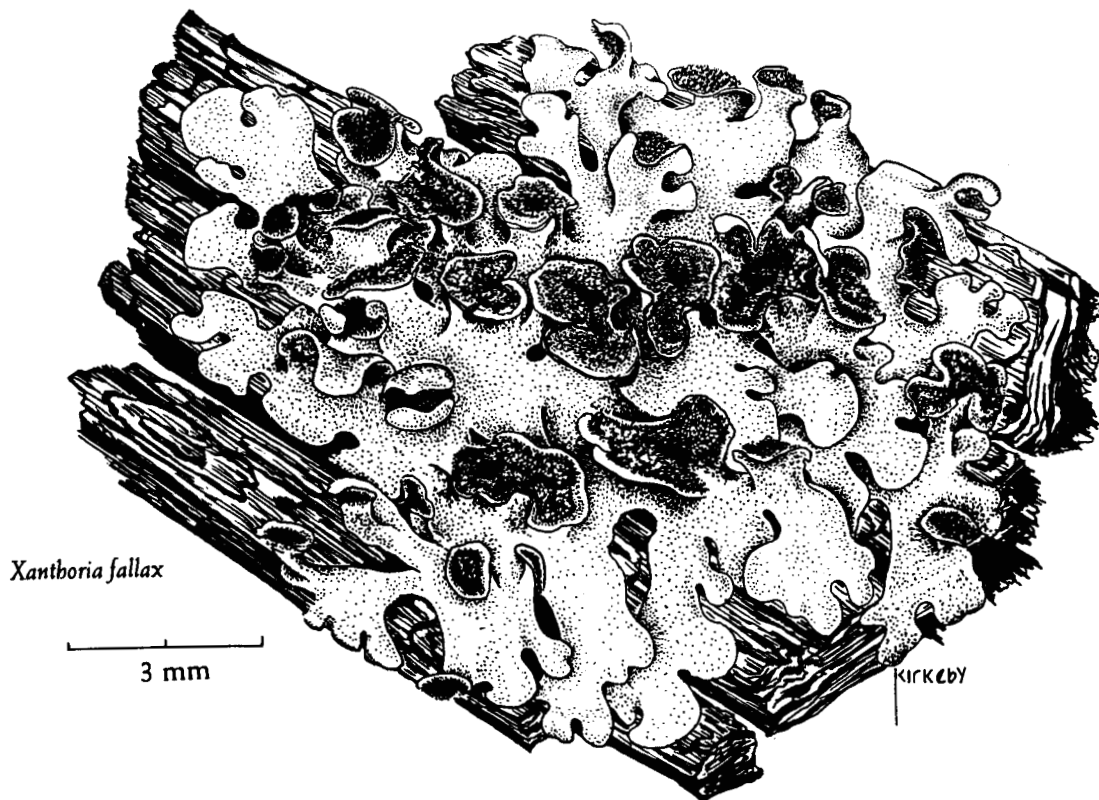


**THE LICHENS OF  
KNIFE RIVER INDIAN VILLAGES  
AND  
FORT UNION TRADING POST NATIONAL HISTORIC SITES**

PREPARED FOR  
NATIONAL PARK SERVICE  
AND  
U.S. GEOLOGICAL SURVEY  
BIOLOGICAL RESOURCES DIVISION  
MADISON, WISCONSIN

PURCHASE ORDER # 8MWSA00037



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April 1999



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**KNIFE RIVER INDIAN VILLAGES**  
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**Final Report**

**Prepared for**  
**National Park Service**  
**and**

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**Biological Resources Division**  
**Madison, WI**

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## ABSTRACT

**This** study of the lichens of Knife River Indian Villages and Fort Union Trading Post National Historic Sites was designed to collect lichens for lichen species lists and to collect lichens for elemental analysis (if suitable species **occurred**). Each park is treated in a separate section of **this** report. Ten localities were studied in Knife River and four in Fort Union. **No** suitable species were found in either park for elemental analysis.

The lichen floras **are** reasonably diverse for each **area**. There were **46** species present in Knife River **and** **41** species present in Fort Union. **One** locality in Fort Union was especially rich (Bodmer Overlook) **and** should be protected. All of the lichens found were in good health and with **normal** fertility. There **seemed** to be no **indications** of threatening **air quality** problems (primarily from *sulfur* dioxide) in these parks.

Recommendations are for a complete lichen restudy of the lichen **flora** every 10-15 years. If construction or maintenance activities are **planned** within these areas a lichenologist should be **consulted to** prevent loss of critical habitats **and** species.

