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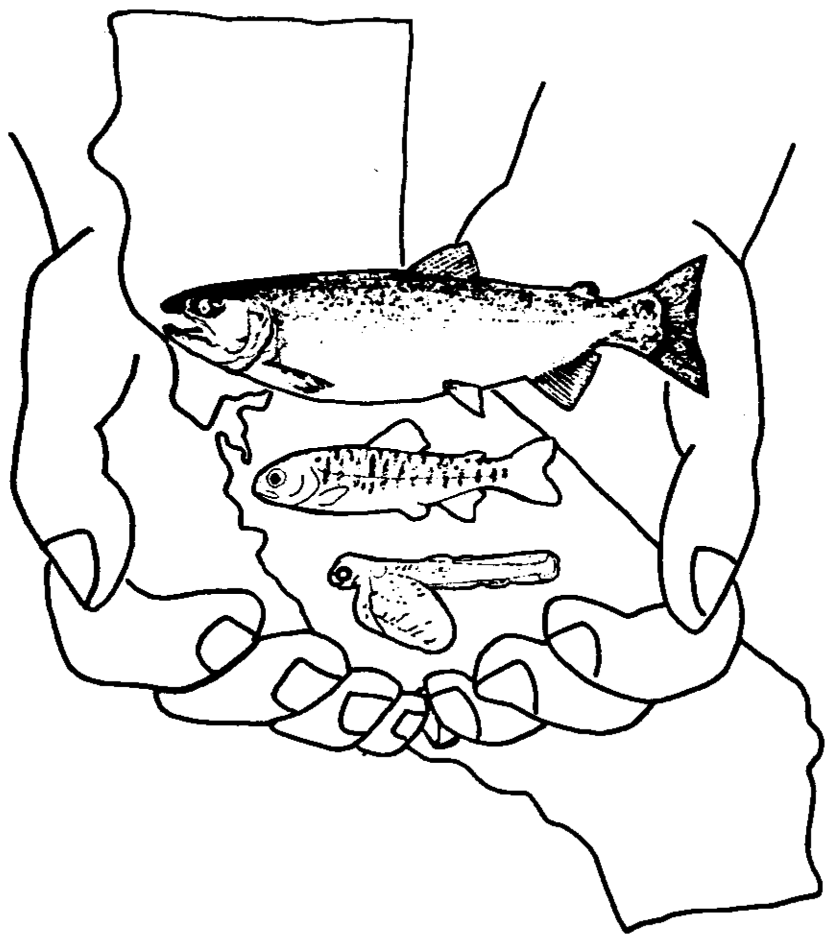
PROCEEDINGS OF THE SEVENTH CALIFORNIA SALMON, STEELHEAD AND TROUT RESTORATION CONFERENCE

FEBRUARY 24-26, 1989
EUREKA, CALIFORNIA



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PROCEEDINGS OF THE SEVENTH CALIFORNIA SALMON, STEELHEAD, AND TROUT RESTORATION CONFERENCE

February 24-26, 1989
Arcata, California

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THE CALIFORNIA SALMON, STEELHEAD, AND TROUT RESTORATION FEDERATION

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FISHERMEN'S ASSOCIATIONS
REDWOOD COMMUNITY ACTION AGENCY

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Humboldt Fishermen's Marketing
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American Fisheries Society
Commercial Fishermen's Wives of Humboldt
University of California Coop. Extension/Sea Grant

Edited By: Christopher Toole
University of California Cooperative Extension/Sea Grant Program

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PREFACE

This Proceedings is intended to serve as an overview of presentations given at the Seventh Annual California Salmon, Steelhead and Trout Restoration Conference. Speakers were asked to submit 2-3 page summaries of their talks prior to the conference and these have been incorporated into this report in the approximate order of presentation. Summaries from a few of the speakers were not received in time for publication, but materials may be handed out at the conference. Also, many handouts will be distributed during the Technical Mini-Sessions. This report was assembled in a loose-leaf format so that notes and handouts distributed during the conference can be inserted into the appropriate sections.

The efforts of all the speakers and session coordinators in preparing these summaries is greatly appreciated. Thanks also to Debbie Marshall, who did all the typing, and to Jud Ellinwood and Nancy Reichard, who reviewed drafts of several sections of this report. Illustrations by John King are excerpted by permission from California's Salmon and Steelhead: Our Valuable Natural Heritage by Diane Higgins. Compilation of these papers and preparation of the Proceedings was handled by the Univ. of Calif. Cooperative Extension/Sea Grant program at the request of the Federation. Additional copies can be ordered from the address listed inside the front cover.

C. Toole

THE SALMON, STEELHEAD, AND TROUT RESTORATION FEDERATION

HISTORY

Begun in 1986, the Federation was originally formed to provide an organizational framework for individuals in the restoration community interested in holding an annual conference, which up to then had been planned and chiefly funded by the U.C. Extension Sea Grant Marine Advisory Program. The Federation as it is presently constituted is a membership non-profit organization. Funding for its activities is derived from membership dues paid by individual and affiliate members, donations, and conference and workshop registration fees.

In the past year, in addition to planning and organizing its annual conference, the Federation began publication of a newsletter and production of restoration technique workshops, established an information network within the restoration community, and informed public officials and resource agency representatives of the extent and benefits of the State's salmonid restoration program and ways in which the program can be improved. As the Federation grows, the scope of its activities will continue to be influenced and defined by its objective to promote the wise management, protection, and restoration of California's salmon, steelhead, and trout populations and their habitat.

For more information, contact the Federation at Post Office Box 4260, Arcata, CA 95521.

PRESIDENT'S ADDRESS

Jud Ellinwood
Humboldt Fish Action Council
P.O. Box 4260
Arcata, CA 95521

In the past year, despite a funding crisis that has tested the restoration community's commitment and resourcefulness, most of you have overcome formidable obstacles that threatened to block the success of your projects. In the face of such adversity, the contribution you have made to the ongoing effort to revive and revitalize California's salmonid resources takes on special meaning. With the exception of our families, mates, and friends, relatively few people are aware of the personal sacrifices we make and the hardships we endure in order to make our projects succeed. I know what the cost of your dedication is; like you, spare time more often than not is spent on thankless and often tedious tasks: weeknights, weekends, and even vacation time is not sacrosanct. There never seems to be enough time to repair and maintain equipment, do community outreach work, plan projects and write reports, or involve ourselves in the myriad of restoration activities that demand our attention. Volunteered time and labor are inseparable and routine components of our involvement in restoration projects. Having worked with many of you and helped represent all of you in the last year has left me with a heartfelt sense of pride in being a part of the restoration community. It therefore gives me a great deal of pleasure to welcome you on behalf of the California Salmon, Steelhead and Trout Restoration Federation to the Seventh Annual Restoration Conference.

This year's conference has come about as a result of the efforts of several individuals and groups. At this time I'd like to acknowledge their contributions: first of all the Conference Coordinating Team consisting of Nancy Reichard, Chris Toole, and Harry Vaughn has spent innumerable hours organizing the volunteer workforce, acquiring and setting up the equipment, preparing the proceedings and other printed matter, and taking care of all the other organizational details we take for granted. Session Coordinators Aldaron Laird, Dianne Higgins and Scott Downie, Mike Kossow, and Pat Higgins invited our speakers to make presentations several months ago and have since spoken with them on several more occasions in order to provide them with guidance and advice. As members of the Federation Board of Directors or the Conference Planning Committee Jerry Fitzpatrick, Pat Higgins, Steve Klausner, Gary Peterson, Scott Downie, Michael Kossow, Forrest Reynolds, Chris Toole, Nancy Reichard, Tom Weseloh, and Harry Vaughn attended four Saturday planning meetings in Ukiah which culminated with the selection of this year's agenda topics.

This year, for the first time, all of the conference's expenses are being underwritten by co-sponsors. The donations, which ranged from $500 - $1000, made it possible for the Federation to use last year's conference receipts for non-conference purposes. As a result, the Federation was able to begin publication of the newsletter and mount a phone and letter writing campaign to save this past year's state restoration funds. We would like to acknowledge and extend our gratitude to the following co-sponsors for their support of this conference and their commitment to restoring California's salmon, steelhead, and trout resources:

The California Department of Fish and Game;
The Marin Rod and Gun Club;
The Salmon Restoration Association;
Cal Trout; and
The Northern California Council, Federation of Flyfishermen
Redwood Community Action Agency

Before returning to my introductory remarks I'd like to take a moment to say a few words about our current membership drive. This next year is going to be a pivotal period in the history of California's efforts to restore its salmonid resources. As the development of a statewide restoration plan progresses in the DFG's Sacramento headquarters, administrators, legislators, water developers, and other special interest groups are simultaneously pursuing a course of action that may well cripple any attempt to fund restoration projects in the next fiscal year. If the Federation is going to transmit your concerns to the State plan's authors, represent your interests in Sacramento and keep you informed of new developments, we will need your financial support. Last year's accomplishments were achieved with a shoestring budget of less than $2500. It should be pointed out that none of the Directors asked for or received repayment of the expenses they incurred while conducting Federation business. Every dime of our operating budget that's been spent has been spent to help you achieve your goals. To help reach our modest funding goal of $5000 we will be accepting membership applications and donations at our table located in the lobby during session breaks and at the banquet.

For those of us who were involved in planning this year's conference it was easy to become retrospective and recall that only seven short years ago a small dedicated group of technically unsophisticated but enthusiastic restoration workers convened the first conference in Bodega Bay. Looking around this hall it is apparent that the cooperation and sense of community that bound us together then still flourishes today. What has changed, and changed dramatically, is the range of our skills and the scope of our activities. This year's session topics were chosen in large part because they represent the next step in our learning curve. They also signify that our evolution, like that of the species we seek to benefit, continues to be dynamic and adaptive.

INVENTORY AND RESTORATION PLANNING: ADDRESSING LIMITING FACTORS

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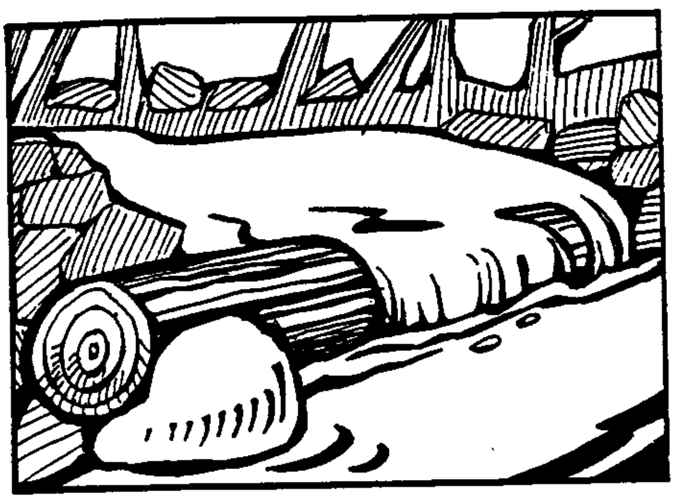

INSTREAM FISH HABITAT CLASSIFICATION

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There is a growing appeal and need for adoption of standardized, replicable methodologies that classify stream channels and fish habitat. The classification schemes need to be based upon the processes that form and maintain discrete recognizable units. Standardized terms will result in the ability to increase the understanding of information communicated between different resource agencies/landowners in describing and understanding stream conditions, which has not been possible previously. Habitat typing yields detailed information that can be used for several purposes, such as fish habitat restoration planning, instream project design, and baseline documentation. It is a valuable monitoring and evaluation methodology in basin-wide fisheries management.

Basin-Level Habitat Typing Inventory Applications:

1. Physically describe 100% of habitat availability and accessibility within a basin, without extrapolation from limited representative index reaches.
2. Establish baseline data of physical habitat diversity, habitat type frequency, structural complexity, residual depths, surface area, volume and substrate conditions by habitat type. This data can be used to monitor responses to restoration efforts or to document cumulative effects from upslope and upstream activities upon the physical aquatic system.
3. Provide a physical habitat data base, to be used in concert with fish habitat relationships for conducting limiting factor analysis of a basin's fishery.
4. Provide design parameters for instream restoration planning and fishery management.

