1993

Distribution And Occurrence of Eriogonum Visheri A. Nels. On The Medora And McKenzie Districts, Little Missouri National Grasslands, In North Dakota

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DISTRIBUTION AND OCCURRENCE OF **ERIOGONUM VISHERI** A. NELS. ON THE MEDORA AND McKENZIE DISTRICTS, LITTLE MISSOURI NATIONAL GRASSLANDS, IN NORTH DAKOTA

Report to the
North Dakota Natural Heritage Program
Bismarck, ND

Institute for Ecological Studies
University of North Dakota
Research Report #44
10 December 1993

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INTRODUCTION

Eriogonum visheri A. Nels. (Polygonaceae) is a plant species whose distribution in North Dakota is incompletely known. The plant species is listed by North Dakota Heritage Program personnel as a G5/S2S3 [G5 = demonstrably secure globally, although it may be rare; S2 = imperiled in the state (6-20 occurrences) or vulnerable to extirpation; S3 = rare in the state (20+ occurrences)]. The species is Federally listed as C2 [current information indicates that listing as endangered or threatened may be warranted, but information about the species is presently inadequate to support immediate ruling] (Northern region, USDA Forest Service, 1991). The limited amount of information about the occurrence of the species, and the biology of the species prevents an assessment of status of the species as threatened or endangered. The project described in this report was designed as a preliminary survey to determine distribution of E. visheri on the Little Missouri National Grasslands in western North Dakota.

Available information about the habitat and known occurrences of E. visheri indicated that the Medora and McKenzie districts of the Little Missouri National Grasslands, USDA Forest Service, Northern Region (subsequently referred to by district, or LMNG in this report) had abundant habitat suitable for occurrence of the species. Consequently, funds administered by the North Dakota Natural Heritage Program were designated to support surveys for the species, and other species of concern to the LMNG and the ND Natural Heritage programs, on the Medora and McKenzie districts during the growing season in 1993. The field work was coordinated and staffed through the Institute for Ecological Studies at the University of North Dakota. The project was designed to conduct a target plant survey for E. visheri on the Medora and McKenzie districts and included the following elements: location of populations, and collection of population and habitat data for each population. Other species of concern to the state or to the LMNG were to be similarly assessed if discovered during the course of this investigation.

METHODS

Successful completion of the project was dependent upon exhaustive field work, and available funds and resources were focused on field work. The annual habit, short stature, coloration, and sparse organization of leaves and floral structures of E. visheri make it difficult to see from any distance (see Fig. 1, taken from Ode, 1987). The color of the plant blends with the red-brown gravel scattered on the surface of the clay outwash pans characteristic of the habitat in western North Dakota and makes individuals and colonies of the plants inconspicuous. As a result it is necessary to physically inspect the small, clay buttes or badlands formations and clay outwash pans around those features to determine whether E. visheri is present.

Five populations of E. visheri had been located on the McKenzie district in 1992 and 1993 by R. Clark, a seasonal biologist with the USFS. Surveys of these known sites and the surrounding grassland at the beginning of this project indicated it was possible that E. visheri was limited to the very conspicuous small-scale badlands formations, or eroding clay buttes, characteristic of the LMNG. However, close inspection of each butte and the surrounding erosion zone was necessary in order to determine if E. visheri occurred at that site.

Therefore, the survey method used was to identify potential sites - small-scale eroding clay buttes, with an extensive and low-relief clay outwash plain at the base - from a distance or on aerial photographs, and then visit each site located. Once a population had been located, the surrounding area was surveyed intensively for additional populations. This method was time-consuming and exhaustive, but resulted in the location of 21 populations of E. visheri during this survey. Overall distribution of populations is mapped in Fig. 2.

The survey was initiated in the area where populations had been located earlier by USFS personnel - the Horse Creek School drainage area (Appendix B, LMNG map, McKenzie District). Institute personnel located an additional 11 populations of E. visheri in the Horse Creek School drainage during a period of 8 field days. As one of the concerns of the LMNG personnel was the distribution across the LMNG, Institute personnel consulted with the Forest Service botanist and Natural Heritage Program director and decided to extend the search to other areas of the LMNG. The Horse Creek School area undoubtedly contains additional populations of E. visheri.

Institute personnel then initiated a survey of the McKenzie district and the Medora district to identify other areas with concentrations of E. visheri. As shown on the attached map (Appendix B, McKenzie and Medora districts) other concentrations were located in the Trotters SE quad in the McKenzie district, and in the Rocky Ridge South and Wannagan Creek West quads of the Medora district. Institute personnel were unable to survey all of the LMNG due to limited time and funds available.

Each population of E. visheri was evaluated following Natural Heritage Methodology, with the "Rare Plant Survey" form, the Base Map Grid form, and

the associated elements form being completed at each site. These forms are included in a separate packet. The extent and distribution of the population with respect to site micro-features, number of individuals, and habitat characteristics was evaluated at each site. Associated plant species were identified and/or collected at each site to include those immediately associated with the E. visheri. No attempts were made to identify elements of the adjacent grassland communities where E. visheri did not occur. Technical identification of associated species was completed by S. Vanderpool, at the University of North Dakota. Lists of associated species were subsequently corrected by S. Vanderpool based on those identifications (Table 1, Appendix A, and included with originals of field forms). Sources used included Vascular Plants of Wyoming (1992), Flora of the Great Plains (Great Plains Flora Association, 1986) and Handbook of North Dakota Plants (Stevens, 1963).

Although not a part of the survey project, materials were also collected at each site to begin biological evaluation of the species. These materials included seed, seed soil bank information, and herbarium specimens. Results of the biological assessment of the species will be made available when the studies are completed. Interim requests for information will be honored as information becomes available. Photographic slides were taken at Sites 1, 2, 19, and 20 to show both habit and habitat. Those slides are labeled and included in a separate packet with this report.

A comprehensive evaluation of the status of E. visheri in North Dakota or on the LMNG is not warranted based on the preliminary nature of the 1993 survey conducted by Institute personnel. However, tentative hypotheses and recommendations are included in the Discussion portion of this report.

