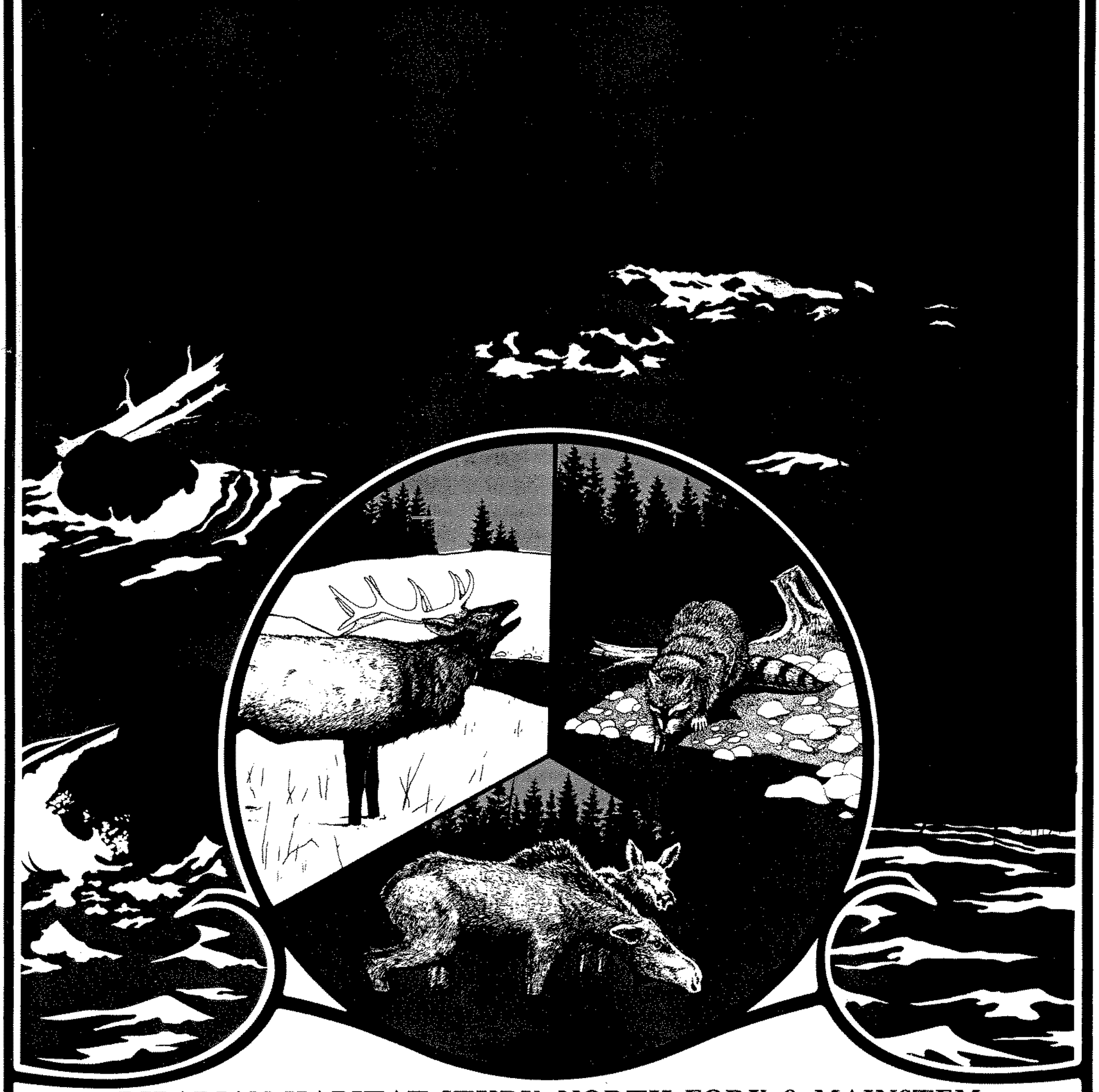
FLATHEAD



RIPARIAN HABITAT STUDY, NORTH FORK & MAINSTEM FLATHEAD RIVER, MONTANA

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WILDLIFE HABITATS IN RIPARIAN ZONES
OF THE NORTH FORK & MAINSTEM
FLATHEAD RIVER, MONTANA

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1.0 INTRODUCTION

The Flathead River Basin is a region rich in natural resources and of great physical beauty. Areas such as Glacier-Waterton International Peace Park, Flathead Lake, the largest natural lake west of the Mississippi River, and the vast expanses of the Bob Marshall Wilderness Area form a mosaic of natural resources that are recognized nationally and attract millions of recreational users each year from throughout the world. The scenic, recreational, and biotic resources of Glacier-Waterton Park have recently been recognized with its formal designation as an International Biosphere Reserve.

A primary focus of recreation and wildlife use within the region are the three major rivers which drain the basin, the North Fork, South Fork, and Middle Fork of the Flathead River, and their respective watersheds. All combine above Flathead Lake to form the Mainstem of the Flathead River. All forks, under different classifications, have been included as a part of the Wild and Scenic River System. The wild country within the Flathead River Basin forms one of the last bastions in the continental U.S. for the endangered grizzly bear, and it supports large numbers of big game animals including elk, moose, white-tailed deer, mule deer, black bear, and mountain goat. Wolverine, river otter, and occasionally timber wolves, all important mammalian indicators of a quality environment, are sometimes seen in the wilderness regions of the basin.

Because of its great physical beauty and the diversity of its natural resources, the Flathead River Basin has long been considered a desirable place to live. Today, however, the environmental amenities which attract so many people are in growing conflict with the demands for increased development, particularly of energy resources within the basin. This study was undertaken to better understand the long-range impacts of potential land-use changes on the plant and animal resources of the river floodplains of the North Fork and mainstem of the Flathead River so that they may be planned for accordingly.

2.0 BACKGROUND

2.1 THE BASIS OF THE OVERALL FLATHEAD RIVER BASIN STUDY

Throughout the early twentieth century, the basin enjoyed a slow but steady, and therefore manageable, increase in population. However, in the 1970s, population in the basin began to increase dramatically. Between 1970 and 1980, the population in Lake and Flathead Counties increased by 32 percent.

This growth has been coincident with the the growth and potential growth in energy production industries. The Bureau of Reclamation has undertaken a study to investigate the potential for developing a regulating dam below Hungry Horse Reservoir. Oil and gas leases have been issued on both state and federal lands within the basin. Of major importance, are large-scale open-pit coal mines proposed in the vicinity of the headwaters of the North Fork River drainage in British Columbia. Plans for mining this coal are proceeding rapidly. In recognition of the incremental impacts that accelerated resource utilization and development could have on the basin, and in recognition of the need for a detailed understanding of the resource base, the U.S. Congress directed the Environmental Protection Agency (EPA) to conduct a five-year study of the basin to provide a data base against which to compare and better understand the impacts of future development. The EPA in turn set up a steering committee comprised of resource managers, government officials, and private citizens to set policy, direct the study, and develop management tools.

2.2 THE BASIS FOR THE RIPARIAN HABITAT STUDY.

This study of Riparian Habitats was one of many biological and socio-economic studies funded under the EPA's Flathead River Basin Environmental Impact Study. It was the last to be initiated, with field work commencing in July 1981. Duration of the study was eighteen months. This study focused primarily on the fauna and plant communities of the riparian zone, i.e., those areas either on, or on terraces adjacent to the floodplains of the North Fork and mainstem of the Flathead River.

The Flathead River drainage is typical of other river valleys of the Western United States which have undergone significant physical and biological changes since the 1800's. The fertility of alluvial bottomlands was long recognized by native American Indians. With the settlement by Anglo-Americans, with their increased technological capabilities, riparian habitats became the focus of ever increasing agricultural activities and livestock grazing. River water was channeled and irrigation canals dug to supply outlying lands thus expanding operations. Stream side vegetation was removed. The long-term result of such activities has been, almost without exception, a deterioration of western riparian habitats that are integrally linked to the consumptive land utilization practices of man (Carothers 1977).

Today, there is a growing awareness of the value of riparian habitats as natural ecosystems. After more than a century of abuse, the importance of riparian habitats, for aesthetics, recreation, wildlife, and other nonconsumptive values is being widely recognized. The influence of riparian habitats on wildlife is also not limited to those species restricted in distribution to that zone. Populations of animals in habitats adjacent to riparian zones are often influenced by the presence of the riparian area (Stevens et al. 1977).

Despite this new awareness, lands, such as those along the western side of the North Fork of the Flathead River are still the focus of regional development. At present, the resources on unprotected lands within this zone are undergoing a variety of changes, e.g., land conversion to subdivisions, commercial purposes, and agriculture and grazing operations; clearcuts, select cuts, and salvage logging; and increased recreational use; all related to increased population densities and mobility within the basin. It is likely that a major secondary impact of the energy development proposals currently contemplated for the Flathead River Basin will be an acceleration of the land-use changes already taking place in the basin, and thus a further alteration of the faunal and vegetal resources of the riparian zone.

3.0 OBJECTIVES

A major objective of this study was to provide a synthesis of all pertinent biological data collected within the riparian zone primarily of the North Fork and secondarily of the Mainstem of the Flathead River above Flathead Lake. These data provide a baseline against which effects of future disturbances and impacts on the wildlife and floodplain habitats can be monitored and documented.

The North Fork of the Flathead River offers several advantages in meeting this broad objective. The entire North Fork drainage is bordered to the east by Glacier National Park, a relatively unaltered environment which becauseof it of its restrictive management provides an ideal control. Secondly, the North Fork from Camas Creek north to the international boundary follows gradient of decreasing total precipitation but, more importantly, increasing winter snowfall. This factor plays an important role in winter ungulate distribution. Thirdly, as one follows this gradient north, access becomes more difficult, particularly in winter, and this has historically influenced the patterns of land development and use.

Similar gradients do not appear to exist along the Mainstem of the Flathead River. There, a state conservation unit near Columbia Falls, and a section of private farmland managed as a preserve south of Kalispell were chosen as the principle study areas.

Specific objectives of the research were to:

1. Identify and map the major plant communites found on the floodplains in the study area;

2. To describe the distribution and habitat preferences of wintering cervids in the North Fork, with special emphasis on identifying key winter range areas;

3. To describe the environmental factors governing the distribution of cervids on the winter range;

4. To describe avian community structure on the floodplain; and

5. To identify the habitat features regulating avian community structure.

A third objective was, to develop a predictive model of cervid and avian habitat selection, and use this model to examine the results of potential land-use disturbances. Timber-cutting practices employed on the forested lands in and adjacent to the riparian zone were the primary disturbances investigated.

4.0 AN OVERVIEW OF THE RESOURCES IN THE REGION

4.1 CLIMATE

The climate of the North Fork and Flathead River Valleys can be generally classed as Pacific Maritime, as most of the variation in regional weather patterns is due to the easterly flow of lower atmospheric layers common in the Pacific Northwest. These patterns are modified by continental effects and the upwind mountains in Washington, Idaho, and Western Montana (Delk 1972). The precipitation in the region varies widely with the season, elevation and location. In general, it increases with elevation and latitude, and is greater on the eastern side of the valley. In Polebridge, the mean annual precipitation is 59 cm and the mean annual temperature is 4°C (Allen 1980), with a mean January minimum of -14 °C and a July maximum of 27 °C (Delk 1972).

Precipitation occurs in all months, however, 67 percent falls between October and April, primarily as snow. The mean annual snow accumulation is 311 cm at Polebridge (Allen 1980). Most of the snow is stored until spring runoff. June is also a high precipitation month, with most occurring as rain. The combination of snow accumulation and warm spring rains make for an almost annual flood hazard along the North Fork (Delk 1972), the severity of which is determined by the amount of snow accumulation and warm spring rainfall.

4.2 GEOLOGY AND SOILS

The North Fork Valley was created during the early Tertiary period, when, along the Lewis Overthrust Fault, a huge mass of precambrian sedimentary rock slid eastward, separating the Livingston and Whitefish Ranges. After the movement along the front ceased, the floor of the resultant gap dropped downward, creating the North Fork Valley. The valley floor was then filled with alluvial sediment during the late Tertiary (Alt and Hyndman 1973). Glaciation during the Pleistocene carved out portions of this sediment leaving deposits of glacial till on top of the finer sediments, and forming benches of various heights adjacent to the floodplain (Allen 1980).

The parent soil material in areas adjacent to the North Fork is primarily alluvium, derived from recent gravel, sand, silt and some Pleistocene glacial outwash. Alluvial areas are bordered by areas where the parent material is from quaternary glacial deposits which are comprised primarily of silt, clay, drift, gravel, and alluvial fan material (Jones 1970). The substrate and soils along the northern sections of the North Fork range from cobble to coarse sand, silty clays, and deep layers of finer textured alluvium with a well developed humus layer. Allen (1980) found random and heterogeneous soil patterns along the North Fork, and attributed this to the scouring and depositional actions of the river.

The soils on alluvial landforms are primarily coarse textured, shallow to moderately deep, and range from well to poorly drained. A description of the soils along with suitability and development potentials is given in Table 4.2.1. Other than a recent U.S. Forest Service overview study, (U.S. Dept. Agriculture 1982), there have been no soil studies conducted for the region.

Below the confluence of Big Creek, the North Fork flows though a narrow "V" shaped valley, as it passes through the Apgar Mountains. Although here the riparian area is located primarily on alluvium, the river is closely bordered by lands originating from the Kishenehn, Kintla, Shepard, and Rooseville formations (Jones 1970). Soils range from loamy to coarse, soil depth from shallow (bare rock) to moderately deep, and slopes are generally steep. The general characteristics of the soils of the North Forkare given in Table 4.2.1.

4.3 THE PLANT COMMUNITIES

4.3.1 North Fork Floodplain Plant Communities

The vegetation of the North Fork of the Flathead River is a dynamic complex reflecting the interaction between river flow, channel alteration, soil deposition, elevation above the river, and slope.

TABLE 4.2.1 General characteristics of the soils along the North Fork. (Modified from Delk 1972)

Land Form	Internal Drainage		Relative Soil Interpretive Ratings for:			Development Potentials for:		
	Surface	Subsoil	Soil Mass Movement	Soil Compactibility	Suitability for Sanitation Drainage Fields:	Roads	Trails	Septic Systems
River Bottoms: Alluvial bottoms along the rivers, slopes are gentle, soils are coarse textured over sand & gravel.	High: Coarse textured	High: gravelly & sandy	Slight Slopes are gentle	Slight	Moderate: When more than 6' of watertable Severe in areas that flood or are less than 6' to watertable.	Slight limitations, gentle land, may be subject to seasonal flooding.	Slight: Some trails may flood during spring runoff & high water.	Moderate: When more than 6' to watertable, Severe: In areas that flood.
Lacustrine Bottoms: Nearly level lake-laid soil deposits, soils are deep, silty & usually poorly drained.	Slow: Silty soils	Slow: Wet silty soils	Slight for level areas, bare gentle slopes are very erosive	Severe	Severe: soils have restricted drainage &/or seasonal high watertable, some areas subject to seasonal flooding.	Severe - wet silty soils have low stability and are subject to frost heave.	Severe - trails are muddy & are difficult to maintain.	Severe: Seasonal high watertable & restricted internal soil drainage.
Glacial Low Terraces & Benches: Gently sloping till benches with steep terrace escarpments to river or bench below, soils are well drained & medium texture, glacial till substratum has a moderate to low permeability.	High: Moderate permeability	Moderate: Where till has been reworked by water Slow: for compact glacial till	Slight: on gentle benches Moderate to Severe: on terrace escarpments due to geologic erosion from stream meandering	Moderate:	Moderate on benches with permeable substratum over glacial till Severe: on terrace escarpments due to steep slopes.	Slight on gentle benches Severe on terrace escarpments, steep cut slopes ravel.	Slight on gentle benches Severe on terrace escarpments.	Moderate on benches with permeable substratum over till. Severe on terraces due to steep slopes.

The North Fork flows some 67 km through a broad "U" shaped valley from the Canadian border south to the confluence of Big Creek, the primary area of concern to this study. The constant action of the river, eroding and cutting embankments on the outer portions of curves, depositing new sediment on the inner portions, continually alters the structure of the vegetative community. The result is that on one side of the river, the oldest communities are often being undercut and removed while on the other side of the river, new habitat is being created by sedimentation and deposition. A comparison of aerial photos from the 1960's and 1970's by Allen(1980) showed extensive lateral migrations of the North Fork. It is likely that similar channel alterations have been occuring for 100's of years. The resulting mosaic of vegetation types in the alluvial zone represents a continuum of seral stages, and succession on the floodplain can be setback or accelerated at any point (Foote 1965). However, in spite of this dynamic environment, the successional sequence of vegetation communities is, to a large degree, predictable. An outline of the major plant communities found on the floodplain and adjacent terraces follows. We have attempted to integrate our classifications with others who have done work in the region. The major species found in each of the communities are listed in Table 4.3.1. This table and the text also contains the map units associated with each species to provide a cross reference with subsequent sections.

4.3.1.1 Wash Forb and Wash Shrub Communities

The most recently formed habitats are exposed gravel and sand bars or other zones of deposition which in their initial stages are often subject to annual flooding. These highly disturbed sites are characterized by sparse plant cover and low species diversity (Allen 1980). Because of the dominance of herbaceous annual forbs, these areas can be devoid of vegetation throughout much of the year, and appear as a barren gravel wash. They correspond to map unit H4. With stable conditions, over a period of a few years, these gravel bars are rapidly colonized by seedlings of willow and cottonwood, and correspond to map unit D1. They are analogous to the pioneering wash of Biggs and Armour (1981).

4.3.1.2 Mature Cottonwood

As the plant communities age and where the soils remain relatively shallow, often with an exposed cobble substrate, a mature cottonwood community, map unit D3, slowly emerges (Key 1979, Allen 1980). Subsequent changes in these plant communities are often not predictable, given the shallow soil and the fact that chance events such as floodplain shape, and the composition of adjacent communities play significant roles in determining the pattern of future stages. Pfister et al. (1977) have indicated that those stands occuring in relatively wet areas of the upper North Fork sometimes appear to be successional to spruce habitat types in the absence of severe flooding.

4.3.1.3 Cottonwood Spruce Transition

Where the mature cottonwood communities develop on deeper soils, the succesional series is more predictable. Here, a dense understory of red osier dogwood is found and it is at this stage that spruce becomes well established on the floodplain (Allen 1980, Key 1979). Map unit D6 is representative of this community. Because young cottonwood is shade intolerant, the successional sere, if undisturbed from this stage on, tends toward a community were both spruce and cottonwood achieve a co-dominance in the overstory canopy which corresponds to map unit S2 (Allen 1980).

4.3.1.4 Bottomland Spruce Climax

The climax of the successional sere on the floodplain of the North Fork is spruce/horsetail (Picea/Equisetum arvense) a habitat type of Pfister et al. (1977). This community type may occur adjacent to the river or be separated from the river by other floodplain plant communities. Within this community, mapped as S1, most spruce are a hybrid of white and Engelmann spruce (Picea glauca) and (Picea engelmannii) (Habeck and Weaver 1969). Soils are wet throughout the year and there is often a thick layer of organic soil and humus present.

4.3.1.5 Other Spruce Dominated Types

On drier sites such as the benches and gentle north slopes although still lying within the moist bottom lands, the above successional sequence results in a climax of the spruce/queencup bellily (Picea/Clintonia uniflora) habitat type of Pfister et al.

(1977), shown as map unit S3. On other higher elevation sites, the spruce will merge with subalpine fir and an occasional western larch to form a seral state of the subalpine fir/queencup bellily (Abies lasiocarpa/Clintonia uniflora) habitat type of Pfister et al. (1977). On still drier sites with generally acidic, gravelly loams, in the absence of periodic fire, spruce tends to dominate along with Douglas fir and western larch. This type is representative of the spruce/dwarf huckleberry (Picea/Vaccinium caespitosum) habitat type of Pfister et al.(1977), and is shown as map unit S7.

4.3.1.6 Hydric Shrubland

In areas of poor drainage, either in riparian zones which are often maintained by beaver activity, or in natural seeps, shrub bogs occur. These often occur on uplands or at the base of the river terraces on the floodplain. This community is not a part of the floodplain successional sere, and is more or less a dead-end. It is mapped as unit D2. Tall shrubs dominated by willows, alderleaf buckthorn, and white alder dominate.

4.3.1.7 Hydric Bog

Occasionally, on poorly drained soils, a community of rushes, grasses and shrub seedlings will sometimes develop. Like the hydric shrubland, this community is also not part of the floodplain successional sere and it apparently will persist as long as the soil moisture remains high (Key 1979, Allen 1980). This community corresponds to map unit H3.

4.3.2 North Fork Upland Terraces

Moist areas above the floodplain, upwards of 3200 feet in elevation, and therefore on the periphery of the zone of interest of this study contain a mixture of subalpine fir, spruce, Douglas fir, larch, and lodgepole pine. Map units differentiated in this zone are discussed below.

4.3.2.1 Fir Communities

Those dense, relatively old-aged stands where subalpine fir is found with western white pine have been mapped as unit F1, and are classed within the subalpine fir/menziesia(_Abies lasiocarpa/Menziesia ferruginea_) habitat type of Pfister et al. (1977). Where spruce hybird is found with the subalpine fir, the areas have been mapped as unit F3 and they fall within the Abies lasiocarpa/Clintonia uniflora habitat type of Pfister et al. (1977).

Those relatively dry areas with a dense canopy of Douglas fir, occurring singlely or mixed with larch and representative of several Douglas fir habitat types are mapped as unit F4. Similar sites, where ponderosa pine is mixed with the Douglas fir and the canopy is more open are mapped as unit F6. Where lodgepole pine, either alive, or dead is a component of the canopy, map unit F7 has been used. Finally, dense stands of young Douglas fir (5 to 20 years old) are mapped as unit F9.

4.3.2.2 Lodgepole Pine Communities

Kessell (1976) and Singer (1975) both have suggested that over 95 percent of the forests in Glacier National Park below 1500 m have burned in the past 400 years. Fire periodicity seems to range from a few years for the dry grasslands, to between 10 and 15 years for the open dry savannahs, to perhaps between 25 to 100 years for other, low elevation, semi-dry forest communities. Nowhere is the influence of fire more apparent than on the alluvial benches and moraines bordering the floodplain, where dense stands of fire maintained lodgepole are found. The densest stands are often less than 40 years of age, with very little undergrowth, and are occasionally mixed with western larch. These are shown as map unit L1. Many of the older lodgepole stands in the North Fork Valley, possibly because of increased fire protection over the last century, have been under severe attack from the mountain pine beetle (Dendroctonus ponderosai), resulting in a large-scale die-off of trees (Hoe and Amman 1970). Young, dense lodgepole stands, generally less than 20 years of age on relatively moist sites are mapped as unit L3. Mixtures of live and dead lodgepole pine, of a similar age, on more mesic sites have been mapped as unit L5. Moist sites where old dead lodgepole pine is being invaded by spruce are mapped as unit L4, and mesic/xeric sites where the dead lodgepole pine is being invaded by western larch, aspen, and Douglas fir are mapped as unit L8. A final lodgepole pine category are those sparse canopy, older lodgepole stands with a significant understory of grasses, which can be classed as a savannah and are mapped as unit L7.

4.3.2.3 Western larch Communities

Western larch and its associates are designated in three map units. Mature western larch either in pure stands or mixed with spruce, subalpine fir, or Douglas fir is shown as unit C1. Young larch, either alone, mixed with the above species, or mixed with lodgepole pine is shown as unit C3. Mature larch as a component of stands containing dead lodgepole pine is shown as unit C7.

4.3.2.4 Grassland Communities

Several small grasslands, locally called prairies, are found on the elevated benches and moraines bordering the floodplain of the North Fork (Biggs and Armour (1981). These communities appear to represent a mixture of components of the Palouse Prairie to the southwest and the Alberta fescue grasslands to the northeast (Koterba and Habeck 1971). These authors identified both mesic (map unit H2) and xeric (map unit H1) phases of these grassland communities along a gradient of increasing, although low precipitation, which, along with the occurrence of a coarse, porous subsoil, seems to have provided the ingredients for the development of these grasslands. It appears that historically, wildfires were important in interrupting the slow but steady invasion of these grasslands by coniferous species (Koterba and Habeck 1971, Ayres 1900). Areas protected from fire have a savannah-like appearance, with both lodgepole and ponderosa invading the grasslands. This is mapped as unit L7. On the true prairie grasslands, the drier sites are dominated by bluebunch wheatgrass and Idaho fescue, the more mesic sites by rough fescue and timber oat grass.

4.3.3 Mainstem Plant Communities

The plant communities of the floodplain on the mainstem of the Flathead River in many ways parallel those of the North Fork. Here, however, the river channel is more stable and the gradiant is lower. These conditions permit a greater development of mature plant communities. Therefore, on lands unaltered by development or agricultural operations, extensive old growth bottomland forests of spruce and Douglas fir (unit M1), or spruce, Douglas fir, and cottonwood (M2) are found as well as large stands of mature cottonwood (D3). On drier sites, open stands of ponderosa pine (M3) and ponderosa pine and Douglas fir (M4) are found. All of the early successional stages such as the pioneer wash and hydric shrublands discussed above are also found here.

Lands under agriculture (map units P), which are occupied by different types of water bodies (map units W), which have been subjected to various type of timber harvesting practices (map units C), which have recently burned (map units B), or which have been altered by commerical or residential development (units U and Z) have also been delineated on the land use cover maps.

Table 4.3.1 Plant species representative of the vegetative communities mapped and described in the text.

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1. WASH FORB H4

Polemonium pulcherrimum (POPU)	Jacob's ladder
Dryas drummondi (DRDR)	dryas
Astragalis missouriensis (ASMI)	Misscuri milkvetch
Solidago canadensis (SOCA)	goldenrod
Arabis sp.	rockgrass
Epilobium latifolium (EPLI)	alpine latifolium

2. WASH SHRUB, PIONEER WASH D1

Populus trichocarpa (POTR)	black cottonwood
Salix sp.	willow
Elaegnus commutata (ELCO)	silverberry

3. HYDRIC BOG H3

Juncus sp.	rush
Agrostis alba (AGAL)	red top
Carex flava (CAFL)	yellow sedge

4. HYDRIC UPLAND SHRUB D2

Cornus stolonifera (COST)	red osier dogwood
Alnus sinuata (ALSI)	white alder
Crataegus douglassii (CRDO)	black hawthorne
Rosa sp.	wild rose
Populus trichocarpa (POTR)	cottonwood
Alnus incana (ALIN)	mountain alder
Salix sp.	willow
Betula glandulosa (BEGL)	bog birch
Vicia americana (VIAM)	American vetch

5. MATURE COTTONWOOD D3

Populus trichocarpa (POTR)	black cottonwood
Alnus incana (ALIN)	mountain alder
Salix sp.	willow
Scenecio streptanthifolius (SCST)	aster
Achillea millefolia (ACMI)	yarrow
Gaillardia aristata (GAAR)	brown-eyed susan
Arnica chamisscnis (ARCH)	arnica
Senecio pseudaureus (SEPS)	groundsel

6. MESIC UPLAND SHRUB D5

Amelanchier alnifolia (AMAL)	serviceberry

Acer glabrum (ACGL)	mountain maple
Physocarpus malvaceus (PHMA)	ninebark

7. COTTONWOOD-SPRUCE TRANSITION D6

Populus trichocarpa (POTR)	black cottonwood
Cornus stolonifera (COST)	red osier dogwood
Picea glauca/engelmannii (PIGL)	spruce

8. SPRUCE BOTTOMLAND (INCLUDES PICEA/EQAR HABITAT TYPES) S1

Picea glauca/engelmannii (PIGL)	spruce
Cornus canadensis (COCA)	bunchberry dogwood
Cornus stolonifera (COST)	red osier dogwood
Equisetum arvense (EQAR)	horsetail
Angelica arguta (ANAR)	white angelica
Galium triflorum (GATR)	sweetscented bedstraw

9. OTHER SPRUCE DOMINATED TYPES INCLUDING PICEA/CLUN AND ABLA/CLUN HABITAT TYPES, S3,S4,S6, and S7

Picea glauca/engelmannii (PIGL)	spruce
Clintonia uniflora (CLUN)	queencup bedlily
Berberis repens (BERE)	Oregon grape
Arnica chamissonis (ARCH)	arnica
Fragaria virginia (FRVI)	wild strawberry
Symphoricarpus alba (SYAL)	snowberry
Amelanchier alnifolia (AMAL)	serviceberry
Thalictrum occidentale (THOC)	western meadowrue
Chimaphila umbellata (CHUM)	pipsissewa

10. SUBALPINE FIR INCLUDING ABLA/MEFE AND ABLA/CLUN HABITAT TYPES, F1, F3

Abies lasiocarpa (ABLA)	subalpine fir
Rubus parviflora (RUPA)	thimbleberry
Spirea betulifolia (SPBE)	white spirea
Oryzopsis asperifolia (ORAS)	mountain rice grass
Larix occidentalis (LAOC)	western larch
Xerophyllum tenax (XETE)	beargrass
Vaccinium membranaceum (VAME)	blue huckleberry
Pinus monticola (PIMO)	western white pine

11. DOUGLAS FIR MAP UNITS, F4, F6, F7,F9

Linnaea borealis (LIBO)	twin flower
Calamagrostis rubescens (CARU)	pine grass
Pseudotsuga menziesii (PSME)	Douglas fir
Clintonia uniflora (CLUN)	queencup beadlily
Picea glauca/engelmannii (PIGL)	spruce
Pinus ponderosa (PIPO)	ponderosa pine
Vaccinium caespitosum (VACA)	dwarf huckleberry
Larix occidentalis (LAOC)	larch
Xerophyllum tenax (XETE)	beargrass

Symphoricarpus alba (SYAL)	snowberry
Arctostaphylos uva-ursi (ARUV)	kinnikinnick

12. LODGEPOLE PINE MAP UNITS

12a. YOUNG LIVE LODGEPOLE PINE FORESTS L1

Pinus contorta (PICO)	lodgepole pine
Larix occidentalis (LAOC)	western larch

12b. MIXED LIVE AND DEAD LODGEPOLE PINE FORESTS L3,L5,L8

Calamagrostis rubescens (CARU)	pinegrass
Vaccinium caespitosum (VACA)	dwarf huckleberry
Acer glabrum (ACGL)	mountain maple
Arctostaphylos uva-ursi (ARUV)	kinnikinnick
Pinus contorta (PICO)	lodgepole pine

12c. DEAD LODGEPOLE PINE, SPRUCE L4

Clintonia uniflora (CLUN)	queencup beadlily
Linneae borrealis (LIBO)	twinflower
Chimaphila umbellata (CHUM)	pipsissewa
Pinus contorta (PICO)	lodgepole pine
Picea glauca/engelmannii (PIGL)	spruce

12d. LODGEPOLE PINE SAVANNAH L7

Festuca idahoensis (FEID)	Idaho fescue
Festuca scabrella (FESC)	rough fescue
Agropyron spicatum (AGSP)	bluebunch wheatgrass
Pinus contorta (PICO)	lodgepole pine
Artemisia tridentata (ARTR)	big sagebrush

13. WESTERN LARCH MAP UNITS

13a. MATURE LARCH C1

Larix occidentalis (LAOC)	western larch
Picea glauca/engelmannii (PIGL)	spruce
Abies lasiocarpa (ABLA)	subalpine fir

13b. YOUNG WESTERN LARCH

Larix occidentalis (LAOC)	western larch
Pinus contorta (PICO)	lodgepole pine
Pseudotsuga menziesii (PSME)	douglas fir
Picea glauca/engelmannii (PIGL)	spruce
Abies lasiocarpa (ABLA)	subalpine fir

14. GRASSLAND HABITAT TYPES

14a. MESIC GRASSLANDS H2

Festuca scabrella (FESC)	rough fescue
Poa pratensis (PAPR)	Kentucky bluegrass
Stipa richardsonii (STRI)	Richardson's needlegrass
Lupinus sericeus (LUSE)	silky lupine
Geum triflorum (GETR)	sweet scented bedstraw
Taraxacum officionale (TAOF)	dandilion
Danthonia intermedia (DAIN)	timber oatgrass
Achillea millefolia (ACMI)	yarrow

14b. XERIC GRASSLANDS H1

Agropypron spicatum (AGSP)	bluebunch wheatgrass
Koeleria cristata (KOCR)	prairie junegrass
Danthonia intermedia (DAIN)	timber oatgrass
Festuca idahoensis (FEID)	Idaho fescue
Eriogonum flavum (ERFL)	sulphur plant
Achillea millefolia (ACMI)	yarrow

4.4 CERVIDS A HISTORICAL PERSPECTIVE

4.4.1 Presettlement Period

The primeval distribution and abundance of cervids in the North Fork of the Flathead Valley is poorly documented, but early explorations of the United States Biological Survey provided useful qualitative descriptions (Bailey 1918). Then, as now, the North Fork comprised a vast expanse of lowland forests, which were studded with numerous wetlands and alluvial brushfields.

Elk were absent, or at most, local in distribution and rare in the late 19th century North Fork. In fact, Bailey described elk populations as being scarce throughout the coniferous mountain area, although a small population of less than 50 elk, was observed on the interface of forest and plains on the east side of the current Glacier National Park.

Bailey (1918) believed that moose were more abundant than elk primevally, and numbered in the realm of several hundred throughout the park. The greatest population centers were in the bottomlands and tributaries of the North Fork. Winter yards were described on Dutch, Camas, and Logging Creeks and opposite Starvation Creek (Bailey, 1918). Early trappers believed moose were being depleted rapidly at the turn of the century for use as bear bait, but at the time of his writing, Bailey believed moose numbers were increasing again and occupying new range.

Little is known about early distributions and abundance of white-tailed and mule deer, but Bailey described whitetails as being abundant at upwards of 2000 deer, which were distributed primarily on bottomlands of westside drainages. Mule deer numbered in the hundreds, and attained greatest densities on east side slopes. The accuracy of both estimates is hard to determine.

Primevally, the North Fork of the Flathead Valley was the eastern limit to the range of Woodland Caribou in the contiguous United States. Caribou numbers are unknown, although there are published accounts of Indians hunting them on the North Fork. A summary of caribou sitings indicated none were observed prior to 1915, primarily because the area was unsettled or unexplored. In later years, one to six sitings of caribou groups were reported in the North Fork each decade through the 1950's (Evans 1964).

4.4.2 Population Trends

Unfortunately, historical numbers of white-tailed deer, elk and moose in the North Fork are unknown. The best estimates of past numbers are presented in Table 4.4.1 and are based on ground counts of animals and previous experience of park personnel. They therefore reflect both the variability of count data and inherent biases of subjecting estimates; however, they may depict real trends in the relative abundance of species. The early estimates support the belief that elk were rare primevally, whereas moose and white-tailed deer were comparatively abundant.

Wasem (1967) reviewed those factors which historically influenced the ecological relations of ungulates in the North Fork. Fire apparently was a potent ecological force on ungulate populations in the 1920's and 1930's, with forest fires burning vast acreages near Round Prairie in 1910, and the Apgar Range, Huckleberry Mountain, Polebridge Area and Trail Creek in the late 1920's. Concurrently, a fervent campaign was levied against predators in the 1920's, which depleted native wolf populations (Singer 1975) and undoubtedly reduced local coyote numbers.

White-tailed deer reached peak densities in the early 1930's, apparently in response to the release of herbaceous and shrub regrowth after burning, and conceivably to lower predation. Vast brushfields, which grew up following burning, also benefited elk populations and promoted expansion of elk into

TABLE 4.4.1 Population estimates of white-tailed deer, elk and moose in the Northfork, 1933-1982.

