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David M. Mushet
Northern Prairie Wildlife Research Center

Ned H. Euliss, Jr.
Northern Prairie Wildlife Research Center

Stephen P. Lane
Northern Prairie Wildlife Research Center

Christopher M. Goldade
Northern Prairie Wildlife Research Center

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DAVID M. MUSHET[1], NED H. EULISS, JR., STEPHEN P. LANE, and CHRISTOPHER M. GOLDADE

U.S. Geological Survey, Northern Prairie Wildlife Research Center
8711 37th Street SE, Jamestown, ND 58401

ABSTRACT -- The 92 ha Cottonwood Lake Study Area is located in south-central North Dakota along the eastern edge of a glacial stagnation moraine known as the Missouri Coteau. The study area has been the focus of biological and hydrological research since the U. S. Fish and Wildlife Service purchased the site in 1963. We studied the plant communities of the Cottonwood Lake Study Area from 1992 to 2001. During this time period, the vascular flora of the study area consisted of 220 species representing 52 families. Over half of the species were perennial forbs (117 species). Perennial grasses (26 species) and annual forbs (22 species) made up the next two largest physiognomic groupings. The flora, having a mean Coefficient of Conservatism of 4.6 and a Floristic Quality Index of 62, consisted of 187 native species. Thirty-three species were non-natives. Our annotated list should provide information useful to researchers, graduate students, and others as they design and implement future studies in wetlands and uplands both in and around the Cottonwood Lake Study Area.

Key words: Cottonwood Lake Study Area, flora, floristic quality, mixed-grass, prairie, wetlands.

The U. S. Fish and Wildlife Service purchased the 92 ha Cottonwood Lake Study Area, which is located approximately 16 km southeast of Woodworth, North Dakota along the eastern edge of the Missouri Coteau (Fig. 1), on 6 August 1963 as the Eddy Waterfowl Production Area. Soon after the site was purchased, scientific investigations of the chemical characteristics, invertebrate communities, and plant communities of the wetlands were initiated (Swanson 1987). In 1977, a network of

[1]E-mail address: david_mushet@usgs.gov

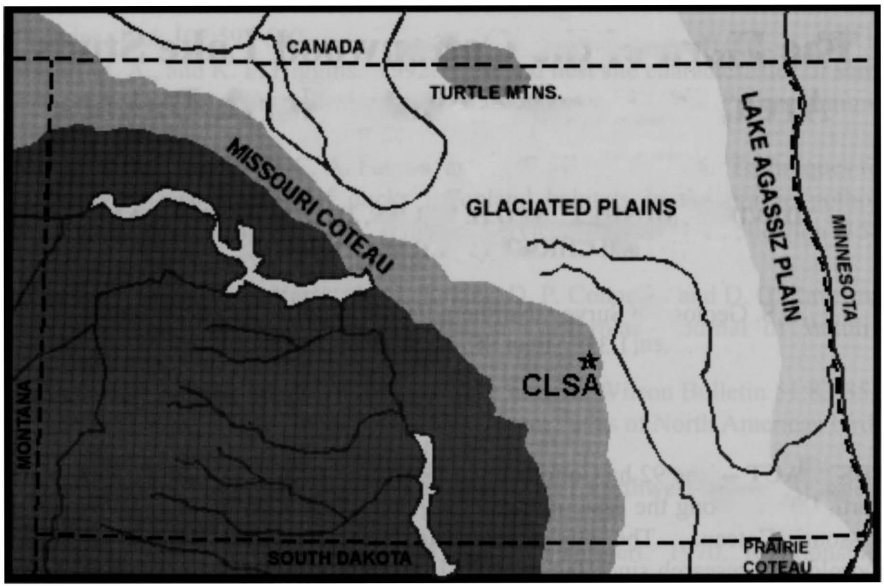

Figure 1. Map of North Dakota showing physiographic regions and the location of the Cottonwood Lake Study Area (CLSA). Solid lines represent rivers, and dashed lines indicate state and international boundaries.

wells and piezometers was installed to monitor ground-water movement at the study site to help explain differences among wetlands identified by the earlier biological and chemical research. In 1992, additional quantitative investigations of the invertebrate, amphibian, bird, and plant communities were initiated. More than 80 scientific publications, graduate student theses, and presentations at scientific conferences have resulted from studies at the Cottonwood Lake Study Area (see www.npwrc.usgs.gov/clsa). Additionally, research at the study area has provided invaluable baseline data on the hydrological, chemical, and biological attributes of natural prairie wetlands upon which comparisons with ongoing research, including studies on wetland restoration and monitoring, have been based.

The Missouri Coteau is a large stagnation moraine formed of low-permeability glacial till. The topography is very hummocky with most of the depressions containing wetlands. Relief within the Cottonwood Lake Study Area is about 28 m. The highest elevations (approximately 579 m above sea level) occur in the southeast corner sloping to the lowest (approximately 551 m above sea level) in the northwest corner (Fig. 2).

The study area contains approximately 75 ha of uplands and 17 ha of wetlands. Eighteen percent of the upland area was cultivated at the time of

