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Riparian Management Reference

National Forests in Minnesota

1996

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Chapter One

Chapter 1: Structure and Function of Riparian Zones

PURPOSE AND CONTENTS

Riparian areas have received a great deal of attention in recent years as managers and scientists developed a greater awareness of their importance for fish and wildlife habitat, recreation, and as buffer zones to reduce the effects of flooding and erosion. The USDA Forest Service has increasingly recognized the economic and ecological values of these areas, and that management plans must consider their multiple functions. This recognition is consistent with the current Forest Service emphasis on “Ecosystem Management”, and reaffirms the National Forest Management Act (NFMA). Forest Service policy mandates management of “riparian areas in the context of the environment in which they are located, recognizing their unique value” (FSM 2526.02). It also directs managers to “give preferential consideration to riparian dependent resources when conflicts among land use activities occur” (FSM 2526.03).

This riparian reference is designed to provide an understanding of the significance and ecology of riparian areas in natural resource management. It is intended to promote the establishment of site specific objectives to protect and enhance the multiple functions of riparian areas. Proactive management to achieve these objectives is encouraged. The document includes an overview of our current knowledge and concepts of the ecology of riparian areas. The multiple resource values of riparian areas are highlighted, and management considerations at three spatial scales - landscape, watershed, and individual project - are described. In addition, rehabilitation and monitoring of riparian areas are discussed, and a list of selected references and a glossary are included.

Recognizing that knowledge about riparian areas continues to evolve, the Minnesota National Forests view this document as a starting point to pull together references which point out the important attributes of riparian areas. Hopefully, the document will contribute to ongoing discussions in Minnesota, and perhaps elsewhere, about how forests can be better managed to protect and enhance these attributes. This document will continue to evolve as new and improved science becomes available.

INTENDED USES

The Minnesota National Forests (Chippewa and Superior) intend to jointly use this reference, along with others, as a scientific basis for addressing riparian area management in the forest planning process. Current Forest Plans which guide management of the Minnesota National Forests are very general and non-restrictive in relation to management of riparian areas. Until Forest Plans undergo a revision process, National Forest managers are encouraged to use, on a site-by-site basis, any management technique or practice designed to improve the structure and function of riparian areas. Such efforts also must comply with project-level NEPA (National Environmental Policy) requirements, Best Management Practices for water quality and wetland protection, and any specific standards and guidelines outlined in current Forest Plans. This reference guide should help form the scientific basis for using riparian area management techniques or practices.

In addition, this reference document will be used in the Forest Plan Revision process, with full public participation, to develop management standards and guidelines which improve riparian area management on National Forest land in Minnesota. Although the document is written with reference to the Chippewa National Forest, the scientific basis for riparian area management should be largely applicable to the Superior National Forest, and perhaps throughout the Lakes States. Other groups may similarly use the document to assess the need for, and perhaps develop, riparian management guidelines applicable to forest management statewide.

CONCEPTS AND DEFINITIONS

Several definitions of riparian areas have been offered depending upon the perspective of the agency or scientist. The word “riparian” is derived from the Latin word for bank or shore, and simply refers to land adjacent to a body of water. This had been the common legal usage until recently. Verry (1992) wrote that riparian means “life on the bank of a river or lake.” Riparian ecosystems have been defined as “the band of forest that has a significant influence on the stream ecosystem, or conversely, is significantly influenced by the stream” (Hunter 1990). More specifically, it has been described as the three dimensional zone with direct interaction between aquatic and terrestrial ecosystems (Gregory et. al 1991). The Forest Service (1978) defined riparian areas as aquatic ecosystems, riparian ecosystems and wetlands. This encompasses all stream channels, lake and estuary beds, biotic and habitat features of streams, lakes and estuaries, and the transition zone between aquatic and terrestrial ecosystems, plus wetlands. Several agencies, including regulatory agencies such as the Corps of Engineers, adopt definitions based on soil moisture conditions and plant communities associated with soils that are saturated or have free water, at least seasonally. With these definitions, wetland areas become included, and riparian areas do not necessarily stop a short distance from a stream or lake, but can vary greatly in shape and include areas with little or no adjacent surface water.

In the broadest sense, **riparian areas** consist of the aquatic ecosystems, adjacent riparian zones, and wetlands (Figure 1). On the Chippewa National Forest this is not a trivial percent of the landscape. The combined acreage of lakes, streams, and wetlands represents nearly 49% of the 1.6 million acres within the Chippewa National Forest boundary, with approximately 358,936 acres of lakes and streams, and 398,916 acres of wetlands (Chippewa National Forest Final Environmental Impact Statement (FEIS)).

Riparian zones are ecotones (i.e. three-dimensional transition zones) of direct interaction between terrestrial and aquatic systems. These zones extend outward from the edge of the aquatic ecosystem or wetland, upward into the canopy of the riparian vegetation, and downward into the soils (Figure 1). This guide will use a functional definition for riparian zones based upon ecosystem functions and interactions. Different functions will extend through different portions of the three-dimensional zone, such as bank protection being in the immediate vicinity of the shore, and the processes influencing groundwater quality extending well back from the water’s edge. The functions overlap, sometimes broadly, and the strength of each interaction progressively decreases away from the stream, lake, or wetland.

Operationally, it is useful to make a distinction between the riparian zone as described above and a **riparian management zone**, which is a term used to describe a zone established for management practices within riparian areas. Riparian management zones are contained within, but may not necessarily include all of the riparian zone. Once riparian management objectives are set, such as maintaining inputs of large organic debris, the functions or interactions which need to be considered to achieve the objectives become clear.

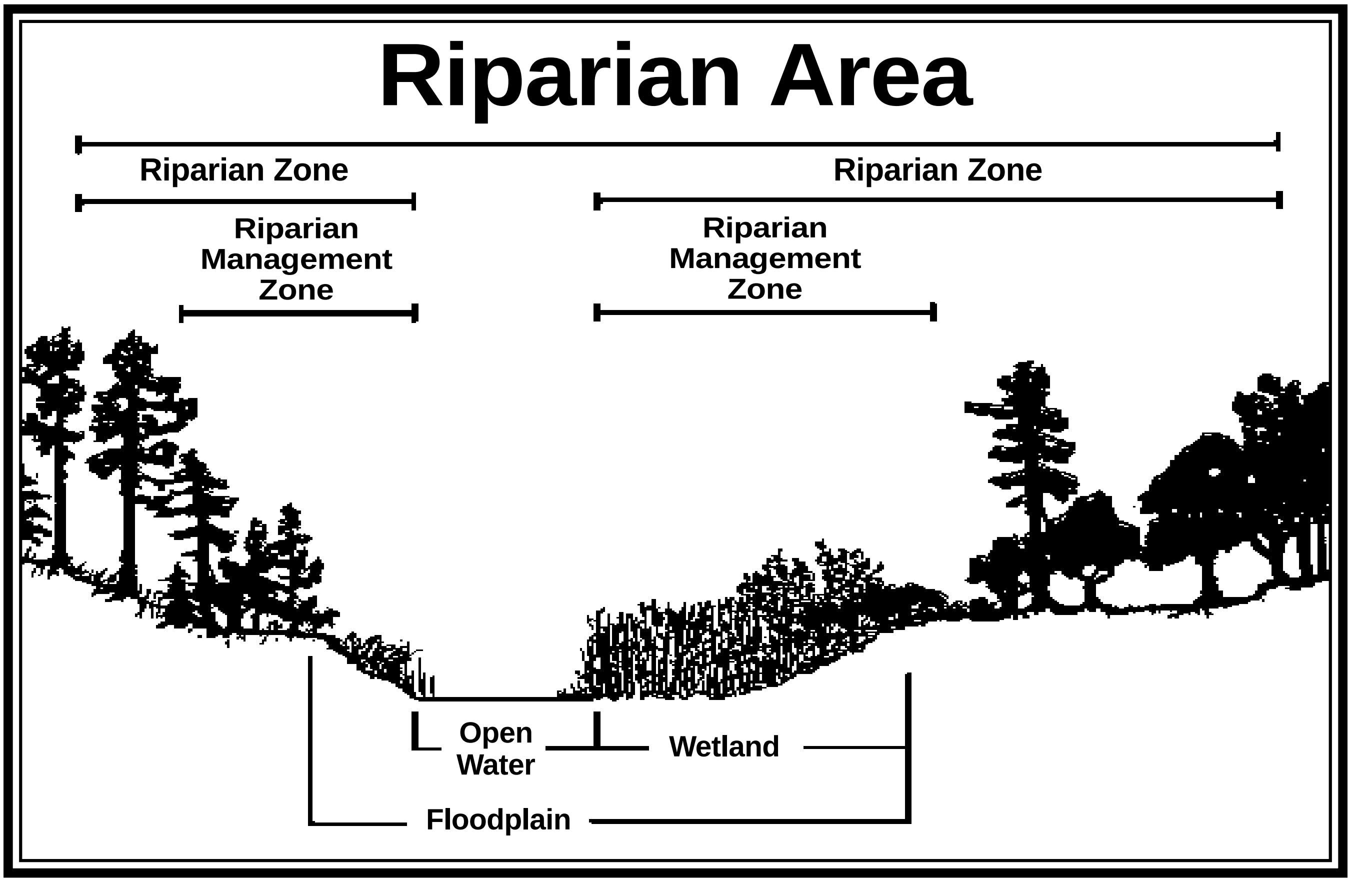

Figure 1. *Cross-section of a riparian area and adjacent uplands. Note that the actual riparian area may extend into the uplands, encompassing zones of influences for shading, litter inputs, and wood loading. The riparian management zone may be significantly narrower than the riparian area.*

Those portions of the three-dimensional zone of interaction which provide for the function(s) of interest can be described and marked on the ground or a map.

It is important to note that while a project may focus on a small portion of a stream, lake, or wetland and include careful consideration of local characteristics of that system, planning and analysis needs to be conducted at the larger landscape and watershed scales. Riparian areas can serve as corridors across the landscape, linking upland habitats, and linking headwater streams to lower portions of the watershed. Thus, management activities in a specific riparian management zone are not just important locally, but on watershed and landscape levels as well.

IMPORTANCE OF RIPARIAN AREAS

Why do riparian areas merit special consideration by natural resource managers? There are many reasons. Riparian areas normally occupy a relatively small area, but they are key sites that control transfers of energy, nutrients, and sediment between the terrestrial and aquatic ecosystems. From an ecological and biological point of view, riparian areas are extremely dynamic, productive, and resource-rich. They provide ecological services which distinguish them from uplands, including water transport of energy and materials, storage of flood waters and sediments, and habitats that require flood pulses (Bayley 1995) or which occur below the ordinary high water. Riparian areas also provide ecological services that may occur on uplands and are not unique to riparian areas such as old growth habitat, wildlife corridors and human trails.

Riparian areas are frequently the most species-rich habitats to be found in a landscape and provide critical corridors linking favored wildlife habitats. Forty percent of the Chippewa's wildlife species are riparian dependent. Their needs that are uniquely provided by riparian areas are ecological services that differentiate the composition, structure and function of riparian areas from uplands. In addition, the remaining sixty percent of the wildlife species that inhabit the Chippewa do not depend on riparian areas, but they do use them.

Riparian areas were important to our prehistoric ancestors and are no less so to modern society, if for somewhat different reasons. Because hunting and gathering cultures of the past used riparian areas extensively as places to live and obtain food, cultural resources are often located there. Today, we are drawn to the water's edge for spiritual, aesthetic, and recreational reasons. The resulting public pressure can be very heavy, and pose major management challenges. National Forest management is constantly balancing different resources and the pressures on them. Riparian areas are especially rich in resources and issues; thus, their management requires special consideration.

STRUCTURE AND COMPOSITION OF RIPARIAN ZONES

Geomorphic processes such as erosion and deposition are constantly shaping the topography of the landscape. Nowhere is this more obvious than in riparian areas where the time scale for significant changes can be quite short. A single big flood along a river, or a big wind storm on a lake which rafts ice onto a shore can cause dramatic changes in channel or shoreline. In regions such as the Lake States, which were profoundly shaped by glacial advances and retreats, today's changes are minor variations on old themes. But while today's geomorphic processes may not be very significant in reshaping landscapes, they are important in determining the structure and composition of riparian vegetation by providing the template on which vegetation develops and the disturbance regime which regulates succession.

Vegetation, however, is very important in regulating many of the geomorphic processes. For example, upland vegetation influences runoff through interception, transpiration, regulation of snowmelt, buildup of litter and soil organic matter, and creation of soil macropores. It regulates surface erosion and nutrient loss. In the riparian zone, vegetation stabilizes streambanks and lakeshores, traps sediment in overbank deposition, and provides coarse woody debris to the aquatic ecosystem. This interaction between vegetation and geomorphic processes occurs at spatial scales from the reach or stand to the landscape. The landscape pattern of vegetation types and successional stages can dramatically affect runoff and consequently the disturbance regime of the riparian zone (Verry 1983,1986).

Because flooding is a dominant disturbance process in riparian zones, geomorphic surfaces at different heights can have very different disturbance regimes. Surfaces such as active channels, channel shelves, bars, streambanks, and emergent zones near lakeshores experience chronic disturbance. Floodplains, terraces, old meander channels, and lakeshores have a more episodic disturbance regime. Steep gradients in frequency and severity of disturbance are often found across riparian zones, and these gradients contribute to the patchiness and diversity found there.

When compared with upland systems, riparian vegetation is often more complex in structure and composition (Gregory et al. 1991; Kauffman and Krueger 1984; Kauffman et al. 1984). Streamside riparian areas are often species rich and structurally heterogeneous, both horizontally and vertically. Studies in the Pacific Northwest (Lee 1983) and the eastern US (Hupp 1982, 1983; Hupp and Osterkamp 1984, 1985) have shown a strong relationship between geomorphic surface types and plant communities. For example, a very patchy mosaic of plant communities often occurs along lakes and streams as a result of frequent disturbance by flooding or battering. Because steep environmental gradients exist going away from lakes, streams, and wetlands, the geomorphic surfaces and plant communities are often linearly arrayed along shorelines and have lengths several times greater than their widths. This produces the characteristic banding pattern of vegetation seen along the shoreline, going from herb- to shrub- to tree-dominated vegetation with increasing distance from the water.

As in upland habitats, vegetation in riparian zones is strongly influenced by soil type and water availability. Local geology and topography determine the abundance of sand, silt, and clay particles, and the region's weather determines the timing and size of flooding. The abundance of organic matter is a function of vegetation types and decomposition processes. Along high-gradient streams, soils can be extremely variable in particle size and organic matter content and can exhibit a very patchy mosaic pattern over small distances (Gillham 1989). Along relatively low-gradient streams and lakeshores, patchiness should be less pronounced. The seasonality and year-to-year variation in depth to water table plays a profound role in determining riparian vegetation community patterns. Plant species differ greatly in their tolerance to flooding and saturated soils (Minore 1979; Walters et al. 1980). Plant species commonly found in lakeshore, streamside, and wetland communities are well adapted to the anaerobic soil conditions associated with saturation.

Vegetation succession in riparian zones is determined by the local disturbance regime and soil conditions including depth to water table. Along streamsides with moderate disturbance, succession is often characterized by high species richness (Nilsson 1987; Nilsson et al. 1989) and high cover of herbs and shrubs. Because of the large length to width ratio of the geomorphic surfaces on which the vegetation is developing, edge effects can be especially strong. As stream size increases, it is expected that the patch size of vegetation types would increase and edge effects would decrease.

FUNCTIONAL LINKAGES BETWEEN TERRESTRIAL AND AQUATIC ECOSYSTEMS

The riparian zone is the site for many functional linkages between the terrestrial and aquatic ecosystems. Linkages of particular interest to natural resource managers include: 1) inputs of coarse debris and fine litter, 2) retention of nutrients, sediment, energy, 3) water quality and transpiration, 4) bank and shoreline stabilization, and 5) animal habitat.

Riparian vegetation is an important source of coarse woody debris and fine litter to lakes, streams, and wetlands. Standing dead and down trees play the very same roles in riparian zone forests as they do in upland stands, providing habitat, structural complexity, sediment capture, and a source of soil organic matter. Downed wood in wetlands harbors beetles, grubs, and other insects that are protein-rich food sources for wildlife. Riparian forests are often the sole source of coarse woody debris, which is important in shaping the physical structure of the aquatic system as well as in providing habitat.

Tree species differ in their decomposition rates, but the slower decomposition rate of wood in water than on land (a function of oxygen availability; Aumen et al. 1983, 1985) means a given piece of debris performs its functional roles for a longer period of time in the aquatic ecosystem. The stability of the individual piece is related to how well it is “anchored”, with root wads and branches increasing stability along with how much of the piece is up on the shore during high water (Swanson et al. 1976; Swanson et al. 1982). The probability of a tree falling into a lake, stream, or wetland is a function of its height and distance from the water’s edge. Studies have indicated that more than half the inputs come from a distance of less than half the height of the canopy (McDade et al. 1990; VanSickle and Gregory 1990).

Riparian vegetation plays a very important role in retaining nutrients, sediments, and organic matter in the local riparian area, slowing the rate of their transport out of the ecosystem. On the geomorphic surfaces which periodically flood, the vegetation traps suspended material and slows the water velocity allowing sediment to settle out. It also slows downslope movement of leaves, branches, soil, etc. providing time for decomposition and recapture of nutrients and energy. The inputs of coarse debris into streams and lakeshores create sites for retention. Coarse debris traps smaller debris which in turn traps fine debris, sediment, and organic matter. These accumulations provide channel structure, sites where organic matter can be processed, and form new geomorphic surfaces for colonization by plants and animals. In wetlands, coarse debris provides essential substrates for wetland organisms and processes.

The riparian zone influences water quality of lakes and streams. In addition to trapping sediment, the vegetation captures nutrients in the soil solution moving downslope toward the water, and the near-shore plants absorb nutrients directly from the water. Intact riparian vegetation acts as a very effective filter to maintain or improve water quality. The high water table and frequently saturated soils of the riparian zone create conditions where denitrification occurs.

Bank stabilization by vegetation is another important functional linkage between the terrestrial and aquatic ecosystems. Roots and rhizomes of riparian vegetation stabilize and reinforce shorelines. Coarse woody debris, especially large, stable accumulations of stems and branches, slows the water during floods which leads to increased sediment deposition and natural levee formation. Roots proliferate into the fresh sediment deposits, helping to stabilize them. In addition, root systems allow the formation of overhanging banks which provide excellent habitat for aquatic organisms.

One of the most conspicuous ecosystem functions of riparian zones is animal habitat, not only in terms of areas for nesting, cover, and foraging, but also by providing corridors for movement between other habitats. Riparian zones are important habitat for invertebrates as well as vertebrates, and many species are found only in these areas or spend critical portions of their life cycle there.

Transfers of energy through the food chain go both ways between terrestrial and aquatic ecosystems. Aquatic species feed on terrestrial organisms such as ants and grasshoppers, and in the case of muskellunge and northern pike, small mammals. Terrestrial species such as kingfishers, mink, otters, eagles, and amphibians feed on aquatic organisms. The riparian zone is also a location where many aquatic insect species mate.

ECOSYSTEM MANAGEMENT OF RIPARIAN AREAS

Ecosystem management is the management of natural resources based on ecological understanding, and it is philosophically grounded on maintaining the sustainability of productivity and the biological diversity of the landscape. It assumes that humans are a part of, and use resources derived from the ecosystem.

The overall goals of ecosystem management include the sustainable production of goods and services from National Forest land. Fish, wildlife, water, plants, recreation, wildlife observation, and timber production are all examples of equally valid goods and services to be considered.
Moreover, the overall goals include maintenance of:

- long-term productivity,
- ecosystem processes,
- biological diversity, and
- management options.

Ecosystem management requires that riparian areas are considered an important part of the whole landscape, and that management decisions are based on both stand- or reach- scale analyses as well as integrated landscape analyses. That is, consideration of the effects at the scale of the individual management unit is inadequate, and evaluation of effects at larger spatial scales is necessary.

Riparian Resource Composition

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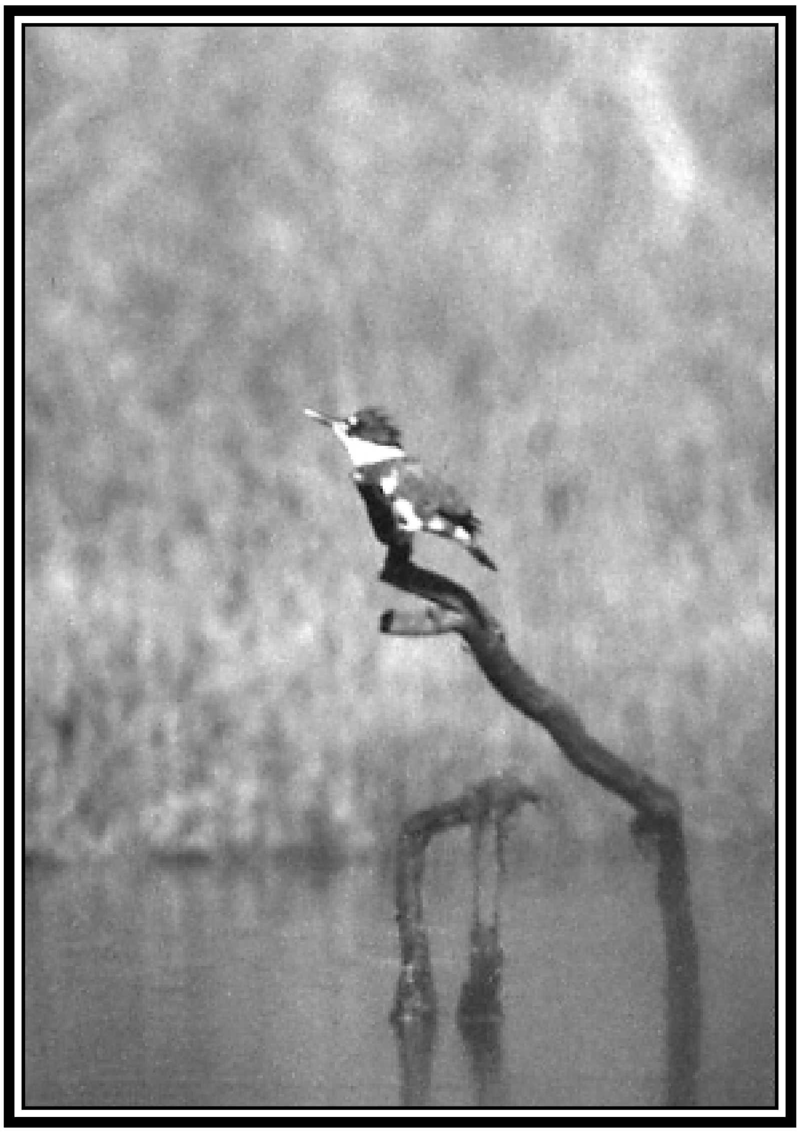


Chapter Two

Chapter 2: Riparian Resource Composition

The Chippewa National Forest encompasses nearly 1.6 million acres of land. With lakes, streams, and wetlands comprising approximately 49% of the total acreage within the Forest boundaries, a significant portion of the Forest is considered riparian habitat. These riparian areas provide many ecological, economic, and social benefits to the Forest and the nation. Seven major categories of resources are found in riparian areas which can be profoundly affected by management activities:

- water,
- fish,
- wildlife,
- vegetation,
- timber,
- recreation, and
- heritage resources.

This chapter describes the linkages between riparian zone structure and function and these resources.

WATER

Healthy riparian vegetation along streams, lakes, and wetlands provides a buffer from natural and human-caused disturbances, helping to ensure good water quality. Because water flows from headwater streams and wetlands to larger lakes and streams, disturbances to riparian vegetation can affect water quality in downstream areas.

Water Temperature

One of the most obvious effects of riparian vegetation on water quality is the regulation of water temperature. The degree to which groundwater vs. shading affects water temperature can vary a great deal and is determined by local geology and soils. Small, undisturbed headwater streams and wetlands are often completely shaded by riparian vegetation. These small streams contribute cool water to more open downstream regions and complement the groundwater influence. Sources of cool water throughout a watershed can be vital to certain aquatic organisms such as fish, macroinvertebrates, and aquatic plants. Therefore, shading by riparian zone vegetation throughout a watershed can be critical, particularly during summer low flows.

Stream temperature in an individual clearcut-logged unit is rarely more than 1 to 3ºF warmer than adjacent forested reaches (Brown 1970; Brown and Krygieer 1970; Beschta et al. 1987). However, the cumulative effects of stream temperature increases in recently logged units within a watershed may lead to significant warming of downstream reaches and lakes, adversely affecting certain aquatic organisms. At warmer water temperatures, the competitive interactions of aquatic plants or macroinvertebrates may change to favor less desirable species, and some species may be lost from lakes and streams as temperatures exceed their tolerance limits for extended periods. Consequently, small increases in water temperatures may lead to shifts in the aquatic community structure which are considered undesirable.

Sedimentation and Turbidity

Riparian zones act as buffers and filters of suspended sediments and surface erosion. Throughout a watershed, plant roots and accumulations of large woody debris stabilize lakeshores, streambanks and hillslopes. This in turn reduces sediment input into wetlands, lakes, and streams. During floods, the vegetation in riparian zones slows the water and dissipates its energy, causing suspended sediments to settle out instead of being transported further downstream. Riparian zones with broad floodplains act as additional storage sites for sediment and water.

Although these processes operate throughout a watershed, they can be of critical importance in small intermittent or ephemeral tributaries. The relative stability of these channels can significantly affect the amounts of sediment transported downstream to larger channels and lakes. Woody debris contributes to the structure of small stream channels, which is essential for trapping sediments and reducing water velocity during major runoff events.