		ESTIMATED POPULATION			
DATE	CENSUS[a]	WTD	ELK	MOOSE	DATA SOURCE
1933	McD-NF	2200			Estimate, Wasem (1967)
1933	NF	1525	73	164	Estimate, GNP Files
1936	NF	1310	130	164	Estimate, GNP Files
1938	NF	1500	163	150	Estimate, GNP Files
1947	McD-NF	1000	650		Estimate, Wasem (1967)
1953	McD-NF		650		Midwinter Aerial Count, GNP Files
1953	NF	394	440	51	Estimate, GNP Files
1955	NF	226	257	26	Estimate, GNP Files
1959	NF	223	390	44	Estimate, GNP Files
1960	McD-NF	250	350		Estimate, GNP Files
1970	NF	190	275	20	Estimate, Annual Report
1979-1982	NF[b]	>225	290		Estimate[c]; Annual Report

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a/ McD = McDonald Creek Valley
NF = North Fork of the Flathead Valley

b/ Recent estimates were restricted to Bowman Creek, Big Prairie, Kintla Creek, Lone Pine-Sullivan-Logging areas along standard road courses.

c/ Estimates are averaged over 3-yr. period using high estimates when ranges were given.

previously unoccupied area. Wasem (1967) reported that the range of elk rapidly expanded up the North Fork from a population center in the Belton Hills to the south; elk appeared in the Anaconda Creek area early in the 1930's and were reported in the Kishenehn drainage, near the Canada line in 1939. These newly established populations increased rapidly in response to favorable food supplies and peaked in the late 1940's and early 1950's.

Concomitant to the rise of elk numbers, deer populations crashed, apparently in response to a depleted forage base and competition with newly established elk. Heavy mortality of deer was reported in the mid 1930's due largely to combined circumstances of malnutrition and parasites (Aiton 1937). Deer were fed artificially, at Polebridge and Logging Ranger Stations throughout this period to alleviate this condition and sustain high densities of deer. But feeding was discontinued in 1936 and deer numbers declined subsequently and stabilized at lower densities in the mid-1950's.

Density estimates of both deer and elk would indicate populations have remained stable from the 1950's through the present, but because of their secretive habits, we believe estimates of deer numbers have been consistently low. The most recent estimate of 225 deer was concordant with earlier estimates, but estimates were obtained in specific areas along known routes, and we know of population centers of deer on floodplains of Anaconda and Camas Creek which were not sampled. Inclusion of these areas in the survey would increase estimates of deer numbers substantially.

Fire remains a potent ecological force in the North Fork, especially in drier upland sites, and currently has a high potential of influencing distribution and abundance of ungulates. Extensive areas burned on Huckleberry Mountain in 1967 and more recently in the Moran Creek drainage. South and west-facing slopes of the Huckleberry Mountain burn, are used by elk and mule deer during winter and spring, and the Moran Creek burn is used extensively by white-tailed deer and elk as spring range. However the affects of these burns on ungulate carrying capasity is unknown.

Moose apparently were more numerous in the past than in recent decades. Early rangers in the area believed the moose population was declining in the North Fork and attributed this loss to overharvest and unrestrained poaching (unpublished data, Biennial Animal Census Reports on file Glacier National Park). Competitive interactions of elk and moose are unknown, but expanding elk populations also may have affected moose adversely. Long-term residents of the North Fork believe moose populations have declined further since the 1950's and still believe combined legal and illegal harvest maintains moose at low population levels (L. Downes, T. Ladenburg, personal communication).

4.4.3 Cervid Range Trends

With increased deer numbers in the early 1930's, came reports of deer crowding and depletion of forage resources.

Early investigators described overbrowsing, especially in the Logging Creek area (Sumner 1936). Overbrowsing was especially prevalent under conifer shelter, with heaviest use on floodplains. Photographs showed examples of rose, serviceberry, elderberry, dogwood, and cedar virtually gnawed to snow level along deer travel routes, whereas spruce and lodgepole were 'highlined' to the maximum deer reach. To the north, browse damage decreased noticeably and reportedly, was almost non-existant a couple miles north of Polebridge (Sumner 1936).

Unfortunately, the first transects for browse trends were not measured until the 1960's. Several transects were then established by Montana Department of Fish and Game, with one on a serviceberry site in our present study area. Measurements were taken annually from 1960 at least until 1971. Utilization was high, averaging 76%, with 2-40% of the shrubs in hedged form. Wasem (1967) measured willow, serviceberry and aspen use on prime elk wintering areas within the park. Willow, serviceberry and aspen use over four range sites averaged 78%, 65%, and 67%, respectively. Use of bunchgrasses on early spring ranges averaged 21-55% and was considered within acceptable limits. Moose browse was measured in the far north of the study area by Jonkel (unpublished data, Montana Dept. Fish and Game 1963). Utilization varied extremely between seasons and range sites, and apparently was influenced by winter conditions and the habits of moose to yard in very restricted and heavily used areas. Use of willows ranged from 0-89%, reflecting areas of light and concentrated moose use in different years.

4.5 AVIAN COMMUNITIES IN THE RIPARIAN ZONE

A synecological study of avian community structure involves the study of avian communities as a whole, rather than just individual species. Several attributes are typically examined to when considering avian community structure; bird species richness, diversity, equitability, and total bird density. Species richness is simply the number of species within a community. It alone does not adequately describe community structure by itself, for it does not take into account the numbers of individuals of each species. Therefore, bird species diversity is an often used measure. Species diversity has two components, species richness and the relative distribution of abundances of those species in the community. Equitability is a measure of the relative diversity of a community and corresponds to the evenness of the abundances of the species within a community. Total bird density is a measure of the number of individuals per unit area.

The characteristics of individual species must also be incorporated in synecological studies. Two avian communities with a similar species richness, diversity and total density are not alike if they consist of different species. Therefore, a study of avian community structure must necessarily include a list of species and at least their respective abundances. A measure of community similarity can then be computed by examining the proportional abundances of species common to both communities.

When considering potential impacts of habitat alterations on avian communities, we also needed a measure of the level of habitat specialization of each species. Refered to as niche width, this measure reflects the relative distribution of a species across the habitat.

The avian communities on the floodplain of the North Fork of the Flathead River have received little study in the past. Glacier National Park personnel maintain species lists and notes, primarily of raptors, herons and uncommon or accidental species. The only previous research was a study by Eng and Herbert (1976) during the summer of 1976, which was never completed. During that season, 105 species of birds were observed in the valley. Of those, 79 were observed on the floodplain study plots and 30 species were classified as nesting. The remainder of this section will briefly review environmental factors which influence avian communities in the riparian zone.

The importance of riparian habitats to breeding birds has become well established in North America (Carothers and Johnson 1975, Gaines 1977, Wauer 1977, Bull 1978). Stauffer and Best (1980) observed that bird species richness increased with the width of wooded riparian areas. Johnson et al. (1977) found that 77% of breeding bird species in the southwestern United States were dependent on riparian habitats. Szaro (1980) concluded that no other habitat in North America is as important to noncolonial, nesting birds.

Research on habitat selection of birds has focused on finding associations between birds and the vegetative physiognomy of a site. MacArthur and MacArthur (1961) concluded that birds were selecting for subtle differences related primarily to structural features of the habitat. MacArthur (1964) related bird species diversity to the vertical foliage profile, and demonstrated that the bird species diversity was greatest when foliage was equally distributed among three vertical layers. Evidence supporting these observations has come from Recher (1969), Balda (1975) and Stiles (1980). Willson (1974) also found total percent vegetation cover to be associated with bird species diversity. Bird species richness is thought to be a function of the presence or absence of trees, i.e. additional vertical layers (Stiles 1980, Wilson 1974). Conflicting results concerning relationships between bird density and vegetation structure have been reported and no final conclusions have yet been reached (Willson 1974, Wiens and Rotenberry 1981, Morrison 1981, Freedman et al. 1981).

The plant communities along the North Fork of the Flathead River represent a continuum of successional stages. A general increase in bird species diversity, richness and bird density has been shown to accompany increasing ecological age of seral stages, presumably due to an associated increase in the structural complexity of the stand. This increase in diversity, richness, and density is not linear, and depending on the area, may reach a maximum in the climax (Odum 1950, Conner et al. 1979) or the preclimax stage. (Shugart and James 1973, Smith and

MacMahon 1981, Beedy 1981).

4.6 MAMMALIALIAN SPECIES OF THE RIPARIAN ZONE

This section briefly summarizes by species, the important characteristics of the major small, medium, and large terrestrial mammals found in the upper Flathead River Basin, or whose distribution includes this region. This section discusses species not emphasized in this study. In most cases there has been little research carried out on any of these species in the region. Where necessary, background information from studies in similar environments has been used. This section concludes with a brief summary of the potential effects that land development and resource exploitation may have on selected species.

4.6.1 Small Mammals of the Floodplain

Sorex vagrans. Key (1979) found the greatest abundance of vagrant shrews on the North Fork Floodplain to be in or near spruce forest types. However they also occur in grasslands, wash communities, and clearcuts in the region (Ramirez 1981).

Sorex cinereus. On the North Fork, the common shrew occurs in conjunction with the vagrant shrew, and in such cases it is less abundant and thought to be partially restricted to more xeric forests (Hoffmann and Pattie 1968).

Sorex palustris. The Northern water shrew is usually found within one foot of water. It prefers fast mountain streams, where it hunts in areas containing favorable cover of large stones, tree roots, and over hangs (Conaway 1952), although it has also been found in marshy areas (Dice 1923).

Microsorex hoyi. The pygmy shrew is considered rare throughout its range, and is a species of concern in Montana (Flath 1981). One specimen was caught by Key (1979) on the North Fork floodplain in a spruce-cottonwood forest stand.

Thomomys talpoides. Pocket gophers were rarely caught by Key (1979) on the North Fork floodplain, however they were not his target species, and they most likely are more abundant on older river terraces where the soil is deeper and less rocky.

Zapus princeps. The western jumping mouse is most abundant in grasslands, open forests, and on forest edges, of the North Fork floodplain where it was often a co-dominant small mammal (Key 1979).

Peromyscus maniculatus. Deer mice constituted over 50% of the small mammals trapped on the North Fork by Key (1979). They were most abundant in drier areas with dense shrubby cover and low coverage of forest canopy, where they were often the dominant small mammal, and were less abundant in dense coniferous forests. In clearcuts on the South Fork of the Flathead Valley deer mice reached peak abundance 2-5 years after cutting, and decreased to populations levels equivalent to that in native forests 15 years after cutting (Ramirez 1981).

Neotoma cinerea. The bushy-tailed wood rat occurs on the floodplain mostly in or near buildings where suitable nest sites are abundant (Key 1979).

Clethrionomys gapperi. The red-backed vole is found principally in mesic coniferous forests of the region where it is often the dominant small mammal (Key 1979, Ramirez 1981, Weckworth and Hanley 1962). It tends to avoid clearcuts and other open cover types (Ramirez 1981).

Phenacomys intermedius. Montane heather voles occur most often in coniferous habitats, although they are not very abundant on floodplain and other low elevation sites (Hoffmann and Pattie 1968, Weckworth and Hanley 1962).

Microtus pennsylvanicus. The meadow vole is found primarily in marshes, mesic meadows, and other grassy areas within the region (Hoffmann and Pattie 1968, Key 1979, Murie 1962).

Microtus longicaudus. The long-tailed vole occurs in a variety of habitats and areas on the North Fork. (Key 1979) found it to be most numerous in open, brushy and grassy habitats, and although they were not as common as deer mice and red-backed voles, they were co-dominant in some habitats.

Arvicola richardsoni. The water vole is a large, semi-aquatic species that occurs along swift streams and small lakes (Hoffmann and Pattie 1968). Although it is most numerous at high elevations, it may occur on the floodplain in the upper reaches of the North Fork. One was taken along Coal Creek (Hoffmann et al 1979b).

Synaptomys borealis. The range of the northern bog lemming is thought to be restricted to sedge-alder bogs within or on the edge of spruce-fir and lodgepole pine forests in Montana where they are considered a species of concern or special interest. The only recorded population in the state is in the North Fork drainage (Hoffmann and Pattie 1968).

Eutamias amoenus. The yellow pine chipmunk is the most common chipmunk in western Montana. It is typically found along forest edges, in open forests such as cottonwood or ponderosa pine stands, or in grassy areas where brushy or rocky cover is present (Hoffmann and Pattie 1968, Key 1979).

Eutamias ruficaudus. Red-tailed chipmunks primarily inhabit subalpine fir-spruce forests, and forest edges, although their range may extend somewhat into Douglas fir-Ponderosa Pine stands. Key (1979) did not observe any in his study of floodplain small mammal communities, and he hypothesized that they do not range near the river.

Tamiasciurus hudsonicus. The red tree squirrel is common throughout western Montana (Hoffmann and Pattie 1968).

Glaucomys sabrinus. Northern flying squirrels occur throughout montane and sub-alpine coniferous forests, and perhaps into cottonwood stands. Because they are difficult to capture, little is known about their distribution and abundance, although they are thought to be most abundant in northwestern Montana (Hoffmann and Pattie 1968).

Spermophilus columbianus. On river floodplains, the Columbian ground squirrel is most numerous in open areas, such as meadows, forest clearings, and clearcuts, where there is an abundance of grasses and sedges and sufficient soil depth for their burrows (Manville 1959).

4.6.2 Summary of the Small Mammal Information

The variety of riparian habitats along the North Fork and mainstem of the Flathead Rivers support a diverse fauna of small mammals. Some species, such as the bog lemming and the water shrew, are tied to specific cover types or areas. Others, such as the deer mouse are generalists and are found in a variety of cover types, although even these species are more abundant in preferred habitats. Development within the drainage will result in a change in small mammal species composition and relative abundance, primarily through the removal or alteration of preferred habitats.

The removal of bottomland spruce forests will probably result in a decreased abundance of the red backed vole andthe flying squirrel, and increased abundance of species which favor open areas such as the deer mouse, jumping mouse, and Columbian ground squirrel. The creation of openings for residences will further reduce species diversity through the removal of brushy cover that species such as deer mice and yellow pine chipmunks prefer, and through the actions of residents to remove species that are usually considered incompatable with man, such as ground squirrels and pocket gophers. Some species, such as the brushy-tailed woodrat, may increase in abundance. Key (1979) observed that the biomass and diversity of small mammals on the North Fork floodplain were greatest in coniferous forests, and least in grasslands. However it is evident that the maintenance of a diversity of habitats, including grasslands and brush fields, is necessary for maintaining the maximum diversity of small mammals.

4.6.3 Medium and Large Mammals of the Floodplain

Ondatra_zibethicus. Muskrats are common in the study area in habitats such as marshes, and along the river (Dice 1923).

Castor_canadensis.The beaver occurs in lakes, rivers, and marshes throughout Montana. Personal observations of several individuals indicate that beavers tend to be less common along the North Fork than in previous years. This may be a function of heavier trapping on the western side of the river.

Erethizon__dorsatum. Key (1969) did not observe any porcupines on the floodplain during his study, and suggested they may be more numerous at higher elevations.

Lepus_americanus. Snowshoe hares are most abundant in areas of heavily stocked timber (Adams 1959), primarily seral lodgepole pine stands (Koehler et al. 1979).

Lepus_townsendii. The white-tailed jack rabbit inhabits open grasslands. There is a record of white-tailed jack rabbits occurring eight miles north of Kalispell (Hoffman et al. 1969b).

Lynx_rufus. Bobcat occur occasionally in northwest Montana. Key (1979) saw no bobcat sign during his study and on the South Fork of the Flathead drainage they were one of the least abundant predators (Hornocker and Hash 1981).

Lynx_canadensis. The range of lynx extends southward into the mountains of western Montana (Hoffmann and Pattie 1968), where they are a species of concern (Flath 1981). Lynx prey principally on showshoe hares. Since snowshoe hares are found principally in dense, seral coniferous forests in Montana, Lynx have also been found to be most abundant and to concentrate their activities in these areas (Koehler and Hornocker 1979).

Felis concolor. The cougar is widespread and relatively common in western Montana (Hoffmann and Pattie 1968), and is classified as a big game species. On the North Fork drainage, mountain lions are considered common (Singer 1976), with an estimated minimum of 10 occuring in the northern, park-side portion of the drainage. Key (1979) observed mountain lion tracks on both floodplain and upland sites, although they were most numerous in upland coniferous stands (Shea 1976).

Procyon lotor. Raccoons were originally considered scarce in Montana, but their range has been expanding from the south in recent years (Hoffmann and Pattie 1968). The first record of raccoons in the park occurred in 1971 (Gildart 1975) Key (1979) saw none during his study, but thought that they were in the area.

Mephitis mephitis. Striped skunks are common in Montana, and inhabit a variety of habitats. They are known to adapt to the presence of humans, and consequently occupy even cultivated areas along the mainstem of the Flathead River (Hoffmann and Pattie 1968).

Lutra canadensis. River otters are still fairly common (Hoffmann and Pattie 1968), and are considered a significant furbearer in the state. Otters have been recorded in the North Fork drainage by many authors (Gilbert 1975, Key 1979, Shea 1975), although specific information on their behavior and activities is lacking.

Taxidea taxus. In northwest Montana, unlike other areas of the west, badgers may have increased in abundance since presettlement times due to the increased amount of forest openings created by logging and settlement activities (Hoffmann and Pattie 1968). In the North Fork drainage badgers are found primarily in the natural meadows, where they prey principally upon Columbian ground squirrels and northern pocket gophers.

Gulo gulo. As was the case throughout most of northern North America, wolverine populations in and around Glacier were greatly reduced during the early 20th century due to unlimited harvesting. In 1918, Bailey thought that there were no wolverines in Glacier National Park, and by 1927 they were considered extirpated from Montana (Newby 1955). However in 1933, soon after the Park Service stopped removing predators, they were again seen in the park, and they have been seen there each year since. The first record of wolverines outside the park occurred in 1939, and now the wolverine is thought to have recolonized most of its former range in Montana. The return of wolverine to Montana is thought to have resulted from recolonization, initially from Canada, and later from the park (Newby 1955). At present the wolverine is listed in Montana as a species of concern or special interest.

Wolverines in the South Fork drainage preferred areas of medium stocked or scattered mature timber, and forest ecotonal sites. They used densely stocked, young timber or open or brushy areas less frequently. In the summer wolverines were found primarily in higher elevations and were thought to feed on a variety of items. During the winter they moved to lower elevations and fed primarily on carrion. The wolverine density in the area was one per 65 sq. km. This relatively high density appeared to result from the large and diverse population of area ungulates (Hornocker and Hash 1981), and the consequently greater carrion supply.

Several authors have observed wolverines in the North Fork drainage (Key 1979, Shea 1976), however there have been no studies of wolverines there. Hornocker and Hash (1981) suggested that remote areas are necessary for the continued survival of wolverine due to conflicts between wolverine and man, resulting from their scavenging, wide ranges, and their easy succeptability to traps.

Martes americana. The marten is common in the western third of Montana (Hoffmann and Pattie 1968), and is a sigrificant furbearer. Key (1979) found them to be the most abundant predator in upland coniferous forests in the floodplain of the North Fork. Martens avoided open habitats, such as meadows and clearcuts, in the winter, but used them to some extent in the snow free months. Martens fed primarily on voles, especially the abundant red-backed vole. They also ate squirrels, fruit, carrion, and insects. Marten densities in the North Fork have ranged from one per .8 sq. km to one per 2.6 sq. km over a period of several years. The change in density was related to the change in the number of juveniles able to establish home ranges in the area, which in turn was correlated to prey abundance. In years of low prey availability more juveniles dispersed out of the area and marten density was consequently lower. In areas of mature coniferous stands the size of adult male and female home ranges were 2.9 sq. km and .9 sq km respectively, with little range overlap occurring between adults of the same sex. However in areas with more clearcuts and other open types, the home range size increased, and population density decreased (Burnette 1981, Hawley and Newby 1957, Weckworth and Hawley 1962).

Martes pennanti. Due to pressures from market hunting, fishers were extirpated from Montana by the 1920's. In 1959-1960 they were successfully introduced into western Montana, and the first record in the North Fork drainage was in 1962 (Weckworth and Wright 1968). Fishers are still considered rare in the park, and are considered a species of special concern in Montana (Flath 1981). A study in the South Fork drainage showed that three male fishers preferred primarily mesic sites at all elevations, primarily using mature coniferous stands. They also moved to lower elevations during the winter (Hash and Hornocker 1979).

Mustela vison. Mink are a semi-aquatic species which are abundant in riparian areas throughout Montana (Hoffmann and Pattie 1968). Mink forage primarily in riparian vegetation, overhanging banks, logjams, and sweepers. They are opportunistic feeders, changing their diet with changes in prey density. Fish and small rodents dominate the diet, although muskrats, birds, and invertebrates were also taken (Whitman 1981). On the North Fork in the winter, mink were the second most common predator in areas bordering the river (Key 1979).

Mustela ermine̲a̲. The short-tailed weasel or ermine is common in subalpine coniferous forests, and also occurs in montane forests, intermountain valleys, and alpine areas of Montana (Hoffmann and Pattie 1968). Ermine prey primarily on voles and other small rodents and shrews, and seem to prefer moist or mesic areas (Yaich 1972). Winter track counts in the North Fork drainage revealed ermine to be most numerous on the floodplain, and the most abundant carnivore in all habitats except upland forests (Key 1979).

Mustela frenata. The long-tailed weasel, where it occurs with the ermine (as in western Montana) is thought to be most common in more xeric sites, and to prey principally upon deer mice (Yiach 1972). In the North Fork drainage, long-tailed weasels were less common than the ermine, especially on the floodplain. They were more abundant in upland sites, particularly in cottonwood stands, and were second in abundance to the ermine (Key 1979).

Vulpes vulpes. The red fox was originally considered rare in Montana. However, it has recently expanded its range (Hoffmann and Pattie 1968). They are still considered rare in the park (Gildart 1975). Key (1979) saw none during his study of Noth Fork floodplain mammals, but stated that he thought that they were in the area. Only ten out of 5442 predator tracks seen during five years of a winter study in the South Fork drainage were of red fox (Hornocker and Hash 1981).

<u>Canis latrans</u>. The coyote is common and occurs on a variety of habitats in the North Fork drainage (Aiton 1938, Shea 1976, Singer 1976). Its diet includes a wide range of items, including carrion, small mammals, ungulates, and vegetation (Dice 1923).

<u>Canis lupus</u>. The timber wolf was almost exterminated in the Western U.S., and it is listed on the federal endangered species list. One of the few areas where wolves are thought to remain is in the North Fork drainage. Wolf population estimates in the area vary from year to year, ranging from 1 to 10 (Ream 1979, Chadwick 1975). Since 81 percent of the observations in the drainage were of single individuals, and no den has been found on the U.S. side of the border, it is thought the wolves seen in the area are Canadian wolves which make occasional use of the valley (Kaley 1976), or possible immigrants from Alberta. These hypotheses are further supported by the fact that wolves have been increasing in southern Alberta and in parts of British Columbia (Ream 1979).

An adult female wolf was equipped with a radio-collar 10 km north of the border, along the river, in 1979. All of her observations from April through July were concentrated along riparian zones of the river valley. Because of a wide array of food, and the large amount of remote areas in the region, it is believed that wolf recovery could occur in the North Fork drainage if the existing population of wolves is protected and natural immigration from Canada continues. However, concern has been expressed about the impact of increasing logging activites and residential and energy development in the area on possible wolf recovery (Singer 1975, Beam 1979).

Ursus americanus. The black bear is common in forested areas of western Montana (Hoffman and Pattie 1968). In the North Fork, black bears occur primarily in coniferous forests, although they make seasonal use of areas such as meadows, snowslides, and riparian zones. Black bears avoid clearcuts until they are about 10 years old and densely vegetated (Jonkel and Cowan 1971). Black bear feed on a variety of items, including carrion,and small mammals, but the majority of their diet consists of vegetation. They establish non-overlapping home ranges, and populations seem to be partially regulated by the number of juveniles able to establish a range in the area. The black bear population in Glacier National Park is estimated at 500, or approximatly one bear per 8.3 sq. km (GNP Bear Management plan). Outside the park in the Big Creek drainage the black bear population ranged from one bear per 2.01 sq km to one per 4.37 sq km in a year of poor berry crop and increased hunting (Jonkel and Cowan 1971).

Ursus arctos. Grizzly bears are classified nationally as a threatened species. The largest population of grizzly bears in Northwest Montana is in and around Glacier National Park. The grizzly population in the park is thought to be stable at about 200 bears (Martinka 1974), or about one bear per 26 sq. km (Singer 1976). The density of grizzlys outside the park is unknown. Grizzly bear home ranges are large, usually non-territorial, and typically consist of several disjunct seasonal ranges. Preferred foraging sites are typically in open sites such as in brushfields, alpine meadows, prairies, and avalanche chutes, but also include river bottoms and moist forests (Mealey et al. 1976). The influence of logging activities on grizzley bears is unclear. They have been observed to forage in certain clearcut areas. Grizzlys made least use of clearcuts in which the soil was greatly disturbed, where grassy cover was dominant, and shrub cover reduced (Zagar 1978). Grizzly bears concentrate on the North Fork floodplain in the spring and the fall, where densities of one bear per 3.4 sq. km. have been observed (Singer 1976).

Like black bears, grizzlys are omnivorous. In the North Fork drainage, succulant forage, especially umbelliferae, forbs, and gramenoids, are the most important food items. They are the predominant food in the spring, and the most important supplement during the late summer and fall. Fruit become the primary food source in late summer and fall. Animal material, particularly carrion, is an important supplement during the spring and fall (Husby and McMurray 1978).

4.6.4 Summary of the Medium and Large Mammal Studies

The North Fork and Mainstem drainages of the Flathead River support a diverse population of large mammals, due in part to the large amount of remote and undeveloped land in the drainage. The abundance and diversity of many mammals also depends on the pristine and undeveloped nature of the river and the surrounding floodplain. If the water quality diminishes as a consequence of upstream development, the prey base for aquatic predators may decrease. Efforts to control the river flow, such as through channelization and removal of debris, will result in the removal of preferred and productive foraging areas of otter and mink. The activity of beaver along side drainages is often considered undesirable by humans, sometimes resulting in the removal of problem animals, although the habitats they create are often productive foraging areas for other species of wildlife. The maintenance of riparian vegetation for security cover, den sites, and foraging areas is extremely important for aquatic species such as the water shrew, mink, and otter.

The variety of natural vegetation types in the area also has a significant effect on the species diversity of medium and large mammals. Certain species depend on specific habitats; badgers and grizzly bears in meadows, marten and black bears in mature spruce forests, and lynx and snowshoe hares in seral lodgepole pine stands. The maintenance of a diversity of plant communities is essential to maintain a diverse mammalian community. Accelerated harvesting of climax spruce and fir forests would result in decreased abundance of marten for example, whereas the exclusion of fires could result in decreased availability of seral lodgepole pine stands and consequent decreased abundance of lynx. Although the wolverine prefers mature coniferous stands, the maintenance of wolverines depends upon the maintenanceof habitats suitable for ungulates. Other predators, such as the cougar and coyote, also make extensive use of the floodplain in the winter because it is an ungulate winter range.

For wide-ranging species whose activities may often be in conflict with humans, such as the grizzly bear, wolf, wolverine, and cougar, this is one of the few areas in continental U.S. where they can range normally and avoid conflict with people. Increasing settlement of the basin would change this, resulting in more human contact and conflicts, and eventually, an increased pressure to remove offensive individuals and species. Populations in portions of the area, particularly the park, serve as sources for restocking and recolonization of developed areas (Burnette 1981, Martinka 1974). Increased development of the area would also cause increased access, and consequently increased harvesting pressure on species classified as furbearers. Even protected species will experience greater human related losses, for although they may not be the target species, they are taken incidentally. (Hash and Hornocker 1981).

5.0 SAMPLING METHODS

5.1 PLANT COMMUNITY CLASSIFICATION

5.1.1 Classification and Mapping Techniques

A vigorous debate has been underway for years among plant ecologists over the most meaningful way to interpret plant community organization. Although several philosophies have been developed two primary schools of thought have emerged: 1) the first considers that distinct vegetation types develop at a climax stage and are repeated over the landscape at points of similar environmental conditions; the second advocates that even at a climax stage, vegetation varies continuously, adjusting to even minor change in environmental conditions (Whittaker 1962).

Resource managers have traditionally held to the first philosophy and have viewed natural communities in terms of categories. This is especially true in the Western United States where the habitat type approach has been widely applied (Daubenmire 1966). The second philosophy has its origins in the studies of Ramensky (1926), Whittaker (1956, 1960), Bray and Curtis (1957), and was applied to Glacier National Park through the studies of Kessell (1977). Kessell argued that since most natural communities do not fall into district categories but rather exhibit compositional characteristics which vary continuously in space and time in response to environmental gradients, categorizing these communities results in an inherent loss of information due to the natural variation in each class. The only way to minimize this loss of information would be to increase the complexity of the classification system.

The vegetation in the riparian zone of the North Fork appears to us as a continuum, reflecting environmental gradients related to elevation, aspect, plant succession, floodplain disturbances, and ungulate grazing influences. However, for the purposes of this study, we developed an ecologically based classification. In it plant communities and land-use categories have been classified and mapped according to the dominant plant community present on the site. Plant communities were not classed by habitat type due to the large number and diversity of successional vegetation types making up the study areas. However, when possible, the communities identified were keyed to the accepted habitat types identified for this region of Montana by Pfister et al. (1977).

We mapped vegetation types and classified land-uses for the entire riparian zone of the North Fork drainage from the international border south to the confluence of the Middle Fork (32 minutes latitude). Two broad study zones along the mainstem of the Flathead River representative of riparian conditions in that region were also mapped. The areas mapped began just south of Columbia Falls and extended to a point about 2 km north of Flathead Lake (15 minutes latitude).

The primary focus of our study was the active river floodplain and the terraces immediately adjacent to it. However, areas delineated for mapping were river-centered and extended about 3 km to either side, thus extending beyond the borders of the riparian zone. The exact lateral limits of the mapping were arbitrary, depending upon topography, plant cover and environmental disturbance. An attempt was made to include all amenities important to wildlife inhabiting the river corridor. Maps were produced at a scale of 1:24,000, to overlay standard U.S. Geological Survey 7.5 minute topographic maps. The vegetation maps of the North Fork covered at least portions of the following 1:24,000 scale USGS quadrangles: Polebridge, Trail Creek, Demers Ridge, Huckleberry Mountain, McGee Meadows, and Columbia Falls North. On the Mainstem, vegetation maps covered portions of the following quadrangles: Columbia Falls South, Creston, and Kalispell.

The maps were produced using a projection/tracing method whereby high altitude NASA color infrared photographs at a nominal scale of 1:30,000 were projected onto translucent drafting film on which relevant environmental features were delineated (key 1979). Features were mapped based on extensive prior experience with the flood plain vegetation of the North Fork (Key 1979). The resulting maps were further ground-truthed and redefined where necessary by field researchers during the summer of 1982.

Due to the large amount of information to be placed on each of the vegetation land-use maps, a hierarchial categorization was developed which allowed the information to be placed on separate overlays. Six separate overlays were created for each quadrangle of the North Fork. Each overlay represented unique categories of the riparian system. On the Mainstem, four overlays were created because of the decreased forest cover and predominance of impacted areas. A listing of the information included on each set of overlays is given in Table 5.1.1. The specific land use and land cover categories that were mapped are discussed in Section 6.0.

Several criterea were used to define the map categories. These included: 1) the ability to identify a given category on the available aerial photography and delineate it at the chosen scale of reproduction; 2) the importance of the category to wildlife; 3) its relevance in understanding the role of different land-use distrubances in the region; and 4) the size or importance of the category within the basin. In setting up a classification scheme, the herbaceous vegetation types,

Table 5.1.1 Plant communities and land-use classification overlays initially developed for each of the respective topographic base maps covering the study areas.

A. North Fork Drainage

1. All roads logging trails, and tributary streams.

2. Land-use disturbances, which included clearcuts, mining activities, agricultural-grazing operations, and burns.

3. Major water resources and natural non-forested areas.

4. Non-forested areas, including grassland and herbaceous types, shrubs, cottonwood and aspen stands.

5. Forest types dominated by lodgepole pine.

6. All other coniferous forest types.

B. Mainstem - Flathead River

1. All roads.

2. Land-uses, such as commercial and residential development.

3. River corridor, other major water resources, and natural non-forested areas.

4. Natural forest and non-forest types, deciduous hardwoods, grasslands and shrubs.

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shrub types, and deciduous woodlands were defined by variables of predominant species, canopy closure, and moisture condition following an adaptation of Koterba and Habeck (1971), Key (1979), and Allen (1980). In the absence of an alternative cover type classification, coniferous forest types were classified by predominant species, canopy closure, moisture condition, age (as indicated by crown diameter) and, where possible, understory species. In many cases, understory species composition and moisture condition were determined by interpretive clues derived by looking at the aerial photographs through a stereoscope and by the analyst's familiarity with the study area. Unpublished data from F.J. Singer, S.R. Kessell, and R.H. Hall, were used, and ecologists with past experience in the area, were also consulted.

The land areas of all mapped categories on all overlays were determined through the use of a hand operated digital planimeter. The outline of each category was traced three times and the average was recorded. The areas of each map unit have been retained, but were aggregated by quadrangle in subsequent discussions concerning the habitat characteristics of the river basin. A second use for these data was in the development and validation of simulation models which examined the successional process and cervid habitat use along the North Fork.

5.1.2 Vegetation Surveys

Structure and composition of vegetation were measured in summer 1982 along routes used in the winter survey of cervids. Fifty four sample stands, representing diverse vegetation types, were allocated nearly evenly between three latitudinal sectors of the valley and between cover types. However, samples were limited primarily to the riparian vegetation of the valley floodplain.

Ten variables, which described overstory and shrub layers of vegetation, were measured in each stand. Overstory parameters were measured at 10 randomly selected points in each stand, and included a measurement of:

1) crown closure, measured using a convex spherical densiometer (Lemmon 1956) at each sample point;
2) canopy height, by measuring heights of representative trees of each species at each point, using a forest clinometer;
3) canopy composition, using ocular estimates of contribution of each species to canopy cover;.
4) species densities, using distance measures of the Point-Centered Quarter method (Cottam and Curtis 1956).

5) species dbh, by assigning trees selected in the point quarters to the following diameter classes.

1 - 5 - 15 cm
2 - 15 - 30 cm
3 - 30 - 50 cm
4 - 50 - 70 cm
5 - 70 -100 cm
6 - > 100 cm

6) species basal areas, based on measurements of tree density and dbh.

Parameters of the shrub layer, including stem density, height and basal diameter and above-ground biomass, were measured at the first six to nine sample points. Stem densities were counted in five 6 m2 circular plots which were clustered systematically at each sample point. Thus, 30-45 plots were evaluated in each stand. Singly rooted stems of each species were enumerated in each plot; however, if branching occurred below the humus layer each emergent stem was tallied.

Basal diameters and heights were measured on the two stems of each species nearest to each plot center. Optimally, 40 stems of each species were measured in each stand, although rarer species were actively sought until a minimum of 10 stems were measured.

In the estimation of biomass, 20 individuals of 13 common shrubs were harvested in late August during the presumed period of peak biomass. Individual stems of disparate sizes were actively sought, and were cut at approximately two cm above the humus layer. Basal diameters were measured to the nearest .1 mm using verneir scaled calipers. In the lab, shrubs were separated into leaf, annual twig and wood components, oven dried at 60 C to constant weight and weighed to the nearest 0.01 gm. Simple linear regression techniques on log-transformed variable (Ln Wt = a + ln BSD) were used to determine the best predictive equation relating basal stem diameter to the biomass of shrub components (leafs and twigs) and the total standing crop biomass.

save Shrub biomass in forest stands was derived from density estimates of each species and estimated mean biomass of individual stems. Average biomass was derived using measures of average basal diameters of each species in prediction equations. In the less common shrub species, where no prediction equations were derived, predictor equations for species with similar life forms or a general predictor equation from the pooled sample was employed.

5.2 METHODS USED IN THE CERVID STUDIES

5.2.1 Surveys

Winter distribution of cervids was monitored along 120 km of observation routes. Routes were selected in a manner which attempted to sample each vegetation type in each of three study sectors which spanned the length of the North Fork from Big Creek to the Canada line. Routes were plotted on vegetation maps of

Winter distribution of cervids was monitored along 120 km of observation routes. Routes were selected in a manner which attempted to sample each vegetation type in each of three study sectors which spanned the length of the North Fork from Big Creek to the Canada line. Routes were plotted on vegetation maps of the study area and the length in each vegetation stand was measured. Observation routes were travelled periodically on cross-country skis, between 22 January and 4 April 1982. The location of each of the ski routes is shown on Fig. 5.2.1.

During each trip through a study stand, numbers of fresh deer, elk and moose tracks which were intercepted by the ski route were tallied, and representative snow depths and hardness were measured. Fresh tracks were distinguished by the presence of unmelted scuff-marks and hoof imprints in the snow. Snow depths were measured directly with a calibrated ski-pole whereas snow hardness was evaluated by dropping a 0.6 kg weight from a height of 2m and measuring the depth of its penetration. Hardness was expressed as the ratio of depth of penetration to total snow depth and thus ranged continuously from 0 to 1.

