MANAGEMENT OF STREAMBANK ZONES IN NORTHEASTERN CALIFORNIA

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Preface

In the fall of 1985, Pacific Gas and Electric Company's Department of Engineering Research asked the University of California's Wildland Resources Center to organize a special workshop on streambank zone management in California. The Center responded by forming a steering group to explore the dimensions of the proposal and plan the workshop. The steering group narrowed the geographic scope of the workshop to northeastern California and invited 33 specialists to participate. PGandE provided use of a facility plus a generous grant to defray costs of organizing the workshop and producing a report.

On May 28, 29, and 30, 1986, specialists worked at three field areas, chosen to represent the headwaters of a stream, midcourse of a small stream, and lower reaches of a larger stream.

Leaders and members of the teams contributed written reports and notes of their findings and recommendations. These documents underlie sections of this publication dealing with dominant and multiple uses of resources, and needs for research and extension.

Acknowledgements

This cooperative undertaking between the University of California (UC) and the Pacific Gas and Electric Company (PGandE) marks the beginning of what is hoped will be an ongoing association, initially proposed by Dr. Don C. Erman and W. Chris Chouteau. In 1983, Dr. Erman, Professor of Fisheries Ecology, in UC's Department of Forestry and Resource Management at Berkeley, and Mr. Chouteau, then Acting Director of Research, Development, and Demonstration in PGandE's Department of Engineering Research at San Ramon, hoped to utilize the University's scientific and technical capabilities in approaching PGandE's problems in research and management of lands and resources. (PGandE is one of the largest private landholders in California.) Their initiative and enthusiasm led UC and PGandE to enter into this cooperative undertaking.

Specifically, Lin Y. Bowie, Biologist in PGandE's Department of Engineering Research, deserves credit for having started planning of this workshop and for arranging the financial gift from PGandE that supported it. Her assistant, Donna S. Lindquist, led PGandE's team on the steering group and its participants at the workshop. Ms. Lindquist's staff work was of great importance to the success of the workshop. In addition, Roland Risser and Nancy E. Brose of PGandE contributed to the workshop's steering group.

Four faculty members of UC's Department of Forestry and Resource Management at Berkeley worked as members of the steering group and as leaders of resource-oriented teams during and after the workshop: Dr. Reginald H. Barrett, Associate Professor of Wildlife Ecology and Management; Dr. James W. Bartolome, Associate Professor of Range Ecology and Management; Dr. John A. Helms, Professor of Silviculture; and Dr. Erman. This group managed the technical output from the workshop and helped with the text related to their particular resources.

Dr. Robert Curry, Professor in Environmental Geology at UC's campus at Santa Cruz, served as a team leader during the workshop and coordinated the team's report on water and soil.

Photographs in this report were made during the workshop by Jerald Morse, of UC's Department of Forestry and Resource Management, Berkeley.
Contents

Preface ........................................................................... i
Acknowledgements ........................................................... i
Executive Summary ......................................................... 1
Introduction .................................................................... 5
Goals and objectives ....................................................... 5
Concerns of organizers ................................................... 5
Problem statement ......................................................... 5
Organizing the Workshop .................................................. 6
Teams of specialists ....................................................... 6
Sites chosen for visits .................................................... 6
An assumed landowner ................................................... 7
Conduct of workshop .................................................... 7
Dominant Use of Each Resource ....................................... 9
Water and soil resources ................................................ 9
Fisheries ..................................................................... 13
Range for livestock ....................................................... 14
Outdoor recreation ........................................................ 16
Forests for timber ......................................................... 18
Wildlife ........................................................................ 20
Interaction among uses .................................................. 21
Multiple Use ................................................................. 24
Headwaters .................................................................... 25
Midcourse reaches ........................................................ 25
Lower reaches ............................................................... 26

Needs for Research and Extension ................................. 27
Water and soil .............................................................. 28
Fisheries ................................................................. 28
Range for livestock ....................................................... 29
Recreation ................................................................. 30
Forests for timber ......................................................... 30
Wildlife ....................................................................... 31
Aesthetic resources ....................................................... 31
Multiple use ............................................................... 31
Policy ......................................................................... 31

Conclusions ................................................................... 32
Why is the streambank zone a "problem"? ..................... 32
What can be done about the "problem"? ......................... 33
What organizational means to address these problems are lacking? .................................................. 34
What is not being done because technology is lacking? ................................................................. 35

Appendices
A—A glossary of terms related to management of streambank zones ........................................... 37
B—List of attendees ........................................................ 41
C—Assignments of specialists to teams ......................... 42
D—Conclusions expressed by the steering group after the workshop .............................................. 43

Tables
1. Typical activities during management of each resource .............................................................. 10
2. Impacts of managing for dominant use of a resource on other uses of resources ....................... 22
Executive Summary

Streambank zones have special importance to California's forests and rangelands. Human activities on the land and water within these zones have significant impacts on habitats for wildlife and fish, and on the quantity, quality, and timing of water flow and instream conditions. Managers of streambank zones must give these areas special consideration.

In May 1986, a unique 3-day workshop, organized by the University of California's Wildland Resources Center and sponsored by the Pacific Gas and Electric Company's (PGandE's) Department of Engineering Research, was held near Fall River Mills in northeastern California. Specialists knowledgeable about individual resources were invited to analyze activities for managing streambank zones either for dominant use of a single resource or for integrated multiple uses.

During three half-day sessions, workshop participants visited areas representative of headwaters conditions, midcourse reaches, and lower reaches of streams. Several sites in each area were examined. At the last site in each area, resource-oriented teams outlined their recommendations for dominant use. Then, participants were reassigned to multiple-use teams and developed strategies for multiple use of resources in the area.

Dominant use

Assuming that resources are available and demand is high, a landowner may opt for a single, dominant use of a streambank zone. Other uses may or may not be included, but are always secondary in importance. Each team proposed managerial activities and output for its resource (see table 1).

**Water and soil.** Management would aim at maintaining, restoring, or enhancing the quality of water; increasing stream flow; and improving stability of stream channels. Teams strongly recommended that ways be found for downstream owners who benefit from upstream improvements to share in the costs of improvements.

In headwater areas, management for water would include reduction of tree cover and deeply rooted perennial vegetation, stabilization of stream channels, reduction of grazing and timber harvest, and restoration of deteriorated meadows.

**Timber.** Activities would include production of sawlogs, poles, and chips for fuel. Inventories of timber resources showing soils and site quality would aid in determining the kind and location of
timber stands and return on investments in treatments. Sanitation and salvage cuttings would be followed by management in even- or uneven-aged stands. In either case, precommercial thinning and intermediate commercial harvests would enhance the quality and value of the remaining timber. Measures would be taken to stabilize surface soils. Regeneration would depend on planting and control of competing weeds.

**Wildlife.** Dominant use for wildlife would produce harvestable crops of game while meeting needs for diverse wildlife communities. Specific objectives would include maintenance of threatened or endangered species, increasing game species, encouraging diversity of nongame species, and minimizing problems caused by animal pests. Inventories of wildlife would provide guidance for management. A diversity of habitat structure, both vertical and spatial, would be developed.

Streambanks and meadows would be protected from livestock grazing, and remaining old-growth forests would be left unlogged. Roads would be closed wherever feasible. Prescribed burning of the understory would be used to improve habitats. Timber harvesting would be dispersed to retain snags and hardwoods and allow for shrub development during regeneration. Use by people and livestock would be minimized or eliminated. Deer, quail, and turkey, in particular, would support a fee-hunting program on larger properties.

**Impacts of Each Dominant Use on Other Resources**

Dominant use of any one resource would be expected to have significant impacts on uses of other resources (see table 2). Deciding to favor one use over another or to move to a mix that would provide multiple benefits would require many compromises.

Dominant management for:

- **Water**—would have significant effects on most other uses of forest and rangeland. Stocking of trees and livestock would be reduced.

- **Fisheries**—would have minimal effects on wildlife, water, and soils, but would have substantial effects on timber, range, and recreation.

- **Range**—would result in more forage, but less timber, and in impacts on habitats for wildlife, fisheries, and recreation.

- **Recreation**—would significantly interfere with water quality, timber production, and utilization of forage, and would disturb habitats and populations of wildlife and fish.

- **Timber**—would result in less forage for livestock and fewer old-growth habitats for wildlife.

- **Wildlife**—would have negative effects on production of timber and forage for livestock and on certain types of recreation, but would have little impact on fisheries, water, and soils.

**Multiple Use**

Participants in each of four multidisciplinary teams integrated activities for dominant uses of an area into a package that would provide maximum benefits to the landowner, given existing constraints. The four multiple-use teams usually recommended a similar mix of outputs.

One team urged that ways be found to fund or reduce the cost of rehabilitation of degraded watersheds, possibly through the formation of nonprofit conservation organizations or through special legislation. All participants recognized that downstream landowners should share the costs incurred by upstream landowners for restoration and conservation measures that benefited all.

**Headwaters areas.** Most teams established a goal of maximizing joint income from timber and livestock grazing, recognizing that timber would generate the most income. The downstream value of water from headwaters was estimated to be approximately 20 percent of the value of timber in these areas.

All teams recommended improving water quality by stabilizing stream channels and gradients. Timber would be harvested in small clearcut blocks. Regeneration would be by planting, with periodic thinning. Five percent of the area would be allocated to old-growth timber stands to provide habitat for certain species of wildlife. Wide bands of vegetative canopy would be maintained along streambanks and around meadows.

Prescribed burning at about 20-year intervals would improve deer habitat and production of forage for livestock. Meadows and major streambank zones would be fenced to control season of grazing. Speckled dace would be reintroduced into streams where they had been native, and shade along streams would be increased by replanting.

**Midcourse reaches.** Water quality would be enhanced by stabilizing and revegetating streambanks and by controlling access of livestock and recreationists. Spawning and rearing areas for fish would be enhanced. Impoundments would be constructed to stabilize water flows and to catch and
hold sedimentation from upstream sources. A goal for all teams was to protect and enhance riparian vegetation.

Teams varied in their recommendations for management of livestock grazing and timber, but all teams agreed that recreational facilities might be developed.

**Lower reaches.** Water was believed to be the resource of greatest value. Enhancement of water storage capacity and regulating flows of water would be primary goals.

Development of a portion of land along lower reaches was proposed for restricted recreational use, with fees for hiking, camping, fishing, hunting, and ORV use.

**Research and Extension**

Topics for research emerged when participants were unable to answer a technical question or when they knew that knowledge available elsewhere could be adapted to meet needs in northeastern California. Although problems were identified, a program to solve them was not within the scope of the workshop; however, almost 100 resource-oriented needs are identified and prioritized in this report. Those deemed to be of highest priority were:

- **Soils and water**—Identify sources, sinks, and transport of sediment; budget for sediment in the watershed; understand dynamics of water in meadows; establish economics of storing water and retaining sediment on upland sites; develop a classification system for stream bank zones.

- **Fisheries**—Determine appropriate species composition and density of streambank vegetation at headwaters; determine whether so-called best management practices will restore badly degraded streams and biota.

- **Range**—Determine sources of sediment in streams; determine effectiveness of plants to prevent sediment from entering streams; understand the autecology and taxonomy of critical plant species in riparian zones.

- **Recreation**—Determine local, regional, and statewide demands for recreational uses of forests and rangelands; identify patterns of and conflicts between recreational use by local citizens and those who travel long distances to use resources.

- **Timber**—Build a model to simulate growth of small trees and plantations; develop best management practices to reduce erosion associated with production of timber.

- **Wildlife**—Develop computerized systems for evaluating management options for private land; determine responses of each species of game to manipulation of forest and rangeland habitats; determine significance of clashes between wildlife and both livestock and recreationists.

- **Multiple use**—Evaluate societal, political, economic, and productivity trade-offs associated with managing streambanks for multiple use.

- **Policy**—Determine effects of current state and federal regulations on capacity of forest landowners to vary multiple output on sites of different quality and location; determine effects of alternative new policies to encourage cooperation.

**Conclusions**

Multiresource and multidisciplinary approaches to management are vital in streambank zones. The profusion of related laws, regulations, and policies should be assessed to determine their effectiveness.

Streambank zones are troublesome because pressures of land and water uses are focused on a very small, sensitive, but highly significant area. Whole-watershed approaches to streambank evaluation are lacking; there are no organizations to represent the collective interests of watershed owners. Conflicts between public water rights and private land rights have not even been identified, let alone resolved. Currently, too few scientists and specialists are seeking solutions to the numerous problems of these zones.

Applicable information and technology exist, but much of what is available is underutilized or not utilized at all. If managers are made aware of the impacts of dominant use on other resources within a streambank zone, they may be willing to compromise on activities that have negative consequences.

Multiple-disciplinary teams should be built to analyze costs and benefits, evaluate existing managerial activities, and prepare prescriptions for managing streamside areas using multiple-use concepts. Despite difficulties of organization and financing, the private sector has urgent need of a multidisciplinary planning structure.
Introduction

Streambank zones, like a system of veins, carry surface water from California's forests and rangelands. Unusual combinations of technical expertise and ecological understanding are required to make appropriate decisions about managing the multiple resources found on these streambank habitats. On May 28-30, 1986, an unprecedented workshop was organized jointly by the Wildland Resources Center of the University of California (UC) and the Department of Engineering Research of the Pacific Gas and Electric Company (PGandE). The workshop led to significant findings and recommendations about management of streambank zones in northeastern California and identified problems requiring attention by research and extension.

Streams draining forests and rangelands have special importance in California's wildlands. Ninety-five percent of California's water yield flows through these streams. Riparian areas that include these streams provide unique and critical habitats for wildlife and fish and conditions that are preferred by people and livestock. Being more moist than surrounding uplands, riparian areas display greater productivity, but they are also more heavily used and subject to damage.

Human activities on lands adjacent to streams or within streamcourses can profoundly affect instream conditions and the quantity, quality, and timing of water flow. Managers of forests and rangelands must give special consideration to these zones. A single resource or output cannot dominate without causing less favorable consequences on most other resources and output.

Knowledge and methodology in several technical areas are required for managing streambank zones. Understanding of ecological interconnections between land, air, and water systems is necessary. Specialists can be found who focus on one system; however, it is unusual to find people who have assimilated and integrated the multidisciplinary and complex technologies needed to manage streambank zones effectively.

The workshop, held near Fall River Mills in northeastern California, facilitated interaction among 33 invited specialists. First, the specialists met in resource-oriented teams—timber, range, water, fisheries, and wildlife—to propose objectives and activities pertinent to dominant use of each resource. Rearranged in multidisciplinary teams, the specialists negotiated and agreed on objectives and activities for multiple use of resources. Finally, they identified needs for research and extension to fill gaps in available technology.

Goals and Objectives

Land management practices need to be integrated to achieve a desired, sustainable, and predictable output from the total set of resource values at a reasonable cost. Based on this understanding, the goal of the workshop was to recommend a mix of integrated activities for managing streambank zones, through coordinated, interdisciplinary groups of resource specialists.

Objectives of the workshop were:

1. Find and gather people knowledgeable about individual resources found in streambank zones and encourage their constructive interaction.
2. Propose alternatives for managers ranging from dominant use of each resource to multiple use of resources, and offer several alternatives for multiple use.
3. Identify gaps in our knowledge and methodology for managing streambank zones. These would then become targets for research and demonstration programs.

Concerns of Organizers

The foremost concern was that rights of all landowners be respected. The purpose of the workshop was not to criticize land owners or managers, but rather was to concentrate on what can and should be done to improve a situation. Also, recommendations were to be generalized for this region of California to make them applicable to many landowners or managers and to conditions other than those specifically observed in the field. Finally, it was hoped that recommendations would be relevant to those objectives and activities deemed economically reasonable and prudent by a conservative investor.