Riparian forests and large woody debris in larger streams can also serve to limit the downstream impacts of sedimentation. Streamside forests reduce the potential for major channel changes and erosion, and downstream riparian stands intercept and impede the flow of sediment and debris.

Increased suspended sediment and turbidity associated with management activities is an issue in Lake States Forests because the low-gradient streams will not redistribute the sediment very efficiently. Seemingly small loadings can become a local problem, and the effects can be long lasting. These increases in sedimentation reduce potability to downstream users and may cause serious damage to fish and wildlife resources. Poorly located and constructed roads can be major sources of sediment, as can on-site logging practices, trails, recreation sites, and private developments. Although these activities may occur in small headwater streams, the turbid waters flow downstream, eventually affecting larger streams, lakes, and wetlands.

Management practices that increase sediment loads to streams, lakes, and wetlands have obvious deleterious effects on fish and invertebrates. Sediment deposition over stream beds or lake bottoms reduces the habitat available for aquatic insect communities. Even at relatively low levels, fine sediments deposited in fish spawning areas can kill eggs or emerging fry. At higher concentrations, suspended sediments can damage gill tissues of fish. In wetlands, suspended sediments can reduce photosynthesis, decrease oxygen concentrations, kill benthic organisms, and interfere with the feeding and nutrition of aquatic mammals.

Nutrients

Riparian zones are both sources and storage sites of nutrients needed by aquatic and terrestrial ecosystems. These areas transform important nutrients, such as nitrogen, into forms used by both terrestrial and aquatic organisms. Riparian vegetation regulates the timing of nutrient input into lakes and streams. For example, when nutrients are lost from uplands, riparian vegetation can intercept, store, and eventually release them.

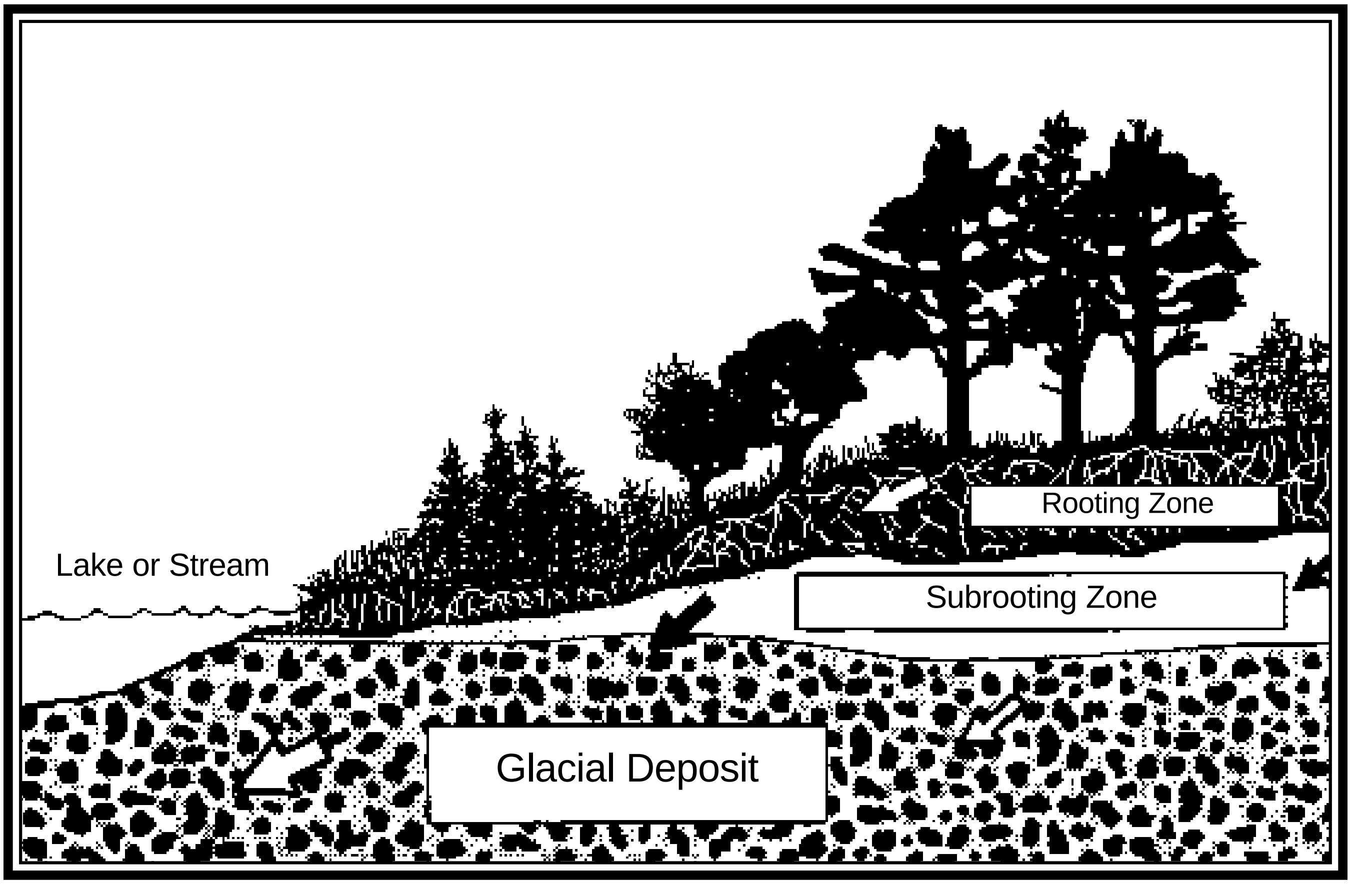


Figure 2. *Dissolved nutrients are routed downslope through the rooting zone of the riparian area and filter through soil into the subrooting zone.*

In addition to regulating this lateral uptake of nutrients, riparian zones are important filters (Figure 2). Complex stream channel structure, particularly in the vicinity of debris dams, reduces water velocity and increases the time available for nutrients to be used by aquatic and nearby terrestrial plants. The off-channel habitats provided by broad floodplains retain nutrients more effectively than the main channel.

FISH

The Chippewa National Forest is home to 56 species of fish. Intact riparian areas provide these species with good water quality, food, and necessary habitats for all stages of their life cycles.

Habitat

Fish require adequate habitat at all stages of their life cycle. Edges of stream channels are particularly important habitats because stream energy decreases in the shallow, low-velocity margins. Young-of-the year species of many fish favor lake, pond, and stream margins, backwaters, and side channels, particularly those with protective cover. These lateral habitats usually contain more algae and dead organic matter than deep water and main channel habitats. As a result, aquatic insects are usually much more numerous than in the middle of ponds, lakes, and main channels. As flood waters rise, these areas also provide cover and low velocity refuge for adult and juvenile fish. The braided channels common in broad floodplains increase this edge habitat. In streams, adult fish are most frequently found in pools.

Pool habitats provide cover, a refuge during both high and low stream flows, and a source of easily captured food from drifting invertebrates. However, in order to be effective fish habitat, pools must also contain internal cover for refuge from both predators and floods.

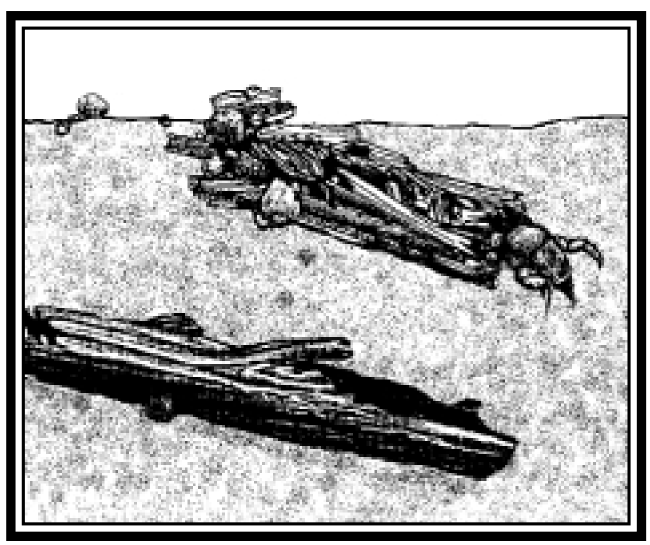
Large woody debris creates pools, stores sediment and organic matter to control water quality, traps spawning gravels, and provides fish with cover in both lakes and streams. Different size classes of wood play different roles in stream ecosystems. Very large logs are key stabilizers in lateral accumulations and debris jams. Intermediate sizes may serve the same function in smaller channels, but in larger streams they form the interlocking structure of debris accumulations. Smaller pieces of wood, such as branches, twigs, and broken pieces, create “sticky wickets” that trap leaves and sediments. Such accumulations also create habitat for invertebrates that process the energy and provide food for higher trophic levels.

Riparian zones around lakes also contribute to critical fish habitat. Trees that fall into lakes supply cover for fish in shallow shoreline areas and serve as habitat and food for aquatic invertebrates. Lake tributaries, shoreline habitats, and adjoining wetlands are used for spawning and rearing of juvenile fish. Delivery of sediment or changes in water temperature around these areas can affect fish populations significantly.

Food

Riparian vegetation exerts a strong influence on the amounts and types of food available to invertebrates and thus to fish. Many fish in streams and lakes of the Lake States depend on aquatic insects and other invertebrates for their food. In small, shaded streams, this invertebrate community is dependent on riparian leaf and needle inputs for its food or energy base. Conifer needles are low in food quality but enter the aquatic system year round. Deciduous leaves, on the other hand, are higher in

Backwater and edge habitat created by wood and boulders along stream margins are important habitats for fish.



Leaf litter provides both food and habitat for many aquatic insects, including this caddisfly nymph.

food quality but enter the aquatic system only during a short period in autumn. The combination of the two leaf litter types provides a stable, diverse food base for aquatic invertebrates. In larger open-canopy streams and lakes, aquatic invertebrates also feed on algae growing on rocks and emergent vegetation. This algae is a more nutritious food than terrestrial litter. Along lakes, the vegetation near the shoreline, whether from trees, shrubs, or herbs, provides an important food base.

Maintaining much of this food base in streams requires the presence of complex filters, including boulders, vegetation, and wood. Without these complex filters, leaves entering the stream quickly flow downstream and out of the local area before being eaten by insects. Large woody debris also supplies a low-quality, but long-lasting source of organic matter.

WILDLIFE

The productive and diverse plant communities of riparian areas provide a variety of habitats needed for many species of wildlife (Hodorff et al. 1988). Of the 326 wildlife species found on the Chippewa National Forest, approximately 60% use non-forested wetlands for some portion of their life history, and about 40% require riparian zones (Figure 3). These associations are displayed in Appendix 2.

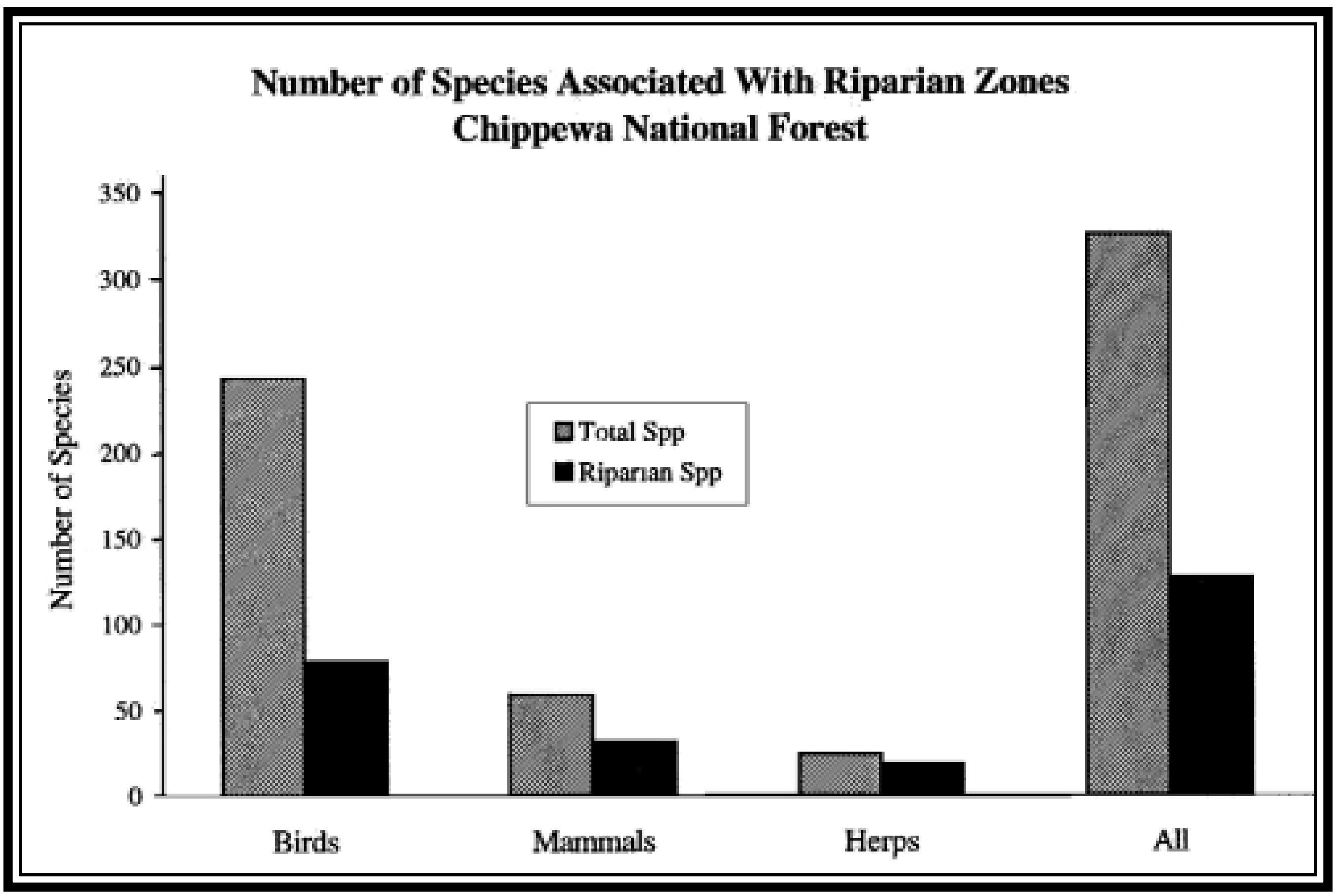


Figure 3. *Of the 326 vertebrates on the Chippewa National Forest, nearly 40% are associated with riparian zone habitats.*

Habitat

Riparian zones provide habitat for thermal cover, foraging, hiding, nesting, breeding, and rearing. Species such as mink, wood ducks, and spotted salamanders depend primarily on riparian areas to fulfill all of their habitat requirements. Riparian vegetation buffers temperature and humidity extremes, thereby creating favorable microclimates for many organisms. In summer, riparian zones tend to be slightly cooler and more humid than uplands, and species such as black bears seek wetlands and dense thickets of balsam fir saplings for shade (Rogers et al. 1988). In winter, riparian areas provide overwintering habitat for many amphibians, turtles, and aquatic invertebrates. The winter hydrology of these systems can be critical for overwinter survival. White-tailed deer rely on lowland conifer forests for forage and cover in winter (Beier and McCullough 1990).

The dense vegetation, complexity of landforms, and presence of water in riparian areas combine to provide hiding and resting cover (Kirby 1975; Probst et al. 1983). Small mammals and birds use the dense thickets along streams and lakes as refuges from predators. Waterfowl require riparian vegetation for resting places and for protection during severe weather. Small mammals such as water shrews and voles depend on the cover and increased habitat heterogeneity provided by downed timber in riparian areas. Wetlands provide specific habitat for many species of amphibians.

Riparian zones often provide denning habitats for mammals and nesting sites for many species of birds. Upland pine forests adjacent to forested wetlands provide the primary refuge trees for female black bears with cubs (Rogers et al. 1988). Ospreys and bald eagles build their nests in tree snags along lakes and large rivers. Cavity-dwelling birds, which nest in standing dead trees, are a significant component of riparian wildlife communities. The importance of riparian zones to waterfowl is obvious.

Riparian areas can form corridors across the landscape, providing natural migration routes for many game and non-game wildlife species. Radio telemetry studies in Maine have found that carnivores, such as coyotes, bobcats, red foxes, martens, and fishers, travel along stream corridors more often than would be expected by chance (Hunter 1990). While not every riparian area will serve as corridor habitat, this function should be a consideration in determining management objectives for the site.

Food

The same complexity and diversity of vegetation in riparian areas also provide rich sources of many types of food. In the Lake States, riparian areas such as wetlands are very important sources of food during the winter months. Where prolonged winters combine with heavy snow, populations of large ungulates, such as deer and moose, are directly dependent upon the quality and quantity of vegetation in forested wetlands (Welsch et al.1995).

Seed eaters and herbivores find a wider array of herbaceous, shrubby, and woody species in riparian areas than the upland. Species as diverse as deer, snakes, beavers, bats, woodpeckers, and wolves all depend on the riparian area for food at some time of the year. The grass understory of forested wetlands provides an important source of food for black bears in the spring (Rogers et al. 1988).

Aquatic insects emerging from streams, lakes, and wetlands are predictable food sources for insectivorous amphibians, birds, and mammals. Some species, such as kingfishers, otters, and ospreys, are totally dependent on aquatic organisms as a source of food. Riparian areas also are critical sources of drinking water for most wildlife species.

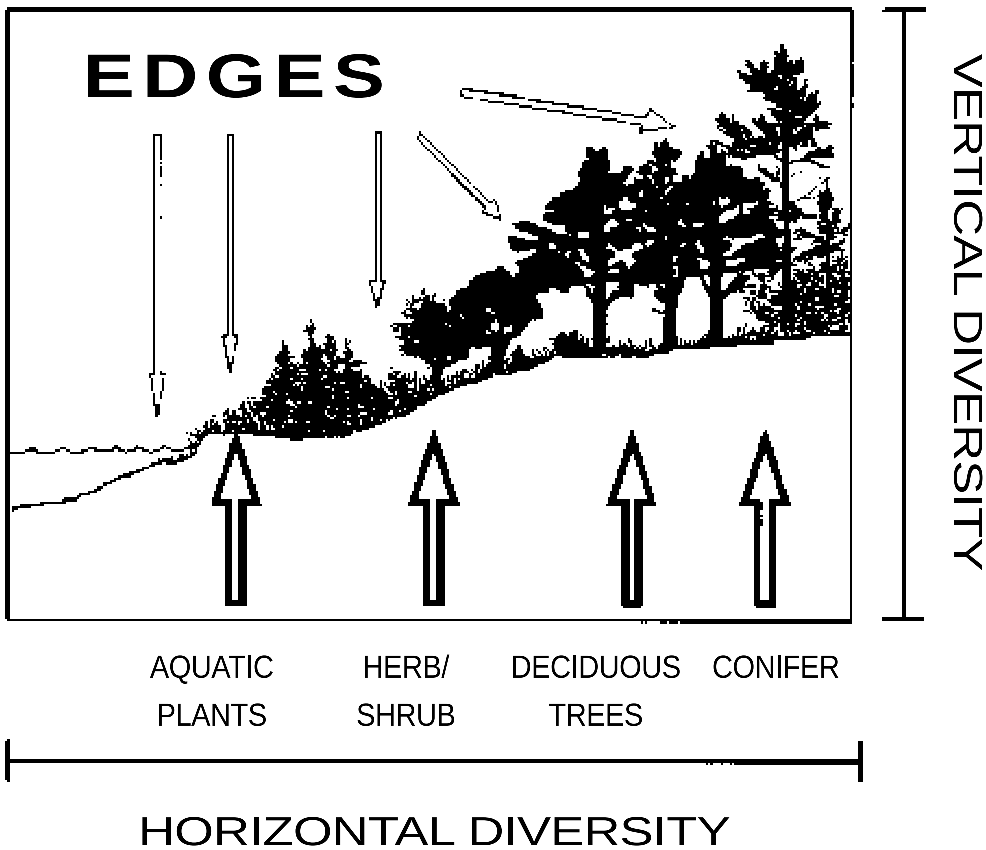


Figure 4. *Horizontal and vertical diversity created by the normal sequence of plant communities extends from the active channel to the upland forests.*

TERRESTRIAL VEGETATION

Riparian areas are critical contributors to plant diversity in forest ecosystems of the Lake States. Much of this diversity stems from the complex array of geomorphic surfaces and habitats such as gravel bars, islands, and floodplains present in riparian areas. These topographic features vary in disturbance frequency, substrate composition, soil moisture content, nutrient regime, depth to water table, and distance from water. Different successional stages of plant communities occur in a mosaic of patches in the riparian area. Because of this patchiness, the number of plant species in riparian zones is often much greater than that of hillslope forests. Wetlands, such as bogs, swamps, or marshes, often contain unique associations of plants, and may harbor rare species.

These diverse plant communities associated with numerous channel and floodplain surfaces along a river valley increase horizontal complexity. Downed logs and other woody debris, which originate from the riparian and upland forests, also contribute to horizontal structural complexity. The numerous patches of herbs, shrubs, deciduous and coniferous trees, and standing dead snags also create a multilayered canopy, leading to high vertical diversity (Figure 4).

The complex vegetation structure of riparian areas provides habitat for a diverse community of plants and animals.

In addition to providing horizontal and vertical diversity, openings over streams, lakes, and wetlands provide distinct gaps or natural breaks in the forest canopy. The complexity of riparian plant communities is mirrored in the high numbers of animal species, both aquatic and terrestrial, which are dependent on the riparian area.

During catastrophic wildfires, riparian plant communities may have a higher survival rate than nearby upland areas. The higher humidities and damper soils adjacent to lakes, streams, and wetlands may help protect plants in these areas, particularly the larger conifers. As a consequence, riparian zones may play critical roles in recolonizing upland plant communities following wildfire and other major disturbances.

TIMBER

Riparian areas can include very valuable and productive timber stands within a landscape, but they can also include areas of low productivity, and unsuitable or damage- prone growing sites. Riparian soils are often poorly developed assortments of stream sediments, flood deposits, and decaying riparian litter. Rooting zones are frequently inundated by elevated water tables with attendant anaerobic conditions, which can lead to shallow rooting and poor nutrient regimes. During floods, streamside trees are battered, and young trees are frequently uprooted or buried. Undercut and oversteepened streambanks often increase the rate of mortality of streamside trees. Riparian areas contain potential timber resources, but the ecological values of riparian trees for riparian-dependent resources may be higher than their commercial timber value and should be considered.

RECREATION

Except for certain types of hunting, most of the Chippewa National Forest's dispersed recreation occurs in the riparian area, where scenic values are high. Many recreational activities depend on healthy riparian areas, including picnicking, hunting and fishing, wildlife viewing, canoeing, swimming, and boating. All developed campgrounds and most dispersed campsites in the Chippewa National Forest are located within riparian zones along streams and lakes. In fact, over 70% of the total recreational use on the Chippewa and Superior National Forests is associated with riparian areas (Ilhardt and Parrott 1990).

Riparian resources provide a variety of recreational uses, including dispersed and developed camping, swimming, fishing, hunting, and boating.

HERITAGE RESOURCES

Humans throughout time have tended to live near water even though climatic conditions were very different through the Paleoindian era (10,000-5,000 B.C.) to the Archaic (5,000- 500 B.C.) and Woodland (500 B.C.-1650 A.D.) periods. The availability of water and aquatic resources probably had a major effect on human subsistence strategies. Lifestyles changed from nomadic in the Paleoindian era to those with more structured social and spiritual organizations in the Woodland period. These changes were probably due, in part, to the increased availability and stability of water and water-dependent resources such as wild rice and fish.

Riparian archeological and historical sites therefore are rich in aquatic and riparian ecological information and data on human interaction and their influence on the environment.

SUMMARY

Intact riparian areas serve a major role in the maintenance of numerous forest-wide resources. Riparian areas also draw more people for recreation than any other area. Their protection and rehabilitation are essential for maintenance of these resource values. Moreover, interconnected, intact riparian areas are essential for the maintenance of their diverse functional values. Managers should carefully consider riparian management throughout watersheds and over the forest landscape. Riparian areas provide the critical links among an array of different forest-wide resource values.

Landscape Management

3

Chapter Three

Chapter 3: Landscape Management

This chapter addresses ecosystem management of riparian areas at large spatial scales. Ecosystem management is based on maintaining the key ecosystem components such as species, structures, processes, and patterns to ensure the long-term productivity of the landscape as well as maintain the biological diversity. More specifically, the key ecosystem considerations for riparian area management at the landscape scale would be:

- the riparian-dependent biological diversity;
- the patterns of plant communities of different composition, structure, and age classes;
- the geomorphology of terrestrial and aquatic systems, and soils; and
- the large-scale processes such as movement of big game, and disturbances such as wildfire and flooding.

Analyses should focus on key ecological linkages at large spatial scales. Examples would include how desired future conditions for stands would affect hydrology and water quality, or how the relative abundance of different habitat would determine populations of wildlife species or their ability to move through the landscape.

Ecosystem processes operate at many different scales from microbial N-fixation in a rotting log to movement of species across landscapes in response to climate change. Planning for riparian area management, as all planning, should recognize the different scales of interest. It also should be designed to view scales from a hierarchical perspective, considering relationships among scales, both up and down. While it is obvious, it is worth emphasizing that the various biological, ecological, and social- economic factors should be evaluated at the most appropriate scale.

Generally, coarser scales of analysis will determine policies and broad objectives which in turn guide the formation of project objectives at finer scales. It will be necessary, however, to revisit broad objectives to see if the site-level actions/prescriptions will meet those objectives.

The primary goal of riparian management is to provide productive and self-sustaining riparian areas that will ensure the desired future conditions of riparian resources. Effective riparian management can take advantage of the natural ability of terrestrial and aquatic ecosystems to sustain their structure and function. Land use practices that maintain the natural patterns and dynamics of riparian communities across the landscape can eliminate long-term degradation of riparian resources.