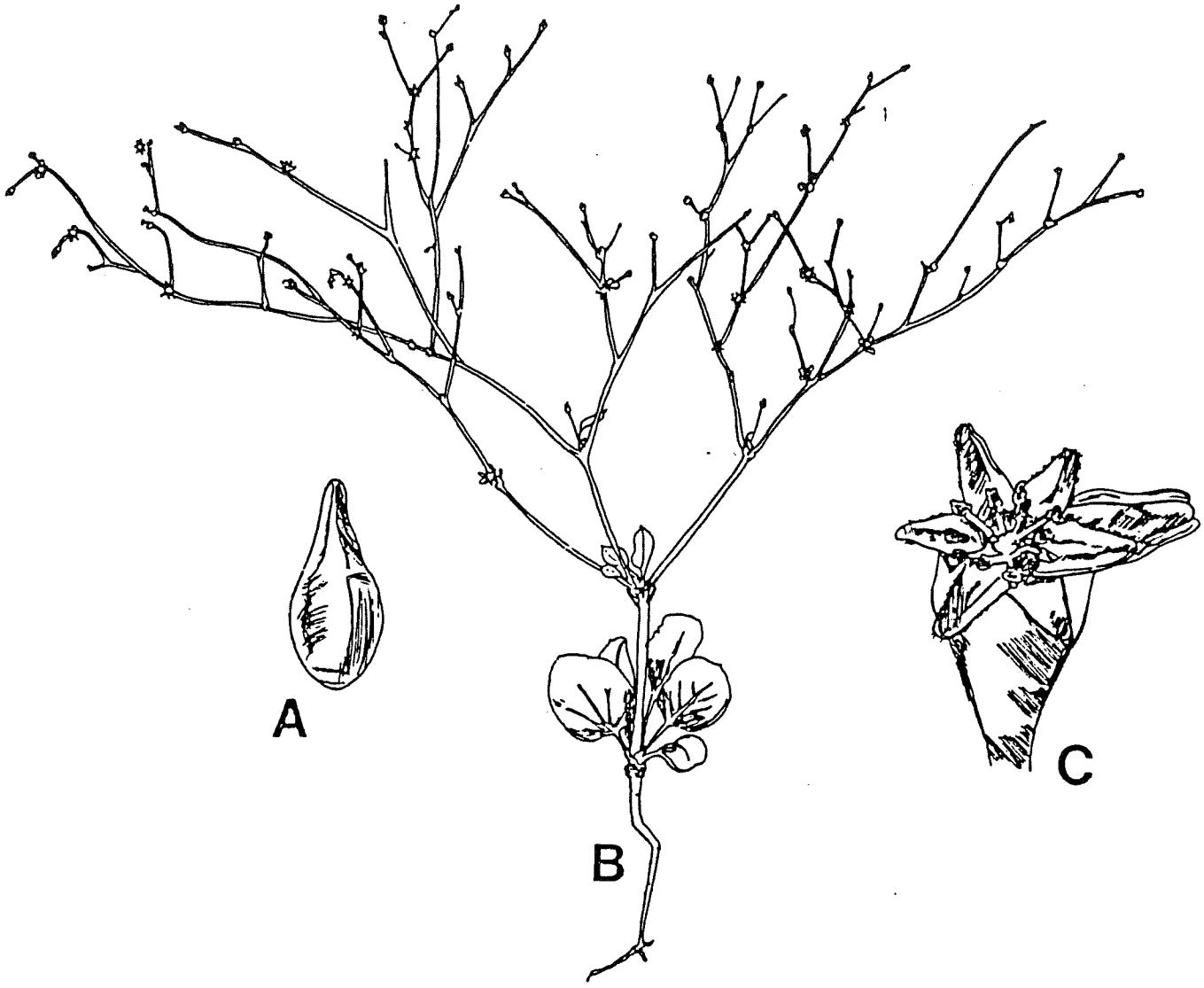

Figure 1. Sketch of Dakota Buckwheat, A-seed (X15), B-mature plant (near life size), C-involucre with flowers (X10).

Figure 1. From Ode, 1987.