Wintering behavior of ungulates was also evaluated by measuring habitat characteristics at locations with fresh ungulate sign or at points of direct observations. At observation points, the species, activity and time of day were recorded, whereas generally only the species could be discerned from ungulate tracks. At each point the following variables were recorded:

--snow depth and hardness,

--canopy closure, with a convex spherical densiometer

--shrub cover, canopy compostion, and canopy height by

ocular estimates

--Tree density by estimating mean distances between trees.

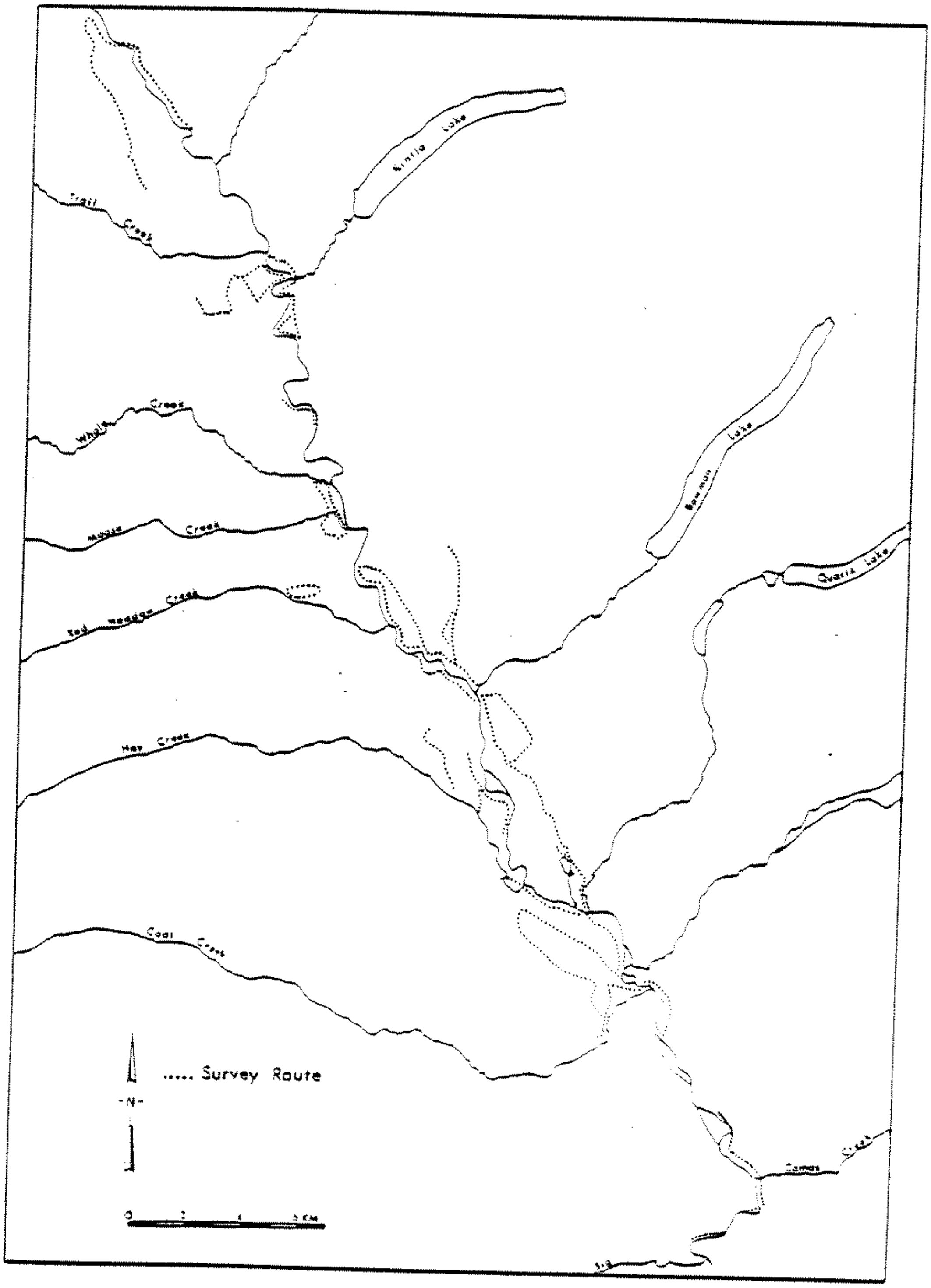

Fig. 5.2.1 Location of ski routes used for winter surveys of cervids in the North Fork of the Flathead Valley.

5.2.2 Browse Utilization Surveys

Ungulate browse utilization was determined on 104 sites, representative of the floodplain and upland vegetation types found in the North Fork drainage. Utilization of three key browse species; willow, red-osier dogwood and serviceberry was measured. Study sites were thus selected based on presence of one or more of these species. Within each site, the plot center was located randomly and the twenty nearest shrubs of a key species were chosen using the wandering quarter method (Cantana 1963). Percent utilization was measured between 1 May and 5 June, after cervids switched from shrub forage to herbaceous growth (Singer 1975), but before production of new growth obscured evaluation of winter use.

Browse utilization was calculated based on counts of browsed twigs and estimating the proportion of weight consumed per twig. A twig was defined as annual woody growth, greater than 3cm long and was recognized as the portion of a plant distal to the last bud scar. Because browsing was not uniform among twig types, we defined two types of twig based on size. Leader twigs were stout, terminal branches greater than 3mm in diameter, whereas lateral twigs were defined as those less than 3mm in diameter. The total numbers of leaders and lateral twigs were counted and numbers browsed by cervids were recorded on each of twenty selected shrubs (i.e, rooted stems). Two leaders and two laterals were selected randomly on each shrub and diameters at current growth (DCY) and point of browsing (DPB) were measured at the bud scar and the browsed distal tip, respectively. The percentages of browsed leaders and laterals and the average basal and distal diameters of the leader and twig samples were recorded at each site.

To establish relationships between twig diameters and weights, 700 twigs were collected in March 1982, during shrub dormancy. The 700 included samples of approximately 50 twigs, of three species (willow, dogwood, serviceberry) at four or five environmentally disparate range sites. Twigs were selected to represent the full range of size classes and clipped at the base of current growth. The twigs were air dried, basal diameters were measured, and twigs were weighed to nearest hundreth gram after drying to a constant weight at 60 C. A simple linear regression using logarithmic transformations of the dependent and independent variables was used to determine relationships between twig weight and diameter (Telfer 1969). These are given in Appendix 2. Regression coefficients of each species differed significantly ($p < 0.05$) between collection sites. However, when a multiple regression analysis incorporating the collection site as an additional independent variable was computed, the collection site explained less than five percent of the sample variation in twig weight. Based on this, regression equations from the different collection sites were considered similar enough to be pooled and provide one predictor equation per browse species for general application in the study area (Appendix 2).

Twig counts and weight predictions of twigs, based on diameter, were used to estimate percent utilization from a modification of Lyons (1970) method. In our case, with two classes of twigs, we calculated percent browse utilization using a weighted average of leader utilization and lateral utilization as follows:

$$U = (B1X1/W1 + B2X2/W2)/X1 + X2$$

where U = total percentage of browse consumed.

B1 = average weight of consumed portion of leaders

W1 = average weight of pre-browsed leaders

X1 = total weight estimate of leaders in 20 plant samples

B2 = average weight of consumed portion of laterals

W2 = average weight of pre-browsed laterals

X2 = total estimated weight of laterals in 20 plant samples

5.2.3 Analytical Methods

Analyses of relative density of ungulates and habitat selection where stratified in three study sectors, which partitioned the latitudinal gradient of snow depths. The boundaries of these sectors roughly corresponded to the three U.S.G.S. topographic quadrangles covering the area; Demers Ridge, Polebridge, and Trail Creek. Throughout the remainder of this report, these study zones are referred to as the southern, middle, and northern sectors respectively. Specifically, the south sector extended from Big Creek at the south end of the study area to Quartz Creek on the north. The middle sector encompassed the area from Quartz Creek north to Moose Creek, and the north sector extended from Moose Creek to the Canada line.

Selective use of vegetation types by wintering white-tailed deer, elk and moose was evaluated by comparing usage and availability of vegetation types in each sector. Usage was estimated as the proportion of total winter tracks of each species counted in each vegetation type, whereas, availability was defined as the percentage of ski route in each type, as measured on vegetation maps. In some instances the percentage of ski route in a vegetation type, did not accurately reflect the true availability (ie. percentage) of the ytpe within the study area; however, the percentage of tracks and the percentage of route in each vegetation type was suited to standard analyses of utilization and availability data (Neu et al. 1974). Chi-square statistics were used to test the hypotheses that vegetation types were used in proportion to availability. If the null hypothesis was rejected ($p < 0.05$) confidence intervals were employed using the Bonferroni Z-statistic (Neu et al 1974) to determine which vegetation types were used in proportions greater than or less than availability. Individual tests were significant at $p < 0.02$, yielding a family confidence level of .80 for simultaneous tests.

Affinity of wintering ungulates to microhabitat characteristics was evaluated using Spearman Rank Correlation Coefficients. Absolute counts of ungulates in each stand were converted to relative indices by expressing them as the number of tracks per 100 m of transect; correlations of these indices to the forest stand measurements were then evaluated.

5.3 METHODS USED IN THE AVIAN STUDIES

5.3.1 Avian Communities

Four stands in each floodplain plant community were studied along the North Fork (Table 5.3.1). These stands were selected based on three criteria: (1) size, (2) homogeneity and (3) accessability. To examine the influence of habatat alteration, study sites within three select cuts on the North Fork floodplain were selected. Five sites along the Flathead River were also selected to examine community structure in those locations (Table 5.3.1).

One line transect was set in each study site by placing numbered, wooden stakes at fifty meter intervals, running lengthwise through the center of the stand, and by flagging along the transect line. The transect lengths ranged from 200 meters to 500 meters, depending on the size of the stand (Table 5.3.1). The transect locations are given in Appendix 3 and 4.

The transects were censused between 26 May, 1982 and 15 July, 1982. Transects along the North Fork were censused five times each. Transects along the Flathead River were censused four times each, except one, which was censused only twice. Censuses began at sunrise and ended within two hours after sunrise. Censuses were not made on windy days or during inclement weather. The census takers walked the length of the transect and for each bird heard or seen, recorded the species, perpendicular distance from the transect line, age, sex, activity and observation type (i.e., visual or auditory). Additional observations of birds, especially raptors, waterfowl and herons were recorded seperately.

The general equation for estimating the density of objects from transect data is:

$$\hat{D} = \frac{n}{2LW}$$

where W = effective strip width. The problem is to estimate W, which is the area under the detection curve g(x) (see Burnham et al. 1980). Traditional methods have assumed that g(x) was described by some existing function (Emlen 1971, Emlen 1977, Gates et al. 1968, Gates 1969). However, if that chosen function did not accurately fit the data, a biased density estimate would result. Burnham et al. (1980) described a new method which fits a general polynomial model to the data. Only after fitting the best model to the data is a density estimate obtained.

After pooling our bird-census data over all transects, a slight movement of birds away from the transect line was indicated (Fig 5.3.1). This violates the assumption of no movement of animals away from the line before being seen (Burnham et al. 1980) and can produce biased results. However, Burnham et at. (1980) suggest that the use of a nonincreasing, generalized parametric estimator will decrease the bias. The half-normal model is one such estimator robust to slight movements of birds away from the transect line. Total bird density was estimated using the half-normal model of the computer program "TRANSECT".

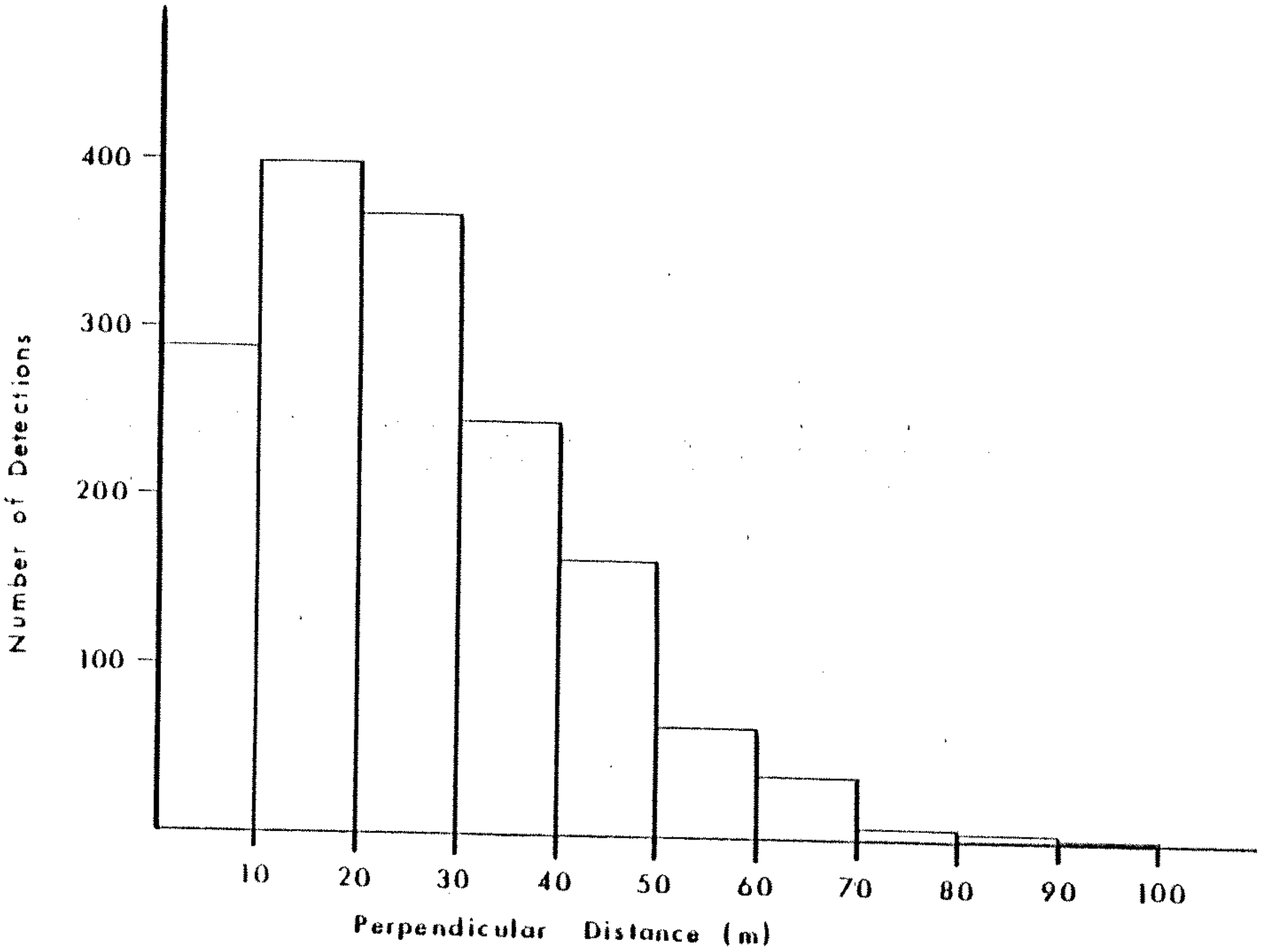

Fig. 5.3.1 Distribution of pooled detection distances.

TABLE 5.3.1 Avian community transects.

PLANT COMMUNITY	TRANSECT NAME	TRANSECT NO.	LENGTH	
HERBACEOUS WASH	180 BAR 1	121	250 m.	
	CLIFF FLATS 1	131	350	
	BIG PRAIRIE 2	22	200	
	RIVER CAMP 3	33	350	
				(1150)
SHRUB WASH	180 BAR 2	122	350	
	CLIFF FLATS 2	132	200	
	KINTLA WELL 1	11	200	
	NORTH POLEBRIDGE 1	141	500	
				(1250)
MATURE COTTONWOOD	DOWNE'S 1	65	300	
	KINTLA WELL 3	13	250	
	COAL CREEK 2	42	250	
	SONDERSON'S 1	191	300	
				(1100)
COTTONWOOD/SPRUCE	WILHELM'S	52	350	
	NORTH POLEBRIDGE 2	64	250	
	HAMILTON'S 1	151	400	
	HAMILTON'S 2	152	350	
				(1450)
SPRUCE	RIVER CAMP 2	32	500	
	LADENBURG'S 4	64	250	
	KINTLA WELL 4	14	200	
	HAY CREEK	161	500	
				(1450)
HYDRIC SHRUB	LADENBURG'S 6	66	250	
	ROUND PRAIRIE	171	200	
	SONDERSON's 2	192	300	
	SONDERSON'S 3	193	300	(1050)
SELECT-CUT	POLEBRIDGE 1	51	250	
	LADENBURG's 1	61	200	
	COAL CREEK 1	41	400	
				(850)

MAIN FLATHEAD	ROBCCHER 1	91	500
	ROBCCHER 2	92	350
	KOKANEE BEND 1	81	450
	KOKANEE BEND 3	83	200
	KIWANIS LANE	102	270
			(1170)

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1. Only one select cut per plant community was sampled: 51 was in cottonwood/spruce, 61 in spruce and 41 in Douglas fir/lodgepole.
2. 91 was in birch/cottonwood, 92 in douglas fir, 81 and 83 in cutover douglas fir and 102 in a picnic area.

Bird species diversity (H') was computed for each transect by the Shannon-Wiener Index (Shannon and Weaver 1949):

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where P = the proportion of total birds belonging to the i species and

S = the number of species

Equitability (J') was computed by Pielou's index of equitability (Pielou 1969):

$$J' = \frac{H'}{H' \text{ maximum}}$$

where H' maximum = ln S. An index of community similarity (CSI) was calculated by the Sonderson community similarity index (Mueller-Dumbois and Ellenberg 1974).

$$CSI = \frac{2Mw}{Ma + Mb}$$

where Mw = The sum of the smaller relative densities of species common to both communities;

Ma = the sum of the relative densities of all species
in one community; and

Mb = the sum of the relative densities of all species in
the other communities.

Niche widths were computed by the Petraitis index (Petraitis 1979):

$$W = r^{(\Sigma p_{ij} \log_r q_j - \Sigma p_{ij} \log_r p_{ij})}$$

where r = the number of resource states

pij = the proportion of species i using
resource state J; and

qj = the proportion of total area
sampled belonging to resource
state

5.3.2 Habitat Selection

After the censuses were completed, significant components of the habitat along each of the transects were measured. One point was randomly located in each fifty meter interval of transect, and this served as the center of a vegetation sampling plot. Vegetation was sampled by a combination of modifed techniques of James and Shugart (1970) and Noon (1981).

The number of stems of each tree species (d.b.h.>5 cm) were counted within a .04 hectare circle (radius = 11.3 m). Canopy cover was measured with a spherical densiometer. A sixty meter measuring tape was laid down perpendicular to and bisected by the transect line. The heights of the four closest trees to each end of the tape and to its center were measured with a clinometer.

The number of stems of each shrub species (d.b.h. < 5 cm and height > 0.5 m) were counted within a plot formed by the observers outstretched arms (width = 1.7 m) and the measure tape. The intercept of each shrub species was totalled along the tape. At every five meters along the tape, the heights of the two closest shrubs were measured and the vertical foliage profile estimated by recording the presence or absence of foliage intersecting a vertical pole in each of six strata (0-1/2 m, 1/2-3 m, 3-10 m, 10-20 m, 20-40 m and >40 m). Intersections in strata higher than three meters were visually estimated.

An ocular estimate of the percent cover and height of the ground cover was made at each plot. The ground cover was further broken down by estimating the percent composition of grass, forbs and woody plants.

An index of vegetation volume was calculated by multiplying the aerial cover by the mean height of each plant form (i.e., ground cover, shrubs and trees). For each vegetation plot, the 14 habitat variables listed in Table 5.3.2 were computed. These were averaged over each transect to provide mean values for each stand.

Table 5.3.2 A list of habitat variables measured during the Avian Studies

- index of ground cover volume
- index of tree volume
- shrub stem density
- percent shrub cover
- mean tree height
- foliage height diversity
- index of total vegetation volume
- index of shrub volume
- tree stem density
- percent canopy cover
- percent ground cover
- mean shrub height
- plant species richness
- plant species diversity

5.3.3 Bird/Habitat Association

Differences in bird species diversity, bird species richness and total bird density among plant communities were tested for by the Mann-Whitney U Test protected by the Kruskal-Wallis Test (Daniel 1978). Nonparametric tests were necessary due to lack of normality (Kolomogorov-Smirnov D statistic). The select cuts and Flathead River sites were not included in the statistical analyses, but served for the collection of inventory data.

Pearson correlation coefficients were computed and with stepwise and least squares regression used to determine associations between avian community attributes and habitat variables.

5.4 DEVELOPMENT OF LAND-USE SIMULATION MODELS

A computer model simulating plant community development on the North Fork floodplain, and cervid utilization of these communities, was developed to predict potential impacts of forest alterations on floodplain vegetation and wildlife communities. This model followed the format of compartmental flow models used by Shugart et al. (1973), and Bledsoe and Van Dyne (1971). In our model, the compartments represented the different plant communities found in the successional sequence on the North Fork. The model contains six seral plant communities; a herbaceous wash, wash shrub, cottonwood, cottonwood spruce, spruce cottonwood, and mature spruce. An additional state, separate from the successional sequence, the hydric shrub community is also contained because of its importance to the cervids. The quantity in a given compartment represents the proportion of the total floodplain land area occupied by that plant community at a given point in time.

To mimic successional development, the proportion of the area occupied by the respective plant communites, except for the hydric shrub community which is kept constant, changes yearly. The proportional area of the hydric shrub community was kept constant because we had no data on rates of change, and based on the examination of older aerial photos, these areas appeared to be quite stable. These changes are controlled by a set of constant coefficients which allow the transfer of a set proportion of the land area from one community to another each year.

An underlying assumption of the model is that the proportions of the seral and climax vegetation types on the floodplain are in a dynamic equilibirum; i.e, the overall proportions in each category remain constant. The build up of land area in climax stands is offset by continual erosion of land surfaces which are assumed to be deposited down river, thus creating an equal area of pioneer substrate. The aim of the model is thus to produce a steady state which mimics the current composition of floodplain forests irrespective of the starting point. In the model, factors such as erosion cause plant communities at any seral stage to revert to a pioneer type. Erosion rates were not measured, and they were arbitrarily assigned. The rates varied, with proportionally larger erosion rates assigned to the wash shrub and cottonwood communites reflecting a greater probability that a devastating flood could alter these communities creating a new channel and scouring part of the area clean. The lower erosion rates affecting the mature conifer types mainly represented undercutting and erosion of the bank. The erosion, succession, and retention rates for each of the plant communities were determined only for the undeveloped or pristine lands in the region. The rates of change between the plant communities were obtained through an iterative multiplication of the matrix of transfer coefficients with the vector which contained the proportion of land area in each seral stage. This procedure is similar to a first order Markov process.

To simulate the influence of timber harvest, two additional states were added to the model. One was a clearcut condition, which depending on harvest strategy, received transfers from both the spruce and spruce cottonwood compartments. After a harvest was intiated, the land remained in this category for 40 years. It was then moved to a second growth compartment which provided a transition state ranging between 40 to 100 years, after which the stand succeeded to a spruce cottonwood type. Although it is unlikely that a clearcut spruce stand would regenerate cottonwood, we felt the advanced second growth stage would more closely resemble this younger spruce type than the climax spruce community.

Impacts of harvesting floodplain forests on ungulates were simulated using data on habitat affinities of white-tailed deer, elk and moose for different stages of the forest succession. Hypothetical populations of 513 deer, 100 elk, and 50 moose were used to initiate model runs. These hypothetical populations were distributed among the forest types, based on actual frequencies of tracks observed in the field. Hypothetical densities of deer, elk and moose in each in each forest type were determined from hypothetical numbers, and known areas of each forest type. After each iteration of the simulation, new populations of ungulates were calculated from the new acreage values of forest types and hypothetical densities in each.

6.0 RESULTS

6.1 VEGETATION STUDIES

6.1.1 Vegetation Mapping

The series of plant community overlays which corresponded to each set of quadrangles were redrafted and combined, so that one final map was produced for each U.S.G.S. quadrangle. These were then photographically reduced, and are contained in the appendix of this report. The original overlays have been retained and are also available. Our study identified and mapped 37 different vegetation classes, and 31 different land-use classes on 81,550 acres throughout the drainage. These classes, are defined in Tables 6.1.1 and 6.1.2 respectively. For all vegetation classes, the percent canopy cover, moisture regime of the site, and where appropriate, the age of the stand was used to differentiate between otherwise similar land cover classes.

The cover and land-use categories identified on each map unit, and the land areas associated with each are listed in Tables 6.1.3 through 6.1.7. As would be expected, land along the North Fork, being primarily undeveloped supported a far higher diversity of natural communities. Here, an average of 26 natural communities were identified in the riparian zone and adjacent uplands on each map.

Table 6.1.1. Selected Characteristics of Mapped Land Cover Units.

Herbaceous Types

		Moisture[1]	Canopy[1]
H1	xeric grass, forb, sage meadow	1-2	2-3
H2	mesic grass, forb meadow	3	3-4
H3	hydric sedge, grass, bog	4	3-4
H4	wash forb	1-4	2
H5	marsh	4	3-4

Shrub Types and Deciduous Woodland

		Moisture	Canopy
D1	wash shrub	3-4	3-4
D2	hydric upland shrub	3	4
D3	mature cottonwood	3	3
D4	aspen	3	3
D5	mesic upland shrub	2	3
D6	mature cottonwood, spruce hybrid	3	3
D7	subalpine fir krumholtz	2-3	3

Coniferous Forest Types

		Canopy	Moisture	Age[1]
L1	live lodgepole pine, western larch	4	3	1-2
L3	dead lodgepole pine	4	2-3	1
L4	dead lodgepole pine, spruce hybrid	3	3	2-3
L5	live and dead lodgepole pine	4	2-3	1
L7	lodgepole pine savannah	1	2	2-3
L8	dead lodgepole pine, western larch, Douglas fir, aspen	3	2	2
S1	spruce hybrid, bottomland	4	4	3
S2	spruce hybrid, black cottonwood	3-4	3	2-3
S3	spruce hybrid, dead lodgepole pine	3-4	3	3
S4	spruce hybrid, subalpine fir, western larch	4	3	3
S6	spruce hybrid or subalpine fir	4+	3	1
S7	spruce hybrid, Douglas fir; western larch, ponderosa pine, or subalpine fir	4	2-3	3
F1	subalpine fir, western white pine, western larch	4	3	3
F3	subalpine fir, spruce hybrid	4	3	3
F4	Douglas fir, western larch	4	2	2-3
F6	Douglas fir, ponderosa pine, western larch	3	2	3
F7	Douglas fir, dead and live lodgepole pine	3	2	2
F9	Douglas fir	4+	2	1
O1	western larch; spruce hybrid, subalpine fir, Douglas fir, or lodgepole pine	3-4	2-3	3
O3	western larch; spruce hybrid, subalpine fir, Douglas fir, or lodgepole pine	3-4	2-3	1
O7	western larch, dead lodgepole pine	3	2	2-3
M1	Douglas fir, spruce hybrid bottomland	4	3	3
M2	Douglas fir, spruce hybrid, cottonwood	4	3	3
M3	ponderosa pine	2	2	3
M4	Douglas fir, ponderosa pine	1	2	3

[1] Key to codes:

	1	2	3	4
moisture	xeric	xeric/mesic	hydric/mesic	hydric
canopy (%)	5-20	20-40	40-70	70-100
age	young	mid-age	old	undifferentiated

Table 6.1.2. Other Land-Use and Cover Categories Included on the Maps.

Water Resources	
W1	natural, deep clear body
W2	natural, shallow, clear body
W3	man-made, deep body
W4	man-made, shallow body
Land Resources	
Barren Lands	
A4	mud flat, silt bed
Urban, Industrial, Commercial	
U1	residential
U2	commercial
U3	utilities or transportation
U4	recreation
Extractive Industry	
Nonrenewable	
Z1	sand, gravel, rock pit
Z2	petroleum, mine site
Renewable	
C1	recent clear cut, low density tree regeneration
C2	older clear cut, medium to high density tree regeneration
C3	selective cut
C4	commercial thinning
C5	seed tree cut
C6	shelterwood cut
C7	reforested cut containing mature or nearly mature forest canopy
Agricultural Production	
P1	irrigated field crops
P2	non-irrigated field crops
P3	irrigated pasture
P4	non-irrigated pasture
P5	fallow land
P6	undifferentiated agricultural land
P7	abandoned grasslands
Burns (less than 20 years old)	
B1	high density shrub regeneration - birch, mountain maple, aspen, willow
B2	high density lodgepole pine regeneration
B3	high density lodgepole pine and western larch regeneration
B4	high density western larch regeneration
B5	low to medium density lodgepole pine or western larch regeneration with low to medium density shrub cover
B6	krumholtz or scree slope of low vegetation cover

TABLE 6.1.3 The areas within each of the defined land cover categories mapped on the Demer's Ridge Quadrangle.

MAP UNIT	CLASSIFICATION	AREA (acres)	% OF TOTAL AREA
D1	Wash shrub	317	1.3
D2	Hydric upland shrub	663	2.6
D3	Mature cottonwood	259	1.0
D4	Aspen	116	.5
D5	Mesic upland shrub	210	.8
D6	Cottonwood, spruce	214	.8
H2	Mesic grassland	462	1.8
H3	Hydric grassland	247	1.0
H4	Wash forb	474	1.9
S1	Spruce bottomland	1434	5.6
S2	Spruce, cottonwood	743	2.9
S3	Spruce, dead lodgepole pine	814	3.2
S4	Spruce, subalpine fir, western larch	2466	9.7
S7	Spruce, Douglas fir, western larch	113	.4
L1	Lodgepole pine, western larch	6265	24.7
L3	Dead lodgepole pine	257	1.0
L4	Dead lodgepole pine, spruce	472	1.9
L5	Live & dead lodgepole pine, spruce	3433	13.5
L7	Lodgepole pine savannah	77	.3
L8	Dead lodgepole pine, larch, D. fir	615	2.4
O1	Mature western larch, spruce	733	2.9

MAP UNIT	CLASSIFICATION	AREA	% OF TOTAL
O3	Young western larch, spruce	101	.4
O7	Western larch, lodgepole pine	19	.07
F4	Douglas fir, western larch	874	3.4
F6	Douglas fir, western larch, P.pine	760	3.0
F7	Douglas fir, lodgepole pine	54	.2
P2	Non-irrigated field crops	69	.3
P4	Non-irrigated pasture	67	.3
P7	Abandoned grasslands	705	2.8
B1	Burn with dense shrub regeneration	68	.3
B2	Burn with dense new lodgepole	45	.2
C1	Recent clearcut, low density regen.	390	1.5
C2	Older clearcut, medium density regen.	903	3.6
C3	Select cut	251	1.0
C4	Commercial thin	49	.2
C5	Seed tree cut	643	2.5
C6	Shelterwood cut	11	.04
U1	Residential area	4	0
Z2	Sand or gravel pit	3	0
	Total	25,400	

TABLE 6.1.4 The areas within each of the defined land cover categories mapped on the Polebridge Quadrangle.

MAP UNIT	CLASSIFICATION	AREA (acres)	% OF TOTAL AREA
D1	Wash shrub	156	.5
D2	Hydric upland shrub	481	1.7
D3	Mature cottonwood	66	.2
D4	Aspen	9	.03
D6	Cottonwood, spruce	61	.2
H1	Xeric grassland	511	1.8
H2	Mesic grassland	1388	4.9
H3	Hydric sedge	427	1.5
H4	Wash forb	347	1.2
S1	Spruce bottomland	1311	4.6
S2	Spruce, cottonwood	225	.8
S3	Spruce, dead lodgepole	1663	5.8
S4	Spruce, subalpine fir, western larch	709	2.5
S6	Spruce, Douglas fir, western larch	45	.2
L1	Live lodgepole pine, western larch	4802	16.8
L3	Dead lodgepole pine	1125	3.9
L4	Dead lodgepole pine, spruce	1787	6.2
L5	Live & dead lodgepole pine	3928	13.7
L7	Lodgepole pine savannah	488	1.7
O1	Mature western larch, spruce	73	.2
O3	Young western larch, spruce	417	1.5

MAP UNIT	CLASSIFICATION	AREA	% OF TOTAL
O7	Western larch, dead lodgepole pine	215	.7
F4	Douglas fir, western larch	2985	10.4
F6	Douglas fir, larch, ponderosa pine	271	.9
F7	Douglas fir, lodgepole pine	63	.2
F9	Douglas fir	505	1.8
P2	Non-irrigated field crops	19	.07
P3	Irrigated pasture	23	.08
P4	Non-irrigated pasture	184	.6
P5	Fallow land	3	.01
B2	Burn, high density lodgepole regen.	23	.08
C1	Recent clearcut, low density regen.	757	2.6
C2	Older clearcut, moderate regen.	298	1.0
C3	Selective cut	552	1.9
C4	Commercial thinning	173	.6
C6	Shelterwood cut	986	3.4
C7	Reforested cut, mature canopy	484	1.7
U1	Residential area	152	.5
	Total	28,570	

TABLE 6.1.5 The areas within each of the defined land cover categories mapped on the Trail Creek Quadrangle.

MAP UNIT	CLASSIFICATION	AREA (acres)	% OF TOTAL AREA
D1	Wash shrub	240	.9
D2	Hydric upland shrub	200	.7
D3	Mature cottonwood	189	.7
D4	Aspen	252	.9
D5	Mesic upland shrub	27	.1
D6	Cottonwood, spruce	161	.6
H2	Mesic grassland	531	1.9
H3	Hydric grassland	170	.6
H4	Wash forb	332	1.2
S1	Spruce bottomland	1389	5.0
S2	Spruce, cottonwood	111	.4
S3	Spruce, dead lodgepole pine	1108	4.0
S4	Spruce, subalpine fir, western larch	3007	10.9
S6	Spruce, subalpine fir	123	.5
L1	Lodgepole pine, western larch	2992	10.8
L3	Dead lodgepole pine	1400	5.1
L4	Dead lodgepole pine, spruce	1315	4.8
L5	Live & dead lodgepole pine, spruce	5221	18.9
L7	Lodgepole pine, savannah	147	.5
O1	Mature western larch, spruce	393	1.4
O3	Young western larch, spruce	3501	12.7

MAP UNIT	CLASSIFICATION	AREA	% OF TOTAL
O7	Western larch, dead lodgepole pine	348	1.3
F4	Douglas fir, western larch	1141	4.1
F7	Douglas fir, lodgepole pine	159	.6
E5	Fallow land	126	.5
C1	Recent clearcut, low density regen.	600	2.2
C2	Older clearcut, medium density regen.	755	2.7
C3	Select cut	469	1.7
C4	Commercial thin	247	.9
C5	Seed tree cut	84	.3
C6	Shelterwood cut	677	2.5
C7	Mature reforested cut	116	.4
U1	Residential area	45	.2
	Total	27,576	

TABLE 6.1.6 The areas within each of the defined land cover categories mapped on the Columbia Falls South Quadrangle.

MAP UNIT	CLASSIFICATION	AREA (acres)	% of TOTAL AREA
D1	Wash shrub	1064	3.8
D2	Hydric upland shrub	135	.5
D3	Mature cottonwood	1102	3.9
D6	Cottonwood, spruce	643	2.3
H2	Mesic grassland	51	.2
H3	Hydric grassland	103	.4
H4	Wash forb	260	.9
H5	Marsh	298	1.1
F6	Douglas fir, western larch, P. pine	867	3.1
M1	Douglas fir, spruce bottomland	341	1.2
M2	Douglas fir, spruce, cottonwood	979	3.5
M3	Ponderosa pine	56	.2
M4	Ponderosa pine, Douglas fir	266	.9
P1	Irrigated field crops	229	.8
P2	Non-irrigated field crops	929	3.3
P4	Non-irrigated pasture	32	.1
P5	fallow land	77	.3
P6	Undifferentiated agricultural land	19,414	68.7
C1	Recent clear-cut, low density regen.	77	.3

MAP UNIT	CLASSIFICATION	AREA	% OF TOTAL
C3	Selective cut	91	.3
A4	Silt bed, mud flat	142	.5
U1	Residential area	974	3.4
U2	Commercial area	40	.1
U3	Utilities or transportation	4	0
Z1	Sand or gravel pit	80	.3
	Total	28,254	

TABLE 6.1.7. The areas within each of the defined land cover categories mapped on the Creston Quadrangle.