The range of natural ecosystem states can serve as an important reference for establishing desired future conditions at all scales including the landscape. The range of natural states may not, in itself, define the desired future conditions, but rather suggest risks associated with management decisions which depart from the natural state. A current working hypothesis of ecosystem management is that an increase in the deviation from natural ecosystem states increases the risk of losing key components. Stated another way, it is less likely that goals will be met if management practices radically deviate from, or are counter to, natural conditions and processes.

The Chippewa National Forest has been divided into smaller landscape units called Landtype Associations (LTA) based on glacial geology. LTA's might prove a useful level of stratification for landscape planning. They range in size from about 25,000 acres to a few hundreds of thousands of acres (Figure 5). Specific project areas would occupy only a small portion of a particular LTA.

Effective land management maintains the ecological linkages of riparian resources throughout the entire forest landscape, however. Focusing only on LTA's or the individual project areas within them may jeopardize the long-term integrity of riparian resources at larger spatial scales. Management of forest landscapes must identify and retain the natural patterns of riparian resources at scales ranging from specific logging sites to multiple drainages.

The above discussion has focused on spatial scales, but the effects of forest management on riparian resources also spans time scales ranging from immediate post- harvest effects to long-term changes in vegetation and geomorphology over centuries. The spatial considerations must be evaluated through long time periods, preferably two rotations or more.

LANDSCAPE PATTERNS

Riparian corridors can help provide a natural connectivity between different management areas distributed throughout the Chippewa. For example, late succession or old-growth forests could be better linked by the mature to old-growth forests within riparian areas than by patches of young clearcuts or plantations. These riparian areas can also serve as corridors for the dispersal of plants and animals between logged and roadless areas, special habitat management areas, and designated recreational lands. The landscape of the Chippewa National Forest includes portions of two major drainages (Hudson Bay and Mississippi River), 699 lakes, and vast tracts of wetlands all of which could provide the continuity (Figure 6; Table 1).

Sub-Watershed Name	Acres Within National Forest	Number of Lakes	Acres of Lakes	Miles of Stream
Red River	10,200	4	270	4
Upper Bowstring	107,300	68	11,456	64
Bowstring River	62, 500	20	15,781	36
Popple River	92,100	22	9,386	74
Big Fork River	121,700	42	3,577	133
Rice River	45,100	82	4,902	45
Turtle River	103,400	43	8,434	90
Cass Lake	59,300	26	26,974	10
Third River	47,400	15	1,375	50
Lake Winnibigoshish	184,100	48	60,276	65
Boy River	118,500	86	24,735	60
Leech Lake	302,300	87	124,372	62
Leech Lake River	111,000	18	4,892	59
Deer River	21,100	33	1,631	9
Mississippi River	109,600	24	8,969	90
Prairie River	41,500	68	10,414	20
Willow River	60,000	13	3,736	53
Totals	1,597,100	699	321,180	924

Table 1. *Acres of lakes and miles of streams within sub-watersheds of the Chippewa National Forest.*

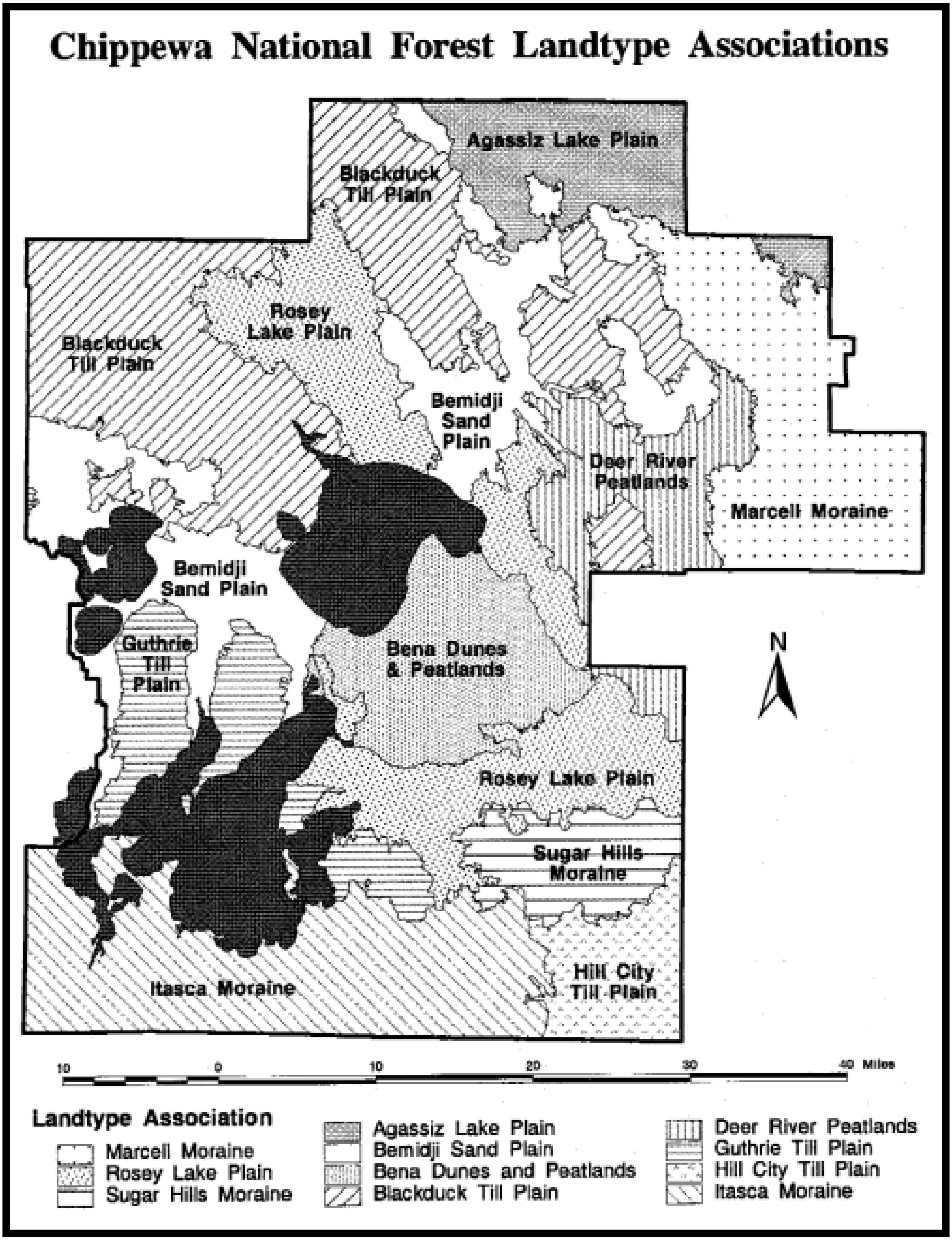


Figure 5. *Chippewa National Forest Landtype Associations.*

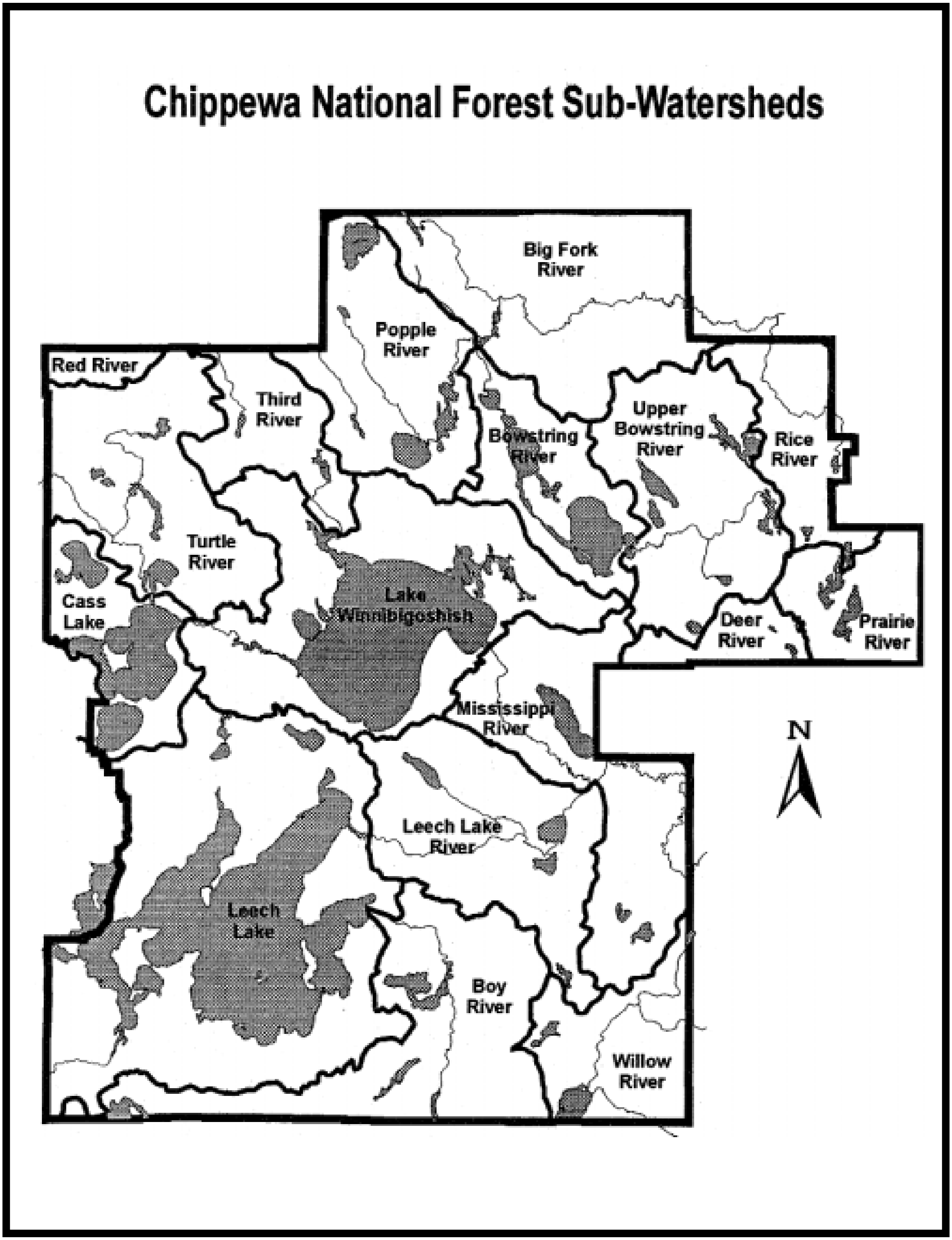


Figure 6. *Chippewa National Forest sub-watersheds and major lakes and streams.*

As forest landscapes are changed by land use practices, catastrophic disturbances, or climate change, riparian areas serve as networks for the routing of water and sediment and the dispersal of plants and animals. Transport of water, suspended matter, and organisms from headwaters to lowlands is a conspicuous function of streams and rivers, but upstream transport and dispersal through lakes also occurs, either through active movement of organisms or passive transport of propagules and material. The rich pool of plant and animal species enhance the role of riparian areas in dispersal across the landscape. This ecological function is even more critical when fire or other disturbances alter upslope forests more than those associated with streamsides.

The natural landscape of the Chippewa National Forest was formed primarily by glaciers, resulting in a mosaic of upland and wetland vegetation types of varying patch sizes. A fundamental characteristic of this landscape is that patches of similar vegetation are frequently isolated and unconnected.

Since they dominate the landscape, aquatic systems on the Chippewa National Forest tend to be more connected than the upland systems, which are more fragmented because they are separated by varying soil types and aquatic systems. Intricate networks of streams, lakes, and wetlands link remote areas of the Forest. In addition, the unique topography and environment of riparian areas alter patterns of terrestrial disturbances such as wildfire and insect outbreaks.

The flora and fauna native to the Chippewa National Forest have evolved with this landscape pattern, and landscape management should consider the dynamics and characteristics of this pattern. No other landscape feature rivals the importance of riparian forests in linking forest resources and the multitude of land use designations across the Chippewa National Forest. The connectivity of aquatic systems should be maintained to serve as refuge and dispersal corridors. Connectivity of upland habitats is more a function of spatial distribution and proximity to other patches of similar habitat. Riparian management can be used to enhance these spatial attributes.

LONG-TERM CHANGES IN FORESTS

Consideration of broader spatial scales in landscape management also requires broader temporal scales over which processes such as forest succession and channel development operate. From the perspective of human lifetimes or forest rotations, we often think of 10-50 years as "long-term". However, the ages of old-growth pine forests on the Chippewa can exceed 250 years. Over that interval of time, streamside forests have the potential to change successionally from young stands of shrubs and deciduous trees to stands including significant amounts of pine. As mortality creates canopy gaps, through time those stands will begin to develop characteristics of old-growth forests. The rather short rotations associated with current forest management on the Chippewa cover only a fraction of the potential natural age of many forest stands.

Geomorphic processes operating during the ice age have shaped the landforms of the Chippewa National Forest. Rare flood events that occur at intervals of several decades to centuries reshape the stream channels, and wind storms and ice reshape lakeshores. However, land use changes over the last century have more radically altered the riparian areas than disturbance by flooding or storms. Over the last century, the Forest has been exposed to gradual changes in carbon dioxide, atmospheric pollutants, point-source and non-point-source discharges into streams, and possible climate change. Timing of these events has ranged from acute, immediate impacts to barely perceptible change. The future integrity of the forest and stream ecosystems depends heavily on our ability to recognize and respond to environmental change. Monitoring programs are essential for detecting shifts in the status of forests and streams. Management of riparian resources across the Forest should maintain intact, functional ecosystems with sufficient continuity for the dispersal of organisms and resources.

MARGINS FOR UNCERTAINTY

The Forest Service has identified the unique ecological importance of riparian resources and floodplains and has established national policies to guarantee their integrity. Forest Service policy states that riparian-dependent resources receive preferential consideration in forest management along streams and around lakes and wetlands (FSM 2526.03). Any removal of riparian vegetation should be justified, both ecologically and administratively.

Given the high value of riparian resources on the Chippewa National Forest and the associated administrative and economic benefits, a policy of managing riparian areas for riparian objectives should be seriously considered. This maintains a diverse array of options for future forest management. Prioritizing the management of riparian resources for their ecological values will not only promote effective management of water quality, aquatic resources, and wildlife resources, but also provides essential elements for integrated management of other forest resources.

CONCLUSIONS

Over the long time frames of geomorphic processes and forest succession, issues of forest fragmentation, catastrophic disturbances, and cumulative effects are no longer hypothetical questions. These environmental changes are inevitable consequences of patterns imposed on the landscape and occurrence of infrequent, but highly probable events. The major questions facing land managers are not whether these processes will occur, but rather what the rate and magnitude of change will be.

An ability to develop a broader landscape context for site-specific Forest practices would help shape future riparian management. Entire floodplains must be managed to function during the large flood events that occur at 50 to 100-year intervals. Managers must understand the processes of regeneration, growth, and mortality that determine the unique stand dynamics of riparian forests. These challenges require new and broader perspectives of our forests, lakes, and streams across the landscape of the Forest.

4

Watershed Management

Chapter Four

Chapter 4: Watershed Management

WATERSHED STRUCTURE AND FUNCTION

Watersheds are made up of a network of collective streams, wetland complexes, and riparian corridors. Processes in upper hillslopes and headwater areas influence downstream regions through the continuity of riparian areas and streams. Floods sculpt existing channels and deposit sediments on floodplains. These floods alter development of riparian plant communities and provide fresh surfaces for plant colonization.

Geomorphic processes determine the structure of riparian areas and the shape and size of streams, lakes, and wetlands. Adjacent hillslopes may locally restrict river valleys, but gentle topography and broad valleys may allow development of extensive floodplains in other areas. Within a watershed, local landforms determine the hydrology, channel and lake morphology, location and distribution of wetland types, and floodplains in successive downstream reaches.

Stream channels and valley floors may be **constrained** by geomorphic features such as bedrock, hillslopes, earthflows, or alluvial fans (Figure 7). Such streams and valleys will be "pinched" and relatively straight, with few secondary channels, backwaters, or lateral complexity. The narrow valley floor also means the riparian area will be relatively narrow and simple. Riparian plant communities may be similar in species composition to the adjacent upland communities. During floods, stream flows are confined in the narrow valley; consequently, the erosive energy of the stream increases rapidly with increasing discharge.

Stream channels in a flat landscape or where the valley floors are not confined by geomorphic features are termed **unconstrained** (Figure 7). These portions of a watershed have broad floodplains upon which streams can meander, often forming a complex network of secondary, intermittent, and ephemeral channels. Riparian vegetation is characterized by mixed patches of herb, shrub, and tree-dominated communities, and are almost always distinctly different from adjacent upland vegetation. At high flows, the stream may spread across the broad valley floor, dissipating much of the water's energy. These broad floodplains and riverine wetlands offer complex, yet productive, habitats for fish and wildlife.

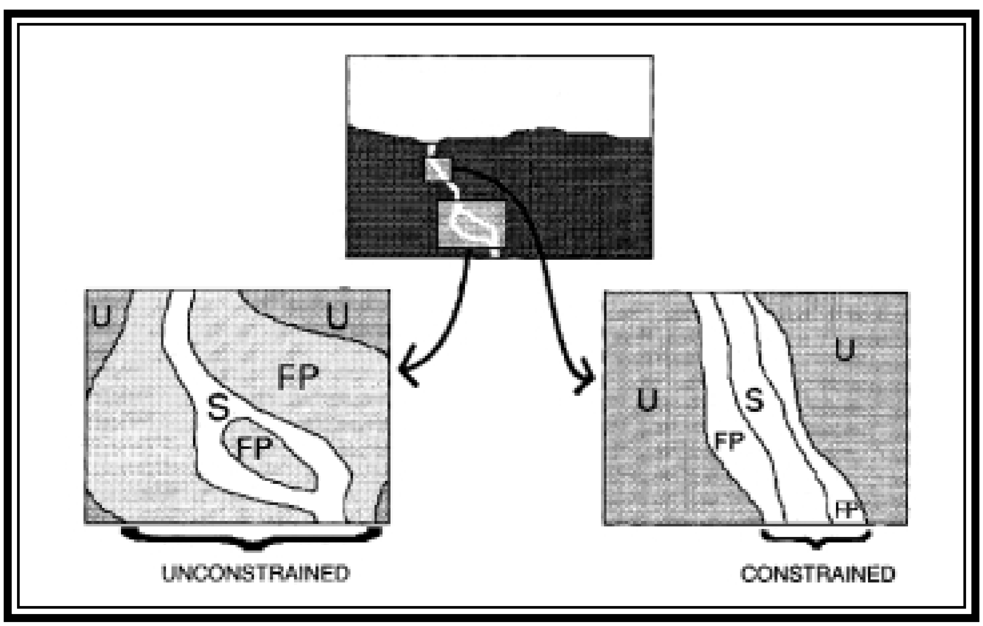


Figure 7. *Constrained and unconstrained stream channels. Note the more complex channels on the broad floodplain. S-stream; FP-floodplain; U-upland.*

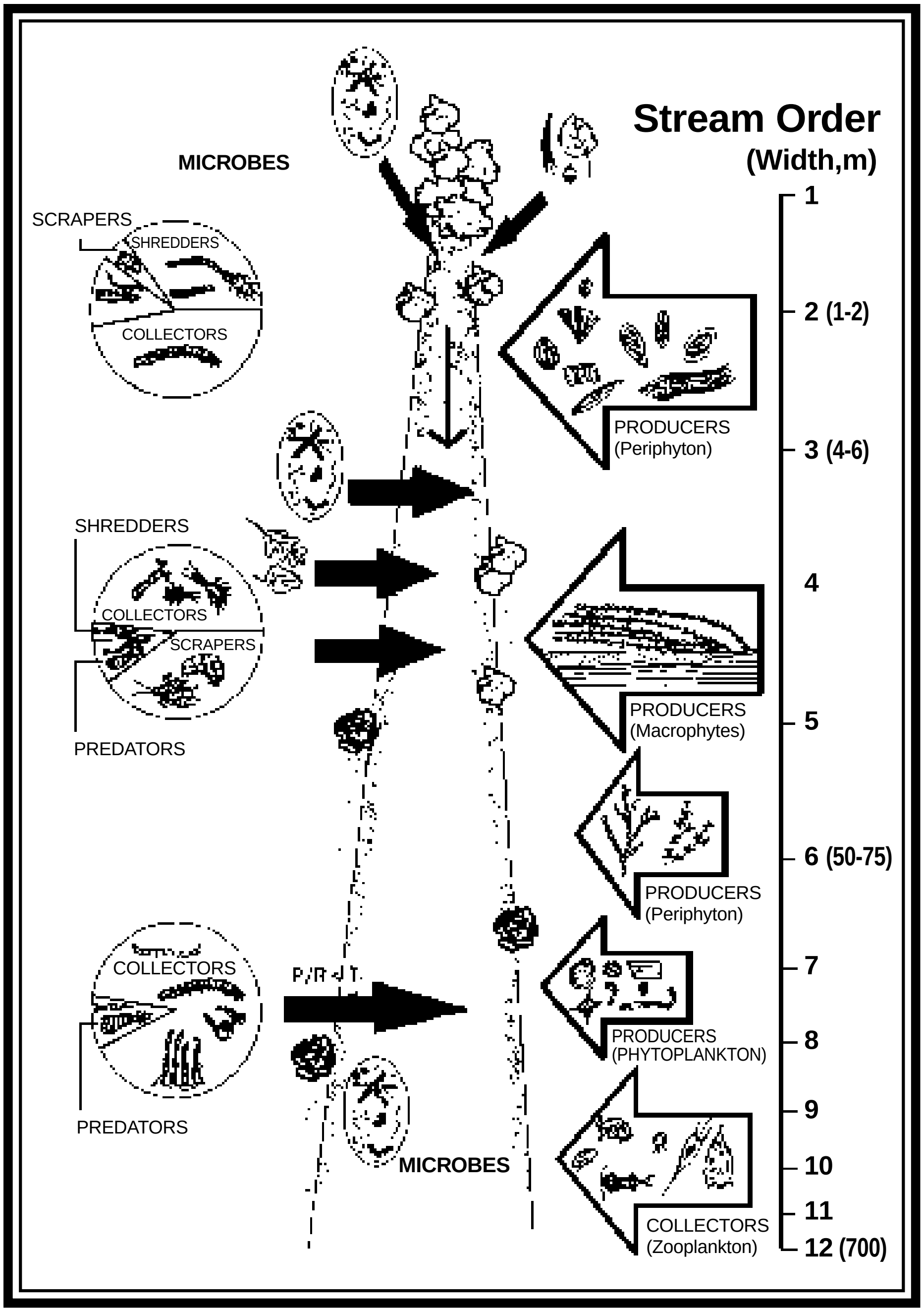


Figure 8. *Changes in aquatic communities from small streams to large rivers illustrate the River Continuum Concept.*

Unconstrained stream channels generally provide more habitat for fish and wildlife than constrained channels.

Although they may be locally controlled by geomorphology, streams also modify the landscape. They alter valley form by erosion and sediment deposition, creating terraces and floodplain surfaces of varying heights and ages. Within the stream channel, floods create or destroy islands and gravel bars, and redistribute sediment and woody debris.

Watershed perspectives are essential for developing management objectives for both flowing and standing waters. Lakes and wetlands frequently are viewed as isolated bodies of water, but they receive water supplies from the surrounding forests, and they are frequently connected hydrologically to river systems. Thus, land use practices in upland forests within a watershed can greatly affect these aquatic systems. Even seemingly isolated wetlands and lakes within a watershed can be connected to one another and to streams and rivers through groundwater.

The River Continuum Concept

The structure of aquatic communities and rates of ecological processes in streams and rivers change from small headwater streams to downstream rivers which in turn influence the lakes and ponds they flow in and out of. These longitudinal patterns reflect changes in both the geomorphic processes that create stream channels and floodplains and the interactions of streams with the adjacent terrestrial ecosystems.

Linkages between the structure and function of stream ecosystems and the physical processes and environment of streams is the basis for a major conceptual framework in stream ecology known as the River Continuum Concept (Figure 8; Vannote et al. 1980).

Small Streams

In small headwater streams (First to Second Order), the food base is composed primarily of leaves, needles, wood, and insects from the adjacent forest. The small stream channel is heavily shaded by the forest canopy. As a result, little sunlight reaches the stream and aquatic plant production is low. The input of terrestrial litter provides the bulk of the food base (energy) for the aquatic organisms that make up the stream communities.

In these shaded streams, aquatic invertebrate communities are composed primarily of shredders, which are organisms that feed by tearing large particles apart. Most shredders in these streams are feeding on the detritus, or dead organic matter, derived from the forest litter. Invertebrate predators make up approximately 25% of the invertebrate communities, a proportion that remains fairly constant from small streams to large rivers (Hawkins and Sedell 1981; Minshall et al. 1983). Fish community assemblages in these small streams tend to be simple and are usually composed of minnow and darter species.

Intermediate Streams

In streams of intermediate size (Third order), the wider stream channels create natural openings in the forest canopy, allowing more sunlight to reach the water surface. Production of algae and other aquatic plants increases with greater light intensities, while the relative contribution of forest litter decreases because inputs are restricted largely to stream margins.

In intermediate streams, the aquatic invertebrate communities are composed of both scrapers and shredders, reflecting the shift in the food base. Scrapers are invertebrates which obtain their food by scraping algae, bacteria, etc., off the surface of rocks and other substrates. In streams as well as in ponds and lakes, microscopic plants or algae create a film over every wetted surface, and the scrapers feed primarily on this food resource. Shredders are still found, but they make up a smaller proportion of the total. Fish communities become more diverse, commonly including larger minnows, chubs, and sucker species.

