CHENOPODIUM SUBGLABRUM SURVEY
LITTLE MISSOURI NATIONAL GRASSLANDS
DAKOTA PRAIRIE GRASSLANDS
2002 FIELD SEASON

NOTE: LOCATIONS AND PHOTOS HAVE BEEN REMOVED FROM THIS WEBVERSION

ABSTRACT

Smooth goosefoot (*Chenopodium subglabrum*) surveys were performed along the Little Missouri River in Slope County, ND during July and August 2002. Two surveyors conducted a thorough inspection of sandstone cliffs, sandbars, riverbanks, and exposed terraces along all U. S. Forest Service riverfront from Marmarth, ND to the C. Hande Ranch just north of the Slope/Billings County line. Two populations of smooth goosefoot were found. One population contained about 1000 plants scattered along 280 m of an eroding sandstone cliff at water's edge that was well stocked with *Psoralea lanceolata*. The other population contained two plants on a coarse sandbar with dense *Melilotus alba*. Many promising habitats were found but with no results. A search for four historic populations was unsuccessful. The populations along the Little Missouri River appear to be at a modest risk due to the limited human activity. The greatest threat to the populations and habitat is competition from noxious weeds, most notably *Euphorbia esula*. The second greatest threat appears to be overgrazing and severe trampling by cattle, followed by inundation by beaver dams, damage from recreational vehicles, and the natural processes of erosion and deposition. It is recommended that noxious weed controls be implemented, stocking levels and pasture rotations be manipulated to ensure overgrazing does not occur, and that anthropogenic factors that would alter the natural hydrology of the river be minimized.

PROJECT INFORMATION

Smooth goosefoot, or *Chenopodium subglabrum*, is a plant found in the western United States and Canada. In North Dakota it is found on the Little Missouri National Grasslands (LMNG) of the Dakota Prairie Grasslands (DPG). It is considered rare throughout its range. It is listed as S1 with North Dakota and Sensitive with the US Forest Service. It is a primary succession species that prefers riparian areas with major active sandy areas with finer and more compacted sands. These include dune slacks, blowouts, and west facing actively eroding slopes. It is considered xerophytic, halophytic, and alkali tolerant. (Smith and Bradley 1992)

An inventory and assessment for this species was undertaken on the LMNG during the 2002 field season. This survey was directed toward the riparian zone on LMNG lands along the Little Missouri River from Marmarth, ND, north to the Slope/Billings county line. This is on the Medora Ranger District. The objective of the inventory was to revisit historic smooth goosefoot populations, locate and map new populations, collect population data, and obtain an overview of the status and condition of these populations.

Darla Lenz and Joe Washington, Forest Service Botanists with the DPG supervised the project. David and Amy Schmoller of Yellowfield Biological Surveys conducted the survey during July and August of 2002.

METHODS

The surveys were conducted during late July and August of 2002 so as to coincide the surveys with known flowering times of smooth goosefoot. Topographic maps, GPS standards, a list of historic smooth goosefoot sites, and taxonomic references were provided by the DPG. Sites were accessed by means of pickup truck, foot, and kayak.

An effort was made to make a thorough inspection all LMNG land in the survey area that contained habitat with a high potential for supporting a population of smooth goosefoot. Generally, these were poorly vegetated sandy sites such as the base of sandstone cliffs, exposed terraces, riverbanks, and bars of the Little Missouri River. Element occurrence records were reviewed and historic populations were revisited. Some private or state land that was encountered along the survey route was inspected. Habitats with a lower potential for smooth goosefoot were inspected with less intensity. These habitats included all bars, banks, terraces and uplands with dense ground cover, vertical cliff faces, exposed siltstones, claystones, and mudstones, and mudflats in the river bottoms.

During high flows of the Little Missouri River, one vehicle would be dropped off downstream then another vehicle with the kayaks would be dropped off upstream. The surveyors would then kayak downstream toward

the first vehicle. Each surveyor would be responsible for one side of the river. When the river dropped and kayaking was no longer possible, one vehicle was used. The surveyors would park the vehicle at a central location. Then they would walk on either side of the river in a loop, ending up back at the truck. Or they would set off in opposite directions, walking on one side of the river until reaching some distant point, then return on the opposite side of the river. These strategies enabled the team to cover as many as 23.5 miles of shoreline in a day.

General habitat, rare plant populations, and unusual features were described. Population densities were determined by visual estimate or actual count. Voucher specimens were collected. Detail and panoramic photographs were taken. All hours and miles spent on the project were logged. Populations of smooth goosefoot were mapped with the aid of a Garmin 12XL GPS and a Trimble Geoexplorer 3 GPS unit. Population locations were displayed on aerial photographs and topographic maps.

