Chapter 20

Riparian Area Management: Themes and Recommendations

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The end results of most of our management actions are reflected by the health of our rivers, streams, and lakes. Michael Dombeck, Chief, USDA Forest Service

In this final chapter, we consider the overriding themes of riparian area management and list highlights and recommendations from each chapter.

The Water's Edge

The quote above alludes to the difference between forest management and riparian forest management. Riparian forest management is concerned with the water as well as the forest. The combination of water and forest is both a feature of the landscape, and a priority in our values that has focused resource management on riparian issues. Riparian management has passed from a history of intense exploitation a century ago, through recent decades of neglect, to the intense demand for shared decisions we see today. Protecting the essential links between land and water ensures quality water and quality aquatic habitats. Best Management Practices, which govern logging activities and tree removals in and around riparian areas, are a good example of how we design management options to reduce impacts on water quality. Silvicultural prescriptions to meet Desired Future Conditions for riparian areas give primary consideration to protection of water temperature and contributions of particulate matter and coarse woody debris to aquatic habitats. Managing for recreation in riparian areas addresses the impacts on water quality and impacts on our perception of a quality personal experience at the water's edge.

Our Values

Human values and desires shape the way riparian areas are managed. Values and desires often overlap or conflict, and there is a need to find common ground. The axiom "good stewardship is shared stewardship" is especially appropriate for riparian area management. It has given insight to complex management recommendations that consider use and the relationships among resources. Riparian areas should receive "active" management, with "hands-off' being one option.

Connected, Complex, and Fuzzy

Riparian areas are difficult to define and delineate. Physical or biological criteria seldom allow finding a location where one might comfortably say "My right foot is in the riparian area, and my left foot is not." Perhaps more than any other landscape feature, riparian areas focus our concept of landscape connections for fish and animal communities, for the interaction of forest regeneration with forest-site, and for the interaction of our personal economics with our personal recreation. Each of our disciplines (wood, water, wildlife, fisheries, recreation, farming, and transportation) finds reasons to sharpen its perception of interdisciplinary management in a landscape framework with multiple owners. This connected landscape is where land ownership and community stewardship tests the boundary between private rights and states rights. Because our riparian landscape winds through many social boundaries, and is managed with many levels of knowledge, we realize how fuzzy the boundaries really are. We need both the protection of a one-size-fits-all approach (perhaps a 2- or 3- sizes-fit-all approach), and the challenge of the custom-fit approach where we weigh our knowledge of land and water as we read the landscape and prescribe a Desired Future Condition for each riparian area we manage.

Chapter Highlights and Recommendations

The Challenge of Managing for Healthy Riparian Areas

We have lived by and traveled our streams, rivers, and lakes for millennia, and the conflicts now at the water's edge are at least two centuries old: squatter's rights (private rights), forest management (regulation of forest structure on the basis of age class and acreage), flooding and sedimentation (geologic or antbropogenic), states rights (BMPs), subsidies or grants, and regional sedimentation (the landscape perspective or the site-specific guide).

We have re-awakened to the values we find so compelling at the water's edge.

Desired Future Condition is socially derived, and takes real, personal work to achieve.

Broaden your competence to manage riparian areas using both your discipline and the disciplines of others.

The acid test of our understanding is not whether we can take ecosystems apart on paper. . . but whether we can put them together in practice and make them work.

Find the knowledge to read the land and river, When you do, we have no fear of what you will do for them.

2 Defining Riparian Areas

Historically, we have based our definitions of riparian area on the vernacular of a particular discipline, or a particular agency.

We review the literature and offer a definition based on how a riparian area functions: **A riparian area is a three-dimensional ecotone of interaction that includes the terrestrial and aquatic ecosystems, that extends down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at a variable width.**

- The On-The-Ground Key offers two ways to define riparian areas for streams, rivers, lakes, ponds, and wetlands: read the land and water, or use rules of thumb based on stream width and mature tree height.

3 Diversity in Riparian Landscapes

- Riparian areas are crowded neighborhoods. Neighboring and functionally connected ecosystems within riparian areas are often dense, giving rise to greater biodiversity.