## PREFACE

Under a purchase order **from** the Biological **Resources** Division of the US Geological Survey, Madison, **WI**, a lichen study was performed in Knife River and Fort Union National Historic Sites. The objectives were to survey **the** lichens in each park, produce an inventory of the lichen flora, collect and analyze lichens for chemical contents (if suitable species were present), **and** evaluate the lichen flora with reference to the **air** quality. **This** establishes **baseline** data to determine the future changes in the lichen flora and contributes to the knowledge of the biodiversity of the National Parks. All herbarium work was done at the University of Minnesota Herbarium with consultation with Dr. James P. Bennett of USGS and **with** personnel in the parks.

The floristic parts of ~~this~~ report **are** divided into two sections one for each park.

All Park Service personnel have **been** very helpful during the field work which has contributed significantly to the **success** of the project. The study was made possible by **funds** from the **USGS** Biological **Resources** Division. Dr. James **P. Bennett** contributed in discussions and ideas and in **making** the **funds** available for the study. The **assistance** of all of these is gratefully acknowledged.

## INTRODUCTION

Lichens are composite plants composed of two different **types** of organisms. The lichen plant body (**thallus**) is made of fungi and algae living together in a symbiotic arrangement **in** which both partners **are** benefited and the composite plant body can grow in places where neither component could live alone. The **thallus** has no protective layer on the outside, such **as** the epidermis of a leaf, **so** the **air** in the **thallus** has free exchange with the atmosphere. Lichens are slow growing (a few millimeters **per** year) and remain alive for many years and so they must have a habitat that is relatively **undisturbed** in order to survive. Lichens vary greatly in their ecological requirements but almost **all** of them can grow in places that only receive periodic moisture. When moisture is lacking they go dormant **until** the next rain or dew-fall. Some species can grow in habitats with very **infrequent** **occurrences** of moisture while others need high **humidity** and frequent wetting in order to survive. This difference in moisture requirements is very important in the distribution of lichens.

Lichens are known to be very sensitive to low levels of many atmospheric pollutants. Many **are** damaged or killed by levels of **sulfur** dioxide, nitrogen **ox-**ides, fluorides or ozone alone or in various combinations. Levels of **sulfur** dioxide **as low as** 13  $\mu\text{g}/\text{cubic meter}$  (**annual** average) will **cause** the death of some lichens (LeBlanc et al., 1972). Other lichens are less sensitive and a few can tolerate levels

of sulfur dioxide over **300**  $\mu\text{g}/\text{cubic meter}$  (Laundon, 1967, Trass, 1973). The algae of the thallus are the **first** to be **damaged** in areas with air pollution and the first indication of damage is discoloring and death of **the** algae causing bleached lobes, which quickly leads to the death of the lichen. After the lichen dies it disappears from **the** substrate within a few months to a year **as** it disintegrates and decomposes (Wetmore, 1982).

Lichens **are more** sensitive to **air** pollution when they **are** wet and physiologically active and **are** least sensitive **when dry** (Nash, 1973, Marsh & Nash, 1979) and **are** more sensitive when growing on acid substrates.

Contrary to some published **reports** (Medlin, 1985) there **is** little evidence **that** most lichens **are** good **indicators** of acid precipitation. However, Sigal & Johnston (1986) have reported that one species of Umbilicaria shows visible damage due to artificial acid **rain**. They also **report** that **similar** symptoms were found in collections from various localities in North America. Lechowicz (1987) reported that acid rain only slightly reduced **growth** of Cladina stellaris but Hutchinson et al. (1986) reported that extremely acid precipitation (less than pH 3.5) killed or damaged some **mosses** and lichens. Scott & Hutchinson (1987) showed temporary reduction of photosynthesis in Cladina stellaris and C. rangiferina after artificial acid **rain**.

Lichens **are** able to accumulate chemical elements in excess of their metabolic needs depending on the levels in **the** substrate and the **air**, and, **since** lichens are slow **growing** and long lived, **they** serve **as good summarizers** of the environmental conditions in which they **are** growing. Chemical analysis of the **thallus** of lichens growing in **areas** of high fallout of **certain** elements **will** show elevated levels in the **thallus**. Toxic **substances** (such as *sulfur*) **are** also accumulated and determination of the levels of these toxic elements can provide indications of the sublethal but elevated levels in the **air**.

