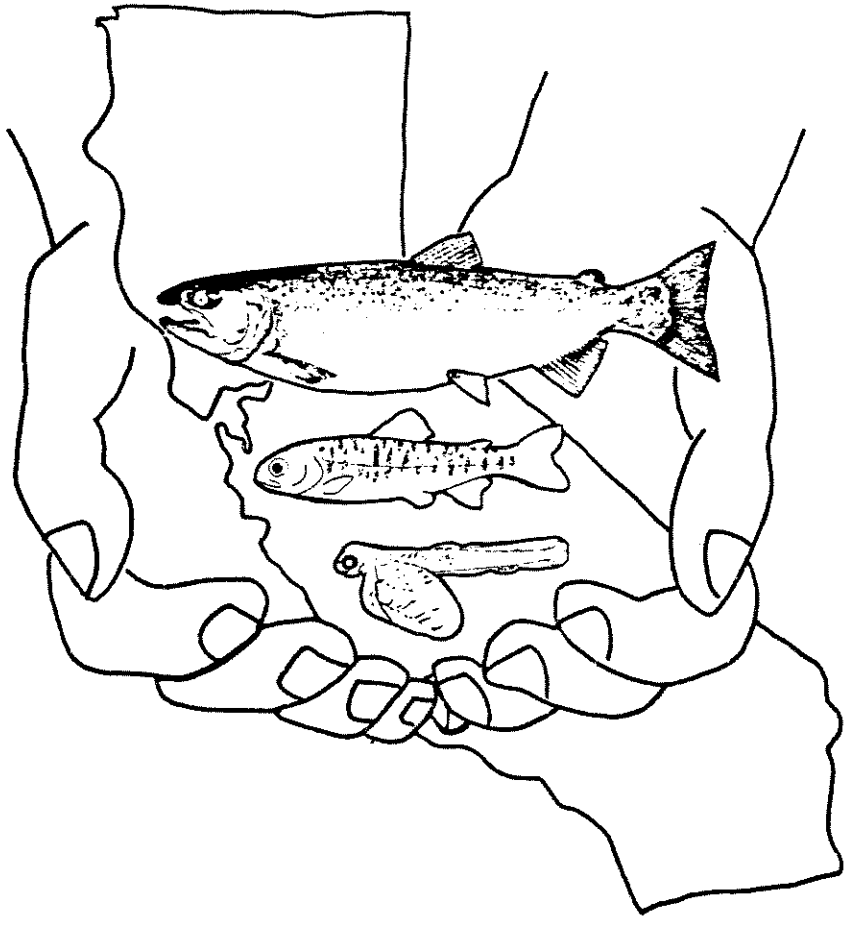
PROCEEDINGS OF THE ELEVENTH ANNUAL CALIFORNIA SALMON, STEELHEAD AND TROUT RESTORATION CONFERENCE

March 18 - 21, 1993
Eureka, California



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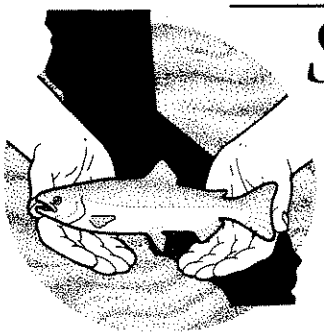

Salmonid Restoration Federation

P.O. BOX 4260 • ARCATA, CALIFORNIA 95521 • (707) 444-8903

1993 CALIFORNIA SALMON STEELHEAD AND TROUT RESTORATION CONFERENCE

FINAL REPORT

The 1993 California Salmon Steelhead and Trout Restoration Conference, produced by SRF, was held in Eureka, California March 18 through March 21, 1993 at College of the Redwoods.

The purpose for producing the conference was to disseminate information to individuals about fish habitat restoration opportunities, technical and educational methodologies and innovative technical developments; provide hands-on training; acquaint people with reference sources and materials and commercially displayed products and services; facilitate communication and cooperation among restoration practitioners and between contractors and interactive resource management agencies; and highlight specific regional and local restoration problems and treatments.

The Conference consisted of four all-day workshops, a half-day plenary session, two half-day series of concurrent technical sessions, and exhibition of commercial products and services used by habitat restorers and information displays of public and private restoration programs and projects.

The enclosed Conference Program provides more detail about the subject and content of the workshops, and plenary and concurrent sessions. The enclosed copy of the conference Proceedings contains summaries of the plenary and concurrent session presentations that were submitted by speakers for inclusion in this publication.

The event was attended by approximately 300 individuals. They included representatives of a multitude of natural

resource management agencies, non-profit and for-profit private and public contractors, fish conservation organizations, and public schools and school districts.

Over 1000 hours of work were required to complete primary coordination tasks; of these hours, 400 were paid for, and the remainder were volunteered. An additional 1000-1500 hours were volunteered by the conference production's other participants.

Appendix A: Agenda

Appendix B: Proceedings

SATURDAY MARCH 20

Banquet: At the Adorni Center in Eureka.

6:00	Happy hour
6:30	Serving begins
8:00	Entertainment
8:45	Presentation of annual outstanding achievement award.
8:50	Banquet Speaker. John Sullivan—Deputy Director Calif.Dept.of Fish & Game.
9:30	Music.

SUNDAY MARCH 21

in FM 103

8:30–9:00 **Announcements**

Sunday Concurrent Sessions
(9:15–12:15)
Session 1 in FM 100
Water Diversion Treatments: Water Diversions and the Drought—Treatments and Alternatives that Save Water and Fish.
Moderator: Dennis Maria (Calif.Dept. of Fish & Game).

9:15	"Screening of water diversions: requirements and technology" Dan Odenweller (Calif.Dept. of Fish & Game).
10:00	Break
10:15	"Water diversion screen design: criteria, construction, and maintenance" Ron Dotson (Calif.Dept. of Fish & Game).
10:55	"Alternative pumping systems" Jonathan Hill (Integral Energy Systems).
11:35	"Dealing with water rights abuse: If all else fails—file!" Bob Balocchi (Calif. Sport Fishery Protection Alliance).

Session 2 in FM 103
Grant Writing Techniques
Moderator: Shirley Kossow

9:15–12:15	"Money—how to get it!" Mimi Lufkin (Development Consulting Services)
12:30	**CSSTRF membership meeting**

CO-SPONSORS

Environmental Protection Agency • U.S. Fish & Wildlife Service—Klamath River Fisheries Restoration Program • California Department of Fish & Game • Salmon Restoration Association • Pacific Coast Federation of Fishermen's Associations • Sport Fishing Institute • Trout Unlimited • U.S. Forest Service • U.S. Fish & Wildlife Service/U.S. Bureau of Reclamation—Trinity River Restoration Program • Soil Conservation Service

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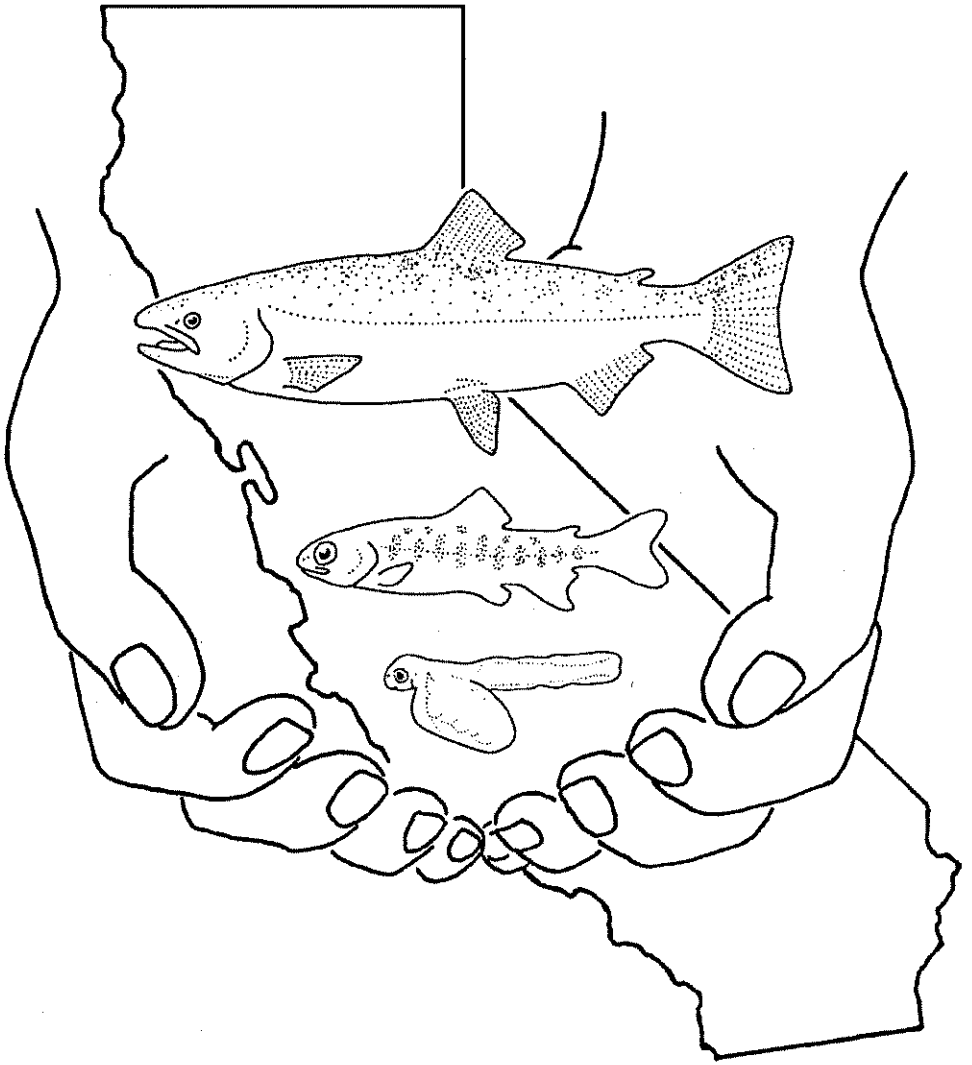
THE CALIFORNIA SALMON, STEELHEAD AND TROUT RESTORATION FEDERATION'S

ELEVENTH ANNUAL CALIFORNIA SALMON, STEELHEAD AND TROUT RESTORATION CONFERENCE



MARCH 18–21, 1993

College of the Redwoods, Eureka, California

CSSTRF's ELEVENTH ANNUAL SALMON, STEELHEAD, AND TROUT RESTORATION FEDERATION CONFERENCE AGENDA

THURSDAY MARCH 18

(8:00–5:00)

Workshop: Timber Harvest and Erosion Control. Emphasis on Road Planning, Construction, Maintenance, and Removal in FM 100.

FRIDAY MARCH 19

(8:00-5:00)

Workshop: Culvert Design, Installation and Maintenance: Fish Passage Considerations and Modifications in FM 100.

Symposium: Development of statewide organization and coordination of fish conservation education projects and programs at Humboldt Bay Municipal Water District Building.

SATURDAY MARCH 20

In FM 103

7:00 **Registration:** Coffee and baked goods will be available.

8:30 **Conference Welcome:** Dave Hope, CSSTRF President.

8:40 **Keynote Address:** "Oldgrowth forests and fish; the case for a new forestry paradigm". Jeff DeBonis (Assoc. of Forest Service Employees for Environmental Ethics).

Saturday Plenary Session in FM 103
(9:00–12:00)
Managing forests to protect salmonid stocks of special concern"
Moderator: Dr. Terry Roelofs (Humboldt State Univ.,Fisheries Dept.).

9:00 "Historic sediment production in the Salmon River: its use in developing a predictive model to assess consequenses and plan management activities" John R. West (USFS, Klamath Natl. Forest).

9:40 "Current California forest practice rules—follow up on the Grand Accord", Jim Steel (Calif.Dept. of Fish & Game).

10:15 **Break**

10:30 "The Gang of Four Report and Salmonids—current status" Gordon Reeves (USFS, Corvallis Forest & Range Experimental Station).

