area

MVP = Minimum Viable Population

Rush-pea = slender rush-pea

STXPRT = South Texas Plant Recovery Team

USDA-NRCS = U.S. Department of Agriculture – Natural Resource Conservation Service

USFWS = U.S. Fish and Wildlife Service