Protection and Enhancement

of

Riparian Ecosystems
(An Annotated Bibliography)

Arizona Riparian Council
Protection and Enhancement Committee
1990

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PROTECTION AND ENHANCEMENT OF RIPARIAN ECOSYSTEMS (AN ANNOTATED BIBLIOGRAPHY)

PREPARED BY THE PROTECTION AND ENHANCEMENT COMMITTEE OF THE ARIZONA RIPARIAN COUNCIL

1990

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The Protection and Enhancement Committee of the Arizona Riparian Council began this project in 1986 to assist those working in riparian areas. The purpose was to provide a literature review that dealt with protecting and enhancing riparian ecosystems.

The literature reviewed in this bibliography was selected by availability and applicability. It is recognized that this review is not a thorough compilation of riparian ecosystem research. Assistance by those using this document is asked in acquiring and/or modifying pertinent articles so revisions can be made.

The focus of this bibliography is on the following categories: Bank stabilization techniques; Beavers; General information; Influence of and protection from livestock; Management of riparian areas (i.e., policy); Natural history; Plant propagation; Revegetation techniques; Seedlings and regeneration; Vegetation management.

The Arizona Riparian Council wishes to acknowledge the following agencies who have assisted in the publication of this document.

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BANK STABILIZATION

Binns, N. A. 1986 Stabilizing eroding stream banks in Wyoming: A guide to controlling erosion in streams. Wyoming Game and Fish Department. 42pp.

The article provides basic information on stream mechanics and the benefits of healthy aquatic and riparian habitat. It proceeds to give practical advice on methods to protect and improve conditions including livestock exclusion, rip-rap, gabions, tree revetments, log cribs and placement of rocks in key locations. It also cautions against use of bulldozers, car bodies to stabilize banks, channelization and river alterations.

Area: Wyoming

Henderson, J. E. 1986 Environmental designs for streambank protection projects. Water Resources Bulletin 22(4):549-558.

Three designs for streambank protection have been shown to minimize environmental impacts. The first is based on channel flow characteristics utilizing revetments and reducing the use of structural protection by matching the erosion potential of flow with the materials used. The second design is based on streambed stabilization to prevent bank failure by undermining, resulting in preserving and establishing streamside vegetation. The third design is based on deflection of erosive flows, e.g. dikes, to minimize disturbance to bank vegetation and create backwater areas.

Area: General

Jackson, W. L. and B. P. Van Haveren. 1984 Design for a stable channel in coarse alluvium for riparian zone restoration. Water Resources Bull. 20(5): 695-703.

When a stream channel is in an unstable condition, floods may be so frequent and severe that riparian vegetation cannot get started. Calculations are presented for designing gabion structures to hold streams beds and banks until vegetation begins to stabilize the substrate.

Area: Colorado

Lines, I. L., J. R. Carlson and R. A. Corthell. 1979 Repairing flood-damaged streams in the Pacific Northwest. Pages 195-200 in Strategies for protection and management of flood plain wetlands and other riparian ecosystems. Proc. National Riparian Ecosystems Symp. Dec. 11-13, 1978, Callaway Gardens, Georgia. USDA Forest Service Gen. Tech. Report WO-12. Washington, D.C. 410 pp.

Use of vegetation to aid in bank stabilization is being intensified. Use of new plant species and plantings of shrubs, grasses and legumes is considered as part of an overall strategy of bank stabilization projects.

Area: Northwestern U. S.

McBride, J. R. and J. Strahan. 1983 Evaluating rip-rapping and other streambank stabilization techniques. California Agriculture 37(4):7-9.

Methods for preserving streambanks for the protection of agricultural land from erosion are examined. Riprapping willow planting and other techniques are considered limiting to the establishment of riparian woodland. Techniques that do not prevent establishment of riparian woodland species provide additional streambank protection. Techniques examined include car body riprapping, rock riprapping, concrete rubble and tire riprapping, bamboo planting, wood fencing and hog-wire and chain link fencing.

Area: California

Miller, C. R. and W. M. Borland. 1963 Stabilization of Fivemile and Muddy Creeks. Am. Soc. Civil Eng., J. Hydraulics Div. 89(HY1): 67-98.

Inherent in the development of an irrigation project are changes in the regime and stability of the natural drainageways within or adjacent to the project area. Deterioration of Fivemile and Muddy Creeks in the area of the Riverton Project, Wyoming and analyses used in arriving at a comprehensive plan for stabilization are examined. Emphasis is placed on stabilization methods used, adequacy and effectiveness of protective works installed, and results obtained after 7 years. Stabilization methods included use of brush- or rock-filled groins, jacks, vegetation and pervious fencing. All methods met with some success.

Area: Wyoming

Patterson, D. W. 1976 Evaluation of habitats resulting from streambank protection projects in Siskiyou and Mendocino Counties, California. California-Nevada Wildlife Transactions 1976:53-59.

Seven streambank protection projects by SCS in California were assessed. The data showed the treated sections provided deeper water, more shade and more cover benefiting both fish and wildlife. Some donickers (large riprap rocks) had dropped to the toe and a few feet into the stream. They provided resting areas and cover for fish which does not occur on untreated streams. The cost for rock riprapping is $30+/linear foot compared with $60 to $80/linear foot for rail and wire revetments.

Area: California

Sheeter, G. R. and E. W. Claire. 1980 The use of juniper trees to stabilize eroding streambanks on the South Fork John Day River. USDI Bureau of Land Management, Burns, Oregon.

Use of juniper trees anchored to banks proved beneficial for bank stabilization. Trees with bushy or heavy crown are preferred. Trees are angled downstream, tree butts tied with wire and attached by cable to an anchor point. Water velocities reduced, silt deposited with native plants invading sites during first growing season, deepening of channel. Failure of junipers caused by placement of trees on outside curves and poor anchoring.

Area: NE Oregon

Van Haveren, B. P. and W. L. Jackson. 1986 Concepts in stream riparian rehabilitation. Pages 1-18 in Proc. Wildlife Management Institute 51st North American Wildlife and Natural Resources Conference, March 21-26, 1986, Reno, Nevada.

Describes different stream channel conditions and the management strategies that should be most effective in each. Stresses that when channels are either laterally unstable of undergoing stream incision, these conditions must stabilize before a successful revegetation program can be initiated. Deals primarily with the physical structures and management strategies to be used to produce a stable area for revegetation projects.

Area: None

Whitlow, T. H., R. W. Harris and A. T. Leiser. 1979 Use of vegetation to reduce levee erosion in the Sacramento-San Joaquin Delta. Dept. of Environmental Horticulture, University of California, Davis.

Summarizes efforts to establish and maintain vegetation on multiple use levees in Sacramento-San Joaquin Delta. Emphasizes the use of vegetation to stabilize levees and retard erosion.

Area: California

Kindschy, R. R. 1985 Response of red willow to beaver use in Southeastern Oregon. J. of Wildl. Manage. 49(1):26-28.

Red willows, Salix lasiandra, used by beaver were able to maintain high growth rates and increased in basal diameter similar to the rates of unused trees. Beaver use normally occurred in August after the willow completed growth and majority of food reserves were translocated to stumps and roots. Reduction of willow in this area was not attributed to beaver utilization.

Area: Southeastern Oregon

Munther, G. L. 1982 Beaver management in grazed riparian ecosystems. Pages 234-241 in J. M. Peak and P. D. Dalk, editors. Proc. 10, Wildlife-Livestock Relationships Symposium. Univ. of Idaho, Forest and Range Experiment Station, Moscow, Idaho. 614 pp.

In some small drainages, beavers create conditions favorable to the creation and expansion of riparian habitat. Their introduction into certain drainages, with of without cattle, should be evaluated in relation to their effects on habitat.

Area: Montana

Rasmussen, D. I. 1940 Beaver-trout relationship in the Rocky Mountain region. Trans. North American Wildlife Conference 5:256-263.

This study dealt with water conditions and trout and how they were effected in beaver habitats. Beaver ponds had slightly higher water temperatures and lower O_2 than streams and were not considered adverse factors. Beaver dams do present obstructions to fish movement and this appeared to be the most harmful effect of beaver activity on trout.

Area: Northeastern Utah

Smith, B. H. 1980 Not all beaver are bad, or, an ecosystem approach to stream habitat management, with possible software applications. Unpubl. Report. USDI Bureau of Land Management, Rock Springs D. O. WY 6 pp.

Beaver ponds can increase productivity and carrying capacity of a free flowing stream through sediment storage, elevated water table and bank recharge. Through analysis of the streams in the Rock Springs BLM Dist., apparent that stream habitat quality was often directly related to the condition of associated beaver complexes and their riparian zones. Discussion of the "boom and bust" cyclic nature of beaver activity and proposes that managers could supply the limiting factors, ie food and material supplies, to the beaver. After two years of testing, the proposal (which is low cost and easy to manage) has shown success in stream improvement.

Area: Wyoming

Strong, P. I. V. 1979 Beaver-cottonwood interactions and beaver ecology in Big Bend National Park. Unpubl. M. S. Thesis. Oklahoma State Univ. 82 pp.

Native cottonwood and willow stands were located on the Rio Grande flood plain along with beaver population estimates in order to establish a base of information for their management in Big Bend National Park. Willow made up the bulk of the beaver's diet for 44% of the population. Cottonwood was not a major food item on the beaver in the Park.

Area: Texas

GENERAL INFORMATION

Brown, D. E., C. H. Lowe, J. F. Hausler. 1977 Southwestern riparian communities: their biotic importance and management in Arizona. Pages 201-211 In Importance, Preservation and Management of Riparian Habitat. Proc. Symp. July 9, 1977, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-43. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 217 pp.

Riparian communities are classified into five major categories. A physical and ecological description, history and specific examples of each community type are provided. The article ends with six recommendations dealing with riparian classification, limiting factors, establishment of long-term study areas, livestock grazing, and management of water and watersheds.

Area: Arizona

Bureau of Land Management. 1986 Riparian Management Bibliography, C. Winzel and C. Clifton (eds.). BLM, Idaho State Office.

Compliation of literature that deal with riparian systems throughout the United States.

Area: United States

Gore, J. A. 1985 Restoration of rivers and streams: theory and experiences. Butterworth Publishers, Stoneham, Mass. 320 pp.

A review of stream and flood plain restoration techniques emphasizing river restoration as a process of recovery enhancement. Recovery enhancement enables the stream ecosystem to stabilize at a much faster rate than through the natural physical and biological processes of habitat development and colonization. Areas covered include restoration of water quality, stream geomorphic characteristics, vegetation, macroinvertebrates, fish habitat, and methods for determining successful reclamation.

Area: United States

Gunderson, D. R. 1968 Floodplain use related to stream morphology and fish populations. J. of Wild. Manage. 32(3):507-514.