Large Rivers and Lakes

In the larger rivers (Fourth order and larger), the food base largely reflects instream plant production, organic matter from upstream reaches, and organic material from adjacent floodplains. These larger river channels may be extremely wide, with the forest canopy restricted to a relatively narrow fringe along the edge. When the rivers are shallow and clear, aquatic plant production on the river bottom can still provide the majority of the food base. In deeper, more turbid rivers, phytoplankton or suspended algae are a major component of the aquatic plant production. In both cases, the delivery of organic matter from upstream reaches is a significant component of the food supply. Often this organic matter is made up of small particles that have been broken or eaten by organisms in upstream areas.

The energy base for lakes and ponds is derived primarily from the primary production of aquatic plants, emergents, attached algae, and phytoplankton. The productivity of these aquatic systems is a function of the nutrient regime which is determined by inputs from streams, riparian wetlands, and groundwater. Inputs of litter and coarse debris to the aquatic system still play important roles, but their contributions to the energy flow through the food chain are proportionally less.

At first glance, one might assume that the interaction of the forest with the stream is diminished in larger rivers because of the wider channels and limited riparian fringe, but this is not the case. Development of extensive floodplains in large rivers creates a new facet in the interaction of forests and streams. During most of the year, floodplain forests produce tremendous quantities of organic matter that are stored on the surface of the floodplain. During floods, the river captures some of this organic matter and delivers it to the main channel. In addition, the flushing of dissolved material from the floodplain soils contributes a rich supply of dissolved nutrients for aquatic communities. In many rivers, production of fisheries and other aquatic communities increase after major floods, a phenomenon known as the flood pulse concept (Junk et al. 1989). Thus, floodplains along streams and rivers increase the interactions of the stream with the adjacent forests, creating important ecological linkages between land and water throughout a river drainage.

Invertebrate communities in large rivers are dominated by collectors, a functional feeding group of aquatic organisms that obtain their food by collecting small particles. Collectors may obtain their food in this flowing environment either by gathering or filtering. Gatherers sweep up the fine particles by brush-like appendages. Filterers attach nets to the bottom that filter particles from the water. Other filterers have comb-like appendages that filter particles from the water around them. Scrapers still make up an important component of invertebrate communities, but shredders are a small portion of the assemblage. Fish communities in lower rivers contain many more species such as walleye, muskellunge, redhorse, and suckers. Many species found in the smaller streams are not present or become rare, and several species that are found only in larger rivers are added to the community.

This natural progression of communities and ecological processes in streams is based on interactions with adjacent forests and physical processes that shape stream channels. Land use practices can change both of these factors and subsequently may alter the natural pattern of stream and lake ecosystems within a watershed. Recognition of the intricate linkages between terrestrial and aquatic ecosystems and from headwater streams to downstream lakes and rivers is essential for effective management of aquatic resources within a watershed.

Wetlands

The wetland/upland edge has an important effect on the flux of water and materials in a landscape; an effect which diminishes with increasing distance from the wetland edge (Johnston et al. 1990). Undisturbed wetlands retain nutrients and sediments and act as filters for receiving waters. Cycling of nutrients in wetlands includes the breakdown or storage of plant material. Decomposition releases soluble materials to the water, where many are taken up by growing vegetation. Other products of decomposition, such as carbon dioxide, methane, and hydrogen sulfide, are recycled into the atmosphere (Carter et al. 1978).

Headwater wetlands tend to be discharge areas where soil water and ground water surface to become the origin of streams. The location and distribution of wetlands within a basin influence the flow distribution in streams. Tributary wetlands desynchronize tributary and main channel peaks (Carter et al. 1978).

In addition to trapping sediments and providing flood water storage, wetlands provide habitat and food chain support for both aquatic and terrestrial animals. Many species of wildlife inhabit headwater wetlands, including spring salamanders, wood turtle, common mergansers, and neotropical birds, among others (Welsch et al. 1995). Amphibians and reptiles rely on the edge effect of wetlands. Amphibians tend to use wetter zones, such as vernal pools and headwater wetlands, for reproductive purposes, but exploit drier sites, along the wetland margins, for other purposes. Reptiles use wetter zones for food and cover, but migrate to drier sites to lay their eggs (Wigley and Roberts 1994).

Cumulative Effects

Processes in headwater areas influence downstream regions through the riparian network. Consequently, poor management practices along small, headwater streams can be transmitted and can even be amplified throughout a watershed in the form of altered streamflow, water quality, and sediment transport. Small, individual activities can have significant, additive impacts or cumulative effects when combined on a watershed level.

An example of terrestrial processes resulting in cumulative impacts is the change in run-off patterns and streamflows after harvest. Practices such as felling, yarding, roading, and slash burning occur on relatively small units. These activities lead to changes in site processes, such as increases in snow accumulation, snow melt rate, and surface erosion. During a single large flood event, these individual alterations collectively may lead to substantial increases in streamflows and erosion rates downstream.

Research at the Marcell Forest Experiment Station has shown that young stands of aspen have a more rapid rate of snowmelt because the dense suckers act as heat sinks and reradiate the heat to hasten snowmelt (Verry et al. 1983). Cumulative effects from this process become most critical in a landscape where more than 30% of the area is in agricultural land, more than 2% of the forest area is being cut per year, and where the topography has only a small area of wetlands (which buffer run-off) and higher-gradient streams.

Within streams, cumulative impacts may result from forest practices which result in the removal of woody debris from stream channels, banks, and floodplains. Removing this woody structure can destabilize stream channels, often resulting in wider, more shallow streams. During storms and floods, increased sediment loads from small channels will be more easily routed into larger streams and deposited lower in the watershed.

These processes emphasize the strong linkages between terrestrial and aquatic systems, between hillslopes and valley floors, and between upper and lower portions of a drainage network. This connectivity has important implications for management practices. Changes in one part of the watershed may strongly affect other areas. Upland conditions are especially important to riparian areas. For example, poor harvest practices and roads can input large amounts of sediment to lakes, wetlands, and stream channels from the uplands. Roads, trails, parking lots, and clearcuts may increase surface run-off and peak discharges, which, in turn, significantly affect stream channel and valley floor morphology, riparian area vegetation, and fish and wildlife survival. Other types of cumulative effects include changes in water temperature, stream chemistry, and visual quality of scenic corridors.

WATERSHED PLANNING

Land use planning in the National Forest system has operated at two scales: broad project areas that may encompass several thousand acres and individual harvest units within a project area. Ideally, any project should include an analysis of effects on the watershed, including effects on riparian areas, and as discussed in the previous chapter, a landscape-scale analysis should also be conducted.

Planning for riparian management is part of a broader planning process that includes an analysis of all Forest resources within a watershed or collection of smaller watersheds. This scoping phase, which must meet the requirements of the National Environmental Policy Act, includes the following sequence of tasks:

1) Form an interdisciplinary planning team of experts in the necessary technical fields. The team considers both riparian and hillslope areas.

2) Document watershed management objectives as a basis for developing specific proposed actions.

3) Identify watershed management objectives of all federal, state, and local resource management agencies.

4) Assemble preliminary resource information based on inventories.

5) Inventory riparian resources within the project area, if additional information is necessary.

6) Identify issues and opportunities within specific watersheds.

7) Identify the desired future conditions.

8) Develop alternative strategies for meeting project objectives.

9) Analyze direct and indirect effects and cumulative impacts of the alternatives.

10) Identify a preferred alternative.

11) Design a monitoring plan to determine if the desired future conditions are being achieved.

The scoping phase outlined above examines all Forest resources. Riparian objectives related to the watershed scale are described below. More specific riparian objectives are provided in Chapter 6 on Project Planning.

Watershed planning should focus on at least four major items:

- minimizing the potential for cumulative effects;
- maintaining potential inputs of woody debris;
- maintaining continuous riparian corridors, with structurally complex plant communities and downed timber throughout the watershed; and
- rehabilitating degraded riparian resources within the watershed.

Cumulative Effects

Protection of riparian areas minimizes the potential for deleterious cumulative effects. To minimize or to prevent cumulative impacts in a given watershed, the planner must first assess their probability of occurrence before deciding to implement land-disturbing activities. Systematic analyses of cumulative effects are applied at a watershed scale. Cumulative effects analysis for each watershed includes preliminary information based on resource inventories of:

- hydrologic condition,
- composition of aquatic communities,
- composition and condition of upland vegetation,
- stream temperature patterns,
- erosion potential,
- history of erosion,
- location and condition of roads,
- present riparian condition, and
- degree of riparian continuity.

Potential impacts of future activity within National Forests and downstream from the Forest boundary should then be estimated. Secondly, objectives for minimizing cumulative effects are developed. Finally, watershed management practices are prescribed.

Large Woody Debris

Watershed management should consider the maintenance of future sources of woody debris in riparian areas of wetlands, lakes, and streams. This may be a primary vegetation management objective within riparian management zones, especially where woody debris has been removed or lost. Rehabilitation projects may be required to replace woody debris over the short- and long-term. Where desired, the reestablishment of mature riparian forests should be considered to provide sizes and amounts of woody debris characteristic of undisturbed forests. Riparian areas may require as much as a century to recover the ability to supply woody debris at natural amounts and rates to floodplains, wetlands, stream channels, and lakes.

Riparian Corridors

Riparian areas should be assessed over entire watersheds to evaluate their continuity and to identify unique riparian resources. Systematic inventories of valley landforms and plant community structure and diversity provide a framework for watershed assessment. Geographic information systems (GIS) can greatly simplify such analyses.

Rehabilitation

Watershed planning includes evaluation of riparian areas in previously harvested or damaged areas as well as intact or uncut locations. In damaged watersheds, protection of riparian resources beyond routine management practices may be required to promote riparian recovery. In addition, intensive rehabilitation projects may accelerate the return to desired ecological conditions. Management of riparian areas for sustained ecological function over the long term is ultimately more cost-effective than short-term gains in convenience or commodity. To this end, management strategies, both at the watershed and site-specific levels, should be responsive to current and future riparian conditions.

Project Planning

5

Chapter Five

Chapter 5: Project Planning

Site-specific riparian management prescriptions can be developed after watershed management objectives for riparian areas have been identified by the planning team. A single prescription or cookbook approach is not appropriate for riparian management. The following chapter outlines considerations and techniques for protecting, managing and enhancing riparian area conditions. Although these considerations and techniques represent our best attempt to apply the science, we recognize that there may be other equally valid means of achieving desired conditions in riparian areas. To achieve the most effective riparian management, current site conditions and desired future conditions or site objectives should be considered in developing prescriptions for individual sites (Figure 9).

MANAGEMENT OBJECTIVES

Site planning must meet the requirements of the National Environmental Policy Act and all Executive Orders directed at riparian resources (EO 11988 and 11990). Stream size and flow regime strongly influence both unit and watershed management objectives, as do size and condition of lakes and wetlands. Site-specific objectives for management of riparian zones are described in the following sections. Evaluation of riparian areas within a site should consider specific objectives for:

- water quality,
- active channel and floodplain,
- woody debris,
- fish,
- wildlife,
- vegetation,
- recreation and visual quality, and
- heritage resources.

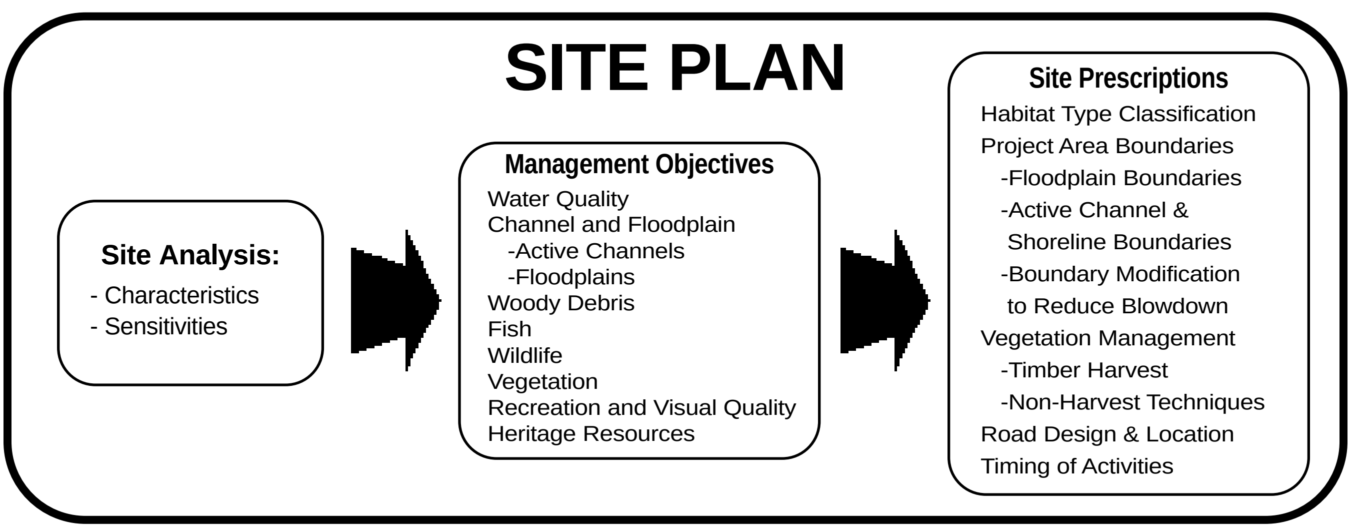


Figure 9. *Components involved in developing a Site Plan.*

Water Quality

The Chippewa National Forest's water quality objectives are designed to:

- maintain natural water temperature variation,
- minimize increases in sediment loading and transport,
- minimize increases in nutrient loading above natural levels,
- prevent decreases in dissolved oxygen concentrations,
- minimize physical alterations to wetlands, and
- maintain the biologic integrity of aquatic and wetland systems.

In warm and cold water (Class 2A) lakes and streams, there must be no material increase above naturally-occurring water temperatures (MN Standards 7050). In warm water lakes and streams (Class 2B and 2C) temperatures must not exceed 5º F above natural levels in streams and 3º F above natural levels in lakes (based on a monthly average of maximum daily temperatures), and in no case shall it exceed a daily average temperature of 86º F.

In Class 2A lakes and streams, turbidity should not exceed 10 NTU's, and dissolved oxygen concentrations should meet a 7 mg O2/l daily minimum. In Class 2B and 2C lakes and streams, turbidity should not exceed 25 NTU's, and dissolved oxygen should meet a 5 mg O2/l daily minimum (MN Standards 7050).

Fecal coliform levels in all lakes and streams from March 1 through October 31 will not exceed 200 organisms/100ml as a geometric mean of not less than 5 samples in any calendar month. Nor shall more than 10% of all samples taken during any calendar month exceed 2,000 organisms/100ml. In all waters, pH will range from 6.5 to 9.0 , and there will be no material increase in slime growths or aquatic plants, including algae. There will not be a significant increase in pesticides, sediments, or other residues that may have a negative effect on the aquatic biota. The migration of fish and aquatic biota will not be prevented or hindered by activities (MN Standards 7020).

Water quality standards for Class 2B waters apply to all wetlands, except that temperature, pH, and dissolved oxygen will be maintained within a range exhibited under natural background conditions (MN Standards 7050).

To meet these standards on all larger streams, water quality of upstream channels must also be maintained. These smaller streams have significant effects on water quality of the larger channels throughout the watershed, particularly during summer low flows. In addition, areas of subsurface flow (i.e., debris accumulations, floodplain wetlands, seeps, and springs) provide cool, well-oxygenated water to downstream reaches.

Water quality objectives can usually be met through stringent riparian area protection. Use of forest chemicals (e.g., herbicides, fertilizers, insecticides, road oils) near riparian areas is discussed under specific Chippewa National Forest Standards and Guidelines.

Channel and Floodplain

The overall objectives for channels and floodplains are to:

- maintain channel complexity and stability,
- maintain full floodplain functions, and
- minimize risks of cumulative effects.

In general, land use practices should minimize changes in geomorphic stability, sediment loading, and storage capacity for sediment and water.

Management of first-order and intermittent streams should: 1) maintain local geomorphic stability, and 2) provide large woody debris to create stable channel structure. These objectives are designed to protect downstream riparian-dependent resources. In second- order and larger streams, the geomorphic objectives of riparian management are (1) to maintain the physical characteristics of the stream channel and floodplain and (2) to minimize delivery of sediment to the channel.

Riparian areas around lakes are managed to maintain shoreline integrity and habitat. Wetlands, such as seeps or marshes, may have irregular, poorly-defined margins, and riparian management should retain the complexity of these edges which contributes to habitat.

Active Channels

Management should capitalize on natural processes to maintain or restore the geomorphic structure to a more natural condition. The following characteristics of stream configuration should be evaluated and monitored to help ensure long-term stream stability:

- width and depth,
- stream course,
- channel gradient,
- streambed topography,
- streambed and bank materials, and
- large woody debris.

Stream channels are dynamic and are re-shaped during major flood events. If geomorphic stability is decreased by road construction or other management activities, channels will be more susceptible to erosion and will shift more frequently and dramatically. Logs and boulders help dissipate the erosive energy of the stream and are particularly important in maintaining channel characteristics.

Floodplains

Maintenance of floodplain functions is an extremely important and frequently overlooked component of riparian management. Floodplains are formed by deposits of sediment during extremely high flood events. Riparian vegetation protects these areas, and removal of this vegetation by activities such as road construction, recreation site development, or timber harvest makes them vulnerable to massive erosion during subsequent floods.

The riparian management zone should include the entire floodplain. Failure to do so will seriously jeopardize riparian management objectives during major floods. The Forest Service is required by

Executive Orders 11988 and 11990 (FSM 2527.03) to:

- "Recognize floodplains and wetlands as specific management areas."
- "Avoid adverse impacts which may be associated with the occupancy and modification of floodplains and with the destruction, loss, or, degradation of wetlands."
- "Not permit floodplain development and new construction in wetlands wherever there is a practicable alternative."

Streams and floodplains extend beyond the upstream and downstream boundaries of individual harvest units. Site evaluation of riparian areas must consider upstream features that could affect the channel and floodplain within a harvest unit, as well as consequences of harvest activities downstream. Local channel stability and storage potential should be maximized if there are upstream areas with high rates of sediment input or water delivery, or if there are particular downstream resources at risk.

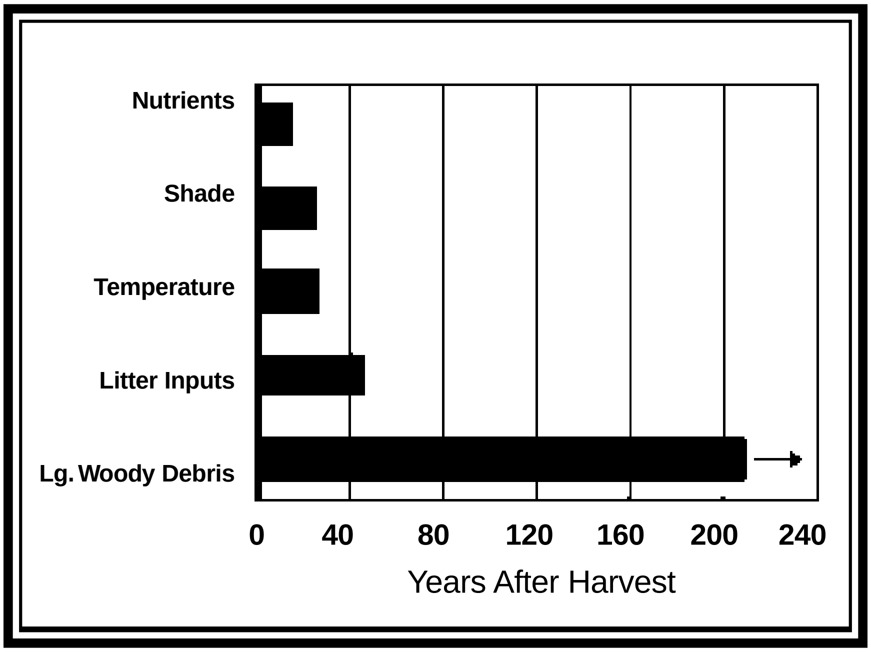


Figure 10. *Years required for ecological recovery of riparian functions after timber harvest.*

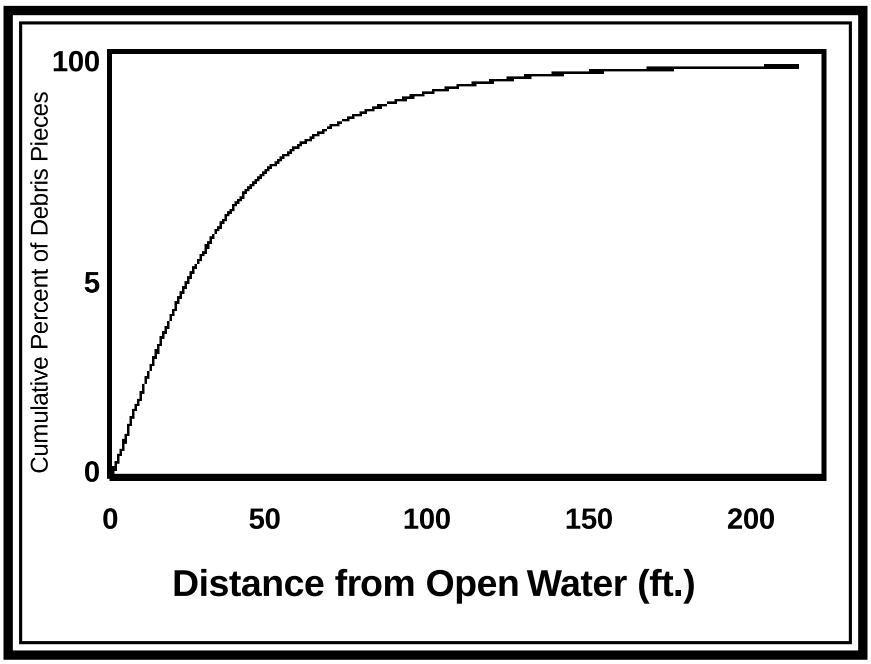


Figure 11. *Proportion of total loading of woody debris from the riparian forest as a function of the distance from stream edge (adapted from McDade et al. 1989).*

Woody Debris

Of all the ecological functions of riparian areas, the process of woody debris loading into channels, lakes, and floodplains requires the longest time for recovery after harvest (Figure 10). Although young forests begin to deliver woody debris after several decades, large diameter logs cannot be provided by forests in much less than a century. Most future riparian functions will be guaranteed if natural abundances and distributions of all sizes of woody debris are maintained in streams, lakes, floodplains, and lower hillslopes.

Accumulations of logs are natural features of streams that contribute to the stability of channels and floodplains.

Large woody debris is contributed to the active channel or lake shoreline by adjacent riparian forest. A recent study of streams in old-growth forests in the Cascades and Coast Range found that 90% of the large wood in the channel originated a distance approximately equal to half the height of the tallest trees in the area (Figure 11; McDade et al. 1989). In consideration of the timber types and slopes on the Chippewa National Forest, managing for long-term inputs of large woody debris to lakes, streams, and wetlands can probably be accomplished within 50 feet of the water's edge. However, consideration of other floodplain functions and wildlife habitats may require wider management zones.

Future sources of woody debris in lakes and streams, including intermittent streams, can be maintained by actively managing for large diameter, decay-resistant trees in riparian zones. In small stream channels, particularly those with unstable, easily eroded soils, woody debris in the channel and on the banks stabilizes the stream and creates new habitat.

Fish

The numerous lakes and streams in the Chippewa National Forest contain over 50 species of fish (Appendix 1). The primary objective for fish habitat management on the Chippewa National Forest is to maintain the quality of habitat and food supply for resident fish populations at all stages of their life cycles. This goal is best accomplished through floodplain, channel, and shoreline protection and maintenance of long-term sources of woody debris to provide:

- spawning substrate of specific size ranges,
- low rates of sedimentation,
- rearing habitat for young fish (complex side channels, backwaters, shallow edges),

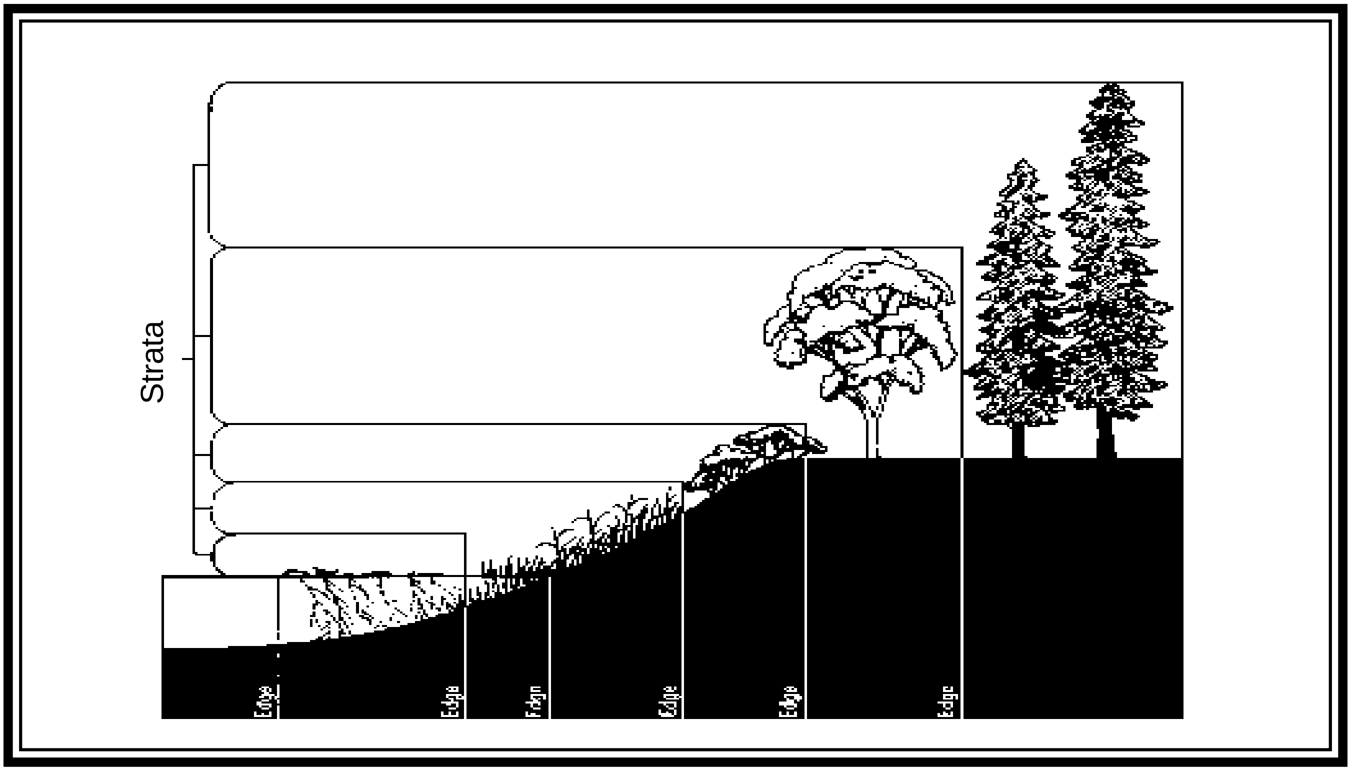


Figure 12. *Riparian zones frequently have a high number of edges and strata in a comparatively small area, which produce habitat for a greater number of species (adapted from Wildlife Habitats in Managed Forests, USDA 1979).*

- cover and food sources for adult fish (pools, debris jams, stable undercut banks, aquatic vegetation), and
- refuge from floods and predators (large woody debris, backwaters, side channels, aquatic vegetation).