## METHODS

Field work was done during **June 1998** by the author. A complete list of collection localities for each park is given at the end of each park section of the report. Collection localities, about **1** acre in **size**, were selected **first** to give a general coverage of the park, **second**, to sample **all** vegetational **types**, and third, to be in localities that should be rich in lichens. Undisturbed **as well as disturbed** habitats (such **as** old roadsides and **trails**) were studied. At each locality voucher specimens of **all** species found were collected to record the total flora for each locality and to avoid missing different species that might appear similar in the field. No species were found that would be satisfactory for elemental **analysis**. While collecting at each locality observations were made about the general health of the lichens. Lichen health was evaluated by looking for damaged or dying lichens where collections were **made**. **The** presence of many dead, dying, or abnormal thalli of particular species at a locality would indicate poor health, but **an** occasional damaged **thallus** is not significant.

Identifications were carried out at the University of Minnesota with the aid of comparison material in the herbarium **and** using **thin** layer chromatography for identification of the lichen substances where **necessary**. **The** original packet of each collection has **been** deposited in the University of Minnesota Herbarium. All specimens deposited at **the** University of Minnesota have **been** entered into the herbarium computerized database maintained there.

The following **lists** of lichens **are** based on these collections. Species found only **once** are indicated by "Rare". In the first columns the letters indicate the sensitivity to **sulfur** dioxide, if known, according to the categories proposed by Wetmore (1983): S=Sensitive, I=Intermediate, T=Tolerant. S-I is intermediate **between** Sensitive and Intermediate and I-T is intermediate **between** Intermediate and Tolerant. Species in the Sensitive category are absent when **annual** average levels of sulfur dioxide are above **50**  $\mu\text{g}$  per cubic meter. The Intermediate cate-

gory includes those species present **between 50** and 100  $\mu\text{g}$  and those in the Tolerant category are present at over 100  $\mu\text{g}$  per cubic meter. **Those** species without sensitivity designations have unknown sensitivity.

Some of the species found only **once are** rare wherever they **are** found throughout their distributional range and might be found at other localities with further searching **and** others **may require** special substrates that are rare in the park. The cases of rarity do not necessarily reflect sensitivity damage from *sulfur* dioxide.

The lack of species in the most sensitive category probably does not indicate poor **air** quality. Most of the species with known sensitivities **are** northern species which are lacking in the parks **because** of climatic factors. The presence of some lichens with blue green algae (that **are** more sensitive to *sulfur* dioxide) also indicates that there is probably no **air** quality problem in the parks. In addition, there are no important pollution **sources** near the parks.

Most lichen species **are** unknown as to sensitivity category. In areas of high *sulfur* dioxide the tolerant category would have more species and the most sensitive categories would have fewer species. The Rare species in **are** not **necessarily** related to **air** quality (see above). The only way to determine past **air quality** impacts on the present lichen species inventory is by comparison with historical **data** (from **before** the presumed impacts *occurred*). **Since there are** no historical plant lists from these parks it cannot be determined whether **the** present lichen **flora has** changed prior to this study.

## KNIFE RIVER NATIONAL HISTORIC SITE

This park in **central** North Dakota was established in **1974** and has almost **1,760** acres. The park includes low bluffs along the Knife River and one area in the northern part with low **hills** overlooking the Missouri River with some rocky prairies on top. The most common trees along the river are **green ash** (Fraxinus pennsylvanica), cottonwood (Populus deltoides), **willow** (Salix), boxelder (Acer negundo), and a few american elm (Ulmus americana). In a few places there are juniper (Juniperus).

Lichen collections were made at 10 localities in the park and **191** collections were made.