Two sections of a stream, one grazed and the other ungrazed, were compared. The ungrazed section had 76% more cover per acre than the grazed. Brown trout was estimated to be 27% more numerous and weigh 44% more, although the rate of growth was similar in the two stream sections.

Area: Montana

Knox, R. F. and J. D. McCall. 1979 Habitat mitigation in Indiana's authorized channelization projects. Pages 582-585 In The Mitigation Symposium: a national workshop on mitigating losses of fish and wildlife habitats. G. A. Swanson, ed. Proc. The Mitigation Symp., July 16-20, 1979, Fort Collins, Colorado. USDA Forest Service Gen. Tech. Report RM-65. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 669 pp.

Description of mitigation techniques used to protect riparian areas in Indiana by the Soil Conservation Service, Indiana Department of Natural Resources, and the U.S. Fish and Wildlife. Such techniques as installation of sediment traps, rip-rap fishpool deflectors, and one-sided channel work.

Area: Indiana

Manci, K. M. 1989 Riparian ecosystem creation and restoration: a literature synthesis. U. S. Fish and Wildl. Biol. Rept. 89( ). 111pp.

Report synthesized the Wetland Creation/Restoration (WCR) Data Base which consists of 1,000 articles pertaining to creation or restoration of various wetland types. Includes a good bibliography.

Area: United States

Motroni, R. 1980 The importance of riparian zones to terrestrial wildlife. USDI Fish and Wildlife Service, Sacramento, California.

An extensive annotated bibliography of 254 papers.

Area: General

Mutz, K. M., D. J. Cooper, M. L. Scott, and L. K. Miller (tech. coords.) 1988 Restoration, creation and management of wetland and riparian ecosystems in the American West. Symp. of the Rocky Mountain Chapter of the Society of Wetland Scientists. Nov. 14-16, 1988. Denver, Colorado. 239 pp.

Contributed papers on restoration projects, reestablishment and propagation techniques, and management of riparian areas.

Area: Western U. S.

Ohmart, R. D., W. O. Deason and S. J. Freeland. 1975 Dynamics of marsh land formation and succession along the lower Colorado River and their importance and management problems as related to wildlife in the arid southwest. Transactions of North American Wildlife & Natural Resources Conference 1975: 240-251.

The lower Colorado River has historically had relatively few backwater areas. The formation of some major backwaters and their disappearance by succession are traced through historical descriptions and present-day observations. The value of backwaters and associated vegetation to wildlife are discussed and recommendations are made for creating and managing artificial backwaters.

Area: Arizona, California

Ohmart, R. D., and B. W. Anderson. 1982 North American Desert Riparian Ecosystems. Pages 433-479 In Reference Handbook on the Desert of North America. G. L. Bender (ed.). Greenwood Press, Westport, Conn., London, England. 594 pp.

An excellent overview of the major components in desert riparian ecosystems. Areas discussed are: physical considerations, e.g., surface runoff, soils, flooding, drainages: floral considerations, e.g., historical development of vegetation, vegetation at terraces and their specific adaptations; development of riparian communities.

Area: Southwestern U.S.

Ohmart, R. D., and B. W. Anderson. 1986 Riparian Habitat. Pages 169 - 201 in A. Y. Cooperrider, R. J. Boyd, and H. R. Stuart, ed. Inventory and Monitoring of Wildlife Habitat. USDI -Bureau of Land Management. Service Center, Denver, Colorado. 858 pp.

This article was geared towards wildlife managers. Areas covered were classification system, habitat attributes to wildlife, data collection priorities, and effects of land management activities on riparian systems. A broad overview of riparian habitats is given with good literature citations.

Area: Southwest

Ohmart, R. D., B. W. Anderson, and W. C. Hunter. 1988 The ecology of the lower Colorado River from Davis Dam to the Mexico-United States International Boundary: A Community Profile. U. S. Fish Wildl. Serv. Biol. Rep. 85(7.19). 296 pp.

The lower Colorado River is completely controlled by a series of upstream impoundments that regulate the flow of the river. This report correlates hydrology and vegetation with fish and wildlife habitats and populations along the river in regards to changes that have occurred and factors influencing this change. Areas discussed are the limnology of the river, extent of agriculture in the valley, human uses, and floral and faunal communities. An assessment of the health of the present-day ecosystem is provided.

Area: Colorado River

Platts, W. S., C. Armour, G. D. Booth, M. Bryant, J. L. Bufford, P. Cuplin, S. Jensen, G. W. Lienkaemper, G. W. Minshall, S. B. Monsen, R. L. Nelson, J. R. Sedell, J. S. Tuhy. 1987 Methods for Evaluating Riparian Habitats With Applications to Management. USDA. Forest Service. Intermountain Research Station, General Technical Report INT-221. 155 pp.

This report compiles the latest methods for resource specialists to use in managing, evaluating, and monitoring riparian conditions adjacent to streams, lakes, ponds, and reservoirs. Primary emphasis is on streams. Sampling techniques, vegetation measurement, soil classification, remote sensing are examples of some of the topics included in this handbook.

Area: Southwest

Robinson, T. W. 1964 Phreatophyte research in the Western states, March 1958 to July 1964. U. S. Geological Survey Circular 495.

The Phreatophyte Subcommittee of the Pacific Southwest Inter-Agency Committee formed a task force to study the kinds and amounts of vegetation as a prerequisite to preparation of plans for water salvaging. This report summarized 48 projects underway during 1959-1964 in 8 Western States. Arizona had 15 projects. The view at the time of this report was that phreatophytes had low economic value and the water they used was wasted and ways were needed to salvage this water.

Area: Western U. S.

Warner, R. E. and K. M. Hendrix. 1984 California riparian systems, ecology, conservation and productive management. University of California Press, Los Angeles, California. 1034 pp.

128 articles dealing with various issues concerning riparian areas, such as ecosystem functioning, wildlife interactions, law and policy, and restoration techniques. Primary focus is on California, with several articles written about Arizona areas.

Area: California and Arizona

LIVESTOCK

Anseth, B. 1983 Rancher fences creek to slow erosion. Rangelands 5(5):204.

Rancher uses fences to improve soil and water resources on his property with positive results.

Area: SW Montana

Bohn, C. C. and J. C. Buckhouse. 1985 Some responses of riparian soils to grazing management in Northeastern Oregon. J. of Range Manage. 38(4):378-381.

Management grazing options were applied: four-pasture rest-rotation, deferred rotation, season-long grazing, and no grazing using 3.2 ha/AUM. Infiltration rates increased and compaction and sediment production decreased in the exclosure pastures. Rest-rotation appeared to favor recovery. Deferred rotation and season-long grazing did little or hindered recovery. Short-duration, high intensity deferred rotation grazing showed a positive infiltration response in September, however the same scheme applied in October showed a negative response possibly due to onset of fall rains.

Area: Northeast Oregon

Bryant, L. 1982 Response of livestock to riparian zone exclusion. J. Range Management 35:780-785.

This study was conducted for only one season in two pastures and plant community types had to be pooled because expected values within types were too small for appropriate statistical analysis. It was conducted on 345 ha. in a mountainous rangeland from 1158 to 1396 m with 50 cm of annual precipitation in NE Oregon. Preliminary conclusions are that: livestock select riparian over upland during summer and upland over riparian during the fall. They prefer slopes less than 35% and their distribution is not greatly affected by salt placement. Cows distributed themselves more uniformly than yearlings and both concentrated their use in riparian areas. It is recommended that riparian pastures be grazed late in the season to achieve better use of upland forage resources and to minimize impacts to the riparian zone.

Area: NE Oregon

Buckhouse, J. C. 1984 Riparian shrubby vegetation protection against herbivore browsing. Final Report for Project No. 373904, USDI Geological Survey, Reston, Virginia. 7 pp.

Physical barriers and chemical repellents were tested as a lower cost, non-fencing alternative to protect willow shoots from herbivore browsing under field and feedlot conditions in Oregon. Vexar[R] tubing, nylon mesh netting and big game repellent were ineffective in preventing cattle browsing but somewhat effective in preventing deer and beaver browsing. Vandalism and cattle damage could be reduced by making the barriers green instead of yellow. The nylon mesh may actually increase damage because it fluttered and attracted cattle.

Area: Oregon

Claire, E. W. and R. L. Storch. 1977 Streamside management and livestock grazing in the Blue Mountains of Oregon: A case study. In: J. Menke, editor. Proc. Workshop on Livestock and Wildlife-fisheries Relationships in the Great Basin. Special Publ. 3301. Agric. Sci. Publ., Div. of Agric. Sci., Univ. of Calif., Berkeley, Calif. 173 pp.

Detailed description of plant communities and effects of various uses, including livestock, recreation, timber, transportation and herbicides on each riparian community. Management alternatives and rehabilitation techniques are presented. Physical structures and vegetative plantings are suggested to improve streamside conditions.

Area: Oregon

Crouch, G. L. 1978 Long-term changes in cottonwoods on a grazed and an ungrazed plains bottomland in northeastern Colorado. USDA Forest Service Research Note RM-370. 4 pp.

Numbers of cottonwood trees declined between 1961 and 1978 on grazed and ungrazed bottomland in NE Colorado. Trees were taller on the ungrazed area. The author concludes that cottonwood seedling germination was inhibited on the ungrazed plot by lack of bare, moist mineral soil caused by the invasion of grass and forbs in the spring. On the grazed plot, grazing caused erosion by removing plant cover and creating extensive seedbeds for cottonwood germination. However, spring and summer grazing consumed all seedlings. Other limiting factors to cottonwood re-establishment include upstream controls that prevent overbank flooding and beaver predation.

Area: Colorado

Davis, J. W. 1982 Livestock vs riparian habitat management - there are solutions. In: J. M. Peek and P. D. Dalk, editors. Proc. 10, Wildlife-Livestock Relationships Symposium. Univ. of Idaho, Forest and Range Experiment Station, Moscow, Idaho. 614 pp.

Livestock impacts to riparian vegetation can be modified by exclosures, protective fencing of individual trees, pasture rotation systems and changes in stocking rates or season of use. Riparian vegetation can be established by pole plantings and enhanced by drip irrigation. Stresses the need for site specific management geared to the individual situation.

Area: Arizona

Kauffman, J. F. and W. C. Krueger. 1984 Livestock impacts on riparian ecosystems and streamside management implications: a review. J. Range Mgmt. 37(5): 430-437.

Majority of paper reviews articles on importance of riparian habitat and what is known about the impacts of livestock upon riparian vegetation, aquatic life and wildlife. Final section reviews articles on exclusion of livestock, alternative grazing schemes, changes in the kind of class of animals, managing riparian zones as species use pastures, in-stream structures and several basic range management practices.

Area: None

Kaufmann, J. B., W. C. Krueger, and M. Vavra. 1983 Effects of late season cattle growing on riparian plant communities. J. of Range Manage. 36(6):685-691.

