Section 6 Report Review

Attachment to letter dated August 07, 2002

Project: The Effects of an Invasive Exotic Grass Species, Kleberg Bluestem *Dichanthium annulatum* (Forsk.) Staph on the Endangered Slender Rush-pea *Hoffmannseggia tenella* (Tharp and Williams)

Final or interim report? Final

Job #: WER 34 (83)

Reviewer's Station: Corpus Christi Ecological Services Field Office

Lead station was contacted and concurs with the following comments:
___ Yes ___ No X Not applicable (reviewer is from lead station)

Report: X is acceptable as is

___ is acceptable as is for an interim report, but the following comments are made for future reference

___ needs revision (listed below)

Comments: (Note to commenter: If you make comments directly on a copy of the report, write legibly and dark so comments will reproduce well when photocopied.)

FINAL REPORT

As Required by

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. E-1-11

Endangered and Threatened Species Conservation

Project 83: The Effects of an Invasive Exotic Grass Species, Kleberg Bluestem *Dichanthium annulatum* (Forsk.) Staph on the Endangered Slender Rush-pea *Hoffmannseggia tenella* Tharp and Williams

Prepared by: Loretta Pressly

TEXAS PARKS & WILDLIFE

John Herron
Program Director, Wildlife Diversity

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Executive Director

April 30th, 2002

FINAL REPORT

STATE: Texas **GRANT NO:** E – 1 – 11

PROGRAM TITLE: Endangered and Threatened Species Conservation

PERIOD COVERED: September 1, 1996 – August 31, 1999

PROJECT NUMBER: WER 34 (83)

PROJECT TITLE: The Effects of an Invasive Exotic Grass Species, Kleberg Bluestem *Dichanthium annulatum* (Forsk.) Staph on the Endangered Slender Rush-pea *Hoffmannseggia tenella* Tharp and Williams

PROJECT COST (Last Segment): $759.12

PROJECT OBJECTIVE:

To determine the effects of the Kleberg Bluestem on slender rush-pea with both field and greenhouse experiments.

PREPARED BY: Loretta Pressly April 22, 2002

APPROVED BY: Neil E. Carter, Federal Aid Coordinator June 6, 2002 Date

I. NEED

The Slender Rush-pea is a Federal and State listed endangered plant species known from only four populations in Nueces and Kleberg, Counties, Texas. Historically, the species was reported from other localities in these two counties of the Texas Coastal Bend, but these occurrences have not been reconfirmed. The Texas Parks and Wildlife Department has tentatively identified the species as a High_Priority Species (Draft Plan for Action to Conserve Rare Resources in Texas, 1995), indicating the need for management research. The U. S. Fish and Wildlife Service (USFWS) has assigned a Recovery Priority of 2 to this species.

As the Recovery Plan (1988) suggests, the main threat to the continued existence of slender rush-pea is destruction of Gulf Coastal Prairie habitat. Additional human impacts may be associated with further decreases in population numbers. Of the four known localities, one in southern Nueces County is currently being examined for roadway reconstruction. Population size is being determined at this time. A second population is in the right-of-way of Interstate Highway 77, adjacent to a row crop agricultural field. The area at this site is approximately 200 X 10 meters, where the number of individuals remains unknown. A third population is within the St. James Cemetery in Bishop, Texas. This population is estimated at approximately 10,000 plants (United States Fish and Wildlife Recovery Plan 1988). The area within the cemetery totals approximately six hectares.

The Kleberg Bluestem is an exotic plant, highly competitive, with long creeping rhizomes, and continual production of seed throughout the year under favorable conditions. The height of the plant when mature may reach approximately 60 cm, thereby shading lower growing native plant species. Exotic plants may affect natural habitats in a number of ways. Shading and root competition (i.e. water absorption, spatial competition by the bluestem), may affect native species at the known rush-pea population sites. Repeated mowing of the Kleberg Bluestem grass at the rush-pea population sites may alleviate the problem of shading and bluestem seed production. This management strategy may be beneficial to the continued existence of the rush-pea populations.

II. OBJECTIVE

To determine the effects of the Kleberg Bluestem on slender rush-pea with both field and greenhouse experiments.

III. APPROACH

1. Field studies-May 1996 through June of 1997. A replicated experiment will be implemented to evaluate the effectiveness of mowing as a management tool in minimizing competitive interactions between Kleberg Bluestem and the rush-pea.

