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**THE NIOBRARA VALLEY PRESERVE:
AN INVENTORY OF A BIOGEOGRAPHICAL CROSSROADS**

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ABSTRACT

This paper synthesizes results of a biological inventory of a 219-km² nature preserve in the central Niobrara Valley of Nebraska. The two-year inventory documented the presence of 80 species of mosses and liverworts, 581 of vascular plants, 130 of aquatic invertebrates and 278 of vertebrate animals. Comparison with distribution records from four other counties in Nebraska shows that the Niobrara study site has higher vertebrate species diversity despite its smaller area. Although the study area is in the central grasslands of North America, many of the species here are more typical of forest biomes far to the east, north and west. Local geohydrological features and historical events contribute to this unique mix of species and communities.

† † †

The one-hundredth meridian in the North American grasslands has long been recognized for a transition in eastern and western plant and animal communities (Bessey, 1887; Pound and Clements, 1898; Tolstead, 1942, 1947; Webb, 1931). In recognition of the biogeographical significance of this area, The Nature Conservancy, a private, non-profit land preservation organization, purchased in 1980 a 219-km² tract in the Niobrara Valley of north central Nebraska. Although the Conservancy obtained title to the land before hard data were obtained on the preservation significance of this particular parcel, there was sufficient evidence (anecdotal or published) that significant elements of biological diversity were present in the area. During 1982 and 1983, the Conservancy conducted basic research and inventory work at the site. The objectives of the inventory were to document the preservation significance of the preserve and to provide a core of biological data for a comprehensive management plan to guide the Conservancy in long-term management

and use of the preserve. Although certain pieces of inventory results have been published elsewhere (Brogie and Mossman, 1983; Churchill, 1985; Churchill et al., 1988; Freeman and Churchill, 1983; Kaul et al., 1988; Mossman and Brogie, 1983), the sole comprehensive report on the results of this intensive ecological survey is available only as an unpublished, internal report to the Conservancy (Kantak, 1983). Thus the purpose of this paper is to synthesize inventory results and quantify vertebrate species diversity in order to document the biogeographic significance of the Niobrara Preserve area.

STUDY AREA

The study area is located in north-central Nebraska along an approximately 50-km stretch of the Niobrara River in northwestern Brown, northeastern Cherry, and southwestern Keya Paha counties (Fig. 1). The inventory focused on the Niobrara Valley Preserve, the tract purchased and managed by The Nature Conservancy, although some of the surveys covered parcels of adjacent land under private ownership.

This reach of the Niobrara River valley is distinctive in the co-occurrence of several distinctly different habitat types within only a few kilometers of each other. An eastern deciduous forest element covers much of the river floodplain and south wall of the valley. On this side of the river, tallgrass prairie is found in some of the lowland meadows, with sandhills prairie at higher elevations between the canyons cut by tributaries of the Niobrara River. Western pine forest is well-developed on the steep eroding cliffs of the north wall of the river valley, with mixed prairie on the flat tableland above. In some favorable habitats such as

around cold springs or springfed seeps on the south wall of the river valley is found a boreal-type community with paper birch (*Betula papyrifera*) and associated species of mixed conifer-aspen forests or cold-water marsh and fen habitats.

FIELD METHODS

Flora

Two botanists surveyed the plants; one was in the field from 26 April to 22 October 1982 and during portions of June and August 1983, the other from 17 May to 20 August, 1982. An attempt was made to document all species present in the study area by means of checklists and collections. Field surveys emphasized springbranch canyons, escarpments and floodplain forests although all vegetation zones were surveyed during the two-year inventory. Because of the potential for the occurrence of species at the extremes of their ranges, all of the major springbranch canyons on the south side of the Niobrara River and the only known springbranch canyon on the north side were surveyed. Relatively little sandhill prairie was surveyed as this was not habitat for the outlier species potentially occurring in the study area. A full set of herbarium specimens is deposited at the University of Nebraska-Lincoln State Museum; representative sets are at Kansas State Uni-

versity and the New York Botanical Garden and a reference collection is at the Niobrara Valley Preserve.

Aquatic sampling

One field assistant collected fulltime from 17 May to 3 September 1982. Twenty sites on the Niobrara River between the Ft. Niobrara Wildlife Refuge and the Meadville Bridge were sampled. Forty-three of the approximately 108 springbranch tributaries to this segment of the Niobrara were also sampled. Some of the larger creeks were sampled at several locations. The Niobrara River was sampled with a 50-ft (15.2 m) bag seine with quarter-inch (0.6 cm) mesh. A 10-ft. (3 m) minnow seine with quarter-inch mesh and dipnets with eighth-inch (0.3 cm) mesh were used to sample most of the major springbranch creeks and some of the smaller creeks in the study area, as well as beaver ponds. Aquatic invertebrates were collected with nets or by hand. Representative individuals of fish species and macroinvertebrates at each site were collected. All fish and representative invertebrate specimens are in the Niobrara Valley Preserve collection. Some duplicates of invertebrates were retained by the Kansas Biological Survey which helped identify specimens.

