RMRScience

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USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO

A Roads Field Guide for Riparian Restoration

Riparian areas and wetlands make up a small percentage of total land area in the United States, but are essential for maintaining water quality and quantity, ground water recharge, and dissipating stream energy. They also provide tremendous community benefits in the form of wildlife, fisheries and recreation, along with other uses, and are indicators of watershed health, as they are among the first landscape features to reflect damage from improper management.

A common threat to these sensitive areas is improperly constructed or maintained roads. Negative effects can include: decreased vegetation cover, water quality and recreational opportunities; and increased bank and channel erosion, sediment deposition, flooding, and animal mortality or injury; and dewatered meadows.

In August 1999, the Forest Service sanctioned the formation of the National Riparian Roads Team (NRRT) to provide training on the techniques used for roads in riparian areas – techniques that will minimize negative impacts on riparian/wetland areas and restore or improve ecosystem health.

This group of select scientists, biologists, conservationists, water specialists, and engineers has collected information from site visits to several ecoregions, restoration literature reviews, and through collective experience to produce a two-volume field guide (published by the Rocky Mountain Research Station) that presents information in a practical, user-friendly format to help resource managers and professionals restore riparian areas near roads. Volume I covers: riparian area considerations; monitoring; planning projects; laws and regulations; Forest Service road maintenance levels; construction methods and sequencing; controlled public access; road relocation or realignment; temporary erosion control; and outsloping. Volume II highlights field techniques such as: retaining walls; revegetation; invasive species; biotechnical stabilization; landslide mitigation; ditch treatments; roadway dips; culverts; energy dissipaters and debris racks; bridges; surfacing techniques; stream channel modification structures; log jam complexes; wildlife and fish passages; beaver pond structures; and wetland maintenance.

Riparian Area Considerations

The diversity of riparian areas across the country and within an ecoregion is remarkable. Rocky Mountain Research Station Research Hydrologist Roy Jemison, a member of the NRRT, says it is important to identify physical and biological differences to successfully maintain, protect and restore these areas. "Five basic elements – topography, hydrology, local climate, soil properties and vegetation – define the structure and function of riparian areas and need to be assessed before restoration efforts begin," says Jemison. "Road construction and operation in and adjacent to riparian zones can cause negative impacts to processes, structures and functions. These road impacts can be reduced and riparian areas restored by using solutions in the field guides," he said.

Monitoring

Monitoring is an effective way of documenting the degree of success or failure of road restoration efforts. Monitoring should be identified as a cost component in the restoration project, according to Jemison. The NRRT suggests a seven-step template for restoration monitoring that includes: 1) define participants and budget; 2) establish clear goals and objectives; 3) design monitoring to detect change; 4) prioritize monitoring activities; 5) implement field prescriptions and techniques; 6) analyze data and report results; and 7) modify objectives based on new information. Additional monitoring designs and tools can be found on the Internet at http://www.itre.ncsu.edu/cte and http://search.bts.gov/ntl.

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Planning Projects

Volume I of the field guides contains a section on planning restoration monitoring projects and helps the reader develop guidelines for restoration and monitoring objectives; parameters monitored; methods used; where and when to monitor; experimental design; expectations, assumptions and data limitations; and distribution and archival of results.

Jemison points out that due to the complex, interdisciplinary nature of riparian restoration, it is easy for jargon and functional interests to result in inadvertent misunderstandings. "A 'charter' that documents agreements onsite by participants can go a long way toward clarifying expectations," says Jemison. The Roads Riparian Restoration website (http://www.fs.fed.us/rm/RRR) provides such a tested design for users. The field guides also contain a glossary that will help avoid misunderstandings by providing a common language base.