11:10 "The decline of salmonids in California" Dr. Ron Yoshiyama (U.C. Davis, Department of Wildlife and Fisheries Biology).

12:00 **Lunch:** in the college cafeteria.

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SATURDAY MARCH 20

Saturday Concurrent Sessions
(1:30–5:00)
Session 1 in FM 100
Revegetation and bioengineering techniques.
Moderator: Evan Engber (Bioengineering Associates).

1:30 "Incorporating revegetation and bioengineering techniques into traditional soil stabilization methods in the Walker Creek Watershed" Liza Prunuske (Prunuske Chatham Inc.).

2:15 "Riparian restoration—successful revegetation methods" Karen Gaffne (Circuit Rider Productions, Inc.).

3:00 Break

3:15 "Bioengineering Techniques" Kevin Finney and Evan Engber (Bioengineering Associates).

4:00 "Trees and trout in town: urban stream riparian habitat restoration" Nancy Reichard (Redwood Community Action Agency).

4:45 Panel Question and Answer Period

Session 2 in FM 103
Gravel mining techniques that minimize environmental disturbance:
River processes and mining regulation issues.
Moderator: Dr. Bill Trush (Institute for River Ecosystems, Humboldt State Univ., Fisheries Dept.).

1:30 "Understanding basic river processes for aggregate mining" Dr. Andre Lehre (Humboldt State Univ., Geology Dept.) and Dr. Bill Trush (Institute for River Ecosystems).

2:30 "Aggregate mining in Mendocino County streams" Dennis Jackson (Hydrologist, Mendocino Co. Water Agency).

3:00 "A case study in gravel mining: Redwood Creek" Vickie Ozaki (Redwood National Park).

3:30 Break

3:45 "Aggregate Mining and the Public Trust: Russian River" Aldaron Laird (Trinity Restoration Associates).

4:15 "Monitoring for instream gravel mining in rivers: why, what, where, how, and when" Randy Klein (Redwood National Park).

Session 3 in FM 205
Pre- and post- project evaluation.
Moderator: Carl Harral (Calif. Dept. of Fish & Game).

1:30 "A basin context for habitat restoration: lessons from Streamboat Creek, Oregon" Jeffrey Dambacher(Oregon Dept. of Fish & Wildlife).

2:30 "Monitoring of instream fish habitat improvement structures on Six Rivers National Forest" David Fuller (USFS, Six Rivers Natl. Forest).

3:20 Break

3:35 "Project evaluation; the missing link has surfaced" James Hopelain (Calif. Dept. of Fish & Game).

4:20 "Evaluation of instream restoration projects in mid-Klamath River tributaries" Alan Olson (USFS, Klamath Natl. Forest).

PROCEEDINGS OF THE ELEVENTH ANNUAL

CALIFORNIA SALMON, STEELHEAD AND TROUT

RESTORATION CONFERENCE

MARCH 18 - 21, 1993
EUREKA, CALIFORNIA

SPONSORED BY:

CALIFORNIA SALMON, STEELHEAD & TROUT RESTORATION FEDERATION

CO-SPONSORED BY:

California Department of Fish & Game
Environmental Protection Agency/
State Water Resources Control Board
Klamath River Fisheries Restoration Program
Pacific Coast Federation of Fishermen's Associations
Salmon Restoration Association
Soil Conservation Service
Sport Fishing Institute
Trout Unlimited
U.S. Fish & Wildlife Service
U.S. Fish & Wildlife Service / U.S. Bureau of Reclamation - Trinity River Restoration Program
U.S. Forest Service

EDITED BY: Jim Waldvogel
Univ. of Calif. Cooperative Extension/Sea Grant

ADDENDUM TO

PROCEEDINGS OF THE ELEVENTH ANNUAL CALIFORNIA SALMON, STEELHEAD AND TROUT RESTORATION CONFERENCE

10 YEARS OF TIMBER HARVEST RULE CHANGES

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Timber harvest rules designed to protect fisheries have improved over the past 10 years. Looking back to the early 1960's, timber harvest practices were governed by a loose set of rules which proclaimed that sediment and debris must be kept out of fish bearing streams in amounts which could damage fisheries. The controversy existed whether running log skidding tractors up draws and streambeds, cutting all the riparian trees and falling them into the stream damaged the fishery. Twenty years of discussion, not to mention the Federal and State Clean Water Acts, finally produced the basis for the 1980's Watercourse and Lake Protection Rules.

These provisions were prescriptive rules based on a system which classifies waterbodies into four protection levels beginning with fish bearing streams as the highest protection class. Standard protection was comprised of resource recognition by a Registered Professional Forester in a timber harvest plan and protection zone delineation which minimized operations, provided a filter strip for sediment, and left a protective canopy to create low water temperatures. The width of the zone depended on the classification (value) and the steepness of the sideslope (risk of sedimentation). In addition, other rules reduced erosion from bared soil and unstable areas.

Did these rules work? A study begun in 1986 reported that the rules and process to enforce them did not provide the best feasible protection, but the framework was capable of doing so with some modification. Since this study, special task forces to develop improved protection have added rules which govern tractor operation; landing and road building and their use; site preparation before planting; erosion control practices; and watercourse, lakes, and wet area buffers.

The final provision which will fine tune timber rules is being developed today. Beginning this year, a pilot study designed to determine the most effective methods to monitor for compliance and protection effectiveness will be initiated. Starting in 1994, continuous feedback monitoring is designed to help timber operators protect the State's fisheries and promises to be the best change to date.

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PREFACE

These Proceedings serve as a compendium of presentations given at the Eleventh Annual California Salmon, Steelhead and Trout Restoration Conference. Summaries of speaker's talks have been incorporated into the proceedings. Three full day workshops on timber harvest and erosion control techniques, culvert designs to improve fish passage, and coordination of fish conservation education programs were held prior to the conference. Technical papers available at these workshops are not presented in the proceedings.

The efforts of speakers and session coordinators who prepared their summaries are greatly appreciated. Editing and compilation of these papers and preparation of the Proceedings was accomplished by the University of California Cooperative Extension/Sea Grant program at the request of the Federation.

Jim Waldvogel
Editor

MANAGING FORESTS TO PROTECT SALMONID STOCKS OF SPECIAL CONCERN

Moderator: Terry Roelofs
Department of Fisheries
Humboldt State University
Arcata, CA 95521

HISTORIC SEDIMENT PRODUCTION IN THE SALMON RIVER: ITS USE IN DEVELOPING A PREDICTIVE MODEL TO ASSESS CONSEQUENCES AND PLAN MANAGEMENT ACTIVITIES

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INTRODUCTION

A study of the Salmon River basin conducted by geologists from the Klamath National Forest had two principle goals: 1) to improve current understanding of sediment production rates in the basin and their relationship to fish habitat conditions; and 2) to determine the effects of historic floods on the river system to aid in planning future watershed and fish habitat restoration.

The Salmon River, a tributary to the Klamath River, drains an area of about 751 square miles and provides high quality habitat for a variety of anadromous fish, including: spring and fall run chinook salmon (*Oncorhynchus tshawytscha*); summer, fall, and winter run steelhead (*O. mykiss*); and coho salmon (*O. kisutch*). Approximately 45% of the watershed is managed as Congressionally designated wilderness area, the remainder is a mixture of general forest with a small amount of private land. Elevations in the watershed range between 500 and 9000 feet, and precipitation is predominantly snow at elevations above 4000 feet. Annual precipitation ranges from 40 to 80 inches, with the amount decreasing in an easterly direction. Situated in the Klamath Mountains physiographic province, three distinct rock types are dominant (metamorphic, granitic, and ultramafic) and landsliding is a common geomorphic process. About 90% of the watershed is covered by hardwood, mixed conifer, douglas-fir, and true fir conifer forest. Prior to establishment of the National Forest and effective fire control, infrequent low intensity fires occurred in the area.

METHODS

Thirteen electronic data layers were developed and manipulated using ARC/INFO geographic information system. Four other data layers were manipulated using other techniques. A sediment budget was developed for the entire watershed and its 57 subbasins to accomplish three principle tasks:

1) Determine historic sediment production - Estimate the volume of sediment which was delivered to the Salmon River by landslides, surface erosion, and mining during the period 1904-1989. Aerial photo interpretation and validating field measurements of over 500 landslides, mining sites, and surface erosion plots were principle tools used to estimate historic sediment production.

2) Develop coefficients for predicting future landslide rates - The data acquired in determining historic sediment production was used to generate landslide production coefficients (yds^3/acre) for each of the geomorphic terrains. Coefficients were designed to represent potential effects of a climatic sequence similar to that of the 1965-1975 period. Coefficients pertain to three disturbance classes: roaded, harvested or burned, and undisturbed.

3) Predict future sediment production rates - Future landslide and surface erosion production was predicted for two disturbance conditions, those existing in 1989 and undisturbed. Watersheds likely to experience accelerated future landslide rates were identified. This information will be used to aid in planning the location and type of restoration activities and potential affects of other management activities proposed in the future. Assumptions used include: a) future storms will produce lanslides at rates similar to past storms; b) recovery of logged and burned land is essentiallly complete after 50 years; c) roads increase or maintain a potential for landsliding in ways which recover little over time; d) Order 3 soil layer identifies soil groups which exhibit similar erosion rates; and e) USLE (as validated with site specific information during this study) is a reasonable estimate of surface erosion in mountainous terrain.

RESULTS

During the period 1904-1988, a total of 27.7 million cubic yards of sediment entered the Salmon River system. Mining (57%) and landslides (38%) were the principle sources with surface erosion as a relatively small contributor (5%). Landslides associated with the 1964 flood occurred mainly on undisturbed ground (67% of the total landslide volume), second in areas associated with roads (30% of the total landslide volume), and least with timber harvest (2%) and fire disturbance (1%).

The 1975 disturbed area (12,055 acres or 2.5% of the basin) was composed of 7,962 acres of timber harvest, 2,893 acres of road, and 1,220 acres of hydraulic mine sites. By 1989 the total disturbed area had increased to 18.7% (89,721 acres) as a result of high intensity fires in 1977 and 1987.

Mining - Hydraulic mining of the main river valleys occurred from about 1870 to 1950 and produced an estimated 15.8 million cubic yards of sediment discharged into the river system. This resulted in major channel modifications, especially in the Upper South Fork Salmon River.

Road Construction - Road construction began in the early 1900's and by 1944 about 188 miles of road were present in the basin. By 1989, 762 miles of road had been built. The highest construction rate occurred between 1955 and 1975. During this period, landslides associated with roads contributed an estimated 3.1 million cubic yards of sediment to the river system.

Timber Harvest - Timber harvest began in conjunction with mining and homestead activity. By 1974, there were about 7,500 acres of harvested public land in the basin. By 1989, the acreage harvested had increased to about 30,000 acres (18,000 acres of that total was harvested in response to fires which burned in 1977 and 1987). During the period, landslides associated with timber harvest have contributed an estimated 0.2 million cubic yards of sediment to the river system.

Fire - Large fires involved about 70,000 acres in 1917/1918, 57,500 acres in 1977, and 102,400 acres in 1987. Though fires did not contribute significantly to landsliding (0.1 million cubic yards of sediment) surface erosion accelerated considerably after their occurrence.

DISCUSSION AND CONCLUSIONS

Natural and human influenced events have contributed to accelerated fish habitat damage in the Salmon River. Sediment produced from hydraulic mining caused major changes in channel morphology and aggravated the devastating effects of the 1964 flood in certain channel reaches. During the 20th century, landslides have contributed significant volumes of sediment to the river system. Most of the landslides are associated with flood events and occur on undisturbed ground. However, landsliding was accelerated by construction of an extensive

road system built between 1955 and 1975. Timber harvest and wildfire both result in nominal landslide rate increases, but significantly affect surface erosion in the short term.

The predictive model developed by the USFS estimates that under a climatic sequence like that of 1965-1975, existing disturbance levels in the Salmon River basin would produce about 2.7 million cubic yards of sediment from landslides. Under the same scenario, but in undisturbed watershed condition, the model predicts that about half that amount (1.3 million cubic yards) would be produced by landslides.