Problem Statement

In northeastern California, streambank zones are productive, unique, and suited to many uses, but in some areas, earlier uncontrolled, intensive use of these zones led to accelerated erosion, unstable stream banks, changes in hydrologic balance, and sedimentation of streams, lakes, and reservoirs. Managers and experts from various disciplines and
professions often have divergent and sometimes conflicting viewpoints on how streambank zones should be managed and past damages rectified. The problem, simply stated, is to learn how to manage these lands, whether for dominant use or multiple uses, while minimizing erosion and sedimentation.

In this region, streambank zones are a primary focus for management because of their high productivity, their uniqueness and importance as habitat for fish, wildlife, and livestock, their recreational values, and their effects on water quality. Due to these desirable characteristics, they are also the focus of increasing use by a spectrum of resource users. Uncontrolled and intense use in some locations has caused severe damage to vegetation, soils, and water quality. Many landowners in northeastern California are committed to responsible stewardship of these zones and to restoring degraded or damaged areas.

Managerial systems and methodology must be prescribed to assure that effective and efficient care and restoration of streambank zones are accomplished. These systems must be tailored to the goals and objectives of the landowner and must also be attentive to the current environment of governmental oversight, policies, and regulations. Public agencies, like USDA Forest Service and USDI Bureau of Land Management, are legislatively committed to manage for multiple uses, but immediately adjacent private owners might have the goal of dominant use of a single resource. Management costs time and money, so capability and willingness to pay must be considered when systems are proposed and put into place.

Conflicts exist among resource uses, and trade-offs among uses must be negotiated before management can proceed. In resource management, practices designed to enhance the value of any one resource commonly conflict with practices designed to enhance the values of others.

Organizing the Workshop

Concepts and procedures embodied in this workshop were generated by a steering group. The steering group clarified the workshop’s goal and objectives, selected the geographic region and areas to be visited, and nominated specialists for resource-oriented teams.

Eight persons comprised the bi-agency steering group: Donna S. Lindquist, Roland Risser, and Nancy E. Brose from PGandE, and Reginald H. Barrett, James W. Bartolome, Don C. Erman, and John A. Helms from UC’s Department of Forestry and Resource Management. Chair and rapporteur of the group was Robert Z. Callaham, Program Coordinator of UC’s Wildland Resources Center.

An early action of the steering group was to narrow the geographic scope of the workshop. Management of streambank zones was assumed to vary substantially according to predominant vegetation, pattern and amount of rainfall, geologic conditions, erodibility of soils, and risk of mass movement. From the various regions considered, the group chose northeastern California, roughly the area lying north of Mt. Lassen and east of Mt. Shasta. This area was chosen for its comparatively uniform conditions, relative lack of information about the region, PGandE’s substantial land holdings in the Pit River Basin, and opportunities to see conflicts between management’s objectives and resource requirements.

The workshop was held at PGandE’s facility at the Pit 1 Powerhouse, located just south of Highway 299, about 4 miles west of Fall River Mills, and 12 miles east of Burney. This site was chosen to provide an isolated location, free of distractions, and close to streambank zones to be visited.

Teams of Specialists

The steering group created teams of specialists concerned with five resources: timber, range, water and soil, fisheries, and wildlife. Later, recreation was identified as a sixth resource, to be addressed by a single specialist. Each team generally included representatives from state and federal agencies, PGandE, private interests, and individuals experienced in management of streambank zones or related resources. The 33 specialists participating (Appendix B) were divided into resource-oriented and multiple use-oriented teams (Appendix C).

Sites Chosen for Visits

The three areas visited represented different streambank conditions: headwaters, midcourse reaches, and lower reaches.

Headwater regions are typically at higher elevations and at greatest distances from human activities. Streams originating from springs and meadows may be permanent, ephemeral, or intermittent. From these sources, stream channels emerge. First- and second-order streams character-
ize headwater areas. Though fish may not occur in them, natural forces or human activities at headwaters have profound effects on downstream fisheries, and, therefore, are of managerial concern.

Midcourse reaches may have fifth- or sixth-order streams. Stream flow depends on gradient. Streambanks are generally pronounced. Flood plains are narrow and infrequent. Valley walls along such reaches are relatively young, with steeper slopes. Fisheries usually are present. Spawning areas may occur for larger fish that reside in lower reaches. These reaches attract more human interest and activity for livestock, timber, and recreation.

Lower reaches of streams become broad and full. Down cutting is less and side cutting increases due to reduced gradients and water velocity. The stream meanders from side to side on a widened valley floor. Along lower reaches human activities are greatest. Fish may be more abundant and attain greatest size.

An Assumed Landowner

Each owner of land has a basic philosophy, one or more goals, and specific objectives that guide decisions related to management of land and resources. To focus the team’s analyses, participants discussed a set of assumptions about the landowner for whom they were working. Draft assumptions seemed to describe a Utopian landowner, and a front row participant said, “Sounds like nirvana.” From that time on, the hypothetical landowner was “Nirvana Enterprises,” and was agreed to have the following attributes:

- Private ownership
- In business to make a profit, but not necessarily every year in every sector
- In business for the long haul
- Economically conservative; invests in reasonable proposals
- Value based on land and output from resources
- Not solely dependent on land; has other economic enterprises
- Has high level of social concern for employees and communities
- Prefers mix of output
- Accepts responsibilities for good stewardship

- Has a manager nearby with a small professional staff who operate through contracts and temporary employment

The process of the workshop brought out the desirability of having information about four other attributes of the landowner: size and geography of land tracts, scope of economic activities, goals of managers (vis-a-vis owners), and owner’s situation among other owners. Earlier assumptions about these attributes would have facilitated the workshop’s process.

“Nirvana Enterprises” was chosen as the landowner for this workshop to avoid constraints inherent in managing land owned by government or closely regulated companies. The intent was to focus on effective management strategies without being sidetracked.

Conduct of Workshop

An opening, three-hour session at the Pit 1 facility provided for introductions, agreement on the goal, objectives, and assumptions; explanation of the schedule and process of the workshop; and first meetings of resource-oriented teams. Their meetings were to agree upon general goals and objectives, to outline activities and output for dominant use of each resource; identify constraints on dominant use; and anticipate impacts on a resource resulting from dominant use of other resources.

Field sites were visited, with teams traveling together in vans so that technical issues could be developed and discussed during travel. The vans made several brief stops in each area to allow participants to observe conditions. At the final stop, teams gathered for private deliberations on their assignments. Then, all participants assembled to hear reports from each team. Once again, the reports, with associated questions and commentary, led to meaningful discussions and contributed to an emerging awareness of the strengths, weaknesses, and diversity of viewpoints in management of streambank zones.

Afterward, the four multiple-use teams met for half an hour to discuss what had been reported by the resource-oriented teams and to shape their goals, objectives, and activities for multiple-use management.

Oral reports from the four teams to all participants proposed differences in emphasis for multi-
A streambank in need of stabilization and revegetation along a midcourse reach.

The resource-oriented team for wildlife confers on dominant use of a headwater area.

Each team boarded a van at the Pit 1 facility for field trips.

Participants discuss conditions along a midcourse reach.

All participants heard and discussed reports by each resource-oriented team, and later by each multiple-use team.
Headwaters of streams in northeastern California often are in large meadows ringed by pines.

Lower reaches of a stream.

Workshop wrap-up reports were made at the Pit 1 clubbous.

ple use. As expected by the steering group, the multiple use teams recommended contrasting uses of resources.

In a four-hour period, the workshop traveled up to 55 miles to see and discuss a variety of conditions and problems in a headwaters area. Each participant had worked more than an hour on two separate teams. Reports had been heard and filed from six resource-oriented teams and from four multiple-use teams. On the following day, this scenario was repeated in two additional areas: an area with midcourse reaches was visited in the morning and an area of lower reaches was visited in the afternoon.

The concluding session of the workshop back at the Pit 1 facility provided for completing documentation of all reports and identification of needs and priorities for research and extension.

Dominant Use of Each Resource

If appropriate resources are available and demand is sufficient, then the landowner may opt for one main, dominant use. Land use naturally depends not only upon the resources present and demand for those resources, but also upon the philosophy or mission and goals of the landowner. Other uses may or may not be excluded by dominant use, but they always are secondary in importance.

Asked to think in terms of management for dominant use, each of the six resource-oriented teams wrote its general goal and specific objectives. They identified significant constraints imposed on such management by existing laws, regulations, and policies. Responding to observed and expected conditions at each field site, the teams proposed managerial activities, listed expected output (table 1), and anticipated effects of dominant use of their resource on uses of other resources.

Water and Soil Resources

Goal, objectives, and constraints. Management for dominant use of water and soil resources would have as its goal the maintenance and enhancement of the quantity, quality, and timing of water produced on a sustained basis and maintenance of the productivity of soils. One specific objective would be to maintain, restore, or
Table 1. Typical activities during management of each resource

<table>
<thead>
<tr>
<th>Water, Soil, and Air</th>
<th>Fisheries</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activities:</strong></td>
<td><strong>Activities:</strong></td>
<td><strong>Activities:</strong></td>
</tr>
<tr>
<td>1. Survey and monitor to determine status, trends, uses, and needed treatments</td>
<td>1. Survey and monitor streams and riparian zones to determine status, trends, and needed treatments</td>
<td>1. Control livestock by herding and by placing water and salt to improve utilization and to rotate use of forage</td>
</tr>
<tr>
<td>2. Stabilize streambanks by using revetment, deflectors, cribs, and riprap</td>
<td>2. Stabilize streambanks by using revetment, deflectors, cribs, and vegetation</td>
<td>2. Control brush by mechanical or chemical means, or by fire</td>
</tr>
<tr>
<td>3. Control gradients of streams by constructing check dams</td>
<td>3. Improve road crossings over streams</td>
<td>3. Dispose of debris following other treatments to improve aesthetics or forage, or to reduce fire hazard</td>
</tr>
<tr>
<td>4. Revegetate eroding areas</td>
<td>4. Restore gradients of streams by small check dams</td>
<td>4. Manage undesirable forbs and herbaceous range plants, noxious farm weeds, and poisonous plants</td>
</tr>
<tr>
<td>5. Construct water bars in roads, trails, and skid trails</td>
<td>5. Modify channels to create pools, scouring, gravel beds, and fish passages by placement of obstacles to flow that increase roughness and provide instream cover for rest, protection, and provision of food.</td>
<td>5. Seed by drilling, broadcasting, and other techniques</td>
</tr>
<tr>
<td>6. Avoid placing roads in riparian zones</td>
<td>6. Remove proven pest fish by chemical treatments, shocking, or draining</td>
<td>6. Burn by prescription to improve forage, remove residues, improve nutrient content, and increase production</td>
</tr>
<tr>
<td>7. Stabilize gullies</td>
<td>7. Release hatchery or naturally reared fish</td>
<td>7. Manage rodent populations detrimental to the range resource</td>
</tr>
<tr>
<td>8. Enlarge or remove culverts</td>
<td>8. Provide streamside vegetation for shade, cover, and food</td>
<td>8. Create water developments</td>
</tr>
<tr>
<td>9. Minimize pollution of soil, air, and water by smoke, chemicals, and fugitive dust</td>
<td>9. Stabilize watersheds to reduce sedimentation and peak flows</td>
<td>9. Fence to manage distribution of livestock</td>
</tr>
<tr>
<td><strong>Output:</strong></td>
<td><strong>Output:</strong></td>
<td><strong>Output:</strong></td>
</tr>
<tr>
<td>1. Water yield</td>
<td>1. Viiable populations of featured species of permanent, summer, or winter residents</td>
<td>1. Carrying capacity expressed in animal unit months; stocking rate of livestock</td>
</tr>
<tr>
<td>2. Quality water meeting prescribed standards</td>
<td>2. Viiable populations of nongame, native fish</td>
<td>2. Herbage and browse; current year's production of leafy or twig material</td>
</tr>
<tr>
<td>3. Storm runoff</td>
<td>3. Viiable populations of sport fish in good condition for each species available for state-licensed fishing</td>
<td>3. Animal output value per acre of livestock; reflects expected gains in animal productivity and quality resulting from more intensive management</td>
</tr>
<tr>
<td>5. Soil stability: changes expected in surface soil movement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Soil quality: changes expected in fertility, structure, or drainage of the soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Air quality: carbon, other chemicals, and particulate content of the atmosphere</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Employment generated by full use of the water-associated output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Recreation, Landscape, and Other Societal Values

**Activities:**
1. Survey and monitor to determine carrying capacities and actual uses for recreation
2. Conform cutting boundaries to natural contours
3. Pile and burn slash along roads
4. Modify cutting patterns along roads and adjacent to water
5. Manage and develop for camping and day-use of areas
6. Manage hunting
7. Manage fishing
8. Manage use of off-road vehicles
9. Close and revegetate unused roads and trails

**Output:**
1. Environmental beauty: aesthetic impact upon the landscape, scenic appeal or spiritual appeal
2. Fishing: impact upon the number (availability) of healthy sport fish
3. Hunting: impact upon the number of healthy game animals
4. Depressed area impact: economic impact of a strategy upon the residents of an economically depressed area
5. Employment generated by full use of the recreation-associated output
6. Cultural heritage: impact of a treatment upon an established local tradition, image of life, mores, institutional or environmental characteristic when viewed as affecting both residents of the local environment and nonresidents

### Timber

**Activities:**
1. Inventory growth and yield, and monitor site productivity
2. Combine entries for sanitation or salvage of dead or dying trees, but leave snags and cull logs for wildlife
3. Thin precommercial stands to control growing stock and improve yield
4. Harvest stands of intermediate age to capture and improve yield
5. Harvest mature stands to capture yield and regenerate the stand
6. Prepare sites for planting
7. Control timing, stocking level, and survival of natural or planted seedlings
8. Control brush competing with trees by mechanical or chemical means, or by use of fire
9. Manage destructive insects and diseases
10. Dispose of logging slash by prescribed use of fire

**Output:**
1. Tree growth and net yield of merchantable wood
2. Employment generated by full use of the timber-associated output
3. Habitats for rare and endangered animals and plants and for species having special status

### Wildlife

**Activities:**
1. Survey and monitor habitats and populations of wildlife to determine status, trends, and needed treatments
2. Provide a broad diversity of habitat conditions
3. Protect habitats by restricting or excluding other uses
4. Manipulate vegetation so factors limiting food, cover, and access to water are made less limiting for featured species

**Output:**
1. Viable populations of nongame species
2. Productive populations of game animals
3. Employment generated by full use of the wildlife-associated output
enhance the quality of water. Other objectives would be to increase stream flow, particularly during drier seasons, and maintain and improve the stability of stream channels. Still another objective would be to find ways of establishing equity between the producers of water and those who have the rights to use it, including recompense to producers for increasing yields, reducing sediment, or otherwise improving water quality.

Major constraints on the management and use of other resources to assure minimal impacts on water quality are provided under the federal Water Pollution Control Act of 1972 (PL92-500) and rules promulgated under its Section 208. Many of the regulations under the California Forest Practice Act also are directed at protecting and enhancing the quality and quantity of water produced from forest lands.

**General activities.** Dominant use of water and soil resources would require a number of activities directed at increasing water yields, improving water quality, and prolonging flows. Timber stands would be thinned and harvested to increase through-fall of precipitation and accumulation and delayed melt of snowpack. Activities directed at improving water quality would be to stabilize and revegetate stream-banks and gullies, and revegetate eroding areas. Other important activities would be to control stream gradients and remove or enlarge culverts in roads. In many cases, roads built in the wrong places or to improper standards would have to be obliterated or relocated. Construction and maintenance of new roads through forests and rangelands would have to meet higher standards.

Since the stream is the integrator of the watershed’s condition, management of the stream-bank zones in a basin would be approached on a coordinated, multidisciplinary basis. Models and data bases would be developed to show the interaction among variables and the status and trend of these variables over time. Such a team approach to management of streambank zones would not be used for a dominant-use strategy, but it might be used for a multiple-use strategy. The responsibility of a managerial team for the streambank zone would be to identify sources of sediment. Answers would be needed to questions: What portion of the sediment is from upland erosion? What portion is from streambank erosion? Such a team would also be able to monitor changes over time in vegetation, soils, and yields of sediment.

