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HIGH DIVERSITY RESTORATION OF A CENTRAL TEXAS GRASSLAND

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ABSTRACT

This study is an analysis of procedures and results of a native plant restoration project completed on a ½-acre steep, rocky gully in Central Texas which had previously been the site of a city dump. The nearby model was a relatively undisturbed steep grassland habitat of Upper Glen Rose limestone, dominated by a mosaic of grassland (*Schizachyrium scoparium, Muhlenbergia reverchonii, Bouteloua hirsuta* var. *pectinata* complex with diverse forbs and evergreen shrubs) and a *Quercus-Juniperus* woodland. After covering the dump with partially pulverized limestone and dolomitic limestone from local sources, the gully was reshaped and stabilized with erosion control structures constructed with rock and brush devices. A design for thirty test plots was implemented, using native species from harvested wild seeds and local transplant stock. No topsoil, fertilizer, or supplementary water was utilized. Success was determined after a spring and fall planting, with current updates continuing. The original planting was completed in April 1985 and, by August 1985, there was an almost complete coverage with a significant diversity. A chart of over 100 species, derived from data collected, gives priorities for inclusion in seed mixtures, quantity of seed planted in the spring and fall of 1985, location of seeding and transplants, and overall results.

SCOPE OF A DUMP RESTORATION

Location

Wild Basin Wilderness Preserve is a 200-acre county park in the Balcones Escarpment in Travis County, Texas. It is an excellent example of Central Texas Hill Country oak/juniper/grassland habitat within the Glen Rose limestone formations.

Problem

On the northern border of the Wild Basin Wilderness Preserve, there are five acres that the City of Austin used as a municipal dump under contract, beginning in 1947, with the property owner, Mr. Ed Clark. This site was used for dumping after the expiration of the lease and, perhaps, before. A steep gully at the eastern edge of the dump area connects with the North Hollow tributary of Bee Creek, which is the main stream channel in this drainage basin. Over the years, erosion progressively opened this gully. Glass and metal were exposed; in some places, there were ten-foot-deep cuts; debris was washing into North Hollow but had not yet reached Bee Creek.

Solution

Since the drainage from this gully enters the Wild Basin Wilderness Preserve, the staff decided to stabilize the erosion problems and to restore the dump site along the gully, using native vegetation natural to this site. Over a several-year period, a concensus on a solution to the problems caused by the dump was developed. Discussions were coordinated by the Wild Basin staff with the numerous entities involved, including the City of Austin, the Texas Department of Health, Travis County, the Texas Historical Commission, Eanes School District (which was negotiating to buy a portion of the dump site), the Texas Highway Department, and Davenport Ranch (which owned the dump site). In 1984, the Committee for Wild Basin Wilderness, Inc. contracted with the City of Austin to restore and revegetate approximately ½-acre of the dump, including the large gully. In addition, the contract included a report on the restored site, a demonstration site for the City of Austin, and a manual on erosion control and sedimentation guidelines (1). In March 1985, the work of completing data collection and writing the report was subcontracted to David Mahler and Judy Walther through their research firm, Environmental Survey Consulting.

ANALYSIS OF THE SITE

Primary Analysis

In 1981, the location of the dump and the impacted drainage channels were indicated on a Wild Basin Wilderness Preserve map. Later, a more detailed map was drawn of the dump site within Wild Basin, and included the location of superficial deposits of glass, recent surface piles of debris, deep compacted deposits of burned and broken debris, and washout accumulation in drainage channels. All maps and photographs mentioned in this report are on file with the City of Austin, Wild Basin Wilderness Preserve, and Environmental Survey Consulting.

A series of water tests was completed by the Texas Department of Health in September and October of 1981 within the dump site and upstream and downstream of the site along North Hollow. No acid or base/neutral priority pollutants were detected. The tests for pesticides were at acceptably low levels, and the tests for metals showed no significant levels except for higher levels of iron coming from the dump, and somewhat elevated levels of arsenic coming from both the dump area and from upstream of the entire dump area.