THE DECLINE OF SALMONIDS IN CALIFORNIA

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Recent population assessments of wild salmonid populations in California show a continous decline from historical levels. In some cases population sizes and their survival prospects are low. Many salmonid populations have been severely reduced because of habitat loss and degradation, including the loss of water. Specifically, construction of dams and water diversion structures have blocked access for fish to former spawning areas, agricultural diversions have reduced or dried up streams, and mining and logging operations have caused erosion of streamside areas and severe siltation of streambeds.

Sacramento River winter-run chinook salmon have declined since 1966. Average yearly numbers of spawners dropped from 86,500 in the late 1960's and 28,000 in the 1970's to less than 600 fish in 1989 and 1990. Spring-run chinook, once numbering 200,000-500,000 adults in the San Joaquin drainage are now completely absent. Historically, annual salmonid runs in the Sacramento-San Joaquin drainage averaged 500,000 to 1 million fish and runs in the Klamath-Trinity drainage were equally large. Wild spring chinook now number about 1,000 fish in the upper Sacramento River and perhaps 1,000-2,000 in the Klamath-Trinity drainage. Fall-run chinook have stayed relatively abundant, but even they have shown a significant decline in recent years. The San Joaquin drainage had tens of thousands of spawners in the 1980's; in comparison, there were only about 900 spawners in the 1990-1991 season and <600 spawners in 1991-1992.

Little is known about past abundances of summer steelhead trout in California. Summer steelhead now number between 1,500-4,000 spawners, divided among 25 or more isolated populations. The three largest populations (using 1991 estimates) are in the North Fork Trinity River (1,000 fish), Middle Fork Eel River (700) and New River (600). Most populations have as few as 10 - 100 steelhead and many of these populations are close to extinction. Their "holding over" pattern in deep isolated pools during the summer months makes them vulnerable to poaching. Winter-run steelhead are still widespread and abundant (except in Southern California) despite a reduction in distribution since historical times. The Southern California populations (San Luis Obispo Co. southward) are called "southern steelhead". Southern steelhead have distinctive life histories and ecological characteristics. Historically, these numbered in the tens of thousands but have been eliminated from at least 11 streams and now occupy about 1% of their former range. Currently, there appears to be a total of <500 adults distributed primarily in 3-4 streams.

Coho salmon have been less enumerated than the more valuable chinook, but have also shown significant declines in abundance. The historical abundance of coho salmon prior to exploitation times was not known. During the 1940's, the coho population may have ranged from 100,000-200,000 up to 1 million fish. In the 1980's the annual statewide average for wild spawners was 33,500. Currently, there are about 30,000 coho spawning in California, but most are now hatchery fish or hatchery derived stock. There are less than 5,000 wild coho spawners found in small populations. The largest wild population is in the South Fork Eel River, with perhaps 500-600 fish. Many coastal streams have lost their coho runs. Some 582 central-northern California streams were known to have had coho runs in the past. Almost 50% of these streams may have essentially lost their coho populations.

Pink salmon are rare in California and only minor runs existed in historical times. The last significant run of pink salmon in California occurred in 1937, when hundreds were observed spawning in the Garcia River. Small numbers of chum salmon juveniles and spawning adults have been observed in recent years in the Klamath and Trinity drainages. Also, adults has been observed in a Smith River drainage during the 1980's. A few stray chum salmon have been recorded from the Sacramento drainage over the past several decades.

The decline of salmonid populations in California has been paralleled by declines in non-salmonid anadromous fishes: Delta smelt, longfin smelt, eulachon, lamprey, striped bass, and green sturgeon. Delta smelt and longfin smelt were among the most abundant fishes in the Sacramento-San Joaquin Estuary, but have declined significantly. Longfin smelt have virtually disappeared from Humboldt Bay. Delta smelt are now being considered by the U.S. Fish and Wildlife Service for listing as a threatened species, and a petition to list longfin smelt was recently submitted to the USFWS. Eulachon were abundant in the Klamath River and adjacent streams up until the mid-1980's. Since then they have been caught only in low numbers by tribal fishermen. Green sturgeon have also shown indications of decline, due in large part to sport fish harvesting. The only known spawning runs in North America occur in the Rogue River (Oregon), Klamath River and the Sacramento-San Joaquin drainage. Green sturgeon populations are considered rare in Canada, reportedly are close to extinction in Russia, and have been extinct in Japan for at least 40 years. The concurrent declines of salmonids and other anadromous fishes indicate system-wide deteriorations of environments and require long-term and large-scale remedies.

REVEGETATION AND BIOENGINEERING TECHNIQUES

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BIOENGINEERING TECHNIQUES

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Bioengineering Associates will make this presentation in two parts. Kevin Finney of the University of Oregon will present the history of bioengineering as a method of landscape repair. Evan Engber, founder of Bioengineering Associates, will present a slide show detailing bioengineered structures built for bank stabilization, water filtration, and the recovery and rebuilding of blown out streambanks. The structures utilize live vegetated baffles to reduce the tractive force of floods. This causes the subsequent deposition of fines, a perfect growing medium for riparian vegetation downstream of the baffles.

The slide show depicts a half mile section of Streeter Creek (a tributary to Ten Mile Creek), the main drainage of the Laytonville area and a major tributary of the South Fork Eel River. The first slides show a 300 ft. creek section blown out in an oxbow shape. It was repaired using two live vegetated " L " shaped baffles and a 150 ft. brush mattress set in a standard 3' x 3' toe trench. The butt ends of willows were set in the trench and held in place with 2 ft quarried rock rip rap. The slides cover the growth of these structures over a four season time span.

We have also included slides of a recently constructed brush mattress in the Tomki Creek watershed. Other slides depict a section of Streeter Creek over a ten year time span. The structures include several live vegetated baffles, double walled cribs and gabion bank supports placed to save a large maple that had been severely undercut by scouring current during the 1982-83 floods. After the slide show a question and answer session will be held.

INCORPORATING REVEGETATION AND BIOENGINEERING TECHNIQUES INTO TRADITIONAL SOIL STABILIZATION METHODS IN THE WALKER CREEK WATERSHED

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Walker Creek, in west Marin County, drains into Tomales Bay near its entrance to the Pacific Ocean. The watershed is 73 square miles, mostly privately-owned agricultural land used for cattle and sheep grazing, with a few dairy farms in the flatter valleys. Tomales Bay is one of California's most pristine coastal estuaries. It supports a tremendous variety of marine and bird life, including a thriving local shellfish industry. Walker Creek is characterized by extreme channel erosion. Bare streambanks 30 ft. tall and 20 ft. deep gullies are common. Where the soil is stable and cattle access limited, dense stands of riparian vegetation remain. The stream continues to support steelhead trout and a remnant coho salmon population.

In 1982, following a catastrophic January storm, the State Coastal Conservancy began a resource Enhancement Program for Tomales Bay. Sedimentation was identified as a major threat to the Bay. Rapid expansion of the Walker Creek delta into the deepest part of the Bay had the potential to significantly reduce flow in and out of Tomales Bay, and thereby alter its basic ecology. In 1986, the Conservancy granted the Marin County Resource Conservation District (MCRCD) $1 million to reduce erosion in the Walker Creek Watershed.

MCRCD contracted with Prunuske Chatham, Inc. (PCI) to manage the erosion control program. Over the next five years, fifteen projects were developed throughout the watershed. Project sites were selected based on the current or potential amounts of sediment contributed to Walker Creek, accessibility and landowner cooperation. PCI had previously identified over $6 million worth of erosion control projects in 1985 in the watershed.

MCRCD and PCI had worked together on another Coastal Conservancy project in the Lagunitas Watershed where low-tech, hand-constructed erosion control methods were used. Because of the severity and size of the Walker Creek channel erosion, it was decided that such methods were not appropriate for this watershed. However, since our goals were to restore habitat and control erosion, we wanted to incorporate revegetation into our designs whenever possible.

Two of the following three examples illustrate the combination of revegetation and traditional soil stabilization techniques. The third shows an experimental design using a willow post revetment.

Example 1: Walker Creek Ranch Streambank Stabilization

This site had an actively eroding bank along mainstem Walker Creek. The bank was 30 ft. tall and approximately 250 ft. long. Also, a small tributary drainage was forming a gully in the middle of the bank failure reach. Mean annual flow at this site is 2420 cfs (cubic feet/ second) with a 25 year storm flow of 6300 cfs.

The upper portion of the bank was beginning to heal, but erosion was active at the toe and threatened the stability of the upper bank. Bank repair consisted of five components: 1) rock riprap and willow revetment to the level of the annual flood; 2) Enkamat erosion fabric extending beyond the riprap to the 100

Example 3: Gambonini Ranch Willow Post Streambank Repair

This site is on Salmon Creek, a major tributary in the upper watershed. Before repair, it was a sheer, actively eroding bank 20 ft. tall and 300 ft. long. Mean annual flow is 580 cfs with a 25 year storm flow of 1260 cfs. A smaller tributary enters Salmon Creek just upstream of the project site.

The first step was to design a new stream configuration based on a uniform curve from the small tributary to the downstream end of the erosion. A willow post revetment was then constructed along this curve using 10 ft. long poles with a minimum diameter of 4", set into drilled holes 6 ft in the channel bottom. The poles were placed 4 ft. on center. Then 1-3 in. diameter willow branches were woven through the uprights and fastened with nails. Heavy-duty excelsior mat was placed behind the revetment, followed by a 2 ft. wide layer of willow brush.

The bank was reshaped to a 2:1 slope. Lightly compacted fill was placed from the willow post revetment to the toe of the new slope. Its purpose was to recreate a flood terrace at the 5-year storm elevation. All exposed areas were covered with grass seed, fertilizer and straw mulch and a fence was installed around the entire site (except along the stream channel). Willow sprigs were planted in the new terrace, half with Vexar protectors to reduce herbivore damage.

This repair has functioned well. All the poles and many of the willow branches behind the excelsior mat have rooted and are growing vigorously. Rooting and growth is not as uniform in the horizontal members. One 12 ft. section near the upstream end has scoured and the revetment has slumped, although the poles continue to grow. In a similar downstream repair site, we added a riprap toe to the design to mitigate for this problem.

Cattle moving freely up and down the stream browsed heavily on the wall until we pounded posts horizontally into the revetment and installed a solar-powered electric fence. One unexpected bonus of the fence is that willow and alder sprouts have taken hold at the toe of the revetment.

year flood level with overlaying grass seed, fertilizer and straw mulch; 3) shaping of the upper bank to a 1.5:1 slope and application of grass seed, fertilizer, straw mulch with a light erosion control netting; 4) installation of a subsurface drain parallel to the top of the bank to intercept groundwater; and 5) construction of a fence 20 ft. from the top of the bank to restrict cattle access. The gully was stabilized with fencing, rock-lined channels, loose rock checkdams, willows and grass seedings.

The willows were collected from trees near the site. As in all revegetation work, it is important to use plant materials that are specifically adapted to the unique conditions of each site. Willows were collected the previous winter and rooted into "tree-pot" (4"x4"x14") containers. Cuttings were approximately 3 feet long to allow the tops to stick out above the cap of the rock riprap. Timing is important in this sort of project. Late season construction is better because the rooted willows need to be irrigated until the first rains. Unrooted willows can be used, however, construction needs to be done in October to maximize the rooting potential of these trees. Willows root best when cut and installed during their dormancy. Dormancy usually begins in November, therefore, working with rock in a stream channel requires that construction be completed earlier.

After the filter fabric and large toe rocks (minimum size - 4 ft.x2ft. x2ft.) were installed, additional riprap and willows were placed by hand in alternate layers. Holes were sliced into the filter fabric and the willows planted into the bank. The willow stems were protected with a pad of soil before the next layer of rock was installed.

The project has been extremely successful to date. Several mild winters allowed the willows to grow before the revetment was seriously tested. The willows in the riprap area are so dense that the rock is hidden from view. They provide critical salmonid habitat that helps cool water temperatures in exposed reaches of Walker Creek. Some willows were also planted through the Enkamat and the top layer of erosion control netting. They have not done as well, probably because the subsurface drain at the top of the bank has eliminated summer water flows.