Laws and Regulations

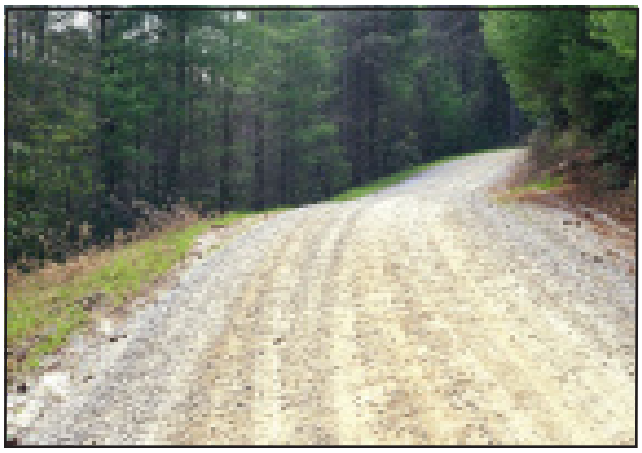
Work on roads in riparian areas on federal lands may require a federal permit or compliance with state laws and regulations. Volume I offers a brief overview of the most common federal laws and regulations pertaining to wetlands and waters of the U.S. Contact the appropriate agency before project work begins for information about permitting and compliance, especially your state agency, as state laws and regulations vary.

Field Techniques

The last section of Volume I, and all of Volume II, contain chapters on field techniques. Topics include:

Controlling public access removes or modifies recreational and other uses within a riparian area. The guides provide methods to help reverse the effects of unrestricted public access and restore vegetation diversity and vigor, improve water quality, decrease erosion and sediment transport, maintain or restore wildlife and fish habitat, and improve riparian function.

Road relocation or realignment removes a road from areas of concern or changes the placement to reduce or eliminate negative impacts on the surrounding ecosystems. Benefits include: improved wildlife and fish habitat; restored floodplain structure and function; reduced risk of road failures; and creation of new recreational areas.



Outsloping of roads has been used effectively where it is important to maintain dispersed surface runoff for ecological reasons.

Temporary erosion control devices slow runoff, trap small amounts of sediment, and are usually associated with construction activities. Such applications include sediment barriers such as filter fences and straw bales, retention structures and mulches.

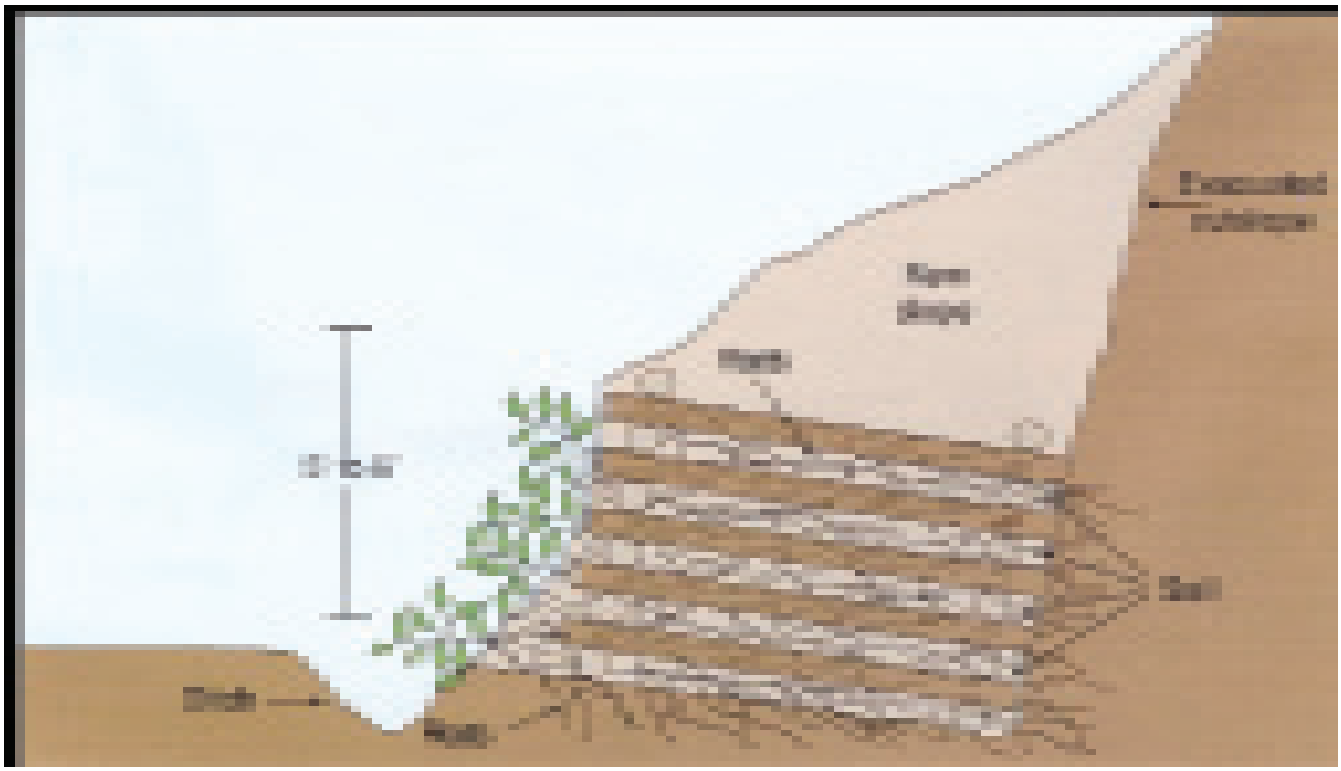
Outsloping reduces erosion by minimizing concentration of surface runoff. Outsloped roads are designed to drain al surface water to the downhill side. This eliminates inside ditches, decreases road maintenance, occupies less land, and lowers initial costs associated with road clearing and construction.