RESULTS AND DISCUSSION

1) General description of project area: The riparian area along the Little Missouri River lies within the mixed grass prairie. The river channel itself is largely unvegetated, being subject to rather intense erosional processes of illuviation and colluviation. Upslope from the river channel the mixed grass prairie becomes well established. The benches along the river valley typically display large expanses of *Artemisia cana*. Old river channels are often lined with *Populus deltoides* and *Salix exigua*. The river bottoms contain modern and older alluvium and alluvial fans. The surrounding uplands are a) terraces of Holocene origin or b) badlands of the Sentinel Butte Formation or the underlying Bullion Creek Formation of the Paleocene Fort Union Group. The badlands are composed of sandstones, siltstones, claystones, and mudstones. They contain many geological oddities such as glacial erratics, petrified wood, lignite, clinker, chalcedony, iron-sulfide nodules, iron carbonate nodules, iron oxide concretions, silicrete, slumps, and hoodoos. The badlands lack soil features and are not classified as soils. Where soil formation does occur, it is Flasher, Havre, Patent, or Banks soil series. Banks soils represent recent alluvial deposits, dominate the lowest portions of the river bottomlands, and support *Populus deltoides*. Patent soils tend to form upslope from the Banks soils in ecently deposited sediments on colluvial fans. Havre soils are of alluvial origin and tend to form upslope from the Banks soils in valley bottomlands. They are dominated by *Artemisia cana*. Flasher soils form in localized sandstone outcrops. (Biek and Gonzalez 2001, Heidel, 1990)

2) Description of potential habitat from uplands to river bottom: Four zones of potential habitat were observed in the survey area. All were erosionally/depositionally active with fine sandy substrates and classified as cliffs, terraces, banks, or bars.

Cliffs

Numerous cliffs, particularly along bends in the river channel, bound the Little Missouri River. The vast majority of the cliffs appeared to be Bullion Creek siltstones, claystones, and mudstones. There were occasional outcrops of lignite and clinker ***(Figures 1-3)***. The cliff formations with the greatest potential for smooth goosefoot were exposures of Bullion Creek sandstones. These represent river channel and point bar deposits. Although small sandy areas were common, there were five principle locations along the survey area with significant amounts of sandstone ***(Sites A-E, Appendix C)***. Sites A and B were 100 foot tall vertical ledges of sandstone with distinct climbing ripples and soft-sediment deformation. Site C was a 20 foot cliff of more consolidated sandstone featuring pitted weathering and planar cross-beds. It was on private land. Site D was an outcrop of sandstone blocks that tumbled down the slope. They featured pitted weathering and planar cross-beds. Site E was a 100 foot high, 50 degree sandstone embankment. The sandstone at this site was softer and less consolidated sandstone than all others and displayed no noticeable weathering pattern. Wind and water erosion and mass wasting were highest at this site, resulting in deep loose sands at the base of the embankment.

Vegetation at the base of these sandstone cliffs was sparse. Erosion and mass wasting combined to produce an incessant rain of sand that accumulates at the base of the cliffs, limiting the development of soil and vegetation. The vegetation increased in density and variety with distance from the cliff. On upper slopes, the most common plants were *Psoralea lanceolata, Glycyrrhiza lepidota, Helianthus petiolaris, Kocia scoparia, Chenopodium album,* and *Ambrosia psilostachya*. On lower slopes the most common plants were *Spartina pectinata, Ambrosia psilostachya, Calamovilfa longifolia*, *Glycyrrhiza lepidota*, *Kocia scoparia*, *Equisetum laevigatum*, and *Helianthus petiolaris.*

Though all five sites were promising, only one sandstone cliff was populated by smooth goosefoot. This was cliff Site B, or smooth goosefoot Site 1, described below. This was a robust, expansive population, the largest of any population recorded in Slope or Billings counties. Reasons for the absense of smooth goosefoot at the base of these cliffs might be due to extreme flooding in the 1990's, lack of seed source, or excessively active sand.

Terraces
Terraces of gravel, sand, silt and clay of modern to Holocene age continue along the entire length of the Little Missouri. Biek and Gonzalez (2001) identify four Holocene-age terraces as well as the modern flood plain along the Little Missouri River. The terraces with the most exposed soil and least vegetation were those closest to the river bottom. Old river channels within the lowest terraces were often filling in with *Salix exigua* and *Populus deltoides*. As one progressed upslope toward older terraces, exposed soils decreased, vegetation density increased, and the suitability of the habitat for smooth goosefoot decreased. Common plants on the lower terraces were *Spartina pectinata, Ambrosia psilostachya, Calamovilfa longifolia*, and *Glycyrrhiza lepidota. Artemesia cana* and *Stipa comata* dominated the uppermost terraces.

Some terraces were exposed Bullion Creek Formation with sandstone blocks and lignite veins. ***(Figures 5 and 6)***. The lowest terraces were often deeply incised by small, dry creeks that emptied into the Little Missouri River.

Wind and high water maintain exposed sand on some terraces, presenting prime conditions for smooth goosefoot. In fact, eight out of ten historic populations of smooth goosefoot in Billings and Slope counties were described as being in sandy terraces ***(See Table 2)***. However, no smooth goosefoot was found at these sites during this survey. The absence of any smooth goosefoot despite these historic sightings of the plant on terraces raised questions. This absence might be explained by the extreme flooding that occurred during the 1990's, by the obscurity of smooth goosefoot beneath the willow and cottonwood saplings that dominate many of terraces, or by the gradual conversion of these formerly active sandy areas to stable, inactive, well-vegetated communities.