Example 2: Mendoza Ranch Gully Repair

The site was an actively eroding gully 20 ft. deep and 1300 ft. long in the lower portion of the watershed. An existing rock headcut repair was threatened by downcutting. The gully banks were also growing wider; at the lower end of the gully they exceeded 50 ft.

Repairs were fairly traditional and consisted of laying back the gully banks, constructing seven loose rock checkdams and one earth dam surfaced with grouted rock at the downstream end, seeding and fencing. Willow poles and sprigs were installed throughout the fenced area. At one point, just upstream of the grouted rock dam, garbage was removed and replaced with fill. During the first winter an area of fill began to slump. We immediately planted willow poles 2 ft. on center in the entire fill slope. The poles were approximately 5 ft. long and 1.5" in diameter. They were pounded 4 ft. into the soil.

Three years later, the gully is thoroughly stabilized. The dense willow poles in the slump provide excellent habitat immediately adjacent to the pond formed by the earth and mortared rock dam. Mortality in the willow sprigs and poles further upstream appeared high after the first year because of rabbit damage. However, enough of these plants have regained vigor that we expect the gully will be largely forested within ten years. Two improvements that are recommended for future projects include using native grasses and managing the enclosed area with mowing, or carefully controlling grazing to restrict noxious weed growth.

RIPARIAN RESTORATION - SUCCESSFUL REVEGETATION METHODS

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Restoration of riparian ecosystems which have been adversely impacted by human activities requires a clear understanding of the processes that initially formed the ecosystem. The term "restoration" implies arrogance on the part of the restoration practitioner - what may have been marvelously simple to destroy in a few weeks or years is never as simple nor speedy to "reassemble". Despite the fact that we must accept the limitations placed upon us by time and our own ignorance of natural processes, there are a number of methods which have proven successful in laying the groundwork for the long term process known as ecological restoration.

PROJECT PLANNING AND DESIGN

1. Success Criteria:

What are the goals of the restoration project? Wildlife habitat enhancement? Fishery restoration? Restoration of specific habitat for threatened and endangered species? Small scale comprehensive restoration with significant attention to detail, or a large scale project which sets the stage for restoration? Restoration to a known, or theorized pre-existing condition? Bank stabilization? Silt reduction?

Design the project based on a clear set of goals and objectives. It is important to set criteria for judging whether the project is successful. In the interest of being honest and objective, write down project success criteria prior to project implementation.

2. Know the Site:

It is crucial to understand the restoration site from a field perspective. Projects designed solely on paper are not successful. In fact, there are numerous examples of nightmarish, surrealistic "restoration" projects which were designed with a complete lack of on-site understanding. Not only are such projects a waste of money and effort, they often cause harm to an already impacted ecosystem. One facet of a successful project is an understanding of the restoration site during all seasons, and under a variety of conditions, such as summer drought and winter flood events.

3. Understand your time frame:

It is problematic to design and implement a quality revegetation project in one year. Because riparian ecosystems are not comprised of willow and cottonwood genetic clones (ie, the result of dormant cuttings taken from a limited number of source plants), you may need to propagate container plants to ensure diversity. Site specific collection and propagation of container materials usually requires eighteen months of lead time.

PLANT SELECTION AND PROPAGATION

When you have the luxury of ecological sampling of on-site vegetation prior to impacts, take advantage of it. In most cases, rely on sampling adjacent or nearby sites, anecdotal evidence, historic photos, or knowledge of appropriate species composition and density based upon local experience. Again, a book or paper should not be the only source for generating a species list. Once a species list and planting plan have been developed (taking into account such items as available moisture, topography, geomorphology, flood return interval, climate, slope and exposure), it is time to address the collection and propagation of plants.

It is important to collect site specific seeds and cuttings for revegetation projects. Not only is genetically appropriate plant material more likely to succeed, it preserves the integrity of the ecosystem. Plants from the Los Angeles river watershed would not be appropriate for a revegetation project on the Smith river. The definition of "site specific" is fluid and is species dependent rather than habitat dependent. One must have a clear understanding of individual species' seed dispersal and reproductive mechanisms to make an informed decision about the appropriate level of site specificity.

In the restoration of riparian ecosystems, it is not essential to collect seeds and cuttings immediately adjacent to the site. "Watershed specific" is a more appropriate rule of thumb for riparian revegetation, since seeds and vegetation are regularly transported many miles through riparian systems by wind and water. Differences such as coastal seed source versus inland seed source for an individual species can be significant.

Always collect substantially more seed than is needed. We collect from a number of plant sources to ensure a good genetic mix (at ratios of 3:1 up to 5:1) depending upon the germination success for a given species. Once collected, seeds must be cleaned and stored appropriately. Pre-germination treatments are often required.

Make sure that a qualified native plants nursery propagates your plants - if you have spent significant time or money collecting seed for your project. You do not want plants at the end of the year which are rootbound, infested with pests, or too undeveloped to survive the rigors of wildland outplanting.

When propagating container plants, big is not always better. We have found that plants grown in ten cubic inch leach tubes, with minimal top growth and a well developed root system, are well suited to wildland planting. In areas susceptible to flooding, we propagate plants in twenty cubic inch deepots, or one gallon treepots. The larger size enables the plant to withstand high water events.

PROJECT IMPLEMENTATION

Timing is everything. Revegetation plants should be propagated for a fall/winter planting. It is crucial to install plants when soil moisture levels are at their highest, usually October through January depending upon elevation and climate. Equally important is allowing the maximum amount of time possible for root development prior to the dry season.

Container plants may be used in conjunction with other methods, such as dormant cuttings, to ensure project success. Large cottonwood or willow poles are often more appropriate for flood way revegetation than propagated plants. We normally protect our liner plants from rodent, insect and deer browse with protective hardware such as screens/collars and fabric mulch. However, these protective measures are often inappropriate in riparian areas subject to periodic flooding.

MONITORING AND FOLLOW-UP

Projects should be monitored for problems. Many problems can be resolved before they become irreparable. For example, drought stress can be resolved by periodic dry season watering and browse mortality can be avoided by installing temporary browse protection. If monitoring of the project reveals unexpected problems, modification of the design should be considered. Ecological restoration is an ongoing process; being rigidly attached to an initial concept is often detrimental. After monitoring the restoration effort, refer back to the success criteria - constructively evaluate the project and learn from possible errors in the initial assumptions.

PROBLEMS TO AVOID

Those with a botanical or biological background often focus on issues like successional status, species composition and ideal percent or canopy cover without looking at the fluvial processes which effect a given riparian ecosystem. It is important to design and plan projects with appropriate plant material, identify realistic species composition and percent cover. However, this effort is wasted if the entire project is transported to the next county during the first big flood event. As restoration planners we need to embrace a broad range of disciplines, including hydrology, geomorphology, wildlife and fisheries biology, as well as plant ecology.

No one likes to consider the possibility of project failure, but as resource managers, we must plan for the worst case scenario. In planning restoration and revegetation projects, designs should contain the minimum structural components required for project success. In some cases (a large river restoration project) the minimum requirement may be significant structural components and large scale geomorphic modifications involving heavy equipment. In many cases (small streams) heavy handed designs have negatively impacted the ecosystem.

A low impact approach ensures that if a project "heads downstream", it can be absorbed into the natural environment. Responsible restoration planners should ask themselves some hard questions before initializing a project: If the project fails, what will its' components look like strewn around the riparian habitat? What sort of impacts might they have on fish and wildlife? Are they biodegradeable after they have served their structural purpose, or have provisions been made for removal of structural components? Is there the potential to adversely affect the ecosystem by implementing the project? These are examples of problems to consider when conducting revegetation projects.

TREES AND TROUT IN TOWN:
URBAN STREAM RIPARIAN HABITAT RESTORATION

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Although the restoration of urban streams does not generally represent a large potential to increase salmonid populations, it does provide the opportunity to expose numbers of people to restoration concepts and benefits. Urban streams can serve as showcases for every type of habitat injury that humans are capable of inflicting. This makes streams great places to demonstrate a variety of restoration techniques.

There are constraints to the restoration of urban streams that are not encountered in wildland settings. Flood management, solar access, and visual aesthetics are just a few of the issues that must be considered for urban stream restoration to be successful. These issues are especially relevant to restoration of riparian habitats in urban settings.

The Redwood Community Action Agency (RCAA) has designed and implemented riparian restoration projects along several north coast urban streams. Biotechnical streambank stabilization was a major project component in several projects. Where stable stream situations occurred, reestablishing native vegetative diversity was a primary goal. This slide presentation illustrates some of the problems we encountered and the solutions we have developed.

In order to facilitate the restoration of urban riparian habitat, RCAA is preparing "A Manual for Restoration of Urban Riparian Vegetation in Coastal Humboldt & Del Norte Counties". The draft table of contents is included on the following pages. It provides an initial checklist of considerations for restoration of riparian habitat in urban settings.

It is our hope that the manual will be useful to streamside landowners, municipalities, citizens groups and others. By addressing real and perceived problems associated with riparian vegetation, this information can be used to overcome landowner's resistance to establishing vegetation. Also, it will help to avoid the future creation of problems. Every effort must be made to insure that riparian vegetation is seen by landowners, agencies and the public as an asset and not a liability.

Interested readers are encouraged to contact RCAA regarding the availability of the Manual. We hope to have it printed by the end of 1993.

A Manual for Restoration of Urban Riparian Vegetation in Coastal Humboldt & Del Norte Counties

Prepared by
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GRAVEL MINING TECHNIQUES THAT MINIMIZE DISTURBANCE: RIVER PROCESSES AND MINING REGULATION ISSUES

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AGGREGATE MINING IN MENDOCINO COUNTY STREAMS

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The streams of Mendocino County provide valuable anadromous fish habitat and high quality aggregate (gravel). Mendocino County has rugged mountainous terrain, few well developed valleys and is underlain by Franciscan soils. Erosion of this Franciscan Complex produces aggregates of low durability and creates large quantities of suspended sediment. These aggregates tend to concentrate in the active stream channel as storage bars and riffles. Hence they play important roles in providing anadromous fish habitat. Fluvial transport converts the aggregates of low durability to sand, thereby increasing the concentrations of the more durable aggregates. This results in a competition for the limited supply of good gravel in Mendocino County streams.

The California "Surface Mining and Reclamation Act" (SMARA) designates counties as a lead agency for the CEQA (California Environmental Quality Act) process. To comply with CEQA, the Mendocino County Department of Planning and Building Services must assure that no adverse environmental impacts will occur from any in-stream aggregate extraction use permit they issue. The limitation of adverse impacts from in-stream aggregate extraction requires a careful evaluation of the fluvial geomorphology of the permit stream.

The first aspect that must be investigated is the long term relationship between the bedload supply and the stream transport capacity of the stream. The supply-transport relationship varies spatially along a stream and temporally with flow conditions. However, the morphology of the stream dictates the general nature of the long term supply-transport relationship.

There are three types of supply-transport relationships. The Russian River is an example of a system where the transport capacity greatly exceeds the bedload supply. The Russian River is cutting into its bed and exposing the Ukiah formation (a clay and gravel conglomerate with little habitat value). The Mendocino County portion of the Eel River is an example of a system where the bedload supply exceeds the transport capacity for most flow conditions. The Eel River is renown for its large relic storage bars deposited during the 1964 flood event. The Garcia River represents a system where the supply-transport relationship is in balance. A portion of the Garcia River runs along the San Andres fault, resulting in a natural high sediment supply. However, the Garcia has a high gradient and large unit runoffs to effectively transport this sediment supply.

Clearly, aggregate extraction should be avoided in a system with an inadequate supply of bedload. It is preferable to avoid aggregate extraction in most systems where the supply-transport relationship is in balance. However, political and economic pressures often demand aggregate extraction from balanced systems. This presents the challenge to limit the potential adverse impacts to the system through careful designs of projects, and monitoring or enforcing permit conditions. Aggregate extraction should be allowed in systems where the bedload supply exceeds the transport capacity, however, careful project design, monitoring and enforcement are still needed to avoid adverse impacts.