MAP UNIT	CLASSIFICATION	AREA (acres)	% of TOTAL AREA
D1	Wash shrub	839	3.2
D2	Hydric upland shrub	851	3.2
D3	Mature cottonwood	1575	6.0
D6	Cottonwood, spruce	643	2.4
H2	Mesic grassland	166	.6
H3	Hydric grassland	260	1.0
H4	Wash forb	68	.3
H5	Marsh	609	2.3
F6	Douglas fir, western larch, P. pine	123	.5
M1	Douglas fir, spruce bottomland	14	.05
M2	Douglas fir, spruce, cottonwood	386	1.5
M3	Ponderosa pine	40	.2
M4	Ponderosa pine, Douglas fir	54	.2
P1	Irrigated field crops	203	.8
P2	Non-irrigated field crops	1022	3.9
P4	Non-irrigated pasture	22	.08
P5	Fallow land	83	.3
P6	Undifferentiated agricultural land	18654	70.7
C3	Selective cut	104	.4
A4	Silt bed, mud flat	93	.4

MAP UNIT	CLASSIFICATION	AREA	% OF TOTAL
U1	Residential area	372	1.4
U2	Commercial area	154	.6
Z1	Sand, gravel pit	54	.2
	Total	26,389	

Along the North Fork, the natural communities comprised approximately 88 percent of the land area mapped. On the Mainstem, natural communities made up less than 22 percent of the area mapped. The various spruce cover types found in the alluvial bottomlands were the dominant cover type in the riparian zone of the North Fork. Live and dead lodgepole pine either alone, or in combination with other species was the dominant cover type of the adjacent uplands.

Although the north-south gradient in elevation, on the North Fork is reflected in changes in elevation, precipitation, and snowfall, it did not appear to alter either the composition of the plant communities found on the respective map overlays, or in the land areas occupied by the different cover types. Each of the three map units has an almost identical length of river corridor. It is probable that the segment of the river corridor mapped is too short (72 km) to show any apparent changes in vegetative composition. In addition, the environmental gradients are very gradual, and their influence on the plant composition and distribution is probably too subtle to be determined at the scale we were working at. Although there is also an apparent gradient of decreasing land development along the North Fork, this factor was also not reflected in our land-use maps. The land areas in a developed or managed category are, in all cases, very small. Approximately 51 percent of the total areas mapped fell with in the boundaries of Glacier National Park. A preliminary analysis revealed few differences between floodplain cover types on lands within or outside Glacier National Park. Because of differences in aspect and slope, which would make direct comparisons difficult, this analysis was not conducted on the terraces adjacent to the floodplain. However, as would be expected, a major difference in cover types was that there were no logging activities in the park.

6.1.2 Shrub Biomass Trends and Floodplain Succession

Twenty-one species of deciduous trees and shrubs occurred in the study plots. They included five species of tree saplings, 11 tall shrubs, and five low shrubs. Equations for estimating shrub biomass were derived for the 13 most common species. Equations for the remaining species were either borrowed from similiar species, or general equations from the pooled sample were applied. A listing of all of the equations is given in Appendix 2. The shrub biomass contributed by those species for which a generalized or borrowed equation was derived was small, averaging

3.6 percent of the total shrub biomass for the stands measured. because of this small potential error, we felt justified in using the generalized equations.

The prediction equations were developed to estimate twig, leaf and total shrub biomass for all 21 species. These equations accounted for between 44 to 99 percent of the sample variation in biomass. All but five of these equations had r2 values greater than about .75. The equations estimating twig biomass were least reliable (r2 = .44 to .98), while the equations for estimating the total above ground biomass were consistently precise (r2 = .92 to .99).

The results of these equations where combined with estimates of the densities of the individual species to determine total shrub biomass within the stands sampled. These stands were situated primarily along the seral continuum from bare gravel to mature spruce on the river floodplain. Data from all stands discussed in this section are listed in Table 6.1.8, and the mean biomass of shrubs in each of the vegetation types is given in Fig. 6.1.1.

The gravel wash communities supported an average shrub biomass of 258 kg/ha. In these stands, most of the biomass consisted of willows and black cottonwood, both of which sprout vigorously after flooding. In the absence of catastrophic flooding and scouring, wash-shrub communities gradually develop on gravel-wash substrates. Shrub biomass in these stands averaged 1977 kg/ha. This increase in biomass is due primarily to the continued establishment of pioneer species. Though tall

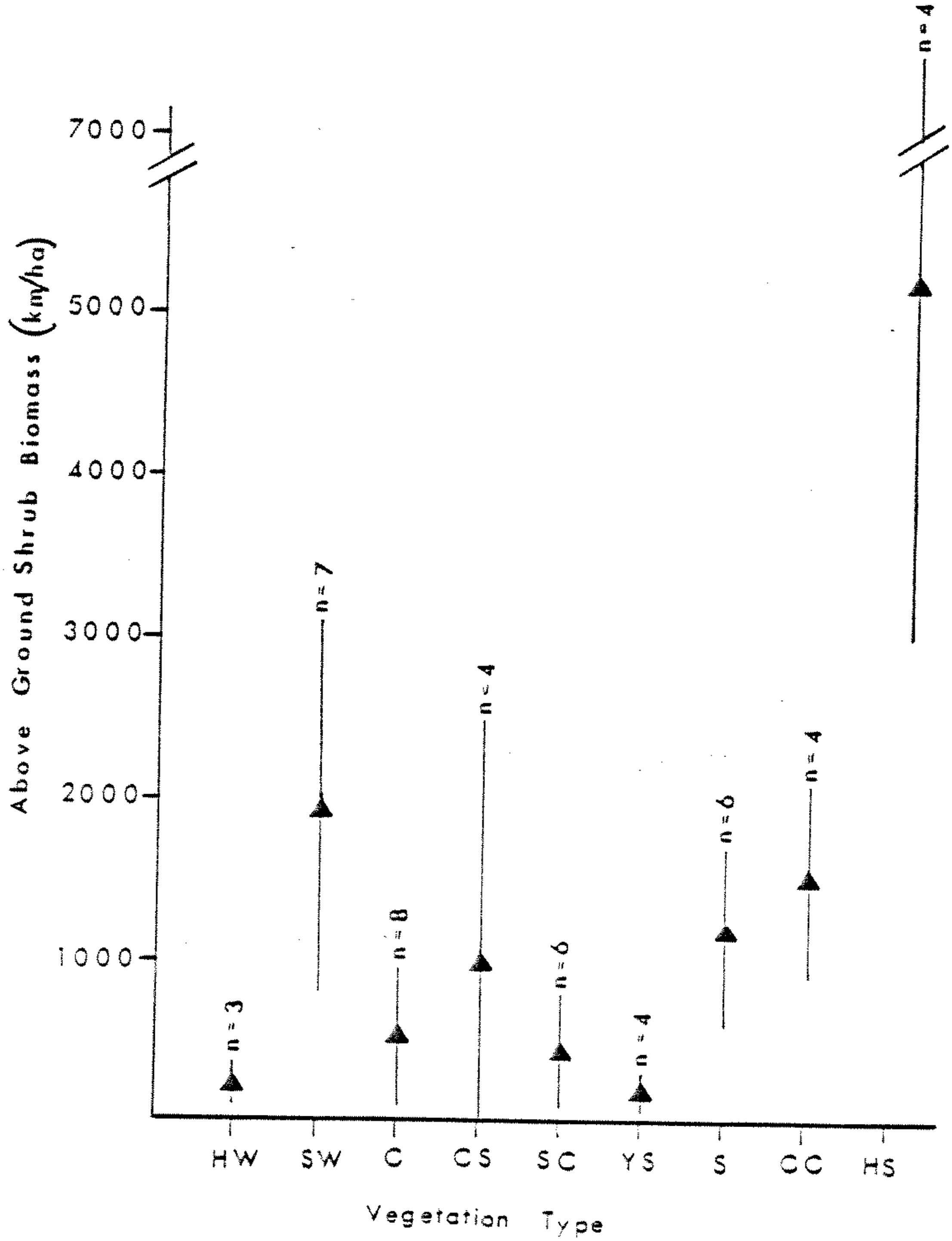

Fig. 6.1.1 Mean biomass of shrubs (±SE) in vegetation types of the floodplain sere, in the North Fork of the Flathead Valley.

TABLE 6.1.8 Total above ground biomass of deciduous saplings, tall shrubs and low shrubs in 12 vegetation types in the North Fork Flathead Valley.

VEGETATION TYPE	STAND NO.	BIOMASS (Kg/Ha) DECIDUOUS SAPLINGS	TALL SHRUBS	LOW SHRUBS[a]	TOTAL BIOMASS
Gravel Wash	1328	130	24	2	156
	2019	85	203	1	289
	2222	119	208	0	328
Wash Shrub	305	2517	1125	94	3736
	617	1194	1243	25	2462
	1104	454	47	1	502
	1111	1429	273	8	1709
	1327	513	866	12	1392
	2016	3014	0	0	3014
	2221	633	388	0	1021
Cottonwood	209	43	107	15	164
	210	1097	179	5	1281
	304	263	392	88	744
	613	482	221	30	732
	820	58	87	111	255
	1326	16	133	38	187
	1606	166	614	89	869
	2015	3	70	37	110
Cottonwood-Spruce	505	5	66	18	89
	708	632	2064	582	3277
	1103	208	459	36	704
	2217	92	103	16	211
Spruce-Cottonwood	301	1	335	81	416
	502	20	125	41	186
	504	7	598	62	667
	706	7	983	75	1065
	1102	84	104	106	295
	1807	73	97	75	245
Young Spruce	208	0	243	80	323
	501	0	74	41	115
	1613	140	98	87	324
	1805	0	34	15	48

Mature Spruce	201	0	466	222	689
	606	533	1416	96	2045
	709	19	1871	199	2089
	1325	181	678	46	906
	2018	41	825	140	1007
	2102	98	420	72	590
Cutover Spruce	503	8	985	148	1142
	610	198	724	174	1097
	711	342	1788	378	2508
	1607	57	796	336	1190
Lodgepole	1406	0	19	12	31
	1602	0	15	2	17
Lodgepole Savanna	1004	0	108	622	730
Douglas-Fir	102	10	172	55	237
	818	0	364	62	426
Upland Spruce	1307	0	43	14	57
	1314	0	446	23	469
Hydric Shrub	704	188	388	171	4583
	1608	644	4224	108	3821
	1802	58	3068	23	3722
	2216	1301	3641	135	8777

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[a] Snowberry was not sampled at the onset of the study and is not included in the estimate of low shrub biomass.

shrubs, which were predominantly willows remain abundant, tree saplings contributed proportionately more to estimates of total shrub biomass than in the early pioneer stage. Black cottonwood contributed an average 60.5% of the understory production of these seral stands, reflecting the competitive advantages of cottonwood over willow with increased stand age.

Shrub biomass decreased in the cottonwood forest, the next seral stage, to an average of 543 kg/ha. In terms of shrub biomass, such stands represent a transitional phase. The young cottonwood saplings which pioneered the wash shrub communities and contributed to their early shrub biomass, have by this stage, matured, and tend to shade subsequent understory growth. New understory growth is also hindered because the soils are still poorly developed. These the shallow rocky soils support instead a primarily herbaceous understory. Occasionally, deep soils do occur in this successional phase, and on them, tall shrubs are abundant. One example of this type is stand 1606. Here, red osier dogwood contributed 53% of the total biomass and superceded willow as the dominant tall shrub.

The mature cottonwood forests in the 80 to 100 year age class, contain the most variable stage of understory development, reflecting broad substrate differences. Here, shrub biomass averaged 1070 kg/ha, but ranged from 89 to 3277 kg/ha. Stand 708, represented the black cottonwood-dogwood community of Allen (1980) and was characterized by deep, well drained soils. The understory was a dense canopy of red-osier dogwood which contributed over 2000 kg/ha to the total shrub biomass. Alder saplings and snowberry dominated the middlestory and low shrub layers with 63 and 56 kg/ha, respectively. This stand was in contrast to most cottonwood-spruce types where shallow soils supported a grassy ground layer and relatively depauperate shrub understory which averaged between 90 and 700 kg/ha.

The final stages of the successional sequence represents a transition from cottonwood forests to mature spruce. The transition apparently occurs via two successional pathways on the North Fork floodplain. In the first, and most common, spruce invades the understories of cottonwood stands and gradually attains dominance, giving rise to the spruce-cottonwood type. In the second comparatively rare case, young spruce stands arise in the absence of cottonwood and succeed through a young spruce forest stage. These stands, have a structurally uniform appearance, with relatively even-aged trees approximately 60 years old and dense overstory closure. One such stand apparently arose from the complete and selective harvest of young cottonwoods by beaver which apparently favored the early establishment of spruce.

Biomass of shrubs in the young spruce forest type averaged 262 kg/ha and with the gravel wash, was lowest of all the floodplain communities. The diminished shrub layer resulted from the nearly complete closure of the overstory canopy, low light penetration and the resultant elimination of dogwood. White alder dominated the middlestory in light gaps where canopies were interupted along river channels. Low shrubs, particularly snowberry and rose, are proportionately more abundant and dominated understories of these dense young spruce stands.

The transitional spruce-cottonwood stands are structurally more diverse than young spruce. Shrub biomass was variable, but averaged 479 kg/ha. Red-osier dogwood and white alder dominated the understories.

Mature spruce forests of the floodplain bottomlands represent the climax condition on the developing river terraces (Allen 1980). The stands are uneven aged, with the oldest spruce occassionally upwards of 200 years old. With such age and the ensuing decadence of large trees, frequent blowdowns create a patchy mosaic of small forest clearings and dense coniferous cover. Biomass of shrubs and regenerating spruce form a dense understory cover in the open patches. Shrub biomass averaged 1221 kg/ha in six old growth spruce stands, thus exceeding the biomass of all seral stages of forest development except the shrub wash. Understories of spruce stands are dominated by the tall shrubs with upwards of 670 kg/ha. As in the seral communities, understories are primarily a dense layer of red-osier dogwood. Many localized areas of high moisture support a continuous cover of alderleaf buckthorn, and bearberry. Saplings were almost exclusively white alder, though Rocky Mountain maple occurred sparingly.

Shrub biomass was also measured in four selectively cutover spruce stands, for comparison to the old growth. In each stand, the majority of spruce was harvested leaving scattered cottonwoods, the younger spruce and patches of aspen. Dates of cuts were unknown. The removal of the spruce overstory greatly increases light energy available to the pre-existing shrub layer. Biomass of shrubs averaged 1484 kg/ha, reflecting a slight increase in understory biomass following overstory removal. Species compositions remained largely unchanged with red-osier dogwood, snowberry and alderleaf buckthorn dominating.

The greatest browse biomass of all vegetation types occurred in hydric shrub communities. Shrub biomass here averaged 5213 kg/ha. Understory biomass was dominated by tall shrubs and deciduous saplings which often attained such density as to shade out low growing shrubs. Tall shrubs are dominated by willows which contribute a minimum of 2482 kg/ha. Alderleaf buckthorn, and white alder are locally abundant.

Biomass was also sampled sparingly in five upland forest types for comparison to floodplain types. The two stands placed in a lodgepole cover type were nearly devoid of shrub biomass, with biomass averaging 24 kg/ha. The shrub biomass in the one lodgepole savannah stand which was sampled was 730 kg/ha, but this was overwhelmingly dominated by low shrubs, which would be largely unavailable to ungulates as winter browse. Biomass of shrubs was found to be 237 kg/ha and 426 kg/ha in two Douglas-fir stands, but these estimates did not include snowberry, which was not measured at the onset of the study. Snowberry is abundant in Douglas-fir stands and would have bolstered estimates of total shrub biomass substantially. Nevertheless, tall shrubs, which were of primary importance to wintering cervids were less abundant in Douglas-fir stands than in most spruce bottomlands. Douglas-fir types differed compositionally from spruce stands, with serviceberry contributing 64.5% and 96.1% to the biomass of tall shrubs in the two stands.

Shrub biomass was also widely different in the two samples placed in upland spruce stands. In stand No. 1314, with denser understory, serviceberry contributed 307 kg/ha and dominated the forest understory.

6.2 SNOW SURVEY FINDINGS

Snow depth and hardness have long been recognized as one of the dominant environmental characteristics influencing ungulate winter range use. A knowledge of the temporal and spatial dynamics of snow deposition and melt along the North Fork was therefore an important part of our study of the distribution of white-tailed deer, Rocky Mountain elk, and moose.

Snow depth, the resultant product of snowfall, snow density and melt, may be expected to vary with elevation, aspect, slope, canopy, latitude and seasonality. This study was limited primarily to level floodplain and terraces of the North Fork; consequently the full range of elevations, aspects and slopes were not sampled. However, snow depths were recorded on a latitudinal gradient from Big Creek on the south, to the Canada boundary in the north. This latitudinal gradient of approximately 50 aerial km also corresponds to an altitudinal cline from 1030 m in the south to about 1220 m in the north. The results of independent snow surveys during the period of snow deposition (25-30 January) and a period of maximum snow depths (15-20 February) depicted similar trends in snow depth as shown in Fig. 6.2.1. Depths increased curvilinearly with increased latitude, and were nearly twice as great on the north edge of the study area. A third snow survey during the late winter period of snow melt, indicated snow was less persistant in the south where a greater likelihood of rain caused proportionally greater melt than occurred in the northern sectors.

Local patterns of snow depth were governed largely by characteristics of forest overstories. Coniferous overstories generally mediate snow depth by intercepting snowfall. However forests are also structural barriers to wind and incoming solar radiation which act to reduce snow depths. Thus the relationship of snow depth to the overstory mosaic is intricate, with deposition, drifting and melt of snow all influenced by forest overstory and in constant state of flux.

The relationship of snow depth to coniferous cover in the North Fork forests is shown in Fig. 6.2.2. Surveys during two mid-winter periods (1 February - 6 February and 25 February - 1 March) indicated that snow depths were greatest in sparse forest stands (20-30% closure), and less in treeless stands where greater winds presumeably drifted snows on the edges of more sheltered sites. With increased forest cover, snow depths were greatly reduced and nearly absent under largest full-crowned trees. In the late winter, March 25 through March 30, when melting was predominant, snow pack remained longer in the shade of forest canopy and receded more rapidly in open habitats where incoming radiation was unobstructed.

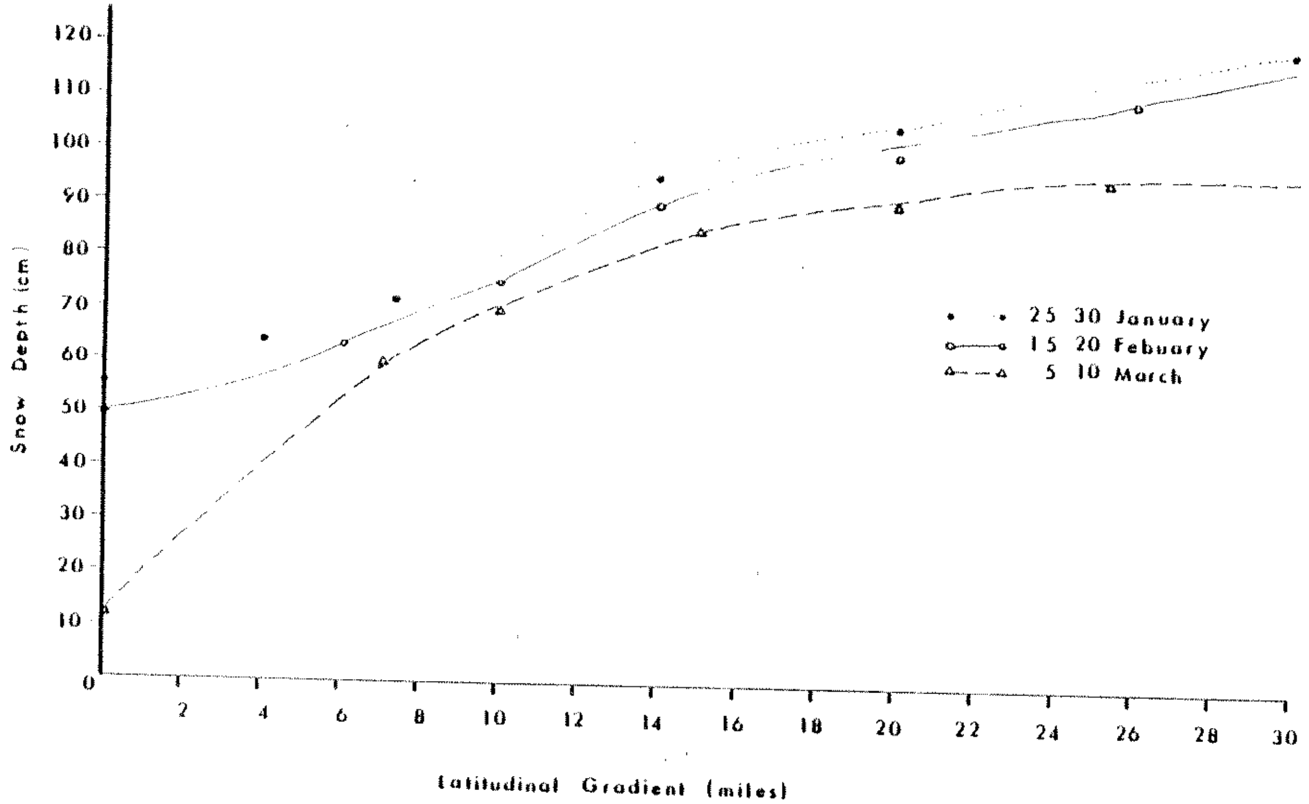

Fig. 6.2.1 Snow depths in open-growth floodplain communities along a latitudinal gradient, from Big Creek (Mile 1) to the Canada border (Mile 31). Sampling dates corresponded to periods of snow deposition (25 - 30 Jan.), maximum snow depth (15 - 20 Feb.), and early thawing (5 - 10 March).

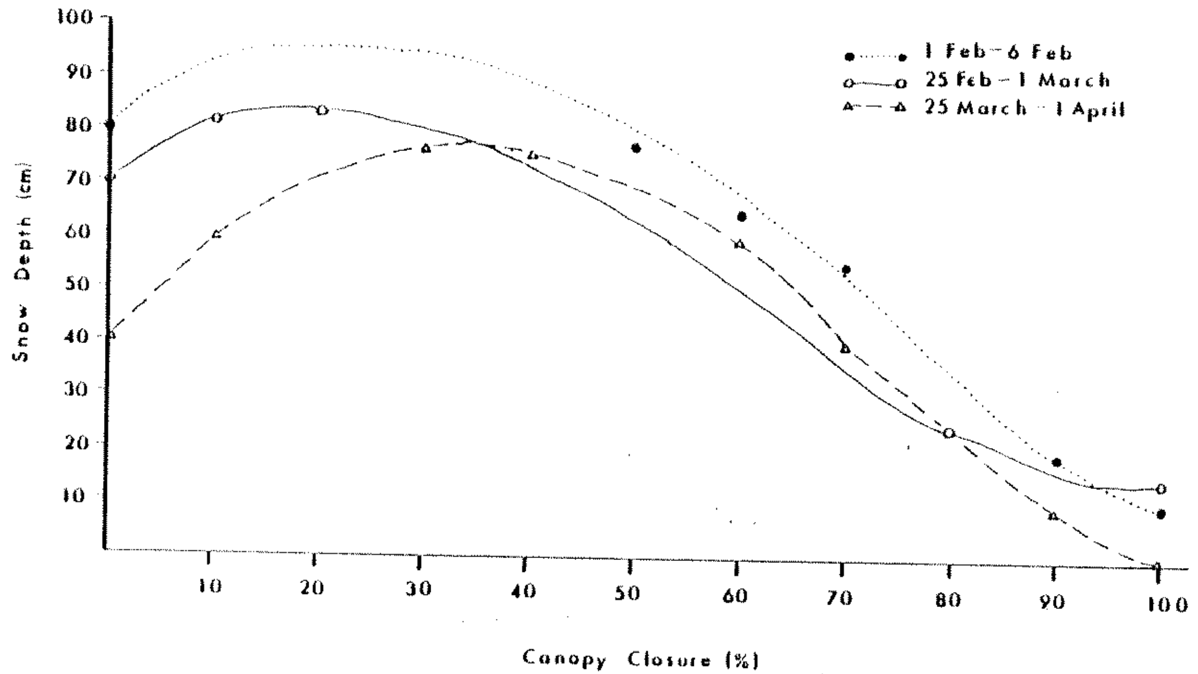

Fig. 6.2.2 Snow depths in relation to forest canopy closure during periods of late deposition (1 – 6 Feb), early melting (25 Feb – 1 March) and late melting (25 March – 1 April).

6.3 RESULTS OF THE CERVID STUDIES

6.3.1 Distribution of Wintering Cervids

Throughout the winter and spring field seasons in 1982, locations of all observed white-tailed deer, mule deer, Rocky Mountain elk and moose were plotted, thus providing a broad overview of primary wintering areas in the basin (Fig. 6.3.1). In the winter, white-tailed deer were observed primarily to the south of Quartz Creek. White-tailed deer were also observed near Bowman and Kintla Creeks which corresponded largely to deer observed near south facing slopes of these drainages. Except in local pockets, bottomlands north of Quartz Creek were almost devoid of deer, despite the continued presence of apparently similar habitats.

Elk were distributed more evenly over a wide range of the watershed (Table 6.3.1). Although there was great overlap in deer and elk range between Logging and Quartz Creeks, observation of elk were less frequent in the primary deer range. Singer (1979) noted that white-tailed deer, elk and moose were segregated spatially on the North Fork winter range, with elk, deer and moose rarely sighted in the same stand within 1 km of each other. The data intimated, that beyond the spatial segregation mediated by individual habitat preferences of species, direct behavioral interference between species could also restrict distributions of ungulates in the North Fork.

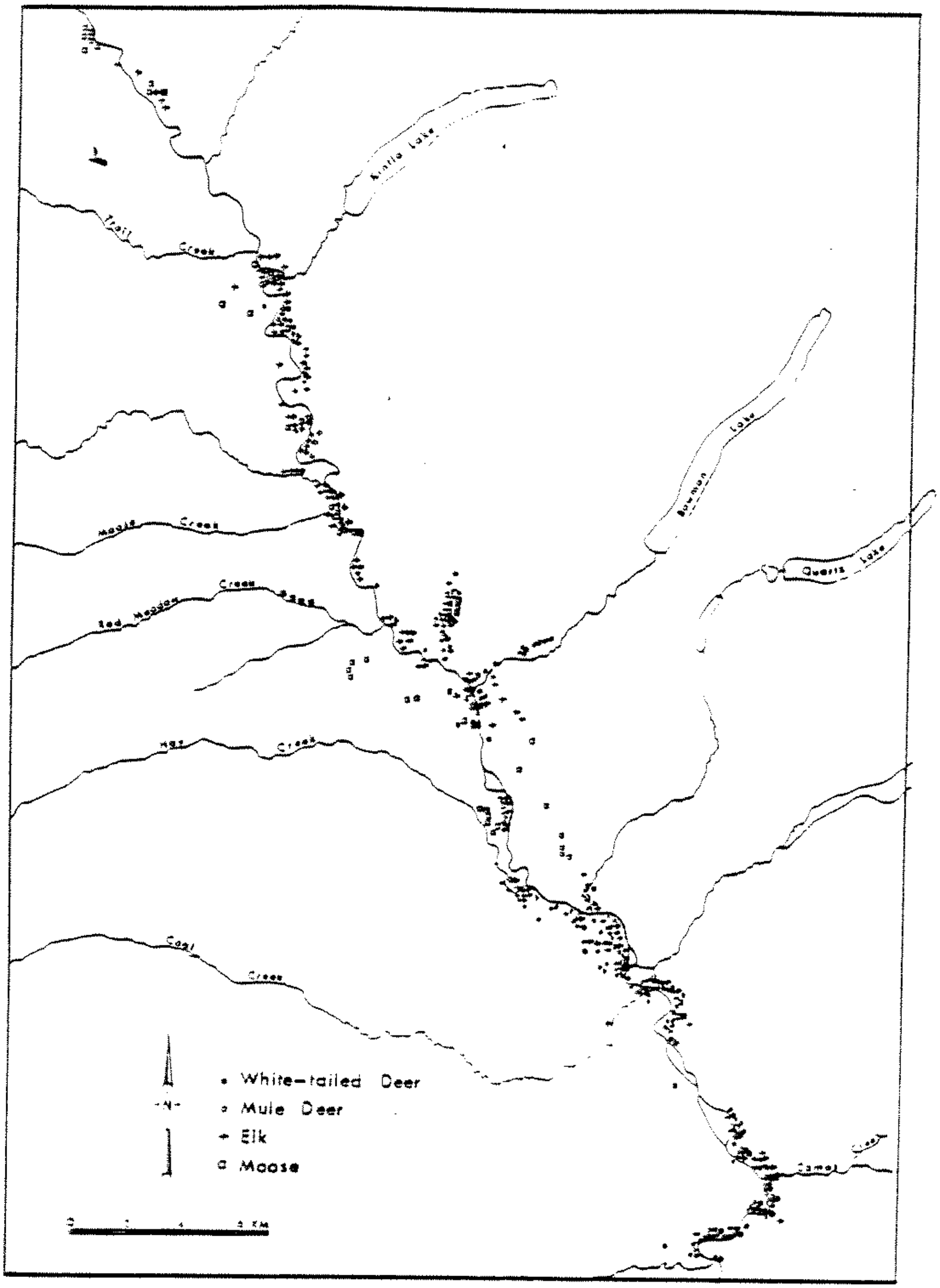

Fig. 6.3.1 Locations of cervids observed in the North Fork of the Flathead Valley, between 15 January - 15 April 1982.

An abrupt transition, or broadly speaking, an ecotone between a deer winter yard and an elk yard was observed outside the park in the Home Ranch Bottoms area. The area from Coal Creek to Quartz Creek was densely populated by white-tailed deer, whereas areas to the north near Hay and Moran Creeks were primary elk centers. It remains unclear, whether the absence of deer in the northern area was related to a threshold in snow depths, or whether competitive interference has resulted in a demarcation of elk and deer wintering areas.

Distribution of moose apparently was influenced by location of hydric shrub and willow communities. Moose were observed over the entire study area, but were observed rarely in the primary deer area.

Mule deer were locally abundant near Polebridge, where a herd of 40 individuals was observed frequently. Mule deer were also observed on the high south-facing slopes of the Huckleberry Mountain burn, and very rarely on floodplain communities north of Polebridge. Because tracks of mule deer and white-tailed deer were indistinguishable, the presence of mule deer in the Polebridge area confounded our studies based on track counts in this area. However, mule deer were effectively absent from the primary deer area, which enabled unobstructed analyses of white-tailed deer behavior in that area.

Relative densities of cervids were estimated in each sector from track counts (Table 6.3.1). For all species and sectors, densities were greater in the floodplain zone than the uplands. Ratios of deer to elk to moose were approximately 34:10:1 in the south sector, but decreased to approximately 1:21:13 in the northern sector. Moose were nearly eight times as abundant in the northern sector than in the south, whereas deer were nearly 60 times as abundant in the southern sector. Elk were more evenly distributed in all study sectors.

With receding snowlines and emergent new growth in early spring, white-tailed deer dispersed from primary wintering areas and populated grasslands and deciduous brushfields in all segments of the valley (Fig. 6.3.2). Deer and elk or mule deer frequently were observed within view of each other on cutover lands and pastures near Home Ranch Bottoms, Moose Creek and in natural meadows from Camas Creek north to Polebridge. Moose remained distributed throughout bottomlands in the spring, but observations were admittedly sparse.

TABLE 6.3.1 Indices of white-tailed deer, elk and moose abundance (tracks/m) in floodplain and upland zones of three study sectors. Indices are means from each vegetation type per zone, weighted by land area of each vegetation type.

PHYSIOGRAPHIC ZONE		SOUTH SECTOR	
	DEER[1]	ELK	MOOSE
FLOODPLAIN	4.97	1.11	0.27
UPLAND	3.03	0.92	0.06
TOTAL	3.40	0.96	0.10
		MIDDLE SECTOR	
	DEER	ELK	MOOSE
FLOODPLAIN	1.16	1.31	0.60
UPLAND	1.12	0.90	0.20
TOTAL	1.13	0.94	0.24
		NORTH SECTOR	
	DEER	ELK	MOOSE
FLOODPLAIN	0.30	2.10	0.74
UPLAND	0.03	1.19	0.57
TOTAL	0.06	1.30	0.77

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[1] Mule deer and white-tailed deer tracks are not distinguished.

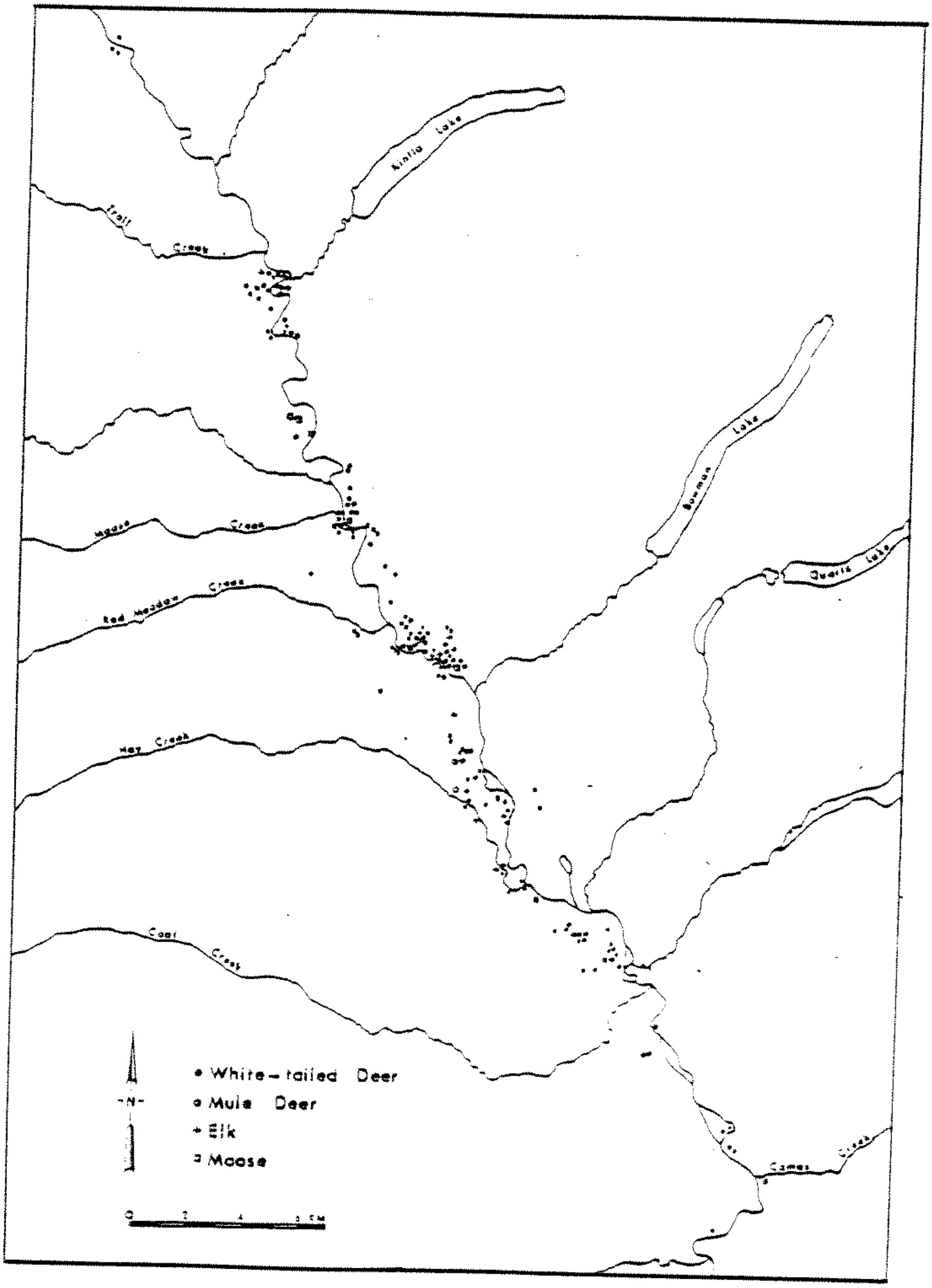

Fig. 6.3.2 Locations of cervids observed in the North Fork of the Flathead Valley between 15 April - 15 July 1982.

