NORTH DAKOTA GAME AND FISH DEPARTMENT

Final Report

Restoring Tall-grass and Mixed-grass Prairie in Cropland-dominated Landscapes of Northeastern North Dakota

Project T-21-D

July 1, 2007 – December 31, 2011

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Submitted by
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March 2012

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SWG Federal Aid No. – T-21-D

Cooperators – Alliance Pipeline, Delta Waterfowl Foundation, The North Dakota Natural Resources Trust, The North Dakota Game and Fish Department, and The U.S. Fish and Wildlife Service

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March 21, 2012

Introduction

In 2007, a State Wildlife Grant was awarded to the USFWS' Devils Lake Management District (DLWMD) under the auspices of the North Dakota Game and Fish Department's (NDGF) State Wildlife Grant Program (SWG). A partnership was forged between Federal, State and NGO's to achieve a 1:1 match with these primary objectives;

Objective 1. Restore 600-800 acres of grasslands using diverse, multi-species native vegetation mixtures on priority Waterfowl Production Areas throughout the DLWMD in 2008 – 2011 and beyond.

Objective 2. Continue to monitor the vegetative and bird response to native seeded, restored grasslands in the DLWMD indefinitely.

Objective 3. After 6 to 8 years of data collection, develop a decision matrix for managers to use based on results of monitoring that will help identify grass, forb, and shrub species that provide adequate cover for species of conservation priority and provide the highest likelihood of achieving success for establishment and management.

Objective 4. Actively seek partners to assist in research related to using restoration of grasslands as a method for weed control in North Dakota.

The need for this type of project stem from an increasing desire to increase biological diversity on the landscape, and to test whether sustainability and resilience could be achieved by implementation of a diverse suite of grass and forb species. In addition, grassland nest obligate species were likewise investigated to measure their use and density in these restored landscapes. Past restoration efforts lacked the diversity of species, and included non-native species such as tall and intermediate wheatgrass, alfalfa and sweet clover, and termed dense nesting cover (DNC). The goal of the overall project was to re-create some of the native-dominated grassland habitat that formerly covered most of northeastern North Dakota pre-settlement (i.e. pre 1900). This was accomplished by seeding native perennial herbaceous mixtures on formerly cropped Waterfowl Production Areas managed by the USFWS – DLWMD. Priority areas were selected that provided blocks of wetland and grassland habitat under perpetual protection.

Methods

Blocks of Waterfowl Production Areas (WPA) and National Wildlife Refuges (NWR) have increasingly degraded with regards to habitat quality and species richness, as many sites were restored 20- 30 years ago with low diverse, non-native species mixtures. The current process and method of upland restoration was often lengthy (2 - 4 years), and required numerous prescriptions to achieve successful restoration.

1) Site Preparation – Because of the biology of noxious weeds and invasive species, all sites slated for "prairie reconstruction" were farmed for minimum of 2 – 4 years. Without local farmers, the restoration costs can be expensive, but many of these costs were minimized with the use of "Cooperative Farming Agreements" (CFA) with local farmers who generally farm Federal lands with close supervision of DLWMD managers. The initial break-up of lands was purely a DLWMD expense and included a multitude of treatments including burning, herbicide spraying, and cultivation. Once pre-site preparations were complete, the cooperative farmer negotiated with the DLWMD manager and a CFA was crafted to guide the farmer during years of pre-

restoration. The ultimate objective of the CFA is to farm a crop in the final year of the CFA that is well suited to improve successful seed – soil delivery and to minimize the likelihood of invasive species and noxious weed encroachment. Crops such as canola or soy beans were ideal set-up crops prior to planting native grasses and forbs.

2) Seed Planning – Biotic and abiotic factors were investigated and crucial to selecting seed mixtures. Soils differ from saline, loamy, sandy etc., and not all species are suited for all soil types. Additionally, biotic factors were considered in species seed mixture selection using every available biological tool (thunderstorm maps, local knowledge, and historic presence) to maximize specific species use of restored landscapes. During this phase, wetlands were likewise restored to thwart unwanted emergent vegetation such as hybrid cattails, and remove unwanted sediment from wetlands. Therefore, the DLWMD District Biologist played a significant role in assisting management with seed mixture selection and configuration.

3) Implementation – The placement of grass and forb seed was critical, and a well prepared seed bed and use of DLWMD grass drills ensured that seed was planted in the precise zone between 1/8 – 1/4 of 1 inch depth. Drill calibration was another factor that must be precise as these native mixtures are expensive and the investment of getting a site to this stage of development was lengthy, and failure at this point was not an option. Once planted, Mother Nature was in charge and ample precipitation was desired.

4) Monitoring – As important as any other phase of prairie reconstruction methodology, site monitoring ensured or at least indicated the success, partial success, partial failure or failure of a restored site. For the first 3 years on each restored site, a Daubenmire protocol was established and used to assess species specific presence and abundance. Also, site monitoring was critical in elucidating potential problems with invasive species and noxious weed encroachments and a target threshold of 20% was established to measure the level of invasion. After 3 years, a site is not monitored for the following 2 years, and is/will be revisited in year 6 to reassess and compare with previous monitoring efforts. Typical metrics gleaned at each site included; species composition, species abundance, invasive and noxious weeds densities, litter depths, and visual obstruction readings. A recommendation was then made to the unit manager based upon these criteria.

Results

Acres on the Ground

Between 2007 – 2011, over 27 sites containing 2,704 acres were affected. Of these 27 sites, 12 sites totaling 971 acres have been completely restored and monitoring efforts begun to assess success and serve as a baseline for adaptive management. Due to the lengthy and involved nature of restoration, not all 27 sites have yet been restored (Table 1). For 2012, 5 sites totaling 412 acres were scheduled to be planted. SWG funding was used for site prep and seed purchase of these sites. Lastly, 10 sites totaling 1,302 acres are scheduled for seeding in 2013, 2014, 2015 and 2016. SWG funding was used in the initial breakup and preparation of these sites, and CFA's are fully underway and will continue until the planting year arrives. Funding to purchase seed and planting will be paid for from DLWMD base budget funds. Table 1 describes all locations where projects have been restored, or are in progress of being restored.

Table 1. Site name, County, acreage, status and decimal degree location was provided for sites restored with T-21-D funds between 2007 and 2011.