The objective of this study was to compare differences in succession, composition, productivity, and structure between riparian plant communities that were ungrazed (exclosed) ant those that were grazed under a late season grazing strategy. Dry and moist meadows and open canopy of Douglas hawthorn were preferred. Management implications were given.

Area: Eastern Oregon

Krueger, H. O. and S. H. Anderson. 1985 The use of cattle as a management tool for wildlife in shrub-willow riparian ecosystems. Pages 300-304 in Riparian ecosystems and their management: reconciling conflicting uses. Proc. First North American Riparian Conference, April 16-18, 1985, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-120. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 532 pp.

Cattle enhanced high altitude shrub-willow communities by creating tunnels in dense areas. The increased habitat structural diversity benefited birds and mammals.

Area: Wyoming

Platts, W. S. 1981 Effects of Sheep Grazing on a Riparian-Stream Environment. USDA, Intermountain Forest and Range Experiment Station. Research Note INT-307. 6pp.

Describes changes in a riparian-stream system where one area had been herded and managed under a deferred rotation system while grazing was heavy in another area. The stream in the overgrazed area was wider, shallower, contained more fine sediment, had more unstable banks, less bank undercut, and higher summer temperatures.

Area: Sawtooth Natl Rec. Area, Idaho

Platts, W. S. 1984 Progress in range riparian-stream research at the Intermountain Forest and Range Experiment Station. Pages 78-84 in D. L. Archer, editor. Proc. Bonneville Chapter, American Fisheries Society, Salt Lake City, Utah.

Describes the eight options available to land managers for riparian management: 1) eliminate grazing; 2) reduce stocking rate; 3) implement special grazing strategy; 4) improve livestock distribution; 5) change season of use; 6) change kind or class of livestock; 7) exclude livestock from riparian zone; and 8) rehabilitate by vegetation plantings or artificial stream structures.

Area: Utah, Nevada, Idaho

Platts, W. S. and F. J. Wagstaff. 1984 Fencing to control livestock grazing on riparian habitats along streams: is it a viable alternative? N. Amer. J. of Fisheries Mgmt. 4:266-272.

Reviews many studies on the impacts of livestock upon riparian and aquatic habitat. Results of livestock exclosures on riparian habitats and fish populations are presented. A discussion of economic costs and benefits of exclosures follows. The high financial cost of exclosures in comparison to recreational fishing benefits suggests that solutions other than exclosures be developed.

Area: None

Storch R. L. 1979 Livestock/streamside management programs in Eastern Oregon. Pages 56-59 in O. B. Cope, editor. Proc. Forum on grazing and the riparian/stream ecosystem, Nov. 3-4, 1978, Denver, Colorado. Publ. Trout Unlimited, Inc. 94 pp.

Because of rapid improvement in riparian vegetation following construction of an exclosure, a program was initiated to improve all riparian areas on Malheur National Forest, Oregon. Because rest-rotation grazing did not result in an adequate rate of improvement (although good condition areas could be maintained), artificial means of restoration were implemented. Plantings of native shrubs, banks armed with cut junipers, small checkdams, and rock deflectors to protect banks were all used to reduce erosion and increase riparian vegetation.

Area: Oregon

Szaro, R. C.,and C. P. Pase. 1983 Short-term Changes in a Cottonwood-Ash-Willow Association on a Grazed and an Ungrazed Portion of Little Ash Creek in Central Arizona. Journal of Range Management 36(3):382-284.

The recovery of one plot where grazing was excluded over a 2 and 4 year time frame was studied and compared with a plot still being grazed. A modified Daubenmire and Daubenmire vegetation sampling technique was used. Percentage of herbaceous cover was significantly greater on the ungrazed plot. Tree growth was not affected by grazing practice, however a definite difference in size class distribution of Fremont cottonwood was shown. Cottonwood and ash seedling reproduction was higher on the ungrazed plot indicating the potential recovery of this area from grazing.

Area: Prescott Nat'l Forest, Arizona

Winnegar, H. H. 1977 Camp Creek channel fencing - plant, wildlife, soil and water response. Rangeman's J. 4(1): 10-12.

Four miles of Camp Creek, a tributary of the Crooked River, Crook County, central Oregon, were fenced. Native riparian vegetation became well established. The plant cover affected soil deposition and channel stability, apparently by retaining much of the suspended solids formerly carried by the flow. The sediments accumulated on the stream bottom and raised the water table within the protected channel. Within 9 years, 36 inches of material had been deposited between the vegetated bank and the stony streambed. This process buried the vegetation. Plants then regrew and the process repeated itself to establish bankside meadow.

Area: Oregon

MANAGEMENT

Barclay, J. S. 1980 Impact of Stream Alternatives on Riparian Communities in Southcentral Oklahoma. Office of Biological Services, Fish and Wildlife Service, Contract 14-16-0008-2039. FWS/OBS-80/17. 91pp.

Evaluation of the effects of stream channelization and impoundment on riparian vegetation and associated bird, mammal, amphibian, and reptile populations in the grassland regions of Oklahoma. The study's conclusion found that channelization along Rush and Wildhorse Creeks have been a major factor in elimination of riparian forests and a negative influence on species richness and diversity. It is recommended that where channelization is authorized there should be broad channels, gentle bank slopes, and wide curves.

Area: Southcentral Oklahoma

Duff, D. A. 1979 Riparian habitat recovery on Big Creek, Rich County, Utah: A summary of 8 years of study. Pages 91-92 In O. B. Cope, editor. Proc. Forum on Grazing and the Riparian/stream Ecosystem, Nov. 3-4, 1978, Denver, Colorado. Publ. Trout Unlimited, Inc. 94 pp.

Studies from 1973 to 1978 show the riparian habitat inside a 1006 m exclosure recovered significantly due to the rest, while areas outside the exclosure continued to decline due to livestock use. The area inside the exclosure showed increased growth and density in native willows and were migrating outward from the stream due to increased ground water reserves. On the grazed areas, dryland vegetation continue to encroach toward the streambank. Within 3 years, in the exclosed area trout populations increased 360% and small mammals and songbird/raptor use and diversity increased 350%.

Area: Big Creek, Utah

Fenner, P., W. W. Brady, and D. R. Patton. 1985 Effects of Regulated Water Flows on Regeneration of Fremont Cottonwood. Journal of Range Management 38(2):135-138.

Dams along the Salt River has altered the magnitude and changed the timing of flows in such a way that the habitat is less adapted for regeneration of Populus fremontii. Existing cottonwoods are distinctly bimodal in age class distribution with only large, decadent trees and very young individuals present due to the relationship between river flow and seed dispersal. Analysis of river flow is covered in detail.

Area: Salt River (above Granite Reef Dam), Arizona

Hunt, C. E. and V. Husen 1988 Down by the River: the impact of Federal Water Projects and Policies on Biological Diversity. Island Press 266 pp.

The book discusses the impacts of Federal policies and management on water projects in the U.S. impacts such as the effects on dam construction, aquatic and terrestrial life with case studies on the Columbia, the lower and upper Colorado, the Missouri, and the Mississippi Rivers. Good references.

Area: U.S. and Arizona

Jackson, W. L., B. Shelby, A. Martinez, and B. P. Van Haveren. 1989 An interdisciplinary process for protecting instream flows. J. of Soil and Water Cons. 44:121-126.

Explanation of the value-based, interdisciplinary process for determining and protecting instream flow needs with six basic steps: (1) preliminary assessment and study design, (2) description of flow-dependent values, (3) description and quantification of hydrology and geomorphology, (4) description of the effects of flows on resource values, (5) identification of minimum flows to protect values, and (6) development of a strategy to protect flows. This process has been applied successfully by BLM on Beaver Creek National Wild River in central Alaska, and the San Pedro River Riparian Conservation Area in southern Arizona.

Area: San Pedro River, Arizona

Knopf, F. L.,R. R. Johnson, T. Rich, and F.B. Samson, and R. C. Szaro. 1988 Conservation of Riparian Ecosystems in the United States. Wilson Bulletin 100(2):272-284.

Evaluates the management policies of riparian ecosystems by resource agencies. Presently, federal land-management agencies operate under executive and legislative mandates for riparian conservation. Specific federal authorities for conserving riparian vegetation do not exist; however guidelines for management of riparian ecosystems on public lands are provided in Exec. Order 11988-"Floodplain Management" and Exec. Order 11990-"Protection of Wetlands". Internal guidelines based on executive and legislative authority vary with the federal agencies. Conservation recommendations are offered to assist agencies in management of the declining riparian areas.

Area: U.S. - general

Nelson, R. W. and E. C. Weller 1984 A better rationale for wetland management. Environmental Management 8(4):295-308.

Five orders of impact were discussed in regards to better wetland management. The determination of baseline hydrology, soil composition, or water quality of all regulated wetlands is advance of project planning for construction and development is cost prohibitive. A practical rationale for management relies on factors that can be weighed efficiently and economically. Use of aerial photo interpretation and remote sensing imagery and ten mapping wetland areas in greatest need of protection are primary ways of accomplishing this task.

Area: U.S. - General

Riley, A. and A. Sands 1984 The design and planning approach to flood damage reduction-a way to restore the riparian environment. pp. 82-86. In Proceedings of the Native Plant Revegetation Symposium. 15 Nov. 1984, San Diego, Calif. (J. P. Reiger and B. A. Steele, eds.)

This paper recognizes the current conflict between preserving riparian ecosystems and development of floodplains. Advocates no development in floodplains but rather leaving them as open space for river action.

Area: General

Swift, B. L. 1984 Status of Riparian Ecosystems in the United States. Water Resources Bulletin 20(2):223-228.

Review of available data to estimate original coverage of woody riparian vegetation and how much remains today. An estimated 75 to 100 million acres were originally covered by woody riparian communities in the contiguous 48 states. Only 23 million acres remain in near natural condition today. The status of 10 regions in the U. S. are presented: California, Pacific Northwest, Rocky Mountain, Arid Southwest, Plains-Grasslands, Lake States, Corn Belt, Mississippi Delta, Northeast Appalachian, and Southeast.

Area: General U.S.

Aldon, E. F. 1977 Survival of three grass species after inundation. USDA Forest Service Research Note RM-344. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Three grass species characteristically found in Southwestern areas that are periodically flooded were studied to determine how long they could remain under water and still survive. Desert saltgrass, alkali sacaton and western wheatgrass were either totally or partially submerged for periods of 0, 3, 6, 12, and 24 days. All three species can survive at least 24 days of complete or partial inundation.

Area: Southwest

Asplund, K. K. and M. T. Gooch 1988 Geomorphology nd the distributional ecology of Fremont Cottonwood (Populus fremontii) in a desert riparian canyon. Desert Plants 9(1):17-27.