6.3.2 Cover Type Selection

In all three study sectors, we found that each cervid species occupied vegetation types disproportionately to their availability ($p < 0.05$). Deer in the southern sector were strikingly selective of spruce bottomland vegetation and the upland Douglas fir type (Fig. 6.3.3). Open vegetation types, such as the deciduous stands, shrub stands and meadows were used in low proportions, and cutover stands were strongly avoided. Because snow depths were greatly reduced in the preferred forest types, it appeared snow depth was the primary determinant of habitat occupancy by deer.

Deer use of vegetation types was not analyzed in the northern two sectors, because white-tailed deer were rare and tracks were confused with those of mule deer. However, observations indicated that deer in the northern sectors were strongly dependent on Douglas fir stands on south facing slopes and rarely found on densely timbered spruce bottomlands. The high association of deer to south aspects and the widespread absence of deer from the floodplain would indicate, that prevailing snow depths were less negotiable to deer in the northern sectors.

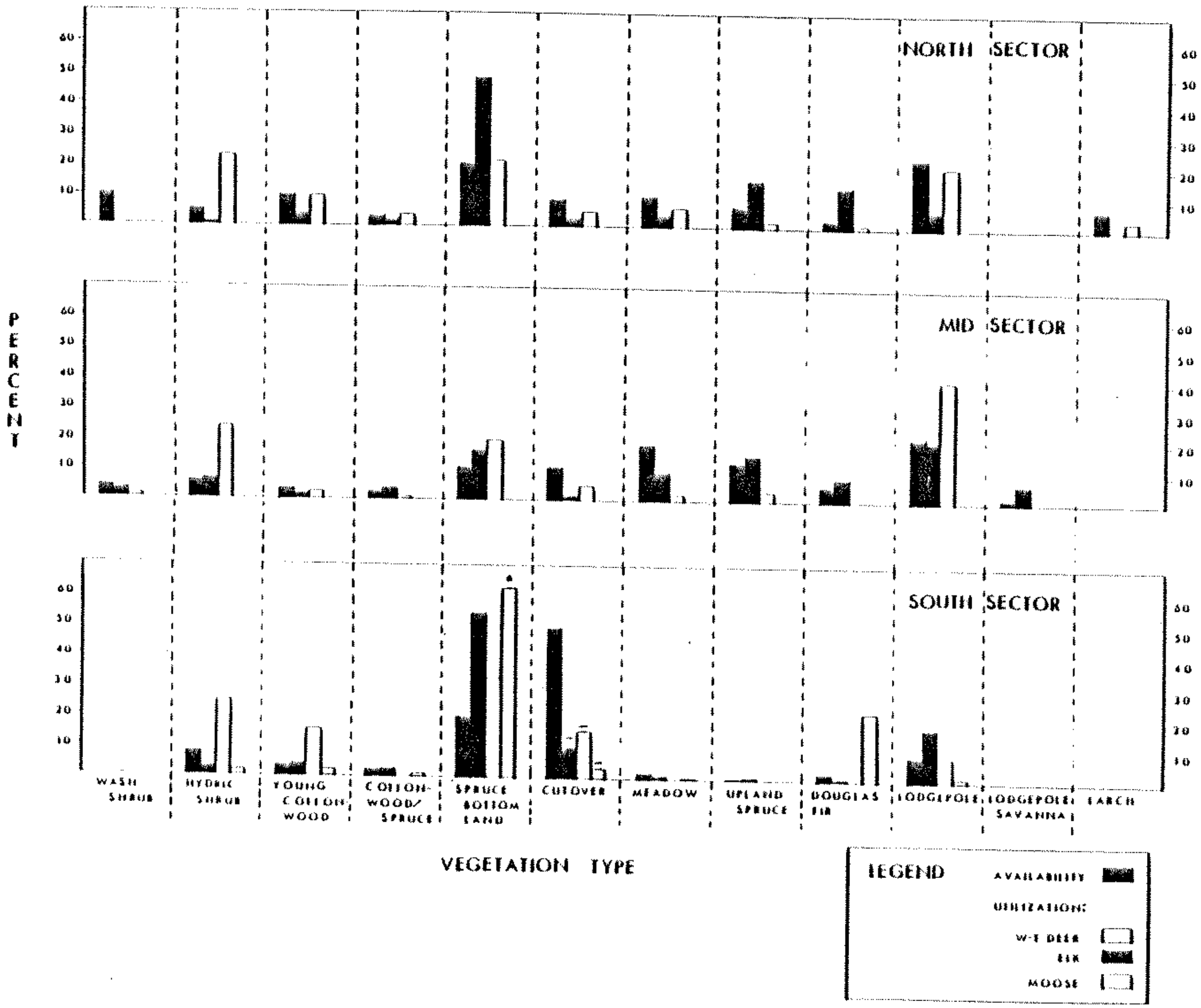

Fig. 6.3.3 A comparison of availability of vegetation types with utilization by white-tailed deer, elk and moose, in winter 1982, in three study sectors. Deer were not evaluated in middle and northern sectors. * denotes significant habitat selection and (-) denotes significant habitat avoidance at the .90 confidence level (Neu et al. 1974).

Rocky Mountain elk were observed in nearly all habitats, reflecting more general patterns of habitat selection, especially in the middle sector, where survey coverage was most extensive. As with deer, elk selectively occupied spruce bottomlands (Fig 6.3.3). Early seral communities of the river floodplain were used less but in proportion to availability. Cutover forests were significantly avoided, though they were used more by the elk than deer.

Upland forests were used in proportion to availability. Lodgepole savannahs were undersampled in this study, but limited data indicated that open lodgepole types were preferred by elk. Elk were observed often to dig foraging craters at the bases of large lodgepoles and feed on the cured winter bunchgrasses. In both the upland lodgepole types and the lodgepole savannah, elk fed heavily on black lichens which draped the lodgepole limbs.

Moose selectively occupied hydric shrub vegetation in each of the study sectors (Fig 6.3.3). Spruce bottomlands were generally used greater than availability and also were important winter habitats with over 20 percent of the total observations. These findings, supported by empirical observations, indicated that ecotones between hydric shrub and spruce-bottomlands were the single most important habitat complex for moose. Hydric shrub communities which were most heavily used by moose, were those with a mosaic of intrusions or habitat islands of spruce. Conversely, the greatest usage of spruce types by moose was in proximity to the hydric shrub type. Moose apparently were linked to hydric shrub communities for feeding, but used nearby spruce stands extensively for bedding.

Other open habitats, such as cottonwood and cutover stands were used more frequently by moose than by elk and deer, but usually in proportions less than or equal to availability. Nevertheless, cutover lands in the south sector were avoided by moose. Lodgepole stands were used by moose in proportions, at least equaling availability. Moose fed primarily on young spruce or sub-alpine fir which regenerated in the understories of older lodgepole stands.

6.3.3 Micro-Habitat Selection

Seasonal differences in habitat selection by white-tailed deer, elk and moose were evaluated using correlation analyses (Figs. 6.3.4., 6.3.5, and 6.3.6). Abundance of deer in the south sector during the deep snow period of January and February, was significantly related to size of trees and conifer basal area. Though not significant statistically, deer avoided deep snow areas. With decreased snow depths in March, deer were less selective of conifer forests, and concurrently were significantly correlated with browse biomass. In the same season and sector, abundance of elk was not strongly tied to any of the habitat features. With onset of spring, elk became less selective of forest cover, yet did not shift to areas of high browse biomass as did deer. Rather, elk shifted more to open meadow types where dried grasses were sought under the reduced snowpack.

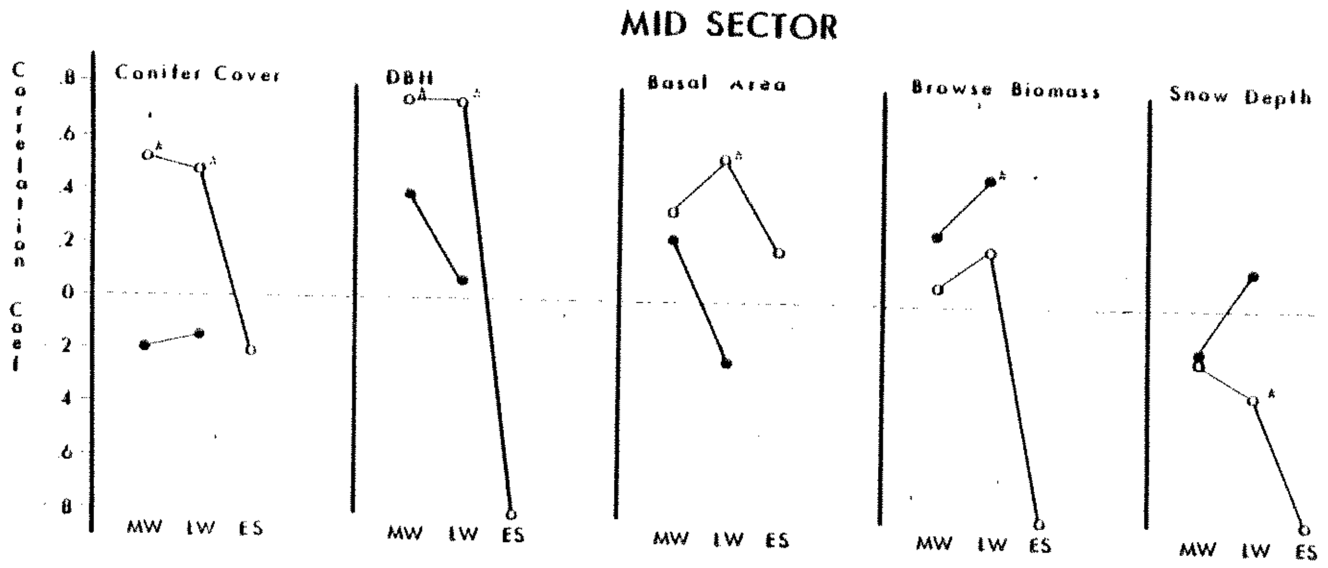

Fig. 6.3.4 Correlations of habitat characteristics to abundance of elk and moose tracks during mid-winter (MW), late-winter (LW) and early spring (ES) periods in the mid-study sector. Tracks were sampled in 21 stands in midwinter, 44 stands in late-winter and 4 stands in early spring. * denotes significant correlation at the 0.05 confidence level.

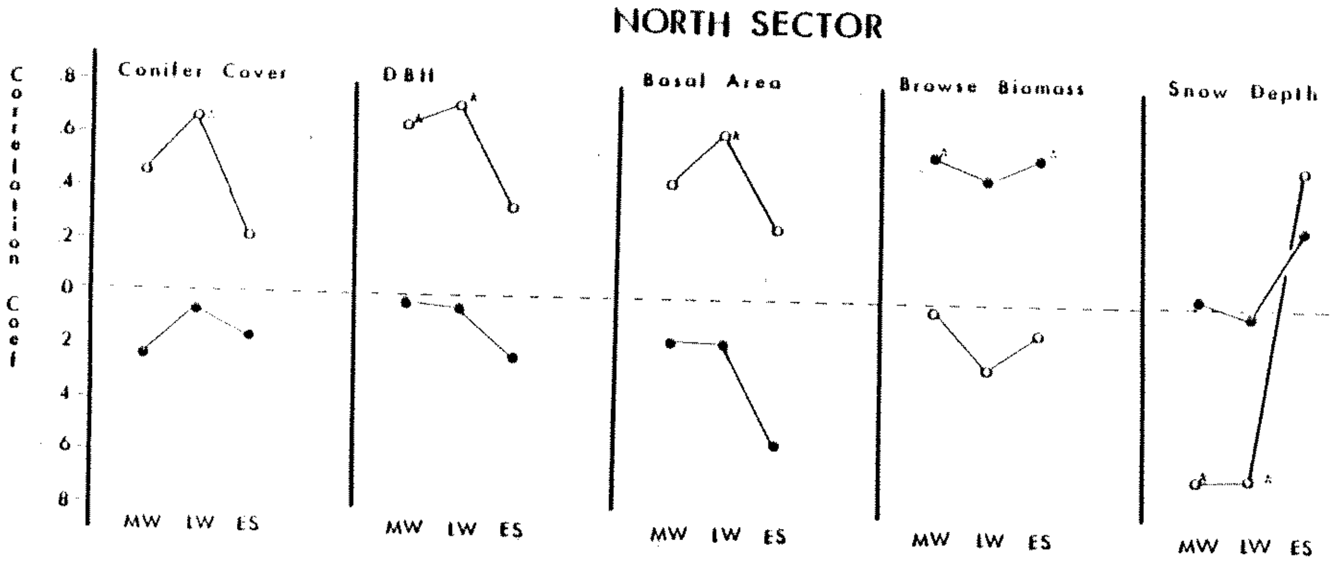

Fig. 6.3.5 Correlations of habitat characteristics to abundance of elk and moose tracks during midwinter (MW), latewinter (LW) and early spring (ES) periods in the north study sector. Tracks were sampled in 12 stands in midwinter, 20 stands in late winter and 13 stands in early spring. * denotes significant correlation at the 0.05 confidence level.

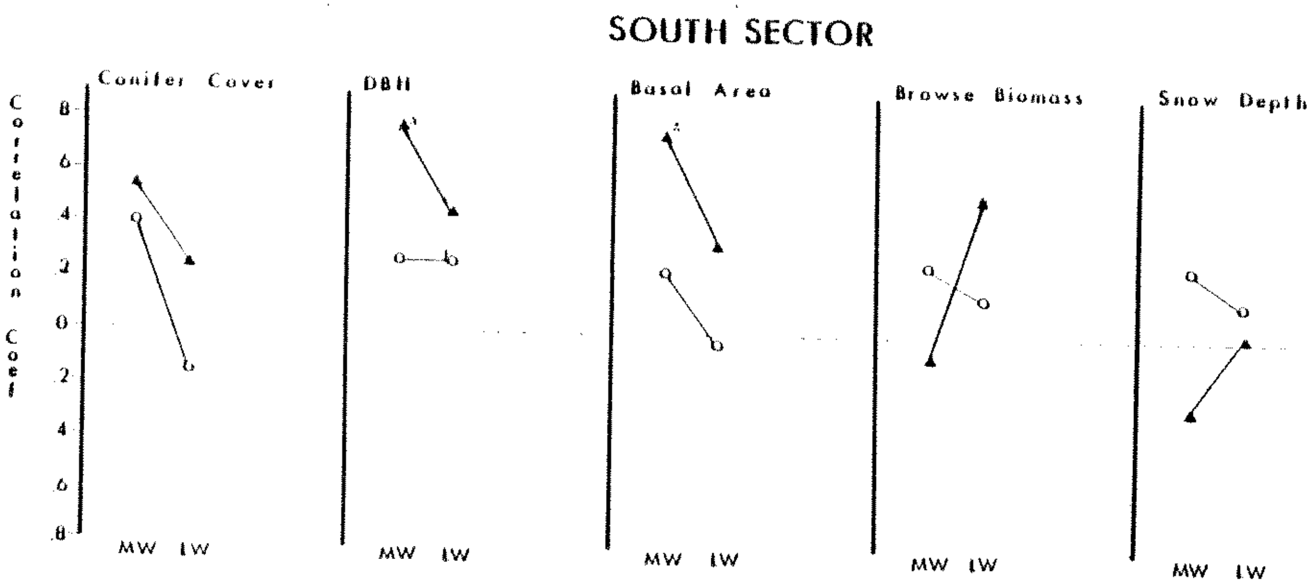

Fig. 6.3.6 Correlations of habitat characteristics to abundance of white-tailed deer and elk tracks during mid-winter (MW) and late winter (LW) periods in the south study sector. Tracks were sampled in 9 and 14 stands, respectively in MW and LW periods. * denotes significant correlation at the 0.05 confidence level.

In contrast, elk in the middle and northern sectors, where snows were progressively deeper, assumed habitat selection patterns much like those of white-tails to the south. Abundance of elk tracks was significantly related to conifer cover, basal area, and size of trees, but was negatively influenced by snow depth. In the middle and northern sectors, elk were restricted largely to mature conifer stands until snow depths diminished in April. Though the April sample was small in the middle sector, elk responded to low snow depths by seeking open, grassy habitats where new emergent growth was sought.

In each of the winter periods and study sectors, abundance of moose tracks was largely independent of the forest stand characteristics. The absence of correlations between moose abundance and conifer characteristics might be expected because moose use such disparate vegetation types as the hydric shrub and spruce-bottomlands. Moose however, were strongly associated with browse biomass and were less affected by snow depths of those open habitats than were elk. With onset of spring, moose continued to depend on availability of browse biomass but generally were less associated with tree cover.

6.3.4 Browse Utilization

A summary of the utilization of the major browse species is given in Table 6.3.2. The null hypothesis tested for each species was that utilization differed significantly ($p < 0.05$) between vegetation types. The Kruskall-Wallis test and Wilcoxon signed rank test was used for multiple comparisons. We were unable to demonstrate different browsing pressure on willows in the wash shrub, hydric shrub or cottonwood communities. Utilization of willows averaged 24 percent overall (S.E. 14 percent). Because willow habitats were more uniform structurally than other vegetation types, by virtue of the open canopy, we expected there would be no selective browsing pressure by ungulates on willows in the three types.

Utilization of dogwood differed significantly between five floodplain vegetation types. Pairwise comparisons indicated utilization in most cover types was comparable, but consumption of dogwood was significantly greater in the spruce-cottonwood and mature spruce types than in cottonwood stands. Greater browsing pressure in spruce vegetation reflects the strong affinities of deer and elk for sheltered, coniferous habitats and the corresponding shallow snows. These trends reiterate verbal descriptions in early reports that browsing pressure was greatest in sheltered sites on the valley floodplain.

TABLE 6.3.2 Summary of ungulate utilization of willow, red-osier dogwood and serviceberry in 11 vegetation types in the North Fork of the Flathead Valley.

VEGETATION TYPE	N	FORM CLASS $\overline{X}$	SE	UTILIZATION $\overline{X}$	SE	MEDIAN
		WILLOW				
Wash shrub	16	3.01	0.98	0.26	0.16	0.24
Hydric shrub	7	2.43	0.77	0.27	0.11	0.23
Cottonwood	6	2.06	0.95	0.19	0.13	0.24
Cottonwood, spruce	1	2.55		0.21		0.21
Spruce cutover	1	2.88		0.23		0.23
Lodgepole cutover	1	0.50		0.00		0.00
		DOGWOOD				
Wash shrub	5	3.66	0.61	0.46	0.12	0.48
Cottonwood	9	2.94	1.24	0.34	0.19	0.34
Cottonwood, spruce	7	3.40	1.22	0.54	0.17	0.52
Spruce, cottonwood	9	4.62	0.72	0.66	0.19	0.73
Spruce	15	4.01	1.39	0.59	0.30	0.48
Aspen	2	5.35	1.02	1.73	1.30	1.73
Spruce cutover	3	3.42	1.11	0.31	0.20	0.31
Upland spruce	4	3.91	1.20	0.39	0.10	0.38
Douglas-fir	2	4.50	0.99	0.53	0.13	0.53
Western larch	1	3.25		0.51		0.51

VEGETATION TYPE	N	FORM CLASS $\bar{X}$	FORM CLASS SE	UTILIZATION $\bar{X}$	UTILIZATION SE	UTILIZATION MEDIAN
		SERVICEBERRY				
Cottonwood, spruce	2	3.76	0.59	0.34	0.13	0.34
Spruce, cottonwood	2	3.81	0.08	0.50	0.04	0.50
*Spruce	3	2.94	3.40	1.01	0.66	1.21
Aspen	2	3.30	0.28	0.25	0.02	0.25
Spruce cutover	1	2.50		0.13		0.13
Upland spruce	2	3.52	1.78	0.52	0.02	0.52
*Lodgepole	5	2.18	0.75	0.24	0.20	0.14
*Lodgepole savahna	3	5.41	0.80	0.73	0.28	0.69
*Lodgepole cutover	5	2.71	0.80	0.05	0.04	0.06
*Douglas fir	4	4.31	1.59	0.52	0.25	0.61

Utilization of dogwood was not compared statistically in the remaining five vegetation types because samples were limited. It appeared however, that utilization in upland forest types was comparable to that on floodplain forests. Two aspen stands were measured with widely contrasting dogwood utilization. In one stand, a wet seep bordering Lone Pine Prairie, use of dogwood was well above 100%, with the stems of several years growth gnawed back. Our general observations indicated elk used the area intensively in late winter, before the emergence of new herbaceous growth. Use of dogwood in three cutover spruce stands was well below that in the mature forest stands and more closely resembled levels of use in the open cottonwood habitats.

Use of serviceberry browse differed significantly between five forest types. Browsing pressure in the lodgepole savannaH, spruce bottoms and Douglas fir types were comparable, but serviceberry was used significantly less in lodgepole and cutover lodgepole stands. Furthermore, browsing of serviceberry in the cutover lodgepole stands was less than in the uncut lodgepole. The extreme low use in cutover lodgepole stands reflected both the low stature and vigor of serviceberry in the cut stands and deeper winter snows which would cover much available browse and hamper deer and elk movement. Our general observations indicated deer and elk use of cutover lodgepole stands peaked in spring after cervids had switched to a predominately herbaceous diet.

Sampling of serviceberry utilization in other forest types was very limited. However, trends in serviceberry use seemed to support those which were previously discussed for red-osier dogwood. Browsing levels in the conifer types were similar to those measured in Douglas fir, larch and spruce bottoms. Use of serviceberry in cottonwood and cutover spruce stands appeared to be less, further reflecting the winter habitat preferences of deer and elk for sheltered conifer types.

We also looked at the difference in browsing intensity on willow and dogwood in each of the three study sectors, (Table 6.3.3). The hypothesis tested was that there were no significant differences in willow and dogwood use beweteen the three sectors. We were unable to demonstrate unequal use of willows. Dogwood utilization was compared only in spruce stands to minimize the Effects of differing sample sizes and browsing levels between habitats. Dogwood use varied significantly between sectors, with the south sector sustaining the greatest use. There was, however, no difference in browsing levels of dogwood between middle and north, or south and north sectors. Coefficients of variation in dogwood use were 0.21, 0.42, and 0.62 in the south, middle and north sectors respectively, indicating browsing pressure was most uniform in the south sector. This south sector, with the greatest and most uniform browsing pressure corresponds to the primary deer wintering area in the North Fork.

TABLE 6.3.3 Summary of ungulate utilization of willow and red-osier dogwood in south, middle and north study sectors in the North Fork Flathead Valley.

		FORM CLASS		UTILIZATION		
SECTOR	N	X	SE	X	SE	MEDIAN
Willow						
South	8			0.29	0.11	0.28
Middle	13			0.20	0.17	0.23
North	11			0.24	0.13	0.22
Dogwood						
South	7			0.73	0.15	0.75
Middle	10			0.53	0.22	0.46
North	7			0.60	0.37	0.54

1. Comparison of dogwood useage limited to spruce and spruce cottonwood vegetation types.

/ Comparisons of dogwood usage limited to spruce and spruce-cottonwood vegetation types.

The lack of historical data makes it difficult to draw any but the most general conclusions regarding range trend. However early investigators described browsing as very light north of Polebridge. In the present study, utilization of dogwood was

TABLE 6.3.3 Summary of ungulate utilization of willow and red-osier dogwood in south, middle and north study sectors in the North Fork Flathead Valley.

	SECTOR	N	FORM CLASS X±SE	UTILIZATION X±SE	MEDIAN
Willow					
	South	8	2.85±0.73	0.29±0.11	0.28
	Middle	13	2.31±0.88	0.20±0.17	0.23
	North	11	2.77±1.29	0.24±0.13	0.22
Dogwood					
	South	7	4.86±0.71	0.73±0.15	0.75
	Middle	10	4.04±1.04	0.53±0.22	0.46
	North	7	3.89±1.66	0.60±0.37	0.54

1. Comparison of dogwood useage limited to spruce and spruce cottonwood vegetation types.

The lack of historical data makes it difficult to draw any but the most general conclusions regarding range trend. However early investigators described browsing as very light north of Polebridge. In the present study, utilization of dogwood was moderate in the mid-sector, averaging 53%, but ranged as high as 96% on some sites. On the basis of our measurements and earlier evaluations, it appears that the middle sector sustained greater browsing today than in previous decades. We speculate that this difference reflects the influx and establishment of elk populations in these middle and northern sectors.

Less is known on the magnitude of browsing pressure in the south sector. Aiton (1937) and others described the main deer yards as heavily overbrowsed in the 1930's, and browsing pressure remains high today. However, judging from the extreme descriptions of highlined and hedged browse in the early documentations it would seem browsing pressure probably is less today. This conjecture is supported by population estimates of deer which indicates densities have decreased substantially since the 1930's. Certain ecological theories would predict that periods of such severe overbrowsing would be followed by evolution of a stable vegetation - herbivore equilibrium (Caughley 1976). The equilibrium would be manifested initially by a reduction in forage biomass and deer numbers, as was apparently seen in the 1930's, followed by a period when numbers and productivity of deer and browse resources would remain at lower, but stable numbers. It is possible that baseline data contained in this report could be used at a later date to test hypotheses that forage resources are indeed stable in the undisturbed forest stands.

6.4 RESULTS OF AVIAN STUDIES

6.4.1 Avian Community Structure

6.4.1.1 Bird Species Richness

Increased bird species richness was found to accompany increased ecological age of the stand and the associated increase in complexity of the vegetation (Fig. 6.4.1). The herbaceous wash community exhibited a significantly lower bird species richness than any of the other communities (p <.01). No other communities were significantly different from each other.

6.4.1.2 Bird Species Diversity

Bird species diversity was nonlinearly correlated with bird species richness (r = .955058) (Fig. 6.4.2). As species richness increased, additional species contributed less to diversity. Species diversity exhibited a trend similar to species richness, although diversity leveled off before the climax stage (Fig. 6.4.1) as would be expected given the nonlinear relationship between bird species diversity and bird species richness. Diversity was significantly lower in the herbaceous wash community then in any of the other communities (p <.01). The remaining communities did not exhibit any significant differences in bird species diversity.

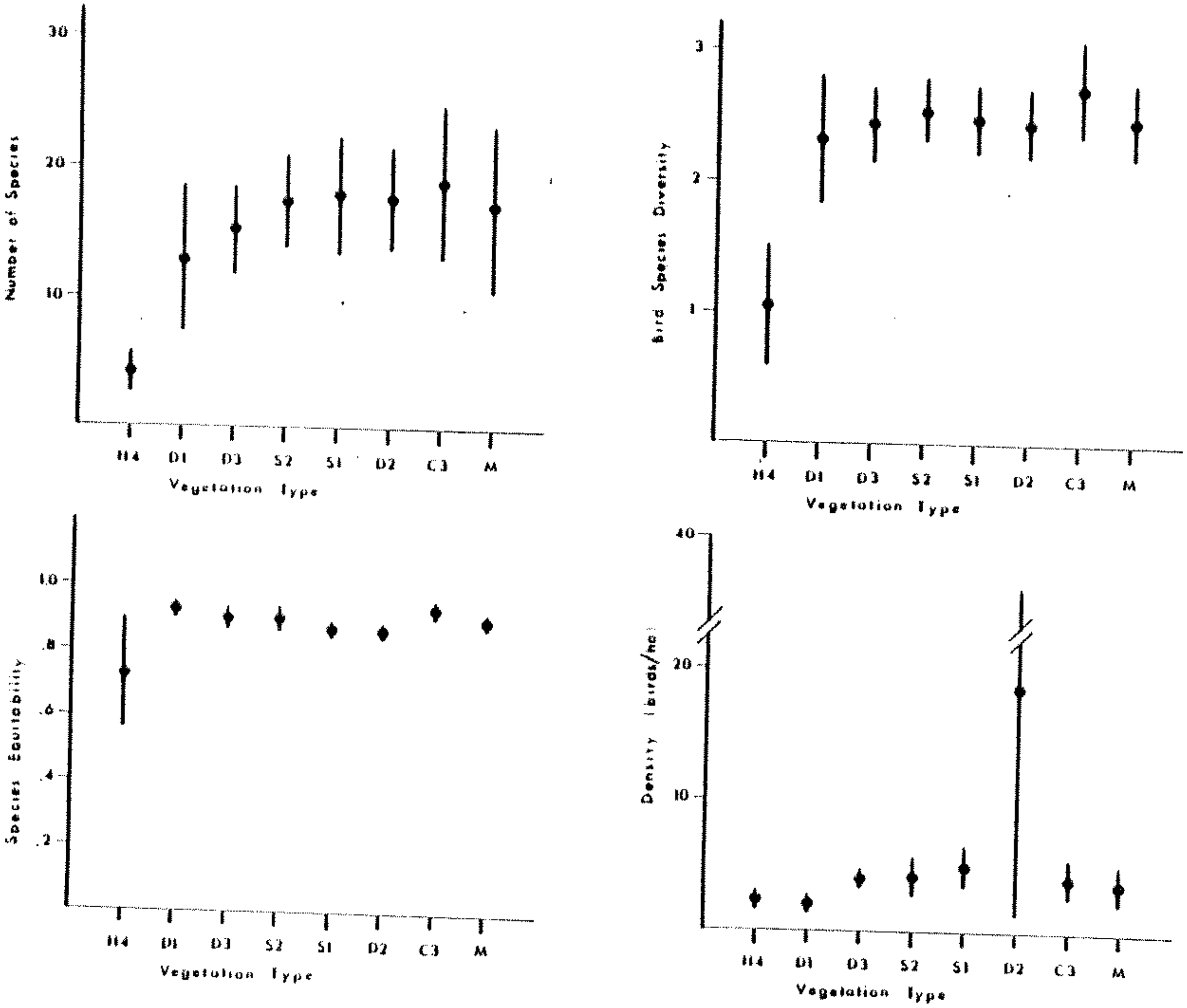

Fig. 6.4.1 Bird species richness, diversity, equitability and density for each vegetation type. Bars represent parametric 95% confidence intervals.

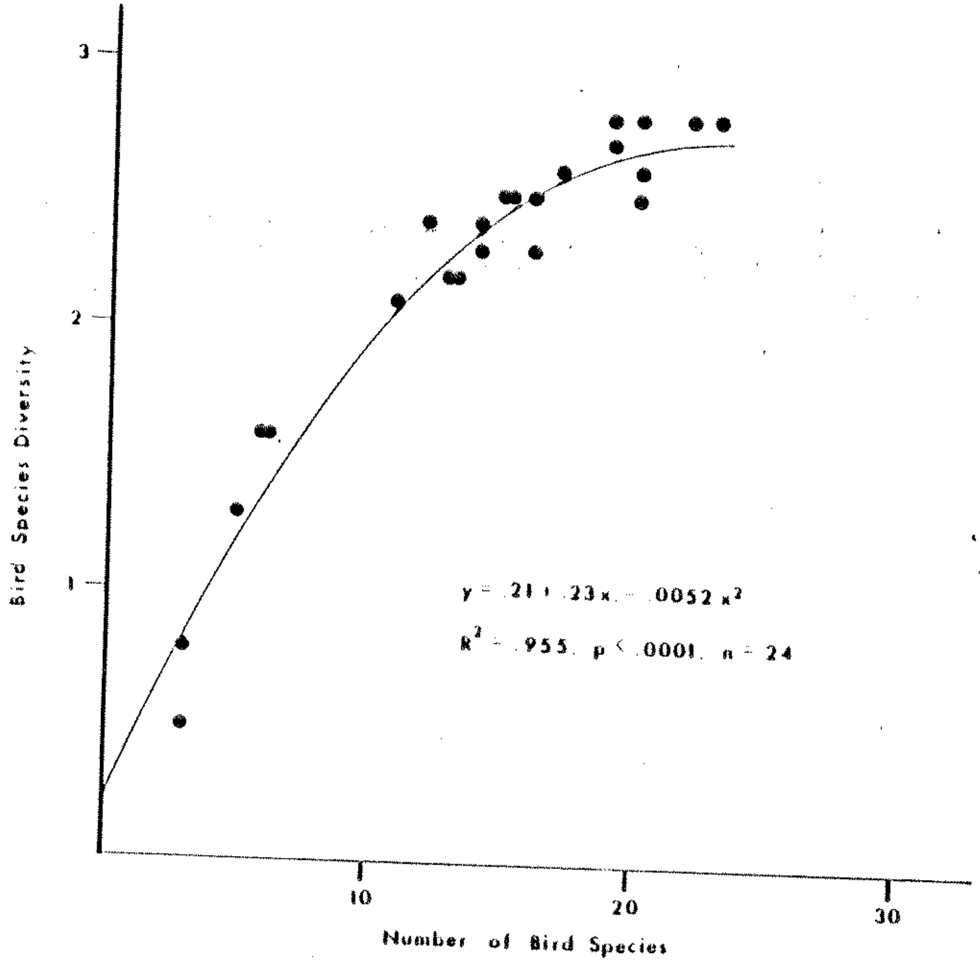

Fig. 6.4.2 Bird species diversity vs. bird species richness.

6.4.1.3 Bird Species Equitability

Bird species equitability was lower in the herbaceous wash community than in any other community except the mature spruce ($p < .05$) (Fig. 6.4.1). No meaningful trends were apparent in the other communities.

6.4.1.4 Total Bird Density

Total bird density exhibited a somewhat different trend than the other community attributes (Fig. 6.4.1). The herbaceous wash and shrub wash communities were both significantly lower in bird density than the other communities ($p < .025$). The three forested types, cottonwood, spruce/cottonwood and mature spruce were intermediate. The hydric shrub had the highest bird densities; with as high as 45 birds per hectare.

6.4.1.5 Community Similarity

The fact that some of the floodplain communities did not differ in bird species richness, diversity, or total bird density should not imply that these avair communities were identical. There were sometimes obvious differences in bird species composition (Table 6.4.1). With the exception of the disclimax hydric shrub community, the general trend was for each community in the floodplain successional sere to most closely resemble in bird composition the communities closest to it in ecological age (Fig. 6.4.3). The herbaceous wash community was most similar to the shrub wash community. The shrub wash community was most like the mature cottonwood community. The mature cottonwood community most strongly resembled the spruce/cottonwood codominant and was also similar to the shrub wash. The spruce/cottonwood shared species of both the cottonwood and spruce climax communities and the spruce climax was most similar to this community. The hydric shrub community was most similar to the other deciduous community, the mature cottonwood.

6.4.1.6 Niche Widths

Nineteen of the 63 bird species found on our floodplain study plots were restricted to only one community (Table 6.4.1). Fifteen species were restricted to two communities. These 34 species are considered habitat specialists and have narrow niche widths. The remaining 29 species were found in three or more communities and are habitat generalist with broad niche widths. Only one species, the pine siskin was found in all the floodplain communities, demonstrating its wide foraging habits.