Project Area	County	Acres	Status	Location	
Avocet Island	Ramsey	200	Prep - 2013	-98.8319	48.5893
Banner	Cavalier	125	Plant 2012	-98.6310	48.5763
Brekke 1	Ramsey	72	Plant in 2012	-98.8077	48.5657
Brekke 2	Ramsey	60	Prep - 2015	-98.8077	48.5657
Digerness	Cavalier	116	Prep - 2013	-98.8336	48.5560
Elias	Ramsey	90	Prep - 2016	-98.6065	48.5510
Gette	Ramsey	120	Prep - 2015	-98.8565	48.5186
Hall	Ramsey	60	Restored	-98.7694	48.4896
Hofstrand	Benson	80	Restored	-98.7802	48.4752
Hofstrand forbs	Benson	40	Restored	-98.5902	48.4651
Jeglum 1	Grand Forks	98	Prep 2013	-98.6925	48.4469
Jeglum 2	Grand Forks	78	Prep 2015	-98.6925	48.4469
Kellys Slough NWR	Grand Forks	30	Plant 2012	-98.6925	48.4469
Kneeling Moose	Ramsey	120	Restored	-98.6118	48.4461
LANWR North	Ramsey	95	Restored	-99.1120	48.3310
Magnuson LANWR	Ramsey	80	Restored	-99.1120	48.3310
Martinson 1	Ramsey	231	Restored	-99.0164	48.2746
Martinson 2	Ramsey	105	Restored	-99.0164	48.2746
Martinson 3	Ramsey	144	Plant 2012	-99.0164	48.2746
Neer	Benson	60	Plant in 2012	-99.6223	48.2389
Register Fld 38	Towner	10	Restored	-99.4636	48.2191
Rock Lake Vollrath	Towner	45	Restored	-97.2288	47.9979
Stinkoway	Cavalier	130	Prep - 2015	-97.2558	47.9877
Tarvested - LANWR	Ramsey	5	Restored	-99.1120	48.3310
Thorson	Cavalier	174	Prep - 2013	-99.3349	47.8939
Twin Lakes	Benson	100	Restored	-99.2148	48.8233
Wengeler	Cavalier	236	Prep - 2014/2015	-99.2503	48.5898

Seed Selection

Various discussions and methodologies regarding seed selection have been ongoing over past years; philosophies of each can differ greatly amongst restoration biologists. This project used cultivars exclusively grown from within the local ecosystem as recommended by various individuals. A strong effort was made to obtain seed from no further than 200 miles south of planting locations, or 300 miles east or west of the same location. Table 2 describes a typical divers mixture used on a loamy site used during this project.

Table 2. A typical planning sheet used for upland restoration on selected sites within the Devils Lake Wetland Management District. This example was from the 45 acre Vollrath WPA in northern Towner County and planted in 2008.

[1] SPECIES NO.	[2] SPECIES NAME	2 VARIETY	3 Full seeding rate pls.	4 % desired in mix	5 seeded pls. lbs/ac	6 Acres to be seeded	7 Total pls. lbs	8 Cost per pls. lb.	9 TOTAL COST
25	BLUE GRAMA	Bad River	2.5	5.0%	0.13	45	5.6	$8.00	$45.00
17	BIG BLUESTEM	Bison	7.9	8.0%	0.63	45	28.4	$5.00	$142.00
19	LITTLE BLUESTEM	Itasca	5.0	5.0%	0.25	45	11.3	$9.00	$101.00
20	INDIANGRASS	Tomahaw k	7.9	8.0%	0.63	45	28.4	$7.00	$199.00
21	SWITCHGRASS	Dacotah	4.5	5.0%	0.23	45	10.1	$2.00	$20.00
26	WESTERN WHEATGRASS	Rodan	12.0	11.0%	1.32	45	59.4	$4.25	$252.00
22	GREEN NEEDLEGRASS	Lodorm	7.1	17.0%	1.21	45	54.3	$3.75	$204.00
30	NEEDLE AND THREAD	Any Local	9.5	2.0%	0.19	45	8.6	$95.00	$812.00
35	CANADA WILDRYE	Mandan	7.5	5.0%	0.38	45	16.9	$4.50	$76.00
39	PRAIRIE DROPSEED	Local	5.0	5.0%	0.25	45	11.3	$90.00	$1,013.00
23	PRAIRIE SANDREED	Goshen or Local	5.0	5.0%	0.25	45	11.3	$8.00	$90.00
64	STIFF SUNFLOWER		12.8	0.5%	0.06	45	2.9	$150.00	$432.00
	Stiff Goldenrod		8.0	0.5%	0.04	45	1.8	$130.00	$234.00
63	MAX. SUNFLOWER	Medicince Ck.	1.0	2.5%	0.03	45	1.1	$40.00	$45.00
66	PURPLE CONEFLOWER		9.0	2.0%	0.18	45	8.1	$23.00	$186.00
69	LEWIS FLAX		9.0	3.5%	0.32	45	14.2	$16.00	$227.00
	Golden ALEXANDER		8.0	1.0%	0.08	45	3.6	$90.00	$324.00
47	BLACK-EYED SUSAN		0.8	2.0%	0.02	45	0.7	$20.00	$14.00
68	WILD BERGAMOT		9.0	1.0%	0.09	45	4.1	$115.00	$466.00
65	PRAIRIE CONEFLOWER		1.5	3.0%	0.05	45	2.0	$30.00	$61.00
	IRONWEED		5.0	0.5%	0.03	45	1.1	$120.00	$135.00
76	WHITE PRAIRIECLOVER		3.9	2.0%	0.08	45	3.5	$16.00	$56.00
62	PURPLE PRAIRIECLOVER		3.8	4.0%	0.15	45	6.8	$12.00	$82.00
61	LEADPLANT		5.4	1.0%	0.05	45	2.4	$70.00	$170.00
77	PRAIRIE ROSE		24.0	0.5%	0.12	45	5.4	$120.00	$648.00
				100.0%	**TOTAL ESTIMATED GRASS SEED COSTS**				**$6,034.00**

Varieties or cultivars for grasses were easily obtained from most seed companies; however cultivars for forb seed have not generally been developed. The need for forb cultivars perhaps is not warranted, but as the science of upland habitat becomes more refined, at least using forbs grown within the same geographical location is sagacious. Full seeding rates have been carefully examined by the USDA-Plant Materials Center in Bismarck, North Dakota, and have been strenuously reviewed through the adaptive management process. These rates may change over time but are currently the best tools we have for creating diverse, resilient stands of tall or mixed-grass prairie. Seed costs vary with market demand. But generally speaking and using Table 2 as a typical example, the cost of a diverse mixed stand FOR SEED ONLY is roughly $130.00 per acre for pure live seed. Costs however are usually driven by forb species. In Table 2, note the prairie rose cost of $120.00 per pound, and the full seed rate of 24 pounds of pure live seed per acre. In this example, only .5% of the overall mixture consisted of prairie rose which comprised 10% of the total project seed cost. This conundrum must be evaluated by the restoration biologist or manager and while prairie rose's diversity was welcomed, does the cost of the species justify is presence within a mixture? Another critical question which must be answered and comes with much uncertainty is will prairie rose at .5% of the mix be enough to establish this species successfully across the site? This is the difference between the model world and real world scenarios and must be considered by restorationists.   Manipulation of the seed planning sheet allows the restoration biologist or managers the ability to create a desired stand related to visual obstruction, forb diversity, warm and cool season grass structure etc. (Figure 1).

Figure 1. Photograph of the 45 acre Vollrath WPA restoration site with a compliment of botanical diversity as planned. These photographs were taken in 2011 and the field was planted in 2008. Grass establishment has begun and is robust, but is certainly not a dominant feature in this planting yet.