Some procedure also needs to be devised for balancing the income or returns resulting from the use of resources downstream with the costs incurred upstream for remedial or special treatments to assure that quantity and quality of water are retained (or increased).

**Headwaters—specific activities.** Headwater areas are crucial for management to restore or improve the quantity and quality of water produced. If increased water yield were of serious concern, then manipulation of vegetation to reduce the percent of tree cover and to reduce deeply rooted perennial vegetation would be prescribed. Allowable extent of channel formation must be decided vis-à-vis channel degradation resulting from abuse of land or resources. Check dams may be required in degraded watersheds to stabilize or reduce channel gradients and to protect banks. Grazing and timber harvest might be reduced or even banned if they contributed significant amounts of sediment reaching stream courses. Roads located in riparian areas would be relocated if possible. Roads where they cross streams would be redesigned to assure that their placement and construction would minimize water pollution.

A primary goal in dominant use of headwater areas would be restoration of deteriorated meadow habitats to a self-sustaining state where vegetation is in equilibrium with soil and water. This would require maintaining groundwater levels, perhaps through a series of check dams or other appropriate structures if channels were degraded.

To avoid water pollution resulting from impacts of livestock on soils and vegetation, prescriptions for grazing within meadows would have to be written. Fences would be required to separate meadows from upland areas and to manage the season and extent of use by livestock.

**Midcourse reaches—specific activities.** Dominant management for water and soil resources in
midcourse reaches would be aimed at reducing generation and movement of sediment. Grazing and timber harvesting would be eliminated unless they could be kept well away from streamcourses and could be shown not to cause sedimentation that resulted in water pollution. Stabilization of streambanks in degraded watersheds would be the first order of business. Increasing the proportion of riparian vegetation where it is lacking would be another goal.

**Lower reaches—specific activities.** Areas around lower reaches of streams have needs for management aimed at dominant use of water that are very similar to those at the midcourse reaches. In lower courses, streambank stabilization and reduction of erosion on adjacent lands would have high priority. Recreational areas, particularly those heavily used by off-road vehicles, might have to be closed if regulations and policing did not result in reduction of water pollution.

**Fisheries**

**Goal, objectives and constraints.** The goal for management aimed at dominant use of fisheries would be to maintain and enhance diverse and productive fisheries. Seven site-specific objectives would be:

- maintain habitats capable of supporting site objectives
- restore all fishery habitats to their potential
- enhance those habitats
- maintain and enhance compatible indigenous species
- maintain and enhance other self-sustaining desirable species
- improve fishing opportunities compatible with other fishery resource objectives
- manage use of the resource

The major constraint affecting management for dominant use of fisheries would be control of water quantity. Water in California may be removed from the channel, stored, diverted, and so forth, for beneficial uses. Although instream beneficial uses (e.g., fisheries) must be considered, historical allocations have tended to favor non-instream uses. Recent allocations and requests have moved to water courses nearer headwaters, formerly less appropriated, with consequent potential reductions in aquatic habitat and fisheries potential. Changes in existing appropriations would be extremely difficult.

Other constraints would be the manipulation (additions or removals) of fish populations that require Department of Fish and Game permits.

Where existing stream water quality is inadequate (because of permitted land uses or water extraction) for certain species, future management to improve or enhance fisheries would be constrained.

**General activities.** Management for dominant use of fisheries would feature a number of activities focused on streambank zones. The first would be to survey and monitor streams and riparian zones to determine their status, trends or changes, and any needed treatments. Streambanks in some cases would be stabilized by using structures (revetments, deflectors, cribs, and ripraps). Other cases would require reestablishment of vigorous riparian vegetation. Roads where they cross over streams would be improved with respect to alignment, grade, and stability of both the road surface and any associated cuts or fills. Particular attention would be given to the placement and design of culverts. Gradients of degraded streams would be controlled by constructing small check dams. Stream channels would be treated to create pools, additional cover, scouring, gravel beds, and fish passages. Obstacles to flow would be placed to increase roughness while providing instream cover for rest, protection, and feeding. Verified pest fish would be removed by chemical treatments, shocking or draining. Their migration into treated waters would be blocked by impediments. Fish reared naturally or in hatcheries would be released to restore "wild" fisheries or in some cases to provide "put-and-take" fisheries. Streamside vegetation would be manipulated and augmented to provide adequate shade and cover over water and streamcourses. Measures would be taken to stabilize watersheds in order to reduce sedimentation and peak flows.

**Headwaters—specific activities.** Considerations in managing headwater streams and springs for fisheries would relate to maintenance and enhancement of natural diversity and improvement of conditions to benefit downstream fisheries. Some activities to meet these objectives without regard to the vegetation type in which the headwater occurs would be the following:

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2 A detailed outline for this section was written by Don C. Erman, Department of Forestry and Resource Management, University of California, Berkeley.
review land-use practices in entire watersheds
understand and, insofar as possible, control
distribution of livestock to assure stability of
stream banks
survey streams and riparian zones to determine
their current status and assess potentials
for their enhancement by management
return speckled dace and other native fishes to
appropriate areas
monitor populations of indigenous indicator
species to determine success of watershed
management practices
improve road crossings that contribute sedi­
ment to streams and that are obstructing move­
ments of fish
utilize opportunities to speed natural healing
processes

Midcourse reaches—specific activities. The
goal for management to attain dominant use of
fisheries in midcourse reaches again would assert
the need to maintain and enhance diverse and pro­
ductive fisheries. Specific objectives in midcourse
reaches would be the maintenance and enhance­
ment of quality habitats for spawning and rearing in
order to maintain and augment downstream
fisheries in the lower reaches. Another objective
would be to maintain and enhance natural diversity
of habitats. A third objective would be to reduce
and minimize, to the extent possible, the down­
stream movement of sediment into lower reaches of
streams through restoration of areas that were con­
tributing sediment to the stream.

Specific actions in midcourse reaches would be
to allow logging practices that conformed to the
California Forest Products Act and did not contri­
bute unduly to the movement of sediments.
Unneeded logging roads would be obliterated and
revegetated. Logging in streambank zones would
be excluded if sediment would be delivered directly
into streams. Feasibility studies would determine
whether reservoirs might be installed to control the
timing and flow of water and sediment, to reduce the
temperature of water, and to develop a fee­
fishing enterprise. Grazing would be eliminated
from streambank zones by fencing.

Lower reaches—specific activities. Lower
reaches of streams would be most accessible and
have the largest numbers and sizes of fish. Object­
ives in managing such areas for dominant use
would be to maintain and enhance existing fisheries
and to maintain natural diversity of the stream­
course. Activities to achieve these objectives would
be several:
reduce bank erosion caused by anglers, lives­
tock, and wildlife
preserve the natural character of the stream
ban uses of off-road vehicles that conflict with
the dominant use of fisheries
enhance the pastoral and visual nature of the
stream and of angling experiences
limit entry into the most popular areas in order
to maintain quality fishing experiences
accelerate proliferation of vegetation overhang­
ing the streamcourse
periodically monitor the fishery and water quali­

Range for Livestock3

Goal, objectives, and constraints. The goal in
managing range resources for livestock would be to
optimize both production and utilization of forage.
Acceptable sustained multiple-uses of other
resources on forest and rangelands would be
allowed so long as they did not interfere with this
goal. General objectives for management would be
to maximize forage production, use management
strategies to optimize forage utilization, and derive
maximum income from each unit of forage.

Numerous constraints would influence dominant
management of range resources for livestock.
Included would be length of the grazing season,
forage quality and quantity, kind and class of liv­
stock available, flexibility of the grazing operation
dependent upon availability of alternative forage
sources, size of pasture, and accessibility.

General activities. Dominant use of range
resources for livestock would require a number of
specific managerial activities. Most important would
be activities to assure proper distribution and
numbers of livestock. Determination of stocking
rates and season of use would depend on availability
of specific range types and conditions of forage.
Fencing, water developments, herding, and salting
would be planned to enhance distribution of animals
throughout the grazing unit. Water developments
would enable better utilization of dry uplands. Facili­
ties such as pipes to troughs located away from
water sources would protect wetlands. Some wet­

3 This section was written by James W. Bartolome,
Department of Forestry and Resource Management,
University of California, Berkeley.
lands might be drained to improve forage for livestock.

If ranges were severely deteriorated, direct manipulation of vegetation might be necessary. Brush would be controlled by mechanical, chemical, or fire treatments. Plowing, chaining, pushing, disking, root plowing, crushing, cutting, aerial or ground spraying, and prescribed burning might be required. Timber would be thinned to increase forage production on the exposed soil beneath trees. Debris resulting from treatments would be disposed of to improve yields of forage and reduce fire hazards, and for aesthetic reasons. Techniques for disposal would include burning, crushing, beating, and chaining.

Unpalatable and poisonous herbaceous range plants, as well as noxious farm weeds, would be controlled by chemical, biological, or mechanical means or by fire.

Productivity of rangelands would be enhanced by seeding with native or introduced improved grasses and clovers. Seed would be drilled, broadcast, or dispersed by other techniques. Fertilization would increase range production, but cost-effectiveness must first be evaluated.

Burning by prescription would be used as a technique to improve species composition, remove coarse herbaceous residue, improve plant nutrient content, and increase productivity.

Perhaps the most important improvement needed for deteriorated range would be a properly designed and implemented grazing system. Efficient use of range forage would require detailed information about potential impacts to sensitive range types, forage availability, and range condition. Decisions to move animals or to change a grazing regime, which often must be made on short notice, would require either a resident range expert or detailed guidelines for decisions keyed to range pasture units. Allotment management plans would be used for planning. Implementation of a new system would probably require additional developments for proper distribution of animals.

Headwaters—specific activities. A headwaters area would be likely to have two obvious divisions: one riparian and the other adjacent uplands. Fencing would be installed to control season of grazing on large meadows of riparian sites separated from nearby upland areas. Drift fences would be used where appropriate. Areas of meadows where severe deterioration had occurred would be fenced, rested from grazing, and perhaps reseeded to allow recovery. Cattle would be rotated between upland and riparian pastures at predetermined increments; timing and intensity of forage use would be controlled.

Members of the resource-oriented team for range livestock prepare recommendations on grazing in a headwater area.

Optimum utilization of forage stages in both upland and riparian areas needs to be assured. Fencing, distributing water and salt, and herding would be used to improve the distribution of livestock and their utilization of forage. The need for riders to move cattle would be determined by the degree to which available forage was utilized. Forests in the riparian and upland areas would be thinned to enhance production of forage on the forest floor, but the recommended degree of thinning would go beyond that which is traditional in forestry. After thinning, timbered areas would be seeded to high-quality forage.

Prescribed burning at uplands would be used at intervals of about 20 years to remove brush and undergrowth and encourage forage development. Such burning would be done only in the fall after desirable forage species had shed mature seed.

Management of livestock would assure that uplands were utilized first. Forage from headwaters would have highest value for production of livestock if alternative sources of forage were available elsewhere. Use of uplands in spring followed by movement of animals to alternative pastures in early sum-
mer would enable full utilization of riparian forage during late summer. Rest-rotation schedules would be used to allow meadows to recover from overuse. Consideration would be given to modifying the grazing schedule to remove residual vegetation in meadows.

Midcourse reaches—specific activities. Management of grazing in the midcourse reaches would follow one of two strategies directed toward improving condition and productivity. Season-long, light utilization of available forage through grazing would be one alternative. The second alternative would be to graze heavily, but only during the fall season. Other activities, such as fencing or herding, might prove to be impractical.

All unnecessary roads would be closed along the streams to deter unnecessary vehicle use, to reduce sedimentation into the streams, and to produce forage on reseeded roadbeds. Aspen groves would be regenerated, possibly through prescribed burning. Individual trees would be killed selectively along the streamcourse to create snags for wildlife. Thinning would enhance understory forage in timber stands.

Lower reaches—specific activities. Areas around lower reaches have the greatest potentials for conflicts between livestock and other uses of forest and rangelands. If management of livestock for dominant use is the desired objective, then roads, traffic, and use by ORVs would have to be limited and controlled. Sturdy fences and locked gates, with patrols to assure that they were not violated, would be essential.

Potential for improvement in lower reaches, in contrast to upper reaches, would be much greater on upland sites. Fertilization would be used to encourage growth of improved dryland pastures. Additional seedings would be considered if the site potential would justify the expense. Where star thistle was a problem, early grazing by sheep would be used as a biological control. This alternative would require a herder to control the location of sheep and to utilize a pump to provide water for livestock away from the stream.

Outdoor Recreation

Goal, objectives and constraints. Recreational use of streambank zones is characterized by a number of different and often conflicting types of recreational activity. Therefore, management for outdoor recreation as a dominant use of streambank zones would necessitate determining the variety and extent of recreational use patterns specific to each streambank site. The overall goal would be to optimize the number and quality of recreational experiences related to streambank zones. Achieving a balance of activities consistent with user demand and the ability of the streambank to sustain these recreational activities in the future would be a primary goal. Emphasis would be placed on stabilizing streambanks where they are exposed, eroding, or otherwise deteriorating; increasing quantity and diversity of riparian vegetation; and providing, yet controlling, adequate access for users. Since most streambank zones are fragile and subject to erosion, controlling road and trail development here and in the riparian zone would be particularly important. This would include controlling unregulated use of these zones by ORVs.

Unavailability of funds or lack of economic return would be a major constraint on dominant use of a resource for outdoor recreational purposes. Another major constraint would be the extent of recreational demand relative to the carrying capacity of the streambank zone to provide for such experiences. In addition, the types of recreational activities and desirable use levels—ORV use and hiking, high intensity car camping, and more "primitive" backpacking and tent camping—often would be in conflict. Due to cost constraints, recreational use often would be tied to other resource uses. Resource development for other uses (e.g., timber, livestock, and hydroelectric power) would provide access to a streambank zone for recreationists, as noted throughout the workshop. However, these uses would produce additional constraints to recreation.

General activities. Activities to achieve the goals and objectives for dominant use of outdoor recreation would include inventories of recreational resources, planning for recreational use, and management for recreation. Inventories of streambank zones would look at current and potential types of recreational activity. Slow-running or still water would encourage swimming, fishing, or floating. Faster-running water would provide different types of fishing or boating opportunities. Areas adjacent to the streambank zone or where the stream could be viewed from above would be suitable for camping, picnicking, and controlled use of ORVs.

4 A partial outline and suggestions for this section were provided by Nancy E. Brose, Pacific Gas and Electric Company, San Francisco.
In these inventories consideration would be given to soils, vegetation, wildlife, and access. Primary concerns would be over stability of soils and the soils' ability to withstand traffic without compaction. Vegetation should provide shade and be able to sustain impacts of intense human use. With respect to wildlife, concerns would be for the presence of endangered, threatened, or special species and critical habitats. The final aspect of resource inventories would concern existing access and potentials for developing access.

A major activity in recreational planning would be analyses of current types and patterns of use and uses that might be projected for the future. Nearby population centers would be analyzed to determine if they would increase in size and thereby increase the demand on the resource. Use by recreationists from outside of the region would be estimated and projected. Activities in greatest demand would be determined. The most difficult, and yet perhaps the most important, part of this analysis would be to determine trends for use of developed recreational areas versus dispersed recreational areas.

After inventories and analyses were completed, a plan for recreational uses would be the basis for managing camping and day-use (including site development), hunting, fishing, use of ORVs, hiking, and dispersed recreation. Often a resource would need to be altered to provide for the recreational demand while protecting the resource. This would include activities such as closing and revegetating unused roads, trails, and recreational sites and modifying treatments of vegetation along roads adjacent to streamcourses to enhance landscapes.