Bisson (1981) stated, "The lack of a precise language describing the components of the physical environment may limit our ability to predict a stream's productivity for a species of interest. The often-used names 'riffle' and 'pool' convey a notion of relative water depth and current velocity, but beyond this they give little indication of living conditions relative to substrate, flow patterns, and cover. Not surprisingly, considerable variation exists in fish utilization of these general categories within the stream". For these reasons, Pete Bisson developed a habitat classification scheme which has since been expanded and modified.

Lynn Decker of the Pacific Southwest Experiment station of the USFS, working with Bisson's earlier work, expanded the system to highly descriptive micro-habitat terms which are now being employed throughout California to describe highly variable stream conditions.

Habitat types can be classified based on three components (Decker et al., 1985):

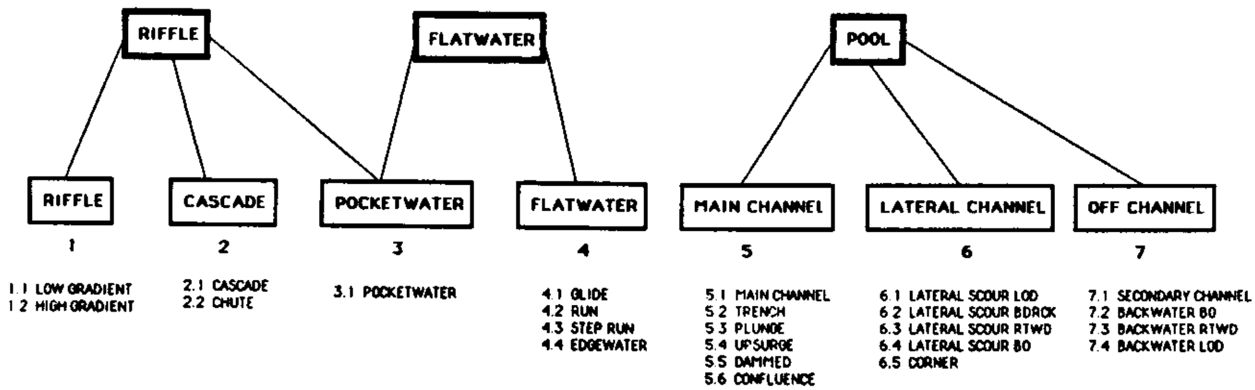
1. The location of the habitat feature within the channel; Main, Lateral, Side channel.
2. The pattern of water flow through the habitat feature; Rapid, Slow.
3. The nature of the flow-controlling structures; Bedrock, Boulder, Large Organic Debris (LOD), Rootwad/Overhanging Bank.

Kathleen Sullivan (1986) has provided habitat unit hydraulic responses to changes in flow discharge (peak storm flow, winter base flow, summer base flow, and lowest flow). Based upon the ability to identify discrete habitat types through all of these discharges, three levels of habitat descriptors are presented: macro-, mesa- and micro-habitat types. The number and combination of parameters such as water slope, velocity, depth, and relative submergence needed to identify habitat types increases from macro- to micro-habitat types. A detailed discussion of average hydraulic conditions that distinguish units at these three levels under varying discharges is presented in Sullivan's research.

Macro-Habitat Types
Depth
Mesa-Habitat Types
Water surface slope
Micro-Habitat Types
Velocity, Depth

Depending upon the objectives of your habitat type inventory, you may employ any one of these habitat type levels. An important feature of utilizing micro-habitat level inventory is that of greater physical description facilitating greater detailed documentation for baseline data or for pre-project monitoring. Data collected at a higher degree of habitat type resolution (micro-habitats) will give you the flexibility to later collapse your data during your analysis. But collapsing your data (macro- or mesa-habitat types) in the field does not permit you to expand your habitat type resolution (micro-habitat types) later. Once you become experienced in habitat typing, recognizing and recording data at the micro-habitat level is not markedly more difficult or time consuming. Table 1 serves to illustrate the different levels of habitat typing. It also can be used as a key to identify your habitat types. This multi-level approach offers an expandable system. Should you encounter habitat types in other geologic parent materials that are not previously described, they can be added on without changing the present number system.

Table 1. Habitat type hierarchical classes.



A factor of micro-habitat typing is inferring the structural complexity of the unit. Additionally, a shelter/structural rating scheme can be employed at any level of habitat typing for each unit that attempts to quantify and qualify the shelter/structural complexity dominating the habitat type unit. This shelter/structural rating system is a replicable field procedure intended to rate amount of and type of habitat unit structural complexity that serves as instream shelter or that creates areas of diverse velocities which affect salmonid utilization of the habitat. In this system, structural shelter is considered to be those elements within a stream channel that provide: protection from predation for salmonids, areas of reduced water velocities in which fish can rest and conserve energy, and divisions of units to reduce density-related competition. This approach does not consider elements affected by changes in discharge, such as water surface turbulence and water depth, or seasonal factors, such as overhanging terrestrial vegetation, which also offer shelter but not structural complexity.

Percent cover refers to the percentage of the habitat area occupied by the dominant instream shelter/structural component or cover selected by the targeted fish species and cohorts. The area is estimated from a plan (overhead) view.

To reduce the shelter/structure to weighted shelter rating, adjusted values for the unit's shelter/structural rating can be obtained by multiplying the percent of escape cover by the shelter complexity value. The weighted shelter/structural rating can be further delineated to document in greater detail the longitudinal/plan, cross sectional/channel, and vertical column position of structural elements.

SHELTER COMPLEXITY: Shelter complexity is a value assigned to instream habitat structure and its resulting velocity complexity. This value is a measure of the quantity of instream structure and its composition (organic-inorganic).

Value	Shelter/Structural Complexity
0.0	No Shelter
1.0	A) Cobble: 2.5-10.0', 6.4-25.4 cm
	B) Bedrock ledges
2.0	A) 1 or 2 pieces of Large Organic Debris (> 1' dia, 30.5 cm)
	B) 1 or 2 Boulders (>10.0", 25.4 cm)
	C) Single Rootwad piece
3.0	A) Combinations/matrices of single pieces of:
	B) Multiple pieces: > 2 LOD complex
	C) Multiple pieces: > 2 Boulder/Rock matrix
	D) LOD/Boulder/Stump-Rootwad
	E) Overhanging Banks/Live root systems
	F) Submerged/floating full tree crowns

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CONSIDERATIONS FOR ANALYSIS OF FACTORS LIMITING SALMONID POPULATIONS

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Limiting factors may be defined as those habitat parameters required to support a species lifestage, that are in shortest supply relative to those habitat parameters required to support other lifestages for the species. In order to accurately identify factors that are limiting salmonid production, a relationship must be developed between biological data describing species habitat requirements, survival estimates and smolt production, to physical estimates of available habitat.

The first step is to identify the current habitat fishery levels that are present in the area of study. To begin, each life stage that each species will exhibit during their freshwater residency needs to be accurately identified, and the habitat requirements for each life stage described. The habitat requirements for each identified lifestage should change reflecting changes in growth or physical endurance, feeding behavior, or possible environmental changes that occur with each season (Nickelson 1985). For example, identified life stages for steelhead trout may include adult migration, spawning, incubation, fry, juvenile summer rearing, juvenile over-wintering, and smolt migration. Once accurate life stages are determined, habitat types can be defined by the life stage habitat requirements for each species.

Bisson et al.(1981) and Anderson (1985) describe habitat typing systems based on physical habitat characteristics rather than specific species habitat requirement data. These two methodologies have been proven to provide accurate limiting factor analysis provided low summer flow habitat limits production. In streams where winter habitat or other factors are responsible for limiting salmonid production these methodologies are not applicable.

Biological sampling of each habitat type will provide data to determine habitat type/life stage densities and survival rate estimates between each life stage during the sample year. Enough habitat types should be sampled to yield satisfactory variances on corresponding life stage densities per habitat type. More than one habitat type may be identified for each life stage; however, if the species' life stages are found to utilize selected habitat types in equal numbers, identified life stages or habitat type should be redefined.

In systems that are severely degraded it is possible that preferred habitat types may not be present within the stream under consideration. Under these circumstances it would be impossible to obtain accurate habitat requirement information for limiting factor analysis. Biologists must then make some professional judgments, based on literature searches or experience in similar streams, as to what important habitat types may be lacking and the appropriate action necessary to proceed further.

A physical description of the stream or system's available habitat can now be completed utilizing the habitat types that were selected. This information combined with the biological sampling will provide an estimate of the stream's carrying capacity for each identified life stage during the sample year.

The best indicator of production would be an estimate of smolt migration from the system under study. This information should yield an understanding of the habitat fishery conditions that exist at the time of the study and will help verify the biological data results regarding carrying capacity and survival.

The second step in the process is to determine a potential optimum amount of habitat to maximize smolt production. A starting point would be to estimate the number of smolts that would be produced by one female spawner under ideal habitat conditions. This can be achieved by estimating the number of eggs produced by one female, multiplied by a survival estimate for each succeeding life stage until the number of smolts produced by one spawning pair is obtained. The amount of habitat needed to support each life stage of the progeny from a single female can then be estimated by dividing the capacity for each life stage by the observed habitat densities that have already been determined.

A comparison between the available habitat carrying capacities and potential habitat carrying capacities should yield insight to where habitat limiting factors may occur within the system. Table 1 depicts a simplified example of the type of computer spreadsheet comparisons that are possible under this methodology.

Table 1. A simplified example for comparing available steelhead trout habitat carrying capacities to potential habitat carrying capacity in determining possible limiting factors to smolt production.

	Current Habitat Conditions			Potential Habitat		
Life Stage	Habitat Available	Density (fish/ft)	Carrying Capacity	Survival Rate	Potential Capacity	Habitat Need
Spawn	10,000	0.1	1,000			
Incub.	10,000	200	2,000,000	0.3		
Fry	500,000	0.5	250,000	0.4	600,000	1,200,000
Juvenile						
Summer	1,300,000	0.2	260,000	0.7	240,000	1,200,000
Winter	25,000	0.35	8,750	0.7	168,000	480,000
Smolts Produced			6,125		117,600	

An interactive computer spreadsheet enables instant recalculation of defined values as various parameters are manipulated. In the example in Table 1, based on our knowledge of habitat requirements and our assumptions regarding survival, it appears that both fry and juvenile over-wintering habitat may be in short supply for the amount of spawning habitat currently available.

Analysis of limiting factors must be completed for each species within the system. Comparisons can then be made between the habitat needs for each species and some predictions can be made regarding habitat gains and losses for each species before habitat work is completed.

Although we usually think of limiting factors in terms of habitat, other biological and physical parameters can influence total salmonid production in any given year. Everest and Sedel (1986) have stated that natural salmonid populations may fluctuate by more than 100 percent per year. Biological parameters (disease, predation, competition, and food availability) and physical parameters (water quality, weather, water management practices, and Acts of God) certainly account for some of the variation in salmonid populations over time. Although habitat quality and quantity may influence the relationship of these biological and physical parameters on total salmonid production, each of these parameters also can severely impact salmonid production regardless of existing habitat conditions. For these reasons it is imperative that biological sampling be done over several years if effective results are to be achieved. Should budget constraints prevent such an intensive analysis, then biologists must be prepared to accept some degree of acceptable risk before habitat manipulations are carried out.

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PUBLIC EDUCATION: MEETING THE CHALLENGE

Coordinator: Diane Higgins
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PRIMARY LEVEL CLASSROOM AND FIELD ACTIVITIES

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This is the third year that we have been studying salmonids in the classroom throughout Humboldt County. Scott Downie and Bill Eastwood from Eel River Restoration Council started our project at Redway School. Through their conscientious supervision and advice we have developed a very successful program. At the present time, we have established the program in the first and second grades. In the future, we are hoping to extend the study into the intermediate level.

First graders as well as primary children in general, are very responsive and receptive learners. They are a most sincere and incredibly sensitive group of people. They put their whole hearts and energy into what they believe in. Their level of enthusiasm escalates as they watch the eggs that Scott brings hatch and grow. Their desire to learn is virtually unlimited and it is inspiring to me to keep ahead of them. They actually develop a personal relationship with the fish. The fish become their responsibility. They are no longer someone else's responsibility.

When I first heard about this program, I thought it would be fun to do a unit on fish with my class. Little did I realize that the intensity of their interest would generate such a spectacular addition to our curriculum. We learned together at first. The concepts and vocabulary seemed pretty technical for this age group but it was amazing how quickly they were using the vocabulary with ease and understanding. The second graders became even more sophisticated in their communication.