Herptiles

One person worked fulltime on surveying herptiles

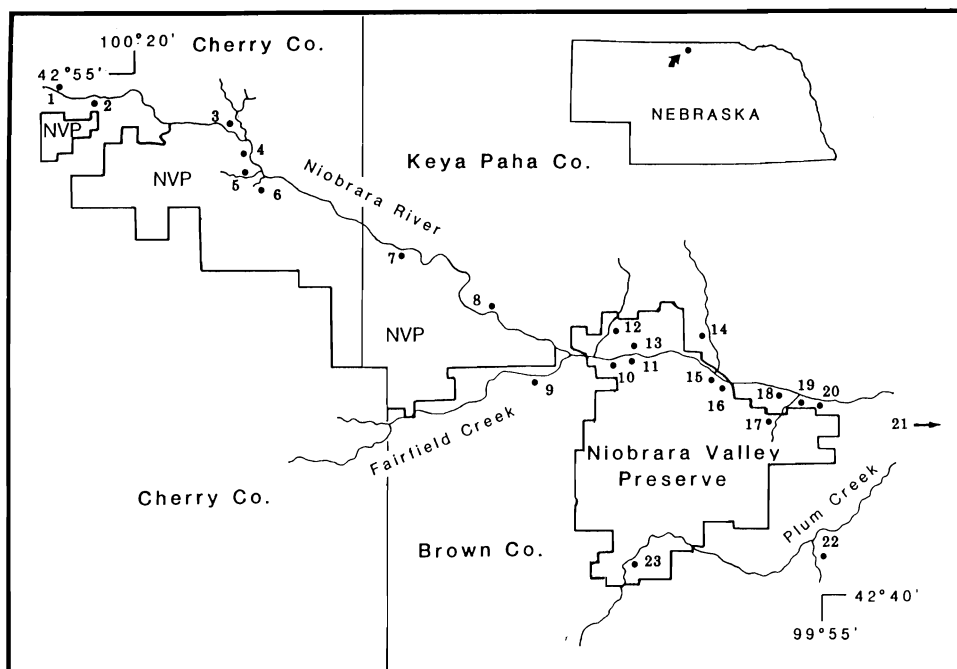


Figure 1. Map of the Niobrara Valley Preserve (NVP) and adjacent land in north-central Nebraska. Preserve boundaries are as of 1982-1983. Numbers 1-23 refer to major sites surveyed and to local names given to collections during the inventory: 1. canyons S and W of Sparks; 2. Berry Bridge; 3. canyons S of Sparks; 4. Smith Falls; 5. Big Cedar Creek; 6. Little Cedar Creek; 7. Rock Barn Marsh; 8. Sunnybrook Marsh; 9. Fairfield Creek; 10. NVP headquarters area; 11. Birch Hollow; Horsetail Canyon and Dicranum Gorge; 12. East Middle Creek; 13. Turkey Vulture Point; 14. Turkey Creek; 15. Barney Creek; 16. Garden Creek; 17. Hazel Creek; 18. Old Kirkpatrick Ranch; 19. Jeff Creek; 20. Tickclover Canyon, Aggrivation Rockbed and Smith Creeks, Rhodobryum Gorge and Kantak Coulee; 21. Buzzard Canyon and Dutch Creek; 22. Quinn Canyon; 23. Plum Creek area.

during the period 17 May to 27 August 1982. Most effort was directed toward mesic habitats where peripheral species might be found, namely floodplain and wetland communities. Less time was allocated toward sandhill prairie, mixed prairie or ponderosa pine woodland as these were not likely to produce species of biogeographical interest. Springbranch canyons were best surveyed south of the Niobrara River; only two canyons north of the river and west of the Niobrara Valley Preserve headquarters were sampled. Visual surveys of herptiles were recorded and voucher specimens were collected. Representative specimens were retained for the Niobrara Valley Preserve collection whereas specimens documenting county records were donated to the University of Nebraska–Lincoln Museum. Other duplicates were donated to Texas A & M University.

Birds

Two personnel worked fulltime on bird surveys from 5 April to 3 September 1982; one of them continued until 1 October 1982. Birds were surveyed by walking transects and locating birds by sight or sound. Owls were solicited at night with tape-recorded calls. Records or leads were solicited from other personnel and from local residents. No netting or other collecting was done. Most of the study area was surveyed several times except for canyons in the northwest sector which were difficult to survey due to transportation problems.

Mammals

One person surveyed mammals fulltime from 12 April to 5 November 1982 with occasional help from other personnel. Not all sites were surveyed for all mammals because of the variety of survey techniques required and limited time, personnel and equipment. Visual observation was done by daylight or at night with the aid of a spotlight. Nocturnal-predator calling and spotlight surveying by truck and on foot were used to survey some predators. The two largest prairie-dog towns (in North Hanna and Salzman pastures) were surveyed monthly at night with spotlights for black-footed ferrets (*Mustela nigripes*) but none were spotted. Tomahawk livetraps or leg-hold traps modified to minimize injury were set in appropriate habitat in attempts to locate other carnivores (e.g. weasels, foxes, skunks). Small mammals were trapped in scattered locations mostly south of the Niobrara River. Pitfall traps were placed in appropriate habitat for shrews and Sherman livetraps were used to sample small rodents. Occurrences of the eastern woodrat (*Neotoma floridana* subsp. *baileyi*) were noted by trapping or by discovery of active middens reported by inventory staff. Bats were sampled mostly in springbranch canyons or on river terraces, although some waterholes in the sandhills were sampled as well. Mist nets and bat traps were set up along bat flyways and checked throughout the night. Voucher

specimens of each of the bats and small rodents captured during the inventory are deposited at the Niobrara Valley Preserve. Duplicates of some are located at the University of Nebraska–Lincoln and at the University of Nebraska at Kearney.