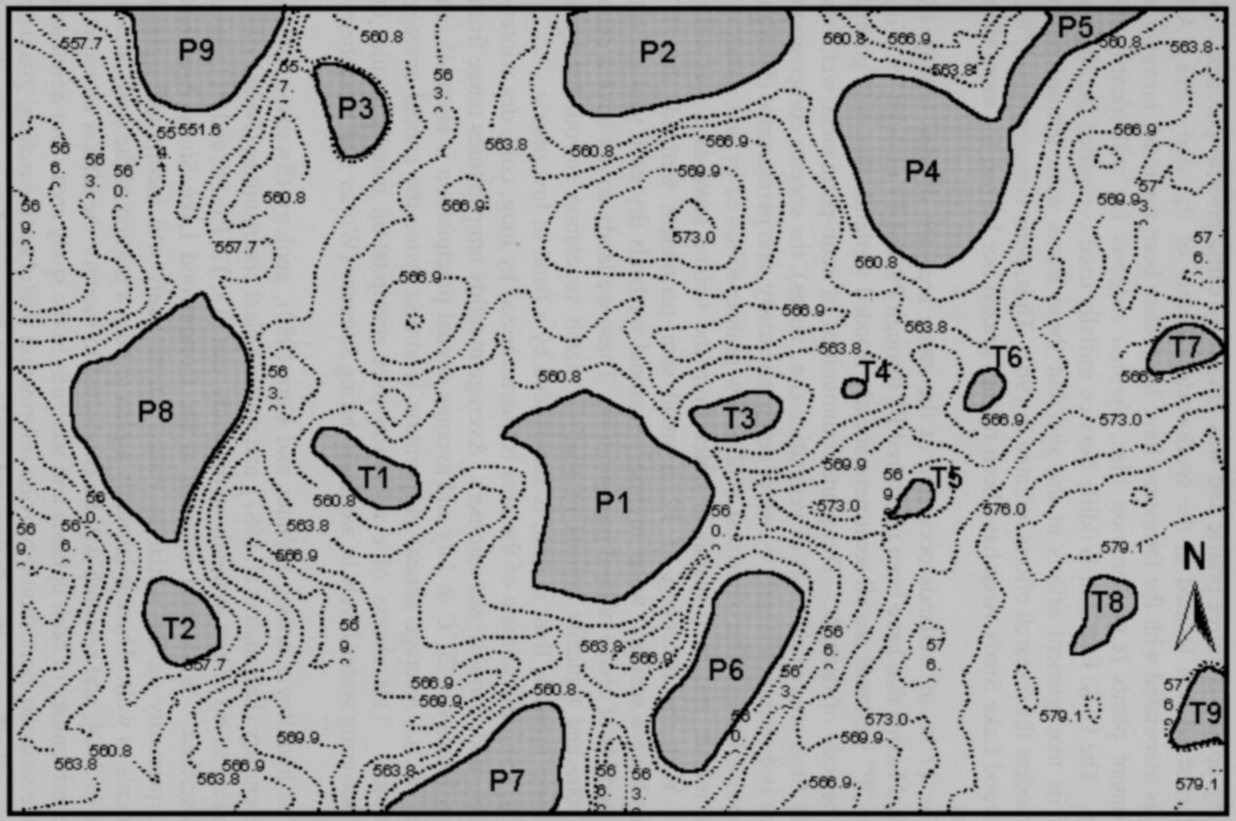

Figure 2. The Cottonwood Lake Study Area, Stutsman County, North Dakota.

purchase. The cultivated area, consisting of two fields, subsequently was seeded with smooth brome (*Bromus inermis* Leyss.) and alfalfa (*Medicago sativa* L.). The remaining upland is native prairie and was grazed by cattle prior to purchase. A small farmstead was located in the southwestern corner of the study area. All structures associated with the farmstead have long since been removed; however a few remnant plants (e.g., common lilac, *Syringa vulgaris* L.) still identify its location. The U. S. Fish and Wildlife Service initially used controlled burning as part of its management efforts at the site, but these burns were terminated to accommodate the research efforts initiated in 1967. Thus, plant communities of the Cottonwood Lake Study Area have been neither grazed nor burned for more than 35 years.

The 17 ha of wetlands occurring at the study area are divided among 18 individual basins that have been numbered P1 through P9 and T1 through T9 (Fig. 2). The "P" wetlands are all semi-permanently flooded wetlands that only go dry during periods of drought. The plant communities of semi-permanent wetlands typically form concentric rings of vegetation (i.e., zones), the species composition of which is determined largely by water depth, chemistry, and permanence (Stewart and Kantrud 1971). The outermost zone is low prairie, followed by wet meadow, shallow marsh, and deep marsh in order from the upland towards a wetland's center. With the exception of T2, a small semi-permanent wetland, the "T" wetlands have a seasonal water regime. Seasonal wetlands dry each year except during periods of above normal precipitation. These wetlands do not have a deep marsh zone and typically consist of shallow marsh vegetation surrounded by a band of wet meadow that, in turn, is surrounded by a band of low prairie.

The semi-arid climate of the area is characterized by long, cold, dry winters and short, mild, variably wet summers. Average monthly temperatures range from -13°C in January to 20°C in July and average annual precipitation is about 45 cm (Jensen 1972). Average annual evaporation is almost twice the annual average precipitation. This excess of evaporation over precipitation usually results in rapidly lowering water levels in wetlands during summer (Winter and Rosenberry 1995).

The hydrologic setting (Winter and Carr 1980), geology (Swanson 1990), water chemistry (LaBaugh et al. 1987), and wetland plant communities (Poiani 1990, Poiani et al. 1996) of key wetlands on the study area (T8, T3, P1, P8, and P11) have been described. While past research at the Cottonwood Lake Study Area has focused primarily on the wetlands, future efforts likely will incorporate upland components as well. There is currently a plan to burn a portion of the study area's uplands in 2004, and research will be conducted to monitor the effects on various biotic communities of both uplands and wetlands in the study area. Our annotated list of the vascular flora should provide information useful to researchers, graduate students, and others as they design and implement future studies in wetlands and uplands both in and around the Cottonwood Lake Study Area.

ANNOTATED LIST

The following list of the vascular flora of the Cottonwood Lake Study Area is based on our collections and observations made at the site from April 1992 through September 2001. During this ten-year time period, conditions at the site ranged from very dry (1992 was the last year of a severe drought that began in 1988) to extremely wet. Nomenclature follows the *Flora of the Great Plains* (Great Plains Flora Association 1991). We listed species phylogenetically according to the *Flora of the Great Plains* and provided synonyms (following annotations) when names used in the *Flora of the Great Plains* differed from those of the Natural Resource Conservation Service's PLANTS database (USDA/NRCS 2001). Colloquial names also have been derived from the *Flora of the Great Plains* and are placed in brackets if otherwise.