Site Monitoring

Because site monitoring can be time consuming, a subset of monitoring was used. Of the 10 restored locations, 7 have been monitored for the primary 3 years after seeding (Figure 2). Most results have yielded good successful growth (abundant rainfall has been a major factor), but our data is suggesting that even though we rigorously use farming and CFA's, noxious weeds (absinth wormwood and Canada thistle primarily) and to a lesser degree invasive species (Kentucky bluegrass, smooth brome, quackgrass, yellow/white sweet clover, alfalfa) have all become concomitantly established in reconstructed stands. Table 3 is a typical example of information gleaned from site monitoring. Although the spreadsheet used can be overwhelming with respect to the amount of data collected, it reveals valuable information regarding stand success particularly with respect to these variables; 1) Stand deviation of grass/forb model vs. actual composition, 2) Amount of species deviation from grass forb model vs. actual composition, 3) presence and level of invasive species and noxious weed intrusion within a restored stand.

Figure 2. Site monitoring of the 45 acre Vollrath WPA restoartion site to ensure stand performance objectives were met. Monitoring required collection of species present, their abundance, stand structure by visual obstruction, and litter depths. This field was planted in 2008 and this photograph was taken during the summer, 2011.

Table 3. A Daubenmire habitat monitoring spreadsheet used to assess post planting conditions of a restored upland site with a diverse mixture of native grasses and forbs, Towner County, North Dakota. Note the summary box at the bottom of the spreadsheet that describes the level of grass, forb and noxious weed abundance present at time of data collection. These spreadsheets allowed biologists to gauge the level of success during stand development. Pay particular attention to the "blue box", as this describes the stand deviation from the original planting mix.

Daubenmire Summary
Study Location: Register WPA
Number of Transects: (25M) 10

Date: Data collected in 2011 field season
Number of Quadrats: 30
Field #: 101

Native Planting Evaluation Matrix

grasses

Cover Class	Mid-Point	Species: Slender Wheatgrass		Species: Western Wheatgrass		Species: Kentucky Bluegrass		Species: Green Needlegrass		Species: Little Bluestem		Species: Indiangrass		Species: Side-oat Grama		Species: Switchgrass	
		Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product
1 1-5%	2.5	24	60	19	47.5	2	5	7	17.5	6	15	11	27.5	4	10	8	20
2 5-25-%	15		0	2	30	1	15	2	30		0	3	45		0	4	60
3 26-50%	37.5		0	4	150	1	37.5		0		0	3	112.5		0		0
4 51-75%	62.5		0		0	1	62.5		0		0		0		0		0
5 76-95%	85		0		0		0		0		0		0		0		0
6 96-95%	97.5		0		0		0		0		0		0		0		0
Total Canopy			60		227.5		120		47.5		15		185		10		80
# of Samples			30		30		30		30		30		30		30		30
% Canopy Cover			2.00		7.58		4.00		1.58		0.50		6.17		0.33		2.67
% Frequency			80.00		83.33		16.67		30.00		20.00		56.67		13.33		40.00

Cover Class	Mid-Point	Species: Big Bluestem		Species: Smooth Brome		Species: Quackgrass		Species: Tall Wheatgrass		Species: Intermediate Wheatgrass		Species: Needle and Thread		Species: Canada Wildrye	
		Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product
1 1-5%	2.5	12	30		0	1	2.5	1	2.5	1	2.5	1	2.5	12	30
2 5-25-%	15	7	105	2	30		0		0		0		0	3	45
3 26-50%	37.5	2	75		0		0		0		0		0	1	37.5
4 51-75%	62.5	1	62.5		0		0		0		0		0		0
5 76-95%	85		0		0		0		0		0		0		0
6 96-95%	97.5		0		0		0		0		0		0		0
Total Canopy			272.5		30		2.5		2.5		2.5		2.5		112.5
# of Samples			30		30		30		30		30		30		30
% Canopy Cover			9.08		1.00		0.08		0.08		0.08		0.08		3.75
% Frequency			73.33		6.67		3.33		3.33		3.33		3.33		53.33

forbs

Cover Class	Mid-Point	Species: Maximilian Sunflower		Species: Wild Bergamot		Species: Canada Milk Vetch		Species: White Prairie Clover		Species: Purple Prairie Clover		Species: Purple Coneflower		Species: Black-eyed Susan	
		Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product
1 1-5%	2.5	3	7.5	15	37.5	14	35	6	15	2	5	2	5	3	7.5
2 5-25-%	15	3	45	2	30		0	2	30	1	15		0		0
3 26-50%	37.5	3	112.5	1	37.5		0		0		0		0		0
4 51-75%	62.5		0		0		0		0		0		0		0
5 76-95%	85	1	85		0		0		0		0		0		0
6 96-95%	97.5		0		0		0		0		0		0		0
Total Canopy			250		105		35		45		20		5		7.5
# of Samples			30		30		30		30		30		30		30
% Canopy Cover			8.33		3.50		1.17		1.50		0.67		0.17		0.25
% Frequency			33.33		60.00		46.67		26.67		10.00		6.67		10.00

Cover Class	Mid-Point	Species: Goldenrod spp		Species: Milkvetch spp		Species:		Species: Unknown Forb		Species: Unknown Forb		Species: Unknown Forb	
		Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product
1 1-5%	2.5	1	2.5	1	2.5		0	1	2.5	1	2.5	1	2.5
2 5-25-%	15		0		0		0		0		0		0
3 26-50%	37.5		0		0		0		0		0		0
4 51-75%	62.5		0		0		0		0		0		0
5 76-95%	85		0		0		0		0		0		0
6 96-95%	97.5		0		0		0		0		0		0
Total Canopy			2.5		2.5		0		2.5		2.5		2.5
# of Samples			30		30		30		30		30		30
% Canopy Cover			0.08		0.08		0.00		0.08		0.08		0.08
% Frequency			3.33		3.33		0.00		3.33		3.33		3.33

weeds

Cover Class	Mid-Point	Species: Sow Thistle		Species: Canada Thistle		Species: Sweet Clover		Species: Field Bindweed		Species: Alfalfa		Species: White Campion		Species:		Species:		Species:		Species:	
		Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product
1 1-5%	2.5	12	30	15	37.5	3	7.5	3	7.5	2	5	2	5		0		0		0		0
2 5-25-%	15		0	5	75	1	15		0		0		0		0		0		0		0
3 26-50%	37.5		0		0	1	37.5		0		0		0		0		0		0		0
4 51-75%	62.5		0		0	1	62.5		0		0		0		0		0		0		0
5 76-95%	85		0		0		0		0		0		0		0		0		0		0
6 96-95%	97.5		0		0		0		0		0		0		0		0		0		0
Total Canopy			30		112.5		122.5		7.5		5		5		0		0		0		0
# of Samples			30		30		30		30		30		30		30		30		30		30
% Canopy Cover			1.00		3.75		4.08		0.25		0.17		0.17		0.00		0.00		0.00		0.00
% Frequency			40.00		66.67		20.00		10.00		6.67		6.67		0.00		0.00		0.00		0.00