GOALS OF THE PROGRAM

1. To develop an environmental consciousness.

2. To develop sensitivity to the relationship between themselves and their environment.

3. To develop a sense of stewardship for the fish.

4. To develop knowledge that will enable the children to make wise decisions concerning their environment.

5. To develop an environmental conscience.

6. To develop an understanding of people's dependence on salmon - past, present, future.

7. To develop an understanding of the need for wise use of land and water resources.

8. To develop an understanding that hatcheries are a substitute for maintaining and increasing salmon populations through natural processes. The ultimate goal is to restore as much of the natural habitat as possible so that the salmon can continue and maintain their populations on their own naturally.

EMPHASIS FOR STUDY IN PRIMARY GRADES:

1. Discover the characteristics of fish - externally and internally.

2. Discover the life cycle of the salmon.

3. Discover habitat needs at each stage of development in the cycle.

4. Discover characteristics and needs of the co-inhabitants.

5. Discover the ecological network - food chain, and the inter-relationships between physical and living things.

6. Discover the characteristics of a watershed and what can be done to protect and restore it.

7. Discover that quality water and quality habitat are essential.

MULTIDISCIPLINARY SKILLS CHILDREN USE

1. Observing, experimenting (use of senses, gathering data).

2. Communicating - (journals, stories).

3. Measuring, ordering, sequencing.

4. Researching.

5. Discussing, listening, reading.

ACTIVITIES INCORPORATED INTO THE STUDY OF SALMONIDS

(Some of these ideas and materials will be on display later.)

1. Taking field trips (video).

2. Using a microscope and making their own slides.

3. Doing art projects.

4. Creating graphs (classroom).

5. Creating classroom story charts.

6. Story writing, journal writing, letter writing and even poetry (cinquains).

7. Creating bulletin boards and murals.

8. Learning songs, poems and chants.

9. Brainstorming vocabulary.

COMMUNITY INVOLVEMENT

Several community service organizations have expressed interest in this project:

1. Rotary - contribution

2 Soroptomists - expressed interest in helping

3. Parents - wonderful feeling and support

We as adults have come to realize the influence of the political system on California fisheries. Salmon need a broad-based political support. We are all aware of the many threats that growing population and increasing demand for water resources present to the salmon population. With these things in mind, it is imperative to nurture a sense of stewardship in our young people. It is my hope that they will develop an appreciation for the wildlife legacy that is theirs to protect and enhance. Within twelve years these six and seven-year-olds will be voters. I believe that even though they may not take an active role as advocates of salmon, they will be supportive and make wise decisions with an environmental conscience.

SALMON AND TROUT EDUCATION PROGRAM

Barry Burt
Monterey Bay Salmon and Trout Project
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I first piloted the in-class incubator program for raising steelhead in the classroom three years ago during the 1986-87 school year. With the help of our school's release-time science teacher, whose assignment included nine upper grade elementary classrooms (4th-6th grades), and the cooperation and support of the Monterey Bay Salmon and Trout Project, we were able to present a science unit on the life cycle and conservation of native anadromous fish to over two hundred and seventy students. The availability of resource material posed a real problem for use during that first year, but with the help of materials sent to us by Chris Toole and the Ministry of Fisheries and Oceans in British Columbia, we were able to put together a skeleton curriculum which adequately supported the use of the aquarium incubators. The enthusiastic response of students and parents along with newspaper articles and coverage by local TV channels generated considerable interest from other schools in our district and throughout the county.

In the following 1987-88 school year, it became apparent to me that if the incubator program was going to be effective and possibly spread to other schools, it needed to be accompanied by an easy-to-use curriculum guide with plenty of hands-on activities, so I applied for a grant through the County Office of Education to provide funds to collect existing resource materials and develop a curriculum guide which focused on the life cycle and conservation of native anadromous fish. It also provided for money to create multi-media science resource kits for the three school sites in our district and to in-service teachers describing how to implement the curriculum in their schools. When the grant money finally came in for that cycle, we not only received funds from the County Office of Education but also from the Sierra Club Ventana Chapter, the Soquel Water District, the Monterey Bay Salmon and Trout Project and Schools Plus, which is an organization that utilizes money from local businesses to support exemplary educational programs. This was the beginning of the Salmon and Trout Education Program or S.T.E.P. as it is known. There was an open invitation to all interested educators to attend the in-service and the response was tremendous.

Educators from three counties representing over ten different school districts ranging in grade level from first grade to high school were in attendance as well as people from the Environmental Planning Department and University of California Sea Grant Extension. With presentations from Dr. Jerry Smith of San Jose State University and Matt McCaslin from the Monterey Bay Salmon and Trout Project, the teachers were provided with extensive background information on the life cycle and habitat of salmon and steelhead in our area. I presented an overview of the materials and activities in the curriculum guides, demonstrated how to set up and operate the aquarium incubators and asked the teachers to take the curriculum back to their classrooms and try it out.

Twelve incubator systems were set up in classrooms throughout the county and many classrooms, upon receiving eggs for their incubators, were given the opportunity to help the Monterey Bay Salmon and Trout Project plant smolt steelhead into local streams via a bucket brigade. The incubator systems achieved a high degree of success in the face of many adversities. Drought conditions and high water temperatures led to many unique innovations in the incubator systems. With permission from the Department of Fish and Game, the students were allowed to release the fry, which they had successfully raised, into local rivers and streams throughout the county.

By the end of the 1987-88 school year, over one thousand students had been involved with the S.T.E.P. program in our area and, judging from the past program evaluations sent in by participating teachers, the students' appreciation, awareness and concern for the salmon and steelhead population in our area, as well as the watershed that supports it, had taken on a new dimension. The students have come to realize that they can, in fact, make a difference and that along with this new stewardship comes a new set of responsibilities.

The 1988-89 school year poses many new challenges for the S.T.E.P. Program. The curriculum guides have just been revised into a much more usable form for the classroom teacher, and we are now working on a scope and sequence so that the materials can be taught year after year without redundancy. A new organizational structure has been developed to accommodate the anticipated increase in the number of schools that will be participating. The counties have now been divided into regions according to their geographical proximity to different drainage systems. These regions will be headed by a regional coordinator who will oversee the different schools in that particular area. Each school will, in turn, adopt a S.T.E.P. parent who will be a community member and will be responsible for assisting classroom teachers at the school site. It is our hope that by putting this structure into effect, the S.T.E.P. program will have the foundation to support itself on its own and accommodate new growth year after year. Also, by deferring the responsibilities over the hierarchy of various positions we avoid burn-out, but increase involvement. I feel that the support of these people to the classroom teacher will insure the success of the program.

Our second year in-service will take place in February and the real challenge is going to be to give the new-comers a sound background in the subject matter and still provide new, stimulating experiences and materials for the second year vets. We are hoping to utilize teachers who were involved in the program last year to teach demonstration lessons from the curriculum to those in attendance. We also hope to provide, at that time, several options on aquarium incubator designs so that those who choose to raise fish in the classroom will have a choice that will fit their budget. Teachers who wish to raise fish in the classroom this year will have to submit a written application in order to receive their eggs. This will provide us with important information as to where the fish will be released, the location of the school, and how many students will be able to work with the tank.

Educators involved in S.T.E.P. and other programs like it, face the challenging task of preparing our future generation for the stewardship of tomorrow's environment. It is their responsibility to instill the knowledge that will foster a greater awareness and protection of our natural resources. When we are able to successfully achieve this goal, we will be able to rest assured that the up-coming generation will be committed to wise management and preservation of our lands and waters.

AQUATIC ECOLOGY IN EDUCATION - THE ROOTS OF RESTORATION

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PROGRAM EVOLUTION

The Eureka City Schools Aquatic Ecology Program has evolved from the combined efforts of teachers, administrators, government personnel and community sponsors. Classroom units grew through teachers participating in the Sea Grant Marine Advisory Program's "Steelhead in the Classroom" workshop. This interest led to district support of a science program that adds a new dimension to our elementary curriculum.

Eureka received State Department of Education funding to develop a K-6 Aquatic Ecology Program, build a Model Stream/Hatchery at Washington Elementary School, produce educational videos on "Salmonid Life History" and "Habitat Restoration" and implement and disseminate the final curriculum statewide.

We have completed the Model Stream/Hatchery, the "Life History" video and the rough draft of the curriculum. By June, 1989, the "Habitat Restoration" video and the final K-6 curriculum will be available for dissemination. Educators throughout the county and state are piloting the materials this semester and providing valuable feedback.

PROGRAM DESCRIPTION

The Eureka Aquatic Ecology Program is designed to encourage teachers to involve their students in meaningful, hands-on activities that teach science concepts and environmental ethics. The curriculum is aligned with the district science scope and sequence and the state science framework. At each grade level, specific units are identified and allow for establishing basic concept understanding for future use.

The program emphasizes developing process skills which are important to critical thinking and problem solving. The curriculum is integrated across the subjects so science is taught through reading, writing, math and art as well as DOING science! Social studies is stressed through historical uses of the resources, modern uses and management of the resources, study of man's impact on the environment and the ethical decisions we must concern ourselves with. The Eureka Aquatic Ecology Program's main goal is to encourage and develop responsible students who will be able to make rational decisions in the future about our resources.

PROGRAM DETAILS

Teacher training is a vital component of our program. Biannual staff development workshops have improved teacher knowledge, confidence and self-esteem. School site inservice and training have established a communication network and provide quality time to work on curriculum. Teacher involvement and preparation in all stages of development have added to the strength of this program.

The Washington Model Stream/Fish hatchery is one-of-a kind in the nation. It provides the perfect laboratory situation at a school site. Every K-6 student works in the facility during the school year. Each student observes and follows the salmonid life cycle from spawning to fry release each year. With cooperation from the California Department of Fish and Game Mad River Hatchery, we bring adult steelhead in to spawn.

The 2,000 to 3,000 eggs are incubated in trough trays, and the alevins are raised to fry size and released in the Mad River on a school field trip. Students are involved at all stages of rearing the steelhead. Intermediate students pair up with primary "buddies" and work as a team on their assigned tasks.

The Model Stream portion of our facility is under construction and will include as natural as possible a stream environment with native fish, aquatic plants and insects, invertebrates and abiotic elements. Around the building will be aquariums to raise specimens of specific aquatic insects. These insects will double as models for our fly tying activities.

Two educational videos, "The Life History of Salmonids" and "Habitat Restoration", are a valuable component of our curriculum. Both videos will include teacher's guides with background information and pre- and post-activities. The guides will be organized by primary and intermediate grade emphasis.

PROGRAM IMPLEMENTATION AND DISSEMINATION

The Eureka Aquatic Ecology Program curriculum will be piloted and disseminated statewide this school year. Presentations at state science conferences and the national science convention in Seattle, Washington are providing an avenue for dissemination outside Humboldt County. Local teachers are involved in the piloting and rewrite stages of development.

School districts that commit to the adoption of the Eureka Aquatic Ecology Program will be offered training workshops and implementation support. Continued involvement with the teachers using the Steelhead in the Classroom program will also be part of the implementation and dissemination plan.

By the end of the 1989-90 school year, the Eureka Aquatic Ecology Program will be part of the science curriculum in schools throughout California and possibly other western states.

SUMMARY

Through local, regional and statewide support, the students of Eureka are receiving an enriched science training based on environmental and science concepts. The development of our experiential, integrated Aquatic Ecology Program and the educational products produced will give educators throughout the state the opportunity to teach this curriculum to their students. All it takes is the commitment to strive for a quality education that everyone deserves.

CASA GRANDE NATURAL RESOURCES PROGRAM FOR HIGH SCHOOL STUDENTS

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The United Anglers of Casa Grande is an organization formed to guide high school-aged students who are interested in the fields of fisheries, wildlife biology and environmental resource protection.

For the past three years students who are members of the Casa Grande Natural Resource Program have been actively working after school hours and on weekends as well as holidays towards the rehabilitation of Adobe Creek in Petaluma. Their ultimate goal is to restore the steelhead and salmon spawning grounds that were once a source of pride in our community.

During the past decade a host of environmental impacts have caused the runs of anadromous fish to decline to a point at which complete extinction seems inevitable unless restoration efforts are implemented.

The club members established a small fish hatchery on campus using an abandoned greenhouse for the tanks, pumps and other materials. This is a unique fish hatchery, one of two now in operation in the United States. (The other is in Skagway, Alaska). The funds to purchase materials needed to start up the hatchery were provided by raffles, spaghetti feeds, car washes, etc., all under the control of the club members.