Detailed Analysis of Potentially Altered Areas

The dump area and the adjacent building site area for the future Wild Basin Interpretive Center were mapped to locate existing trails, machined areas, dump stabilization areas, building and road sites, and plant salvage areas. A map titled "Detailed Vegetation Map of Work Area Vicinity" indicates the location, species, and height of the woody vegetation and ranks the diversity of the understory for possible transplant information. The "General Map of Test Plots and Erosion Control in Revegetation Area" locates stabilizing rock terraces and walls and brush terraces built within the dump area. This map also shows the vegetation test plot divisions.

Material to be Salvaged

The future Wild Basin building site was assessed for priority species for transplant use. The dominant forbs were little bluestem (#419), blackfoot daisy (#331), hairy zexmenia (#355), twisted-leaf yucca (#444), and slim tridens (#430), as well as a large variety of other species. Almost no non-natives were found. A finger cactus (#33) found on the building site was recommended for rescue prior to construction.

Site Analysis
The dump site was documented before restoration. Using existing engineering maps and survey pins, a boundary map of the disturbed area to be restored was calculated and drawn. Next, all existing features were placed on the map, including notable trees and trails. Comparable undisturbed areas were studied to determine the choice of plants to be used in the dump restoration.

Continuing Analysis
The research area was divided into thirty test plots, and records were kept on seeding, transplants, and results. Photographic documentation was kept throughout the project.

DESIGN OF THE SITE

Based on six years of habitat studies at Wild Basin, lists were developed for dry and wet areas. A small number of species were sowed in each of the test plots at the upper edge of the restoration area to better determine germination success of individual species. In an attempt to establish high diversity, the lower plots received different mixtures of many species.

DESCRIPTION OF SEED HARVEST

Seeds used in this project were hand-collected by volunteers under supervision. All seeds, except for a few noted exceptions, were collected from the immediate Wild Basin area. For the spring 1985 planting, seed was harvested in fall 1984. For the fall 1985 planting, seed was harvested in spring and summer 1985. The included chart has specific quantities and names of species harvested.

Seeds were stored in paper bags. Fall-harvested seed was kept in Wild Basin's metal, un-air-conditioned shed over the winter. Most seed harvested in spring and summer was moved during midsummer to an air-conditioned room, but some heat damage may have already occurred.

SITE WORK

Pre-Machine Work
Prior to machine work, glass and metal material found near the area to be machined was raked into the gully, where it would be covered. Limits of construction were marked with a string line, and temporary erosion control brush berms were placed below the limits of construction at the bottom of the gully.

Machine Work
Approximately 900 cubic yards of fill material, consisting of all sizes of rock from pulverized powder up to three-foot-diameter stones, were brought in from identical Glen Rose V limestone strata. Small amounts of topsoil were included but not separated for use in top dressing. The source material, essentially free of non-native seed, was dumped at the head of the gully and worked downward by machine. Fill depths range from six inches to ten feet. The surface was a rough mixture of large to small particles of limestone and dolomitic limestone, with almost no topsoil.

Permanent Erosion Control
Several permanent erosion control structures were placed in the gully. Two large sedimentation check dams, approximately twenty feet long and two to four feet high, were constructed of large rock with a layer of cedar branches on the upstream side. Uphill from the check dams, a stream channel was formed and reinforced using large rocks. Low rock terraces were constructed across the steep sections of the gully. Also, a low rock wall was placed along the western edge of the fill in order to catch slippage of glass and metal from a steep unrestored slope. An access path of rock and anchored cedar logs was constructed. Along the upper section, permanent brush terraces were built to spread water, catch soil, and restructure the slope into terraces.