RESULTS OF PLANT INVENTORY

Mosses

The inventory recorded 73 species of mosses and seven species of liverworts from the Niobrara Valley Preserve area (Churchill, 1985). Fourteen mosses were new state records, nine of which are biogeographically important (peripheral species or range extensions). The distributional affinities of representative taxa are given in Table 1. Most species have eastern affinities, but among these are taxa that are rather restricted within the central plains, e.g. *Thuidium delicatulum*, which is known for extreme eastern Kansas, the Black Hills of South Dakota and Wyoming, and northern North Dakota. Other eastern species reach their westernmost range limits within the plains via the Niobrara River Valley, e.g., *Pylaisiella selwynii*. Some of the primarily northern species also extend into eastern United States, e.g. *Brachythecium rivulare*, in Nebraska known only from the Niobrara Valley Preserve. Similarly, the western taxa are rarely found farther east than Nebraska and many of them reach their easternmost limits in the Niobrara Valley Preserve. Interesting exceptions to this are *Jaffuliobryum raii* and *J. wrightii* which are even more distant disjuncts in the driftless region of Iowa and Wisconsin. The main ranges of these species are in the southwestern United States (*J. wrightii*) or the southwest and intermountain region (*J. raii*) (Churchill, 1987).

Vascular plants

A total of 581 species of vascular plants distributed among 332 genera and 105 families were recorded for the Niobrara Valley Preserve area based on collections made by the inventory botanists and on historical collections in the University of Nebraska State Museum; see Churchill et al. (1988) for a complete listing of species. The biogeographical diversity of the study area is illustrated by representative species in Table 2; see Kaul et al. (1988) for a more extensive tabulation. As in the bryophytes, most species show a strong eastern and northeastern affinity followed by species with northern and lastly western affinities. Species of particular interest include *Botrychium campestre* Wagner & Farrar, which was originally reported as *B. matricariifolium* A. Br. by Freeman and Churchill (1983). This species appears to be endemic to the east-central Plains region. The Pleistocene relict nature of this area is particularly evident by the presence of *Betula papyrifera* and the hybrid *Populus grandidentata* × *P. tremuloides*, which suggests boreal affinities (Kaul