- The cause of crowding is the physiographic diversity encountered and created by rivers as they flow through the landscape. They create variation in the topography of floodplains and terraces, they mediate the space and time patterns of soil moisture, and they influence vegetation composition and structure.

- Management begins with ecosystem classification and mapping.

- Maintain or restore the physical processes that regulate riparian ecosystems.

- Put on your landscape glasses if you really want to understand and manage riparian areas.

- Manage for timber when and where appropriate.

- Buffer width depends on landscape context.

- Favor native species.

4 Classifying Ecosystems and Mapping Riparian Areas

- The size and complexity of the natural world demands that we classify and map so we can comprehend and remember what is important about Mother Nature with wet feet.

- Use the hierarchical approach to classify both aquatic and terrestrial ecosystems, and use ecological functions to group things rather than arbitrary boundaries imposed by institutions or professions.

- For aquatic classification systems, the hierarchy is split on world climate zones first, then on the similarity or difference of fish species in the community, and on the topography of watershed boundaries.

- For terrestrial classification systems, the hierarchy is split on similar world and regional climate zones, then on geologic and potential vegetation boundaries.

- The aquatic and terrestrial classification systems overlap and nearly coincide at the world climate zone and the terrestrial subsection/aquatic subbasin scales.

- Also for streams, develop Valley Segments that incorporate both physical and chemical components you can directly relate to fish, invertebrate, or mussel communities using stream width, water temperature, and alkalinity (your system's place on the acid/base titration curve), and possibly trophic status (phosphorus, nitrogen, biomass).

- For streams, use the system of Natural Stream Types to group stream reaches into common types that identify how the stream and its valley handle the energy of flowing water and sediment. Use the Types to communicate with your colleagues.

- For terrestrial units, use Land Types to group ecosystems because they relate to landscape position, geologic makeup and potential vegetation.

- Use Valley Segments as descriptors in Land Type associations or Land Types.

- Use Land Type as descriptors in aquatic types.

- With the advent of GIS and relational databases, you can map and handle information on the basis of resource hierarchal groupings, administrative boundaries, or a combination of both. How do you want to accumulate your information in a world where resource decisions are shared rather than discipline oriented?

5 Linkages Between Forests and Streams: A Perspective in Time

- Evaluate the relative contributions of your forest to streams and lakes on the basis of its successional stage: (0 to 10, 11 to 30, 31 to 80, 81 to 125, and 126 to 250' years old).

- You'll have to cut 20% of a watershed, or 25% of mature basal area to measurably increase the yield of water on an annual basis.

- If you cut the whole thing, the annual yield of water can be 40% higher than from the mature forest condition; most of this comes in the growing season when water is converted from transpiration to subsurface flow; it may take 15 years to diminish.

- Forests free of recent disturbance are the best possible vegetative cover for protecting against flooding. If your landscape is heavily cut, peak flow increases of 150% are possible (see Chapter 6).

- Intensify timber sale administration and use BMPs. Realize that sediment yield is closely related to individual storms and the condition of roads used for access. Give special attention to chronic disturbance problems at landings, roads, and stream crossings.

- Sediment yields from well-regulated forest landscapes are small, generally in the 25 to 40 lbs/acre/year range.

- Following BMPs will reduce on-site erosion.

- Site nutrient loss is highest before significant regrowth and from old stands (more than 80 or 100 years old), especially if atmospheric inputs of nitrogen and sulfur are high.

- High atmospheric inputs of nitric and sulfuric acids can denude soils of essential base cations (e.g., calcium, magnesium), especially on base-poor sands; limit biomass removal on these sites.

- Retain your stream shade. Loss of forest shade can warm streams by 9°F to 18°F unless cold, groundwater flows dominate.

- Models such as JABOWA, FORTNITE, LINKAGES, and BROOK can help you assess changes in nutrients, woody debris, forest structure, and water yield.

- Use the combination of Current Condition, Desired Future Condition, and BMPs to manage riparian forests, and manage upslope forests first because they will change riparian conditions. Consider emulating the early mature stage (80 to 125 years old) near water to provide a continuing supply of organic matter and CWD.