The second aspect that must be investigated is the importance of stream channel topography. Bedload transport capacity depends on the water surface slope and depth of flow. Slope and flow are influenced by stream channel topography. Bedload supply is also influenced by channel topography. Understanding the transport-topography and supply-topography relationships is essential to designing in-stream extraction projects that will have minimal adverse impacts.

The third aspect that needs investigation involves measuring impacts which result from decreasing the in-channel storage of aggregates and how this affects areas downstream from the extraction site. This is an extremely difficult question to investigate since the downstream response depends on the actual sequence of flow events over time. Also, the topography survey information necessary to evaluate impacts is frequently not available.

Long term monitoring is an important aspect of project design. A monitoring program must be able to detect significant changes in the stream system. The monitoring program must be done consistently and data must be analyzed correctly. There also needs to be a legally binding method of altering the project if monitoring results show adverse impacts on the channel.

MONITORING FOR INSTREAM GRAVEL MINING IN RIVERS: WHY, WHAT, WHERE, HOW, AND WHEN

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INTRODUCTION

Commercial mining of river gravel has become a controversial issue in recent years. A wide range of negative impacts has been attributed to instream mining. These include aquatic and riparian ecology; destruction of private property; damage to local, state, and federal public works (bridges, levees, etc.); loss of recreational opportunities; and reduced aesthetic values. However, establishing direct cause and effect linkages becomes difficult due to the lack of quantitative information and the complex behavior of rivers. In this talk, I'll only be addressing the most common aspects to physical monitoring, although documentation of biological effects is also an important consideration in any comprehensive monitoring program.

WHY MONITOR?

Much time, energy, and money can be wasted on discussions revolving around the effects of gravel mining based on inadequate quantitative information and information which is obsolete. A properly designed monitoring program would provide the data necessary for resolving many issues. Only with an adequate monitoring program can we begin to understand how instream mining directly affects the river by mechanical site disturbance and indirectly by influencing geomorphic processes. Without this understanding, intelligent planning decisions cannot be made which balance the economic benefits of mining with other concerns.

WHAT TO MONITOR?

Specific objectives must be identified for a monitoring program. These should be based on known or anticipated effects and these goals should track direct or indirect effects. The exercise of clearly defining objectives will bring important issues to the forefront and direct monitoring activities appropriate for a specific river reach.

The need to characterize changes in the physical form of a river reach will be common to all monitoring programs. Changes in bar heights relative to the thalweg, slope of the river, width, depth, sinuosity, elevation of the thalweg, and amount of gravel stored in a section of the river are all important elements of a river's form which can only be obtained by monitoring.

WHERE TO MONITOR?

Site specific monitoring will give information on the direct effects of mining. For example, alterations to vegetation patterns and hydraulic geometry from skimming operations on a point bar may be documented using cross sections and mapping from sequential aerial photos.

From a geomorphic perspective, it is important to understand the overall trends in large segments of the river. Is it aggrading (rising in elevation) or degrading (downcutting)? Is it widening, becoming narrower, or migrating laterally? These types of geomorphic trends have obvious implications for aquatic and riparian habitat and the stability of engineered instream structures and are not adequately characterized by site specific monitoring. A relatively large mining operation, or a cluster of smaller ones, may cause changes in the river which extend upstream and downstream beyond the extraction site(s). Documenting such effects requires monitoring of the channel some distance from the operation(s), usually off the properties of those involved. While this can become problematic from an administrative and legal standpoint, offsite monitoring is important.

HOW TO MONITOR?

Characterizing the river's physical form is accomplished by topographic surveys. The most commonly applied method for obtaining topographic information is to establish cross sections. These are survey lines which cross the channel perpendicular to the centerline of the active channel, giving a two dimensional representation of the river. Cross sections must be spaced close enough together to allow interpolation for calculating volumetric changes in stored sediment (gravel). Use over a period of several years requires that permanent endpoints be established which extend beyond the horizontal limits of the active channel. They need to be referenced to some common vertical datum (such as mean sea level, or NGVD) and to horizontal control points.

Alternatively, topography can be characterized by three dimensional mapping. Modern surveying equipment and computerized handling of data makes this type of mapping a cost-effective alternative to more traditional cross sections. With a three-dimensional data set in digital form for a river reach, greater flexibility is possible for the types of analyses performed.

Also essential for monitoring is sequential aerial photography. This is the most cost-effective means of obtaining information on changes in the platform of the river and can be valuable for filling in topographic details which were not covered by surveys.

On large rivers, cross sections will be large. In some instances, repeated surveys need not cover the entire width of the cross sections. Post-mining surveys should cover the mechanically disturbed areas and post winter surveys should cover areas inundated by the previous winter's high flow. Limiting surveys to areas where topography may have changed can reduce costs.

Where trenching is proposed, a survey of longitudinal profiles of the thalweg may be needed to document degradation. While cross sections give thalweg elevations, they are usually too far apart to give sufficient detail to develop a longitudinal profile. In three-dimensional surveys, a longitudinal profile can be incorporated as part of the survey job.

WHEN TO MONITOR?

Climatic changes in northern California make monitoring physically impossible for much of the year. River surveys depend on flow rates that allow wading or floating to survey points across the deepest part of the channel (thalweg). This is generally possible only from May through September and coincides with the predominant mining season.

A spring survey is necessary to characterize the net effects on the river from high flows. If a river reach is mined during the year a survey is necessary following the end of the mining season. Using this type of schedule, the spring surveys can be considered the "after" condition relative to the previous high flow season and the "before" condition relative to the upcoming mining season.

Vice-versa, the post extraction surveys can be considered the "after" condition relative to the mining season and the "before" condition relative to the upcoming high flow season.

SUMMARY

The foregoing is a brief discussion of certain aspects of monitoring instream gravel mining. Situations will arise which will require other types of monitoring not mentioned here. Additionally, I've only mentioned elements related to collection of important information.

Equally important to any successful monitoring program is analysis and interpretation of the information by a qualified geomorphologist with assistance from an engineer when cases involve instream structures. This last step is often excluded and information is simply filed without being used to guide river management. With ever increasing demands on river resources, monitoring and interpretation will become more important to developing sound river management strategies.

PRE- AND POST- PROJECT EVALUATION

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A BASIN CONTEXT FOR HABITAT RESTORATION: LESSONS FROM STEAMBOAT CREEK, OREGON

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This talk will summarize research on the ecology of juvenile steelhead in the Steamboat Creek basin, Oregon. Concepts gained from this work have been extended to a general approach for the interpretation of basin-wide fish and habitat inventory results.

Steamboat Creek is the largest spawning tributary of the North Umpqua River drainage for summer- and winter-run steelhead. Early logging practices in the basin denuded riparian canopies and removed large woody structures in the stream channels. Prior to this study, intensive habitat restoration efforts by the USFS had placed over 500 habitat structures within the basin, primarily in upper tributary channels. These restoration efforts occurred witho ut a basin context, or a clear indication of factors limiting smolt production. To provide such a context, stream habitat and fish populations were inventoried in the summers of 1987 and 1988, and juvenile steelhead emigration was monitored in 1988.

Inventory results were interpreted at two spatial scales: 1) the stream segment level and 2) the habitat unit level. The first and most useful result for a basin inventory is simply "how many fish and where." Perceptions about what areas of a basin are important for fish rearing are often formed by relative comparisons of fish densities obtained from isolated stream reaches, and not by an account of the total basin population. The relative "impo-rtance" of a stream segment within a basin is best defined by what percentage of the population is rearing there. A surprising result from this study was the relative contribution of different tributary and mainstem segments to the total numbers of steelhead greater than one year of age (age >1). The majority of age >1 fish in the basin were in two mainstem channels segments. Although tributaries had relatively high densities, they individually made minor contributions to total fish numbers.

Interpretation of inventory results at the habitat unit level explained patterns of fish abundance at the stream segment level. While comparisons of fish densities in habitats "within" a given stream segment can be useful, such comparisons "between" segments can overlook underlying patterns and be misleading when total fish density between segments differs greatly. Habitat utilization between stream segments was described by electivity indices that allow for the comparison of resource uses which differ in availability.

Habitat utilization differed greatly between tributary and mainstem channels. Age >1 steelhead showed a high selection of pools in tributary channels, and riffles in mainstem channels. Age 0 fish appeared to be less selective in their use of habitat. This phenomenon can be explained by differences in riffle depth and the relative body size of the two age classes, where age >1 fish were apparently excluded from shallow riffles in tributary channels.

Summer stream temperatures throughout the basin approached or exceeded lethal limits reported for juvenile steelhead in laboratory studies. These high stream temperatures appeared to affect habitat utilization. With

increasing stream temperature, the use of riffle habitat by both age 0 and >1 steelhead increased and the use of pool habitat decreased. Research at a microhabitat level indicates that this is a response to increased metabolic rates, which increase with temperature in fish. To maintain growth at higher temperatures, fish move to swifter focal points where they encounter greater invertebrate drift.

The factors of stream size and temperature appeared to have an over-riding control on fish abundance. Fish abundance was limited in some channels as a function of riffle depth, and was lowest in warm low gradient mainstem segments that lacked riffle habitat. It was concluded that the single most important factor limiting age >1 steelhead rearing in the basin was stream temperature.

The monitoring of juvenile steelhead emigration revealed that a small number (4,100) of smolts were produced in the basin, while a large number (62,000) of age >1 parr emigrated during the spring and summer. Smolts leaving the basin were of relatively small size and were expected to achieve poor smolt-to-adult survival. Therefore, Steamboat Creek provided only partial juvenile-to-smolt rearing for most steelhead originating in the basin. The majority of parr emigrated during the spring prior to low stream flows and high water temperatures. I suggest that the emigration of parr from Steamboat Creek may be a life history adaptation that takes advantage of rearing conditions downstream in the North Umpqua River. Emigrant parr rearing in the North Umpqua River may be the major contributor to adult steelhead returns.

An analysis of benefits from potential habitat restoration structures in four candidate tributaries of Steamboat Creek (given highly optimistic conditions of success) estimated a net return of only 66 adults. When compared with a projected return of 2,580 adults from natural production, it is apparent that habitat structures are not an important management option in this basin, given the possible life history patterns of steelhead in this basin and the present temperature regime. Substantial recovery of stream temperatures and structure in the Steamboat Creek basin depends upon continued long term recovery of riparian zones.

MONITORING OF INSTREAM FISH HABITAT IMPROVEMENT STRUCTURES ON SIX RIVERS NATIONAL FOREST

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Over the past 15 years, fisheries biologists have been using instream structures to restore or enhance fish habitat in streams with important fishery resources. In California, funding for instream structures was made available through a series of legislation and state bond proposals. Funding was specified for use towards materials and labor only, thus design monitoring for these projects was often un-funded. As a result, numerous instream structures have been placed into streams but little information is known about their effects on stream morphology or aquatic communities.

Six Rivers National Forest, in cooperation with the California Department of Fish and Game and the USFS Pacific Southwest Research Station has undertaken several short-term, intensive studies of instream structures. Over the past 12 years approximately 1200 instream structures have been placed into anadromous fish streams throughout the Forest. In 1989, we began a Forest-wide long-term monitoring program of instream structures in an effort to learn how different structures effect the stream and to make more effective use of fishery restoration monies.

Physical and biological effects of structures are monitored in the project areas before and after project implementation. Once a project site is identified, the entire area that will be affected by the structure is mapped using a Redy-Mapper (a quick mapping tool) which produces an accurate planar map of the area. For structures such as deflectors, boulder clusters, weirs, or digger logs that are intended to create localized changes in channel morphology, we shoot a longitudinal profile of the area and cross-sections through locations that are intended to be modified. These data yield three-dimensional documentation of the physical attributes of a site before instream structures are installed.