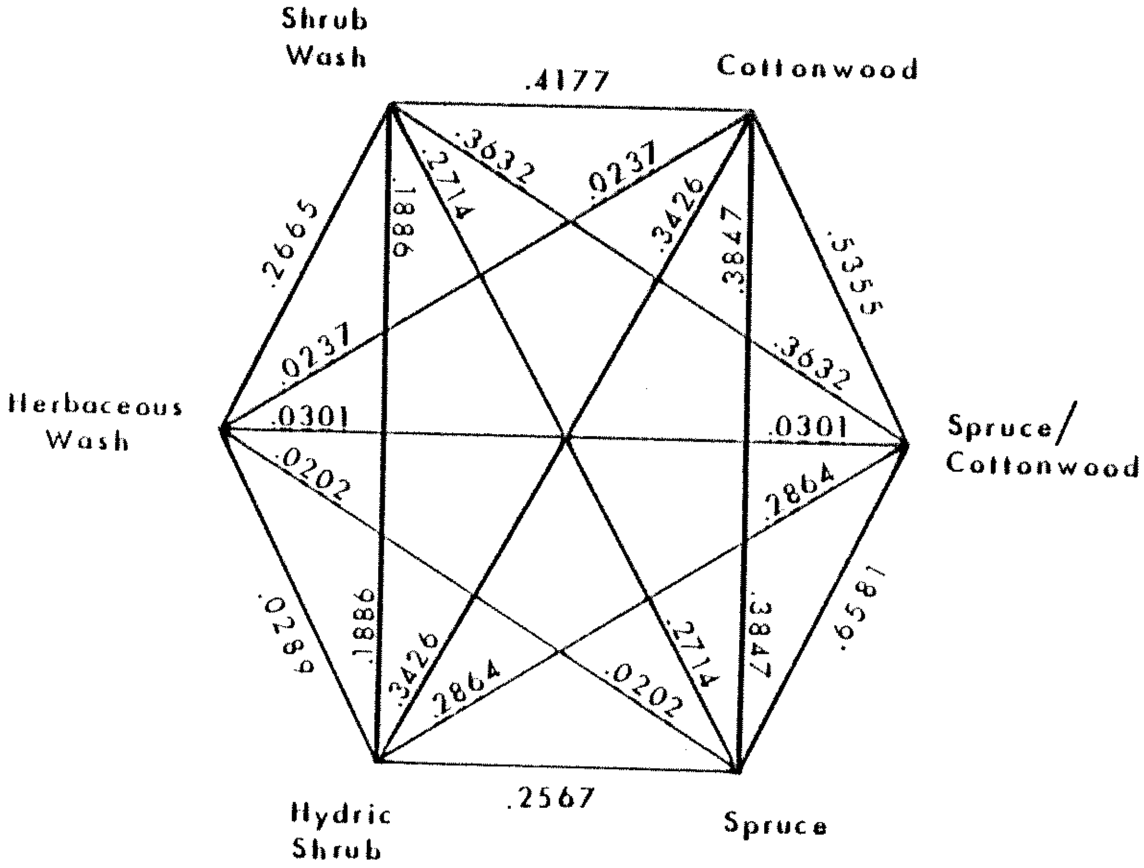

Fig. 6.4.3 Bird species similarity between all pairs of floodplain plant communities. Maximum range of values is 0 to 1, 1 meaning the communities are identical.

6.4.2 Bird/Habitat Association

6.4.2.1 Richness

The number of bird species observed is at least partially dependent on the area censused. Species-area curves for birds are, however, not available. Due to the mosaic pattern of plant communities on the floodplain, it was not possible to establish transects all of equal length. However, transect length was poorly correlated with bird species richness (r=.395) and did not make a significant contribution when added to the regression of bird species richness on the habitat variables. This suggests that the transects were long enough to adequately account for all bird species, negating the need to compute relative bird species richness values.

Bird species richness was most significantly correlated to plant species richness (r=.681) (Fig. 6.4.4). No other variables entered the model at the .05 level of significance. Willson (1974) suggested that the addition of species is a stepwise function related to the presence of additional layers of vegetation. Although we obtained a significant correlation between the number of bird species and the number of plant species, such a correlation may mask the underlying relationship. The scatter plot of bird species richness versus plant species richness (Fig. 6.4.4) demonstrated that the data fall out into two distinct groups, neither showing an apparent relationship between bird species richness and plant species richness. Those stands with fewer than four plant species contained a maximum of six bird species (Average 5.8). There was only one exception, (transect 11, BSR=12), which is dicussed below. When the number of plant species surpassed four the number of bird species took a sudden leap to a minimum of eleven (x=16.84).

This sudden increase in the number of bird species at plant species numbers greater than four appears to be related to the development of a tree layer. When the density of trees was near zero, bird species richness reached a maximum of six (Fig. 6.4.4). At tree densities even slightly greater than zero, bird species richness, with one exception (transect 132, tree density = 343.75, BSR = 6) was 11 or greater. The one anomalous study plot (transect 132) contained many trees near our arbitrary definition of a tree (d.b.h. > 5 cm). It is likely that this definition of a tree is not the same criteria used by birds and that a minimum diameter breast height greater than five centimeters may more accurately match those criteria used by birds. This interpretation of the relationship between bird species richness and the presence of a tree layer also explains the excepted study plot (transect 11) in the stepwise relationship of bird species richness and plant species richness. This transect, although having fewer than four plant species (Fig. 6.4.4) contained a tree layer (Fig. 6.4.4) and it contained more than six bird species.

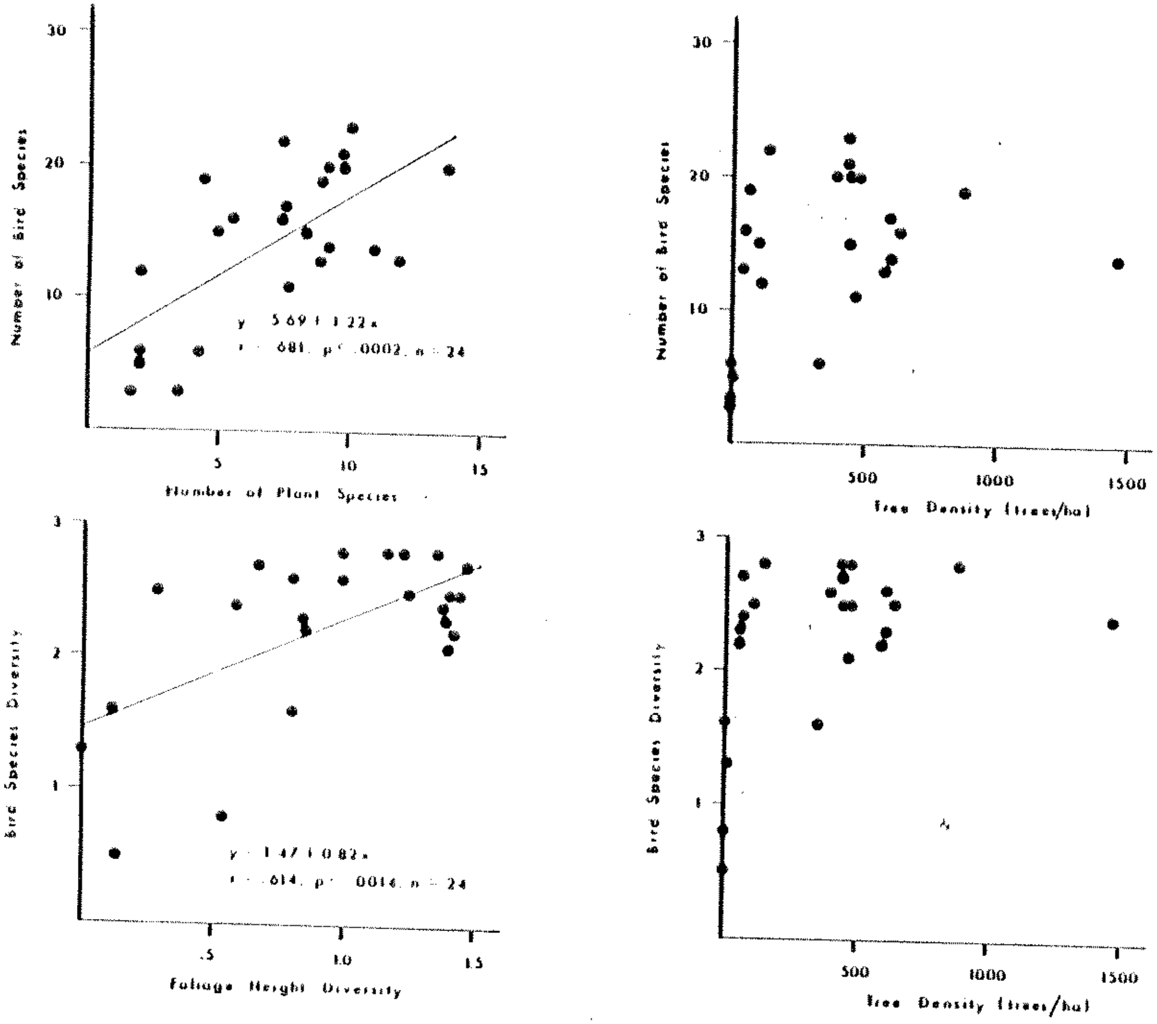

Fig. 6.4.4 Bird species richness vs. plant species richness and tree density, and bird species diversity vs. foliage height diversity and tree density.

6.4.2.2 Bird Species Diversity

Bird species diversity was correlated with foliage height diversity (r=.614) (Fig.6.4.4). No other variables explained additional variation in bird species diversity at the .05 level of significance. Despite this significant correlation, little of the total variation in bird species diversity was explained by foliage height diversity (r =.368). Higher correlations between bird species diversity and foliage height diversity were reported in other studies by Willson (1974), Recher (1969) Balda (1975), and MacArthur (1964), but these studies were conducted in predominantly hardwood forests. Because of the physiognomic differences between coniferous and hardwood forests this relationship may not hold for the spruce forests of the North Fork floodplain.

There is some evidence that bird species diversity responded in a stepwise function to the vegetation physiognomy in a manner similar to bird species richness. Again the data fell out into two groups, neither showing a relationship between bird species diversity and foliage height diversity (Fig. 6.4.4) This stepwise function also appeared to be related to the presence of a tree layer. With tree densities at or near zero, bird species diversity reached a maximum of 1.59 (x=1.06) (Figure 4). With tree densities even slightly greater than zero, bird species diversity, with one exception (transect 132, BSD=1.62) was greater than 2.11 (x=2.46). The anomalous transect may again be explained by our arbitrary definition of trees (d.b.h.>5cm.).

6.4.2.3 Total Bird Density

We found the log of total bird density to be highly correlated with percent shrub cover (r=.867) (Fig. 6.4.5). Other variables were also significant at the .05 level in a stepwise multiple regression. These were; shrub stem density, plant species diversity and stand length. However, because some were highly inter-correlated or biologically difficult to interprete, we preferred to use the simple linear relationship between the log of total bird density and percent shrub cover (Fig. 6.4.5).

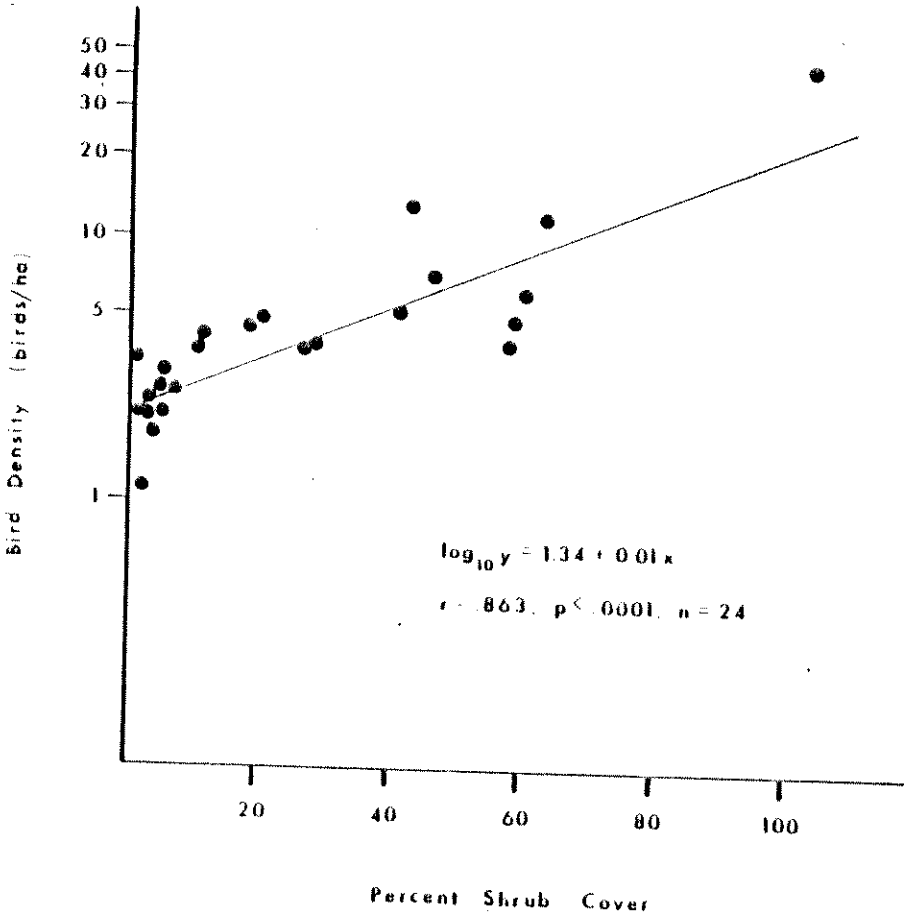

Fig. 6.4.5 Bird density vs. percent shrub cover.

TABLE 6.4.1 Mean Number of Birds Per Km and Niche Widths

SPECIES	H4	D1	D3	S2	S1	D2	NICHE WIDTH
Bank swallow	0.15						0.1554
Osprey	0.25						0.1554
Killdeer	5.95	2.23					0.2784
R. winged swallow	0.78	0.28					0.3020
Vesper sparrow	0.28	0.40					0.3240
Spotted sandpiper	4.70	0.93		0.13		0.33	0.3091
White-crowned sp.	0.13	1.40				0.33	0.3007
Tree swallow	0.50	0.15				0.65	0.4376
Chipping sparrow	0.20	0.48	0.50	0.60	0.90		0.7426
Pine siskin	0.50	0.10	0.53	0.68	1.90	0.50	0.7565
Hairy woodpecker		0.15	0.15				0.3575
Common flicker		0.15	0.33				0.2932
Mallard		0.25		0.15			0.3575
Common nighthawk		0.65	0.20	0.33			0.4721
Dusky flycatcher		2.18	3.33	1.08			0.4613
Rufous hummingbird		0.15	0.33	0.55		0.80	0.4519
Song sparrow		0.53	0.18		4.15		0.3157
Common yellowthroat		0.25	0.58		0.20	11.68	0.2641
Brown-headed cowbird		0.10		0.25	0.20	1.23	0.5931
Yellow warbler		0.15	0.73			8.68	0.2585
Red-eyed vireo		0.10	2.25	1.80		0.33	0.4313
Warbling vireo		0.20	3.30	0.93	0.10	4.68	0.5530

SPECIES	H4	D1	D3	S2	S1	D2	N W
Dark-eyed junco		0.20	0.60	2.18	1.15	0.80	0.6606
Hammond's flycatcher		1.58	3.63	4.50	4.55	0.65	0.7168
Swainson's thrush		0.20	0.65	2.78	3.60	3.33	0.6945
Yellow-rumped warbler		0.45	1.08	2.68	3.05	0.40	0.6361
American robin		1.28	1.63	0.40	1.55	1.45	0.7605
Ruffed grouse		0.10	0.38	0.25	0.75	0.65	0.7556
Ruby-crowned kinglet		0.20	0.60	2.20	3.95	3.08	0.5650
Bl. capped chickadee		0.10	0.38	0.40	0.50	0.50	0.7677
American redstart		0.15	4.15	1.65	0.70	6.38	0.6025
Orange-crowned warbler		0.10	0.70	0.28	0.20	1.05	0.6906
Northern waterthrush		0.78	1.25	0.78	1.30	6.55	0.7220
MacGillivray's warbler		0.53	0.78	1.45	2.05	5.23	0.7192
Veery			0.50				0.1486
Great-blue heron			0.33				0.1486
Least flycatcher			0.68				0.1486
Western tanager			0.20		0.30		0.3209
Wilson's warbler			0.20		0.30	5.95	0.2635
Fox sparrow			0.58			5.48	0.2319
Cedar waxwing			0.18			3.30	0.2021
Willow flycatcher			0.18			16.58	0.1583
N. 3 -toed woodpecker				0.15			0.1892

SPECIES	H4	D1	D3	S2	S1	D2	N W
Steller's jay				0.18			0.1892
Mountain chickadee				0.15			0.1892
Varied thrush				0.15	0.10		0.3851
Common raven				0.15	0.10		0.3851
Pileated woodpecker				0.18	0.10		0.3851
Red-brested nuthatch				0.28	0.30		0.3787
Golden-crowned kinglet				1.10	4.05		0.3437
Townsend's warbler				2.88	5.20	0.50	0.3816
Y-bellied sapsucker				0.18	0.20	0.50	0.5068
Winter wren					0.30		0.1959
Wh. winged crossbill					0.20		0.1959
Red crossbill					0.55		0.1959
Olive-sided flycatcher					0.20		0.1959
Solitary vireo					0.10		0.1959
Vaux's swift					0.10		0.1959
Downy woodpecker						0.90	0.1419
Common snipe						0.83	0.1419
Lincoln's sparrow						6.33	0.1419
Barred owl						0.33	0.1419
Calliope hummingbird						0.50	0.1419

6.5 RESULTS OF THE SIMULATION MODEL

6.5.1 Plant Succession

A diagram of the compartmental simulation model constructed for this study along with the values of the transfer coefficients is shown in Fig. 6.5.1. The derived flow rates are those which meet a primary assumption of the model, that the proportion of the seral and climax vegetation types on the floodplain are stable. When the model is run with these parameters as a starting point, the proportions of land area in each vegetation type remain constant. Fig. 6.5.2 shows the cyclical pattern of development of the respective plant communities when the model is run starting with all of the land area in the first stage, the herb wash. This would be the case, for instance, following a large flood which would cause a large proportion of the floodplain to revert to a primary successional phase. Note in this figure that once the stable proportion of each plant community is achieved, the cycles cease.

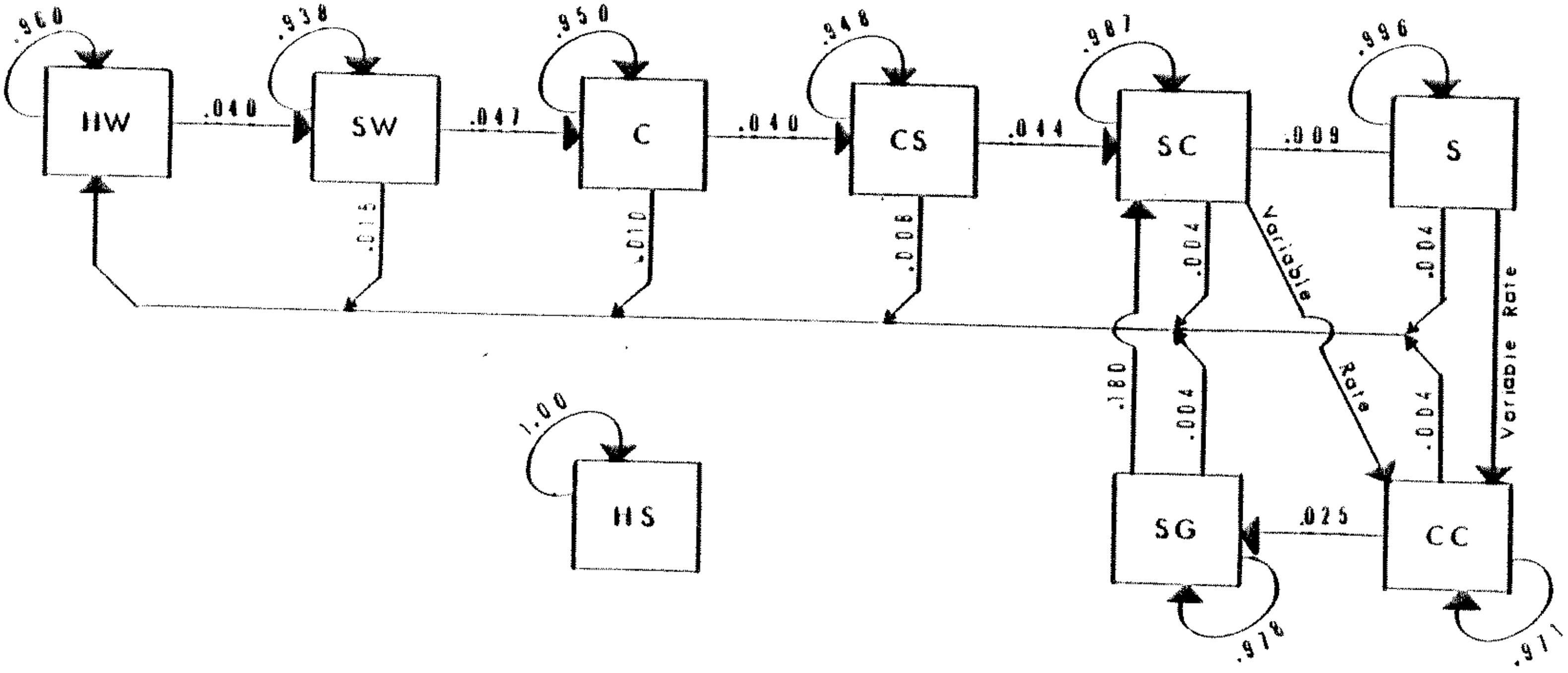

Fig. 6.5.1 A compartment model of successional development in the spruce floodplain forests in the North Fork, and transfer coefficients between communities. Hydric shrub (HS) communities occurred on floodplains but successional status was unknown. (HW = herbaceous wash, SW = shrub wash, C = cottonwood, CS = cottonwood spruce, SC = spruce-cottonwood, S = mature spruce, CC = clearcut, SG = second growth, HS = hydric shrub).

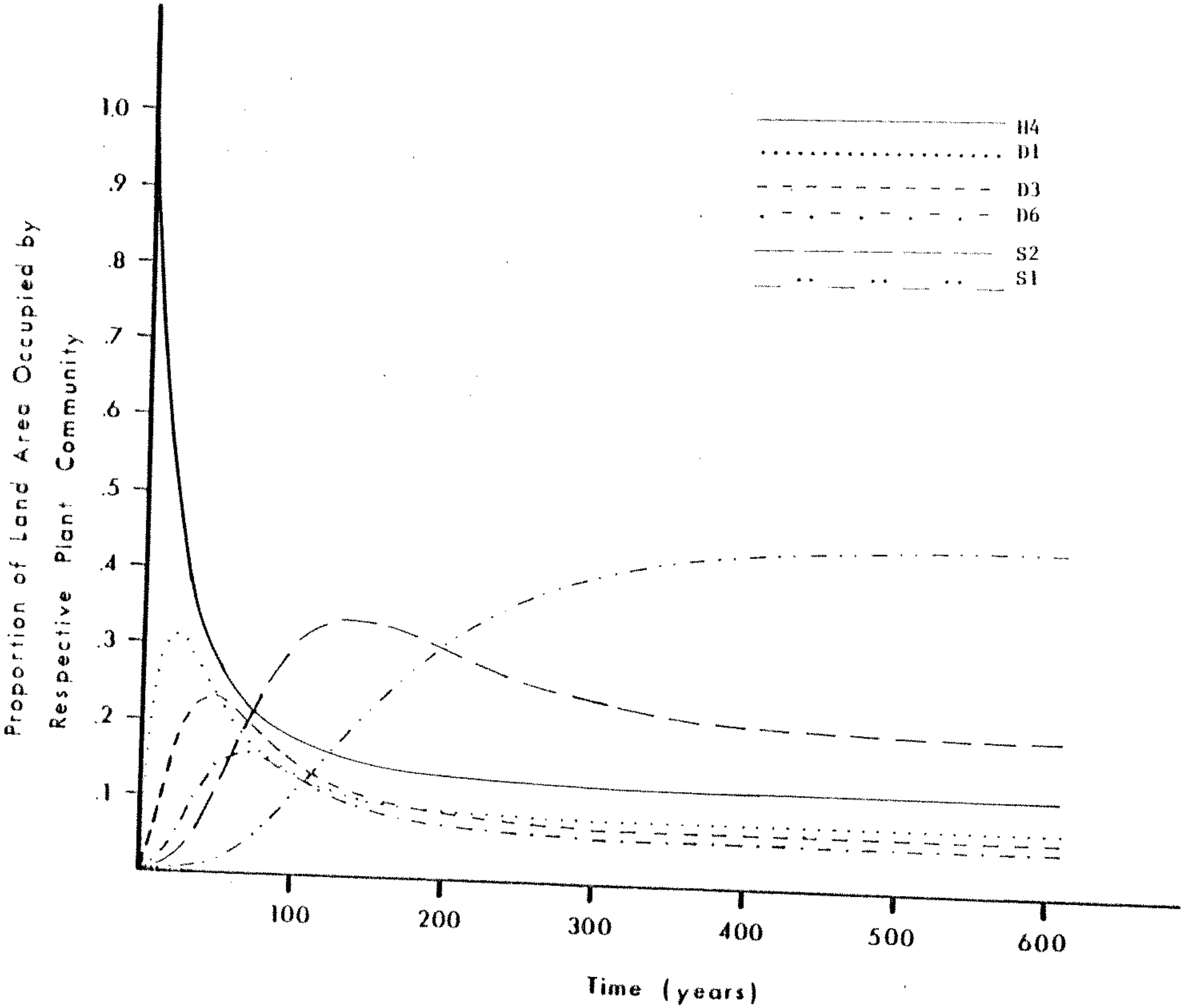

Fig. 6.5.2 Output of simulation model run starting with all of the land area in the first successional stage, the herb wash community.

The validity of the derived flow rates and thus of the underlying assumption was evaluated by predicting the average time a given land unit existed in each stage of community development as shown in Table 6.5.1. A comparison of actual stand ages with predicted ages, based on the derived flow rates, inidcated close agreement of the model to actual rates of succession.

6.5.2 Cervid Habitat Preference

Beyond developing a better understanding of floodplain successional processes, a primary purpose of the model was to examine the influence of different habitat alterations on the cervid populations. These habitat alterations arise from different timber harvest strategies. We had originally intended to include the influences of fire and recreational use and development on the floodplain as additional influences on cervid habitat preference. However, we found little data to indicate that fire played an important role in habitat alteration on the floodplain (Kessell 1977), and our own observations substantiated this finding. While recreational use of the floodplain has clearly been increasing in recent years, the negliable proportion of land occupied by such uses (<.02 percent) makes it difficult to incorporate it as a factor in a model of this type. Hypothetical populations of 513 deer, 100 elk, and 50 moose were allocated among vegetation types based on track frequencies, and hypothetical densities for each type were then calculated using known land areas of each (Table 6.5.2). The plant community acreages are those measured on the

Demer's Ridge quadrangle (See Table 6.1.3). However, these floodplain seral stages were present in similar proportions throughout the drainage. After each iteration of the simulation, new populations of ungulates were calculated based on new acreages of the vegetation types and the hypothetical densities in each. Impacts of forest harvest in the middle (Polebridge) and northern (Trail Creek) study sectors, were examined separately using hypothetical densities of elk in vegetation types based on measures of habitat selection in those locations (Table 6.5.3).

Table 6.5.1 Estimated ages of the floodplain vegetation types predicted by the simulation model, and the actual ages derived from field measurements of the oldest trees.

VEGETATION TYPE	SUCCESSION RATE	AGE	AGE SINCE START OF SUCCESSION	FIELD MEASUREMENTS	
				MEAN AGE	N
herb wash	.040	25	0-25	7.5	2
shrub wash	.047	21	25-46	18.0	5
cottonwood	.040	23	47-70	50.0	5
cot-spruce	.044	23	71-94	80.0	3
spruce-cot	.009	110	85-195	135.0	6
spruce			195-up	185.0	10

Four harvesting policies were implemented in the model. The first assumed five percent of the remaining spruce would be harvested yearly. The second policy was to harvest five percent of both mature spruce and spruce cottonwood stands yearly. The third and fourth policies were to harvest 25 and 50 percent, respectively, of all spruce cottonwood and mature spruce over a 40 year period, and then to cease harvesting completely. The first and second policies would not be politically feasible under current management because the majority of mature spruce is protected in Glacier N.P. However, the third and fourth scenarios, where fixed proportions were logged, could realistically simulate stepped up harvesting outside the park to salvage spruce timber from projected beetle kills.

TABLE 6.5.2 Initial values of state variables used to compute cervid populations following logging.

Vegetation Type	Land Areas (Acres)	Actual Track Frequencies			Hypothetical Densities (Animals/acre)[a]		
		DEER	ELK	MOOSE	DEER	ELK	MOOSE
Herb wash	474	.008	.193	.000	.008	.041	.000
Shrub wash	317	.001	.028	.013	.002	.009	.0021
Cottonwood	259	.000	.072	.068	.000	.028	.0132
Cott-Spruce	214	.016	.031	.000	.037	.014	.0000
Spruce-Cott	743	.330	.258	.000	.222	.035	.0000
Spruce	1434	.616	.288	.302	.215	.020	.0105
Clearcut	171	.009	.048	.047	.026	.028	.0137
Second growth	80	.017	.001	.000	.106	.001	.0000
Hydric shrub	663	.003	.082	.569	.0025	.012	.043
Hypothetical Population of Cervids[b]		1.0	1.0	1.0	513	100	50

a/ Hypothetical densities (animals/acre)=(track frequency X hypothetical population)/land area (acres)

b/ Hypothetical population=hypothetical density (animals/acre) X land area (acres)

TABLE 6.5.3 Initial values of state variables used to predict elk populations following logging in the Polebridge and Trail Creek area.

		Track Frequency		Hypothetical Density (elk/ac)	
Vegetation Type	Land Area (ac)	Pole-bridge	Trail Creek	Pole-bridge	Trail Creek
Herbaceous wash	474	.035	.004	.007	.001
Shrub wash	317	.030	.020	.009	.006
Cottonwood	259	.006	.033	.002	.013
Cott-spruce	214	.053	.020	.025	.009
Spruce-cott	743	.239	.256	.032	.034
Spruce	1434	.358	.649	.025	.045
Clearcut	171	.014	.016	.008	.009
Second growth	80	.001	.001	.001	.001
Hydric shrub	600	.263	.000	.044	.000
Total Elk Population				100	100

6.5.3 Responses to Timber Harvests

The effects of the four harvest policies on vegetation development are shown in Fig. 6.5.3. Constant harvesting of mature spruce as would be expected, caused an initial reduction in spruce and an increase in the acreage of clearcuts. This was followed by increased second growth and spruce-cottonwood as the clearcut stands matured. When both the spruce and spruce-cottonwood types were harvested, clearcut acreage increased proportionally more, followed later by greater increases in second growth forests. Mature spruce and spruce cottonwood stands were both significantly reduced. The policy of clearcutting fixed proportions of spruce timber and then ceasing harvest caused sharp increases in clearcuts at year 40 followed by a reduction in clearcuts and a subsequent increase in second growth. The acreage of spruce stands increased gradually after the cessation of harvest.

The responses of the three cervid species to the same forest harvest strategies are shown in Figs. 6.5.4 and 6.5.5. The constant yearly harvest of five percent of the spruce and/or spruce and spruce- cottonwood stands caused a sharp decline in the deer population for the first 50 years, after which the population increased gradually as the initial pulse of clearcuts passed to the second growth stage (Fig 6.5.4). Elk populations remained comparatively constant over the same period, responding favorably to the early abundance of clearcuts and declining slightly as the non-productive second growth stands predominated.

Similarly, the moose population increased initially, but declined steadily after twenty years, as clearcuts matured.

Population levels of cervids are also shown from year 40 to year 140 after the logging quotas were achieved under the latter two harvest policies (fig 6.5.5). Deer populations at year 40 were much reduced from the equilibrium condition, but elk and moose populations were above the pre-logging levels. Deer populations however, increased steadily in the absence of logging and attained equilibrium densities 50 to 80 years after logging ceased. Elk and moose populations declined after cessation of logging. Under the 25 percent harvesting plan, elk numbers never dipped below the equilibrium level, but moose responded negatively to the prolonged mid-seral stage of forest regeneration. When a 50 percent harvest strategy was implemented, elk and moose both decreased as large areas simultaneously matured to second growth. Elk increased 50 years after harvesting, but moose populations remained low throughout the projected time interval.

In the Trail Creek and Polebridge study sectors, habitat selection by elk was influenced by the deeper snows which existed. Elk avoided clearcuts with proportionally greater use in the mature spruce. Elk populations showing these habitat affinities declined in computer harvest simulations (Fig 6.5.6). The greatest reduction in elk numbers occurred in the northernmost sector where snows were deepest and habitat preferences of elk were most profound.

The foregoing discussion of the computer simulations illustrated the relative susceptibilities of white-tailed deer, elk and moose to forest harvest and the gradient of susceptibility of elk in the northern sectors. These findings point out the value of the simulation approach in projecting long-term impacts on ungulates over entire rotations in the management of forests. However, the simulations of elk population demonstrated that outcomes depend heavily on initial vectors of habitat selection. Results must be interpretted with the perspective that data during this study were collected during a period of above normal snowfall, whereas winter distribution of ungulates will vary markedly between years in response to the severity of winters. The model was not designed to simulate the influence of forest harvesting on habitat diversity or the relation of these changes to cervid densities. In actuality, however, decreased diversity of habitats as a result of high logging quotas could exacerate the negative impacts of forest harvesting on cervids.

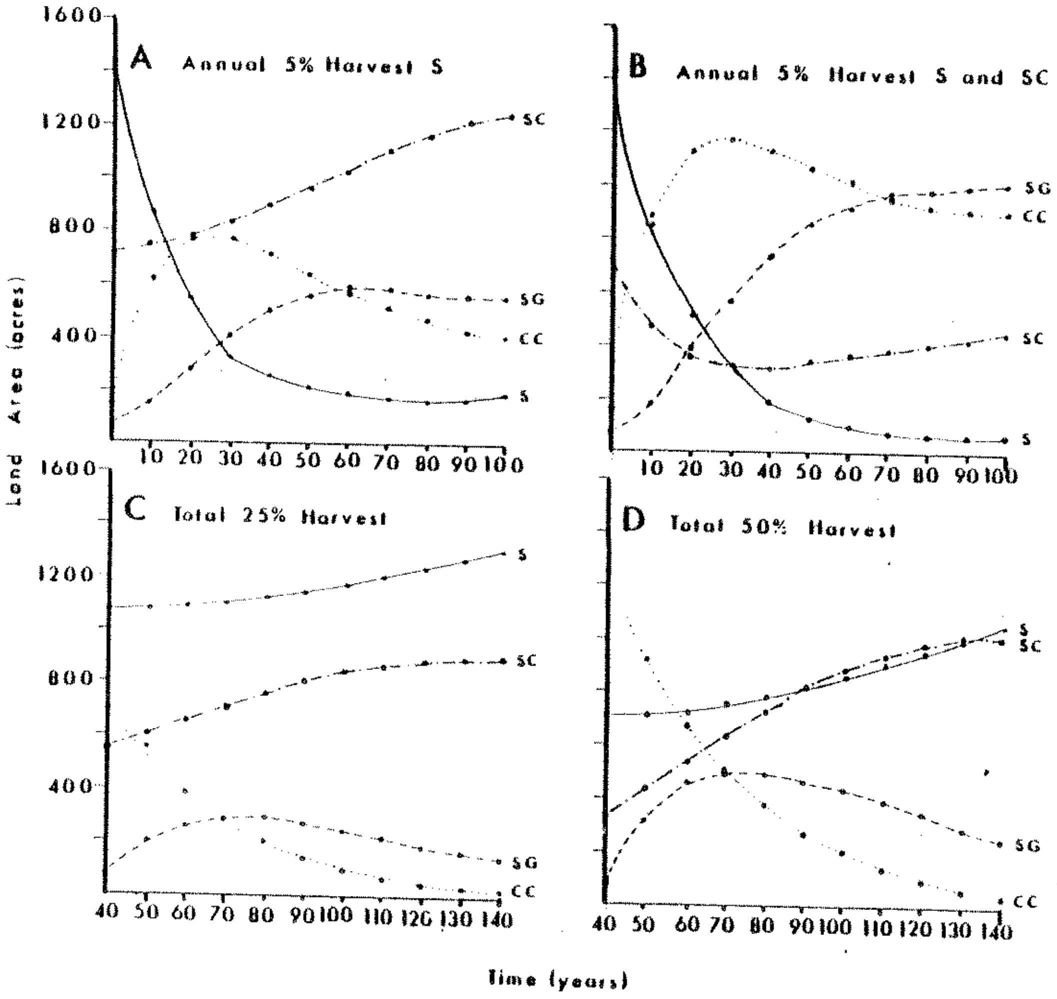

Fig. 6.5.3 A simulated response of land areas in mature spruce (S), spruce-cottonwood (SC), clearcut (CC) and second growth (SG) stands, to 4 forest harvesting plans.