Banks
The material composing the banks of the Little Missouri River varied from clay to stone. Gently sloping banks behind the point bars of the river were usually more heavily vegetated and prone to deposition. Banks along the straight stretches generally saw both erosion and deposition, depending upon their distance from the riverbed and location relative to the curves in the river. The cut banks along the outside bends of the river were actively eroding with exposed sand, clay, and stone. Vegetation on these cut banks was generally thick up to river's edge. Vegetation on all banks of the river tended to be *Spartina pectinata, Ambrosia psilostachya, Calamovilfa longifolia*, and *Glycyrrhiza lepidota*. ***(Figures 6 and 7)***

Some of the banks were littered with sandstone blocks. Sentinel Butte sandstone concretions with their oval and log like structure were rare, but far more common were the Bullion Creek sandstones displaying climbing ripples.

Erosion and deposition by the Little Missouri River maintained numerous open, sandy locations along the banks. Many of these areas presented the fine, active sand preferred by smooth goosefoot. In addition, the weathering of sandstone blocks at some locations was sufficient to create a deep, active layer of sandy waste, seemingly prime habitat for smooth goosefoot. However, no smooth goosefoot was found. It is likely that the absence of smooth goosefoot on banks during this survey is due to factors similar to those cited in the discussion on terraces: Extreme flooding that occurred during the 1990's, the obscurity of smooth goosefoot beneath the *Spartina pectinata, Calamovilfa longifolia*, and *Glycyrrhiza lepidota* that dominated many of the banks, the absence of a seed source, or the conversion of active areas into inactive, vegetated areas with their increased competition and shade.

Bars
Bars were found at every turn in the riverbed. Substrates varied from rock to sand ***(Figures 8-11)***. Depressions in the bars, such as old river channels, were filled with mud and silt from recent flooding ***(Figure 7).*** Most bars were crusty with alkali ***(Figures 12 and 13)***. Many fish were stranded in pools of water left by the receding river. The riverbed was littered with dead fish from Van Daele Ranch to Logging Camp Ranch ***(Figure 14)***. These species included *Ictalarus punctatus*, *Stizostedion vitreum*, *Cyprinus carpio,* and possibly *Aplodinotus grunniens* and *Hiodon alosoides.*

Vegetation was generally sparser than that found on terraces and banks. Species found on the bars included *Melilotus alba, Melilotus officinalis, Ambrosia psilostachya, Descurainia richardsonii, Artemisia campestris, Artemisia dranunculus, Grindellia squarrosa, Xanthium strumarium, Polonsia dodecandra, Kocia scoparia, Polygonum arenastrum, Polygonum ramosissimum*, seedlings of *Populus deltoides* and several *Chenopodium* including *C. album, C. leptyphyllum, C. glaucum,* and *C. freemontii*. Sandbars had the same species as gravel bars but would support *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota.* As the bars stabilized, they would be colonized by *Populus deltoides* and *Salix exigua* ***(Figure 15)***. The mud filled depressions in the bars presented fresh *Populus deltoides* seedlings.

While the bars often displayed fine, active sands, and there have been historical sightings of smooth goosefoot on active sandbars, only one population consisting of two plants was discovered on a sandbar in this survey. This was Site 2, described below. Reasons for this rarity may be extreme flooding in the 1990's, recent flooding which inundated and covered many bars with mud, the fleeting nature of an annual such as this, lack of seed sources, or cattle grazing and trampling. The grazing and trampling was pronounced nearest the river, undoubtedly the result of cattle gravitating toward the water in the torrid summer heat.

3) Discovery of New Populations: Two new populations of smooth goosefoot were found in this survey. See ***Appendix A*** for photos.

SITE 1

Numbering an estimated 1000 plants, this population of smooth goosefoot appears to be one of the largest populations observed in its range. The Natural Heritage Database shows approximately 225 plants on 10 sites in Slope and Billings counties in North Dakota. In 1992, the total population of smooth goosefoot in Alberta was under 100 individuals. (Smith and Bradley 1992) Three populations discovered in Saskatchewan in 1996 numbered a total of 107 plants. (Robson 1997)

The population extends for a distance of 280 meters along the base of a Bullion Creek sandstone cliff. It extended from the cliff face downslope to the edge of the riverbank. Sand is continually sifting down from the cliff face and accumulating at the base of the cliff, creating the active, sand that this species prefers. The population is on a western exposure, the plants shaded by the cliff until late morning. Slopes are from 10 to 20 degrees overall. This population resides fairly well above the riverbed, as many as 10 feet above the flows seen in this survey. This affords the population a respite from frequent episodes of flooding that the bank and bar populations would experience.

The steady influx of sand prevents any soil formation. The sands are fine to medium textured. Alkali is visible in the sandbars and eroding riverbank below the population, suggesting the high pH of the substrate. Soil moisture is poor. In all probability, salinity is high, as the Havre and Patent soils are characterized by a build-up of salts and solonetz formation (Heidel 1990). Dryland farming is present on plateaus above the river. These are linked to the increase in saline seeps in the shortgrass and mixed grass prairies (Alt and Hyndman 1986).