Recruitment of Fremont Cottonwood (Populus fremontii) in the canyon area of Burro Creek was found to depend on geomorphological features and flood refugia rather than the absence of grazing. Distributions and germination requirements of other riparian trees are discussed in regards to geomorphological processes.

Area: Burro Creek, Arizona

Bryan, K. 1928 Change in plant associations by change in ground water level. Ecology 9(4):474-478.

Uses historical references to show change in San Pedro River, Arizona from shallow cienegas with few deep cuts to an intermittent stream with a deeply cut, wide, sandy bottom. Suggests cause is primarily a change to a drier climate that was further accelerated by over-grazing of the watershed. Discusses occurrence of arroyo cutting before overgrazing began.

Area: Arizona-San Pedro

Crouse, M. and R. Kindscky. 1984 A method for predicting riparian vegetation potential of semiarid rangelands. Pages 18-24 In Proc. 1984 Pacific Northwest Range Management Short Course, Oregon State University, Corvallis, Oregon.

The author developed a key for classifying stream and reservoir riparian habitat potential in semiarid rangelands in Oregon. Characteristics assessed for streams are: persistence of stream flow, extent of water level fluctuation, stream gradient and soil type. Characteristics assessed for reservoirs are: water level fluctuation and soil type. The key allows the user to concentrate management on the streams and reservoirs with the greatest potential for improvement.

Area: Oregon

Davis, G. J. and M. M. Brinson. 1980 Responses of submersed vascular plant communities to environmental change. U. S. Fish and Wildlife Services. FWS/OBS-79/33.

Provides an awareness of those factors that regulate the growth of aquatic macrophytes. Restricted to submersed, rooted macrophytes-the vascular plants whose life cycle is spent mostly below the surface of the water.

Area: General

Everitt, B. L. 1968 Use of the cottonwood in an investigation of the recent history of a flood plain. American J. of Science 266:417-439.

This study mapped the age of cottonwoods in a floodplain and made an analysis of the meandering of the river channel and the turnover of sediment in the valley. Age distribution of cottonwood, Populus sargentii indicate germination and growth is intricately related to discharge of the Little Missouri River, movement of the channel, and development of the flood plain. The cottonwoods show an orderly increase in age upvalley and away from the channel. The older trees occur at higher elevations because sedimentation has continued longer in these areas.

Area: W. North Dakota

Harris, R. W., A. T. Leiser and R. E. Fissell. 1975 Tolerance to flooding. Summary report to USDA Forest Service. Grant Contract No. A 5fs-16565. Dept. of Environmental Horticulture, Univ. of Calif., Davis. 33 pp.

Several species of trees, shrubs and grasses (mainly exotic species) were tested to determine the length of time they could survive flooding along a reservoir in California. The most tolerant species was Salix alba tristis, which survived continuous flooding for 2.5 years. Side effects such as trunk bending, weakened roots and increased mortality in the year following initial inundation are discussed. Data is not well presented or interpreted.

Area: California

Harris, R. R. 1987 Occurrence of Vegetation on Geomorphic Surfaces in the Active Floodplain of a California Alluvial Stream. Am. Midl. Nat. 118(2):393-405.

Conditions for the establishment and growth of vegetation is largely controlled by periodic flooding. (In this study, flood disturbance not anaerobic soil conditions following flooding was the major environmental control on spatial distribution of riparian communities). Surfaces frequently flooded and subject to severe scouring and deposition were dominated by Salix hindsiana and annual grasses. Populus fremontii attained or shared dominance with S. hindsiana on less frequently flooded surfaces and where particle size indicated less disturbance by erosion or deposition. Juglans hindsii, Quercus lobata or mixed stands of P. fremontii/J. hindsii/Q. lobata/S. hindsiana were dominant on infrequently disturbed surfaces.

Area: Cottonwood Creek, North central California

Harris, R. R. 1988 Associations between stream valley geomorphology and riparian vegetation as a basis for landscape analysis in the eastern Sierra Nevada, California, USA. Environmental Management 12(2):219-228.

Landscape units with distinctive geomorphic settings were described for usefulness in ecological studies, management, and impact assessment. Impacts assessed were hydroelectric development, evaluation of streamflow-groundwater relationships and riparian plant ecophysiology. Poplar, Salix, and Betula were among the genera covered.

Area: Sierra Nevada, Calif.

Horton, J. S. 1964 Notes on the introduction of deciduous tamarisk. USDA Forest Service Research Note RM-16. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 7 pp.

Discusses Tamarisk taxonomic revisions and documents herbarium specimens prior to 1920. Gives references to introduction of Tamarisk into the United States in the early 1800's and into California by 1856. First references to Arizona occurrence were in 1898 at Gila Bend and in 1901 at Tempe.

Area: U. S.

Hosner, J. F. 1958 The effects of complete inundation upon the seedlings of six bottomland tree species. Ecology 39:371-373.

Effects of total inundation upon seedling black willow and box elder were tested. All survived 8 days except box elder seedling, all died by the 32nd day. However, all willow seedling were still alive at 32 days. There are limits to the duration of submersion riparian plants can survive.

Area: S. Illinois

Irvine, J. R. and N. E. West. 1979 Riparian tree species distribution and succession along the lower Escalante River, Utah. Southwestern Naturalist 24(2):331-346.

Attempts to correlate distribution patterns of riparian trees (Populus fremontii, Salix exigua and Tamarix pentandra) with geologic strata, river bank morphology and river flow on a relatively pristine southwestern river. Populus was found only on broad flood terraces beyond zone of usual flooding; most Tamarix was found behind large boulders providing protection from full force of flood water; Salix was found throughout but was least dense in narrow canyons where Tamarix occurred. Concludes that Tamarix invasion is not due solely to river flow regulation, but that a decrease in river fluctuations could cause Tamarix to dominate.

Area: Utah

Kozlowski, T. T. 1984 Responses of woody plants to flooding. Pages 129-164 in T. T. Kozlowski, editor. Flooding and plant growth. Academic Press, Orlando, Florida. 356 pp.

Flood tolerance varies greatly between species, ecotypes and plants of different provenances. Poor soil aeration that accompanies flooding of soil is associated with physiological changes in woody plants that variously influence their growth. Angiosperms generally are more flood tolerant than gymnosperms and older trees tolerate flooding better than seedlings or saplings of the same species. Trees are injured much more by standing water than by flowing water. Flooding during the growing season affects trees at all stages of development with inhibition of seed germination, shoot, cambial and root growth, arrested reproductive growth, morphological changes, and often death.

Area: General

Lacey, J. R., P. R. Ogden, and K. E. Foster 1975 Southern Arizona Riparian Habitat: Spatial distribution and analysis. A Report of Work Performed Jointly under NASA Grant No. NGL03-002-313 and the School of Renewable Natural Resources College of Agriculture, University of Arizona. OALS Bulletin 8. 148 pp.

Objectives of this study were to map and inventory riparian vegetation along portions of 4 stream channels in southern Arizona; the Gila River, San Simon Creek, San Pedro River, Pantano Wash. Products and changes of riparian vegetation and historical changes of composition and distribution of riparian vegetation are covered.

Area: Southern Arizona

Reichenbacher, F. W. 1984 Ecology and evolution of Southwestern riparian plant communities. Desert Plants 6(1):15-22.

Discusses the relationship between the distribution of plants in the floodplain and the physical site factors that influence the vegetation. The information is general for the southwest with specifics given for Trout Creek, Arizona. Reproductive adaptations of Populus and Salix are given along with evolutionary relations.

Area: Trout Creek, Arizona and Southwestern streams

Robinson, T. W. 1965 Introduction, spread and areal extent of salt cedar (Tamarix) in the Western states. Professional Paper 491-A. U. S. Geological Survey. 12 pp.

Saltcedar was introduced into the U. S. more than 100 years ago. It has become a nuisance plant in the arid and semiarid regions of the Western States due to its high water consumption, salt tolerance, and dense growth along stream channels presenting barriers to flood flows. The spread of Saltcedar from its recorded appearance to 1970 are presented.

Area: Western U. S.

Stiles, W. A. 1978 A brief review of natural revegetation in excavated stream channels. Santa Clara Valley Water District, California.

Deals with Santa Clara County, California projects. Discusses specific creeks that have been altered and left for natural revegetation.

Area: California

Tarrant, R. and J. Trappe. 1971 The role of Alnus in improving the forest environment. Plant and Soil Special Volume: 335-348.

Alder Alnus rubra has been shown to symbiotically fix nitrogen. Associated vegetation has increased vigor and growth. Alder may also suppress pathogens of coniferous roots.

Area: General

Teskey, R. O. and T. M. Hinckley. 1977 Impact of water level changes on woody riparian and wetland communities. Vol. I: Plant and soil responses to flooding. FWS/OBS-77/58. USDI Fish and Wildlife Service.

This publication discusses short-term effects of water level changes on physiological processes of both bottomland and upland species. It classifies tree tolerances to flooding based on the condition of the root system when inundated. The publication also discusses metabolic and physical adaptations enabling plants to tolerate anaerobic conditions associated with flooding. Critical factors affecting a plant's response to changes in water level are 1) time of year, 2) flood frequency, 3) flood duration, 4) water depth, and 5) siltation.

Area: General

Walters, M. A., Teskey, R. O. and T. M. Hinckley. 1980 Impact of water level changes on woody riparian and wetland communities. Vol VIII: Pacific Northwest and Rocky Mountain Regions. FWS/OBS-78/94. USDI Fish and Wildlife Service.

Summarizes impacts to riparian vegetation in the Pacific Northwest and Rocky Mountain Regions from natural and man-caused water level fluctuations. The publication also discusses tolerance levels of a number of regional riparian species to flooding and drought and some of these physiological mechanisms.

Area: Pacific NW, Rocky Mts

Walters, M. A., Teskey, R. O. and T. M. Hinckley. 1980 Impact of water level changes on woody riparian and wetland communities. Vol VII: Mediterranean Region, Western Arid and Semi-arid Region. FWS/OBS-78/93. USDI Fish and Wildlife Service.

The publication summarized physiological impacts to riparian vegetation from man-caused and natural water level fluctuations in the Mediterranean, Western Arid, and Semi-Arid regions of the United States. It also discusses drought and flooding tolerances of many of the regional riparian species and some related physiological mechanisms.

Area: Western U. S.

Whitlow, T. H. and R. W. Harris. 1979 Flood tolerance in plants: a state-of-the-art review. / U. S. Army Corps Eng. Tech. Rep. No. E-72-2. U.S.A.C.E. Waterways Exp. Stn. Environ. Lab., Vicksburg, Mississippi. Dept. of Environmental Horticulture, University of California, Davis.

Basic aspects of flood tolerance in plants and the applied aspects of establishing vegetation on reservoir shorelines.

Area: General

PHREATOPHYTE CONTROL

Graf, W. L. 1983 Dynamics and control of phreatophytes along the upper Gila River, Southeast Arizona. Report to U. S. Army Corps of Engineers, Los Angeles Dist. Office. Contract No. CACWO9-82-M2524. Arizona State University, Tempe. 115 pp.