6 Water Flow in Soils and Streams: Sustaining Hydrologic Function

- As rainfall increases soils become saturated farther and farther fromtbe stream's edge. This is the variable-source-area concept which states that the area that generates streamflow expands and contracts with the weather. It applies to mineral and organic soils in the watershed.

- Most of the water in forest streams is delivered as subsurface flow (within a foot or so below the surface) of either mineral or organic soils, and where deep aquifers exist, from groundwater discharging into the channel bottom.

- Depth to the water table (up 18 inches) controls the attainment of maximum vegetation height. Soil texture and organic matter content control water availability in deeper, well-drained soils, and (along with nutrients) determine the maximum vegetation height attained on these soils.

- Unless the soil is really dry or frozen, the water table must be at least 18 inches below the surface to support equipment and avoid soil compaction.

- Keep vegetation growing to its potential by keeping the water inside the soil moving -protect the macropore structure of soils so they can contain optimum amounts of air and water.

- Optimum water and air occur in surface mineral soils (to a depth of 6 inches) if soil bulk density is less than 1.3 (less than 0.1 in organic soils). In the 6- to 12-inch horizon, keep mineral soil bulk density less than 1 .5. Reductions must be made to the initial bulk density values of weight and volume for soils with high rock content. These are made by subtracting the weight and volume of rocks before making the final bulk density calculation.

- Soils compacted to levels greater than above commonly reduce future biomass productivity by 20 to 30%.

- Judge water flow in streams by understanding Natural Stream Types.

- Learn what Bankfull Elevation really is and how to find it at the water's edge.

- Channels that are changing from one Natural Type to another are unstable.

- Use both deductive reasoning and Fisher statistics to evaluate watershed condition.

- Snowmelt peak flows can increase by 150% if more than 2/3 of a basin is harvested in the span of 15 years. The minimum watershed size where these increased peak flows can actually cause in-channel erosion is 1 square mile in basins with high slopes (30% or more) and 10 square miles in flat basins (slopes less than 3%).

- Restrict soil drainage networks (ditches) to less than 1/3 of a basin.

- Restrict ditched roadway area to less than 15% of the basin.

- Vigorous, strong root systems at the water's edge will minimize channel over-widening.

- Road crossings at streams are major sediment sources to the channel. Reduce fine sand inputs by blacktopping the road (to the top of the terrace slopes on each side of the road) or by surfacing with crushedrock (that will pass a 1 ½ inch sieve) in a layer 6 inches deep.

- Size round culverts at crossings by adding a foot to the bankfull channel width, or ask an engineer or hydrologist to design them for a specific site. Lay them with the same slope as the channel, and bury the bottom to 1/6 of their vertical diameter (to keep them from perching and blocking fish passage).

- In wetlands, where culverts are used underneath roads (but not in channels) use 24-inch culverts or larger, and bury the bottom half below the peat surface so the culvert will carry the everyday flows (subsurface flow).

- When deep road fills across stream valleys wash out, use a second culvert (the same size as the channel culvert) placed on top of the floodplain about halfway between the channel and the terrace slope. This "floodplain relief' culvert and the channel culvert will pass at least the 50-year flood.

7 Debris isn't so Bad

- Let everyone know that organic matter in streams is an asset to be husbanded.
- Manage the riparian area. In a natural system, change will come with or without management, wise management presents the greatest potential for watershed enhancement.
- Develop a strategy to limit "emergency cleanup" by removing only necessary amounts of woody debris in the aftermath of natural disasters.
- Manage for a component of 50- to 200-year-old trees in the riparian zone to supply near natural inputs of large wood capable of forming debris dams.
- Manage for a diversity of native species typical of riparian areas in the region to provide a natural supply of detritus that supports the needs of the macroinvertebrate community.
- Do not disrupt natural flood inputs of organic matter to streams.
- Remove trees felled into streams during logging only after consulting with a biologist or other resource specialist in charge of the timber sale.
- Leave dead and down trees in the riparian area to avoid damaging the integrity of the streambank and to enhance habitat for amphibians and other animals.
- Discourage extensive dense thickets of rhododendrons in the riparian area because they provide neither high-quality detritus nor long-term potential for large wood recruitment.
- In high-water-table floodplains, protect dense grass and sedge that bind banks and narrows channels.