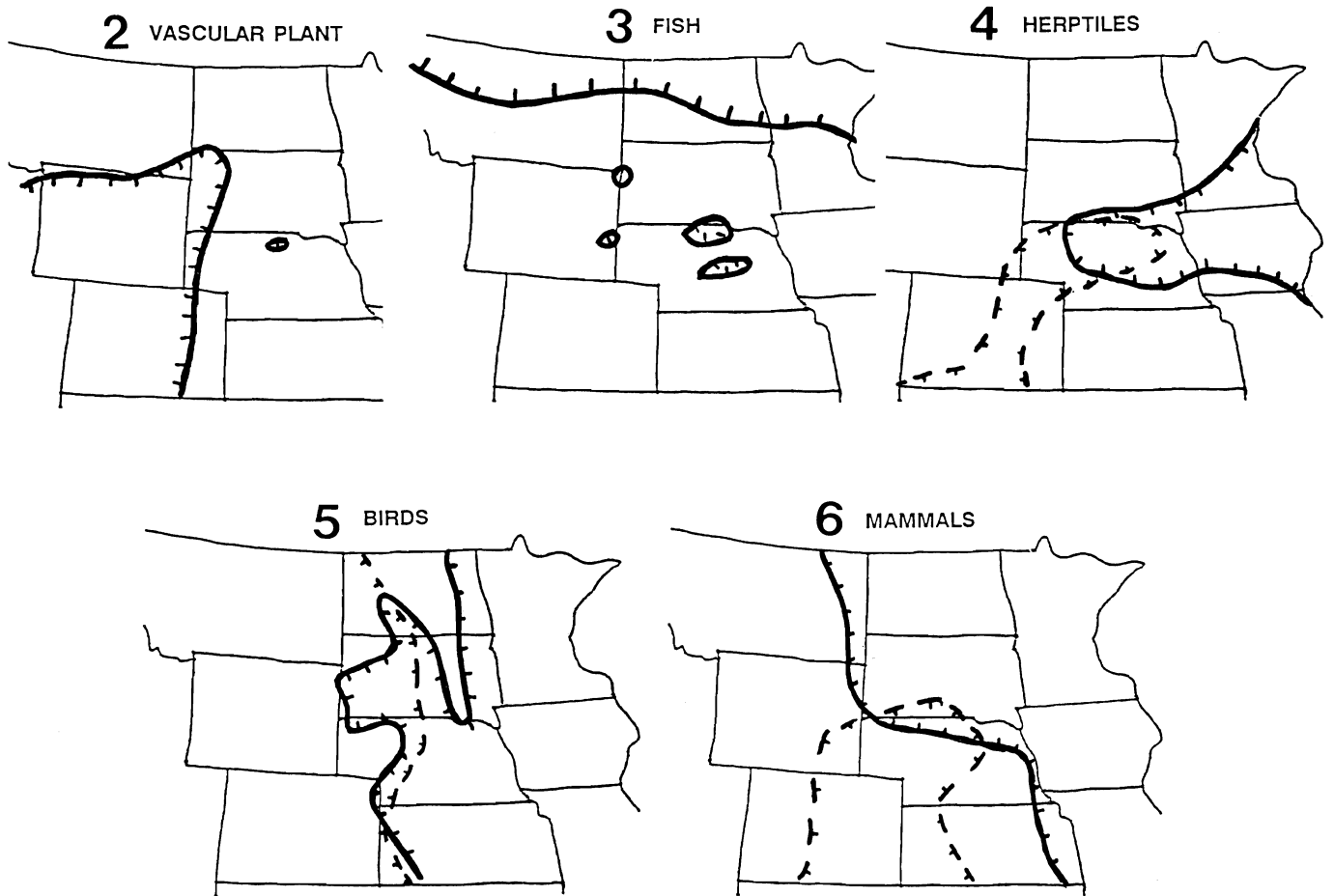


Figure 2-6. Distributions of species of special interest. 2. Distribution of *Pterospora andromedea*, a species of mainly western and northern affinities with disjunctions in the Great Lakes region and the east. 3. Distribution of *Phoxinus neogaeus*, a northern fish species with presumably glacial relict populations in the Great Plains. 4. Distributions of *Emydoidea blandingii* (solid line), a turtle with a range mainly in the Great Lakes region, and *Eumeces multivirgatus* (dashed line), a skink with a range extending from Nebraska to the southwest. 5. Distributions of *Passerina cyanea* (solid line), a bunting with a largely eastern range, and its counterpart from the west, *P. amoena* (dashed line). 6. Distributions of *Myotis septentrionalis* (solid line), a northern bat, and *Spermophilus spilosoma* (dashed line), a southwestern ground squirrel.

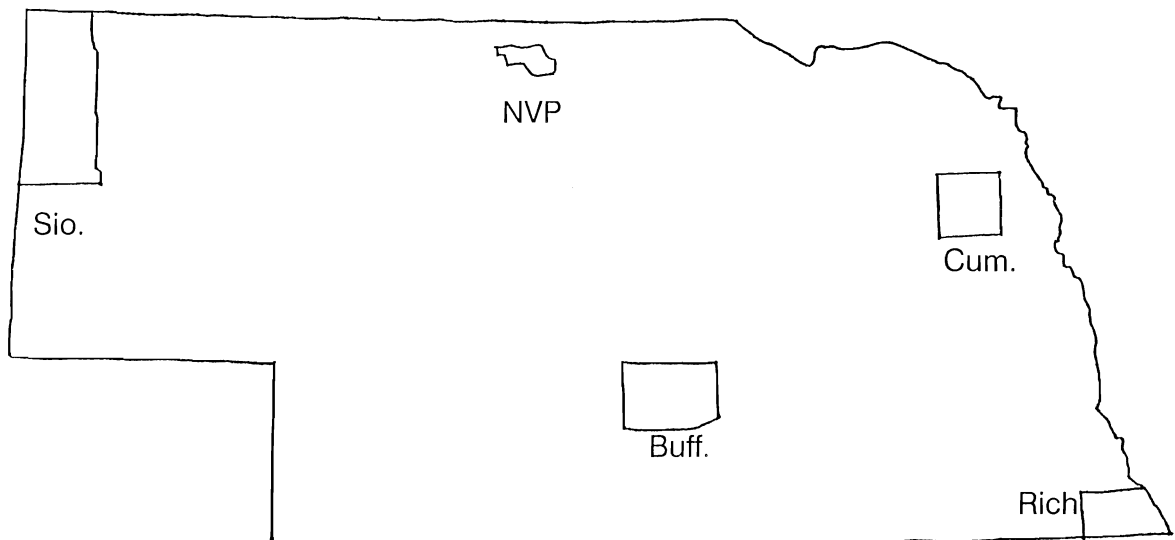


Figure 7. Map of Nebraska and locations of Niobrara Valley Preserve (NVP) and Sioux, Richardson, Buffalo and Cuming counties.

et al., 1988). A species of mainly western affinity with a restricted disjunction in the Great Lakes region and the east is *Pterospora andromedea* (Fig. 2). Finally, one plant, *Lythrum salicaria*, actually threatens the existence of the rich marsh vegetation in the Niobrara Valley Preserve and elsewhere in the valley. This aggressive species is rapidly spreading in North America (Stuckey, 1980) and was first recorded in Nebraska only in 1976 (Churchill et al., 1976).