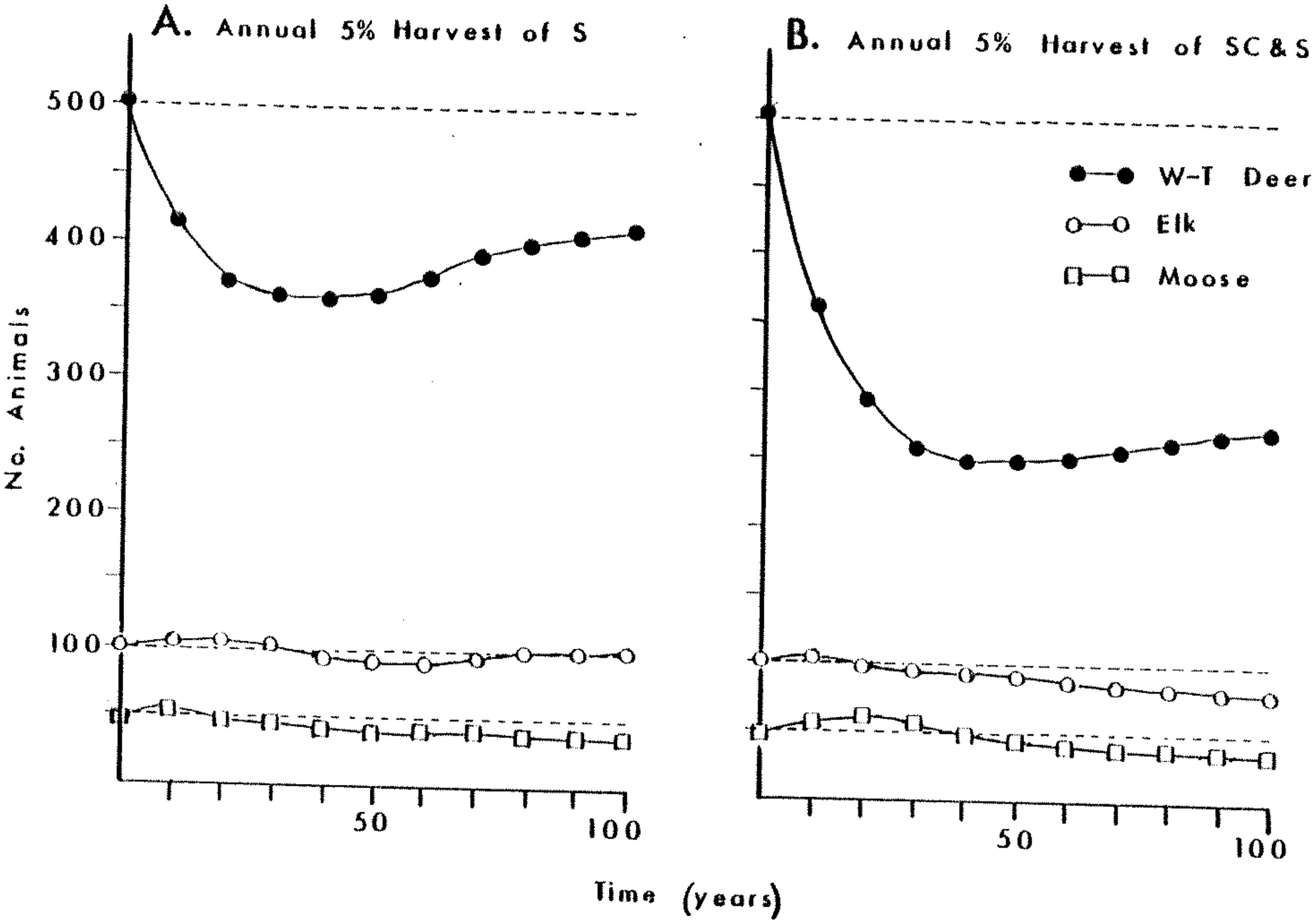

Fig. 6.5.4 Projected response of white-tailed deer, elk and moose to a 5% harvesting rate of spruce stands (A) and spruce-cottonwood stands (B). Dashed lines indicate equilibrium densities of cervids in the absence of forest harvesting.

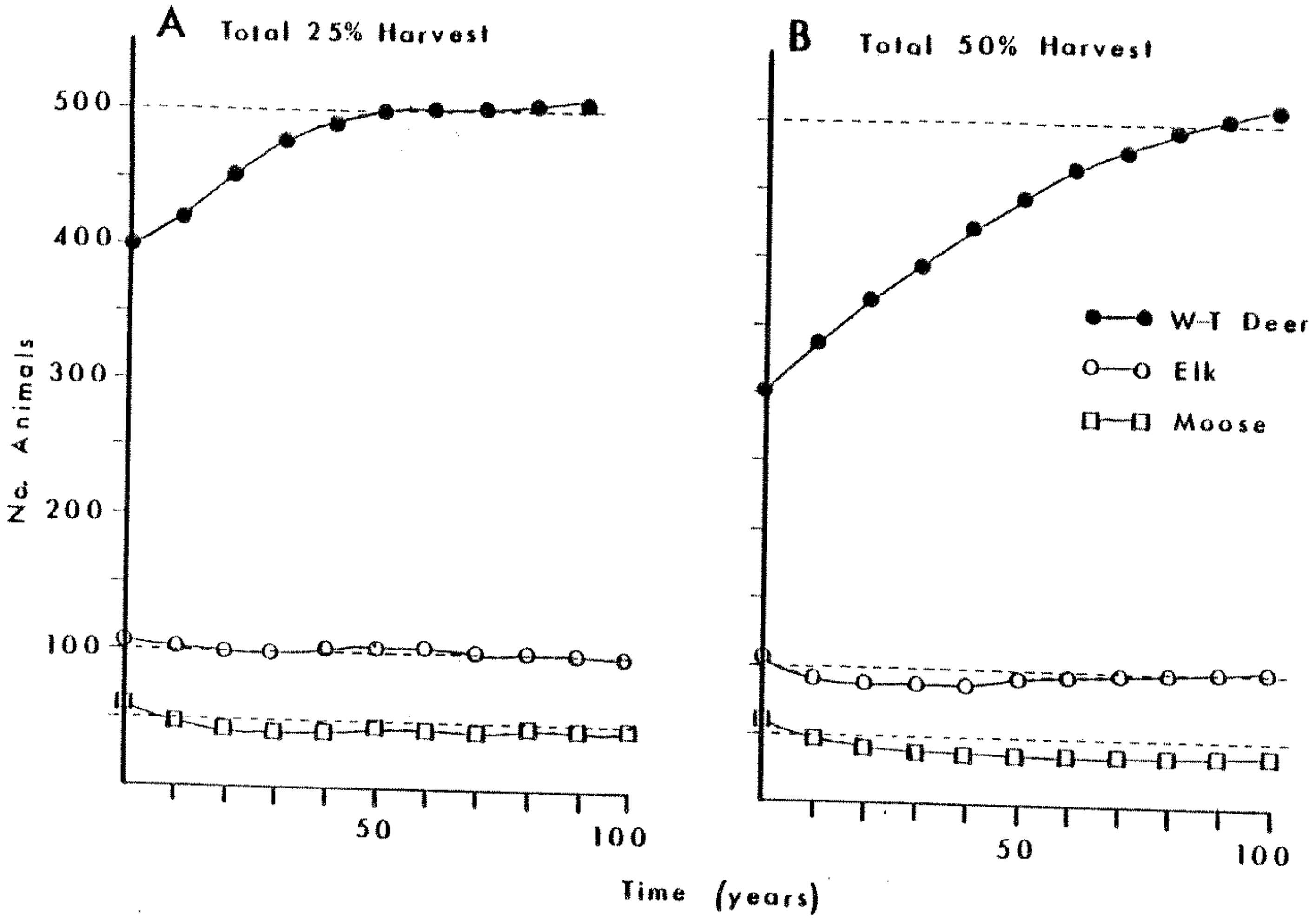

Fig. 6.5.5 Projected response of white-tailed deer, elk and moose to 25% harvesting (A) and 50% harvesting (B) of mature spruce and spruce cottonwood, over a 40 year period. Responses are shown for 100 years after ceasing to harvest. Dashed lines indicate the equilibrium densities of cervids in the absence of forest harvesting.

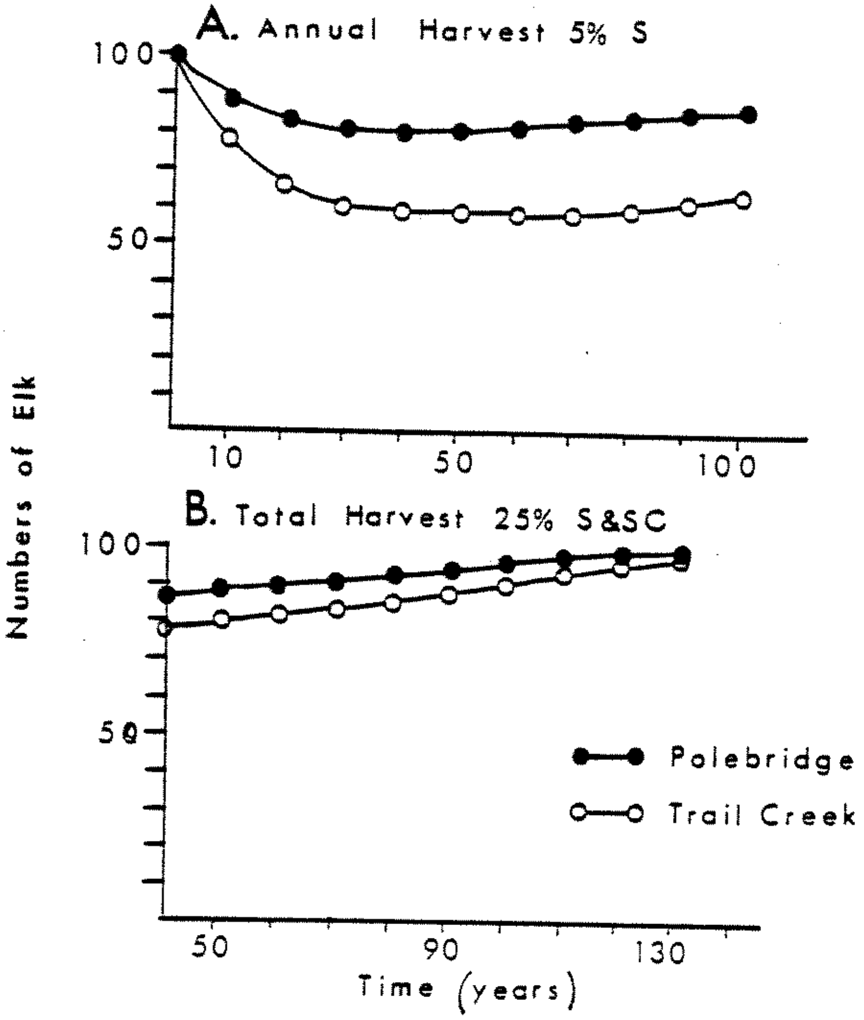

Fig. 6.5.6 Projected response of elk populations following two logging treatments in the Polebridge and Trail Creek study sectors.

SUMMARY & CONCLUSIONS

The riparian zones of the North Fork and Mainstems of the Flathead River have proved to be fascinating places in which to work. The dynamic nature of the plant communities, particularly along the North Fork, became particularly evident when viewed in the context of the simulation model of plant succession. As indicated at the outset, a major objective of this study was to collect baseline data on the resources of the riparian zone. This included data collected as part of this tudy as well as a synthesis of previous works. Special emphasis was given to those species most susceptible to habitat changes in the riparian zone: cervid species for which the area serves as critical winter range, and avian species which nest and forage there.

An understanding and identification of the various habitat attributes of the seral plant communities was fundamental to all studies. The preceding sections have discussed the various attributes of the different plant communities on the floodplain. Additional data are contained in the Appendices. The detailed vegetation maps should provide a valuable baseline with which to compare future changes in land use and cover. The following two sections overview what we have learned on the cervids and avian species.

7.1 CERVID SUMMARY

Throughout much of the northern Rockies, densities of cervids appear to be limited by the availability of winter range. Populations are often forced from higher elevations by deep winter snows and congregate in comparatively small areas in valley bottoms and south-facing or wind swept slopes. The winter distribution of cervids, may, however, differ appreciably between years, depending on the severity of the weather. Singer (1975) found that in mild winters on the North Fork, elk were widely dispersed over an extensive grassland and lodgepole pine complex, but in severe winters their range was constrained. With the advent of spring, cervids dispersed in the face of comparative resource abundance.

A basic premise of this study was that cervid populations were limited largely by forage availability and critical habitats during severe winters. This study was conducted during a winter of above normal snowfall. It was aimed at identifying these critical winter habitats, describing possible limiting factors, and predicting impacts of human development on wintering cervids. Clearly this interpretation will depend on understanding the winter-habitat relations of cervids.

Of the three species we studied, distribution of white-tailed deer was the most limited. Deer were primarily found in the south study sector and in local pockets on or near south facing slopes of the Bowman and Kintla drainages. Deer undoubtedly occurred on other south facing slopes as well. In mid-winter, deer occupied mature coniferous forests, especially spruce bottomlands and Douglas fir types. Abundance here was significantly related to stand basal area, and the average size of trees, and was negatively associated with snow depths. Abundance of deer was independent of the biomass of deciduous browse. Though such relationships do not necessarily confer cause and effect, it appeared that the structural elements of forested stands were more important to deer than availability of deciduous shrubs. This importance of coniferous forest types to wintering white-tailed deer has long been recognized (Cheatum 1951, Severeghaus 1947). White-tailed deer in Northern Idaho have been found to select dense stands of cedar and fir with an average 88% overstory (Owens 1981). Deer in the Swan Valley of Montana selected coniferous riparian habitats for resting and security, and favored the nearby forested uplands for foraging (Mundinger 1981). Deer avoided natural and artificial forest openings in both areas.

The thermal cover provided by coniferous forests appears to be a crucial habitat component in northern environments. In winter, it is advantageous for deer to conserve energy, and therefore it is adaptive for them to seek environments where energy loss through convection and radiation is minimized (Moen 1973). Shallow snows would also be favored under this strategy, because energy expended in movement would be minimized. The formation of deer yards in coniferous forests with their more favorable thermal properties such as lower wind speeds, more constant temperatures, and shallower snows, is a common adaptation in northern environments (Ozoga and Bysel 1972, Ozoga 1968).

In the North Fork, distribution of deer, appeared to be limited by excessive snow depths. The primary wintering areas of deer corresponded to the areas of shallowest snows. Within those areas, coniferous forests were sought, where dense crowns of mature spruce and Douglas fir intercepted and retained appreciable amounts of snow. Track samples indicated that deer frequently travelled from one tree well to the next, while bedding at the base of trees and feeding on emergent shrubs. It thus appeared to us that the North Fork was marginal winter range for deer in periods of deep snow. The mature coniferous habitats do, however, help mediate these harsh environmental conditions. As was shown on the land-cover maps, these bottomlands only comprise a relatively small area of the North Fork. However, since they are used so intensively by deer, any alterations in the habitat which may seem small relative to the entire watershed, could affect a significant proportion of wintering deer. Currently, logging and residential development are such alternatives which pose significant threats critical to deer wintering areas. Recent outbreaks of the spruce bark beetle endanger hundreds of acres of merchantable spruce timber in the deer range. Large tracts are in private ownership and ultimately have potential for more housing.

The computer simulations illustrated that the harvest of the floodplain spruce forest could dramatically reduce numbers of deer for several decades. The results of our field studies and computer model simulations meet with general agreement in the literature. The potential impacts of forest harvesting on winter ranges of white-tailed deer have been discussed by Boer (1978), Drolet (1978) and Lyon and Jenson (1980). In northern Idaho, Owens (1981) believed clearcuts exceeding 8 ha. would displace white-tailed deer or alter the thermal conditions of the winter range. Mundinger (1981) believed that clearcutting practices which have altered 45% of the total winter range in the Swan Valley, has caused a 50% decline in wintering populations of white-tailed deer. That possibility is consistent with our simulated projections of deer numbers after high levels of logging. To ammelicrate this condition, Mundinger (1981) recommended that floodplain spruce forests be managed to retain old-growth characteristics with only minor select cutting allowed. Upland forests should be managed in 20 acre units employing selection cutting which would maintain at least 70% crown closure. Small 5-acre clearcuts may be used to improve the value of even-aged lodgepole stands for white-tails.

Elk exhibited the widest distribution and the most general habitat selection patterns of the cervids examined in this study. In all three study sectors, elk, like deer, favored the spruce bottomland forests. In the south sectors, where snows were relatively shallow, elk also used clearcuts and alluvial communities, although they were used less than their availability. Lodgepole, upland spruce, grasslands and lodgepole savanna communities were used more by elk than the other cervids. These findings are also consistent with much of the regional literature which shows that elk occupy a diverse array of habitats throughout their range. In Northern Idaho and Western

Montana, elk wintered predominantly on lower montane slopes and valleys, where they subsisted mostly on winter browse (Irwin 1978, Gaffney 1941). In contrast, throughout much of Colorado (Boyd 1975), eastern Montana (Knight 1970) and Wyoming (Ward 1975) elk wintered on open windswept grasslands in the mountain foothills.

Severe winter weather and limited cover on many winter ranges has caused new speculation on the requirements of elk for thermal cover. Peek et al. (1982) concluded that because of larger body size, elk do not require forest cover for thermal regulation. However, forests are apparently important to elk as security cover, particularly in response to human activity along roads (Irwin and Peek 1979, Peek et al. 1982). Additionally, elk may seek conifer forests for shallower snows which exist there. Leege and Hickey (1977) and Martinka (1976) both reported that elk sought forested cover when snow depths exceeded 60 cm and consequently, hindered the movement of elk.

We found the distribution of elk on the North Fork to be influenced by snow depths and, to lesser a degree, by the availability of browse. In the south sector, where snow depths were least (60 cm), abundance of elk was unrelated to any of the environmental factors which were measured. Elk were more closely associated than were deer to availability of browse in this area of shallowest snows. With increasing latitude and snow depths, behavior of elk resembled that of white-tailed deer; abundance of elk was highly correlated to coniferous cover, and size class of trees, and negatively correlated to browse availability. The coniferous forests were very important when the snow depths exceeded 60 cm.

The results of our simulations on the response of elk to timber harvest practices reflect this species' use of a wide array of habitats. Faced with a constant harvest of varying proportions over a 50 year period, elk populations in areas of low snow depths, remained relatively constant, responding favorably to the early abundance of clearcuts, then declining slightly as the non-productive second growth stands predominated. In areas where snow depth became limiting, elk populations declined as a consequence of increased forest harvest. Here, elk avoided clearcuts and showed a higher proporticnate use of mature spruce communities. The greatest reduction in numbers occurred in the northern sector where snows were deepest and habitat preferences of elk were most pronounced.

Unlike the other species, we found that the abundance of moose was highly correlated with biomass of browse, reflecting the large daily intake required by moose (Gassaway and Coady 1974). In this respect, the interface of hydric shrub and spruce forests was the single most important habitat complex for moose. However, although the hydric shrub communities provided the greatest biomass of browse per unit area on the North Fork; other communities along stream banks, aspen stands, and river alluvium also provided high browse biomass and were important moose habitats. We found no correlation of moose with forest cover, which was expected because moose used such disparate vegetation types as open-canopied willow communities and denser spruce forests. Abundance of moose was slightly correlated to snow depths, which reflected dependence of moose for open habitats where the greatest biomass of browse and snow depths co-occurred.

Despite the apparent selection for snow depths, general observations of moose tracks, indicated moose avoided excessive travel through deep snows. Tracks of feeding moose were primarily near the edge of forest cover; and diminished with distance from cover. Coady (1974) reported that movements of moose were hindered at snow depths of 70-90 cm. if moose were unable to walk atop a surface crust. These conditions prevailed in the northern part of this study area until late February when rains and refreezing occurred. In summary, it appeared moose required brush habitats to sustain their relatively high energy requirements, but used habitats on the forest edge as a travel corridor to minimize travel through deep snows.

This study, and others (Jonkel 1963, Sage Creek Coal, Stage II report 1982) have noted that evidence of cervid browsing on willow is low overall, but is highly variable. This finding has led some to conclude that populations of moose in the North Fork are below carrying capacity, which would imply that moose displaced by habitat alteration would relocate elsewhere. Clearly, more information is needed on the relative roles of natural predation, hunting and food supply in regulating moose populations. However, one hypothesis suggested by our observations is that moose populations are limited by the availability of forage in specialized habitats. Moose were relegated by deep snows to a small proportion of available willow habitats along forest edges. Here, willow was largely unavailable underneath snow pack, which would protect willows from over utilization. A similar mechanism, whereby the interaction of snow depths and the availability of willow regulated moose populations on the Snake River floodplain was proposed by Houston (1968).

In all three sectors of this study, the relative abundance of cervids as derived from track counts, was greater on the floodplain than the adjacent uplands. Habitat selection and movements of cervids are the result of separate individuals reacting to a complex environment to meet their daily and seasonal needs. These needs include acquisition of nutrients, water, and minerals, seeking optimal thermal environments and seeking protection from predators and other harrassment. At critical periods, such as winter, one would expect cervids to seek out environments which provide an optimal arrangement of required resources. Floodplain communities appear to provide this environment.

The value of the diversity of vegetation types in the riparian zone to cervids has long been recognized by wildlife biologists as the central tenet of the "edge effect" (Leopold 1933). In the North Fork drainage, frozen river corridors and oxbows had very shallow snows, were frequently used as travel corridors, and thus provided easy access to dense river bank vegetation. Mature spruce stands provided important cover value to wintering cervids, yet also supported a dense canopy of red-osier dogwood, which appeared to be a mainstay of winter diets (Singer 1975). River alluvium provided pioneer substrate for willows and cottonwood seedlings. This abundant source of forage in seral communities was in close proximity to forest shelter; consequently, cervids were able to exploit the cover values of the coniferous forests and still forage in nearby successional brushfields when transient snow conditions were favorable for travel.

In conclusion, this study demonstrated that white-tailed deer, elk, and moose had unique habitat requirements which largely governed winter distributions. Among upland communities, Douglas fir types and south facing slopes were particularly important to white-tailed deer, and shrub forest ecotones were favored by moose. Overall, the floodplain assemblage of habitats were exceptional winter ranges for elk, deer, and moose. Because such a small proportion of watershed supports such a large proportion of native game animals, we believe management options should be favored which perpetuate the old-growth characteristics and natural diversity of floodplain forests.

In this respect, the complex pattern of land ownership in the North Fork, poses significant problems in managing this common resource. Private lands will probably continue to be managed at the discretion of their owners. However, substantial state and federal lands exist where an array of suitable land management approaches might be employed. Several management guidelines which might be applied to the North Fork are listed below.

1) Classify the entire floodplain system as a

riparian-cervid habitat zone, and managing it to perpetuate the old-growth forests, and the natural flora diversity. In this respect, the natural processes of the river system, flooding, erosion, and sedimentation should be allowed to operate freely. Clearcuts adjacent to the river and water diversion or channelization projects which would alter existing hydrologic conditions should be prohibited.

2) Because habitat conditions and the behavior of deer, were similar to that encountered by Mundinger in the Swan Valley, we recommend his guidelines with respect to timber harvests be followed. Spruce forests should be retained where possible in old-growth. Upland forests should be managed in 20 acre units employing selection cutting which would maintain at least 70% crown closure. Small 5 acre clearcuts may be used to improve the value of even-aged lodgepole stands for white-tails, elk and moose.

3) Human disturbance, including additional road construction and land clearing in the floodplain corridor should be minimized where possible. While it is unlikely that little development of any consequence will take in Glacier National Park, such activities continue on private lands in the drainage. The efforts by the U.S. Forest Service to purchase private lands within the river corridor or to obtain scenic easements is in accordance with this objective.

4) Undertake additional research to evaluate the influence of cattle grazing in riparian habitats, on browse availability, and on the winter densities of cervids.

5) The hydric shrub community appears to be a particularly important and sensitive habitat component. Every attempt should be made to minimize disturbances in these communities in these communities. It appears that many of these hydric shrub bogs are the result of past beaver activity. Beaver populations appear to be declining over the past several decades, due in part to over-harvest. Research is needed to determine the role of beavers in creating and maintaining the hydric shurb ecosystems, existing beaver colonies should be monitored, and a ban on beaver trapping instituted if necessary.

6) Research on both ungulate and avian habitat utilization on the North Fork will continue throughout 1983 as the graduate students involved fulfill their thesis requirements. Much of this research will be oriented toward expanding and testing the simulation model presented in this study. The results of this research will be made available to those agencies concerned with management or establishing policies for the river basin.

7.2 AVIAN STUDIES

The structure of the avian communities on the floodplain of the North Fork showed a trend of increasing complexity as the ecological age of the stand increased. Species richness increased nonlinearly from a minimum in the pioneering herbaceous wash stage to a maximum in the climax spruce stage. These results match those found in studies by Kendeigh (1948), Odum (1950), Johnston and Odum (1956), Karr (1968) and Shugart and James (1973) in both deciduous and coniferous seres. We measured the highest bird species diversity on the North Fork in the preclimax spruce/cottonwood stage. Species diversity was lower in the climax stage. This again matches studies by Karr (1968) and Smith and MacMahon (1981), but differs from Shugart and James (1973) who found the highest diversity in climax conditions. A maximum bird species diversity in the later successional stages is to be expected, given the relationship that we found between bird species richness and species diversity. As species diversity increased, additional species added proportionately less to the overall diversity, and this measure eventually leveled off at a maximum. The observed decline in species diversity at the climax stage, may only represent random or sampling variation and may not be statistically significant.

Richness and diversity were statistically significant in only one case: they were lower in the pioneering herbaceous wash than in any of the communities. They did not differ significantly in any of the other communities. As a result, although bird species diversity and species richness tended to increase with stand age, we could not demonstrate a statistical difference in either species richness or species diversity among the non-pioneering floodplain communities (i.e., shrub wash, mature cottonwood, spruce/cottonwood, climax spruce and disclimax hydric shrub).

Total bird density on the North Fork also tended to increase as the age of the plant communities increased; with a maximum density occurring in the climax community. However, when tested statistically, densities of birds in the three forested stages (i.e., mature cottonwood, spruce/cottonwood and climax spruce) were not significantly different; nor were densities in the two nonforest stages (i.e., herbaceous wash and shrub wash). Bird density in the herbaceous wash and shrub wash was significantly lower than in the older stages. A similar trend has been observed by Kendeigh (1948) and Odum (1950) in a coniferous sere. Odum (1950) and Johnston and Odum (1956) in a deciduous sere observed a decrease in density from the preclimax to the climax. Again, although a trend of increasing bird density with age of the plant communities was apparent, we can only conclude that the total bird density was lower in the herbaceous wash an shrub wash stages than in the mature cottonwood, spruce/cottonwood, climax spruce or disclimax hydric shrub.

Special notice should be made of the disclimax hydric shrub community. There was no significant difference in bird species richness and bird species diversity between the hydric shrub and any of the other non-pioneering communities, but the hydric shrub supported much higher densities of birds, in one case as high as 45 individuals per hectare.

Crawford et al. (1981) stated that succession of bird species was sequential from open-canopy obligatory species to closed-canopy obligatory species. Although canopy cover was not correlated to species abundance in the North Fork, species changed sequentially from the pioneer to the climax stage of forest development. As succession proceeded, species were replaced by others and numerical dominance shifted between different species, thus maintaining or increasing species richness and diversity. This shift in species became more pronounced if the plant communities were of increasingly different ages. Many bird species occupied different seral stages if the ages of these communities were not too dissimilar. The two exceptions to this were birds found in the herbaceous wash and hydric shrub communities. Species in these communities tended to have narrower niche widths than species in the other communities and thus were considered habitat specialists. This is not to imply that there were no habitat specialists in the other communities, but that the herbaceous wash and hydric shrub were unique in that they, more than the other communities, were dominated by species with narrow habitat niche and specialized for life in only these communities.

In associating avian community structure to vegetation structure, we found that each avian community attribute was most closely associated to an analogous attribute of the habitat. Bird species richness was positively correlated with plant species richness, reflecting the fact that when new niches are created by the addition of new plant species, they are filled by new bird species. Our data suggested that this was not a continuous, but rather a stepwise function, with the the greatest addition of niches, thus bird species, occurring with the addition of a tree layer. Willson (1974) suggested the same stepwise relationship.

Bird species diversity was associated with foliage height diversity. Our correlation coefficient was lower than those in other studies, e.g., (MacArthur 1964, Recher 1969, Willson 1974, Balda 1975), but these were conducted in deciduous forests. MacArthur and MacArthur (1961) suggested that the relationship may not be as strong in coniferous forests as in deciduous forests because of differences in physiognomy. Deciduous forests vary principally in the vertical dimension, whereas coniferous forests differ horizontally.Thus, this relationship may break down in spruce forests, and bird species diversity may be high in spruce forests even if few vertical layers are present (MacArthur and MacArthur 1961). There was also a stepwise relationship between bird species diversity and foliage height diversity. Species diversity appeared to be largely composed of its species richness component and we would expect it to respond to the habitat in a manner similar to that of species richness. Both responded to the addition of a tree layer.

We initially felt that total bird density would be associated with total vegetation volume. However, total bird density was most strongly correlated in a non-linear manner with percent shrub cover. This relationship held even when the anomolous hydric shrub sites was omitted. Others have failed to find a correlation between bird density and any habitat variable (Willson 1974, Wiens and Rotenberry 1981). However, many of the avian succession studies have reported the highest bird densities in shrub communities (Kendeigh 1946, Johnston and Odum 1956).

The association of bird density to percent shrub cover may be due to the influence of water on the floodplain. Well drained xeric sites tended to be savannah like, without a well developed shrub layer. Such sites were less productive than mesic sites and supported less cover and food. An increase in water availability increased the cover of shrubs, especially red-osier dogwood, mt. alder, and willow, and supported a greater production of food items, thus supporting a greater total density of birds. The immediate availability of standing water may also be important.

All of the avain succession studies previously cited were conducted in secondary successional seres. The pioneering stages in those studies followed habitat alterations such as clearcut logging, land clearing or strip mining and were often on already well developed soils. Climax stages often developed in less than 100 years. The floodplain of the North Fork provided a unique opportunity to examine primary succession on developing river terraces.

The fact that our results agree with those from studies of secondary succession suggested that similar community processes are occurring and that our results may be applied to habitat alteration and the resulting successional sere. For example, because select logging does not set the site back to a stage comparable to either the herbaceous wash or shrub wash and more specifically does not remove the tree layer and maintains shrub cover, we would predict that select logging would not reduce bird species richness, bird species diversity or total bird density. Our sampling in three select logged sites, one each in a different plant community, supported this prediction. However, select logging would selectively eliminate specific bird species with narrow niche widths dependent on that community, (e.g., winter wren). Eliminated species would be replaced by species more tolerant of open canopy forests. In this respect, not only must the general avian community attributes be taken under consideration when planning a habitat alteration, but also the effect the manipulation will have on individual species of concern.

Clearcut logging presents a different situation. As the tree layer is totally removed, we would predict a decrease in bird species numbers and bird species diversity. However, if the clearcut is confined to mesic sites with well developed soils, a shrub layer should develop and total bird density would be maintained. If the clearcut is on a xeric site with well drained soils, a shrub layer may not develop and bird density should also decrease. Birds tend to show a high degree of site tenacity and no differences may be observed in the first year after clearcutting (Emlen 1970). Freedman et al. (1981) found total density to be similar in uncut and clearcut sites, but species richness dropped and the composition changed in the clearcut. Conner and Adkisson (1975) found the lowest bird species diversity in one year old clearcuts.

Recreational use of the floodplain does not appear to present a serious threat to the avian communities. Camping is being discouraged on the Glacier National Park side of the river (J. DeSanto personal communication) and is generally not allowed on the private lands on the west side of the river. Boaters and river rafters spend little time on shore and have minimal impacts on the avian communities. However, special caution should be exercised in specific areas where easily disturbed species of concern nest or forage. There are at least two heron rookeries on the floodplain (Appendix 3). Ospreys nest near the river on tributaries and hunt on the North Fork (Appendix 3). These areas should be restricted during the breeding season and they should be excluded from habitat alteration and an appropriate buffer zone maintained.

7.3 CONCLUDING WORDS

The small size of the riparian zones of the North Fork and Mainstem belie their importance as sites for foraging, shelter, and nesting. Our studies have demonstrated the high productivity of the various seral plant communities on the floodplain as compared to those of adjacent uplands. Studies throughout the west have amply demonstrated the tenuous future many riparian areas face. The habitat attributes which identify these zones can be easily altered and destroyed. Often it is those factors most important to particular species, such as the mature spruce bottomlands on the North Fork.

A comparison of the land-cover maps of the North Fork and Mainstem show the influence of less than 125 years of settlement. We can only guess at what original conditions might have been in much of the Flathead River Valley prior to settlement. The primevil conditions along much of the North Fork are easier to reconstruct. Change is, however, inevitable and can be beneficial or detrimental, depending on viewpoint. It is to be hoped that the results and data presented here provides some basis for evaluating that change.

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APPENDIX 2.1

Equations for predicting ovendried weights (W in gms) of twigs from diameters at the base of current growth (DCE).

SPECIES & COLLECTION SITE	EQUATION	n	r^2	RANGE OF SAMPLE DCG (mm)
Red Osier Dogwood (Cornus Stoloifera)				
Site 1	ln W = -4.45 + 3.54 (ln DCG)	53	0.89	1.45 - 5.85
Site 2	ln W = -3.78 + 2.60 (ln DCG)	80	0.79	1.22 - 5.42
Site 3	ln W = -4.26 + 3.14 (ln DCG)	35	0.87	1.37 - 3.85
Site 4	ln W = -4.80 + 3.54 (ln DCG)	34	0.74	1.40 - 3.65
[1]GRAND EQUATION	ln W = -4.21 + 3.11 (ln DCG)	202	0.81	1.22 - 5.85
Serviceberry (Amalanchier alnifolia)				
Site 1	ln W = -5.32 + 4.43 (ln DCG)	53	0.88	1.22 - 3.78
Site 2	ln W = -4.51 + 3.85 (ln DCG)	39	0.92	1.33 - 3.57
Site 3	ln W = -4.51 + 3.88 (ln DCG)	54	0.85	1.42 - 3.87
Site 4	ln W = -4.64 + 3.94 (ln DCG)	52	0.85	1.40 - 4.00
Site 5	ln W = -3.75 + 3.27 (ln DCG)	49	0.93	1.38 - 4.75
[2]GRAND EQUATION	ln W = -4.57 + 3.91 (ln DCG)	247	0.85	1.22 - 4.75
Willow (Salix sp)				
Site 1	ln W = -3.93 + 3.05 (ln DCG)	48	0.96	1.70 - 8.35
Site 2	ln W = -3.66 + 2.85 (ln DCG)	53	0.92	1.25 - 5.40
Site 3	ln W = -3.66 + 2.73 (ln DCG)	47	0.85	1.17 - 4.05
Site 4	ln W = -4.46 + 3.41 (ln DCG)	46	0.90	1.20 - 4.80
Site 5	ln W = -3.81 + 3.02 (ln DCG)	58	0.95	1.40 - 8.00
[3]GRAND EQUATION	ln W = -3.96 + 3.08 (ln DCG)	252	0.93	1.17 - 8.35

[1] Site influence explained additional 2% of total variation

[2] Site influence explained 3% total variation

[3] Site influence explained 1% total variation

APPENDIX 2.2

Equations for predicting ovendried total above-ground, total foliage and total twig weights (W in gms) of 21 deciduous species from basal stem diameters (BSD in millimeters).