Summary		Current Cover Measure	Planned Cover Measure
% Planted grasses COVER	33.75		
frequency PG	453.33	**55.28% Grasses**	**50%**
%cover inv grass	1.25		
%cfreg inv grass	16.67	**2.03% Inv Grasses**	
%Cover PF	15.75		
% Freq PF	200.00	**24.39% Forbs**	**50%**
% cover weeds	9.42		
% freq weeds	150.00	**18.29% Weeds**	**Canada Thistle Abundance**
			3.75
			66.67 **8.13%**
	820.00		

Additional Biological Surveys

In addition to this project, other biological activities designed to measure waterfowl nest success and nest densities, and grassland bird abundance were performed and are nearly completed. These measurements were critical to assess native stand performance related to these critical biological resources. Future biological monitoring efforts will continue to focus on these resources, and will likely include pollinator use compared with DNC stands across the DLWMD. These results now indicate that with respect federal trust species and species of concern to the NDGF, planted native stands will compete equally with DNC and shall be incorporated within the arsenal of habitat restoration tools.

Waterfowl

Please see Appendix 1 for a complete description of waterfowl nest success and nest density measurements performed in the DLWMD between 2009 – 2011. Essentially this study was designed to make side-by-side comparisons of restored native stands vs. DNC. Additionally, Delta Waterfowl Foundation investigated many of these restore native sites before and during the implementation of this project. Several PhD and graduate student projects were funded by Delta to investigate various questions related directly or indirectly to this grant project. Table 4 lists the Delta Waterfowl projects that shed light on the value of a native restored landscape.

Table 4. Project title, author and focus of Delta Waterfowl Foundation studies occurring before or during the establishment of this SWG project between 2007 - 2011.

Project Title	Student Author	Project Status
Density Dependence of Upland Nesting Waterfowl	Mr. Matt Pieron, PhD Student, Louisiana State University	Project Complete
Effects of Predator Management and Brood Densities on Mallard Brood Survival	Ms. Courtney Amundson, PhD Student, University of Minnesota	Project Complete
Mallard Microhabitat Nest Selection and Density Dependent Effects on Mallard Post Fledging Survival and Subsequent Homing Rates	Ms. Laura Beaudoin, PhD Student, University of Guelph	Project Complete
Predatory Mammal and Avian Densities in response to Predator Reduction	Mr. Chris Martin, MSc Student, University of Guelph	Project Complete
Aquatic Invertebrate Response to Duck Population Densities as a Results of Predator Management	Ms. Jen McCarter, MSc Student, University of Guelph	Project Complete

Several of these Delta Waterfowl Foundation sponsored studies are now published within peer reviewed journals.

Grassland Bird Abundance

A graduate student from the University of North Dakota conducted 3 years of research investigating grassland songbird densities in both native restoration sites vs. DNC. While this songbird project is nearly complete, final results are pending and a Master's Thesis and publication to a peer reviewed journal is expected by December, 2012. Essentially the results indicated that songbird use was equally distributed between native restoration sites compared with DNC. In addition to investigating these to habitat types, old DNC (smooth brome dominated) and remnant native prairie were likewise investigated. Preliminary results indicated that both planted natives and DNC rates were significantly higher amongst species richness and abundance, followed by remnant native prairie, and finally old DNC which showed the lowest use regarding grassland bird abundance and richness.

<u>Project Funding</u>

Multiple partners made this project possible. A 1:1 non-federal match was required and met for acquisition of this project. The total project budget was $80,000. Federal funds used for the project totaled $40,000.00 (USFWS-DLWMD base budget allocations). Most federal dollars spent during the project were in the form of salary for tractor operators, herbicide and fuel and equipment maintenance to assist with site prep, and some grass and forb seed costs. The remaining $40,000 was contributed by non-federal grant partners and included;

1) North Dakota Game and Fish Department - $7,000
2) The North Dakota Natural Resources Trust - $3,000
3) Delta Waterfowl Foundation - $10,000
4) Alliance Pipeline - $20,000.

<u>Conclusion</u>

Native reconstruction of upland habitat is in its infancy with respect to uncertainty of success; preliminary results with this study and work done by others indicate that this technique has great promise. The establishment of permanent monitoring sites within these restoration sites will allow biologist and managers the ability to investigate the efficacy in both short term (1 – 10 years) and long term (10+ years) timeframes. This will undoubtedly add to the existing database and improve our conservation delivery using upland restoration techniques. Management of reconstructed prairie habitat is vital to longer term success, and this must also be monitored to insure that management strategies employed have desired effects on both the habitat and the resources utilizing that habitat. Literature strongly suggest that resilience with respect to native, deep rooted perianal and annual native plants should persist, and offer potentially long term solutions to more “semi-permanent” cover such as DNC. While DNC in the short term can be quickly established and is renowned for providing premium nest cover for priaire ducks, DNC is certainly not as a long term upland habitat restoration solution. What we have learned thus far is additive with respects to becoming more proficient with landscape restoration techniques. Our habitat restoration activities coupled with avian monitoring efforts show that native prairie reconstruction methodology is sound. Our research simply has shown that this technique is as good as or better than planting DNC. What are unknowns are the other benefits native reconstruction provides such as pollinator use rates, use by amphibians and reptiles, ability of these deep rooted plants to actually store more water on the upland landscapes, and the overall ability of diverse mixtures to reduce invasive species/noxious weed infestations. The unknowns certainly justify more exhaustive research to address and quantify the additional benefits that diverse multispecies native mixture provide to the entire prairie ecosystem.

Literature suggests in various locations that using diverse mixtures creates a competitive exclusion thereby reducing the potential of invasive species invasions. This project unfortunately did not reduce invasive species invasions per se, but as an objective of this project, we established a “trigger threshold” percentage for noxious weeds of 20% which we met and was indicated in our site monitoring. If stands exceeded 20%, our main management option became burning, grazing, haying as herbicide applications were no longer a viable tool to combat weeds. Our primary questions remain; will these same stands continue to limit these invaders beyond a 10 year timeframe? Long term monitoring of these restored sites must be continued and will assist restorationists with confirming our hypothesis, and perhaps as these stands increase with age, their resistance to invasive species will become more evident. With global climate change looming on the horizon and a reduction and extirpation of common species from the landscape, a creation or effort to infuse biological diversity across a degraded landscape is a pragmatic approach that we must continue to refine and share with others, to achieve quality landscapes for the natural resource we are entrusted to manage, and for the benefit of the American public. A detailed description and annotated notes from this project and others can be found in Appendix 2. This will lead the reader to more detailed descriptions of the overall philosophy of where, when and why to use a multispecies diverse native mixture as a management tool.