Vegetation structure was entirely forbs, no shrubs or trees. Vegetation density was low. Bare ground was over 90% along the base of the cliff and decreased to 50% at the outer limits of the smooth goosefoot populations, that is, where the population neared the riverbank. Associated species varied from the base of the cliff to the edge of the bank. Smooth goosefoot was most numerous within the first two feet from the base of the cliff, co-dominant with *Psoralea lanceolata*. *Salsola iberica* and *Kocia scoparia* specimens were present in small numbers. As the population neared the riverbank, other associates appeared and increased in number. These included *Glycyrrhiza lepidota, Calamovilfa longifolia*, *Xanthium strumarium, Melilotus alba, Melilotus officinalis, Spartina pectinata, Equisetum laevigatum, Chenopodium album, Ambrosia psilostachya,* and *Helianthus petiolaris.*

The smooth goosefoot specimens were largely in very robust form. About 95% of the living plants were in flower. About 10% of the total specimens were dead, and these were concentrated toward the riverbank, where competition from other plants was greatest. About half of the living plants were at least 3dm tall. Some reached 6dm. There was no sign of browsing or grazing. No chlorosis, necrosis, disease or blight could be seen.

No disturbance other than that wrought by natural erosional processes was observed.

This population was photographed. Five specimens were taken for mounting. The site was mapped with both the Garmin 12XL GPS and the Trimble Geoexplorer 3 GPS units. Satellite geometry was poor due to the high cliff that blocked satellite contact to the east. No polygon readings were possible. It was necessary to climb to the top of the cliff or to stand in a breach in the cliff wall to obtain an adequate signal. Figure 5 is taken from the top of the cliff wall. From these locations, three points were obtained.

SITE 2

Two robust smooth goosefoot plants were discovered on a gravelly and sandy bar that appeared to straddle the boundary between Federal and private land. The bar contained coarse sand overlain by gravel surface only a few inches deep. The composition of the substrate was 90% sand, 5% gravel, and 5% silt. This bar rested only a few inches above the current water level and thus was in constant threat of inundation, erosion, and deposition. This prohibited the formation of soil and maintained the active sandy conditions that favor smooth goosefoot.

The specimens were growing within 4dm of each other. Each was about 3dm high. Each was in flower and fruit. There was no evidence of grazing, browsing, chlorosis, necrosis, disease, or predation. There was no slope to the sandbar; the site was open, in full sun.

Vegetation structure was entirely herbaceous. No shrubs or trees were within 20m of the plants. The ground surface was 50% bare ground. Associated species were limited to but a few, the vast majority of which were *Melilotus alba* and *Melilotus officinalis*. Also present were *Xanthium strumarium* and *Salsola iberica.*

Natural disturbance processes of stream erosion and deposition dominate this site and serve to maintain suitable habitat. However, the location of this population in a zone prone to frequent flooding indicates that this population is one on the move. It may very well be descended from the historic population 1.5 miles upstream, a population that was not relocated in this survey despite a thorough search. In addition, cattle trampling and grazing are also heavy on the bars along the river, and this site was no exception. By in large, the *Melilotus* specimens were grazed down to a few inches in height and hoof prints were scattered about the bar. The smooth goosefoot actually stood above most of the *Melilotus*, indicating that it is not selected by cattle ***(Figure 16)***. Although not as heavily trampled or grazed as other allotments, the potential for impairment of this population by cattle does exist.

This population was photographed. No specimens were taken. The site was mapped with both the Garmin 12XL GPS and the Trimble Geoexplorer 3 GPS units.

4) Survey of previous sites: Four populations of smooth goosefoot had been documented in the survey area.

Population PDCHE091G0*001 A survey in 1946 located the species in a “sand bar of river.”

In this survey, no smooth goosefoot was found at this location. The sand bars at this location presented nothing out of the ordinary, being gravelly to coarse sand, sparsely vegetated with *Melolitus alba*, and *Xanthium strumarium.* But about 1.5 miles downstream from this location a new population of smooth goosefoot was located. This is the population at Site 2, described above.

Population PDCHE091G0*008 In a survey in 1991 these observations were made: ‘A small population with apparently limited suitable habitat.’ “8 plants scattered in small sand opening. Surrounding vegetation dominated by Calamovilfa isngofolia. Assoc. species: Oryzopsis hymenoides, Psoralea lanceolata, Melilotus alba, Thlasp arvense, Agropyron cristatum, Salsola kaki, Chenopodium berlandjeri, Ambrosia trifida, Euphorbia spithulata. Vigorous plants in late fruiting stage.”

No smooth goosefoot was found at this location in this survey. The habitat consisted of gravelly to sandy bars dominated by *Xanthium strumarium, Melilotus alba* and *Melilotus officinalis*, sandy to gravelly banks with *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota* and sandy to gravelly terraces with *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota.*

Population PDCHE091G0*009 In a survey in 1991 these observations were made: “2 plants in sandy openings. Assoc species: Oryzopsis hymenoides, Calamovilfa longifolia, Elymus canadensis, Populus deltoides saplings.” “The sandy 1st terrace above the river. Elymus canadensis, Oryzopsis hymenoides,

Populus deltoides saplings are scattered. Elev. @ 2405 ft. The flat surface of the terrace, @ ½ way across from the river bank to the next higher terrace."

No smooth goosefoot was found at this location during this survey. This site was at a well-used ford in the river. It was inspected twice during this survey. The river bottom presented nothing out of the ordinary: The habitat consisted of rocky to sandy bars dominated by *Xanthium strumarium, Melilotus alba* and *Melilotus officinalis*, sandy to rocky banks with *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota*, and sandy to rocky terraces with *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota*.

