Working

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

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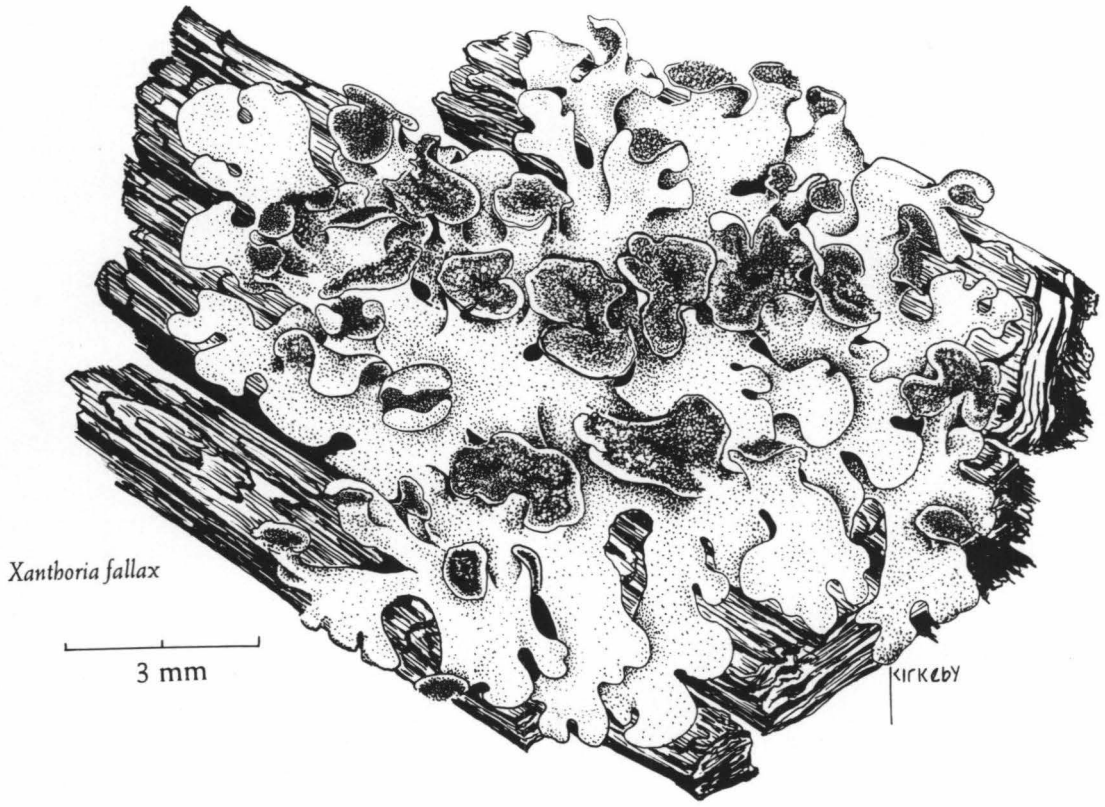

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Final Report

Prepared for

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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 oxides, fluorides or ozone alone or in various combinations. Levels of sulfur dioxide as low as 13 μg/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 μg/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 μg per cubic meter. The Intermediate cate-

gory includes those species present between 50 and 100 μg and those in the Tolerant category are present at over 100 μg 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 species 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 Caloplaca cerina (Ehrh.) Th. Fr.
Caloplaca chrysophthalma Degel.
S Caloplaca flavorubescens (Huds.) Laund. **Rare**
Caloplaca 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 symphycarpa (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 (Hoffm.) Moberg
Phaeophyscia hirsuta (Meresch.) Essl.
Phaeophyscia melanchra (Hue) Hale
I Physcia adscendens (Th. Fr.) Oliv.
I Physcia aipolia (Ehrh. ex Humb.) Fürnr.

Physcia biziana (Mass.) Zahlbr.
Physcia caesia (Hoffm.) Fürnr. **Rare**
Physcia stellaris (L.) Nyl.
Psora decipiens (Hedwig) Hoffm.
Rhizoplaca 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 Arn.) Arn.
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 Caloplaca 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 Missouri 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 headquarters. 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 Stanton. 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 (Salix). 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 Caloplaca cerina (Ehrh.) Th. Fr. **Rare**
Caloplaca decipiens (Arn.) Blomb. & Forss. **Rare**
Caloplaca lactea (Mass.) Zahlbr. **Rare**
Caloplaca 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.) Körb. **Rare**
Endocarpon pusillum Hedw. **Rare**
Fulgensia subbracteata (Nyl.) Poelt **Rare**
Lecidella euphorea (Flörke) 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 (Flörke) Moberg **Rare**
I Physcia adscendens (Th. Fr.) Oliv.

I Physcia aipolia (Ehrh. ex Humb.) Fürnr. **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 Arn.) Arn.
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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