PROJECT DESCRIPTION

In 2010 and 2011, the Devils Lake Wetland Management District (DLWMD) embarked upon a waterfowl nest response study designed to monitor nest initiation and success of different land management treatments. Treatments included restored uplands habitats (native diverse mixtures vs. non-native restored mixtures) at various locations across the DLWMD. The primary purpose was to compare nest effort and nest success in both restored habitat types. Results were intended to yield waterfowl use data of native restoration sites versus non-native restoration sites, and to provide this information to land managers whom may have uncertainty selecting upland restoration treatments and its performance related directly toward waterfowl productivity.

OBJECTIVES AND ALTERNATIVES

Objectives of this study included; 1) Make side-by-side comparisons to monitor waterfowl nest densities and nest success at either multi-species diverse native landscape mixtures versus non-native planted nest cover (Dense Nest Cover (DNC)), 2) Assess vegetative components both at duck nests and randomly across study fields to compare site selection by nesting hens with random vegetative structure, 3) Compare and measure additional landscape variables (wetland densities, wetland regimes, nest distance to roads, noxious weeds, invasive species densities, field size, etc.) and compare with duck nest densities and nest success, and 4) Analyze waterfowl use data to replicate results and provide management recommendations at other existing and newly restored locations both within the DLWMD and other locations across the Priaire Pothole Region.

METHODS AND PROTOCOLS

Field Components: Nest Searching - Between early May - early July in 2010 and 2011 we surveyed the following two habitat types for nesting waterfowl: 1) native seeded sites - areas planted with a diverse, multi-species native mix and 2) Dense Nesting Cover. To estimate nest success and densities we conducted nest searches every 5 days throughout the nesting season. Nest searches were conducted using two ATVs and a modified cable chain drag (Klett et al. 1986). Nest searches occurred between 0700 and 1400 to maximize the detection of all nests, including those in the laying stage (Gloutney et al. 1993, Loos and Rohwer 2004). Once nests were located they were marked using numbered wooden lathe placed 10 m from the nest, as well as with an orange rod (3mm diameter, 0.95 m length) placed at the nest bowl. UTM coordinates of each nest were recorded. When nests were discovered and at every subsequent nest check we "candled" eggs to determine stage of development (Weller 1956). At the end of the nest check, we placed a grass X-marker on top of the nest material to detect potential nest abandonment due to investigator disturbance. Nest initiation dates were determined by backdating with the assumption that females lay one egg per day. Nests were checked approximately weekly to determine nest fate. This information was used to determine Mayfield nest success results.

Vegetation monitoring included the following methods: 1) belt transect and modified belt transect to estimate the composition/frequency of vegetation classes (Grant et al. 2004) and 2) Robel Pole and litter depth as an index to vegetation cover quality (density and height; Robel et al. 1970). The belt transect method consisted of a 25 m transects randomly placed using ARC Map software. Vegetation classes were recorded at 0.5 m intervals and Robel Pole readings taken at 6 m intervals along the vegetation transect. In addition, Robel Pole readings were recorded once at nest sites in each of the four cardinal directions (Robel et al. 1970). To ensure consistent placement among years, the vegetation transects were marked and replicated in both 2010 and 2011 with a Trimble GPS unit (sub-meter accuracy) and with stake chasers.

DATA ANALYSIS / MODELS

Upon completion of each field season, waterfowl nest success and densities were estimated for each habitat type (objectives 1 and 4) using Dinsmore's model in program MARK to estimate Mayfield nest success and to estimate nest density (Johnson and Shaffer 1990, Dinsmore et al. 2002, McPherson et al, 2003). Evidence for a treatment effect on nest success was determined using an Akaike Information Criterion (AIC) (objectives 2 and 3) by comparing a model that included cover type versus a model that excluded cover type. Other information modeled included landscape variables such as wetland density, edge parameters and predator effects. Information gleaned from all of the models compared the impacts of the multiple variables that exist across and between the study sites and measured the goodness of fit of the model.

We used analysis of variance with estimated Mayfield nest success via program MARK as the dependent variable and cover types as the independent variable to test for evidence of an effect of cover type on nest density (SAS/STAT 9.2) (objectives 1, 2, 3, and 4).

Vegetation data was again analyzed (SAS/STAT 9.2) to compare landscape variables of habitat patches from GIS land cover data. Landscape variables include the following: 1) trees/shrubs, 2) wetlands, 3) disturbance (nearest road, agriculture practices), 4) surrounding land cover type (waterfowl production area, national wildlife refuge, private lands, grass cover, agriculture, water, road), 5) vegetation structure and composition (objectives 2, 3, and 4).

DATA MANAGEMENT

Data management tools primarily used to store and access data included Microsoft excel spreadsheets. Nest data was recorded using a standard "nest card" developed by NPWRC (NPWRC 2000, Rev. 01-2000) and was the primary field collection tool. Also, nest depredation was likewise recorded using a standard USGS nest depredation card (NPWRC 2000, Rev. 04-2003).

PARTNERS

Over 20 people have been involved in the project representing 4 agencies/organizations. Partners include Southern Illinois University, the North Dakota Game and Fish Department, USGS Northern Prairie Wildlife Research Center, and the U.S. Fish and Wildlife Service.

SOURCES OF SUPPORT

This project was a collaborative effort and funded through various sources. The North Dakota Game and Fish provided $34,520 via the State Wildlife Grant (SWG) program, and the University of Southern Illinois provided $34,500 of monetary match to assist in obtaining the SWG. The USFWS Division of Biological Resources provided $12,500 to assist with data collection in 2011. The Devils Lake WMD provided roughly $8,000 of base budget (1261) funding to cover additional expenses such as fuel, office space, and vehicle maintenance costs. Finally, the USGS-NPWRC provided an estimated $5,000 of in-kind match to assist with Mayfield method analysis of waterfowl nest success and nest depredation data.

Appendix 1. Waterfowl productivity results between 2009-2011 comparing waterfowl nest densities and nest success within restored multi-species native stands versus dense nesting cover, Devils Lake WMD, 2011.

CURRENT STATUS

The project is complete. It is anticipated that a M.S. Thesis will be completed by March 2012, and all parties involved will be provided a final, hardbound copy of the thesis. Also, it is anticipated that several peer-review publications will be produced and submitted to journals of the Principal Investigators (PI) choice.

Overall nest success for all fields under investigation was 50.35% in 2010 and 34.43% in 2011. Nest success was variable across fields ranging from 17.14% to 77.18% in 2010, and 5.16% to 56.02% in 2011. In 2010, restored native planting nest success was 53.44% while DNC nest success was 47.89%. Restored native plantings nest success in 2011 dropped considerably to 18.56% while DNC was comparable with 2010 results at 42.76%. Nest densities (n = 2,721) varied widely between fields ranging from 1.09 nest/ha to 15.06 nest/ha in 2010, and .52 nest/ha to 12.05 nest/ha in 2011. AIC data was not completed at the time of this report. Cover type did not have an effect on density ($F_{1,13} = 0.78$, $p=0.3861$), as DNC plantings had an average density of 5.91 nest/ha and restored native plantings had 5.74 nest/ha for both years combined.