Discusses history and dynamics of riparian vegetation along the Gila River in Southeast Arizona. Evaluation of techniques of tamarisk control by chain/cutting, plowing/grubbing, burning, herbicides, biological control, drowning and desiccation are presented. The costs and success rates of each technique are evaluated. No one technique was considered effective and frequent retreatment will be necessary.

Area: Arizona-Gila River

Hollingsworth, E. B., P. C. Quimby, and D. C. Jaramiilo 1979 Control of Saltcedar by Subsurface Placement of Herbicides. Journal of Range Management 32(4):288-291.

Foliar sprays would defoliate and kill aerial parts of saltcedar but seldom killed the root system resulting in bud resprouting. Method developed by cutting the tap root at a selected depth while simultaneously applying a herbicide close to the severed roots with a spray boom attached to the rear edge of the plow blade. The remaining active roots in or immediately above the layer of herbicide readily absorb it. Picloram and dicamba were the most effective.

Area: New Mexico

Horton, J. S. 1972 Management problems in phreatophyte and riparian zones. J. Soil and Water Conservation 27(2):57-61.

Defines phreatophyte and riparian zones and their economic and biological values. Clearing of tamarisk, cottonwood and mesquite resulted in a temporary water savings of almost 2 acre feet per acre of cleared vegetation. Wildlife and other values are emphasized. If clearing is done, recommends that a stable channel and wildlife populations can be maintained, and wind erosion can be prevented by selective clearing and proper channel cutting.

Area: None

PLANT PROPAGATION

Aldon, E. F. 1970 Fourwing saltbush can be field planted successfully. USDA Forest Service Research Note RM-173. Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico. 2 pp.

Fourwing saltbush, Atriplex canescens, survived well and grew more than 1 ft during the first year when native seed was grown to 4-6 week-old transplants, then transferred to low sites that received some flooding before planting.

Area: New Mexico

Chmelar, J. 1974 Propagation of willows by cuttings. New Zealand J. Forestry Science 4(2):185-190.

The rooting capacity of 107 willow (Salix) species was tested, indicating that most species have excellent capability to be propagated vegetatively from cuttings. Suggestions for enhancing rooting success are given, but no specific information for each species is provided.

Area: None

Cooper, D. T. 1982 Observations and recommendations for improving field survival of cottonwood cuttings. Pages 12-18 In North American Poplar Council, 19th meeting, Rhinelander, Wisconsin.

Report examines ways that nursery practices, cutting preparation, and planting procedures can be modified to improve rooting and survival of cottonwood cuttings.

Area: Southern U. S.

Dannenberg, W. W. no date Site and Planting Requirements for Artifical Regeneration of Cottonwood.

For regeneration of cottonwoods, it is necessary to have proper site evaluation, well-aerated soils, with ample moisture, rich in nitrogen, phosphorus, and potassium for optimal tree growth. In the Lower Mississippi Valley, the planting season is from December through mid-March using unrooted cuttings that are 20 inches long and have diameters 3/8" to 11/2" inches from 1-2 year old stock. Wands collected from cutting stock are submerged in pits filled with water and covered with burlap to exclude sunlight. Storage can be up to 3 weeks.

Area: Lower Mississippi Valley

Everett, R., R. Meeuwig and J. Robertson. 1978 Propagation of Nevada shrubs by stem cuttings. J. of Range Management 31(6):426-429.

Rooting success of various native shrubs was compared under controlled conditions but cutting material varied in age, diameter phenologic stage of parent plant nor part of plant (lateral or terminal shoot). Salix and Vitis were the two (2) Arizona species tested. Rooting success for several species of Salix ranged from 54 - 89%. Vitus cutting success was 60%.

Area: Nevada

Gooding, L. N. 1938 Notes on native and exotic plants in Region 8 with special reference to their value in the soil conservation program. USDA, Soil Conservation Service, Region 8, Albuquerque, New Mexico. 152 pp.

Contains observations on erosion control potential of many riparian trees, shrubs, forbs and grasses with some suggestions on propagation techniques. Important from a historical perspective demonstrating the long term commitments to rehabilitate riparian areas.

Area: Arizona and New Mexico

Hansen, E. A., H. M. Phipps, and D. N. Tolsted. 1979 Rooting Greenwood Tip Cuttings of a Difficult-To-Root Populus Clone. Tree Planter's Notes 30: 16-18.

Tips of dormant cottonwood clone, 3-4 inches, were clipped and the base of each cutting was dipped for 5 seconds in IBA-NAA hormone solution. The cuttings were planted in perlite and kept at elevated temperatures. Treatments between 76° - 85°F and 2000 - 4000 p/m IBA-NAA produced 70 - 100 % rooting.

Area: General

Holloway, P. and J. Zasada. 1979 Vegetative propagation of 11 common Alaska woody plants. USDA Forest Service Research Note PNW-334. Pacific Northwest Forest Experiment Station, Portland, Oregon. 12 pp.

Vegetative propagation trials were conducted with stem, root and rhizome cuttings from 11 common woody plants, including Alnus, Salix and Populus species. Stem cuttings of Salix and Populus produced roots. Rooting media, wounding and hormone treatments did not affect rooting of stem cuttings in most trials.

Area: Alaska

Hudak, H. 1979 A technique for establishing woody riparian plants from cuttings. Southwest Habitater.

Successful technique to reestablish willows. Cuttings collected near planting site, with the terminal end cut 6-10 inches and discarded (this portion contains flowering part of plant), and cuttings trimmed to 12-15 inches long. Cuttings stored and allowed to root in 5 gallon buckets of water (at room temp.) containing nutrient mixture of 5% recommended concentration of "Miracle-Gro" and vitamin B-1. Aeration of water is recommended. Plant cuttings in 1/2" diameter hole 2 days after appearance of roots (approx. 1 week in bucket) and after snowmelt, with 2-5 inches of cutting exposed.

Area: Coconino Nat'l Forest, Arizona

Krinard, R. M., and W. K. Randall. 1979 Soaking aids survival of long, unrooted cottonwood cuttings. Tree Planter's Notes 30:16-18.

Unrooted 1 year-old cottonwood switches (Populus deltoides Bartr.) from 5 clones when soaked in water for 5 days before planting, had a first-year survival rate of 96% compared to a 86% survival rate for unsoaked cuttings.

Area: General

Peterson, L. A. and H. M. Phipps. 1976 Water soaking pretreatment improves rooting and early survival of hardwood cuttings of some Populus clones. Tree Planter's Notes 27(1): 12 and 22.

Effectiveness of soaking cuttings in water before planting and optimum duration of soaking were experimentally tested. Bank swelling was noticeable on the 5th day of soaking, bark rupture occurred on days 7-9, and roots emerged about 5 days later. Unsoaked cuttings and cuttings soaked for 7 days were planted in nursery plots. Unsoaked cuttings of two clones failed to flush any buds; 30-100% of soaked cuttings flushed buds. Rooting success varied widely (67%, 57%, and 10%) among the 3 clones tested.

Area: General

Pollock, D. 1982 Cottonwood pole planting as a riparian rehabilitation technique. Wildlife Habitater 3(7). USDA Forest Service, Albuquerque, New Mexico. 3 pp.

Description of technique to re-establish cottonwoods on portions of Verde River in areas protected from cattle grazing and not require supplemental watering. Sites located away from primary direction of flow were preferred. Holes dug $2^1/_2$ to 6 feet deep to ground water, plantings less than $2^1/_2$ feet lack stability against high flows and cattle. Cuttings with basal diameter of $2^1/_2$" and at least 12' long were used and planted in or at ground water. Three planting projects on the Verde have been done. 253 poles were planted 5 Feb 1981 with 47% still living ($1^1/_2$ years later) and flourishing. 41% were desiccated due to river shut offs from Bartlett Dam. The remaining 12% were lost to beaver.

Area: Tonto Nat'l Forest, AZ

Ruffner, G. A., D. A. Fedock and S. W. Carothers. 1985 Transplanting native Sonoran desert plants. Pg 498, In Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. Proc. First North American Riparian Conference, April 16-18, 1985, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-120. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Introduction to a poster session display that presented a successful technique for transplanting desert shrubs and trees. Article provides no information on the actual technique.

Area: Arizona

Stiles, W. A. 1975 A landscaping guide to native and naturalized plants for Santa Clara County. Santa Clara Valley Water District, California.

Easy-to-use guide to native and naturalized plant materials. Most are indigenous to Santa Clara, others naturalized.

Area: California

Zsuffa, L. 1976 Vegetative propagation of cottonwood by rooting cuttings. Pages 99-108 in B. A. Thielges and S. B. Land, Jr., editors. Symp. on Eastern cottonwood and related species, Sept. 28-Oct. 2, 1976, Greenville, Mississippi.

Several techniques applicable to Arizona are presented. Rooting ability is dependent upon genetics. Some cuttings have more rooting primordia than others. Successful rootings are from cuttings from young trees,and basal areas and large diameter. Rooting is more reliable in fall and winter and decreases at the time of flower initiation. The presence of high nitrogen levels in tissue decreased rooting. Light has a negative influence on root formation. Temperatures of 20 - 27 C (68-81F) hastens the rooting process. High moisture is indispensible for rooting. The optimum pH was 6.0 - 6.5.
Cuttings as short as 20 cm if they have a bud will grow but cuttings 25-50 cm are more successful as they have more stored energy. Very long poles, up to 7m are used for deep plantings to ground water.

Area: Arizona

Aldon, E. F., D. Cable and D. Scholl. 1977 Plastic drip irrigation systems for establishing vegetation on steep slopes in arid climates. Pages 107-112. In Proc. Fourth Symp. on Surface Mining and Reclamation, NCA/BCR Coal Conference and Expo III, October 1976.

Three irrigation emitter systems were tested (full-circle spray, single-jet spray, and surface emitter) in establishing grasses in semi-arid grassland in New Mexico (1900 m) on a tailings dam with a 36-40% slope. Annual average precipitation was 25 cm, with 15 cm occurring during the growing season. The surface emitter gave the best over-all results: good plant cover (256 plants/m^2), moderate soil loss (6m^3/Ha) and acceptable cost ($4400/Ha). The single-jet spray cost less ($1200/Ha) but established less vegetation (124 plants/m^2). The full-circle emitter (cost $4300/Ha) had larger labor costs and greater soil erosion (18 m^2/Ha), although it established the most vegetation cover (396 plants/m^2)

Area: New Mexico

Anderson, B. W. and R. D. Ohmart. 1979 Riparian revegetation: an approach to mitigating for a disappearing habitat in the Southwest. Pages 481-487 In The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats. G. A. Swanson, ed. Proc. The Mitigation Symp., July 16-20, 1979, Fort Collins, Colorado. USDA Forest Service Gen. Tech. Report RM-65. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 669 pp.