Good water quality is essential for fish production. Cool temperatures and low suspended sediments are essential for all fish. Water quality must be protected or enhanced, both in lakes and streams containing fish, and in smaller streams which are tributary to fish- bearing waters.

Fish such as northern pike may move into small perennial and intermittant streams during certain seasons for spawning. Other species may use these streams for rearing or winter refuge. Tributary junctions with fourth-order streams should be closely examined for fish use. These small perennial and intermittent streams are important seasonally for fish habitat and should be managed as though they were fourth-order and larger streams.

Wildlife

A fundamental objective of riparian area management is to maintain habitat diversity critical to wildlife and the forest ecosystem. Wildlife use riparian areas disproportionately more than other forest habitats. Reasons for this disproportionate use include the presence of water, plant species diversity, higher biomass of vegetation due to ideal growing conditions, and complex structure within a relatively small area (USDA 1979). The linear shape of riparian areas provides an increased amount of edge per acre, as well as migration and travel corridors for many wildlife species. Additionally, the more mature the vegetation in the riparian area, the more distinct the edges and strata become, intensifying the edge effect and the structural diversity (Figure 12).

Maintenance of compositional and structural diversity in riparian areas is essential to providing the wildlife habitat which makes these areas so unique. In most situations, even-aged forest management is typically not consistent with maintaining this diversity. The corridor effect of riparian areas should not be fragmented through timber harvest or development activities.

Riparian areas gain much of their diversity through natural disturbance factors which through time, create habitat complexity. Streams and lakes, through current, wave action and flooding, are disturbance factors which can set back riparian area succession, change vegetative structure and alter geomorphology, thereby increasing complexity. These processes through time and space are responsible for the enhanced edges and strata which make up wildlife habitat. Historically, fire also influenced riparian areas in some parts of the Forest. The role of fire should be evaluated in planning and management of specific riparian areas, and should be reintroduced when appropriate.

Beavers are another source of disturbance to riparian areas. Although beavers population levels are high (1995 Aerial Beaver Lodge Survey, Minnesota Department of Natural Resources unpublished data), they have always been a part of the disturbance process and are significant habitat manipulators. Their role in providing the unique characteristics of riparian habitat should be considered when planning and managing riparian areas. Specific consideration should be given to:

- preserving patterns of complex, multilayered canopy for structural diversity, and maintenance of micro-climate and soil moisture conditions,
- maintaining microhabitats for increased species diversity,
- maintain existing and future sources of snags and down woody debris for small mammals, amphibians, reptiles, raptors and cavity dependent species,
- maintaining patterns of mature riparian forest to preserve maximum diversity and edge,
- maintaining dense cover required for nesting and fawning, protecting ponds, seeps and springs which are important breeding areas and microhabitats,
- protecting lakeshores and streambanks used as nesting areas,
- preserving riparian continuity throughout watersheds to ensure contiguous travel corridors for migrating and wide-ranging species such as salamanders and fishers,
- maintaining the disturbance factors which are integral to providing all of the above.

Vegetation

Riparian vegetation is often very rich in species. This is often attributed to the frequent disturbances which provide new areas for establishment, the steep environmental gradients in riparian zones, and extremely variable soil types. Riparian vegetation plays a critical role in the dynamics of forest plant communities as well as providing numerous ecological functions for other aquatic and terrestrial communities. A major objective of riparian management should be to provide species diversity, age composition, and structural complexity of riparian forests.

tiger salamander

Riparian areas contain a diversity of plant communities and complex canopy layers which should be retained.

Recreation and Visual Quality

Riparian areas are among the most heavily used recreation sites in the Chippewa National Forest. Present and future recreational opportunities (e.g., hiking, fishing, camping, boating) should not be impaired by management activities. To this end, visual quality, user access, unique features, and future recreational potential should be evaluated for all proposed management activities. Influence of management activities on recreational values of adjacent areas should be considered.

Conflicts between recreation and ecological values of riparian areas are inevitable due to high demand for these areas. For example, roads and trails provide public access to riparian areas and recreational facilities provide numerous benefits to recreationists, but both can impair riparian resource values if poorly designed. Canoeing and boating on rivers and lakes create possible conflicts between recreation and other riparian resources. Jams of coarse debris and floating logs are hazards for canoes, kayaks, and motorized boats, but this debris is ecologically essential. Compromises between safety and ecological value will be inevitable, particularly at popular recreational areas.

Lakes and their surrounding riparian areas are important recreation sites in the Chippewa National Forest.

Heritage Resources

The primary management objective for the heritage resources program is the protection and enhancement of significant resource values. This can be accomplished by inventory and evaluation to locate significant resources, and design of project activities to avoid or mitigate affects. Specific consideration should be given to inventory and evaluation which provides a framework for understanding:

- changes in heritage site distribution through time,
- human use of riparian resources and influence on the ecosystem, and
- paleoenviromental changes and their effects on human populations.

Although the area of every planned project is individually examined for the presence of heritage resources, research tends to focus on riparian areas. Identifiable late Pleistocene and Holocene coastal and fluvial landforms such as beach ridges or strand lines are known to be especially likely to contain sites. These areas should receive concentrated attention during inventories, even though they may not be associated with modern bodies of water. The reasons for an emphasis on riparian areas is obvious: human beings tend to live near water. Riparian areas provide a variety of both aquatic and terrestrial subsistence resources, as well as travel routes which provide increased resource availability and access to other human groups for socialization and trade.

A particular threat to heritage resources in riparian areas is through erosion. Geomorphic features such as shorelines and terraces tend to be destabilized by hydrologic activity, especially in fluvial environments. Human activities such as construction and concentrated visitor use only exacerbate the problem. In some cases shoreline stabilization may be necessary to protect heritage resource sites.

PROJECT SITE PRESCRIPTIONS

Prescriptions for management projects within riparian areas should be designed to achieve watershed goals and long-term conditions desired for the site (Figure 9). The major components of riparian management for specific project areas include:

- habitat type classification,
- project area boundaries,
- vegetation management,
- road design & location,
- timing of activities.

Habitat Type Classification

The aquatic habitat type associated with a given project must be determined as this forms the basis for developing the site prescription. Specific riparian management guidelines can be developed for major types of aquatic habitats: streams, wetlands, and lakes. Streams and rivers include both perennial streams of different orders and intermittent streams. The riparian management zone will likely vary in size depending on the stream order.

Shallow wetlands, including ponds, swamps, marshes, bogs, and wet meadows, support a prevalence of vegetation or aquatic life requiring permanently or periodically saturated soil conditions for growth and reproduction (FSM 2527.05) and the adjacent riparian area.

Lakes and ponds include major bodies of standing water that are represented on topographic maps of the Forest (either USGS quadrangles or National Forest maps). They include both natural lakes and man-made reservoirs.

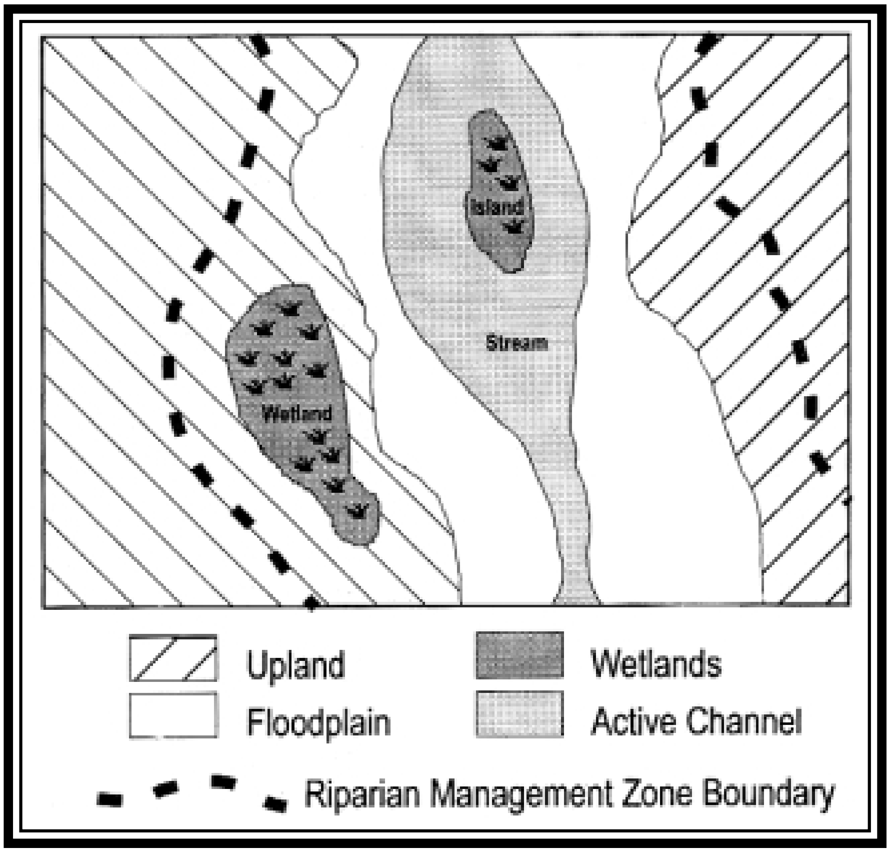


Figure 13. *Riparian management zones along streams should have variable widths in order to protect complex channel structure and unique riparian resources. The entire floodplain should be included as well.*

Correct classification is important because habitat type should be integral in determining riparian management zone boundaries. The Chippewa National Forest has determined stream order for most perennial streams. In smaller headwater streams, especially intermittent streams, existing information on the aquatic biology or the flow regime may be inadequate. The site must then be reviewed on the ground to determine stream order and habitat class.

Criteria for identifying riverine wetlands are described in *Federal Manual for Identifying and Delineating Jurisdictional Wetlands (1987) and in Classification of Wetlands and Deepwater Habitats of the United States.*

Project Area Boundaries

Project area boundaries should maintain riparian continuity within the watershed and preserve riparian floodplain functions. Land managers should establish the location of riparian management zone boundaries, roads, and landings in project design.

For optimal management of riparian resources, riparian management zones should have variable widths that are delineated at ecological boundaries, not at arbitrary distances from the stream, lake or wetland. Riparian areas are naturally irregular or asymmetrical in shape, in response to local topography, geology, groundwater, and plant communities. Consideration of topographic irregularities can both protect riparian resources and simplify project design. Straight, uniform riparian management zones resembling picket fences should be avoided. Unique riparian resources, such as small springs, seeps, osprey nest trees, or sites of active beaver use frequently exist outside standard/average riparian management boundaries. In these instances, managers should consider modifying boundaries to include such areas (Figure 13).

Delineating the boundaries of the riparian management zone will largely determine the effectiveness of subsequent management in meeting riparian objectives. The following sequence of decisions is required to establish boundaries of riparian management zones:

- identify floodplain boundaries,
- locate margins of active channels and shorelines, and,
- modify riparian zone boundaries to reduce risk of blowdown.

Floodplain Boundaries

The entire floodplain should be included within the riparian management zone (Executive Orders 11988 and 11990; FSM 2527.03; Figure 13). The topographic break in slope between the upland and floor of the river valley defines floodplain boundaries. The relatively flat landscape of the Chippewa National Forest sometimes makes floodplain boundaries difficult to discern. Several floodplains of increasing heights may occur between the active channel and the hillslope, reflecting surfaces created during past flood events. Vegetation may change in age or composition at floodplain boundaries; however, many floodplains have forests as old or older than upland stands.

Small, deeply incised streams, and non-riverine wetlands and lakes frequently lack floodplains. In the absence of floodplains, historical high water levels should be considered in these aquatic habitats. These areas may be indicated by evidence of erosion by wave action, reduced plant cover, and sharp transitions in plant community composition.

Active Channel and Shoreline Boundaries

After floodplains have been identified, widths of riparian management zones are established along active stream channels. Delineation of the riparian management zone starts at the edge of the active channel or bankfull level, and extends horizontally on both sides.

Active channels consist of all portions of the stream channel carrying water at normal high flows, not just the current wetted channel. The boundaries are indicated by topographic breaks where frequent channel scour has steepened streambanks. This includes side channels and backwaters which may not carry water during summer low flow. All islands and gravel bars are part of the active channel and not part of the riparian management zone. Frequently, plant abundance is reduced in this area of active channel modification, and plant communities are dominated by herbs and forbs.

Riparian management zones around lakes and wetlands should be measured from the mean annual high water level. In lakes, mean annual high water level is indicated by evidence of recent wave action and absence of extensive plant cover. In wetlands, shoreline boundaries should be determined using 1987 delineation criteria (U.S. Army Corps of Engineers 1987). Breaks in plant community structure and topographic features provide the best means of immediate identification. With most wetlands, case-by-case, on-site determinations of boundaries are required.

Boundary Modification to Reduce Blowdown

Natural accumulations of woody debris in lakes and streams support numerous riparian functions.

One of the major functions of riparian management zones is to provide a future source of large woody debris through windthrow, insects, and disease. The abrupt break in tree height between riparian management zones and upslope openings or harvest units increases their susceptibility to windthrow. Catastrophic blowdown of the majority of trees within the riparian management zone will result in a more abrupt and pulsed loading of debris than intended. Thorough consideration of factors that contribute to blowdown can reduce the risk of catastrophic blowdown.

The stability of riparian management zones adjacent to upland harvest units is associated with factors such as:

- distance to uncut forest in wind direction,
- timber stand density,
- soil moisture, and
- water table depth.

Tree species are known to differ in their susceptibility to windthrow. In the Lake States, red and white pine are the most windfirm, followed by northern hardwoods. This pattern may vary according to geographic location, site history, and local stand conditions.

Steinblums et al. (1984) developed a detailed procedure for analyzing riparian management zone stability in the Willamette, Mt. Hood, and Umpqua National Forests. The local topography, vegetation, and stream channel are evaluated on site, and old windfalls and the pit and mound topography are examined to determine direction of damaging winds and history of blowdown. Indicators of potential natural instability (e.g. jack-strawed trees, bank cutting, debris dams, swamps) are noted. Trees growing in more open stands present less wind resistance and thus less risk of blowdown; natural windswept tree forms provide greater stability.

Layout of riparian management zones can be modified to reduce risk of catastrophic blowdown. Boundaries of riparian management zones can be positioned closer to natural windbreaks (e.g. maturing forests, ridgelines). Riparian management zones can be blended into upslope patches of mature trees within the harvest unit. Areas of maximum width of riparian management zones can be shifted upstream or downstream to take advantage of shelter created by adjacent streamside forests.

Vegetation Management

There are numerous functions and benefits of vegetation and woody debris in riparian areas, and treatment of standing trees, snags, and downed logs should be based on objectives and conditions of the landscape, watershed, and site. Vegetation provides stability to lakeshores and streambanks, intercepts nutrients in run-off, and provides shade, which is important for many aquatic species. Shade helps moderate water temperatures by minimizing warming of water bodies and streams which are tributary to water bodies. Recommended practices to maintain shade have been outlined for Minnesota sites in "Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota".

Large woody debris is crucial to numerous riparian functions over both the short-term (seasons to decades) and long-term (decades to centuries) life of the forest in specific sites as well as downstream areas. Management activities in the riparian management zone should provide for a long-term supply of woody debris to wetlands, streams, lakes, and floodplains.

Silvicultural treatments will often be required to restore or maintain desired vegetation in riparian management zones. Riparian management objectives for a specific riparian zone must first be developed, followed by a prescription of silvicultural treatments which focus on managing vegetative conditions to achieve desired riparian objectives. Silvicultural practices, both conventional and unconventional, may be needed to meet objectives for the site, including: clearcutting for stand replacement, thinning to increase the diameter of remaining trees, underplanting for manipulation of species composition and stand structure, girdling trees to create canopy gaps, felling of trees to provide large woody debris, or burning to improve regeneration. Generally, more intensive silvicultural treatments will be required to rehabilitate or restore degraded riparian areas. Because few silvicultural techniques have been developed for management of riparian values, complete documentation and evaluation of the treatments will greatly benefit future riparian management.

Timber Harvest

Timber harvest is a tool which may be used to achieve some riparian management objectives. Examples include thinning and planting to speed succession or to modify species mix, or falling of trees to increase the loadings of large woody debris. In addition, timber may be felled if needed for rehabilitation or habitat enhancement purposes. Such judgements will be made on a project-by-project basis, as required to meet riparian management objectives. Harvest techniques should, at a minimum, meet the standards outlined in "Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota". Trees left within areas of partial harvest should be distributed in locations that maximize the resistance to windthrow.

In riparian areas, trees damaged or killed by blowdown, fire, disease, or insect outbreaks should usually be retained to maintain biological diversity and to provide future snags and downed woody debris, which will eventually fall into lakes, streams, and wetlands. Windthrow is the most common source of natural debris loading. Despite careful planning for the location and configuration of riparian management zones, windthrow may occur on some units. The blowdown event accelerates debris loading faster than anticipated, but it is not a disaster from an ecological view, merely a change in timing.

Timber may be salvaged from riparian areas where it helps accomplish riparian objectives. For example, a carefully controlled salvage operation may be desired to reduce fuels and the potential for catastrophic fire, control insect and disease epidemics, or for aesthetic reasons. Partial debris removal is preferable to complete salvage. Complete removal of riparian timber could result in a loss of woody debris from active channels, lakes, and floodplains, increased risk of sedimentation, and exposure of the stream channels to direct solar radiation. Dead or dying trees that present safety hazards for recreational users may be felled to eliminate the hazard, but should be left on the ground in the riparian area or in the stream channel. Where logs in rivers present a safety hazard to boaters, site-specific conditions should be evaluated.

Residue Management: Direct inputs of logging slash to wetlands, lakes, perennial, and intermittent stream channels should be minimal. Logging slash has the potential to retard streamflow, reduce dissolved oxygen concentrations, dam culverts and bridges, and initiate erosion.

Logging Systems: The design of the logging system for a particular project should consider the riparian area and its degree of protection. The best planned riparian management zone will be ineffective if logs are carelessly yarded through it.

Landings: Landings should be located outside riparian areas. Landing sites should be selected on the basis of the least amount of excavation and erosion potential

Skidding Corridors: Efforts should be made to protect riparian vegetation during skidding operations. Except in areas of poor drainage, removal of timber by cabling or diffuse skidding (skidding not concentrated on a few main skid trails, but distributed over the harvest area) should be acceptable. On slopes susceptible to erosion, skidding should occur only under frozen conditions. Roads or skid trails within the riparian management zone should each be limited in numbers and width, and particular care should be taken to minimize vegetation damage. Skidding trees or products across streams should not occur.

Non-Harvest Techniques

Although timber harvest can be a useful tool in managing riparian vegetation, silvicultural prescriptions should consider a variety of techniques, including harvest and non-harvest options. Non-harvest techniques for managing riparian vegetation may be more appropriate for use in meeting riparian management objectives on some sites. For example, leaving a riparian zone undisturbed may be the best management technique to facilitate natural successional conversion to a desired state or to allow desired ecological processes to occur. Precommercial thinning, prescribed burning, girdling, felling and leaving it lay, planting to reintroduce desired species, or site preparation for natural or artificial regeneration to meet vegetation objectives are all examples of techniques which could be used to manage riparian vegetation to meet specified objectives. These techniques and others can be used in combination with or in lieu of timber harvest to accelerate development or maintenance of desired conditions.

Prescribed Burning: Prescribed fire may be necessary to maintain a vegetation type or direct succession to a desired future condition. Fire lines in the riparian management zone should be designed to avoid erosion and soil compaction.

Road Design and Location

Road and stream crossing construction, and erosion from poorly designed, located, and maintained roads and crossings contribute more sediment to riparian areas than any other management activity. Sound construction methods and road locations can significantly reduce potential for long-term cumulative effects. Construction should, at a minimum, meet the standards in "Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota". Roads with high use during rainy portions of the year should be constructed and maintained to minimize sedimentation increases. Proper location of roads adjacent to riparian management areas and on hillslopes is a crucial component of effective riparian management.

The following can be used as guidelines:

- Locate roads outside the riparian area, except where no practical alternative exists.
- Limit stream and wetland crossings to areas where no practical alternative is available.
- Prohibit the use of equipment in stream channels, lakes, and wetlands when not frozen, and limit their use in riparian areas, except for activities designed to enhance or restore aquatic or riparian resources.
- Consider additional surface, fill, and drainage stabilization measures for roads that contribute sediment to streams, lakes and wetlands.
- Consider closure or reclamation of existing roads in areas where riparian resources or values are impaired.
- Construct and maintain all roads and structures to minimize direct or indirect additions of sediment to streams.
- Design culverts and other stream crossings to maintain fish passage in streams.
- Restrict in-stream construction activities to specified flow periods.

Timing of Activities

Seasonal impacts of vegetation management activities need to be evaluated. Those that may generate unacceptable levels of erosion and sedimentation should be carried out when the ground is frozen. In addition to concerns about sedimentation, the timing of critical biological processes needs to be factored in to the scheduling of activities. Management activities should not interfere with biological activities such as fish spawning, bird nesting or emergence and movement of fry.

Construction activities in a stream (e.g., bridges, culverts, rehabilitation structures) normally should be limited to the period from late summer to late fall, except in trout streams. Activities in trout streams should be scheduled to avoid the fall spawning period. Activities outside the channel, but likely to contribute sediment to stream channels should adhere to the same operating season and should use special installations to prevent sediment from reaching the stream.

Riparian Rehabilitation

6

Chapter Six

Chapter 6: Riparian Rehabilitation

Although no formal assessment has been done, it is obvious that many of the aquatic ecosystems on the Chippewa National Forest have been altered by human activities. The alterations include, but are not limited to, dams on rivers and streams, dredging, channelization, modification of riparian zone and littoral zone vegetation, road building, and creation of shoreline structures (houses, docks, breakwaters, etc.). The effects of the alterations on biological diversity and ecosystem function may be indirect and are largely unquantified. However, casual observations suggest that the following direct effects exist in some, if not many, places:

- **sedimentation** (caused by road crossings over rivers and streams) - Example: County Road 83 crossing over the Shingobee River.
- **accelerated erosion** (caused by raising of lake levels by dams) - Example: Lake Winnibigoshish shoreline.
- **habitat simplification** (caused by dredging and channelization of rivers and streams) - Example: Leech Lake River.
- **shortage of high quality large woody debris** (caused by clearing of shorelines of rivers and lakes for homes and past timber harvesting activities) - Example: Long Lake near Longville.
- **decreased quantities and varieties of littoral zone vegetation** (caused by boat landings, construction of docks, and boat activity) - Example: Round Lake.
- **changes in above and below ground water flow which affects vegetation** (caused by road crossings) - Example: Boy River Orchid Bog.
- **blockage of fish migration, warming of stream temperatures, and/or slowing of water flow by beaver dams** (caused by changing riparian vegetation from long-lived tree species to early successional stage species, primarily aspen) - Example: Dunbar River.

EVALUATION AND ASSESSMENT

Rehabilitation of riparian areas presents a complex problem on the Chippewa National Forest because of multiple ownership patterns of riparian zones and multiple (often conflicting) objectives for management or use of aquatic ecosystems. There are few instances in which the National Forest has complete ownership of lands surrounding a lake or river system. Additionally, no watershed analyses have been completed in which ecological conditions have been assessed, public opinions sampled, and consensus reached on a desired condition.

The temptation exists to implement aquatic restoration projects without having completed an evaluation of the conditions. We recommend completing such evaluations before carrying out rehabilitation projects except in such cases where resources are imperiled by existing conditions such as erosion, flooding, or stream blockage.

Evaluations of aquatic ecosystems should include, but not necessarily be limited to: floral and faunal components (plants, fish, invertebrates, aquatic birds and mammals), structural characteristics of lakes and streams, conditions of riparian zones, hydrology, chemical properties of the waters, and natural and man-caused disturbance events and patterns. Establishing benchmark or reference aquatic ecosystems and developing indices of ecosystem health and integrity will play an important role in these evaluations.