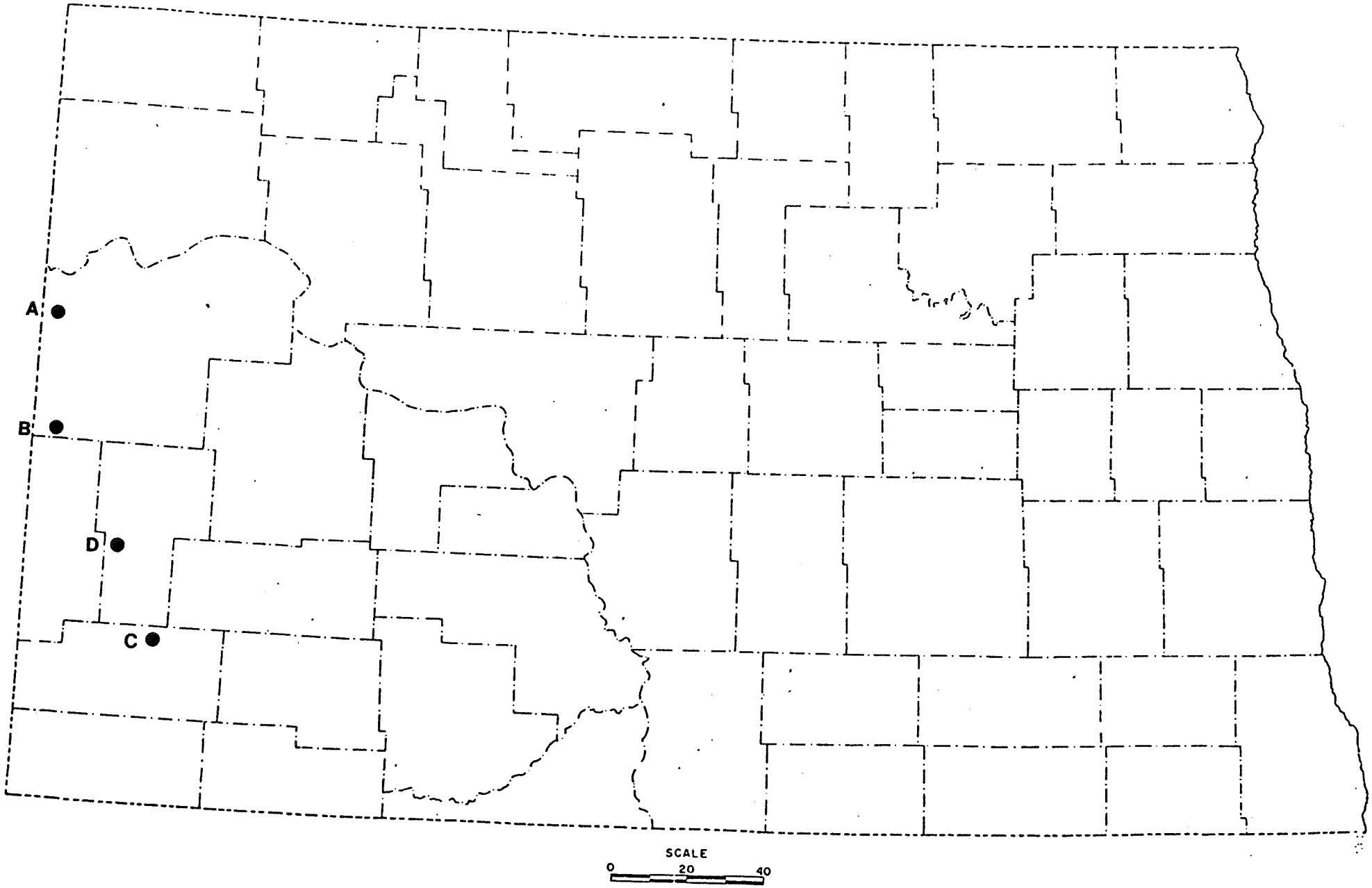

Figure 2. General areas where populations of Eriogonum visheri were located in the 1993 survey for the species. Area A corresponds to Sites 1-13; Area B corresponds to Sites 12-18; Area C to Sites 19-20; and Area D to Site 21. Areas A, B, and D are west of the Little Missouri River.

RESULTS

During the survey period 5 August through 1 October, 1993, a total of 320 person-hours were expended in the survey of U.S. Forest Service holdings in the McKenzie and Medora districts of the LMNG in western North Dakota. Twenty-one populations of Eriogonum visheri A. Nels. were located and described using Natural Heritage methods. At each of the sites the Natural Heritage 'Rare Plant Survey' form was completed. Those forms are included with this report. Each site report is summarized in the following section. Each site is referred to by the source code and assigned a sequential site number. The summary includes the following information, in sequence: **source code, county, quad name, location, directions, habitat description, and estimate of number of individuals in population; person(s) completing the survey, and date of the survey.** Associated species characteristic of the sites are summarized in Table 1 and detailed in Appendix A. An overview of areas where populations of E. visheri were located is given in Fig. 2. A detailed map of areas surveyed and sites of populations located is included in Appendix B. Annotated quadrangle maps of specific survey areas have been included in a separate file. No other species of concern at the Federal or state level were located during this survey. Individuals completing field work on this project included Staria Scott Vanderpool, Kari Frost Rogers, Dionn Arva Schaaf, and Mary K. Engelhard.

Voucher specimens collected are currently being examined and processed at the Institute for Ecological Studies at the University of North Dakota. The first specimen of each collection will be deposited at the North Dakota State Herbarium at North Dakota State University in Fargo, ND. Additional specimens will be deposited at Rocky Mountain Herbarium, and the University of North Dakota Facey Herbarium in Grand Forks. Photographic slides taken during this project are included in a separate envelope. An index to slides submitted is included in Appendix C.

Additional materials collected during this survey are being analyzed to provide preliminary population and reproductive biology data about the species. The data include age structure of populations, and germination and establishment requirements of the species. This information will be made available when completed.

Summary Description of Populations Located

F93SSV1X - Site 1

McKenzie Co., Horse Creek School quad, T149N R104W SENE Sec. 26. 0.9 miles N of ND Hwy 68 on Forest Road 845. Site is located at base of badlands formation along western side of valley. Additional sites in general area include Clark 1 & 2 to north approximately 500 yds. Clay outwash community at base of moderate - low relief badlands feature, relatively smooth, east-facing exposure, soil a dense compact fine-grained clay, with surface scattering of gravel. Individuals were most numerous adjacent to microdrainages across the outwash pan. Scattered clumps of individuals were also found along crest of the butte.

Vegetative cover 25%, E. visheri 5%. An estimated 1400 individuals occurred in the population. Vanderpool/Engelhard, 5 August 1993.

F93SSV2X - Site 2

McKenzie Co., Horse Creek School quad, T149N, R104W, NE NE Sec 26. 0.9 miles N of ND Hwy 68 on Forest Rd. 845. NE of scoria road along base of small clay buttes. Clay outwash community at base of badlands formation; aspect 132 SE, slope 2-5%, substrate clay with clay and gravel on surface. Basal cover 10-15%, basal cover of E. visheri 1%. Approximately 1800 individuals occurred in the population. Plants senescent although no sub-freezing temperatures had occurred. Rogers/Schaaf/Vanderpool, 7 September 1993.

F93SSV3X - Site 3

McKenzie Co., Horse Creek School quad, T149N, R104W, NW NW Sec 25. 0.9 miles N of ND Hwy 68 on Forest Rd. 845. Site is NE of scoria road along base of small clay buttes. Clay outwash community with clay/gravel substrate at base of badlands formation, aspect 140 SE, relief smooth. Population sandwiched between clay butte slope and grassland. Pipeline immediately downslope of population. Site naturally erosive. Approximately 42,000 individuals in population. Rogers/Schaaf, 7 September 1993.

F93SSV4X - Site 4

McKenzie Co., Horse Creek School quad, T149N,R104W, SE SE Sec 26. 0.9 miles N of ND Hwy 68 and FDR 845 junction to the pipeline crossing, follow ridgeline from that point to the NE ca. 3/4 of a mile. Along base of ridge in outwash area above riparian area. Clay outwash community, 5-7% slope from toe of butte base to grassland. Basal coverage 20-25%, basal coverage of E. visheri 1-3%. Approximately 130,000 individuals in population. Rogers/Schaaf, 7 September 1993.

F93SSV5X - Site 5

McKenzie Co., Horse Creek School quad, T149N, R104W, SW SW Sec 13. Approximately 1 mile on FDR 845 from junction with ND Hwy 68, then follow trail along ridgetop approximately 1 mile to the end and walk N. Clay outwash community on gentle slope below knob, aspect 280 W, clay substrate with clay/gravel surface. Population bounded by established grasslands and grass patches in clay outwash. Basal coverage of site 25%, with E. visheri coverage 1%. Approximately 27,000 individuals in community. Rogers/Schaaf , 8 September 1993.