Following the colloquial name, we provide the coefficient of conservatism value (range = 0 to 10) assigned to each native species by the Northern Great Plains Floristic Quality Assessment Panel (2001). The coefficients of conservatism (C) were assigned by the panel members based on their collective knowledge of the patterns of occurrence of plant species and their confidence that a particular species is natural area dependent. Plant species vary in their ability to tolerate disturbances. Species that do not tolerate disturbance and therefore are virtually restricted to high quality natural areas are termed "conservative" species and were assigned high C values (e.g. 8, 9, or 10). Weedy species that can flourish in highly disturbed habitats were assigned low C values (e.g., 0, 1, or 2). Remaining species were assigned intermediate values based on the likelihood that each would be natural area dependent. The 35 introduced species we observed are identified with an asterisk instead of a numerical coefficient in our list as they were not assigned C values by the Northern Great Plains Floristic Quality Assessment Panel (2001) and are not used in subsequent calculations.

Using the coefficients and a species list for an area, a mean C value and a Floristic Quality Index (FQI) can be calculated, which offers an objective way to measure the quality of native plant communities (Swink and Wilhelm 1979, 1994, Taft et al. 1997). The mean C value is obtained by dividing the summation of the C values for a species list by the total number of native species present. Incorporating species richness into the calculations by multiplying the mean C value by the square root of the total number of native species present results in the FQI for an area. By developing species lists and calculating the mean C and FQI values, the quality of plant communities can be identified, compared, and monitored; and habitat management and restoration efforts can be evaluated (Swink and Wilhelm 1979, 1994, Taft et al. 1997).

In addition to the C value, we also provided the physiognomic grouping of each species (Northern Great Plains Floristic Quality Assessment Panel 2001). The

physiognomic groupings we used are vascular cryptogams, grasses, sedges, forbs, vines, shrubs, and trees. The grasses, sedges, and forbs are further identified as annuals, biennials, or perennials and the vines as herbaceous or woody. Although these designations sometimes imperfectly depict the habit of a plant taxon and are subject to interpretation, they can be useful in identifying structural differences or changes in a plant community.

We use the words very rare (less than 5 individuals observed during the entire study period), rare (sporadically present in very low numbers), scarce (present most years but in low numbers), moderately common (present all years in low numbers or most years in moderate numbers), common (present all years in moderate numbers), and very common (present all years in large numbers) in our list to describe the relative occurrence of each species throughout the study area. The different habitat types we use are road edges, disturbed areas, prairie, dry prairie, low prairie, wet meadow, shallow marsh, deep marsh, open water, woody areas, and drawdown areas. Voucher specimens for all species are housed in the herbarium of the U. S. Geological Survey's Northern Prairie Wildlife Research Center located in Jamestown, North Dakota.

Equisetaceae Rich., Horsetail Family

Equisetum hyemale L. common scouring rush 3 Vascular Cryptogam. Moderately common, in low prairie.

Polypodiaceae S. F. Gray, True Fern Family [Dryopteridaceae]

Cystopteris fragilis (L.) Bernh. fragile fern 8 Vascular Cryptogam. Rare, in woody vegetation (P2).

Ceratophyllaceae S. F. Gray, Hornwort Family

Ceratophyllum demersum L. hornwort, coontail 4 Perennial Forb. Common, (submerged) in deep marsh and open water.

Ranunculaceae Juss., Buttercup Family

Actaea rubra (Ait.) Willd. baneberry 8 Perennial Forb. Rare to scarce, in woody vegetation.

Anemone canadensis L. meadow anemone, [Canada anemone] 4 Perennial Forb. Very common, in low prairie.

Anemone cylindrica A. Gray candle anemone, [thimbleweed] 7 Perennial Forb. Moderately common, in prairie.

Anemone patens L. pasque flower 9 Perennial Forb. Scarce, in dry prairie. [*Pulsatilla patens* (L.) P. Mill.]

Ranunculus cymbalaria Pursh shore buttercup 3 Perennial Forb. Scarce, in drawdown areas and shallow marsh.

Ranunculus macounii Britt. Macoun's buttercup 4 Annual Forb. Moderately common, in wet meadow (T8 and T9).

Ranunculus rhomboideus Goldie prairie buttercup 8 Perennial Forb. Scarce, in dry prairie.

Ranunculus sceleratus L. cursed crowfoot, [ditch buttercup] 3 Annual Forb. Moderately common, in wet meadow.

Urticaceae Juss., Nettle Family

Parietaria pensylvanica Muhl. ex Willd. Pennsylvania pellitory 3 Annual Forb. Rare, in woody vegetation (P1).

Urtica dioica L. stinging nettle 0 Perennial Forb. Very common, in low prairie.

Nyctaginaceae Juss., Four-O'Clock Family

Mirabilis hirsuta (Pursh) MacM. hairy four-o'clock 4 Perennial Forb. Very rare, in prairie (one specimen only: P6).

Chenopodiaceae Vent., Goosefoot Family

Chenopodium album L. lamb's quarters * Annual Forb. Common, in dry seasonal wetlands and disturbed areas.

Chenopodium rubrum L. alkali blite, [red goosefoot] 2 Annual Forb. Scarce, in drawdown areas.

Caryophyllaceae Juss., Pink Family

Cerastium arvense L. prairie chickweed, [field chickweed] 2 Perennial Forb. Common, in prairie.

Stellaria crassifolia Ehrh. fleshy stitchwort 9 Perennial Forb. Rare, in drawdown areas (T4).

Polygonaceae Juss., Buckwheat Family

Polygonum erectum L. erect knotweed * Annual Forb. Common, on road edges and in disturbed areas.

Polygonum amphibium L., *sens. lat.* water smartweed 0 Perennial Forb. Common, in wet meadow and shallow marsh.

Polygonum lapathifolium L. pale smartweed, [nodding smartweed] 1 Annual Forb. Scarce, in wet meadow and drawdown areas.

Polygonum convolvulus L. climbing buckwheat, wild buckwheat * Herbaceous Vine. Rare, in prairie.

Polygonum scandens L. false [climbing] buckwheat 0 Herbaceous Vine. Moderately common, in prairie and woody vegetation.

Rumex crispus L. curly dock * Perennial Forb. Common, in low prairie.

Rumex maritimus L. golden dock 1 Annual Forb. Moderately common, in wet meadow and drawdown areas.

Rumex mexicanus Meisn. willow-leaved dock 1 Perennial Forb. Common, in wet meadow. [*Rumex salicifolius* Weinm. var. *mexicanus* (Meisn.) C. L. Hitchc.]