Determination of limiting factors of biological processes of interest (e.g. fish migration, high water events, channel-forming features and processes, stream temperature, primary producers) will also be an important step in setting objectives and prioritizing projects.

REHABILITATION TECHNIQUES

There are a variety of techniques which have been used to restore degraded conditions in aquatic ecosystems. The following sections briefly describe some of the techniques most applicable on the Chippewa National Forest. Additional details can be found in handbooks and technical papers.

Shoreline erosion on the Mississippi Headwaters reservoirs impacts recreation and visual quality and contributes to sedimentation of fish and wildlife habitats.

Vegetation Management

Rehabilitating degraded riparian areas will often require manipulating vegetation in riparian zones. Silvicultural practices typically used in regenerating merchantable timber in upland forests will have some use in riparian rehabilitation. Planting, release from competition, and protection of tree seedlings will be important in many areas where there is limited or no seed source for desired species and heavy browsing. Seldom used practices, such as girdling and felling of trees without removing the merchantable wood fiber, may also have applications in riparian zone rehabilitation. All silvicultural actions should encourage natural patterns of succession. High priority should be given to creating taxonomically diverse and structurally complex riparian plant communities.

Shading

Reestablishment of shade over stream channels and lakeshores can be accelerated by protecting existing vegetation, especially young trees. Promoting late successional stage tree species tolerant of high moisture conditions will provide the longest lasting shade effect. On the Chippewa, ash, sugar maple, red maple, northern white cedar, white pine, and balsam fir are the most desirable species in riparian zones. Some of these species are in low abundance or are absent in riparian forests. They may need to be planted and protected from browsing mammals. If fast-growing species such as aspen or balsam poplar are needed to provide shade where short-term canopy recovery is required, the trees should be protected from beaver cutting by using individual tree guards or fencing or by reducing local beaver populations.

Woody Debris

If woody debris is lacking in lakes or streams and there is a need to add wood to the system quickly to improve specific habitat conditions (cover for fish, sites for plant and invertebrate growth), trees can be felled from the riparian zone to provide these conditions. Transporting woody debris from outside the riparian zone is also an option. Species with complex forms and slow decay rates and those that are unpalatable to beaver are the best candidates. On the Chippewa, these are primarily conifers, including northern white cedar, white spruce, balsam fir, red pine, and white pine. Of the deciduous species, ash, oak, and maple are best. Aspen and birch trees usually rot quickly, and the smaller branches which are most valuable in providing complex structure are favored by beaver.

Other resource considerations, such as shading, bank stabilization, visual quality, and wildlife habitat, must be considered before cutting live or dead trees to provide large woody debris. It may be best to provide smaller trees of lesser quality and allow higher quality trees to be recruited into the aquatic systems through natural events (senescence, windthrow, bank undercutting).

Control of Erosion and Sedimentation

A buffer of fast-growing herbaceous plants should be established quickly to effectively slow or completely stop the movement of soil into rivers or lakes. Grasses and forbs that grow quickly, form dense clumps or mats, and hold the soil will be most desirable. However, reestablishing woody species (trees and shrubs) will often be a part of any long term riparian area goal. Long-term solutions to erosion problems will often require a combination of vegetative and physical changes, such as modification of road banks or culverts, or may require administrative changes, such as closing a campsite or boat access.

Woody debris in lakes and streams of the Chippewa National Forest provides cover for fish and sites for plant and invertebrate growth.

Restoring Aquatic Plants

Herbaceous plants growing on lake and river margins and into the littoral zone are important features of riparian areas for many reasons (food, habitat structure, dampening of wave effects on shorelines). In some areas, these plants have been removed or decreased to a point where their absence affects the functioning of the aquatic ecosystem. Protecting existing beds of vegetation and creating new beds can improve the condition of riparian areas. The species and locations of emergent aquatic vegetation should be identified and avoided during construction of boat accesses and piers. Some species, such as bulrushes and arrowheads, can be transplanted by using cuttings from rhizomes. Transplanting can speed up the restoration of degraded sites (i.e. abandoned boat accesses) and can be used to provide wave breaks in areas with high erosion potential.

STRUCTURAL AND ADMINISTRATIVE CHANGES

Some of the aquatic ecosystems on the Chippewa National Forest have been irreversibly altered because of prevailing public sentiment and social values associated with the changes. For example, the dams on Leech and Cass lakes, and Lake Winnibigoshish, as well as on some smaller lakes, have raised water levels to a point that would be difficult and perhaps undesirable to change. The results of these basin-level changes, however, include destabilization of lakeshores and alteration of channel form in outlet rivers. There are techniques that can be used to partially restore the values and functions of downstream areas.

Water Flow Manipulation

The large dams on the Forest are usually operated by the U.S. Army Corp of Engineers (COE) in a fashion to provide water level conditions which vary by season within an acceptable operating band. Small dams located at waterfowl impoundments are primarily managed for values and functions within the impoundments. Flow from these large and small dams affect channel development, flooding and low-water regimes, and aquatic and riparian vegetation on downstream rivers. It may be possible to work with the COE to develop water level management plans for the dams to allow downstream flows which are appropriate for maintaining riparian values. In addition, waterfowl management plans for impoundments should include provisions for maintaining downstream riparian functions. These plans could include maximum and minimum discharges and seasonal water flow patterns.

Beaver dams are present on virtually every river and stream on the Forest. They vary from large structures to small dams which do not hold back water. Removal may be desirable to improve conditions for spawning fish or to protect trees such as ash or white cedar from flood damage. Removal of dams by hand is preferred over other methods because it is possible to regulate the release of water. A combination of dam removal, directed trapping, and manipulation of riparian vegetation is probably the best way to reduce the effects of beaver dams.

Some roads and bridges on the Forest have altered water flow in streams and wetlands. Modified culvert designs may be necessary to allow surface and subsurface flows to be maintained at near pre-road conditions. Ditches that allow water to continue to flow into adjacent wetlands instead of draining water parallel to roads should be considered.

Channel Form

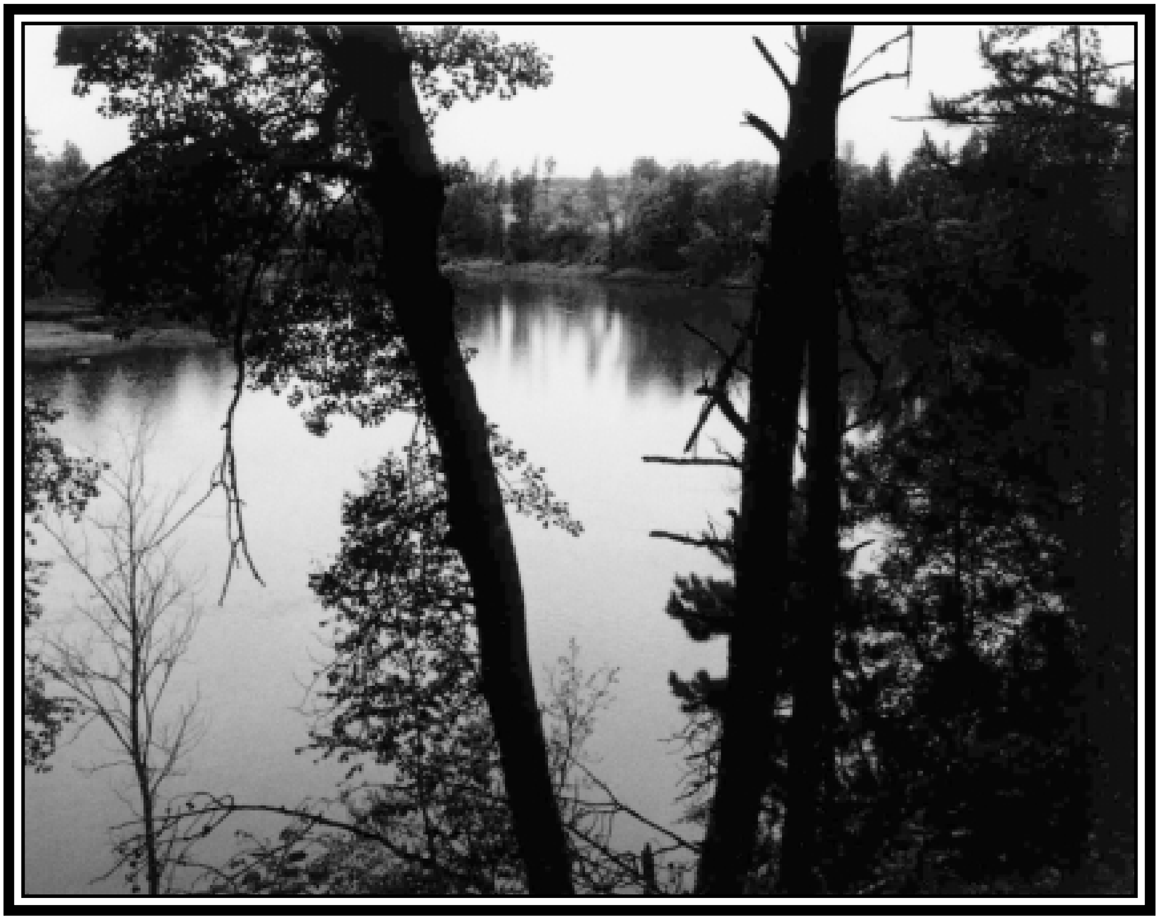
Some rivers and streams have been channelized or have had drainage ditches dug to change the water flow pattern. The results of these activities have included down-cutting of stream channels and altered flows through naturally-occurring channels, backwaters, and oxbows. Instream and riparian vegetation have been changed also. Dredge spoil piles occur on some riverbanks. If proper evaluation is completed and an objective to partially or completely restore channel form is agreed upon, there are some activities which can be considered. Blockage of drainage ditches or artificial channels to divert flow back into natural channels, backwaters, and oxbows. The addition of boulders or piles of smaller rocks may reestablish pools or riffles which have become absent. Downed logs or trees can be put into streams to protect unstable banks, slow down, speed up, or deflect water flow (depending on their position) into areas where side-cutting is desired.

SUMMARY

There are many opportunities to rehabilitate aquatic ecosystems and their riparian zones on the Chippewa National Forest. Rehabilitation projects will be more complex because of the multiple ownership pattern within the Forest boundaries. Evaluation of existing conditions within watersheds and development of a consensus on desired conditions is a necessary first step. A combination of vegetation manipulation and structural techniques or administrative actions may be necessary to achieve short-term objectives. Long-term goals may be best met by restoring as many of the naturally occurring components and processes to these systems in the proper amounts and in time and space. Monitoring riparian rehabilitation efforts will be necessary to determine if techniques are successful, if short-term objectives have been met and to track progress toward long term goals.

7

Monitoring Riparian Areas



Chapter Seven

Chapter 7: Monitoring Riparian Areas

Riparian monitoring evaluates the effectiveness of past management practices and provides information for developing future management policies. Identification of the desired future condition of riparian areas is a fundamental basis for any monitoring and evaluation of resource information. Desired future conditions for riparian areas have not been identified.

Monitoring programs of the National Forest System consist of three types: implementation, effectiveness, and validation.

With regard to riparian systems, **implementation monitoring** determines if a given project is being implemented as planned and whether the Forest's Standards and Guidelines are being met. This type of monitoring answers the question, "Did we do what we said we'd do?" Environmental assessments and project design documents are reviewed, and compliance with riparian prescriptions is checked on the ground.

Effectiveness monitoring ascertains whether riparian prescriptions and plans are achieving the overall objectives of the projects or policies. This type of monitoring answers the question, "Are we getting the desired result?" It is conducted at several scales, ranging from individual sites to large watersheds, and includes monitoring of rehabilitation projects.

Validation monitoring establishes whether the underlying assumptions used in resource models and planning are correct. It answers the question, "Do we really know how the system works?" To answer these questions with a measurable certainty, validation monitoring has to be carefully designed, and is essentially a research project. In most cases, both managed and undisturbed or natural areas require monitoring. Validation monitoring over several decades is essential for detecting major trends in resource status.

The land base of the Chippewa National Forest encompasses a wide range of natural landscape features and management patterns. As a result, monitoring of riparian areas cannot be concentrated at one or two sites and then extrapolated to cover the entire Forest. At the same time, logistical and financial constraints require a stratified monitoring program that includes:

- post-project site review,
- reference areas,
- watershed monitoring,
- water quality network, and
- landscape synthesis of monitoring data.

This stratified monitoring program examines different aspects of riparian areas at several scales of space and time. It provides information on channel and floodplain functions, water quality, fish and wildlife habitat and numbers, and riparian plant diversity and dynamics.

Monitoring invertebrate populations can provide valuable information for assessing the condition of aquatic ecosystems.

POST-PROJECT REVIEW

The post-project review determines if Chippewa National Forest Standards and Guidelines for riparian management are being implemented, in terms of environmental assessments, site analyses, site prescriptions, and operator compliance with prescriptions. A proportion of projects Forest-wide, including rehabilitation efforts, undergo an office review of environmental assessments and contracts. They are also reviewed on the ground immediately after operations, to determine whether the prescriptions were appropriate for the specific site, and whether they were implemented properly.

REFERENCE AREAS

Reference areas are selected for long-term systematic effectiveness and validation monitoring across the entire Chippewa National Forest. These locations should include both intensively managed and relatively undisturbed or natural areas. Reference areas should be selected to provide information on riparian resources across a range of forest conditions, management practices, and ecological types. Within each selected area, reference stream reaches or sites are chosen, and their boundaries are monumented and documented for long-term repeated measurements.

Each group of reference areas should contain both harvested and unharvested riparian areas. The areas with no timber harvest serve as controls to distinguish changes caused by management practices from those related to natural variation.

Aquatic ecologic types include all streams, lakes and wetlands. Reference areas should include representative reaches of all stream types present. Aquatic and terrestrial parameters are intensively monitored within these reaches. In addition to stream types, lakes of different ecologic types should also be monitored.

The monitoring process in reference areas should evaluate channel, streambank and shoreline structure, streamside and lakeside vegetation (including plant diversity), fish communities, and wildlife habitat.

WATERSHED MONITORING

Watershed surveys are designed to provide a broad overall assessment of fish habitat and populations and to evaluate watershed condition. Instead of concentrating on small individual standard reaches within the reference areas, watershed inventories cover many miles of streams and lakes.

Watershed monitoring describes channel and lakeshore structure, streamside and lakeshore vegetation, woody debris in lakes and streams and aquatic communities.

WATER QUALITY NETWORK

Water quality monitoring on the Chippewa National Forest requires frequent sampling over a broad spatial scale. Consequently, a network of monitoring stations will be established across the Forest. The areas for watershed-level water quality monitoring are selected from the reference areas used for intensive riparian monitoring. Lakes representing a range of ecologic types are included in the water quality network. Water temperature and water chemistry are critical components of water quality for assessment of lakes and streams. In general, all sampling will be done at regularly scheduled intervals and in response to significant episodic events, such as drought conditions or major storms.

Temperature is particularly critical in fish-bearing streams, and can be strongly affected by its tributary streams. Stream temperature patterns are monitored during summer low-flow periods, to ensure that State Water Quality standards are being met. Lake temperature and oxygen profiles are measured during the period of maximum thermal stratification (usually late August).

Dissolved nutrient concentrations are an important factor in water quality analysis. Concentrations of elements such as nitrogen, phosphorus, and organic carbon commonly increase after forest harvest. Basic chemical parameters in water quality monitoring include conductivity, pH, alkalinity, nitrate, ammonium, nitrate, orthophosphate, total phosphorus, dissolved organic carbon, calcium, magnesium, sodium, potassium, chloride and sulfate.

The frequency of all monitoring will be determined once specific monitoring objectives are developed and is subject to other resource constraints.

The purpose of any monitoring type is the assessment of conditions and effectiveness of management activities. The results of monitoring are use to calibrate management activities, standards and guidelines, policy and priorities to meet the intended objectives.

Adaptive management is the ultimate result, where information learned from monitoring is used to adjust riparian management activities to meet riparian resource objectives. As more is learned, more change is likely to occur.

Glossary

Glossary

Active Channel: The portion of the valley floor flooded annually, including low flow wetted channel and streambanks.

Aggradation: The geologic process of filling and raising the level of the streambed or floodplain by deposition of material eroded and transported from other areas.

Alluvial Fan: A fan-shaped accumulation of sediments deposited by streams, usually at their mouths.

Alluvium: A general term for all sediments transported and deposited by streams. Alluvium may accumulate on streambeds, fans, lakes or estuaries.

Aquatic Ecosystem: Any body of water, such as a stream, river, pond, lake, or estuary, and all of the associated organisms, habitat features, and nonliving components.

Aquatic Habitat: Habitat for fish and other aquatic organisms within lakes, wetlands, or wetted channels of streams.

Backwater: An off-channel pool or eddy at lateral margins of the channel. Protected from high velocity flows, usually by abundant woody debris or boulders. Opening to main channel is less than the long axis of the backwater itself.

Bank Storage: Infiltration of water into stream bank deposits during flood flows.

Bankfull Width: Width of stream channel at flood flow of an average year.

Bank Stability: The ability of stream banks to withstand the erosive forces of water. Bank stability increases in the presence of deeply rooted plants.

Bar: A ridge-shaped deposit of alluvial material in the channel, along stream banks, or at the mouth of a stream.

Base Flow: Typical flow for a given stream at a particular time of year.

Basin: The area of land that drains water, sediment and dissolved materials to a common point along a stream channel.

Bedload: Particles, ranging in size from clay to boulders, which are carried by the water, but which are in at least partial contact with the bottom.

Benthos (n), Benthic (adj): Organisms living on or within the substrates of aquatic habitats.

Biological Stability: The inherent capacity for biological systems to resist change: the absence of fluctuations and the ability to withstand disturbances without significant changes in composition.

Blowdown: A tree or trees uprooted or felled by the wind.

Buffer: An area of vegetation left or managed to reduce the impact of a treatment or action of one area on another.

Canopy Cover: The more or less continuous cover of branches and foliage formed by the crowns of adjacent trees and other woody growth.

Carrying Capacity: The number of individuals of a particular species that the resources of a given habitat can support.

Channel: A waterway that contains moving water either periodically or continuously. A channel has a definite bed and banks.

Channel stability: The resistance of a stream to changes in bedform.

Climax Community: The final biotic community in a successional sequence. Usually a community that is self-perpetuating unless disturbed by outside forces.

Connectivity: Unbroken linkages in a landscape, typified by streams and riparian areas.

Constrained: A narrow valley limited in width by adjacent landforms, with a valley floor width less than two active channel widths. Valley walls are usually steep; the stream cannot meander and is a single simple channel.

Cover: Any feature that provides protective concealment for fish and wildlife. Cover may consist of live or dead vegetation or geomorphic features such as boulders and undercut banks. Cover may be used for purposes of escape from predators, feeding, or resting.

Critical Habitat: The portion of the living area of a species that is essential to the survival and perpetuation of the species.

Crown Cover: See canopy cover.

Cull: A snag, green tree, or log that is of little or no economic value.

Cumulative Effects: Effects on the environment resulting from individually minor but collectively significant actions taking place over a period of time.

Debris (organic): Logs, trees, limbs, branches, leaves, bark that accumulate, often in streams or riparian areas. Debris may be naturally occurring or the result of man's activities.

Debris Jam: An accumulation of many sizes of woody debris, generally within the stream channel, but often extending onto the banks or low terraces. Also referred to as debris dams or debris accumulations, they may be naturally occurring or the result of poor management.

Debris Loading: The amount of debris located in a specific area; it may accumulate as a result of natural processes or human activities.

Degradation: Lowering of a stream bed by erosion (vs. aggradation).

Deposition: The settlement of material out of the water column and onto the stream or lake bed (vs. erosion).

Detritus: Organic matter formed by the breakdown of decomposing plants and animals.

Diameter Breast High (DBH): The standard diameter measurement for standing trees, taken at 4.5 feet above the ground on the uphill side of the tree.

Discharge: A measure of the amount of water flowing in the stream channel. Discharge depends on both the velocity of the water and the area of the wetted channel, and is generally measured in m3/sec or ft3/sec (cfs).

Diversity: The variety and relative abundance of species in a given area.

Drainage Area: See basin.

Ecosystem: A complete interacting system of organisms considered together with their environment; a biotic community and its abiotic environment.

Ecosystem Management: is a style or philosophy of natural resource management that considers all the species, habitats, and ecological processes of a biogeographic province in its management and policies. The primary objectives are to maintain the long-term productivity of the landscape and ensure that no species goes extinct by the activities of people. Extraction of natural resources is allowed to the extent that it does not negate the primary objectives.

Ecotone: A transition or junction zone between two or more naturally occurring diverse communities.

Edges/Edge Effect: Areas where two physical or biological zones meet. The increased diversity in these areas is known as the edge effect.

Flood: Abrupt increase in discharge. Frequently, flows that exceed the bankfull capacity of a given stream.

Floodplain: Relatively flat surfaces adjacent to active channels, formed by deposition of sediments during major flood events. It may be covered by water at flood flows.

Flow: Any movement of water (see discharge).

Food chain: The transfer of food energy from plants through a series of consumers by repeated eating and being eaten. Food chains interconnect to form food webs, which represent energy flow through an ecosystem.

Forage: Herbaceous plants and portion of woody species (twigs, leaves) used for food by wildlife.

Functional Groups: A classification of animals based on how they gather their food, rather than what they eat. Generally used in describing communities of stream and lake benthos.

Fry: Recently hatched fish, up to one year of age.

Game Species: Species of fish or wildlife for which seasons and bag limits have been imposed, and which are harvested under State or Federal regulations.

Geomorphology: The geological study of land form evolution and configuration.

Gradient: The rate of vertical elevation change per unit horizontal distance; also known as slope.

Habitat: The area where a plant or animal lives and grows under natural conditions. Habitat consists of living and non-living attributes, and provides all requirements for food and shelter.

Habitat Diversity: The number of different types of habitat found within a given area.

Hillslope: Adjacent hillsides above the influences of flooding.

Horizontal Diversity: Abundance and variety of plant communities on an areal basis.

Indirect Effects: Secondary effects which occur in locations other than the initial action or significantly later in time.

Litter: Dead plant material, commonly leaves, needles, twigs, etc on the soil surface.

Mature Forest: A forest which is at or just past the culmination of mean annual increment.

Microclimate: Localized climate conditions; microclimatic conditions in riparian areas are generally less extreme than adjacent hillslopes.

Migration Corridor: The portion of the landscape serving as a routine passageway for fish or wildlife species as they that move from one habitat to another, often on a seasonal basis.

Mitigation: Actions to avoid, minimize, reduce, eliminate or rectify the impact of management practices.

Monitoring: Actions undertaken to assess and evaluate, including the results of management activity on a species or process.

Multiple-use: A concept of land management in which a number of resources are simultaneously managed for and produced from the same land base.

Noncommercial Thinning: The selective cutting of unmerchantable sizes and species of trees.

Non-game: Species of wildlife and fish not managed as sport hunting resources.

Old-Growth: A forest comprised of many large trees which are old for their species, large snags, and numerous large down logs; having a multi-layered canopy composed of several species of trees; and normally characterized by large horizontal and vertical structural diversity; the latter stages of forest succession. Old-growth stands have a wide range of ages and sizes of trees

Peak Flow: The highest discharges attained during a particular flood event for a given stream.

Plant Community: An assemblage of plant species in a given area.

Precommercial Thinning: Removal of some trees in a stand before they attain merchantable size so the remaining trees will grow more quickly.

Rearing Habitat: Areas required for successful survival to adulthood by young animals. For trout, rearing areas may be the edges of streams, while for deer, they may be thickets in the riparian area.

Recovery: Return of an ecosystem to a defined condition after a disturbance.

Rehabilitation: The process of restoring a site to a former state or desired condition.

Resident Fish: Fish species that complete their entire life cycle in fresh-water.

Residue: Plant material remaining after harvest operations.

Retention: The capability of a stream system to retain either water, nutrients, or suspended particles for any length of time.

Riparian Area: The aquatic ecosystem and the adjacent upland areas that directly affect it, and associated wetlands.

Riparian Management Zone: A site-specific area with boundaries established to define limits of management activities within riparian areas. Because influences of terrestrial ecosystems on aquatic ecosystems decrease with distance from the water, riparian areas cannot be easily defined by discrete boundaries on the ground. Riparian Management Zones will be determined by management objectives, and may not contain all of the riparian area.

Riparian Zone: The three-dimensional area of direct interaction between the aquatic and terrestrial ecosystems. These zones extend outward from the water's edge, upward into the canopy of the riparian vegetation, and downward into the soils.

Salvage: The logging of trees that are dead, dying, or blowndown and deteriorating before they lose their commercial timber value.

Second Growth: Plant growth that has come up after some perturbation, such as fire or clearcutting, has removed the previous forest.

Sediment: Material carried in suspension by water, which will eventually settle to the bottom.

Side Channel: A portion of the active channel that does not carry the bulk of the streamflow. Side channels may carry water only during winter flows, but are still considered part of the total active channel.

Slash: Residue (boles, branches, leaves, bark, twigs, roots, etc) left on the ground after logging.

Slope Stability: The degree to which a slope resists the downward pull of gravity. The more resistant, the more stable.

Snag: A standing dead tree usually greater than 20 feet high and 6 inches dbh. Its interior may be sound or rotted.

Spawning Gravel: Sorted, clean gravel patches of a size appropriate for the needs of gravel-spawning fish.

Standing Crop: Amount of living biomass, plant or animal, present in a given location. Usually expressed as mass per unit area.

Stocking: A loose term for the amount of anything (number, basal area, biomass), be it trees or fish, in a given area, particularly in relation to a pre-determined optimum.

Stream Bank: The part of a stream channel, when seen in cross-sections, that restricts sideways water movement at normal flows. It represents a distinct break in slope from the stream bed.