Retaining walls, such as mechanically-stabilized backfill, stabilize slopes where erosion and safety are a concern by eliminating the output of soil and debris to the ditchline. Retaining walls reduce road maintenance needs and subsequent costs.

Slope rounding lays back hillslopes to a natural angle of repose to reduce runoff and sediment transport, and promotes vegetation growth. These slopes are often more visually appealing as well.

Revegetation following road construction is critical to regulating stream microclimates, providing food and cover for wildlife, and controlling erosion.

Soil bioengineering stabilization uses live vegetation (roots and stems) as the main structural and mechanical element in a slope protection system to stabilize surface erosion features and shallow rapid landslips. These treatments provide sufficient stability so that native vegetation can gain a foothold and eventually take over.



Live cribwalls, a form of soil bioengineering stabilization, are box-like structures constructed of timbers, backfilled with soil, then planted with branch cuttings extending outward. Cribwalls cannot resist large, lateral earth stresses.

Invasive species (exotic plants and animals) can disrupt ecological processes. Roaded riparian areas are particularly vulnerable. Volume II covers control strategies such as prevention, identification, prioritization, treatment and monitoring.

Biotechnical stabilization is similar to soil bioengineering, but uses mechanical elements such as concrete, wood and stone, in combination with plants, to arrest and prevent slope failures and erosion.

Landslide mitigation strategies include avoidance, stabilization, control, prevention and acceptance of recurring road maintenance. Mitigation techniques highlighted in Volume II include: surface and subsurface drainage, increased resisting forces and reduced driving forces.

Ditch treatments are man-made features that channel water away from the road. Variations include vegetated, rock-lined and lead-out ditches, and raised curbs and berms. These treatments can have immediate and long-term benefits to roadside areas, including less erosion, better habitat, reduced sediment transport, and lower long-term maintenance.

Roadway dips modify road drainage by altering the road template and allowing surface flows to frequently disperse across the road. They may replace or supplement culverts fro cross drainage. Dips may reduce maintenance costs, sediment transport, the need for culverts, and the risk of catastrophic road or slope failure.