F93SSV6X - Site 6

McKenzie Co., Horse Creek School quad, T149N, R104W, NE NW Sec. 24. 1 mile N of jct. ND Hwy 68 and FDR 845, on 845, then turn NE on a 2-track road along ridgetop for ca. 1 mile. Clay outwash community at base of clay butte; aspect 114 ESE, slope 1% - 10%. Basal coverage 10-20% for all vegetation, E. visheri = 1%. Approximately 24,000 individuals in population. Rogers/Schaaf, 8 September 1993.

F93SSV7X - Site 7

McKenzie Co., Horse Creek School quad, T149N,R104W, NE NE Sec 36 and T149N,R103W NW NW Sec 31.

1 mile W of Jct. ND Hwy 68 and County Rd #3 on #3, then walk N approximately 1/3 mile along point of long narrow ridge. Clay outwash community with clay substrate and clay/gravel surface. Aspect 352 N, slope is 0-5%. Population bounded by clay slopes and grassland. Approximately 24,000 individuals in population. Basal coverage in area ca. 10-20%, basal coverage of E. visheri ca. 0.5-1.0%. Rogers/Schaaf, 9 September 1993.

F93SSV8X - Site 8

McKenzie Co., Horse Creek School quad, T149N, R103W, SE NW Sec 31. Park along ND Hwy 86 approximately 0.5 miles W of county road #3, then walk north. Clay outwash community below a badlands formation. Aspect 22 N, relief smooth, clay substrate with clay/gravel surface. Approximately 220 individuals in population. Rogers/Schaaf, 9 September 1993.

F93SSV9X - Site 9

McKenzie Co., Horse Creek School quad, T149N,R104W SE NE Sec 36. Travel 1.25 miles W on Hwy 68 from jct Hwy 68 and County Rd. #3. Walk due north over small ridge. Site is at base of ridge and parallel to wooded draw. Clay outwash community with clay substrate and clay/gravel surface, aspect 345 N. Basal cover of all plants is approximately 10%, E. visheri less than 1%. E. visheri sandwiched between toe of clay butte and grassland vegetation. Approximately 4000 individuals in population. Rogers/Schaaf, 9 September 1993.

F93SSV10 - Site 10

McKenzie Co., Horse Creek School quad, T149N, R104W, SE SE Sec 26. Junction of ND Hwy 68 and FDR 845, adjacent to junction in ditch, and to left of FDR 845 and ca. 100 yds. around extensive badlands formation. Clay outwash community at base of small clay buttes. Aspect 168 S, clay substrate with clay/gravel surface. Site highly disturbed, powerline, fenceline, and pipeline construction impacting immediate area. Basal coverage of entire clay outwash area ca. 10-20%, basal coverage of E. visheri ca. 1%. Approximately 30,000 individuals in area. Population vigorous, and skeletons of plants from previous year indicate that the site has produced E. visheri for at least two years. Vanderpool/Rogers/Schaaf, 10 September 1993.

F93SSV11 - Site 11

McKenzie Co., Horse Creek School quad, T149N, R104W, NE SW Sec 26. North 1/8 - 1/4 mile on FDR 845 from jct. ND Hwy 68 and FDR 845; from there walk due west across 2 small draws to top of knob overlooking Hwy 68. Bentonite plateau at the end of a low ridge with standard outwash community, second part of site is typical (see F93SSV1-11) clay outwash plain. Approximately 103,000 individuals on entire site. Rogers/Schaaf, 10 September 1993.

F93KFR1X - Site 12

McKenzie Co., Trotters SE quad, T145N,R103W,NW 1/4 Sec 30.

From the junction of Hwy 68 and Hwy 16 travel south on Hwy 16 for 28.8 mi to FDR 813. Drive east on 813 and travel ca. 3 miles to jct with FDR 867. Turn south on 867 and travel ca. 1.5 miles to jct with FDR 801. Sites A-I are located in triangle between jct. FDR 876 and FDR 801. Clay outwash community with a clay/gravel surface. E. visheri at base of low relief hills with exposed clay sides. Numerous sub-populations in area, described independently as A - I. Approximate number of individuals 31,000. Rogers, 27 September 1993.

F93KFR2X - Site 13

McKenzie Co., Trotters SE quad, T145N, R103W, SW1/4 Sec 30.
From the jct of Hwy 68 and 16, travel S on Hwy 16 for ca. 28.8 miles to FDR 813. Turn east on 813 and travel ca. 3.5 miles to junction with FDR 876 and travel ca. 1.5 miles to jct. with FDR 801. Clay outwash community with clay substrate and a clay/gravel surface. One subsite is found on the downstream side of a stockpond dam on the draw. Approximately 1000 individuals in population. Rogers, 27 September 1993.

F93KFR3X - Site 14

McKenzie Co., Trotters SE, T145N,R104W SE SE 25 and R103 W, SW SW 30.
From the jct of Hwy 68 and Hwy 16, travel South on Hwy 16 for 28.8 miles to FDR 813. Turn east on 813 and travel ca. 3.5 miles to jct. with FDR 876. Turn S on 876 and travel ca. 1.5 miles to jct. with FDR 801. Clay outwash community with clay substrate and a clay/gravel surface. E. visheri found at the base of low relief hills having exposed clay sides, and extending up slopes to 5 feet above outwash plain. Approximately 6000 plants on the site. Rogers, 28 September 1993.

F93KFR4X - Site 15

McKenzie Co., Trotters SE quad, T145N, R103W, SE NW sec. 31. From the jct. Hwy 68 and 16, travel S on Hwy 16 for 28.8 miles to FDR 813. Turn left on 813 and travel ca. 3 miles to jct. with FDR 876. Turn right on 876 and travel ca. 1.5 miles to jct with FDR 801. From this point continue south on 867 and travel ca. 1.5 miles to jct with 2-track dirt road. Substrate is clay and with a clay/gravel surface. Subsite A is found at the upper end of a bentonite slump; subsite B is immediately adjacent to a wet area where willows are growing, and is in a clay outwash area. Approximately 4,000 individuals present at site. Rogers, 28 September 1993.