CHALLENGES

Challenges potentially influencing 2011 nest success results for native planted fields included noxious weed management of several tracts during the study. We speculated that management of lands under investigation potentially could and did skew nest success and nest density results. However, results from this study coupled with management activities provided valuable adaptive management lessons, and provided valuable results as to the positive, negative, short term and long term effects management may have upon the prairie landscape and annual waterfowl productivity.

MORE INFORMATION

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Appendix 2. Native grass restoration white paper document submitted to all USFWS Dakota Zone Project Leaders and Wildlife Biologists as a result of lessons learned from State Wildlife Grant project T-21-D.

Native Grass Restoration and Noxious Weed White Paper – Observations from the Devils Lake WMD

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September 15, 2011

Introduction: We have begun using multi-species mixtures to restore prairie landscapes between 1995 thru 2011 in the Devils Lake Wetland Management District, the following paragraphs depict field observations from the Devils Lake WMD with respect to what has worked well, partially worked, and what has failed. "Working well" is defined as native grass stands which are high in waterfowl productivity and resilient to invasive species invasion. "Partial" and "failed" native stands lack one or both of these qualities. Managers should never remove dense nesting cover from their arsenal of landscape restoration techniques, but using native mixtures offers an alternative technique to providing upland cover with the potential of increased resiliency towards noxious weeds and invasive species, while potentially providing adequate cover for nesting birds, specifically waterfowl and other migratory birds.

What works and what doesn't:

a. Native stands appear to have resiliency towards invasive species such as smooth bromegrass and Kentucky bluegrass. This appears to be the trend, but many of our stands have still not had enough time to adequately test this hypothesis (stands <7 years old). We began accelerating our native upland restoration activities in 2004. However, even native stands established >10 years ago show a resiliency towards invasive species and noxious weeds. This trend appears to be working. Why – it is the deep rooted nature of the many of the native grasses that tend to use a different niche than many of the noxious weeds we encounter. Also, the diverse mixtures (> 20 species) including forbs will fill most niches adequately and provide competitive exclusion towards invasion from noxious weeds and invasive species. This is our working hypothesis. However, issues still exist especially with respect to noxious weeds. Absinth wormwood and Canada thistle continue to be problems <u>in early stand establishment</u>, so "how long" does it actually take to establish a native stand in the absence of chemicals, and specifically noxious weeds. What are non-chemical options managers can use if these issues arise? Fire for wormwood? Multiple yeas of clipping for thistle? Haying and grazing will keep weeds under control, but for how long do we have to do this? Is planting grasses only and interseeding forbs at a later date a workable option? Is idling habitat despite weed intrusions a feasible a tenable solution and will County weed boards and neighbors accept this as a reason NOT to control weeds? Perhaps the creation of a management handbook consolidating all methods used by managers and biologists directed at native stand establishment is warranted. If we do a better job of farming and site prep to get the native stands established, we stand a good chance of succeeding. At many locations across the DLWMD, we have embarked upon 3-5 year cooperative farm agreements dedicated to answering these questions. From results on fee title and private lands in the DLWMD where retired farm ground had decades of cropping history, weeds seem to be very slow getting started and this hypothesis tends to be regularly observed provided the immediate native establishment (years 1 and 2) are excellent in the face of above average soil moisture. Obvious site prep techniques include packing and post-emerge weed control (round-up) which are normal processes and work well. In cases where round-up resistant crops could be encountered, several approved herbicides (approved on our list of chemicals) exist with minimal soil activity (little persistence).

b. One trend that is becoming a potential issue in all native stands is that cool season grass and forb resiliency tends to decrease with time. This is somewhat concerning since the cool season grass component tends to be a driver with respects towards waterfowl productivity in the DLWMD. A departure from warm season dominance this far north is normal, and a balance of both cool and warm season grasses thru time should be expected. In our oldest stands, this however does not seem to be the case as we seem to be losing our cool season structure native grass stands. DNC stands can be planted and productive for waterfowl for at least 6-8 years before management, while it is recommended that native stands be managed every 3-5 years. Will native stands require more management and will this result in decreased waterfowl productivity? Our primary concern is will our native efforts produce stands of grasses and forbs which will remain structurally balanced (cool and warm season grasses and forbs) over time. If stands develop warm season dominance, will our waterfowl productivity decline? This is our current dilemma and will be researched.

c. Waterfowl nesting appears to be productive in native stands vs. non-native stands. Three years of intensive field work show this trend. Table 1 below illustrates the nest search results directly designed to compare waterfowl nest success and density in native stands compared with dense nesting cover within the DLWMD.

Table 1. Waterfowl productivity results for side by side comparisons of waterfowl nest efforts and successes located within the DLWMD between 2009 and 2011.

Field Type	Acres Searched 2009	Total Nests 2009	Avg. Nests/ Acre Searched 2009	Mayfield Nest Success 2009	Acres Searched 2010	Total Nests 2010	Avg. Nests/ Acre Searched 2010	Mayfield Nest Success 2010	Acres Searched 2011	Total Nests 2011	Avg. Nests/ Acre Searched 2011	APPARENT Nest Success 2011 **
DNC	281	214	.76	53.33%	708	1,191	1.7	47.89%	672	1,423	2.11	42.76%
Native	211	153	.72	55.33%	610	798	1.3	53.43%	579	977	1.68	18.56%
3 Years Total	492 ac. searched	367 nests			1,318 ac. Searched	1,989 nests			1,251 ac. Searched	2,400 nests		

**Mayfield nest success results for 2011 not yet available.

Brief discussion of results. DNC averaged 48% nest success during the3 year period while native stands averaged 42%. Nest densities averaged 1.5 nests found per acre searched in DNC while 1.2 nests founds per acre searched in natives. The only difference between these data sets was a sharp decrease in nest success in native fields during 2011. We hypothesize that the decrease is a direct result of management of native stands for weed control, which left residual cover less than optimal the following breeding season. Habitat conditions in native stands investigated in 2011 were sub-optimal with respect to visual obstruction, as most stands were clipped, hayed or grazed for weed control. Other reasons could explain this decrease in nest success of course, however unmanaged sites continued to remain steady with nest success approaching typical 3 year averages. Again, this is only speculative but is the best explanation accounting for the decline in nest success in an otherwise consistent data set. Nest densities remained relatively consistent during the 3 year period. It appears that 2010 management (weed clipping, grazing, haying) had direct impacts to the 2011 nest densities and nest success, as the fields managed for weeds were significantly reduced with respect to nest initiation in 2011. Over management? Do we have to manage more intensively to reduce noxious weed invasions in natives during the establishment phase, if so, 2011 data shows that management may reduce the following years of waterfowl nest productivity. Most grass stands under investigation were relatively young with respect to their planting dates, especially native stands which have not had enough time to become resistant and resilient to noxious weed invasions. Once stands mature (> 5 – 10 years), the management of native stands should become less intensive and improve with respect to visual obstruction and litter accumulation annually. In other words, over a 20 year time frame waterfowl productivity potentially should be higher in natives due to the lack of re-establishment needed periodically with non-native stands. At this date, this is speculative and will require annual data over time to prove or disprove this hypothesis. Particularly interesting in the non-native stands was a field of smooth bromegrass and Canada thistle which showed high nest densities (2.5 nests/ acre) and nest success (70% apparent). This stand of grass was planted in 1988. Nobody is arguing that we should plant smooth bromegrass for waterfowl management, but this illustrates the functionality of a grass stand in an area with high wetland densities. Further, could idling grass stands and forgetting about noxious weeds become a management strategy? Obviously our neighbors will complain, and we are mandated to control noxious weeds on our lands so this idea is likely not workable.