RESULTS OF ANIMAL INVENTORY

Invertebrates

Over 130 species of aquatic invertebrates were identified by personnel at Southwest Texas State University and by the Kansas Biological Survey. A number of these (Table 3) document the occurrence in the Preserve area of species which are near their distributional limits.

Fish

Twenty-four fish species were collected in the study

area. (Table 4). Two of the northern species, *Culaea inconstans* and *Phoxinus neogaeus* (Fig. 3), are best described as glacial relicts in Nebraska (R. Stasiak, pers. comm.).

Herptiles

Twenty-five species of herptiles were collected during the 1982 inventory (Table 5). Most species are plains or grassland species and are presumably post-glacial immigrants. The inventory established county records for nine species. *Emydoidea blandingii* and *Eumeces multivirgatus* (Fig. 4) are good examples of co-occurrence of species of generally disparate ranges.

Birds

A total of 186 bird species was recorded during the 1982 field season. A complete list is published in Brogie and Mossman (1983). The inventory established many new breeding records for north-central Nebraska and for some species provided the first breeding evidence in decades (Mossman and Brogie, 1983). Evidence of breeding was obtained for a number of species threatened or

Table 1. Representative mosses of biogeographical importance for the Central Plains found in the Niobrara Valley Preserve area. Range designations extracted from Churchill, 1982, 1985, 1987 and unpublished data.

AFFINITY

Eastern

Anomodon minor
*Atrichum altecristatum*¹
Brachythecium acuminatum
*Brachythecium rivulare*²
*Desmatodon plinthobius*¹
*Entodon cladorrhizans*¹
Funaria americana^{1,2}
Lindbergia brachyptera
Orthotrichum diaphanum
Plagiomnium ellipticum
*Pylaisiella selwynii*¹
Rhodobryum ontariense
*Thuidium delicatulum*²
Timmia megapolitana subsp. *m.*
Tortella humilis^{1,2}

Northern

*Brachythecium rivulare*²
Dicranum muhlenbeckii^{1,2}
*Orthodicranum montanum*²
Orthotrichum obtusifolium
Rhodobryum ontariense
*Saelania glaucescens*¹
*Thuidium delicatulum*²

Western

*Barbula acuta*¹
*Brachythecium collinum*¹
Coscinodon calyptrata^{1,2}
*Encalypta vulgaris*¹
*Hypnum vaucheri*¹
Jaffuliobryum raii
Jaffuliobryum wrightii
Orthotrichum obtusifolium
Plagiomnium ellipticum
*Thuidium delicatulum*²

Southern

Orthotrichum diaphanum

¹taxa whose ranges end at the Niobrara Valley Preserve

²first state record

Table 2. Geographic affinities of selected species of vascular plants from the Niobrara Valley Preserve area. Range designations extracted from Great Plains Flora Association, 1977, 1986; Kaul et al., 1988.

AFFINITY	
Eastern	Western
<i>Apios americana</i> , groundnut	<i>Clematis ligusticifolia</i> , western clematis
<i>Aralia racemosa</i> , spikenard	<i>Phlox andicola</i> , plains phlox
<i>Carex peckii</i> , a sedge	<i>Pinus ponderosa</i> , ponderosa pine
<i>Circaea lutetiana</i> subsp. <i>canadensis</i> , enchanter's nightshade	<i>Psoralea hypogaea</i> , breadroot
<i>Corylus americana</i> , hazelnut	<i>Pterospora andromedea</i> , pine-drops
<i>Dryopteris spinulosa</i> , wood-fern	
<i>Juglans nigra</i> , black walnut	
<i>Osmorhiza claytonii</i> , sweet cicely	
<i>Ostrya virginiana</i> , ironwood	
<i>Physocarpus opulifolius</i> , ninebark	
<i>Quercus macrocarpa</i> , bur oak	
<i>Tilia americana</i> , basswood	
 Northern	 Central
<i>Aralia nudicaulis</i> , wild sarsparilla	<i>Botrychium campestre</i> , a grape-fern
<i>Betula papyrifera</i> , paper birch	
<i>Campanula rotundifolia</i> , harebell	
<i>Carex saximontana</i> , a sedge	
<i>Helianthemum bicknellii</i> , frostweed	
<i>Heracleum spondylium</i> subsp. <i>montanum</i> , cow parsnip	
<i>Populus grandidentata</i> × <i>P. tremuloides</i> , a hybrid aspen	
<i>Pterospora andromedea</i> , pine-drops	
<i>Ribes oxycanthoides</i> , a gooseberry	

Table 3. Invertebrate taxa of distributional significance collected during the 1982 inventory. Range designations from Pennak (1978, 1989) and Kiefer (unpublished data).

AFFINITY	
Eastern	Western
<i>Acroneuria</i> sp., a stonefly	<i>Zaitzevia parvula</i> , an aquatic beetle
<i>Anacaena</i> sp., a water-scavenger beetle	
<i>Crenitis</i> sp., a water-scavenger beetle	
<i>Cura foremanii</i> , a flatworm	
<i>Ilybius</i> sp., a predaceous diving-beetle	Southwestern
<i>Lissorhoptrus simplex</i> , an aquatic weevil	<i>Ambrysus mormon</i> , a creeping water-bug
<i>Onychylis</i> sp., an aquatic weevil	
<i>Paragnetina</i> sp., a stonefly	
 Northeastern	 Southern
<i>Agabetes</i> sp., a predaceous diving-beetle	<i>Ochthebius</i> sp., an aquatic beetle

Table 4. Geographic affinities of fish species collected during the 1982 inventory. Range designations extracted from Bliss and Schainost (1973), Lee et al. (1980), Madsen (1985), and Morris et al. (1972).