Special attention would be given to cultural resources that may be present in a streambank zone. Historic buildings and archaeological sites are examples of resources that might be developed for use and enjoyment by the public, but that also could cause or compound problems of managing use around these resources.

**Headwaters—specific activities.** Headwater areas, being at greater distances from human development and activity, would provide opportunity for dispersed recreational activity. Little or no development would take place in these areas, and management for recreation would be at a low level of intensity.

**Midcourse reaches—specific activities.** Areas having midcourse reaches of streams would have more potential for concentrated and dispersed recreational use than would headwater areas. Development of parking areas, sanitary facilities, and traffic controls would be considered. Ways would have to be found for allowing dispersed recreational access up- and downstream for a variety of experiences such as fishing, swimming, nature study, and hiking. Recreational use of areas would be monitored to determine whether trails and parking areas are needed. If the logistics were right, possibilities would exist for developing campgrounds and picnic facilities for which fees could be charged to offset costs for construction, maintenance, and operation.

**Lower reaches—specific activities.** Closer to human habitations and places of work, lower reaches would receive the maximum recreational pressure. Water-based recreation would be of highest priority, but other recreational uses of streambank zones, such as hiking, picnicking, and ORVs, would be considered. Due to the characteristics of lower reaches, greatest conflicts among users would be anticipated. Care would be taken first to avoid extending use beyond carrying capacity of the land and recreational developments, then to enhance the visual quality of environment, and finally to protect any cultural resources.

Specific managerial activities for lower reaches would include development of trails, roads, and parking areas for access to stream-based recreation. Design and construction of these accesses would include measures to prevent erosion and sedimentation that might occur from exposed surfaces and slopes. Consideration might be given to rotating access to areas of the streambank where erosion or deterioration of the streambank itself was becoming a problem. Use of ORVs would be restricted to areas where they would not damage the stream. Unnecessary roads would be closed and revegetated in order to recapture aesthetics and environmental integrity. Cultural resources, most likely and evident in these areas, would be given special consideration and protection as warranted. Both timber cutting and grazing would be discouraged in riparian zones. Only the removal of hazardous trees would be permitted. Additional streambank planting would be established, where needed, for aesthetic appeal, shade, and shelter.

Use of areas would be monitored to determine whether campgrounds and picnic areas would be developed and whether concessionaires to manage such developments might succeed financially. If recreational values warranted and profitability were likely, then a lodge or other recreational structure might be constructed to meet the public's need and to generate income.
Forests for Timber

Goal, objectives, and constraints. The goal would be to manage the land primarily for production of sawlogs, the highest-value product, and secondarily for poles and chips for fuel energy. This would not necessarily mean maximizing volume production, value production, or cash flow, especially in the short run. Timber management would be constrained by ecological, managerial, economic, and regulatory factors, and by consideration of other resource values.

General activities. An early activity of timber management would be to inventory the forest resource. This includes analyzing site quality and characteristics of growing stock and soils. Estimates of timber volume and growth would permit determination of allowable harvest. Evaluation of soils and site quality would enable projections of yields. These would aid in determining the kind, location, and cost-effectiveness of treatments. Development of specific managerial approaches would require information about access to timber, markets, and decisions on relative proportion of alternative forest products to be produced.

The first treatment to control structure of a timber stand usually would be an entry to improve stand vigor by sanitation and salvage cuttings. Subsequent silvicultural treatments could then move toward either even-aged or uneven-aged stand structure. Cost-effectiveness, labor requirements, and productivity of the two approaches would depend on existing stand characteristics and intensity of management. Even-aged systems would usually be preferred where stands need to be regenerated and managed intensively. Uneven-aged systems might be preferred where existing stands are well stocked with mixed species or where there is a wide range in size classes. Both approaches might involve precommercial thinning and intermediate commercial harvests to control stocking and to enhance quality and value of stands.

Even in dominant-use situations, some consideration of other resource values would modify desired stand structure in order to provide wildlife habitat or aesthetic characteristics, or to enhance watersheds. These considerations usually would result in either higher costs or reduced timber yields or both conditions. In addition, retention of snags, down logs, and stands displaying old-growth characteristics often would incur added fire hazard and susceptibility to insects or disease.

Dominant management of timber would be sensitive to soil erosion potentials and special values of riparian zones. Minimum standards set by the California Forest Practice Rules to protect riparian areas would be met or exceeded. Management practices would be designed to minimize movement of surface soils. Strict controls would be exerted on location, building, and maintenance of roads, methods and direction of timber yarding, size of harvest units, and type of site preparation.

Successful regeneration of stands would depend upon control over competing weeds and the timing, stocking level, and survival of natural or planted seedlings. Natural regeneration would provide least control over these factors, and germinating seeds and seedlings would be more susceptible to mortality due to insects and competition from surrounding trees. Successful regeneration would be more likely where sites were prepared, leaving a competition-free environment, and where seedlings having high root-growth-capacity were carefully planted. Determination of relative cost-effectiveness of alternatives for regenerating stands would require analyses both of front-end costs and of later costs to control weeds and stocking level until a commercial entry could be made.

Commercial timber stands burned in earlier times, or recently burned, would be regenerated quickly. New stands would be established by planting with 2-0 ponderosa pine at 12 by 12 foot spacing. Weeds would be controlled by mechanical means or by aerial application of herbicides. Setback from streams for spraying would depend upon topography, but would be at least 100 feet. Drift from spraying would be controlled.

Headwaters—specific activities. Headwaters areas might be characterized by relatively pure two-storied interior ponderosa pine stands with interspersed meadows, and with western juniper on the poorest sites. The pine stands would generally have low productivity (Dunning Site Class IV—100 feet tall at 300 years, or productivity of 50 cu.ft./ac./yr. at culmination of mean annual increment). The overstory might be decadent, residual old growth carrying about 8,000 bd.ft./ac. The understory might be 80 to 100 year-old ponderosa

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5 This section was written by John A. Helms, Department of Forestry and Resource Management, University of California, Berkeley.
pine, with a basal area of 120 sq.ft./ac., and volume of 5,000 to 8,000 bd.ft./ac.

To manage these stands for dominant timber production, the slow-growing overstory would be harvested. The understory would be precommercially thinned (leaving basal area of 60 to 80 sq.ft./ac.). During the next 40 years, growth would average about 350 to 400 bd.ft./ac./yr. Stands would then be clearcut in blocks 5 to 30 acres in size. Because of low site quality, stands would not be fertilized or pruned. After final harvest, sites would be prepared and planted. This procedure would be preferred over natural regeneration because it would provide control over timing and stocking of regeneration, and growth of weeds. Regenerated stands would be precommercially thinned at 15 years of age. These recommended treatments and growth projections are supported by computer simulations of growth for such stands using CACTOS and PROGNOSIS models.

The meadows and surrounding timber are the main aesthetic resource in the headwaters area. Even with emphasis on timber production, it would be important to consider aesthetic values and maintain the timber margins intact. Therefore, around the more important meadows, stands within 100 to 200 feet of the meadow edge would be harvested by selecting individual trees. On less visually important meadows, stands might be clearcut and planted right up to the meadow's edge.

Mixed stands of western juniper and ponderosa pine would not receive active management. Ponderosa pines in such situations usually are growing in natural "flowerpot" areas of better soil surrounded by rock or soils that cannot sustain tree growth. In these areas, trees would be salvaged as they died and natural regeneration would be utilized.

Throughout the headwaters area, and particularly within mixed stands of pine and juniper, an average of 10 to 15 snags per 10 acres would be left as habitat for wildlife.

Midcourse reaches—specific activities. Areas of midcourse reaches might have one or two main forest cover types—interior ponderosa pine (Dunning Site Class IV) and Sierra Nevada mixed conifer (Dunning Site Classes II and III—120 to 224 cu.ft./ac./yr.).

The interior ponderosa pine type commonly would be two-storied with scattered larger trees in the overstory. The prescription for management of such timber would be similar to that given for headwaters areas.

Stands of Sierra Nevada mixed conifers typically would be all-aged with residual old growth. These would be harvested by individual tree selection where natural regeneration of the more tolerant white fir was desired, or by group selection where pines or Douglas-fir were to be reestablished either by natural regeneration or by planting. Emphasis would be placed on maintaining high proportions of valued species: ponderosa pine, sugar pine, and Douglas-fir. The main objective would be to control stocking in order to maintain stand vigor and obtain rapid growth of individual trees. At the time of later entries, management could include both even- and uneven-aged systems.

A main constraint to management would be the streamcourse protection zones where harvesting would be by individual tree selection. In these zones, trees would be felled away from the stream, riparian vegetation would be protected, use of heavy equipment would be restricted, and special emphasis would be placed on maintaining shade.

Existing roads would be evaluated to limit soil erosion and sediment transport. Roads needed for access to timber would be stabilized. Excess roads would be blocked, particularly near water courses.

Lower reaches—specific activities. Areas around lower reaches of streams may or may not have commercial conifers, depending on soils and climate. Areas with commercial conifers would be managed for timber production by maintaining existing even-aged structures. Harvested and understocked stands would be regenerated by planting. Expansion of timber producing areas might be possible. Soils would be analyzed to identify sites that could support timber stands. Normal constraints to timber management in these areas would include visual aesthetics, recreational usage, and presence of cultural resources.

Scattered oak, digger pine, and ponderosa pine growing on areas having lower site quality would not currently have potential for timber management. On these areas, some values could be obtained by harvesting trees that were dead, dying, or of high risk. Site quality would not warrant expenditures for artificial regeneration.

In riparian areas, tree cover would be maintained to provide shade and streamside protection. No harvesting would be done except to enhance vigor of trees. Endangered raptors, if present, would constrain management by requiring maintenance and replacement of larger trees in both commercial and noncommercial timber stands. In areas where soil conditions warrant, additional conifers, hard-
woods, and riparian vegetation might be planted to expand streamside vegetation.

Wildlife

**Goal, objectives, and constraints.** The goal for managing wildlife would be to produce harvestable crops of game species to supply the demand for paid recreational hunting, while meeting the desire of society in general for a diverse wildlife community. Objectives would then be to maintain viable populations of any threatened or endangered species, increase game species for which there was a fee-hunting market, encourage a diversity of nongame species, and minimize problems caused by any pest species.

Unlike most other resources, wildlife is the property of the people, not just the landowner. This is clearly spelled out in state and federal legislation which provides a wide range of regulations dealing with the "taking" of wildlife, and even land use practices in the case of critical habitat for certain endangered species. Thus, constraints on wildlife management practices on private lands are sometimes severe. In California the situation has eased somewhat since the "Private Lands Bill" was passed in 1984. This legislation provides for variances in state hunting regulations if a landowner succeeds in obtaining approval by the California Fish and Game Commission for a wildlife management plan. Typically such a plan designates certain habitat improvement projects to be accomplished by the landowner in return for more liberal seasons or bag limits.

A final note regarding constraints: because there are literally dozens of species of wildlife on any property, it is not sufficient to simply "manage for wildlife." Many species of wildlife have conflicting requirements. Therefore, the manager must be specific as to which species are to be featured. Moreover, two species with opposing habitat requirements cannot be featured in the same area. In a sense, designing a wildlife management program is similar to designing a multiple-use program for all natural resources.

**General activities.** Preferably an inventory of wildlife would be made on the property by a certified wildlife biologist. All species of terrestrial vertebrates would be considered. Guidance regarding the species likely to be found and their habitat requirements would be obtained from the California Wildlife-Habitat Relationships Data Base maintained by the California Department of Fish and Game. This information and an analysis of the opportunities for fee hunting would be used to determine whether threatened or endangered species were present, select game species to feature, specify guidelines for management of nongame species, and pinpoint any species likely to be a pest.

Specific habitat management activities would vary widely depending on the species targeted. In general, care would be exercised to consider whether an activity to enhance one species might eliminate another desirable species. Very few management practices would affect only one species. A diversity of habitat structure, both vertically and spatially, would promote a diversity of wildlife. Thus, a mix of aquatic, herb, shrub, and tree components typically would be most beneficial to wildlife. Such mixes would be maintained as they occur naturally along unmanipulated riparian zones.

**Headwaters—specific activities.** Headwater areas might be characterized by relatively small water courses with minimal riparian vegetation interspersed among large blocks of forest. Occasional springs with associated small meadows and small patches of old-growth forest would provide habitat for many wildlife species not found elsewhere. Red fox would be an example of a rare species of interest. However, other than protection from trapping and shooting, little management would be practical. Featured game species might include deer, pronghorn, bear, coyote, and bobcat; however, because of the long distance to urban centers, the market for fee hunting would be marginal. Simply allowing local residents access to the area would be the most practical use of wildlife in such areas. To maintain a diversity of nongame species, streambank zones and meadows would be protected from livestock gazing, and a series of old-growth forest stands would be left unlogged. Logging would be dispersed through the property; some snags, hardwoods, and brush patches would be retained. Most roads would be closed whenever feasible. Understory burning might be prescribed to improve habitats for certain species.

**Midcourse reaches—specific activities.** Midcourse reaches would have better developed streambank zones, supporting a greater diversity of wildlife. Meadows and lakes would add to the diversity of wildlife. An example of a featured endangered species would be bald eagle, if lakes of sufficient size were present. Game species to be featured might include deer, bear, coyote, and bob-
cat. If the streambank property were over 5,000 acres and included sufficient meadows, streambank zones, or forest openings, it might provide deer with summer range of sufficient quality to support fee hunting.

A diversity of nongame wildlife would be maintained by ensuring spatial diversity through appropriate logging practices. Such practices would include dispersed cutting blocks of moderate to small size, retaining snags and hardwoods, and allowing for some shrub development during regeneration. Use by livestock would be minimized or eliminated, especially along streambank zones and in small meadows. Use by people, especially with off-road vehicles, would be minimized by road closures. Understory burning might be prescribed to improve habitat for certain species.

**Lower reaches—specific activities.** Lower reaches provide large streams and associated wide riparian zones, often surrounded by chaparral and oak woodland. These areas, being closer to urban areas and transportation corridors, would be more suitable for providing fee hunting and other recreation, and would have the greatest potential for active wildlife management. Bald eagles would find the larger rivers and lakes suitable for winter habitat, so large trees would be retained for roosting sites along rivers and lakes. Game species to be featured would include deer, quail, turkey, dove, waterfowl, and fur bearers. Deer, quail, and turkey, in particular, would support a fee hunting program on larger properties. Trapping rights for fur bearers might also be leased. Recreational activities associated with fee hunting would include trap and skeet shooting and fishing, plus all the activities provided by a lodge with swimming pool and picnic area.

Lower reaches would be most amenable to development of a fee-hunting program under the Private Lands Bill. Logging opportunities would be limited, but a conservative fuelwood cutting program designed to enhance existing hardwood stands might be feasible. Cutting in riparian zones would remove only individual trees that pose a hazard to people. Activities would promote featured game species and provide for a diversity of nongame wildlife. Included would be conservative grazing of uplands, no grazing of riparian zones, prescribed burning of chaparral, development of springs, planting of mast-producing shrubs and trees preferred by wildlife, and provision of various nesting structures (e.g., wooden nest boxes for ducks along water courses). Intensive recreational activities, such as ORV use, would be minimized, and most roads would be closed to regular traffic.

**Interactions Among Uses**

Dominant use of any one resource would be expected to have significant impacts on uses of other resources. Forest structure would be very different depending on whether management’s objectives were specifically for water, forage, timber, or aesthetics. Surprisingly, management for optimum production of water would not be identical to management for the optimum production of fisheries. For example, water production might concentrate on impoundments rather than on instream flows.

To consider these multiple effects, each resource-oriented team was asked to list, first, the effects of its dominant use on uses of other resources and, second, the effects on its resource of dominant uses of other resources. The results of this approach is a matrix suggesting impacts of the dominant use of each resource on other resources (table 2).