Transplanting
Transplanting took place in April 1985, using material from the nearby site of the planned Wild Basin building. Transplants were placed along the upper side of brush terraces and scattered throughout the whole site. Little bluestem was used for half of the transplant stock. Additionally, blackfoot daisy, agarita (#14), twisted-leaf yucca, side-oats grama (#383), grapevine (#158-60), nolina (#439-40), hairy zexmenia, Texas sage (#244), slim tridens, switchgrass (#415), seep muhly (#409), elbow bush (#252), and Lindheimer muhly (#408) were transplanted.

Seeding
Harvested seed amounts were estimated, then each species was assigned to one or more test plot areas. All test plots were seeded with a diversity of species, consisting of various combinations and ratios. Spring seeds were broadcast and raked over their test plot area; there was no watering or fertilizing. The included chart lists the amounts and locations of each species. Fall seeds were assigned to various test plots and were over-seeded without raking, except in one new bare area.

RESULTS

Summary
Overall, stabilization and restoration efforts were highly successful. A nearly complete vegetative covering from both seeding and transplanting, combined with structural work, resulted in no dump material or sediment, other than suspended clays, being washed into the North Hollow tributary of Bee Creek. Even though initial seeding was completed later than the optimum time due to delays in machine work, sufficient subsequent rainfall resulted in a proliferation of diverse species. Small areas invaded by non-natives such as K-R bluestem and Johnson grass have been kept under control by hand removal.

Spring 1985 Seeding
Successes:
The most successful grasses were poverty dropseed (#425), tall dropseed (#424), little bluestem, slim tridens, plains lovegrass (#401), Indian grass (#422), and inland sea oats (#392). Poverty dropseed, an annual grass with a high rate of seed production, is an early-successional plant which quickly holds the soil while building up mulch for later species. Lovegrass, tridens, and tall dropseed are important intermediate-successional perennial grasses. Little bluestem is a climax perennial grass which is an important component in Texas Hill Country grasslands. The most successful wildflowers were cowpen daisy (#349), goldeneye (#354), prairie tea (#134), and ironweed (#352).

Failures:
Few seedlings of woody species have yet been observed. This may reflect a delay in germination or a low seed viability. However, it is suspected that many of these woody species do not appear in sunny, disturbed, early-successional sites, but rather are later-successional species which germinate primarily beneath older juni-

pers. Some wildflower species sown have not yet been observed, perhaps due, in part, to late planting, specific weather requirements, or other unknown factors.

Spring 1985 Transplants
Successes:
There was an almost 100-percent success rate for little bluestem transplants. Other major successes were blackfoot daisy, agarita, twisted-leaf yucca, side-oats grama, nolina, Texas sage, slim tridens, seep muhly, and switchgrass.

Failures:
A significant number of woody plant transplants were lost, probably due to late planting and lack of water while transplanting.

Fall 1985 Seeding
As of May 1986, there is a diversity of species from seeds sowed in early fall 1985, including Texas sage, red-seeded plantain (#251), star thistle (#297), Indian blanket (#312), and Texas star (#328).

Erosion Control
No sediment is entering the North Hollow tributary of Bee Creek from this site, other than a minor film from suspended clays. Adequacy of the check dams and stability of the slopes and gully were proven by three intense storm events in May 1986 ranging from two to three-and-a-half inches of rain each. A small amount of sediment accumulated behind the check dams, but vegetation is beginning to spread to these areas. The successful change of the gully from highly erosive to almost stable can be attributed to the erosion control structures and lack of unsuitable topsoil.

POTENTIAL FUTURE STUDIES

Germination
Further data could be collected over several years of monitoring. Additional species will probably germinate, thus providing more complete information on germination needs and schedules.

Inhibition
Further tests could help determine whether some species actually inhibit the growth of other species. In particular, sumpweed (#324), ragweed (#288), and buffalo burr (#212)--all weedy invader plants--seem to be inhibited in some plots, yet invasive in others.

Dominance
Continued monitoring could result in information on whether the native later-successional plants will be dominant over the non-native and early-successional plants.