d. Nest structure seems to be annually consistent in DNC, while native stands seem to be decreasing in forbs and cool season components and this issue was briefly described in Section b of this report. This trend was confirmed by 3 years waterfowl nesting work conducted in the DLWMD. If we are losing the forb (bunchy) and cool season components and have to "over manage" stands to get these components back, what will our waterfowl and other ground nesting bird nest densities look like in the future? Does it pay to plant the multi-species mixtures if our true goal is waterfowl productivity into the future? Is it cheaper to go with DNC expecting do "re-do" these stands in 10 – 12 years vs. trying to manage natives every 3-5 years? Cost and benefit ratios and WPA goals should be considered when planning restoration activities. More research of older stands of natives to confirm these findings, especially species compositions and visual obstruction readings of each stand over time must be performed to absolutely confirm this hypothesis.

e. Certain grassland songbird presence and abundances seems to be slightly higher in native sites than DNC, although this data has still not been confirmed. Preliminary data of 3 years of research comparing these grass habitats (DNC vs. Native Planting vs. Native Prairie) is leaning towards this conclusion, but several common grassland species are showing no affinity for either habitat type. Several grassland sparrow species which are federal trust resources show higher use in natives than DNC, but they are also present in DNC. When this data set is completely analyzed, it will be provided.

f. Saline soils continue to be challenging for complete native restoration. Although few native species are saline tolerant, establishment of good nest cover on these sites has shown partial success. Fortunately, noxious weeds have difficulty establishing themselves on these soils. We have combined native and non-native grasses on these soils, the non-native species, tall wheatgrass, is perhaps the easiest grass to establish on saline soils, along with western and slender wheatgrass. The species of forbs we generally use in native restorations do not perform well in these soils, and therefore our structure is generally grass only. We do not recommend using highly diverse, expensive mixtures on saline sites, and DNC with other halophytes is warranted. Hopefully this will change if anybody discovers a mixture that works. Spend your dollars on your best soils and conduct a thorough soil examination before planting. Tools such as the USDA Web Soil Survey, or ARCGIS based soil layers are critical to successful establishment on any site, and are the first step in planning upland restorations.

g. Native grass and forb mixtures that are persisting in the environment and appear to be well established include restorations that contained at least 12 species of grasses and 12 species of forbs (see attached list as example). The most native diverse mixtures are showing structural promise, and we will continue to monitor these stands to determine what if any structural shifts may occur over time (losing forbs, losing cool season components, warm season increasers, invasive species invasion, noxious weed management with non-chemical means, etc.) Some of the original native mixtures planted over 10 years ago seem robust and resistant to invasive species and responsive to management. However, what is the current structure – what plant species have increased and decreased in these older stands? How have the stands performed for waterfowl productivity over time and how much have they deviated from their initial intended structure? What can we learn from these stands? This begs further investigation especially towards waterfowl production. We are planning to monitor these questions over the next 5 years.

h. Costs associated with these mixes are a concern to most. In the Rock Lake NWR example seed mix sheet, the cost for a 45 acre "super diverse" mixture was about $134 per acre. At the Nikolaisen WPA one restoration effort (25 species mix) cost was $300/acre for seed which is certainly extreme. Also, some highly diverse native seed mixes constitute certain expensive species that constitute a small percentage of the total mixture. For example, a recently restored WRP project (spring 2011) in Cavalier county occurred where stiff sunflower and prairie rose made up 2% of the mixture, but totaled 50% of the seed cost. Is it worth it to abandon these species? Are they critical for songbird and waterfowl productivity? Most think it is cost prohibitive, and the structure does not justify the cost. So we go back to the "Anchor Species" concept put forward by Dwight Tober (Retied NRCS plant materials center, Bismarck ND, Manager). We find that in our mixtures, we want yellow coneflower, blanketflower, purple coneflower, Canada and American milk vetch, purple and white priaire clover, blue flax, black-eyed Susan, wild bergamot, and lead plant. These species represent at least the 10 forbs that are likewise recommended by Tyler Larson (NDSU graduate thesis) who recommends at least 10 spp's of forbs for diverse mixture success along with at least 9 spp's of grasses. Our typical native grass compositions are green needlegrass, western wheatgrass, Canada wildrye, slender wheatgrass, big bluestem, little bluestem, indiangrass, switchgrass, and the grammas. Larson recommends planting at least 50% grass and 50% forbs. Grasses possess a stronger ability to spread among the landscape; while forbs are less aggressive therefore this percentage of grass/forb mixtures seems a logical choice. If we prove that we are in fact losing our cool season components in our restored native stands, could we increase the amount of these species to offset this loss? Will it work by adding a higher percentage of a desired species? This is the direction of further investigations in our native restored stands.

i. Our knowledge of forb mixtures and their minimum/maximum rates need further investigation. To put prairie rose in a mix and make it cost effective, we bring it down to a "half" a percentage because rose is expensive and is one of the 1% of mix – 50% of cost species. But will one half of one percent mixture of rose and stiff goldenrod for example be an appropriate amount of seed to get these species going and for them to persist? We have minimum and maximum rate recommendations for grasses, but we do not have this for forbs. We only have appropriate pure live seed per acre rates for forbs. Therefore, are we wasting money by planting a half of one percent of a species in a mixture and will this species persist over time? We need to have a minimum percentage rate for forbs to ensure success. We are monitoring this at certain sites.

j. Native harvest vs. cultivars – in Devils Lake, the native harvest fields have had miserable success and we do not use these mixes anymore. Cultivars tend to be successful and we count on them to restore the landscape, we've had excellent success with cultivars, and have not bothered with native harvest within our own stands as a restoration technique. Other stations plant native harvests regularly and report success with this technique. Perhaps cultivars, especially warm season grass cultivars which are breed to be aggressive are part of our cool season decrease. Cultivar seed is very clean, and will work in a grass drill very well.

k. Drilling vs. broadcast seeding. It was recently suggested/recommended that we broadcast seed and fall dormant plant all of our species to restore priaire landscapes with native grasses. We in Devils Lake and along the northern tier of the Dakota will try this, but on a small scale to start. WHY? NRCS/Bismarck Plant materials center (Dwight Tober) still does not recommend fall dormant planting warm season grasses, but the service is doing this in southern ND, Minnesota and SD. We are concerned, at least in DLWMD, that our growing climate is harsher than the southern Dakota's (shorter growing seasons primarily) and therefore would not fully embrace the recommendations until we conduct our own investigations designed to try these techniques. Drilling had always been the technique used, which does not mean it is the right technique, but it does work repeatedly well in Devils Lake. If we use the broadcast seeding technique, does this mean doubling the rate of seed, doubling the cost? Major advantages of snow seeding and broadcasting are the ability to plant in any conditions therefore extending the window to plant habitat.

l. Continue to research all aspects of native restoration. The presence and absence of pollinators, amphibians, and other invertebrates in native restoration sites compared with DNC continues to be unknown. There continues to remain many unanswered questions.