Dominant management for water would have significant effects on most other uses of forest and rangeland. Stocking of trees might be reduced to cut back interception of precipitation and possibly to reduce transpiration of groundwater. Stocking of livestock would be reduced in order to avoid soil compaction and erosion. More meadows and wetlands would be available for certain wildlife species. But on the other hand, treatments of forests and range vegetation to enhance water production might provide inferior habitat for particular kinds of wildlife. Here again, management for maximum production of water might be deleterious to trout fisheries if quality deteriorated, for example by unsuitable water temperatures or reduced influx of organic materials required for fish nutrition, but reservoirs might be good for other species of fish.
<table>
<thead>
<tr>
<th>Water</th>
<th>Fisheries</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality increases; peak flows reduced and delayed; more water available during dry seasons; water quality improves to natural levels</td>
<td>Little or no impact on water quantity; water quality improves to natural or undisturbed levels; management for certain fishes decreases ability to manage water for hydropower or irrigation</td>
<td>Less percolation and recharge of groundwater; more runoff, erosion, and destruction of streambanks; water quality deteriorates due to pollution and sediment</td>
</tr>
<tr>
<td>Little or no impact; soils return to natural, undisturbed conditions; midwatersheds trap sediments and keep sediments out of streams</td>
<td>Little or no impact; less erosion</td>
<td>Compaction common in areas where animals concentrate; soil moves due to surface erosion</td>
</tr>
<tr>
<td>Water quality improves to natural levels; greater instream flows above impoundments but less instream flow below impoundments; diversions of water increase; dams block migratory routes for fish; fewer habitats for fish</td>
<td>Maximum production of fish and best status for fish habitats</td>
<td>Livestock impact streambanks unless fenced out or intensively herded; vegetation reduced or removed; water temperatures increase; water quality decreases; erosion of streambanks increases; more instream sediment and nutrients</td>
</tr>
<tr>
<td>Limits on AUMs due to sedimentation and compaction; haying could increase; water flows to lower hay meadows in late seasons could increase</td>
<td>Less livestock production where it impacts aquatic habitats; streambank zones and water bodies fenced or excluded from use; costs for fencing and management increase; AUMs reduced in the short term</td>
<td>Maximum production of forage; high costs for intensive culture offset by greater returns; productivity increases to cost-effective potential</td>
</tr>
<tr>
<td>Forest more open; wet meadows enhanced; stabilized streambanks improve aesthetics and recreation; patterns of timber cutting appear unnatural; greater and prolonged flow above impoundments; lesser and shortened flows below impoundments; impoundments increase opportunities for lake-based recreation</td>
<td>Better sport fishing; landscape diversity increases; less use or access for recreation other than fishing</td>
<td>More livestock in landscapes and streamcourses; aesthetic qualities of streamcourses degrade; more fences and other developments impact vistas and access to streambank zones; livestock and recreationists compete for space; fewer sites for dispersed recreation; less hunting and fishing</td>
</tr>
<tr>
<td>Stocking of trees reduced to lower interception and transpiration; harvests patterned to catch snow and retard melt; cumulative impacts and limits on sedimentation constrain harvesting and road building; wide stream protection zones limit timber production</td>
<td>Wide stream protection zones reduce productivity; longer intervals between timber harvests; less harvest in short-term; fewer access roads; cost of road building increases; added constraints on operations on hazardous soils</td>
<td>Lower stocking of trees provides more forage; delays or impacts to regeneration by more livestock; livestock control competing vegetation and reduce fuel hazard</td>
</tr>
<tr>
<td>More meadows and wetland habitats available; fewer trees and livestock enhance habitat for wildlife; some riparian habitats for wildlife may be altered</td>
<td>Aquatic and streambank habitats improve; more riparian-dependent species, unless beaver and predators of fish must be controlled; production of game species increases; forage for wildlife increases</td>
<td>More high-quality forage, but less residual forage for wildlife; habitats provide less shelter and food; damage to habitats by livestock; livestock compete on key wildlife areas; timber and brush converted to grassland; wetlands drained; more fencing restricts movement of wildlife; mosaics of vegetation types may provide more habitat for certain species</td>
</tr>
<tr>
<td>Recreation/Landscape</td>
<td>Timber</td>
<td>Wildlife</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Holding water in impoundments enhances late-season releases; greater instream</td>
<td>Water yields, sedimentation, and turbidity increase slightly until all</td>
<td>Vegetation necessary to minimize sedimentation maintained; riparian</td>
</tr>
<tr>
<td>flows required below impoundments during dry seasons; white water recreation</td>
<td>stands under management; retention of snow in regeneration areas</td>
<td>trees may alter water quality; some bank erosion due to elk and over-</td>
</tr>
<tr>
<td>competes with recreational use of impounded water; soil compaction reduces</td>
<td>prolongs runoff; wet meadows may benefit</td>
<td>grazing of willows by deer, elk, beaver, muskrats; beaver enhance</td>
</tr>
<tr>
<td>percolation; erosion and sedimentation increase</td>
<td></td>
<td>upstream sediment storage and flow retardation</td>
</tr>
<tr>
<td>Sedimentation increases from use, particularly by ORVs; compaction of soils</td>
<td>Moderate soil movement on each entry for harvest; possible soil</td>
<td>Little or no impact</td>
</tr>
<tr>
<td>where recreationists congregate</td>
<td>compaction from entries in spring season</td>
<td></td>
</tr>
<tr>
<td>Recreationists disturb fisheries; more interest and funds for managing sport</td>
<td>Extensive road net increases fishing pressure and sedimentation; frequent</td>
<td>Little or no impact; streambank cover improves; no disturbance to</td>
</tr>
<tr>
<td>fisheries; increased riparian vegetation favors fish habitats</td>
<td>entries for treatments and harvests could increase sediment; cover</td>
<td>watercourses; introduction of beaver impedes movement of fish; certain</td>
</tr>
<tr>
<td></td>
<td>over streams regulated by California Forest Practices Act</td>
<td>predators may reduce fish populations; greater diversity of species;</td>
</tr>
<tr>
<td>No livestock in streambank zones; available forage not fully utilized; human</td>
<td>Seral stages short; less forage in regenerated areas due to site</td>
<td>more riparian vegetation</td>
</tr>
<tr>
<td>activities disturb livestock</td>
<td>preparation; early stand closure; full stocking of trees provides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>little forage under closed stands</td>
<td></td>
</tr>
<tr>
<td>Cost-effective recreational uses maximized; landscapes enhanced</td>
<td>Harvest areas on 7 to 10 percent of the total area, visually less</td>
<td>Recreational uses enhanced by natural diversity and abundance of habitats:</td>
</tr>
<tr>
<td></td>
<td>appealing; fewer sites for dispersed recreation; more hunting</td>
<td>more hunting and wildlife observation; landscape aesthetics and low</td>
</tr>
<tr>
<td></td>
<td>opportunity; road net provides greater access for recreationists</td>
<td>intensity recreation favored; less high-intensity recreation due to road</td>
</tr>
<tr>
<td>Costs of timber management increase; more uneven-aged stands; more old growth;</td>
<td>Maximum cost-effective production of saw logs and other wood products;</td>
<td>less overall visitor use; restrictions on use of ORVs; less recreational</td>
</tr>
<tr>
<td>natural patterns of cutting; less frequent entry; recreationists compete for use</td>
<td>higher costs offset by return of higher benefits</td>
<td>use other than hunting or nature study; better wildlife/recreation-</td>
</tr>
<tr>
<td>of roads; recreationists increase danger and costs from fires; higher costs</td>
<td></td>
<td>oriented activities</td>
</tr>
<tr>
<td>for fire protection; limits on size and position of harvesting units reduce yields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and increase costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disturbance of wildlife habitats; high intensity recreation and ORVs unfavorable</td>
<td>Old-growth habitats almost eliminated; serral stages shorter; larger</td>
<td>Maximum production from natural diversity and habitat improvement;</td>
</tr>
<tr>
<td>to wildlife; more interests and funds for managing game spec</td>
<td>cutting blocks decrease edges and eliminate wildlife travel zones;</td>
<td>featured species multiply</td>
</tr>
<tr>
<td></td>
<td>fewer snags and tall trees for roosts and nests; fewer culls on the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ground; fewer hardwoods; less understory burning; fewer shrubs for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>browse or cover; human disturbances of wildlife increase</td>
<td></td>
</tr>
</tbody>
</table>
Dominant management for fisheries would have minimal effects on wildlife, water, and soils, but might have substantial effects on timber, range, and recreation. Dominant use for fisheries undoubtedly would restrict timber harvest in streambank zones or make it more costly. Similarly, range livestock would have to be restricted from impacting streambank zones through expensive fencing or herding. Use by certain recreationists probably would be increased as the fisheries improved, but reduced roading would hinder access by anglers.

In a similar vein, dominant management for livestock would result in more forage and less timber. Habitats for wildlife and fisheries would be damaged. Wetlands might be drained to improve forage for livestock. Brush or forestlands might even be converted to grasslands in order to increase livestock production. More fences and gates would interfere with travel by wildlife, recreationists, and others used to traveling without such impediments. Conflicts between ranchers and recreationists, hunters, or fishermen would be most severe under this option.

Dominant management for recreation and landscape would maximize the aesthetic appearance of forest and rangelands and intensify recreational uses; however, it would significantly interfere with water quality, timber production and utilization of forage, and disturb populations and habitats of wildlife and fish. Recreationists, as they used trails, roads, parking, and especially ORVs, would have a substantial negative impact on the quality of habitat for fish and wildlife, and on compaction of soils.

Effects of dominant management for timber production would depend on whether stands were managed on an even- or uneven-aged system. In general, there might be less forage for livestock and no old-growth habitats on sites of higher quality. Wildlife habitat would be either increased or decreased in diversity depending on the system of management. A dense network of roads required for intensive timber management, with possible multiple stream crossings, would require good management in order to minimize sedimentation into fish habitats.

Management for dominant use by wildlife would have negative effects on production of timber and forage and on certain types of recreation, but would have little impact on fisheries, water, or soils.

Impacts of management for one resource on another quite often would be negative, but occasionally they would be positive. These are the trade-offs that must be made when deciding to favor one use over another or to move toward a mix that would provide multiple benefits from an area and its resources. The move toward multiple use requires resolution of conflicts, compromise, and striking balances among trade-offs.

**Multiple Use**

Management of forests and rangelands for multiple use is a common goal of many landowners in northeastern California. Federal and state agencies, PGandE, many ranchers, and many owners of forest lands have multiple use rather than dominant use as their goal for management. How multiple use is put into practice is determined by the interaction between owners, managers, resources on the land, and demands for those resources. A rancher in the livestock business would view and interpret multiple use differently from the way the supervisor of a national forest would. Multiple use means different things to different people.

All participants at the workshop were given the definition of multiple use in the glossary (Appendix A), but we did not strive to arrive at, or require, concurrence on a definition. Rather, each person worked on a multidisciplinary,7 multiple-use team (see Appendix C) using a personal interpretation of the meaning of the term.

After their work in resource-oriented teams had been completed in each area, participants were reassigned to multidisciplinary teams. Each multidisciplinary team was structured so that no team would have a preponderance of people from any one employer. The task for the multidisciplinary teams was to integrate the activities recommended for each dominant use of the area into a package of uses that would provide maximum benefits to the landowner given existing political and legal constraints. Teams were required to do this in a relatively short period of time, usually in 20 to 30 minutes. Representatives of dominant uses readily supported positions that would provide a reasonable level of output from the most logically predominant resource yet encourage output from other resources as well.

As anticipated, the four multiple-use teams usually recommended a similar mix of output at each area. These recommendations plus unique features

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7 See Appendix A for the distinction between multidisciplinary team and interdisciplinary team
of each team’s report are included in the following synopsis. The overall outcome of this portion of the workshop was a general framework for multiple use in each area, but with points of emphasis derived from reports by different teams.

**Headwaters**

Most teams established a goal of maximizing joint income from timber and livestock grazing with recognition that timber would generate most of the income. One team estimated that income from range might amount to only 1 percent of the income from timber. Two teams recognized that the downstream value of water from headwaters would approximate 20 percent of the value of the timber in the area. All teams accepted the ideal of improving water quality by minimizing erosion and sedimentation.

Harvesting of timber from clear-cut blocks, ranging in size from 5 to 30 acres, would be compatible with multiple use. Blocks of this size would provide both diversity of habitats for wildlife and dispersed areas for grazing by livestock. Individual tree selection or group selection would be used to harvest in streambank zones. Location and boundaries of cut blocks would be compatible with natural topography. Potential for displacement of soil and erosion would be minimized. On every 10-acre parcel, 10 to 15 snags would be left to provide habitat for pole-nesting wildlife. Decisions about the size and position of clear-cut blocks would reflect consideration of foraging patterns of livestock and migratory routes and habits of antelope and deer.

After regeneration by planting, timber stands would be thinned periodically to concentrate growth on fewer trees and to provide forage for livestock and wildlife.

Approximately 5 percent of the area would be allocated to old-growth timber stands providing habitat for certain species of wildlife. These old-growth stands would be maintained in 50- to 100-acre blocks. Where possible, stands of mixed ages would be encouraged to provide diversity for wildlife. Management for multiple use would result in more uneven-aged forest stands. Wide bands of vegetative canopy would be maintained along streambank zones and around meadows.

Road systems would receive special attention. Layout would be improved and mileage of the system would be reduced where redundant roads exist. Road upkeep would be improved, especially at stream crossings and culverts. Skid trails and roads would be located and maintained to avoid adverse effects on streambank zones and generation of sediment. Seeding of abandoned skid trails and roads would enhance wildlife and range resources.

Prescribed burning could be used at the time of the first commercial entry, about age 20 years, to improve habitat for deer by enhancing production of forage for livestock. Burning of upland areas would produce forage that could relieve pressure on streambank zones. Prescribed burning for range improvement would be done only in the fall after seeds had been shed by desired forage plants.

Meadows and major streambank zones would be fenced to control season of grazing. Upland forage under timber stands would be utilized early in the season while grazing would be deferred on meadows until later in the season. Costs and returns for managing livestock would be analyzed to determine whether increased costs of management to reduce impacts on streambanks would exceed the value to be derived from grazing. These meadows are valued because they maintain groundwater and prolong flows of water in summer for users and fisheries downstream. However, responsibility for maintaining flows and quality of water devolves upon those who manage headwater areas and who are unrecompensed for their stewardship.

Special care would be taken in all operations to minimize erosion and compaction of soil and sedimentation.

Speciated dace would be reintroduced into streams where they had been native. Where needed, shade along streams would be increased by exclusion of grazing and replanting. Care would be taken to reverse the decline of aspen and of willows along streams.

No special provisions would be made for recreation near headwaters since recreational use would be dispersed rather than concentrated in this area.

**Midcourse reaches**

Management of midcourse reaches for multiple use would strive to achieve several goals. Paramount would be reduction of both sediment within stream courses and sediment being delivered to streams. Another important goal would be maintaining and enhancing spawning and rearing areas for fish living in lower reaches. A goal for all teams was protection and enhancement of riparian vegetation. Only one team established a goal to improve hunting, fishing, and other recreational opportunities.
As the teams approached their assignment in this area, they felt the need for more information than had been provided during the workshop. Major unanswered questions related to extent of use of midstream reaches by fish residing in lower reaches. Spawning and rearing areas needed to be located and studied. The potential output of timber and livestock managed under constraints of multiple use needed to be determined. The time and place of origin of sediment needed to be established.

One team recognized that historical practices of managing land and resources have contributed substantially to present conditions within streambank zones and that best-management practices henceforth may not be sufficient to allow streambank zones in degraded watersheds to return to a desired condition. Additional specific treatments would be needed to accelerate the process of recovery.

Management of water in midreach areas would offer possibilities of building impoundments to stabilize water flows and to catch and hold sedimentation from upstream sources. However, such impoundments would interfere with movement of fish, would significantly affect wildlife habitats, and would be costly to build and maintain. Instream structures would be a viable alternative in the proper situation, but would be sited and constructed with discretion. While not a cure-all for erosion problems, they may accelerate recovery on a degraded site.