AFFINITY	
<p>Central <i>Carpiodes carpio</i>, river carpsucker <i>Esox americanus</i>, grass pickerel <i>Hybopsis gracilis</i>, flathead chub <i>Ictalurus melas</i>, black bullhead <i>Notropis lutrensis</i>, red shiner <i>Notropis stramineus</i>, sand shiner</p> <p>Plains <i>Fundulus sciadicus</i>, plains topminnow</p> <p>Northern <i>Catostomus commersoni</i>, white sucker <i>Culaea inconstans</i>, brook stickleback <i>Hybognathus hankinsoni</i>, brassy minnow <i>Notropis dorsalis</i>, bigmouth shiner <i>Phoxinus neogaeus</i>, finescale dace <i>Rhinichthys cataractae</i>, longnose dace</p>	<p>East/Central <i>Lepomis cyanellus</i>, green sunfish <i>Notemigonus crysoleucus</i>, golden shiner <i>Semotilus atromaculatus</i>, creek chub</p> <p>Widespread <i>Cyprinus carpio</i>, carp <i>Esox masquinongy</i>, muskellunge <i>Lepomis macrochirus</i>, bluegill <i>Micropterus salmoides</i>, largemouth bass <i>Pimephales promelas</i>, fathead minnow <i>Pomoxis nigromaculatus</i>, black crappie <i>Salmo gairdneri</i>, rainbow trout <i>Salmo trutta</i>, brown trout</p>

rare in Nebraska or of special concern in North America: great blue heron, sharp-shinned hawk, Cooper's hawk, sharp-tailed grouse, upland sandpiper, long-billed curlew, piping plover, eastern screech-owl, burrowing owl, common nighthawk, least flycatcher, eastern bluebird, loggerhead shrike, dickcissel and grasshopper sparrow. Species of biogeographic significance are presented in Table 6. Of special note is the co-occurrence in the study area of eastern/western pairs of related species or races, including the red- and yellow-shafted forms of the northern flicker, the Baltimore and Bullock's races of the northern oriole, and the indigo and lazuli buntings (Fig. 5).

Mammals

The presence of 43 species of mammals was noted during the 1982 field season (Table 7). Several biogeographical provinces are represented; northern and southwestern representatives are illustrated in Figure 6. The biogeographically most significant of the mammals is the eastern woodrat, *Neotoma floridana baileyi*, which occurs in the study area as a disjunct subspecies 190 km from the contiguous ranges of other subspecies.

FAUNAL DIVERSITY

To illustrate the uniqueness of the mid-Niobrara Valley vertebrate fauna, we compiled county records from four Nebraska counties for comparison with the Niobrara fauna. The counties were chosen to be representative of various biogeographic provinces (Figure 7).

Sioux County is in the extreme northwest corner of the State and is west of the 100th meridian; hence, Sioux County is expected to show stronger northern or western affinities than the other locations. Richardson County is at the opposite extreme, located in the southeast corner of the State and bordering the Mississippi River. A priori one would expect this county to show stronger eastern or southern affinities relative to the other locations. Similarly, Cuming County is located to the east of the 100th meridian but is expected to have more of a northern and less of a southern influence than Richardson County. And lastly, Buffalo County was included in the comparison because it is similar to the Niobrara Valley Preserve in its central location along an east-west gradient in Nebraska. It is expected to have more southern and fewer northern species than the Niobrara Valley study area. Distribution records and affinities were taken from inventory data and the following sources: Bliss and Schainost, 1973; Czaplewski et al., 1979; Hall, 1981; Johnsgard, 1978, 1979a, b; Jones, 1964; Jones and Birney, 1988; Jones et al., 1983; Lee et al., 1980; and Lynch, 1985. Although one cannot control the intensity of sampling effort in such comparisons of distribution records, the fact that the four county sites are homes to or close to universities and colleges leads us to expect that these counties have been adequately surveyed.

Results in Table 8 show that the Niobrara study site has the greatest vertebrate species richness, despite the fact that the other four sites each encompass a

Table 5. Geographic affinities of amphibian and reptile species collected during the 1982 inventory. County name (Brown, Keya Paha) indicates new county record. Range designations extracted from Catalogue of American Amphibians and Reptiles (1962 et seq.) and Lynch (1985).