Population PDCHE091G0*010 In a survey in 1991 these observations were made: 'One lone plant was documented in 1991 along the east side of the river in the sandy, lower terrace.' "Sandy openings. 1 plant (F91DUE69) 'The sides of the river had a lot of silt deposition. The river had been unusually high this year the the pop.could very well be wiped out.' (F93GUE16) Dominant species: Spo cry. Other species: Ory hym, Ero ann, Art lud, Pso lan, Mel alb. (F91DUE69)." A visit to this location in 1995 failed to locate any specimens.

In this survey smooth goosefoot was not found despite two visits to this location. High water enabled access by kayak on the first visit while the second visit was on foot. The habitat consisted of gravelly to sandy bars dominated by *Melilotus alba* and *Melilotus officinalis*, sandy to gravelly banks and terraces with *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota*. The high water had deposited a layer of mud over much of the river bottom.

Summary: The failure to relocate any of these historic populations might be the result of extreme flooding in the 1990's, recent flooding which inundated and covered many bars with mud, the fleeting nature of annuals, lack of seed sources, conversion of active sandy areas to stable vegetated areas, obscurity beneath *Calamovilfa longifolia, Spartina pectinata*, and *Glycyrrhiza lepidota,* or destruction of populations and habitat by cattle grazing and trampling. Many of the populations were quite small and may have had little chance of maintaining their hold on the site. There is the possibility that the goosefoot may have been misidentified on previous surveys.

5) Threats to population viability: In this survey area, several forces were identified which could pose a threat to the populations and suitable habitat of smooth goosefoot.

Cattle grazing and trampling
The river bottom saw greater trampling and grazing by cattle than the uplands because of the concentration of cattle along the Little Missouri River during the hot summer months. Some locations were lightly affected, while others experienced heavy damage. At times the damage would be noticeably more severe on the Federal lands than on the adjacent private lands ***(Figures 17 and 18)***.

It is not certain whether grazing by ungulates adversely or favorably impacts smooth goosefoot. Over the course of one season, a misplaced hoof could uproot an entire population, the populations being as small as they are. On the other hand, the movement of cattle may serve to disperse the seeds and till the soil. Over the long term, the impact might be varied as well. Cattle appear to avoid the plant. Indications are that old bison trails may make suitable habitat for smooth goosefoot (Heidel 1990). And it appears that grazing and movement of cattle at appropriate times can maintain sand dune blowouts, a preferred habitat for smooth goosefoot in Alberta. But some populations in Alberta are declining under heavy summer use by cattle (Smith and Bradley 1992).

Beaver dams
About 15 beaver dams were observed along the survey route. These have the potential to inundate habitat and populations of smooth goosefoot for years ***(Figure 19)***.

Noxious weeds
Leafy spurge, or *Euphorbia esula*, was not present in any large numbers. But an outbreak was observed along the banks and terraces on both sides of the Little Missouri River between the two Van Daele Ranches (T137N, R103W, S33 to T136N, R103W, S4). ***(Figure 20)*** This weed has the potential to displace not only smooth goosefoot but most other species as well.

Recreational vehicles

While surveying just north of the R. Williams ranch (T134N, R105W, S30) a group of about six men on all terrain vehicles and dirt bikes rode by, heading to the north. They crisscrossed the riverbed, sandbars, banks, and terraces along the way, exiting around 3V Ranch. Surveys later in the week revealed that the tracks began as far south as Marmarth ***(Figure 21)***.

This sort of activity has the potential to disturb both habitat and populations of smooth goosefoot. In addition, these particular enthusiasts left a trail of beer cans and other debris in their wake, which the surveyors attempted to gather up and disposed of properly.

Natural erosional processes
Both erosion and deposition can change an active sandy area to an inactive stable area or vice versa. If these forces are altered by human activity, as in reduced stream flow due to stock dam construction, irrigation, or increased runoff over croplands or urbanized lands, then, at least in theory, it would be possible to halt any negative impacts these forces may have upon the populations or habitat of smooth goosefoot

Examples of deposition are seen in ***Figures 22 and 23***. Stabilization of a former sandbar with colonization by *Populus deltoides* and *Salix exigua* is seen in ***Figure 24***.

6) Day by day log: A synopsis of the daily log is presented below.