Stream Blockage: Accumulation of solid, rock, organic material, or any obstruction in a stream channel that prevents fish from moving upstream.

Stream Class: A classification of streams based on their hydrology, fisheries, and usage. Class I streams are perennial or intermittent and have significant fisheries, domestic water use, or influence on other Class I streams; Class II streams also have perennial or intermittent flow with moderate fisheries (game fish or the potential to maintain game fish populations), domestic water use, or influence on other Class I or II streams; Class III streams are perennial but do not meet criteria for Class I and II streams; and Class IV streams are ephemeral or intermittent, but do not meet criteria for Class I, II or III streams.

Stream Cleanout: Removal of debris from streams. With regard to large organic debris, logs specifically, this is no longer considered wise management.

Stream Order: A measure of the position of a stream in the hierarchy of tributaries. First-order streams are unbranched (no tributaries). Second-order streams are formed by the confluence of two or more first order streams, and are considered second order until they join a larger stream. Third order channels are form by the confluence of two or more second order streams, etc.

Stream Structure: The arrangement of logs, boulders, and meanders which modify the flow of water, thereby causing the formation of pools and gravel bars in streams. Generally, there is a direct, positive relationship between complexity of structure and fish habitat. Complex stream structure is also an indication of overall watershed stability.

Structure: The physical configuration of elements, parts, or constituents of a habitat, plant, or animal community.

Substrate: The material forming the underlying layer of streams. Substrates may be bedrock, gravel, boulders, sand, clay, etc.

Succession: The progressive development of biological communities, plant or animal, represented by the shift in species composition through time; the replacement of one plant community by another.

Suspended Load: Particles, usually small in size, carried in suspension by the stream; these particles do no contact the streambed.

Terrace: Sediment deposits between the valley walls and the floodplain or the active channel. They may be formed by fluvial, volcanic, or glacial activities.

Tolerance Limits: The physiological band within which an organism can survive. Above or below these limits, organisms will become stressed and eventually die. Tolerance limits exist for each species for may different parameters, such as temperature, oxygen availability, amount of light, amount of suspended sediments, etc.

Turbidity: The relative clarity of the water, which may be affected by suspended material.

Unconstrained: A wide valley floor, generally greater than two active channel widths, with extensive floodplain surfaces. The stream can meander to form a complex channel.

Upland: The portion of the landscape above the valley floor.

Valley Floor: The part of the landscape containing the stream and its floodplain.

Vertical Diversity: Within a plant community, the amount of layering along a vertical axis. Areas of high vertical diversity will have a complex mix of herb, shrub, and tree canopies at different heights.

Watershed: A portion of at the forest in which all surface water drains to a common point. Watersheds can range from a few tens of acres that drain a small intermittent stream to many thousands of acres for a stream that drains hundreds of connected intermittent and perennial streams.

Wetland: Those areas periodically inundated by surface or ground water. They support vegetation or aquatic species requiring wholly or partially saturated soils. Wetlands include marshes, bogs, fens, sloughs, vernal pools, potholes, river overflows, mud flats, wet meadows, seeps and springs.

Woody Debris: Dead woody material greater than 10 cm in diameter and longer than one meter, usually composed of boles and large branches. Various terms, such as large woody debris (LWD), coarse woody debris (CWD), and large organic debris (LOD), have been used to describe this material.

Large woody debris is material greater than 20 inches (50 cm) in diameter and 33 ft (10 m) in length. Woody material greater than 4 inches (10 cm) in diameter and 3 ft (1 m) in length but less than 20 inches (50 cm) in diameter and 33 ft (10 m) in length is considered to be **small woody debris** and consists of small trees, tops of large trees, and large branches. Small branches, twigs, and slash from logging operations less than 4 inches (10 cm) in diameter and 3 ft (1 m) in length are considered fine woody debris.

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Appendices

Appendix 1: Riparian Fish & Wildlife Species of the Chippewa National Forest

BIRDS

Alder Flycatcher	*Empidonax alnorum*
American Avocet	*Recurvirostra americana*
American Bittern	*Botaurus lengtiginosus*
American Coot	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
American Kestrel	*Falco sparverius*
American Magpie	*Pica pica*
American Redstart	*Setophaga ruticilla*
American Robin	*Turdus migratorius*
American White Pelican	*Pelecanus erythrorhynchos*
American Widgeon	*Anas americana*
American Woodcock	*Scolopax minor*
Baird's Sandpiper	*Calidris bairdii*
Bald Eagle	*Haliaetus leucocephalus*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Barred Owl	*Strix varia*
Bay-breasted Warbler	*Dendroica castanea*
Belted Kingfisher	*Ceryle alcyon*
Black and White Warbler	*Mniotilta varia*
Black Duck	*Anas rubripes*
Black Tern	*Chlidonias niger*
Black-backed Woodpecker	*Picoides arcticus*
Black-bellied Plover	*Pluvialis squatarola*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Black-capped Chickadee	*Parus atricapillus*
Black-crowned Night Heron	*Nycticorax nycticorax*
Blackburnian Warbler	*Dendroica fusca*
Blue Jay	*Cyanocitta cristata*
Blue-winged Teal	*Anas discors*
Bobolink	*Dolichonyx oryzivorus*
Bonapartes Gull	*Larus philadelphia*
Boreal Chickadee	*Parus hudsonicus*
Boreal Owl	*Aegolius funereus*
Broad-winged Hawk	*Buteo platypterus*
Brown Creeper	*Certhia americana*
Bufflehead	*Bucephala albeola*
Canada Goose	*Branta canadensis*
Canada Warbler	*Wilsonia canadensis*

Canvasback	*Aythya valisineria*
Cape May Warbler	*Dendroica tigrina*
Caspian Tern	*Sterna caspia*
Cedar Waxwing	*Bombycilla cedrorum*
Chipping Sparrow	*Spizella passerina*
Clay-colored Sparrow	*Spizella pallida*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Goldeneye	*Bucephala clangula*
Common Grackle	*Quiscalus quiscula*
Common Loon	*Gavia immer*
Common Merganser	*Mergus merganser*
Common Moorhen	*Gallinula chloropus*
Common Raven	*Corvus corax*
Common Redpoll	*Carduelis flammea*
Common Snipe	*Gallinago gallinago*
Common Tern	*Sterna hirundo*
Common Yellowthroat	*Geothlypis trichas*
Connecticut Warbler	*Oporornis agilis*
Coopers Hawk	*Accipiter cooperii*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpina*
Eared Grebe	*Podiceps nigricollis*
Eastern Kingbird	*Tyrannus tyrannus*
Forster’s Tern	*Sterna forsteri*
Fox Sparrow	*Passerella iliaca*
Franklins Gull	*Larus pipixcan*
Gadwall	*Anas stepera*
Golden-crowned Kinglet	*Regulus satrapa*
Gray Catbird	*Dumetella carolinensis*
Gray Jay	*Perisoreus canadensis*
Gray-cheeked Thrush	*Catharus minimus*
Great Blue Heron	*Ardea herodais*
Great Egret	*Casmerodius albus*
Great Gray Owl	*Strix nebulosa*
Great Horned Owl	*Bubo virginianus*
Greater Scaup	*Aythya marila*
Greater Yellowlegs	*Tringa melanoleuca*
Green Heron	*Butorides striatus*
Green-winged Teal	*Anas crecca*
Hairy Woodpecker	*Picoides villosus*
Herring Gull	*Larus argentatus*
Hoary Redpoll	*Carduelis hornemanni*
Hooded Merganser	*Lophodytes cucullatus*
Horned Grebe	*Podiceps auritus*
House Wren	*Troglodytes aedon*

Hudsonian Godwit	*Limosa haemastica*
Killdeer	*Charadrius vociferus*
Lapland Longspur	*Calcarius lapponicus*
Least Bittern	*Ixobrychus exilis*
Least Sandpiper	*Calidris minutilla*
LeConte's Sparrow	*Ammodramus leconteii*
Lesser Golden-Plover	*Pluvialis dominica*
Lesser Scaup	*Aythya affinis*
Lesser Yellowlegs	*Tringa flavipes*
Lincolns Sparrow	*Melospiza lincolnii*
Long-eared Owl	*Asio otus*
Magnolia Warbler	*Dendroica magnolia*
Mallard	*Anas platyrhynchos*
Marsh Wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Mourning Warbler	*Oporornis philadelphia*
Nashville Warbler	*Vermivora ruficapilla*
Northern Goshawk	*Accipiter gentilis*
Northern Harrier	*Circus cyaneus*
Northern Hawk Owl	*Surnia ulula*
Northern Oriole	*Icterus galbula*
Northern Parula	*Parula americana*
Northern Pintail	*Anas acuta*
Northern Rough-winged Swallow	*Stelgidopteryx ruficollis*
Northern Saw-whet Owl	*Aegolius acadicus*
Northern Shoveler	*Anas clypeata*
Northern Waterthrush	*Seiurus noveboracensis*
Old Squaw	*Clangula hyemalis*
Osprey	*Pandion haliaetus*
Palm Warbler	*Dendroica palmarum*
Pectoral Sandpiper	*Calidris melanotos*
Peregrine Falcon	*Falco peregrinus*
Philadelphia Vireo	*Vireo philadelphicus*
Pied-billed Grebe	*Podilymbus podiceps*
Pileated Woodpecker	*Dryocopus pileatus*
Pine Grosbeak	*Pinicola enucleator*
Pine Siskin	*Carduelis pinus*
Piping Plover	*Charadrius melodus*
Purple Martin	*Progne subis*
Red Crossbill	*Loxia curvirostra*
Red Knot	*Calidris canutus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-breasted Merganser	*Mergus serrator*
Red-breasted Nuthatch	*Sitta candensis*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*

Red-necked Grebe	*Podiceps grisegena*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-throated Loon	*Gavia stellata*
Red-winged Blackbird	*Agelaius phoeniceus*
Redhead	*Aythya americana*
Ring-billed Gull	*Larus delawarensis*
Ring-necked Duck	*Aythya collaris*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Rough-legged Hawk	*Buteo lagopus*
Ruby-crowned Kinglet	*Regulus calendula*
Ruddy Duck	*Oxyura jamaicensis*
Ruddy Turnstone	*Arenaria interpres*
Ruffed Grouse	*Bonasa umbellus*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Rusty Blackbird	*Euphagus carolinus*
Sanderling	*Calidris alba*
Sandhill Crane	*Grus canadensis*
Scarlet Tanager	*Piranga olivacea*
Sedge Wren	*Cistothorus platensis*
Semipalmated Plover	*Charadrius semipalmatus*
Semipalmated Sandpiper	*Calidris pusilla*
Sharp-tailed Grouse	*Pedioecetes phasianellus*
Sharp-tailed Sparrow	*Ammospiza caudacuta*
Snow Goose	*Chen caerulescens*
Snowy Owl	*Nyctea scandiaca*
Solitary Sandpiper	*Tringa solitaria*
Solitary Vireo	*Vireo solitarius*
Song Sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
Spotted Sandpiper	*Actitus macularia*
Spruce Grouse	*Dendragapus canadensis*
Stilt Sandpiper	*Micropalama himantopus*
Surf Scoter	*Melanitta perspicillata*
Swainsons Thrush	*Catharus ustulatus*
Swamp Sparrow	*Melospiza georgianna*
Tennessee Warbler	*Vermivora peregrina*
Tree Sparrow	*Spizella arborea*
Tree Swallow	*Iridoprocne bicolor*
Trumpeter Swan	*Cygnus buccinator*
Tundra Swan	*Cygnus columbianus*
Veery	*Catharus fuscescens*
Virginia Rail	*Rallus limicola*
Warbling Vireo	*Vireo gilvus*
Water Pipit	*Anthus spinoletta*
Western Sandpiper	*Calidris mauri*

Whimbrel	*Numenius phaeopus*
White-breasted Nuthatch	*Sitta carolinensis*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-throated Sparrow	*Zonotrichia albicollis*
White-winged Crossbill	*Loxia leucoptera*
White-winged Scoter	*Melanitta deglandi*
Willet	*Catoptrophorus semipalmatus*
Wilsons Phalarope	*Steganopus tricolor*
Wilsons Warbler	*Wilsonia pusilla*
Winter Wren	*Troglodytes troglodytes*
Wood Duck	*Aix sponsa*
Wood Thrush	*Hylocichla mustelina*
Yellow Rail	*Coturnicops noveboracensis*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow-throated Vireo	*Vireo flavifrons*

AMPHIBIANS

American Toad	*Bufo americanus*
Blanding's Turtle	*Emydoidea blandingii*
Blue-spotted Salamander	*Ambystoma laterale*
Central Newt	*Notophthalmus viridescens*
Common Garter Snake	*Thamnophis sirtalis*
Cope's Tree Frog	*Hyla chrysoscelis*
Eastern Hog-nosed Snake	*Heterodon platyrhinos*
Four-toed Salamander	*Hemidactylium scutatum*
Gray Tree Frog	*Hyla versicolor*
Green Frog	*Rana clamitans*
Mink Frog	*Rana septentrionalis*
Mud Puppy	*Necturus maculosus*
Northern Leopard Frog	*Rana pipiens*
Painted Turtle	*Chrysemys picta*
Prairie Skink	*Eumeces septentrionalis*
Red-backed Salamander	*Plethodon cinereus*
Red-bellied Snake	*Storeria occipitomaculata*
Snapping Turtle	*Chelydra serpentina*
Spiny Soft-shell Turtle	*Trionyx spiniferus*
Spring Peeper	*Hyla crucifer*
Striped Chorus Frog	*Pseudacris triseriata*
Tiger Salamander	*Ambystoma tigrinum*
Wood Frog	*Rana sylvatica*

MAMMALS

Arctic Shrew	*Sorex arcticus*
Beaver	*Castor canadensis*
Big Brown Bat	*Eptesicus fuscus*
Black Bear	*Ursus americanus*
Bobcat	*Felis rufus*
Canada Lynx	*Felis lynx*
Coyote	*Canis latrans*
Eastern Cougar	*Felis concolor*
Fisher	*Martes pennanti*
Gray Fox	*Urocyon cinereoargenteus*
Gray Wolf	*Canis lupus*
Heather Vole	*Phenacomys intermedius*
Hoary Bat	*Lasiurus cinereus*
Least Chipmunk	*Eutamias minimus*
Least Weasel	*Mustela nivalis*
Little Brown Bat	*Myotis lucifugus*
Long-tailed Weasel	*Mustela frenata*
Masked Shrew	*Sorex cinereus*
Meadow Jumping Mouse	*Zapus hudsonius*
Meadow Vole	*Microtus pennsylvanicus*
Mink	*Mustela vison*
Moose	*Alces alces*
Muskrat	*Ondatra zibethicus*
Northern Bog Lemming	*Synaptomys borealis*
Northern Flying Squirrel	*Glaucomys sabrinus*
Northern Myotis	*Myotis septentrionalis*
Porcupine	*Erethizon dorsatum*
Pygmy Shrew	*Microsorex hoyi*
Raccoon	*Procyon lotor*
Red Bat	*Lasiurus borealis*
Red Fox	*Vulpes vulpes*
Red Squirrel	*Tamiasciurus hudsonicus*
Red-backed Vole	*Clethrionomys gapperi*
River Otter	*Lutra canadensis*
Short-tailed Shrew	*Blarina brevicauda*
Short-tailed Weasel	*Mustela erminea*
Silver-haired Bat	*Lasionycteris noctivagans*
Snowshoe Hare	*Lepus americanus*
Southern Bog Lemming	*Synaptomys cooperi*
Star-nosed Mole	*Condylura cristata*
Water Shrew	*Sorex palustris*
White-tailed Deer	*Odocoileus virginianus*
Woodland Deer Mouse	*Peromyscus maniculatus gracilis*
Woodland Jumping Mouse	*Napaeozapus insignis*

FISHES

Chestnut Lamprey	*Ichthyomyzon castaneus*
Bowfin	*Amia calva*
Brook Trout	*Salvelinus fontinalis*
Lake Trout	*Salvelinus namaycush*
Rainbow Trout	*Oncorhynchus mykiss*
Brown Trout	*Salmo trutta*
Lake Whitefish	*Coregonus clupeaformis*
Cisco	*Coregonus artedi*
Dwarf Cisco	*Coregonus artedi*
Central Mudminnow	*Umbra limi*
Northern Pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Longnose Dace	*Rhinichthys cataractae*
Hornyhead Chub	*Nocomis biguttatus*
Creek Chub	*Semotilus atromaculatus*
Golden Shiner	*Notemigonus crysoleucas*
Bluntnose Minnow	*Pimephalus notatus*
Fathead Minnow	*Pimephaus promelas*
Pugnose Shiner	*Notropis anogenus*
Emerald Shiner	*Notropis atherinoides*
Mimic Shiner	*Notropis volucellus*
Bigmouth Shiner	*Notropis dorsalis*
Common Shiner	*Notropis cornutus*
Weed Shiner	*Notropis texanus*
Spotfin Shiner	*Notropis spilopterus*
Spottail Shiner	*Notropis hudsonius*
Blacknose Shiner	*Notropis heterolepis*
Brassy Minnow	*Hybognathus hankinsoni*
Bigmouth Buffalo	*Ictiobus cyprinellus*
Northern Redhorse	*Moxostoma macrolepidotum*
Silver Redhorse	*Moxostoma anisurum*
Greater Redhorse	*Moxostoma valenciennesi*
White Sucker	*Catostomus commersoni*
Brown Bullhead	*Ameiurus nebulosus*
Black Bullhead	*Ameiurus melas*
Yellow Bullhead	*Ameiurus natalis*
Tadpole Madtom	*Noturus gyrinus*
Trout-Perch	*Percopsis omiscomaycus*
Burbot	*Lota lota*
Banded Killifish	*Fundulus diaphonus*
Brook Stickleback	*Culaea inconstans*
Ninespine Stickleback	*Pungitius pungitius*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieui*
Rock Bass	*Ambloplites rupestris*

Green Sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lepomis gibbosus*
Black Crappie	*Lepomis nigromaculatus*
Yellow Perch	*Perca flavescens*
Walleye	*Stizostedion vitreum*
Log Perch	*Percina caprodes*
Johnny Darter	*Etheostoma nigrum*
Iowa Darter	*Etheostoma exilis*
Blackside Darter	*Percina maculata*
Mottled Sculpin	*Cottus bairdi*

Appendix 2: Wildlife Associated with Riparian Zones and Wetland Habitats

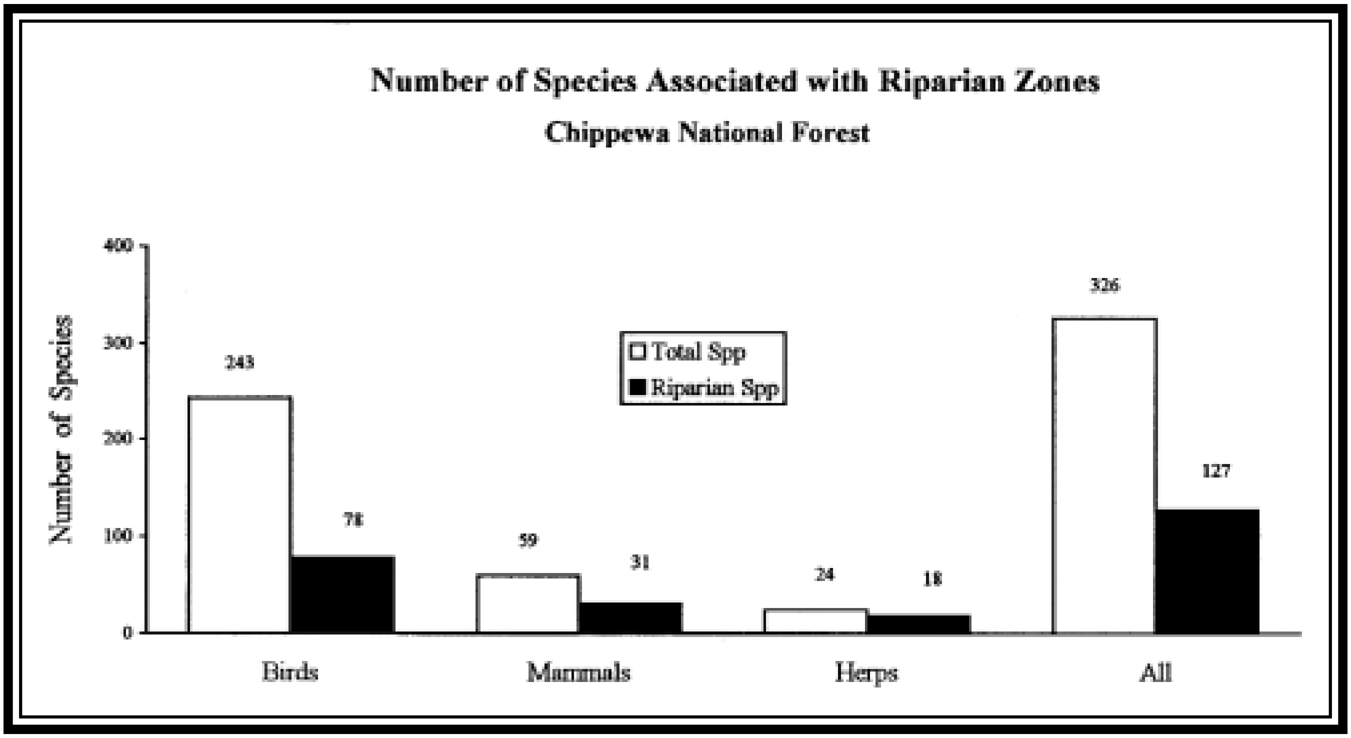

Figure 2.1

- Of the 326 vertebrates on the Chippewa National Forest, nearly 40% (127) are associated with riparian zones for some portion of their life.
- Over one-half of all the mammals and three-fourths of the reptiles and amphibians are associated with riparian zones.
- Birds, as a group, are least associated with riparian zones, with about one-third of all the species having this relationship.

Management Implications: Altering riparian zone communities has great potential to affect habitat suitability for many wildlife species.

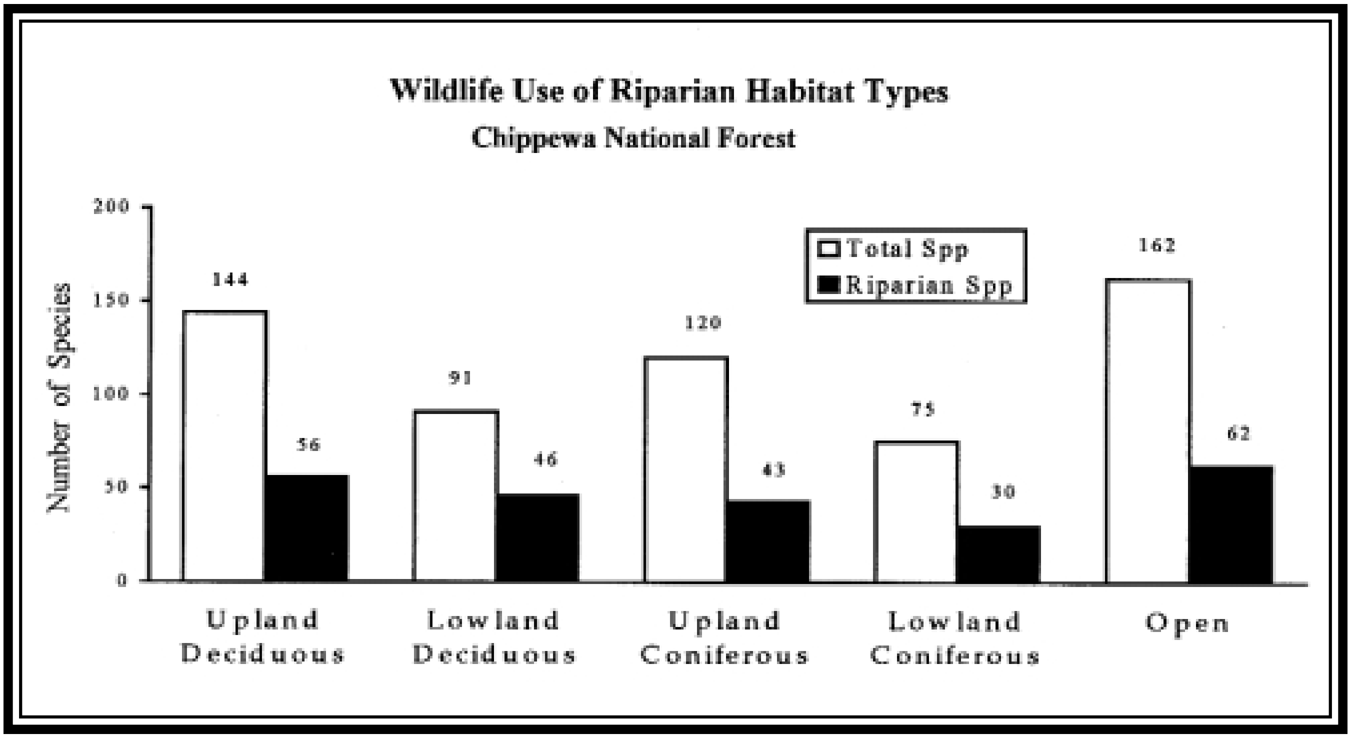

Figure 2.2

- Species associated with riparian zones (riparian species) occur in all habitats, but some habitats are selected more often than others.

- About one-half of all the vertebrates associated with lowland deciduous forests also use riparian zone habitats.

- Species associated with upland coniferous forests occur in riparian zone habitats less often than species occurring in any of the other four habitat types.

- Of the 162 species occurring in open or non-forested habitat, 62 (38%) are also associated with riparian zones.

Management Implications: Riparian zones should contain a diversity of habitat types, including open areas, when species richness is an objective. Deciduous types and open areas should be favored over coniferous types.