Two test plots along the lower Colorado River have been revegetated to test the feasibility of using this technique for mitigation of habitat losses or for operational enhancement. Biotic community models developed from 6 years of plant and animal data collection were used to design plant communities that would provide maximum wildlife use values. Revegetation sites have so far produced higher wildlife use values than predicted.

Area: Arizona, California

Anderson, B. W., R. D. Ohmart, and J. Disano. 1979 Revegetating the riparian flood plain for wildlife. Pages 318-331 In Strategies for protection and management of flood plain wetlands and other riparian ecosystems. Proc. National Riparian Ecosystems Symp. Dec. 11-13, 1978, Callaway Gardens, Georgia. USDA Forest Service Gen. Tech. Report WO-12. Washington, D.C. 410 pp.

Discusses vegetation characteristics to which birds respond. Both horizontal and vertical foliage diversity and the presence of cottonwood and/or willow trees were positively correlated with number of bird species in an area. Cottonwood, willow, honey mesquite and quail bush were planted and watered and data on growth rates and survival are presented.

Area: Arizona, California

Anderson, B. W. and R. D. Ohmart. 1984 Vegetation Management Study for the enhancement of wildlife along the Lower Colorado River-1984. Final Report 1984. Bureau of Reclamation, Boulder City, Nevada.

Project began in 1972 to study riparian vegetation of the lower Colorado River and the vertebrate species associated with it. The objectives were: 1) reduce water loss caused by evapotranspiration by replacing exotic salt cedar with native plants; 2) reduced total vegetation at heights of 4 to 6 feet in the floodplain so that flood flows can pass unhindered by the damming effect of dense vegetation; and 3) explore the economic and technical feasibility of revegetating areas.

Area: Arizona, California

Anderson, B. W., J. Disano, D. L. Brooks, and R. D. Ohmart 1984 Mortality and growth of cottonwood on dredge-spoil. Pages 438-444. In California Riparian Systems, Ecology, and Conservation and Productive Management. (Warner, R. E. and K. M. Hendrix, eds.) University of California Press, Los Angeles, Calif. 1034 pp.

Techniques for revegetation a 30 ha dredge-spoil site located on the lower Colorado River. Trees grew 3-5 m annually and survival approached 100% when planting was accomplished by tillage to a depth of 3 m in sandy soil. Irrigation for 5 months during the year of planting was adequate for maximum growth and survival.

Area: Arizona - Colorado River

Anderson, B. W. and R. D. Ohmart. 1985 Riparian revegetation as a mitigating process in stream and river restoration.
Pages 41-79. In J. A. Gore, editor. The restoration of rivers and streams: theories and experience. Butterworth Publishers, Boston.

Summarizes results of field data taken on the lower Colorado River with techniques for revegetating desert riparian areas. Revegetation designs were implemented, monitored and wildlife use was quantified. Experimental variables included tillage, soil density, weeds, and irrigation frequency and duration. Compares overall and itemized costs for the two types of irrigation systems tested plus estimates for a hypothetical case.

Area: Arizona, California

Anderson, B. W. and R. D. Ohmart 1985 Riparian revegetation as a mitigating process in stream and river restoration. Pages 41-79. In The Restoration of Rivers and Streams: Theories and Experience. (Gore, J. A., ed.) Butterworth Publishers, Boston.

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Area: Arizona - Colorado River

Anonymous. 1925 Protecting steep banks by planting live willow poles. Eng. News-Record 94 (20):822-823.

Instead of planting cuttings in slopes, large live willow poles are laid perpendicular to the shoreline, 5 feet apart in shallow trenches extending up the river bank with their tops anchored at the top of the bank and their butts anchored and buried in shallow trenches in the moist toe of the bank. The poles obtain water through their butts and take root without depending on moisture in the bank. Rock mattresses made by filling wire nets with rocks and brush, laid between the live poles and held down with wire fencing, protect the slope.

Area: U. S. and Canada

Arnold, G. 1979 Memorandum - Riparian revegetation general information. USDI Fish and Wildlife Service, Portland, Oregon.

Techniques suggested for planting and maintenance of riparian vegetation. Propagation techniques for specific plant species.

Area: General

Baird, K. 1989 High quality restoration of riparian ecosystems. Restoration and Management Notes 7(2):60-64.

Several factors are identified that are critical for successful restoration of riparian ecosystems. Projects designed to provide habitat for a particular species or if the goal is to create a functioning, self-sustaining approach. Implementing the six restoration projects in California, details are given on weed control, importance of soil flora (most riparian species are ectomycorrhizal) and criteria for success.

Area: California

Bell, A. L., E. D. Holcombe and V. H. Hicks. 1974 Vegetating stream channels - a multipurpose approach. USDA Soil Conservation Service, Temple, Texas.

Ideas to help protect riparian habitats before, during and after alteration.

Area: Texas

Braun, E. L. and T. J. Beland. 1958 Mendocino National Forest stream improvement. California Fish and Game 44(3):261-274.

Reports on the feasibility of establishing streamside vegetation in California. Surveys indicated that flooding was the major cause of riparian vegetation damage. Cottonwood, mule fat and willow were successfully grown from cuttings, and oak and walnut from seed. Bare root plantings failed due to drought and grazing.

Area: California

Broadfoot, W. M. 1973 Water table depth and growth of young cottonwood. USDA Forest Service Research Note SO-167. Southern Forest Experiment Station, New Orleans, Louisiana. 4pp.

Planted cottonwood trees grow best when the water table is about 2 feet deep, providing a sufficient zone above the moisture supply with well aerated soil. When water tables are raised high enough in porous root zones to saturate the soil, death is likely to occur near the end of the second growing season.

Area: Southeastern U. S.

Carlson, J. R. and J. O. Preston. 1976 Streamco purpleosier willow. Am. Nurseryman 144 (2):12, 73.

Streamco purpleosier willow is a medium-sized shrub used successfully to revegetate stream banks after tropical storm Agnes. After two growing seasons, good plantings averaged 5-6 feet high. It should be planted on banks that have been graded and cleared of debris and trees. It has been planted successfully throughout New England, New York, Pennsylvania, New Jersey, Virginia, West Virginia, Kentucky and Michigan. It can adapt wherever the species is found naturalized in the U. S. and Canada.

Area: Eastern U. S. and Canada

Carlson, J. R. 1979 Streamside revegetation. Technical Notes - 55: Plant Materials. USDA Soil Conservation Service, Portland, Oregon. 9 pp.

Effects of streambank alteration on riparian habitat and actual revegetation practices used in Washington.

Area: Washington

Christensen, M. 1976 The Germans plant alongside water courses to prevent growth of water weeds. Hedeselskabets Tidsskrift 97(8):164-165.

Rows of trees are used along banks of canals and drainage channels in northwest Germany for control of water weeds. The shade reduces water temperatures as well as available sunlight. Bank erosion and need for edge mowing are greatly reduced by trees plantings. Alder and ash are the chief species planted, but all the usual shelterbelt species, e.g., willows and poplars, are used. In most cases, trees are planted on only one side to allow access for maintenance. Results are good but are even better when both sides are planted.

Area: Northwest Germany

DeBano, L. F., J. J. Brejda and J. H. Brock. 1984 Enhancement of riparian vegetation following shrub control in Arizona chaparral. J. Soil and Water Conservation 39(5):317-320.

Brush-to-grass conversions in Central Arizona chaparral at 1000-1560 m elev. with mean annual precipitation 53 to 71 cm resulted in water yield increases in both duration and amount of stream flow delivered from these watersheds over a 20 year period. The density of riparian plants increased from 2.3/100m^2 to 7/100m^2 below

the treated watersheds. It is hypothesized that continuity of flow is more important than total streamflow increases in enhancing the riparian zone. The establishment of riparian habitat was concluded to have little negative impact on water availability downstream.

Area: Arizona

Dupre, D. D.,Jr. 1948 Willow mats economical for bank protection. Roads and Streets 91(2):92-94.

Live willows and other live tree branches were tied down with fence wire. This is practical, efficient and inexpensive, when compared with stone rip-rap. Specifications and photographs are provided.

Area: Ohio

Fowler, D. K. and J. B. Maddox. 1974 Habitat improvement along reservoir inundation zones by barge hydroseeding. Soil and Water Conservation 29(6):263-265.

Japanese millet, common buckwheat and Italian ryegrass were successfully established in reservoir inundation zones, using a barge with hydroseeding equipment mounted on it.

Area: Tennessee (TVA res.)

Fowler, D. K. and D. A. Hammer. 1976 Techniques for establishing vegetation on reservoir inundation zones. Soil and Water Conservation 31(3):116-118.

Evaluates three techniques for seeding sloping inundation zones: the aquaseeder, which is a small pontoon boat equipped with hydroseeding equipment; air cushion vehicles with cyclone seeders; and helicopters. The helicopter was the most efficient on large areas and the air cushion vehicle on small areas.

Area: Tennessee

Gray, R. L., R. Snieckus and G. Wilcox. 1984 Riparian revegetation in California. California-Nevada Wildlife Transactions 1984:26-??

Riparian revegetation projects carried out by the USDA Soil Conservation Service in California are reviewed. The complexity of revegetation efforts varies from planting willow cuttings along channel banks to designing and installing multispecies plant communities that require irrigation systems. Techniques and results are described and case studies are presented.

Area: California

Heilman, P. E., D. M. Greer, S. E. Braven and A. S. Baker. 1978 Habitat development field investigations, Miller Sands Marsh and upland development site, Columbia River. Oregon office, Chief of Engineers, US Army, Washington, D.C.

This report describes the study area, methods and results of habitat development experiments conducted at Miller Sands, a dredged material disposal site near the mouth of the Columbia River. Study consisted of investigations and experimental plantings. Very detailed.

Area: Oregon, Washington

Hoffman, G. R. 1977 Artificial establishment of vegetation and effects of fertilizer along shorelines of Lakes Oahe and Sakakawea, mainstream Missouri River reservoirs. Pages 95-109 In Proc. Workshop on the Role of Vegetation in Stabilization of the Great Lakes Shoreline. Great Lakes Basin Commission, Ann Arbor, Mich.

The portion of the reservoir shore-line that is flooded annually by fluctuations in water level does not support permanent vegetation, although vegetation does become established each year. In experiments, a number of plant species were grown in the fluctuation zone with and without added fertilizers. Biomass increased on fertilized plots from 0.5% to 10% above that on unfertilized control plots. Long-term effects of this fertilization are unknown.

Area: North Dakota

Jordan, W. R., M. E. Gilpin, and J. D. Aber (eds.) 1987 Restoration Ecology: A synthetic approach to ecological research. Cambridge University Press, Cambridge. 342 pp.