Table 1: ***Daily Log of Activites***

Date	Activity	Details	Persons working	Person-miles hiked on all frontage	Person-miles hiked on USFS frontage	Person-hours
7/28	Drive	Drive from WI to ND. Leave 1500. Stopped in Fargo, ND.				
7/29	Drive	Arrive in Bismarck @1330, got GPS at Frontier Precision, met with Darla and Phil @USFS SO				
7/30	Drive/ Survey	Met with Joe W. @ Dickinson RD. Started fieldwork N of Marmarth. S13, S8.	2	4.5	1.5	16
7/31	Tools/ Office	Travel to Rapid City to get kayaks. River too high to cross. Kayaks cost $945.48. Do paperwork, maps.	1			8 office
8/1	Repair/ Office	Pickup overheating, bring it to repair shop in Bowman to fix thermostat. Do paperwork, maps.	1			5 office
8/2	Survey	Kayak from S13 to S25, Williams Ranch.	2	16	6	22
8/3	Survey	Water level drops. Walk from S30, Williams Ranch, to S19, Bradek Ranch, and S8 S of Clark Ranch.	2	8	5	22
8/4	Survey	Walk from Brown Ranch upstream to Clark Ranch. S28, 29, 32,33	2	13.5	8.5	16
8/5	Office	Equipment repair, data entry, plant ID, office work, paperwork at motel.	1			8 office
8/6	Survey	Walk Brown Ranch N to S10.	2	16.5	6	22
8/7	Find Access	Drove roads near Marmarth looking for access to several parcels. Spoke to permittee on N side of town.	1			8 access
8/8	Survey	Walked S30 N of Marmarth, S20 NE of Marmarth, drove to Boyce Creek. Spoke to Darrel Strom about access.	1	2	1	12
8/9	Day off	Some paperwork, plant ID, resting up.				
8/10	Survey	Stopped at 3V to ask for access but no results. Walked S of Johnson Ranch, S15, 16, 17, 20. Rancher left note on car.	2	11	8	24
8/11	Survey	Walked near Van Daele Ranch, S31 to S6. Very hot day.	2	8	2	14
8/12	Survey	Walk to E and W of Logging Camp Ranch. Got as far N as Hande Ranch, S31.	2	23.5	12	26
8/13	Survey	Walk SW of 3V Ranch. Got permission from George. S1, 2, 11, 12.	2	13	6	24
8/14	Survey	Walk to S4 by Van Daele Ranch, S1 W of Logging Camp Ranch, got permission from Haefele's.	1	3	1	10
8/15	Office	Officework: Download GPS, Plant ID, mapping, report writing, field notes.	1			8 office
8/16	Drive	Leave for WI				
TOTALS			**25 persons**	**119 miles**	**57 miles**	**29 office 8 access 208 field**

7) Hours of Labor Required: The total hours spent in this survey, from its inception to the completion of the written report were 315 hours. Of this total, 245 person-hours were spent during the period of July 28 to August 16 when the field surveys were taking place. Of this total, ***208 person-hours, or an equivalent of 26 working days, were spent performing field surveys***, 29 person hours were spent in office work during the

field surveys, and 8 person hours were spent looking for access routes to the survey site. An additional 20 hours were required during the weeks leading up to July 28 for pre-field work such as arranging for motels, reading plant keys, making maps, sending for maps, consulting with USFS personnel. About 50 hours were spent in the weeks following August 16 writing up the report for this survey.

A few other time expenditures: Although the distance from the home office to the survey site is too variable for consideration in future surveys, the effort required for this trip are noted. Two vehicles were taken requiring two drivers. The round trip drive between the home-office in Woodruff, WI to Bowman, ND was approximately 30 hours. There was a trip to Rapid City, SD to purchase two kayaks. The unexpectedly high water on the river during the early days of the field survey made this 10 hour trip necessary.

Since it took 208 hours to survey 119 miles of riverfront, then each mile took an average of 1.75 hours to survey. But only 57 of those miles were National Grasslands riverfront and the focus of this survey. Thus, this survey required ***3.65 hours to survey each mile*** of National Grasslands riverfront.

Table 2: ***ND NHP Smooth Goosefoot Population Data for Slope and Billings Counties.***

#	COORDINATES	SITE NUMBER	DATE	QUAD	T/R/S	¼	COUNTY
1		PDCHE091G0*001*ND	7/5/46				Slope
2		PDCHE091G0*002*ND	6/27/89				Billings
3		PDCHE091G0*003*ND	6/29/89				Billings
4		PDCHE091G0*004*ND	7/11/89				Billings
5		PDCHE091G0*005*ND	9/28/89				Billings
6		PDCHE091G0*006*ND	7/5/90				Billings
7		PDCHE091G0*007*ND	7/5/90				Billings
8		PDCHE091G0*008*ND	7/31/91				Slope
9		PDCHE091G0*009*ND	8/3/91				Slope
10		PDCHE091G0*010*ND	8/22/91				Slope

#	COMMENTS/HABITAT
1	No comments. / Sand bar of river
2	It's a poor competitor and there is a spurge invasion. / Sandy channel and sandbar w/ young sapling cottonwoods. Lt density understory veg, mostly annuals but w/ perennial grasses encroaching.
3	Small scattered population. / Fine sand terrace, 2-3 m abover water level w/out dominance of perennial grasses.
4	Sparse, unhealthy population. / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.
5	Excellent habitat, only one plant found. / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.
6	No comments. / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.
7	High threats, low viability. / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.
8	Small population, apparently limited suitable habitat. / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.
9	No comments / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.
10	Small population size. / Old sandy floodplain terrace. Loose sandy soils in open area of old trail seldom used now.