Permanent, randomized, one square meter plots will be established to collect information. Baseline measurements will be taken before the mowing treatment, and then again at quarterly intervals throughout the year. If the information collected at the end of one year is enough to offer informed statistical analysis, the field measurements will cease. The treatment replicates will be as follows:

A. Fifteen unmowed plots (Controls).
B. Fifteen plots mowed frequently enough to maintain a grass height of approximately 20 cm. (Treatment 1).
C. Fifteen plots mowed once in early summer (Treatment 2).
D. Fifteen plots mowed once in. early winter (Treatment 3).

Within each plot, there will be no less than three plant groups of rush-pea. Measurements will be taken every three months to record coverage and recruitment within each plot of Slender Rush-pea. The response variable to be accessed in this experiment will be percent cover of the rush-pea. Altogether 60 plots will be measured (a control, three treatments, 15 plots each).

2. Greenhouse studies-May 1996 through June of 1997. Seed material will be provided by the Kika De La Garza-Plant Materials Center USDA, under USFWS Permit #PRT-67681 1. The greenhouse will be provided by Texas A&M University-Corpus Christi.

The treatment replicates will be as follows:

A. A minimum of five replicates will be used to affect a shading experiment on the rush-pea in a greenhouse environment Five samples with shade cloth and five samples without shade cloth will be used to perform this study. Each replicate will contain sixteen rush-pea individuals. Measurements will be taken each month, for one year.

B. A minimum of five replicates will be used to affect a root-competition study of the rush-pea and the bluestem grass in the greenhouse environment. Five containers will contain six rush-pea plants with bluestem scattered uniformly throughout the container. Five containers will have only the six rush-pea plants.

Measurements to be taken for statistical analysis will be stem growth, leaflet number, and seed production.

Seed produced during the study will be handled according to the existing USFWS Permit #676811 regulations.

IV. ACCOMPLISHMENTS

The slender rush-pea *Hoffmanseggia tenella* (Tharp and Williams) is a Federal and State-listed endangered plant species, currently known from only four populations in South Texas. The main threat to the rush-pea is destruction of the Texas Gulf Coastal Prairies due to agricultural row crop practices, reducing natural vegetative communities and leaving small, remnant areas for native plants (USFWS 1988). Known populations can be found on private, federal, and public lands along highway and gas pipeline rights-of-way, in Nueces and Kleberg Counties, Texas. Historically, the rush pea was reported from other locations within Nueces and Kleberg Counties (Jones 1975), but these occurrences have not been re-confirmed.

The recovery plan for the Slender Rush-pea addresses the need for research on the effects of invasive grasses. The purpose of this research was to determine the effects if any, of the invasive exotic grass, Kleberg bluestem *Dichanthium annulatum* (Forssk) Staph, on the slender rush-pea.

Kleberg bluestem grass is native to India, China, North Africa, Egypt, and was found growing in Kleberg County in 1945 by a south Texas area agronomist who increased cultivation of the grass for cattle fodder, although it later proved to hold not much nutritive value (Hatch, et al 1999). It can occur as an escapee from pastures, roadsides, and residential lawns throughout the Gulf Coast. It is a highly competitive plant, with long creeping rhizomes, and continual production of seed throughout the year under favorable conditions. Kleberg bluestem grass is a warm season perennial with erect, green, slender stems, reaching a height of up to 100 cm and taller, containing seedheads with 2-10 purplish branches with numerous seed. The grass volunteers aggressively, and tolerates drought well. It and other exotic grasses are used for erosion control on highway and pipeline rights-of-way. The species can be found growing from extreme southern Texas and northwards into central Texas and is able to spread quickly into remnant native areas in south Texas by wind, or hitchhiking on the wheels of traveling motor vehicles.

Grass species with shallow fibrous root systems, have the potential to absorb moisture and nutrients more quickly than tap-rooted species that must wait for moisture to penetrate deeper into the soil (D'Antonio & Mahall 1991). Spatial and temporal dynamics of successful biosystems depend on the ability of organisms to compete without detrimental effects to neighboring species. A competitive plant can utilize system resources rapidly, whereas a stress tolerant plant survives resource depletion but with decreased production (Chapin 1980). As vegetative productivity increases in faster growing plants, their canopies shade slower growing plants (Goldberg 1990).

Methods

In the shade-house experiment, attempts were made to collect the data in the same way for two years, although conditions the first year (plant disease, aphids, invasions of moss) forced the observer to gather data at the end of the growing season. Results were conclusive to offer valuable information.