AFFINITY	
<p>Northern/Eastern <i>Emydoidea blandingii</i>, Blanding's turtle <i>Heterodon platyrhinos</i>, eastern hognose snake (Brown)</p> <p>Southwestern <i>Eumeces multivirgatus</i>, many-lined skink (Brown) <i>Holbrookia maculata</i>, northern earless lizard</p> <p>Widespread <i>Coluber constrictor</i>, yellow-bellied racer (Keya Paha) <i>Pituophis melanoleucus</i>, bull snake <i>Rana catesbeiana</i>, bullfrog <i>Rana pipiens</i>, northern leopard frog</p>	<p>Plains/Central <i>Acris crepitans</i>, cricket frog <i>Ambystoma tigrinum</i>, tiger salamander (Brown) <i>Bufo cognatus</i>, plains toad (Brown) <i>Bufo woodhousii</i>, Woodhouse's toad <i>Chelydra serpentina</i>, common snapping turtle <i>Chrysemys picta</i>, painted turtle <i>Cnemidophorus sexlineatus</i>, prairie racerunner (Keya Paha) <i>Crotalus viridis</i>, prairie rattlesnake <i>Heterodon nasicus</i>, western hognose snake <i>Lampropeltis triangulum</i>, milk snake (Keya Paha) <i>Nerodia sipedon</i>, northern water snake <i>Pseudacris triseriata</i>, chorus frog <i>Scaphiopus bombifrons</i>, Plains spadefoot toad <i>Sceloporus undulatus</i>, prairie lizard <i>Terrapene ornata</i>, box turtle (Keya Paha) <i>Thamnophis radix</i>, western plains garter snake (Brown) <i>Thamnophis sirtalis</i>, red-sided garter snake</p>

Table 6. Geographic affinities of selected bird species for which evidence of breeding was obtained during the 1982 inventory. Range designations extracted from American Ornithologists' Union (1983), Johnsgard (1978, 1979a, 1979b), and Short (1961).

AFFINITY	
<p>Eastern <i>Aix sponsa</i>, wood duck <i>Butorides striatus</i>, green-backed heron <i>Caprimulgus vociferus</i>, whip-poor-will <i>Cardinalis cardinalis</i>, northern cardinal <i>Colaptes auratus</i> (<i>auratus</i> group), yellow-shafted flicker <i>Colinus virginianus</i>, bobwhite <i>Contopus virens</i>, eastern wood-pewee <i>Hylocichla mustelina</i>, wood thrush <i>Icterus galbula</i>, Baltimore oriole <i>Melanerpes carolinus</i>, red-bellied woodpecker <i>Mniotilta varia</i>, black-and-white warbler <i>Passerina cyanea</i>, indigo bunting <i>Piranga olivacea</i>, scarlet tanager <i>Sayornis phoebe</i>, eastern phoebe <i>Seiurus aurocapillus</i>, ovenbird <i>Setophaga ruticilla</i>, American redstart <i>Sialia sialis</i>, eastern bluebird <i>Sitta canadensis</i>, red-breasted nuthatch <i>Sitta carolinensis</i>, white-breasted nuthatch <i>Vireo olivaceus</i>, red-eyed vireo</p>	<p>Western <i>Colaptes auratus</i> (<i>cafer</i> group), red-shafted flicker <i>Icterus galbula</i>, Bullock's oriole <i>Numenius americanus</i>, long-billed curlew <i>Passerina amoena</i>, lazuli bunting <i>Phalaenoptilus nuttallii</i>, common poorwill <i>Pheucticus melanocephalus</i>, black-headed grosbeak <i>Pica pica</i>, black-billed magpie <i>Sitta canadensis</i>, red-breasted nuthatch</p> <p>Northern <i>Certhia americana</i>, brown creeper <i>Empidonax minimus</i>, least flycatcher <i>Gallinago gallinago</i>, common snipe <i>Melospiza georgiana</i>, swamp sparrow <i>Spizella pallida</i>, clay-colored sparrow <i>Tachycineta bicolor</i>, tree swallow</p> <p>Southern <i>Mimus polyglottos</i>, northern mockingbird</p>

greater area. This implies that the range of habitats available at each site or some other factor is more important than area per se. As predicted, faunas of each county showed the geographic biases expected on the basis of relative location within the State. However, the Niobrara site is not only richer overall, but it shows less bias (more evenness) in faunal affinities. This conclusion is quantified in Table 9, where Shannon diversity indices (Magurran, 1988) were calculated on the number of species within each affinity category (North, East, South, West, or Central). Biogeographic diversity is highest at the Niobrara site for all groups except fishes. Sioux County has fewer species of fish but their more even affinities produce a higher Shannon index. Overall, the results in Tables 8 and 9 show a higher species diversity at the Niobrara site due not to a disproportionately heavy contribution from a single biogeographic province, but because of stronger contributions from several provinces.

DISCUSSION

The high species richness documented for this relatively small area can be attributed in part to local topographic and hydrologic conditions which provide suitable microenvironments for species of disparate biogeographical affinities. These geohydrological conditions are described more fully elsewhere (Kaul et al., 1988; Churchill et al., 1988). Briefly, permanently flowing water on the south side of the river has produced seeps, springs, springbranch canyons and sub-irrigated meadows. This side of the river valley is also shaded and protected from the prevailing southerly winds of the growing season. Thus, various places along the south wall of the valley provide appropriate environmental conditions for the more mesic plant species and associated animal species characteristic of eastern deciduous forest, northern boreal forest, or

Table 7. Geographic affinities of mammal species trapped or sighted during the 1982 inventory. Nomenclature and range designations extracted from Hall (1981), Jones (1964), Jones and Birney (1988), Jones et al. (1983), Paulson (1988), and van Zyll de Jong (1985).