Water quality would be enhanced by controlling access to streambanks by livestock and recreationists and by stabilizing and revegetating stream courses. Willow-wattles (barriers of interwoven branches) were suggested as an alternative. Steps would be taken to regenerate groves of aspen in riparian zones.

Teams varied in their recommendations about management of grazing by livestock. One team gave priority to inventorying range resources and to developing strategies for utilizing the range without degrading streambank zones. Another team recommended a 3- to 5-year ban on grazing in streamside zones to allow recovery, to evaluate responses of streamside vegetation, and to plan alternatives for managing grazing while protecting streamside zones.

Demand for recreational use of midcourse reaches would be determined. Special consideration would be given to uses by people in the local communities. Trailheads and off-stream parking would be developed to control damage to streams and aesthetic resources. Recreational areas used spontaneously by local people would be developed to reduce damage to currently used sites.

Timber management activities would be altered only slightly from those recommended for dominant use of timber in midreach areas. Conflicts between teams were obvious. One team recommended removal of the remaining old-growth overstory within 40 years. Another group recommended that the multi-aged class structure in mixed conifer stands be maintained.

Teams varied in their recommendations about timber harvest within buffering streambank zones. One team wanted a uniformly wide buffer zone along streams that would limit timber harvest. Another team recommended stream buffers of variable width, with and without removal of vegetation. A third team recommended a moratorium on timber harvest within 100 feet of streams, until a multidisciplinary team prepared criteria and options for managing harvest of timber in riparian zones. One team recommended special consideration be given to yarding parallel to and outside of riparian zones. These divergent recommendations reflect a lack of agreement on objectives and practices that will protect midcourse streams.

Access roads would be reduced in number, especially adjacent to and within streambank zones. Damaged roads and stream crossings would be restored with appropriate culverts to reduce sedimentation.

Aware that recommended actions would be costly, one team recommended that ways be explored to fund or reduce the costs of rehabilitation of degraded watersheds. One suggestion was to form nonprofit conservation organizations or to seek special legislation that might provide financial incentives to do the needed work. All participants recognized that downstream landowners should share upstream landowners' costs for conservation measures that will have joint benefits.

**Lower reaches**

All teams recognized that in lower reaches water has the greatest value. Enhancement of water storage capacity and regulated flows of water should be the primary goals of land management. All other resources would be maintained, perpetuated or improved. Fisheries, nongame wildlife, hunttable game, and livestock production all would be managed for multiple use.

One team proposed to develop a portion of the land for restricted use subject to payment of
appropriate fees based upon fisheries and hunt­able wildlife. Development of fish and wildlife resources for economic profit would be considered because of proximity to urban areas. A high-quality fishery plus a hunt­able game population might support a lodge or a facility providing recreational experiences for which substantial fees would be charged. Another alternative would leave most areas open to the general public and would use only the most productive habitats for an exclusive, fee-based hunting and fishing reserve. Hunt­able game would include turkey, quail, deer, and waterfowl. To reduce excessive use of the public area, a lottery would be arranged, or use would be limited on a first-come, first-served basis. Income from this use of land and resources would be directed toward enhancing fisheries and hunting such as instream improvements and stabilization of streambanks trampled during fishing. Degradation of streambanks caused by fishermen might also be reversed by regulating use under a rest/rotation management strategy.

Fee campgrounds and fees for access to trails and playgrounds for ORVs would be another possible alternative. Nature trails would be developed to educate the public and increase awareness of the importance of conservation and wise use of renewable natural resources.

ORVs would be restricted to areas where their use would not conflict with streambank zone management. Their use would be controlled to avoid environmental degradation and conflict with other recreationists. Areas damaged by unrestricted past use of ORVs would be revegetated in order to stop erosion and sedimentation.

Grazing was recognized as a valuable economic use of land and forage near lower reaches of streams. Grazing would be limited by fencing to upland areas, where fertilization might be used to improve productivity. Seeding and management of grazing in upland meadows would restore perennial vegetation. Research would determine whether perennial vegetation was limited by available nutrients, and whether opportunities would exist for raising water tables in these regions. Rotational grazing, special herding and pumping of water would be needed to keep animals out of the riparian zone and to assure full utilization of the available upland forage.

Sheep might be recommended to control certain noxious weeds, but herding would be necessary to avoid overuse of forage near bedding grounds. Good possibilities exist for mixing the management of sheep and wildlife, by managing for quality vegetation with increased new growth.

All teams agreed that timber stands in close proximity to streambanks would be left for amenity value and would not be harvested except for purposes of sanitation or salvage. Timber stands in the streambank zone, particularly if their productive potential were low, would have less economic priority than at areas located upstream. Only timber growing on highly productive sites would be managed intensively for the production of sawlogs. The remaining timber stands would be managed extensively, or not at all, for fuelwood and primarily as habitats for wildlife. Special attention would be given to protection and enhancement of hardwoods because of the mast they provide as food for wildlife. Potentials for Christmas trees and fuelwood could be considered as could plantings in the riparian zone to enhance habitats for fish and wildlife.

Needs for Research and Extension

Throughout the workshop, but particularly at the concluding session, participants identified problems requiring research and extension to fill gaps in available technology. The problems emerged when participants were unable to answer a technical question or when participants knew that technology available elsewhere could be demonstrated and adapted to meet needs in northeastern California. The problems identified were those that this group of specialists considered as needing further research.

Some of the identified problems were in disciplines outside the collective technical expertise of the participants. For example, no one was expert in forest entomology or forest pathology. Consequently, the list of research and extension needs must be used with discretion. Partial answers, or appropriate, adequate technology may be available to solve the indicated problems.

Teamwork at the workshop identified gaps in our knowledge and methods for managing streambank zones. Participants recognized that it would take another workshop to sort out these needs for research and extension and to propose a program to solve the highest priority problems. Such a workshop is not contemplated at this time. Therefore, the following lists of needs, prioritized by teams for each resource, should be taken as indicative of the directions for research and extension.
programs on streambank problems in northeastern California.

A. Water and soil
1 Sources of sediment
   a. Determine sources, sinks, transport and budgets for sediment in watersheds (see also C.1, E.3.a, i)
   b. Determine impacts of road systems and of alternative systems for managing timber and range on generation and movement of sediment in watersheds, giving particular attention to riparian zones [see also B.1.a(1), C.1, E.3.a, E.3.f, E.3.g]
   c. Develop and apply a simple method for sampling suspended sediment in targeted streams
   d. Monitor suspended sediment in selected streams
   e. Monitor deposition and movement of sedimentary bed loads, giving particular attention to potential impacts on downstream reservoirs and spawning redds
   f. Determine causes of head-cutting through meadows and methods for prevention
   g. Improve procedures for placing debris to stabilize stream channels
2. Water yields and flows
   a. Understand dynamics of groundwater in meadows
   b. Determine effects on water tables in wet meadows of utilizing forage by livestock and of managing adjacent timber (see also B.1.b, E.3.i)

3. Economics
   a. Evaluate economics of storage of water—in ground, lakes, meadows, and snowpack—and of retaining sediment on upland sites.
   b. Evaluate economics and effects on yields of water and sediment resulting from alternative land management practices (see also B.2.a and c, C.6, E.3.i)
   c. Develop and evaluate alternatives for exchanging equity between those who benefit from water downstream and those who incur costs for managing upstream resources

   d. Explore mechanisms for providing financial incentives to managers of resources near headwaters and midcourse streams for enhancing yields and quality of water, e.g., by using the Public Utility Commission’s rate base to subsidize upstream owners for reducing sediment in streams
   e. Evaluate alternative organizational means for exchanging benefits and costs among owners so as to encourage decisions about individual sites in consonance with objectives for an entire watershed or basin, focusing on the variety of state-led, corporate-led, or cooperative models already being used in California

4. Managerial information system
   a. Develop a classification system for riparian and streambank zones (see also C.5, F.8)
   b. Improve and accelerate mapping of soils, associated vegetation, stream gradients and streambank characteristics
   c. Provide historical analyses of changes in land use and their association with changes in condition of riparian habitats and streambank zones

5. Pilot action research and demonstration project
   a. Undertake a practical trial of riparian zone management in one or more basins where dominant owners and counties would be supportive
   b. Perfect and demonstrate best management practices including: structural and nonstructural methods of restoring meadows and stream channels, techniques for dry meadows and forests adversely affected by roads or ORVs, management of livestock, and manipulation of timber cooperation (see also C.6, E.2.d, E.3.a)
   c. Compare alternatives for developing cooperation among landowners and for extending information to landowners (see also C.7, 8, 9, E.3.h)

B. Fisheries
1. Headwaters
   a. Determine appropriate species composition and density of streambank vegetation in headwater reaches necessary to:
      1) protect stream channel from grazing, temperature, human activity, and sedimentation (see also A.1.b, E.3.a)
2) enhance instream resources
3) provide appropriate downstream export of matter, energy, and water

b. Determine impacts of grazing, logging, water diversion, revegetation, and other activities on spring outputs and water tables (see also A.2.b)

c. Determine natural responses of stream­bank vegetation to changes in instream flows and time needed to reach equilibrium after disturbances

d. Determine linkages and importance of headwater areas to downstream reaches including export of matter and energy from springs, seeps, and intermittent and ephemeral streams

e. Understand ecology of woody streambank plants in order to understand conditions needed for reproduction and establishment, growth, and contributions to protection of streambanks and habitats for fish (see also C.3, E.2.b,c)

2. Midcourse reaches

a. Determine whether “best management practices” will allow recovery of stream conditions and biota when the current stream system is degraded [see also A.3.b, B.1.a(1), B.3.a, E.3.a]

b. Determine rates of recovery for stream systems—substrate, fish habitat, and biota—after disturbance and sedimentation are reduced

c. Develop techniques to speed and direct recovery of disturbed stream systems

d. Establish the differences between recovery processes that occur naturally and those enhanced by management

e. Assess existing and potential inherent economic and aesthetic values of stream­bank zones in comparison with other resource values such as timber and grazing (see also A.3.b, C.6)

f. Determine role and dynamics of midcourse reaches in providing spawning areas and producing juveniles for fisheries in lower reaches

3. Lower reaches

a. Determine whether so-called “best management practices” adequately protect stream resources from timber harvesting, grazing, and other activities [see also A.1.b, A.3.b, B.1.a(1), B.2.a, E.3.a] (Note: three state agencies and the California Forest Protective Association currently are studying the timber harvesting part of this problem.)

b. Develop procedures and methods for monitoring effects of “best management practices” and their effects on information about instream resources and streambank zones

c. Develop interactive data bases that provide information about stream resources and access to new stream and streambank management technologies

d. Develop methods to determine carrying capacity of streambank zones for human use

e. Develop management techniques for minimizing damage by human use in streambank zones

f. Develop methods to enhance streams, as through changes in productivity; improved habitat, such as siting and anchoring boulders; better access for anglers

g. Determine factors that limit fish populations in streams

h. Determine areas and habitats needed during each season by fishes in streams in northeastern California

C. Range for livestock

1. Determine sources of sediment in streams (see also A.1.a)

2. Determine ability of plants to prevent sediment from entering streams [see also B.1.a(1)]

3. Understand autecology and taxonomy of critical (benchmark) plant species in riparian zones (see also E.2.b and c)

4. Understand responses of plant communities to grazing and especially with respect to season of use

5. Develop and apply a classification system for riparian areas (see also A.4.a, F.8)

6. Develop and apply techniques for valuation of costs and benefits of various range management practices (see also A.3.b, A.5.b, B.2.e, E.3.e, F.2)

7. Communicate positive values derived from grazing by livestock (see also F.3)
8. Provide educational programs designed to inform the public about biological, managerial, and economic issues associated with management of range resources related to streambank zones (see also E.3.h, G.4)
9. Teach people proper use of coordinated resource management plans (see also E.3.h)
10. Develop university-level courses on management of riparian areas
11. Utilize demonstration plots in extension

D. Recreation
1. Determine patterns of recreational use by local citizens and by those who travel long distances to use a resource
2. Determine whether conflicts occur between use of resources by local recreationists versus those who travel long distances to use a resource
3. Determine local, regional, and statewide demands for recreational uses of forests and rangelands (see also D.5,6)
4. Determine through a resource inventory the recreational carrying capacity of streambank zones within the state and determine whether they can meet demands now and in the future (see also D.3)
5. Analyze current and historic demand for both low- and high-cost recreational uses to determine whether demand is increasing to a point where amenity-enhanced recreation—resorts, fishing clubs, etc.—might be used economically to restrict use of highly valued, sparse resources (see also D.3 and 6)
6. Determine current demands for both dispersed and developed recreational uses of resources (see also D.3 and 5)
7. Determine the effectiveness of current techniques designed to alleviate degradation of streambanks and other critical resources by dispersed recreational use (e.g., economic restrictions, use rotation, site design, and permits)
8. Develop incentives to expand use of successful techniques for protecting streambanks and other critical recreational resources
9. Determine whether economic incentives and protection against liability could be used to encourage private landowners to allow recreational use of their resources
10. Develop an extension program aimed at educating and informing recreationists to improve their protection of streambanks and other critical resources (see also C.8,9, E.3.h, G.4)

E. Forests for timber
1. Growth and yield
   a. Build a model to simulate growth of small trees in plantations, with varying levels of brush and grass competition, from establishment of seedlings until trees are approximately 6 inches dbh. (Growth of stands larger than 6 inches dbh can be adequately projected using existing CAC-TOS or PROGNOSIS models. Note: the California Forestry Research Cooperative, headquartered at UC Berkeley, is working on a model to simulate growth of small trees.)
   b. Build a model that projects growth and ingrowth for uneven-aged, irregularly stocked stands of mixed species
   c. Build a model that projects varying proportions of multiple output in terms of both economics and productivity
2. Regeneration
   a. Understand autecology of mule's ear (Wyethia mollis), with possible allelopathic effects on regeneration (see also F.6)
   b. Understand autecology of grasses and shrubs in relation to both control of understory competition and potential utilization by wildlife and livestock (see also B.1.e, C.3, F.6)
   c. Understand autecology and causes of senescence of willows and aspens along stream courses (see also B.1.e, C.3, E.3.c., F.6)
   d. Develop cost-effective alternatives for site preparation and weed control (see also A.5.b)
   e. Develop cost-effective methods for managing damage to coniferous trees by pocket gophers
   f. Learn how to regenerate trees and shrubs in riparian zones
   g. Determine effects of current fire-exclusion policies on regeneration of forests, especially on regeneration of streamside vegetation and aspen
h. Develop regeneration systems that reflect multiple resource values

3. Management
a. Develop best management practices to minimize erosion associated with production of timber on both upslope and riparian areas (see also A.1.a and b, A.5.b, B.1.a(1), B.2.a, B.3.a, C.1)
b. Estimate economic trade-offs in production of timber associated with range management and other uses of forests
c. Understand heart-rot in aspen and effects on longevity (see also E.2.c)
d. Develop management systems for enhancing growth and yield of hardwoods
e. Determine effects of manipulating timber on grazing values, wildlife maintenance, and landscape amenity values of adjacent meadows (see also A.2.b, C.6, F.2)
f. Determine extent to which best management practices limit movement of surface soil in the long run.
g. Determine cumulative environmental effects of sequential treatments of forests within a watershed
h. Develop strong educational programs designed to inform the public about biological, managerial, and economic issues associated with management and conservation of forests in streambank zones (see also C.8 and 9, D.10, G.4)
i. Develop techniques for managing timber in streambank zones so as to recognize special attributes of water supplies, visual amenities, recreational uses, and habitats for wildlife and fish [see also A.1.b, A.2.b, A.3.b, B.1.a(1), B.1.e, F.2]

F. Wildlife
1. Develop computerized systems for evaluating options for management of private lands (see also F.4)
2. Determine responses of each species of game (deer, turkey, and quail) to manipulation of forest and rangeland habitats (see also C.6, E.3.e,i)
3. Determine significance of conflicts between wildlife and livestock or recreationists, and find ways of minimizing any important conflicts (see also C.7)

4. Evaluate economics of fee hunting operations (see also F.1)
5. Evaluate socioeconomic benefits to landowners, communities, and counties that are associated with wildlife
6. Determine the autecology and develop methods for regenerating plants preferred by wildlife (see also C.3, E.2.a,b,c)
7. Validate existing models of wildlife habitat relationships and extend use of the models
8. Develop a system for classifying riparian zones (see also A.4.a, C.5)
9. Inventory riparian zones in California

G. Aesthetic resources
1. Determine the public’s perceptions of values of streambank landscapes
2. Provide guidelines (or criteria) for inventorying visual landscapes of streambank zones
3. Provide criteria and methods for evaluation of aesthetics of streambank zones
4. Interpret natural processes within the streambank zone for lay audiences (see also C.8 and 9, D.10, E.3.h)

H. Multiple use
Evaluate societal, political, economic, and productivity trade-offs associated with managing land for multiple use rather than for dominant use

[See also A.1.b, A.2.b, A.3.b, A.4.c, A.5.a,b, B.1.a(1), B.1.b, B.1.e, B.2.e, B.3.a, B.3.c, E.1.b, E.2.b, E.3.b, F.3]

I. Policy

[See also A.3.a,b,c,d,e; A.5.b,c; B.3.a; D.3.5.7,8,9; E.3.a,b,f, g; F.4.5; H]
1. Determine effects of current state and federal regulations on capacity of forest landowners to vary multiple output on sites of different quality and location within a watershed
2. Determine effects of new policies which encourage cooperation among owners in land management
3. Develop new policies that encourage BMPs and address the inequity that arises from situations where costs of management are borne by upstream owners, but the benefits are
dispersed downstream and enjoyed by the general public.