Violaceae Batsch, Violet Family

Viola adunca J. E. Sm. hook-spurred violet, [early blue violet] 8 Perennial Forb. Moderately common, in low prairie.

Viola nephrophylla Greene northern bog violet 8 Perennial Forb. Scarce, in wet meadow (P8 and T2).

Viola nuttallii Pursh Nuttall's violet, yellow prairie violet 8 Perennial Forb. Scarce, in dry prairie.

Viola pedatifida G. Don prairie violet, larkspur-violet 8 Perennial Forb. Moderately common, in dry prairie.

Salicaceae Mirb., Willow Family

Populus deltoides Marsh. subsp. *monilifera* (Ait.) Echenw. (sect. *Aigeiras*) cottonwood 3 Tree. Very rare, in low prairie (1 specimen only: T9).

Populus tremuloides Michx. (sect. *Populus*) quaking aspen 4 Tree. Common, in low prairie. (T8, P7, and P2).

Salix exigua Nutt. sandbar willow, coyote willow 3 Shrub. Common, in low prairie.

Brassicaceae Burnett, Mustard Family

Arabis hirsuta (L.) Scop. var. *pycnocarpa* (Hopkins) Rollins [creamflower] rockcress 7 Biennial Forb. Very rare, in wet meadow (2 specimens only: T7).

Descurainia sophia (L.) Webb ex Prantl. flixweed * Annual Forb. Scarce, in disturbed areas and dry prairie.

Rorippa palustris (L.) Bess. bog [marsh] yellow cress 2 Annual Forb. Scarce, in wet meadow.

Thlaspi arvense L. field pennycress * Annual Forb. Common, in disturbed areas.

Grossulariaceae DC., Currant Family

Ribes americanum P. Mill. wild black currant 7 Shrub. Moderately common, in prairie and woody vegetation

Saxifragaceae Juss., Saxifrage Family

Heuchera richardsonii R. Br. alumroot 8 Perennial Forb. Moderately common, in prairie.

Rosaceae Juss., Rose Family

Agrimonia striata Michx. striate agrimony 5 Perennial Forb. Rare, in low prairie and woody vegetation.

Amelanchier alnifolia Nutt. Saskatoon service-berry 6 Shrub. Moderately common, in woody vegetation and prairie.

Crataegus rotundifolia Moench northern hawthorn 6 Shrub. Common in woody vegetation and prairie. [*Crataegus chrysocarpa* Ashe]

Fragaria virginiana Duchn. wild strawberry 4 Perennial Forb. Scarce, in low prairie and woody vegetation.

Geum aleppicum Jacq. yellow avens 4 Perennial Forb. Scarce, in prairie and wet meadow.

Geum triflorum Pursh torch flower, maidenhair, [prairie smoke] 8 Perennial Forb. Moderately common, in dry prairie.

Potentilla anserina L. silverweed 2 Perennial Forb. Common, in wet meadow. [*Argentina anserina* (L.) Rydb.]

Potentilla arguta Pursh tall cinquefoil 8 Perennial Forb. Scarce, in dry prairie.

Potentilla hippiana Lehm. [wooly] cinquefoil 8 Perennial Forb. Rare, in dry prairie.

Potentilla norvegica L. Norwegian cinquefoil [rough cinquefoil] 0 Annual, Biennial, or Short-lived Perennial Forb. Scarce, in wet meadow.

Prunus virginiana L. choke cherry 4 Shrub. Common, in woody vegetation and prairie.

Rosa arkansana Porter prairie wild rose 3 Shrub. Common in prairie and woody vegetation.

Fabaceae Lindl., Bean Family

Amorpha canescens Pursh lead plant 9 Shrub. Common, in prairie.

Astragalus agrestis Dougl. ex G. Don field milk-vetch 6 Perennial Forb. Scarce, in prairie.

Astragalus canadensis L. Canada milk-vetch 5 Perennial Forb. Scarce, in prairie.

Astragalus crassicarpus Nutt. ground-plum 7 Perennial Forb. Scarce, in dry prairie.

Astragalus flexuosus (Hook.) G. Don pliant milk-vetch 4 Perennial Forb. Scarce, in prairie.

Dalea purpurea Vent. var. *purpurea* purple prairie clover 8 Perennial Forb. Common, in prairie.

Glycyrrhiza lepidota Pursh wild licorice 2 Perennial Forb. Very common, in low prairie.

Lotus purshianus (Benth.) Clem. & Clem. prairie trefoil, deer vetch, [American bird's-foot trefoil] 3 Annual Forb. Very rare, in prairie (northwest of P8). [*Lotus unifoliolatus* (Hook.) Benth. var. *unifoliolatus*]

Medicago sativa L. alfalfa * Perennial Forb. Common, in prairie.

Melilotus alba Medic. white sweet clover * Biennial Forb. Common, in prairie and on road edges.

Melilotus officinalis (L.) Pall. yellow sweet clover * Biennial Forb. Common, in prairie and on road edges.

Psoralea argophylla Pursh. silver-leaf scurf-pea 4 Perennial Forb. Moderately common, in dry prairie. [*Pediomelum argophyllum* (Pursh) J. Grimes]

Psoralea esculenta Pursh breadroot scurf-pea 9 Perennial Forb. Moderately common, in dry prairie. [*Pediomelum esculentum* (Pursh) Rydb.]

Vicia americana Muhl. ex Willd. var. *americana* American vetch 6 Herbaceous Vine. Moderately common, in dry prairie.

Vicia americana Muhl. ex Willd. var. *minor* Hook. American vetch 3 Herbaceous Vine. Scarce, in dry prairie.

Elaeagnaceae Juss., Oleaster Family

Elaeagnus commutata Bernh. silverberry 5 Shrub. Very common, in dry prairie.

Shepherdia argentea (Pursh) Nutt. [silver] buffaloberry 5 Shrub. Very rare, in prairie (north of P1).

Haloragaceae R. Br., Water Milfoil Family

Myriophyllum exalbescens Fern. American watermilfoil 3 Perennial Forb. Scarce, (submerged) in deep marsh and open water (P8). [*Myriophyllum sibiricum* Komarov]

Onagraceae Juss., Evening Primrose Family

Calylophus serrulatus (Nutt.) Raven plains yellow primrose [shrubby evening primrose] 7 Perennial Forb. Common, on dry prairie.