Shadehouse Application - Light Competition Study

An application of different cloth materials provided shading to simulate grass/rush pea light competition in the field. A lux meter was used to select the various cloth material needed for the additional light reduction after determining light reduction values of the grasses in the field.

One set of ten restaurant bussing trays was planted with rush pea plants, and used as the control for the purpose of comparison with the shade and root competition portion of the project. Ten trays were covered with an additional 10% light reducing shade cloth, and 10 trays had an additional 20% light reducing shade cloth. The entire shade-house was covered with a 30% reduction shade cloth. Five rush-pea seedlings were planted in each tray, giving 10 replications and a total of 50 plants to gather data. Five trays were randomly selected to collect data every two weeks. Data included the number of petioles, numbers of pods, greatest number of pinnae, and survival.

Shadehouse Application - Mowing Application

The study was performed to determine the effects of mowing of Kleberg bluestem at different heights with slender rush-pea present. Both grass and rush-pea seedlings were planted together in each tray. In one set of ten trays, cutting was performed to maintain the grasses at an approximate 15.5 cm (6.10 in) height, and in another 10 trays the grasses were cut and maintained at an approximate 31cm (12.20 in) height. An additional ten trays were planted with grass and rush pea, and the grasses were allowed to grow naturally. Measurements were taken every two weeks. Data included the number of petioles, numbers of pods, greatest number of pinnae, and survival.

Shadehouse Application - Root Competition Study

The ten trays that had grasses cut at 15.5 cm (6.10 in) provided information on the effects of root competition between the rush-pea and the grass. Measurements were taken approximately every two weeks. Data included the number of petioles, numbers of pods, greatest number of pinnae, and survival.

Field Study

*During the process of collecting the data necessary for the field experiment extreme drought conditions and human disturbance at the study site made attempts to perform this portion of the research impossible.

Statistics

Procedures: Statistics: Compare Means: One Way ANOVA, One-way analysis of variance for a quantitative dependent variable by an independent variable.

ANOVA was used to determine whether there were substantial differences in petiole number, pinnae number, pod number, and root mass of the slender rush pea. Descriptives to calculate number of cases, mean, standard deviation, standard error of the mean, minimum, maximum, and 95% confidence intervals for each variable was performed. Assumptions for the one-way ANOVA=Homogeneity-of-variance test for equality of group variances – p value 0.05 were performed. Post-hoc test were implemented when differences did occur; pair wise multiple comparisons to test the differences between each pair of means; tests to compare means between groups. Line graphs were produced to augment the confirmation of the statistical analysis, and are included at the end of this report.

Additional Aspects of the Study

Additional information was documented to address vegetative growth, reproduction, pollination, and other physical aspects of the slender rush pea plant as determined in the recovery plan.

Results

Descriptive Results Year 1998

Table 1. All Treatments – Means and Standard Deviation Petioles, Pinnae, Pods

Treatment	Petiole (x) (Standard Deviation)	Pinnae (x) (Standard Deviation)	Pods (x) (Standard Deviation)	Survival
Control	61.5 (15.74)	6.8 (0.32)	3.32 (1.68)	All plants survived
Forty % Shade	43.8 (14.49)	6.9 (0.38)	5.3 (3.69)	All plants survived, (moss, aphids present)
Fifty % Shade	50.74 (23.90)	6.5 (0.51)	2.3 (2.20)	All plants survived(moss, aphids present)
15.5 cm Cut Grass	1.72 (1.24)	3.42 (1.84)	000	All plants eventually died
30.0 cm Cut Grass	1.44 (0.79)	2.74 (1.48)	000	All plants eventually died
Natural Length Grass	0.26 (0.32)	0.44 (0.46)	000	All plants eventually died

Analysis shows slight to medium differences between petiole means of the control treatment and shaded treatments. In 6 out of 10 replicates the control group surpassed the number of pods produced than in all other groups. Significant correlations were detected between numbers of petioles in the control and shaded groups compared to the number of petioles in the grass/rush pea combination groups. Means for pinnae were comparable among the control group and the shaded group, although in the grass/rush pea combination there were significant differences. Pod numbers at this period of collection were small. Again no pods were produced in the grass/rush pea combination replicates. All plants in the control and shaded groups survived within the time period of the experiment, although the rush pea plants within the grass/rush pea combinations did not.

In the shade-house experiment, attempts were made to collect the data in the same way for two years, although conditions the first year (plant disease, aphids, the invasion of moss) forced the observer to gather data at the end of the growing season. Results were conclusive to offer valuable information.