KEY TO WILD BASIN DATA CHART

The following list is an explanation of the headings and entries from the Wild Basin Data Chart:

Species Number
These refer to the numbering system devised in the "Annotated List of the Vascular Plants of Wild Basin Wilderness Preserve" compiled by Judy Walther in October 1985 (2).
* = Commercial
N = Not collected in Wild Basin

Priorities
A: These priority listings were determined before the restoration was started.
B: These are the priority listings for seed mixes based on data analyzed after one year of results.
C: These are the priority listings for transplants based on data analyzed after one year of results.
1 = High priority
2 = Medium priority
3 = Low priority

Seeding
Quantity: Approximate seed quantities were estimated using a fractional count.
Location: The location letters refer to test plots.
Results: 3 = Prolific amount of species growth
2 = Moderate amount of species growth
1 = Trace amount of species growth
0 = No identifiable growth to date

Transplanting
Location: Occas = Occasional transplanting
Thru = Transplanted throughout site
Trace = Trace amounts transplanted
Results: 3 = High survival
2 = Moderate survival
1 = Low survival
0 = No apparent survival
H = Hitchhiker: species brought in with transplant sod

WILD BASIN DATA CHART

Species Number	Scientific Name	Priority			Seeding					Transplanting	
		A	B	C	Spring 1985 Quantity	Spring 1985 Location	Fall 1985 Quantity	Fall 1985 Location	Overall Results	Location	Results
10	*Juniperus Ashei*	3	2	2	750-100	P S			0	Occas	3
11	*Anemone heterophylla*	3	2	2						Occas	0
12	*Clematis Drummondii*	2	2	2	1000-2000	S V	5-10,000	V X Y Z	1		
14	*Berberis trifoliolata*	2	3	1						Trace	2
42	*Abutilon incanum*	2	2	2			2000-3000	A A P S	2		
43	*Allowissadula holosericea*	1	2	1	1000-2000	R-W	1000-2000	K S Y Z	1		
60	*Lepidium austrinum*	3	2	3			20,000	W	2		
66	*Bumelia lanuginosa*	2	3	3						Trace	0
80	*Cercis canadensis*	2	3	1	150-200	O S			0	Trace	0
84-5	*Desmanthus* sp.	2	1	2			800-1000	AA	0		
84-5 N	*Desmanthus* sp.	2	1	2			2000-4000	AA S	0		
104	*Psoralea* sp.	1	3	2			98	P	0	Trace	3
113	*Sophora secundiflora*	2	3	1	400-500	Q S			1		
118	*Calylophus Drummondianus*	1	1	2			2000-3000	AA S	2	Occas	2H
124	*Garrya Lindheimeri*	2	3	1	500-700	O S			0	Trace	0
127	*Ilex vomitoria*	1	3	1						Occas	2
134	*Croton monanthogynus*	2	2	3	5-10,000	BHOR-TVW			2		