Epilobium angustifolium L. subsp. *circumvagum* Mosquin willow-herb [fireweed] 5 Perennial Forb. Very rare, in prairie (four specimens only: south of P2). [*Chamaenerion angustifolium* (L.) Holub subsp. *circumvagum* (Mosquin) Kartesz]

Epilobium ciliatum Raf. willow-herb [fringed willowherb] 3 Perennial Forb. Common, in wet meadow.

Gaura coccinea Pursh scarlet gaura 4 Perennial Forb. Moderately common, in dry prairie and on road edges.

Oenothera biennis L. common evening primrose 0 Biennial Forb. Moderately common, in prairie.

Oenothera nuttallii Sweet white-stemmed evening primrose 8 Perennial Forb. Very rare, in dry prairie (four specimens only: Northwest of T1).

Cornaceae Dum., Dogwood Family

Cornus stolonifera Michx. red osier [redosier dogwood] 6 Shrub. Rare, in woody vegetation. [*Cornus sericea* L.]

Euphorbiaceae Juss., Spurge Family

Euphorbia esula L. leafy spurge * Perennial Forb. Scarce, in prairie.

Vitaceae Juss., Grape Family

Parthenocissus vitacea (Knerr) Hitchc. woodbine, thicket creeper 2 Woody Vine. Common, in woody vegetation.

Linaceae S. F. Gray, Flax Family

Linum rigidum Pursh [stiffstem flax] 5 Annual Forb. Rare, in prairie.

Anacardiaceae Lindl., Cashew Family

Toxicodendron rydbergii (Small) Greene. [western] poison ivy 3 Shrub. Common, in woody vegetation and low prairie.

Oxalidaceae R. Br., Wood Sorrel Family

Oxalis stricta L. yellow wood sorrell 0 Perennial Forb. Scarce, in disturbed areas and woody vegetation.

Apiaceae Lindl., Parsley Family

Cicuta maculata L. common water hemlock 4 Perennial Forb. Common, in wet meadow.

Zizia aptera (A. Gray) Fern. [heart-leaved alexander] 8 Perennial Forb. Common, in low prairie and on hillsides.

Gentianaceae Juss., Gentian Family

Gentiana andrewsii Griseb. closed gentian, bottle gentian 10 Perennial Forb. Scarce, in wet meadow (T4 and T6).

Apocynaceae Juss., Dogbane Family

Apocynum cannabinum L. Indian hemp dogbane, prairie dogbane 4 Perennial Forb. Very common, in wet meadow and low prairie.

Asclepiadaceae R. Br., Milkweed Family

Asclepias ovalifolia Dcne. ovalleaf milkweed 9 Perennial Forb. Common, in prairie.

Asclepias speciosa Torr. showy milkweed 4 Perennial Forb. Scarce, in prairie and disturbed areas.

Asclepias viridiflora Raf. green milkweed 8 Perennial Forb. Very rare, in prairie (1 specimen only: north of P7).

Solanaceae Juss., Potato or Nightshade Family

Physalis virginiana P. Mill. Virginia ground cherry 4 Perennial Forb. Moderately common, in prairie.

Solanum ptycanthum Dun. ex DC. black nightshade 0 Annual Forb. Rare, in woody vegetation and disturbed areas.

Boraginaceae Juss., Borage Family

Hackelia deflexa (Wahl.) Opiz. [wood] stickseed 0 Biennial-Perennial Forb. Scarce, in woody vegetation.

Lithospermum canescens (Michx.) Lehm. hoary puccoon 7 Perennial Forb. Common, in prairie.

Lithospermum incisum Lehm. [narrow-leaved puccoon] 7 Perennial Forb. Moderately common, in dry prairie.

Onosmodium molle Michx. var. *occidentale* (Mack.) Johnst. false gromwell 7 Perennial Forb. Moderately common, in dry prairie.

Verbenaceae St.-Hil., Vervain Family

Verbena bracteata Lag. & Rodr. prostrate vervain 0 Annual Forb. Scarce, on road edges and in disturbed areas.

Verbena hastata L. blue vervain 5 Perennial Forb. Scarce, in wet meadow.

Lamiaceae Lindl., Mint Family

Lycopus americanus Muhl. ex Bart. American bugleweed 4 Perennial Forb. Common, in wet meadow.

Lycopus asper Greene rough bugleweed, [water horehound] 4 Perennial Forb. Very common, in wet meadow.

Mentha arvensis L. field mint 3 Perennial Forb. Moderately common, in wet meadow.

Nepeta cataria L. catnip * Perennial Forb. Moderately common, in woody vegetation.

Scutellaria galericulata L. marsh skullcap 7 Perennial Forb. Scarce, in low prairie (P8).

Stachys palustris L. subsp. pilosa (Nutt.) Epling hedge-nettle, marsh betony 3 Perennial Forb. Common, in wet meadow. [*Stachys pilosa* Nutt. var. *pilosa*]

Plantaginaceae Juss., Plantain Family

Plantago major L. common plantain * Perennial Forb. Common, on road edges, in disturbed areas and in low prairie.

Oleaceae Hoffmsg. & Link, Olive Family

Syringa vulgaris L. common lilac * Shrub. Very rare, in prairie (farmstead site only).

Scrophulariaceae Juss., Figwort Family

Penstemon gracilis Nutt. slender beardtongue 6 Perennial Forb. Scarce to rare, in dry prairie.

Lentibulariaceae Rich., Bladderwort Family

Utricularia vulgaris L. common bladderwort 2 Perennial Forb. Common, (submerged) in deep marsh and shallow marsh. [*Utricularia macrorhiza* Le Conte]

Campanulaceae Juss., Bellflower Family

Campanula rotundifolia L. harebell 7 Perennial Forb. Common, in dry prairie.

Lobelia spicata Lam. palespike lobelia 6 Perennial Forb. Very rare, in wet meadow (T3).

Rubiaceae Juss., Madder Family

Galium boreale L. northern bedstraw 4 Perennial Forb. Common, in prairie.

Galium trifidum L. small bedstraw 8 Perennial Forb. Scarce, in woody vegetation.