Descriptive Results Year 1999

Table 2. Petiole means and standard deviation in 5 collection periods (year 2)

Treatment	Event 1 Mean (Std. Dev.)	Event 2 Mean (Std. Dev.)	Event 3 Mean (Std. Dev.)	Event 4 Mean (Std. Dev.)	Event 5 Mean (Std. Dev.)
Control	22.28 (4.67)	19.6 (4.75)	33.10 (14.54)	19.40 (6.53)	14.32 (8.80)
40 % Shade	22.65 (10.17)	17.40 (6.5)	23.29 (9.92)	12.96 (4.0)	16.32 (12.90)
50 % Shade	*25.12* 16.33)	17.28 (3.84)	*39.04* 20.20)	*25.12* 7.34)	*24.12* (11.09)

*Survival All plants survived until the end of the data collection period. No data collection was performed on the root competition nor the mowing aspect, as the earlier analysis proved that this would not be prudent.

More petioles were produced in the fifty percent shade group. In four out of the five data collection events, the fifty percent shade group possessed more petioles than both the control group and the forty percent shade group. In three out of five events the control group produced more petioles than the forty percent shade group.

Table 3. Pinnae means and standard deviation in 5 collection periods (year 2)

Treatment	Event 1 Mean (Std. Dev.)	Event 2 Mean (Std. Dev.)	Event 3 Mean (Std. Dev.)	Event 4 Mean (Std. Dev.)	Event 5 Mean (Std. Dev.)

Control	**6.92 (1.12)**	**7.2 (0.90)**	**6.40 (0.96)**	**6.88 (12.8)**	**6.2 (1.61)**
40 % Shade	**7.40 (1.06)**	**6.6 (1.58)**	**6.70 (0.79)**	**6.48 (1.12)**	**6.64 (0.90)**
50 % Shade	**7.36 (0.70)**	**7.0 (0.57)**	**9.4 (12.8)**	**6.8 (0.76)**	**6.64 (0.95)**

In three out of the five collection events, the fifty percent shade treatments had higher numbers of pinnae. There were leaves on several of the fifty percent shade treatment plants that had 9 pinnae on one petiole branch of the bi-pinnately compound leaves. Some of the leaves in the fifty percent shade treatments had additional rachi on the main petiole. The remaining values of control and shade treatment are fairly consistent.

Table 4. Pod means (x) and standard deviation in 5 collection periods (year 2)

Collection Period	**Control (Std. Dev.)**	**Forty % Shade (Std. Dev.)**	**Fifty % Shade (Std. Dev.)**
Event # 1	**2.20 (2.17)**	**0**	**1.0 (2.16)**
Event # 2	**1.80 (4.02)**	**1.80 (4.02)**	**0**
Event # 3	**0.20 (0.44)**	**0**	**1.0 (2.23)**
Event # 4	**1.40 (1.67)**	**0**	**0**
Event # 5	**0.2 (0.44)**	**0.20 (0.44)**	**0**

Pod production in the control group was noted in every data collection period, and numbers in both the shaded treatments were less than the control group.

Root Mass

Below ground material was carefully removed from the trays, soil was washed off, and weights were taken of the root material after the samples were placed in a drying oven at 44 degrees CE (113 FE) for 84 hours. The mass means and standard deviations for the control, forty % shade treatment, and fifty % shade treatment were; 11.70 gm (0.41 oz) (Std. Dev.=1.62), 10. 67 gm (0.37 oz) (Std. Dev.=1.20), and 11.92 gm (0.420 oz) (Std. Dev.=1.23), respectively. There were no significant root mass differences between the treatment groups. Some roots reached a length of approximately 259 cm (8 ½ feet), and were coiled in a circle at the bottom of the tray.

Discussion

Based on the information provided with collection of data there were no consistent, significant differences in petiole number between the control group and/or shaded treatment groups. There were however differences in the height and length of petioles of the rush pea. This was observed and noted. Individual lengths were not measured as this probably would have disrupted the health of the plants and not incorporated into the scope of the project. Most of the control group plants exhibited prostrate vegetative growth, whereas many of the plants in the shaded treatments extended upwards. This aspect of vertical growth has been exhibited in the field where rush pea plants compete for sunlight with the associated invasive grasses. Some of the plants in the fifty percent shade treatment produced petioles that were different in form (twisted) and additional rachis were present, which may have been a response to lowered light conditions.