SPECIES	PREDICTION EQUATION	n	r^2	RANGE OF SAMPLE BSD'S (mm)
	Deciduous Saplings			
Black Cottonwood (*Populus trichocarpa*)				
TOTAL	$\ln W = -2.88 + 2.64 (\ln BSD)$	19	.99	1.9 - 44.0
LEAF	$\ln W = -2.93 + 2.11 (\ln BSD)$	19	.97	1.9 - 44.0
TWIG	$\ln W = -4.15 + 1.71 (\ln BSD)$	18	.76	1.9 - 44.0
[1]Hawthorn (*Cratavus douglassii*)				
TOTAL	$\ln W = -2.54 + 2.65 (\ln BSD)$			
LEAF	$\ln W = -2.66 + 2.04 (\ln BSD)$			
TWIG	$\ln W = -3.39 + 1.74 (\ln BSD)$			
[2]Quaking Aspen (*Populus tremuloides*)				
TOTAL	$\ln W = -2.88 + 2.64 (\ln BSD)$			
LEAF	$\ln W = -2.93 + 2.11 (\ln BSD)$			
TWIG	$\ln W = -4.15 + 1.71 (\ln BSD)$			
Alder (*Alnus incana*)				
TOTAL	$\ln W = -3.59 + 2.89 (\ln BSD)$	19	.96	3.9 - 47.0
LEAF	$\ln W = -4.80 + 2.64 (\ln BSD)$	19	.87	3.9 - 47.0
TWIG	$\ln W = -3.47 + 1.44 (\ln BSD)$	19	.57	3.9 - 47.0
[1]Mountain Maple (*Acer glabrum*)				
TOTAL	$\ln W = -2.54 + 2.65 (\ln BSD)$			
LEAF	$\ln W = -2.66 + 2.04 (\ln BSD)$			
TWIG	$\ln W = -3.39 + 1.74 (\ln BSD)$			
	Tall Shrubs			
[3]Choke cherry (*Prunus virginianus*)				
TOTAL	$\ln W = -2.44 + 2.68 (\ln BSD)$			
LEAF	$\ln W = -2.94 + 2.10 (\ln BSD)$			
TWIG	$\ln W = -3.56 + 1.82 (\ln BSD)$			

APPENDIX 2.2 cont.:

SPECIES	PREDICTION EQUATION	n	r^2	RANGE OF SAMPLE BSD'S (mm)
	Tall Shrubs Cont.			
[1]Red Elderberry (*Sambucus racemosa*)				
TOTAL	$\ln W = -2.54 + 2.65 (\ln BSD)$			
LEAF	$\ln W = -2.66 + 2.04 (\ln BSD)$			
TWIG	$\ln W = -3.39 + 1.74 (\ln BSD)$			
[1]Mountain Cranberry (*Viburnum edule*)				
TOTAL	$\ln W = -2.54 + 2.65 (\ln BSD)$			
LEAF	$\ln W = -2.66 + 2.04 (\ln BSD)$			
TWIG	$\ln W = -3.39 + 1.74 (\ln BSD)$			
[1]Utah Honeysuckle (*Lonicera utahensis*)				
TOTAL	$\ln W = -2.54 + 2.65 (\ln BSD)$			
LEAF	$\ln W = -2.66 + 2.04 (\ln BSD)$			
TWIG	$\ln W = -3.39 + 1.74 (\ln BSD)$			
	Low Shrubs			
Raspberry (*Rubus ideus*)				
TOTAL	$\ln W = -2.49 + 2.70 (\ln BSD)$	19	.98	1.4 - 7.9
LEAF	$\ln W = -2.33 + 2.23 (\ln BSD)$	19	.95	1.4 - 7.9
TWIG	$\ln W = -5.18 + 3.82 (\ln BSD)$	19	.98	1.4 - 7.9
Snowberry (*Symphoricarpus alba*)				
TOTAL	$\ln W = -2.54 + 2.85 (\ln BSD)$	19	.96	1.9 - 10.5
LEAF	$\ln W = -2.63 + 2.10 (\ln BSD)$	20	.93	1.9 - 10.5
TWIG	$\ln W = -3.82 + 2.44 (\ln BSD)$	19	.65	1.9 - 10.5
Current (*Ribes spp*)				
TOTAL	$\ln W = -2.84 + 2.84 (\ln BSD)$	19	.92	1.3 - 9.3
LEAF	$\ln W = -2.79 + 2.42 (\ln BSD)$	20	.86	1.4 - 9.3
TWIG	$\ln W = -4.08 + 2.25 (\ln BSD)$	20	.64	1.4 - 9.3

APPENDIX 2.2 cont.:

SPECIES	PREDICTION EQUATION	n	r^2	RANGE OF SAMPLE BSD'S (mm)
	Tall Shrubs Cont.			
Serviceberry (*Amalanchier alnifolia*)				
TOTAL	ln W = -2.44 + 2.68 (ln BSD)	20	.99	1.2 - 22.0
LEAF	ln W = -2.94 + 2.10 (ln BSD)	20	.98	1.2 - 22.0
TWIG	ln W = -3.56 + 1.82 (ln BSD)	20	.80	1.2 - 22.0
Red Osier Dogwood (*Cornus stolonifera*)				
TOTAL	ln W = -2.53 + 2.71 (ln BSD)	20	.96	1.4 - 28.5
LEAF	ln W = -2.97 + 2.23 (ln BSD)	20	.98	1.4 - 28.5
TWIG	ln W = -3.48 + 1.74 (ln BSD)	20	.78	1.4 - 28.5
Willow (*Salix sp.*)				
TOTAL	ln W = -2.74 + 2.81 (ln BSD)	18	.97	1.3 - 27.6
LEAF	ln W = -2.98 + 2.23 (ln BSD)	18	.96	1.3 - 27.6
TWIG	ln W = -3.84 + 2.17 (ln BSD)	18	.85	1.3 - 27.6
[4]Buffaloberry (*Sheperdia canadensis*)				
TOTAL	ln W = -3.28 + 2.85 (ln BSD)			
LEAF	ln W = -3.11 + 2.20 (ln BSD)			
TWIG	ln W = -3.66 + 1.89 (ln BSD)			
Silverberry (*Eleagnus commutata*)				
TOTAL	ln W = -3.28 + 2.85 (ln BSD)	19	.98	2.6 - 31.6
LEAF	ln W = -3.11 + 2.20 (ln BSD)	19	.96	2.6 - 31.6
TWIG	ln W = -3.66 + 1.89 (ln BSD)	19	.86	2.6 - 31.6
Alderleaf Buckthorn (*Rhamnus alnifolia*)				
TOTAL	ln W = -3.34 + 3.04 (ln BSD)	19	.98	1.6 - 24.8
LEAF	ln W = -4.08 + 2.64 (ln BSD)	19	.92	1.6 - 24.8
TWIG	ln W = -4.87 + 2.35 (ln BSD)	20	.86	1.6 - 24.8
Bearberry (*Lonicera involucrata*)				
TOTAL	ln W = -3.09 + 2.93 (ln BSD)	20	.97	2.2 - 19.1
LEAF	ln W = -2.56 + 1.82 (ln BSD)	20	.87	2.2 - 19.1
TWIG	ln W = -2.25 + 1.16 (ln BSD)	20	.44	2.2 - 19.1

APPENDIX 2.2 cont.:

SPECIES	PREDICTION EQUATION	n	r^2	RANGE OF SAMPLE BSD'S (mm)
	Low Shrubs Cont.			
Wild Rose (Rosa spp)				
TOTAL	ln W = -2.91 + 3.11 (ln BSD)	19	.93	1.4 - 11.6
LEAF	ln W = -2.79 + 2.42 (ln BSD)	20	.86	1.4 - 11.6
TWIG	ln W = -4.08 + 2.25 (ln BSD)	20	.64	1.4 - 11.6
Thimbleberry (Rubus penvifolium)				
	ln W = -2.67 + 2.73 (ln BSD)	21	.96	2.1 - 9.1
	ln W = -2.32 + 2.22 (ln BSD)	21	.94	2.1 - 9.1
	ln W = -5.32 + 3.37 (ln BSD)	21	.80	2.1 - 9.1

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[1] Species not sampled, general equations from pooled sample were applied

[2] Species not sampled, equations from cottonwood sample was applied

[3] Species not sampled, equations from serviceberry sample was applied

[4] Species not sampled, equations from silverberry sample was applied

Appendix 3.1 The areas within each of the defined land cover categories mapped on the Demer's Ridge Quad located within or outside Glacier National Park.

CLASSIFICATION	AREA WITHIN PARK (acres)	%	AREA OUTSIDE PARK (acres)	%
Wash forb	107	34	210	66
Hydric upland shrub	356	54	307	46
Mature cottonwood	89	34	170	66
Aspen	35	30	82	70
Mesic upland shrub	210	100	-	-
Cottonwood, spruce	69	32	145	68
Mesic grassland	317	69	145	31
Hydric grassland	244	99	3	1
Wash forb	221	47	253	53
Spruce bottomland	1083	64	602	36
Spruce, cottonwood	285	38	458	62
Spruce, dead lodgepole pine	458	81	105	19
Spruce, subalpine fir, larch	601	24	1865	76
Spruce, Douglas fir, larch	113	100	-	-

Lodgepole pine, larch	1326	21	4939	79
Dead lodgepole pine	257	100	-	-
Dead lodgepole pine, spruce	472	100	-	-
Live + dead lodgepole pine, spruce	2339	68	1094	32
Lodgepole pine, savannah	77	100	-	-
Dead lodgepole pine, larch, Douglas fir	544	88	71	12
Mature larch, spruce	691	94	42	6
Young larch, spruce	71	70	30	30
Young larch, lodgepole pine	19	100	-	-
Douglas fir, larch	874	100	-	-
Dougals fir, larch, ponderosa	760	100	-	-
Douglas fir, lodgepole pine	-	-	54	100
Burn, dense shrub	-	-	68	100
Burn, dense lodgepole	45	100	-	-
All clearcuts (C1-C6)	-	-	2247	100
All pastures (P2, P4, P7)	-	-	841	100

Development (a1, Z2)	-	-	7	100
TOTALS:	11663	46	13737	54

Appendix 3.2 The areas within each of the defined land cover categories mapped on the Polebridge Quad located within or outside Glacier National Park.

CLASSIFICATION	AREA WITHIN PARK (acres)	%	AREA OUTSIDE PARK (acres)	%
Wash shrub	46	29	110	71
Hydric upland shrub	352	73	129	27
Mature cottonwood	49	74	17	26
Aspen	9	100	-	-
Cottonwood, spruce	-	-	61	100
Xeric grassland	456	89	55	11
Mesic grassland	799	58	589	42
Hydric sedge	317	74	110	26
Wash forb	162	47	185	53
Spruce bottomland	722	55	589	45
Spruce, cottonwood	54	24	171	76
Spruce, dead lodgepole	1416	85	247	15
Spruce, subalpine fir, birch	307	43	402	57
Spruce, subalpine fir	849	99	9	1
Spruce, Dougals fir, larch	45	100	-	-

Lodgepole pine, larch	1844	38	2958	62
Dead lodgepole pine	146	13	979	87
Dead lodgepole pine, spruce	1787	100	-	-
Live & dead lodgepole pine	2189	56	1739	44
Lodgepole pine, savannah	488	100	-	-
Mature larch, spruce	-	-	73	100
Young larch, spruce	297	71	120	29
Larch, dead lodgepole pine	142	66	73	34
Douglas fir, western larch	2826	95	159	5
Douglas fir, larch, ponderosa	271	100	-	-
Douglas fir, lodgepole	63	100	-	-
Douglas fir	498	99	7	1
Burn, lodgepole regeneration	23	100	-	-
All clearcuts (C1-C7)	-	-	3250	100
All pastures (P2-P5)	-	-	229	100
Development a1	-	-	152	100

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TOTALS:  16157              57      12413              43
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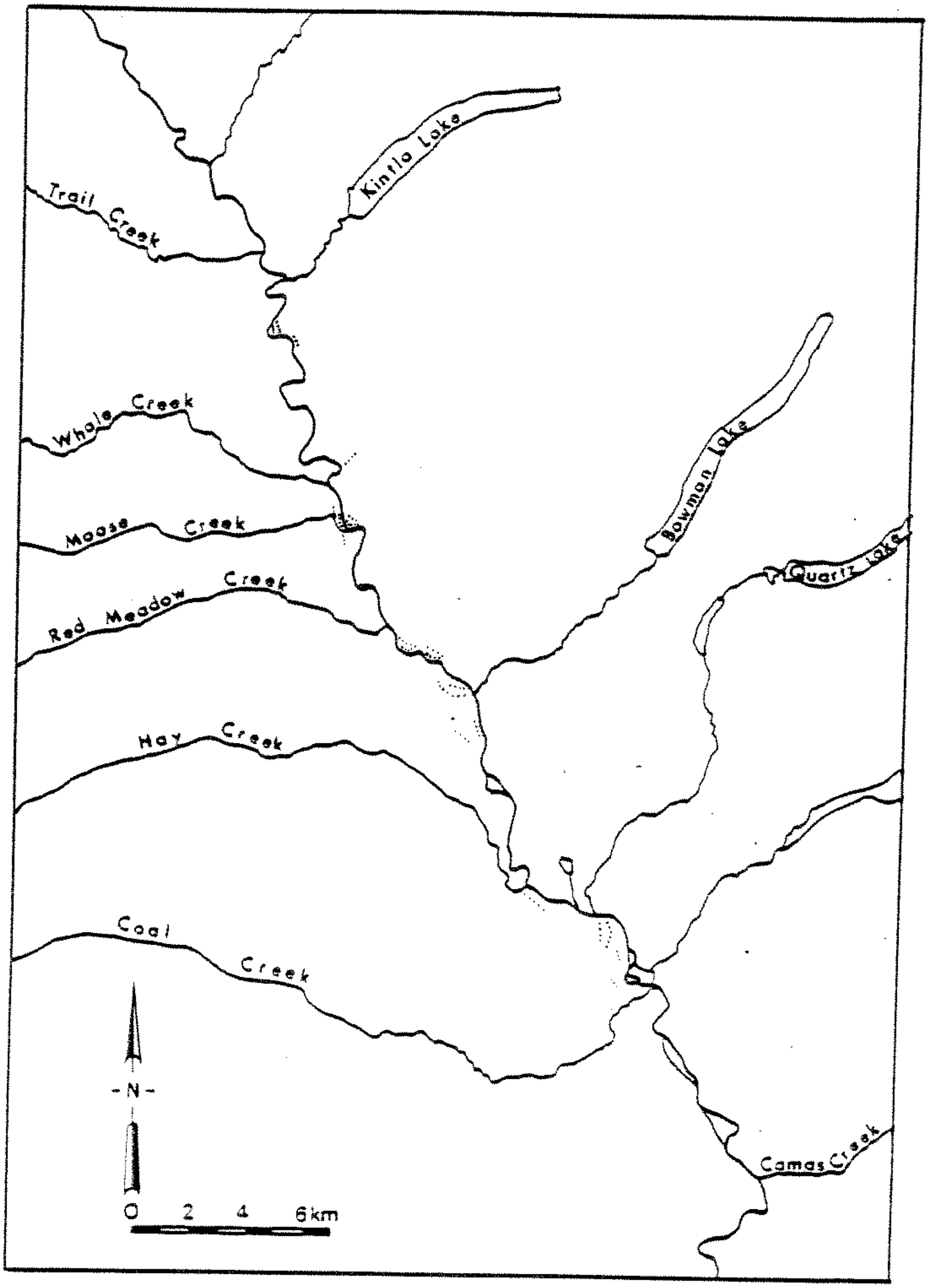
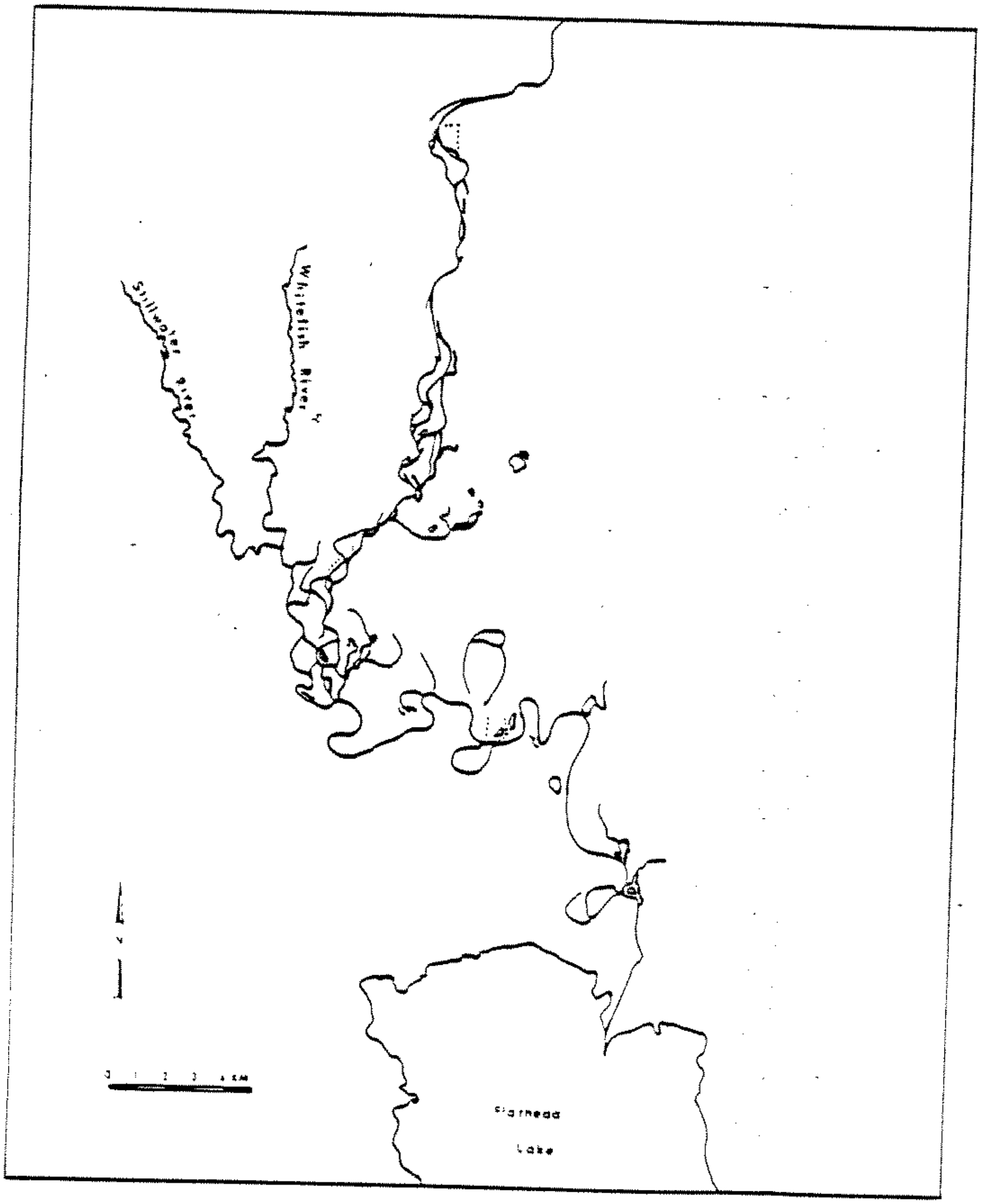
Appendix 3.3 The areas within each of the defined land cover categories mapped on the Trail Creek Quad located within or outside Glacier National Park.

CLASSIFICATION	AREA WITHIN PARK (acres)	%	AREA OUTSIDE PARK (acres)	%
Wash shrub	153	63	47	37
Hydric upland shrub	148	74	52	26
Mature cottonwood	87	46	102	54
Aspen	252	100	-	-
Mesic upland shrub	-	-	27	100
Cottonwood, spruce	55	34	106	66
Mesic grassland	250	47	281	53
Hydric grassland	81	48	89	52
Wash forb	196	59	136	41
Spruce bottomland	1169	84	220	16
Spruce, cottonwood	74	67	37	33
Spruce, dead lodgepole pine	630	57	478	43
Spruce, subalpine fir, larch	2198	73	809	27
Spruce, subalpine fir	123	100	-	-
Lodgepole pine,				

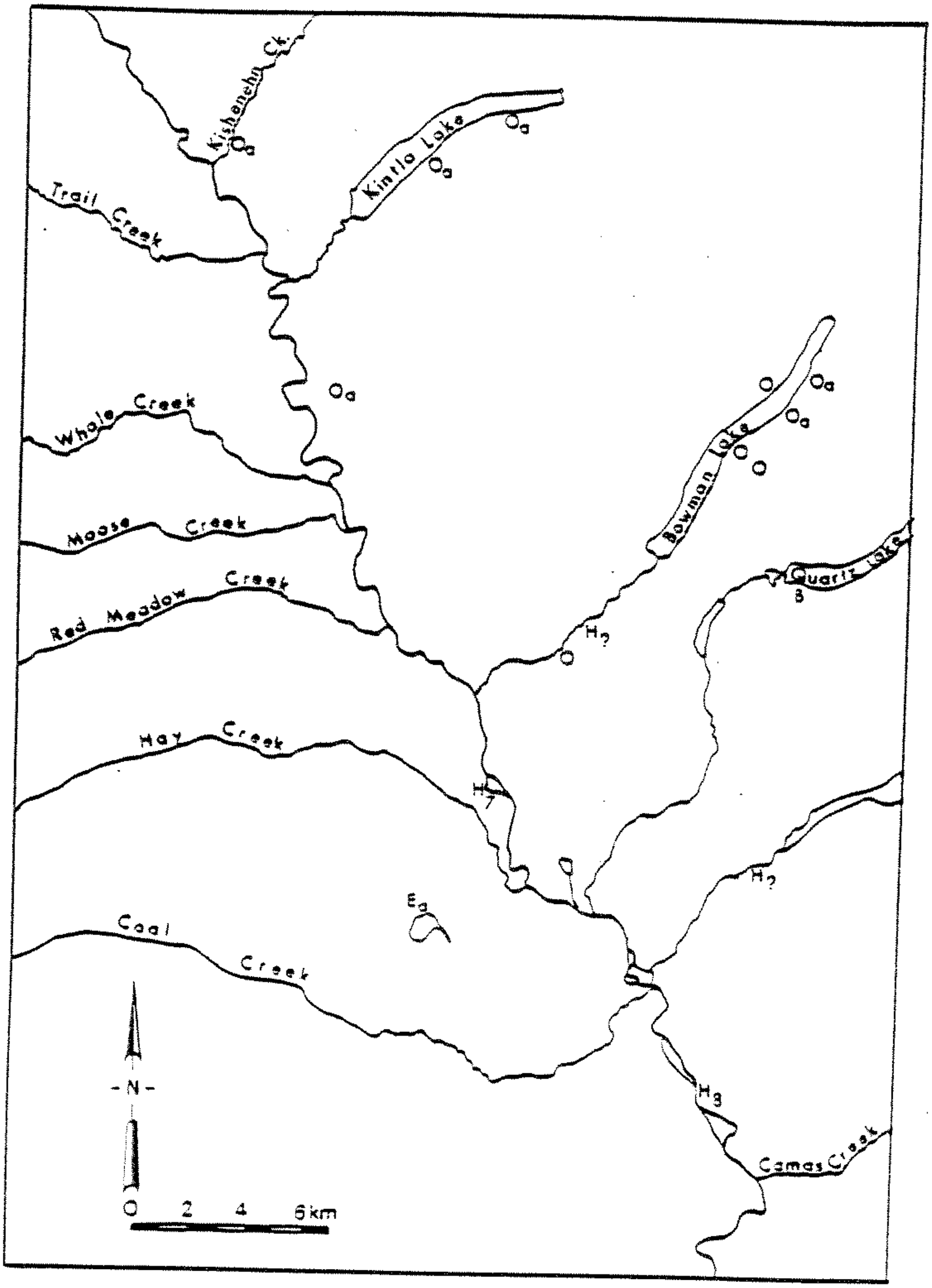
western larch	1292	43	1700	57
Dead lodgepole pine	618	44	782	56
Dead lodgepole pine, spruce	1311	99	4	1
Live + dead lodgepole pine	1869	36	3352	64
Lodgepole pine, savannah	108	74	39	26
Mature western larch, spruce	393	100	-	-
Young western larch, spruce	1031	29	2470	71
Western larch, dead lodgepole	348	100	-	-
Douglas fir, western larch	1141	100	-	-
Douglas fir, lodgepole pine	159	100	-	-
All clearcuts (C1-C7)	-	-	2948	100
Fallowland	-	-	126	100
Residential	-	-	45	100
TOTALS:	13686	50	13890	50



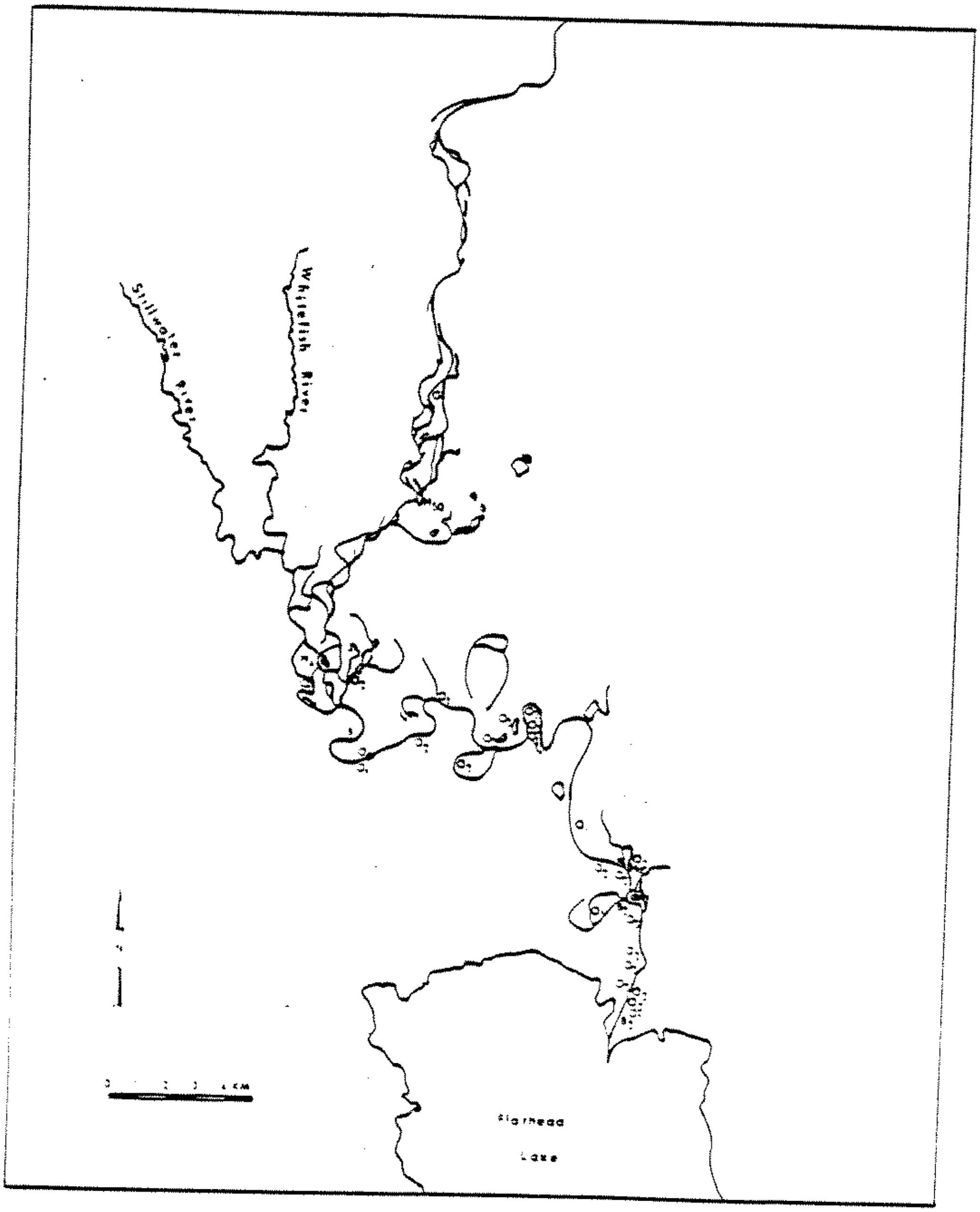
Appendix 3.3 Location of bird transects along the North Fork of the Flathead River.



Appendix 3.4 Location of bird transects along the Flathead River.



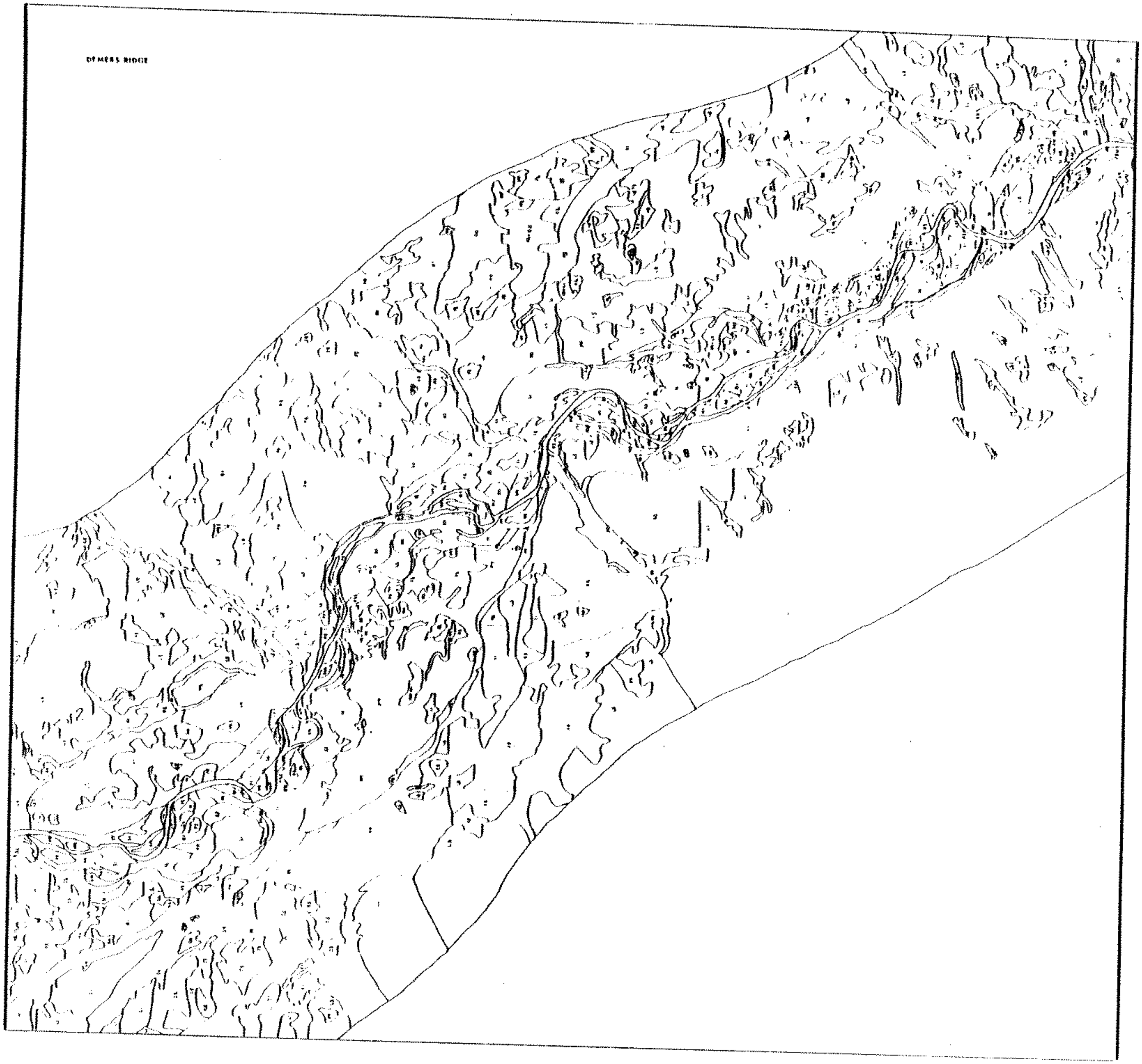
Appendix 3.5 Location of raptor nests and heron rookeries in the North Fork Valley. O = osprey, B = bald eagle, H = heron rookery, a = occupied in 1982 and number represents number of nests in heron rookery. If subscript is missing, nest was not occupied in 1982. From current research; Glacier National Park records; Jerry DeSanto, subdistrict ranger, G.N.P.; and U.S. Forest Service, Glacier View District, Flathead National Forest, Columbia Falls, MT.

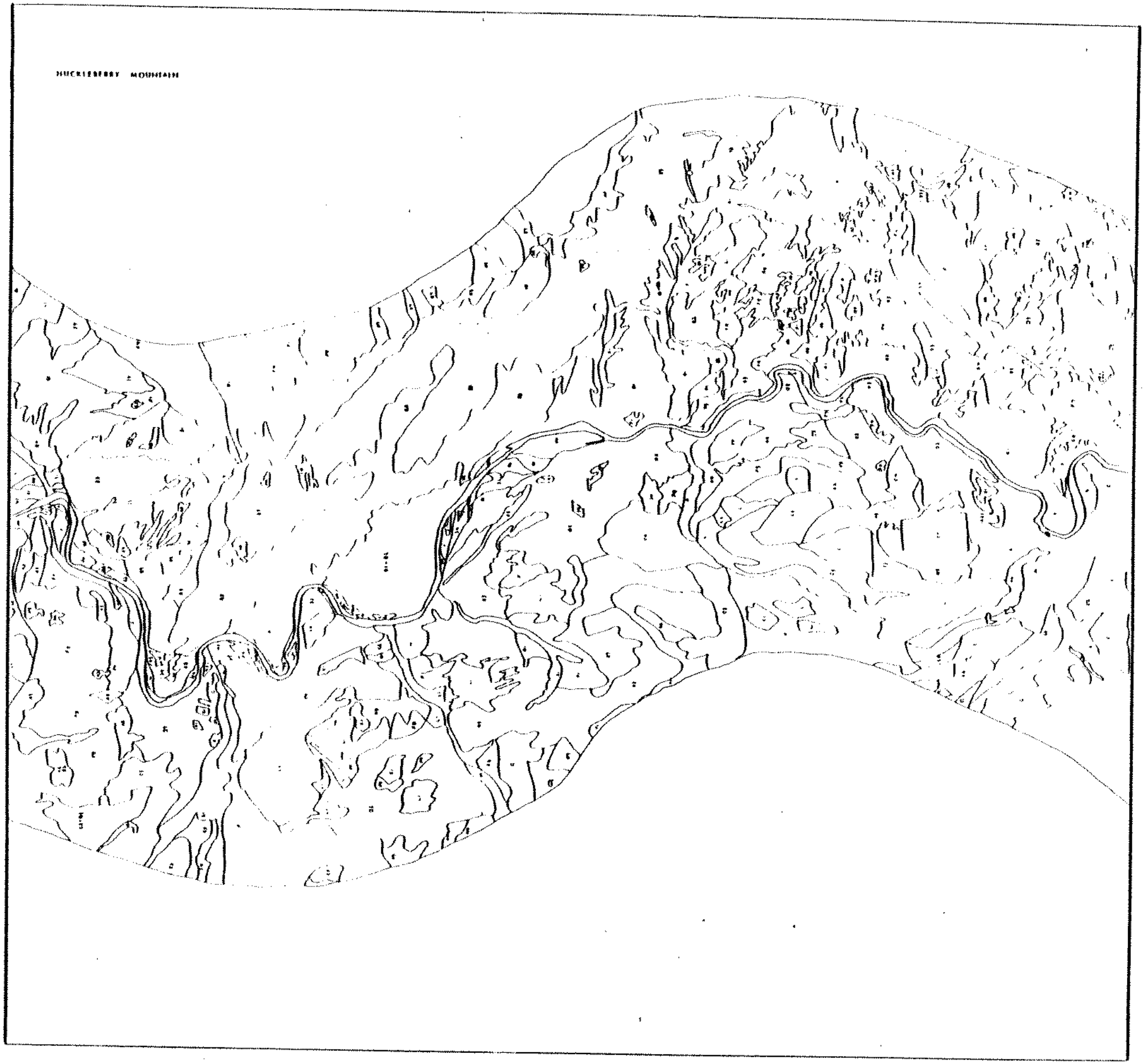


Appendix 3.6 Location of raptor nests and heron rookeries occupied in 1982 along the Flathead River. O = osprey, B = bald eagle, G = golden eagle and H = great-blue heron. Subscripts represent number of young osprey or eagles or number of nests in heron rookery. If subscript is missing, nest was not occupied in 1982. From U.S. Fish and Wildlife Service annual raptor productivity survey, USFWS, Creston, MT.


BEAR CREEK


POLEBRIDGE


DEMERS RIDGE


HUCKLEBERRY MOUNTAIN

COLUMBIA FALLS SOUTH