Contributions from various restoration ecologists. The area of restoration ecology is looked upon as applied ecology. Broken parts of an ecosystem are put together and has increased our understanding of the whole system. Many areas are discussed such as the need for mycorrhizae research in successful restoration projects. Restoration ecology is essential basic research.

Area: General

Juelson, T. C. 1980 Suggestions for streambank revegetation in western Washington. Informational Report. Washington Department of Game, Applied Wildlife Ecology, Habitat Management Division.

Benefits of riparian habitat and recommendations for plant species use for riparian revegetation.

Area: Washington

Logan, L. D. 1979 Native vegetation for streambank erosion control. Pages 15-18 in Riparian and wetland Habitats of the Great Plains. Proc. Great Plains Agricultural Council Forestry Committee 31st Annual Meeting, June 18-21, 1979, Colorado State Univ., Fort Collins, Colorado. Great Plains Agricultural Council Publ. No. 91. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 88 pp.

Discusses zones of inundation on banks of rivers and lakes. Shows different planting techniques for the "splash", "bank" and "terrace" zones and explains possible problems with revegetation.

Area: Great Plains

Mangum, A. 1980 Guidelines for landscape and wildlife habitat preservation and restoration, stream and channel systems, Louisiana. Louisiana Watersheds Bulletin No. LA16-0- 1. USDA Soil Conservation Service.

Recommendations on restoration and maintenance, including suggested plant species.

Area: Louisiana

McCluskey, D. C., J. Brown, D. Bornholdt, D. A. Duff and A. H. Winward. 1984 Willow plantings for riparian habitat improvement. Technical Note 363, USDI Bureau of Land Management, Denver, Colorado. 21 pp.

Techniques, tools and criteria for successfully planting willow cuttings are discussed. Use of the methodologies described has resulted in plant survival of at least 80 percent. Appendices contain information on supplies needed, estimated costs and sources of bare root willow stock.

Area: General

McKnight, J. S. 1970 Planting cottonwood cuttings for timber production in the South. USDA Forest Service Research Paper SO-60. Southern Forest Experiment Station, New Orleans, Louisiana. 17 pp.

The article is geared toward large-scale plantation use of the cottonwood Populus deltoides. Techniques given on soil choice and preparation, field protection from wildlife and insects, preparation and plantings of cuttings, and plantation management are beneficial in revegetation methods. Cuttings are used due to their success and cost effectiveness.

Area: Southern U. S.

Millar, C. I. and W. J. Libby 1989 Disneyland or native ecosystem: genetics and restorationist. Restoration and Management Notes 7(1):18-24.

Recreation of native communities, there is a need to replicate the genetic structure. This will allow the greatest potential for the introductions to survive over long periods. 1) species are genetically structured, and in most, the patterns of their genetic structure are hierarchical. 2) the patterns of variation can often be understood to reflect adaptations of the trees to the unique environments in which ancestral populations have evolved.

Area: General

Platts, W. S. and J. N. Rinne. 1985 Riparian and stream enhancement management and research in the Rocky Mountains. North American J. Fisheries Management 5: 115-125.

Emphasizes fishery benefits. Good overview of past research on mountain stream enhancement projects. Grazing exclusion and grazing systems that remove less than 65% of herbage and avoid late summer and fall stocking are beneficial to riparian habitat. Not all streams can be enhanced.

Area: Rocky Mountains

Reiner, R. and T. Griggs 1989 TNC undertakes riparian restoration projects in California. Restoration and Management Notes 7(1):3-8.

Two restoration projects were discussed. The first was the Kern River where red willows (Salix laevigata) and cottonwoods (Populus fremontii) were planted as rooted cuttings with hopes of recovery for the yellow-billed cuckoos. The second

was restoration of oak woodland along the Consumnes River. Acorns were planted 1-2 cm deep in a hole lined with 1 qt plastic cup (bottom removed). The cups protected seedlings from weed roots and supported aluminum screening that protected above ground sprouts from herbivores.

Area: California (Consumnes and Kern Rivers)

Swenson, E. A. and C. L. Mullins. 1985 Revegetating riparian trees in Southwestern floodplains. Pages 135-138 in Riparian ecosystems and their management: reconciling conflicting uses. Proc. First North American Riparian Conference, April 16-18, 1985, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-120. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 532 pp.

Dormant pole cutting of willows and cottonwoods were placed in holes drilled in areas with water tables 7 to 12 feet deep. Survival varied with depth of water table and height of poles above the water table but was at least 60%. Plantings needed fencing to protect them from beaver and cattle. The technique proved to be simple and inexpensive.

Area: New Mexico

Thornburg, A. 1977 Use of vegetation for stabilization of shorelines of the Great Lakes. Pages 39-54 in Proc. Workshop on the Role of Vegetation in Stabilization of the Great Lakes Shoreline. Great Lakes Basin Commission, Ann Arbor, Michigan.

The area to vegetated must be on a stable slope, and adapted plants must be used. The author discusses the criteria for selection of species, the role of introduced and native species, and techniques for site preparation and establishment developed by the Soil Conservation Service, USDA. The paper includes a guide to species adapted to various moisture ranges. The guide includes native and introduced grasses, legumes, trees and shrubs.

Area: Great Lakes

Yoakum, J., W. P. Dasmann, H. R. Sanderson, C. M. Nixon and H. S. Crawford. 1980 Habitat improvement techniques. Pages 329-403 in S. D. Schemnitz, editor. Wildlife management techniques manual. The Wildlife Society, Washington, D.C.

Provides a lengthy and detailed discussion of many habitat improvement techniques. Vegetation propagation, regeneration, rejuvenation and release are discussed. Wetland improvements for marches and reservoirs including development of water, plantings near water and water management structures are also discussed.

Area: None

York, J. C. 1985 Dormant stub planting techniques. Pages 513-514 in Riparian ecosystems and their management: reconciling conflicting uses. Proc. First North American Riparian Conference, April 16-18, 1985, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-120. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 532 pp.

Dormant cottonwood and willow poles 3-6 inches in diameter and 6 feet long were planted at the toe of dikes over a 3 foot water table. First year survival was 95%. Planting techniques and problems to avoid are presented.

Area: Arizona

SEEDLINGS AND REGENERATION

Glinski, R. L. 1977 Regeneration and distribution of sycamore and cottonwood trees along Sonoita Creek, Santa Cruz County, Arizona. Pages 116-123 In Importance, Preservation and Management of Riparian Habitat. Proc. Symp. July 9, 1977, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-43. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 217 pp.

The effects of livestock grazing and streambed erosion on the distribution and regeneration of cottonwood and sycamore trees was studied. Cattle effectively prevented cottonwood reproduction by grazing and trampling the seedlings. Streambed scouring by floodwaters removed any remaining seedlings. Sycamores were able to reproduce from trunk and root sprouts that were protected from livestock by mature trunks or dense brush.

Area: Arizona

Horton, J. S., F. C. Mounts and J. M. Kraft. 1960 Seed germination and seedling establishment of phreatophyte species. USDA Forest Service Station Paper No. 48. Rocky Mountain Forest and Range Experiment Station, Fort Collins. 26 pp.

Examines factors that affect dispersal and germination of windborne seeds of tamarisk, cottonwood, willow, seepwillow, broom baccharis and arrowweed. Factors included viability, moisture, light, drought, submergence and growth rates.

Area: Arizona - Salt River

McBride, J. E. and J. Strahan. 1984 Establishment and survival of woody riparian species on gravel bars of an intermittent stream. Am. Midl. Nat. 112(2): 235-245.

Discusses factors that influence seedling establishment of sandbar willow, Fremont cottonwood, red willow and white alder on gravel bars adjacent to the stream channel. Establishment was correlated with sediment texture, high winter flows and swiftness of the current.

Area: California (Sonoma Cty.)

Warren, D. K. and R. M. Turner. 1975 Salt cedar (Tamarix chinensis) seed production, seedling establishment and response to inundation. J. Arizona Academy of Science 10(3): 135-144.

Rapid spread of salt cedar around reservoir edges and along streams and rivers is attributed to: 1) high rate of seed production and effective dissemination, compared with two native species (seepwillow and cottonwood) and 2) ability of mature plants to survive prolonged inundation.

Area: Arizona - San Pedro, Gila

STREAM IMPROVEMENT

Brookes, A. 1988 Channelized Rivers: perspectives for environmental management. John Wiley and Sons, Chichester. 326 pp.

Principles of fluvial geomorphology are presented in an understandable way. Physical and biological impacts of channelization are discussed along with revised construction procedures, mitigation and restoration techniques. Restoration such as establishing pool and riffles with channel deflectors and use of riprap for channel meanders.

Area: General

Gladson, J. 1983 The Stream Doctor. Oregon Wildlife 38(7):5-9.

Popular article describing stream rehabilitation of the John Day River system in Oregon through exclusion of livestock from riparian areas by fencing, and installation of structures to stabilize streambanks and provide fish spawning areas. Fish populations have responded dramatically.

Area: Oregon

Lowrance, R., R. Leonard, J. Sheridan. 1985 Managing Riparian Ecosystems to Control Non-point Pollution. J. of Soil and Water Conservation 40:87-91.

Streams that are adjacent to agricultural watersheds drain these areas of water, nutrients, pesticides, and sediments. Due to this relationship, riparian ecosystems form a buffer between agriculture and streams and can help control non-point pollution. Storage of water in alluvial soils are affected by vegetation and soil in the riparian ecosystem. Freshwater wetlands can filter out nutrients and improve water quality.

Area: General

McKirdy, H. J., J. N. Rinne, and J. Stefferud. 1982 Stream Habitat Improvements for the Southwest. Southwest Habitater. 3(9).

Four types of stream structures trash-catcher, log, gabion, and concrete dams have been used by Forest Service on 50 streams, 3150 structures used. These structures regulate flow, increase bottom and surface area, prevent extreme seasonal changes in volume and temperature of the water, provide shelter for trout and improve food supply.

Area: Arizona, New Mexico

Nelson, R. W., G. C. Horak and J. E. Olson. 1978 Western reservoir and stream habitat improvements handbook. FWS/OBS-78/56. USDI Fish and Wildlife Service, Office of Biological Services. 250 pp.

The broad purpose was to document successful and potentially successful habitat and population improvement measures accompanying water resource development projects. The projects of primary interest were dams and reservoirs in the Western U. S., including diversion dams and canals. The research findings are expected to aid the effectiveness of contributions by the Fish and Wildlife Service and State Fish and Game agencies in project planning and design.

Area: Western U. S.

Nunnally, N. R. 1978 Stream Renovation: An Alternative to Channelization. Environmental Management 2(5):403-411.

There is increasing evidence that suggests that channelization is counterproductive. This can be overcome by employing channel designs that do not destroy the hydraulic and morphologic equilibria that natural streams possess. Designs such as minimal straightening; promoting bank stability by leaving trees, minimizing channel reshaping, and employing bank stabilization techniques; and emulating the morphology of natural stream channels.