4. Develop organizational means and incentives that encourage adjacent landowners to function together and cooperate in managing streambank zones.

5. Develop organizational and administrative structures that encourage interdisciplinary, multidisciplinary, and interagency research.

Conclusions

Preceding sections of this report, dealing with needs for R&D, and effects of dominant use and multiple use, could be regarded as the conclusions of the workshop. All participants agreed that they had experienced a broadening of their perspectives, that they had learned from their close teamwork with other specialists and had grown in knowledge and understanding within their own specialty. More important, they had increased their appreciation of the complexities and potentials—both social and technical—of managing other resources.

The primary importance of social and political issues was well put by Gary Nakamura, Area Forestry Specialist for UC Cooperative Extension at Redding. After the workshop, he wrote:

"The issues in management of streambanks are not technical ones so much as they are social or political ones. There are many unanswered questions: What do we want or expect of our streams? What specific objectives do we have for our streams? Are they and their condition central to our managerial objectives (as for fisheries and recreation), are they secondary (as water for cattle), or are they merely present and a nuisance (as for timber harvests)?

"To cast the issue in political terms is not to dismiss it, but rather to render unto science what science can do and unto politics what politics can do. Science can tell us how much land is needed to support a spotted-owl and how many spotted-owls are necessary to sustain it as a species, but science cannot tell us if we should maintain spotted-owls at the minimum viable population, or at 50 percent above that, or at all.

"The answers to these fundamental questions lie in society's moral sense of good and bad, right and wrong, fair and unjust, and private property rights vs. public responsibilities. The fundamental issue in streambank management is: what is the common good? Undefined and thus unsupported we will grope for it forever, not realizing when we have achieved it. Well defined and supported, we can bring to bear our computer programs, Teflon, and spliced genes in achieving it."

The conclusions about technical questions were easier to enumerate. The steering group was asked in a buzz session after the workshop to identify the explicit conclusions they felt resulted from the workshop. Their list of conclusions (Appendix D) spans the gamut from generalities to specificities, from disciplinary to multidisciplinary, from viewpoints of landowners and managers to viewpoints of scientists and specialists. Their conclusions point out that:

- multiresource and multidisciplinary approaches to management have special importance to streambank zones;
- management of streambanks and streambank zones has had too little attention;
- management of streams and fisheries requires great care and technical attention;
- needs are great for research and extension related to streambank zones;
- social and economic benefits related to streambank zones are neither quantified nor returned to those who may pay the costs;
- a profusion of laws, regulations, and policies relate to streambank zones.

Under these six points, their numerous conclusions were effectively grouped to answer four important questions:

- Why is the streamside zone a "problem"?
- What can be done about the "problem"?
- What organizational means to address these problems are lacking?
- What is not being done because technology is lacking?

Why is the streambank zone a "problem"?

The streambank zone focuses conflict because it concentrates social pressures and consequences of land and water uses in a very small, sensitive, but significant area. Although streambank-related laws, regulations, and policies are numerous, they lack effectiveness. These laws, regulations, and policies are weak when compared to the immense pressures on the zone and tend to deal with effects rather than causes of streambank conditions.

Suggestions for this grouping and much of the following text were provided by Jeffrey M. Romm, Department of Forestry and Resource Management, University of California, Berkeley.
Areas in the streambank zone are poorly understood. This is partly because knowledge of these zones has been derived from disciplinary and professional perspectives motivated by specialized interests in the zone, and without awareness or appreciation of perspectives of other disciplines and professions. There are, as yet, no whole-watershed approaches to streambank evaluation. Neither are there organizations that adequately represent the collective interest of watershed owners. A watershed-system approach is needed to understand the streambank zone and the policies and managerial measures to which it might respond.

Streambank zones accumulate and retain effects of natural and man-caused events. Streams bear for many decades, even for centuries, the sedimentary burdens resulting from volcanic eruptions, torrential rains, geologic uplifting, and more recent, man-caused, abusive mining, overgrazing, and logging. Because these effects are integrated over time and throughout the length of the streamcourse, it is difficult to assess whether currently observed degradation results from recent or historic events, or whether these events were natural or man-caused.

Degradation of streambank zones often can be directly related to inappropriate management and uses of resources in the past, or even at present. No matter how careful our efforts to utilize resources of forests and rangelands, some impacts will be realized in streambank zones. When these impacts move from being tolerable to intolerable, conflicts arise. Determining societal levels of tolerance for impacts is another dimension of the problem in streambank zones.

There are still more dimensions to the problems of streamside zones. Management of these zones has received relatively little scientific and technical attention, so our knowledge and methodology for management are deficient. The zones mean different things to different interests according to whether they are owned or used, or according to whether one’s interests are scientific and technical, economical and practical, or purely visual and aesthetic. Because streambank zones respond to conditions outside the zones, the leverage of directly managing streambank zones does not offer promise in solving problems. Furthermore, there has been little work on measures of streambank health and on the benefits associated with them. Approaches being used to regulate what is being done inside or outside of streambank zones have not been evaluated.

That streambank zones are private property touches on still another category of problems. Our national values and laws specially recognizes private property rights, irrespective of location. Yet, the water in streambank zones is a kind of moving “common,” with mixed private and public rights. Conflicts between these public water rights and private land rights have not even been identified, let alone resolved.

What can be done about the “problem”?

Impacts of dominant use of each resource within streambank zones needs to be explained to users of resources. Information and educational programs should be directed at owners and managers who practice dominant use. If enlightened, they may be willing to compromise on activities directed at dominant use of one resource in order to minimize adverse impacts on other resources. Our need is four-fold: first, to document these impacts; second, to inform or educate owners and managers who need to know about them; third, to organize; and fourth, to support viable organizations with effective policies. Specialists familiar with each resource and its uses could interact, using a team approach, to meet this need.

Substantial information and technology applicable to streambank zones existe, but much of what is available is unutilized or underutilized. Furthermore, successful management of streambank zones often occurs but is unheralded. Organizations such as UC’s Cooperative Extension could marshal their forces, gather what is known, and quickly make it available to a variety of audiences. At least this would document practices now being used successfully.

Currently, very few scientists and specialists are seeking solutions to the numerous problems of streambank zones in northeastern California. More people could be put to work on these problems by either redirecting them from work elsewhere or finding new financial support. Yet, redirecting scientists and specialists to work on streambank zones would be nearly impossible to accomplish. Attempts to redirect people and their resources often lead to political tug-of-war and can incur heavy costs due to lost progress on problems dropped as a result of the redirection. New funds for new people would be the cleanest way to proceed, but would not be easily accomplished unless political support were forthcoming.
Additional funding for research and extension would be hard to come by in this era of tight budgets and intense competition for federal, state, and private funds. Here again, political pressure would be the key to opening up new sources of money to support research and extension. If new funds were to be provided, some should be spent on interdisciplinary approaches to solve a few critical problems, but most new money should be spent on interdisciplinary and multidisciplinary teams in research and extension.

Multidisciplinary teams would be built to analyze and evaluate existing managerial activities and to prepare prescriptions for managing multiple use under a variety of streamside conditions. The need is to gather the technical expertise, cause interaction through teamwork, and produce guidelines for management. Beyond producing guidelines for management, efforts would be needed to inform and involve owners and managers of land and resources, so that such guidelines would be accepted and put into practice. Such an overwhelming task can only be accomplished through a multi-agency, cooperative effort with resources contributed by participants.

Many problems related to management of streambank zones stem from inadequate information on costs and benefits of use of resources. Who pays, how much, in what ways? Who receives what returns, when, and how? Such questions can and should be answered before we can improve upon decision-making processes. Such questions should not hinder progress or delay initiation of management decisions.

Because downstream owners and users benefit from good practices upstream, some means are needed to reimburse upstream owners and managers for actions which have downstream benefits. This obviously is a complex social problem fraught with legal and political ramifications. Perhaps it cannot be solved, but until we try, we will not know what might be done voluntarily and what might be done through new organizational or legal means.

**What organizational means to address these problems are lacking?**

Certainly the teamwork among specialists referred to above is lacking because specialists tend to be organized and to function within their disciplines. USDA Forest Service in its recent, special planning situation created multidisciplinary teams to solve just such problems as those occurring in streambank zones. Needed for the private sector is a comparable organizational capability. It would pull together multidisciplinary teams to provide analyses and recommendations for owners and managers of private lands. How such multidisciplinary teams would be financed and organized is a two-pronged problem.

Governmental organizations and special interest groups have obvious effectiveness in creating laws and regulations; however, they are less attentive to monitoring effectiveness of those laws and regulations. Organizations having a neutral or even adversarial view of these laws and regulations would be in the best position to evaluate them. Associations of owners or professional organizations might be in the best position to make these kinds of evaluations. However it is done, the myriad laws, regulations, and policies pertaining to streambank zones should be examined critically. Do existing laws apply to current needs? Do they conflict in their implementation and effects? Should amendments or new laws, regulations, and policies be developed?

Not yet addressed is the need to organize owners in ways that would stimulate their interests in science, monitoring, and the management of resources for some common objective. We cannot talk about "management" or "management research" without first assuming some actual or potential mode of organization within which decisions are made. Nor can we talk about effective extension without considering the organizational basis of contact. In this respect, modes of organization deserve explicit focus.
What is not being done because technology is lacking?

The lengthy list of problems for research and development presented earlier demonstrates the extent of deficiencies and gaps in our technology for managing streambank zones. If we turn the situation around and start with the stability of streams as the primary objective for use and management of each resource, then we need to find those practices which can be accepted or tolerated. Multidisciplinary approaches to problem solving are needed to determine the interrelationships between such variables as range and fisheries, timber and water, timber and wildlife, timber and landscape aesthetics, and impacts of outdoor recreation on the management of all resources. Technologies for the most part are adequate for achieving dominant use of each resource. Integration of these technologies as a basis for planning and management of multiple resources is weak. Improved coordination and communication among specialists is necessary to promote development of multi-use resource plans, where the most successful combination of technologies can be used to attain the overall management goals.

The needs for technology are multifaceted. If all current wildland research and development forces in California were focused on only these problems, we probably would have barely enough effort to solve them in a reasonable time. Multimillion dollar investments will be needed over periods of 10 to 20 years to solve just the problems identified in this report. If we do not get mobilized soon, future generations will replay the record of this workshop and find that nothing has changed in the intervening years.
Appendix A. A glossary of terms related to management of streambank zones

**Activity**

Any process to achieve specific objectives of purposes of management.

**Aesthetics**

Amenity values perceived and enjoyed from the visual and physical components found variably related with the streamside landscape.

**Carrying capacity (Holding capacity)**

All definitions of the concept "carrying capacity" (as it relates to wildland planning) must involve specification of some (1) level of use (2) which will allow for the perpetual maintenance (3) of some level of environmental quality (4) within some management objective level set with respect to the cost of maintenance resource quality (5) at a level which will provide resource user satisfaction. (After G.P.)*

**Baseline data**

Data representative of a particular base period. Normally means representative of the undisturbed or undeveloped state. (USDA Forest Serv. 1979 Manage. Practice Documentation)

**Best management practice**

A practice, or a combination of practices, that is determined by a state (or designated area-wide planning) agency after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals. (USDA Forest Serv. 1979 Manage. Practice Documentation)

**Carrying capacity, Ecological**

(Inherent capability, Inherent carrying capacity, Natural carrying capacity, Physical carrying capacity, Resource bearing capacity, Site capacity, Biotic carrying capacity)

1. The number (or weight) of organisms of a given species and quality that can survive in, without causing deterioration of, a given ecosystem through the least favorable environmental conditions that occur within a stated interval of time. (Ford-Robertson 1971)*

2. The limit of a natural ecosystem’s ability to sustain user impacts (After Conservation Foundation 1972)*

3. Strictly speaking, any level of use greater than zero will always result in some alteration of natural environments, and therefore, it is not useful to define ecological carrying capacity in "no change" terms. Some decision about what is an acceptable amount of alteration of natural values must first be made before ecological carrying capacity can be operational for setting levels of use. (C.F.S.)*

4. "Biotic carrying capacity" used in a recreational context. That level of development and use beyond which the site's capacity to provide a sustained high level of satisfaction becomes impaired due to severe damage. (La Page 1963)*

5. "Physical carrying capacity". The effect of use on the nonliving aspects of the habitat—e.g., the ability of a particular terrain to resist trail erosion, but also the ability of the terrain to absorb trails, roads, and other man-made objects. (Conserv. Found. 1972)*

**Carrying capacity, range**

In its true sense, the maximum number of individual animals that can survive the greatest period of stress each year on a given land area. It does not refer to sustained yield.

In range management, the term has become erroneously synonymous with grazing capacity. (Amer. Soc. Range Manage. 1964)*

**Carrying capacity, wildlife**

1. The number of animals of a given species that a habitat supports, measured at the low stage of any annual population cycle. (After Allen)*

2. The upper limit of population growth beyond which no major increase can occur. (After Odum 1959)*

3. The number of animals that a habitat can maintain in a healthy, vigorous condition. (After Dasmann 1945)*

4. The level at which a population is normally held by hunting and predation. (After Ernston 1945)*

5. The level of population above which intraspecific tolerance permits no further increase. (After Leopold 1933)*

**Constraints**

Circumstances that confine, restrict, preclude, compel, or oblige certain activities, processes, or effects; usually includes laws, regulations, policies, codes, ethics, physical realities, time, or other resources.

**Degraded watershed**

A catchment basin which has suffered environmental damage, either from natural or man-made causes, which is resulting in accelerated soil loss to the quantifiable detriment of other resources. (USDA Forest Serv. 1979 Manage. Practice Documentation)

**Dominant use**

A concept in which land and water resources are classified and managed for one main type of use. Other uses may or may not be excluded but are always of secondary importance to the optimum development for the dominant use. (Sesco, et al. 1973)*

Also see Dominant use management.

**Dominant use management**

Management based on the idea that although land may be capable of many uses it will provide for one use better than any other. The land

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is managed for the single purpose of maximizing that use to the exclusion of other uses where conflicts exist.