8 Mammal and Bird Habitat In Riparian Areas

Landscape level considerations

- Consider variable-width and wider stream buffers.
- Limit new road building in **riparian** areas.
- Avoid long, linear clearcuts adjacent to buffer areas.
- Consider the potential tree species composition.
- Limit grazing activities at the water's edge.
- Limit borrow pit development,

Stand level considerations

- Favor variety and diversity.
- Manage the habitat to meet goals of typical species.

Within stand or structure considerations

- Base decisions on site potential.
- Retain higher densities of cavity trees and snags, emphasizing large diameters.
- Consider a variety of canopy closures, **raptor** nesting potential and perch tree potential.
- Consider softwood-to-hardwood and mast-to-non-mast basal area ratios.
- Consider increasing large dead and down woody debris potential, both in-stream and terrestrial.
- Favor multiple canopy layers: shrub thicket, grass/sedge, and herbaceous ground cover.

9 Managing for Fish in Riparian Areas

- No more than 2/3 of the watershed should be in young stands (<15 yrs old) where snowmelt may result in channel erosion and sedimentation. Where agricultural land use exceeds 30% of the watershed area, the portion of young forest should be less.
- To be effective, riparian guidelines must include small streams and dry channels.
- Design roads and trails to minimize interception and concentration of both surface water and groundwater flow.
- Design roads and trails so that bridges and culverts do not occupy low points in the road or design to divert surface runoff from the road prior to the crossing point.
- Consider designing riparian forest buffers with a width equal to at least two tree lengths for fish habitat protection.
- Consider establishing reference streams and using indices of biological integrity to evaluate streams and the impacts of management.

10 Amphibians and Reptiles in Riparian Habitats

- Maintain or restore hardwood forest canopies to maintain microclimate, leaf litter, and coarse woody debris.
- Schedule forest management activities and select equipment to avoid soil compaction.
- Severely restrict livestock's access to streams.
- Consider using buffer zones based on the seven Riparian Habitat Types and the needs of the herptofauna in question.
- Manage the aquatic edge as well as the upland edge of the riparian area, again based on a holistic assessment of the needs of the species present.
- When in doubt, manage to mimic historic disturbances that provided the evolutionary basis for natural community structure.
- Obtain a complete data set on the life histories of species inhabiting the area.

- Develop an understanding of population and seasonal dynamics and the range of threats for the species involved.
- Monitor to determine trends and to detect changes in species composition among sites.
- Hire experienced herptologists and train field personnel to conduct such studies.

11 Human Dimensions

- The human dimension is a critical and an increasingly important component of riparian management.
- For effective riparian management, it is necessary to integrate the human dimensions information early in the planning process.
- People's values, attitudes, beliefs, knowledge, and expectations are as important as plant and animal population and distribution.
- Accommodate the human dimensions by developing an array of reasonable alternatives rather than trying to "sell" your recommendation.
- A variety of qualitative and quantitative methods are available for collecting human dimensions information. These range from in-depth interviews of a small number of individuals to broad population surveys providing generalized results. Which method is chosen is dependent on the questions managers are seeking answers to.
- Human dimensions information is useful in developing management and planning options as well as in facilitating a dialogue with the public.

12 Lake Riparian Areas

- Use volunteer monitors and lake organizations in education, protection, and management programs for lake riparian areas.
- Educate lake users and lakeside landowners about the value of coarse woody debris (CWD) and discourage unnecessary removal.
- Increase habitat complexity by managing forests for a continued supply of CWD.

- Plan riparian forests in conjunction with other protective practices where trees are the natural riparian vegetative cover.

- Consider basin morphology and prevailing winds in managing riparian areas where wind stress on the surface of the lake is a problem.

- Retain lake-associated wetlands, because they are considered important sources of dissolved organic matter.

13 Integrated Management of Riparian Areas

- Social, economic and political interests along with biological considerations have added complexity to riparian management, requiring an integrated approach.

- Integrated management is characterized by collaboration, pursuit of long-term goals, dissemination and use of information, and modification of actions based on monitoring of progress (adaptive management).

- Developing integrated management plans involves setting direction, inventorying values and resources, developing alternatives, selecting a preferred alternative, and implementing.