NOXIOUS WEEDS

WHAT WORKS and WHAT DOSEN'T – Observations form Devils Lake WMD.

a. Biological control seems to be effective with spurge beetles; many sites are showing success albeit slow. Thistle bugs to control Canada thistle failed after 4 years of investigation at Devils Lake as sites showed no difference before and after release. Others claim success using Canada thistle beetles. We were told to be patient, but 5 years of 0 results on 2 sites makes managers reluctant to use them. If others have had success, please share this information. No biological control for wormwood exists. Musk thistle weevils are showing some success, but eradication will never be achieved using this method. Purple loosestrife has not been a widespread problem at Devils Lake, but biological control methods work in other locations of the country. Toadflax biological control weevils have shown promise in Wyoming, and releases have occurred on non-FWS lands in Red River Valley via the Cavalier County weed board. Long term results are unknown.

b. Chemical results are positive and over the past 8 years we have conducted test plots to address many questions (see attached graphs). Some have indicated that some forbs are tolerant to Milestone, yet after 24 month after treatment, we have a clean stand of grass, but no forbs – none at all. Milestone herbicide appears to be a very good chemical for thistle and wormwood control. Currently, milestone is our herbicide of choice. We have gone away from Curtail herbicide which was used extensively years ago. Also, Redeem herbicide is another herbicide we use less of anymore. Both of these herbicides persist in the soil and have the propensity to leach into groundwater if applied in course soils. Milestone has one significant environmental advantage, the lack of one chlorine molecule which makes it safer around water or in course soils, compared with tordon, curtail, and redeem which persist and can leach into groundwater (because of the clopyralid). Despite environmental contamination, all of these herbicides work to control broad leaved weeds. Hay – spray rotations are still a popular and an effective choice for thistle and wormwood control. Control of leafy spurge using tordon (8 oz.) and plateau (4 oz.) herbicides is recommended by NDSU Extension Service. All should have copies of the NDSU Weed Control Guide, and be certain to get the annual updated version as they are published.

c. Cultural results are pending. Wormwood control with fire has promise; if anybody has good data on this, share it. We are preparing to study burning a 3 year old native mixed grass stand that is infested with wormwood. Fire has not shown success for Canada thistle or spurge. Grazing is used as a land management technique to improve stand vigor, but we have no data suggesting the use of grazing and weed responses.

d. Mechanical control for noxious weeds is inconsistent, sometime mechanical works for Canada thistle, sometime not. Certainly not for spurge as we need chemical or biological control. One needs to have a better understand of plant physiological responses to mechanical control. Mowing seems to perpetuate weeds, but mowing then spraying is very effective.

e. HYBRID CATTAILS – an invasive species we think it worthy of mention as how this problem is growing with no end in sight! Sedimentation and a prolonged wet cycle go hand in hand with hybrid cattails and we really have no idea to what degree – this could be a LCC funded study across the state. The end results from DLWMD observations are that this invader has become a major component with wetlands, and has shown to decrease productivity within wetland stands by directly limiting hydrophyte diversity, thereby decreasing invertebrate diversity and ultimately decreasing waterbird diversity. This is the next major issue we face in Devils Lake, and directly relates to decreased productivity of our wetland resources.

Summarize for weed control (nothing new to most):

Wormwood – cut stems in late spring before heading/seed, return in 6 weeks and spray as plant are actively growing as recommended by the North Dakota weed control guide. Use milestone at 5 – 7 oz./acre to control. This works very well. Try fire to control wormwood as well.

Canada thistle – the rosette technique and fall rosette technique continue to be the most widely accept method for control (hay – spray rotations). Cut plants for hay after July 15, then return in fall by mid-September and apply milestone (5-7 oz.), curtail (2-4 pints), tordon, redeem (3 pints) to the rosettes. But remember – IF YOU DO NOT HAVE ADEQUATE COVER UNDER THE THISTLE (IE. GOOD ROBUST GRASS TO REPLACE THE THISTLE) YOU WILL NOT SUCCEED. Your weed treatments will last about 24 months, sometime less.

Musk thistle – a broad leaved herbicide applied to this biennial plant in spring when the plant is in rosette stage will work, musk seems to be relatively easy to control. We had success with milestone, redeem and a BASF herbicide called OVERDRIVE (which can be tank mixed with any of the aforementioned broadleaved herbicides to give added control). Because musk thistle is a biennial plant, prepare to spend about 4 years treating this plant, and remain vigilant.

Leafy spurge – control with beetles, but be mindful of several factors – soil types (avoid sandy soils) and aspect (avoid north facing slopes). Herbicide works well, but for short duration. In 2 field trials, we found plateau herbicide worked for 24 months, and then spurge returned as if we did never treated the plants. The mixture used today and recommended by NDSU is 8 ounces Tordon and 4 ounces of Plateau. Dr. Rod Lym of NDSU does not recommend use of 2, 4-D in the mix anymore, and found it was not needed and an additional costs. The cost is $18 per acre and the control 85% 24 months after treatment. BEWARE of Plateau herbicide as it will cause grass injury to non-native cool season grasses such as KBG and brome – IF you plan to use this type of habitat with grazing or haying.

Houndstounge – NDSU recommended 2, 4-d amine or ester at 2 pints, or Escort (metsulfuron) 1 – 2 oz / acre or Plateau herbicide at 8 – 12 ounces (plus non-ionic surfactant). Apply from May to June. We do not have the issues here, so others may have better more up to date data.

Toadflax, yellow or Dalmatian – Use of chemical controls is just being investigated. Perspective herbicide (which has not been approved for USFWS lands) is showing success when applied at 6 ounces per acres (active ingredient Aminocyclopyrachlor and Chlorsulfuron) late summer, however, a one year grazing restriction with this herbicide s required.   Fall applications of Tordon (1-2 qts) and Overdrive (4-6 oz.) is also shown success. Bio-controls for toadflax exist and are stem mining, flower feeding, and seed feeding weevil, with minimal success reported.

Purple loosestrife – spray with broad leaved herbicide approved for over water. Biological control agents exist and have shown excellent results in other parts of the country (Oregon for example). I think biological control was attempted in the Valley City District, but we're not sure if it was attempted and if it was, was it successful.