Devoting each land unit to the use it best provides for is assumed to be the most efficient allocation of resources. This assumption has been shown to be erroneous by the science of operations research, among others. Dominant use management is prohibited on the National Forests under the Multiple Use-Sustained Yield Act. (E.C.T.)*

**Effect**

That which is directly produced by an action, process, or agent and is the exact correlation of cause.

**Extension**

As used by Cooperative Extension in the land-grant college system, refers to the gamut of work—applied research, development, applications of technology, training, and education—to solve practical problems. Extension conducts field trials and demonstrations, repackages technology, and uses a variety of media to communicate with selected audiences.

**Floodplain**

The lowland and relatively flat areas adjoining inland and coastal waters, including debris cones and flood-prone areas of offshore islands including, at a minimum, that area subject to a 1 percent (100-year recurrence) or greater chance of flooding in any given year. (USDA Forest Serv. 19728)

**Goal (Plan goals, Management goal)**

1. A concise statement of an organization’s central strategy in addressing a problem expressed in terms of a desired state or process that operating programs are designed to achieve.

A goal is normally expressed as a broad, general statement, is usually not quantifiable, and is timeless in that it usually has no specific date by which it is to be completed. Often, it would not be expected that a “goal” could ever be completely achieved. The “goal” is the principal statement from which objectives must be developed.

For example, U.S. Department of Agriculture goals relating to their mission to work on problems associated with agricultural production are (1) to work for disease and pest control and (2) to conduct research on production. (USDA Off. Manage. and Finance 1974)*

2. Characteristically, “goals” are enduring statements of purpose, often not attainable in the short term, and frequently incapable of expression in quantifiable terms. (USDA Forest Serv. 19728)*

3. The broad end toward which effort is directed. In the context of land use planning, goals are normally stated in terms of the fulfillment of broad public needs, the preservation of fundamental constitutional principles, the achievement of targeted levels of excellence, the alleviation of major problems, or other justifiable purposes or purposes to be served by government effort. (USDA Forest Serv. 19728)*

4. A goal is societal consensus of that which is good for the constituency at some level of generalization—the particular level being determined by the planning level (such as state, metropolitan region, city). (After Hills, Love, and Lacate 1970)*

**Headcutting, Headward erosion**

Wearing away of rock or soil by erosive agents at the upper end of a channel as evidenced by gullying, undermining by springs, and slumping.

**Interdisciplinary team**

A group of two or more individuals with different training assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad to adequately solve the problem. The members of the team proceed to solution with frequent interaction so that each discipline may provide insights to any stage of the problem and disciplines may combine to provide new solutions. This is different from a multidisciplinary team, where each specialist is assigned a portion of the problem and their partial solutions are linked together at the end to provide the final solution. The forming of the team, the data collection and analysis, team discussion, interactive evaluation, and joint resolution of the problem is the Interdisciplinary Process (USDA Forest Serv. 1979 Manage. Practice Documentation)*

**Mission**

A major, continuing problem or concern that programs are designed to address. Missions represent the basic reasons for the existence of an organization in a governmental agency and characterize an organization’s role in solving problems.

For example, some of the 11 missions of the US Department of Agriculture are to work on problems associated with (1) environmental improvement, and resource development and use, (2) rural development, (3) agricultural production efficiency, etc. (After USDA Off. Manage. Finance 1974)*

**Multidisciplinary team**

1. A joint effort by two or more people having different scientific training and/or backgrounds all assigned responsibilities in the same activity or effort. Each specialist is assigned a portion of the problem and their individual solutions are combined to provide the complete solution. (After USDA Forest Serv. 19728)*

2. A group of individuals with different training assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad to adequately solve the problem. The problem is broken into pieces and each specialist works on a portion of the problem. Their partial solutions are then linked together to provide the final solution. This is different from an interdisciplinary team, which does not break the problem apart by disciplines but instead works with frequent interaction so that each discipline may provide insights into any part of the problem and disciplines may combine to provide new solutions beyond the scope of any single discipline. (E.C.T.)*

Also see Interdisciplinary team.

**Multiple use**

1. Three somewhat different ideas are involved: (1) different uses of adjacent subareas which together form a composite multiple-use area, (2) the alternation in time of different uses on the same area, and (3) more than one use of an area at one time.

In the first two ideas it is implicit that direct competition between
uses is avoided by alternating them in space or in time. The third idea involves multiple use in the sense of simultaneous use of one space and must concern itself with complementary versus conflicting activities, and compatible versus incompatible uses.

Where spatially coincident uses are involved at a given time, conflicts between resource users will almost always occur and the concept of such forms of multiple use should be realistically interpreted as a dominant use with secondary uses integrated only insofar as they are compatible with the first. However, where the idea of incompatibility relates to the economics of productivity and maximization of single resource yields, management and multiple use can perhaps be validated in terms other than single-resource production efficiency. (After Rowe and Mc Cormack 1968)*

2. Multiple use is also a modern social concept whereby the consumer public demands a variety of values from a resource in ways that, to the single purpose resource user, may seem inefficient or economically ruinous. Under this concept the aim of resource use allocation is to maximize the national well-being, promoting general social and economic prosperity.

Social needs are not necessarily best served by maximizing the production of a single resource (or even by maximizing the production of several resources) but by that over-all mix of total national resource uses that brings the greatest social and economic benefits. (After Rowe and Mc Cormack 1968)*

Multiple use management

Multiple Use-Sustained Yield Act usage. The management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output. (Multiple Use-Sustained Yield Act)*

Objective (Plan objectives, Management objective, End result, Target)

1. A clear and specific statement of planned results to be achieved within a stated time period. The results indicated in the statement of objectives are those which are designed to achieve the desired state or process represented by the goal. An objective is measurable and implies precise time-phased steps to be taken and resources to be used which, together, represent the basis for defining and controlling the work to be done.

An objective must include four essential elements. (1) It must state the desired outcome—i.e., what is to be accomplished. (2) It must indicate the time period within which the expected outcome is to be achieved. (3) It must include measurement factors, such as quantity, quality, or cost, so that the fact that the objective has been accomplished can be verified. (4) It must indicate who is responsible for achieving the indicated results. Desirable, but not absolutely essential, elements of objectives are a description of how it will be achieved and an indication of who will determine whether the result has been achieved. (USDA Forest Serv. 1963)*

2. The specific, attainable ends toward which concentrated effort is directed.

When achieved, objectives represent significant and measurable progress toward the attainment of a broader, longer-range "goal."

Characteristically, objectives are subordinate to "goals," are narrower and shorter range in nature, have a reasonable probability of attainment within specified time periods and resources, and are attained through measurable and quantifiable achievements. Expected results are defined in terms of milestones accomplished, services produced, or some other objective measure, even though the specific contribution toward achieving the building block objective may not be measurable. (USDA Forest Serv. 1972B)*

3. "Objectives" are more specific and quantifiable than "goals" because (1) they mainly apply to a smaller constituency, (2) they usually apply to a narrower field of welfare, and (3) they can be framed with greater detailed understanding of immediate needs. (After Hills, Love, and Lacate 1970)*

Output

A broad term for describing any result, product, or service that a process or activity actually produces. (USDA Forest Serv. 1972B)*

Output, induced

The indirect result of system activities. They are generally the primary outputs of another result system. An example is a specific form of timber harvest (primary) that produces improved wildlife habitat (induced). (USDA Forest Serv. 1974A)*

Output, primary

The main goods, services, or environmental conditions of a resource system—the key indicator used to identify with meeting a goal.

For example, the production of animal-unit-months of forage for livestock or board feet of timber harvested. (USDA Forest Serv. 1974A)*

Process

The action of moving forward progressively from one point to another on the way to completion. The action of passing through continuous development from a beginning to a contemplated end. The action of continuously going along through each of a succession of developmental stages. (Webster 1963)*

Land use planning is often described as being a "process" rather than a single, finite, irreversible event in time or space. (C.F.S.)*

Reforestation

The natural or artificial restocking of an area with forest trees; most commonly used in reference to the latter. (USDA Forest Serv. 1979 Manage. Practice Documentation)
Research (including development)
Activity leading to discovery of new facts, their correct interpretation, and revision of accepted conclusions and theories. Basic research pushes back the frontiers of knowledge and provides new scientific methodology. Applied research seeks solutions to practical rather than scientific problems. As used in this report, research is extended to include development work, the "D" of "R&D." Development—focusing on delivery of new products, processes, or systems—strives for practicality by adapting, testing, evaluating, and modifying.

Revegetation
The replacement of vegetative cover which has been harvested or lost due to natural occurrences such as wildfire. Accomplished either through planting of nursery stock or seeding, or through natural processes. (USDA Forest Serv. 1979 Manage. Practice Documentation)

Riprap
A system of armoring, protective coverings, and structures used to displace the erosive force of water.

Riparian
1. In loose usage, referring to the land bordering a stream, lake, or tidewater. (Hanson 1962)
2. Of, pertaining to, or situated on the banks of a river (though by common usage extended to include any stream, irrespective of size). (Stamp 1961)

Riparian area
A geographically delineated area with distinctive resource values and characteristics that is comprised of the aquatic and riparian ecosystems. (Adopted by USDA Forest Serv. and USDI Bur. Land Management)

Riparian area boundaries
Aquatic ecosystem, floodplains, riparian ecosystems, wetlands, and the land and vegetation extending at least 100 feet, measured horizontally, from all perennial streams. (CDF Forest Practice Rules)

Riparian ecosystem
The transition area between the aquatic ecosystem and terrestrial ecosystem, identified by soil characteristics and distinctive vegetation communities that require free or unbound water. (Adopted by USDA Forest Serv. and USDI Bur. Land Management)

Riparian rights
1. The rights of owners of lands on the banks of watercourses or bodies relating to the water, its use, ownership of soil under the stream, shoreline accretions, etc. (US Bur. Outdoor Recreation 1974)
2. The rights accruing to a landowner on the bank of a natural watercourse, lake, or ocean. These rights vary with state law. Riparian rights cease at the water's edge and do not interfere with use of the water area by others offshore. (After Abrams 1971)

Significant disturbance
Man-created disturbance of surface resources, including soil, water and vegetation, which has the potential to generate degradation of water quality to the magnitude which would require corrective action. (USDA Forest Serv. 1979 Manage. Practice Documentation)

Site preparation
The activity of preparing a site for revegetation. It can be accomplished by either mechanical, chemical, or biological means, or controlled fire. (USDA Forest Serv. 1979 Manage. Practice Documentation)

Site specific
Pertains to a discernible, definable area or point on the ground where a project or activity will (or is proposed to) occur. (USDA Forest Serv. 1979 Manage. Practice Documentation)

Stream or streamcourse
A natural configuration in the land surface which transports water in perennial, intermittent, or ephemeral circumstances. (USDA Forest Serv. 1979 Manage. Practice Documentation)

Streambank
Steeped sloped earth or rocks demarking the channel of a watercourse. Streambanks may adjoin valley walls or be separated from them by a floodplain.

Streambank zone
Land adjacent to and water within any stream or streamcourse where human activities can have direct consequences on the quantity, quality, or timing of water flow or instream conditions.

Streamside
Edge of a stream as defined by a high-water line associated with "bank full" discharge of perennial streams. (USDA-Forest Service Manual, Chapter 2400)

Streamside management zone
A designated area along streams and wetlands where prescriptions are made that will minimize effects of nearby logging and related activities disturbing to land. (USDA Forest Serv. 1979 Manage. Practice Documentation. Practice 1.8)

Wattle
A woven wall or fence made of intertwined twigs or branches.

Wetlands
Those areas that are inundated by surface or groundwater with a frequency sufficient to support, and under normal circumstances does or would support, a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds. (USDA Forest Serv. 1979 Manage. Practice Documentation)

Watercourse and lake protection zone
An area clearly identified on the ground with paint or flagging, given special consideration to ensure retention of canopy for shade and to filter and stop sedimentation through marking of trees either to be retained or to be harvested. Width of the WLZ varies from 50 to 200 feet according to slope percent and class of watershed. (CDF Guidebook to Board of Forestry Watercourse and Lake Protection Rules July 1983)
Appendix B. Specialists attending the workshop

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Redding, CA 96009

Sherman Swanson  
Dept. of Range, Wildlife & Forestry  
University of Nevada  
Reno, NV 89557
### Appendix C. Assignment of specialists to teams

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<th><strong>Dominant Use Team</strong></th>
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<td>Michael Aceituno</td>
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*Team leader*
Appendix D. Conclusions expressed by the steering group after the workshop

A. Multiresource and multidisciplinary approaches to management have special importance for stream-bank zones.

1. More forums on multiple-use are needed.
2. Technical expertise is available, but people are not interacting and using available technology.
3. Management’s objectives and expectations must be defined in terms of multiple resources and acceptable alternative uses for each resource.
4. Specialists familiar with each resource should interact with other resource specialists and use a team approach to plan activities.
5. The potential impact of an exclusive resource use on multiple resource values is not fully appreciated; conversely, the impact on a single resource of using multiple resources may be overestimated.
6. Conflicts among users of resources vary in intensity, but those between grazing and fishing seem strongest in this region.
7. Conflicts among some uses may be so strong that the uses are incompatible.
8. Several different resource uses have problems that are technically related, as in regeneration of critical vegetation.
9. Specialists have the ability, in multidisciplinary or multiresource settings, to resolve conflicts, and to modify objectives and management of their particular resource in order to reach acceptable compromises.
10. Parallel teams, each comprised of a mix of resource specialists, often proposed identical or similar activities and objectives in management for multiple uses.

B. Management of streambanks and streambank zones has had too little attention.

1. Streambank zones are not well defined in the field and are difficult to define in words.
2. Streambank zones are impacted heavily by all uses of forestlands and rangelands.
3. Many streambanks have been degraded by inappropriate uses and management of resources.
4. Vegetation indicates health of streambanks and streambank zones and protects their stability.
5. Stable, healthy streambanks offer more managerial flexibility.
6. Effective controls on access by the public and livestock are essential for management of streambanks.
7. Best management practices are not being applied in management of streambank zones.
8. Effects of management practices on stability of streambank zones have commonly not been quantified.
9. Planning for management of streambank zones should utilize a systemwide approach within a watershed.
10. Controlled management of the multiple values of streambank zones is essential in order to prevent a decline in the quality and quantity of water yields.

C. Management of streams and fisheries requires great care and technical attention.

1. Stability of a stream should be of primary concern in use and management of each resource.

2. Streams integrate effects, as impacts or consequences, of management of nearby resources.

3. Streams bear for many decades, even for centuries, the sedimentary burdens resulting from activities such as road building, mining, exploitative logging, and overgrazing.

4. Inadvertent, severe damage to streams by past actions may be irreparable because natural recovery processes are so slow.

5. It is difficult to assess whether currently observed degradation of streams resulted from recent or historic events.

6. Streams channel powerful, dynamic, and unpredictable hydraulic forces.

D. Needs are great for research and extension related to streambank zones.

1. Substantial amounts of information and technology are available, but underutilized or not utilized at all.

2. Solutions to many problems will only come from integrated research and extension by multidisciplinary teams.

3. Problems requiring research and extension cover the spectrum from basic science through applied research and development to applications of technologies.

E. Social and economic benefits related to streambank zones are not quantified.

1. Information on economics of use of resources is inadequate for decision-making processes except perhaps for timber and grazing.

2. Means need to be found for partitioning and transferring the downstream benefits associated with water to those who incur costs to manage resources in headwater and midcourse areas.

3. Aesthetics and recreational values can be quantified or evaluated by techniques that permit the inclusion in resource analysis, and landowners and managers should be trained in these techniques.

F. A profusion of laws, regulations, and policies relate to streambank zones.

1. Mechanisms need to be developed to improve adherence to existing regulations aimed at sound management of streambank zones.

2. Regulations and policies pertaining to uses of a single resource should be reviewed to determine their effect on multiple resource values.