F93KFR5X - Site 16

McKenzie Co., Trotters SE quad, T145N,R104W SESE Sec. 36 and SW SW Sec 31.
From the jct. of Hwy 68 and 16, travel S on Hwy 16 ca. 28.8 miles to FDR 813. Turn east on 813 and travel ca. 3 miles to junction with FDR 876. Turn south on 876 and travel approximately 2.5 miles to where scoria road turns due east. At this point continue south on 2-track dirt road for ca. 0.7 miles. Natural clay outwash community; clay substrate with clay and gravel surface. Approximately 900 plants in population. Rogers, 28 September 1993.

F93KFR6X - Site 17

McKenzie Co., Trotters SE quad, T145N,R103W, NE SE Sec 30 and NW SW 29.
From the jct. of Hwy 68 and 16, travel south on Hwy 16 ca. 29 miles to FDR 813. Turn east on 813 and travel ca. 3 miles to jct with FDR 876. Turn south on 867 and travel ca. 1.6 miles to jct. with FDR 801 to the east. Travel ca. 0.5 miles east on 801. Substrate of clay and clay/gravel surface typical; outwash at base of low hills; along a small ridge or saddle of bentonite , bentonite slump All subsites bounded by established grassland vegetation. Extensive site, with numerous scattered sub-populations. Approximately 1100 individuals altogether. Rogers, 30 September 1993.

F93KFR7X - Site 18

McKenzie Co., Trotters SE quad, T145N,R103W, SW 1/4 Sec. 30 and SW Sw Sec. 29. From the jct. of Hwy 68 and 16, travel south on Hwy 16 ca. 29 miles to FDR 813. Turn left on 813 and travel ca. 3 miles to jct. with FDR 876. Turn right on 876 and travel ca. 1.6 miles to jct. with FDR 801 to the east. Travel ca. 0.5 miles east on 801. Disturbed areas of clay and gravel surface, usually in clay outwash at base of clay slope. Sites are xeric and very exposed. Extensive development of subpopulations along scoria road as described by subsites A-I. Approximately 20,000 individuals total. Rogers, 30 September 1993.

F93DAS1X - Site 19

Slope Co., Rocky Ridge South quad, T136N,R101W, SE NW Sec 23.
Drive 24 mi south of Belfield on Hwy 85, then 6.5 miles W on FDR 769, past corral. E. visheri on side of dam SE of road and adjacent to fence. Clay outwash community on flat to low relief clay outwash just below eroded hill. Clay substrate with clay/gravel surface. Population sandwiched between steep slopes and grassland vegetation. Basal coverage of all vegetation ca. 15%, basal coverage of E. visheri on clay outwash ca. 0.5%. Estimated number of individuals in population 9,000. Schaaf, 16 September 1993.

F93DAS2X - Site 20

Slope Co., Rocky Ridge South quad, T136N,R101W, NWSE Sec 9.
Population adjacent to road, and between road and old trail in an area ca. 75 feet wide. Clay outwash community at base of badlands formation, clay substrate with clay/gravel surface. Approximately 100,000 individuals in area. Schaaf, 16 September 1993.

F93DAS3X - Site 21

Billings Co., Wannagan Creek West quad, T141N,R102W,SW SW Sec 30.
1.3 miles down FDR 730 from jct with FDR 726, then 0.5 miles east of old corral. Clay outwash community in clay outwash below badlands formation. Clay substrate with clay/gravel surface. Basal cover of entire outwash area ca. 10%, Basal cover of E. visheri ca. 0-1%. Cowpath and numerous signs of cattle in subsite A, with fenceline adjacent. Area heavily impacted by cattle. Approximately 66,000 individuals in populations. Schaaf, 22 September 1993.

Table 1. Plant species associated with Eriogonum visheri A. Nels. Percentages indicate percentage of sites surveyed where species were found in immediate association with E. visheri, (n=21). Nomenclature follows that used in Flora of the Great Plains (Flora of the Great Plains Association, 1986). Occurrence of each species by site is noted in Appendix A.

Percent of Sites	Taxon
100	*Grindelia squarrosa* (Pursh) Dun.
95	*Agropyron smithii* Rydb.
95	*Gutierrezia sarothrae* (Pursh) Britt. & Rusby
90	*Ceratoides lanata* (Pursh) Howell
90	*Oenothera caespitosa* Nutt.
86	*Distichlis spicata* (L.) Greene var. stricta (Torr.) Beetle
81	*Atriplex nuttallii* S. Wats.
81	*Eriogonum pauciflorum* Pursh
67	*Melilotus officinalis* (L.) Pall
67	*Suaeda moquinii* (Torr.) Greene
62	*Bouteloua gracilis* (H.B.K.) Lag. ex. Griffiths
62	*Comandra umbellata* (L.) Nutt.
62	*Opuntia polyacantha* Haw.
62	*Puccinellia nuttalliana* (Schulte.) A. Hitchc.
57	*Machaeranthera canescens* (Pursh) A. Gray
52	*Hordeum jubatum* L.
48	*Artemisia frigida* Willd.
43	*Kochia scoparia* (L.) Schrad.
43	*Salsola iberica* Senn. & Pau
38	*Artemisia cana* Pursh
38	*Atriplex argentea* Nutt.
38	*Schedonnardus paniculatus* (Nutt.) Trel.
38	*Tragopogon dubius* Scop.
33	*Chrysothamnus nauseosus* (Pall.) Britt.
33	*Plantago elongata* Pursh
33	*Sphaeralcea coccinea* (Pursh) Rydb.
29	*Lappula cenchrusoides* A. Nels.
24	*Agropyron spicatum* (Pursh) Scribn. & Sm.
19	*Aster ericoides* L.
19	*Helianthus rigidus* (Cass.) Desf.
19	*Oryzopsis hymenoides* (R.& S.) Ricker
14	*Rudbeckia hirta* L.
10	*Artemisia longifolia* Nutt.
10	*Artemisia tridentata*
10	*Atriplex dioica* (Nutt.) Macbr.
10	*Artriplex subspicata* (Nutt.) Rydb.
10	*Chenopodium album* L.
10	*Danthonia spicata* (L.) Beauv. ex R. & S.
10	*Koeleria pyramidata* (Lam.) Beauv.
10	*Oxytropis sericea* Nutt.