AFFINITY

Eastern

Blarina brevicauda, northern short-tailed shrew
Didelphis virginiana, Virginia opossum
Scalopus aquaticus, eastern mole
Sciurus niger, fox squirrel
Sylvilagus floridanus, eastern cottontail

Northern

Lepus townsendii, white-tailed jackrabbit
Microtus pennsylvanicus, meadow vole
Myotis septentrionalis, northern myotis
Zapus hudsonius, meadow jumping mouse

Widespread

Canis latrans, coyote
Castor canadensis, beaver
Eptesicus fuscus, big brown bat
Lasiurus borealis, red bat
Lasiurus cinereus, hoary bat
Lynx rufus, bobcat
Mephitis mephitis, striped skunk
Mustela frenata, longtail weasel
Mustela vison, mink
Odocoileus virginianus, white-tailed deer
Ondatra zibethicus, muskrat
Peromyscus leucopus, white-footed mouse
Peromyscus maniculatus, deer mouse
Procyon lotor, common raccoon
Taxidea taxus, badger
Vulpes vulpes, red fox

Western

Antilocapra americana, pronghorn
Dipodomys ordii, Ord's kangaroo rat
Myotis ciliolabrum, western small-footed bat
Odocoileus hemionus, mule deer
Reithrodontomys megalotis, western harvest mouse

Southwestern/Plains

Lepus californicus, black-tailed jackrabbit
Perognathus fasciatus, olive-backed pocket mouse
Spermophilus spilosoma, spotted ground squirrel

Southeastern

Neotoma floridana baileyi, eastern woodrat

Central

Chaetodipus hispidus, hispid pocket mouse
Cynomys ludovicianus, black-tailed prairie dog
Geomys bursarius, plains pocket gopher
Microtus ochrogaster, prairie vole
Myotis septentrionalis, northern myotis
Onychomys leucogaster, northern grasshopper mouse
Perognathus flavescens, plains pocket mouse
Reithrodontomys montanus, plains harvest mouse
Sorex haydeni, Hayden's shrew
Spermophilus tridecemlineatus, thirteen-lined ground squirrel

Table 8. Biogeographical affinities of vertebrate species recorded from the Niobrara Valley Preserve (NVP) and four counties of Nebraska. Affinity denotes number of species whose geographical range lies mainly to the North (N), East (E), South (S), or West (W) of Nebraska. (C) denotes number of species having a central range or a distribution circumscribing Nebraska.

	LOCALE	AFFINITY					Total
		N	E	S	W	C	
Fish	Buffalo	1	2	0	0	17	20
	Cuming	1	1	0	0	7	9
	NVP	5	2	0	0	12	19
	Richardson	1	5	1	0	18	25
	Sioux	3	1	0	0	4	8
Herps	Buffalo	2	2	3	1	15	23
	Cuming	1	4	0	0	18	23
	NVP	2	3	4	1	15	25
	Richardson	0	11	2	0	15	28
	Sioux	1	0	3	3	12	19
Birds	Buffalo	0	18	2	12	68	100
	Cuming	2	20	1	6	67	96
	NVP	8	23	1	19	77	128
	Richardson	2	38	4	4	71	119
	Sioux	9	4	1	32	65	111
Mammals	Buffalo	4	7	1	5	30	47
	Cuming	4	8	1	3	30	46
	NVP	4	8	1	7	29	49
	Richardson	2	13	2	2	26	45
	Sioux	2	4	2	11	30	49
Total	Buffalo	7	29	6	18	130	190
	Cuming	8	33	2	9	122	174
	NVP	19	36	6	27	133	221
	Richardson	5	67	9	6	130	217
	Sioux	15	9	6	46	111	187

Table 9. Shannon biogeographical diversity indices for vertebrate groups in Niobrara Valley Preserve (NVP) and four counties in Nebraska.

	Fish	Herptiles	Birds	Mammals
Buffalo	.52	1.11	.90	1.10
Cuming	.68	.63	.88	1.06
NVP	.88	1.18	1.11	1.17
Richardson	.82	.89	.97	1.09
Sioux	.97	1.03	1.04	1.10

tallgrass prairie. In contrast, to the north of the Niobrara River, streams are intermittent and permanently flowing springs and seeps are rare. In addition, this north wall is exposed to southerly winds and greater insolation. Hence the plant species found on the north slopes tend to be relatively shade intolerant, xeric species characteristic of western pine forest, whereas those on the tablelands at the top of the north slopes are species typically found in mixed-grass prairie.

Historical factors must also be evaluated in regard to their influence on the distributions we have documented (also in Kaul et al., 1988). Some species in the Valley today may be relicts of cooler glacial and post-glacial times when much of Nebraska was covered by boreal and cool-temperate forests. Other species are most likely immigrants which colonized the valley from the east or west during postglacial times as the climate warmed. Thus the uniqueness and diversity of the central Niobrara Valley arise from its role as a refugium during both the past Pleistocene climate and the current semi-arid grassland climate.

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