With respect to the grass/rush pea combination treatments, there were significant differences in both petiole and pinnae numbers as well as survival. Two attempts were made to perform this portion of the project, to no avail. Several reasons for this are possible; 1. The fast growing grass absorbed much of the nutrients that in turn were not made available for the rush pea, 2. possible allelopathic properties of the grass hindered the growth of the rush pea, 3. heat produced from the grass and associated humid conditions caused fungal problems that attacked the rush pea. This was observed in the very early stages of the experiment. All or part may contribute to reduction of rush pea seedling production in areas with thick grass growth.

Pinnae growth in both years remained constant across the span of the experiment. No substantial differences were presented except for a few plants that had fewer than 4 pinnae on one rachis, and some that had 9 pinnae on one rachis and continued to produce additional vegetated material and pods. Again, the number of pinnae produced on the grass/rush pea combination treatments were reduced substantially.

The number of pods produced within each treatment was sporadic in that the first year, more pods were produced in the forty % shade treatment, and in the second year more were produced in the control group. The plants in the fifty % shade cover treatment, did produce reduced numbers of pods than the other two groups. This may be due to expending energy to develop vegetative material for photosynthesis with the decrease in sunlight. Based on the information provided with collection of data there were no consistent, significant differences in petiole number in the control group and/or shaded treatment groups. There were however differences in the height and length of petioles of the rush pea. This was observed and noted, although individual lengths were not measured as this probably would have disrupted the health of the plants and was not incorporated into the scope of the project. Most of the control group plants exhibited prostrate vegetative growth, whereas many of the plants in the shaded treatments extended upwards. This aspect of vertical growth has been exhibited in the field where rush pea plants compete for sunlight with the associated invasive grasses. Some of the plants in the fifty percent shaded treatment produced petioles that were different in form (twisted) and number of rachis present, which may have been a response to lowered light conditions.

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Additional Biological Data

Morphology In the shadehouse, physical characteristics were noted and include the following:

1. Stems in some plants reached a length of 23 cm, with leaves producing at internodes,
2. The inflorescence can have from 1 to 16 flowers that undergo pollination, and pod production at the tip of the inflorescence developed less seed,
3. Leaves reached a length of approximately 16 cm especially in the shaded treatments,
4. Some leaflets reached a length of approximately 6 cm, with an average of 6 - 7 pair per pinnae.
5. Some of the pods grew to a length of 10 mm, and produced 9 seeds.

Pollination Slender rush pea flowers will undergo self fertilization. Micro mesh cloth material was sewn, producing a pocket in which the inflorescence was carefully placed with the end gathered to screen out any possible pollinators. All of the fluorescence that were placed in the prophylactic device produced pods and viable seed from which seedlings developed. Although, with the bright orange-crimson color of the corolla, it would seem that pollination by visitors is apparent in the natural setting.

Germination Seed of the slender rush pea does not have to undergo a period of dormancy. The seed will germinate readily with the onset of warm air and available moisture. Some of the pods collected during the first portion of the experiment fell to the soil, the seed germinated and broke through the top of the seed coat, turned downward past the seed coat making contact with the soil and produced a seedling. If reintroduction plans were to occur in the future, the lighter colored and more robust seed will germinate more readily that the darker colored seeds, and the seed should be removed from the coat for higher germination rates.

Vegetative Reproduction Long stems that were still attached to a parent plant were placed shallowly into the soil and held down with metal clips to see if the plants would reproduce vegetatively. The plants did produce new leaves at the internodes of the stems and grew up upwards through the soil, although, no root production was seen at the internode sites when looked at under a microscope. Therefore if reintroduction projects were to be performed the best choice for propagation and development would be seed production.

Conclusion

Mature slender rush pea plants that are already established within a native community will probably be able to survive the aggressive biological disposition of this species of invasive exotic grass. Seedling production would continue to decrease as mature plants die, especially after the grass becomes abundant, reducing genetic variability in the already stressed small populations that occur in the natural environment.

Too few populations are still known to occur and with the aggressive nature of this grass and other species of plants not native to this area of South Texas, and the small numbers of plants within each population. There is the likelihood that the slender rush pea could become extinct in the very near future. Removal of the grass by means of a grass-specific herbicide, (painted on not sprayed), may help to reduce the development of the aggressive grass. Prompt and immediate attention should be taken to plant native grasses and forb species at the site to control erosion.

Literature Cited

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