Table 1. Continued from previous page

Percent of Sites	Taxon
10	*Stipa comata* Trin. & Rupr.
5	*Agropyron cristatum* (L.) Gaertn.
5	*Arctium minus* Bernh.
5	*Artemisia dracunculus* L.
5	*Bouteloua curtipendula* (Michx.) Torr.
5	*Calamovilfa longifolia* (Hook.) Scribn.
5	*Chenopodium berlandieri* Moq.
5	*Conringia orientalis* (L.) Dum.
5	*Dalea candida* Michx. ex Willd.
5	*Euphorbia serpyllifolia* Pers.
5	*Lactuca serriola* L.
5	*Linum rigidum* Pursh
5	*Penstemon* sp.
5	*Poa pratensis* L.
5	*Polygala alba* Nutt.
5	*Suckleya suckleyana* (Torr.) Rydb.

DISCUSSION AND CONCLUSIONS

Community type and habitat. In the Little Missouri National Grasslands in North Dakota Eriogonum visheri was found predominantly at the base of low relief badlands topography on barren, erosively active microsites identified as clay outwash sites. These sites are distinguished from the river badlands on the basis of extreme grade of the river badlands and the proportionally smaller outwash areas at the base of the badlands formations. Sites where populations of E. visheri were located occurred as breaks in the rolling upland grasslands or along interior valleys. No populations were located in river badlands in this investigation, or that of Heidel (1990) in her survey of rare plants in Theodore Roosevelt National Park.

Substrates characteristic of the badlands sites are not classified as soils since they represent the result of active geologic erosion and geologic conditions. One example of this is the Patent clay land type which generally lies at the base of buttes or other upland areas that are subject to active erosion. Approximately 30-85% of the surface is barren of vegetation, or sparsely vegetated. Vegetation frequently includes salt-tolerant species such as Distichlis spicata or Suaeda depressa or S. moquinii. Other common species are drought-tolerant species as Gutierrezia sarothrae or Opuntia polyacantha. Grass species such as Puccinellia nuttalliana, Bouteloua gracilis, and Agropyron smithii are invasive from the surrounding grassland (USDA, 1978; USDA, 1944; USDA, 1942).

The 21 populations of E. visheri located in this survey were similar with respect to topography, relief, substrate, percent basal coverage, and associated species, as reported in the site summary in Results, and in Table 1 (see also field survey forms for more detailed information). Three sites (Sites 10, 13, and 21) occurred in areas of recent human construction, and/or areas of high livestock activity. Population numbers and distribution at these sites did not appear to vary from those in similar sites with low, non-native disturbance. Weathered senescent remnants of the previous years population at Site 10 indicated that Site 10 supported populations of E. visheri in the previous growing season.

Overall, site microcharacteristics were similar for most populations surveyed. In general, populations of E. visheri occurred in a relatively narrow zone, sandwiched between the steep gradient of the butte face and the grassland vegetation typical of the mixed-grass prairie. The substrate of the microsite consisted of dense alkaline (or saline) clays with a surface scattering of 0.5-1.0 cm diameter gravel. The surface was typically dissected with micro-drainage channels to a depth no greater than 10 cm. At the outer edge of the outwash plain - along the interface with grassland - hummocks and clumps consisting of Bouteloua gracilis were common. Associated species on the site (see Table 1; Appendix 1) occurred as scattered individuals, or clumps of several individuals as in the case of Eriogonum pauciflorum. Within this microsite, E. visheri occurred as scattered individuals, or in dense clusters. Clusters of E. visheri frequently occurred in close association with the microdrainage ditches, and in association with dense concentrations of gravel. The distribution of E. visheri across the site suggested that seeds were dispersing along site drainage patterns. In some sites,

for example Site 1, 10, and 14, scattered individuals of E. visheri were also found at the top of the buttes and eroding formations, although in fewer numbers than below.

Population structure. The apparent age structure of the populations and distribution across the microsites suggests that the 1993 populations may have represented several successive waves of germination and establishment of individuals. Although the climate statistics are not yet available in summary form, the summer of 1993 in western North Dakota was characterized by unusually high precipitation and low average temperatures. This growing season may have resulted in the exposure and germination of successive groups of seed from the seedbank. The unusually benign summer conditions could then have enhanced the establishment and survival of late-germinating seeds. This comment is based on a single season of observations, but the available data indicate that the 1993 season was a season of hyper-abundance for many native plant species. The population structure and numbers of individuals observed may be atypical for the region.

Associated species. Each population of E. visheri was evaluated in order to determine associated plant species in the community. Care was taken to collect those species occurring within the bounds of E. visheri distribution across the site and not those species characteristic of the adjoining grassland. Individuals were clearly confined to the outwash area, and did not invade the surrounding grassland. Therefore, associated species were also collected within the boundaries of the outwash area, and not from the area of secondary succession where grasses were established.

The outwash area was characterized by sparse vegetation, with a basal coverage of less than 25%. Associated species typically occurred as scattered individuals. Fifty-six species (Table 1) were identified as occurring on one or more of the 21 sites investigated. Of these, 16 species, or 29%, were found on over half of the sites. Twenty-four species, or 43%, occurred on fewer than three sites. Ode (1987) reported only five species, or 12%, as occurring on half or more of the the 40 populations reported in South Dakota. Between the 56 associated species reported in this investigation and the 42 species reported from South Dakota, there are 25 species that overlap. Of the 25 species in common, only two - Gutierrezia and Melilotus - occur in more than 50% of the sites investigated. It is possible that on the McKenzie and Medora districts of LMNG E. visheri is at the northern limit of its range and exhibits less plasticity in terms of habitat parameters essential for population maintenance.

Three families, the Asteraceae, the Chenopodiaceae, and the Poaceae, accounted for 75% of the plant species identified as associated species. Of these species, several, such as Distichlis spicata, Suaeda moquinii and Atriplex spp. are considered characteristic of saline and/or alkaline soils. Others are considered elements of primary succession - for example Grindelia squarrosa and Hordeum jubatum. In general, many of these species are considered pioneers in newly available areas, or characteristic of dry, arid, alkaline soils, and as such are characteristic of the habitat where E. visheri occurs.

Conclusions and Recommendations

The distribution of populations of E. visheri located on the McKenzie and Medora districts of the LMNG suggest that the twin strategies of identification of potential sites through the use of low altitude aerial photographs, and targeting those upland rolling grasslands with extensive and well-developed low relief badlands formations that have an extensive outwash plain at the base, would be the most efficient way to organize future surveys. In this survey populations were apparently clustered in drainage areas like the Horse Creek School drainage system (Sites 1-11), Trotters SE quad (Sites 12-17), and the Rocky Ridge South area (Sites 18, 19). On the McKenzie district extensive surveys of the western side of the district (Appendix B; field maps submitted separately) did not reveal any populations of E. visheri in the intervening region between the Horse Creek School area and the Trotters area. The survey of probable sites will still require inspection given the general inconspicuous character of the species and the rare occurrence of populations of the species on suitable landforms.