### KNIFE RIVER SPECIES LIST

- T Amandinea punctata (Hoffm.) Coppins & Scheid.  
S-I Calodlaca cerina (Ehrh.) Th. Fr.  
Calodlaca chrysophthalma Degel.  
S Calodlaca flavorubescens (Huds.) Laund. **Rare**  
Calodlaca lactea (Mass.) Zahlbr.  
Caloplaca microphyllina (Tuck.) Hasse  
S-I Candelaria concolor (Dicks.) B. **Stein**  
Candelariella aurella (Hoffm.) Zahlbr.  
Candelariella deflexa (Nyl.) Zahlbr.  
Candelariella rosulans (Müll. Arg.) Zahlbr. **Rare**  
Candelariella subdeflexa (Nyl.) **lett.**  
Catapyrenium lachneum (Ach.) R. **Sant. Rare**  
Cladonia rei Schaer. **Rare**  
Cladonia symphylicarpa (Ach.) Fr. **Rare**  
Diploschistes muscorum (Scop.) R. **Sant.**  
Endocarpon pusillum Hedw.  
I Evernia mesomorpha Nyl. **Rare**  
Fulgensia subbracteata (Nyl.) Poelt  
Hypocenomyce friesii (Ach. in Lilj.) P. James & G. Schneid.  
T Lecanora hagenii (Ach.) Ach. **Rare**  
Lecanora impudens Degel.  
Lecanora piniperda Körb.  
I Lecanora saligna (Schrad.) Zahlbr.  
Parmelia flaventior **Stirt.**  
I-T Parmelia sulcata Tayl. **Rare**  
Peltula patellata (Bagl.) Swins. & Krog **Rare**  
Phaeophyscia cernohorskyi (Nadv.) Essl.  
Phaeophyscia ciliata (Hoffi.) **Moberg**  
Phaeophyscia hirsuta (Meresch.) Essl.  
Phaeophyscia melanchra (Hue) Hale  
I Physcia adscendens (Th. Fr.) **Oliv.**  
I Physcia aipolia (Ehrh. ex Humb.) Färnrr.

Physcia biziana (Mass.) Zahlbr.  
Physcia caesia (Hoffm.) Färn. Rare  
Physcia stellaris (L.) Nyl.  
Psora decipiens (Hedwig) Hoffm.  
Rhizopla melanophthalma (DC. in Lam. & DC.) Leuck. & Poelt Rare  
Rinodina dakotensis Magn.  
Rinodina milliaria Tuck.  
Sarcogyne regularis Körb. Rare  
 S-I Usnea hirta (L.) Weber ex Wigg. Rare  
Verrucaria glaucovirens Grumm. Rare  
Verrucaria muralis Ach.  
Verrucaria nigrescens Pers. Rare  
 S-I Xanthoria fallax (Hepp in Am.) Am.  
Xanthoria hasseana Räs.

## DISCUSSION OF LICHEN FLORA

This species list of 46 species gives the first lichen records from the park. Most of the species are the common ones found on trees in the central United States. The low precipitation and lack of abundant rocks limits the numbers of lichens present and the single locality above the Missouri River was the only one with sparsely vegetated prairie where the soil species usually occur. The most common lichens were Calodlaca cerina, Candelaria concolor, Phaeophyscia melanchra, Physcia adscendens, and Xanthoria fallax. These are very common on most of the trees.

The locality with the greatest number of rare lichens was Locality 4, at the north end of the park above the Missouri River with six rare species. This locality probably is more moist on the steep east-facing bluff and has bare soil along the crest, both providing better habitats for lichens. It is the only such habitat in the park. The lichens found there are not rare in other parts of the country.

## KNIFE RIVER NATIONAL HISTORIC SITE COLLECTION LOCALITIES

Collection numbers are those of Clifford Wetmore. All collections are listed in ascending order by number and date of collection. All localities are in Mercer County, North Dakota. The latitude and longitude were taken by GPS unit at each of the collection sites.

Locality 1. #79826-79844: At N edge of **Stanton** and **S** edge of park along Knife River. In woods above river with cottonwood, **green** ash, and boxelder. Sec. 6, T144N, T84W. 47°19'28"N, 101°22'30"W. 18 June 1998.

Locality 2. #79845-79859; 2 **mi** N of visitors center. In woods **on** W side of Knife River with dead **green** ash, willow, elm, and boxelder. **Sec.** 28, T145N, R84W. 47°21'08"N, 101°23'33"W. 18 **June** 1998.

Locality 3. #79860-79871: 2 **mi** N of headquarters **on** E side of Knife River. Along river with green ash, willow, and boxelder. **Sec.** 27, T145N, R84W. 47°21'18"N, 101°22'56"W. 18 June 1998.

**Locality 4.** #79872-79908: North end of park above Missouri River. **On** steep E facing hillside with **green** ash, boxelder, and dead **american** elm. Sec. 16, T145N, R84W. 47°22'41"N, 101°23'23"W. 19 June 1998.

Locality **5.** #79909-79913: North end of park **on** prairie ridges above **Mis-**  
**souri** River with some glacial erratics. Sec. 16, T145N, R84W. 47°22'26"N, 101°23'19"W. 19 June 1998.

Locality 6. #79914-79928; **Missouri** River **bottom**, 2.5 **mi** N of headquar-  
**ters.** In woods along river flats with green ash, willow, and boxelder. **Sec.** 21, T145N, R84W. 47°22'38"N, 101°23'09"W. 19 June 1998.