Low water crossings and fords pass water and transport debris over a road continuously or intermittently. They include vented or un-vented fords and low water bridges. These structures can range from simple, stream-grade elevations, to larger more massive structures. Benefits include lower construction and maintenance costs.

Permeable fills with culvert array are generally used to cross meadows and promote the passage of sheet and subsurface flows with minimum flow concentration and maximum spreading. Permeable fills can maintain and/or restore natural wet meadow hydrology, along with wildlife habitat, vegetation diversity and water storage.

Road-associated landslides are cut slope failures and fill slope failures caused by the road and/or natural landslides.

Debris racks at culvert inlets can prevent clogging.

Culverts are used for roadway drainage and channel crossings. They are made of a variety of materials, including corrugated pipe, concrete and plastic. Culverts control flow path and keep water separate from roadways.

Raised culvert inlets are raised by constructing a dike around the culvert, or by installing a culvert elbow. They keep water on the land longer and promote infiltration. These inlets increase vegetation vigor and diversity, reduce flash flooding, create sediment barriers, and raise water tables.

Energy dissipaters and debris racks are used at culvert inlets and outlets to reduce water velocity and erosion. Dissipaters include riprap, vegetated ditches, concrete or steel baffles, and tiger teeth. Debris racks should be installed only when regular maintenance is possible.

Bridges provide safe and easy access over naturally impassable features such as waterways, canyons or tidal areas. They minimize road impacts on surrounding areas by limiting disturbance, and provide better passage for fish and wildlife than culverts.

Surfacing techniques bind or seal roadway material. These treatments reduce dust, decrease erosion, and help maintain roadside vegetation, biological health and diversity.

Bridges that span entire riparian areas at floodprone width instead of just the active stream channel width allow larger wildlife species such as deer and bear to pass safely under roads.

Mobile rock crushing/rotor trimmer machines crush oversized waste rock into graded material suitable for road surfacing. Road maintenance reconstruction costs using crushers is generally 10 percent of the cost of traditional gravel road resurfacing.

Stream channel modification structures protect road embankments from channel scour and erosion. In-channel and channel bank structures can reduce the high maintenance or reconstruction costs resulting from road prism failures due to scour and erosion.

Reconnecting cutoff water bodies can result in significant restoration of aquatic habitat, and help the long-term recovery of floodplain structure and function. Culverts and bridges can reconnect side channels, ponds and wetlands within floodplains that have become isolated or cut off from the main channel due to road construction.

Log jam complexes are multiple log structures placed in rivers and streams to protect channel banks, roadways and other adjacent features by emulating natural river processes. They protect roads; deflect and control woody debris; promote vegetation establishment; improve fish habitats; and restore and maintain natural river system characteristics.

Fish passage provides unrestricted passage for fish across roads or other barriers via bridges or culverts. Structure type, length, width and installation grade re determined by stream, fish and site surveys.

Wildlife crossings, such as culverts or bridges, can effectively reduce wildlife/vehicle collisions and restore habitat connectivity. High bridges are the most effective type of wildlife crossing structure. Directional fencing may be necessary to encourage larger wildlife to use constructed crossings.

Beaver pond structures can maintain fish and wildlife habitat created by beavers, while reducing damage to roads. They allow water movement but prevent complete removal of water from the ponded area.

Wetland maintenance structures, such as culverts, are commonly used along diked, dammed and drained river floodplains to restore and maintain wetland functions where hydrology has been al-

For your copy of *Management and Techniques for Riparian Restoration: Roads Field Guide, Volumes I and II*, request General Technical Report RMRS-GTR-102 from the Rocky Mountain Research Station.

Publication Reviews

Wildland Fire in Ecosystems: Effects of Fire on Air
(RMRS-GTR-42, Vol. 5)

This state-of-knowledge review about the effects of fire on air quality can assist land,fire and air resource managers with fire and smoke planing, and their efforts to explain to others the science behind fire-related program policies and practices to improve air quality. Chapter topics include air quality regulations and fire; characterization of emissions from fire; the transport, dispersion and modeling of fire emissions; atmospheric and plume chemistry; air quality impacts of fire; social consequences of air quality impacts; and recommendations for future research. Copies of General Technical Report RMRS-GTR-42, Vol. 5 are available online at http://www.fs.fed.us/rm/pubs/rmrs_gtr42_5.pdf.