Caprifolaceae Juss., Honeysuckle Family

Lonicera tatarica L. Tatarian honeysuckle * Shrub. Moderately common, in woody vegetation.

Symphoricarpos occidentalis Hook. western snowberry, wolfberry, [buckbrush] 3 Shrub. Very common, in prairie.

Viburnum lentago L. nannyberry, sheepberry 8 Tree. Scarce, in woody vegetation.

Asteraceae Dum., Sunflower Family

Achillea millefolium L. yarrow 3 Perennial Forb. Common, in dry prairie and disturbed areas.

Agoseris glauca (Pursh) Dietr. false dandelion 8 Perennial Forb. Scarce, in dry prairie.

Ambrosia psilostachya DC. western ragweed 2 Perennial Forb. Common, in prairie, disturbed areas and on road edges.

Arctium minus Bernh. common burdock * Biennial Forb. Rare, in woody vegetation.

Artemisia absinthium L. wormwood * Perennial Forb. Very common, in disturbed areas, on road edges and in prairie.

Artemisia biennis Willd. biennial wormwood * Biennial Forb. Moderately common, in low prairie.

Artemisia campestris L. subsp. *caudata* (Michx.) Hall & Clem. western sagewort 5 Biennial Forb. Common, in dry prairie.

Artemisia dracunculus L. silky wormwood 4 Perennial Forb. Common, in dry prairie.

Artemisia frigida Willd. [prairie sagewort] 4 Shrub. Common, in dry prairie.

Artemisia ludoviciana Nutt. white sage 3 Perennial Forb. Common, in prairie.

Aster ericoides L. white aster, [many-flowered aster] 2 Perennial Forb. Very common, in prairie. [*Symphyotrichum ericoides* (L.) Nesom var. *ericoides*]

Aster oblongifolius Nutt. aromatic aster 8 Perennial Forb. Rare, in dry prairie (north of P7). [*Symphyotrichum oblongifolius* (Nutt.) Nesom]

Aster simplex Willd. var. *ramosissimus* (T. & G.) Cronq. panicled aster 3 Perennial Forb. Very common, in low prairie. [*Symphyotrichum lanceolatum* (Willd.) Nesom subsp. *lanceolatum* var. *lanceolatum*]

Bidens cernua L. nodding beggar-ticks 3 Annual Forb. Moderately common, in wet meadow and drawdown areas.

Bidens frondosa L. [devil's] beggar-ticks 1 Annual Forb. Moderately common, in wet meadow and drawdown areas.

Chrysopsis villosa (Pursh.) Nutt. golden aster 3 Perennial Forb. Moderately common, in dry prairie, on hillsides and road edges. [*Heterotheca villosa* (Pursh) Shinners]

Cirsium arvense (L.) Scop. Canada thistle, field thistle * Perennial Forb. Very common, in prairie and wet meadow.

Cirsium vulgare (Savi) Ten. bull thistle * Biennial Forb. Common, in prairie.

Conyza canadensis (L.) Cronq. horse-weed 0 Annual Forb. Rare, in disturbed areas, on road edges and in prairie.

Echinacea angustifolia DC. purple coneflower 7 Perennial Forb. Common, in dry prairie.

Erigeron annuus (L.) Pers. annual fleabane 3 Annual Forb. Common, in dry prairie.

Euthamia graminifolia (L.) Nutt. [grass-leaved goldenrod] 6 Perennial Forb. Very rare, in wet meadow (3 specimens only: T4).

Grindelia squarrosa (Pursh) Dun. curly-cup gumweed 1 Biennial Forb. Common, on road edges and in disturbed areas.

Helianthus maximilianii Schrad. Maximilian sunflower 5 Perennial Forb. Common, in low prairie.

Helianthus rigidus (Cass.) Desf. stiff sunflower 8 Perennial Forb. Common, in dry prairie. [*Helianthus pauciflorus* Nutt. ssp. *pauciflorus*]

Lactuca oblongifolia Nutt. blue lettuce 1 Perennial Forb. Common, in prairie. [*Lactuca tatarica* (L.) C. A. Mey. var. *pulchella* (Pursh) Breitung]

Lactuca serriola L. prickly lettuce * Annual Forb. Scarce, in prairie.

Liatris ligulistylis (A. Nels.) K. Schum. [rough blazing star] 10 Perennial Forb. Common, in prairie.

Liatris punctata Hook. [dotted blazing star] 7 Perennial Forb. Common, in dry prairie.

Lygodesmia juncea (Pursh) Hook. skeletonweed 2 Perennial Forb. Scarce, in dry prairie.

Prenanthes racemosa Michx. subsp. *multiflora* Cronq. [glaucous white lettuce] 10 Perennial Forb. Scarce, in low prairie (T3 and T6).

Ratibida columnifera (Nutt.) Woot. & Standl. prairie coneflower 3 Perennial Forb. Common, in prairie.

Rudbeckia hirta L. var. *pulcherrima* Farw. black-eyed susan 5 Biennial Forb. Moderately common, in prairie.

Senecio congestus (R. Br.) DC. swamp ragwort 2 Annual Forb. Moderately common, in drawdown areas and shallow marsh.

Senecio integerrimus Nutt. [entire-leaved groundsel] 7 Biennial or Perennial Forb. Rare, in dry prairie (North of P7).

Solidago canadensis L. Canada goldenrod 1 Perennial Forb. Very common, in prairie.

Solidago gigantea Ait. late goldenrod, [giant goldenrod] 4 Perennial Forb. Scarce, in low prairie.

Solidago missouriensis Nutt. prairie goldenrod 5 Perennial Forb. Scarce, in dry prairie.

Solidago mollis Bartl. soft goldenrod 6 Perennial Forb. Rare, in dry prairie.

Solidago ptarmicoides (Ness) Boivin sneezewort aster, [white prairie aster] 8 Perennial Forb. Very rare, in dry prairie (south of T5). [*Oligoneuron album* (Nutt.) Nesom]

Solidago rigida L. rigid goldenrod 4 Perennial Forb. Common, in dry prairie. [*Oligoneuron rigidum* (L.) Small var. *rigidum*]

Sonchus arvensis L. field sow thistle * Perennial Forb. Very common, in low prairie.

