Protection and Enhancement of Riparian Ecosystems (An Annotated Bibliography)

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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.

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BANK STABILIZATION


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


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


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
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.


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


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

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


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


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
**BEAVER**


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


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

Area: Montana


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

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


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


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


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

Area: United States

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


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


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


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


An extensive annotated bibliography of 254 papers.

Area: General

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

Area: Western U. S.


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


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.

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


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


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

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.


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


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

Area: SW Montana


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


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

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 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


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


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
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


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


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


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

Area: Wyoming

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


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


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
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

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

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


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


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


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

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


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


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
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

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

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.

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


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


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

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


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


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
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


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


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.

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.


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


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
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


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


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

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.


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

Area: California


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


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

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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


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.


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

Area: General
PHREATOPHYTE CONTROL


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


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


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


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


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

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


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


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


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


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

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 2½ to 6 feet deep to ground water, plantings less than 2½ feet lack stability against high flows and cattle. Cuttings with basal diameter of 2½" 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 (1½ 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


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

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 (68-81°F) hastens the rooting process. High moisture is indispensable 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
REVEGETATION TECHNIQUES


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$^2$/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


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

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


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


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

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


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

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

Area: General


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


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

Area: Texas


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
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.


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


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

Area: Washington


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


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 2.3/100m² to 7/100m² 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


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


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.)


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

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


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


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

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


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

Area: Washington


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


Recommendations on restoration and maintenance, including suggested plant species.

Area: Louisiana
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


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.


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


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


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)


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


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

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

Area: None


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

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


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


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.)

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


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


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


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


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

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.


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


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


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


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


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


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


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.


Area: California


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.


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


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

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.


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


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


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

Area: Arizona

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


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


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


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


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.**


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**


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

**Area: Oregon**


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**