Area: General

Petts, G. E. 1984 Impounded Rivers: Perspectives for ecological management. John Wiley and Sons, Chichester. 326 pp.

Discusses changes to areas downstream of dams - i.e., loss of fine sediments, lower oxygen levels, less organic matter. Fluvial geomorphological processes are presented in an understandable way. The changes to flora and fauna are discussed along with management problems and prospects.

Area: General

Risser, R. J. and R. R. Harris 1989 Mitigation for impacts to riparian vegetation on Western Montane streams. pp 235-250. In Alternatives in Regulated River Management (J. A. Gore and G. E. Petts, eds.)

The characteristics and resource values of riparian vegetation are described relating the effects of streamflow diversion on resource values, developing a framework for designing effective mitigation, and presenting methods to avoid or reduce the impact and to restore lost riparian vegetation where it is practical.

Area: Western streams

White, R. J. 1968 Stream improvement. Pages 106-110 In R. D. Teague, editor. A manual of wildlife conservation. The Wildlife Society, Washington, D.C.

Stream management of banks, current, vegetation and channel bed have shown to increase numbers of trout in the midwest and North Central States. Techniques mentioned provide more living space and shelter, preserving natural cover, instream structures to deepen the channel and low dams, but were not elaborated on as how they were built or where.

Area: General

Wydoski, R. and D. Duff. 1978 Indexed bibliography on stream habitat improvement. Tech. Note 322. USDI Bureau of Land Management, Denver, Colorado. 35 pp.

Compilation of literature on stream habitat improvement with 390 references categorized into 20 key subjects including riparian vegetation, streambank stabilization, streamflow (and control) techniques.

Area: General

VEGETATION MANAGEMENT

American Fisheries Society. 1982 The best management practices for the management and protection of western riparian stream ecosystems. American Fisheries Society, Western Division. 45 pp.

Provides management guidance for livestock grazing, mining, water development and irrigation, road construction, agriculture, urbanization and timber harvest. General concepts that will prevent or mitigate damage to riparian habitats are listed by topic and references are provided.

Area: Arizona, California

Bayha, K. D. and R. A. Schmidt. 1983 Management of cottonwood-willow riparian associations in Colorado. The Wildlife Society, Colorado Chapter. 53 pp.

A comprehensive handbook for multiple-use management of cottonwood-willow communities. Sections are devoted to: 1) description of inherent values; 2) identification of problem areas; 3) background information for the manager; 4) practical management techniques. Most of ;this manual would be applicable to lower elevations throughout the Southwest.

Area: Colorado

Campbell, C. J. 1970 Ecological implications of riparian vegetation management. J. Soil and Water Conservation 25(2):49-52.

Managing riparian vegetation in the Southwest to increase water yield may require selective clearcutting rather than complete removal of riparian plants to maintain a biological balance and thus prevent thermal pollution, channel erosion, and destruction of aquatic and wildlife habitats. Manage for both water yield and recreation.

Area: Southwest U.S.

Davis, L. C., S. I. Iton and P. T. Azanck. 1967 Pilot levee maintenance study, Sacramento-San Joaquin Delta. Dept of Water Resources, State of California.

Pilot levee maintenance study to serve the needs of esthetics, recreation and wildlife, as well as the primary purpose of flood control. Vegetative techniques and maintenance tested.

Area: California

Davis, G. A. 1977 Management alternatives for the riparian habitat in the Southwest. Pages 59-76, In Importance, Preservation and Management of Riparian Habitat. Proc. Symp. July 9, 1977, Tucson, Arizona. USDA Forest Service Gen. Tech. Report RM-43. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 217 pp.

Literature on the importance of riparian habitats to wildlife is reviewed, followed by a discussion of the types of ecological information needed before

management of riparian habitats can begin. A technique for evaluating the ecological condition of riparian habitats is presented. As examples of management alternatives, the consequences of managing riparian habitats for maximum water yield and for maximum forage for livestock are reviewed.

Area: Southwestern U. S.

Dawson, K. J. 1985 Avian-vegetative relationships in riparian landscape restoration. UCES Project CA-D-EHT-4131-H (submitted to Landscape Journal).

Abundance of indicator bird species was related to the vertical and horizontal structure composition of riparian forest in Elkhorn Regional Park. Factors influencing the present condition of the forest was inferred from historical land use information. Planting design guidelines were developed from the data on vegetation structure preferences of birds and include frameworks for developing working drawings, installation specifications and guidelines for maintenance and management.

Area: Elkhorn Natl Park, N. California

Debano, L. F. and L. J. Schmidt 1990 Healthy riparian areas as related to watershed stability. pp 57-66. In Proceeding of Conference XXI Erosion Control: Technology in Transition. Feb 14-17, 1990, Washington, D. C.

This paper describes relationships between riparian areas and the condition of surrounding watersheds. Some causes for erosion and deposition in riparian areas are outlined. Control treatments are discussed that can be used for rehabilitating deteriorated watersheds and their riparian areas.

Area: General

Graf, W. L. 1980 Riparian management: a flood control perspective. J. Soil and Water Conservation 35(4):158-161.

A review of riparian vegetation change in the Southwest, and examines the relationship between channel vegetation and water resources. Three management alternatives are suggested to deal with flood control/phreatophyte growth problems: 1) no-action, 2) clearing and maintenance, 3) restoration of nearly original conditions.

Area: Southwest U. S.

Heede, B. H. 1977 Study of watershed rehabilitation project: Alkali Creek, Colorado. USDA Forest Service Research Paper RM-189. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 18 pp.

Gullies to be converted to vegetation-lined waterways should be first- or second-order channels in broad valley bottoms. They must meander to achieve decreased gradients compared to the original gullies and should have good potential for plant growth. Headwaters of Alkali Creek watershed were fenced and cattle grazing was excluded from 1958 to 1966. Gullies with check dams or vegetation-lined waterways experienced only one-third of the erosion seen in untreated gullies. Perennial streamflow was regained.

Area: Colorado

Horton, J. S. 1974 Management alternatives for the riparian and phreatophyte zones in Arizona. Pages 40-42 In Proc. 18th Annual Arizona Watershed Symposium, Arizona Water Commission, Phoenix.

Discusses the potential for water-saving through phreatophyte clearing; specifically, how much water per year various species use and potential resource conflicts following clearing.

Area: Arizona

Horton, J. S. and C. J. Campbell. 1974 Management of phreatophyte and riparian vegetation for maximum multiple use values. USDA Forest Service Research Paper RM-117, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Evaluation of water losses from moist site vegetation in arid situations. Management suggestions under various water table conditions.

Area: Arizona

Jankiewicz, C. J. 1984 Cottonwood Sprout Protection. Southwest Habitater 5(6). 2 pp.

Downfallen limbs were placed in a match stick arrangement around patches of cottonwood saplings as protection from browsing in 1981. In 1984, many saplings had grown out of the reach of grazing animals. The technique is low cost, needs little skill in construction and no need to remove barriers once they fulfill their purpose.

Area: Cibola Nat'l Forest, New Mexico

Krause, A. 1977 On the effect of marginal tree rows with respect to the management of small lowland streams. Aquatic Botany 3: 185-192.

In Germany managers have solved a problem of submerged and emergent vegetation slowing or blocking small rivers, streams or ditches. Rather than spraying herbicides or repeated cutting they have planted rows of native riparian trees to shade the stream. Alder (Alnus glutinosa) has advantage as it roots penetrate below the saturated zone. Riparian trees reduce choking vegetation, reduce erosion and stabilize the toe of the slope. Maintenance costs have been greatly reduced, wildlife habitat created and the landscape enriched.

Area: Germany

Nabhan, G. P. and T. E. Sheridan. 1977 Living fencerows of the Rio San-Miguel, Sonora, Mexico: traditional technology for floodplain management. Human Ecology 5(2): 97-111.

Farmers in eastern Sonora, Mexico use propagated fencerows of live cottonwoods and willows to maintain, extend and enhance floodplain fields, protect fields from cattle, harbor birds as agents of biological control of insect pests and provide renewable supplies of wood. Farmers do not perceive cottonwoods and willows as phreatophytic pests. Stability of the San Miguel ecosystem contrasts with severely eroded conditions within the region's other arid watersheds.

Area: Sonora, Mexico

Shafer, D. M. 1980 Management of riparian vegetation for Southwest wildlife. Unpubl. M. S. Thesis. Univ. of Arizona, Tucson, Ariz. 75 pp.

Describes management options for protection and enhancement of mixed-broadleaf, cottonwood-willow, mesquite, tamarisk and riparian shrub communities. Each community is described, its value to wildlife presented, management problems explained and management techniques provided. A series of management recommendations is presented for each riparian community.

Area: Southwest

Shafer, D. M., P. F. Ffolliott and D. Patton. 1982 Management of riparian vegetation for Southwestern wildlife. Wildlife Unit Technical Report. USDA Forest Service, Albuquerque, New Mexico. 20 pp.

A compilation and brief review of literature on riparian vegetation and wildlife in the Southwest. Impacts of human activities on each community are emphasized

and a list of management recommendations is presented for each of the five low elevation communities discussed.

Area: Southwest U. S.

Smith, B. H. 1979 Riparian willow management: its problems and potentials within the scope of multiple use on public land. In Proc. of the 9th Wyoming Shrub Ecology Workshop. Fisser, H.G. and K.L. Johnson, ed. Lander, Wyoming. 12 pp.

Willows are one of the most important significant elements in establishing and maintaining both the physical stability and biological diversity of riparian ecosystems. Intensive and repeated grazing pressures are leading to a loss of fisheries and beaver habitat. The BLM Rock Springs Dist. in 1980 began implementation of a program incorporating an integrated approach to riparian zone management. One of the outcomes was the development of grazing programs which are ecosystem oriented.

Area: Wyoming

Thomas, J. W., C. Maser and J. E. Rodiek. 1979 Wildlife habitats in managed rangeland-the Great Basin of Southeast Oregon - riparian zones. USDA Forest Service Gen. Tech. Report PNW-80). Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon. 18 pp.

Primarily describes values of riparian habitat and its sensitivity to disturbance. Contains management recommendations for roads, campgrounds, livestock and enhancement projects.

Area: Oregon

USDA-Forest Service. no date Interdisciplinary riparian management guidelines for the Payette National Forest. McCall, Idaho.

Guidelines were developed with 10 key riparian types identified. Resource protection objectives were characterized for each riparian type - erosion and sedimentation, fisheries, water quality, soil productivity, range management and wildlife. Practices such as livestock, 'ORV' use and mining were also defined for each riparian type. The Guideline's purpose is to provide a framework within which the costs of commodity production as well as production trade-offs could be evaluated on a forest-wide basis.

Area: Payette Nat'l Forest, Idaho