- Management direction is the combination of long-term goals and the actions needed to achieve those goals.

- Long-term goals may be limited by laws, regulations, and organizational objectives.

- Inventory includes both assessing existing information as well as on-the-ground data collection. In both cases, efforts should reflect the value of the resource being inventoried.

- Develop mechanisms for sharing and evaluating information to facilitate collaboration.

  Considering social values at the outset can reduce the potential for legal, political, or jurisdictional battles that arise when concerned citizens and citizen groups are excluded from the process.

- Identify constituents early in the process, being careful not to confuse stakeholders and constituents that are concerned with special interests. The real stakeholders are the people who live in the watershed and drink the water.

- Consider multiple spatial scales. Some effects of resource management will go beyond the scale of the project area.

- Involve all the interests and disciplines, and establish a clear decisionmaking process.

- Develop alternatives to reach the same desired end. Evaluate the different approaches, effects, benefits, and costs associated with each. Make these trade-offs obvious to the decisionmakers and the public.

- Each alternative considered must be based on the capability and limitations of the ecosystem and must move the project toward the long-term goal.

- Document the fact that you have listened to concerns, evaluated results, explored options, and selected an alternative based on the objectives.

- Monitor progress and adjust accordingly.

14 Ecologic Principles of Riparian Silviculture

- Understand the characteristics of the system. Use your knowledge of the land and the water to apply silviculture across the ecotone from the water's edge into the upland. Consider what fits the land best as well as BMP guidelines.

- Include maintenance or restoration of riparian functions as a principal silvicultural objective. Traditional silviculture aims at producing wood, riparian silviculture aims at maintaining riparian functions. When you apply riparian silviculture, you are managing the water as well as the forest.

- Remember that riparian forests are ecotones. Consider how the values of each riparian function taper off with distance from the water, and how the need to protect the water resource intensifies approaching the water's edge.

- Apply site-specific, comprehensive silvicultural prescriptions in riparian areas. Learn how to manage with clump and patch patterns that allow a combination of single-cohort (even aged, single canopy) and multiple-cohort (uneven aged, multiple canopied) tree stands. Retain large trees at the bank, use clump and patch patterns to maximize biomass production in the second tier away from the water, and feather into single-cohort stands where desired on the upland terrace. In uneven-aged, multiple-cohort stands, consider clump and patch patterns instead of evenly spaced residuals.

15 Harvesting Options for Riparian Areas

- Route planning and equipment selection can minimize ground disturbance in the riparian zone (see our evaluations in Chapter 15).

- Wait 2 days after the day of heavy rains, so soils will drain. This allows them to convert from mud (they are at their liquid limit in this period) to the field capacity condition (gravity has drained all the water it can) when they can again support equipment.

- Use geotextiles and temporary crossing mats where weak soils must be traversed.

- Be familiar with state BMPs and apply them appropriately.

- Avoid putting sediment into stream channels. Plan road systems efficiently.

- Surface permanent haul roads with crushed rock at stream crossings.

- As a first choice, use temporary bridges to cross stream channels.

- As a second choice, use temporary culverts, pipe bundles, corduroy (pole fords in NH), or snow and ice to cross channels, but avoid pushing earth into the channel or adjacent to the bank. Remove these crossings before spring or fall peakflows do it for you.

Oversee the harvesting process

- Prepare comprehensive harvest plans. Tailor them to each site.

- Meet with the operator on-site beforehand to ensure the plan provisions are well understood.

- Supervise during the operation to ensure the plan is being properly implemented.

16 Best Management Practices

- Planning is the most important BMP.

- Mark riparian management zone boundaries, and include the operating restrictions in the language of the contract, and provide on-site administration to ensure activities comply with the contract.

- Decide the purpose and degree of protection to give to each of the various types of water bodies to be encountered.

- Involve resource specialists, industry, and concerned constituents in the development of guidelines to work toward a balance among science, practicality, and economics.

- Recognize the importance of operating with less physical intrusion and more care in riparian areas.

- The riparian area may be viewed as a zone of closely managed activity, rather than a zone of exclusion.

- BMPs applied to variable width riparian areas may be more costly and time consuming to implement, but they will likely provide greater resource protection (see Chapters 2 and 14).