The unusual weather conditions of the 1993 growing season in western North Dakota may have resulted in an inflation of the typical number of sites and individuals of E. visheri on the McKenzie and Medora districts of the LMNG. In those populations surveyed by the author, weathered remains of E. visheri from the previous season were scattered and infrequent. While a survey of the skeletal remnants of annual plants always underestimates previous population levels, there were significantly fewer stems present than 1993 populations would indicate. Furthermore, the benign conditions of the 1993 growing season may have enhanced the condition and survival of those individuals at sites 10, 13, and 21, where populations are subjected to pressure from human and livestock activity.

Results from the 1993 growing season should be regarded as preliminary and not as the sole basis for determining land use. Sites located during 1993 should be relocated in successive growing seasons and evaluated to determine if the numbers of individuals and the apparent resistance of populations to human impact observed in this survey are characteristic of E. visheri populations under normal climatic conditions. Study plots to investigate the effect of secondary succession on E. visheri populations should also be initiated. The microhabitat characteristics suggest that the species may require low vegetation coverage, or possibly, be restricted to the alkaline clays of the outwash plains. Ode (1986) suggests that E. visheri may be at a competitive disadvantage with invasive, nonnative species such as Salsola iberica. The impact of human disturbance on these sites in terms of opening them to invasion by nonnative weedy species should be evaluated.

The preliminary results from this survey of E. visheri distribution on the McKenzie and Medora districts of the LMNG indicate that survey methods developed in conjunction with Forest Service personnel are effective. Sufficient numbers of populations were located and evaluated during this season to allow the establishment of monitoring plots during future seasons. As E. visheri is an

annual, monitoring plots should be established at the population and subpopulation level rather than focusing on individuals. Again, as an annual on sites experiencing active erosion, seedbank studies will be critical in evaluating the biology of the species.

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APPENDIX 1. Species characteristic of clay outwash communities in the western North Dakota Badlands. Occurrence of each species on the site is indicated by an X under that site number. Lack of an X does not indicate that the species did not occur at that site, only that it was not observed there. Surveys were conducted in late autumn and it was not always possible to identify all associated species. Species are alphabetically listed under family names.

TAXA	SITE NUMBER 1	2	3	4	5	6	7	8	9	10	11
Asteraceae											
Arctium minus									X		
Artemisia cana				X		X					X
Artemisia dracunculus			X								
Artemisia frigida					X	X	X	X			X
Artemisia longifolia				X					X		
Artemisia tridentata							X				
Aster ericoides			X			X	X				
Chrysothamnus nauseosus		X	X	X		X					X
Grindelia squarrosa	X	X	X	X	X	X	X	X	X	X	X
Gutierrezia sarothrae	X	X		X	X	X	X	X	X	X	
Helianthus rigidus	X										X
Lactuca serriola	X										
Machaeranthera canescens				X							X
Rudbeckia hirta	X					X				X	
Tragopogon dubius	X	X				X	X	X	X		
Boraginaceae											
Lappula cenchrusoides	X		X			X					
Brassicaceae											
Conringia orientalis	X										
Cactaceae											
Opuntia polyacantha	X	X	X	X	X	X	X				X

TAXA	SITE NUMBER 1	2	3	4	5	6	7	8	9	10	11
Chenopodiaceae											
Atriplex argentea			X				X			X	
Atriplex dioica	X										
Atriplex nuttallii	X			X	X	X	X		X	X	X
Atriplex subspicata									X		
Ceratoides lanata	X	X		X	X	X	X	X	X		X
Chenopodium album							X				
Chenopodium berlandieri						X					
Kochia scoparia	X	X				X					X
Salsola iberica	X	X	X	X		X				X	
Suaeda moquinii			X	X		X	X	X	X	X	X
Suckleya suckleyana	X										
Euphorbiaceae											
Euphorbia serpyllifolia	X										
Fabaceae											
Dalea candida			X								
Melilotus officinalis	X	X	X	X	X	X	X		X	X	X
Oxytropis sericea									X		X
Linaceae											
Linum rigidum					X						
Malvaceae											
Sphaeralcea coccinea						X				X	X
Onagraceae											
Oenothera caespitosa	X	X	X	X		X	X	X	X	X	X
Plantaginaceae											
Plantago elongata	X	X					X				

TAXA	SITE NUMBER 1	2	3	4	5	6	7	8	9	10	11
Poaceae											
Agropyron cristatum										X	
Agropyron smithii	X		X	X	X	X	X	X	X	X	X
Agropyron spicatum	X	X									
Andropogon scoparius											
Bouteloua curtipendula											
Bouteloua gracilis	X	X	X	X		X		X	X	X	X
Calamovilfa longifolia											X
Danthonia spicata		X									
Distichlis spicata	X	X	X	X	X		X	X	X		X
Hordeum jubatum	X	X		X		X	X			X	X
Koeleria pyramidata				X	X						
Oryzopsis hymenoides			X			X	X				
Poa pratensis											
Puccinellia nuttalliana	X	X	X	X		X	X		X		X
Schedonnardus paniculatus	X	X	X	X		X	X				
Stipa comata					X			X			
Polygalaceae											
Polygala alba		X									
Polygonaceae											
Eriogonum pauciflorum	X		X	X		X	X	X	X		X
Santalaceae											
Commandra umbellata		X	X	X	X	X					
Scrophulariaceae											
Penstemon sp.							X				

Appendix 1. Species characteristic of clay outwash communities in the western North Dakota Badlands. Occurrence of each species on the site is indicated by an X under that site number. Lack of an X does not indicate that the species did not occur at that site, only that it was not observed there. Surveys were conducted in late autumn and it was not always possible to identify all associated species. Species are alphabetically listed under family names.