The hatchery has been on line since October, 1987, and has received the plaudits of students, administrators and parents. Media and television news coverage has been frequent as stories follow the kids' efforts to "make a difference" cleaning the creek and rearing steelhead for Adobe Creek.

As news of the hatchery and clean-up work on the creek project has spread, there has been an ever-increasing community interest and involvement by parents of the members and "Friends of the Project". It is obvious that the entire community wishes to see this joint school/club/community project become reality for all to participate in and become a part of sharing the results.

During this past May the hatchery produced approximately 500 catfish that were released in Petaluma's Lucchessi Pond and 2,000 fingerling trout were released on a farm pond by the club members.

Both of these plants were met with enthusiasm from the community, as well as Department of Fish and Game officials. The farm pond plants will allow the members to commence seining projects to gather growth rate data and tagging for future releases into Adobe Creek in the spring of 1989.

This past June the hatchery project received a devastating blow with the announcement that the greenhouse hatchery building would have to be closed down to all activities due to a large number of unrepairable building code violations.

News of the closing and the need to replace the building have presented new challenges to the kids but certainly have not diminished their desires to "make a difference" and create an environmental change that will benefit all.

ORGANIZING FOR COMMUNITY PARTICIPATION

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Whether you are involved in restoration, education, or both, you know that our work is often hard and demanding, yet it can be equally fun and rewarding. During the course of these challenges, how many times have you wished that you had more help or better funding to make your goals easier to reach. Well, perhaps you will find this outline helpful. The single largest resource immediately available to you is your community. The very nature of your work attracts and interests nearly everyone. Once interested, it is merely a matter of providing the opportunity for your community to support you.

The following outline is a brief overview. Keep in mind that these items will take time to be integrated for long-lasting success. Education and exposure lay the foundation for developing resources.

I. Establish and clearly outline your project goals.

   1. Determine the needs to accomplish these goals; ie, manpower, materials, costs, etc.

   2. Try to work your goals in with other local agency or group efforts, when possible. This will not only consolidate resources but it will also help develop future opportunities.

II. Educate your community about the resources and your project through public exposure. Education should include:

   1. "The Resource" status

   2. Your goals and objectives

   3. Past related experiences

   4. Rewarding experiences

   5. Current efforts

   6. Cooperative efforts

   7. Results

   8. Related materials

III. Public exposure may be through the media (local news reporters are good), presentations, or displays. You may find these key points helpful.

1. Media Tips
   a. Advance notice
   b. Be punctual
   c. Select your choice of words
   d. Encourage interesting pictures

2. Presentations - the presentor should be:
   a. Knowledgeable
   b. Interesting
   c. Enthusiastic

   Note: Remember, you're a reflection of your restoration effort. People can only judge this effort by the way you portray it.

3. Displays can be used at fairs, public centers, forums, and at related programs. Use pictures to capture action, results, human involvement, etc. Displays should be:
   a. Organized
   b. Informative
   c. Attractive

IV. Support - It is up to you to provide an opportunity for your community to support you. A great direct benefit of community support, is that the participating members become vested in the protection of the resource.

1. Funding sources
   a. Industrial organizations
   b. Service clubs
   c. Associations
   d. Sportsmen groups
   e. Fishermen
   f. Councils
   g. Commissions
   h. Water districts
   i. Others

2. Volunteers
   a. Associations
   b. Service clubs
   c. Sportsmen groups
   d. Fishermen
   e. Students
   f. Teachers
   g. Youth groups
   h. Programs

Note: When using volunteers, make sure the task they have been given is obtainable. Initial projects should be selected for successful and obvious results. Recognize their needs. Make them feel "at home". Lastly, try to provide the proper tools for the job. All of these things will help lend to a quality experience.

With a little thanks, some recognition, and a follow through contact after assistance has been given, future support and strong long lasting friendship between your project and your community will be insured. Opportunity awaits <u>you</u>. Good luck!

RIPARIAN ZONE RESTORATION AND MANAGEMENT: STRATEGIES THAT IMPROVE FISH HABITAT

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THE IMPORTANCE OF RIPARIAN ZONES TO STREAM ECOSYSTEMS

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Riparian zones occur at the interface of two major ecosystems - the aquatic ecosystem and the terrestrial ecosystem. As a consequence, riparian zones are transitional areas between ecosystems and exhibit gradients in ecological processes and community structure between the two major systems. Riparian zones often are defined according to a specific set of static attributes, such as the presence of hydrophilous plants, moisture content of soils, elevation above water level, or linear distance from the stream channel. These perspectives often form the basis for riparian management decisions that require rigid delineation of riparian boundaries. However, these views offer little insight into the structural and functional relationships between riparian zones and the stream ecosystems they encompass.

From a structural-functional perspective, *riparian zones can be viewed as three-dimensional zones of interaction between terrestrial and aquatic ecosystems*. The riparian zone extends outward from the stream channel to the limits of flooding and upward into the canopy of streamside vegetation (Figure 1). Riparian zones occur within dynamic portions of the landscape that are subject to both fluvial and terrestrial disturbance. Flooding reshapes geomorphic surfaces within riparian zones on a frequent basis, while movements of hillslope materials (e.g., landslides, earthflows) occasionally modify riparian surfaces and their vegetation. Consequently, *riparian zones are mosaics of geomorphic surfaces that are created and maintained by disturbance*. This mosaic of geomorphic surfaces determines the spatial arrangement and succession of riparian plant assemblages. The geomorphic template and associated vegetation then determine the structure and function of stream ecosystems. This perspective of riparian zones recognizes the major linkages between terrestrial and aquatic ecosystems as manifested in riparian zones and also incorporates the physical processes that create and modify landforms along river valleys.

Critical functions of riparian zones include (1) input of litter and woody debris to streams, (2) shading of streams for temperature control, (3) bank stabilization which limits inputs of fine sediment, (4) uptake and exchange of nutrients with aquatic habitats, (5) retention of organic matter during high flow, and (6) provision of complex stream-edge habitat for both aquatic and terrestrial wildlife. This *riparian zone of influence* varies in dimension according to the specific interaction between forest and stream (Figure 1). For example, forest litter such as leaves and needles generally enter streams from a relatively narrow band of vegetation in close proximity to the stream. Woody debris, on the other hand, can enter streams from a broader zone that extends to the height of the tallest riparian trees. The zone of shading influence may vary in different basins according to orientation, local topography, and stand density.

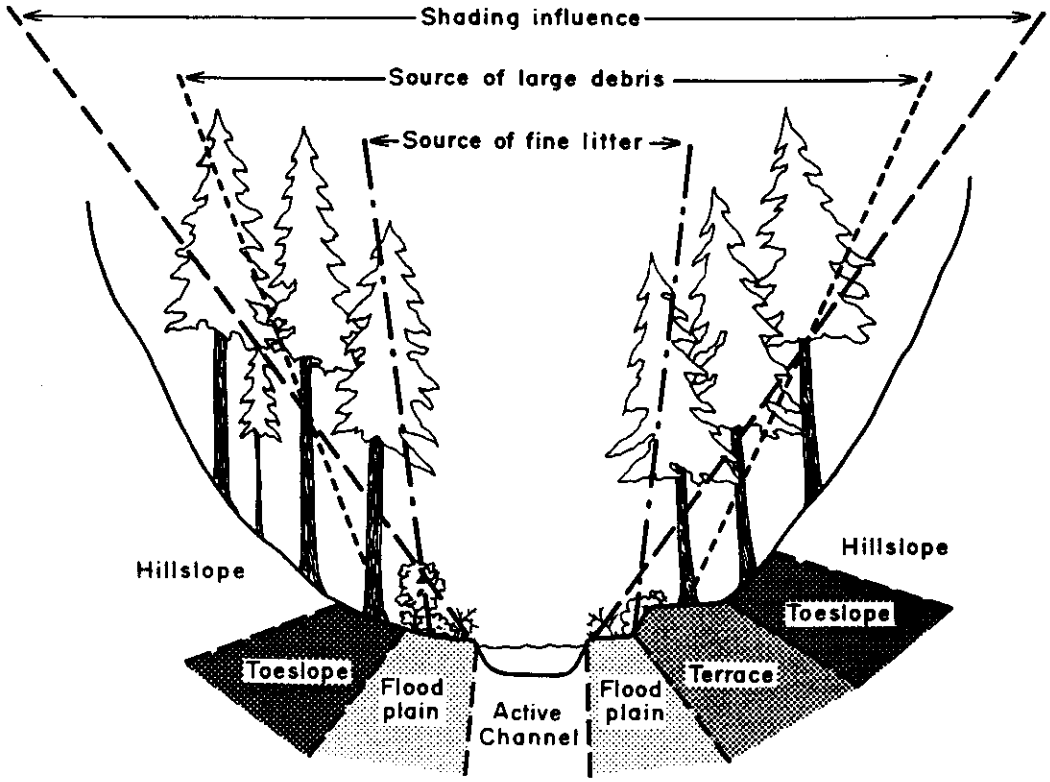

Figure 1. Diagrammatic representation of functional roles of riparian zones.

Because of their linear nature, streams are highly influenced by the adjacent system. The energy base of stream ecosystems is formed by a combination of ***allochthonous*** inputs (organic matter contributed by riparian zones) and ***autochthonous*** production (plant growth within the stream, such as algae and mosses). Riparian vegetation contributes plant litter such as leaves, needles, seeds, cones and twigs to the stream. The riparian canopy also allows infiltration of solar radiation that allows benthic primary production. Leaf litter that enters streams is colonized by heterotrophic microorganisms (bacteria and fungi) and later consumed by detritivorous stream macroinvertebrates known as ***scrapers***. Part of this organic matter is fragmented into small particles by feeding and abrasion, and then suspended into the water or deposited into slow-moving stream habitats where it is consumed by invertebrates known as ***collectors***. Invertebrate and vertebrate ***predators*** such as stoneflies and trout consume all other groups of invertebrates.

Retention of organic matter within stream ecosystems is essential for its later processing because the unidirectional flow of water tends to transport organic matter out of stream reaches. This trapping of organic matter is enhanced by structural complexity of the stream channel. The presence of woody debris, high bed roughness, and complex lateral (stream margin) habitats all contribute to retention of organic matter. Large woody debris also provides important structural elements that stabilize and protect streambanks, while providing off-channel habitat necessary for the rearing of juvenile salmon and trout. During flood events, woody debris dissipates stream power thereby reducing the erosive action of high flow. Accumulations of woody debris store sediments for salmonid spawning gravel, impound water into pools utilized by invertebrates and fish, and trap organic matter that provides food for aquatic organisms. The wood itself is slowly decomposed by microorganisms and colonized by algae and invertebrates, thereby providing a long-term carbon source for the stream ecosystem. The maintenance of sources of woody debris, both coniferous and hardwood, in riparian zones is essential to the long-term stability of stream ecosystems throughout the Pacific Northwest.

Riparian zones with healthy plant communities provide a buffer against upslope processes with potential deleterious effects on stream habitats. For example, riparian zones intercept and retain fine sediment before it can enter stream channels and blanket sediments with their associated invertebrates or smother salmonid eggs. Riparian zones are also active sites of nutrient uptake and transformation. Riparian plants absorb nutrients and later return them to the stream in the form of nutrient-rich litter. Nutrients may be absorbed or otherwise retained by riparian soils and later remobilized into streamwater and utilized by stream organisms. In other instances, excess nutrients may be transformed by soil microorganisms into gases, as occurs during denitrification. Shading by riparian vegetation helps limit solar heating of water, and is especially important in hot arid regions where water temperatures may routinely approach tolerance limits for fish and invertebrates. Although the proximate effects of reduced riparian canopy on water temperature may be minimal, it is important to remember that cumulative downstream effects may occur. For example, small incremental increases in water temperature in headwater tributaries may result in a large temperature rise in downstream areas. Thus, healthy riparian zones help ensure that high-quality water reaches steam ecosystems and is maintained down stream courses.