Planar maps are constructed for structures that are solely intended to increase cover. The same data set is collected after structures have been placed and sufficient flows have occurred. The data is collected multiple times in future years to document the evolution and effective life span of different structures placed in different channel types. The planar maps, longitudinal profiles, and cross-sections are stored in Design-Cad (v. 4.0) software that enables maps to be stored on different layers and then overlayed. Pre-project maps and profiles can then be overlayed with post-project maps and profiles to detect the effects of the structures.

Biological monitoring of instream structures varies with the intent of the structure and the fish species occurring in the area. Instream structures on the Six Rivers National Forest are targeted to create or improve habitat for salmon and steelhead during rearing and/or spawning phases of their life cycles. In most cases, only a few other fish species inhabit these streams.

For streams containing chinook salmon populations, spawning index reaches are surveyed repeatedly every seven to ten days during the spawning season (October through January). Structures, such as weirs, deflectors, and boulder clusters, sort and collect gravels suitable for chinook spawning. The amount of

spawning associated with these structures is documented during spawning surveys. In some streams, spawning associated with structures comprises more than half of the spawning within index reaches.

The intent of most structures on the Forest is to increase depth, cover, and habitat complexity for both spring rearing of chinook salmon juveniles and late-summer rearing of one- and two-year old juvenile steelhead. If habitat quality is increased, it is believed that fish utilization of these areas should increase.

Fish counts are conducted in structure reaches several years prior to the project construction and periodically after structures are installed. Monitoring of these structures is done by direct snorkel observation fish counts within the entire stream reach affected by the structures. Paired divers start at the downstream end of a structure reach and work slowly upstream counting all salmonids in the reach. Association with specific structures is noted. In conjunction, nearby control reaches are counted on the same day. Since natural year-to-year fluctuations in fish populations are great, control reaches are necessary to separate the effect of structures from the effect of natural variation in population size.

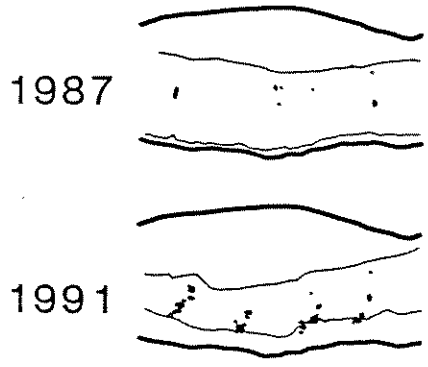
Chinook salmon counts are conducted during the spring (April through June) and steelhead counts are conducted during summer low-flow conditions (August and September). Due to uncertain stream conditions during spring dives, counting juvenile chinook salmon has shown limited success.

The methods described above have particular strengths and weaknesses. Their main strengths include cost effectiveness, easy implementation and usable data (Figure 1). The weaknesses include: 1) they don't tell us whether the production of the targeted species is actually increased or not; 2) they only focus on the targeted species (salmon and steelhead); and 3) they ignore other members of the stream community that could be affected by the structures. We recently obtained information on the effects of boulder deflectors on a species of frog and now plan to expand our knowledge of the effects of structures on non-target species.

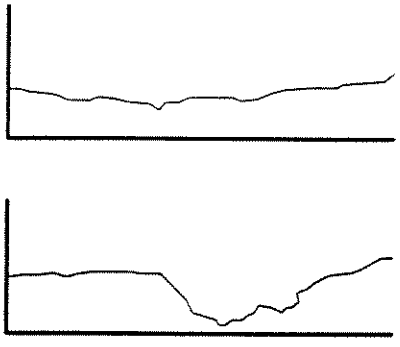
The success of this monitoring program will be determined over time. We hope to be able to increase our knowledge of the effectiveness of various structure types and use this knowledge to refine future instream structure technology.

Figure 1. Sample of data collected from monitoring instream fish habitat improvement structures on Six Rivers National Forest:

A. Before and after planar maps of a stream reach treated with boulder wing deflectors;



B. Before and after cross-section profiles of a stream reach treated with boulder wing deflectors;



C. Numbers of juvenile steelhead counted in a stream reach before and after treatment with boulder wing deflectors and in a stream reach designated as a "control" reach.

PROJECT EVALUATION; THE MISSING LINK HAS SURFACED

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The Department of Fish and Game has administered about 2,000 individual restoration project contracts since 1981, when significant funding became available for salmon and steelhead enhancement and restoration. Funding criteria specifically eliminated pre-project assessment studies or post-project evaluations. Therefore, during the past decade when hundreds of habitat projects were completed, only a handful were evaluated for environmental benefits. The Department of Fish and Game has been overdue in addressing the question of "what are the benefits of past restoration efforts?" To answer this question and investigate the effectiveness of specific habitat manipulation techniques, the DF&G recently commenced a program to evaluate selected projects completed during the past decade.

The present evaluation program was initiated in May 1992, and some preliminary data collection and analysis has occurred. Since no completed evaluation analyses exist, this presentation focuses on the approaches and methodology that post-project evaluation programs are expected to achieve.

Initially, the evaluation process involved placing completed habitat restoration or enhancement projects into the following categories:

A. Fish passage improvement.
B. Stream and riparian habitat enhancement structures.
C. Erosion and sediment control.
D. Rearing and trapping.

Since most projects of concern lack pre-project data that describes the project site physically or biologically, post-project evaluations are structured to address the following concerns:

1. Physical integrity of the structures.
2. Habitat quality and quantity resulting from the project.
3. Use of the project area by adult and/or juvenile fish.
4. Success of riparian and upslope vegetation improvements.
5. Has the employed habitat manipulation achieved the desired objective?

The evaluation program also coordinates the collection of baseline and pre-project data in selected areas. These data are expected to allow comparisons between pre- and post-project habitat conditions. Baseline data will include habitat typing, sediment sampling, riparian vegetation densities, adult and juvenile fish abundance, and water quality features.

The positions (latitude and longitude) of completed and proposed projects are also being determined using global positioning system (GPS) technology for incorporation into a geographic information system (GIS). The GIS program will enable rapid retrieval and mapping of habitat restoration project locations throughout California.

EVALUATION OF INSTREAM RESTORATION PROJECTS IN MID-KLAMATH RIVER TRIBUTARIES

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Considerable attention and funding has been invested in fish habitat enhancement and restoration throughout the Pacific Northwest in the last two decades. Only recently have managers begun evaluating the effectiveness of those activities that have centered on modification of instream habitat. Increasing scrutiny by the public and the scientific community in face of continued declines in fish populations has prompted these evaluations.

The restoration of anadromous fisheries habitat in mid-Klamath tributaries has been facilitated through cooperative investigation and project implementation. Restoration opportunities in Indian Creek (a fifth order tributary near Happy Camp, California) were identified during habitat assessment inventories funded by the U.S. Fish and Wildlife Service (USFWS) and U.S. Forest Service (USFS) in 1988-89. Funding for instream projects was provided by the California Department of Fish and Game (CDFG) and USFS for implementation in 1990. The purpose of this talk is to provide an assessment of the effectiveness of the restoration projects.

The objectives of the project were to 1) increase available spawning habitat, 2) create habitats similar to those "preferred" by juvenile salmon and steelhead, and 3) enhance habitat complexity, providing summer/winter rearing cover for juvenile salmonids. Our restoration design included placement of boulders and rootwads to form deflectors, clusters, and weirs at four sites within a 8.5 km reach of Indian Creek. Structure type and arrangement were configured to suite local channel conditions.

METHODS

Changes in physical habitat were evaluated by project level habitat typing and topographic surveying with monumented benchmarks. Monitoring of abundance and distribution patterns of juvenile salmon and steelhead was evaluated by direct observations (snorkel counts) from May through October. Diver observations of rearing salmonids were mapped to describe spatial distribution and cover association by species and age class. Spawning ground counts were conducted during fall and spring to assess chinook, coho, and steelhead spawning habitat utilization. Redd construction associated with treatment areas was evaluated with respect to average use and availability in untreated habitat.

RESULTS AND DISCUSSION

Results from the project monitoring indicated an increase in sympatric utilization by juvenile salmon and steelhead in modified habitat, shifting from uses dominated by a single species or age class. In addition, juvenile salmon and yearling steelhead densities were higher in treated versus untreated habitats. These observations were common to all treatment sites and appeared to correspond to increased habitat complexity. Juvenile salmonids were associated more frequently with complex combinations of boulders and rootwads than relatively simple arrangements of boulders alone.

Utilization of treated habitat by spawning adults remained inconclusive because significant increases in suitable spawning habitat did not occur. To date, physical changes in channel form have been minor, due to the absence of channel forming flows since the initiation of instream work. Holding adults, present in summer and fall, have frequently been observed using cover within treated habitats. The addition of cover and complexity within habitat units has been significant and should increase through time as wood and other organic materials collect.

It is important to recognize that temporal patterns of habitat use exist and that monitoring strategies be tailored to effectively evaluate restoration objectives. The effectiveness of particular monitoring techniques will be determined by the species and age class evaluated, season, and environmental conditions present during sampling. Response of non-game community species to our restoration activities in Indian Creek was not effectively monitored, due to the monitoring techniques used. Also, overwinter utilization of treatment sites remained unknown because of the absence of sampling during this period.

Evaluation of project effectiveness is routinely required by agencies sponsoring stream channel restoration. However, most monitoring guidelines are seldom specific. Monitoring is designed to reflect the degree to which the project met its stated objectives. A desired condition for measuring habitat parameters should identify habitat needs and restoration prescriptions.

The resources of local agencies and restoration programs are frequently insufficient to assess changes in fish production resulting from restoration activities. However, the evaluation of the effectiveness of project activities cannot be ignored if we are to practice responsible fish habitat rehabilitation.

WATER DIVERSION TREATMENT:
WATER DIVERSIONS AND THE DROUGHT -
TREATMENTS AND ALTERNATIVES
THAT SAVE WATER AND FISH

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WATER DIVERSION SCREEN DESIGN: CRITERIA, CONSTRUCTION AND MAINTENANCE

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Water diversions in public streams divert more than just water from those streams. The fish that depend on water for their survival are also vulnerable to being syphoned off into water delivery systems; destined to becoming fertilizer in some irrigated farm field or pasture. In order to avoid this occurrence, the California Department of Fish and Game (CDFG) has been engaged in operating and maintaining screening devices that keep fish in the stream and out of these diversions. The Department continues to research new designs that are cost-effective and require minimal maintenance ("self-cleaning"), while still meeting specific design criteria to assure maximum fish protection (see criteria list in Dan Odenweller paper).

Screening of water diversions within the Klamath River Basin is not new. The first fish screens were installed over 60 years ago. One of the earliest "self-cleaning" screen structures was designed and built by the original California Conservation Corps in 1933. This screen consisted of a sloping perforated steel plate and contained a water driven paddle wheel used to power a wiper blade which moved up and down. Such a screen, in use on Patterson Creek (Siskiyou County) for many years, is now on display at the Yreka Stream Improvement Headquarters.

This original sloping plate design and similar designs did not provide for fish bypass and the wiper device was found to kill fish under certain stream flow conditions in association with relatively heavy concentrations of debris. Many sloping plate screens still in use today have electric-motor driven gang wiper assemblies. To reduce fish kills associated with past wiper designs, wipers are now designed to move from side to side instead of up and down. Fish bypass and debris buildup problems still exist with this design because of their perpendicular orientation to the flow. Stop logs (logs placed across the stream surface) placed upstream of the screen device are used to help alleviate debris related problems.

Rotary Drum Screen: During the early 1940's, many new fish screen designs emerged. One was the rotary drum screen. Although this screen held up better to stream debris related problems, it had other problems. The screen had difficulty maintaining a fish-tight seal, making small fish vulnerable. In addition, the rubber seals placed at the ends of the rotating drum required relatively constant maintenance. To operate properly and effectively, these screens required constant water levels and needed a reliable fish bypass device installed. Although they were built to be water driven, most rotary drum screens are electric-motor driven to increase their reliability under various stream conditions.