#	POPULATION DATA
1	No data.
2	About 160 plants. Assoc species: Salix exigua, Psoralea lanceolata, Melilotus sp, Descurainia sp, Helianthus petiolaris, Bromus tectorum, B. japonicus, Ambrosia psilostachya, Conyza canadensis, Chenopodium leptophyllum.
3	Low numbers of scattered plants occupying tiny open areas of loosely sparsely vegetated sand. Plants nearby include: Populus deltoides, Salix amgdaloides, Oryzopsis hymenoides, Calomovilfa longifolia, Thlasp arvense, Conyza canadensis, Bromis inermis.
4	21 plants. Assoc species: Kocia scoparia, Helianthus petiolaris, Lepidium densiflorum, Melilotus sp. Good seed production. It's small open area along the trail is surrounded by Calomovilfa, Sporobolus, Oryzopsis, Psoralea lanceolata, sand-stabilizing plants.
5	1 plant found. Assoc species: Chenopodium leptophyllum, Salsola kali, Calamovilfa longifolia.
6	Over 10 plants, scattered among Populus deltoides, Melilotus spp, Artimesia ludoviciana, Conyza canadensis, Glycyrrhiza lepodota, Thlaspi arvense. Located within 1m of cutbank edge on level terrace.
7	7 plants in cottonwood stand and 2 remote plants on bare sand and scoria-sand shore. 1st: Populus deltoides, Psoralea esculenta, Ambrosia biennis, Euphorbia esula, Collomia linearis, Chenopodium leptophyllum. 2nd: Cleome, Hordeum, Salix petiolaris.
8	8 plants scattered in small sand opening. Surrounding vegetation dominated by Calamovilfa isngofolia. Assoc. species: Oryzopsis hymenoides, Psoralea lanceolata, Melilotus alba, Thlasp arvense, Agropyron cristatum, Salsola kaki, Chenopodium berlandjeri, Ambrosia trifida, Euphorbia spithulata. Vigorous plants in late fruiting stage.
9	2 plants in sandy openings. Assoc species: Oryzopsis hymenoides, Calamovilfa longifolia, Elymus canadensis, Populus deltoides saplings.
10	Sandy openings. 1 plant (F91DUE69) "The sides of the river had a lot of silt deposition. The river had been unusually high this year the the pop.could very well be wiped out." (F93GUE16) Dominant species: Spo cry. Other species: Ory hym, Ero ann, Art lud, Pso lan, Mel alb.(F91DUE69).

SUMMARY AND RECOMMENDATIONS

Summary: Revisiting the four historic smooth goosefoot populations that existed within this project area failed to relocate the plants. This failure might be the result of extreme flooding in the 1990's, recent flooding which inundated and covered many bars with mud, the fleeting nature of annuals, lack of seed sources, conversion of active sandy areas to stable vegetated areas, obscurity beneath *Calamovilfa longifolia*, *Spartina pectinata, Populus deltoides, Salix exigua*, and *Glycyrrhiza lepidota*, or destruction of populations and habitat by cattle grazing and trampling.

While the four historic populations were not relocated, the discovery of a very large and robust population within a large active sandy area bodes well for the species along this corridor of the Little Missouri River. This population, being situated at the base of a continuously eroding sandstone cliff and well above only the most extreme of flood events, is in position to provide a steady source of seeds that could establish sites downstream. The population found at Site 2 is encouraging in that it exists a short trip downstream from a historic site, suggesting that the historic site did not disappear completely, but was migrating downstream.

As with the failure to relocate historic populations, the failure to locate any smooth goosefoot on promising habitats may be due extreme flooding in the 1990's, recent flooding which inundated and covered many bars with mud, the fleeting nature of annuals, lack of seed sources, conversion of active sandy areas to stable vegetated areas, obscurity beneath *Calamovilfa longifolia, Spartina pectinata, Populus deltoides, Salix exigua,* and *Glycyrrhiza lepidota,* or destruction of populations and habitat by cattle grazing and trampling.

This survey gave further indications of the preferred habitat of smooth goosefoot. The presence of open, active, sandy areas with finer sands and sparse vegetation is well established. In this locale, it appears that outcrops of Bullion Creek sandstones would be more likely to harbor the species. Along the sandstone cliff it inhabited the same niche as *Psoralea lanceolata*, suggesting that this species may be a fair indicator of the presence of smooth goosefoot. All of these features of the preferred habitat add to the model needed to predict the likelihood of smooth goosefoot.

Recommendations: The most urgent need for maintaining populations and habitat of smooth goosefoot is the control or elimination of noxious weeds. The most threatening noxious weed in this survey area is without a doubt *Euphorbia esula*, the dreaded Leafy spurge. The traditional approaches of mechanical and chemical treatment are welcome, but additional steps may be taken. Biological control using natural or introduced competition, as with the *Aphthona*flea, is recommended. A combination of methods appears to be the most effective way in reducing leafy spurge. The North Dakota Extension Service observed that a treatment with "the herbicide Tordon (picloram) plus 2,4-D from early September to mid October on leafy spurge with an established flea beetle population provided increased control compared to using either flea beetles or herbicides alone…grazing by sheep or goats after mid August can increase leafy spurge control with *Aphthona*flea beetles." (Lym and others 1999). Cultural controls such as quarantine, closure, certified weed-free fodder, alteration in grazing patterns, wildlife manipulation, and ecosystem restoration are advised.

The second threat is severe trampling and overgrazing by cattle. Regardless of the impact of this upon smooth goosefoot populations, overgrazing and severe trampling is a transcendent danger, posing risks to many other species and the integrity of the entire ecosystem. These effects could be reduced through altered grazing patterns or stocking levels.