- Complying with BMPs, although easier to measure on fixed width riparian areas, does not necessarily indicate protection of water quality.

- Establish a management emphasis within the riparian area by considering direction of lean and proximity to water as well as other factors in determining the relative riparian and aquatic value of individual trees.

- Design BMP's to prevent (or mitigate) adverse impacts from sediment input, temperature shifts, flow changes, chemical inputs, waste disposal, or habitat alteration.

- To prevent adverse impacts visit existing problem and sensitive areas within the riparian area to evaluate the location and degree of disturbance from access before operations begin, and to plan remedial work required.

- Select stream crossing methods and locations to avoid disturbing fish and amphibian migrations, deforming the bank or channel, or mining stream gravel.

- Avoid fueling, equipment servicing, and pesticide applications within the riparian area.

17 Monitoring the Effects of Riparian Area Management

- Establish an understanding of the time and cost associated with monitoring and secure the necessary commitments from all concerned.

- Identify the monitoring objective. The question to be answered and the audience to be informed will dictate the measurements to be made and the level of precision necessary.

- Measuring change is not an end in itself, the harm caused by the change must be explained.

- Follow the key steps for conducting monitoring activities by MacDonald et al. (1991).

- Understand natural sources of variation such as climate, geology and acid bog drainage, which may affect monitoring results.

- Understand the potential long-term effect of historic land use such as mining and agriculture. Elevated sediment loads have been documented as long as 60 years after farm abandonment.

- Monitor streamflow on smaller watersheds. Flow increases become measurable only from the entire watershed when more than 25% of the basal area is removed.

- Use readily available information from the United States Geological Survey, other state and federal agencies, and other sources when appropriate.

- Remember that sample points must be comparable and watershed size and stream order alone are not good indicators of comparable conditions.

- Macroinvertebrate populations are governed by substrate composition.

- Macroinvertebrate populations recover rapidly following impairment from stream sedimentation, unless the source of sediment continues to supply excessive amounts.

- Macroinvertebrate numbers are a more sensitive indication of short-term sedimentation than diversity indices or fish populations. Long-term changes can be documented with macroinvertebrate indices and fish community assemblages.

Use the following knowledge of common changes documented by past monitoring activities to develop current management alternatives

- Harvests can increase the number of stems on floodplains and increase the hydraulic roughness and sediment deposition on the floodplain. Maintain near-bank trees to prevent bank erosion.
- Harvests that increase direct sunlight to streams generally increase water temperature.
- Harvests within a tree length of the channel will reduce the supply of coarse woody debris to the stream and reduce pool development in sand and gravel channels.
- Harvesting over 25% of the basal area on an entire watershed generally increases summer flows.
- Other land-use changes in the watershed can mask and add to the changes resulting from forestry activities.

18 Riparian Restoration

- Cooperate to develop a clear vision shared by all key participants.
- Set achievable, measurable goals specific enough to test against during the monitoring phase.
- Create detailed action plans that relate back to the goals.
- Provide consistent, committed leadership that can empower others throughout the duration of the project.
- Integrate the technical, environmental, economic, and social requirements and limitations of the project.
- Nurture partnerships for political, emotional, physical, and financial support.

- Use ecological classification to identify existing condition, potential conditions, and the departure of existing conditions from potential.

- Perform a watershed analysis using the best available science and information to establish the cause of a problem and avoid treating symptoms.

- Use the most natural and least intrusive methods.

- Monitor progress and give credit to partners.

19 Dams: A Watershed Restoration Opportunity

- Use the Federal Energy and Regulatory Commission (FERC) re-licensing process to make major changes in the hydrology, channel habitat, aquatic community, and flood plain community of dammed watersheds.

- This is a one-time opportunity to impact riparian and river management for 50 years.

- FERC can require the dam owner to pay for your studies and planning.

- It’s a NEPA process that can be approached with a settlement agreement that encourages partners to work together in a *win-win* situation.

We have no fear that in time you will read the land and the river, to manage them as a unit for many resources, indeed, we are excited about what you will do for them (adapted from Leopold 1949).

Sandy Verry

Sunset or sunrise? Voyager's National Park, Minnesota.