Tube Screens: Tube screens, a design best suited for small diversions (<2 cfs), are constructed of perforated plate material. As the name implies, this design is a screened tube or cylinder whose open end is placed over a diversion pipe or culvert. One of the big advantages of this design is that it contains no moving parts to fail or wear out. However, tube screens still require periodic cleaning by hand and water elevations must be controlled for the screen

to operate properly. Tube screens should be designed to provide an approach velocity of 0.0825 feet-per-second (fps) and should be cleaned to prevent approach velocities from exceeding 0.33 fps. (Note: approach velocity is defined as the local velocity component which is perpendicular to the screen face.)

Vertical Diagonal: As this screen name implies, the screen stands upright in the stream and runs diagonally across the directions of stream flow. This layout helps reduce approach velocities, preventing small fish from being impinged against the screen. This design first appeared in the early 1960's. When properly constructed it is nearly 100 percent fish tight. Installation of this design requires the construction of a concrete foundation and walls to support the screen and wiper assembly. The wiper assembly can be water powered or motor driven. Fish bypasses can be easily incorporated into this design, allowing for unimpeded fish migration past the screening facility. The design is best suited where fluctuating water levels occur, allowing these screens to operate in streams with high spring flows or low late-summer flows. A major drawback to the design is the weight that the wiper assembly puts (added pressure) on the track bearings, causing the bearings to fail more frequently.

Sloping Vertical Diagonal: Developed in the late 1970's, the sloping vertical diagonal (SVD) screen has proven to be the most cost effective and successful design to date. As with the vertical diagonal screen, the SVD screen provides for parallel stream flows past the screen face, allowing for lower approach velocities. The screen panel lays back at a 12 to 15 degree angle allowing the wipers to rest on it. This helps remove much of the load on the track assembly and results in extended life for the track bearings. This self-cleaning wiper design can be water powered or motor driven and can be used in stream flows ranging from 1.5 cfs to over 100 cfs.

Fifty-eight water diversion screens are currently being operated by CDFG in Siskiyou County. These screens are saving an estimated 1 - 2 million, "young-of-the-year" salmon and steelhead annually. There is a substantial maintenance effort required to keep these screens operating. Improved screen designs and constant maintenance of screen facilities already in operation will be required to continue to save salmon and steelhead for our future generations.

GENERAL FISH SCREENING CRITERIA[1]

1. Structure Placement
   - A. Streams and Rivers (flowing water):
     The screen face shall be parallel to the flow and adjacent bankline with the screen at or streamward of the annual low flow water's edge. The bankline shall be warped to match the screen structure, eliminating eddies in front, upstream, and downstream of the screen. Intake structures shall not be constructed shoreward from the normal bankline in locations where parallel velocities past the screen cannot be provided
   - B. Lakes and Reservoirs (non-flowing waters):
     Diversion structures and/or intakes shall be constructed offshore to minimize fish contact with the diversion. Velocity from any direction toward the screen shall not exceed the approach velocities in No. 2 below.

2. Approach Velocity (Local velocity component perpendicular to screen face)
   - A. The approach velocity shall not exceed 0.33 feet/second.
   - B. The approach velocity shall be uniformly distributed across the face of the screen.
   - C. The actual wetted screen area, excluding area affected by structural components, required at the minimum stream stage is calculated by dividing the maximum diverted flow by the allowable approach velocity.
   - D. Fish screens shall be considered continually cleaned when a cleaning cycle can be completed and continues at 5 minute intervals or less.
   - E. Fish screens shall be cleaned as frequently as necessary to prevent impedance of flow and violation of the approach velocity criteria.
   - F. Screens which are not continually cleaned shall be designed with an approach velocity of 0.0825 feet/second and shall be cleaned when the approach velocity becomes 0.33 feet/second.

3. Velocities Past Screens
   - A. In flowing streams, the component of the velocity parallel and adjacent to the screen face shall be at least two times the allowable approach velocity. Screen faces shall be placed flush with any adjacent screen bay piers or walls to allow an unimpeded flow of bypass water parallel to the screen face.

4. Screen Openings
   - A. Continually cleaned screens shall have a minimum open area of 1½ square feet per cubic foot/second. Screens not continually cleaned shall have a minimum opening of 6 square feet per cubic foot/second.
   - B. Round openings in screening shall not exceed 5/32 inch.
   - C. Square openings in screening shall not exceed 5/32 measured diagonally.
   - D. Slotted openings in screening shall not exceed 3/32 inch.
   - E. Orientation of the long axis of slot or rectangular openings shall be vertical when installed in flowing water.

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[1] Criteria developed pursuant to Fish and Game Code Sections 1600, 5900, and 6100

5. Screen Construction

A. Screens may be constructed of any rigid material, perforated or woven, that provides water passage while physically excluding fish.

B. Corrosion resistant screening material is recommended for the screening material to reduce opening clogging due to corrosion blocking.

C. Plans shall be provided to the Department which show that all the applicable screening criteria have been met before written approval can be granted by the Regional Manager.

D. All fish screens constructed after 1982 shall be designed and constructed to satisfy these criteria. Owners of existing screens approved by the Department prior to 1982 shall be required to upgrade their facilities to satisfy the revised criteria as: 1) the screen components deteriorate and require replacement (ie., change mesh size or mesh orientation when the mesh on panels or rotary drum sections needs replacing, or 2) during modification/ reconstruction of the intake facilities (ie., change screen alignment or increase screen area to satisfy approach velocity requirement), or 3) when the owner proposes to increase the rate of diversion which would result in violation of the approach velocity criteria without the construction of additional screen area.

E. Supplemental criteria may be issued by the Department in the future to accommodate new fish screening technology which may be developed or to modify these "Screening Criteria" if new scientific data warrants revision.

F. Written variances to these screening criteria may be granted with the approval of the Regional Manager and concurrence with the Environmental Services Branch and Anadromous Fisheries Branch or Inland Fisheries Branch chiefs.

SCREENING OF WATER DIVERSIONS: REQUIREMENTS AND TECHNOLOGY

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INTRODUCTION

The screening of water diversions has been and continues to be a challenge for the Department of Fish and Game (DFG) and water users. Until recently, screening was guided by the following Fish and Game code sections:

Section 5980 - Covers diversions over 250 CFS. Diversions shall be screened, if ordered by DFG, and the costs shall be shared. There is an exception to cost sharing provisions if the diversion is part of a project which generates power.

Section 6020 - Covers diversions less than 250 CFS. DFG may screen and operate, at its own cost, if it deems the installation necessary.

Section 6100 - Covers new diversions installed since the effective data of the act (about 1971). A diversion must be screened if DFG determines that it affects salmon or steelhead. All costs incurred are to be borne by the operator of the diversion.

The recent Appellate Court decision in the ACID - Bonneyview Pumps case has "clarified" the intent of the first two Fish and Game code sections. Essentially, the court ruled these Fish and Game code sections were intended to allow the Department of Fish and Game to screen the diversions, but did not transfer the responsibility for protecting the "Public Trust" resources impacted by these diversions to the Department with respect to the Endangered Species Act. The decision also "clarified" the definition of "Take" to include the entrainment of fish into a diversion. These recent actions have upset the longstanding "status quo", which is based on the premise that if fish screens are installed on pre-1971 diversions, the Department has to participate in the cost of the installation and its operation.

This issue will be significant if the Delta smelt is listed as Endangered by the U.S. Fish and Wildlife Service this year. Listing of the Delta smelt will expand the window of time that diversions in the Delta will be required to be curtailed or screened. Presently, a limited time frame has been established for protection of winter run chinook salmon.

GENERAL FISH SCREENING CRITERIA

To assist diverters in their planning and design efforts, the Department of Fish and Game has developed "General Fish Screening Criteria" (Appendix A). These criteria represent a set of guidelines that will assure the diverter of approval from the Department. The guidelines provide a mechanism for alternative screening technology that can be used, with the approval of the chiefs of the Inland Fisheries and Environmental Services Divisions and the appropriate Regional Manager.

These General Design Criteria are based on DFG research which was conducted in California using test fish collected from the wild. Data from other sources were used to confirm the criteria. Other design criteria are available from Canada, Washington, Oregon, National Marine Fisheries Service and the Environmental Protection Agency. However, they are not a substitute for DFG criteria.

TECHNOLOGICAL SOLUTIONS

The easiest solution to a fish screening problem is to change the timing of the diversion to avoid the need to build a fish screen. As simple as this sounds, this "low-technology" solution is often overlooked and has been used in a number of situations where alternative water sources are available.

The "low velocity - positive barrier" fish screen is the solution addressed by the General Design Criteria. Numerous variants are available, depending on the specific constraints of the site and fish to be protected. Two new screen types have been installed recently and bear mentioning.

The first, a "torpedo" or horizontal cylinder screen, is now in use at the City of West Sacramento intake near Bryte and at the Anderson - Cottonwood Irrigation District (Bonneyview Pumps) installation near Redding. Both sites are located on the Sacramento River. These screens use an air burst cleaning system, although a spray could be adapted if desired. The second type is the Lakos (Plum Creek) screen being marketed by the Claude Laval Corporation. This screen has been used with considerable success in the midwest as a filter for "pivot and drip" irrigation systems. We have recently tested this screen in California and have been impressed with its results. Both screens require a source of power at the screen site, a drawback for remote locations.

The perceived market for fish screens has brought a number of old ideas out of the closet. Two deserve mentioning, the use of electricity and sound as fish guidance systems. Both concepts are "behavioral screening devices" and have been tested repeatedly over the years without much success. However, new experimenters in these two areas have ideas which show promise but neither has been demonstrated to work in field installations. Experimental fish screens cannot be used to protect listed species. They can only be used in situations if the diverter agrees to replace the experimental screen in the event it fails during the evaluation.

CONCLUSION

The future holds a great opportunity to address longstanding fishery protection issues and accept these challenges. We look forward to working cooperatively with water diverters to resolve these issues with a positive and active approach, rather than relying on the legal system. To accomplish this, we must all work together to provide protection for the fishery resources and the legitimate use of water for other beneficial purposes.

ALTERNATIVE PUMPING SYSTEMS

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Next to air, water is the most important substance for the existence of life as we know it. A reliable water supply can mean the difference between a thriving garden or a desert, and it is essential for livestock. In the past, it was necessary to install a fossil fuel powered generator and an electric pumping system to provide water supplies. Use of irrigation ditches were another common way to meet these needs. In many cases, these methods are still appropriate and require no alteration. In other cases, either the generator or the irrigation ditch are too costly to provide and/or maintain over a prolonged period. Therefore, alternative means of providing a reliable water supply are needed. Some are new and others have been around for some time (even before the turn of the century). What follows is a brief description of the more popular alternative means of providing water to a site.

1. DC diaphragm well pumps - The majority of solar powered well pumps currently in use are a diaphragm type. These can lift water over 250 feet, provide flows of 2 gallons per minute (gpm) or more, and sell for under $1000. These pumps are powered by 12 or 24 volt batteries and are connected directly to the solar array with a linear current booster (LCB) controller. These are more efficient than an AC submersible pump powered by an invertor. They require more maintenance than their AC counterpart because the diaphragm should be changed after 2,500 hours of operation. With a solar tracker and 2-51 watt photovoltaic modules, a good solar site can provide between 500 and 900 gallons per day (GPD), depending on lift.

2. DC centrifugal solar well pumps - For larger pumping applications requiring more output, there is a DC centrifugal submersible pump available. While its cost is considerably higher than the diaphragm pump, it has several advantages. It can lift as high as 450 feet and provide up to 30 gpm. Centrifugal pumps do not require a separate controller. As with the diaphragm pumps, they can be operated directly from the panels, or from batteries. Modular system designs allow for more water by simply adding panels. Centrifugal pumps can produce as much as 15,000 gallons per day in low head applications. Hundreds of solar centrifugal pumps are currently in use worldwide. Both the centrifugal and diaphragm pumps will fit in a 4" or larger well casing.

3. Solar powered jack pumps - If you've ever seen a hand pump or an old-style wind pump, chances are it was a jack pump. These reliable pumps have been around for many years. They can lift water over 1000 feet. Jack pumps consist of a surface mounted reciprocating drive mechanism (generally a gas or electric motor, or windmill) connected to a pump cylinder at the bottom of the well via a long rod called a "sucker rod". They require a steel drop pipe the same diameter as the cylinder, in which the water travels to the surface.