An Environmental History of the Middle Rio Grande Basin
(RMRS-GTR-005)

Various human groups have greatly affected the processes and evolution of Middle Rio Grande Basin ecosystems, especially riparian zones, from A.D. 1540 to the present. Overgrazing, clearcutting, irrigation farming, fire suppression, intensive hunting and introduction of exotic plants have combined with droughts and floods to bring about environmental and associated cultural changes in the Basin. As a result of these changes, public laws were passed and agencies created to rectify or mitigate various environmental problems in the region. Although restoration and remedial programs have improved the overall "health" of Basin ecosystems, most old and new environmental problems persist. General Technical Report RMRS-GTR-005 is available online at http://www.fs.fed.us/rm/pubs/rmrs_gtr005.html.

RMRScience is a quarterly report from the USDA Forest Service's Rocky Mountain Research Station. Each issue highlights on-going or recently completed research, and features findings useful to land managers and other natural resource specialists. To be added to the mailing list, free-of-charge, write *RMRScience*, Rocky Mountain Research Station, 2150 Centre Ave., Bldg. A, Fort Collins, CO 80526; or e-mail rfletcher@fs.fed.us; or fax (970) 295-5927. Comments and suggestions are always welcome.

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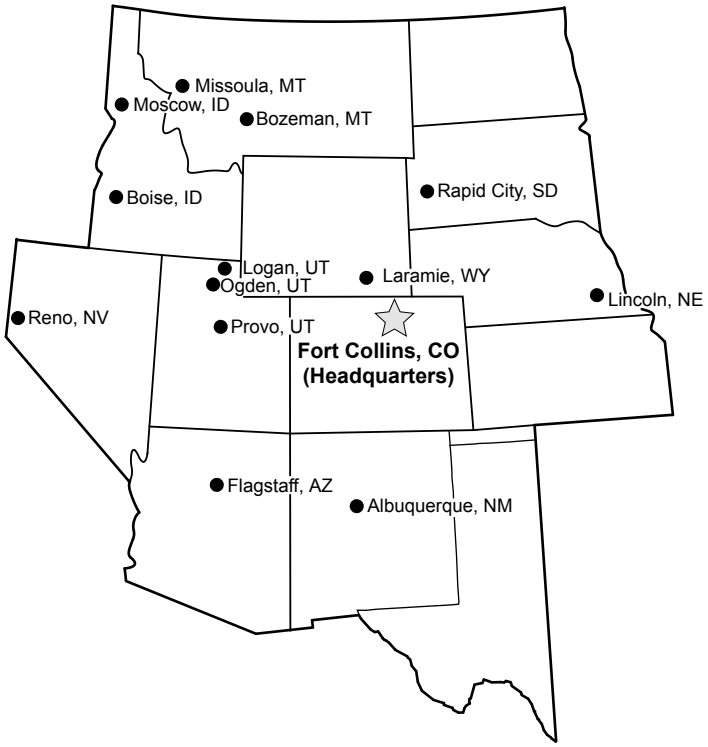

The USDA Forest Service's Rocky Mountain Research Station is one of seven units nationwide that make up the most extensive natural resource research organization in the world. Headquartered at the foot of the Rockies in Fort Collins, CO, the Station maintains 14 field laboratories within a 14 state territory (see map). Scientists conduct studies nationwide, with emphasis on the Rocky Mountains, Great Basin, Great Plains, and Southwest. Research serves the Forest Service, as well as other federal agencies, international organizations, private groups, and individuals. For more information, visit our website at http://

http://www.fs.fed.us/rm