Locality 7. #79929-79947: South end of park along loop trail **NE** of **Stan-**  
**ton.** In river flats with **green** ash and boxelder. **Sec.** 34, T145N, R84W. 47°19'53"N, 101°22'32"W. 19 **June** 1998.

Locality **8.** #79948-79977; **Half** mile **NE** of headquarters. In woods **along**  
Knife River with dead **green** ash **and** boxelder and *small* prairie **knoll.** **Sec.** 33, T145N, R84W. 47°20'23"N, 101°23'10"W. 20 June 1998.

Locality 9. #79978-79994: 1.5 **mi** N of headquarters. **Near** Knife River in  
**mostly** dead green ash woods with some boxelder and cottonwood. **Sec.** 28, T145N, R84W. 47°21'00"N, 101°22'59"W. 20 June 1998.

Locality 10. #79995-80016: North edge of park **0.5** mi N of **small** road east

on Missouri River lowlands. In woods with green ash, boxelder, and some american elm. Sec. 21, T145N, R84W. 47°21'42"N, 101°23'03"W. 20 June 1998.

## FORT UNION NATIONAL HISTORIC SITE

This park is in the western edge of North Dakota along the **Missouri** River and was established in 1966 with about **445** acres. The park is largely grassland with narrow river bluffs but the unit north of the road **has a** hill (Bodmer Overlook) in a pasture. Most of the **grasslands** around the fort have recently **been** cultivated to restore the prairie vegetation and now have no lichens. The river floodplain and banks have cottonwood (Populus deltoides), **green** ash (Fraxinus pennsylvanica), boxelder (Acer negundo), and willow (**Salk**). Bodmer overlook is in an active pasture with **natural** prairie vegetation and rocks but **no trees** on the hilltop.

Lichen collections were made at four localities and 90 collections were made along the north bank of the river and on the ridgetop at Bodmer Overlook. The unit south of the river is a river floodplain and was checked but no collections were made there.

## FORT UNION SPECIES LIST

- Agrestia hispida (Meresch.) Hale & W. Culb. **Rare**  
Buellia elegans Poelt **Rare**  
S-I CaloDlaca cerina (Ehrh.) Th. Fr. **Rare**  
CaloDlaca decipiens (Arn.) Blomb. & Forss. **Rare**  
Caloplaca lactea (Mass.) Zahlbr. **Rare**  
CaloDlaca trachyphylla (Tuck.) Zahlbr. **Rare**  
S-I Candelaria concolor (Dicks.) B. **Stein**  
Candelariella aurella (**Hoffm.**) Zahlbr. **Rare**  
Candelariella deflexa (Nyl.) Zahlbr.  
Candelariella rosulans (Müll. Arg.) Zahlbr. **Rare**  
Catapyrenium lacinulatum (Ach.) Breuss **Rare**  
Cladonia symphycarpa (Ach.) Fr. **Rare**  
Collema tenax (Sw.) Ach. **Rare**  
Diplotomma venustum (Körb.) Korb. **Rare**  
Endocarpon pusillum Hedw. **Rare**  
Fulgensia subbracteata (Nyl.) Poelt **Rare**  
Lecidella euphorea (Fldrke) Hert. **Rare**  
Lecidella patavina (Mass.) Knoph & Leuck. **Rare**  
Parmelia exasperata De Not. **Rare**  
Peltula patellata (Bagl.) Swins. & Krog **Rare**  
Phaeophyscia Ciliata (Hoffm.) Moberg **Rare**  
Phaeophyscia hirsuta (Meresch.) Essl.  
Phaeophyscia melanchra (Hue) Hale  
I-T Phaeophyscia nigricans (Fldrke) Moberg **Rare**  
I Physcia adscendens (Th. Fr.) Oliv.

- I **Physcia** **aiopolia** (Ehrh. ex Humb.) Färn. Rare  
**Physcia** **biziana** (Mass.) Zahlbr.  
**Psora** **cerebriformis** W. Weber Rare  
**Psora** **decipiens** (Hedwig) Hoffm. Rare  
**Rhizoplaca** **chrysoleuca** (Sm.) Zopf Rare  
**Rinodina** **bischoffii** (Hepp) Mass. Rare  
**Rinodina** **dakotensis** Magn. Rare  
**Rinodina** **milliaria** Tuck. Rare  
**Sarcogyne** **regularis** Körb. Rare  
**Staurothele** **areolata** (Ach.) Lett. Rare  
**Staurothele** **drummondii** (Tuck.) Tuck. Rare  
**Toninia** **sedifolia** (Scop.) Timdal Rare  
**Verrucaria** **muralis** Ach. Rare  
**Xanthoria** **elegans** (Link) Th. Fr. Rare  
S-I **Xanthoria** **fallax** (Hepp in Am.) Am.  
**Xanthoria** **hasseana** Räs. Rare