Riparian zones and stream ecosystems are modified by the configuration of the valley floors in which they reside. In steep-sided basins with narrow valley floors (*constrained* reaches), riparian zones often are limited in extent and their vegetation is similar in composition to hillslope communities. Streams are relatively straight, single channels with little lateral heterogeneity or floodplain development. The absence of lateral stream habitats required by juvenile fish may limit fish production within these reaches. By contrast, in basins with wide valley floors (*unconstrained* reaches), riparian zones are broad bands of diverse vegetation that gradate into hillslope communities. Streams in these areas often exhibit complex, braided channels with high lateral heterogeneity and floodplain development. These complex channels support diverse fish habitat and provide lateral refuge during floods. The interaction between riparian zones and stream ecosystems must be considered within the context of valley floor configuration. Management goals for riparian zones should be sufficiently robust to encompass this spatial variation in land-water interaction.

Riparian zones are one of the most physically complex and biologically diverse portions of the landscape. Riparian zones are interfaces between terrestrial and aquatic ecosystems, and incorporate physical and biological properties of both ecosystems. Stream ecosystem processes are largely controlled by the dynamic interaction between valley floor landform, riparian vegetation, and stream structure. Aquatic organisms such as salmonids are strongly influenced by the habitat and nutritional resources provided by channel structure and streamside vegetation. Thus because of their central role in forest-stream interactions, riparian zones are critical components of the landscape.

PRELIMINARY RESPONSE OF FISH TO EROSION CONTROL MEASURES IN THE NORTHERN SIERRA NEVADA

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INTRODUCTION

The North Fork Feather River (NFFR) watershed is located on the west slope of the Northern Sierra Nevada in California, and includes an area of 1,953 square miles. It has been long recognized for its recreational and aesthetic value, and has been the focus of many land uses including fishing, hunting, mining, timber harvesting, livestock grazing, agriculture, and hydroelectric generation. This watershed is an important component of the California State Water Project and the Central Valley Project, which supply water for the cities, farms, and industries of central and southern California. In addition, a significant amount of hydroelectric power is produced from a series of dams and reservoirs that are operated by Pacific Gas and Electric Company and the California Department of Water Resources.

In recent decades, sedimentation has dramatically increased in the NFFR due to accelerated erosion of streambanks and surrounding uplands high in the watershed. Reconnaissance studies have indicated that the accelerated erosion condition is due in part to natural causes such as flooding, wildfires, and erosive alluvial soils, but activities of man such as timber harvesting, grazing, mining, and road construction are major contributors in the instability of this system. Where control of land use is inadequate, these practices have often led to the loss of riparian and upland vegetation, which has reduced streambank stability and increased surface flow.

The consequent poor water quality has presented problems for landowners, managers, and resource users. Livestock producers are concerned with the reduction in forage production in alluvial valleys due to the drop in the water table associated with downcutting channels. Recreationists find that fish populations are reduced due to the poor water quality, lack of overhanging vegetation, warm water temperatures, and changes in stream channel morphology. Inadequate protective cover also reduces nesting and rearing habitat for waterfowl and other wildlife species. Hydroelectric producers must contend with increased sedimentation in reservoirs, which creates operational and environmental concerns. These effects are symptoms of the degraded state of the watershed.

PROJECT PLANNING

In response to the accelerated erosion problems evident in this watershed and their effect on fish, wildlife, range and hydroelectric production, a cooperative, interagency effort was initiated in 1985 to develop and implement a regional erosion control plan. Fourteen federal, state, and county agencies, and private sector groups have committed manpower, equipment, funding, and technical resources to the development of the project. The commitments of each group are specified in a Memorandum of Agreement (MOA) that has been recently finalized, and which serves to organize and coordinate project tasks.

The objective of the project includes identifying and prioritizing the sources of accelerated erosion in the watershed, and determining an action plan for restoring these areas using a cooperative systems approach. Planning at the local level was facilitated by entering into a Coordinated Resource Management Plan (CRMP) which is often used to solve complex resource problems that involve several landowners, interest groups or agencies. With this approach, decisions are made by consensus, so the needs of each participant are addressed in development of the final plan. Planning at the regional or watershed level is being initiated by the USDA Soil Conservation Service (SCS) in the form of a River Basin Study, authorized by Public Law 566 (PL-566), to evaluate the cost-effectiveness of controlling erosion in the watershed. The final report will be used to secure federal PL-566 funds for implementation of a regional erosion control plan.

DEMONSTRATION PROJECT

Due to the complexity associated with watershed restoration, the CRMP participants decided to initiate a small demonstration project in the headwaters of the watershed as a first step in developing a regional erosion control plan. The goal of the demonstration was to test the effectiveness of various erosion control techniques in restoring streambank stability, reducing sedimentation, and enhancing fish and wildlife habitat, and to develop a cooperative planning process that could be used to coordinate the activities of interested groups to solve resource problems on other sites. Restoration measures were designed to include both biological and engineering techniques that emphasize the use of available resources in order to minimize costs.

SITE DESCRIPTION

The demonstration project is being conducted on a one-mile stretch of privately owned land on Red Clover Creek, which is 25 miles east of Quincy, California, on the eastern boundary of the watershed. The creek flows through Red Clover Valley which is a highly erodible alluvial valley at an elevation of 5,500 feet. It contributes large amounts of sediment to the NFFR system via Indian Creek. The valley is 6 miles long and 2 miles wide and is surrounded by sparsely timbered land administered by the Plumas National Forest. The drainage area contributing to the alluviated portion of the valley is about 75 square miles, while the drainage area of the entire channel system is about 100 square miles. The climate is relatively dry, annual precipitation is highly variable, and soils are less fertile than valleys on the west side of the crest.

The vegetation is composed predominantly of undesirable shrubs and grasses such as sagebrush, rabbitbrush, and cheatgrass, while sparse willows, alders, and cottonwoods line old stream channels. Many native perennial grasses and forbs have been replaced by less desirable weedy species due to the impact of land use on vegetation and the lowering of the water table. The actively eroding channel is 50-60 feet wide and has vertical cut banks 8-10 feet deep. Vegetation cover and mix of species have significantly declined since the turn of the century in response to loss of protective vegetation cover on streambanks and uplands, limited ground water storage, and variable precipitation.

EROSION CONTROL MEASURES

In order to stabilize eroding streambanks in Red Clover Creek, a four-part restoration program was developed. Four loose rock check dams (gradient control structures) were constructed to reduce water velocity, trap sediment, and stabilize streambanks. They were designed to reduce erosional forces on the streambank and to encourage the establishment of streamside vegetation. Second, exclosure fencing was installed to control livestock access and to protect monitoring equipment. Third, a revegetation plan was implemented that involved planting riparian vegetation along the banks and seeding herbaceous vegetation on upland areas impacted by construction of the dams. Last, a monitoring plan was developed to test the efficiency of these techniques in meeting project objectives.

MONITORING

Monitoring plans were developed to track the response of fish, wildlife, channel shape, streamflow, water quality, water table elevation, and vegetation to erosion control measures. In addition to fisheries population sampling, water quality and temperature data were also collected but will not be included in this report.

FISHERIES RESULTS

In 1985, trout were in very low abundance at Station C-1 (the downstream control site), where three rainbow trout with approximate fork lengths (FL) of 70 mm, 150 mm, and 165 mm were captured. No trout were captured upstream at Station T-1, within the study area. These results were as expected, based on the low quality of the habitat, which is characterized by the lack of overhead cover, sufficient water depth, and heavily silted substrates.

In 1986, trout were again very scarce at Station C-1, where only one juvenile was captured. At Station T-1, 20 adult trout were captured. Eighteen were rainbow trout, ranging from 135 mm to 286 mm FL, and the other two were brown trout, measuring 211 mm and 300 mm FL. These trout evidently moved in from other sections of Red Clover Creek during high flows in the winter or spring. Possible sources include movement from lower Red Clover Creek, beaver ponds in the vicinity of Station C-1, and headwater stream sections that are reputed to be good trout habitat. Although it appeared that trout could leave the impoundments at the time of sampling, the low flow over the rock dams probably deterred such movement.

In 1987, the largest number of trout to date, 4, were captured at Station C-1. These fish were between 210 mm and 340 mm FL, compared to the smaller trout (70-165 mm) captured there in previous years. This may be due to a low beaver dam that was constructed at the lower end of the station which enhanced fish habitat in the control area. This dam enlarged the pool that had existed there in previous years. Also, a substantial bed of aquatic vegetation had been established due to the pool for the first time, providing cover suitable for large fish. Only six adult trout were collected at Station T-1 in 1987, compared to 20 the year before. Five of the trout were rainbows, ranging in size from 165 mm to 329 mm FL. the sixth was a brown trout measuring 305 mm FL.

Data collected in 1988 indicate that no trout were captured at Station C-1 and five rainbow trout were captured at Station T-1. They ranged from 71 mm (the first young-of-the-year captured) to 364 mm in length.

The reduction in the number of trout at Station T-1 from 1986 to 1988 did not appear to be due to physical changes in habitat. Aquatic plant (macrophyte) production appeared equal to or greater than the previous year. Instead, the reduction may have been the result of several factors, including 1) lack of high winter and spring flows to encourage movement of fish into the ponds; 2) intensive fishing pressure in the ponds behind the check dams; and 3) mortality due to anchor worm parasites, which were present on most of the fish in 1987.

CONCLUSIONS

Rainbow and brown trout are limited by habitat conditions in the study section of Red Clover Creek. Adult individuals of both species rely on deeper pools; they were found almost exclusively in the study pond and the portion of the control station that was backed up by the beaver dam. Such deep-water habitat in Red Clover Valley is provided only by occasional small pools and by beaver ponds in the western end of the valley.

Rainbow and brown trout are also limited by lack of suitable spawning and/or juvenile rearing habitat. In four years of sampling, only two juvenile trout have been captured at the control station, and one at the test station. Spawning habitat appears to be extremely limited. The small amounts of gravel substrate in the stream appear to contain a large percentage of fines (sand and silt), which severely degrade the quality of the gravel for spawning. Consequently, the occurrence of adult trout at the test and control stations is dependent upon recruitment from other section of Red Clover Creek.

Rehabilitation of Red Clover Creek as a quality trout stream will require substantial expansion of pool or deep run habitat for adult trout, as well as improvement of riffle habitat for spawning and juvenile rearing. Construction of the ponds and removal of the cattle from the stream will provide the necessary rehabilitation to the extent that they succeed in narrowing and stabilizing the channel so that 1) summer flows provide adequate depths for adult trout; 2) the input of fine sediments is greatly reduced; 3) stable, undercut streambanks develop to provide cover for trout; and 4) water temperatures are reduced during summer by increased velocities and depths in combination with decreased solar radiation due to a narrower, vegetated channel.

The ponds, as they currently exist, probably will not achieve much in the way of re-establishing the trout populations in Red Clover Creek until stabilization occurs and vegetation begins to establish. Although they provide good adult trout habitat, their populations rely on the recruitment of fish from other sections of the stream. In addition, they provide stillwater habitat that appears to promote the production of anchor worm parasites as well as dissolved oxygen concentrations that are lower than recommended for trout. Future monitoring of the fish populations will determine whether the parasites were abundant in 1987 because of the low runoff conditions or whether they will become a recurring problem. Additional water quality monitoring will be required to determine if trout in the ponds frequently are subject to low dissolved oxygen levels.

Monitoring will be continued through 1990 and an evaluation of fisheries impacts will be completed at the time. It is expected that habitat suitability for fish will increase over time, but recovery rate is dependent on the extent of restoration in other degraded sections of stream.

MINIMIZING THE IMPACTS OF TIMBER HARVESTING ON FISHERIES:

PREVENTION, NOT CONFRONTATION

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CUMULATIVE IMPACTS OF TIMBER HARVEST ON FISHERIES: "ALL THE KING'S HORSES AND ALL THE KING'S MEN..."

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There are some things, like Humpty-Dumpty and watersheds, that cannot be put back together again. Not even by experts. Although we may be able to help speed a few of the complex natural processes that allow ecosystems to recover, we lack the technical understanding, technological ability, and economic resources necessary to restore watersheds and streams to their pristine state. Surely our acquisition and attempts to restore Redwood National Park have shown us this. Yet this would be so even if our social and political commitment to the problem were uncompromised. Certain biological resources, such as the multitude of locally-adapted, coevolved stocks of salmon and steelhead upon which our fisheries depend, when lost are gone forever.