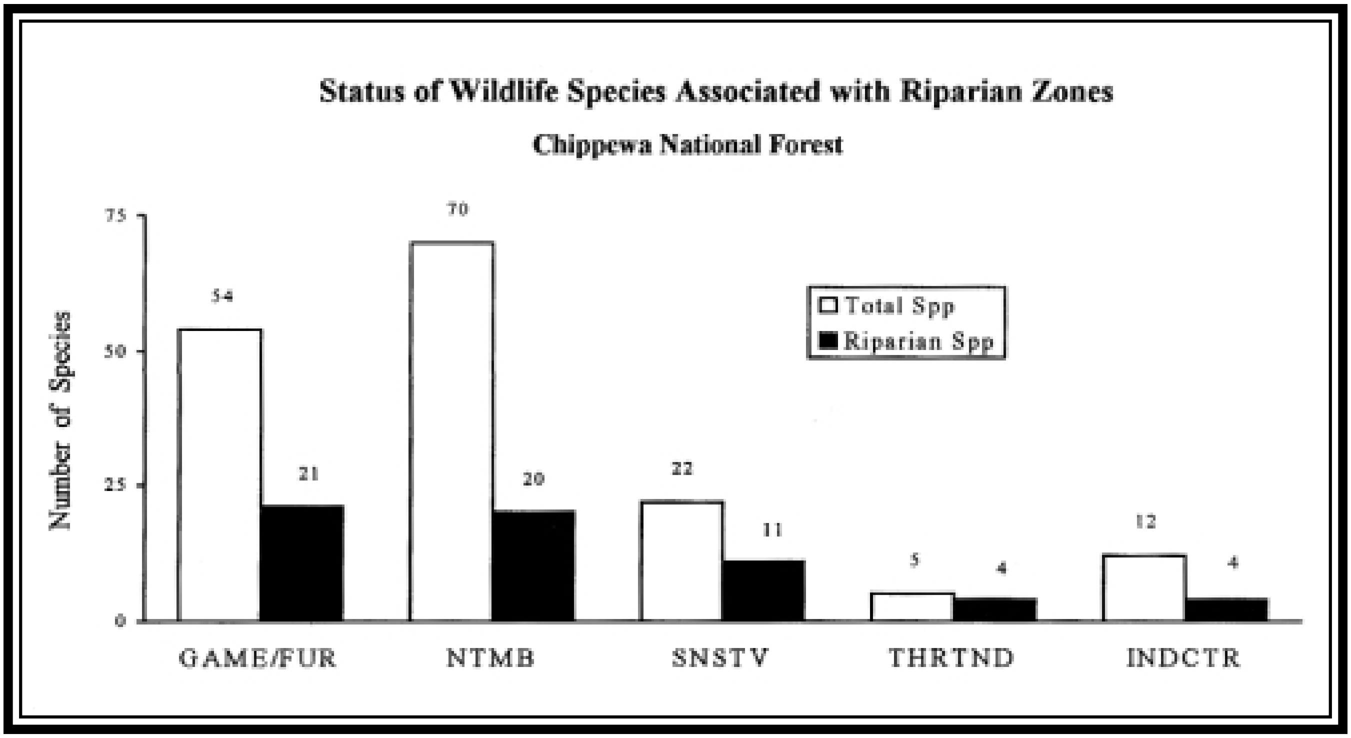

Figure 2.3

- One-half of the sensitive species (SNSTV) and four of the five threatened species (THRTND) are associated with riparian zones.
- Of the 70 neotropical migrant birds (NTMB), almost one-third are associated with riparian zones.
- Four of the 12 indicator species (INDCTR) are riparian-oriented.
- Riparian zones are important for 21 game/fur species, or 39 percent of all species in this group.

Management Implications: Alteration of riparian zones can potentially affect a large number of species whose populations are considered at risk. Monitoring the populations of indicator species associated with riparian zones will help to determine the health of these ecosystems.

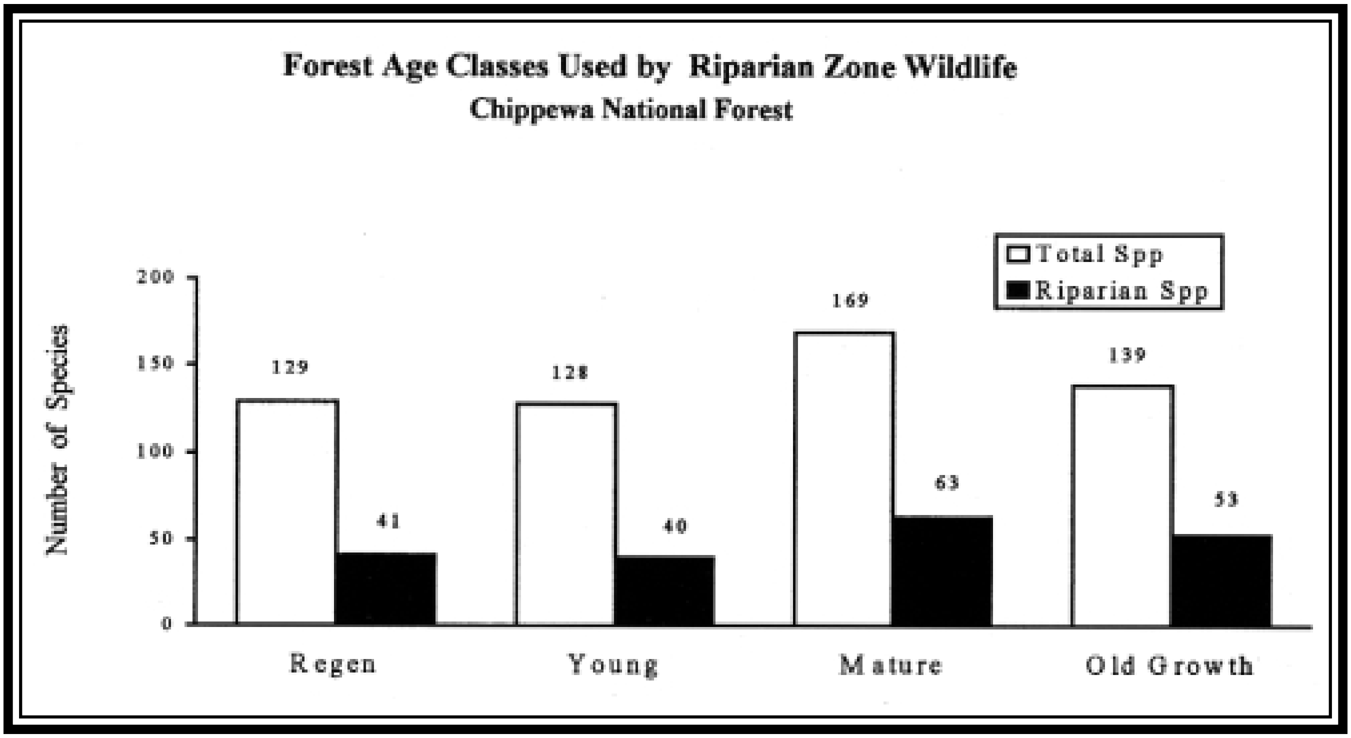

Figure 2.4

- Riparian vertebrates are associated with all age classes of forested ecosystems.
- Almost one-third of all the species that require regenerating or shrub-land habitat (REGEN) are riparian zone species.
- There is a tendency for riparian zone species to be more closely associated with mature and old growth forest than with other age classes.

Management Implications: If species richness is an objective, riparian zones should be managed to provide a range of age classes, with emphasis on mature and old growth conditions.

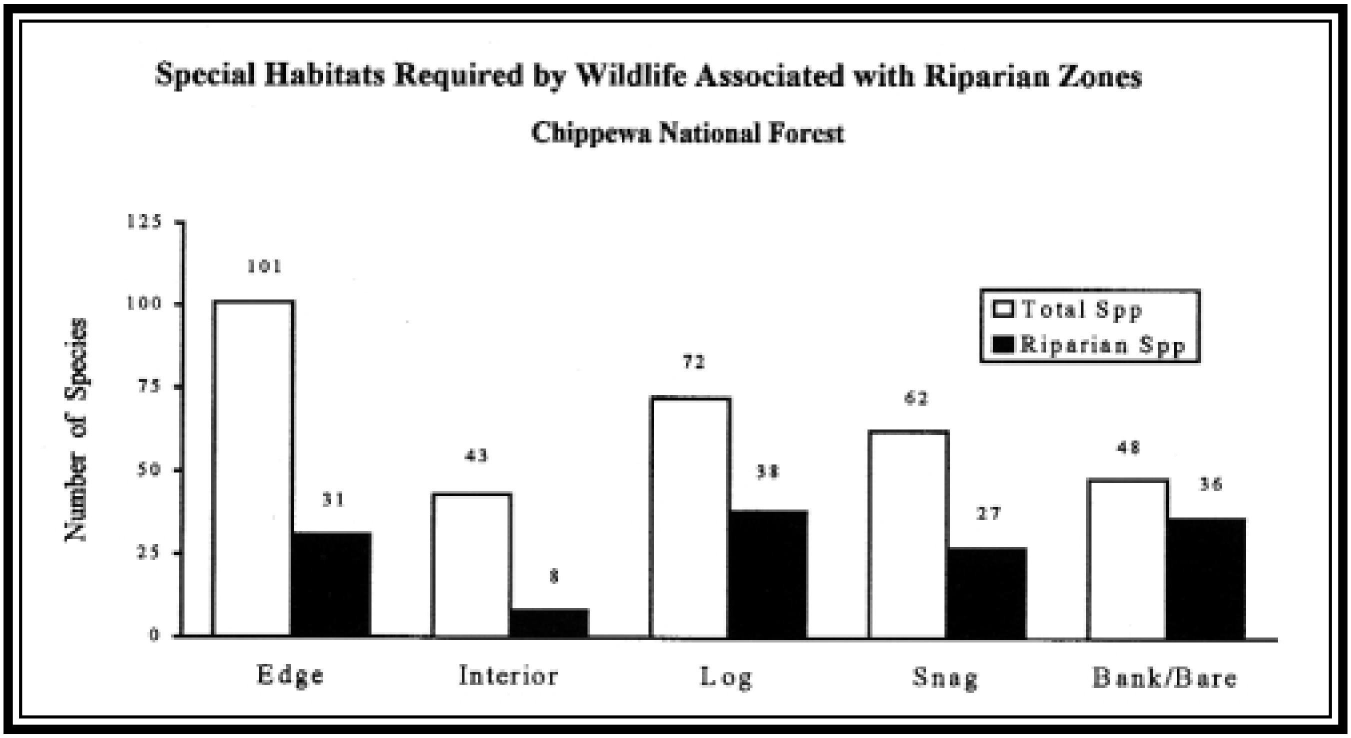

Figure 2.5

- About one-third of all the species occurring in edge habitats are also associated with riparian zones. Conversely, only 19 percent of the species that are interior-related are riparian species.
- Downed-logs and snags are particularly important habitat components for wildlife in riparian areas.
- Of all the species that require vertical banks and/or bare ground, three-fourths are riparian species.

Management Implications: To maintain or improve habitat for riparian wildlife, management prescriptions should provide for an abundance of snags and downed logs, and some exposed banks and bare ground.

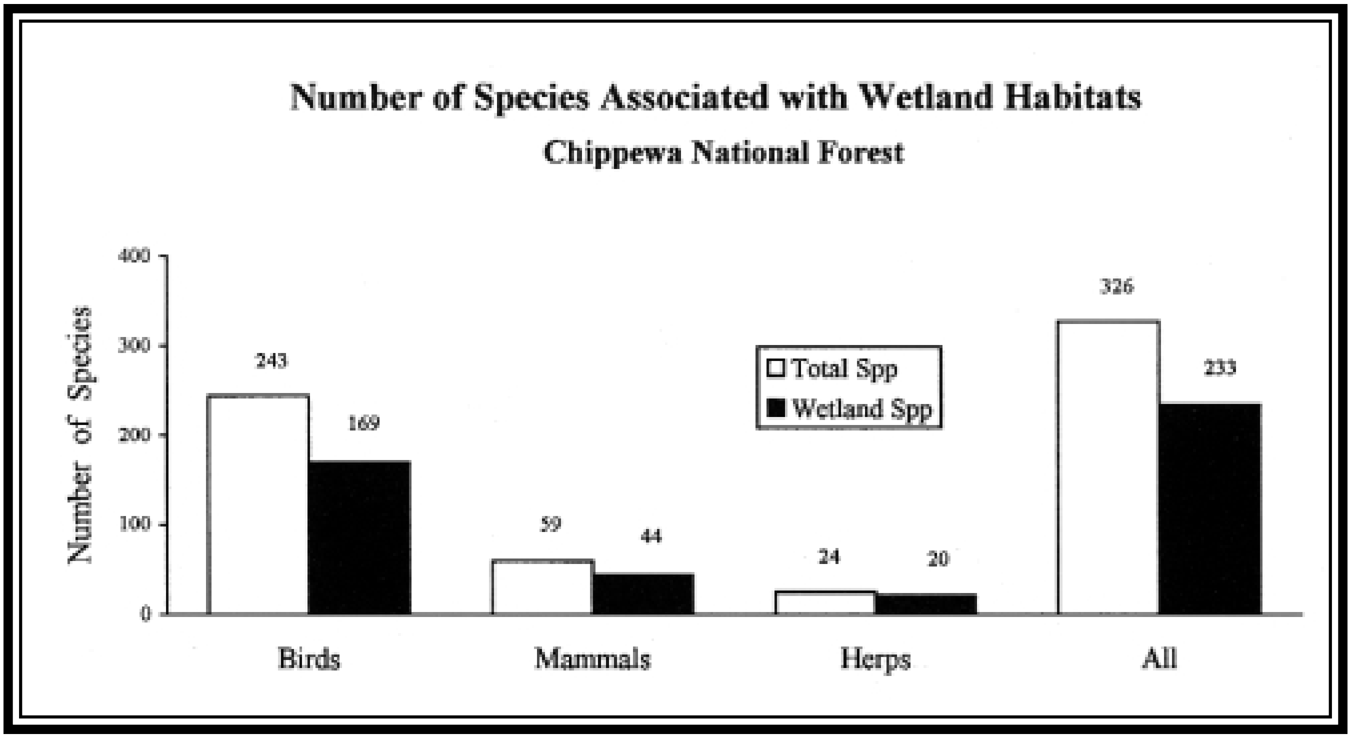

Figure 2.6

- Of the 326 vertebrates on the Chippewa National Forest, almost 75% are associated with at least one of the wetland communities.

- Although a large number of avian species are associated with wetlands, the relationship is not as strong as it is for mammals and herps.

Management Implications: Altering wetland communities has great potential for affecting habitat suitability for a large number of vertebrates among all classes.

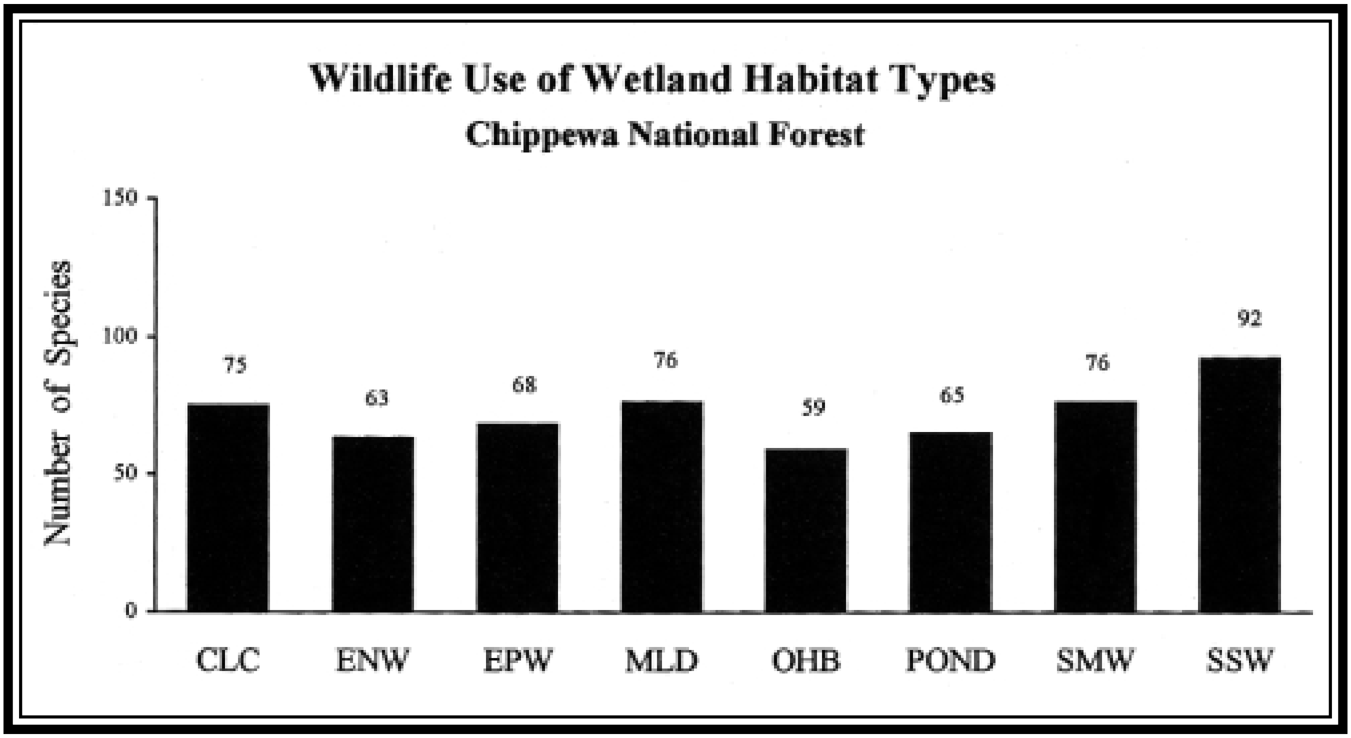

Figure 2.7

CLC - lowland conifer, ENW - emergent non-persistent wetland, EPW - emergent persistent wetland, MLD -mature lowland deciduous, OHB - open heath bog, POND - open water <10 acres, SMW - sedge meadow wetland, SSW - shrub swamp wetland

- Of the eight wetland types, shrub swamp wetlands support the greatest number of species.
- Open heath bogs support the least number of species.

Management Implications: Management actions in wetlands can potentially affect a large number of species.

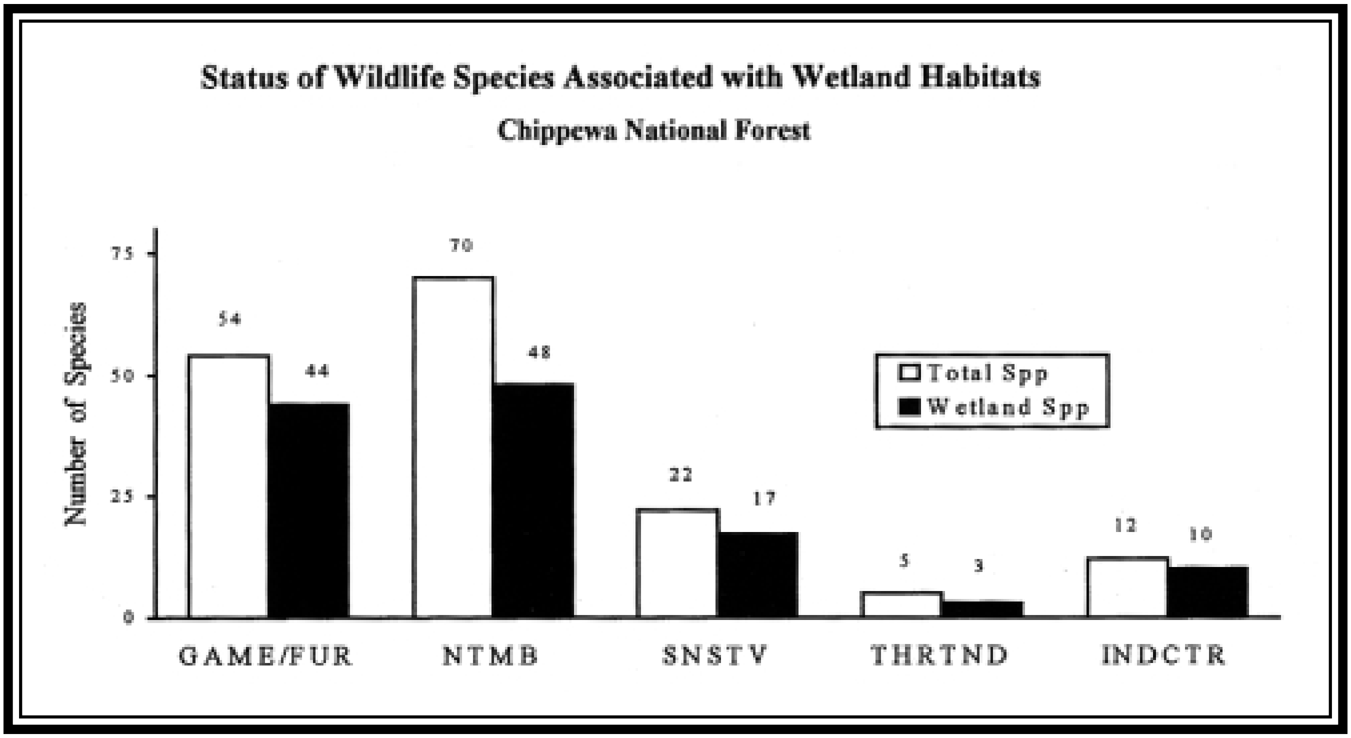

Figure 2.8

- Over three-fourths of the sensitive species (SNSTV) and three of the five threatened species (THRTND) are associated with wetland communities.

- Of the 70 neotropical migrant birds (NTMB), almost two-thirds are associated with wetlands.

- Ten of the 12 indicator species (INDCTR) are wetland-oriented.

- Wetland habitat is important for over 80 percent of game/fur species.

Management Implications: Alteration of wetlands can potentially affect a large number of species whose populations are considered at risk. Monitoring the populations of indicator species associated with wetlands will help to determine the health of these ecosystems.

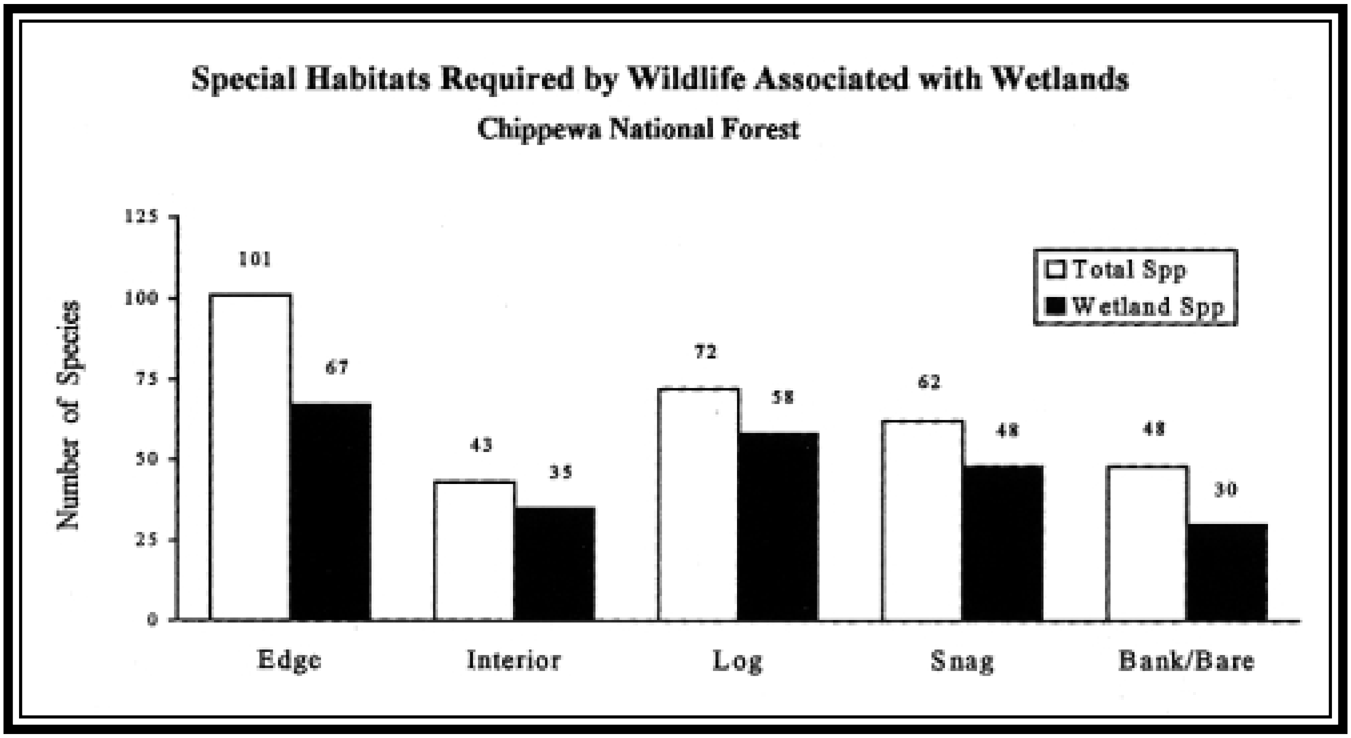

Figure 2.9

- Over one-half of all the species occurring in edge habitats are also associated with wetlands. Conversely, nearly all of the interior species have a wetland relationship.
- Downed logs and snags are particularly important habitat components for wildlife in wetland communities.
- Of all the species that require vertical banks and/or bare ground, over one-half are wetland species.

Management Implications: To maintain or improve habitat for wetland wildlife, management prescriptions should provide for an abundance of snags and downed logs, and some exposed banks and bare ground.

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