## DISCUSSION OF LICHEN FLORA

This lichen list of **41** species is the **first** for the park. The lichen **flora** of the river banks and floodplain is poor and **uniform** and the species **are** those common on trees in the **central United States**. Bodmer Overlook is much richer **because** of less vascular plant competition **and** more **open rocky** soil. The **grazing** activity on the **hill** seems not to be so **intense as** to damage the lichen flora. The most common species in the park along the river were **Candelariella** **deflexa**, **Phaeophyscia** **melanchra**, **Physcia** **biziana**, and **Xanthoria** **fallax**. These are common lichens on the trees along the river.

The locality with the greatest number of Rare lichens was locality **4**, Bodmer Overlook, with **25** Rare species. The Bodmer Overlook locality was unique because of the rocks and the **thin** soil with less vascular plant competition. It is the **only** such habitat in the park. The lichens found there are not rare in other parts of the country. **This** area deserves **special** protection **since** over **half** of the species in the park lichen flora were found there. **The** pasture **grazing** need not be **curtailed** but should not be increased in intensity. Additional tourist activity would probably damage the soil lichens and should **be** discouraged.

## FORT UNION COLLECTION LOCALITIES

Collection numbers **are** those of Clifford Wetmore. All collections are listed in ascending order by number and **date** of collection. Localities **are** in Williams County, **North** Dakota and Roosevelt County, Montana. The latitude and longitude were taken by **GPS** unit **at** each of the collection sites.

Locality 1. #80195-80204: **North** Dakota, **Williams** Co. Along Missouri River below fort. **On** trees along upper **bank** of river **with** cottonwood, **green** ash, and some willow, elev. 1900 ft. **Sec.** 7, T152N, R104W. 47°59'46"N, 104°02'27"W. 25 June 1998.

Locality 2. #80205-80227: Montana, Roosevelt Co. Along Missouri River W of fort. In **flood** plain with boxelder, **green** ash, and some american elm, elev. 1900 ft. **Sec.** 13, T26N, R59E. 48°00'03"N, 104°02'49"W. 25 June 1998.

Locality 3. #80228-80239: **North** Dakota, Williams Co. **At** E end of park **near** residences. **On** bank above **flood** plain with boxelder, green **ash**, and american elm, elev. 1900 ft. **Sec.** 7, T152N, R104W. 47°59'46"N, 104°01'54"W. 25 June 1998.

Locality 4. #80240-80284: **North** Dakota, Williams Co. Bodmer Overlook, N of fort. **On** hill in prairie with some glacial erratics, elev. 2000 ft. **Sec.** 7, T152N, R104W. 48°00'36"N, 104°01'51"W. 26 June 1998.

## ELEMENTAL ANALYSIS

This sensitive method of indicating the presence of **air** pollution could not **be used** in either of these parks. **The** best lichens for elemental analysis **are** foliose or fruticose species growing **on trees**. Lichens **on rocks** and **soil** **are** less efficient accumulators of air pollutants. Adequate quantities of suitable species were not present in either park.

## CONCLUSIONS FROM THE STUDY OF BOTH PARKS

The species reported will significantly contribute to the knowledge of the biodiversity of these parks and the state. The lichen floras of these parks are typical of the western prairies and these studies provide important baselines for these areas.

There are no indications that the lichens of the two parks are being damaged by the air quality. The lichen flora is normal for such areas and there is no impoverishment of the lichen flora in either park. The rarity of some species seems to be due more to ecological and climatic conditions than pollution since these species are quite healthy when present. There is no evidence of damaged or dead lichens in any area where healthy ones are not also present.

One locality in each park is noteworthy of special protection because of the relatively large number of rare lichens found there. These are Locality 4 in Knife River NHS, hillside overlooking the Missouri River, and Locality 4 in Fort Union, Bodmer Overlook. These localities are special because the habitats they include are rare in the parks. The rare species found in these areas are not rare in other parts of North America.

## RECOMMENDATIONS

These recommendations apply to both parks.

1. A complete floristic restudy should be done every 10-15 years.
2. The localities with numerous rare lichens should receive special protection to prevent loss of species.
3. If plans are developed to do extensive trail construction or maintenance in the parks, a lichenologist should be consulted to help design the work so that rare lichens are not lost.

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