We say this not to paint a gloomy picture of the future--which need not be gloomy at all--but to emphasize the inestimable value of those habitats and populations that we still have. The first charge of a restoration program is to ensure that the resources which are still intact remain that way. These few rivers and their fisheries function to sustain our economy and our way of life, serve as models to demonstrate what the goals and tactics of a restoration program can and should be, and provide the genetic resources necessary for reestablishment of fish runs in nearby basins whose stocks have been lost. They do this on their own, without requiring any major capital investment from us, and for that reason their true value is often overlooked or ignored by agencies both public and private.

We believe there is an urgent need for organizations like the Salmon, Steelhead and Trout Restoration Federation to publicly reaffirm and re-emphasize these tenets. The National Forest Plans have recently been released for public review, and anyone who has not attempted to read one of these documents should. Many Forests promise many things to many people. However, there are two things you will find in few or none of the Forest Plans on the west coast: first, any kind of policy committing the agency to ensuring the survival of indigenous, locally-adapted stocks of salmonids; and second, any policy stating or providing that protection of fish habitats which are presently unimpaired will be the first priority, with programs to restore habitat limited to those areas that have suffered from past impacts.

On the contrary, you may find, as one group did when we reviewed the Draft Plan of the Siskiyou National Forest in southwest Oregon, that millions of dollars of public funds have been budgeted for "enhancement" projects that are expected to do little more than compensate for the further damage to fish habitat caused by the timber program over the next twenty years (Oregon Chapter of American Fisheries Society, 1988). The Forest Service is not alone. This one aspect of a problem which has been growing since the potential of restoration programs began to be sold in political circles in the 1970's; for the naive layman (or the politician), it is natural to ask why, if we know so much about how to "rebuild streams," should we bother to protect them any longer? Can't we now simply "rebuild" them so that they are even better than they were before? Funding a restoration program then, becomes a rationale for relaxing the regulations intended to protect fish habitat. Have you noticed this: the timber industry <u>likes</u> hatchboxes and log weirs. It promotes them. It kicks in money. Stream-bred, wild fish, however, which cost nothing, make the industry very nervous.

Another thing common to most National Forest Plans, and also to plans of other agencies, is denial or ignorance of the magnitude of the problem of cumulative, downstream-propagating impacts of accelerated erosion and sedimentation in watersheds that have been disturbed by timber harvest. The National Forests, for example, generally do not evaluate the effects of sediment (including suspended material and fine and coarse bedload) that originates from National Forest land but impacts downstream, off-Forest areas. Even if "lip service" is paid to these situations in the plan, you will find that any such impacts have not been computed into the models that predict the effects of management alternatives on fishery values.

In fact, in the Siskiyou National Forest Draft Plan, the primary variable determining fishery values in the planning model is the amount of money spent on instream structures. Even the effects of increased turbidity, which aside from its ecological impact can be devastating for a river sport fishery, are not accounted for. The equation apparently goes something like this:

More Logging + More Sediment + More Structures = More Fish.

Somehow the sediment term gets canceled out--we're not sure exactly how, but we suspect the structures are supposed to do that.

There are two big problems with the assumption that structures are going to take care of everything. One is that, even though we have already spent vast sums of money on them, we don't yet know whether artificial structures work, at least for anadromous fish on the west coast. In fact, despite the best efforts of some agencies to prevent it, information has emerged that many such projects are biologically ineffective or even detrimental (Everest and Sedell 1984, Petrosky and Holubetz 1986, Fontaine 1987, Frissel and Nawa in press). Furthermore, many projects in southwest Oregon have had high rates of physical failure, particularly those situated in watersheds with a history of logging-related erosion, sedimentation, and channel instability (Frissell and Nawa in press).

The second problem is that it is the larger, flatter, mainstem reaches of rivers which may suffer most severely and persistently the cumulative effects of watershed disturbance (Hagans *et al*. 1986, Frissell and Liss 1986). These low-gradient reaches, many lying downstream from steep, erosive federal lands, probably supported the bulk of historic anadromous fish production, and continue to be critical to remaining stocks. They serve as holding, spawning and summer rearing areas for chinook salmon, and important wintering areas for juvenile steelhead, which may travel many miles between winter and summer habitats. Yet attempts at placing artificial structures in larger streams have generally met with abject failure. In view of this, we think it is important that the Forest Service admit that sediment will cancel out artificial structures in the mythical fish equation, and not the other way around.

If something is said often enough, it tends to become accepted as the truth, regardless of its original validity. The myth that fish are a mere product of a commodity like artificial structures, separate from their watersheds, is loudly touted today, and rarely questioned. Perhaps our world is more like Humpty-Dumpty--watersheds have complex organization and histories, fish are just a part of the watershed, complex and unique in their own right, and the whole system, when broken, can't ever be quite the same again. Our scientific understanding tells us the Humpty-Dumpty model is closer to the truth.

This may make life difficult for agencies and politicians, who are best-equipped to deal with systems that are simple and have interchangeable parts. But there are, here and there among the agencies and industry, exemplary policies and far-sighted personnel. There are methods for mapping watersheds and streams to predict and avoid damage from erosion. There are techniques for logging that leave slopes far less prone to failure and gullying. There are ways to managing harvest so that native stocks are not over-fished. And there are examples of policies to ensure that restoration programs do not become excuses for continued habitat degradation. Most of these procedures and policies cost relatively little money, beyond the need to support intelligent people to explain them and carry them out. It is time that we focus attention on such approaches to management of our watersheds and fishery resources, and insist that they become paramount in our restoration programs.

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A SCIENTIFIC AGENDA FOR RESTORATION

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Traditionally, science has not followed an agenda specifically aimed at managing a watershed's fishery. Effective salmon and steelhead restoration hinges on this agenda. Our knowledge concerning salmonid populations' biological and physical requirements within individual basins is piecemeal because scientific investigations of limited scope have been performed over a wide array of watershed types and sizes. Synthesis of this investigative patchwork has permitted considerable qualitative understanding of watershed and fishery interaction, but limited quantitative understanding. Without quantitative insight, scientific contribution to the restoration process often is reduced to broad qualitative recommendations. This tentativeness reduces the credibility and utility of our prescriptions to the timber industry and natural resource management agencies. Scientific research has limited applications to fisheries restoration for a given river basin without pursuing the following interrelated research perspectives:

(1) identification and quantification of bottlenecks throughout the entire salmonid life cycle;
(2) incorporation of broad spatial and temporal scales in experimental designs;
(3) synthesis of trophic level interactions.

This paper will address the importance of each perspective in the scientist's contribution to salmon and steelhead restoration.

Bottlenecks can be defined as physical or biological factors that limit yearly salmonid abundance. Research by Connor and Trush in the upper South Fork Eel River of Mendocino County has shown that the annual density of yearling steelhead remained relatively constant in several tributaries while the yearly number of redds and annual densities of the young-of-the-year fluctuated. The potential bottleneck, a 'cap' on yearling densities, may result from limited habitat availability; yearling densities were correlated with several measures of physical habitat. Should restoration aim for higher yearling densities by physically modifying stream habitat? As usual, the response is maybe, for several reasons. First, there is no guarantee that greatly improved habitat conditions will support more yearlings, but simply attract yearlings from other regions of the stream. Second, primary or secondary productivity may not support higher yearling densities regardless of improved physical habitat. Third, it makes managerial sense to identify and mitigate the most limiting bottleneck first. Few aspects of steelhead life history have been examined in the South Fork Eel River, making identification of yearling density as the critical bottleneck difficult.

A watershed's anadromous fish population is dependent on the interaction of several spatial and temporal geomorphic scales. While physical characteristics of individual tributary watersheds exert a strong influence on salmonid populations, larger spatial scales encompassing the entire river basin, and ultimately the open ocean, clearly are important. Year-to-year persistance of an anadromous population requires (1) adequate adult upstream migration and (2) adequate smolt numbers and successful outmigration. Each salmonid population must overcome (or adapt to) constraints at several spatial and temporal scales in order to satisfy both requirements.

Arrangement of stream channels within a basin illustrates the effect of spatial and temporal scale on steelhead populations. The junction of a first and second order channel typically does not exhibit a sharp break in slope. Although storm discharge in the first order channel peaks slightly earlier than in the second order channel, the timing of their respective storm hydrographs is sufficiently similar to allow migrating adults to swim from the second order channel into the first order channel during most winter flows. The junction of a first and fourth order channel often does exhibit a sharp slope break, with the first order channel rapidly dropping to the fourth order floodplain. This steep portion of the first order channel often must be partially flooded by the rising stage of the fourth order channel before adults can negotiate the junction. However, by the time the fourth order channel flow is peaking, flow in the first order channel already has been declining. The effect of stream junctures on adult migration can be diagramed in the storm hydrographs for two stream channels differing by only one stream order (Figure 1), with the following terminology:

Q_{s1}..range of flows allowing steelhead to reach favorable spawning habitat while in Watershed #1 (the smaller channel);
Q_{s2}..range of flows (in the larger channel, WSHD #2) needed by steelhead to negotiate the mouth of Watershed #1 (flows below this range in WSHD #2 are a barrier to WSHD #1);
T_A ..number of hours to negotiate the stream junction;
T_s ..number of hours for reaching upper regions of WSHD #1.

As the difference in size between watersheds (or stream order) increases, T_A and T_s decrease because greater flows are needed in the larger channel to flood the junction. A first order stream joining a fourth order stream greatly limits T_A and T_s. Partial stream barriers, acting in a similar fashion to stream junctions, also can affect migration depending upon their structure, location and sequence within the stream channel network. Barrier removal and culvert design for fish passage should consider the downstream route leading up to the culvert, make estimates for time of travel, and determine flood hydrograph characteristics (developed from regional hydrographs as a function of drainage area and valley slope).

Potential impacts of timber harvest include indirect effects on lower trophic levels, the plants and invertebrates. Often, researchers imply that increased primary and invertebrate production promotes anadromous fish standing crops when using lower trophic levels as 'litmus paper' indicators of environmental change. Given the complexity of stream ecosystems, measured

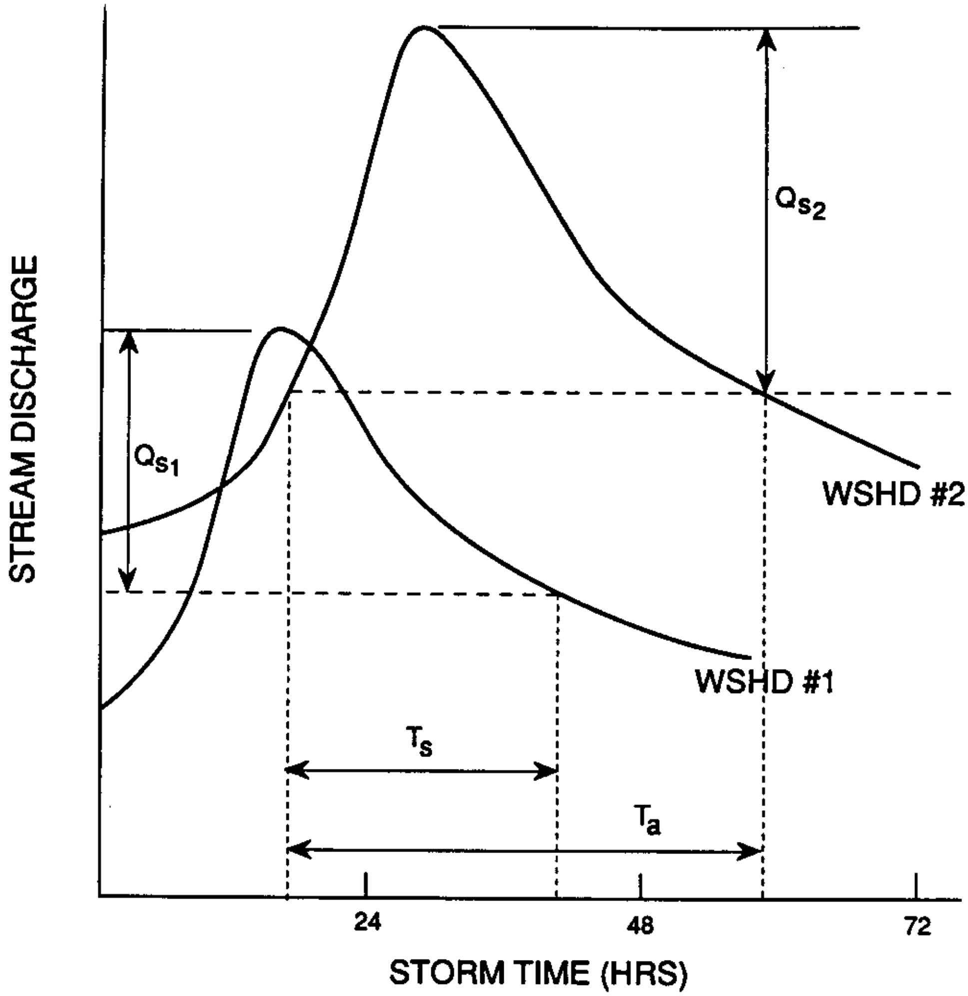

Figure 1. Storm hydrographs for two stream channels differing by one stream order. See text for explanation of symbols.

changes in algal production or macroinvertebrate densities can be very difficult to translate into prescriptions for timber management. For example, Ligon and Erman found that timber harvesting tended to increase the production of algae by increasing nutrient and light availability in a coastal Mendocino stream. A long green filamentous algae, Cladophora, comprised most of the increased production. Diatoms, the dominant algae in closed canopy streams, was reduced. Does Cladophora, as a food source, change invertebrate species composition and, in turn, affect juvenile salmonid feeding? Without initially designing the study with fish production in mind, the effects of changes in lower trophic levels on juvenile anadromous fish cannot be addressed.