Tanacetum vulgare L. common tansy * Perennial Forb. Rare, in prairie (farmstead site only).

Taraxacum officinale Weber common dandelion * Perennial Forb. Scarce, in prairie. Common, in disturbed areas.

Tragopogon dubius Scop. goat's beard * Biennial Forb. Moderately common, in prairie.

Alismataceae Vent., Water Plantain Family

Alisma plantago-aquatica L. var. *americanum* R. & S. American water plantain 2 Perennial Forb. Moderately common, in drawdown areas and shallow marsh.

Sagittaria cuneata Sheld. arrowhead 6 Perennial Forb. Very rare, in shallow marsh (2 specimens only: T2).

Potamogetonaceae Dum., Pondweed Family

Potamogeton pusillus L. var. p*usillus* baby pondweed 2 Perennial Forb. Scarce, (submerged) in open water and shallow marsh (T8 and T9).

Lemnaceae S. F. Gray, Duckweed Family

Lemna gibba L. [turion duckweed] 1 Perennial Forb. Common, in shallow marsh, deep marsh and open water. [*Lemna turionifera* Landolt]

Lemna trisulca L. star duckweed 2 Perennial Forb. Common, in shallow marsh, deep marsh and open water.

Juncaceae Juss., Rush Family

Juncus balticus Willd. Baltic rush 5 Perennial Forb. Very common, in wet meadow.

Juncus dudleyi Wieg. Dudley rush 4 Perennial Forb. Scarce, in low prairie.

Juncus torreyi Cov. Torrey's rush 2 Perennial Forb. Scarce, in wet meadow.

Cyperaceae Juss., Sedge Family

Carex atherodes Spreng. [slough sedge] 4 Perennial Sedge. Very common, in wet meadow and shallow marsh.

Carex brevior (Dew.) Mack. ex Lunell. [fescue sedge] 4 Perennial Sedge. Scarce, in wet meadow and shallow marsh.

Carex lanuginosa Michx. [woolly sedge] 4 Perennial Sedge. Very common, in wet meadow. [*Carex pellita* Muhl ex Willd.]

Carex praegracilis W. Boott. [field sedge] 5 Perennial Sedge. Common, in wet meadow.

Carex vulpinoidea Michx. [fox sedge] 2 Perennial Forb. Scarce, in wet meadow.

Eleocharis acicularis (L.) R. & S. [least spikerush] 3 Perennial Sedge. Rare, in shallow marsh.

Eleocharis macrostachya Britt. spikerush 4 Perennial Sedge. Common, in shallow marsh or wet meadow. [*Eleocharis palustris* (L.) Roemer & J. A. Schultes]

Scirpus acutus Muhl. [hardstem bulrush] 5 Perennial Sedge. Scarce, in deep marsh and shallow marsh. [*Schoenoplectus acutus (*Muhl. ex Bigelow) A. & D. Love var. *acutus*]

Scirpus fluviatilis (Torr.) A. Gray [river bulrush] 2 Perennial Sedge. Scarce, in deep marsh (P8). [*Schoenoplectus fluviatilis* (Torr.) M. T. Strong]

Scirpus pallidus (Britt.) Fern. [pale bulrush] 5 Perennial Sedge. Rare, in wet meadow (P8).

Scirpus pungens Vahl [American bulrush] 4 Perennial Sedge. Rare, in wet meadow and shallow marsh (T2 and P8). [*Schoenoplectus pungens* (Vahl) Palla]

Poaceae Barnh., Grass Family

Agropyron cristatum (L.) Gaertn. crested wheatgrass * Perennial Grass. Scarce, in dry prairie.

Agropyron dasystachyum (Hook.) Scribn. [thickspike wheatgrass, northern wheatgrass] 3 Perennial Grass. Scarce to moderately common, in dry prairie. [*Elymus lanceolatus* (Scribn. & J. G. Sm.) Gould]

Agropyron repens (L.) Beauv. quackgrass * Perennial Grass. Very common, in low prairie. [*Elytrigia repens* (L.) Gould]

Alopecurus aequalis Sobol. short-awn foxtail 2 Perennial Grass. Moderately common, in wet meadow and drawdown areas.

Andropogon gerardii Vitman big bluestem 5 Perennial Grass. Moderately common, in prairie.

Andropogon scoparius Michx. little bluestem 6 Perennial Grass. Moderately common, in dry prairie. [*Schizachyrium scoparium* (Michx.) Nash]

Beckmannia syzigachne (Steud.) Fern. American sloughgrass 1 Annual Grass. Moderately common, in wet meadow and drawdown areas.

Bouteloua curtipendula (Michx.) Torr. sideoats grama 5 Perennial Grass. Moderately common, in dry prairie.

Bouteloua gracilis (H. B. K.) Lag. ex Griffiths blue grama 7 Perennial Grass. Moderately common, in dry prairie.

Bromus inermis Leyss. subsp. *inermis* smooth brome * Perennial Grass. Very common, in prairie.

Buchloe dactyloides (Nutt.) Engelm. buffalo grass 4 Perennial Grass. Rare, in dry prairie.

Calamagrostis stricta (Timm.) Koel. [northern reedgrass] 5 Perennial Grass. Common, in wet meadow.

Dactylis glomerata L. orchard grass * Perennial Grass. Very rare, in low prairie (T7).

Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould Scribner dichanthelium 6 Perennial Grass. Moderately common to scarce, in prairie.

Echinochloa muricata (Beauv.) Fern. var. *microstachya* Wieg. [rough barnyard grass] 0 Annual Grass. Scarce, in low prairie.

Glyceria grandis S. Wats. ex A. Gray tall mannagrass 4 Perennial Grass. Scarce to rare, in wet meadow.

Hierochloe odorata (L.) Beauv. sweetgrass 10 Perennial Grass. Rare, in wet meadow.

Hordeum jubatum L. foxtail barley 0 Perennial Grass. Common, in disturbed areas, low prairie, and drawdown areas.

Koeleria pyramidata (Lam.) Beauv. Junegrass 7 Perennial Grass. Scarce, in prairie. [*Koeleria macrantha* (Ledeb.) J. A. Schultes]

Panicum capillare L. common witchgrass 0 Annual Grass. Scarce, in wet meadow.