Species Number	Scientific Name	Priority			Seeding					Transplanting	
		A	B	C	Spring 1985 Quantity	Spring 1985 Location	Fall 1985 Quantity	Fall 1985 Location	Overall Results	Location	Results
147	*Stillingia texana*	2	3	2			700-800	P	0		
158-60	*Vitis* sp.	2	2	1						Trace	3
162	*Linum rupestre*	2	2	3			2000-5000	S R	2	Occas	H
172	*Rhus lanceolata*	1	2	1	21-28,000	ACFSTVW			0		
174	*Rhus virens*	2	3	1	4000-6000	Q S			0	Occas	0
177 N	*Thamnosma texana*	2	2	2			100-200	AA	0		
178	*Zanthoxylum hirsutum*	2	3	1	80	P S			0		
183	*Erodium texanum*	2	2	3			200	AA	0		
184	*Geranium texanum*	2	2	3			1500	AA C	2		
194 N	*Centaurium Beyrichii*	1	1	2	50-100,000	C-E I-M	5000	AA K	2		
197	*Amsonia ciliata*	1	2	2			400-500	AA E	0		
198	*Asclepias asperula*	2	2	2			500-1000	P	0	Trace	3
223	*Nemophila phacelioides*	2	2	2			500-1000	Q	0	Occas	H
231	*Phyla incisa*	2	2	2			20-30,000	AA C Y Z	2	Trace	3
232	*Verbena bipinnatifida*	1	1	2			2000-4000	AA	0	Occas	H
233	*Verbena canescens*	1	2	3			75-150,000	AA R S	2	Occas	H
234	*Verbena Halei*	2	2	3			100-300,000	AA V W Y	2	Occas	H
238	*Hedeoma acinoides*	1	1	3			350,000	A AA CC S	2	Occas	H
239	*Hedeoma Drummondii*	1	1	2			5-10,000	AA BB R U	2	Occas	3H
242	*Monarda citriodora*	2	2	3			10-20,000	AA V Y Z	3		
243	*Salvia Roemeriana*	1	2	1	50-100	N	1000-2000	X	1		
244	*Salvia texana*	1	1	2			5-10,000	AA BB T U V	3	Occas	3H
247	*Scutellaria Wrightii*	1	2	2						Occas	3H
249	*Teucrium canadense*	2	2	3			4000-5000	T Y Z	0		
250	*Plantago Helleri*	1	1	3			10,000	A AA	2		
251	*Plantago rhodosperma*	1	1	3			30-40,000	AABBCCRVW	3		
252	*Forestiera pubescens*	1	3	1						Occas	3
275	*Triodanis coloradoensis*	2	2	3			500	V	1		
280	*Hedyotis nigricans*	2	2	2						Occas	H
286	*Achillea millefolium*	2	1	2			300-500,000	AA T U V	2		
295	*Brickellia cylindracea*	1	1	2	Trace	M			0		
297	*Centaurea americana*	2	2	2			1000-1500	S V	3		
302a	*Coreopsis* sp.	2	1	3			90-150,000	AACCVWYZ	1		
308	*Eupatorium rugosum*	1	2	2	10-30,000	Q-T V W			2		
309	*Eupatorium serotinum*	2	1	3	15-40,000	R S V			2		
310	*Evax prolifera*	1	2	3			±1,000,000	AABBCCTUV	2		
312	*Gaillardia pulchella*	1	1	2			50-100,000	AABBCCRUW	3		
316	*Gymnosperma glutinosum*	2	2	2	2000-8000	PRSTVW			2	Occas	3
317	*Helenium elegans*	2	1	3			1000-5000	V Y Z	2		
323	*Hymenoxys scaposa*	2	1	2						Occas	3H
327	*Liatris mucronata*	2	1	1	50-200	H			1		
328 N	*Lindheimera texana*	2	1	3			100-200	AA S	3		
331	*Melampodium leucanthum*	1	1	2	Trace	G	500-1000	F R	1	Thru	2H
332	*Palafoxia callosa*	1	1	3	2000-4000	ABGHOR-TW			2	Occas	H
337	*Ratibida columnaris*	2	2	3			250-375,000	AACCRYZ	2		
338	*Rudbeckia hirta*	2	1	3			200-300,000	Y Z	2		
341	*Solidago canescens*	2	2	2	2000-5000	DELMOR-TW			0		
342	*Solidago nemoralis*	2	2	2	0-5000	CIJKPRSTV			0		
347	*Tetragonotheca texana*	1	1	3	750-1250	AGORSTWV			1	Trace	H
348	*Thelesperma simplicifolium*	2	2	3			5000-8000	AA S	2	Occas	H
349	*Verbesina encelioides*	3	2	3	6-15,000	IJPRSTUW	7000-9000	?	3		
350	*Verbesina Lindheimeri*	2	2	2	50-100	L	2000-3000	A R	0	Occas	3
351	*Verbesina virginica*	2	2	3	25-40,000	S U V			2		
352	*Vernonia Lindheimeri*	1	1	2	50-2000	Q R	100-200,000	AAACCSTUV	2		
354	*Viguiera dentata*	1	1	2	25-50,000	FNQRSTVW			3	Occas	3H
355	*Wedelia hispida*	1	1	2	500-1000	QRSTVW	10-20,000	AACCSTUW	2	Occas	3H
364-5	*Juncus* sp.	2	2	3			4,000,000	Y Z	0	Trace	H
364-5	*Juncus* sp.	2	2	3			500,000	Y Z	0		
377-9	*Aristida* sp.	2	2	3	Trace	M	25,000	AA CC	2		
383	*Bouteloua curtipendula*	1	1	3	Trace	N			0	Trace	2
383*	*Bouteloua curtipendula*	2	1	3	Trace	T			0		
384	*Bouteloua hirsuta*	1	1	1	Trace	G			0	Thru	3
386	*Bouteloua rigidiseta*	2	1	3			Trace	C	0		
387	*Bouteloua trifida*	2	2	2	Trace	H			0		
392	*Chasmanthium latifolium*	2	2	3	50-100,000	JRSU	30,000	Y Z	2		
401	*Eragrostis intermedia*	1	2	3	200-400,000	FNQRSTVW	300-800,000	AA CC	2	Occas	3
402a	*Erioneuron pilosum*	2	1	3			1000-50,000	AA K	0		
404	*Leptoloma cognatum*	2	1	3	2000-4000	O R S T			0	Occas	2
407	*Muhlenbergia involuta*	3	3	2	Trace	K			0		
408	*Muhlenbergia Lindheimeri*	1	2	1	100-500,000	R S V			0	Occas	1
409	*Muhlenbergia Reverchonii*	1	1	1	Trace	I S T			0	Occas	2
411	*Panicum Hallii*	2	2	2	2000-3000	P R			0	Occas	2H