Fishery scientists have the necessary tools for prescribing restoration and timber harvest practices, but have traditionally lacked the coordination to examine the wide range of spatial and temporal factors ultimately affecting salmonid populations for a single major basin. Prioritization of bottlenecks in pristine and disturbed basins is essential, but cannot occur unless a broader perspective is practiced. Current studies on Redwood Creek and South Fork Trinity River basins have taken a broader perspective. A major beneficiary of a basin-wide understanding of watershed - anadromous fish interactions will be the timber industry. Better definition and prioritization of the bottlenecks in a basin should lead to more effective management.

TIMBER HARVESTING OPTIONS AND FACTORS AFFECTING IMPACTS ON WATERCOURSES

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The perception of the ideal result of harvesting changes as our knowledge of natural systems increases. My current impression is that, from a fish habitat standpoint, a logging operation should a) minimize additional movement of material into perennial streams, b) create little or no direct physical disturbance to the streams from logs or equipment, c) minimize reduction of shading of streams and d) retain larger trees in the riparian zone for future recruitment of large organic debris.

Any harvesting system will have some negative impacts, yet harvest planners and loggers have considerable control over the severity of the effects, via their choice of equipment, geographical layout of the harvest unit and mode of operation. Harvesting systems can be classified by the method used to transport logs from the stump to the haul road:

1. Tractive systems employ crawler or rubber-tired tractors to skid logs, generally downhill to the road because of production and load limitations when logging uphill. Ground slopes should generally be less than 40% to limit ground disturbance, and yarding distances for tractors are limited to about 700 ft.

2. Highlead cable systems use winches and towers to drag logs on the ground, uphill over distances of up to 1000 ft. Lack of control of loads limits their operation downhill to 300 ft.

3. Skyline systems also use wiches and towers, but rely on a tensioned skyline to fully or partially suspend payloads above the ground. The variety of skyline equipment can be baffling, yet much of the potential relative impact of skylining relates to the two variables which determine lift capacity: 1) deflection and 2) tension capacity of the skyline.

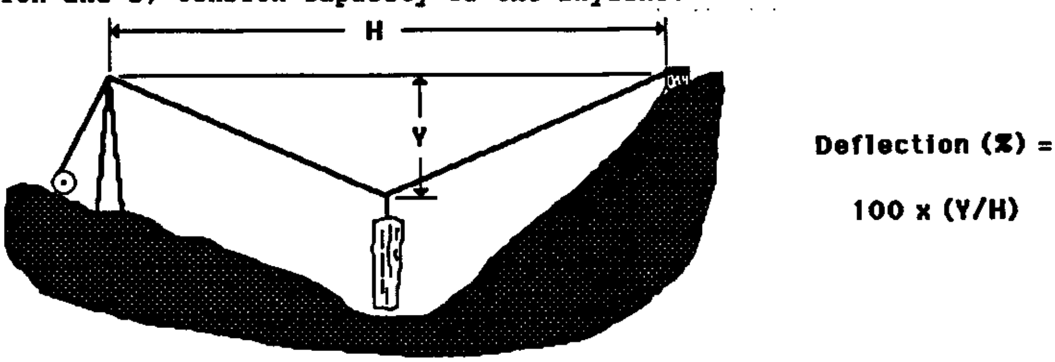

Figure 1. Definition of deflection for a skyline system.

Deflection refers to the distance the skyline can be depressed vertically relative to the horizontal span between supports (Figure 1). Because of the mechanical force balance, the weight which can be fully suspended by a skyline increases in almost direct proportion to deflection, and to skyline tension capacity. Deflection is affected primarily by the vertical profile of the terrain, but can be increased in many cases by shortening the span (which usually means building more roads), increasing the height of the tower or tailspar, or supporting the skyline at intermediate points along the span.

Larger, more costly yarders generally have higher tension capacities and taller towers. Disadvantages of bigger machines include the need for more and bigger anchors for guylines, bigger landings and increased setup costs.

The type of yarder determines whether it can operate uphill or downhill, in partial cuts or only in clearcuts. Some machines have enough cable to yard 4000 ft, if deflection is adequate.

4. Logging balloons are currently operated by only one company in the world. Their capabilities to fully suspend loads of 20,000 lb or more are not affected by deflection, and this along with the ability to yard out to 5000 ft, are the primary advantages. Disadvantages include the need for a large bedding area for winter tiedown, a large cost to move the equipment between sales, and susceptibility to weather shutdowns. Balloons are considered clearcut systems and generally operate downhill.

5. Many helicopters, with load capacities of 15,000 lb or more, have been used for logging. They can operate on almost any terrain and have high production potentials compared to skylines, however they require large areas for landing and decking logs and are sensitive to weather conditions.

Rough estimates of ranges of yarding costs for the various systems include:

	$/Thousand Board Feet
Tractive	15 - 60
Cable (Highlead/Skyline)	40 - 250
Balloon	100 (typical)
Helicopter	150 - 250

Many factors affect costs, and the various systems are sensitive to different variables. Cable logging costs increase rapidly with yarding distance, while those for helicopters do not. Terrain and timber density also affect cable systems, while balloon costs are very sensitive to the total volume of timber on a sale. Helicopter payload capacities and therefore yarding costs depend on elevation and air temperature.

Much of the increased sediment yield following harvesting has originated from roads. Roads are already in place in many areas and it may not be feasible to change their locations or add more. In unroaded areas, location and spacing of roads must be tied to the choice of harvesting system. Modified construction techniques on newer roads, including fitting the road to the terrain, using steeper road grades to keep roads on ridgetops and full-bench cuts, have potential to reduce sediment at increased construction cost.

Movement of material to streams is probably correlated with the amount of surface disturbance. Estimates for various systems include:

	Percent of Surface Disturbed
Tractor/Highlead	25 - 50
Skyline	5 - 20
Helicopter	2 - 5

These figures vary with the layout of the unit and with how the equipment is operated. Designated skid trails for tractor logging reduce disturbance with little increase in cost.

Skylines can cause considerable disturbance when lift capacity is inadequate, resulting in plowing by the choked ends of the logs. Under partial suspension, logs sweep out wide corridors when yarding is carried out across slope or downhill.

Helicopters create little disturbance because payloads are fully suspended. Roads are spaced farther apart as well.

Only systems with full suspension capability (skyline, balloon and helicopter) can operate over the riparian zone. Balloons and helicopters have little or no impact in the zone, but skylines can have significant impact if planning and operation is not carried out correctly. Poor deflection, inadequate tension capacity or downhill logging can result in logs dragged through streams. In partial cutting, lateral excursion of the skyline can damage or pull over trees in the riparian zone if the skyline is positioned within the canopy.

Reduced impact involves a trade-off with increased cost in many situations, but this is not always the case. For example, helicopters provide minimum impacts, yet may be the least-cost options on some terrain where road building is difficult and deflection is poor.

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ACHIEVING BENEFITS WHILE MINIMIZING IMPACTS OF LOGGING ON FISHERIES IN SANTA CRUZ COUNTY

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This paper will present the methods used by Santa Cruz County to minimize the negative impact of logging on fisheries and will stress the importance of promoting a win-win situation for both the logging industry and the environment.

Watershed management efforts to benefit fisheries and water quality have a long history in Santa Cruz County. Since the early 1970's we have monitored surface and groundwater quality, developed watershed management plans, carried out stream enhancement work, and developed and enforced regulations designed to preserve and enhance the stream/riparian environment.

Stream water quality monitoring has indicated that many sources of contaminants exist. Two effects on stream quality that I have been most involved with are urbanization and timber harvest—related impacts. In the case of urbanization we are continuing to see impacts that lead to a serious degradation of water quality and stream habitat. The recent urban development and other factors in the San Lorenzo River Watershed lead to a 95% loss in salmon and steelhead populations. Studies of the San Lorenzo River Management Plan show that watershed urbanization has led to increases in sediment yield, runoff rates and vegetation removal along stream banks. Programs begun by our office have resulted in progress in reducing these impacts but much more work is needed to reverse these trends.

Conversely, pristine streams exist in undeveloped areas of Santa Cruz County that rival the quality of any stream in the state. The County regards these undisturbed watersheds as a vital resource for dwindling anadromous fisheries populations which must be preserved.

While the creation of parks and reserves are one contribution that the State and County have made to this effort, we cannot depend solely on property maintained by government to provide adequate open space due to the expense involved. The majority of open space in our State is privately owned. Therefore it is necessary to help private landowners maintain their property as quality open space. Economic pressures, however, can hinder this task.

One of the greatest pressures faced by landowners is the financial burden of high taxes or large monthly mortgage payments that exceed the income derived from uses on the land. The County of Santa Cruz has turned to Conservation Easements and Timber Preserve Zoning as means to lower taxes on privately owned timbered open spaces. Other tax incentives are available to other agriculturally viable lands. Reduced taxes improve the landowner's prospects for gaining long term income derived from logging. In exchange for a reduction in tax rates timber land owners are restricted as to the amount of development that may occur on their property. Because logging can negatively affect wildlife habitat and water quality, steps must also be taken to insure that harvesting occurs in a controlled manner.

In our redwood dominated forests, sustained yield silviculture is achieved by limiting cuts to 60% of trees over 18" DBH, or 55% of those trees over 12" DBH. This strategy gives the timberland owner the ability to harvest on a continuing basis and produces the type of income needed to minimize changes in property ownership, which improves a sense of stewardship.

Attempts to reduce timber harvest impacts have been ongoing since the early 1970's in Santa Cruz County. Special rules were adopted at that time to create a Timber Harvest Ordinance. This ordinance took into account local conditions and incorporated the concerns of the industry and the public. This process resulted in an effective set of rules that were aimed at the heart of what the public, foresters and government officials felt would solve the negative effects of logging. In 1983 local control was preempted by Senate Bill 856. Provisions in that bill allowed the County to approach the Board of Forestry for special local rules, and to have a participant on the State Timber Harvest Review Team.

The ability to have a representative on the State Review Team has been instrumental in allowing us to affect the process. Locally the review team has evolved into a cooperative group that can deal with the evaluation of Timber Harvest Plans in a manner which provides protection for the environment while still considering the needs of the local industry.

While speaking on all the benefits of the review team are beyond the time I've been allotted, I will attempt to highlight a few of the most important aspects. To be effective, the Review Team must consist of a good cross section of professionals in the fields related to forestry. Ideally this team should also include the Licensed Timber Operator. One problem with even the best conceived plan is that plan particulars do not get transferred to the operators or crew effectively. Adding the L.T.O. to the Review Team interjects a healthy dose of pragmatism into a process that has potential to become a mental exercise and insures better transfer of information to the ground crew. With this combination of participants, disagreements on how to protect the fisheries habitat are reduced because these professionals can prove their points through knowledge and experience in the field. Our experience has indicated that Timber Harvest Plans can be effectively reviewed and designed to eliminate most deficiencies through the use of Review Teams such as that described.