TAXA	SITE NUMBER									
	12	13	14	15	16	17	18	19	20	21
Asteraceae										
Arctium minus										
Artemisia cana	X		X				X	X	X	
Artemisia dracunculus										
Artemisia frigida	X		X				X	X		X
Artemisia longifolia										
Artemisia tridentata									X	
Aster ericoides		X								
Chrysothamnus nauseosus					X			X		
Grindelia squarrosa	X	X	X	X	X	X	X	X	X	X
Gutierrezia sarothrae	X	X	X	X	X	X	X	X	X	X
Helianthus rigidus	X						X			
Lactuca serriola										
Machaeranthera canescens	X	X	X	X	X	X	X	X	X	X
Rudbeckia hirta										
Tragopogon dubius	X						X			
Boraginaceae										
Lappula cenchrusoides		X	X				X			
Brassicaceae										
Conringia orientalis										
Cactaceae										
Opuntia polyacantha	X	X						X	X	X

TAXA	SITE NUMBER 12	13	14	15	16	17	18	19	20	21
Chenopodiaceae										
Atriplex argentea	X	X	X			X				X
Atriplex dioica		X								
Atriplex nuttallii	X			X	X	X	X	X	X	X
Atriplex subspicata	X									
Ceratoides lanata	X	X	X	X	X	X	X	X	X	X
Chenopodium album	X									
Chenopodium berlandieri										
Kochia scoparia	X	X		X		X	X			
Salsola iberica	X				X				X	
Suaeda moquinii	X		X		X		X		X	X
Suckleya suckleyana										
Euphorbiaceae										
Euphorbia serpyllifolia										
Fabaceae										
Dalea candida										
Melilotus officinalis	X						X	X	X	
Oxytropis sericea										
Linaceae										
Linum rigidum										
Malvaceae										
Sphaeralcea coccinea	X	X				X	X			
Onagraceae										
Oenothera caespitosa	X	X	X	X	X		X	X	X	X
Plantaginaceae										
Plantago elongata	X		X			X	X			

TAXA	SITE NUMBER 12	13	14	15	16	17	18	19	20	21
Poaceae										
Agropyron cristatum										
Agropyron smithii	X	X	X	X	X	X	X	X	X	X
Agropyron spicatum		X		X			X			
Andropogon scoparius								X		
Bouteloua curtipendula	X									
Bouteloua gracilis	X	X					X	X		
Calamovilfa longifolia										
Danthonia spicata	X									
Distichlis spicata	X	X	X	X	X	X	X	X	X	
Hordeum jubatum	X	X	X				X			
Koeleria pyramidata										
Oryzopsis hymenoides							X			
Poa pratensis	X									
Puccinellia nuttalliana	X			X	X	X	X			
Schedonnardus paniculatus		X			X					
Stipa comata										
Polygalaceae										
Polygala alba										
Polygonaceae										
Eriogonum pauciflorum	X	X	X	X		X	X	X	X	X
Santalaceae										
Commandra umbellata	X	X	X	X		X	X	X	X	
Scrophulariaceae										
Penstemon sp.										

APPENDIX B

Key to Interpretation of Field Maps

Quadrangle maps of areas surveyed by K. F. Rogers and D. A. Schaaf in this study are circled in pencil or yellow marker, and marked for presence/absence of E. visheri. In addition, USFS botanists were involved in field surveys for rare plants in 1993. Those areas are marked with yellow lines on the maps. Sites where K. F. Rogers and D. A. Schaaf located populations are marked with the source code reference number.

Appendix B consists of a LMNG map showing the general areas where the survey for E. visheri was conducted, and those sites where they located and inventoried populations of E. visheri. The quadrangle maps of each area surveyed are submitted in a separate packet, and are keyed to survey forms, also submitted in a separate packet.

Little Missouri National Grassland

1993 E. visheri Survey

Quadrangle Index

McKenzie District

With E. visheri

1. Horse Creek School
2. Trotters SE

Without E. visheri

1. Bear Butte
2. Burning Mine Butte
3. Cartwright
4. Charbonneau
5. Charlson
6. Cinnamon Creek
7. Fairview
8. Flat Rock Butte
9. Lone Butte
10. Lone Butte NE
11. Lone Butte SE
12. Long X Divide
13. Phillip Spring
14. Red Wing Creek
15. Sather Lake
16. Schafer SE
17. Sheep Creek
18. Sidney NE
19. Skaar NE
20. Sperati Point
21. Squaw Gap
22. Trotters'

Medora District

With E. visheri

1. Rocky Ridge South
2. Wannagan Creek West

Without E. visheri

1. Bullion Butte
2. Chimney Butte
3. Cliffs Plateau
4. Fryburg
5. Fryburg NE
6. Gorham SE
7. Gorham Sw
8. Juniper Spur
9. Medora
10. Scairt Woman Draw
11. Tracy Mountain
12. Wannagan Creek East

APPENDIX C

List of slides of E. visheri submitted

1 - 7. Clark # 1 & 2. T149N, R104W, Sec. 26. 4 August 1993

1. Habitat - close
2. Habitat - close
3. Eriogonum. visheri - close-up, scale
4. E. visheri - close-up
5. E. visheri - close-up & habitat
6. E. visheri - close-up & habitat
7. E. visheri - habitat

8 - 21. F93SSV1X. T149N, R104W, NE SE Sec. 26. 5 August 1993

8. E. visheri - habitat
9. E. visheri - habitat
10. E. visheri - habitat
11. E. visheri - close-up habitat
12. E. visheri - site
13. E. visheri - site
14. E. visheri - site
15. E. visheri - habitat
16. E. visheri - close-up habitat
17. E. visheri - habitat
18. E. visheri - single plant
19. E. visheri - close-up
20. E. visheri - single plant
21. E. visheri - single plant

22 - 26. F93DAS1X. T136N, R101W, SW NW Sec 23. 16 September 1993

22. E. visheri - habitat
23. E. visheri - habitat
24. E. visheri - habitat
25. E. visheri - habitat from above
26. E. visheri - habitat from above

27-32. F93DAS2X. T136N, R101W, NW SE Sec 9. 16 September 1993

27. E. visheri - habitat
28. E. visheri - habitat
29. E. visheri - habitat
30. E. visheri - close-up habitat
31. E. visheri - close-up habitat
32. E. visheri - close-up; late season

33 - 37. Clark # 5. T149N R104W N central Sec 28. 4 August 1993

33. Orobanche ludoviciana - close-up
34. O. ludoviciana - close-up
35. O. ludoviciana - close-up
36. O. ludoviciana - close-up
37. O. ludoviciana - close-up