Species Number	Scientific Name	Priority			Seeding					Transplanting	
		A	B	C	Spring 1985 Quantity	Spring 1985 Location	Fall 1985 Quantity	Fall 1985 Location	Overall Results	Location	Re-sults
415	*Panicum virgatum*	1	1	1	10-20,000	R S V			2	Occas	3
419	*Schizachyrium scoparium*	1	1	1	Trace	L			3	Thru	3
422	*Sorghastrum avenaceum*	1	1	2	Trace	J R S V			2		
424	*Sporobolus asper*	1	1	2	200-500,000	DLPRSTVW			2	Occas	3
425	*Sporobolus vaginaeflorus*	1	1	3	2-3,000,000	AGORSTV			3	Occas	H
428	*Tridens Buckleyanus*	1	1	1	5-15,000	Q R			1		
429	*Tridens flavus*	2	2	2	40-80,000	EMQRST			1	Occas	3
430	*Tridens muticus*	1	1	2	50-150,000	BHORSTVW			2	Occas	3
431	*Tripsacum dactyloides*	1	3	1			?	Y	0		
436	*Allium Drummondii*	2	2	3						Occas	H
440	*Nolina texana*	1	2	1						Occas	3
442	*Schoenocaulon texanum*	1	3	2			250-7500	AA	0		
443	*Smilax bona-nox*	1	3	3	300-500	S			0		
444	*Yucca rupicola*	1	3	1						Occas	3
445	*Nemastylis geminiflora*	1	2	1			200	U	0		
446-9	*Sisyrinchium* sp.	2	2	2			200	T	1	Occas	H

REFERENCES

(1) Mahler, David B; Walther, Judith C. "The Process of Habitat Restoration with Specific Application to the Upper Glen Rose Geologic Formation of Central Texas." 1986. City of Austin.

(2) Walther, Judith C. "Annotated List of the Vascular Plants of Wild Basin Wilderness Preserve (Rough Draft)." October, 1985. The Committee for Wild Basin Wilderness, Inc.