Because the amount of staff time available for review is limited, Review Teams need to focus on potential major impacts. For streams, the main impacts are sedimentation and retention of stream bank vegetation. Roads and other disturbances that may change drainage patterns are the source of most erosion. These areas of bared soils and concentrated runoff are the single most important issue for erosion control in logging. Roads should be designed not to change sheet flow or natural drainage patterns. Adequate vegetative capacity must be maintained between roads and water courses, to enable erosional fines to be filtered before reaching streams. Keeping roads to a minimum, outsloping and using wide equipment exclusion zones along streams are used locally as an effective way to solve these problems.

Leaving woody debris in streams can also help the sediment storage and encourage pool and cover habitat. Tractor crushing of woody debris on roads combined with other mulch coverings are effective ways of solving erosion from roads that do not have adequate filter between streams.

Obviously many more techniques can be employed to reduce erosion in the field, but these are two areas that must be watched closely. With these few examples we have been able to effectively promote better stream quality and solve many problems that I have seen elsewhere in the state.

THE WASHINGTON STATE TIMBER, FISH AND WILDLIFE AGREEMENT: AN ALTERNATIVE TO CONFRONTATION AND REGULATION

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In 1986, extreme controversy developed in Washington State regarding proposals for regulation of timber operations in riparian zones. Rather than engaging in prolonged confrontation, timber interests, environmental groups, natural resource agencies and Indian tribes decided instead to seek resolution of issues through the help of a mediator. With the assistance of the Northwest Renewable Resources Center, a group of 45 participants met over 100 times during a six-month period. The result was the Timber/Fish/Wildlife agreement, a tool that combines flexible, site-specific forest planning with open discussion and better protection for fish, wildlife and archaeological/cultural resources. In 1987-89, the Washington legislature appropriated $4.5 million to implement the agreement. The jury is still out on how effective, in practice, the agreement is.

In an era of friction between the timber industry and environmental interests regarding effects of timber operations on other resources, a maze of regulations and judicial decisions has been created in California. Collaborative planning may be a better approach for California's North Coast. Six steps are necessary to effect cooperative change (Smitch 1987):

1. All constituencies must want a change in the way of doing business, and all must be included in any solution.

2. All parties to a conflict must together identify the problems, consider the choices, and evaluate the consequences of alternatives.

3. Participants must "agree to agree".

4. Technical participants must reach agreement on a single set of facts and assumptions or agree on a process to identify those facts.

5. Each negotiator must strip away postures and focus on real needs and real issues.

6. Everyone must work together and recognize the need to "give to get".

It is necessary for people to feel dissatified with the situation whether or not their interests are "winning" at the moment. Its a difficult decision for adversaries to admit their need for each other. Yet, in many resource management disputes, conflict resolution has proven successful. Washington's T/F/W agreement is just one such case. Coordinated Resource Management Planning (Anderson and Baum 1988) is another approach used primarily for range management planning to date but potentially applicable to other concerns.

In my view, creative cooperation is required in several areas relevant to North Coast forestry. These include: cumulative impacts on wildlife and fisheries, sustained yield of commodity and non-commodity resources, community stability and economics and rehabilitation of degraded resources.

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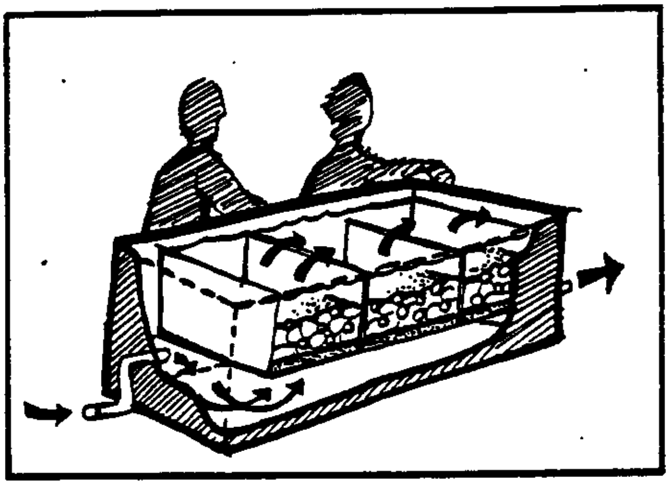
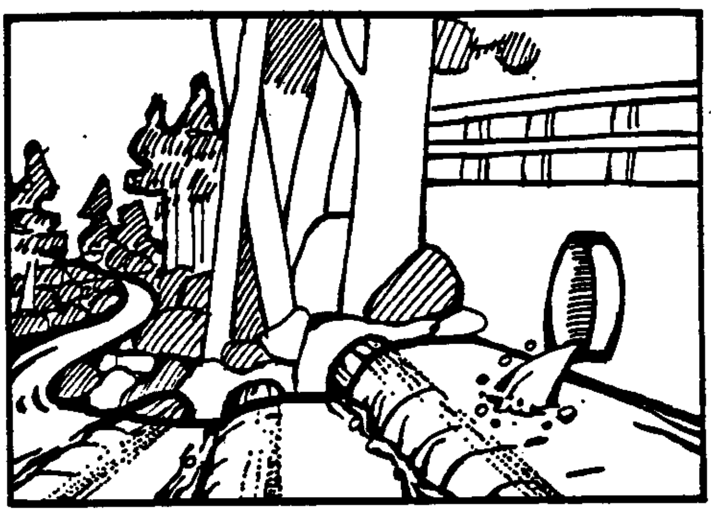


TECHNICAL MINI-GROUP DISCUSSIONS



MINI SESSION OUTLINE

EDUCATION

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3125 Foster Ave
Arcata, CA 95521

The education mini session will provide an opportunity for educators to display elements of their salmonid education programs through poster boards, student-made materials, curriculum and video products. The programs being represented are briefly outlined below.

ADOPT-A-WATERSHED PROGRAM - Kim Stokely, Mountain Valley Unified School District, P.O. Box 339, Hayfork, CA 96041.

This program evolved from concern for protection of natural resources and the need for a unifying, central theme to tie together the many diverse subjects of this school district's science curriculum. Each kindergarten class is given a watershed to adopt and study, using subjects from the science curriculum as they progress through the grade levels. This gives students a chance to observe one watershed for up to thirteen years. Anadromous fish are one of the main focal points of the program, and restoration of streams and salmonid populations is one of the major goals.

ADOBE CREEK RESTORATION BY CASA GRANDE HIGH SCHOOL STUDENTS - United Anglers of Casa Grande, Tom Furrer - Advisor, 333 Casa Grande Rd, Petaluma, CA 94952.

The United Anglers of Casa Grande, part of the Natural Resources Program, established a fish hatchery where catfish and trout were raised and later released into ponds. Students will gather growth rate data and will tag the fish, which they hope to release into Adobe Creek in spring, 1989. Students have devoted many hours to the rearing project and to cleaning up Adobe Creek, so that salmonid spawning habitat might again become usable.

<u>CALIFORNIA'S SALMON AND STEELHEAD TROUT: Our Valuable Natural Heritage,</u> Teacher's Guide and Student Activities for Grades K-6, Diane Higgins, Coordinator, 3125 Foster Ave, Arcata, CA 95521.

This curriculum package was commissioned by the California Advisory Committee on Salmon and Steelhead Trout. It is multidisciplinary, and focuses on life cycle, habitat, importance to people, threats and restoration. The first edition was field tested by teachers in five northern California counties in 1988. The revised edition will be printed in spring, 1989 with funds from Trout Unlimited, Humboldt A.F.S. and the Marin Rod and Gun Club. Slide shows on habitat and restoration accompany the curriculum.

EUREKA CITY SCHOOLS AQUATIC ECOLOGY PROGRAM - Jeff Self, Eureka City Schools, 3200 Walford Ave., Eureka, CA 95501.

This program consists of a fish hatchery and model stream at Washington School, where salmonids are spawned and raised to fry. The model stream portion will simulate a natural stream environment, which will serve as a laboratory for students. Videos on the life history of salmonids and on habitat restoration are a part of the curriculum, which is currently being developed for grades K-6. The main goal of the program is to encourage and develop responsibility toward our resources.

MONTEREY BAY SALMON AND TROUT EDUCATION PROGRAM - Barry Burt, 324 Swanton Rd, Davenport, CA 95017.

Raising steelhead in aquarium-incubators was the catalyst for developing this program, which has received wide community support and has expanded into surrounding counties. A package of materials was compiled from existing curricula, and teacher training workshops were provided. Involvement of over 1,000 students has greatly increased general awareness of the salmonid resource. Smolts from the Monterey Bay Salmon and Trout Project were placed into local streams by a student bucket brigade.

REDWAY ELEMENTARY SCHOOL - PRIMARY SALMONID EDUCATION PROGRAM - Kathie Prince, Redway Elementary School, P.O. Box 369, Redway, CA 95560.

Children in the first and second grades are most receptive to new ideas and quickly develop caring attitudes towards salmonids when classroom incubation brings these beautiful creatures into the children's immediate environment. The students develop a sense of responsibility that will undoubtedly last a lifetime. Although some of the vocabulary and concepts are a little sophisticated, these young students learn them easily since they are so highly motivated by raising the fish.

WIDOW WHITE CREEK STUDY SITE/ADOPT-A-STREAM PROGRAM - Cathy Momber, Morris Elementary School, 2395 McKinleyville Ave., McKinleyville, CA 95521.

Students in grades 4-6 are helping to restore runs of cutthroat, steelhead and coho by cleaning out the creek and learning about stream ecology at the living laboratory it provides. All classes are rearing steelhead or coho, and the students will in turn teach children in grades 1-3 about the fish. Upper grade teachers have been trained at several in-services, and a scope and sequence has been developed. One of the goals is to develop an appreciation and sense of stewardship among students and their parents. Students will share their knowledge and experiences with the community at an open house.

MINI SESSION OUTLINE:

TRAPPING, SPAWNING, AND REARING

Coordinator: Jud Ellinwood

Panel Members: Tom Wesloh
Del Milligan
Bill Eastwood
Gary Peterson

I. Presentation: "The Argument for Using and a Description of Enhancement Strategies that Maximize Genetic Variation in Salmon and Steelhead Populations" - Jud Ellinwood

II. Panel discussion of enhancement technical problems and possible solutions. (Discussion will be interactive and follow a question and answer format). Subject areas of the mini-session include:

A. Trapping equipment and methods;

B. Spawning equipment and methods;

C. Rearing equipment and methods;

D. Transportation equipment and methods;

E. Disease prevention, identification, and control

MINI SESSION OUTLINE:

INSTREAM HABITAT RESTORATION (PROGRESS, PRESENT, FUTURE)

Coordinator: Dave Hope
Santa Cruz County Resource Section
Room 406 B, 701 Ocean Street
Santa Cruz, CA 95060

I. Logjams
   A. Historical work;

   B. Progress in the field;

   C. Present work being done in the field; and

   D. Future uses of jams (creation of jams).

II. Instream Structures
   A. Cover;

   B. Weirs;

   C. Bank cribbing;

   D. Gabion structures; and

   E. Deflectors, etc.

III. Barrier Mitigation
   A. Ladders
      1. Deneal;
      2. Concrete box

   B. Pool work
      1. Raising height;
      2. Increasing depth; and
      3. Pool creation.

   C. Weirs
      1. In series at site; and
      2. Lifting bed for long section.

MINI SESSION OUTLINE:

UPSLOPE WORK - SOME EROSION CONTROL TOPICS

Coordinator: Nancy Reichard, Director
Natural Resources Services
Redwood Community Action Agency
904 G Street
Eureka, CA 95501

Prevention is the best medicine, but what do you do when your watershed is already unravelling?

I. **Watershed Inventories**
   A. Identifying existing and potential erosion problems
      1. Is all erosion "bad"?

   B. Prioritizing treatment
      1. Costs vs. benefits

II. **Sediment Sources**
   A. Soil (surface) erosion - sheet, rill, gully, piping

   B. Mass movement - "landslides"
      1. Are large mass movements treatable?

   C. Streambank erosion

   D. Roads - failing fills, damaging drainages
      1. Who's really responsible for the road you are looking at?

III. **Prescriptions** - Reduce the forces causing erosion, increase the forces resisting erosion.
   A. Revegetation
      1. Are the right plants available?

   B. Road work
      1. Culverts, fill removal, outsloping, waterbars

   C. Soil surface protection

   D. Livestock control

   E. Structural measures for mass movements, streambanks, gullies