The third threat is beaver. The impact of beaver is undetermined. Historic levels of beaver in the mixed prairie were much higher, as were the levels of most of the native prairie fauna, but under the agrarian system that now prevails, their impact may be magnified. Maintenance of predator levels would affect beaver populations as well as fur and bounty values.

The fourth threat is recreational vehicle traffic. The remoteness of the location made it difficult to observe any infractions of Forest Service rules concerning recreational vehicles. This may be mitigated by the relative rarity of such traffic. In the two weeks of fieldwork along the river bottom, there was only one observed incident of motorized recreation.

The fifth threat is the natural process of erosion and deposition. As is the lesson of history, any attempt to alter this natural process with the aim of protecting smooth goosefoot would probably create more problems than it solves. It is advised only that a semblance of the original hydrology of the Little Missouri River be maintained, primarily through the alteration of the cultural factors that affect the natural processes. These

would be matters such as proliferation of stock dams, expanded irrigation, expanded dryland farming, dikes, levees, urbanization, sodbusting, and overgrazing.

The two populations identified in this survey should be revisited on an annual basis to monitor the variations in population quality and quantity and to link these variations, if any, in relation to climate, fire, river flows, and anthropogenic factors such as cattle grazing and dryland farming. This would aid in predictive modeling.

The prime potential sites observed during this survey should be revisited. The best sites appear to be outcrops of Bullion Butte sandstones and the river bottom immediately downstream from these outcrops. Four of the Bullion Butte sandstone outcrops observed along the Little Missouri River (Sites A, C, D, and E) did not present smooth goosefoot. These would be well worth revisiting. There were innumerable sandbars and frequent sandy terraces along the survey route that appeared to be prime habitat for smooth goosefoot, but for unknown reasons did not harbor the plant. All of these active sandy locations might support populations of this mobile species in the future and would likewise be worth revisiting.

Proactive surveys on potential sites should be conducted throughout the public land base for all rare species. Stretches of the Little Missouri River not surveyed in this project, particularly the length from the Slope/Billings county line to Medora, ND, should be surveyed for smooth goosefoot.

This sort of survey work gives valuable information. To locate and monitor these species is to get a notion of the health of the entire ecosystem, and in turn, the environment that sustains us.

SELECTED REFERENCES

Alt, David and Donald W. Hyndman. 1986. *Roadside Geology of Montana.* Mountain Press Publishing Company, Missoula, MT.

Biek, Robert F. and Mark A. Gonzalez. 2001. *The Geology of Theodore Roosevelt National Park*. North Dakota Geological Survey, Bismarck, ND.

Dueholm, Keith H. 1993. *Bullion Butte Rare Plant Survey, Little Missouri National Grasslands.* Natural Heritage Inventory, North Dakota Parks and Recreation Department, Bismarck, ND.

Gleason, Henry A. and Arthur Cronquist. 1991. *Manual of Vascular Plants of Northeastern United States and Canada*. The New York Botanical Garden, Bronx, NY.

Guenther, Debbi. 1993. *Little Missouri National Grasslands Rare Plant Surveys.* Natural Heritage Inventory, North Dakota Parks and Recreation Department, Bismarck, ND.

Heidel, Bonnie. 1990. *Inventory of Rare Plant Species in Theodore Roosevelt National Park.* Natural Heritage Inventory, North Dakota Parks and Recreation Department, Bismarck, ND.

Hitchcock, C. Leo and Arthur Cronquist. 1973. *Flora of the Pacific Northwest*. University of Washington Press, Seattle, WA.

Holmgren, Noel H. 1998. *Illustrated Companion to Gleason and Cronquist's Manual.* The New York Botanical Garden, Bronx, NY.

Johnson, James R. and Gary E. Larson. 1999. *Grassland Plants of South Dakota and the Northern Great Plains.* South Dakota State University College of Agriculture and Biological Sciences, Brookings, SD.

Larson, Gary E. and James R. Johnson. 1999. *Plants of the Black Hills and Bear Lodge Mountains*. South Dakota State University College of Agriculture and Biological Sciences, Brookings, SD.

Lym, Rodney G., Denise L. Olson, and Donald A. Mundal. 1999. *Leafy Spurge Control Using Flea Beetles*. North Dakota State University Extension Service, Fargo, ND.

McGregor, Ronald L. II and T. M. Barkley. 1986. *Flora of the Great Plains*. University of Kansas Press, Lawrence, KS.

Robson, Diana B. 1997. *Smooth Goosefoot Discovered in the Webb Sandhills*. Blue Jay 55(2):106-107.

Smith, Bonnie and Cheryl Bradley. 1990. *Status Report on the Smooth Goosefoot, Chenopodium subglabrum, in Canada.* Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, Canada.

Free, Jim and Barbra Mullin. 2000. *Guidelines for Coordinated Management of Noxious Weeds: Development of Weed Management Areas.* US Government Printing Office, Denver, CO

Van Bruggen, Theodore. 1976. *The Vascular Plants of South Dakota.* Iowa State University Press, Ames, IA.

Voss, Edward G. 1979. *Michigan Flora.* 3 vols. Cranbrook Institute of Science, Bloomfield Hills, MI.