Solar jack pumps are electric-powered pumps with the electricity provided by a solar array. While an effective, time-proven method of lifting water from a deep well, they have their drawbacks. Costs are high since a typical solar jack pump system often exceeds $5000. Installation can be complicated and should not be attempted by the inexperienced installer.

A new type of pump will soon appear on the market called the "Solaram". Similar to the jack pump, it has a surface mounted drive mechanism and a pump cylinder in the well which are connected by a hydraulic line instead of a mechanical linkage. This improves efficiency and reliability while reducing cost and simplifying installation. The Solaram will provide up to 8 gpm at a depth of up to 1000 feet.

4. Wind driven compressor pumps - An alternative to the old-fashioned "windmill" type jack pump is a wind powered compressor pump, commonly referred to by its brand name "Bowjon". Unlike other wind-pumps, the Bowjon does not have to stand over the well. It can be placed wherever the wind achieves maximum velocity, up to ¼ mile away. Maximum lift is approximately 250 feet. The wind powered compressor pump can lift up to 7 gpm. If more water is required, several units can serve a single well.

The Bowjon works like this: the wind drives blades attached to a compressor which pumps air into the well and this operates a cylinder that pumps water to the surface. A Bowjon can also be used to lift water from a pond, tank, stream or ditch.

5. DC diaphragm type surface pumps - This is the most common pump used for pumping water from a surface source (i.e., a spring, creek or pond). These pumps have several advantages: low initial cost, ability to pump dirty water, and availability. They can lift over 200 feet and pump as much as 4 gpm. They are light-duty pumps and should not be operated in continuous use applications. Diaphragm pumps can be used in array-direct or battery-powered applications and are often used as booster pumps in pressurizing applications.

6. DC rotary vane surface pumps - If you need to lift water over 200 feet or need a heavier duty pump than a diaphragm, consider using a rotary vane pump. They can provide over 4 gpm and lift up to 450 feet. Rotary vanes are a commercial quality process pump designed for continuous duty applications.

Initially costs are higher than the diaphragm pump, however, the rotary vane pump will operate for many years with no maintenance. They are also more efficient, resulting in a savings on photovoltaic modules and batteries. These pumps do require a filter before the pump and will not tolerate grit or abrasive material due to the close tolerances inherent in its design. Rotary vane pumps should be used with a dry run switch to prevent overheating, if running dry is a possibility.

Diaphragm pumps and rotary vane pumps work well in array-direct or battery powered applications. In array direct applications, an LCB type pump controller is recommended. Rotary vane pumps can also be used as booster pumps for pressurizing applications.

7. DC centrifugal type surface pumps - Designed for domestic irrigation and livestock watering, the DC centrifugal surface pump can lift substantial quantities of water from a shallow well, pond, tank or ditch. It will not be harmed by running dry or by small particles in the water, there, a dry run switch or filter is not needed. Flow rates range from 5 to 50 gpm. Maximum lift is 100 feet. With only one moving part, maintenance is minimal. The DC centrifugal pump works equally well in array-direct or battery powered applications. A pump controller is not required in array-direct applications.

8. Ram pumps - The hydraulic ram is a device that has been used for over 100 years to pump falling water uphill. It works on the "water hammer" effect: ie, it uses the energy of a volume of water moving downhill in a pipeline that is suddenly stopped by a valve in the ram. As the water column is stopped, a

pressure peak (a "hammer") is created which can be used to force some of the water uphill higher than the original source. This process is repeated continuously. To calculate the maximum quantity of water delivered by a ram pump, use the following formula:

$$\text{Output (gpm)} = \frac{\text{Input (gpm) x Fall (ft)}}{\text{2 x Total lift (ft)}}$$

Remember that output is the maximum quantity of water delivered and is seldom achieved. Ram pumps require a minimum input of 2 - 5 gpm.

Rams are a time-honored means of pumping water uphill. They possess some features that may be objectionable (such as noise, tuning problems, installation difficulties, and periodic maintenance), but can be very effective if used in the right circumstances. Ideal applications include an abundant water supply, low inlet pressure (very little fall), modest lift, and a patient operator.

9. High Lifter pumps - By harnessing the energy from a head of water, the High Lifter pump drives a portion of the water uphill. It is a positive displacement pump that uses a large volume of low pressure water to pump a small volume at a high pressure water. The percentage of source water that is pumped uphill is dependent upon the volumetric ratio of the pump. Thus a "9:1" ratio pump would deliver one gallon of water at the top of the hill for every nine gallons of water from the source. The 2" High Lifter pump is designed for applications up to 750 - 1500 gpd and will operate on inputs as small as one quart per minute. Maximum lift is over 1000 feet.

GRANT WRITING TECHNIQUES

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MONEY: HOW TO GET IT!

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As government funding and financial assistance decreases, the need for creatively financing programs becomes necessary. Creative financing can run the gamut from fundraising events, direct mail campaigns, loans, and grants to profit businesses within a non-profit organization. Competition for funding has become fierce and getting a grant based solely on the value of your work is a thing of the past. This presentation will focus on the grantwriting process from the private foundation and government perspectives.

FOUNDATION FUNDING

A "grant making" foundation is defined as a non-profit, non-governmental institution, managed by its own board of directors or trustees, whose purpose is to support educational, artistic, religious, health, social service, or other charitable activities primarily through the making of grants. There are two types of grant-making foundations: private and community. Typically, foundations set grant-making priorities. These priorities may be stated in very general terms such as "to improve human services", or in more specific terms such as "to finance low-income housing for economically disadvantaged persons". Furthermore, many foundations have established geographical areas where they "exclusively" or "typically" target their funds. The task of the researcher is to match an organization's purpose and funding needs with a foundation's targeted geographical area and funding priorities.

The following information is intended to provide an overview of how to seek foundation funds.

1. Research the Foundation
   - A. Make a prospect list using The Foundation Directory, The Directory of the Major California Foundations, Comsearch Printouts or other foundation resources. These publications are often available at your public library or nearest Foundation Center Library.
   - B. Narrow the list by finding those Foundations whose areas of interest reflect the needs of the "prospecting organization". Eliminate those that identify limitations such as geographic areas or types of ineligible organizations. Be sure the Foundation's average grant size reflects the amount requested.
   - C. Review the annual reports and other available information to get a better feel if the foundation you have selected will fund a program like yours.

2. Make an initial inquiry
   - A. Contact the potential foundation. Ask to speak with a "program officer". Be prepared to concisely state why money is needed and specifics about the proposed project.
   - B. Request a written copy of the guidelines and confirm the following: funding cycle/year, priorities and focus of the foundation's funding, details about the application procedure, who and where the proposal/letter of intent should be addressed to, suggested length of a proposal/letter of intent and size of the average grant.

3. Write letter of intent and/or proposal
   A. Follow instructions/guidelines. Typically a letter of intent should read like a concise proposal, 1-2 pages. Other foundations will simply request a proposal. If no recommendations are provided regarding suggested length, consider a maximum of 10 pages.
   B. A "1-2 page" letter of intent should include:
      - brief description of the organization, it's goals or purpose, the community it serves, key projects or significant achievements, and past and current sources of financial support.
      - sentence or two about the governing board or structure.
      - brief description of skills and qualifications of people involved.
      - brief description of the project and how funding from the foundation can help.
      - brief reference to other funding sources for the organization.
      - an offer to develop a full proposal or supply additional information upon request from the foundation.
      - a contact person from the organization who has full knowledge of the project and can answer specific questions upon request from the foundation.
      - an invitation for the foundation staff to visit the project and talk with the likely people who would be served by the foundation funds.
   C. A full proposal should address the same information that is in the letter of intent, however it must be more complete and detailed. Consult a guide such as "Program Planning and Proposal Writing" available from The Grantsmanship Center, Los Angeles, California (213/ 689-2222).
   D. Review the proposal carefully!
   E. Send in the proposal.

4. Follow up and respond to foundation requests.
   A. Make a follow up call after 10 days to confirm the proposal's status. Ask about the notification process. Be prepared to hear that the foundation would like a rewrite or some additional information.
   B. Submit revisions if requested.
   C. Submit a new proposal. Consider a rejected proposal as simply one step in the process of building a relationship with the foundation.

5. Take the idea to other foundations.
   A. Tailor each letter of intent and/or proposal.

GOVERNMENT FUNDING

Government generated revenue, including those derived from taxes, are subject to and the result of the political process. Legislation spawns dollars in the public sector and this takes place at every level, from city hall to Sacramento to Capitol Hill. There are two basic types of government grants, known as formula grants and project grants.

Formula grants are non-competitive and generally broad in program coverage or focus. Also known as block grants, they are often made from one unit of government to another, particularly from federal departments or agencies to what are known as state planning agencies. It is not unusual for units of government receiving formula grants to redistribute, or "pass through", funds to nonprofit organizations. This is typically done by making project grants available for competition. Project grants may be available directly from government funding sources at the federal, state or local levels.

Government grants are attractive to fundraisers because to their size (more money) and their duration (multiple years). However, you should realize that over-reliance on such funding has caused organizations considerable difficulty when money has dried up or been reduced through changes in legislation. It makes

good sense for organizations seeking dollars in the public sector to learn about legislators and their staff members.

It is important to know what's likely to be involved in many government grants before applying for one. Sometimes matching funds are required, either as a hard match (cash) or a soft match (in-kind goods and services' values). Associated administrative costs not necessarily covered in a program grant may exist. Government funding carries with it a heavy volume of paperwork. While you may have to wait six months to a year for a response to a government funding application, it is likely your funder will expect your program to begin rapidly.

The most important skill for organizations seeking government funding is to know when is it available and how to apply. This process varies depending on the level of government you are seeking funds. There is no set application format for all funding sources. Each funding source will be prescriptive about applications content. Be prepared to follow the application procedure exactly. Any deviation from the prescribed content, format, inclusion of information and even order of pages can be enough to disqualify your application.

Resources for further research on government funding:

1. Federal Funding
   - A. Federal Register - Published every day and includes a section titled "Notices", with data about available funds. Information on how to obtain application forms and who to contact for technical assistance is included. The Register can be found in many public, legal or college/university libraries and federal government agencies.
   - B. Catalog of Federal Domestic Assistance - Available at the Funding Information Center. It is the single most complete listing of federal programs for organizations and individuals in the U.S. It includes eligibility requirements, application procedures, and deadlines.
   - C. Commerce Business Daily - Appears daily and includes the "Requests for Proposals" information about contracts the federal government intends to award through competition. Check your Federal Depository Library for a copy.

2. State Funding
   - A. Catalog of California State Grants Assistance - Contains information about programs administered by California governmental agencies funded with state monies, or federal "pass-through" dollars. Available at the Funding Information Center.

3. Local Government Funding
   - A. Things get a bit tougher here. Check with your County Board of Supervisors for County funding sources and your City Council for City funding sources. At this level it is important that you be willing to seek out local city and county politicians (especially the staff who work for them) to get information about additional local funding opportunities.

Happy Grant Seeking!

CALIFORNIA SALMONID STREAM HABITAT RESTORATION MANUAL

The California Salmonid Stream Habitat Restoration Manual is now available from the California Department of Fish and Game (DFG). The manual defines and explains the DFG approach to fish restoration, and describes acceptable and preferred methods. This manual formally explains and describes the DFG ground level approach to cooperative restoration of fishery resources, and standardizes descriptive terminology and technical methods. Principal emphasis is on salmon, steelhead and trout; therefore this manual is intended to be used to assist future restoration efforts for those species in California.

Topics covered in the manual include:

- Policy and history of salmon and steelhead restoration in California
- Preliminary watershed assessment
- Habitat inventory methods
- Fish distribution
- Data presentation
- Project planning
- Project implementation
- Tools
- Project monitoring and evaluation

To order a copy of the California Salmonid Stream Habitat Restoration Manual

Send $10.00 to:

California Department of Fish & Game
Inland Fisheries Division
1416 Ninth Street
Sacramento, CA 95814

ATTN: Ron Comacho