Panicum virgatum L. switchgrass 5 Perennial Grass. Scarce, in low prairie.

Phalaris arundinacea L. reed canary grass 0 Perennial Grass. Common, in wet meadow and shallow marsh.

Phleum pratense L. timothy * Perennial Grass. Scarce, in low prairie.

Poa palustris L. fowl bluegrass 4 Perennial Grass. Common, in wet meadow.

Poa pratensis L. Kentucky bluegrass * Perennial Grass. Very common, in prairie.

Scolochloa festucacea (Willd.) Link sprangletop, [whitetop] 6 Perennial Grass. Scarce, in shallow marsh and wet meadow.

Setaria viridis (L.) Beauv. green foxtail * Annual Grass. Moderately common, in low prairie and disturbed areas.

Spartina pectinata Link prairie cordgrass 5 Perennial Grass. Common, in wet meadow.

Stipa comata Trin. & Rupr. needle-and-thread 6 Perennial Grass. Scarce, in dry prairie. [*Hesperostipa comata* (Trin. & Rupr.) Barkworth ssp. *comata*]

Stipa viridula Trin. green needlegrass 5 Perennial Grass. Moderately common, in dry prairie. [*Nassella viridula* (Trin.) Barkworth]

Sparganiaceae Rudolphi, Bur-reed Family

Sparganium eurycarpum Engelm. [giant bur-reed] 4 Perennial Forb. Moderately common, in shallow marsh.

Typhaceae Juss., Cat-tail Family

Typha angustifolia L. narrow-leaved cat-tail * Perennial Forb. Common, in wet meadow, shallow marsh and deep marsh.

Typha latifolia L. broad-leaved cat-tail 2 Perennial Forb. Common, in wet meadow, shallow marsh and deep marsh.

Typha x *glauca* Godr. (pro sp.) [*angustifolia* x *latifolia*] [hybrid cat-tail] * Perennial Forb. Common, in wet meadow, shallow marsh, and deep marsh.

Liliaceae Juss., Lily Family

Allium stellatum Ker. pink wild onion 7 Perennial Forb. Moderately common, in prairie.

Allium textile A. Nels. & Macbr. [white wild onion] 7 Perennial Forb. Scarce, in dry prairie.

Asparagus officinalis L. [asparagus] * Perennial Forb. Very rare, in prairie (south of P3 and south of T3).

Hypoxis hirsuta (L.) Cov. yellow stargrass 8 Perennial Forb. Rare, in wet meadow.

Lilium philadelphicum L. wild lily, [prairie lily] 8 Perennial Forb. Moderately common, in low prairie.

Smilacina stellata (L.) Desf. spikenard, [false solomonseal] 5 Perennial Forb. Scarce, in woody vegetation (P1, P2, and P7). [*Maianthemum stellatum* (L.) Link]

Zigadenus elegans Pursh white camass 8 Perennial Forb. Rare, in prairie.

Iridaceae Juss., Iris Family

Sisyrinchium montanum Greene blue-eyed grass 8 Perennial Forb. Scarce, in prairie.

Smilacaceae Vent., Catbrier Family

Smilax herbacea L. carrion-flower 8 Herbaceous Vine. Very rare, (2 specimens only: P8 and T2).

DISCUSSION

The vascular flora of the Cottonwood Lake Study Area consisted of 220 species (187 native and 33 non-native) representing 52 families and 147 genera. The five families with the largest number of species were Asteraceae (45 species), Poaceae (30 species), Fabaceae (15 species), Rosaceae (12 species), and Cyperaceae (11 species). Twenty-one families were represented by only a single species. Perennial forbs (117 species) accounted for over half of the total species present (Fig. 3). Perennial grasses (26 species) made up the next largest physiognomic group, followed by annual forbs (22 species).

The mean C for the vascular flora of the Cottonwood Lake Study Area calculated from our list was 4.6 with a FQI of 62, which indicated that the area has a relatively intact native plant community. Theoretically, an intact native plant community will have representatives of all coefficient of conservatism categories (0

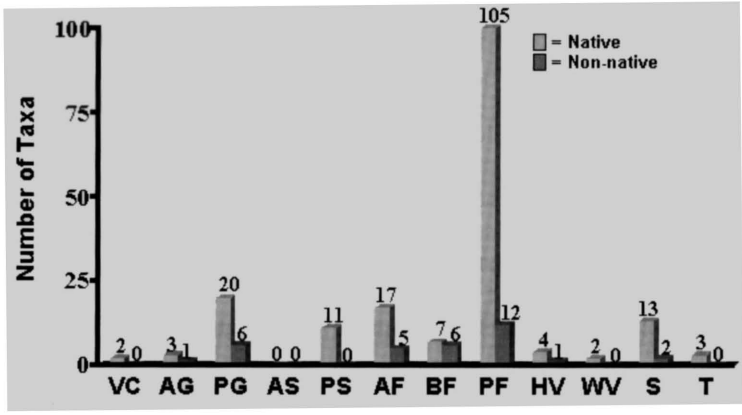

Figure 3. Distribution of native and non-native plant taxa occurring in the Cottonwood Lake Study Area, Stutsman County, North Dakota, by physiognomic class. VC = vascular cryptogams, AG = annual grasses, PG = perennial grasses, AS = annual sedges, PS = perennial sedges, AF = annual forbs, BF = biennial forbs, PF = perennial forbs, HV = herbaceous vines, WV = woody vines, S = shrubs, and T = trees.

to 10) and therefore a mean C value close to five. Mean C values greater than 3.5 or FQI values greater than 35 rarely are achieved in even the best attempts at prairie ecosystem restoration (Swink and Wilhelm 1994). Thus, loss of sites such as the Cottonwood Lake Study Area that have relatively high mean C and FQI values likely would be an immitigable event, given current restoration technology. By conducting floristic surveys and performing floristic quality assessments, other areas with high quality native plant communities can be identified (Northern Great Plains Floristic Quality Assessment Panel 2001). Additionally, qualitative changes to the native plant communities can be identified and monitored by repeating surveys and tracking mean C and FQI values over time.

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